The Parable of the Hare and the Tortoise

Small Worlds, Diversity and System Performance

David Lazer and Allan Friedman

not funny

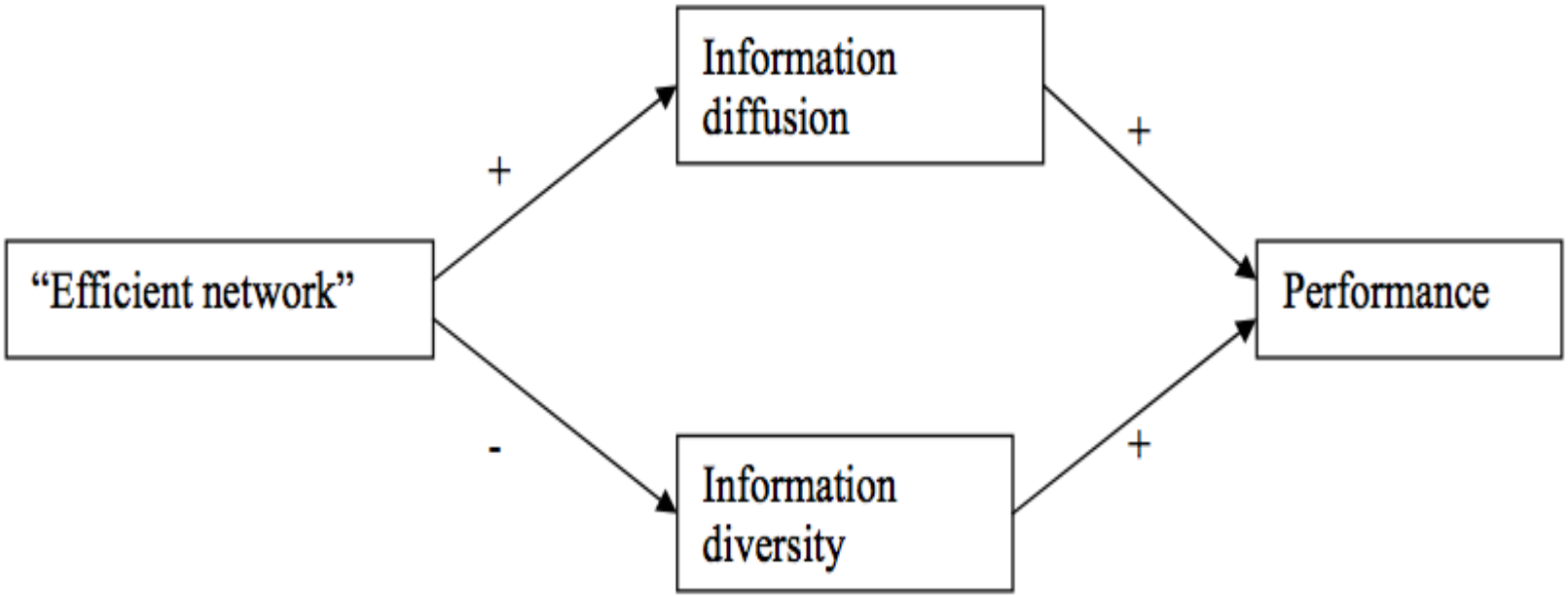
Slides by Carlos Fenollosa and Sofia Panagiotidi

Introduction

- Networks as suitable architecture of systemic adaptation:
  - Units of social systems seek for success
  - Networks provide success related information flow mechanism
- Network structure related to level success
- Previous research
- Better network -> better short run, worse long run

Information Flow in Networks

Information diffusion against diversity



Problem Space

- NK space
  - Agents get assigned a random binary string/solution (put in space randomly)
  - Each one has initial score of the point they sit on

- In this world agents observe neighbours and
  - Imitate/Adopt

    or...
  - Reform/Tinker

Research Design - Scenario

- Variables
  - Types of network: linear, full, random, small world
  - Velocity of information

