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Artificial Intelligence in Healthcare

Abbreviations

AI	Artificial Intelligence
WHO	World Health Organisation
GDP	Gross Domestic Product
EHR	Electronic Health Record
NHS	National Health Service
NLP	Natural Language Processing
IT	Information Technology
AWS	Amazon Web Service
API	Application Programming Interface
OECD	Organisation for Economic Cooperation and Development
CT	Computed Tomography
FDA	Food and Drug Administration
CAR	Canadian Association of Radiologists
DFKI	German Research Centre for AI
CIO	Chief Information Officers
GPU	Graphics Processing Unit
MR	Magnetic Resonance
LANA	Live and Adaptive Nutrition Advisor
HIS	Hospital Information System
DR	Diabetic Retinopathy
VC	Venture Capitalist
SaaS	Software as a Service
GSK	GlaxoSmithKline

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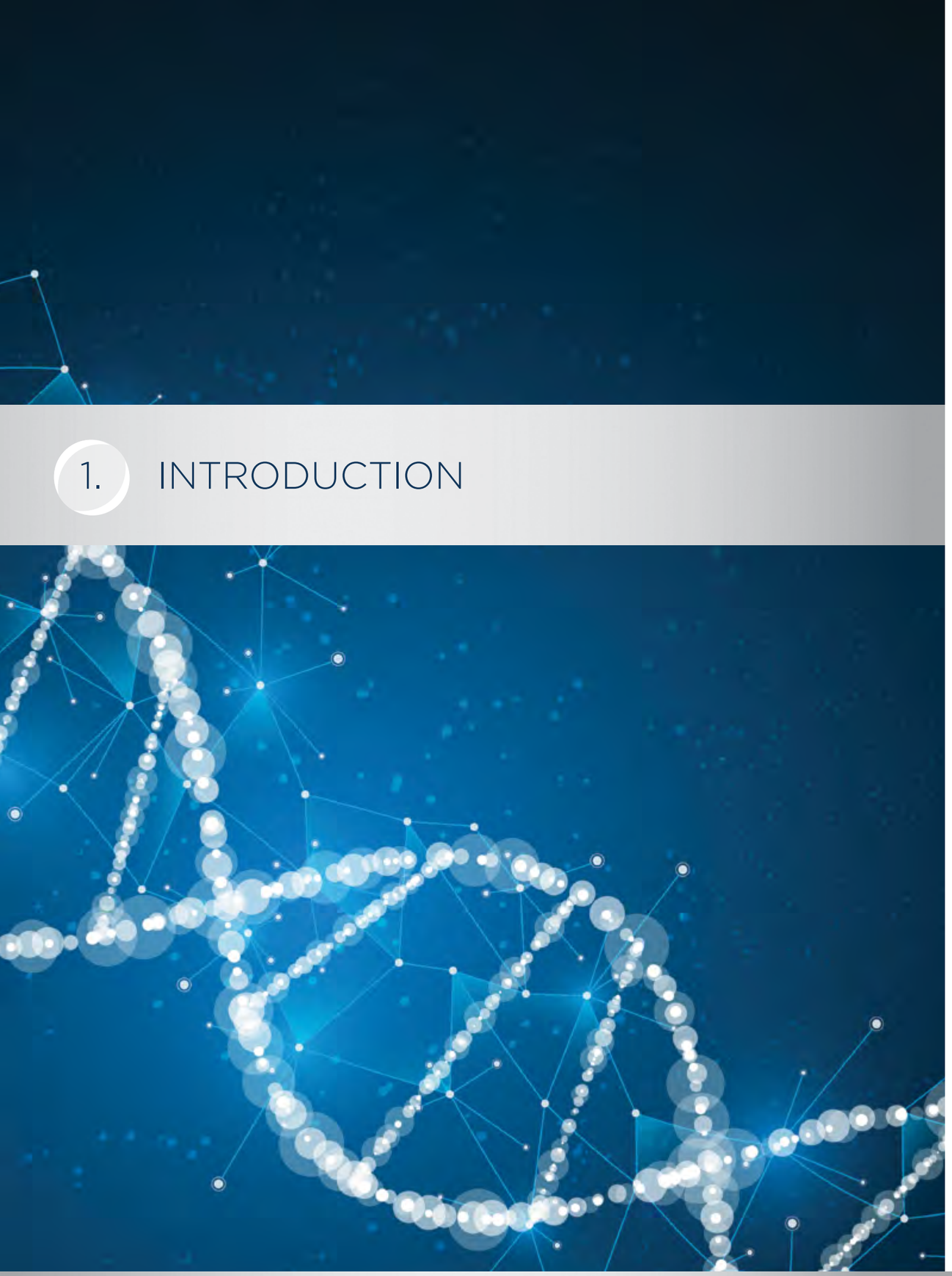

1. INTRODUCTION

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Gone are the days when Artificial Intelligence (AI) was considered science fiction; we are increasingly seeing tangible, real-world impact of AI across various industries, including healthcare.

Advances in AI have accelerated the innovation landscape in healthcare, resulting in improved health outcomes whilst reducing the cost of providing healthcare.

AI is now enabling new possibilities in healthcare which were assessed as not feasible earlier. For example, due to the digitization of health records in most of the advanced economies using Electronic Health Record (EHR) applications, mining of unstructured medical data is possible now and using this, various evidence-based decisions can be readily taken by physicians. Big tech companies like IBM and Google are leveraging a huge quantum of data to continuously train their programmes or platforms for advanced healthcare applications like treatment protocol support, drug discovery, diagnosis of diseases and others. IBM's Watson and Google's DeepMind are solving real-world problems in medicine, free from cognitive biases, by partnering with various healthcare players.

Digital transformation, like in other sectors, is believed to transform the provision of healthcare, by enabling the provision of accessible, affordable and quality healthcare to people. Many countries, enabled by AI technologies, are showing progress in transforming the legacy models from being physician centric to become more patient centric.

This report focuses on the evolution of AI in healthcare, key AI technologies, the impact of AI on jobs and business models, the future scope of AI, and trends in adoption of AI within healthcare. The report also touches on how AI is helping key stakeholders like hospitals, diagnostic labs and pharmaceutical companies in various ways, along with covering the key AI healthcare vendors including large technology companies and emerging start-ups alike.

2. EXECUTIVE SUMMARY

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2. Executive Summary

2.1 The rise of AI in healthcare

AI has been breaking grounds in the healthcare sector by assisting doctors, hospitals, pharma companies and others in tackling practical challenges. There has been an increase in the number of companies focusing on implementing AI in the healthcare sector. A growing population across the globe is witnessing (and contributing to) a shortage of healthcare workers, and the gap is seen to be widening over time. As per the World Health Organization (WHO), the world will be short of about 13 million healthcare workers by 2035.

Advanced and developed economies like US, Germany, Canada, Australia and the UK spend a huge proportion of their Gross Domestic Product (GDP) on healthcare. However, the adoption of emerging, proven technologies like AI is yet to gain importance in their health systems. In most of these economies, irrespective of the stages of development, the cost and demand for care is rising, thereby increasing the need for digital technologies like AI.

Recently, the US market has seen a relatively greater adoption of AI technology primarily to decrease the cost of care and improve the outcomes. This was driven by regulatory push for value-based care through various legislations, which forced the providers to adopt EHR platforms. In the UK, the National Health Service (NHS) deployed an AI-based Chatbot on trial last year, to ease pressure on the emergency triage process.

2.2 Healthcare applications of AI

AI involves the use of technologies such as Natural Language Processing (NLP), Deep Learning, Context aware processing, and Intelligent Robotics, which help AI in providing robust solutions to the healthcare sector. When analytics is coupled with AI, it can play a crucial role in data mining of medical records, thereby becoming an effective platform in the healthcare sector. While analytics is based on pre-defined set of programs, AI has the capability to self-learn using historical data.

AI already has multiple applications in healthcare ranging from automated imaging to intelligent drug design and AI powered surgical robots. Currently, the healthcare industry employs data mining to develop early detection systems by using clinical and diagnosis data. Tech giants, such as Google and IBM are using AI to unearth patient data which is both structured and unstructured,, extracted by mining the medical records or by deciphering physician-patient interactions.

2.3 The emerging landscape of AI technology providers in healthcare

In the last couple of years, we have seen numerous start-ups entering the healthcare sector to provide AI solutions using their machine learning and big data analytics capabilities, and a number of these start-ups getting acquired by bigger and more established companies. Google acquired DeepMind in 2014 to compete with major tech companies and gain a stronghold of deep learning in healthcare. Another tech giant, Intel acquired Nervana Systems, a deep learning start-up in 2016.

2.4 Challenges to AI adoption in healthcare and the way forward

The adoption of AI in healthcare is currently at an initial stage with the growth being slow due to paucity of digitization of patients' records in many of the emerging economies. The fear of losing jobs has also slowed down the adoption of AI among healthcare workers. Nevertheless, AI adoption is estimated to increase in the future, thereby, improving the diagnosis and treatment procedure in healthcare. AI in healthcare would have advantages of increased efficiency leading to higher volume of care delivered ,and lowering costs of treatment, resulting in higher profits, and employment opportunities.

3. EVOLUTION OF AI IN HEALTHCARE

3. Evolution of AI in Healthcare

Among the many technology changes over the last decade, we have seen the substantial growth of data analytics for handling, processing, and gainfully using large amounts of data. However, since data analytics can only work with historical data and give outcomes as predefined by humans, specific rule-based algorithms were developed to augment data analytics, thereby imparting the 'self-learning' capability to computers, which is now referred to as "Machine Learning". Machine learning did not require the computers to be explicitly programmed, which is a definitive advantage. Machine learning was then combined with data analytics to analyze data and develop complex algorithms to predict models, which was named as predictive analytics. Predictive analytics is driven by a set of rules defined by humans, known as predictive algorithms which are used to analyze historical data to predict future outcomes.

3.1 AI is now addressing identified gaps in healthcare services

With its growing population, the world is seeing a shortage of healthcare workers, and this gap continues to widen. As per the World Health Organisation (WHO), the world will be short of about 13 million healthcare workers by 2035. Moreover, training physicians and health workers has been challenging as the demand for qualified trainers remains largely unmet in various countries.

Despite advanced technologies and developments, there were some discrepancies between the outcomes and the results predicted by humans which led to the evolution of AI. AI mainly refers to systems and computers that have been designed to provide solutions to problems without the need for human inference. With the concept of AI gaining popularity in the recent years, healthcare has been able to cope with some of the present challenges.

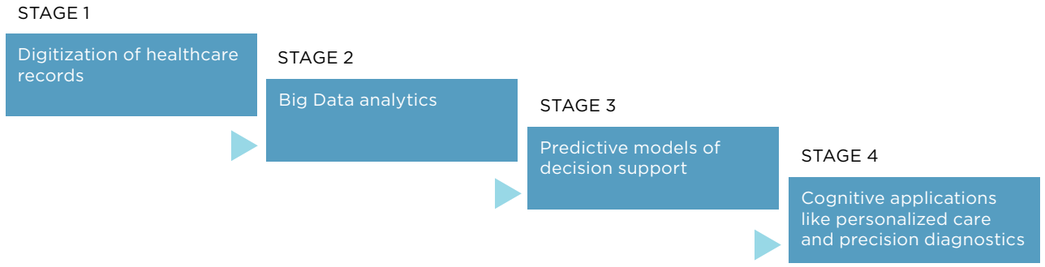
AI has been breaking grounds in the healthcare sector by assisting doctors, hospitals, pharma companies and others in tackling practical challenges. There has been an increase in the number of companies focusing on implementing AI in the healthcare sector. Recently, it has been observed that hospitals and other players are shifting from using the cloud platforms solely for data storage to using the infrastructure for customized AI-based applications like clinical decision support, patient diagnosis, drug discovery and so on, largely due to the various capabilities of cloud platforms like Amazon Web Services (AWS), Microsoft Azure, IBM Bluemix and others.

