Advances in Semantically Augmented Flow Data for Dynamic Impact Assessment, Response Selection, and Alert Prioritization

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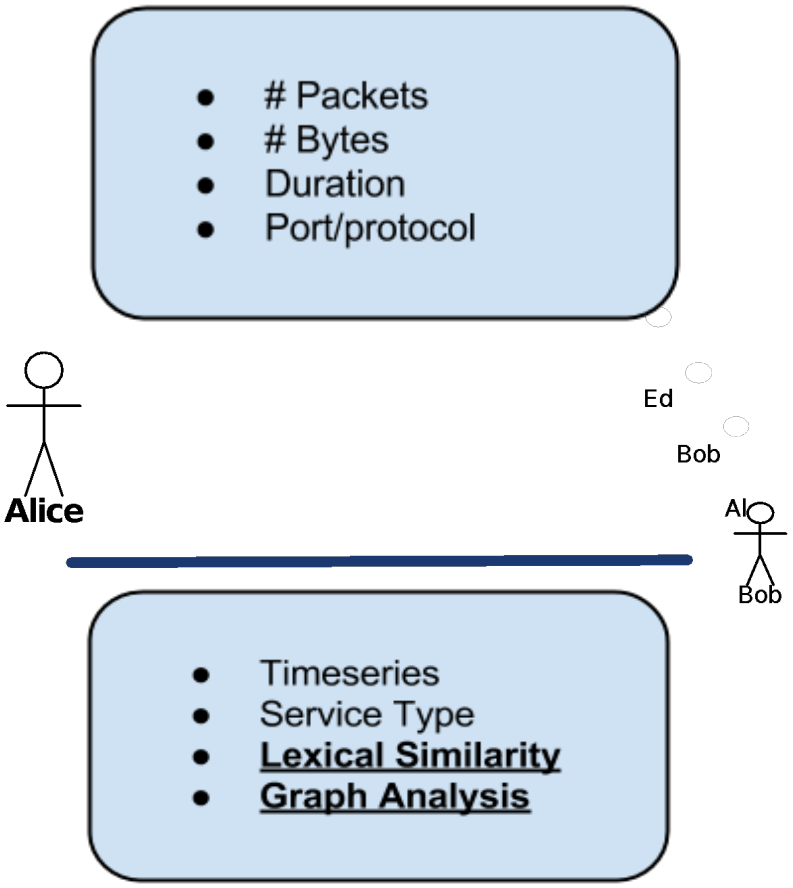
* - Presenting

Outline

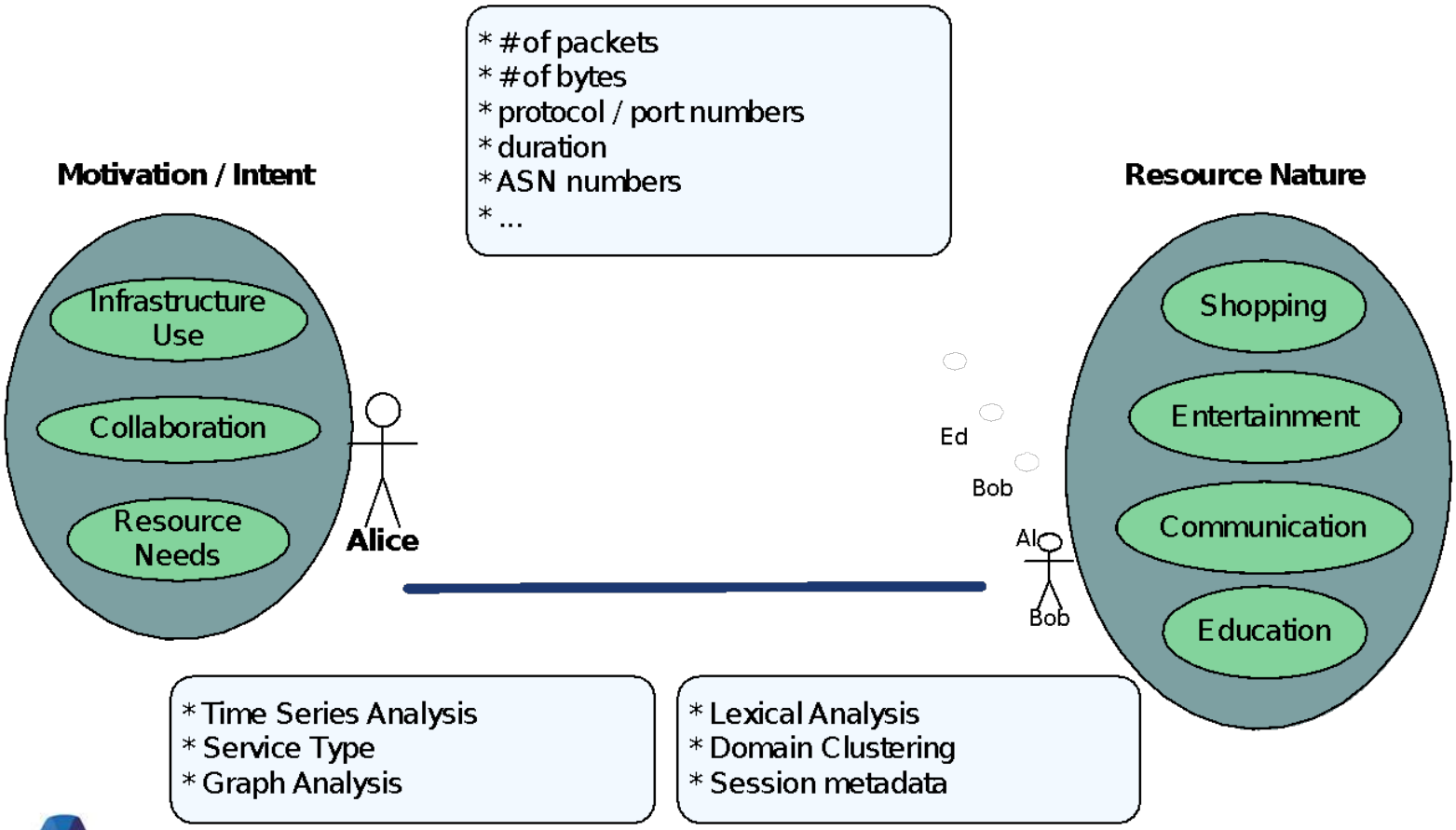
1. Semantic Augmentation Overview
2. Lexical Augmentation
3. Augmentation through Graph Analysis
4. Visualization, Data Exploration, User Interfaces

