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Framework of Perceptive Artificial Intelligence using Natural Language Processing (P.A.I.N)

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Abstract

Artificial Intelligence systems like Expert Systems, Neural Networks have opened new pathways for humans. In real time applications like chat-bots and smart assistants, these systems have exhibited much more expertise in solving problems than human experts would have. Yet there have been shortcomings when it comes to A.I. The time spent in the development and training of such systems is a lengthy process. Also, the ability to imitate human intelligence is far behind than is actually desired. By going through some of the applications in different fields and the way they function would help us understand their limitations. Some of the prominent A.I based technologies like Google Assistant, Siri and Cortana are only about 50-88 per cent efficient when handling user queries. P.A.I.N is a virtual assistant, which has been designed keeping in mind the present scenario and programmed to overcome many of those problems. When completed, we expect take those figures beyond 90 per cent having the advantages of handling complex queries and possibly more abilities with very few inconsistencies. Finally, by listing the practical aspects, we could assess the framework of our system and realize a goal to work toward.

Keywords: Artificial Intelligence, Natural Language Processing, Machine Learning, Expert Systems, Neural Networks

1. Introduction

When it comes to efficient problem solving and data handling, computer systems have been powerful since way back. Even now that the technology is thriving, when we think about it, the power that lies with the machines has grown exponentially. The only thing that stops them from reaching their true potential is the capability to think. If that was somehow possible, they would be able to simplify complex processes and help humans save a lot of time and efforts spent on such tasks.

1.1. The birth of Artificial Intelligence

Classical philosophers used to strive for a way to explain the process of human thinking. There were a lot of different notions which dubbed human nature to be mainly three basic activities which were thinking, feeling and acting. People couldn't actually predict how human reasoning works even though they could envision the process. Understanding human reasoning would pave way for a better future and solve a lot ofproblems. The greatest problem that lied was the inability to handle the enormous amount of data from a brain. Even processing it was difficult mainly because we trailed behind when it came to technology. Even though the term "Artificial Intelligence" was coined in 1955 by John McCarthy and it was later recognized as a discipline in 1956, the work toward development of systems with logical reasoning had already started in the early 1940's [1]. Now with the passage of time modern technologies came into existence which gave rise to new ways we could handle data and this made working on Artificial Intelligence possible. AI is an effort at replicating how human minds think thereby performing

tasks using such a form of reasoning. It allows computer systems to learn with the help of efficient algorithms along with a fast and iterative processing. This allows it to modify its rules and definitions based on which it takes various decisions.

1.2 What qualifies as an AI?

For years programmers and scientist relied on the Turing test to determine if a computer system is capable of thinking like a human being. The Turing test was developed by Alan Turing in 1950 [2]. It was basically a test to ascertain if a machine has the ability to generate responses just as a human would. The test involves an evaluator, a human and a machine. During the test, the evaluator is allowed to interact with both the human and the machine using a textonly mode and decide which one is human. If the evaluator is unable to do so, only then the machine qualifies for an intelligent system just like a human. Since the Turing test didn't pay attention to whether the machines actually possess intelligence, it received a lot of criticism. However in recent years, systems are being developed based on modified versions of Turing test where other aspects of intelligence are also being tested.

1.3 Expert Systems

A computer program which has a knowledge repository and can use logical reasoning to solve complex problems is called a Knowledge-based System (KBS) [4]. Expert systems belong to the class of primitive Knowledge-based Systems but the latter has evolved since then. Expert systems aid in decision making for a human expert. Instead of relying on procedural code, they solve complex problems by reasoning using If-Then rules by referring their knowledge base. These systems were built in a software development environment without any domain-specific knowledge (shells), and thus removing the need for trained programmers [5], [6].

