Report from Dagstuhl Seminar 19381

Application-Oriented Computational Social Choice

Edited by

Umberto Grandi[1], Stefan Napel[2], Rolf Niedermeier[3], and Kristen Brent Venable[4]

1 **University Toulouse Capitole, FR,** umberto.grandi@ut-capitole.fr
2 **Universität Bayreuth, DE,** stefan.napel@uni-bayreuth.de
3 **TU Berlin, DE,** rolf.niedermeier@tu-berlin.de
4 **IHMC – Pensacola, US,** bvenable@ihmc.us

Abstract

This report documents the program and the outcomes of Dagstuhl Seminar 19381 "Application-Oriented Computational Social Choice". The seminar was organised around four focus topics: group recommender systems, fair allocation, electoral systems, and interactive democracy. For each topic, an invited survey was given by one of the participants. 26 participants presented their research in a regular talk, and two rump sessions allowed other participants to present their ongoing work and open problems in short talks. A special session was dedicated to software demonstrations, and 3 voting experiments were run during the seminar, also thanks to a mobile experimental laboratory that was brought to Dagstuhl. Finally, three afternoons were dedicated to group works.

Seminar September 15–20, 2019 – http://www.dagstuhl.de/19381
2012 ACM Subject Classification Theory of computation → Algorithmic game theory and mechanism design
Keywords and phrases ai for the social good, collective decision making, multi-agent systems, social choice
Digital Object Identifier 10.4230/DagRep.9.9.45
Edited in cooperation with Arianna Novaro, Dominik Peters

1 Executive Summary

Umberto Grandi (University Toulouse 1 Capitole – FR)
Stefan Napel (Universität Bayreuth – DE)
Rolf Niedermeier (TU Berlin – DE)
K. Brent Venable (IHMC – US)

Computational social choice (COMSOC) combines models from political science and economics with techniques from computer science, to analyze collective decision processes from a computational perspective. Classical contributions include the study of the computational barriers to various forms of manipulation in elections, the definition of novel procedures for distributed resources among a group of human or artificial agents, as well as the study of complex collective decisions such as multi-winner voting rules and voting in combinatorial domains. COMSOC is a thriving field of research, with an international bi-annual workshop now at its 7th edition and a handbook published in 2016 which structures more than a decade of research, but future success will depend on the practical applicability of its findings.

Application-Oriented Computational Social Choice, *Dagstuhl Reports*, Vol. 9, Issue 9, pp. 45–65
Editors: Umberto Grandi, Stefan Napel, Rolf Niedermeier, and Kristen Brent Venable

Dagstuhl Reports
Schloss Dagstuhl – Leibniz-Zentrum für Informatik, Dagstuhl Publishing, Germany

The purpose of this seminar was to address this challenge by stimulating application-driven research in computational social choice, i.e., theoretical studies modeling existing practical problems in all their complexity.

Four areas of COMSOC, which have already proven or bear particular potential for synergies and applicability to real-life problems, were identified as the focus of the seminar. Each of these areas addresses present-day challenges that provide an opportunity for an interdisciplinary approach building on contributions from computer scientists, economists, mathematicians, and political scientists:

- **Recommender systems** is a very successful application that combines several artificial intelligence techniques. Indeed, there have been few other examples of autonomous reasoning tools with comparable impact and pervasiveness in practice.
- **Fair division** has already proven a successful testbed for the application of theoretical work, thanks for the recently launched Spliddit webpage, which provides a user-friendly implementation for a number of algorithms in this field. This experience poses a number of questions and challenges for application-oriented research in fair division and beyond, such as data collection and analysis, possibly leading to new theoretical problems.
- **Interactive democracy** comprises a variety of approaches to make democratic processes more engaging and responsive. For instance, successful design and implementation of online decision platforms presents a multidisciplinary research challenge.
- **Real electoral systems** often have features that are absent in the single or multi-winner systems analyzed in textbooks and scientific papers. Voting theory and computational methods can help to identify non-monotonicity problems of real electoral systems, to provide normative benchmarks for institutional design, and to conduct influence and performance comparisons of different voting arrangements.

The Dagstuhl Seminar 19381 "Application-Oriented Computational Social Choice" brought together 46 invited participants of 15 different nationalities from 4 different continents, with three additional participants choosing to attend our seminar before participating to the Heidelberg Laureate Forum. The list of participants included researchers in Computer Science, Economics, and Political Science, three researchers from the industry (Microsoft, IBM, WinSet Group), and a lab technician.

For each of the focus topics described above, a 1-hour survey was prepared by one of the participants, obtaining an up-to-date overview of current research in the field and its main open problems. Each survey was scheduled on a different day, with 26 regular talks by participants complementing them in the program. Two rump sessions at the beginning of the week allowed a number of the participants to present recent findings, open problems and on-going research in a quick and informal way, stimulating the discussion for the rest of the week.

Given the focus of the seminar on application-oriented research, a special session was dedicated to the presentation of software developed by researchers participating to the seminar. Voting platforms were presented (Whale[1] and OPRA[2]), a library for preference data (Preflib[3]), a platform for online deliberation and consensus building (Vilfredo[4]), as well as a number of tools to support experimental research in social choice. Moreover, the seminar hosted three live voting experiments during the week, two of which used a mobile

[1] https://whale.imag.fr/
[2] https://opra.cs.rpi.edu/polls/main
[3] http://www.preflib.org/
[4] https://www.vilfredo.org/

experimental laboratory that was brought to Dagstuhl thanks to French CNRS and the help of a lab technician from University of Rennes. A detailed report of the experiments and an abstract of all the talks can be found below.

At the beginning of the week short sessions were reserved for individual self-introductions and for the proposition of potential group work. The organisers chose not to organize groups in advance, but to let them form in an iterative fashion during the seminar. A number of proposals were first made, then discussed and adapted, before participants signed up for specific group sessions. A total of 6 hours during the week was dedicated to group works, which led to significant advancements – a detailed report can be read below.

