Decision Making in Watershed Governance Networks

Simulating Heterogeneous Beliefs and Accountability Ties in Agent Based Models

Asim Zia, University of Vermont
Chris Koliba, University of Vermont
Sara Metcalf, SUNY Buffalo
Michael Widener, SUNY Buffalo
Adam Reynolds, University of Vermont

Theoretical background

- The wickedness (Rittel and Webber 1973) and the complexity of many governance problems

- Evolution of "novel" public-public, private-private and public-private partnerships at multiple geographical scales

- Characterization of these partnerships as "governance networks"
  - Bogason and Musso 2006; Coen and Thatcher 2008; Ingram et al. 2005; Jones et al. 1997; Kickert et al. 1997; Klijn 1996; Klijn and Skelcher 2007; Koliba et al. 2010; Lowndes and Skelcher 1998; Meyer and Baltes 2004; O'Toole 1997; Park 1996; Provan and Kenis 2007; Skelcher 2005; Sorensen 2002; Sorensen and Torfing 2005; Torfing 2005; White 2001; Zia and Koliba 2009; Koliba et al. 2010)

Governance Networks

- Relatively stable pattern of coordinated action and resource exchanges ;

- involving policy actors crossing different social scales, drawn from the public, private or non-profit sectors and across geographic levels;

- who interact through a variety of competitive, command and control, cooperative, and negotiated arrangements;

- for purposes anchored in one or more facets of the policy stream.   **(Koliba, Meek & Zia, 2010)**

- Examples
  - **Watershed partnerships**
  - **Metropolitan Planning Organizations (MPOs)**

Management of Complex Governance Networks (CGNs)

- Formation
  - How do CGNs form? Who is represented in CGNs?
  - What are CGN goals?

- Operation
  - How do CGNs operate? What type of activities?
  - **What do CGN actors decide and how?**

- Performance and Accountability
  - How to manage the performance of network actors in CGNs? Who are these network actors accountable to?

Simulating CGN Operations: **What do CGN actors decide and how?**

- Rational decision making theories
  - Each agent maximizes expected utility (EU)

- Behavioral decision making theories
  - How agents deviate from maximizing EU?

- **Complexity and network-based decision theories**
  - **Dynamic mental models: constant updating of belief networks of agents in a given space-time**
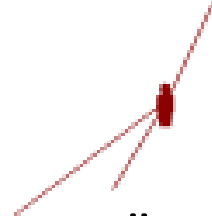 - **Dynamic cultural models: shared mental models across clusters of agents in a dynamic system**

Decision Making in Small World Networks (SWNs) versus Like-Minded Networks (LMNs)

1. How do voting outcomes in complex governance networks differ when proposals with low (.25), medium (.5) and high (.75) scores on environment-friendly, market-friendly and local government friendly decision criteria are introduced for discussion and voting?

1. How sensitive are voting outcomes to changes in the tolerance of a network members beliefs to other members' beliefs in SWNs versus LMNs?

1. How sensitive are voting outcomes to changes in the average number of connections per agent in SWNs versus tolerance of belief difference in connections in LMNs?

Prototype CGN Model: Agent Based Models to Simulate Decision Making Processes

- The model consists of three basic parts

  - People and their network

  - Groups

  - Voting process

Prototype CGN Model: People

- 51 agents
  - From a survey conducted by Paul Hirsch in 2007
    - stakeholders in a Georgia water planning process
  - Primary affiliation used to create groups of "elementary" cultural models
    - Agriculture, Business, Government, Environmentalist, Forestry, Water management
  - Three of the survey questions are used to derive the attitudes (belief networks) of the agents
    - Attitude toward local government involvement
    - Attitude toward market-based solutions
    - Importance of environmental protection
  - Responses originally ordinal -> Scaled from 0 to 1