3.2 Leading technology players can potentially disrupt the AI healthcare market

IBM's Watson, a specialized AI platform, which competes with human intelligence, has recently proven to have enormous potential in healthcare, after it managed to diagnose a woman suffering from leukaemia. Now, AI is being deployed in various other applications such as mining medical records, designing treatment plans, assisting in repetitive jobs, providing consultations, drug creation, using avatars for clinical training, among others.

Google is also creating waves of disruption using AI for healthcare through DeepMind – capable of detecting and analyzing health risks through data collection and predictive analytics. Google recently partnered with UK's NHS in a healthcare AI project using computer vision algorithms. In this partnership, Google is helping NHS in analyzing the medical images collected from patients for detecting cancer at an early stage.

With the increasing volumes of healthcare data captured using cloud-based applications, AI would eventually become a fool-proof and scalable solution, covering the whole spectrum of clinical applications from prevention to diagnostics to treatment, as well as non-clinical applications like patient engagement, workflow process and claims processing.



3.3 AI and Analytics

Analytics and AI can go hand in hand to make work more simple and efficient. Analytics relies on combined capabilities of computer programming, statistics and operations research to quantify performance. It is used to interpret large amount of data and draw meaningful conclusions out of the available data. When analytics is coupled with AI, it can play a crucial role in data mining of medical records and become an effective platform in the healthcare sector. Along with data mining, analytics can be used with AI to develop predictive models which can help doctors diagnose diseases at an early stage. In order to achieve the above outcomes, analytics and AI need to work in conjunction, which would not only improve but revolutionize the healthcare sector.

The following table compares AI and Analytics on several parameters.

Parameter	AI	Analytics
Primarily used for	Depicting human behaviour and emotions	Data interpretation and turning them into meaningful patterns
Learning Capabilities	Self-learning using historical data	Pre-defined by set of programs
Process	Non-repetitive	Repetitive
Judgement	Self-judgment based on previous actions and results	Pre-defined judgments
Functionality Basis	Corpus based	Command based
Maturity Level	Growing Stage	Matured Stage
Tools/Platform	Application Programming Interface (API)/ Cloud based	API based
Examples	IBM Watson, Google DeepMind	Google Analytics
Design	Complex design	Involves use of algorithms and software, Comparatively easier design than AI
Assistance	Compliments human intelligence	Compliments human labour of data sorting
Integration	Complex integration	Easy integration

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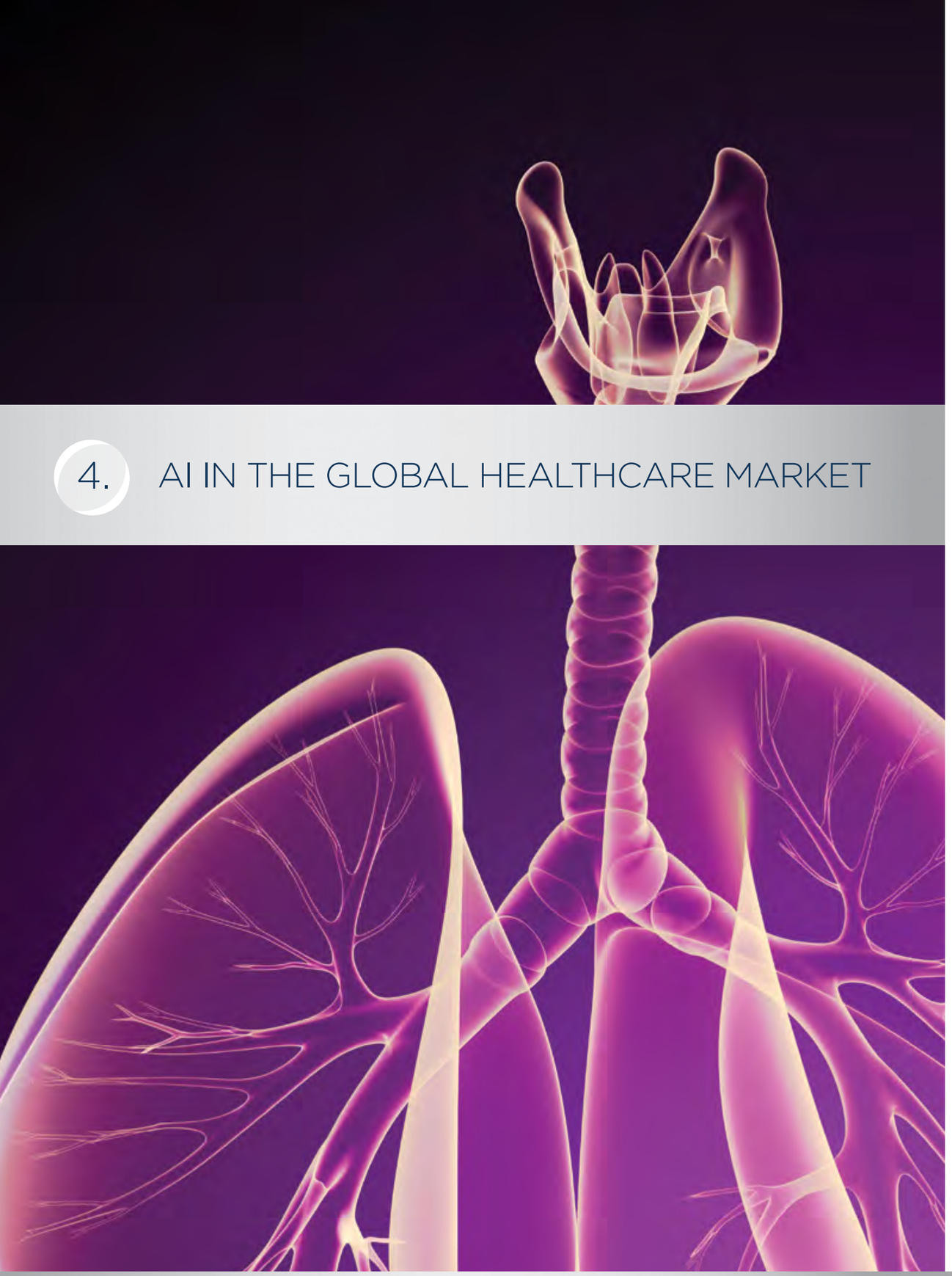
3.4 Current Trends of AI in Healthcare

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.

3.5 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.



4. AI IN THE GLOBAL HEALTHCARE MARKET

4. AI in the Global Healthcare Market

Similar to other industries, healthcare is witnessing a shift to consumerization, pushing payers and providers to focus on value-based care and improve the health outcomes. Across various geographies, advanced tools like AI are being implemented to address varied stakeholders challenges and augment care provision. In most economies, irrespective of the stages of development, the cost and demand for care is rising, thereby increasing the need for digital technologies. It becomes imperative to provide seamless and integrated care by leveraging the benefits of the connected ecosystem, where patients, providers, payers and other stakeholders are increasingly adopting technology to simplify the processes.

Advanced and developed economies like US, Germany, Canada, and UK spend a huge proportion of GDP on healthcare, however, the adoption of proven technologies like AI is yet to gain importance in their health systems. Though US is the highest spender on healthcare globally, as a percentage of its GDP, it faces challenges like rising cost of healthcare provision, shortage of primary care professionals, poor-quality outcome and lack of coverage for a high percentage of the population. US spends two and a half times higher than the average of Organisation for Economic Co-operation and Development (OECD) countries on healthcare, with significant proportion being out of pocket or voluntary coverage. It also has the highest rates of medication errors compared to other OECD countries. The average insurance subscription in US is about USD 400 a month and significant amount of healthcare service contributions are co-payments / out of pocket share.

Recently, the US market has seen higher adoption of AI to decrease the cost of care and improve the outcomes. This was driven by regulatory push for value-based care through various legislations, which forced the providers to adopt EHR platforms. The effective implementation of EHR can act as a foundation for AI to leverage the medical data. Healthcare, compared to other industries, will see a greater potential for AI, addressing many challenges relating to care provision, diagnostics, and drug discovery.

In US, AI applications and platforms which have been put to practical use, especially in hospital setting, have resulted in tangible benefits like early diagnosis of conditions, operational improvements like reduction of wait time and improving care provision workflow, and targeted therapy administration. It is expected that, within the next two years, about 35% of healthcare organizations plan to adopt AI to improve patient experience. Arterys, which helps diagnose heart problems in 15 seconds, was approved by Food and Drug Administration (FDA) and has already been put to use with its artificial self-learning network across multiple cases. Mayo Clinic has collaborated with health tech start-ups like Tempus and AliveCor. Tempus helps Mayo Clinic offer customized treatment options using genomic based therapy to treat conditions like cancer. AliveCor, with its AI platform helps Mayo Clinic in early detection of Cardiac Arrythmia. Silicon Valley based El Camino Hospital has drastically reduced the fall rate of patients by analyzing the likelihood of falls using machine learning.

Canada is well-positioned to leverage the integrated nature of its health system that provides access to a large amount of data to test AI applications. Canada is among the few nations, which has advanced AI capabilities. Different researches are underway, including a research by the Canadian Association of Radiologists (CAR) to deploy AI-driven systems in imaging by working with the federal government. League, a health benefit start-up which provides the digital alternative to traditional health, has recognized that new risk models, claims adjudication, fraud prevention, and care navigation are just a few areas that will be impacted by AI. In Canada, the city of Hamilton's health department has collaborated with IBM to build AI capabilities that can improve health outcomes and decrease the cost of care, by leveraging existing patient data.

The German Research Centre for AI (DFKI), covering 5 cities and 29 Fraunhofer institutes, is the biggest AI research centre worldwide and is paving the way for technologies that can reduce healthcare costs by more than USD 170 billion in Europe in the next 10 years. German AI start-up XBird, which has been accelerated by Bayer pharma, uses data captured by smartphones and wearables to analyze and detect adverse health events before they occur, and can save disease burden significantly.

Countries like UK and Australia, where healthcare is majorly controlled by the government, face a lot of challenges to provide effective coverage of treatment. Some of the challenges include long waiting time for elective surgery and higher burden of chronic disease in rural areas. Compared to countries like US and Canada, the healthcare systems of Australia and UK, despite the superior quality of care, are yet to achieve significant efficiency gains. This gap can be addressed with the efforts of policymakers, by incentivizing the adoption of digital tools like AI for better patient outcomes.

In UK, the NHS put an AI-based chatbot, developed by Babylon Health, on trial last year, to ease the pressure on the emergency triage process. This is a part of NHS' goal of modernization. The chatbot helps in categorizing the conditions based on the symptoms witnessed by the patients thereby accelerating the response time for minor complaints and reducing the strain on services. start-ups like Babylon Health and Ada are building sophisticated AI-powered doctor consultation and diagnostic facilities to address the challenges faced by the health system. These platforms have been trained for several years using real world cases and constantly 'learn' through positive reinforcement feedback loops.

Chief Information Officers (CIO) in healthcare organizations are ready to engage AI platforms to achieve greater customer experience, particularly as a recent survey by HCF revealed that over 80 percent of Australians are comfortable with AI being used to diagnose common medical problems and interpret test results.

