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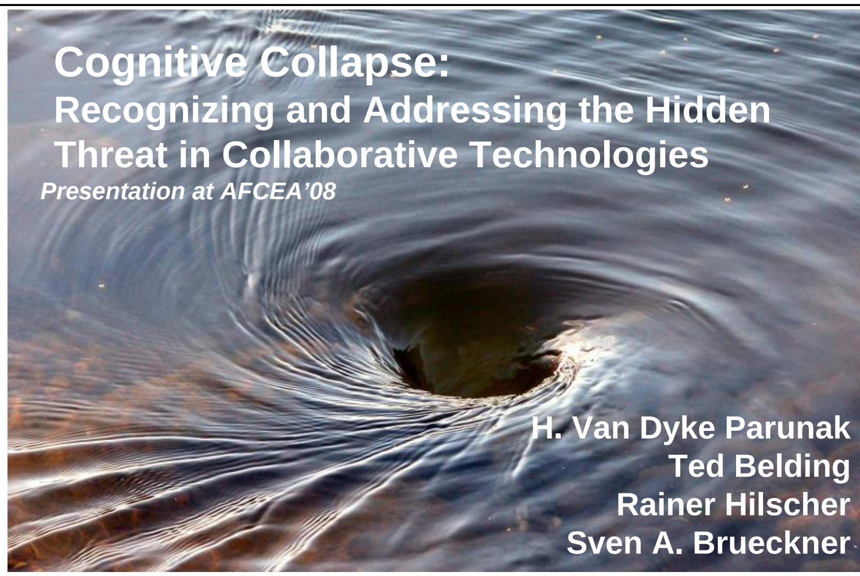

Cognitive Collapse:
Recognizing and Addressing the Hidden Threat in Collaborative Technologies

Presentation at AFCEA'08

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www.newvectors.net

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Overview

- The Phenomenon of C^3
- Some Relevant Research
- An Agent-Based Model of C^3
- Conclusion

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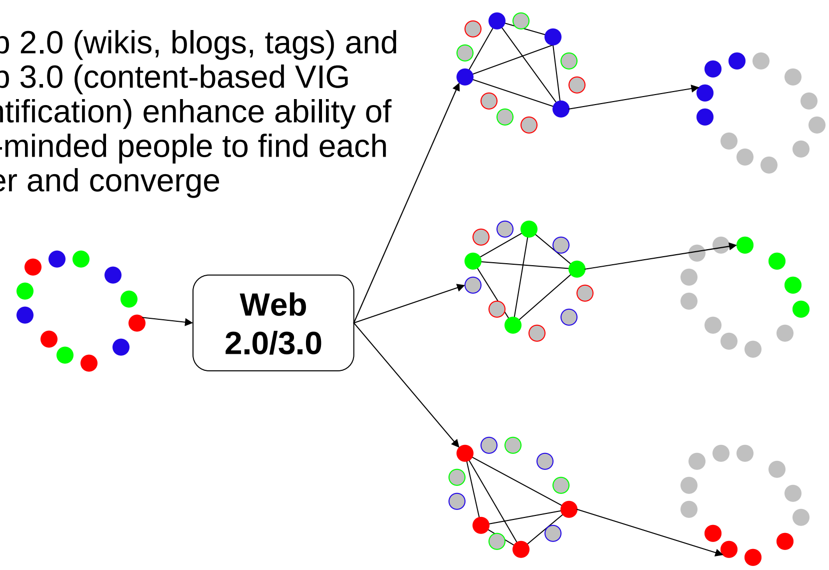
The Phenomenon of Collective Cognitive Convergence (C^3)

- Repeated interactions among members of the same group makes them "think alike"
- Examples:
  - Research Communities
  - Political/Religious Associations
  - Persistent Adversarial Configurations (e.g., Cold War)
  - Intelligence/Economic Analysts Studying a Topic
- Pro: creates efficiencies through faster consensus
- Con:
  - Reduced diversity of concepts
  - Resistance to alternative views
  - Increased vulnerability to unexpected change
  - In extreme cases, group can experience cognitive collapse

