Visualization of multi-dimensional relationships in dynamic networks

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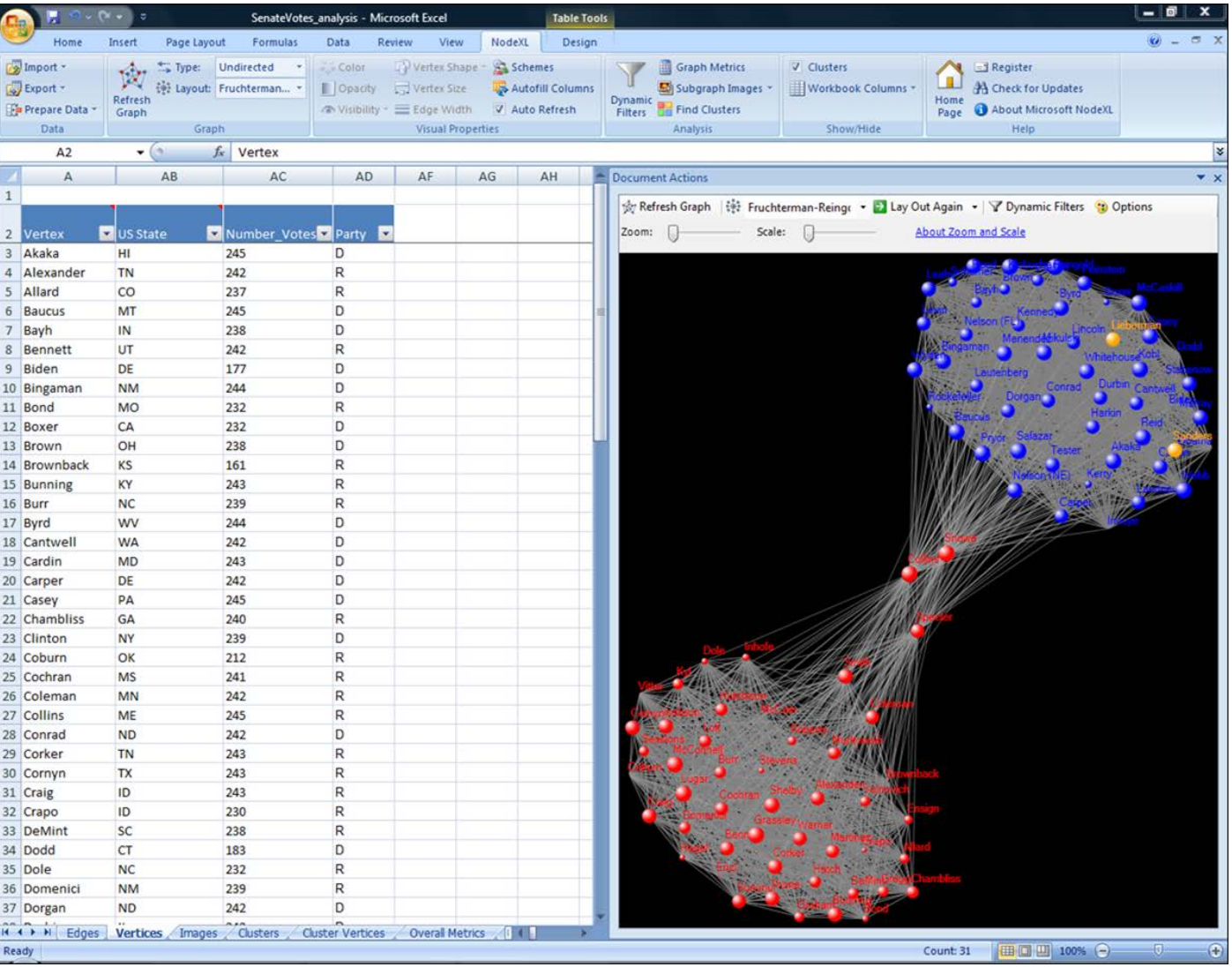
What is Information Visualization?

- ***The projection of information into one or more visual dimensions…***
- ***…in such a way as to accelerate engagement with that information…***
- ***...by leveraging spatial, color, and other low-level neuron processes.***

What is Information Visualization?



Vertex	US State	Number_Votes	Party
Akaka	HI	245	D
Alexander	TN	242	R
Allard	CO	237	R
Baucus	MT	245	D
Bayh	IN	238	D
Bennett	UT	242	R
Biden	DE	177	D
Bingaman	NM	244	D
Bond	MO	232	R
Boxer	CA	232	D
Brown	OH	238	D
Brownback	KS	161	R
Bunning	KY	243	R
Burr	NC	239	R
Byrd	WV	244	D
Cantwell	WA	242	D
Cardin	MD	243	D
Carper	DE	242	D
Casey	PA	245	D
Chambliss	GA	240	R
Clinton	NY	239	D
Coburn	OK	212	R
Cochran	MS	241	R
Coleman	MN	242	R
Collins	ME	245	R
Conrad	ND	242	D
Corker	TN	243	R
Cornyn	TX	243	R
Craig	ID	243	R
Crapo	ID	230	R
DeMint	SC	238	R
Dodd	CT	183	D
Dole	NC	232	R
Domenici	NM	239	R
Dorgan	ND	242	D

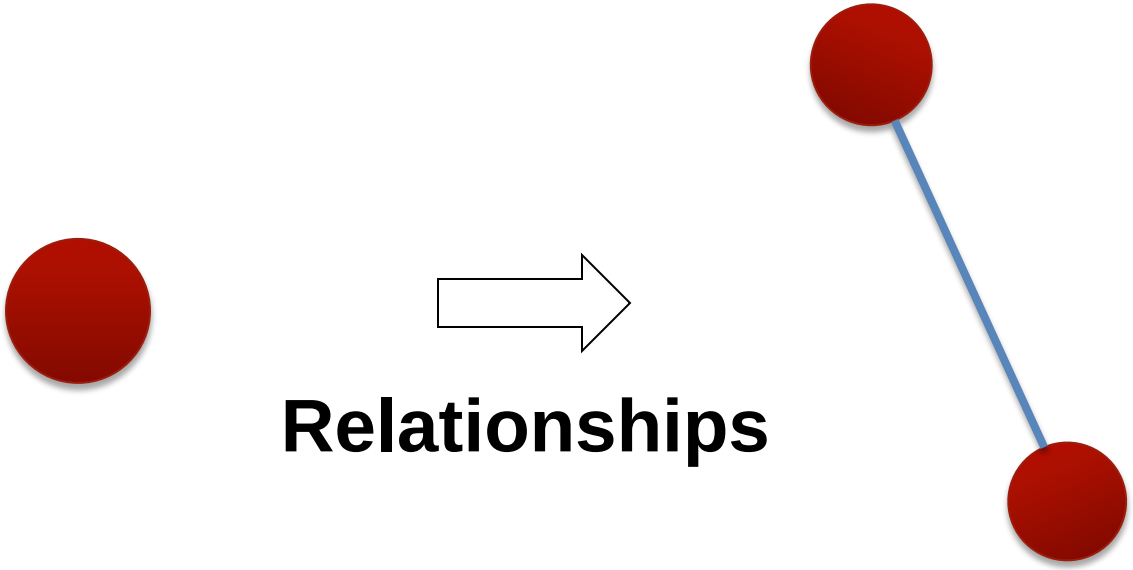
The projection of information into one or more visual dimensions in such a way as to accelerate engagement with that information by leveraging spatial, color, and other low-level neuron processes.

