CS 886: Multiagent Systems

Cheriton School of Computer Science

University of Waterloo

Winter 2025

UNIVERSITY OF WATERLOO

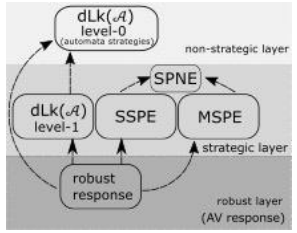
Who Am I?

- Professor in the Cheriton School of Computer Science
- I am interested in environments where there are multiple interacting agents (software agents, humans,…)
  - How do you make a decision on behalf of a group that appropriately reflects the preferences and values of the group members ?
  - What sort of strategic behavior arises in different (computational) settings?
  - How do we reason about and design systems or institutions that can support group behavior?

What I am Interested In

The impact that limited information and computational resources have on strategic behaviour, mechanism outcomes, and learning processes, and how this can support or disrupt cooperative outcomes (e.g. [AL2024, BAL2024, MSL2023, STLC2022, MML2021, ML2019, ML2018, ML2017, TSL2018,TL2016,BL2011,LS2001b])

Models of bounded rationality (e.g. [SLC2023, SLC2022, SLC2021, d'EL2020])



Sarkar, Larson, Czarnecki, 2022

	Ordinal algorithms	Adaptive threshold query algorithms (for any $\epsilon > 0$, $\lceil \frac{\log(n^2 \cdot 1/\epsilon)}{\log(1+\epsilon/2)} \rceil$ queries per agent)	Non-adaptive threshold query algorithms (at most 1 query per (agent, object) pair)
unit-sum valuations	UB: $O(n^2)$ [Theorem 1] LB: $\Omega(n^2)$ [Theorem 1]	$1+\epsilon$ [Theorem 3]	UB: $O(n^{2/3})$ [Theorems 4 and 6] LB: $\Omega(\sqrt{n})$ [Theorem 7]
unit-range valuations	UB: $O(n)$ [Theorem 9] LB: $\Omega(n)$ [Theorem 9]	$1+\epsilon$ [Theorem 3]	UB: $O(\sqrt{n})$ [Theorem 10] LB: $\Omega(\sqrt{n})$ [Theorem 11]

Ma, Menon, Larson, 2022

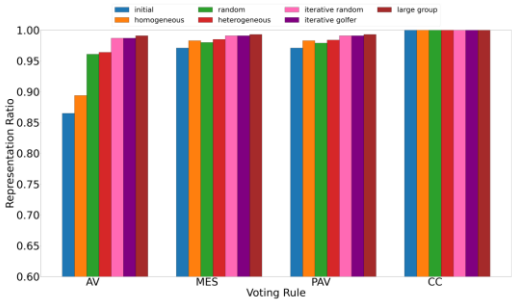


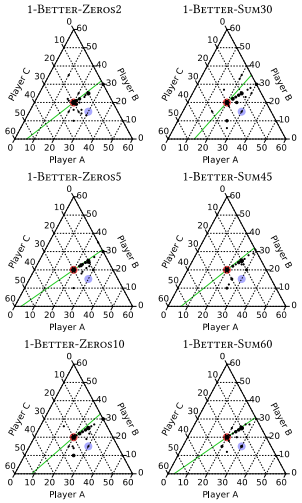
Figure 3: Representation ratio across deliberation mechanisms.

Kanav, Sreenivas, Larson, 2023

Cooperative game theory and negotiation (e.g [G+2024, L+2023, d'EL2020, d'ELL2019, KLS2015, BL2009, LS2001a])

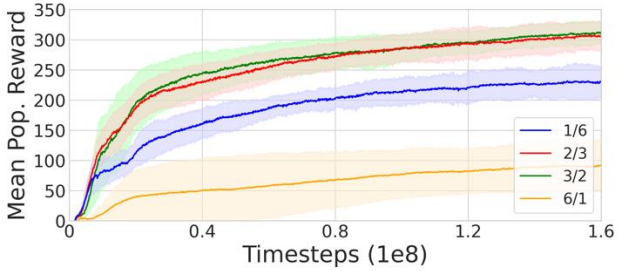
$$\min_{p,\epsilon} \quad \epsilon$$
$$s.t. \quad v(c) - \epsilon - p^\top c \leq 0 \quad \forall\ c$$
$$\sum_{i=1}^{n} p_i = 1$$
$$p_i \geq 0 \quad \forall\ i \in I.$$

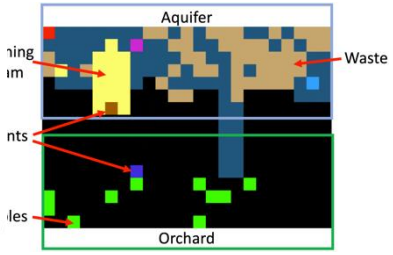
Gemp et al, 2024



d'Eon and Larson, 2020

Supporting the emergence of cooperative behaviour in social dilemmas (e.g. [RLBK2023, RLB2023, RLB2022, D+2022])





Radke, Larson, Brecht, 2022

Who Are You?

