

AI Enabled Genetic Testing for Earlier Disease Detection

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Outline of the Presentation

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- Applications of AI
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- Oncology
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- Medical Diagnosis
- Early Detection of Deadly Diseases
- Medical Assistance
- Decision Making in Surgical Robots
- What is Cognitive AI?
- Difference Between AI and Cognitive AI
- Cognitive AI in Healthcare
- Summary

Artificial Intelligence (AI) & Machine Learning (ML)

Artificial Intelligence (AI): When cognitive human capabilities such as Learning, Decision Making and Problem Solving are embedded in a machine, it behaves intelligently and this machine smartness is referred to as Artificial Intelligence or AI.

Machine Learning (ML): It is a subset of AI that grants machines the ability to learn and improve through experience without precisely programmed for a particular task.

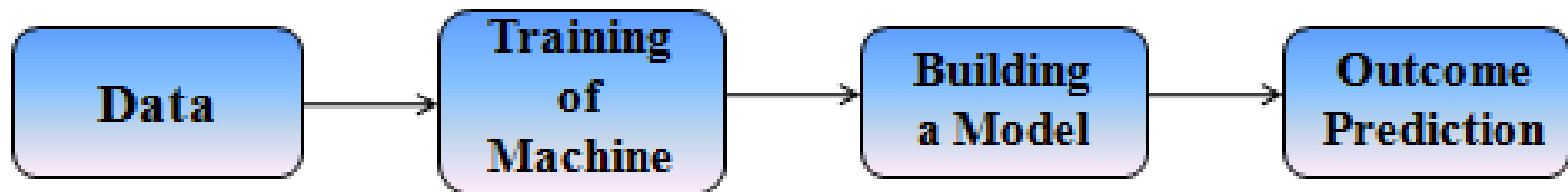


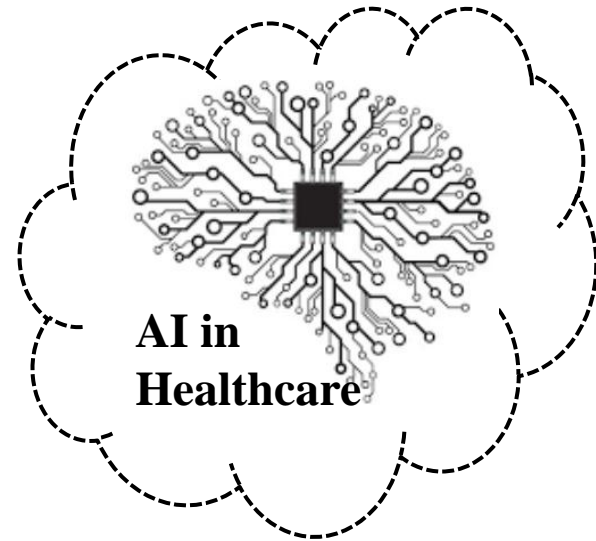
Figure – Steps in Machine Learning

Applications of AI

- Marketing
- Banking
- Finance
- Agriculture
- Gaming
- Space Exploration
- Autonomous Vehicles
- Chatbots
- Artificial Creativity
- Mining Industry
- Healthcare Industry

AI in Healthcare

- The medicine and healthcare industry is becoming smart with the machine learning algorithms that can make modern healthcare machines to predict, comprehend, learn and act.
- There are huge applications of AI in healthcare industries as follows.
 - Efficient diagnosis of diseases with reduction in error rates
 - Early and more accurate cancer diagnosis
 - Patient's symptom checking with the help of Chatbot
 - Getting actionable insights with the help of AI deep learning
 - Earlier cancer detection
 - Fast detection of deadly blood diseases is becoming reality with AI
- Also with AI, it is possible to develop new medicines, assistants such as radiology assistant can be trained, targeted treatment is possible with the help of deep learning.
- Better patient experience is observed with AI that allows hospitals to treat more patients in a day.
- Most repetitive processes in healthcare industry are being automated with AI.
- Many operational challenges can be resolved with AI by patient flow optimization, tracking of hospital waiting times, providing fastest ambulance routes in time, increasing access to healthcare in time.



**Wearable
Devices**

Telemedicine

**Personalized
Genetics**

**AI
Chatbots**

**Physical
Health**

**Mental
Health**

**Drug
Discovery**

**Skin
Health**

**Information
& Clinical
Trials**

**Lifestyle
Management**

**Genetic
Research**

**Disease
Management**

**Hospital
Management**

**Medical
Records**

**Data
Analytics**

**Medical
Imaging**

Radiology

- Development of Deep Learning based algorithm using more than 50,000 normal chest images and 7000 scans with active TB in 2018.
- This algorithm outperformed normal radiologist's diagnosis.
- AI is emerging as second reader for physicians with better screenings and precise diagnostics.

