

Mausam · Andrey Kolobov

# Planning with Markov Decision Processes

An AI Perspective

# Planning With Markov Decision Processes An Ai Perspective Mausam

**Mausam, Andrey Kolobov**



## **Planning With Markov Decision Processes An Ai Perspective Mausam:**

*Planning with Markov Decision Processes* Mausam, Andrey Kolobov, 2012 Provides a concise introduction to the use of Markov Decision Processes for solving probabilistic planning problems with an emphasis on the algorithmic perspective It covers the whole spectrum of the field from the basics to state of the art optimal and approximation algorithms [Planning with Markov Decision Processes](#) Mausam Natarajan, Andrey Kolobov, 2022-06-01 Markov Decision Processes MDPs are widely popular in Artificial Intelligence for modeling sequential decision making scenarios with probabilistic dynamics They are the framework of choice when designing an intelligent agent that needs to act for long periods of time in an environment where its actions could have uncertain outcomes MDPs are actively researched in two related subareas of AI probabilistic planning and reinforcement learning Probabilistic planning assumes known models for the agent's goals and domain dynamics and focuses on determining how the agent should behave to achieve its objectives On the other hand reinforcement learning additionally learns these models based on the feedback the agent gets from the environment This book provides a concise introduction to the use of MDPs for solving probabilistic planning problems with an emphasis on the algorithmic perspective It covers the whole spectrum of the field from the basics to state of the art optimal and approximation algorithms We first describe the theoretical foundations of MDPs and the fundamental solution techniques for them We then discuss modern optimal algorithms based on heuristic search and the use of structured representations A major focus of the book is on the numerous approximation schemes for MDPs that have been developed in the AI literature These include determinization based approaches sampling techniques heuristic functions dimensionality reduction and hierarchical representations Finally we briefly introduce several extensions of the standard MDP classes that model and solve even more complex planning problems Table of Contents Introduction MDPs Fundamental Algorithms Heuristic Search Algorithms Symbolic Algorithms Approximation Algorithms Advanced Notes **Cognitive Electronic Warfare: An Artificial Intelligence Approach**

Karen Haigh, Julia Andrusenko, 2021-07-31 This comprehensive book gives an overview of how cognitive systems and artificial intelligence AI can be used in electronic warfare EW Readers will learn how EW systems respond more quickly and effectively to battlefield conditions where sophisticated radars and spectrum congestion put a high priority on EW systems that can characterize and classify novel waveforms discern intent and devise and test countermeasures Specific techniques are covered for optimizing a cognitive EW system as well as evaluating its ability to learn new information in real time The book presents AI for electronic support ES including characterization classification patterns of life and intent recognition Optimization techniques including temporal tradeoffs and distributed optimization challenges are also discussed The issues concerning real time in mission machine learning and suggests some approaches to address this important challenge are presented and described The book covers electronic battle management data management and knowledge sharing Evaluation approaches including how to show that a machine learning system can learn how to handle novel environments are also

discussed Written by experts with first hand experience in AI based EW this is the first book on in mission real time learning and optimization

**Agents and Artificial Intelligence** Ana Paula Rocha, Luc Steels, Jaap van den Herik, 2024-03-14 This book contains the revised and extended versions of selected papers from the 15th International Conference on Agents and Artificial Intelligence ICAART 2023 held in Lisbon Portugal during February 22 24 2023 The 23 full papers included in this book were carefully reviewed and selected from 306 submissions The conference was organized in 2 tracks as follows One track focuses on Agents Multi Agent Systems and Software Platforms Distributed Problem Solving and Distributed AI in general The other track focuses mainly on Artificial Intelligence Knowledge Representation Planning Learning Scheduling Perception Reactive AI Systems and Evolutionary Computing and other topics related to Intelligent Systems and Computational Intelligence

**Statistical Relational Artificial Intelligence** Luc De Raedt, Kristian Kersting, Sriraam Natarajan, David Poole, 2022-05-31 An intelligent agent interacting with the real world will encounter individual people courses test results drugs prescriptions chairs boxes etc and needs to reason about properties of these individuals and relations among them as well as cope with uncertainty Uncertainty has been studied in probability theory and graphical models and relations have been studied in logic in particular in the predicate calculus and its extensions This book examines the foundations of combining logic and probability into what are called relational probabilistic models It introduces representations inference and learning techniques for probability logic and their combinations The book focuses on two representations in detail Markov logic networks a relational extension of undirected graphical models and weighted first order predicate calculus formula and Problog a probabilistic extension of logic programs that can also be viewed as a Turing complete relational extension of Bayesian networks