What is Semantic Flow Augmentation



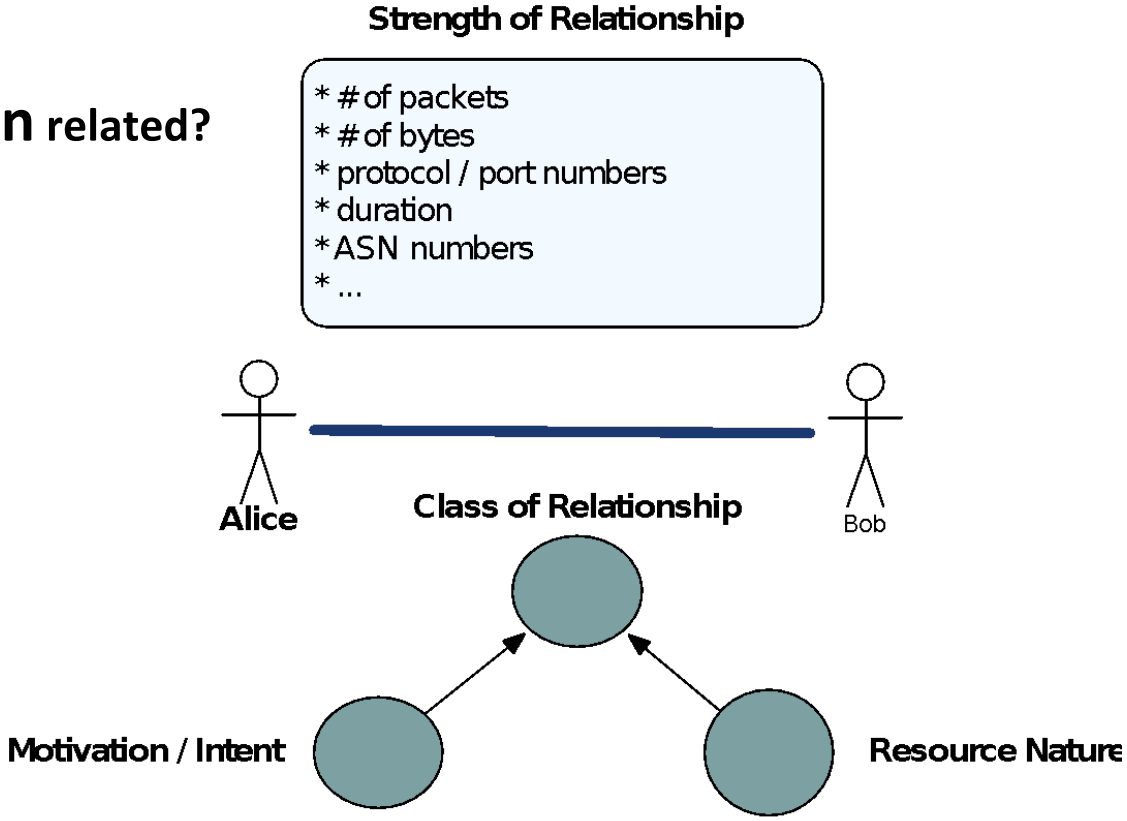
What is Semantic Flow Augmentation

- Semantic – *Of or relating to meaning…*

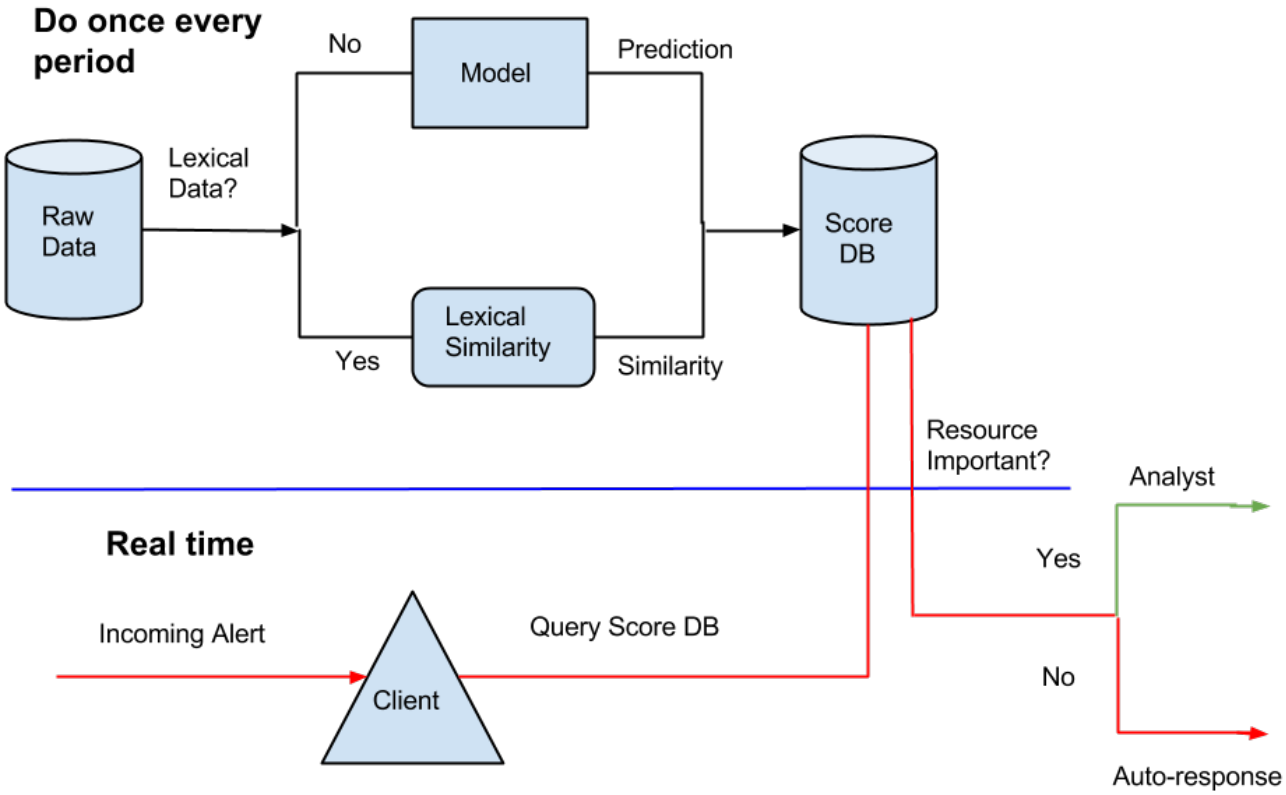


Why Semantic Augmentation

Is it mission related?



