Dissertation

The Unforeseen Consequences of Artificial Intelligence (AI) on Society

A Systematic Review of Regulatory Gaps Generated by AI in the U.S.

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Abstract

As a formal discipline, Artificial Intelligence (AI) is over 60 years old. In this time, breakthroughs in the field have generated technologies that compare to or outperform humans in tasks requiring creativity and complex reasoning. AI's growing catalog of applications and methods has the potential to profoundly affect public policy by generating instances where regulations are not adequate to confront the issues faced by society, also known as regulatory gaps.

The objective of this dissertation is to improve our understanding of how AI influences U.S. public policy. It systematically explores, for the first time, the role of AI in the generation of regulatory gaps. Specifically, it addresses two research questions:

1. What U.S. regulatory gaps exist due to AI methods and applications?
2. When looking across all of the gaps identified in the first research question, what trends and insights emerge that can help stakeholders plan for the future?

These questions are answered through a systematic review of four academic databases of literature in the hard and social sciences. Its implementation was guided by a protocol that initially identified 5,240 candidate articles. A screening process reduced this sample to 241 articles (published between 1976 and February of 2018) relevant to answering the research questions.

This dissertation contributes to the literature by adapting the work of Bennett-Moses and Calo to effectively characterize regulatory gaps caused by AI in the U.S. In addition, it finds that most gaps: do not require new regulation or the creation of governance frameworks for their resolution, are found at the federal and state levels of government, and AI applications are recognized more often than methods as their cause.

Executive Summary

As a formal discipline, Artificial Intelligence (AI) is over 60 years old. In this time, breakthroughs in the field have generated technologies that compare to or outperform humans in tasks requiring creativity and complex reasoning. All sectors of the economy are increasingly subject to this technology's influence thanks to rapid advances in information processing and consumer demand for competitive offerings.

Many of AI's applications or methods have no discernible effect on how existing regulations or policies are interpreted or applied.[1] In other words, they are policy agnostic. However, AI has the potential to profoundly impact public policy. The progress towards achieving parity between machine processing and human cognition has generated instances where public policies are not adequate to confront the issues faced by society, also known as regulatory gaps.

The literature on the relationship between policy and AI is generally siloed and, as Calo points out, limited resources have been dedicated to taking a broad look across the corpus of this technology's impact.[2,3] The objective of this dissertation is to respond to the challenge for a thorough and systematic analysis of the literature on the intersection between AI and policy. It contributes to this field's scholarship by systematically identifying, for the first time, the role of AI in the generation of regulatory gaps. Specifically, it addresses two research questions:

1. What U.S. regulatory gaps exist due to AI methods and applications?
2. When looking across all of the gaps identified in the first research question, what trends and insights emerge that can help stakeholders plan for the future?

To answer these questions, I performed a systematic review of the literature. This methodology was selected because it "attempts to collect and analyze all evidence that answers a specific question" through a "broad and thorough search of the literature."[4] The implementation of the systematic review was guided by a protocol that initially identified 5,240 candidate articles within four academic literature databases that incorporate different lenses in the hard and social sciences (they include legal and computer science scholarship, among others). A screening process reduced the sample to a final set of 241 articles (published between 1976 and February of 2018) that were directly relevant to answering these research questions.

Two ideas were fundamental in characterizing the regulatory gaps in the systematic review. The first is a framework adapted from Bennett-Moses's work that describes the origin of regulatory gaps. [5] The left side of Table 1 identifies four ways in which technology can create a gap. The second idea, on the right side of Table 1, is adapted from Ryan Calo's work on uncovering the

[1] Lyria Bennett-Moses, *Recurring Dilemmas: The Law's Race to Keep up with Technological Change*, UNSW LAW RESEARCH PAPER (2007).
[2] Ryan Calo, *Artificial Intelligence Policy: A Primer and Roadmap*, SSRN (2017).
[3] Calo alludes that "notably missing is any systematic review of the ways AI challenges existing legal doctrines." Id. at.
[4] CDC, *Systematic Reviews*(2019), *available at* https://www.cdc.gov/library/researchguides/sytemsaticreviews.html.
[5] Bennett-Moses, UNSW LAW RESEARCH PAPER, (2007).

social themes where policy interacts with AI.[6] These ideas made it possible to carefully review the regulatory gaps within the 241 articles and explore their trends.

Table 1 – Key Ideas Used to Detect and Categorize Regulatory Gaps			
Characterization of Regulatory Gaps by Bennett-Moses (2007)		**Regulatory Gap Themes by Ryan Calo (2017)**	
Novelty	Technology creates behavior that requires bespoke government action.	**Use of Force**	Utilization of autonomous weapon systems.
Targeting	With respect to a policy goal, technology causes circumstances in which its application is not directed to the goal but fall within its scope (over-inclusiveness) or if there are circumstances falling outside its scope where its application would further the goal (under-inclusiveness).	**Safety and Certification**	Role of government in preventing humans from experiencing harms.
		Privacy	Shielding an individual's information from society.
		Personhood	Assigning human rights and responsibilities to non-humans.
		Displacement of Labor	Role of technology in replacing humans in the labor force.
Uncertainty	Conflict arises because there are contradictions, inconsistencies, or doubts about a technology's classification.	**Justice System**	Effects of technology on the operation of courts.
Obsolescence	A technology makes a regulation irrelevant or unenforceable.	**Accountability**	Responsibility for pecuniary and non-pecuniary harms.
		Classification of Individuals	Utilization of labels to discriminate people.

This systematic review identified 50 regulatory gaps caused by AI methods or applications. These were catalogued based on: the type of gap (Bennett-Moses's framework), theme they fell under (Ryan Calo's taxonomy), level of government involved (federal, state, or local), their temporality (whether it describes a gap experienced today or speculates of one in the future), and if the gap is caused by an application (a technology's purpose) or method (process/procedure to accomplish its purpose) of AI. It is important to note that articles in the systematic review were not screened based on a specific definition of AI. Instead, it relied on the review process within academic publications to validate the use of the term.

Each characterization of a gap roughly follows the same format. It begins by asserting the type of regulatory gap identified (based on Bennett-Moses' framework), includes background information on the subject, and presents evidence that supports its classification. To analyze overarching trends throughout the systematic review, I examined the tally of categories and complemented any conclusions with the context gained by writing about the gaps.

The research confirmed that the ideas in Table 1 are effective in framing the AI-policy relationship and may serve future stakeholders in similar efforts. Bennett-Moses's framework withstood scrutiny. Its four categories were capable of characterizing the regulatory gaps in all scenarios. Calo's original themes served as the inspiration for an empirically updated version. This dissertation expanded it to eight themes that clustered gaps along shared characteristics.

[6] Calo, SSRN, (2017).

Uncertainty (42%) and targeting (26%) were the most prevalent gaps, while the least likely to appear was novelty (12%). The fact that few gaps were classified as new problems suggests that, on average, their resolution requires the adaptation or clarification of extant policies, rather than the development of new ones. This finding indicates that—so far—AI is not overtaking policymaking to the point of requiring completely new approaches for the administration of government.

This systematic review found an even split between regulatory gaps happening in the present and those expected in the future. Based on this, the U.S. may find itself in the middle of a transition period. One where applications and methods of AI are permeating society, but it is anticipated that more will reach the market and eventually generate challenges to public policy.

The majority of the regulatory gaps clustered at the federal and state level, indicating that local governments have limited interaction with the implications of AI. Some could argue that omitting this level of government is reasonable. They can claim that most of the gaps generated by technologies such as AI are generalizable to jurisdictions with authority over swaths of the population that are larger than a city or county. The data from this effort supports this argument.

The vast majority of gaps are caused by AI applications rather than methods.[7] The most referenced application was autonomous vehicles (AV). In many ways, they serve as a good analogy for applications in other sectors. For instance, the insights on AV are useful for understanding the accountability of parties (e.g. users, owners, manufacturers, and government) when commercial applications generate pecuniary and non-pecuniary harms. Conversely, AV are somewhat unique in that they are heavily regulated by both state and federal policies, which is not comparable to the public oversight of many consumer products.

As a complement to the analysis of the systematic review, two case studies highlight under-represented issues. The first focuses on local government regulatory gaps. The dearth of literature on issues relevant to these stakeholders was the inspiration to examine the policy playbook developed to curtail the first generation of the urban sprawl. This case study examines how the playbook fares in limiting the revenue repercussions of a new AV-induced urban sprawl. The second under-represented issue is facial recognition technology, an application of AI. It highlights selected public policies and laws that constrain or guide the handling of biometric information through this application at the local, state, and federal level.

This research has several limitations. The review of the literature is systematic, not comprehensive. It is based on a subset of articles identified through a protocol and it does not intend to reveal all the gaps caused by AI in the U.S. Further, the interpretation of gaps is likely missing key details due to information that is not present in the sample of literature or was published after the completion of the study. This may lead subject matter experts to find that significant events or arguments that have an impact on the governance of AI are excluded.

[7] This article differentiates between an application or the purpose of a technology versus a methodology or the process/procedure to accomplish a purpose.

In addition, this dissertation was performed by one individual and, inevitably, the processing of information is subject to bias. Meaning that others may have interpreted and classified gaps differently with the same dataset. Lastly, no effort was taken to solve any of the regulatory gaps identified. Doing so is a process that requires developing a theory of governance with respect to the role of regulation in society. Future scholars should research plausible alternatives to mend the gaps identified in this document.

This article represents one of the first efforts to review the corpus of the literature on the relationship between AI and public policy in the U.S. Its long-term objective is to introduce a compelling alternative to frame how we understand and discuss the interaction between policy and AI. Specifically, its desired impact is to serve stakeholders through three concrete outcomes. First, the systematic review can become a reference guide for policymakers at all levels of government (in the U.S. and beyond) on the policies susceptible to AI-based regulatory gaps.[8] Second, the case studies draw attention to policy areas that have yet to attract cognitive resources. They are intended to jump start novel lines of research on fields that will influence society in the medium to long-term. Lastly, private sector representatives can gauge whether the return on investment in their pipeline of AI products or methods will be affected by the current state of regulatory gaps.

[8] The Government of the UK has emphasized the need to identify regulatory gaps created by AI. This results of this work can serve as a refence: "The Government Office for AI, with the Centre for Data Ethics and Innovation, needs to identify the gaps, if any, where existing regulation may not be adequate." Luke Hussey, et al., AI in the UK: ready, willing and able? (House of Lords 2017)..

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Finally, I would like to thank Ryan Calo and Lyria Bennett-Moses. Their work served as the inspiration for this dissertation and my hope is that this effort can do the same for scholars wishing to understand the relationship between artificial intelligence and policy.

Introduction

As a formal discipline, Artificial Intelligence (AI) is over 60 years old. In this time, breakthroughs in the field have generated technologies that compare to or outperform humans in tasks requiring creativity and complex reasoning. All sectors of the economy are increasingly subject to this technology's influence thanks to rapid advances in information processing and consumer demand for competitive offerings.

Many of the applications or methods powered by AI have no discernable effect on how existing policies are interpreted or applied.[9] In other words, they are policy agnostic. However, AI has the potential to profoundly impact public policy. The progress made in achieving parity between machine processing and human cognition has generated instances where public policies are not adequate to confront the issues faced by society, also known as regulatory gaps.

The literature on the relationship between policy and AI is generally siloed and limited resources have been dedicated to taking a broad look across the corpus of this technology's impact.[10,11] The objective of this article is to improve our understanding of how AI influences U.S. public policy. It contributes to the literature by systematically exploring, for the first time, the role of AI in the generation of regulatory gaps. Specifically, it addresses two research questions:

1. What U.S. regulatory gaps exist due to AI methods and applications?
2. When looking across all of the gaps identified in the first research question, what trends and insights emerge that can help stakeholders plan for the future?

The answers to these research questions are divided into six chapters. Chapter one offers background information on regulatory gaps, a concept that describes the clash between technology and policy. Chapter two examines AI. It briefly characterizes the technology by discussing one of its definitions, differentiates between methods and applications, and identifies a taxonomy of themes that describes the sectors of society where AI is expected to have an impact.

Chapter three contains a protocol for a systematic review of the literature on the relationship between AI and policy. A systematic review is a methodology that "attempts to collect and analyze all evidence that answers a specific question" through a "broad and thorough search of the literature."[12] In fact, systematic reviews featuring AI already exist. Many are published in health and engineering journals that focus on the effectiveness of a medical treatment, among other subjects. [13] Because limited efforts have been undertaken to examine the corpus of AI's

[9] Bennett-Moses, UNSW LAW RESEARCH PAPER, (2007).
[10] Calo, SSRN, (2017).
[11] Calo alludes that "notably missing is any systematic review of the ways AI challenges existing legal doctrines." Id. at.
[12] CDC. 2019.
[13] Khalid S Khan, et al., *Five steps to conducting a systematic review*, (2003);JULIAN PT HIGGINS & SALLY GREEN, COCHRANE HANDBOOK FOR SYSTEMATIC REVIEWS OF INTERVENTIONS (2011);Sarah M. Yannascoli, et al., *How to Write a Systematic Review: A Step-by-Step Guide*, UNIVERSITY OF PENNSYLVANIA ORTHOPAEDIC JOURNAL (2013);Andy Siddaway, *WHAT IS A SYSTEMATIC LITERATURE REVIEW AND HOW DO I DO ONE? at*

impact on U.S. public policy, this methodology was selected as a means to thoroughly gather literature on this issue.[14]

Chapter four answers this dissertation's first research question by identifying 50 regulatory gaps caused by AI methods or applications.[15] These gaps were catalogued based on: the type of gap (Bennett-Moses's framework), the theme they fell under (adapted from Calo's taxonomy), level of government involved (federal, state, and local), their temporality (whether they describes an event happening in the present or speculates about one in the future), and if the gap is caused by an application (a technology's purpose) or method (process/procedure to accomplish its purpose) of AI.

Chapter five uncovers insights from the systematic review by harnessing the labels used to analyze screened-in articles. Subsequently, chapter six documents under-represented areas of research using two case studies on: the role of local government in protecting its revenue streams from an autonomous vehicle-induced urban sprawl and the relationship between government and facial recognition technology in the U.S.

When completed, the long-term objective of this dissertation is to introduce a compelling alternative to frame how we understand and discuss the interaction between policy and AI. Specifically, the desired impact is that it serves stakeholders through three concrete outcomes. First, the systematic review can become a reference guide for policymakers at all levels of government (in the U.S. and beyond) on the policies susceptible to AI-based regulatory gaps.[16] Government entities outside of the US may use it Second, the case studies will draw attention to policy areas that have yet to attract cognitive resources from policymakers or academia. They are intended to jump start novel lines of research on fields that will influence society in the medium to long-term. Lastly, private sector representatives can gauge whether the return on investment in their pipeline of AI products or services will be affected by the current state of regulatory gaps.

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https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0ahUKEwjr24mr9NDYAhUp_4MKHRkcBaoQFggpMAA&url=https%3A%2F%2Fwww.researchgate.net%2Ffile.PostFileLoader.html%3Fid%3D5996c4eb48954ceeca4bf303%26assetKey%3DAS%253A528656902234112%25401503053035526&usg=AOvVaw1yokTc3llwdmCrT2PvG-Jn.

[14] Calo, SSRN, (2017).

[15] A detailed Table of Contents listing each regulatory gap is found in Appendix 1.

[16] The Government of the UK has expressed a need for this type of analysis: "The Government Office for AI, with the Centre for Data Ethics and Innovation, needs to identify the gaps, if any, where existing regulation may not be adequate." Hussey, et al. 2017.

1 Regulatory Gaps

Policy serves as the formal mechanism or explicit corpus of rules that represents a group's shared values and government is the authority vested with the power to uphold these interests.[17,18] No standard operating procedures exist for policy's role when it intersects with technology. In most cases, policymakers are not overwhelmed by the introduction of technology in the market because their attention is not required for every product or service. Most technologies fall under the aegis of existing policies.[19] For instance, 3M's Post-it® represents a leap in productivity and creativity, but its use by consumers does not motivate adjustment to how government performs its duties.

There are technologies that do not conform to extant policies. They catalyze behavior that may create a vacuum in the status quo and force policymakers to adjust the tools at their disposal to either maximize their benefits or minimize drawbacks. Scenarios where this type of action is needed are called **regulatory gaps**, also known in the literature as policy vacuums or the pacing problem.[20] Regulatory gaps are defined as instances where public policies cease to adequately confront the issues faced by society.

The concept of a regulatory gap is not novel. In fact, the characterization of policy orthodoxy being outrun by technology is a truism in the literature.[21] As time passes, the number of regulatory gaps catalyzed by technology seems to have increasingly made it difficult for policymakers to match the pace of change. The former Office of Technology Assessment of the U.S. described this trend over thirty years ago stating that:

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[17] Julia Black, Critical Reflections on Regulation (LSE 2002);Arthur J. Cockfield, *Towards a Law and Technology Theory*, 30 MANITOBA LAW JOURNAL (2004).

[18] Throughout this document, the term policy is used interchangeably to designate mechanisms enforceable by government (hard-law) such as: regulation, law, among others.

[19] Lyria Bennett-Moses, *Why have a Theory of Law and Technological Change?*, 8 MINNESOTA JOURNAL OF LAW, SCIENCE & TECHNOLOGY (2007).

[20] James H. Moor, *What is computer ethics?*, (1985);Karinne Ludlow, et al., *Regulating Emerging and Future Technologies in the Present*, 9 NANOETHICS (2015).

[21] Alan Heinrich, et al., *Introduction*, LOYOLA L.A. LAW REVIEW (2000);Michael Kirby, *The Commonwealth Lawyer: Law in an Age of Fantastic Technological Change*, High Court of Australia(2003), *available at* http://www.hcourt.gov.au/assets/publications/speeches/former-justices/kirbyj/kirbyj_thecommonwealthlawyer.htm;Colin B. Picker, *A View from 40,000 Feet: International Law and the Invisible Hand of Technology*, 23 CARDOZO LAW REVIEW (2001);Office of Technology Assessment, Intellectual Property Rights in an Age of Electronics and Information (U.S. Congress ed., U.S. Government Printing Office 1986);Erica Palmerini, *The interplay between law and technology, or the RoboLaw project in context*, *in* LAW AND TECHNOLOGY. THE CHALLENGE OF REGULATING TECHNOLOGICAL DEVELOPMENT (E. Palmerini and E. Stradella ed. 2013);David M. Wasieleski & Mordechai Gal-Or, *An enquiry into the ethical efficacy of the use of radio frequency identification technology*, 10 ETHICS AND INFORMATION TECHNOLOGY (2008);Diana M. Bowman, *The hare and the tortoise: an Australian perspective on regulating new technologies and their products and processes*, *in* INNOVATIVE GOVERNANCE MODELS FOR EMERGING TECHNOLOGIES (Gary E. Marchant, et al. eds., 2013);Ludlow, et al., NANOETHICS, (2015);L.A. Clark, et al., *Innovation Policy Vacuum: Navigating Unmarked Paths*, 33 TECHNOLOGY IN SOCIETY (2011).

> "[o]nce a relatively slow and ponderous process, technological change is now outpacing the legal structure that governs the system, and is creating pressures on Congress to adjust the law to accommodate these changes." [22]

Fundamentally, these gaps are caused by the nature of policy and technology. Policy is a by-product of the circumstances, individuals, and politics relevant at the time of its creation. The process is comparable to estimating the rules and tools applicable to society in an unknown version of the future. One where decision-makers can opt to plan for the worst-case scenario or for a sample of situations that are "likely" to occur.[23]

In effect, policy-making is a best guess approximation contingent on assumptions that may not hold true and relies on a network of formal and informal decision-makers that balance constituent accountability, transparency, or personal interests, but not necessarily expediency.[24] To identify, understand, measure, and analyze their options, these actors require layers of information on how technology-based phenomena affect policy.[25] Procuring this data without asymmetries or lag is not only problematic, most times it is untenable. As a result, policy reaction times are slower than technology. If action is rushed, it can disadvantage future technological progress or segments of the population affected by it.[26]

Technology is created by individuals and firms that face a different environment. One where supply and demand is king and the generation of new products and services is not generally beholden to the barriers of policy or the policy-making process. Instead, technologies are mainly bounded by the creativity of engineers or managers running the firm and the resources at their disposal to execute their vision. Such flexibility endows this population with the power to act without having the democratic process as an obstacle or face the same scrutiny as public officials. In effect, members of the private sector could be described as the anti-policymaker, one that can subject society to the consequences of their actions without consent.[27]

Having described regulatory gaps and briefly explained their origin, this chapter's objective is to supply readers with two pieces of information. First, it introduces a framework adapted from Bennett-Moses's research on classifying regulatory gaps into four categories: uncertainty, targeting, obsolescence, and novelty.[28] This framework is one of the key ideas used in framing the systematic review within this dissertation.

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[22] Heinrich, et al., LOYOLA L.A. LAW REVIEW, (2000);Kirby. 2003;Picker, CARDOZO LAW REVIEW, (2001);Office of Technology Assessment. 1986;Palmerini. 2013;Wasieleski & Gal-Or, ETHICS AND INFORMATION TECHNOLOGY, (2008);Bowman. 2013;Ludlow, et al., NANOETHICS, (2015);Clark, et al., TECHNOLOGY IN SOCIETY, (2011).

[23] Warren E. Walker, et al., *Addressing deep uncertainty using adaptive policies: Introduction to section 2*, 77 TECHNOLOGICAL FORECASTING AND SOCIAL CHANGE (2010).

[24] Warren E. Walker, et al., *Adaptive policies, policy analysis, and policy-making*, 128 EUROPEAN JOURNAL OF OPERATIONAL RESEARCH (2001).

[25] BRONWEN MORGAN & KAREN YEUNG, AN INTRODUCTION TO LAW AND REGULATION: TEXT AND MATERIALS (Cambridge University Press. 2003).

[26] Ludlow, et al., NANOETHICS, (2015).

[27] Joel R. Reidenberg, *Lex Informatica: The Formulation of Information Policy Rules through Technology*, 76 TEXAS LAW REVIEW (1998).

[28] Bennett-Moses, UNSW LAW RESEARCH PAPER, (2007).

Second, it examines the option space available to government for the resolution of regulatory gaps. To adjust the policy status quo with the purpose of increasing the likelihood of positive outcomes, authorities can act: **proactively** to mitigate future technological challenges, **reactively** by awaiting a trigger that compels decision-making, or through **limited action** where they step aside from decision-making or outsource their powers to other bodies (e.g. self-regulation by commercial entities).[29] Because this dissertation does not suggest solutions to the regulatory gaps found in the systematic review, this taxonomy receives limited attention outside of this chapter. It is included so that readers are aware of how policymakers can act in response to gaps.

1.1 Classification of Regulatory Gaps

With the power to introduce technology at any point in time, the private sector can directly affect government by generating regulatory gaps. According to Bennett-Moses, technology can challenge regulation in one of four ways: uncertainty, novelty, obsolescence, and targeting.[30] This section defines each category and provides a brief example (see Table 2).[31]

Table 2 – Classification of Regulatory Gaps

Uncertainty	Targeting	Obsolescence	Novelty
A new technology is not easily classified. Inconsistency in the application of policy leads to conflict.	With respect to a policy goal, one can ask whether there are circumstances in which its application is not directed to the goal but fall within its scope (over-inclusiveness) or whether there are circumstances falling outside its scope where its application would further the goal (under-inclusiveness).	Policy becomes irrelevant when its target behavior or justification is no longer pertinent to current conditions or the cost of violating or enforcing it changes.	Policies need to be created to resolve a challenge. A technology can instigate behaviors that are unique to the point that policymakers had not thought of addressing them or there are new reasons to act on existing situations that require bespoke attention.
Illustrative Examples			
Application of common carrier status to the telegraph industry created uncertainty when courts compared the delivery of an electronic message to packages and letters.	Fingerprint evidence was under-included in the justice system as a means to identify criminals.	Determination of paternity based on the visual resemblance of a child to a parent (bald eagle test) or co-habitation status were made obsolete by blood tests.	Testing technology for a genetic disease made possible the discrimination of individuals in a manner that was not considered by existing anti-discrimination policies.

Source: [32]

[29] Gaia Bernstein, *The Paradoxes of Technological Diffusion: Genetic Discrimination and Internet Privacy*, 39 CONNECTICUT LAW REVIEW (2006);ROGER BROWNSWORD, RIGHTS, REGULATION, AND THE TECHNOLOGICAL REVOLUTION (Oxford University Press. 2008);Bert Jaap Koops, Ten Dimensions of Technology Regulation - Finding your Bearings in the Research Space of an Emerging Discipline (2010);Lyria Bennett-Moses, *Sharing ideas about technology regulation*, *in* BRIDGING DISTANCES IN TECHNOLOGY AND REGULATION (Ronald Leenes & Eleni Kosta eds., 2013).

[30] Bennett-Moses, UNSW LAW RESEARCH PAPER, (2007).

[31] The identification of regulatory gaps is inherently a subjective process. Individuals with contrasting views may differ in their interpretation of these phenomena.

[32] Bennett-Moses, UNSW LAW RESEARCH PAPER, (2007).

1.1.1 Uncertainty

Technology can instigate uncertainty when there are contradictions, inconsistencies, or doubts about its classification.[33] Misclassification occurs because policy is not created to foresee all conceivable permutations and combinations of events or behaviors. At times, vague language within policy instruments is observed when a word or statement has more than one meaning or is deemed contestable if alternate explanations are available.[34] As a result, the outcomes experienced by society can be haphazard and contingent on the jurisdiction or judgement of individuals involved in interpreting policy.

1.1.1.1 Example of Uncertainty: Common Carriage in the Telegraph Sector

The telegraph instigated uncertainty when customers, telegraph firms, and the government were unsure about its classification as a common carrier. As old as the roman empire, the concept of common carriage originally denoted the obligation of businesses that serve the public to do so without discrimination.[35] The U.S. inherited this legal tradition via English common law through the law of bailments and franchises.[36]

The law of bailments describes the responsibilities borne by businesses as custodians of goods. It was created as a mechanism to determine liability in situations where shippers lost or damaged cargo. Shippers covered the damage to goods in all cases, except those caused by foreign enemies or acts of God.[37] This measure incentivized shippers to take care of the goods under their possession and gave rights to customers. For telegraph companies, their business model relied on the transportation of an idea in the form of a message, rather than a good.

The law of franchises was a monopoly granted to a business by the Crown with the condition that it could not discriminate between customers able to pay for their services. The telegraph received a franchise when the state of New York granted its patent holders the right to "construct lines…from point to point and across any of the waters within the limits" of the state.[38] This monopoly on the construction of infrastructure was conditioned on the requirement that no customer of the technology could be discriminated, even if this included other telegraph companies. This model of legislation was replicated throughout the country, beginning with Virginia (1847), Michigan (1847), and Connecticut (1848).[39]

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[33] Id. at.

[34] Jeremy Waldron, *Vagueness in Law and Language: Some Philosophical Issues*, 82 CALIFORNIA LAW REVIEW (1994);Robert C. Post, *Reconceptualizing Vagueness: Legal Rules and Social Orders*, see id. at Cited Pages|;Edward Craig, Routledge Encyclopedia of Philosophy (1998);Timothy Endicott, *The Value of Vagueness*, *in* VAGUENESS IN NORMATIVE TEXTS (Vijay K. Bhatia & Peter Lang eds., 2005).

[35] James C. Hardman & Joseph Winter, *The Interstate Commerce Act and the Allocation of the Risk of Loss or Damage in the Transportation of Freight*, 7 TRANSPORTATION LAW JOURNAL (1975);Eli M. Noam, *Beyond Liberalization II: The Impending Doom of Common Carriage*, Columbia University(1994), *available at* http://www.columbia.edu/dlc/wp/citi/citinoam11.html#txt8.

[36] William Jones, *The Common Carrier Concept as Applied to Telecommunications: A Historical Perspective*(1980), *available at* http://www.cybertelecom.org/notes/jones.htm#II.

[37] Jr. Joseph H. Beale, *The Carrier's Liability: Its History*, 11 THE HARVARD LAW REVIEW ASSOCIATION (1897);Jones. 1980.

[38] JOHN WORTH EDMUNDS, et al., STATUTES AT LARGE OF THE STATE OF NEW YORK: GENERAL STATUTES IN FORCE TO JULY, 1862 (Weed Parsons. 1869).

[39] Jones. 1980.

With the advent of the industrial revolution, common law was used to assign common carriage responsibilities. Courts followed a test to determine common carrier status: "who by virtue of his calling undertakes, for hire, to transport persons or personal property, from one place to another, for all who choose to employ him."[40] Once common carriage was established, the following set of commercial obligations were expected:[41]

1. Fulfill the demand of its services to any party able to pay for them;
2. Care for the property with which it has been entrusted; and,
3. Cover "incidental damages" due to the inability to fulfill its contractual duties (e.g. lateness or damage of goods).

A telegraph operator's job is to translate a message into the language of dots and dashes, and relay it through wires to its destination. Any typographical mistakes or delays could significantly alter its meaning or utility. When such actions negatively affected customers, parties often sought reparations through judicial means (i.e. a lawsuit). As an alleged breach of contractual obligations, claimants argued that an operator's error caused harms. However, a definite interpretation of the responsibilities of telegraphic companies in these scenarios was unclear. This was the source of the uncertainty regulatory gap.

At the heart of many cases was an argument for breach of contract based on the notion of common carriage. Parties that disagreed stated that the limited societal understanding of this electricity-based form of communication was sufficient to distinguish it from other services bound by common carriage. Lawyers also contrasted the responsibilities of carriers of goods with those of telegraph operators. They argued that shippers maintained exclusive control over the goods transported and were able to estimate their value through an appraisal, which was not the case with telegraphic messages. They also remarked that a telegraph company is entrusted with a good that is not transported in its original form. Instead of receiving the original message, parties are delivered a copy and any damages are not necessarily relatable to the value of the transmission.

Depending on their jurisdiction and legal reasoning, plaintiffs received different judgements regarding the common carrier status of telegraphy.[42] Two cases demonstrate the disparities faced by the public. In Breese v. U.S. Telegraph Co. a message to buy $700 worth of gold was changed to request the purchase of "seven thousand dollars in gold".[43] On their contract, the telegraph company stated that "messages of importance should be sent back to the customer to ensure that the correct message reached its destination" (this service cost half the price of the original fee).[44] Even though the judge admitted that telegraph companies could be considered

[40] REUBEN LESLIE MAYNARD, THE LIABILITY OF THE COMMON CARRIER AS INSURER (Cornell Law School. 1891).
[41] Noam. 1994.
[42] Benjamin F. Rex, *Liability of Telegraph Companies for Fraud, Accident, Delay and Mistakes in the Transmission and Delivery of Messages*, 32 U. PA. L. REV. (1884).
[43] Court of Appeals of the State of New York, BREESE ET AL. V. U.S. TELEGRAPH CO (Court of Appeals of the State of New York 1871);Gregory N. Mandel, *History Lessons for a General Theory of Law and Technology*, 8 MINNESOTA JOURNAL OF LAW, SCIENCE & TECHNOLOGY (2007).
[44] Court of Appeals of the State of New York. 1871;Mandel, MINNESOTA JOURNAL OF LAW, SCIENCE & TECHNOLOGY, (2007).

common carriers and, as such they could not establish limitations on their liability, the inclusion of this condition was sufficient for the court to relinquish the firm's responsibility for the losses incurred by the plaintiff.

In contrast, the case of Parks vs. Alta California Telegraph Co. was one where the court considered that a telegraph company was a common carrier.[45] The issue at stake was the inability of the operator to send a message in a timely manner, which resulted in the plaintiff defaulting on a loan.[46] In its judgement, the court compared the postal service with the telegraph. Finding no difference between the use of wires or physical means to deliver a message, the telegraph company was declared a common carrier responsible for penalties incurred by the plaintiff.

Contrasting rulings in lower courts finally escalated to the Supreme Court in 1901. The case entailed a Western Union office who charged a local newspaper less than its competitor for the same Associated Press information.[47] The judges argued that telegraph companies could not discriminate between its customers if the service provided was comparable. Therefore, they resolved that "such being the business and occupation of the defendants, they are to be regarded as common carriers, and, in the absence of stipulations to the contrary, subject to all the legal responsibilities of such carriers".[48]

1.1.2 Targeting

Policies are created with a goal or purpose in mind and they target behaviors based on the conditions prevalent at the time. Technology may generate situations that affect a policy's purpose in two ways. They can be under-inclusive with respect to the policy's purpose. This means that they create conditions that fall outside its scope, but would further its objective if included.[49] Alternatively, they can be over-inclusive. This describes a situation that lies outside the scope of a policy's purpose, but is nonetheless included in it.[50]

1.1.2.1 Example of Targeting: Fingerprint Identification

The identification of individuals through their fingerprints is an example of a technology that was under-included in court proceedings within the justice system. Ridges on human digits are endowed with three characteristics that make them a reliably identification system.[51] First, the patterns on each digit never change; second, each digit has its own pattern; finally, these variations can be classified systematically.

Over 2,000 years ago, the Chinese were the first to acknowledge the uniqueness of fingerprints to identify people in criminal proceedings.[52] The U.S. government adopted fingerprints haphazardly. As early as 1882, a Department of Interior surveyor (Gilbert Thompson) prevented

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[45] Mandel, MINNESOTA JOURNAL OF LAW, SCIENCE & TECHNOLOGY, (2007);Rex, U. PA. L. REV., (1884).
[46] Supreme Court of California, Parks v. Alta Cal. Tel. Co. -- Parks v. Alta Cal. Tel. Co., 13 Cal. 422 (Cal. 1859) (Supreme Court of California 1859).
[47] SCOTUS, Western Union Telegraph Company v. Call Publishing Company (SCOTUS 1901);Noam. 1994.
[48] SCOTUS. 1901;Noam. 1994.
[49] Bennett-Moses, UNSW LAW RESEARCH PAPER, (2007).
[50] Id. at.
[51] Andre A. Moenssens & Stephen B. Meagher, *Fingerprints and the law*, *in* FINGERPRINT SOURCEBOOK (2011).
[52] Z Xiang-Xin & L Chun-Ge, *The Historical Application of Hand Prints in Chinese Litigation*, 38 JOURNAL OF FORENSIC IDENTIFICATION (1988).

the forgery of his checks by signing his name and including a fingerprint.[53] Its institutional use began with the New York City Civil Service Commission. Its purpose was to ensure that candidates for employment in the police and fire departments were not contracting third-parties to complete their entrance examination.[54] In 1904 the New York State Bureau of Prison began fingerprinting all inmates and the St. Louis police department became the first in the nation to create a department focused on fingerprinting.[55]

Although this technology was utilized to catalog sentenced criminals, courts under-included it due to the lack of recognition as a legitimate source of evidence. The case that created the precedent for the inclusion of fingerprint technology was presented in the Illinois Supreme Court in 1911, *People v. Jennings*.[56] In this case, four impressions of Thomas Jennings were found in the home of Clarence Hiller, who was assassinated. Four expert witnesses testified and concluded that the prints were a match.[57] Based on this evidence, the accused was convicted and, on appeal, the defense argued that there were no statutes that allowed the introduction of fingerprints as evidence, hence the case should be dismissed.

In the decision by Justice Carter, he confirmed that no precedent existed in the country. However, the judge found that the experience of courts outside of the U.S. was sufficient to justify its admissibility:[58]

> *"No case in which this question has been raised has been cited in the briefs, and we find no statutes or decisions touching the point in this country. This class of evidence is admitted in Great Britain….. These authorities state that this system of identification is of very ancient origin, having been used in Egypt when the impression of the monarch's thumb was used as his sign manual, that it has been used in the courts of India for many years and more recently in the courts of several European countries; that in recent years its use has become very general by the police departments of the large cities of this country and Europe; that the great success of the system in England, where it has been used since 1891 in thousands of cases without error, caused the sending of an investigating commission from the United States, on whose favorable report a bureau was established by the United States government in the war and other departments."*

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[53] FRANCIS GALTON, FINGER PRINTS (Macmillan and Co. . 1892).

[54] SIMON A COLE, SUSPECT IDENTITIES: A HISTORY OF FINGERPRINTING AND CRIMINAL IDENTIFICATION (Harvard University Press. 2009).

[55] Jeffrey G. Barnes, *History*, *in* FINGERPRINT SOURCEBOOK (2011);State of New York, *Origins of the New York State Bureau of Identification*, Division of Criminal Justice Services(1997), *available at* http://www.criminaljustice.ny.gov/ojis/history/tofc.htm.

[56] Andre A. Moenssens, *Admissibility of Fingerprint Evidence and Constitutional Objections to Finger-printing Raised in Criminal and Civil Cases*, 40 CHICAGO-KENT LAW REVIEW (1963);Jennifer L Mnookin, *Fingerprint Evidence in an Age of DNA Profiling*, 67 BROOKLYN LAW REVIEW (2001);Moenssens & Meagher. 2011;Simon A. Cole, *Grandfathering Evidence: Fingerprint Admissibility Rulings from Jennings to Llera Plaza and Back Again*, 41 AMERICAN CRIMINAL LAW REVIEW 1189(2004).

[57] Supreme Court of Illinois, People v. Jennings (Supreme Court of Illinois 1911).

[58] Id. at.

This decision was used by judges in other jurisdictions to confirm that no two sets of fingerprints were the same. As the number of courts allowing this technology increased, judges began to trust it and eventually include it as an approved means to identify individuals in the justice system.

1.1.3 Obsolescence

There are two ways for technology to impact policy to the point of becoming irrelevant. First, the policy's target behavior or its justification are no longer pertinent to current conditions (see below for a thorough example). For example, up until the introduction of motorized vehicles, horses where a popular sight on roads. Today, they are relegated to tourist attractions or found in rural parts of the country. Hence, traffic laws requiring women to wear a corset when riding in public or making it illegal to throw a banana peel because a horse might slip, do not apply to the traffic conditions experienced by most consumers.[59]

Second, a technology may increase the enforcement costs of a policy, which creates disincentives to implement it. It can do so by creating barriers to its application, thus rendering it irrelevant. For example, prior to algorithms that searched the Internet for copyrighted material, the practice of electronically sharing music among peers made the protection of intellectual property difficult to enforce.[60]

1.1.3.1 Example of Obsolescence: Paternity Tests

The discovery of blood testing to determine paternity led to the obsolescence of methods reliant on the visual scrutiny of a father or his "access" to the child's mother. Although everyone carries over a gallon of blood in their bodies, it was not until the end of the 19th century (1900) that Karl Landsteiner discovered that every drop contained unique elements that classified people into groups.[61] Specifically, Landsteiner combined the blood from subjects and found that samples reacted differently to each other, they either clumped together (also referred to agglutination) or did not.[62] Via experimentation, he divided the behavior of distinct blood types into three groups: A, B, and O (he failed to find the remaining fourth blood group AB because it exists in a small proportion of the population).

Landsteiner's work was the foundation for the field of blood analysis. The primary market for this discovery were criminal and civilian proceedings in the justice system, paternity tests being the most popular. First hypothesized in 1910, the inheritance of blood type from parents to offspring

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[59] Lynda Polk, *More strange horse laws*(2008), *available at* https://blog.chron.com/hoofbeats/2008/03/more-strange-horse-laws/.

[60] Tom McCourt & Patrick Burkart, *When creators, corporations and consumers collide: Napster and the development of on-line music distribution*, 25 MEDIA, CULTURE & SOCIETY (2003);William Landes & Douglas Lichtman, *Indirect Liability for Copyright Infringement: Napster and Beyond*, 17 JOURNAL OF ECONOMIC PERSPECTIVES (2003);Raymond Shih Ray Ku, *The Creative Destruction of Copyright: Napster and the New Economics of Digital Technology*, 69 THE UNIVERSITY OF CHICAGO LAW REVIEW (2002);Jeff Langenderfer & Don Lloyd Cook, *Copyright Policies and Issues Raised by A&M Records v. Napster: "The Shot Heard 'Round the World" or "Not with a Bang but a Whimper?"*, 20 JOURNAL OF PUBLIC POLICY & MARKETING (2001);Bryan Pfaffenberger, *The Napster Decision: What's It All About?*, LINUX JOURNAL, 2001.

[61] Laura Geggel, *How Much Blood Is in the Human Body?*, LiveScience(2016), *available at* https://www.livescience.com/32213-how-much-blood-is-in-the-human-body.html.

[62] Hans Peter Schwarz & Friedrich Dorner, *Karl Landsteiner and his major contributions to Haematology*, 121 BRITISH JOURNAL OF HAEMATOLOGY (2003).

was confirmed in 1925 (see Table 3 for possible combinations).[63] This breakthrough led to advances such as the detection of M and N antigens in 1927 and the Rh system in 1940.[64] Used in tandem, these tests could exclude an alleged father of a child at least 50% of the time.[65]

Table 3 - Inheritance of Blood Type

Blood groups of parents	Blood group of children	
	Possible	Not possible
O x O	O	A, B, AB
O x A	O, A	B, AB
O x B	O, B	A, AB
O x AB	A, B	O, AB
A x A	A, O	B, AB
B x B	B, O	A, AB
A x B	O, A, B, AB	None
A x AB	A, B, AB	O
B x AB	B, A, AB	O
AB x AB	A, B, AB	O

Source: [66]

Prior to blood analysis, determination of paternity was largely subjective. One standard employed in trials was the bald eagle test where the resemblance of the child to the father could serve as evidence to establish a familial link.[67] Another standard was the presumption of parentage based on legal family ties. In other words, a child was the lawful son of a father if he cohabitated with his mother at the time of conception or had "access to her".[68] Both policies became obsolete in the justice system with the advent of more effective means of confirming paternity through blood-based tests.

1.1.4 Novelty

Novelty regulatory gaps occur when policies, or any of its variants, need to be created to resolve a challenge. A technology can instigate behaviors that are unique to the point that policymakers had not thought of addressing them or there are new reasons to act on existing situations that require bespoke attention.[69]

Policymakers have a range of options to solve novelty regulatory gaps. If they perceive a technology as dangerous, they can implement an outright ban. For instance, advocates against the adoption of nanotechnology in weapons systems argue that it can destabilize the balance of

[63] James F. Crow, *Felix Bernstein and the First Human Marker Locus* 133 GENETICS (1993).
[64] Margery W. Shaw, *Paternity Determination*, 250 JAMA (1983).
[65] Id. at.
[66] Robert Ratimorszky, *Blood Tests in Paternity Cases*, 19 CLEVELAND STATE LAW REVIEW (1970).
[67] E. Donald Shapiro, et al., *The DNA Paternity Test: Legislating the Future Paternity Action*, 7 JOURNAL OF LAW AND HEALTH (1992).
[68] David D. Meyer, *The Constitutionality of Best Interests Parentage*, 14 WILLIAM & MARY BILL OF RIGHTS JOURNAL (2006).
[69] Bennett-Moses, UNSW LAW RESEARCH PAPER, (2007).

power between nations.[70] Similarly, groups against genetically modified organisms state that their release in the market could negatively affect the health of the ecosystem and people.[71] Conversely, they can opt to spur the adoption of a technology perceived as beneficial. In the 19th and 20th century, the emergence of railroads, automobiles, and airplanes fueled economic development and convinced policymakers throughout the globe to create incentives to assist in their expansion.[72] Bans or incentives are not the only tools in a government's toolkit, they may also introduce new standards, benchmarks, or processes.

1.1.4.1 Example of Novelty: Genetic Discrimination

The mid-20th century witnessed the invention of diagnostic tools for sickle cell disease (SCD). The push to identify carriers of SCD in all walks of life led to cases of discrimination based on an unprotected demographic variable, genetics. This situation presented a novel regulatory gap because no policies existed to shield individuals against unequal treatment due to their genetic profile.

In 1910 James B. Herrick discovered a mutation that distorts blood cells into a "C" shape and impedes their flow thorough veins and arteries.[73] Known today as SCD, 100,000 people in the U.S. have the disease and suffer lifelong symptoms such as chronic body pain, brain stokes, and infections. The disease is predominantly diagnosed in individuals with African descent, where 1 in 13 babies are born with the trait (not afflicted by the negative effects of SCD), while 1 in 365 experience the disease.[74] Other ancestries that share the hereditary risk of SCD include those from the Spanish speaking western hemisphere (1 out of every 16,300 are born with the disease), the Mediterranean, and the Middle East.[75]

Periodic advances in the 20th century allowed the scientific community to distinguish how the hemoglobin in patients with the disease differed from the rest of the population.[76] A distinguishing factor was its hereditary nature, whereby a carrier was characterized as a person with one faulty gene that would rarely experience complications. If two carriers conceive a child, there is a 25% risk of being born with two faulty genes and have SCD.[77] The technology to screen SCD also advanced leaps and bounds. In the 1930's, the disease could be detected only through the manual examination of blood samples. Thirty years later, easy-to-use test kits were available on a massive scale.[78]

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[70] Center for Responsible Nanotechnology, *CRN Research: Overview of Current Findings*, CRN(2008), *available at* http://www.crnano.org/dangers.htm.

[71] Human Genetics Alert, (2015), *available at* http://www.hgalert.org/.

[72] David W. Gillen, *Transportation Infrastructure and Economic Development: A Review of Recent Literature*, 32 LOGISTICS AND TRANSPORTATION REVIEW (1996).

[73] Lincoln Institute of Land Policy & Minnesota Center for Fiscal Excellence, 50-State Property Tax Comparison Study;NIH, A Century of Progress: Milestones in Sickle Cell Disease Research and Care (2010).

[74] CDC, *Sickle Cell Disease (SCD)*, CDC(2017), *available at* https://www.cdc.gov/ncbddd/sicklecell/data.html.

[75] Id. at.

[76] CDC, Hemoglobinopathies: Current Practices for Screening, Confirmation and Follow-up (CDC 2015);Hari Prabhakar, et al., *Sickle cell disease in the United States: Looking back and forward at 100 years of progress in management and survival*, 85 AMERICAN JOURNAL OF HEMATOLOGY (2010).

[77] ASH, *Sickle Cell Anemia*(2017), *available at* http://www.hematology.org/Patients/Anemia/Sickle-Cell.aspx.

[78] Prabhakar, et al., AMERICAN JOURNAL OF HEMATOLOGY, (2010).

For decades, SCD was an untreatable, but diagnosable disease that garnered little attention from public health officials. Empowered by the civil rights movement and the advent of low-cost screening technology, a growing number of African American public officials in the 1960's and 70's marshalled state and federal health initiatives focused on the disease.[79]

In the early 1970's, campaigns in over a dozen states successfully advocated for legislation that mandated mass SCD screening in all realms of life.[80] Programs were created for its detection in newborns, entrance to pre-school, application to obtain a marriage licensing, job interviews, among others. At the federal level, President Nixon signed the National Sickle Cell Anemia Control Act in 1972. This legislation effectively heightened the research priority of the disease by increasing NIH grants by a factor of 10 compared to those in 1968 (from 22 to 215).[81]

Unfortunately, misinformation about the disease caused unintended consequences. Test results signaling a carrier status, meaning that complications are seldom felt, led to discrimination. Air Force Academy candidates with carrier status were denied entry to a Job Corps program implemented by the Department of Labor. Instead, they were directed to careers that were less physically demanding. Individuals were denied health coverage and life insurance, and some states barred children with carrier status from registering to school because they erroneously believed SCD was an infectious disease.[82]

The Civil Rights Act of 1964 prohibited discrimination on the basis of race, color, sex or ethnic origin, while the American with Disabilities Act of 1990 did the same with individuals who have an ailment.[83] The spirit of these policies where meant to protect individuals against discrimination due to characteristics that were out of their control. Nonetheless, their passage did not consider the repercussions of mandatory SCD screenings that made possible new forms of discrimination due to an individual's genetic profile.

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[79] AUBREY MILUNSKY, GENETICS AND THE LAW (Springer Science & Business Media. 2012);Howard Markel, *Appendix 6. Scientific advances and social risks: historical perspectives of genetic screening programs for sickle cell disease, Tay-Sachs disease, neural tube defects and down syndrome, 1970-1997**, *in* PROMOTING SAFE AND EFFECTIVE GENETIC TESTING IN THE UNITED STATES (1997).

[80] Ira M. Rutkow & Jeffrey M. Lipton, Some Negative Aspects of State Health Departments' Policies Related to Screening for Sickle Cell Anemia (1973);LORI B. ANDREWS, et al., ASSESSING GENETIC RISKS: IMPLICATIONS FOR HEALTH AND SOCIAL POLICY (National Academies Press. 1994).

[81] Lauren A. Smith, et al., *Sickle Cell Disease: A Question of Equity and Quality*, 117 PEDIATRICS (2006).

[82] ANDREWS, et al. 1994;Markel. 1997;Ludlow, et al., NANOETHICS, (2015);James E. Bowman, *Genetic Screening Programs and Public Policy*, 38 PHYLON (1977).

[83] National Archives, *The Civil Rights Act of 1964 and the Equal Employment Opportunity Commission*(2018), *available at* https://www.archives.gov/education/lessons/civil-rights-act;ADA National Network, *What is the Americans with Disabilities Act (ADA)?*(2018), *available at* https://adata.org/learn-about-ada.

1.2 Role of Policymakers in Managing Regulatory Gaps

Through their mandate, policymakers influence and manage the evolution of technology with the purpose of increasing the likelihood of positive outcomes.[84] Their toolkit to address regulatory gaps consists of three strategies. They can:

- **Proactively** mitigate risk by preempting how a technology shapes society;
- **React** to a trigger event, not under their control, that forces a decision-making process to search for status quo alternatives; or,
- Choose **limited action** policies that either ignore the effects of a technology or outsource regulatory power to other forces (e.g. self-regulation by the market).

1.2.1 Proactive

A proactive strategy is one where policy is made resilient against future indirect or direct shocks.[85] Technology neutrality and futures analysis are examples of such strategies. Technology neutrality is the act of drafting goal-oriented policies that purposefully avoid referencing extant technologies. Its mission is to prepare policies for any scenario, all while not considering the likelihood of how future technologies will affect society. A successful implementation is the constitution of the U.S. Even though it was originally conceived during the industrial revolution over 200 years ago, it has remained relevant to contemporary issues.

A second proactive approach is the prediction of technological shocks by analyzing past trends and current events. Known as technology futures analysis, it centers on compiling historical information or expert opinions and interpreting them using one of several families of methods. It was originally developed by the U.S. military to map the evolution of weapons systems and inform stakeholders on future states of the world. Today, its use spans beyond defense. Government agencies employ it to estimate the impact of a technology and manage future policymaking.

1.2.1.1 Technology Neutrality

When a policy is created, governments cannot foresee when its underlying assumptions will expire. One way to ensure a brief shelf-life is by explicitly mentioning a technology in legislation, thus exposing it to technological transitions. To avoid this outcome, technology neutral policy (also known as principles-based policy) future-proofs regulation by avoiding the mention or discrimination between technologies.[86]

The viability of technology-neutral policies is largely determined by their purpose and language.[87] In terms of purpose, neutrality is achievable by emphasizing the outcome of a behavior. For instance, if a university's code of ethics bans students from cheating, administrators may feel tempted to specify the techniques or instruments that fall within the scope of this unethical

[84] Cockfield, MANITOBA LAW JOURNAL, (2004);Heinrich, et al., LOYOLA L.A. LAW REVIEW, (2000);LAWRENCE LESSIG, CODE AND OTHER LAWS OF CYBERSPACE (Perseus Books Group. 1999);Bernstein, CONNECTICUT LAW REVIEW, (2006);BROWNSWORD. 2008.

[85] Ludlow, et al., NANOETHICS, (2015).

[86] Chris Reed, *Taking Sides on Technology Neutrality*, 4 SCRIPT-ED (2007).

[87] BERT JAAP KOOPS, SHOULD ICT REGULATION BE TECHNOLOGY-NEUTRAL § 9 (T.M.C. ed., Asser Press. 2006).

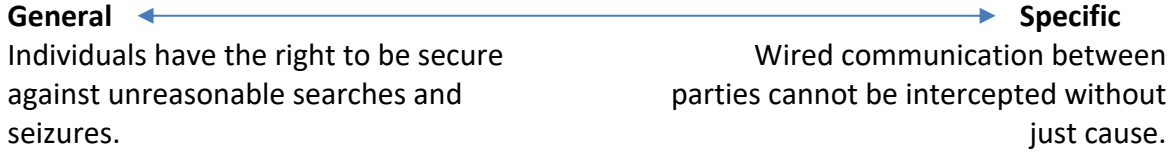
behavior. Doing so limits the conditions under which the policy is valid. A technology neutral code of ethics would focus solely on the unwanted behavior (i.e. cheating). Thus, no difference would exist between a student that breaks the code using a paper and pencil, hacking a computer, or through biometric identity theft.

Protecting the purpose of the policy also entails considering its jurisdiction. Koops cites unwanted mail (known as spam) as a case that reveals the complexities in applying a technology neutral approach. [88] In an imaginary scenario where spam is universally banned, distinct behaviors and technologies fall under its aegis. Spam delivered through a fax, compared to email, differ in how they affect users. Electronic spam diminishes worker productivity by clogging inboxes with unwanted information. Conversely, when an unwanted fax is received, paper and ink is wasted in undesired quantities. Developing technology neutral regulation that controls spam in either case should equally protect consumers from unwanted messages and target the modality of the behavior that warrants attention.

Language is a vital element of technology neutrality. The choice of words written into policy affects its accessibility and implementation. The use of esoteric or specialized terms limit its comprehension by operators in the field. On the other hand, generic language is conducive to interpretation.[89] This can lead to uncertainty, which can catalyze lawsuits that syphon time and resources from public coffers to clarify the policy.

A successful example of a technology neutral policy is the Fourth Amendment of the Constitution. For much of the country's history, the interpretation of the Amendment has evolved to protect citizens from unlawful searches of private property that ranges from homes to hard drives (see Figure 1). Although the amendment exemplifies this approach, its use throughout government is not prevalent. In the U.S., future-proofing is seldomly used. Rather, specialized agencies are delegated to act nimbly in response to new trends. The Federal Communications Commission (FCC), for instance, was founded to consolidate the administration of radio, telephone, and television policies.[90] Resistance to the development of technology neutral policies is understandable considering that they are optimized for venues where significant time and effort is required for change.

Figure 1 - Technology neutrality in action



A scenario that may have benefitted from a technology neutral approach is the state of California's experience in decreasing its carbon footprint with the Zero Emission Vehicle (ZEV)

[88] Id. at.

[89] Julia Black, *Forms and Paradoxes of Principles Based Regulation*, 13 LSE LAW - SOCIETY AND ECONOMY WORKING PAPERS (2008).

[90] Aryeh S. Friedman, *Law and the Innovative Process: Preliminary Reflections*, COLUMBIA BUSINESS LAW REVIEW (1986).

mandate. Instead of implementing climate change targets that car manufacturers could reach with their preferred combination of technologies, authorities championed battery technology and required that 2% of California's vehicles be powered by it (increasing it to 10% in 2003) (Marchant, 2008).

ZEV forced firms to speed-up the development of batteries to comply with the law. Ultimately, this effort was unsuccessful. The advances to make cost-effective cars with a range that would convince consumers of their usefulness was unavailable. Alternatives such as hybrid vehicles, cars with a battery and internal combustion engine, where excluded from ZEV. Eventually, hybrids became the gateway technology that spurred manufacturers to invest in battery technology to the point that all-electric vehicles are slowly becoming appealing to consumers.

1.2.1.2 Technology Futures Analysis

Although uncertainty exists about what will happen in 1, 10, or 100 years, there is no doubt that a future, any kind of future, will occur. Technology futures analysis is a methodology that attempts to approximate, rather than predict, a future state. Scholars define it as a "systematic process to produce judgments about emerging technology characteristics, development pathways, and potential impacts of a technology."[91]

This method originates from the need of the U.S. Department of Defense (DOD) to forecast the evolution of weapons systems after World War II.[92] To solve this problem, the RAND Corporation developed the Delphi Method, a system to improve decision-making by eliciting the opinions of subject matter experts, sharing this information with the group anonymously, and facilitating a consensus-building process. Along with Delphi, hundreds of methodologies have spawned an eclectic mix of qualitative and quantitative tools organized into nine families (see Table 4).

Table 4 - Types of Technology Futures Tools

Type	Explanation
Expert opinion	Subject matter experts reach conclusions on the likelihood of events. The most widely used method is Delphi, based on communicating forecasts and iterating with participants until a consensus is reached.
Trend analysis	Combines historical data with techniques such as regression analysis or growth curve fitting to pinpoint the stages of development of a technology (adoption, growth, maturity, and declining).
Monitoring and intelligence	Scans the markets to gather information on the acceptability and penetration of products. Expert panels are frequently used to keep track of new data.
Statistical methods	Finds patterns in data through correlation analysis that compares the growth of new to established technologies. Patterns are also sought using bibliometrics to explore up-and-coming research areas.
Modeling and simulation	Creates a simplified version of the real world, analysts isolate how variables react to different factors. Agent modeling and systems simulation are popular tools in this field.

[91] Technology Futures Analysis Methods Working Group, *Technology futures analysis: Toward integration of the field and new methods*, 71 TECHNOLOGICAL FORECASTING AND SOCIAL CHANGE (2004);Hariolf Grupp & Harold A. Linstone, *National Technology Foresight Activities Around the Globe: Resurrection and New Paradigms*, 60 see id. at Cited Pages|. (1998).

[92] R. Johnston, *Historical Review of the Development of Future-Oriented Technology Analysis*, *in* FUTURE-ORIENTED TECHNOLOGY ANALYSIS (Cristiano Cagnin, et al. eds., 2008).

Scenarios	Using pre-defined assumptions, scenarios are written by experts that represent alternate outcomes.
Valuing/decisions/economics	Dissects the goals of a technology hierarchically and estimates the likelihood that each will be achieved.
Descriptive and matrices	Road mapping is a consensus approach to breaking down the milestones desired for features of a technology. Analysts are asked to estimate product generations or years required to reach the milestones so that the market can have a better sense of expected advancements.
Creativity	Science fiction writing and brainstorming are used to analyze the viability of technologies.

Source: [93]

Outside the realm of defense, public and private sector stakeholders employ futures analysis to map scientific advances and prepare policies that may overcome expected challenges.[94] Examples include the protection of citizens from the negative impact of nanotechnology and setting funding priorities for Science and Technology (S&T) research portfolios.

Governments differ on their reliance of this methodology. For over 21 years, the U.S. had an Office of Technology Assessment (OTA) within the legislative branch whose mission was to inform Congress about emerging technologies using futures analysis until 1995 (today it is relegated to a unit within the Government Accountability Office).[95] European governments have actively pursued the methodology by maintaining bodies like the OTA (e.g. United Kingdom, France, Germany, Denmark, the Netherlands, Finland, Greece and Italy) to perform work at the national and state level, while also coordinating activities with the rest of the European Union.[96] The Japanese government is a paragon of the method, having decided over 40 years ago to apply the Delphi process on a quinquennial basis to model their S&T policy priorities.[97]

The application of futures analysis to set policy strategy faces numerous qualitative and quantitative challenges.[98] One is the inherent bias of subject matter experts. With Delphi, individuals may intentionally or unintentionally contaminate the process by setting an agenda or creating self-fulfilling prophecies. Another is its ability to model complex adaptive systems.[99] The number of variables involved in the simulation of social phenomena such as human interaction, investment decisions, technology pathways, or consumer preferences, makes it incredibly difficult to forecast realistic futures.

1.2.2 Reactive

A reactive strategy is characterized by the presence of a trigger before a policy decision is made. In many cases, policymakers have no choice but to be reactive because regulatory mechanisms are unprepared to cope with the consequences of a technology. The element of surprise may

[93] Technological Forecasting - A Review. (2008).
[94] Ahti Salo & Kerstin Cuhls, *Technology Foresight - Past and Future*, 22 JOURNAL OF FORECASTING (2003).
[95] Johnston. 2008.
[96] Lyria Bennett-Moses, *Agents of Change*, 20 GRIFFITH LAW REVIEW (2014);Grupp & Linstone, TECHNOLOGICAL FORECASTING AND SOCIAL CHANGE, (1998).
[97] Kerstin Cuhls, Japanese S+T Foresight 2035 (The European Foresight Monitoring Network 2004).
[98] Salo & Cuhls, JOURNAL OF FORECASTING, (2003).
[99] Technology Futures Analysis Methods Working Group, TECHNOLOGICAL FORECASTING AND SOCIAL CHANGE, (2004).

force policy to be adjusted or created in haste, with insufficient information, or without having a mastery over the problem at hand.

The reactive approaches described in this section have been used to systematize policymaking in uncertain scenarios. This section begins with the precautionary principle, which serves as a planning mechanism that delineates triggers and actions to be taken in technological transitions with unknown consequences. It is followed by adaptive policymaking, an approach to create flexible policy able to change considering new conditions or needs. Essentially, it institutionalizes mechanisms to make policymaking predictable, even when technology spurs unpredictable events.

1.2.2.1 Precautionary Principle

The popular saying "better safe, then sorry" embodies the precautionary principle. It describes the prescription of action to anticipate threats due to a trigger, even when the explanation of a phenomenon is incomplete or the time frame for its impact is unknown.[100] Diplomacy at the international level has embraced this approach. Ahteensuu performed a review of its implementation throughout multilateral institutions and found a predictable sequence of clauses: a trigger condition and a precautionary response.[101] The trigger condition is divided into:

- **The damage threshold** identifies a situation or hazard that constitutes an undesirable threat to be avoided.
- **The knowledge threshold** places a bound for the information/data required to substantiate the need for a precautionary response.

The precautionary response guides stakeholders on the actions to be performed when faced with a threat that fulfills the triggers. Table 5 includes three examples of how the principle is used in international charters to protect the environment and global health.

Table 5 - Usage of the Precautionary Principle in Multilateral Settings

Source	***Trigger Condition***		***Precautionary Response***
	Damage Threshold	Knowledge Threshold	
Rio Declaration on Environmental and Development	Where there are threats of serious or irreversible damage	Lack of full scientific certainty	Cost-effective measures to prevent environmental degradation
Cartagena Protocol on bio-safety	Potential adverse effects of a living modified organism on the conservation and sustainable use of biological diversity	Lack of scientific certainty due to insufficient relevant scientific information and knowledge	Taking a decision, as appropriate, with regards to the import of the living modified organism in question…to avoid or minimize such potential adverse effects

[100] Daniel Gervais, *The Regulation of Inchoate Technologies*, 47 HOUSTON LAW REVIEW (2010).
[101] Marko Ahteensuu, Rationale for taking precautions: normative choices and commitments in the implementation of the precautionary principle (2007).

World Charter for Nature	Potential adverse effects	Effects are not fully understood	The activities should not proceed

Adapted from [102]

While the precautionary principle has simplicity in its favor, it may not be pragmatic. Defining clear thresholds (damage or knowledge) while the threat is uncertain is challenging. Broad definitions in the trigger conditions can lead to a society that is cautious to the point of paralysis.[103] In effect, every technological innovation has risks and, though the scientific method is able to provide "a high level of confidence, it can never provide certainty….absolute proof requires a proof of a negative, a proof that something does not exist."[104]

Gervais and Mandel discourage policies, like the precautionary principle, that aim to shape novel technologies in the process of embedding themselves into society.[105] It may be argued that to recognize the true effects of a technology, society first needs to experiment with it. This is the crux of the Collingridge dilemma. It states that "there is always a trade-off between knowing the impact of a given technology and the ease of influencing its social, political, and innovation trajectories."[106] That is, as society gains a deeper awareness of the potential threats of a technological innovation, the less likely it will be able to control the escalation of its consequences.

1.2.2.2 Adaptive Policy-Making

Stability in policy begets certainty. What if policymakers could organize a system that identifies emerging technological issues and reacts to them systematically? The principle behind adaptive policy-making is the promise of confidence in uncertain times. It enables government to build credibility by following through with its commitments to face threats or risks triggers in an organized and predictable manner. In turn, non-government or private sector stakeholders benefit from the ability to plan and execute a medium to long-term strategy that responds to the requirements of the law.

Adaptive policy-making recognizes the impossibility of asking government to anticipate all outcomes or factors required to foresee the needs of society and that flexibility can be used to adjust regulation.[107] The essence behind adaptation in government was discussed early in the

[102] Id. at.
[103] Joh N. Hathcock, *The Precautionary Principle - An Impossible Burden of Proof for New Products*, 3 AGBIOFORUM (2000).
[104] Id. at.
[105] Gervais, HOUSTON LAW REVIEW, (2010);Mandel, MINNESOTA JOURNAL OF LAW, SCIENCE & TECHNOLOGY, (2007).
[106] Evgeny Morozov, *What is your Favorite Deep, Elegant, or Beautiful Explanation?* Edge *at* https://edge.org/response-detail/10898;Armin Grunwald, *Responsible Research and Innovation: An Emerging Issue in Research Policy Rooted in the Debate on Nanotechnology*, 13 (2014);DAVID COLLINGRIDGE, THE SOCIAL CONTROL OF TECHNOLOGY (Francis Pinter. 1980).
[107] Walker, et al., TECHNOLOGICAL FORECASTING AND SOCIAL CHANGE, (2010).

20th century by John Dewey, who remarked that "policies and proposals for social action [should] be treated as working hypotheses, not as programs to be rigidly adhered to and executed."[108]

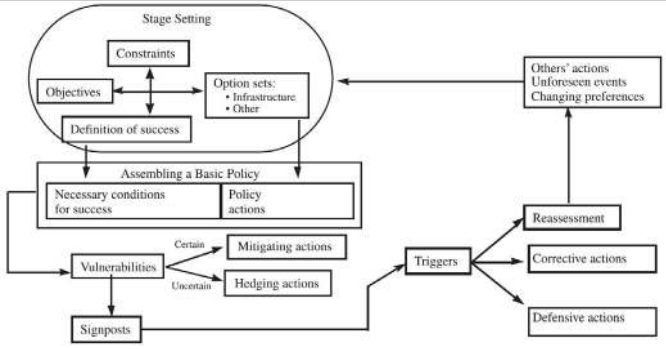
According to Swanson, the concept of adaptive policy-making was formally introduced by Kai Lee in 1994 to refer to policies "designed from the outset to test clearly formulated hypotheses about the behavior of an ecosystem being changed by human use."[109] Few examples of adaptive policy-making exist and a determining element of its viability is organizational in nature.[110]

A review by McCray et al. of environmental, health, and safety regulation in the U.S. found only four entities with adaptive practices.[111] Their application does not appear naturally for several reasons. First, in these cases action was not voluntary. An external force mandated they be put in place; specifically, Congress.[112] Second, the resources (economic and human) required for monitoring compliance represent a higher expense compared to non-adaptive policy-making. Finally, some institutions are unwilling to threaten their reputation by becoming nimble. Actively reconsidering or repealing a policy in a dynamic manner may create uncertainty for the stakeholders that depend on the entity for regulatory guidance.

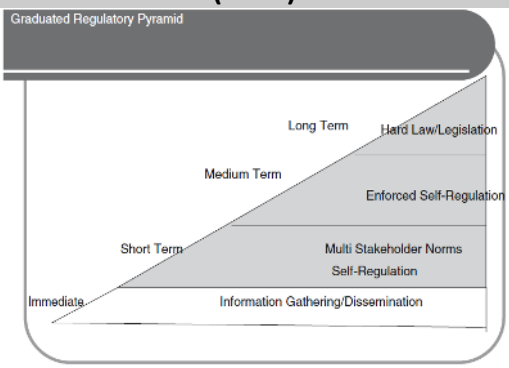
There is no standard adaptive policy-making model. Because it has not widely been adopted, scholars have developed alternatives to inspire policymakers. Figure 2 illustrates the diversity of approaches. One proposal by Walker et al. systematized the process into four steps.[113] The first two represent the policy-making process we know (static policy) and begin by specifying a policy's objective, constraints, definition of success, and available options.

Figure 2 - Adaptive policy-making alternatives

Walker et al. (2001)



Marchant et al. (2008)



Source: [114]

[108] JOHN DEWEY & MELVIN L. ROGERS, THE PUBLIC AND ITS PROBLEMS: AN ESSAY IN POLITICAL INQUIRY (Penn State Press. 2012).
[109] KAI N. LEE, COMPASS AND GYROSCOPE: INTEGRATING SCIENCE AND POLITICS FOR THE ENVIRONMENT (1994);Darren Swanson, et al., *Seven tools for creating adaptive policies*, 77 TECHNOLOGICAL FORECASTING AND SOCIAL CHANGE (2010).
[110] B. Smit, et al., *The Science of Adaptation: A Framework for Assessment*, 4 MITIGATION AND ADAPTATION STRATEGIES FOR GLOBAL CHANGE (1999).
[111] Lawrence E. McCray, et al., *Planned adaptation in risk regulation: An initial survey of US environmental, health, and safety regulation*, 77 TECHNOLOGICAL FORECASTING AND SOCIAL CHANGE (2010).
[112] Id. at.
[113] Walker, et al., EUROPEAN JOURNAL OF OPERATIONAL RESEARCH, (2001).
[114] Id. at;Gary E. Marchant & Douglas J. Sylvester, *Risk Management Principles for Nanotechnology*, 2 NANOETHICS (2008).

