Scaling Agency Up and Down

CHAIN Winter School, Lecture 4

Dr. Nick Brancazio, Feb 8th, 2023

Recap

- Agency as
  - Self-generated activity
  - Behavior with an end, aim, purpose, or goal (or the capacity to have goals)
  - Something that needs to be understood through teleological language
- Agential explanations
  - Might tell us why a system engages in a purposive action
  - Might tell us how a system engages in a purposive action
  - Might seek to provide a theory/breakdown/formalization of goals/purpose
- Does the epistemic (heuristic) value of agential explanation make it useful regardless of whether or not agency is a “real” capacity?

Barandiaran et al.'s Account of Agency

- Agency: "an autonomous organization that adaptively regulates its coupling with its environment and contributes to sustaining itself as a consequence"
- Barandiaran, Di Paolo, and Rohde (2009) outline three conditions for agency:
  - Individuality
  - Interactional Asymmetry
  - Normativity

(1) Individuality

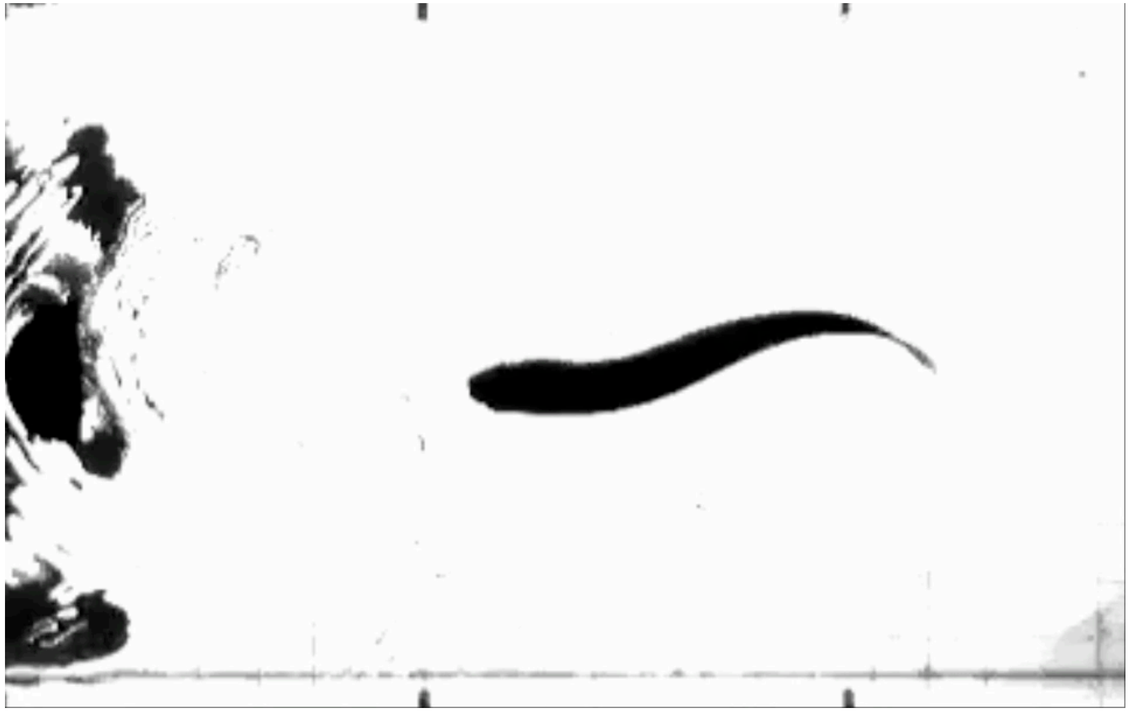
- The system is non-arbitrarily individuated from its environment

- The individual to whom agency is attributed must be distinct from its environment in a way that is not observer dependent (based on the arbitrary judgement of an observer)
- Intrinsic process of individuation performed by the system
- “capable of defining its own identity as an individual and thus distinguishing itself from its surroundings; in doing so, it defines an environment in which it carries out its actions”

(2) Interactional Asymmetry

- “an agent is a source of activity, not merely a passive sufferer of the effects of external forces” (Barandiaran et al. 2009, p. 370)
- What they propose is in contrast to two common ways of understanding being the ‘causal source’ of activity
  - Statistical sense
    - Locates the causal influence of a system by ““identify[ing] statistically significant patterns and [inferring] causal structure from the temporal ordering of events” (2009, p. 371)

- Energetic sense (most common)
  - the system's use of **energy** to actively engage with the environment is what designates it as the source of activity (Wilson 2005)
- Problem with the statistical sense:
  - Person diving/person falling
- Problem with the energetic sense:
  - Bird refraining from activity to utilise a wind current



