Task-groups: what's the optimal organization?

Is there a global brain?

When does a group of cooperating individuals solve a problem more efficiently than the individuals working in isolation?

Does diversity matter?

José F. Fontanari
Universidade de São Paulo
Brazil

4° Workshop de High Performance Computing

Task: find the global maximum of NK fitness landscapes

Kauffman & Levin (1987)

state space: 2^N binary strings of length N $\quad x = \left(x_1, x_2, \ldots, x_N\right) \quad x_i = 0,1$

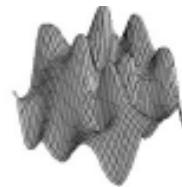K epistasis parameter: tunes landscape's ruggedness

fitness landscape: $x = \left(x_1, x_2, \ldots, x_N\right) \rightarrow f(x) \in \Re$

global maximum is unique
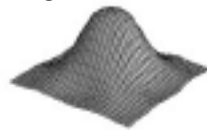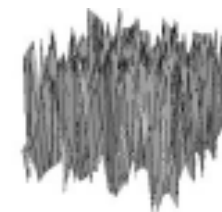
K=0   0<K<N-1   K=N-1

Derrida's Random Energy Model

Agents

are binary strings

(0,0,1,1,1,1,0,0,0,0)

that search the state space by flipping a bit randomly

(0,0,1,1,0,1,0,0,0,0)   with probability **1-p**

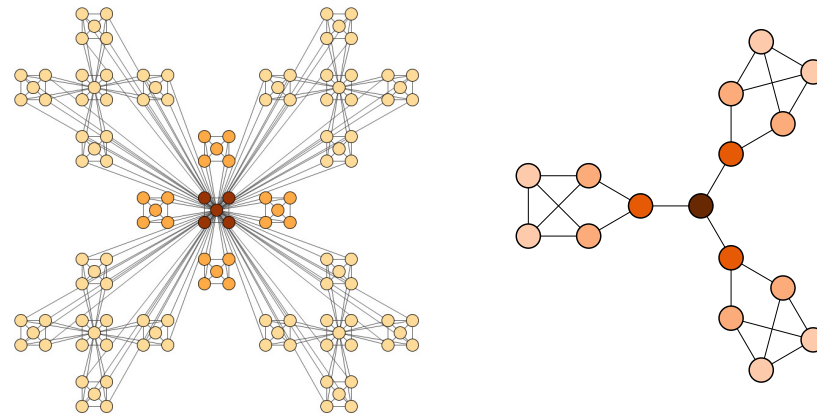or copy a bit of the most successful agent in their neighborhood

with probability **p**

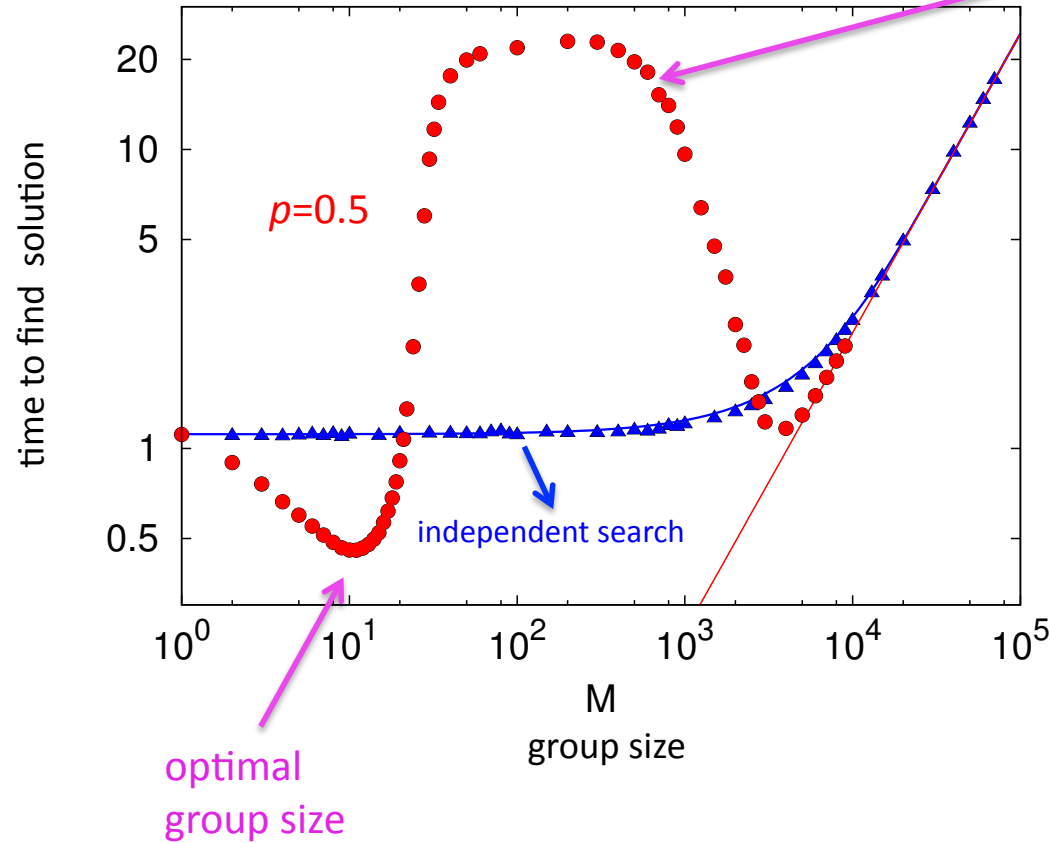*copy propensity*

$$p \in [0,1]$$

group size

$$M > 1$$

hierarchical

fully connected network

N=12 K=4

p=0.5

time to find solution

independent search

optimal
group size

M
group size

Groupthink: psychological
studies of policy decisions
and fiascoes (1982)

computer demand

For each parameter set:
10^3 landscapes
10^6 searches per landscape

Conclusions

• More isn't (always) better

J. F. Fontanari, Imitative Learning as a Connector of Collective Brains, *PLoS ONE* **9**, e110517 (2014)

J. F. Fontanari, Exploring NK fitness landscapes using imitative learning, *Eur. Phys. J. B* **88**, 251 (2015)

• Centralized and modular (i.e., hierarchical) organizations are the best

J. F. Fontanari and F. A. Rodrigues, Influence of network topology on cooperative problem-solving systems, *Theory in Biosciences* **135**, 101 (2016)

S. M. Reia and J. F. Fontanari, Effect of group organization on the performance of cooperative processes, *Ecological Complexity* (2016)

• More of the same can be better

J. F. Fontanari, When more of the same is better, *EPL* **113**, 28009 (2016)