Implementing Artificial Intelligence Solutions to improve Global Health System

World Health Organization (WHO)

WHO
Implementing Artificial Intelligence
Solutions to improve Global Health System
Max Eibel, Valentin Vormende & Yara de Leon

Table of Contents

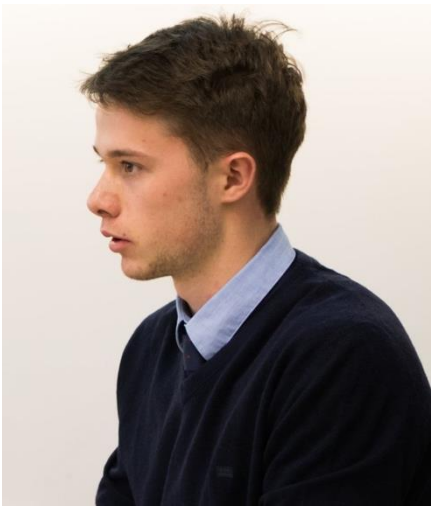
WHO
Implementing Artificial Intelligence
Solutions to improve Global Health System
Max Eibel, Valentin Vormende & Yara de Leon

I. Letter from the chairs

Esteemed Delegates,

It is with utmost pleasure that we can welcome you to Lake MUN 2019 in Friedrichshafen.

We are Max, Yara and Valentin and we will be your chairs for the World Health Organisation. Our Topic is "Implementing Artificial Intelligence Solutions to improve Global Health Systems". We believe that this is a topic that is very up to date and affects everyone. The world is evolving, and we are making more and more improvements in the Technological Department and finding ways to implement them into everyday life is crucial to grow as humanity. These ways have to be with security and without risking peoples health or countries sovereignties. That's why we believe that this topic is very important and needs to be discussed at this years conference. We hope you all have the time to prepare well with this background guide and also hope you go beyond and do your own research. Seeing as this is a beginner committee, we expect that you have read the Rules of Procedure but not that you dominate them yet. As your Chairs we will provide you with all the support you need so please do not hesitate to approach us on any questions you might have.



We look forward to meeting you all in Friedrichshafen in October.

Yara, Valentin, Max

II. Introduction to the Committee

Welcome to the World Health Organization or for short WHO. The WHO was founded on the 7th of April in 1948, which is also the day where we celebrate the "World Health Day".[1]

Some of the work done by WHO is visible and familiar: the response teams sent to contain outbreaks, the emergency assistance to people affected by disasters, or the mass immunization campaigns that protect the world's children from killer diseases.

Some activities undertaken by WHO are largely invisible, quietly protecting the health of every person on this planet, every day. By assigning a single international name to drugs, WHO helps ensure that a prescription filled abroad is what the doctor ordered back home.[2]

The World Health Assembly is attended by delegations from all Member States and determines the policies of the Organization. The Executive Board is composed of members technically qualified in health and gives effect to the decisions and policies of the Health Assembly. The core function is to direct and coordinate international health work through collaboration. WHO partners with countries, the United Nations system, international organizations, civil societies, foundations, academia and research institutions. [3]

[1] WHO, "World Health Day" https://www.who.int/world-health-day/2012/toolkit/introduction/en/
[2] WHO, "Introduction to the WHO"
https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&cad=rja&uact=8&ved=2ahUKEwi-qNzJ68HkAhXjsIsKHQeUC7MQFjABegQIBRAC&url=https%3A%2F%2Fwww.who.int%2Fabout%2Fbrochure_en.pdf&usg=AOvVaw1WvA2_mrE3HIGlEkqICI6e
[3] WHO, "About WHO", https://www.who.int/about

III. Topic: Implementing Artificial Intelligence Solutions to improve Global Health System

1. Introduction

Al's potential to identify early symptoms, diagnose diseases, help carry out operations, predict when an epidemic will break out and undertake hospital administrative tasks such as making appointments and registering patients, explain its huge applicability in the health sector.[4] However, the progress in the implementation and use of AI in the healthcare sector has been very slow due to basic factors including non-existent data repositories, outdated computer systems and doctor shortages. Additionally, this sector also poses unique problems like extracting data from handwritten patient files or PDFs which hamper the efficient implementation of AI as data is required to flow freely through AI systems to achieve results.[5]

Unfortunately, we are a long way from achieving the goal. According to the WHO, almost half of the world's population lacks access to basic healthcare facilities and almost 100 million people are pushed into extreme poverty every year because of out-of-pocket health spending. In a recent speech by Dr. Tedros Adhanom Ghebreyesus, Director-Generale of the World Health Organization, the WHO has made the following three strategic targets to keep the organization accountable.

- 1 billion more people benefitting from universal health coverage;
- 1 billion more people better protected from health emergencies; and
- 1 billion more people enjoying better health and well-being.

