ORA - TIN

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Generation of Influence Networks from Dynamic Network Data

- GOAL: semi-automated generation of influence networks
  - Reduce time to generate the network
  - Provide a first pass at an influence network that SME can modify
- What might be inferable?
  - Whether or not an activity can occur
  - Whether or not an individual or group might take an activity
  - Whether or not an individual or group will be successful in that activity
- Problem: DNA the nodes are entities but in Influence networks the nodes are statements
- Approach
  - Use Organizational theory to create rules for inferring statements from the meta-network
  - Focus on generation of structure not the probabilities
  - Generate influence network that can be used by Pythia to propagate the marginal probabilities and estimate final success

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Introduction

- Describe heuristics for generating an Influence Network from a meta network
  - Nodes in the influence network
    - Task X is done - from a task network
    - Task X is complex - from assessing the task's complexity
    - Task X is important - from assessing the task's importance
    - Task X has sufficient assigned personnel - from counting the agents assigned to the task
    - Resource A, a required resource of task X - from observing the number of assigned agents with the resource
- Illustration of use of ORA to generate an influence network from the Kenya embassy bombing case and utilize Pythia to evaluate the likelihood of task completion

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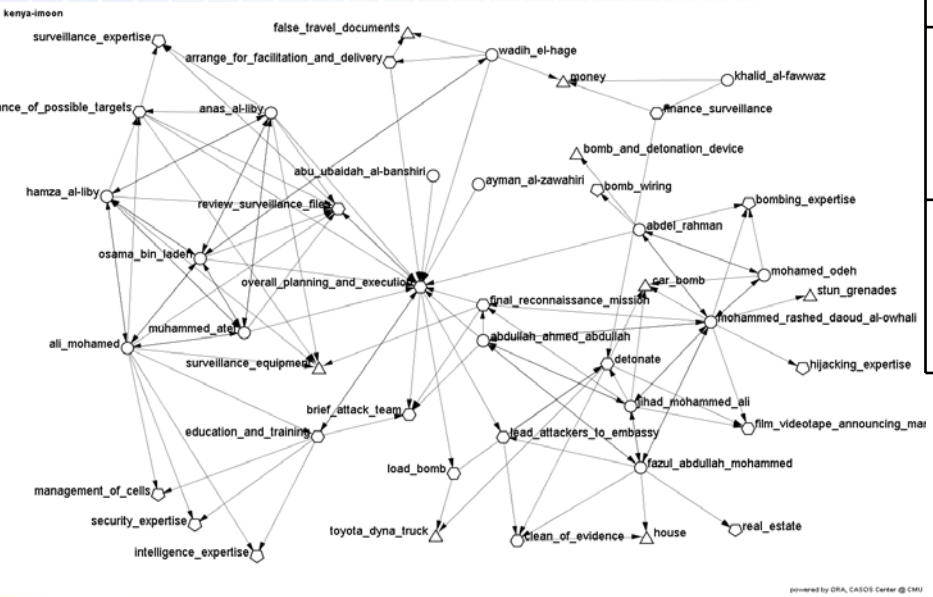
Dataset – Kenya Embassy Bombing

ORA visualization



	Terrorist	Expertise	Resource	Task
Terrorist (17)	Social Network (0.147)	Knowledge Network (0.095)	Resource Distribution Network (0.088)	Task Assignment Network (0.126)
Expertise (8)		Not used	Not used	Required Information Network (0.048)
Resource (8)			Not used	Required Resource Network (0.076)
Task (13)				Task Precedence Network (0.121)

Meta-Network structure

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How to generate an Influence Network (1)

- Input from analysts
  - A social network, a specific task to be analyzed and a set of parameters for the identified nodes and links in the influence network
- Political, Military, Economic, Information and Infrastructure, or PMESII, aspects are the elements of assessing a situation
- Six factors contributing to a task completion
  1) prior task completion
  2) task importance
  3) task complexity
  4) personnel assignment
  5) accessible expertise
  6) available resources
- The task network forms a skeleton of the influence network since we want to propagate the task completion likelihood to the final task
  - This is done by extracting Task X is done node (prior task completion node) and linking them to form the task network
- The other five task completion factors are represented as nodes and linked to a particular task

