









Certificate Course in

Healthcare Technology (CCHT)

Module 2 : Technology-led Health Care Part-1

Artificial intelligence and its application in Healthcare











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Artificial intelligence and its application in Healthcare

Learning Objectives:

- To create awareness to the HealthCare doctors, nurses and health worker community about AI as a technology
- Familiarize with the terminologies and definitions of AI
- Make them aware of how AI can be leveraged in HealthCare
- Provide pointers through examples the art of the possible using these technologies

Overview of Session:

- The Buzz Around AI
- Basic Terminologies and Definitions
- Al Application in HealthCare
- · Challenges and Way Forward
- References and Acknowledgements











Detailed reading content:

The Buzz around Al

Artificial intelligence as an academic discipline was founded in the 50s. Actually the "Al" term was coined by *John McCarthy*, an American computer scientist, back in 1956 at The Dartmouth Conference.

AI works at its best by combining large amounts of data sets with fast, iterative processing and intelligent algorithms.

Al technologies will continue disrupting in 2020 and beyond and will become even more widely available due to affordable cloud computing and big data explosion.

<u>Unlimited access to computing power</u> Today we have super-fast GPUs with highest computational power and

<u>Huge fall in cost of storing data</u> Unlimited storage available at affordable price to develop and simulate models

<u>Explosion in data that is digitized</u> Availability of abundant data both structured and unstructured made available through digital technologies which has matured to be able to decipher images, voice, speech, text and video.

Al is basically an umbrella term for it all

Al is not about just one technology. It is a constellation of technologies that enable machines to act with higher levels of intelligence and emulate the human capabilities of sense, understand and respond

AI IS NOT STATIC – IT LEARNS AND THINKS

It is the learning component that makes AI different from historical approaches to building machines or programming software. Coupling such learning with the modern capabilities available to software programs, including Internet connectivity, the ability to store and process huge volumes of data quickly and without fatigue, and recall data perfectly, leads to machines that can complement and augment human capabilities.

AI AMPLIFIES HUMAN CAPABILITIES Of the cognitive functions listed earlier, the detail oriented, indefatigable nature of the machine lends itself well to comprehension, expression, perception, calculation, recall, organization, and reasoning (specifically in terms of working out inferences and entailment in answer to a question).











Related AI Terminologies

ANI: Artificial Narrow Intelligence

Artificial Narrow intelligence is also known as weak AI and it is the only type of AI that exists in our world today. Narrow AI is goal oriented and is programmed to perform a single task and is very intelligent in completing the specific task that it is programmed to do. Some examples of ANI are Siri, Auto pilot in an airplane, chat bots, self-driving cars etc.

Narrow AI systems are not conscious, sentient or driven by emotions as humans are, they use information from a specific dataset and do not perform any task that is outside of the single task that they are designed to perform.

AGI: Artificial General Intelligence

Artificial General Intelligence also referred to as strong AI is a concept in which machines exhibit human intelligence. In this the machines have the ability to learn, understand and act in a way that is indistinguishable from a human in a given situation. The General AI does not currently exist but has been used in many sci-fi Hollywood movies in which the humans interact with machines that are conscious, driven by emotions and self-aware.

Using strong AI, we can have the ability to build machines that can think, strategize and perform multiple tasks under uncertain conditions. They can integrate their prior knowledge in decision making to come up with innovative, creative and unconventional solutions.

ASI: Artificial Super Intelligence

I am sure you remember Arnold Schwarzenegger's "The Terminator" where a machines cognizance superseded human intelligence in all aspects. Artificial Super Intelligence is a hypothetical AI where machines will be capable of exhibiting intelligence that surpasses that of the brightest humans. In this type of AI, apart from having multifaceted intelligence of human beings' machines will have greater problem solving and decision-making capabilities that will be far superior than human beings. It is the type of AI that will have great impact on humanity and may lead to extinction of the human race from the planet.

Machine Learning

What is Machine Learning?

Machine Learning is a subset of Artificial Intelligence that uses statistical learning algorithms to build systems that have the ability to automatically learn and improve from experiences without being explicitly programmed.











Most of us use machine learning in our day to day life when we use services like recommendation systems on Netflix, YouTube, Spotify; search engines like google and yahoo; voice assistants like google home and amazon Alexa. In Machine Learning we train the algorithm by providing it with a lot of data and allowing it to learn more about the processed information.