The Phenomenon of C^3

Web 2.0 (wikis, blogs, tags) and Web 3.0 (content-based VIG identification) enhance ability of like-minded people to find each other and converge



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Some Relevant Research

- **Sociology**
  - **C.R. Sunstein "group polarization": a group with a slight tendency toward one position will tend to become more extreme in its position through interaction**
- **Computational Social Science**
  - **Axelrod's adaptive culture model: emergence of disjoint regions of cultural (cognitive) homogeneity as agents interact with those who are adjacent to them spatially**
  - **Studies of consensus formation (see table, next slide)**
  - **Bednar et al.: competition of desire for internal consistency and external conformity slows convergence**
- **Evolutionary Biology**
  - **Speciation Models: C^3 = runaway sexual selection speciation model with mutual mate choice**
  - **Sewall Wright "Shifting Balance Theory": subdivided population with intermittent migration could exhibit more rapid evolutionary change than a single cohesive breeding population**

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Studies of Consensus Formation

Study	Belief	Topology	Arity	Preference?
Krause	Real variable	Random	Many	Yes
Sznajd-Weron	Binary variable	Lattice	Two	No
Deffuant	Real variable	Random	Two	Yes
	Binary vector	Random	Two	Yes
Axelrod	Nominal vector	Lattice	Two	Yes
Bednar	Nominal vector	Random	Many	No
This paper	Binary vector	Random	Many	Yes

Analytical results available only for

- **Single real variable $x(t+1) = Ax(t)$, no preferences (common)**
- **Six or fewer agents with preferences (Krause)**
- **Vector belief but binary interaction and no preferences (Bednar)**

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  - **Experiments with Group Characteristics**
  - **Experiments with Variation**
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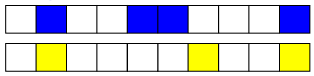
A Simple Model
(Specification)

a. Agent = vector of binary interests



Concurrent interaction of multiple interests

b. Agent distance = Jaccard distance $1-\frac{|A\cap B|}{|A\cup B|}$

→ 1-(2/5) = 0.6

Similar interests promote interaction

Community(*A*) = all agents within θ of *A*

CommunityFocus(*j*) = % of agents in community with bit *j* = 1

c. Learning

With probability p_{Learn},
- Pick random bit *j*
- If interest *j* = 0, set to 1 with probability CommunityFocus(*j*)

Interaction strengthens shared interests…

d. Forgetting

With probability p_{Forget},
- Pick random bit *j*
- If interest *j* = 1, set to 0 with probability 1 - CommunityFocus(*j*)

…and weakens private interests

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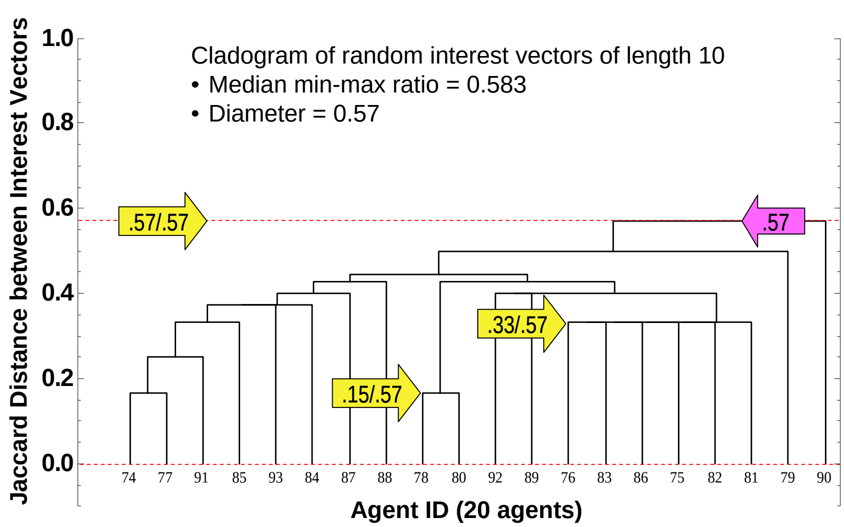
A Simple Model
(Metrics)