However, it is important to note that to achieve these targets, Digital technologies and Artificial Intelligence would play a vital role. Artificial Intelligence is already playing an increasing role in disease surveillance, our defenses against outbreaks and digital

[4] ITU News, Dr. Winnie Tang,"How AI for healthcare can overcome obstacles and save lives", August 2018, https://news.itu.int/ai-healthcare-overcome-obstacles/
[5] Forbes, Charles-Towers Clark, "Using Artificial Intelligence to fix healthcare, https://www.forbes.com/sites/charlestowersclark/2018/11/22/using-artificial-intelligence-to-fix-healthcare/#31cd516d220c

technologies are becoming more and more integrated with the traditional treatments. Mobile technology and telemedicine are making a huge difference in helping to reach people in the remotest villages with medical services.[6]

Furthermore, it is crucial to also understand that the use of technology to promote global health is a supplement to the already provided health facilities and infrastructures. Therefore, the development of AI for health must not happen at the stake of the development of basic health care facilities in developing countries.[7] Hence, a key issue is also to have a policy framework for the efficient use and allocation of AI and technology to balance the digital revolution with social development.

2. What is AI and how does it work?

Artificial Intelligence in short A.I. is the ability of a digital computer-controlled system to perform tasks commonly associated with intelligent beings.[8] There exist four different types of definitions of Artificial Intelligence, which divide further into a human-centered approach and an ideal performance centered approach.[9]

2.2.1 Acting humanly

"(The automation of) activities that we associate with human thinking, activities such as decision-making, problem solving, learning..."[10]

The British mathematician, computer scientist and logician Alan Turing designed in the after him called *Turing Test* a way to determine artificial intelligence. In his terms a computer was intelligent, if a human being cannot tell, after posing written questions to the computer, if the written response came from a computer or human. In order to successfully

[6] Speech, World Health Organization, Dr Tedros Adhanom Ghebreyesus, "Artificial Intelligence for Good Global Summit", https://www.who.int/dg/speeches/2018/artificial-intelligence-summit/en/
[7] Made for minds, "Medical drones: Ghana to follow Rwanda's example", https://www.dw.com/en/medicaldrones-ghana-to-follow-rwandas-example/a-46690095
[8] Copeland, CJ. *"Artificial Intelligence"* Encyclopedia Britannica, published: 9th of May, 2019 at www.britannica.com/technology/artifical-intellegence, accessed: 27th of July, 2019
[9] Stuart J. Russell and Peter Norvig "*Artificial Intelligence A Modern Approach, Third Edition"*, Person Education Inc., ISBN-13: 978-0-13-604259-4
[10] Bellman (1978) cited in Stuart J. Russell and Peter Norvig "Artificial Intelligence A Modern Approach, Third Edition", Person Education Inc., ISBN-13: 978-0-13-604259-4

complete this task, the computer would need to process language, have some kind of knowledge base, automatic reasoning to use the information stored in the knowledge base to understand and answer the questions, and machine learning to adapt to new circumstances and create patterns. Even though Alan Turing created this theory almost 70 years ago, all these abilities apply to Artificial Intelligence. Yet the definition is flawed, since it imitates human intelligence, and is not based on the principles of intelligence.

2.2.3 Thinking humanly

"The study of how to make computers do things, at which, at the moment, people are better"[11]

In order to make computers better in fulfilling typical "human tasks", science must understand how humans think. Nowadays exist three ways to do so: Trough introspection, psychological experiments or brain imaging. The intradisciplinary field of cognitive science brings these approaches together with models of AI. Once we have a theory of how humans think, this theory can be applied in computers. This definition corresponds with the "bottom up" method to design artificial intelligence. Researchers, who followed this method though, faced the difficulty, that even those theories are an oversimplification of the real world. This model even failed to mimic the brain of the *Caenorhabditis elegans*, a very well-studied worm, which has only approximately 300 neurons.[12] In comparison, the human brain has around 86 billion neurons.[13]

2.2.4 Thinking Rationally

"The study of the mental faculties, through the use of computational models"[14]

[11] Rich and Knight (1991) cited in Stuart J. Russell and Peter Norvig "Artificial Intelligence A Modern Approach, Third Edition", Person Education Inc., ISBN-13: 978-0-13-604259-4
[12] Copeland, CJ. *"Artificial Intelligence"* Encyclopedia Britannica, published: 9th of May, 2019 at www.britannica.com/technology/artifical-intellegence, accessed: 27th of July, 2019
[13] Herculano-Houzel S. (2012). The remarkable, yet not extraordinary, human brain as a scaled-up primate brain and its associated cost. Proceedings of the National Academy of Sciences of the United States of America, 109 Suppl 1(Suppl 1), 10661–10668. doi:10.1073/pnas.1201895109
[14] Charniak and McDermott (1985) cited in Stuart J. Russell and Peter Norvig "Artificial Intelligence A Modern Approach, Third Edition", Person Education Inc., ISBN-13: 978-0-13-604259-4

The rational-thinking approach to AI is based on so-called syllogisms. In the 4th century BC. Aristotle set rules, defining argument structures that always yield correct conclusions given the right premises. "All men are mortal, Socrates is a man; therefore, Socrates is mortal". In this manner, Logicians, who call back to Aristotles logic tradition, try to build Artificial Intelligence. There are two obstacles to their approach. First, in order to think rationally the Intelligence needs 100% certain information, which becomes less likely in complex tasks. Second, this approach needs guidance, as to which reasoning process steps to try first. This makes this approach in practice not applicable, as "non- theoretical" problems consist of hundreds or even more facts.

