Cognitive Computing Dives Into Medical Research

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Abstract

This paper illustrates the use of cognitive computing for new insights into medical research and discoveries. Since the late 20th Century general artificial intelligence and machine learning artificial intelligence have been integrated into the medical field. However, as the medical field continues to expand on its data information and research, it has become too complex for machine learning AI to handle. The vast amounts of data is an issue cognitive computing targets. IBM's supercomputer, Watson, a form of cognitive computing, has been integrated into the medical field, particularly oncology and genetics. The ease of use of Watson in these fields exemplifies how it becomes possible for researchers to focus more on new discoveries using these technologies. Professionals are equipped to find new insights into the genetic makeup of a human by applying cognitive computing to the identification of specific disease-related genes. These methods can be applied to find humans born with or prone to cancer, amongst many other diseases such as Alzheimers. The methods used with cognitive computing opened more doors within medical research; this is a quality that general AI, including machine learning, were not able to achieve. Further research in the medical field with the use of cognitive computing will help find cures for several diseases, including cancer. Overall, it is shown that cognitive computing is more effective than artificial intelligence in supporting new discoveries and insights in medical research.

Cognitive Computing Dives Into Medical Research

Introduction

Technology has grown at a fast rate and caused huge impacts in people's everyday lives and its innovations continue to expand. Technology is a vast subject that branches into several concepts such as artificial intelligence. The innovations made upon artificial intelligence include machine learning AI and cognitive computing. Artificial intelligence runs specific task based algorithms to find patterns and make a decision without human supervision. Machine learning AI performs similar methods of AI but expands its use of more data in convoluted networks of algorithms. Furthermore, cognitive computing is able to query enormous amounts of data to result a collection of accurate results. This computation integrates human judgment to reach an ultimate decision based on the results. Overall, these technologies are made to improve the efficiency of tasks in various fields. Medical research is a vast and important field that integrates technology such as artificial intelligence to improve its insights. Cognitive computing, a new revolutionary form of augmented intelligence is more effective than artificial intelligence in supporting new discoveries and insights in medical research. While artificial intelligence, including machine learning AI, can improve medical research, it is prone to risk of errors, and becomes inefficient when data rapidly expands. Cognitive computing parses through more data than artificial intelligence and humans could. This technology involves professionals in narrowing their duties. Both the analyzation of information and the involvement of human judgement expands medical research.

Background

Artificial intelligence is an important concept in technology. Furthermore, AI contains fundamental subsets of technology such as machine learning and cognitive computing. Nowadays, cognitive computing is the booming new branch of artificial intelligence that continues to develop. This form of computation can be described as “augmented intelligence”. IBM’s Watson is one of the most well known supercomputers that implements cognitive computing. Watson is a complex form of technology that combines artificial intelligence and analytical software to produce a question and answering machine (Chaudhry, 2013). It would take dozens of algorithms and interact with a machine learning framework which then joins to hardware platforms in order to retrieve a correct set of answers (Chaudhry, 2013). The involvement of human judgement is detrimental for cognitive computing. The involvement of human judgment to make a decision leaves less room for error caused by artificial intelligence. Cognitive computing aids professionals parse through extensive amount of data to result with a set of correct answers to help humans construct a final decision. Cognitive computing and artificial intelligence are two important concepts of technology with differences in uses, methods, and efficiency. Even though both technologies make various jobs easier in day to day lives, artificial intelligence itself has its limitations. An artificial intelligence program automatically makes a decision and produces a singular result by using specific task based algorithms. However, this becomes inefficient and inaccurate for various assignments. Specifically, the medical field constantly and rapidly evolves causing the quantity of data to become hard for artificial intelligence alone to handle. Medical research is constantly explored to find innovated solutions such as new medications or treatments for various studies such as oncology. Research in the fields of oncology and genetics is also conducted to find diseases at an early stage. The insights and discoveries in medical research are never-ending.

