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Introduction to sequential decision processes covers use of dynamic programming in studying models of resource allocation, methods for approximating solutions of control problems in continuous time, production control, more. 1982 edition. Dynamic programming is a powerful method for solving optimization problems, but has a number of drawbacks that limit its use to solving problems of very low dimension. To overcome these limitations, author Rein Luus suggested using it in an iterative fashion. Although this method required vast computer resources, modifications to his original schem A successor to the first and second editions, this updated and revised book is a leading companion guide for students and engineers alike, specifically software engineers who design algorithms. While succinct, this edition is mathematically rigorous, covering the foundations for both computer scientists and mathematicians with interest in the algorithmic foundations of Computer Science. Besides expositions on traditional algorithms such as Greedy, Dynamic Programming and Divide & Conquer, the book explores two classes of algorithms that are often overlooked in introductory textbooks: Randomised and Online algorithms — with emphasis placed on the algorithm itself. The book also covers algorithms in Linear Algebra, and the foundations of Computation. The coverage of Randomized and Online algorithms is timely: the former have become ubiquitous due to the emergence of cryptography, while the latter are essential in numerous fields as diverse as operating systems and stock market predictions. While being relatively short to ensure the essentiality of content, a strong focus has been placed on self-containment, introducing the idea of pre/post-conditions and loop invariants to readers of all backgrounds, as well as all the necessary mathematical foundations. The programming exercises in Python will be available on the web (see http: //www.msoltys.com/book for the companion web site). Contents: Preliminaries Greedy Algorithms Divide and Conquer Dynamic Programming Online Algorithms Randomized Algorithms Algorithms in Linear Algebra Computational Foundations Mathematical Foundations Readership: Students of undergraduate courses in algorithms and programming and associated professionals. Keywords: Algorithms;Greedy;Dynamic Programming;Online;Randomized;Loop InvariantReview:0 Ideal as a comprehensive introduction to fundamental algorithms for basic curves and surfaces, or for a deeper understanding of entities with which readers may be familiar, this book presents a simple approach to the entire structure of algorithms. The Art and Theory of Dynamic Programming A successor to the first edition, this updated and revised book is a great companion guide for students and engineers alike, specifically software engineers who design reliable code. While succinct, this edition is mathematically rigorous, covering the foundations of both computer scientists and mathematicians with interest in algorithms. Besides covering the traditional algorithms of Computer Science such as Greedy, Dynamic Programming and Divide & Conquer, this edition goes further by exploring two classes of algorithms that are often overlooked: Randomised and Online algorithms — with emphasis placed on the algorithm itself. The coverage of both fields are timely as the ubiquity of Randomised algorithms are expressed through the emergence of cryptography while Online algorithms are essential in numerous fields as diverse as operating systems and stock market predictions. While being relatively short to ensure the essentiality of content, a strong focus has been placed on self-containment, introducing the idea of pre/post-conditions and loop invariants to readers of all backgrounds. Containing programming exercises in Python, solutions will also be placed on the book's website. Contents:PreliminariesGreedy AlgorithmsDivide and ConquerDynamic ProgrammingOnline AlgorithmsRandomized AlgorithmsAppendix A: Number Theory and Group TheoryAppendix B: RelationsAppendix C: Logic Readership: Students of undergraduate courses in algorithms and programming. Keywords:Algorithms;Greedy;Dynamic Programming;Online;Randomized;Loop InvariantKey Features:The book is concise, and of a portable size that can be conveniently carried around by studentsIt emphasizes correctness of algorithms: how to prove them correct, which is of great importance to software engineersIt contains a chapter on randomized algorithms and applications to cryptography, as well as a chapter on online algorithms and applications to caching/paging, both of which are relevant and current topicsReviews: “Summing up, the book contains very nice introductory material for beginners in the area of correct algorithm's design.” Zentralblatt MATH In this report, a number of Dynamic Programming algorithms for three versions of the Aircraft Sequencing problem are developed. In these, two alternative objectives are considered: How to land all of a prescribed set of airplanes as soon as possible, or alternatively, how to minimize the total passenger waiting time. All these three versions are "static", namely, no intermediate aircraft arrivals are accepted until our initial set of airplanes land. The versions examined are (a) The single runway-unconstrained case, (b) The single runway-Constrained Position Shifting (CPS) case and (c) The two-runway-unconstrained case. In the unconstrained case, no priority