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Christopher S. Tang, University of California, Los Angeles, CA, USA

Supply Chain Management (SCM), long an integral part of Operations Management, focuses on all elements of creating a product or service, and delivering that product or service, at the optimal cost and within an optimal timeframe. It spans the movement and storage of raw materials, work-in-process inventory, and finished goods from point of origin to point of consumption. To facilitate physical flows in a time-efficient and cost-effective manner, the scope of SCM includes technology-enabled information flows and financial flows.

The Springer Series in Supply Chain Management, under the guidance of founding Series Editor Christopher S. Tang, covers research of either theoretical or empirical nature, in both authored and edited volumes from leading scholars and practitioners in the field – with a specific focus on topics within the scope of SCM.

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Editors

The Elements of Joint Learning and Optimization in Operations Management

Springer

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To our parents:

Jianming Chen and Xiaohong Yu
Andi Wirawan Jasin and Sandra Widjaja
Xiping Shi and Qiong Yao

and to our families:

Yingze Wang and Andrew Chen
Yan Huang
Miao Ni and Janie Shi and Anna Shi

Preface

The last decade has seen an explosion of research at the intersection of operations research and machine learning. While the classical operations research has focused largely on optimizing the system under the assumption of known dynamics and known parameters, in reality, the "known" are typically unknown and need to be estimated from the continuously generated data. The later gives rise to the problem of joint learning and optimization, which is one of the core research topics in the machine learning community. However, while the machine learning community has largely focused on solving problems that are directly relevant for computer science applications, the operations research community has its own long list of problems that are not typically considered in the context of joint learning and optimization. This presents a wonderful opportunity for combining operations research and machine learning techniques to solve some of the most fundamental analytic problems.

This book consists of 15 chapters written by some of the world's leading experts on the subject, covering a wide range of topics such as price optimization, assortment optimization, inventory optimization, and healthcare operations. As noted above, the field has grown very quickly within the last decade, and it is not our intention to provide a comprehensive overview of the field. Rather, we have a more modest aim to introduce interested readers to some fundamental results that have been developed in the field within the last decade. This book is a suitable reading for graduate students (either PhD or advanced master's) in operations research and/or machine learning. It is also suitable for researchers in other fields who are interested in the topic of joint learning and optimization.

For a better organization, we cluster the 15 chapters into five different parts:

Part I. Generic Tools The first part of the book consists of Chaps. 1–3 and covers standard tools and concepts that are commonly used in the learning literature. Many of the topics discussed in this part are also covered in more details in other more specialized books. Our objective here is to quickly introduce readers to some of the key tools and concepts. Chapter 1 discusses fundamental algorithms for multi-armed bandit; Chap. 2 discusses fundamental algorithms for reinforcement learning;

and Chap. 3 discusses optimal learning from the perspective of statistical design of experiments.

Part II. Price Optimization The second part of the book consists of Chaps. 4–7 and covers a variety of topics on joint learning and price optimization. Chapter 4 discusses state-of-the-art parametric and non-parametric learning algorithms for single-product and multiple-product settings; Chap. 5 discusses learning algorithms in the presence of inventory constraints; Chap. 6 provides literature review on joint learning and pricing in non-stationary environments; and Chap. 7 discusses learning algorithms for high dimensional setting.

Part III. Assortment Optimization The third part of the book consists of Chaps. 8–10 and covers a variety of topics on joint learning and assortment optimization. Chapter 8 discusses recent advances in non-parametric estimation of choice models; Chap. 9 discusses learning algorithms for assortment optimization under the popular multinomial logit (MNL) choice model; and Chap. 10 discusses learning algorithms for assortment optimization under non-MNL choice model.

Part IV. Inventory Optimization The fourth part of the book consists of Chaps. 11–13 and covers a variety of topics on joint learning and inventory optimization. Chapter 11 discusses state-of-the-art algorithms on inventory optimization with censored demand; Chap. 12 discusses learning algorithms for the joint inventory and price optimization problem where both the price and inventory decisions need to be simultaneously optimized; and Chap. 13 discusses optimization in the "small data, large scale" regime.

Part V. Healthcare Operations The fifth part of the book consists of Chaps. – 15 and covers topics related to healthcare operations. Chapter discusses bandit algorithms/procedures for clinical trials and Chap. 15 provides an in-depth overview of dynamic treatment regime.

This book would not have been possible without the excellent contribution of all authors and the help of the team at Springer, for which we are forever grateful.

New York, NY, USA Xi Chen
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Xi Chen is a professor in the Department of Technology, Operations, and Statistics at Stern School of Business, New York University. He is also Professor of Computer Science at the Center for Data Science at New York University. His research and teaching have been recognized by numerous awards, including The World's Best 40 under 40 MBA Professors by Poets & Quants, NSF CAREER Award, Forbes 30 Under 30, the Inaugural International Chinese Statistical Association Outstanding Young Researcher Award, and Faculty Research Awards, and by a number of leading technology and financial giants, such as Google, Facebook, Adobe, JPMorgan, and Bloomberg. In addition, he is an elected member of the International Statistical Institute (ISI) and an associate editor of Management Science, Operations Research, and Annals of Statistics.

Stefanus Jasin is a professor in the Department of Technology and Operations at the Ross School of Business, University of Michigan, Ann Arbor. His research focuses on algorithmic and/or prescriptive business analytics and has been recognized by numerous awards, including INFORMS Revenue Management and Pricing Section Prize Award, and INFORMS eBusiness Section Best Paper Award. He is a department editor of Production and Operations Management. In addition, he is also an associate editor of Management Science, Operations Research, Manufacturing and Service Operations Management, Production and Operations Management, and Naval Research Logistics.

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