

POSSIBILITIES, LIMITATIONS AND ECONOMIC ASPECTS OF ARTIFICIAL INTELLIGENCE APPLICATIONS IN HEALTHCARE

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Abstract

The increasing importance of achieving sustainable development is largely positively influenced the emergence and increasing the level of application of artificial intelligence in different spheres of human activity, but especially in the field of health care. It is this trend and initiated that in work devote special attention to precisely to the analysis of potential opportunities, and economic effects of the use of artificial intelligence in the direction of improving efficiency, but the economic effects of health care.

Key words: *artificial intelligence, healthcare, medical services, IBM Watson*

JEL Classification: *I15, O31, O35*

I. INTRODUCTION

Artificial intelligence (AI) is one of the newest fields in science and engineering (Russell and Norvig, 2014, p.1). In the wide sense AI is the art of creating machines that perform functions that require intelligence when performed by people (Kurzweil, 1990; Russell and Norvig, 2014, p.2), ie it represents the intelligence demonstrated by specific machines or software. This is precisely the reason why the AI and usually defined as intelligent behaviour with the creation of artefacts that exhibit such behaviour (Shapiro, 1992; Ramesh et al, 2004, pp. 334-338) or as a science and engineering intelligent machines (McCarty, 2007). The main goal of AI is to design "intelligence" and intelligent ways of information processing and decision-making in manner analogous way the human brain works (Ilić and Marković, 2015, p. 412). Precisely such an approach places an emphasis that AI study in attempts to create an intelligent agent (Poole et al, 1998, p.1). The intelligent agent is a system that is able to anticipate their environment and to take actions that maximize the probability of successful performance of the given task (Russell and Norvig, 2014, p. 34). Unlike the original idea of intelligent system in which basic measure of intelligence of the system is represented by the ability to get from a limited set of data with established rules find a solution as a higher level of accuracy, Ai operate at significantly different principles which can be illustrated by the following example. If you ask a question to google.com which is "who is the best medicine to give a child against colds asthma; google search will most likely provide an answer which shows the 3*10⁶ Web pages with mentioned keyword. Unlike the Google search engine AI (cognitive computer) will offer you the following answer: with 82% accuracy on the previous question in the following form: "three teaspoons of marshmallow syrup twice a day (Ilić and Marković, 2015, p.412). The above example indicates that the target AI gives answers to real problems and to have "the ability of machines to understand" and not to manipulate information (Manoj, 2011). Due to all this even more significant gains conclusion Yann LeCun renowned expert in the field of AI in which one of the greatest challenges of today represents an automatic or at least semi-automatic extracting knowledge from data (Singh, 2014).

II. CHALLENGES FACED HEALTHCARE AND CONDUCTIVE TO WIDER APPLICATION OF AI IN THIS AREA

The first and most important challenge before which is the current system of health care refers to the high rate of inefficiency and unprofitability. According to official statistical data presented by the Institute of Medicine in the US, 30% of total financial assets, which on average amount to 2.3 trillion USD annually, which is intended for health protection of US citizens are economically unjustified, that is wasted capital. Also, according to official statistics of the total invested funds in the United States in healthcare annually, 30% is never really spent on medical care (not spent on some real medical intervention or maintenance of the system as such).

Similar statistically data exist for other Western economies where the percentage dissipation roughly the same as in the US (Well Point, 2014).

Another challenge facing a current system of health care, the necessity of reducing an extremely complex system of health care in order to improve efficiency and profitability. The method of reducing the complexity of the system itself, or in our case, improving profitability and efficiency of the system, has given by Herbert A. Simon complexity theorem (Winston, 2010) according to which the complexity of behavior follows from the complexity of the environment and can be displayed in the following form: $C_{(behavior)} = \max[C_{(system)}, C_{(environment)}]$.

