AI Software in everyday life: A Survey

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Abstract

This paper is a survey of how Artificial Intelligence (AI) has gradually matured into a technology, from pure theory and research. We have briefly reviewed the various streams of AI such as Neural Networks, Fuzzy Logic, Agents, Genetic Algorithms, Natural Language Processing and Knowledge Based Systems. The stress is more on the usage than on the concept itself. Through this paper we show how AI software has already influenced many disciplines and is very much an accepted tool in the industry.

Introduction

Artificial Intelligence (AI) to the layman is all about androids, humanoids and robots. It is about machines going out of control, replacing humanity and world domination. More than anything else, Hollywood seems to raise expectations as far as AI goes. AI seems to be more of a dream rather than reality to most people. This paper is an attempt to change this stereotyped thinking and introduce a more realistic picture of AI.

Artificial Intelligence is more evolutionary than revolutionary. The effects of AI will not be seen as a sudden paradigm shift that will change our lives all at once. Instead we will slowly move to a scenario where AI will be used more and more effectively.

AI is the result of a merge of disciplines as varied as philosophy, mathematics, psychology, neurology, linguistics, computer science and other fields such as genetic engineering and evolutionary sciences. Just as its origins are diverse so is its scope of application. In this respect Thomas Ray quotes:

> The umbrella of Artificial Life is broad, and covers three principal approaches: . . .. "In hardware (e.g., robotics, nanotechnology), in software (e.g., replicating and evolving computer programs), in wetware (e.g., replicating and evolving organic molecules, nucleic acids or others)."

Since its birth during the post-war period (1945-1956), AI has gradually moved out of the exclusive domain of scientists into the more practical domain of engineers. The scientists are more involved with the very challenge of infusing AI; while the engineers are busy putting AI to a more practical use. The wide varieties of applications developed in the last few years indicate the effect of AI in practical life. Today, there seems to be a level of maturity in the field, where sheer curiosity is complemented by practicality. AI and its implications are now being harnessed to change the way software is being developed and used.

If we had to describe AI it would be something along the lines of (excerpts from Russell and Norwig 1995):

> "[The automation of] activities that we associate with human thinking, problem solving, learning…"
> (Bellman 1978)

> "The study of mental faculties through the use of computational models"
> (Charniako and McDermott 1985)

> 'The study of how to make computers do things at which, at the moment, people are better"
> (Rich and Knight 1991)

> "The branch of computer science with the automation of intelligent behavior"
> (Luger and Stubblefield 1993)

To appreciate the AI industry, we reviewed the various technologies that constitute AI. An understanding of this, we believe, will provide insights and help us realize the potential of this growing industry. The emphasis is on what AI is and what AI can do rather than what AI can be. This paper is a survey of AI in terms of various software applications.

Artificial Neural Networks

Artificial Neural Networks are computer programs modeled after the biological neural networks. In order to process vague, noisy, or incomplete information, researchers are turning to biological neural systems as a model for a new computing paradigm. A software

developer may not have enough skills to develop specialized software for disease analysis, for example. In situations, where there is no expert to consult, Artificial Neural Networks can be trained to compensate for the absence of an expert. They have the ability to extract rules and "learn" skills from the data shown to them during training. Artificial neural systems are trained through experience. By experience or training we mean feeding the computer past data.

The following list of applications is edited from (Promised Land Technologies, Inc.):

- Neural Networks are useful in predicting staffing requirements, can be used in criminology and spotting trading patterns.
- Diagnose diseases such as Pulmonary Embolism where x-ray and ventilation-perfusion scans can be fed as data for diagnosis.
- Predict pollution based on the composition of trash coming into an incinerator.
- Predict Sales and Costs or a company's corporate bond rating.
- Appraise Real Estate.
- Predict the outcomes of sporting events.
- Predict Solar Flares.
- Recognize welds which are most likely to fail under stress
- Test beer - Anheuser-Busch identifies the organic contents of its competitor's beer from vapors, with 96% accuracy.
- Predict which prison inmates could benefit from less expensive alternative programs (as applied in Delaware correctional system).