considerations exist for the airplanes of our system. By contrast, CPS prohibits the shifting of any particular airplane by more than a prespecified number of positions (MPS) from its initial position in the queue. All three algorithms exploit the fact that the airplanes in our system can be classified into a relatively small number of distinct categories and thus, realize drastic savings in computational effort, which is shown to be a polynomially bounded function of the number of airplanes per category. The CPS problem is formulated in (b) in a recursive way, so that for any value of MPS, the computational effort remains polynomially bounded as described above. All algorithms of this work are tested by various examples and the results are discussed. Implementation issues are considered and suggestions on how this work can be extended are made. I wanted to compute 80th term of the Fibonacci series. I wrote the rampant recursive function, int fib(int n){ return (1==n 2==n) ? 1: fib(n-1) + fib(n-2); } and waited for the result. I wait... and wait... and wait... With an 8GB RAM and an Intel i5 CPU, why is it taking so long? I terminated the process and tried computing the 40th term. It took about a second. I put a check and was shocked to find that the above recursive function was called 204,668,309 times while computing the 40th term. More than 200 million times? Is it reporting function calls or scam of some government? The Dynamic Programming solution computes 100th Fibonacci term in less than fraction of a second, with a single function call, taking linear time and constant extra memory. A recursive solution, usually, neither pass all test cases in a coding competition, nor does it impress the interviewer in an interview of company like Google, Microsoft, etc. The most difficult questions asked in competitions and interviews, are from dynamic programming. This book takes Dynamic Programming head-on. It first explain the concepts with simple examples and then deep dives into complex DP problems. A complete resource to Approximate Dynamic Programming (ADP), including on-line simulation code Provides a tutorial that readers can use to start implementing the learning algorithms provided in the book Includes ideas, directions, and recent results on current research issues and addresses applications where ADP has been successfully implemented The contributors are leading researchers in the field This book presents a class of novel, self-learning, optimal control schemes based on adaptive dynamic programming techniques, which quantitatively obtain the optimal control schemes of the systems. It analyzes the properties identified by the programming methods, including the convergence of the iterative value functions and the stability of the system under iterative control laws, helping to guarantee the effectiveness of the methods developed. When the system model is known, self-learning optimal control is designed on the basis of the system model; when the system model is not known, adaptive dynamic programming is implemented according to the system data, effectively making the performance of the system converge to the optimum. With various real-world examples to complement and substantiate the mathematical analysis, the book is a valuable guide for engineers, researchers, and students in control science and 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. 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 is the 3rd edition of a research monograph providing a synthesis of old research on the foundations of dynamic programming (DP), with the modern theory of approximate DP 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 DP 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 DP, and 2) The new class of semicontractive models, exemplified by stochastic shortest path problems, where some but not all policies are contractive. The 3rd edition is very similar to the 2nd edition, except for the addition of a new chapter (Chapter 5), which deals with abstract DP models for sequential minimax problems and zero-sum games, The book is an excellent supplement to several of our books: Neuro-Dynamic Programming (Athena Scientific, 1996), Dynamic Programming and Optimal Control (Athena Scientific, 2017), Reinforcement Learning and Optimal Control (Athena Scientific, 2019), and Rollout, Policy Iteration, and Distributed Reinforcement Learning (Athena Scientific, 2020). The real challenge of programming isn't learning a language's syntax—it's learning to creatively solve problems so you can build something great. In this one-of-a-kind text, author V. Anton Spraul breaks down the ways that programmers solve problems and teaches you what other introductory books often ignore: how to Think Like a Programmer. Each chapter tackles a single programming concept, like classes, pointers, and recursion, and open-ended exercises throughout challenge you to apply your knowledge. You'll also learn how to: –Split problems into discrete components to make them easier to solve –Make the most of code reuse with functions, classes, and libraries –Pick the perfect data structure for a particular job –Master more advanced programming tools like recursion and dynamic memory –Organize your thoughts and develop strategies to tackle particular types of problems Although the book's examples are written in C++, the creative problem-solving concepts they illustrate go beyond any particular language; in fact, they often reach outside the realm of