- Instead of causation, they propose thinking in terms of *modulation* of an interaction (or coupling with the environment)
- Interactional asymmetry: the agent is "capable of engaging in some modulations of the coupling and doing so at certain times, but not necessarily always" (p. 372)

(3) Normativity

- The (biological) *meaning* for the organism separates action from mere movement
- “Agents have goals or norms according to which they are acting, providing a sort of reference condition, so that the interactive modulation is carried out in relation to this condition” (p. 372)
- These arise from the existential needs of the organism provided through biological adaptation and the organism’s history of interaction

- Organisms are *precarious* - they must actively seek to maintain their network of mutually supporting processes and boundaries… or perish

Collective Agents?

- Is a university or a corporation an agent?
- Jimmy Lewis-Martin (2022, forthcoming)
  - Individuality
    - Operational closure (actively produce and maintain their constitutive network of processes)
  - Interactional Asymmetry
  - Normativity
    - Norms of the group agent are determined by its structure and persistence conditions

Back to the Questions

- What is an agent?
- What is agency?
  - Where is (the demarcation for) agency?
  - —> Where (spatially/interactively) is agency?
  - —> “When is agency?” (Credit to Tailer Ransom)
- So far we’ve focused mostly on purpose and goals
- Return to action itself

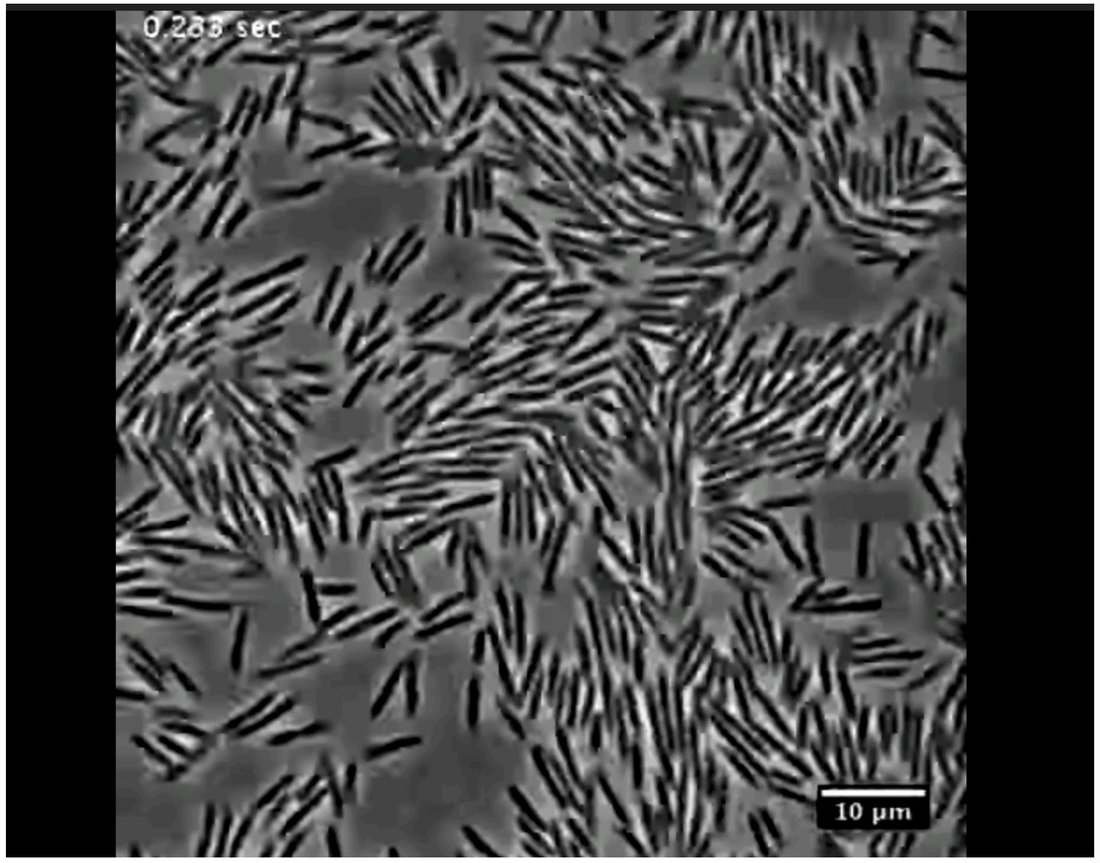
Studying Agency without Agents

- From Manuel's lecture
  - Examples of agency without cognition
  - Examples of agency without life
- If we don't have a precise definition of agency, nor an understanding of what agents are, can we still study agency?