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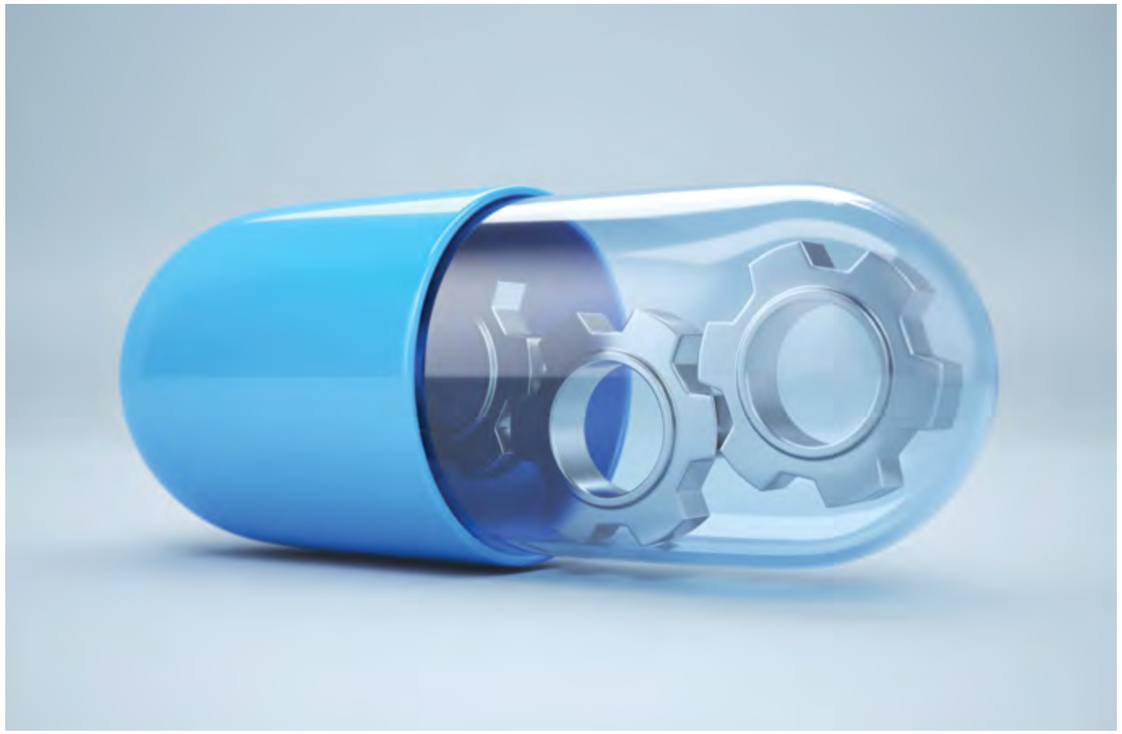
Challenges and opportunities for AI in the healthcare system of developed countries

Country	Spend on GDP (%)	Per capita spend (USD)	Challenges	Opportunity areas for AI
US	17.2%	9,892	Higher administrative costs, medical errors and shortage of primary care physicians	Care provision, Diagnostics and Claims Validation
UK	9.7%	4,192	Higher Waiting time, need for efficiency and archaic process	Improving efficiency of Care, Robotic Surgery
Australia	9.6%	4,708	Widening Healthcare inequity (Indigenous population), rural neglect	Primary Care and Prevention of Chronic Disease
Canada	10.6%	4,753	Higher cost of care, Integration challenges, wait time	Improving Efficiency of Care
Germany	11.3%	5,551	Ageing population, chronic ailments, wait times	Patient Safety, Diagnostics



5. AI TECHNOLOGIES

5. AI Technologies

5.1 Key AI technologies transforming healthcare

Technologies such as NLP, Deep Learning, Context aware processing, and Intelligent Robotics are seen as the backbone to build real-world AI. These technologies are transforming the healthcare landscape.

Natural Language Processing (NLP)

AI plays an important role in converting complex data into simple meaningful insights; and this work is made easier by NLP. NLP focuses on mimicking human-like responses, by using algorithms to respond to queries and hold conversations. NLP in healthcare sector can be used to summarize long narrative text, such as academic journal articles or clinical notes by pointing out the key concepts or phrases in the reference document. NLP can also map data elements in EHRs, which are present as unstructured text, into structured meaningful data to improve clinical decision making. For example, Intermountain Healthcare has used NLP to identify the cause of an illness in a person, by mining medical record data of patients to identify cases like stroke, cancer, heart failure, and cases with venous thromboembolisms (formation of blood clots in the deep veins of the leg).

Deep Learning

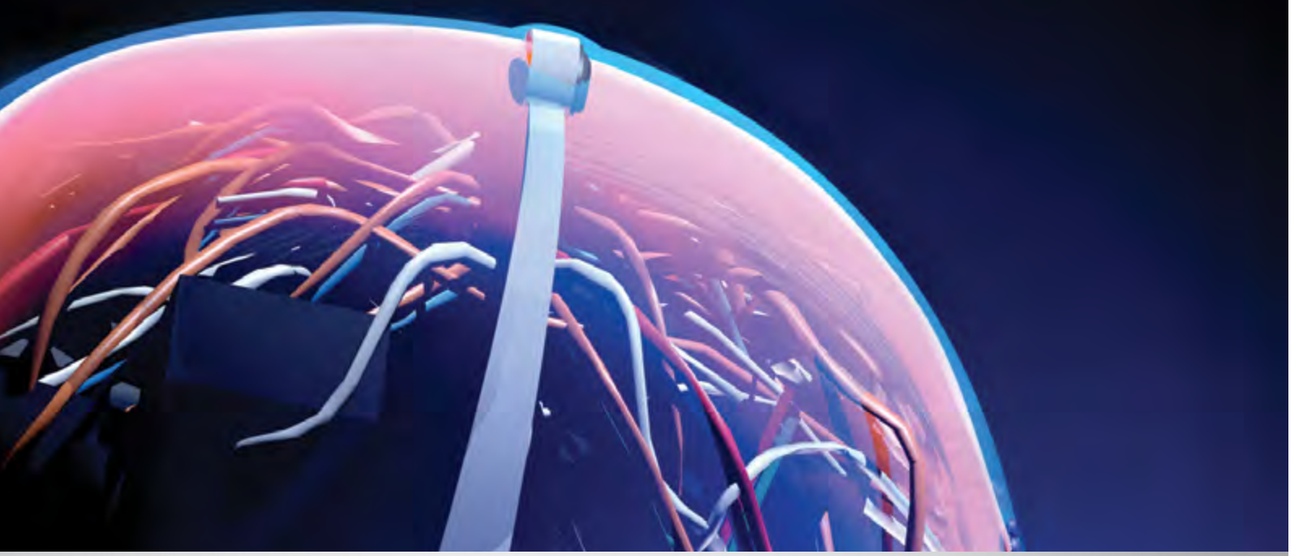
The diagnosis and treatment of diseases is likely to further improve with the implementation of AI in the healthcare sector. Deep learning, a component of AI, can be used to analyze medical data and images to enhance the ability of physicians to treat diseases. Deep learning can help the visually challenged make sense of the environment, i.e., AI uses computer vision and text-to-speech to narrate the text, identify facial cues of the people nearby, study the surroundings and describe the environment. Three trends that drive the deep learning revolution include sophisticated neural network algorithms modelled on the human brain, more powerful Graphics Processing Units (GPUs), and access to the enormous amounts of data from the internet. For example, IBM Watson is being trained to help doctors with medical diagnosis using cognitive computing and a deep learning approach.

Context Aware Processing

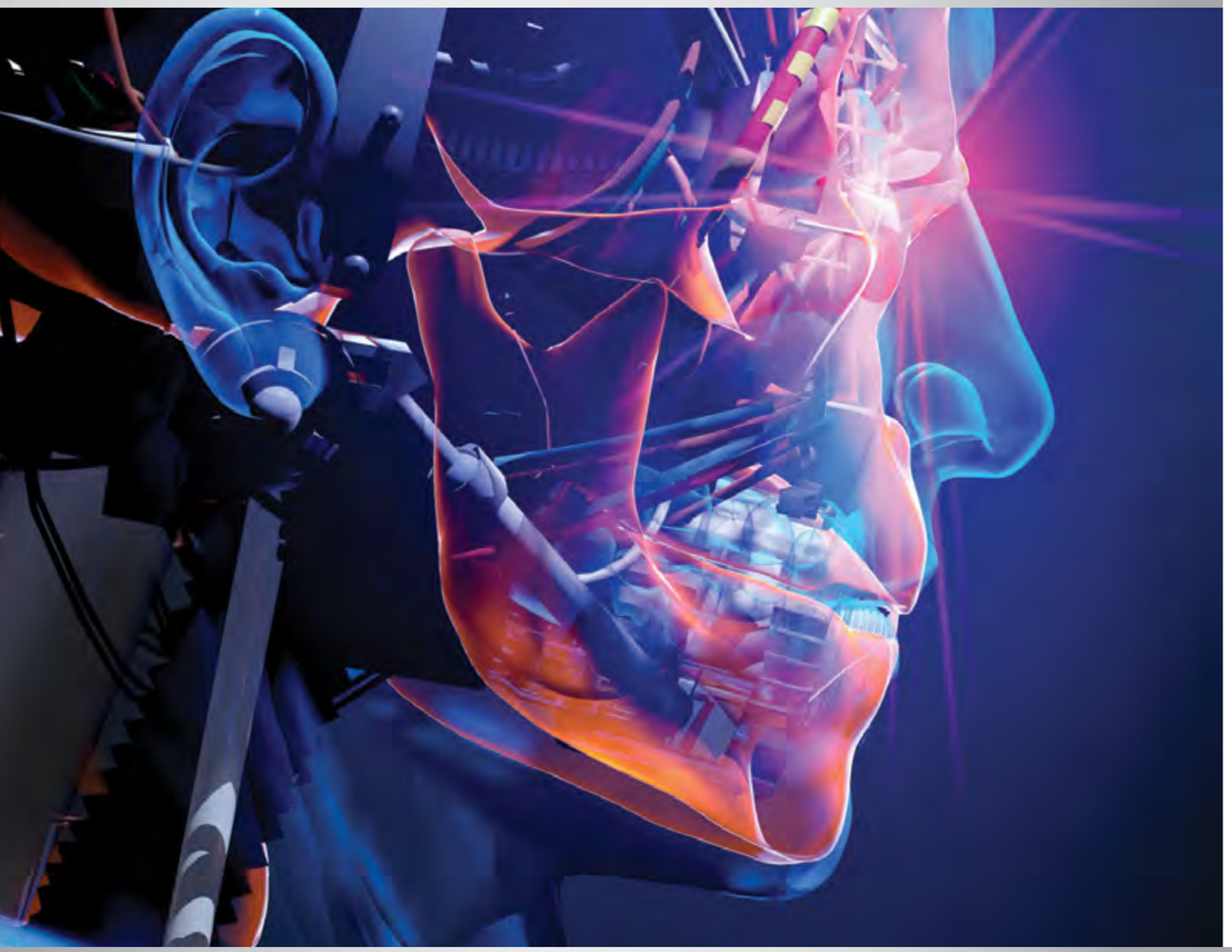
AI can be utilized for virtual assistant applications like Apple's Siri, Google Assistant, Amazon Alexa and Microsoft Cortana, in the healthcare sector, which can perform tasks as directed by the programmer. AI chatbots, when used in healthcare, can phenomenally reduce the burden on medical professionals to coordinating care and detecting issues or diagnosable health concerns. Bots would be an evolution of health assistants. For example, Bots like HealthTap or Your.Md use AI to find solutions to the most common symptoms. However, chatbots act as enablers in the process to direct the patients to the right physician for diagnosis and therapy. They would be supplementary to the duties of an experience doctor.

Intelligent Robotics

AI can also be used with robotics. Physical robots can revolutionize life care facilities, by helping people stay healthy and reduce hospitalization needs. AI, coupled with the advanced humanoid design, is powering robots to have conversations and social interactions with aged patients to keep their minds sharp. Since robots have greater flexibility and reach, they can be used for making smaller incisions with more precision in the affected areas. Certain robots can serve as a social partner to treat mental health issues or to alleviate loneliness. Companies such as Blue Frog Robotics (developer of BUDDY), National Institute of Advanced Industrial Science and Technology, or AIST (developer of PARO), among others have augmented the concept of companion robots to the healthcare sector.



6. CURRENT AI USE CASES WITHIN HEALTHCARE



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6. Current AI Use Cases within Healthcare

6.1 Healthcare "Data Mining" with AI can predict diseases

In the era of ubiquitous technology, data becomes an important fuel to drive innovation. Data mining is being deployed to find insights and patterns from large databases. The healthcare industry captures large volumes of patient records. With appropriate analysis of this data, using machine learning tools, the healthcare sector can address a plethora of diseases prior to their occurrence.

Currently, the healthcare industry employs data mining to develop early detection systems by using clinical and diagnosis data. Tech giants, such as Google and IBM are using AI to unearth patient data which are structured and unstructured. The data is extracted by mining the medical records or by deciphering physician-patient interaction (voice and non-voice-based interactions).

6.2 AI in "Medical Imaging and Diagnostics" provides precise information

Over the past couple of years, AI has expanded substantially in the fields of medical imaging and diagnostics, thereby enabling medical researchers and doctors to deliver flawless clinical practice.

