Emergent Networks as Distributed Reputation System

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Themes, conjectures…

- Friendship or trust networks link nodes who trust each other
- If a chain or route of trust can be found between two distant nodes
- Then can operate as a kind of distributed reputation system
- Humans appear to be able to produce these endogenously
- Based on on-going interactions
- Such networks are potentially very valuable
  - For example: credit networks could be used to replace the global money system eliminating the need for central banks
  - Ripple P2P money
- But can such processes be captured computationally?
- Can we produce artificial trust networks without user involvement?
- This could be useful for many P2P applications

Ripple Project

To develop a standard protocol for routing payments through arbitrary currency networks

What is Ripple?

A payment network	A common protocol allows users on different servers to keep accounts with each other, forming a trust network that can process payments along paths between participants.
Open	Any server running Ripple software can join the network and any two servers in the network can communicate. The Ripple protocol is open so anyone can write Ripple server software. Official Ripple server software will be released as free open source software.
Decentralized	There is no central credit-issuing body: participants grant credit to each other, and accounts track obligations between participants themselves. No single server controls or regulates the network.
Accountable	Participants only accept obligations from those they have indicated they trust. Payment occurs by exchanging obligations held by the payer for obligations acceptable to the recipient, often through several intermediaries.
Private	Account information is secret.
A monetary system	A bank account is nothing but a bank obligation, and these bank obligations make up 95% of our money. Ripple follows the same accounting and payment model as the banking system, except anyone can be an intermediary. Therefore, Ripple constitutes a monetary system in its own right, without many of the drawbacks of existing centrally-controlled monetary systems.
Built on modern technology	Network routing methods allow Ripple to find payment paths through complicated networks, where the regular banking system is restricted to a simple hierarchical structure that is simple to route through, but has a central point of failure. The

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File-sharers forced to play fair

By Colin Barras
Technology reporter

Researchers have found a way to enforce good manners on file-sharing networks by treating bandwidth as a currency.

Tribler has also been made to work with the PlayStation 3

The team has created a peer-to-peer system called Tribler in which selfless sharers earn faster upload and download speeds but leechers are penalised.

The technology is being assessed by a European broadcasting body looking at ways of piping TV across the net.

Tribler has also been used to turn Sony's PlayStation 3 into a video-sharing device.

Fair sharing

While file-sharing networks are good ways to help lots of

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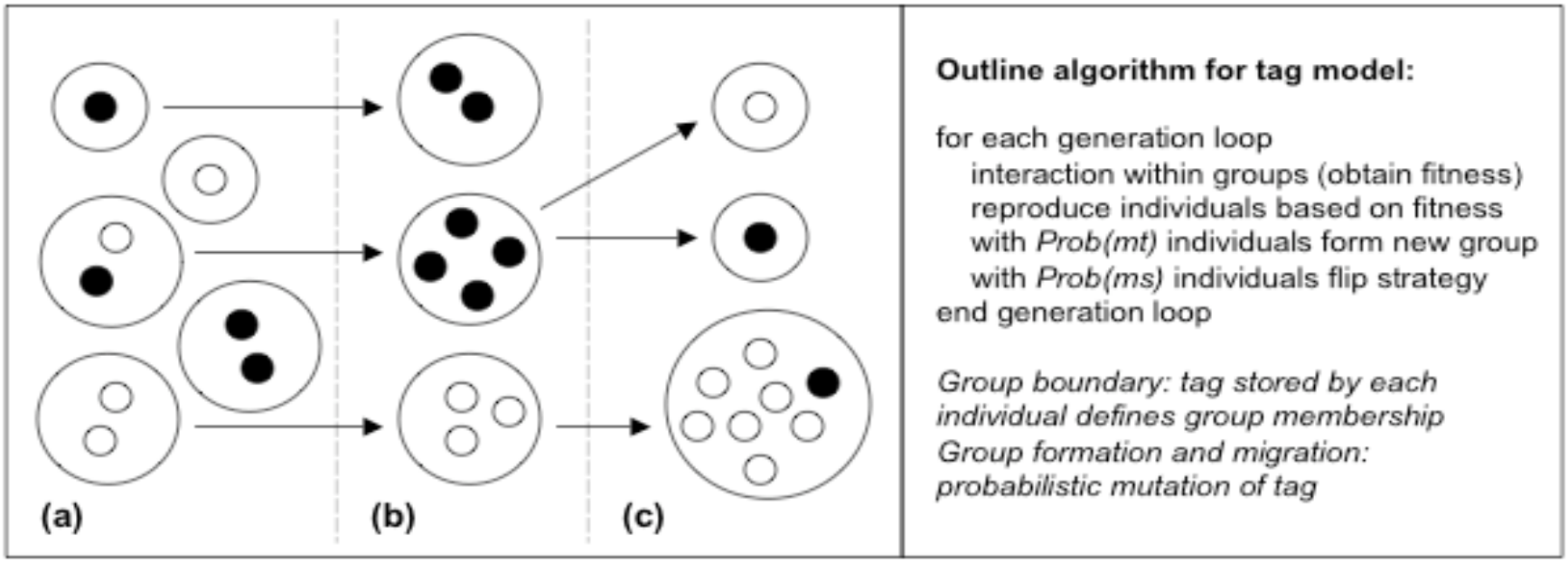
New Group Selection Models

