The Ikea-effect in Collective Problem Solving

An agent-based simulation model

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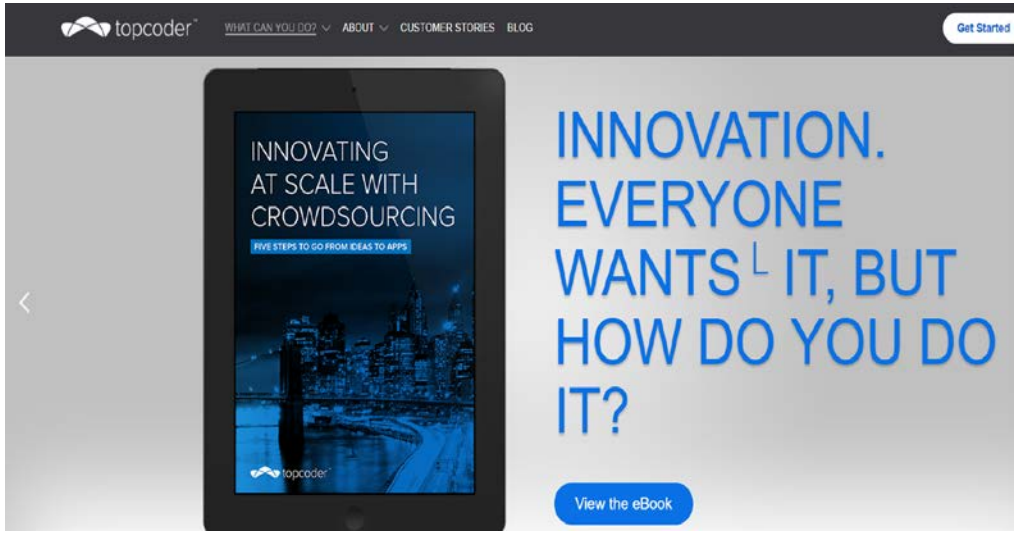
Overall aim and question

Overall aim: How to design collective problem solving? (CPS)

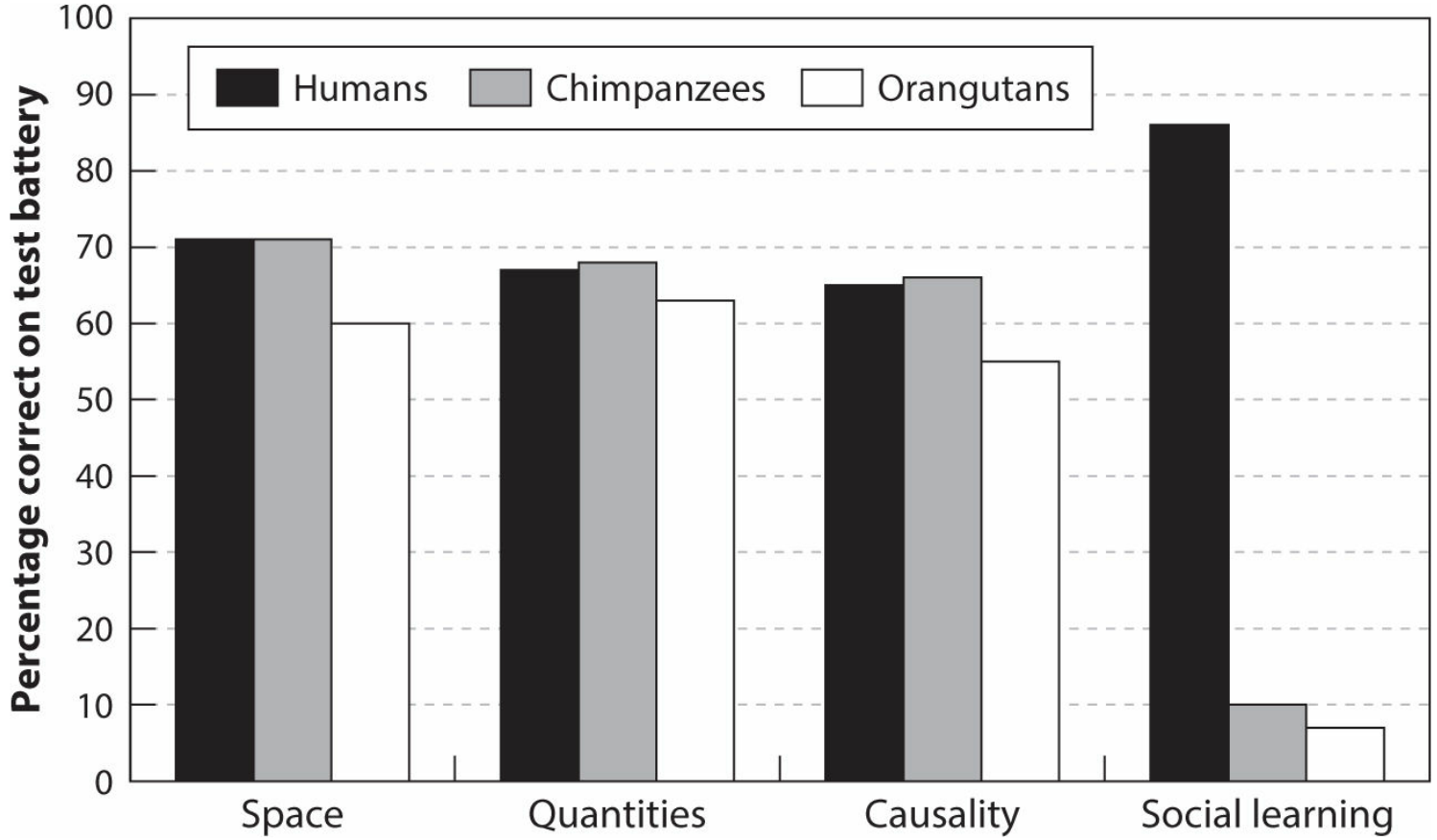


The empirical context (Lazer and Friedman 2007):

