Sustaining Ecological-economic Norms for a Sustainable Environment (SENSE)

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The Problem

We live in a Global Commons…

-- individual actions affect the general welfare
-- for good or bad
-- cost & benefits to individual agents do not reflect costs to society, biosphere, global community

How do we foster mutual cooperation to sustain Commons?

Tragedy of the Commons

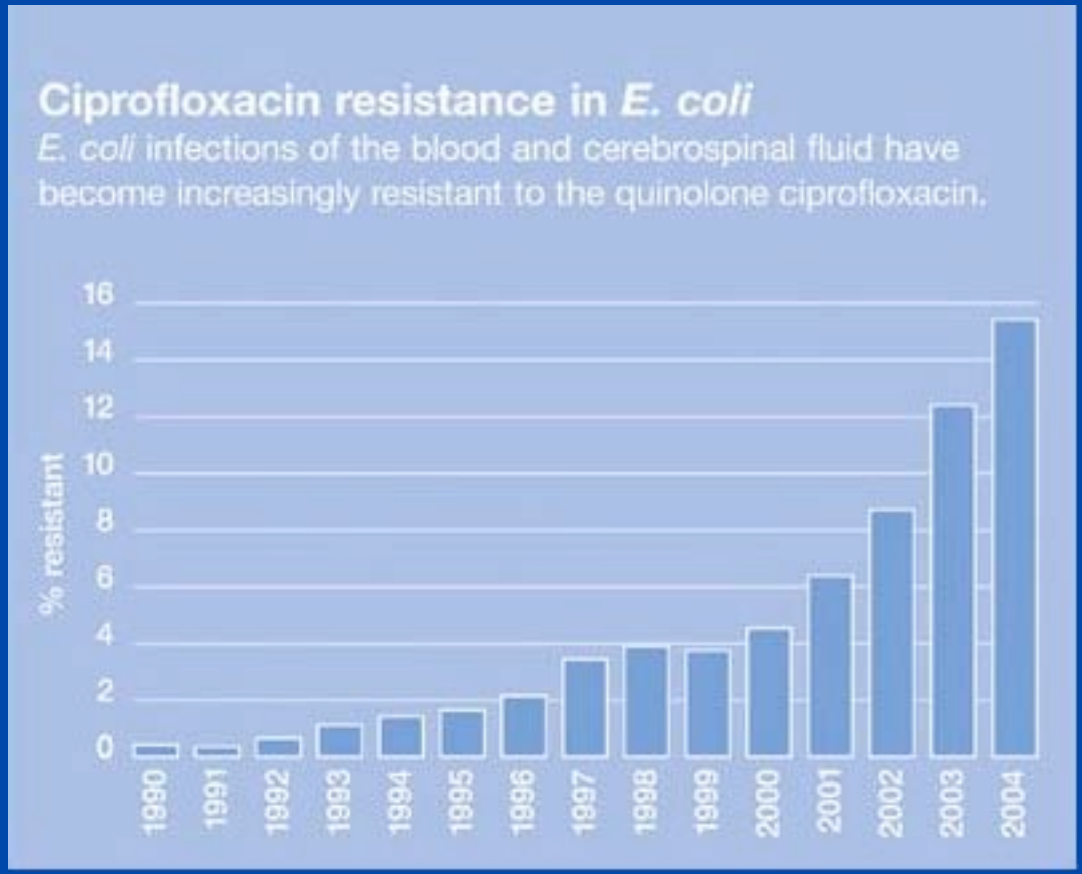
The greedy gain for awhile, but mutual ruin eventually comes.

- Garrett Hardin's Solution…

-- 'Mutual coercion, mutually agreed upon'
-- solution will depend as much on addressing human behavior as it will on scientific/engineering innovation

Problems of the Commons

- Grasslands
- Fisheries
- Aquifers
- Pollution
- Antibiotics



Common Good or Personal Gain?

Altruism?

Selfishness?