- Population:100
- N=19
- K=5
- Initial Number of Solutions=1000

Types of network

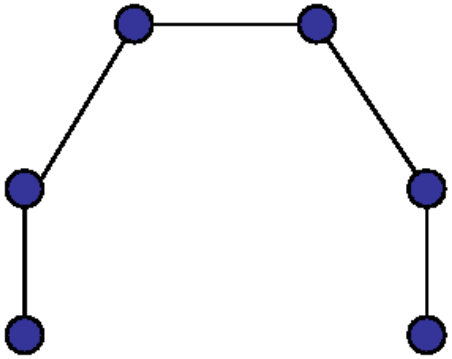


Figure 5a: A linear network

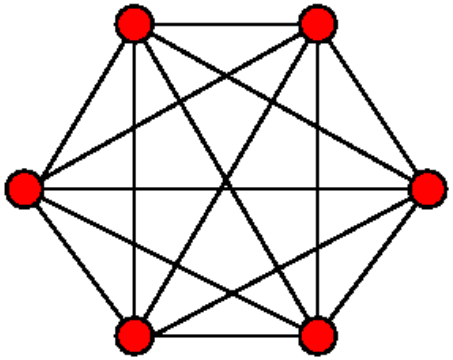


Figure 5b: A fully-connected network

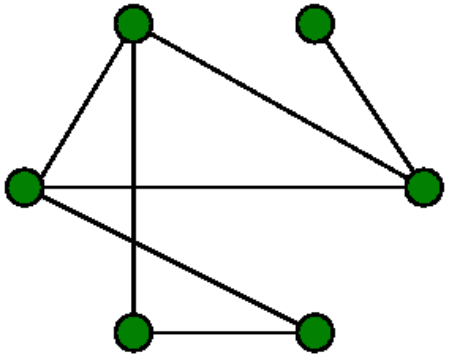


Figure 5c: A random network (p=.3)

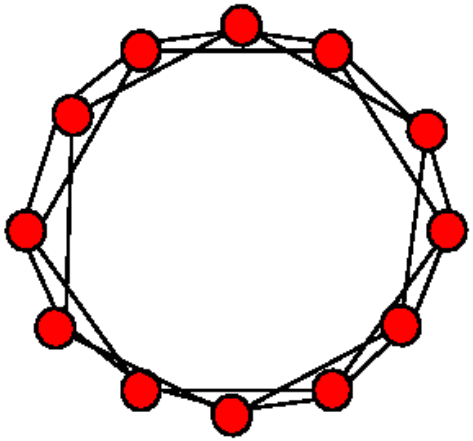


Figure 6a: A regular lattice with each node connected to its 4 closest neighbors, with an average path length of 1.909

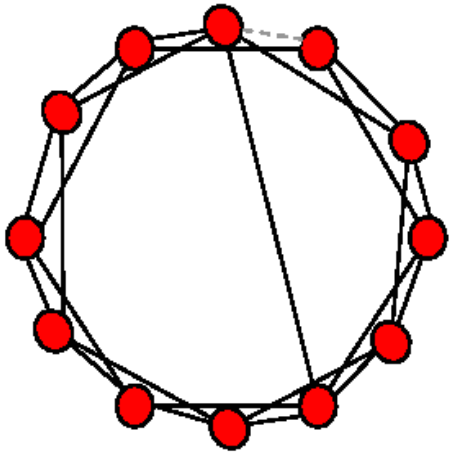
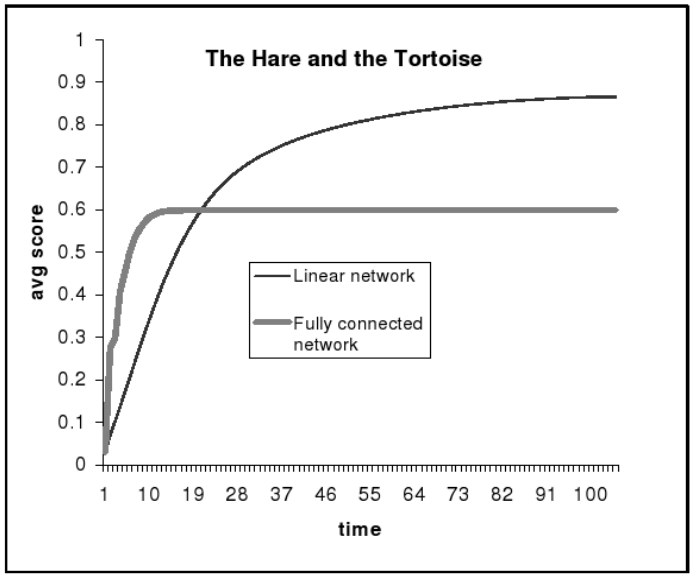
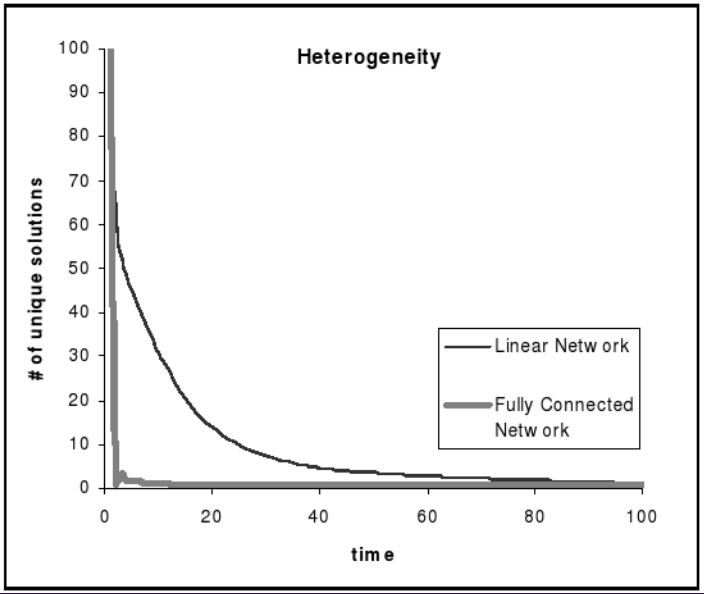


Figure 6b: The lattice with one link rewired to connect to a distant node, shortening the average path length to 1.833. In a 100-node lattice, a single rewired link can reduce average distance by over 20%.

