Electronic Nose: Algorithmic Challenges

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Preface

Electronic nose is an electronic olfactory system constructed to mimic the biological olfactory mechanism, which is also an important scientific field of artificial intelligence. Recently, electronic nose has attracted worldwide attention and a number of research findings have been developed in related areas including sensor arrays, bionic systems, and pattern recognition algorithms. These findings proved the feasibility and effectiveness of electronic nose in odor recognition, environmental monitoring, medical diagnosis, food quality monitoring, etc. However, there are several fundamental challenges in electronic nose community, such as sensor drift issue, disturbance issue, and discreteness issue, which seriously prohibit the scientific progress and industrial development of olfactory intelligence. Unfortunately, there are very few researches contributing to the above-mentioned challenges. Therefore, this book aims to systematically describe and define these challenges in electronic nose community and present specific methods, models, and techniques to effectively and efficiently address these important issues. To our best knowledge, this will be the first book to review and address the newest algorithmic challenges.

Specifically, this book focuses on four algorithmic challenges. First, in Part II, for general electronic nose, the algorithmic challenge in pattern recognition and machine learning (challenge I) will be described, including the odor recognition algorithms and concentration estimation algorithms. Second, in Part III, the sensor drift issue (challenge II) that would decrease the aging of E-nose will be introduced and described, with specific solving schemes in models and algorithms. Third, in Part IV, the disturbance issue (challenge III) that would break the general use of E-nose will be introduced and described, with specific approaches and techniques. Finally, in Part V, the discreteness issue (challenge IV) that would prohibit the large-scale industrial application of E-nose instruments will be introduced and described, with the effective models and algorithms proposed to address the issue.

All of the technologies, algorithms, and applications described in this book were applied in our research work and have proven to be effective in electronic nose. In this book, there are totally 20 chapters. Chapters 1 and 2 will describe the background of electronic nose with the unsolved issues and the literature review. From Chaps. 3 to 8, the odor recognition algorithms and gases concentration estimation

algorithms will be introduced, which address the first odor recognition challenge in general E-nose. From Chaps. 9 to 14, different models, algorithms, and techniques for addressing the second long-term sensor drift compensation challenge will be gradually described. From Chaps. 15 to 17, specific approaches and strategies for addressing the third background disturbance elimination challenge will be presented. From Chaps. 18 and 19, the detailed algorithms and schemes for the fourth large-scale discreteness correction challenge will be presented and discussed. Finally, Chap. 20 gives the book review and future work. This book will benefit the researchers, professionals, graduate and postgraduate students working in the field of signal processing, pattern recognition, artificial intelligence, electronics and instrumentation science.

Our team has been working on the electronic nose research over 10 years. Under the grant support (Grant No. 61401048, No. 61771079) from National Natural Science Foundation of China (NSFC) and the grant support (Grant No. cstc2017zdcy-zdzx0077) from Chongqing Science and Technology Commission, we had started our studies on this topic. We would like to express our special gratitude to Dr. Zhaotian Zhang, Dr. Xiaoyun Xiong, and Dr. Ke Liu in National Natural Science Foundation of China (NSFC) for their help and support. The authors would also like to thank Dr. Zhifang Liang and Lijun Dang for their useful contribution to some chapters in this book.

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