The third challenge facing the health sector is the fact that in developed countries, patient information and history of their disease doubled every five years. Articles about this trend evidenced by the fact that even 90% of the information that exist about the users of health services occurred in the past year. The amount of information about the users of health care will further magnify especially with the increasing shift to the Internet of Things (IoT for short), which will complicate the possibility of searching and processing. The development of "smart" infrastructure based on the IoT certainly intensify generate volumes of information, and the use of classical information technology is already not adequate because it is not able to efficiently and cost-efficient manner extracted important information from the wealth of information (Rometty, 2013), which once again highlights the importance of use IoT and AI, especially in the direction of sustainable development and the health care sector people.

These trends and increasing requirements for cost-effectiveness economic impact on the transformation of the present way of functioning of health care. Modern approach to improving the efficiency and cost-effectiveness of health care system initiates a reduction of the specific problems of last resort for the most part and initiate the implementation of AI in this field, which generally relate to the following (Kohn and Skarulis, 2012):

- Every fifth diagnosed in the world is considered to be inaccurate or incomplete;
- In the United States each year is issued 1.5 million inappropriate prescriptions;
- Annual dying between 44,000 and 98,000 US citizens due to medical errors that could have been prevented;
- 81% of doctors do not spend more than 5 hours per month on reading literature;
- According to the findings McKinski Institute 30% of jobs are algorithmic while the remaining 70% of jobs in the health care stochastic by nature;
- Health care is one of the areas in which work remotely at least represented in percentage;
Men are weak in testing all paths which a problem can be developed; Men are weak in examining all possible paths (path to the cause-and-effect, and overall network path connecting two nodes in a network environment, which is crucial for finding a logical solution) (McCarthy, 2007);
A lot of resources without any gain (Omohundro, 2007), which leads to greater financial unprofitability of the entire health care system.

III. ANALYSIS OF OPPORTUNITIES, WAYS, AND ECONOMICAL VALIDITY OF APPLYING AI IN THE HEALTHCARE SECTOR

The growing expectations of patients and the wider community for better and more efficient health protection puts pressure on healthcare workers to improve their own knowledge and skills. However, in such problem, it is necessary to point out certain specifics concerning the necessity of training and specialization of health workers. In fact, in certain cases, doctors, due to preoccupation training are not able to adequately devote to each individual patient practice, and to adequately applying the latest knowledge and the best experience in practice (Szolovits, 1982). In the absence of the time most doctors health decisions based on common practice that suits the type of statistical normalized ensure patients. In some cases, such a diagnosis or prescribed treatment are inadequate because the specificity of certain diseases are not taken sufficiently into consideration in making the diagnosis. Yet there is a solution that, through wider application of AI in this area, which pointed Schwartz (1970, pp. 1257-1264), according to which, computers have become an intellectual tool that can transform the health and safety and make it more effective.

Another problem that is becoming more serious and which poses health agencies and the public administration is related to the insufficient number of doctors required the community in order to promote sustainable development. Western economies now have a constant lack of skilled medical workforce. In addition as a major problem of inefficiency of the health system according to the following. Specifically within the existing health care system often appear enormous transport and other related costs as pacjent for individual phases of medical care must be physically transported from one clinical center depending on the specific disease, the patient. The AI this problem would largely be solved and costs significantly reduced due to the greater availability, reliability and timeliness of the crucial information needed to diagnose (Medrano, 2014).

The use of AI in medicine is a relatively new area, so the number of studies dealing with the analysis of options, different ways, as well as the economic feasibility of use in this area are very limited. However, despite the small number of publicly available studies on the importance and economic justification of the use of AI in the healthcare sector, these examples clearly emphasize the importance of applying AI as follows:

- By applying AI improves the efficiency of the entire health care process, but particularly the positive results achieved in the process control during the decision-making process in relation to the analysis of the decisions made and their justification, the qualifications, reliability and efficiency. Using artificial intelligence improves the system of assessment required level of knowledge of doctors and other health workers. Positive effects of AI in this area are definitely related and advancement opportunities impartial ranking physician of knowledge and skills that demonstrate and apply in practice and observed by specialization, but also the accuracy and timeliness of diagnosis and determination of medical treatments;
- By applying AI improves the efficiency of health care planning (Ferrer, 2013) which certainly positively influence the reduction of health care costs. That is why it is often pointed out that AI represents a logical engine for medical testing hypotheses (Medical hypotheses engine);
- The introduction of AI, or as digital avatars of health assistants / advisors or as a substitute for medical and administrative staff improves the overall efficiency of the system. One indicator of how much in recent years progressed systems for automatic answer is the fact that some patient so accepted these "friendly" machines that they could not distinguish from real people and even the record where callers trying to chatbot with which the talked invited to date (George, 2013);
- Personalization of content is one of the most common ways of applying AI service and is used by nearly all the major ISPs. Considering this fact, the question arises whether the right content personalization (at cardboard or history of disease) that is necessary to doctors to bring argued decisions. One of the first applications of AI in medicine just referred to personalization delivering content of interest to physicians and ensure patients;
- The University of California has developed an algorithmic driven system prescriptions may that without a fault combines the symptoms, diagnosis and medication far more efficiently than men (Steiner, 2012). The algorithms developed by NASA (approximately 6,000,000 algorithms) for a psychiatric assessment of the candidates today are linked into a single software system that analyzing manner of speaking, "read thoughts" that determines the psycho personality typology and transfers the call to the same this type of personality, increasing the probability that two of the same type of personality easier and faster to agree, or to be critical information to be on time. These same algorithms are used for the assessment of candidates when forming teams and working groups for specific projects.
- Artificial intelligence is used to assist general practitioners doctors, enabling them to make medical decisions without the necessary and constant consultation with a specialist doctor (Hussain et al. 2002);
- The AI significantly improves the process of risk assessment and consequence of individual treatment, ie, improves the process of finding optimal times for treatment or maintaining health condition;
- AI can also be used to detect fraud, both financial and those with insurance policies or replacement of identity (Wage, 2013, pp.17-79). Thanks to tools such as IBM Cognos (Zimmer, 2014) it is possible to recommend a specific treatment, but also detect fraud based on insurance, because the diagnosis based on the AI and contextual processing of the case based on the history of the patient, but also to ensure patients beyond medical information such as a family history of on what basis and calculated inclinations and predispositions to certain diseases. However, to achieve the AI functionality necessary to enable digital agents to access to certain data which are considered private, and whose access to the necessary special permits or judicial authorization.

Application of AI means that more and more software and services based on AI should be able to for each of its recommended actions provide an answer to the question "Why?" ie must have the so-called a module for an explanation / support decisions which not only provides a high degree of reliability, but also establishes a trust between doctors and artificial intelligence tools that assist him. One very important feature of this system is easy to apply to coach and train health care workers in terms of new diseases or conditions with which the trainee or student has not met. Although the programs that use artificial intelligence based on mechanisms similar to human thinking always as a confirmation solutions obtained artificial intelligence require the consent of human intelligence, ie AI, and that man come to the same conclusion in the present case, representing approval for any further action that they apply the diagnosis, treatment, care or further data mining in case.

IV. ANALYSIS OF USE OF IBM WATSON AI IN HEALTH CARE

IBM is the creator of the first cognitive computer called Watson who from 2014 available as a public service of artificial intelligence (Ilić and Marković, 2015, pp.412-415). The functioning, ie decision-making process at IBM Watson AI consists of the following steps (IBM, 2015):

- Watson learn language, jargon and customs domains for problems to be studied;
- Analizar and compare the problem with similar problems; Sets, ranked hypotheses and searches for evidence to confirm or overthrow the hypotheses (Ferrucci et al. 2010, pp. 59-79); Creates a statistical model for each hypothesis by assessing the likelihood of its authenticity, based on the results obtained by statistical comparison with known patterns (Ferrucci and Lally, 2004, pp.327-348);
- It provides answers to the questions in the form of spoken language or one of the available templates taken from a given domain with a view to greater understanding of the person who is asked the question; Most of the data about how he feels pacjent stated spoken language rather than professional diagnosis. The idea that "cracking" the spoken language has greatly helped the wide application of AI;
- Establishes and builds a body of knowledge which fundamentally requires the use of supervised learning. Monitoring learning carried out by experts from the aforementioned domains, and through the following steps: 1. feeding data and primary knowledge; 2. Expert helps him to interpret the data while the minimum Watson starts to find patterns (applies machine learning pairs of questions and answers and case-based reasoning where the similarity counts as: $Sličnost(T, S) = \sum_{i=1}^n f(T_i, S_i)w_i$ wherein the T-target case, S - the original case, n-number of attributes in each case, w significance i-attribute; 3. learn linguistic patterns of a given domain; 4. update with new information (Ilić and Marković, 2015, pp.412-415).