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Common Experimental Parameters

- **20 agents**
- **Interest vectors of length 10**
- $p_{Learn} = p_{Forget} = 0.9$

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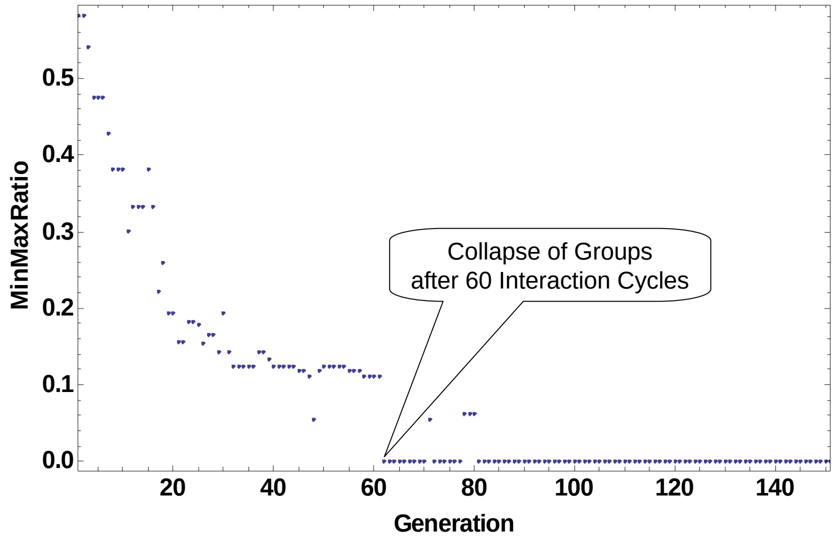
A Simple Model
(Experiments)

Neighborhoods defined by θ > 0.5



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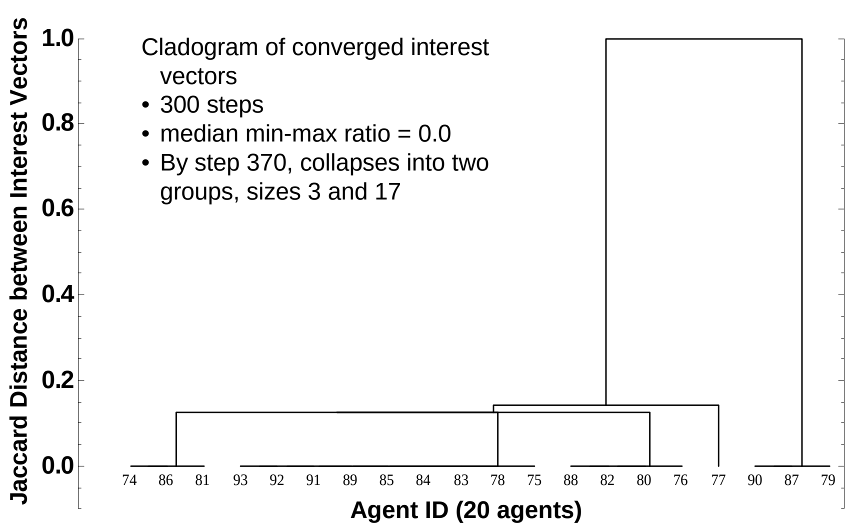
A Simple Model
(Metric)



