

AI in Healthcare

Dr. Sachin Kumar

Associate Professor

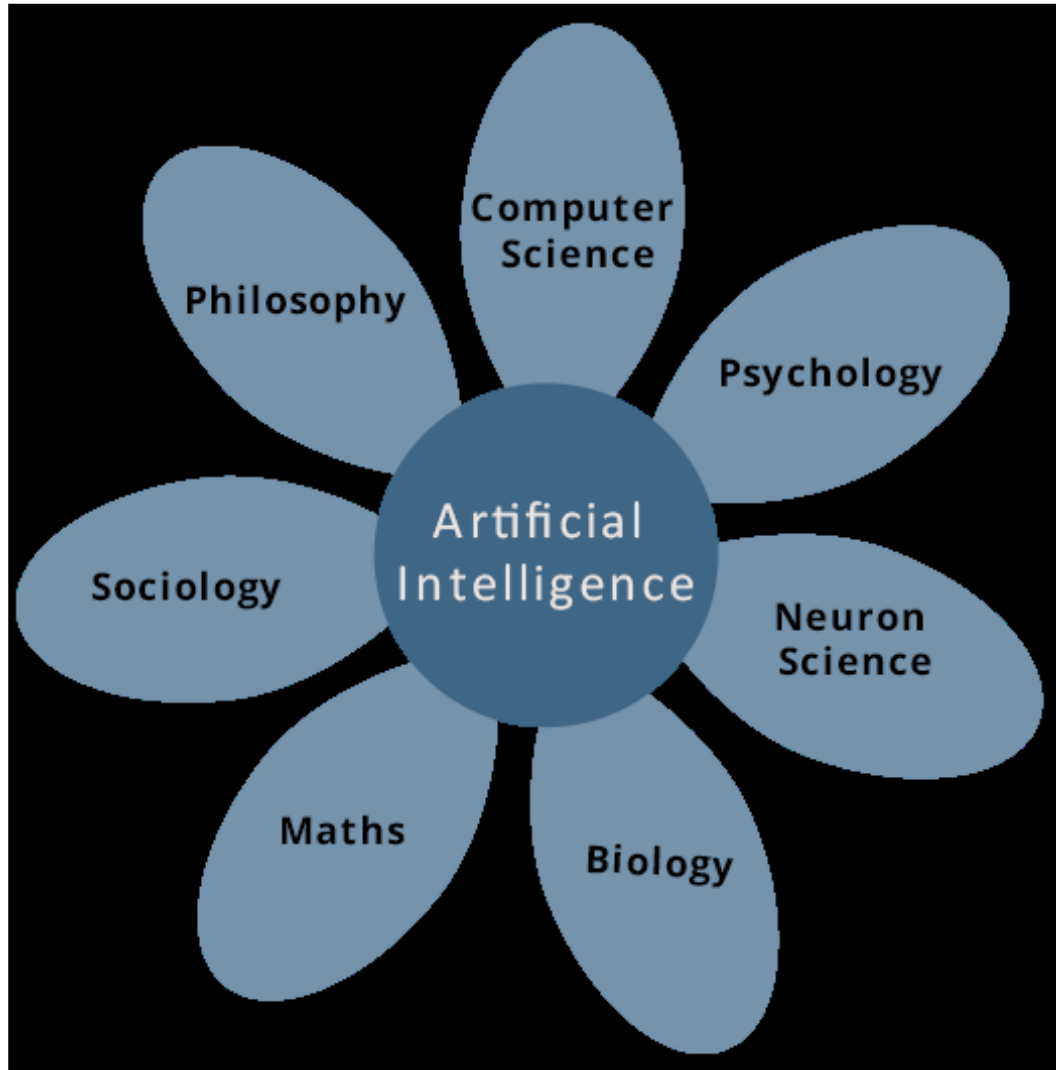
Amity University U.P., Lucknow campus

In computer science, **artificial intelligence (AI)**, sometimes called **machine intelligence**, is intelligence demonstrated by machines, in contrast to the **natural intelligence** displayed by humans and animals.

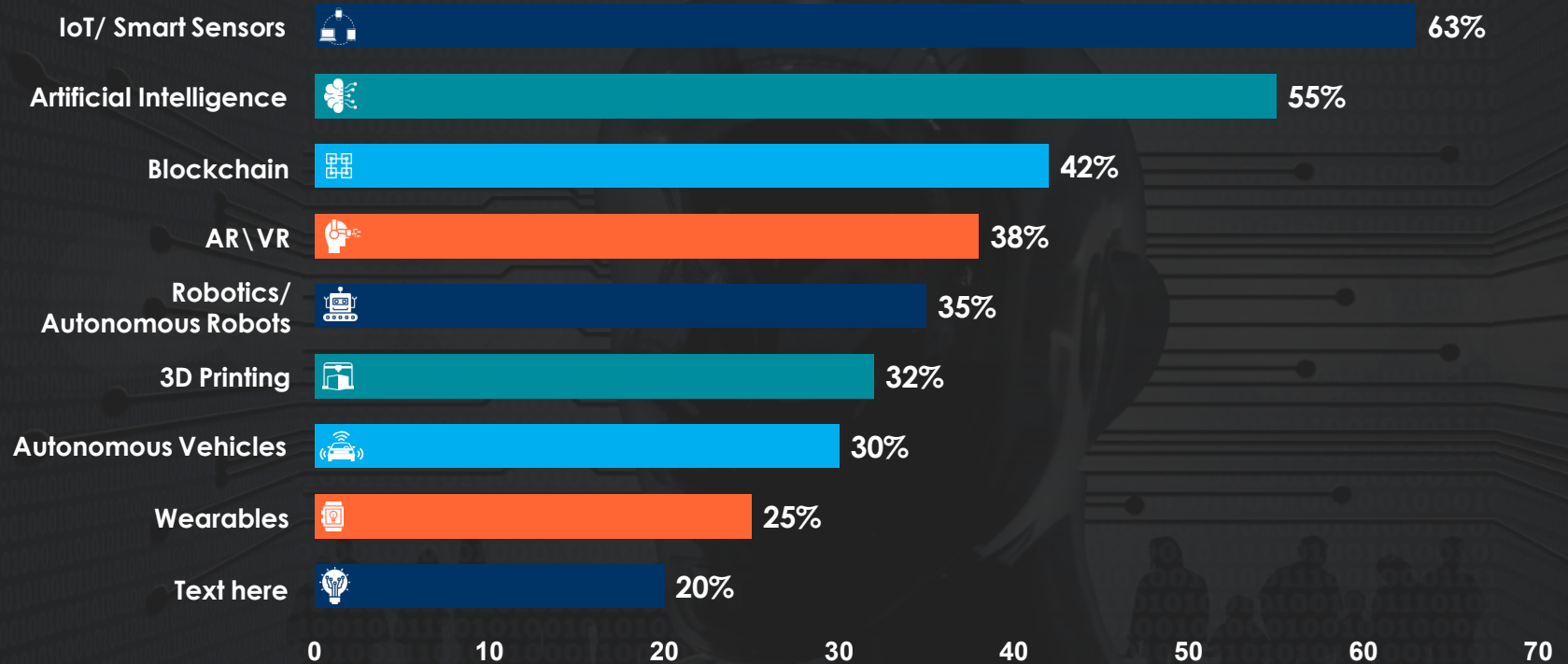
The term "artificial intelligence" is used to describe machines that mimic "cognitive" functions that humans associate with other human minds, such as "learning" and "problem solving".