Overall, judging both from anecdotal personal feedback as well as the official results from the anonymous "Survey for Dagstuhl Seminar 19381" (with a median score of 10 out of 11 on the summary question "All in all, how do you rate the scientific quality of the seminar?" and similarly positive answers on the mix of participants, working atmosphere, etc.), the seminar was a very successful experience. It stimulated an already thriving research field to explore more applied research topics and scout for real-world problems. It allowed researchers to get first hand experience on how to run voting experiments, either on an Internet voting platform or in a laboratory, and allowed them to share their research practices. The work conducted in the groups was overall fruitful, already resulting in some paper drafts under preparation. The few suggestions for improvements mostly related to further broadening the mix of participants (more PhD students and junior researchers, more colleagues from nearby fields) and having a slightly less dense program (shorter talks, more time for work in small groups or unplanned activities).

The organisers wish to thank all the Dagstuhl staff for their professional support, the participants of the seminar for their positive attitude and enthusiasm, and the two collectors for putting together the abstracts that compose this report.

2 Table of Contents

3 Abstracts of Invited Surveys

3.1 Developments in Multi-agent Fair Allocation

Haris Aziz (UNSW – Sydney, AU)

I survey some of the recent developments in fair allocation. I also draw some connections with other strands of social choice where fairness can be an important concern.

3.2 From Computational Social Choice to Digital Democracy

Markus Brill (TU Berlin, DE)

Digital Democracy is an umbrella term that encompasses a variety of approaches to make democratic decision making processes more engaging and interactive by utilizing digital instruments such as online citizen participation platforms. In contrast to traditional democratic systems, such online platforms aim to leverage citizen expertise by providing an open collaborative environment with novel interaction possibilities.

The successful design of digital democracy platforms and procedures presents a multidisciplinary research challenge; a particularly pertinent area is the theory of collective decision making (aka social choice theory).

In this talk, I demonstrate how concepts and techniques from social choice theory can be employed to aid the design of online participation platforms and other digital democracy tools. I argue that insights from computational social choice, an active research area at the intersection of computer science, economics, and political science, are particularly relevant for this endeavor.

3.3 A Walk Down K-Street and Beyond: Case Studies in Spatial Vote Modeling

Joseph Godfrey (WinSet Group, LLC – Falls Church, US)

Joint work of Bernard Grofman, Joseph Godfrey

The talk reviewed a set of "case studies" in the application of spatial vote modeling to "real world" settings, ranging from early efforts to sell a software product to K-street lobbyists, through consulting in both governmental and academic communities.

The case studies highlight issues in model specification, the operationalization of social choice constructs, including the use of revealed preferences to locate ideal points, estimation of the status quo and of proposals, the construction of agent-specific indifference curves, and associated computational challenges. Specifically, computation of the Shapley-Owen voting power index, solution concepts such as the strong point, yolk, win set, and uncovered set, as well as dealing with uncertainty, bounded rationality, and the creative/inductive use of data are discussed.

The final case study, and paper, concerns spatial vote models developed using the Siegel-Simon aspirational approach. There are many situations where voters must choose a single alternative and where both the voters and the alternatives can be characterized as points in a one- or two or more-dimensional policy space. In committees and legislatures, often choice among these alternatives will be done via a decision agenda in which alternatives are eliminated until a choice is made, sometimes requiring a final vote against the status quo. A common form for such an agenda is what has been called by Black (1958) standard amendment procedure, a "king of the hill" procedure in which there is an initial alternative who is paired against another alternative, with the winner of that pairwise contest becoming the new winner, and the processes continuing until either the set of feasible alternatives is exhausted or there is a successful motion for cloture. Beginning with a seminal experiment on five person voting games conducted by Plott and Fiorina (1978), there have been a number of experiments on committee voting games with a potentially infinite set of alternatives embedded in a two dimensional policy space. In games where there is a core, i.e., an alternative which, for an odd number of voters, can defeat each and every other alternative in paired comparison, outcomes at or near the core are chosen, but there is also considerable clustering of outcomes even in games without a core. A major concern of the literature has been to develop models to explain the pattern of that clustering in non-core situations. Here, after reviewing the present state of the art, we offer a new family of models based on the Siegel-Simon aspiration approach, in which voters satisfice by choosing "acceptable" alternative, and the set of outcomes that are considered acceptable by each voter changes as the game continues.

3.4 Recommendations and Wagering: Some Surprising Connections to Social Choice

David Pennock (Microsoft – New York, US)

Joint work of David Pennock, Rupert Freeman, C. Lee Giles, Eric Horvitz, Andreas Krause, Dominik Peters, Jens Witkowski, Jenn Wortman Vaughan
Main reference Rupert Freeman, David M. Pennock, Jennifer Wortman Vaughan: "An Equivalence between Wagering and Fair-Division Mechanisms", in Proc. of the The Thirty-Third AAAI Conference on Artificial Intelligence, AAAI 2019, The Thirty-First Innovative Applications of Artificial Intelligence Conference, IAAI 2019, The Ninth AAAI Symposium on Educational Advances in Artificial Intelligence, EAAI 2019, Honolulu, Hawaii, USA, January 27 – February 1, 2019, pp. 1957–1964, AAAI Press, 2019.
URL https://doi.org/10.1609/aaai.v33i01.33011957

I present two applied setting with direct connections to social choice: recommender systems and wagering mechanisms. I survey recommender systems, emphasizing the history and big picture of the field, including a remembrance of its co-founder, John Riedl, who died of cancer in 2013. I present how some of the usual voting axioms make sense in the context of recommender systems. I discuss some of the practical issues of deployed systems that go beyond the theory. In Part Two, I present truthful wagering mechanisms and show that they are identical to allocation mechanisms in fair division. Wagering mechanisms also correspond to forecaster selection mechanisms and truthful no-regret machine learning algorithms. Finally, wagering connects in interesting ways to participatory budgeting.

