SLACER:

Randomness to Cooperation

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Self-Organising Cooperation in Peer-to-Peer Systems

- Algorithm based on social simulation models of “tags”
  - Introduced by Holland early 1990’s
  - Developed recently by Riolo; Hales; Edmonds.
- Tags are observable “markings”, labels or social cues, attached to agents (e.g. hairstyle, dress, accent)
- In an evolutionary algorithm tags evolved just like any other artificial gene in the “genotype”
- They are displayed directly in the “phenotype”
- When agents bias interactions towards those with similar tags, even selfish evolution selects for cooperative and altruistic behaviour

Self-Organising Cooperation in Peer-to-Peer Systems

We translated the tag algorithm into a network

- nodes move to find “better” neighbors
- producing a kind of evolution in the network
- “bad guys” become isolated

Results in a “duplicate and re-wire” rule

- Producing a kind of “group selection” between clusters
- Clusters of “good guys” persist and grow, clusters with “bad guys” are unstable and break-up

SLACER Algorithm

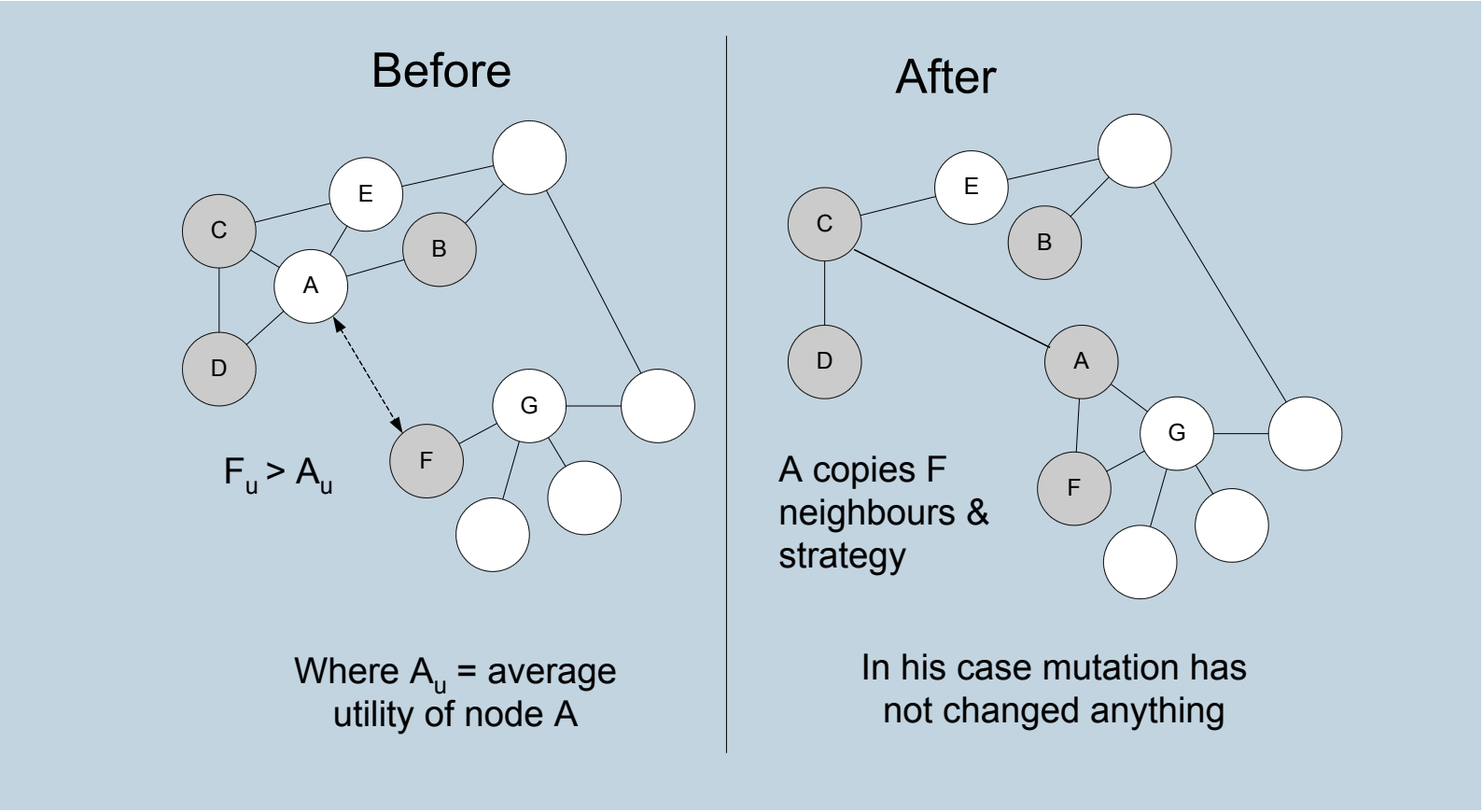
Outline Algorithm

- Periodically **do**
  - Each node compare “utility” with a random node
  - **if** the other node has higher utility
    - Link to that node and copy its strategy and links, *probabilistically retaining some existing links*
    - mutate (with a low probability):
      change strategy (behavior)
      change neighborhood (links), *probabilistically retaining some existing links*
  - **fi**
- **od**

