Computational Social Choice: Spring 2019

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Plan for Today

I will try to give an overview of what I consider some of the most exciting directions for future work in COMSOC.

At the end of the lecture, we will also briefly discuss:

- resources, publication venues
- exam preparation

Probabilistic Social Choice

For all formal results discussed in this course we insisted on rules being deterministic. But in practice *randomisation* can be sensible.

To study strategic behaviour we now need to *lift preferences* from alternatives to *lotteries over alternatives*. Different ways of doing that.

Some ways lead to similarly negative results as the G-S Theorem (basically: only randomised dictatorships work).

But for other assumptions more positive results are possible.

Opportunity: Has not yet been studied for judgment aggregation.

F. Brandt. Rolling the Dice: Recent Results in Probabilistic Social Choice. In U. Endriss (ed.), *Trends in Computational Social Choice*. AI Access, 2017.

Multiwinner Voting Rules

We focused on (possibly irresolute but) *single-winner* voting rules.
But many applications require us to elect k winners.

Lots of recent work on *multiwinner* voting rules.

Connections to topics discussed in this course:

- Axiomatics, truth-tracking, complexity, manipulation: all relevant.
- Can be seen as an instance of voting in combinatorial domains.
- Lifting of preferences (cf. manipulation of irresolute rules).

P. Faliszewski, P. Skowron, A. Slinko, and N. Talmon. Multiwinner Voting: A New Challenge for Social Choice Theory. In *Trends in COMSOC*. AI Access, 2017.

Incomplete Preferences

In the classical (Arrovian) model of preference aggregation in SCT all agents are assumed to have (and report) *complete preferences*.

But in many scenarios preferences actually are *incomplete:*

- Bounded rationality: agents cannot reason about all alternatives
- Bounded attention: agents do not care about all alternatives
- Bounded scope: agents are not being asked about all alternatives

Related to but different from *informational barriers* to manipulation (discussed in the course) and *possible winners* (not discussed).

<u>Remark:</u> Similar issues arise also in judgment aggregation.

Z. Terzopoulou and U. Endriss. Aggregating Incomplete Pairwise Preferences by Weight. IJCAI-2019.

Liquid Democracy

"Liquid Democracy" is the idea of allowing voters to choose between voting and delegating their votes to others (in a transitive manner).

Used in practice (famous example: *Piratenpartei* in Germany), but development of sound theoretical foundations still lacking.

The entire methodological battery of COMSOC can be brought to bear on the study of such novel models of collective decision making.

M. Brill. Interactive Democracy. AAMAS-2018 Blue Sky Ideas Track.

Social Choice on Social Networks

In practice, agents engaging in collective decision making will often be situated in a social network constraining their interactions:

- fair allocation: can only envy / can only deal with neighbours
- truth tracking: modelling violations of independence assumption
- manipulation: manipulator only has information about neighbours
- opinion / preference diffusion in social networks

<u>Note:</u> Liquid Democracy = social choice mechanism on social network

U. Grandi. Social Choice and Social Networks. In U. Endriss (ed.), *Trends in Computational Social Choice*. AI Access, 2017.

Ethical AI

Question: *Can we use SCT to inform research into "Ethical AI"?*

Some have proposed to use *crowdsourcing* to arrive at conclusions about what constitutes ethical behaviour (example: self-driving cars).

Interesting but controversial idea. Surely would need to be based on sound foundations for how to aggregate the information gathered: SCT.

V. Conitzer, J. Schaich Borg, and W. Sinnott-Armstrong. Using Human Subjects' Judgments for Automated Moral Decision Making. Whitepaper for *Workshop on Trustworthy Algorithmic Decision-Making*, 2017.

Beyond Aggregating Preferences

<u>Idea:</u> Apply the methodology developed in COMSOC to analyse the aggregation of (mostly) preferences also in other domains.

Lots of scenarios involve (agent-oriented) *aggregation of information:*

- crowd recommendation
- rank aggregation for information retrieval
- crowdsourced annotation of data
- consensus clustering
- collective argumentation
- ontology merging
- aggregating social networks

Judgment aggregation has clear potential as a very general framework. Somewhat closer to some of the applications above: *graph aggregation*

U. Endriss and U. Grandi. Graph Aggregation. *Artificial Intelligence*, 2017.

Computational Social Choice and Data

The *theoretical/normative* approach of much of SCT is perfectly suited to many questions of fundamental interest. But *data* is also useful.

Examples for questions we can approach if we have data on preferences:

- What are reasonable domain restrictions?
- How frequent are problems (Condorcet cycles, . . .) in practice?
- What is the average-case complexity of a problem of interest?