2.2.5 Acting rationally

"Computational Intelligence is the study of the design of intelligent agents"[15]

In opposite to the "laws of thought" approach, described above, the rational agent approach emphasizes the action towards the best or best excepted outcome. Although making the right inferences could be a big part of acting towards the best outcome under some circumstances, making correct inferences is not all of rationality. In some situations, human intelligence, acts without even reasoning. We call these situations reflexes, in which we act without even thinking about it. For example, pulling back your hand from a hot surface is more efficient than a slowly action taken after careful deliberation.

This example depicts, that correct inferences are just one mechanism of acting rational.

Today AI research pursuits three main goals: strong AI, applied AI, and cognitive simulation.
Research on the field of strong AI aims to make artificial intellectual ability indistinguishable from that of a human being. Confronted by the immense intricacy of natural thinking, it remains doubtable, if human-like artificial intelligence will ever exist. Cognitive simulation does not recreate human intelligence, rather than helps to

[15] Poole et al.,(1998) cited in Stuart J. Russell and Peter Norvig "Artificial Intelligence A Modern Approach, Third Edition", Person Education Inc., ISBN-13: 978-0-13-604259-4

understanding how the human mind works. It is already a powerful tool in neuroscience and cognitive psychology.
Applied AI, which has enjoyed the most success of all three fields, aims to produce intelligent systems, specified for one task, like in medical diagnosis systems, aiming systems, weather simulations, or stock-trading systems.[16]

2.3 Application of Artificial Intelligence in Medical Science

Using data satellites to predict cholera

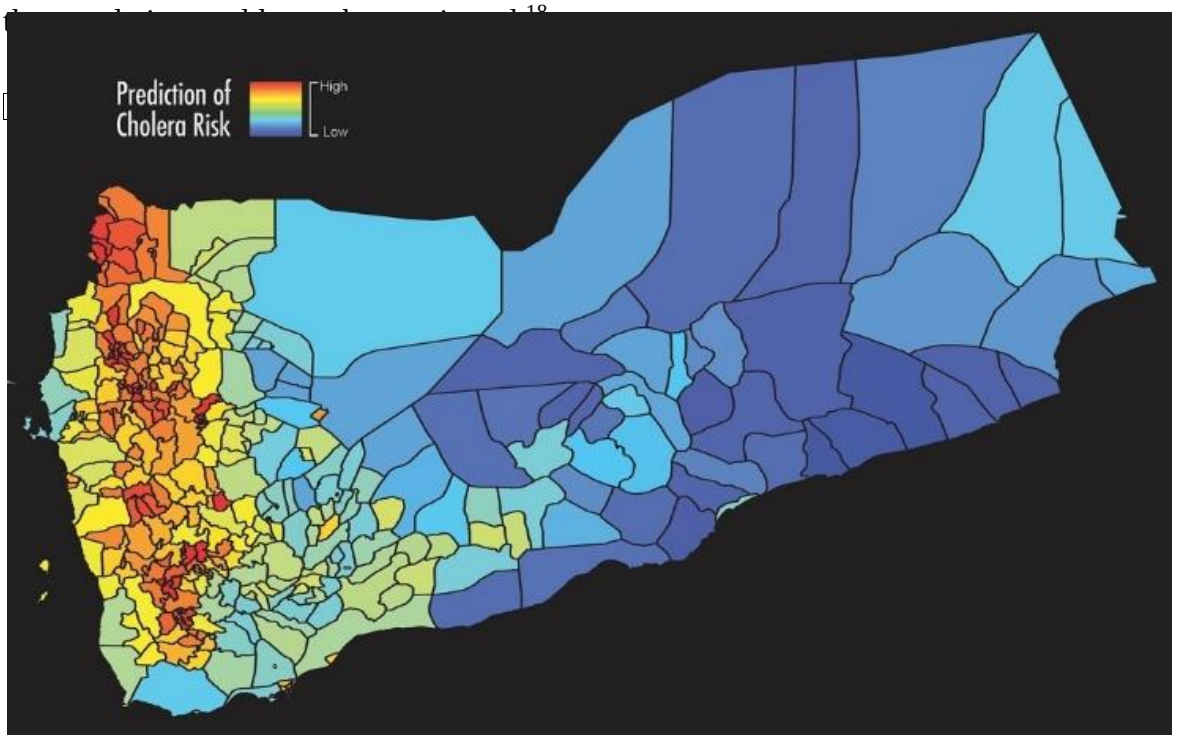
Cholera is a deadly diarrheal disease, threatening 1.3 million to 4.0 million people. In Yemen, poverty, the lack of humanitarian aid and the civil war aggravate the causes of Cholera, which lead to the infection of 1 Million people.
An American Research Team around Rita Colwell delved into the causes for Cholera outbreaks.

