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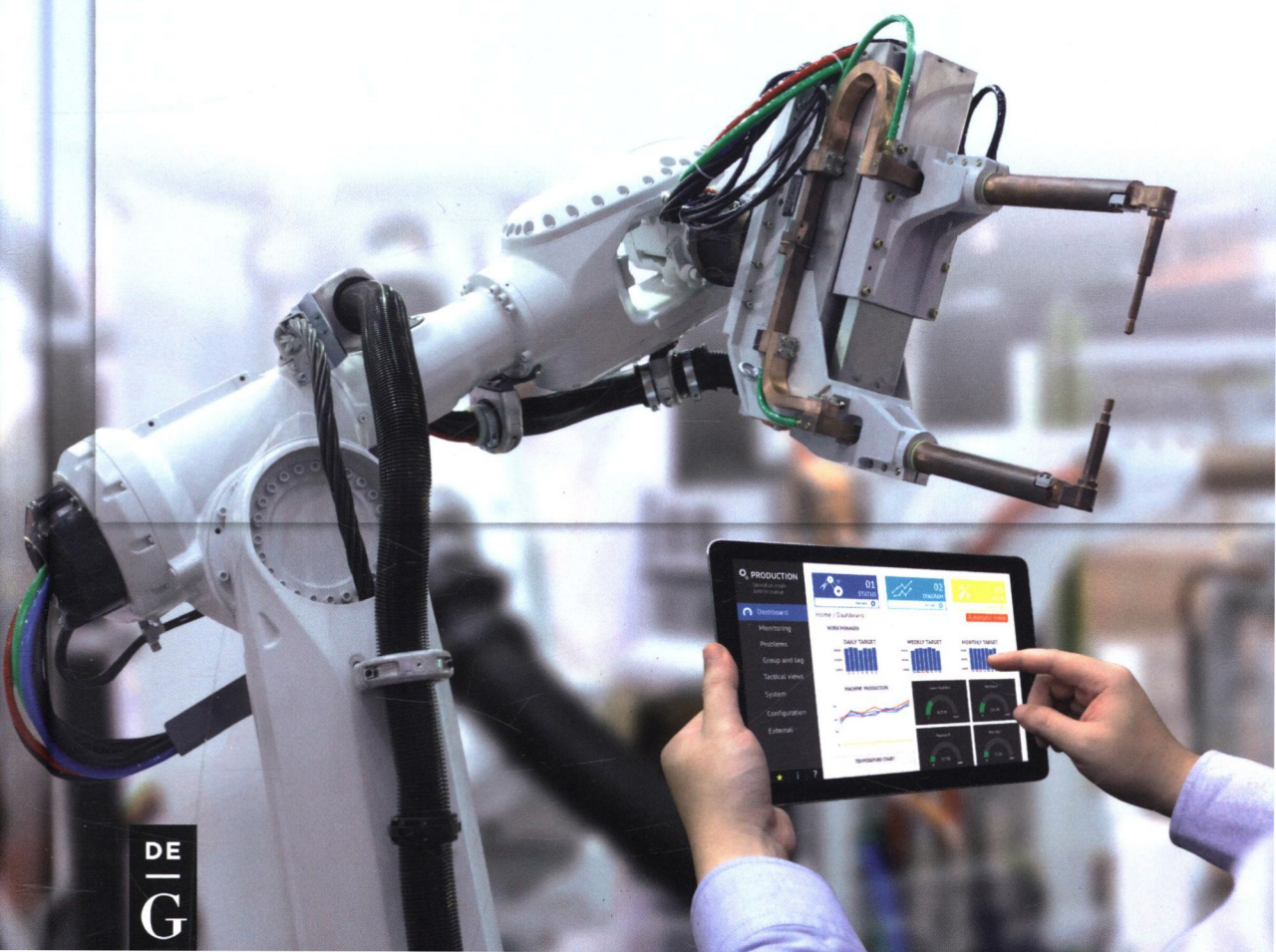
Li Fanzhang, Zhang Li, Zhang Zhao

DYNAMIC FUZZY MACHINE LEARNING



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Machine learning is widely used for data analysis. Dynamic fuzzy data are one of the most difficult types of data to analyse in the field of big data, cloud computing, the Internet of Things, and quantum information. At present, the processing of this kind of data is not very mature. The authors carried out more than 20 years of research, and show in this book their most important results. The seven chapters of the book are devoted to key topics such as dynamic fuzzy machine learning models, dynamic fuzzy self-learning subspace algorithms, fuzzy decision tree learning, dynamic concepts based on dynamic fuzzy sets, semi-supervised multi-task learning based on dynamic fuzzy data, dynamic fuzzy hierarchy learning, examination of multi-agent learning model based on dynamic fuzzy logic.

This book can be used as a reference book for senior college students and graduate students as well as college teachers and scientific and technical personnel involved in computer science, artificial intelligence, machine learning, automation, data analysis, mathematics, management, cognitive science, and finance. It can be also used as the basis for teaching the principles of dynamic fuzzy learning.

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Dynamic Fuzzy Machine Learning

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Preface

As an important method of data analysis, machine learning technology has been widely used in academic and industrial circles. In particular, the development of cloud computing, logistics networks, big data, and quantum information has played an unprecedented role in promoting the globalization of machine learning. In modern data analysis, studying the technical level of computing may limit the whole process of scientific research. As an analogy, analyzing the physical properties of a material or the physical properties of molecular structures is quite hard to achieve through calculations alone. The fundamental reason is the deep relationship between these data structures and the semantic uncertainty, which makes it difficult to complete certain tasks using only computing technology.

