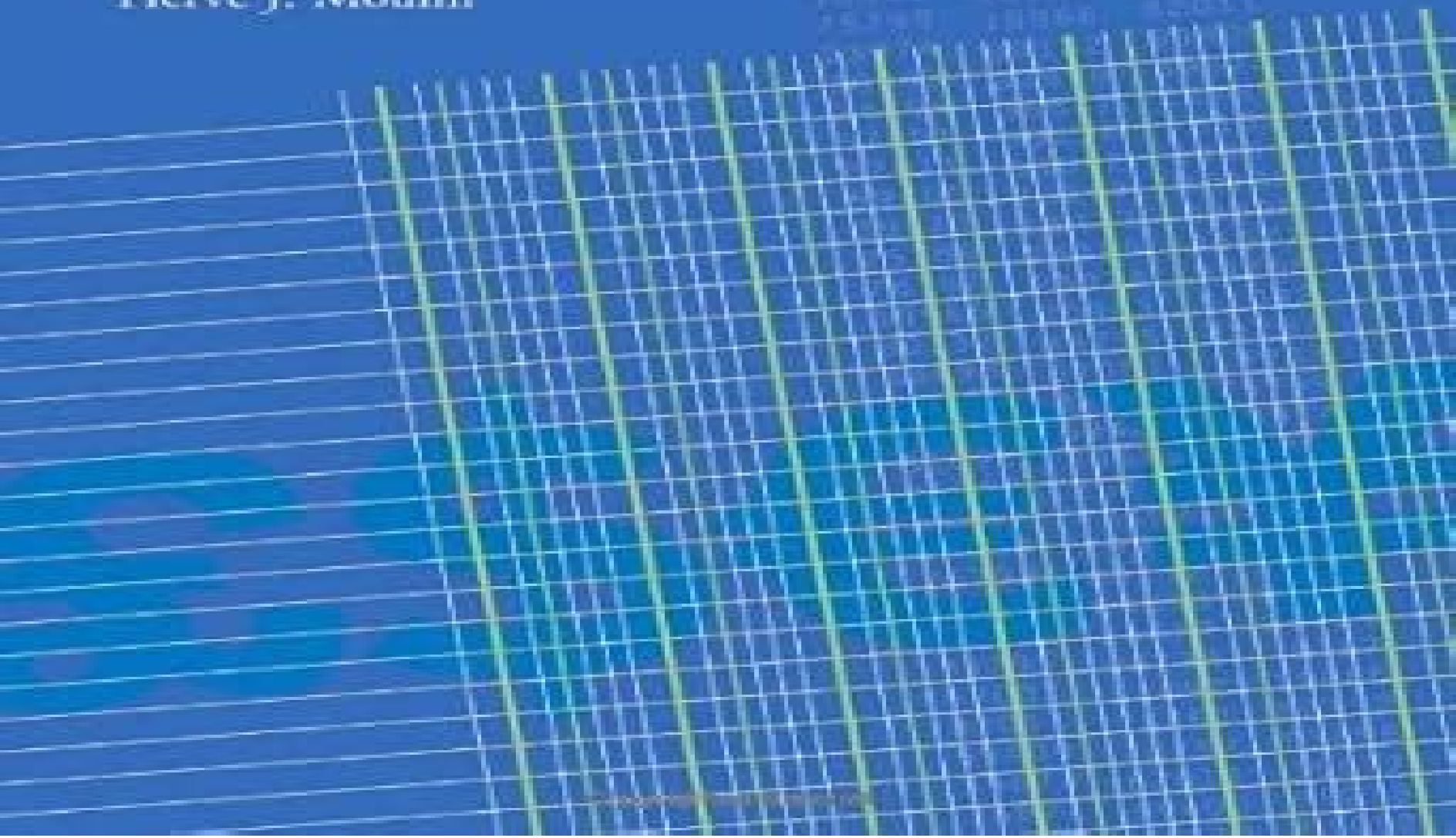# FAIR DIVISION AND COLLECTIVE WELFARE

Hervé J. Moulin

Fair Division Collective Welfare

Arthur Charpentier

Fair Division Collective Welfare:

<u>Fair Division and Collective Welfare</u> Herve Moulin,2004-08-20 The concept of fair division is as old as civil society itself Aristotle s equal treatment of equals was the first step toward a formal definition of distributive fairness The concept of collective welfare more than two centuries old is a pillar of modern economic analysis Reflecting fifty years of research this book examines the contribution of modern microeconomic thinking to distributive justice Taking the modern axiomatic approach it compares normative arguments of distributive justice and their relation to efficiency and collective welfare The book begins with the epistemological status of the axiomatic approach and the four classic principles of distributive justice compensation reward exogenous rights and fitness It then presents the simple ideas of equal gains equal losses and proportional gains and losses The book discusses three cardinal interpretations of collective welfare Bentham s utilitarian proposal to maximize the sum of individual utilities the Nash product and the egalitarian leximin ordering It also discusses the two main ordinal definitions of collective welfare the majority relation and the Borda scoring method The Shapley value is the single most important contribution of game theory to distributive justice A formula to divide jointly produced costs or benefits fairly it is especially useful when the pattern of externalities renders useless the simple ideas of equality and proportionality The book ends with two versatile methods for dividing commodities efficiently and fairly when only ordinal preferences matter competitive equilibrium with equal incomes and egalitarian equivalence The book contains a wealth of empirical examples and exercises *Fair Division and Collective Welfare* Herve Moulin,2004-08-20 The concept of fair division is as old as civil society itself Aristotle s equal treatment of equals was the first step toward a formal definition of distributive fairness The concept of collective welfare more than two centuries old is a pillar of modern economic analysis Reflecting fifty years of research this book examines the contribution of modern microeconomic thinking to distributive justice Taking the modern axiomatic approach it compares normative arguments of distributive justice and their relation to efficiency and collective welfare The book begins with the epistemological status of the axiomatic approach and the four classic principles of distributive justice compensation reward exogenous rights and fitness It then presents the simple ideas of equal gains equal losses and proportional gains and losses The book discusses three cardinal interpretations of collective welfare Bentham s utilitarian proposal to maximize the sum of individual utilities the Nash product and the egalitarian leximin ordering It also discusses the two main ordinal definitions of collective welfare the majority relation and the Borda scoring method The Shapley value is the single most important contribution of game theory to distributive justice A formula to divide jointly produced costs or benefits fairly it is especially useful when the pattern of externalities renders useless the simple ideas of equality and proportionality The book ends with two versatile methods for dividing commodities efficiently and fairly when only ordinal preferences matter competitive equilibrium with equal incomes and egalitarian equivalence The book contains a wealth of empirical examples and exercises **The Geometry of Efficient Fair Division** Julius B.

Barbanel,2005-01-24 What is the best way to divide a cake and allocate the pieces among some finite collection of players In this book the cake is a measure space and each player uses a countably additive non atomic probability measure to evaluate the size of the pieces of cake with different players generally using different measures The author investigates efficiency properties is there another partition that would make everyone at least as happy and would make at least one player happier than the present partition and fairness properties do all players think that their piece is at least as large as every other player s piece He focuses exclusively on abstract existence results rather than algorithms and on the geometric objects that arise naturally in this context By examining the shape of these objects and the relationship between them he demonstrates results concerning the existence of efficient and fair partitions   Handbook of Group Decision and Negotiation D. Marc Kilgour,Colin Eden,2010-08-02 Publication of the Handbook of Group Decision and Negotiation marks a milestone in the evolution of the group decision and negotiation GDN eld On this occasion editors Colin Eden and Marc Kilgour asked me to write a brief history of the eld to provide background and context for the volume They said that I am in a good position to do so Actively involved in creating the GDN Section and serving as its chair founding and leading the GDN journal Group Decision and Negotiation as editor in chief and the book series Advances in Group Decision and Negotiation as editor and serving as general chair of the GDN annual meetings I accepted their invitation to write a brief history In 1989 what is now the Institute for Operations Research and the Management Sciences INFORMS established its Section on Group Decision and Negotiation The journal Group Decision and Negotiation was founded in 1992 published by Springer in cooperation with INFORMS and the GDN Section In 2003 as an ext sion of the journal the Springer book series Advances in Group Decision and Negotiation was inaugurated   **The Oxford Handbook of Political Economy** Barry R. Weingast,Donald Wittman,2008-06-19 Over its lifetime political economy has had different meanings This handbook views political economy as a synthesis of the various strands of social science treating it as the methodology of economics applied to the analysis of political behaviour and institutions   **The Routledge Companion to Social and Political Philosophy** Gerald F. Gaus,Fred D'Agostino,2013 This comprehensive work provides an up to date survey of social and political philosophy charting its history and key figures and movements and addressing enduring questions as well as contemporary research   **Structural Information and Communication Complexity** Zvi Lotker,Boaz Patt-Shamir,2018-10-30 This book constitutes the refereed post conference proceedings of the 25th International Colloquium on Structural Information and Communication Complexity SIROCCO 2018 held in Ma ale HaHamisha Israel in June 2018 The 23 full papers and 8 short papers presented were carefully reviewed and selected from 47 submissions They are devoted to the study of the interplay between structural knowledge communications and computing in decentralized systems of multiple communicating entities and cover a large range of topics   *Algorithmic Game Theory* Maria Serna,2012-10-06 This book constitutes the refereed proceedings of the 5th International Symposium on Algorithmic Game Theory SAGT 2012 held in Barcelona Spain in October