SLAC algorithm

Self-Organising Cooperation in Peer-to-Peer Systems

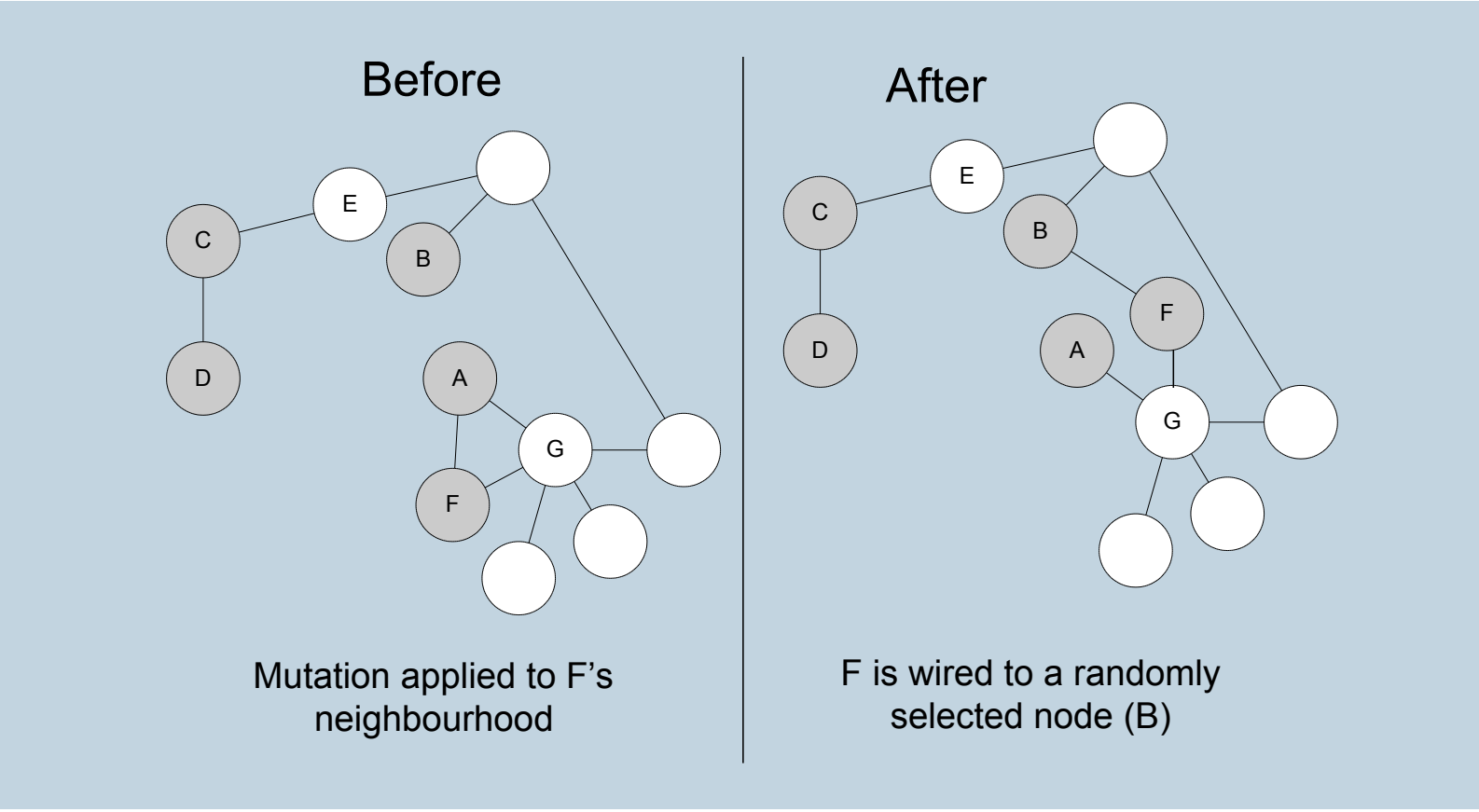
"Reproduction" = copying a more successful node



