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Artificial Intelligence Used in Human Health Care

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ABSTRACT

Artificial intelligence (AI) aims to mimic human cognitive functions. It is bringing a paradigm shift to healthcare, powered by the increasing availability of healthcare data and rapid progress of analytics techniques. We survey the current status of AI applications in healthcare and discuss its future. AI can be applied to various types of healthcare data (structured and unstructured). Popular AI techniques include machine learning methods for structured data, such as the classical support vector machine and neural network, and the modern deep learning, as well as natural language processing for unstructured data. Major disease areas that use AI tools include cancer, neurology, and cardiology. We then review in more detail the AI applications in stroke, in the three major areas of early detection and diagnosis, treatment, as well as outcome prediction and prognosis evaluation. We conclude with a discussion about pioneer AI systems, such as IBM Watson, and hurdles for the real-life deployment of AI.is being used or trialed for a range of healthcare and research purposes, including detection of disease, management of chronic conditions, delivery of health services, and drug discovery. AI has the potential to help address important health challenges, but might be limited by the quality of available health data, and by the inability of AI to display some human characteristics.

INTRODUCTION:

Artificial intelligence (AI) is defined as the intelligence of machines, as opposed to the intelligence of humans or other living species. AI can also be defined as the study of “intelligent agents”—that is, any agent or device that can perceive and understand its surroundings and accordingly take appropriate action to maximize its chances of achieving its objectives. AI also refers to situations wherein machines can simulate human minds in learning and analysis, and thus can work in problem-solving. This kind of intelligence is also referred to as machine learning (ML). Typically, AI involves a system that consists of both software and hardware. From a software perspective, AI is particularly concerned with algorithms. An artificial neural network (ANN) is a conceptual framework for executing AI algorithms. It is a mimic of the human brain—an interconnected network of neurons, in which there are, weighted communication channels between neurons. As a result, the neural network (NN) can generate outputs as its responses to environmental stimuli—just as the human brain reacts to different environmental changes. NNs are typically layered structures of various configurations. Researchers have devised NNs that can do ① supervised learning, where the task is to infer a function that maps an input to an output based on example pairs of inputs and outputs; ② unsupervised learning, where the task is to learn from test data that has not been labeled, classified, or categorized, to identify common features in the data and, rather than responding to system feedback, to react based on the existence or inexistence of identified common features in new data; and ③ reinforced learning, where the task is to act within the given surroundings to maximize rewards and minimize penalties, both according to some form of accumulative nature. With the advancement of computation power, NNs have become “deeper,” meaning that more layers of neurons are involved in the network to mimic a human brain and carry out learning. Also, more functions can be incorporated into the NN, such as merging feature extraction and classification functions into a single deep network—hence the technical term “deep learning. From a hardware perspective, AI is mainly concerned with the implementation of NN algorithms on a physical computation platform. The most straightforward approach is to implement the NN algorithm on a general-purpose central processing unit (CPU), in a multithread or multicore configuration. Furthermore, graphical processing units (GPUs), which are good at convolution computations, are advantageous over CPUs for large-scale NNs. CPU and GPU co-processing has turned out to be more efficient than CPU alone, especially for spiking NNs. Moreover, some programmable or customizable accelerator hardware platforms, such as field-programmable gate arrays (FPGAs) and application-specific integrated circuits (ASICs), can implement NNs toward a customized application in a more efficient way, in terms of computation capability, power efficiency, and form factor. Compared with GPU and CPU, these platforms can be customized for a specific application and thus can be more power-efficient and compact than GPU and CPU platforms. To deploy AI in edge devices, such as mobile phones in wireless networks or sensor nodes in the Internet of Things (Iota), further improvements in power efficiency and form factor are needed. Researchers have tried to implement AI algorithms using analog integrated circuits, spintronic, and mersisters. Some of these new platforms, such as mersister crossbar circuits, can merge computation with memory and thus avoid the problem of access to the “memory wall” of traditional von Neumann architectures. This access is mandatory to update needed parameters. Recently, researchers have tried to improve the efficiency of AI implementation by reducing the number of bits used for data representation. It turns out that the computation accuracy can be maintained when the data representation goes from 32 or 16 bits down to 8 bits. The advantage is faster computation, less power, and smaller form factor. However, the “memory wall” limits remain. On the other hand, the adoption of appropriate training methods (e.g., deep training instead of surface-level training or using pre-training technique and the use of balanced datasets, sufficient amounts of data, and constant availability of datasets are important factors to consider to achieve the satisfactory performance of ANNs. Due to the rapid development of AI software and hardware technologies, AI has been applied in various technical fields, such as Iota, machine vision, autonomous driving, natural language processing, and robotics. Most interestingly, researchers in the biomedical fields have been actively trying to apply AI to help improve analysis and treatment outcomes and, consequently, increase the efficacy of the overall healthcare industry.