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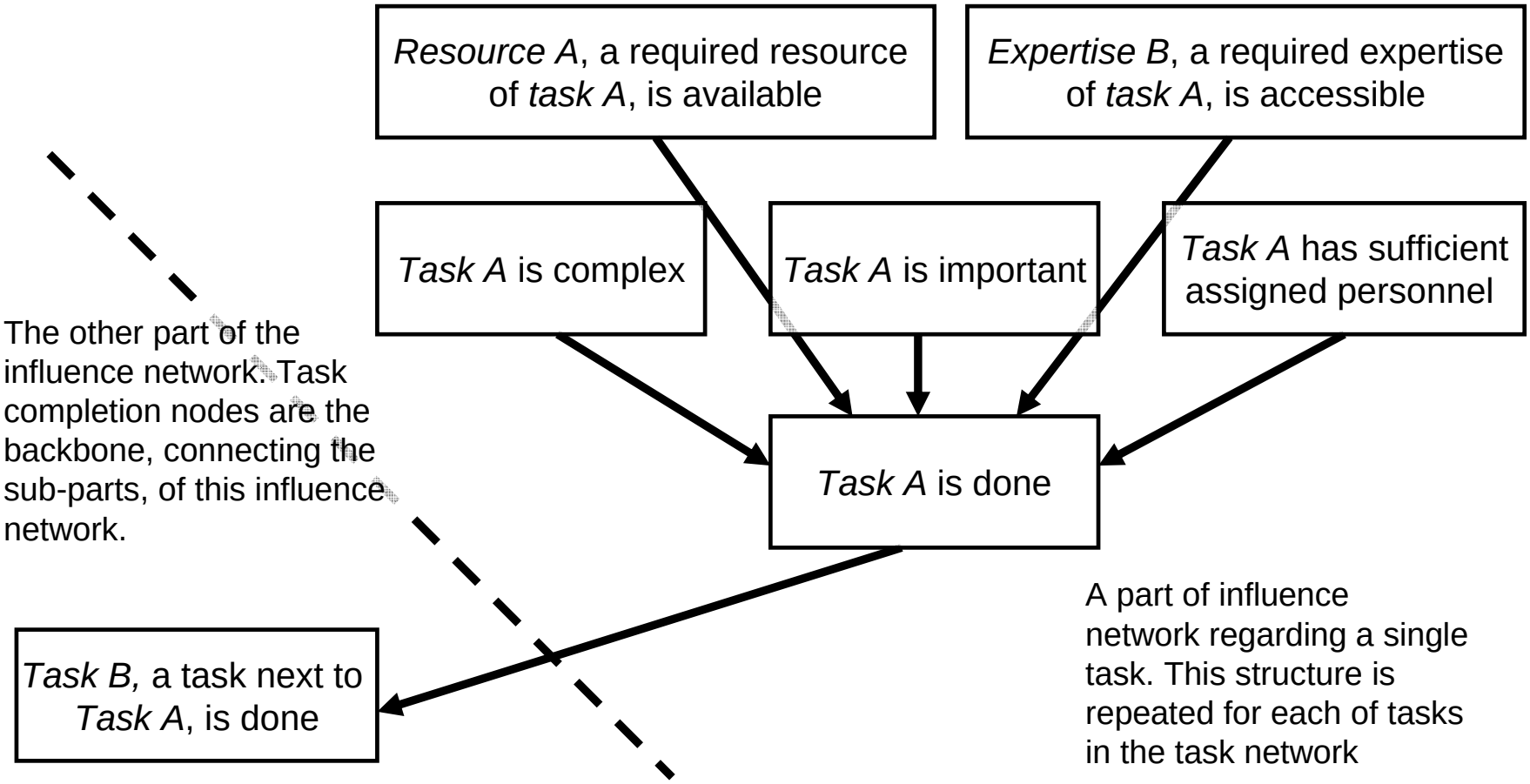
How to Generate an Influence Network [2]



The other part of the influence network. Task completion nodes are the backbone, connecting the sub-parts, of this influence network.