**Introduction to Symbolic Plan and Goal Recognition** Reuth Mirsky, Sarah Keren, Christopher Geib, 2022-05-31 Plan recognition activity recognition and goal recognition all involve making inferences about other actors based on observations of their interactions with the environment and other agents This synergistic area of research combines unites and makes use of techniques and research from a wide range of areas including user modeling machine vision automated planning intelligent user interfaces human computer interaction autonomous and multi agent systems natural language understanding and machine learning It plays a crucial role in a wide variety of applications including assistive technology software assistants computer and network security human robot collaboration natural language processing video games and many more This wide range of applications and disciplines has produced a wealth of ideas models tools and results in the recognition literature However it has also contributed to fragmentation in the field with researchers publishing relevant results in a wide spectrum of journals and conferences This book seeks to address this fragmentation by providing a high level introduction and historical overview of the plan and goal recognition literature It provides a description of the core elements that comprise these recognition problems and practical advice for modeling them In particular we define and distinguish the different recognition tasks We formalize the major approaches to modeling these

problems using a single motivating example Finally we describe a number of state of the art systems and their extensions future challenges and some potential applications

*Robot Learning from Human Teachers* Sonia Chernova,Andrea L. Thomaz,2022-06-01 Learning from Demonstration LfD explores techniques for learning a task policy from examples provided by a human teacher The field of LfD has grown into an extensive body of literature over the past 30 years with a wide variety of approaches for encoding human demonstrations and modeling skills and tasks Additionally we have recently seen a focus on gathering data from non expert human teachers i e domain experts but not robotics experts In this book we provide an introduction to the field with a focus on the unique technical challenges associated with designing robots that learn from naive human teachers We begin in the introduction with a unification of the various terminology seen in the literature as well as an outline of the design choices one has in designing an LfD system Chapter 2 gives a brief survey of the psychology literature that provides insights from human social learning that are relevant to designing robotic social learners Chapter 3 walks through an LfD interaction surveying the design choices one makes and state of the art approaches in prior work First is the choice of input how the human teacher interacts with the robot to provide demonstrations Next is the choice of modeling technique Currently there is a dichotomy in the field between approaches that model low level motor skills and those that model high level tasks composed of primitive actions We devote a chapter to each of these Chapter 7 is devoted to interactive and active learning approaches that allow the robot to refine an existing task model And finally Chapter 8 provides best practices for evaluation of LfD systems with a focus on how to approach experiments with human subjects in this domain

**Representing and Reasoning with Qualitative Preferences** Ganesh Ram Santhanam,Samik Basu,Vasant Honavar,2022-05-31 This book provides a tutorial introduction to modern techniques for representing and reasoning about qualitative preferences with respect to a set of alternatives The syntax and semantics of several languages for representing preference languages including CP nets TCP nets CI nets and CP theories are reviewed Some key problems in reasoning about preferences are introduced including determining whether one alternative is preferred to another or whether they are equivalent with respect to a given set of preferences These tasks can be reduced to model checking in temporal logic Specifically an induced preference graph that represents a given set of preferences can be efficiently encoded using a Kripke Structure for Computational Tree Logic CTL One can translate preference queries with respect to a set of preferences into an equivalent set of formulae in CTL such that the CTL formula is satisfied whenever the preference query holds This allows us to use a model checker to reason about preferences i e answer preference queries and to obtain a justification as to why a preference query is satisfied or not with respect to a set of preferences This book defines the notions of the equivalence of two sets of preferences including what it means for one set of preferences to subsume another and shows how to answer preferential equivalence and subsumption queries using model checking Furthermore this book demonstrates how to generate alternatives ordered by preference along with providing ways to deal with inconsistent preference specifications A

description of CRISNER an open source software implementation of the model checking approach to qualitative preference reasoning in CP nets TCP nets and CP theories is included as well as examples illustrating its use