The third step signals the inclusion of adaptation by asking policymakers to analyze two kinds of vulnerabilities: certain and uncertain. Certain vulnerabilities can be anticipated and mitigated, such as having back-up energy generation and distribution plans in case of a blackout. Uncertain vulnerabilities can be managed by implementing hedging actions that "reduce or spread the risk of the possible uncertain adverse effects of a policy."[115] One example is climate change and the effects that surging water levels may have on the population residing in coastal cities of the U.S. A hedging policy to this vulnerability is to curb the production of greenhouse gases by increasing fuel efficiency standards.

Having identified vulnerabilities, the fourth step asks decision-makers to generate indicators or signpost that monitor the assumptions, validity, or opportunities for the improvement of the policy. For the transportation sector, a signpost could be the penetration of automotive technologies that modify licensing requirements of vehicles that no longer require human interaction (i.e. autonomous vehicles). For these to work, they need to be paired with "triggers", which signal a call to action. For autonomous vehicles, an announcement by a firm stating the release of a product that can tackle traffic without the need of a driver could force authorities to study the modification of policy.

The final step is implementation. It is defined by the monitoring of signpost and reaction to its triggers. The latter may result in one of three responses: defensive action (clarification of the policy), corrective action (adapting it to current conditions), or reassessment (current conditions have changed the underlying assumptions and alter the relevance of policy). The systematic approach proposed by Walker et al. is one of a universe of alternatives.[116] In addition, there is a rainbow of tools with adaptive elements found throughout the literature such as the use of non-binding regulation (also known as soft law) through threats.

1.2.2.2.1 Regulatory Threats

Hard or binding law is the prevalent form of regulation. Policymakers in dynamic industries may find themselves in a position where the time required to define their stance, once a new technology arrives, is insufficient. In the interim of the decision-making process, unclear regulations can burden the commercialization of technology that essentially becomes policy orphan.[117]

Alternative arrangements from the status quo are an opportunity for government to calibrate its power and react to current conditions. In support of soft law approaches (non-binding law), scholars argue for the acceptance of threats as a way to reach "tentative government arrangements" that nimbly guide society and increase flexibility in harnessing authority.[118] A threat is an alternative policy option that delivers short to medium-term guidance to

[115] V. A. W. J. Marchau, et al., *Dynamic adaptive transport policies for handling deep uncertainty*, 77 TECHNOLOGICAL FORECASTING AND SOCIAL CHANGE (2010).
[116] Walker, et al., EUROPEAN JOURNAL OF OPERATIONAL RESEARCH, (2001).
[117] The Impact of Regulation on Innovation in the United States: A Cross-Industry Literature Review. (2010).
[118] Daniele Rotolo, et al., Mapping the De Facto Governance in the Case of Emerging Science and Technologies (ESADE 2013);Nathan Cortez, *Regulating Disruptive Innovation*, 29 BERKELEY TECHNOLOGY LAW JOURNAL (2014).

stakeholders. Though they potentially arm agencies with the flexibility to react to changes in the industry, they can be overused and harm the credibility of the implementing entity.

The Food and Drug Administration exercised this approach when it issued draft policy standards to regulate the software of medical devices in 1989 as a threat to the industry and did not follow up with actual rules for over 20 years.[119] In comparison, the FCC used threats in a favorable manner (and in a shorter time frame – 6 years) to confront Internet service providers about discriminating between sites visited by users (known as net neutrality).

The time needed to reach any policy decision should be balanced between the uncertainties faced by entities who seek concrete guidance and the discussion of policy alternatives by authorities. According to Cortez, policymakers can: make a decision as quickly as possible, issue a threat, or do nothing. [120] Threats are a viable solution compared to preemptive legislation that can lead to ill-informed action or inaction.

1.2.3 Limited Action

Limited action is a strategy where government does not act to contain or promote a technology. Instead, it takes a step back and waits for a technology to develop before deciding on a course of action or it outsources decision-making to third parties.

Entities that are independent of government can act through the development of mechanisms (e.g. codes of conduct, industry standards, among others) that are not enforceable by authorities, known as soft law.[121] One soft law alternative is embodied in the idea of Responsible Research and Innovation (RRI).[122] It is defined as:

> "*a transparent, interactive process by which societal actors and innovators become mutually responsive to each other with a view to the (ethical) acceptability, sustainability and societal desirability of the innovation process and its marketable products (in order to allow a proper embedding of scientific and technological advances in our society).*" [123]

RRI is characterized as the process of limiting the scope of government by outsourcing policymaking to a body of professionals involved in the development of a technology. This third-party is accountable to society in exploring the benefits of a discovery in the frontier of knowledge and attempt to mitigate its negative effects. This approach is relevant in emerging sectors were regulatory and scientific bodies share a comparable level of ignorance regarding the consequences of a technology.

A similar proposal to RRI is Lex Informatica. It describes a community of information and communication technology specialists that supplant or complement orthodox regulation that

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[119] Cortez, BERKELEY TECHNOLOGY LAW JOURNAL, (2014).

[120] Id. at.

[121] Gary Marchant, *"Soft Law" Governance Of Artificial Intelligence*, AI Pulse(2019), *available at* https://aipulse.org/soft-law-governance-of-artificial-intelligence/.

[122] Grunwald, (2014).

[123] René von Schomberg, *Prospects for Technology Assessment in a framework of responsible research and innovation*, *in* TECHNIKFOLGEN ABSCHÄTZEN LEHREN: BILDUNGSPOTENZIALE TRANSDISZIPLINÄRER METHODEN (M. Dusseldorp & R. Beecroft eds., 2011).

surpasses national jurisdictions.[124] Rather than rely on laws that change by country, technologies such as the Internet have one jurisdiction, the network itself. Though it remains difficult for governments to pursue action for an activity related to the Internet outside of their borders, the community charged with the network does not have this problem.

Another virtue is flexibility and customization. Though internal politics may exist, the community can be unbound by the bureaucracy of governments. Alterations and upgrades to how the network functions are executed without the debates or check and balances common in democracies. By decreasing the lag in time to apply changes, "policies" can react and address novel situations in a way that would be impossible with traditional policymaking. Finally, the enforcement of regulation in this model is transformed from an activity that is usually pursued ex-post to one that is not permitted ex-ante. This mean that individuals who seek to break with standards or regulations within the network are not only monitored, but their activities are prevented via the usage of protocols that verify obedience to the community's "codes."[125]

With cyberspace as a backdrop, Easterbrook argues that rational beings, with their ability to interact and bargain with each other, are better able to adapt to changing conditions then laws and regulations ever will.[126] In the brief examination of the limited action models, there are fundamental choices asked of society: [127] Do we prefer a self-regulating world that can catalyze the discovery of new technological innovations at the risk of our safety? Should we depend on a government authority that forces the scientific community to limit the capabilities of technology in favor of minimizing risks? Each society will answer these questions considering their interests and values.

The challenge to self-regulation is determining the extent of autonomy that society wishes to allocate to professionals outside of government. Limiting involvement by elected officials and their representatives in these matters essentially entails the outsourcing of responsibilities.[128] The lack of participation by authorities in regulating technologies can decrease the accountability of these bodies to the rest of society, which becomes a problem in scenarios where actions performed by stakeholders generate negative effects. Conversely, such a system may incent nimbleness in solving issues or enable the experimentation of solutions that would not be possible with the hurdles of designing, implementing, monitoring, and enforcing regulations.[129]

[124] Reidenberg, TEXAS LAW REVIEW, (1998).
[125] LESSIG. 1999.
[126] Frank H Easterbrook, *Cyberspace and the Law of the Horse*, 207 UNIVERSITY OF CHICAGO LEGAL FORUM (1996).
[127] Friedman, COLUMBIA BUSINESS LAW REVIEW, (1986).
[128] Grunwald, (2014).
[129] MORGAN & YEUNG. 2003.

2 Background on Artificial Intelligence

One of the many definitions for technology describes it as any tool that modifies the environment for a purpose (see Appendix 2 for additional definitions).[130] This understanding of the term encompasses virtually everything created by intelligent beings, be it physical or conceptual, regardless of how it is branded by popular culture, including: a wheelbarrow, chair, car, mobile phone, or an algorithm.

AI is an example of technology. The term was coined by John McCarthy in 1955 who, as a professor of Mathematics at Dartmouth, requested funding from the Rockefeller Foundation for a conference on harnessing newly available computers into learning language.[131] Even though this proposal broke contemporary knowledge barriers, it was not the first time that research was performed on enhancing the capabilities of machines for the completion of tasks requiring "intelligence." It follows a legacy of disciplines as varied as philosophy, mathematics, physics, and engineering who have attempted to design and develop machines to solve problems (Appendix 3 contains selected historical precedents for AI).[132]

This chapter briefly contextualizes AI for the non-technical audience of this dissertation. It characterizes the technology, differentiates between its methods and applications, and presents a taxonomy by Calo that identifies the sectors of society where AI is expected to impact policy.[133] The information herein is not meant to be comprehensive or answer this dissertation's research questions. It is included to equip readers with baseline knowledge of this field and facilitate their grasp of subsequent chapters.

2.1 Defining Artificial Intelligence

Although there is no consensus definition for AI, Russell and Norvig offer an oft cited perspective describing its capabilities through a two-dimensional framework (see Table 6).[134] The first dimension characterizes the type of intelligence or cognition possessed by a machine, either human or rational actor. Human-like cognition is associated with behaviors such as learning, creativity, or exhibiting "goal-seeking behavior."[135] Achieving it assumes that "every aspect of [human] learning or any other feature of intelligence can in principle be so precisely described that a machine can be made to simulate it."[136]

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[130] Cockfield, MANITOBA LAW JOURNAL, (2004);Koops, Ten Dimensions of Technology Regulation - Finding your Bearings in the Research Space of an Emerging Discipline. 2010.

[131] Dartmouth Artificial Intelligence Conference, *The Dartmouth Artificial Intelligence Conference: The next fifty years*, Dartmouth University(2005), *available at* https://www.dartmouth.edu/~ai50/homepage.html;J . McCarthy, et al., A PROPOSAL FOR THE DARTMOUTH SUMMER RESEARCH PROJECT ON ARTIFICIAL INTELLIGENCE (The Rockefeller Foundation 1955).

[132] AAAI, *A Brief History of AI*(2018), *available at* https://aitopics.org/misc/brief-history.

[133] Calo, SSRN, (2017).

[134] STUART RUSSELL & PETER NORVIG, ARTIFICIAL INTELLIGENCE: A MODERN APPROACH (Pearson. 2014).

[135] Alchemy and Artificial Intelligence. (1965);McCarthy, et al. 1955;Nils J. Nilsson, Problem-Solving Methods in Artificial Intelligence (1971).

[136] McCarthy, et al. 1955;Roger C. Schank, *The Current State Of AI: One Man's Opinion*, 4 AI MAGAZINE (1983);M.W. EYSENCK, THE BLACKWELL DICTIONARY OF COGNITIVE PSYCHOLOGY (Basil Blackwell Ltd. 1990).

Table 6 - Classification of Artificial Intelligence

	Human	Rational
Think	Systems that think like humans	Systems that think rationally
Act	Systems that act like humans	Systems that act rationally

Source: [137]

Conversely, a different approach is to forget the nuance, bias, and irrationality expected from human cognition. Rational agent intelligence is represented by the efficient solution of problems. In fact, they use the term "rational agent" to identity entities able to perform tasks in a manner that "achieves the best outcome or, when there is uncertainty, the best expected outcome."[138] [139]

Russell and Norvig's second dimension distinguishes the scope of decision-making. A technology whose sole purpose is to processes inputs and generate outputs is limited to what the authors would call reasoning or thinking. Thinking is the precursor of acting. A machine that takes the additional step of "operat[ing] autonomously, perceiv[ing] their environment, persist[ing] over a prolonged time period, adapt[ing] to change, and creat[ing] and pursu[ing] goals" is said to have the ability to act.[140]

2.1.1 Thinking and Acting Humanly

Humans are the organisms with the highest level of observable intelligence. As such, emulating our thought processes requires an understanding of how we make decisions. Yet, science has not reached this point. Theories try to explain our cognition based on the results of thought experiments (or actual ones) in an effort to create guidelines on how we process information. In effect, an assortment of social science research theorizes about our rational and irrational decision-making.[141]

To design a machine that reproduces human thought with fidelity, it would need to experience inputs and interpret them like humans do. Researchers in AI rely on cognitive science as the field dedicated to filling this gap by grouping knowledge in philosophy, psychology, linguistics, and neuroscience to create "testable theories of the human mind."[142]

[137] RUSSELL & NORVIG. 2014.

[138] Wm Leler, Re: definition of AI (1985);DAVID L. POOL & ALAN K. MACKWORTH, ARTIFICIAL INTELLIGENCE: FOUNDATIONS OF COMPUTATIONAL AGENTS (2017);RUSSELL & NORVIG. 2014.

[139] Leler. 1985;POOL & MACKWORTH. 2017;RUSSELL & NORVIG. 2014.

[140] RUSSELL & NORVIG. 2014.

[141] DANIEL KAHNEMAN, THINKING, FAST AND SLOW (Farrar, Straus and Giroux. 2013);SIGMUND FREUD, INTRODUCTORY LECTURES ON PSYCHOANALYSIS (Liveright. 1989).

[142] RUSSELL & NORVIG. 2014;Paul Thagard, *Cognitive Science*, Stanford University (2014).

One of the first technologies to emulate human thought was the General Problem Solver (GPS) by Newell and Simon.[143] It mimics human problem solving by utilizing means-ends analysis based on heuristics, whereby a program "finds differences between current and desired situations, finds an operator relevant to each difference, and applies the operator to reduce the difference."[144]

This type of analysis can be exemplified with the process of ordering a pizza. The system would begin by identifying the sub-goals needed to satiate our hunger: finding a pizza place that delivers food, examining the menu, choosing an item, calling the establishment, and so on. The completion of each sub-goal increases our proximity to the ultimate goal, ordering a pizza. Any technology that synthesizes human thought will process information using methods such as those exhibited in GPS, but also via nuances characteristic to our species. Specifically, they may incorporate theories of cognition where outputs could be as instinctive, deliberately logical, or irrational when presented with social constructs that confound decision-making.[145]

The difference between human thought and action is the ability to perform independently, have memory, and learn. Machines that act as humans need to think as such and adapt to their environmental conditions without assistance. In 1950, Alan Turing proposed a challenge to determine if machines were capable of acting intelligently as humans.[146] He called it the imitation game (contemporarily known as the Turing Test).[147] It consisted of an interrogation scenario where a machine interacted with a person remotely through a typewriter. The challenge for the human was to engage in a conversation and discern whether their counterpart was a machine or a human. Conversely, the challenge to the machine and its maker was to not only process information as a human would, but also seamlessly engage with another human to fool it.

2.1.2 Thinking and Acting Rationally

Rational thinking is described as problem solving on the basis of well-defined rules. Mathematics, through arithmetic or algebraic operations, is an example of a straightforward approach to reaching an answer by manipulating numbers though the implementation of a standardized order of operations. Modern examples of rational thought that follows a set of instructions are found everywhere in our technology-laden world: Excel macros, Stata do-files, scrapping the internet using R, etc. Today, rational agent algorithms are tasked with complex duties such as assisting physicians with the mining of medical files for diagnostics or provide parole or jail term suggestions in the justice system.[148] These tools are classified as thinking rationally because they follow a set of instructions to find answers to problems.

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[143] Herbert A. Simon & Allen Newell, HUMAN PROBLEM SOLVING: THE STATE OF THE THEORY IN 1970 (Carnegie-Mellon University 1970).
[144] Id. at.
[145] KAHNEMAN. 2013;DAN ARIELY, PREDICTABLY IRRATIONAL (Harper Perennial; . 2008).
[146] Graham Oppy, The Turing Test (2016).
[147] A.M. Turing, *COMPUTING MACHINERY AND INTELLIGENCE*, 49 MIND (1950).
[148] Osonde Osoba & William Welser, An Intelligence in Our Image: The Risks of Bias and Errors in Artificial Intelligence (RAND Corporation 2017);AN Ramesh, et al., *Artificial intelligence in medicine*, 86 ANN R COLL SURG ENGL (2004).

A system that acts rationally does so "to achieve the best outcome or, when there is uncertainty, the best expected outcome."[149] The added complexity is that acting rationally requires a machine to perform tasks "autonomously, perceive their environment, persist over a prolonged time period, adapt to change, and create and pursue goals."[150] In these conditions, a rationally acting system confronts scenarios where a decision needs to be made, even when the most efficient course of action is unavailable. A technology under development that meets the criteria of a rational actor is autonomous vehicles (AV). Currently being tested by several firms, AV are programmed to operate in environments full of unpredictable factors: human drivers, changing road conditions, weather, and pedestrians.

2.2 Methods and Applications

When discussing AI, its methods and applications should be differentiated. Methods refer to approaches to accomplish a goal (e.g. neural networks), while applications are the goal itself (e.g. autonomous vehicles). In this field, the methodological paradigms are divided into symbolic and sub-symbolic (sometimes described as connectionist).[151] Symbolic methods are based on the idea that it is possible to catalogue knowledge and explicitly define intelligence.[152] It entails the combination and execution of symbols, thoughts, or actions that form logical statements or expressions which eventually lead to the processing of information for a purpose.[153]

Instead of expressing intelligence through a formal set of symbols and expressions or developing a library of knowledge, sub-symbolic AI is inspired by the biological properties of neurons.[154] Those that favor this approach contend that the evolutionary process for producing evermore complex organic brain structures is a template to be followed by AI.[155]

Early work in this field established the idea of creating an artificial network of neurons (initially named perceptrons) that do not encode information into any formal language.[156] Instead, data is processed through three kinds of neurons or units (input, hidden, and output) where each connection is distinguished by having a positive (that excites) or a negative (that inhibits) weight.[157] Learning by neurons takes place by feeding the network with information or iterating scenarios.[158] Essentially, a machine tries to understand trends in the past to create predictions without requiring explicit coding. This process is performed in a supervised manner, where users

[149] RUSSELL & NORVIG. 2014.
[150] Id. at.
[151] NILS J NILSSON, ARTIFICIAL INTELLIGENCE: A NEW SYNTHESIS (Elsevier. 1998).
[152] Arthur R Miller, *Copyright Protection for Computer Programs, Databases, and Computer-Generated Works: Is Anything New Since CONTU?*, HARVARD LAW REVIEW (1993).
[153] MARIUSZ FLASIŃSKI, INTRODUCTION TO ARTIFICIAL INTELLIGENCE (Springer. 2016);ALLEN NEWELL & HERBERT A SIMON, COMPUTER SCIENCE AS EMPIRICAL INQUIRY: SYMBOLS AND SEARCH (ACM. 2007).
[154] Ron Sun, *Artificial intelligence: Connectionist and symbolic approaches*, (1999).
[155] NILSSON. 1998.
[156] Frank Rosenblatt, *The perceptron: a probabilistic model for information storage and organization in the brain*, 65 PSYCHOLOGICAL REVIEW (1958);Principles of neurodynamics. perceptrons and the theory of brain mechanisms. (1961);Miller, HARVARD LAW REVIEW, (1993).
[157] David S Touretzky & Dean A Pomerleau, *What's hidden in the hidden layers*, 14 BYTE (1989);Chris Woodford, *Neural networks*(2018), *available at* http://www.explainthatstuff.com/introduction-to-neural-networks.html.
[158] ETHEM ALPAYDIN, INTRODUCTION TO MACHINE LEARNING (MIT Press. 2014).

provide examples on how to process information successfully or unsupervised, where the machine is expected to find the structure of the data on its own.[159]

Symbolic and sub-symbolic methods have generated applications that solve problems. A prime example is the Logic Theorist and GPS by Simon and Newell. Using symbolic methods, these tools emulate human-based cognitive models via an explicit set of rules (i.e. means-ends analysis) to prove mathematical theorems or solve Euclidean geometry.[160] In the field of natural language processing, researchers have developed programs that understand and solve word problems in IQ tests (ANALOGY) and algebra workbooks (Project MAC).[161] They have also engaged users through keyboard-based conversation while assuming several roles, including that of a "psychotherapist" (ELIZA).[162]

A widely-used application of AI is expert systems software, a tool that compiles specialized information to assist humans. "Dendral" is an iteration of this application made to codify the knowledge and decision-making of chemists. It successfully interpreted organic chemical compounds to the point of being the first machine to make a discovery worthy of publishing in a peer-reviewed journal.[163] Similar systems exist to facilitate internal medical diagnostics (e.g. Mycin and Internist).

One way to test AI's capabilities in problem solving and planning is to create applications that challenge humans in game play. The first semblance of an AI-game was created in 1912. The "Ajedrecista" was limited to playing three pieces of chess autonomously on an electromagnetic board.[164] In the late 50's and 60's, advances in the study of checkers led to a machine learning program that required 8-10 hours of training to become a worthy rival to a high-performing human.[165] This was followed by a Chess program (denominated MacHack) that earned a rating equivalent to a competitive high-school player.[166]

Advances in gaming have culminated in impressive results where world class players were challenged and defeated by machines. In checkers, a computer beat the world's leading human player in 1994.[167] Subsequently, academics created an engine that solved checkers (a game with over 5 x 10^{20} possible positions) without making a mistake.[168] Chess, a game with over 10^{120} possible variations, became the next frontier. IBM's Deep Blue defeated the world champion,

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[159] Trevor Hastie, et al., *Unsupervised learning*, *in* THE ELEMENTS OF STATISTICAL LEARNING (2009).

[160] PAMELA MCCORDUCK, MACHINES WHO THINK (A K Peters, Ltd. 2004).

[161] Thomas G. Evans, A HEURISTIC PROGRAM TO SOLVE GEOMETRIC-ANALOGY PROBLEMS (1964);Daniel G. Bobrow, A QUESTION-ANSWERING SYSTEM FOR HIGH SCHOOL ALGEBRA WORD PROBLEMS (1964).

[162] Joseph Weizenbaum, *ELIZA—a computer program for the study of natural language communication between man and machine*, 9 COMMUNICATIONS OF THE ACM (1966).

[163] B. G. Buchanan, et al., *Applications of artificial intelligence for chemical inference. 22. Automatic rule formation in mass spectrometry by means of the meta-DENDRAL program*, 98 J. AM. CHEM. SOC. (1976).

[164] Francisco Gonzalez de Posada & Francisco A. Gonzalez Redondo, *Leonardo Torres Quevedo (1852-1936) 1a Parte. Las m´aquinas alg´ebricas*, 7 LA GACETA DE LA RSME (2004).

[165] A. L. Samuel, *Some Studies in Machine Learning Using the Game of Checkers*, 3 IBM JOURNAL OF RESEARCH AND DEVELOPMENT (1959).

[166] Richard Greenblatt, Oral History of Richard Greenblatt (2005).

[167] Alexis C. Madrigal, *How Checkers Was Solved*, THE ATLANTIC 2017.

[168] Jonathan Schaeffer, et al., *Checkers Is Solved*, SCIENCE (2007);Madrigal, THE ATLANTIC. 2017.

Garry Kasparov in 1997; however, unlike checkers, chess has not been solved.[169] The latest news in the field saw an algorithm (created by DeepMind) defeat the world champion of Go in 2016, a game thought to have an estimated 2 x 10^{170} possible variations.[170]

AI applications have tackled problems in perception, motion, and interaction with the environment. One of the first autonomous robots was built by Grey Walter in the 1940's, who created two mechanical "turtles" capable of sensing light and touch.[171] The mechanization of decision-making reached a critical point in the 1960's when the Stanford Research Center began a program with a novel long range goal: "to develop intelligent automata capable of gathering, processing, and transmitting information in a hostile environment."[172] A result of this effort was "Shakey," a robot endowed with the ability to move in a controlled environment assisted by sensors that recognized obstacles and software that made it "learn" from mistakes.[173]

This breakthrough was joined by others embodied by the Stanford Cart and Carnegie-Mellon's Rover projects, all of which pioneered the development of machines that interpreted and reacted to their environment.[174] Further investments in foundational research on autonomy were catalyzed by government agencies with a variety of objectives.[175] This includes inter-planetary missions, such as NASA's Jet Propulsion Lab robot that traversed long distances semi-autonomously in a Martian environment in the 70's, to prototypes of battlefield ground vehicles in the 80's.[176]

Machine autonomy advances continued with the vehicle built by Japanese Tsukuba Mechanical Engineering Lab in the 70's. It navigated the road from a starting to an ending position while avoiding obstacles at speeds of 30 Km per hour.[177] From 1987 to 1995, the European Union provided funding of ~€750 million research for its Prometheus project.[178] Its most important outcome was the VaMoRs-P platform outfitted into vehicles that drove for over 3,000 Km on public roads at speeds of up to 80 KM per hour.[179]

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[169] Steven Levy, *WHAT DEEP BLUE TELLS US ABOUT AI IN 2017*, WIRED 2017;Claude E. Shannon, *Programming a Computer for Playing Chess*, 41 PHILOSOPHICAL MAGAZINE (1950).

[170] Joon Ian Wong & Nikhil Sonnad, Google's AI won the game Go by defying millennia of basic human instinct (Quartz 2016);John Tromp, Number of legal Go positions (2016).

[171] University of Bristol, *Grey Walter and his tortoises*(2008), *available at* http://www.bristol.ac.uk/news/2008/212017945378.html.

[172] C. A. Rosen, et al., A Research and Development Program in Applications of Intelligent Automata to Reconnaissance—Phase 1 (Stanford Research Institue 1965).

[173] Nils J. Nilsson, Shakey The Robot (SRI International 1984).

[174] H. P. Moravec, The Standford Cart and CMU Rover (Robotics Institue Carnegie-MEllon University 1983).

[175] Anita M. Flynn, Redundant Sensors for Mobile Robot Navigation (1985) MIT);Douglas W. Gage, *UGV HISTORY 101: A Brief History of Unmanned Ground Vehicle (UGV) Development Efforts*, 13 UNMANNED GROUND VEHICLES (1995).

[176] Richard A. Lewis & Antat K. Bejczy, Planning consideration for a roving robot with arm (1973);Henry C. Davies, et al., Autonomous navigation in a dynamic environment (1991).

[177] Sadayuki Tsugawa, *Vision-Based Vehicles in Japan: Machine Vision Svstems and Driving Control Svstems*, 41 IEEE TRANSACTION ON INDUSTRIAL ELECTRONICS (1994).

[178] EUREKA, EUREKA: 30 years of looking ahead (Eureka Secretariat 2015).

[179] Markus Maurer, et al., VaMoRs-P: an advanced platform for visual autonomous road vehicle guidance (1995).

A smaller, yet crucial effort was the Defense Advanced Research Projects Agency Grand Challenge initiative. [180] Using the format of a race, DARPA offered $1 million to teams that could navigate a 142-mile course across the Nevada dessert.[181] During its first year, no team completed the challenge. In its second and third iteration, several teams finished the desert and urban races for a $2 million grand prize.

These applications represent a small proportion of AI-based achievements. What they have in common is that each is tailor-made to a particular scenario or purpose, described in the literature as "narrow AI" or weak AI.[182] As of the writing of this document, no application has garnered the capabilities of what researchers call Artificial Generalized Intelligence or strong AI. A system that is not application-specific and can "match or exceed the real time cognitive (not physical) abilities of a smart, well-educated human."[183]

2.2.1 AI as a General-Purpose Technology

Scholars believe that AI is a candidate for the general-purpose technology (GPT) classification.[184] GPT are defined by their pervasiveness, improvement over time, and the spawn of applications that push the frontiers of knowledge.[185] Throughout history, examples of technologies that fit this description are electricity, computers, the Internet, and biotechnology.

Pervasiveness is a measure of market penetration where a product experiences growth and reaches a dominant position in the aggregate of the economy and in a diversified set of sectors. Jovanovic & Rousseau illustrate pervasiveness using the adoption of electricity as an example. Its adoption began with a 5% market share in 1889 by the transportation, textile, paper, and printing industries and overtook competitors (e.g. steam) by 1919 with a penetration of 90%.[186]

Unlike electricity, it is unlikely that AI's market penetration has experienced its apex. Global estimates from commercial research firms find that its participation in the market is growing. For instance, revenues based on AI services and products rose from $400 million in 2014 to a predicted 35, 60, or even 90 billion by 2025 depending on the source consulted.[187] Though

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[180] DARPA, *The DARPA Grand Challenge: Ten Years Later*, DARPA, *available at* http://www.darpa.mil/news-events/2014-03-13.

[181] Id. at.

[182] David Weinbaum & Viktoras Veitas, *Open ended intelligence: the individuation of intelligent agents*, 29 JOURNAL OF EXPERIMENTAL & THEORETICAL ARTIFICIAL INTELLIGENCE (2017).

[183] Peter Voss, *What is AGI?*, Medium(2017), *available at* https://medium.com/intuitionmachine/what-is-agi-99cdb671c88e.

[184] Timothy F. Bresnahan & M. Trajtenberg, *General purpose technologies 'Engines of growth'?*, JOURNAL OF ECONOMETRICS (1995).

[185] Boyan Jovanovic & Peter L. Rousseau, *General Purpose Technologies*, *in* HANDBOOK OF ECONOMIC GROWTH (Philippe Aghion & Steven N. Durlauf eds., 2005);Bresnahan & Trajtenberg, JOURNAL OF ECONOMETRICS, (1995).

[186] Jovanovic & Rousseau. 2005.

[187] Grand View Research, *Artificial Intelligence Market Analysis By Solution*(2017), *available at* https://www.grandviewresearch.com/industry-analysis/artificial-intelligence-ai-market;Tractica, *Artificial Intelligence Software Market to Reach $89.8 Billion in Annual Worldwide Revenue by 2025*(2018), *available at* https://www.tractica.com/newsroom/press-releases/artificial-intelligence-software-market-to-reach-89-8-billion-in-annual-worldwide-revenue-by-2025/;Statista, *Revenues from the artificial intelligence (AI) market worldwide, from 2016 to 2025 (in million U.S. dollars)*(2018), *available at* https://www.statista.com/statistics/607716/worldwide-artificial-intelligence-market-revenues/.

estimates vary, sources appear to agree that a range of sectors will experience some form of AI impact.[188]

GPT improvement over time are marked by efficiency gains that create a downward pressure on a per unit cost basis as they mature. The transistor is an example of a product that drastically changed its size and cost. The continuous confirmation of Moore's law, which predicts that the number of transistors per square inch on integrated circuits would double about every two years, made possible the integration of this technology as a necessary component in life as we know it.[189] In effect, five decades since the prediction was made, the cost of an integrated circuit (in today's dollars) has gone from $30 to a nano dollar and shrunk from an adult fist to as large as an atom.[190]

Hand in hand with the evolution of the transistor, the cost and availability of performing AI-related tasks has decreased. Today, non-commercial users can harness AI for facial recognition and natural language processing at relatively low costs. However, there is no straightforward methodology to compare the evolution of AI costs throughout time as applications are not necessarily priced on a per unit basis.

Finally, for a GPT to push the barriers of knowledge it has to open "up new opportunities rather than offering complete, final solutions."[191] For instance, the semi-conductor was a conduit for the generation of industries and technologies that were enabled by its invention. Advances in mathematics, medicine, physics, and communication technologies would not be possible without this fundamental piece of technology. In the same way, as illustrated in the description of AI applications, this technology is responsible for breakthroughs in a gamut of sectors such as: facial recognition, autonomous vehicles, medical diagnostics, among others.

2.3 Repercussions of AI on Public Policy

AI methods and applications increasingly influence our economic, social, and cultural development. They have made possible technologies that compare to or outperform humans in tasks requiring creativity and complex reasoning in gaming (e.g. chess and Go), mining medical files, or autonomously test-driving millions of miles.[192]

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[188] Jacques Bughin, et al., ARTIFICIAL INTELLIGENCE THE NEXT DIGITAL FRONTIER? (Mckinsey Global Institute 2017).
[189] Gordon E. Moore, *Cramming More Components onto Integrated Circuits*, ELECTRONICS 1965.
[190] Chris Mack, The Multiple Lives of Moore's Law (IEEE 2015);Sharon Gaudin, *The transistor: The most important invention of the 20th century?*, IDG(2007), *available at* http://www.computerworld.com/article/2538123/computer-processors/the-transistor--the-most-important-invention-of-the-20th-century-.html;Tech Blog, *The single-atom transistor is here – the amazing evolution of microprocessors* Pingdom(2012), *available at* http://royal.pingdom.com/2012/02/29/the-single-atom-transistor-is-here-the-amazing-evolution-of-microprocessors-infographic/.
[191] Bresnahan & Trajtenberg, JOURNAL OF ECONOMETRICS, (1995).
[192] Sean O'Kane, *Waymo's self-driving cars are racking up miles faster than ever*, THE VERGE, 2017;Rich Haridy, *2017: The year AI beat us at all our own games*, NEW ATLAS, 2017;Steven E. DilsizianEliot L. Siegel, *Artificial Intelligence in Medicine and Cardiac Imaging: Harnessing Big Data and Advanced Computing to Provide Personalized Medical Diagnosis and Treatment*, 16 CURRENT CARDIOLOGY REPORTS (2013);Driving to Safety: How Many Miles of Driving Would It Take to Demonstrate Autonomous Vehicle Reliability? (2016);Moore, ELECTRONICS. 1965.

Regardless of the exciting economic opportunities generated by AI, the pursuit to achieve parity between machine processing and human cognition has motivated ample discussion of its policy implications. Calo proposes a taxonomy that serves as a starting point to classify the scope of this literature.[193] It begins with **justice and equity**, a category that describes AI's involvement in upholding or denying the rights of individuals. One such right concerns the protection from discrimination, exemplified with the use of predictive policing to target neighborhoods with a high proportion of minorities, or introducing algorithmic bias in sentencing recommendations.[194] In either case, the use of AI opens a debate on how this technology should respect legal precedents meant to ensure fairness, accountability, and transparency.[195]

The **use of force** literature explores endowing machines with the capability of taking lives. Concerns regarding the integration of AI in warfare have grown amid the ever-increasing automation of systems such as the Aegis and Patriot. Scholars in this field discuss issues such as what entities are responsible for the illegal actions of these machines and how much human control should be mandated in their operation.

The body of work within **safety and certification** looks at the accountability of AI in the interest of safeguarding humans. It explores policies that encompass the safe operation of systems. This includes minimizing the errors of AV or making sure that a diagnosis from an AI-based medical device is not dangerous. This section also discusses the advent of AI as a supplier of technical and professional services such as tax or legal advisory and the need to protect consumers through service standards or certifications. Traditionally, non-AI lawyers and financial advisors require schooling and/or degrees to perform their duties.[196] Reliance on AI in this area has forced the consideration of similar protocols and standards so that machines apply prescribed policy to an equal or higher degree as their human counterparts.

Literature within the **privacy and power** scholarship reflects on the ability of firms to infer personal information from a growing proportion of the population through AI.[197] In effect, individuals no longer need to subscribe or be a user of a service to be subject to scrutiny. They can be tracked through third-party sources. Further, as the market in this sector consolidates, the compilation of information is concentrating on a small number of companies. Their growing grip on this data infrastructure may avertedly control the information market, thus limiting new entrants and creating bottlenecks for competition.

Finally, there is **taxation and displacement of labor**. The rise and fall of professions is part of the natural order of the economy. Those who studied Morse code at the turn of the 20th century saw the demand for their skills change as the telephone gained popularity. Today, AI can become the catalyst for economic transitions at a larger scale such as the introduction of ever-more

[193] Calo, SSRN, (2017).
[194] Osoba & Welser. 2017;Kelly K. Kloss, *Leveraging Predictive Policing Algorithms to Restore Fourth Amendment Protections in High-Crime Areas in a Post-Wardlow World*, 301 CHICAGO-KENT L. REV. (2015).
[195] Calo, SSRN, (2017).
[196] Dow Jones, *Financial Planning Software*, Dow Jones(2018), *available at* https://www.dowjones.com/financial-planning-software/.
[197] Eric Horvitz & Deirdre Mulligan, *Data, privacy, and the greater good*, 17 SCIENCE (2015).

autonomously driven freight vehicles that gradually replace the 1.8 million truck drivers on today's roads.[198]

The potential economic and social effects of job loss have instigated the discussion of policies to ameliorate the automatization of labor. One option is supplementing household revenues through a universal basic income.[199] Theoretically, this scheme would guarantee families a minimum level of resources in a future where earning a living due to technological advancements is difficult. However, policies that rely on increasing government expenditures face the conundrum of a reduction in revenues from income taxes. Alternatives to fund the government (and policies such as universal basic income) include placing a tax on AI-based technologies (such as robots) to replace the loss of human-generated fiscal revenue.[200]

[198] Alex Davies, *MEET THE TESLA SEMITRUCK, ELON MUSK'S MOST ELECTRIFYING GAMBLE YET*, WIRED, 2017;BLS, *Occupational Outlook Handbook*, BLS(2016), *available at* https://www.bls.gov/ooh/transportation-and-material-moving/heavy-and-tractor-trailer-truck-drivers.htm.

[199] James J. Hughes, *A Strategic Opening for a Basic Income Guarantee in the Global Crisis Being Created by AI, Robots, Desktop Manufacturing and BioMedicine*, 24 JOURNAL OF EVOLUTION AND TECHNOLOGY (2014).

[200] R Abbott & BN Bogenschneider, *Should Robots Pay Taxes? Tax Policy in the Age of Automation*, HARVARD LAW & POLICY REVIEW (2018).

3 Protocol for the Systematic Review

The first two chapters of this dissertation introduced the concept of regulatory gaps and offered an overview of AI. This chapter contains the protocol to implement a systematic review of the literature on regulatory gaps caused by AI. It describes the process undertaken to identify and screen articles relevant to this effort's research objectives. This protocol conforms to the PRISMA guidelines and a version of it is published in the Open Science Framework (see Appendix 4 for the PRISMA Checklist). [201, 202]

The systematic review methodology was selected because it "attempts to collect and analyze all evidence that answers a specific question" through a "broad and thorough search of the literature."[203] In fact, systematic reviews featuring AI already exist. Many focus on the effectiveness of AI applications and methods in science, engineering, and medicine. As Calo points out, limited efforts have been undertaken to examine the corpus of AI's impact on U.S. public policy. [204] This effort serves as a response to Calo's challenge for a thorough and systematic analysis of the literature on the intersection between AI and policy.[205]

3.1 Objective of this Systematic Review

This protocol outlines the steps taken to conduct a systematic review that identifies regulatory gaps generated by AI methods and applications in the U.S. It represents a first approach to developing an overarching understanding of how this technology interacts with policy by answering the following research questions:

1. What U.S. regulatory gaps exist due to AI methods and applications?
2. When looking across all of the gaps identified in the first research question, what trends and insights emerge that can help stakeholders plan for the future?

3.2 Information Sources

Because of its multi-disciplinary nature, this systematic review considered databases with publications in the social (e.g. political science, philosophy, law reviews, and public policy) and hard sciences (e.g. computer science, artificial intelligence, and systems engineering). Valuable research that links AI with policy can be found in both types of databases; hence, neither warrants exclusion. With the assistance of a research librarian at the RAND Corporation, six databases that covered literature within the fields of interest were contemplated. Two of them provide a legal lens by covering articles in law reviews (Lexis Nexis and Hein Online), three combine literature from all fields (Scopus, Web of Science, and JSTOR), and one focuses on public policy (Policy File Index).

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[201] David Moher, et al., *Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement*, PLOS MEDICINE (2009).
[202] The protocol can be found at https://osf.io/f9uzy/.
[203] CDC. 2019.
[204] Calo, SSRN, (2017).
[205] Calo alludes that "notably missing is any systematic review of the ways AI challenges existing legal doctrines." Id. at.

Table 7 - Systematic Review Databases

Databases	Information Covered
Scopus	Over 5,000 publishers and 1.4 billion cited references in science, mathematics, engineering, technology, arts, and humanities.
Web of Science	Its core collection has over 18,000 journals and 1.3 billion cited references in the sciences, social sciences, arts, and humanities.
JSTOR	Humanities, social sciences, sciences, and mathematics. 2,300 journals and 1,000 publishers.
Lexis Nexis	Law review database that covers over 740 law journals from the U.S. from 1982 to today.
Policy File Index	Reports from over 300 active think tanks, research organizations, and advocacy groups.
Hein Online – Law library	Contains more than 2,500 law and law-related periodicals.

3.3 Search Strategy

The selection of keywords to extract relevant articles from databases is an art. Three strategies were tested to detect publications that answered both research questions (see Table 8). The keywords from each strategy are broken down into words related to technology (in the form of AI methods and applications) and those relevant to a policymaker's role in society. Strategy one minimizes the number of technology terms by only including the name of the field. Strategy two consist of synonyms related to AI taken from another systematic review.[206] Strategy three is a compromise between strategies one and two. It contains the name of the technology and a limited number of methodologies associated with it.

Table 8 - Keyword Search Strategy

	Technology Keywords	Policy Keywords
Strategy 1	Artificial Intelligence	(law* OR policy OR govern* OR regulat* OR public OR oversight* OR legislation OR enforce*)
Strategy 2	"Machine Learning" OR "Artificial Intelligence" OR "Natural Language Processing" OR "Neural Networks" OR "Support Vector Machine" OR Machine learning OR Artificial Intelligence OR Naive Bayes OR bayesian learning OR Neural network OR Neural networks OR Natural language processing OR support vector* OR random forest* OR boosting OR deep learning OR machine intelligence OR computational intelligence OR computer reasoning	(law* OR policy OR govern* OR regulat* OR public OR oversight* OR legislation OR enforce*)
Strategy 3	("Machine Learning" OR "Artificial Intelligence" OR "Natural Language Processing" OR "Neural Networks")	(law* OR policy OR govern* OR regulat* OR public OR oversight* OR legislation OR enforce*)

[206] Joeky T. Senders, et al., *Natural and Artificial Intelligence in Neurosurgery: A Systematic Review*, NEUROSURGERY (2017).

To test the effectiveness of each keyword strategy, the 200 most recent titles in each database were evaluated. Any title that linked AI to public policy was deemed relevant. The strategy with the highest proportion of relevant articles was selected and any database within that strategy that had less than a 10% relevance rate was dropped. All articles in the selected strategy were evaluated against the inclusion/exclusion criteria.

3.4 Screening of Articles

Articles underwent three phases of screening. First, duplicates and excluded categories were eliminated. Second, titles and abstracts were subject to an evaluation based on the inclusion and exclusion criteria (Table 9). Third, the entire text of screened-in articles was read.

Included articles generally connected methods or applications of AI with public policy in the U.S. (e.g. liability implications of autonomous vehicles or the discovery of bias in AI algorithms developed for the criminal justice system). Articles with no clear link between policy and AI were discarded (e.g. new neural network methodologies or technical policies to create more efficient algorithms). Furthermore, articles that discussed how AI methods and applications could benefit or augment public policy were deemed to be outside of this review's purview (e.g. improving dynamic traffic light management). Inconclusive articles were screened-in to assess their full-text against the inclusion and exclusion criteria.

Table 9 - Screening Criteria for Systematic Review

Inclusion	Exclusion
• Written in English • Academic papers or reports • Mention of AI methods or applications • Mention of policy repercussions connected to AI • Content is accessible to the author • To the extent possible, U.S. publications or articles that emphasize U.S. policy implications	• Comments and notes within law journals • Technical articles in the field of the hard sciences that do not mention policy issues • Symposium/conference articles, books, reviews, PowerPoint presentations, news, blogs, theses, and pamphlets

Where possible, works published outside of the U.S. were excluded (Hein Online is the only database that discriminates the geographic origin of articles). Notes and comments, pieces written by graduate students in law reviews, were excluded because they represent a medium of expression for scholars in development (Hein Online is the only database that labels these documents). In the Policy File Index, dissertations, classified ads, and news articles were excluded. Symposiums and conference proceedings were omitted because they may represent draft versions of documents that are subsequently evaluated by academic journals.

Articles in this systematic review were not screened based on an author's definition of AI. Instead, it relied on the review process within academic publications to validate the use of the term.

3.5 Analysis

Regulatory gaps caused by AI in the U.S. were identified from articles that successfully passed the three phases of screening. The analysis is divided into three steps: a narrative synthesis of the

gaps, description of the overarching trends, and the development of case studies on under-researched issues.

3.5.1 Narrative Synthesis

Articles deemed relevant at this point underwent a process where excerpts were extracted and labeled (see Table 10). The first label is Bennet-Moses' framework for classifying regulatory gaps caused by technology.[207] Next is Calo's taxonomy that groups the interaction by AI and public policy into social themes.[208] This is followed by labels for government jurisdiction, temporality of the gap (they are currently experienced by policymakers or speculated to occur in the future), and type of AI (whether the gap is caused by a method, refers to approaches to accomplish a goal, or an application, the goal itself). It is possible that the information gathered from the systematic review may encourage the modification or adjustment of the labels.

Table 10 – Systematic Review Labels

Regulatory Gap (Bennett-Moses 2007)	Policy Theme (Calo 2017)	Level of Government	Temporality	Type of AI
Uncertainty	Justice and Equity	Local	Present	Method
Novelty	Use of Force	State	Future	Application
Targeting	Privacy and Power	Federal		
Obsolescence	Safety and Certification			
	Taxation and displacement of labor			

Labeled excerpts were used to identify and characterize regulatory gaps into a narrative synthesis. These narratives roughly followed the same format. They begin by asserting the type of regulatory gap found (based on Bennett-Moses' framework), they offer background information on the subject, and present evidence that supports a position on the type of gap. While the focus of this systematic review is on the screened-in articles, literature from outside of this corpus is included to either correctly cite information or provide appropriate context.

3.5.2 Identification of Trends

The narrative synthesis is the main source for any insights or meta-trends of the regulatory gaps caused by AI in the U.S. An analysis of this section may point out if a type of regulatory gap is more prevalent than others, if data from one social theme poses interesting questions, a correlation between two or more labels, or if a particular level of government is over or under-represented.

3.5.3 Highlight Under-represented Areas of Research

A limited number of under-presented issues is highlighted in this work through a case studies approach. This methodology recounts the social processes and events relevant to the selected

[207] Bennett-Moses, UNSW LAW RESEARCH PAPER, (2007).
[208] Calo, SSRN, (2017).

issues.[209] The choice of these case studies is made subjectively based on the trends from the narrative synthesis.

3.6 Limitations

This systematic review is constrained by a number of issues. The most important is its nature. This effort is systematic and not comprehensive or exhaustive. Thus, important regulatory gaps in the literature are not represented. Moreover, only a sample of sources from 1976 to 2018 were consulted. Which means that a number of important events or arguments that have an impact on the governance of AI are probably excluded.

The implementation of the protocol relied on the effort of one researcher. Having a limited number of contributors increases the likelihood of bias in assigning labels or interpreting trends. It is possible that peers with similar data could have reached diametrically different conclusions. Therefore, all asseverations within this document should be subject to further scrutiny.

This work represents a first attempt to provide an empirical basis to the characterization of regulatory gaps caused by AI in the U.S. Critics may rightfully argue that the time lag between the last published date of an article in the systematic review (February of 2018) and its completion (2020) diminishes its usefulness to stakeholders. While this is a valid point, government action on any subject tends to function at a slower speed than change generated by a technology. Based on this, it is expected that the information within this work will continue to be relevant for the foreseeable future.

Lastly, no effort was taken to solve any of the regulatory gaps identified. Doing so is a process that requires developing a theory of governance with respect to the role of regulation in society. Future scholars should research plausible alternatives for the gaps identified in this systematic review.

3.7 Implementation of the Protocol

This protocol was implemented between February of 2018 and January of 2020. The following is an account of the results from the evaluation of keywords and screening of articles.

3.7.1 Search Strategies

The search strategies produced between ~31,000 and 835,000 articles (see Table 11). Strategy one searched for articles that specifically mentioned the term “artificial intelligence” and various synonyms for public policy. A criticism of this approach is the limited scope for the technology of interest. As the sole keyword to identify articles related to it, it ran the risk of excluding research that specifically targets the technology’s methods or applications.

[209] Christopher Paul, et al., *Between Large-N and Small-N Analyses: Historical Comparison of Thirty Insurgency Case Studies*, 46 HISTORICAL METHODS: A JOURNAL OF QUANTITATIVE AND INTERDISCIPLINARY HISTORY (2013).

Table 11 – Results for the Keyword Strategies

	Strategy 1	Strategy 2	Strategy 3
Scopus	20,074	76,683	46,658
Web of science	1,070	34,497	15,146
JSTOR	5,686	Not possible	9,743
Policy file index	50	682	83
Hein Online	2,099	723,150	2,568
Lexis Nexis	2,014	Not possible	2,587
Total	30,993	835,012	76,785

To address this limitation, the second strategy expands the number of words that identify AI articles. It relies on the work of previous systematic literature reviews that compiled synonyms for the technology.[210] With almost a million hits in the second strategy, the third strategy represents a compromise that limits the number of technology keywords. This restriction was aimed at including popular AI terms that may appear in policy-centric articles, while excluding those most likely used in a non-policy context.

3.7.2 Evaluation of Strategies

To uncover the strategy and databases with the largest number of relevant articles, an evaluation of 200 titles per strategy/database was performed on February of 2018. In this step, any title that appeared to connect AI and public policy was considered relevant. To minimize bias, articles were sorted in chronological order (most recent first). This was done to avoid relying on each database's unknown criteria to arrange articles according to their "relevance." The results of this exercise evinced a higher prevalence of articles relevant to this work using the first strategy (Table 12). It is worth noting that search strategy two could not be performed with JSTOR or Lexis Nexis due to the database's character limit in their search parameters.

Table 12 - Evaluation of Relevant Articles

Database	Strategy 1	Strategy 2	Strategy 3
Scopus	13/200	1/200	0/200
Web of science	24/200	0/200	1/200
JSTOR	7/200	NA	5/200
Policy file index	16/50	19/200	23/83
Hein Online	74/200	1/200	53/200
Lexis Nexis	46/200	NA	41/200
Total	17.3%	3.5%	11.35%

Table 13 breaks down the relevance rate for articles within databases in strategy one. I found that those with content predominantly in the social sciences were more likely to include screened-in articles. This was especially the case for databases with journals in the legal field

[210] Senders, et al., NEUROSURGERY, (2017).

(Hein Online and Lexis Nexis). It is important to note that 81% of the journals published within Lexis Nexis were also in Hein Online.[211]

Table 13 - Summary of Strategy 1 Evaluation

Database	% Relevant	Relevant articles	Total # of articles
Hein Online	37%	74/200	2,108
Policy File Index	32%	16/50	50
Lexis Nexis	23%	46/200	2,012
Web of science	12%	24/200	1,070
Scopus	7%	13/200	20,074
JSTOR	4%	7/200	5,686

Based on the results of this exercise, databases with a relevance rate below 10% were excluded from the systematic review. With rates of 4% and 7, the 25,760 articles in JSTOR and Scopus did not undergo further consideration. This left a total of 5,240 articles to be evaluated using the previously described screening criteria.

Several lessons were gathered from this evaluation. First, it appears that the inclusion of terms denoting diverse AI methods or applications (e.g. machine learning, natural language processing, among others) increased the prevalence of articles devoted solely to the hard sciences. This was encountered in strategies two and three, where titles related to public policy did not appear as frequently as those in the first strategy.

Second, a proportion of articles discussing AI do not mention the term within the title, abstract, or body of the text. For example, a search for autonomous vehicles and policy can lead to results that forego the term AI. To mitigate this, the systematic review could develop a list of AI applications and methodologies and run separate searches for policy-relevant articles linked to each one. However, completing this task may unintentionally exclude technologies or the large number of search results could pose logistical challenges to the completion of this systematic review. Further, the outcome of the second strategy indicates that running additional searches may not be optimal or necessary. In this case, including AI synonyms increased the number of search results, but the proportion of relevant articles was significantly lower than that of the first strategy.

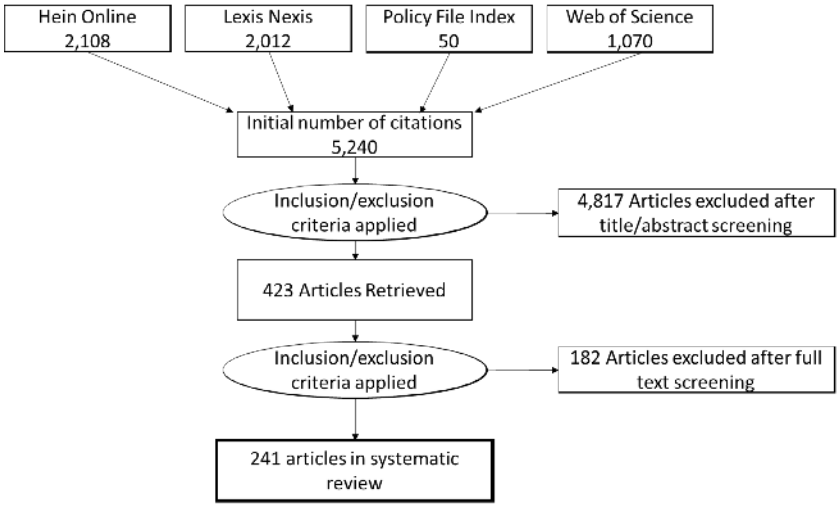
The objective of this systematic review is to embark in an initial effort to map the regulatory gaps caused by AI in the U.S. Future research projects may choose to clarify the policy relevance of specific methodologies or applications. Considering these lessons, this effort utilizes the four databases with the most relevant number of articles from strategy one.

3.7.3 Screening of Articles

Having selected the databases and universe of articles (a total of 5,240), the next step was to discriminate between relevant and irrelevant literature. The screening criteria was implemented in the three steps described in the protocol (see Figure 3 and Appendix 5).

[211] In terms of articles examined in the preliminary evaluation, 35% of all pre-screened and 31% of screened-in titles were found in both databases.

Figure 3 - Flow chart of citations reviewed



The process began by conducting a search for duplicates and categories explicitly excluded in the protocol, which led to the elimination of 1,614 articles. The titles and abstracts of the remaining 3,626 articles were evaluated. In the absence of abstracts, as was the case in a proportion of law review articles, part or the entire introduction section was read. The second step in this screening process led to the elimination of 3,203 articles (see Appendix 5). The third screening consisted of reading the entire text of 423 articles, out of which 241 were deemed relevant.

4 Cases of Regulatory Gaps Identified in the Systematic Review

The analysis of 241 articles in the hard and social sciences led to the identification of 50 regulatory gaps generated by methods and applications of AI (see Table 14 and Appendix 6). The information within this chapter answers this dissertation's first research question: what U.S. regulatory gaps exist due to AI methods and applications?

Table 14 - Distribution of Citations in the Systematic Review*							
Total Citations in the Systematic Review: **241**							
Personhood	Use of Force	Privacy	Accountability	Classification of Individuals	Safety and Certification	Displacement of Labor	Justice System
69	**51**	**45**	**38**	**35**	**27**	**15**	**5**
							***Citations can appear in more than one section.**

The gaps are organized into eight thematic families based on an empirically updated version of Calo's taxonomy. Each characterization of a gap roughly follows the same format. It begins by asserting the type of regulatory gap identified (based on Bennett-Moses' framework), includes background information on the subject, and offers evidence that supports its classification.

It is important to remember that the gaps described in this chapter are the result of a systematic review and not a comprehensive or exhaustive effort. Due to the fact that a sample of sources were consulted, important regulatory gaps in the literature are not represented. This also affected how labels were applied to each case. Experts in each of the fields represented in this work will probably find that significant events or arguments that have an impact on the governance of AI are excluded. This limitation likely affects the veracity of information and analysis presented in the following sections.

4.1 Privacy

Privacy is the frontier between an individual and society.[212] It embodies the rights and obligations that shield the distribution of personally identifiable data, ideas, opinions, or correspondence from the rest of the world. It also distinguishes private from public property and the circumstances under which it can be trespassed by others with the purpose of gathering information.

Context drives the perception and treatment of privacy. As opposed to Europe's General Data Protection Regulation, there are no comprehensive privacy rights in the U.S..[213] At the Constitutional level, the Fourth Amendment is a blueprint for the protections available to U.S. residents from government surveillance.[214] Over time, the Supreme Court has interpreted how regulations from the 18th century apply to our present understanding of privacy.[215]

[212] Omer Tene, *A new Harm Matrix for cybersecurity surveillance*, 12 COLO. TECH. LJ (2014).
[213] Hillary Brill & Scott Jones, *Little Things and Big Challenges: Information Privacy and the Internet of Things*, 66 AM. UL REV. (2016).
[214] U.S. Const., amend. IV.
[215] U.S. v Jones, 565 U.S. 400;U.S. v Knotts, 460 U.S. 276, (1983);United States v. Miller, 425 U.S. 435, (1976);Katz vs. US, 389 U.S. 347, (1967).

At the federal level, a sectoral patchwork of regulations guide firms on their responsibilities in handling data.[216] For example, health information is protected by the Health Insurance Portability and Accountability Act of 1996 (HIPAA), data gathered from minors under the age of 13 is governed by the Children's Online Privacy Protection Rule (COPPA), and financial information is protected by the Fair Credit Reporting Act.[217] Similarly, state and local governments supplement federal laws with additional safeguards or by defining key terms differently, distinguishing even further how privacy depends on where a person lives.[218]

AI's impact on exacerbating existing privacy issues is split between five regulatory gaps in the collection and analysis of information.[219] The first two gaps contain opinions by Supreme Court Justices on the need to rethink privacy standards in the collection of information (reasonable expectation of privacy and third-party doctrine). The third gap discusses under-inclusion in the collection and analysis of health information by entities not covered under HIPAA. The last two regulatory gaps examine the uncertainty in implementing laws that protect the privacy of people from uninvited surveillance (intrusion upon solicitude) and the obsolescence of enforcing laws that protect consumers from manipulation (see Table 15).

Table 15 - Regulatory Gaps in Privacy

Issue	Regulatory Gap	Type of Gaps	Government Level	Time Frame	Type of AI
Privacy in Public	Reasonable Expectation of Privacy	Uncertainty	Federal	Present	Application
Sharing Information	Third-Party Doctrine	Uncertainty	Federal	Present	Application
Entities not Subject to Data Protection	Healthcare Data	Targeting (under)	Federal + State	Present	Application
Surveillance	Intrusion Upon Solitude	Uncertainty	State	Present	Application
Fair Business Practices	Consumer Manipulation	Obsolescence	Federal	Present	Application

4.1.1 Reasonable Expectation of Privacy

The Fourth Amendment of the Constitution outlines the standard of privacy expected in the U.S.:

> *The right of the people to be secure in their persons, houses, papers, and effects, against unreasonable searches and seizures, shall not be violated, and no warrants shall issue, but upon probable cause, supported by oath or affirmation, and particularly describing the place to be searched, and the persons or things to be seized.* [220]

[216] Kim A Taipale, *Data mining and domestic security: Connecting the dots to make sense of data*, 5 COLUMBIA SCIENCE AND TECHNOLOGY LAW REVIEW (2003);Brill & Jones, AM. UL REV., (2016);Andrew J McClurg, *A thousand words are worth a picture: A privacy tort response to consumer data profiling*, 98 NW. UL REV. (2003).

[217] Federal Trade Commission, Fair Credit Reporting Act (FTC 2019);HHS, *Summary of the HIPAA Privacy Rule*(2013), *available at* https://www.hhs.gov/hipaa/for-professionals/privacy/laws-regulations/index.html;Federal Trade Commission, Children's Online Privacy Protection Rule ("COPPA") (FTC 2019).

[218] Stephanie Segovia, *Privacy: an issue of priority*, 11 HASTINGS BUS. LJ (2015).

[219] Taipale, COLUMBIA SCIENCE AND TECHNOLOGY LAW REVIEW, (2003).

[220] *Const.*

The interpretation of the over 200-year-old Amendment has not remained static. Throughout time, the Supreme Court has contextualized it based on prevailing conditions.[221] Today, the capabilities of AI applications have convinced a member of the Court to reconsider their understanding of one of its central tenets, the reasonable expectation of privacy doctrine.[222] This section examines the regulatory gap of uncertainty caused by a Justice's reinterpretation of the doctrine due to AI's capability for making long-term surveillance of people massively accessible. In other words, applications of AI have created doubts in the Supreme Court about which activities can the public reasonably expect to be classified as private.

In the early 20th century, the consensus on the Fourth Amendment was that unless government agents physically intruded a space to gather information, the rights of individuals were not infringed and warrants were unnecessary. This was confirmed in the Olmstead v. U.S. case, where the justice system convicted an individual of selling alcohol during prohibition with information obtained through off-site warrantless wiretaps.[223] The court sided with the government's argument that because "there was no entry of the houses or offices," the defendant's rights were not breached.[224]

This paradigm lasted four decades until Katz v. U.S.[225] In this case, a person was convicted on charges of transmitting gambling information across state lines with evidence obtained through a listening device placed outside a telephone booth. The government believed that because the person was making a call-in public, no Fourth Amendment protection was warranted. In a reversal of precedent, the Justices stated that people could expect Fourth Amendment protections outside of their homes or offices, or in their words the "amendment protects people, rather than places."[226]

Furthermore, to determine when an individual can expect privacy they created a two part test (now known as the reasonable expectation of privacy doctrine): "first that a person have exhibited an actual (subjective) expectation of privacy and, second, that the expectation be one that society is prepared to recognize as reasonable."[227] For the defendant in the Katz case, the Justices argued that Mr. Katz had a reasonable expectation of privacy when he entered a phone booth and closed the door to keep his conversation from being heard. In overturning Olmstead, the Supreme Court reinterpreted what constituted an expectation of privacy. No longer was it enough for agents to avoid the physical intrusion of a space to collect evidence, they now had to consider if the person's actions were intended to safeguard their information from others.

[221] Adam R Pearlman & Erick S Lee, *National Security, Narcissism, Voyeurism, and Kyllo: How Intelligence Programs and Social Norms Are Affecting the Fourth Amendment*, 2 TEX. A&M L. REV. (2014).
[222] Margaret Hu, *Small Data Surveillance v. Big Data Cybersurveillance*, 42 PEPP. L. REV. (2014).
[223] Olmstead v. United States, 277 U.S. 438, (1928).
[224] Id. at.
[225] John Villasenor, What You Need to Know about the Third-Party Doctrine (The Atlantic 2013).
[226] Katz vs. US, U.S.
[227] Id. at.

Per the Supreme Court's Katz standard, individuals currently do not have the right to a reasonable expectation of privacy when performing activities in public.[228] This means that if we find ourselves walking down a street or driving in a public road, anybody can legally track us via pictures or video.[229] In many cases, this aggregation of data is protected by a First Amendment right to gather information, be it to inform the public or for other motives.[230]

The emergence of AI has created unprecedented surveillance capabilities in public spaces. Efforts that would have required significant resources in the past can now be automated at a large scale. This has raised concerns in the Supreme Court.[231] Specifically, Justice Alito stated that the long-term monitoring of an individual's movements is likely to violate a reasonable expectation of privacy by revealing characteristics of a personal nature such as: "whether he is a weekly church goer, a heavy drinker, a regular at the gym, an unfaithful husband, an outpatient receiving medical treatment, an associate of particular individuals or political groups."[232]

Contemporary AI applications enable long-term surveillance at a scale that validates Justice Alito's reservations regarding what activities should fall under the interpretation of today's reasonable expectation of privacy standard, thus generating a regulatory gap of uncertainty. For instance, placing license plate readers throughout a city makes possible the real-time detection of a population's travel patterns.[233] Likewise, facial recognition technology (FRT), an AI application that translates facial features into a digital fingerprint, can recognize and track individuals in public jurisdictions (state or local), potentially revealing information that was expected to be private.[234]

4.1.2 Third-party Doctrine

The U.S. v. Katz decision spawned a second Fourth Amendment principle that faces an uncertainty regulatory gap because of AI applications, the third-party doctrine.[235] This doctrine was developed by subsequent rulings to Katz that strived to break down thresholds for the expectations of privacy deemed reasonable by society.[236] The doctrine states that "people are not entitled to an expectation of privacy in information they voluntarily provide to third parties."[237] A Supreme Court Justice believes that AI could undermine this doctrine by enabling the compilation of data freely provided by consumers and aggregating it into what can become an intrusion of privacy. In this case, the uncertainty regulatory gap is caused by AI's capability to

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[228] Yana Welinder, *Facing real-time identification in mobile apps & wearable computers*, 30 SANTA CLARA HIGH TECH. LJ (2013);Melanie Reid, *Rethinking the Fourth Amendment in the Age of Supercomputers, Artificial Intelligence, and Robots*, 119 W. VA. L. REV. (2016).

[229] U.S. v Knotts, U.S. .

[230] Adam D Thierer, *The internet of things and wearable technology: Addressing privacy and security concerns without derailing innovation*, (2015).

[231] Elizabeth E Joh, *Policing by numbers: big data and the Fourth Amendment*, 89 WASH. L. REV. (2014).

[232] U.S. v Jones, U.S. .

[233] Elizabeth E Joh, *The new surveillance discretion: Automated suspicion, big data, and policing*, 10 HARV. L. & POL'Y REV. (2016).

[234] Thierer, (2015);Welinder, SANTA CLARA HIGH TECH. LJ, (2013).

[235] Katz vs. US, U.S.

[236] Segovia, HASTINGS BUS. LJ, (2015);Smith v. Maryland, 442 U.S. 735, (1979);United States v. Miller, U.S. ;Katz vs. US, U.S.

[237] Richard M. Thompson, The Fourth Amendment Third-Party Doctrine (Congressional Research Service 2014).

generate doubt as to the limits of this doctrine, potentially requiring its reinterpretation by the Supreme Court.

There are important distinctions regarding what information is covered by the doctrine. Data protected by the Fourth Amendment includes voice conversations between two individuals or messages within an email. Although third-party services are generally utilized to transmit these examples of communication, the courts have interpreted that it is reasonable for participants in these activities to have an expectation of privacy.[238] In addition, there are examples of voluntarily disclosed information eligible for protection. At the federal level, standards exist to avoid the disclosure of identifiable patient data in healthcare settings. At the state level, legislatures throughout the country have emulated California's privacy regime where data collected by private sector firms that could lead to identify theft (social security number, driver's license number, credit card number, among others) are protected regardless of the context.[239]

The scope for unprotected information is wide. It includes metadata such as phone numbers, web addresses, information gathered by intermediaries (e.g. telecommunications companies) in the provision of services, and any other data disclosed to firms meant to be shared with a wider audience.[240]

Since the third-party doctrine was developed in the 20th century, much has changed in terms of information availability. Access to individuals' data has gone from a limited number of Fourth Amendment protected vectors (voice conversations and mail received through the post office) to an avalanche of data exhaust.[241] Today, consumers are accustomed to divulging streams of detailed information on themselves, family, co-workers, and friends through social networks, search engines, Internet connected devices, and purchases.[242] Under the third-party doctrine, most of this information is not protected by the Fourth Amendment. Which means that government agents can request access to it via an administrative order or subpoena.[243]

AI performs two roles in this regulatory gap: data extraction and analysis. In data extraction, AI-based applications serve as a conduit to gather detailed consumer information.[244] Examples include:

- Online bots that develop virtual friendships with trillions of data points on their users.[245]

[238] Tene, COLO. TECH. LJ, (2014).
[239] Segovia, HASTINGS BUS. LJ, (2015).
[240] Tene, COLO. TECH. LJ, (2014);Hu, PEPP. L. REV., (2014).
[241] Arthur R Landever, *Electronic Surveillance, Computers, and the Fourth Amendment-The New Telecommunications Environment Calls for Reexamination of Doctrine*, 15 U. TOL. L. REV. (1983).
[242] Kevin Miller, *Total Surveillance, Big Data, and Predictive Crime Technology: Privacy's Perfect Storm*, 19 J. TECH. L. & POL'Y (2014);Anita L Allen, *Protecting One's Own Privacy in a Big Data Economy*, 130 HARV. L. REV. F. (2016).
[243] Dorothy J Glancy, *Privacy in autonomous vehicles*, 52 SANTA CLARA L. REV. (2012).
[244] Omer Tene & Jules Polonetsky, *Judged by the tin man: Individual rights in the age of big data*, 11 J. ON TELECOMM. & HIGH TECH. L. (2013).
[245] Eric Boughman, et al., *"Alexa, Do you Have Rights?": Legal Issues Posed by Voice-Controlled Devices and the Data they Create*, BUSINESS LAW TODAY (2017);Ian R Kerr & Marcus Bornfreund, *Buddy bots: How turing's fast friends are undermining consumer privacy*, 14 PRESENCE (2005).

