Abstract argumentation for agent-based social simulations

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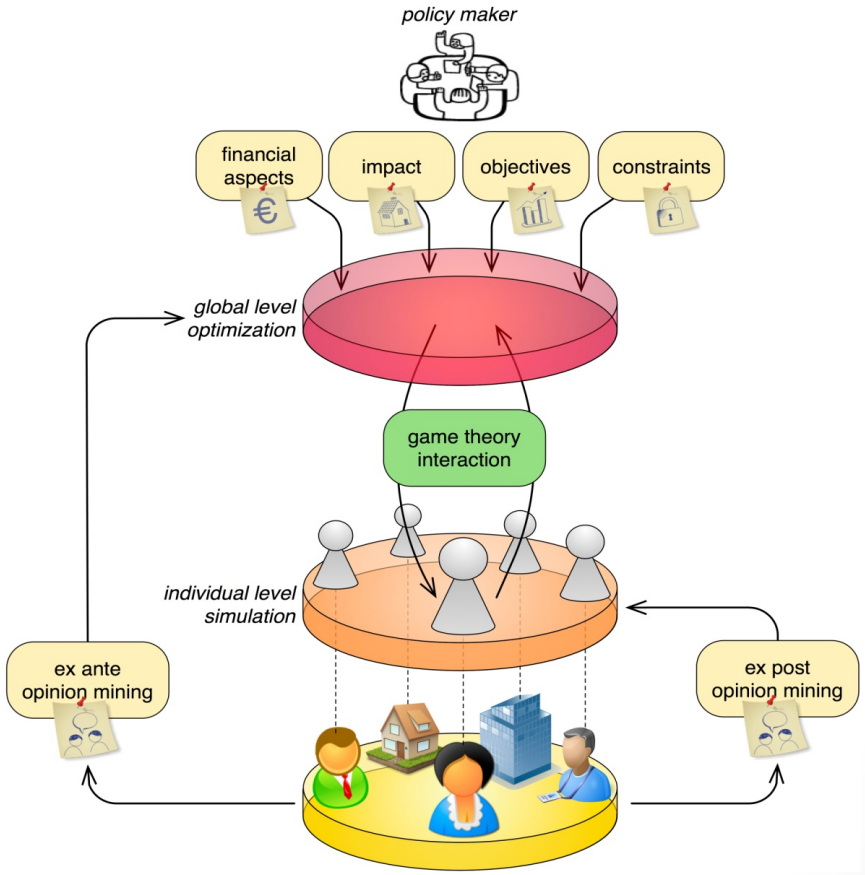
Background

ePolicy

- Engineering the POlicy-making LIfe Cycle
  - Objective ICT-2011.5.6 target (a) *ICT solutions for Governance and Policy Modeling*



Background

- Agent models have become an increasingly popular approach in social simulation.
- There are two main streams of research:
  - mathematical, game theoretical or evolutionary computing techniques;
  - formal logic approaches.

Agent-based Social Simulations

- BDI frameworks have not encountered a wide diffusion among sociologists
- Most BDI architectures reportedly too complex to understand and to use by non-computer-scientists
- On the other hand, agents are mainly called social just because they are linked in network structures, but no reasoning is actually implemented

