DELIS

Dynamically Evolving, Large-scale Information Systems

Evolving networks for cooperation

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Dagstuhl CCT3 DELIS
Workshop Sept 3rd-4th 2005

Information Society Technologies

Bologna People / Overview

- Bologna (UniBO) involved in SP4, SP5 and SP6 directly
- People with some involvement in DELIS:
  - Ozalp Babaoglu – DELIS site leader
  - David Hales – DELIS postdoc (SP4..6 evolving networks)
  - Stefano Arteconi – PhD student (SP5 evolving P2P networks)
  - Mark Jelasity – BISON postdoc (SP6 distributed ranking)
  - Edoardo Mollona – Faculty / DELIS (economics SP4)

Areas of overlap support in CCT3

- SP1 – analysis and visualisation of evolving networks – but for us, not the web-graph but a p2p topology – but we can supply time-series data (arrange)
- SP1 – p2p simulation, we can supply an open source p2p simulator, peersim.sourceforge.net, knowledge and people (speculative)
- SP2 – analysis of “phase transitions” in our evolving networks – I think we have some examples already (arrange)
- SP3 – maybe we can adapt our approach and apply to some optmisation scenarios, but not sure (speculative).
- SP4 – linking simulation to game theory, perhaps certain kinds of coalition games with local information (on-going)
- SP6 – dynamic maintain. “artificial friendship network” to control selfishness, maliciousness and possibly to cluster nodes via shared semantic interests (on-going)

Evolving networks for cooperation

David Hales & Ozalp Babaoglu (UniBO)

- Ideas from Computational Social Science show how boundly rational simple greedy optimizers can, via their interactions, come to behave in a socially cooperative way
- Many mechanisms, some simple, some complex
- My interest: Tags (Holland, Riolo, Axelrod – Michigan group)
- Created mean-field single-round PD version (TagWorld)
- So far: adapted a mean-field abstract model (playing PD) into:
- simple network scenario playing PD (NetWorld)
- Into a more realistic P2P file-sharing / query scenario (FileWorld)
- Adapted to show that same technique can support cooperative specialization (SkillWorld)

Tribal Approach

David Hales & Ozalp Babaoglu (UniBO)

- P2P approach
- Start from assumption that conflict of interests is enevitable
- Rather than try to stop conflict, harness it for social integration
- A “tribe” is a set of nodes working together for collective interests
- In competition with other tribes
- Composed of, essentially selfish individualists, but without perfect information or rationality
- Hence, so far, nodes represented as selfish greedy optimisers
- Contradiction between whole network interests, tribal interests and individual interests

Tribal Dynamics

- Individuals have freedom to move between tribes – based on self-interest
- So tribes cease to exist if they can not retain their members
- Individuals also have ability to copy the behaviours of others – based on self-interest (problematic)
- So tribes can embody some set of behaviours over time (a kind of proto-culture)
- Through tribal selection (tribes competing for members) those tribes which satisfy the individual interests best will tend to survive.
- Tribes that do not adequately balance the negative collective aspects of individualism will therefore vanish

Tribal Systems Requirements

David Hales & Ozalp Babaoglu (UniBO)

- To get Tribal systems that work we need
- A way to link tribe members, so they can find each other
- A way nodes can leave one tribe and join another
- A way for nodes to be able to compare performance with other nodes and copy behaviors of other nodes (problematic)

Basic Tag idea in Networks

- The basic idea behind Tags is that agents interact within subpopulations (groups, cliques, niches, tribes or whatever)
- But, agents can compare their utility in some way with agents in other tribes and move to them if they appear to be doing better also copying better agents behavior in some way
- The “tag” is just the identifier that indicates which tribe the agent is in. Hence agents sharing the same tag inhabit the same tribe and hence interact (rather than interacting randomly or directly with other tribes)
- When translated into P2P overlay networks the tag becomes simply the neighbour list or view – because nodes sharing the same neighbour lists form a cluster of interaction
- Recent thought: This kind of thing can be compared to “adhesion” mechanisms in Biology

Basic Tag Idea in Networks

David Hales & Ozalp Babaoglu (UniBO)

- If you let nodes in a network try to optimise their individual utility by copying the views and behaviours of other randomly chosen nodes (with a little mutation) from the network with higher utility then…
- Counter intuitive things happen….
- In a range of scenarios, high levels of cooperation and altruistic like social behaviours and structures emerge
- But why?
- Since the copying and mutation process is analogus to replication in evolution, a kind of evolutionary process occurs
- This process favours cooperative tribes (since nodes in poorly performing tribes will tend to move away)
- A kind of weak “cultural group selective” process