Precedents and Related Work

Since the 1950s artificial intelligence sparked a technological revolution. Artificial intelligence was targeted to perform tasks the human brain and mind could. Various methods developed for the performance of AI depending on how they carry out assignments. Artificial intelligence relies on algorithms that use data through decision trees, rule-based processes, or clustering methods (Jones, 2017). While the parsing of data can solve many problems, such as playing a chess game, it becomes difficult for a program to perform tasks as the quantity of data grows. Consequently, sub-fields of artificial intelligence emerged. Since the 1980s, machine learning was a major sub fields that greatly advanced. Machine learning bases most of its algorithms on mathematical statistics and optimizations (Jones, 2017). The objectives of expanding artificial intelligence with machine learning is to implement a self learning aspect. This aspect can be supervised, partially supervised, or unsupervised. With machine learning, computer systems can perform various tasks through examples or by analogy to a similar, previously solved task (Carbonell, Michalski, & Mitchell, 1983). Similarly, deep learning improves machine learning, relying on a set of algorithms that implement various networks without supervision (Jones, 2017). As the growth of artificial intelligence rapidly continues, the government realizes its need for regulation. Policies for security, cyber-security, intellectual property rights, privacy, safety, etcetera are ambiguous and at times, impedes with innovation (IEEE-USA, 2017). Ultimately, the government wants and continues to set regulations to both protect public safety while allowing for the progress of artificial intelligence (Felton, 2016).

While these regulations for artificial intelligence are constantly debated and improved upon, the regulations for cognitive computing should be set to a similar but separate collection based on its advanced branches.

Support

While the regulations for cognitive computing should be set to protect public safety, the innovations for artificial intelligence should not be restricted. In 1950, Alan Turing, a mathematician invested in the world of technology, developed the Turing test for artificial intelligence. The test aimed to determine whether a computer can think like the human mind. In 2011, authors Modha, Ananthanarayanan, Esser, Ndirango, Sherbondy and Singh in the *Communications of the ACM* describe the science behind cognitive computing and its future. Defying audience criticism, the authors argue that “cognitive computing aims to develop a coherent, unified, universal mechanism inspired by the mind’s capabilities” (Modha et al., 2011, pg. 62). They further discuss how the human brain functions along with its different aspects and capabilities. Modha et al. demonstrate algorithms they have developed, along with simulations performed on mammals such as rats, cats, and monkeys (Modha et al., 2011, pg. 64). The algorithms developed and tested are useful for describing how similar functions can be implemented within cognitive computing systems. Ultimately, by dissecting their research into the human brain, they aspire to formulate algorithms that will continue to improve cognitive computing.

Algorithms used for cognitive computing

The algorithms made for cognitive computing varies and will continue to formulate. However, a popular and more efficient form of algorithms for cognitive computing are meta-algorithms. These meta-algorithms make other algorithms run faster and return more accurate results. Sellmann, who leads a team of over 40 researchers at the Global Research Center at General Electric published an article in 2017. His article, *Meta-Algorithms in Cognitive Computing* explores the various forms of popular algorithms and explains the importance of meta-algorithms specifically in cognitive computing. He argues that “meta-algorithms can help achieve the vision of autonomous cognitive computing” (Sellmann, 2017, pg. 38). Sellmann continues by supporting how meta-algorithms tested in certain tasks within prescriptive analytics is effective for minimizing time. This proves how the various implementations of running algorithms for cognitive computing systems is more efficient than the algorithms popularly reused within general AI.

Technology and the medical field

The innovations made to the algorithms in order to improve cognitive computing further aids professionals expand their research in various fields. Various professions struggle with the overwhelming amount of data that needs to be handled. Many of the fields have gradually integrated technology to help make tasks easier using the required data. Big data incorporated with cognitive computing is useful for various life sciences. The spectrum of data to analyze for a single professional leads to inaccurate results and weak innovations. With the use of cognitive computing big data becomes manageable for professionals to work with. Life science is the major branch for the use of big data for the expansion of research. Data mining within life science is able to lead for new insights such as drug discovery, genetic discoveries, and personalized medicine. Ying & Chen work for IBM Almaden Research Center and published a paper, *How Cognitive Computing Can Be Applied to Big Data Challenges in Life Sciences*