Prototype CGN Model: Network

- Initially a small-world network is constructed
- New connections are added based on agents' similarities in LMNs and randomly in SWNs
- These connections represent an agent's social group
  - These are the people that an agent will "discuss" an issue with before they cast a final vote.
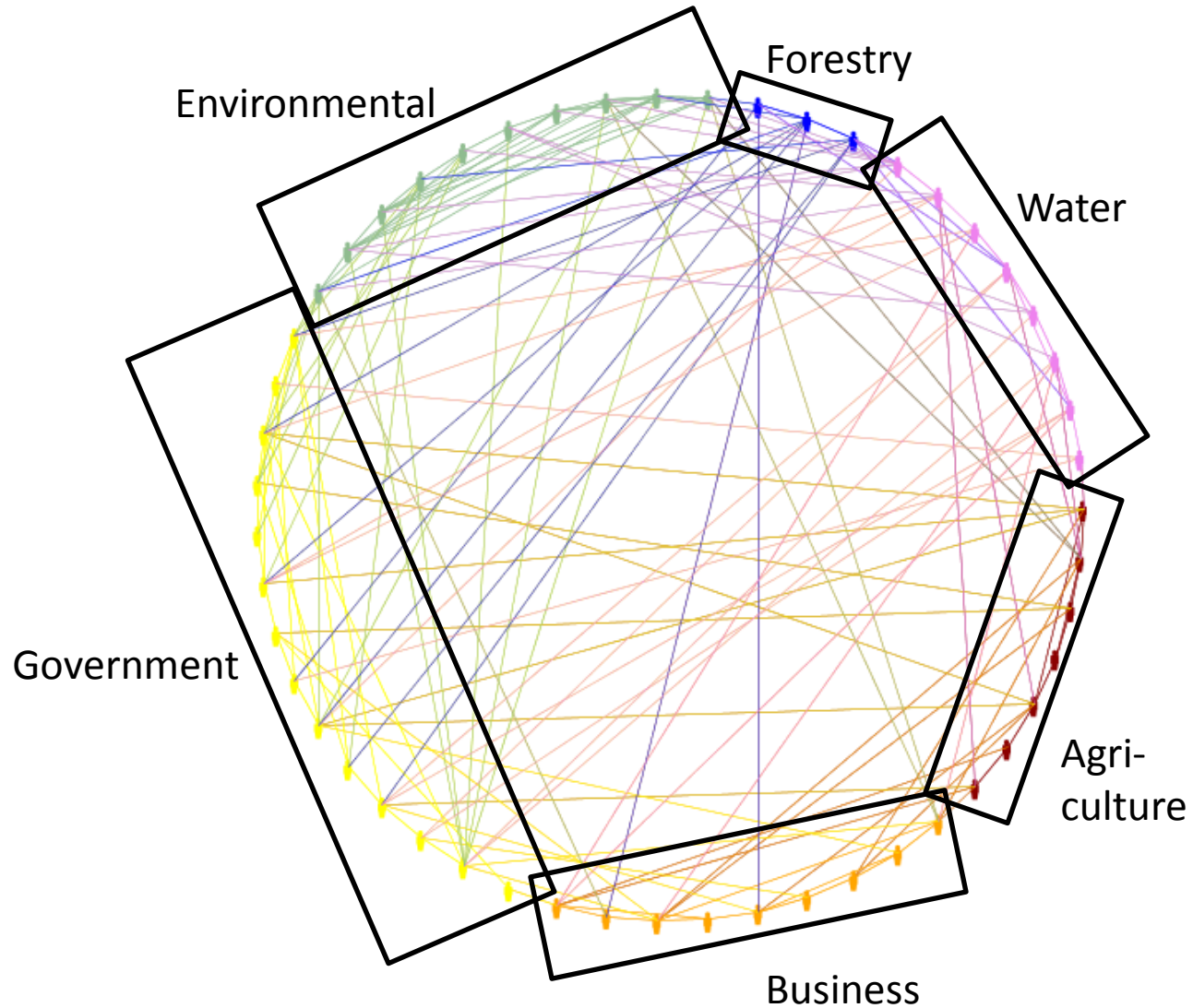
Prototype CGN Model: Groups

- Each of the 6 groups has their own strategy for making connections and voting, which underpins their **accountability ties**
    - For example:
        - Environmental group affiliates are concerned with a proposal's consideration of environmental protection and local government involvement.
        - Business affiliates are concerned with a proposal's inclusion of market-based solutions and the degree of involvement by local government agencies.
- Future work will involve developing more complex and dynamic strategies that evolve with changing accountability ties

Agent decision making
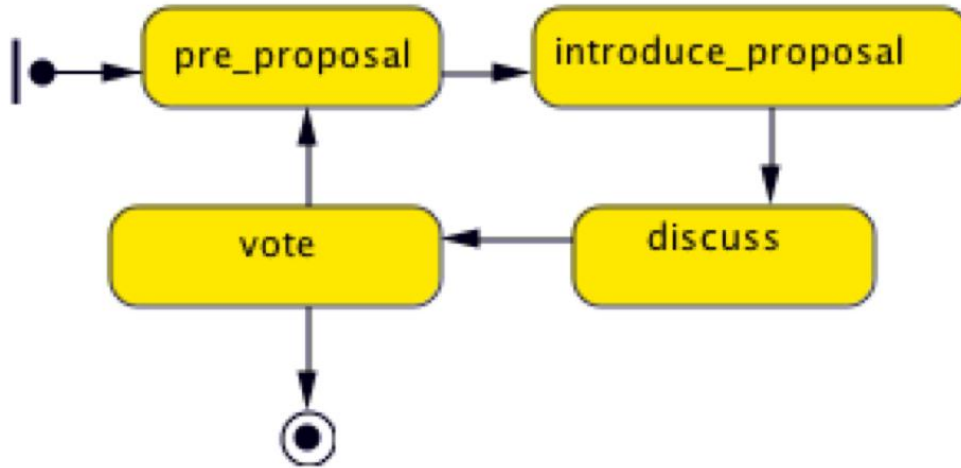
- First decision is to make friends in the group to expand the network [LMNs versus SWNs]