CURRENT RESEARCH:

Radiology:

The ability to interpret imaging results with radiology may aid clinicians in detecting a minute change in an image that a clinician might accidentally miss. A study at Stanford created an algorithm that could detect pneumonia at that specific site, in those patients involved, with a better average F1 metric (a statistical metric based on accuracy and recall), than the radiologists involved in that trial.[25] Several companies (isometric, QUIBIM, Robovision, have popped up that offer AI platforms for uploading images to. There are also vendor-neutral systems like UMC Utrecht's MAGR AI. These platforms are trainable through deep learning to detect a wide range of specific diseases and disorders. The radiology conference Radiological Society of North America has implemented presentations on AI in imaging during its annual meeting. The emergence of AI technology in radiology is perceived as a threat by some specialists, as the technology can achieve improvements in certain statistical metrics in isolated cases, as opposed to specialists.

Imagine:

Recent advances have suggested the use of AI to describe and evaluate the outcome of maxillo-facial surgery or the assessment of cleft palate therapy regarding facial attractiveness or age appearance.

In 2018, a paper published in the journal Annals of Oncology mentioned that skin cancer could be detected more accurately by an artificial intelligence system (which used a deep learning convolutional neural network) than by dermatologists. On average, the human dermatologists accurately detected 86.6% of skin cancers from the images, compared to 95% for the CNN machine.

Disease Diagnosis:

There are many diseases and there also many ways that AI has been used to efficiently and accurately diagnose them. Some of the diseases that are the most notorious such as Diabetes and Cardiovascular Disease (CVD) which are both in the top ten for causes of death worldwide have been the basis behind a lot of the research/testing to help get an accurate diagnosis. Due to such a high mortality rate being associated with these diseases there have been efforts to integrate various methods in helping get accurate diagnoses. An article by Jiang, et al. (2017) demonstrated that there are several types of AI techniques that have been used for a variety of different diseases. Some of these techniques discussed by Jiang, et al. include Support vector machines, neural networks, Decision trees, and many more. Each of these techniques is described as having a "training goal" so "classifications agree with the outcomes as much as possible.

To demonstrate some specifics for disease diagnosis/classification there are two different techniques used in the classification of these diseases include using "Artificial Neural Networks (ANN) and Bayesian Networks (BN). From a review of multiple different papers within the timeframe of 2008-2017[36] observed within them which of the two techniques were better. The conclusion that was drawn was that "the early classification of these diseases can be achieved by developing machine learning models such as Artificial Neural Network and Bayesian Network." Another conclusion Alic, et al. (2017)[36] was able to draw was that between the two ANN and BN that ANN was better and could more accurately classify diabetes/CVD with a mean accuracy in "both cases (87.29 for diabetes and 89.38 for CVD).

Telehealth:

The increase of telemedicine has shown the rise of possible AI applications. [37] The ability to monitor patients using AI may allow for the communication of information to physicians if possible disease activity may have occurred. [38] A wearable device may allow for constant monitoring of a patient and also allow for the ability to notice changes that may be less distinguishable by humans.