2012 The 22 revised full papers presented together with 2 invited lectures were carefully reviewed and selected from 65 submissions The papers present original research at the intersection of Algorithms and Game Theory and address various current topics such as solution concepts in game theory efficiency of equilibria and price of anarchy complexity classes in game theory computational aspects of equilibria computational aspects of fixed point theorems repeated games evolution and learning in games convergence of dynamics coalitions coordination and collective action reputation recommendation and trust systems graph theoretic aspects of social networks network games cost sharing algorithms and analysis computing with incentives algorithmic mechanism design computational social choice decision theory and pricing auction algorithms and analysis economic aspects of distributed computing internet economics and computational advertising **Ethics in Artificial Intelligence: Bias, Fairness and Beyond** Animesh Mukherjee,Juhi Kulshrestha,Abhijnan Chakraborty,Srijan Kumar,2023-12-29 This book is a collection of chapters in the newly developing area of ethics in artificial intelligence The book comprises chapters written by leading experts in this area which makes it a one of its kind collections Some key features of the book are its unique combination of chapters on both theoretical and practical aspects of integrating ethics into artificial intelligence The book touches upon all the important concepts in this area including bias discrimination fairness and interpretability Integral components can be broadly divided into two segments the first segment includes empirical identification of biases discrimination and the ethical concerns thereof in impact assessment advertising and personalization computational social science and information retrieval The second segment includes operationalizing the notions of fairness identifying the importance of fairness in allocation clustering and time series problems and applications of fairness in softwaretesting debugging and in multi stakeholder platforms This segment ends with a chapter on interpretability of machine learning models which is another very important and emerging topic in this area **Mathematical Optimization Theory and Operations Research** Igor Bykadorov,Vitaly Strusevich,Tatiana Tchemisova,2019-10-26 This book constitutes revised and selected papers from the 18th International Conference on Mathematical Optimization Theory and Operations Research MOTOR 2019 held in Ekaterinburg Russia in July 2019 The 40 full papers and 4 short papers presented in this volume were carefully reviewed and selected from a total of 170 submissions The papers in the volume are organised according to the following topical headings combinatorial optimization game theory and mathematical economics data mining and computational geometry integer programming mathematical programming operations research optimal control and applications **Web and Internet Economics** Xujin Chen,Nikolai Gravin,Martin Hoefer,Ruta Mehta,2020-12-05 This book constitutes the proceedings of the 16th International Conference on Web and Internet Economics WINE 2020 held in Beijing China in December 2020 The 31 full papers presented together with 11 abstracts were carefully reviewed and selected from 136 submissions The issues in theoretical computer science artificial intelligence operations research are of particular importance in the Web and the Internet that enable the interaction of large and diverse populations The Conference on Web