*Introduction to Graph Neural Networks* Zhiyuan Liu, Jie Zhou, 2022-05-31 Graphs are useful data structures in complex real life applications such as modeling physical systems learning molecular fingerprints controlling traffic networks and recommending friends in social networks However these tasks require dealing with non Euclidean graph data that contains rich relational information between elements and cannot be well handled by traditional deep learning models e g convolutional neural networks CNNs or recurrent neural networks RNNs Nodes in graphs usually contain useful feature information that cannot be well addressed in most unsupervised representation learning methods e g network embedding methods Graph neural networks GNNs are proposed to combine the feature information and the graph structure to learn better representations on graphs via feature propagation and aggregation Due to its convincing performance and high interpretability GNN has recently become a widely applied graph analysis tool This book provides a comprehensive introduction to the basic concepts models and applications of graph neural networks It starts with the introduction of the vanilla GNN model Then several variants of the vanilla model are introduced such as graph convolutional networks graph recurrent networks graph attention networks graph residual networks and several general frameworks Variants for different graph types and advanced training methods are also included As for the applications of GNNs the book categorizes them into structural non structural and other scenarios and then it introduces several typical models on solving these tasks Finally the closing chapters provide GNN open resources and the outlook of several future directions

**Metric Learning** Aurélien Mui, Amaury Yang, 2022-05-31 Similarity between objects plays an important role in both human cognitive processes and artificial systems for recognition and categorization How to appropriately measure such similarities for a given task is crucial to the performance of many machine learning pattern recognition and data mining methods This book is devoted to metric learning a set of techniques to automatically learn similarity and distance functions from data that has attracted a lot of interest in machine learning and related fields in the past ten years In this book we provide a thorough review of the metric learning literature that covers algorithms theory and applications for both numerical and structured data We first introduce relevant definitions and classic metric functions as well as examples of their use in machine learning and data mining We then review a wide range of metric learning algorithms starting with the simple setting of linear distance and similarity learning We show how one may scale up these methods to very large amounts of training data To go beyond the linear case we discuss methods that learn nonlinear metrics or multiple linear metrics throughout the feature space and review methods for more complex settings such as multi task and semi supervised learning Although most of the existing work has focused on numerical data we cover the literature on metric learning for structured data like strings trees graphs and time series In the more technical part of the book we present some recent statistical frameworks for analyzing the generalization performance in metric learning and derive results for some of

the algorithms presented earlier Finally we illustrate the relevance of metric learning in real world problems through a series of successful applications to computer vision bioinformatics and information retrieval Table of Contents Introduction Metrics Properties of Metric Learning Algorithms Linear Metric Learning Nonlinear and Local Metric Learning Metric Learning for Special Settings Metric Learning for Structured Data Generalization Guarantees for Metric Learning Applications Conclusion Bibliography Authors Biographies

*An Introduction to Constraint-Based Temporal Reasoning* Roman Barták, Robert A. Morris, K. Brent Venable, 2022-05-31 Solving challenging computational problems involving time has been a critical component in the development of artificial intelligence systems almost since the inception of the field This book provides a concise introduction to the core computational elements of temporal reasoning for use in AI systems for planning and scheduling as well as systems that extract temporal information from data It presents a survey of temporal frameworks based on constraints both qualitative and quantitative as well as of major temporal consistency techniques The book also introduces the reader to more recent extensions to the core model that allow AI systems to explicitly represent temporal preferences and temporal uncertainty This book is intended for students and researchers interested in constraint based temporal reasoning It provides a self contained guide to the different representations of time as well as examples of recent applications of time in AI systems

**Graph-Based Semi-Supervised Learning** Amarnag Subramanya, Partha Pratim Talukdar, 2022-05-31 While labeled data is expensive to prepare ever increasing amounts of unlabeled data is becoming widely available In order to adapt to this phenomenon several semi supervised learning SSL algorithms which learn from labeled as well as unlabeled data have been developed In a separate line of work researchers have started to realize that graphs provide a natural way to represent data in a variety of domains Graph based SSL algorithms which bring together these two lines of work have been shown to outperform the state of the art in many applications in speech processing computer vision natural language processing and other areas of Artificial Intelligence Recognizing this promising and emerging area of research this synthesis lecture focuses on graph based SSL algorithms e g label propagation methods Our hope is that after reading this book the reader will walk away with the following 1 an in depth knowledge of the current state of the art in graph based SSL algorithms and the ability to implement them 2 the ability to decide on the suitability of graph based SSL methods for a problem and 3 familiarity with different applications where graph based SSL methods have been successfully applied Table of Contents Introduction Graph Construction Learning and Inference Scalability Applications Future Work Bibliography Authors Biographies Index