Outline of the SLAC protocol (W=1)

Active thread:	Passive thread:
i ← this node periodically with prob. P reproduce: j ← SelectRandom(node) j.GetState(n1) if i.Utility ≤ j.Utility i ← CopyStatePartial(j) Mutate(i)	j ← this node GetState(i): Send j.Utility to i Send j.Links to i Send j.Strategy to i
Function CopyStatePartial(j):	**Function Mutate(i):**
i.Strategy ← j.Strategy drop each link from i with prob. W i.Links ← j.Links	with prob. M mutate i.Strategy with prob. MR mutate i.Links: drop each link with prob. W i.addLink(SelectRandom(node))

SLAC and SLACER

- Selfish Link Adaptation for Cooperation (SLAC)
- Used in the previous scenarios (NetWorld, FileWorld, SkillWorld)
- But produced disconnected components (okay for these scenarios)
- To get a fully connected network – overlapping cooperative clusters or tribes…
- Selfish Link Adaptation for Cooperation Excluding Rewiring
- SLACER is just SLAC but with W=0.9 (or some value < 1)
- Marginally less cooperation (98-99% not 99-100% of nodes)
- Creates a kind of “Artificial Social Network” – small worldish (high C and low L compared to random)
- But different from real social networks….
- Recently been looking at “Connected Cooperative Clusters” (CCC’s) – the number of CCC’s >= number of components
- This seems like a useful measure for some possible tasks

Problems and possible solutions

- Random sampling of the network – solution = NEWSCAST (Jelasity et al) already tested in simulation and works well
- Why should a node transmit the correct Utility, Strategy, Links?
  - Cleaver Greedy Cheating Liars (CGCL's) – interestingly, it is in the objective interests of CGCL's to support cooperation – some experiments, net can tolerate quite a lot of CGCL's
  - Nasty Nihilists Nodes (N3's) – could destroy cooperation – experiments pending.
- More general solution – move to a Satisfying model and drop utility comparisons, could be fruitful since each node could have it's own "preferred service level"
- This could make the technique less general however…

CCC's in SLAC and SLACER

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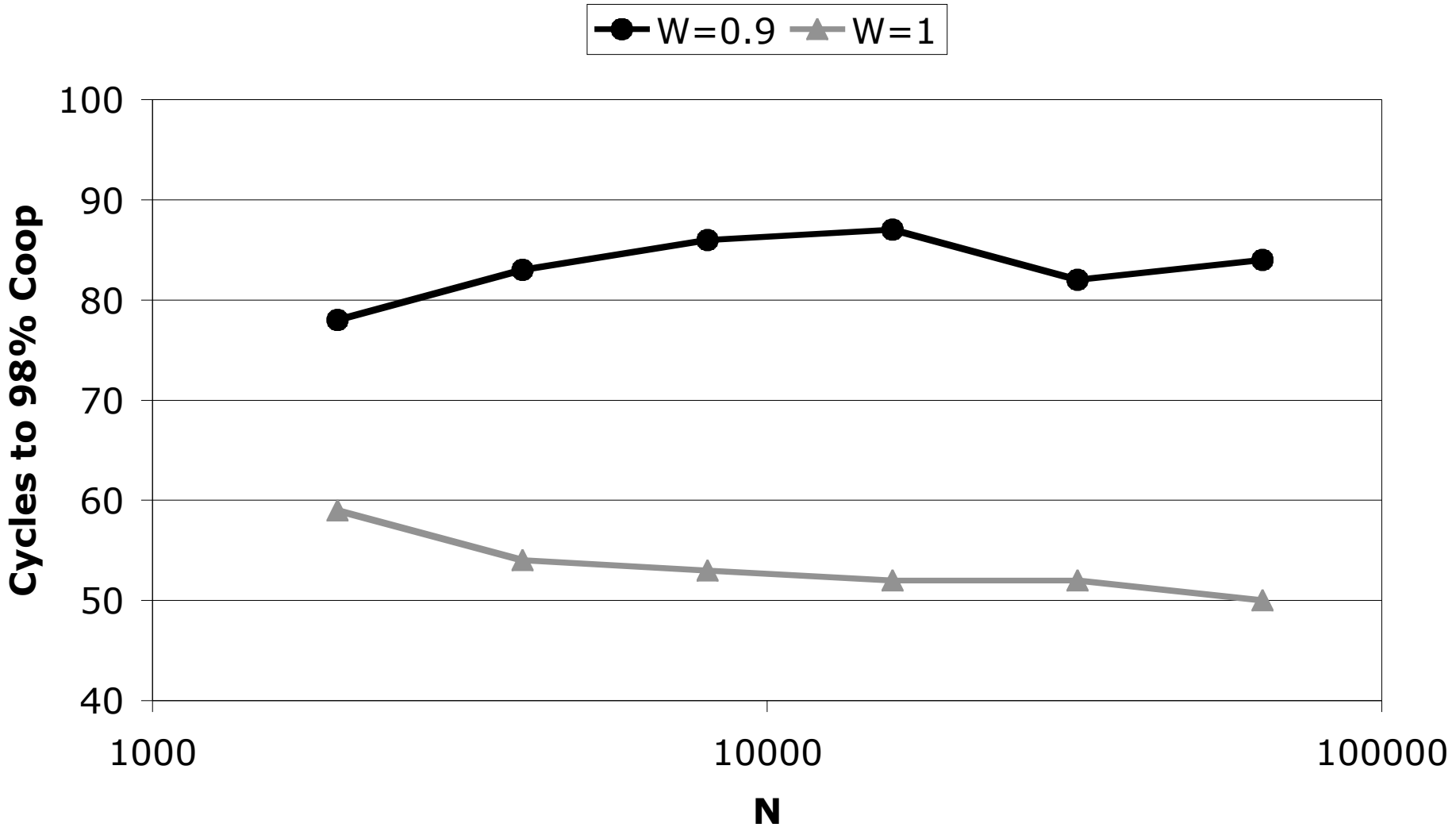