Architecture Overview



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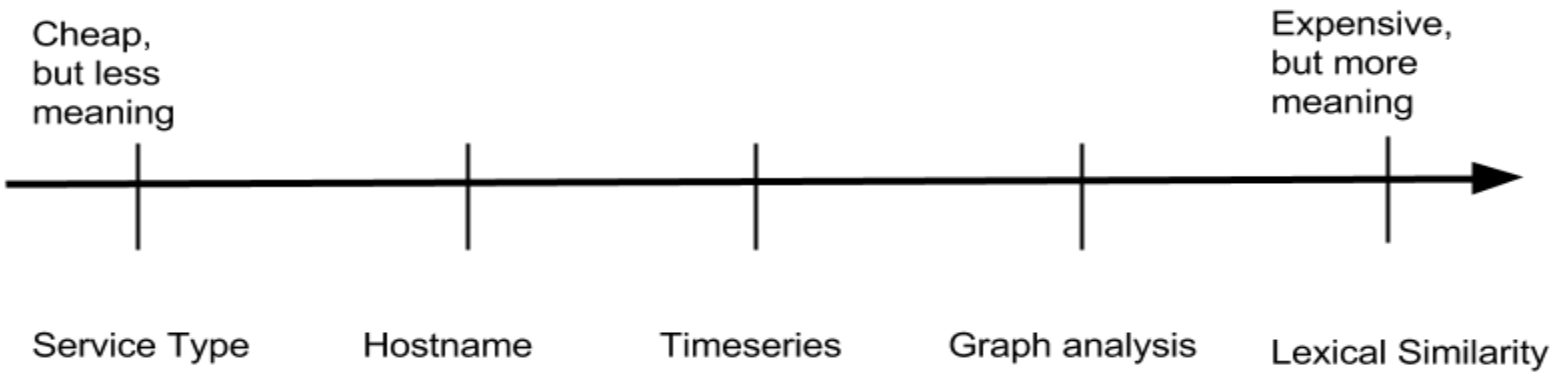
Semantic Data Sources



Challenges in Lexical Data Collection

- Can be very slow
- Tough to scale
- Noisy, machines may get blocked/blacklisted for scraping
- Complicated bootstrap/software install process