Our model is…

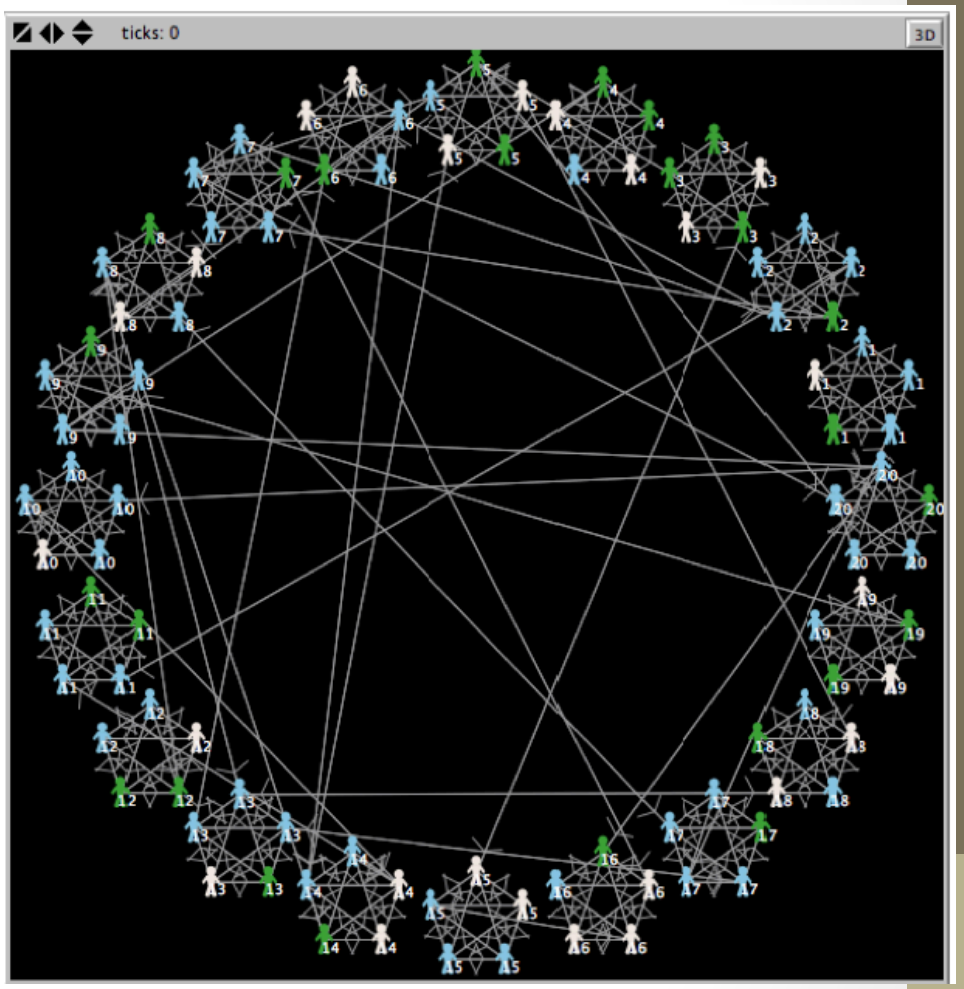
- …a new paradigm to model social agents which may result appealing for both streams of research in social simulation
- The result is an agent-based model which simulates a population of social agents that:
  - interact within a relational structure;
  - exchange information by means of simulated discussions;
  - possibly reach an agreement.

Embeddedness in ABSS

- Embeddedness is represented with networks
- The concept has been developed by Granovetter
- Bridges between clusters are called “weak ties”
- Weak ties permits the flow of resources, particularly information, between otherwise unconnected clusters

Network topology

- Disconnected caveman graph
  - It represents a small-world where clusters are maximally dense.



Network settings

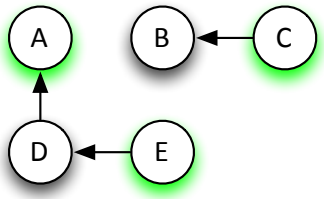
- We then allow for two kind of structural settings:
  - a first one where clusters are disconnected
  - a second one where a random number of bridges is added between the clusters
- The network structure is imposed exogenously to agents and kept static once generated.
- Bridges are treated as weak links and thus are supposed to carry all the information beyond that available in a single cave.

Network settings

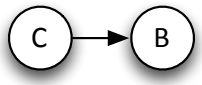
- Links:
  - have no positive or negative values;
  - represents the possibility of communication between any two pair of agents;
  - Transmits a bit of information which may be positive or negative depending on the receiver's set of beliefs.
- We call the stream of information exchanged between two agents a "simulated dialogue".
- The dialogue mechanism represents the micro-level assumption that governs our model and builds on Mercier & Sperber's work.