Since Cholera is waterborne bacterial, and spreads via water, Colwell analyzed factors like rainfall, water temperature, the salt content of the water on the shores of Yemen and Bangladesh with data from NASA Satellites. With this information, she forecasted the spread of Cholera from 1986 to 1996 and published the results in 2000.[17]

In January 2018, the British DFID (Department for International Development) took notice of her studies and gave her access to the Met-Office Computer in Exeter, which processes about 215 Million weather data every day. With this large database Colwell predicted a Cholera Outbreak in Yemen in 2018, four weeks before it exploded.

[16] Copeland, CJ. *"Artificial Intelligence"* Encyclopedia Britannica, published: 9th of May, 2019 at www.britannica.com/technology/artifical-intellegence, accessed: 27th of July, 2019
[17] Wommack, K Eric & Colwell, Rita. (2000). Virioplankton: Viruses in Aquatic Ecosystems. Microbiology and molecular biology reviews: MMBR. 64. 69-114. 10.1128/MMBR.64.1.69-114.2000.

With an efficiency of 92%, Colwell is confident, that her forecasts will help providing aid before and after the outcome. By expanding the forecast period from four to eight weeks,



[18]

[18] Roman Goergen: „Mit dem Algorithmus gegen Cholera“; Spektrum der Wissenschaft, 27.06.2019 https://www.spektrum.de/news/mit-dem-algorithmus-gegen-cholera/1655968

2.4 Artificial Intelligence in health systems

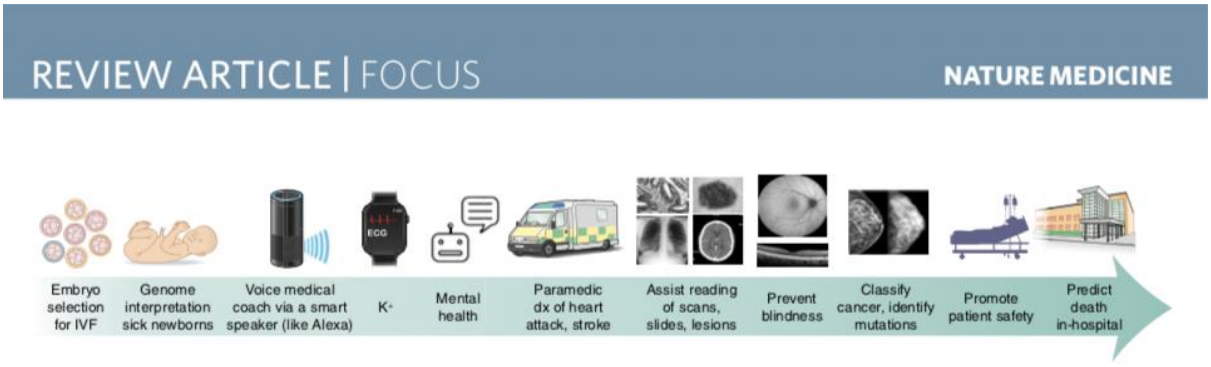


Fig. 2 | Examples of AI applications across the human lifespan. dx, diagnosis; IVF, in vitro fertilization K+, potassium blood level. Credit: Debbie Maizels/ Springer Nature

The use of Artificial Intelligence in modern health systems is extensive, from selecting Embryos for In vitro fertilization, to predicting the risk of death of a patient in a hospital. Some methods are still in research, while others are applied in a clinical setting.[19]

Although in a study, which was carried out retrospectively on two large datasets, AI recommended the use of the right medication for patients with sepsis more efficient than human medicals, there are still differences between predicting retrospectively a cohort and predicting an individual.[20]

Today, on the other hand, AI assists medicals in microsurgery, such as that inside of an eye[21], and AI applied in imagining processes might reduce time and costs, while providing a better outcome.[22]

2.5 Public Artificial Intelligence for health

Even though the development of AI, enabling the public to take their health care in their own hands is still lagging behind the development of AI for the clinical use, products like

[19] Topol, Eric. (2019). High-performance medicine: the convergence of human and artificial intelligence. Nature Medicine. 25. 10.1038/s41591-018-0300-7
[20] Komorowski, M. et al. The Artificial Intelligence Clinician learns optimal treatment strategies for sepsis in intensive care. Nat. Med. 24, 1716–1720 (2018)
[21] Gehlbach, P. L. Robotic surgery for the eye. Nat. Biomed. Eng. 2, 627–628 (2018)
[22] Zhu, B. et al. Image reconstruction by domain-transform manifold learning. Nature 555, 487–492 (2018).

the Apple Watch 4th Generation have received FDA (U.S. Food and Drug Administration) approval. Apples algorithm uses the sensors of the smartwatch, to learn the users heart rate in at rest and while physical activity and warns the user if there is a significant deviation from expected.[23] .