4 Abstracts of Talks

4.1 How Hard Is the Manipulative Design of Scoring Systems?

Dorothea Baumeister (Heinrich-Heine-Universität Düsseldorf, DE)

Joint work of Dorothea Baumeister, Tobias Hogrebe
Main reference Dorothea Baumeister, Tobias Hogrebe: "How Hard Is the Manipulative Design of Scoring Systems?", in Proc. of the Twenty-Eighth International Joint Conference on Artificial Intelligence, IJCAI 2019, Macao, China, August 10-16, 2019, pp. 74–80, ijcai.org, 2019.
URL http://dx.doi.org/10.24963/ijcai.2019/11

In an election, votes are often given as ordered lists over candidates. A common way of determining the winner is then to apply some scoring system, where each position is associated with a specific score. This setting is also transferable to other situations, such as sports tournaments. The design of such systems, i.e., the choice of the score values, may have a crucial influence on the outcome. We study the computational complexity of two related decision problems. In addition, we provide a case study of data from Formula 1 using ILP formulations. Our results show that under some mild conditions there are cases where the actual scoring system has no influence, whereas in other cases very small changes may lead to a different winner. This may be seen as a measure of robustness of the winning candidate.

4.2 Building an Experiment on Multiwinner Elections

Sylvain Bouveret (University of Grenoble, FR), Jérôme Lang (University Paris-Dauphine, FR), and Vincent Merlin (Caen University, FR)

Joint work of Sylvain Bouveret, Ayça GiritliGil, Jérôme Lang, Vincent Merlin

Since the pioneer works of Plott (1967), and Florina, Morris and Plot (1978), experimental economics, either through lab experiments and or field experiments, contributed to the advancement of research on voting roles, to precise how voters react, adapt their preferences, and vote when confronted to different voting mechanisms. A stream of research aims to understand how voters act strategically in voting and election (Myerson et al., 1993; Laslier et al., 2010). Another direction is to understand how people would react to a modification of the electoral rule (Baujard et al., 2014). A third option is to elicit, under a veil of ignorance, the principles that the voters would back when confronted to a choice. In this line, the major contributions are due to Sertel and Giritligil (2003) and Giritligil and Sertel (2005). These panel studies aim to extract preferences of subjects on how to aggregate individual preferences in a social choice context. Sertel and Giritligil (2003) attempt to empirically understand public preferences concerning four social choice rules of focus, namely Plurality, Plurality with Runoff, the Majoritarian Compromise and the Borda Rule. Giritligil and Sertel (2005), on the other hand, aim to test whether the support for the Borda winner or the Condorcet winner increases when they are among the "Majoritarian Approved" candidates. Recently, researchers working on the axiomatic analysis of committee election rules have emphasized the fact that some voting rules are more suitable in certain context than in others (Faliszewski et al., 2017). They distinguish between three types of contexts. We may wish to select a committee 1) to elect an assembly that represents the preferences of the voters 2) to

shortlist a number of candidates, based on their excellence, 3) to get a menu of objects as diverse as possible, so that the tastes of each participant are somehow satisfied. But one may wonder whether these distinctions are pertinent. Our objective in the experiment is to understand the principles that govern the preferences of voters in committee elections in specified and neutral contexts. To do so, we borrow the experimental protocols used by Sertel and Giritligil (2003) and Giritligil and Sertel (2005). In this presentation, we will make the participant of the seminar test the experiment, we will discuss the protocol we are currently working on, and we will comment preliminary results from a pilote.

References

1 Baujard, A., Igersheim, H., Lebon, I., Gavrel, F., Laslier, J.F. 2014. "Who's favored by evaluative voting? An experiment conducted during the 2012 French presidential election", Electoral Studies, 34, 131-145.
2 Faliszewski, P., Skowron, P., Slinko, A., Talmon, N. 2017. "Multiwinner voting: A New Challenge for Social Choice Theory". Trends in Computational Social Choice. Editor: Endriss, U. AI Access.
3 Fiorina, M., Plott, C. R. 1978. "Committee decisions under majority rule: An experimental study", American Political Science Review, 72, 575-598.
4 Forsythe, R., Myerson, R.B., Rietz, T.A., Weber, R.J. 1993. "An experiment on coordination in multi-candidate elections: The importance of polls and election histories", Social Choice and Welfare, 10(3), 223-247.
5 Gehrlein, W.V. 1985. "The Condorcet criterion and committee selection", Mathematical Social Sciences 10(3), 199-209.
6 Giritligil Kara, A. E., Sertel, M. R. 2005. "Does majoritarian approval matter in selecting a social choice rule? An exploratory panel study", Social Choice and Welfare, 25(1), 43-73.
7 Plott, C. R. 1967. "A notion of equilibrium under majority rule", American Economic Review, 57, 787-806. Press.
8 Van der Straeten, K., Laslier, J. F., Sauger, N. 2010. "Strategic, sincere, and heuristic voting under four election rules: An experimental study", Social Choice and Welfare, 35(3), 435-472.

4.3 Simple Characterizations of Approval Voting

Florian Brandl (Stanford University, US) and Dominik Peters (University of Oxford, GB)

Approval voting allows every voter to cast a ballot of approved alternatives and chooses the alternatives with the largest number of approvals. Due to its simplicity and superior theoretical properties it is a serious contender for use in real-world elections. We support this claim by giving seven characterizations of approval voting based on normatively appealing axioms. All our results involve the reinforcement axiom, which requires choices to be consistent across different electorates. In addition, we consider strategyproofness, consistency with majority opinions, consistency under cloning alternatives, and invariance under removing inferior alternatives. We prove our results by reducing them to a single base theorem, for which we give a simple and intuitive proof.

