Preface

For years ever since the early days of AI, researchers have been struggling with the issue of machine generalization — a capability exclusive to humans and an ability to learn inductively from entity to concepts. However, AlphaGo outsmarts the human Go master and shows that it is possible for machines to learn from examples and generalize concepts. Deep learning as a game changer has set an exciting trend in the machine learning domain in recent years. It has achieved great success in many challenging research areas, such as image recognition, audio recognition and natural language processing. The key merit of deep learning is to automatically learn a very good feature representation from massive amounts of data. Nowadays, various sensors are deployed in different scenarios and thus we can easily collect large amounts of data from these sensors. Clearly, this deep learning technology can be a very good candidate for various sensing applications, including activity sensing, remote sensing and medical sensing. Various deep learning algorithms can thus be developed in many real-world scenarios to facilitate impact on practical applications.

The objective of this book is to disseminate inspiring research results and exemplary best practices of deep learning approaches to tackle the technical challenges in various sensing applications. The book will cover the fundamentals of deep learning techniques and their applications in real-world problems including activity sensing, remote sensing and medical sensing. It will demonstrate how different deep learning techniques help to improve the sensing capabilities and enable scientists and practitioners to make insightful observations and invaluable discoveries from data.

Organization of the Book

This book consists of 12 chapters, which are organized into four major parts: Introduction of Deep Learning Algorithms (Part I), Deep Learning for Activity Sensing (Part II), Deep Learning for Remote Sensing (Part III) and Deep Learning for Medical Sensing (Part IV).

Part I is composed of Chapter 1. In Chapter 1, we first briefly introduce various deep learning algorithms for improving sensing capability. We also discuss their advantages and disadvantages for different applications.

Part II is composed of Chapters 2–6 and introduces deep learning for activity sensing. In particular, Chapter 2 presents a new hierarchically aggregated convolutional neural network (CNN) architecture that can more effectively deal with long-term dynamics presented in action videos. In particular, the proposed network takes a long term video as input and exploits temporal information at multiple levels of the network hierarchy capturing more complex dynamics of the input sequence. Chapter 3 proposes to combine domain knowledge and deep learning in order to improve activity recognition models, where the domain knowledge focuses on the topological structure of on-body sensor-deployments and the mutual interactions among the sensors. Chapter 4 introduces how deep learning and unsupervised domain adaptation method further empower WiFi-based sensing. Chapter 5 focuses on how to weaken the accuracy differences among individuals in human activity recognition and improves the robustness in a single indoor environment. Chapter 6 introduces a spatial temporal graph convolutional network (GCN)-based prediction network for skeleton-based video anomaly detection.

Part III is composed of Chapters 7–9 and presents deep learning for remote sensing applications. Particularly, Chapter 7 reviews the current approaches and discusses ways forward to develop new deep learning methods for Earth sciences. Chapter 8 presents an empirical evaluation for built-up area detection from remote sensing images using deep learning methods including double-stream CNN (DSCNN), lightweight multi-branch CNN (LMB-CNN) and fully convolutional networks (FCN). Chapter 9 presents GCN variants by combining GCN with manifold assumptions to exactly acquire the spatial structure information of graph-structured data for remote sensing image recognition. In particular, the GCN variants include two-order GCN, Hypergraph p-Laplacian GCN, manifold regularized dynamic GCN.

Part IV is composed of Chapters 10–12 and focuses on deep learning for medical sensing applications. In particular, Chapter 10 proposes a deep learning-based retinal image non-uniform illumination removal called NuI-Go, which combines the powerful capabilities of CNN with the

characteristics of retinal images with non-uniform illumination. Chapter 11 presents and evaluates deep learning models (e.g., SqueezeNet and GoogLeNet) to classify brain tumor MRI images. In Chapter 12, the deep learning algorithms with long short-term memory (LSTM) and bi-directional LSTM are unitized to recognize dementia-related wandering patterns based on the orientation data available in mobile devices.

In this book, we have introduced deep learning algorithms and their applications to improve the sensing capabilities, including activity sensing, remote sensing and medical sensing. Taking human activity recognition as an example, it is a crucial technology for many real-world human-centric applications, especially in the areas of eldercare, healthcare, smart home, security, pervasive and mobile computing, etc. However, it is a challenging task to achieve very accurate prediction results, due to device heterogeneity, environment changes and difficulties to recognize concurrent activities and group activities. Similarly, for remote sensing and medical sensing applications, they usually require domain knowledge and could also be affected by environment changes. We have thus covered representative latest research outcomes and practices in this book that could be very useful for addressing the challenging research problems in the above sensing applications.

We would like to take this opportunity to thank all the authors who contributed to the exciting and important research topics of developing deep learning approaches for various sensing applications. Our heartfelt thanks also go to our book reviewers who have provided very useful comments and valuable feedback, and to the publishing team at World Scientific for providing invaluable contributions and guidance throughout the whole process from inception of the initial idea to the final publication of this book.