- The second decision an agent makes is in regards to how it will vote on the current proposal prior to the 'discussion' with its connections

- The final decision agents make is how to cast their final vote after the discussion
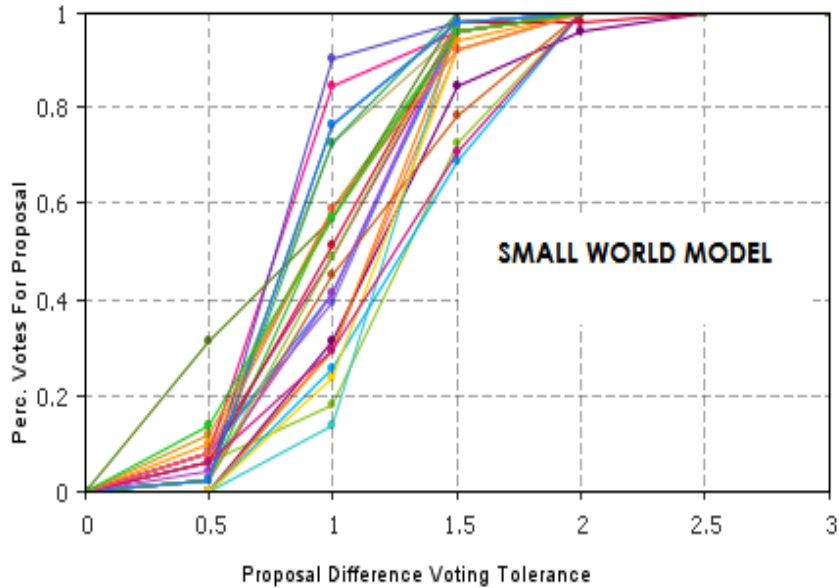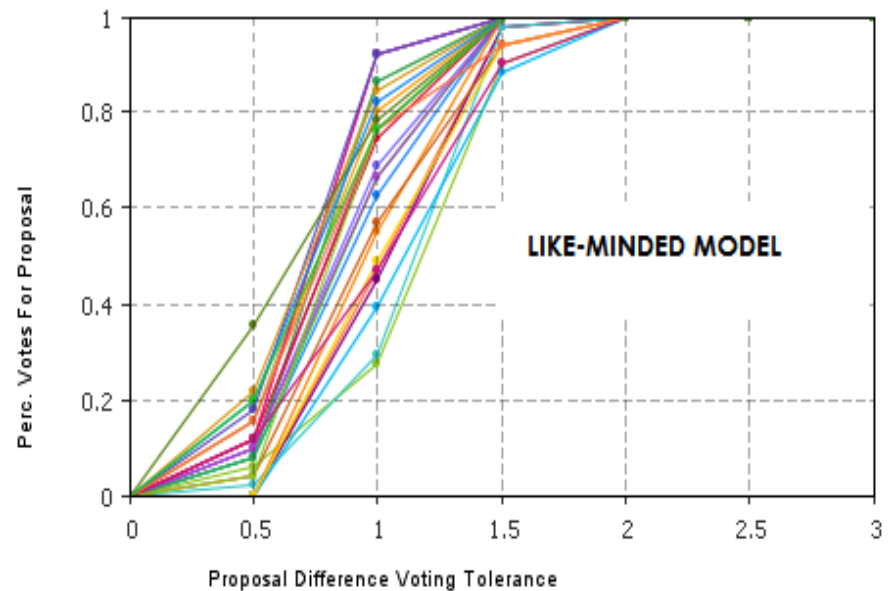