A part of influence network regarding a single task. This structure is repeated for each of tasks in the task network

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Assign Parameter to the Generated Influence Network (1)

Six evaluation criteria used to determine task completion

- Each of the criteria considers different aspects of a task
- The assessment rule & parameters for the generated nodes differ by task aspect
- Baseline probabilities are assigned for each factor
- The probability assignment rule is same for the same factors for different tasks
- Three parameters characterize a link in an influence network - time delay, promoter and inhibitor
- ORA defaults are:
  - time delay 0
  - promoter 0.5
  - inhibitor -0.5

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Assign Parameter to the Generated Influence Network (2)

Factor	Distribution	Baseline assessment
Task A is done	0.5	An Influence node form the task network has only one level of baseline prob.
Task A is Complex	Very Low: 0, Low: 0.25, Medium:0.5, High: 0.7, Very High: 0.8	- Very Low baseline probability if 1 person required and 0 resource/expertise required - Low baseline probability if 2 persons required and 1 resource/expertise required - Medium baseline probability if 3 persons required and 3 resources/expertise required - High baseline probability if 6 persons required and 7 resources/expertise required - Very High baseline probability for the rest of cases
Task A is important	Very Low: 0, Low: 0.25, Medium:0.5, High: 0.7, Very High: 0.8	- Very Low baseline probability if less than 0 degree centrality and 0 betweenness centrality - Low baseline probability if less than 0.25 degree centrality and 0.25 betweenness centrality - Medium baseline probability if less than 0.5 degree centrality and 0.5 betweenness centrality - High baseline probability if less than 0.75 degree centrality and 0.75 betweenness centrality - Very High baseline probability for the rest of cases
Task A has sufficient assigned personnel	Very Low: 0, Low: 0.25, Medium:0.5, High: 0.7	- Very Low baseline probability if the task has 0 personnel assigned. - Low baseline probability if the task has personnel covering 50% of required resources/expertise - Medium baseline probability if the task has personnel covering 75% of required resources/expertise - High baseline probability if the task has personnel covering 100% of required resources/expertise
Resource A, a required resource of *task A,* is available	Very Low: 0, Low: 0.25, Medium:0.5,	- Very Low baseline probability if the task has 0 assigned personnel with the resource (or expertise) - Low baseline probability if the task has 1 assigned personnel with the resource - Medium baseline probability if the task has 2 or more assigned personnel

