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Artificial intelligence—Developments in medicine in the last two years

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Dear Editor,

Artificial intelligence (AI) is the theory and development of computer systems that are able to perform tasks that normally require human intelligence, such as visual perception, speech recognition, decision-making, and translation between languages. There are some knowledge and thinking tasks that humans cannot perform as perfectly as they wish to or should be able to. These tasks are closely related to security and responsibility. A multitude of cognitive distortions have been well explored[1] and present opportunities to use AI for powerful assistance in thinking tasks. The core of the Industrial Revolution 4.0 is the adoption of AI methods. This revolution has affected all aspects of human activities and medicine is one example.

AI systems can usually include formal algorithms for subtasks that can be solved using logic, for example, a decision tree. The task solution process moves from logic point to logic point similar to a train on a railway. These algorithms are fast and have the ability to explain. One of the most common is well described in the publication of Fei Jiang et al.[2] in 2017, which divides AI features into language processing and machine learning tasks. In conjunction with his colleagues, he published different algorithms in the Pubmed database and found that the most frequently used are support vector machines, neural networks, logistic regression, discriminant analysis, random forest, linear regression, naïve bayes, nearest neighbor, decision tree, and hidden Markov.

The goal of this study was to show qualitative change to AI development that has occurred over the last two years by examining the trends in Pubmed publications, including dynamics interest in AI topic, dynamics of non-English language publications, and implementations of AI in modern practice. The literature for this research included books related to the topic, included *Goodfellow's Deep Learning*[3] and a *Deep Learning in R*.[4] We also used Google patent search, specialized journal "Artificial intelligence" articles, and the Pubmed database.

All abstracts with keyword "artificial intelligence" have been downloaded to txt files from the Pubmed database https://www.ncbi.nlm.nih.gov/pubmed/. Microsoft Access Visual Basic program was used to import these abstracts into the database. We then performed machine analysis of the dataset. The dataset includes names of all authors, all Mesh tags, year, language, and all words from the title and abstract. This information was extracted to tables, which were linked to the table of abstracts using a unique key. All non-informative words were marked as non-informative, and then the remaining keywords were grouped with generalizing words. We classified the present applications of AI in medicine by generalizing topics. We then

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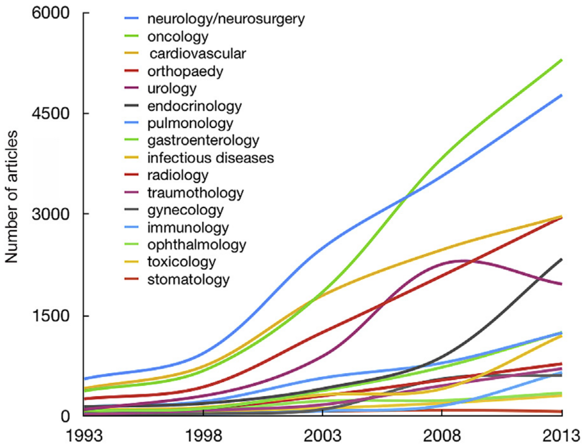

Fig. 1. Interest in artificial intelligence in different medicine fields.

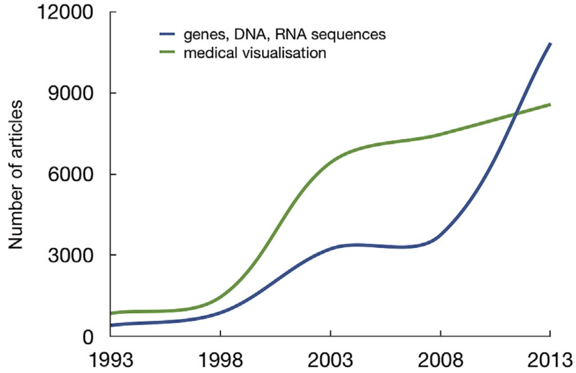

Fig. 2. Most frequent tasks performed with artificial intelligence.

made structured query language (SQL) queries to make frequency tables. Using this research, we classified the AI technologies.

A total of 78,420 abstracts were extracted, including 30,835 journal articles, 37,332 research supports, 5558 reviews, 304 randomized controlled trials, 247 multicenter studies, and 4137 other publication types. We observed that the exponential growth of interest in AI solutions slowed down in middle of 2010. This followed the typical phenomenon of "S"-like development of innovation curves. It illustrates effectiveness of old technology and predicts the stagnation or a new stage of development.[5]

English was the most often used language in publication, followed by Chinese and then German. Non-English publications decreased over the last five years, especially Chinese publications.

Fig. 1 shows that around 2010, interest to AI in oncology accelerated. The main reason was the development of medical visualization AI. It was mostly targeted to recognize tumors on images and the genome (Fig. 2).

From this dataset, 809,451 Mesh tags were extracted from the abstracts of 77,964 articles that had Mesh tags in the abstracts. Mesh tags were grouped and added to the united table of grouped keywords. Then the typical applications were classified (Table 1). Poole D[6] marked out AI agent subclasses that could be a coupling of a computational engine with physical actuators and sensors, called a robot. Examples include autonomous delivery robots or cleaning robots. It could also be the coupling of an advice-giving computer, an expert system, with a human who provides the perceptual information and who carries out the task, for example, a diagnostic assistant. An agent could also be a program that acts in a purely computational environment, an infobot. An "infobot" could search for information on a computer system for naïve users such as company managers.