ML algorithms can be broadly classified into three categories Supervised, Unsupervised and Reinforcement learning.

Supervised Learning

In supervised learning we have input variables (x) and an output variable (Y) and we use an algorithm to learn the mapping from input to output. In other words, a supervised learning algorithm takes a known set of input dataset and its known responses to the data (output) to learn the regression/classification model. A learning algorithm then trains a model to generate a prediction for the response to new data or the test datasets.

Unsupervised Learning

Unsupervised Learning is used when we do not have labelled data. Its main focus is to learn more about the data by inferring patterns in the dataset without reference to the known outputs. It is called unsupervised because the algorithms are left on their own to group the unsorted information by finding similarities, differences and patterns in the data. Unsupervised learning is mostly performed as a part of exploratory data analysis. It is most commonly used to find clusters of data and for dimensionality reduction.

Reinforcement Learning

In simple terms, reinforcement learning can be explained as learning by continuously interacting with the environment. It is a type of machine learning algorithm in which an agent learns from an interactive environment in a trial and error way by continuously using feedback from its previous actions and experiences. The reinforcement learning uses rewards and punishments, the agents receive rewards for performing correct actions and penalties for doing it incorrectly.

Deep Learning

What is Deep Learning?

Deep learning is a machine learning technique that is inspired by the way a human brain filters information, it is basically learning from examples. It helps a computer model to filter the input data through layers to predict and classify information. Since deep learning processes information in a similar manner as a human brain does, it is mostly used in applications that people generally do. It is the key technology behind driver-less cars, that enables them to recognize a stop sign and to distinguish between a pedestrian and lamp











post. Most of the deep learning methods use neural network architectures, so they are often referred to as deep neural networks.

Deep Learning is basically mimicking the human brain, it can also be defined as a multi neural network architecture containing a large number of parameters and layers. The three fundamental network architectures are as listed below:

Machine Learning involves the use of algorithms to parse data and learn from it and making a determination or prediction as a result

Deep Learning is technique for implementing Machine Learning. Deep learning was inspired by the structure and function of the Brain, specifically the interconnecting of many neurons.

<u>Artificial Neural Networks</u> (ANNs) are algorithms based on the Biological structure of the brain.

Convolutional Neural Networks Similarly you have what they call as Convolutional Neural Network which is a Deep Learning algorithm which can take in an input image, assign importance (learnable weights and biases) to various aspects/objects in the image and be able to differentiate one from the other. The architecture of a ConvNet is analogous to that of the connectivity pattern of Neurons in the Human Brain and was inspired by the organization of the Visual Cortex. Individual neurons respond to stimuli only in a restricted region of the visual field known as the Receptive Field. A collection of such fields overlaps to cover the entire visual area.

NLP (Natural Language Processing) The ability of computers to work with computers the way humans do

Computer Vision is the discipline of teaching "the machine how to see "

Al Applications in Healthcare

Healthcare is expected to grow to USD280 billion by 2020, at a CAGR of upwards of 16%, from the current ~USD100 billion. Major challenges of quality, accessibility and affordability for a large section of the population across the world

Shortage of qualified healthcare professionals and services

0.76 doctors and 2.09 nurses per 1,000 population (as compared to WHO recommendations of 1 doctor and 2.5 nurses per 1,000 population respectively) and 1.3 hospital beds per 1,000 population as compared to WHO recommended 3.5 hospital beds per 1,000 population











Challenges in the Indian context

Non-Standardized Hospital Information Systems (HIS), Lack of adoption of terminology standards, Heterogeneity and varying priorities between hospital to hospital

Al in healthcare is about systems that assist and support the wisdom and experience of well-trained clinicians in making better data-driven decisions and taking actions that best support the needs of those they serve.

The opportunity for AI in healthcare is not just about making doctors and healthcare providers more efficient in their work; it's about making the lives of the patients better and saving lives. The application of AI is nascent.

The advantage of deep leaning technique is that it can understand specific details from images. And most of these diseases remain asymptomatic as all of this appear suddenly one day. So with deep learning with vast amount of training it can identify and distinguish infinitesimal changes which is otherwise ignored by even experienced doctors and this forms the fundamental basis for AI for Health care

ML & DL algorithms are used in radiology, cardiology and pathology based on the size of datasets.