and Internet Economics WINE is an interdisciplinary forum for the exchange of ideas and results on incentives and computation arising from these various fields   **Foundations of Intelligent Systems** Denis Helic,Gerhard Leitner,Martin Stettinger,Alexander Felfernig,Zbigniew W. Raś,2020-09-17 This book constitutes the proceedings of the 25th International Symposium on Foundations of Intelligent Systems ISMIS 2020 held in Graz Austria in October 2020 The conference was held virtually due to the COVID 19 pandemic The 35 full and 8 short papers presented in this volume were carefully reviewed and selected from 79 submissions Included is also one invited talk The papers deal with topics such as natural language processing deep learning and embeddings digital signal processing modelling and reasoning and machine learning applications   **Water Resources and Environmental Engineering I** Maheswaran Rathinasamy,S. Chandramouli,K.B.V.N. Phanindra,Uma Mahesh,2018-09-01 The book is a compilation of the papers presented in the International Conference on Emerging Trends in Water Resources and Environmental Engineering ETWREE 2017 The high quality papers are written by research scholars and academicians of prestigious institutes across India The book discusses the challenges of water management due to misuse or abuse of water resources and the ever mounting challenges on use reuse and conservation of water It also discusses issues of water resources such as water quantity quality management and planning for the benefits of water resource scientists faculties policy makers stake holders working in the water resources planning and management The research content discussed in the book will be helpful for engineers to solve practical day to day problems related to water and environmental engineering   **Algorithmic aspects of resource allocation and multiwinner voting: theory and experiments** Kaczmarczyk, Andrzej,2021-12-10 This thesis is concerned with investigating elements of computational social choice in the light of real world applications We contribute to a better understanding of the areas of fair allocation and multiwinner voting For both areas inspired by real world scenarios we propose several new notions and extensions of existing models Then we analyze the complexity of answering the computational questions raised by the introduced concepts To this end we look through the lens of parameterized complexity We identify different parameters which describe natural features specific to the computational problems we investigate Exploiting the parameters we successfully develop efficient algorithms for spe cific cases of the studied problems We complement our analysis by showing which parameters presumably cannot be utilized for seeking efficient algorithms Thereby we provide comprehensive pictures of the computational complexity of the studied problems Specifically we concentrate on four topics that we present below grouped by our two areas of interest For all but one topic we present experimental studies based on implementations of newly developed algorithms We first focus on fair allocation of indivisible resources In this setting we consider a collection of indivisible resources and a group of agents Each agent reports its utility evaluation of every resource and the task is to fairly allocate the resources such that each resource is allocated to at most one agent We concentrate on the two following issues regarding this scenario The social context in fair allocation of

indivisible resources In many fair allocation settings it is unlikely that every agent knows all other agents For example consider a scenario where the agents represent employees of a large corporation It is highly unlikely that every employee knows every other employee Motivated by such settings we come up with a new model of graph envy freeness by adapting the classical envy freeness notion to account for social relations of agents modeled as social networks We show that if the given social network of agents is simple for example if it is a directed acyclic graph then indeed we can sometimes find fair allocations efficiently However we contrast tractability results with showing NP hardness for several cases including those in which the given social network has a constant degree Fair allocations among few agents with bounded rationality Bounded rationality is the idea that humans due to cognitive limitations tend to simplify problems that they face One of its emanations is that human agents usually tend to report simple utilities over the resources that they want to allocate for example agents may categorize the available resources only into two groups of desirable and undesirable ones Applying techniques for solving integer linear programs we show that exploiting bounded rationality leads to efficient algorithms for finding envy free and Pareto efficient allocations assuming a small number of agents Further we demonstrate that our result actually forms a framework that can be applied to a number of different fairness concepts like envy freeness up to one good or envy freeness up to any good This way we obtain efficient algorithms for a number of fair allocation problems assuming few agents with bounded rationality We also empirically show that our technique is applicable in practice Further we study multiwinner voting where we are given a collection of voters and their preferences over a set of candidates The outcome of a multiwinner voting rule is a group or a set of groups in case of ties of candidates that reflect the voters preferences best according to some objective In this context we investigate the following themes The robustness of election outcomes We study how robust outcomes of multiwinner elections are against possible mistakes made by voters Assuming that each voter casts a ballot in a form of a ranking of candidates we represent a mistake by a swap of adjacent candidates in a ballot We find that for rules such as SNTV k Approval and k Borda it is computationally easy to find the minimum number of swaps resulting in a change of an outcome This task is however NP hard for STV and the Chamberlin Courant rule We conclude our study of robustness with experimentally studying the average number of random swaps leading to a change of an outcome for several rules Strategic voting in multiwinner elections We ask whether a given group of cooperating voters can manipulate an election outcome in a favorable way We focus on the k Approval voting rule and we show that the computational complexity of answering the posed question has a rich structure We spot several cases for which our problem is polynomial time solvable However we also identify NP hard cases For several of them we show how to circumvent the hardness by fixed parameter tractability We also present experimental studies indicating that our algorithms are applicable in practice Diese Arbeit befasst sich mit der Untersuchung von Themen des Forschungsgebiets Computational Social Choice im Lichte realer Anwendungen Dabei tr gt sie zu einem besseren Verst ndnis der Bereiche der fairen Zuordnung und der