4.4 Efficient and Envy-Free Resource Allocation with Few Agents: Theory and Experiments

Robert Bredereck (TU Berlin, DE) and Rolf Niedermeier (TU Berlin, DE)

Joint work of Robert Bredereck, Andrzej Kaczmarczyk, Dusan Knop, Rolf Niedermeier
Main reference Robert Bredereck, Andrzej Kaczmarczyk, Dusan Knop, Rolf Niedermeier: "High-Multiplicity Fair Allocation: Lenstra Empowered by N-fold Integer Programming", in Proc. of the 2019 ACM Conference on Economics and Computation, EC 2019, Phoenix, AZ, USA, June 24-28, 2019, pp. 505–523, ACM, 2019.
URL https://doi.org/10.1145/3328526.3329649

On the theoretical side we study the (parameterized) computational complexity of problems in the context of fair allocations of indivisible goods. More specifically, we show fixed-parameter tractability results for a broad set of problems concerned with envy-free, Pareto-efficient allocations of items (with agent-specific utility functions) to agents. In principle, this implies efficient exact algorithms for these in general computationally intractable problems whenever we face instances with few agents and low maximum (absolute) utility values.

On the practical side, we show that our theoretical framework can be implemented in a practically useful way. As opposed to what theoretical performance guarantees suggest, we are able to solve reasonably large instances within seconds (e.g. all spliddit.org instances). We discuss preliminary experimental results and discuss possible extensions of our framework.

4.5 Hedonic Diversity Games

Edith Elkind (University of Oxford, GB)

Joint work of Edith Elkind, Niclas Boehmer, Robert Bredereck, Ayumi Igarashi
Main reference Robert Bredereck, Edith Elkind, Ayumi Igarashi: "Hedonic Diversity Games", in Proc. of the 18th International Conference on Autonomous Agents and MultiAgent Systems, AAMAS '19, Montreal, QC, Canada, May 13-17, 2019, pp. 565–573, 2019.
URL https://dl.acm.org/doi/10.5555/3306127.3331741
Main reference Niclas Boehmer, Edith Elkind: "Individual-Based Stability in Hedonic Diversity Games", CoRR, Vol. abs/1911.08669, 2019.
URL https://arxiv.org/abs/1911.08669

We consider a coalition formation setting where players belong to two types and have preferences over the ratio of the two types in their coalition. We formalize this setting as a hedonic game and consider existence and complexity of finding stable outcomes for various hedonic games solution concepts, such as Nash stability, individual stability and core stability. We consider two ways of extending our model to more than two types of players and provide initial results for this more general setting.

4.6 How Similar Are Two Elections?

Piotr Faliszewski (AGH University of Science & Technology – Krakow, PL)

Joint work of Piotr Faliszewski, Piotr Skowron, Arkadii Slinko, Stanislaw Szufa, Nimrod Talmon
Main reference Piotr Faliszewski, Piotr Skowron, Arkadii Slinko, Stanislaw Szufa, Nimrod Talmon: "How Similar Are Two Elections?", in Proc. of the The Thirty-Third AAAI Conference on Artificial Intelligence, AAAI 2019, The Thirty-First Innovative Applications of Artificial Intelligence Conference, IAAI 2019, The Ninth AAAI Symposium on Educational Advances in Artificial Intelligence, EAAI 2019, Honolulu, Hawaii, USA, January 27 - February 1, 2019, pp. 1909–1916, AAAI Press, 2019.
URL https://doi.org/10.1609/aaai.v33i01.33011909

In this we discuss the problem of measuring distances between elections. We are given two elections, $E_1 = (C_1, V_1)$ and $E_2 = (C_2, V_2)$, where $|C_1| = |C_2|$ and $|V_1| = |V_2|$. That is, both elections have the same number of candidates and the same number of voters, but these are possibly different candidates and voters. In both elections, each voter ranks the candidates from best to worst. We seek a distance that is neutral and anonymous, i.e., which is invariant with respect to permuting the names of the candidates and voters. We introduce a family of what we call *isomorphic distances* which satisfy this condition. Unfortunately, these distances turn out to be computationally very challenging. With one (not so useful) exception, they are NP-hard to compute and hard to approximate with better than linear approximation ratios. While there are FPT algorithms for them, they are quite slow. Then we briefly discuss a very different kind of distance and we show a visual presentation of the distances between elections generated according to a number of classic statistical cultures (including the impartial culture model, Mallows models, urn models, and Euclidean elections).

4.7 Foundations for Liquid Democracy: An Overview

Davide Grossi (University of Groningen, NL)

Liquid democracy is a proxy voting method where proxies are delegable: individual A may delegate her vote to B, who in turn may delegate it to C and so on. Ultimately, an individual's vote carries the weight given by the number of other individuals who (directly or indirectly) entrusted her as proxy. The method has been popularized by the Piratenpartei in Germany as well as other small parties and grassroots organizations worldwide, and it has recently been object of a series of publications in the computational social choice and multi-agent systems communities. In this talk I will overview this stream of work and point to open research directions.

4.8 Fair and Efficient Allocation: Moving Beyond Additivity

Ayumi Igarashi (University of Tokyo, JP)

Joint work of Ayumi Igarashi, Nawal Benabbou, Mithun Chakraborty, Yair Zick

We present new results on the fair and efficient allocation of indivisible goods to agents that have monotone, submodular, non-additive valuation functions over bundles. In particular, we show that, if such a valuation function additionally has binary marginal gains, a socially optimal (i.e. utilitarian social welfare-maximizing) allocation that achieves envy-freeness up to one item exists and can be computed efficiently. We also prove that the Nash welfare-maximizing and the leximin allocations both exhibit this fairness-efficiency combination, by showing that they can be achieved by minimizing any symmetric strictly convex function over utilitarian optimal outcomes. Moreover, for a subclass of these valuation functions based on maximum (unweighted) bipartite matching, we show that a leximin allocation can be computed in polynomial time.

