Dynamics in Organizational Problem Solving and the Leveraging of Social Capital: An ABM Perspective

A Dissertation Defense

by

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Collective Intelligence for Problem Solving

Can we mimic the success within an organization?

VS

Organizational Problem Solving

Exploitation

- Improve existing solutions
- Accelerate knowledge dissemination

Exploration

- Search for better solutions
- Preserve knowledge diversity

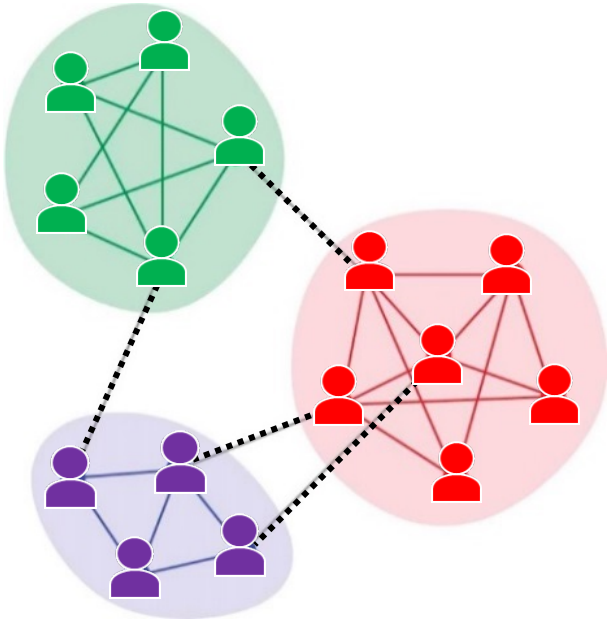
Organizations

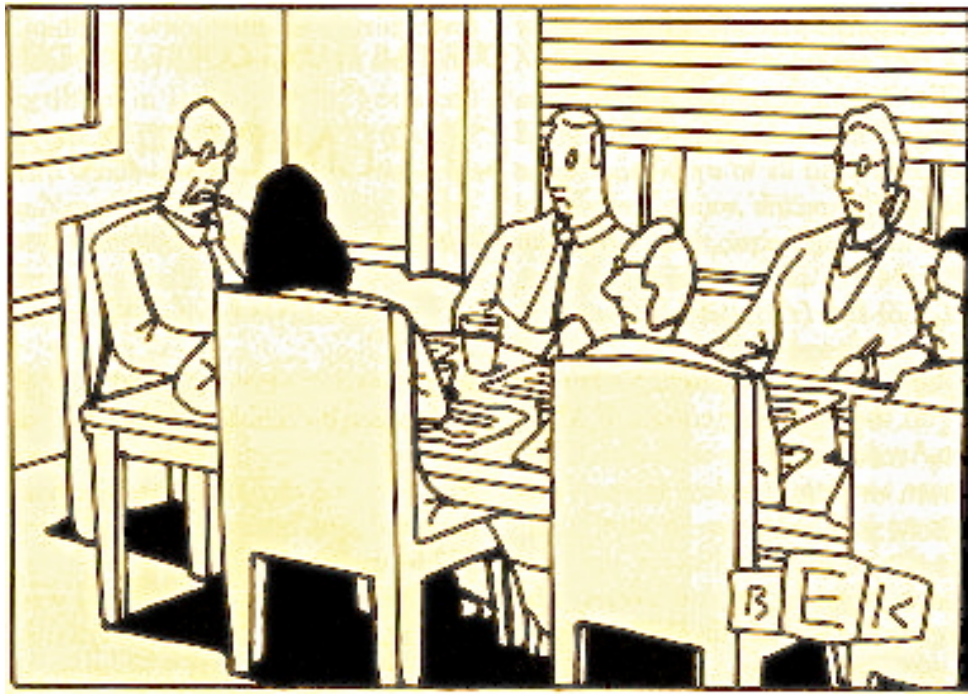
- Resource constraints (budget, people)
- Performance pressure (time)

学而不思则罔，思而不学则殆。
——孔子·《论语·为政》

Organizational Structure as a lever

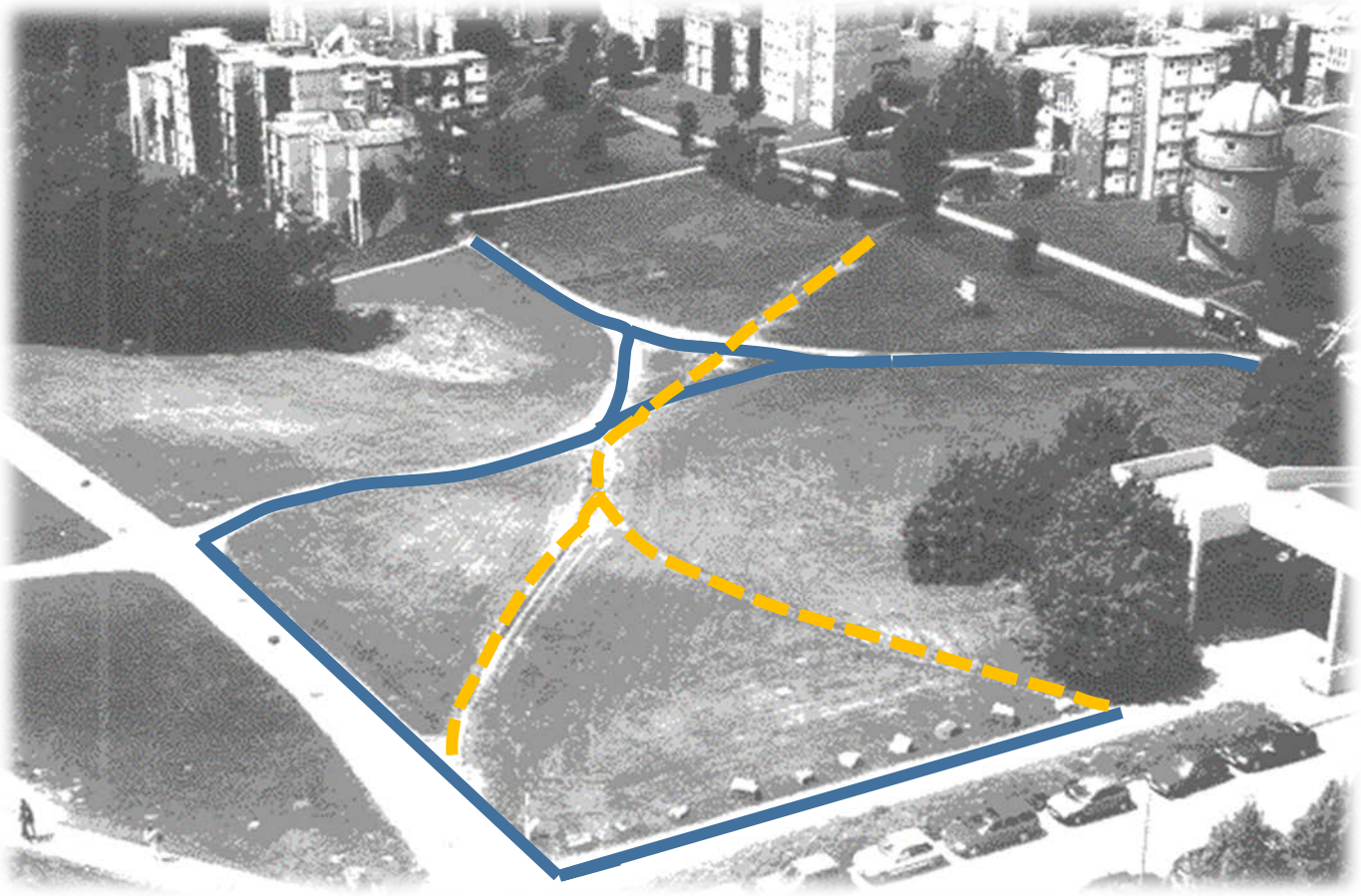
- Semi-isolated groups (Fang et al., 2010)





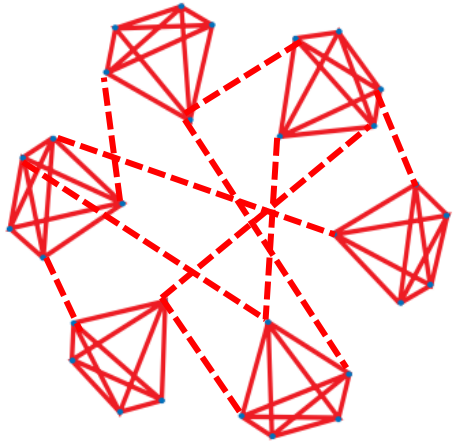
"It's time to call in other people who don't know more but are just different."

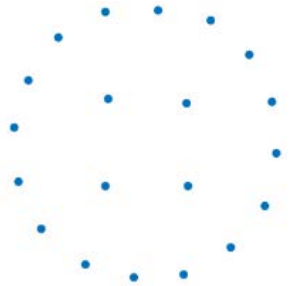
Do people always follow structure?

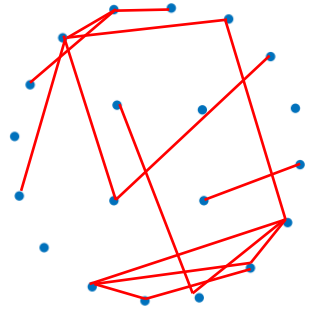


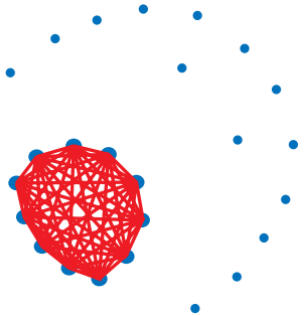
Helbing, D., Keltsch, J., & Molnar, P. (1997). Modelling the evolution of human trail systems. *Nature*, *388*(6637), 47-50.
Figure 1: Between the straight, paved ways on the university campus in Stuttgart-Vaihingen a trail system has evolved.