According to the father of Artificial Intelligence **John McCarthy**, it is

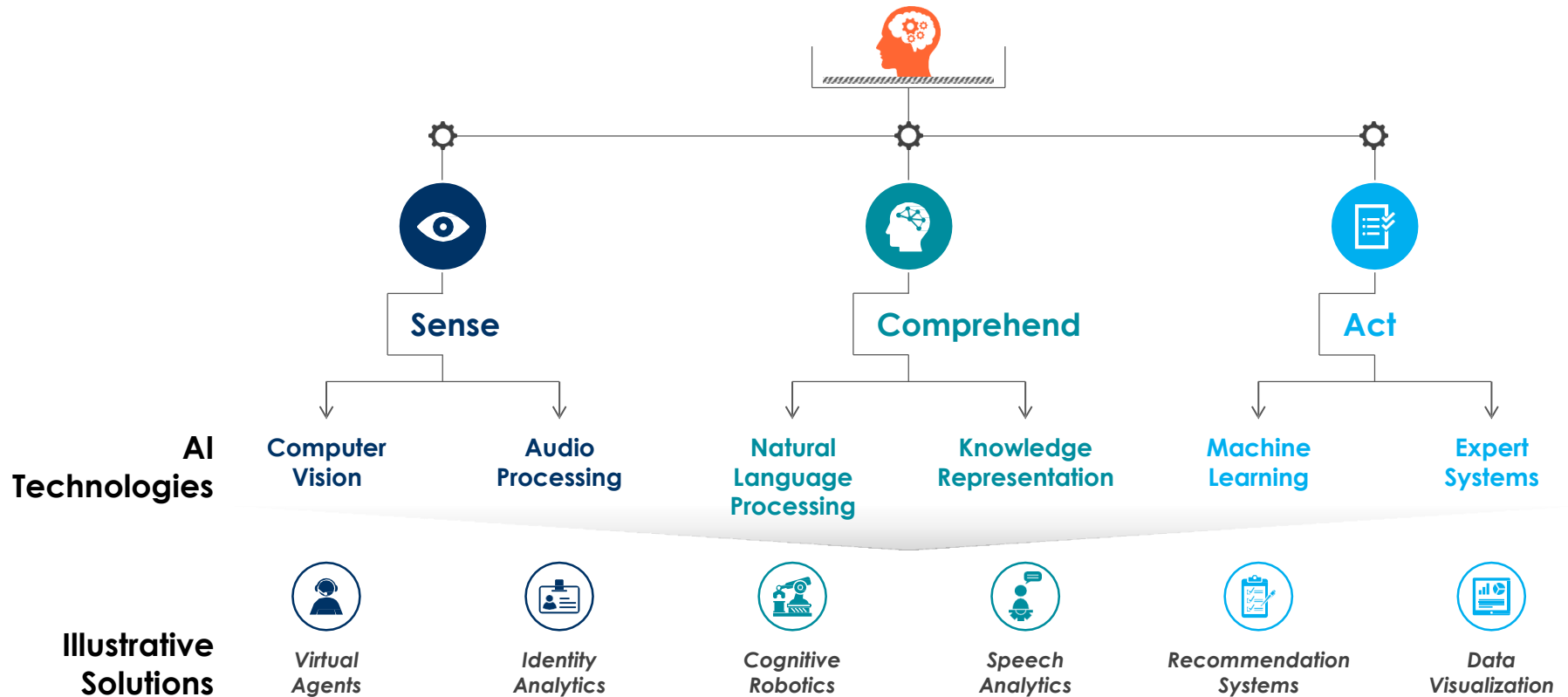
"The science and engineering of making intelligent machines, especially intelligent computer programs".



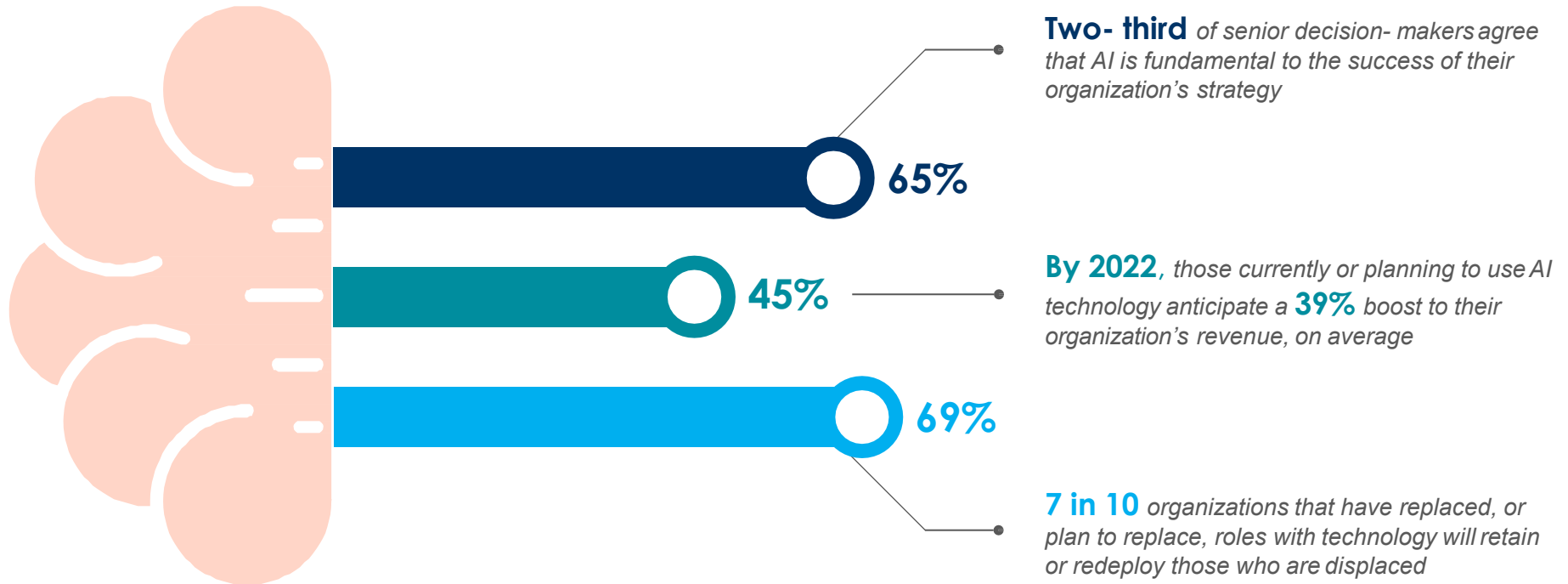
Survey on Adoption of Emerging Technologies