Paving the way for quantification and standardization, deep learning is aiding in prevention of errors in diagnostics and improving the test outcome. Further, AI is improving the assessment in medical imaging to detect cases such as malignancy and Diabetic Retinopathy (DR). It is also assisting with quantifying blood flow and providing visualization.

According to European Radiology Experimental's recent poll, over 50% of global healthcare leaders expect the role of AI in monitoring and diagnosis to grow significantly.

Recently, Arterys, a Deep Learning medical imaging technology company, partnered with General Electric (GE) Healthcare. This partnership combines Arterys' quantification and medical imaging technology with GE Healthcare's Magnetic Resonance (MR) cardiac solutions. By collaborating these technologies, it is now possible to conduct cardiac assessments in a fraction of the time as compared to the conventional cardiac MR scans.

6.3 AI in "Lifestyle Management and Monitoring" is changing the way we live

Increase in digitization enables individuals to manage their own health and comfort. Data generated from digitization fuels the AI technology of tomorrow. Today, parents can monitor their infants to check their health, sleeping patterns and development.

Recently, Fedo, a start-up, found a solution to encounter individual's risks for lifestyle diseases. They have developed a risk stratification algorithm, using AI, to predict individuals' readiness for 7 non-communicable diseases such as Diabetes II and Cardiovascular disease – Myocardial Infarction.

6.4 AI in "Nutrition" is enhancing the journey to a healthy and fit lifestyle

Currently, an extensive number of nutrition related apps are available in stores, with different functions and accuracies. With the integration of AI, nutrition apps can give customized recommendations and suggestions based on a person´s preferences and habits.

VITL, a start-up based in London, is applying AI to diagnose patients' nutritional needs and deficiencies. Along with the diagnosis, it further provides users with a bespoke nutrition plan and daily vitamin pack. To map out the logic and thought process of human nutrition experts, the start-up uses an AI engine called LANA (Live and Adaptive Nutritional Advisor) which employs a broad range of lifestyle and diet data points.

6,5 AI in “Emergency Room and Surgery” is saving lives

The first surgical robot, named as da Vinci Surgery System, which was approved by the FDA for general laparoscopic surgery, was developed about 15 years ago. Since then, many other surgical robots were introduced, including the current generation of robots which are integrating AI in surgery.

The next generation of surgical robots are being powered by machine learning and AI. In the near future, we will witness AI platforms such as DeepMind, IBM Watson and other advanced AI tools enabling physicians and hospitals to deliver promising surgical interventions.

IBM Watson has advanced medical cognitive and NLP capabilities to respond to surgeon’s queries. Further, similar AI platforms aid in monitoring blood in real time, detect physiological response to pain, and can provide navigation support in arthroscopy and open surgery.

6.6 AI in “Hospital Information System (HIS)” can enrich the delivery of healthcare services

Currently most of the hospitals and clinics have HIS software to handle the process of appointment, treatment follow-up, and other administrative processes, by integrating with EHRs of patients. There is great potential for these systems to be used for offering superior health services.

For instance, Google’s DeepMind Health team is working with NHS hospitals to monitor a patient’s conditions via a mobile application. The app allows the hospitals to promptly identify any deterioration in the patient’s conditions and thus provide treatment as quickly and accurately as possible.

Furthermore, AI in healthcare provides support to clinicians for predictive analytics in real-time and solves operational challenges across the hospital functions. It also saves staff time, reduces steps, and removes paper-based processes through automated data collection, analysis, reporting and communication.

6.7 AI in “Research” is providing fascinating insights

AI enables healthcare providers to create a digital profile of humans. This can help in understanding immunosequence, thereby generating a new class of immune diagnostics in oncology. Additionally, it is being used to accomplish reproducible research in bioinformatics, genomics and life science. Adaptive Biotechnologies, a start-up addressing genomic based therapy, partnered with Microsoft to find out insights of immnosequence.

6.8 AI in “Mental Health” is building a strong support system for patients

We live in a world where 1 in 4 people suffer from mental disorders, making it one of the leading causes of disability and ill-health.

Healthcare, being relatively slow in adoption of new technologies, has seen some of the greatest advances in AI recently including early identification of mental health symptoms. Certain factors such as a person’s tone, word choice, and the duration of a phrase are considered when studying an individual.

Wysa, an AI-based emotionally intelligent penguin, developed by Touchkin, can listen, chat and help users build mental resilience. Within 3 months, Wysa had witnessed a million chats with 50,000 users and assisted them to overcome mental health troubles. Some of these users had been suicidal, others lived with Post traumatic stress disorder (PTSD), social anxiety, depression, or bipolar disorders. Thus, for the millions of people who feel lonely and need the support of friends and psychiatric therapists, AI can build resilience, offer support, and save lives.

6.9 AI in “Pharma” is enabling the discovery of a new class of diagnostics and treatment

AI is revolutionizing the way pharmaceutical companies develop medicines. AI searches biological systems to understand how a drug can affect a patient’s tissues/cells. For instance, applications like precision medicine and predictive medicine are used to predict a patient’s treatment rather than investigating a bigger set of patients.

BERG, a pharmaceutical start-up, has created an AI platform that uses biological data as cells transform from healthy to malignant ones. The software utilizes information from the 2003 Human Genome Project in addition to over 14 trillion data points in a single cell tissue. This research allowed BERG to develop a new cancer drug that could potentially reverse this process.

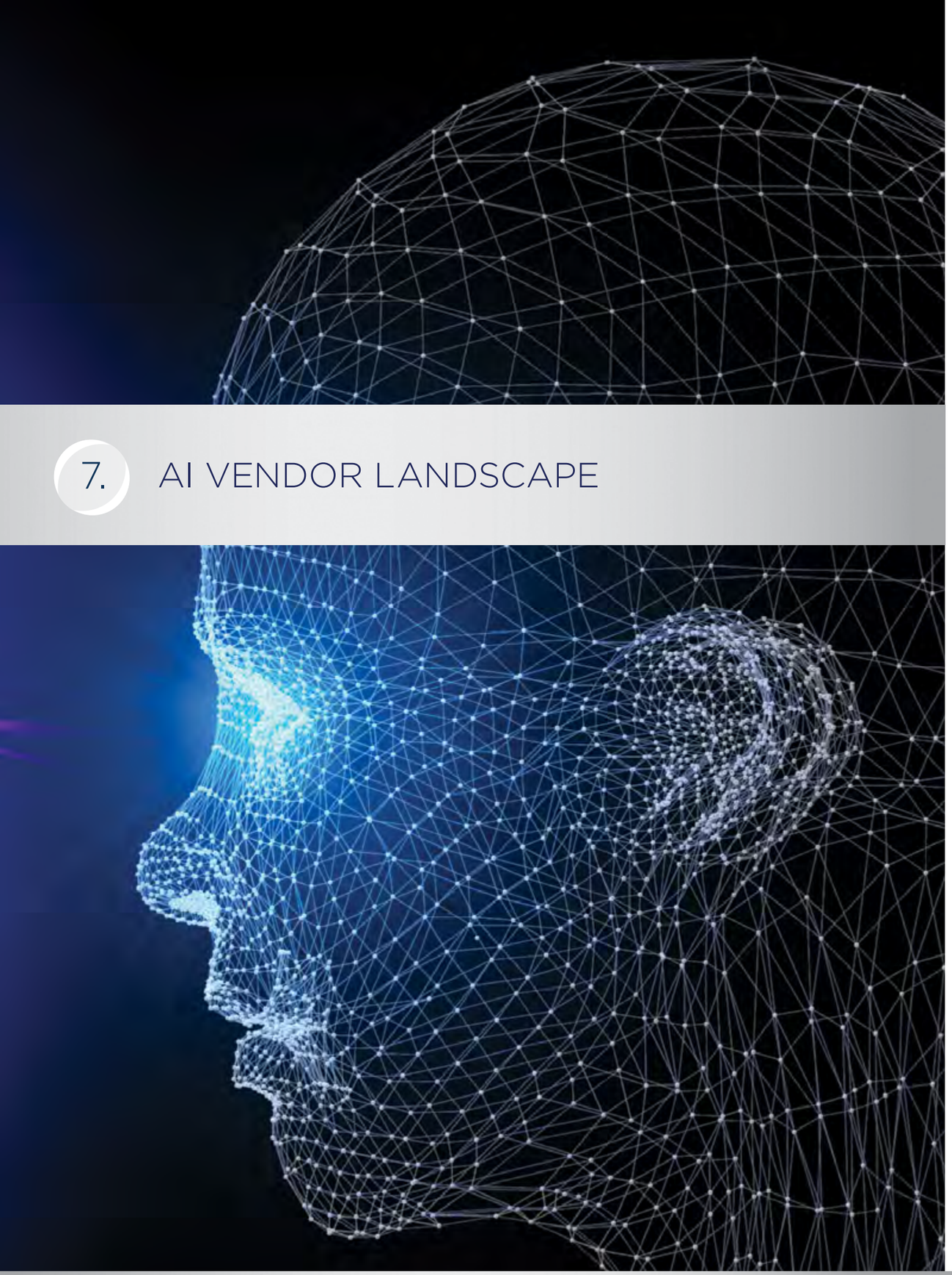
6.10 AI technology in “Virtual Assistant” to communicate with patients in an efficient way

Virtual Assistants/AI assistants are being created to help and enhance human-like interactions, thereby saving time and resources. Nuance, a company which has developed a Medical Virtual Assistant, streamlines clinical workflows for the 500,000 clinicians who rely on Dragon Medical every day for their clinical documentation. It enables individuals who are using specialized medical terminologies to communicate naturally with high accuracy.

6.11 AI in “Wearables” is making us proactive to take healthy decisions

Miniaturization is the upcoming trend in AI applications and thus, wearables such as smart-watches, clothes, and shoes will be trending in near future.

Researchers and manufacturers alike are looking to benefit from this trend by making it available for everyday use and clinical grade applications. In the absence of an AI engine, the data from a product would yield zero value to the user. Hence, AI engines are being integrated within the product’s health solutions to capture health insights of an individual. Thus, on detection of an abnormality through clinical grade wearable technology, users can approach the physician or can also opt for an AI doctor.



7. AI VENDOR LANDSCAPE

7. AI Vendor Landscape

7.1 Overview of the current AI vendors in healthcare by technology application

Category	List of companies
Data mining	Pathway Genomics, Viz.ai, Apple, Zephyr Health, Infermedica, Hindsait, GE Health Care, Flow Health, Google's DeepMind, IBM Watson, NVIDIA Corporation, Amazon Alexa, Apixio, Infervision, Lumiata, Health Fidelity, Whole Biome, Microsoft Corp., Medalogix, Morpheo, Careskore, CloudMedx, Medal, Flashback Technologies, pulseData, Oncora Medical, MedAware, Profility, RxPREDICT, EnsoData, Lytics, Deep 6 AI, HealthNextGen, Clinithink, Roam Analytics
Emergency room and surgery	Gauss Surgical, Medasense, MedyMatch Technology
Hospital management system	Siemens Healthineers, analyticsMD, Jvion, Saykara, Qualaris Healthcare Solutions, Amara Health Analytics
Lifestyle management and monitoring	Healthmir, Ovuline, SkinVision, LifeGraph, Wellframe, Lucina Health, PeerWell, Healint, WellTok, AiCure, DreaMed Diabetes, Intendu, Ten3T
Medical imaging and diagnostics	Butterfly Network, Imagia Cybernetics, General Vision Inc., Philips, Qure. Ai, Aindra, Predible Health, Arterys Inc, Imagen Technologies, Zebra Medical Vision, Deep Genomics, Enlitic, Freenome, SigTuple, Bay Labs, Lunit, Mindshare Medical, Entopsis, Keen Eye Technologies, Proscia, EaglEyeMed, Niramai Health Analytix, VisExcell, Maxwell MRI, Advenio Technosys, Smart Healthcare, Behold.ai, CureMetrix
Mental health	Ginger.io, TAO Connect, Avalon
Nutrition	VITL, Nuritas
Pharma	Turbine, benevolent.ai, Recursion Pharmaceuticals, 3Scan, Numerate, Atomwise, NuMedii, twoXAR, Cloud Pharmaceuticals, InSilico Medicine, Globavir Biosciences, Envisagenics
Research	iCarbonX, Inside DNA, Desktop Genetics
Virtual mate	Ada Health, Babylon Health, MedWhat, Sophie Bot, Your.MD, Sense.ly, Buoy Health, Care Angel
Wearables	QorQL, BIOBEATS, Atlas Wearables, Inc., Cyrcadia, Touchkin, TinyKicks, Magnea, PhysIQ, Sentrian

