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This groundbreaking book uniquely integrates four distinct disciplines-Markov design processes, mathematical programming, simulation, and statistics-to demonstrate how to successfully model and solve a wide range of real-life problems using the techniques of approximate dynamic programming (ADP).The reader is introduced to the three curses of dimensionality that impact complex problems and is also shown how the post-decision state variable allows for the use of classical algorithmic ...

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Slide 1 Approximate Dynamic Programming: Solving the curses of dimensionality Multidisciplinary Symposium on Reinforcement Learning June 19, 2009

Approximate Dynamic Programming: Solving the curses of ...
Approximate dynamic programming: solving the curses of dimensionality, published by John Wiley and Sons, is the first book to merge dynamic programming and math programming using the language of approximate dynamic programming.

Approximate dynamic programming
» We still have to solve a problem that looks like » This means we still have to deal with a maximization problem (might be a linear, nonlinear or integer program) with an expectation. tt tt t ff t ... Approximate dynamic programming ...

Approximate Dynamic Programming: Solving the curses of ...
Abstract: Approximate dynamic programming (ADP) is a broad umbrella for a modeling and algorithmic strategy for solving problems that are sometimes large and complex, and are usually (but not always) stochastic. It is most often presented as a method

What you should know about approximate dynamic programming
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Once we cannot determine the true value V t associated to each state S t, we use an approximate dynamic programming algorithm (see for a comprehensive treatment) to determine the value V n t, which...

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A complete and accessible introduction to the real-world applications of approximate dynamic programming With the growing levels of sophistication in modern-day operations, it is vital for practitioners to understand how to approach, model, and solve complex industrial problems.

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Abstract. An approximate dynamic programming that incorporates a combined policy, value function approximation and lookahead policy, is proposed. The algorithm is validated by applying it to solve a set of instances of the nurse rostering problem tackled as a multi-stage prob-lem. In each stage of the problem, a weekly roster is constructed taking

Approximate Dynamic Programming With Combined Policy ...
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Approximate Dynamic Programming - W F Howes Ltd
Approximate Dynamic Programming (ADP) Template 1. Compute a value function approximation or continuation value function approximation 2. Estimate lower bounds by simulating the induced heuristic policy in Monte Carlo simulation 3. Estimate upper bounds using the information relaxation and duality approach

Praise for the First Edition "Finally, a book devoted to dynamic programming and written using the language of operations research (OR)! This beautiful book fills a gap in the libraries of OR specialists and practitioners." —Computing Reviews This new edition showcases a focus on modeling and computation for complex classes of approximate dynamic programming problems Understanding approximate dynamic programming (ADP) is vital in order to develop practical and high-quality solutions to complex industrial problems, particularly when those problems involve making decisions in the presence of uncertainty. Approximate Dynamic Programming, Second Edition uniquely integrates four distinct disciplines—Markov decision processes, mathematical programming, simulation, and statistics—to demonstrate how to successfully approach, model, and solve a wide range of real-life problems using ADP. The book continues to bridge the gap between computer science, simulation, and operations research and now adopts the notation and vocabulary of reinforcement learning as well as stochastic search and simulation optimization. The author outlines the essential algorithms that serve as a starting point in the design of practical solutions for real problems. The three curses of dimensionality that impact complex problems are introduced and detailed coverage of implementation challenges is provided. The Second Edition also features: A new chapter describing four fundamental classes of policies for working with diverse stochastic optimization problems: myopic policies, look-ahead policies, policy function approximations, and policies based on value function approximations A new chapter on policy search that brings together stochastic search and simulation optimization concepts and introduces a new class of optimal learning strategies Updated coverage of the exploration exploitation problem in ADP, now including a recently developed method for doing active learning in the presence of a physical state, using the concept of the knowledge gradient A new sequence of chapters describing statistical methods for approximating value functions, estimating the value of a fixed policy, and value function approximation while searching for optimal policies The presented coverage of ADP emphasizes models and algorithms, focusing on related applications and computation while also discussing the theoretical side of the topic that explores proofs of convergence and rate of convergence. A related website features an ongoing discussion of the evolving fields of approximation dynamic programming and reinforcement learning, along with additional readings, software, and datasets. Requiring only a basic understanding of statistics and probability, Approximate Dynamic Programming, Second Edition is an excellent book for industrial engineering and operations research courses at the upper-undergraduate and graduate levels. It also serves as a valuable reference for researchers and professionals who utilize dynamic programming, stochastic programming, and control theory to solve problems in their everyday work.