1.4 Natural Language Processing

Natural Language Processing (NLP) is an approach in order to make systems understand humans better. It is an effective way to handle information which may be complex as well as diverse in nature. The system is taught how to handle data that is involved in natural human communication without relying on the input being consistent with programming languages. Instead of using conventional programming techniques, they use machine learning algorithms to achieve tasks like classification, text/speech recognition, prediction, etc. from examples. The domain shares its roots with Machine Learning (ML), Artificial Intelligence (A.I.), Deep Learning, Computer Science and many other related fields [6].

1.5 Neural Networks

The human brain consists of a network of nerve cells, called neurons, which communicate with each other using impulses. These impulses are nothing but short-lived electrical signals from one neuron to other to bring about activities like thinking, waving, etc. Artificially creating such a network by using nodes to achieve similar functioning is known as Artificial Neural Networks (ANN). Instead of using conventional algorithmic techniques, they use parallel distributed computing to achieve tasks like classification, image/speech recognition, prediction, etc. Even though it takes a lot of time and effort to develop an efficient artificial neural networks because of the time spent on developing algorithms however they have great potential. They can learn continuously from examples and exhibit experience when something similar takes place. The training of a neural network requires a whole lot of test data before it can actually exhibit knowledge [6], [18], [19].

2. Existing real world applications

With the advancement of research in fields like Artificial Intelligence (AI) and the Internet of Things (IoT), we have witnessed increase in the usage of computers, mobile phones and related devices. The need for comfort and ease of access has given rise to the intelligent virtual assistants such as Amazon Alexa, Siri, Google Assistant and Microsoft Cortana. These assistants support a number of features like speech recognition, browsing the web and also making use of Natural Language Processing (NLP) to handle to the user input. For those lacking other forms of input mechanism, an audio interface is crucial. We are going to discuss some existing intelligent programs and their limitations when it comes to real world applicability [11]. We will go through each of those virtual assistants

and assess how and why they fall behind when it comes to natural language processing.

2.1 Google Assistant

Relatively new compared to other A.I backed virtual assistants, Google Assistant was released as a segment of Allo (messaging application) in May 2016. Despite being new to the market, it has performed better than its rivals like Cortana, Siri, etc. It also revamped the shortcomings its predecessors faced and worked on it to get the ball rolling [25].

As we can see in Fig.1, even if Google Assistant did well when it comes to carrying out of tasks and responding to user queries, it fails to perform while handling of the gathered data or how it perceives the information it receives. One such case occurred with a person, following up with a question, after having enquired for directions to a restaurant and got a response „10" from an application which Google Assistant had suggested him. It turned out to be one which returns the UV index of the area [22].