Group Selection Models

- Recent models of “group selection”
- Based on individual selection
- Producing dynamic social structures
- Limit free-riding
- Increasingly group-level performance
- Don’t require reciprocity
- Could be very useful in P2P

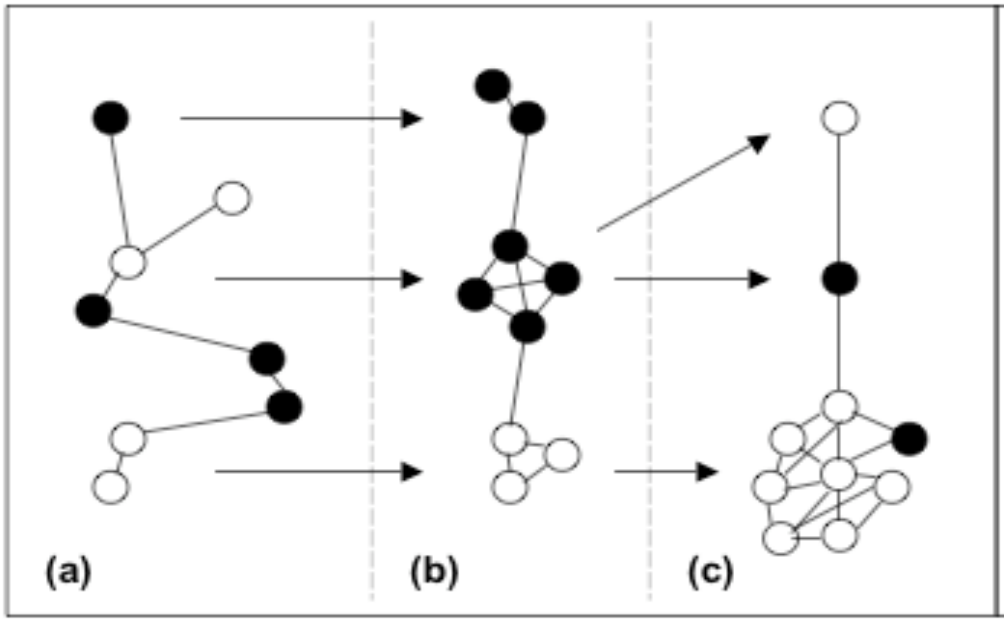
Evolutionary Group Selection Models

- *Group boundary* - a mechanism which restricts interactions between agents such that the population is partitioned into groups
- *Group formation* - a process which forms groups dynamically in the population
- *Migration* - a process by which agents may move between different groups
- *Conditions* - cost / benefit ratio of individual interactions and other conditions which are sufficient for producing group-level selection



Schematic of the evolution of groups in the tag model. Three generations (a-c) are shown. White individuals are pro-social (altruistic), black are selfish. Individuals sharing the same tag are shown clustered and bounded by large circles. Arrows indicate group linage. When ***b*** is the benefit a pro-social agent can confer on another and ***c*** is the cost to that agent then the condition for group selection of pro-social groups is: ***b > c and mt >> ms***

Riolo, Axelrod, Cohen, Holland, Hales, Edmonds…



Outline algorithm for network model:

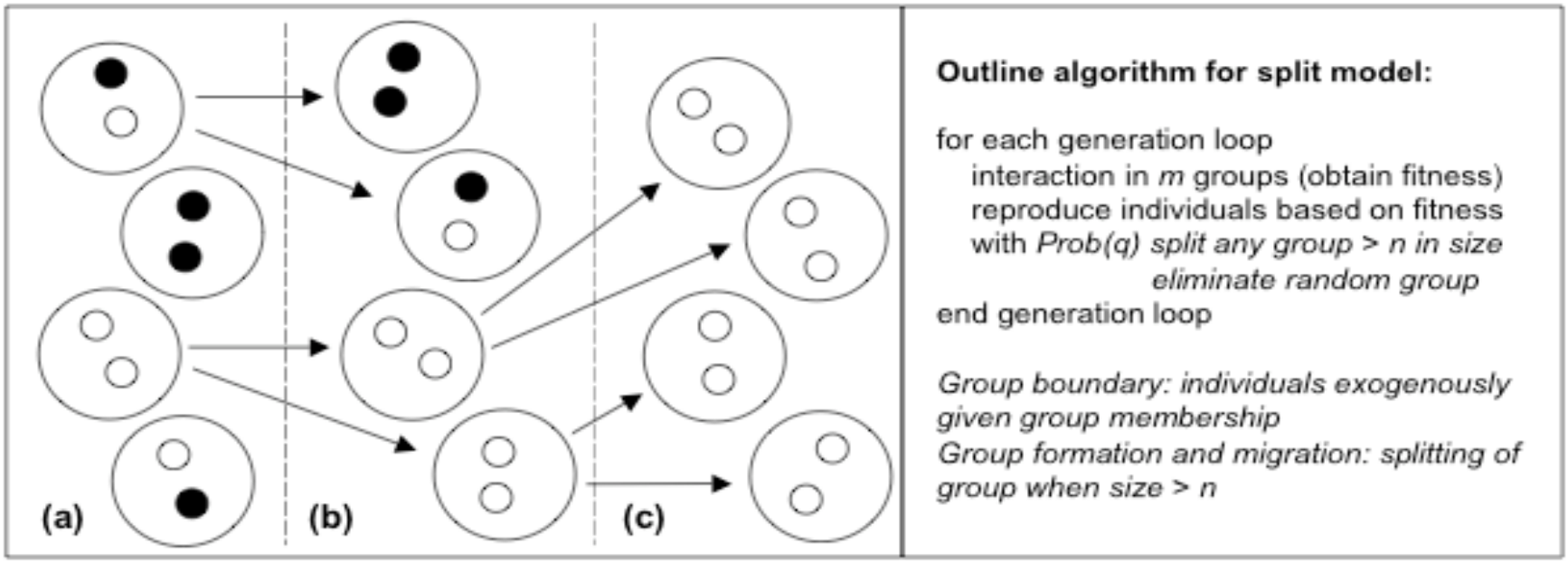
for each generation loop
interaction within groups (obtain fitness)
reproduce individuals based on fitness
with *Prob(t) copy new links*
with *Prob(mt)* individuals form new group
with *Prob(ms)* individuals flip strategy
end generation loop

Group boundary: individuals directly linked in the network
Group formation and migration:copying of links probabilistically

Schematic of the evolution of groups in the network-rewire model. Three generations (a-c) are shown. Altruism selected when:***b > c and mt >> ms.*** When ***t = 1***, get disconnected components, when ***1 > t > 0.5***, get small-world networks

Hales, D. & Arteconi, S. (2006) Article: SLACER: A Self-Organizing Protocol for Coordination in P2P Networks. IEEE Intelligent Systems, 21(2):29-35

Santos F. C., Pacheco J. M., Lenaerts T. (2006) Cooperation prevails when individuals adjust their social ties. PLoS Comput Biol 2(10)



Schematic of the evolution of in the group-splitting model. Three generations (a-c) are shown. Altruism is selected if the population is partitioned into ***m*** groups of maximum size ***n*** and ***b / c > 1 + n / m.***

Traulsen, A. & Nowak, M. A. (2006). Evolution of cooperation by multilevel selection. Proceedings of the National Academy of Sciences 130(29):10952-10955.

SLAC: Network re-wire P2P model

- Agents = nodes in a P2P overlay network
- Each node links to some neighbors (view) in overlay
- Assume:
  - Interaction between neighbors to achive some application task
  - Behavior: Application behavior (i.e. share files or leech files, cooperate or defect)
  - Utility: Evaluated at application level (i.e. number of files downloaded, performace metric)

SLAC algorithm

Each node *p* periodically executes the following:

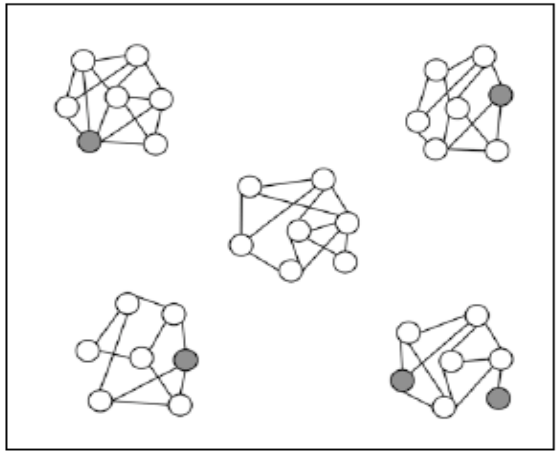
q = SelectRandomPeer()
if $\text{utility}_q > \text{utility}_p$
    drop all current links
    link to node *q* and copy its strategy and links
    mutate (with low probability) strategy and links
fi

SLAC playing the PD

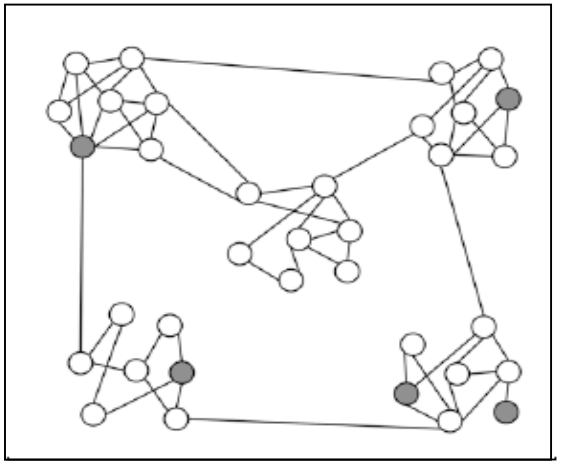
- We tested SLAC with Prisoner's Dilemma (PD)
  - Captures the conflict between "individual rationality" and "common good"
  - Defection (*D*) leads to higher *individual* utility
  - Cooperation (*C*) leads to higher *global* utility
  - *DC* > *CC* > *DD* > *CD*
- Prisoner's Dilemma in SLAC
  - Nodes play PD with neighbors chosen randomly in the interaction network
  - Only pure strategies (always *C* or always *D*)
  - Strategy mutation: flip current strategy
  - Utility: average payoff achieved