- My argument: Yes! One way is through the study of agential dynamics - processes that scaffold or constrain behaviour possibilities

Active Matter Systems

- Active matter systems are “a distinct kind of nonequilibrium system” (Ramaswamy, 2017, p. 2) made up of independently active entities that collectively engage in interesting patterns of activity.
- Active matter systems are made up of individual self-propelled agents
- At a collective level, these agents generate interesting macro-scale behaviors such as swarming, flocking, or schooling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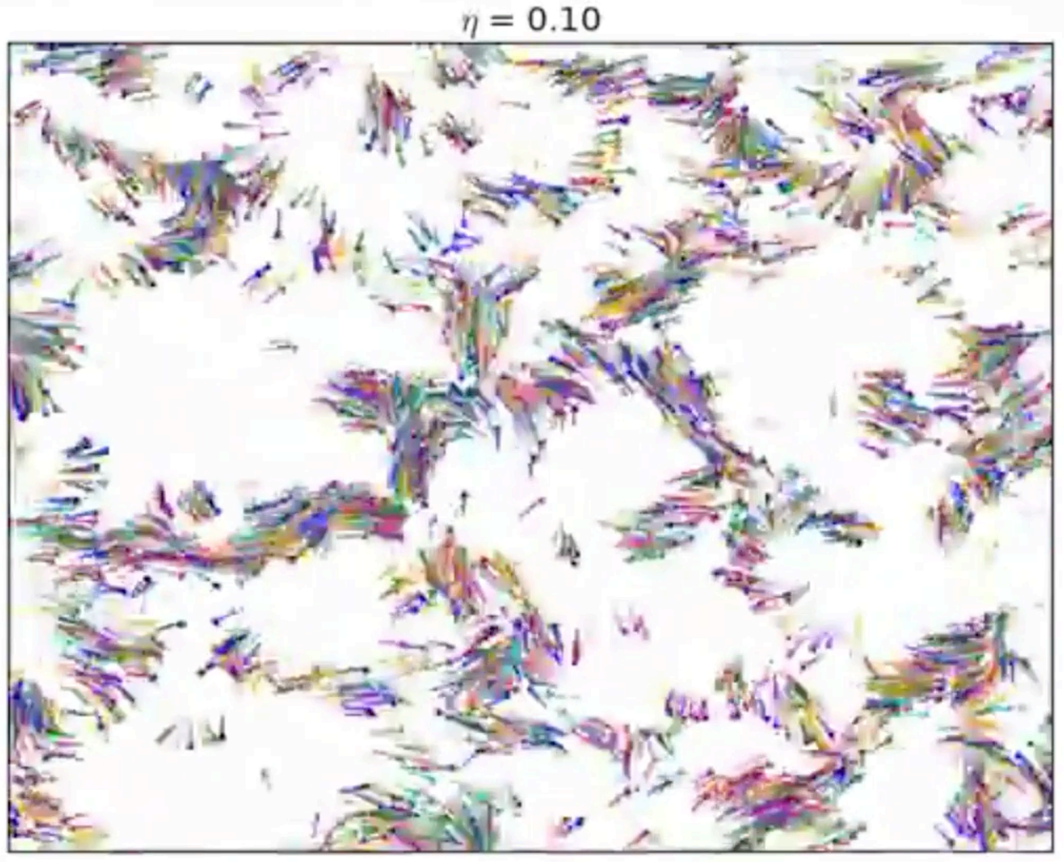
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- Some systems can respond to environmental features (clustering, obstacle avoidance, following trails or gradients, re-forming after perturbances, etc)
- Their collective behaviors can often be modelled using very simple rules (whether individuals are highly complex or relatively simple entities)

- E. Coli (video by Matthew Copeland, University of Wisconsin, Madison)
- Vicsek Model (video by Sri Vallabha Deevi)
- More videos: Fraden Lab (Brandeis), Dogic Lab (UCSB), Thomson Lab (CalTech), Needleman Lab (Harvard)

- Vicsek models are useful for all kinds of active matter systems because they ignore material and cognitive complexity, using only a simple rules for individuals: alignment mechanism, self-propulsion, & noise
- Within the model, agents change the direction of their movement based on the direction of their neighbors
  - Can vary density of population
  - Can vary strength of alignment mechanism (internal noise)
  - Attraction / repulsion dynamics
  - Varying external noise
  - Velocity matching

Non-Living Active Matter Systems

Paul Chaikin's Lab, NYU

- ·Recent studies have shown we can still get many of the complex features of flocking, swarming, and/or clustering through:
  - vision or vision-like perception alone and response to instantaneous cues (Barberis and Peruani 2016).
  - Local jamming of self-propelled elongated particles can result in alignment (Abaurrea Velasco et al. 2018)
  - steric interactions, which concern only the attraction and repulsion dynamics that take place between individuals of certain material or chemical makeups (Abaurrea Velasco et al. 2018)
  - only repulsion dynamics (Fodor and Marchetti 2018)
- Non-living groups have also been shown to be able to follow thermal gradients (Meredith et al., 2021) as well as navigate obstacles (Bechinger et al., 2016).

