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Representation Discovery using Harmonic Analysis

Sridhar Mahadevan

*SYNTHESIS LECTURES ON ARTIFICIAL
INTELLIGENCE AND MACHINE LEARNING*

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Representation Discovery Using Harmonic Analysis

Sridhar Mahadevan

Rina Kraus



Representation Discovery Using Harmonic Analysis Sridhar Mahadevan:

Representation Discovery using Harmonic Analysis Sridhar Mahadevan, 2008-07-08 Representations are at the heart of artificial intelligence AI This book is devoted to the problem of representation discovery how can an intelligent system construct representations from its experience Representation discovery re parameterizes the state space prior to the application of information retrieval machine learning or optimization techniques facilitating later inference processes by constructing new task specific bases adapted to the state space geometry This book presents a general approach to representation discovery using the framework of harmonic analysis in particular Fourier and wavelet analysis Biometric compression methods the compact disc the computerized axial tomography CAT scanner in medicine JPEG compression and spectral analysis of time series data are among the many applications of classical Fourier and wavelet analysis A central goal of this book is to show that these analytical tools can be generalized from their usual setting in infinite dimensional Euclidean spaces to discrete finite dimensional spaces typically studied in many subfields of AI Generalizing harmonic analysis to discrete spaces poses many challenges a discrete representation of the space must be adaptively acquired basis functions are not pre defined but rather must be constructed Algorithms for efficiently computing and representing bases require dealing with the curse of dimensionality However the benefits can outweigh the costs since the extracted basis functions outperform parametric bases as they often reflect the irregular shape of a particular state space Case studies from computer graphics information retrieval machine learning and state space planning are used to illustrate the benefits of the proposed framework and the challenges that remain to be addressed Representation discovery is an actively developing field and the author hopes this book will encourage other researchers to explore this exciting area of research Table of Contents Overview Vector Spaces Fourier Bases on Graphs Multiscale Bases on Graphs Scaling to Large Spaces Case Study State Space Planning Case Study Computer Graphics Case Study Natural Language Future Directions

Representation Discovery using Harmonic Analysis Sridhar Mahadevan, 2022-05-31 Representations are at the heart of artificial intelligence AI This book is devoted to the problem of representation discovery how can an intelligent system construct representations from its experience Representation discovery re parameterizes the state space prior to the application of information retrieval machine learning or optimization techniques facilitating later inference processes by constructing new task specific bases adapted to the state space geometry This book presents a general approach to representation discovery using the framework of harmonic analysis in particular Fourier and wavelet analysis Biometric compression methods the compact disc the computerized axial tomography CAT scanner in medicine JPEG compression and spectral analysis of time series data are among the many applications of classical Fourier and wavelet analysis A central goal of this book is to show that these analytical tools can be generalized from their usual setting in infinite dimensional Euclidean spaces to discrete finite dimensional spaces typically studied in many subfields of AI Generalizing harmonic analysis to discrete spaces poses many challenges a discrete

representation of the space must be adaptively acquired basis functions are not pre defined but rather must be constructed Algorithms for efficiently computing and representing bases require dealing with the curse of dimensionality However the benefits can outweigh the costs since the extracted basis functions outperform parametric bases as they often reflect the irregular shape of a particular state space Case studies from computer graphics information retrieval machine learning and state space planning are used to illustrate the benefits of the proposed framework and the challenges that remain to be addressed Representation discovery is an actively developing field and the author hopes this book will encourage other researchers to explore this exciting area of research Table of Contents Overview Vector Spaces Fourier Bases on Graphs Multiscale Bases on Graphs Scaling to Large Spaces Case Study State Space Planning Case Study Computer Graphics Case Study Natural Language Future Directions