The ability of machine learning Watson was able to learn the rules of any domain, as well as to answer any question from a given domain, even in situations where the missing part of information and knowledge in the field of his knowledge or in the characteristics of the question (Ilić and Marković, 2015, pp.412-415). Thanks to these principles functioning Watson represents an ideal platform for improving business decision-making, but also for addressing the social, legal, and especially the problems in the health care sector. According to the famed pediatrician Alan Greene future development and application of AI in this field is inevitable, because in his words, "something like Watson will soon be the world's best diagnosticar - whether you ask the man or machine" (Kelly, 2014).

Advantages that Watson AI has in relation to the agents of the health system are many. The most frequently mentioned reasons, ie outrank the use of AI in the healthcare sector are (Ilić and Marković, 2015, pp.412-415):

- Improving efficiency - IBM Watson is capable of all medical records generated by certain medium-sized hospitals in the United States to read in less than 6 seconds, and it is additionally important because medical knowledge increased almost two times every 5 years, and today the volume of medical knowledge beyond physical incapacity of man to adequately understand and use;
- The reduction of the impact of the authoritative doctors - very often specific diagnosis is not reviewed even when it is suspected that they are wrong because they were set up by renowned doctors. A large number of diagnosis is based on history of the patient, that is based on the belief that the previous instace providing medical care was not wrong. Number of automatic extension therapy greatly exceeds the number of those that are controlled by specialized medical staff.

The methodology is already applied in practice to generate a medical diagnosis, largely based on the use of the IBM Watson AI. Namely, instead of vague questions Watson Ai used in medical diagnostics method of specific questions relating to certain scenarios that are essentially based on a valid and available medical documentation. From the initial questions develops discussion based on the relation: question - answer. The mere discussion can be viewed from two different angles, which are: external - where Watson Ai answer the questions of medical professionals / doctors, and internal - where, after finding concepts, Watson from the same form of network graphs which represent a connection internally generated questions that Watson sets himself and corresponding to. At this stage of information processing Watson on the basis of some of the algorithms time trying to shorten the processing time information necessary to verify the authenticity of each connection, ie trying to strengthen each link in order to obtain a logical path that leads to a single diagnosis. Analysis of scenarios in which such recognition concepts and their logical connection to the formal medical language (the language of clinical practice) and identification of clinical factors precede the formation of graphs connection and check their consistency and logical consistency of individual connections. Analyzing a medical data related to the case (medical records, medical history, various laboratory analysis, ultrasound, x-ray, NMR), Watson finds the key terms and check their connections to other concepts found and perform pairing indicators and symptoms and then builds a hypothesis that will continue to check. It is important to note that Watson has the option of fine tuning depths of Search and management required level of reliability which is crucial to system

performance and enables physicians to communicate Watson Search that the levels should skip / stop (since they are already passed or are extremely small probability). Watson interactive process assists in guiding the diagnostic process, and suggests ways of treatment on the basis of the recommended medical practice and expertise. Closer said Watson serves as the aggregator of information on patient synthesizing short synopsis for doctors who carry out review and formulate medical history patient with recommendations for further treatment based on evidence collected in knowledge bases.