Electronic health records:

Electronic health records are crucial to the digitalization and information spread of the healthcare industry. However, logging all of this data comes with problems like cognitive overload and burnout for users. EHR developers are now automating much of the process and even starting to use natural language processing (NLP) tools to improve this process. One study conducted by the Center stone research institute found that predictive modeling of EHR data has achieved 70–72% accuracy in predicting individualized treatment response at baseline. Meaning using an AI tool that scans EHR data can pretty accurately predict the course of disease in a person.

Drug Interactions:

Improvements in natural language processing led to the development of algorithms to identify drug-drug interactions in the medical literature. Drug-drug interactions pose a threat to those taking multiple medications simultaneously, and the danger increases with the number of medications being taken. To address the difficulty of tracking all known or suspected drug-drug interactions, machine learning algorithms have been created to extract information on interacting drugs and their possible effects from medical literature. Efforts were consolidated in 2013 in the DDI Extraction Challenge, in which a team of researchers at Carlos III University assembled a corpus of literature on drug-drug interactions to form a standardized test for such algorithms. Competitors were tested on their ability to accurately determine, from the text, which drugs were shown to interact and what the characteristics of their interactions were. Researchers continue to use this corpus to standardize the measurement of the effectiveness of their algorithms.

Other algorithms identify drug-drug interactions from patterns in user-generated content, especially electronic health records and/or adverse event reports. Organizations such as the FDA Adverse Event Reporting System (FAERS) and the World Health Organization's VigiBase allow doctors to submit reports of possible negative reactions to medications. Deep learning algorithms have been developed to parse these reports and detect patterns that imply drug-drug interactions.

Creation of New Drug:

DSP-1181, a molecule of the drug for OCD (obsessive-compulsive disorder) treatment, was invented by artificial intelligence through joint efforts of Exscientia (British start-up) and Sumitomo Dainippon Pharma (a Japanese pharmaceutical firm). The drug development took a single year, while pharmaceutical companies usually spend about five years on similar projects. DSP-1181 was accepted for a human trial.

Industry:

The subsequent motive of large based health companies merging with other health companies, allow for greater health data accessibility. Greater health data may allow for more implementation of AI algorithms.

A large part of the industry focus of implementation of AI in the healthcare sector is in the clinical decision support systems. As the number of data increases, AI decision support systems become more efficient. Numerous companies are exploring the possibilities of the incorporation of big data in the health care industry.

The following are examples of large companies that have contributed to AI algorithms for use in healthcare.

IBM

IBM's Watson Oncology is in development at Memorial Sloan Kettering Cancer Center and Cleveland Clinic. IBM is also working with CVS Health on AI applications in chronic disease treatment and with Johnson & Johnson on the analysis of scientific papers to find new connections for drug development. In May 2017, IBM and Rensselaer Polytechnic Institute began a joint project entitled Health Empowerment by Analytics, Learning, and Semantics (HEALS), to explore using AI technology to enhance healthcare.

Microsoft:

Microsoft's Hanover project, in partnership with Oregon Health & Science University's Knight Cancer Institute, analyzes medical research to predict the most effective cancer drug treatment options for patients. Other projects include medical image analysis of tumor progression and the development of programmable cells.

Other:

Digital consultant apps like Babylon Health's GP at Hand, Ada Health, and Your.MD use AI to give medical consultation based on personal medical history and common medical knowledge. Users report their symptoms into the app, which uses speech recognition to compare against a database of illnesses. Babylon then offers a recommended action, taking into account the user's medical history. Entrepreneurs in healthcare have been effectively using seven business model archetypes to take AI solutions to the marketplace. These archetypes depend on the value generated for the target user (e.g. patient focus vs. healthcare provider and payer focus) and value capturing mechanisms (e.g. providing information or connecting stakeholders).

The use of AI is predicted to decrease medical costs as there will be more accuracy in diagnosis and better predictions in the treatment plan as well as more prevention of disease.

Limitation of Human Mind:

- An object of recognition. People cannot properly explain how they recognize objects.
- Face recognition. Cannot be passed on to another person by explanation.
- The naming of colors. Based On Learning Not On Absolute Standards.

Barriers to Artificial Intelligence Implementation

There are pros and cons to everything, and AI is no different.

Or should we call these cons, fear?