Research in 2016. Their article explains the various concerns with big data in different life science categories. Furthermore, they support how science and medicine cooperate with technology to find new discoveries. They argue that “cognitive computing technologies can be configured to make cross-domain linkages” which will further expand the technologies’ data and find more insights from many sources (Ying, & Chen., 2016, p 3). The medical field is a large and broad profession that constantly updates its methodologies and research. Research spurs innovation and expansion to find new insights into branches of medical studies such as oncology and genetics. While the medical world has integrated many forms of technology, its most helpful tool is artificial intelligence. In 2004, Ramesh, Kambhampati, Monson, and Drew from the University of Hull Academic Surgical Unit, practicing at Castle Hill Hospital in Cottingham, UK, write about implementing artificial intelligence in the medical field. Their article, *Artificial intelligence in medicine* describes the use of specific artificial intelligence methods such as neural networks integrated to simplify diagnosis and prognosis. The neural networks they describe are categorized as machine learning artificial intelligence.

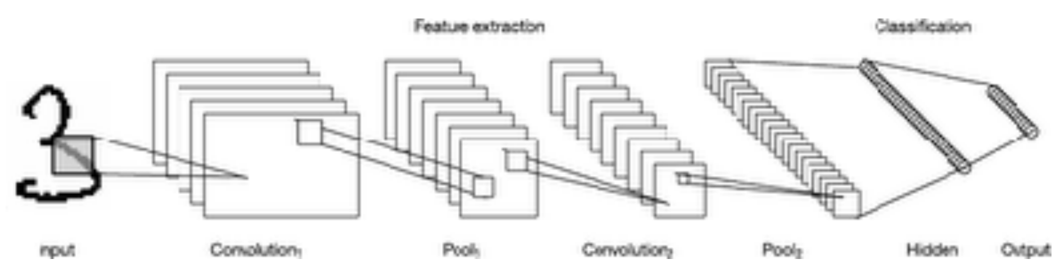

Figure 1. Convolutional neural network architecture.

Figure 1 displays the architecture behind a neural network which uses various layers of data to build interconnected networks and algorithms to produce a result, in this case a single prognosis or diagnosis (Jones, 2017, p.13). While these techniques are known to help professionals, there are uncertainties and speculations about their use. Professionals express their uncertainties towards the use of this technology in the decision-making process (Ramesh, Kambhampati, Monson, & Drew, 2004, pg. 334). Although this article is dated, it proves that technology has rapidly grown and improved to find new forms of artificial intelligence that addresses concerns about machine learning AI. Furthermore, the article demonstrates the exponential growth of data medical professionals need to handle is overwhelming and disrupts healthcare. Cognitive computing eliminates the ability for a computer to make the final decision in prognosis and diagnosis procedures while maintaining larger amounts of data than any other computer system. Cognitive computing is the most recent revolutionary form of augmented intelligence, and is more effective than artificial intelligence in supporting the medical field.

Cognitive computing and healthcare

Cognitive computing is more effective than artificial intelligence because it aims to ease the concern that human cognitive capacity plateaus. While the medical field keeps expanding with pools of healthcare-related information such as health records, reports, images, recordings, etc., professionals become unable to continue learning and keeping up to date with the massive quantities of information. Authors Ahmed, Toor, O'Neil, and Friedland published *Cognitive computing and the future of healthcare* in *IEEE PULSE* in 2017. They all work for IBM under the department of Watson and Cognitive Solutions, and explain how cognitive computing is a beneficial tool to improve health information sharing for better patient outcomes. Its efficient ability to parse through big data can personalize healthcare with greater diagnostic certainty

(Ahmed, Toor, O'Neil, & Friedland, 2017). A cognitive computing system is able to take massive amounts of unstructured data such as medical history reports, and locate keywords in order to

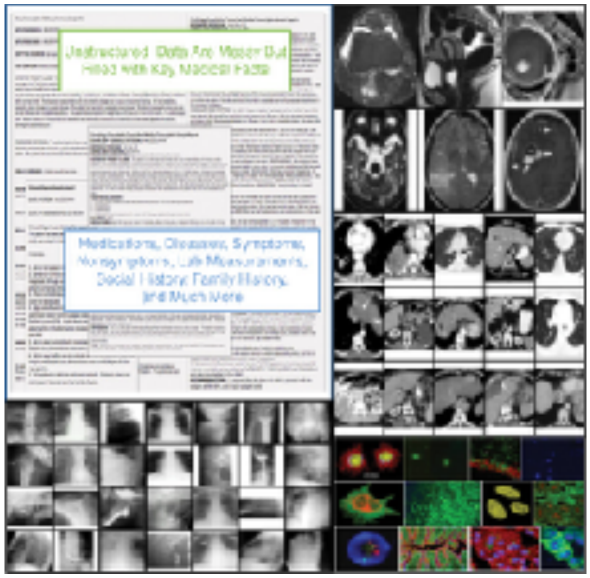

Figure 2. Unstructured data being collected about a patient.