4.9 Empirical Evidence for Consensus Among Voting Rules

Christian Klamler (Universität Graz, AT)

Joint work of Christian Klamler, Andreas Darmann, Julia Grundner

We use preference data from the 2015 Styrian parliament election to analyze different voting rules. An exit poll right after the election collected data on ordinal and cardinal preferences from approximately 1000 actual voters. First, we determine the hypothetical social outcomes under different voting rules. Second, we provide a categorization of different types of parties and analyze the impact of certain voting rules on the performances of the parties. In addition, distance measures have been considered to determine the closeness to changes for the different voting rules. It turns out, that despite the similarity of the voting results, certain outcomes are closer to being changed than others. Finally, based on the ranking data, a bootstrap analysis has been performed. In general, most of the conclusions from behavioral social choice about the consensus among voting rules in real-world elections can be confirmed.

4.10 Decisions with a Continuum of Options

Sascha Kurz (Universität Bayreuth, DE)

Joint work of Sascha Kurz, Issofa Moyouwou, Hilaire Touyem
Main reference Sascha Kurz: "Measuring voting power in convex policy spaces", Economies 2(1): 45–77, 2014.
URL https://doi.org/10.3390/economies2010045

The Shapley-Shubik index was designed to evaluate the power distribution in committee systems drawing binary decisions and is one of the most established power indices. It was generalized to decisions with more than two levels of approval in the input and output. In the limit we have a continuum of options. You may think of e.g. tax rates. For these games

with interval decisions we prove an axiomatization of a power measure and show that the Shapley-Shubik index for simple games, as well as for (j,k) simple games, occurs as a special discretization. This relation and the closeness of the stated axiomatization to the classical case suggests to speak of the Shapley-Shubik index for games with interval decisions, that can also be generalized to a value. Also for the Penrose-Banzhaf index there exists a variant for games with interval decisions in the literature on aggregation functions. The general framework of games with a continuum of options deserves to be explored more. We collect a list of some open problems in that direction.

4.11 Fairness in Long-Term Group Decision Making

Martin Lackner (TU Wien – Austria)

Joint work of Martin Lackner, Paul Harrenstein, Marie-Louise Lackner
Main reference Paul Harrenstein, Marie-Louise Lackner, Martin Lackner: "A Mathematical Analysis of an Election System Proposed by Gottlob Frege", CoRR, Vol. abs/1907.03643, 2019.
URL http://arxiv.org/abs/1907.03643

I am discussing fairness in long-term group decision making, primarily based on the paper "A Mathematical Analysis of an Election System Proposed by Gottlob Frege" by Paul Harrenstein, Marie-Louise Lackner, and Martin Lackner.

4.12 2018 Participatory Budgeting in Portugalete: a Case Study

Annick Laruelle (University of the Basque Country – Bilbao, ES)

TIn Europe participatory budgeting by cities usually consists of a five-steps procedure: (1) a city announces an amount to be allocated and a voting rule; (2) citizens make proposals for improving the city; (3) the city administration selects a set of feasible projects and assigns a cost to each of them; (4) citizens vote for projects according to the voting rule; (5) the city announces the winning proposals. Those proposals are implemented. The voting step is usually described as a classical multi-winner election. The only economic constraint is that the total cost of the winning projects must not exceed the amount decided by the city. In this talk we a case study is analysed: the 2018 participatory budgeting of the city of Portugalete (Spain). This analysis give insight on the properties that participatory budgeting mechanisms should display.his is a dummy text.

4.13 Life of the Party

Omer Lev (Ben Gurion University – Beer Sheva, IL)

Joint work of Omer Lev, Yoram Bacharach, Allan Borodin, Yoda Lewenberg, Jeffery S. Rosenschein, Nisarg Shah, Tyrone Strangway, Yair Zick

Main reference Allan Borodin, Omer Lev, Nisarg Shah, Tyrone Strangway: "Primarily about Primaries", in Proc. of the The Thirty-Third AAAI Conference on Artificial Intelligence, AAAI 2019, The Thirty-First Innovative Applications of Artificial Intelligence Conference, IAAI 2019, The Ninth AAAI Symposium on Educational Advances in Artificial Intelligence, EAAI 2019, Honolulu, Hawaii, USA, January 27 - February 1, 2019, pp. 1804–1811, AAAI Press, 2019.

URL https://doi.org/10.1609/aaai.v33i01.33011804

Main reference Allan Borodin, Omer Lev, Nisarg Shah, Tyrone Strangway: "Big City vs. the Great Outdoors: Voter Distribution and How It Affects Gerrymandering", in Proc. of the Twenty-Seventh International Joint Conference on Artificial Intelligence, IJCAI 2018, July 13-19, 2018, Stockholm, Sweden, pp. 98–104, ijcai.org, 2018.

URL https://doi.org/10.24963/ijcai.2018/14

Main reference Yoram Bachrach, Omer Lev, Yoad Lewenberg, Yair Zick: "Misrepresentation in District Voting", in Proc. of the Twenty-Fifth International Joint Conference on Artificial Intelligence, IJCAI 2016, New York, NY, USA, 9-15 July 2016, pp. 81–87, IJCAI/AAAI Press, 2016.

URL https://www.ijcai.org/Abstract/16/019

When a decision making process is composed of sub-units which have their own internal decision-making processes, such as political parties, it is useful to consider this as a multi-staged electoral process. In particular, we discuss two settings:

1. Primaries, in which 2 political parties (composed of a sizable part of the electorate) decide on their candidate, and the two final candidates go on to a the general electorate. We show this process can increase the distortion by O(1) compared with the direct case (in which all candidates run in the general election), while it can decrease the distortion by O(n).
2. District voting, in which each district makes its choice from among all the candidates, and the candidate with the plurality of districts is the winner. We show the price of districting (again, compared to the direct case), and show that geographical distribution matters significantly, even beyond gerrymandering, showing the urban/rural party divide is meaningful in this setting.