Living Active Matter Systems

- In animal groups, collective motion (macro-scale) such as starling murmurations, fish schooling, and wildebeest migrations arises from repeated local interactions (Couzin 2009).
- Interacting living individuals with local sensing abilities are said to follow a small number of behavioural rules: collision avoidance, velocity matching, and flock centering (staying near to flockmates) (Reynolds 1987) that lead to alignment.
- This enables collective behaviors such as the amplification and dampening of collective responses, where rapid information sharing is possible through the motions of a few individuals.


BBC

Why/How Questions

- Answering “why” questions about the behaviour of individual fish requires looking at the ways that the group’s behaviour scaffolds and constrains the range of action possibilities

- The collective does not intervene in the top-down “executive” sense - there is no ‘directive’ from above
- There are interesting agential dynamics in the interactions *between* members

Questions from Physics

- “How do individual self-driven units, such as wildebeest, starlings, fish or bacteria, flock together, generating large-scale, spatiotemporally complex dynamical patterns [51]? What are the rules which govern these dynamics and how do the principles of physics constrain the behaviour of each such unit? Finally, what are the simplest possible models for such behaviour and is there any commonality to the description of these varied problems [46–48]?” (Menon 2013, p. 1-2)

Methodological Individualism in Agency

- Agency is treated as a property or capacity of an individual
- Questions about the why & how of agency (or agential behavior) then also focus on the individual (Longino 2021)
- Investigating/understanding agency focuses on the individual
- The methodological individualism we find in definitions focused on demarcating agential from non-agential individuals is not necessarily problematic given the types of questions we usually want to pose.
- As Longino explains it: “[I]n any particular inquiry researchers have particular aims and particular characterizations of the phenomena to be explained. The appropriate characterization of the phenomena will depend on what we want to know about it” (2021, p. 14)

Concerns

- (1) focus on individuality leaves other aspects of agency (such as interaction) out of our study of agential dynamics in action/behavior
- (2) risks attributing too much at the individual level before even beginning to investigate the role of interactive dynamics
- Likewise, theoretically overloading a definition of agency is, for the project of looking at regularities in interactive dynamics, neither necessary nor especially useful.
- Active matter shows that looking at interactions can reveal important inter-individual regularities inexplicable in terms of individual or collective properties or capacities.

Pre-theoretical Definition of Agency

- Stapleton and Froese (2016): “At the very least the term ‘agent’ implies (1) an individual, and (2) a capacity for action” (p. 221)
- Useful in all of these domains
  - Individual
  - Interactive
  - Collective

Interactive Agential Dynamics

- **Interactive agential dynamics**: mutually dependent, multi-agent processes that scaffold or constrain agency, in which an individual agent directly participates but does not (wholly) self-produce.
- These interactive processes are sustained by individuals in a group but cannot be explanatorily reduced to the activities of those individuals nor attributed to any emergent properties of the group as a whole.
- The agents involved directly participate in the activities that sustain the group behavior, and the interactive behavior is necessary (though not sufficient) for explaining the activity of the individuals.

Agency & Cognition

- Agential Dynamics & Cognitive Dynamics:
- Looking at interactive dynamics can be an altogether different (though supplemental and supporting) project from determining agential capacities & dynamics.
- What makes the dynamics agential rather than cognitive is that the individuals do work using their own energy, satisfying a pre-theoretical definition of agency to which variables can be added as interactions grow more complex.
- A simple, pre-theoretical definition of agency is useful for looking at interactive regularities on all scales because it does not involve attributing cognitive capacities. The important factor is that the agent is energetically responsible for its own movement.

Concluding Thoughts

- Coming up with an account for any particular kind of agential phenomena, or any particular type of agency, might (wager - probably does) involve the integration of scales that require the use of different frameworks.
- That is, we need to understand the relationships between scales and how they serve to scaffold and/or constrain particular types of agency and related actions.
- There are probably a lot of *different* kinds of agency that will not fit under one definition or theory or approach or framework
- That is very cool

Discussion Questions

- Think about Barandiaran & colleagues definition of agency and apply it to some examples from yesterday. Do you think it is a good theory of agency? Why or why not?

- Does the epistemic (heuristic) value of agential explanation make it useful regardless of whether or not agency is a “real” capacity?

- Ball rolling down the hill - where is the agency happening?