Mehrgewinnerwahlen bei F r beide Konzepte schlagen wir inspiriert von realen Anwendungen verschiedene neue Begriffe und Erweiterungen bestehender Modelle vor Anschlie end analysieren wir die Komplexit t der Beantwortung von Berechnungsfragen die durch die eingef hrten Konzepte aufgeworfen werden Dabei fokussieren wir uns auf die parametrisierte Komplexit t Hierzu identifizieren wir verschiedene Parameter welche nat rliche Merkmale der von uns untersuchten Berechnungsprobleme beschreiben Durch die Nutzung dieser Parameter entwickeln wir erfolgreich effiziente Algorithmen f r Spezialf lle der untersuchten Probleme Wir erg nzen unsere Analyse indem wir zeigen welche Parameter vermutlich nicht verwendet werden k nnen um effiziente Algorithmen zu finden Dabei zeichnen wir ein umfassendes Bild der Berechnungskomplexit t der untersuchten Probleme Insbesondere konzentrieren wir uns auf vier Themen die wir gruppiert nach unseren beiden Schwerpunkten unten vorstellen F r alle Themen bis auf eines pr sentieren wir Experimente die auf Implementierungen der von uns neu entwickelten Algorithmen basieren Wir konzentrieren uns zun chst auf die faire Zuordnung unteilbarer Ressourcen Hier betrachten wir eine Menge unteilbarer Ressourcen und eine Gruppe von Agenten Jeder Agent gibt eine Bewertung des Nutzens jeder Ressource ab und die Aufgabe besteht darin eine faire Zuordnung der Ressourcen zu finden wobei jede Ressource h chstens einem Agenten zugeordnet werden kann Innerhalb dieses Bereiches konzentrieren wir uns auf die beiden folgenden Problemstellungen Der soziale Kontext bei der fairen Zuordnung unteilbarer Ressourcen In vielen Szenarien in denen Ressourcen zugeordnet werden sollen ist es unwahrscheinlich dass jeder Agent alle anderen kennt Vorstellbar ist beispielsweise ein Szenario in dem die Agenten Mitarbeiter eines gro en Unternehmens repr sentieren Es ist h chst unwahrscheinlich dass jeder Mitarbeiter jeden anderen Mitarbeiter kennt Motiviert durch solche Szenarien entwickeln wir ein neues Modell der graph basierten Neidfreiheit Wir erweitern den klassischen Neidfreiheitsbegriff um die sozialen Beziehungen von Agenten die durch soziale Netzwerke modelliert werden Einerseits zeigen wir dass wenn das soziale Netzwerk der Agenten einfach ist zum Beispiel wenn es sich um einen gerichteten azyklischen Graph handelt in manchen F llen faire Zuordnungen effizient gefunden werden k nnen Andererseits stellen wir diesen algorithmisch positiven Ergebnissen mehrere NP schweren F llen entgegen Ein Beispiel f r einen solchen Fall sind soziale Netzwerke mit einem konstanten Knotengrad Faire Zuteilung an wenige Agenten mit begrenzter Rationalit t Begrenzte Rationalit t beschreibt die Idee dass Menschen aufgrund kognitiver Grenzen dazu neigen Probleme mit denen sie konfrontiert werden zu vereinfachen Eine m gliche Folge dieser Grenzen ist dass menschliche Agenten in der Regel einfache Bewertungen der gew nschten Ressourcen abgeben beispielsweise k nnten Agenten die verf gbaren Ressourcen nur in zwei Gruppen erw nschte und unerw nschte Ressourcen kategorisieren Durch Anwendung von Techniken zum L sen von Ganzzahligen Linearen Programmen zeigen wir dass unter der Annahme einer kleinen Anzahl von Agenten die Ausnutzung begrenzter Rationalit t dabei hilft effiziente Algorithmen zum Finden neidfreier und Pareto effizienter Zuweisungen zu entwickeln Weiterhin zeigen wir dass unser Ergebnis ein allgemeines Verfahren liefert welches auf eine Reihe verschiedener