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Overview

- The Phenomenon of C³
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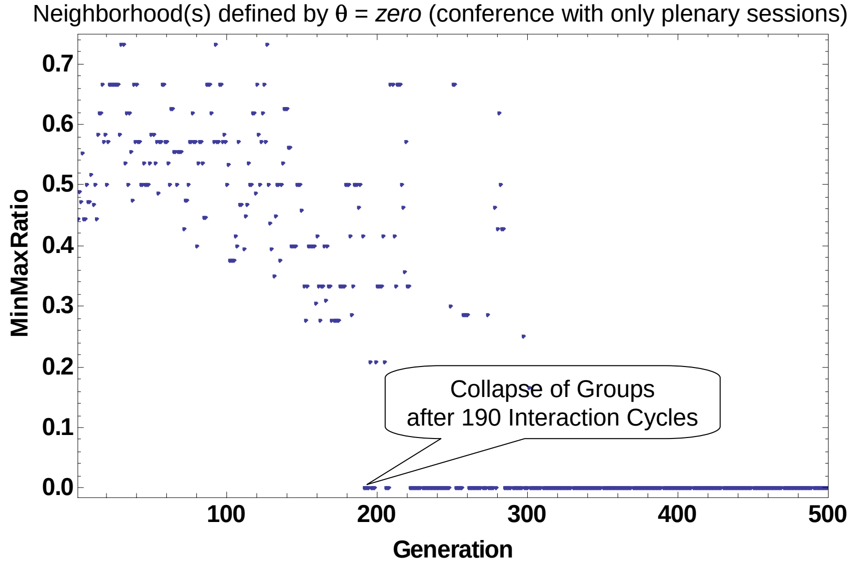
A Simple Model

(Experiments with Grouping Characteristics)

Neighborhood(s) defined by θ = *zero* (conference with only plenary sessions)



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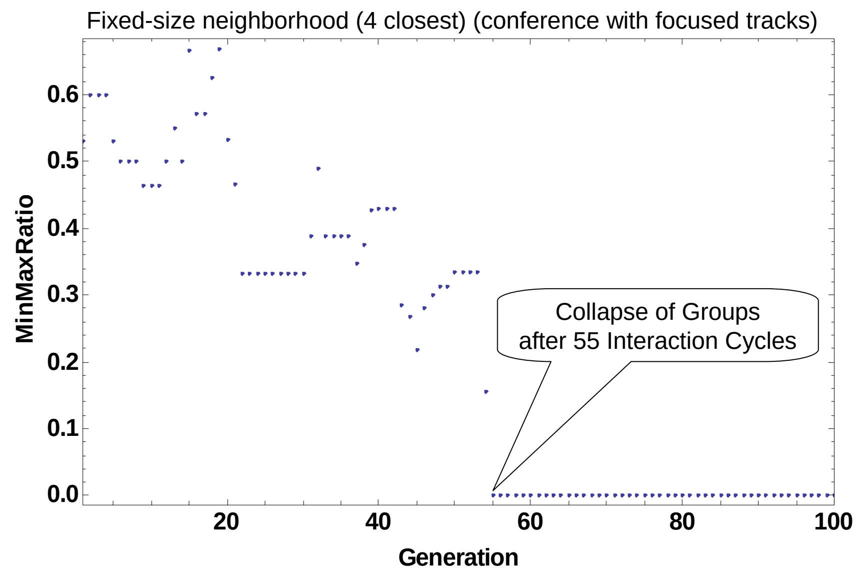
A Simple Model
(Experiments with Grouping Characteristics)



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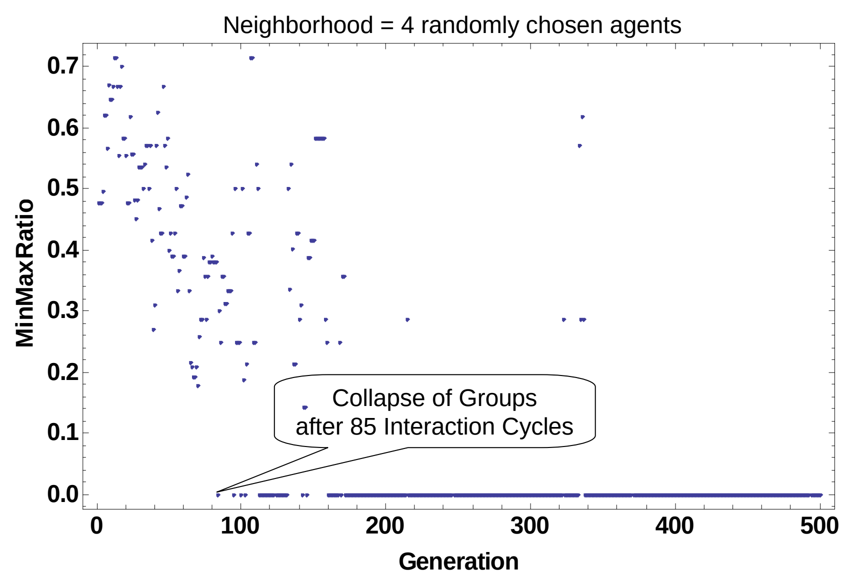
A Simple Model
(Experiments with Grouping Characteristics)



