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Computational Aspects of Cooperative Game Theory

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Computational Aspects of Cooperative Game Theory Georgios Chalkiadakis, Edith Elkind, Michael Wooldridge, 2022-05-31

Cooperative game theory is a branch of micro economics that studies the behavior of self interested agents in strategic settings where binding agreements among agents are possible Our aim in this book is to present a survey of work on the computational aspects of cooperative game theory We begin by formally defining transferable utility games in characteristic function form and introducing key solution concepts such as the core and the Shapley value We then discuss two major issues that arise when considering such games from a computational perspective identifying compact representations for games and the closely related problem of efficiently computing solution concepts for games We survey several formalisms for cooperative games that have been proposed in the literature including for example cooperative games defined on networks as well as general compact representation schemes such as MC nets and skill games As a detailed case study we consider weighted voting games a widely used and practically important class of cooperative games that inherently have a natural compact representation We investigate the complexity of solution concepts for such games and generalizations of them We briefly discuss games with non transferable utility and partition function games We then overview algorithms for identifying welfare maximizing coalition structures and methods used by rational agents to form coalitions even under uncertainty including bargaining algorithms We conclude by considering some developing topics applications and future research directions

Game Theory And Mechanism Design Y Narahari, 2014-03-13 This book offers a self sufficient treatment of a key tool game theory and mechanism design to model analyze and solve centralized as well as decentralized design problems involving multiple autonomous agents that interact strategically in a rational and intelligent way The contents of the book provide a sound foundation of game theory and mechanism design theory which clearly represent the science behind traditional as well as emerging economic applications for the society The importance of the discipline of game theory has been recognized through numerous Nobel prizes in economic sciences being awarded to game theorists including the 2005 2007 and 2012 prizes The book distills the marvelous contributions of these and other celebrated game theorists and presents it in a way that can be easily understood even by senior undergraduate students A unique feature of the book is its detailed coverage of mechanism design which is the art of designing a game among strategic agents so that a social goal is realized in an equilibrium of the induced game Another feature is a large number of illustrative examples that are representative of both classical and modern applications of game theory and mechanism design The book also includes informative biographical sketches of game theory legends and is specially customized to a general engineering audience After a thorough reading of this book readers would be able to apply game theory and mechanism design in a principled and mature way to solve relevant problems in computer science esp artificial intelligence machine learning computer engineering operations research industrial engineering and microeconomics

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

Game Theory and Machine Learning for Cyber Security Charles A. Kamhoua,Christopher D. Kiekintveld,Fei Fang,Quanyan Zhu,2021-09-15 GAME THEORY AND MACHINE LEARNING FOR CYBER SECURITY Move beyond the foundations of machine learning and game theory in cyber security to the latest research in this cutting edge field In Game Theory and Machine Learning for Cyber Security a team of expert security researchers delivers a collection of central research contributions from both machine learning and game theory applicable to cybersecurity The distinguished editors have included resources that address open research questions in game theory and machine learning applied to cyber security systems and examine the strengths and limitations of current game theoretic models for cyber security Readers will explore the vulnerabilities of traditional machine learning algorithms and how they can be mitigated in an adversarial machine learning approach The book offers a comprehensive suite of solutions to a broad range of technical issues in applying game theory and machine learning to solve cyber security challenges Beginning with an introduction to foundational concepts in game theory machine learning cyber security and cyber deception the editors provide readers with resources that discuss the latest in hypergames behavioral game theory adversarial machine learning generative adversarial networks and multi agent reinforcement learning Readers will also enjoy A thorough introduction to game theory for cyber deception including scalable algorithms for identifying stealthy attackers in a game theoretic framework honeypot allocation over attack graphs and behavioral games for cyber deception An exploration of game theory for cyber security including actionable game theoretic adversarial intervention detection against advanced persistent threats Practical discussions of adversarial machine learning for cyber security including adversarial machine learning in 5G security and machine learning driven fault injection in cyber physical systems In depth examinations of generative models for cyber security Perfect for researchers students and experts in the fields of computer science and engineering Game Theory and Machine Learning for Cyber Security is also an indispensable resource for industry professionals military personnel researchers faculty and students with an interest in cyber security

Artificial Intelligence & Games Georgi Togeli,2024-09-03 As has been pointed out by several industrial game AI developers the lack

of behavioral modularity across games and in game tasks is detrimental for the development of high quality AI 605 171 An increasingly popular method for ad hoc behavior authoring that eliminates the modularity limitations of FSMs and BTs is the utility based AI approach which can be used for the design of control and decision making systems in games 425 557 Following this approach instances in the game get assigned a particular utility function that gives a value for the importance of the particular instance 10 169 For instance the importance of an enemy being present at a particular distance or the importance of an agent's health being low in this particular context Given the set of all utilities available to an agent and all the options it has utility based AI decides which is the most important option it should consider at this moment 426 The utility based approach is grounded in the utility theory of economics and is based on utility function design The approach is similar to the design of membership functions in a fuzzy set A utility can measure anything from observable objective data e.g. enemy health to subjective notions such as emotions mood and threat The various utilities about possible actions or decisions can be aggregated into linear or non linear formulas and guide the agent to take decisions based on the aggregated utility The utility values can be checked every n frames of the game So while FSMs and BTs would examine one decision at a time utility based AI architectures

Artificial Intelligence and Games Georgios N. Yannakakis, Julian Togelius, 2018-02-17 This is the first textbook dedicated to explaining how artificial intelligence AI techniques can be used in and for games After introductory chapters that explain the background and key techniques in AI and games the authors explain how to use AI to play games to generate content for games and to model players The book will be suitable for undergraduate and graduate courses in games artificial intelligence design human computer interaction and computational intelligence and also for self study by industrial game developers and practitioners The authors have developed a website <http://www.gameaibook.org> that complements the material covered in the book with up to date exercises lecture slides and reading

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 *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 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

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.

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