DL algorithms are trained to look into images, identify abnormalities and diagnoses the patient's condition. Improves accuracy efficiency and reliability of processes.

Deep learning algorithm helps dermatologists in identifying skin cancer. Universal access to health care was on the minds of computer scientists at Stanford when they set out to create an artificially intelligent diagnosis algorithm for skin cancer. They made a database of nearly 130,000 skin disease images and trained their algorithm to visually diagnose potential cancer. From the very first test, it performed with inspiring accuracy.

Cancer detection using AI by NHS

In recent years, a global increase in cancer cases has coincided with a decline in the number of pathologists around the world. Traditional pathology involves manual processes that have remained unchanged for years, where slides are analysed by pathologists using microscopes, and reporting is often carried out on pieces of paper. Limited availability of pathologists requires couriers to transport glass slides containing tissue samples between different locations to access expert opinions. The shortage of pathologists in the UK has led to delays in cancer diagnosis, which can take up to six weeks, and together with increased demand, is exerting tremendous pressure on pathology departments while raising concerns about diagnostic accuracy.











This is an example of how NHS streamlined their diagnostic processes using LDPath, a service provider of NHS using AI powered solution integrated into the digital pathology workflow. With this solution LDPath was able to diagnose with high accuracy using AI algorithms the glass slides of tissue samples. The algorithm will alert any significant difference what the machines infers against what the experts would have concluded. This provided a safety net to reduce the diagnostic errors caused by humans and enhance the quality control as well as the 6 weeks delay was reduced to less than 24 hours

As mentioned by me earlier, Computer scientists at Stanford have created an AI diagnosis algorithm for skin cancer that matched the performance of board-certified dermatologists.

Google has developed a DL algorithm to identify cancerous tumors on mammograms and achieved 89 % accuracy, beyond the 73 % score of a human pathologist.

Medical Diagnostics using AI

Prostate Cancer detection at University of Pittsburgh

Here is an example of work carried out by University of Pittsburgh Medical Center on detection and diagnosis of Prostate Cancer using AI. This example clearly demonstrates the amount of hard work one has to do to collect sample data for coaching the algorithms before you put to actual use. The first step was to collect more than a million parts of stained tissue slides taken from different patients, and the next step is to label them by expert pathologists to teach the AI algorithms to discriminate between a healthy and an abnormal tissue. And then the algorithm was tested on a separate set of 1,600 slides taken from 100 consecutive patients seen at UPMC for suspected prostate cancer. During testing, the AI demonstrated 98% sensitivity and 97% specificity at detecting prostate cancer — significantly higher than previously reported for algorithms working from tissue slides. In medical diagnosis, test sensitivity is the ability of a test to correctly identify those with the disease (true positive rate), whereas test specificity is the ability of the test to correctly identify those without the disease (true negative rate). Also, this is the first algorithm to extend beyond cancer detection, reporting high performance for tumor grading, sizing and invasion of the surrounding nerves. These all are clinically important features required as part of the pathology report. All also flagged six slides that were not noted by the expert pathologists. This doesn't necessarily mean that the machine is superior to humans. For less experienced pathologists, though, the algorithm could act as a failsafe to catch cases that might otherwise be missed.











Conversational Expert systems

There have been examples in the development of what we call as Conversational Expert systems or sometime called Conversational Intelligence. These systems are able to carry out a sensible conversation with the end user either through speech or text. The Conversation is very contextual and it has to have the intelligence about the context of the queries asked by the end user

Drug Discovery using Al

In the fields of medicine, biotechnology and pharmacology, **drug discovery** is the process by which new candidate medications are discovered. Historically, drugs were discovered by identifying the active ingredient from traditional remedies or by serendipitous discovery, as with penicillin.

Drug development is the process of bringing a new <u>pharmaceutical drug</u> to the market once a <u>lead compound</u> has been identified through the process of <u>drug discovery</u>.. It includes <u>preclinical research</u> on microorganisms and animals, filing for regulatory status, such as via the United States <u>Food and Drug Administration</u> for an <u>investigational new</u> <u>drug</u> to initiate <u>clinical trials</u> on humans, and may include the step of obtaining <u>regulatory</u> <u>approval</u> with a <u>new drug application</u> to market the drug.