Why Information Visualization?

- ***Understanding Results (Analysis)***
- ***Communicating Results (Telling stories)***
- ***Suggesting Novel Approaches or Hypotheses (Finding what you didn't know you were looking for)***

"Without experimentation there can be no network science."

Key to Information Visualization in Network Science?



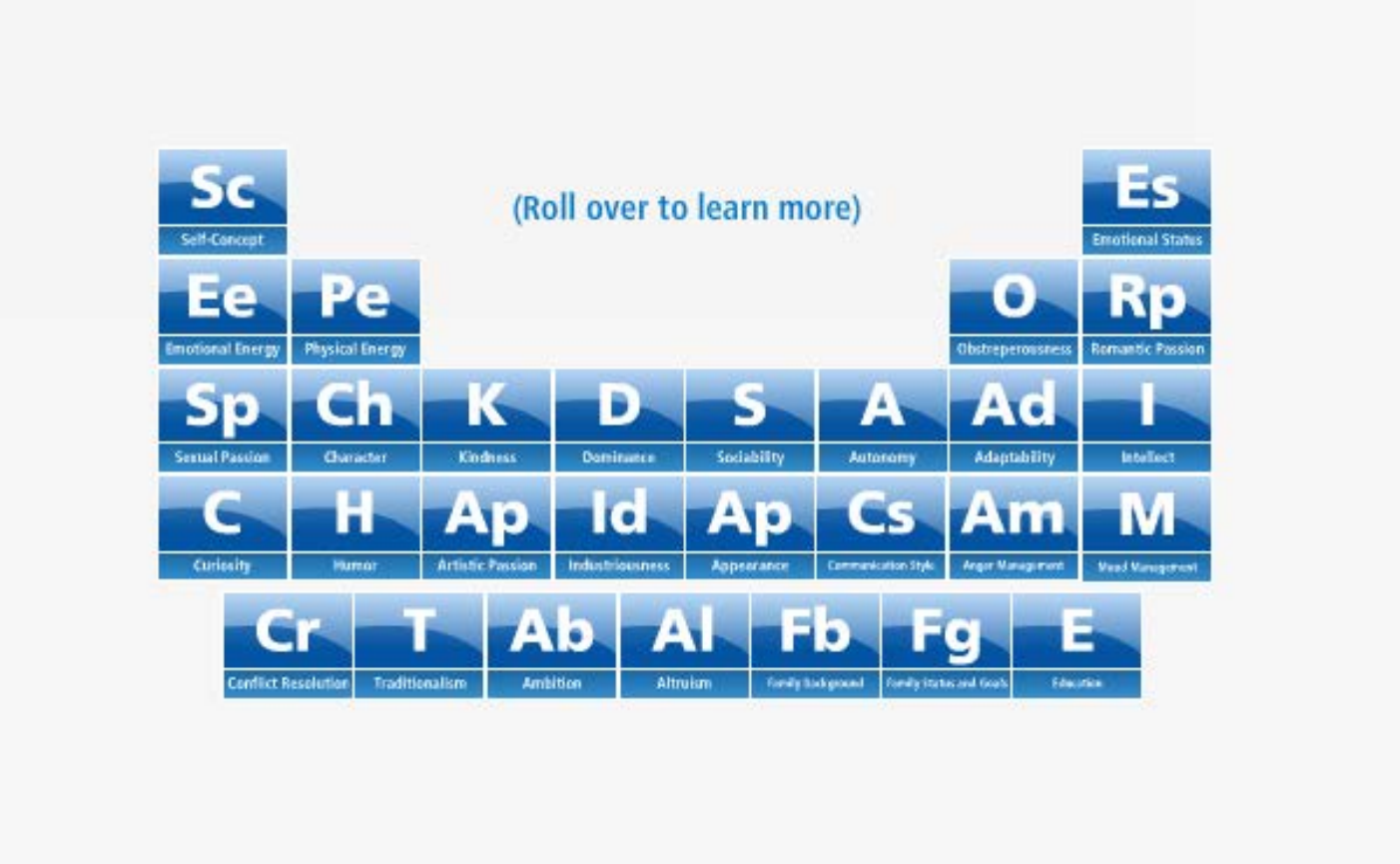
Real Relationships are Multi-Dimensional

YOUR MALE FRIENDS.

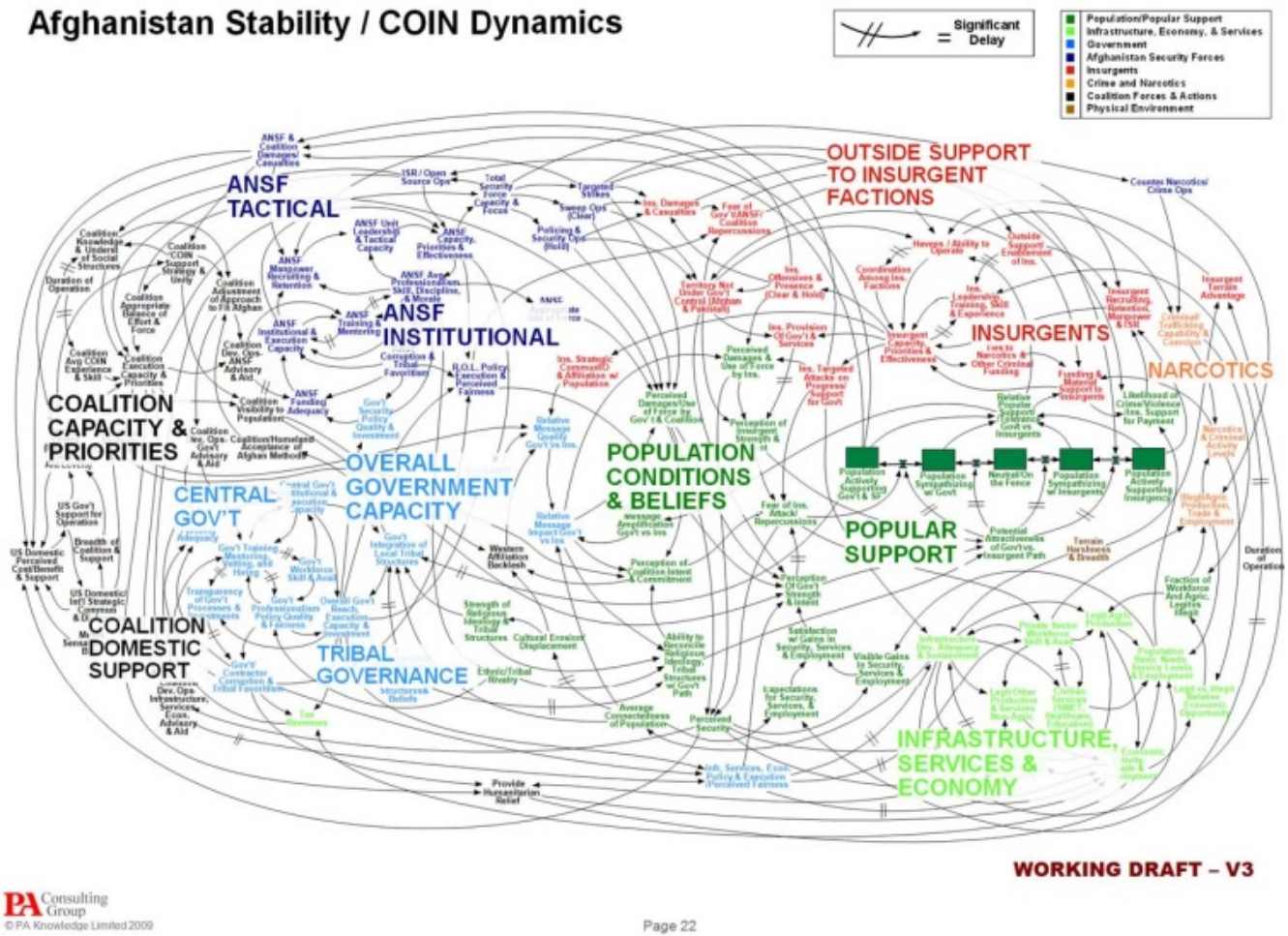
Darken the oval under the name if:

34. you went to his house in the last seven days.
    - best male friend 1 ..... S34A
    - male friend 2 ..... S34B
    - male friend 3 ..... S34C
    - male friend 4 ..... S34D
    - male friend 5 ..... S34E
35. you met him after school to hang out or go somewhere in the last seven days.
    - best male friend 1 ..... S35A
    - male friend 2 ..... S35B
    - male friend 3 ..... S35C
    - male friend 4 ..... S35D
    - male friend 5 ..... S35E
36. you spent time with him last weekend.
    - best male friend 1 ..... S36A
    - male friend 2 ..... S36B
    - male friend 3 ..... S36C
    - male friend 4 ..... S36D
    - male friend 5 ..... S36E
37. you talked with him about a problem in the last seven days.
    - best male friend 1 ..... S37A
    - male friend 2 ..... S37B
    - male friend 3 ..... S37C
    - male friend 4 ..... S37D
    - male friend 5 ..... S37E
38. you talked with him on the telephone in the last seven days.
    - best male friend 1 ..... S38A
    - male friend 2 ..... S38B
    - male friend 3 ..... S38C
    - male friend 4 ..... S38D
    - male friend 5 ..... S38E

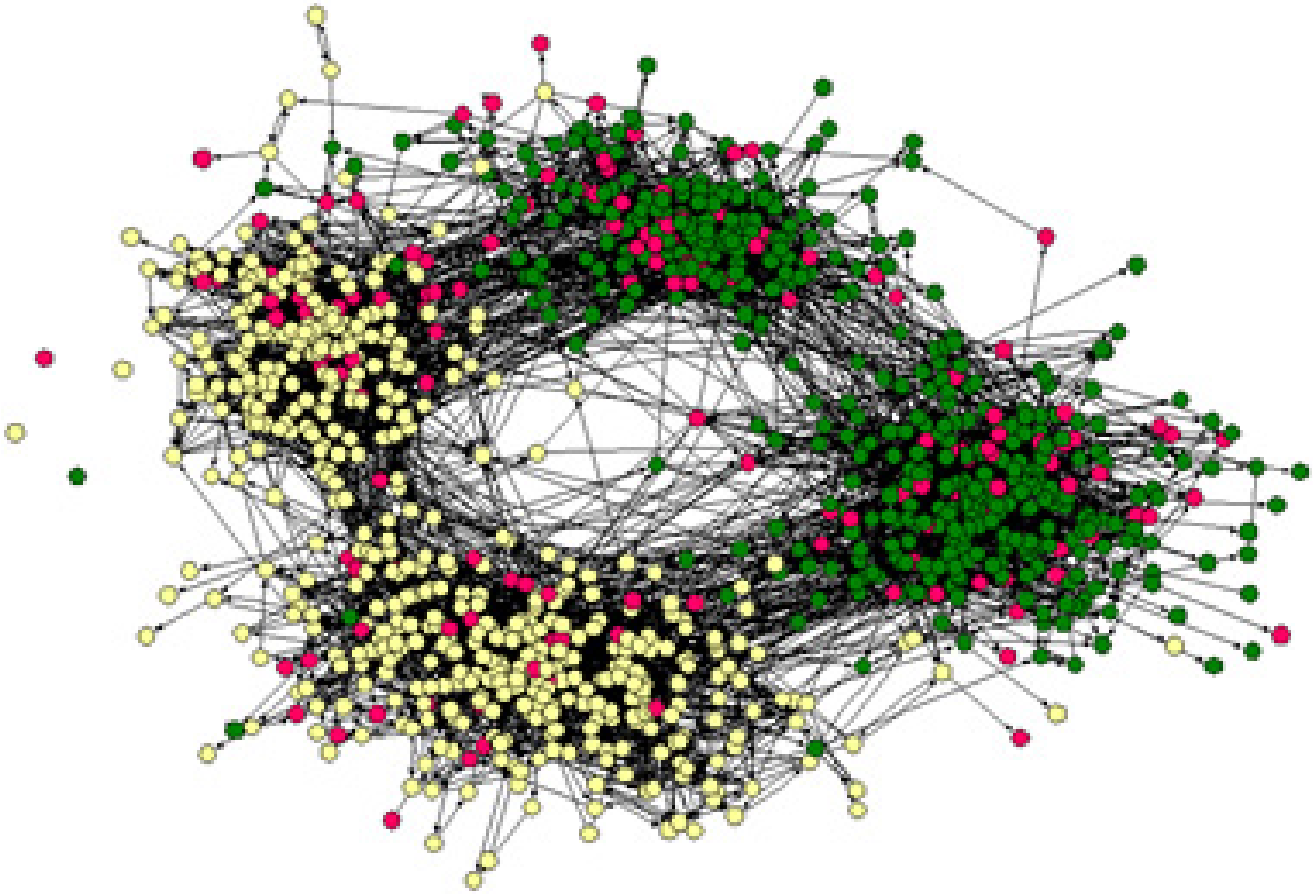
Real Relationships are Multi-Dimensional



