ISSN 2229-3531 (Print)

JUCIT Vol. 10(3), 29- 35 (2019). Periodicity-2-Monthly

ISSN 2455-9997 (Online)

JOURNAL OF ULTRA COMPUTER & INFORMATION TECHNOLOGY
An International Open Free Access Peer Reviewed Research Journal of Computer Science Engineering & Information Technology
website:- www.compitjournal.org
Estd. 2010

Analytical study on Artificial Intelligence: The Next Generation to Healthcare, Pharmaceutical Industry and Medical Research

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http://dx.doi.org/10.22147/jucit/100302

Acceptance Date 26th June, 2019, Online Publication Date 29th June, 2019

Abstract

AI techniques have sent vast waves in the field of healthcare and medical science, even fueling an active discussion of whether AI doctors will eventually replace human physicians in the future. Our belief is that human doctors and researchers will not be replaced by machines in the future, but AI can definitely assist physicians to make better clinical decisions or even replace human judgement in certain functional fields of healthcare (e.g. radiology). The increasing availability of healthcare data and rapid development of big data analytic methods has made possible the recent successful applications of AI in healthcare. Advised by possible clinical questions, powerful artificial intelligence techniques will not ravel clinically relevant information hidden in the massive amount of data, which in turn can assist clinical decision making. This study centers on how computer-based decision procedures, under the vast umbrella of artificial intelligence (AI), can assist in improving health and health care. Although advanced statistics and machine learning provide the base for AI, there are currently revolutionary advances underway in the sub-field of neural networks. This has created huge excitement in many fields of science, including in medicine and public health. First demonstrations have already appear showing that deep neural networks can perform as well as the best human clinicians in well-defined diagnostic tasks. In addition, AI-based tools are already appearing in health based apps that can be employed on handheld, networked devices such as smart phones. AI is actually a software means computer programs with the capacity to perform operations analogous to learning and decisions-making in humans. This tool is being increasingly applied in the pharmaceutical, medical device, and healthcare sectors to aid various stages of research and development, as well as treatment of patients. AI as a software, and in particular software that incorporates machine learning, which provides the ability to learn from data without rule-based programming, may streamline the process of translating a molecule from original inception to a market-ready product.

Key words: Artificial Intelligence, Artificial Neural Network and Machine Learning

Introduction

Artificial Intelligence (AI), where computers perform tasks that are usually assumed to require intelligence, is currently being discussed in nearly every domain of science and engineering. Major scientific competitions like ImageNet Large Scale Visual Recognition Challenges are providing evidence that computers can achieve human-like competence in image recognition. AI has also enabled significant progress in speech recognition and natural language processing. All of these advances open questions about how such capabilities can support, or even enhance, human decision making in health and health care. Two recent high-profile research papers have demonstrated that AI can perform clinical diagnostics on medical images at levels equal to experienced clinicians, at least in very specific examples. AI has been around for decades and its promise to revolutionize our lives has been frequently raised, with many of the promises remaining unfulfilled. Fuelled by the growth of capabilities in computational hardware and associated algorithm development, as well as some degree of hype, AI research programs have ebbed and flowed. AI in health care promises great benefits to patients, it equally presents risks to patient safety, health equity and data security. The only reasonable way to ensure that the benefit share maximized and the risks are minimized is if doctors those from across the wider health and care landscape take an active role in the development of this technology today. The use of artificial intelligence in pharmaceutical technology has increased over the years, and the use of technology can save time and money while providing a better understanding of the relationships between different formulation and process parameters. Neural networks, genetic algorithms, and fuzzy logic are rapidly growing technologies that could be applied to the formulation and processing of pharmaceutical products.

AI is the fast growing technology in healthcare. By providing relevant information to patients and HCP with on-demand medical and clinical confidence, it has advanced healthcare professional and patient communications.

Focus of Study: AI will shape the future of public health, community health, and health care delivery. We focused on technical capabilities, limitations, and applications of AI in the field of medical research, healthcare and pharmaceutical industry. Artificial intelligence technology is trialled for a scope of healthcare and research purposes, including detection of disease, management of chronic conditions, delivery of health services, and drug discovery. A key challenge is that artificial intelligence technology is developed and used in such a way that it is transparent and compatible with the public interest, whilst stimulating and driving innovation in the sector.