Parallel Problem Solving

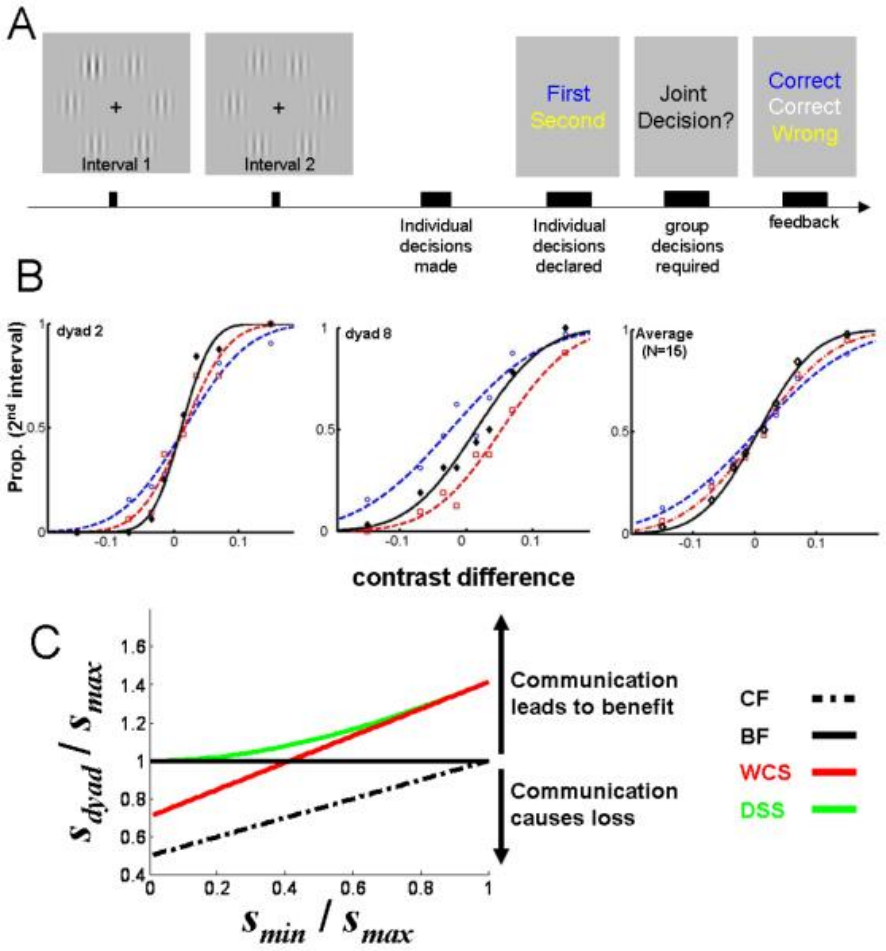
Consider the situation of the manager of a research and development lab, who needs his or her engineers to solve some complex problem. This problem has many plausible solutions, although it is difficult at the outset to judge which approach will yield good results. One of the challenges confronting the manager is how to structure the communication among his or her engineers. Would it be wise to have high frequency meetings, so that engineers who were developing promising approaches could share their ideas with others? Or would it be better to let things just slowly and inefficiently diffuse? This scenario is an example of what we label parallel

Social learning is ubiquitous..



Source: Henrich, Joseph. *The secret of our success: how culture is driving human evolution, domesticating our species, and making us smarter*. Princeton University Press, 2015.

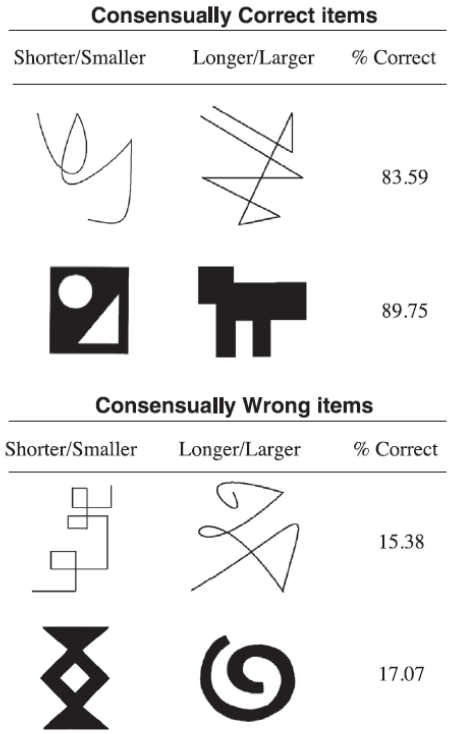
..and useful.. (Bahrami et al. 2010)



"communication conferred a significant benefit and, at least on this task, two heads did better than one."

Y: each individual can observe the accuracy of their performance and can communicate their confidence to their peer

..sometimes (Koriat 2012)



Consensually Correct items

Shorter/Smaller	Longer/Larger	% Correct
		83.59
		89.75

Consensually Wrong items

Shorter/Smaller	Longer/Larger	% Correct
		15.38
		17.07

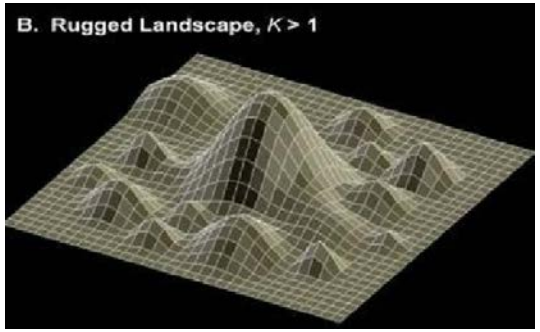
Fig. 1. Examples of the stimuli used in studies 3 and 5, divided into those for which the consensual answer was the correct answer (consensually correct) and those for which the consensual answer was the wrong answer (consensually wrong).

Virtually paired up: selected on each trial the decision of the more confident member of a virtual dyad (s*ubjective confidence)*

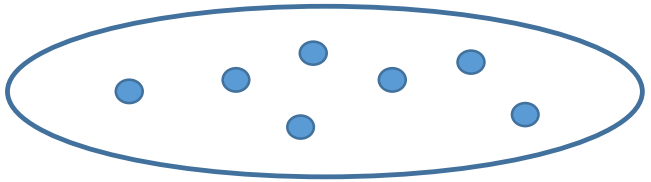
“When most participants were in error, reliance on the more confident member yielded worse decisions than those of the better individual.” -> it depends on the task.

How does this work at a collective level (in groups vs dyads)

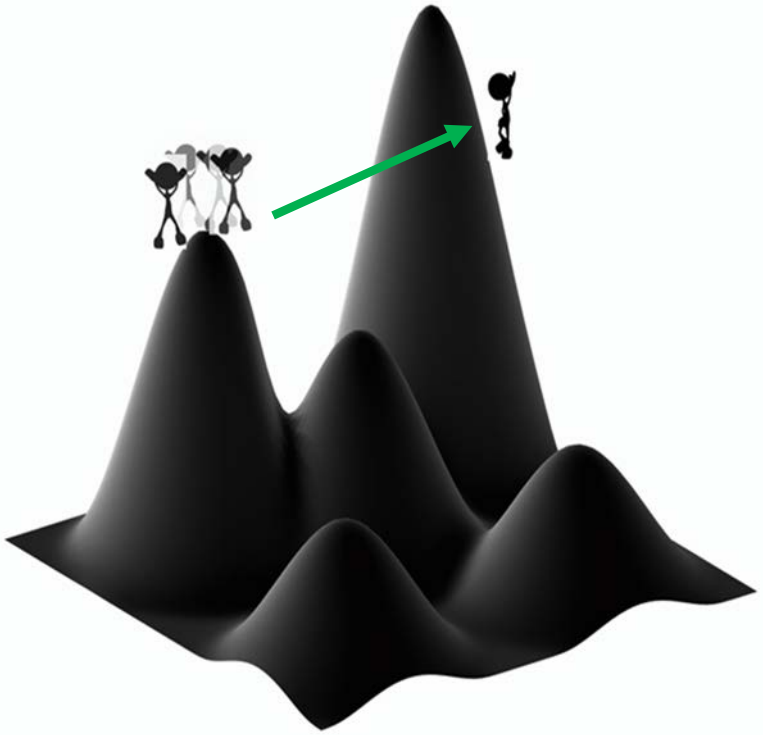
- Main question: What kind of networks facilitate collective problem solving?