SLAC algorithm

Self-Organising Cooperation in Peer-to-Peer Systems

"Mutation of the neighbourhood" = random movement in the net



SLAC Applied to the PD

Self-Organising Cooperation in Peer-to-Peer Systems

Applied to a simulated Prisoner's Dilemma Scenario:

- Where selfish behavior produces poor performance – Nash Eq.
- Nodes store a pure strategy, either cooperate or defect
  - *Play the single round PD with randomly selected neighbours*
  - *Using their strategy*
- We take average payoff as the node utility
- Mutation of strategy: flip strategy
- Nodes randomly selected to play a random neighbours some number of times each period

The Prisoner's Dilemma Game

Given: $T > R > P > S$ and $2R > T + S$

Player 1 / Player 2	C	D
C	R (3), R (3)	S (0), T (5)
D	T (5), S (0)	P (1), P (1)

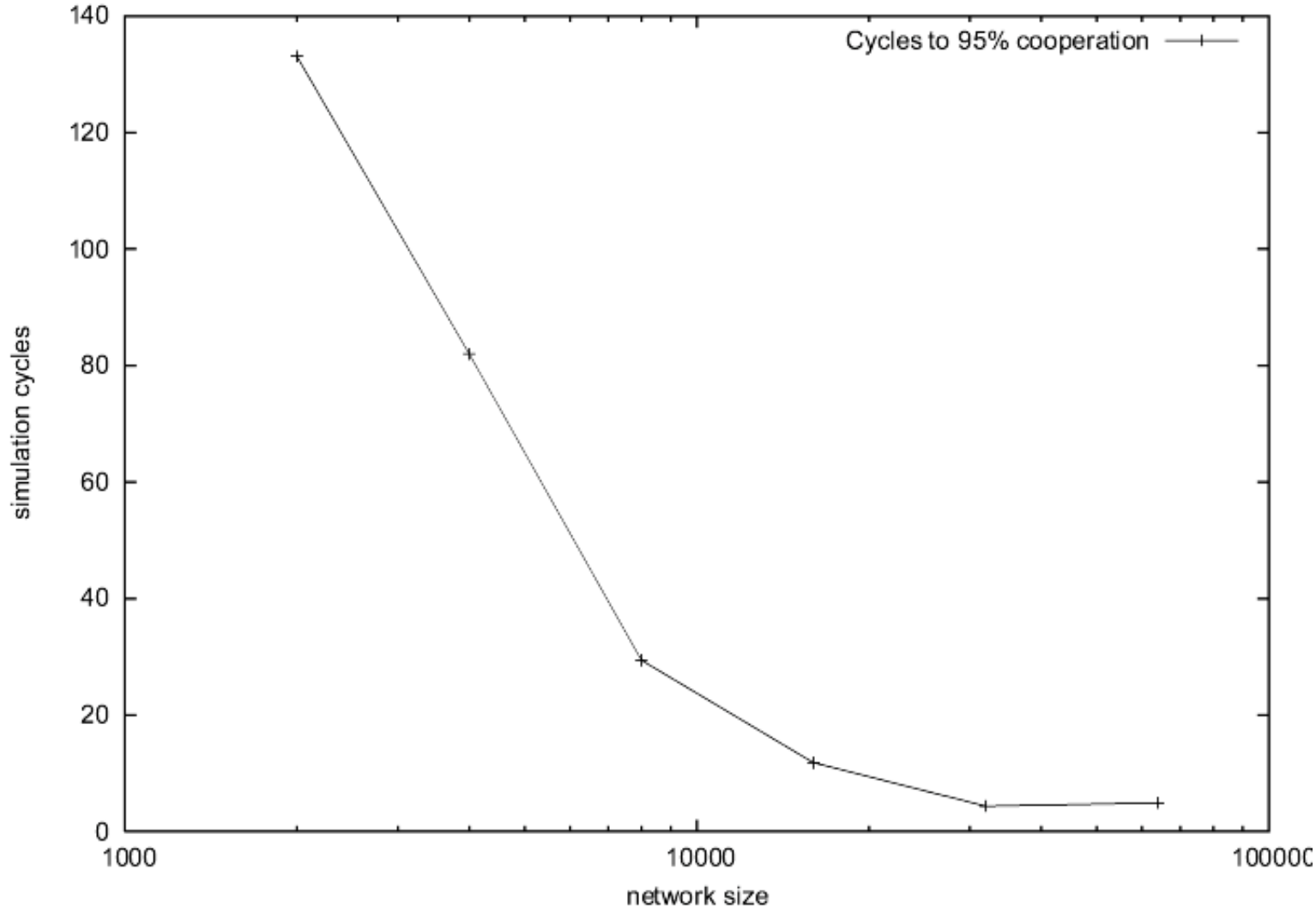
The Prisoner's Dilemma Game

David Hales (University of Bologna)