- Future owners of AV could have their location, time of travel, and destination tracked.[246]
- AI home robots can access sensitive information or conversations subject to government surveillance because of the third-party doctrine.[247]

While large quantities of data are gathered from the public, this technology facilitates its analysis. AI can be extremely accurate in finding inferences within databases with a virtually infinite number of variables.[248] Its output can create profiles of consumer tastes, patterns of behavior, opinions, life experiences, background, or link them to public records for the benefit of advertisers and eventually government surveillance.[249]

Upon this background, a Justice of the Supreme Court has expressed that existing standards for the third-party doctrine may not address society's needs, generating a regulatory gap of uncertainty and making a new interpretation necessary.[250] Justice Sotomayor stated that in today's technological environment, an expectation of privacy should exist even when consumers give away information in the course of everyday activities.[251] Take for instance the aggregation of millions of individually unharmful authorized privacy intrusions that, when analyzed with the assistance of AI, reveal deep insights about a person and create a privacy violation.[252] Bearing in mind the prevalence of such scenarios, Justice Sotomayor opined that information provided to a third-party could be reclassified to receive Fourth Amendment protection:

> *It may be necessary to reconsider the premise that an individual has no reasonable expectation of privacy in information voluntarily disclosed to third parties…..But whatever the societal expectations, they can attain constitutionally protected status only if our Fourth Amendment jurisprudence ceases to treat secrecy as a prerequisite for privacy. I would not assume that all information voluntarily disclosed to some member of the public for a limited purpose is, for that reason alone, disentitled to Fourth Amendment protection.*

Along with Justice Sotomayor, researchers believe that the compilation of innocuous information can lead to insights that disclose personal facts that push the boundaries of what society believes constitutes a reasonable expectation of privacy.[253] These concerns are the foundation of mosaic

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[246] Stephen P Wood, et al., *The potential regulatory challenges of increasingly autonomous motor vehicles*, 52 SANTA CLARA L. REV. (2012);Dorothy J Glancy, *Privacy in autonomous vehicles*, see id. at Cited Pages|.

[247] Margot E Kaminski, *Robots in the home: What will we have agreed to*, 51 IDAHO L. REV. (2014);Margot E Kaminski, et al., *Averting Robot Eyes*, 76 MD. L. REV. (2016).

[248] Peter Margulies, *Surveillance By Algorithm: The NSA, Computerized Intelligence Collection, and Human Rights*, 68 FLA. L. REV. (2016);Taipale, COLUMBIA SCIENCE AND TECHNOLOGY LAW REVIEW, (2003);Andrew Guthrie Ferguson, *The Internet of Things and the Fourth Amendment of effects*, 104 CAL. L. REV. (2016).

[249] Kenneth Glenn Dau-Schmidt, *The Impact of Emerging Information Technologies on the Employment Relationship: New Gigs for Labor and Employment Law*, (2017);Tene & Polonetsky, J. ON TELECOMM. & HIGH TECH. L., (2013);McClurg, NW. UL REV., (2003).

[250] Segovia, HASTINGS BUS. LJ, (2015).

[251] SCOTUS, UNITED STATES v. JONES (SCOTUS 2011).

[252] Miller, J. TECH. L. & POL'Y, (2014).

[253] Steven M Bellovin, et al., *When enough is enough: Location tracking, mosaic theory, and machine learning*, 8 NYUJL & LIBERTY (2013).

theory, which describes how the aggregation of individual pieces of data are collected to deduce "facts that are not otherwise ascertainable."[254]

Without the protection of the Constitution, government agencies take advantage of the third-party doctrine to learn about different populations. Local police departments mine social media or purchase information systems that gather public data to assist in their investigative and surveillance efforts.[255] Although the IRS is already entitled to detailed information on tax payer's household, health expenses, religious affiliations, among others; it purchases information from private sources to monitor tax code compliance.[256] Through its FinCEN program, the Treasury Department indiscriminately scours banking data, links it to government databases, and utilizes AI to detect financial crimes.[257] Finally, the National Security Agency aggregates "essentially anonymous data in the commercial world and turns it into individually identifiable information, using it in a way the individual never imagined" to identify terrorist threats.[258]

The secondary repercussions of not addressing the uncertainty of the third-party doctrine can affect population autonomy. Surveillance of social media can impinge on the First Amendment's protection of freedom of speech and the "expression of political dissent."[259] Owners of AV may have no privacy in terms of their movements if they believed that traveling to a particular destination would incite negative repercussions.[260] Described as a "chilling effect", under these conditions users may feel the need to self-censor or create false behaviors to meet social expectations, which can alter the level of discourse and creativity.[261]

4.1.3 Healthcare Data

The privacy of medical data is regulated by the Health Insurance Portability and Accountability Act of 1996 (HIPAA). This legislation defines the healthcare information that qualifies for privacy protection ("individually identifiable health information" from devices, clinical charts, and claims documents) and the entities obligated to secure it (health plans, providers, among others).[262] The spirit of the policy aims to set privacy standards for medical information. Remarkably, its exclusion of a number of parties generates a targeting regulatory gap of under-inclusion because it allows the collection or analysis of sensitive data, that could be classified as medical, by entities not subject to HIPAA.

There are two dimensions to this regulatory gap. The first entails the collection of identifiable medical information. Existing AI applications make it possible for HIPAA-exempt firms to record

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[254] Id. at;Joh, WASH. L. REV., (2014).
[255] Joh, HARV. L. & POL'Y REV., (2016).
[256] Michael Hatfield, *Taxation and Surveillance: An Agenda*, (2014);Landever, U. TOL. L. REV., (1983).
[257] Steven A Bercu, *Toward Universal Surveillance in an Information Age Economy: Can We Handle Treasury's New Police Technology?*, JURIMETRICS (1994).
[258] Taipale, COLUMBIA SCIENCE AND TECHNOLOGY LAW REVIEW, (2003);Gabe Maldoff & Omer Tene, *Putting Data Benefits in Context: A Response to Kift and Nissenbaum*, 13 ISJLP (2016);Margulies, FLA. L. REV., (2016).
[259] Wood, et al., SANTA CLARA L. REV., (2012).
[260] Dorothy J Glancy, *Privacy in autonomous vehicles*, see id. at Cited Pages|.
[261] Miller, J. TECH. L. & POL'Y, (2014);Ryan Calo, *People can be so fake: A new dimension to privacy and technology scholarship*, 114 PENN ST. L. REV. (2009).
[262] Drew Simshaw, et al., *Regulating healthcare robots: Maximizing opportunities while minimizing risks*, 22 RICH. JL & TECH. (2015);HHS. 2013;Nicolas P Terry, *Protecting patient privacy in the age of big data*, 81 UMKC L. REV. (2012).

extensive user data that could be classified as medical.[263] Firms (even pharmaceutical companies) can legally commercialize fitness trackers or robotic personal assistants that gather sensitive health information such as vital signs (e.g. the Apple watch can take a person's electrocardiogram) or medically-relevant behavior that would otherwise generate confidential data if performed by covered entities.[264]

A second dimension of the targeting regulatory gap is the emergence of healthcare practice with the assistance of medical AI applications, commonly referred as medical algorithms or black-box medicine. This technology relies on large quantities of data to "discover connections between specific patient attributes and specific symptoms, diseases, or treatments."[265] It can serve as a means to circumvent HIPAA protection in data that is not apparently medical or covered by regulation, but can lead to health-relevant conclusions. A prime example is patient behavior or sentiment data, which in many cases is only covered under a company's privacy policy.[266] Purchase patterns can also lead to health-related inferences. The retail chain Target uses it to identify expecting mothers and tailor their marketing towards this group.[267]

Even without the inclusion of the 18 variables considered by HIPAA as "identifiable", firms can still access information about a patient's diagnosis, hospital name, age, year of visit, and a partial ZIP code.[268] Therefore, de-identified data could be matched to patients to create a shadow medical record. [269] Combining this information with that of other commercial databases may foreseeably eliminate the anonymity of patients. It could even allow insurance companies to infer demographic information, discriminate customers based "on previously undisclosed or even misinterpreted data," or be used to redline neighborhoods.[270]

Since it came into existence, HIPAA has not remained stagnant. The policy evolved to cover a larger array of healthcare entities. In 2013 it included business associates, denoting individuals or organizations that perform services requiring the disclosure of health information on behalf of covered entities (e.g. "legal, actuarial, accounting, consulting, administrative…services").[271] However, this modification does not capture all sources of health data.

Several solutions have been proposed by researchers. One entails expanding HIPAA to persons or businesses that capture, process, and store health data.[272] Another is the creation of an

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[263] Donna S Harkness, *Bridging the Uncompensated Caregiver Gap: Does Technology Provide an Ethically and Legally Viable Answer*, 22 ELDER LJ (2014).

[264] Simshaw, et al., RICH. JL & TECH., (2015);Apple, *Taking an ECG with the ECG app on Apple Watch Series 4*, Apple(2019), *available at* https://support.apple.com/en-us/HT208955;Terry, UMKC L. REV., (2012).

[265] Roger Allan Ford, et al., *Privacy and Accountability in Black-Box Medicine*, 23 MICH. TELECOMM. & TECH. L. REV. (2016).

[266] Terry, UMKC L. REV., (2012).

[267] Charles Duhigg, *How Companies Learn Your Secrets*, NEW YORK TIMES, 2012.

[268] Paul Ohm, *BROKEN PROMISES OF PRIVACY: RESPONDING TO THE SURPRISING FAILURE OF ANONYMIZATION*, 57 UCLA L. REV. (2010).

[269] Duhigg, NEW YORK TIMES, 2012.

[270] Jillisa Bronfman, *Weathering the Nest: Privacy Implications of Home Monitoring for the Aging American Population*, 14 DUKE L. & TECH. REV. (2016);Ford, et al., MICH. TELECOMM. & TECH. L. REV., (2016).

[271] HHS. 2013;Bronfman, DUKE L. & TECH. REV., (2016).

[272] Bronfman, DUKE L. & TECH. REV., (2016).

intermediary in the form of a personal data vault, a "licensed, certified, regulated privacy professional who would be responsible for secure maintenance of information relating to the individual's personal health, and would consequently be entitled to assert a privilege of confidentiality on behalf of his or her clients."[273]

Others have suggested expanding state solutions to the national level. For instance, California's Confidentiality of Medical Information Act expands the definition of a HIPAA covered entity by including a provision that states ""[a]ny business organized for the purpose of maintaining medical information in order to make the information available to an individual or to a provider of health care at the request of the individual or a provider of health care, for purposes of allowing the individual to manage his or her information, or for the diagnosis and treatment of the individual, shall be deemed to be a provider of health care subject to the requirements of this part."[274]

4.1.4 Intrusion Upon Solitude

In scenarios where a reasonable expectation of privacy exists, each state's civil code protects citizens from an undesired invasion through the intrusion upon seclusion tort. It asserts that "one who intentionally intrudes, physically or otherwise, upon the solitude or seclusion of another or his private affairs or concerns, is subject to liability to the other for invasion of his privacy, if the intrusion would be highly offensive to a reasonable person."[275] AI applications generate uncertainty regarding the recourse available to citizens when these technologies intrude on their privacy.

Scholars in the systematic review foresee a future where AI-powered applications can encroach on consumers who do not explicitly agree to their terms of service or invite them into their private affairs.[276] They have thought of scenarios where home robots or drones are able to autonomously gather information, surveil the population, and share it with other parties instantaneously. The collection of data (e.g. audio, video, or other forms) through walls or over the air could pose a privacy threat to the point of committing the tort of intrusion upon seclusion.[277]

States like California have explicit administrative remedies against such scenarios and affected parties may also be entitled to self-help remedies, or actions that enforce one's rights without the assistance of a public authority.[278,279] Under the self-help remedy, individuals can do

[273] Harkness, ELDER LJ, (2014).
[274] State of California, Confidentiality of Medical Information Act (2013);Terry, UMKC L. REV., (2012).
[275] Restatement (Second) of Torts § 652 (American Law Institute 1977).
[276] A Michael Froomkin & P Zak Colangelo, *Self-Defense Against Robots and Drones*, 48 CONN. L. REV. (2015);Kaminski, IDAHO L. REV., (2014).
[277] DMLP, *Elements of an Intrusion Claim*(2019), *available at* http://www.dmlp.org/legal-guide/elements-intrusion-claim;Kaminski, et al., MD. L. REV., (2016).
[278] California Civil Code, §1708.8(b) (2015);Kaminski, IDAHO L. REV., (2014);Froomkin & Colangelo, CONN. L. REV., (2015).
[279] (b) "A person is liable for constructive invasion of privacy when the person attempts to capture, in a manner that is offensive to a reasonable person, any type of visual image, sound recording, or other physical impression of the plaintiff engaging in a private, personal, or familial activity, through the use of any device, regardless of whether

everything in their power to prevent the occurrence of a harm (i.e. protect their privacy), including the interference or destruction of the AI application. But because it may be impossible for an individual to distinguish the capabilities or purpose of an AI-powered device (e.g. drone), its intrusion on a person's privacy would make it reasonable to assume that information will be gathered and transmitted to third parties. If this were the case, the damage to that person could be immediate and any legal recourse would not only take time, but may not resolve the harms caused.

The uncertainty regulatory gap in this scenario concerns the reasonableness of having a person act against an apparent violation of their privacy. On one hand, individuals have a right to protect themselves from irreparable harms due to the invasion of their privacy and the distribution of information that cannot be contained. On the other, empowering people to assert their privacy via self-help remedies could provoke negative consequences that break other regulations.[280] It creates an incentive to damage what could be authorized government surveillance. Individuals that engage in self-help remedies may also pose a risk to the safety of third parties if the destruction of an information-gathering AI application generated damage to people or property.

4.1.5 Consumer Manipulation

With unknown quantities of data on the history of consumer preferences and behavior available, AI applications detect patterns that would be impossible to discern otherwise. Researchers have hypothesized that a sufficiently detailed database on an individual could be used to nudge their decision-making to the benefit of an entity's interests.[281] Current regulations at the federal level already offer protection against businesses that knowingly manipulate consumers. In this respect, AI generates a regulatory gap of obsolescence as it reduces the ability of authorities to enforce laws that protect consumer autonomy.

The Federal Trade Commission (FTC) is the entity charged with acting against unfair business practices.[282] Section 5 of the FTC Act clarifies that a practice needs to create substantial injury, must not be reasonably avoidable, or must not be outweighed by countervailing benefits to consumers or competition.[283] The issue with applying this statute in the age of AI is that to identify this offense, authorities must distinguish between an independent versus a dependent decision. This can be extremely difficult if a consumer is oblivious to the control of their choices, potentially making Section 5 unenforceable.

At the moment, there are several vectors in which AI constrains autonomy in one way or another. The personalization of search results is one of them. Firms that provide this service purposefully

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there is a physical trespass, if this image, sound recording, or other physical impression could not have been achieved without a trespass unless the device was used" Code. 2015.

[280] Froomkin & Colangelo, CONN. L. REV., (2015).

[281] Matt Chessen, The MADCOM Future (The Atlantic Council 2017);Woodrow Hartzog, *Unfair and deceptive robots*, 74 MD. L. REV. (2014);Brittainy Cavender, *The Personalization Puzzle*, 10 WASH. U. JURISPRUDENCE REV. (2017).

[282] Hartzog, MD. L. REV., (2014);Thierer, (2015);Simshaw, et al., RICH. JL & TECH., (2015).

[283] Federal Trade Commission, *FTC Policy Statement on Unfairness*(1980), *available at* https://www.ftc.gov/public-statements/1980/12/ftc-policy-statement-unfairness;Federal Trade Commission, *Federal Trade Commission Act Section 5: Unfair or Deceptive Acts or Practices*, FTC(2016), *available at* https://www.federalreserve.gov/boarddocs/supmanual/cch/ftca.pdf;Brill & Jones, AM. UL REV., (2016).

censor search results based on the profile of users to improve their relevance.[284] In the long-term, this may lead to an "autonomy trap."[285] As users continue to provide firms with information, their search queries will become ever-more tailored to their tastes. At the end of this cycle, firms gain the capability of constraining the information individuals are exposed to and, in some respects, narrow their decision-making capability.

The manipulation of search results is protected by the First Amendment, much like the work of editors and publishers.[286] Nevertheless, the limits of autonomy in this marketplace are buttressed by the lack of transparency in the profiling of consumers.[287] Users are unaware of the variables used to tailor search results and their reliance on these services inevitably blocks them from accessing sites that are incompatible with their profile.

Similar to search engines, social media interfaces can target users according to their disposition. Recent findings evince the use of data to target populations for the purpose of manipulating their intention to vote during elections.[288] In effect, communication tools can be used to dominate the online conversation and manipulate opinions on an issue.[289]

The proliferation of AI-based home robots can become another vector for manipulation. They differentiate themselves from search engines in that, in addition to compiling data on users, they are able to form social relationships. These bonds can mislead individuals (including vulnerable populations such as children or the elderly) by anthropomorphizing these products into significant social relationships that open the door for firms to emotionally exploit human decision-making.[290]

[284] Cavender, WASH. U. JURISPRUDENCE REV., (2017).
[285] Tal Z Zarsky, *Mine your own business: making the case for the implications of the data mining of personal information in the forum of public opinion*, 5 YALE JL & TECH. (2002).
[286] Cavender, WASH. U. JURISPRUDENCE REV., (2017).
[287] Oren Bracha & Frank Pasquale, *Federal Search Commission-Access, Fairness, and Accountability in the Law of Search*, 93 CORNELL L. REV. (2007).
[288] David Levine, *Confidentiality Creep and Opportunistic Privacy*, (2017).
[289] Chessen. 2017.
[290] Kaminski, et al., MD. L. REV., (2016);Woodrow Hartzog, *Unfair and deceptive robots*, 74 see id. at Cited Pages|. (2014).

4.2 Use of Force

Autonomous weapon systems (AWS) complement or substitute human decision-making in battlefield scenarios. Their incorporation into the inventory of armed forces has the power to alter the calculus of war.[291] These applications of AI are able to reduce an army's exposure to chemical or biological weapons, eliminate the concern for a soldier's self-preservation instinct, and replace human judgement in the selection and engagement of targets.[292] The U.S. is a leading developer of weapons and the first government to adopt an AWS definition.[293] Because of these reasons, 2010-2020 represent a decade where debate on the future of AWS has come to the fore.[294]

The use of force section examines seven regulatory gaps related to AWS (see Table 16). The first six relate to nation-to-nation combat. The governance of battlefield weaponry is a global affair discussed through multilateral channels. As a major player, the position of the U.S. has significant ramifications on other stakeholders. The analysis begins with the uncertainty of whether AWS exist. Governments and non-governmental organizations throughout the world have conflicting views on what constitutes an AWS. On one end of the spectrum, these weapons have yet to be created. On the other, militaries have manufactured, inventoried, and utilized these systems for over 30 years. The lack of a shared understanding of this technology's characteristics hampers its governance and fuels uncertainty.

Table 16 - Regulatory Gaps in Use of Force

Issue	Regulatory Gap	Type of Gaps	Government Level	Time Frame	Type of AI
Defining AWS	Confirming their Existence	Uncertainty	Federal	Present	Application
Meaningful Human Control	Interaction Between Human and AWS	Uncertainty	Federal	Present	Application
Accountability	Foreseeability of Illegal Acts	Novelty	Federal	Present	Application
Legality of AWS	Distinction	Targeting (Under)	Federal	Present	Application
	Proportionality	Targeting (Under)	Federal	Present	Application
	Humanity	Targeting (Under)	Federal	Present	Application
Domestic Use of Force	Second Amendment and AWS	Uncertainty	Federal + State + Local	Future	Application

The next gap examines the conflicting standards sought by governments at the multilateral level to keep humans in control of AWS decision-making. To date, the positions of stakeholders under the banner of meaningful human control and its variants are subject to disagreement and prone

[291] Heather M Roff, *Lethal autonomous weapons and jus ad bellum proportionality*, 47 CASE W. RES. J. INT'L L. (2015).
[292] Michael N Schmitt & Jeffrey S Thurnher, *Out of the loop: autonomous weapon systems and the law of armed conflict*, 4 HARV. NAT'L SEC. J. (2012);Jeroen van den Boogaard, *Proportionality and Autonomous Weapons Systems*, 6 JOURNAL OF INTERNATIONAL HUMANITARIAN LEGAL STUDIES (2015);John O McGinnis, *Accelerating AI*, 104 NW. UL REV. (2010).
[293] Campaign to Stop Killer Robots, *New US policy*(2013), *available at* https://www.stopkillerrobots.org/2013/04/new-us-policy/;DOD, Directive 3000.09 (DOD 2012).
[294] Mia Gandenberger, *CCW adopts mandate to discuss killer robots*, Reaching Critical Will(2014), *available at* http://reachingcriticalwill.org/news/latest-news/8583-ccw-adopts-mandate-to-discuss-killer-robots.

to inconsistent application, leading to the regulatory gap of uncertainty. As a result, no global standard outlines the relationship between a member of the armed forces and AWS.

The foreseeability of illegal acts issue deals with the indirect accountability of commanders and manufacturers for an AWS.[295] The regulatory gap of novelty found in this literature is caused by the absence of standards to determine the responsibility for the potentially unpredictable decision-making of this technology.[296] Policymakers need to address this problem to avoid having AWS be used as a scapegoat in the commitment of atrocities.[297]

The next three regulatory gaps concentrate on the legality of AWS decision-making. The rules and conditions for conducting warfare are encapsulated under the umbrella of the Law of Armed Conflict (LOAC) (also referred to as the Law of War or International Humanitarian Law).[298] They were conceived in an era where only humans decided whether to target and kill people. The advent of AWS allows non-humans to make these choices and, because of this, the LOAC suffers from a regulatory gap of targeting (under-inclusion).

The last regulatory gap moves away from nation-to-nation conflict and delves into domestic policy. The Second Amendment of the Constitution entitles individuals to bear arms. Its application to AWS generates the regulatory gap of uncertainty due to the conflicting views of how the judicial and executive branches will interpret the right to carry and use them.

4.2.1 Existence of AWS

Through DOD directive 3000.09, the U.S. became the first government to adopt a definition for AWS.[299,300] Since then, many entities have developed their own definition to describe the characteristics of this application. The diversity of views on this issue has prevented multilateral agreement on the role of AWS in the future of war. The following paragraphs present the conflicting perspectives on what weapons, if any, fit under the AWS umbrella, fueling the regulatory gap of uncertainty.

The regulation of battlefield weaponry is a global affair discussed through multilateral channels. The U.S. is a leading developer of weapons and the first government to adopt an AWS definition.[301] As a major player, its position has significant ramifications on the views of governments, non-profits, and researchers. Although players in this field have their own definition of AWS (employing terms like automatic, semi-autonomous and autonomous) these

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[295] Eric Talbot Jensen, *The Future of the Law of Armed Conflict: Ostriches, Butterflies, and Nanobots*, 35 MICH. J. INT'L L. (2013).

[296] Thompson Chengeta, *Accountability Gap: Autonomous Weapon Systems and Modes of Responsibility in International Law*, 45 DENV. J. INT'L L. & POL'Y (2016);Christopher M Ford, *Autonomous Weapons and International Law*, (2017);Ryan Jenkins, *Averting the Moral Free-for-All of Autonomous Weapons*, 41 FLETCHER F. WORLD AFF. (2017).

[297] Mark Gubrud, *Stopping killer robots*, 70 BULLETIN OF THE ATOMIC SCIENTISTS (2014).

[298] Rebecca Crootof, *War Torts: Accountability for Autonomous Weapons*, 164 U. PA. L. REV. (2015).

[299] Campaign to Stop Killer Robots. 2013;DOD. 2012.

[300] The definition states that an AWS is: "a weapon system that, once activated, can select and engage targets without further intervention by a human operator. This includes human-supervised autonomous weapon systems that are designed to allow human operators to override operation of the weapon system, but can select and engage targets without further human input after activation" DOD. 2012.

[301] Campaign to Stop Killer Robots. 2013;DOD. 2012.

weapons can be classified via four attributes (Appendix 7 contains a selection of definitions and **Table 17** contains a sample of classifications):

- **Human interaction:** participation of humans in the tasks of an AWS. In theory, the more a system requires an operator to function, the less it can autonomously complete a mission.[302]
- **Adaptability:** flexibility to act in unforeseen circumstances. An autonomous system should cope with scenarios that are not pre-programmed.[303]
- **Discretion:** degree to which an AWS can make decisions. Specifically, to complete a mission, it should have the independence to alter its operating parameters to achieve a goal.[304]
- **In what phase does autonomy take place:** differentiates the parts of the decision-making process where a human cedes control to an AWS with respect to battlefield decision-making. The OODA loop is a useful reference for this attribute. OODA was developed to divide battlefield operations into a four-step process.[305] In it, individuals **Observe** and gather data about the world, **Orient** themselves by interpreting this information, **Decide** a course of action based on the knowledge obtained, and then **Act** on their decision.[306] Definitions vary as to what part of the loop is most relevant for an AWS. Some believe that the stages where lethal actions take place should become the threshold for classifying an AWS (deciding and acting), many are agnostic as to which step in the loop is controlled by a machine, while others believe autonomy is required in the entire process.

As of 2019, a global consensus on what constitutes an AWS has yet to emerge. There are two camps in this debate. One argues that AWS do not exist. They believe that all weapons within military caches are under the control of humans. The other side disagrees, they state that AWS operate throughout the world and point out that weapon systems within many arsenals already comply with the definition of an AWS. The following sub-sections contrast views on the existence of AWS that lead to a regulatory gap of uncertainty.

[302] William C Marra & Sonia K McNeil, *Understanding the Loop: Regulating the Next Generation of War Machines*, 36 HARV. JL & PUB. POL'Y (2013).
[303] Id. at.
[304] Id. at.
[305] John Boyd, Destruction & Creation (1976);Marra & McNeil, HARV. JL & PUB. POL'Y, (2013).
[306] Marra & McNeil, HARV. JL & PUB. POL'Y, (2013).

Table 17 - A Selection of AWS Classifications

U.S. DOD	U.K. MOD	HRW	Crootof (2014)	Beard (2013)	Ford (2017)	AFRL
Autonomous weapon system	Autonomous system	Human-out-of- the- loop	Autonomous combatant systems	AWS	Fully automated	Fully autonomous
Semi-autonomous weapon system	Automated system	Human-on-the-loop	Autonomous defense system	Semi-AWS	Largely automated	Battlespace cognizance
		Human-in-the-loop	Fire and forget	Automated	Automated in many functions	Battlespace knowledge
			Autonomous combatant systems	Inert weapon	Little to no automation	Real time multi-vehicle cooperation
						Real time multi-vehicle coordination
						Fault/event adaptive vehicle
						Robust response to real time faults/events
						Changeable mission
						Execute preplanned mission
						Remotely piloted vehicle

4.2.1.1 AWS Do Not Exist

Several factors contribute to the belief that AWS do not exist. One is the idea that humans have not relinquished control over the lethal functions of any weapons in contemporary inventories.[307] Essentially, this refers to the Act step in the OODA loop. The position of the U.S. (stated in its DOD directive and communicated in international fora) is that AWS are "potential future systems and not existing weapon systems using some form of autonomy."[308] Outside of government, Human Rights Watch (HRW) agrees with this position. Their stance is that "humans retain control over the decision to use lethal force" in all existing systems; therefore, rather than considering existing weapons autonomous, HRW labels them as automatic.[309]

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[307] Merel AC Ekelhof, *Complications of a common language: why it is so hard to talk about autonomous weapons*, 22 JOURNAL OF CONFLICT AND SECURITY LAW (2017);Kelly Cass, *Autonomous Weapons and Accountability: Seeking Solutions in the Law of War*, 48 LOY. LAL REV. (2014).

[308] Michael W. Meier, *The Concention on Certain Conventional Weapons (CCW) Informal Meeting of Experts on Lethal Autonomous Weapons Systems*(2016), *available at* http://www.reachingcriticalwill.org/images/documents/Disarmament-fora/ccw/2016/meeting-experts-laws/statements/12April_USA.pdf;Michael W. Meier, *The Concention on Certain Conventional Weapons (CCW) Informal Meeting of Experts on Lethal Autonomous Weapons Systems*(2016), *available at* http://www.reachingcriticalwill.org/images/documents/Disarmament-fora/ccw/2016/meeting-experts-laws/statements/11April_UnitedStates.pdf;Michael W. Meier, *The Concention on Certain Conventional Weapons (CCW) Informal Meeting of Experts on Lethal Autonomous Weapons Systems*(2015), *available at* http://reachingcriticalwill.org/images/documents/Disarmament-fora/ccw/2015/meeting-experts-laws/statements/13April_US.pdf;Ian McKay, *The Concention on Certain Conventional Weapons (CCW) Informal Meeting of Experts on Lethal Autonomous Weapons Systems*(2018), *available at* http://reachingcriticalwill.org/images/documents/Disarmament-fora/ccw/2018/gge/statements/9April_US.pdf;DOD. 2012;Christof Heyns, *Report of the Special Rapporteur on extrajudicial, summary or arbitrary executions*, General Assembly of the United Nations(2013), *available at* https://www.ohchr.org/Documents/HRBodies/HRCouncil/RegularSession/Session23/A-HRC-23-47_en.pdf.

[309] Bonnie Docherty, *Losing Humanity: The Case against Killer Robots* HRW IHRC(2012), *available at* https://www.hrw.org/sites/default/files/reports/arms1112ForUpload_0_0.pdf.

Another reason used to invalidate a weapon's AWS classification is its defensive nature. The intuition of parties arguing this point is that these systems are stationary, work in relatively controlled environments, and perform their duties under set parameters. The U.S. concurs with this view and has explicitly excluded defensive weapons systems (e.g. Patriot and AEGIS) from consideration of AWS status.[310] Cass, Sauer, and Heyns also agree that weapons performing defensive maneuvers without human intervention (e.g. Phalanx) should be considered automatic rather than autonomous.[311,312]

Weapons systems are further excluded from an autonomous classification by establishing a high bar for what qualifies as such. Ford and Chengeta believe that an AWS must perform most or every step of the OODA loop without human intervention.[313] Concretely, these weapon systems should move in "dynamic, unstructured, open environments" in potentially unpredictable ways to "identify, search, track, and decide who to kill without human assistance or intervention once they are activated."[314]

In the same spirit, Noone and Noone and the U.K.'s Ministry of Defense (MOD) have a futuristic AWS standards where a weapon should perform the OODA loop in a manner similar to or better than humans.[315] These weapons should be "cognizant of possible harmful consequences of its actions" and convert data to "knowledge" so as to make an appropriate decision.[316] They also need to be "capable of understanding higher level intent and direction", be "self-aware", and achieve "the same level of situational understanding as a human."[317]

4.2.1.1.1 Exclusion of cyberweapons

Cyberweapons with autonomous capabilities are electronic variants of AWS.[318] Some scholars purposefully exclude these systems from AWS debates. One reason cited is their non-kinetic nature. They point out that AWS should be limited to weapons that directly cause physical damage, whereas cyberweapons only do so indirectly.[319] This is troubling considering that cyber-

[310] Meier, The Concention on Certain Conventional Weapons (CCW) Informal Meeting of Experts on Lethal Autonomous Weapons Systems. 2016;Meier, The Concention on Certain Conventional Weapons (CCW) Informal Meeting of Experts on Lethal Autonomous Weapons Systems. 2016.

[311] As with the term autonomous, the concept of denoting a weapon system as automatic is subject to interpretation. Heyns (2013) describes automatic as a system that "functions in a predictable way within a predictable environment". Other authors and organizations, as can be seen in Table 2, have their own view of what distinguishes an autonomous vs. automatic weapon system.

[312] Cass, LOY. LAL REV., (2014);Frank Sauer, *Stopping'Killer Robots': Why Now Is the Time to Ban Autonomous Weapons Systems*, 46 ARMS CONTROL TODAY (2016);Heyns. 2013.

[313] Ford, (2017);Thompson Chengeta, *Defining the Emerging Notion of Meaningful Human Control in Weapon Systems*, 49 NYUJ INT'L L. & POL. (2016).

[314] Chengeta, NYUJ INT'L L. & POL., (2016);Ford, (2017);Sauer, ARMS CONTROL TODAY, (2016);Heyns. 2013.

[315] Gregory P Noone & Diana C Noone, *The debate over autonomous weapons systems*, 47 CASE W. RES. J. INT'L L. (2015);MOD, *THE UK APPROACH TO UNMANNED AIRCRAFT SYSTEMS* (2011), *available at* https://www.law.upenn.edu/live/files/3890-uk-ministry-of-defense-joint-doctrine-note-211-the.

[316] Noone & Noone, CASE W. RES. J. INT'L L., (2015).

[317] MOD. 2011.

[318] Christopher M Kovach, *Beyond Skynet: reconciling increased autonomy in computer-based weapons systems with the laws of war*, 71 AFL REV. (2014).

[319] Kenneth Anderson, *Why the Hurry to Regulate Autonomous Weapon Systems-But Not Cyber-Weapons*, 30 TEMP. INT'L & COMP. LJ (2016).

based AWS attacks could have more impact than their kinetic counterparts by generating an "information environment [that] devolves into a morass of manipulative machine-driven speech."[320]

The classification of cyberweapons as AWS is seen by some as incorrect due the belief that software autonomy cannot be achieved. One author expresses that actions performed by computer programs are the result of "conscious design or programmer oversight…autonomy in cyberweapons seems something of a misnomer."[321] Finally, some parties exclude these systems without providing an explanation. This is the case for U.S. policy, which dismisses cyberweapons in its DOD directive and, as the first government to make this distinction, its position influences other parties.[322,323]

There is no consensus on the reasons to exclude cyberweapons from an AWS designation. Conflicting viewpoints add to the uncertainty for justifying their relegation from the international debate to regulate these tools of war.

4.2.1.2 AWS Exist

To maintain that AWS exist is to accept that machines have been given decision-making power in the battlefield. One side of this argument sets a low bar for what classifies as autonomous. Asaro defines AWS as "any automated system that can initiate lethal force without the specific, conscious, and deliberate decision of a human operator, controller, or supervisor."[324] Gubrud believes that "a system is autonomous if it is operating without further human intervention."[325] The shortcoming of these views is their inclusivity. Relying on them qualifies a wide spectrum of weapons as AWS including spring guns, landmines, sophisticated drones (e.g. Predator), and yet to-be-developed technologies such as sentient killer robots.[326]

The position of the International Committee of the Red Cross (ICRC) is more restrictive as to what weapons can be considered autonomous. Although this institution shares a similar definition of AWS with the DOD, they recognize that autonomy is present in the critical functions of existing weapon systems.[327, 328] To prove this, they cite over 40 examples of AWS in categories such as:

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[320] Chessen. 2017.

[321] Kovach, AFL REV., (2014).

[322] Duncan B Hollis, *Setting the Stage: Autonomous Legal Reasoning in International Humanitarian Law*, 30 TEMP. INT'L & COMP. LJ (2016);DOD. 2012.

[323] "Does not apply to autonomous or semi-autonomous cyberspace systems for cyberspace operations; unarmed, unmanned platforms; unguided munitions; munitions manually guided by the operator (e.g., laser- or wire-guided munitions); mines; or unexploded explosive ordnance." DOD. 2012.

[324] Peter Asaro, *On banning autonomous weapon systems: human rights, automation, and the dehumanization of lethal decision-making*, 94 INTERNATIONAL REVIEW OF THE RED CROSS (2012).

[325] Gubrud, BULLETIN OF THE ATOMIC SCIENTISTS, (2014).

[326] Rebecca Crootof, *The Killer Robots Are Here: Legal and Policy Implications*, 36 CARDOZO L. REV. (2014).

[327] Ekelhof, JOURNAL OF CONFLICT AND SECURITY LAW, (2017).

[328] *"Any weapon system with autonomy in its critical functions—that is, a weapon system that can select (search for, detect, identify, track or select) and attack (use force against, neutralize, damage or destroy) targets without human intervention" Neil Davison, Autonomous weapon systems under international humanitarian law, INTERNATIONAL COMMITTEE OF THE RED CROSS(2018), available at https://www.icrc.org/en/document/autonomous-weapon-systems-under-international-humanitarian-law.*

missile and rocket defense, anti-personnel sentry, sensor-fused munitions, missiles and loitering munitions, torpedoes, and encapsulated torpedo mines.[329]

According to researchers, over thirty countries have stocked AWS able to select and engage targets without human supervision for over thirty years.[330] In effect, they agree with the ICRC, in that these systems not only exist, but are prevalent. They refer to a number of examples:

- The Aegis is incorporated in over 70 ships and can identify and eliminate threats. It has a casualty mode where it assumes that human operators are unavailable and can perform tasks independently.[331]
- The Phalanx is a Gatling gun that, according to the Navy, "autonomously perform[s] its own search, detect, evaluation, track, engage and kill assessment functions."[332] While it is engaged, humans have veto power. However, they must exercise it at such high speeds that it may limit their judgement of the circumstances.[333]
- Israel's Harpy can patrol an area until it detects an enemy radar installation and independently destroy it.[334] When launched, the officer charged with monitoring the device will not be informed on the selected target, but knows that only those that meet its criteria will be engaged.[335] A variant, the Harpy-2, hunts UAV by self-destructing at contact.[336]
- South Korea's SGR-Ai surveilles the demilitarized zone and can operate autonomously in the selection and engagement of targets without human intervention.[337]

Part of the literature accepting the existence of AWS is dedicated to criticizing the positions of government and non-government entities who maintain that these tools cannot be classified as autonomous. For instance, Crootof (2014) declares that the U.K.'s MOD definition is unrealistic. She maintains that the standard set by this government describes a technology probably decades away from production.

Jenks disagrees with HRW and the UN. HRW divides weapons into three groups (see Appendix 7) and AWS are designated as those where humans are out-of-the-loop or, in some cases, on-the-

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[329] ICRC, *AUTONOMOUS WEAPON SYSTEMS*, ICRC(2016), *available at* https://shop.icrc.org/autonomous-weapon-systems.html?___store=default;ICRC, *Views of the International Committee of the Red Cross (ICRC) on autonomous weapon system* ICRC(2016), *available at* https://www.icrc.org/en/document/views-icrc-autonomous-weapon-system.

[330] Chris Jenks, *False Rubicons, Moral Panic, & Conceptual Cul-De-Sacs: Critiquing & Reframing the Call to Ban Lethal Autonomous Weapons*, 44 PEPP. L. REV. (2016).

[331] Crootof, CARDOZO L. REV., (2014);Crootof, U. PA. L. REV., (2015);Joel Hood, *The Equilibrium of Violence: Accountability in the age of autonomous weapons systems*, 11 INT'L L. & MGMT. REV. (2015).

[332] Navy, *MK 15 - PHALANX CLOSE-IN WEAPONS SYSTEM (CIWS)*(2019), *available at* https://www.public.navy.mil/surfor/Pages/Phalanx-CIWS.aspx;Ekelhof, JOURNAL OF CONFLICT AND SECURITY LAW, (2017).

[333] Jack M Beard, *Autonomous weapons and human responsibilities*, 45 GEO. J. INT'L L. (2013).

[334] Vivek Sehrawat, *Autonomous weapon system: Law of armed conflict (LOAC) and other legal challenges*, 33 COMPUTER LAW & SECURITY REVIEW (2017).

[335] Paul Scharre, Autonomy, "Killer Robots," and Human Control in the Use of Force – Part I (Just Security 2014).

[336] Beard, GEO. J. INT'L L., (2013).

[337] Crootof, U. PA. L. REV., (2015).

loop, but with such limited human supervision that oversight is virtually absent.[338] The author believes that this taxonomy fails as an effective means to identify AWS because it does not provide sufficient information to classify existing weapons systems. For instance, the "limited" supervision standard is not quantified, which makes it difficult to recognize what weapons are in fact AWS. In addition, HRW excludes defensive systems from their taxonomy.[339] According to Jenks, not doing so would require recognizing that a number of systems already qualify as AWS.[340]

Jenks continues by rebutting how the UN differentiates between autonomous and automatic weapons.[341] The UN contends that automatic weapons operate only in structured and controlled environments (they even compare them to "household appliances") and cites several systems as examples, among them the Phalanx.[342] The only system it recognizes as autonomous is Israel's Harpy. Jenks believes that the exclusion of these systems is unwarranted.[343] He states that, not only are these weapons autonomous, considering their characteristics, but they have been used in active war zones, many of which would not be described by participants as structured or predictable.[344]

4.2.2 Meaningful Human Control

The principle that a human decides whether another lives plays a fundamental role in multilateral discussions of AWS.[345] Member states of the United Nations convened in 2013, under the auspices of the Convention on Certain Conventional Weapons, to discuss this subject through several lens: meaningful human control, appropriate levels of human judgement, and intelligent partnership.[346] Their objective was to create a standard that holds humans responsible over the decisions made by this technology.[347] Unfortunately, competing proposals have catalyzed a regulatory gap of uncertainty since it is unknown which standard will prevail.

Under the umbrella of meaningful human control, a continuum of benchmarks is proposed by researchers and advocates (see Appendix 8). [348] In all of them parties can interpret the human

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[338] Docherty. 2012;Jenks, PEPP. L. REV., (2016).
[339] Docherty. 2012.
[340] Jenks, PEPP. L. REV., (2016).
[341] Id. at.
[342] Heyns. 2013.
[343] Jenks, PEPP. L. REV., (2016).
[344] Id. at.
[345] Crootof, CARDOZO L. REV., (2014);George R Lucas Jr, *Automated warfare*, 25 STAN. L. & POL'Y REV. (2014).
[346] Chengeta, NYUJ INT'L L. & POL., (2016);Ekelhof, JOURNAL OF CONFLICT AND SECURITY LAW, (2017);UNOG, *Background on Lethal Autonomous Weapons Systems in the CCW*(2019), *available at* https://www.unog.ch/80256EE600585943/(httpPages)/8FA3C2562A60FF81C1257CE600393DF6?OpenDocument;Tetyana Krupiy, *Of souls, spirits and ghosts: transposing the application of the rules of targeting to lethal autonomous robots*, 16 MELB. J. INT'L L. (2015).
[347] Jenkins, FLETCHER F. WORLD AFF., (2017).
[348] Paul Scharre, *Centaur Warfighting: The False Choice of Humans vs. Automation*, 30 TEMP. INT'L & COMP. LJ (2016);ICRAC, ICRAC statement on technical issues to the 2014 UN CCW Expert Meeting (ICRAC 2014);Article 36, *Key elements of meaningful human control*(2016), *available at* http://www.article36.org/wp-content/uploads/2016/04/MHC-2016-FINAL.pdf;Michael C. Horowitz & Paul Scharre, *MEANINGFUL HUMAN CONTROL in WEAPON SYSTEMS: A Primer*, Center for a New American Security (2015), *available at* https://s3.amazonaws.com/files.cnas.org/documents/Ethical_Autonomy_Working_Paper_031315.pdf?mtime=20160906082316.

role in the decision-making process of an AWS differently.[349] One could require that all actions are human-approved. Another may focus on human supervisors with veto power over decisions. A third could trust the restrictions placed by a programmer as sufficient to control an AI agent. As is apparent, no consensus exists on how to implement meaningful human control.

The U.S. has expressed that meaningful human control is a subjective term that lacks clear meaning.[350] Instead, all autonomous and semi-autonomous systems within its inventory should follow an "appropriate levels of human judgement" standard.[351] By advocating this position, the U.S. military believes that AWS can perform its duties without the need for human supervision.[352] However, applying appropriate levels of human judgement is not straightforward. The absence of a definition for "appropriate" generates uncertainty as to how the military will use AWS.[353] For any given engagement, it is unclear what level of human attention and/or inputs are required prior, during, and subsequent to an attack.[354]

Regardless of how much control humans are given over AWS, the training of armed forces personnel can make a difference in guaranteeing that these weapons are used legally.[355] A well-trained operator is more likely to evaluate their alternatives to avoid a violation of an LOAC, while a poorly-trained one can rubberstamp its decisions even if there is evidence of errors (known as automation bias).[356]

It is clear that for the foreseeable future the activation of an AWS will begin with a human.[357] Once activated, this technology can perform a vast number of autonomous operations within its

[349] Rebecca Crootof, *A Meaningful Floor for Meaningful Human Control*, 30 TEMP. INT'L & COMP. LJ (2016).

[350] Michael W. Meier, *U.S. Supports Continued Substantive Discussion of LAWS in the CCW*, U.S. Mission to International Organizations in Geneva(2016), *available at* https://geneva.usmission.gov/2016/04/11/laws/;Ford, (2017).

[351] DOD. 2012;Jenkins, FLETCHER F. WORLD AFF., (2017);Dan Saxon, *A Human Touch: Autonomous Weapons, Directive 3000.09, and the" Appropriate Levels of Human Judgment over the Use of Force"*, 15 GEORGETOWN JOURNAL OF INTERNATIONAL AFFAIRS (2014).

[352] Gubrud, BULLETIN OF THE ATOMIC SCIENTISTS, (2014).

[353] Id. at.

[354] Saxon, GEORGETOWN JOURNAL OF INTERNATIONAL AFFAIRS, (2014).

[355] Alan L Schuller, *At the Crossroads of Control: The Intersection of Artificial Intelligence in Autonomous Weapon Systems with International Humanitarian Law*, 8 HARV. NAT'L SEC. J. (2017);Chengeta, DENV. J. INT'L L. & POL'Y, (2016);Jody M Prescott, *Building the Ethical Cyber Commander and the Law of Armed Conflict*, 40 RUTGERS COMPUTER & TECH. LJ (2014);Markus Wagner, *The dehumanization of international humanitarian law: Legal, ethical, and political implications of autonomous weapon systems*, 47 VAND. J. TRANSNAT'L L. (2014);Charles J Dunlap, *Accountability and Autonomous Weapons: Much Ado about Nothing*, 30 TEMP. INT'L & COMP. LJ (2016);Beard, GEO. J. INT'L L., (2013);Gubrud, BULLETIN OF THE ATOMIC SCIENTISTS, (2014).

[356] Crootof, TEMP. INT'L & COMP. LJ, (2016);Shane Harris, *Autonomous Weapons and International Humanitarian Law or Killer Robots are Here: Get Used to It*, see id. at Cited Pages|;Schuller, HARV. NAT'L SEC. J., (2017).

[357] Nathan Reitinger, *Algorithmic Choice and Superior Responsibility: Closing the Gap between Liability and Lethal Autonomy by Defining the Line between Actors and Tools*, 51 GONZ. L. REV. (2015);Schmitt & Thurnher, HARV. NAT'L SEC. J., (2012);DOD, FY2009–2034 Unmanned Systems Integrated Roadmap (DOD 2009);Schuller, HARV. NAT'L SEC. J., (2017);Cass, LOY. LAL REV., (2014);Hood, INT'L L. & MGMT. REV., (2015).

OODA loop.[358] Without human supervision, many stakeholders believe AWS will "lack moral autonomy" to understand the consequences of their participation in warfare.[359]

For AWS to reliably and consistently make a determination on the legality of its actions (known as the Arkin test), policymakers should specify which one of these loops fall under human responsibility, when can decisions be made independently, what level of unpredictability is acceptable, and how do these standards apply to cyber AWS.[360] Until this moment arrives, the implementation of different standards to guide the interaction between humans and AWS will not only reflect a country's values, but it may force them to choose between compliance to these standards and the potential safety of their personnel.[361]

4.2.3 Foreseeability of Illegal Acts

Releasing an AWS into the battlefield generates questions as to what entity is responsible for breaking the LOAC.[362] Regulatory gaps are not found when a party intentionally commits an illegal act using this technology. Prosecuting this crime would be no different from any other. A regulatory gap of novelty is found in the absence of standards to determine the indirect responsibility for using an AWS.[363] In other words, to what extent should parties be accountable for its unforeseeable behavior?

The policies for holding individuals liable for LOAC infringement fall under the umbrella of command responsibility.[364] The U.S. is not party to international treaties on command responsibility, such as Article 28 of the Rome Statute of the International Criminal Court (ICC) or the Additional Protocols of the Geneva Convention.[365] Nevertheless, the ICRC has identified that U.S. armed forces manuals and legislation assign command responsibility for violations of the LOAC that are similar to international law; hence, the country is bound to it by customary law.[366]

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[358] Chantal Grut, *The challenge of autonomous lethal robotics to International Humanitarian Law*, 18 JOURNAL OF CONFLICT AND SECURITY LAW (2013);Beard, GEO. J. INT'L L., (2013);Amos N Guiora, *Accountability and Decision Making an Autonomous Warfare: Who Is Responsible*, UTAH L. REV. (2017);Marra & McNeil, HARV. JL & PUB. POL'Y, (2013).

[359] Crootof, U. PA. L. REV., (2015);Aiden Warren & Alek Hillas, *Lethal Autonomous Weapons Systems: Adapting to the Future Unmanned Warfare and Unaccountable Robots*, 12 YALE J. INT'L AFF. (2017);Robert Sparrow, *Killer Robots*, 24 JOURNAL OF APPLIED PHILOSOPHY (2007);Chengeta, DENV. J. INT'L L. & POL'Y, (2016).

[360] Anderson, TEMP. INT'L & COMP. LJ, (2016);Rebecca Crootof, *A Meaningful Floor for Meaningful Human Control*, see id. at Cited Pages|;Ronald C. Arkin, et al., *An Ethical Governor for Constraining Lethal Action in an Autonomous System* Georgia Institute of Technologia(2009), *available at* https://www.cc.gatech.edu/ai/robot-lab/online-publications/GIT-GVU-09-02.pdf;Dunlap, TEMP. INT'L & COMP. LJ, (2016);Schuller, HARV. NAT'L SEC. J., (2017).

[361] Saxon, GEORGETOWN JOURNAL OF INTERNATIONAL AFFAIRS, (2014);Scharre, TEMP. INT'L & COMP. LJ, (2016);Gubrud, BULLETIN OF THE ATOMIC SCIENTISTS, (2014).

[362] Saxon, GEORGETOWN JOURNAL OF INTERNATIONAL AFFAIRS, (2014);Beard, GEO. J. INT'L L., (2013).

[363] Chengeta, DENV. J. INT'L L. & POL'Y, (2016);Ford, (2017);Jenkins, FLETCHER F. WORLD AFF., (2017).

[364] Jamie Allan Williamson, *Some considerations on command responsibility and criminal liability*(2008), *available at* https://www.icrc.org/en/doc/assets/files/other/irrc-870_williamson.pdf;ICC, Rome Statute of the International Criminal Court (ICC 1998);Prescott, RUTGERS COMPUTER & TECH. LJ, (2014).

[365] ICC. 1998;ICRC, Command responsibility and failure to act (ICRC 2014).

[366] ICRC, Practice Relating to Rule 149. Responsibility for Violations of International Humanitarian Law (ICRC 2018);ICRC, Practice Relating to Rule 151. Individual Responsibility (ICRC 2018);ICRC, Practice Relating to Rule 152. Command Responsibility for Orders to Commit War Crimes (ICRC 2018);ICRC, Practice Relating to Rule 153. Command Responsibility for Failure to Prevent, Punish or Report War Crimes (ICRC 2018).

In addition, directive 3000.09 on AWS states that "persons who authorize the use of, direct the use of, or operate autonomous and semiautonomous weapon systems must do so with appropriate care and in accordance with the law of war, applicable treaties, weapon system safety rules, and applicable rules of engagement."[367]

There are two forms of command responsibility: direct and indirect.[368] Direct responsibility exists when a commander issues an order to subordinates with the knowledge that an LOAC will be broken. In these cases, the U.S. recognizes that violation of the LOAC leads to punishment.[369] Among the offenses that can be charged are: "conspiracy, direct incitement, and attempts to commit, as well as complicity in the commission of, crimes against peace, crimes against humanity, and war crimes."[370]

Indirect command responsibility describes scenarios where a commander faces dereliction of duty. This means that they should have reasonably known if entities under their supervision would commit an illegal act and, because of neglect or culpable inefficiency, did not stop them. Even though a commander "did not act, did not order, and did not know the outcome of an event before it happened", they are still responsible for their actions.[371,372] Usage of AWS in battlefields generates a novelty regulatory gap because a standard that acknowledges the indirect command responsibility threshold for these unpredictable entities does not exist.[373]

Indirect responsibility may also apply to manufacturers of AWS.[374] Through the development of code, manufacturers lay the foundation for any future decision taken by an AWS and scholars

[367] DOD, Directive 3000.09. 2012.

[368] Reitinger, GONZ. L. REV., (2015);Crootof, U. PA. L. REV., (2015);Aaron Gevers, *Is Johnny Five Alive or Did It Short Circuit: Can and Should an Artificially Intelligent Machine Be Held Accountable in War Or Is It Merely a Weapon*, 12 RUTGERS JL & PUB. POL'Y (2014);Chengeta, DENV. J. INT'L L. & POL'Y, (2016);Ford, (2017);Cass, LOY. LAL REV., (2014);Kovach, AFL REV., (2014);Wagner, VAND. J. TRANSNAT'L L., (2014);Benjamin Kastan, *Autonomous Weapons Systems: A Coming Legal Singularity*, U. ILL. JL TECH. & POL'Y (2013);Dunlap, TEMP. INT'L & COMP. LJ, (2016);Noone & Noone, CASE W. RES. J. INT'L L., (2015);Beard, GEO. J. INT'L L., (2013);Grut, JOURNAL OF CONFLICT AND SECURITY LAW, (2013);John F Weaver, *abhor a vacuum: the Status of artificial Intelligence and aI drones under International law*, NH BAR J. (2013).

[369] Cass, LOY. LAL REV., (2014);ICRC, Practice Relating to Rule 151. Individual Responsibility. 2018;Weaver, NH BAR J., (2013).

[370] ICRC, Practice Relating to Rule 151. Individual Responsibility. 2018.

[371] Reitinger, GONZ. L. REV., (2015).

[372] Dereliction of duty is supported by various precedents such as the Rendulic rule: "a commander's liability is based on the information reasonably available at the time of the commander's decision" and a finding by the International Criminal Court of how information by commanders should alert them of inherent risks Ryan Dowdy, et al., *Law of Armed Conflict Deskbook* The Judge Advocate General's Legal Center and School(2015), *available at* http://www.loc.gov/rr/frd/Military_Law/pdf/LOAC-Deskbook-2015.pdf;Jason S DeSon, *Automating the Right Stuff-The Hidden Ramifications of Ensuring Autonomous Aerial Weapon Systems Comply with International Humanitarian Law*, 72 AFL REV. (2015);Prosecutor v. Pavle Strugar, Case No. IT-01-42-A Criminal Tribunal for the Former Yugoslavia (International Tribunal for the Prosecution of Persons Responsible for Serious Violations of International Humanitarian Law Committed in the Territory of the Former Yugoslavia since 1991 2008)..

[373] Wagner, VAND. J. TRANSNAT'L L., (2014);Docherty. 2012.

[374] Chengeta, DENV. J. INT'L L. & POL'Y, (2016);Gevers, RUTGERS JL & PUB. POL'Y, (2014);Kovach, AFL REV., (2014);Tim McFarland & Tim McCormack, *Mind the Gap: Can Developers of Autonomous Weapons Systems be Liable for War Crimes?*, 90 INTERNATIONAL LAW STUDIES/NAVAL WAR COLLEGE (2014);Wagner, VAND. J. TRANSNAT'L L., (2014);Paulius Čerka, et al., *Liability for damages caused by artificial intelligence*, 31 COMPUTER LAW & SECURITY REVIEW (2015).

propose charging them as facilitators to the commission of a crime via article 25 (c) of the Rome Statute.[375] In one interpretation of international law, the private sector can be prosecuted for "aiding and abetting" a crime even if they had no knowledge or coordinate how the armed forces used their products.[376,377] The challenge with holding manufacturers accountable for these charges mirrors that of indirect command responsibility.

For indirect responsibility to apply to either party (commanders or manufacturers), an entity should have reasonably known the outcome of an AWS behavior. In battlefields where this technology is present, the standards for what constitutes a reasonable warning of a machine's future behavior have not been created. This void generates a novelty regulatory gap where policymakers should create a standard considering the following questions:[378]

- If there is knowledge of illegal actions taken by one AWS, would these be sufficient notice for that unit or would that also apply to all units with similar software?
- "Would fully autonomous weapons be predictable enough to provide commanders with the requisite notice of potential risk?"
- "Would liability depend on a particular commander's individual understanding of the complexities of programming and autonomy?"

4.2.4 Legality of AWS Decision-Making

The rules for conducting warfare were created to protect individuals within and outside the battlefield from the most autonomous of all weapons, human beings.[379] This section stresses how AWS are excluded from the main assumption of the LOAC, that humans are the only decision-makers in war. The advent of non-human decision-makers generates a regulatory gap of targeting, where the LOAC under-includes the ability of AWS to commit illegal acts.

The LOAC is international in nature and it is codified through treaty and customary international law.[380] Treaties are documents where parties explicitly agree to conditions. The four versions of the Geneva Convention on conducting warfare are a treaty and so are its three additional protocols.[381] The same applies to the Convention on Certain Conventional Weapons. It prohibits weapons that cause "unnecessary or unjustifiable suffering" such as mines, flamethrowers, or blinding lasers.[382]

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[375] "For the purpose of facilitating the commission of such a crime, aids, abets or otherwise assists in its commission or its attempted commission, including providing the means for its commission" ICC. 1998..

[376] UN, *International Tribunal for the Prosecution of Persons Responsible for Serious Violations of International Humanitarian Law Committed in the Territory of the Former Yugoslavia since 1991*, ICC(1999), *available at* http://www.icty.org/x/cases/tadic/acjug/en/tad-aj990715e.pdf.

[377] "In the case of aiding and abetting no proof is required of the existence of a common concerted plan, let alone of the pre-existence of such a plan. No plan or agreement is required: indeed, the principal may not even know about the accomplice's contribution" id. at.

[378] Crootof, U. PA. L. REV., (2015).

[379] Id. at.

[380] DOD, Law of War Manual (DOD 2016);Cass, LOY. LAL REV., (2014).

[381] ICRC, The Geneva Conventions of 1949 and their Additional Protocols (ICRC 2010);Malcolm Shaw, Geneva Conventions (Encyclopædia Britannica, inc. 2018).

[382] UN, The Convention on Certain Conventional Weapons (United Nations 2019).

Customary law refers to international practices that, although they have not been formally agreed upon, are legally binding because of their consistent application over time.[383] If a country declines to participate in treaties, but implements principles of the LOAC, then it can be bound to them as a matter of customary law.[384]

The U.S. is bound to the LOAC by both treaty and customary law. It has ratified the Geneva Convention, but declined doing the same for Additional Protocols I and II.[385] Nevertheless, through its customary law database, the ICRC found that the U.S. adapted principles contained in these protocols throughout its military manuals, governments' reports, and pronouncements.[386] Thus, under customary law, the U.S. government is expected to abide by these principles.

This section examines three principles of the LOAC: distinction, proportionality, and humanity. They are ambiguously written to cover a universe of unexpected scenarios and are meant to be interpreted by humans judging other humans on the reasonability of their actions. The introduction of a new entity capable of battlefield decision-making, in the form of AWS, is under-included in these principles because, although they can act autonomously in ways that break the LOAC, non-human decisions are not subject to these regulations.

In the following paragraphs, the selected LOAC principles are defined (distinction, proportionality, and humanity) and the regulatory gap of targeting is highlighted by documenting how a human-centered approach excludes non-human decisionmakers.

4.2.4.1 Distinction

Article 48 of Additional Protocol 1 in the Geneva Convention contains the principle of distinction: parties to a conflict "shall at all times distinguish between the civilian population and combatants and between civilian and military objectives and accordingly shall direct their operations only against military objectives."[387] When war arises, civilians are part of a legally protected class where their physical integrity and the infrastructure that serves them should not be subject to attack.[388]

Today, the status of an individual is determined by a combatant's understanding of what defines a civilian.[389] For this, there are several references to consider. Additional Protocol I declares that a civilian is an individual that does not fit the description of a combatant.[390,391] The ICRC published

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[383] LII, *Customary International Law*, Cornell Law School(2019), *available at* https://www.law.cornell.edu/wex/customary_international_law.

[384] Wagner, VAND. J. TRANSNAT'L L., (2014);Cass, LOY. LAL REV., (2014);Gubrud, BULLETIN OF THE ATOMIC SCIENTISTS, (2014).

[385] ICRC, States Party to the Geneva Conventions and their Additional Protocols (ICRC 2017);Dunlap, TEMP. INT'L & COMP. LJ, (2016).

[386] ICRC, *Customary IHL database*, ICRC(2018), *available at* https://www.icrc.org/en/war-and-law/treaties-customary-law/customary-law.

[387] ICRC, Additional Protocol 1 - Article 48 (ICRC 1977).

[388] Kovach, AFL REV., (2014);David T Laton, *Manhatten_Project. exe: A Nuclear Option for the Digital Age*, 25 CATH. UJL & TECH (2016).

[389] Schmitt & Thurnher, HARV. NAT'L SEC. J., (2012).

[390] Cass, LOY. LAL REV., (2014);ICRC, Additional Protocol 1 - Article 50 (ICRC 1977).

[391] From ICRC, Additional Protocol 1 - Article 43 (ICRC 1977).: Article 43 - Armed forces

guidance on identifying a hostile act, one that, if performed by an individual, would deny civilian status.[392,393] Overall, civilians maintain their status until they are directly linked to hostilities.[394]

Through the principle of distinction, we have collectively agreed that human decision-making to discriminate between civilians from non-civilians is subjective. As it stands, humans judge their peers on whether the principle of distinction is respected. Even when it is steered by guidance from the LOAC, emotions like empathy, compassion, and self-preservation play a role in this process.[395] The introduction of AWS in the battlefield highlights the under-inclusion of this technology because it presents a scenario where a non-human autonomous decision-maker is not subject to the LOAC.[396]

In practical terms, compliance to the principle of distinction depends on the context. Humans have yet to reach a 0% error rate in "consistently and accurately" identifying targets.[397] In some war scenarios, 70% of collateral damage is due to mistaken identification of combatants; while in others, human-controlled drone strikes have mistakenly killed between 18 to 26% of targets.[398] For its part, an AWS would likely have no issues in differentiating between military and civilian targets in remote locations in the high seas or deserts.[399] On the contrary, urban scenarios with a high concentration of civilians presents problems that require a solution to the targeting gap

1. The armed forces of a Party to a conflict consist of all organized armed forces, groups and units which are under a command responsible to that Party for the conduct of its subordinates, even if that Party is represented by a government or an authority not recognized by an adverse Party. Such armed forces shall be subject to an internal disciplinary system which, ' inter alia ', shall enforce compliance with the rules of international law applicable in armed conflict.
2. Members of the armed forces of a Party to a conflict (other than medical personnel and chaplains covered by Article 33 [Link] of the Third Convention) are combatants, that is to say, they have the right to participate directly in hostilities.
3. Whenever a Party to a conflict incorporates a paramilitary or armed law enforcement agency into its armed forces it shall so notify the other Parties to the conflict.

[392] Nils Melzer, Interpretive guidance on the notion of direct participation in hostilities under international humanitarian law (ICRC 2009);Ford, (2017).

[393] From Melzer. 2009.:

1. The act must be likely to adversely affect the military operations or military capacity of a party to an armed conflict or, alternatively, to inflict death, injury, or destruction on persons or objects protected against direct attack (threshold of harm), and
2. There must be a direct causal link between the act and the harm likely to result either from that act, or from a coordinated military operation of which that act constitutes an integral part (direct causation), and
3. The act must be specifically designed to directly cause the required threshold of harm in support of a party to the conflict and to the detriment of another (belligerent nexus).

[394] ICRC, Additional - Protocol II - Article 13 (ICRC 1977);Andrew Clapham & Paola Gaeta, The Oxford Handbook of International Law in Armed Conflict (Oxford University Press 2014).

[395] Schmitt & Thurnher, HARV. NAT'L SEC. J., (2012).

[396] ICRC, Additional Protocol 1 - Article 48. 1977.

[397] Kastan, U. ILL. JL TECH. & POL'Y, (2013);Gevers, RUTGERS JL & PUB. POL'Y, (2014);Hood, INT'L L. & MGMT. REV., (2015).

[398] Gregory S. McNeal, *Targeted Killing and Accountability*, 102 GEORGETOWN LAW JOURNAL (2014);Michael J. Boyle, *The costs and consequences of drone warfare*, 89 INTERNATIONAL AFFAIRS (2013).

[399] Kastan, U. ILL. JL TECH. & POL'Y, (2013);Cass, LOY. LAL REV., (2014);Ford, (2017);Schmitt & Thurnher, HARV. NAT'L SEC. J., (2012).

herein presented. One where, although the goal of the policy is clearly written with humans in mind, current standards are not applicable to the actions of an AWS.[400]

4.2.4.2 Proportionality

Article 51 and 57 of Additional Protocol 1 in the Geneva Convention define proportionality: parties should "refrain from deciding to launch any attack which may be expected to cause incidental loss of civilian life, injury to civilians, damage to civilian objects, or a combination thereof, which would be excessive in relation to the concrete and direct military advantage anticipated."[401]

Similar to the principle of distinction, subjective decision-making is expected when a combatant assesses proportionality. The absence of an accepted definition of "excessive" means that each attack is based on a case-by-case calculus of its military advantage compared to the collateral damage of non-military objectives.[402] Because of uncertainty in the battlefield, rather than aspiring to perfection when implementing proportionality, reasonableness of an action is an acceptable standard for determining if an action is considered illegal.[403]

Current standards were made for the application of the principle on human decisions. As a non-human, AWS is excluded from judgement on its proportionality analysis or the reasonability of its actions. As written, the current version of the principle excludes non-human decision-makers.

Governments and scholars have developed methods to guide proportionality decisions that could be applied to AWS. The DOD published a "Collateral Damage Estimation Methodology" for the identification of scenarios and targets that would limit military action.[404] Wallach and Thomas argue that any calculation of collateral civilian damage should consider the value of statistical life from citizens in the attacking nation.[405] Applying this methodology would, in theory, avoid the discounting of lives of countries with different standards of living. Hence, casualties will cost more for countries with higher levels of wealth.[406]

These suggestions represent a limited set of alternatives that could guide how an AWS interprets proportionality. Whatever metric is agreed upon by the international community needs to be flexible enough to adjust to any battle scenario.[407] Such a standard could ensure that lethal action is consistent, regardless of battle conditions and prevent operator error.[408]

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[400] Cass, LOY. LAL REV., (2014).
[401] ICRC, Additional Protocol 1 - Article 51 (ICRC 1977);ICRC, Additional Protocol 1 - Article 57 (ICRC 1977).
[402] Schmitt & Thurnher, HARV. NAT'L SEC. J., (2012).
[403] Id. at;Cass, LOY. LAL REV., (2014).
[404] CJCSI, *No-strike and the collateral damage estimation methodology*, DOD(2012), *available at* https://info.publicintelligence.net/CJCS-CollateralDamage.pdf;Gubrud, BULLETIN OF THE ATOMIC SCIENTISTS, (2014).
[405] Evan Wallach & Erik Thomas, *The Economic Calculus of Fielding Atonomous Fighting Vehicles Complaint with the Laws of Armed Conflict*, 18 YALE JL & TECH. (2016).
[406] Id. at.
[407] Cass, LOY. LAL REV., (2014).
[408] Gevers, RUTGERS JL & PUB. POL'Y, (2014).

4.2.4.3 Humanity

The Martens Clause was first published in the Hague Convention on the Regulations Concerning the Laws and Customs of War on Land, and appears in Additional Protocols I and II of the Geneva Convention.[409] It states that "until a more complete code of the laws of war is issued, the High Contracting Parties think it right to declare that in cases not included in the Regulations adopted by them, populations and belligerents remain under the protection and empire of the principles of international law, as they result from the usages established between civilized nations, from the laws of humanity, and the requirements of the public conscience."[410]

The understanding of the clause is that in the absence of "positive treaty law" on a subject, parties to a war should consider "customary international law, the principles of humanity, and public conscience" to determine a course of action.[411] For human decision-makers, humanity and public conscience are interpreted as the prevention of unneeded suffering and pain to achieve military objectives (e.g. capturing a combatant rather than wounding them or wounding a combatant rather than killing them).[412] This principle has also been utilized to preempt the use of inhumane weapon systems in battlefields.[413]

In consonance with the principles of distinction and proportionality, the implementation of the Martens Clause is subject to a combatant's understanding.[414] For an AWS to carry out an attack with humanity or public conscience, there is a need for clear criteria that are accepted by the international community so that a machine can consistently interpret these concepts. These do not exist in the LOAC, creating a regulatory gap where these systems are under-included. If criteria is created, AWS could become a more efficient and humane combatant by sparing soldiers from unnecessary pain.[415]

4.2.5 Domestic Use of Force

The use of force literature is dominated by research on AWS and their effect on the future of nation-to-nation combat. Less popular of a topic are the legal questions surrounding its domestic ownership. U.S. law on the possession of weapons emanates from the Second Amendment of the Constitution. Although the right to bear arms is a settled question, the extent to which AWS are considered an arm is untested in the justice system. The regulatory gap addressed in this section is the uncertainty of how AWS will fit domestic regulations on the possession and use of arms.

