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Automation of Knowledge Work in Medicine and Health care: Future and Challenges

Farzan Majidfar[1]

[1] PhD Management of Technology, Doctor of Medicine, Msc Biomedical Engineering, Management School, Allameh Tabatabai University, Tehran, Iran

Mini Review Article

Abstract

Increment of computing speed, machine learning and human interface, have extended capabilities of artificial intelligence applications to an important stage. It is predicted that use of artificial intelligence (AI) to automate knowledge-based occupations (occupations such as medicine, engineering and law) may have an global enormous economic impact in the near future. Applications based on artificial intelligence are able to improve health and quality of life for millions in the coming years. Although clinical applications of computer science are slow moving to real-world labs, but there are promising signs that the pace of innovation will improve. In the near future AI based applications by automating knowledge-based work in the field of diagnosis and treatment, nursing and health care, robotic surgery and development of new drugs, will have a transformative effect on the health sector. Therefore many artificial intelligence systems should work closely with health providers and patients to gain their trust. The progress of how smart machines naturally will interact with healthcare professionals, patients and patients' families is very important, yet challenging. In this article, we review the future of automation of knowledge enabled by AI work in medicine and healthcare in seven categories including big medical data mining, computer Aided Diagnosis, online consultations, evidence based medicine, health assistance, precision medicine and drug creation. Also challenges of this issue including cultural, organizational, legal and social barriers are described.

Keywords: Automation of Knowledge work, Artificial intelligence, Medicine, Healthcare, Future

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Introduction

In recent years advances in increasing the speed of computing, machine learning and human interface , have extended capabilities of artificial intelligence applications to an important stage. It is predicted that use of artificial intelligence to automate knowledge-based occupations (occupations such as medicine, engineering and law) may have annual economic impact of $ 5.2 to 6.7 trillion dollars in 2025 (Manyika et al., 2013).

Now computers can act according to unstructured instructions and respond to simple questions and even have accurate judgments. They can identify patterns and relationships in big data. Also they can

Corresponding Author:
Farzan Majidfar
Email: farzan.majidfar@gmail.com

interpret the human speech and wishes and even understand vague commands by advanced interface.

Applications based on artificial intelligence are able to improve health and quality of life for millions in the coming years. Although clinical applications of computer science are slow moving to real-world labs, but there are promising signs that the pace of innovation will improve. In the near future AI based applications by automating knowledge-based work in the field of diagnosis and treatment, nursing and health care, robotic surgery and development of new drugs, will have a transformative effect on the health sector. Therefore many artificial intelligence systems should work closely with health providers and patients to gain their trust. The progress of how smart machines naturally will interact with healthcare professionals, patients and patients' families is very important, yet challenging.

Automation of knowledge work

Advances in hardware and software have opened up possibilities to automate routine cognitive tasks' 'for the process of knowledge. The intelligent softwares that can process large data sets using unstructured commands and subtle judgments and have the ability to learn 'on the run' are an important step toward the automation of the work of knowledge. Automation of routine work knowledge also offers a premise of any access to smart tools and experts to non-experts. Biomedical industry and health care are more important domains where rapid advances in the automation of work second generation of knowledge can have a significant impact. At the same time, as there are very few routine tasks in the biomedical industry or health-care professional in comparison with others, will also be a difficult feat to achieve (Naik & Bhide, 2014).

AI and automation of knowledge work

Artificial Intelligence (AI) is defined as computational procedures for the automated processing of perception, learning, reasoning and decision-making (AAAI, 2009, p. 1). Artificial intelligence is taken as a system that mimics the solution of complicated problems by humans during the course of life (Kornienko et al., 2015).AI is a general term that involves the use of a computer for intelligent behavior model with minimal human intervention (Peek et al., 2015). Artificial Intelligence should be distinguished from other concepts of intelligence such as business intelligence or technology intelligence (Majidfar et al., 2013; Tagva et al., 2014).

