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OPPORTUNITY TO USE ARTIFICIAL INTELLIGENCE IN MEDICINE

Nada Pop-Jordanova

Macedonian Academy of Sciences and Arts, Skopje, RN Macedonia

Corresponding author: Nada Pop-Jordanova, popjordanova.nadica@gmail.com

ABSTRACT

Over the past period different reports related to the artificial intelligence (AI) and machine learning used in everyday life have been growing intensely. However, the AI in our country is still very limited, especially in the field of medicine.

The aim of this article is to give some review about AI in medicine and the related fields based on published articles in PubMed and Psych Net. A research showed more than 9 thousand articles available at the mentioned databases.

After providing some historical data, different AI applications in different fields of medicine are discussed.

Finally, some limitations and ethical implications are discussed.

Keywords: artificial intelligence, medicine, ethical problems

INTRODUCTION

In the last period different reports related to the artificial intelligence (AI) and machine learning in everyday life have been growing intensely. Although the research related to machine learning has a longer history, the algorithms based on the neural network included in the artificial intelligence are relatively new. Consequently, it could be said that AI in medicine is relatively a new field. The aim of this article is to give some review about AI in medicine and the related fields. AI is used in different fields of medicine such as anaesthesiology, ophthalmology, surgery, rheumatology, cardiology, mental health etc. I will try to give a review about AI used in medicine today.

METHODOLOGY

This article is a review based on published articles. If we use the key words: AI and medicine, more than 9 thousands of articles become available on PubMed and PsyNet. The growing tendency of published articles related to the artificial intelligence is shown on Fig. 1 [1].

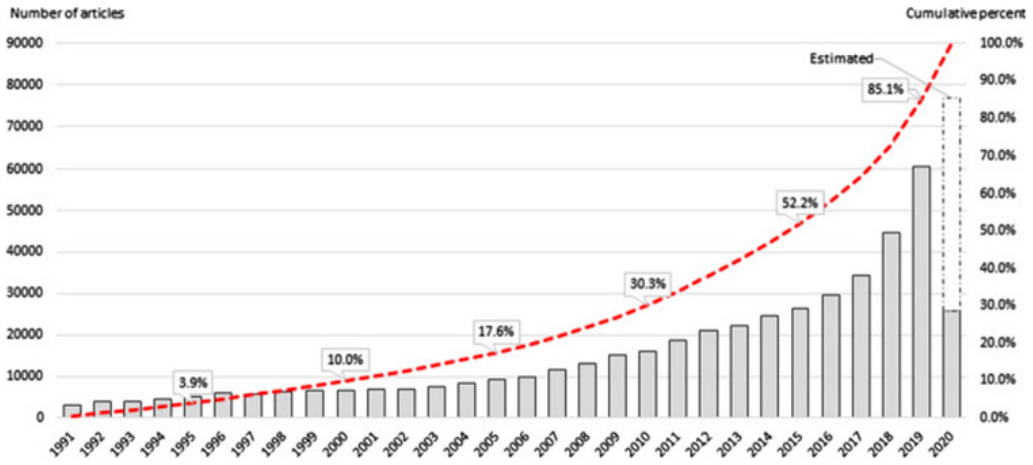


Fig. 1. *Artificial intelligence publication outputs, 1991–2020*

HISTORICAL DATA

The AI approach has a long history, starting in the 1950s. It began as attempts to investigate, understand, and build computational models based on scientific knowledge used in the biomedical field, by developing computational systems for processing and interpretation clinical data. The results in the first phase of AI in medicine research appeared in the mid-1970s when the SUMEX-AIM time-sharing resource at Stanford University was succeeded followed by series of AI workshops in medicine [2, 3].

As it is known, traditional computer programs are based on explicit instructions bringing out certain behaviours from a machine based on specific characteristics. Machine learning, additionally, allows programs without explicit programming, where data are broader, including numbers, images, text, speech and sound data. The programs include algorithms used to solve some problem based on learning. Machine learning problems are often separated into those that require classification (dividing data into discrete groups) and those that require regression (modelling data to better understand the relationship between two or more continuous variables with the potential for prediction) [4]. The main subdivisions of AI are presented in Fig. 2.