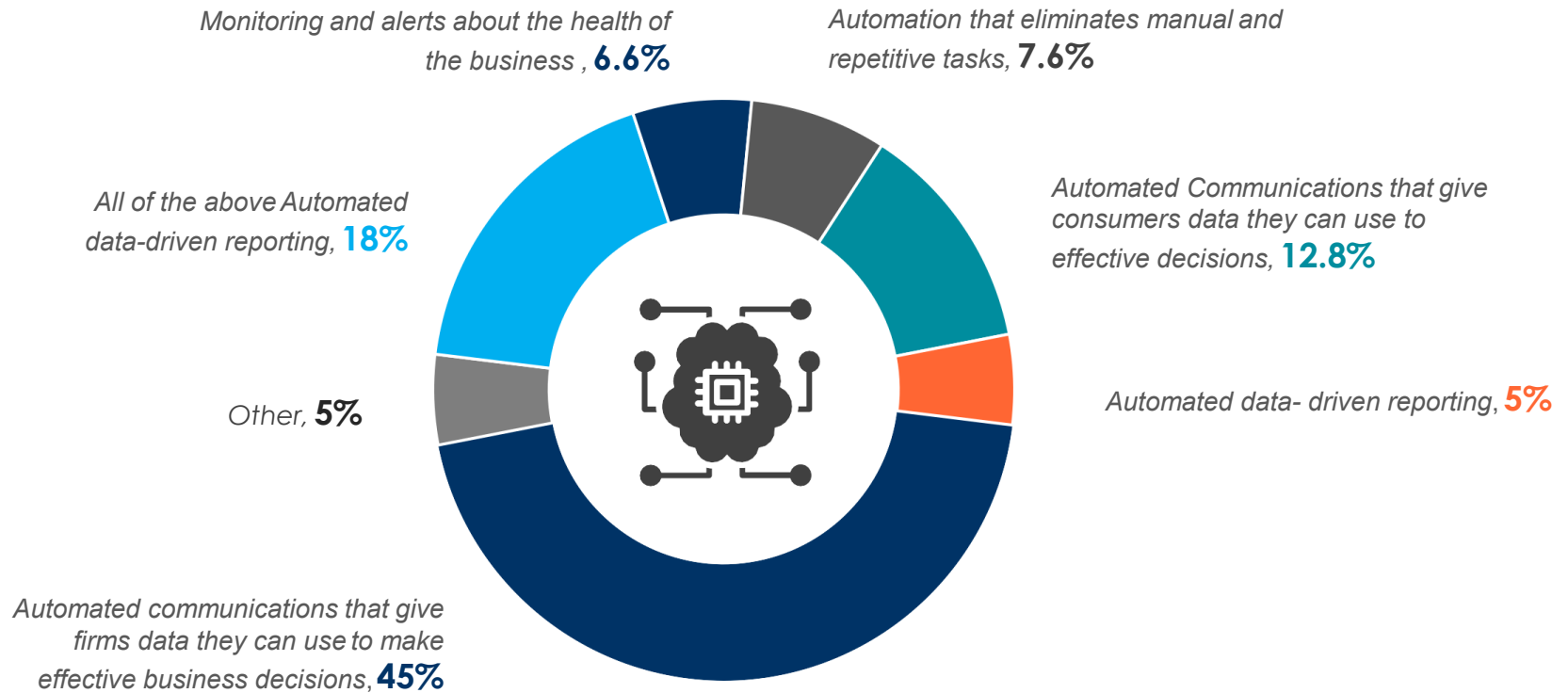
Artificial Intelligence Introduction



Artificial Intelligence Key Statistics



Reasons for using Artificial Intelligence



Artificial Intelligence in various Sectors

Transport



To reduce accidents and cut operational costs

Health



To minimize chronic and dangerous diseases

Water



To conduct analysis and studies to provide water sources

Technology



To increase productivity and help with general spending

Environment



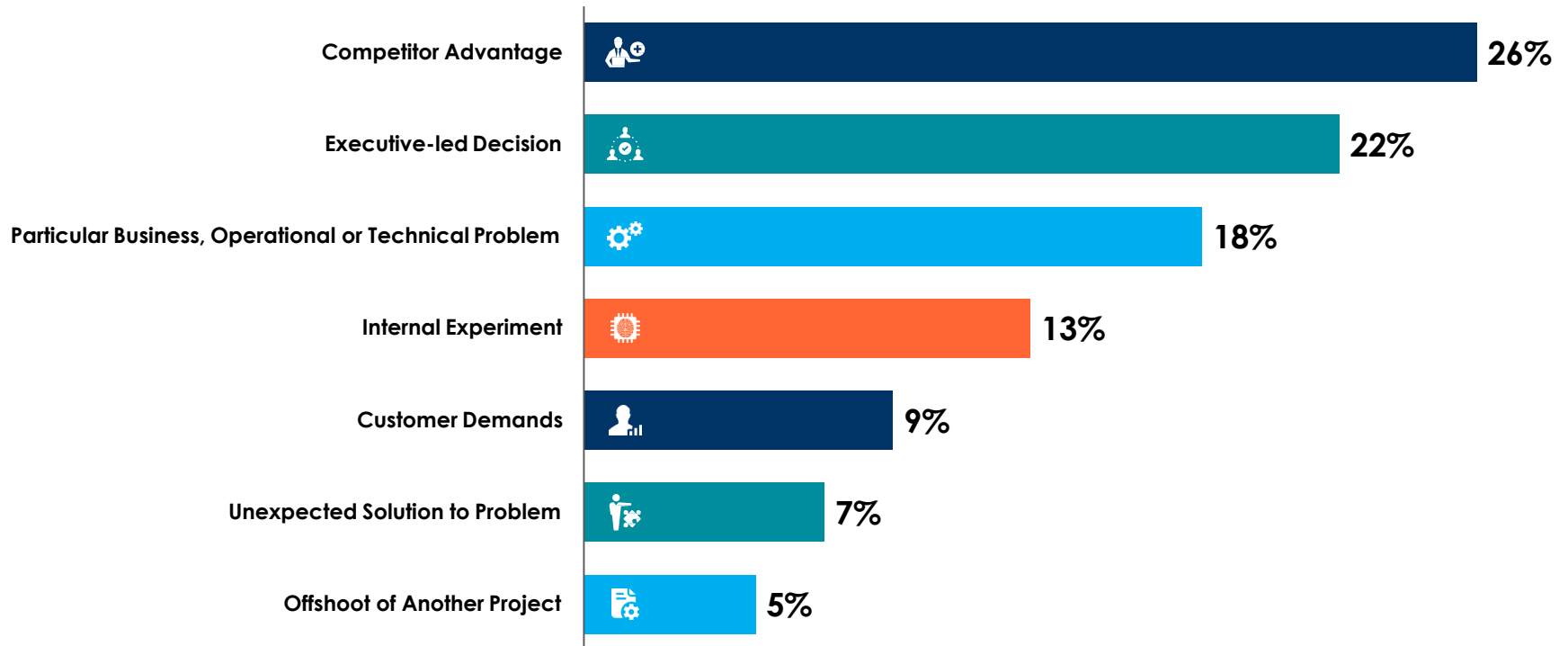
To increase forestation rate

Traffic

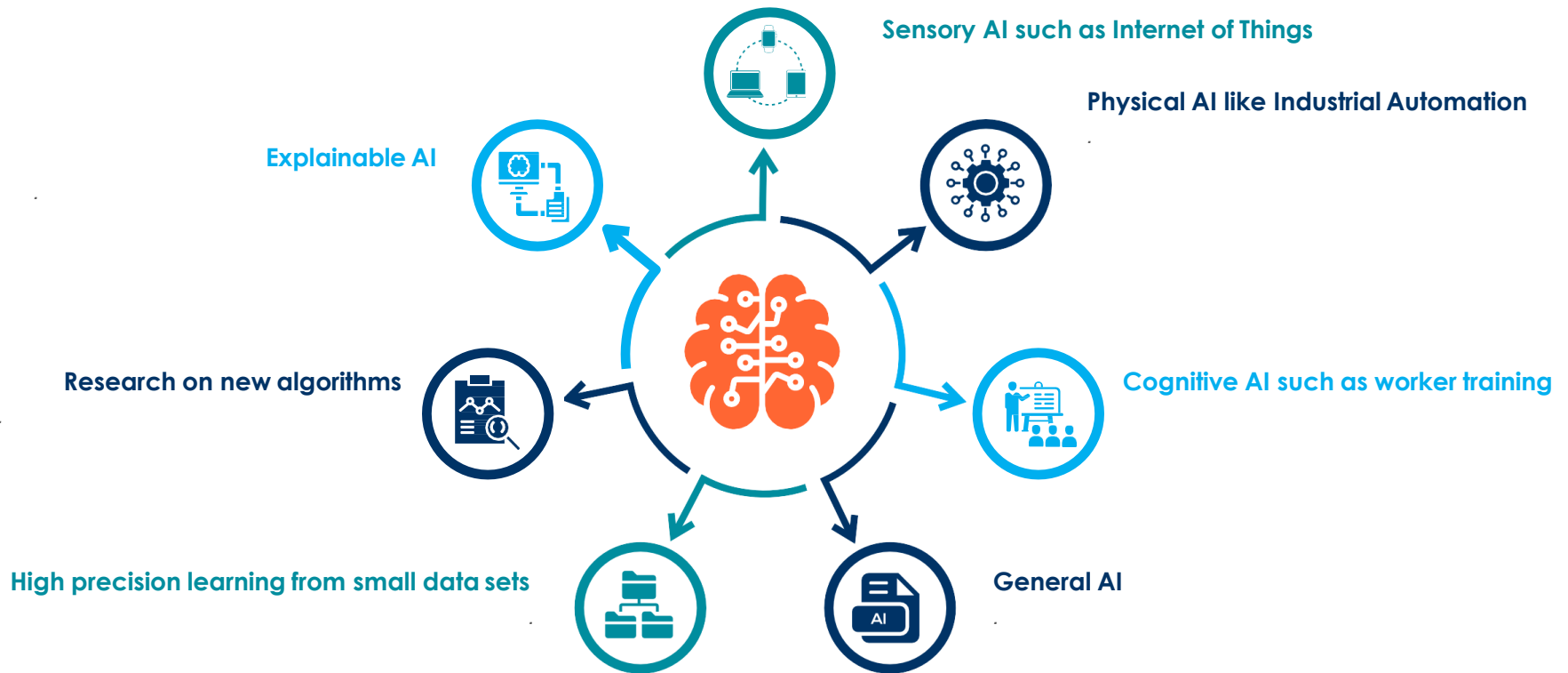


To reduce accidents & traffic jams & draw more effective traffic policies

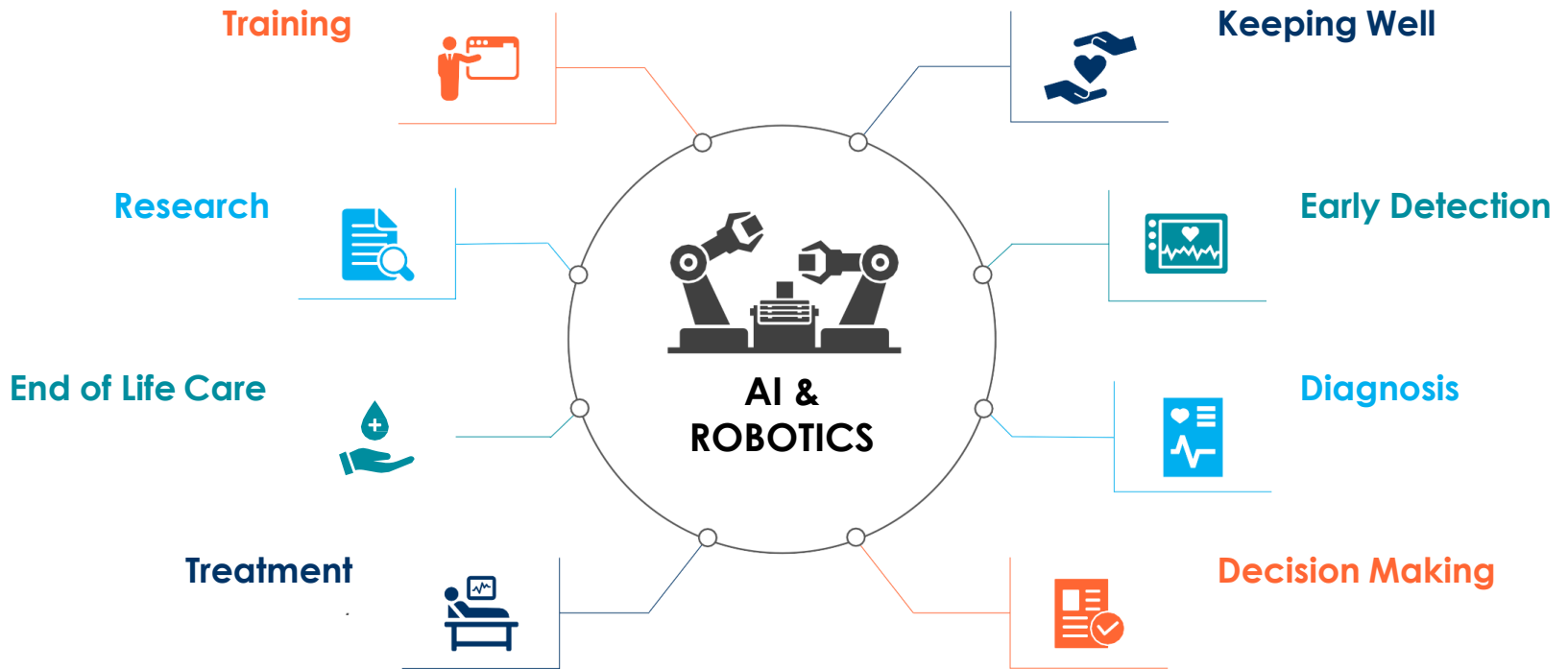
Driving Force behind Artificial Intelligence Maturity