SLAC and SLACER

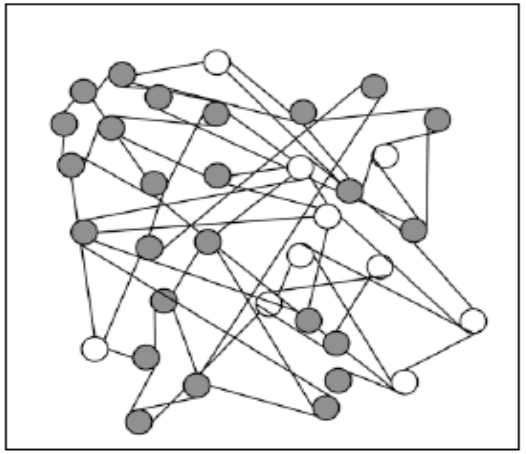
W=1



W=0.9



W=0.3



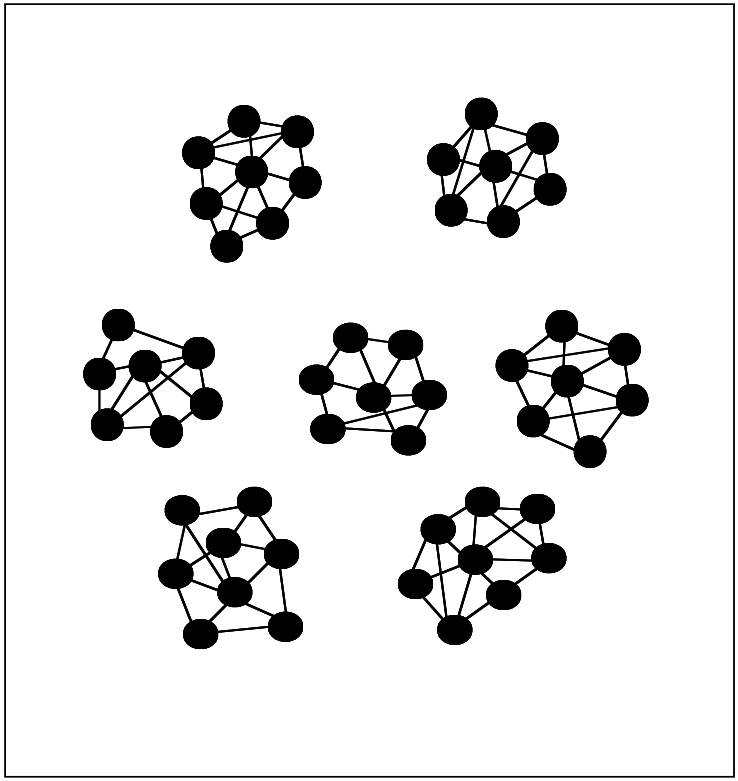
SLAC

SLACER

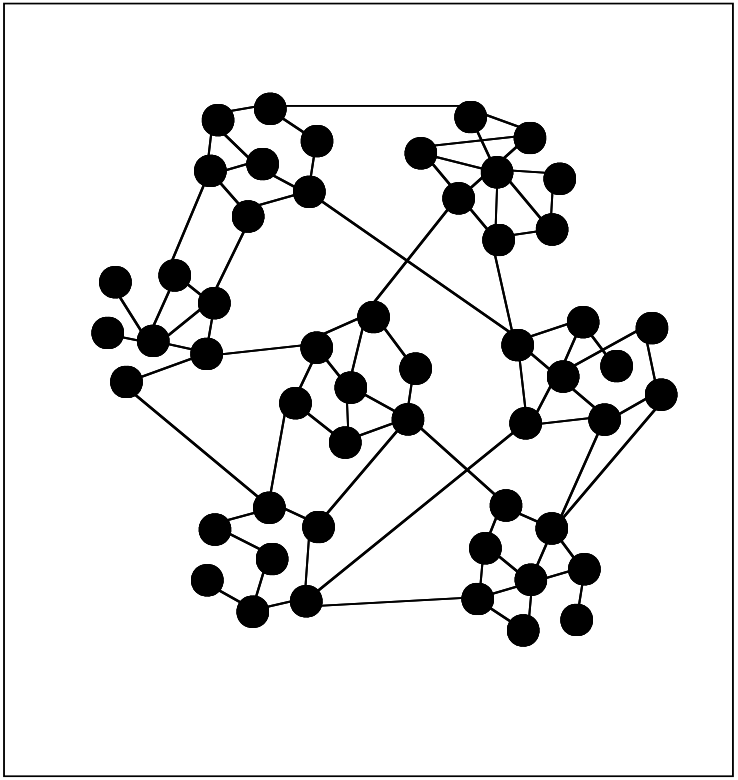
As W is increased (probability of dropping a link when moving) then the network becomes more random and cooperation reduces. Intermeidate points give small-world fully connected networks

SLAC to SLACER

David Hales (University of Bologna)