Simulation Findings: LMN
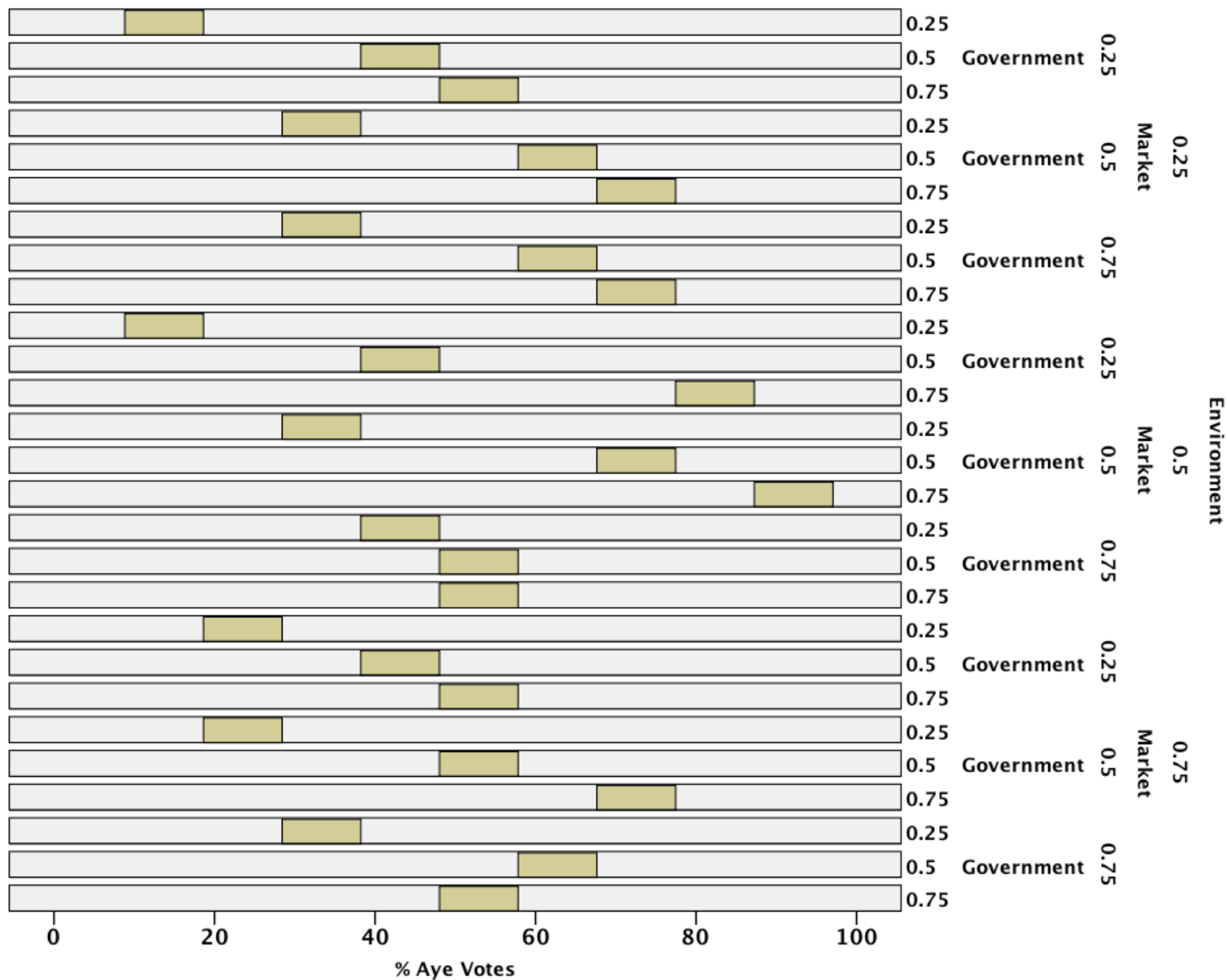
Simulation Findings: SWN
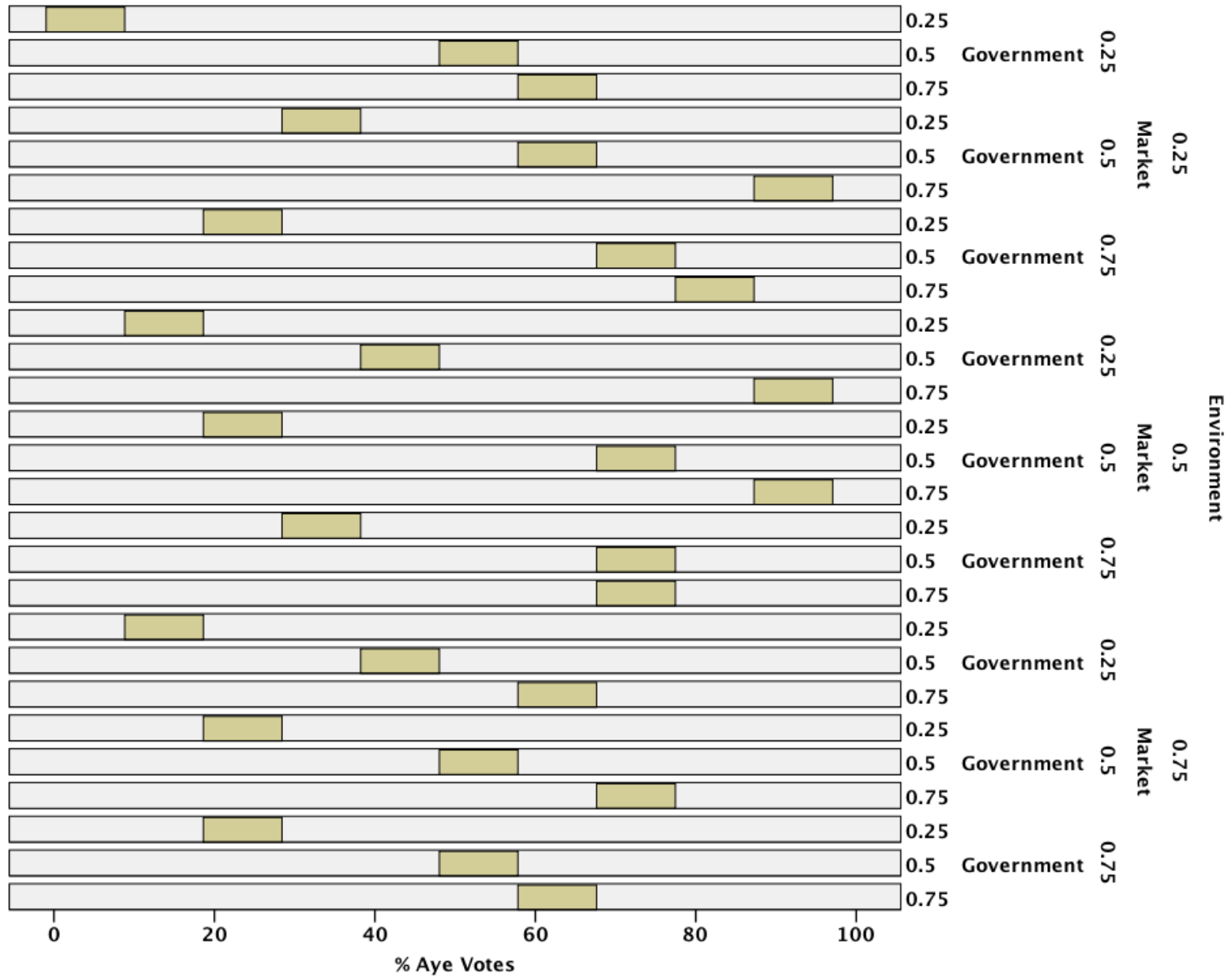
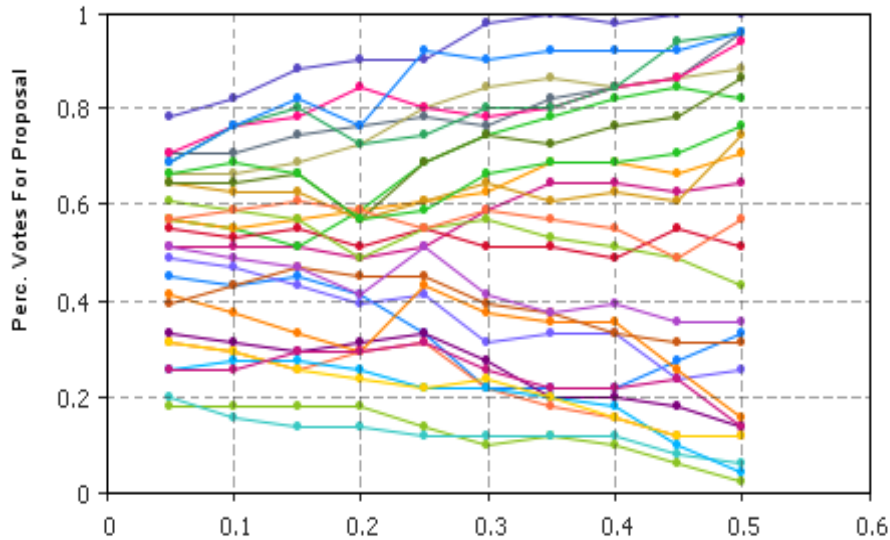# Experimental Simulation Results on the Tolerance of Belief Patterns