BioXcel Therapeutics, Inc. is a clinical stage biopharmaceutical company utilizing artificial intelligence to identify improved therapies in neuroscience and immuno-oncology.

Berg is a clinical stage AI powered biotechnology company. They harness the power of AI, coupled with patient biology, to accelerate clinical identification and pursuit of promising therapeutic targets to treat disease. This means faster discovery and development of treatments, more effective precision treatments for individuals as well as a reduction in costs to our healthcare systems.

XtalPi Inc. operates as a pharmaceutical technology company that offers digital drug development solutions. The company was founded in 2014 and is based in Cambridge, Massachusetts with additional office in China.

XtalPi is reinventing the industry's approach to drug research and development with its Intelligent Digital Drug Discovery and Development (ID4) platform. With tightly interwoven quantum physics, artificial intelligence, and high-performance cloud computing algorithms, the platform provides accurate predictions on the physiochemical and pharmaceutical properties of small-molecule candidates for drug design, solid-form selection, and other critical aspects of drug development.

Atomwise, Inc. develops AI solutions for drug discovery. Atomwise, Inc. was founded in 2012 and is based in San Francisco, California.

Deep Genomics Inc. develops an AI-powered discovery platform that supports geneticists, molecular biologists, chemists, toxicologists, and drug developers in the











identification and development of genetic medicines. Deep Genomics Inc. was founded in 2014 and is based in Toronto, Canada.

Medical Prognosis using Al

Researchers at Cardiff University in the UK have demonstrated that AI is just as accurate as traditional methods at providing an accurate and reliable prognosis of cardiovascular disease.

While there are reliable methods of forecasting people according to their degree of risk of serious heart events, AI promises new ways of interrogating data and the likelihood of more reliable classification of risk.

In the study, the research team trialled a technique called genetic programming (GP). GP is a method which involves computer programs encoding a set of genes that are then iteratively modified or evolved.

GP is said to be better than algorithms produced by humans because it reduces bias and the possibility of human error while allowing for any changes in the environment to be automatically integrated into mathematical formulas.

During the Cardiff University study, GP was used to assess the future risk of a cardiovascular event in over 3,800 cardiovascular patients, aged between 19 and 83 years old, over a ten-year period.

The machine-learning algorithms relied on 25 predictors taken from patient data, including age, BMI, sex, alcohol and smoking habits and blood pressure. The results showed that the AI could perform comparably to traditional methods when predicting the risk associated with individual patients.

Medical Treatment using AI

RaySearch has headquarters in Sweden and operations across world. They focus on software related to cancer treatment. RaySearch Laboratories is a Swedish medical technology company that develops software used in radiation therapy of cancer. The company markets its products worldwide and has subsidiaries in the US, Singapore, Belgium, France, Germany and the UK.

Varian Medical Systems is an American radiation oncology treatments and software maker based in Palo Alto, California. Their medical devices include linear accelerators and software for treating cancer and other medical conditions with radiotherapy, radiosurgery, proton therapy, and brachytherapy. The company supplies software for managing cancer clinics, radiotherapy centers, and medical oncology practices. Varian is a supplier of tubes and digital detectors for X-ray imaging in medical diagnostics,











dentistry, veterinary care, scientific, security, industrial inspection including high-energy X-ray technology for cargo screening. Varian Medical Systems employs more than 7,100 people at manufacturing sites in North America, Europe, and China and approximately 70 sites globally.

Streamline Processes

Qventus, Inc. provides software solutions. The Company offers artificial intelligence based software platform to improve pharmacy operations. Qventus serves healthcare sector in the State of California.

Adoption of AI in the Health Care Industry

The key challenges in Healthcare Industry:

- Non-Standardized Hospital Information Systems (HIS)
- Lack of adoption of terminology standards
- Heterogeneity and varying priorities between hospital to hospital
- Varying levels of HIS maturity and adoption

Our approach to address this complex domain in India has been based on three technological levers

- 1. One is about developing a platform which engages TECHNOLOGY, PEOPLE and PROCESSES in a holistic way to match the unique strengths and needs of healthcare.
- 2. Secondly it focuses on HEALTHCARE DELIVERY making it accessible to millions of people
- 3. Thirdly the platform has a unique & patented way of COMBINING STRUCTURED AND UNSTRUCTURED DATA into one cohesive picture.

