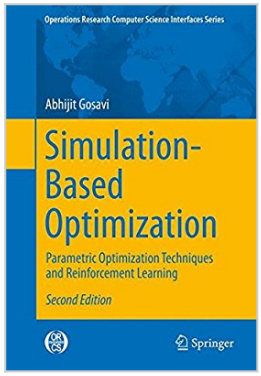

Simulation-Based Optimization: Parametric Optimization Techniques and Reinforcement Learning (Operations Research/Computer Science Interfaces Series)

By Abhijit Gosavi

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*This book introduces to the reader the evolving area of **simulation-based optimization**, also known as **simulation optimization**. The book should serve as an **accessible** introduction to this topic and requires a background **only** in **elementary mathematics**. It brings the reader up to date on cutting-edge advances in simulation-optimization methodologies, including dynamic controls, also called **Reinforcement Learning** (RL) or **Approximate Dynamic Programming** (ADP), and static optimization techniques**,** e.g., **Simultaneous Perturbation**, **Nested Partitions**, **Backtracking Adaptive Search**, Response Surfaces, and **Meta-Heuristics**. Special features of this book include:*

Stochastic Control Optimization:

- An Accessible Introduction to Reinforcement Learning Techniques for Solving **Markov Decision Processes** (**MDPs**), with Step-by-Step Descriptions of Numerous Algorithms, e.g., **Q-Learning**, **SARSA**, **R-SMART**, **Actor-Critics**, **Q-P-Learning**, and Classical **Approximate Policy Iteration**
- A Detailed Discussion on Dynamic Programing for Solving MDPs and Semi-MDPs (**SMDPs**), Including Steps for Value Iteration and Policy Iteration
- An Introduction to **Function Approximation** with Reinforcement Learning
- An In-Depth Treatment of Reinforcement Learning Methods for **SMDPs**, **Average Reward Problems**, **Finite Horizon Problems**, and **Two Time Scales**
- **Computer Programs** (available online)
- A Gentle Introduction to **Convergence Analysis** of Simulation Optimization Methods via **Banach Fixed Point Theory** and Ordinary Differential Equations (**ODEs**)

Stochastic Static Optimization:

- A Step-by-Step Description of Stochastic Adaptive Search Algorithms, e.g., **Simultaneous Perturbation**, **Nested Partitions, Backtracking Adaptive Search, Stochastic Ruler,** and Meta-Heuristics**, e.g., Simulated Annealing**, **Tabu Search**, and **Genetic Algorithms**

- A Clear and Simple Introduction to the Methodology of **Neural Networks**

The book ends with a chapter on **case studies** that explain how these methods can be applied in real-world settings; an online repository of computer programs that can be downloaded from a website is also available.

The book was written for students and researchers in the fields of engineering (industrial, electrical, and computer), computer science, operations research, management science, and applied mathematics. An attractive feature of this book is its **accessibility** to readers new to this topic.

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Simulation-Based Optimization: Parametric Optimization Techniques and Reinforcement Learning (Operations Research/Computer Science Interfaces Series) By Abhijit Gosavi Bibliography

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- Binding: Hardcover
- 508 pages

Editorial Review

Review
The following reviews are from Google books and may have been corrected for minor grammatical errors:

"One of the great books. I have found every detail I needed and he has done (an) excellent job. I will definitely recommend the book." -- *A reader from Google Books*

From the Author
The main motivation for writing this book was to provide an **accessible** account of methods based on **Reinforcement Learning** (closely related to what is now also called *Approximate Dynamic Programming*) and **Meta-Heuristics** (closely related to what is now also called *Stochastic Adaptive Search*) for optimization in discrete-event systems via simulation. Reinforcement Learning (RL) is typically used for solving Markov decision problems (**MDPs**), which are dynamic optimization problems where the underlying discrete-event stochastic system is driven by Markov chains, while Meta-Heuristics are used for solving static optimization problems where the underlying system is any discrete-event stochastic system (not necessarily driven by Markov chains).
This book provides a selected collection of topics, mostly focused on **model-free** techniques, which are useful when one does not have access to the structure of the objective function (in static optimization) or the transition probability function (in dynamic optimization). My goal was neither to overwhelm the reader with mathematical details nor was it to cover every topic. Rather, the goal was to provide the reader with an overview of the fundamental concepts and at the same time provide the details required for solving real-world stochastic optimization problems via simulation-based techniques.
Some of the main topics covered are:

- Reinforcement learning techniques for discounted and average reward MDPs
- Detailed recipes for Reinforcement Learning algorithms such as **Q-Learning**, **SARSA**, **R-SMART**, and **Actor Critics**
- Static optimization techniques rooted in meta-heuristics (**simulated annealing**, **genetic algorithms**, and **tabu search**) and stochastic adaptive search (**nested partitions**, **stochastic ruler**, and **backtracking adaptive search**) for discrete solution spaces and **simultaneous perturbation** for continuous solution spaces
- **Neural network** algorithms useful for function approximation in response surface methods for static optimization and in reinforcement learning for MDPs with large state-action spaces
- A detailed background on **dynamic programming** (**value and policy iteration**)
- A special coverage of semi-MDPs (**SMDPs**), **average reward** problems, finite horizon MDPs, and two time scales in RL
- A gentle introduction to convergence analysis of simulation optimization methods via Banach fixed point theory and Ordinary Differential Equations
  Preview

From the Back Cover

Simulation-Based Optimization: Parametric Optimization Techniques and Reinforcement Learning

introduces the evolving area of static and dynamic simulation-based optimization. Covered in detail are *model-free* optimization techniques – especially designed for those discrete-event, stochastic systems which can be simulated but whose analytical models are difficult to find in closed mathematical forms.

Key features of this revised and improved Second Edition include:

· Extensive coverage, via step-by-step recipes, of powerful new algorithms for static simulation optimization, including simultaneous perturbation, backtracking adaptive search, and nested partitions, in addition to traditional methods, such as response surfaces, Nelder-Mead search, and meta-heuristics (simulated annealing, tabu search, and genetic algorithms)

· Detailed coverage of the Bellman equation framework for Markov Decision Processes (MDPs), along with dynamic programming (value and policy iteration) for discounted, average, and total reward performance metrics

· An in-depth consideration of dynamic simulation optimization via temporal differences and Reinforcement Learning: *Q-Learning*, *SARSA*, and *R-SMART* algorithms, and policy search, via *API*, *Q-P-Learning*, actor-critics, and learning automata

· A special examination of neural-network-based function approximation for Reinforcement Learning, semi-Markov decision processes (SMDPs), finite-horizon problems, two time scales, case studies for industrial tasks, computer codes (placed online), and convergence proofs, via Banach fixed point theory and Ordinary Differential Equations

Themed around three areas in separate sets of chapters – **Static Simulation Optimization, Reinforcement Learning,** and **Convergence Analysis** – this book is written for researchers and students in the fields of engineering (industrial, systems, electrical, and computer), operations research, computer science, and applied mathematics.

Users Review

From reader reviews:

Mike Yerkes:

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