Results > Linear vs Full networks

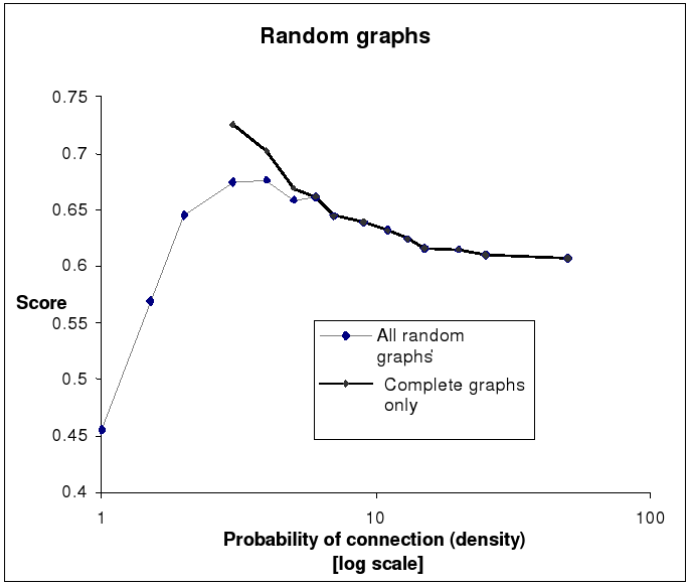


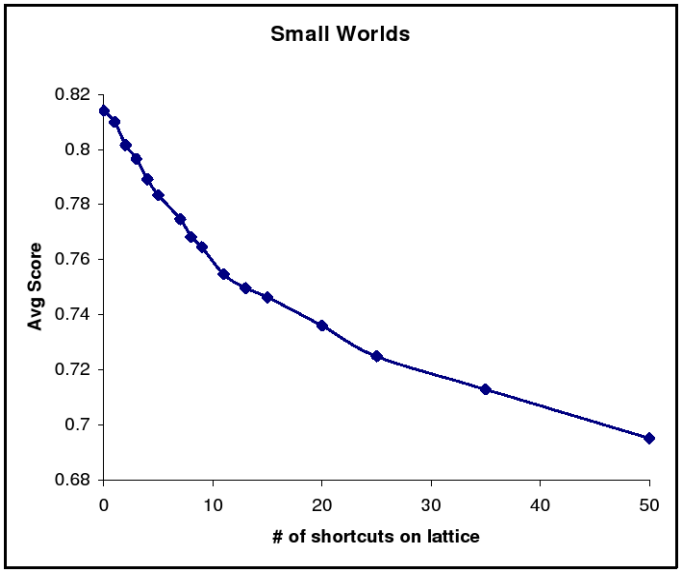
- The linear network is slower but better in the long run



- We see that the unique solutions in a fully connected network drop to 1 or 2 after the first round

