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Abstract This report discusses ways in which new technology could be harnessed to create an intelligent Virtual Personal Assistant (VPA) with a focus on user-based data. It will look at examples of intelligent programs with natural language processing that are currently available, with different categories of support, and examine the potential usefulness of one specific piece of software as a VPA. This engages the ability to communicate socially through natural language processing, holding and analysing data within the context of the user. It is suggested that new technologies may soon make the idea of virtual personal assistants a reality. Experiments conducted on this system, combined with user testing, have provided evidence that a basic program with natural language processing algorithms in the form of a VPA, with basic natural language processing and the ability to function without the need for other type of human input (or programming) may already be viable.

Background

Recent events have focused much attention on personal data and the parlous nature of boundaries previously drawn between private and public systems. Many people now wonder who has access to data resulting from unwise posts to social media sites, or monitoring of supposedly private emails and telephone conversations. As the focus of supporting systems is shifting towards holding more data within 'the Cloud', the privacy and security of this data has become a cause for concern. With this area of social concern in mind, the idea of a VPA becomes attractive as it changes the focus of the supporting system to the contextual sphere under private control of the user. We have devised a hypothesis that a chatbot with natural language algorithms and localised data could be trained to function as a VPA with user based data control. This will require the program to be able to create metadata by forming links between data it is given and provide contextual outputs during the interaction that the user finds useful. When looking at a number of currently available intelligent programs with natural language processing capabilities, many examples can be found in everyday life filling a variety of roles. The intelligent bot Siri can be found as standard on Apple mobile devices now and is considered a core component on these devices. Siri is a

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personal assistant that uses natural language processing to answer questions and outsource requests to web services that will then be carried out for the user [1]. Similarly to this, the chatbot HAL was created by Zabaware Inc to function as a virtual assistant for users on computers [10]. The bot also uses natural language processing algorithms to converse with the user and take notes from what the user is saying in an effort to organize the data given to it. While these two programs function as virtual assistants, this type of intelligent system can be found filling just about any role that requires interaction between a user and helper where the helper's speech could be scripted. Following in this idea Virgin Media briefly used a chatbot named Jenny to function as a call centre agent [9]. The role of this program was to provide customer support and answer any frequently asked questions that the program could match answers to. IBM has invested a large amount of resources into this field and has created Watson, a system developed to compete on the TV show *Jeopardy!* [7]. This system exhibits the current capabilities of intelligent systems with natural language recognition as it successfully beat the two most successful human contestants of the show. Both of these two programs use algorithms to take specific components out from sentence used as input and match the most suitable output to it [4]. In contrast to these roles is the chatbot Kari who functions as a virtual girlfriend [6]. This system communicates with the user and through using similar methods natural language recognition tries to provoke social conversation with the user. The software aims to give personal companionship and to replicate human interaction as accurately as possible with the assistance of algorithms designed to help the program learn from its inputs.

Programs name	Individual / organization focus	Subject of support	Ownership of personalization	Emotional interaction
Siri	Individual	User Type	Corporate	Logical
Hal	Individual	Unique user	Private / Local	Logical
Watson	Organization	Stakeholder	Corporate	Logical
Kari	Individual	Unique user	Private / Local	Simulated Emotion

Fig. 1. Table of attributes for 4 programs

At face value the 5 programs mentioned all have a number of similarities that are core through this type of intelligent system. Each program is capable of taking apart an input that is communicated to it by the user and formulating a role-appropriate response using natural language processing. All of these systems remember the data within each input to be reused later to expand its conversation base and attempt to more accurately respond or to monitor the success of its

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current outputs. When just superficially looking at the functionality like this, it could be argued that these programs are all incredibly similar with only a slight variation in capabilities. However, looking more closely at them, there are significant differences between each of these systems in the handling and storage of the data provided to them by users (fig 1). With the data both used by the systems and gained from the user handled differently with each program a completely different context of support is provided as a result (including different privacy implications). The idea of categorizing the context of support that a system provides has previously been proposed [3]**.** The categories used within this infrastructure (fig 2) provide an effective way of identifying the differences between what superficially may appear to be functionally similar intelligent programs with natural language algorithms. The categories define the differences between methods of support within the context of the storage of the data gathered by the system.