computer science. As the most skillful programmers know, writing great code is a creative art—and the first step in creating your masterpiece is learning to Think Like a Programmer. THIS TEXTBOOK is about computer science. It is also about Python. However, there is much more. The study of algorithms and data structures is central to understanding what computer science is all about. Learning computer science is not unlike learning any other type of difficult subject matter. The only way to be successful is through deliberate and incremental exposure to the fundamental ideas. A beginning computer scientist needs practice so that there is a thorough understanding before continuing on to the more complex parts of the curriculum. In addition, a beginner needs to be given the opportunity to be successful and gain confidence. This textbook is designed to serve as a text for a first course on data structures and algorithms, typically taught as the second course in the computer science curriculum. Even though the second course is considered more advanced than the first course, this book assumes you are beginners at this level. You may still be struggling with some of the basic ideas and skills from a first computer science course and yet be ready to further explore the discipline and continue to practice problem solving. We cover abstract data types and data structures, writing algorithms, and solving problems. We look at a number of data structures and solve classic problems that arise. The tools and techniques that you learn here will be applied over and over as you continue your study of computer science. The main purpose of the book is to show how a viscosity approach can be used to tackle control problems in insurance. The problems covered are the maximization of survival probability as well as the maximization of dividends in the classical collective risk model. The authors consider the possibility of controlling the risk process by reinsurance as well as by investments. They show that optimal value functions are characterized as either the unique or the smallest viscosity solution of the associated Hamilton-Jacobi-Bellman equation; they also study the structure of the optimal strategies and show how to find them. The viscosity approach was widely used in control problems related to mathematical finance but until quite recently it was not used to solve control problems related to actuarial mathematical science. This book is designed to familiarize the reader on how to use this approach. The intended audience is graduate students as well as researchers in this area. The management of agricultural and natural resource systems; The methods of dynamic programming; Dynamic programming applications to agriculture; Dynamic programming applications to natural resources. An introduction to the mathematical theory of multistage decision processes, this text takes a "functional equation" approach to the discovery of optimum policies. The text examines existence and uniqueness theorems, the optimal inventory equation, bottleneck problems in multistage production processes, a new formalism in the calculus of variation, multistage games, and more. 1957 edition. Includes 37 figures. I wanted to compute 80th term of the Fibonacci series. I wrote the rampant recursive function, int fib(int n){ return (1==n || 2==n) ? 1 : fib(n-1) + fib(n-2); } and waited for the result. I wait… and wait… and wait… With an 8GB RAM and an Intel i5 CPU, why is it taking so long? I terminated the process and tried computing the 40th term. It took about a second. I put a check and was shocked to find that the above recursive function was called 204,668,309 times while computing the 40th term. More than 200 million times? Is it reporting function calls or scam of some government? The Dynamic Programming solution computes 100th Fibonacci term in less than fraction of a second, with a single function call, taking linear time and constant extra memory. A recursive solution, usually, neither pass all test cases in a coding competition, nor does it impress the interviewer in an interview of company like Google, Microsoft, etc. The most difficult questions asked in competitions and interviews, are from dynamic programming. This book takes Dynamic Programming head-on. It first explain the concepts with simple examples and then deep dives into complex DP problems. A student introduction to the design of algorithms for problem solving. Written from a functional programming perspective, the text should appeal to anyone studying algorithms. Included are end-of-chapter exercises and bibliographic references. Mathematical programming: an overview; solving linear programs; sensitivity analysis; duality in linear programming; mathematical programming in practice; integration of strategic and tactical planning in the aluminum industry; planning the mission and composition of the U.S. merchant Marine fleet; network models; integer programming; design of a naval tender job shop; dynamic programming; large-scale systems; nonlinear programming; a system for bank portfolio planning; vectors and matrices; linear programming in matrix form; a labeling algorithm for the maximun-flow network problem. Master's Thesis from the year 2016 in the subject Economy - Environment economics, grade: 1,7, Technical University of Munich, course: Finance & Information Management, language: English, abstract: The impact of global warming on the global economy has been widely discussed in literature