Who would deny their child antibiotics to maintain global effectiveness?

Aims & Objectives of Collaborative Project

Identify…

-- conditions

-- strategies

-- policies

… to foster mutual coercion, mutually agreed upon for sustainable use of the Global Commons

Focus on collective decisions…

-- individuals to groups

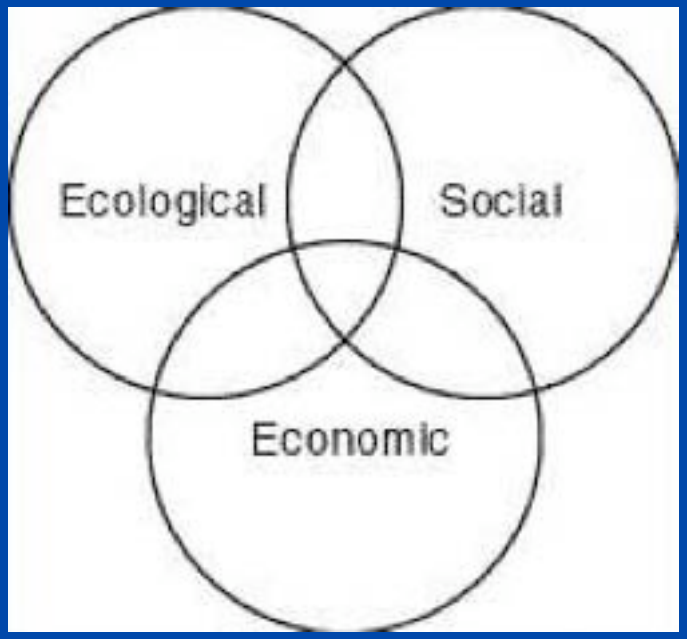
-- groups to nations

-- nations to the world's population

… to create framework for achieving mutual benefits from mutual action.

Draw on evolutionary principles from animals and humans

Melding Evolutionary Ecology and Economics



1) Linking systems is key for environmental protection & economic growth

2) Ecological & economic systems are similar

- involve competition/cooperation
- complex adaptive systems

… integrate phenomena across scales

… global behavior emerges from collective action of individuals, which feedbacks on their behavior

How Does Behavior Become Coordinated in Heterogeneous Groups?

Couzin, et al. and Levin

Some know where to go, other do not.

How is coordination achieved?

Depnds on zones of:

- attraction
- repulsion
- neutrality & alignment

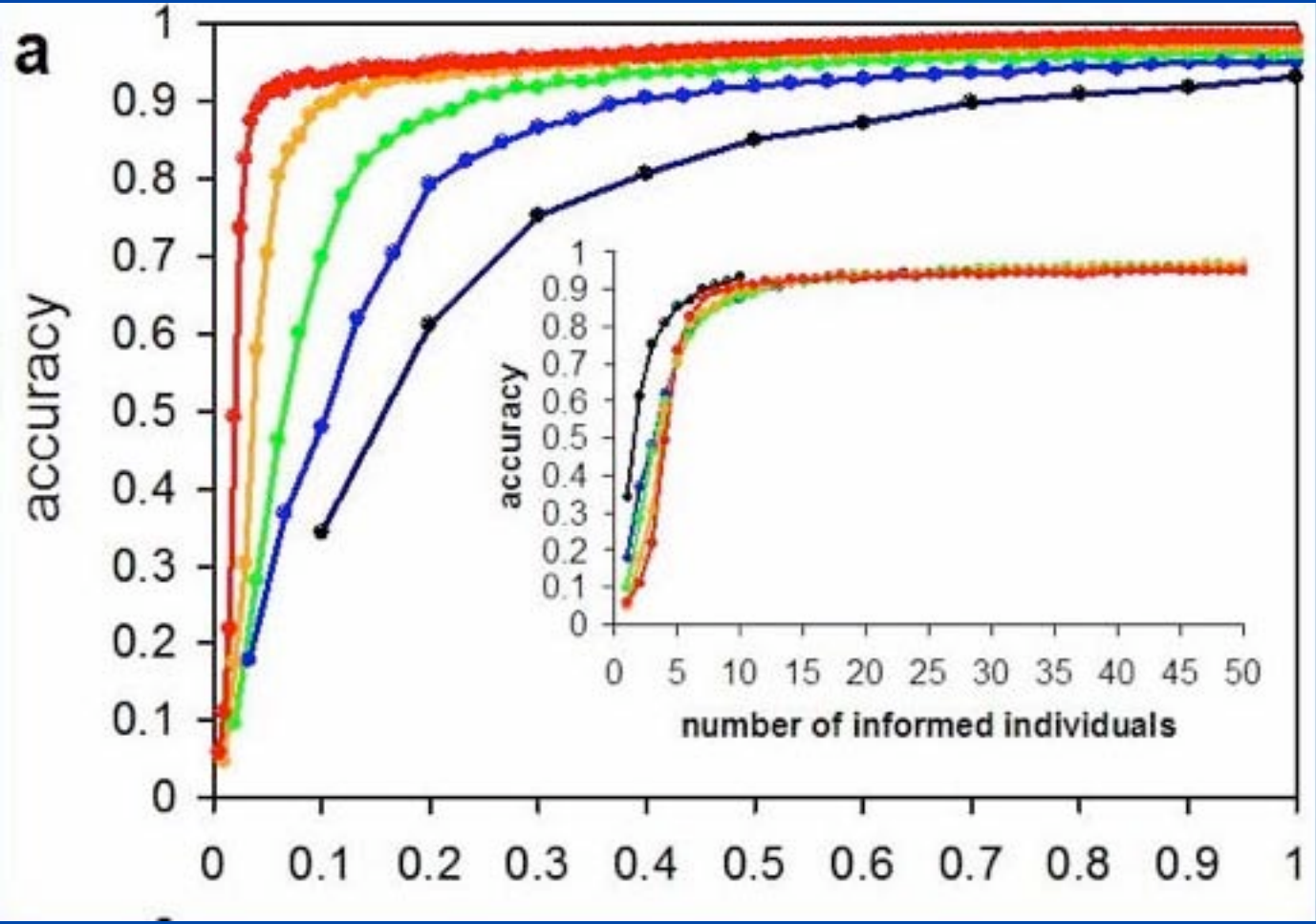
1 informed individual in 100

Simulations by Couzin

5 informed individuals in 100

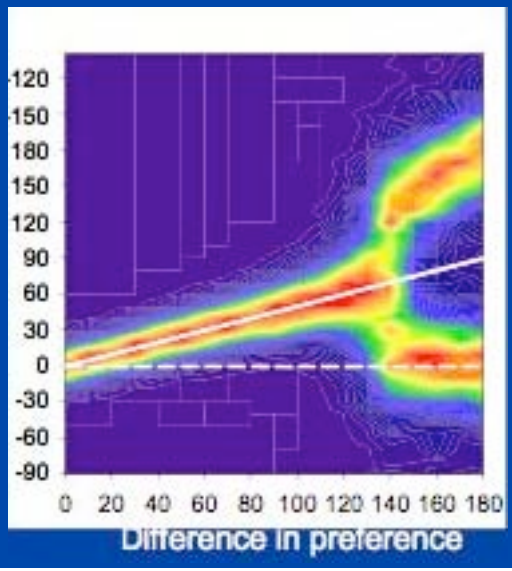
10 informed individuals in 100

How many leaders are necessary?



Not many!

What happens when preferences compete?



As individuals approach one target, the other may become more favored because those individuals become more coherent in their goals….