This book provides a straightforward overview for every researcher interested in stochastic dynamic vehicle routing problems (SDVRPs). The book is written for both the applied researcher looking for suitable solution approaches for particular problems as well as for the theoretical researcher looking for effective and efficient methods of stochastic dynamic optimization and approximate dynamic programming (ADP). To this end, the book contains two parts. In the first part, the general methodology required for modeling and approaching SDVRPs is presented. Itpresents adapted and new, general anticipatory methods of ADP tailored to the needs of dynamic vehicle routing. Since stochastic dynamic optimization is often complex and may not always be intuitive on first glance, the author accompanies the theoretical SDO-methodology with illustrative examples from the field of SDVRPs. The second part of this book then depicts the application of the theory to a specific SDVRP. The process starts from the real-world application. The author describes a SDVRP with stochastic customer requests often addressed in the literature, and then shows in detail how this problem can be modeled as a Markov decision process and presents several anticipatory solution approaches based on ADP. In an extensive computational study, he shows the advantages of the presented approaches compared to conventional heuristics. To allow deep insights in the functionality of ADP, he presents a comprehensive analysis of the ADP approaches.

Reinforcement learning (RL) and adaptive dynamic programming (ADP) has been one of the most critical research fields in science and engineering for modern complex systems. This book describes the latest RL and ADP techniques for decision and control in human engineered systems, covering both single player decision and control and multi-player games. Edited by the pioneers of RL and ADP research, the book brings together ideas and methods from many fields and provides an important and timely guidance on controlling a wide variety of systems, such as robots, industrial processes, and economic decision-making.

This book presents classical Markov Decision Processes (MDP) for real-life applications and optimization. MDP allows users to develop and formally support approximate and simple decision rules, and this book showcases state-of-the-art applications in which MDP was key to the solution approach. The book is divided into six parts. Part 1 is devoted to the state-of-the-art theoretical foundation of MDP, including approximate methods such as policy improvement, successive approximation and infinite state spaces as well as an instructive chapter on Approximate Dynamic Programming. It then continues with five parts of specific and non-exhaustive application areas. Part 2 covers MDP healthcare applications, which includes different screening procedures, appointment scheduling, ambulance scheduling and blood management. Part 3 explores MDP modeling within transportation. This ranges from public to private transportation, from airports and traffic lights to car parking or charging your electric car. . Part 4 contains three chapters that illustrates the structure of approximate policies for production or manufacturing structures. In Part 5, communications is highlighted as an important application area for MDP. It includes Gittins indices, down-to-earth call centers and wireless sensor networks. Finally Part 6 is dedicated to financial modeling, offering an instructive review to account for financial portfolios and derivatives under proportional transactional costs. The MDP applications in this book illustrate a variety of both standard and non-standard aspects of MDP modeling and its practical use. This book should appeal to readers for practitioning, academic research and educational purposes, with a background in, among others, operations research, mathematics, computer science, and industrial engineering.

From household appliances to applications in robotics, engineered systems involving complex dynamics can only be as effective as the algorithms that control them. While Dynamic Programming (DP) has provided researchers with a way to optimally solve decision and control problems involving complex dynamic systems, its practical value was limited by algorithms that lacked the capacity to scale up to realistic problems. However, in recent years, dramatic developments in Reinforcement Learning (RL), the model-free counterpart of DP, changed our understanding of what is possible. Those developments led to the creation of reliable methods that can be applied even when a mathematical model of the system is unavailable, allowing researchers to solve challenging control problems in engineering, as well as in a variety of other disciplines, including economics, medicine, and artificial intelligence. Reinforcement Learning and Dynamic Programming Using Function Approximators provides a comprehensive and unparalleled exploration of the field of RL and DP. With a focus on continuous-variable problems, this seminal text details essential developments that have substantially altered the field over the past decade. In its pages, pioneering experts provide a concise introduction to classical RL and DP, followed by an extensive presentation of the state-of-the-art and novel methods in RL and DP with approximation. Combining algorithm development with theoretical guarantees, they elaborate on their work with illustrative examples and insightful comparisons. Three individual chapters are dedicated to representative algorithms from each of the major classes of techniques: value iteration, policy iteration, and policy search. The features and performance of these algorithms are highlighted in extensive experimental studies on a range of control applications. The recent development of applications involving complex systems has led to a surge of interest in RL and DP methods and the subsequent need for a quality resource on the subject. For graduate students and others new to the field, this book offers a thorough introduction to both the basics and emerging methods. And for those researchers and practitioners working in the fields of optimal and adaptive control, machine learning, artificial intelligence, and operations research, this resource offers a combination of practical algorithms, theoretical analysis, and comprehensive examples that they will be able to adapt and apply to their own work. Access the authors' website at www.dcsc.tudelft.nl/rlbook/ for additional material, including computer code used in the studies and information concerning new developments.