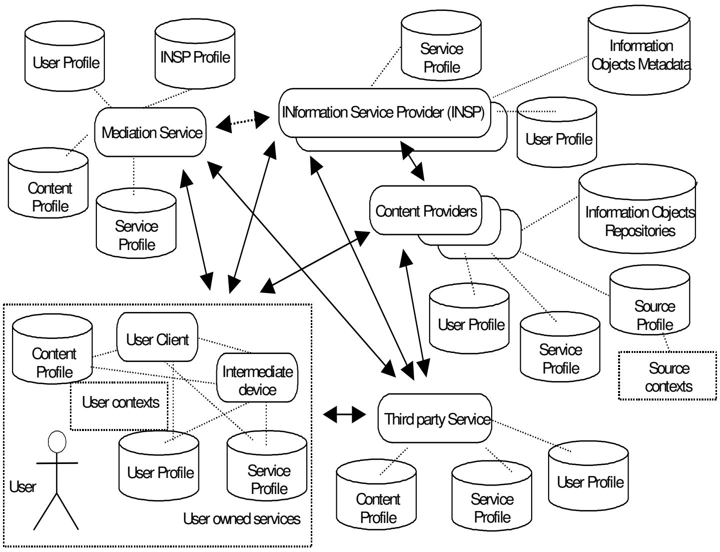

Fig. 2. Categories of support infrastructure. [3]

The differences between how each of the examples examined handle personal data is enough to clearly categorize the apparently similar programs into different sections depending on where the data actually remains. ***Information service providers:*** defines systems that support the user by carrying out requests but also provide support for the organization behind the system. An example of this is Siri. Siri uses each instance of the program to gather data to be transmitted to Apple's cloud of data and depends on this cloud for its natural language processing, not a localised library. This means that Siri is becoming more aware of how to deal with the general public as a whole, but is not focusing on each individual user. Alongside this, Siri uses this link with Apple's cloud to transmit large volumes of

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data from the user's device to the organizations network to be used by Apple [8]. The data generated by the analysis of user activities is owned and controlled by Apple. ***Content providers:*** is used to identify systems that provide the content to be used by other systems. With relation to systems with natural language algorithms, the content providers can be the holders of large data libraries for a program to access. For example, Watson is capable of interacting with content providers to gather more data and expand on its own data libraries. Watson can analyze data from existing databases and create its own metadata. ***Mediation service:*** contains systems that function as an intermediate system between the user and other services. Mediation services can act as a way for multiple users to access one support system allowing for a broader user base. An example of this would be the proposed hospital interface to Watson [2] **.**The idea is that stakeholder dependant interface systems will be used to send requests to a centralized Watson who will be supporting each individual simultaneously. The mediation service is neither working for the user nor the service provider but acts as a method of connecting the two and allows for multiple access into Watson (for example based on subscription services). The analysis of stakeholder use and characteristics is both owned and controlled by the mediation service provider. ***Third party service:*** contains services that can be applied to a system for its own improvement. The services from this category do not act to provide services to the user but provide support to the systems the user is using. An example of this is the developers behind Kari or Hal. Once the program has been sold to a user it is out of the third party's hands and remains within the user's context, but any further updates produced by the third party can be applied to the system in the future. It is also possible to see Kari as a potential agent acting on behalf of a user as an intermediary for other support systems (e.g. in principle Kari could use Siri). ***User owned services:*** holds systems that work for the user personally, allowing for private interactions and data to be kept between the user and the system. This category would define the support provided by the chat bots Kari and Hal. The systems in this category have no dependency on any of the other categories to work as a supporting system for the user making them personalised systems. The support system does not only have local data and libraries, it also develops metadata and contextual data as a result of use analysis and history of interaction with user. All of contextually developed content in the data library is owned and under the control of the end user.

