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Deep Learning for Medical Decision Support Systems

 Springer

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Foreword by Dr. Deepak Gupta

Artificial intelligence is briefly an engineering perspective for designing and developing flexible and robust solutions, which can be widely applied to real-world-related problems. As associated with many remarkable technologies such as computer, communication, and electronics, outputs of the field of artificial intelligence has already been seen in different areas at the start of the twenty-first century. Now, it can be seen that the use of artificial intelligence is in its way to be a common thing used widely by people during daily life. That is because innovative devices gained great rise as a result of more increases in need for using, changing and changing the information even instantly worldwide. By the way, effective advantages of artificial intelligence-based methods and techniques for automated decision-making have been taking researchers' interests for a very long time, as taking us back to even starting times of the artificial intelligence. It seems that the decision support will be one of the most critical roles of artificial intelligence-based systems of the future because more intense digital data requires automated analysis and evaluation phases as it may take time and be very difficult for humans to make that even without errors. Because of that we can see active uses of decision support systems in both natural and social sciences, and the field of medical is among them as it includes decision-making phases during symptom analyzes, diagnosis, and treatment.

It is a pleasure for me to write a foreword for this book as it includes recent achievements and skills–knowledge combination in the context of deep learning and medical decision support systems. As the current, more advanced form of the machine learning, the deep learning is a wide collection of neural networks currently, and it is applied with improved success rates in problems of medical. Thanks to its relation with especially data processing techniques; it has been even easier and faster to get better, more accurate and effective outcomes for the medical applications. In that context, this book takes readers from brief introduction to the essential concepts, and then goes with diagnosis-related different applications including uses of different deep learning techniques as well as different diseases in the target. It is good to see that all subjects covered in the book are explained in enough technical details and giving further information about what can be learned and how to

proceed next. The chapters also generally get combinations of deep learning and data processing to ensure automated diagnosis so that medical decision supports accordingly. I suggest the readers to have a start from Chap. 1, and then read the Chaps. 2–9 for better learning about skills for performing alternative research. I liked also that the final Chap. 10 have a final discussion about future perspectives for the future of medical decision support systems and also give a scenario for using current and future technologies for tracking and controlling pandemics, as it is very critical because the world and the existence of the human is nowadays under the attack by the COVID-19, which is a fatal virus type.

I suggest the book to be used during the courses regarding the fields of computer science/engineering, medical and biomedical engineering, and also it will be a good reference for the data science-oriented courses, too. The level of technical details and the used language is all appropriate for the students at the level of B.Sc., M.Sc., Ph.D., and also post-docs. I take interests the readers to also suggestions made by the authors at the end of each chapter, in order to continue improving their knowledge.

I would like to thank Dr. Utku Kose and his co-authors Dr. Omer Deperlioglu, Dr. Jafar Alzubi, and Dr. Bogdan Patrut for their valuable work and also wish the readers to have enjoyable learning as well as research experiences with the support of that book.

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Foreword by Dr. Jose Antonio Marmolejo-Saucedo and Dr. Igor Litvinchev

Recent advances in information technologies result in evolution of decision support systems involving various techniques for analyses and handling big data. These systems are applied in a broad range of disciplines, e.g., in administration, engineering, and health systems.

In the field of medical informatics, designing and developing tools to support decision-making were highly motivated by advances in biometrics. Among different applications in health systems, medical diagnostics is especially important. Diagnostics is often challenging since many signs and symptoms are hidden and nonspecific. To cope with this problem, a correlation of the information must be analyzed, combined with recognition and differentiation of patterns. Algorithms for data analysis are among various techniques used in diagnostic procedures. Among them, neural networks and deep learning approaches play an important role. In medical diagnostics, the deep learning frequently provides more robust results comparing with the artificial neural networks. The deep learning techniques were successfully used for cancer diagnostics. Many other fields of medicine are also open for high-level decision support systems that can diagnose and treat better than humans.

In this book, different medical data handling techniques are used to develop medical decision support systems in the context of diagnosis perspective. The objective is to use all available information in the decision-making to improve the quality of medical care and to help less experienced doctors in diagnostics.

Challenges and problems associated with implementations of medical decision support systems are discussed, as well as strategies for their development and validation. The book describes theoretical foundations used for developing decision support systems. Basic information on medical diagnostics in different situations is also presented. Finally, perspectives of medical decision support systems are discussed and related with that of the progress in artificial intelligence, deep learning, and modern innovative technologies such as Internet of Health Things.

Today, epidemics like COVID-19 have tested the ability of health systems to meet the new challenges. This book provides a valuable impact in the developing medical decision support systems and with this in obtaining better solutions for the future.

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Preface

Deep learning is currently the biggest problem solution way and the technology side of the field of artificial intelligence. As a result of increased uses of digital world and the digital data created with the tasks done in that world, it has been a great necessity to run more advanced form of machine learning. Thus, the concept of deep learning has been designed in order to define advanced forms of neural networks, which is the most successful technique of machine learning. Maybe, the future will bring us different techniques of deep learning, as out of the neural network modeling approach, but it is clear that the deep learning has a remarkable popularity nowadays, and it seems that it will be still widely applied in competitive problems in the future.