For AWS to become legal, the justice system will likely tackle three issues. First, is the common use denomination. In the case of the District of Columbia v. Heller, the Supreme Court defined

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[409] Gubrud, BULLETIN OF THE ATOMIC SCIENTISTS, (2014);Crootof, CARDOZO L. REV., (2014).

[410] ICRC, Convention (II) with Respect to the Laws and Customs of War on Land and its annex: Regulations concerning the Laws and Customs of War on Land - Preamble (ICRC 1899).

[411] Crootof, CARDOZO L. REV., (2014).

[412] Rupert Ticehurst, *The Martens Clause and the Laws of Armed Conflict*, ICRC(1997), *available at* https://www.icrc.org/en/doc/resources/documents/article/other/57jnhy.htm.

[413] Gubrud, BULLETIN OF THE ATOMIC SCIENTISTS, (2014).

[414] Beard, GEO. J. INT'L L., (2013).

[415] Gevers, RUTGERS JL & PUB. POL'Y, (2014).

weapons as those that are in common use for a lawful purpose, as is the case of firearms.[416] In 2019, no domestic AWS were available to the public, thus they do not fit the definition set by the Supreme Court and are not legal.[417] In fact, Congress at the state and federal level could ban these weapons to prevent them from ever becoming popular.[418] If they decide not to act, the judicial system would have to clarify several aspects of common use:

- What is the minimum quantity of AWS that qualifies as common use?
- Which categories of AWS are eligible (e.g. lethal, non-lethal, stationary, non-stationary, etc.)?

The second issue AWS will face references the word bear.[419] Justices in the case of the District of Columbia v. Heller deliberated on the relationship between a weapon's wearability and its lawfulness. Definitions from the time the Amendment was written interpreted the meaning of the word as the capacity to be carried. As a result, the Supreme Court established that, as long as a weapon can be carried, it is legal.[420]

Does this mean that an AWS that cannot be carried is illegal? Not necessarily. Ezell v. Chicago overturned a ban on firing ranges arguing that it hampered the auxiliary rights of the Second Amendment (protections that ensure that the core right is not infringed, such as practicing one's sharpshooting skills or purchasing bullets).[421] Future litigation on the matter could contend that the usage of a robot bodyguard is an auxiliary right that increases the effectiveness of a firearm when a user is unskilled for the purposes of self-defense.[422]

Evidence to support this view is found in the limitations imposed on the Second Amendment rights of felons.[423] A federal court established that felons cannot employ armed bodyguards to circumvent their prohibition on carrying a weapon.[424] Because the bodyguards are under the employment of a felon, these individuals are essentially in control over their weapons even if they are not carried by them. Terzian suspects that the inverse of a felon's restriction rights could apply to individuals and their domestic AWS.[425] A case could be made that an AWS would qualify as legal weapons because it is under the control of their owners.

Lastly, once bodyguard robots are prevalent, local governments throughout the country will need to take a stand on the incorporation of robotic law enforcement.[426] A police force that utilizes a

[416] District of Columbia v. Heller, 554 U.S. 570, (2008).
[417] Dan Terzian, *The Right to Bear (Robotic) Arms*, 117 PENN ST. L. REV. (2012).
[418] Froomkin & Colangelo, CONN. L. REV., (2015).
[419] Terzian, PENN ST. L. REV., (2012).
[420] District of Columbia v. Heller, U.S.
[421] Glenn Harlan Reynolds, Second Amendment Penumbras: Some Preliminary Observations (University of Tennessee - Knoxville- College of Law 2012);Terzian, PENN ST. L. REV., (2012).
[422] Terzian, PENN ST. L. REV., (2012).
[423] District of Columbia v. Heller, U.S.
[424] United States v. Weaver, et al., No. 10-4885, (4th Cir. 2011).
[425] Terzian, PENN ST. L. REV., (2012).
[426] Elizabeth E Joh, *Private Security Robots, Artificial Intelligence, and Deadly Force*, 51 UCDL REV. (2017).

modern version of RoboCop will need to define the powers these representatives of the law can yield while performing their duties:[427]

- Can they use lethal force?
- Can they disable or kill a robot guardian committing a crime and, if so, what are the Fourth Amendment implications of this action?

[427] Joh, HARV. L. & POL'Y REV., (2016).

4.3 Accountability

Entrusting AI applications with autonomously making decisions will eventually lead to pecuniary and non-pecuniary harms requiring remedy.[428] This section surveys the regulatory gaps generated by commercial AI applications (See Table 18). It excludes the accountability gaps targeted at holding this technology responsible for its actions. These can be found in the Personhood section.

Table 18 - Regulatory Gaps in Accountability

Issue	Regulatory Gap	Type of Gaps	Government Level	Time Frame	Type of AI
Individuals	User	Targeting (Over)	State	Future	Application
	Owner	Uncertainty	State	Present + Future	Application
	Malpractice	Uncertainty	State	Future	Application
Firms	Manufacturing and Design Defects	Obsolescence	State	Future	Application
	Calibrating Liability Exposure	Uncertainty	State	Future	Application
	Connected vs. Disconnected Vehicles	Uncertainty	Federal + State	Future	Application

Accountability for the decisions of a consumer-grade AI application depend on the: degree of operator control, the existence of an umbilical cord to the producer, or if a product's ecosystem is closed or open to third parties.[429] These variables determine who responds for the decisions of an AI agent. In this debate, the literature dedicates most of its attention to autonomous vehicles (AV), a technology that promises to reduce accidents caused by human error.[430]

AV serve as a good proxy for determining the accountability of AI applications because they share similar accountable parties (i.e. operators, owners, manufacturers, the AI application itself, and government). However, its usefulness is limited by a unique regulatory context. All vehicles, including AV, are under the jurisdiction of state and federal law. Through the National Highway Traffic Safety Administration (NHTSA) the federal government establishes guidelines of required safety equipment. For instance, the Federal Motor Vehicle Safety Standards (FMVSS) dictates the characteristics of breaks that are activated by a person's foot, manual turn signals, visual alerts,

[428] Joanna J Bryson, et al., *Of, for, and by the people: the legal lacuna of synthetic persons*, 25 ARTIFICIAL INTELLIGENCE AND LAW (2017);Sabine Gless, et al., *If Robots cause harm, Who is to blame? Self-driving Cars and Criminal Liability*, 19 NEW CRIMINAL LAW REVIEW: IN INTERNATIONAL AND INTERDISCIPLINARY JOURNAL (2016);Leon E Wein, *Responsibility of Intelligent Artifacts: Toward an Automation Jurisprudence*, 6 HARV. JL & TECH. (1992).

[429] Jack Boeglin, *The costs of self-driving cars: reconciling freedom and privacy with tort liability in autonomous vehicle regulation*, 17 YALE JL & TECH. (2015);Ryan Calo, *Open robotics*, 70 MD. L. REV. (2010).

[430] Bryant Walker Smith, *Human Error as a Cause of Vehicle Crashes*, Center for Internet and Society(2013), *available at* http://cyberlaw.stanford.edu/blog/2013/12/human-error-cause-vehicle-crashes;Mark Geistfeld, *A Roadmap for Autonomous Vehicles: State Tort Liability, Automobile Insurance, and Federal Safety Regulation*, (2017);Nidhi Kalra James M. Anderson, Karlyn D. Stanley, Paul Sorensen, Constantine Samaras, Oluwatobi A. Oluwatola, *Autonomous Vehicle Technology: A Guide for Policymakers*, RAND Corporation(2016), *available at* http://www.rand.org/pubs/research_reports/RR443-2.html;Todd Litman, *Autonomous Vehicle Implementation Predictions*, Victoria Transport Policy Institute(2017), *available at* http://www.vtpi.org/avip.pdf.

and the position of the rearview mirror.[431] The 50 jurisdictions of state motor vehicle agencies are responsible for standards on the "licensing, registration, traffic law enforcement, safety inspections, infrastructure, and insurance and liability regulations."[432]

The six regulatory gaps in this section explore the frontiers of accountability divided into two parties: individuals through users, owners, and practitioners, and the private sector via manufacturers.

4.3.1 User

In the future, drivers will have the choice of operating a non-AV, semi-AV, or completely AV. The level of human input required for these technologies differs. For over a hundred years, we have grown accustomed to the non-AV, whose operation depends on a person. Semi-AV complement navigation, but require different levels of supervision.[433] A completely AV discounts the need for a driver and may not even include a steering wheel or a brake pedal.[434]

Policymakers in 50 independent jurisdictions are charged with defining the legal basis for operating these vehicles.[435,436] Although states are divided between those with and without AV-specific regulation, it is possible to find the same regulatory gap of targeting in both (over-inclusion). Particularly, users of completely AV will be held accountable for the actions of their vehicles despite technological capabilities that limit or do without human participation.

Jurisdictions without AV regulation hold drivers accountable for driving behavior regardless of the technological characteristics of their vehicle.[437] In Minnesota, a driver is "every person who drives or is in actual physical control of a vehicle."[438] Definitions like these do not discriminate

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[431] Daniel A Crane, et al., *A Survey of Legal Issues Arising from the Deployment of Autonomous and Connected Vehicles*, 23 MICH. TELECOMM. & TECH. L. REV. (2016).

[432] Ben Husch & Anne Teigen, A ROADMAP FOR SELF-DRIVING CARS (NCSL 2017);Geistfeld, (2017).

[433] Justin Hughes, *Car Autonomy Levels Explained*, The Drive(2017), *available at* http://www.thedrive.com/sheetmetal/15724/what-are-these-levels-of-autonomy-anyway.

[434] SAE International, *Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles*(2016), *available at* http://standards.sae.org/j3016_201609/;NHTSA, *Preliminary Statement of Policy Concerning Automated Vehicles*(2013), *available at* https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0ahUKEwicupSHq9fRAhUY84MKHeQvBpgQFggfMAA&url=https%3A%2F%2Fwww.nhtsa.gov%2Fstaticfiles%2Frulemaking%2Fpdf%2FAutomated_Vehicles_Policy.pdf&usg=AFQjCNFUzBYs9dSLasE7Qg_rbwrUX52xvg&sig2=A__9T4O6UXjr7IB9CyN4iw&bvm=bv.144224172,d.amc&cad=rja.

[435] Geistfeld, (2017).

[436] Interestingly, some states allow non-humans to be considered drivers Bryant Walker Smith, *Automated Vehicles Are Probably Legal in the United States*, 411 TEXAS A&M LAW REVIEW (2014);Danielle Lenth, *Chapter 570: Paving the Way for Autonomous Vehicles*, 44 MCGEORGE L. REV. (2013).. Two examples are:

- **Michigan:** "Person" means every natural person, firm, copartnership, association, or corporation and their legal successors Michigan Vehicle Code, §257 (2016)..
- **California:** "Person" includes a natural person, firm, copartnership, association, limited liability company, or corporation California Vehicle Code, §470 (State of California 2017).

With respect to the Federal government, the NHTSA has made it clear that a completely autonomous system "is the equivalent of a human driver for federal regulatory purposes" Geistfeld, (2017).

[437] Smith, TEXAS A&M LAW REVIEW, (2014).

[438] State of Minnesota, MINN. STAT. § 169.011 (State of Minnesota 2018).

between individuals operating different types of vehicles, which leads to a targeting regulatory gap of over-inclusion.

States that have enacted regulation incorporating AV also over-include these users.[439] California's code defines an operator as "the person who is seated in the driver's seat, or, if there is no person in the driver's seat, causes the autonomous technology to engage."[440] In Georgia, an operator is "any person who drives or is in actual physical control of a motor vehicle or who causes a fully autonomous vehicle to move or travel with the automated driving system engaged."[441] These states commit the same targeting regulatory gap as their counterparts by over-including drivers of vehicles with distinct capabilities.

Current regulations treat users of any vehicle equally, despite their features.[442] For completely AV, it is unlikely that humans will have any input in their operation.[443] Some models may not include equipment for a person to interact with. Without the possibility of intervening or preventing an accident, these drivers should not be held responsible for the decisions of their autonomous agent. A good example of over-inclusion is found in Colorado's regulation for driving under the influence. If alcohol or drugs are the proximate cause of a murder in a vehicular accident, the driver is automatically held accountable for the death.[444,445] Consequently, drunk drivers of completely AV in Colorado who happen to be in a car that malfunctions and kills third-parties, may be charged with a crime for which they did not contribute to the decision-making process that led to the accident.[446]

4.3.2 Owner

Accountability for AV is not derived solely from driving, ownership can generate liability.[447] Scholars underscore a regulatory gap of uncertainty regarding what model of AV responsibility will owners face when their property is responsible for harms. Analogies between current practices that cover organic (dogs and horses) and non-organic (elevators) property illustrate the range of possibilities for attributing accountability.

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[439] W. Perry Hicks & Alan J. Ponce, *SB 219 - Autonomous Vehicles*, 34 GEORGIA STATE LAW REVIEW (2017);Smith, TEXAS A&M LAW REVIEW, (2014);Adeel Lari, et al., *Self-driving vehicles and policy implications: current status of autonomous vehicle development and minnesota policy implications*, 16 MINN. JL SCI. & TECH. (2015).

[440] California Vehicle Code, §38750 (2012).

[441] State of Georgia, Georgia Code Title 40. Motor Vehicles and Traffic § 40-1-1 (State of Georgia 2017).

[442] Tracy Hresko Pearl, *Fast & Furious: The Misregulation of Driverless Cars*, 73 NYU ANN. SURV. AM. L. (2017).

[443] Id. at.

[444] Colorado Revised Statutes, §18-3-106 (2016).

[445] The regulation in Colorado states: "(b) (I) If a person operates or drives a motor vehicle while under the influence of alcohol or one or more drugs, or a combination of both alcohol and one or more drugs, and such conduct is the proximate cause of the death of another, such person commits vehicular homicide. This is a strict liability crime" id. at..

[446] Jeffrey K Gurney, *Driving into the unknown: Examining the crossroads of criminal law and autonomous vehicles*, 5 WAKE FOREST JL & POL'Y (2015);Paul J Pearah, *Opening the Door to Self-Driving Cars: How Will This Change the Rules of the Road*, 18 J. HIGH TECH. L. (2017).

[447] Lawrence B Solum, *Legal personhood for artificial intelligences*, 70 NCL REV. (1991).

Animals share some characteristics of completely AV.[448] Neither have legal personality, they are considered property, they can make decisions autonomously, and may cause injury or damage to third parties.[449] If AV fell under the regulations of dogs, owners would be subject to two regimens.[450] Some states apply a "one-bite rule" where an injured party has the onus of proving that an owner knew, or should have known, of a dog's history of violent behavior.[451] The AV version of a "one-bite rule" would blame an owner whose AV has a documented record of failing, irrespective of their or the manufacturer's efforts to repair it.

In most states, an owner is responsible for a dog's behavior regardless of its history, known as strict liability.[452] Applying this regimen to AV would discount the need to prove a vehicle's troubled past and owners would automatically be accountable for its decisions. Duffy and Hopkins advocate for AV strict liability because they believe it is the most straightforward avenue to quickly diffuse the accountability dilemma.[453] Nevertheless, they recognize that such a system would create disincentives for AV ownership and increase insurance costs.

A mechanical parallel to the completely AV is the elevator. In this technology, passengers have no control over how they reach their destination.[454] When an accident occurs, the consensus in the legal system is that owners and maintenance companies share responsibility for an elevator user's well-being.[455] For AV, maintenance companies would correspond to manufacturers or dealers that service the vehicle. In this sense, the onus falls on two parties, the owner and the manufacturer, to guarantee that inspections and repairs are performed.

King points out the parallels between owners of semi-AV and horses.[456] Horse owners are liable for accidents when they do not verify that a rider has the skills to control an animal.[457] If this analogy is followed, liability would depend on owners confirming that a driver is knowledgeable of a semi-AV controls and its approach to traffic. Without standardization in the market, drivers are confronted with learning driving paradigms and controls from a wide variety of manufacturers, while owners need to effectively test this knowledge.[458]

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[448] Smith, TEXAS A&M LAW REVIEW, (2014).

[449] Sophia H Duffy & Jamie Patrick Hopkins, *Sit, stay, drive: The future of autonomous car liability*, 16 SMU SCI. & TECH. L. REV. (2013).

[450] Coulter Boeschen, *"One-Bite" vs. Strict Liability Rules for Dog Bite Injury Cases*, All Law(2019), *available at* https://www.alllaw.com/articles/nolo/personal-injury/one-bite-strict-liability-dog-bite.html.

[451] LLI, *One-bite rule*, Cornell University(2019), *available at* https://www.law.cornell.edu/wex/one-bite_rule.

[452] Boeschen. 2019.

[453] Duffy & Hopkins, SMU SCI. & TECH. L. REV., (2013).

[454] Jeffrey R. Zohn, *When Robots Attack: How Should the Law Handle Self-driving Cars that Cause Damages*, 2 JOURNAL OF LAW, TECHNOLOGY & POLICY (2015);David King, *PUTTING THE REINS ON AUTONOMOUS VEHICLE LIABILITY:WHY HORSE ACCIDENTS ARE THE BEST COMMON LAW ANALOGY*, 19 NORTH CAROLINA JOURNAL OF LAW & TECHNOLOGY (2017).

[455] Zach Matthews & Christopher K. Jones, *Defending the First Wave: Autonomous Trucking and the Death of Driver Negligence?*, TRUCKING LAW (2015).

[456] King, NORTH CAROLINA JOURNAL OF LAW & TECHNOLOGY, (2017).

[457] Id. at.

[458] Harry Surden & Mary-Anne Williams, *Technological opacity, predictability, and self-driving cars*, 38 CARDOZO L. REV. (2016).

Each of these analogies offers a different model for how AV owners will account for their property when a harm occurs. A wide scope of possibilities exist. Because of this, it is unclear what path policymakers will take in scoping the responsibility of individuals that acquire AI-powered applications.

4.3.3 Malpractice

Malpractice is the act of "negligence or incompetence" by a professional that fails to follow the common standards expected from their community of practice and is the proximate cause of damages to a person (e.g. client or patient).[459] Practitioners in the medical and legal industries (these professions are governed by state bodies) will face the regulatory gap of uncertainty concerning the use of AI applications as an aid to their decision-making. Frank describes it best as a journey in which, as the availability and capacity of these products increases, professionals are "forced to navigate between the Scylla of overreliance on imperfect human contrivances and the Charybdis of liability for failure to utilize available technology."[460]

Currently, AI applications complement the practice of professionals, who are able to act reasonably by learning about their capabilities and decide to what extent they are used.[461] As time passes, they may increasingly rely on technology as evidence suggests it is more effective than their judgement.[462]

Scholars in the systematic review believe there will be a transition period where the evolution of these systems causes a regulatory gap of uncertainty by placing practitioners in a dilemma. One where they face malpractice lawsuits if they rely on their experience and disregard the recommendations of an AI system, or vice versa.[463] Regardless of their choices, professionals may be blamed for negligent practice and left without direction as to what action is the most appropriate or legal. Eventually, as the reliability of these systems grows, professions may lose their monopoly over their field of knowledge and their scope of practice may be limited to supervising or maintaining their field's AI applications.[464]

4.3.4 Manufacturing and Design Defects

The introduction of completely AV in the car park possibly denotes a transition in the accountability of accidents from individuals to manufacturers.[465] The literature reveals that this application of AI generates the regulatory gap of obsolescence because it alters the cost of enforcing policies meant to protect customers and victims of harms. In practice, claims could

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[459] Bryan A. Garner, Malpractice (2019).

[460] Steven J Frank, *Tort Adjudication and the Emergence of Artificial Intelligence Software*, 21 SUFFOLK UL REV. (1987).

[461] Marshall S Willick, *Professional malpractice and the unauthorized practice of professions: Some legal and ethical aspects of the use of computers as decision-aids*, 12 RUTGERS COMPUTER & TECH. LJ (1986).

[462] Frank, SUFFOLK UL REV., (1987);J Stephen O'Donnell, *Artificial Intelligence Use in the Legal Profession: What are Its Liabilities*, 4 SOFTWARE LJ (1990).

[463] Willick, RUTGERS COMPUTER & TECH. LJ, (1986).

[464] Frank, SUFFOLK UL REV., (1987).

[465] Bryant Walker Smith, *Automated driving and product liability*, MICH. ST. L. REV. (2017);Adam Thierer & Ryan Hagemann, *Removing roadblocks to intelligent vehicles and driverless cars*, 5 WAKE FOREST JL & POL'Y (2015);Jeffrey K. Gurney, *Sue My Car Not Me: Products Liability and Accidents Involving Autonomous Vehicles*, 247 J.L. TECH. & POL'Y (2013);Geistfeld, (2017);Andrew M Brown, *Blame It on the Machines: How Autonomous Vehicles Will Impact Allocation of Liability Insurance and the Resulting Impact on the Legal Community*, 95 NCL REV. ADDENDUM (2016).

become onerous to the point that accountability is not pursued for non-major accidents and, in criminal cases, guilty parties may escape punishment.

AV are made up of hardware and software components. Hardware failures largely fall within the scope of existing policies and do not generate regulatory gaps.[466] Software is a different story. Breakdowns in software raise accountability questions because of the need to settle who is responsible for a malfunction or decision that causes pecuniary or non-pecuniary harm. To assuage the public, three firms (Volvo, Google, and Mercedes-Benz) have proactively offered to cover the costs of accidents caused by their products.[467] These offers have yet to be tested since no completely AV are on the road.

If consumers had access to this technology, the most discussed alternative to hold manufacturers responsible is through product liability claims.[468] Depending on a person's jurisdiction, this offense is subject to strict liability, where evidence of a product defect does not require manufacturer intent, or negligence, where intent needs to be proven, among others.[469] Most states have three types of product liability and the following paragraphs focus on the first two:[470]

- **Manufacturing defects:** a good is not produced according to the standards or specifications of the manufacturer. For an AV, this means that a consumer owns a vehicle that does not conform to the manufacturer's production guidelines.
- **Design defects:** a product is "dangerous to an extent beyond that which would be contemplated by the ordinary consumer who purchases it."[471] If found, this would imply that all AV share an underlying design error.
- **A failure to warn:** obligation of manufacturers to instruct consumers on how to use their product and avoid potential dangers.

Plaintiffs looking to sue under a manufacturing defect claim would argue that an error in a completely AV software caused a consumer harm.[472] Unfortunately, judicial precedent states that non-mechanical elements of a product, such as an AV software, are not eligible for a

[466] Geistfeld, (2017).
[467] Volvo, Volvo Cars responsible for the actions of its self-driving cars (Volvo 2015);Bill Whitaker, Hands off the Wheel (60 Minutes 2015).
[468] Smith, MICH. ST. L. REV., (2017);John W Terwilleger, *Navigating the Road Ahead: Florida's Autonomous Vehicle Statute and Its Effect on Liability*, 89 FLA. BJ (2015);Jessica S Brodsky, *Autonomous vehicle regulation: how an uncertain legal landscape may hit the brakes on self-driving cars*, 31 BERKELEY TECH. LJ (2016);Amir Khoury, *Intellectual Property Rights for Hubots: On the Legal Implications of Human-like Robots as Innovators and Creators*, 35 CARDOZO ARTS & ENT. LJ (2016);Brown, NCL REV. ADDENDUM, (2016).
[469] F Patrick Hubbard, *Sophisticated Robots: Balancing Liability, Regulation, and Innovation*, 66 FLA. L. REV. (2014);LII, *Products liability*, Cornell Law School(2019), *available at* https://www.law.cornell.edu/wex/products_liability;Crane, et al., MICH. TELECOMM. & TECH. L. REV., (2016);Dorothy J Glancy, *Autonomous and automated and connected cars-oh my: first generation autonomous cars in the legal ecosystem*, 16 MINN. JL SCI. & TECH. (2015);Adeel Lari, et al., *Self-driving vehicles and policy implications: current status of autonomous vehicle development and minnesota policy implications*, see id. at Cited Pages|.
[470] Gurney, J.L. TECH. & POL'Y, (2013);Glancy, MINN. JL SCI. & TECH., (2015);Geistfeld, (2017).
[471] Restatement (Second) of Contracts § 402A(i) (American Law Institute 1965).
[472] Geistfeld, (2017).

manufacturing defect case.[473] To circumvent this roadblock, plaintiffs could opt for the malfunction doctrine. In it, they would not have to assert that an AV software was responsible for harm. Instead, this doctrine allows owners of a properly used, unaltered product, to claim that it was defective without needing to pinpoint what specific part caused the harm.[474]

Design defects are sought when consumers allege that a faulty design is responsible for a harm.[475] Although states apply different rules, consumers generally rely on the consumer expectation or risk-utility test to make their case.[476] In the consumer expectations test, a court assesses what is a reasonable expectation for a product.[477] For AV, expectations will originate from a manufacturer's marketing material. Cautious firms will balance their messaging on the safety benefits of AV with warnings about their potential dangers.[478] Even if they are successful in their communication efforts, firms are threatened with an uphill battle in helping consumers understand that overall improvements in safety may not prevent all permutations of accidents.[479] The risk-utility test considers "when the foreseeable risks of harm posed by the product could have been reduced or avoided by the adoption of a reasonable alternative design."[480] Under this test, the onus is on consumers to identify design alternatives that could have reasonably prevented their harm.[481] For firms, this means that their software will be evaluated specifically on how it performed in a particular scenario.[482]

Manufacturing and design defects are two vectors that consumers can pursue for restitution of harms from AV manufacturers, or any AI application for that matter, due to software issues. The regulatory gap of obsolescence originates in how these alternatives substantially alter the cost of consumers that seek justice.

Take for example non-major accidents. At present, it is relatively straightforward for the justice system to determine what driver is at fault and request that the harm be repaired. With completely AV, proving a manufacturing or design defect involves significant effort and cost. Including requesting that a manufacturer share its intellectual property and hire experts that

[473] Michael C. Gemignani, *Product Liability and Software*, 173 RUTGERS COMPUTER & TECH. L.J. (1981);Smith, MICH. ST. L. REV., (2017);Gurney, J.L. TECH. & POL'Y, (2013);David C Vladeck, *Machines without principals: liability rules and artificial intelligence*, 89 WASH. L. REV. (2014).
[474] David G. Owen, *Manufacturing Defects*, 53 SOUTH CAROLINA LAW REVIEW (2002).
[475] Hubbard, FLA. L. REV., (2014).
[476] Jeffery K Gurney, *Crashing into the unknown: An examination of crash-optimization algorithms through the two lanes of ethics and law*, 79 ALB. L. REV. (2015);Brown, NCL REV. ADDENDUM, (2016).
[477] Gurney, ALB. L. REV., (2015);Restatement (Second) of Contracts § 402A(i). 1965.
[478] Gurney, J.L. TECH. & POL'Y, (2013);Smith, MICH. ST. L. REV., (2017).
[479] Smith, MICH. ST. L. REV., (2017).
[480] Restatement, Third, Torts: Products Liability (2019).
[481] Smith, MICH. ST. L. REV., (2017).
[482] Id. at;Hubbard, FLA. L. REV., (2014).

intimately understand these products in order to find a mistake amongst the millions of lines of code from the AI software.[483,484]

Without the means to cover these expenses, victims of relatively low-cost accidents could be left to cover these claims out-of-pocket.[485] The same is true with criminal liability. If a product killed an individual, it is unlikely that a programmer or representative of the manufacturing company would be jailed due to their role in their design.[486] For them to be held negligently responsible, courts would have to establish that these individuals should have known that the criminal actions of the AI agents were a "natural, probable consequence" beyond a reasonable doubt.[487]

As there appears to be limited to no outlet to enforce liability, policies meant to provide justice become obsolete. A corollary, but important issue in obsolescence, is what to do with the liability of a manufacturer once it files for bankruptcy. If their products are still in use and the corporate entity is no longer in business, seeking justice due to manufacturing or design defects will not be possible since the parties would no longer be in business.[488]

4.3.5 Calibrating Liability Exposure

The regulatory gap of uncertainty will be encountered in the guidelines that define a firm's accountability for harms caused by AV and its impact on how they self-regulate their liability exposure.[489] If state government's select a regimen of manufacturer strict liability, products could be programmed to minimize the resources needed to settle a claim. Casey and Gurney identify several scenarios worth considering if firms are placed in this position.[490] Firms may program products to favor: damage to vehicles that are less expensive; strike motorcyclist/bicyclist wearing a helmet as opposed to those without one, since they are likely to sustain less injuries; or sacrifice one passenger over a school bus full of children.[491]

This calculus changes in a world where contributory negligence is taken into consideration, a determination where courts assess if victims contributed to the accident. In these cases, it is possible to think of a scenario where an AV would prefer to impact a group of pedestrians that

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[483] Vladeck, WASH. L. REV., (2014);Andrea Renda, *Ethics, algorithms and self-driving cars–a CSI of the 'trolley problem'*, (2018);Robert W. Peterson, *NEW TECHNOLOGY-OLD LAW: AUTONOMOUS VEHICLES AND CALIFORNIA'S INSURANCE FRAMEWORK*, 52 SANTA CLARA LAW REVIEW (2012).

[484] Vehicles without automated driving software can have 150 million lines of code Isabelle Baas, *A glimpse into the future of travel and its impact on marketing*, The Drum(2016), *available at* https://www.thedrum.com/opinion/2016/01/11/glimpse-future-travel-and-its-impact-marketing.

[485] Hubbard, FLA. L. REV., (2014).

[486] Gurney, ALB. L. REV., (2015);George S Cole, *Tort liability for artificial intelligence and expert systems*, 10 COMPUTER/LJ (1990).

[487] Gabriel Hallevy, *I, Robot–I, Criminal"—When Science Fiction Becomes Reality: Legal Liability of AI Robots Committing Criminal Offenses*, 22 SYRACUSE SCI. & TECH. L. REP. (2010);Gabriel Hallevy, *The Criminal Liability of Artificial Intelligence Entities-From Science Fiction to Legal Social Control*, 4 AKRON INTELL. PROP. J. (2010).

[488] Robert W Peterson, *New technology-old law: Autonomous vehicles and California's insurance framework*, 52 SANTA CLARA L. REV. (2012).

[489] Bryan Casey, *Amoral machines, or: How roboticists can learn to stop worrying and love the law*, 111 NW. UL REV. (2016).

[490] Id. at;Gurney, ALB. L. REV., (2015).

[491] Renda, (2018).

illegally crosses the road and are responsible for the accident, then damage property to avoid them.[492]

4.3.6 Connected vs. Disconnected AV

Firms confront the regulatory gap of uncertainty when distinguishing their liability from completely AV that are connected or disconnected from their control.[493,494] Disconnected AV do not communicate with the manufacturer once they leave the factory floor.[495] They will evolve in unique ways over time, some of them unforeseeable.[496] Which means that manufacturers may ignore the scope of their decision-making. Connected products have an umbilical cord to the manufacturer, who can theoretically manage, detect, and correct any software defect or control its decision-making.

Considering their important differences, manufacturers lack certainty as to how these vehicles will be distinguished under the law, if at all. Policymakers need to confirm whether the federal government will oversee this issue as a matter of regulating equipment under the FMVSS or if state have jurisdiction under their remit to enforce regulations related to road behavior. In particular, they require regulatory clarity as to the limits of their accountability or if insurance-like protection will be available to cover cases of hacking, miscommunication, and manufacturing/design defects.[497] Although firms in the transportation sector are the focus of this literature, applications of AI in all sectors are subject to how policymakers at the federal and state level differentiate the liability between products with and without an umbilical cord.

[492] Casey, NW. UL REV., (2016).
[493] Boeglin, YALE JL & TECH., (2015).
[494] Firms include entities such as "automotive manufacturers, component suppliers, software providers, data providers, fleet operators, and infrastructure managers, among others" Smith, MICH. ST. L. REV., (2017);Terwilleger, FLA. BJ, (2015)..
[495] Khoury, CARDOZO ARTS & ENT. LJ, (2016).
[496] Čerka, et al., COMPUTER LAW & SECURITY REVIEW, (2015);Renda, (2018).
[497] Crane, et al., MICH. TELECOMM. & TECH. L. REV., (2016);Geistfeld, (2017);Gurney, WAKE FOREST JL & POL'Y, (2015);Renda, (2018).

4.4 Displacement of Labor

Demand for human labor is a historical constant. Society has benefited from the payment or coercion of individuals to deliver their physical or cognitive outputs for a purpose. Since AI was first introduced to the public, questions arose about its role in modifying the demand for labor. They centered on the social repercussions of machines capable of combining strength with cognitive abilities equal or superior to that of humans.

The systematic review evinced few examples of regulatory gaps in the displacement of labor literature. Those identified center on the role of applications and methods of AI in changing the demand for labor and its effects on the provision of government services. They contemplate speculative scenarios where these services, in the form of public education and the social safety net, are unable to cope with the needs of the population. The lack of literature identifying gaps is complemented by a rich archive of articles that analyze the history and characteristics of the substitution of human labor due to AI. Therefore, the ensuing paragraphs provide a summary of this literature, followed by a brief analysis of the two regulatory gaps in Table 19.

Table 19 - Regulatory Gaps in Displacement of Labor

Issue	Regulatory Gap	Type of Gaps	Government Level	Time Frame	Type of AI
Public Programs	Public Education	Novelty	Federal + State + Local	Future	Application
	Social Safety Net	Novelty	Federal + State + Local	Future	Application

A truism highlighted in this research is that transitions in the demand for labor due to technology are not new. In fact, several antecedents exist. The 19th century gave the world the industrial revolution, a time where the large-scale availability of cost-effective machines served as an alternative to humans.[498] At the time, the composition of the workforce in many sectors changed drastically. In farming, the supply of machines that performed the work of animals and improved productivity was a contributing factor for a 95% reduction in the number of farm workers in the U.S. from 1900 to 2000 (40% to 2% of the population, respectively).[499] Similarly, it is estimated that almost 90% of the jobs lost in the first decade of the 2000's in U.S. manufacturing can be attributed to the replacement of workers by machines.[500]

Having experienced several waves of emerging technologies, history has taught scholars that technology-based labor transitions have yet to eliminate the overall demand for a human workforce. They refute the belief that a set number of jobs in the economy exist, where once a

[498] MIKAEL HÅRD & ANDREW JAMISON, THE INTELLECTUAL APPROPRIATION OF TECHNOLOGY: DISCOURSES ON MODERNITY, 1900-1939 (MIT Press. 1998);Johan Schot, *The Contested Rise of a Modernist Technology Politics*, *in* MODERNITY AND TECHNOLOGY (2003);Harry J. Holzer, *Will robots make job training (and workers) obsolete? Workforce development in an automating labor market*, Brookings(2017), *available at* https://www.brookings.edu/research/will-robots-make-job-training-and-workers-obsolete-workforce-development-in-an-automating-labor-market/.

[499] Carolyn Dimitri, et al., The 20th Century Transformation of U.S. Agriculture and Farm Policy (USDA 2005).

[500] Michael J. Hicks & Srikant Devaraj, The Myth and the Reality of Manufacturing in America (CONEXUS 2015).

job is lost it cannot be replaced (known as the lump labor fallacy).[501] In fact, technology has the inverse effect. According to the Organisation for Economic Cooperation and Development, not only do these transitions generate more income than the jobs they eliminate, they also tend to increase overall employment.[502]

In a competitive market economy, this process theoretically works in the following manner. Firms that replace workers with technology do so to increase productivity and decrease production costs.[503] Savings from the replacement of workers are then recycled into the economy. To compete, firms offer their products at lower prices, which increase the relative wages of consumers able to purchase more goods for the same amount of income.[504] A higher income can lead to new demand for products or services in alternative sectors that require labor, which makes possible the creation of jobs that did not exist in the past (e.g. three-dimensional printing or cybersecurity). These jobs were not foreseen decades ago and future employment opportunities may spur novel employment in areas that are difficult to forecast.[505]

Concomitant with this view, researchers agree that AI will be a net creator of jobs, improve productivity, reduce costs, expand the economy, and rescue humans from performing mundane activities for a living.[506] They cite the example of AV as a product that will force the adjustment of labor skills.[507]

Concretely, mechanics use to working on non-AV will adapt and seek training that would open the AV market for them. Many services that currently hire humans, such as taxi services or truck drivers, will no longer need them. These individuals will lose their employment, but new industries will demand their labor in the same way that horse-drawn carriage operators learned to drive internal combustion vehicles. In the long-term, the Polanyi's paradox states that jobs will always exist where humans retain a comparative advantage. It assumes that the limited understanding of the human brain represents a natural barrier for us to precisely reduce to code the performance of creative or common-sense tasks that are innate to our species.[508]

Not all positions are equally at risk during technological transitions. High skilled workers often use technology to their advantage, allowing them to complement their jobs and obtain higher wages.[509] Alternatively, low-skill workers perform tasks that can be too difficult to emulate in a cost-effective manner. This is in line with Moravec's paradox, which compares the computational

[501] The Economist, Economics A-Z terms beginning with L (The Economist 2018).
[502] OECD, *THE OECD JOBS STUDY*, OECD(1994), *available at* http://www.oecd.org/employment/emp/1941679.pdf.
[503] Holzer. 2017.
[504] Robert Atkinson, *'It's Going to Kill Us!'And Other Myths About the Future of Artificial Intelligence*, (2016).
[505] Edward Alden & Robert E Litan, *A New Deal for the Twenty-First Century*, (2017).
[506] Aaron Smith & Janna Anderson, *AI, Robotics, and the Future of Jobs*, 6 PEW RESEARCH CENTER (2014);Lewis D Solomon, *The Microelectronics Revolution, Job Displacement, and the Future of Work: A Policy Commentary*, 63 CHI.-KENT L. REV. (1987).
[507] Thierer & Hagemann, WAKE FOREST JL & POL'Y, (2015).
[508] John Danaher, Polanyi's Paradox: Will humans maintain any advantage over machines? (2015);MICHAEL POLANYI, THE TACIT DIMENSION (1966).
[509] Alden & Litan, (2017).

power required between tasks that are seemingly difficult and easy for a human.[510] The paradox contrasts "high-level" complex reasoning tasks that generally require minimal amounts of computation power with the emulation of "sensorimotor" skills, those that can easily be performed by a toddler or an adult, but involve large amounts of information processing.

Between these two tiers of employees (high and low-skilled) is the middle-skilled labor force who perform routine tasks such as organizing, storing, or manipulating their environment or information.[511] Their work is the most cost-effective to reduce and reproduce using non-humans. Because of this, they are likely to become the first victims of displacement, a trend often described as job polarization or skill-biased technological change.[512]

Consistent with this trend, today's AI capabilities are limited to work that is "well-defined, repetitive or routine, and for which performance is easy to judge."[513] Several frameworks have been developed to identify the characteristics of jobs likely to be displaced by this technology.[514] One of them was developed by Osoba and Welser, who divide jobs into a two-dimensional framework (see Table 20).[515] In it, the amount of chaos in a task comprises the first dimension. It acts as a proxy for expected predictability in a work environment. A job with high levels of chaos is one where environmental characteristics are constantly changing and quick adaptation is needed, whereas low levels of chaos are experienced by workers in a regimented space where change is unexpected. The second dimension, typical response time, is an indicator for the average time needed for the effective performance of a task.

Table 20 - Framework for Characterizing Occupational Susceptibility to Automation

		Response time	
		Long	Short
Level of chaos	High	Legal profession	Teacher
	Low	Accountant	Assembler

Adapted from: [516]

Based on the technology available in the middle of the 2010's, Osoba and Welser hypothesize that jobs with low amounts of chaos and long response times are more vulnerable to being replaced by AI. An exemplar are accountants, who apply specific rules on the management of resources. Educators in a classroom are less vulnerable to replacement due to their work

[510] Hans Moravec, Mind Children (Harvard University Press 1990).
[511] Kenneth G Dau-Schmidt, *Labor Law 2.0: The Impact of New Information Technology on the Employment Relationship and the Relevance of the NLRA*, 64 EMORY LJ (2014);Dau-Schmidt, (2017).
[512] Dau-Schmidt, EMORY LJ, (2014);Dau-Schmidt, (2017);Alden & Litan, (2017).
[513] Osonde Osoba & William Welser, *The Risks of Artificial Intelligence to Security and the Future of Work*, (2017).
[514] Id. at;Frank Pasquale & Glyn Cashwell, *Four Futures of Legal Automation*, 63 UCLA L. REV. DISCOURSE (2015).
[515] Osoba & Welser, (2017).
[516] Id. at.

environment. Multiple unpredictable students vie for the attention of an instructor that must balance the facilitation of learning, creating incentives for good behavior, and accommodate their needs.

Lastly, researchers extol the international relations consequences of AI; specifically, the reversal of the outsourcing of employment to developing economies.[517] In essence, the use of AI by developed nations can make the comparative advantage of low-cost labor mute. This benefits countries such as the U.S. at the expense of others unable to implement AI on their own and widens the gap between economies for the foreseeable future, potentially leading to conflict on a global scale.[518]

Conversely, job automation could be sent to countries were controls on labor do not exist, which entails taking jobs outside of the U.S..[519] To mitigate this risk, labor unions in developed countries have promoted initiatives to protect the employment of their workforce.[520] In Japan, union members forbade a car company from firing workers when robots where integrated into the manufacturing process. In the U.S., the International Association of Machinists created a "Technology Bill of Rights," where displaced workers were entitled to benefits that would help them find employment or retrain to continue with their employer.

Researchers interested in the fate of government policies in the age of AI posit that its diffusion may instigate society-wide consequences. One where the labor force encounters conditions in which they are unable to train for new employment or sustain their family due to the lack of opportunities. The regulatory gaps presented below are future-facing, speculative, and concise. They describe a world where the penetration of AI in the market surpasses policymakers' ability to adapt and believe that public programs, such as the educational system or the social safety net, will require bespoke attention.

4.4.1 Transition of Educational Paradigms

Public education is a core function of society that involves every level of government (local, state, and federal). Its objective is to prepare individuals with skills that translate to positive labor outcomes. The regulatory gap identified in this case is novelty. In the short-term, experts believe that the education system is unlikely to face a negative outcome.[521,522] In the medium to long-term, this can drastically change. Scholars believe that the emergence of AI applications that replace humans could force authorities to rethink how the education system adapts to meet the needs of the market.[523]

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[517] Wendy N Duong, *Ghetto'ing Workers with Hi-Tech: Exploring Regulatory Solutions for the Effect of Artificial Intelligence on Third World Foreign Direct Investment*, 22 TEMP. INT'L & COMP. LJ (2008).

[518] Michael Gemignani, *Laying down the law to robots*, 21 SAN DIEGO L. REV. (1983).

[519] Solomon, CHI.-KENT L. REV., (1987).

[520] Raymond August, *Corpus Juris Roboticum*, 8 COMPUTER/LJ (1987).

[521] Lee Rainie & Janna Anderson, *The future of jobs and jobs training*, PEW RESEARCH CENTER RETRIEVED FROM HTTP://WWW. PEWINTERNET. ORG/2017/05/03/THE-FUTURE-OF-JOBS-AND-JOBS-TRAINING (2017).

[522] Rainie and Anderson (2017) canvassed 1,408 experts. 70% of them expressed a belief that the market, and its institutions, will adapt to meet the demand for labor.

[523] Tim Kane, *The Terrifying liberation of labor*, 20 NOTRE DAME JL ETHICS & PUB. POL'Y (2006).

The main issue in the delivery of education is the speed with which the demand for skills may change. As it stands today, the majority of U.S. students receive training in phases limited to the first two decades of their lives. Considering that the emerging applications and methods of AI will continuously adapt and improve, limiting the provision of technical skills to the initial stages of a person's life hampers their ability to adapt to technologies that did not exist at the time they received training.[524] Therefore, policymakers must consider new educational models to address the capabilities gap that American workers may confront.

The literature suggests several alternatives to remedy this problem. One is to alter the educational system so that learning takes place throughout the career of a worker.[525] With this in mind, scholars argue for increasing the availability of new modalities of education – college and online courses - to the workforce so that it can "retool" itself during technological transitions.[526] Another is to prepare the population for sectors that will not be affected by the skills gap. Jobs that require creativity, collaboration, abstract and systems thinking, complex communication, and adaptability in diverse environments play on the strengths of humans.[527] Individuals with these skills could excel in scenarios that are currently impossible for machines to replicate.[528]

4.4.2 Social Safety Net

Each level of governments serves their constituents with an assortment of benefits and services (e.g. medical or job-related) when they are unable to procure an income. Referred as the social safety net in this review, scholars posit a future where AI is the catalyst for spectacularly rapid changes in the labor market. These lead to the mass displacement of laborers to the point of burdening government programs to levels for which they are unprepared. Under these conditions, scholars from the systematic review contend that the influence of AI in the workforce could force policymakers to consider new models to deliver an effective social safety net, thus generating a novelty regulatory gap.

Is it possible that the demand for labor will decrease to zero and government will have to re-think its public assistance programs? According to research, it is unlikely that a technological transition of this magnitude will occur.[529] Experts have forecasted a negative short-term impact of AI on the workforce. In a survey of 371 Chief Human Resource Officers by the World Economic Forum, respondents believed that, on average, this technology will decrease the overall availability of existing jobs by 1.56% between 2015 and 2020.[530] In this time period, AI may improve the opportunities for high skilled laborers and reduce them for their low skilled counterparts.[531]

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[524] Id. at.
[525] Holzer. 2017.
[526] Id. at.
[527] Rainie & Anderson, PEW RESEARCH CENTER RETRIEVED FROM HTTP://WWW. PEWINTERNET. ORG/2017/05/03/THE-FUTURE-OF-JOBS-AND-JOBS-TRAINING, (2017);Holzer. 2017;Kane, NOTRE DAME JL ETHICS & PUB. POL'Y, (2006).
[528] Rainie & Anderson, PEW RESEARCH CENTER RETRIEVED FROM HTTP://WWW. PEWINTERNET. ORG/2017/05/03/THE-FUTURE-OF-JOBS-AND-JOBS-TRAINING, (2017);Kane, NOTRE DAME JL ETHICS & PUB. POL'Y, (2006).
[529] OECD. 1994.
[530] Till Alexander Leopold, et al., The Future of Jobs (World Economic Forum 2016).
[531] Smith & Anderson, PEW RESEARCH CENTER, (2014);Solomon, CHI.-KENT L. REV., (1987).

In the long-term, job replacement could drive all skill levels (even high-skilled ones) out of employment. This may happen if the complexity of systems increases to the point that no human is able to operate, maintain, or keep up with AI-based technologies.[532] As new jobs emerge at a rapid pace, an accelerating skills mismatch would impede most workers from training at a rate that meets demand, convincing employers to further automate tasks.[533] Therefore, there is a non-zero chance that a sizable proportion of the population does not adapt and requires a new model of public assistance than the one available. The current state of the safety net is not designed to fully support a massive number of families in a future where they are unable to gain employment in the medium to long-term.

[532] Gemignani, SAN DIEGO L. REV., (1983).
[533] Solomon, CHI.-KENT L. REV., (1987).

4.5 Personhood

The rights and responsibilities enjoyed by organic and non-organic entities have a fluid history in the U.S..[534] The last 200 years are marked by a decline in the reliance of demographic factors (e.g. sex and race) to deprive individuals from the benefits of personhood.[535] At the same time, rights for non-human entities have expanded (e.g. Freedom of speech via the Citizens United Supreme Court case) and arguments in favor of bestowing privileges from the "Second, Third, Fourth, Fifth and Six Amendments" are increasing.[536]

AI methods and applications benefit from the second trend. As their capabilities increase, legal distinctions between a human and a sufficiently autonomous non-human AI agent can become progressively more difficult to make. Although AI systems have limited to no rights today, Solum posits that future humans may argue against the provision of legal personhood to non-biological counterparts based on their lack of characteristics that are perceived to be exclusive to humans: consciousness, freewill, emotion, or intentionality.[537] Notwithstanding the ability of AI agents to act as if they possessed these characteristics, policymakers and the courts will be the arbiters of what rights bestowed to adults are granted to these entities.[538]

This section examines the frontier of this debate (see Table 21). Applications of AI are gradually performing achievements that complement or substitute humans, thus generating eight regulatory gaps that challenge our perception of personhood. Intellectual property is an example. AI agents are capable of creating works and discoveries worthy of protection through copyright and patents, but their under-inclusion from regulation leads people to fraudulently attribute knowledge to undeserving parties or use trade secrets to limit their dissemination. With freedom of speech, entities such as corporations have obtained this right because their opinions emanate from groups of humans. Scholars express uncertainty about the limits of expression once the human umbilical cord is cut and AI agents spread ideas on their own.

Table 21 - Regulatory Gaps in Personhood

Issue	Regulatory Gap	Type of Gaps	Government Level	Time Frame	Type of AI
Intellectual Property Rights	Copyrights	Targeting (Under)	Federal	Present	Application
	Patents	Targeting (Under)	Federal	Present	Application
Freedom of Speech	First Amendment and AWS	Uncertainty	Federal	Present	Application
Accountability	Mens Rea for AI Agents	Targeting (Under)	Federal + State	Future	Application

[534] Hutan Ashrafian, *Artificial intelligence and robot responsibilities: Innovating beyond rights*, 21 SCIENCE AND ENGINEERING ETHICS (2015);F Patrick Hubbard, *Do Androids Dream: Personhood and Intelligent Artifacts*, 83 TEMP. L. REV. (2010).

[535] Mark Goldfeder & Yosef Razin, *Robotic marriage and the law*, 10 JL & SOC. DEVIANCE (2015).

[536] Angelo Guisado, *When Harry Met Sallie Mae: Marriage, Corporate Personhood, and Hyperbole in an Evolving Landscape*, 10 JOURNAL OF LAW AND SOCIAL DEVIANCE (2014);Anthony J Bellia Jr, *Contracting with electronic agents*, 50 EMORY LJ (2001).

[537] Froomkin & Colangelo, CONN. L. REV., (2015);Solum, NCL REV., (1991).

[538] Čerka, et al., COMPUTER LAW & SECURITY REVIEW, (2015);Solum, NCL REV., (1991);Hubbard, TEMP. L. REV., (2010);Thomas A Smith, *Robot Slaves, Robot Masters, and the Agency Costs of Artificial Government*, 1 CRITERION J. ON INNOVATION (2016).

	Punishing AI Agents	Uncertainty	Federal + State + Local	Future	Application
Commercial Agency	Non-Human Representation	Uncertainty	State	Present	Application
Marriage	Consent of Non-Human	Uncertainty	State	Future	Application
AI Agent Rights	Protecting non-organic entities from Harm	Uncertainty	Federal	Future	Application

It is undeniable that AI agents will commit illegal acts where a responsible party will face justice. An option highlighted by scholars is to charge AI agents directly with these crimes. Regulatory gaps within this literature cross two themes of the dissertation: personhood and accountability. Due to its focus on AI agents, both gaps dealing with intent to commit a crime and the punishment of this technology are included in this section.

In commerce, personhood is required to represent the interests of another individual or entity. Court cases and theoretical exceptions to state law have cast doubt on the legality of non-humans performing these duties. Finally, limitations on marriage between consenting adults have gradually been removed in the U.S.[539] The civil union between a human and non-human could generate a regulatory gap of uncertainty. In this scenario, policymakers will debate whether human standards of consent apply to non-humans.

4.5.1 Intellectual Property Rights

> *"[Congress shall have power] to promote the progress of science and useful arts, by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries."*[540]

Written when the country was founded, this statement defends the fruits of intellectual property through the allocation of a monopoly. These monopolies are known as copyrights and patents. They incentivize individuals to create and communicate ideas that benefit all of society.

Both instruments explicitly exclude non-humans from obtaining intellectual property rights. This is despite the ability of AI-agents to generate works or discoveries that meet the standards required to allocate these rights. The lack of alternatives for protecting these outputs creates a targeting regulatory gap. Non-human AI agents are under-included in current policy, which can lead to undesirable behavior such as human appropriation of outputs or the concealment of knowledge that may improve the state of the art in science and the creative arts.

4.5.1.1 Copyrights

Copyright is a government-mandated monopoly for "original works of authorship fixed in any tangible medium of expression."[541] Policy establishes a low bar for an original work. In effect, no creativity requirement exists. Instead, an author must contribute to its creation, it cannot be copied from other works, and it must be captured in a medium (e.g. book, musical piece, or

[539] With the exception of restrictions on unions due to consanguinity.
[540] *U.S. Const., Section 8.*
[541] U.S. Code, Title 17 § 102 (2016).

electronic file).[542] It also presupposes that authors are human. Non-humans are not considered authors and ineligible to receive a copyright. This stipulation is the main barrier for protecting works "authored" by non-human AI agents.

Existing applications of AI are fueling a regulatory gap of targeting (under-inclusion) because original works that comply with the goal of the policy cannot be assigned property rights since non-humans are excluded from receiving copyrights. The following paragraphs will inform the reader on the basis for denying copyright to AI agents, describe the lack of alternatives to allocate these rights, and highlight the repercussions of under-including non-humans.

Up until the second half of the 20th century there was no need to question how or if the output of non-humans could receive copyright protection.[543] The first mention of this issue is found in the 1965 annual report of the Copyright Office.[544] Having experienced substantial interest in the protection of software, the Office rhetorically asked how it would judge the authorship of a work created by a machine, rather than a person.[545][546] Subsequently, the federal government organized the National Commission on New Technological Uses of Copyrighted Works (CONTU) to tackle how computers would affect copyright.[547] In its final report, CONTU affirms that "there is no reasonable basis for considering that a computer in any way contributes authorship to a work produced through its use" and compared it to inert objects that serve as tools, much like a camera or typewriter, rather than originators of creative output.[548] Less than a decade after this report was published, advances in technology convinced the Office of Technology Assessment to diverge from CONTU's conclusions. It stated that "it is still an open question … whether machines or interactions with machines might produce a pattern of output that would be considered creative or original if done by a human."[549]

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[542] Gemignani, SAN DIEGO L. REV., (1983);Annemarie Bridy, *Coding creativity: copyright and the artificially intelligent author*, STAN. TECH. L. REV. (2012);Shlomit Yanisky-Ravid & Luis Antonio Velez-Hernandez, *Copyrightability of Artworks Produced by Creative Robots and Originality: The Formality-Objective Model*, 19 MINN. JL SCI. & TECH. (2018);Evan H Farr, *Copyrightability of computer-created works*, 15 RUTGERS COMPUTER & TECH. LJ (1989);Bruce E Boyden, *Emergent Works*, 39 COLUM. JL & ARTS (2015);Pamela Samuelson, *Allocating ownership rights in computer-generated works*, 47 U. PITT. L. REV. (1985);Timothy L Butler, *Can a computer be an author-copyright aspects of artificial intelligence*, 4 COMM/ENT LS (1981).

[543] Boyden, COLUM. JL & ARTS, (2015).

[544] Miller, HARVARD LAW REVIEW, (1993);Bridy, STAN. TECH. L. REV., (2012).

[545] USCO, *ANNUAL REPORT OF THE REGISTER OF COPYRIGHTS FOR THE FISCAL YEAR ENDING JUNE 30, 1965*, USCO(1965), *available at* https://www.copyright.gov/reports/annual/archive/ar-1965.pdf.

[546] From USCO (1965): "The crucial question appears to be whether the work is basically one of human authorship, with the computer merely being an assisting instrument, or whether the traditional elements of authorship in the work (literary, artistic, or musical expression or elements of selection, arrangement, etc.) were actually conceived and executed not by man but by a machine."

[547] Farr, RUTGERS COMPUTER & TECH. LJ, (1989);Miller, HARVARD LAW REVIEW, (1993);Yvette Joy Liebesman, *The Wisdom of Legislating for Anticipated Technological Advancements*, 10 J. MARSHALL REV. INTELL. PROP. L. (2010).

[548] CONTU, *National Commission on New Technological Uses of Copyrighted Works*(1978), *available at* http://digital-law-online.info/CONTU/.

[549] Office of Technology Assessment. 1986.

Although the Copyright Act does not define what an "author" is, the Supreme Court has made personhood a requirement by declaring that the party "who actually creates the work, that is, the person who translates an idea into a fixed, tangible expression entitled to copyright protection."[550] Several sections of the Act suggest the need for human personhood.[551] It mentions phenomena that are unique to humans such as the treatment of these rights upon death and specifies who can inherit them.[552,553] Further, the administrative manual that guides how authorities enforce the Copyright Act explicitly exclude non-humans from obtaining these rights.[554,555]

Several court cases have tested the rights of non-human authors. In 2011, a macaque monkey took a picture of itself with the camera of an artist that subsequently copyrighted it.[556] Courts found that non-humans cannot assert property rights over an image and placed this intellectual property in the public domain. In Urantia Foundation V. Maaherra, a religious group made the case that their sacred text was authored by non-human celestial entities that dictated it to its followers.[557] Despite the non-human origin, the court granted copyright protection to this text because the followers provided creative input to the work as they "compiled, selected, coordinated, and arranged the Urantia teachings" which qualifies as a compilation.[558] These cases are representative of a consensus where non-human AI agents are not considered authors and their creative works are ineligible for protection unless humans have creative input.

Scholars in this field have explored (and refuted) whether different categories of humans may receive a copyright for an AI agent's output. Programmers are one option. Their work in

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[550] J Weaver, *Siri is my client: A first look at artificial intelligence and legal issues*, 52 NEW HAMPSHIRE BAR JOURNAL (2012);Commun. for Non-Violence v. Reid, 490 U.S. 730, (1989).

[551] Ralph D Clifford, *Intellectual property in the era of the creative computer program: Will the true creator please stand up*, 71 TUL. L. REV. (1996);Robert C Denicola, *Ex Machina: Copyright Protection for Computer Generated Works*, 69 RUTGERS UL REV. (2016);Darin Glasser, *Copyrights in Computer-Generated Works: Whom, If Anyone, Do We Reward?*, 1 DUKE LAW & TECHNOLOGY REVIEW (2001);Liebesman, J. MARSHALL REV. INTELL. PROP. L., (2010);Dane E Johnson, *Statute of Anne-Imals: Should Copyright Protect Sentient Non-Human Creators*, 15 ANIMAL L. (2008).

[552] U.S. Code, Title 17 § 304 (2016);id. at, § 203.

[553] From U.S. Code, Title 17. 2016;id. at, § 203.:

- **Death:** "Copyright in a work […] endures for a term consisting of the life of the author and 70 years after the author's death."
- **Marriage and children:** "The widow or widower owns the author's entire termination interest unless there are any surviving children or grandchildren of the author, in which case the widow or widower owns one-half of the author's interest."

[554] USCO, *Compendium of U.S. Copyright Office Practices*, USCO(2017), *available at* https://www.copyright.gov/comp3/docs/compendium.pdf;Denicola, RUTGERS UL REV., (2016);Khoury, CARDOZO ARTS & ENT. LJ, (2016).

[555] "The U.S. Copyright Office will register an original work of authorship, provided that the work was created by a human being" USCO, Compendium of U.S. Copyright Office Practices. 2017..

[556] Andrés Guadamuz, *The Monkey Selfie: Copyright Lessons for Originality in Photographs and Internet Jurisdiction*, INTERNET POLICY REVIEW (2016).

[557] Urantia Foundation v. Maaherra, 895 F. Supp. 1337, (D. Ariz. 1995).

[558] Christina Rhee, *Urantia Foundation v. Maaherra*, BERKELEY TECHNOLOGY LAW JOURNAL (1998).

developing computer programs can receive protection as literary works.[559] No copyright protection is available if an AI agent independently creates a work without the input of a programmer (i.e. conceiving the finished product, predicting its outcome, or affixing it to any medium).[560] Moreover, these outputs cannot be characterized as derivative works as long as they do not contain a "recognizable block of expression" from the original coding.[561,562]

Even if it was possible to allocate copyright to a programmer, the literature speculates that it would create disadvantageous economic incentives for all parties. Programmers would need to share their property rights with upstream contributors in the form of an "operating system programmer, the owner of the microcode embedded in the hardware, or the programmer who wrote the optimizing compiler that transformed the source code for the generator program into machine-readable form."[563] Users could be dissuaded from purchasing a product if the programmer can reap two types of rewards: financial gain from its sale or license and a stake in outputs they did not participate in creating.[564]

Users of AI are an alternative for the allocation of copyright. It is acknowledged that if AI serves as a tool for the creation of a work (much like a camera or a brush), then copyright should be granted to its user.[565] We can think of scenarios where individuals could ask an AI-powered assistant to generate a poem for their significant other that highlights a number of key life experiences. For these works, users may be entitled to copyright because they contributed creative input and could anticipate the output of the AI agent.[566] This would not be the case if a user presses a button and has no expectation of the outcome. Then, like their programmer counterparts, users cannot receive copyrights from works they did not assist in creating.[567]

Scholars have even contemplated designating the programmer and user as collaborators in the creation of an AI-generated work. According to the Copyright Act, a joint work is one "prepared by two or more authors with the intention that their contributions be merged into inseparable

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[559] Miller, HARVARD LAW REVIEW, (1993);Todd Shuster, *Originality in Computer Programs and Expert Systems: Discerning the Limits of Protection Under Copyright Laws of France and the United States*, 5 TRANSNAT'L LAW. (1992);Morton David Goldberg & David O Carson, *Copyright Protection for Artificial Intelligence Systems*, 39 J. COPYRIGHT SOC'Y USA (1991).

[560] Samuelson, U. PITT. L. REV., (1985);Gemignani, SAN DIEGO L. REV., (1983);Farr, RUTGERS COMPUTER & TECH. LJ, (1989).

[561] Glasser, DUKE LAW & TECHNOLOGY REVIEW, (2001).

[562] From U.S. Code (2016): "A derivative work is a work based upon one or more preexisting works, such as a translation, musical arrangement, dramatization, fictionalization, motion picture version, sound recording, art reproduction, abridgment, condensation, or any other form in which a work may be recast, transformed, or adapted. A work consisting of editorial revisions, annotations, elaborations, or other modifications, which, as a whole, represent an original work of authorship, is a derivative work".

[563] Samuelson, U. PITT. L. REV., (1985).

[564] Glasser, DUKE LAW & TECHNOLOGY REVIEW, (2001);Samuelson, U. PITT. L. REV., (1985);Denicola, RUTGERS UL REV., (2016);Andrew J Wu, *From Video Games to Artificial Intelligence: Assigning Copyright Ownership to Works Generated by Increasingly Sophisticated Computer Programs*, 25 AIPLA QJ (1997).

[565] Dan Rosen, *A Common Law for the Ages of Intellectual Property*, 38 U. MIAMI L. REV. (1983);Bridy, STAN. TECH. L. REV., (2012);Denicola, RUTGERS UL REV., (2016).

[566] Gemignani, SAN DIEGO L. REV., (1983);Khoury, CARDOZO ARTS & ENT. LJ, (2016).

[567] Glasser, DUKE LAW & TECHNOLOGY REVIEW, (2001);Boyden, COLUM. JL & ARTS, (2015).

or interdependent parts of a unitary whole."[568] For the copyright to be shared amongst these parties, they need to establish an intent to work together as co-authors in the production of an output.[569] If this intent is absent, and an AI agent creates a work autonomously, users and programmers would not fulfill the conditions for a joint work.

The literature on this subject has also debated the implications of the Copyright Act's "work for hire statute" on AI.[570] In this relationship, an "employer", in the form of a human, would not need to have any role in the creation of the work that merits a copyright.[571] If a user is designated as the employer of an AI system capable of generating copyrightable outputs then, in theory, it would become the owner of these works.[572] The problem with this hypothetical is that an employment relationship requires that the "employee" attain personhood.[573] As of today, AI agents are ineligible for personhood, cannot be deemed employees, and may not endorse the copyright of their outputs to an "employer."

We find ourselves in a world where the output of AI agents can objectively pass the low bar of originality set by the Copyright Act.[574] Yet, these works cannot receive a government monopoly and are subject to being placed in the public domain.[575]

The under-inclusion of these works means that the humans charged with developing or operating these AI systems cannot protect or reap the rewards of outputs that may benefit society.[576] Without incentives, individuals may choose to hide their work from the public or register copyrightable outputs under their name.[577] This was done in the early days of computer technology where humans registered two novels generated by AI agents (titled: The Policeman's Beard is Half Constructed and Just This Once).[578]

The targeting of current policies must address the lack of alternatives for the allocation of copyrights to works created by AI agents. The U.S. can learn from countries that incorporate non-

[568] U.S. Code, Title 17 § 101 (2016).
[569] Samuelson, U. PITT. L. REV., (1985);Margot Kaminski, *Authorship, Disrupted: AI Authors in Copyright and First Amendment Law*, (2017);Glasser, DUKE LAW & TECHNOLOGY REVIEW, (2001);Farr, RUTGERS COMPUTER & TECH. LJ, (1989);Butler, COMM/ENT LS, (1981).
[570] The Copyright Act defines work for hire as: "a work prepared by an employee within the scope of his or her employment" U.S. Code, Title 17. 2016.
[571] Wu, AIPLA QJ, (1997);Kaminski, (2017);Glasser, DUKE LAW & TECHNOLOGY REVIEW, (2001).
[572] Clifford, TUL. L. REV., (1996).
[573] Denicola, RUTGERS UL REV., (2016);Kalin Hristov, *Artificial Intelligence and the Copyright Dilemma*, 57 IDEA (2016);Bridy, STAN. TECH. L. REV., (2012).
[574] Yanisky-Ravid & Velez-Hernandez, MINN. JL SCI. & TECH., (2018).
[575] Liebesman, J. MARSHALL REV. INTELL. PROP. L., (2010);Glasser, DUKE LAW & TECHNOLOGY REVIEW, (2001);Weaver, NEW HAMPSHIRE BAR JOURNAL, (2012);Khoury, CARDOZO ARTS & ENT. LJ, (2016);Boyden, COLUM. JL & ARTS, (2015);Farr, RUTGERS COMPUTER & TECH. LJ, (1989);Bridy, STAN. TECH. L. REV., (2012);Hristov, IDEA, (2016);Evan D Brown, *Copyright on the Semantic Web: Divergence of Author and Work*, 19 WIDENER LJ (2009).
[576] Miller, HARVARD LAW REVIEW, (1993);Ryan Abbott, *I Think, Therefore I Invent: Creative Computers and the Future of Patent Law*, 57 BCL REV. (2016);Hristov, IDEA, (2016).
[577] Samuelson, U. PITT. L. REV., (1985).
[578] Wu, AIPLA QJ, (1997).

humans into its property rights system such as the U.K.[579] It must also consider extraordinary long-term scenarios where autonomous AI agents can perform feats not contemplated by current policies. One is the brute-force generation of copyright content (e.g. music, poems, literature) that would place every conceivable combination of words or chords in the public domain. This outcome would, at the very least, disincentivize human creativity. [580] Another scenario is one were humans are completely absent from the copyright process, as speculated by Wu below:[581]

- Programmer is not human;
- There is no user;
- The lack of the former two makes it impossible for a joint work;
- Output fulfills the originality requirement; and,
- AI has discretion over when and how it creates an output.

4.5.1.2 Patents

Whereas the threshold of creativity in copyright is "virtually" absent, a higher standard of scrutiny is applied to patents. Conferring one entails the discovery of "any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement."[582] The regulatory gap of targeting observed in patents is identical to the one found with copyrights. There are no legal alternatives to protect discoveries by non-human agents through a government monopoly.[583] Hence, these outputs are under-included in the regulation that incentivizes the generation of new intellectual property.