Despite all the benefits (which we will discuss next), the fear surrounding more intelligent solutions can often be a controversial topic.

Today, there are still barriers to the widespread adoption of AI, and not just in the healthcare industry. As a whole, some challenges need to be addressed and overcome before moving forward and implementing AI.

R&D Magazine, which provides research and development news for more than 50 years, points out four key obstacles:

1. Integration of data is complex, which can result in missing and disparate data.
2. Challenges such as trust, legal and liability issues
3. Time and energy limitations to consider and the need for better hardware designs.
4. Talent shortage - specific skills and knowledge needed to succeed with AI.

Let's take a granular look at the healthcare industry.

What are the general *fears* of AI in healthcare?

- Fear of job replacement:
  - Concern that computers will replace physicians and staff
- Less human interaction and affectionate care
- Data privacy
  - Data usage could be interpreted as an infringement of a patient's right to privacy
- Understanding and learning new techniques in the workplace
- Development costs
- Cyber security threats or vulnerabilities

Potential Challenges in the Healthcare AI Market

The healthcare industry faces an uphill battle for full AI integration. TM Capital Corp. prepared an in-depth industry spotlight highlighting their thoughts on the nine potential challenges.

The healthcare industry faces an uphill battle for full AI integration. TM Capital Corp. prepared an in-depth industry spotlight highlighting their thoughts on the below nine potential challenges.

Based on information gathered from Global Market Insights, “Healthcare AI Market Size, Competitive Market Share & Forecast, 2024” (2017) and Markets and Markets, “Artificial Intelligence in Healthcare Market” (2017).

- High initial Capital Requirement
- Potential for increased Unemployment
- Difficulty in Deployment.
- Reluctance among Medical Practitioners To Adopt AI
- Ambiguous Regulatory Guideline For Medical Software
- Lack Curated Health Care Data
- Concern Regarding Privacy And Security
- Lack Of Interoperability Between AI Solution
- State And Federal Regulation

Source: Based on information gathered from Global Market Insights, "Healthcare AI Market Size, Competitive Market Share & Forecast, 2024” (2017) and Markets and Markets, “Artificial Intelligence in Healthcare Market” (2017).

According to the study, a major concern is State and Federal regulators, "they are a key hurdle facing AI".

The healthcare leadership team at TM Capital adds,

"Certificates of Need, risk-based capital requirements, and burdensome reporting can create major barriers to new entrants and innovations".

Even with its challenges, the question remains...

Do the benefits outweigh the potential challenges and fears?

Advantages of Artificial Intelligence in Healthcare for an Improved Future

The healthcare AI market is projected to grow at a 39.4% CAGR to more than $10 billion in worldwide revenue by 2024. And with good reason...

Artificial intelligence offers several advantages when exploring the healthcare landscape. It promises innovation in the healthcare system for a **better future**.

Let's go back and address a few of those fears from earlier:

- *Computers will replace doctors.* Not necessarily - they will complement them. AI technology can assist doctors in making **better data-driven decisions**.

- There can be a positive impact on the reduction in mortality rates. AI can help improve the **efficiency of disease diagnosis**, management, and treatment.

  - Accessibility of information can be positive and is not always an infringement of privacy.

Keith Kirkpatrick, a principal analyst at Tractica who focuses on emerging interface technologies, adds,

"AI applications are designed to address specific, real-world use cases that make the diagnosis, monitoring, and treatment of patients more efficient, accurate, and available to populations around the world".

- Based on a study by Frost & Sullivan, the market for AI has the potential to improve healthcare outcomes by 30 to 40 percent while simultaneously **cutting treatment costs in half by:**

  - **Integrating information** such as medical records with operating metrics can help assist physicians.

  - **Reducing unnecessary hospital visits** by alerting staff only when patient care is needed.

  - **Creating time-saving administrative duties** such as voice-to-text transcription

The benefits, including better patient care, reduced costs and leveraging the many opportunities offered by the integration of AI, significantly outweigh the fears and challenges.

Below we highlight a quick side-by-side comparison of the pros and cons of AI in healthcare.