Fuzzy Logic

Fuzzy Logic is a form of knowledge representation suitable for notions that cannot be defined precisely but which depend on their context. It enables computerized devices to reason more like humans. It was specifically designed to mathematically represent uncertainty and vagueness. It provides formalized tools for dealing with the imprecision intrinsic to many problems. For example, if we had to classify the heights of students in a class as short, tall and very tall then there would be no precise boundaries that would define the heights into each of the categories. In such situations fuzzy logic systems prove very effective.

The following list of applications is edited from (Fuzzy Logic Laboratorium Linz, Hagenburg):

- Camera aiming for the telecast of sporting events *(as applied in Omron)*
- Efficient and stable control of car-engines *(as applied in Nissan)*

- Substitution of an expert for the assessment of stock exchange activities *(as applied in Yamaichi, Hitachi)*
- Automatic motor-control for vacuum cleaners with recognition of surface condition and degree of soiling *(as applied in Matsushita)*
- Back light control for camcorders *(as applied in Sanyo)*
- Single button control for washing-machines *(as applied in Matsushita, Hitatchi)*
- Controlling of subway systems in order to improve driving comfort, precision of halting and power economy *(as applied in Hitachi)*
- Improved fuel-consumption for automobiles *(as applied in NOK, Nippon Denki Tools)*
- Prediction system for early recognition of earthquakes *(as applied in Inst. of Seismology Bureau of Metrology, Japan)*
- Medicine technology: cancer diagnosis *(as applied in Kawasaki Medical School)*
- Recognition of handwritten symbols with pocket computers *(as applied in Sony)*
- Recognition of handwriting, objects, voice *(as applied in CSK, Hitachi, Hosai Univ., Ricoh)*

Software Agents

"A piece of software which performs a given task using information gleaned from its environment to act in a suitable manner so as to complete the task successfully. The software should be able to adapt itself based on changes occurring in its environment, so that a change in circumstances will still yield the intended result." (G.W. Lecky-Thompson)

The idea of an agent is that of autonomous software entity that goes around from place to place in a computer or on the Internet collects information and finally returns to its source. The concept is unique in the sense that we are no longer using the resources of any single computer.

Some of the key characteristics of software agents are Autonomy (operate without the direct intervention of humans or others), Social Ability (interact with each other), Reactivity (perceive their environment), Proactivity (exhibit goal-directed behavior by taking the initiative), Temporal Continuity (continuously running processes), Goal Oriented-ness (ability to decide at what task level a given job should be solved at). Some of the fields of application are Mobile Access / Management, Mail and Messaging, Information Access and Management, Collaboration, Workflow and Administrative Management, Electronic Commerce, Adaptive User Interfaces, Systems and Network Management (Hermans 1996).

The following list of products is edited from (Caglayan and Harrison 1997):

- Desktop Agents in Operating Systems: The learning agent *Open Sesame!* in the MacOS and the System Agent in the Windows environment are real time examples of agents in use. They have been used to study user patterns and also computer maintenance cycles.
- Internet Agents: Silk and InfoTicker are Internet agents that help perform multiple searches at the same time. Other agents are used in newspaper services on the web. For example, NewsPage has agents that automatically update news according a user's personal interests. Another one is NewsHound from San Jose Mercury. For business professionals there's InfoSage from IBM that caters to business news.
- Internet Agents—Notifiers, Mobile and Process Automation: AdHound from AdOne is another agent is used for personal notification services. It basically keeps track of schedules and emails the user on the particular day. Telescript agents by ATT PersonalLink services go places and allow secure execution of tasks based on what the user specified tasks are. Edify offers agents in the field of Process Automation where agents are used to process customer requests.

Knowledge Based Systems

Knowledge Based Systems are software that is used to assist in decision-making. More importantly they can be used to automate decision-making. They can be used to exploit rare expertise and also apply it with speed and efficiency. They are often used in conjunction with Fuzzy Logic to help them reason more like humans.

