Effects of Social Network Topology on Norm Emergence

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Norms

- **Norm**: a convention for socially accepted behavior

  "*a convention is an equilibrium that everyone expects in interactions that have more than one equilibrium*" [Young, 1996]

- Need for norms
  - Multiple behaviors can be equally effective
  - Individuals must select the same behavior
  - Absence of central authority or law
- Norms emerge in a society as individuals adapt over repeated interactions
- **Research Goal**: Develop and use computational models/ simulations to evaluate and analyze the effect of social network topologies on norm emergence

Representative Norms

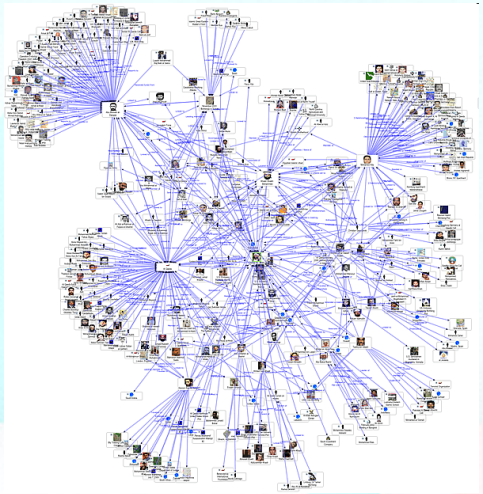
- Human interaction protocols
  - Greetings, communication motifs
- Fashion
- Choice of Software/Hardware Products
  - Social networking sites, chat facilities, Computers/OS
- Social behaviors and trends
  - Recycling/"Green" Phenomenon
  - Reciprocal gestures
  - Which side of the road to drive on

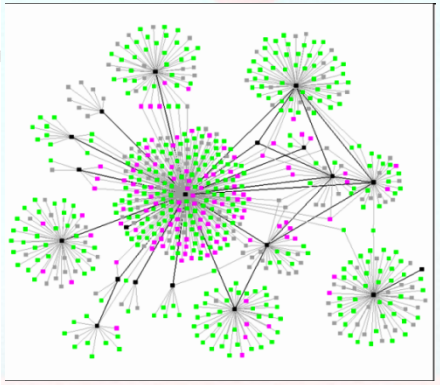
Related Work

- Axelrod (1986): Norms are powerful tools for regulating conflict with no central authority
- Young (1996): Discusses applications of norms in economics, but assumes global knowledge
- Castelfranchi (1998): Interactionist view of norm emergence (as opposed to observationist)
- Albert and Barabasi (2000): Provide algorithm to generate scale-free networks.
- Delgado et.al. (2003): Examines norm emergence in scale-free networks generated by various algorithms (incl. Albert-Barabasi).

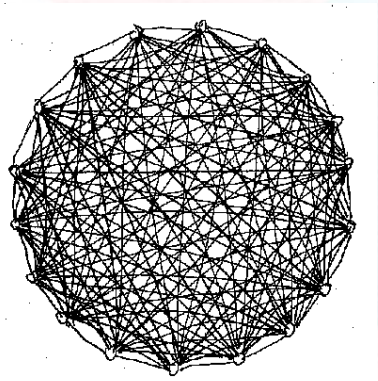
Social Network Topologies Evaluated

- Scale-Free Networks
  - Node connectivity follows a power law distribution
  - Few hubs with many neighbors, many nodes with few neighbors





- Ring Networks
  - Nodes linked to all nodes within a certain distance (*neighborhood size*)

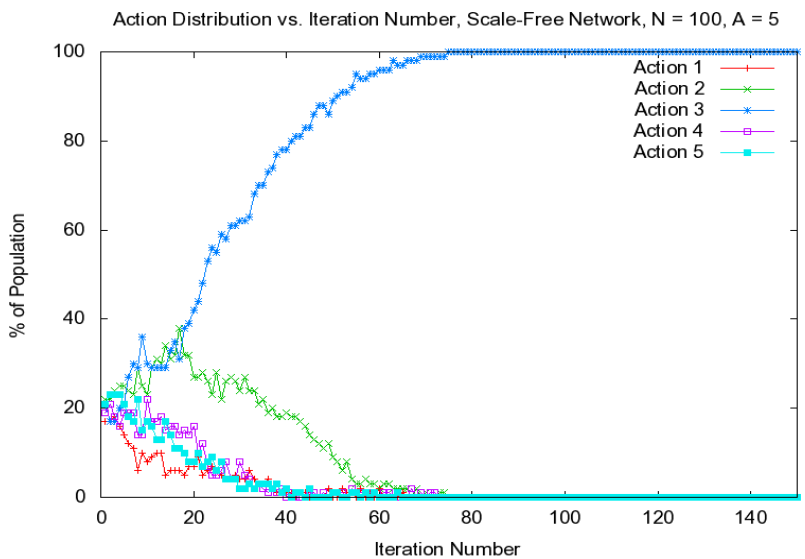


- Fully-connected networks
- **Diameter**: greatest distance between any two nodes in a network