Dermatology

- Use of Deep Learning Neural Network for identification of skin cancer.
- More than 100000 images with malignant traces were used.
- This technique found to provide more accurate detection than Dermatologists.

Oncology

- IBM Watson, AI enabled system is being used for cancer diagnosis and treatment.
- Many hospitals have adopted it with medical judgment.

AI Algorithms used in Various Cancer Diagnosis

Sr. No	Type of Cancer	Mutation Observed in/ Risk Factors	Related Tests	AI Technique Used
1	Breast Cancer	BRCA1 and BRCA2	BRCA Blood Test	Deep Learning
2	Ovarian Cancer	p53, BRAF	Biomarker Identification (CA-125)	miRNA-Neural Network Combination
3	Colon Cancer	KRAS Pathway, Deletion of DCC Gene	Nucleic Acid Sequencing, RTPCR	Artificial Neural Network, EM
4	Prostate Cancer	Formation of TMPRSS2-ETS Fusion Gene	Needle Biopsy, Urinary Tests	Galen Prostate AI
5	Pancreatic Cancer	Chemical Carcinogens, HNPCC	USG or CT Scan	Artificial Neural Network
6	Melanoma	CDKN2A Gene	Punch Biopsy	Deep Learning
7	Kidney Cancer	VHL Gene	Blood, Urine Tests, Imaging Techniques	RNN, XGBoost Model
8	Stomach Cancer	Germline Mutation in E-Cadherin Gene, H.pylori Infection	Upper Endoscopy	PLS-DA
9	Sarcoma	Inherited Genetic Syndromes, Radiation Exposure	Plain X-Ray, CT scans	Deep Learning

Cardiology

- All over the world, the reason for highest deaths is cardiovascular diseases.
- For both management and treatment of all such diseases, early detection is very important.
- AI based prediction is the ray of hope and it can turn out to be life saver.
- Deep Learning methods are used to detect markers by looking at the eye of the patient.
- Retinal Images are quick, cost effective and non-invasive mechanism.

Managing Medical Data

- Medical data is usually huge and at the same time it is vague. Managing this data is critical and tedious task.
- AI based robots can collect, store, re-format and trace the data by providing quick and steady access.

Medical Diagnosis

- Large and complex datasets such as MRI scans are handled by Neural Networks and Deep Learning.
- With AI, medical imaging and diagnosis is witnessing about 40% growth BY 2024.
- VoxelMorph Convolutional Neural Network can perform MRI analysis within seconds which otherwise take 2-7 hours with conventional analysis.

Early Detection of Deadly Diseases

- Smart watch by Apple is AI enabled that collects data such as heart rate, sleep cycle, breathing rate, activity level, blood pressure, etc.
- It monitors user's health and predicts the occurrence of a heart attack.
- Many wearable health trackers are available in the market including FitBit, Apple, Garmin, etc.

Source: Global Market Insights

Medical Assistance

- Virtual Nursing Assistants are a great relief for monitoring critical patients.
- These assistants are very prompt in providing self care, clinical advice, appointment scheduling, etc.
- Speech Recognition, Natural language processing and wireless integration with medical monitoring devices are the supporting building blocks of such assistants.

Decision Making

- Surgical Robots with AI enabled smartness can reduce case based variations and they increase efficiency of the surgeons.
- The Da Vinci surgical robot allows surgeons to perform variety of complex operating procedures with good amount of flexibility and control.
- It also provides surgeon with advanced set of medical instruments for the minimal invasive surgery.

Source: Xiao-Yun Zhou, Yao Guo, Mali Shen, Guang-Zhong Yang, "Artificial Intelligence in Surgery", PhysicsMed 2019.