The following step in AI development was the use of fuzzy logic theory, which was firstly described in 1965. As known, standard logic allows the concept of bimodal choose (true -1 and false- 0), while in fuzzy logic system it was possible to choose partial truth (value between 0 and 1). In this context, my team published in 1991 the article named "MEXYS2: A Fuzzy Reasoning Expert System Based on the Subject Emotions Consideration". Fuzzy logic often uses rule-based systems that have been largely applied in control systems where precise mathematical functions do not accurately model phenomena. Our research was related to an expert system for personality and

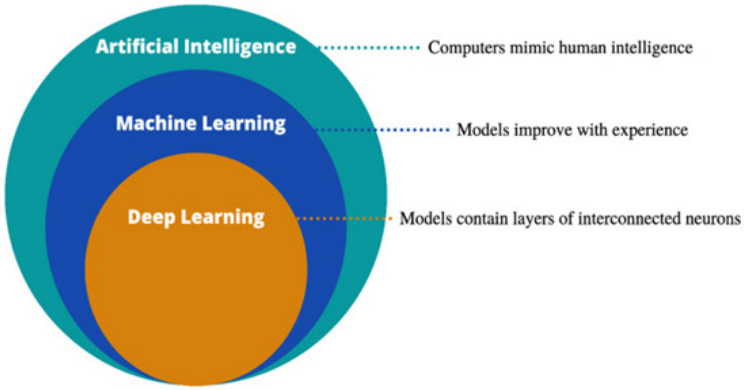


Fig. 2. *Artificial intelligence and its sub-divisions*

emotional profile assessment. The expert knowledge and the basic computational procedure were based on a standard psychological test, where fuzzy reasoning and uncertainty assessment are features of this system. In this context, we showed a great interest for application of new methods in the field of medicine and psychology [5].

Classical machine learning uses properties within data to perform tasks, where features are analogous to independent variables in a logic regression or used to perform classification.

Today, the neural networks model is the most used one in machine learning, based on the biological function of the nervous system [6 7,8]. Here, process signaling is passed by layers of computational units (neurons) in which the input data have passed different mathematical transformations providing the result. Multiple connections between neurons exist in the layers which are further parametrized to different weights depending on the input-output maps, giving information on particular task (i.e. image recognition, classification, etc.). Neural networks are a technique that has now been applied in different subfields of artificial intelligence having the flexibility in analysing various types of data. In the field of machine learning we have published the article "Machine learning approach for classification of ADHD adults", Int. J Psychophysiology, (2014). In our study the measurements are taken for four different conditions: two resting conditions (eyes open and eyes closed) and two neuropsychological tasks (visual continuous performance test and emotional continuous performance test). We divided the sample into four data sets, one for each condition. Each data set was used for training of four different support vector machine classifiers, while the output of classifiers is combined using logical expression derived from the Karnaugh map. The results showed that this approach improves the discrimination between ADHD and the control groups, as well as between the ADHD subtypes [9].

Natural language processing is a subfield of artificial intelligence that focuses on machine understanding of the human language. In medicine, the most natural application of the natural language processing is the automated analysis of electronic health record data [10].

Computer vision is additionally one other field of AI which comprises machine understanding of images, videos, and other visual data (e.g., computed tomography). In medicine, the application of computer vision in pathology and radiology allowed the reduction of errors in diagnosis based on slides and x-rays that have a high probability of demonstrating pathology [11].

AI IN DIFFERENT FIELDS OF MEDICINE

The latest article in JAMA reports provide authors, researchers, reviewers, and editors with some guidance for transparent and accountable reporting for the use of AI in research and publication, where a guideline and update recommendations and Instructions for Authors are presented [12]. The same author pointed out that in medical research, data sharing facilitates new discovery and innovation, transparency, and reproducibility, and, ultimately, trust in science [13]. In this context, JAMA network journals expanded the requirement for data sharing to all authors giving them some guidance. So, in all fields of science it is very important to publish and share own results with other researchers. I will cite in this paragraph the opinion of my husband (J. PJ) who accentuated that if you do not publish and share the results of your own performed research it means that this research did not exist!?

Rivera SC et al. [14] aiming to improve the completeness of clinical trial protocol reporting, published the standard protocol items – recommendations for interventional trials (SPIRIT-AI). Interventions involving artificial intelligence additionally need to undergo rigorous, prospective evaluation to demonstrate their impact on the health outcomes which led to extension of SPIRIT-AI in CONSORT-AI including new items where AI intervention will be integrated.

AI methods are broadly used in surgical education and research and are summarized in the JAMA surgical guide to statistics and methods website [15]. This guide provides an overview of the important steps in using AI in surgical education research.