Fairnesskonzepte angewendet werden kann wie zum Beispiel Neidfreiheit bis auf ein Gut oder Neidfreiheit bis auf irgendein Gut Auf diese Weise gewinnen wir effiziente Algorithmen f r eine Reihe fairer Zuordnungsprobleme wenige Agenten mit begrenzter Rationalit t vorausgesetzt Dar ber hinaus zeigen wir empirisch dass unsere Technik in der Praxis anwendbar ist Weiterhin untersuchen wir Mehrgewinnerwahlen bei denen uns eine Menge von W hlern sowie ihre Pr ferenzen ber eine Reihe von Kandidaten gegeben sind Das Ergebnis eines Mehrgewinnerwahlverfahrens ist eine Gruppe oder eine Menge von Gruppen im Falle eines Unentschiedens von Kandidaten welche die Pr ferenzen der W hler am besten einem bestimmten Ziel folgend widerspiegeln In diesem Kontext untersuchen wir die folgenden Themen Die Robustheit von Wahlergebnissen Wir untersuchen wie robust die Ergebnisse von Mehrgewinnerwahlen gegen ber m glicher Fehler der W hler sind Unter der Annahme dass jeder W hler eine Stimme in Form einer Rangliste von Kandidaten abgibt modellieren wir einen Fehler als einen Tausch benachbarter Kandidaten in der Rangliste Wir zeigen dass f r Wahlregeln wie SNTV k Approval und k Borda die minimale Anzahl an Vertauschungen welche zu einer Ergebnis nderung f hrt einfach zu berechnen ist F r STV und die Chamberlin Courant Regel ist diese Aufgabe allerdings NP schwer Wir schlie en unsere Untersuchung der Robustheit unterschiedlicher Wahlregeln ab mit einer experimentellen Evaluierung der durchschnittlichen Anzahl zuf lliger Vertauschungen die zu einer nderung des Ergebnisses f hren Strategische Abstimmung bei Wahlen mit mehreren Gewinnern Wir fragen ob eine bestimmte Gruppe von kooperierenden W hlern ein Wahlergebnis zu ihren Gunsten manipulieren kann Dabei konzentrieren wir uns auf die k Approval Wahlregel Wir zeigen dass die Berechnungskomplexit t der besagten Manipulation eine reiche Struktur besitzt Auf der einen Seite identifizieren wir mehrere F lle in denen das Problem in Polynomzeit l sbar ist Auf der anderen Seite identifizieren wir jedoch auch NP schwere F lle F r einige von ihnen zeigen wir wie die Berechnungsschwere durch parametrisierte Algorithmen umgangen werden kann Wir pr sentieren zudem experimentelle Untersuchungen welche darauf hindeuten dass unsere Algorithmen in der Praxis anwendbar sind

Insurance, Biases, Discrimination and Fairness Arthur Charpentier,2024-05-13 This book offers an introduction to the technical foundations of discrimination and equity issues in insurance models catering to undergraduates postgraduates and practitioners It is a self contained resource accessible to those with a basic understanding of probability and statistics Designed as both a reference guide and a means to develop fairer models the book acknowledges the complexity and ambiguity surrounding the question of discrimination in insurance In insurance proposing differentiated premiums that accurately reflect policyholders true risk termed actuarial fairness or legitimate discrimination is economically and ethically motivated However such segmentation can appear discriminatory from a legal perspective By intertwining real life examples with academic models the book incorporates diverse perspectives from philosophy social sciences economics mathematics and computer science Although discrimination has long been a subject of inquiry in economics and philosophy it has gained renewed prominence in the context of big data with an abundance of proxy variables capturing sensitive attributes and

