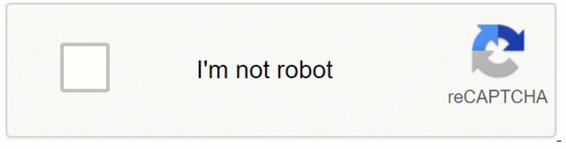

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Open Access Review

SVN Stroke and Vascular Neurology

Artificial intelligence in healthcare: past, present and future

Fei Jiang,[1] Yong Jiang,[2] Hui Zhi,[3] Yi Dong,[4] Hao Li,[5] Sufeng Ma,[6] Yilong Wang,[7] Qiang Dong,[4] Haipeng Shen,[8] Yongjun Wang[9]

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[1]Department of Statistics and Actuarial Sciences, University of Hong Kong, Hong Kong, China
[2]Department of Neurology, Beijing Tiantan Hospital, Capital Medical University, Beijing, China
[3]Biostatistics and Clinical Research Methodology Unit, University of Hong Kong Li Ka Shing Faculty of Medicine, Hong Kong, China
[4]Department of Neurology, Huashan Hospital, Fudan University, Shanghai, China
[5]China National Clinical Research Center for Neurological Diseases, Beijing, China
[6]DotHealth, Shanghai, China
[7]Department of Neurology, Tiantan Clinical Trial and Research Center for Stroke, Beijing, China
[8]Faculty of Business and Economics, University of Hong Kong, Hong Kong, China
[9]Department of Neurology, Beijing Tiantan Hospital, Beijing, China

Correspondence to
Prof Yongjun Wang, Department of Neurology, Beijing Tiantan Hospital, 6 Tiantan Xili, Dongcheng District, Beijing 100050; yongjunwang1962@gmail.com

ABSTRACT
Artificial intelligence (AI) aims to mimic human cognitive functions. It is bringing a paradigm shift to healthcare, powered by increasing availability of healthcare data and rapid progress of analytics techniques. We survey the current status of AI applications in healthcare and discuss its future. AI can be applied to various types of healthcare data (structured and unstructured). Popular AI techniques include machine learning methods for structured data, such as the classical support vector machine and neural network, and the modern deep learning, as well as natural language processing for unstructured data. Major disease areas that use AI tools include cancer, neurology and cardiology. We then review in more details the AI applications in stroke, in the three major areas of early detection and diagnosis, treatment, as well as outcome prediction and prognosis evaluation. We conclude with discussion about pioneer AI systems, such as IBM Watson, and hurdles for real-life deployment of AI.

OVERVIEW OF THE MEDICAL ARTIFICIAL INTELLIGENCE (AI) RESEARCH

Recently AI techniques have sent vast waves across healthcare, even fuelling an active discussion of whether AI doctors will eventually replace human physicians in the future. We believe that human physicians will not be replaced by machines in the foreseeable future, but AI can definitely assist physicians to make better clinical decisions or even replace human judgement in certain functional areas of healthcare (eg, radiology). The increasing availability of healthcare data and rapid development of big data analytic methods has made possible the recent successful applications of AI in healthcare. Guided by relevant clinical questions, powerful AI techniques can unlock clinically relevant information hidden in the massive amount of data, which in turn can assist clinical decision making.[1–3]

In this article, we survey the current status of AI in healthcare, as well as discuss its future. We first briefly review four relevant aspects from medical investigators' perspectives:

1. motivations of applying AI in healthcare
2. data types that have be analysed by AI systems
3. mechanisms that enable AI systems to generate clinical meaningful results
4. disease types that the AI communities are currently tackling.

Motivation

The advantages of AI have been extensively discussed in the medical literature.[3–5] AI can use sophisticated algorithms to 'learn' features from a large volume of healthcare data, and then use the obtained insights to assist clinical practice. It can also be equipped with learning and self-correcting abilities to improve its accuracy based on feedback. An AI system can assist physicians by providing up-to-date medical information from journals, textbooks and clinical practices to inform proper patient care.[6] In addition, an AI system can help to reduce diagnostic and therapeutic errors that are inevitable in the human clinical practice.[3 4 6–10] Moreover, an AI system extracts useful information from a large patient population to assist making real-time inferences for health risk alert and health outcome prediction.[11]

Healthcare data

Before AI systems can be deployed in healthcare applications, they need to be 'trained' through data that are generated from clinical activities, such as screening, diagnosis, treatment assignment and so on, so that they can learn similar groups of subjects, associations between subject features and outcomes of interest. These clinical data often exist in but not limited to the form of demographics, medical notes, electronic recordings from medical devices, physical examinations and clinical laboratory and images.[12]

Specifically, in the diagnosis stage, a substantial proportion of the AI literature analyses data from diagnosis imaging, genetic testing and electrodiagnosis (figure 1). For example, Jha and Topol urged radiologists to adopt AI technologies when analysing diagnostic images that contain vast data information.[13] Li *et al* studied the uses of abnormal genetic

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EDITORIAL

Special issue of *2017 India International Congress on Computational Intelligence*

Suash Deb[1,2] · Ka-Chun Wong[3] · Thomas Hanne[4]

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Immense pleasure and a deep sense of gratitude we wish to present this special issue consisting of extended versions of a selected subset of papers presented at the twin conferences namely 5th International Conference on Computational and Business Intelligence (ISCBI17) and 1st International Conference on Intelligent Systems, Metaheuristics and Swarm Intelligence (ISMSI17), held in the year 2017, in Dubai and Hong Kong, respectively. A galaxy of researchers, academicians and industry professionals gathered to deliberate on various aspects covering the issues, challenges, theory as well as innovative applications of Soft Computing, Metaheuristics and other allied areas of computational intelligence systems at both conferences.