The eligibility criteria for patents is clear, only humans that conceive a discovery can obtain a government-endorsed monopoly.[584] In fact, the definition for the term inventor references an "individual…[or]…individuals" and, to complete a patent application, a claimant must declare that they believe "himself or herself to be the original inventor."[585] Non-humans cannot apply for a patent and any of their discoveries would automatically be placed in the public domain.[586] Similar to copyrights, alternatives to allocate intellectual property rights in the form of invent-for-hire arrangements, where employees assign their inventions to employers, have a personhood requirement that limit its application to AI agents.[587]

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[579] Burkhard Schafer, et al., *A fourth law of robotics? Copyright and the law and ethics of machine co-production*, 23 ARTIFICIAL INTELLIGENCE AND LAW (2015);Denicola, RUTGERS UL REV., (2016).
[580] Kirk Sigmon, *How to Kill Copyright: A Brute-Force Approach to Content Creation*, 14 WAKE FOREST J. BUS. & INTELL. PROP. L. (2013).
[581] Wu, AIPLA QJ, (1997).
[582] U.S. Code, Title 35 § 101 (1952).
[583] Clifford, TUL. L. REV., (1996);Abbott, BCL REV., (2016).
[584] Liza Vertinsky & Todd M Rice, *Thinking About Thinking Machines: Implications of Machine Inventors for Patent Law*, 8 BUJ SCI. & TECH. L. (2002);Clifford, TUL. L. REV., (1996);Abbott, BCL REV., (2016).
[585] U.S. Code, Title 35 § 115 (1952).
[586] Vertinsky & Rice, BUJ SCI. & TECH. L., (2002);Ryan Abbott, *Patenting the Output of Autonomously Inventive Machines*, 10 LANDSLIDE (2017);Ben McEniery, *Physicality and the Information Age: A Normative Perspective on the Patent Eligibility of Non-Physical Methods*, 10 CHI.-KENT J. INTELL. PROP. (2010).
[587] United States v. Dubilier Condenser Corp., 289 U.S. 178, (1933).

Humans that develop or utilize AI agents to produce novel work are the only entities able to recognize if a discovery is significant enough to deserve protection.[588] But, because policy omits and penalizes the work of non-humans, there are incentives for humans to under-report and appropriate the fruits of an AI agent's work.[589] Abbott points out two examples of approved patents where humans falsely assumed the role of inventor: "Apparatus for Improved General-Purpose PID and non-PID Controllers" and "Device for the Autonomous Generation of Useful Information."[590]

The spirit of the law bestows patent monopolies for discoveries that benefit humanity. Under-including circumstances where humans have no role in a discovery promotes the protection of intellectual capital through trade secrets or lying to appropriate intellectual property rights.[591] Future generations of policymakers must develop solutions that allow humans to benefit from these discoveries regardless of their non-human origin.

4.5.2 Freedom of Speech

The First Amendment of the Constitution states that "congress shall make no law…. abridging the freedom of speech, or of the press."[592] In its simplest form, the Amendment allows individuals and groups of people to communicate ideas without the fear of government censorship. Up until this point in history, First Amendment speech originates with individuals, be it alone or as members of groups (e.g. corporations). The regulatory gap of uncertainty emerges when scholars inquire about the protections afforded to AI agents that are disconnected from any human influence or contact. Eliminating humans from the speech equation poses interesting questions about what limits on expression can be imposed on non-humans.

The interpretation of speech that falls under the protection of the First Amendment has evinced a number of transitions.[593] Until the middle of the 20th century films were not covered.[594] In the 21st century, the Supreme Court confirmed that speech cannot be limited based on the identity of the speaker.[595] Meaning that organized groups of people, in the form of corporations or labor unions, were granted rights equivalent to those enjoyed by individuals.[596] Not all speech is free

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[588] Abbott, BCL REV., (2016);Abbott, LANDSLIDE, (2017);McEniery, CHI.-KENT J. INTELL. PROP., (2010).

[589] Liza Vertinsky, *Boundary-Spanning Collaboration and the Limits of Joint Inventorship Doctrine*, (2017);Ben Hattenbach & Joshua Glucoft, *Patents in an Era of Infinite Monkeys and Artificial Intelligence*, 19 STAN. TECH. L. REV. (2015);McEniery, CHI.-KENT J. INTELL. PROP., (2010).

[590] Stephen L. Thaler, Device for the autonomous generation of useful information § US5659666A (USPTO ed., 1994);Martin A Keane, et al., Apparatus for improved general-purpose PID and non-PID controllers § US6847851B1 (USPTO ed., 2002);Abbott, BCL REV., (2016).

[591] Abbott, BCL REV., (2016).

[592] U.S. Const., amend. I.

[593] Kaminski, (2017).

[594] Joseph Burstyn, Inc. v. Wilson, 343 U.S. 495, (1952);Mutual Film Corp. v. Industrial Comm'n of Ohio, 236 U.S. 230, (1915).

[595] Teneille R Brown, *In-Corp-O-Real: A Psychological Critique of Corporate Personhood and Citizens United*, 12 FLA. ST. U. BUS. REV. (2013);Citizens United v. Federal Election Commission, 558 U.S. 310, (2010);Toni M Massaro & Helen Norton, *Siri-ously? Free Speech Rights and Artificial Intelligence*, 110 NW. UL REV. (2015).

[596] Brown, FLA. ST. U. BUS. REV., (2013);Toni M Massaro, et al., *SIRI-OUSLY 2.0: What Artificial Intelligence Reveals about the First Amendment*, 101 MINN. L. REV. (2016).

from scrutiny. The government does have the power to regulate the content of any false, misleading speech, or compelling disclosures.[597]

Applications of AI have already received First Amendment scrutiny. Courts supported the rights of Google and Baidu programmers in the creation of algorithms that behave much like editors or publishers of periodicals when selecting and sorting the information displayed in search results.[598] In these cases, AI applications were understood as conduits for the opinions of the individuals within these firms.[599]

The regulatory gap of uncertainty is confronted when interpreting the treatment of expressions that are disconnected from the human umbilical cord. If an autonomous AI agent expresses an idea, independently from a human, courts will have to determine if it qualifies for First Amendment protection.[600] The systematic review offers insights into the contrasting opinions of scholars on this issue.

One argument is that speech is limited to qualified speakers and what AI agents perform is akin to conduct.[601] In this literature, conduct is behavior only protected by the First Amendment if it contains an expressive component.[602] The burning of the American flag was considered an expressive conduct that denotes disagreement with policies of the U.S. government.[603] If AI output is classified as conduct that is not expressive or if courts deem that an AI agent does not qualify as a speaker, it loses constitutional protection.[604]

Bambauer analyzes whether data can be considered speech.[605] She concludes that as long as the output serves to create knowledge or, as stated by the author, "freedom from intentional or excessive government restraints on learning something new", First Amendment protection should be afforded. Massaro, Norton et al. believe that all expressions, regardless of their source, should receive protection to guarantee the free flow of information.[606] Wu proposes a more restrictive approach.[607] According to the author, not all output of an intelligent non-human should automatically be protected. Only instances where "speech products" that "are viewed as

[597] Massaro & Norton, NW. UL REV., (2015);Massaro, et al., MINN. L. REV., (2016).
[598] Cavender, WASH. U. JURISPRUDENCE REV., (2017);Eugene Volokh & Donald Falk, *First Amendment Protection for Search Engine Search Results -- White Paper Commissioned by Google*, 12 UCLA SCHOOL OF LAW RESEARCH PAPER (2012);Bracha & Pasquale, CORNELL L. REV., (2007);id. at;Massaro, et al., MINN. L. REV., (2016);Boughman, et al., BUSINESS LAW TODAY, (2017);Seema Ghatnekar, *Injury by Algorithm*, 33 LOY. LA ENT. L. REV. (2012).
[599] Boughman, et al., BUSINESS LAW TODAY, (2017).
[600] Id. at.
[601] Massaro, et al., MINN. L. REV., (2016).
[602] Caroline Mala Corbin, *Speech or Conduct? The Free Speech Claims of Wedding Vendors* 65 EMORY LAW JOURNAL (2015).
[603] Texas v. Johnson, 491 U.S. 397, (1989).
[604] In Spence v. Washington, the Supreme Court established a two-part test to identify expressive conduct: "An intent to convey a particularized message was present, and in the surrounding circumstances the likelihood was great that the message would be understood by those who viewed it" Spence v. Washington, 418 U.S. 405, (1974)..
[605] Jane Bambauer, *Is Data Speech?*, 66 STANFORD LAW REVIEW (2014).
[606] Massaro, et al., MINN. L. REV., (2016).
[607] Tim Wu, *Machine Speech*, 161 UNIVERSITY OF PENNSYLVANIA LAW REVIEW (2013).

vessels for the ideas of a speaker, or whose content has been consciously curated" should fall under the First Amendment.[608]

4.5.3 Accountability

Historical antecedents exist for assigning animals and non-organic objects with "deodand" liability (e.g. weapons, railroad locomotives, and ships) over harms caused to society.[609] AI agents are the newest iteration of this lineage. This section identifies two regulatory gaps in the literature instigated by society's desire to hold this technology accountable for its illegal acts. These gaps were not included in the accountability section due to their relationship to the personhood of AI agents.

4.5.3.1 Mens Rea for AI Agents

It is within the realm of possibility that a crime is committed, yet no human, or an entity controlled by humans, perpetrated or prevented it.[610] In these cases, there is support among scholars in the systematic review for holding AI agents responsible for acts that would be deemed illegal if performed by people.[611] The regulatory gap of targeting (under-inclusion) is witnessed if and when AI agents are charged for crimes that require proof of mens rea or the intent to commit a crime. Due to the fact that they lack recognition as a legal person, one with duties and responsibilities to society, they are not subject to mens rea standards and cannot be held responsible.

In civil criminal cases, Hallevy asserts that the justice system could directly charge an AI entity if two elements are demonstrated: actus reus and mens rea. Actus reus is an action (e.g. slapping a person) or omission of action (e.g. a lifeguard that watches a person drown in a pool) that produces a crime.[612] Evidence of an AI agent committing a crime through an act (physical or electronic) or through omission, if there was a duty to act, suffices to establish actus reus.[613] Mens rea is the intent to commit a crime.[614] Many states divide mens rea into four hierarchical categories depending on the level of malice in perpetrating a crime, starting with doing so purposefully, knowingly, recklessly, and negligently.[615] Due to the fact that AI agents lack personhood, these categories cannot be applied to them.

An example of crimes that could be carried by an AI agent and require mens rea are market manipulation cases. Humans who perform practices such as "banging the close, wash trading, or spoofing" or create algorithms with the intention to incent monopolistic behavior can have demonstrable mens rea.[616] Since AI agents are not legal persons, there is no recourse to apply

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[608] Id. at.

[609] Wein, HARV. JL & TECH., (1992).

[610] Curtis EA Karnow, *Liability for distributed artificial intelligences*, BERKELEY TECHNOLOGY LAW JOURNAL (1996).

[611] Id. at;Wein, HARV. JL & TECH., (1992);Gevers, RUTGERS JL & PUB. POL'Y, (2014);Hollis, TEMP. INT'L & COMP. LJ, (2016);Paul C. Giannelli, *Criminal Law Defenses*, 319 FACULTY PUBLICATIONS (1996).

[612] LLI, *Actus Reus*, Cornell University(2019), *available at* https://www.law.cornell.edu/wex/actus_reus;Hallevy, AKRON INTELL. PROP. J., (2010).

[613] Hallevy, SYRACUSE SCI. & TECH. L. REP., (2010);Hallevy, AKRON INTELL. PROP. J., (2010).

[614] LLI, *Mens Rea*, Cornell University(2019), *available at* https://www.law.cornell.edu/wex/mens_rea.

[615] Id. at;Karnow, BERKELEY TECHNOLOGY LAW JOURNAL, (1996).

[616] Gregory Scopino, *Do Automated Trading Systems Dream of manipulating the Price of Futures Contracts-Policing Markets for Improper Trading Practices by Algorithmic Robots*, 67 FLA. L. REV. (2015);Tom CW Lin, *The New Financial*

mens rea to similar acts committed by them. Another example is the accountability for defamatory speech by an AI agent.[617] The Supreme Court found that a claim of defamation or libel can only be sustained if the defendant can show culpable intent.[618] As with financial crimes, these non-legal persons are excluded from culpability because of their personhood. Maintaining the status quo means that an AI application free from human control would live in a society without the tools to hold it accountable for its actions.

4.5.3.2 Punishing AI Agents

Economic and non-economic punishment has the purpose of dissuading humans from committing a crime. The justice system has a portfolio of penalties applicable to humans or entities under their control (e.g. firms) when they are judged as guilty (e.g. ranging from a fine to capital punishment). Scholars posit that AI agents in the future may autonomously perform an illegal act, forcing society to rethink the penalties that should be applied to entities that are not controlled by humans. This scenario creates an uncertainty regulatory gap where policymakers need to determine which forms of existing punishment should be applied to non-humans. Solving this gap is important to deter the use of AI agents as liability shields that avoid accountability over illegal acts.[619]

Monetary compensation is one channel to satisfy one's duties to society. For centuries, inanimate objects have been personified under the precedent of deodand liability.[620] Maritime law stipulates that liability for an accident can be placed on a ship if the owners did not participate or have knowledge of its acts.[621] Even though the crew was charged with its navigation, the precedent released owners from any claims and allows the property to be arrested, forfeited, and sold to cover the damages.[622] Autonomous AI agents are unlike naval vessels subject to deodand liability because they are not controlled by humans and they may not have owners accountable for their actions. However, policymakers must determine if this precedent serves the needs of society. If yes, it would mean that guilty AI agents are sold and the proceeds would comprise the maximum amount that a party receives. Further, if the agent has no residual value, liability could be covered through insurance schemes, among other alternatives.[623]

Industry, 65 ALA. L. REV. (2013);Tom CW Lin, *The new market manipulation*, 66 EMORY LJ (2016);Yesha Yadav, *The Failure of Liability in Modern Markets*, VIRGINIA LAW REVIEW (2016);Ariel Ezrachi & Maurice E Stucke, *Artificial intelligence & collusion: When computers inhibit competition*, U. ILL. L. REV. (2017).

[617] Massaro & Norton, NW. UL REV., (2015).

[618] New York Times Co. v. Sullivan, 376 U.S. 254, (1964).

[619] Bryson, et al., ARTIFICIAL INTELLIGENCE AND LAW, (2017).

[620] Kastan, U. ILL. JL TECH. & POL'Y, (2013);Beard, GEO. J. INT'L L., (2013).

[621] Michal Chwedczuk, *Analysis of the Legal Status of Unmanned Commercial Vessels in US Admiralty and Maritime Law*, 47 JOURNAL OF MARITIME LAW AND COMMERCE (2016).

[622] Fed. R. Civ. P., C;Carlo Corcione, *Bring the vessel to court: The unique feature of the action in rem in the admiralty law proceedings*, 7 INTERNATIONAL REVIEW OF LAW (2013);William Tetley, *Arrest, Attachment, and Related Maritime Law Procedures*, 73 TULANE LAW REVIEW (1999);Kastan, U. ILL. JL TECH. & POL'Y, (2013);Chwedczuk, JOURNAL OF MARITIME LAW AND COMMERCE, (2016).

[623] Gless, et al., NEW CRIMINAL LAW REVIEW: IN INTERNATIONAL AND INTERDISCIPLINARY JOURNAL, (2016);Jean-Francois Lerourge, *The use of electronic agents questioned under contractual law: Suggested solutions on a European and American Level*, 18 J. MARSHALL J. COMPUTER & INFO. L. (1999);Bryson, et al., ARTIFICIAL INTELLIGENCE AND LAW, (2017);Bert-

Outside of economic harms, which are resolved by paying a fine, non-economic harms require the apportionment of justice. Humans who commit a non-economic crime are essentially subject to two types of sanctions: imprisonment and capital punishment.[624,625] AI agents that generate harms that cannot be recovered through monetary payments (e.g. murder) will challenge future generations of policymakers. As no human would be responsible for the agent, society will need to appropriately account for their actions through existing penalties. They could be classified as wild animals (those without an owner) and sentenced to death if they attack or kill a human. For lesser crimes, they may be treated as humans and have their autonomy restricted. In all cases, policymakers will need to disambiguate what classification is the most appropriate so that AI agents are subject to a comparable and sufficient form of justice as their organic peers.

4.5.4 Commercial Agency

The Restatement (Third) of Agency affirms that only humans can represent the interests of another human.[626,627] Despite the absence of a unifying federal regulation on this matter and the 50 potential variations on its interpretation at the state level, a common understanding is that an entity without personhood cannot act as a legal agent.[628] This section presents scenarios that confound this norm and generate a regulatory gap of uncertainty where the inconsistent application of the law attributes personhood to non-human entities that act as agents of firms or serve as their own agent. Although some of the examples do not mention AI-powered applications, scholars in this literature utilize these precedents to speculate on uncertainty gaps that firms can encounter when AI agents behave in unexpected ways.[629]

In Bayern's interpretation of state statutes that describe the creation and dissolution of businesses (i.e. limited liability corporations), AI agents could indefinitely hold autonomous control over a firm with corporate personhood.[630] This would happen under specific conditions that require a human with a controlling interest to cede power to an AI agent, leave the firm so that it becomes member-less, and allow it to exist indefinitely. Theoretically, Bayern believes that

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Jaap Koops, et al., *Bridging the accountability gap: Rights for new entities in the information society*, 11 MINN. JL SCI. & TECH. (2010).

[624] Gless, et al., NEW CRIMINAL LAW REVIEW: IN INTERNATIONAL AND INTERDISCIPLINARY JOURNAL, (2016);Hallevy, SYRACUSE SCI. & TECH. L. REP., (2010);Čerka, et al., COMPUTER LAW & SECURITY REVIEW, (2015).

[625] Capital punishment is the "deprivation of life" and imprisonment is the "deprivation of liberty" Hallevy, SYRACUSE SCI. & TECH. L. REP., (2010)..

[626] Restatement (Third) of Agency: Definitions § 1.01 (American Law Institute 2006).

[627] "Agency is the fiduciary relationship that arises when one person (a "principal") manifests assent to another person (an "agent") that the agent shall act on the principal's behalf and subject to the principal's control, and the agent manifests assent or otherwise consents so to act" id. at..

[628] Stuart D. Levi & Alex B. Lipton, *An Introduction to Smart Contracts and Their Potential and Inherent Limitations*, Harvard Law School(2018), *available at* https://corpgov.law.harvard.edu/2018/05/26/an-introduction-to-smart-contracts-and-their-potential-and-inherent-limitations/;Čerka, et al., COMPUTER LAW & SECURITY REVIEW, (2015);Shawn Bayern, *The Implications of Modern Business–Entity Law for the Regulation of Autonomous Systems*, 7 EUROPEAN JOURNAL OF RISK REGULATION (2016).

[629] David Marc Rothenberg, *Can Siri 10.0 Buy Your Home: The Legal and Policy Based Implications of Artificial Intelligent Robots Owning Real Property*, 11 WASH. JL TECH. & ARTS (2015);Suzanne Smed, *Intelligent Software Agents and Agency Law*, 14 SANTA CLARA COMPUTER & HIGH TECH. LJ (1998);Bayern, EUROPEAN JOURNAL OF RISK REGULATION, (2016);Bellia Jr, EMORY LJ, (2001).

[630] Bayern, EUROPEAN JOURNAL OF RISK REGULATION, (2016).

these AI-controlled firms may provide non-humans with commercial agency and, more importantly, limited personhood.[631]

Two cases provide credence to the notion that AI agents could enjoy commercial agency. In the first case, State Farm Mutual Automobile Insurance Company v. Bockhorst, a person retroactively renewed an expired insurance policy due to a computer error.[632] Although the paperwork was mistakenly processed by a computer, this technology became the agent of the insurance company when it authorized a commercial transaction and made the firm liable for its mistake.[633] In the second case, McEvans v. Citibank, a customer deposited funds in an ATM that were subsequently lost.[634] This deposit represented the creation of a bailment relationship on behalf of the bank and, because of it, the courts deemed the bank responsible for the error.[635]

In both cases, non-humans served as agents in the creation of duties that are not supposed to exist.[636] Considering this, Rothenberg believes that applications of AI may push the boundaries of regulatory uncertainty to an unknown degree.[637] One where AI agents generate decisions in an infinitely large pool of occupations that require answering questions such as: [638]

- Does an AI agent's personhood reside in its software or hardware?
- Is a registration system necessary to confirm the identity of agents?

4.5.5 Marriage

Marriage is a construct that formalizes relationships between individuals through the signing of a social contract. Considering the cornucopia of rights and responsibilities available to non-humans in the form of corporations, the literature finds a regulatory gap of uncertainty when organic and non-organic entities decide to marry.[639] The crux of the uncertainty is whether AI agents have an equal capacity to consent to a decision as do their human counterparts.

The crucial element in all legal marriages, regardless of the jurisdiction, is that parties must consent to participate. For a human, this means that they must have the capacity to:[640]

- Understand the concept of marriage;
- Communicate a decision;
- Be free from coercion; and
- Remember decisions.

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[631] Id. at.
[632] State Farm Mutual Automobile Insurance Company v. Alfred E. Bockhorst et al., 453 F.2d 533, (10th Cir. 1972).
[633] Id. at.
[634] McEvans v. Citibank, N A., 96 Misc. 2d 142 (1978).
[635] Id. at.
[636] Smed, SANTA CLARA COMPUTER & HIGH TECH. LJ, (1998).
[637] Rothenberg, WASH. JL TECH. & ARTS, (2015).
[638] Tom Allen & Robin Widdinson, *Can Computers Make Contracts?*, 9 HARVARD JOURNAL OF LAW & TECHNOLOGY (1996);Michael Vincent, *Computer-managed perpetual trusts*, JURIMETRICS (2011).
[639] Goldfeder & Razin, JL & SOC. DEVIANCE, (2015).
[640] Id. at.

As seen above, society has deemed that marriage between individuals must be a willing choice. The advent of scenarios where organic and non-organic autonomous agents desire to form a social union does not inherently alter the notion of consent. What future public administrators will confront is the question of whether non-humans have the capacity to consent to a decision. In other words, can they be attributed the same legal wherewithal as humans? Were this to happen, government will need to consider if non-organic entities can be classified as "individuals" whose decision to marry potentially pose no harm to third-parties.[641]

4.5.6 AI Agent Rights

Ashrafian suggests that policymakers in the future may face an uncertainty regulatory gap in classifying AI agents as humans in order to bestow them with protections against violence or harm.[642] The scholar advocates for a future where interactions between human and AI agents are encompassed within the scope of the Universal Declaration of Human Rights.[643] This contrasts with the present state of affairs where AI agents (e.g. robots) have little to no rights, while their owners may exert property rights over them.[644]

Efforts to anthropomorphize the rights assigned to humans exist in the context of other non-human organic entities (e.g. animals). Yet, this idea considers a future where AI agents are valued to the point of protecting them through legal mechanisms. Ashrafian imagines a society that debates whether to classify entities as humans to afford them rights in a manner similar to their organic counterparts.[645]

As has been detailed in this section, future policymakers will confront the transformation of an American democracy where non-organic entities may claim a number of rights that are exclusively held today by humans today. Although few answers are available in this dissertation to guide these generations, the questions posed by researchers in this systematic review signal the beginning of a discussion on how to mold a society that reflects its values.

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[641] Gary Marchant, *A.I. Thee Wed*, Slate(2015), *available at* https://slate.com/technology/2015/08/humans-should-be-able-to-marry-robots.html.

[642] Hutan Ashrafian, *AIonAI: A humanitarian law of artificial intelligence and robotics*, 21 SCIENCE AND ENGINEERING ETHICS (2015).

[643] Id. at.

[644] Froomkin & Colangelo, CONN. L. REV., (2015).

[645] Ashrafian, SCIENCE AND ENGINEERING ETHICS, (2015).

4.6 Safety and Certification

This section describes scenarios where government assumes the role of an intermediary to protect individuals from two types of harm (see Table 22). There is physical harm, where the safety or bodily integrity of a person is preserved. The systematic review identified cases where a method or application of AI can cause such harms in medicine and transportation. Non-physical harms are suffered when a person's interests are negatively affected. Catalogued under certification, it depicts professions where the imposition of barriers to entry guarantee a minimum level of competence to serve a target population.

Table 22 - Regulatory Gaps in Safety and Certification

Issue	Regulatory Gap	Type of Gaps	Government Level	Time Frame	Type of AI
Safety	FDA Approval of Black-Box Medicine	Novelty	Federal	Present	Application
	Medical Services	Uncertainty	Federal + State	Future	Application
	Discrimination of Foreign Vessels	Obsolescence	Federal	Future	Application
	Differentiation Between Vehicle Capabilities	Targeting (over)	State	Future	Application
	Driver Licensing	Targeting (over)	State	Future	Application
	California Insurance Standards	Obsolescence	State	Future	Application
	Seldomly Enforced Rules	Obsolescence	State	Future	Application
	Subjective Driving Standards	Obsolescence	State	Future	Application
	FMVSS Guidelines	Novelty	Federal	Present	Application
	Human and Semi-AV Interaction	Novelty	State	Present	Application
	Baseline Safety Standards	Uncertainty	Federal + State	Present	Application
Certification	Financial Services	Targeting (under)	Federal	Present	Application
	Legal Services	Uncertainty	State	Present	Application
	Public Office	Uncertainty	Federal	Future	Application

4.6.1 Safety

Humans have a natural tendency to avoid circumstances where they are threatened by danger. To complement these efforts, government utilizes policy levers to mitigate against threats to the safety of their constituents. This section examines regulatory gaps related to protecting individuals from harms caused by AI in healthcare and transportation.

In healthcare, black-box medicine is catalogued as a medical device that falls under the aegis of the Food and Drug Administration (FDA).[646] Although clear standards exist to establish the risk profile and testing standards for most medical products, black-box medicine causes two gaps: novelty because current policies do not accommodate its unique features and uncertainty because the technology questions the authority ultimately charged with regulating the practice of medicine.

[646] Medical algorithms or black-box medicine refer to products that discover complex relationships between a patient's characteristics and potential diagnoses or treatments through "opaque computational models" W. Nicholson Price, *Regulating Black-Box Medicine*, 116 MICH. L. REV. (2017);W. Nicholson Price, *Black-box medicine*, 28 HARV. JL & TECH. (2014).

The commercial release of land and sea-faring vehicles that dispense of humans, via the automation of navigation, have overarching policy implications that produce regulatory gaps. In the maritime industry, internationally registered autonomous vessels confront the regulatory gap of obsolescence in regulations that create unnecessary distinctions between equally safe domestic and foreign vessels. On land, autonomous vehicles (AV) are widely discussed by scholars in the systematic literature review. Eight regulatory gaps related to safety are examined in areas as diverse as driver licensing, California's insurance standards, and the lack of differentiation between vehicle capabilities by state governments.

4.6.1.1 Black-Box Medicine

Medical algorithms or black-box medicine refer to products that discover complex relationships between a patient's characteristics and potential diagnoses or treatments through "opaque computational models."[647] The word opaque indicates the use of AI methods (i.e. machine learning) where it may not be possible (even by the developer) to detail the mechanism by which conclusions are reached or causality is currently extremely difficult or impossible to confirm.[648] These features, among others, lead government agencies charged with authorizing healthcare technologies to confront a regulatory gap of novelty. Although black-box medicine fits under the FDA's medical devices standard, the agency's policies and procedures aimed at testing and guaranteeing the safe operation of high-risk products cannot accommodate its characteristics, hence the need for new policies.

The FDA inspects all medical devices in the market. Its goal is to protect "public health by ensuring the safety, efficacy, and security of human and veterinary drugs, biological products, and medical devices."[649] To identify products within its control, the agency analyzes commercial speech or the claims made by firms in their marketing and promotional material.[650] The FDA has jurisdiction over any company whose products intend to diagnose or treat a disease. Developers of black-box medicine have made health claims about their products in the past. By doing so, they subject themselves to government regulation.[651]

In 2014, the FDA issued a policy threat declaring that products with the capabilities of black-box medicine could require rigorous testing under the high-risk medical device designation.[652] Medical devices are defined as: "an instrument, apparatus, implement, machine, contrivance, implant, in vitro reagent, or other similar or related article, including a component part, or accessory which is: intended for use in the diagnosis of disease or other conditions, or in the cure, mitigation, treatment, or prevention of disease, in man or other animals."[653]

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[647] Price, HARV. JL & TECH., (2014);Price, MICH. L. REV., (2017).
[648] Price, HARV. JL & TECH., (2014).
[649] FDA, *About FDA*, FDA(2018), *available at* https://www.fda.gov/aboutfda/whatwedo/default.htm.
[650] Jane Bambauer, *Dr. Robot*, (2017).
[651] Price, MICH. L. REV., (2017).
[652] Sally Howard, Letter to the Committeee on Health, Education, Labor and Pensions (FDA ed., Department of Health and Human Services 2014).
[653] FDA, *Is The Product A Medical Device?*, FDA(2018), *available at* https://www.fda.gov/medicaldevices/deviceregulationandguidance/overview/classifyyourdevice/ucm051512.htm.

Prior to commercialization, medical devices are required to obtain premarket-approval (PMA) based on a tiered risk analysis model (from I, lowest risk, to III, highest risk).[654] Not all medical software that uses AI methods is considered high-risk. The FDA does not intend to target low-risk applications (e.g. coaching or fitness applications).[655] Instead, its priority are products that pose "greater risk to patients if they don't work as intended."[656] Black-box medicine technologies likely fall under class III, which compel extensive pre-and post-market testing (e.g. clinical trials and monitoring).

Black-box medicine causes regulatory novelty because it does not fit the paradigms of testing that validate existing products undergoing the PMA process. For one, clinical trials may not be possible because they require assembling a cohort of similar people that are randomized into treatment and control groups to observe differences in outcomes. Black-box medicine does not work this way. Instead of grouping people, this technology can tailor its solutions to the characteristics of individuals. This precludes the recruitment of a clinical trial to predict the "individual responses of individual patients."[657]

Another barrier is the fluid nature of black-box medicine. As researchers feed data to the machine learning algorithm, it can constantly train and improve itself. Realistically, the algorithm and its outputs can change on a daily basis. The dynamic nature of this technology contrasts with the FDA's product testing protocols.[658] The PMA process is not designed to cope with verifying the safety of algorithms that change daily. The system in place for high-risk medical devices was not created to evaluate rapidly evolving machines or algorithms and may restrict consumer access to life-saving technologies.

4.6.1.1.1 Medical Services

The preceding section highlights the novelty regulatory gap that black-box medicine confronts because of the FDA's PMA process. Once resolved, the evolution and penetration of this technology may generate a second regulatory gap. One where there is uncertainty regarding what government level regulates the practice of medicine. Today, there are two players in this scenario. The FDA has authority over the commercialization of medical devices (this covers black-box medicine), while each state governs how medicine is practiced by health care professionals.[659]

In the status quo, humans are wholly charged with caring for patients. If the influence of black-box medicine spreads to the point of becoming the main source for the comprehensive diagnosis and treatment of patients, the human practice of medicine could be overshadowed by the output

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[654] FDA, *Overview of Device Regulation*, FDA(2018), *available at* https://www.fda.gov/medicaldevices/deviceregulationandguidance/overview/default.htm.

[655] FDA, *Mobile Medical Applications*, FDA(2018), *available at* https://www.fda.gov/medicaldevices/digitalhealth/mobilemedicalapplications/default.htm.

[656] Id. at.

[657] Ford, et al., MICH. TELECOMM. & TECH. L. REV., (2016).

[658] Id. at.

[659] Robert Kocher, *Doctors Without State Borders: Practicing Across State Lines*(2014), *available at* https://www.healthaffairs.org/do/10.1377/hblog20140218.036973/full/;Medical Board of California, Guide to the Laws Governing the Practice of Medicine by Physicians and Surgeons (Medical Board of California 2013).

of a medical device.[660] Although the FDA has no authority in dictating the practice of medicine, scholars speculate that the increasing reliance on this technology can make it the de facto agency charged with these standards.[661] The idea is that a transition from a human-centered healthcare system to one dominated by black-box medicine may create a scenario where the FDA and state agencies clash over which one has the power to determine how medicine is practiced. Until such situation is confronted, there is no way to know what level of government will prevail.

4.6.1.2 Autonomous Vehicles (AV)

Whether it is horses, cars or ships, individuals have historically played a central role in navigating vehicles capable of transporting people and cargo. At the turn of the 21st century, developments in AI promises to outsource the operation of vehicles away from human hands. While we enter this transition, society confronts a state of affairs where existing safety regulations for land or sea vehicles are created on the assumption of human control. As a consequence, this systematic review finds that AV generate nine regulatory gaps.

4.6.1.2.1 Nautical-based Autonomous Vessels

Nautical regulations in the U.S. differentiate between the minimum number of crew needed to safely operate domestic and foreign registered vessels. While domestic autonomous ships can theoretically travel in U.S. waters without any crew, this privilege is not extended to their international counterparts. When this technology becomes available, policies that treat similarly equipped autonomous vessel differently because of their country of registration will confront the regulatory gap of obsolescence.

Domestically, registered vessels are afforded flexibility by the Coast Guard in the determination of the minimum number of crew that can safely navigate in U.S. waters.[662] If sufficient evidence exists that an autonomous vessel can operate without a human, it may be granted permission to navigate.[663] Regulations applicable to foreign vessels differ from their domestic counterparts. Discretion in the number of crew required for safety is eliminated for non-U.S. registered vessels. This means that there is an absolute minimum number of licensed professionals that must be present at all times.[664]

The U.S. can restrict the traffic of foreign registered vessels for reasons other than safety, such as the promotion of its maritime shipping industry. The Jones Act serves this purpose by requiring that ships traveling between U.S. ports be registered and built in the U.S. and staffed by its citizens.[665] The regulations referenced in this regulatory gap have a different objective, to ensure the safe navigation of vessels in U.S. waters. The discrimination between potentially identical vessels due to geographic restrictions is appropriate for instances where differences in crew training and staffing could alter their safety. With autonomous vessels, the variation in terms of

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[660] Price, MICH. L. REV., (2017).
[661] Id. at.
[662] 46 CFR, § 15.715 1996.
[663] "(a) Coast Guard acceptance of automated systems to replace specific personnel or to reduce overall crew requirements is predicated upon the capabilities of the system, the system's demonstrated and continuing reliability, and a planned maintenance program that ensures continued safe operation of the vessel" id. at..
[664] Chwedczuk, JOURNAL OF MARITIME LAW AND COMMERCE, (2016).
[665] LLI, *Jones Act*, Cornell Law School(2019), *available at* https://www.law.cornell.edu/wex/jones_act.

safety may be virtually eliminated. Therefore, restrictions on foreign autonomous vessels become irrelevant if the Coast Guard is discriminating between equally safe vessels. Maintaining this barrier may artificially increase the cost of commerce between the U.S. and the world. This is especially important considering that, because of tax and governance considerations, only 1.5% of ships engaged in global foreign trade in 2015 were registered in the U.S.[666]

4.6.1.2.2 Land-based Autonomous Vehicles

In today's marketplace, firms are investing in the development of cars with varying levels of automation.[667] Vehicles catalogued as semi-AV require driver supervision (e.g. Tesla's autopilot), while completely AV discount the need for a driver, making the on or off-board computer responsible for directing its navigation, acceleration, and braking.[668] Although the latter is not commercially available, firms (e.g. Waymo, Toyota, and Uber) are attempting to bring them to market.[669] If successful, scholars believe that this technology could decrease a proportion of the 90% of car crashes caused by human error, which in 2017 contributed to the death of over 40,000 individuals.[670]

All regulation related to vehicles on U.S. roads are subject to a shared jurisdiction between federal and state agencies.[671] Through the National Highway Traffic Safety Administration (NHTSA), the federal government implements guidelines for vehicle safety equipment and its testing. For instance, the Federal Motor Vehicle Safety Standards (FMVSS) dictate the characteristics of breaks activated by a person's foot, manual turn signals, visual alerts, and the position of the rearview mirror, among others.[672] In turn, state motor vehicle agencies are responsible for "licensing, registration, traffic law enforcement, safety inspections, infrastructure, insurance and liability regulations."[673]

AV represent a transition from human-centric to AI agent-based navigation. Emancipating humans from the control of their vehicles produces regulatory gaps that affect state and federal jurisdictions. The following sub-sections compile these scenarios.

4.6.1.2.2.1 Differentiation Between Vehicle Capabilities

A targeting regulatory gap of over-inclusion emerges when vehicles are treated equally despite their capabilities. In principle, non-AV, semi-AV, and completely AV require different levels of

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[666] Mark H. Buzby, *The State of the U.S. Flag Maritime Industry*, Department of Transportation (2018), *available at* https://www.transportation.gov/content/state-us-flag-maritime-industry.

[667] SAE International. 2016;NHTSA. 2013.

[668] Tesla, *Autopilot*, Tesla(2018), *available at* https://www.tesla.com/autopilot;Hughes. 2017.

[669] Waymo, *Journey*, Waymo(2018), *available at* https://waymo.com/journey/;Angela Monaghan, *Toyota to invest $500m in Uber for self-driving car programme*(2018), *available at* https://www.theguardian.com/business/2018/aug/28/toyota-to-invest-500m-in-uber-for-self-driving-car-programme.

[670] CIS, *Human error as a cause of vehicle crashes*(2015), *available at* http://cyberlaw.stanford.edu/blog/2013/12/human-error-cause-vehicle-crashes;NSC, *2017 Estimates Show Vehicle Fatalities Topped 40,000 for Second Straight Year*(2018), *available at* https://www.nsc.org/road-safety/safety-topics/fatality-estimates.

[671] Sarah E Light, *Advisory Nonpreemption*, 95 WASH. UL REV. (2017).

[672] Crane, et al., MICH. TELECOMM. & TECH. L. REV., (2016);Lenth, MCGEORGE L. REV., (2013).

[673] Husch & Teigen. 2017;Levine, (2017).

driver/passenger attention. Yet, state laws do not differentiate them when regulating driving behavior.[674]

States like New York and Massachusetts require drivers to have at least one hand on the steering wheel of a moving vehicle.[675] Vehicles with higher levels of autonomy, specially completely AV, are over-included in these regulations because the amount of attention drivers/passengers devote to road conditions may not improve their safety.[676]

4.6.1.2.2.2 Driver Licenses

Overinclusion is similarly evinced in the allocation of driver licenses.[677] Today's status quo is that drivers in most states are required to pass the same examination regardless of their vehicle.[678] In reality, non-AV drivers are expected to command comparatively more skills than their completely AV counterparts.

Forcing equal testing standards for a license limits the participation of individuals with disabilities or those unable to control a vehicle from maximizing the benefits of a completely AV.[679] Therefore, state government over-include drivers of completely AV that do not need motoring skills to "drive" vehicles that will do so on their own.

4.6.1.2.2.3 California Insurance Standards

California's insurance standards are meant to promote safe driving behavior, yet completely AV could make them an example of an obsolescence regulatory gap. In 1988 voters passed proposition 103, it mandated the implementation of several practices by vehicle insurance companies operating in the state.[680] Most notably, insurance quotes had to be calculated based on factors such as driving safety record and years of driving experience. If completely AV replace non-AV as the dominant form of transportation, this policy could become obsolete because driving experience would no longer be a proxy for a safe driving record.[681]

The proposition also obligates firms to offer a 20% good driver discount to qualifying clients with a record of safe driving.[682] If AV significantly improve the safety of road conditions, owning these vehicles would likely qualify any individual for this discount. Thus changing the conditions that made this policy relevant. As AV make up a larger share of the car park, the provision of this safety "subsidy" may challenge the financial sustainability of insurance companies.

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[674] FindLaw, *State Traffic Laws*, Thomson Reuters(2018), *available at* https://traffic.findlaw.com/traffic-tickets/state-traffic-laws.html;FindLaw, *Distracted Driving*, Thomson Reuters(2018), *available at* https://traffic.findlaw.com/traffic-tickets/distracted-driving.html.

[675] NY Veh & Traf L, Title 7 Art. 33 §1226 (2014);Mass. Gen. Laws, ch. 90 §13 (2019).

[676] Pearl, NYU ANN. SURV. AM. L., (2017);Smith, TEXAS A&M LAW REVIEW, (2014).

[677] Crane, et al., MICH. TELECOMM. & TECH. L. REV., (2016).

[678] Brodsky, BERKELEY TECH. LJ, (2016).

[679] Crane, et al., MICH. TELECOMM. & TECH. L. REV., (2016).

[680] California Department of Insurance, *Information Sheet: Proposition 103 Intervenor Process*, California Department of Insurance(2019), *available at* http://www.insurance.ca.gov/01-consumers/150-other-prog/01-intervenor/info.cfm;Proposition, 103 (California State Legislature 2005).

[681] Peterson, SANTA CLARA L. REV., (2012).

[682] Id. at.

4.6.1.2.2.4 Seldomly Enforced Rules

Obsolescence also appears in state driving policies that are no longer enforced by authorities. Gurney highlights a New Jersey law that requires drivers to honk whenever they pass any vehicle (including cyclist and skateboarders).[683] Drivers do not follow these rules and traffic officers seldomly fine individuals for violating them. Nevertheless, completely AV would codify these road regulations and, in the case of New Jersey, will at the very least irritate other drivers and, at most, cause a deadly crash.

4.6.1.2.2.5 Subjective Driving Standards

Road regulations intended for subjective human interpretation could generate a regulatory gap of obsolescence if and when they are applied to completely AV.[684] These laws were promulgated for the express purpose of providing individuals with discretion over changing road conditions. For instance, North Carolina has a traffic law stating that **"**[n]o person shall drive a vehicle on a highway or in a public vehicular area at a speed greater than is reasonable and prudent under the conditions then existing."[685]

Subjective regulations face a number of challenges that could lead to obsolescence. One relates to their translation into the rules that manage the "behavior" of a completely AV. Presumably, this technology will already be programmed to confront unexpected environments and variables. Thus, these regulations would not contribute to improving their safety. More importantly, the emphasis on human drivers will decrease their relevance in a future where people are no longer tasked with navigating vehicles.[686]

4.6.1.2.2.6 Federal Motor Vehicle Safety Standards (FMVSS) Guidelines

At the federal level, the FMVSS standards designate the equipment required for the safe operation of vehicles in the U.S. (e.g. manual switches, pedals, and controls).[687] One of the many visions of completely AV, which are not currently available, is to obviate any instruments that enable human navigation. Depending on the design, they remove key elements of currently mandatory equipment from the FMVSS, such as the steering wheel and pedals for braking or accelerating.[688] Because of this, these AI applications face a regulatory gap of novelty where new rules are needed to include completely AV within the FMVSS' safety baseline.

The commercialization of this technology transforms the long-standing belief that human interaction with a vehicle's controls is necessary for navigation. For these standards to remain pertinent to the safety of vehicles, federal regulations need to codify the inclusion of a completely AV characteristics. Even though the federal government has issued industry guidance and

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[683] Gurney, WAKE FOREST JL & POL'Y, (2015).
[684] Brodsky, BERKELEY TECH. LJ, (2016).
[685] N.C. Gen. Stat., §20-141 (2013).
[686] Gurney, WAKE FOREST JL & POL'Y, (2015).
[687] Crane, et al., MICH. TELECOMM. & TECH. L. REV., (2016);Smith, TEXAS A&M LAW REVIEW, (2014).
[688] NHTSA, *NHTSA response to Google on AV technology*, NHTSA(2016), *available at* http://isearch.nhtsa.gov/files/Google%20--%20compiled%20response%20to%2012%20Nov%20%2015%20interp%20request%20--%204%20Feb%2016%20final.htm.

measures to exempt automakers from existing guidelines, the regulatory landscape has yet to reach a resolution.[689]

4.6.1.2.2.7 Human and Semi-AV Interaction

As previously mentioned, state governments regulate driver behavior. Most jurisdictions stipulate that users of any vehicle must continuously pay attention to road conditions.[690] Drivers of semi-AV, those that require driver supervision, confront a novelty regulatory gap. Concretely, these vehicles lack safety guidelines that specifically tackle the transition between human and vehicle control of navigation. Today, drivers are responsible for supervising their vehicles until a complex maneuver forces them to take over control. However, a successful transition between a human and their vehicle is crucial for road safety. As of today, no standards exist on the optimal visual, auditory, or tactile alerts to communicate that the attention of a driver is needed.[691]

4.6.1.2.2.8 Baseline Safety Standards

The regulatory gap of uncertainty is found when determining what entity should create baseline standards for an AV safety algorithm.[692] Authorities could outsource decision-making to the private sector, where manufacturers or industry groups would create their own standards for driver decision-making.[693] Alternatively, states could assume control of a vehicle's safety algorithm by arguing that their jurisdiction oversees driving behavior; although in this case, humans are replaced by computers.[694] Federal authorities may overrule states by asserting that these standards are an element of a vehicles equipment and covered in the FMVSS. In all cases, guidelines will need to be formulated so that decision-making software performs on the road in a manner that maximize safety as well as, or better than, human drivers.[695]

4.6.2 Certification

Society has determined that certain professions impose barriers of entry (e.g. licenses, degrees, exams, or elections) to restrict individuals from entering these sectors and protect consumers from non-physical harms, those suffered when a person's interests are negatively affected. Three regulatory gaps related to certification were identified in the systematic review: the under-inclusion of AI agents in financial services regulation meant to assure competence, the uncertain status of services that compete with lawyers by offering automated legal advice, and the uncertainty in the delegation of government power to non-human entities.

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[689] NHTSA, *Automated Vehicles for Safety*(2020), *available at* https://www.nhtsa.gov/technology-innovation/automated-vehicles-safety;NHTSA, NHTSA response to Google on AV technology. 2016;NHTSA, Federal Automated Vehicles Policy (U.S. Department of Transportation 2016);NHTSA, Preliminary Statement of Policy Concerning Automated Vehicles. 2013.

[690] L. 2014;Laws. 2019.

[691] Wood, et al., SANTA CLARA L. REV., (2012);Hicks & Ponce, GEORGIA STATE LAW REVIEW, (2017);Pearl, NYU ANN. SURV. AM. L., (2017).

[692] Wood, et al., SANTA CLARA L. REV., (2012).

[693] Light, WASH. UL REV., (2017);Pearah, J. HIGH TECH. L., (2017).

[694] Levine, (2017).

[695] NHTSA, *Test Procedures*, NHTSA(2018), *available at* https://one.nhtsa.gov/Vehicle-Safety/Test-Procedures.

4.6.2.1 Financial Services

Professionals in the financial services sector are bound by regulations that verify their competence through a licensing process.[696] It entails training on fraud, standards of conduct, and passing background checks. Financial applications of AI that emulate the work of humans in this field skirt regulations meant to control participation in this profession. Therefore, they are under-included in the policies that license or certify humans to safeguard the market from unwanted behavior.

For consumer-facing professionals, such as financial advisors, barriers to entry protect a society filled with consumers who are mostly non-experts and for whom it is difficult to gauge the quality of services.[697] AI in this profession serves as a cost-effective alternative that enables the mass-market availability of portfolio guidance. The use of AI applications is covered by regulations when qualified financial advisors complement their services with them.[698] When firms cut the intermediary and allow customers to directly interface with AI-based financial advisors, current regulations that protect the competence, honesty, and suitability of financial guidance do not apply.

This problem is also observed by non-consumer facing professionals in the commodities trading market. There, AI applications significantly increase the speed of analysis and execution of market orders. Specifically, the registration of individuals is undertaken by an independent entity, the National Futures Association, which does not make stipulations for software programs, known as Automated Trading Systems (ATS), that perform similar tasks to their human counterparts.[699]

Since their introduction, ATS have become an important part of the operation of financial firms in deciding their market positions and executing trades at speeds beyond that of human capacity. According to Scopino's analysis, this technology is overtaking human operators in most aspects of decision-making. [700] Nonetheless, these machines do not undergo the training and background checks meant to minimize the probability of causing a systemic risk to the market. This means that current policies only cover human market makers and may under-include AI applications. In an effort to consider the market implications of regulating ATS, the Commodity Futures Trading Commission has used its power to issue a policy threat to the sector via a request for comments on the issue.[701]

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[696] Tom Baker & Benedict GC Dellaert, *Regulating Robo Advice Across the Financial Services Industry*, (2017).

[697] Iris HY Chiu, *Fintech and Disruptive Business Models in Financial Products, Intermediation and Markets-Policy Implications for Financial Regulators*, 21 J. TECH. L. & POL'Y (2016).

[698] Baker & Dellaert, (2017).

[699] Gregory Scopino, *Preparing Financial Regulation for the Second Machine Age: The Need for Oversight of Digital Intermediaries in the Futures Markets*, COLUM. BUS. L. REV. (2015).

[700] Id. at.

[701] Commodity Futures Trading Commission, *Concept Release on Risk Controls and System Safeguards for Automated Trading Environments*, Federal Register(2014), *available at* https://www.federalregister.gov/documents/2014/01/24/2014-01372/concept-release-on-risk-controls-and-system-safeguards-for-automated-trading-environments.

4.6.2.2 Legal Services

The dearth of legal services targeted at medium and low-income customers opened a market for AI applications that provide tailored advice. Although these applications have expanded access to justice, uncertainty exists as to their legality (formally referred to as unauthorized practice of law). At the heart of this debate is the extent to which AI is used and by whom.

The American Bar Association is the non-governmental body that regulates the practice of law at the state level. Similar to financial service professionals, they may argue that legal services are credence goods where clients can find it difficult to assess the quality or value of what they receive.[702] For this reason, a standardized body can be helpful in regulating how legal advice is dispensed. In addition, consumers should be protected against errors caused by non-humans that provoke irreparable harm.[703]

The opinion of the ABA is that law firms can outsource work to non-lawyers who use AI, as long as fees are not shared and they do not perform the duties of a lawyer.[704] But what are the duties of a lawyer? A clear definition does not exist, but proxies for it do.[705] Courts throughout the nation have attempted to distinguish between the work of a lawyer and a lay person. Many have focused on evaluating the difference between a service that completes a legal form using the information given by a customer from one that assists in analyzing which form is the most appropriate and how to properly complete it.[706] Some have concluded that the latter constitutes the unlawful provision of legal services.[707]

Lauritsen argues that AI-based software is protected as a form of expression under the First Amendment.[708] If true, the ABA may have an opinion as to what constitutes a legal service, but it cannot limit the protection of a First Amendment right to legal information, in the form of software, offered to the public. Determining the difference between what constitutes a source of knowledge with a service that functions as a lawyer is at the crux of this debate. In other words, a grey area exists in determining if software that dispenses legal advice equates to the illegal provision of legal services.

4.6.2.3 Public Office

AI has been incorporated into government to complement decision-making, increase the nimbleness of action, and keep up with the analytic capabilities of the private sector.[709] One speculative scenario that creates uncertainty relates to the delegation of duties to non-humans by Congress. Under the Constitution, legislative powers are vested in members of Congress who

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[702] Tanina Rostain, *Robots Versus Lawyers: A User-Centered Approach*, 30 GEO. J. LEGAL ETHICS (2017).
[703] Dana Remus & Frank Levy, *Can Robots Be Lawyers: Computers, Lawyers, and the Practice of Law*, see id. at Cited Pages|.
[704] John O McGinnis & Russell G Pearce, *The great disruption: How machine intelligence will transform the role of lawyers in the delivery of legal services*, 82 FORDHAM L. REV. (2013).
[705] Dru Stevenson & Nicholas J Wagoner, *Bargaining in the shadow of big data*, 67 FLA. L. REV. (2015).
[706] Willick, RUTGERS COMPUTER & TECH. LJ, (1986);Remus & Levy, GEO. J. LEGAL ETHICS, (2017).
[707] Marc Lauritsen, *Liberty, Justice, and Legal Automata*, 88 CHI.-KENT L. REV. (2012).
[708] Id. at.
[709] Thomas J Barth & Eddy Arnold, *Artificial Intelligence and Administrative Discretion: Implications for Public Administration*, 29 THE AMERICAN REVIEW OF PUBLIC ADMINISTRATION (1999).

have the capacity to delegate them as long as they are restricted in scope, also known as the intelligible principle test.[710]

Thus far, this prerogative has only been vested in humans. In the future, AI entities could be given the power to either make administrative decisions or to execute actions on behalf of the government. In the short-term, scholars do not believe that the delegation of administrative duties to non-humans could lead to an improper transfer of power.[711] In the long run, it has yet to be determined what level of power could a congressionally-mandated AI application assume and what repercussion could this delegation of authority have on constituents.

[710] NCSL, *SEPARATION OF POWERS—DELEGATION OF LEGISLATIVE POWER*, NCSL(2018), *available at* http://www.ncsl.org/research/about-state-legislatures/delegation-of-legislative-power.aspx.

[711] Cary Coglianese & David Lehr, *Regulating by robot: administrative decision making in the machine-learning era*, 105 GEO. LJ (2016).

4.7 Classification of Individuals

AI methods and applications enable the processing of vast quantities of information for the purpose of labeling individuals in a manner that affects their lives. This section detects regulatory gaps in cases where these labels are implemented by authorities in consequential decision-making acts or when they generate inequality (See Table 23).[712]

Consequential decision-making gaps are those where government entities utilize AI to classify people in ways that weaken the Constitutional protections of due process and probable cause. These protections limit authorities from an indiscriminate use of power and, in many cases, AI has increased the difficulty in defending them.[713] Examples include the reliance on predictive policing to identify suspects, excluding people from benefit management systems, or designating them as dangerous in the federal Terrorist Watch List.

Inequality in application describes gaps where protected classifications of people are a factor in decision-making. An instance of this gap occurs when government and the private sector are barred from using an assortment of labels to make decisions in specific circumstances, yet AI methods enable the concealment of their role. Another is a futuristic example involving AI applications able to enhance human cognition. Their introduction opens up a world where "standard" humans could be subject to intellectual discrimination. To protect these individuals, sentencing guidelines exist to differentiate criminal punishment based on the intent to purposefully prey on a class of vulnerable people. However, victims in this scenario may not be protected due to the variability in how these guidelines are applied throughout the country.

Table 23 - Regulatory Gaps in the Classification of Individuals

Issue	Regulatory Gap	Type of Gaps	Government Level	Time Frame	Type of AI
Consequential Decision-Making	Due Process	Obsolescence	Federal + State	Present	Application + Method
	Probable Cause	Obsolescence	Federal + State + Local	Present	Method
Inequality in Application	Algorithmic Bias	Obsolescence	Federal + State + Local	Present	Method
	Intellectual Discrimination	Uncertainty	Federal	Future	Application

4.7.1 Consequential Decision-Making

Consequential decision-making regulatory gaps are found in cases where government entities rely on AI to classify people in ways that weaken their rights, such as the Constitutional protections of due process and probable cause. Due process is a shield against the deprivation of rights or entitlements without receiving notice, redress grievances, or having a neutral arbiter.[714]

[712] Calo, SSRN, (2017).
[713] Kiel Brennan-Marquez, *Plausible Cause: Explanatory Standards in the Age of Powerful Machines*, 70 VAND. L. REV. (2017).
[714] Coglianese & Lehr, GEO. LJ, (2016);LLI, *Procedural due process*, Cornell University(2019), *available at* https://www.law.cornell.edu/wex/procedural_due_process;Tene, COLO. TECH. LJ, (2014).

Probable cause contemplates that any arrest, search, or warrant must articulate the facts that connect an individual to the commitment of a crime or its planning.[715]

Authorities may impinge due process and probable cause rights via AI in a variety of settings: intelligence gathering, provision of benefits, and predictive policing efforts. Applications of this technology can make decisions without providing notice or allowing individuals to redress grievances to a neutral party. At the same time, methods can infer complex relationships, but these capabilities have a tradeoff in that their accuracy come at the cost of explainability.[716] Authorities can offer the justice system a description of how these results were processed, but they cannot pinpoint the variables taken into consideration to reach a particular conclusion.[717]

At the core of these rights is the requirement that authorities justify their decisions or provide individuals with the tools to questions them. An obligation that, if certain methods or applications of AI are employed, cannot be fulfilled. Hence, this technology may alter society's ability to enforce these rights, which leads to a regulatory gap of obsolescence.

4.7.1.1 Due Process

Due process rights in the Fifth and Fourteenth Amendment of the Constitution represent "an assurance that all levels of… government must operate within the law" and treat individuals fairly.[718,719] In this context, rights or entitlements should not be deprived without receiving notice, redress grievances, or having a neutral arbiter.[720] Policymakers have adopted AI applications and methods to complement or substitute the delegation of their authority.[721] These systems can infringe due process rights and cause a regulatory gap of obsolescence by altering how society enforces or protects them.[722]

State and federal entities delegate authority to applications of AI, which catalyze obsolescence by placing individuals in a consequential status without providing notice or giving them an opportunity to redress a decision to a neutral party.[723] At the state level, government management systems have mislabeled people as not paying child-support or incorrectly

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[715] Const., amend. IV;LLI, *Probable Cause*, Cornell University(2019), *available at* https://www.law.cornell.edu/wex/probable_cause;Tene, COLO. TECH. LJ, (2014);Miller, J. TECH. L. & POL'Y, (2014);Brennan-Marquez, VAND. L. REV., (2017).

[716] Margulies, FLA. L. REV., (2016);Lina Zhou, et al., *A Comparison of Classification Methods for Predicting Deception in Computer-Mediated Communication*, 20 JOURNAL OF MANAGEMENT INFORMATION SYSTEMS (2014).

[717] Margulies, FLA. L. REV., (2016).

[718] David Lehr & Paul Ohm, *Playing with the Data: What Legal Scholars Should Learn About Machine Learning*, 51 UCDL REV. (2017);Danielle Keats Citron & Frank Pasquale, *The scored society: due process for automated predictions*, 89 WASH. L. REV. (2014);Miller, J. TECH. L. & POL'Y, (2014);LLI, *Due Process*, Cornell University(2019), *available at* https://www.law.cornell.edu/wex/due_process.

[719] Fifth Amendment: "No person [shall] be deprived of life, liberty, or property, without due process of law" U.S. Const., amend. V.
Fourteenth Amendment: "[N]or shall any state deprive any person of life, liberty, or property, without due process of law" U.S. Const., amend. XIV.

[720] Coglianese & Lehr, GEO. LJ, (2016);LLI, Procedural due process. 2019;Tene, COLO. TECH. LJ, (2014).

[721] Citron & Pasquale, WASH. L. REV., (2014).

[722] Margaret Hu, *Big Data Blacklisting*, 67 FLA. L. REV. (2015).

[723] Lehr & Ohm, UCDL REV., (2017);Citron & Pasquale, WASH. L. REV., (2014);Miller, J. TECH. L. & POL'Y, (2014).

terminated benefits such as Medicaid or food stamps.[724] These acts lead to wage garnishments, credit bureau reports, revocation of driving and professional licenses, homelessness, or death due to denial of medical attention. [725] In some cases, correcting these mistakes has either been very difficult or impossible. At the federal level, classified and non-classified systems (e.g. E-Verify, the Terrorist Watch List, and the No-Fly List) comb through databases that connect personally identifiable information with surveillance from the intelligence community.[726] Similar to their state counterparts, decisions by these systems alter the livelihoods of affected parties without any notice and limited means to redress an erroneous classification.[727]

AI also contributes to obsolescence at the federal and state level when entities employ methods that decrease the transparency of inferences from an ever-growing number of databases.[728] As the data exhaust of consumers increases, a larger swatch of the population is subject to becoming "digitally blacklisted" without notice.[729] Their participation in social media, online purchases, and location tracking can label them as false positives in government lists that essentially creates a system of "guilty until proven innocent."[730]

Many of these systems make incorrect decisions or generate predictions of social phenomena at the expense of transparent explanations of how these conclusions are reached.[731] This state of affairs decreases the explainability of government decisions and denies due process rights to affected parties that require clarifications for their inclusion in lists that deprive them of freedoms such as life, liberty, or property.[732] Given that this technology can restrain society's defense of due process, they generate a regulatory gap of obsolescence.

4.7.1.2 Probable Cause

The Fourth Amendment of the Constitution describes probable cause as a means to protect individuals by rationing government interference in their lives.[733,734] It is interpreted as a requirement that any arrest, search, or warrant must articulate the facts that connect a person to the commitment of a crime or its planning.[735] In the 20th century, the Supreme Court created

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[724] Danielle Keats Citron, *Technological due process*, 85 WASH. UL REV. (2007).
[725] Id. at.
[726] Hu, FLA. L. REV., (2015);Citron, WASH. UL REV., (2007).
[727] Coglianese & Lehr, GEO. LJ, (2016);Miller, J. TECH. L. & POL'Y, (2014).
[728] Citron, WASH. UL REV., (2007).
[729] Hu, FLA. L. REV., (2015);Lindsey Barrett, *Reasonably Suspicious Algorithms: Predictive Policing at the United States Border*, 41 NYU REV. L. & SOC. CHANGE (2017).
[730] Hu, FLA. L. REV., (2015);Brennan-Marquez, VAND. L. REV., (2017);Tal Z Zarsky, *Transparent predictions*, U. ILL. L. REV. (2013).
[731] Margulies, FLA. L. REV., (2016);Brennan-Marquez, VAND. L. REV., (2017).
[732] Coglianese & Lehr, GEO. LJ, (2016);Margaret Hu, *Algorithmic Jim Crow*, 86 FORDHAM L. REV. (2017);Const., amend. V.
[733] Brennan-Marquez, VAND. L. REV., (2017).
[734] "The right of the people to be secure in their persons, houses, papers, and effects, against unreasonable searches and seizures, shall not be violated, and no Warrants shall issue, but upon probable cause, supported by Oath or affirmation, and particularly describing the place to be searched, and the persons or things to be seized" Const., amend. IV..
[735] Id. at;LLI, Probable Cause. 2019;Tene, COLO. TECH. LJ, (2014);Miller, J. TECH. L. & POL'Y, (2014);Brennan-Marquez, VAND. L. REV., (2017).

a new standard below probable cause in the form of reasonable suspicion, where an officer of the law can investigate an individual if they reasonably presume, based on their training or facts, that they will or have committed a crime.[736] Scholars argue that the implementation of predictive policing by authorities, applications that use AI methods to create risk profiles, may subvert the protections afforded by probable cause and reasonable suspicion.[737] They believe that the reliance on methods that cannot make transparent the reasoning for government action on an individual alters society's capacity to enforce these rights, producing a regulatory gap of obsolescence.

Jurisdictions throughout the country employ predictive policing as a tool to complement law enforcement in identifying individuals at risk of committing a crime or locations where illegal activity may occur.[738] This information is generated by combing through a universe of variables in databases with imperfect information and detecting patterns from it.[739] Some methods of AI (e.g. neural networks) generate these patterns in ways that do not provide details as to how a conclusion is reached. Put another way, a neighborhood may be classified as a crime "hot spot" or an individual as highly likely to commit an illegal act due to correlations that cannot be explained to a judge or jury.[740]

When an individual is arrested or searched, probable cause requires that authorities articulate a justification for their actions. These may include evidence gathered through wiretaps, financial transactions, and social media postings.[741] If officers depend solely on AI methods-based predictive policing tools for their decision-making, such an explanation may be impossible.[742] Instead, they acquire a predictive analysis emanating from diverse sources such as "expressions of political opinion in chat rooms, a recent report of a lost passport (indicating an attempt to conceal a visit to a terrorist training camp in Afghanistan or Pakistan), attempts to use or deploy a common encryption technique, and patronage (picked up through public video surveillance and facial recognition software) of a store specializing in pre-paid cell phones."[743] Although it could be argued that connecting patterns among disperse databases would have eluded a human analyst, the Constitution affords individuals the right to understand the reasons for their arrest or search.

Having law enforcement depend on these tools increases the obsolescence of the protections conferred by probable cause and reasonable suspicion in several ways.[744] First, the vast amount

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[736] Terry v. Ohio, 392 U.S. 1, (1968);Michael L Rich, *Machine Learning, Automated Suspicion Algorithms, and the Fourth Amendment*, 164 U. PA. L. REV. (2015);Barrett, NYU REV. L. & SOC. CHANGE, (2017).
[737] Barrett, NYU REV. L. & SOC. CHANGE, (2017).
[738] Andrew Guthrie Ferguson, *Big data and predictive reasonable suspicion*, 163 U. PA. L. REV. (2014);Miller, J. TECH. L. & POL'Y, (2014);Jessica Saunders, et al., *Predictions Put Into Practice: A Quasi-Experimental Evaluation of Chicago's Predictive Policing Pilot*, 12 JOURNAL OF EXPERIMENTAL CRIMINOLOGY (2017).
[739] Rich, U. PA. L. REV., (2015);Hu, FORDHAM L. REV., (2017);Barrett, NYU REV. L. & SOC. CHANGE, (2017).
[740] Margulies, FLA. L. REV., (2016).
[741] Id. at.
[742] Barrett, NYU REV. L. & SOC. CHANGE, (2017).
[743] Margulies, FLA. L. REV., (2016);Reid, W. VA. L. REV., (2016).
[744] Joh, WASH. L. REV., (2014);Laura Myers, et al., *Big Data and the Fourth Amendment: Reducing Overreliance on the Objectivity of Predictive Policing*, 8 FED. CTS. L. REV. (2014).

of data available on individuals, especially when it is incorrect, makes it easier to arrive at probable cause and weakens Fourth Amendment rights.[745] Second, these applications only consider data in a format that the system can comprehend, which may exclude exculpatory evidence.[746] Third, it reinforces the biases inherent in these systems.[747] Fourth, it serves as an excuse by officers to supplant their training, observation skills, or intuition and depend solely on the technology. Although this behavior has been deemed illegal by the Supreme Court, officers can shield themselves by generating a fake justification for an arrest after the fact [748]

4.7.2 Inequality in Application

Inequality in application describes cases of regulatory gaps where variables that safeguard against discrimination are a factor in decision-making. Governments and the private sector are barred from carrying out algorithmic bias by using characteristics of individuals in delimited circumstances prescribed by the law.

This section describes two cases of regulatory gaps where inequality in application were found in the systematic review. In the first one, AI methods generate a regulatory gap of obsolescence by facilitating the concealed use of protected variables in discriminatory activities. In the second, the regulatory gap of uncertainty is witnessed in the haphazard application of sentencing guidelines that differentiate the criminal punishment for individuals that target vulnerable populations.

4.7.2.1 Algorithmic Bias

Algorithmic bias refers to the use of AI methods to discriminate or negatively affect a class of individuals. Unregulated algorithmic bias denotes activities that are not illegal.[749] Instances where social norms are challenged can be viewed as troubling, but are inherently lawful. Firms that target individuals for marketing purposes based on demographic characteristics or the lack of racial representation in a search engine's image recognition service can be thought of as reprehensible, but they do not generate regulatory gaps.[750] Illegal algorithmic bias, activities where decision-making based on the characteristics of people is not permitted is the focus of this section.[751] The reliance on AI methods to discriminate classes of the population endangers

[745] Barrett, NYU REV. L. & SOC. CHANGE, (2017);Miller, J. TECH. L. & POL'Y, (2014);Joh, WASH. L. REV., (2014);Hu, FORDHAM L. REV., (2017).
[746] Lehr & Ohm, UCDL REV., (2017);Rich, U. PA. L. REV., (2015).
[747] Barrett, NYU REV. L. & SOC. CHANGE, (2017);Miller, J. TECH. L. & POL'Y, (2014).
[748] Miller, J. TECH. L. & POL'Y, (2014);Illinois v. Wardlow, 528 U.S. 119, (2000).
[749] Omer Tene & Jules Polonetsky, *Taming the Golem: Challenges of Ethical Algorithmic Decision-Making*, 19 NCJL & TECH. (2017).
[750] Tom Simonite, *When It Comes to Gorillas, Google Photos Remains Blind*, Wired(2018), *available at* https://www.wired.com/story/when-it-comes-to-gorillas-google-photos-remains-blind/;Zarsky, YALE JL & TECH., (2002);Kerr & Bornfreund, PRESENCE, (2005);David C Vladeck, *Consumer Protection in an Era of Big Data Analytics*, 42 OHIO NUL REV. (2015);Atkinson, (2016);Tene & Polonetsky, NCJL & TECH., (2017);Frank Pasquale, *Restoring transparency to automated authority*, 9 J. ON TELECOMM. & HIGH TECH. L. (2011);Baker & Dellaert, (2017);Terrell McSweeny & Brian O'Dea, *The Implications of Algorithmic Pricing for Coordinated Effects Analysis and Price Discrimination Markets in Antitrust Enforcement*, 32 ANTITRUST (2017).
[751] Tene & Polonetsky, J. ON TELECOMM. & HIGH TECH. L., (2013).

society's ability to protected against this behavior, thus weakening the enforcement of anti-discrimination regulation and generating a regulatory gap of obsolescence.