This platform developed by TCS consists of two cutting edge innovation in the area of AI/ML and Data Analytics

Concentric Data Repository (CDR) is a technology solution built ground-up understanding the need of the industry in both India and Global scenario. Healthcare Data evolves over every transaction and the technology platform aggregates these data points over time in a seamless way. This becomes as the first unified repository in next 5 years

Clinicograph – A graphical representation of longitudinal patient record combining both structured and unstructured data is the next big innovation on the Bridgital Healthcare Platform. This form of visualizing healthcare data is very unique, easy and represented to bring contextual knowledge to the Doctor on a patient's health condition.











Developing India as a global AI service delivery hub – DiSQ case study

We have an opportunity to develop India as a global AI Service Delivery Hub or an AI Garage as we would call it. To illustrate this I would like talk about the TCS sponsored Social Entrepreneurship innovation center based out of Nashik to create a social impact through the use of inclusive design and digital technologies.

The Innovation Center focuses on 7 social themes that form the fabric of our lives - health and hygiene; education and skills; financial and personal security; energy, water, and the environment; food and agriculture; housing and transportation; and citizen empowerment and transparency

It has created 340+ innovators from across India handpicked from our colleges, with an average age of 22 years. 6 potential start-ups incubating in GROW mode

A few initiatives from DISQ

Trestle Labs is an Assistive Technology company empowering the Blind and visual-impaired community towards inclusive Education and Employment by enabling real-time access to any Printed, Handwritten and Digital content through audio across 12 Indian and multiple international languages. **The** platform enables **scanning of printed material** and leverages **Image processing, Al & ML** for accessing printed material in the audio and digital form with appropriate context. This helps 20 K+ Visually impaired student users across 3 countries and 15 states in India

Challenges and Way Forward

Ethical Al

For AI to be trustworthy, it should be "human-cantered" – designed in a way that augments human ingenuity and capabilities – and that its development and deployment must be guided by ethical principles that are deeply rooted in timeless values - of fairness, inclusivity, transparency, accountability and reliability

Responsible Al

Responsible AI is a framework for ensuring AI is uses in a manner consistent with user expectations, organizational values and societal laws and norms.

Data Privacy is an important aspect of Responsible AI. Systems that maintain and use Patient health records, transactions monitoring have to be protected from cyberattacks. There has to be laws to protect the privacy of the patient's data as well as ensure anonymization of patient's data











Explainable Al

Explainable is about clarity on system's capabilities and limitations, traceability of inputs and outcomes. The entire step by step process is explainable for the clarity it provides for the various actions it performs.

Last mile

Non-uniform accessibility to healthcare across the country with physical access continues to be the major barrier to both preventive and curative health services, and glaring disparity between rural and urban India. These have a major impact of the quality of services delivered to the patients especially we have the added challenge of shortage of qualified healthcare professionals and services like qualified doctors, nurses, technicians and infrastructure.

References & Suggested readings:

- <u>https://towardsdatascience.com/notes-on-artificial-intelligence-ai-machine-learning-ml-and-deep-learning-dl-for-56e51a2071c2</u>
- https://news.stanford.edu/2017/01/25/artificial-intelligence-used-identify-skin-cancer/
- <u>https://www.mercurynews.com/2017/03/03/google-computers-trained-to-detect-cancer/</u>
- <u>https://www.clearobject.com/single-post/edge-iot-technology-edge-ai-healthcare-2020</u>
- <u>https://niti.gov.in/writereaddata/files/document_publication/NationalStrategy-for-Al-</u> <u>Discussion-Paper.pdf</u>
- https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0202685
- Image Ref : https://res.6chcdn.feednews.com/assets/v2/278aa3bd1a34c8e8e042c84c1ce3cca0
- https://cardiffstudentmedia.co.uk/gairrhydd/cardiff-uni-researchers-develop-new-ai-diagnosismethod/





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Indian Institute of Space Science and Technology

Certificate Course in

Healthcare Technology (CCHT)

Module 2 : Technology -led Health Care Part 1

Artificial intelligence and its Application in Healthcare



PR Krishnan, Executive Vice President & Global Head, Enterprise Intelligence Automation & Artificial Intelligence, TCS

PR Krishnan (PRK) is Executive Vice President & Global Head, Enterprise Intelligent Automation & Artificial Intelligence (EIA & AI) at Tata Consultancy Services (TCS). In this role, PRK helps business and technology leaders drive innovation and integrate digital technologies – AI, smart automation, machine learning and cognitive computing – into their business model for growth and transformation. PRK has strategized innovations that drive human - machine collaboration that serve as the guiding force for elevated growth and success in the Business 4.0 era. PRK's team creates new opportunities for enabling the world's leading enterprises to become AI ready and harness human ingenuity together with machine precision.