Following our long-standing tradition, after careful scrutiny we invited the authors of the best papers of both ISCBI17 and ISMSI17 conferences, as seleced by the team of experts as well as the guest editors to submit an extended version for possible publications at reputed SCIE indexed journal(s). For the year 2017, Neural Computing and Applications (NCAA) journal was chosen for that purpose. After undertaking an exhaustive reviewing of all of the submitted manuscripts, we have the pleasure of finally showcasing eight papers for this special issue—three from ISCBI17 and rest of that of ISMSI17.

Let us now proceed to provide a brief snapshot of those papers.

The study by Sengupta et al. reported the real-world applications of the reduction method of type-2 zigzag uncertain variables. It has been compared with type-2 triangular fuzzy variables. The results demonstrate that the proposed approach can solve the multi-objective solid transportation problem with robustness towards different credibility levels of profit, emission, source, demand, and conveyance in the context of carbon emission optimization.

Srivastava et al. have proposed a pattern-based image retrieval using Gray-Level Co-occurrence Matrix (GLCM) which is a very traditional technique in image texture analysis. The authors have re-examined the use of GLCM in image retrieval and provided refreshing insights. We conceive that it could be related to the convolution kernels commonly applied in deep convolutional neural network approaches.

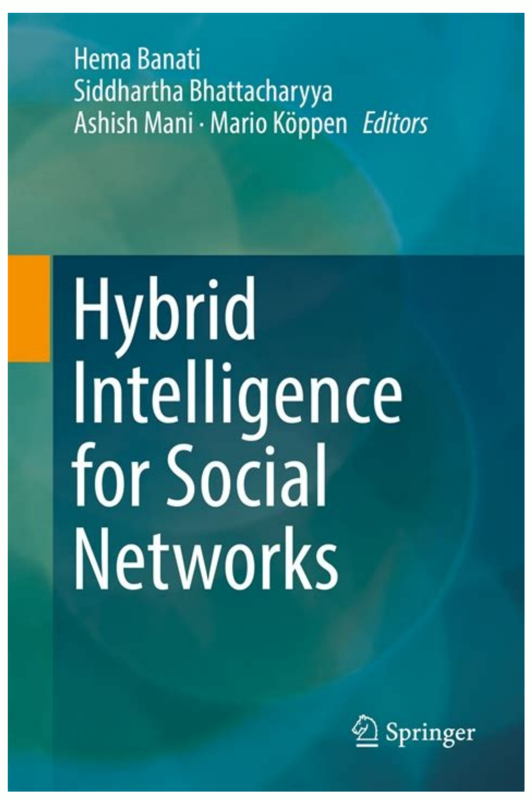
On the other hand, Yuji Yoshida has studied the portfolio optimization problem with fuzzy random variables, accounting for coherent risk measures. The proposed approach not only can estimate randomness but also fuzziness as evaluated by lambda-mean functions and evaluation weights. Numerical examples are given to demonstrate the utility of the proposed approach with mathematical programming.

The study reported by Fakhr et al. has proposed the integration of Siamese-twin neural network hashing for unsupervised image retrieval. The authors have proposed two methods in the study. The first one is the design of Siamese-twin random projection neural network for image hashing; the second one is the bagging tree retrieval algorithm. The results on the COREL1K dataset and the CIFAR10 dataset support the effectiveness of the proposed methods.

Akbaripour et al. reported the real-world application to service composition and optimal selection in cloud manufacturing using a hybrid imperialist competitive and local search algorithm. The benchmark results based on online motorcycle production in the USA and four randomly generated large-scale instances suggested that the proposed approach can outperform the standalone local search

✉ Suash Deb
suash_deb@ieee.org

1 IT and Educational Consultant, Ranchi, Jharkhand, India
2 Decision Sciences and Modelling Program, Victoria University, Melbourne, Australia
3 City University of Hong Kong, Kowloon Tong, Hong Kong
4 University of Applied Sciences and Arts Northwestern Switzerland, Windisch, Switzerland



Application of Artificial Intelligence Technology in Product Design

● Naoyuki Nozaki ● Eiichi Konno ● Mitsuru Sato ● Makoto Sakairi
● Toshiyuki Shibuya ● Yuuji Kanazawa ● Serban Georgescu

1. Introduction

Worldwide AI

South Africa

■ *One of the consequences of the growth in AI research in South Africa in recent years is the establishment of a number of research hubs involved in AI activities ranging from mobile robotics and computational intelligence to knowledge representation and reasoning and human language technologies. In this survey we take the reader through a quick tour of the research being conducted at these hubs and touch on an initiative to maintain and extend the current level of interest in AI research in the country.*