Individuals in the U.S. are protected from discrimination through several policies. The equal protection clauses of the Fifth and 14th Amendment prohibit federal or state agencies from discriminating based on protected demographic characteristics.[752,753] Government entities can utilize demographic variables to make decisions, as long as there is no intention or "purpose to discriminate."[754]

Discrimination-free treatment from the private sector is required under specific circumstances. The Fair Housing Act prohibits covered entities from considering race, color, religion, sex, disability, familial status, or national origin to finance, rent, or purchase a home.[755] The Equal Credit Opportunity Act has similar limitations for determining the reception of public assistance when approving a credit or setting its terms.[756] The FTC can act against firms that utilize algorithms for unfair trade practices that mischaracterize and harm consumers.[757] In addition, it is unlawful for employers to treat job candidates or employees differently because of their race, color, religion, sex, or national origin.[758]

AI methods disrupt traditional grounds for identifying discrimination, potentially making their enforcement obsolete. They do so by masking an illegal discriminative practice. Instead of relying on protected variables as a determining factor in a decision, entities can program their systems so that the importance of protected variables are hidden via limitless data points and models that change dynamically through time.[759]

Entities that desire to discriminate can do so through several vectors in the design of an algorithm.[760] Although they cannot predict the outcome of their model, programmers can define output variables that advantage or disadvantage certain groups.[761] They may also feed a model

[752] Const., amend. XIV;Russell W Galloway, *Basic Equal Protection Analysis*, 29 SANTA CLARA REVIEW (1989).
[753] The Due Process clause of the 5th Amendment is interpreted as an Equal Protection Clause applicable to the federal government, while the clause in the 14th Amendment does the same for state governments LII, *Equal Protection*, Cornell Law School (2019), *available at* https://www.law.cornell.edu/wex/equal_protection..
[754] Coglianese & Lehr, GEO. LJ, (2016);Akins v. Texas, 325 U.S. 398, (1945).
[755] U.S. Department of Housing and Urban Development, HOUSING DISCRIMINATION UNDER THE FAIR HOUSING ACT (Department of Housing and Urban Development 2019).
[756] Federal Trade Commission. 2019.
[757] Citron & Pasquale, WASH. L. REV., (2014).
[758] EEOC, *Title VII of the Civil Rights Act of 1964*(2019), *available at* https://www.eeoc.gov/laws/statutes/titlevii.cfm.
[759] Hu, FORDHAM L. REV., (2017);Tene & Polonetsky, J. ON TELECOMM. & HIGH TECH. L., (2013);Vladeck, OHIO NUL REV., (2015);Tene & Polonetsky, J. ON TELECOMM. & HIGH TECH. L., (2013);Richard D Taylor, *The next stage of US communications policy: The emerging embedded infosphere*, TELECOMMUNICATIONS POLICY (2016);Baker & Dellaert, (2017).
[760] Tene & Polonetsky, J. ON TELECOMM. & HIGH TECH. L., (2013).
[761] Lehr & Ohm, UCDL REV., (2017);Solon Barocas & Andrew Selbst, *Big Data's Disparate Impact*, 104 CALIFORNIA LAW REVIEW 671 (2014);Deven R Desai & Joshua A Kroll, *Trust But Verify: A Guide to Algorithms and the Law*, (2017).

with biased historical training data that enhances the likelihood of statistical relationships with a discriminatory outcome.[762]

Moreover, if proof of intent is needed in a discrimination suit, it would be difficult to assert the malice of a model for which it is impossible to determine, a priori, what relationships will be found.[763] Hu exemplifies this via the government's No Fly List treatment of the Muslim community.[764] As a vetting mechanism, it does not focus on a legally protected class. In fact, the Supreme Court has rejected cases alleging that this program contravened the Equal Protection Clause because it was found that AI methods analyzed passengers "in a[n]…equal manner."[765]

An example of legal biased training data is found in facial recognition algorithms from cameras that lack ethnic representation to the point that they are more likely to recognize white males more than any other race or gender.[766] A potentially unlawful counter example is the data utilized by providers of predictive policing software. The variables in this application are key in determining the risk profile of individuals and locations, and their selection can perpetuate bias.[767] Emphasizing variables that are subjective (e.g. location of arrest) or that minimize the representation of a particular group may increase the presence of police officers in minority communities, raise their crime rates, and weaken the protection against illegal bias.[768]

4.7.2.2 Intellectual Discrimination

Our cognitive capabilities depend on our baseline intelligence and how it is shaped by the environment, known as the interaction of nature and nurture. Brenner and Hubbard speculate of a future where this is no longer the case.[769] They imagine a world where the private sector develops an application of AI allowing consumers to upgrade their cognition. Enhancing humans opens the door for one group to take advantage of the other. To protect "vulnerable" victims, or individuals without access to this application, federal sentencing guidelines impart harsher penalties to perpetrators based on a limited set of characteristics.[770] The regulatory gap observed

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[762] Atkinson, (2016);Lehr & Ohm, UCDL REV., (2017);Taylor, TELECOMMUNICATIONS POLICY, (2016);Benjamin LW Sobel, *Artificial Intelligence's Fair Use Crisis*, (2017).

[763] Coglianese & Lehr, GEO. LJ, (2016);Marcy Peek, *Passing beyond Identity on the Internet: Espionage & (and) Counterespionage in the Internet Age*, 28 VT. L. REV. (2003).

[764] Hu, FORDHAM L. REV., (2017).

[765] Id. at.

[766] Sobel, (2017).

[767] Barrett, NYU REV. L. & SOC. CHANGE, (2017).

[768] Elizabeth E Joh, *Policing police robots*, 64 UCLA L. REV. DISCOURSE (2016);Barrett, NYU REV. L. & SOC. CHANGE, (2017);Manuel A Utset, *Digital Surveillance and Preventive Policing*, 49 CONN. L. REV. (2016).

[769] Susan W Brenner, *Humans and Humans+: Technological Enhancement and Criminal Responsibility*, 19 BUJ SCI. & TECH. L. (2013);Hubbard, TEMP. L. REV., (2010).

[770] "For purposes of subsection (b), "vulnerable victim" means a person (A) who is a victim of the offense of conviction and any conduct for which the defendant is accountable under §1B1.3 (Relevant Conduct); and (B) who is unusually vulnerable due to age, physical or mental condition, or who is otherwise particularly susceptible to the criminal conduct.

Subsection (b) applies to offenses involving an unusually vulnerable victim in which the defendant knows or should have known of the victim's unusual vulnerability. The adjustment would apply, for example, in a fraud case in which the defendant marketed an ineffective cancer cure or in a robbery in which the defendant selected a handicapped victim. But it would not apply in a case in which the defendant sold fraudulent securities by mail to the general public

in this scenario is the uncertainty of whether courts that hear cases of cognitive discrimination facilitated by this AI application will have a restrictive or permissive approach in applying these guidelines.

Imagine a world where a firm offers an application of AI that, once installed within a human, it improves memory, concentration, and coordination. The sole barrier of entry is its price. Individuals with resources gain access to a cognitive advantage over those unable to afford it. This technology ultimately divides the population into two groups, people with improved capabilities versus those without.[771]

Individuals with diminished capabilities are protected by society through federal sentencing guidelines that enhance the punishment of criminals who target vulnerable victims. Four characteristics designate vulnerability: age, physical or mental condition, and anyone "who is otherwise particularly susceptible to the criminal conduct."[772]

Dyckman explains that the implementation of this standard divides courts into those with restrictive or permissive views.[773] Courts with restrictive views limit the application of punishment enhancements to characteristics that victims cannot control and that hamper their ability to defend themselves. Permissive courts take advantage of the open-ended "otherwise particularly susceptible" statement to cover a wide gamut of vulnerabilities and apply them more liberally to cases outside the scope of the age or mental and physical condition restrictions.[774]

Although this scenario speculates about a technology yet to be discovered, its implications on social equity are significant. With the presence of upgraded individuals, treating every person as an "equal before the law actually creates opportunities for inequality."[775] This is because individuals with superior capabilities can take advantage of their cognitive skills to trick vulnerable "normal" people by convincing them to sign complex contracts or participate in unfair schemes.[776] The regulatory gap of uncertainty will be observed in the conflicting application of sentencing guidelines by the justice system meant to disincentivize harm against "standard" humans by their enhanced counterparts.

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and one of the victims happened to be senile. Similarly, for example, a bank teller is not an unusually vulnerable victim solely by virtue of the teller's position in a bank" United States Sentencing Commission, *Guidelines Manual* (2018), *available at* https://www.ussc.gov/sites/default/files/pdf/guidelines-manual/2018/GLMFull.pdf..

[771] Hubbard, TEMP. L. REV., (2010).

[772] United States Sentencing Commission. 2018.

[773] Jay Dyckman, *Brightening the Line: Properly Identifying a Vulnerable Victim for Purposes of Section 3A1.1 of the Federal Sentencing Guidelines*, 98 COLUMBIA LAW REVIEW (1998).

[774] United States Sentencing Commission. 2018.

[775] Brenner, BUJ SCI. & TECH. L., (2013).

[776] Id. at.

4.8 Justice System

A functioning court system is the basis for the pursuit of justice. This section surveys the literature on the implications of methods and applications of AI in the operation of the judicial branch. The regulatory gaps identified in the articles reviewed fall in one of two buckets (Table 24).

Table 24 - Regulatory Gaps in the Justice System

Issue	Regulatory Gap	Type of Gaps	Government Level	Time Frame	Type of AI
Judicial Vetting of AI	FISA Courts	Targeting (Under)	Federal	Present	Application + Method
	Pre-Trial Discovery	Targeting (Under)	Federal + State	Present	Application
	AI Expert Witness	Uncertainty	Federal + State	Future	Method
Replacement of Judges	Elimination of New Judicial Precedents	Obsolescence	Federal + State + Local	Future	Application

The first bucket centers on the Daubert standard for admitting scientific testimony by an expert witness. Researchers argue that the under-inclusion of this standard may limit the ability of judges to effectively assess how AI is utilized in the courtroom. Others contemplate a future where courts are uncertain about the applicability of the standard to AI-based expert witnesses.

The second bucket discusses another future scenario where judges are replaced by AI agents. This transition could change the nature of the common law system by eliminating the development of new judicial precedent. Scholars argue that without judges, all cases will rely on the database of existing precedent and no new precedent is created to face unanticipated circumstances.

4.8.1 Judicial Vetting of AI

A fundamental element of the judicial system is the evaluation of evidence. All courts at the federal, and some at the state level, follow the Daubert standard for admitting scientific testimony by an expert witness.[777] In their role as "gatekeepers", judges are asked to consider five factors when deciding if a methodology presented by an expert witness is valid:[778]

1. *Whether the theory or technique in question can be and has been tested;*
2. *Whether it has been subjected to peer review and publication;*
3. *Its known or potential error rate;*
4. *The existence and maintenance of standards controlling its operation; and.*
5. *Whether it has attracted widespread acceptance within a relevant scientific community.*

The judicial vetting of methods and applications of AI as evidence generates the regulatory gaps of targeting and uncertainty. Whether this evidence is presented at the Foreign Intelligence Surveillance Court, pre-trial discovery, or as an expert opinion generated by an AI application,

[777] LII, *Daubert Standard*, Cornell Law School(2019), *available at* https://www.law.cornell.edu/wex/daubert_standard.
[778] Daubert v. Merrell Dow Pharmaceuticals, Inc., 509 U.S. 579, (1993).

the literature emphasizes scenarios where the Daubert standard is either not currently applied or there is uncertainty as to how it will be interpreted.

4.8.1.1 FISA Court

In the opinion of Hu, a targeting gap (under-inclusion) is confronted by judges in the Foreign Intelligence Surveillance Court.[779] This body oversees the electronic surveillance for foreign intelligence gathering by agencies of the executive branch such as the NSA.[780]

The objective of the Dauber standard is to assess the admissibility of expert testimony. FISA judges are not subject to Dauber and, because of this, they cannot hold government experts to the same standard utilized in other courts to verify the validity of claims about AI-based methods and applications used by applicants.[781] The under-inclusion of this standard means that these judges could be making ill or mis-informed decisions when assessing the approval for error-prone technologies that generate evidence to criminally implicate individuals.

4.8.1.2 Pre-Trial Discovery

Pre-trial discovery is a process where legal counsel for the defendant and plaintiff exchange evidence to prepare for a trial.[782] During this phase of deliberations, the implementation of an AI application, denominated a computer assisted review, can catalyze disagreements between parties.[783] These disagreements are subject to resolution by a judge. In the opinion of Waxse and Yoakum-Kriz, there is a regulatory gap of targeting (under-inclusion) because the rules of evidence do not apply in this phase, which denies courts the ability to scrutinize AI applications through a Dauber proceeding.[784]

Waxse and Yoakum-Kriz argue that Daubert should be applied when experts present their knowledge in the discovery phase to better inform the court on each party's argument.[785] Further, they believe that this exclusion hampers judges from making "informed decisions" on how these technologies are used in the pursuit of a "just, speedy, and inexpensive determination of every action and proceeding."[786]

4.8.1.3 AI Expert Witness

The last regulatory gap in the judicial vetting of evidence is future facing. Society is increasingly reliant on technology for evidence gathering (e.g. breathalyzers, video cameras, genetic testing), yet it has not faced a scenario where it validates the AI methods used by applications that serve

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[779] FISA, *About the Foreign Intelligence Surveillance Court*, *available at* https://www.fisc.uscourts.gov/about-foreign-intelligence-surveillance-court;Hu, PEPP. L. REV., (2014).
[780] FISA. 2019.
[781] Hu, PEPP. L. REV., (2014).
[782] LII, *Discovery*, Cornell Law School(2019), *available at* https://www.law.cornell.edu/wex/discovery.
[783] David J Waxse & Brenda Yoakum-Kriz, *Experts on Computer-Assisted Review: Why Federal Rule of Evidence 702 Should Apply to Their Use*, 52 WASHBURN LJ (2012).
[784] Id. at.
[785] Id. at.
[786] Fed. R. Civ. P., 1.

as expert witnesses in court.[787] As envisioned by Karnow, this future generates a regulatory gap of uncertainty.[788] In other words, it is difficult to predict if the AI methods used by these "experts," who have yet to be developed, will be treated the same as their human counterparts in the justice system.

The author offers arguments for admitting this source of knowledge in a court despite the impossibility, in some cases, to account for how a conclusion is reached. One argument compares this application to the expertise demonstrated by recognized professional opinions. Today, these opinions are admissible in court even though individuals cannot "fully articulate the foundation for it."[789] This is the case for art professionals or doctors whose credentials and experience are considered sufficient evidence for the validity of their opinions. A reliable application could theoretically also demonstrate tacit experience through similar social validation or credentialing of its AI methods.

Another argument compares this application to FDA approved drugs that treat a disease. According to Karnow, a number of medical products have been studied and accepted as valid by society, notwithstanding the lack of scientific evidence regarding how they work.[790] Much like these drugs, the reliability of a neural network's results can be demonstrated through statistical analyses. While the comparisons are compelling, the AI methods behind the applications described above have yet to undergo scrutiny by the courts.[791]

4.8.2 Replacement of Judges

Klingensmith and D'Amato speculate of a future where humans no longer serve as judges in courtrooms. They are replaced by AI agents who decide the fate of cases based on existing regulations and precedent. If this scenario occurred, the practice of creating new judicial precedent would face a regulatory gap of obsolescence, since the authors presume that AI agents would be unable to create new precedents based on changing social conditions. Making this doctrine irrelevant.

The doctrine of judicial precedent denotes the use of decisions from other courts by judges to rule on cases that have similar conditions, also known as stare decisis.[792] It is an important part of the legal system for two reasons. First, it allows courts to reference decisions without needing to reevaluate accepted legal arguments or doctrines.[793] Second, when confronted with new situations, the decisions by courts can create new precedents to be followed by other jurisdictions.

Klingensmith and D'Amato suggest that the replacement of judges with AI agents would have a perilous effect on the common law system, ultimately eliminating its ability to update itself.[794]

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[787] Andrea Roth, *Machine Testimony*, 126 YALE LJ (2016).
[788] Curtis EA Karnow, *The Opinion of Machines*, (2017).
[789] Id. at.
[790] Id. at.
[791] Id. at.
[792] LII, *Stare Decisis*, Cornell Law School(2019), *available at* https://www.law.cornell.edu/wex/appropriation.
[793] Id. at.
[794] Anthony D'Amato, *Can/should computers replace judges*, 11 GA. L. REV. (1976);Mark W Klingensmith, *Computers Laying down the Law: Will Judges Become Obsolete*, 90 FLA. BJ (2016).

They argue that the lack of human judges would "stagnate" the interpretation of the law and irrelevant legal doctrines would not be challenged or overturned, thus hampering the evolution of common law.[795] These positions assume that future judicial AI agents are capable of making complex decisions on the merits of cases, but lack an ability to establish new paradigms of judicial doctrine or their decisions will not be accepted by society as the basis for new doctrine.

[795] D'Amato, GA. L. REV., (1976);Klingensmith, FLA. BJ, (2016).

5 Overview of the Systematic Review

Chapter four answers this dissertation's first research question by identifying regulatory gaps caused by AI methods and applications in the U.S. It does so via a systematic review designed to screen a sample of articles in the academic literature and uncover where AI pushes the boundaries of public policy. This chapter contextualizes these gaps by answering the second research question: when looking across all of the gaps identified in the first research question, what trends and insights emerge that can help stakeholders plan for the future?

The overarching trends presented below comes from the analysis of labels that describe the regulatory gaps in this dissertation: policy theme, type of regulatory gap, level of government, temporality, and type of AI. Readers of this chapter should keep in mind that these findings are informed by a sample of the literature on this subject and are not intended to be a definitive account of AI's policy repercussions. In addition, they reflect the past and are not meant to prescribe the future.

Considering these limitations, there are a number of interesting findings. First, this dissertation validated the combination of Bennet-Moses's and Calo's ideas as an effective means to characterize regulatory gaps caused by AI. Second, the scarcity of novelty regulatory gaps in the systematic review indicates that existing policies are largely adequate to withstand the issues generated by this technology. Third, there is an even split between existing regulatory gaps and those expected in the future. This is interpreted as a sign that the U.S. is in the middle of a transition where applications and methods of AI are permeating society and policymakers should expect more regulatory gaps. Fourth, local government decision-makers have limited exposure to gaps compared to their state and federal counterparts. Lastly, applications of AI, particularly AV, caused the majority of the gaps found in this dissertation.

5.1 Validation and Adaptation of Key Ideas

The systematic review confirmed that an adapted version of Bennett-Moses's and Calo's ideas are effective in contextualizing the phenomenon of regulatory gaps. Bennett-Moses's framework characterizes "legal problems…[that]… arise from technological change."[796] Applying the framework to one technology (AI) in 50 cases of regulatory gaps corroborated its ability to withstand scrutiny. No cases where found in which the uncertainty, novelty, targeting, or obsolescence categories were not applicable.

Calo's taxonomy was conceived as a guide to understand the "contemporary policy environment around artificial intelligence" for "policymakers, investors, scholars, and students."[797] This work was not created to classify AI-based regulatory gaps. To adapt it, this dissertation implemented a systematic review to develop an empirically updated version of the taxonomy that clustered regulatory gaps around themes (see Table 25). This resulted in the deletion and creation of themes and sub-themes tailored to this dissertation's perspective of the AI and policy relationship.

[796] Bennett-Moses, UNSW LAW RESEARCH PAPER, (2007).
[797] Calo, SSRN, (2017).

Table 25 - Adaptation of Calo's Taxonomy

Original Version	Adapted Version
Safety and Certification	Safety and Certification
Taxation and Displacement of Labor	Displacement of labor
Privacy and Power	Privacy
Use of Force	Use of Force
Justice and Equity	Justice System
	Classification of Individuals
	Accountability
	Personhood

An important change to Calo's taxonomy was the elimination of the taxation and power themes (see Table 25). Originally, the taxation literature featured a number of important problems stemming from the decline in income tax revenue caused by the loss of employment opportunities. [798] This theme was dropped because no regulatory gaps linked to it were found. The power theme denotes the creation of monopolies due to the management of consumer data. Similarly, insufficient evidence was found that AI methods and applications contributed to the generation of regulatory gaps in this issue.

The justice and equity theme initially covered a broad spectrum of issues within "fairness, accountability, and transparency."[799] To improve its targeting of regulatory gaps, three themes were created. Accountability examines the question of what entity is responsible for remedying pecuniary and non-pecuniary harms caused by AI agents.[800] The classification of individuals theme focuses on how governments and the private sector use labels to make important decisions about people. The justice system theme concentrates on the impact of AI in the operation of courtrooms.

One of this dissertation's contributions is the creation of a theme not originally covered in Calo's work: personhood. It contains the regulatory gaps caused by the provision of rights and responsibilities associated with humans or juridical persons to AI agents. As the capabilities of this technology's methods and applications improve, the legal distinctions between a human and a sufficiently autonomous non-human can become progressively more difficult to make. This theme examines the frontier of this debate, where the regulatory gaps generated challenge our perception of personhood.

5.2 Type of Gaps

Bennett-Moses's framework describes the role of technology in generating instances where public policies are not adequate to confront the issues faced by society, known as regulatory gaps. This systematic review searched for gaps catalyzed by applications or methods of AI in the U.S. The distribution of gaps in Table 26 is a window into the nature of policy challenges found in the screened-in literature of this dissertation. At first glance, it shows that targeting (under-

[798] Id. at.
[799] Id. at.
[800] Bryson, et al., ARTIFICIAL INTELLIGENCE AND LAW, (2017).

inclusion) was the least prevalent gap (6%) and uncertainty was the most prevalent (42%). Upon closer examination, the more interesting story for stakeholders is the proportion of novelty gaps found in this sample.

Table 26 – Distribution of Regulatory Gaps in the Systematic Review by Prevalence

Type of Gap	Definition	# of Regulatory Gaps
Targeting (over)	With respect to a policy goal, technology causes circumstances in which its application is not directed to the goal but fall within its scope (over-inclusiveness).	3
Novelty	Technology creates behavior that requires bespoke government action.	6
Obsolescence	A technology makes a regulation irrelevant or unenforceable.	10
Targeting (under)	With respect to a policy goal, there are circumstances falling outside its scope where its application would further the goal (under-inclusiveness).	10
Uncertainty	Conflict arises because a new technology is not easily classified.	21

A novelty gap is one where a technology instigates behaviors that are unique to the point that policymakers had not thought of addressing them or there are new reasons to act on situations requiring bespoke attention. This dissertation found that only 12% of gaps are classified as novelty, which implies that few scenarios entail the creation of regulation. At least in the short-term, it does not appear to be necessary for policymakers to implement new approaches for the administration of government or create government agencies specialized in this technology.

The majority of regulatory gaps (88%) caused by applications or methods of AI occur for reasons unrelated to novelty. In other words, adaptions rather than new laws are required to solve most gaps. My interpretation of this finding is that the status quo of U.S. policymaking is largely adequate to withstand the issues generated by AI. Although policymakers and the public can undoubtedly expect to be tested by this technology, the resolution to these problems is not new regulation. A good example are uncertainty gaps. These denote instances where a technology leads to differences in opinion about its classification between jurisdictions or levels of government. Once an authority clarifies the interpretation of the gap, it should no longer exist.

Future research should address the optimal solutions for the gaps within this work. This dissertation purposefully avoided offering alternatives for bridging or resolving these issues because doing so is a political process reliant on the ideology or theory of governance of a public administration. Any action taken by government to address challenges should consider the relevant context and define their preferred modality of action.

In general, policymakers can implement and combine hard and soft law instruments. Hard law references enforceable action by government (e.g. laws and treaties). This is a purposefully deliberative process that slowly digests the effects of emerging technologies. The political consensus-making required for this type of action makes it difficult to create or change a government act once it is approved and its effectiveness depends on the credibility and power of the enforcer.

Alternatively, soft law mechanisms "set substantive expectations that are not directly enforceable by government" (e.g. codes of conduct, industry standards, among others).[801] Even though they are voluntary, their flexibility means that any entity can experiment with ideas to solve a problem. Soft law may serve as a bridge solution between no regulation and hard regulation, or used in conjunction to it. This trait is advantageous considering that emerging technologies, such as AI, may be in their infancy and neither policymakers or consumers truly understand their repercussions, making any action to control it untimely or premature.[802]

5.3 Temporality of Gaps

The analysis of gaps involved determining when AI policy challenges are encountered. This systematic review found a virtual split between gaps experienced today or speculated to occur in the future (see Table 27). An explanation for this finding is that the U.S. is in the middle of a transition. One where applications and methods of AI are permeating society and policymakers should expect more regulatory gaps.

Table 27 – Temporality of Gaps

Temporality	Definition	Distribution in the systematic review
Future	The gap is speculated to occur in the future.	24
Present	The gap is currently experienced.	27

With existing gaps that were not proactively addressed, governments are limited to one of two strategies: reactive or limited action. A reactive strategy is characterized by the presence of a trigger before a policy decision is made. In many cases, policymakers have no choice but to react because regulatory mechanisms are unprepared to proactively identify policy challenges. The element of surprise may force government to adjust or create regulation in haste, with insufficient information, or without having a mastery over the problem at hand. Limited action is a strategy where government takes a step back and either outsources its regulatory powers to third parties or waits for a technology to develop before a course of action is taken.

The use of force and privacy literature are particularly affected by existing gaps. Weapon systems with autonomous features are arguably already stocked in the inventories of armies throughout the world. Yet the parameters for human control, their legal use, and a consensus definition remain unresolved. In privacy, AI is currently altering the social norms on the treatment of personal information and all of the regulatory gaps identified in this section are being experienced by consumers.

For regulatory gaps in the future, governments have time to plan for the implications of AI. Unlike challenges in the present, future ones can be proactively studied and addressed. An application that dominates the conversation in this regard is completely AV. Even though no vehicle on the

[801] Marchant, "Soft Law" Governance Of Artificial Intelligence. 2019.
[802] Andrew Tutt, *An FDA for algorithms*, (2016).

road is built with completely autonomous capabilities, the future impact of this technology is extensively discussed in the safety and certification, and accountability literature.

Overall, no prescription on the timeliness for resolving a regulatory gap exists. Proactive measures may negatively impact consumers by limiting their access to technology with significant benefits. Reactive ones may be implemented after a social rubicon that makes them unenforceable or obsolete. A limited or no action strategy can subject policymakers to the will of non-government actors.

With all strategies, stakeholders face a Collingridge dilemma.[803] On the one hand, they lack information as to the potential effects of an emerging technology when it is introduced in the market. Thus, they cannot predict how extensively it will challenge policies and act on it. On the other, delaying action until more information is available could risk addressing a regulatory gap until after the technology diffuses in society. By this point, the power of policymakers to control its effects could be diminished.

5.4 Government Level

Federal (70%) and state (60%) authorities garnered the most attention from scholars (see Table 28). This made the literature on local government (14%) an uncommon sight in the systematic review. The data from this dissertation supports the view that gaps generated by AI appear to fall under jurisdictions with authority over swaths of the population that are larger than a city or county.

Table 28 - Government Levels of Gaps

Government Level	Distribution in the systematic review
Federal	35
State	30
Local	7

Local policymakers are the first and, in many cases, only contact with government services for individuals. Despite the dearth of literature on regulatory gaps under their jurisdiction, there are gaps caused by AI left unaddressed in this systematic review. One of them is the focus of a case study in this dissertation. It examines the policy playbook developed to curtail the first generation of the urban sprawl and how it fares in potentially decreasing a vital revenue stream (property taxes) due to the introduction of AV.

Like their counterparts at the state and federal level, local policymakers are limited in their ability to address the medium and long-term implications of emerging technologies by short-term politics and the immediate needs of denizens in their jurisdiction. As a new generation of AI applications and methods crystalizes, the potential to learn from actions taken at different jurisdictions offers a first approach to guide the policy playbook for local government. Further, to combat the scarcity of literature on local AI policy challenges, these policymakers could resort

[803] COLLINGRIDGE. 1980.

to thematic or national associations that agglomerate their interests with the purpose of researching, analyzing, and forecasting how AI shapes regulation.

5.5 Applications Versus Methods of AI

This dissertation distinguishes between applications and methods of AI. Methods refer to approaches to accomplish a goal (e.g. neural networks), while applications are the goal itself (e.g. autonomous vehicles). The systematic review found that applications of AI were the dominant cause of regulatory gaps (see Table 29).

Table 29 – Applications vs. Methods of AI

Use of AI	Distribution in the systematic review
Applications	47
Methods	5

All applications in this dissertation represent narrow or weak forms of AI, those developed for a specific purpose. Out of these, AV were the most referenced. Their role in creating regulatory gaps in commercial accountability can serve as an analogy for assigning the pecuniary and non-pecuniary responsibility for applications outside of the transportation sector. This is less so the case of AV mentions in the safety section, where their regulatory particularities (e.g. shared jurisdiction between federal and state government) have limited relevance to other sectors.

An important number of applications with present and future social consequences are virtually absent from this systematic review such as: autonomous airplanes or facial recognition technology. The latter is the subject of the second case study of this dissertation in which local, state, and federal policies related to the protection of biometric data are examined. Notably, the next step in the evolution of AI, general artificial intelligence or strong AI, "highly autonomous systems that outperform humans at most economically valuable work," does not appear in this systematic review.[804] Explanations for this phenomenon include sampling issues with the protocol or a lack of incentives in academia to research the policy implications of applications that are unlikely to occur in the short or medium term.

Few regulatory gaps in the systematic review were caused by AI methods. The majority were catalyzed by the need for explainability and transparency in regulatory contexts. AI methods such as neural networks can produce extremely accurate predictions, but may do so without justifying the variables or processes that led to a conclusion. This generates conflict in settings where understanding the reasoning for an output is crucial (e.g. probable cause and due process).

[804] OpenAI, *About OpenAI*(2019), *available at* https://openai.com/about/.

6 Case Studies on Under-Represented Issues in the Systematic Review

The last chapter of this document complements chapter five by answering this dissertation's second question. It does so by highlighting under-represented issues in the systematic review through two case studies, a methodology that recounts the social processes and events relevant to the selected issues.[805] These cases are illustrative of the large number of clashes between AI and public policy that were left unaddressed in this dissertation and that future scholars can undertake.

One of this dissertation's findings was that local policymakers have limited exposure to regulatory gaps caused by AI applications and methods. The first case study recognizes the diverse issues faced by authorities at this level of government. Specifically, it examines how the policy playbook developed to curtail the first generation of the urban sprawl fares in limiting the local government revenue repercussions of a new autonomous vehicle (AV)-induced urban sprawl.

The second case study analyzes the policy implications of an AI application that is mostly absent from this systematic review due to the timing of the literature analyzed. Prior to 2018, facial recognition technology (FRT) was neglected by academics within this work's sample of articles. In the past couple of years, the literature on FRT has increased in prevalence and became a cost-effective means of identifying and surveilling individuals. The work presented in this chapter is an analysis of public policies at all levels of government related to FRT.

[805] Paul, et al., HISTORICAL METHODS: A JOURNAL OF QUANTITATIVE AND INTERDISCIPLINARY HISTORY, (2013).

6.1 A New Wave of Urban Sprawl: Influence of Autonomous Vehicles in the Policy Toolkit of U.S. Local Governments

Economic and technological transitions in the eighteenth century heralded the transformation of urban demographic patterns in the U.S. Beginning with the industrial revolution, cities became synonymous with prosperity as they offered a supply of employment unavailable in rural environments. These opportunities drove a migration towards the downtown of cities throughout the country, which became the epicenters of growth. However, changing conditions in the twentieth century created new geographic incentives for families. A combination of public policies and market forces catalyzed a phenomenon known as the urban sprawl, where individuals exchanged their confined downtown spaces for homes at the border of the urban footprint that afforded higher per person living space.

Scholarship on the urban sprawl points to the ownership of vehicles and policies that favored this form of transportation as important culprits of the phenomenon. These factors generated efficiencies that convinced individuals of increasing the distance between their homes and workplaces. Recently, the promise of a new transportation technology, in the form of the Autonomous Vehicle (AV), has the potential to reshape urban demographic patterns, much like the non-AV did in the twentieth century, and cause a new generation of the urban sprawl.

The introduction of AV into the urban car park can affect cities in a variety of ways. In this article, I speculate that their economic and time advantages could motivate individuals to adjust their residential preferences toward homes that are farther away from their workplace. If correct, these migrations could entail crossing county lines which would lead their original jurisdiction to lose property tax revenue (the largest source of own-sourced income at the local level). This article contributes to the literature by analyzing how the local policy playbook developed to curtail the first generation of the urban sprawl fares in limiting the revenue repercussions of a new AV-induced urban sprawl.

This work is divided into two sections. First, it provides an account of the first generation of the urban sprawl, its causes, and introduces the policy playbook employed to address its negative consequences. In the second section, I compare the benefits of AV to non-AV and argue that the latter could produce a second urban sprawl. Further, I draw attention to the importance of property taxes for local governments and suggest that, in the future, AV could endanger this source of revenue. With this in mind, I finalize by assessing how the local policy toolkit available to fight the first wave of the urban sprawl withstands the test of time to protect the budgets of local governments from an AV-induced second wave of this phenomenon.

6.1.1 Urban Sprawl

The term urban sprawl describes the uncontrolled expansion of a city's footprint.[806] Theoretically, it manifests itself through the interplay of decentralization and changes in density.[807] On average,

[806] Edward L. Glaeser & Matthew E. Kahn, Sprawl and Urban Growth (National Bureau of Economic Research 2003).
[807] Id. at;KAHNEMAN. 2013.

it is witnessed in cities where distances between residential and commercial neighborhoods grow (high decentralization) and the number of people living and working in any given square mile decreases (low density).[808]

This section characterizes the first wave of the urban sprawl. It begins by discussing its origins and identifying the market and policy factors that played a role in catalyzing it. Subsequently, I describe the policy playbook developed to counter its negative effects.

6.1.2 Origins of the Urban Sprawl

The origin of the urban sprawl is the preponderance of cities as centers of prosperity that prompted rural residents to migrate towards urban parts of the country in the ninteenth and twenieth century.[809] New economic opportunities during the industrial revolution gradually shifted the U.S. demographic landscape throughout several decades. In the late eighteenth century, less than 5 percent of the population lived in urban areas.[810] After 50 years, this proportion increased to 15 percent, and in the second decade of the twenieth century, half of the country lived in cities. By the end of the first decade in the twenty first century, the transition between farm and city living saw most of the people in the U.S. (80 percent) call urban areas home.[811]

Ninteenth century rural families settled in city centers due to their proximity to employment.[812] With time, growing incomes allowed them to transition from the confines of downtown to cost-effective options in the urban periphery.[813] Albeit at a slow pace, people left city centers, thus beginning the development and settlement of suburban and peri-urban zones. The long-term aggregation of this trend marked the beginning of what is now known as the urban sprawl. As a consequence, before the Second World War only 13 percent of Americans lived in the suburbs, while in 2010 this increased to over half of the population.[814] This movement of people can be explained, in part, by two factors: decreasing transportation costs and policies supporting a car-centric infrastructure.

6.1.2.1 Decrease in transportation prices

Scholars have identified the decline in transportation costs as a culprit of the urban sprawl.[815] The Ford Corporation is partly responsible for this trend. It introduced its Model T in 1908 at an initial price of $950. Through innovations in assembly line manufacturing, each vehicle had adjusted its cost to about $300 by 1924.[816] Plummeting vehicle prices and rising wages in the

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[808] Glaeser & Kahn. 2003.
[809] Traffic, Urban Growth and Suburban Sprawl (2003);Glaeser & Kahn. 2003.
[810] U.S. Census, *2010 Census Urban Area Facts*, U.S. Census(2010), *available at* https://www.census.gov/programs-surveys/geography/guidance/geo-areas/urban-rural/ua-facts.html;Thomas J. Nechyba & Randall P. Walsh, *Urban Sprawl*, 18 AMERICAN ECONOMIC ASSOCIATION (2004).
[811] Census. 2010.
[812] Jan K. Brueckner, Urban Sprawl: Lessons from Urban Economics (Brookings-Wharton Papers on Urban Affairs 2001).
[813] Id. at.
[814] Becky Nicolaides & Andrew Wiese, Suburbanization in the United States after 1945 (Oxford University Press 2017).
[815] Census. 2010;Nechyba & Walsh, AMERICAN ECONOMIC ASSOCIATION, (2004).
[816] Jean-Paul Rodrigue, et al., The Geography of Transportation Systems (Hofstra University 2017).

post-war periods, led to massive gains in ownership. In the 1950's, over 50 percent of households in the U.S. owned one car, in the 1970's this decreased to 35 percent, but ownership of two or more vehicles was at 50 percent, and by the mid 90's multiple car ownership rose to 69 percent.[817] With access to transportation, families chose to relocate to the periphery of cities where they could afford improved living conditions.[818]

6.1.2.2 Car-centric infrastructure

Coupled with the affordability of vehicles, governments at all levels prioritized investments in the expansion of roads and highways over the construction of public transportation networks.[819] The crown jewel of this effort was the interstate highway system. As of today, it consists of over 46,000 miles of roads and highways, and the federal government paid for over 90 percent of its $129 billion cost.[820] Following this lead, state and local authorities prioritized the investment of their limited resources in connecting their communities to this network, rather than mass transit alternatives. Under these circumstances, urbanites were not only incentivized to own a vehicle, in some cases it became the only viable method of transportation.

6.1.3 Government local policy playbook against the first wave of the Urban Sprawl

There are 89,004 local governments within 3,031 counties in the U.S.[821] In many ways, county governments are the first and most likely interaction that residents will encounter with a public authority. In addition to their accountability in the provision of services and maintaining everyday infrastructure, local policymakers are responsible for pursuing actions in the best interests of their jurisdictions.

The urban sprawl is a phenomenon worthy of being addressed by cities because its negative consequences make it undesirable. From an efficiency perspective, the per-capita cost of providing public services grows as the density in urban areas declines.[822] Transportation-wise, as people move farther from their workplace, they are forced to drive a higher number of miles, which increases congestion, public investment on car-centric infrastructure, pollution, and accidents.[823] Also, the encroachment of real estate development in the urban periphery decreases the availability of open spaces and nature, which affects resident quality of life.[824]

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[817] Glaeser & Kahn. 2003;Don Pickrell & Paul Schimek, Growth in Motor Vehicle Ownership and Use: Evidence from the Nationwide Personal Transportation Survey (Volpe National Transportation Systems Center 1999).
[818] Nechyba & Walsh, AMERICAN ECONOMIC ASSOCIATION, (2004).
[819] Glaeser & Kahn. 2003.
[820] Federal Highway Administration, *Highway History*, Federal Highway Administration(2017), *available at* https://www.fhwa.dot.gov/interstate/faq.cfm.
[821] U.S. Census, *Census Bureau Reports There Are 89,004 Local Governments in the United States*, U.S. Census(2012), *available at* https://www.census.gov/newsroom/releases/archives/governments/cb12-161.html.
[822] John I Carruthers & Gudmundur F Ulfarsson, *Urban sprawl and the cost of public services*, 30 ENVIRONMENT AND PLANNING B: PLANNING AND DESIGN (2003).
[823] Randall G. Holcombe & DeEdgra W. Williams, *Urban Sprawl and Transportation Externalities*, 40 THE REVIEW OF REGIONAL STUDIES (2010).
[824] Nechyba & Walsh, AMERICAN ECONOMIC ASSOCIATION, (2004).

The local policy playbook to curb the consequences of the urban sprawl includes regulations focused on zoning and pricing mechanisms.[825]

6.1.3.1 Zoning

In the 1920's, the federal government enacted the Standard Zoning Enabling Act to empower local authorities to control land usage within their borders.[826] Once upheld by the Supreme Court, it essentially allowed the development of policies that separated residential communities from pollution-emitting industrial zones.[827] The first jurisdiction to pass a zoning law in the U.S. was New York City.[828] It divided the metropolitan area into zones (commercial, residential, and industrial) and restricted the height of buildings.

With zoning, local policymakers shape their city's growth in the long-term. They can choose to limit the density of residential areas from one dwelling per plot to multifamily housing or from one store to malls. Promoting low-density housing inevitably covers a significant amount of territory, which means that a growing city needs to extend outwards to accommodate new residents.

Zoning also empowers local officials to establish conditions for the development of real estate. A popular requirement in the U.S. is the setting of a minimum number of parking spaces depending on the type of construction and its surface area. Utilizing this lever decreases the density of land and favors the private ownership of vehicles.[829]

To fight the urban sprawl, local policymakers can utilize zoning to increase land density or change the construction requirements to promote dense residential and commercial buildings. Other than modifying the density of land, a popular zoning policy is establishing an artificial border to control the development of property outside a predetermined area. Known as an urban growth boundary (UGB), this lever represents a long-term zoning measure that manages land usage rights to foster city densification. The first UGB in the U.S. was created in Lexington, Kentucky and over 100 cities in the country have followed its example.[830]

The most cited implementation of the UGB is Portland, Oregon. A state government initiative in 1980 clustered the urban planning of over 24 cities within three counties.[831] Multiple studies on its effects point to inconclusive evidence of whether the initiative has limited the urban sprawl.[832]

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[825] Jan K. Brueckner, *Urban Sprawl: Diagnosis and Remedies*, 23 INTERNATIONAL REGIONAL SCIENCE REVIEW (2000);Brueckner, Urban Sprawl: Lessons from Urban Economics. 2001;Michael Overton, *Sorting through the determinants of Local Government Competition* 1AMERICAN REVIEW OF PUBLIC ADMINISTRATION (2016);Thomas J. Nechyba, *Local Property and State Income Taxes: The Role of Interjurisdictional Competition and Collusion*, 105 JOURNAL OF POLITICAL ECONOMY (1997).

[826] Advisory Committee on Zoning, A Standard State Zoning Enabling Act (Department of Commerce 1926).

[827] William Howard Taft, Euclid v. Ambler, 272 U.S. 365 (Supreme Court of the United States ed., 1986).

[828] NYPAP, 1961 New York City Zoning Resolutio (2016);Andrew S. Dolkart, The Architecture and Development of New York City (Columbia University 2003).

[829] Donald Shoup, The High Cost of Free Parking, Updated Edition (American Planning Association 2011).

[830] Michael E. Gleeson, *Effects of an Urban Growth Management System on Land Values*, 55 LAND ECONOMICS (1979).

[831] Oregon Metro Government, *Urban growth boundary*(2017), *available at* http://www.oregonmetro.gov/urban-growth-boundary.

[832] Myung-Jin Jun, *The Effects of Portland's Urban Growth Boundary on Urban Development Patterns and Commuting*, 41 URBAN STUDIES (2004).

Jun argues that the UGB may have diverted population growth to a county not under the control of the Portland metropolitan authority in a different state (Clark County, Washington state).[833] As an excluded jurisdiction, the study found that residential development in this area grew at a faster pace than its homologues within Oregon. Hence, the lack of interstate cooperation may have incited an unplanned outlet for the growth of the Portland metropolitan area. A policy trade-off for the UGB is that limiting the geographic extension of a city can increase household prices.[834] This may exacerbate options for low-income households as their demand is displaced to real estate alternatives away from city limits.

In all its permutations, zoning is an instrument that affects property values by controlling the supply of residential or commercial real estate. As such, land-owners interested in protecting their investment can politicize this lever to influence decision-making against the construction of homes or offices that will depreciate their assets.[835]

6.1.3.2 Pricing mechanisms

Rather than setting density constraints through zoning, pricing mechanisms focus on the behavior of people or firms contributing to the formation of urban sprawls. The scholarship in this field identifies three groups worth targeting: commuters, developers, and owners of real estate.

6.1.3.2.1 Commuters

Commuters do not completely absorb the total social costs of their movement to the periphery of cities. By choosing to drive on public roads, they contribute an additional vehicle to the traffic conditions withstood by the rest of society without paying a penalty.[836] That is to say, the price of congestion is artificially inexpensive since anyone with a vehicle can add to the total amount of traffic experienced by all those stuck in a highway at no expense.[837]

Policy levers aimed at commuters have the express goal of increasing the cost of driving. The intuition behind these measures are that rising prices linked to commuting can motivate people to live closer to their workplace, thus decreasing the sprawl. Policymakers can target this behavior by creating a congestion tax, where rush-hour commuters are charged a fee based on their usage of roads during peak traffic times.[838] The implementation of this fee through tolls would make it more expensive to utilize roads, but it may also encourage carpooling and decrease congestion.[839]

A variant of a congestion tax can take the shape of geographic boundaries. This policy consists of designating borders where users are charged each time they enter or exit them. Theoretically, individuals face a fee when they cross through a single point on a road (point pricing) or an

[833] Id. at.
[834] Nechyba & Walsh, AMERICAN ECONOMIC ASSOCIATION, (2004).
[835] Marion Clawson, *Urban Sprawl and Speculation in Suburban Land*, 38 LAND ECONOMICS (1962).
[836] David Schrank, et al., Urban Mobility Scorecard (The Texas A&M Transportation Institute 2015).
[837] Brueckner, Urban Sprawl: Lessons from Urban Economics. 2001;Brueckner, INTERNATIONAL REGIONAL SCIENCE REVIEW, (2000).
[838] Brueckner, INTERNATIONAL REGIONAL SCIENCE REVIEW, (2000).
[839] Hideo Konishi & Se-il Mun, *Carpooling and congestion pricing: HOV and HOT lanes*, 40 REGIONAL SCIENCE AND URBAN ECONOMICS (2010).

imaginary line drawn around an area (cordon pricing).[840] In the context of an urban sprawl, fees can influence where commuters chose to live. A jurisdiction can place this pricing mechanisms around its borders at a price that dissuades people from living in a neighboring city or county. These fees can generally be avoided by staying away from the border or substituting private driving with public transportation. The latter is only possible in cities with well-connected systems.

To date, most examples of point or cordon pricing have primarily served as a policy to reduce congestion. In 1975, Singapore was the first country to successfully implement cordon pricing in the busiest areas of the island nation.[841] Throughout its initial years, local policymakers learned that an unintended outcome of their decision was to shift congestion from one part of city to another. Hence, they adjusted the scheme to include a temporal element where prices for peak and off-peak entrance to the congestion zone were differentiated. Several cities continue to experiment with such a scheme with positive results. In 2003, London's implementation of its own cordon pricing policy managed to decrease the flow of vehicles by 20,000 a day during the first few months of operation.[842]

6.1.3.2.2 Developers

The next set of prices are aimed at the construction of homes in the periphery by developers. These entities fail to internalize several of the social costs that their construction impose on an urban environment. For one, the conversion of open spaces into residences diminish the ability of citizens to enjoy nature. Depending on their jurisdiction, they also fail to account for the investments by local authorities to provide a minimum standard of living for commercial and residential structures. This includes sewers, roads, and the availability of desirable services such as education or police protection. Although eventual residents of these homes will contribute to local coffers via the payment of taxes (i.e. sales, property, among others), the onus is on current residents to cover the up-front costs of this infrastructure.

The objective of price mechanisms aimed at developers is to control the rate of growth of property and promote density by adding cost barriers to construction. An urban sprawl-specific fee is the development tax, where authorities account and charge for each acre of agricultural land that is transformed into a building.[843] Hypothetically, the price paid by developers should equal the benefits lost from the vacant land. Determining this cost has become a barrier faced by authorities due to the difficulty in accurately reflecting the public appreciation for open spaces.[844]

Another fee in the policymaker's playbook is forcing developers to pay the cost of the infrastructure needed to support their buildings up-front. Known as impact fees, local governments can request cash payments or in-kind capital investments in the form of streets,

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[840] JOSE A GOMEZ-IBANEZ & KENNETH A. SMALL, ROAD PRICING FOR CONGESTION MANAGEMENT: A SURVEY OF INTERNATIONAL PRACTICE (National Academy Press. 1994).

[841] Id. at;Sock-Yong Phang & Rex S. Toh, *Road Congestion Pricing in Singapore: 1975 to 2003*, AMERICAN SOCIETY OF TRANSPORTATION & LOGISTICS (2004).

[842] Todd Litman, London Congestion Pricing: Implications for Other Cities (Victoria Transport Policy Institute 2006).

[843] Brueckner, INTERNATIONAL REGIONAL SCIENCE REVIEW, (2000).

[844] Id. at.

sewers, or other structures as a requirement for the approval of their project.[845] This policy was not fashionable prior to the 1960's when less than 10 percent of local governments adopted it. This changed after the 1980's when over 90 percent of municipalities supplemented the costs of urban expansion through it.[846]

The literature on the effect of the impact fee is mixed. Nelson oints out that impact fees in some counties are flat rates, and because they don't consider the value of a property, this makes them regressive.[847] Such a practice highlights the related issue of who eventually pays for the fee. Do developers pass it on to consumers (of which low-income households could pay a higher percentage than their high-income homologues) or do they use their profits to cover this expense? Evidence from Pinellas County, Florida, where a cash payment of $1,500 per new single-family home is required, found that developers were passing these costs to consumers.[848]

6.1.3.2.3 Owners of real estate

The last pricing mechanism is directed at owners of real estate through property taxes. These taxes can be altered to fluctuate the demand for housing; nevertheless, their effect on the urban sprawl is uncertain. Scholarship on this subject finds that a rise in the property tax rate may negatively affect the number of homes built (improvement effect), therefore decreasing the density of land.[849] At the same time, consumers may increase their demand for more affordable compact homes on smaller lots (dwelling size effect), which increases density.[850]

Cities can distinguish themselves by lowering the overall property tax rate or differentiate the base rates in a way that land and the structures that sit on top of it pay contrasting amounts, this is known as a split-rate tax.[851] This variation on the property tax incentivizes dense construction by charging structures at a lower rate than the land beneath it. The intuition behind this proposal is that owners of real estate will prefer to minimize their tax burden by purchasing homes in high-density plots of land. Although this approach is not widely adopted (it is used by less than 20 cities in the U.S.), evidence suggests that it may increase the number of homes by about 3-6 percent on a piece of land per decade as compared to cities that do not implement it.[852]

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[845] Id. at.

[846] Jan K. Brueckner, *Infrastructure financing and urban development: The economics of impact fees*, 66 JOURNAL OF PUBLIC ECONOMICS (1997);LAN A. ALTSHULER & JOSE A. GOMEZ-IBANEZ, REGULATION FOR REVENUE: THE POLITICAL ECONOMY OF LAND USE EXACTIONS (Brookings Institution Press. 1993).

[847] Arthur C. Nelson, *Development Impact Fees: The Next Generation*, 26 URB. LAW. 541(1994).

[848] Id. at.

[849] Jan K. Brueckner & Hyun-A Kim, *Urban Sprawl and the Property Tax*, 10 INTERNATIONAL TAX AND PUBLIC FINANCE (2003);Robert W. Wassmer, *Further empirical evidence on residential property taxation and the occurrence of urban sprawl*, 61 REGIONAL SCIENCE AND URBAN ECONOMICS (2016).

[850] Brueckner & Kim, INTERNATIONAL TAX AND PUBLIC FINANCE, (2003);Yan Song & Yves Zenou, *Property tax and urban sprawl: Theory and implications for US cities*, 60 JOURNAL OF URBAN ECONOMICS (2006).

[851] Jeffrey P. Cohen & Cletus C. Coughlin, *An Introduction to Two-Rate Taxation of Land and Buildings* 87 FEDERAL RESERVE BANK OF ST. LOUIS REVIEW (2005);Alanna Hartzok, *Pennsylvania's Success with Local Property Tax Reform: Tbe Split Rate Tax*, 56 AMERICAN JOUMAL OF ECONOMICS AND SOCIOLOGY (1997).

[852] H. Spencer Banzhaf & Nathan Lavery, *Can the land tax help curb urban sprawl? Evidence from growth patterns in Pennsylvania*, 67 JOURNAL OF URBAN ECONOMICS (2010).

Actively competing in a revenue war with adjoining counties using levers such as the property tax rate is equivalent to endangering the flow of resources needed to pay for the public goods expected by residents (e.g. local infrastructure and services). In effect, simulations and natural experiments have demonstrated that as competition escalates between neighboring authorities, property tax rates are likely to decrease to a point where public goods are under-provided due to the shortage of funding.[853] An entire literature is dedicated to the strategic behavior and response of authorities over property tax rates under the name of *tax competition*.[854]

6.1.3.3 Competion among jurisdictions

When implementing zoning or pricing mechanisms, it is imperative that policymakers consider the characteristics of adjacent jurisdictions. If a metropolitan area experiences high levels of concentration or is monocentric, it has more power over a larger share of the population or economic output and is unlikely to face competition from its neighbors when it implements policies to curtail the urban sprawl.

Polycentric metropolitan areas, or those with more than one social, economic, or residential pole, have the opposite problem. Coordination between cities with differing priorities may create challenges in the development of a common agenda. The higher the number of governments involved, the more difficult it can be for cities to work together to stop the urban sprawl.[855] Competition between jurisdictions may lead to the supply of incentives that promote the "expansion of the urban area beyond what would be driven by market forces."[856]

Any inter-municipal action, through cooperation or competition, depends on three factors: concentration, collusion, and contestability:[857]

- **Concentration** relates to the number of cities that are in proximity to a metropolitan area.
- **Collusion** amongst local governments maintains the status quo. If high levels of it exists, residents of a metropolitan area will have a harder time in comparison shopping neighboring jurisdictions for residential alternatives. Another issue to consider is the proportion of GDP distributed among cities. The more parity amongst local governments, the higher the collusion and the less able is one county to influence or dominate others.[858]
- **Contestability** are the barriers that differentiate a city:
    - *Economic barriers* in the form of sustained long-term investments that improve the conditions of one competitor over others can generate higher barriers to entry.

[853] Jack Mintz & Henry Tulkens, *Commodity tax competition between member states of a federation: Equilibrium and efficiency*, 29 JOURNAL OF PUBLIC ECONOMICS (1985);David E. Wildasin, *Nash Equilibria in Models of Fiscal Competition* 35 see id. at Cited Pages|. (1987).

[854] Jan K. Brueckner & Luz A Saavedra, *Do Local Government Engage in Strategic Property-Tax Competition?*, 54 NATIONAL TAX JOURNAL (2001).

[855] Bryce Dyer, *The controversy of sports technology: a systematic review*, 4 SPRINGERPLUS (2015).

[856] Therese J. McGuire & David L. Sjoquist, *Urban Sprawl and the Finances of State and Local Governments*, *in* STATE AND LOCAL FINANCES UNDER PRESSURE (2002).

[857] Jean Hindriks & Gareth D. Myles, (MIT Press 2004);Overton, AMERICAN REVIEW OF PUBLIC ADMINISTRATION, (2016).

[858] Brueckner & Saavedra, NATIONAL TAX JOURNAL, (2001).

- *Political barriers* are reflected in controversial decisions that produce benefits for a local government, but because of high political costs, cannot be replicated by competing administrations.

6.1.4 A New Urban Sprawl

The first wave of the urban sprawl was spurred, in part, by the supply of low-cost vehicles and policies that subsidized a car-centric road infrastructure. In the twenty first century, a new transportation technology is poised to offer benefits that may instigate a second generation of the urban sprawl, the AV.

This section begins by describing how the advantages of AV could instigate a migration towards a city's periphery. Subsequently, it highlights a hypothetical problem local jurisdictions may face with the penetration of AV: the loss of property tax revenue because residents emigrate to neighboring jurisdictions. If this scenario were to occur at a massive scale, the most important source of funds for local governments would be jeopardized. Lastly, the policy playbook developed to control the first generation of the urban sprawl is assessed against the role of AV in endangering the procurement of local property taxes.

6.1.4.1 Influence of the AV on catalyzing a new Urban Sprawl

Research on replacing a person's senses, complying with the rules of the road, and appropriately responding to its surroundings is a complex task that has been at the crux of academic and industry efforts spanning over 50 years. Much progress remains for AV to become a reality. As of the writing of this document (2019), consumers cannot purchase an AV that can take over a human in the task of traveling from one point to another without assistance. Technologies do exist, as part of standard or optional equipment, to aid in the decision-making of a human operator such as: adaptive cruise control, blind spot monitoring, automatic parking, and lane assist. In fact, two classifications are available to categorize the capabilities of these technologies in taking over driving activities (see Table 30).

Table 30 - Classification for Level of Autonomy

	Level 0	**Level 1**	**Level 2**	**Level 3**	**Level 4**	**Level 5**
SAE	No driving automation	Driver assistance	Partial driving automation	Conditional driving automation	High driving automation	Full driving automation
NHTSA	No automation	Function specific automation	Combined function automation	Limited self-driving automation	Full self-driving automation	

Source: [859]

As previously noted, transportation played an important role in facilitating the expansion of city footprints in the twentieth century. When the urban sprawl began, manufacturing innovations led to mass-produced inexpensive vehicles available to middle and low-income workers. The combination of affordability with a subsidized car-centric public infrastructure incentivized

[859] NHTSA, Preliminary Statement of Policy Concerning Automated Vehicles. 2013;SAE International. 2016.

families to migrate from city centers to the periphery in search of affordable housing. At the end of the second decade of the twenty first century, it is impossible to know if AV will instigate a new sprawl. A number of policymakers charged with transportation policies believe this technology will increase the sprawl.[860] Scholars that explore this issue have found arguments in favor and against this possibility.[861] Two factors to consider in understanding the likelihood of AV causing an urban sprawl are: efficiencies that decrease congestion and savings in the cost of transportation that lower the barriers for the technology's adoption.

6.1.4.1.1 AV road efficiencies

Researchers have hypothesized how AV will impact urban traffic patterns. In simulations, vehicles able to "platoon" translated to a larger number of units capable of operating in a surface area compared to human-operated vehicles.[862] This benefit is contingent on economies of scale.[863] A small number of AV have a negligible impact on overall traffic since they can only optimize their own behavior. Furthermore, they would need to cautiously maneuver the external cues from the unpredictable behavior of human drivers.

If all the vehicles in a city where AV that coordinated their movements, the likelihood of efficient traffic formations and the surface area available for vehicles may increase. The achievement of such efficiencies and its application at a large scale may reduce commuting times. In terms of market penetration, simulations show that the deployment of AV at a rate of 10 percent, 50 percent, and 90 percent of the total car park may result in lane capacity increases by 1 percent, 21 percent, and 80 percent, respectively.[864]

Expanding the availability of AV is one way to drop the average commuting time; another is minimizing the number of traffic accidents due to human error. In the U.S., human error is responsible for over 90 percent of crashes and 25 percent of traffic congestion that does not occur on a regular basis.[865] Hypothetically, the usage of a technology that reacts at a faster rate than humans, and with greater awareness of road conditions, may lower the propensity of accidents and the overall congestion experienced by drivers.

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[860] Yonah Freemark, et al., *Are Cities Prepared for Autonomous Vehicles?*, 85 JOURNAL OF THE AMERICAN PLANNING ASSOCIATION (2019).

[861] Fábio Duarte & Carlo Ratti, *The Impact of Autonomous Vehicles on Cities: A Review*, 25 JOURNAL OF URBAN TECHNOLOGY (2018).

[862] Pedro Fernandes & Urbano Nunes, *Platooning With IVC-Enabled Autonomous Vehicles: Strategies to Mitigate Communication Delays, Improve Safety and Traffic Flow*, 13 IEEE TRANSACTIONS ON INTELLIGENT TRANSPORTATION SYSTEMS (2012).

[863] James M. Anderson, et al., Autonomous Vehicle Technology: A Guide of Policymakers (RAND Corporation 2014);Litman. 2017.

[864] Daniel J. Fagnant & Kara Kockelman, *Preparing a nation for autonomous vehicles: opportunities, barriers and policy recommendations*, 77 TRANSPORTATION RESEARCH (2015).

[865] Federal Highway Administration, *Reducing Non-Recurring Congestion*, U.S. Department of Transportation(2017), *available at* https://ops.fhwa.dot.gov/program_areas/reduce-non-cong.htm;John Maddox, *Improving Driving Safety Through Automation*, National Highway Traffic Safety Administration(2012), *available at* http://www.roboticscaucus.org/schedule/2012/Automationforsafety-CongressionalroboticsCaucus-Maddox7-25-12.pdf.

6.1.4.1.2 Savings in transportation costs

To reach these theoretical time efficiencies, AV first need to become commercially available. An AV at a SAE level 5 or NHTSA level 4 cannot be purchased in 2019. However, the cost barriers in procuring a vehicle with AV capabilities mirrors the downward trend confronted by non-AV at the turn of the twenieth century. A level 2 SAE AV at $80,000 in 2014 (Tesla Model S) can now be purchased for under $40,000 in 2018 (Tesla Model 3).[866] This pricing behavior is consistent with the theory of innovation diffusion, where technology permeates throughout society in stages prior to becoming a commodity.[867]

Despite the decline in prices, demographic trends indicate that new generations of adults (i.e. millennials) are less likely to replicate the driving patterns of their baby boomer counterparts. They tend to drive less miles per year and delay the purchase of vehicles due to economic strains.[868] In many cases, their acquisition power is limited due to the rising proportion of their income needed to cover student debt, which rose from an average of $13,000 in 2005 to $21,000 in 2014.[869]

If the penetration of AV relied on twentieth century purchase patterns, then their expected efficiencies could take several generations to become a reality. Interestingly, market alternatives are emerging to remove the up-front cost barrier and the maintenance fees associated with vehicle ownership (an average of $6,399 per year is spent for a medium sedan in the U.S.).[870]

Ride-hailing firms in the sharing economy (e.g. Uber and Lyft) are investing resources in the development of large AV networks.[871] Their objective is to provide a point-to-point transportation system that takes advantage of economies of scale to offer cost and time-effective access to this technology. Municipalities throughout the country are also considering incorporating AV in the form of buses, among other services, into their fleet.[872] If successful, these initiatives may alter urban transportation by decreasing congestion, remove ownership barriers, and optimize the usage of the car park, which in developed countries find themselves parked over 95 percent of the time.[873]

At the end of the second decade of the twenty first century, the effects of introducing AV into our transportation ecosystem are unknown. Even though it is impossible to forecast how this technology will influence housing or commuting patterns or if it will catalyze a new urban sprawl,

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[866] Tesla, *Model S*(2017), *available at* https://www.tesla.com/models/;Tesla, *Model 3*(2018), *available at* https://3.tesla.com/model3.

[867] EVERETT M. ROGERS, DIFFUSION OF INNOVATION (The Free PRess. 1983).

[868] Steven E. Polzin, et al., *The impact of millennials' travel behavior on future personal vehicle travel*, 5 ENERGY STRATEGY REVIEWS (2014);Noreen C. McDonald, *Are Millennials Really the "Go-Nowhere" Generation?*, 81 JOURNAL OF THE AMERICAN PLANNING ASSOCIATION (2015);Nicholas J. Klein & Michael J. Smart, *Millennials and car ownership: Less money, fewer cars*, 53 TRANSPORT POLICY (2017).

[869] Scott Berridge, *Millennials after the Great Recession*, Bureau of Labor Statistics(2014), *available at* https://www.bls.gov/opub/mlr/2014/beyond-bls/millennials-after-the-great-recession.htm.

[870] AAA, Your driving costs (AAA 2016).

[871] Monaghan. 2018.

[872] City & County of San Francisco, Preparing for Municipal Use of Autonomous Vehicles (City & County of San Francisco 2018).

[873] Shoup. 2011.

evidence points to benefits (access to transportation) and drawbacks (urban sprawl) that mirror those of its direct antecessor, the non-AV.

6.1.4.2 A new Urban Sprawl and its effect on local government revenue

Due to the efficiencies in congestion and the pricing of transportation, AV could influence the residential decision-making calculus of urbanites and produce a new wave of the urban sprawl. With it, many of the negative effects from the first generation may reemerge. In this section, I highlight a hypothetical issue that local government should consider with the introduction of AV and their effect in the procurement of revenue through property taxes.

To fund all public services, governments rely on a monopoly over the taxation of individuals within their jurisdiction. In the realm of local government revenue, property taxes are a channel to extract resources through fees on the ownership of real estate based on its assessed value (usually below its market value). The relevance of this stream has evolved over time for different levels of government within the U.S. Specifically, the share of property taxes relative to other public revenue generated by state and local entities has decreased. For comparison's sake, Table 31 illustrates how in 1902 property taxes represented 45 percent of state and 78.2 percent of local own-sourced revenue.[874] By 2014, constitutional amendments and several generations of economic shifts brought this proportion down to 1 percent and 47 percent, respectively.

Table 31 - Share of Property Taxes from Own-sourced General Revenue

Year	State Government (percent)	Local Government (percent)
1902	45.3	78.2
1913	38.9	77.4
1952	3.4	71.0
1982	1.5	48.0
1999	1.7	48.1
2014	1.0	47.0

Sources: Selected information retrieved from [875]

The diversification of tax revenues is linked to historic events. The confirmation of the 16th amendment in 1913 prompted governments to tax the income of residents as a means to take advantage of gains in national economic growth.[876] The crisis of the Great Depression in the late 1920's and 1930's erased these gains as income declined precipitously. As a result of the inability of public coffers to sustain themselves, a reform was promoted to develop a tax on the consumption of goods (sales tax).[877] Today, the differing levels of reliance on property tax as a source of income is connected to the continued diversification of revenues (e.g. sales and income tax) and the participation of the federal government in granting refundable and non-refundable funds.

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[874] Glenn W. Fisher, *History of Property Taxes in the United States*(2002), *available at* https://eh.net/encyclopedia/history-of-property-taxes-in-the-united-states/.

[875] Richard Henry Carlson, A Brief History of Property Tax (2004);U.S. Census, *American Fact Finder*(2017), *available at* https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=SLF_2014_00A1&prodType=table.

[876] Carlson. 2004.

[877] Id. at.

All localities collect property taxes; nonetheless, their dependence on them is far from uniform. Each county, township, or city can determine its own fees based on how they desire to fund their budget. For example, the city of Bridgeport, Connecticut has one of the highest rates in the country (3.88 percent), but its residents don't pay local sales or income tax; meanwhile the people of Birmingham, Alabama pay a low rate (0.66 percent), but are subject to sales and income tax.[878] Although a negative trend in the relative importance of property taxes for local governments is observed in Table 39, they remain, on average, the largest stream of own-source revenues collected by these bodies. The essential nature of these funds cannot be underscored, as they are vital to pay for local services enjoyed by all residents including: education, police, and infrastructure.[879]

Having explained the relevance of property taxes, I postulate that the efficiencies experienced by residents due to AV can be consumed in one of two ways. Commuters may internalize their surplus time by dedicating it to activities that improve their quality of life: sleeping, studying, or interacting with their family. Conversely, these gains can be exchanged for improved housing opportunities situated farther away from their workplace, potentially in a neighboring county. For example, a driver's total commute of 30 minutes that is halved because of an AV, could consider sleeping for an extra 15 minutes or moving 15 minutes farther away from their current residence, potentially crossing a county line.

As of 2016, 23.9 percent of the population over the age of 16 crosses county lines to reach their workplace.[880] This means that over three quarters of the U.S. population are subject to changing their jurisdiction by realizing the time gains promised by AV. This scenario does not only promote further urban sprawl, it can have budgetary implications for local government since a jurisdictional emigration by families impacts property tax revenue.

6.1.4.3 Resilience of existing policy toolkit against an AV-induced Urban Sprawl and its hypothetical effects on property tax revenue

As the main source of revenue and growth, residents are the most valuable natural resource of any city. Thus, the effects of AV on society will "not occur in a policy vacuum."[881] Local authorities have agency in reacting to the expansion of a city by employing the policy playbook at their disposal to control the urban sprawl. This section examines how policy levers that were developed in the first wave of urban sprawl may address the threat of a second wave triggered by AV (see Table 32).

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[878] Lincoln Institute of Land Policy & Minnesota Center for Fiscal Excellence. 2016.

[879] Tax Policy Center, *State (and Local) Taxes*, Urban Institute Brookings Institution(2016), *available at* http://www.taxpolicycenter.org/briefing-book/how-do-state-and-local-property-taxes-work.

[880] U.S. Census, 2012-2016 American Community Survey 5-Year Estimates (U.S. Census Bureau 2016).

[881] William Riggs & Michael R. Boswell, *Why Autonomous Vehicles Probably Won't Induce Sprawl*, Planetizen(2016), *available at* https://www.planetizen.com/node/88324/why-autonomous-vehicles-probably-wont-induce-sprawl.

Table 32 - Impact of Urban Sprawl Policies

	Temporality	Potential impact
Zoning		
Higher density residential zoning	Long-term	May succeed when implemented proactively
Pricing mechanisms		
Commuter	Short-medium term	Depends on the fee and the cooperation of neighboring jurisdictions
Developer	Medium to long-term	Likely ineffective in conurbated jurisdictions, effective in isolated ones
Owner of real estate	Short-medium term	Inconclusive

The following scenario will be the basis for evaluating the effectiveness of these policies: residents emigrate to a neighboring jurisdiction due the benefits of AV. Notwithstanding the asseverations made in this article, the phenomenon of the urban sprawl and the use of policies to limit its effect are inherently multidimensional. Therefore, the analysis herein is speculative in nature and all inferences regarding the outcomes in the utilization of policy levers are based on generalizations. This article provides an approximation of the relationship between the urban sprawl, local policymakers, and AV without considering the unique characteristics of particular metropolitan areas.