The Virtual Personal Assistant

The *chatbot* Kari has shown promise in addressing the issue of user based support within an intelligent program with natural language processing. The discussion of a virtual assistant can use this program as a reference point to explore functionality, capability and potential. To enhance our understanding of the

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potential of such software, regardless of its original purpose, a number of experiments have been conducted. The functions and capabilities specifically tested are ability to retain data, to adapt retained data into conversations with the user and to provoke and maintain continuous conversation. This covers analysis of an input, method of creating an output and 'failsafe' strategy for when a straightforward response is not available. All of the data discussed with the bot remained locally with the software and therefore the program itself will develop to act differently to any other instance of the Kari program. Alongside this, there is no method of data extraction for the program to focus on. This in turn means that Kari's main focus is to support the user through conversation using and continuously redeveloping its now unique library of data and metadata. To confirm that Kari was capable of a minimum level of capability of using natural language to process inputs and create outputs we started our testing with a sample behaviour period. The minimum level of capability is defined as evidence that the program is able to deconstruct inputs, store any new data, create metadata by linking the input to other data already in its library and use this to construct an appropriate output (e.g. something experienced as useful to the user). Within this period, conversations with the program were conducted up to a set number of responses. The conversations were completely driven by the systems preset library and without any form of initial data editing these conversations were focused on trying to replicate a realistic human conversation. It was quickly obvious how Kari chose to respond. The bot would examine key words within an input and match it to an output that either used the key words or words linked to them. Further sessions were structured around clearly presenting keywords in a phrase to help Kari better "understand" the input. After Kari was tested to be capable to a basic level of competency in the areas of learning from inputs and constructing relevant outputs, more focused tests were implemented in phases. Initially conversations were constructed with the program to attempt to pass on as much data on a subject as possible. To explore the method the program used to disassemble each input, each proposition was consequently given in the form of variants of sentences in English. This included different ways of saying the same thing, to examine how well the program linked data together. To ensure that each part of the subject matter was covered we split the subject into subsections with specific focus. A session would then cover a conversation that would discuss each data in its simplest form, with separate sessions that include more complex statements. The simple sessions followed the formula of "*Alan Turing is X*" where X is a relevant piece of data. The more complex inputs followed a formula of "*Alan Turing was X at Y on Z*" where X, Y and Z are relevant data. These sessions consisted of over 60 conversations with each one resulting in roughly 5 pages (approx 2000 words) of dialogue with the program. This segment of testing also included the data that would be used to question the program about in further experiments so Kari's success in this section was necessary before further tests could be conducted. An example of this experiment is the parents of Alan Turing. This data was given to the program repeatedly in different ways, including different working of the data