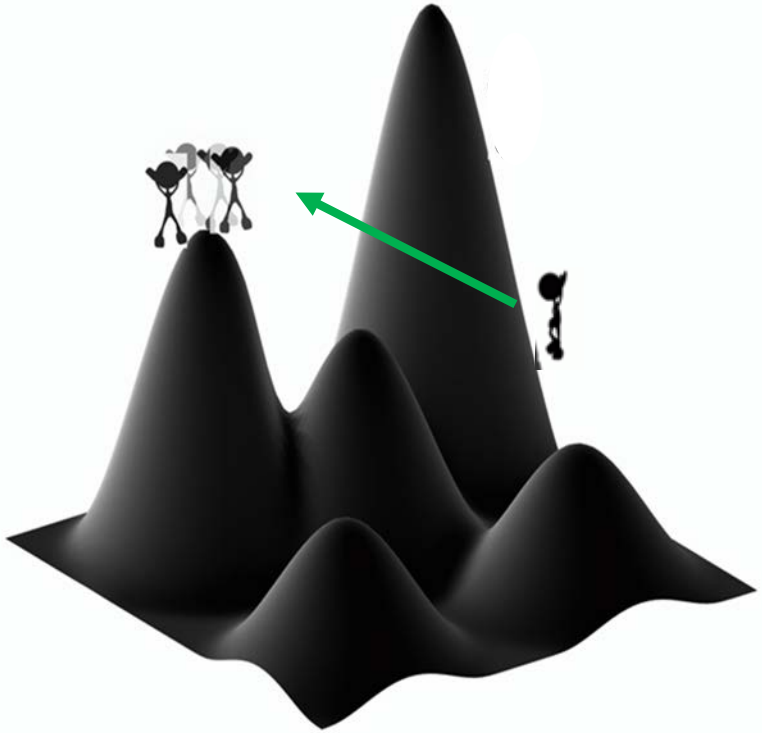


- Efficient vs. inefficient networks
  - If inefficient: Slow(er) information sharing, more diversity (Lazer & Friedman 2007; Derex et al. 2016)
  - If efficient: Quick(er) information sharing, less diversity (Mason & Watts 2012)



Collective search on a complex problem
Lazer and Friendman 2007: Social learning is good, but...





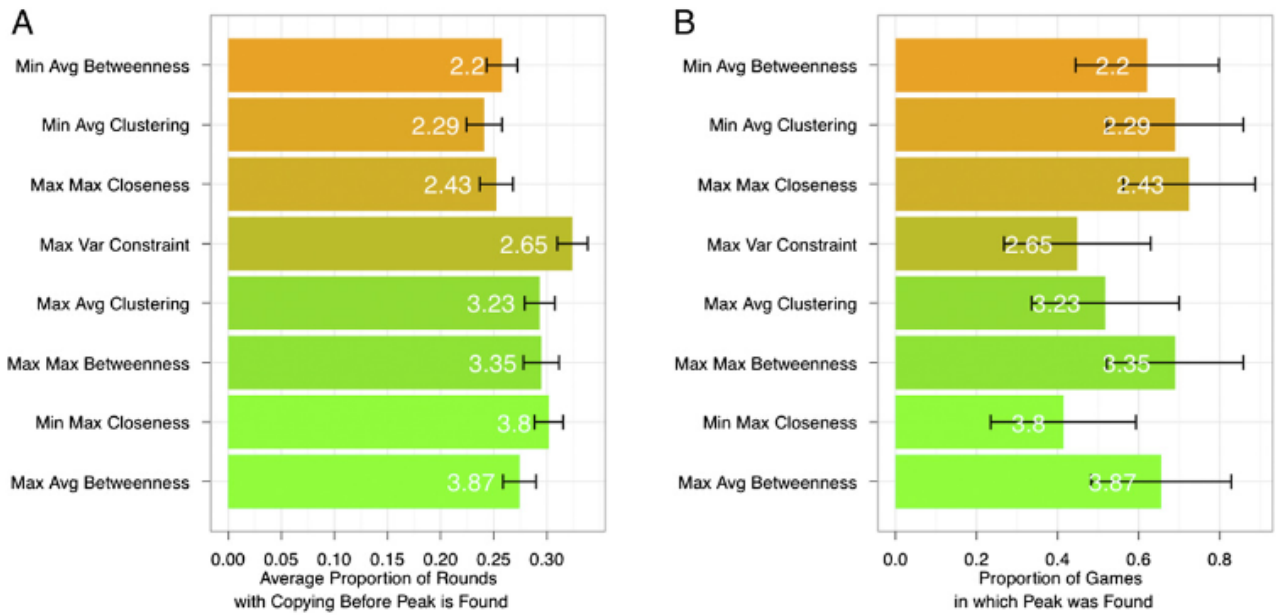
Too much and immediate information sharing might not be beneficial.

Solution: Inefficient networks

If you can't see the superior solution, you won't copy it…

Collective search on a complex problem

Mason & Watts (2012): efficient networks outperformed inefficient networks



"Unfortunately, although the shortcomings of the assumptions underpinning the O strategy are now evident, the solution is not" (MW2012)

- O+ strategy: If score>60, exploit (**perfect information**)
- Non-NK landscape: complex vs simple problems
- Continuous landscape: Local search radius
- Social learning: Imitation

The Ikea-effect: Individuals overvalue own solutions

a) Ikea-effect (Norton et al. 2012): Individuals 'overvalue' own solution

i) Like own solution
ii) Noise in assessing others'
iii) Cost of switching

b) Individuals don't immediately jump to better solutions (Morgan et al. 2012, Eriksson & Strimling 2009, Hargadon and Bechky 2006, Boudreau & Lakhani 2015)

c) Solution: 10% bonus to agent's own solutions (or penalty on social information)

An agent-based simulation model
6 key parameters

i) *100 agents search an NK landscape (N=20, K= 0, 6)*

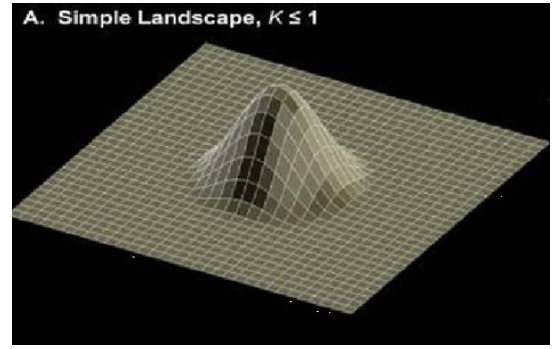
ii) Efficient vs. inefficient networks (Watts & Strogatz 1998)

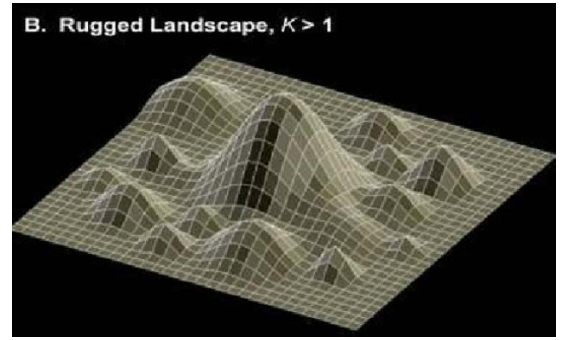
iii) First social learning, then individual search

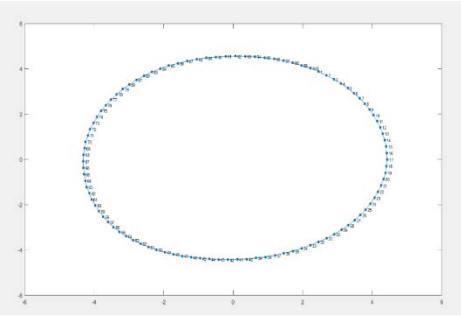
iv) Ikea-effect of 10% bonus added to agent's own solution