Central Issues

1) How do details of collective behavior change across taxa?
   - What is the interplay among 4 ‘social glues’ (altruism towards kin; mutualism & reciprocity among strangers; & coercion)?
2) Where does ‘mutual coercion, mutually agreed upon’ arise?
   - Can we draw from animal policing to derive lessons for humans?
3) How does punishment arise?
   - Does it interact with voluntary, societally-beneficial actions?
4) How do social norms arise and spread?
   - Do constraints explain why seemingly irrational behavior appears?
5) Does cooperation at one level entail competition at the next?
   - Is it possible to achieve cooperation at highest level of aggregation?
6) Do networks of interactions arise & shape individual actions?
   - What is the role of information flow within these networks?

Project Teams

Austrian Team: Karl Sigmund

-- how punishment affects spread of cooperation through large diffuse societies

US Team: Simon Levin & Dan Rubenstein

-- how cooperation is affected by social norms and social structure in animal and human societies

Dutch Team: Aart De Zeeuw

-- how cooperation across levels can lead to effective management of global resources

Altruistic Punishment

Austrian Team: Karl Sigmund (PI) [U. Vienna]
H. Brandt [U. Vienna]
Dirk Semmann [U. Vienna]

Investigate various aspects of punishment, using modeling, agent-based simulation & experimental economics

Evolution of Punishment

Overarching Issue:

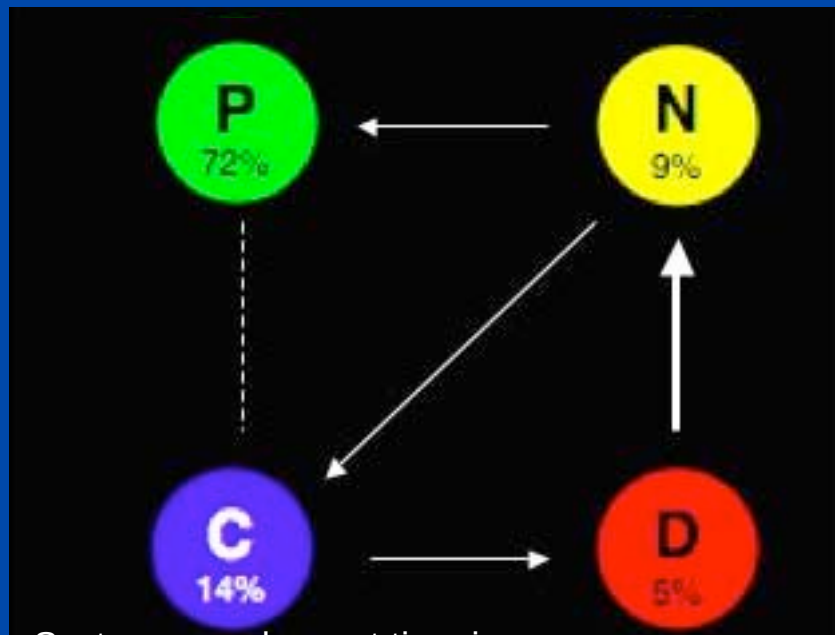
Joint action in human societies is often enforced by institutions that impose sanctions on defectors (free riders). Even without institutional sanctions, individuals (in expts.) often punish defectors at a cost. Such behavior is stable, but can it evolve?

Solution:

Develop games in large, but finite populations, in which cooperators, punishers, defectors and *non-participators* interact.