About This Course

This course will introduce key challenges that arise within multiagent systems, namely how should we design and build agents and shape interactions in complex settings so as to best support cooperation and coordination. We will consider human users to also be a critical part of any system and so will also consider some of the fundamental challenges associated with recent alignment approaches.

Learning Outcomes

- Discover research challenges raised by today's multiagent systems.
- Learn whether newly proposed research directions and solutions from academia or industry address these challenges.
- Identify opportunities for further authentication research and undertake some novel research.
- Improve your technical writing and presentation skills.

Course Organization

- Mondays from 8:30-11:20 in DC2585
  - I expect that many weeks we will end a bit earlier.
    - If you are interested in taking CS860 (Algorithmic Spectral Graph Theory) which is at 11:00 on Mondays, it should be fine.

- Office Hours:
  - 11:30-12:00 on Mondays or by appointment

- Communication
  - Website: www.cs.uwaterloo.ca/~klarson/teaching/W25-886
  - Piazza (see instructions on website for signing up)

Grading Scheme

- This is a seminar course. We will spend most of our time reading and discussing recent research papers.

- Paper Presentations: 20%
- Paper Critiques (also a presentation): 16%
- Paper Reviews: 12%
- Class Participation (includes presentation feedback): 12%
- Project: 40% (15% presentation + 25% final report)

Paper Reading

- Goal: Learn what makes a good paper
- Every student will read all papers to be covered in class beforehand
- Study Keshav's "How to Read a Paper". Do 3 passes over the paper
  1. Get a general idea about the paper
  2. Grasp the content, but not necessarily the details
  3. Understand the paper in depth
     - If you are not presenting the paper, you can probably skip the appendices
     - Don't get stuck trying to understand tricky minor points
- To start you will likely take several hours to read and review a paper. It will get better as you gain more experience!

Paper Reviews

- Every student is **required** to submit a review for both papers being presented each week (unless you are presenting – you do not need to review a paper that you present)
  - Discuss contributions, presentation, weaknesses, etc
  - We will be using a submission system which includes a review form. Also available on the course website.
  - Reviews are due before the start of class (by 7:00 am).
- You will see each others' (anonymized) reviews
  - Useful to learn from each other
- **No.** You can not use Generative AI (ChatGPT/NotebookLM/Gemini/Claude/Llama/…) to write your reviews. It is against course policy (see the course website) and it means **you** lose out practicing an important research skill.

Paper Presentation

- Goal: Practice your presentation skills
- Every student will present one or two research papers during the term.
  - You will choose your papers through a bidding process
- Workshop/conference style presentation
  - 30 minutes in length
- Email me the slides before the lecture

Paper Critiques

- A pair of students will be responsible for “critiquing” each paper presented.
  - This is a critique of the paper NOT the presentation!

- You need to prepare a 10 minute response to a paper focusing on
  - Key assumptions, limitations, connections to other research, potential future directions
  - You can decide to prepare slides or not
  - We will have already seen the presentation of the paper, you do not need to repeat anything about the paper content
- The paper presenter AND the ”critiquers” will help run the class discussion.

(You have probably never seen this before since it is not common in CS conferences. However, they do this in some economics workshops and it can be quite interesting)

Presentation Feedback

- Feedback is essential when it comes to training speaking skills.
- Every student is required to submit a review for each presentation by 12:00pm (noon) the day after the presentation.
  - We are using a submission system (similar to the one used for paper reviewing)
- The review form is available on the course website
  - Please look over it before preparing your presentation!
- The presenter will see (anonymized) reviews.
- Provide **constructive** feedback!

Course Project

- Goal: explore new ideas in multiagent systems that can lead to novel research
- Typically done in groups of two
- I am always happy to discuss project ideas

- Key dates
  - Proposal: Feb 14th
  - Presentation: March 31
  - Report: April 11

Next Steps

- Sign up for the course on Piazza

- Non-CS students need my permission to register
  - Send me your email with your student ID
  - Briefly explain why you would like to take the course and your background

- Watch for information about paper bidding and enrollment into the paper and presentation reviewing systems.
  - Paper bids are due Jan 12 – start looking over the paper list now
    - https://cs.uwaterloo.ca/~klarson/teaching/W25-886/schedule.html