Agent's reasoning and interaction

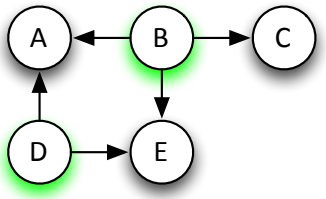
A1's Argumentation Framework



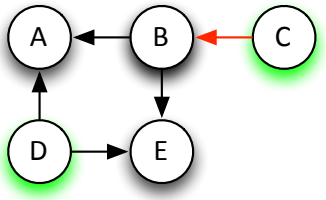
A1 says:



A2's Argumentation Framework

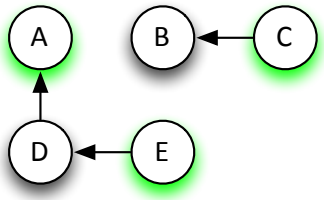


A2 trusts A1 and revises its AF:



Agent's reasoning and interaction

A1's Argumentation Framework



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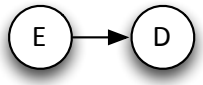
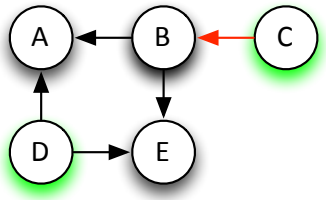


A2's Argumentation Framework



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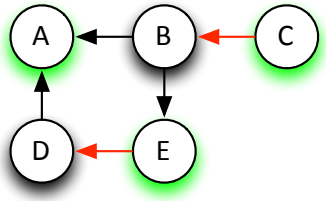

Agent's reasoning and interaction

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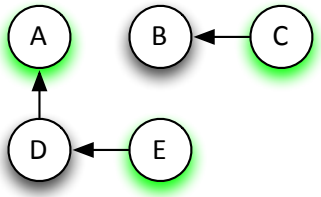
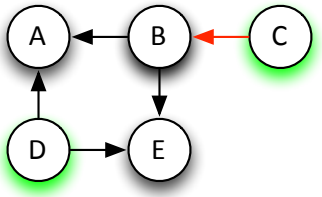


A2's Argumentation Framework



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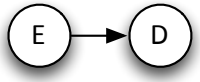
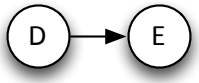
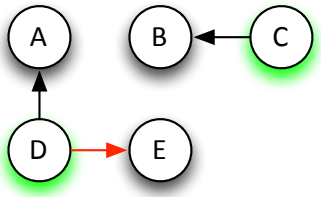