The following list of applications is edited from (Fish, Knowledge Based Systems, Applied Intelligence Ltd, United Kingdom):

- The Inland Revenue uses a KBS to identify suspicious Self-Assessment tax returns, and provide a risk score for every taxpayer.
- General Accident and Eagle Star use a KBS to assess claims for bodily injury, using rules covering anatomical knowledge, case law and building society policy.
- FinCEN (Financial Crimes Enforcement Network of US Department of the Treasury) use a KBS to review databases of large cash transactions to identify potential money laundering, fraud, etc.
- SUVA (Swiss National Accident Insurance Company) uses a KBS to classify companies and calculate the correct accident premiums.
- Still other applications are Diagnosis and Troubleshooting of Devices, Systems of All Kinds including Planning and Scheduling, Financial Decision Making, Knowledge Publishing, Process Monitoring, Control, Design and Manufacturing.

Natural Language Processing

Natural Language Processing (NLP) is the understanding and generating of natural human language by a computer. It can also be considered as a range of computational techniques for analyzing and representing naturally occurring texts at one or more levels of linguistic analysis. This is useful for achieving human-like language processing for a range of tasks or applications. Natural language processing assumes that if we can define the patterns by which we as humans learn language and then describe those patterns to a computer then the computer will understand language.

The following is an edited list of products from (Sun Solutions Catalog, Sun Microsystems Inc., California):

- Advanced Language Translation Operating System (ALT/OS) (by TCC Communications Corporation): ALT/OS is specifically designed for the automatic translation of colloquial (everyday) language. Colloquial language is primarily used on televisions and telephones.
- Delta System (by Eloquent Technology, Inc.): The Delta System is a programming language and interactive environment for natural language processing, with specialized features for speech synthesis.
- InQuizit developed by Inquizit Technologies: Intelligent Text Processing, Inc. (ITP) understands the meaning of plain English text, and retrieves only or all the information requested.
- Instantspeech (by ABLA): Developing advanced speech recognition systems using semantic interpreter and adaptive dialogue.
- LinguistX Platform: The LinguistX Platform automates services that are critical to search and text mining applications and supports 15 languages.
- Power Translator Pro (by Globalink, Inc.): The software, Barcelona translates English to/from French, Italian, German, Spanish, and Portuguese. It is a natural language translation engine that does a complete syntactic and semantic analysis of a sentence, and then synthesizes a translation of the sentence in a different language.

Genetic Algorithms and Evolutionary Software

An evolutionary algorithm is a general term used to describe computer-based problem solving systems that use the principles of natural selection to solve problems. This is done by the creation within a machine of a population of individuals represented by chromosomes, in essence a set of character strings that are analogous to the base-4 chromosomes that we see in our own DNA. The individuals in the population then go through a process of evolution (FAQ on Genetic Algorithms, CMU).

Genetic Algorithms solve two types of problems: single objective and multi-objective problems. In solving a single objective problem, a GA designs many solutions until no further improvement (no increase in fitness) can be achieved or some predetermined number of generations have evolved or when the allotted processing time is complete. The idea is to generate the best solution out of a class of solutions for a given problem. The fittest solution in the final generation is the one that maximizes or minimizes the objective (fitness) function; this solution can be thought of as the GA-recommended choice.

The following applications are edited from (Applications on Genetic Algorithms, Imperial College of Science, London):

- Finance Applications: Models for tactical asset allocation and international equity strategies have been improved with the use of GAs. They report an 82% improvement in cumulative portfolio value over a passive benchmark model and a 48% improvement over a non-GA model designed to improve over the passive benchmark.
- Information Systems: Distributed computer network topologies are designed by a GA, using three different objective functions to optimize network reliability parameters, namely diameter, average distance, and computer network reliability.
- Production/Operation Applications: Genetic Algorithms have been used to schedule jobs in a sequence dependent setup environment for a minimal total tardiness. They provide a collection of satisfactory solutions for a two objective environment (minimizing cell load variation and minimizing volume of inter cell movement), allowing the decision maker to then select the best alternative.