2.6 History of AI

Throughout the history of AI, medicine has been a popular topic among AI researchers. AI in Medicine efforts started in the 1970s with efforts to automate diagnosis. These efforts produced some interesting results but without much acceptance in the medical community. At the time, one of the initial observations was that doctors could not trust AI systems since these systems could not explain how they reached their decisions. In the 1980's, the community shifted its attention to AI systems that explained their findings. Regrettably, the ability to explain results did not make an impact for acceptance and use of these systems. In retrospect, one might surmise that people did not have a burning need for AI assistance with cognitive tasks such as diagnosis and planning.[24] However, by 1991, the need to develop national and international biomedical networking infrastructures for communication, data exchange, and information retrieval was identified. Today, we see remarkable progress in this area, with growing dependence on electronic communication, e-publishing, and online collaborative activities based on Web 2.0 and related concepts.

To go back in history, the Early AI in medicine (AIM) researchers had discovered the applicability of AI methods to life sciences, most visibly in the Dendral experiments of the late 1960s and early 1970s, which brought together computer scientists (e.g., Edward Feigenbaum), chemists (e.g., Carl Djerassi), geneticists (e.g., Joshua Lederberg), and philosophers of science (e.g., Bruce Buchanan) in collaborative work that demonstrated the ability to represent and utilize expert knowledge in symbolic form.[25] The Dendral project was the first major application of heuristic programming to experimental analysis in an empirical science, a practical problem of some importance. It was one of the first large-scale programs

[23] Fingas, R. Apple Watch Series 4 EKG tech got FDA clearance less than 24 hours before reveal
[24] Rowanalytics, "AI in Medicine – A Historical Perspective", https://rowanalytics.com/blog-post/ai-in-medicine-a-historical-perspective/
[25] PMC, US National Library of Medicine National Institutes of Health, "The Coming of Age of Artificial Intelligence in Medicine", https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2752210/

to embody the strategy of using detailed, task-specific knowledge about the problem domain as a source of heuristics, and to seek generality through automating the acquisition of such knowledge.[26]

2.7 Description of the issue and main concepts

We can conclude that the potential of AI in healthcare is surging. However, the adoption of AI is still in early days due to a number of challenges impeding its momentum. One of the major challenges concerning the implementation of AI in health sector is the lack of basic medical facilities and infrastructures in poor and middle-income countries. A lot of countries (eg. Rwanda) still suffer from necessary medical services and the right proportion of technological involvement in health sectors of these developing economies must be addressed. In this regard, user adoption in poor economies is the bigger barrier to utilization. For example, the human touch of interacting with a doctor can be lost with these types of tools. Numerous questions concerning whether the patients on one hand, are willing to trust a diagnosis with a software algorithm and whether clinicians on the other hand are prepared to embrace these new solutions still float around.[27]

One of the major challenges concerns the regulations. Developing regulations for a technology that is cloud-based and constantly evolving poses obvious challenges. As agreed under the General Data Protection Regulation (GDPR) directives, some degree of transparency in decision making will be required. However, it is hard to tell from the directives what level of transparency will be enough and a set of preliminary court cases in the short run will only explain where the border lies. Other issues are likely to result from the requirement for informed consent. For example, will it still be possible to perform research

[26] Science Direct, Robert K.Lindsay Bruce G.Buchanan, Edward A.Feigenbaum and JoshuaLederberg, "DENDRAL: A case study of the first expert system for scientific hypothesis formation", https://www.sciencedirect.com/science/article/pii/000437029390068M
[27] International SOS, "How AI is transforming the future of healthcare", https://www.internationalsos.com/client-magazines/in-this-issue-3/how-ai-is-transforming-the-future-ofhealthcare

on dementia under the new regulations, considering some of the participating individuals may not be able to give informed consent?[28]

2.8 Subtopics

2.8.1 AI in Medical Diagnosis

There is abundant research being conducted on the use of artificial intelligence (AI) to improve diagnosis and clinical decisions. For example, convolutional neural networks which were recently trained using large image libraries have achieved parity with dermatologists in discriminating between benign and malignant lesions. There are expectations that these systems, as they improve and are implemented in mobile electronic devices, will revolutionize diagnosis. Substantially less attention has been given to the use of AI to guide management options following a diagnosis.[29]

2.8.2 AI in precision medicine

One of the most valuable examples of AI in healthcare is precision medicine, which is currently touted as the paradigm-shifting healthcare practice. The foundation of precision medicine relies on the copious amounts of data collected from many disruptive technological innovations, including health sensors patients use at home, cheap genome sequencing and advanced biotechnology. Precision medicine refers to "tailoring of medical treatment to the individual characteristics of each patient". Medical practices are now rapidly shifting from making decisions based on few seemingly overlapping features among patients, to adopting a more personalized format.[30]

