

# Preface

Traditionally, economic optimization and control of chemical processes have been addressed with a hierarchical approach. In the upper layer, a static economic optimization problem is solved to compute an optimal process steady state. The optimal steady state is sent down to the lower feedback control layer to force the process to operate at the optimal steady state. In the context of the lower feedback control layer, model predictive control (MPC) has become a ubiquitous advanced control methodology used in the chemical process industry owing to its ability to control multiple input, multiple output process/systems while accounting for constraints and performance criteria. Recent pressure to make chemical processes operate more efficiently, cost effectively, and reliably has motivated process control researchers to analyze a more general MPC framework that merges economic optimization with process control. In particular, economic MPC (EMPC), which incorporates an economically motivated stage cost function in its formulation, has attracted significant attention and research over the last 10 years. The rigorous design of EMPC systems that operate processes in an economically optimal fashion while maintaining stability of the closed-loop system is challenging as traditional notions of stability may not apply to the closed-loop system under EMPC.

This book covers several rigorous methods for the design of EMPC systems for chemical processes, which are typically described by nonlinear dynamic models. The book opens with a brief introduction and motivation of EMPC and a background on nonlinear systems, control and optimization. An overview of the various EMPC methods proposed in the literature is provided. Subsequently, an EMPC scheme designed via Lyapunov-based techniques, which is the main focus of this book, is described in detail with rigorous analysis provided on its feasibility, closed-loop stability and performance properties. Next, the design of state-estimation-based EMPC schemes is considered for nonlinear systems. Then, several two-layer EMPC frameworks are presented that address computational efficiency and industrially relevant control designs. The book closes with additional EMPC designs that address computational efficiency and real-time implementation.

Throughout the book, the EMPC methods are applied to chemical process examples to demonstrate their effectiveness and performance.

The book requires some knowledge of nonlinear systems and nonlinear control theory. Because EMPC requires the repeated solution of a nonlinear optimization problem, a basic knowledge of nonlinear optimization/programming may be helpful in understanding the concepts. This book is intended for researchers, graduate students, and process control engineers.

We would like to acknowledge Dr. Mohsen Heidarinejad, Dr. Xianzhong Chen, Dr. Liangfeng Lao, Helen Durand, Tim Anderson, Dawson Tu, and Anas Alanqar all at UCLA who have contributed substantially to the research efforts and results included in this book. We would like to thank them for their hard work and contributions. We would also like to thank our many other collaborators and colleagues who contributed in some way to this project.

In particular, we would like to thank our colleagues at UCLA and the University of Alberta, and the United States National Science Foundation and the Department of Energy for financial support. Finally, we would like to express our deepest gratitude to our families for their dedication, encouragement, patience, and support over the course of this project. We dedicate this book to them.

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Economic Model Predictive Control  
Theory, Formulations and Chemical Process  
Applications

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2017, XXIV, 292 p. 95 illus., 16 illus. in color., Hardcover

ISBN: 978-3-319-41107-1