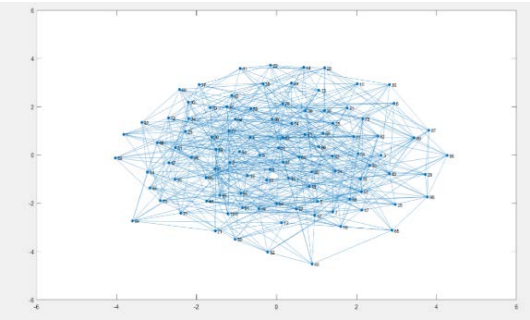
v) Perfect imitation vs. randomly copying (Axelrod 1997)

vi) Greedy vs. non-greedy local search

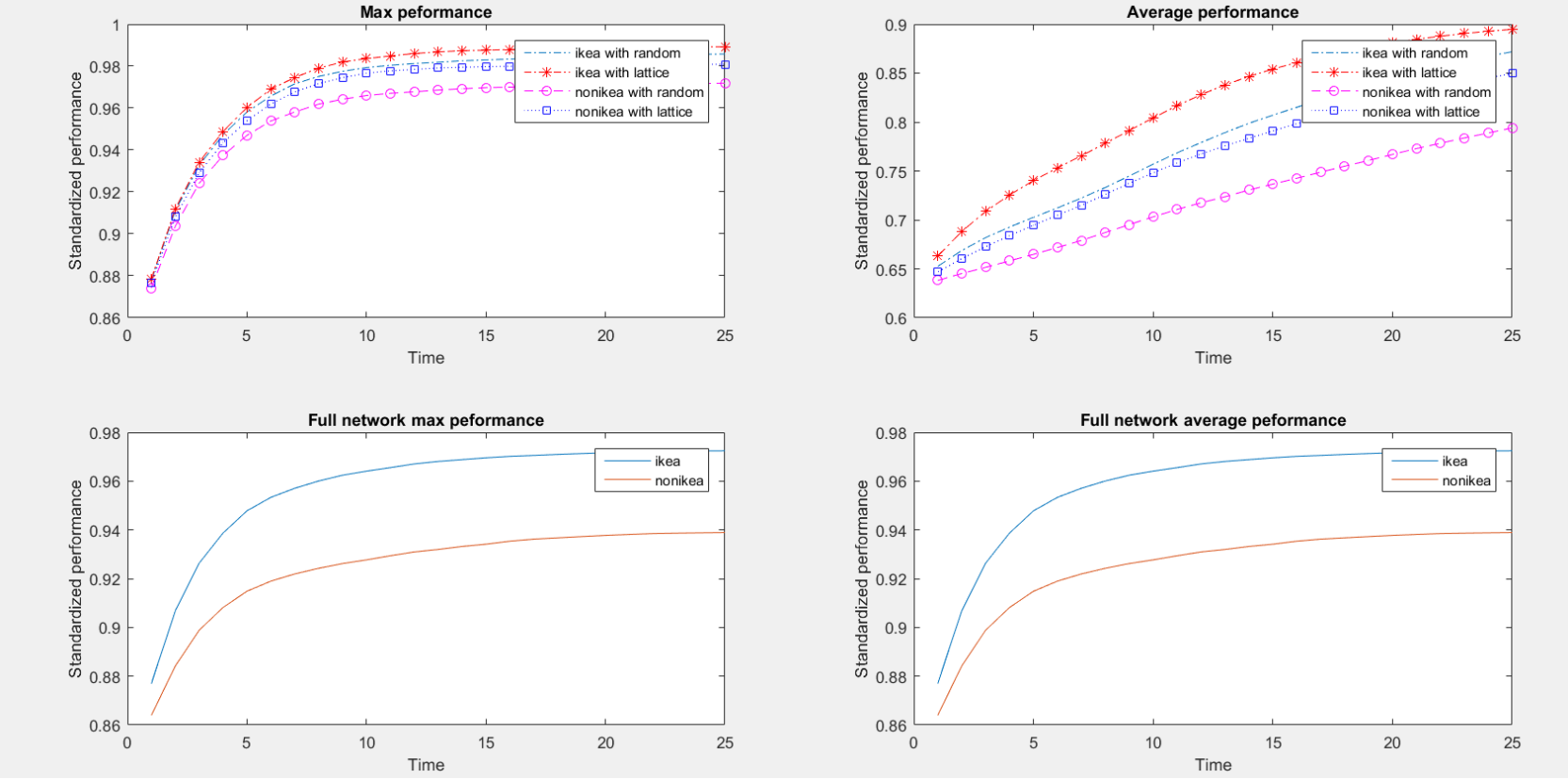






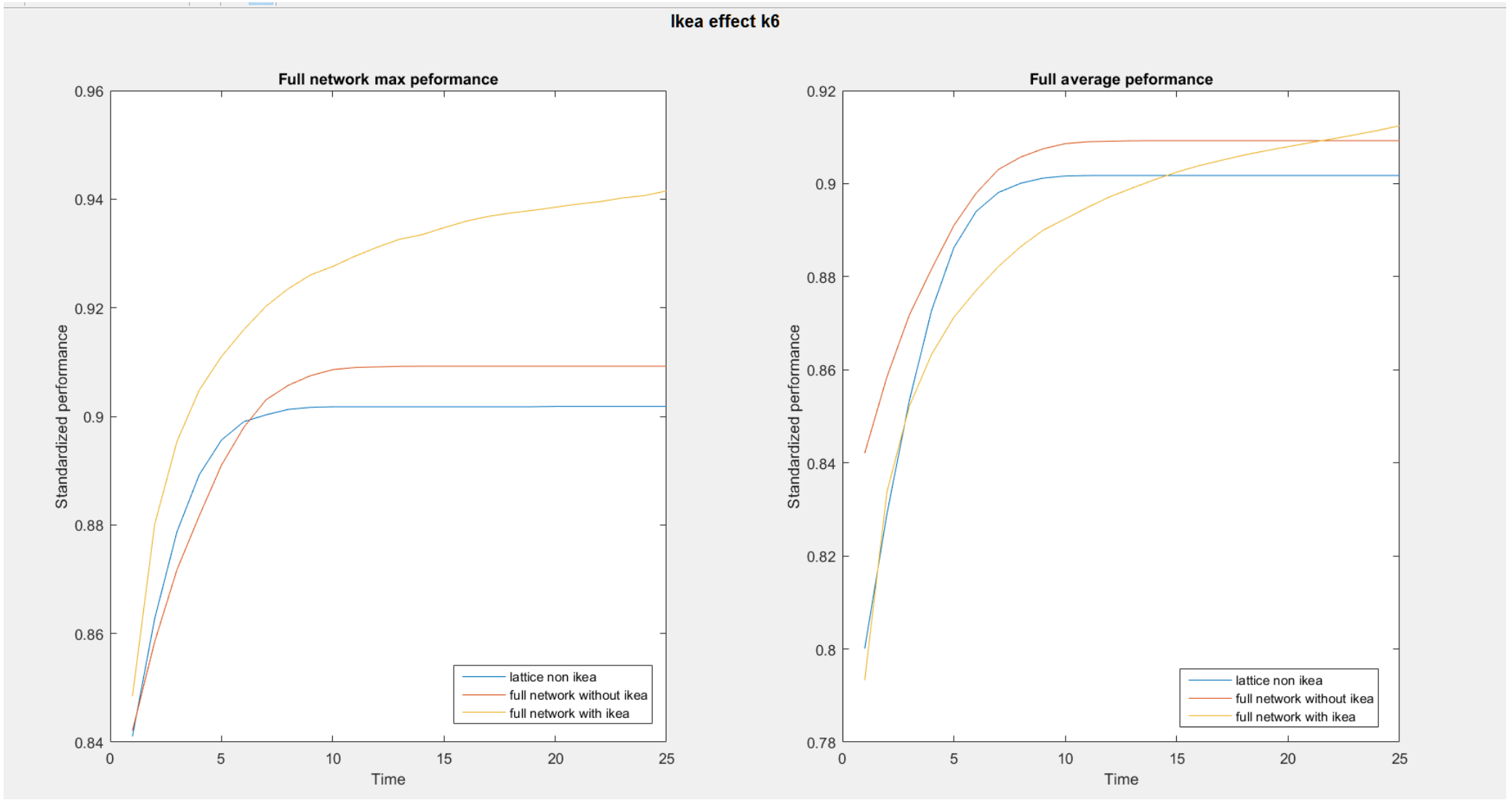


Main finding: Ikea-effect → increases CPS performance



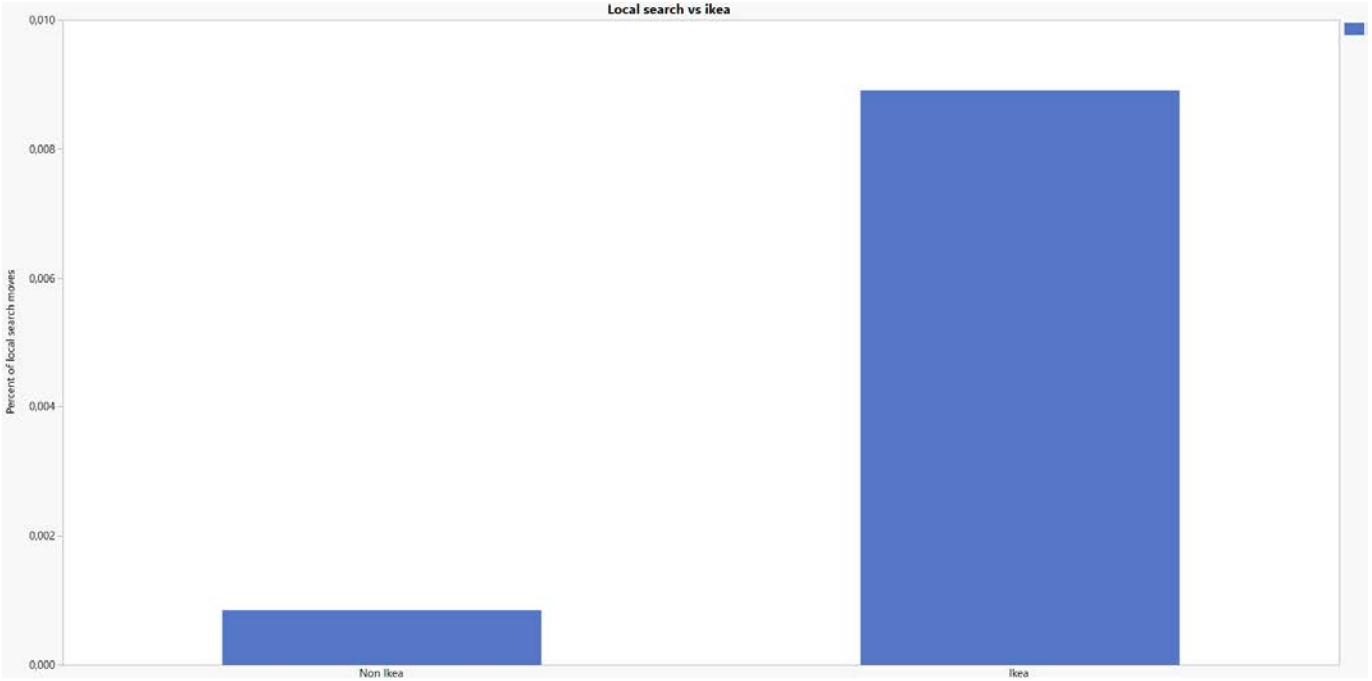
- Ikea-effect increases collective performance across all types of networks
- Stronger effect in ‘efficient’ networks

Ikea effect


Ikea effect k6
Full network max peformance
Standardized performance
Time
lattice non ikea
full network without ikea
full network with ikea
Full average peformance
Standardized performance
Time
lattice non ikea
full network without ikea
full network with ikea

