NetBreaker
Terrorist Organization Simulation

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*FOR THE UNITED STATES*
DEPARTMENT OF ENERGY

The Goal is to Elucidate
Possible Terrorist Networks Before They Act

- **Determining the key players and relationships in terrorist networks is a major challenge:**
  - Most networks are obvious in hindsight, after they create a tragedy
  - The challenge is elucidating possible networks before they act
- **Terrorist network structures depend partly on chance, but are not accidental:**
  - Terrorist networks are ultimately human social networks
  - Human social networks obey rules that we are now beginning to understand
  - Some of these rules can now be considered in computational models

The Problem: Can Large Social Network Structures Be Inferred From Small Amounts of Data?

- Can small samples of social network relationships be leveraged into pictures of entire networks?
- What overarching structures are most likely to produce the field observations?
- What questions should be asked next to reveal the most information about the *hidden networks*?
- Can the remaining uncertainties be quantified?
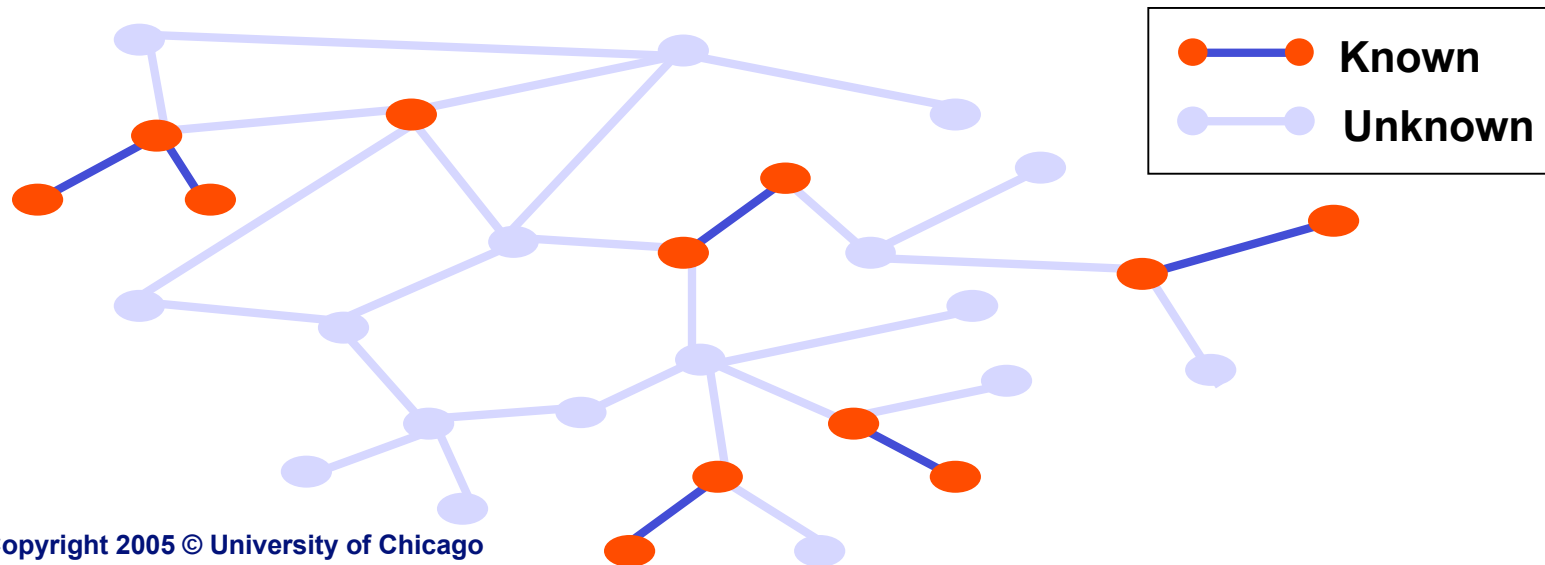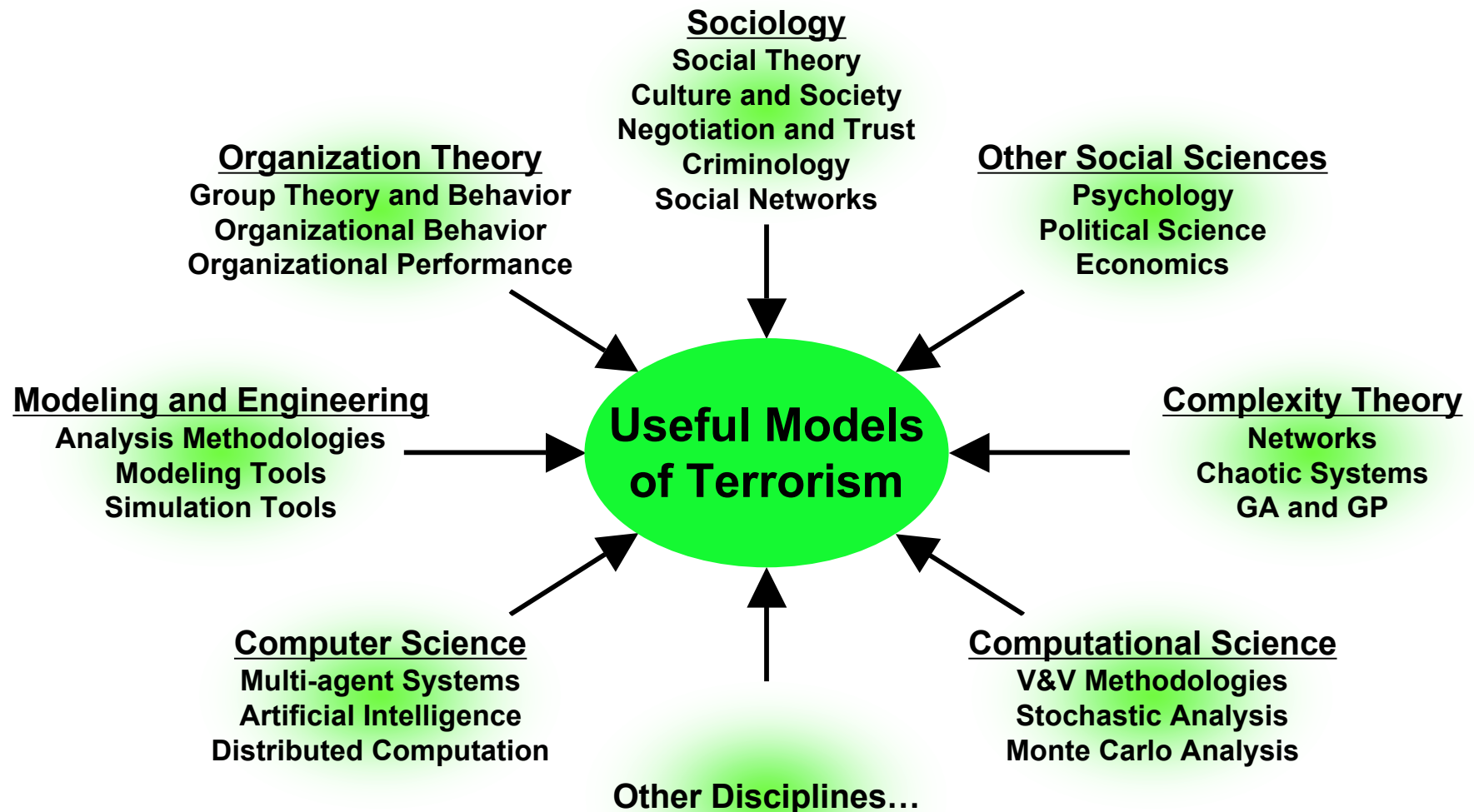