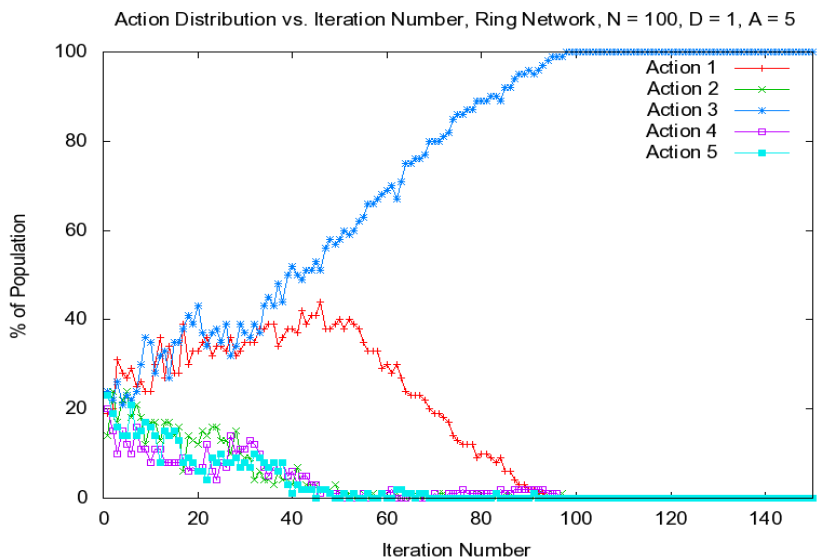
Agent Behavior in Networks

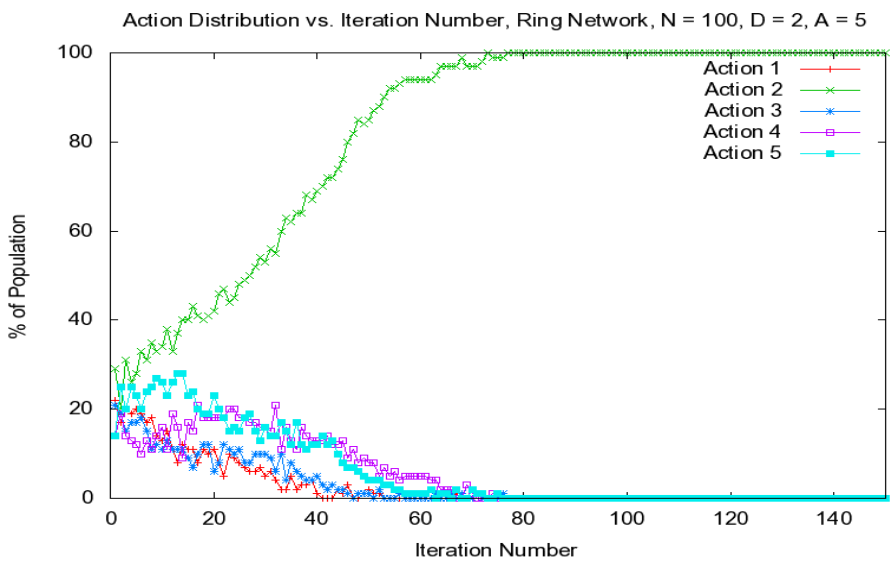
- Agents repeatedly interact with random neighbors
  - Every agent plays once per time step
  - Paired individuals choose actions
  - Identical actions produce positive reward (+4), conflicts produce negative reward (-1)
- Utility of chosen action adjusted by Q-learning:
  $Q_t(a) = Q_{t-1}(a)\,(1-\alpha) + \alpha R$
- Actions chosen semi-deterministically