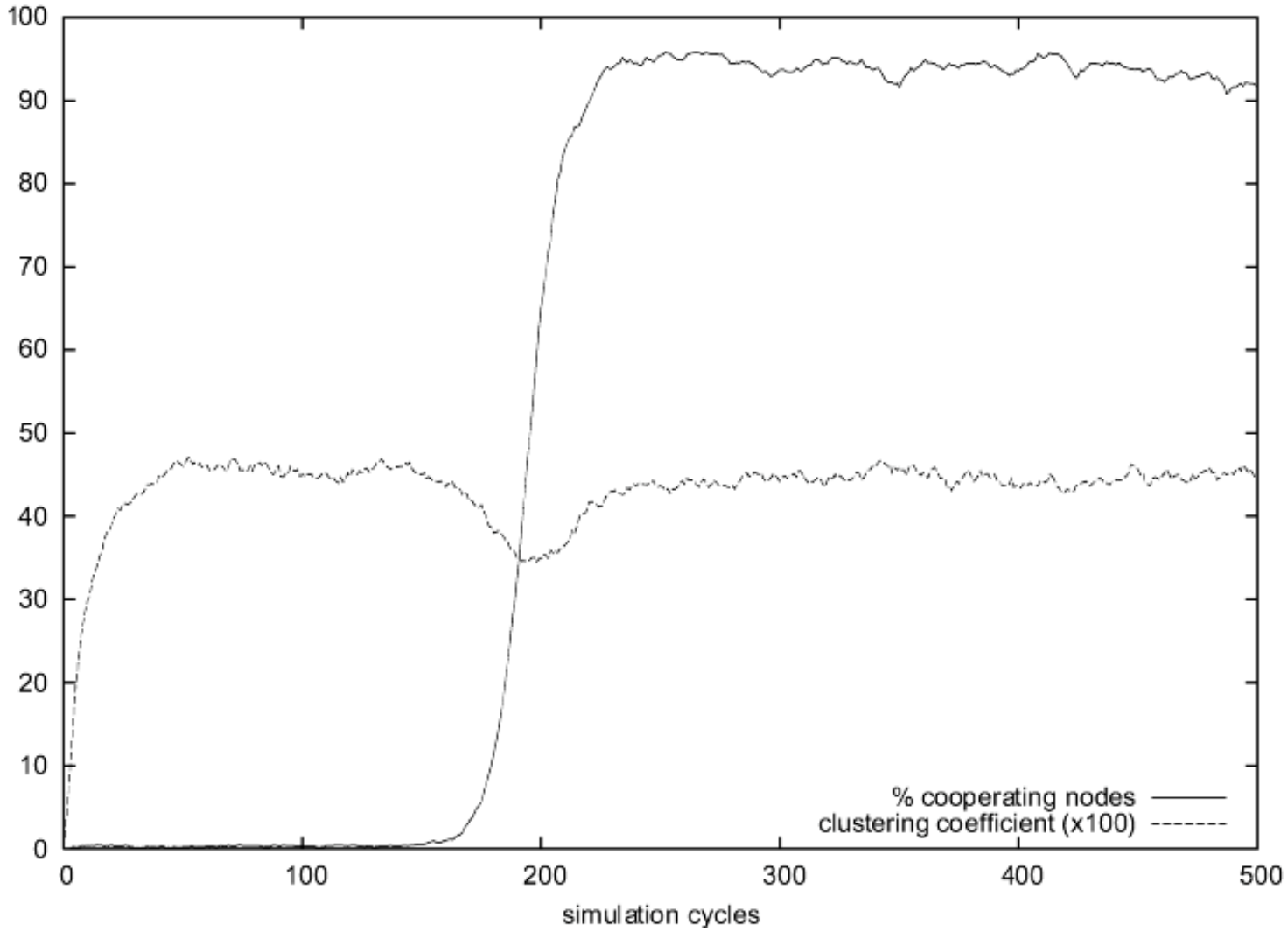
Players =>	P1	P2	P1	P2	P1	P2	P1	P2
Moves =>	C	C	C	D	D	C	D	D
Payoffs =>	R	R	S	T	T	S	P	P
Values =>	(3)	(3)	(0)	(5)	(5)	(0)	(1)	(1)
Total =>	(6)		(5)		(5)		(2)	

A contradiction between collective and individual interests: *Nash Equilibrium* = DD

