Networks and Propagation for Fun, Profit and Social Good

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(1) URBAN-NET: A System to Understand and Analyze Critical Infrastructure for Emergency Management

- A licensed (ORNL+VT) toolkit that integrates
  - Network construction
  - CIS visualization
  - Failure cascade modeling
  - HotSpots algorithm to identify critical facilities
  - Scenario generator & simulator
Graph-based Module

Hard to identify cascade from overall CI network

Identifying physical interdependencies by perturbing some CI nodes

Initial perturbed nodes

<table>
<thead>
<tr>
<th>Energy</th>
<th>Water</th>
<th>Communication</th>
<th>Transportation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>Name</td>
<td>Name</td>
<td>Name</td>
</tr>
<tr>
<td>Gas_Stations</td>
<td>Waster_Water_Trea...</td>
<td>Cellular_Towers</td>
<td>Roads</td>
</tr>
<tr>
<td>10</td>
<td>6</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Transmission_lines</td>
<td>Dams</td>
<td>Cellular_Service_Ar...</td>
<td>Railroads</td>
</tr>
<tr>
<td>9</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Substations</td>
<td>NHD_Flow_Line_M...</td>
<td>FM_Antennas</td>
<td>Railroads_Substatio...</td>
</tr>
<tr>
<td>7</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Electric_Power_Gen...</td>
<td>USACE_Reservoirs</td>
<td>Internet_Exchange...</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Substation_Service...</td>
<td>Water_Poly_Bound...</td>
<td>Internet_Service_Pr...</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

Overall

Energy: 31
Water: 6
Communication: 5
Transportation: 0

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URBAN-NET Web Interface Demo

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Cut-n-Reveal: Time Series Segmentations with Explanations (ongoing)

- Identify different phases of hurricane based on severity of grid failure.
- Identify culprit counties automatically which faced severe damage in hurricane?

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(2) Query Relation Mining for E-Commerce

- Generate
  - Generate **meaningful** Customer Interaction **Networks** from engagement data
- Understand
  - Develop **insights** of the nature of the generated networks
- Exploit
  - Leverage new **insights** for Query Mining tasks

With:

- @WalmartLabs

**Paper at:**

WWW 2018

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E-Commerce Applications

Intent-based Clustering

"Phone" "Mobile" "TV" "Television"

Our Approach
Query Reformulation Network

Q1 → Q2 → Q3
 Q5
 Q4

Intent-based Partitions
Q1 → Q2 → Q3 → Q5 → Q4

Item Recommendation

Rare Query: "unicorn"

Our Approach
Item Recommendation for query Q4

Q1 → Q2 → Q3 → Q4
 Q5
 Q1
 Q2
 Q3
 Q4

Critical Queries

"iPhone" → "Phone" →

Performance of a query can impact performance of other queries

Question: Which queries have highest cumulative effect on others?

Our Approach
PART 1: Model user behavior to produce reformulation logs
PART 2: Pick queries that appear in most reformulation logs

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(3) Learning to Summarize

- **Given** a problem $Prob$ and a distribution $D$ of network instances
- **Learn** how to generate meaningful network summaries that generalizes to unseen instances from $D$?

Example:
- Similar human signaling networks
- Protein interaction network of similar proteins
- Viral Marketing
- Transportation

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Experiments: NetGist

Netgist outperforms the baselines

Community detection

Influence maximization

Detecting anomalies on mobility graphs

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Feedback-based summarization for visualization (ongoing)

- Aggregating human feedback with the learning process.

Application:

Collaborative Visualization in intelligence analysis

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Resources

Part 1: Critical Infrastructure Management
- [https://vtechworks.lib.vt.edu/bitstream/handle/10919/82747/explane.pdf?sequence=1](https://vtechworks.lib.vt.edu/bitstream/handle/10919/82747/explane.pdf?sequence=1)

Part 2: Query Relation Mining for E-Commerce
- Paper: WWW 2018:

Part 3: Learning to Summarize
- Paper: IEEE ICDM 2018
- Code: [https://github.com/SorourAmiri/NetGist](https://github.com/SorourAmiri/NetGist)