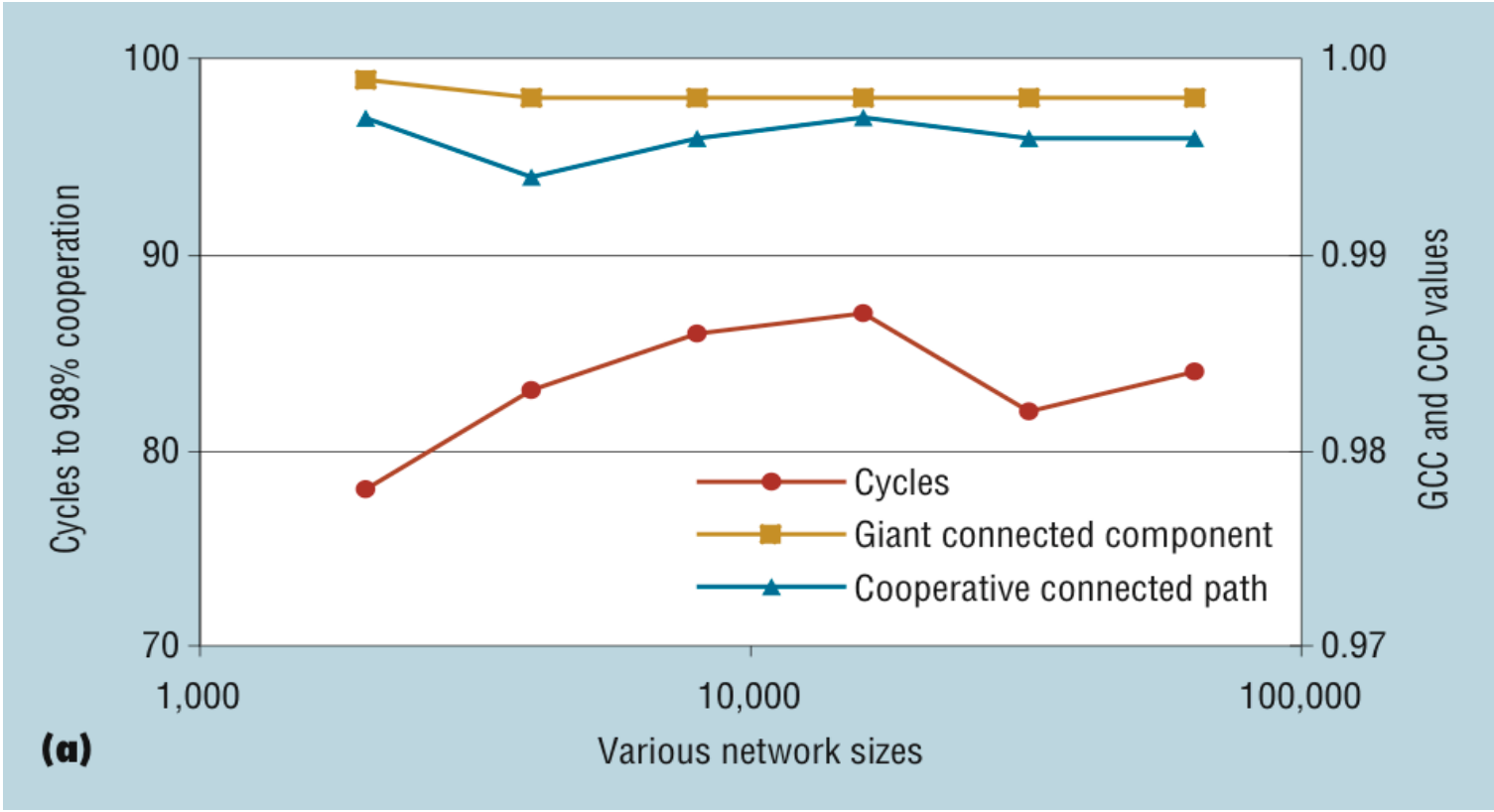


SLAC



SLACER

SLACER – Some Results