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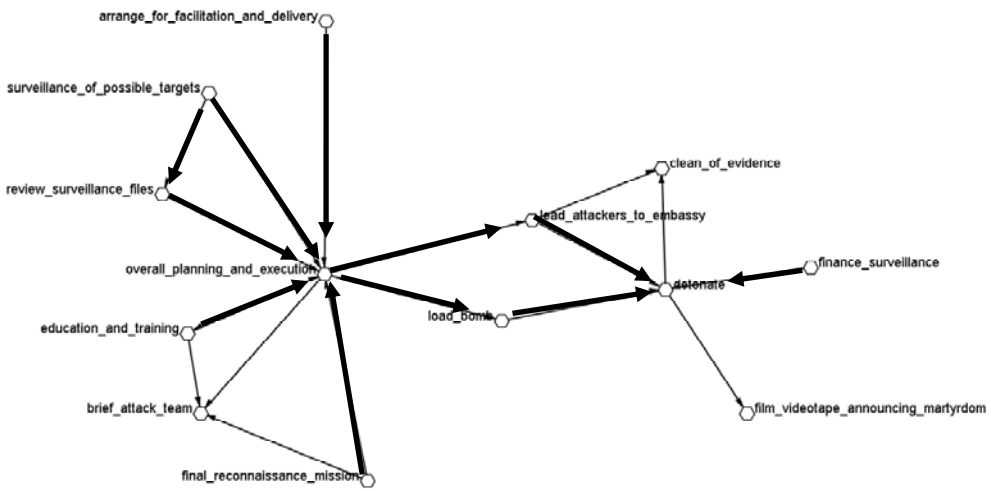
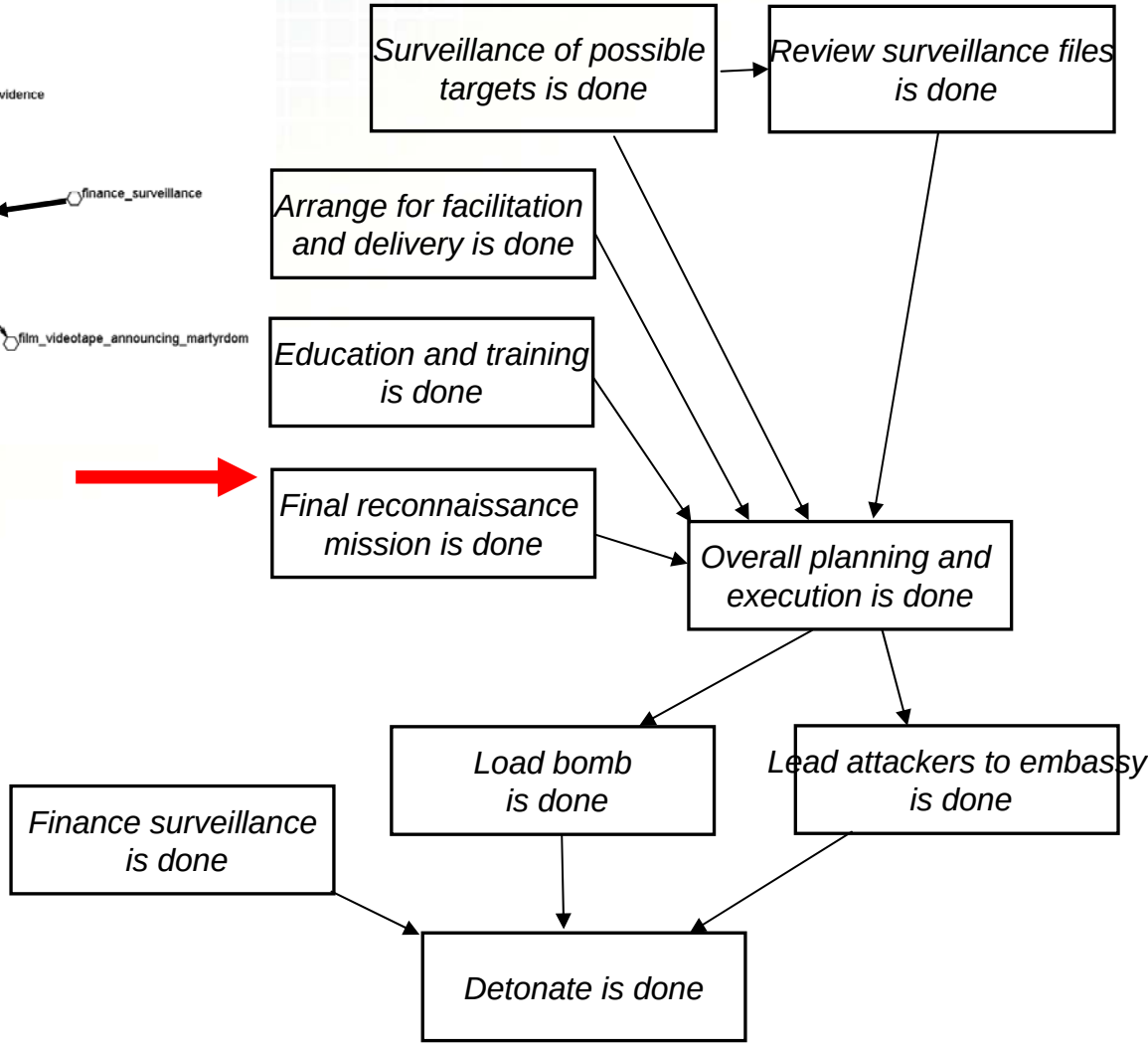
Task Network (Prior Task Completion)





- The task network becomes the basis of the generated influence network
- Through this network, the likelihood of task completion propagates to the target task to be analyzed