7.2 Top AI startups revolutionizing the healthcare industry

Startup name	Founded year	Head count	Headquarters	Funding details (USD million)	Investors
Flatiron Health	2012	201-500	New York, US	313	Allen & Company, Baillie Gifford & Co., Casdin Capital, Google Ventures, Roche Venture Fund
iCarbonX	2015	51-200	Hong Kong	305	China Bridge Capital, Tencent, Vcanbio & Gene Engineering Corp., Ltd.
WellTok	2009	51-200	Denver, US	239	Bessemer Venture Partners, Catholic Health Initiatives, EDBI, Emergence Capital Partners, Flare Capital Partners, Georgian Partners, Hearst Ventures, IBM Watson Group, InterWest Partners, Miramar Digital Ventures, Miramar Venture Partners, New Enterprise Associates, Okapi Venture Capital, Qualcomm Ventures, TriZetto Corporation
benevolent.ai	2013	51-200	London, England	141	Lansdowne Partners, Lundbeck, Upsher Smith Laboratories, Woodford Investment Management
Butterfly Network	2011	11-50	Guilford, US	100	Aeris Capital, Jonathan M. Rothberg
Recursion Pharmaceuticals	2013	11-50	Salt Lake City, US	84	Obvious Ventures, EPIC Ventures, Mubadala Investment Company, menlo-ventures, CRV, Data Collective, Lux Capital, Felicis Ventures, Advantage Capital, Two Sigma Ventures, Square 1 Bank, AME Cloud Ventures, Wild Basin Investments
Apixio	2009	51-200	California, US	45	Bain Capital Ventures, First Analysis, SSM Partners, Undisclosed Angel Investors,
Arterys Inc	2011	11-50	San Francisco, US	44	New York Presbyterian Hospital, ORI Capital, Northwell Ventures, Emergent Medical Partners, Temasek Holdings, GE Ventures, Varian Medical Systems, MedTech Innovator, Morado Venture Partners, Asset Management Ventures (AMV), StartX, Norwich Ventures, Farzad (Zod) Nazem
Pathway Genomics	2008	51-200	San Diego, US	40	Edelson Technology Partners, Founders Fund, IBM Watson Group
H2O.ai	2012	51-200	California, US	34	Capital One Growth Ventures, Nexus Venture Partners, Paxion Capital Partners, Transamerica Ventures
Zephyr Health	2011	51-200	San Francisco, California	34	Google Ventures, Icon Ventures, Kleiner Perkins Caufield & Byers, Susa Ventures
Infervision	2016	51-200	Beijing, China	28	Sequoia Capital, Qiming Venture Partners, Innoangel Fund, Powercloud Venture Capital, Genesis Capital
Ginger.io	2010	11-50	San Francisco, US	28	Ari Buchler, Bill Warner, ENIAC Ventures, James Joaquin, Kaiser Permanente Ventures, Kapor Capital, Khosla Ventures, LaunchCapital, Romulus Capital, Techstars, True Ventures, Ty Curry, Walt Winshall
Babylon Health	2013	51-200	London, England	25	DeepMind Technologies, Hoxton Ventures, Innocent Drinks, Kinnevik
Gauss Surgical	2011	11-50	California, US	25	AVIA Health Innovation, Jump Capital, LifeForce Ventures, Promus Ventures, Providence Ventures, StartX, Summation Health Ventures, Taube Investment Partners, Texas Medical Centre Accelerator (TMCx), United Healthcare (UHC)

7.3 Mergers and acquisitions and the race for AI

The funding for AI startups in healthcare, particularly by top Venture Capitalists (VCs), has consistently risen through the years.

Over the past couple of years, numerous startups have been entering the healthcare sector to provide AI solutions using their machine learning and big data analytics capabilities. Big players like Google, Apple, and GE are keen to tap into the AI market, thereby acquire top startups to gain a competitive advantage.

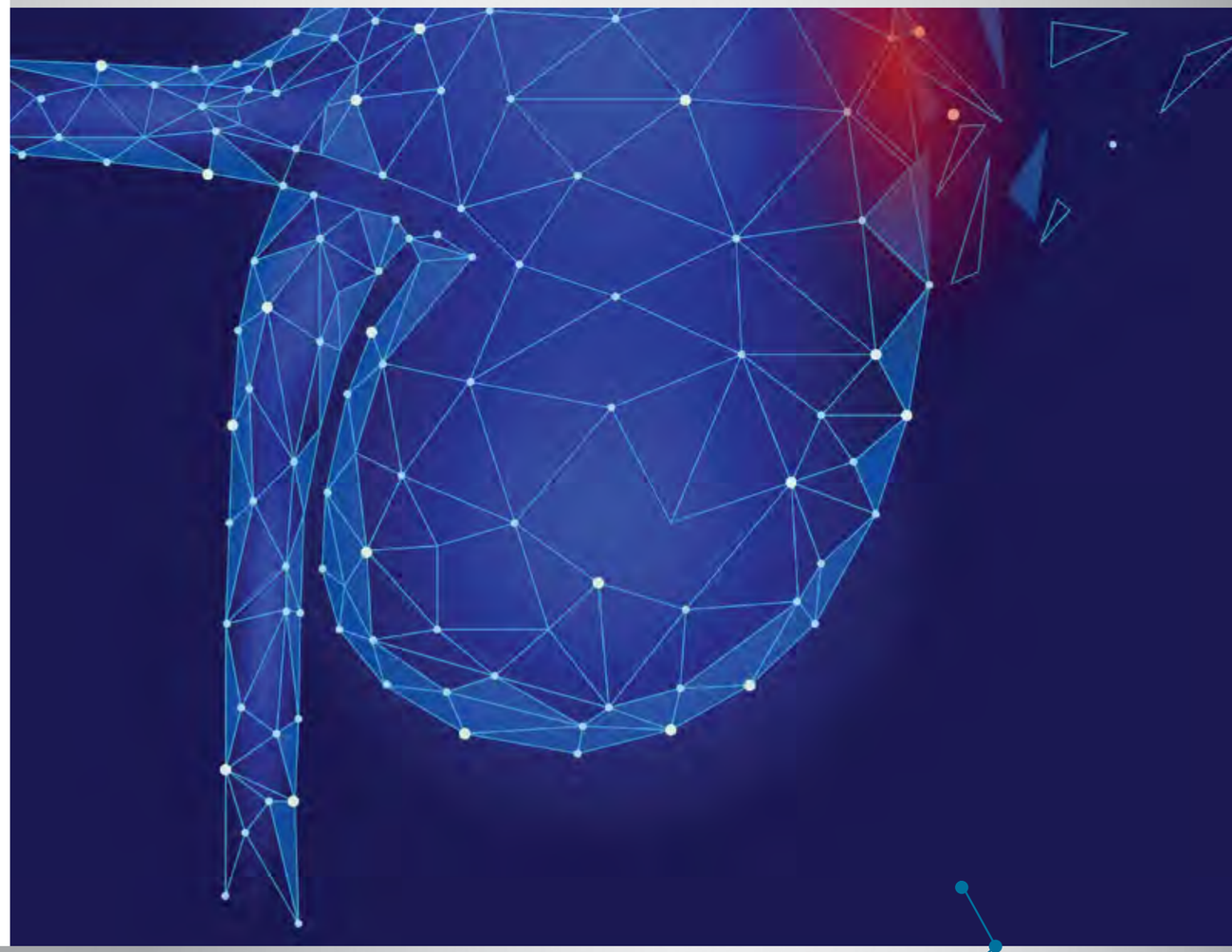
In 2015, IBM created Watson Health, with its headquarters in Cambridge, MA. Within a span of a year, it has acquired disruptive startups providing AI-powered healthcare solutions like Merge Healthcare, Phytel and Explorys. Google acquired DeepMind in 2014 to compete with major tech companies such as IBM (who was an early leader with its Watson Health business) and to gain a stronghold of deep learning in healthcare. Another tech giant – Intel, acquired Nervana Systems, a deep learning startup in 2016. Many other tech firms have also realized the huge potential of AI in healthcare, thereby participating in the race to acquire or fund startups providing AI tools for healthcare.

In the near future, we expect a further increase in the number of acquisitions related to AI in healthcare. The startups will be more focused on providing specialized solutions, such as predictive prevention, smart imaging, drug research, and virtual assistance, to attract more investors and possible acquisition by top tech giants.

Some of the key mergers and acquisitions in healthcare AI in the recent years are highlighted below.

Acquirer	Company	Type	Deal value (USD million)	Year
Google	DeepMind	Acquisition	Over 600	2014
IBM Watson	Merge Healthcare	Acquisition	1000	2015
	Phytel	Acquisition	Undisclosed	2015
	Explorys	Acquisition	Undisclosed	2015
Intel	Nervana Systems	Acquisition	408	2016
Apple	Lattice Data	Acquisition	200	2017
Philips	VitalHealth	Acquisition	Undisclosed	2017
Siemens Healthineers	Medicalis	Acquisition	Undisclosed	2017
GE Healthcare	Nvidia and Intel	Partnership	–	2017

8. IMPACT OF AI IN HEALTHCARE



8. Impact of AI in Healthcare

8.1 Trends in AI Adoption

With the rising number of patients and subsequent demands for quality and affordable treatment, healthcare organizations are realizing the benefit of technology adoption.

The adoption of AI in healthcare is currently at an early stage. This is largely due to limited digitization of patient records in many emerging economies. Certain countries in South Asia and Africa are still reliant on physical documentation to maintain their records. However, the adoption of AI is relatively less challenged in developed nations such as US and UK, where majority of the healthcare records have already been digitized, and the technology has flourished.

To effectively utilize AI in the healthcare industry, there is a need to build a database with all the historic data of patients, required to identify the patterns and accordingly use AI for diagnosis and therapy. If customized accurately, AI would not only be 'intelligent' but also highly user-friendly.

Some of the key reasons and barriers for AI adoption in the healthcare sector can be seen below.

Reasons for AI adoption in Healthcare	**Barriers** for AI adoption in Healthcare
Increase in digital data and difficulties in handling large amount of patients' records is pushing end-users to adopt AI.	With the addition of new parameters in healthcare information such as images, audio and video, AI is desired to have context specific capability for decision making.
Increase in number of diseases and need to understand and diagnose better with the help of deep learning.	Despite the growth in electronic data, many healthcare organizations still lack an integrated platform. This is a challenge when establishing the building blocks for AI implementation.
Through content analytics using NLP tools, AI can enable speedy diagnosis of patient's conditions, thereby supporting the provider in administering effective and efficient treatment protocols.	One of the major roadblocks for AI in healthcare is the low level of consistency among the records of healthcare providers resulting in inaccurate analysis of the captured data.
With the adoption of AI, many healthcare organizations have experienced a reduction in the costs and improvement in efficiency by treating larger number of patients.	Limited availability of skilled employees in healthcare who can initiate AI-based projects, is creating a hindrance for healthcare organizations.

The above-mentioned barriers in healthcare are limiting organizations from implementing full-fledged AI solutions. Though many healthcare providers are currently adopting it for search, classification and reasoning, as more and more digitization of patient records occurs, and advancement in AI technologies such as NLP, text and image analytics, and others continues, AI will showcase its full potential. In the future, enhanced functionalities of AI will revolutionize the way healthcare organizations operate.

8.2 Impact of AI on jobs

Emergence of AI in healthcare has instigated a fear among people about losing jobs, eventually slowing down the adoption of AI among healthcare workers. Most federal governments and policy makers have a misconception that with increasing adoption of AI, jobs would become redundant, thus adversely affecting the economic goal of job creation.