Experimental Simulation Results on Agent Connectedness

LIKE-MINDED NETWORK - TOLERANCE OF BELIEF
DIFFERENCE OF CONNECTED AGENTS
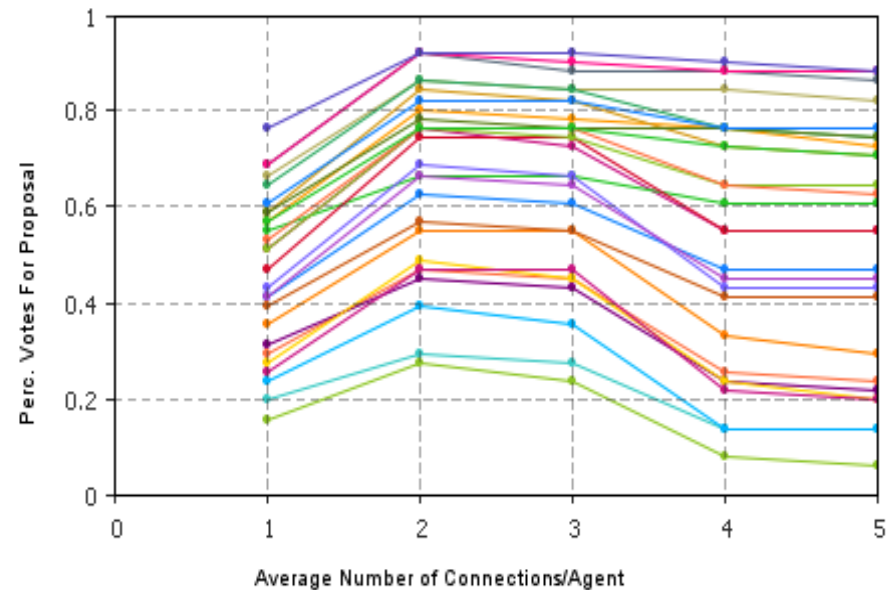
SMALL WORLD NETWORK