Core Areas of Artificial Intelligence



Potential Use cases of AI in Healthcare

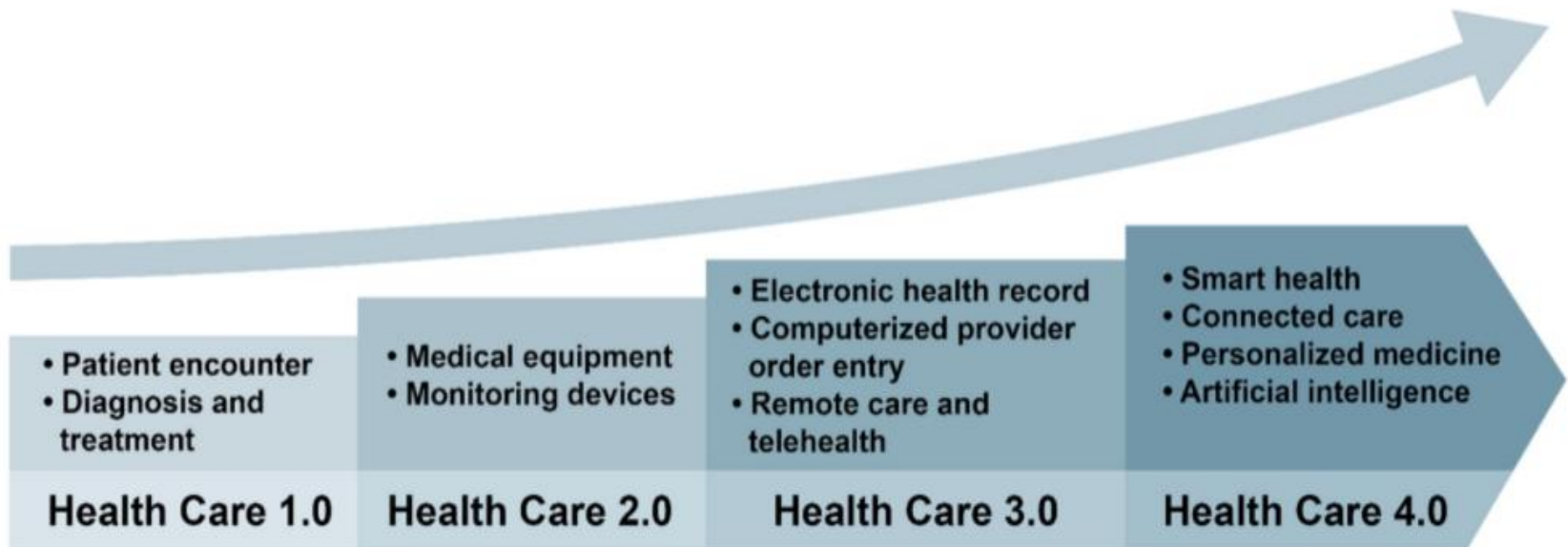


- Health Care 1.0 refers to the basic patient-clinician encounter. During such an encounter, a patient visits a clinic and meets with a physician and other members of the care team. Through consultation, testing and diagnosis, the clinician (or care team) provides prescription for medications and a care plan for treating a disease, as well as follow-up plans
- Along with major development in health, life science and biotechnology, numerous new medical equipment and devices have been invented, developed and tested, and are increasingly used in health care delivery. For instance, imaging test equipment (e.g. MRI, ultrasound, CT scan), monitoring devices (e.g. pulse oximeter, arterial lines), and surgical and life support equipment (e.g. da Vinci robot, chest tubes) are increasingly used in hospitals and other care settings to support diagnosis, treatment, and monitoring. We refer to this development as Health Care 2.0.

- Since last decade, in conjunction with the development of information systems, electronic health or medical records (EHR or EMR) have been implemented to manage care of patients across units and departments of health care organizations.
- Numerous activities are time-stamped and recorded in the EHR, and many manual processes have been computerized (e.g. order entry in CPOE or computerized provider order entry) and digitalized (e.g. electronic AVS or after visit summary).
- In addition, using available computer networks, remote care and telehealth have become possible, and electronic visits (e.g. communication between a patient and their physician through a patient portal) are beginning to replace some face-to-face encounters.
- The current COVID-19 pandemic has increased demand for telehealth and virtual visits.
- All of these have led to multifarious revolutionary changes in health care delivery. We categorize this revolution as Health Care 3.0.

- The fourth health care revolution is now emerging in parallel with Industry 4.0. In such a context, the health care delivery process becomes a cyber-physical system equipped by IoT, RFID (radio-frequency identification), wearables, and all kinds of medical devices, intelligent sensors, medical robots, etc., which are integrated with cloud computing, big data analysis, artificial intelligence, and decision support techniques to achieve smart and interconnected health care delivery.
- In such a system, not only the health care organizations and facilities (e.g. hospital, clinics, and long-term care facilities) are connected; but also all the equipment and devices, as well as the patients' home and communities are linked together.
- Patient-related information, e.g. medication history, diagnostic notes, lab results, treatment plans, pharmacy refills, billing, and insurance claims, can be potentially shared through adequate protocols.

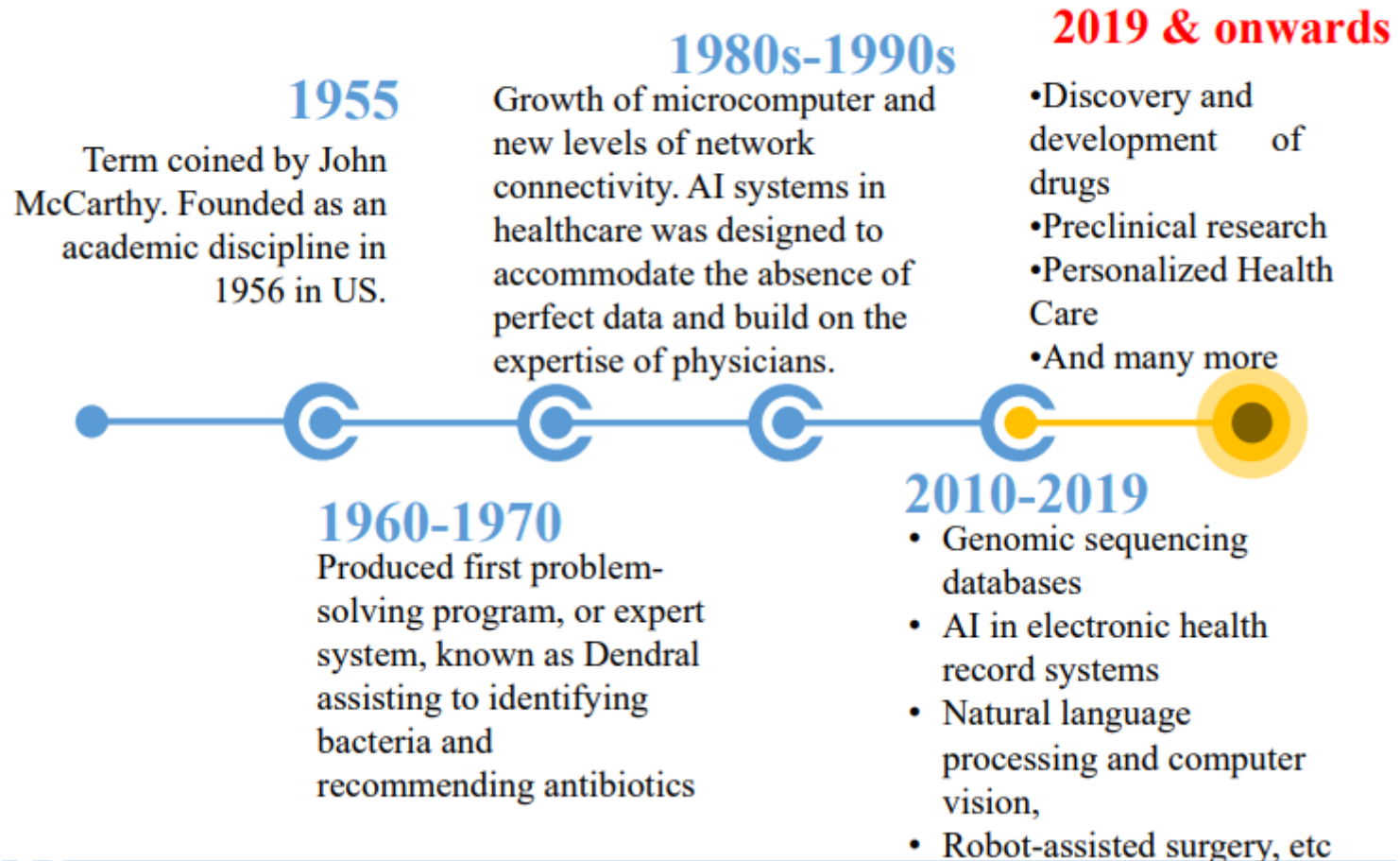
- In addition, through AI techniques, we can envision proactive treatment, disease prediction and prevention, personalized medicine, and enhanced patient-centered care.
- Thus, a pervasive, smart, and interconnected health care community emerges, which leads to the paradigm of Health Care 4.0.