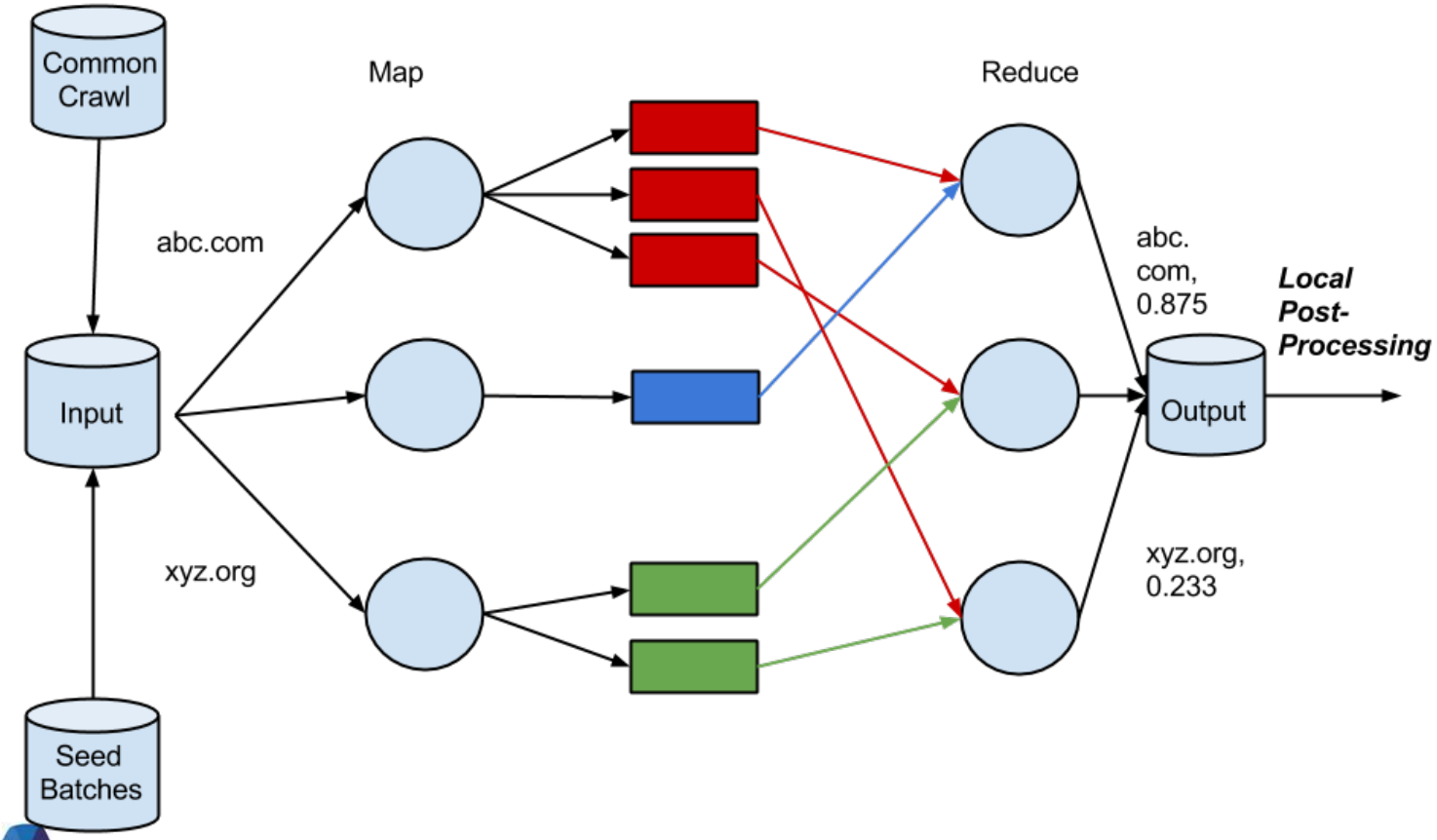
Non-solutions

- Extract data on the wire -- too slow, political concerns
- local 24/7 scraper(s) -- orgs don't want to run scrapers, machines/netblocks get blocked, angry emails
- outsource: scrape remotely -- leak traffic stats to 3rd party

Scalable, Distributed Solution

- Need a large, public data set
- Need to parallelize
- A real solution!

Amazon Elastic MapReduce



The Data

- Characteristics
- Cost
- Coverage

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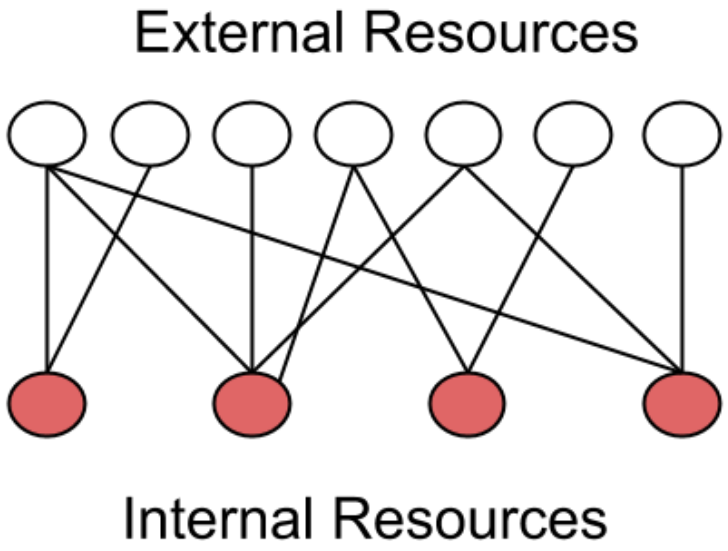