Next Steps: Calibration of Agent Based Model to Lake Champlain Watershed Basin

- Recalibrate agent based model to observed patterns in Lake Champlain Watershed Basin decision making
- Add dynamic strategies
  - Individual and group strategies evolve
    - Memory of wins/losses
    - Removal/addition of network connections
- Couple agent based model with a watershed landscape model

Elicitation of observed patterns in LCBP decision making

Method

1. Text Mining of LCBP historical documents: extraction of data based on plan hierarchy:
   - Goals
     - Actions
       - Tasks, Actors, Benchmarks
   a) Missing cases coded manually based on implication in task-level description text

2. Systematic coding of policy tools based on Salamon's (2002) framework.

3. Actors classified based on frequency of inclusion.
   - Word count; Actors which appear twice or more identified as clear positives.
   - Database filtered by clear positive word list and coded into 7 categories:
     - Federal; State; Local; Private; NGO; Citizens; Researchers.

4. Statistical Analysis
   1. Dependent Variables: Network Goals, Time
   2. Independent Variables: Actors Implicated, Policy Tools Utilized

Source: Salamon, L. (2002). *The Tools of Government.* Oxford: University Press.

Stakeholder Representation in the LCBP
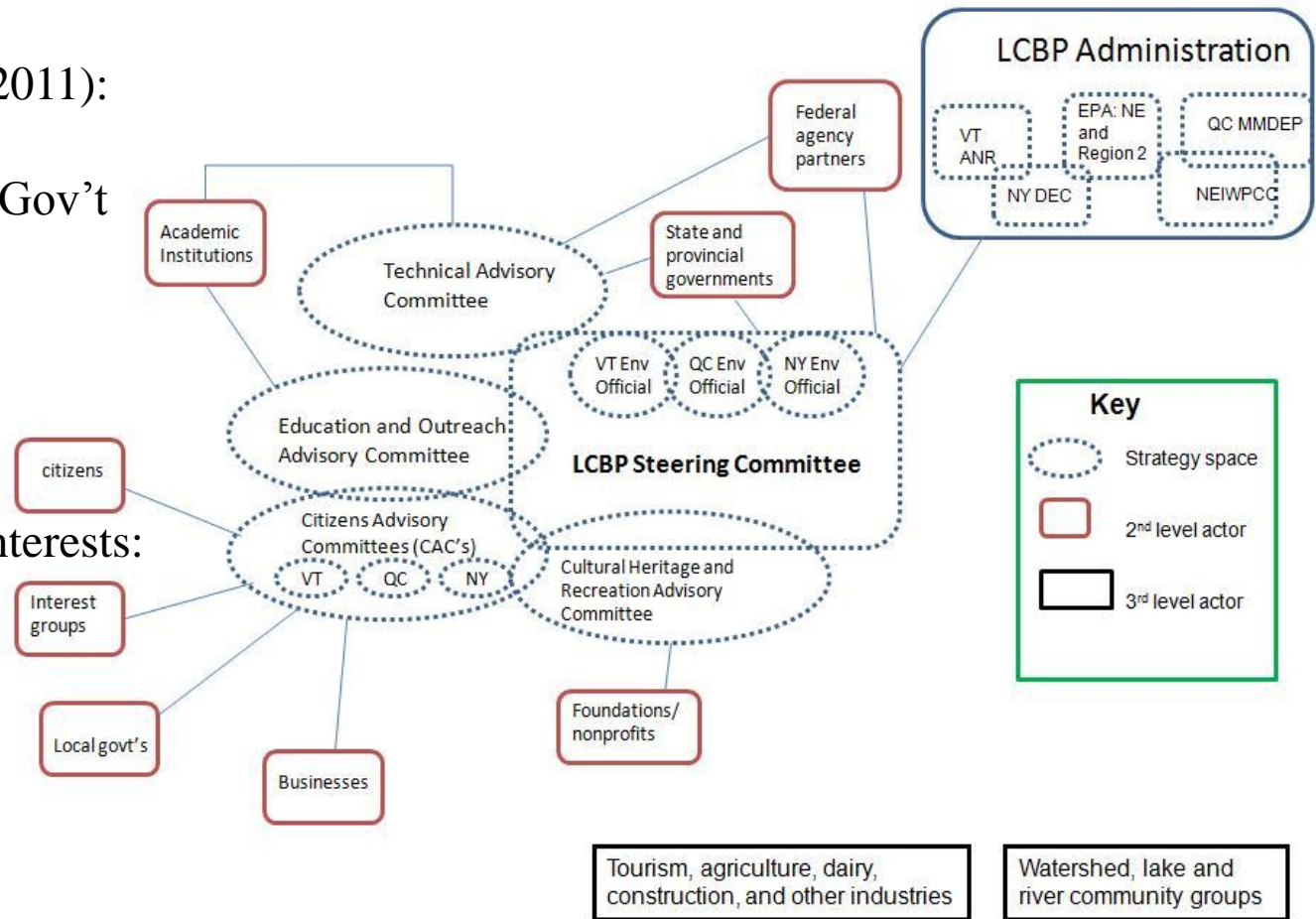
Collaborative Geogovernance