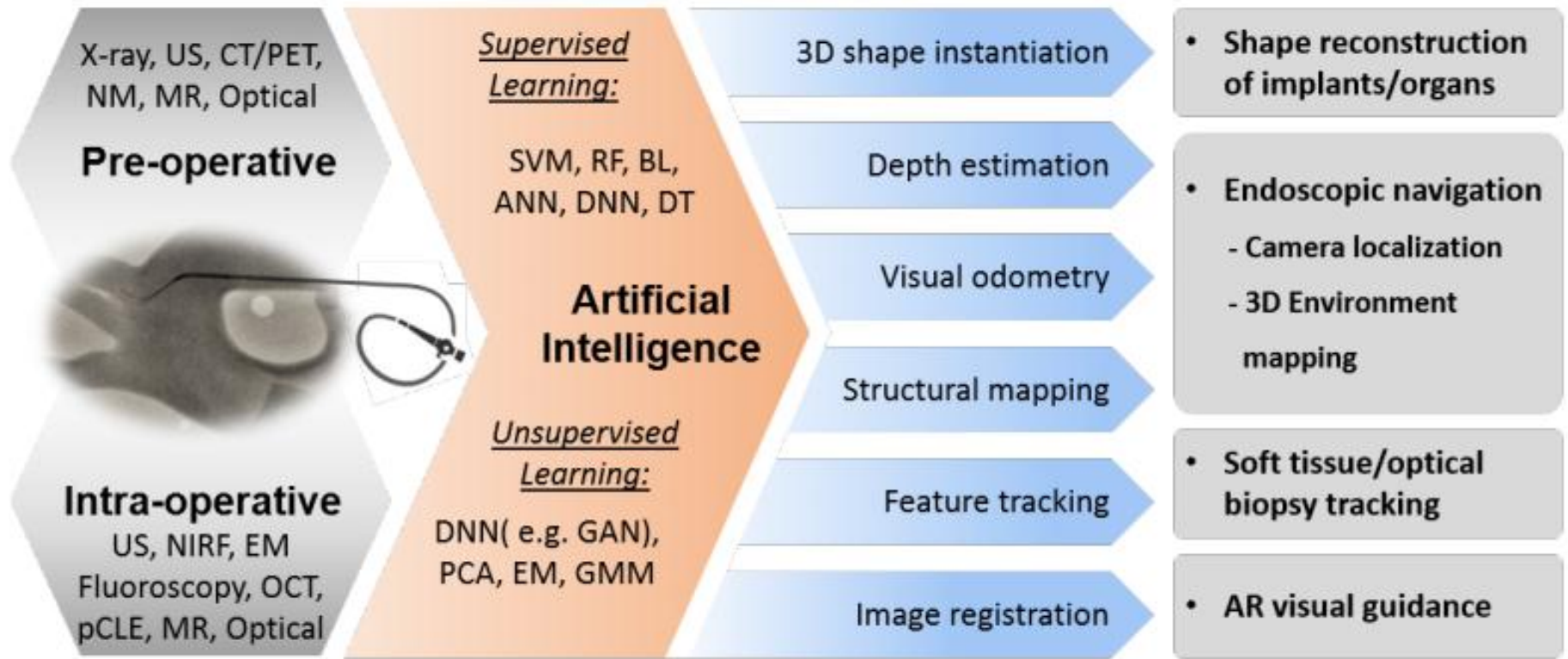


Figure: AI for Intra-operative Guidance

(US - ultrasound; NIRF - near infrared fluorescence ; OCT - optical coherence tomography; pCLE - probebased confocal laser endomicroscopy; EM sensor - electromagnetic sensor; RF - random forests; BL - bayesian learning; DT - decision tree; EM - expectation maximization; GMM - gaussian mixture models.)