Dynamic fuzzy data (DFD) is one of the most difficult data types in the field of big data, cloud computing, the Internet of Things, and quantum information. To investigate the deep structure of relations and the data semantic uncertainty of DFD, our research group has been studying this field since 1994, and we have proposed various set, logic, and model system theories for uncertain datasets. To effectively handle DFD, dynamic fuzzy sets, and dynamic fuzzy logic (DFL) are introduced into the machine learning field, and the dynamic fuzzy machine learning theory framework is proposed.

Our work has been published in international journals and presented at international conferences. The first draft of "*Dynamic Fuzzy Machine Learning*" has been taught to master's and doctoral students at Soochow University as an independent 54-hour course. Based on this, several revisions have been made. To meet the requirements of the readers of this book, the course is published here over a total of seven chapters.

In the first chapter, the dynamic fuzzy machine learning model is discussed. This chapter is divided into six sections. In the first section, we define the problem. In the second section, we introduce the dynamic fuzzy machine learning model. In the third section, we study some related work. The fourth section presents the algorithm of the dynamic fuzzy machine learning system and the related process control model. In the fifth section, we introduce the dynamic fuzzy relational learning algorithm. The sixth section summarizes the chapter.

The second chapter describes the dynamic fuzzy autonomous learning subspace learning algorithm. This chapter is divided into four sections. In the first section, we analyse the current state of autonomous learning. In the second section, we present an autonomous learning subspace theoretical system based on DFL. In the third section, we introduce the autonomic subspace learning algorithm based on DFL. In the fourth section, we summarize this chapter.

The third chapter is devoted to fuzzy decision tree learning. This chapter is divided into six sections. In the first section, we examine the current state of decision tree

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learning. In the second section, we study the dynamic fuzzy lattice decision tree method. In the third section, we discuss special attribute processing for dynamic fuzzy decision trees. In the fourth section, we study the pruning strategy for dynamic fuzzy decision trees. In the fifth section, we describe some applications of dynamic fuzzy decision trees. The sixth section summarizes this chapter.

In the fourth chapter, we consider dynamic concepts based on dynamic fuzzy sets. This chapter is divided into seven sections. In the first section, we analyse the relation between dynamic fuzzy sets (DFS) and concept learning. In the second section, we introduce the model of DF concept representation. In the third section, we model the DF concept learning space, and the fourth section describes the concept learning model based on the DF lattice. In the fifth section, we present a concept learning model based on dynamic fuzzy decision tree. In the sixth section, we discuss some applications of the dynamic concept based on dynamic fuzzy sets and analyse their performance. In the seventh section, we summarize this chapter.

The fifth chapter concentrates on semi-supervised multi-task learning based on dynamic fuzzy learning. This chapter is divided into six sections. The first section introduces the notion of multi-task learning. In the second section, we describe the semi-supervised multi-task learning model. In the third section, we introduce a semi-supervised multi-task learning model based on DFS. In the fourth section, we introduce a dynamic fuzzy semi-supervised multi-task matching algorithm. The fifth section extends this to a dynamic fuzzy semi-supervised multi-task adaptive learning algorithm. The sixth section summarizes this chapter.

In the sixth chapter, we study dynamic fuzzy hierarchy learning. This chapter is divided into seven sections. The first section introduces the idea of hierarchical learning. In the second section, we describe the design of an inductive logic program. The third section discusses dynamic fuzzy hierarchical relational learning (HRL). In the fourth section, we study dynamic fuzzy tree HRL, and the fifth section discusses dynamic fuzzy graph HRL. In the sixth section, we give some applications of dynamic concepts based on dynamic fuzzy sets and analyse their performance. The seventh section summarizes this chapter.

In Chapter 7, we consider a multi-agent learning model based on DFL. This chapter is divided into five sections. The first section introduces multi-agent learning. In the second section, we introduce the agent mental model based on DFL. In the third section, we introduce the single agent learning algorithm based on DFL. The fourth section extends this idea to a multi-agent learning model based on DFL. In the fifth section, we summarize this chapter. This book systematically introduces the relevant content of dynamic fuzzy learning. It can be used as a reference book for senior college students and graduate students as well as college teachers and scientific and technical personnel involved in computer science, artificial intelligence, machine learning, automation, mathematics, management science, cognitive science, financial management, and data analysis. The text can also be used as the basis for a lecture course on dynamic fuzzy learning.

This book was designed and revised by Professors Li Fanzhang, Zhang Li, and Zhang Zhao. Huang Shuning, Cui Jingmei, Zoupeng, Luo Xiaohui, Wu Xinjian, Li Meixuan, Yin Hongwei, and Xu Xiaoxiang also assisted with the writing of the book. We are grateful for the wisdom and work of all teachers and students involved in the process. This book has also cited a large number of references, and it is our honour to express our deep gratitude to the authors of all references. Thanks to the National Natural Science Foundation (61033013, 60775045, 61672364, 61672365), Soochow scholar program (14317360, 58320007) and the key subjects of Jiangsu province "Technology of computer science" and "Software engineering" for the support of this book.

Finally, I wish the book can bring happiness and inspiration to readers! Because this work is the first attempt, combined with the author's experience and knowledge being limited, if there is any improper place, please contact us. Contact method: E-mail: lfzh@suda.edu.cn, Tel.: 13962116494.

Li Fanzhang
December 12, 2016
Soochow University

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