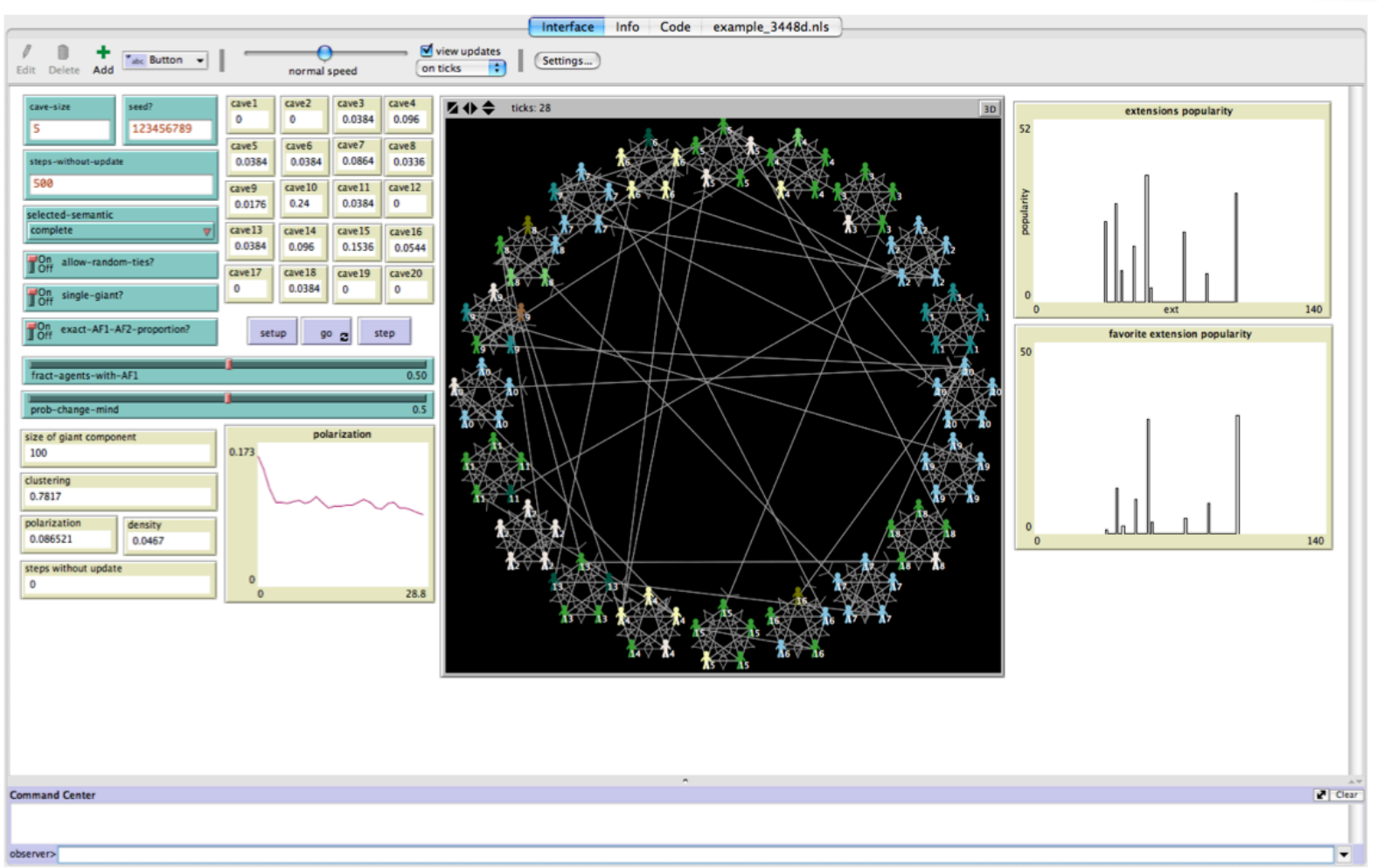
A2 does not trust A1 and rebuts:



A1 trusts A2 and revises its AF:



The model: NetArg



Polarization

- Polarization: Variance of distribution of AF **distances**

$$P_t = \frac{1}{N(N-1)} \sum_{i \neq j}^{i=N, j=N} (d_{ij,t} - \gamma_t)^2$$

$$d_{ij} = \frac{U_E^i \setminus U_E^j \cup U_E^j \setminus U_E^i}{|A|}$$

- A perfectly polarized population contains two opposing factions whose members agree on everything with each other and fully disagree on everything with the out-group.