4.14 A Computational Framework for Identity

Janelle C. Mason (North Carolina A&T State University – Greensboro, US)

This presentation presents a computational framework for identity (initially concerning a culprit in a crime scene), which draws its background from various sources across multiple disciplines. Situation theory (as articulated by Barwise and Perry and partially formalized by Devlin) provides a background for the structure of information as situations support information and can carry information about other situations. Semantic Web resources are used to capture information and its structure. The resources used include the Web Ontology Language (OWL) for constructing ontologies, the Resource Description Framework (RDF) for encoding scenarios in triple stores per these ontologies, SPARQL Protocol and RDF Query Language (SPARQL) for querying the triple stores, Semantic Web Rule Language (SWRL) for representing rules, and Jena as an overall Semantic Web framework. The aim is to use the structured information in the RDF triple stores as evidence for identity hypotheses

regarding human agents. Collaboration is done with the Criminal Justice Department at North Carolina A&T State University as criminal justice specializes in identifying agents. Identity is an equivalence relation and that it is addressed computationally in term rewriting. Given the structured information, Dempster-Shafer theory is used to reason about how evidence for various identity hypotheses combines and is discounted. In producing a case for the identity of an agent, measures of belief indicate how the evidence conspires to support given identity hypotheses, but they do not flesh out a case. For this we use argumentation schemes, which are forms that allow one to identify and evaluate types of argumentation that occur in everyday discourse. Most of the arguments of interest are defeasible, that is, the conclusion can be tentatively accepted given the known evidence but may have to be altered as new evidence is introduced.

4.15 Flexible Representative Democracy: An Introduction with Binary Issues

Nicholas Mattei (Tulane University – New Orleans, US)

Joint work of Nicholas Mattei, Ben Abramowitz
Main reference Ben Abramowitz, Nicholas Mattei: "Flexible Representative Democracy: An Introduction with Binary Issues", in Proc. of the Twenty-Eighth International Joint Conference on Artificial Intelligence, IJCAI 2019, Macao, China, August 10-16, 2019, pp. 3–10, ijcai.org, 2019.
URL https://doi.org/10.24963/ijcai.2019/1

We introduce Flexible Representative Democracy (FRD), a novel hybrid of Representative Democracy (RD) and direct democracy (DD), in which voters can alter the issue-dependent weights of a set of elected representatives. In line with the literature on Interactive Democracy, our model allows the voters to actively determine the degree to which the system is direct versus representative. However, unlike Liquid Democracy, FRD uses strictly non-transitive delegations, making delegation cycles impossible, and maintains a fixed set of accountable elected representatives. We present FRD and analyze it using a computational approach with issues that are binary and symmetric; we compare the outcomes of various democratic systems using Direct Democracy with majority voting as an ideal baseline. First, we demonstrate the shortcomings of Representative Democracy in our model. We provide NP-Hardness results for electing an ideal set of representatives, discuss pathologies, and demonstrate empirically that common multi-winner election rules for selecting representatives do not perform well in expectation. To analyze the behavior of FRD, we begin by providing theoretical results on how issue-specific delegations determine outcomes. Finally, we provide empirical results comparing the outcomes of RD with fixed sets of proxies across issues versus FRD with issue-specific delegations. Our results show that variants of Proxy Voting yield no discernible benefit over RD and reveal the potential for FRD to improve outcomes as voter participation increases, further motivating the use of issue-specific delegations.

4.16 Aggregation of Incomplete CP-nets

Arianna Novaro (Paul Sabatier University – Toulouse, FR)

Joint work of Arianna Novaro, Adrian Haret, Umberto Grandi
Main reference Adrian Haret, Arianna Novaro, Umberto Grandi: "Preference Aggregation with Incomplete CP-Nets", in Proc. of the Principles of Knowledge Representation and Reasoning: Sixteenth International Conference, KR 2018, Tempe, Arizona, 30 October - 2 November 2018, pp. 308–318, AAAI Press, 2018.
URL https://aaai.org/ocs/index.php/KR/KR18/paper/view/18069

In this short talk I presented the framework of incomplete, or generalized, CP-nets and their aggregation according to different semantics known in the literature (ie., Pareto, max, maj, and rank). A motivating example for such a setting is that of an online booking service where multiple people (eg., a group of friends) may want to provide their conditional preferences in a flexible way. From a computational complexity perspective, most of the dominance and optimality problems in this setting turn out to be as hard as their single-agent counterpart (PSPACE).

4.17 Pie-Chart Voting: An Annotated Bibliography

Dominik Peters (University of Oxford, GB)

A group of agents owns a common resource (their budget) and needs to decide how to split the budget among various projects. If the projects can receive an arbitrary level of funding (and the budget is perfectly divisible), then the result of the decision process can be visualized as a pie chart. I give a survey of recent work on this topic, focussing on fairness and on strategic issues. The presentation is guided by different possible applications, and which aggregation rules are suitable for them.

4.18 Learning rankings for job recommendations (with constraints)

Karishma Rajesh Sharma (USC – Los Angeles, US)

Joint work of Karishma Rajesh Sharma, Kuan Liu, Anoop Kumar, Prem Natarajan
URL https://github.com/ksharmar/Recsys17

This is part of a rump session.

We address the problem of learning rankings in recommender systems under cold start and constrained settings. We presented our solution to the job recommendation task for ACM RecSys 2017 challenge. The two key challenges addressed are (1) cold start – we need to recommend new items (jobs) with no history of preferences from users (2) constraints – we want to limit the number of recommendations pushed to a user and also ensure maximum utility (relevance) of recommendations to both users and items (companies posting the jobs). We propose a matrix factorization approach for collaborating filtering and incorporate content embeddings to address the cold start items. The model is formulated to obtain

preferences (rankings) of users on items and preferences (rankings) of items on users. We then utilize the stable matching algorithm to select optimal recommendation pairs that maximize preferences of both users and items and limit the number of recommendations pushed to a user. The details of the working paper and implementation are available at https://github.com/ksharmar/Recsys17.