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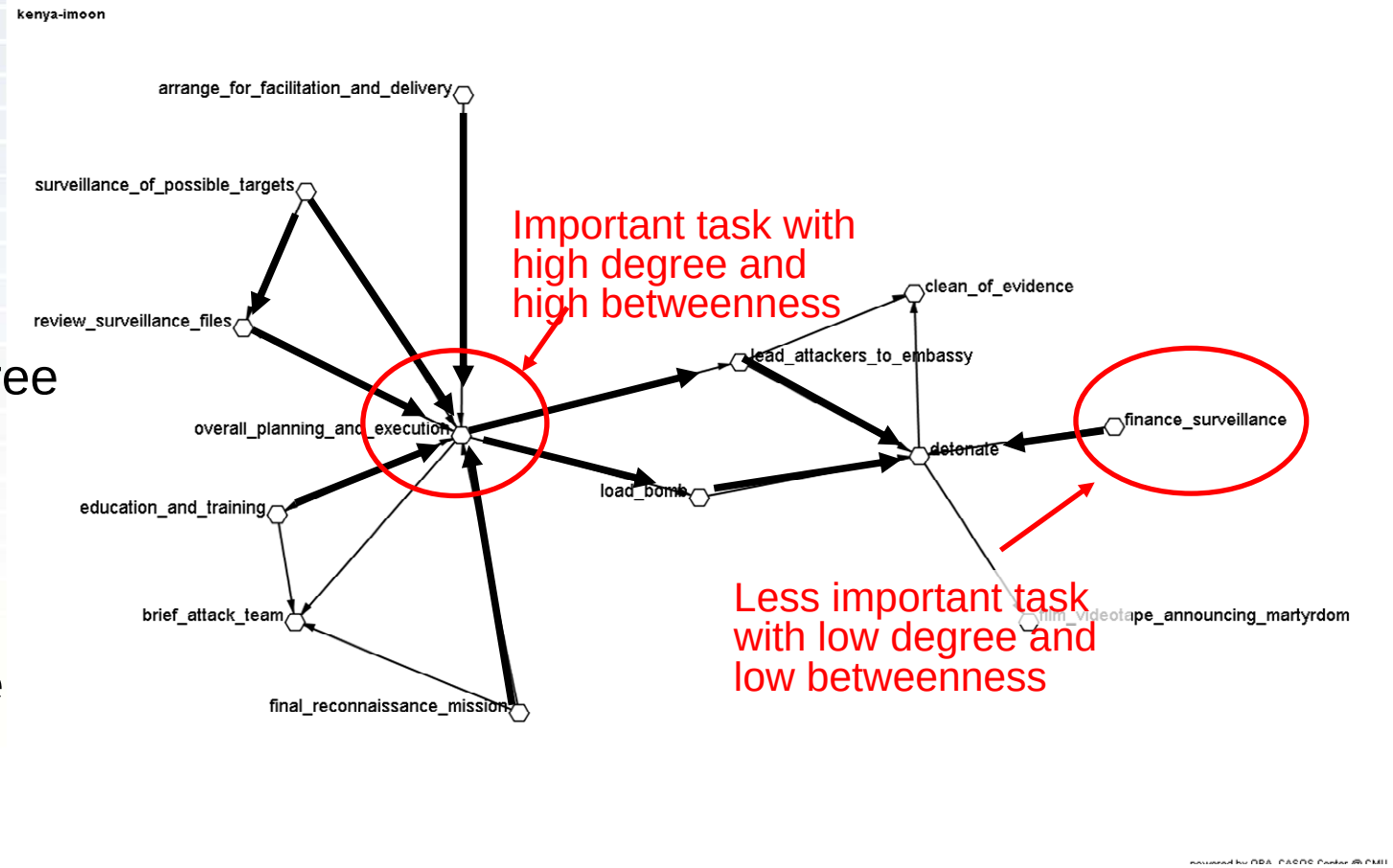
Task Importance

- A task is important if it has high degree centrality and high betweenness centrality
- If a task is important, the task is more likely to be executed



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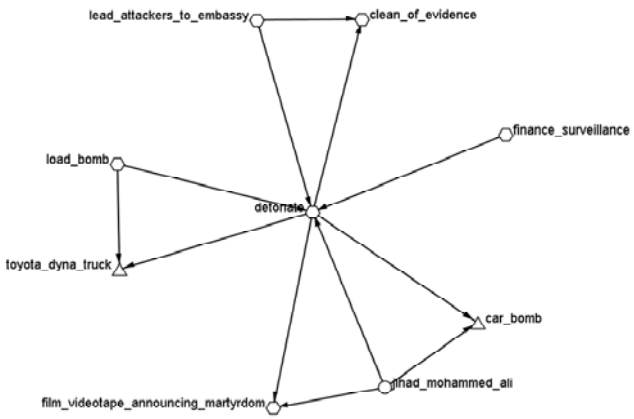
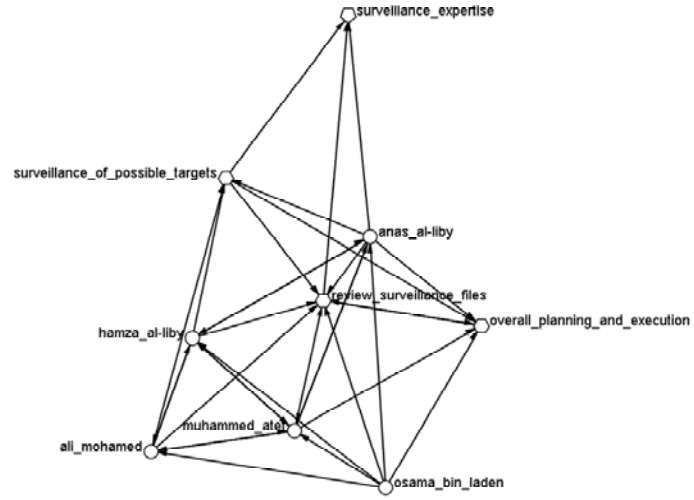
Task Complexity

