

Course Proposal: Collective cognition

Lucas Gautheron

November 14, 2024

In what ways collective cognition subdues 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? This course provides an interdisciplinary approach to these questions, drawing from wide 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 the course) and by reflecting upon their own process.

The goal of the course is twofold. The first goal 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:

- 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.
- Understand the epistemic implications of organizational and institutional design for groups and societies.
- 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 Contents

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

1.1 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]

1.2 Division of labor and cooperation in collective cognition

- Exploration/exploitation trade-off in collective cognition: multi-armed bandits in multi-agent systems [6, 7]
- It’s all fun and games: selfishness and cooperation in collective cognition [8–11]
- Inverse problems and statistical inference for collective cognition: working with experimental or observational behavioral data [6, 12, 13]

1.3 Diversity in collective problem-solving

- 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, 10]
- Pitfalls of diversity (issues in judgment aggregation [22]; polarization [23]; the trade-off between diversity and coordination [24])

1.4 Adaptive systems, self-organization, and hierarchies

- Collective problem-solvers and complex adaptive systems [25, 26]
- Specialization and compositionality
- Conflict, self-organization and hierarchies: the case of Wikipedia [27, 28]
- Markets and central planning in economics and organizations [29–32]
- Challenges in collective cognition: collective stupidity [33, 34], collective adaptation [35], and artificial intelligence.

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, students hand out short individual reports (a) describing their individual 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.

Bibliography

- [1] M. Muthukrishna and J. Henrich. “Innovation in the collective brain”. In: *Philosophical Transactions of the Royal Society B: Biological Sciences* 371.1690 (2016).
- [2] H. Mercier and D. Sperber. *The Enigma of Reason*. Harvard University Press, 2017.
- [3] F. Hayek. “The use of knowledge in society”. In: *The American Economic Review* 35.4 (1945).
- [4] J. Ober. *Democracy and knowledge: Innovation and learning in classical Athens*. Princeton University Press, 2008.

- [5] C. Mayo-Wilson, K. J. S. Zollman, and D. Danks. “The Independence Thesis: When Individual and Social Epistemology Diverge”. In: *Philosophy of Science* 78.4 (2011).
- [6] R. Marjeh, A. Gokhale, F. Bullo, and T. L. Griffiths. *Task Allocation in Teams as a Multi-Armed Bandit*. 2024.
- [7] S. Shahrampour, A. Rakhlin, and A. Jadbabaie. “Multi-armed bandits in multi-agent networks”. In: *2017 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*. IEEE, 2017.
- [8] N. E. Leonard and S. A. Levin. “Collective intelligence as a public good”. In: *Collective Intelligence* 1.1 (2022).
- [9] E. Kummerfeld and K. J. S. Zollman. “Conservatism and the Scientific State of Nature”. In: *The British Journal for the Philosophy of Science* 67.4 (2016).
- [10] B. de Courson, L. Fitouchi, J.-P. Bouchaud, and M. Benzaquen. “Cultural diversity and wisdom of crowds are mutually beneficial and evolutionarily stable”. In: *Scientific Reports* 11.1 (2021).
- [11] H. Rubin and C. O’Connor. “Discrimination and Collaboration in Science”. In: *Philosophy of Science* 85.3 (2018).
- [12] L. Gautheron. *Balancing Specialization and Adaptation in a Transforming Scientific Landscape*. 2024.
- [13] L. Gautheron. “When her family finds [out] you are using the wrong metric...”: dilemmas and trade-offs in the diffusion of scientific conventions. 2024.
- [14] P. E. Smaldino, C. Moser, A. Pérez Velilla, and M. Werling. “Maintaining Transient Diversity Is a General Principle for Improving Collective Problem Solving”. In: *Perspectives on Psychological Science* 19.2 (2023).
- [15] K. J. S. Zollman. “The Communication Structure of Epistemic Communities”. In: *Philosophy of Science* 74.5 (2007).
- [16] K. J. S. Zollman. “The Epistemic Benefit of Transient Diversity”. In: *Erkenntnis* 72.1 (2009).
- [17] P. Jenni, T. S. Virdee, L. Pontecorvo, and S. Liyanage. “Chasing Success: The ATLAS and CMS Collaborations”. In: *Big Science, Innovation, and Societal Contributions*. Oxford University Press/Oxford, 2024, pp. 22–55.
- [18] L. Hong and S. E. Page. “Groups of diverse problem solvers can outperform groups of high-ability problem solvers”. In: *Proceedings of the National Academy of Sciences* 101.46 (2004).
- [19] L. Hong and S. E. Page. “Some microfoundations of collective wisdom”. In: *Collective wisdom* (2012).
- [20] S. Page. *The difference: How the power of diversity creates better groups, firms, schools, and societies-new edition*. Princeton University Press, 2008.
- [21] H. Landemore. “Democratic reason: Politics, collective intelligence, and the rule of the many”. In: (2012).
- [22] F. Dietrich and C. List. “Arrow’s theorem in judgment aggregation”. In: *Social Choice and Welfare* 29.1 (2007).
- [23] C. O’Connor and J. O. Weatherall. “Scientific polarization”. In: *European Journal for Philosophy of Science* 8.3 (2018).

- [24] R. Schimmelpfennig, L. Razek, E. Schnell, and M. Muthukrishna. “Paradox of diversity in the collective brain”. In: *Philosophical Transactions of the Royal Society B: Biological Sciences* 377.1843 (2021).
- [25] S. Page. *Diversity and Complexity*. Princeton: Princeton University Press, 2011.
- [26] J. H. Miller and S. E. Page. *Complex Adaptive Systems: An Introduction to Computational Models of Social Life: An Introduction to Computational Models of Social Life*. Princeton University Press, 2009.
- [27] J. Yoon, C. Kempes, V. C. Yang, S. Lee, et al. “What makes Individual I’s a Collective We; Coordination mechanisms & costs”. In: *arXiv preprint arXiv:2306.02113* (2023).
- [28] S. DeDeo. “Conflict and Computation on Wikipedia: A Finite-State Machine Analysis of Editor Interactions”. In: *Future Internet* 8.3 (2016).
- [29] H. A. Simon. “Organizations and Markets”. In: *Journal of Economic Perspectives* 5.2 (1991).
- [30] L. Phillips and M. Rozworski. *The people’s republic of walmart: How the world’s biggest corporations are laying the foundation for socialism*. Verso Books, 2019.
- [31] D. Chisholm. *Coordination without hierarchy: Informal structures in multiorganizational systems*. Univ of California Press, 1992.
- [32] O. E. Williamson. “Markets and hierarchies: some elementary considerations”. In: *The American economic review* 63.2 (1973).
- [33] C. O’Connor and J. O. Weatherall. *The Misinformation Age: How False Beliefs Spread*. Yale University Press, 2019.
- [34] A. W. Lo and R. Zhang. “The wisdom of crowds versus the madness of mobs: An evolutionary model of bias, polarization, and other challenges to collective intelligence”. In: *Collective Intelligence* 1.1 (2022).
- [35] M. Galesic, D. Barkoczi, A. M. Berdahl, D. Biro, et al. “Beyond collective intelligence: Collective adaptation”. In: *Journal of The Royal Society Interface* 20.200 (2023).