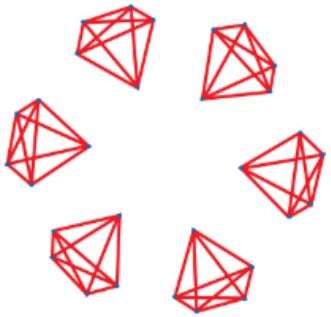

I Wish...



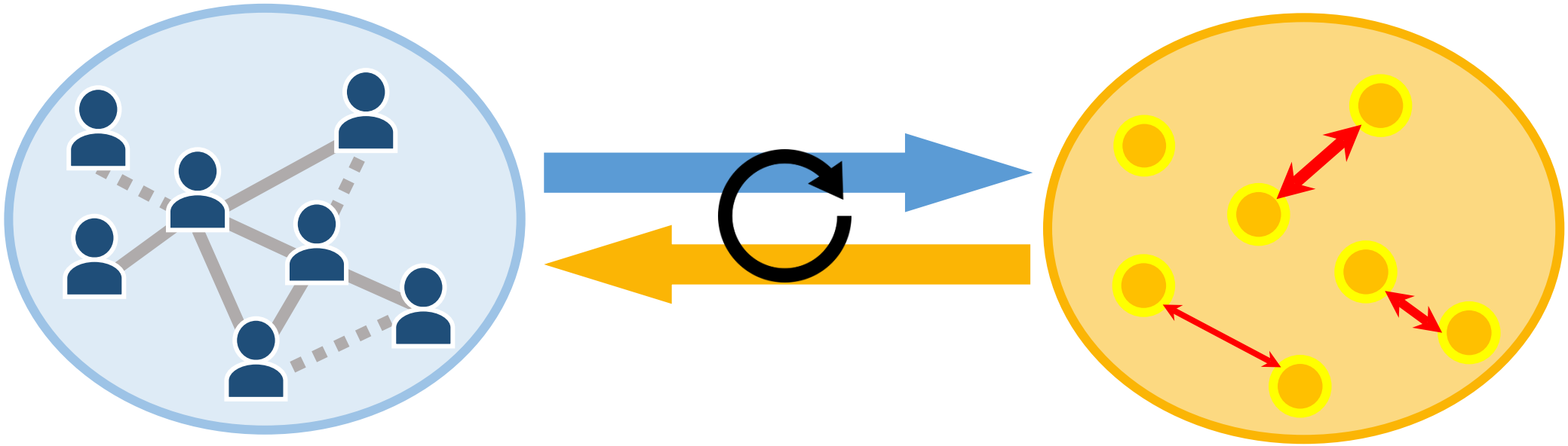






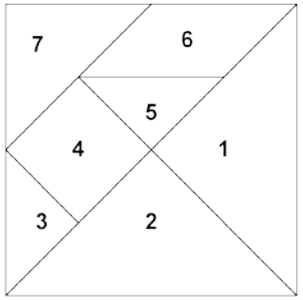


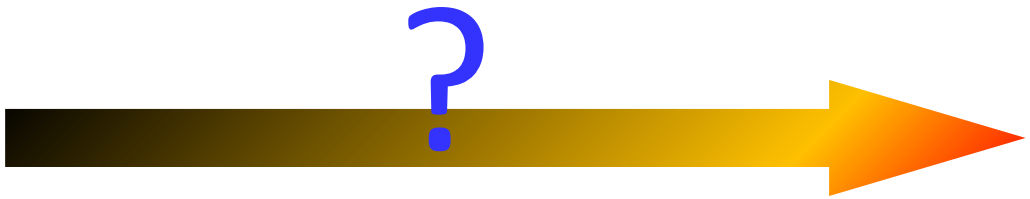
Research Question

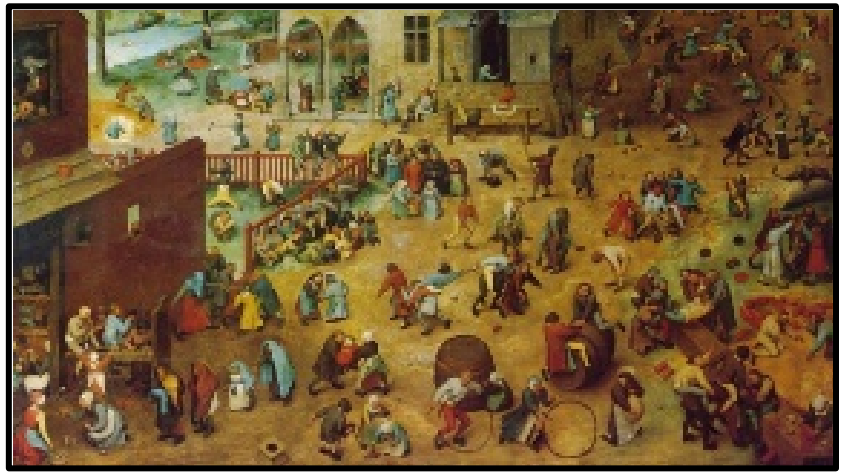


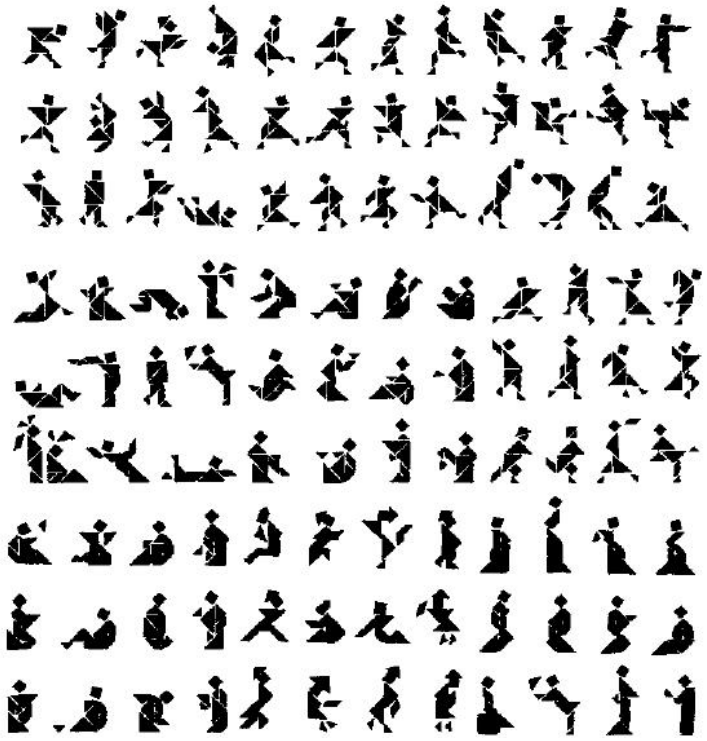
Given the coevolution, how would individual members' autonomous problem-solving behaviors collectively impact the organization's problem-solving performance?