SLACER individual rule

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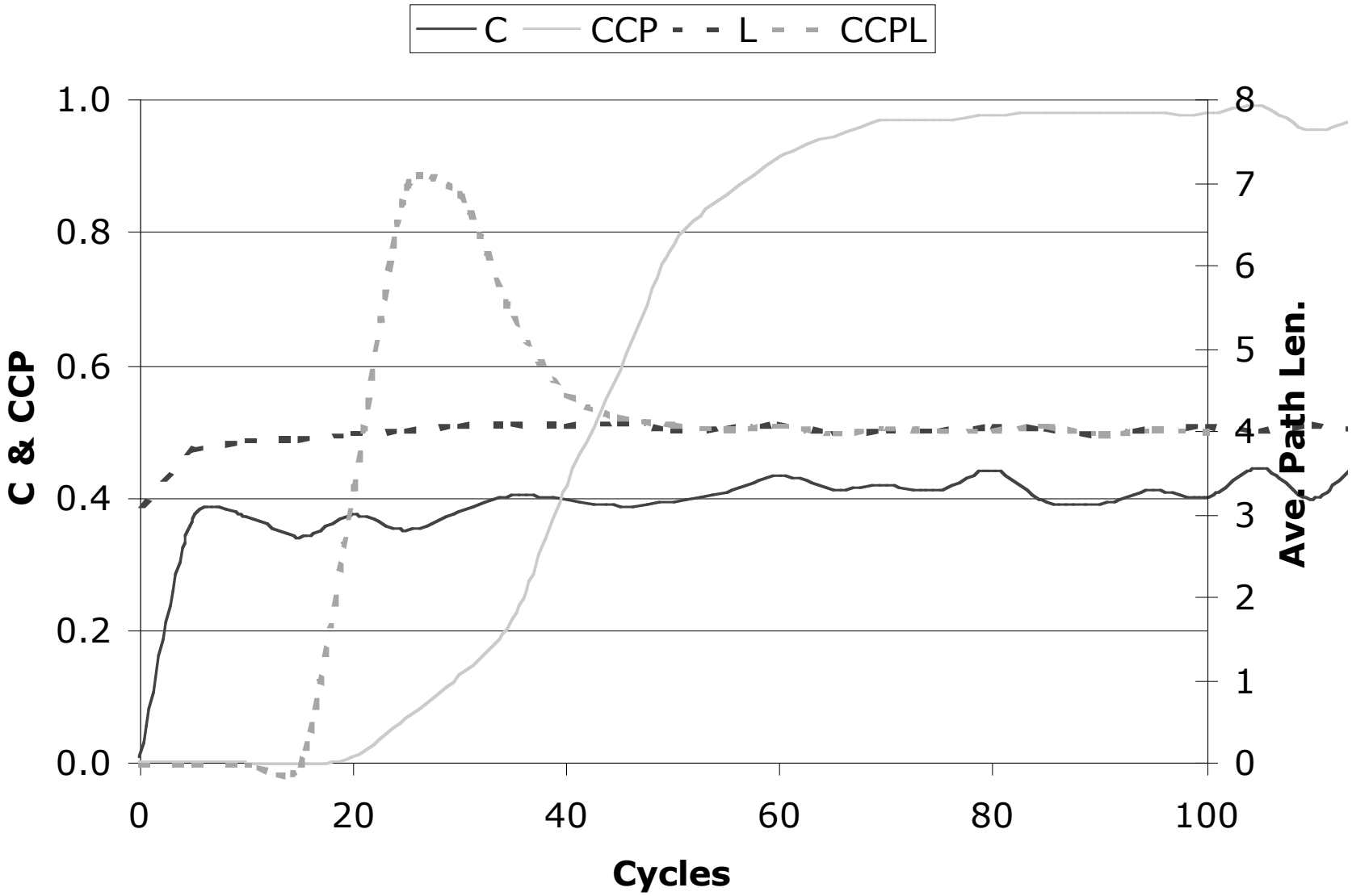
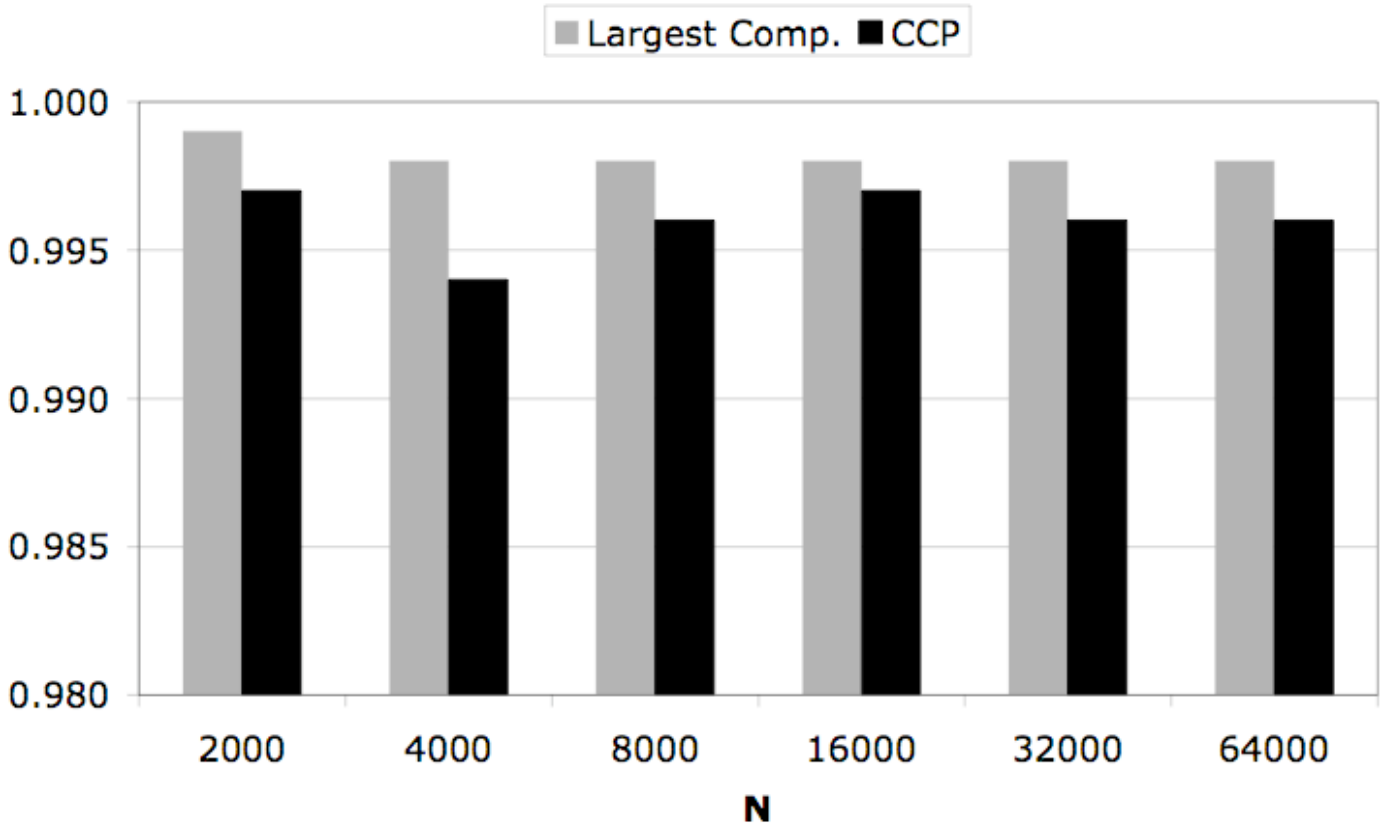