offering a broad variety of estimates. Some papers have examined global impacts of climate change, whereas some studies have focused on regional or local consequences. Taking into account various different publications, the first part of this master's thesis proposes individual functions at a country level that illustrate the impact of global warming. These functions are further used to simulate the countries' behaviour over time using dynamic programming. We provide an analysis of the interaction between the abatement costs, the ecological impact caused by a certain temperature increase and the abatement efforts made by the countries. A detailed analysis of their behaviour including the formation of coalitions rounds out the first part of the thesis. The second part considers recent proposals from the academic and political world. The 21st session of the Conference of Parties (COP21) in December 2015 was described as a fundamental breakthrough in climate negotiations by many commentators. However, several issues such as the establishment of binding quotas for the Parties being linked to the 2C global mitigation target remain unsolved. We simulate the efforts of the Parties to reduce their emissions based on individual abatement targets. To the best of our knowledge, our approach is the first one to analyze the behaviour of countries in a climate change context using dynamic programming. All components of the Matlab program providing the results are flexible and can be changed according to the assumptions. The first edition won the award for Best 1990 Professional and Scholarly Book in Computer Science and Data

Processing by the Association of American Publishers. There are books on algorithms that are rigorous but incomplete and others that cover masses of material but lack rigor. Introduction to Algorithms combines rigor and comprehensiveness. The book covers a broad range of algorithms in depth, yet makes their design and analysis accessible to all levels of readers. Each chapter is relatively self-contained and can be used as a unit of study. The algorithms are described in English and in a pseudocode designed to be readable by anyone who has done a little programming. The explanations have been kept elementary without sacrificing depth of coverage or mathematical rigor. The first edition became the standard reference for professionals and a widely used text in universities worldwide. The second edition features new chapters on the role of algorithms, probabilistic analysis and randomized algorithms, and linear programming, as well as extensive revisions to virtually every section of the book. In a subtle but important change, loop invariants are introduced early and used throughout the text to prove algorithm correctness. Without changing the mathematical and analytic focus, the authors have moved much of the mathematical foundations material from Part I to an appendix and have included additional motivational material at the beginning. 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. Approximate Dynamic Programming is a result of the author's decades of experience working in large industrial settings to develop practical and high-quality solutions to problems that involve making decisions in the presence of uncertainty. 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 strategies from operations research to treat complex stochastic optimization problems. Designed as an introduction and assuming no prior training in dynamic programming of any form, Approximate Dynamic Programming contains dozens of algorithms that are intended to serve as a starting point in the design of practical solutions for real problems. The book provides detailed coverage of implementation challenges including: modeling complex sequential decision processes under uncertainty, identifying robust policies, designing and estimating value function approximations, choosing effective stepsize rules, and resolving convergence issues. With a focus on modeling and algorithms in conjunction with the language of mainstream operations research, artificial intelligence, and control theory, Approximate Dynamic Programming: Models complex, high-dimensional problems in a natural and practical way, which draws on years of industrial projects Introduces and emphasizes the power of estimating a value function around the post-decision state, allowing solution algorithms to be broken down into three fundamental steps: classical simulation, classical optimization, and classical statistics Presents a thorough discussion of recursive estimation, including fundamental theory and a number of issues that arise in the development of practical algorithms Offers a variety of methods for approximating dynamic programs that have appeared in previous literature, but that have never been presented in the coherent format of a book Motivated by examples from modern-day operations research, Approximate Dynamic Programming is an accessible introduction to dynamic modeling and is also a valuable guide for the development of high-quality solutions to problems that exist in operations research and engineering. The clear and precise presentation of the material makes this an appropriate text for advanced undergraduate and beginning graduate courses, while also serving as a reference for researchers and practitioners. A companion Web site is available for readers, which includes additional exercises, solutions to exercises, and data sets to reinforce the book's main concepts.