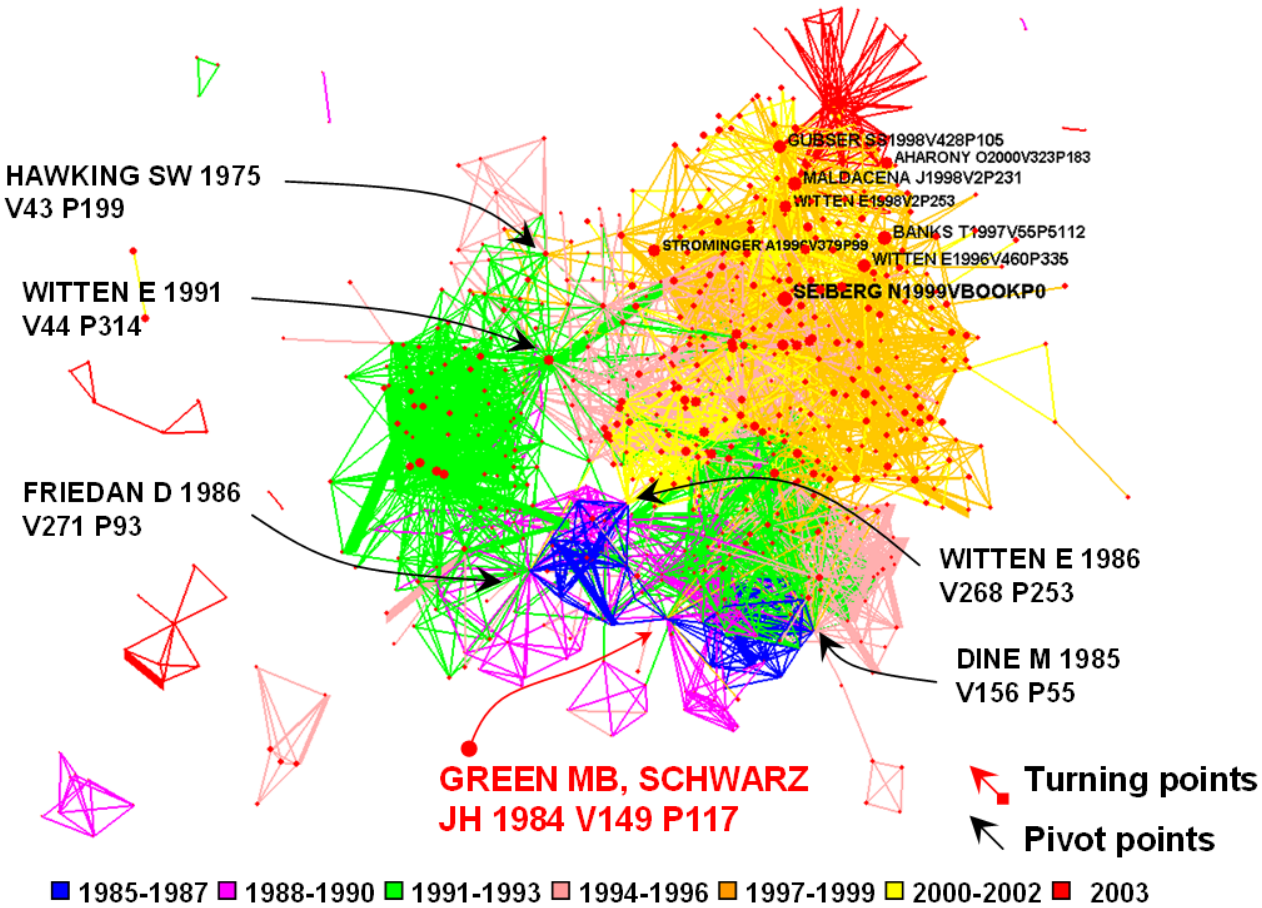
Real Relationships are Complex



Visualized Relationships Are… Not so Complex



… a Little More Complex



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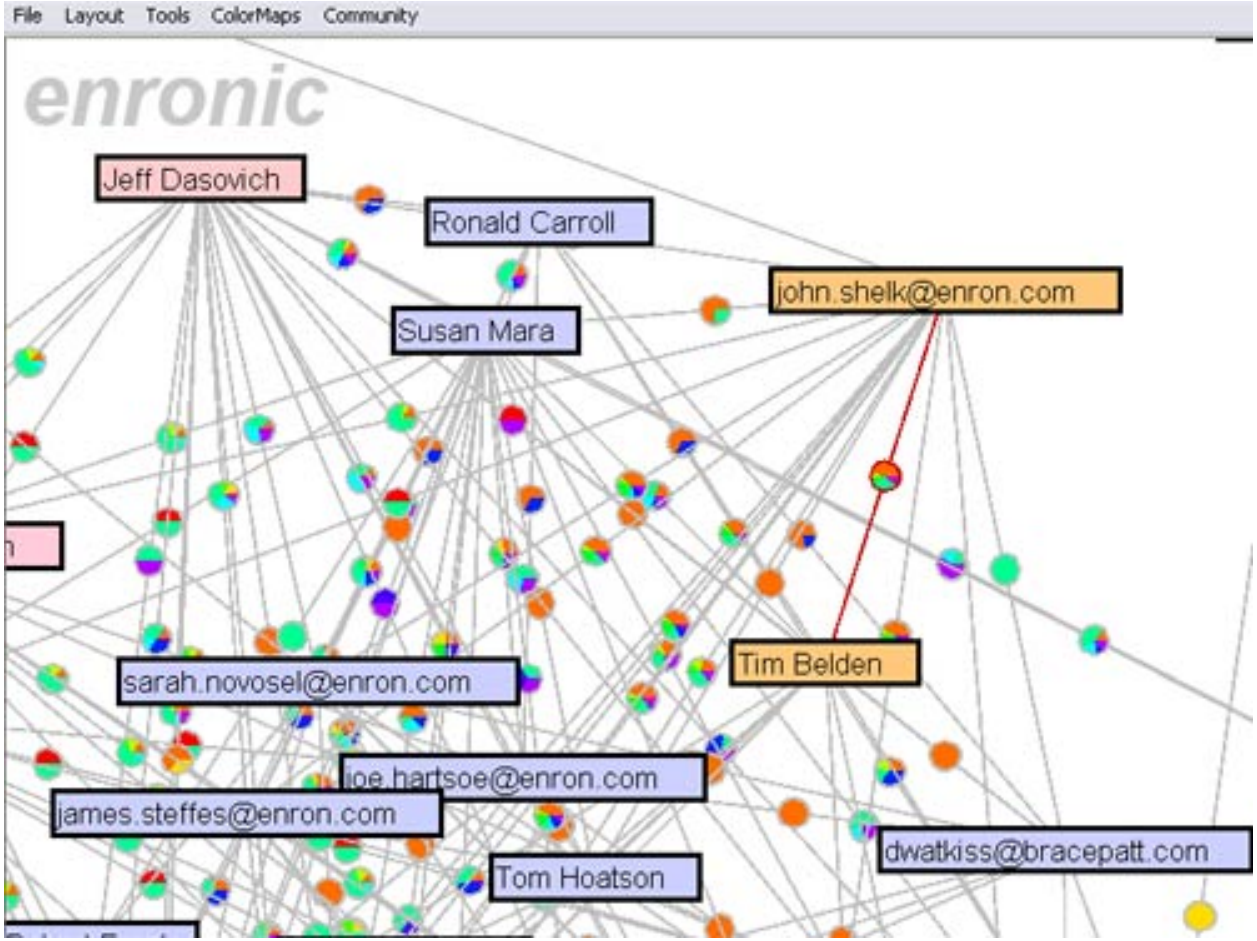


My Basic Problem

***Relationships are incredibly** complex **and constantly** changing**, but many of our tools just give us** .*

Why?