CCPs in SLACER



CCPs in SLAC

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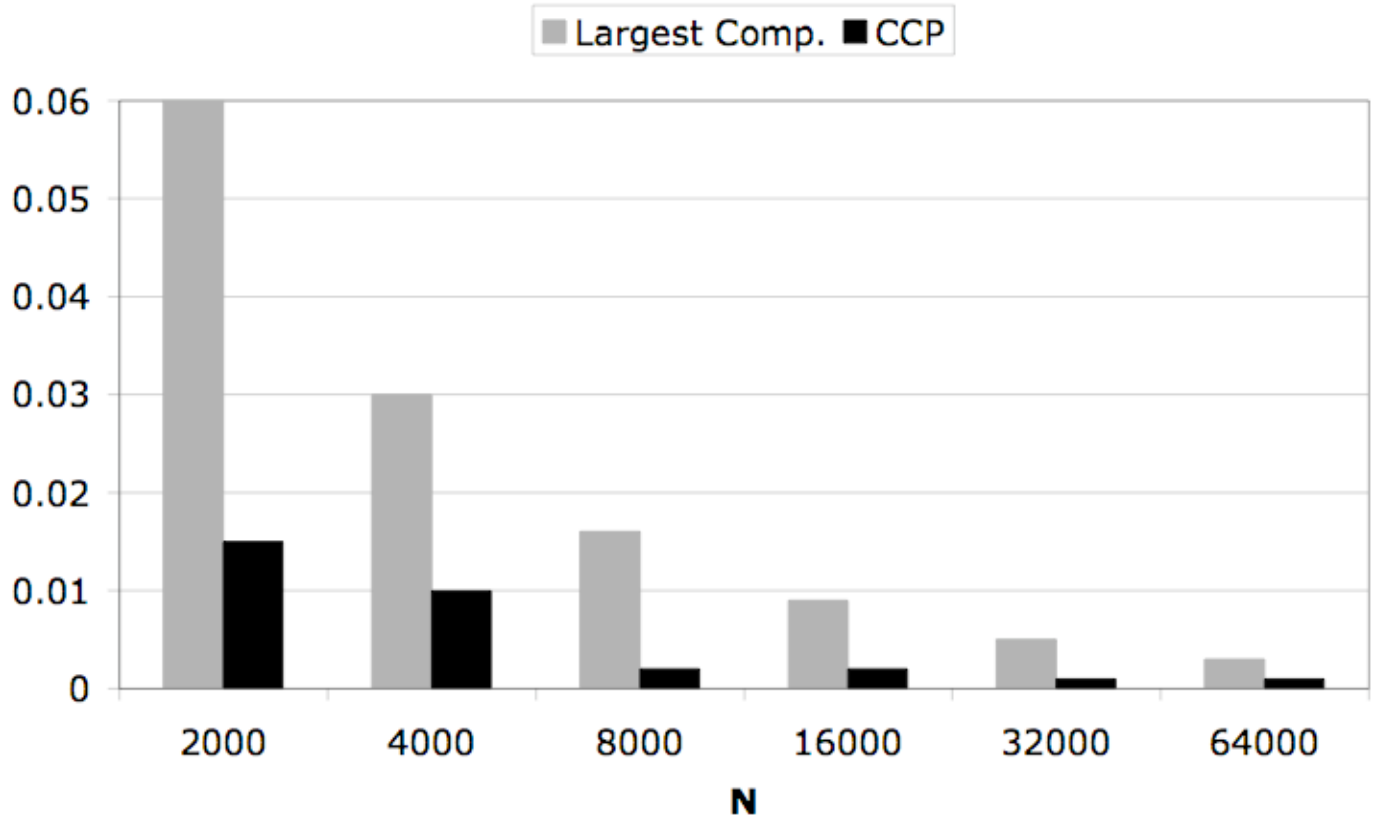