6.1.4.3.1 Zoning

Zoning is a policy lever whose effects are observed in the long-term. An immediate modification in land use may take decades for low-density real estate, in the form of homes or parking lots to be bought, demolished, and re-built. Its use is also highly politicized because by altering the density of construction the stock of homes grows, which decreases their average price and dilutes the home equity of residents that vote in local elections.

Due to its time scale, policymakers in cities can take the most advantage of zoning if implemented proactively prior to the full-scale penetration of AV. This action would mitigate the emigration of residents seeking housing opportunities outside of a jurisdiction by gradually attracting new residents that would offset property tax loses.

Unfortunately, as no AV are available in the market, local authorities confront a Collingridge dilemma in utilizing zoning measures to control a second wave of the urban sprawl.[882] On the one hand, they lack information as to the rate at which AV will become prevalent. Thus, they cannot predict how extensively they will affect the decision-making of the population. On the other hand, delaying action until more information is available implies that addressing the urban sprawl would take place until AV have diffused in society. By that point, the power of

[882] Morozov. 2012;Grunwald, (2014);COLLINGRIDGE. 1980.

policymakers to control the migration of residents could be diminished by the fact that commuters will begin to take advantage of their time surplus and move to a different jurisdiction.

Zoning is an inherently sovereign decision by local governments. Nevertheless, alternatives such as the UGB depend on the cooperation of neighboring counties. High levels of cooperation in the implementation of a UGB represent an opportunity whereby the flow of residents and property tax revenues can be moderated in a manner beneficial for all jurisdictions. If a neighboring jurisdiction does not take part in the UGB, it can implement its own policies to syphon residents from counties not party to a metropolitan zoning plan.

6.1.4.3.2 Pricing mechanisms

The imposition of fees by local governments to commuters, developers, and owners of real estate act as mechanisms to regulate behavior. Their effectiveness in restraining the consequences of a second generation of the urban sprawl are mixed.

6.1.4.3.2.1 Commuters

Commuters are individuals that drive from their residence to a workplace. If an AV technology propagates in the form of private vehicle ownership, authorities can counter their time savings by establishing a cordon pricing scheme throughout a jurisdiction's border. Essentially, any vehicle that enters from a neighboring jurisdiction would be subject to a fee. The principle behind this option is to increase the price of living outside of a county to the point where it is most cost-effective to remain within the border. As long as the fee is high enough to dissuade migrants and incentivize immirants (because of time surplus, difference in cost of living, price of housing, etc.), this option should negatively correlate with the urban sprawl.

In applying this policy there are countervailing factors to consider. One of them are innovations in public transportation. Historically, cordon pricing is not applied to straphangers. Thus, new modalities of AV transportation can take advantage of existing vehicle-centric infrastructure to improve service and increase ridership. Specifically, buses and private services that pool commuters (e.g. Uber and Lyft) can become viable alternatives for individuals wishing to avoid or minimize the costs of entering a jurisdiction. This would be of particular advantage to smaller metropolitan areas that have historically under-invested in public transportation infrastructure.

Another factor is the reaction of neighboring counties to a fee-based border. Monocentric cities that house a majority of a metropolitan area's economic growth could impose cordon pricing on relatively weaker counterparts, but would alienate neighboring jurisdictions in the long-term. In polycentric cities with comparable economies, the placement of cordon pricing can result in a free-for-all where the worst-case scenario would translate to barriers of trade and commuting in each county border.

6.1.4.3.2.2 Developers

Local governments can establish financial barriers on firms to discourage the construction of residences within their jurisdiction via impact fees or development taxes. The introduction of AV may limit the effectiveness of these levers to contain a second wave of an urban sprawl in certain scenarios. This is the case in conurbated metropolitan areas where cities spread beyond county lines. Because each government is limited to imposing these levers within their borders, developers can avoid the policies that inflate their construction costs by crossing into a

neighboring jurisdiction. Therefore, residents thinking about emigrating to a destination in another county can benefit from a supply of housing at affordable prices in county's with comparatively advanteagous developer fees.

Conversely, policy levers aimed at developers could be effective in cities that are relatively isolated from other jurisdictions. Authorities would utilize these fees to limit the construction at the periphery and control the proximity of housing to the nearest city. If the distance to alternative residential options is maximized, local governments could mitigate against the motivation of residents to exchange their AV-induced time savings for favorable housing opportunities outside of their jurisdiction.

6.1.4.3.2.3 Real estate owners

Although property tax rates can be modified to target the owners of real estate, evidence of their effectiveness in containing the urban sprawl is mixed. This makes it difficult to ascertain how this lever could be used to contain a second urban sprawl. Some researchers state that charging higher property taxes could incent developers into building smaller dwellings that would increase density, while others argue that it would dissuade land owners from building homes. In contrast, scholarship on tax rate competition stresses that a decrease could instigate a race to the bottom between neighboring jurisdictions, which endangers the flow of revenue for all parties.

One way to contain a new urban sprawl is for cities to cooperate via tax base sharing. It entails the pooling of a proportion of tax revenues followed by a redistribution to priority areas previously determined by policymakers.[883] The benefit from its implementation is the creation of a common agenda that reduces the motivation to compete for residents, while promoting policies that increase residential density, conservation of open spaces, and generally consider the needs of neighboring communities.[884]

The most prominent example of tax base sharing is the Twin Cities Fiscal Disparities Program between Minneapolis–St. Paul in Minnesota. Since 1971, seven counties agreed to pool the resources generated from growth in the commercial and industrial tax base, which are then distributed considering the number of residents and the per capita total local property tax.[885] This alliance fomented the signing of a regional strategic plan that, among other things, details urban development and zoning preferences meant to control land use policies.[886]

6.1.5 Conclusion

The availability of affordable transportation technologies and its infrastructure in the early twentieth century changed residential housing patterns. Researchers have identified this phenomenon as one of the main causes for urban decentralization and decreasing land density. Concretely, families that purchased vehicles could commute to the central business district in

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[883] Myron Orfield & Thomas Luce, *Regional Tax-Base Sharing: A Policy to Promote Fiscal Equity and Efficient Development Practices at the Metropolitan Scale*, ACTIVATING MARKETS FOR SOCIAL CHANGE (2016).

[884] Eran Razin, *Policies to Control Urban Sprawl: Planning Regulations or Changes in the `Rules of the Game'?*, 35 URBAN STUDIES (1998).

[885] Orfield & Luce, ACTIVATING MARKETS FOR SOCIAL CHANGE, (2016).

[886] H. V. Savitch, *How Suburban Sprawl Shapes Human Well-Being*, 80 JOURNAL OF URBAN HEALTH: BULLETIN OF THE NEW YORK ACADEMY OF MEDICINE (2003).

exchange for larger affordable homes in periphery communities. Many families seized this opportunity and, as more of them made equivalent decisions, the footprint of cities grew, rural real estate was developed, and jurisdictions that bordered city centers became metropolitan suburbs that welcomed downtown migrants.

In the same way that the revolution of the Fort Model T instigated the urban sprawl, the advantages hypothesized of the AV make a case for it becoming a twenty first century analogue to the non-AV. For one, their potential to communicate and coordinate with other vehicles could decrease total commuting time by increasing the number and speed of vehicles per square mile of road. Simultaneously, the introduction of fee-for-service car transportation network companies (e.g. Lyft and Uber) that substitute vehicle ownership may open AV benefits to disadvantaged populations such as those with low-income or individuals with disabilities. Even though all reported AV advantages are the result of simulation or early-stage testing, their commercialization can impact the decision-making process of urban residents to relocate outside the jurisdiction of their local government.

Such relocation at a massive scale may impact the most important source of municipal revenue in the U.S., local property taxes. To hedge against this outcome, the policy toolkit created to address the first wave of the urban sprawl is a good starting point. Zoning is a solution most effective when implemented proactively. Fees on consumers may dissuade individuals from relocating, but lack of cooperation from neighboring jurisdictions may incite detrimental competition. Developer fees are ineffective in conurbated areas, but could protect the generation of revenue in locations where residential options are located at distances that outweigh the benefits of AV. Lastly, although uncertainty exists on the effectiveness of property tax changes to prevent a sprawl, competition to the bottom amongst jurisdictions is likely to endanger the flow of revenue for all parties.

There are reasons to believe that the AV-induced urban sprawl is not a forgone conclusion. There is contrasting data on how interested newer generations are in settling in urban or suburban housing arrangements. On the one hand, Nielsen reports that 62 percent of individuals regarded as part of the millennial generation (born between 1977-1995) have a preference for residing in urban centers that are in proximity of commercial and entertainment areas.[887] On the other, a trade group partial to the construction of residences funded a survey where two thirds of this demographic (68 percent) is interested in moving to a single-family home, like those available in the suburbs.[888]

Other trends may affect the decision-making of individuals. One is telecommuting, whose popularity has increased in the U.S. workforce. In 2016, about 43 percent of employees performed some of their tasks away from their coworkers, up four percentage points from 2012.[889] The continuation of this trend would ameliorate the commuting benefits of AV. Another factor are the savings produced by the successful launch of services that eliminate the need for

[887] Nielsen, Millenials - Breaking the Myths (2014).

[888] National Association of Home Builders, Millennials to Shape Housing Preferences – Once They Start Buying (2016).

[889] Gallup, State of the American Workplace (Gallup 2017).

car ownership without sacrificing access to transportation solutions. If firms such as Uber and Lyft launch an AV service or if cities create efficient AV bus networks, then millennials may utilize the savings from withholding the purchase of a vehicle to cover the costs of acquiring a home that is closer to their workplace.

Like their counterparts at the state and federal levels, policymakers at the local level are limited in their ability to address the medium and long-term implications of a new technology, such as AV, by short-term politics and the immediate needs of denizens in their jurisdiction. As a new generation of urban sprawl crystalizes, the potential to learn from historical measures offers a first approach to guide the policy playbook for local government. Further research is required to generate new alternatives that optimize revenue, while also minimizing conflict between jurisdictions that are unlikely to change in the short-term.

6.2 Facial Recognition Technology and Public Policy

This section is taken from a forthcoming RAND publication by: Yeung, Balebako, Gutierrez, Chaykowsky.

6.2.1 Selected Face Recognition Technology Policies in the United States

In this section, we highlight selected public policies and laws that constrain or guide the use of FRTs. In doing so, we also briefly describe some FRT programs and applications that might be affected or governed by these policies. This is intended to show some of the considerations that shape how FRTs are used, particularly at different levels or in different sectors of government. The information herein is not meant as an exhaustive account of every FRT-related public program or policy. Rather, it is a compilation of sectors in which this technology is applied to identify or surveil people. Table 33 presents the jurisdiction that different levels of government have over the sectors considered in this section: schools, law enforcement, the private sector, and national security.

Table 33 - Selected Policies That Currently Govern Face Recognition Technology Programs, by Sector and Level of Government

	Level of Government		
Sector	**Local**	**State**	**Federal**
Schools	x	x	
Law enforcement	x	x	x
Private sector		x	x
National security			x

6.2.1.1 Schools

In the wake of violent incidents in schools throughout the United States, local districts have considered installing FRT systems to improve the security of staff and students. The objectives for such systems vary from managing the entry of adults into buildings (one-to-many matching) to warning administrators of the presence of people who could represent a risk (some-to-many matching). Specifically, the latter type of systems is designed to identify people in databases of sex offenders, expelled students, and former employees. As an added benefit—one not related to face recognition per se—some systems are also capable of detecting the presence of guns.

An example of a one-to-many system being tested is called SAFR ("secure, accurate facial recognition") by RealNetworks. It is a software-based solution currently implemented in a Seattle school that works with existing hardware and verifies the identities of teachers and parents who have opted into the program.[890] The developer provides no information about the accuracy of its

[890] Issie Lapowsky, *Schools Can Now Get Facial Recognition Tech for Free. Should They?*(2018), *available at* https://www.wired.com/story/realnetworks-facial-recognition-technology-schools/.

software, and all considerations about the security, privacy, and consent of the data gathered from participants are left up to each school.[891]

Other approaches do not contemplate a consent mechanism through which users can opt in. Several school districts either are planning or have already invested resources to install many-to-many FRT systems. For instance, in its latest "Safety and Security Master Plan," the Fort Bend Independent School District in Texas proposes a system that would identify unauthorized individuals on campus and use a mobile phone application to alert students and staff.[892] A district in New York, Lockport City, used a state grant of $4 million to purchase 300 FRT-capable cameras and equipment for eight schools that would alert district officials when someone found in any of a variety of databases or someone with an open-carry permit for a weapon was detected.[893] Authorities in Lockport City argued that such a system would enhance security and the utility of its existing camera infrastructure because the system was, at that time, used only to review events after they happened.[894] Similarly, the Magnolia School Board in Arkansas purchased more than 200 cameras at a cost of $300,000 for a system with capabilities comparable to those of the system in Lockport City.[895]

As to privacy and data security, each school district is charged with determining how its FRT system will be used. In the case of Lockport City, authorities in the New York State Education Department approved the use of the FRT system and assured the public that data would not be shared with third parties and that all the video collected would be subject to the school district's "data use and storage policies."[896] Groups that monitor civil liberties and rights, such as the American Civil Liberties Union (ACLU), have requested further information in several of these districts. Such groups are interested in detailed information about who has access to the logs of the FRT system (private parties; local, state, or federal government officials) and whether images will be used for other activities (such as immigration enforcement). [897]

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[891] RealNetworks, *SAFR for K–12 Implementation Best Practices* SAFR Support Center(2018), *available at* http://safr.zendesk.com/hc/en-us/articles/360008225013-SAFR-for-K-12-Implementation-Best-Practices.

[892] Fort Bend Independent School District, *Safety and Security Master Plan*(2019), *available at* http://www.fortbendisd.com/site/Default.aspx?PageID=936;Theresa D McClellan, *School District Exploring Options to Improve Safety, Security at Schools*, Fort Bend Star(2018), *available at* http://www.fortbendstar.com/school-district-exploring-options-to-improve-safety-security-at-schools/.

[893] Tim Fenster, *Local School Districts Look to Security Cameras for Safety*, Niagara Gazette(2018), *available at* http://www.niagara-gazette.com/news/local_news/local-school-districts-look-to-security-cameras-for-safety/article_82e2b2a8-774d-534a-a747-d1df3a00872e.html;Jenn Schanz, *Facial Recognition' Software in Lockport City Schools Sparks Concern from NYCLU*, WIVB(2018), *available at* https://www.wivb.com/news/local-news/-facial-recognition-software-in-lockport-city-schools-sparks-concern-from-nyclu/1251795204.

[894] Schanz. 2018.

[895] "Magnolia School District Buying Advanced Camera Surveillance Technology for MHS", Magnolia Reporter(2018), *available at* http://www.magnoliareporter.com/education/article_3734adf2-2693-11e8-bbc1-97d4c055b608.html.

[896] Schanz. 2018.

[897] ACLU of Arkansas, *ACLU of Arkansas Warns Schools of Privacy Risks of Biometric Surveillance Systems*(2018), *available at* https://www.acluarkansas.org/en/press-releases/aclu-arkansas-warns-schools-privacy-risks-biometric-surveillance-systems;ACLU of New York, *NYCLU Urges State to Block Facial Recognition Technology in Lockport Schools*(2018), *available at* https://www.nyclu.org/en/press-releases/nyclu-urges-state-block-facial-recognition-technology-lockport-schools.

Scarce evidence exists about how effective FRT systems are in a school setting. Administrators value the advantage provided by active video surveillance that is capable of automating a process that would otherwise require substantial resources to complete. Nevertheless, some have observed that violent incidents in schools tend to be carried out by students with the right to be on campus.[898] Thus, an FRT system aimed at identifying people who lack permission to be on school property might have limited value in protecting these communities.[899]

6.2.1.2 Law Enforcement

Law enforcement agencies at all levels of government have adopted FRTs for two purposes: to verify (confirm) an identity or identify (recognize) an unknown person.[900] At the local and state levels, these institutions have a degree of autonomy in determining their data privacy policies (Global Justice Information Sharing Initiative, 2017).

One effort to examine this variation is Georgetown University Law Center's Center on Privacy and Technology study, "The Perpetual Line-Up," on the use of FRTs by the 50 largest law enforcement agencies in the country.[901] Table 34 presents a sample of its results, which reflect multiple aspects evaluated from a department's FRT policy. High marks in *accuracy* indicate agencies that have done most of the following: tested their algorithms with the National Institute of Standards and Technology, have contracts with vendors that stipulate that tests for accuracy will be performed in the future, have humans involved in validating the results of queries, and use FRT results "as investigative leads only." Agencies that had performed slightly fewer of these activities were described as "medium accuracy," while those that performed the fewest were described as "low accuracy." In terms of *consent to appear* in these databases, entities with high marks include only mug shots of arrested individuals and exclude images from cases in which there was a not-guilty verdict or in which no charges were filed. Medium-ranking departments included mug shots of arrested individuals but removed a mug shot only when the person had applied for and been granted expungement. Low-ranking departments include in their databases all mug shots and photos from driver's license records. High-ranking departments in the field of *public transparency* have FRT policies reviewed by legislative agencies or civil liberty groups. Medium-ranking departments in public transparency also had FRT policies but those policies had not been reviewed or approved. Low-ranking departments had no such policy that was publicly available.

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[898] Jaana Juvonen, *School Violence: Prevalence, Fears, and Prevention*, RAND Corporation(2001), *available at* https://www.rand.org/pubs/issue_papers/IP219.html.

[899] Valerie Strauss, *And Now, Facial-Recognition Technology Used in Casinos Is Going into a Public School District*, Washington Post(2018), *available at* https://www.washingtonpost.com/news/answer-sheet/wp/2018/05/24/and-now-facial-recognition-technology-used-in-casinos-is-going-into-a-public-school-district/.

[900] Clare Garvie, et al., *The Perpetual Line-Up: Unregulated Police Face Recognition in America*, Center on Privacy and Technology(2016), *available at* https://www.perpetuallineup.org/.

[901] Id. at.

Table 34 - Sample of Results from "The Perpetual Line-Up"			
Ranking	**Accuracy**	**Consent to Appear in Database**	**Public Transparency**
Low	Florida and Maryland	Florida and Iowa	Florida and Maine
Medium	Maricopa County and San Francisco	Albuquerque and Hawaii	Hawaii and Michigan
High	Michigan and Vermont	None	San Diego and Seattle

Source: [902]

At the federal level, two laws govern the collection of personal information: The Privacy Act of 1974 [903] and the E-Government Act of 2002.[904] They mandate that government programs notify the public about the collection, disclosure, and use of personal information through a system-of-records notice and privacy impact assessments (PIAs). The Federal Bureau of Investigation (FBI), the main agency charged with federal law enforcement, maintains two databases that apply FRTs. The first is a database of more than 30 million images of faces, representing about 16.9 million people.[905] Called the Next Generation Identification (NGI) Interstate Photo System (IPS), this database consists of both criminal mug shots and civilian pictures from varied sources, such as forms from "applicants, employees, licensees, and those in positions of public trust."[906] A state or government agency can submit a face image to the FBI, which will then return the top 50 matches, along with fingerprint and other identifying information.

This FRT is a one-to-many identification system: One image submitted by the state agency is compared with 30 million images, and a set of best matches is returned. The images in the database might have been gathered cooperatively; for example, a driver's license photo will consist of someone sitting in front of a camera and (likely) respecting the requirements of the photo (as opposed to walking by or deliberately trying to obscure the image). However, in this case, the FBI is storing these images and making them available for a secondary use. Someone cooperating with capturing the image for a driver's license will consider the primary use to be that of state identification and might expect it to be used to identify themselves to law enforcement (e.g., at a traffic stop). However, they might be unaware that their images can be added to a collection of mug shots to be probed in law enforcement investigations as stipulated by a system-of-records notice or PIA published by the relevant government agency.

[902] Id. at.

[903] Public Law 93-579, Privacy Act of 1974 (1974);U.S. Department of Justice, *E-Government Act of 2002*(2014), *available at* https://www.justice.gov/opcl/e-government-act-2002.

[904] Public Law 107-347, *E-Government Act of 2002*(2002), *available at* https://www.govinfo.gov/app/details/PLAW-107publ347;U.S. Department of Justice, *Privacy Act of 1974*(2015), *available at* https://www.justice.gov/opcl/privacy-act-1974.

[905] U.S. Government Accountability Office, *Face Recognition Technology: FBI Should Better Ensure Privacy and Accuracy*(2016), *available at* https://www.gao.gov/products/GAO-16-267.

[906] Federal Bureau of Investigation, Interstate Photo System (2015).

The PIA for the NGI IPS details key pieces of information about the privacy, accuracy, and consent of subjects whose pictures are included in the database.[907] One of them is that access to pictures is limited to authorized law enforcement users whose identity and search results are preserved. Results may be used only to aid an investigation, not for positive identification. In keeping with standards by the National Archives and Records Administration, a picture can be destroyed either when the subject reaches 110 years of age or seven years after the administration receives notification of the subject's death. In terms of consent, anyone whose civilian photo is requested because of licensing or employment may refuse to submit their picture, but this might affect their ability to comply with the regulations of agencies managing these processes. Conversely, someone whose picture is obtained through arrest is unable to decline to participate in this database. Finally, in terms of accuracy, the FBI has determined that, in 85 percent of cases in which at least 50 results are found, at least one picture of the subject will be included.[908]

The second database maintained by the FBI is the Facial Analysis, Comparison, and Evaluation (FACE) service; its use is limited to the bureau's own investigations. The main difference between the two databases is that FACE has access to criminal photos from law enforcement and images from external partners, such as the U.S. Department of Defense (DoD), the consular database for the U.S. Department of State (DOS), and photos of criminal and noncriminal subjects from 16 states, totaling more than 411 million pictures.[909] Privacy standards similar to those mentioned for the NGI IPS database apply to FACE.

Throughout government, the procurement of FRT depends on software and hardware provided by the private sector. Recently, several companies have publicly acknowledged concerns about this technology's effects on civil liberties. Some have chosen to advocate for stronger privacy protections at the national level, while others have decided not to offer their solutions to law enforcement agencies.[910] Then again, the threat to civil rights has motivated policymakers in San Francisco and Massachusetts to pursue a moratorium on FRTs in all government agencies under their control. [911]

6.2.1.3 Private Sector

Firms in many sectors of the economy are taking advantage of FRTs to provide innovative services to consumers and organizations. Technology companies have released devices, such as the Apple iPhone X, that use face recognition for authentication processes (one-to-one). Google and

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[907] Id. at.

[908] U.S. Government Accountability Office. 2016.

[909] Id. at.

[910] Amazon Web Services, *The Facts on Facial Recognition with Artificial Intelligence*(undated), *available at* https://aws.amazon.com/rekognition/the-facts-on-facial-recognition-with-artificial-intelligence/;Brad Smith, *Facial Recognition: It's Time for Action*(2018), *available at* https://blogs.microsoft.com/on-the-issues/2018/12/06/facial-recognition-its-time-for-action/;Kent Walker, *AI for Social Good in Asia Pacific*, Google(2018), *available at* https://www.blog.google/around-the-globe/google-asia/ai-social-good-asia-pacific/.

[911] City and County of San Francisco - Board of Supervisors, *Administrative Code: Acquisition of Surveillance Technology*(2019), *available at* https://www.documentcloud.org/documents/5699972-ORD-Acquisition-of-Surveillance-Technology.html;Commonwealth of Massachusetts Senate, *Petition to adopt Senate Bill 1385, 191st General Court, an act establishing a moratorium on face recognition and other remote biometric surveillance systems*(2019), *available at* https://malegislature.gov/Bills/191/SD671.

Facebook analyze uploaded images in an attempt to match subjects to their databases of images from more than 2 billion active users (one-to-many). Other commercial FRT products have been marketed and sold as surveillance tools for government agencies, such as Amazon's Rekognition and Panasonic's FacePRO. Rekognition, in particular, has attracted criticism from civil rights groups for its use by law enforcement.[912] Yet FRT use by the private sector in the United States is not governed under a homogeneous set of rules. Instead, different levels of government have established guidelines for how facial images are procured, analyzed, and commercialized.

At the federal level, biometric information is protected under the jurisdiction of legislation distributed in selected sectors and demographics (Table 35). For example, an image of a child's face under the Children's Online Privacy Protection Act of 1998 [913] or an identifiable picture in an electronic medical record under the Health Insurance Portability and Accountability Act of 1996 (HIPAA) is considered protected personal information.[914] Applications of FRT that fall outside the scope of laws in Table 35 are not federally protected.

Table 35 - Examples of Federal Laws Regulating Collection, Use, and Storage of Personal Information

Area	Authority	Description
Health	HIPAA	HIPAA governs the disclosure of individually identifiable health information collected by covered health care entities and sets standards for data security.
Children	Children's Online Privacy Protection Act of 1998 (Pub. L. 105-277, Title XIII)	This act generally prohibits the online collection of personal information from children under 13 without verifiable parental consent.
	Family Educational Rights and Privacy Act (created by Pub. L. 93-380, 1974, § 513, as amendments to the General Education Provisions Act).	This act governs the disclosure of PII from education records.

[912] Elizabeth Dwoskin, *Amazon Is Selling Facial Recognition to Law Enforcement—for a Fistful of Dollars*, Washington Post(2018), *available at* https://www.washingtonpost.com/news/the-switch/wp/2018/05/22/amazon-is-selling-facial-recognition-to-law-enforcement-for-a-fistful-of-dollars.

[913] Public Law 105-277, *Omnibus Consolidated and Emergency Supplemental Appropriations Act*(1999), *available at* https://www.govinfo.gov/app/details/PLAW-105publ277.

[914] Federal Trade Commission, *Complying with COPPA: Frequently Asked Questions*(2015), *available at* https://www.ftc.gov/tips-advice/business-center/guidance/complying-coppa-frequently-asked-questions;Jacquelyn M. Means, et al., *Sharing Clinical Photographs: Patient Rights, Professional Ethics, and Institutional Responsibilities*, Bulletin of the American College of Surgeons(2015), *available at* http://bulletin.facs.org/2015/10/sharing-clinical-photographs-patient-rights-professional-ethics-and-institutional-responsibilities/.

Table 35 - Examples of Federal Laws Regulating Collection, Use, and Storage of Personal Information		
Area	**Authority**	**Description**
Trade	FTC regulations	The FTC is charged with prosecuting unfair and deceptive trade practices. Most enforcement related to the protection of private information is relegated to the enforcement of voluntary privacy policies enacted by firms.
Credit	Fair Credit Reporting Act (created by Pub. L. 91-508, 1970, Title VI, as amendments to the Consumer Credit Protection Act).	This act governs the disclosure of personal information collected or used for eligibility determinations for such things as credit, insurance, or employment.
Electronic communications	Electronic Communications Privacy Act (Pub. L. 99-508, 1986)	This act prohibits the interception and disclosure of electronic communications by third parties unless a specified exception applies.
	Computer Fraud and Abuse Act (Pub. L. 99-474, 1986)	This act prohibits obtaining information from a protected computer through the intentional access of a computer without authorization or exceeding authorized access.
Financial institutions	Gramm–Leach–Bliley Act (Pub. L. 106-102, 1999)	This act governs the disclosure of nonpublic information collected by financial institutions and sets standards for data security.

SOURCE: [915]
NOTE: PII = personally identifiable information.

At the state level, Illinois, Washington, and Texas have enacted legislation that specifically targets private-sector use of biometric information, such as facial images. California has also passed similar legislation that goes into effect in 2020.[916] A common thread of this legislation is defining biometric identifiers that encompass facial images by describing them as "face geometry" or unique biological patterns that identify a person.[917] Another point of emphasis is the onus on a firm to provide notice and procure consent for any commercial use of an identifying image.

[915] U.S. Government Accountability Office, *Facial Recognition Technology: Commercial Uses, Privacy Issues, and Applicable Federal Law*(2015), *available at* https://www.gao.gov/products/GAO-15-621.
[916] State of California, *an act to add Title 1.81.5 (commencing with Section 1798.100) to Part 4 of Division 3 of the Civil Code, related to privacy*(2018), *available at* https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201720180AB375.
[917] Illinois Compiled Statutes, *Chapter 740, Civil Liabilities; Act 14, Biometric Information Privacy Act*(2008), *available at* http://www.ilga.gov/legislation/ilcs/ilcs3.asp?ActID=3004&ChapterID=57%20;Texas Business and Commerce Code, *Title 11, Personal Identity Information; Subtitle A, Identifying Information; Chapter 503, Biometric Identifiers; Section 503.001, Capture or Use of Biometric Identifier*(undated), *available at* https://statutes.capitol.texas.gov/?link=BC;Washington State Legislature, *Concerning Biometric Identifiers, House Bill 1493*(2017), *available at* https://app.leg.wa.gov/billsummary?BillNumber=1493&Year=2017&Initiative=false.

Finally, firms must take reasonable care against third-party access of these data and establish finite retention periods.

One of the main differences between these states' laws is the entity empowered to enforce them. In Texas and Washington, only the state attorney general is charged with this role. In California, the state attorney general and the consumer share responsibility for acting against entities that violate privacy protections. However, in Illinois, any person has the right to pursue action against firms and obtain damages between $1,000 and $5,000 per violation. As a result, such companies as Google, Facebook, and Shutterfly have been sued for collecting and tagging consumers' facial information.[918] The court cases in Illinois have resulted in contentious rulings. Some cases were dismissed because firms asserted that, although they had collected biometric information, plaintiffs could not prove "concrete injuries" because of the defendants' actions.[919] However, the Illinois supreme court recently ruled that the violation of the law was a "real and significant" injury, which could open the door for further legal action.[920]

As of early 2019, momentum for protecting biometric information among state legislatures was increasing, with at least eight additional states introducing bills to protect biometric information: Alaska, Connecticut, Delaware, Massachusetts, Michigan, Montana, New Hampshire, and New York.[921]

Outside of government, the nonprofit sector has also been galvanized by the discussion of protecting biometric information and its repercussions on private firms. One of the most important forums for this debate was hosted by the National Telecommunications and

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[918] Jeffrey Neuburger, *California Court Declines to Dismiss Illinois Facial Recognition/Biometric Privacy Suit Against Facebook on Standing Grounds*(2018), *available at* https://newmedialaw.proskauer.com/2018/03/02/california-court-declines-to-dismiss-illinois-facial-recognition-biometric-privacy-suit-against-facebook-on-standing-grounds/;Jeffrey Neuburger, *Biometric Privacy Claims over Facial Recognition Feature in Videogame Dismissed for Lack of Concrete Harm*, New Media and Technology Law Blog(2017), *available at* https://newmedialaw.proskauer.com/2017/02/02/biometric-privacy-claims-over-facial-recognition-feature-in-videogame-dismissed-for-lack-of-concrete-harm/;Jeffrey Neuburger, *Court Refuses to Dismiss Biometric Privacy Action over Facial Recognition Technology Used by Google Photos*, New Media and Technology Law Blog(2017), *available at* https://newmedialaw.proskauer.com/2017/03/02/court-refuses-to-dismiss-biometric-privacy-action-over-facial-recognition-technology-used-by-google-photos/;Jeffrey Neuburger, *California Court Refuses to Dismiss Biometric Privacy Suit Against Facebook*, New Media and Technology Law Blog(2016), *available at* https://newmedialaw.proskauer.com/2016/05/09/california-court-refuses-to-dismiss-biometric-privacy-suit-against-facebook.

[919] Shannon Liao, *Google wins dismissal of facial recognition lawsuit over biometric privacy act*(2018), *available at* https://www.theverge.com/2018/12/29/18160432/google-facial-recognition-lawsuit-dismissal-illinois-privacy-act-snapchat-facebook;N.D. Illinois District Court, Rivera v. Google LLC. (1:16-cv-02714) (2018).

[920] Supreme Court of Illinois, Rosenbach v. Six Flags (2019);Michael A. Gold & Robert E. Braun, Illinois Expands Protection Of Biometric Information – Who's Next? Opening The Gates To Expensive Class Actions And "Sue And Settle" Lawsuits (2019).

[921] Legislature of the State of Alaska, An Act relating to biometric information (2017);Delaware House of Representatives, AN ACT TO AMEND TITLE 6 OF THE DELAWARE CODE RELATING TO PERSONAL INFORMATION PRIVACY. (State of Delaware 2019);Commonwealth of Massachusetts, Part I - Title XIV - Chapter 90 - Section 13 (2019);State of Michigan, HOUSE BILL No. 5019 (State of Michigan 2017);New York State Assembly, BILL NO S01203 (New York State 2019).

Information Administration,[922] part of the U.S. Department of Commerce. NTIA convened a forum for nonprofit organizations to reach a consensus on best practices for commercial face recognition.[923] Two groups of nongovernmental organizations participated in the forum (see Table 36 for a full list of these organizations). The first group consisted of associations of private-sector firms that represent the views and interests of those firms' shareholders to government bodies and the public. The second group consisted of organizations characterized by their advocacy for consumer rights and the public interest.

Table 36 - Nongovernmental Groups Interested in Face Recognition Technology Policies

Entity	Remit
Private-sector associations	
International Biometrics and Identity Association	"[I]nternational trade group representing the identification technology industry"
Digital Signage Federation	"[T]he only not-for-profit independent voice of the digital signage industry"
Interactive Advertising Bureau	"[E]mpowers the media and marketing industries to thrive in the digital economy"
Consumer Technology Association	"[A]dvocates for the entrepreneurs, technologists, and innovators who mold the future of the consumer technology industry"
NetChoice	"[A] trade association of businesses who [sic] share the goal of promoting free speech and free enterprise on the net"
Consumer and public advocates	
ACLU	Works "to defend and preserve the individual rights and liberties that the Constitution and the laws of the United States guarantee everyone in this country"
Center for Democracy and Technology	"[W]ork to preserve the user-controlled nature of the internet and champion freedom of expression"
Consumer Federation of America	"[A]dvance the consumer interest through research, advocacy, and education"
Electronic Frontier Foundation	"[D]efending civil liberties in the digital world"

Sources: [924]

[922] Zhou, et al., JOURNAL OF MANAGEMENT INFORMATION SYSTEMS.

[923] National Telecommunications and Information Administration, *Privacy Multistakeholder Process: Facial Recognition Technology*(2016), *available at* https://www.ntia.doc.gov/other-publication/2016/privacy-multistakeholder-process-facial-recognition-technology.

[924] International Biometrics and Identity Association, *Who We Are*(undated), *available at* https://www.ibia.org/who-we-are-ibia;Digital Signage Federation, *Who We Are*(undated), *available at* https://www.digitalsignagefederation.org/about;Interactive Advertising Bureau, *Our Story*(undated), *available at*

Both groups agreed on the importance of advocating for consumer protection based on fair information practice principles (FIPPs), which reflect international standards for protecting individual information and were enshrined into federal government practice through the Privacy Act of 1974.[925] They encompass specific practices about consent, retention of information, and access to data, among other issues relevant to PII. However, the main point of contention in debating FIPPs was whether they should be mandatory or voluntary. The industry groups advocated for voluntary standards, by which each firm would decide how to safeguard its FRT data, while consumer groups supported mandatory best practices, potentially implemented through legislation, to protect consumers. This disagreement led several consumer rights advocacy groups to abandon the NTIA forum.[926]

6.2.1.4 National Security

As mentioned in the law enforcement section, national security–focused federal efforts that compile PII, including those that use FRTs, are governed by laws that require the disclosure of how their efforts affect individuals' privacy. This section highlights a variety of programs that feature this technology.

DoD and DHS have developed automated biometric identification systems to document the identities of non-U.S. individuals suspected of terrorism or considered to be a security threat to troops.[927] Once information (such as a photo) is taken for a suspect, these agencies feed it into the identification system, where other federal departments can reference the information in their one-to-many searches. Because of their status, these individuals are unable to refuse consent as to their inclusion of their biometric information into the system, but they are given the opportunity to redress how they are classified. [928]

In the United States, the implementation of FRT has centered on the immigration process. DOS has a one-to-many system capable of identifying someone in the visa application process who

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https://www.iab.com/our-story/;American National Standards Institute, *CTA: Consumer Technology Association*(undated), *available at* https://webstore.ansi.org/sdo/cta;NetChoice, *About Us*(undated), *available at* https://netchoice.org/about;ACLU, *About the ACLU*(undated), *available at* https://www.aclu.org/about-aclu;Center for Democracy and Technology, *About*(undated), *available at* https://cdt.org/about/;Consumer Federation of America, *About CFA*(undated), *available at* https://consumerfed.org/about-cfa/;Electronic Frontier Foundation, *About EFF*(undated), *available at* https://www.eff.org/about.

[925] Public Law 93-579. 1974;Robert Gellman, *Fair information practices: A basic history*, (2017).

[926] National Telecommunications and Information Administration. 2016.

[927] U.S. Department of Homeland Security, *Privacy Impact Assessment for the Automated Biometric Identification System (IDENT)*(2012), *available at* https://www.dhs.gov/publication/dhsnppdpia-002-automated-biometric-identification-system;U.S. Army Test and Evaluation Command, *Department of Defense (DOD) Automated Biometric Identification System (ABIS) Version 1.2: Initial Operational Test and Evaluation Report*(2015), *available at* http://www.dtic.mil/docs/citations/ADA626558;U.S. Government Accountability Office, *DOD Biometrics and Forensics: Progress Made in Establishing Long-Term Deployable Capabilities, but Further Actions Are Needed*(2017), *available at* https://www.gao.gov/products/GAO-17-580.

[928] U.S. Department of Homeland Security. 2012;U.S. Department of Homeland Security, *Privacy Impact Assessment, appendixes*(2017), *available at* https://www.dhs.gov/sites/default/files/publications/privacy-pia-nppd-identappendices-november2017.pdf.

might pose a security concern.[929] The system compares pictures of applicants with photos in databases that include people who were refused visas and are watch-listed by the National Counterterrorism Center.[930] For this program, applicants submit their data voluntarily because they are attempting to obtain permission to enter the country, and the United States notifies them that their information can be stored for cross-validation of identity purposes.

DHS has increasingly adopted FRTs in its airport operations. The DHS Facial Comparison Project is a one-to-one system that validates traveler identity by comparing a traveler's face with that in a single photo.[931] For these FRTs, the traveler scans their microchip e-passport in a machine for verification and has a headshot taken, for which they might be asked to remove head covers or glasses. The system then uses FRT to compare the headshot with the traveler's e-passport information. This system has a few characteristics worth highlighting. First, the FRT is used to determine whether there is a match between the vetted passport photo and the picture taken at the airport. Second, it is assumed that, for both pictures (the one taken for the passport and the one taken at the airport), the person knew that their image was being taken and complied with any request to improve photo quality. Although travelers are not allowed to opt in or out, they have the ability for redress through DHS's Traveler Redress Inquiry Program, and images are retained only for those individuals who are subject to secondary inspection.[932] Other DHS efforts include a 2017 solicitation to create technology to identify people entering the country through land borders without subjects leaving their cars (one-to-many).[933]

Outside the realm of border control, DHS is studying vetting immigrants using social media, but there are many considerations—technical, organizational, measurement, and legal—to be resolved before such a system could be implemented. Accordingly, DHS headquarters and operational (e.g., U.S. Customs and Border Protection) components have begun efforts to expand DHS's ongoing use of social media to accomplish a key mission: screening and vetting people seeking entry into the United States.[934] Part of the desired analytic capabilities include face recognition, which is important for identity resolution—that is, determining that someone is who they say they are. DHS considered this question a crucial part of any social media analytic capability and has explored various technical approaches.

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[929] Mark McKamey, *Legal Technology: Artificial Intelligence and the Future of Law Practice*, 22 APPEAL (2017);Tajha Chappellet-Lanier, *Department of State to Award Sole Source Facial Recognition Contract*, FedScoop(2018), *available at* https://www.fedscoop.com/state-department-facial-recognition-idemia/.

[930] U.S. Department of State, *IBS PIA*(2015), *available at* https://2009-2017.state.gov/documents/organization/246821.pdf;U.S. Department of State, *Privacy Impact Assessment (PIA): Automated Biometric Identification System (ABIS)*(2013), *available at* https://2009-2017.state.gov/documents/organization/242309.pdf.

[931] U.S. Department of Homeland Security, *Privacy Impact Assessment Update for the 1-to-1 Facial Comparison Project*(2016), *available at* https://www.dhs.gov/publication/facial-recognition-air-entry-pilot.

[932] Id. at.

[933] Govtribe, *Land Border Biometric Exit Facial Recognition*(2018), *available at* https://govtribe.com/opportunity/federal-contract-opportunity/land-border-biometric-exit-facial-recognition-70rsat18r00000002.

[934] U.S. Department of Homeland Security, *Privacy Act of 1974; System of Records*(2017), *available at* https://www.govinfo.gov/app/details/FR-2017-09-18/2017-19365.

6.2.1.5 Summary

FRTs are being increasingly implemented in multiple sectors and across different levels of government. As a result, no unified set of rules governs their use; instead, multiple laws and regulations create a disjointed policy environment, limiting the extent to which privacy and bias concerns can be mitigated for these implementations. Addressing these gaps might require more-specific information in each of the sectors in which FRTs are deployed. Chapter Four describes these considerations in further detail for two security-related use cases: border control and airport surveillance.

Conclusion

The purpose of this systematic review was to increase our understanding of the relationship between AI and public policy. It led to the development of a protocol that screened 5,240 articles and uncovered 50 regulatory gaps caused by AI methods or applications in the U.S. These gaps were characterized in several ways, including two lenses adapted from the work of Bennett-Moses's framework and Calo's taxonomy.

Overall, this effort revealed that: most gaps can likely be solved with adjustments to the status quo, the U.S. is in a temporal transition period with respect to AI-based gaps, the vast majority of gaps affect federal and state regulations, and AI applications are recognized more often than methods as the cause of gaps. These results were complemented by two case studies that highlighted under-represented issues. The first focused on a local government regulatory gap and the second on an application of AI that was not featured prominently in the systematic review, facial recognition technology.

It is not speculative to state that AI will continue to push the boundaries of public policy for the foreseeable future. This work contributes to the literature by, for the first time, systematically reviewing the corpus of academic discourse on the subject through lenses that offer stakeholders (policymakers, the private sector, and non-profits) novel insights into this technology's unintended regulatory consequences. It also opens new lines of research for future scholars wishing to duplicate this review on geographies outside of the U.S., scrutinize gaps identified in this document, or employ the labels used for AI on other technologies.

Appendix 1 – Detailed Table of Contents

Appendix 2 – Defining Technology

The public's perception of what constitutes a technology is shaped by social norms in the marketplace.[935] On a daily basis, consumers view commercials that boast about the latest features of a mobile phone or autonomous floor vacuum that are often described as new technology. Yet, less frequently are ordinary objects (chairs or tables) or ideas (e.g. relativity or gravity) described in similar terms. This can lead some to believe that the term technology applies only to electronic gizmos or innovative services. Contrary to popular culture's perspective, scholarship on the definition of technology has generated a spectrum of positions, some context-driven, to disambiguate what can be described as a technology.

One camp has an output-centered view of technology. Academics who hold this view believe that technology necessarily emanates from a firm whose objective is the introduction of a product to the market. Rooted in the industrial revolution, the term is understood to encompass two processes: the compilation of information required for production and an output. For instance, Jones describes technology as a process by which resources are combined and converted into a commodity.[936] Maskus and Tihanyi & Roath emphasize the application of organizational know-how and information (e.g. finance, marketing, management techniques, etc.) to produce a good.[937] Hawkins & Gladwin and Burgelman et al. discuss the application of specialized skills to manage technical processes that lead to economic activities such as the creation of a product or process.[938] Finally, MacKenzie & Wajman divide technology into three levels: as an output of a physical object, the processes and inputs required to manufacture it, and the knowledge needed to link each of these steps.[939]

Conversely, there are scholars who think of technology in more abstract terms. Rather than confine it to the output of products, they interpret it as a means to further the boundaries of knowledge. Hawthorne or Levin envision technology as the use of the scientific method to address a "well-defined" or "practical" problem.[941] Galbraith and Pacey describe it as the systematic application of knowledge to address a defined task or as the combination of data on

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[935] The Second Installment of the ITEA/Gallup Poll and What It Reveals as to How Americans Think About Technology. (2004);ROGERS. 1983.

[936] Ronald Jones, *The Role of Technology in the Theory of International Trade*, *in* THE TECHNOLOGY FACTOR IN INTERNATIONAL TRADE (Raymond Vernon ed. 1970).

[937] KEITH E. MASKUS, ENCOURAGING INTERNATIONAL TECHNOLOGY TRANSFER (UNCTAD. 2004);Laszlo Tihanyi & Anthony S. Roath, *Technology transfer and institutional development in Central and Eastern Europe*, 37 JOURNAL OF WORLD BUSINESS (2002).

[938] R Hawkins & T Gladwin, *A U.S. Home Country View*, *in* CONTROLLING INTERNATIONAL TECHNOLOGY TRANSFER: ISSUES, PERSPECTIVES, AND IMPLICATIONS (Tagi Sagafi-Nejad, et al. eds., 1981);ROBERT A. BURGELMAN, et al., STRATEGIC MANAGEMENT OF TECHNOLOGY AND INNOVATION (Irwin Publishers. 1988).

[939] DONALD MACKENZIE & JUDY WAJCMAN, THE SOCIAL SHAPING OF TECHNOLOGY: HOW THE REFRIGERATOR GOT ITS HUM (Open University Press. 1985).

[940] Rose, et al. 2004;ROGERS. 1983.

[941] E.P. HAWTHORNE, THE TRANSFER OF TECHNOLOGY (OECD. 1971);M Levin, *Technology Transfer in Organizational Development: An Investigation into the Relationship between Technology Transfer and Organizational Change*, 2 INTERNATIONAL JOURNAL OF TECHNOLOGY MANAGEMENT (1996).

organizations, people, organisms, and means of production applied to a practical task.[942] More conceptually, Merrill compares technology to all knowledge utilized for a purpose.[943] Because such understanding can include anything from the creation of a product, dancing, to solving a mathematical problem, technology for these thinkers is closer to the manipulation of information for whatever useful purpose is desired by an individual.

The information revolution of the 20th and 21st century represents a transition point where social, economic, and cultural developments are increasingly shaped by the creation of knowledge rather than the manufacture of physical objects. With this in mind, the definition that best encapsulates an understanding of technology and is likely to remain relevant for the foreseeable future is one developed by Cockfield and Koops: "the human modification of the environment for a useful purpose."[944] Its inclusiveness encompasses virtually all things created by intelligent beings regardless of how they are characterized by popular culture: a wheelbarrow, chair, car, mobile phone, or an algorithm. Therefore, things that can be considered as non-technological are those that have not been manipulated by intelligent beings such as nature.

[942] JOHN KENNETH GALBRAITH, THE NEW INDUSTRIAL STATE (Princeton University Press. 2007);ARNOLD PACEY, THE CULTURE OF TECHNOLOGY (MIT Press. 1983).
[943] Robert S. Merrill, *The Role of Technology in Cultural Evolution*, 19 SOCIAL BIOLOGY (1972).
[944] Cockfield, MANITOBA LAW JOURNAL, (2004);Koops, Ten Dimensions of Technology Regulation - Finding your Bearings in the Research Space of an Emerging Discipline. 2010.

Appendix 3 - Selected Historical Precedents for AI

The precursors of AI span history and disciplines. An early antecedent is found in 17th century mechanism philosophy, derived from the Latin and Greek words for machine.[945] Its central tenant was the discovery of the underlying logic of the natural world. Mechanists such as Descartes were under the impression that all physical phenomena expressed through movement were the consequence of the "principles of geometry and mechanics".[946] Much like any other man-made machine, organisms were thought as biological machines whose movements were dependent on a sequence of explainable and reproduceable instructions.

At the same time, inventors began designing analog machines that replicated a limited set of cognitive processes related to numeracy. In 1642, Blaise Pascal created the first calculator for addition and subtraction.[947] Two decades later, Samuel Morland's calculator could multiply and divide, while Wilhelm Gottfried Leibniz developed the first machine that performed all four arithmetic operations, called the step reckoner.[948] Leibniz also favored binary as a universal language for all arithmetic operations, which, unbeknownst to him, was a key ingredient for 20th century machine information processing. Binary coding eventually made possible the translation of instructions via relay circuits using the number 1 for on and 0 for off.

While the complexity of machines accelerated in the 19th century, their ability to exhibit "intelligence" remained limited to rational information processing or thought. The advent of the industrial revolution expanded the role of machines as operational cost cutters. Industrialists sought to replace humans in repetitive complex tasks by introducing technologies such as the Jacquard Loom, the first programmable machine with instructions to weave cloth and tapestry via punch cards.[949] As a single-purpose technology, the loom could not be reprogrammed for tasks other than weaving, but it was more time-efficient than its human counterparts.

With the idea of a programmable multi-purpose machine in mind, Charles Babbage, with the assistance of Augusta Ada Lovelace, came up with the concept for an analytical engine.[950] One that could solve a number of operations via punch cards (operations and variables), while also storing results in memory or perform parallel calculations. Although a prototype was never built, Lovelace wrote programs for the calculation of Bernoulli numbers and believed that the engine could solve problems outside the scope of the sciences.[951]

In parallel, George Boole was key in the evolution of the codification of logical statements from its syllogism origins. Expanding on the use of binary, he published a system of algebra that

[945] Carl Craver & James Tabery, Mechanisms in Science (2015).
[946] Richard A. Watson, Cartesianism (Encyclopædia Britannica, inc. 2004);S. V. Keeling, *Cartesian Mechanism*, 9 PHILOSOPHY (1934).
[947] Howard Aiken, et al., *Proposed automatic calculating machine*, 1 IEEE SPECTRUM (1964).
[948] J.R. Ratcliff, *Samuel Morland and his calculating machines c.1666: the early career of a courtier–inventor in Restoration London*, 40 THE BRITISH JOURNAL FOR THE HISTORY OF SCIENCE (2007);Gerard O'Regan, *Foundations of Computing*, *in* INTRODUCTION TO THE HISTORY OF COMPUTING (2016).
[949] Ylva Fernaeus, et al., Revisiting the Jacquard Loom: Threads of History and Current Patterns in HCI (2012).
[950] O'Regan. 2016.
[951] POOL & MACKWORTH. 2017.

managed to combine equations with logical statements.[952] It was born with the intention of using mathematics, rather than philosophy, to resolve problems in logic. Boole was also interested in creating a systematic theory of thought to analyze statements by intersections, unions or difference (set theory) to replace Aristotelian syllogistic logic (see **Table 37** for an example of Boolean algebra). [953]

Table 37 - Example of Boolean algebra

Universal class	1	Empty class	0
x is true	x = 1	x is false	x = 0
Either x or y are true	xy = 1	No x is y	xy = 0

Source: [954]

Advances between the 17th and 19th century signaled the transition from analog (the jacquard loom) to digital information processing (electronic computers). In the 20th century, the evolution of computers went from performing calculations with vacuum tubes, to transistors, integrator circuits, and finally to present day microprocessors.[955] The birth of computer science as a field represented a stepping stone to advancements in the performance of increasingly complex problem solving.

It also catalyzed the imagination of fiction writers for fantastic achievements. Worlds were conceived where machines in the form of furniture served as repositories of knowledge that assisted humans in decision-making (much liked today's Internet) or, in the case of Karel Capek, the word robot was invented to conceptualize the creation of artificial people.[956] Building on the idea of robots, Isaac Asimov introduced his three laws to safeguard human-robot interactions:[957]

1. A robot may not injure a human being, or, through inaction, allow a human being to come to harm;
2. Robots must obey the orders given to it by human beings except where such orders would conflict with the First Law; and
3. Robot must protect its own existence, as long as such protection does not conflict with the First or Second Laws.

[952] GEORGE BOOLE, AN INVESTIGATION OF THE LAWS OF THOUGHT ON WHICH ARE FOUNDED THE MATHEMATICAL THEORIES OF LOGIC AND PROBABILITIES (Walton and Maberly. 1854);Encyclopædia Britannica, George Boole (Encyclopædia Britannica, inc. 2017).
[953] Kevin C. Klement, Propositional Logic (2018).
[954] Id. at.
[955] Fabien Gandon, *Computers History*(1999), *available at* https://www.cs.cmu.edu/~fgandon/documents/lecture/uk1999/history/history.pdf.
[956] KAREL CAPEK, R.U.R (1920);Vannevar Bush, *As we may think*, THE ATLANTIC 1945.
[957] Isaac Asimov, (Runaround ed., 1942).

Appendix 4 – PRISMA Checklist

PRISMA-P (Preferred Reporting Items for Systematic review and Meta-Analysis Protocols) 2015 checklist: recommended items to address in a systematic review protocol*

Section and topic	Item No	Checklist item	Reported on Page
ADMINISTRATIVE INFORMATION			
Title:			
Identification	1a	Identify the report as a protocol of a systematic review	34
Update	1b	If the protocol is for an update of a previous systematic review, identify as such	-
Registration	2	If registered, provide the name of the registry (such as PROSPERO) and registration number	34
Authors:			
Contact	3a	Provide name, institutional affiliation, e-mail address of all protocol authors; provide physical mailing address of corresponding author	Title Page
Contributions	3b	Describe contributions of protocol authors and identify the guarantor of the review	-
Amendments	4	If the protocol represents an amendment of a previously completed or published protocol, identify as such and list changes; otherwise, state plan for documenting important protocol amendments	-
Support:			
Sources	5a	Indicate sources of financial or other support for the review	Title Page
Sponsor	5b	Provide name for the review funder and/or sponsor	-
Role of sponsor or funder	5c	Describe roles of funder(s), sponsor(s), and/or institution(s), if any, in developing the protocol	-
INTRODUCTION			
Rationale	6	Describe the rationale for the review in the context of what is already known	34
Objectives	7	Provide an explicit statement of the question(s) the review will address with reference to participants, interventions, comparators, and outcomes (PICO)	34
METHODS			
Eligibility criteria	8	Specify the study characteristics (such as PICO, study design, setting, time frame) and report characteristics (such as years considered, language, publication status) to be used as criteria for eligibility for the review	36
Information sources	9	Describe all intended information sources (such as electronic databases, contact with study authors, trial registers or other grey literature sources) with planned dates of coverage	34
Search strategy	10	Present draft of search strategy to be used for at least one electronic database, including planned limits, such that it could be repeated	35
Study records:			
Data management	11a	Describe the mechanism(s) that will be used to manage records and data throughout the review	-

Selection process	11b	State the process that will be used for selecting studies (such as two independent reviewers) through each phase of the review (that is, screening, eligibility and inclusion in meta-analysis)	36
Data collection process	11c	Describe planned method of extracting data from reports (such as piloting forms, done independently, in duplicate), any processes for obtaining and confirming data from investigators	36
Data items	12	List and define all variables for which data will be sought (such as PICO items, funding sources), any pre-planned data assumptions and simplifications	37
Outcomes and prioritization	13	List and define all outcomes for which data will be sought, including prioritization of main and additional outcomes, with rationale	37
Risk of bias in individual studies	14	Describe anticipated methods for assessing risk of bias of individual studies, including whether this will be done at the outcome or study level, or both; state how this information will be used in data synthesis	38
Data synthesis	15a	Describe criteria under which study data will be quantitatively synthesized	-
	15b	If data are appropriate for quantitative synthesis, describe planned summary measures, methods of handling data and methods of combining data from studies, including any planned exploration of consistency (such as I^2, Kendall's τ)	-
	15c	Describe any proposed additional analyses (such as sensitivity or subgroup analyses, meta-regression)	-
	15d	If quantitative synthesis is not appropriate, describe the type of summary planned	36
Meta-bias(es)	16	Specify any planned assessment of meta-bias(es) (such as publication bias across studies, selective reporting within studies)	-
Confidence in cumulative evidence	17	Describe how the strength of the body of evidence will be assessed (such as GRADE)	37

From: Shamseer L, Moher D, Clarke M, Ghersi D, Liberati A, Petticrew M, Shekelle P, Stewart L, PRISMA-P Group. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015: elaboration and explanation. BMJ. 2015 Jan 2;349(jan02 1):g7647.

Appendix 5 – Screening of Articles

Pre-screening

Duplicates	910
Excluded categories	704
First pass	3,626
Sum	5,240

Abstract screening out of articles

Abstracts reviewed	3,626
Articles excluded	3,203

Reasons*

Unrelated to AI	1,570
Unrelated to policy	1,409
Excluded categories	207
Non-US	167
Duplicate	158
Text unavailable	61

*Categories are not mutually exclusive

Full-text screening out of articles

Full text of articles reviewed	423
Articles excluded	182

Reasons*

Unrelated to AI or/and Policy	161
Excluded categories	19
Non-US	2
Text unavailable	5

* Categories are not mutually exclusive

Appendix 6 – Systematic Review Articles

In the following tables, the reader will find the list of articles deemed relevant in all of the systematic review (241 titles) and for each of the eight categories of regulatory gaps according to the updated version of the Calo taxonomy. Readers should note that the parenthesis in the titles of the tables in this section represent the number of articles cited within each section.

Table 38 - All Screened-in Articles in the Systematic Review of the Literature (241)		
Title	**Author**	**Year**
Can/Should Computers Replace Judges	D'Amato, Anthony	1976
Can a Computer be an Author - Copyright Aspects of Artificial Intelligence	Butler, Timothy L.	1981
A Common Law for the Ages of Intellectual Property	Rosen, Dan	1983
Electronic Surveillance, Computers, and the Fourth Amendment - The New Telecommunications Environment Calls for Reexamination of Doctrine	Landever, Arthur R	1983
Laying Down the Law to Robots	Gemignani, Michael	1983
Allocating Ownership Rights in Computer-Generated Works	Samuelson, Pamela	1985
Professional Malpractice and the Unauthorized Practice of Professions: Some Legal and Ethical Aspects of the Use of Computers as Decision-Aids	Willick, Marshall S.	1986
Corpus Juris Roboticum	August, Raymond	1987
THE MICROELECTRONICS REVOLUTION, JOB DISPLACEMENT, AND THE FUTURE OF WORK: A POLICY COMMENTARY	Solomon, Lewis D	1987
Tort Adjudication and the Emergence of Artificial Intelligence Software	Frank, Steven J.	1987
Copyrightability of Computer-Created Works	Farr, Evan H.	1989
Artificial Intelligence Use in the Legal Profession: What are Its Liabilities	O'Donnell, J. Stephen	1990
Tort Liability for Artificial Intelligence and Expert Systems	Cole, George S.	1990
Copyright Protection for Artificial Intelligence Systems	Goldberg, David O., Morton DavidCarson	1991
Legal Personhood for Artificial Intelligences	Solum, Lawrence B.	1991
Copyright Protection for Computer Programs, Databases, and Computer-Generated Works: Is Anything New Since CONTU	Miller, Arthur R.	1992
Originality in Computer Programs and Expert Systems: Discerning the Limits of Protection under Copyright Laws of France and the United States	Shuster, Todd	1992
Responsibility of Intelligent Artifacts: Toward an Automation Jurisprudence	Wein, Leon E.	1992
Toward Universal Surveillance in an Information Age Economy: Can We Handle Treasury's New Police Technology	Bercu, Steven A.	1993
Can Computers Make Contracts	Allen, Robin, TomWiddison	1996
Intellectual Property in the Era of the Creative Computer Program: Will the True Creator Please Stand Up	Clifford, Ralph D.	1996
Liability for Distributed Artificial Intelligences	Karnow, Curtis E. A.	1996
From Video Games to Artificial Intelligence: Assigning Copyright Ownership to Works Generated by Increasingly Sophisticated Computer Programs	Wu, Andrew J.	1997
I. INTELLECTUAL PROPERTY: A. Copyright: 2. Acquisition and Ownership: a) Authorship: Urantia Foundation v. Maaherra	Christina Rhee	1998
INTELLIGENT SOFTWARE AGENTS AND AGENCY LAW *	Smed, Suzanne	1998
Artificial intelligence and administrative discretion - Implications for public administration	Barth, T. J. and Arnold, E.	1999
The Use of Electronic Agents Questioned under Contractual Law: Suggested Solutions on a European and American Level	Lerourge, Jean-Francois	1999

Contracting with Electronic Agents	Bellia, Anthony J. Jr.	2001
iBRIEF/COPYRIGHTS & TRADEMARKS: Copyrights in Computer-Generated Works: Whom, if Anyone, do we Reward?	Glasser, Darin	2001
Mine Your Own Business: Making the Case for the Implications of the Data Mining of Personal Information in the Forum of Public Opinion	Zarsky, Tal Z.	2002
Thinking about Thinking Machines: Implications of Machine Inventors for Patent Law	Vertinsky, Todd M., LizaRice	2002
A Thousand Words Are Worth a Picture: A Privacy Tort Response to Consumer Data Profiling	McClurg, Andrew J.	2003
Data Mining and Domestic Security: Connecting the Dots to Make Sense of Data	Taipale, K. A.	2003
Passing beyond Identity on the Internet: Espionage & (and) Counterespionage in the Internet Age	Peek, Marcy	2003
Buddy bots: How Turing's fast friends are undermining consumer privacy	Kerr, I. R. and Bornfreund, M.	2005
The Terrifying Liberation of Labor	Kane, Tim	2006
Technological Due Process	Citron, Danielle Keats	2007
Recurring Dilemmas: The Law's Race to Keep up with Technological Change	Moses, Lyria Bennett	2007
FEDERAL SEARCH COMMISSION? ACCESS, FAIRNESS, AND ACCOUNTABILITY IN THE LAW OF SEARCH	Bracha, Oren Pasquale, Frank	2007
Ghetto'ing Workers with Hi-Tech: Exploring Regulatory Solutions for the Effect of Artificial Intelligence on Third World Foreign Direct Investment	Duong, Wendy N.	2008
STATUTE OF ANNE-IMALS: SHOULD COPYRIGHT PROTECT SENTIENT NONHUMAN CREATORS?	Johnson, Dane E	2008
Copyright on the Semantic Web: Divergence of Author and Work	Brown, Evan D.	2009
People Can Be So Fake: A New Dimension to Privacy and Technology Scholarship	Calo, Ryan	2009
ACCELERATING AI	McGinnis, John O	2010
Bridging the Accountability Gap: Rights for New Entities in the Information Society	Koops, David-Olivier, Bert-JaapHildebr and t, MireilleJaquet-Chiffelle	2010
Computer-Managed Perpetual Trusts	Vincent, Michael	2010
Do Androids Dream: Personhood and Intelligent Artifacts	Hubbard, F. Patrick	2010
New Directions in Privacy: Disclosure, Unfairness and Externalities	MacCarthy, Mark	2010
Open Robotics	Calo, Ryan	2010
Physicality and the Information Age: A Normative Perspective on the Patent Eligibility of Non-Physical Methods	McEniery, Ben	2010
The Criminal Liability of Artificial Intelligence Entities - From Science Fiction to Legal Social Control	Hallevy, Gabriel	2010
The Wisdom of Legislating for Anticipated Technological Advancements	Liebesman, Yvette Joy	2010
"I, Robot - I, Criminal"--When Science Fiction Becomes Reality: Legal Liability of AI Robots committing Criminal Offenses	Hallevy, Gabriel	2010
Restoring Transparency to Automated Authority	Pasquale, Frank	2011
Big Data for All: Privacy and User Control in the Age of Analytics	Tene, Jules, OmerPolonetsky	2012
Coding Creativity: Copyright and the Artificially Intelligent Author	Bridy, Annemarie	2012
Injury by Algorithm	Ghatnekar, Seema	2012
Liberty, Justice, and Legal Automata	Lauritsen, Marc	2012
New Technology - Old Law: Autonomous Vehicles and California's Insurance Framework	Peterson, Robert W.	2012
Out of the Loop: Autonomous Weapon Systems and the Law of Armed Conflict	Schmitt, Jeffrey S., Michael N.Thurnher	2012
Privacy in Autonomous Vehicles	Glancy, Dorothy J.	2012
Protecting Patient Privacy in the Age of Big Data	Terry, Nicolas P.	2012

The Potential Regulatory Challenges of Increasingly Autonomous Motor Vehicles	Wood, John, Stephen P.Chang, JesseHealy, ThomasWood	2012
The Right to Bear (Robotic) Arms	Terzian, Dan	2012
EMERGING LEGAL ISSUES IN THE DIGITAL AGE: ARTICLE & ESSAY: Experts on Computer-Assisted Review: Why Federal Rule of Evidence 702 Should Apply to Their Use	Waxse, David J Yoakum-Kriz, Brenda	2012
SIRI IS MY CLIENT: A FIRST LOOK AT ARTIFICIAL INTELLIGENCE AND LEGAL ISSUES	Weaver, J	2012
Automated Vehicles Are Probably Legal in the United States	Smith, Bryant Walker	2013
Autonomous Weapons and Human Responsibilities	Beard, Jack M.	2013
Autonomous Weapons Systems: A Coming Legal Singularity	Kastan, Benjamin	2013
Facing Real-Time Identification in Mobile Apps & Wearable Computers	Welinder, Yana	2013
How to Kill Copyright: A Brute-Force Approach to Content Creation	Sigmon, Kirk	2013
Humans and Humans: Technological Enhancement and Criminal Responsibility	Brenner, Susan W.	2013
In-Corp-O-Real: A Psychological Critique of Corporate Personhood and Citizens United	Brown, Teneille R.	2013
Judged by the Tin Man: Individual Rights in the Age of Big Data	Tene, Jules, OmerPolonetsky	2013
Sit, Stay, Drive: The Future of Autonomous Car Liability	Duffy, Jamie Patrick, Sophia H.Hopkins	2013
Sue My Car Not Me: Products Liability and Accidents Involving Autonomous Vehicles	Gurney, Jeffrey K.	2013
The Challenge to Autonomous Lethal Robotics to International Humanitarian Law	Grut, Chantal	2013
The Future of the Law of Armed Conflict: Ostriches, Butterflies, and Nanobots	Jensen, Eric Talbot	2013
The Great Disruption: How Machine Intelligence Will Transform the Role of Lawyers in the Delivery of Legal Services	McGinnis, Russell G., John O.Pearce	2013
The New Financial Industry	Lin, Tom C. W.	2013
Transparent Predictions	Zarsky, Tal Z.	2013
Understanding the Loop: Regulating the Next Generation of War Machines	Marra, Sonia K., William C.McNeil	2013
Vehicle: Chapter 570: Chapter 570: Paving the Way for Autonomous Vehicles	Lenth, Danielle	2013
When Enough Is Enough: Location Tracking, Mosaic Theory, and Machine Learning	Bellovin, Sebastian, Steven M.Hutchins, Renee M.Jebara, TonyZimmeck	2013
ABHOR A VACUUM: THE STATUS OF ARTIFICIAL INTELLIGENCE AND AI DRONES UNDER INTERNATIONAL LAW	Weaver, John F	2013
A Human Touch	Saxon, Dan	2014
AI, Robotics, and the Future of Jobs	Smith, Aaron and Anderson, Janna	2014
Automated Warfare	Lucas, George R. Jr.	2014
Autonomous Weapons and Accountability: Seeking Solutions in the Law of War	Cass, Kelly	2014
Beyond Skynet: Reconciling Increased Autonomy in Computer-Based Weapons Systems with the Laws of War	Kovach, Christopher M.	2014
Big Data and Predictive Reasonable Suspicion	Ferguson, Andrew Guthrie	2014
Black-Box Medicine	Price, W. Nicholson II	2014
Bridging the Uncompensated Caregiver Gap: Does Technology Provide an Ethically and Legally Viable Answer	Harkness, Donna S.	2014
Building the Ethical Cyber Commander and the Law of Armed Conflict	Prescott, Jody M.	2014
Is Johnny Five Alive or Did It Short Circuit: Can and Should an Artificially Intelligent Machine Be Held Accountable in War Or Is It Merely a Weapon	Gevers, Aaron	2014
Labor Law 2.0: The Impact of New Information Technology on the Employment Relationship and the Relevance of the NLRA	Dau-Schmidt, Kenneth G.	2014