**Reasoning with Probabilistic and Deterministic Graphical Models** Rina Kraus, 2022-12-06 Graphical models e g Bayesian and constraint networks influence diagrams and Markov decision processes have become a central paradigm for knowledge representation and reasoning in both artificial intelligence and computer science in general These models are used to perform many reasoning tasks such as scheduling planning and learning diagnosis and prediction design hardware and software verification and bioinformatics These problems

can be stated as the formal tasks of constraint satisfaction and satisfiability combinatorial optimization and probabilistic inference It is well known that the tasks are computationally hard but research during the past three decades has yielded a variety of principles and techniques that significantly advanced the state of the art In this book we provide comprehensive coverage of the primary exact algorithms for reasoning with such models The main feature exploited by the algorithms is the model's graph We present inference based message passing schemes e.g. variable elimination and search based conditioning schemes e.g. cycle cutset conditioning and AND/OR search Each class possesses distinguished characteristics and in particular has different time vs space behavior We emphasize the dependence of both schemes on few graph parameters such as the treewidth cycle cutset and the pseudo tree height We believe the principles outlined here would serve well in moving forward to approximation and anytime based schemes The target audience of this book is researchers and students in the artificial intelligence and machine learning area and beyond

**Introduction to Logic Programming** Michael Genesereth, Vinay K. Chaudhri, 2022-06-01 Logic Programming is a style of programming in which programs take the form of sets of sentences in the language of Symbolic Logic Over the years there has been growing interest in Logic Programming due to applications in deductive databases automated worksheets Enterprise Management business rules Computational Law and General Game Playing This book introduces Logic Programming theory current technology and popular applications In this volume we take an innovative model theoretic approach to logic programming We begin with the fundamental notion of datasets i.e. sets of ground atoms Given this fundamental notion we introduce views i.e. virtual relations and we define classical logic programs as sets of view definitions written using traditional Prolog like notation but with semantics given in terms of datasets rather than implementation We then introduce actions i.e. additions and deletions of ground atoms and we define dynamic logic programs as sets of action definitions In addition to the printed book there is an online version of the text with an interpreter and a compiler for the language used in the text and an integrated development environment for use in developing and deploying practical logic programs

**Introduction to Intelligent Systems in Traffic and Transportation** Ana L.C. Bazzan, Franziska Klügl, 2022-05-31 Urban mobility is not only one of the pillars of modern economic systems but also a key issue in the quest for equality of opportunity once it can improve access to other services Currently however there are a number of negative issues related to traffic especially in mega cities such as economical issues cost of opportunity caused by delays environmental externalities related to emissions of pollutants and social traffic accidents Solutions to these issues are more and more closely tied to information and communication technology Indeed a search in the technical literature using the keyword urban traffic to filter out articles on data network traffic retrieved the following number of articles as of December 3 2013 9 443 ACM Digital Library 26 054 Scopus and 1 730 000 Google Scholar Moreover articles listed in the ACM query relate to conferences as diverse as MobiCom CHI PADS and AAMAS This means that there is a big and diverse community of computer scientists and computer engineers who tackle research that is connected to the



development of intelligent traffic and transportation systems It is also possible to see that this community is growing and that research projects are getting more and more interdisciplinary To foster the cooperation among the involved communities this book aims at giving a broad introduction into the basic but relevant concepts related to transportation systems targeting researchers and practitioners from computer science and information technology In addition the second part of the book gives a panorama of some of the most exciting and newest technologies originating in computer science and computer engineering that are now being employed in projects related to car to car communication interconnected vehicles car navigation platooning crowd sensing and sensor networks among others This material will also be of interest to engineers and researchers from the traffic and transportation community