Research Method – Agent-based Modeling

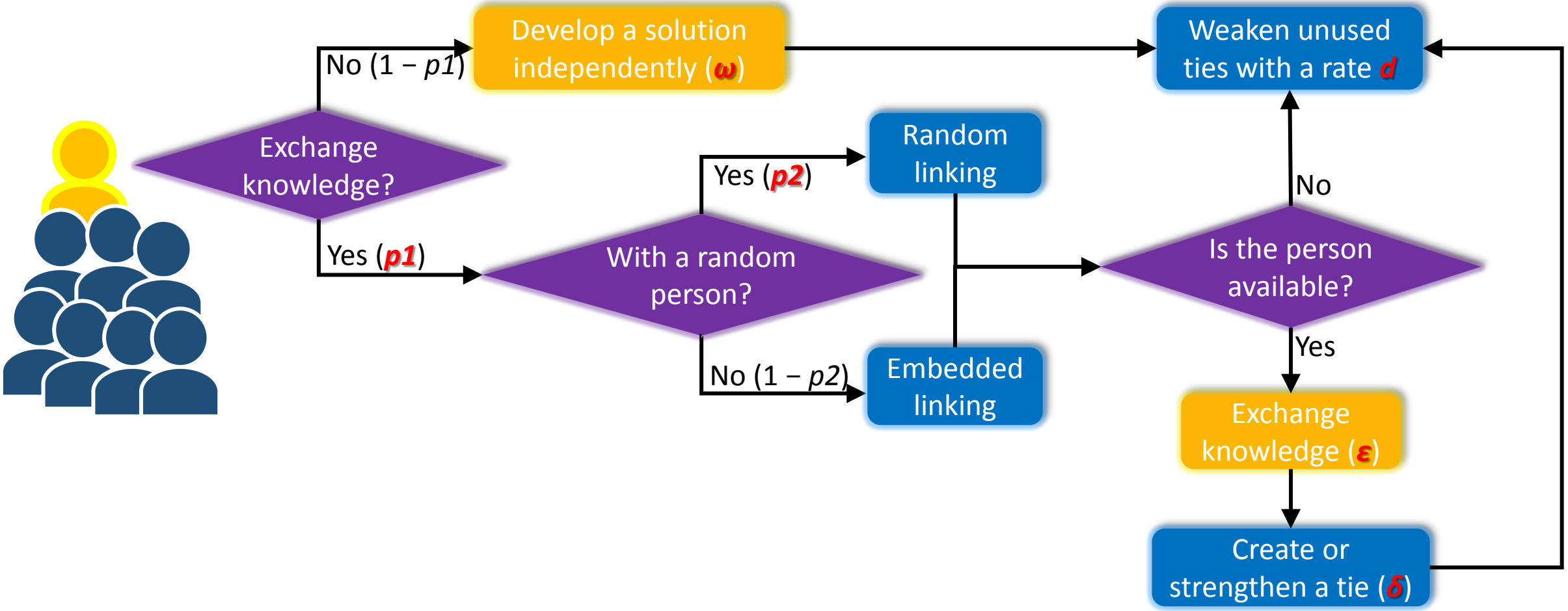




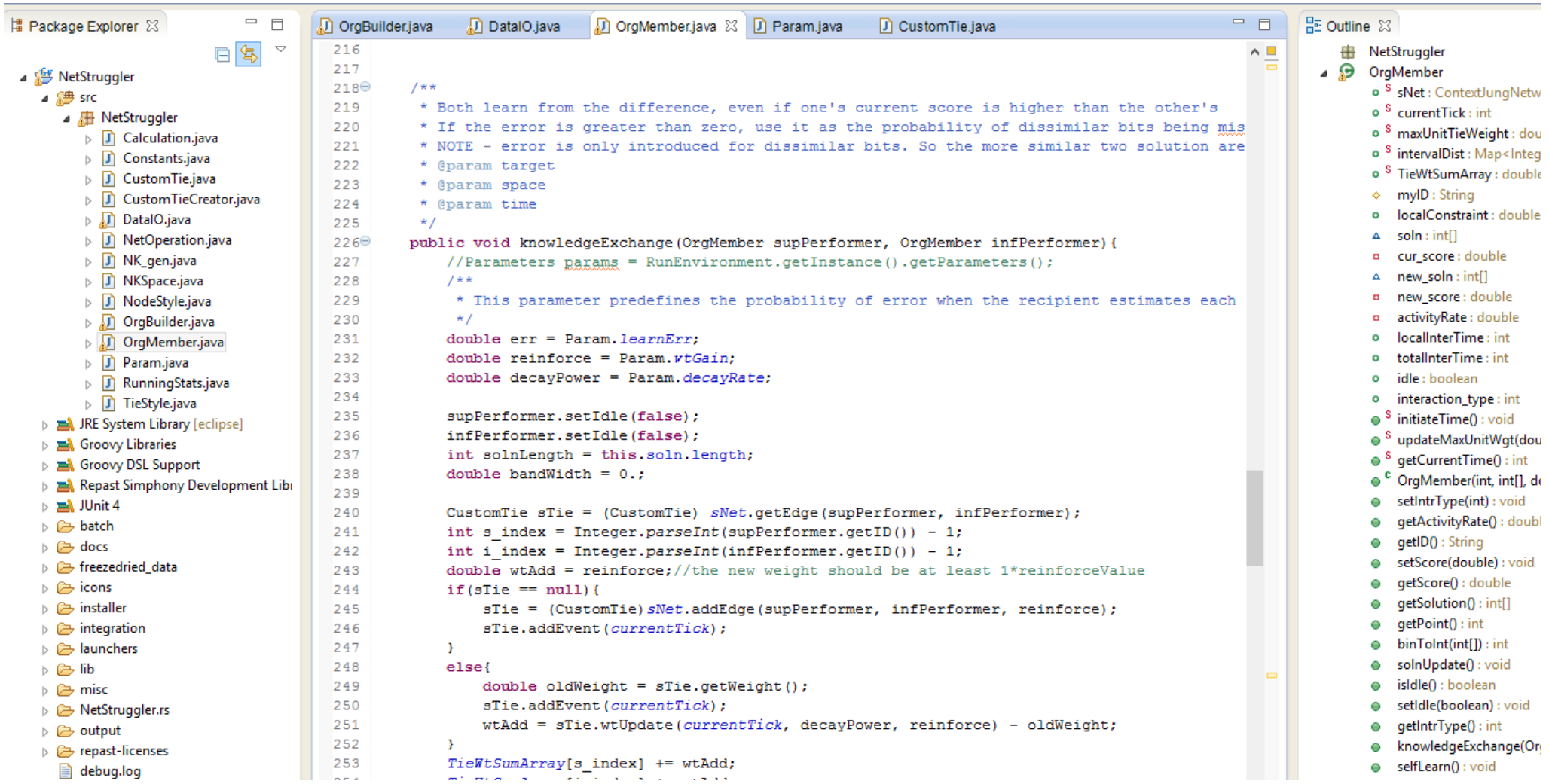




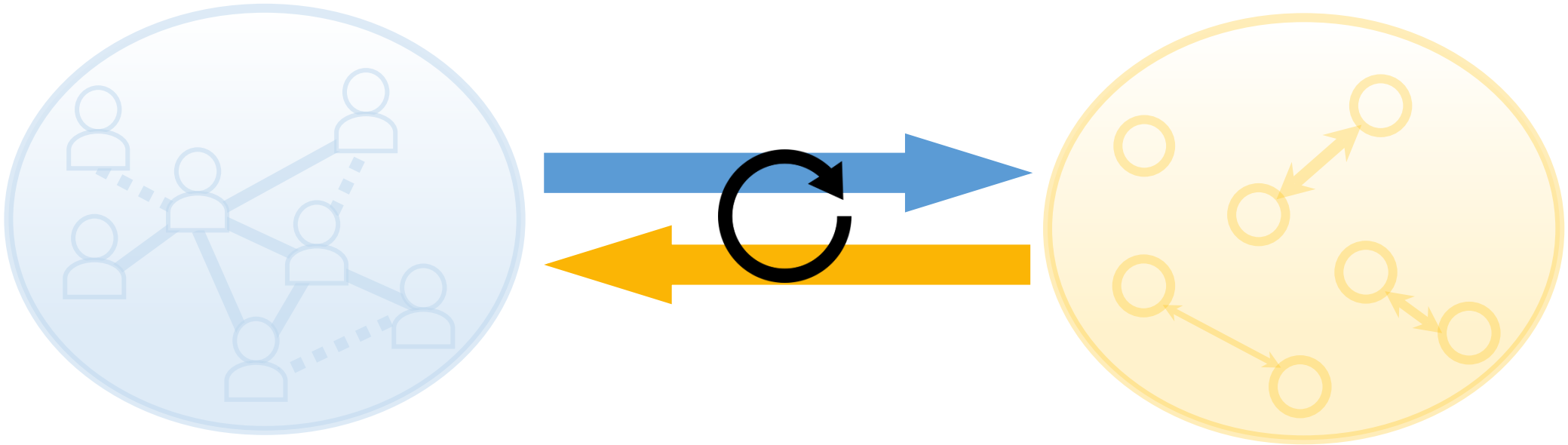
Agent-based Modeling – computer algorithm



Agent-based Modeling – Java code

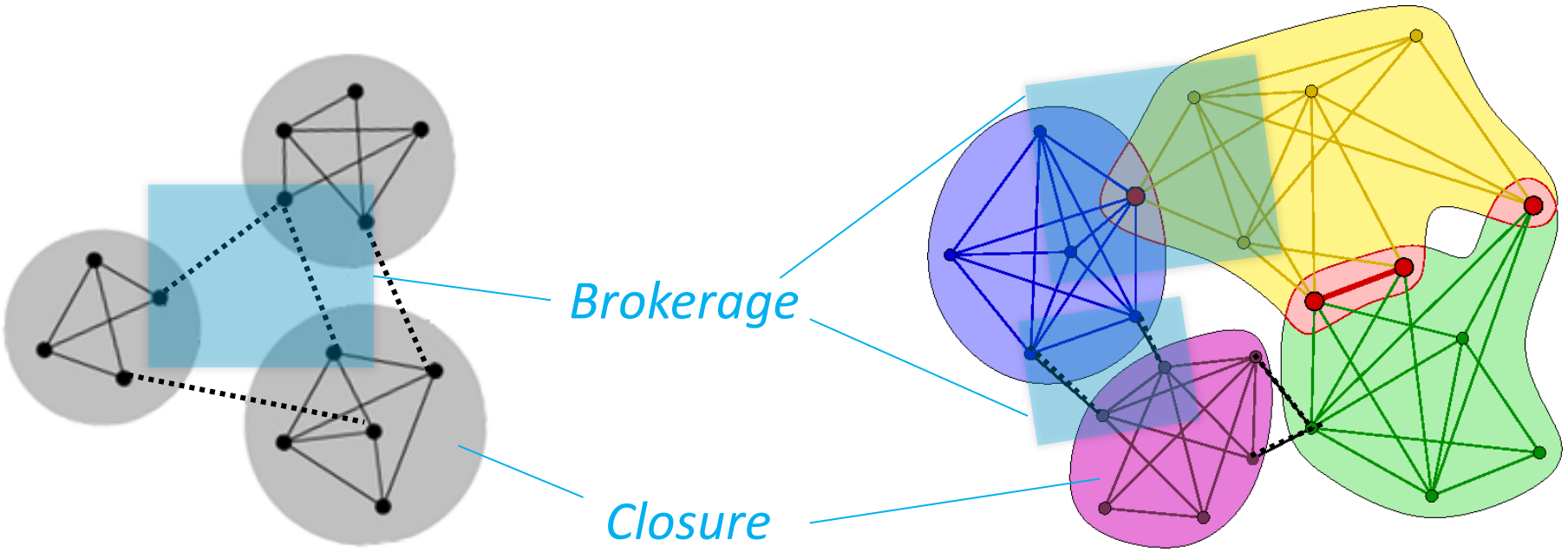


What should be modelled?