Graph Analysis: Another Semantic Data Source

- Can we use graph analysis techniques to predict resource importance?
- Can we visualize relations between remote resources based on their interactions with local resources?
- Can we figure out distinct “classes” of resources?

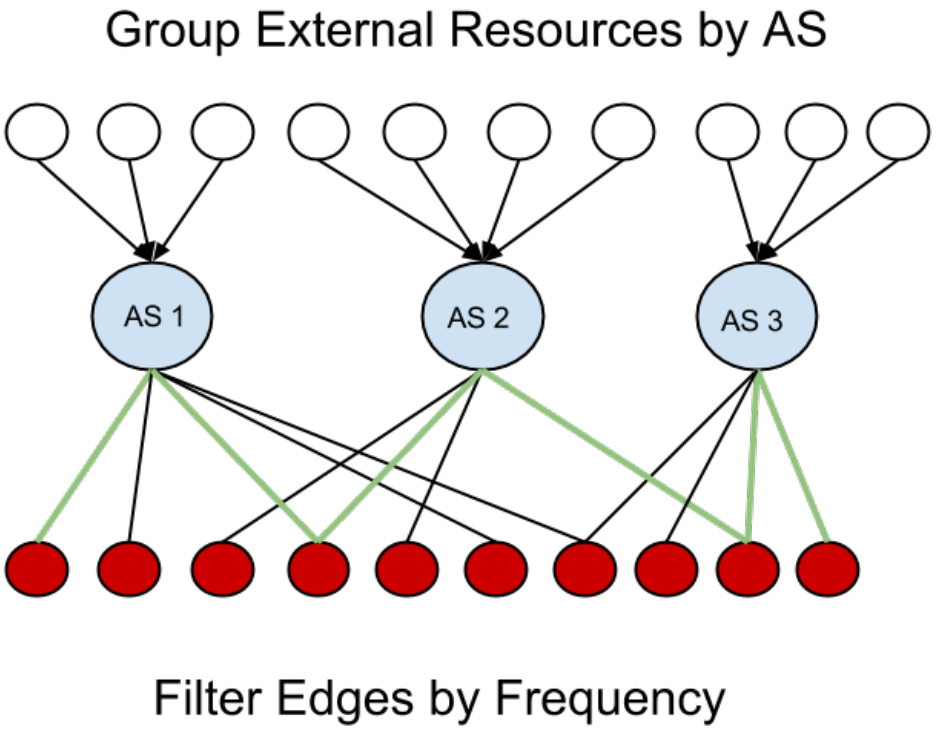
Graph of External and Internal Resources is Bipartite

- Red nodes internal resources
- Black nodes external resources
- Draw an edge if they communicate
- Clustering on this raw data is expensive!



