Micro Simulations in ORA

Tom Magelinski
tmagelin@andrew.cmu.edu
School of Computer Science, Carnegie Mellon
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Agenda

- Micro Simulations Background
- Generate Stylized Networks for Micro Simulation Experiments
- Run Micro Simulations from ORA Visualizer
- Run Micro Simulations from ORA Menu
  - Visualization of networks over time
  - Visualization of agent trails
  - Utilized Network
- Questions
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Simulation

• Networks are complicated!

• Hard if not impossible to find analytical solutions to some key network questions
  – How do nodes interact in a complex network?
  – How does something diffuse in a complex network?
  – How do conflicting ties playout in a complex network?

• Most practical approach is to try it out
  – Set up a probabilistic experiment
  – Repeat the experiment many times
  – Analyze the results
What are Micro Simulations?

- Simulations of something moving through a network over time

- Four Types of Diffusion Models in ORA:
  - “Disease” diffusion
  - “Monetary” diffusion
  - “Idea” diffusion
  - “Technology adoption”

Input / Output of Micro Sims In ORA

- Input:
  - A square network comprised of one node class
    - agent by agent, location by location, etc.
  - A subset of nodes to initialize the diffusion
  - Transmission Resistance
    - Number between 0 and 1
  - Model specific parameters

- Output of Micro Simulations
  - Diffusion networks
  - Dynamic visualizations of the diffusion process over time
    - only if run via ORA Visualizer
Micro Simulation Outline in ORA

- The Diffusion Process
  - Agents with resources try to propagate them to their neighbors
  - Resources are diffused across a link if BOTH checks are passed

- The Link Activation Checks
  - A probabilistic process
  - Link weight check:
    \[ p = \frac{\text{Link weight}}{\text{Maximum Link Weight}} \]
    - Stronger Links -> More Likely to Diffuse
  - Transmission resistance check:
    \[ p = 1 - \text{Transmission Resistance} \]
  - Repeats for each time step

Types of Micro Sims: Idea Diffusion

- An agent can give away information it has access to
- An agent retains information even after giving it away
- An agent never loses information it gains
- An agent never stops giving away information
Types of Micro Sims: Money Diffusion

- An agent can give away money it possesses (all or nothing) to only one of its neighbors (pick randomly)
- Once given, the agent lost the money immediately
- An agent can re-acquire money previously given away

Types of Micro Sims: Disease Diffusion

- An agent can give the disease to other entities while it is infectious.
- A agent will be “cured” after a user-specified number of time periods.
- Once the agent is cured, it becomes immune against it and can not become infected again.
- Additional model parameter: a user-specified parameter indicating the proportion of agents who are immune
Types of Micro Sims: Technology Adoption

- An agent may adopt a technology if enough of its neighbors use the technology.
- An agent can stop using a technology, especially if its neighbors are not using the technology.
- For an agent with no incoming links, it will flip a coin to adopt/drop a technology.
- An agent can re-start using a technology.

Overview of Micro Sim. Types

<table>
<thead>
<tr>
<th></th>
<th>I can give it to others</th>
<th>I lose it after sharing</th>
<th>I lose it after some time</th>
<th>I can get it back</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ideas</td>
<td>YES</td>
<td>No</td>
<td>No</td>
<td>N/A</td>
</tr>
<tr>
<td>Disease</td>
<td>YES</td>
<td>No</td>
<td>YES</td>
<td>No</td>
</tr>
<tr>
<td>Money</td>
<td>YES</td>
<td>YES</td>
<td>No</td>
<td>YES</td>
</tr>
<tr>
<td>Tech</td>
<td>YES</td>
<td>No</td>
<td>YES</td>
<td>YES</td>
</tr>
</tbody>
</table>
Key Takeaways

- **Micros Simulations are random!**
  - The results could be different each time you run the simulation

- **Link weight is important**
  - The larger the link weights are, the more likely diffusion is
  - In a network that has equal weights on links (e.g. binary networks), the probability to pass link weight check will always be 1 on each link

- **Transmission resistance**
  - Transmission resistant $\uparrow$, diffusion $\downarrow$
  - If transmission resistance is 0, the diffusion is solely depends on the weights of every link in the network

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open ORA from where you installed it

Pick ‘small world’
ORA Small World Generation

Change Defaults settings
• Press ‘Create’ then
• Press ‘Close’

Visualize Network

Click the “visualize” button
Small World Visualization

Under “Tools” menu, select “Micro Simulations”
Select Nodeclass and Network for Diffusion

Select node class and appropriate network id, then hit “next” button

Select Initial Agents

We’ll pick two on opposite sides of network and click Next
Choose Simulation Parameters

2. Set Choices in GUI (Diffusion of Ideas, 0.1 resistance) & Run/Pause

3. Run Simulation

observe diffusion in action (green shows diffusion)
Run Simulation

Step through time periods

Save simulation if desired

Run Simulation

Use additional tools to vary number of simulations to run and number of periods per simulation
Run Simulation

1. Increase Sims to Run (2) & Periods per Simulation (10)

Results of Multiple Runs

Run 1 and 2 results
Diffusion of Money

1. Set Parameters
2. Run
3. View

Diffusion of Disease

1. Set Sim Parameters
2. Run
3. View
Adoption of Technology

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Start the Microsimulation

Select “Micro Simulations” from “Simulations” menu

Select Network for Diffusion

select node class and appropriate network id, then hit “next” button
Select Initial Agents

We’ll pick two on opposite sides of network

Choose Simulation Parameters

Set Choices in GUI (Diffusion of Ideas, 0.1 resistance, 50 runs)

Deprecated.
Meta-Network Manager

Good idea to add details to “ID” field
Consider saving files

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Observe diffusion in action (links between agents and knowledge)
As Idea/Knowledge links to more agents, the idea moves to the center of the visualizer.

Another way to view the ties between Ideas/Knowledge and agents.
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Visualization of Trails

Another way to view the ties between Ideas/Knowledge and agents
Visualization of Trails

Choose a Network

Please select a single network to view over time.

Simulation Links

OK Cancel

Change from ‘Graph’ to ‘Simulation Links’

Trails of Information over time
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What is the Utilization Network?

- A end-of-sim view of network links used for transmission

- Link Weight$_{AB}$ = count of times transmission occurred from node A to node B (More useful for money and technology)

- If transmission occurs between Node A and B
  - Link Weight$_{AB}$ := Link Weight$_{AB}$ + 1
Utilized Network

Link Weight === Number of times transmission occurred between agent 5 and agent 6

Micro-Sims vs Near Term Analysis & Construct

- Micro-sims use fixed probabilities of transmission, Construct’s probabilities of interaction vary
- Micro-sims only require one node set and network type to run the simulation, Construct requires many
- Micro-sims used via two ways in ORA GUI, Construct is primarily non-GUI
- Micro-sims treat the examined network as static; none of the other networks (e.g. the knowledge network) will change during the simulation
- Micro-sims do not calculate diffusion metrics
Questions?

Backup Slides
Select the dynamic network generated by Micro-Simulation. Select View Measures over time from Visualizations.

1. Choose click to select
2. In the pop up window, enter exclusivity
3. Choose Exclusivity
4. Click OK and Compute
Exclusivity of Disease/Resource Diffusion Overtime

1. Click 1 and 2 in Idea Level Tab
2. View Exclusivity of idea over time