How Artificial Intelligence Plays a Role in Healthcare [Pros vs. Cons]

Pros	Cons
Better data-driven decisions	Concerns regarding privacy & security
Increased disease diagnosis efficiency	Lack of curated healthcare data
Treatment time cut in half	High initial capital investment
Integration of information	Lack of interoperability
Reduce unnecessary hospital visits	Reluctance from staff to embrace AI
Create time-saving administrative duties	Potential for increased unemployment

The debate over artificial intelligence in healthcare will always be present. Overall, the main goal is to develop AI safely and with a purpose for patients, physicians, and developers.

○ Knowledge-Based Expert System, which can cross-reference symptoms and disease will greatly improve the accuracy of diagnostic.

○ They will probably be increasingly used in the field of medicine.

○ Object recognition will also be a great aid to doctors.

○ Along with images from cat scans or x-ray machines, they will be get preliminary analysis of those images.

○ This course will be possible only if people solve legal questions that arises by giving power to a machine to control or influence the health of human.

Disadvantages

- Application of artificial intelligence
- Robotic surgery
- Virtual Nursing Assistants
- Administrative work Flow Assistance

- Expert System
- Natural language processing
- Speech recognition
- Computer vision

1. ROBOTIC SURGERY?

Robotic or Robot-assisted surgery integrates advanced computer technology with the experience of skilled surgeons. This technology provides the surgeon with a 10x magnified, high-definition, 3D-image of the body's intricate anatomy.

The surgeon uses controls in the console to manipulate special surgical instruments that are smaller, as well as more flexible and maneuverable than the human hand. The robot replicates the surgeon's hand movements while minimizing hand tremors. The surgeon thus can operate with enhanced precision, dexterity, and control even during the most complex procedures.

Robotic surgeries are considered “minimally invasive” — meaning practitioners replace large incisions with a series of quarter-inch incisions and utilize miniaturized surgical instruments.

Cognitive surgical robotics combines information from actual surgical experiences to improve surgical techniques. In this type of procedure, medical teams integrate the data from pre-op medical records with real-time operating metrics to improve surgical outcomes. The technique enhances the physician’s instrument precision and can lead to a 21 percent reduction in a patient’s length of hospital stay post-operation.

The da Vinci technique allows surgeons to perform a range of complex procedures with greater flexibility and control than conventional approaches. Considered to be the world’s most advanced surgical robot, the da Vinci has robotic limbs with surgical instruments attached and provides a high-definition, magnified, 3D view of the surgical site. A surgeon controls the machine’s arms from a seat at a computer console near the operating table. This allows the surgeon to successfully perform surgeries in tight spaces and reduces the margin for error.

Also under the physician’s control is HeartLander — a miniature mobile robot that can enter the chest through an incision below the sternum. It reduces the damage required to access the heart and allows the use of a single device for performing stable and localized sensing, mapping, and treatment over the entire surface of the heart. In addition to administering the therapy, the robot adheres to the pericardial surface of the heart and can autonomously navigate to the directed location.

2 Virtual nursing assistants:

Virtual nursing assistants could reduce unnecessary hospital visits and lessen the burden on medical professionals. According to Syneos Health Communications, 64 percent of patients reported they would be comfortable with AI virtual nurse assistants, listing the benefits of 24/7 access to answers and support, round-the-clock monitoring, and the ability to get quick answers to questions about medications.

San Francisco-based virtual nurse assistant Sensely recently raised $8 million in Series B funding to deploy fleets of AI-powered nurse avatars to clinics and patients. The key goals of the technology are to keep patients and care providers in communication between office visits and to prevent hospital readmission. Ensley's most commonly referenced nurse is Molly, which uses a proprietary classification engine and listens and responds to users.

Care Angel's virtual nurse assistant Angel is another good example for this category. The bot enables wellness checks through voice and AI to drive better medical outcomes at a lower cost. It can manage, monitor, and communicate using unique insights and real-time notifications.

3. Administrative workflow assistance:

Automation of administrative workflow ensures that care providers prioritize urgent matters and can also help doctors, nurses, and assistants save time on routine tasks. Some applications of AI on the administrative end of health care include voice-to-text transcriptions that automate non-patient care activities like writing chart notes, prescribing medications, and ordering tests.