For more than 35 years, PRK has played a pivotal role in coaching large teams, demonstrating thought leadership and innovation towards uncovering insights and creating exponential value for large enterprises. Prior to leading the EIA & AI portfolio, PRK served as Global Head of the IT Infrastructure Services, overseeing the expansion of the TCS services portfolio. In this role, he successfully led several of TCS' global delivery centers (GDC), paving the way for the creation of the company's Global Network Delivery Model (GNDM[™]).

Starting in 2004, he was responsible for creating and running the telecom delivery centers for TCS, where he built a 3000+ strong practice servicing over 40 customers, growing the practice in a time when the telecom industry was just beginning to embrace technological advancements.

PRK has contributed significantly towards leading a very successful SEI CMM Level 5 assessment that became a new benchmark and model across TCS.

Learning Objectives

- To create awareness to the HealthCare doctors, nurses and health worker community about AI as a technology
- Familiarize with the terminologies and definitions of AI
- Make them aware of how AI can be leveraged in HealthCare
- Provide pointers through examples the art of the possible using these technologies



Overview of Session

- The Buzz Around AI
- Basic Terminologies and Definitions
- Al Application in HealthCare
- Challenges and Way Forward
- References and Acknowledgements



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The Buzz Around Al



Slide

Why this sudden interest and buzz around AI

AI has experienced a checkered history of waves of optimism followed by disappointment

A period of inertia since 1950

What has changed now?

Key developments responsible for this optimism

- Unlimited access to computing power
- Huge fall in cost of storing data
- Explosion in data that is digitized



Basic Terminologies and Definitions

Al is basically an umbrella term for it all

- Al is intelligence displayed by machines
- Al is a constellation of technologies
- Al refers to a broad set of methods, algorithms and technologies
- Al is not static it learns and thinks mimics cognitive functions like comprehending, expressing, perceiving, calculating, remembering, organizing, reasoning
- Al amplifies human capabilities stores and processes huge amount of data, quickly without fatigue, recalls data perfectly

Related AI Terminologies

Weak AI describes "simulated" thinking. That is, a system which appears to behave intelligently, but doesn't have any kind of consciousness about what it's doing. For example, a chatbot might appear to hold a natural conversation, but it has no sense of who it is or why it's talking to you.

Strong AI describes "actual" thinking. That is, behaving intelligently, thinking as human does, with a conscious, subjective mind. For example, when two humans converse, they most likely know exactly who they are, what they're doing, and why.

Narrow AI describes an AI that is limited to a single task or a set number of tasks.

General AI describes an AI which can be used to complete a wide range of tasks in a wide range of environments. As such, it's much closer to human intelligence.

Superintelligence is often used to refer to general and strong AI at the point at which it surpasses human intelligence, if it ever does.

Machine Learning (ML)

ML is a subset of AI - uses statistical learning algorithms to build systems. They have the ability to automatically learn and improve from experiences without being explicitly programmed.

Supervised learning algorithm takes a known set of input dataset (labelled) and its known responses to the data (output) to learn the regression/classification model.

Unsupervised Learning is about learning more about the data by inferring patterns in the dataset without reference to the known output. It works on unlabeled data

Reinforcement Learning is a ML algorithm in which an agent learns from an interactive environment in a trial and error way by continuously using feedback from its previous actions and experiences.

Deep Learning (DL)

Deep Learning was inspired by the structure and function of the brain, specifically the interconnecting of many neurons.

Deep Learning is basically mimicking the human brain.

Artificial Neural Networks (ANNs) are algorithms based on the Biological structure of the brain

Convolutional Neural Network (CNNs) is a deep learning algorithm that takes the input image and assigns weights/biases to various aspects or objects in the image, so that it can differentiate one from the other.

Recurrent Neural Networks(RNNs) are called recurrent because they perform the same task for every element of a sequence, with the output being dependent on the previous computations.