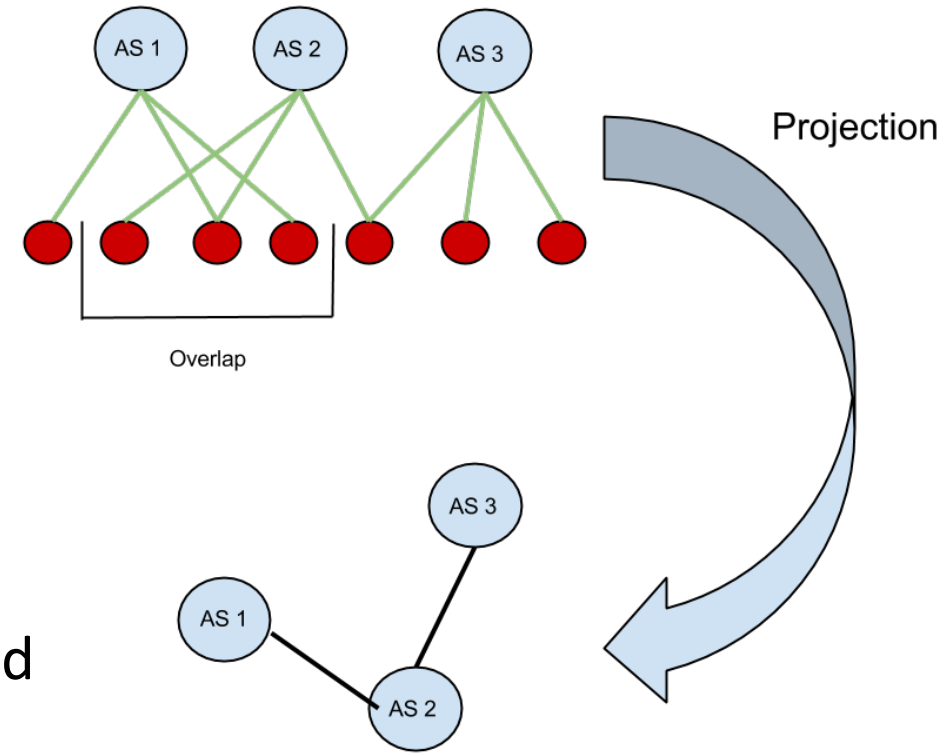
Optimizations

- Preprocess to reduce both nodes and edges
- Nodes: group by Autonomous System
- Edges: only draw an edge if sustained interaction over some time interval