On the contrary, it is being analyzed that with adoption of AI, the employment opportunities are going to increase, and new age skills would be in great demand. Many jobs like care giving and rehabilitation require human emotions and utmost care which AI cannot currently replicate. AI is integrated in healthcare organizations to assist with care provision, not replace it. Moreover, as AI continues to evolve in healthcare, there would be more jobs created for new skill sets. AI in healthcare would have advantages of increased efficiency and decreased costs of treatment, leading to higher volume of care delivered. This would result in higher profits and employment opportunities. Thus, it is a misconception that AI would replace healthcare workers; in reality, it can lead to an increase in demand of a qualified workforce and improve efficiency in services like diagnostics, patient engagement and precision medicine.

In sum, AI could potentially replace certain administrative jobs such as those associated with medical record maintenance and patient engagement, and at the same time, also increase the demand for specialized professionals.

8.3 Impact of AI on existing business models in the healthcare industry

AI has impacted various industries and has transformed the business' operations. Moreover, evolving open source models in AI platforms makes it difficult to harmonize with the earlier Software as a Service (SaaS) based model. Now, with the rise of commercialization of AI, the healthcare industry is also experiencing a paradigm shift in the way of doing business. Many healthcare providers are integrating AI into their daily functions to gather insights from the growing clinical data, thereby, minimising the risk of the patients' life.

El Camino Hospital in Silicon Valley was encountering difficulties in understanding the patients' level of risk. This was majorly attributable to the failure in gathering patients' information from multiple electronic clinical databases. To counter this, El Camino Hospital partnered with Qventus, an expert in providing healthcare technology. They deployed AI to process El Camino Hospital's data. With this implementation, El Camino Hospital was able to predict the patient's level of risk, thus helping caregivers devise appropriate treatment options. Within 6 months of implementation, El Camino Hospital witnessed a 40% decline in the number of patients suffering from life-threatening falls – owing to the accurate treatment.

IBM Watson is adding value to various healthcare providers. Recently, pharmaceutical company GlaxoSmithKline (GSK) partnered with IBM Watson to provide better customer connectivity. It enables GSK's customers to ask questions by voice and text through GSK's online advertisement, thereby, changing the conventional way of customer interactions.

GSK rolled out Watson's question and answer capabilities featuring "Theraflu cold and flu medication", which is based on its core AI functionalities like natural language processing and machine learning. These questions were asked to individuals who searched the web for immediate treatment. Thus, receiving quick and accurate answers to their queries such as – "How do I treat my cough?"

With this upgraded technology, GSK is experiencing an increase in customer acquisition and brand loyalty. Deploying AI provides GSK with a competitive edge over its peers.

In the near future, we will see more healthcare companies transform their business models by implementing AI in their existing businesses, to gain a competitive edge.

8.4 Future scope of AI in healthcare

Although there are many proven applications of AI in the healthcare sector, the extent of implementation is still at a nascent stage. It is expected that increase in the adoption of AI, would result in a transformational change in the healthcare industry. The estimated growth in the future would, thereby, improve the diagnosis and treatment procedure in healthcare. The applicability of AI is vast with numerous opportunities in the healthcare industry.

A few areas where AI will grow in the near future are highlighted below.

- Around 415 million people, globally, suffered from Diabetes in 2017 as per data from National Health Surveys. Recently, the occurrence of DR in diabetic patients was estimated to be about 35%. The major challenge of detecting DR in patients can be resolved with the help of AI, which enables the physician to gather images of patients' retina and run these images through machines. These machines can effectively scan the images and provide a collection of data. The collected data is organized into a pattern by AI specialists, which can then be used to discover the dormant signs of DR. The discovered signs can assist in enhanced early diagnosis and thus, prevent the occurrence of DR among diabetic patients.
- Based on a report published by WHO, there is a an estimated shortage of about 17.4 million healthcare workers and an availability of only 4.45 skilled health professionals per 1000 people globally. This results in increased demand for healthcare professionals. AI-based platforms will be able to improve the entire process of diagnosis by examining historical medical records and patients' data. These systems can collate the test reports of patients and provide advice on treatment based on previous patient records with similar symptoms. This platform would enhance the doctor's efficiency, deliver better results and minimize errors.
- Delivering healthcare facilities in rural and under-developed areas is still a major challenge for the health sector. Shortage of good healthcare amenities, diagnosis centres, doctors and hospitals in such areas have led to a rise in mortality rates across the globe. Implementation of AI can help deliver therapeutic knowledge, predictive technology and diagnostic facilities, freeing up manpower and other health resources for deployment to rural and under-developed areas.

9. CASE STUDIES

9. Case Studies

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.

Well-known and one of the largest hospital in Europe experiments with IBM Watson for mammography screening

END USER PROFILE	Karolinska University Hospital is a university hospital in Stockholm, Sweden, and is one of the largest university hospital in Europe. It is the second largest hospital system in Sweden. It has 15,000 employees and 1,700 patient beds.
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	Stockholm, Sweden
YEAR OF IMPLEMENTATION/ DURATION	2017 (Experimental stage – 1 year)
CATEGORY (CLINICAL/ OPERATIONAL)	Clinical
PROBLEM AREA/ NEED	Every year, more than 1.5 million individuals are determined to have cancer. Advances in early detection and treatment have enhanced survival rates. Despite recent advances in clinical screening methods, breast cancer kills 500,000 individuals around the globe. Early screening and treatment reduces the mortality from breast cancer by about 30 percent. It is being experimented whether the detection of early stages of breast cancer tumours is possible using AI, along with enhancing the work-flow in radiology departments.
SOLUTION/AI TOOLS	AI guided in mammography screening is expected to improve the chances of treating cancers at an early stage. AI-based computer platforms would perform an early sorting of images received during screenings through image processing algorithms and detect the category and stage of malignancy.
IMPACT (METRICS)/ VALUE ADDITION	In present state, it takes two radiologists to check screening images. Using AI, there is a possibility for analysis work with one radiologist. This could free up expertise, and the radiologists would have the capacity to allot more time for follow-up cases which require further examination.

A non-profit hospital in California adopts AI to improve patient experience

END USER PROFILE	El Camino Hospital is a non-profit hospital comprising of 420 beds, based on a 41-acre campus in Mountain View, California. Specialties include cardiac care, dialysis, cancer care, maternal child health services, orthopaedics, neurosurgery and behavioural health. El Camino Hospital implemented the world's first computer-aided medical information system in 1971.
AI VENDOR PROFILE	Qventus's main goal is to streamline how healthcare works so that hospitals and care givers can focus on giving the most ideal care to patients. The organization offers an AI-based platform that helps healthcare groups make better operational choices progressively, with positive effects to financial performance and patient experience.
GEOGRAPHY	California, US
YEAR OF IMPLEMENTATION/ DURATION	2017
CATEGORY (CLINICAL/ OPERATIONAL)	Operational
PROBLEM AREA/ NEED	Perioperative care comprises 50 to 60 percent of healthcare centre income. About 80 percent of preventable same-day surgical cancellations are because of process disappointments, for example, patients not appearing for surgery, absence of equipment's or bed. These cancellations lead to possibly dangerous postpones for patients and additionally missed revenue for hospitals.
SOLUTION/AI TOOLS	The perioperative department is well-suited to AI-based solutions since inefficiencies can lead to significant clinical and financial impact. From case estimation to real-time turnaround management, the platform enables increased OR utilisation and fosters coordination between OR staff, surgeons, anaesthesiologists and their patients.
IMPACT (METRICS)/ VALUE ADDITION	The AI platform is proven to improve the patient satisfaction scores for ambulatory surgery from 80 percent to 96 percent within six months of deployment. The platform is designed to streamline processes with patient communications and has been shown to reduce preventable same day cancellations by approximately 25 percent.

Google's DeepMind is leveraged to detect diabetic retinopathy in oldest ophthalmic specialty hospital in England

END USER PROFILE	Moorfields Eye Hospital is a specialized NHS eye hospital run by Moorfields Eye Hospital NHS Foundation Trust. It is one of the oldest and largest centre for ophthalmic treatment, teaching and research in Europe. It is among the leaders of eye health service providers in the UK. The hospital has 2,300 staff focussing on managing and expanding on the pioneering heritage and assuring the front line of advancements in ophthalmology.
AI VENDOR PROFILE	Google's DeepMind is the world leader in AI research. The company has developed a neural network that is learning to depict human behaviour and emotions. It is acting an assistant to physicians in diagnosis and treatments. Google's DeepMind has developed artificial intelligence to diagnose diseases by analysing medical images, in what could be the first significant application of AI in healthcare.
GEOGRAPHY	Somerset, England
YEAR OF IMPLEMENTATION/ DURATION	2016
CATEGORY (CLINICAL/ OPERATIONAL)	Clinical
PROBLEM AREA/ NEED	Up to 50percent of the people with proliferative diabetic retinopathy who do not get timely treatment will turn out to be legally visually impaired within five years. Up to 98percent of serious vision loss from diabetic retinopathy can be avoided by early recognition and treatment. By productively analysing the enormous amount of results and images taken of the eye each year, AI could guarantee the patients needing treatment at the perfect time by the correct physician.
SOLUTION/AI TOOLS	DeepMind's AI platform works via preparing an algorithm that utilizes a large number of anonymized 3D retinal scans to distinguish indications of three of the most widely recognized eye ailments, glaucoma, age-related macular degeneration and diabetic retinopathy, with the goal that it can identify patterns and reach a diagnosis. The algorithm is said to be able to spot indications of these diseases faster and more effectively than a human expertise.
IMPACT (METRICS)/ VALUE ADDITION	There are more than 350 million patients who suffer from diabetic retinopathy across the globe. AI implementation to analyze the scans of the eye images is expected to prevent people from suffering avoidable sight loss around the world.

An integrated multi-specialty group with primary care focus improves care management and patient satisfaction using AI

END USER PROFILE	Prevea Health is an integrated multi-specialty group with primary care providers and exceptional specialists. Prevea Health's 180 physicians deliver primary care and specialty care in more than 50 specialties at 20 health centers throughout Green Bay and northeast Wisconsin regions of US
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, analyzes 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	Wisconsin, US
YEAR OF IMPLEMENTATION/ DURATION	2016
CATEGORY (CLINICAL/ OPERATIONAL)	Operational
PROBLEM AREA/ NEED	In 2009 Prevea Health's physician group adopted a Patient-Centred Medical Home (PCMH) delivery model to improve the health and satisfaction of patients. Prevea's practices to manage the population health slowed when they attempted to expand the PCMH model. With this adoption, Prevea Health was in need of an infrastructure that could help its physician practices automate population health management and patient engagement.
SOLUTION/AI TOOLS	Prevea implemented Watson Health's population health management solutions to integrate the key functions and attributions required to achieve PCMH recognition. IBM Watson Health system generated automated outreach communication by identifying the last scheduled appointment for patients with selected chronic conditions and are looking ahead to see if they had a future appointment scheduled.
IMPACT (METRICS)/ VALUE ADDITION	Prevea created a high-performing PCMH using the building blocks of the Triple aim of healthcare by achieving better health at reduced costs and improved patient satisfaction. Prevea Health achieved a 250 percent improvement in care management efficiency; increased patients receiving preventive and indicated care; increased office visits by 207 percent for non-compliant diabetics and improved FFS revenue while transitioning to value-based care.