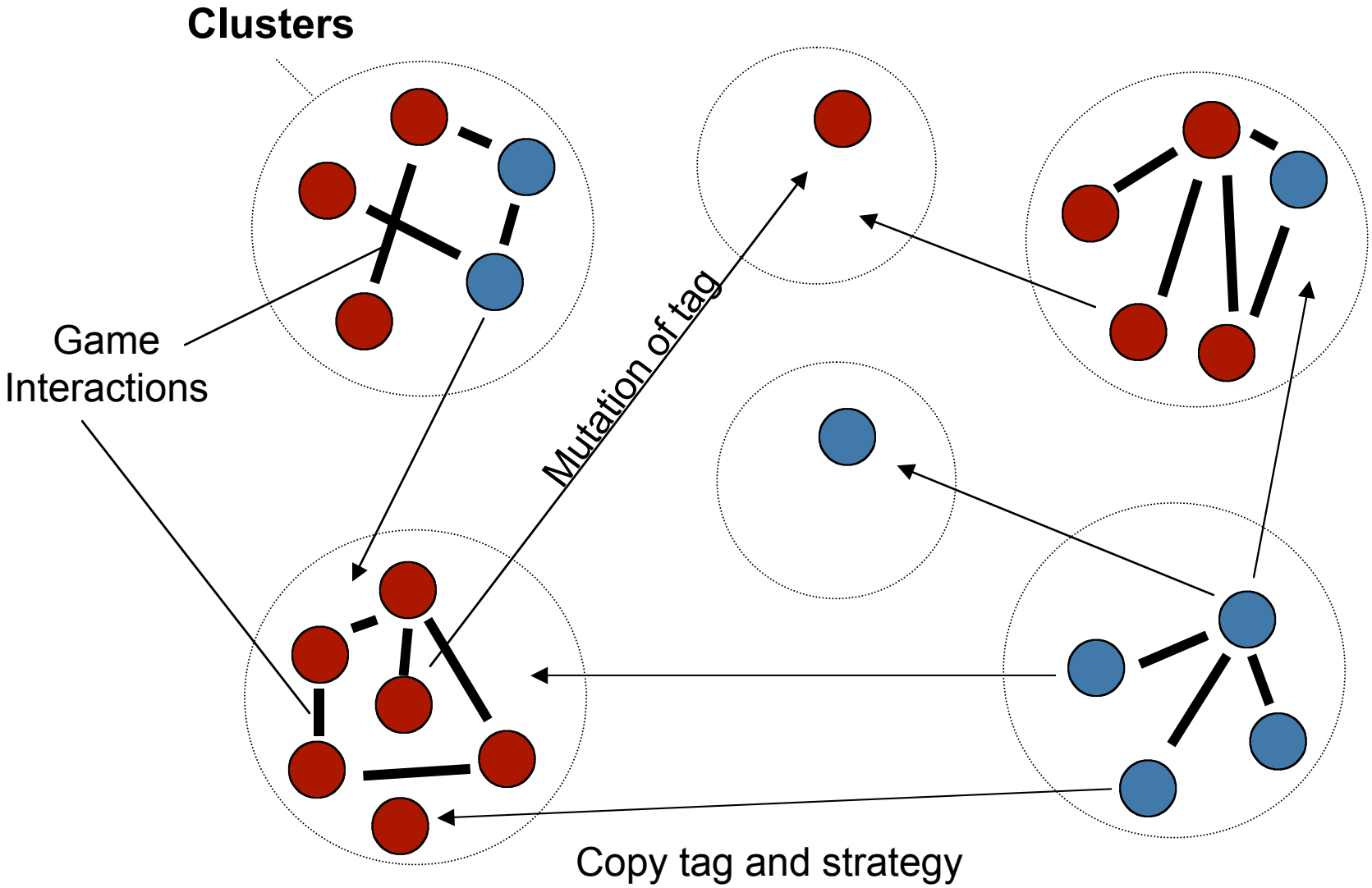
Cycles to High Cooperation



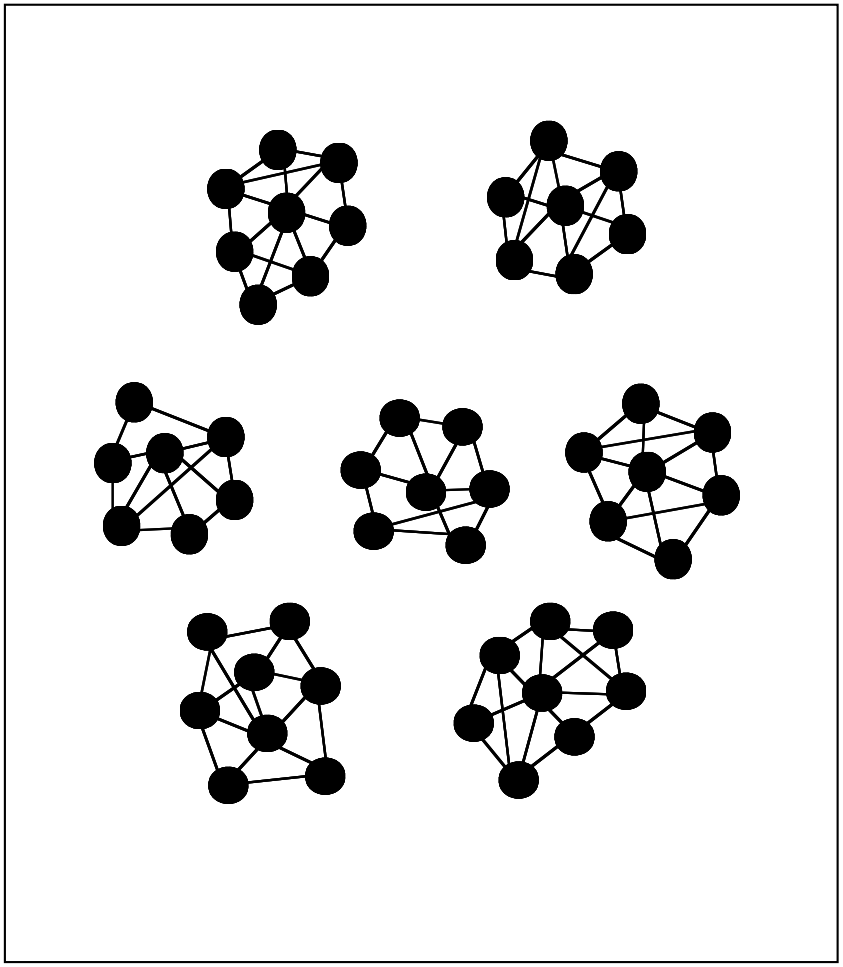