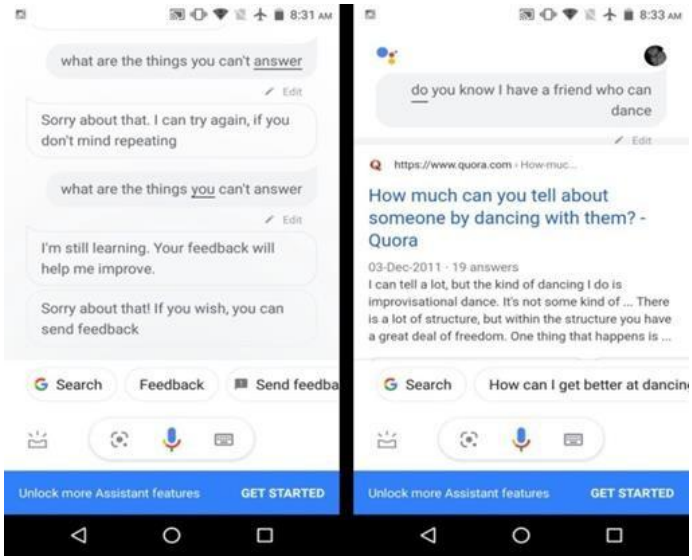

Fig.1. Google Assistant's responses which are out of context

2.2 Siri

Siri was the first virtual personal assistant which became a part of Apple Inc.'s operating systems like iOS, iPadOS, macOS, etc. It was a result of years of research in domains related to Artificial Intelligence (AI) at some point was also a part of the largest-known AI based project in the history of U.S [23], [24]. Although, Siri was introduced in 2007 it"s only in April 2010 that Apple acquired Siri. Later in 2011, Siri debuted as an integral feature which came pre-installed in Apple iPhone 4S. Many wouldn"t know this but an actress/singer, Susan Bennett, was the voice behind Siri which came across as a pioneering technology around that time [23], [24]. It needs to work across multi-platform apps, as required, in order to carry out its tasks. Siri provides a wide range of functionalities like support for extended dictation (users can use this feature to get their voice commands converted to text usually to send e-mails and text messages), to update Facebook status, to share tweets, taking notes, browsing the web and other similar operations. Despite the captivating history, it fails to impress the crowd with its effectiveness in practical situations. According to Digital Personal Assistants accuracy study, Siri was placed at the bottom of the table because of the inability to answer questions at all with only about 40 per cent queries attempted [17].

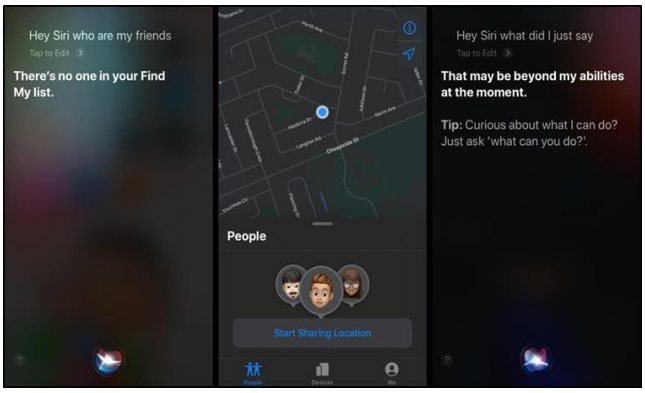

Fig.2. Siri's inability to process basic queries

2.3 Cortana

Back in 2009, engineers Zig Serafin and Larry Heck were already behind curtains working on Cortana. It was only a few years later that it caught the attention of the people when a Lumia phone, enabled with developer mode settings, was accidently sold to a customer. Later in the 2014 Microsoft"s Build developer Conference, Cortana was revealed and later released in the US with Windows Phone 8.1 [12].

Originally, it was designed to function based on progressive prediction in a natural manner. It isn"t unusual that Cortana uses a similar approach, without just relying on standard ways of processing input. The learning curve is gradual as well as iterative, learning about its user and

adjusting to their ways. There are simple things that Cortana might do like assessing a situation to find trends and supplying information even when that was not specifically asked for [16]. Cortana uses natural language interpretation to handle user input and also enquire when needed to provide additional information. Though there have been ongoing research to improve its capabilities, it was found in a Digital Personal Assistants accuracy study conducted by in 2019 that Cortana is capable of answering only about 52 per cent of the user queries correctly [17].

Fig.3. Cortana's responses to basic user inputs

3. P.A.I.N and its components

We are going to talk about a solution to the above problem, faced by artificial agents, which a program is called P.A.I.N. It stands for Perceptive Artificial Intelligence using Natural Language Processing. The emphasis is on an approach to help machines understand humans and help them in preserving their future. In this era, where humans are teaching machines to behave like living beings, it is amazing to find a few lines of code like P.A.I.N which is designed to be intelligent and express what it wants to say rather than what we want to hear. As we can see in Fig. 4, P.A.I.N‟s architecture is similar to an expert system and has mainly four components:

- User
- User Interface
- Inference Engine
- Knowledge Base

We will go through each component and assess their characteristics.

3.1. User

Basically, a user is a person who is responsible for supplying knowledge to the A.I. By methods of interaction like conversation and querying with them, the Inference Engine (another important component) restructures the data acquired into a form that can be used later. Their subjective traits and language skills are crucial for the development of an efficient system on which the users can rely [3]. Now it depends on the type of users with whom P.A.I.N interacts and when supplied with content rich information would also act as an expert system.