What do we do about it?

Can we do something that improves information visualization for all networks and relationships?

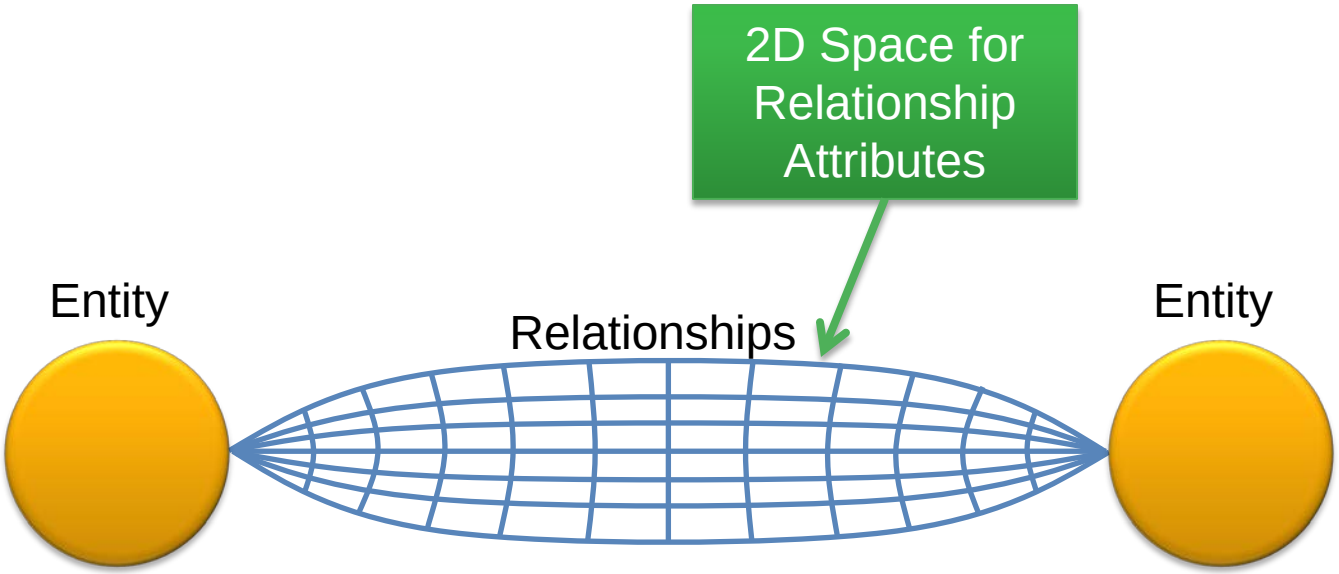
GENERALIZATION

Demo 1

Leibniz, Newton, & Gauss are sending emails back and forth about various topics…

The Main Idea

Provide 2D space for entity/relationship attributes



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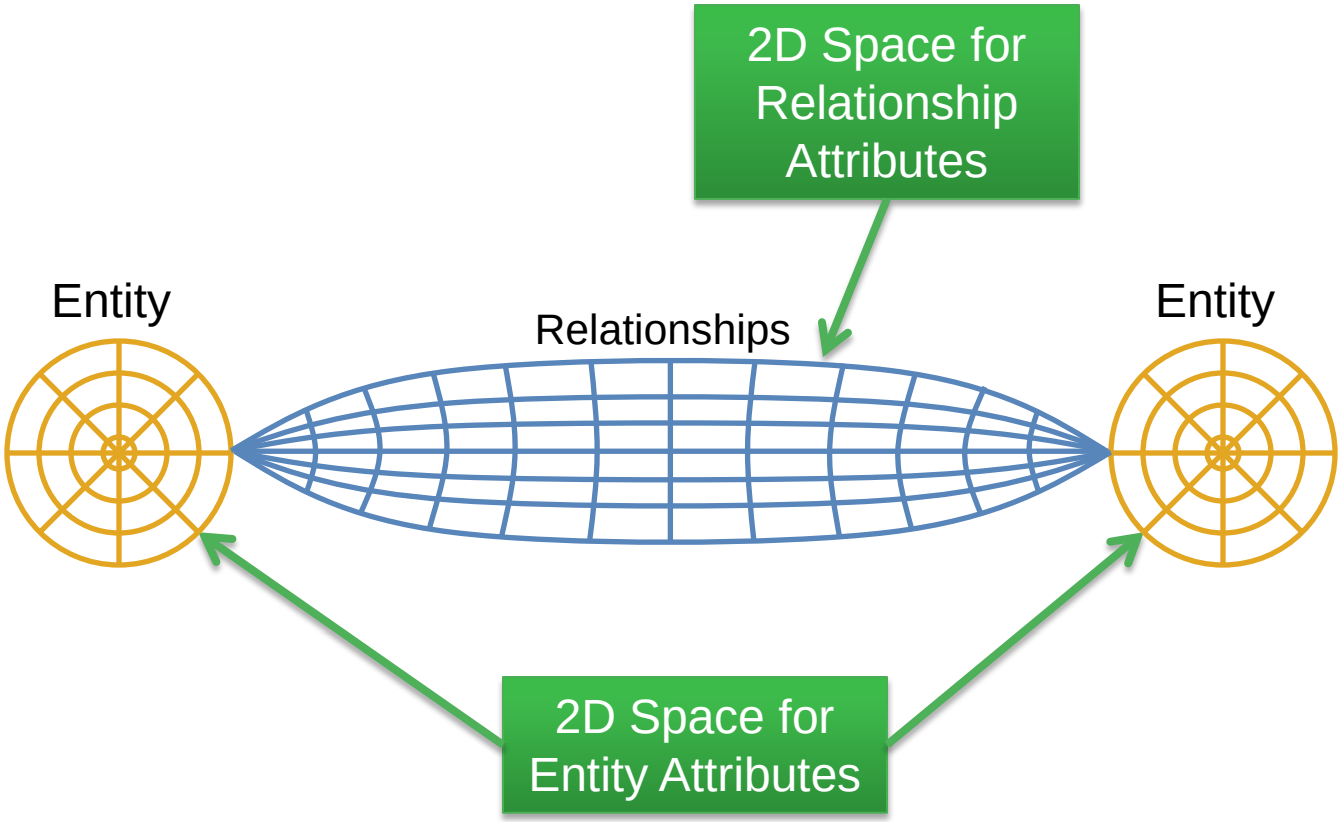

