Artificial General Intelligence, Machine Learning and Language

Introduction:
Since the very first programmable computers, the idea of making electronic brains computer intelligences has inspired countless computer scientist to work towards the goal true computer intelligence. With this goal came the field of Artificial Intelligence and in 1956 the first workshop in the field took place and those that attended thought they’d would solve the problem within their generation. What they would soon realize was just how monumental a task AI would be. To this day the solution still hasn’t been found, but work hasn’t stopped and in the last 20 years major developments in the fields of Artificial Intelligence, machine learning and deep learning have put us ever closer to the goal of an artificial mind. I am personally fascinated with the idea of thinking machines and human thought patterns. AI is the most interesting part of science fiction and one day I hope to contribute to make them science reality. My goal with this paper is to discuss some scientific articles on Artificial General Intelligences and related topics. The first part will cover papers relevant to defining Artificial Intelligence, and second part will examine some approaches that I believe are steps in the right direction. I’m positive this generation of computer scientist will be the first to see true Artificial General Intelligences.

Method:
To find the papers and articles I used for this paper, I scoured internet databases to try and find the best articles to present. I focused specifically on Artificial General intelligence, Machine Learning, and Communication. Search terms like Full or Strong AI were used too. After finding several articles and choosing the most relevant ones, I wrote the paper. Trying to contact a professor about language and finding papers on language was more difficult as I’m not even sure where to start. This prevented me for starting to code. I needed a better introduction to language structures for that portion of the project.
Part I:
The first paper and best paper I found was titled *Intelligence and the Intelligent Model* written by Jun-Min Luo a professor at Xi’an Institute of Computer Science and Technology. *Intelligence and the Intelligent Model* discusses the nature of Human Intelligence and how three schools of artificial intelligence can be formed based on human though to create the AORBCO model. The paper defines human thought as three forms of reality that interact with each other through eight varying human consciousness. These consciousnesses are essentially the sense. The three forms of reality consist of two outer worlds, the seed and pattern which represents new situations and old situations respectively and the inner world, where the human mind interacts with reality. The paper then introduces the three schools of Artificial Intelligence, symbolism connectionism and activism. Symbolism represents human intelligence in the forms of the symbols we use; letters words and sentences that define our ideas. Connectionism is the idea of “unity of the whole and its elements” or in more layman’s terms the mind and the senses acting as one. Activism is the cause and effect relation between the senses and the mind itself. The AORBCO model aims to “abstract Human consciousness” into three structures a computer could understand. The paper then covers derives human thought into a potential code structure. The code representation can be seen in figure 1. W(i,t) represents a set of plans, D(i,t) represents a set of goals, and H(i,t) represents a set of experiences. The variable A, O and R represent the agents, objects and relationships respectively. What this code essentially does is to attempt to achieve its goals according to what the main agent already knows but if the goal is unattainable for any reason an attempt to derive a solution occurs. In the case of that failure to derive a new solution another agent is consulted. The paper concludes with the relationships the AORBCO model shares with other research and what else is required to make the AORBCO model more effective. The AORBCO model is a fascinating description of what an Artificial General Intelligence would look. This paper provides an fantastic in-depth mathematical analysis of what an AGI would consist of, the next paper provides a different perspective entirely.

The second paper was titled *Thematic Correlation of Human Cognition and Artificial Intelligence* written by Dr. Sonakshi Ruhela the program head of the Department of Psychology at Amity University Dubai. Dr. Ruhela’s paper is on a study conducted to define the correlation between artificial intelligence and human cognition. Her hypothesis is that a correlation does exist between the two. She tested 5 applied psychology researchers, 5 data scientists and 5 psychology professors with specialization into cognitive psychology, all with 8 or more years of experience in their field. Dr. Ruhela interviewed these experts and statistically analyzed the group for common themes generated in their focus group discussions. What she found were three key concepts surfaced. First, that Artificial intelligence and psychological science are
related in that each discipline generate ideas a precurses similar ideas in the opposing field. There was a particularly strong correlation in the portions relating to vision, regular dialect and language. The second theme consisted of the idea that any manufacturing thinking framework must be based on a well-defined and commonly agreed on thinking framework. Essentially, the mind must be understood before it can be made. The final theme is that a key to cognition and AI is perception. Several subthemes were also noted, the majority of which covered approaches that have already been taken in the past. The conclusion was a little vague and never answered the hypothesis directly. However, the study itself highlighted a correlation between the two disciplines of Artificial Intelligence and psychological sciences and at least a connection between the Human Cognition and Artificial Intelligence so some conclusion can actually be drawn. The third paper analyzes what an application of an Artificial General Intelligence would look like.