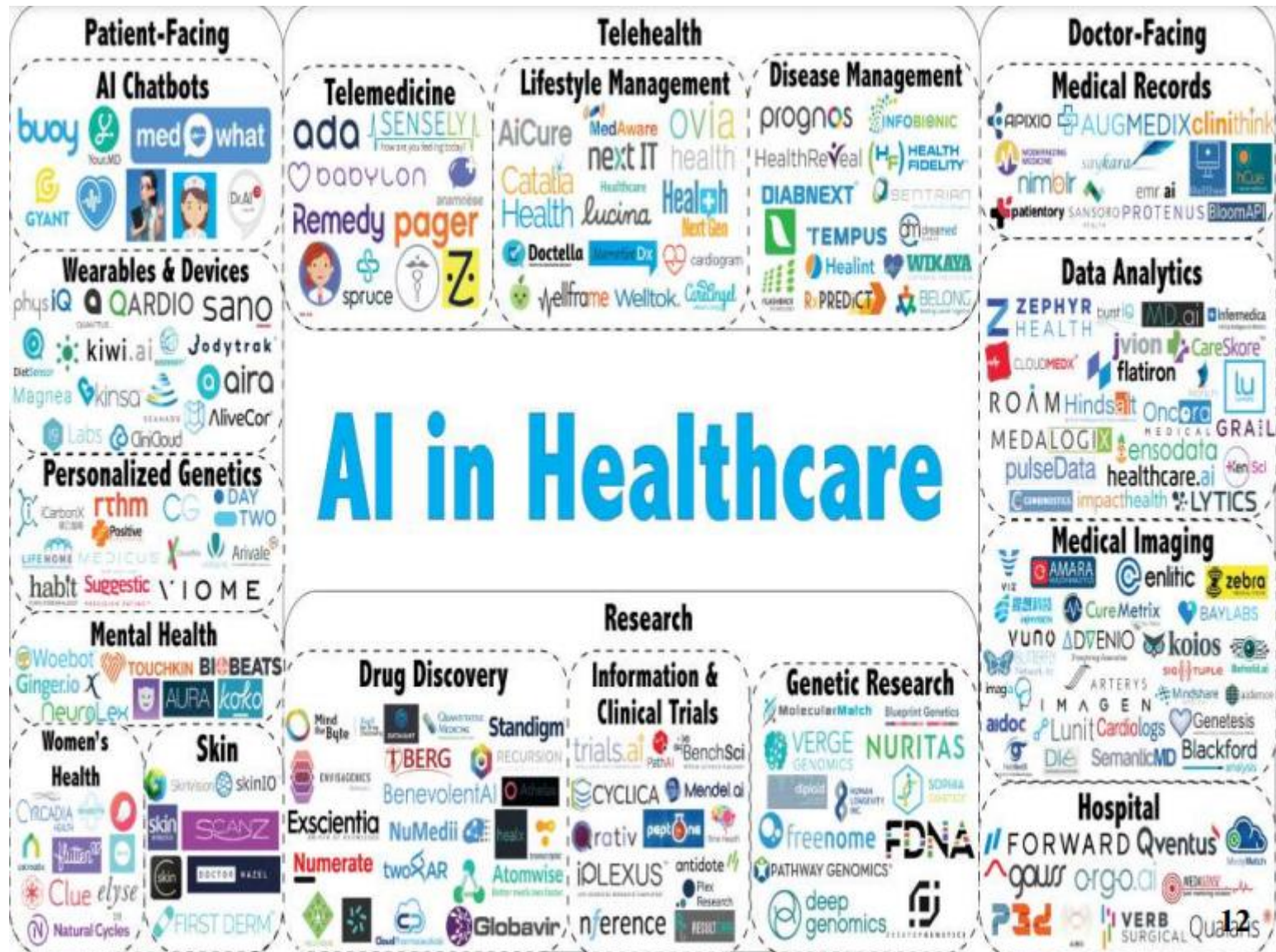


Challenges in adoption of Artificial Intelligence

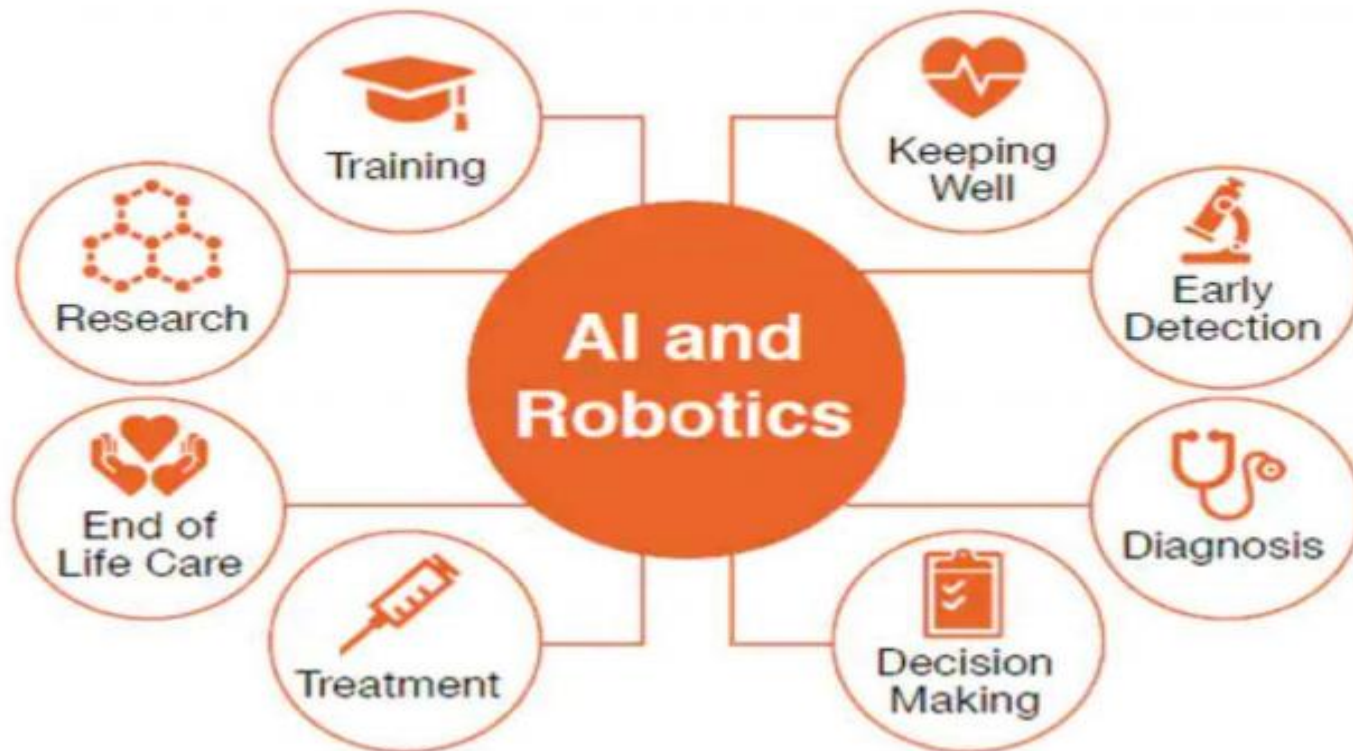


Timeline of AI in health





No longer science fiction, AI is transforming healthcare



Role of Artificial Intelligence in Health



Technology applications and apps encourage healthier behaviour in individuals and help with the proactive management of a healthy lifestyle.