2.8.3 AI medical robots in clinical diagnosis and treatments

Beyond scanning health records to help providers identify chronically ill individuals who may be at risk of an adverse episode, AI can help clinicians take a more comprehensive approach for disease management, better coordinate care plans and help patients to better manage and comply with their long-term treatment programs. Robots have been used in

[28] Pelatrion, Mikael Huss, "Challenges of implementing AI in healthcare", https://peltarion.com/article/challenges-of-implementing-ai-in-healthcare
[29] Mdedge, Raheel Zubair, MD Gina Francisco, MBS Babar Rao, MD, "Artificial Intelligence for Clinical Decision Support", September 2018, https://www.mdedge.com/dermatology/article/173762/practice-management/artificial-intelligence-clinical-decision-support
[30] Kolabtree Blog, Maya Raghunandan, "5 Real World Examples AI in Healthcare", September 2018, https://blog.kolabtree.com/5-real-world-examples-of-ai-in-healthcare/

medicine for more than 30 years. They range from simple laboratory robots to highly complex surgical robots that can either aid a human surgeon or execute operations by themselves. In addition to surgery, they're used in hospitals and labs for repetitive tasks, in rehabilitation, physical therapy and in support of those with long-term conditions.[31]

2.8.4 AI and the Black Box Problem

A problem with AI which is often encountered is the Black Box Problem. Vyacheslav Polonski, UX researcher for Google emphasizes that AI's decision making process is usually too difficult for most people to understand and interacting with something we don't understand can cause anxiety and make us feel we're losing control.98 For the future of healthcare to become a reality, we need access to more data and we need it to be fully interoperable. A block chain-based black

box system could be the solution that we've all been looking for.[32] [33]

2.8.5 AI in Electronic Health Records

Patient records, such as X-ray results, blood samples and DNA sequences, among other records, were previously stored in hard copies with the inflow of enormous raw information. However, with the use of Artificial Intelligence, referencing and analyzing is now easily done with the help of analytic tools, technological advancements and machine learning models. It is also beneficial to other set ups that handle a significant amount of data like hospitals and other healthcare facilities.[34]

2.8.6 AI in infectious disease control

Public outreach campaigns can prevent the spread of devastating yet treatable diseases such as tuberculosis (TB), malaria and gonorrhea. But ensuring these campaigns effectively reach undiagnosed patients, who may unknowingly spread the disease to others, is a major challenge for cash-strapped public health agencies. To create the algorithm, the researchers used data, including behavioral, demographic and epidemic disease trends, to create a model

[31] Niccolo Mejia, Emerj, "Artifical Intelligence in Medical robotics – Current applications and Possibilities", April 24. 2019 https://emerj.com/ai-sector-overviews/artificial-intelligence-medical-robotics/
[32] Medium, Eliezer Yudkowsky, "Black Box Health and AI's Applications in Healthcare", https://medium.com/datadriveninvestor/black-box-health-and-ais-applications-in-healthcare-e7a0461248c1
[33] Forbes, Jason Bloomberg, "Don't Trust Artificial Intelligence? Time to Open the AI 'Black Box", https://www.forbes.com/sites/jasonbloomberg/2018/09/16/dont-trust-artificial-intelligence-time-to-open-the-ai-black-box/#592a11bb3b4a
[34] Innovation Management, Kevin Faber, http://www.innovationmanagement.se/2018/06/21/how-artificial-intelligence-is-transforming-personalized-medicine/

of disease spread that captures underlying population dynamics and contact patterns between people. Using computer simulations, the researchers tested the algorithm on two real-world cases: tuberculosis (TB) in India and gonorrhea in the United States. In both cases, they found the algorithm did a better job at reducing disease cases than current health outreach policies by sharing information about these diseases with individuals who might be most at risk.[35]

2.8.7 AI in healthcare systems management

Effective management of health systems, like the provision of public health or health care, is in essence a lattice of information processing tasks. Policy makers modify health system functions of organization and governance, financing and resource management to achieve health system outputs (health care services and public health) and system goals. The provision of health care itself involves two core information processing tasks: first, screening and diagnosis, which is the classification of cases based on history, examination and investigations, and second treatment and monitoring, which involves the planning, implementation and monitoring of a multistep process to deliver a future outcome. The essential form of these processes across the domains of health system management and the provision of care involve hypothesis generation, hypothesis testing and action. Machine learning has the potential to improve hypothesis generation and hypothesis testing tasks within a health system by revealing previously hidden trends in data, and thus has the potential for substantial impact both at the individual patient and system level.[36]

2.9 Previous International Action

The ITU-T Focus Group on Artificial Intelligence for Health (AI4H) was established by ITU-T Study Group 16 at its meeting in Ljubljana, Slovenia, 9-20 July 2018. The Focus Group will work in partnership with the World Health Organization (WHO) to establish a standardized assessment framework for the evaluation of AI-based methods for health, diagnosis, triage or treatment decisions. Participation in the FG-AI4H is free of charge and open to all.