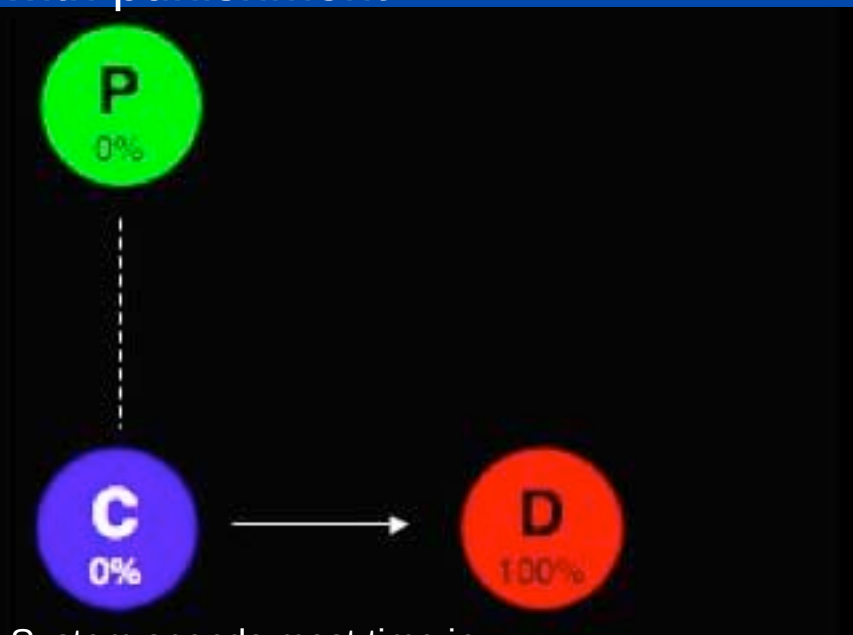
Results I.

Voluntary participation with punishment



System spends most time in homogenous state of punishers

Compulsory participation with punishment



System spends most time in homogenous state of defectors

Assumptions:1) imitation possible & based on highest payoff;
2) mutation/switching rate low

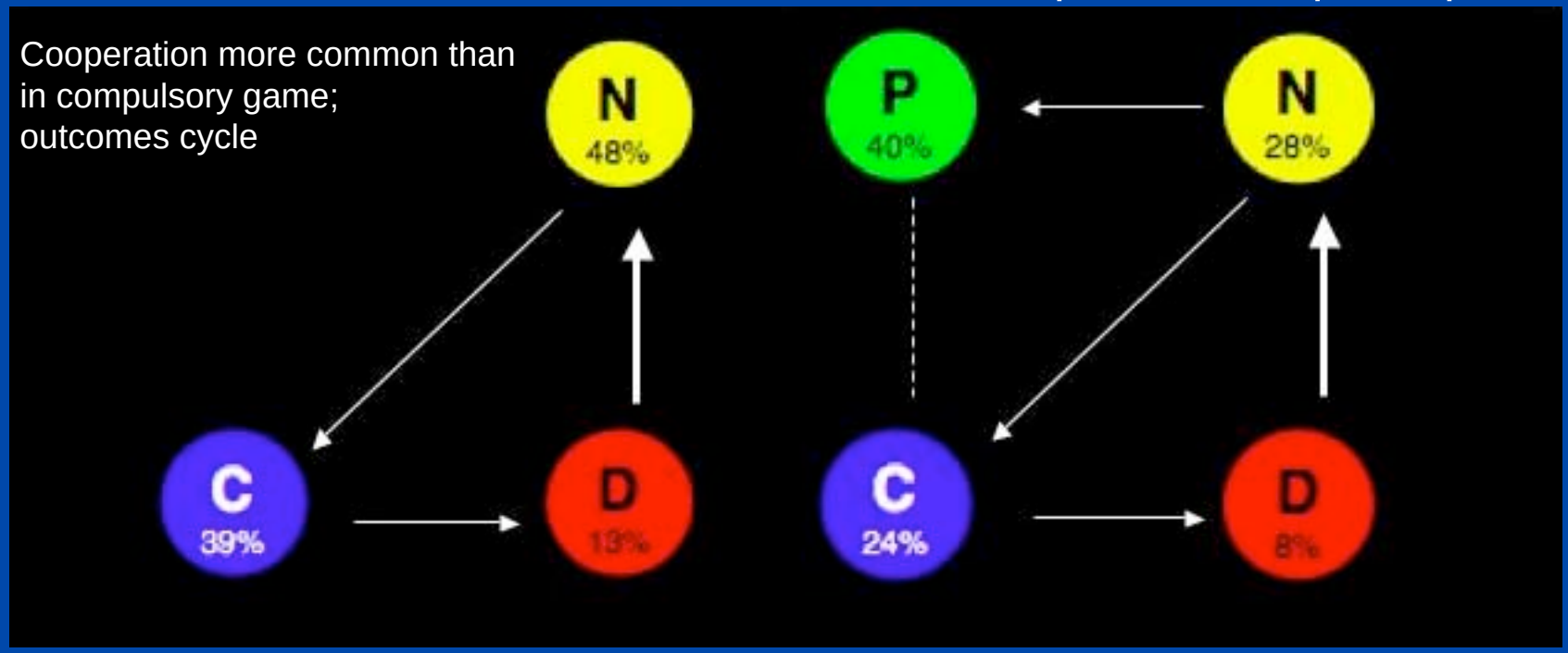
…much like climate preservation where all are affected & defection is common