Known
Unknown

The NetBreaker Model is Designed Address the Network Inference Problem

- **NetBreaker uses agent-based social modeling to find possible terrorist networks bounded by:**
  - Known computable rules of social network formation
  - A given list of participants, along with possible unknown players
  - Existing evidence documenting interactions between the participants, along with possible unobserved, but hypothesized, interactions
- **The result is a "space" of possible terrorist networks:**
  - If the list is large enough, then the space of alternatives will contain the actual network being investigated
  - This space of alternatives can be used to create actionable questions that narrow the possibilities for the actual network
- *NetBreaker's design goal is to reduce surprise by providing and quantifying possibilities, not to determine by itself which possibility is correct*
- *NetBreaker does not remove human analysts from the investigative process, but instead helps them consider more possibilities than they could have before*

The Functions of NetBreaker are Divided into Two Distinct Aspects

- *Agent-based simulation* provides a basis for determining what a group could do including:
  - The dissemination of ideas or opinions
  - Earning, distributing, and spending money
  - Assembling and distributing weapons
- Alternative generation looks at:
  - What shape the network could take
  - Who might interact with whom
  - What these interactions may mean for the overall likelihood and threat of the network

Modeling Terrorism Is Necessarily a Multi-Disciplinary and Inter-Disciplinary Endeavor

Sociology
Social Theory
Culture and Society
Negotiation and Trust
Criminology
Social Networks

Organization Theory
Group Theory and Behavior
Organizational Behavior
Organizational Performance

Other Social Sciences
Psychology
Political Science
Economics

Modeling and Engineering
Analysis Methodologies
Modeling Tools
Simulation Tools

Useful Models of Terrorism

Complexity Theory
Networks
Chaotic Systems
GA and GP

Computer Science
Multi-agent Systems
Artificial Intelligence
Distributed Computation

Computational Science
V&V Methodologies
Stochastic Analysis
Monte Carlo Analysis

Other Disciplines…

NetBreaker Models Social Systems as *Dynamic Social Networks*

- **Both NetBreaker functions rely upon a user created network of nodes and edges representing the terrorist group**
- **This network is dynamically editable by the user during the generation or simulation process**
- **Within this network, nodes represent group members and resource centers**
- **Edges represent the observed or hypothesized interactions between the members**
- **Each edge has a user assigned confidence that represents the likelihood of the connection being correct**
- **The network is composed of a set of orthogonal layers of two types:**
  - **Social layers model social network issues**
  - **Resource layers model resource creation, distribution, and consumption**

Social Layers Represent Social Interactions

- **There are two types and several subtypes of social layers**

Social layers	
Personality	Transient
Greed, Identity, Leadership, Persuasiveness, Propensity for Supporting Violence	Propensity to Act, Support for Cause, Propensity to Provide Support

- ***Ising* sub-models are used to represent the interactions within and between the sub-layers**
- **Network agents may also be characterized by their known skills**

Resource Layers Represent Possession and Exchange of Value

- There are three types and several sub-types of resource layers

Resource layers

Diffuse	Discrete	Assembly
Funds	Conventional Weapons	Nuclear, Chemical, Biological Weapons

- Skills of network agents and resources available to them can be combined to infer a capability of the network organization
- Interactions in these sub-layers are guided by the social layers

NetBreaker Allows Exploration by Generating Feasible Alterative Networks

- **When the user has a satisfactory base network, NetBreaker can generate a space of possible alterative networks:**

  - **To generate derived networks, NetBreaker first finds the most probable shape for the network**

  - **After this has been determined, NetBreaker executes a breadth-first branching algorithm, adding or removing edges according to their effect on the network's likelihood and the agents' social compatibility**

  - **When this process is complete, the space of feasible shapes for the network has been generated and they are ranked according to likelihood or threat**

- **The user can view generated alterative networks or may begin to narrow the size of the space by providing more information in response to questions posed by NetBreaker**

NetBreaker Asks Questions Based on the Generated Alterative Networks

- **As the generation process proceeds, NetBreaker tracks how the connections affect the space of alternative networks**
- **When the generation is complete, NetBreaker has an estimate of the importance of each connection to the space of alternative networks**
- **Using this information on the connections, NetBreaker generates questions the user may answer to shrink the space of alternative networks:**
  - **The answers to these questions remove branches from the tree of derived space of alternative networks, therefore removing groups of networks from the space**
  - **Just as with the base network, the derived networks can be simulated, allowing for comparative analysis of the network's shape**
  - **This is especially useful when combined with NetBreaker's simulation scripting and analysis functions**

