Immediate Impact Analysis

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Presentation Goals

• Introduce **Immediate Impact** Report

• This is a Hands-On Lecture, we will be doing:
  - Replication Analyses (random node removal/entropic change)
  - Immediate Impact (specific node removal/targeted change)
  - Node Addition
What happens if…

- What if
  - You fire someone
  - A group of people retire
  - You arrest members of a cell
  - You use up a resource
- Some resilience researchers call this the “Truck Factor”
- There are two key questions
  - What happens immediately?
  - What will happen after the dust settles – near term?
- The **Immediate Impact** Report helps answer what happens immediately before the network restructures

Purpose of Immediate Impact Report

- Supports what-if analysis of strategic interventions on organizational performance & individuals within
  - Interventions
    - Remove one or more nodes / links
    - Add one or more nodes / links
  - Two types of analyses
    - Impact of n specific node removals
    - Impact of n random node removals averaged over r replications
  - Report includes network- & node-level statistics for pre- & post-intervention organizations
    - Specific node removals yield Reports that include network- & node-level measures related to individual agents, tasks, resources
    - Random node removals yield Reports that include only network-level metrics.
Basic Functionality

- Quick comparison metrics for impact of hypothetical change that involves removal of specific agents, tasks, resources, etc.
- Quick assessment of sensitivity to change based on random node removals
- Easy way to create new meta-networks by removing specific nodes
  - Iterative refinement of intervention strategy
  - Input to other types of analyses via other Reports
    - Once you've removed nodes save the meta-network
    - You can then run any Report comparing the old to the new

General Process

- Random node removal analysis
  - Determine number of nodes to remove
  - Run **Immediate Impact** Report with r replications
- Specific node removal analysis
  - Determine nodes of interest
    - Qualitative analyses, hunches, intuition, etc.
    - Other ORA Reports...
      - **Key Entity** Report
      - **Intelligence** Report, etc.
  - Run **Immediate Impact** Report
  - Optional
    - Create new, post-intervention meta-network
    - Run other ORA Reports in comparison mode
Report Output

Both Analyses
Before, After, %Change
- Number of Nodes
- Overall Complexity
- Performance as Accuracy
- Diffusion
- Clustering Coefficient
- Social Density
- Communication Congruence
- Average Communication Speed
- Number of Isolated Agents
- Fragmentation
- Overall Fragmentation

Specific Node Removal
also includes Rank & Viz
- Emergent Leader
  - (Cognitive Demand)
- Potentially Influential
  - (Betweenness Centrality)
- Centrality
  - (Total Degree Centrality)

What do these things tell us

<table>
<thead>
<tr>
<th>Metric</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Nodes</td>
<td>Will go down – anchors how big is the change</td>
</tr>
<tr>
<td>Overall Complexity</td>
<td>Impact beyond that node – remember this is a meta-network</td>
</tr>
<tr>
<td>Performance as Accuracy</td>
<td>Likelihood the group will make mistakes</td>
</tr>
<tr>
<td>Diffusion</td>
<td>How fast does information flow through the group</td>
</tr>
<tr>
<td>Clustering Coefficient</td>
<td>Local density around nodes, “groupiness”</td>
</tr>
<tr>
<td>Social Density</td>
<td>Density in the social network</td>
</tr>
<tr>
<td>Communication Congruence</td>
<td>The higher the more effective the group</td>
</tr>
<tr>
<td>Average Communication Speed</td>
<td>Typical communication speed</td>
</tr>
<tr>
<td>Number of Isolated Agents</td>
<td>Who’s been entirely cut off from others</td>
</tr>
<tr>
<td>Fragmentation</td>
<td>Are there subgroups and level of subgroups</td>
</tr>
<tr>
<td>Overall Fragmentation</td>
<td></td>
</tr>
</tbody>
</table>
What do these things tell us

Specific Node Removal Report also includes 3 node-level metrics, rankings & visualization

<table>
<thead>
<tr>
<th>Metric</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emergent Leader (Cognitive Demand)</td>
<td>Who will be calling the shots</td>
</tr>
<tr>
<td>Potentially Influential (Betweenness Centrality)</td>
<td>Who will work behind the scenes</td>
</tr>
<tr>
<td>Centrality (Total Degree Centrality)</td>
<td>Who will know what is going on</td>
</tr>
</tbody>
</table>

Before

![Before Network Diagram]

After

![After Network Diagram]

Hands On...

Replication Analysis
The Network of Interest

Open Meta-Network
Select Immediate Impact Report

Generate Reports - Immediate Impact

Select Report: Filter Data, Measures, Negative Links, Transform Data, Remove Nodes

Reports: select a report to run from the list or by category.

Immediate Impact
- Computes Input Requirements Output Formats
- Computes the key actors of the network, and then isolates them individually to determine the effect on measure values.

Meta-Networks: select one or more to analyze in the report.
- Ports
- Arrows
Replication Analysis lets us understand what?

95 locations will be removed at random (10% of locations).

How robust our network is to entropic change!
IMMEDIATE IMPACT REPORT

Replication Analysis

The original input node network has the specified number of nodes from each class removed and the network recomputed. This is repeated, and the average measure values across replications compared.