Hauert, Traulsen, Brandt, Nowak & Sigmund; Science 316; June 2007

Results II.

Voluntary participation without punishment

Voluntary participation
Punishers also punish non-participants



If many defectors => many opt out;
Groups become small & cooperators benefit;
Then defectors can invade.

Hard to establish punishment;
Social coercion counter productive

Voluntary participation & state sanctions flip sides of same coin

Next Steps…

Test assumptions:

Boyd and Mathew point out that:

1) The collective goods must be exculdable;
2) Opting out is better then mutual defection; and
3) There are no economies of scale.

Branch out to ‘Ultimatum Game’ and ‘Indirect Reciprocity’ where reputation matters and scoring can harm punishers;
Will explore the evolution of norms.

Perform experiments where individuals can opt out, take sides;
Allow multiple rounds so second order punishers can become active and the punished can retaliate, or not.

The Role of Social Structure and Social Norms on the Evolution of Cooperation

US Team: Simon Levin & Dan Rubenstein (PIs) [Princeton]
Anthony Appiah [Princeton]
Iain Couzin [Princeton]
Eric Klopfer [MIT]
John List [Chicago]
Eric Maskin [Inst. Advanced Study, Princeton]
Steve Pacala [Princeton]
Deborah Prentice [Princeton]

Determine how social structure--dominance, reputation & network connections--and social norms shape altruistic and mutualistic interactions and examine consequences on the nature and stability of groups.

Impact of Structure and Norms on Cooperation

Explore how nature of structure and norms affect the ways reciprocity, mutualism and coercion operate and generate actions that cross cultural & organizational levels to sustain cooperation

Four questions:

1) Investigate role of social status & image scoring in cooperation;
2) Model development of opinions & social norms in populations;
3) Link norms to game-theoretic study of cooperation;
4) Investigate influence of higher-order structure (networks, hierarchical organizations) on cooperation.

I. Social Status, Reputation and Cooperation

Is cooperation earned through reputation or coerced by status ?
Does pattern of punishment & information availability matter?

Reputation as cooperator (image score)

Status	naughty	nice
dominant	?	?
subordinate	?	?

What are the various likelihoods?
What conditions favor one cell over others?
What properties favor despotic v. egalitarian societies?
What is role of feedbacks & stochasticity?
Does viewing by others affect likelihoods?
Does status uncertainty affect likelihoods?
Does the interaction lead to specific cooperative norms?

Decision-making will depend on *relative* assessments, so markets will be created allowing people to trade cooperatively/competitively.