Why?: Ikea-effect → more indiv. search

Local search moves percentage* 1000



No Ikea-effect

Ikea-effect

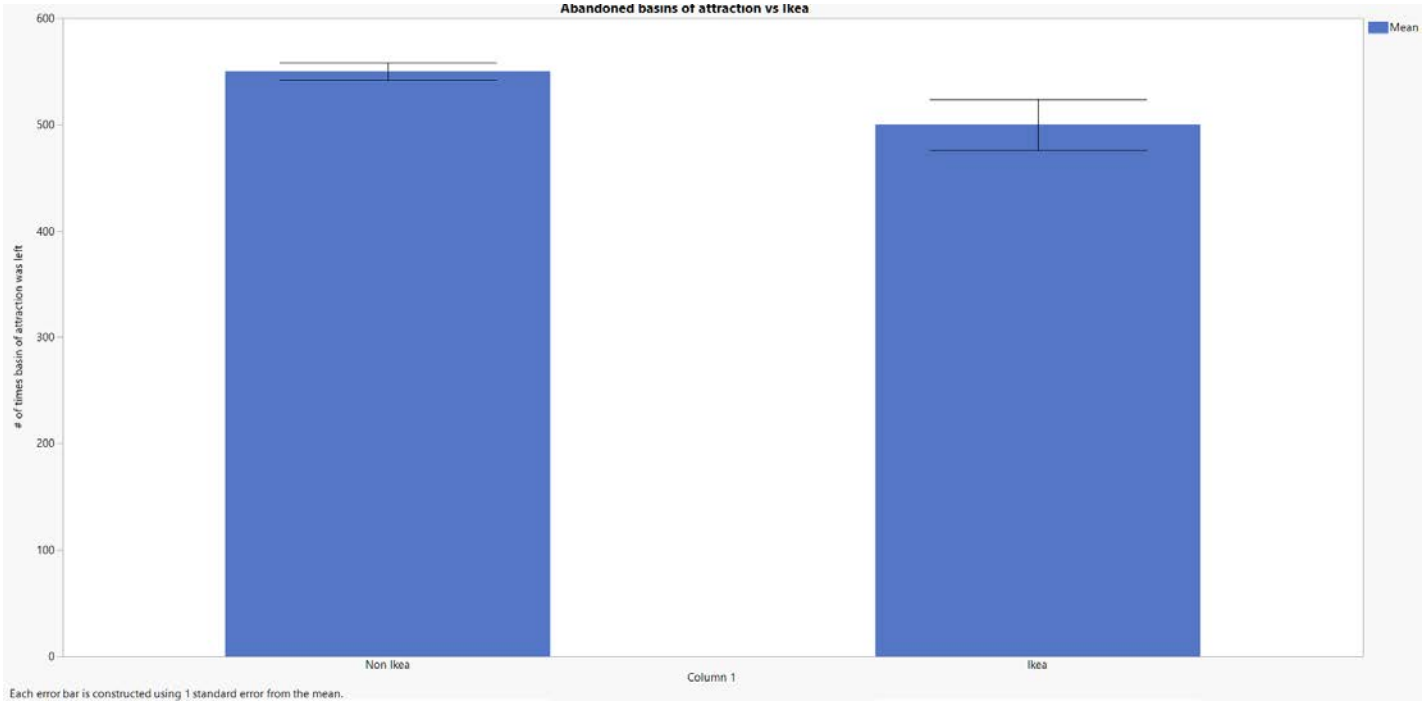
K = 6, fully connected network

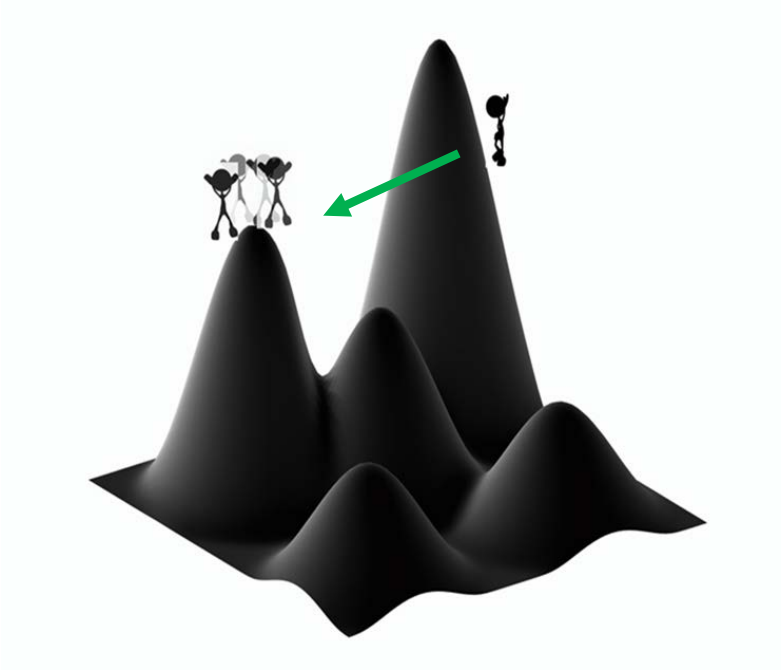
Average % of local search moves across all conditions

The theoretical mechanism: Ikea-effect → more local search, i.e. fewer premature jumps

NB. Local search ALONE does not yield good performance, not even for K0 (although it's very close, due to time constraints)