A leading multispecialty medical group in us improves diagnosis and treatment adherence using AI

END USER PROFILE	Hallmark Health Medical Associates (HHMA) is the ambulatory unit for Hallmark Health System, a hospital and physician network. With 2,850 employees working in 23 practices in nine communities across Boston's northern suburbs in US, HHMA provides a wide range of outpatient medical care, including family medicine, endocrinology, gastroenterology, gynaecology and obstetrics.
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	Huntsville, Alabama, US
YEAR OF IMPLEMENTATION/ DURATION	2016
CATEGORY (CLINICAL/ OPERATIONAL)	Operational
PROBLEM AREA/ NEED	Patients tend to miss regular check-ups and hospitals were slow in following up on patient's health status. Delay in diagnosis leads to irreversible complications. HHMA wanted to empower its caregivers by improving documentation and through pre-visit planning and daily huddles.
SOLUTION/AI TOOLS	HHMA utilized Watson Health to standardize medical data inputs and help enhance the accuracy of the measurements. It necessitated all patient-related data to be captured and fed into its EMR legitimately, even from outside the system. Using numerous solutions on the IBM's Phytel Patient Engagement suite, HHMA provided caregivers with patient summaries highlighting gaps in care and the information needed to rapidly close those gaps.
IMPACT (METRICS)/ VALUE ADDITION	HHMA has shown progress in following metrics: qualified patients finishing mammograms from 61 percent to 70percent; diabetic patients having a diabetic foot test every year from 50percent to 60percent; diabetic patients having diabetic eye test every year from 26percent to 40percent. With the implementation of Watson, HHMA was able to automatically remind more than 83,000 patients about their appointments in the first year after implementation. The revenue of the company has increased by 2 million USD due to appointments booked through automated outreach calls.

A non-profit healthcare provider is driving down length of stay with the incorporation of Jvion's cognitive machine

END USER PROFILE	Baylor Scott and White Health is a non-profit medicinal services framework. It has 48 healing centres, more than 1,000 patient care centres, 5,500 active doctors and 44,000 representatives. It exists to serve all individuals, by giving customized wellbeing and health through exemplary care, training and research as a Christian service of recuperating.
AI VENDOR PROFILE	Jvion provides an AI based cognitive clinical success machine.; It utilizes an Eigen Sphere engine to convey an extensive patient amplified beyond the risk of an event to the clinical actions that will enhance results and drive engagement. It comprehends the massively complex, deficient, assorted and regularly changing group of patient information.
GEOGRAPHY	Texas, US
YEAR OF IMPLEMENTATION/ DURATION	2018
CATEGORY (CLINICAL/ OPERATIONAL)	Operational
PROBLEM AREA/ NEED	Due to the regularly changing assemblage of clinical information and diminishing phase of remain of abnormalities, it becomes essential to examine the patient information beforehand and reduce their length of stay.
SOLUTION/AI TOOLS	Jvion's Cognitive Clinical Success Machine enables doctors to foresee a patient's health condition 30, 60, 90, and 365 days from the point of starting. Baylor Scott and White Health has introduced the tool to their clinicians. The tool would facilitate decreased length of stay and prescriptive basic leadership devices to change how they care for their patients and members.
IMPACT (METRICS)/ VALUE ADDITION	With the execution of Jivon's cognitive clinical set up, hospitals improve lives of more number of patients, successfully and emphatically. Jivon's machine represents 1000 of exogenous elements affecting wellbeing and potential hazard. Segments, which make up 60 percent of the components affecting a man's wellbeing status, help the cognitive mechanism to convey a full representation of the patient that is as near the genuine future condition of a patient's risk and wellbeing as could reasonably be expected.

A community hospital secures clinical documentation workflows and drives cost savings with nuance solutions

END USER PROFILE	Union Hospital is an award-winning, full-service community hospital located in Maryland, US. Nationally recognized for clinical excellence in the treatment and prevention of disease, our 83-licensed bed, not-for-profit hospital provides superior, personalized, quality health care to our neighbours, families and friends.
AI VENDOR PROFILE	Nuance Communications is the pioneer and leader in conversational and cognitive AI developments that bring knowledge to ordinary work and life. It delivers solutions that can comprehend, examine and respond to human dialect, expanding efficiency and intensify human insights.
GEOGRAPHY	Maryland, US
YEAR OF IMPLEMENTATION/ DURATION	2017
CATEGORY (CLINICAL/ OPERATIONAL)	Operational
PROBLEM AREA/ NEED	The Union hospital was keen to improved HIPAA compliance and was in need to adopt innovation to upgrade the clinical work process and perceived the need to institutionalize the information feeding process into the framework. The administration perceived that a protected printing and catch arrangement would help with HIPAA consistency and streamlining the work processes.
SOLUTION/AI TOOLS	Union Hospital deployed Nuance Output Manager, a print management software and Nuance AutoStore document, a data capture software, powered by artificial intelligence and machine learning, to streamline workflows and enable more secure printing. Subtlety arrangements furnish clinic staff with a safe print discharge, approval, and verification process that avoids protected health information (PHI) from being seen by unapproved people. This enables staff to print at any of the doctor's facility's arranged associated printers, conveying data where it is required.
IMPACT (METRICS)/ VALUE ADDITION	The process re-engineering reduced documentation time up to 45 percent, while enhancing quality by 36 percent. Clinicians have an effective, one stop look for printed materials and faxes, enabling them to have more opportunity for patient care. With this implementation, Union Hospital earned Stage 7 on the eight-stage HIMSS Analytics EMR Adoption Model, which measures the degree to which a hospital uses its EMR functions.

One of the largest teaching hospital in the world partnered with GE Healthcare to launch capacity command center to enhance hospital operations

END USER PROFILE	The Johns Hopkins Hospital (JHH) is a biomedical research facility and teaching hospital of the Johns Hopkins School of Medicine, situated in Baltimore, Maryland, U.S. It is one of the largest hospitals in the world. The mission of Johns Hopkins Medicine is to improve the health of the community and the world by setting the standard of excellence in medical education, research and clinical care.
AI VENDOR PROFILE	GE Healthcare is an American multinational headquartered in Chicago, Illinois. It offers AI solutions that are utilized as a part of its imaging & diagnostic tools. GE Healthcare also manufactures medical diagnostic equipment including CT image machines. Further, it develops healthcare technological solutions for medical imaging and information technologies, medical diagnostics, patient monitoring systems, disease research, drug discovery, and biopharmaceutical manufacturing.
GEOGRAPHY	Maryland, US
YEAR OF IMPLEMENTATION/ DURATION	2016
CATEGORY (CLINICAL/ OPERATIONAL)	Operational
PROBLEM AREA/ NEED	Unavailability of historical medical records delays the process of follow ups and early detection of abnormalities in patients. Thus, there is a need to restore and maintain the patients' data.
SOLUTION/AI TOOLS	GE Healthcare designed and built a Capacity Command Centre for JHH that combines the latest in systems engineering, predictive analytics and innovative problem-solving solutions, driven by AI. It improved the clinical efficiency of the hospital by enabling analysis of historic records and recommending suitable therapy.
IMPACT (METRICS)/ VALUE ADDITION	The hospital has seen a 70 percent decrease in operating room holds, 30 percent diminishment in time required to admit a patient from the ER and 21 percent improvement in pre-noon releases.

IBM Watson helps premier healthcare clinic to streamline its value-based care

END USER PROFILE	Utica Park Clinic is a service of Hillcrest Healthcare System (HHS) owned by Ardent Health Services. With over 200 providers in over 20 specialties, it is identified as a premier healthcare provider in Oklahoma region.
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	Oklahoma, US
YEAR OF IMPLEMENTATION/ DURATION	2017
CATEGORY (CLINICAL/ OPERATIONAL)	Operational
PROBLEM AREA/ NEED	Administrators at Utica Park Clinic faced challenges due to a bug in the population health management (PHM) system. They recognized that the group needed to generate new fee-for-service revenue streams in the short term to compensate for the setback being made by pay-for-performance plans. It also needed to improve the quality of care to decrease misfortunes and set the phase for future accomplishment.
SOLUTION/AI TOOLS	Utica Park Clinic responded to problem by incorporating IBM Watson Health in its PHM platform along with Lean Six Sigma principles
IMPACT (METRICS)/ VALUE ADDITION	Utica Park Clinic could produce noteworthy outcomes in various regions with the usage of Watson. Almost 140,000 patients were reminded about their appointments, 65,000 patients were educated about identified care gaps and 6,800 patients interacted with the clinic to close the gap. This resulted in the generation of more than USD 840,000 extra billable income in one year as a part of 60-supplier experimental run program. The aggregate ROI was 14:1, and all PHM endeavours are presently producing their own financing streams.

10. ANNEXURE

10. Annexure

List of AI companies/platforms mentioned in the report

Company name	APP description
AiCure	The clinically-validated platform is driven by AI technologies to reduce risk and optimize patient behaviour.
Aindra	"Astra", an AI algorithm developed by Aindra, analyzes a digitized slide image and segregates the cell into HSIL, LSIL and squamous cell carcinoma segments.
AliveCor	AliveCor's KardiaMobile smartphone app allows users to record their EKG and detect the possibility of Atrial Fibrillation (AF).
Amazon Alexa	Alexa is Amazon's cloud-based voice service. Users can leverage its suite of intuitive analytics to transform data into meaningful insights.
analyticsMD/Qventus	Qventus is an AI-based software platform that solves operational challenges across the hospital including areas such as emergency departments, perioperative areas, and patient safety.
Apixio	Apixio's HCC Profiler utilizes advanced natural language processing, pattern recognition, and machine learning to streamline risk adjustment.
Apple	Apple's ResearchKit collects health information and creates research data via iPhones. Scientists have published data on seizures, asthma attacks and heart disease using the tool.
Arterys	A web-based medical imaging analytics platform powered by AI. The platform combines cloud computing with deep learning to aid physicians in post-processing, diagnostic and therapeutic decisions.
Atlas Wearables	Atlas is a fitness tracker – with the on-wrist display, users can track their entire work-out and get live feedback to optimise their performance and improve on their strength.
Atomwise	AtomNet predicts potential drug cures with the use of supercomputers, artificial intelligence and a specialized algorithm that runs through millions of molecular structures.
Avalon	Deep learning-based computer aided diagnosis tool to facilitate the detection of brain degenerative diseases like Alzheimer's and enable better patient stratification in clinical trials.

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.
CloudMedx	The CloudMedx Analytics platform provides real-time visual insights and predictive analytics around population clinical risk and outcomes based on machine learning and natural language processing.
CureMetrix	CMAudit process images using its platform and compare outcomes against the results of their proprietary algorithm. It provides a statistical analysis of a medical practice's performance and helps identify areas for improvement for its clinical staff.

Company name	APP description
Cyrcadia	The iTBra™ is a comfortable and discreet insert under any brassiere, empowering women to enhance their monthly breast self-examination in the privacy of their home.
da Vinci Surgery System	Surgical robotic system to translate a surgeon's hand movements into smaller, precise movements of tiny instruments inside a patient's body.
Deep Genomics	Deep Genomics is a data and AI-driven platform that supports geneticists, molecular biologists and chemists in the development of therapies.
DeepMind	Google DeepMind Health leverages powerful machine learning algorithms and artificial intelligence to mine medical records in order to provide deep insights on health services to healthcare professionals.
Desktop Genetics	DESKGEN Libraries are AI-driven and tailored to user targets.
DreaMed Diabetes	Glucositter is DreaMed's artificial pancreas technology, for monitoring glucose levels and adjustments in insulin levels.
Enlitic	Enlitic's deep learning technology incorporates a wide range of unstructured medical data, including radiology and pathology images, laboratory results (blood tests and EKGs), genomics, patient histories, and electronic health records (EHRs).
EnsoData	EnsoSleep, EnsoData's autoscoring software, combines AASM scoring recommendations with advanced algorithms to analyze physiology and maximize accuracy.
Entopsis	Entopsis' NuTEC is a single device diagnosing multiple diseases as opposed to numerous individual tests in the hospital, each diagnosing a single disease. It is a platform for regular health monitoring.
Envisagenics	SpliceCore™ is the Envisagenics cloud-based drug discovery platform that uses RNA data from patients to accelerate R&D in therapeutics. This is achieved using artificial intelligence to identify new biomarkers and drug targets.
Flatiron Health	Flatiron's OncoAnalytics platform contains dashboards designed to surface actionable data insights and help improve operations.
Flow Health	Flow Health makes precision medicine possible by applying deep learning to vast amounts of clinical, genomic and patient-generated data to uncover hidden patterns.
Freenome	Freenome's liquid biopsy diagnosis platform detects the cell-free DNA sequencing of cancer.
Gauss Surgical	Gauss Surgical develops real time blood monitoring solutions to provide an accurate and objective estimation of blood loss – helping to optimize transfusion decisions, recognize haemorrhage status and improve patient outcomes.

