Course Proposal: Collective cognition

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In what ways does collective cognition subdue individual cognition? How should we go about solving problems in groups? When should we rely on hierarchy, and when should we facilitate self-organization? How can we reasonably resolve disagreements among peers? How to properly harness the benefits of diversity? What are the epistemic implications of selfishness? This course provides an interdisciplinary approach to these questions, drawing from broad perspectives including managerial and political science, social epistemology, cultural evolution, and complexity and decision theory, all brought under the umbrella of "collective cognition". Students will be invited to transform the classroom itself into an experiment by self-organizing around a joint-project (related to collective cognition) and by reflecting upon their own process.

The goal of the course is twofold. The first aim is to familiarize students with research from disparate bodies of literature relevant to the broader theme of collective cognition. Throughout the course, students will be encouraged to draw connections between these bodies of work. The second goal of the course is to reflect upon the implications of the theoretical issues explored throughout the course for organizational and institutional design: what does collective cognition have to say about democracy, markets, and central planning?

In the process, students will:

- Understand the epistemic implications of organizational and institutional design for groups and societies.
- Learn to model situations of collective cognition using the appropriate frameworks(s): decision theory, game theory, Bayesian belief-updating and complex landscapes, etc.
- Learn empirical approaches to collective cognition using either experimental or observational behavioral data.
- Gain experience with the co-organization of a "large-scale" project.

Students are expected to be familiar with the fundamentals of Bayesian probability, decision theory (in particular probabilistic utility-maximizing decision theory), and game theory. They (or at several of them) should have some computational skills and experience with programming. It is fine, and even better, if students have heterogeneous skills and knowledge.

1 Plan (30 hours, incl. 6 hours of practical work)

The course is organized in four themes. The last theme is more open-ended. Students should be able to start working on their joint-probject before the end of the class.

1.1 From individual cognition to collective cognition (2h)

Collective cognition is key to humans' success, beyond their individual cognitive abilities. We review evidence that causal understanding plays a limited role in innovation and in the transmission and accumulation of culture, and that our ability to reason is more effective in a social context

than as an internal means of acquiring knowledge. Finally, we review the independence thesis, according to which collective cognition does not reduce to individual cognition in a simplistic way. These insights suggest a shift in focus from individual cognition to collective cognition.

- The collective brain as "the secret of our success" [1–4]
- The independence thesis in social epistemology: why collective rationality does not reduce to individual rationality [5]
- The landscape of issues in collective cognition.

In-class activities: reading, in-class discussion.

1.2 Division of labor and cooperation in collective cognition (6h+2h)

Collective cognition can be thought of as the process of diving up a cognitive task among multiple agents. Are there optimal ways of dividing up cognitive work in groups? How is such a division of labor even possible, if agents are motivated by the pursuit of their own interests And how do agents effectively navigate trade-offs involved in the division of cognitive labor (exploitation versus exploration, specialization versus adaptation, etc.)?

- Optimal task allocation and exploration/exploitation trade-offs in collective cognition [5, 6]
- Selfishness and cooperation in collective cognition [7–11]
- Inverse problems for collective cognition: reverse-engineering collective behavior using experimental or observational behavioral data [6, 12, 13]

In-class activities: 2h practical work session.

1.3 Diversity in collective problem-solving (8h+2h)

The efficiency of collective cognition stems in great part from its ability to leverage the diversity of information, knowledge, and skills possessed by individual agents. However, such diversity also raises a number of issues: are certain kinds of diversity detrimental to collective cognition? How to produce coherent collective judgments? How to avoid the polarization of epistemic agents into incompatible and irreconcilable views?

- The benefits of transient diversity: making space for individual and independent exploration [14–17]
- The Hong-Page model: high diversity can exceed high-ability [18]
- The wisdom of the crowds [19–21, 4, 9]
- Challenges and pitfalls of diversity (issues in judgment aggregation and group-decision [22, 23]; polarization [24]; the trade-off between diversity and coordination [25])

In-class activities: 2h practical work session.

1.4 Adaptive systems, self-organization, and hierarchies (6h+2h)

Collective problem-solvers are not necessarily static systems; they may continuously evolve and adapt to the nature of the tasks they purport to solve. In particular, highly complex tasks may demand sophisticated communication structures that would be hard to design by hand but may nevertheless spontaneously emerge through self-organization. Why do difficult tasks require complex structures to develop? How can self-organizing systems achieve success despite the lack of central oversight? What is the function of hierarchical structures in collective cognition?

- Collective problem-solvers and complex adaptive systems [26, 27]
- Specialization, modularity, and compositionality: how agents devise solutions that can be re-used and re-combined [28].
- Conflict, self-organization and hierarchies: the case of Wikipedia [29, 30]
- Markets and central planning in economics and organizations [31–34]

In-class activities: 2h practical work session.

1.5   Challenges in collective cognition (2h)

Collective cognition lies at the core of several major contemporary issues, such as the need to develop innovative technical and social solutions to climate change, the harms caused by online social media, and the disruptions caused by artificial intelligence.

- Collective stupidity: when groups are dumber than isolated agents [35, 36]
- Collective adaptation [37]
- Artificial intelligence [TBD].

2   Evaluation

On the first day, students are asked individually to report their skill sets and domains of expertise (e.g. the programming languages or computational methods they might be familiar with, their favorite courses, etc.). Based on their feedback, the instructor(s) design(s) a joint-project for the class that no single student would be able to accomplish on their own given (i) the scale of the project and (ii) their distribution of skills. The joint-project is related to collective cognition and should involve several of the following tasks: designing formal models, collecting data, conducting an experiment, analyzing data, etc. The project should be rather open-ended in order to make room for creativity. Students will work collaboratively over more than half of the semester and produce a joint-report. In order to be evaluated individually, students hand out short individual reports (a) describing their own contribution and (b) reflecting upon how one or more issues raised during the class may have transpired during the course of the project and how they affected the outcome.

It is likely that students will encounter some of the following issues:

- Carefully balancing exploration (the conception/framing of an interesting project) and exploitation (its actual realization).
- Implementing an *optimal* allocation of tasks (given everyone's expertise).
- Implementing a *fair* allocation of tasks.
- Creating efficient communication structures.
- Devising efficient decision-making structures (which questions should be subject to the entire collective scrutiny? which decisions may be left out to smaller groups or individuals?).
- Ensuring that individual contributions are substantial even in case of collective failure.

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