V. PROJECT CAREPLEX – EXAMPLE USAGE IBM WATSON AI IN PRACTICE

The project, titled "CarePlex" is the result of cooperation between IBM and the Boston Children's Hospital with a view to putting Watson Web AI service in the process of providing health services (Rhodin and Cerutti, 2014). Over time, this project has evolved and today represents a community of medical professionals around the world who use the Web Watson AI services as a platform for the practice of medical practice. The project supports CarePlex groups up to 8 user (doctor) stationed anywhere in the world at the same time working on a specific case. The main way CarePlex contributes to more successful medical treatment is its direct relationship with Watson AI services (Rhodin, 2014). CarePlex Web applications, enables physicians to use a knowledge base and information publicly available histories submit medical documentation Watson, and then through the development of dialogue with Watson, and place the diagnosis, recommended treatment method, aggregate and relevant medical history. The system is dynamic and involves the introduction of medical records, personal medical observations and observations followed by Watson recognizes patterns and forms reports and summary synopsis (Rhodin, 2014).

Use CarePlex system is similar to the use of Watson analytics service, and consists of the following basic steps: preparation of data (transfer from the hospital information system or from medical reports and board of patient), upload whereby Watson automatically examine data consistency; Creating a model that ranks the likelihood of possible diagnoses, then waiting for the next question in a dialogue, in which the dialogue is repeated until the time of diagnosis with which the physician or a panel of doctors disagree completely (Rhodin, 2014). In addition to these advantages, it is necessary to further emphasize that CarePlex Stem possible to overcome the lack of practice in small communities because the system will contact you for your opinion and physicians are available and are active in different geographic areas. Thanks to its concept of openness and public access CarePlex offers educational opportunities and can be the basis for the curriculum of any medical educational institutions. In addition to these, there are numerous web tools AI used in medicine, of which the most popular chatbot and personal assistants like Microsoft Miranda or Apple Siri as well as tools for interactive learning. Tools for learning and later professional training appeared nearly 20 years ago, but have only recently become upotrebnom AI suitable for use.

VI. PROBLEMS AND LIMITATIONS OF APPLICATION AI IN THE HEALTHCARE SECTOR

Profesor Stephen Hawking says the primitive forms of artificial intelligence developed so far have already proved very useful, but he fears the consequences of creating something that can match or surpass humans (Cellan-Jones, 2014). Professor Hawking, and billionaire CEO of Tesla Motors, Elon Musk, officially call to scientists around the world to actively explore a number of options, and the potential hazards that could develop AI had to humanity (Cellan-Jones, 2014). With them agrees Bill Gates who said that we will use AI initially be of great help, but it will give us time to inflict huge headache (Dredge, 2015). In addition to these dangers accelerated development of AI advocates cautious use of artificial intelligence emphasize that it is necessary to differentiate between legal and moral level. Of particular importance to take into consideration all technological, legal, and ethical and moral principles, especially in future times when they brought laws that would more closely control the use of AI in all sectors of human activity, and thus in the health care sector. Despite the indisputable high efficiency and expert levels, crucial for the development and wider use of AI in the public domain, is mentioned and reliability of service. The main reasons, in the opinion of many advocates of prudent use of artificial, which affect the slower development and wider application of AI and that which are numerous, but mainly can be divided into the following groups:

- Fear of job loss, privilege, social position which arises from the knowledge that AI incomparably better and more efficiently perform the job they have been doing;
- Fear of AI based primarily on cultural patterns borrowed from popular culture, media speculation and speculation of all those existing situation suits;
- Fear of dealing with errors that have occurred during previous decision-making process, or the fear of taking responsibility for specific activities undertaken and penalties in this case could be implemented;

In addition to these social and legal constraints wider application of AI, there are a number of technical limitations wider application of AI in the health care of which the following stand out as the most important (Siegel, 2012):