Company name	APP description
GE Health Care	Applied Intelligence from GE provides analytics for sustainable outcomes by leveraging healthcare data to achieve clinical, financial and operational outcomes.
Ginger.io	Ginger.io app offers emotional support coaching, therapy, and psychiatry.
Globavir Biosciences	Globavir's platform assists in diagnosing infectious diseases, including the West Nile, Japanese Encephalitis, Ebola, Marburg, and Hunta viruses.
GNS Healthcare	GNS Healthcare uses AI to transform diverse streams of biomedical and healthcare data into computer models. The models enable doctors to identify patients' responses to treatments.
H2O.ai	H2O.ai is an open source platform, allowing business users to extract insights from data, without the need to have expertise in deploying or tuning machine learning models.
Healint	The Migraine Buddy platform helps users manage and track their migraines. It helps patients, doctors and researchers better understand the real-world causes and effects of neurological disorders.
Health Fidelity	Health Fidelity's platform offers health plans to utilize 100% of members' data to accurately analyze and identify risk across multiple populations.
Healthmir	HealthMir is a Health Engagement Platform that places health content, knowledge and experience sharing at the centre of their engagement engine to enable holistic health condition management.
HealthNextGen	HealthNextGen provides population health solutions that enable learnings for several diseases as well as the statistical prediction of the spread of certain diseases. Apart from predictive analytics, the platform provides tracking functionality for chronic patients, ensuring medication adherence, communication with their doctors, and tracking their vitals to ensure that they stay healthy.
Helix	Helix is a voice controlled virtual assistant powered by artificial intelligence, with applications in laboratory sciences.
IBM Watson	IBM Watson is a supercomputer that combines artificial intelligence and computational analytics to provide deep insights to users based on exponential amounts of data ingested. IBM Watson's Health arm provides cognitive computing that enables more natural interaction between physicians, data and electronic medical records.
iCarbonX	Meum is a digital health management AI platform that enables users to create a digital profile of their lives, so they can understand and monitor their present health status, predict trends, and improve their future.
Imagen Technologies	AI-based software that can detect clinically-meaningful pathologies within medical images.
Imagia Cybernetics	A healthcare artificial intelligence (AI) company developing radiomics biomarkers and clinical decision support systems

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Company name	APP description
Infermedica	Infermedica collects, analyzes and uses medical knowledge to ask diagnostic questions to identify patients' conditions using AI.
InSilico Medicine	The DeepPharma (TM) platform utilizes deep learning to improve the computer analysis of massive structured multi-omics data banks and tissue-specific pathway activation profiles.
Intendu	Intendu is a functional brain-body training console for people with brain impairments. Intendu's life-simulating games focus on 8 main cognitive functions.
Jvion	Jvion's Cognitive Clinical Success Machine uses an Eigen Sphere engine to deliver a comprehensive patient view amplified beyond the risk of an event, including suggesting clinical actions that will improve outcomes and drive engagement.
Keen Eye Technologies	WatCell™ recognizes a large variety of cell morphology. The platform leverages machine learning algorithms and allows users to recognize similar cells.
LifeGraph	LifeGraph is a behavioral monitoring tool that enables the early detection of deterioration in patients who suffer from behavioral illnesses, potentially preventing hospitalization and improving medication management.
Lumiata	Being a Data-as-a-Solution (DaaS) product, the Lumiata Matrix Suite enables America's leading health plans to better manage underwriting, risk adjustment, and care management efforts by accurately predicting the future health trajectories of their members and the associated utilization of healthcare resources.
Lunit Inc	Both Lunit, an AI-powered medical image analysis software product, and Lunit INSIGHT, a web-based medical image diagnostic software, were developed using cutting-edge deep learning technology.
Lytics	Lytics is a customer data platform that helps brands orchestrate relevant marketing with built-in data science.
Magnea	With the help of machine learning, Magnea's wearable sensor detects movements like traumatic falls, walking, standing etc. The data is analyzed in the cloud and relevant information is presented to users and caregivers.
Maxwell MRI	By combining deep learning with modern medical imaging, Maxwell MRI is focused on developing a method of prostate cancer diagnosis.
Mayo Clinic	A clinic which has partnered with Tempus and AliveCor to use AI in the treatment and diagnosis of patients.
Medalogix	A home health predictive model that identifies patients most likely to benefit from hospice, facilitating clinical team coordination.
Medasense	Novel NOL ™ index (Nociception Level Index) is a patented technology platform that enables an objective assessment of the physiological response to pain (nociception).

Company name	APP description
MedAware	MedAware's technology uses big data analytics and machine learning algorithms to analyze electronic medical records and automatically learn how physicians treat patients.
MedyMatch Technology	An acute imaging artificial intelligence engine that leverages deep vision and cognitive analytics to compare large sets of data to identify anomalies.
Merge Healthcare	Merge solutions facilitate image sharing to create an effective and efficient electronic healthcare experience for patients and physicians.
Microsoft Corp.	InnerEye develops machine learning techniques for the automatic delineation of tumors as well as healthy anatomy in 3D radiological images.
Morpheo	Morpheo is a 'Machine Teaching' platform for Healthcare that interfaces with large datasets, algorithms, medical specialists and data scientists to provide characterizations and predictions of pathologies.
Niramai Health Analytix	An artificial intelligence driven diagnostic platform that uses thermal image processing and machine learning algorithms for breast cancer screening.
Nividia	NVIDIA DGX Systems comprises of deep learning and analytics systems that are designed to give data scientists the tools for AI exploration.
NuMedii	NuMedii discovers and de-risks effective new drugs by translating Life Sciences Big Data into therapies.
Numerate	Numerate's AI-driven platform addresses challenges in small-molecule drug discovery and accelerates candidate selection and optimization.
Nuritas	The platform targets, predicts and unlocks novel bioactive peptides from food sources.
Ovuline	OviaTM Fertility analyzes user data to provide insights on when the user is most fertile.
Pathway Genomics	OME™, an AI-powered mobile app, combines personal health and wellness feedback with machine-based deep learning and data science to provide recommendations for physical well-being.
PeerWell	PeerWell's PreHab and ReHab app delivers customized daily lessons to those with scheduled surgery. The program puts patients in control of their surgery outcome.
Philips	Illumeo is a clinically intelligent software that augments the skills of clinicians and redefines how they currently interface with images. It provides the technology and tools that enhance radiologists' expertise and efficiency.
PhysIQ	PhysIQ applies artificial intelligence and machine learning to data streaming from wearable or implantable devices, to learn one's unique vital sign patterns and then detect subtle deviations that may indicate a change in health. The result can be applied across multiple clinical use cases, hardware platforms, and patient populations to generate unprecedented personalized insight.

Company name	APP description
Phytel	Phytel provides medical care solutions and develops prescription, lab and clinical data for health and disease management.
Predible Health	Predibleliver enables the advanced analysis of multi-phase CT scans to deliver better care to cancer patients.
Profility	Profility provides technology that enables personalized care planning, by optimizing decisions and transitions within a healthcare ecosystem and leveraging existing knowledge about how patients will respond to a particular treatment or pathway.
Proscia	Proscia's platform is a software-based laboratory with unified solutions for digital pathology data management, collaboration, and image analysis.
pulseData	Machine learning engines that predict health, so healthcare companies can deliver care precisely to patients & members that would benefit most.
QorQL	Qhealth is a consumer application that helps patients during their illness cycle to engage with clinicians, stay connected and self-manage their care.
Qualaris Healthcare Solutions	QualarisAudit™ is a secure, cloud-based software platform for improving best practices in healthcare.
Qure. Ai	Qure.ai's deep learning algorithms deal with the rich 3-dimensional information contained in medical images. One of the key focus areas is algorithm interpretability, ensuring that the reason for a suggested diagnosis is clear to a doctor.
Recursion Pharmaceuticals	A drug discovery platform involving millions of rapid, automated experiments and analyzes to discover new therapeutics.
Roam Analytics	Roam's platform provides contextual data and machine learning to empower biopharmaceutical and medical device companies with the predictive insights they need to make informed decisions and provide more effective treatments.
RxPREDICT	RxPREDiCT leverages the power of big data with machine learning models that reveal hidden patterns by continuously analyzing and learning trends from a variety of patient level data.
Saykara	Powered by voice recognition and machine learning, Saykara captures data with a new artificial intelligence-based virtual scribe solution that eliminates the need to work with EHRs.
Sense.ly	Sense.ly is an empathy-driven clinical platform that helps clinicians and patients better monitor and manage their health.
Sentrian	The Sentrian's RPI platform is designed to prevent avoidable hospitalization by leveraging the revolution in remote biosensors and machine learning to remotely detect deterioration in patients' health before it becomes acute.
Siemens Healthineers	Siemens Healthineers is a medical technology company innovating its portfolio of products and services in its core areas of diagnostic and therapeutic imaging, laboratory diagnostics, and molecular medicine.

Company name	APP description
SigTuple	Manthana is an AI platform which helps analyse visual medical data. Manthana has enabled the analysis of peripheral blood smears, urine microscopy, semen, fundus & OCT scans and chest x-rays.
TAO Connect	Therapist Assisted Online (TAO) is a suite of online tools for client education, interaction, accountability, and progress assessment to facilitate mental health treatment.
Tempus	Tempus is a technology company that is building the world's largest library of molecular and clinical data and an operating system to make that data accessible and useful.
Touchkin	Compassionate AI chatbot for behavioural health.
Turbine	Turbine uses artificial intelligence to model how cancer works on the molecular level, and tests millions of potential drugs on it each day.
twoXAR	A drug discovery platform that leverages its technology internally to build its own pipeline of therapeutic candidates across diseases as well as collaborate with biotechnology and pharmaceutical companies to jointly discover and develop novel drugs.
Verb Surgical	A digital surgery platform that combines robotics, advanced visualization, advanced instrumentation, data analytics and connectivity.
VisExcell	VisExcell is developing computer-aided detection in mammograms and other imaging modalities through big data and advanced machine learning algorithms.
VitalHealth	Population Health Management develops tools for outcome measurement, patient engagement, care coordination and analytics — to help manage chronic diseases.
VITL	The company's platform uses artificial intelligence to analyze user data and generate personalised recommendations on supplements and nutrition, enabling user insights into how one can proactively manage and improve their health through tailored advice to achieve specific diet/lifestyle goals.
Viz.ai	Viz.ai is a Direct-to-Intervention healthcare company that uses artificial intelligence and deep learning algorithms to analyze medical data and improve medical workflow.
Wellframe	The data collected through the Wellframe platform combined with advanced methodologies increases accountability, learning, and performance to transform clinical services.
WellTok	WellTok's CaféWell health optimization platform™ organizes the growing spectrum of health and condition management programs, communities, apps and tracking devices.
Whole Biome	Whole Biome integrates laboratory science and computational analysis to gain a comprehensive high-resolution view of each individual's microbiome and applies machine learning algorithms to identify broader trends in biochemical and metabolic pathways across populations.
XBird	The company uses data captured by smartphones and wearables to analyze and detect adverse health events before they occur.
Your.MD	An AI-based health information service platform and a marketplace of health service providers and products.
Zebra Medical Vision	Medical data research platform that will produce the needed amount of machine learning algorithms to provide scalable diagnostics.
Zephyr Health	Zephyr Illuminate™ helps Life Sciences companies make decisions across the entire product lifecycle with precise and predictive insights.

AI Ready Checklist

Is your healthcare organization ready to leverage the Artificial Intelligence wave?

Please tick all that apply:

- ◯ You wish to assess the potential of leveraging AI in your healthcare organization
- ◯ You are considering doing an opportunity scan, a business case or a proof of concept for any of the AI use cases listed in this report
- ◯ You wish to discuss any listed case study or application in more detail
- ◯ You are considering the application of any AI (or non-AI) based advanced technologies in your organization (e.g. automation, chatbots etc.)
- ◯ You wish to raise awareness of AI across key stakeholders in your organization

If you ticked any of the boxes above, please get in contact with your local Mindfields office so we can help you grow for tomorrow.

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