Why? Ikea-effect -> less leaving basins of attraction

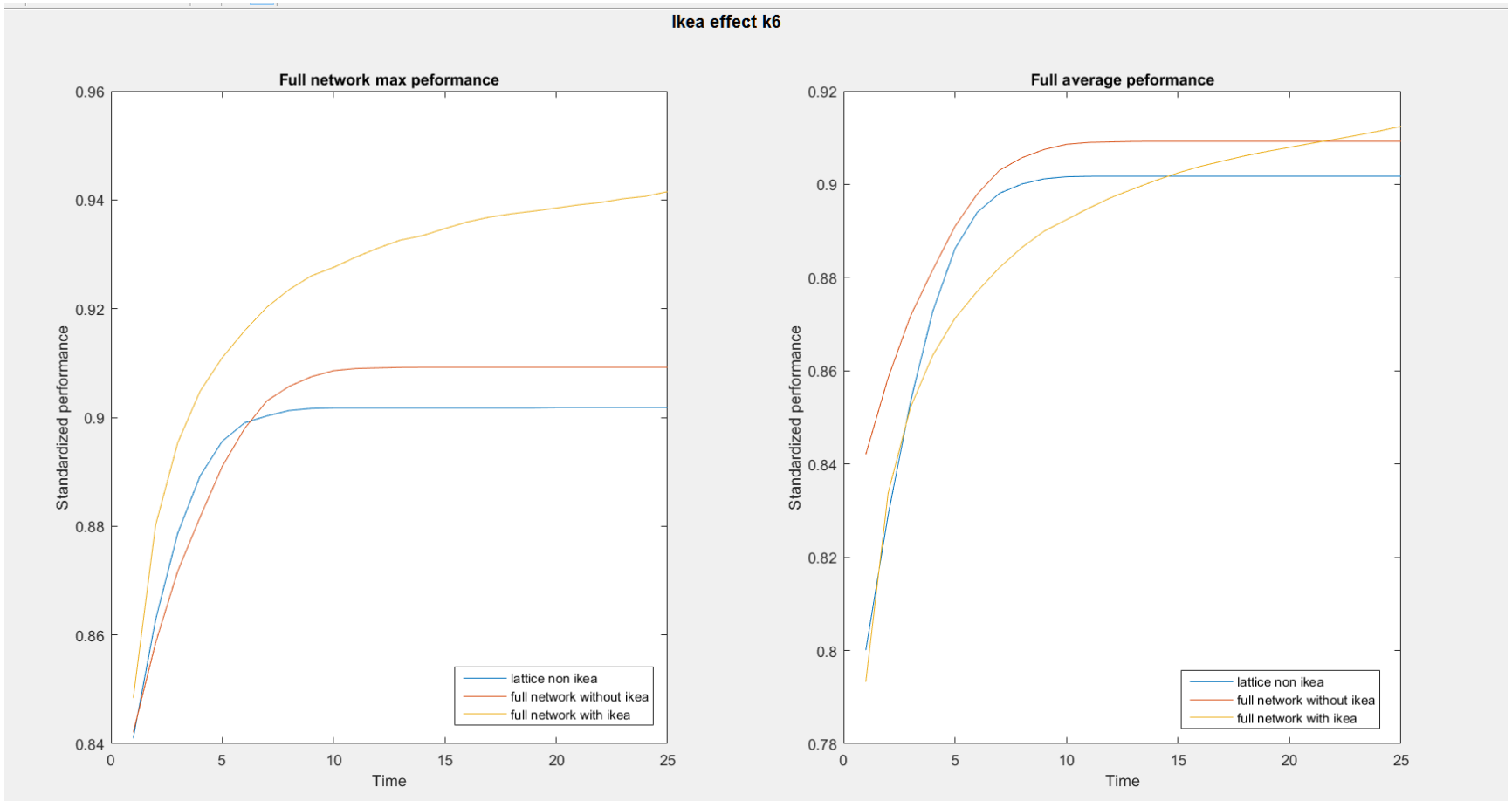




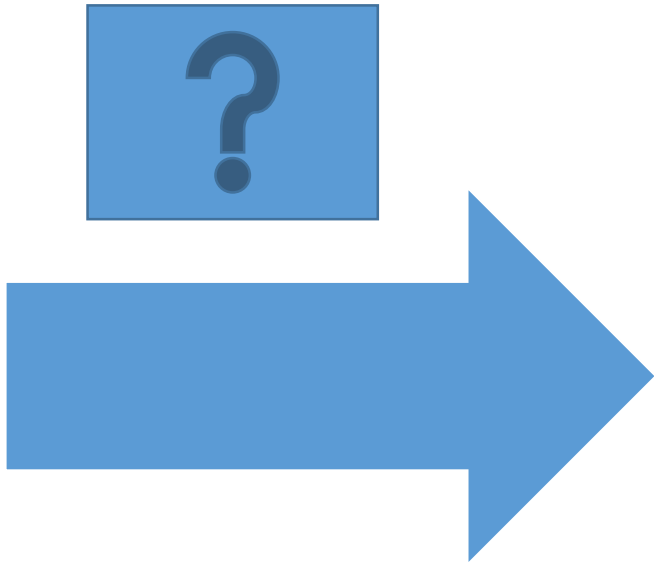
No Ikea-effect

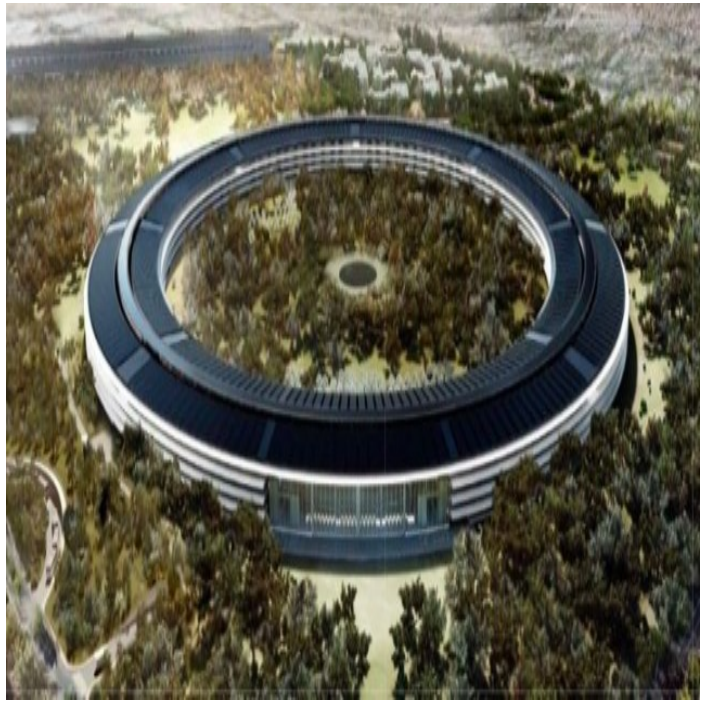
Ikea-effect

Patience is key



Implications..





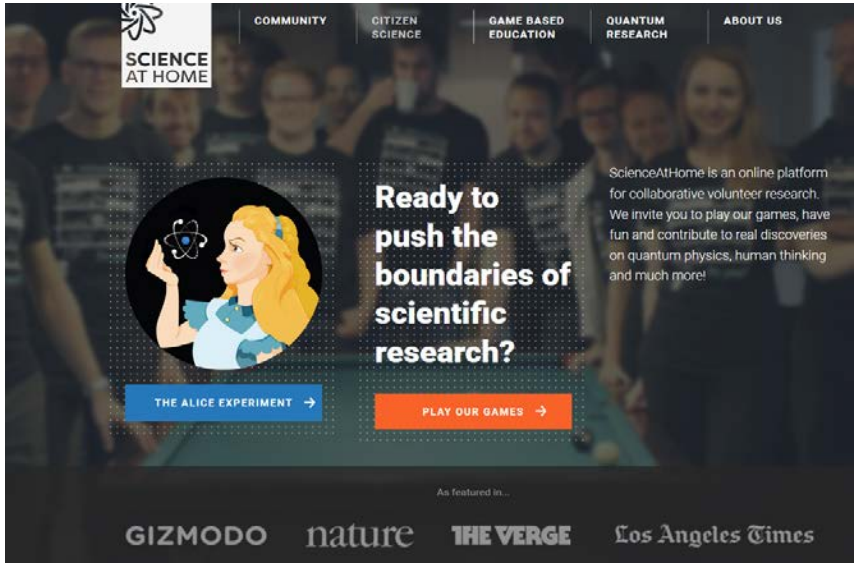
Discussion

- Inefficiency important to maintain diversity within CPS: Either at structural **or** agency level
- Empirically established individual bias → evolutionary effective mechanism at collective level
- Need for empirically founded social learning mechanism >< more sophisticated than pure copying

Practical implications and future research

- Designing CPS
  - Don’t enable (visibility and incentives) social learning too much / often

- Future research
  - Better integration between simulation and experimental research
  - We intend to test simulations experimentally on www.ScienceAtHome.org
  - Vary nature of game (both problem and game design)



Thank you for your attention!