The model: NetArg

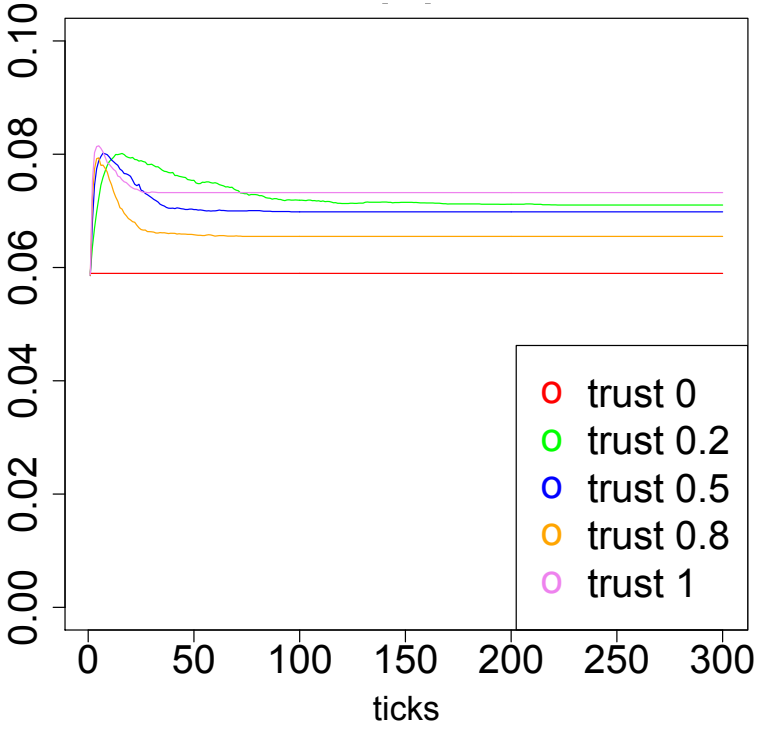
- In each experiment:
  - two alternative AFs
  - among 100 agents
  - divided in 20 caves.
- At each time step:
  - each agent is asked to start a dialogue with one of her neighbors extracted at random
  - Such agent could be restricted to the same cave or not, depending on the presence of bridges.
- After some steps, agents adopt new beliefs as a result of dialogues (attacks, if accepted, may call for belief revision)

Polarization effect

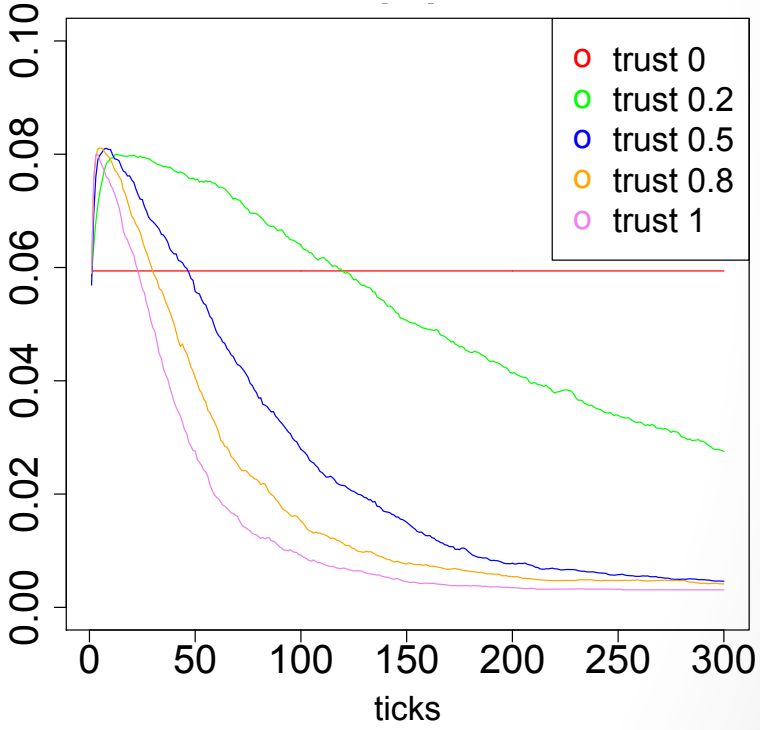
- The belief revision process gives raise to a polarization effect at the population level.
- Does the presence of weak ties (i.e. bridges) lower polarization at the population level?