Additionally, AI increases the ability for healthcare professionals to better understand the day-to-day patterns and needs of the people they care, for better feedback, guidance and support.

Health Monitoring: Tools to Support Interventions and Healthy Behaviors:

Wearable health trackers – like those from FitBit, Apple, Garmin and others – monitors heart rate and activity levels. They can send alerts to the user to get more exercise and can share this information to doctors.



Digital Oncology

Artificial intelligence, chatbots, and the future of medicine



Medical chatbots can offer relevant high-quality information, reassurance, answers, and ways of thinking about the situation related to human behaviour.

Applause filled the room. When the room quieted, I stood. I had already been answering questions at DrGreene.com since 1995, and putting the best of what I knew online. I said that people searching the web for answers to their health questions was absolutely inevitable. It would soon be unthinkable not to learn online. Our job was to help create and point to reliable information online—and to teach how to find, judge, and use it wisely. It was to open

school) has done many years of oncology research. One could see our patient populations as different—mine focusing on the beginning of life, hers often towards the end—yet we have found that there is quite the overlap. Our patients thirst for knowledge. Diseases develop unpredictably, and treatment plans shift frequently. The fields and guidelines are constantly changing, which are often at odds with out-of-date cultural

the National Academy of
Medicine available at <http://www.nationalacademies.org/hmd/Global/Meetings.aspx?activity=%7B4F8388BB-12A8-4B9E-A5A5-017410D27BD2%7D>
For more on the first
pharmaceutical chatbot see
<https://www.hcnews.com/>

Role of Artificial Intelligence in Health



AI is already being used to detect diseases, such as cancer, more accurately and in their early stages.

According to the American Cancer Society, a high proportion of mammograms yield false results, leading to 1 in 2 healthy women being told they have cancer. The use of AI is enabling review and translation of mammograms 30 times faster with 99% accuracy, reducing the need for unnecessary biopsies^[1].

Google's DeepMind Health is working in partnership with clinicians, researchers and patients to solving and detecting real-world healthcare problems.

[1] Wired (2016). <http://www.wired.co.uk/article/cancer-risk-ai-mammograms>



Artificial intelligence for diabetic retinopathy screening in Africa

Blindness from diabetic retinopathy has become another addition to the myriad of demands on eye health systems in low-resource countries. This is driven by the rising number of people living with diabetes all over the world, with the largest increases projected in Asia and Africa.¹

Despite screening for diabetic retinopathy in the

their diabetic retinopathy status without waiting for feedback from reading centres, which often necessitates an extra journey for them. The Article describes a tested methodology using convolutional neural networks and its effectiveness in reading images from African patients. Although Bellema and colleagues' final ensemble model



Using AI for digital retinopathy screening will allow non-clinicians to be trained on retinal imaging, obtaining interpretation of the images within minutes and thus giving patients instant feedback.

Role of Artificial Intelligence in Health



IBM's Watson for Health is helping healthcare organizations review and store far more medical information – every medical journal, symptom, and case study of treatment and response around the world – exponentially faster than any human.

Medical Imaging:

Machine learning algorithms can process unimaginable amounts of information in the blink of an eye and provide more precise than humans in spotting even the smallest detail in medical imaging.

The company Zebra Medical Vision developed a new platform called Profound, which analyze of all types of medical imaging reports that is able to find every sign of potential conditions such as osteoporosis, breast cancer, aortic aneurysms and many more with a 90 percent accuracy rate.

nature

THE INTERNATIONAL WEEKLY JOURNAL OF SCIENCE

LESIONS LEARNT

Artificial intelligence powers detection
of skin cancer from images **PAGES 30 & 115**

LETTER

doi:10.1038/nature21056

Dermatologist-level classification of skin cancer with deep neural networks

Andre Estevez^{1*}, Brett Koppel^{2*}, Roberto A. Novoa^{2,3}, Justin Ko², Susan M. Swetter^{2,4}, Helen M. Blau⁵ & Sebastian Thrun⁶

Skin cancer, the most common human malignancy^{1–3}, is primarily diagnosed visually, beginning with an initial clinical screening and followed potentially by dermoscopic analysis, a biopsy and histopathological examination. Automated classification of skin lesions using images is a challenging task owing to the fine-grained variability in the appearance of skin lesions. Deep convolutional neural networks (CNNs)^{4,5} show potential for general and highly variable tasks across many fine-grained object categories^{6–11}. Here we demonstrate classification of skin lesions using a single CNN, trained end-to-end from images directly, using only pixels and disease labels as inputs. We train a CNN using a dataset of 129,450 clinical images—two orders of magnitude larger than previous datasets¹²—consisting of 2,032 different diseases. We test its performance against 21 board-certified dermatologists on

images (for example, smartphone images) exhibit variability in factors such as room, angle and lighting, making classification substantially more challenging^{13,14}. We overcome this challenge by using a data-driven approach—1.41 million pre-training and training images make classification robust to photographic variability. Many previous techniques require extensive preprocessing, lesion segmentation and extraction of domain-specific visual features before classification. By contrast, our system requires no hand-crafted features; it is trained end-to-end directly from image labels and raw pixels, with a single network for both photographic and dermoscopic images. The existing body of work uses small datasets of typically less than a thousand images of skin lesions^{15,16,17}, which, as a result, do not generalize well to new images. We demonstrate generalizable classification with a new dermatologist-labelled dataset of 129,450 clinical images, including

The AI train a convolutional neural networks (CNNs) using a dataset of 1,29,450 clinical images to classify a type of cancer.

Role of Artificial Intelligence in Health



Improving care requires the alignment of big health data with appropriate and timely decisions, and predictive analytics can support clinical decision-making and actions as well as prioritise administrative tasks.

Digital Consultation

For example, the digital health firm HealthTap developed “Dr. A.I.,” and apps like **Babylon in the UK use AI to give medical consultation** based on personal medical history and common medical knowledge. Users report their symptoms into the app, which uses speech recognition to compare against a database of illnesses and asks patients to specify symptoms to triage whether they should go to the ED, urgent care, or a primary care doctor.

RESEARCH ARTICLE

A data-driven artificial intelligence model for remote triage in the prehospital environment

Dohyun Kim¹, Sungmin You², Soonwon So², Jongshill Lee², Sunhyun Yook², Dong Pyo Jang², In Young Kim², Eunkyong Park³, Kyeongwon Cho³, Won Chul Cha^{4,5}, Dong Wook Shin^{5,6}, Baek Hwan Cho^{3,7*}, Hoon-Ki Park^{8*}

1 Convergence Research Center for Diagnosis, Treatment, and Care of Dementia, Korea Institute of Science and Technology, Seoul, South Korea, **2** Department of Biomedical Engineering, Hanyang University, Seoul, South Korea, **3** Smart Healthcare & Device Research Center, Samsung Medical Center, Sungkyunkwan University School of Medicine, Seoul, South Korea, **4** Department of Emergency Medicine, Samsung Medical Center, Sungkyunkwan University School of Medicine, Seoul, South Korea, **5** Department of Digital Health,

In today's world health emergencies are numerous and medical personnel are limited. This study has designed a consciousness index to substitute the factor by manpower and improved the classification accuracy (triage) by applying a machine learning algorithm.

DP, et al. (2018) A data-driven artificial intelligence model for remote triage in the prehospital environment. PLoS ONE 13(10): e0206006. <https://doi.org/10.1371/journal.pone.0206006>

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In a mass casualty incident, the factors that determine the survival rate of injured patients are diverse, but one of the key factors is the time for triage. Additionally, the main factor that determines the time of triage is the number of medical personnel. However, when relying on a small number of medical personnel, the ability to increase survivability is limited. Therefore, developing a classification model for survival prediction that can quickly and precisely triage via wearable devices without medical personnel is important. In this study, we

Role of AI in Health



Treatment Design

Artificial intelligence systems have been created to analyze data – notes and reports from a patient's file, external research, and clinical expertise – to help select the correct, individually customized treatment path.

Precision Medicine

Instead of developing treatments for populations and making the same medical decisions based on a few similar physical characteristics among patients, medicine has shifted toward prevention, personalization, and precision.

Genetics and genomics look for mutations and links to disease from the information in DNA. With the help of AI, body scans spot cancer and vascular diseases early and predict the health issues people might face based on their genetics.