Aim of Study:
1. Motivations of applying AI in healthcare
2. Data types that have be analysed by AI systems
3. Mechanisms that permit AI systems to generate clinical meaningful results
4. Disease types that the AI communities are presently tackling.

Work Statement: To improve the decision making and action in various applications of healthcare, we apply artificial intelligence to a large sets of complex data. Artificial Intelligence is defined as the intelligence systems that is exhibited by machines and encompasses fields of research and development practiced by computational Computer vision, Natural Language Processing, Robotics, Search and Planning, Multi-Agents Systems, KKR, Social Media Analysis and Machine Learning.

Problems faced in using Artificial Intelligence systems :

1. Explain ability – All the decisions are taken on the bases of large number of connections between 'neurons' and that makes it is difficult for a human beings to understand that how the conclusion was reached and final discussion are taken. This is not easy to assess reliability and detect malicious attacks.

2. Data requirement – For the proper functioning and to get desired results neural networks need to be trained on a large amount of accurate and reliable data. Inaccurate results or misrepresentative database could lead to poorly performing of AI

systems.

3. Transferability - Algorithms may be well optimized for the specific task they have been trained on but may be confidently incorrect on data it has not seen before.

Overarching Observations of AI on Medical and Healthcare systems :

1) Frustration with the legacy medical system,
2) Ubiquity of networked smart devices in our society,
3) Acclimation to convenience and at-home benefits like those provided through Amazon and others.

Healthcare or Medical research organisation and Workforce :

Artificial Intelligence have high potential, due to this AI expertise are incorporate by the healthcare players in their organisation's structure and governance. For the perfect AI organisation, governance and the operating model should be revamped. It plays an important role in planning and resource allocation in health and social care services. For example, The Harrow council piloted the IBM Watson Care Manager System with the target of improving cost efficiency. Therefore, all the healthcare organisations should build AI smart culture and work-force to increase the efficiency, quality and outcomes for patients. As the time is changing the nature of work and employment is also rapidly changing and this will continue so that we can make the best use of both humans an artificial intelligence.

AI is a best way to fill the labour shortage in healthcare. It has power to reduce the burden on clinicians and provide employees the tools to do their jobs better. AI can address unmet clinical demand of 20% in healthcare. By using artificial intelligence we can easy analyse and identify huge and difficult database faster and more accurately than any other previously system. AI helps in combining of different types of data; for example, to aid drug discovery, individual care plans etc.

Impact of AI on Healthcare :

1) AI helps find the best possible diagnosis and its solutions. Cloud-based "Big Data" is applied to artificial intelligence which assist clinicians to comparing and contrasting individual patient's characteristics with other patient database.
2) Chronic conditions patients will be cared by visiting nurses and doctors at their home who can call frequently whenever necessary either in person or through telehealth means.
3) Patients who are unwell and need medical advice can dial into a telehealth services and talk to a nurse. The data on their conditions and symptoms are uploaded from smart phone or smart sensors and next step suggestions are given to the nurse by AI systems.
4) Life-threatening issues and problems are distinguish to understand minor conditions or ignorable symptoms.
5) All the efforts of doctors are assisted, specially of differential diagnosis evidence-based treatment and precision medicine practice by cognitive computing systems.
6) Patients who feel unwell and not able go to a hospital urgent care department are seen by a nurse practitioner. Patient's entire medical history is taken up from privacy protected, universally accessible, electronic health record or EHR.
7) For major surgery, where a hospital is needed, this technology is used extensively, much of which are available in every patient room.
8) Multiple screens around the patients deliver tailored education by AI means a and response to patients request for feedback.
9) AI risk-monitoring and treatment algorithms determine Human medical Staffing ratios according to the individual patients need their electronic health record.
10) Doctors make most of there orders and notes by entering into the EHR through natural language voice recognition software all of which are analysed, charted and displayed as patient wishes.