Emergence of Norms

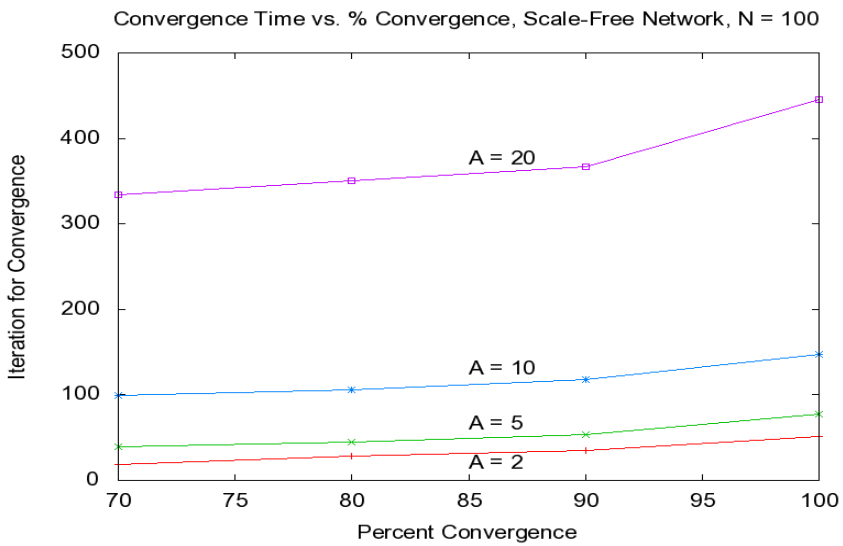


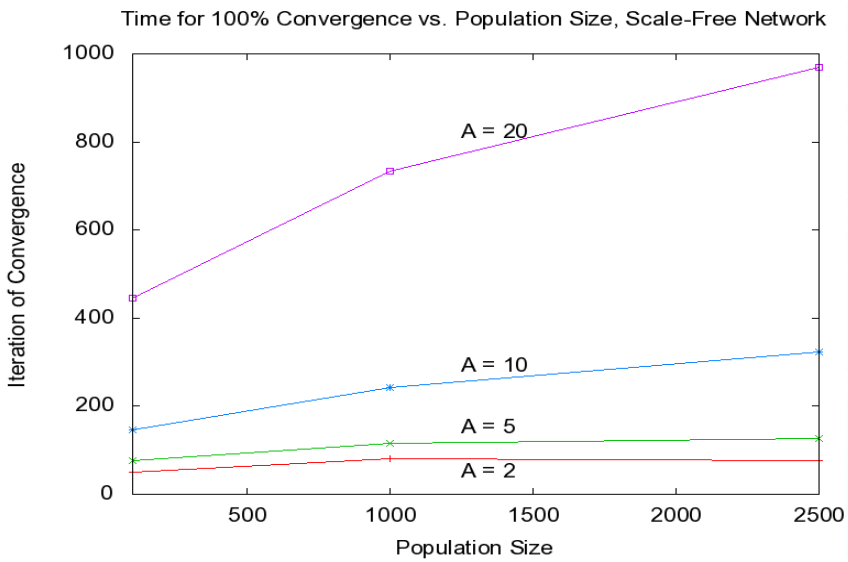
- One action spreads through the population and emerges as a norm in all networks





