

**COLLECTIVE INTELLIGENCE: HOW IT WORKS AND HOW IT FAILS IN
HUMANS, ANIMALS, AND AI**
**Evolution, computation, cooperation, communication can all be significant promoters or
limitations to problem solving by groups.**

Spring 2025

Instructor: Anna Dornhaus

As humans, we often wish that our societies were more collectively intelligent, by which we typically mean organizing themselves in the way we believe to be right. Interestingly, a substantial fraction of both biology and computer science revolves exactly around the question of how intelligent or effective behavior can emerge from a group of interacting, autonomous individuals. In this class, you will learn to view both our society and biological and engineered systems as such groups, and be introduced to the ways in which groups (or ‘complex systems’) can solve problems effectively. We will touch on ant colonies, societies of cells, and computer networks, as well as their similarities to and differences from human teams and organizations. You will also learn about what limits problem-solving in groups, such as when the ‘wisdom of the crowds’ turns into destructive ‘groupthink’, in both biological groups and interacting software.

A big topic when considering group behavior is self-organization: unexpected and apparently ‘free’ structure emerging from interactions. This phenomenon occurs in a huge variety of systems, from molecules forming cellular machinery, nerve cells forming brains, or species assembling into stable ecosystems, and also in some chemical and physical systems, and engineered/human social systems (such as stockmarkets). Whether self-organized outcomes are positive – intelligent – however depends on evolution and the type of cooperation that is involved, something that is often forgotten in discussions of human collective behavior. In this course, we will continuously draw parallels to other biological and human/engineered systems facing similar problems or showing similar outcomes.

This course will be held in a hybrid format, Mondays from 2 PM – 4 PM on January 27, February 3, 10, 17, 24, March 3, 17, 24, 31, and April 7, 2025. Lectures will be live (in person) in the Rubel Room in the Poetry Center on the UA Main Campus, as well as streamed via Zoom.

All readings, videos, and other materials will be made available to students electronically (please refer to your HSP class email for detailed information). No textbook is required.

Course schedule

Date	Topic	Resources
Jan 27	Collective intelligence: amazing examples of groups outperforming individuals	Couzin: Collective cognition (conceptual review paper) Kurzgesagt: Emergence – How Stupid Things Become Smart Together (video) Case: Firefly game about synchronization: https://ncase.me/fireflies/ (browser game)
Feb 3	Cooperation, evolution, and major transitions: when does individual competition lead to collective interest	Dugatkin: Why cooperate? (book chapter) Stated Clearly: How does cooperation evolve? (video) Stated Clearly: What Caused Life's Major Evolutionary Transitions? (video)
Feb 10	Intelligence is a method, not a goal	Kobourov: Problem solving with algorithms (video lecture) Gigerenzer: The irrationality paradox (conceptual review paper)
Feb 17	Our intelligence is probably mostly social	Dornhaus: Aliens are likely to be smart but not ‘intelligent’ (book chapter)

		Tennie, Call, Tomasello: Ratcheting up the ratchet: on the evolution of cumulative culture Roth & Dicke: Evolution of the brain and intelligence
Feb 24	Confirmation bias is the strength and weakness of individuals	Masel: There is no certainty (video lecture) Bergstrom & Bak-Coleman: Information gerrymandering in social networks skews collective decision-making (magazine article)
Mar 3	Positive feedback loops are the strength and the weakness of crowds	Brockmann: Berlin 8am, game about traffic jams (browser game) Crespi: Vicious circles: positive feedback in major evolutionary and ecological transitions (conceptual paper)
Mar 17	Human cooperation and lack of it	Fuentes: It's not all sex and violence: Integrated Anthropology and the Role of Cooperation and Social Complexity in Human Evolution (conceptual review paper) Fehr & Schurtenberger: Normative foundations of human cooperation (review paper)
Mar 24	Imposed organization vs self-organization	Bak-Coleman et al.: Stewardship of global collective behavior (position paper)
Mar 31	Is artificial intelligence 'collective'?	Stoeffelbauer: How Large Language Models Work – from zero to ChatGPT (magazine article)
Apr 7	Collective behavior broadly	Navlakha & Bar-Joseph: Distributed Information Processing in Biological and Computational Systems (conceptual review paper)

Extra/Optional materials:

Dornhaus: What makes us human? (video lecture)
Dornhaus: Evolution of mind (video lecture)
Masel: Evolution: what it is and what it isn't (video lecture)
Ridley: Origins of virtue (book chapter)
Futuyma: Evolution and creationism (book chapter)
Primer: Simulating natural selection (video)
Dennett: Herding Cats and Free Will Inflation (article)
Baluška & Levin: On Having No Head: Cognition throughout Biological Systems (review paper)
Dochtermann: Heritability of behavior (metaanalysis)
Plomin et al: the 10 most replicated findings in genetics (review)
Stix: The It-Factor (magazine article)
Cosmides & Tooby: Evolutionary Psychology: New Perspectives on Cognition and Motivation
Burton: Reason won't save us – it's time to accept the limits of how we think (magazine article)
Stewart et al.: Information gerrymandering and undemocratic decisions (modeling paper)
Flack & Massey: All stars: Is a great team more than the sum of its players? Complexity science reveals the role of strategy, synergy, swarming and more (magazine article)
Glattfelder TEDx Talk (video or transcript)
West & Bergstrom: Misinformation in and about science
Bak-Coleman et al.: Create an IPCC-like body to harness benefits and combat harms of digital tech (magazine article)
Bergstrom: Eight rules to combat medical misinformation
Case, The Evolution of Trust, <https://ncase.me/trust/> (browser game)