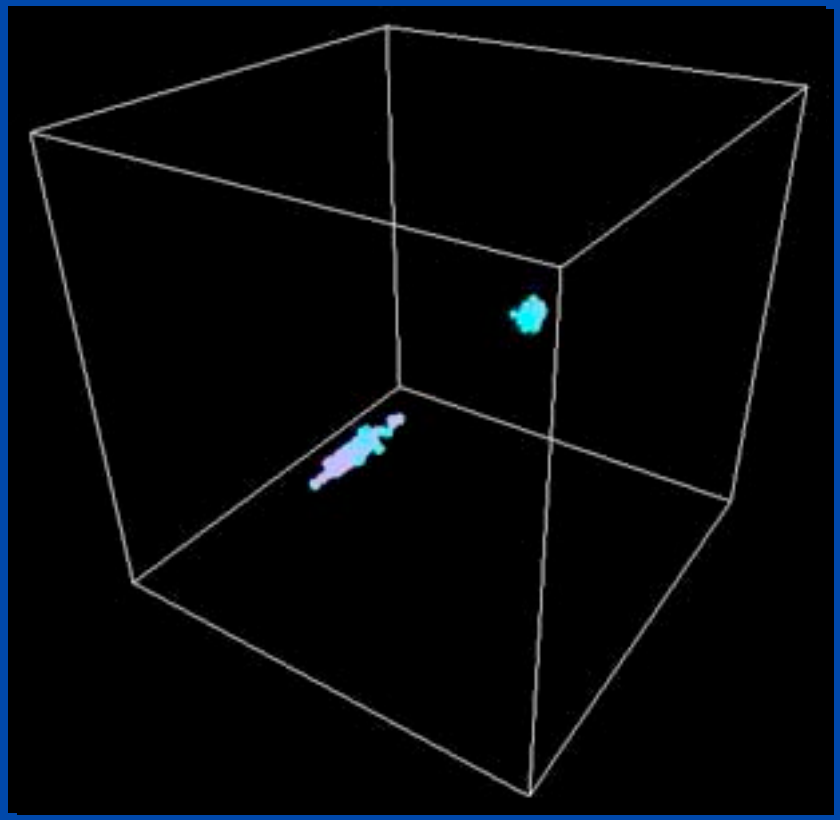
II. Development & Spread of Social Norms

Social norms are conventions within populations, but how do they develop?

Model: - Individuals in D-dimensional ‘opinion space’;
- Individuals interact, asses others and are repelled, attracted or remain neutral
- repeated interactions can change confidence

Results:
- axes of opinions emerge & structure populations
- populations often become divided

Opinion Space Preliminary Results



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Next: *- explore role of status, reputation & network structure*
- what role rewards, punishment & ‘advertising’?

III. Cooperation, Coercion & Higher Order Structure

Understanding the role of interacting collectives in the evolution of cooperation.

The case of Carbon and Climate

- Next 50 years C must be reduced by 150 billion tonnes
- Cost ~ 15 trillion USD
- Much earned by multinational corporations (GE, Toyota, Monsanto, Schlumberger)
- Countries & multinationals mutually tied to each other; they draw on common pool of resources to provide services to citizens

Cooperation, Coercion & Higher Order Structure

Multinationals straddle countries; each regulates only a fraction of each company (but can define standards; eg. California and Ford Motor Co.)

Multinationals can exploit heterogeneity among countries; eg. BP created market for low sulfur fuel in ‘green’ Germany (became gov’t. standard), then Europe

Explore how single country or group of countries or multinationals can create local markets for green technology.

Mutual coercion could reduce prices, leading to mutual agreement to join.

IV. Empirical Tests

1) Role playing experiments on humans.
   - Markets: use gift exchange experiments to explore social preferences and payoff fairness due to 3rd party verification & possibility of sanctioning on trustworthiness.

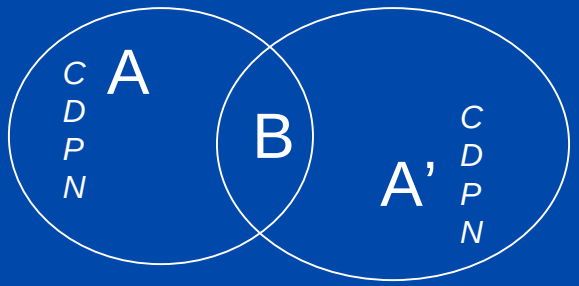
   -Prisoner dilemma games: face-to-face v. instant messaging interactions in small and large groups to examine interaction of status and reputation.