4.19 A Framework for Approval-Based Budgeting Methods

Nimrod Talmon (Ben Gurion University – Beer Sheva, IL) and Piotr Faliszewski (AGH University of Science & Technology – Krakow, PL)

Main reference Nimrod Talmon, Piotr Faliszewski: "A Framework for Approval-Based Budgeting Methods", in Proc. of the The Thirty-Third AAAI Conference on Artificial Intelligence, AAAI 2019, The Thirty-First Innovative Applications of Artificial Intelligence Conference, IAAI 2019, The Ninth AAAI Symposium on Educational Advances in Artificial Intelligence, EAAI 2019, Honolulu, Hawaii, USA, January 27 - February 1, 2019, pp. 2181–2188, 2019.
URL http://dx.doi.org/10.1609/aaai.v33i01.33012181

We define and study a general framework for approval-based budgeting methods and compare certain methods within this framework by their axiomatic and computational properties. Furthermore, we visualize their behavior on certain Euclidean distributions and analyze them experimentally.

4.20 Capacitated Facility Location Problems

Toby Walsh (UNSW – Sydney, AU)

I consider the facility location problem in the one-dimensional setting where each facility can serve a limited number of agents from the algorithmic and mechanism design perspectives. From the algorithmic perspective, the optimization problem, where the goal is to locate facilities to minimize either the total cost to all agents or the maximum cost of any agent is NP-hard. I also consider the problem from a mechanism design perspective where the agents are strategic and need not reveal their true locations. We show that several natural mechanisms for the uncapacitated setting either lose strategyproofness or a bound on the solution quality for the total or maximum cost objective when applied to the capacitated problem. I discuss a new mechanisms that is strategyproof and achieves approximation guarantees that almost match the lower bounds.

4.21 A Mathematical Model For Optimal Decisions In A Representative Democracy

Lirong Xia (Rensselaer Polytechnic Institute – Troy, US)

Joint work of Lirong Xia, Malik Magdon-Ismail
Main reference Malik Magdon-Ismail, Lirong Xia: "A Mathematical Model For Optimal Decisions In A Representative Democracy", in Proc. of the Advances in Neural Information Processing Systems 31: Annual Conference on Neural Information Processing Systems 2018, NeurIPS 2018, 3-8 December 2018, Montréal, Canada, pp. 4707–4716, 2018.
URL http://papers.nips.cc/paper/7720-a-mathematical-model-for-optimal-decisions-in-a-representative-democracy

Direct democracy, where each voter casts one vote, fails when the average voter competence falls below 50%. This happens in noisy settings when voters have lim- ited information. Representative democracy, where voters choose representatives to vote, can be an elixir in both these situations. We introduce a mathematical model for studying representative democracy, in particular understanding the parameters of a representative democracy that gives maximum decision making capability. Our main result states that under general and natural conditions, (1) for fixed voting cost, the optimal number of representatives is linear; (2) for polynomial cost, the optimal number of representatives is logarithmic.

5 Working Groups and Voting Experiments

5.1 Democratic Decision-Making, Deliberation and Blockchain

Davide Grossi (University of Groningen, NL) and Ehud Shapiro (Weizmann Institute – Rehovot, IL)

The group was structured around two main topics: (1) the interface between blockchain protocols and computational social choice; (2) models of deliberative processes that could provide insights for the design of deliberation support platforms (such as Vilfredo, www.vilfredo.org). The discussion of topic (1) managed to provide an inventory of open issues in current blockchain research which may benefit from insights from computational social choice and more broadly economic theory, such as: committee selection during consensus; genuine individual identifiers to dispense with proof-of-work as a method for Sybil resistance; governance (or 'voting on how to vote'); the design of suitable token systems (cryptocurrencies). The discussion of topic (2) managed to focus on a preliminary model representing deliberation as a non-deterministic process of coalition formation on a metric space. We are confident this approach can lead to interesting results and novel insights.

5.2 Outreach Activities and Real-Life Experiments

Annick Laruelle (University of the Basque Country – Bilbao, ES) and Arianna Novaro (Paul Sabatier University – Toulouse, FR)

The group discussed three main topics: (i) outreach activities for the dissemination of COMSOC results, (ii) real-life experiments in participatory budgeting and voting, and (iii) resources and ideas for teaching COMSOC. Members of the group shared their personal experiences and ideas on the three topics, leading to the suggestion of implementing an online platform where members of the COMSOC community could share their resources on teaching, outreach and real-life experiments. Pros and cons of possible implementation designs were also discussed. During the discussion it was also mentioned the possibility of interacting with other fields (e.g., systems engineering) where COMSOC techniques could be directly applied. Finally, innovative teaching practices for explaining voting rules to an audience of non-experts were outlined at the end of the final group session.

5.3 Social Choice With Uncertain Preferences

Lirong Xia (Rensselaer Polytechnic Institute – Troy, US), Haris Aziz (UNSW – Sydney, AU), Edith Elkind (University of Oxford, GB), Piotr Faliszewski (AGH University of Science & Technology – Krakow, PL), Ayumi Igarashi (University of Tokyo, JP), Jérôme Lang (University Paris-Dauphine, FR), Omer Lev (Ben Gurion University – Beer Sheva, IL), Nicholas Mattei (Tulane University – New Orleans, US), Dominik Peters (University of Oxford, GB), Piotr Skowron (University of Warsaw, PL), and Kristen Brent Venable (IHMC – Pensacola, US)

Classical social choice assumes that voters' preferences are represented by a linear order. However, in many situations agents preferences are uncertain. The problem becomes more prominent in modern applications of social choice such as business decision-making, high frequency e-democracy, consensus on blockchains, and many more.

The working group tried to formalize the direction of social choice with uncertain preferences by identifying the following directions (instead of solving open questions):

1. The source of uncertainty can come from: 1. agents are uncertain about their own preferences, 2. the system is uncertain about agents' preferences, or 3. agents are uncertain about other agents' preferences or behavior.
2. Uncertain preferences can be represented by: probabilistic distributions, fuzzy preferences, possibility theory, decision field theory, conjoint measurement
3. The social choice problem can be: (single and multi-winner) voting, participatory budgeting, matching, kidney exchange resource allocation, etc.