Algorithms of Artificial Intelligence (AI) of knowledge have benefited in fields such as law and financial services for the automation of knowledge work. These algorithms are able to analyze multiple financial news, announcements and press releases, make decisions regarding its commercial importance and then act on it faster than any other human operator (Manyika et al., 2013). In the same way Machine-learning techniques such as networks of deep learning are key implementers of the automation of the work of knowledge. We spend large amounts of time in search of the literature in the life sciences domain. To reduce the time required to extract the necessary information from the articles, several methods are developing for the automated extraction of knowledge; based on syntax trees and natural language processing. An example is SENNA 'emantica removal uses a neural network architecture" using semantic relationships using a verb-candidates (Barnickel et al., 2009). In the same way, to analyze and manage unstructured data through the use of statistical methods such as latent semantic indexing (LSI), Bayesian modeling and neural network approaches are also being developed to increase the automation of work of knowledge (Chen et al., 2013). The coming years are likely to see progress on the issues of machine learning, artificial neural networks and smart programs created to mimic the ability to resolve human problem (Barrat, 2013;

Napolitano and Jiang, 2012; Chen et al., 2013; Naik & Bhide, 2014).

AIs can be programmed to achieve some of the goals given. Current AIs have narrow scope, while a hypothetical *superintelligence* would be more effective than human beings in the achievement of almost any goal(Pueyo, 2017). AI experts surveyed in 2012/13 are assigned a probability of 0.1 to cross the threshold of the human level intelligence by 2022, 0.5 by 2040 and 0.9 by 2075 (Muller et al., 2016). The European Commission has recently launched the € 1 billion Human Brain Project with the intention to simulate a complete human brain as soon as 2023, but their chances of success have been questioned (Nature Publishers, 2015), and *superintelligence* is believed to be more easily attainable by the engineering of its first principles than by simulation of the brain (Bostrom, 2014).

To address the issue of AI, the distinction between strong and weak notion of AI is essential (Pueyo, 2017). Strong AI involves a system with human intelligence or superhuman in all facets and today is pure fiction. Currently, only the weak notion of AI is of interest for commercial applications. This concept describes AI in terms of specific tasks that require individual human capabilities, for example, visual perception, context of comprehension, probabilistic reasoning and complexity (Russell and Norvig, 2010). In these domains, machines far outweigh the human capabilities. However, smart technologies are not capable of running smart tasks as ethical judgments, symbolic reasoning, management of social situations or ideation (Brynjolfsson and McAfee, 2014).

AI impact on medicine and healthcare

Biomedical industry and health care are the most important domains where rapid advances in the automation of knowledge work can have a significant impact (Naik & Bhide, 2014).The term is applicable to a wide range of medicine such as robotics, medical diagnosis, medical statistics, human biology, up to and including "omics" of today. AI in medicine, which is the focus of this review, has two main branches: physical and virtual. The virtual branch includes approaches to learning deep computing information management for the control of health management systems, including electronic health records and address of doctors in their treatment decisions. The branch of physics is best represented by the robots used to help the elderly patient or surgeon treating physician. Also incorporated in this branch are nanorobots directed, an exclusive system of delivery of new drugs. The social and ethical complexities of these applications require more thought, proof of its medical usefulness, economic value and the development of interdisciplinary strategies for their wider application (Peek et al., 2015).

The future directions of AI and automation of knowledge work in medicine

Automation of knowledge work in healthcare and medicine enabled by weak notion of AI in the near future will have following seven main directions:

Big medical data mining

Big Data is driving a revolution in information technology and communication. Big data methods are applied in various areas such as meteorology, experimental physics, finance, telecommunications, military surveillance and informatics management. Also the life and biomedical sciences are massively contributing to the Revolution of Big Data, due to the absorption of registry systems (EHR) electronic health in clinical practice, due to the advances in the technology of genome sequencing and the projection of digital image, and because patients are now co-produce health-related data via mobile devices and laptops. Personalized Medicine, which requires the integration of "omic" data with clinical data, require in-depth research efforts and interdisciplinary in different areas such as data structures and indexing structures for the biomedical domain, distributed and parallel (bio-), new data models and query languages for biomedical databases huge and heterogeneous. In addition, other application areas such as the commercial domain have developed methods of storage of information and analysis that seem mature enough to move the biomedical domain, where some requirements are even more challenging. Among them we mention here temporary multidimensional OLAP Analysis, design of temporary data storage, data mining and visual mining, integrated mining and analytical environments (Peek et al., 2015). Recently, Google DeepMind has announced its second collaboration with the NHS, working with Moorfields Eye Hospital in east London to build a machine learning system which will eventually be able to recognize sight-threatening conditions from just a digital scan of the eye (The Guardian, 2016). DeepMind is used to extract the data from the medical records for the purpose of providing health services faster and better (Mesko, 2016).

Computer Aided Diagnosis

Computer-aided diagnosis (CAD) has become a part of the routine clinical work for detection of breast cancer on mammograms at many screening sites and hospitals in the United States(Birdwell et al, 2005; Cupples et al, 2005; Dean et al, 2006; Gilbert et al, 2008; Morton et al 2006).

The computer output for CAD is used as a “second opinion” in assisting radiologists’ image interpretations. The computer algorithm generally consists of several steps, which may include image processing, image feature analysis, and data classification by use of tools, such as artificial neural networks (ANN); these may be referred to as artificial intelligence Most publications on CAD have been concerned with 3 organs—the chest, breast, and colon—but other organs, such as brain, liver, and skeletal and vascular systems, also have been subjected to CAD research. The detection of cancer in the breast, lung and colon is commonly achieved through screening examinations. (Shiraishi, et al., 2011).it is expected that, in the future, many CAD schemes for detection and/or differential diagnosis will be developed for clinical use in various fields.IBM "Sieve" is a "Wizard" with analytical, reasoning and a wide range of clinical knowledge. Sieve is trained to assist in clinical decision-making in radiology and cardiology. The "cognitive health assistant" is able to analyze radiological images to observe and detect problems more quickly and more reliably. On the other hand, deep learning can easily handle a wide spectrum of diseases throughout the body and all the modalities of image (x-rays, CT, etc..) Enlitic, which also aims to pair deep learning with large amounts of medical data storage for the diagnosis of advance and improve patient outcomes, formula the advantages of deep learning **(**Mesko, 2016**).**

Online consultations

A recent study suggests that routine for certain diseases, at least, "see" a doctor online could be as effective as to see a doctor in person. In the study, patients with sinus problems and bladder infections were able to obtain a diagnosis simply by updating their profiles with a description of their symptoms and conditions. The only notable difference was a higher probability of antibiotics prescribed (Mehrotra et al., 2013).

Other examined the effectiveness of the “clinical virtuwell online” (Courneya, et al., 2013). The virtuwell online clinic diagnoses and treats the common conditions such as flu, deer tick bites and yeast infections. The review of the 40,000 cases found that the clinic online reduces costs by $88 per visit compared with the traditional visit in addition saving patients’ time and inconvenience. 98 percent of the patients gave the virtual visit a grade of "would recommend". The British subscription, online medical consultation and health service, "Babylon" launched an application in 2016 that offers medical consultation AI based on the personal health history and medical knowledge. Users report the symptoms of their illness to the application, which is checked against a database of disease through voice recognition. Taking into account the patient's history and circumstances, Babylon offers an appropriate course of action. The application will remember also to patients take their medication and follow-up to know how it feels (Mesko, 2016).