In particular, deep learning has achieved breakthroughs in historically difficult areas of machine learning, such as near-human-level image classification, near-human-level speech recognition, digital assistants such as Google Now and Amazon Alexa, near-human-level autonomous driving, improved search results on the Web, ability to answer natural language questions, and superhuman Go playing.[4]

Table 1
Application of artificial intelligence in clinical medicine.

Classification	Description
Management and optimization	Co-occurrence graphs[7]
	Medical treatment process clustering
	Detecting inconsistencies in clinical guidelines[8]
	Marketing (e.g. trust for medical center investigation[9])
	Data mining
	Registration
	Planning

(continued on next page)

Table 1 (*continued*)

Classification	Description
Signal analysis, encoding, decoding	Tactile sense[10]
	Kinesthetic sense[11]
	Taste sense[12]
	Image analysis (e.g. auto-contouring,[13] segmentation of corneal endothelium,[14] histopathological image cancer identification[15])
	Sound analysis (e.g. lung sound classification)
	Smell analysis (e.g. the predictions for ethanol and ethylene concentrations,[16] electronic nose,[17] breath analysis[18,19])
Detection, identification	Epidemiology (e.g. identifying thalassemia carriers[20])
Prediction, prognosis, modeling, simulation, mapping	Risk modeling (e.g. drug reaction assessment, cancer risk[21])
	Disease modeling (e.g. connections of brain regions in children with autism[22])
Classification, clustering, segmentation	
Monitoring and control	Telemedicine[23]
Text analysis and language processing	Speech intentions from online conversation[24]
	Medical text semantics[25]
	Statistics from death certificates[26]
	Automatic classification of radiological reports[27]
	Classification of multilingual biomedical documents[28]
	Relation classification in medical records[23]
	Natural language processing tasks (e.g. summarization, text classification, relation extraction)
Devices and gadgets	Internet of Health Things (IoHT)[29]
	Smart home and early anomaly detection in elderly[30]
	Portable devices and mobile applications
Decision support and expert systems	Retinopathy by arteriovenous ratio[31]
	Coronary bypass surgery vs coronary stenting[32]
Diagnostics	Diagnostic labeling[33]
	Diagnosis by pattern recognition[34]
	Fatigue by eye tracking[35] >
	Correlations between diseases
	Early anomaly detection in behavior[30]
	Early indicators of Parkinson's disease progression[36]
Treatment	Therapy (e.g. automatic anesthesia[37])
	Surgery (e.g. robotic, remebot, a navigation and orientation robot used for neurosurgery[38])
	Rehabilitation (e.g. prosthesis)
Automatization of tasks above	

The first is the instruments and tools for AI development. AI tools are not currently considered bizarre instruments of future, but available fast algorithms, such are Tensor Flow (https://tensorflow.rstudio.com/) or Keras. Both were released in 2015 and are open source and free. In 2017, Apple introduced CoreML in its Xcode platform with Core ML developer, which can integrate trained machine learning models into the application.[39] Apple has also already developed the framework for Vision, which analyzes images, and Natural Language for natural language processing.

On April 11, 2018, IDx-DR became the first device authorized for marketing that provided a screening decision without the need for a clinician to also interpret the image or results, which made it usable by health care providers who might not normally be involved in eye care.[40] On February 13, 2018, the Food and Drug Administration (FDA) permitted marketing of clinical decision support software for alerting providers of a potential stroke in patients.[41] OsteoDetect software, a computer-aided detection and diagnostic software, uses an AI algorithm to analyze two-dimensional X-ray images for signs of distal radius fracture, a common type of wrist fracture. The software marks the location of the fracture in the image to aid the provider in detection and diagnosis. It was approved by FDA on May 24, 2018.[42]

Interest in the AI topic in the Pubmed library indexed publications is increasing according to the law of innovation development. The number of non-English publications increased until 2018, with English publications being the most common, followed by Chinese, German, and French. After 2018, the number of non-English publications decreased in favor of English publications.

Examples of AI implementation in modern practice are now available to more people than just mathematics professionals. Tools for machine learning are widely available to more mainstream scientists. For example, a scientist can download the R statistic language that is an open source and free from the Comprehensive R Archive Network (CRAN) project site and connect the TensorFlow and Keras libraries, which are free to download as well. There are good books explaining how to start,[4] which can easily be found. There are a lot of local registries in any regional hospital that are available and can be used for machine learning decision support.[32]

FDA-approved tools have become available. This is another change that applies not only to the scientists but also to clinical practitioners as well. They were approved mainly for medical image analysis and demonstrated comparable accuracy to human specialists.

The most fantastic possible use of AI in medicine would be the transfer of a mind from an ill and mortal human body to the upgradable, connectable, and easy-to-fix machine body by scanning parameters of neurons and synapses and then replicating them in the AI machine. There are relationships between carbon, which makes up a portion of the human body, and silicon, which could be used for this application. They are in one column and must have similar characteristics in the Mendeleev periodic table. So next period "silicon life" may be an upgrade to a new life cyborg-form type.

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