Also a few more applications are edited from (Dasgupta and Michalewicz 1997):

- Architectural and Civil Engineering: Genetic Algorithms have been successfully applied to the Generation of form, Optimization of Composite Structures, Flaw Detection and Management, River Management and Design Methodology.
- Computer Science and Engineering: Here GAs have been successfully used in The Identification and Characterization of Workload Classes, Lossless and Lossy Data Compression, Database Design with Genetic Algorithms, Designing Multiprocessor Scheduling Algorithms, Supervised Concept Learning, Physical Design of VLSI Circuits and the Application of Genetic Algorithms.
- Mechanical and Industrial Engineering: Identifying Mechanical Inclusions, Component Design, Job and Open shop Scheduling.

AI In The Gaming Industry

The Gaming Industry is using more and more AI. It is using AI more and more effectively and creatively.

In games like Quake II, there are significant changes with respect to the previous versions such as Quake 1. The ducking routines used by the characters in the game, for example are better in chasing, searching and firing guns. Quake2 uses what we call "state-based" AI where the state of certain character will change depending on what happens around him. Some of the changes that will be seen in future games are the enemies flocking together to attack, retreating to get reinforcement, or dodging more intelligently and using intelligent ambush tactics.

The same is happening in Flight Simulator games where software planes in games are getting more intelligent in terms of attacking, getting defensive or offensive depending on the weaknesses or strength of their enemies. Aircrafts would simply be told to protect home base and they would accomplish the task. For a game programmer these techniques eliminate the need for us to program the tactics. The planes will simply take care of themselves. (Above passages are excerpted from Generation 5, Artificial Intelligence Repository).

AI In Music

Creativity is being introduced to machines. AI is now being used in the music industry to both compose music and also to transpose existing music. Computers naturally have a difficulty in deciding what music is beautiful and what is cacophony. They require human input to tell them this. However, "Variations" developed by Bruce Jacobs uses genetic algorithms to compose music and decides whether or not it is good on its own. B. Jacob describes how this genetic "ear" works in his "Composing With Genetic Algorithms" paper:

"...The [ear] module is a collection of chromosomes, each of which acts as a data filter that identifies harmonic combinations as "good" or "bad." Before composition begins, the chromosomes are evolved to reflect the musical tastes of the human operator. First, sets of randomly generated ear chromosomes are auditioned on how well they filter material. The evaluation mechanism in this process, as in virtually all other genetic music studies, is a human judge. Musical examples are created and passed through the ear chromosomes, and the human operator assigns weights to chromosomes according to how well they agree with his or her inclinations. Chromosomes with high marks are more likely to reproduce and have their alleles present in the next generation. Successive generations therefore exhibit the best traits of previous generations. Once there is a satisfactory set of filters, the [music creating] process...begins..."

GenJam - or the Genetic Jammer by Al Biles is another interesting software that listens to him play through a device called a pitch-tracker that converts the notes from the trumpet into MIDI notes. The program then improvises on the music using an original set of notes. Biles then tells the program which parts of the song sounded bad. GenJam uses a genetic algorithm based engine to develop its notes and riffs and modifies the bad parts based on the good parts.

Transposition is in many ways even harder than composition due to the nature of the human ear and brain. A "trained" human can distinguish instruments, pick out melodies from bass lines, and hear the differences between the drums and a guitar. With a computer, since everything is represented in 0s and 1s, life becomes a little harder! For a computer to listen to a 4-member rock band playing, and to create 4 written pieces of music to correspond perfectly with the guitar, bass, drums and singer would be an incredible task. (Above passages are excerpted from Generation 5, Artificial Intelligence Repository).

Conclusion

AI in its current state is definitely an efficient tool in the software industry. It allows for a new way of thinking, coding and provides logic for a lot of engineering problems that are currently unsolvable by conventional techniques. It has place in all areas in our lives where automation is possible. At the same time it provides adaptability, dynamism and learning to normally static systems. As AI evolves, our software will tend to be more organic in their behavior. In particular, the goal is to develop systems that act upon or react to patterns in data, in much the same way humans process information. Our dependency on AI will be even more in the near future. What its place in the industry is one more of observation rather than conclusions.

Acknowledgements

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