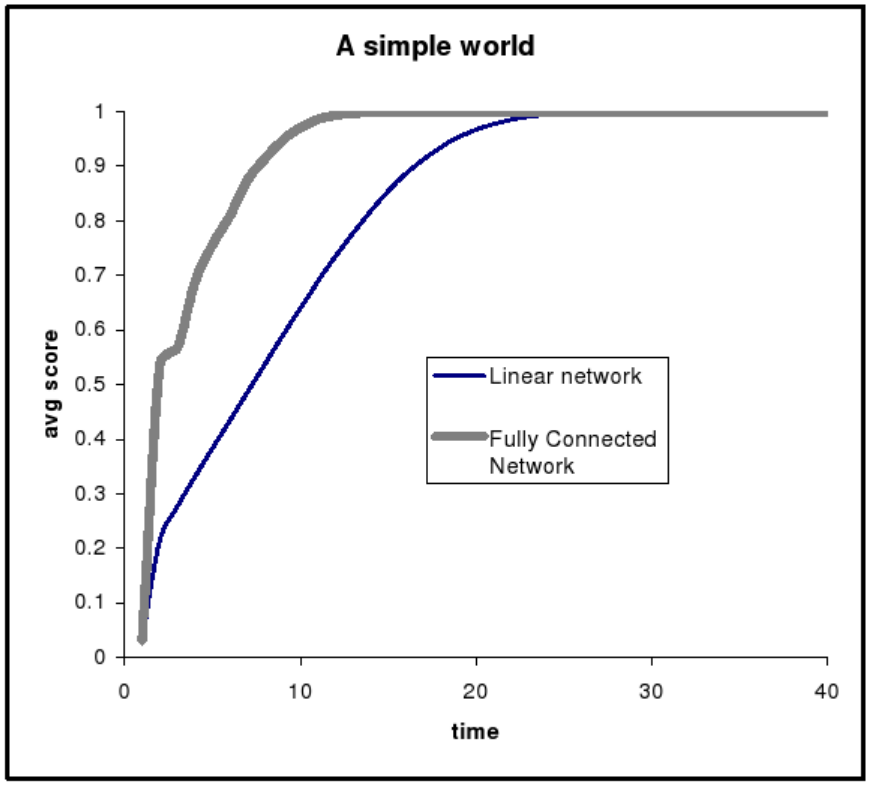
Results > Random vs Small-World





- In random networks, the optimum performance is at in between densities
- Increased rewiring on small-world networks decreases the score, as the graph gets closer to a full-shaped one

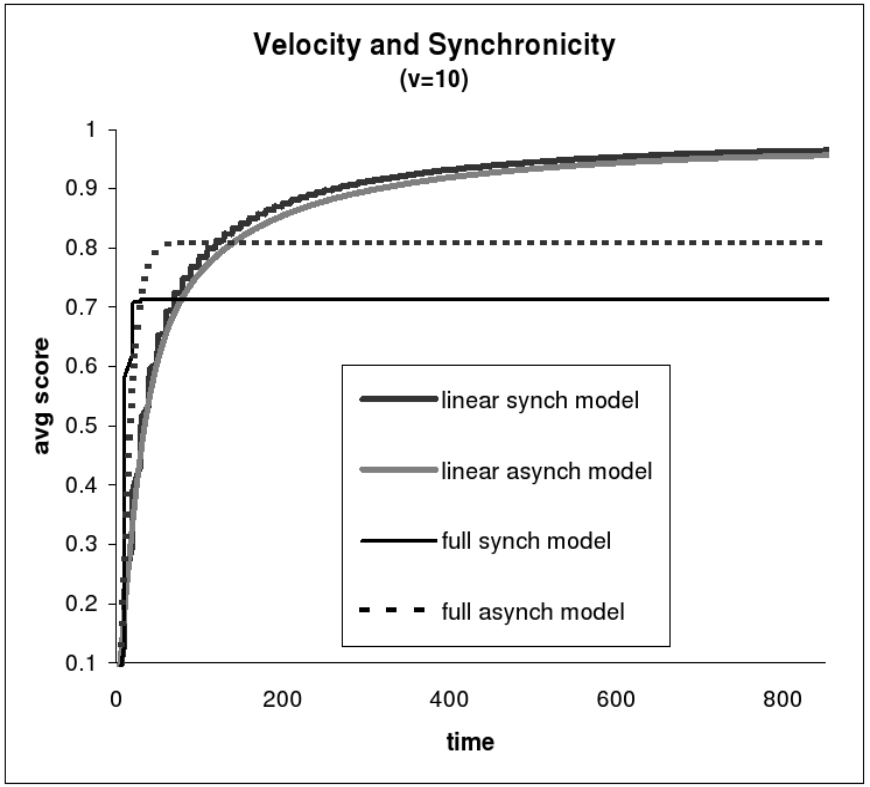
Results > Problem space



- In a world with a single solution, every network finds it, but the more connected one finds it faster, as expected.

Velocity of information

- Agents don't emulate others every round, they spend more time finding
  their own solution
- *Sync model*: All agents emulate others every 10 rounds
- *Async model*: 1/10 probability of emulating
- Result: Use async for full networks—it's kind of "disconnecting" nodes temporarly—but anyway linear networks do better on the long run.



Results > Practical applications

- Jared Diamond (1999), in *Guns, Germs and Steel*, states the following:
  - Europe and Asia built better civilizations than the Americas over the last several centuries because the axis of the continents (east-west) provides similar climates on all areas (better networks)
  - That's why agricultural innovations were easily expanded
  - Asia had the best networks because of the smoothness of its geography
    - Europe = “low connected network”, Asia = “fully connected network”, Americas = “incompatible networks”
  - And, that's why Europe dominated the world all along history

Conclusions

- Highly connected networks are better at quickly converging on the best local solution, but perform worse on the long run because they squeeze out diversity.
- The quick emulation of successful others produces non-optimal convergence
  - Alternatively, agents can populate a world where innovation is rewarded as a goal itself
- It is needed to continue looking for the optimal network for a given situation.

The End

–Thanks for listening

–

–Any questions?