[35] Eurekalert, University of Southern California, “AI to fight the spread of infectious diseases”, https://www.eurekalert.org/pub_releases/2018-02/uosc-atf022018.php
[36] PMC, US National Library of Medicine National Institutes of Health, “The Coming of Age of Artificial Intelligence in Medicine”, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2752210/

With a nearly 20 million health worker shortage worldwide, AI-based decision support can help with early detection, better diagnosis and risk identification, reduce the cost of treatment, support selfmanagement, and improve outcomes. However, a common vetted framework for assessment and benchmarking of AI-based solutions is needed, founded on open source, open data and open standards. The Focus Group was created in July 2018 to address this challenge with their first meeting in September at the WHO Headquarters in Geneva.[37]

The FG-AI4H CfP is an immediate outcome of the first meeting. The CfP is soliciting AI use cases and associated datasets in the fields of clinical and public health. Thomas Wiegand, Executive Director of the Fraunhofer Heinrich Hertz Institute HHI and Professor at TU Berlin, as Focus Group Chair states, "The Focus Group plans to establish a framework and associated processes for the performance evaluation of AI algorithms in health. This will be a complicated and challenging task; one we will undertake step-by-step, beginning with this first Call for Proposals.[38]

2.10 Conclusion

There are clear opportunities to use AI to make health services both more accessible and more effective. By making data collection and triage more efficient, AI can reduce the costs of care, making services more affordable for patients. Collecting more and better data could see services tailored to people's needs, leading to better health outcomes and better-performing health systems. It could also help us predict the risk of future health events from routinely collected data— for example, the onset of a heart attack in a patient with high blood pressure. But the benefits of artificial intelligence are not only a hope for the future. There are many examples of how artificial intelligence is already advancing health. For example, AI is being used to give paraplegic patients improved mobility; to make diagnosis faster and more efficient; to scan the news for emerging and re-emerging disease threats; to manage road traffic, reducing crashes and increasing road safety; and to develop new medicines and vaccines. And there are numerous other ways. Evidently, with every new technology, there

[37] ITU, "Focus Group on "Artificial Intelligence for Health", https://www.itu.int/en/ITU-T/focusgroups/ai4h/Pages/default.aspx
[38] Fraunhofer, "Artificial Intelligence for Health: ITU and WHO call for proposals", https://www.hhi.fraunhofer.de/en/press-media/news/2018/artificial-intelligence-for-health-itu-and-who-call-for-proposals.html

are always risks of abuse. Even as we enjoy the benefits of artificial intelligence, we must not lose sight of human rights.

IV. 3. Relevant Questions

All the flash and blitz of AI in healthcare is accompanied by the flip side: data privacy

issues and ethical usage of AI. Some of the ethical concerns surrounding AI include, but are not

limited to, questions like:

- Who would be held accountable for machine errors can lead to mismanagement of care?
- Would a pre-existing bias (under- or over-represented patient subgroups) in the data being used for training AI, reinforce the bias in diagnosis and analyses instead of eliminating them?
- Would the patients be informed of the extent of role AI is playing in their treatment?
- Would AI encourage patients to not seek advice from a medical practitioner, and indulge in self-diagnosis and medication?
- Could the healthcare practitioners feel threatened by AI about a potential loss in authority and autonomy?
- Would this in turn affect their medical practice?[39]
- Should private companies be part of the research and development, if so how would they be implemented into the research process?
- In which ways can the research be shared between Member States and how should this be regulated?

[39] Kolabtree Blog, Maya Raghunandan, "5 Real World Examples AI in Healthcare", September 2018, https://blog.kolabtree.com/5-real-world-examples-of-ai-in-healthcare/

V. 4. References

WHO, "World Health Day" https://www.who.int/world-health-day/2012/toolkit/introduction/en/

WHO, "About WHO", https://www.who.int/about

ITU News, Dr. Winnie Tang,"How AI for healthcare can overcome obstacles and save lives", August 2018, https://news.itu.int/ai-healthcare-overcome-obstacles/

Forbes, Charles-Towers Clark, "Using Artificial Intelligence to fix healthcare, https://www.forbes.com/sites/charlestowersclark/2018/11/22/using-artificial-intelligence-to-fix-healthcare/#31cd516d220c

Speech, World Health Organization, Dr Tedros Adhanom Ghebreyesus, "Artificial Intelligence for Good Global Summit", https://www.who.int/dg/speeches/2018/artificial-intelligence-summit/en/

Made for minds, "Medical drones: Ghana to follow Rwanda's example", https://www.dw.com/en/medicaldrones-ghana-to-follow-rwandas-example/a-46690095