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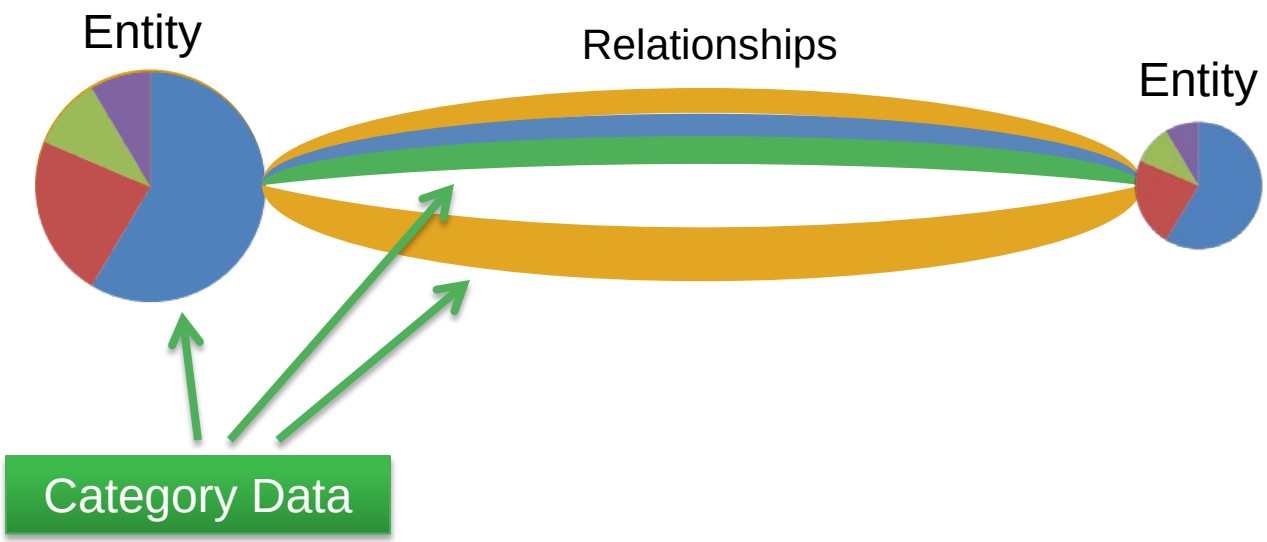


Applying the general tool across a broad class of problems.

SIMPLIFICATION

Event Data

- ***Source***
- ***Destination***

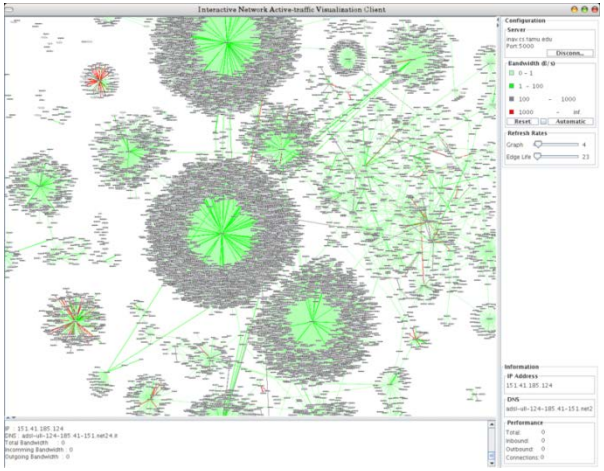
Basic node-link diagrams only convey this information

- ***Time***
- ***Category***

Some diagrams convey this information, but typically not in a scalable way.

Visualizing Multi-Modal Relationships

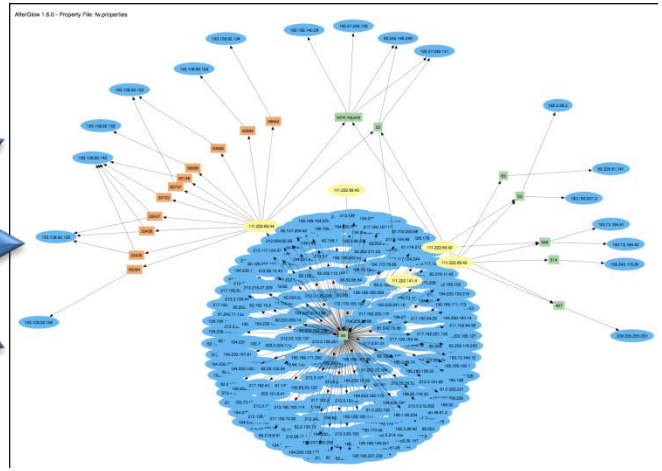
BIG PICTURE (NON-MODAL)
100s-1000s of Nodes/Edges