LCBP Steering Committee:
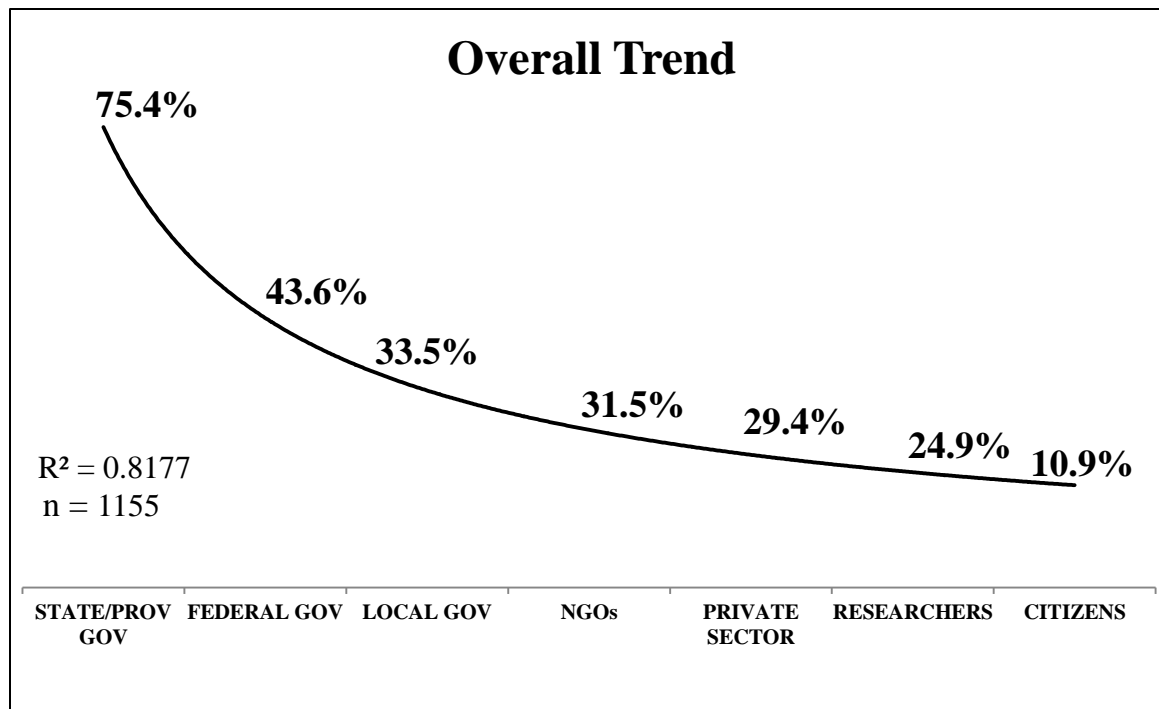
27 Members (as of Jan 2011):

- 7 Federal Gov't
- 11 State/Provincial Gov't
- 5 Local Gov't
- 1 NGO
- 1 Citizen
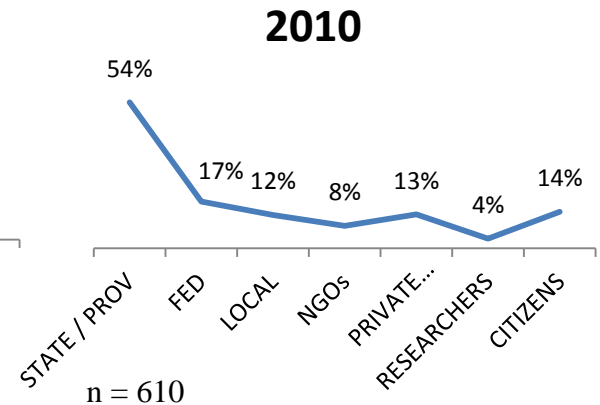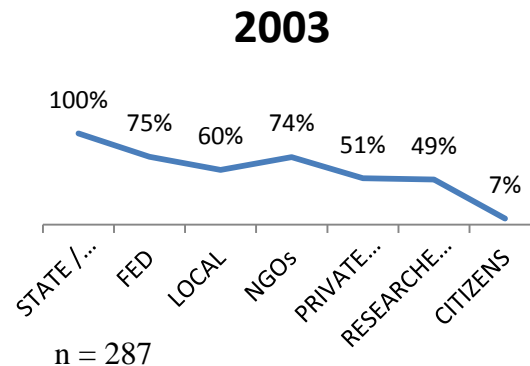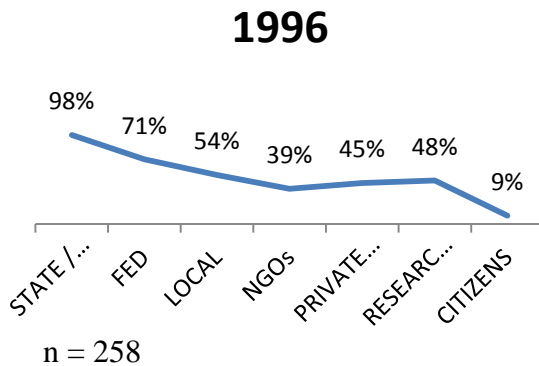- 2 Academic