AI devices: The above discussion suggests that AI devices primarily fall into two major categories. The first category consist of machine learning (ML) techniques that analyse structured data such as imaging, genetic and EP data. In the medical applications, the ML procedures attempt to cluster

patients' traits, or infer the probability of the disease outcomes. The second category consist of natural language processing (NLP) methods that extract information from unstructured data such as clinical notes/ medical journals to supplement and enrich structured medical data. The NLP procedures target at turning texts to machine-readable structured data, which can then be analysed by ML techniques. We comment that the road map starts and ends with clinical activities. As powerful as Artificial intelligence techniques can be, they have to be motivate by clinical problems and be applied to assist clinical practice in the end. applications of Deep Learning have been demonstrated, with attention to quantitative understanding of characteristics of the data sets, the problem definition, and the nature of the comparison standard used for labelling the sets.

Detection of diabetic retinopathy in retinal fundus images: Many diseases of the eye can be diagnosed through non-invasive imaging of the retina through the pupil. Early screening for diabetic retinopathy is important as early treatment can prevent vision loss and blindness in the rapidly growing population of patients with diabetes. Such screening also provides the opportunity to identify other eye diseases, as well as providing indicators of cardiovascular disease.

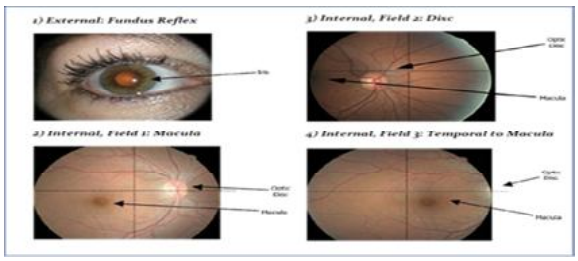

Figure 1: Standard image formats for diabetic retinopathy (right eye).

Dermatological classification of skin cancer: Skin cancer represents a challenging diagnostic problem because only a small fraction (3–5% of about ~1.5 million annual US skin cancer cases) are the most serious type, melanoma, which accounts for 75% of the skin cancer deaths. Identifying melanomas early is a critical health issue, and because diagnosis can be performed on photographic images, there are already services that allow individuals to send their smart -phone photos in for analysis by a dermatologist.

Development of new approaches non-invasive diagnostics: Coronary computed tomographic angiography (CCTA) has been established as a non-invasive technique for screening. However even at its best performance, CCTA-like invasive coronary angiography (ICA) – has limited ability to discriminate which cases of stenosis are truly causing impaired blood flow.

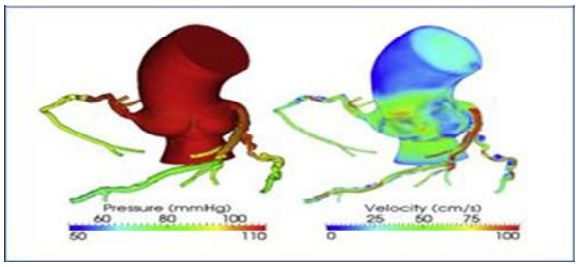

Figure 2 Three-dimensional pressure and velocity fields at one point in the cardiac cycle using FFR-based on CTA imaging (FFRCT).

AI and ML in healthcare and pharmaceutical industry :

In personalised medicine, AI and ML could use patient data to predict responses to particular treatment pathways, enabling tailored and more effective treatments. These technologies have a great potential to accelerate the pharmaceutical drug and manufacturing process development, reduce costs and lead to more qualitative, efficient and safe medicines. It have a great applications in market, which is predicted to exceed USD 4 billion by 2024. AI/ML in diagnostic medical imaging is a tools to process and analyse medical images, which increased to $ 2 billion by 2023. It enhanced productivity, increased diagnostic accuracy, more personalized treatment planning and improved clinical outcomes. AI/ML enabling radiology department to cope with the increasing volume of diagnostic imaging procedures, despite the chronic shortage of radiologists.