NLP (Natural Language Processing) is the ability of computers to work with computers the way humans do

Computer Vision is the discipline of teaching "the machine how to see"

AI Applications in Healthcare

AI Applications in Healthcare

Healthcare as an industry has tremendous potential,

However major challenges exists in terms

- Quality, accessibility and affordability
- Shortage of qualified healthcare professionals and services
- Non-Standardized Hospital Information Systems (HIS)
- Lack of adoption of terminology standards
- Heterogeneity and varying priorities between hospital to hospital

Slide

AI Applications in Healthcare

ML & DL algorithms are used in radiology, cardiology and pathology based on the size of datasets.

DL algorithms are trained to look into images, identify abnormalities and diagnoses the patient's condition. It improves accuracy, efficiency and reliability of processes.

DL and predictive algorithms are used in clinical decision making

For example, in Stanford, DL helped dermatologists in identifying skin cancer. A database of nearly 130,000 skin disease images created and trained their algorithm to visually diagnose potential cancer.

AI Applications in Healthcare

- Diagnostics
- Drug Discovery
- Prognosis
- Treatment
- Streamline processes



Slide

Medical Diagnostics using Al

In Jun 2020, AI based detection in NHS ensured prostate biopsies will be reviewed by AI within 24 hours from a delay of 6 weeks

Computer scientists at Stanford have created an AI diagnosis algorithm for skin cancer that matched the performance of board-certified dermatologists.

Google has developed a DL algorithm to identify cancerous tumors on mammograms - achieved 89 % accuracy, beyond the 73 % score of a human pathologist.



Image Ref: https://www.prnewswire.com/il/news-releases/uk-s-first-rollout-of-ai-based-cancer-detection-for-nhs-patients-as-pathology provider-ldpath-teams-up-with-ibex-medical-analytics-815805480.html

Medical Diagnostics using AI (Contd.)

Prostate Cancer detection at University of Pittsburgh

Recent* study by Univ Of Pittsburgh medical center has shown highest accuracy by AI @ 98% sensitivity and 97% specificity.

This algorithm can detect and also do tumor grading,

sizing and report on invasion of surrounding tissues.

It detected biopsy slides missed by humans ! Algorithm can also be trained for other types of tumors



Image ref: https://scitechdaily.com/artificial-intelligence-identifies-prostatecancer-with-near-perfect-accuracy/

Medical Diagnostics using AI (Contd.)

Conversational "Expert system"

Conversational AI is going to be very popular and help doctors learn symptoms from patients and make better decisions.

- Text chat / Speech interface
- Free format Conversational style English
- Question flow based on user responses
- Provisional diagnosis and advice



18

Drug Discovery using Al

The Stages in Drug Development



ML / DL algorithms applied

- analyze all the available data and identify good target proteins
- To speed up design of clinical trials
- Companies such as Bioxcel, Berg, XtalPi, Atomwise, Deep Genomics are heavily using AI/ML in drug discovery
- For example, XtalPi, Massachusetts based company is reinventing the industry's approach to drug research and development
- It is about a tightly interwoven quantum physics, AI, and high-performance cloud computing,
- Provides accurate predictions on the physiochemical and pharmaceutical properties of small-molecule candidates for drug design and development

Medical Prognosis using Al

AI & ML can give highly accurate and reliable prognoses for patients with cardio vascular diseases.

During the Cardiff University study, Genetic Programming was used to assess the future risk of a cardiovascular event in over 3,800 cardiovascular patients, aged between 19 and 83 years old, over a ten-year period.



This technique used 25 predictors (features) such as age, gender, BMI, alcohol and smoking use and BP.

Genetic Programming (GP) is a type of Evolutionary Algorithm a subset of ML. It mimics gene cross over by doing a crossover of 2 solutions to arrive at a better solutions

Medical Treatment using Al

RaySearch Lab has launched AI based treatment planning system, that can create automated treatment plans

The DL algorithm can generate a treatment plan for the use of radiation oncologists based on patient's parameters.

Varian Medical system has launched "RapidPlan" that enables medical professionals plan various treatment options for their cancer patients



A team of scientists have used AI to identify the right maintenance dosage of Tenovir for HIV patients.

The algorithm considers various parameters of the patient to decide the dose.