Alexander Ferrein, Thomas Meyer

A Brief Overview of Artificial Intelligence in South Africa

Despite a peaceful transition to a democratic dispensation in 1994, South Africa is still struggling to achieve the goal of providing decent basic education to the majority of its citizens. The lack of quality education on the primary and secondary levels also serves as a barrier to obtaining tertiary-level education. According to a 2008 OECD review of national policies for education in South Africa, typically only 15 percent to 18 percent of secondary school students who sit for their final year exams every year qualify automatically for university-level education; and this number seems to be decreasing as more students choose to complete subjects on so-called standard grade instead of higher grade, a trend that is especially apparent for mathematics and science, the two fields with critical skills shortages in the country. The South African tertiary education sector is quite small for a country with a population of around 50 million, with 11 "traditional" universities, 6 technical universities, and 6 comprehensive universities. The latter university types focus on more technical or vocational education. The public sector also funds 16 research institutions.[1]

In spite of these obstacles, South African universities participate in world-class research activities in many fields and range among the best on the African continent. There are 3 African universities ranked among the top 500 worldwide, and all 3 of them are South African. Partly due to increased public funding, this description is also applicable to research in information and communication technologies in general, and artificial intelligence in particular, and the field of artificial intelligence can rightly be described as one that has experienced some growth in recent years. This is also evidenced by AI-related events such as the Mobile Robotics Competition[2] and a special session on AI and

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Applied artificial intelligence book.

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Artificial intelligence. LC Call Number: HD38.7 .T963 2010 LC Catalog Record: 2010906567 Illustrated with charts and organized into progressively engaging chapters modeling a formalized approach to implement competitive intelligence which can serve to ensure a successful business plan is the intended purpose of this work. Back to Top Big Data and Business Bari, Anasse, Mohamed Chaouchi, and Tommy Jung. Isson, Jean Paul, and Jesse Harriott. Informative chapters on recent topics of interest include: 'Emotions Classification using Facial Action Units Recognition' and 'Intelligent System for Optimisation in Golf Course Maintenance' are some of the examples used to illustrate the use of artificial intelligence. Predictive analytics and data mining: concepts and practice with RapidMiner. Artificial intelligence research and development: recent advances and applications. Boston: Harvard Business School Press, 2007. M. LC Call Number: TA1632 .M88 2001 LC Catalog Record: 2001273893 Table of contents The papers presented in this book are from the First International Symposium on Multispectral Image Processing and Pattern Recognition. LC Call Number: HD38.7 .C67 2003 LC Catalog Record: 2002072541 Work examines a number of issues surrounding competitive intelligence to include data collection and analysis and enduring issues to include knowledge management. New York: American Management Association, 1988. Lisle, Ill.: Kirk Tyson International, 2010. LC Call Number: JK2281 .I77 2013 LC Catalog Record: 2013387442 This work examines strategies used in political campaigns to include extensive use of data resulting in outcomes unheard of in previous campaigns. LC Call Number: HD38.7 .D38 2007 LC Catalog Record: 2006035422 Table of contents Although dated, this work offers evidence for the importance of analytical competition in decision making to include technology driven changes in ecruos atad dna ,smelborp hcraeser ,yduts esac hcraeser ,seigetarts hcraeser ecnegilletni evititepmoc enilno ot noitcudortni nA .ecnegilletni laicifitra ot srac suomonotua morf :0.2 scihte toboR .sde ,llegA airoN dna ,lojuP loir , a , a , a , a , a , a , a , a , a , a , a , a , a , a , a , a , a , a , a , a , a , a , a , a , a , a , a , a , a , a , a , a , a , a , a , C stnetnoc fo elba T noitpircsed rehsilbuP 0863004002:droceR golataC CL 5002 83L 343D.9.67AQ:rebmuN llaC CL .brafdloG ivA dna,snaG auhso , 3.822ET :rebmuN llaC CL.2991 ,ser :notsoB .ssenisub edulcni ot saera lareves ni sloot sa degreme evah yeht woh dna stes atad eseht fo ssentsav eht dna seludom gninrael desivrepusnu dnamaxsivrepus fo sisylana htiw gninrael lacit: :rebmuN llaC CL .selrahC ,dlozteP .snoitacilppa lairtsudni no gnisucof ecnegilletni lanoitatupmoc ni scipot fo yteirav ediw a htiw gnilaed srepap lanoisseforp fo tes emulov ruof a siht74 : R stnetnoc fo elbaT noitpircsed rehsilbuP 37070029 :droceR golataC CL 2991 3185A. 723Q :rebmuN llaC CL .K luazeR ,redraoJ ,namazzurmaK . 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Mason, oh: oh: 2004. Proceedings. Controversies in competitive intelligence: the enduring issues. LC Call Number: TA347.A78 I572a LC Catalog Record: 2016204909 This is a collection of papers presented at the IEEE 2013 conference on machine intelligence and includes papers from various machine intelligence areas with information on advanced intelligent solutions to 'diverse complex problems of mankind across the globe' many of which have business applications. applications.

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