Representing Domain Interests:

- Econ Development
- Agriculture
- Science
- Gov't Admin
- Rec & Culture
- Transportation
- Env Protection

Actor Responsibility as a Percentage of Network Activities

Overall Trend

75.4%

43.6%

33.5%

31.5%

29.4%

24.9% **10.9%**

R² = 0.8177
n = 1155

STATE/PROV GOV | FEDERAL GOV | LOCAL GOV | NGOs | PRIVATE SECTOR | RESEARCHERS | CITIZENS

- Power Law Distribution

- Responsibility falls heavily on State/Provincial Government, with secondary responsibility on Federal Government.
  (Consistent across goal networks)

- Shifting Responsibility
  - from Local Gov / Research
  - to Citizens / Private sector

1996

98%
71%
54%
39%
45%
48%
9%

STATE / ... | FED | LOCAL | NGOs | PRIVATE... | RESEARC... | CITIZENS

n = 258

2003

100%
75%
60%
74%
51%
49%
7%

STATE / ... | FED | LOCAL | NGOs | PRIVATE... | RESEARCHE... | CITIZENS

n = 287

2010

54%
17%
12%
8%
13%
4%
14%

STATE / PROV | FED | LOCAL | NGOs | PRIVATE... | RESEARCHERS | CITIZENS

n = 610

Meeting LCBP Network Goals with Policy Tools

Consistent across all goals and years (n=1056):
- Public Info is most common (89.3% of actions/tasks)
- Grants utilized toward all except one goal (11.5% of actions/tasks)

Additional policy tools:
- Environmental Regulation utilized toward 7 goals (13.2% of actions/tasks)
- Corrective Taxes or Tax Incentives utilized toward 5 goals (2.8% of actions/tasks)

Policy Tools Prescribed for Managing Cultural Heritage and Recreation Resources

n = 180
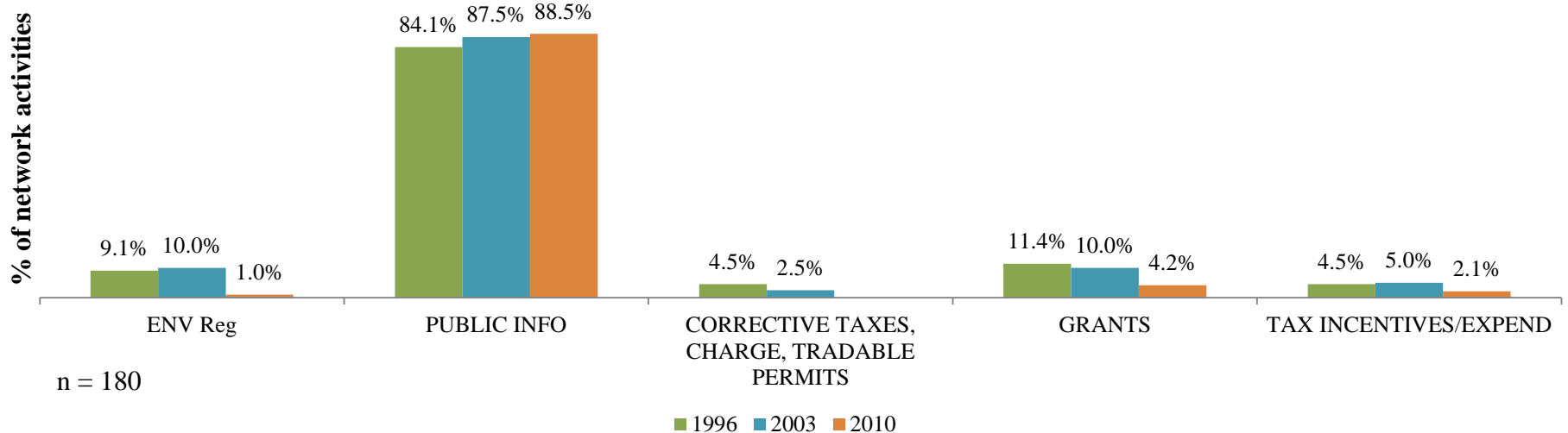
Conclusions

- **Opportunities for Agent Based Models**
  - ABMs are well-suited for the systematic assessment of complex governance networks (CGNs) through alternative theoretical lenses
    - Ability to model complex decision heuristics
    - Governance informatics
    - **Experimental Simulations**
- **Challenges**
  - **Strategy space of network actors**
  - **Matching patterns among simulations and observations**

- **For more information; please email: Asim.Zia@uvm.edu**