   - Collective choice dilemmas: multiple players drawing points from renewing pool, face to face & remote (IM/web) interactions to measure impact on evolution of norms under varying reward/punishment feedbacks, .

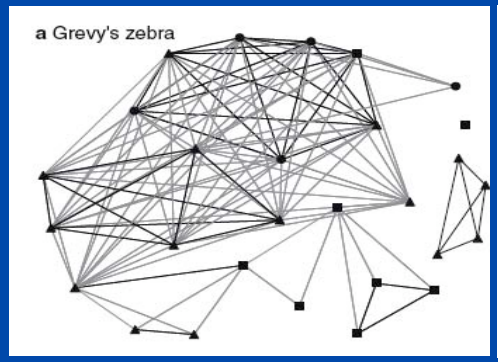
- How do social norms emerge from individuals' actions?
- How does development of norms differ in small and large groups?
- How are developing norms affected by phenotype (status/reputation)?
- Does 'cumulative advantage' play a role in shaping norms?

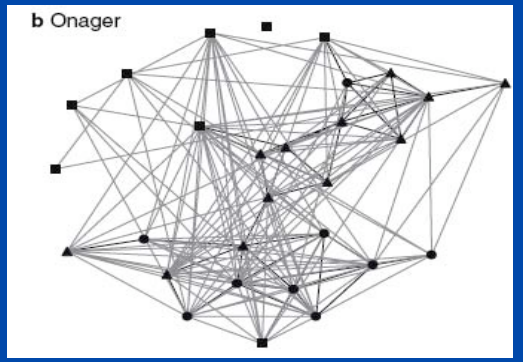
Empirical Tests

2) Comparative analysis of animals
   - primate fights



- equid networks



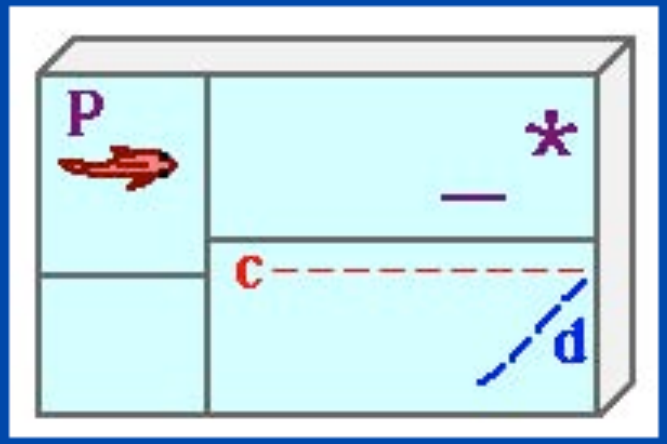


- Status
- Reputation
- Leadership
- Alliances

Similarities?

Empirical Tests II.

- fish followings



Condition fish to change status & use mirrors that magnify or shrink image size

- pastoralists & ultimatum game

Pose quesitons to individuals of different phenotypes on different group ranches

Cooperation at National and International Levels

Dutch Team: Aart de Zeeuw (PI) [U. Tilburg]
Anastasios Xepapadeas [U. Crete]

Determine how cooperation at the international level can be achieved.

Decisions at Different Levels

Issues:

1) Agents at two levels--countries and resource ‘harvesters’ within countries
2) Regulators at two levels--international agencies that negotiate norms for countries and national governments that control resource ‘harvesters’ & other national agents.

Models and Analyses:

3) New policies create a cascade of signals to nations, and based on preferences for the global commons, from nations to national harvesters who react serving their own interests. Design of regulations will depend on rationality behavior: profit maximization (unbounded) v. imitation (bounded).
4) To be explored: optimal regulation design, sharing technology development costs & presence of enforcement/sanctioning.

Ultimate Goal

Identify mechanisms that generate trust and cooperation so that all feel they will gain by sustaining the commons today & for future generations

Focus on collective decisions…

-- individuals to groups

-- groups to nations

-- nations to the world's population

… to create framework for achieving mutual benefits from mutual action.