#### **Judgment Aggregation** Davide Grossi, Gabriella

Pigozzi, 2022-06-01 Judgment aggregation is a mathematical theory of collective decision making It concerns the methods whereby individual opinions about logically interconnected issues of interest can or cannot be aggregated into one collective stance Aggregation problems have traditionally been of interest for disciplines like economics and the political sciences as well as philosophy where judgment aggregation itself originates from but have recently captured the attention of disciplines like computer science artificial intelligence and multi agent systems Judgment aggregation has emerged in the last decade as a unifying paradigm for the formalization and understanding of aggregation problems Still no comprehensive presentation of the theory is available to date This Synthesis Lecture aims at filling this gap presenting the key motivations results abstractions and techniques underpinning it Table of Contents Preface Acknowledgments Logic Meets Social Choice Theory Basic Concepts Impossibility Coping with Impossibility Manipulability Aggregation Rules Deliberation Bibliography Authors Biographies Index

#### **Federated Learning** Qiang Yang, Yang Liu, Yong Cheng, Yan Kang, Tianjian Chen, Han Yu, 2022-06-01

How is it possible to allow multiple data owners to collaboratively train and use a shared prediction model while keeping all the local training data private Traditional machine learning approaches need to combine all data at one location typically a data center which may very well violate the laws on user privacy and data confidentiality Today many parts of the world demand that technology companies treat user data carefully according to user privacy laws The European Union's General Data Protection Regulation GDPR is a prime example In this book we describe how federated machine learning addresses this problem with novel solutions combining distributed machine learning cryptography and security and incentive mechanism design based on economic principles and game theory We explain different types of privacy preserving machine learning solutions and their technological backgrounds and highlight some representative practical use cases We show how federated learning can become the foundation of next generation machine learning that caters to technological and societal needs for responsible AI development and application

#### **Lifelong Machine Learning** Zhiyuan Chaudhri, Bing

Liu, 2022-11-10 Lifelong Machine Learning or Lifelong Learning is an advanced machine learning paradigm that learns continuously accumulates the knowledge learned in previous tasks and uses it to help future learning In the process the

learner becomes more and more knowledgeable and effective at learning This learning ability is one of the hallmarks of human intelligence However the current dominant machine learning paradigm learns in isolation given a training dataset it runs a machine learning algorithm on the dataset to produce a model It makes no attempt to retain the learned knowledge and use it in future learning Although this isolated learning paradigm has been very successful it requires a large number of training examples and is only suitable for well defined and narrow tasks In comparison we humans can learn effectively with a few examples because we have accumulated so much knowledge in the past which enables us to learn with little data or effort Lifelong learning aims to achieve this capability As statistical machine learning matures it is time to make a major effort to break the isolated learning tradition and to study lifelong learning to bring machine learning to new heights Applications such as intelligent assistants chatbots and physical robots that interact with humans and systems in real life environments are also calling for such lifelong learning capabilities Without the ability to accumulate the learned knowledge and use it to learn more knowledge incrementally a system will probably never be truly intelligent This book serves as an introductory text and survey to lifelong learning

### **General Game Playing** Michael Genesereth, Michael

Thielscher, 2022-06-01 General game players are computer systems able to play strategy games based solely on formal game descriptions supplied at runtime in other words they don't know the rules until the game starts Unlike specialized game players such as Deep Blue general game players cannot rely on algorithms designed in advance for specific games they must discover such algorithms themselves General game playing expertise depends on intelligence on the part of the game player and not just intelligence of the programmer of the game player GGP is an interesting application in its own right It is intellectually engaging and more than a little fun But it is much more than that It provides a theoretical framework for modeling discrete dynamic systems and defining rationality in a way that takes into account problem representation and complexities like incompleteness of information and resource bounds It has practical applications in areas where these features are important e.g. in business and law More fundamentally it raises questions about the nature of intelligence and serves as a laboratory in which to evaluate competing approaches to artificial intelligence This book is an elementary introduction to General Game Playing GGP 1 It presents the theory of General Game Playing and leading GGP technologies 2 It shows how to create GGP programs capable of competing against other programs and humans 3 It offers a glimpse of some of the real world applications of General Game Playing