Sr. No.	Healthcare System with AI	Description	Location
1	PathAI	Developing ML Technology for more accurate cancer diagnosis with AI	Cambridge, Massachusetts
2	Buoy Health	An Intelligent Symptom and Cure Checker	Boston, Massachusetts
3	Enlitic	AI Deep Learning for Actionable Insights through Radiology diagnosis	San Francisco, California
4	Freenome	AI in screenings, diagnostic tests and blood sample testing for earlier Cancer Detection	San Francisco, California
5	Beth Israel Deaconess Medical Center	Fast diagnosis of deadly blood diseases	Boston, Massachusetts
6	Zebra Medical Vision	AI Powered Radiology Assistant for automated analysis of Imaging scans	Shefayim, Israel
7	Bioxel Therapeutics	AI in Bio-pharmaceutical Development	New Haven, Connecticut
8	BERG HEALTH	Treating rare disease with AI & Interrogative Biology (Parkinson's Disease Treatment)	Framingham, Massachusetts
9	XTALPI	AI, Cloud & Quantum Physics Based Digital Drug Discovery	Cambridge, Massachusetts
10	Atomwise	Neural Network for Clinical Trials for diseases like Ebola and Multiple Sclerosis	San Francisco, California
11	Deep Genomics	AI enabled developmental drugs related to neuromuscular and neurodegenerative disorders (Project Saturn)	Toronto, Canada
12	BenevolentAI	Deep Learning for Targeted Treatment	London, England
13	Olive	Automation in Healthcare Industry's most Repetitive Processes	Columbus, Ohio
14	Qventus	AI based Software Platform for Real Time Patient Flow Optimization	Mountain View, California
15	Babylon Health	AI to provide personalized and interactive healthcare	New York
16	CloudMedX	ML for Better Patient Journey	San Francisco, California
17	Cleveland Clinic	Personalized Healthcare Plans with AI and IT	Cleveland, Ohio
18	Johns Hopkins Hospital	AI enabled task force for Quick Prioritized Hospital Activity	Baltimore, Maryland
19	Tempus	A massive Clinical and Molecular data library for personalized health in cancer treatment	Chicago, Illinois
20	KenSci	Combination of Big Data and AI for clinical, financial and operational risk	Seattle, Washington
21	Proscia	Digital pathology platform that uses AI to detect patterns in cancer cells	Philadelphia, Pennsylvania
22	H2O.AI	AI enabled data analysis throughout a healthcare system to mine, automate and predict processes	Mountain View, California
23	IBM WATSON	Helping healthcare professionals harness their data to optimize hospital efficiency, better engage with patients and improve treatment.	Armonk, N.Y.
24	Google's DeepMind Health Program	AI software used by hospitals all over the world to help move patients from testing to treatment more efficiently.	London, England
25	ICarbonX	AI and big data to look more closely at human "digital life."	Shenzhen, China
26	Vicarious Surgical	Combines virtual reality with AI-enabled robots so surgeons can perform minimally invasive operations	Charlestown, Massachusetts
27	Auris Health	AI Robots revolutionizing Endoscopy	Redwood City, California
28	Accuray CyberKnife System	Uses robotic arms to precisely treat cancerous tumors all over the body (6D motion-sensing technology)	Sunnyvale, California
29	Intuitive	Da Vinci platforms have pioneered the robotic surgery industry	San Francisco, California
30	Carnegie Mellon University	Heartlander, a miniature mobile robot designed to facilitate therapy on the heart	Pittsburgh, Pennsylvania
31	MicroSure	Robots help surgeons overcome their human physical limitations.	Eindhoven, The Netherlands
32	Mazor Robotics	Surgeons use 3D tools to visualize their surgical plans, read images with AI that recognizes anatomical features and perform a more stable and precise spinal operation	Caesarea, Israel

WWRP: AI for Deadly Disease Detection

AI in Healthcare – Use Cases

(Source: 32 Examples of AI In Healthcare That Will Make You Feel Better About The Future
Sam Daley, July 4, 2019.

<https://builtin.com/artificial-intelligence/artificial-intelligence-healthcare>)

Current Trends of AI in Healthcare

The healthcare sector is undergoing rapid transformation globally due to AI. Following are some of the current AI trends in healthcare.

- AI has already been deployed in a few hospitals to diagnose critical diseases, such as cancer. This is advantageous as it provides more accuracy in detecting the condition at an early stage.
- For example, Enlitic, a US based medical imaging start-up, is using deep learning for tumour detection; its algorithms have been designed to detect tumours in human lungs with the help of Computed Tomography (CT) scan.
- AI is currently being used in data mining of medical records. IBM Watson Health is helping healthcare organizations apply cognitive technology to unlock vast amounts of health data to power diagnosis.
- AI-based chatbots are being used as health assistants and personal trainers. Some of the use cases of chatbots in healthcare include scheduling doctor appointments, providing medication reminders, and identifying the condition based on symptoms.
- Start-ups like Babylon Health and Your MD are well-known AI powered healthcare assistant applications, which helps physicians, patients and care-givers in the above functionalities.

- AI-powered surgical robots are currently being conceptualized by many technology companies, by leveraging the capabilities of machine learning applications like Google DeepMind, IBM Watson and others. Deploying robots with AI capabilities can result in less damage, increased precision and speedy recovery.
- The growing application of AI technologies can also be seen in drug discovery. Helix, an AI start-up uses machine learning to respond to verbal questions and requests, thus enabling researchers to increase efficiency, improve lab safety, stay updated on relevant research topics, and manage inventory.
- It is now possible to automate drug design and compound selection due to AI. Peptone uses AI with Keras and TensorFlow integration to predict protein characteristics and features which would enable researchers to reduce complexity in protein design, detect production and characterization issues, and discover novel protein features.
- AI is also widely used in clinical trials, like GNS Healthcare which uses AI to transform diverse streams of biomedical and healthcare data into computer models. The models enable doctors to identify patients' responses to treatments based on their characteristics, thereby, helping deliver personalized medicine and treatment at scale.