Learn the science of collecting information to make effective decisions Everyday decisions are made without the benefit of accurate information. Optimal Learning develops the needed principles for gathering information to make decisions, especially when collecting information is time-consuming and expensive. Designed for readers with an elementary background in probability and statistics, the book presents effective and practical policies illustrated in a wide range of applications, from energy, homeland security, and transportation to engineering, health, and business. This book covers the fundamental dimensions of a learning problem and presents a simple method for testing and comparing policies for learning. Special attention is given to the knowledge gradient policy and its use with a wide range of belief models, including lookup table and parametric and for online and offline problems. Three sections develop ideas with increasing levels of sophistication: Fundamentals explores fundamental topics, including adaptive learning, ranking and selection, the knowledge gradient, and bandit problems Extensions and Applications features coverage of linear belief models, subset selection models, scalar function optimization, optimal bidding, and stopping problems Advanced Topics explores complex methods including simulation optimization, active learning in mathematical programming, and optimal continuous measurements Each chapter identifies a specific learning problem, presents the related, practical algorithms for implementation, and concludes with numerous exercises. A related website features additional applications and downloadable software, including MATLAB and the Optimal Learning Calculator, a spreadsheet-based package that provides an introduction to learning and a variety of policies for learning.

The capacitated lot-sizing problem (CLSP) is a core problem for successfully reducing overall costs in any production process. The exact approaches proposed for solving the CLSP are based on two major methods: mixed-integer programming and dynamic programming. This thesis provides a new idea for approximating the inventory cost function to be used in a truncated dynamic program for solving the CLSP. In the proposed method, by using only a partial dynamic process, the inventory cost function is approximated, and then the resulting approximate cost function is used as a value function in each stage of the approximate dynamic program. In this thesis, six different algorithms are developed for the CLSP, based on three different types of approximate dynamic programming approaches. The general methodology combines dynamic programming with data fitting and approximation techniques to estimate the inventory cost function at each stage of the dynamic program. Furthermore, three main algorithmic frameworks to compute a piecewise linear approximate inventory cost function for the CLSP are provided. The first approach integrates regression models into an approximate dynamic program. The second approach uses the information obtained by a partial dynamic process to approximate the piecewise linear inventory cost function. The third approach uses slope-check and bisection techniques to locate the breakpoints of the piecewise linear function in order to approximate the inventory cost function for the CLSP. The effectiveness of the proposed methods are analyzed on various types of CLSP instances with different cost and capacity characteristics. Computational results show that approximation approaches could considerably decrease the computational time required by the dynamic program and the integer program for different CLSP instances. Furthermore, in most cases, some of the proposed approaches can accurately capture the optimal solution of the problem.

Introduction to Stochastic Dynamic Programming presents the basic theory and examines the scope of applications of stochastic dynamic programming. The book begins with a chapter on various finite-stage models, illustrating the wide range of applications of stochastic dynamic programming. Subsequent chapters study infinite-stage models: discounting future returns, minimizing nonnegative costs, maximizing nonnegative returns, and maximizing the long-run average return. Each of these chapters first considers whether an optimal policy need exist—providing counterexamples where appropriate—and then presents methods for obtaining such policies when they do. In addition, general areas of application are presented. The final two chapters are concerned with more specialized models. These include stochastic scheduling models and a type of process known as a multiproject bandit. The mathematical prerequisites for this text are relatively few. No prior knowledge of dynamic programming is assumed and only a moderate familiarity with probability— including the use of conditional expectation—is necessary.

A research monograph providing a synthesis of old research on the foundations of dynamic programming, with the modern theory of approximate dynamic programming and new research on semicontractive models. It aims at a unified and economical development of the core theory and algorithms of total cost sequential decision problems, based on the strong connections of the subject with fixed point theory. The analysis focuses on the abstract mapping that underlies dynamic programming and defines the mathematical character of the associated problem. The discussion centers on two fundamental properties that this mapping may have: monotonicity and (weighted sup-norm) contraction. It turns out that the nature of the analytical and algorithmic DP theory is determined primarily by the presence or absence of these two properties, and the rest of the problem's structure is largely inconsequential. New research is focused on two areas: 1) The ramifications of these properties in the context of algorithms for approximate dynamic programming, and 2) The new class of semicontractive models, exemplified by stochastic shortest path problems, where some but not all policies are contractive. The 2nd edition aims primarily to amplify the presentation of the semicontractive models of Chapter 3 and Chapter 4 of the first (2013) edition, and to supplement it with a broad spectrum of research results that I obtained and published in journals and reports since the first edition was written (see below). As a result, the size of this material more than doubled, and the size of the book increased by nearly 40%. The book is an excellent supplement to several of our books: Dynamic Programming and Optimal Control (Athena Scientific, 2017), and Neuro-Dynamic Programming (Athena Scientific, 1996).