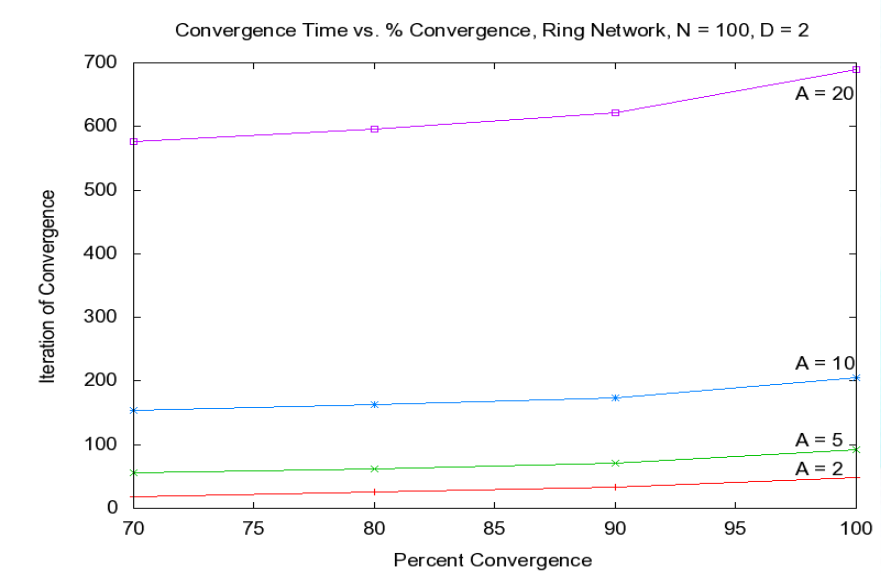
Norm Emergence: Scale-Free Networks

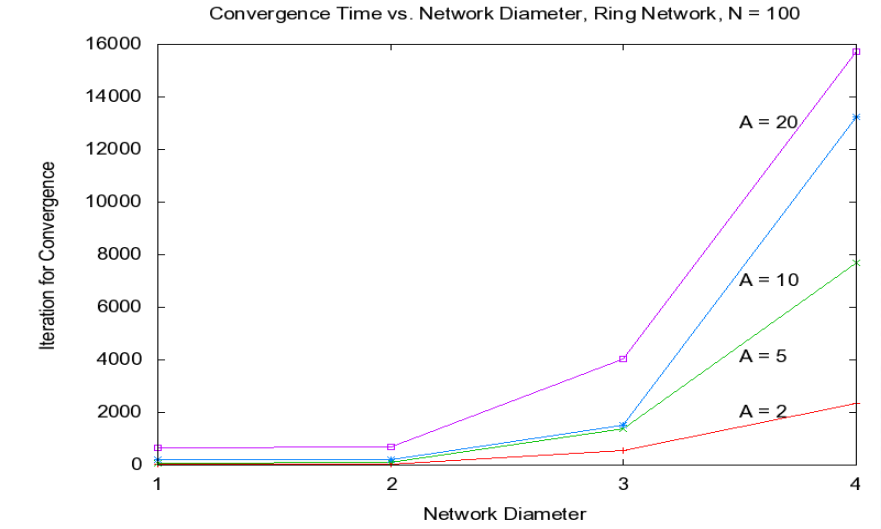




- All systems converge to norms, but with varying speeds
- Convergence is delayed with
  - more actions to choose from
  - larger population size

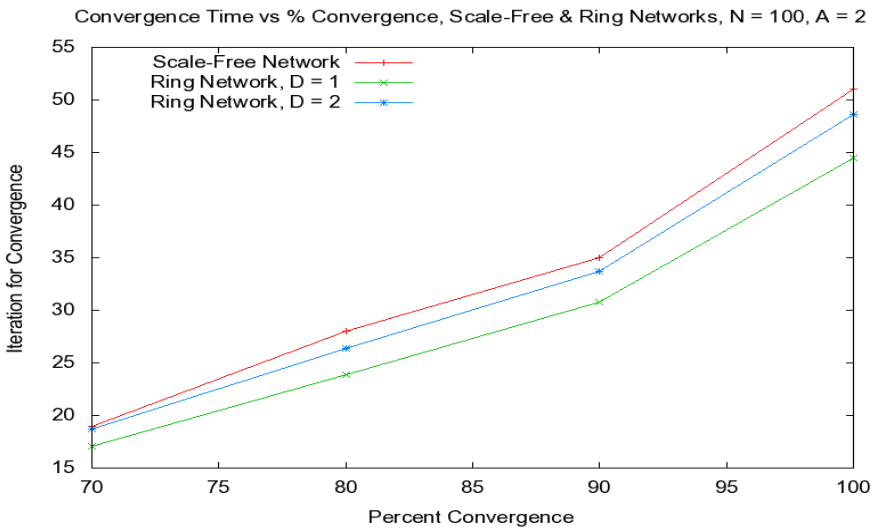
Norm Emergence: Ring Networks

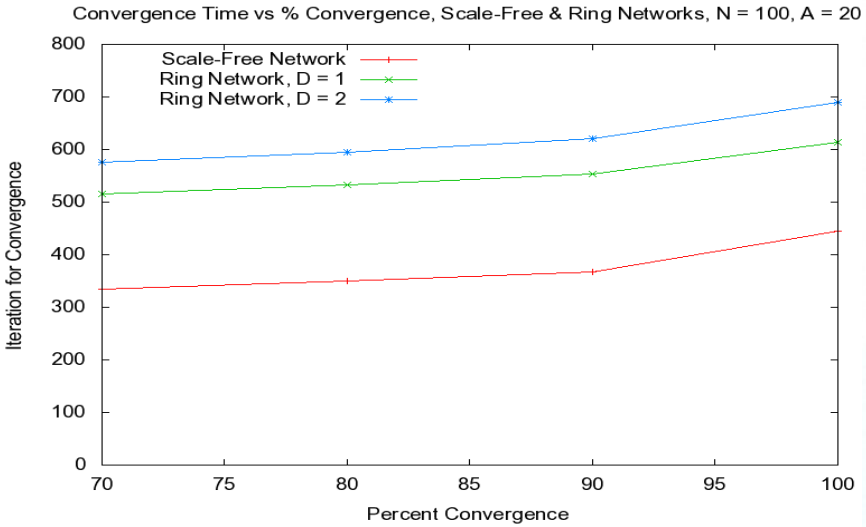




- Larger number of actions delays convergence
- Larger diameters drastically increase convergence time
  - exponential growth

Comparing Scale-Free and Ring Networks





- Ring networks converge faster for few actions
- Scale-free networks converge faster for many actions

Observations

- Norm emergence was achieved in all systems
  - More actions delay convergence
  - Networks with smaller diameters converge faster
  - More paths between nodes facilitate convergence
  - Ring networks perform better with fewer actions, scale-free networks perform better with more actions
- Implications of results
  - We can analyze functioning of existing social networks
  - We can develop models for real-life situations that parallel social networks and predict norm emergence
  - We can study effectiveness of viral or word-of mouth marketing approaches

Questions?