Applications of AI in healthcare currently in the experimental Phase

With the help of deep learning and cognitive computing, AI is helping in the ongoing research to prevent, halt, or reverse the ageing process, i.e., to discover solutions to prevent early ageing.

The aim is to develop medicines to prevent and cure a broad range of diseases associated with ageing such as Alzheimer's, Parkinson's and Cardiovascular diseases.

Healthcare sector is also witnessing the experimental phase of AI being used in voice and face recognition to mimic a therapist, as developed by SimSensei.

SimSensei is a therapy automation platform, acting as a virtual human interviewer, which engages in interactions with patients at deeper levels to help physicians in diagnosis of specific conditions.

Verb Surgical, is working with Johnson & Johnson and Alphabet to introduce surgical robots using machine learning and advanced visualization techniques.

A leading hospital network in India uses AI to enable oncologists with cancer diagnostics

END USER PROFILE	Manipal Hospitals is a constitute of the Manipal Education and Medical Group (MEMG). The hospital is the third largest healthcare group in India with 15 hospitals. Manipal Comprehensive Cancer Centre (MCCC) is one of a select few centres in the country that provides all types of diagnostic facilities and multi-disciplinary approach in the management of various forms of cancers at all stages involving medical, surgical and radiation therapy.
AI VENDOR PROFILE	IBM Watson is the primary cognitive computing technology platform that comprehends the world in the way that people do: through faculties, learning, and experience. The system, delivered through the cloud, analyses high volumes of data, understands complex questions posed in natural language, and proposes evidence-based answers. Watson continuously learns, gaining in value and knowledge over time, from previous interactions.
GEOGRAPHY	Bengaluru, India
YEAR OF IMPLEMENTATION/ DURATION	2016 (2 years)
CATEGORY (CLINICAL/ OPERATIONAL)	Clinical
PROBLEM AREA/ NEED	As per World Health Organization (WHO),the emergence of different kinds of cancer claims roughly 680,000 lives every year in India, making it the second largest cause of death in the nation after heart illness. India faces an intense lack of oncologists, surgical oncologists and radiation specialists in the nation. Further, specialists confront a never-ending battle to remain up to date and construct the most effective procedures in treatment and care administration.
SOLUTION/AI TOOLS	IBM Watson analyses information to recognize evidence-based treatment choices, assisting oncologists to give cancer patients with individualized medicinal services. Watson scales vital knowledge and provides insights and information to help oncologists as they consider treatment options for their patients.
IMPACT (METRICS)/ VALUE ADDITION	More than 200,000 individuals receive care for cancer at Manipal facilities each year. With the introduction of Watson in the healthcare, patients have access to advanced cancer therapy. IBM's AI tools helps physicians identify personalized, evidence-based cancer care options across India.

Company name	APP description
Babylon Health	Babylon allows users to track test results, activity levels and health information.
Bay Labs	Bay Labs' software combines deep learning and cardiovascular imaging to assist in the diagnosis and management of heart diseases.
benevolent.ai	An artificial intelligence platform that helps scientists make new discoveries. The technology is built upon a deep judgement system that learns and reasons from the interaction between human judgement and data.
BERG	This platform combines patient biology and artificial intelligence-based analytics to engage the differences between healthy and diseased environments. The patient's own biology drives the platform's results and guides users in the discovery and development of drugs, diagnostics and healthcare applications.
BIOBEATS	Hear and Now is an app that can help users take control of their stress levels. Through biometric monitoring, artificial intelligence algorithms, individual feedback and targeted interventions, it can deliver an effective stress management solution.
Blue Frog Robotics	BUDDY, a companion and social robot was designed by Blue Frog Robotics. The company claims to be dedicated towards creating innovative robots.
Buoy Health	An online symptom and cure checker that uses an AI algorithm to diagnose patients by leveraging medical data.
Butterfly Network	Butterfly's handheld medical imaging tool uses ultrasound scanners to create 3D images in real-time. It sends the data to a cloud service, zooming in on certain identifying characteristics in the images to help in the diagnosis.
Care Angel	A.I. Powered Caregiving Assistant that keeps families connected, improves outcomes, and lowers costs while improving quality of life.
Careskore	Careskore predicts how likely a patient will be readmitted to a hospital through its Zeus algorithm in real time, based on a combination of clinical, lab, demographic and behavioural data. Based on this information, hospitals are able to improve the quality of care, while patients also have a clearer picture about their health.
Clinithink	Clinithink provides Clinical Data insights to solve challenges in healthcare and life sciences.