Especially, AI is used in the field of anaesthesiology, for anaesthesia monitoring, control, risk prediction, ultrasound guidance, pain management and logistics in the operating room [16–18].

The advance in the field of neurology implies the use of AI and machine learning for enhance neurologist's competence [19]. It is especially use-

ful for the management of neurological diseases and the improvement of the patient's outcome. AI not only helps to analyse the medical data in disease prevention, diagnosis, patient monitoring, and development of new protocols, but can also assist clinicians in dealing with voluminous data in a more accurate and efficient manner [20].

Having in mind that cancer and other malignant diseases are the leading cause for morbidity and mortality today, the role of AI in the diagnosis and treatment of this devastating diseases is very important [21–23]. Different AI tools are used for screening asymptomatic patients at risk of cancer, for investigation and triaging symptomatic patients, as well as for more effectively diagnostics. Figure 3 shows the clinical application of AI in cancer diagnosis.

Practically, there is no medical field where AI was not applied. I will mention the use in ophthalmology [24] especially in the diagnosis of retinal vascular diseases [25], macular degeneration [26], diabetic retinopathy [27], glaucoma [28] etc.

Artificial Intelligence is used, also, in the field of cardiology and in the management of hypertension [29–32].

Additionally, AI can be used in a variety of ways to improve the dental care and dentistry, such as segmenting and identifying teeth, planning of dental implants treatment, for detection and classification of dental plague, for diagnosing maxillary sinusitis on panoramic radiography, for cephalometric landmarks detection, or for root morphological classification, dental caries detection on periapical and bitewing X-ray images, and many other applications [33].

Generally, the main applications of artificial intelligence in medicine are: medical imaging, diagnosis and treatment, drug discovery and development, clinical decision support, chronic disease monitoring and tracking, predictive analytics, and medical research.

It should not be forgotten that AI is used also for mental health and mental illnesses [34]. The use of AI has changed practically all aspects of psychology [35]. Psychologists are also taking a close look at human-machine interaction to understand how people perceive AI and what ripple effects such perceptions could have across society. In psychology practice, artificial intelligence (AI) chatbots can make therapy more accessible and less expensive. AI tools can also improve interventions, automate administrative tasks, and aid in training new clinicians. On the research side, synthetic intelligence is offering new ways to understand human intelligence, while machine learning allows researchers to glean insights from massive quantities of data.

However, AI does not have the capacity to empathize and form genuine connections with the clients, which is vital in therapy. My own opinion is that computer differs from humans by lacking emotions (feelings), which is a very important fact!

Apart from the many benefits that AI usage provides to the medical staff, there are also some limitation and ethical implications. Firstly, the use of AI will not necessarily result in classification

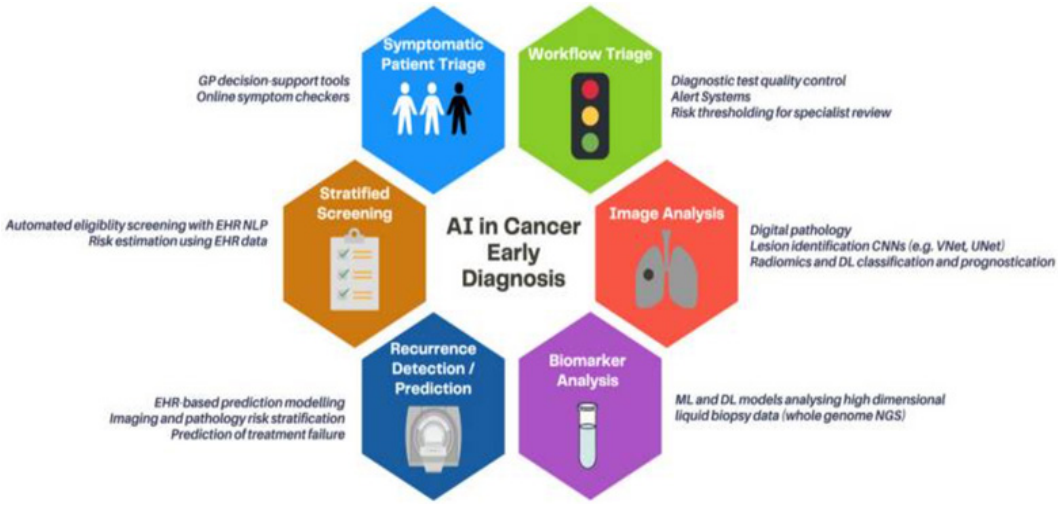


Fig. 3. *Clinical applications of AI in early cancer diagnosis*
[Abbreviations: GP: general practitioner, NLP: natural language processing, EHR: electronic healthcare record, ML: machine learning, DL: deep learning, NGS: next-generation sequencing]