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

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

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

A Concise Introduction to Models and Methods for Automated Planning Hector Geffner,Blai Bonet,2022-05-31 Planning is the model based approach to autonomous behavior where the agent behavior is derived automatically from a model of the actions sensors and goals The main challenges in planning are computational as all models whether featuring uncertainty and feedback or not are intractable in the worst case when represented in compact form In this book we look at a variety of models used in AI planning and at the methods that have been developed for solving them The goal is to provide a modern and coherent view of planning that is precise concise and mostly self contained without being shallow For this we make no attempt at covering the whole variety of planning approaches ideas and applications and focus on the essentials The target audience of the book are students and researchers interested in autonomous behavior and planning from an AI engineering or cognitive science perspective Table of Contents Preface Planning and Autonomous Behavior Classical Planning Full Information and Deterministic Actions Classical Planning Variations and Extensions Beyond Classical Planning Transformations Planning with Sensing Logical Models MDP Planning Stochastic Actions and Full Feedback POMDP Planning Stochastic Actions and Partial Feedback Discussion Bibliography

Author's Biography **Multi-Objective Decision Making** Diederik M. Roijers, Shimon Whiteson, 2022-05-31 Many real world decision problems have multiple objectives For example when choosing a medical treatment plan we want to maximize the efficacy of the treatment but also minimize the side effects These objectives typically conflict e g we can often increase the efficacy of the treatment but at the cost of more severe side effects In this book we outline how to deal with multiple objectives in decision theoretic planning and reinforcement learning algorithms To illustrate this we employ the popular problem classes of multi objective Markov decision processes MOMDPs and multi objective coordination graphs MO CoGs First we discuss different use cases for multi objective decision making and why they often necessitate explicitly multi objective algorithms We advocate a utility based approach to multi objective decision making i e that what constitutes an optimal solution to a multi objective decision problem should be derived from the available information about user utility We show how different assumptions about user utility and what types of policies are allowed lead to different solution concepts which we outline in a taxonomy of multi objective decision problems Second we show how to create new methods for multi objective decision making using existing single objective methods as a basis Focusing on planning we describe two ways to creating multi objective algorithms in the inner loop approach the inner workings of a single objective method are adapted to work with multi objective solution concepts in the outer loop approach a wrapper is created around a single objective method that solves the multi objective problem as a series of single objective problems After discussing the creation of such methods for the planning setting we discuss how these approaches apply to the learning setting Next we discuss three promising application domains for multi objective decision making algorithms energy health and infrastructure and transportation Finally we conclude by outlining important open problems and promising future directions **Game Theory for Data**

Science Boi Faltings, Goran Radanovic, 2022-05-31 Intelligent systems often depend on data provided by information agents for example sensor data or crowdsourced human computation Providing accurate and relevant data requires costly effort that agents may not always be willing to provide Thus it becomes important not only to verify the correctness of data but also to provide incentives so that agents that provide high quality data are rewarded while those that do not are discouraged by low rewards We cover different settings and the assumptions they admit including sensing human computation peer grading reviews and predictions We survey different incentive mechanisms including proper scoring rules prediction markets and peer prediction Bayesian Truth Serum Peer Truth Serum Correlated Agreement and the settings where each of them would be suitable As an alternative we also consider reputation mechanisms We complement the game theoretic analysis with practical examples of applications in prediction platforms community sensing and peer grading **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 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

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

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Decoding **Representation Discovery Using Harmonic Analysis Sridhar Mahadevan**: Revealing the Captivating Potential of Verbal Expression

In a time characterized by interconnectedness and an insatiable thirst for knowledge, the captivating potential of verbal expression has emerged as a formidable force. Its power to evoke sentiments, stimulate introspection, and incite profound transformations is genuinely awe-inspiring. Within the pages of "**Representation Discovery Using Harmonic Analysis Sridhar Mahadevan**," a mesmerizing literary creation penned by a celebrated wordsmith, readers attempt an enlightening odyssey, unraveling the intricate significance of language and its enduring effect on our lives. In this appraisal, we shall explore the book's central themes, evaluate its distinctive writing style, and gauge its pervasive influence on the hearts and minds of its readership.

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