Scalability

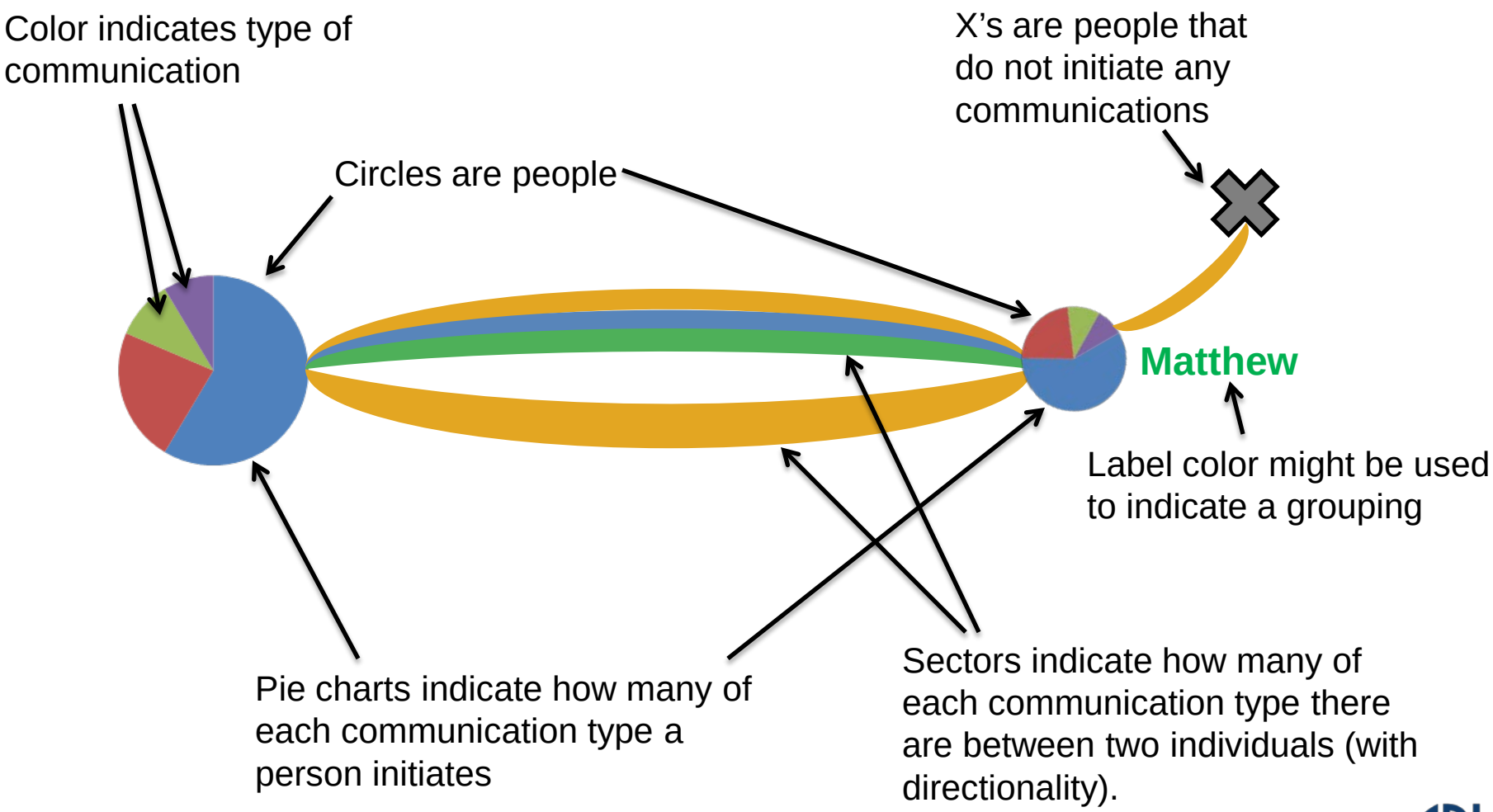
Balance Scalability & Detail

DETAILS (MODAL)
10s-100s of Node/Edges



Detail

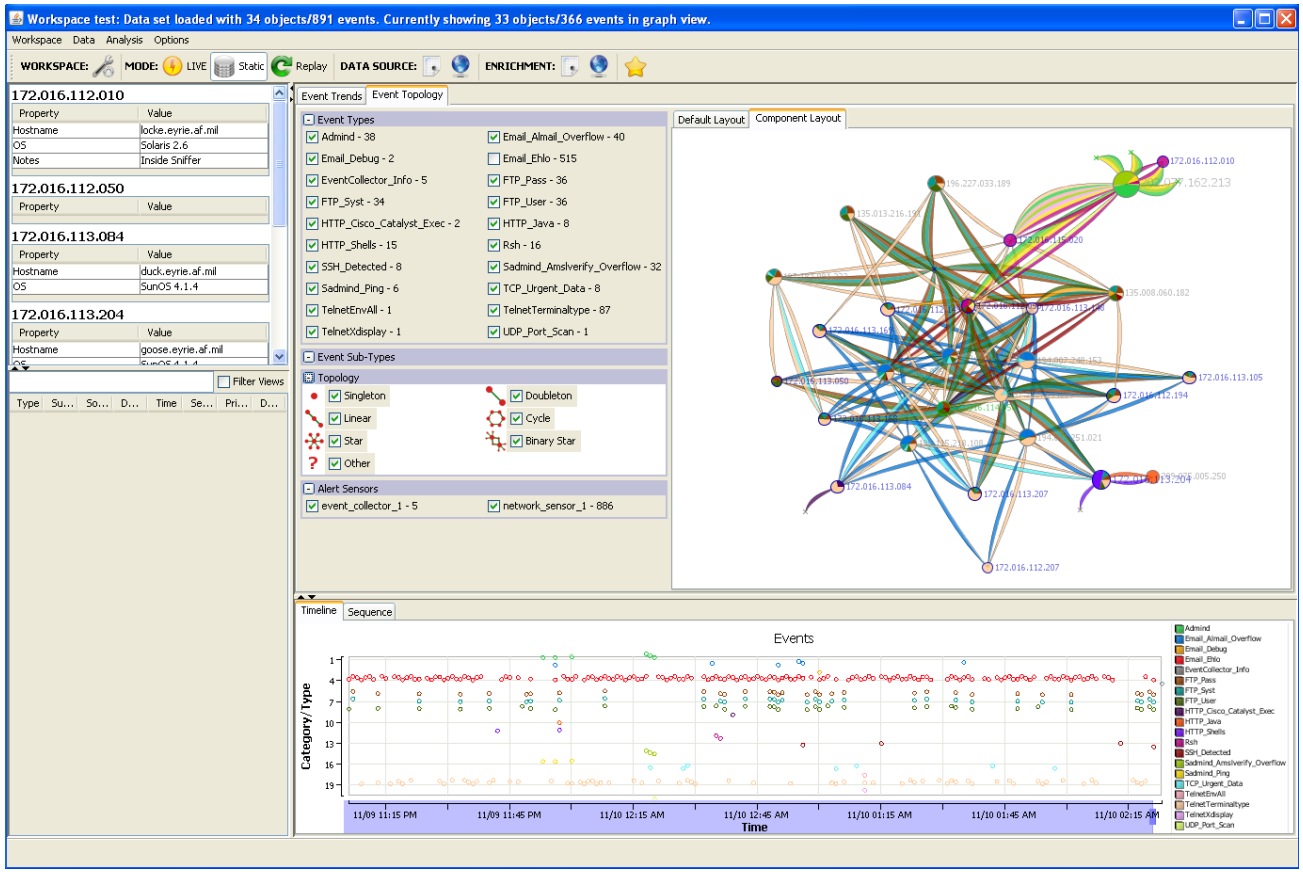
Concrete Example
Modes of Communication



Demo 2

MIT-LL (Lincoln Labs) Network Intrusion Data Set

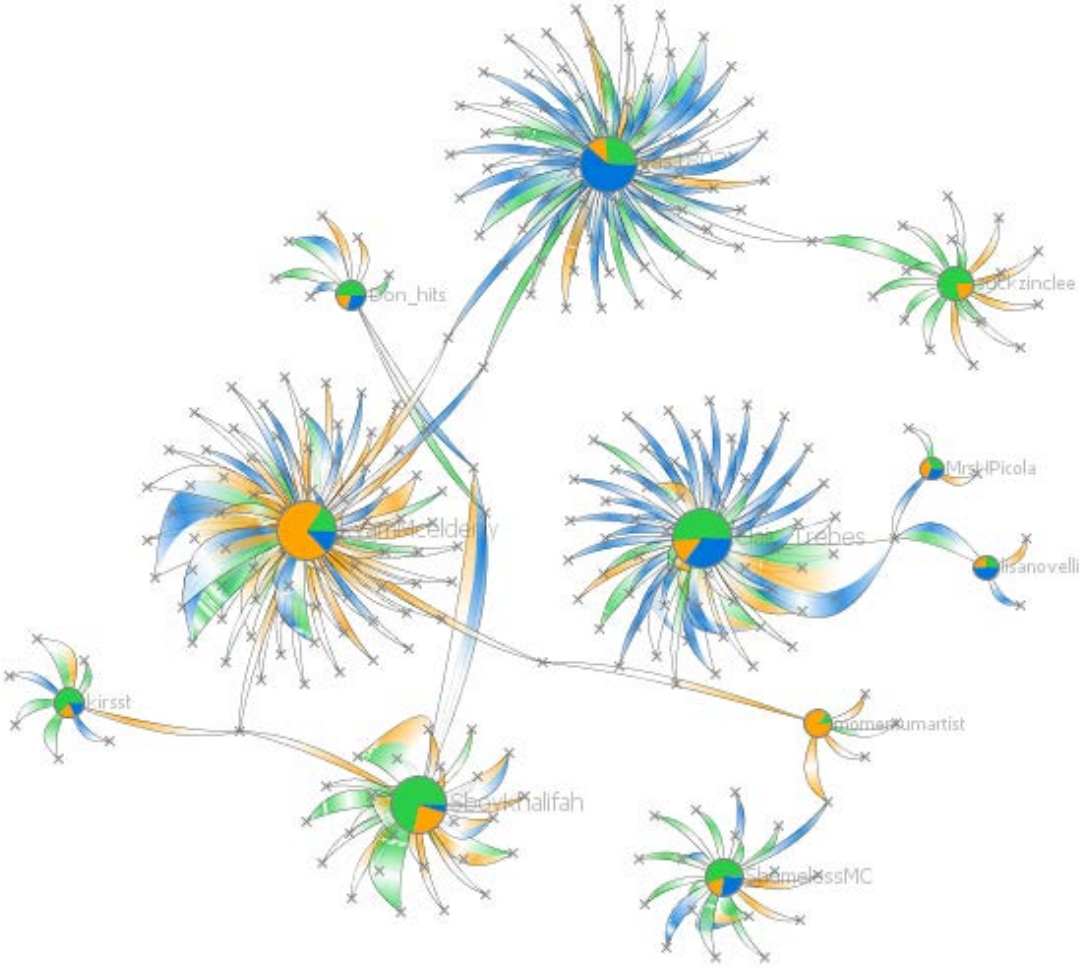
Example: Cyber Data



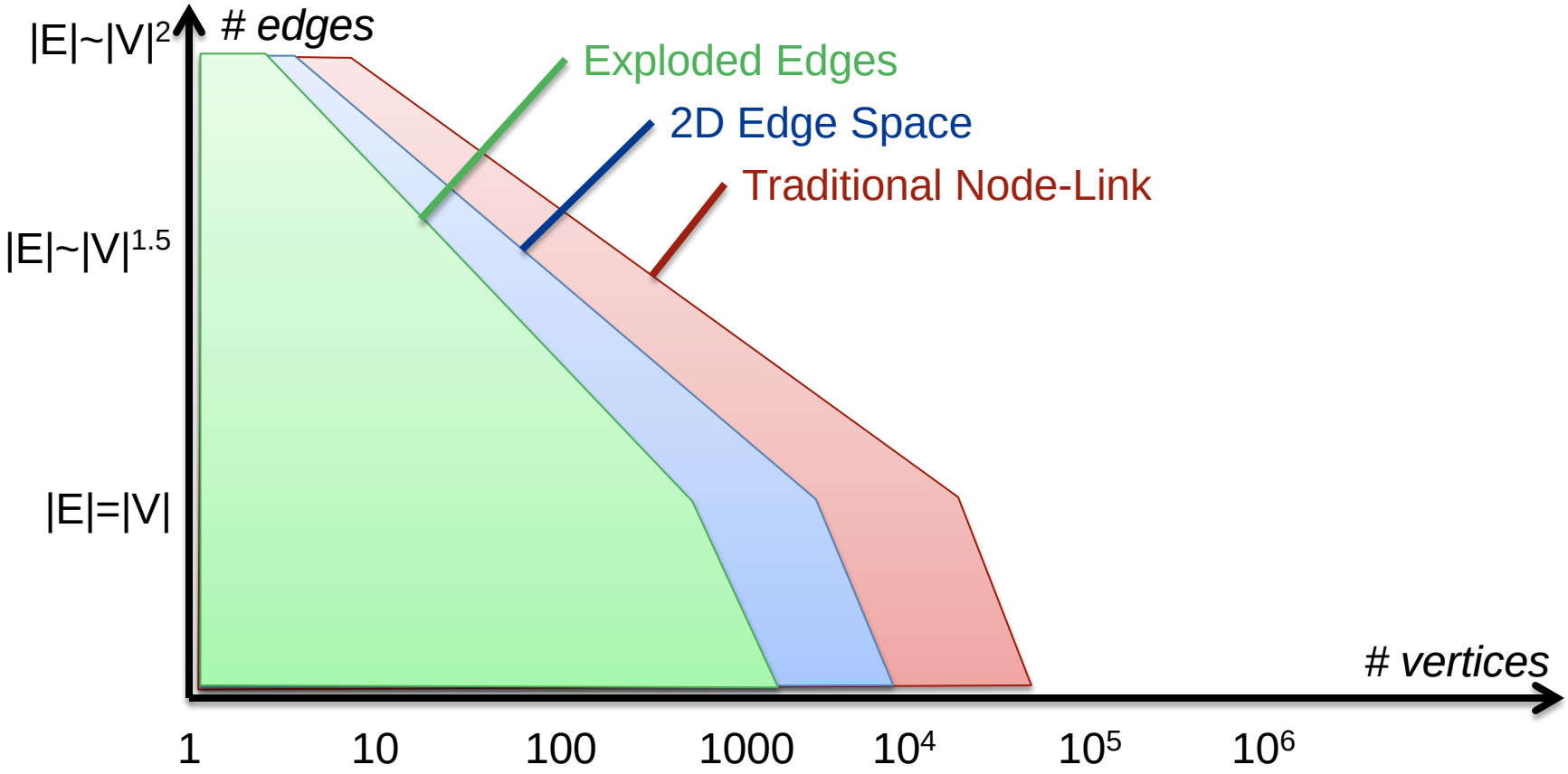
DataSource: IDS data set available at http://www.ll.mit.edu/mission/communications/ist/corpora/ideval/data/index.html