Machines without Principals: Liability Rules and Artificial Intelligence	Vladeck, David C.	2014
National Security, Narcissism, Voyeurism, and Kyllo: How Intelligence Programs and Social Norms Are Affecting the Fourth Amendment	Pearlman, Erick S., Adam R.Lee	2014
Policing by Numbers: Big Data and the Fourth Amendment	Joh, Elizabeth E.	2014
QUANTIFYING HARM STRUCTURE: A NEW HARM MATRIX FOR CYBERSECURITY SURVEILLANCE	Tene, Omer	2014
Robots in the Home: What Will We Have Agreed To	Kaminski, Margot E.	2014
Small Data Surveillance v. Big Data Cybersurveillance	Hu, Margaret	2014
Sophisticated Robots: Balancing Liability, Regulation, and Innovation	Hubbard, F. Patrick	2014
Stopping killer robots	Gubrud, M.	2014
The Dehumanization of International Humanitarian Law: Legal, Ethical, and Political Implications of Autonomous Weapon Systems	Wagner, Markus	2014
The Killer Robots Are Here: Legal and Policy Implications	Crootof, Rebecca	2014
The Scored Society: Due Process for Automated Predictions	Citron, Frank, Danielle KeatsPasquale	2014
Total Surveillance, Big Data, and Predictive Crime Technology: Privacy's Perfect Storm	Miller, Kevin	2014
Big Data and the Fourth Amendment: Reducing Overreliance on the Objectivity of Predictive Policing	Myers, Laura Parrish, Allen Williams, Alexis	2014
Focus on Cyberlaw: UNFAIR AND DECEPTIVE ROBOTS	Hartzog, Woodrow	2014
TAXATION AND SURVEILLANCE: AN AGENDA	Hatfield, Michael	2014
A fourth law of robotics? Copyright and the law and ethics of machine co-production	Schafer, B. and Komuves, D. and Zatarain, J. M. N. and Diver, L.	2015
AIonAI: A Humanitarian Law of Artificial Intelligence and Robotics	Ashrafian, H.	2015
Algorithmic Choice and Superior Responsibility: Closing the Gap between Liability and Lethal Autonomy by Defining the Line between Actors and Tools	Reitinger, Nathan	2015
Artificial Intelligence and Robot Responsibilities: Innovating Beyond Rights	Ashrafian, H.	2015
Automating the Right Stuff - The Hidden Ramifications of Ensuring Autonomous Aerial Weapon Systems Comply with International Humanitarian Law	DeSon, Jason S.	2015
Autonomous and Automated and Connected Cars - Oh My: First Generation Autonomous Cars in the Legal Ecosystem	Glancy, Dorothy J.	2015
Bargaining in the Shadow of Big Data	Stevenson, Nicholas J., DruWagoner	2015
Big Data Blacklisting	Hu, Margaret	2015
Can Siri 10.0 Buy Your Home: The Legal and Policy Based Implications of Artificial Intelligent Robots Owning Real Property	Rothenberg, David Marc	2015
Consumer Cloud Robotics and the Fair Information Practice Principles: Recognizing the Challenges and Opportunities Ahead	Proia, Kris, AndrewSimshaw, DrewHauser	2015
Consumer Protection in an Era of Big Data Analytics	Vladeck, David C.	2015
Crashing into the Unknown: An Examination of Crash-Optimization Algorithms through the Two Lanes of Ethics and Law	Gurney, Jeffery K.	2015
Do Automated Trading Systems Dream of manipulating the Price of Futures Contracts - Policing Markets for Improper Trading Practices by Algorithmic Robots	Scopino, Gregory	2015
Driving into the Unknown: Examining the Crossroads of Criminal Law and Autonomous Vehicles	Gurney, Jeffrey K.	2015
Emergent Works	Boyden, Bruce E.	2015
Liability for damages caused by artificial intelligence	Cerka, P. and Grigiene, J. and Sirbikyte, G.	2015
Machine Learning, Automated Suspicion Algorithms, and the Fourth Amendment	Rich, Michael L.	2015

Of Souls, Spirits and Ghosts: Transposing the Application of the Rules of Targeting to Lethal Autonomous Robots	Krupiy, T.	2015
Patents in An Era of Infinite Monkeys and Artificial Intelligence	Hattenbach, Joshua, BenGlucoft	2015
Preparing Financial Regulation for the Second Machine Age: The Need for Oversight of Digital Intermediaries in the Futures Markets	Scopino, Gregory	2015
Privacy: An Issue of Priority	Segovia, Stephanie	2015
Proportionality and Autonomous Weapons Systems	van den Boogaard, J.	2015
Removing Roadblocks to Intelligent Vehicles and Driverless Cars	Thierer, Ryan, AdamHagemann	2015
Robotic Marriage and the Law	Goldfeder, Yosef, MarkRazin	2015
Self-Defense against Robots and Drones	Froomkin, P. Zak, A. MichaelColangelo	2015
Self-Driving Vehicles and Policy Implications: Current Status of Autonomous Vehicle Development and Minnesota Policy Implications	Lari, Ify, AdeelDouma, FrankOnyiah	2015
THE COSTS OF SELF-DRIVING CARS: RECONCILING FREEDOM AND PRIVACY WITH TORT LIABILITY IN AUTONOMOUS VEHICLE REGULATION	Boeglin, Jack	2015
The Debate over Autonomous Weapons Systems	Noone, Diana C., Gregory P.Noone	2015
The Equilibrium of Violence: Accountability in the Age of Autonomous Weapons Systems	Hood, Joel	2015
THE INTERNET OF THINGS AND WEARABLE TECHNOLOGY: ADDRESSING PRIVACY AND SECURITY CONCERNS WITHOUT DERAILING INNOVATION	Thierer, Adam D	2015
War Torts: Accountability for Autonomous Weapons	Crootof, Rebecca	2015
REGULATING HEALTHCARE ROBOTS: MAXIMIZING OPPORTUNITIES WHILE MINIMIZING RISKS	Simshaw, Drew Terry, Nicolas Hauser, Kris Cummings, ML	2015
INTERNATIONAL REGULATION OF EMERGING MILITARY TECHNOLOGIES: AUTONOMOUS ROBOTIC WEAPONS: LETHAL AUTONOMOUS WEAPONS AND JUS AD BELLUM PROPORTIONALITY	Roff, Heather M	2015
NAVIGATING THE ROAD AHEAD: FLORIDA'S AUTONOMOUS VEHICLE STATUTE AND ITS EFFECT ON LIABILITY	Terwilleger, John W	2015
"It's Going to Kill Us!" and Other Myths About the Future of Artificial Intelligence	Atkinson, Robert D	2016
A Meaningful Floor for Meaningful Human Control	Crootof, Rebecca	2016
A Survey of Legal Issues Arising from the Deployment of Autonomous and Connected Vehicles	Crane, Bryce C., Daniel A.Logue, Kyle D.Pilz	2016
Accountability and Autonomous Weapons: Much Ado about Nothing	Dunlap, Charles J. Jr.	2016
Accountability Gap: Autonomous Weapon Systems and Modes of Responsibility in International Law	Chengeta, Thompson	2016
Amoral Machines, or: How Roboticists Can Learn to Stop Worrying and Love the Law	Casey, Bryan	2016
Analysis of the Legal Status of Unmanned Commercial Vessels in U.S. Admiralty and Maritime Law	Chwedczuk, Michal	2016
Artificial Intelligence and the Copyright Dilemma	Hristov, Kalin	2016
Autonomous Vehicle Regulation: How an Uncertain Legal Landscape May Hit the Brakes on Self-Driving Cars	Brodsky, Jessica S.	2016
Autonomous Weapons and International Humanitarian Law or Killer Robots are Here: Get Used to It	Harris, Shane	2016
Averting Robot Eyes	Kaminski, Cindy M., Margot E.Rueben, MatthewSmart, William D.Grimm	2016

Blame It on the Machines: How Autonomous Vehicles Will Impact Allocation of Liability Insurance and the Resulting Impact on the Legal Community	Brown, Andrew M.	2016
Centaur Warfighting: The False Choice of Humans vs. Automation	Scharre, Paul	2016
COMPUTERS LAYING DOWN THE LAW: WILL JUDGES BECOME OBSOLETE?	Klingensmith, Mark W	2016
Defining the Emerging Notion of Meaningful Human Control in Weapon Systems	Chengeta, Thompson	2016
Digital Surveillance and Preventive Policing	Utset, Manuel A.	2016
Ex Machina: Copyright Protection for Computer Generated Works	Denicola, Robert C.	2016
False Rubicons, Moral Panic, & Conceptual Cul-De-Sacs: Critiquing & Reframing the Call to Ban Lethal Autonomous Weapons	Jenks, Chris	2016
Fintech and Disruptive Business Models in Financial Products, Intermediation and Markets - Policy Implications for Financial Regulators	Chiu, Iris H-Y	2016
I Think, Therefore I Invent: Creative Computers and the Future of Patent Law	Abbott, Ryan	2016
If Robots Cause Harm, Who Is to Blame: Self-Driving Cars and Criminal Liability	Gless, Thomas, SabineSilverman, EmilyWeigend	2016
Intellectual Property Rights for Hubots: On the Legal Implications of Human-like Robots as Innovators and Creators	Khoury, Amir. H.	2016
LAW, PRIVACY & TECHNOLOGY COMMENTARY SERIES: PROTECTING ONE'S OWN PRIVACY IN A BIG DATA ECONOMY	Allen, Anita L	2016
Little Things and Big Challenges: Information Privacy and the Internet of Things	Brill, Scott, HillaryJones	2016
Machine Testimony	Roth, Andrea	2016
Manhatten_Project.exe: A Nuclear Option for the Digital Age	Laton, David T.	2016
Policing Police Robots	Joh, Elizabeth E.	2016
Privacy and Accountability in Black-Box Medicine	Ford, W. Nicholson II, Roger AllanPrice	2016
Putting Data Benefits in Context: A Response to Kift and Nissenbaum	Maldoff, Omer, GabeTene	2016
Regulating by Robot: Administrative Decision Making in the Machine-Learning Era	Coglianese, David, CaryLehr	2016
Rethinking the Fourth Amendment in the Age of Supercomputers, Artificial Intelligence, and Robots	Reid, Melanie	2016
Robot Slaves, Robot Masters, and the Agency Costs of Artificial Government	Smith, Thomas A.	2016
Setting the Stage: Autonomous Legal Reasoning in International Humanitarian Law	Hollis, Duncan B.	2016
SIRI-OUSLY 2.0: What Artificial Intelligence Reveals about the First Amendment	Massaro, Margot E., Toni M.Norton, HelenKaminski	2016
Siri-Ously? Free Speech Rights and Artificial Intelligence	Massaro, T. M. and Norton, H.	2016
Stopping 'Killer Robots': Why Now Is the Time to Ban Autonomous Weapons Systems	Sauer, Frank	2016
Surveillance by Algorithm: The NSA, Computerized Intelligence Collection, and Human Rights	Margulies, Peter	2016
Technological Opacity, Predictability, and Self-Driving Cars	Surden, Mary-Anne, HarryWilliams	2016
The Economic Calculus of Fielding Autonomous Fighting Vehicles Complaint with the Laws of Armed Conflict	Wallach, Erik, EvanThomas	2016
The Failure of Liability in Modern Markets	Yadav, Yesha	2016
The Inadequate, Invaluable Fair Information Practices	Hartzog, Woodrow	2016
The Internet of Things and the Fourth Amendment of Effects	Ferguson, Andrew Guthrie	2016
The New Market Manipulation	Lin, Tom C.W.	2016
The New Surveillance Discretion: Automated Suspicion, Big Data, and Policing	Joh, Elizabeth E.	2016

WEATHERING THE NEST: PRIVACY IMPLICATIONS OF HOME MONITORING FOR THE AGING AMERICAN POPULATION	Bronfman, Jillisa	2016
Why the Hurry to Regulate Autonomous Weapon Systems - But Not Cyber-Weapons	Anderson, Kenneth	2016
The Future of Jobs	Till Alexander Leopold Saadia Zahidi Vesselina Ratcheva	2016
THE IMPLICATIONS OF MODERN BUSINESS-ENTITY LAW FOR THE REGULATION OF AUTONOMOUS SYSTEMS	Bayern, Shawn	2016
A New Deal for the Twenty-First Century	Saadia Zahidi	2017
A Roadmap for Autonomous Vehicles: State Tort Liability, Automobile Insurance, and Federal Safety Regulation	Vesselina Ratcheva	2017
Accountability and Decision Making an Autonomous Warfare: Who Is Responsible	Guiora, Amos N.	2017
Advisory Nonpreemption	Light, Sarah E.	2017
Alexa, Do You Have Rights: Legal Issues Posed by Voice-Controlled Devices and the Data They Create	Boughman, Michael V., EricKohut, Sara Beth A. R.Sella-Villa, DavidSilvestro	2017
Algorithmic Jim Crow	Hu, Margaret	2017
Artificial Intelligence & Collusion: When Computers Inhibit Competition	Ezrachi, Maurice E., ArielStucke	2017
Artificial Intelligence Policy: A Primer and Roadmap	Calo, Ryan	2017
Artificial Intelligence's Fair Use Crisis	Sobel, Benjamin L. W.	2017
At the Crossroads of Control: The Intersection of Artificial Intelligence in Autonomous Weapon Systems with International Humanitarian Law	Schuller, Alan L.	2017
Authorship, Disrupted: AI Authors in Copyright and First Amendment Law	Kaminski, Margot E.	2017
Automated Driving and Product Liability	Smith, Bryant Walker	2017
Autonomous weapon system: Law of armed conflict (LOAC) and other legal challenges	Sehrawat, V.	2017
Autonomous Weapons and International Law	Ford, Christopher M.	2017
Averting the Moral Free-for-All of Autonomous Weapons	Jenkins, Ryan	2017
Boundary-Spanning Collaboration and the Limits of Joint Inventorship Doctrine	Vertinsky, Liza	2017
Complications of a Common Language: Why It Is So Hard to Talk about Autonomous Weapons	Ekelhof, Merel A. C.	2017
Confidentiality Creep and Opportunistic Privacy	Levine, David S.	2017
Dr. Robot	Bambauer, Jane R.	2017
Fast & Furious: The Misregulation of Driverless Cars	Pearl, Tracy Hresko	2017
Lethal Autonomous Weapons Systems: Adapting to the Future Unmanned Warfare and Unaccountable Robots	Warren, Alek, AidenHillas	2017
Of, for, and by the people: the legal lacuna of synthetic persons	Bryson, J. J. and Diamantis, M. E. and Grant, T. D.	2017
Opening the Door to Self-Driving Cars: How Will This Change the Rules of the Road	Pearah, Paul J.	2017
Patenting the Output of Autonomously Inventive Machines	Abbott, Ryan B.	2017
Plausible Cause: Explanatory Standards in the Age of Powerful Machines	Brennan-Marquez, Kiel	2017
Playing with the Data: What Legal Scholars Should Learn about Machine Learning	Lehr, Paul, DavidOhm	2017
Private Security Robots, Artificial Intelligence, and Deadly Force	Joh, Elizabeth E.	2017
PUTTING THE REINS ON AUTONOMOUS VEHICLE LIABILITY: WHY HORSE ACCIDENTS ARE THE BEST COMMON LAW ANALOGY	David King	2017
Reasonably Suspicious Algorithms: Predictive Policing at the United States Border	Barrett, Lindsey	2017
Regulating Black-Box Medicine	Price, W. Nicholson II	2017
Taming the Golem: Challenges of Ethical Algorithmic Decision-Making	Tene, Jules, OmerPolonetsky	2017

The Future of Jobs and Jobs Training	Rainie, Lee and Anderson, Janna	2017
The Impact of Emerging Information Technologies on the Employment Relationship: New Gigs for Labor and Employment Law	Dau-Schmidt, Kenneth G.	2017
The Implications of Algorithmic Pricing for Coordinated Effects Analysis and Price Discrimination Markets in Antitrust Enforcement	McSweeny, Brian, TerrellO'Dea	2017
The MADCOM Future	Chessen, Matt	2017
The next stage of US communications policy: The emerging embedded infosphere	Taylor, R. D.	2017
The Personalization Puzzle	Cavender, Brittainy	2017
The Risks of Artificial Intelligence to Security and the Future of Work	Osoba, Osonde A and Welser, William, IV	2017
Trust but Verify: A Guide to Algorithms and the Law	Desai, Joshua A., Deven R.Kroll	2017
Will Robots Make Job Training (and Workers) Obsolete? Workforce Development in an Automating Labor Market	Holzer, Harry J	2017
An FDA for Algorithms	Tutt, Andrew	2017
An Intelligence in Our Image: The Risks of Bias and Errors in Artificial Intelligence	Osoba, Osonde A and Welser, William, IV	2017
30TH ANNIVERSARY COMMEMORATIVE ISSUE: ARTICLE: Can Robots Be Lawyers? Computers, Lawyers, and the Practice of Law	Remus, Dana Levy, Frank	2017
30TH ANNIVERSARY COMMEMORATIVE ISSUE: RESPONSE ESSAY: Robots Versus Lawyers: A User-Centered Approach	Rostain, Tanina	2017
THE OPINION OF MACHINES +	Karnow, Curtis EA	2017
Copyrightability of Artworks Produced by Creative Robots and Originality: The Formality-Objective Model	Yanisky-Ravid, Luis Antonio, ShlomitVelez-Hern and , ez	2018
Ethics, Algorithms and Self-driving Cars - A CSI of the "Trolley Problem"	Renda, Andrea	2018
Regulating Robo Advice Across the Financial Services Industry	Baker, Tom Dellaert, Benedict GC	2018

Table 39 - Screened-in Articles in Justice System (5)

Title	Author	Year
Can/Should Computers Replace Judges	D'Amato, Anthony	1976
EMERGING LEGAL ISSUES IN THE DIGITAL AGE: ARTICLE & ESSAY: Experts on Computer-Assisted Review: Why Federal Rule of Evidence 702 Should Apply to Their Use	Waxse, David J Yoakum-Kriz, Brenda	2012
Machine Testimony	Roth, Andrea	2016
COMPUTERS LAYING DOWN THE LAW: WILL JUDGES BECOME OBSOLETE?	Klingensmith, Mark W	2016
THE OPINION OF MACHINES +	Karnow, Curtis EA	2017

Table 40 - Screened-in Articles in Classification of Individuals (35)

Title	Author	Year
Mine Your Own Business: Making the Case for the Implications of the Data Mining of Personal Information in the Forum of Public Opinion	Zarsky, Tal Z.	2002
Passing beyond Identity on the Internet: Espionage & (and) Counterespionage in the Internet Age	Peek, Marcy	2003
Buddy bots: How Turing's fast friends are undermining consumer privacy	Kerr, I. R. and Bornfreund, M.	2005

Technological Due Process	Citron, Danielle Keats	2007
Do Androids Dream: Personhood and Intelligent Artifacts	Hubbard, F. Patrick	2010
Restoring Transparency to Automated Authority	Pasquale, Frank	2011
Transparent Predictions	Zarsky, Tal Z.	2013
Judged by the Tin Man: Individual Rights in the Age of Big Data	Tene, Jules, OmerPolonetsky	2013
Humans and Humans: Technological Enhancement and Criminal Responsibility	Brenner, Susan W.	2013
QUANTIFYING HARM STRUCTURE: A NEW HARM MATRIX FOR CYBERSECURITY SURVEILLANCE	Tene, Omer	2014
Total Surveillance, Big Data, and Predictive Crime Technology: Privacy's Perfect Storm	Miller, Kevin	2014
The Scored Society: Due Process for Automated Predictions	Citron, Frank, Danielle KeatsPasquale	2014
Big Data and Predictive Reasonable Suspicion	Ferguson, Andrew Guthrie	2014
Policing by Numbers: Big Data and the Fourth Amendment	Joh, Elizabeth E.	2014
Big Data and the Fourth Amendment: Reducing Overreliance on the Objectivity of Predictive Policing	Myers, Laura Parrish, Allen Williams, Alexis	2014
Big Data Blacklisting	Hu, Margaret	2015
Machine Learning, Automated Suspicion Algorithms, and the Fourth Amendment	Rich, Michael L.	2015
Consumer Protection in an Era of Big Data Analytics	Vladeck, David C.	2015
Surveillance by Algorithm: The NSA, Computerized Intelligence Collection, and Human Rights	Margulies, Peter	2016
Regulating by Robot: Administrative Decision Making in the Machine-Learning Era	Coglianese, David, CaryLehr	2016
Rethinking the Fourth Amendment in the Age of Supercomputers, Artificial Intelligence, and Robots	Reid, Melanie	2016
"It's Going to Kill Us!" and Other Myths About the Future of Artificial Intelligence	Atkinson, Robert D	2016
Policing Police Robots	Joh, Elizabeth E.	2016
Digital Surveillance and Preventive Policing	Utset, Manuel A.	2016
Artificial Intelligence Policy: A Primer and Roadmap	Calo, Ryan	2017
Plausible Cause: Explanatory Standards in the Age of Powerful Machines	Brennan-Marquez, Kiel	2017
Playing with the Data: What Legal Scholars Should Learn about Machine Learning	Lehr, Paul, DavidOhm	2017
Reasonably Suspicious Algorithms: Predictive Policing at the United States Border	Barrett, Lindsey	2017
Algorithmic Jim Crow	Hu, Margaret	2017
Taming the Golem: Challenges of Ethical Algorithmic Decision-Making	Tene, Jules, OmerPolonetsky	2017
The Implications of Algorithmic Pricing for Coordinated Effects Analysis and Price Discrimination Markets in Antitrust Enforcement	McSweeny, Brian, TerrellO'Dea	2017
The next stage of US communications policy: The emerging embedded infosphere	Taylor, R. D.	2017
Trust but Verify: A Guide to Algorithms and the Law	Desai, Joshua A., Deven R.Kroll	2017

Artificial Intelligence's Fair Use Crisis	Sobel, Benjamin L. W.	2017
Regulating Robo Advice Across the Financial Services Industry	Baker, Tom Dellaert, Benedict GC	2018

Table 41 - Screened-in Articles in Accountability (38)		
Title	**Author**	**Year**
Ethics, Algorithms and Self-driving Cars - A CSI of the "Trolley Problem"	Renda, Andrea	2018
Of, for, and by the people: the legal lacuna of synthetic persons	Bryson, J. J. and Diamantis, M. E. and Grant, T. D.	2017
PUTTING THE REINS ON AUTONOMOUS VEHICLE LIABILITY: WHY HORSE ACCIDENTS ARE THE BEST COMMON LAW ANALOGY	David King	2017
Opening the Door to Self-Driving Cars: How Will This Change the Rules of the Road	Pearah, Paul J.	2017
Fast & Furious: The Misregulation of Driverless Cars	Pearl, Tracy Hresko	2017
Automated Driving and Product Liability	Smith, Bryant Walker	2017
A Roadmap for Autonomous Vehicles: State Tort Liability, Automobile Insurance, and Federal Safety Regulation	Vesselina Ratcheva	2017
Autonomous Vehicle Regulation: How an Uncertain Legal Landscape May Hit the Brakes on Self-Driving Cars	Brodsky, Jessica S.	2016
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Amoral Machines, or: How Roboticists Can Learn to Stop Worrying and Love the Law	Casey, Bryan	2016
Analysis of the Legal Status of Unmanned Commercial Vessels in U.S. Admiralty and Maritime Law	Chwedczuk, Michal	2016
A Survey of Legal Issues Arising from the Deployment of Autonomous and Connected Vehicles	Crane, Bryce C., Daniel A.Logue, Kyle D.Pilz	2016
If Robots Cause Harm, Who Is to Blame: Self-Driving Cars and Criminal Liability	Gless, Thomas, SabineSilverman, EmilyWeigend	2016
Intellectual Property Rights for Hubots: On the Legal Implications of Human-like Robots as Innovators and Creators	Khoury, Amir. H.	2016
The New Market Manipulation	Lin, Tom C.W.	2016
Technological Opacity, Predictability, and Self-Driving Cars	Surden, Mary-Anne, HarryWilliams	2016
THE COSTS OF SELF-DRIVING CARS: RECONCILING FREEDOM AND PRIVACY WITH TORT LIABILITY IN AUTONOMOUS VEHICLE REGULATION	Boeglin, Jack	2015
Liability for damages caused by artificial intelligence	Cerka, P. and Grigiene, J. and Sirbikyte, G.	2015
Automating the Right Stuff - The Hidden Ramifications of Ensuring Autonomous Aerial Weapon Systems Comply with International Humanitarian Law	DeSon, Jason S.	2015
Autonomous and Automated and Connected Cars - Oh My: First Generation Autonomous Cars in the Legal Ecosystem	Glancy, Dorothy J.	2015

Crashing into the Unknown: An Examination of Crash-Optimization Algorithms through the Two Lanes of Ethics and Law	Gurney, Jeffery K.	2015
Driving into the Unknown: Examining the Crossroads of Criminal Law and Autonomous Vehicles	Gurney, Jeffrey K.	2015
Self-Driving Vehicles and Policy Implications: Current Status of Autonomous Vehicle Development and Minnesota Policy Implications	Lari, Ify, AdeelDouma, FrankOnyiah	2015
Removing Roadblocks to Intelligent Vehicles and Driverless Cars	Thierer, Ryan, AdamHagemann	2015
Sophisticated Robots: Balancing Liability, Regulation, and Innovation	Hubbard, F. Patrick	2014
Machines without Principals: Liability Rules and Artificial Intelligence	Vladeck, David C.	2014
Sit, Stay, Drive: The Future of Autonomous Car Liability	Duffy, Jamie Patrick, Sophia H.Hopkins	2013
Sue My Car Not Me: Products Liability and Accidents Involving Autonomous Vehicles	Gurney, Jeffrey K.	2013
New Technology - Old Law: Autonomous Vehicles and California's Insurance Framework	Peterson, Robert W.	2012
Open Robotics	Calo, Ryan	2010
"I, Robot - I, Criminal"--When Science Fiction Becomes Reality: Legal Liability of AI Robots committing Criminal Offenses	Hallevy, Gabriel	2010
The Criminal Liability of Artificial Intelligence Entities - From Science Fiction to Legal Social Control	Hallevy, Gabriel	2010
Responsibility of Intelligent Artifacts: Toward an Automation Jurisprudence	Wein, Leon E.	1992
Legal Personhood for Artificial Intelligences	Solum, Lawrence B.	1991
Tort Liability for Artificial Intelligence and Expert Systems	Cole, George S.	1990
Artificial Intelligence Use in the Legal Profession: What are Its Liabilities	O'Donnell, J. Stephen	1990
Tort Adjudication and the Emergence of Artificial Intelligence Software	Frank, Steven J.	1987
Professional Malpractice and the Unauthorized Practice of Professions: Some Legal and Ethical Aspects of the Use of Computers as Decision-Aids	Willick, Marshall S.	1986

Table 42 - Screened-in Articles in Personhood (69)

Title	Author	Year
Can a Computer be an Author - Copyright Aspects of Artificial Intelligence	Butler, Timothy L.	1981
Laying Down the Law to Robots	Gemignani, Michael	1983
A Common Law for the Ages of Intellectual Property	Rosen, Dan	1983
Allocating Ownership Rights in Computer-Generated Works	Samuelson, Pamela	1985
Copyrightability of Computer-Created Works	Farr, Evan H.	1989
Copyright Protection for Artificial Intelligence Systems	Goldberg, David O., Morton DavidCarson	1991
Legal Personhood for Artificial Intelligences	Solum, Lawrence B.	1991
Copyright Protection for Computer Programs, Databases, and Computer-Generated Works: Is Anything New Since CONTU	Miller, Arthur R.	1992
Originality in Computer Programs and Expert Systems: Discerning the Limits of Protection under Copyright Laws of France and the United States	Shuster, Todd	1992
Responsibility of Intelligent Artifacts: Toward an Automation Jurisprudence	Wein, Leon E.	1992

Can Computers Make Contracts	Allen, Robin, TomWiddison	1996
Intellectual Property in the Era of the Creative Computer Program: Will the True Creator Please Stand Up	Clifford, Ralph D.	1996
Liability for Distributed Artificial Intelligences	Karnow, Curtis E. A.	1996
From Video Games to Artificial Intelligence: Assigning Copyright Ownership to Works Generated by Increasingly Sophisticated Computer Programs	Wu, Andrew J.	1997
I. INTELLECTUAL PROPERTY: A. Copyright: 2. Acquisition and Ownership: a) Authorship: Urantia Foundation v. Maaherra	Christina Rhee	1998
INTELLIGENT SOFTWARE AGENTS AND AGENCY LAW *	Smed, Suzanne	1998
The Use of Electronic Agents Questioned under Contractual Law: Suggested Solutions on a European and American Level	Lerourge, Jean-Francois	1999
Contracting with Electronic Agents	Bellia, Anthony J. Jr.	2001
iBRIEF/COPYRIGHTS & TRADEMARKS: Copyrights in Computer-Generated Works: Whom, if Anyone, do we Reward?	Glasser, Darin	2001
Thinking about Thinking Machines: Implications of Machine Inventors for Patent Law	Vertinsky, Todd M., LizaRice	2002
FEDERAL SEARCH COMMISSION? ACCESS, FAIRNESS, AND ACCOUNTABILITY IN THE LAW OF SEARCH	Bracha, Oren Pasquale, Frank	2007
STATUTE OF ANNE-IMALS: SHOULD COPYRIGHT PROTECT SENTIENT NONHUMAN CREATORS?	Johnson, Dane E	2008
Copyright on the Semantic Web: Divergence of Author and Work	Brown, Evan D.	2009
Do Androids Dream: Personhood and Intelligent Artifacts	Hubbard, F. Patrick	2010
The Wisdom of Legislating for Anticipated Technological Advancements	Liebesman, Yvette Joy	2010
Physicality and the Information Age: A Normative Perspective on the Patent Eligibility of Non-Physical Methods	McEniery, Ben	2010
Computer-Managed Perpetual Trusts	Vincent, Michael	2010
"I, Robot - I, Criminal"--When Science Fiction Becomes Reality: Legal Liability of AI Robots committing Criminal Offenses	Hallevy, Gabriel	2010
The Criminal Liability of Artificial Intelligence Entities - From Science Fiction to Legal Social Control	Hallevy, Gabriel	2010
Bridging the Accountability Gap: Rights for New Entities in the Information Society	Koops, David-Olivier, Bert-JaapHildebr and t, MireilleJaquet-Chiffelle	2010
Coding Creativity: Copyright and the Artificially Intelligent Author	Bridy, Annemarie	2012
Injury by Algorithm	Ghatnekar, Seema	2012
SIRI IS MY CLIENT: A FIRST LOOK AT ARTIFICIAL INTELLIGENCE AND LEGAL ISSUES	Weaver, J	2012
In-Corp-O-Real: A Psychological Critique of Corporate Personhood and Citizens United	Brown, Teneille R.	2013
How to Kill Copyright: A Brute-Force Approach to Content Creation	Sigmon, Kirk	2013
The New Financial Industry	Lin, Tom C. W.	2013
Automated Vehicles Are Probably Legal in the United States	Smith, Bryant Walker	2013
Autonomous Weapons and Human Responsibilities	Beard, Jack M.	2013
Autonomous Weapons Systems: A Coming Legal Singularity	Kastan, Benjamin	2013

Is Johnny Five Alive or Did It Short Circuit: Can and Should an Artificially Intelligent Machine Be Held Accountable in War Or Is It Merely a Weapon	Gevers, Aaron	2014
AIonAI: A Humanitarian Law of Artificial Intelligence and Robotics	Ashrafian, H.	2015
Emergent Works	Boyden, Bruce E.	2015
Liability for damages caused by artificial intelligence	Cerka, P. and Grigiene, J. and Sirbikyte, G.	2015
Self-Defense against Robots and Drones	Froomkin, P. Zak, A. MichaelColangelo	2015
Robotic Marriage and the Law	Goldfeder, Yosef, MarkRazin	2015
Patents in An Era of Infinite Monkeys and Artificial Intelligence	Hattenbach, Joshua, BenGlucoft	2015
Can Siri 10.0 Buy Your Home: The Legal and Policy Based Implications of Artificial Intelligent Robots Owning Real Property	Rothenberg, David Marc	2015
A fourth law of robotics? Copyright and the law and ethics of machine co-production	Schafer, B. and Komuves, D. and Zatarain, J. M. N. and Diver, L.	2015
Do Automated Trading Systems Dream of manipulating the Price of Futures Contracts - Policing Markets for Improper Trading Practices by Algorithmic Robots	Scopino, Gregory	2015
I Think, Therefore I Invent: Creative Computers and the Future of Patent Law	Abbott, Ryan	2016
THE IMPLICATIONS OF MODERN BUSINESS-ENTITY LAW FOR THE REGULATION OF AUTONOMOUS SYSTEMS	Bayern, Shawn	2016
Ex Machina: Copyright Protection for Computer Generated Works	Denicola, Robert C.	2016
Artificial Intelligence and the Copyright Dilemma	Hristov, Kalin	2016
Intellectual Property Rights for Hubots: On the Legal Implications of Human-like Robots as Innovators and Creators	Khoury, Amir. H.	2016
SIRI-OUSLY 2.0: What Artificial Intelligence Reveals about the First Amendment	Massaro, Margot E., Toni M.Norton, HelenKaminski	2016
Siri-Ously? Free Speech Rights and Artificial Intelligence	Massaro, T. M. and Norton, H.	2016
Robot Slaves, Robot Masters, and the Agency Costs of Artificial Government	Smith, Thomas A.	2016
Setting the Stage: Autonomous Legal Reasoning in International Humanitarian Law	Hollis, Duncan B.	2016
The Failure of Liability in Modern Markets	Yadav, Yesha	2016
Analysis of the Legal Status of Unmanned Commercial Vessels in U.S. Admiralty and Maritime Law	Chwedczuk, Michal	2016
If Robots Cause Harm, Who Is to Blame: Self-Driving Cars and Criminal Liability	Gless, Thomas, SabineSilverman, EmilyWeigend	2016
Patenting the Output of Autonomously Inventive Machines	Abbott, Ryan B.	2017
Alexa, Do You Have Rights: Legal Issues Posed by Voice-Controlled Devices and the Data They Create	Boughman, Michael V., EricKohut, Sara Beth A. R.Sella-Villa, DavidSilvestro	2017
The Personalization Puzzle	Cavender, Brittainy	2017

Authorship, Disrupted: AI Authors in Copyright and First Amendment Law	Kaminski, Margot E.	2017
Boundary-Spanning Collaboration and the Limits of Joint Inventorship Doctrine	Vertinsky, Liza	2017
Artificial Intelligence & Collusion: When Computers Inhibit Competition	Ezrachi, Maurice E., ArielStucke	2017
Of, for, and by the people: the legal lacuna of synthetic persons	Bryson, J. J. and Diamantis, M. E. and Grant, T. D.	2017
Copyrightability of Artworks Produced by Creative Robots and Originality: The Formality-Objective Model	Yanisky-Ravid, Luis Antonio, ShlomitVelez-Hern and , ez	2018

Table 43 - Screened-in Articles in Displacement of Labor (15)		
Title	**Author**	**Year**
Laying Down the Law to Robots	Gemignani, Michael	1983
Corpus Juris Roboticum	August, Raymond	1987
THE MICROELECTRONICS REVOLUTION, JOB DISPLACEMENT, AND THE FUTURE OF WORK: A POLICY COMMENTARY	Solomon, Lewis D	1987
The Terrifying Liberation of Labor	Kane, Tim	2006
Ghetto'ing Workers with Hi-Tech: Exploring Regulatory Solutions for the Effect of Artificial Intelligence on Third World Foreign Direct Investment	Duong, Wendy N.	2008
AI, Robotics, and the Future of Jobs	Smith, Aaron and Anderson, Janna	2014
Labor Law 2.0: The Impact of New Information Technology on the Employment Relationship and the Relevance of the NLRA	Dau-Schmidt, Kenneth G.	2014
Removing Roadblocks to Intelligent Vehicles and Driverless Cars	Thierer, Ryan, AdamHagemann	2015
"It's Going to Kill Us!" and Other Myths About the Future of Artificial Intelligence	Atkinson, Robert D	2016
The Future of Jobs	Till Alexander Leopold Saadia Zahidi Vesselina Ratcheva	2016
A New Deal for the Twenty-First Century	Saadia Zahidi	2017
The Future of Jobs and Jobs Training	Rainie, Lee and Anderson, Janna	2017
The Impact of Emerging Information Technologies on the Employment Relationship: New Gigs for Labor and Employment Law	Dau-Schmidt, Kenneth G.	2017
The Risks of Artificial Intelligence to Security and the Future of Work	Osoba, Osonde A and Welser, William, IV	2017
Will Robots Make Job Training (and Workers) Obsolete? Workforce Development in an Automating Labor Market	Holzer, Harry J	2017

Table 44 - Screened-in Articles in Privacy (45)		
Title	**Author**	**Year**

Electronic Surveillance, Computers, and the Fourth Amendment - The New Telecommunications Environment Calls for Reexamination of Doctrine	Landever, Arthur R	1983
Toward Universal Surveillance in an Information Age Economy: Can We Handle Treasury's New Police Technology	Bercu, Steven A.	1993
Mine Your Own Business: Making the Case for the Implications of the Data Mining of Personal Information in the Forum of Public Opinion	Zarsky, Tal Z.	2002
Data Mining and Domestic Security: Connecting the Dots to Make Sense of Data	Taipale, K. A.	2003
A Thousand Words Are Worth a Picture: A Privacy Tort Response to Consumer Data Profiling	McClurg, Andrew J.	2003
Buddy bots: How Turing's fast friends are undermining consumer privacy	Kerr, I. R. and Bornfreund, M.	2005
FEDERAL SEARCH COMMISSION? ACCESS, FAIRNESS, AND ACCOUNTABILITY IN THE LAW OF SEARCH	Bracha, Oren Pasquale, Frank	2007
People Can Be So Fake: A New Dimension to Privacy and Technology Scholarship	Calo, Ryan	2009
New Directions in Privacy: Disclosure, Unfairness and Externalities	MacCarthy, Mark	2010
The Potential Regulatory Challenges of Increasingly Autonomous Motor Vehicles	Wood, John, Stephen P.Chang, JesseHealy, ThomasWood	2012
Protecting Patient Privacy in the Age of Big Data	Terry, Nicolas P.	2012
Privacy in Autonomous Vehicles	Glancy, Dorothy J.	2012
Big Data for All: Privacy and User Control in the Age of Analytics	Tene, Jules, OmerPolonetsky	2012
When Enough Is Enough: Location Tracking, Mosaic Theory, and Machine Learning	Bellovin, Sebastian, Steven M.Hutchins, Renee M.Jebara, TonyZimmeck	2013
Judged by the Tin Man: Individual Rights in the Age of Big Data	Tene, Jules, OmerPolonetsky	2013
Facing Real-Time Identification in Mobile Apps & Wearable Computers	Welinder, Yana	2013
Total Surveillance, Big Data, and Predictive Crime Technology: Privacy's Perfect Storm	Miller, Kevin	2014
Small Data Surveillance v. Big Data Cybersurveillance	Hu, Margaret	2014
Robots in the Home: What Will We Have Agreed To	Kaminski, Margot E.	2014
QUANTIFYING HARM STRUCTURE: A NEW HARM MATRIX FOR CYBERSECURITY SURVEILLANCE	Tene, Omer	2014
Policing by Numbers: Big Data and the Fourth Amendment	Joh, Elizabeth E.	2014
National Security, Narcissism, Voyeurism, and Kyllo: How Intelligence Programs and Social Norms Are Affecting the Fourth Amendment	Pearlman, Erick S., Adam R.Lee	2014
Focus on Cyberlaw: UNFAIR AND DECEPTIVE ROBOTS	Hartzog, Woodrow	2014
Bridging the Uncompensated Caregiver Gap: Does Technology Provide an Ethically and Legally Viable Answer	Harkness, Donna S.	2014
THE INTERNET OF THINGS AND WEARABLE TECHNOLOGY: ADDRESSING PRIVACY AND SECURITY CONCERNS WITHOUT DERAILING INNOVATION	Thierer, Adam D	2015
Self-Defense against Robots and Drones	Froomkin, P. Zak, A. MichaelColangelo	2015
REGULATING HEALTHCARE ROBOTS: MAXIMIZING OPPORTUNITIES WHILE MINIMIZING RISKS	Simshaw, Drew Terry, Nicolas	2015

	Hauser, Kris Cummings, ML	
Privacy: An Issue of Priority	Segovia, Stephanie	2015
Consumer Cloud Robotics and the Fair Information Practice Principles: Recognizing the Challenges and Opportunities Ahead	Proia, Kris, AndrewSimshaw, DrewHauser	2015
WEATHERING THE NEST: PRIVACY IMPLICATIONS OF HOME MONITORING FOR THE AGING AMERICAN POPULATION	Bronfman, Jillisa	2016
The New Surveillance Discretion: Automated Suspicion, Big Data, and Policing	Joh, Elizabeth E.	2016
The Internet of Things and the Fourth Amendment of Effects	Ferguson, Andrew Guthrie	2016
The Inadequate, Invaluable Fair Information Practices	Hartzog, Woodrow	2016
Surveillance by Algorithm: The NSA, Computerized Intelligence Collection, and Human Rights	Margulies, Peter	2016
Rethinking the Fourth Amendment in the Age of Supercomputers, Artificial Intelligence, and Robots	Reid, Melanie	2016
Putting Data Benefits in Context: A Response to Kift and Nissenbaum	Maldoff, Omer, GabeTene	2016
Privacy and Accountability in Black-Box Medicine	Ford, W. Nicholson II, Roger AllanPrice	2016
Little Things and Big Challenges: Information Privacy and the Internet of Things	Brill, Scott, HillaryJones	2016
LAW, PRIVACY & TECHNOLOGY COMMENTARY SERIES: PROTECTING ONE'S OWN PRIVACY IN A BIG DATA ECONOMY	Allen, Anita L	2016
Averting Robot Eyes	Kaminski, Cindy M., Margot E.Rueben, MatthewSmart, William D.Grimm	2016
The Personalization Puzzle	Cavender, Brittainy	2017
The MADCOM Future	Chessen, Matt	2017
The Impact of Emerging Information Technologies on the Employment Relationship: New Gigs for Labor and Employment Law	Dau-Schmidt, Kenneth G.	2017
Confidentiality Creep and Opportunistic Privacy	Levine, David S.	2017
Alexa, Do You Have Rights: Legal Issues Posed by Voice-Controlled Devices and the Data They Create	Boughman, Michael V., EricKohut, Sara Beth A. R.Sella-Villa, DavidSilvestro	2017

Table 45 - Screened-in Articles in Use of Force (51)		
Title	**Author**	**Year**
ACCELERATING AI	McGinnis, John O	2010
Do Androids Dream: Personhood and Intelligent Artifacts	Hubbard, F. Patrick	2010
Out of the Loop: Autonomous Weapon Systems and the Law of Armed Conflict	Schmitt, Jeffrey S., Michael N.Thurnher	2012
The Right to Bear (Robotic) Arms	Terzian, Dan	2012

Understanding the Loop: Regulating the Next Generation of War Machines	Marra, Sonia K., William C.McNeil	2013
Autonomous Weapons and Human Responsibilities	Beard, Jack M.	2013
Autonomous Weapons Systems: A Coming Legal Singularity	Kastan, Benjamin	2013
The Challenge to Autonomous Lethal Robotics to International Humanitarian Law	Grut, Chantal	2013
ABHOR A VACUUM: THE STATUS OF ARTIFICIAL INTELLIGENCE AND AI DRONES UNDER INTERNATIONAL LAW *	Weaver, John F	2013
The Future of the Law of Armed Conflict: Ostriches, Butterflies, and Nanobots	Jensen, Eric Talbot	2013
Autonomous Weapons and Accountability: Seeking Solutions in the Law of War	Cass, Kelly	2014
Beyond Skynet: Reconciling Increased Autonomy in Computer-Based Weapons Systems with the Laws of War	Kovach, Christopher M.	2014
The Killer Robots Are Here: Legal and Policy Implications	Crootof, Rebecca	2014
The Dehumanization of International Humanitarian Law: Legal, Ethical, and Political Implications of Autonomous Weapon Systems	Wagner, Markus	2014
Stopping killer robots	Gubrud, M.	2014
Is Johnny Five Alive or Did It Short Circuit: Can and Should an Artificially Intelligent Machine Be Held Accountable in War Or Is It Merely a Weapon	Gevers, Aaron	2014
Automated Warfare	Lucas, George R. Jr.	2014
Building the Ethical Cyber Commander and the Law of Armed Conflict	Prescott, Jody M.	2014
A Human Touch	Saxon, Dan	2014
INTERNATIONAL REGULATION OF EMERGING MILITARY TECHNOLOGIES: AUTONOMOUS ROBOTIC WEAPONS: LETHAL AUTONOMOUS WEAPONS AND JUS AD BELLUM PROPORTIONALITY	Roff, Heather M	2015
Proportionality and Autonomous Weapons Systems	van den Boogaard, J.	2015
War Torts: Accountability for Autonomous Weapons	Crootof, Rebecca	2015
The Debate over Autonomous Weapons Systems	Noone, Diana C., Gregory P.Noone	2015
The Equilibrium of Violence: Accountability in the Age of Autonomous Weapons Systems	Hood, Joel	2015
Self-Defense against Robots and Drones	Froomkin, P. Zak, A. MichaelColangelo	2015
Artificial Intelligence and Robot Responsibilities: Innovating Beyond Rights	Ashrafian, H.	2015
Of Souls, Spirits and Ghosts: Transposing the Application of the Rules of Targeting to Lethal Autonomous Robots	Krupiy, T.	2015
Algorithmic Choice and Superior Responsibility: Closing the Gap between Liability and Lethal Autonomy by Defining the Line between Actors and Tools	Reitinger, Nathan	2015
Liability for damages caused by artificial intelligence	Cerka, P. and Grigiene, J. and Sirbikyte, G.	2015
Defining the Emerging Notion of Meaningful Human Control in Weapon Systems	Chengeta, Thompson	2016
Stopping 'Killer Robots': Why Now Is the Time to Ban Autonomous Weapons Systems	Sauer, Frank	2016
Why the Hurry to Regulate Autonomous Weapon Systems - But Not Cyber-Weapons	Anderson, Kenneth	2016
Setting the Stage: Autonomous Legal Reasoning in International Humanitarian Law	Hollis, Duncan B.	2016
False Rubicons, Moral Panic, & Conceptual Cul-De-Sacs: Critiquing & Reframing the Call to Ban Lethal Autonomous Weapons	Jenks, Chris	2016
Accountability and Autonomous Weapons: Much Ado about Nothing	Dunlap, Charles J. Jr.	2016

Manhatten_Project.exe: A Nuclear Option for the Digital Age	Laton, David T.	2016
The Economic Calculus of Fielding Autonomous Fighting Vehicles Complaint with the Laws of Armed Conflict	Wallach, Erik, EvanThomas	2016
The New Surveillance Discretion: Automated Suspicion, Big Data, and Policing	Joh, Elizabeth E.	2016
Accountability Gap: Autonomous Weapon Systems and Modes of Responsibility in International Law	Chengeta, Thompson	2016
A Meaningful Floor for Meaningful Human Control	Crootof, Rebecca	2016
Autonomous Weapons and International Humanitarian Law or Killer Robots are Here: Get Used to It	Harris, Shane	2016
Centaur Warfighting: The False Choice of Humans vs. Automation	Scharre, Paul	2016
Complications of a Common Language: Why It Is So Hard to Talk about Autonomous Weapons	Ekelhof, Merel A. C.	2017
Autonomous Weapons and International Law	Ford, Christopher M.	2017
The MADCOM Future	Chessen, Matt	2017
Autonomous weapon system: Law of armed conflict (LOAC) and other legal challenges	Sehrawat, V.	2017
Accountability and Decision Making an Autonomous Warfare: Who Is Responsible	Guiora, Amos N.	2017
Averting the Moral Free-for-All of Autonomous Weapons	Jenkins, Ryan	2017
At the Crossroads of Control: The Intersection of Artificial Intelligence in Autonomous Weapon Systems with International Humanitarian Law	Schuller, Alan L.	2017
Lethal Autonomous Weapons Systems: Adapting to the Future Unmanned Warfare and Unaccountable Robots	Warren, Alek, AidenHillas	2017
Private Security Robots, Artificial Intelligence, and Deadly Force	Joh, Elizabeth E.	2017

Table 46 - Screened-in Articles in Safety and Certification

Title	Author	Year
Professional Malpractice and the Unauthorized Practice of Professions: Some Legal and Ethical Aspects of the Use of Computers as Decision-Aids	Willick, Marshall S.	1986
Artificial intelligence and administrative discretion - Implications for public administration	Barth, T. J. and Arnold, E.	1999
Liberty, Justice, and Legal Automata	Lauritsen, Marc	2012
New Technology - Old Law: Autonomous Vehicles and California's Insurance Framework	Peterson, Robert W.	2012
The Potential Regulatory Challenges of Increasingly Autonomous Motor Vehicles	Wood, John, Stephen P.Chang, JesseHealy, ThomasWood	2012
Automated Vehicles Are Probably Legal in the United States	Smith, Bryant Walker	2013
The Great Disruption: How Machine Intelligence Will Transform the Role of Lawyers in the Delivery of Legal Services	McGinnis, Russell G., John O.Pearce	2013
Vehicle: Chapter 570: Chapter 570: Paving the Way for Autonomous Vehicles	Lenth, Danielle	2013
Black-Box Medicine	Price, W. Nicholson II	2014
Bargaining in the Shadow of Big Data	Stevenson, Nicholas J., DruWagoner	2015

Driving into the Unknown: Examining the Crossroads of Criminal Law and Autonomous Vehicles	Gurney, Jeffrey K.	2015
Preparing Financial Regulation for the Second Machine Age: The Need for Oversight of Digital Intermediaries in the Futures Markets	Scopino, Gregory	2015
A Survey of Legal Issues Arising from the Deployment of Autonomous and Connected Vehicles	Crane, Bryce C., Daniel A.Logue, Kyle D.Pilz	2016
Analysis of the Legal Status of Unmanned Commercial Vessels in U.S. Admiralty and Maritime Law	Chwedczuk, Michal	2016
Autonomous Vehicle Regulation: How an Uncertain Legal Landscape May Hit the Brakes on Self-Driving Cars	Brodsky, Jessica S.	2016
Fintech and Disruptive Business Models in Financial Products, Intermediation and Markets - Policy Implications for Financial Regulators	Chiu, Iris H-Y	2016
Privacy and Accountability in Black-Box Medicine	Ford, W. Nicholson II, Roger AllanPrice	2016
Regulating by Robot: Administrative Decision Making in the Machine-Learning Era	Coglianese, David, CaryLehr	2016
30TH ANNIVERSARY COMMEMORATIVE ISSUE: ARTICLE: Can Robots Be Lawyers? Computers, Lawyers, and the Practice of Law	Remus, Dana Levy, Frank	2017
30TH ANNIVERSARY COMMEMORATIVE ISSUE: RESPONSE ESSAY: Robots Versus Lawyers: A User-Centered Approach	Rostain, Tanina	2017
Advisory Nonpreemption	Light, Sarah E.	2017
Confidentiality Creep and Opportunistic Privacy	Levine, David S.	2017
Dr. Robot	Bambauer, Jane R.	2017
Fast & Furious: The Misregulation of Driverless Cars	Pearl, Tracy Hresko	2017
Opening the Door to Self-Driving Cars: How Will This Change the Rules of the Road	Pearah, Paul J.	2017
Regulating Black-Box Medicine	Price, W. Nicholson II	2017
Regulating Robo Advice Across the Financial Services Industry	Baker, Tom Dellaert, Benedict GC	2018

Appendix 7 – Definitions of Autonomous Weapon Systems

U.S. Department of Defense [958]

Autonomous weapon system: A weapon system that, once activated, can select and engage targets without further intervention by a human operator. This includes human-supervised autonomous weapon systems that are designed to allow human operators to override operation of the weapon system, but can select and engage targets without further human input after activation.

Semi-autonomous weapon system: A weapon system that, once activated, is intended to only engage individual targets or specific target groups that have been selected by a human operator. This includes:

Semi-autonomous weapon systems that employ autonomy for engagement-related functions including, but not limited to, acquiring, tracking, and identifying potential targets; cueing potential targets to human operators; prioritizing selected targets; timing of when to fire; or providing terminal guidance to home in on selected targets, provided that human control is retained over the decision to select individual targets and specific target groups for engagement.

"Fire and forget" or lock-on-after-launch homing munitions that rely on TTPs to maximize the probability that the only targets within the seeker's acquisition basket when the seeker activates are those individual targets or specific target groups that have been selected by a human operator.

U.K. MOD [959]

Automated System	In the unmanned aircraft context, an automated or automatic system is one that, in response to inputs from one or more sensors, is programmed to logically follow a pre-defined set of rules in order to provide an outcome. Knowing the set of rules under which it is operating means that its output is predictable.
Autonomous System	An autonomous system is capable of understanding higher level intent and direction. From this understanding and its perception of its environment, such a system is able to take appropriate action to bring about a desired state. It is capable of deciding a course of action, from a number of alternatives, without depending on human oversight and control, although these may still be present. Although the overall activity of an autonomous unmanned aircraft will be predictable, individual actions may not be.

[958] DOD, Directive 3000.09. 2012.
[959] MOD. 2011.

Autonomous systems will, in effect, be self-aware and their response to inputs indistinguishable from, or even superior to, that of a manned aircraft. As such, they must be capable of achieving the same level of situational understanding as a human. This level of technology is not yet achievable and so, by the definition of autonomy in this JDN, none of the currently fielded or in-development unmanned aircraft platforms can be correctly described as autonomous. As computing and sensor capability increases, it is likely that many systems, using very complex sets of control rules, will appear and be described as autonomous systems, but as long as it can be shown that the system logically follows a set of rules or instructions and is not capable of human levels of situational understanding, then they should only be considered to be automated.

Human Rights Watch [960]

Robotic weapons, which are unmanned, are often divided into three categories based on the amount of human involvement in their actions:

- Human-in-the-Loop Weapons: Robots that can select targets and deliver force only with a human command;
- Human-on-the-Loop Weapons: Robots that can select targets and deliver force under the oversight of a human operator who can override the robots' actions; and
- Human-out-of-the-Loop Weapons: Robots that are capable of selecting targets and delivering force without any human input or interaction.

In this report, the terms "robot" and "robotic weapons" encompass all three types of unmanned weapons, in other words everything from remote-controlled drones to weapons with complete autonomy. The term "fully autonomous weapon" refers to both out-of-the-loop weapons and those that allow a human on the loop, but that are effectively out-of-the-loop weapons because the supervision is so limited.3 A range of other terms have been used to describe fully autonomous weapons, including "lethal autonomous robots" and "killer robots."

Fully autonomous weapons, which are the focus of this report, do not yet exist, but technology is moving in the direction of their development and precursors are already in use. Many countries employ weapons defense systems that are programmed to respond automatically to threats from incoming munitions. Other precursors to fully autonomous weapons, either deployed or in development, have antipersonnel functions and are in some cases designed to be mobile and offensive weapons. Militaries value these weapons because they require less manpower, reduce the risks to their own soldiers, and can expedite response time. The examples described in this report show that a number of countries, most notably the United States, are coming close to producing the technology to make complete autonomy for robots a reality and have a strong interest in achieving this goal.

[960] Docherty. 2012.

International Committee of the Red Cross [961]

Any weapon system with autonomy in its critical functions—that is, a weapon system that can select (search for, detect, identify, track or select) and attack (use force against, neutralize, damage or destroy) targets without human intervention.

Center for a New American Security [962]

From a more technical perspective, the following definitions offer a clearer way forward:

- An autonomous weapon system is a weapon system that, once activated, is intended to select and engage targets where a human has not decided those specific targets are to be engaged.
- A human-supervised autonomous weapon system is a weapon system with the characteristics of an autonomous weapon system, but with the ability for human operators to monitor the weapon system's performance and intervene to halt its operation, if necessary.
- A semi-autonomous weapon is a weapon system that incorporates autonomy into one or more targeting functions and, once activated, is intended to only engage individual targets or specific groups of target that a human has decided are to be engaged.

Rebecca Crootof [963]

Levels of automation

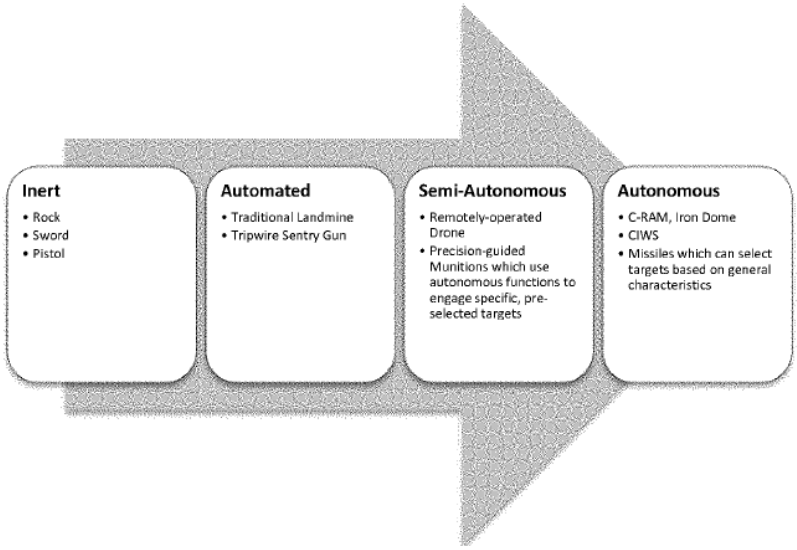
- "inert weapon," as they are all objects requiring contemporaneous operation by a human being to be lethal.
- "Automated" weapon systems are purely reactive; although they may be deployed long before they engage a target, they merely follow commands or preprogrammed rules, without employing gathered information or algorithmic calculations to draw independent conclusions about how to react.
- Semi-autonomous weapon systems have some autonomous capabilities, which may include functions relevant to target selection and engagement, but they cannot independently both select and engage targets.
- Finally, autonomous weapon systems are capable of selecting and engaging targets based on conclusions derived from gathered information and preprogrammed constraints, without any contemporaneous decisional support by a human being.

[961] Davison. 2018.

[962] Paul Scharre & Michael C. Horowitz, *An Introduction to AUTONOMY in WEAPON SYSTEMS*, Center for a New American Security (2015), *available at* https://s3.amazonaws.com/files.cnas.org/documents/Ethical-Autonomy-Working-Paper_021015_v02.pdf?mtime=20160906082257.

[963] Crootof, CARDOZO L. REV., (2014).

Fig. 1: Levels of Autonomy



Continuum of weapon systems automation [964]

- Fire and forget
  - Do not require further operator guidance or involvement after launch. Missiles with guidance systems.
  - It is thus not surprising that the primary U.S. military regulation that establishes "guidelines designed to minimize the probability and consequences of failures in autonomous and semi-autonomous weapon systems that could lead to unintended engagements" is specifically made applicable to "guided munitions that can independently select and discriminate targets. 3
  - Because a human makes the ultimate decision to launch advanced guided munitions at targets, these weapons are often excluded from many discussions of autonomous killing machines.
- Autonomous defense systems
  - Weapons that not only have their own sensory, movement, and attack capabilities after launch, but also have the power (once activated) to decide which targets will be attacked and then act on that "decision."
  - encompass a variety of guard, sentry, barrier, onboard, and point defense weapon systems, many of which are used in the static defense of manned platforms.
  - Anti-personnel landmines. Once these weapons are activated and put in place by humans, they have their own crude but effective sensors, identify and select the targets within their sensor range, and then attack those targets on their own (although humans still play a key role in target selection by placing and then activating the mines in a particular, stationary location).
  - The Phalanx consists of a radar-guided Gatling gun mounted on a swiveling base and is "capable of autonomously performing its own search, detect, evaluation,

[964] Beard, GEO. J. INT'L L., (2013).

track, engage and kill assessment functions." The human is certainly part of the decision making but mainly in the initial programming of the robot. During the actual operation of the machine, the operator really only exercises veto power, and a decision to override a robot's decision must be made in only half a second, with few willing to challenge what they view as the betterjudgment of the machine

- Autonomous combatant systems
    - deployment of mobile, autonomous, combatants that will replace many humans on and above battlefields and at sea. Potentially none exist.
    - some UAV already possess autonomous attack capabilities, at least against certain types of ground targets. For example, Israel has built and deployed a hunter-killer UAV variant (called the Harpy-2) that autonomously loiters over battlefields and is able to suppress enemy air defenses without human intervention by self-destructing into them.

Peter Asaro [965]

It is also necessary to refine the notion of an autonomous weapon system. For now it is sufficient to define the class of autonomous weapon systems as any automated system that can initiate lethal force without the specific, conscious, and deliberate decision of a human operator, controller, or supervisor.

Mark Gubrud [966]

A system is autonomous if it is operating without further human intervention.

Jeroen van den Boogaard [967]

Difference between automated and autonomous weapons

Automated weapons are able to fire when their sensors detect a target, whereas autonomous weapons systems are moreover able to select their targets.

Kelly Cass [968]

Thus, in general, an autonomous weapon is a machine capable of sensing and manipulating its surroundings with limited to no human control.

[965] Asaro, INTERNATIONAL REVIEW OF THE RED CROSS, (2012).
[966] Mark Gubrud, *Autonomy without Mystery: Where do you draw the line?*(2014), *available at* http://gubrud.net/?p=272.
[967] van den Boogaard, JOURNAL OF INTERNATIONAL HUMANITARIAN LEGAL STUDIES, (2015).
[968] Cass, LOY. LAL REV., (2014).

Autonomous functions of a weapon system [969]

*IV – **Fully automated** – Operative without the need for human interaction in any function*				
Examples	**Observe**	**Orient**	**Decide**	**Act**
Level IV systems do not yet exist.	Computer gathers data without direction. Provides no information to a human controller. What is observed is unpredictable.	Computer analyzes data without any human input or report to a human controller. Computer analysis is unseen and unpredictable.	Computer ranks targets and determines where and when to engage. Targeting is unseen and unpredictable.	Computer decides when and where to execute. Actions are potentially unpredictable in time and space.

*III – **Largely automated** – Inoperative without human interaction in some functions*				
Examples	**Observe**	**Orient**	**Decide**	**Act**
Phalanx; Patriot in Automatic Mode; Israeli "Harpy" Counter-Radar System	Computer automatically gathers data based on previously established criteria. Observation is predictable. Information may be provided to human controller.	Computer analyzes data utilizing previously established criteria but without any contemporaneous human input. Analysis is predictable.	Computer ranks targets and determines where and when to engage within previously established parameters. Targeting is predictable.	Computer decides to execute based on previously established parameters. Actions are generally predictable in time and space.

*II – **Automated in many functions** – Inoperative without human interaction in most functions*				
Examples	**Observe**	**Orient**	**Decide**	**Act**
Phoenix over-the-horizon missile; Paladin artillery; Cruise missiles; MIA2 Abrams tank	Computer gathers data at human controller direction. Provides simultaneous information to human controller.	Computer analyzes data utilizing previously established criteria. Contemporaneous human input is present. Analysis is predictable.	Computer ranks targets, but human approval is required. Contemporaneous human input is present. Targeting is predictable.	Computer suggests execution and executes after human approval. Human is shadow for contingencies.

*I – **Little to no automation** – Inoperative without human interaction in all functions*				
Examples	**Orient**	**Orient**	**Decide**	**Act**
Short-range artillery (e.g., M114 155mm howitzer)	Information is primarily directed and gathered by human controller. Computer gathers raw information for human controller.	Human controller analyzes data with assistance from computer systems.	Human ranks targets and determines where and when to engage.	Computer executes on human command.

[969] Ford, (2017).

Airforce Research Laboratory [970]

Level	Level Descriptor	Observe Perception/Situational Awareness	Orient Analysis/Coordination	Decide Decision Making	Act Capability
10	Fully Autonomous	Cognizant of all within Battlespace	Coordinates as necessary	Capable of total indepenance	Requires little guidance to do job
		Battlespace inference - Intent of self and others	Strategic group goals assigned	Distributed tactical group planning	Group accomplishment of strategic goal with
9	Battlespace	(allies and foes).		Individual determination of tactical goal	no supervisory assistance
	Swarm	Complex/Intense environment - on-board tracking	Enemy strategy inferred	Individual task planning/execution	
	Cognizance			Choose tactical targets	
8		Proximity inference - Intent of self and others	Strategic group goals assigned	Coordinated tactical group planning	Group accomplishment of strategic goal with
	Battlespace	(allies and foes)		Individual task planning/execution	minimal supervisory assistance
	Cognizance	Reduced dependance upon off-board data	Enemy tactics inferred	Choose targets of opportunity	(example: go SCUD hunting)
			ATR		
7		Short track awareness - History and predictive battlesp	Tactical group goals assigned	Individual task planning/execution to meet goals	Group accomplishment of tactical goal with
	Battlespace	data in limited range, timeframe, and numbers	Enemy trajectory estimated		minimal supervisory assistance
	Knowledge	Limited inference supplemented by off-board data			
6	Real Time		Tactical group goals assigned	Coordinated trajectory planning and execution to meet	Group accomplishment of tactical goal with
	Multi-Vehicle	Ranged awareness - on-board sensing for long range,	Enemy location sensed/estimated	goals - group optimization	minimal supervisory assistance
	Cooperation	supplemented by off-board data			
					Possible close air space separation (1-100 yds)
5	Real Time	Sensed awareness - Local sensors to detect others,	Tactical group plan assigned	On-board trajectory replanning - optimizes for	Group accomplishment of tactical plan as externally
	Multi-Vehicle	Fused with off-board data	RT Health Diagnosis; Ability to compensate for most	current and predictive conditions	assigned
	Coordination		failures and flight conditions; Ability to predict onset of	Collision avoidance	Air collision avoidance
			failures (e.g. Prognostic Health Mgmt)		Possible close air space separation (1-100 yds) for
			Group diagnosis and resource management		AAR, formation in non-threat conditions
4		Deliberate awareness - allies communicate data	Tactical plan assigned	On-board trajectory replanning - event driven	Self accomplishment of tactical plan as externally
	Fault/Event		Assigned Rules of Engagement	Self resource management	assigned
	Adaptive		RT Health Diagnosis; Ability to compensate for most	Deconfliction	
	Vehicle		failures and flight conditions - inner loop changes		
			reflected in outer loop performance		Medium vehicle airspace separation (100's of yds)
3	Robust Response	Health/status history & models	Tactical plan assigned	Evaluate status vs required mission capabilities	Self accomplishment of tactical plan as externally
	to Real Time		RT Health Diag (What is the extent of the problems?)	Abort/RTB if insufficient	assigned
	Faults/Events		Ability to compensate for most control failures and		
			flight conditions (i.e. adaptive inner-loop control)		
2		Health/status sensors	RT Health diagnosis (Do I have problems?)	Execute preprogrammed or uploaded plans	Self accomplishment of tactical plan as externally
	Changeable		Off-board replan (as required)	in response to mission and health conditions	assigned
	Mission				
1	Execute	Preloaded mission data			
	Preplanned	Flight Control and Navigation Sensing	Pre/Post Flight BIT	Preprogrammed mission and abort plans	Wide airspace separation requirements (miles)
	Mission		Report status		
0	Remotely	Flight Control (attitude, rates) sensing	Telemetered data	N/A	Control by remote pilot
	Piloted	Nose camera	Remote pilot commands		
	Vehicle				

[970] Bruce T. Clough, Metrics, Schmetrics! How The Heck Do You Determine A UAV?s Autonomy Anyway? (Air Force Research Laboratory 2002).

Appendix 8 – Standards for Meaningful Human Control

Paul Scharre [971]

1. **The human as essential operator:** The weapon system cannot accurately and effectively complete engagements without the human operator.
2. **The human as moral agent:** The human operator makes value-based judgments about whether the use of force is appropriate. For example, the human operator decides whether the military necessity of destroying a particular target in a particular situation outweighs the potential collateral damage.
3. **The human as fail-safe:** The human operator has the ability to intervene and alter or halt the weapon system's operation if the weapon begins to fail or if circumstances change such that the engagement is no longer appropriate.

International Committee for Robot Arms Control [972]

ICRAC hold that the minimum necessary conditions for meaningful control are

1. First, a human commander (or operator) must have full contextual and situational awareness of the target area and be able to perceive and react to any change or unanticipated situations that may have arisen since planning the attack.
2. Second, there must be active cognitive participation in the attack and sufficient time for deliberation on the nature of the target, its significance in terms of the necessity and appropriateness of attack, and likely incidental and possible accidental effects of the attack.
3. Third, there must be a means for the rapid suspension or abortion of the attack.

Article 36 [973]

Delineation of the key elements of human control should be the primary focus of work by the international community. Towards such a process, the following key elements can be proposed:

1. Predictable, reliable and transparent technology;
2. Accurate information for the user on the outcome sought, the technology, and the context of use;
3. Timely human judgement and action, and a potential for timely intervention; and
4. Accountability to a certain standard.

Center for a New American Security [974]

1. Human operators are making informed, conscious decisions about the use of weapons.
2. Human operators have sufficient information to ensure the lawfulness of the action they are taking, given what they know about the target, the weapon, and the context for action.

[971] Scharre, TEMP. INT'L & COMP. LJ, (2016).
[972] ICRAC. 2014.
[973] Article 36. 2016.
[974] Horowitz & Scharre. 2015.

3. The weapon is designed and tested, and human operators are properly trained, to ensure effective control over the use of the weapon.