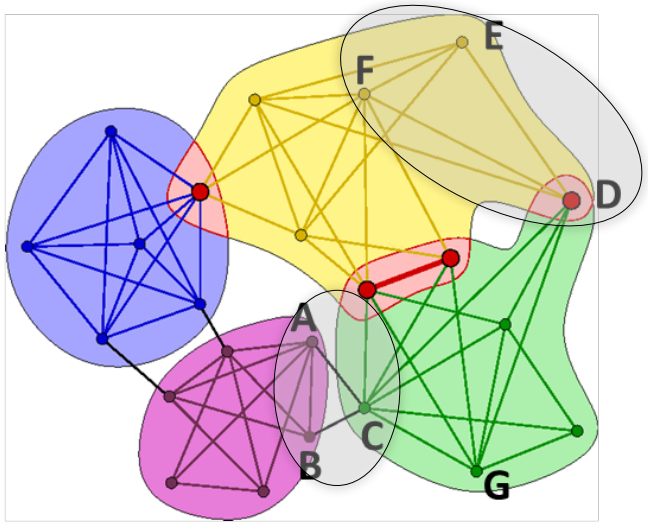


- Theory of Complex Adaptive Systems (Holland, 1976)
- *An iterative micro-macro feedback loop can be maintained through three mechanisms: interaction, variation, and selection*

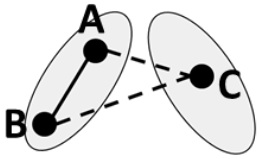
Macro Structure – A Hybrid Macro Network



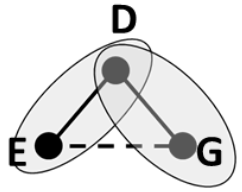
Network Topology



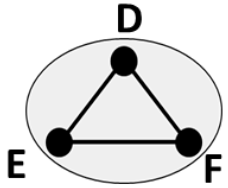
Triads



Bridge triad (two bridges)

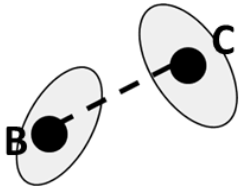


Bridge triad (one bridge)

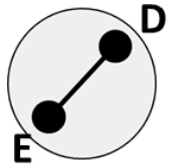


Bond triad (no bridges)

Dyads

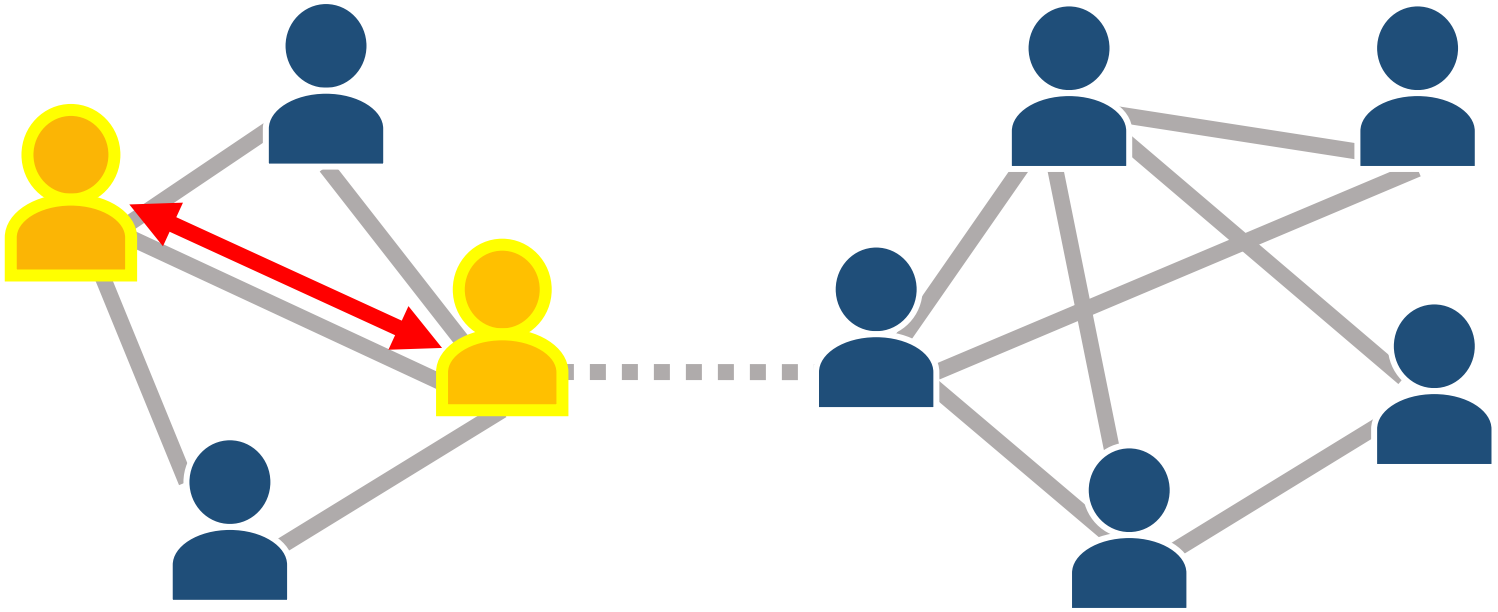


Bridge



Bond

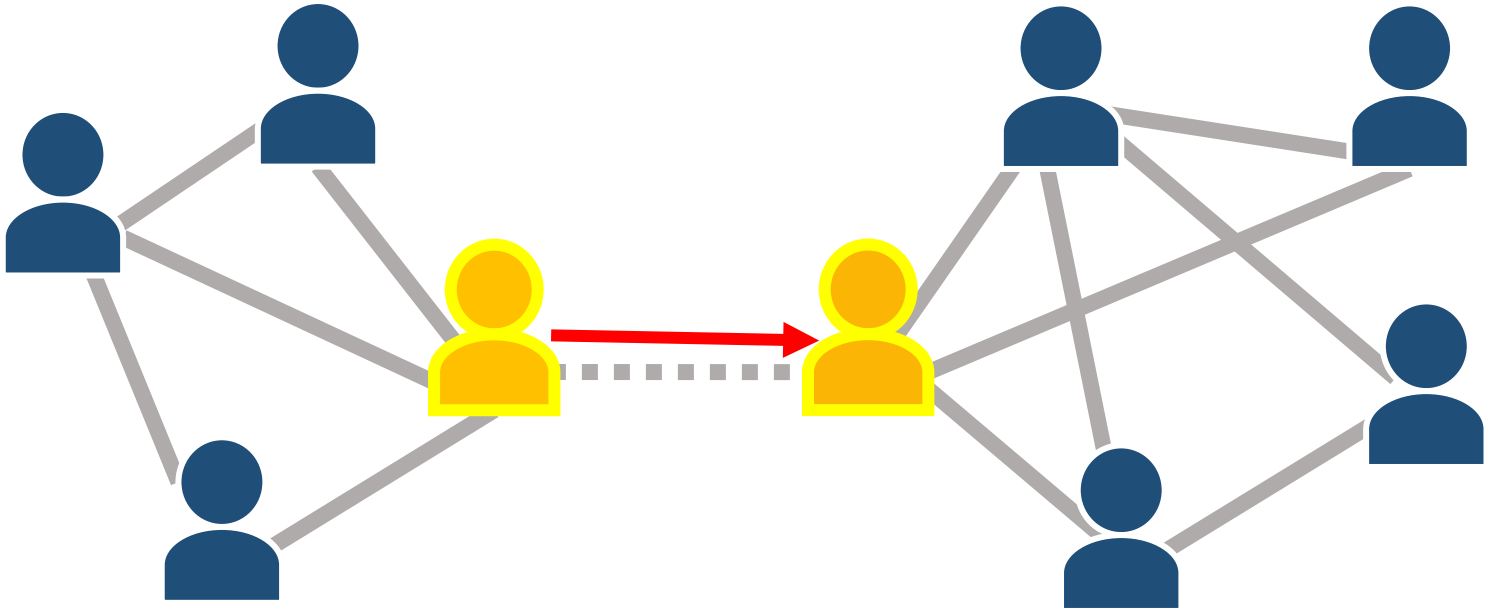
Micro Behavior – Leveraging Social Capital



Bonding

- Exchange knowledge with someone inside the same closure structure
- Create or strengthen a bond

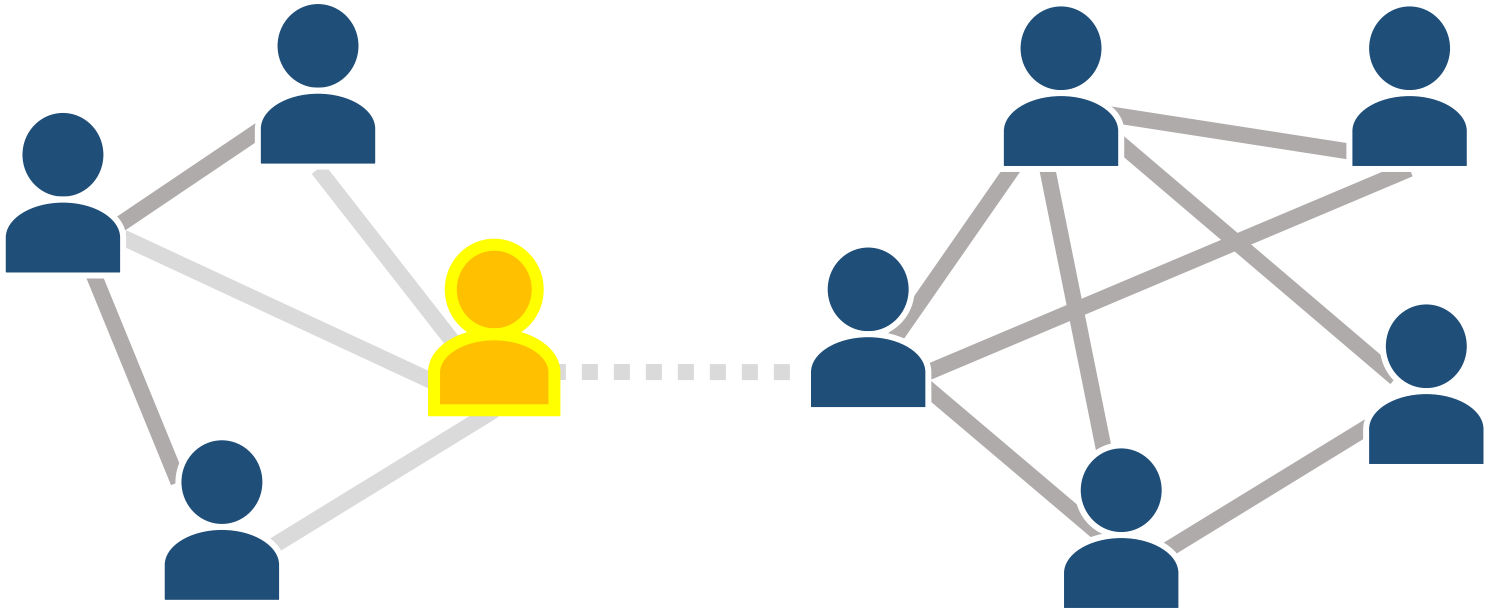
Micro Behavior – Leveraging Social Capital



Bridging

- Exchange knowledge with someone from outside the closure structure
- Create or strengthen a bridge