RaySearch has headquarters in Sweden and operations across world. They focus on software related to cancer treatment. Varian Medical system is another company that focuses only on software related to cancer cure. It is based out of Palo Alto, California

Slide

Streamline Processes

Current Challenges

Patients waiting to be admitted to a hospital bed, taking up ED space

ED crowding increases left-withoutbeing-seen patients and wait times

ICU readmits within 24 hours

Surgery delays or cancellations

Physicians, nurses, and staff overloaded

Delays in transferring patients to appropriate units



Qventus* Realtime Patient Flow optimization software using AI focused on Hospital streamlining solutions

Al powered faster hospital visits implemented at John Hopkins Hospital

60% improvement in ability to admit patients and a 21% increase in patient discharges before noon

Image source: gettyimages.ir

Slide

AI based mobile Apps

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SkinVision

Users can take photo of their skin. Using AI, the app takes 30 seconds to conduct the scan looking for signs of cancer.

ADA – AI Doctor

Asks simple questions, does information extraction from its medical library and gives tips and advice



Binah.ai

Wellness monitoring app. Video based vital signs monitoring app. Can monitor many parameters such as BP, heart rate, oxygen saturation etc

AI based Applications – The Indian Context

<u>Impact of Oncology Common Data Repository (CDR) & Clinicograph</u> **CDR** is a Healthcare Data Repository extracting over every transaction and the technology platform aggregates these data points over time in a seamless way. **Clinicograph** – A graphical representation of longitudinal patient record of structured and unstructured data. This form of visualizing healthcare data is very unique, easy to bring contextual knowledge to the Doctor on a patient's health condition.

<u>Digital Nerve Center(DiNC)</u> Tata Group sponsored program focused on **HEALTHCARE DELIVERY** – making it accessible to millions of people. DiNC connects more than 600 health facilities, 3M+ patients and 2000 specialists on the network. Unique & patented way of combining structured and unstructured data into one cohesive picture

India as global AI Service Delivery Hub TCS sponsored Social Entrepreneurship innovation center in Nashik to create a social impact through inclusive design and digital technologies. Created 340+ innovators handpicked from our colleges, average age of 22 years. 6 potential start ups incubating in GROW mode



Slide

Challenges and Way Forward

Challenges & Way Forward

Ethical Al	For AI to be trustworthy, it should be "human-centered" guided by ethical principles of fairness, inclusivity, transparency, accountability and reliability	
Responsible AI	Responsible AI is a framework for ensuring AI is used in a manner consistent with user expectations, organizational values and societal laws and norms.	
Explainable Al	Clarity on system's capabilities and limitations, traceability of inputs and outcomes. The entire step by step process is explainable for the clarity it provides for the various actions it performs.	
Last mile Connectivity	Convergence of technologies like Edge, IoT, 5G and Cloud to ensure remote locations access, integrated patient data access to doctors and autonomous monitoring of patients	
	Slide	

References & Acknowledgements

- <u>https://towardsdatascience.com/notes-on-artificial-intelligence-ai-machine-learning-ml-and-deep-learning-dl-for-56e51a2071c2</u>
- <u>https://news.stanford.edu/2017/01/25/artificial-intelligence-used-identify-skincancer/</u>
- <u>https://www.mercurynews.com/2017/03/03/google-computers-trained-to-detect-cancer/</u>
- <u>https://www.clearobject.com/single-post/edge-iot-technology-edge-ai-healthcare-</u> 2020
- <u>https://niti.gov.in/writereaddata/files/document_publication/NationalStrategy-for-</u> <u>AI-Discussion-Paper.pdf</u>
- https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0202685
- Image Ref : <u>https://res.6chcdn.feednews.com/assets/v2/278aa3bd1a34c8e8e042c84c1ce3c</u> <u>ca0</u>
- https://cardiffstudentmedia.co.uk/gairrhydd/cardiff-uni-researchers-develop-newai-diagnosis-method/

Certificate Course in Healthcare Technology (CCHT)

Thank You



PUBLIC HEALTH FOUNDATION OF INDIA







For more Information please contact

Program Secretariat – CCHT Public Health Foundation of India Plot No. 47, Sector 44, Institutional Area, Gurgaon -122002, India Tel: 0124-4781400 (Extn. 4511,4596,4512) Fax: 0124- 4722971 Mobile No.: +91- 9582215659, 9958158787 Web: www.phfi.org, ccht@phfi.org