Example: Twitter Data

- ***Public Twitter data set by retweet, categorized by type***

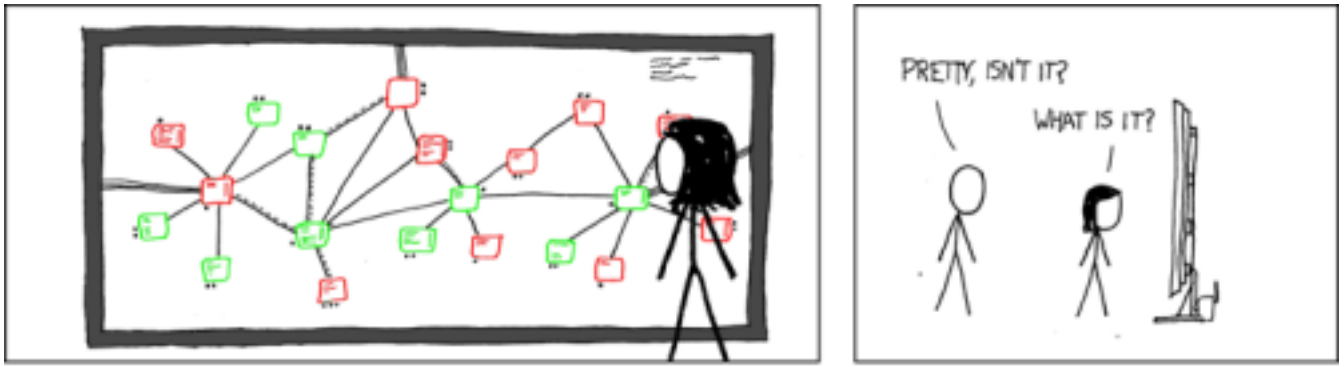


Limitations



Summary

- ***When your data contains complex relationships, don't be satisfied with basic node-link diagrams!***
- ***Node-link diagrams can be generalized by expanding nodes & edges into 2-dimensional areas.***
- ***"Crescent edge" approach is highly scalable and can depict complex relationships for 1000s of nodes and edges.***



QUESTIONS?