Rowanalytics, "AI in Medicine – A Historical Perspective", https://rowanalytics.com/blog-post/ai-in-medicine-a-historical-perspective/

PMC, US National Library of Medicine National Institutes of Health, "The Coming of Age of Artificial Intelligence in Medicine", https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2752210/

Science Direct, Robert K.Lindsay Bruce G.Buchanan, Edward A.Feigenbaum and JoshuaLederberg, "DENDRAL: A case study of the first expert system for scientific hypothesis formation", https://www.sciencedirect.com/science/article/pii/000437029390068M

International SOS, “How AI is transforming the future of healthcare”, https://www.internationalsos.com/client-magazines/in-this-issue-3/how-ai-is-transforming-the-future-ofhealthcare

Pelatrion, Mikael Huss, “Challenges of implementing AI in healthcare”, https://peltarion.com/article/challenges-of-implementing-ai-in-healthcare

Kolabtree Blog, Maya Raghunandan, “5 Real World Examples AI in Healthcare”, September 2018,

https://blog.kolabtree.com/5-real-world-examples-of-ai-in-healthcare/

Mdedge, Raheel Zubair, MD Gina Francisco, MBS Babar Rao, MD, “Artificial Intelligence for Clinical Decision Support”, September 2018, https://www.mdedge.com/dermatology/article/173762/practice-management/artificial-intelligence-clinical-decision-support

Niccolo Mejia, Emerj, “Artifical Intelligence in Medical robotics – Current applications and Possibilities”, April 24. 2019 https://emerj.com/ai-sector-overviews/artificial-intelligence-medical-robotics/

Medium, Eliezer Yudkowsky, “Black Box Health and AI’s Applications in Healthcare”, https://medium.com/datadriveninvestor/black-box-health-and-ais-applications-in-healthcare-e7a0461248c1

Forbes, Jason Bloomberg, “Don’t Trust Artificial Intelligence? Time to Open the AI ‘Black Box”, https://www.forbes.com/sites/jasonbloomberg/2018/09/16/dont-trust-artificial-intelligence-time-to-open-the-ai-black-box/#592a11bb3b4a

Innovation Management, Kevin Faber, http://www.innovationmanagement.se/2018/06/21/how-artificial-intelligence-is-transforming-personalized-medicine/

Eurekalert, University of Southern California, “AI to fight the spread of infectious diseases”, https://www.eurekalert.org/pub_releases/2018-02/uosc-atf022018.php

Copeland, CJ. *"Artificial Intelligence"* Encyclopedia Britannica, published: 9th of May, 2019 at www.britannica.com/technology/artifical-intellegence, accessed: 27th of July, 2019

Stuart J. Russell and Peter Norvig "*Artificial Intelligence A Modern Approach, Third Edition"*, Person Education Inc., ISBN-13: 978-0-13-604259-4

Bellman (1978) cited in Stuart J. Russell and Peter Norvig "Artificial Intelligence A Modern Approach, Third Edition", Person Education Inc., ISBN-13: 978-0-13-604259-4

Rich and Knight (1991) cited in Stuart J. Russell and Peter Norvig "Artificial Intelligence A Modern Approach, Third Edition", Person Education Inc., ISBN-13: 978-0-13-604259-4

Herculano-Houzel S. (2012). The remarkable, yet not extraordinary, human brain as a scaled-up primate brain and its associated cost. Proceedings of the National Academy of Sciences of the United States of America,

Charniak and McDermott (1985) cited in Stuart J. Russell and Peter Norvig "Artificial Intelligence A Modern Approach, Third Edition", Person Education Inc., ISBN-13: 978-0-13-604259-4

Poole et al.,(1998) cited in Stuart J. Russell and Peter Norvig "Artificial Intelligence A Modern Approach, Third Edition", Person Education Inc., ISBN-13: 978-0-13-604259-4

Wommack, K Eric & Colwell, Rita. (2000). Virioplankton: Viruses in Aquatic Ecosystems. Microbiology and molecular biology reviews: MMBR. 64. 69-114. 10.1128/MMBR.64.1.69-114.2000.

Roman Goergen: „Mit dem Algorithmus gegen Cholera"; Spektrum der Wissenschaft, 27.06.2019 https://www.spektrum.de/news/mit-dem-algorithmus-gegen-cholera/1655968

Topol, Eric. (2019). High-performance medicine: the convergence of human and artificial intelligence. Nature Medicine. 25. 10.1038/s41591-018-0300-7

Komorowski, M. et al. The Artificial Intelligence Clinician learns optimal treatment strategies for sepsis in intensive care. Nat. Med. 24, 1716–1720 (2018)

Gehlbach, P. L. Robotic surgery for the eye. Nat. Biomed. Eng. 2, 627–628 (2018)

Zhu, B. et al. Image reconstruction by domain-transform manifold learning. Nature 555, 487–492 (2018).

Fingas, R. Apple Watch Series 4 EKG tech got FDA clearance less than 24 hours before reveal