<table>
<thead>
<tr>
<th>Node</th>
<th>Node removed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>B1</td>
</tr>
<tr>
<td>Potentially Influential (Betweenness Centrality)</td>
<td>0.906</td>
</tr>
<tr>
<td>Input network: Location x Location</td>
<td>0.904</td>
</tr>
<tr>
<td>Potentially Influential (Betweenness Centrality, links included) (network)</td>
<td>0</td>
</tr>
<tr>
<td>Potential Influential (Betweenness Centrality)</td>
<td>0</td>
</tr>
<tr>
<td>Input network: origin-origin</td>
<td>0</td>
</tr>
<tr>
<td>Potential Influential (Betweenness Centrality, links included) (network)</td>
<td>0</td>
</tr>
<tr>
<td>Overall Complexity</td>
<td>0.905</td>
</tr>
<tr>
<td>Import: entire meta-network considered as a single network</td>
<td>4.31e-04</td>
</tr>
</tbody>
</table>

Immediate Impact Analysis
(Targeted Node Removal)
Typical Process

- Run a Report to find nodes to remove
  - Must 1st identify nodes to target with strategic intervention
    - Good candidates for removal depend on your goal
    - Several Reports identify nodes of interest
  - Popular Reports for finding nodes whose removal will degrade organizational performance
    - Key Entities
    - Management
    - Intelligence
- Run **Immediate Impact** Report
  - Remove 1 or more entities identified as notable by prior analyses
  - save the modified meta-network for additional analyses if desired

Where should we target?

**Betweenness Centrality**

The Betweenness Centrality of node \( v \) in a network is defined as: across all node pairs that have a shortest path containing \( v \), the percentage that pass through \( v \). When the data is weighted, the higher the weight the more value the link has. Individuals or organizations that are pathologically influential are positioned to broker connections between groups and to bring to bear the influence of one group on another or serve as a gatekeeper between groups. This agent occurs on most of the shortest paths between other agents. The scientific name of this measure is betweenness centrality and it is calculated on agent by agent matrices.

If the node of interest has a higher than normal value (greater than 1 standard deviation(s)) above the mean the row is colored red. The row is green if the node is within 1 standard deviation of the mean. Finally, the row is colored blue if the node has a lower than normal value (less than one standard deviation(s)) below the mean.

**ANK (88), Anchorage Alaska is by far the highest in betweenness**
Change Analysis lets us understand what?

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Visualization</th>
<th>Ranked Tables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Choose a type of impact analysis</td>
<td>Change Analysis</td>
<td></td>
</tr>
<tr>
<td>Choose nodes to add or remove, and choose links to add, remove, or modify in value. The changes in measure values are then reported.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remove Nodes</td>
<td>Add Nodes</td>
<td>Change Links</td>
</tr>
<tr>
<td>All Node</td>
<td>Located region</td>
<td></td>
</tr>
<tr>
<td>88</td>
<td>Equals</td>
<td></td>
</tr>
</tbody>
</table>

Node Name  | AirportCode  | City  | Lat  | Long  | Time  |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>#88</td>
<td>ANC</td>
<td>Ted</td>
<td>61.17</td>
<td>140.00</td>
<td></td>
</tr>
</tbody>
</table>

Select/Clear All  | Select/Visible | 0 / 951 Selected | 1 / 951 Visible |
| < Back | Next > | Cancel |

How robust our network is to targeted change!
IMMEDIATE IMPACT REPORT

Input: Any user
Start Date: Tue May 26 14:09:06 2020

Data Description:
What is the impact of the removal of selected key entities from the network?

The selected entities are removed from the network and the effects are measured by comparing the values of key metrics before and after their removal. The results are shown graphically in terms of the portion of the network "seen" by the entities that are removed and statistically based on the entire user network. The portion of the network that is "seen" by the entities that are removed is defined as all known entities of the user selected entity classes within a path length of 2 from the target entities.

For example, if the entry class is agent, and the target is Amanda Bled then the displayed network contains all other agents that are directly connected to Bled or are directly connected to someone who is directly connected to Bled.

The following nodes were removed:

<table>
<thead>
<tr>
<th>Node</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td></td>
</tr>
</tbody>
</table>

Before Changes

After Changes

Network Level Measures

<table>
<thead>
<tr>
<th>Metric</th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall Complete Rate</td>
<td>0.008</td>
<td>0.008</td>
</tr>
</tbody>
</table>

Input: entire user network considered as a single network.

Scroll down for specific node measures

Hands On...

Node Addition
What if we open an airport?

Connect new Airport to 10% of other important airports, and assign to a region.
What have we learned?

- Compare change when we remove 10% at random, to when target the airport with highest betweenness
- Complexity = number of alternate paths
  - Implications for traveler options (trip cost)
  - Implications for network sensitivity
- In random removal, complexity increases
- In targeted removal, complexity decreases
- In node addition, complexity increases
- The airport network is robust to random shutdowns, but somewhat vulnerable to targeted outages
  - Classic problem with “hub-spoke” network structures
4 General Isolation Strategies

• Random isolation (removal from network) of 1 or more people, resources, tasks
• Centrality-based isolation
• Betweenness-based isolation
• Scenario-based isolation