Bipartite Projection

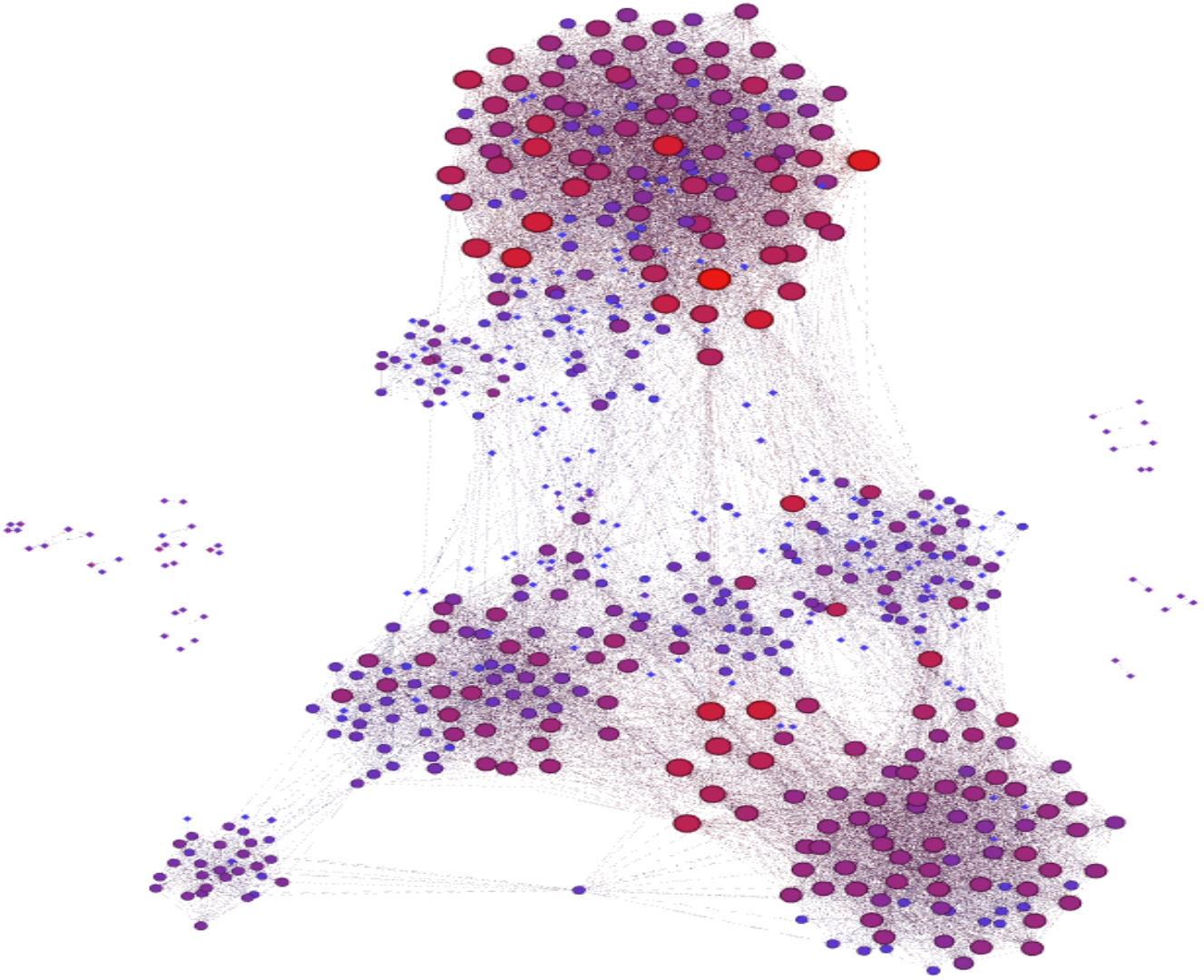
- Remove edge weights
- Use conditioned threshold approach to draw edges between ASs
- 3 threshold approaches:
  - Unconditional
  - Agent-degree conditioned
  - Dual-degree conditioned



Computing Edges Between Autonomous Systems

$$Pr(P_{ij} = x) = \frac{\binom{A}{x}\binom{A-x}{D_i-x}\binom{A-D_i}{D_j-x}}{\binom{A}{D_i}\binom{A}{D_j}} = \frac{\binom{D_i}{x}\binom{A-D_i}{D_j-x}}{\binom{A}{D_j}}$$

Zachary Neal. "The backbone of bipartite projections: Inferring relationships from co-authorship, co-sponsorship, co-attendance and other co-behaviors." Social Networks 39, 2014, 84–97