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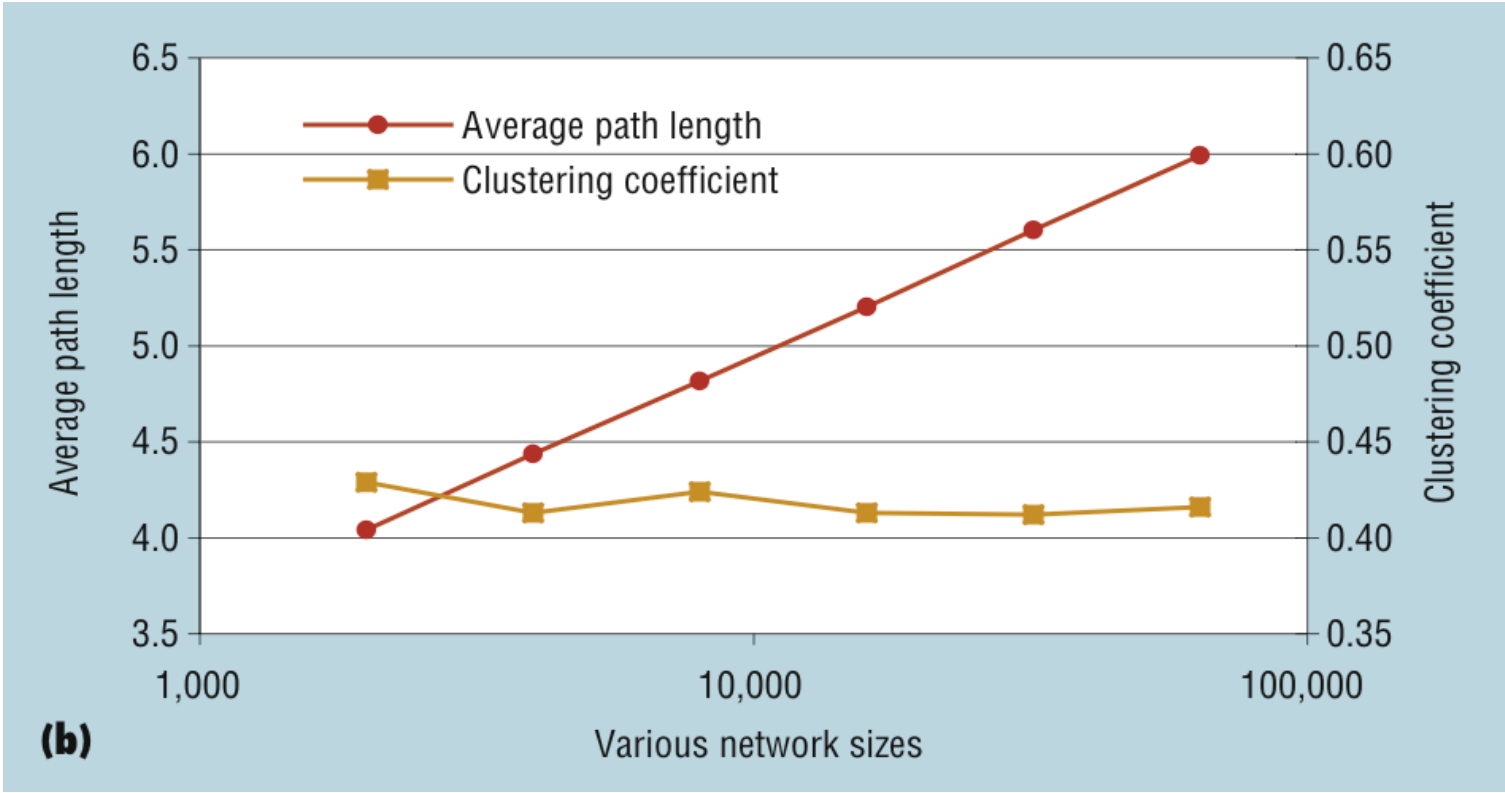