This is the NetBreaker Prototype Model
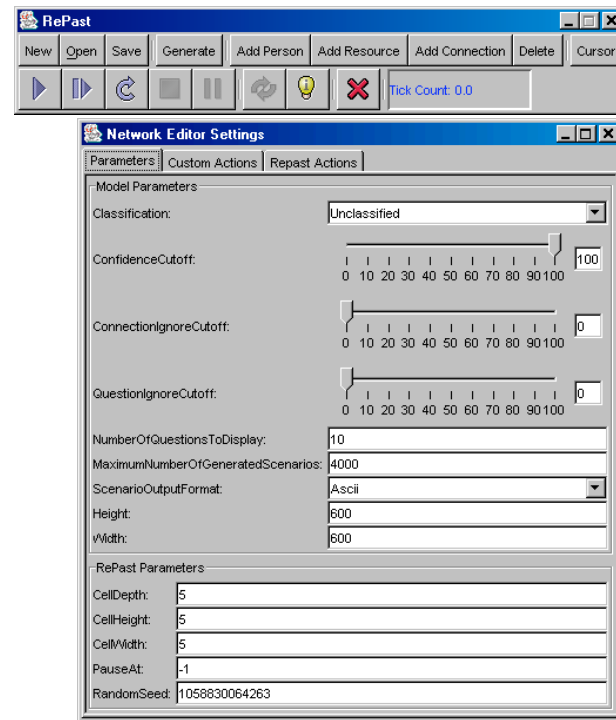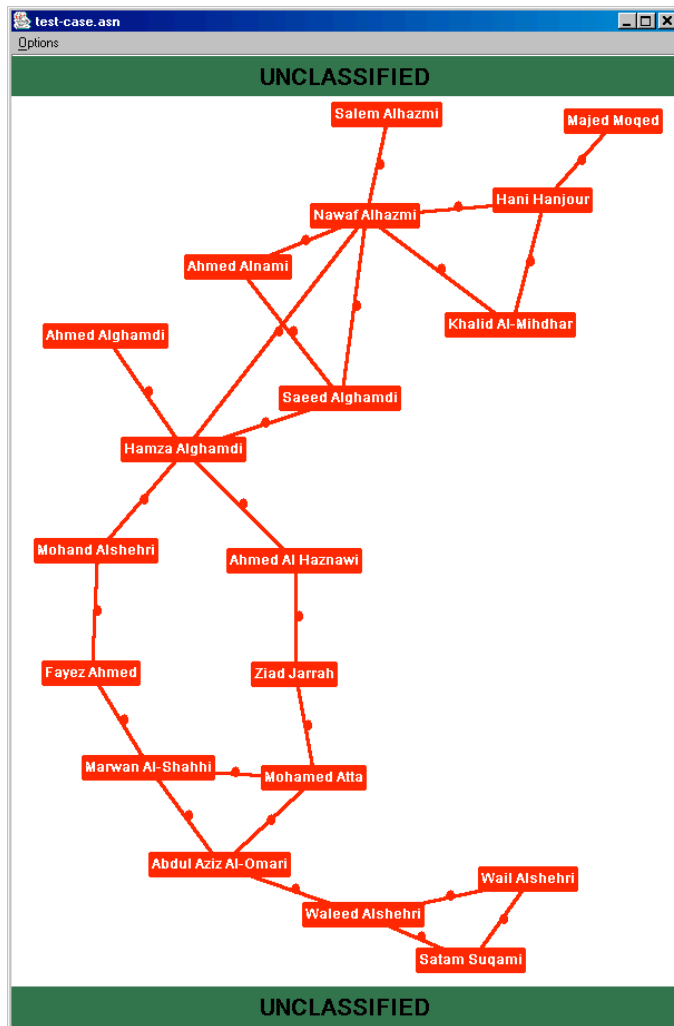
NetBreaker's Use of Social Network Rules Provides Many Advantages

- The NetBreaker model demonstrates key capabilities and concepts of a terrorist network analysis tool
- NetBreaker considers both the social and resource aspects of these networks, providing a view of possible network dynamics
- As an investigation progresses an analyst is provided with:
  - A visual representation of both the shapes the network could take and its dynamics
  - Estimates of the likelihood and threat level of the networks
  - Quantified questions illustrating what new information would be most beneficial for elucidating the network structure
- *NetBreaker is a prototype model*
- *NetBreaker's design goal is to reduce surprise by providing and quantifying possibilities, not to determine by itself which possibility is correct*
- *NetBreaker does not remove human analysts from the investigative process, but instead helps them consider more possibilities than they could have before*

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Questions?

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