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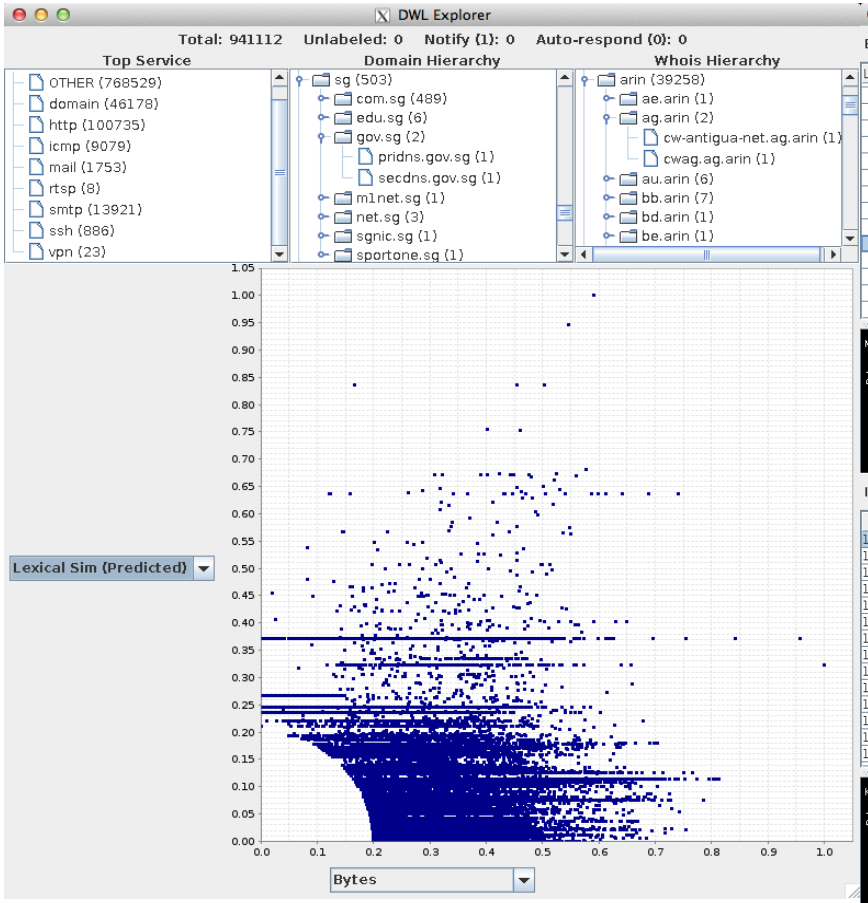
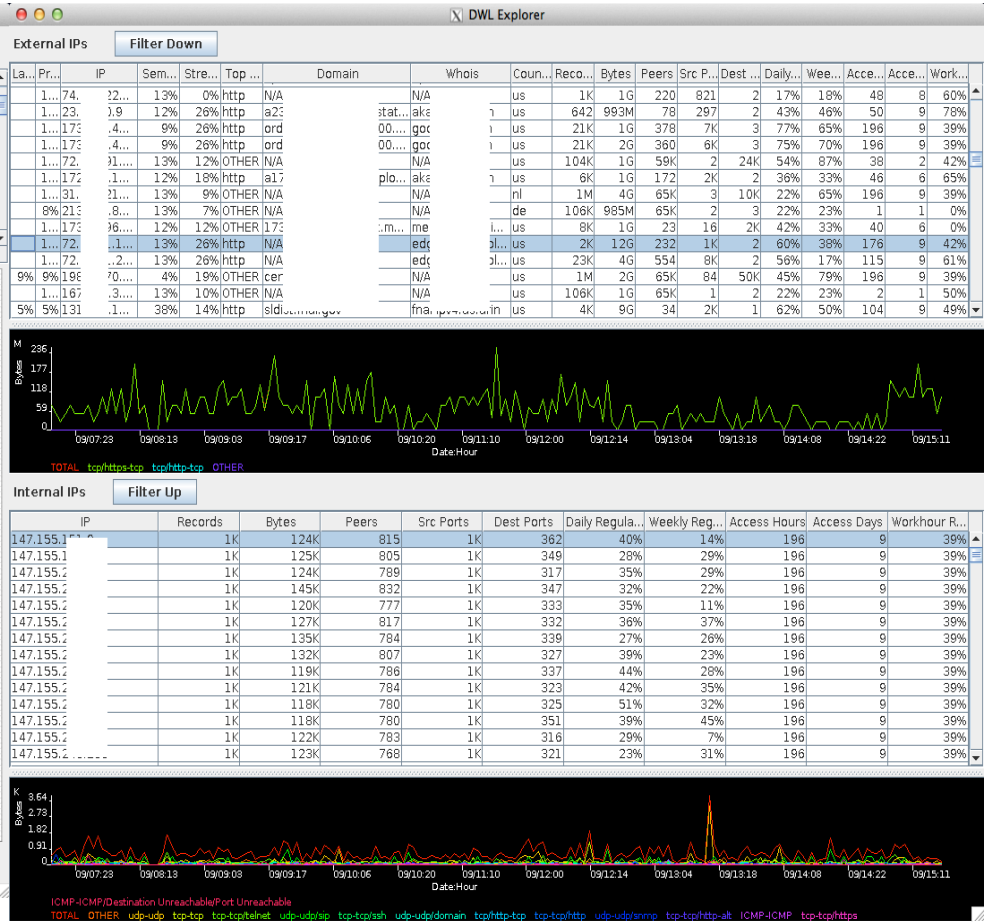
Encouraging Analyst Exploration

- Help analysts explore relationships between resources
- Discover unexpected relationships/anomalies
- Help us figure out new features
- Better understand our own network

Exploration





Software Release Information

- Software is released under BSD License
- https://github.com/Ames-Laboratory-Cyber-Group/Cydime
- Cydime is provided in the hope it will be useful, but it is primarily a research project. It may not be production ready or user friendly. Please get in touch if you'd like to try it out. We'd love to talk to you.
- cstras@ameslab.gov
- htlin@ameslab.gov
- nskinkel@ameslab.gov

Future Work

- Verify and validate lexical information
- Better results for Common Crawl resource coverage (we need more sites with more variety)
- How much information is gained/lost from lexical to bipartite graph?
- Applications beyond network security?

Special Thanks To

CloudHelix

For sponsoring my student conference scholarship.