Expert Review of Precision Medicine and Drug Development

Personalized medicine in drug development and clinical practice

ISSN: (Print) 2380-8993 (Online) Journal homepage: <https://www.tandfonline.com/loi/tepm20>



EDITORIAL



The role of artificial intelligence in precision medicine

Bertalan Mesko

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ARTICLE HISTORY Received 30 July 2017; Accepted 13 September 2017

KEYWORDS Artificial intelligence; future; precision medicine; healthcare; disruptive technology

These technologies such as genomics, biotechnology, wearable sensors, or artificial intelligence (AI) are gradually leading to three major directions. They have been (1) making patients the point-of-care; (2) created a vast amount of data that require advanced analytics; and (3) made the foundation of precision medicine.

patients the point-of-care; (2) created a vast amount of data that require advanced analytics; and (3) made the foundation of precision medicine.

Instead of developing treatments for populations and making the same medical decisions based on a few similar physical characteristics among patients, medicine has shifted toward

3. There is no precision medicine without AI

As the National Institutes of Health described it, precision medicine is 'an emerging approach for disease treatment and prevention that takes into account individual variability

Role of Artificial Intelligence in Health



- We are living much longer than previous generations, and as we approach the end of life, we are dying in a different and slower way, from conditions like dementia, heart failure and osteoporosis. It is also a phase of life that is often plagued by loneliness.

- AI have 'conversations' and other social interactions with people

- to keep aging minds sharp.

- **Medication Management: Improving client adherence**

- The National Institutes of Health have created the **AiCure app** to monitor the use of medication by a patient. A smartphone's

webcam is partnered with AI to autonomously confirm that patients are taking their prescriptions and helps them manage their condition.

Role of AI in Health



Research on Molecular epidemiology:

Recently, the greatest statistical computational challenge in molecular epidemiology is to identify and characterize the genes that interact with other genes and environment factors that bring the effect on complex multifactorial disease.

This phenomenon cannot be solved by traditional statistical method due to the high dimensionality of the data and the occurrence of multiple polymorphism. Hence, there are several machine learning methods to solve such problems by identifying such susceptibility gene which are neural networks (NNs), support vector machine (SVM), and random forests (RFs) in such common and multifactorial disease

Role of Artificial Intelligence in Health



AI allows those in training to go through naturalistic simulations in a way that simple computer-driven algorithms cannot.

The advent of natural speech and the ability of an AI computer to draw instantly on a large database of scenarios, means the response to questions, decisions or advice from a trainee can challenge in a way that a human cannot.



Role of Artificial Intelligence in Health

AI-robot assisted surgery:

Robots have been used in medicine for more than 30 years. Surgical robots that can either aid a human surgeon or execute operations by themselves. They're also used in hospitals and labs for repetitive tasks, in rehabilitation, physical therapy and in support of those with long-term conditions.



Teleoperated robot-assisted surgical system for minimally invasive procedures. (Credit: Intuitive Surgical, Inc.)

Role of AI in Public health



Role of AI in Disease
Surveillance



Role of AI in Epidemic
Prediction



Role of AI in
screening



Role of AI in water
treatment

**ARTIFICIAL
INTELLIGENCE
AND
PUBLIC
HEALTH**



Int. J. Environ. Res. Public Health **2014**, *11*, 8597–8611; doi:10.3390/ijerph110808597

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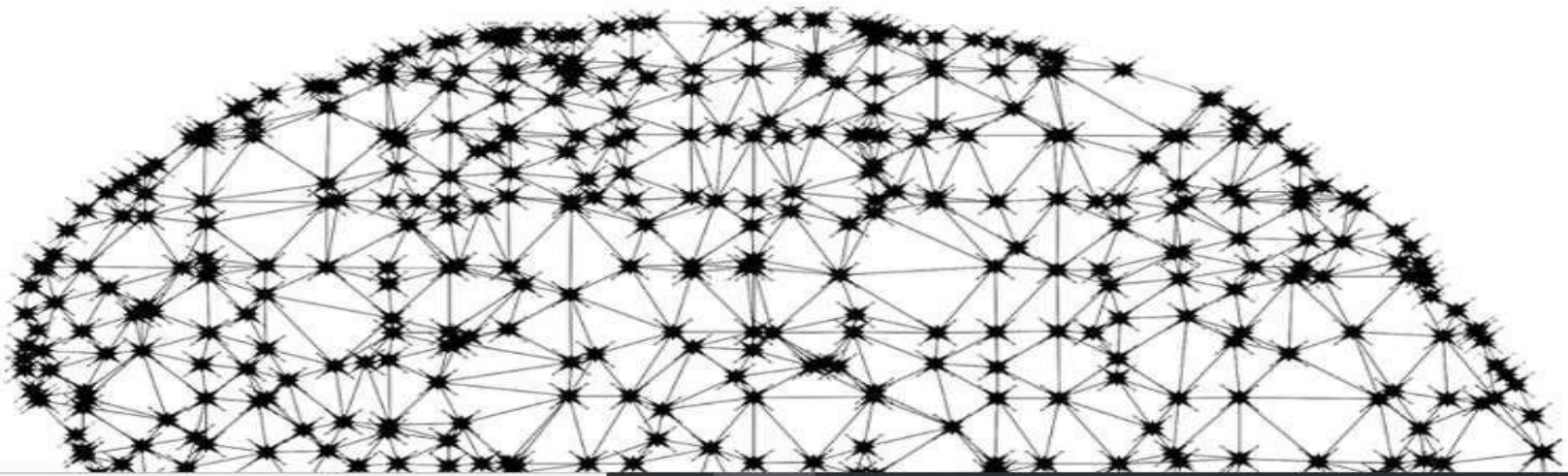
MAGAZINE : PRODUCTS STOREFRONTS TOP PROJECTS CHAN

JUL 18, 2018



AI TECHNOLOGY COULD IMPROVE WATER TREATMENT MONITORING, SAFEGUARD PUBLIC HEALTH

Researchers have developed new software to aid in identifying different cyanobacteria



RSNA News

Research Showing AI May Help Diagnose Tuberculosis in Remote Areas Captures Margulis Award

While imaging plays a pivotal role in the diagnosis and management of tuberculosis (TB), access to radiology is often limited in the developing countries where TB is most prevalent.

BY BETH BURMAN

December 06, 2018

Hoping to bridge that gap, Paras Lakhani, MD, from Thomas Jefferson University Hospital (TJUH) in Philadelphia, and colleague Baskaran Sundaram, MD, investigated the efficacy of an automated method for detecting TB on chest radiographs.

Specifically, Dr. Lakhani used a type of artificial intelligence (AI) — deep learning (DL) — using pre-trained convolutional neural networks (DCNNs) to identify TB on chest X-rays. The results of the research, “Deep Learning at Chest Radiography: Automated Classification of Pulmonary Tuberculosis by Using Convolutional Neural Networks,” published online in April 2017 in *Radiology*, were promising.



SemanticMD AI Box can analyze a chest X-ray within 20 seconds and can run off a portable phone charger

SemanticMD aims to scale its AI solution to provide low-cost, accessible TB detection to vulnerable populations, particularly throughout Southeast Asia, China and Africa.

The company is already working with partners in China, South Africa, The Gambia, Rwanda and Nigeria — offering instant detection for less than \$1 per scan.

The solution integrates with X-ray devices to work. It can be accessed from the cloud or deployed locally (where internet access is limited).

RESEARCH ARTICLE

Developing a dengue forecast model using machine learning: A case study in China

Pi Guo¹*, Tao Liu²*, Qin Zhang³, Li Wang¹, Jianpeng Xiao², Qingying Zhang¹,
Ganfeng Luo¹, Zhihao Li², Jianfeng He⁴, Yonghui Zhang⁴, Wenjun Ma²*

1 Department of Preventive Medicine, Shantou University Medical College, Shantou, China, **2** Guangdong Provincial Institute of Public Health, Guangdong Provincial Center for Disease Control and Prevention,

This study used a combination of case reports, Baidu (China's top search engine) search queries, and climate factors. Then they compared their working models with existing results from five other provinces, and discovered that their data models showed stronger statistical significance.

forecast model using machine learning: A case study in China. PLoS Negl Trop Dis 11(10): e0005973. <https://doi.org/10.1371/journal.pntd.0005973>

an accurate predictive model of dengue.