- As the main obstacle to wider application of AI in the field of healthcare is the unavailability of valid data. Only 2 to 3% of the total number of collected data ensure patients, their current state of health as well as medical history, and indeed it is included in some of the clinical trials.
- Another problem relates to the transfer of medical records to electronic form. The biggest problem about the transfer of medical records to electronic form is tied to a way of implementation because in most cases a "photocopy" paper documentation that is unreadable machine learning agents;
- The next limiting factor is related to an unfavorable distribution (sharing) of data. Namely, a large number of research institutions that have decorated and structured information from certain areas do not want to distribute or share data with agents that possess artificial intelligence. In many cases, the data are considered private property patient, but in a number of cases and ensure patients when given consent to the distribution of personal medical data for scientific purposes, hospitals or other clinical research institutions still do not want to share the information collected;
- Fear of disclosure "of buried" errors that would make greater use of AI become visible;
- Unregulated information, diversity of information systems and nomenclature. No existing meta data, index and non-standardized database and data source;
- The reluctance of the IT infrastructure that AI-based Web Agent provide and allow access to data
- Fear of the development and application of new technologies.

VII. CONCLUSION

Various types of artificial intelligence have the ability to access and use unstructured data and thus provides numerous advantages for professionals in various fields and particularly in the sector of health care. This is precisely the reason why many prominent authors in this field agree that in the near future there will be drastčinog rasata use different forms of AI, especially the use of IBM Watson, primarily due to the ability to achieve the potential of the various so far unknown ways (Margolis, 2013). Specifically speaking IBM Watson in the future could cross the path of development of the things that is interesting in itself to something which is integrated into many more (Rhodin, 2014a). Analogously to the previous finding, an example which highlights that the AI could become a basic cognitive engine Internet of Things (IoT), as well as the democratization of expert knowledge (Ilić and Marković, 2015, pp.412-415), or reaching their full potential with a more equal distribution of specific medical knowledge pedestrian traffic bearing for achieving the maximum possible level of health protection of every citizen of the world. For this to happen to start AI has to "win" the experts in many fields, especially in the fields of application of highly specialized knowledge (Ilić and Marković, 2015, pp.412-415). That this process has already begun are obvious in the statement the best-known financial adviser Ric Edelman, who presented the data that large financial houses already released a number of employees and replace them IBM Watson AI services or some other form of peripheral, AI (Edelman and Diamandis, 2014). Ric Edelman also noted that the above trend replace advisers AI continued and intensified, the relationship will become more common as they matured a new generation of entrepreneurs (Edelman and Diamandis, 2014). According to some preliminary estimates, it is anticipated that the process of transition from human experts in AI largely implemented over the next 3-5 years (Ilić and Marković, 2015, pp.412-415), while the process of transition in health care last much longer. The increasing use of artificial intelligence in health care can be achieved a number of advantages and that:

- Cost reduction;
- Improving efficiency;
- Reduction of the necessary time needed to ask the right diagnosis and to provide adequate health care or treatment of the patient;
- Improving the efficiency of knowledge transfer to other levels of health care;

Reduction and elimination of defects doctors and other medical and non-medical staff in the process of providing health care.

Today there are several different systems for implementing AI in health care, but IBM with its Watson and Cognos Web Services AI went furthest in real convergence of artificial intelligence to end-users and mass application in healthcare. CarePlex platform based on IBM Watson proved to be reliable and applicable even in an environment where English is not their native (first) language.

Although we have already noted, it is necessary to once again point out that in view of the AI becomes more effective if more people use it, clearly leads to the conclusion that both its capabilities and application possibilities grow exponentially over time. The widespread belief today is that the wider application of artificial intelligence to come when mature new generation - to which this technology will not be invasive, but common

and to which will form the basis of their life in the way that today makes us mobile telephony. However, the authors hope to do these paradigm shifts come earlier because wider use of artificial intelligence leads to an increase in its knitivnih capabilities. It is in this conclusion is the greatest advantage of AI, because all the "knowledge" that Watson IBM, Cognos, CorePlex or some other form of AI gain on one area, it is very simple, efficient and almost in real time applied in another field. Early acceptance of introducing artificial intelligence in the sphere of health care will be covered not only significant savings and established a high efficient system of health care, but to create a predisposition for faster and more efficient development of health care services which would ultimately lead to a healthier population sopsobnoj to face and cope with the challenges of modern society.

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Author's Note:

This work was translated into English using Google artificial intelligence, during this process, the agent of artificial intelligence is used module for supervised machine learning