

Preface

Over the past decade, sparse representation, modeling, and learning has emerged and is widely used in many visual tasks such as feature extraction and learning, object detection, and recognition (i.e., faces, activities). It is rooted in statistics, physics, information theory, neuroscience, optimization theory, algorithms, and data structure. Meanwhile, visual recognition has played a critical role in computer vision as well as in robotics. Recently, sparse representation consists of two basic tasks, data sparsification and encoding features. The first task is to make data more sparse directly. The second is to encode features with sparsity properties in some domain using either strictly or approximately K -Sparsity. Sparse modeling is to model specific tasks by jointly using different disciplines and their sparsity properties. Sparse learning is to learn mapping from input signals to outputs by either representing the sparsity of signals or modeling the sparsity constraints as regularization items in optimization equation. Mathematically, solving sparse representation and learning involves seeking the sparsest linear combination of basic functions from an overcomplete dictionary. The rationale behind this is the sparse connectivity between nodes in the human brain.

The necessity and popularity of sparse representation, modeling, and learning are spread over all major universities and research organizations around the world, with leading scientists from various disciplines. This book presents our recent research work on sparse representation, modeling and learning with emphasis on visual recognition, and is aimed at researchers and graduate students. Our goal in writing this book is threefold. First, it creates an updated reference book of sparse representing, modeling, and learning. Second, this book covers both the theory and application aspects, which benefits readers keen to learn broadly sparse representation, modeling, and learning. Finally, we have provided some applications about visual recognition, as well as some applications about computer vision. We try to link theory, algorithms, and applications to promote compressed sensing research.

This book is divided into four parts. The first part, Introduction and Fundamentals, presents the research motivation and purpose, and briefly introduces the definition of sparse representation, modeling, and learning, as well as its applications on visual recognition. The second part, Sparse representation, Modeling and Learning, which

includes sparse recovery approaches, robust sparse representation and learning, efficient sparse representation and modeling, introduces large-scale visual recognition, and situations of efficient sparse coding and sparse quantization. The third part, Visual Recognition Applications, which includes feature representation and learning, sparsity-induced similarity, and sparse representation and learning-based classifiers, is the result of combining pattern recognition and compressed sensing. In different SRLCs, sparsity could be used in sample similarity, histogram generation, local feature similarity, and nearest neighbor classifiers. The fourth part, Advanced Topics, discusses the topic beyond the sparse—low-rank representation which is known as two-dimensional sparse representation. Additionally, Mathematics fundamental, and Computer Programming Resources are included in the appendices.

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Theory, Algorithms and Applications

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