Evidence based medicine

Clinical practice guidelines have been widely accepted as tools for the dissemination of evidence of clinical studies and to support clinical decision making. This is likely to change in the near future. But guideline development, dissemination and application of are still on paper, manual and processes very laborious. At the same time new evidence is piling up faster and faster and in increasingly large volumes. With the widespread adoption of EHR systems in clinical practice, there is a great opportunity to optimize the production of evidence in support of the clinical decision-making (Peek et al., 2015). IBM Watson launched its Special program for oncologists, which is able to provide the clinical treatment options based on evidence. Watson of Oncology has an advanced ability to analyze the meaning and context of structured and unstructured data in clinical notes and reports which may be critical to select a treatment. Through the combination of file attributes of the patient with clinical expertise, external research and data, the program identifies possible plans of treatment for a patient (Mesko, 2016).

Health assistance

Molly first nurse virtual world developed by the Sense.ly medical start-up. It has a friendly, smiling face, coupled with a pleasant voice and its sole purpose is to help people with monitoring of your condition and treatment. The interface uses machine learning support to patients with visits to the doctor between chronic conditions. Offers personalized follow-up, tested and follow-up care, with a strong focus on chronic diseases. In addition, there is already a solution to monitor if patients take their medications of truth. The application of AiCure supported by the National Institutes of Health using a smartphone, webcam and AI independently confirm that patients receive their prescriptions, or with better conditions, helping to make sure that they know how to manage their condition (Mesko, 2016).

Precision medicine

Artificial intelligence will have a great impact on the genetics and genomics as well. Deep genomics aims to identify patterns in large data sets of genetic information and medical records, in search of mutations and the links to the disease. Inventing a new generation of computational technologies that can tell the doctors that will happen within a cell when the DNA is altered by genetic variations, whether natural or therapeutic. At the same time, Craig Venter, one of the fathers of the Human Genome Project is working on an algorithm that could design the physical characteristics of the patient based on their DNA. With his last company, human longevity, he offers to his patients (especially rich) complete the sequencing of the human genome coupled with the exploration of the entire body and very detailed medical check-up. The whole process allows point cancer or vascular disease in its early stages (Mesko, 2016).

Drug creation

Development of pharmaceutical products through clinical trials take sometimes for more than a decade and costs thousands of dollars. This accelerate and make more profitable would have an enormous effect on the health of today and of how the innovations reach the medicine every day. Atomwise uses supercomputers that eradicate the therapies of a database of molecular structures. Last year, Atomwise launched a virtual search of existing drugs, insurance which could be redesigned to treat the Ebola virus. They found two drugs predicted by AI technology of the company that can significantly reduce the infectivity of the Ebola virus. This analysis, which normally would have taken months or years, was completed in less than a day. Another good example for the use of big data for the management of patients is the health of Berg, a biopharmaceutical company headquartered in Boston, which mines the data to find out why some people survive diseases and thus improve the current treatment or create new therapies. Combine the AI with biological data of patients to define the differences between healthy and respectful environments with the disease and helps in the discovery and development of drugs, diagnostics, and healthcare applications(Mesko, 2016).

Future Challenges

Some important questions come to mind with automation of knowledge work (Naik & Bhide, 2014):

Is computational intelligence greater than human intelligence?

Can we be sure that the computational intelligence will produce knowledge free from error?

It is wise for us to rely on computational intelligence and if so, is there a limit to our dependence?

Can we take on decision-making machines for human beings depend on meta cognitive processes, knowledge and sense of intuition?

And the most important thing will be harmless?

What do we need to use all of the capabilities of computational intelligence, simply because we can?

The following suggestions could avoid the future challenges of the application of AI in medicine (Mesko, 2016):

1. Creation of ethical standards that are applicable to and binding for any health care professional 2. Gradual development of the AI in order to allow time for the allocation of possible drawbacks 3. Acquisition of basic knowledge by medical professionals: about how AI works in a medical environment in order to understand how such solutions could help in their daily work

4. Getting accustomed to the artificial intelligence by patients: and discovering its benefits for themselves

5. Making more communication toward the general public on the potential benefits and risks of the use of IA in the medicine by AI developers.

6. Performing all the steps needed in order to be able to measure the success and effectiveness of the AI system in health institutions.

Conflict of Interests

Authors have no conflict of interests.

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