11 Indian Startups Revolutionizing The Healthcare Sector With AI

- 1. Advancells:** Therapeutic applications of Regenerative Medicine, which is a branch of translational research in tissue engineering and molecular biology that deals with the replacing and regenerating human cells, tissues or organs to restore or establish normal function.
- 2. Artelus:** This startup is focused on detecting diabetic retinopathy (DR) using deep learning algorithms. It captures the patient's retina image, analyses it and presents a report out of it.
- 3. ChironX:** detects diseases from large populations of medical images. It has an auto-diagnostic software which uses complex image processing AI algorithms along with classical machine learning techniques.
- 4. LiveHealth:** It is a Pune-based startup that provides diagnostics to customers through automation. This 2014 startup delivers reports to patients or organizations online as soon as they are available. It also offers online payment, monitors all patient activities in real time and enables doctors to access the patient data anytime.
- 5. Lybrate:** Lybrate is the country's first online doctor consultation platform. It has an online application via which patients can connect to doctors and have a consultation online. The patients can also book lab tests and appointments online.

6. NeuroSynaptic Communications Private Limited: It provides a high-quality ReMeDi Remote Healthcare Delivery Solutions. It collects information on various physiological aspects of patients remotely and provides them with its diagnosis. By doing this, they make the whole process of diagnosis affordable.

7.Niramai: The two founders of this startup, after seeing cancer in their family had felt a deep urge to solve this problem in society. Niramai is a Bangalore-based 2016 startup that provides breast cancer screening solutions. They build a machine learning software that helps to detect breast cancer at a much early stage, helping early diagnosis of the cancer.

8. OncoStem Diagnostics: Founded in 2011, this startup uses machine learning algorithms to help in personalised cancer treatment. OncoStem uses Proteomics and Genomics-based platforms and with the aid of a molecular fingerprint of a tumour, predicts cancer.

9. OnliDoc: For end-to-end medical diagnosis OnliDoc uses AI and ML. It has a phone application that is used to find doctors, book appointments and store medical records and prescriptions. Has an artificial intelligence and deep learning symptom checker and provides online delivery of reports.

10. **Qure.ai:** This startup, based in Mumbai and founded in 2016, uses deep learning algorithms in its products. It uses large datasets of medical information to develop its deep learning algorithms. Following are three of its products:

qXR: Trained with a million curated X-rays and radiology reports, this product detects abnormal chest X-rays and then identifies and localises 15 common abnormalities. It also screens for tuberculosis.

qER: This product is for diagnostic assistance in head CT scans. It detects critical abnormalities like bleeds, fractures and midline shift; localises them and quantifies their severity.

qQuant: It is used for quantification and progression monitoring products for CT scan and MRI scan and has fully automated detection, quantification and 3D visualization.

11. **SigTuple:** Founded in 2015, this Bangalore-based startup takes the help of robotics and artificial intelligence and adds it to the medical data to help their healthcare industry make smart diagnostic solutions and make quality healthcare easily accessible and affordable.

What is Cognitive AI?

AI includes:

- Simulation of human senses: sight, hearing, smell, taste, and touch.
- Simulation of learning and processing: deep learning, machine learning.
- Simulations of human responses: robotics.

AI Applications includes problem-solving, game playing, natural language processing, speech recognition, image processing, automatic programming, and robotics.

Cognitive Computing is the combination of individual technologies that perform specific tasks that facilitate human intelligence. These are smart decision support systems that we have been working with since the beginning of the internet boom.

Therefore, cognitive computing refers to:

- Understanding and simulating reasoning
- Understanding and simulating human behavior

Using cognitive computing systems, every day, we make better **human decisions at work.**

Cognitive Computing applications include speech recognition, sentiment analysis, face detection, risk assessment, and fraud detection.

Research Scope

- Genetic Testing for Earliest Cancer Detection
- Smart systems for the surgery students to learn from the actual movements of the main surgeon.
- AI is expected to bring cost effective and usable healthcare solutions for the betterment of mankind.

“Our intelligence is what makes us human, and Cognitive AI is an extension of that quality.”

–Yann LeCun

Thank You....