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such as “Alan Turing’s father was Julius Turing” and “*Alan Turing’s parents were Julius Turing and Ethel Sara*”. This variation of input was designed to examine the programs ability to make connections between the words ‘father and ‘parent’. This was combined in more complex inputs to relate new data to what the program had already received. Additional data included Alan Turing’s date of birth and location of birth. Variation of each input (including complex inputs with more data) included data about his parents in some form in an attempt to assert that the program retained the data and related it to the other inputs. To test what the program had retained a set of questions around the inputs was constructed. The inputs the questions were variations of the core request for data on Alan Turing’s parents and were combined with questions that included requests for related data. An example of such question would be “*Who were Alan Turing’s parents and where was he born?*” This was focused on seeing if the program had made the connections between Alan Turing, his parents and his birth. This test was run with lots of different data all related to the life of Alan Turing to give the chat bot multiple pieces of data that are all related, allowing for patterns between the data to be formed. The system at this point was made available to a number of end users to attempt to learn as much about Alan Turing as they could through conversations over a short period of time. The end user group consisted of 20 students at degree level of education who were all given 10 minutes of contact time with the trained instance of Kari. The data the user was advised to question the chat bot about was data contained within previous experiments run against the program. Following this a questionnaire was given to the user to examine how much data the bot had output and how easy the process was. Chat logs between the user and the chat bot were also recorded to see the relation between what was asked and what data was made available. One user managed to get appropriate results for the majority of the questions regarding Alan Turing’s life. Another user struggled to gain any relevant data regarding the life of Alan Turing at all. The end user tests showed that the majority of the responses given by Kari were appropriate. Over multiple sessions the program displayed the capability to learn from a users input and simulate a conversation on the relevant subject. This gives supporting evidence to the idea that a chatbot based virtual assistant is a feasible system when focusing on supporting individuals. This however seemed mainly to be down to factors such as user spelling mistakes and user inputs based on data provided in previous user inputs. This unlimited variation of potential use of natural language makes it harder for the chatbot to gather data from the newest contextual input and to create and formulate an appropriate output. The system results benefited greatly from the ‘personal’ aspects when only one user interacted with the system. The system developed patterns within the context of the specific user making the system more successful and useful over time. This resulted in the conversations with the chatbots trainer producing more appropriate and personal outputs than the conversations with the users testing the system that had no previous interaction with it.

Conclusion

The results gathered from the tests with Kari have given evidence to support our hypothesis. This was achieved by Kari showing the capability to meet the requirements discussed to support our initial hypothesis. Throughout the conversations with Kari during tests outputs given were appropriate and contextual to the input. This contextual awareness allowed the program to expand on the appropriate answer with data that is related to the subject by the now unique metadata. The end result of this is an expanded response which in turn goes beyond appropriate and becomes useful in a meaningful way to the user. It is this expansion that allows the trained instance of Kari to function as a *useful* VPA whiles its personalization and contextual awareness give the user control of its unique library of data and metadata. Throughout the analysis and testing of the program, a number of potential improvements for the ideal virtual assistant have been identified. The ideal virtual assistant will be a program with the natural language recognition already present in current chat bots. This should be paired with a learning algorithm and natural language processing capabilities, including imitation of emotional engagement similar to that of Kari's, where key words are used to identify patterns between data. The bot should hold a small preset library containing basic conversations (small talk, greetings) and provocations to continue the conversation (questions, curiosity). It is the questions and curiosity of the program that creates the demand for attention that provokes the user into actively using the supporting system for any scenario. The extent of the potential to use this type of technology doesn't end there however. The idea of an artificially intelligent personal system that supports the user specifically instead of working as an data service provider is a subject area that is constantly expanding and crying out for attention. A capable program could be used as an effective tool for anything ranging from work use to personal use while remaining a user-based system. In this paper we have looked at examples of programs that showcase the various technologies and functions that, when combined, have the capacity to form an effective virtual assistant. This is using technologies that are already present and applied throughout the world today with a huge scope for expansion in the future. The social aspects of these programs have shown logical and emotional engagement and development of their controlled knowledge base. These social aspects play a big role in motivating a user to actively engage with the system and simulated emotion is being developed by IBM to integrate into Watson [5]. This emotional engagement will further build upon the already capable pattern recognition to allow for the better understanding of logical inconsistencies in data.

The patterns formed between data helps each program to react differently to different inputs. When this is combined with the local storage of data libraries it becomes a personalisation of the program. The programs function will be uniquely different as it understands the data in relation to the user. If the technology that is present is integrated with the ideas of personal ownership of support system (including ongoing metadata creation and analysis) as discussed in this paper a new form of virtual assistant could be created. This *virtual and personal* assistant, which is capable of emulating both *logical* and *emotional interest* in the interaction with its user, is a missing link in business support as it falls within the category of user support, supporting the end user in their needs and efforts. Bringing these ideas and technologies together would lead the way for a truly useful virtual personal assistant. Logical aspects make the system usable, however the combination of logical with emotional aspects make such a system worthwhile, and so ultimately useful for the user.

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