A great resource for preference data is `PrefLib.org`.

<u>Opportunity:</u> Nothing like this done yet for judgment aggregation.

N. Mattei and T. Walsh. A PrefLib.org Retrospective: Lessons Learned and New Directions. In *Trends in Computational Social Choice*. AI Access, 2017.
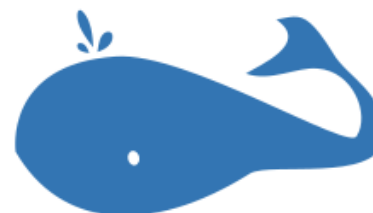
Computational Social Choice and the Web

Building tools to allow users to interact directly with social choice algorithms on the web is not only useful for those users but also an opportunity to collect data and get ideas for new research questions.

Important examples:

spliddit.org   whale.imag.fr

J. Goldman and A.D. Procaccia. Spliddit: Unleashing Fair Division Algorithms. *SIGecom Exchanges*, 2014.

S. Bouveret. Social Choice on the Web. In U. Endriss (ed.), *Trends in Computational Social Choice*. AI Access, 2017.

Automated Reasoning for Social Choice Theory

The SAT solving technique we discussed for (re-)proving impossibility theorems is an exciting tool, with lots of opportunities for expansion.

Can we use other automated reasoning tools?

- First-order theorem provers? Higher-order proof assistants?
- Constraint programming? Logic programming? ASP? Planning?

Can we go beyond (re-)proving known impossibility theorems?

- Systematic search for new (impossibility) theorems
- Synthesis of rules that meet given requirements
- Explaining/justifying outcomes, arguing/reasoning about rules

Can we use these methods outside of voting theory?

C. Geist and D. Peters. Computer-Aided Methods for Social Choice Theory. In U. Endriss (ed.), *Trends in Computational Social Choice*. AI Access, 2017.

O. Cailloux and U. Endriss. Arguing about Voting Rules. AAMAS-2016.

Other Topics of Interest

- Voting with linguistic grades ("majority judgment")

- Peer grading

- Gerrymandering

- Iterative voting

- Opinion polls and information held by strategic voters

- Integration of COMSOC with electronic voting concerns

- Feedback to political science, also computational concerns

Finding out about New Developments

The *Handbook of COMSOC* (2016) represents the state of the art around 2012, when it was conceived.

Trends in COMSOC (2017) covers several important developments that have taken place since then.

A lot of work in COMSOC gets published at major AI conferences:

- AAMAS is the most important multiagent systems conference
- IJCAI, AAAI, ECAI are the main general-purpose AI conferences

At the interface with Algorithmic Game Theory (and Theoretical Computer Science more generally), the most important conference is EC.

In Computer Science most new ideas (first) show up at conferences, but also look at the corresponding journals (JAIR, AIJ, TEAC, JAAMAS).

The most relevant Economics journals are JET, SCW, MSS.

Further Resources

Some work first appears in working papers or at informal workshops. The most important example is the biannual *COMSOC Workshop*.

For the *proceedings* of all past COMSOC workshops, a collection of *PhD theses* in COMSOC, and a few other resources, visit:

`http://research.illc.uva.nl/COMSOC/`

Additional resources (e.g., teaching materials from summer schools) are available from the website of *COST Action IC1205 on COMSOC* (a European research network that ran from 2012 to 2016):

`http://research.illc.uva.nl/COST-IC1205/`

Subscribe to the COMSOC *mailing list* (events, PhD positions, ...):

`https://lists.duke.edu/sympa/info/comsoc`

Exam Preparation

Expect a series of simple questions testing your *familiarity* with and *understanding* of the *concepts* introduced throughout the course.

So these questions will be quite different from the homework questions.

Everything (slides, readings, homework, lectures) is examinable material. But if you are short of time, it's best to focus on the *slides*.

This will be a closed-book exam, but you may bring one piece of paper (A4, double-sided) of *handwritten notes* with you.

Recall that the exam counts for 25% of you final grade for the course (with the proviso that you must pass the exam to pass the course).

Next Steps

- Advanced Topics in Computational Social Choice in June:

  https://staff.fnwi.uva.nl/a.boixel/comsoc-project-2019/

- You are always welcome at the local COMSOC Seminar:

  http://www.illc.uva.nl/~ulle/seminar/

  <u>And:</u> You really should make it a habit to attend research seminars every now and then—this one or any of the many others around.

- The 3rd ILLC Workshop on Collective Decision Making in June, with lots of talks on emerging topics in COMSOC:

  http://www.illc.uva.nl/~ulle/workshop-2019/