Typical Individual Run



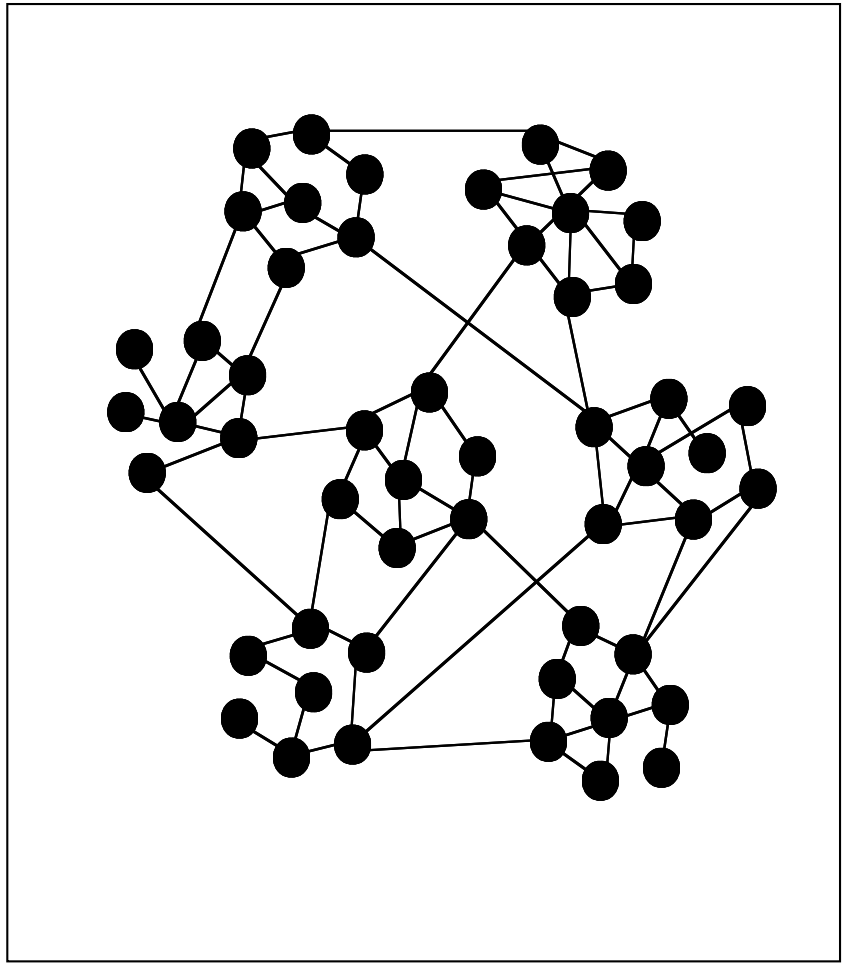
How Does SLACER Work?