extract and categorize the information based on various inputs from professionals. Figure 2 displays how a cognitive system categorizes a patient's information and therefore personalize their medical treatments (Ahmed et al., 2017). Thus, professionals are able to make better, more efficient and cost-effective decisions. Furthermore, Ahmed et al. expand on healthcare improvements through the use of cognitive computing. They discuss how cognitive computing can query papers and works to help researchers gain new insight into relationships among genes, phenotypes, and diseases (Ahmed et al., 2017). The ability to ease the processing of these works allows researchers to then focus on other promising leads and how the pace of discoveries is catalyzed. Ahmed et al. also introduce one of the most well-known cognitive computer systems, IBM's Watson.

Watson, healthcare, and oncology

Watson is a computer system popular for defeating *Jeopardy* world champions and is currently one of the most advanced forms of technology in cognitive computing. Basit Chaudhry, a medical scientist at IBM Research, gave a TED talk on how Watson can be applied to the medical field. Chaudhry introduces IBM's Watson, a cognitive computing project in which is able to help diagnose patients with illnesses. A prominent feature of Watson is that it does not take away the humanistic aspect of making a decision on a diagnosis (Chaudhry, 2013). This aspect is important because it targets the previous speculations mentioned concerning machine learning AI. Watson is shown to be a more effective and useful form of cognitive computing than

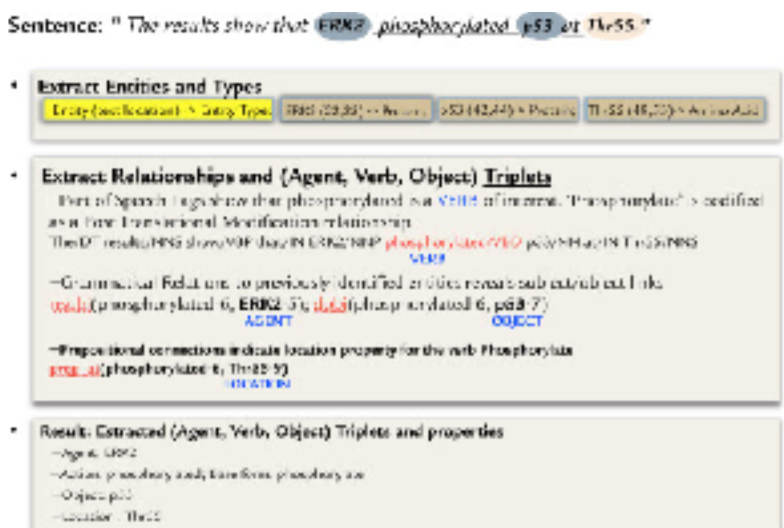

Figure 3. Sample of Watson extracting entities.

other AI through its abilities. Figure 3 accurately portrays how like other cognitive systems, Watson uses various input from professionals to extract specific important information when given a large amount of data per patient (Chen, & Ying, 2016, pg. 4). It uses the input to then parse throughout the convoluted neural networks for a set of results which professionals need in order to give the final diagnosis and correct treatment. This TED talk is effective in portraying how cognitive computing makes the medical field more efficient. Watson is able to learn and analyze vast amounts of data quickly and efficiently in order to improve the way doctors diagnose patients (Chaudry, 2013). The article, *Envisioning Watson as a rapid-learning system for oncology* by Jennifer Malin, a PhD and MD in the study of oncology, explains how cognitive computing is able to help improve practices in oncology. Malin further expands on how Watson is integrated into the medical field, specifically in oncology research. Clinical trial matching is explained to be an important aspect in oncology because no two cancers or people are alike (Malin, 2013). The range of data to be matched becomes complex for professionals; this is where cognitive computing and Watson are equipped to help (Malin, 2013). With Watson easing the process of clinical trial matching, professionals are then able to personalize healthcare to patients. Watson aids professionals by suggesting appropriate methods and treatments required for different patients. This form of cognitive clinical trial matching can help researchers "accelerate the development of new cancer therapies and extend hope to patients" (Malin, 2013). Malin also explains how Watson's abilities are beneficial in a variety of research settings other than oncology, such as the identification of disease-causing genes.