The final paper for this portion of the report was titled The application of cognitive artificial intelligence within C4ISR framework for national resilience. It was collaboratively written by Arwin Datumaya Wahyudi Sumari, Adang Suwandi Ahmad and the Cognitive Artificial Intelligence Research Group (CAIRG) at the School of Electrical Engineering and Informatics in Jawa Barat, Indonesia. This paper discusses the application of an artificial intelligence agent with cognitive abilities and what the potentially applications for said agent would be. The article begins with a longwinded introduction covering the government sponsoring the project, what a cognitive agent is, what system the cognitive agent is to be combined with, and the purpose for the combination. The next portion covers the theoretical background of CAIRG’s research starting with what they call the Human inference system or how knowledge grows in a brain. This system consists of sensing ones surrounding and perceiving the resulting situations. Over time this system grows a repository of knowledge in which to base interactions with the environment off of or in which to grow. The paper mathematically defines this system as a probability the input information has been observed and is correctly being observed based on past inputs. A decision is made based on the probability of a hypothesis from the sensor data. The final section of the theoretical portion describes the C4ISR, a network of sensors, stations and devices that is meant to correlate the strength of military forces in a region in real time. The final part of the paper covers the application of their cognition AI involving C4ISR. The AI will sense, decide, and act on situations as they occur using the cognitive model previously discussed. The AI would examine factors such as weather, satellite patterns and equipment locations and use this information to determine response plans such as strike patterns for planes. They conclude the paper with other potential applications and where the research is to head in the future. Due to this paper dealing with government funded military systems it seems to be intentionally vague and less like a research paper and more like a funding proposal. That being said, the probability mathematics are an interesting take on Artificial General Intelligence. Basing decisions on the likely-hood of past situations is in essence what a machine learning algorithm does however it leaves the possibility dealing with unexpected situations.

There’s plenty of papers that discuss approaches to AI, or applications of AI or even alternative approaches to the field so why these three papers? Aside from Artificial intelligence there is not much of an apparent connection between the three. The first is theoretical paper on the
mathematics behind a model of human thought. The second, psychology experiment that was testing whether or not there’s a connection between the Artificial Intelligence field and psychological sciences. The third boils down to what is essentially a project proposal about applying Artificial Intelligence to networks, specifically the military. The quality of the papers aren’t even comparable. The first has the best understanding of what it is trying to explain, and they fall from there. It’s not a paper but a relevant article the was published from speech that provides an excellent point of commonality. The article is titled *Rethinking Artificial Intelligence* and is by Newton Howard, a Professor of Computational Neuroscience and Neurosurgery at the University of Oxford and the Director of the Synthetic Intelligence Lab at the Massachusetts Institute of Technology. In his speech, Professor Howard discusses the current field of AI and how intelligence benchmarks have been previously defined in the field. He continues on to state the future of the field of artificial intelligence will need to reexamine “fundamental assumptions about the nature of the brain, cognition, computing, and intelligence.” Those fundamentals are what relate these papers.

The relationship between the brain and the computer, cognition and intelligence are perhaps the most important concepts in the field of Artificial General Intelligence. In any paper on the subject you’ll find references to those fundamentals in one form or the other. In Intelligence and the Intelligent Model, the whole point of the paper is to define the relationship between human thought and computer thought. The paper uses a model that defines what human cognition and intelligence is. In *Thematic Correlation of Human Cognition and Artificial Intelligence*, the words are essentially in the title. The purpose of the study was to find the relationships between humans’ cognition and computers intelligence. The application of cognitive artificial intelligence within C4ISR framework for national resilience is using an Artificial intelligence based off of a model of human cognition. There’s another commonality associated with cognition and intelligence. There is not one definition, the first paper has a model with three core tenants and twenty-four relations, while the third paper has a model with two, sensing and perceive. These models share two common themes too, an input based on sensors and a reaction based on some knowledge. The second paper doesn’t provide a model, but two of the common themes in the focus groups included correlation between perception and the idea that the mind must be understood be for it can be replicated. The final major commonality between the three articles is the idea of communication in the form of transferring information. In every article, communication is a major theme, the first is communicating human thought patterns in a way a computer can understand. The second shows subthemes from the focus group that on some level deal with communication and the transfer of information. The final paper presents a model based solely on the communication of information and if said information is presented accurately. These three ideas, the importance of cognition and intelligence, the lack of a proper definition and communication of information, are present in any paper on the topic. I choose these first three papers because how objectively different they were yet they still exhibited the same themes. Professor Howard’s speech, even as short as it is, references the three ideas. In the next portion of my paper I hope to highlight the problem with these commonalities and examine some papers that I believe are steps towards the solution of Artificial General Intelligence.
Part II:
The three major commonalities between anything related to Artificial General Intelligence and with the field of Artificial Intelligence as a whole are the importance of cognition and intelligence or the ability for a computer to think, successful communication of information, and the lack thereof a single accepted definition for Artificial Intelligence and cognition. The third immediately presents a problem as it directly contradicts the first. This invalidates what could be argued as the most important concept in the field. To rectify this contradiction, a definition would have to be assigned, but humanity has been arguing about consciousness, cognition, and intelligence for years without success. The solution lies in the argument itself, the second commonality or total communication of information between one instance to another. Without getting too philosophical, to even begin to define intelligence/cognition, we need not only the current state of the being, but the being’s current thoughts on that state. Humans can’t solve the problem with humans because we never truly exactly know what another human is experiencing in relation to us. In the case of computers however, we already have the first part of communication, translated binary strings, that represent the current state of the computer. What is missing is the computers reaction to the environment and a way to communicate said reaction in a way a human can process. Essentially, what we would need is a computer that could communicate thoughts in a way a human does, a computer that can speak our language. The next two articles and paper highlight different approaches being taken to teaching a computer language.