Polarization and weak ties

No weak ties



Weak ties

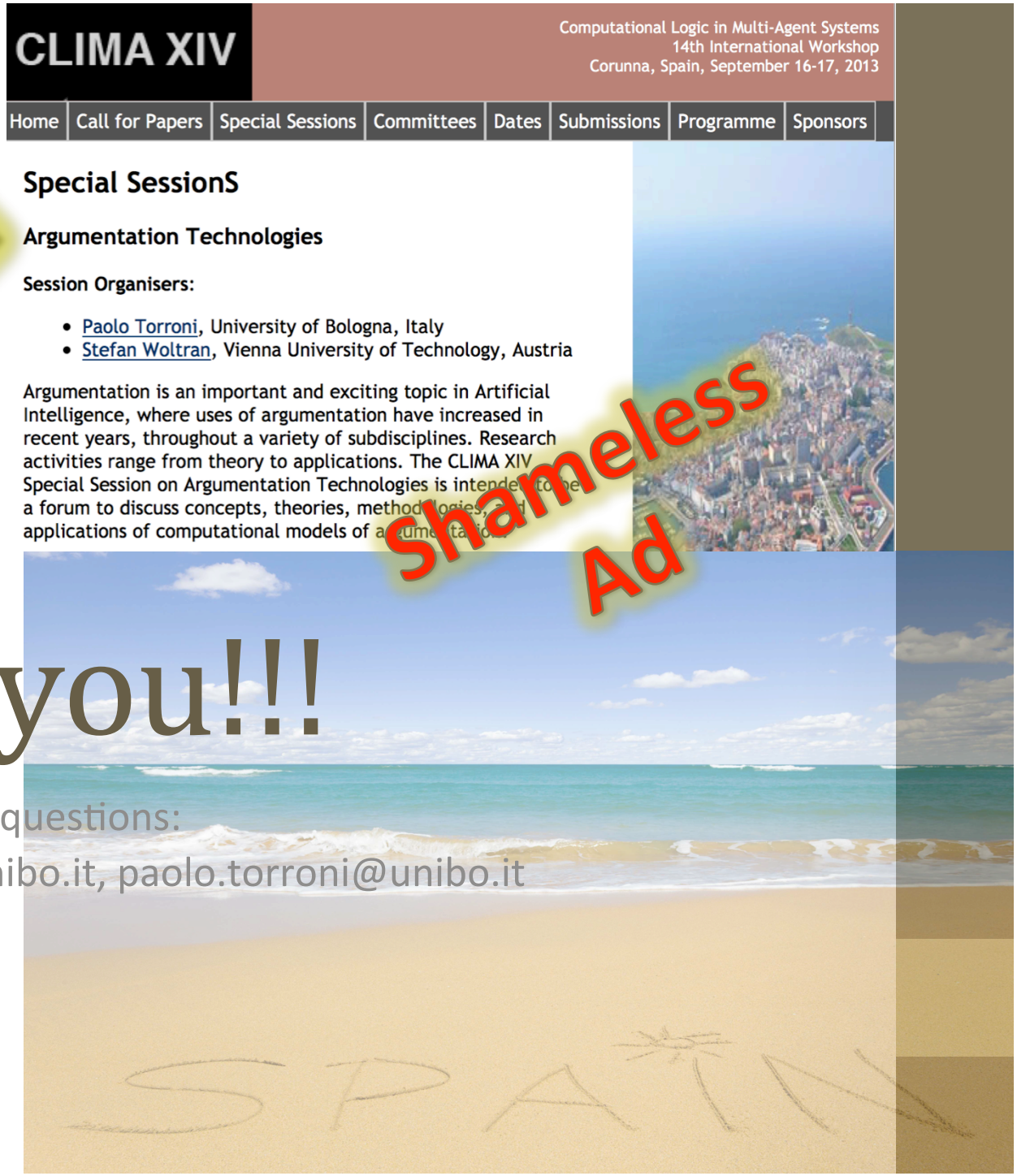


Simulations: results

- With no bridges connecting caves (a), each cave quickly stabilizes at a local minimum.
- When bridges are present (b), polarization levels are lowered considerably.
  - Caves can receive information from other caves.
  - “Small-world” topology lets the population escape local minima.
- **We reproduced a stylized fact that occurs in social simulation literature about weak ties**

Conclusions

- To the best of our knowledge, our proposal is original both in the social sciences and in agent research.
  - Possible new application domain for ArgMAS community?
  - Applications beyond theoretical research: policy-making, e.g., about sustainable energy, political discussions and e-participation.
  - Can also help better understand behavior of argumentation semantics when large populations of agents are involved.
- Currently designing empirical tests to understand if the model is able to forecast the outcome of a discussion by simulating a virtual discussion which starts from similar premises.
- (More about dialogues in later talk)



Thank you!!!

Further comments and questions:

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