kenya-imeen



- Two tasks, *detonate* and *review surveillance files*.
- Detonate: 1 agent, *jihad mohammd ali,* and 2 resources, *toyota dyna truck* and *car bomb*.
- Surveillance: 5 agents, *anas al liby, hamza al liby, muhammed atef, ali Mohamed,* and *osama bin laden*, and 1 expertise, *surveillance expertise*.
- Because the surveillance requires more personnel and similar number of resources and expertise, surveillance has a higher task complexity probability, 0.5, than detonate, 0.25.

- A task is less likely to be completed if it is complex
- We measure task complexity using the number of assigned agents and the number of required resources and expertise



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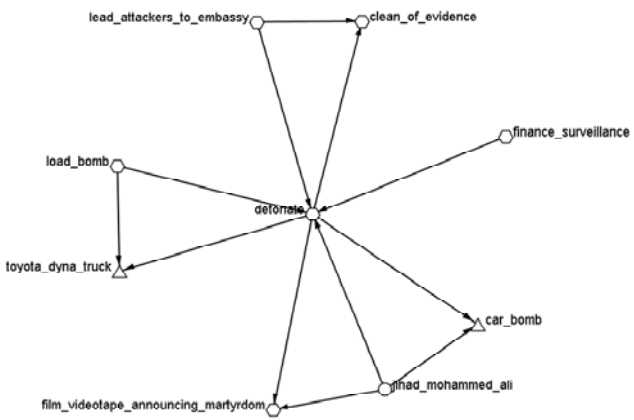
Personnel sufficiency



- *overall planning and execution* has no required resources and expertise, and has 8 assigned agents
  - personnel sufficiency is high, 0.7
- *detonate* requires 2 resources and 1 agent with one required resource
  - personnel sufficiency is low, 0.25

- A task is more likely to be completed if there are sufficient appropriate personnel
- Personnel sufficiency depends on the number of agents, and whether the agent has a required resources or expertise

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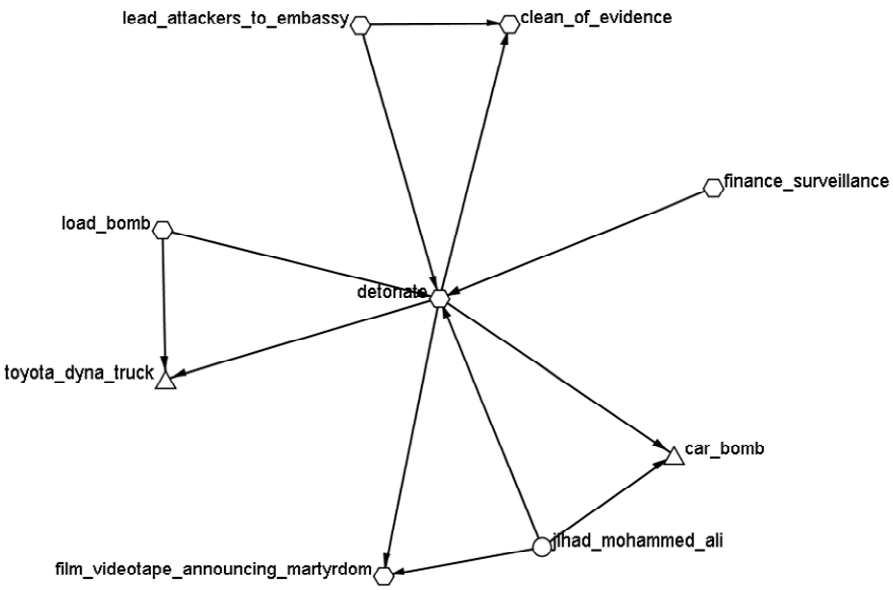
Available Resources/ Accessible Expertise