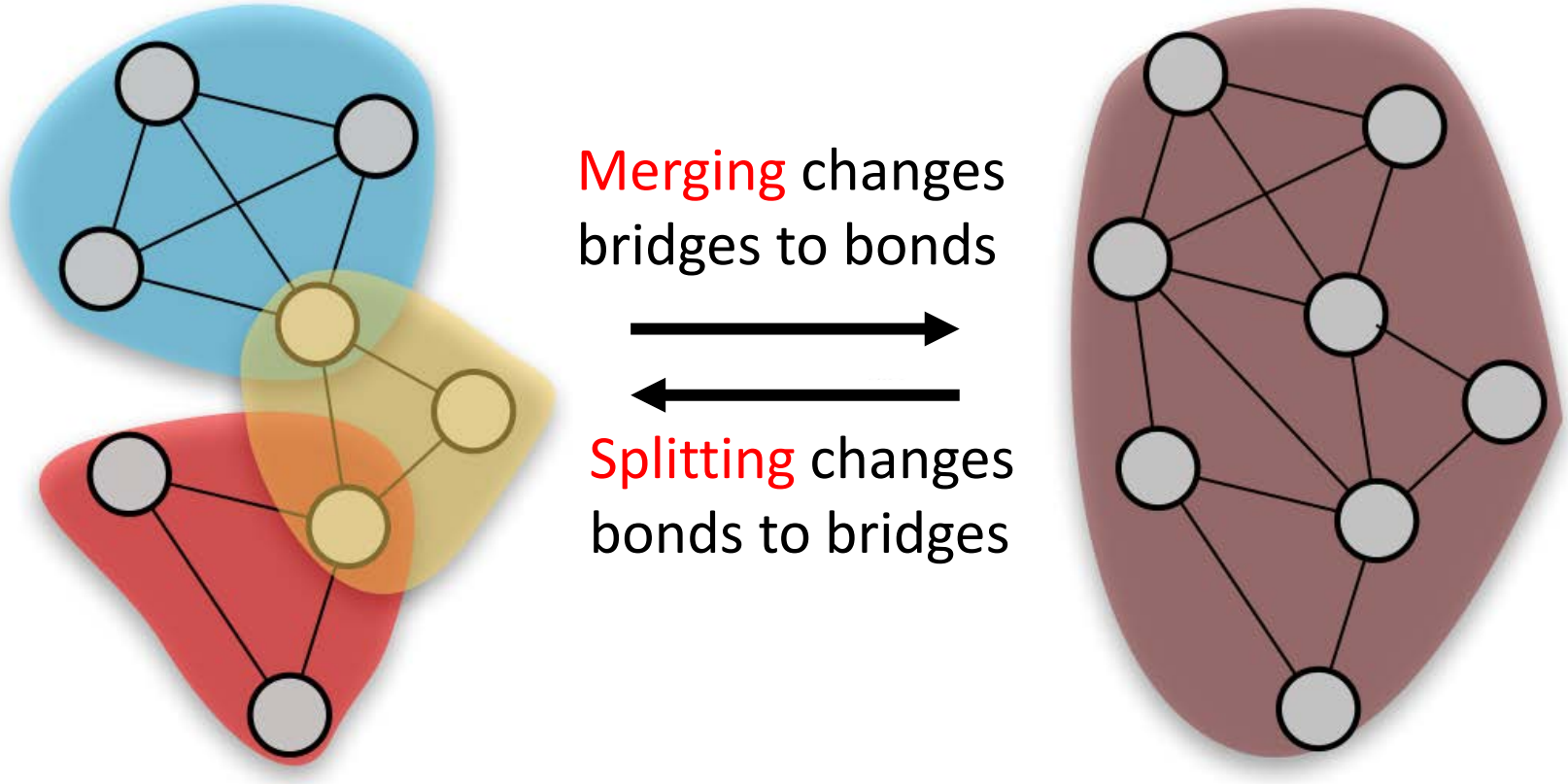
Micro Behavior – Leveraging Social Capital



No use of social capital

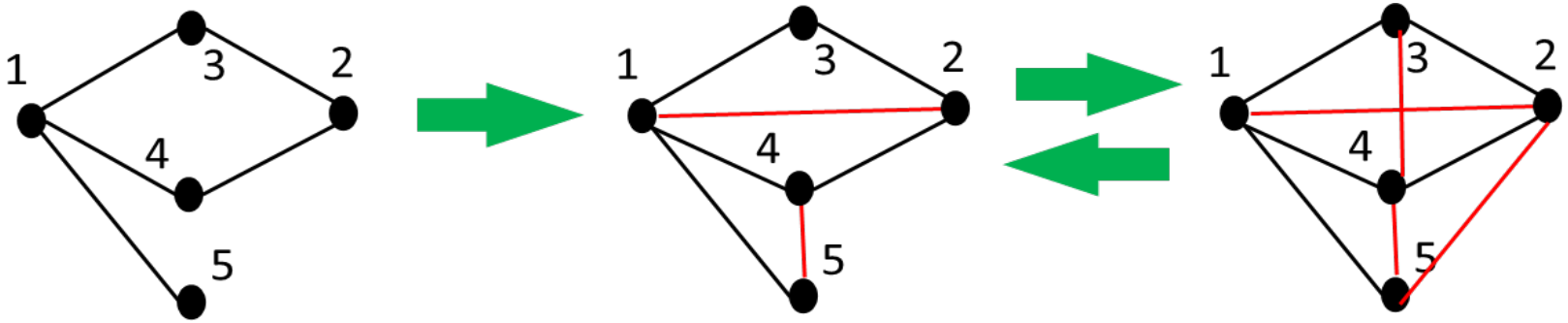
- No knowledge exchange; independent knowledge creation
- All connections decay

How to model bonding and bridging in a dynamic network?



Embedded Knowledge Exchange

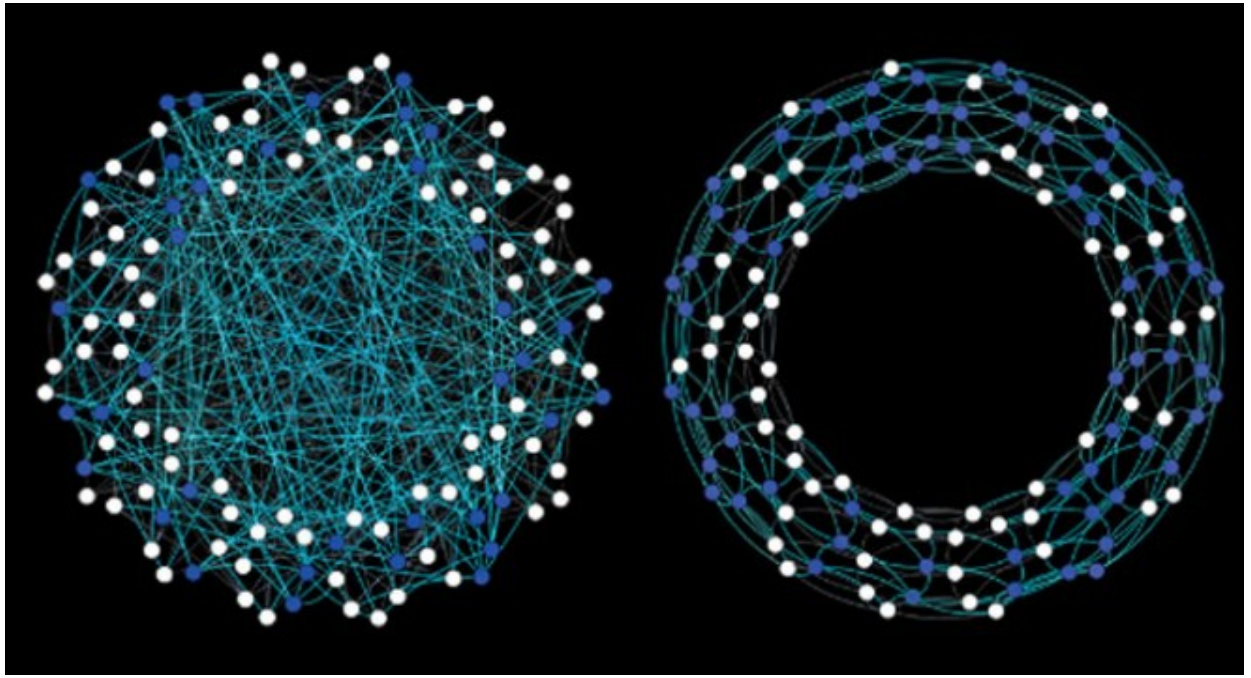
- Two agents interact based on triad closure
- Generate and maintain dense areas (closure)
- Cover bonding behavior



Local Network Constraint $LNC_{ij} = (\tilde{w}_{ij} + \sum_q \tilde{w}_{iq}\tilde{w}_{qj})^2, i \neq q \neq j$