3.2. Knowledge Base

The knowledge repository is laid down with facts and building blocks of information which help with all the decisions about a specific query. Using a knowledge-representation approach, the domain-specific knowledge is procured for the knowledge base. The acquired knowledge from various sources like interacting with users, environment variables, internet, etc. is stored in the knowledge base in the form of certain structured statements, which can be retrieved later. The acquisition of knowledge is usually a gradual process [6]. Now, the ultimate use of a knowledge base is problem-solving.

3.3. Inference Engine

The different pre-programmed functions constitute the rules, which are used by the Inference Engine to solve problems. It is fed with an input (statement) belonging to any domain and evaluated based on those rules and conditions [6]. An inference is drawn out, which leads to the generation of the output statement by the expert system.

The inference engine is built into the expert system shell and separate from the knowledge base. This helps in development of the knowledge base independently or simple, when changes are being made to its rules, it doesn‟t need to affect the knowledge base.

Inference Engine can be thought of as an interpreter of the statements being input and identify as well as structure the information from the knowledge base, which helps the expert system to arrive at conclusions. There are a number of ways the Inference Engine arrives at conclusions:

- Forward Chaining: When we are required to arrive at conclusions about an undetermined problem, learning from a known set of data by using some predetermined rules, we use the forward chaining approach. It involves reducing a complex task into simple steps so that it can be performed consecutively or maybe even simultaneously, to make the process much efficient [8]. Forward Chaining is a bottom-up approach as it focuses on adding new information at the lowest level. It makes use of known facts and If-Then rules to progress sequentially and then logically come to a conclusion about a problem.
- Backward Chaining: Another way for an Inference Engine to arrive at conclusions is backward chaining, where the logic behind generation of a result is checked by going one step behind. This approach too uses a known set of solutions but moves away from the goal to determine the set of rules which led to that goal. It is a top-down approach which looks for possible matches in variables in order to come to a intended conclusion.

  An inference may also be made by using both the forward and backward chaining strategies together but the aim remains to bring clarity and enable the expert system to explain the reasoning behind a decision [9].

3.4. User Interface

The only way a user communicates with the expert system is with the help of a user interface, and thereby making it imperative. Expert Systems may use input methods like mouse clicks, menus, keystrokes or other graphical user interface (GUI) to accept inputs and generate results. At a later stage, P.A.I.N may be designed to interact with the user with a microphone, and in those scenarios the interaction with a user isn‟t direct. The A.I will not have a directly intractable user interface in these cases, and will have some sort of interaction mechanism for receiving inputs from other applications [10].

4. Block Diagram

Fig. 4. below shows the main components of the P.A.I.N application system and shows how they interact with each other. The process includes receiving of user input which is then sent to the Inference Engine for processing. The Inference Engine restructures the input and stores it to the database and corresponding information is retrieved from the Knowledge base. The information is presented according to the user's context.