artificial intelligence or specifically machine learning techniques which often involve less interpretable black box algorithms The book distinguishes between models and data to enhance our comprehension of why a model may appear unfair It reminds us that while a model may not be inherently good or bad it is never neutral and often represents a formalization of a world seen through potentially biased data Furthermore the book equips actuaries with technical tools to quantify and mitigate potential discrimination featuring dedicated chapters that delve into these methods **Twin Peaks for Europe: State-of-the-Art Financial Supervisory Consolidation** Olivia Johanna Erdélyi,2016-06-14 The book addresses the truly interdisciplinary and highly controversial subject of international financial regulation and supervision which has been at the center of academic political and public attention since the start of the current economic and financial crisis Drawing on international financial regulatory and supervisory experience and in line with the European Monetary Union s gradual transformation into a Genuine Economic and Monetary Union it proposes the transformation of the European financial supervisory framework into a hybrid twin peaks model to create the previously missing necessary legal foundation for the adoption of the so called Group Support Regime GSR The latter is a relatively simple and transparent capital management tool for re insurance groups operating in a parent subsidiary structure proposed by the European Commission under the new Solvency II insurance supervisory framework which despite lengthy consideration was eventually rejected by Member States **The Routledge Handbook of Language Policy and Planning** Michele Gazzola,François Grin,Linda Cardinal,Kathleen Heugh,2023-09-28 The Routledge Handbook of Language Policy and Planning is a comprehensive and authoritative survey including original contributions from leading senior scholars and rising stars to provide a basis for future research in language policy and planning in international national regional and local contexts The Handbook approaches language policy as public policy that can be studied through the policy cycle framework It offers a systematic and research informed view of actual processes and methods of design implementation and evaluation With a substantial introduction 38 chapters and an extensive bibliography this Handbook is an indispensable resource for all decision makers students and researchers of language policy and planning within linguistics and cognate disciplines such as public policy economics political science sociology and education *A Unified Framework for Pro-poor Growth Analysis* Boniface Essama-Nssah,2004 Starting with a general impact indicator as an evaluation criterion Essama Nssah offers an integrative framework for a unified discussion of various concepts and measures of pro poor growth emerging from the current literature He shows that whether economic growth is considered pro poor depends fundamentally on the choice of evaluative weights In addition the author s framework leads to a new indicator of the rate of pro poor growth that can be interpreted as the equally distributed equivalent growth rate This is a distribution adjusted rate of growth that depends on the chosen level of inequality aversion Illustrations based on data for Indonesia in the 1990s show a strong link between growth and poverty reduction in that country A decomposition of the observed poverty outcomes reveals the extent to which changes in inequality have blunted the poverty impacts of both

growth and contraction Finally the results also demonstrate that absolute and relative indicators of pro poor growth can lead to conflicting conclusions from the same set of facts This paper a product of the Poverty Reduction Group Poverty Reduction and Economic Management Network is part of a larger effort in the network to understand the distributional implications of economic growth World Bank web site **Advances and Trends in Artificial Intelligence. Theory and Applications** Hamido Fujita,Richard Cimler,Andres Hernandez-Matamoros,Moonis Ali,2024-07-09 This book constitutes the refereed proceedings of the 37th International Conference on Industrial Engineering and Other Applications of Applied Intelligent Systems on Advances and Trends in Artificial Intelligence IEA AIE 2024 held in Hradec Kralove Czech Republic in July 10 12 2024 The 38 full papers and 3 short papers presented were carefully reviewed and selected from 79 submissions The papers focus on the following topics Computer vision Cyber security Data mining E applications Machine learning Neural networks Optimization and Various applications <u>Autonomous Agents and Multiagent Systems. Best and Visionary Papers</u> Francesco Amigoni,Arunesh Sinha,2024-03-29 This book contains visionary and best papers from the workshops held at the International Conference on Autonomous Agents and Multiagent Systems AAMAS 2023 held in London UK during May 29 June 2 2023 The 12 regular papers 5 best papers and 7 visionary papers presented were carefully reviewed and selected from a total of more than 110 contributions to the workshops They focus on emerging topics and new trends in the area of autonomous agents and multiagent systems and stem from the following workshops Workshop on Autonomous Robots and Multirobot Systems ARMS Workshop on Adaptive and Learning Agents ALA Workshop on Interdisciplinary Design of Emotion Sensitive Agents IDEA Workshop on Rebellion and Disobedience in Artificial Intelligence RaD AI Workshop on Neuro symbolic AI for Agent and Multi Agent Systems NeSyMAS Workshop on Multiagent Sequential Decision Making under Uncertainty MSDM Workshop on Citizen Centric Multi Agent Systems C MAS

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