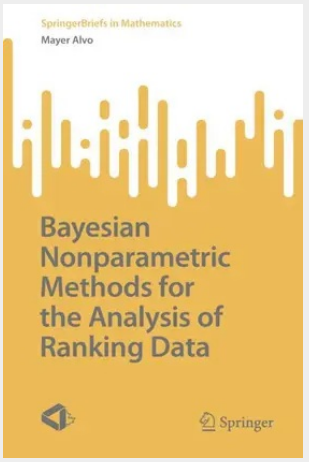
Alvo

Bayesian Nonparametric Methods for the Analysis of Ranking Data



Bayesian methods have become a cornerstone of modern statistical inference, providing a principled framework for combining prior knowledge with observed data to construct probabilistic models. Their ability to incorporate prior information has made them particularly valuable in applications where data are limited or uncertainty is substantial. Classical Bayesian analysis begins by specifying a prior distribution for the parameters of interest and updating it with observed data to obtain a posterior distribution. While conjugate priors often simplify these calculations, many practical problems require more flexible approaches. The development of Markov chain Monte Carlo (MCMC) methods has transformed Bayesian statistics by making it possible to estimate posterior distributions for complex models that lack closed-form solutions. This computational revolution has enabled the widespread use of hierarchical models with many parameters and has significantly broadened the scope of Bayesian methodology. More recently, Bayesian nonparametric methods have emerged as a powerful extension of the Bayesian paradigm. Rather than specifying a prior on a finite-dimensional parameter space, these methods place a prior on an infinite-dimensional space of probability distributions, allowing model complexity to adapt to the data. This flexibility has led to important advances in areas such as clustering, classification, and density estimation, particularly when the number of underlying groups is unknown. Although Bayesian nonparametric methods have been applied across many disciplines, such as marketing, economics, sports, psychology, and the social sciences. However, their use with ranking data remains comparatively underdeveloped. This monograph provides a comprehensive introduction to Bayesian nonparametric methods, with particular emphasis on their application to ranking data. Motivated by the growing availability of ranking data, it presents both the theoretical foundations and practical methodologies needed to analyze these increasingly important data. Following a concise review of classical Bayesian methods, the monograph introduces ranking data and established ranking models. It then develops the fundamental concepts of Bayesian nonparametrics before presenting major modeling approaches and computational techniques. Two major classes of ranking models are examined: the Plackett–Luce model, which represents rankings through latent worth parameters assigned to individual items, and distance-based (Mallows) models, which characterize rankings according to their distance from a central or consensus ranking. The monograph concludes with a selection of applications illustrating the breadth and versatility of Bayesian nonparametric methods. Designed for graduate students, advanced undergraduates, and practitioners, this monograph serves as both an accessible introduction and a practical reference. Readers with a solid undergraduate background in probability and statistics will be well prepared to benefit from its content.

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