Random Knowledge exchange

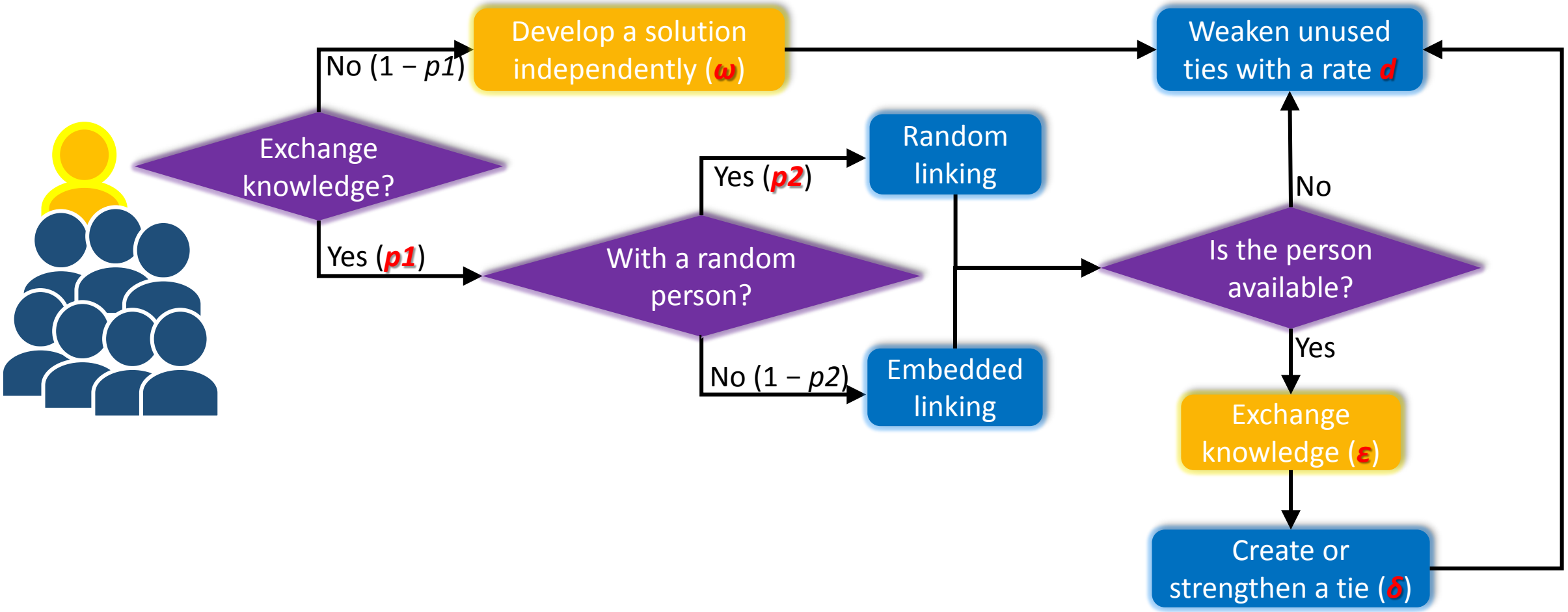
- Two agents interact randomly
- Escape dense areas
- Cover bridging behavior



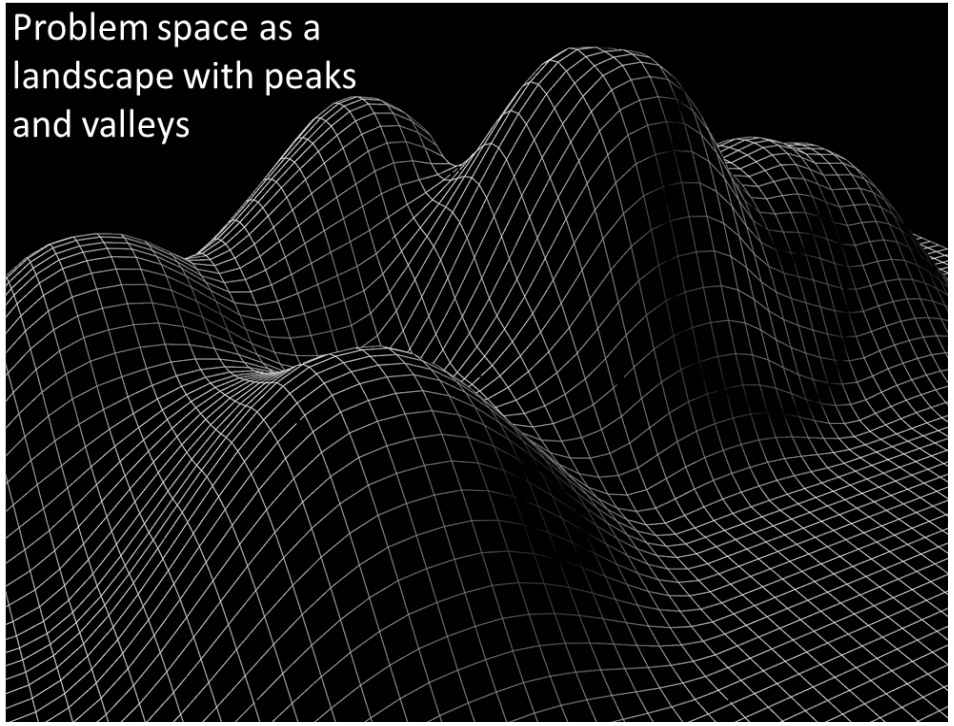
The Model: A Complex Adaptive System (CAS)

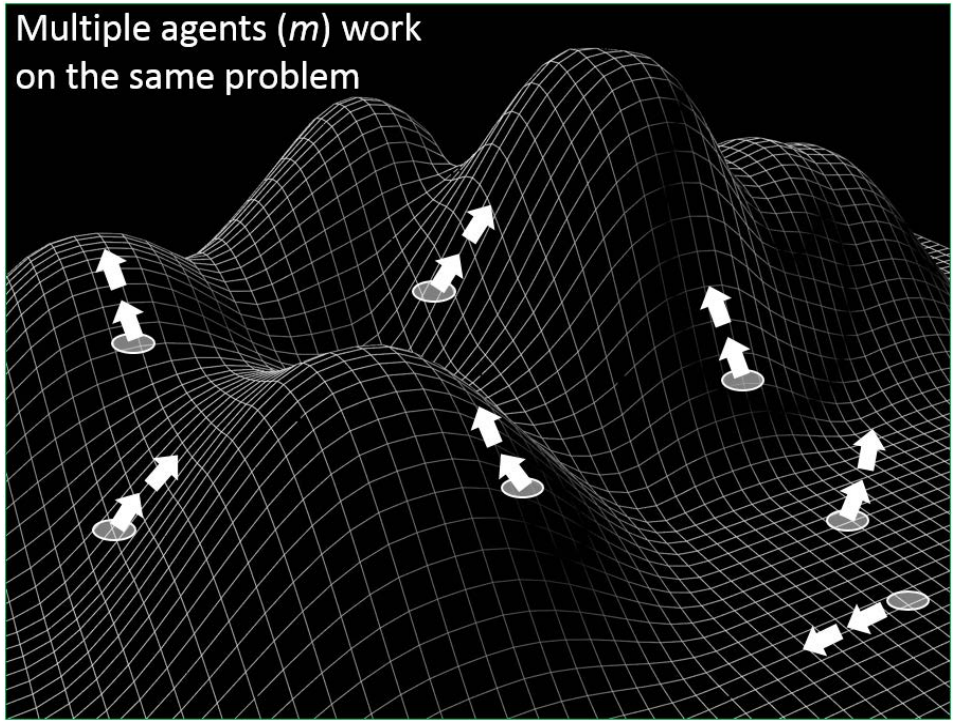
CAS element	Implementation
The system	An organization
Agents	Organizational members
Macro structure	A macro interaction network emerging from interpersonal knowledge exchanges (including no exchange)
Micro interactions	Random and embedded knowledge exchanges
Variation	New bridges and open triads created by random knowledge exchanges
Selection	Mutual reinforcement of closure structures and embedded knowledge exchanges