"tribalism" controlled by drop prob.

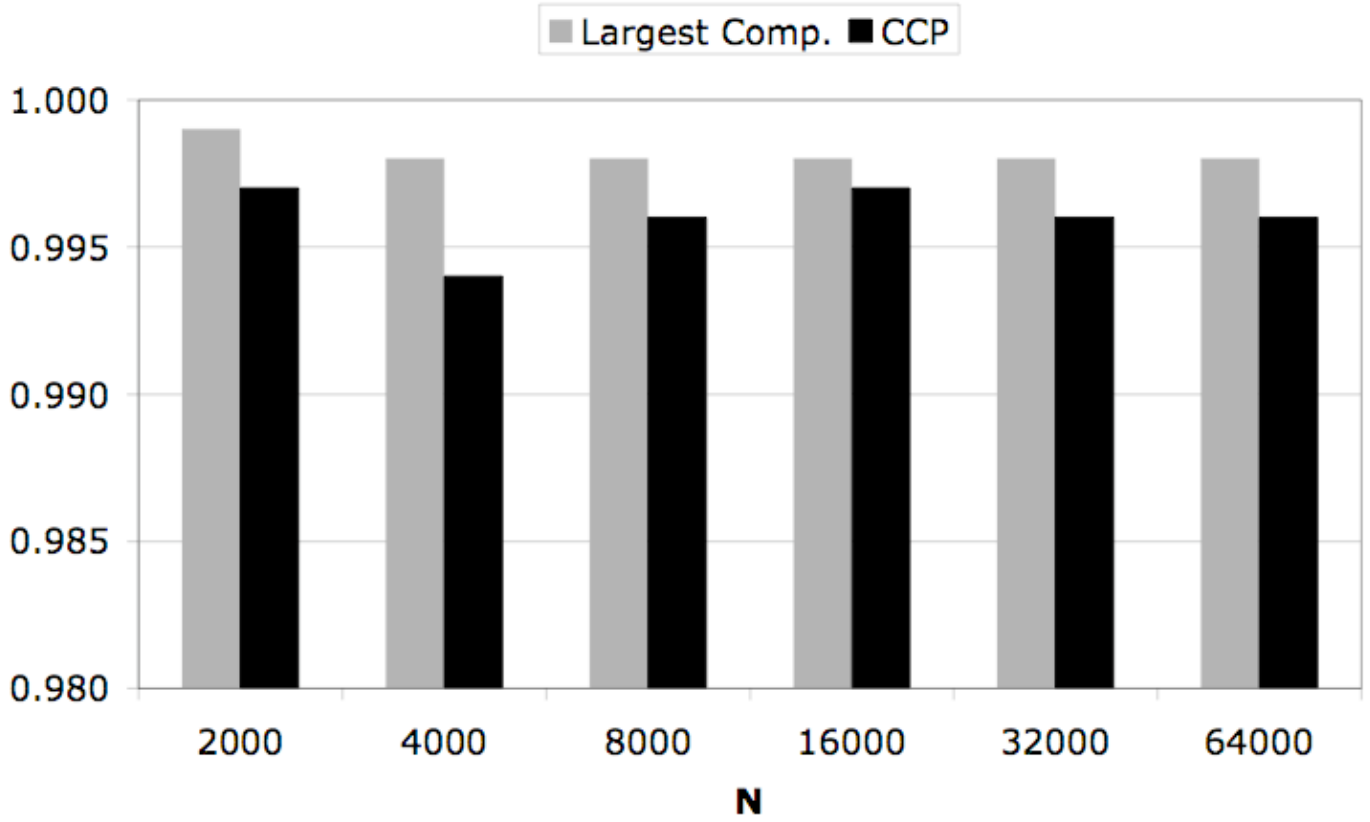


Zero prob.