There are many different fields where artificial intelligence and the deep learning are intensively used. Main purposes of uses are generally related to improvements/increases in terms of successful outcomes, effectiveness, efficiency, and further technological developments. As in the context of these purposes, the field of medical is one of the most critical fields where artificial intelligence and deep learning are used. From pre-analyses of medical data to diagnosis, from diagnosis to the whole treatment phases, it is possible to see wide employments of intelligent systems in order to reach to the desired results at the end. As we have already given emphasis to the deep learning, it can be clearly said that deep learning techniques—architectures are effectively used nowadays for dealing with medical problems. By gathering all of the applications in one hand, we can also indicate that the decision support approach has the highest priority in the context of performed research works.

By combining deep learning and medical decision support systems together, we introduce our book study: *Deep Learning for Medical Decision Support Systems*, to the readers' valuable consideration. We have combined essentials of the main topics, direct explanations for the uses of deep learning solutions in the view of diagnosis, and eventually tried our best to get a good reference book, which can be used by scientist, experts, students in different degrees, and of course anyone

interested to get informed about the covered topics and the most recent state of the associated literature in terms of medical diagnosis processes to ensure the medical support.

We can explain briefly the covered topics in each of the next chapters as follows:

Chapter 1 makes a fresh start to the book by explaining some about artificial intelligence and its role in development of decision support systems. The chapter finalizes its discussion by making connection to the deep learning.

Chapter 2 gives a deep explanation regarding essentials of the widely used deep learning architectures such as convolutional neural network (CNN), recurrent neural network (RNN), autoencoder network (AEN), deep neural network (DNN), and the deep belief network (DBF) as used in the context of medical diagnosis.

Chapter 3 takes the explanations in the previous chapter one-step away and focuses on some recent and remarkable applications of the deep learning architectures—methods used in medical diagnostics for common areas.

Chapter 4 explains a diagnosis approach for the diabetic retinopathy with a deep learning method by using image processing over the colorful retinal fundus images from the Messidor Database and also apply of the convolutional neural network (CNN).

Chapter 5 investigates the diagnosis of Parkinson's disease with a deep learning approach by using the data obtained from the dataset of the Oxford Parkinson Diagnosis, as in the form of sound data.

Chapter 6 focuses on the detection of heart diseases using the Cleveland Heart Disease data set and use of the autoencoder network (AEN) for diagnosis so that it can be shown that the classification success can be increased easily by using AEN without any feature selection process or mixed methods.

Chapter 7 introduces a hybrid system for medical diagnosis. In this sense, a swarm intelligence supported autoencoder-based recurrent neural network (ARNN) has been explained for ensuring a flexible multi-diagnosis system called as SIARNN briefly.

Chapter 8 explains a use of long short-term memory (LSTM) model and facial expression detection approach for ensuring a psychological personal support system, which can perform some analyzes with question–answer period or image-viewing sessions, to get some idea about emotional changes shown by the target person.

Chapter 9 revisits the diagnosis of diabetic retinopathy, and that time, it explains the use of image processing and the Capsule Network (CapsNet), which is a recent deep learning technique, for ensuring effective diagnosis at the end.

Chapter 10 concludes the book by analyzing future perspective of the medical decision support systems by evaluating progress of artificial intelligence, deep learning, and discussing about future components such as Internet of Health Things (IoHT), wearable technologies, robotics, drug discovery, rare disease/cancer diagnosis. The chapter also gives a future scenario perspective against the current world-wide problem: COVID-19 virus and pandemic control in general (We hope that will be a helpful contribution for fighting against the COVID-19).

Now we invite all readers to turn the pages for getting a wide, recent view on the world of deep learning and its applications on diagnosis-related works to achieve medical decision support eventually. Ideas and valuable feedback from readers are always welcome, and we hope you will all like reading the next chapters. We also would like to thank to Profs. Gupta, Marmolejo-Saucedo, and Litvinchev for their kind and valuable forewords.

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About This Book

Artificial intelligence is currently used within all fields of the modern life, and especially machine learning has a great popularity since it includes techniques that are capable of learning from samples to solve newly encountered cases. Nowadays, a recent form of machine learning: deep learning is widely used over complex, higher amount of data because today's problems require detailed analyses of more data. That is critical for especially fields such as medical. Moving from that, objective of this authored book is to provide essentials and some recent uses about deep learning architectures for medical decision support systems. The book consists of a total of 10 chapters providing recent knowledge regarding introduction to the main topics of the book, different applications of deep learning-oriented diagnosis leading to decision support, and some ideas regarding the future state of the medical decision support systems. The target audience of the book includes scientists, experts, M.Sc. and Ph.D. students, post-docs, and any readers interested in the covered subjects. The book is appropriate to be used as a reference work during the courses of artificial intelligence, machine/deep learning, medical as well as the biomedical.

Utku Kose
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