Unsupervised and Semi-Supervised Learning

Series Editor

M. Emre Celebi, Computer Science Department, Conway, Arkansas, USA

Springer's Unsupervised and Semi-Supervised Learning book series covers the latest theoretical and practical developments in unsupervised and semi-supervised learning. Titles – including monographs, contributed works, professional books, and textbooks – tackle various issues surrounding the proliferation of massive amounts of unlabeled data in many application domains and how unsupervised learning algorithms can automatically discover interesting and useful patterns in such data. The books discuss how these algorithms have found numerous applications including pattern recognition, market basket analysis, web mining, social network analysis, information retrieval, recommender systems, market research, intrusion detection, and fraud detection. Books also discuss semi-supervised algorithms, which can make use of both labeled and unlabeled data and can be useful in application domains where unlabeled data is abundant, yet it is possible to obtain a small amount of labeled data.

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- Evaluation of Unsupervised/Semi-Supervised Learning Algorithms
- Applications of Unsupervised/Semi-Supervised Learning

While the series focuses on unsupervised and semi-supervised learning, outstanding contributions in the field of supervised learning will also be considered. The intended audience includes students, researchers, and practitioners.

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Mixture Models and Applications

Springer

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Preface

Increasingly, business, government agencies, and scientists are confronted with large amounts of heterogenous data that are critical for the daily activities, but not well enough analyzed to get the valuable information and knowledge that they potentially hide. The availability of large data sets has changed the scientific approaches to data mining. This has given rise to the need to develop efficient data modeling tools. Among these approaches, mixture models have become a tool of choice in the last years in many scientific domains [1–3]. This is mainly due to their ability to offer a well-principled approach to clustering. New challenges (e.g., Big Data), new approaches (e.g., deep learning), and new technologies (e.g., cloud computing, Internet of Things, etc.) have added new problems when deploying mixture models in real-life scenarios. And several new frameworks based on mixture models have been proposed. The importance of mixture models as a powerful learning machine is evident by the great plethora of papers dedicated to this subject. Such models are finding applications in almost any area of human endeavor. This includes applications in engineering, science, medicine, and business, just to name a few. At the same time, however, there are a lot of challenges related to the development and application of mixture models. Indeed, very few books present a comprehensive discussion about the application of such models to many real-life domains. The present edited book shows clearly that mixture models may be applied successfully in a variety of applications if well deployed.

The book contains 14 chapters that are grouped into 5 parts, namely, Gaussian-based models (3 chapters), generalized Gaussian-based models (2 chapters), spherical and count data clustering (3 chapters), bounded and semi-bounded data clustering (3 chapters), and image modeling and segmentation (3 chapters). In the first chapter, Parsons presents a Gaussian mixture model approach to classify response types. The parameter estimates obtained from fitting the proposed Gaussian model are used in a naive Bayesian classifier to perform the classification task. In Chap. 2, Berio et al. use Gaussian mixtures for the interactive generation of calligraphic trajectories. The authors exploit the stochastic nature of the Gaussian mixture combined with an optimal control to generate paths with natural variation. The merits of the approach are tested by generating curves and traces that are

similar from a geometrical and dynamical point of views to the ones that can be observed in art forms such as calligraphy or graffiti. In Chap. 3, Calinon presents an interesting overview of techniques used for the analysis, edition, and synthesis of continuous time series, with emphasis on motion data. The author exploits the fact that mixture models allow the decomposition of time signals as a superposition of basis functions. Several applications with radial, Bernstein, and Fourier basis functions are presented in this chapter. A generalization to the Gaussian mixture called multivariate bounded asymmetric Gaussian mixture model is proposed by Azam et al. in Chap. 4. The proposed model is learned via expectation maximization and applied to several real-life applications such as spam filtering and texture image clustering. Another generalization is proposed in Chap. 5 by Najar et al. and applied for online recognition of human action and facial expression as well as pedestrian detection from infrared images. In Chap. 6, Fan et al. tackle the problem of spherical data clustering by developing an infinite mixture model of von Mises distributions. A localized feature selection approach is integrated within the developed model to detect relevant features. The resulting model is learned via variational inference and applied to two challenging applications, namely, topic novelty detection and image clustering. A hybrid generative discriminative framework, based on an exponential approximation to two distributions dedicated to count data modeling, namely, the multinomial Dirichlet and the multinomial generalized Dirichlet, is developed in Chap. 7 by Zamzami and Bouguila. Several SVM kernels are developed within this hybrid framework and applied to the problem of analyzing activities in surveillance scenes. A challenging problem when considering the multinomial Dirichlet and the multinomial generalized Dirichlet distribution in statistical frameworks is the computation of the log-likelihood function. This problem is tackled in Chap. 8 by Daghyani et al. by approximating this function using Bernoulli polynomials. The approach is validated via two clustering problems: natural scene clustering and facial expression recognition. A unified approach for the estimation and selection of finite bivariate and multivariate beta mixture models is developed in Chap. 9 by Manouchehri and Bouguila. The approach is based on minimum message length and deployed to several problems (e.g., sentiment analysis, credit approval, etc.). In Chap. 10, Maanicshah et al. tackle the problem of positive vector clustering by developing a variational Bayesian algorithm to learn finite inverted Beta-Liouville mixture models. Applications such as image clustering and software defect detection are used to validate the model. In Chap. 11, Kalra et al. examine and analyze multimodal medical images by developing an unsupervised learning algorithm based on online variational inference for finite inverted Dirichlet mixture models. The algorithm is validated using challenging applications from the medical domain. Kalsi et al. tackle in Chap. 12 image segmentation problem by integrating spatial information within three mixture models based on inverted Dirichlet, inverted generalized Dirichlet, and inverted Beta-Liouville distributions. The same problem is approached in Chap. 13 by Chen et al. by developing a spatially constrained inverted Beta-Liouville mixture model applied to both simulated and real brain magnetic resonance imaging data. Finally, Chap. 14 by Channoufi et al. presents a flexible statistical model for unsupervised image modeling and

segmentation. The model is based on bounded generalized Gaussian mixtures learned using maximum likelihood estimation and minimum description length principle.

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