The first article Automated Dialogue Generation written by Christina R. Strong is a project proposal to create a computer that can generate conversations. The focus of this project is not the syntax of sentences but to devise a way to combine sentences in an interesting manner. The project is made for the video game industry to reduce the number of lines game developers must write while increasing the amount of dialogue options and scenarios. The project would use a creative agent and an existing dialogue tree software to generate semi random conversations based of programmed tree structures. This HTN planner allows animations to be executed with dialogue options. In most games this is a linear progression where the player interacts at the branches of the generated tree. In the case of automated dialogue generation, the AI agent would allow for more dynamic scenarios. While not being an academic paper, I felt this would be a good article to include as it highlights an approach to communicating with a computer. Prior to this, an AI in the game when triggered would repeat a phrase written by the developers but this system will allow the AI to formulate a different response. Ex. Wind blows and the AI responds “This is cold.”, that AI could now respond with “I’m cold” or “That wind is cold” without the developers writing each statement. It’s not truly imaginative, but it allows the AI to feel more human and responsive.

The next article is titled User-Aware Conversational Agents written collaboratively by Q. Vera Liao and Michal Shmueli-Scheuer from IBM, Tsung-Hsien (Shawn) Wen from POLYAI at Cambridge, and Zhou Yu at the University of California. Like the prior article, this is a project proposal about a machine learning workshop to create conversational agent. The work shop took multiple categories of submission including but not limited to machine learning algorithms for speech, ways to develop algorithms based of human interactions, and different ways in
which to teach an algorithm. I included this article because it introduced several approaches to conversational agents. I believe machine learning will be instrumental to creating an Artificial General Intelligence. Approaches like developing algorithms based on human interactions or creating new ways to deliver the information to the agent will be key in creating an AI to communicate with. The key approach this article brought up was algorithms that learn from interactions with users. Any form of relevant communication will require a machine learning algorithm that practices with humans.

This final paper titled *Chatbots, Humbots, and the Quest for Artificial General Intelligence* written by Jonathan Grudin and Richard Jacques, Microsoft employees in the data science and AI field respectively. The paper discusses artificial bots made to interact with humans. The paper starts with an introduction to the bot as a program; where bots came from, what they were originally designed and what they’re used for today. Originally back in the 1950’s, they were programs designed to mimic basic human tasks. Today, they’re used for everything like answering calls, sending emails, chatting with live people etc. With the boom in recent years however, the focus of bots especially chat bots have delved into the artificial intelligence field. Machine learning algorithms are being applied to create more affective bots in all areas and success is being made. They still have several problems associated with chat bots however like scalability and sharing information but more specifically with human communication and language. The paper wraps up with some insights into creating and dealing with chat bots and a brief insight from the authors on entering the Artificial Intelligence era. This paper provided an interesting insight to programs that have been attempting to communicate with humans for the last fifty years. It covered the success’s and where these bots worked and highlighted the problems bots still experience and the challenges associated with them. Bots are the first and longest attempt at Artificial General Intelligence and continue to be the frontrunners for its evolution.

**Conclusion:**

Artificial General Intelligence has a long way to go before it becomes a reality. That being said, with the major boom of Artificial intelligence and Machine Learning we get closer to an AGI every day. The biggest problems to solve will be communication and defining what it means to be intelligent. I was surprised by the difficulty I had finding papers on Artificial Intelligence or Machine learning and communication. Before I started I had though this would’ve been a much bigger field of papers to choose from. It seems like more and more of this research has left the scientific field and transitioned into the corporate field. I also had difficulty getting in contact with a language professor. Both slowed the timeline of my project down by a significant bit. In the end though, I still feel like language communication is the area anyone interested in Artificial General Intelligence should focus on. It’s a major theme in every paper I found on the topic of AI and AGI and there should be more research into it. In conclusion, Artificial General Intelligence is on the horizon somewhere, we just have to find a way to speak its language.
References