- A task is more likely to be completed if appropriate resources and expertise are available because they have been assigned to the relevant agents
- For *detonate*
  - *car bomb* is provided to *jihad mohammed ali*
  - *toyota dyna truck* is not assigned to anyone on the task
- Therefore, an influence node,
  - *car bomb is available*, has a higher probability, 0.25,
  - compared to *toyota dyna truck is available*, 0.
- Availability is assess for both expertise & resources

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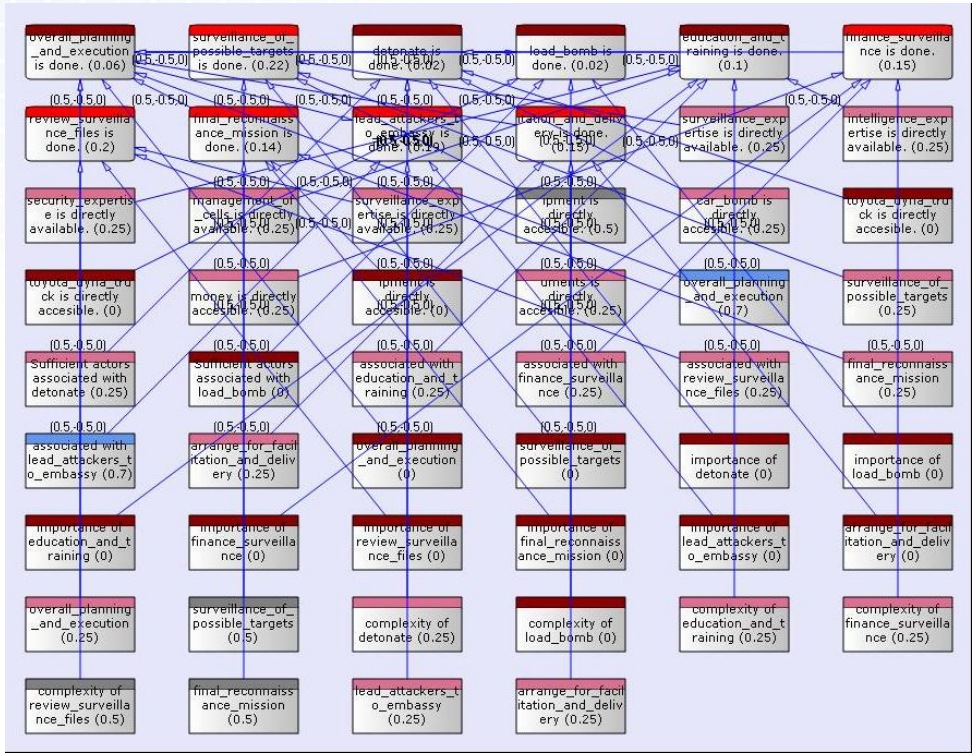
Generated Influence Network and Evaluation Result

Task	Marginal Prob.
Planning & execution	0.0643
Surveillance	0.2199
Detonate	0.0244
Load bomb	0.0186
Education &training	0.1048
Finance surveillance	0.1499
Review surveillance files	0.2041
Final reconnaissance	0.1367
Lead attackers to embassy	0.1895
Arrange for … delivery	0.1499



- ORA generates the influence network which is visualized & evaluated by *Pythia*
- The marginal probability of *detonate* is only 2%, and the mission was successful
- Likelihood diminishes quickly as it propagate through the task network
  - Tasks requiring multiple stages are less likely to be successful

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Additional Information

- ORA can generate and read in influence networks
- The structure of the influence network can be assessed
  - Is there such a thing as a well formed influence network?
- Interoperability was confirmed when ORA generated SLT file was loaded in Pythia and vice versa
- Possible evaluations should include
  - A course of action analysis using Pythia
  - A strategic intervention (node, or agents, removals) analysis by using ORA
- Next steps
  - Generate likely motivations
  - Export to other tools – e.g. netica
  - Enable user to input possible task network and assess capability

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