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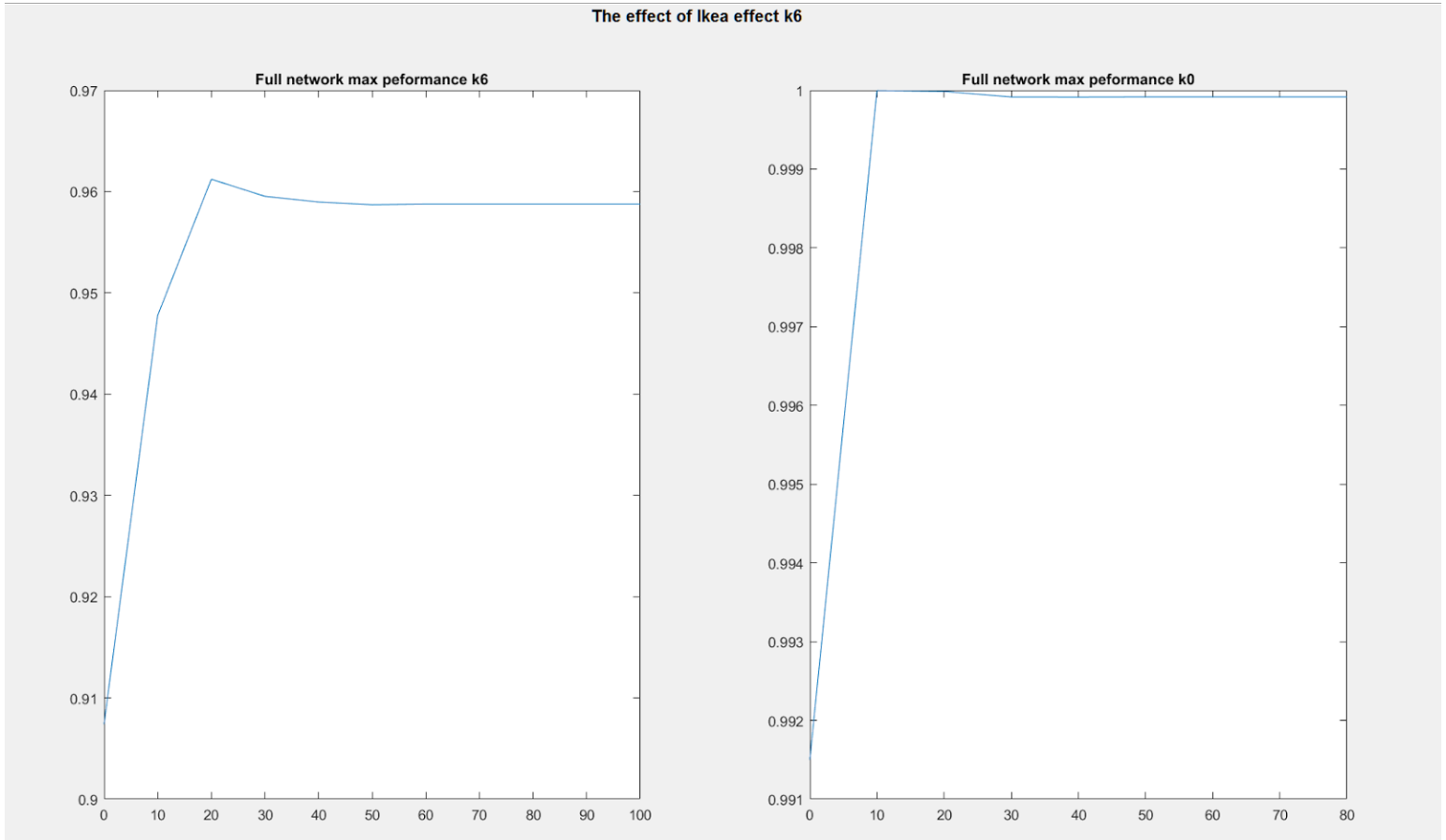
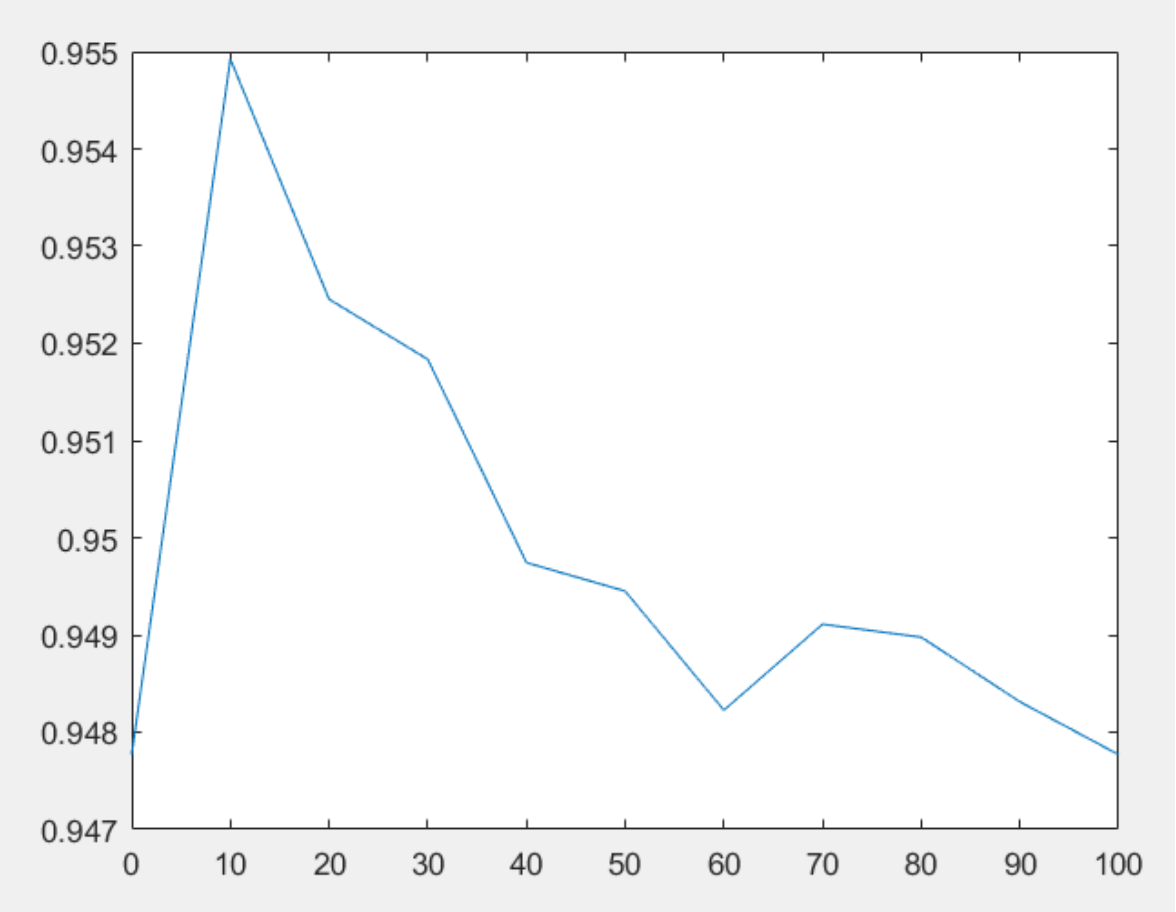
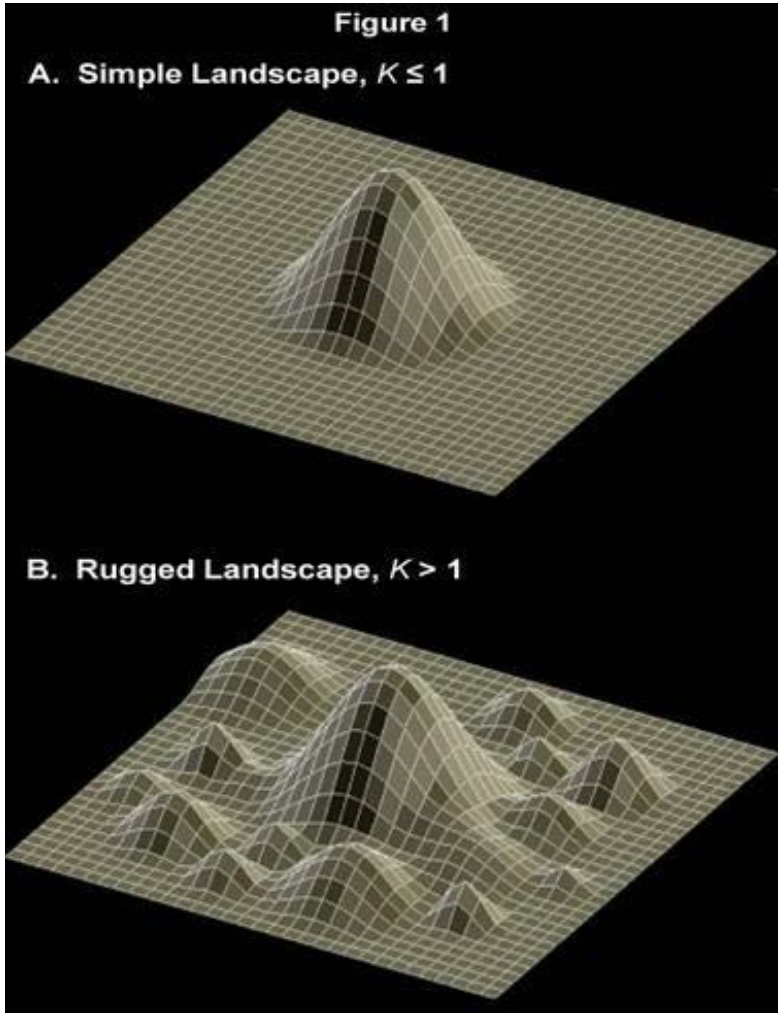
Limits of Ikea



Robustness for forsight k6



Fitness landscapes



Patterns of search: Exploration/ exploitation

The exploration/exploitation trade-off is a widespread occurrence:

Animal foraging

Optimization algorithms

Human search behaviour

Organization search behaviour

NOT JUST NK: any problem can be represented as a set of control parameters vs an objective function. As long as there is a meaningful distance metric, one can describe a fitness landscape.

Our approach: Parameters

Parameters	Levels
Network type	Full network/SW (MW2012)
Social learning type	Axelrod vs imitation
Local search	Regular greedy/LF local search
Foresight	Number of agents in the network an agent can look at before engaging in social learning
Not-Invented-Here penalty	0:10:100 of max peak in the landscape -> an agent will not copy a solution unless it is better than its own + penalty

- N=20; k=0,6*; number of agents = 100.
    - *additional analyses ran on k=19