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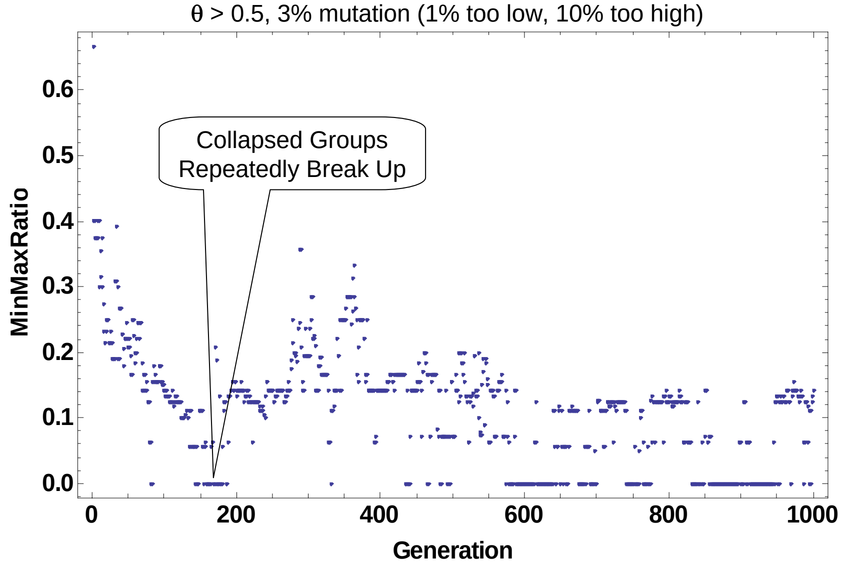
A Simple Model
(Experiments with Variation)

θ > 0.5, 3% mutation (1% too low, 10% too high)



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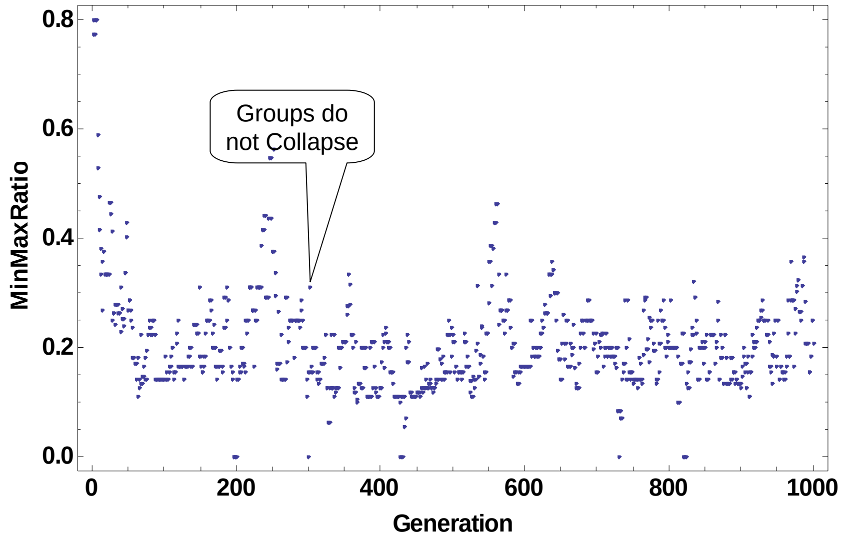
A Simple Model

(Experiments with Variation)