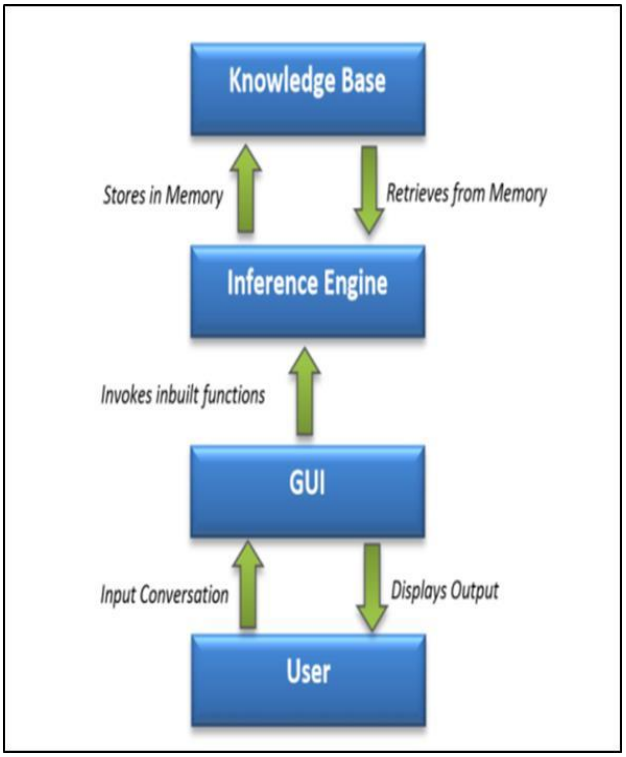

Fig.4. Block Diagram of P.A.I.N

5. Framework

Basically, our research framework considers all the limitations that one might encounter while designing an efficient natural language processing system, and that is why, we aim at keeping things simple. This involves the user communicating with the system using a Graphical User Interface (GUI) and the input being then processed by an inference engine. In this case, the inference engine comprises of pre-designed functions which invoke each other as well as accesses the various files (knowledge base) containing information. The knowledge base can be extended to support cloud storage in the future as this will provide more security as well as integrity. Fig.5. depicts the basic framework of P.A.I.N.

6. Proposed applications

P.A.I.N would fare well when it comes to existing expert systems as well as other intelligent systems like chatbots, personal assistant programs, etc. Its ability to process natural languages and learning capability could be of use

in various fields like Medicine, Military, etc. as it would likely be able to understand humans better.

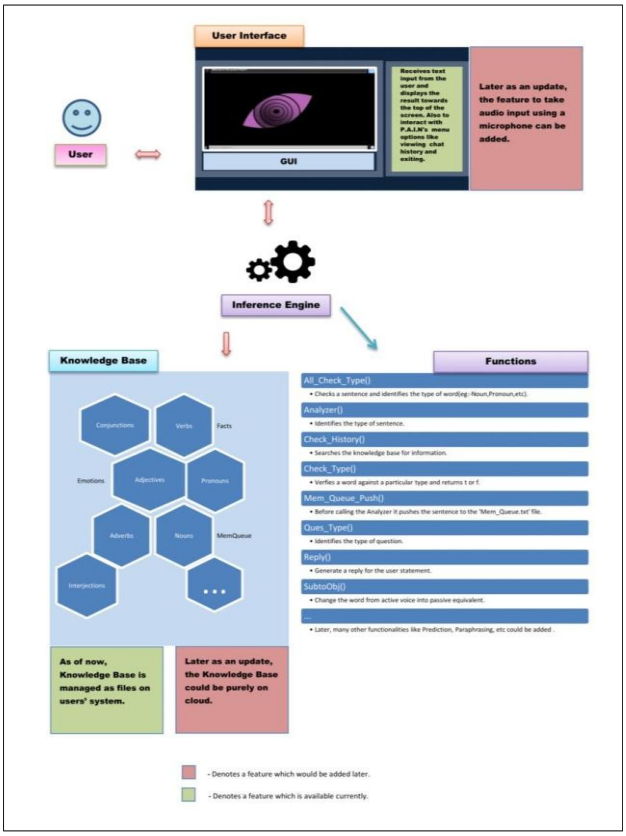

Fig.5.Framework of P.A.I.N

If provided with an expert‟s knowledge, the intelligent system would find its applicability in Psychology with a diverse and subjective response set. With few tweaks and upgrades it could also be connected to the online world which would further extend its potential. At an initial stage, the system would be rolled out as a windows desktop application but soon it would also support multiple platforms like smartphones, web browsers and IOT devices, and have features like inter-operability and portability.