An example of this comes from Nuance. The company provides AI-powered solutions that rely on machine learning to help health care providers cut documentation time and improve reporting quality. Computer-assisted physician documentation (CAPD) offers real-time clinical documentation guidance that helps providers ensure their patients receive an accurate clinical history and consistent recommendations.

Another example of this is a five-year agreement between IBM and Cleveland Clinic that aims to transform clinical care and administrative operations. The collaboration uses Watson and other advanced technologies to mine big data and help physicians provide a more personalized and efficient treatment experience. Watson's natural language processing capabilities allow care providers to quickly and accurately analyze thousands of medical papers to provide improved patient care and reduce operational costs.

John Hopkins Hospital made a similar move in its partnership with GE Healthcare Camden Group. This initiative aims to improve patient care and efficiency via the adoption of hospital command centers equipped with predictive analytics. The strategy will help health care professionals make quick and informed decisions for operational tasks like scheduling bed assignments and managing requests for unit assistance.

Bottom line

While advancements like these can reduce human error and boost overall outcomes and consumer trust, many still question the practical applicability of AI in health care. Patients and caregivers alike fear that lack of human oversight and the potential for machine errors can lead to mismanagement of care, while data privacy remains one of the biggest challenges to AI-dependent health care.

Despite such concerns, the growing involvement of AI in health care is inevitable. But as these advancements suggest, the potential benefits might just outweigh the risks.

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4. Expert System

An expert system is a computer program designed to act as an expert in a particular domain.

Phases in Expert system

Expert Systems currently are designed to assist experts, not to replace them, they have been used in medical diagnosis, chemical analysis, geological exploration, etc.

5. Natural language processing

The goal of NLP is to enable people and computers to communicate in a natural language rather than in a computer language.

The field of NLP is divided into 2 categories

- Natural language understanding
- Natural language generation

6. Speech recognition

- The primary interactive method of communication used by humans is not reading and writing, it is speech.
- The goal of speech recognition research is to give computers to understand human speech. so that they can hear our voice and recognize the words we are speaking.
- It simplifies the process of interactive communication between people and computers, thus it advances the goal of NLP.

7. Computer vision

People generally use vision as their primary means of sensing their environment, we generally see more than we hear, feel or smell or taste.

The goal of computer vision research is to give computers this same powerful facility for understanding their surroundings. Here A. I help computer to understand what they see through the attached cameras.

Table No. 1. Safety Issues for Artificial Intelligence (AI) in Health Care.

Safety Issue	Elements of Hazard	Key Steps to Mitigation
Distributional shift	Out-of-sample predictions	Training of AI systems with large and diverse data sets
Quality of data sets	Poor definition of outcomes Non-representative data sets	Build more inclusive training algorithms using balanced data sets, correctly labeled for outcomes of interest
Oblivious impact	High rates of false-positive and false-negative outcomes	Include outliers in training data sets Enable systems to adjust for confidence levels Sustained and repeated use of AI algorithms Transparent and easily accessible AI algorithms
Confidence of prediction	Uncertainty of predictions Automation complacency	Sustained and repeated use of AI algorithms Transparent and easily accessible AI algorithms
Unexpected behaviors	Calibration drifts	Design and train systems to learn and unlearn and have more predictable behavior
Privacy and anonymity	Identification of patient data	Define layers of security and rules for data privacy
Ethics and regulations	Poor ethical standards and regulatory control for development and deployment of AI	Anonymize data before sharing

CONCLUSION

The potential of artificial intelligence is difficult to ignore. The number of successful case studies and examples will continue to grow as we look toward the future, for the integration of AI in healthcare.

Artificial intelligence promises to make sense of complex medical data, gain insights, and better recognize patterns in behavior. AI is a “decision engine” that can exponentially increase the effectiveness and efficiencies of healthcare organizations.

At CHT, we continue to provide innovative technology solutions that help facilities strive for a simple, safe, and secure way to manage healthcare compliance and patient safety.

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