Genetics

Without cognitive computing the microarray data for genetics in the medical field is too large to analyze for professionals alone. In 2016, Nishiwaki, Kanamori, and Ohwada, all from the department of Industrial Administration, Faculty of Science and Technology in Tokyo University of Science at Chiba, Japan, conducted and presented research at the 15th International Conference on Cognitive Informatics & Cognitive Computing. They use a form of cognitive computing which is made to help identify genes that relate to specific diseases.

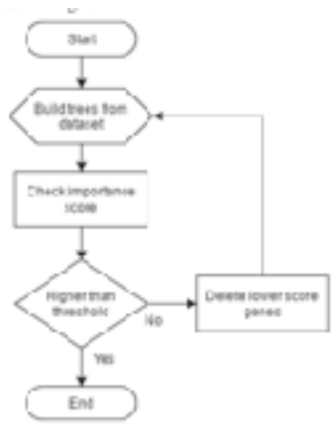

Figure 4. Flowchart of pre-selection.

Figure 4 explains how Nishiwaki et al. based their logic for pre-selecting disease-causing genes (Nishiwaki, Kanamori, & Ohwada, 2016). They also demonstrate methodologies that parse through series of arrays filled with organized genetic information in order to find specific genes responsible for diseases along with genes that aren't which are determined by a medical threshold. Their research focuses on the genes identifying and relating to Alzheimers. Their use of cognitive computing is able to identify new responsible genes previously unrelated to Alzheimers (Nishiwaki et al., 2016). However, since their proposed methodology is efficient for classifying unaffected and affected cells, this makes new knowledge available to professionals (Nishiwaki et al., 2016). Thus, the data is a stepping stone for biologists, medical scientists, and cognitive computing researchers. This source portrays how researchers can expand this gene-identifying practice to other diseases such as cancer. Furthermore, this research is able to be applied to other fields other than the medical one.

Ethical implications

As research expands and the world of technology continues to grow, restrictions and regulations need to be implemented on the new technologies formed. Artificial intelligence, including cognitive computing, should have regulations and policies for the safety of citizens, including users, developers, companies, etc. However, it is important to set these policies without impeding innovation. Philosopher John Rawls proposed a system of incorporating the "veil of ignorance" (Baase, 2013). While this is considered a good tool for implementing policies, it could also benefit the government for setting technological regulations. Ultimately, the government wants and continues to set policies to both protect public safety and allow for progress in artificial intelligence (Felton, 2016).

Conclusion

The laws regarding technology, including all the branches of artificial intelligence are to be continually updated as innovations continue to spur. Artificial intelligence has flourished and branched from general question-and-answer systems to machine learning AI, and now to cognitive computing. While general artificial intelligence, including machine learning AI, has contributed to the medical field, it has become harder to manage the exponentially growing quantities of data information. IBM's supercomputer Watson is implemented in various medical research fields, particularly in oncology and genetics. Watson's capability to parse through large amounts of data helps researchers focus on new insights in various fields. These insights and possible leads to new discoveries are currently portrayed within the medical field such as the search of a cure for cancer, or the eliminations or deductions of diseases based on genetics. Cognitive computing systems prevent professionals from having to extensively learn and organize data for specific patients. Overall, cognitive computing is more efficient than artificial intelligence due to its time-saving methods to query data along with its ease of search and organization. Cognitive computing also eliminates the decision-making process that artificial intelligence implements. Professionals are able to make the final decision based on the set of outputs provided by these systems. Researchers continue to actively develop cognitive computing to find new innovations in the medical field. Is this new form of technology able to make advances towards research such as finding a cure for cancer or at least identify disease-related genes at an early stage to help prevent them?

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