The group also discussed issues in preference data collection, group decision support systems, and open-source packages.

5.4 Voting Experiment: Heuristic Strategies in Uncertain Approval Voting Environments

Kris Brent Venable (IHMC – Pensacola, US) and Nicholas Mattei (Tulane University – New Orleans, US)

Joint work of Jaelle Scheuerman, Jason L. Harman, Kristen Brent Venable, Nicholas Mattei
Main reference Jaelle Scheuerman, Jason L. Harman, Nicholas Mattei, Kristen Brent Venable: "Heuristic Strategies in Uncertain Approval Voting Environments", CoRR, Vol. abs/1912.00011, 2019.
URL https://arxiv.org/abs/1912.00011

In many collective decision making situations, agents vote to choose an alternative that best represents the preferences of the group. Agents may manipulate the vote to achieve a better outcome by voting in a way that does not reflect their true preferences. In real world voting scenarios, people often do not have complete information about other voter preferences and it can be computationally complex to identify a strategy that will maximize their expected utility. In such situations, it is often assumed that voters will vote truthfully rather than expending the effort to strategize. However, being truthful is just one possible heuristic that may be used. In this paper, we examine the effectiveness of heuristics in single winner and multi-winner approval voting scenarios with missing votes. In particular, we look at heuristics where a voter ignores information about other voting profiles and makes their decisions based solely on how much they like each candidate. In a behavioral experiment, we show that people vote truthfully in some situations and prioritize high utility candidates in others. We examine when these behaviors maximize expected utility and show how the structure of the voting environment affects both how well each heuristic performs and how humans employ these heuristics.

5.5 Voting Experiment: Multiple Elections in Iterative Voting

Jérôme Lang (University Paris-Dauphine, FR) and Umberto Grandi (University Toulouse Capitole, FR)

Joint work of Jérôme Lang, Ali Ozkes, Umberto Grandi, Stéphane Airiau

This voting experiment was organised on the Thursday of the workshop for 21 participants. A temporary lab was set up in one of the rooms, using a set of tablets connected on a local network set up by lab technician Elven Priour (CNRS and University of Rennes, France).

Participants were confronted with a multiple election: given a 2x2 matrix, decide if the row will be Top or Bottom, and the column Left or Right. Both decisions would be taken separately by majority. However, the utility of each participant-voter depended on the result of both elections combined. It has been shown in theory that similar elections can generate paradoxical situations in which the collective result is not among the most preferred alternatives (in some cases it is the least preferred) for each voter. In this experiment participants were confronted with an iterated setting, in which each vote would be repeated, and the outcomes of previous votes shown to voters, until the winning combination did not change for three turns. What we could monitor in the data is the evolution of the average Borda score of the winning combination (a parameter also known as ASI), as well as the behaviour of voters facing an uncertain and complex election.

Participants

- Haris Aziz
UNSW – Sydney, AU
- Dorothea Baumeister
Heinrich-Heine-Universität Düsseldorf, DE
- Abdelhak Bentaleb
National University of Singapore, SG
- Sylvain Bouveret
University of Grenoble, FR
- Florian Brandl
Stanford University, US
- Felix Brandt
TU München, DE
- Robert Bredereck
TU Berlin, DE
- Markus Brill
TU Berlin, DE
- Jiehua Chen
TU Wien, AT
- Cristina Cornelio
IBM T.J. Watson Research Center – Yorktown Heights, US
- Ronald de Haan
University of Amsterdam, NL
- Edith Elkind
University of Oxford, GB
- Ulle Endriss
University of Amsterdam, NL
- Piotr Faliszewski
AGH University of Science & Technology – Krakow, PL
- Joseph Godfrey
WinSet Group, LLC – Falls Church, US
- Umberto Grandi
University Toulouse Capitole, FR
- Davide Grossi
University of Groningen, NL
- Ayumi Igarashi
University of Tokyo, JP
- Christian Klamler
Universität Graz, AT
- Sascha Kurz
Universität Bayreuth, DE
- Martin Lackner
TU Wien, AT
- Jérôme Lang
University Paris-Dauphine, FR
- Annick Laruelle
University of the Basque Country – Bilbao, ES
- Omer Lev
Ben Gurion University – Beer Sheva, IL
- Andrea Loreggia
University of Padova, IT
- Nicola Frederike Maaser
Aarhus University, DK
- Janelle C. Mason
North Carolina A&T State University – Greensboro, US
- Nicholas Mattei
Tulane University – New Orleans, US
- Nicolas Maudet
Sorbonne University – Paris, FR
- Reshef Meir
Technion – Haifa, IL
- Vincent Merlin
Caen University, FR
- Stefan Napel
Universität Bayreuth, DE
- Rolf Niedermeier
TU Berlin, DE
- Arianna Novaro
Paul Sabatier University – Toulouse, FR
- David Pennock
Microsoft – New York, US
- Dominik Peters
University of Oxford, GB
- Elven Priour
University of Rennes, FR
- Jörg Rothe
Heinrich-Heine-Universität Düsseldorf, DE
- M. Remzi Sanver
University Paris-Dauphine, FR
- Ehud Shapiro
Weizmann Institute – Rehovot, IL
- Karishma Rajesh Sharma
USC – Los Angeles, US
- Piotr Skowron
University of Warsaw, PL
- Arkadii Slinko
University of Auckland, NZ
- Pietro Speroni di Fenizio
Dublin, IE
- Nimrod Talmon
Ben Gurion University – Beer Sheva, IL
- Paolo Turrini
University of Warwick – Coventry, GB
- Kristen Brent Venable
IHMC – Pensacola, US
- Toby Walsh
UNSW – Sydney, AU
- Lirong Xia
Rensselaer Polytechnic Institute – Troy, US