θ > 0.5, 10% curmudgeons



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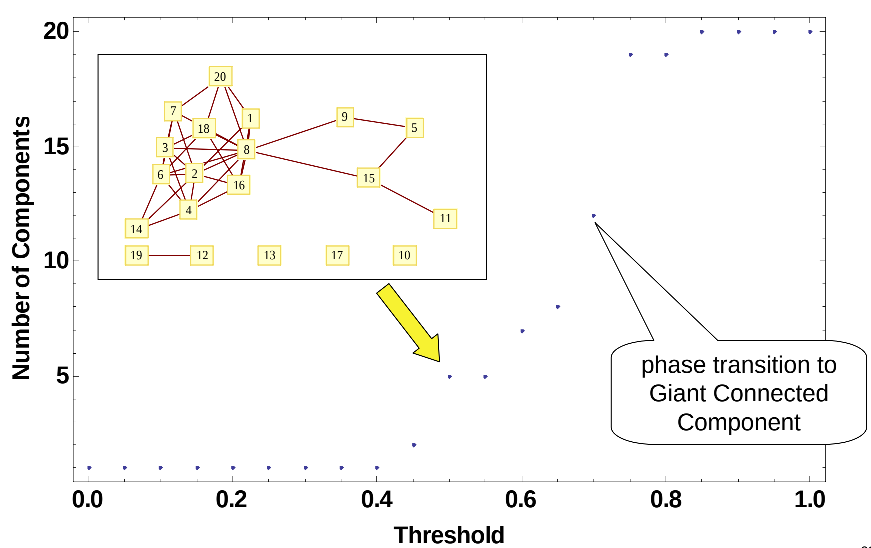
A Simple Model

(Experiments with Variation)

Static neighborhoods based on threshold on initial similarity



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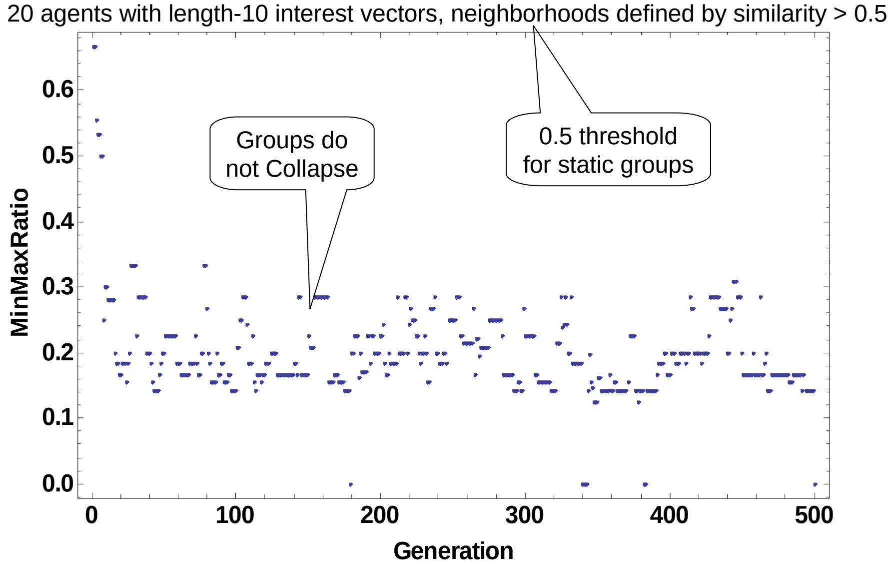
A Simple Model
(Experiments with Variation)

20 agents with length-10 interest vectors, neighborhoods defined by similarity > 0.5



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Conclusion

- Collective Cognitive Convergence is a natural phenomenon
- C^3 facilitates understanding and coordination, but may lead to cognitive collapse, creating blind spots
- Naïve mechanisms (e.g., mixing, globalization, controlling group size) do not prevent collapse
- Management requires a source of variation
  - Mutation requires tuning and leads to intermittent collapse
  - Curmudgeons are more robust, but socially distasteful
  - Bridging interdisciplinary individuals seem to work best

Questions?