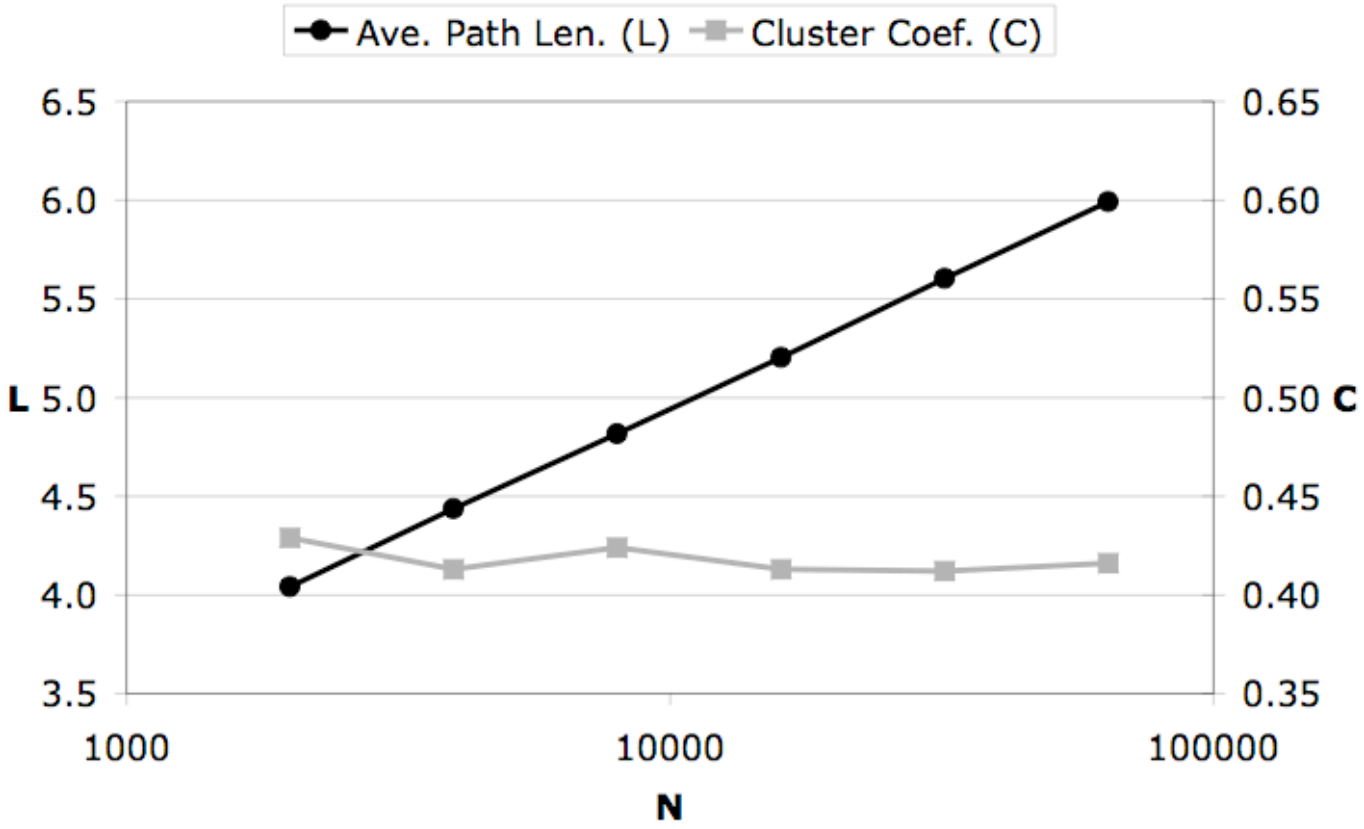


Low prob.

SLACER – Topology at high coop.



SLACER – Topology at high coop.



SLACER – Possible Applications

- By establishing a fully connected “Artificial Social Network” (ASN)
- This could possibly be used as input to existing P2P applications
- Specifically those that assume or require trusted social networks as input
- Currently harvested from e-mail contacts or “buddy lists” in chat applications
- Example: Collective spam filtering:
- *J. S. Kong, P. O. Boykin, B. Rezei, N. Sarshar, and V. Roychowdhury, “Let you cyberalter ego share information and manage spam,” 2005. Available as pre-print: http://xxx.lanl.gov/abs/physics/0504026.*

Conclusion

- Simple copy and rewire algorithm
- No need for centralized trust or enforcement mechanism
- No need for knowledge of past interactions
- Process cooperative behavior even when nodes behave in an egotistical way, locally and greedy optimizing
- Works through a kind of “group selection” – “tribal selection”
- Can produce trusted and cooperative “Artificial Social Networks”
- Could be applied to existing P2P protocols requiring trusted social networks as input
- Available on open source P2P simulation platform Peersim.

Related Publications

Self-Organising Cooperation in Peer-to-Peer Systems

References

- *Hales (2004) "From Selfish Nodes to Cooperative Networks", Fourth IEEE International Conference on Peer-to-Peer Computing (p2p2004), IEEE Press*
- *Hales & Edmonds (2005) "Applying a socially-inspired technique (tags) to improve cooperation in P2P Networks", IEEE Transactions on Systems, Man, and Cybernetics, Part A*
- *Hales & Arteconi (2005) Artificial Friends: Self-Organizing Artificial Social Networks for Trust and Cooperation – (pre-print http://arxiv.org/abs/cs.MA/0509037).*

www.davidhales.com
peersim.sourceforge.net

Finish

- Thank you

The End

Thank you!