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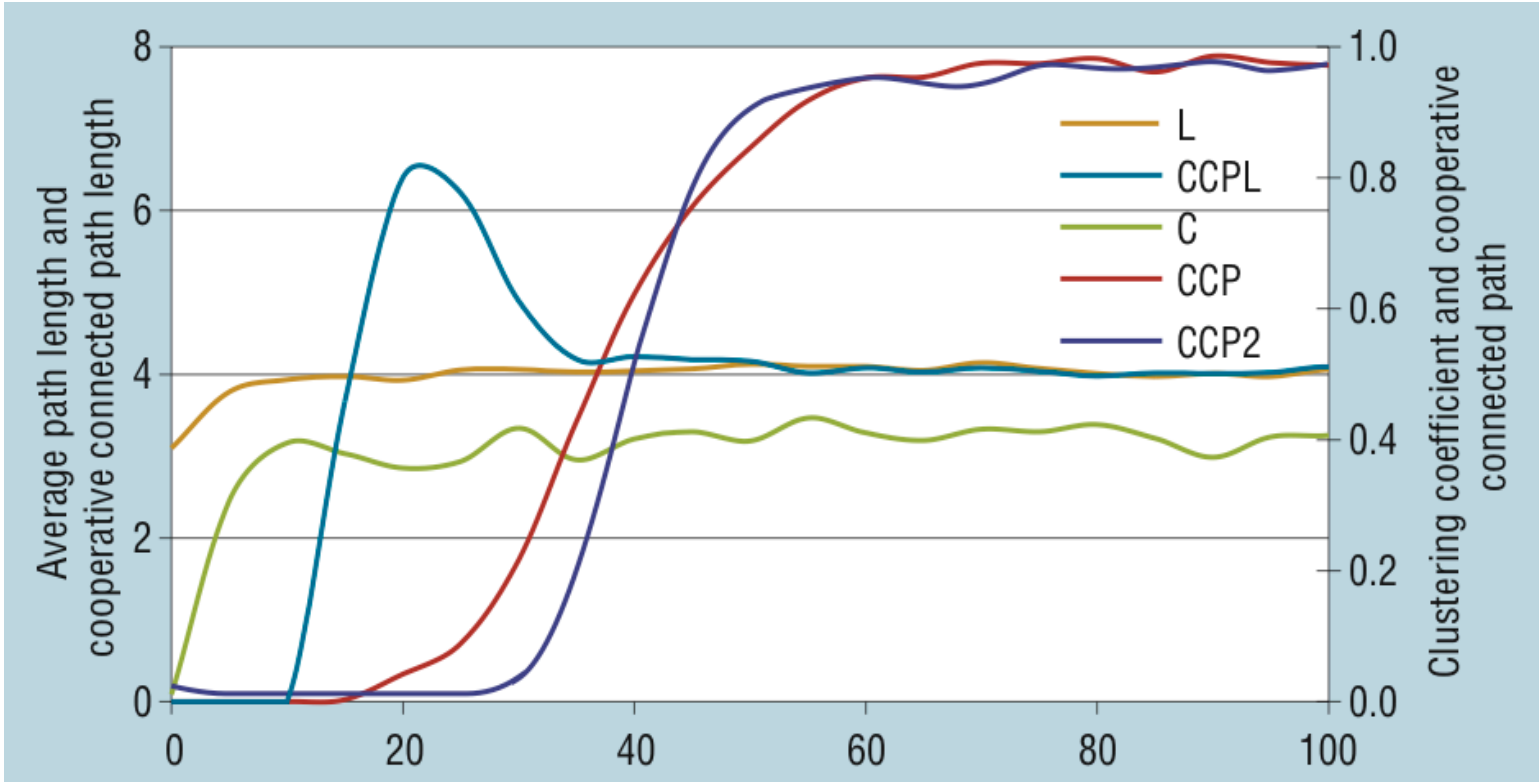
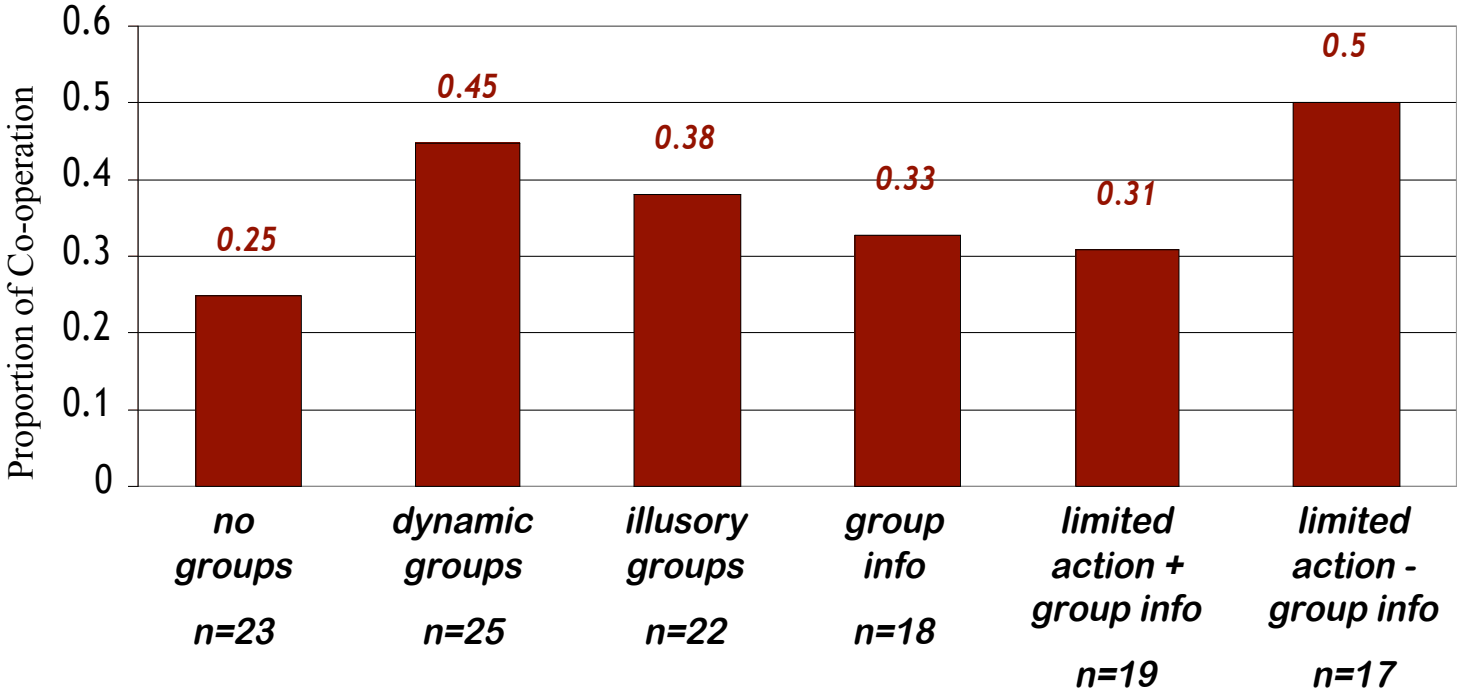


Experimental results with people



Pilot study. Joint work with Jeremy Goslin, Dept. of Psychology, University of Plymouth (paper forthcoming)