Simulation Process



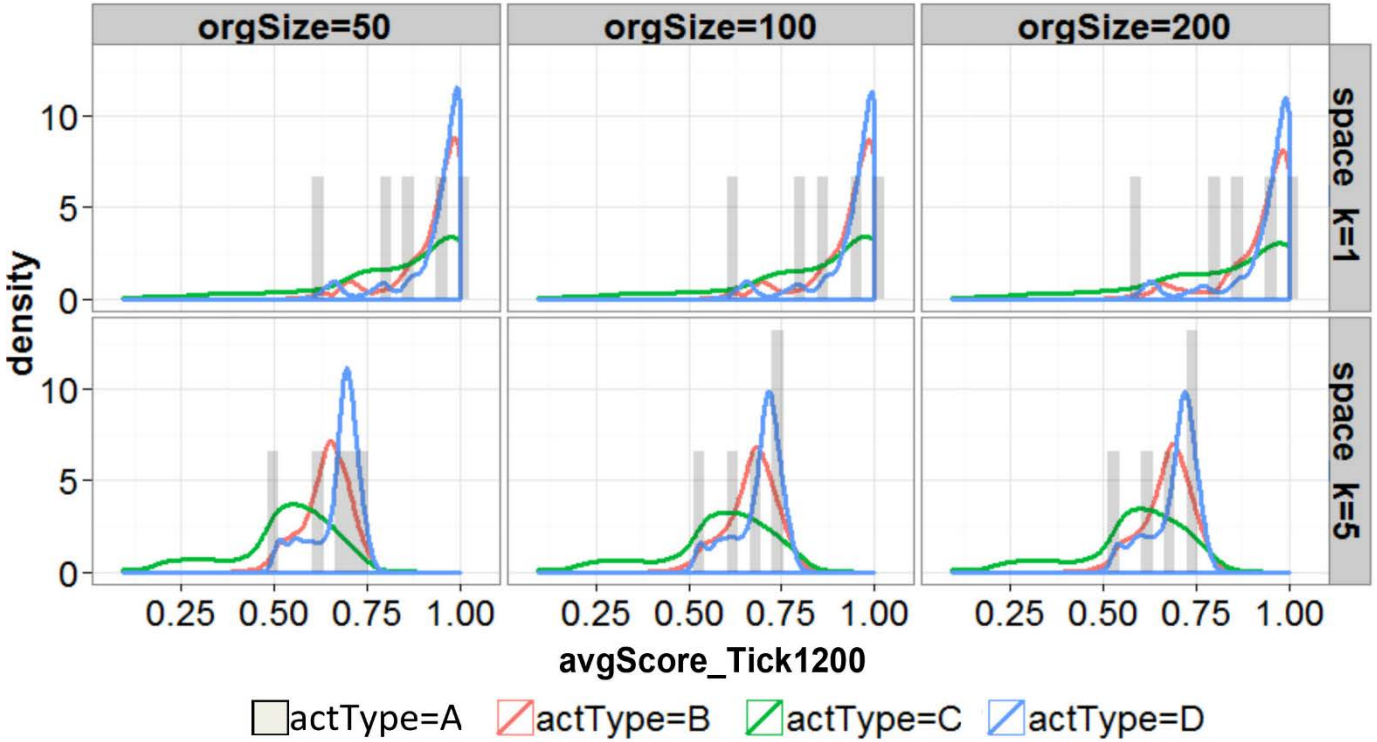
Modeling Organizational Problem Solving





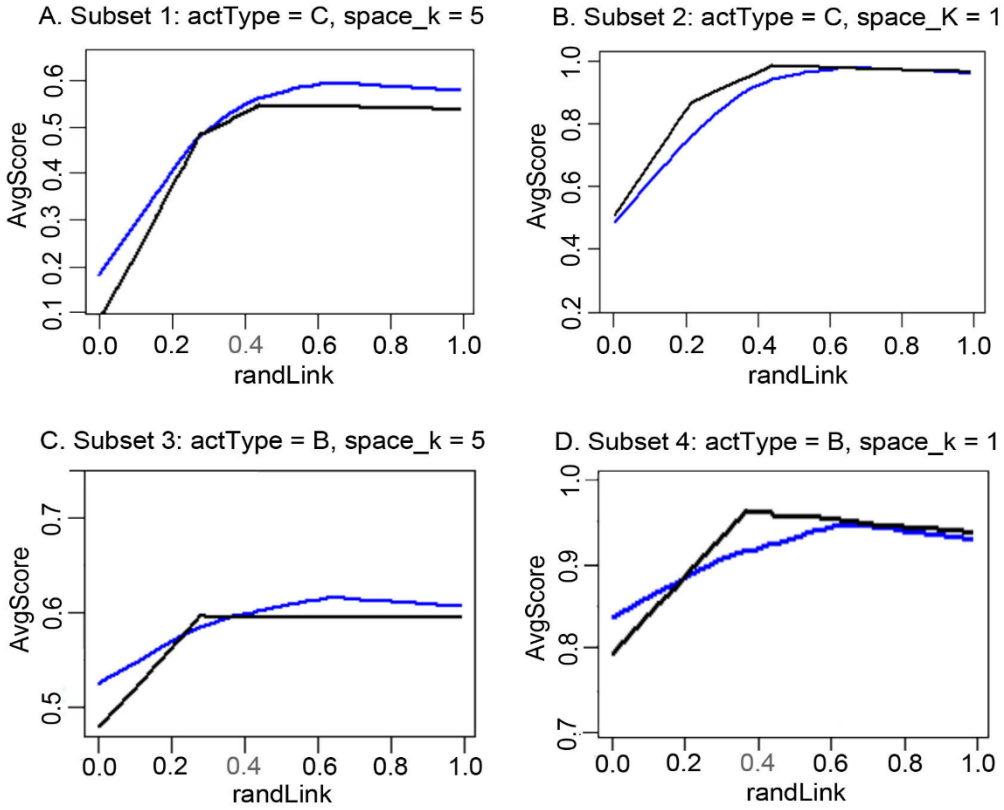
Implication: which behavior is needed?

Related model parameters: individual propensities [p1, p2]



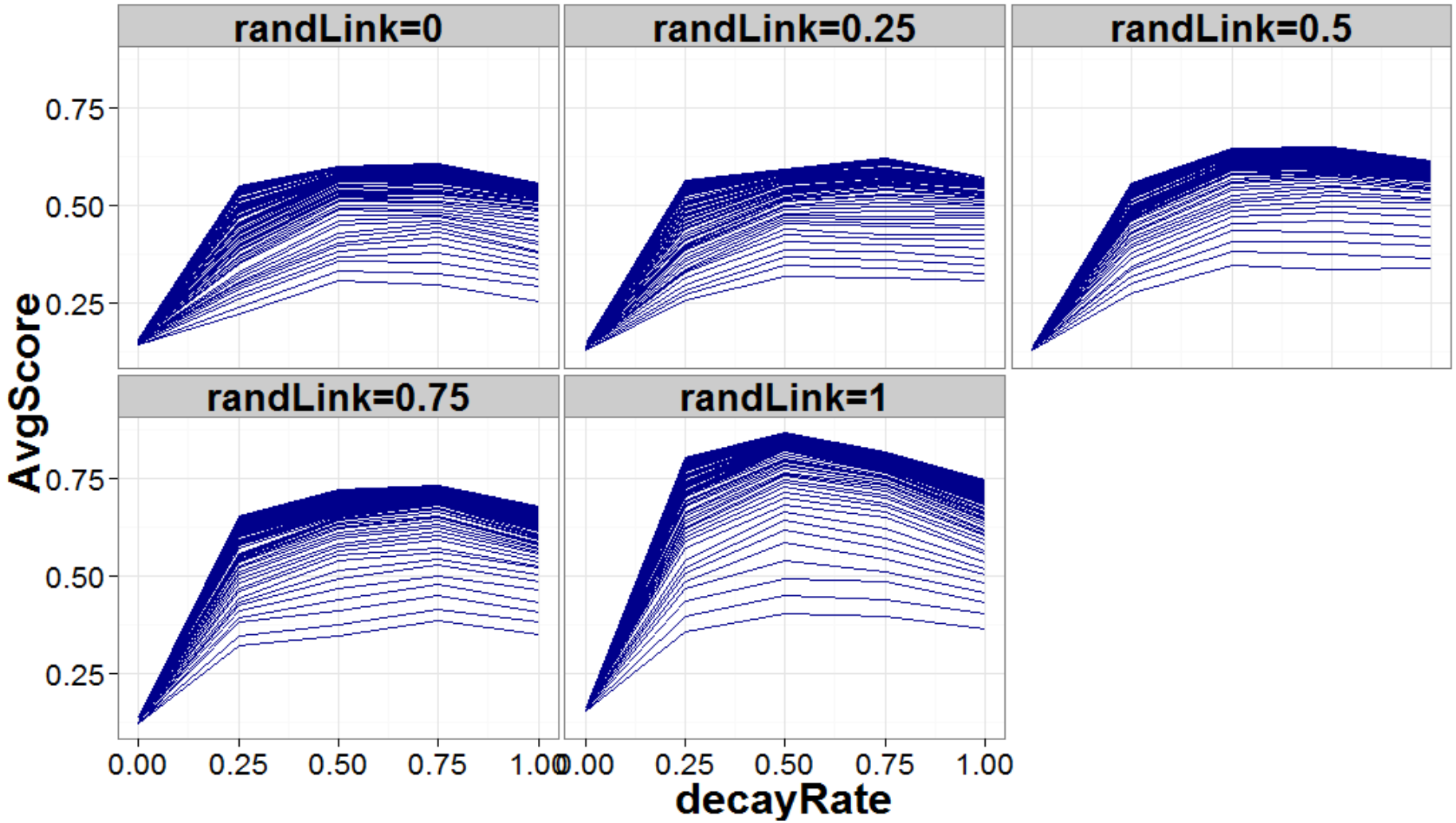
Model Parameter: *p1*

Model Parameter: *p2*

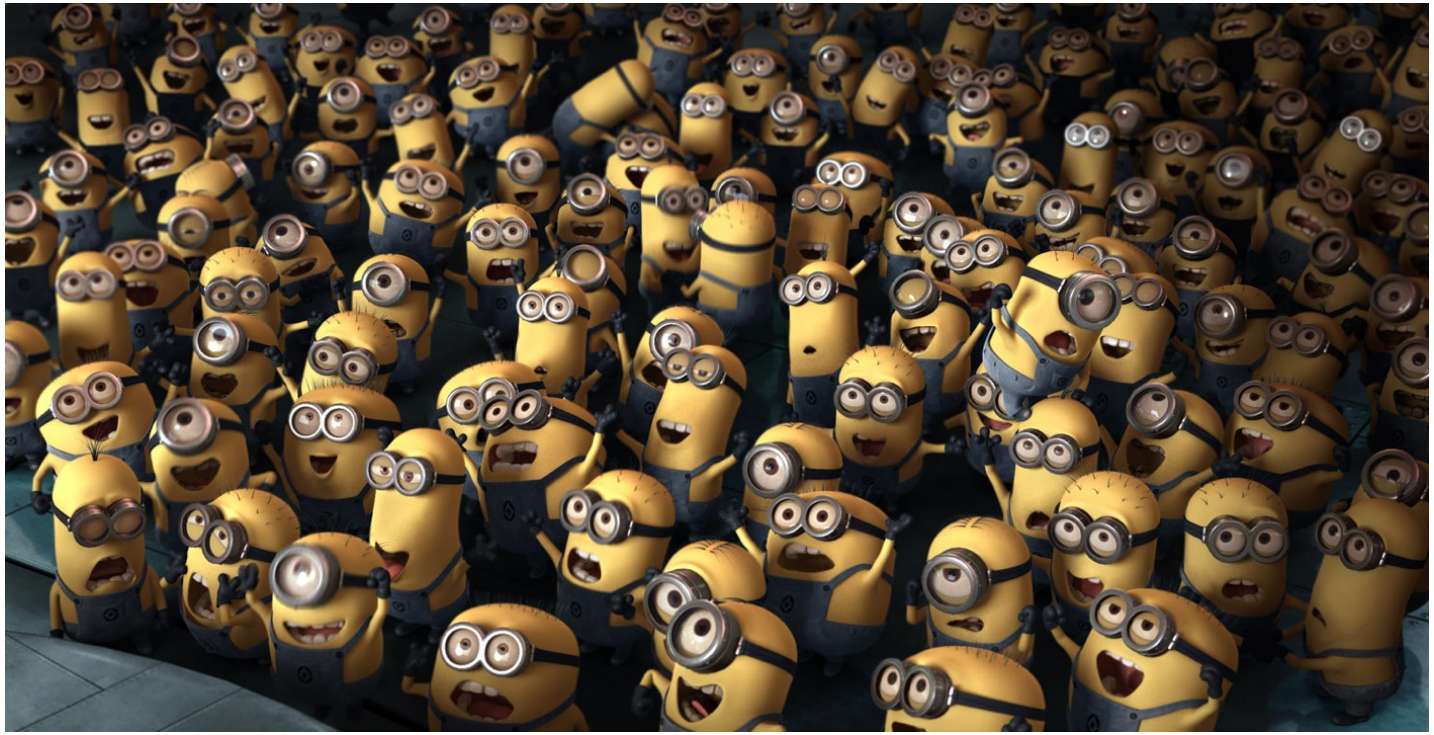


Implication: trapped in your own net?