Methodology/Principal findings

Next Generation Public Health Surveillance

Automated Healthcare data and informal sources, Community Engagement, and Artificial Intelligence



Detect Disease
When and
Where It Happens

Stop Disease
Before It Spreads

Study Disease
to Strengthen
the Science

Improve How
We Prevent
and Control Disease

Keep People
Healthy



Role of AI in Symptoms Screening

OJPHI

ISDS 2016 Conference Abstracts

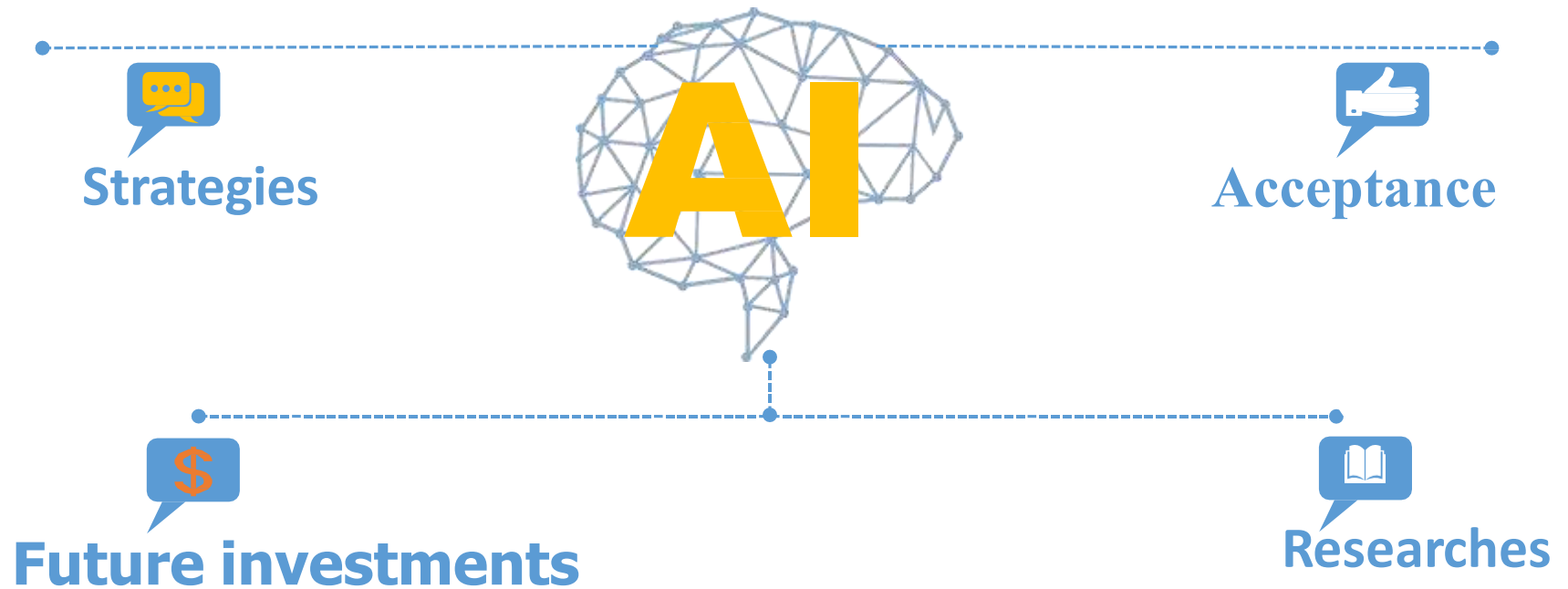
ISDS
INTERNATIONAL SOCIETY
for DISEASE SURVEILLANCE

A Syndrome Definition Validation Approach for Zika Virus

GUARDIAN (Geographic Utilization of Artificial Intelligence in Real-Time for Disease Identification and Alert Notification) surveillance system is automated and operates in real time. From a practical point of view, as soon as the cases come to the Emergency Department, real-time analysis is performed on various aspects of electronic health records (chief complaints, vital parameters, etc.) and laboratory results. This means that a physician is informed and alerted of a case as soon as it is identified.

The main benefit is avoiding delays and preventing further spread of contagious infectious diseases such as influenza, plague and anthrax.

Acceptance and scope of AI in the World





The “AI for Good Global Summit” took place at ITU in Geneva, Switzerland, on 7-9 June 2017 organized by ITU and the XPRIZE Foundation, in partnership with twenty UN agencies.

This summit discussed how Artificial Intelligence (AI) could follow a development course able to assist the achievement of the United Nations’ Sustainable Development Goals.

Countries with AI in its national strategies



Consumers worldwide are open to receiving AI-enabled healthcare



Willing



Unwilling



**Neither willing
nor unwilling**

Source: PwC survey, 2016. "What doctor? Why AI and robotics will define New Health"

- Kim D, You S, So S, Lee J, Yook S, Jang DP, et al. A data-driven artificial intelligence model for remote triage in the prehospital environment. Mumtaz W, editor. PLOS ONE. 2018 Oct 23;13(10):e0206006.
- Rumoro D, Shah S, Hallock MM, Gibbs GS, Trenholme G, Waddell M. A Syndrome Definition Validation Approach for Zika Virus. Online J Public Health Inform [Internet]. 2017 May 2 [cited 2019 Jun 9];9(1). Available from: <http://journals.uic.edu/ojs/index.php/ojphi/article/view/7672>
- AI and big data healthcare in Korea [Internet]. [cited 2019 Jun 3]. Available from: [https://www.nature.com/collections/jfbahfhhhi?utm_source=internal&utm_medium=banners&utm_campaign=cpub-AS_FocalPointAI190328&utm_content=Nature Springer Sciam AI in India.pdf](https://www.nature.com/collections/jfbahfhhhi?utm_source=internal&utm_medium=banners&utm_campaign=cpub-AS_FocalPointAI190328&utm_content=Nature%20Springer%20Siam%20AI%20in%20India.pdf).
- Wahl B, Cossy-Gantner A, Germann S, Schwalbe NR. Artificial intelligence (AI) and global health: how can AI contribute to health in resource-poor settings? BMJ Glob Health. 2018 Aug;3(4):e000798.
- Wong ZSY, Zhou J, Zhang Q. Artificial Intelligence for infectious disease Big Data Analytics. Infect Dis Health. 2019 Feb;24(1):44–8. Artificial intelligence in healthcare. 2018;27.
- Sinčák P, Ondo J, Kaposztasova D, Virčíková M, Vranayova Z, Sabol J. Artificial Intelligence in Public Health Prevention of Legionellosis in Drinking Water Systems. Int J Environ Res Public Health. 2014 Aug 21;11(8):8597–611.
- Panch T, Pearson-Stuttard J, Greaves F, Atun R. Artificial intelligence: opportunities and risks for public health. Lancet Digit Health. 2019 May;1(1):e13–4. Artificial_intelligence_in_healthcare_0119.pdf.
- Esteva A, Kuprel B, Novoa RA, Ko J, Swetter SM, Blau HM, et al. Dermatologist-level classification of skin cancer with deep neural networks. Nature. 2017 Feb;542(7639):115.
- ESCAP_Artificial_Intelligence.pdf [Internet]. [cited 2019 Jun 5]. Available from: https://www.unescap.org/sites/default/files/ESCAP_Artificial_Intelligence.pdf
- First look at cloud-based medical records. [cited 2019 Jun 3]; Available from: <http://www.nature.com/articles/d42473-019-00098-4>
- Gilad. How AI can solve Australia's early detection skin cancer challenge; QODE Brisbane 2019 [Internet]. QODE. 2019 [cited 2019 Jun 3]. Available from: <https://qodebrisbane.com/how-ai-can-solve-australias-early-detection-skin-cancer-challenge-qode-brisbane-2019/>
- Nadda JP. India's leadership to end tuberculosis. The Lancet. 2019 Mar 30;393(10178):1270–2.
- Loh E. Medicine and the rise of the robots: a qualitative review of recent advances of artificial intelligence in health. BMJ Lead. 2018 Jun;2(2):59–63.
- Marchalik D. Physician burnout in the modern era. The Lancet. 2019 Mar 2;393(10174):868–9.
- The future is bright for precision medicine in South Korea. [cited 2019 Jun 3]; Available from: <http://www.nature.com/articles/d42473-019-00095-7>
- Mesko B. The role of artificial intelligence in precision medicine. Expert Rev Precis Med Drug Dev. 2017 Sep 3;2(5):239–41.
- Murray SG, Yim JWL, Croci R, Rajkomar A, Schmajuk G, Khanna R, et al. Using Spatial and Temporal Mapping to Identify Nosocomial Disease Transmission of *Clostridium difficile*. JAMA Intern Med. 2017 Dec 1;177(12):1863.
- Wiegand T, Krishnamurthy R, Kuglitsch M, Lee N, Pujari S, Salathé M, et al. WHO and ITU establish benchmarking process for artificial intelligence in health. The Lancet [Internet]. 2019 Mar 29 [cited 2019 Jun 3];0(0). Available from: [https://www.thelancet.com/journals/lancet/article/PIIS0140-6736\(19\)30762-7/abstract](https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(19)30762-7/abstract)
- Gates B. With immense power to unleash improvements in cost, quality and access, AI is exploding in popularity. Growth in the AI health market is expected to reach \$6.6 billion by 2021—that's a compound annual growth rate of 40 percent (see Figure 1). :8.

Thank You