Recommendations

1. Politicians and policymakers should avoid thinking that AI is going to solve all the problems the health and care systems across the UK are facing. Artificial intelligence in everyday life is still in its infancy. In health and care it has hardly started despite the allegations of some high profile players.
2. As with traditional clinical activity, patient safety must remain paramount and AI must be developed in a regulated way in partnership between clinicians and computer scientists. However, regulation cannot be allowed to stifle innovation.
3. Clinicians can and must be part of the change that will accompany the development and use of AI. This will require changes in behaviour and attitude including rethinking many aspects of doctors' education and careers. More doctors will be needed who are as well versed in data science as they are in medicine
4. For those who meet information handling and governance standards, data should be made more easily available across the private and public sectors. It should be certified for accuracy and quality. It is for Government to decide how extensively that data is shared with non-domestic users.
5. Joined up regulation is key to make sure that AI is introduced safely, as currently there is too much uncertainty about accountability, responsibility and the wider legal implications of the use of this technology
6. External critical appraisal and transparency of tech companies is necessary for clinicians to be confident that the tools they are providing are safe to use. In many respects, AI developers in healthcare are no different from pharmaceutical companies who have a similar arms-length relationship with care providers. This is a useful parallel and could serve as a template. As with the pharmaceutical industry, licensing and post-market surveillance are critical and methods should be developed to remove unsafe systems.
7. Artificial intelligence should be used to reduce, not increase, health inequality geographically, economically and socially.

Conclusion

Artificial Intelligence is broadly defined here as a field that deals with the design and application of algorithms for analysis of, learning from and interpretation of data. AI integrates many branches of statistical and machine learning, pattern recognition, logics and probability theory as well as biologically motivated approaches, such as neural networks, evolutionary computing or fuzzy modeling, collectively described as "computational intelligence". The application of ANN in medical decision making has been intensely successful especially as it applies to disease diagnosis, classification and modeling. We conclude with some thoughts about human perception versus digital data in a timeline further out than has been covered in this report. One of the major obstacles to be overcome in making health and health-care information useful is the gap between human cognition and digital data. Information concerning an individual patient is mostly obtained in forms designed to be accessible to medical personnel. Typical data may consist of X-ray or MRI or ultrasound pictures of the patient, visual records of heart or lung function varying with time, or verbal descriptions of the patient as seen by a nurse or a doctor. On the other hand, when data are stored in information systems and used, in medical research or to develop treatment guidelines, it is often reduced to statistical information which is predominantly digital. The conversion of analog input into digital output is a burdensome task, and may result in a loss of significant information that would have been helpful to the user. A successful AI system must possess the ML component for handling structured data (images, EP data, genetic data) and the NLP component for mining unstructured texts. The sophisticated algorithms then need to be trained through healthcare data before the system can assist physicians with disease diagnosis and treatment suggestions.

Future Scope :

1) ***Opportunities in AI field:*** It provides various ways to improve health & healthcare. AI puts advance efforts to improve individual and community health. There are various evidence that exits regarding AI's relevance for health care. There are various high-value areas on which AI should focused such as reduce cost of expensive treatments, improve

productivity, focus on risk mitigation where impacted population is large etc.

2) ***AI Considerations***
   - **a) *Technical:*** We need to consider the various data sources, its quality, breadth and depth which is essential to support the development of artificial intelligence programs for health & health care. All the technological barriers that may rises due to adoption of new technologies should be removed.
   - **b) *Ethical/legal:*** The potential unintended results of AI should be focused to improve health & healthcare facilities.
   - **c) *Workforce:*** All the necessary workforce changes are important to ensure effective broad based adoption of data-rich AI appiances.

3) ***AI Implementation:*** We should pay more attention to those projects of AI in individual & community health and healthcare field that have potential value of AI and feasibility of scale up.

Acknowledgement

We are heartily thankful to Mr. Durgesh Srivastava (Assistant Professor (CSE), BRCM College of Engineering and Technology, Bahal , Haryana, whose encouragement, guidance and support from the initial to the final level enabled me to develop an understanding of the subject. Lastly, I offer my regards and blessings to all those who supported me in any respect during the completion of this study work.

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