### **Adversarial Machine Learning** Yevgeniy Vorobeychik, Murat

Kantarcioglu, 2022-05-31 The increasing abundance of large high quality datasets combined with significant technical advances over the last several decades have made machine learning into a major tool employed across a broad array of tasks including vision language finance and security However success has been accompanied with important new challenges many applications of machine learning are adversarial in nature Some are adversarial because they are safety critical such as autonomous driving An adversary in these applications can be a malicious party aimed at causing congestion or accidents or

may even model unusual situations that expose vulnerabilities in the prediction engine Other applications are adversarial because their task and or the data they use are For example an important class of problems in security involves detection such as malware spam and intrusion detection The use of machine learning for detecting malicious entities creates an incentive among adversaries to evade detection by changing their behavior or the content of malicious objects they develop The field of adversarial machine learning has emerged to study vulnerabilities of machine learning approaches in adversarial settings and to develop techniques to make learning robust to adversarial manipulation This book provides a technical overview of this field After reviewing machine learning concepts and approaches as well as common use cases of these in adversarial settings we present a general categorization of attacks on machine learning We then address two major categories of attacks and associated defenses decision time attacks in which an adversary changes the nature of instances seen by a learned model at the time of prediction in order to cause errors and poisoning or training time attacks in which the actual training dataset is maliciously modified In our final chapter devoted to technical content we discuss recent techniques for attacks on deep learning as well as approaches for improving robustness of deep neural networks We conclude with a discussion of several important issues in the area of adversarial learning that in our view warrant further research Given the increasing interest in the area of adversarial machine learning we hope this book provides readers with the tools necessary to successfully engage in research and practice of machine learning in adversarial settings

Planning With Markov Decision Processes An Ai Perspective Mausam: Bestsellers in 2023 The year 2023 has witnessed a remarkable surge in literary brilliance, with numerous captivating novels captivating the hearts of readers worldwide. Lets delve into the realm of popular books, exploring the fascinating narratives that have charmed audiences this year. Planning With Markov Decision Processes An Ai Perspective Mausam : Colleen Hoover's "It Ends with Us" This heartfelt tale of love, loss, and resilience has gripped readers with its raw and emotional exploration of domestic abuse. Hoover expertly weaves a story of hope and healing, reminding us that even in the darkest of times, the human spirit can triumph. Uncover the Best : Taylor Jenkins Reids "The Seven Husbands of Evelyn Hugo" This intriguing historical fiction novel unravels the life of Evelyn Hugo, a Hollywood icon who defies expectations and societal norms to pursue her dreams. Reids absorbing storytelling and compelling characters transport readers to a bygone era, immersing them in a world of glamour, ambition, and self-discovery. Planning With Markov Decision Processes An Ai Perspective Mausam : Delia Owens "Where the Crawdads Sing" This evocative coming-of-age story follows Kya Clark, a young woman who grows up alone in the marshes of North Carolina. Owens weaves a tale of resilience, survival, and the transformative power of nature, entrancing readers with its evocative prose and mesmerizing setting. These bestselling novels represent just a fraction of the literary treasures that have emerged in 2023. Whether you seek tales of romance, adventure, or personal growth, the world of literature offers an abundance of compelling stories waiting to be discovered. The novel begins with Richard Papen, a bright but troubled young man, arriving at Hampden College. Richard is immediately drawn to the group of students who call themselves the Classics Club. The club is led by Henry Winter, a brilliant and charismatic young man. Henry is obsessed with Greek mythology and philosophy, and he quickly draws Richard into his world. The other members of the Classics Club are equally as fascinating. Bunny Corcoran is a wealthy and spoiled young man who is always looking for a good time. Charles Tavis is a quiet and reserved young man who is deeply in love with Henry. Camilla Macaulay is a beautiful and intelligent young woman who is drawn to the power and danger of the Classics Club. The students are all deeply in love with Morrow, and they are willing to do anything to please him. Morrow is a complex and mysterious figure, and he seems to be manipulating the students for his own purposes. As the students become more involved with Morrow, they begin to commit increasingly dangerous acts. The Secret History is a masterful and thrilling novel that will keep you guessing until the very end. The novel is a warning tale about the dangers of obsession and the power of evil.

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### **Planning With Markov Decision Processes An Ai Perspective Mausam Introduction**

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