SLACER topology

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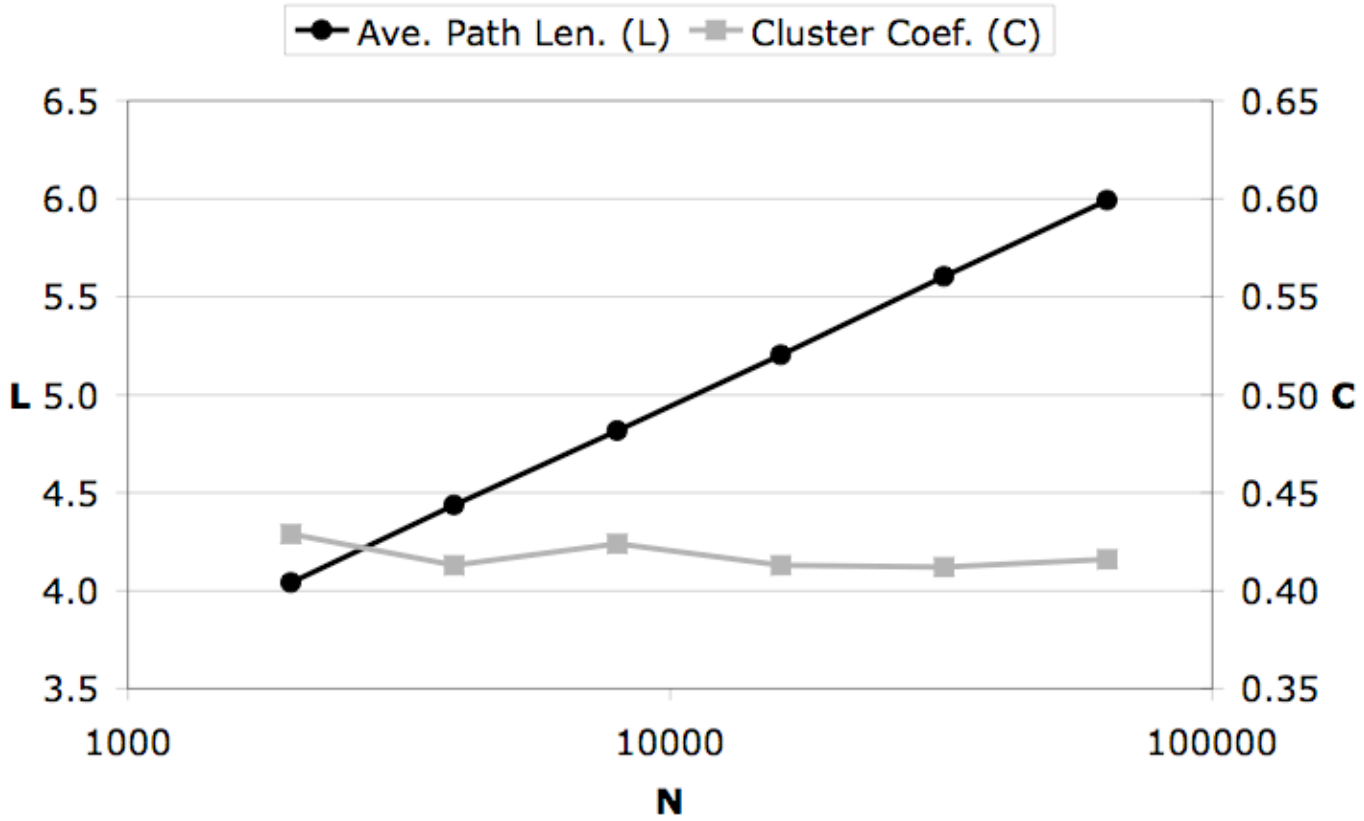

In the context of SP6

- Develop further the “saticficing” approach…?
- Find a good SP6 relevant specific scenario:
- Stopping query flooding?
- Stopping Malicious content, non-cooperative node behaviors?
- Encouraging overlay topology to evolve in a useful way?
- Clustering (forming tribes) around semantic interests?
- Encouraging altruistic node behaviors – storing data and processing queries when producing little?
- Exploiting existing altruistic nodes topologically?
- IDEAS? > dave@davidhales.com

Thanks!

Fini.

PS.

A lot of the detail of the discussed models will be presented at the Paris Complex Systems Workshop

The SkillWorld will be presented at the ESOA Workshop located with AAMAS2005 in Utrecht next week.

Get all papers at www.davidhales.com

Thank you!