or prediction which is superior to current methods. AI must be expanded in the right situation to obtain answers on an appropriate question or to obtain solution for an applicable problem. It is known that the used algorithms in AI can result in "black box" results where the obtained prediction cannot be explained using previous experiences. Additionally, AI is also susceptible to bias in data. In this context, implicit and explicit bias in healthcare system can impact different data used to teach AI machine. Thus, eligibility of specific patient populations for clinical trials, implicit biases in treatment decisions in real world care, and other forms of bias can significantly affect the types of predictions that AI may make and influence clinical decisions [36].

Additionally, the use of AI in medicine is related to significant concerns: In healthcare, the current laws are not enough to protect an individual's health data. Clinical data collected by AI systems can be hacked and used for malicious purposes that minimize privacy and security. Also, some genetics testing and bioinformatics companies, which are not legally audited as per specific regulations or strongly monitored, could sell customer data to pharmaceutical and biotechnology companies. Consequently, the medical staff must be aware that the negative aspects of the AI use might overshadow its benefits. Ethical principles of respect for human autonomy, prevention of harm, fairness, explicability, and privacy were elaborated in more than 2.500 articles on PubMed. I will mention in this context only the publications of Pashkov [38 and 39].

In most of the studies there was a limited examination of the ethical principles related to the design or deployment of the AI tools. However, in the few instances where the ethical principles were considered, fairness, preservation of human autonomy, explicability and privacy were discussed. In the very old book "The Human Use of Human Beings", the author Norbert Weiner [40] as the major challenge of the complex human-machine systems invited to find the balance between the "calculating brain" of humans driven by selfish and economic imperatives with the "altruistic brain" of those clinicians who want to keep their Hippocratic Oath. Whether a good ethical doctor can work with an AI and remain ethical is a major open problem for all of us that will have to be confronted not only scientifically, but also in a socially acceptable and humanistic way in clinical informatics. To overcome this problem, experts must consider humanity and ethics in this regard. In this way, the five news topics that got the most attention in 2020 related to the ethical use of AI were the release of the European Commission's white paper on AI, Google's dismissal of ethics researcher Timnit Gebru, the AI ethics committee formed by the United Nations, the Vatican's AI ethics plan, and IBM's exiting the facial-recognition businesses. I must mention, the case of researcher Timnit Gebru who presented the history of natural-language processing and gave some suggestions for further research. The conflict with Google is related to the big electric consumption needed for AI models which enhance carbon emissions and financial cost. Gebru's paper points out that the sheer resources required to build and sustain such large AI models means they tend to benefit only wealthy organisations, while climate change hits marginalized communities hardest. This statement was sanctioned by Google.

We showed that the development of human-like, interactive systems has been the claim of artificial intelligence (AI) research for decades. All these tools have been greeted with great, and in some cases, irrational enthusiasm, accompanied by breakneck efforts to implement this new technology in the myriad aspects of daily life, including the medicine. However, it must be pointed out that as all new tools in high technology, AI also provides many possibilities and priorities, but also have negative outcome or risks if it is not used in true manner. Consequently, artificial intelligence today must be carefully used, especially with ethical concerns.

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Резиме

МОЖНОСТ ЗА КОРИСТЕЊЕ НА ВЕШТАЧКАТА ИНТЕЛИГЕНЦИЈА ВО МЕДИЦИНАТА

Нада Поп-Јорданова

Македонска академија на науките и уметностите, Скопје, РС Македонија

Во последниот период разните известувања поврзани со вештачката интелигенција и машинското учење применети во секојдневниот живот рапидно растат. Сепак, примената на вештачката интелигенција во нашата земја е сè уште многу ограничена, особено во полето на медицината.

Целта на овој напис е еден вид ревијален приказ за вештачката интелигенција и нејзината примена во медицината и во сродните гранки, базиран на публикувани трудови во базите ПубМед и ПсихНет.

По малку воведни историски податоци, во трудот се дискутира за примената на вештачката интелигенција во разни медицински гранки. На крајот се разгледуваат некои ограничувања и етички импликации.

Клучни зборови: вештачка интелигенција, медицина, етички проблеми