Related model parameter: tie decay rate δ

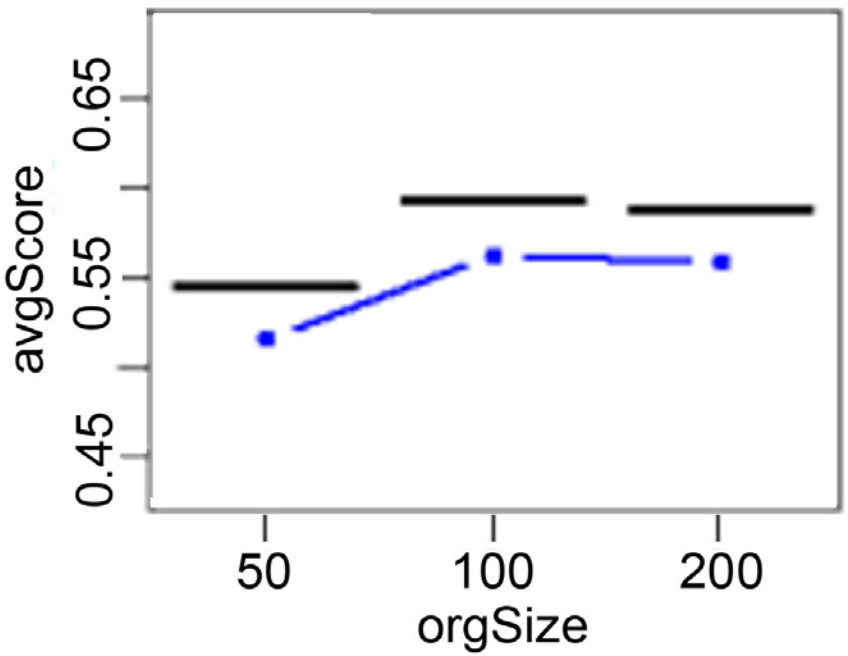

randLink=0
randLink=0.25
randLink=0.5
randLink=0.75
randLink=1
AvgScore
0.75
0.50
0.25
0.00
0.25
0.50
0.75
1.00
decayRate

Implication: an optimal organization size?

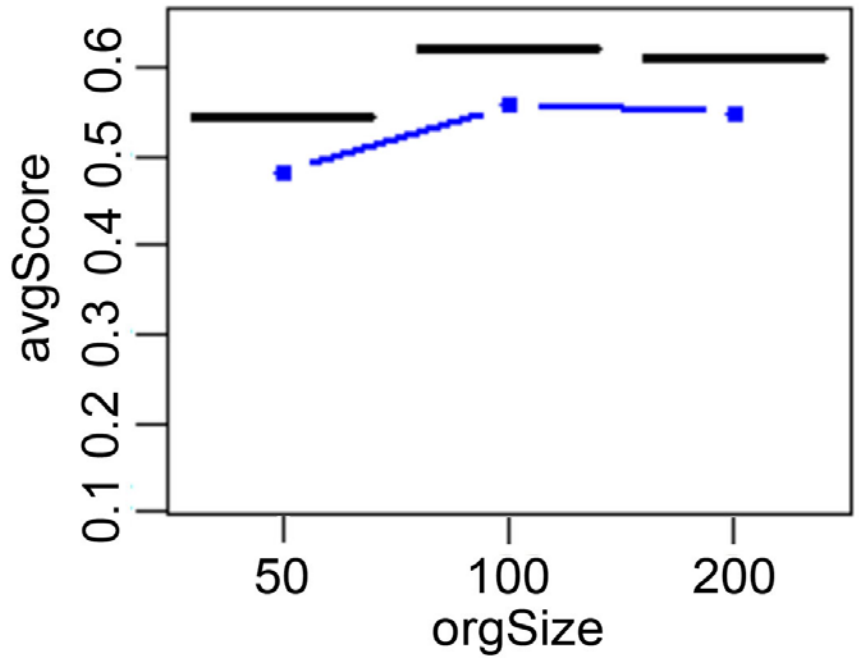


Related model parameter: organization size *m*

A. Subset 1: actType = B, space_k = 5



B. Subset 2: actType = C, space_k = 5



Simulation Experiments

- Latin Hypercube Design for sampling primary model parameters
  - 300 design points (experimental conditions)
- Crossed design for testing all model inputs
  - 1st crossed design: 7,200 design points
  - 2nd crossed design: 3,000 design points
- Each design point has 300 replicate runs
- Each simulation run lasts for 1000 or 1200 steps
- Extreme condition tests
  - 80 design points, each with 50 replicate runs

Contribution

Research area	Specific issue	Contribution of the current study
Organizational ambidexterity	*Ignorance of regular organizational members* • Lack of cross-level research • Lack of research on the underlying micro-mechanisms of contextual ambidexterity	*The collective power of regular organizational members investigated* • Link organizational performances to regular organizational members' characteristics that impact independent and collaborative problem solving • Provide a micro-level and informal structure-based demonstration of contextual ambidexterity
Organizational social capital	*Lack of an appropriate synthesis of various social capital sources* • Overemphasis on network positions • Assume network positions are antecedents to motivations and abilities	*Multiple sources of social capital addressed* • Jointly consider individual members' opportunities, motivations, and abilities to utilize social capital • Separate individuals' motivations and abilities from their network positions
Organizational social networks	*Lack of an appropriate combination of agency and network structure* • Predominance of structure • A local perspective on agency • Insufficient research on the genesis and dynamics of networks	*Structuration theory faithfully modeled* • Implement the iterative mutual impacts between agency and the global network • Model an emergent and dynamic network whose evolution is pushed by endogenous and exogenous (random) factors

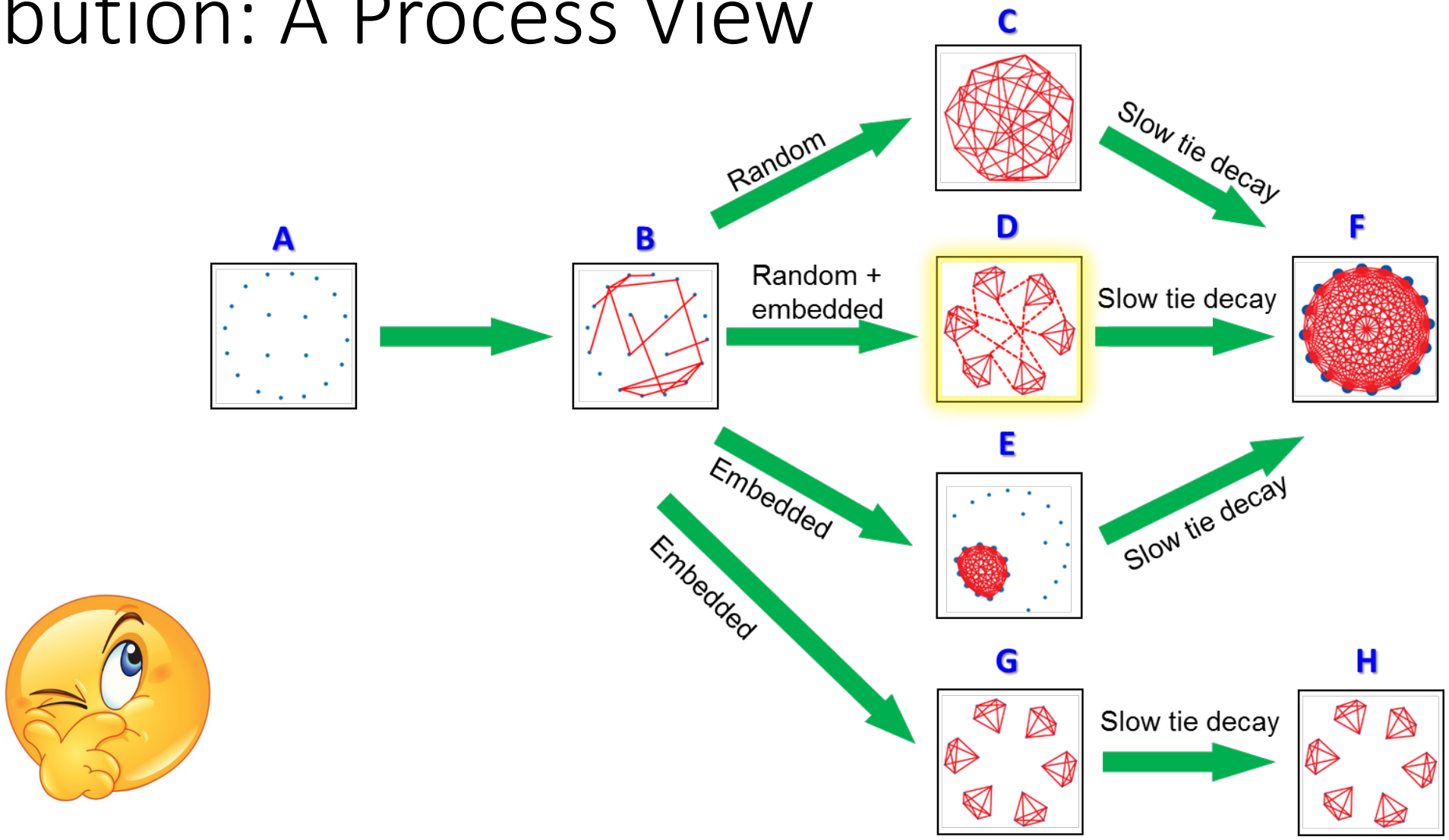
Contribution: extended macro structure

Previous studies

Determine interactions	Stable /static	Exogenous	Predefined	Memory-less
Coevolve with interactions	Changeable/ dynamic	Endogenous	Emergent	Memory-loaded

Current study

Contribution: A Process View



Future Research

- Empirical testing of major findings
  - The influential factors and testable hypotheses revealed by the current study can shed light on and set up directions for future empirical studies.
- Application of the method
  - The methodology of the current study can be applied to other areas to help theorize dynamic phenomena
- Transfer of the model
  - The model developed in the current study can be modified and used for other CAS or micro-macro coevolution related topics.

Thank you!
Questions?