7. Results

Currently, it is too soon and pointless to venture on the topic that how well P.A.I.N does with respect to others. The general aim was not to criticize the shortcomings of these powerful programs but to pave a way for the developers to work towards. By teaching systems to think and giving them human-like qualities, we are already a step closer towards intelligent artificial beings. By adding some basic characteristics to it, the result would be so much more. The motive was to design systems not to answer specific questions with limited answers but to develop systems that would understand words as well as their placement with respect to others. The second most important thing is, to develop generic functions which would be able to focus on controlled randomness. This basically means uncertainty within constraints.

Now, “What will all this lead to?” is an important question and Table 1. should have answered that. In case it isn‟t clear, the end result would be an era of new artificial beings capable of communicating with the humans the way it is meant to. Instead of focussing on what users want to hear, the approach would focus on what the system wants to express.

Table 1. Comparison of various virtually intelligent systems

	Portability	Subjective Responses	Understanding Human Context	Emotional Quotient
Google Assistant	✓	X	X	X
Siri	✓	X	X	X
Bixby	✓	X	X	X
P.A.I.N	✓	✓	✓	✓

* The table represents results which are ideal and possible once the design and development of P.A.I.N is complete.

According to a research conducted by the Nielsen Norman Group in 2018, it became clear that the efficiency rates of artificial intelligent agents are being misrepresented to include results related to simple and primitive queries only. The actual data shows that although there had been steady progress in their performance of virtual agents but theyaren‟t anywhere close to meeting the expectations of the practical world. The study took into consideration various parameters like ability to recognize voice inputs, the processing of Natural language, evaluation of how the results are presented (e.g. voice), interpreting complex information and integration with various technologies and services to be able to come with the solution. Except for correctly representing voice inputs the virtual assistants like Siri, Google Assistant or Alexa failed to show any considerable results [22]. The same has been depicted in

Fig. 6 which makes us realize how work needs to be done towards design of these systems. A framework like P.A.I.N paints an ideal picture where besides being able to process Natural Languages, it would be able link emotions with words. By being able to be able to figure out context will certainly lead to better understand their perspective. Usersshouldn‟t have to adjust to systems‟ understanding rather it should be the other way round.

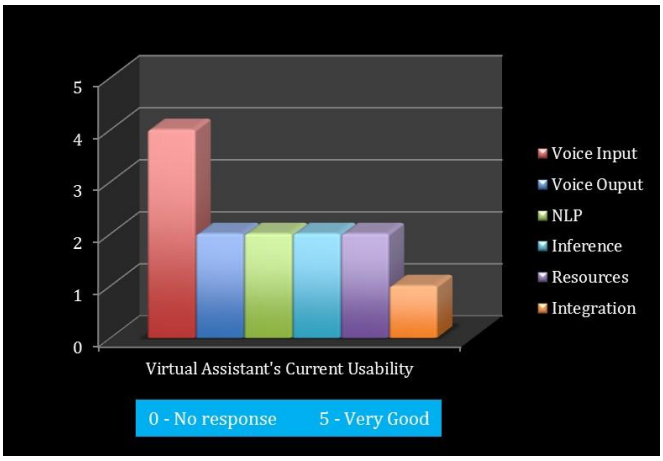

Fig.6.Usability Diagram of P.A.I.N

8. Conclusion

The power these artificially created systems possess is of considerable amount. Their computational power and learning capability have earned them a place in various fields like Military, Psychology, Robotics, etc. P.A.I.N is a leap towards unfathomed potential when it comes to software programs and changes our outlook as to how we perceive them. Since early times, we have admired machines for their abilities but have looked down upon them for their intelligence. P.A.I.N changes that by introducing emotions and consciousness into these machines. Although simple, this approach has its own limitations like time and patience to complete its design. Once that phase is complete, we could only imagine the change that these systems would bring along. We would have created a whole new species of intelligent beings in the end.

9. Future Scope

This framework requires researchers to work further and explore the various goals that can be achieved using this as a foothold. We urge others with similar a mindset to extend the functionalities and work on the limitations if possible.

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