Preface

Biometrics, defined as the automated recognition of individuals based on their behavioral and physiological characteristics, can provide more stable and feasible solutions to personal verification and identification than traditional token-based and knowledge-based methods. In the past few decades, tremendous progress has been achieved in biometrics. Versatile biometric recognition techniques have been developed, including fingerprint, face, iris, palmprint, and ear recognition, and various biometric systems have been deployed in the applications of assess control, forensics, border crossing, network security, etc. Recently, with the ever-growing need for reliable authentication of human identity in the complex physical and network environments, much attention have been given to biometric research for reliable recognition of low-quality data or under unconstrained scenarios, which has imposed new challenges to the field of biometrics.

The development and popularization of sensors shed some light on improving the accuracy and stability of biometric recognition. The deployment of national ID programs, e.g., in India and Mexico, can provide large-scale datasets to facilitate biometric research. Moreover, the emergence of social networks and surveillance networks has reshaped the methodologies in constructing several modalities of large-scale biometric datasets, which offer new opportunities for extending the application scenarios of biometric systems while enhancing the robustness and usability.

Learning method that aims at extracting discriminative features and building powerful classifiers is a core topic in machine learning and pattern recognition community. With the popularity of large-scale biometric datasets, discriminative learning is also becoming increasingly important in biometric research, and has demonstrated its superior performance in developing biometric recognition methods. Linear discriminant analysis and its variants have been widely adopted in biometric feature extraction. Metric learning can provide an elaborate solution for personal verification. Discriminative classifiers, such as discriminative dictionary learning and support vector machines, are also prominent in various biometric recognition systems.

Rather than direct applications of discriminative learning in biometric recognition, new methods can also be developed by considering the characteristics of biometrics. For example, personal identification generally is a classification task with ultrahigh number of classes, while the within-class variations cannot be ignored and the number of available samples for each individual is limited. Moreover, several classifiers suggested for biometric recognition, e.g., sparse representation-based classification, have also achieved great success in image classification and other vision tasks.

This book aims to provide the readers with several representative methods of discriminative learning for biometric recognition. The ideas, algorithms, experimental evaluation, and underlying rationales are also given for the better understanding of these methods. The book is organized into six parts. In Part I, Chap. 1 first introduces some basic knowledge on biometrics, and then provides an overview of representative discriminative learning methods. In Part II, in-depth description is given for two representative discriminative learning methods, viz. metric learning and sparse representation. In Chap. 2, we investigate metric learning from kernel perspective, and suggest two metric learning models, doublet-SVM and triplet-SVM, which can be efficiently solved using the off-the-shelf SVM solvers. We also introduce two other models, PCML and NCML, by enforcing positive semi-definite constraint on the learned matrix. In Chap. 3, we first summarize the framework of sparse representation and discriminative dictionary learning, and then present a multiple representation-based method for face recognition.

In Part III, we describe the feature extraction and matching methods for palmprint recognition. In Chap. 4, we introduce two coding-based methods, namely-improved competitive code based on fuzzy C-means and binary orientation co-occurrence vector. In Chap. 5, we further investigate some issues on multi-scale coding and accurate angular representation. We first introduce a multi-scale competitive coding scheme and further improve it by using sparse coding. Then we utilize steerable filters for accurate extraction and robust matching of angular representation. In Chap. 6, we describe a multifeature palmprint authentication method using both competitive code-based 2D and surface curvature-based 3D palmprint features.

The Part IV introduces the application of representation-based classification in face recognition. To alleviate the adverse effect of insufficient training sample per person, Chap. 7 presents some effective schemes to generate virtual face images. In Chap. 8, we introduce several sparse representation-based methods for face recognition, viz. inverse sparse representation and robust sparse representation.

In Part V, Chap. 9 presents two fusion methods to combine multi-modality of biometric features for enhanced recognition. By investigating the cross-modality correlation, both within- and cross-modality matching scores are combined for the fusion of left and right palmprint. A dynamic score level fusion method is then introduced for joint palmprint and palmvein verification. Finally, Chap. 10 provides a brief recapitulation of the main contents of this book, and points out several encouraging topics on discriminative biometric recognition for future researches.

The book is based on our years of research experience in discriminative learning in biometrics. Since 1998, under the grant support from National Natural Science Foundation of China (NSFC), Hong Kong Polytechnic University, and Harbin Institute of Technology, we had begun our studies on palmprint recognition, and gradually expanded our researches to representative discriminative learning methods, including discriminant analysis, metric learning, and sparse representation-based classification, together with their applications in face recognition and multi-biometrics. We would like to express our special thanks to Mr. Zhaotian Zhang, Mr. Ke Liu, and Ms. Xiaoyun Xiong from NSFC, who consistently supported our research work for decades.

We would like to express our gratitude to our colleagues and Ph.D. students: Profs. Jian Yang, Jie Zhou, Kuanquan Wang, Zhouchen Lin, Guangming Lu, Jane You, Qinghua Hu, and Jinhui Tang, Dr. Hongzhi Zhang, Dr. Zhihui Lai, Dr. Feng Yue, Dr. Wei Li, Dr. Meng Yang, Dr. Jinhua Wang, Dr. Pengfei Zhu, Dr. Yahui Liu, and Dr. Faqiang Wang, for their contributions to the research achievements on discriminative learning in biometrics. It is our great honor to work with them in this inspiring topic recently. The authors owe a debt of gratitude to Xiaohe Wu, Hongliang Yan, and Weiqi Zhang for their careful reading and checking of draft of the manuscript. We are also hugely indebted to Ms. Celine L. Chang and Ms. Jane Li of Springer for their consistent help and encouragement.

Finally, the work in this book was mainly sponsored by the NSFC Program under Grant No.s 61332011, 61271093, and 61272292.

Kowloon, Hong Kong David Zhang
April 2016

http://www.springer.com/978-981-10-2055-1

Discriminative Learning in Biometrics

Zhang, D.; Xu, Y.; Zuo, W.

2016, XIII, 266 p. 110 illus., 73 illus. in color., Hardcover
ISBN: 978-981-10-2055-1