

Social Network Analysis

Part 1 - Introduction to Social
Network Analysis

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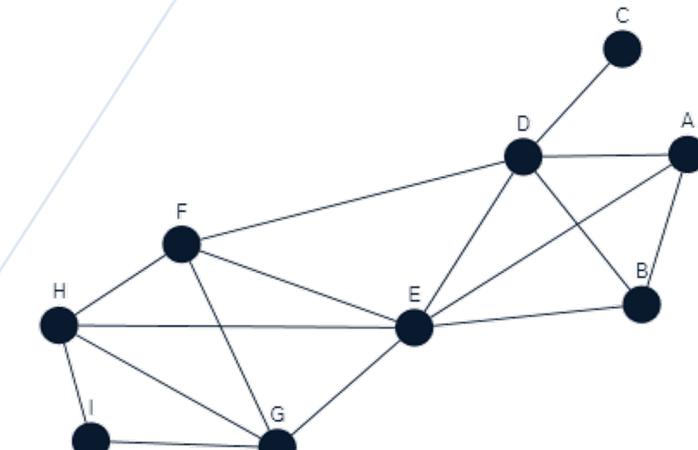
Session I – Fundamentals of Social Network Analysis

Part 1 - Introduction to Social Network Analysis

- Types of social networks
 - Explicit (friendship, affiliation)
 - Implicit (co-authorship, user-generated content interactions, etc.)
- Social media content analysis
 - Text mining: topic classification, sentiment analysis, trend analytics
 - Relation extraction
- Social network analysis for business intelligence applications

Social Network Analysis

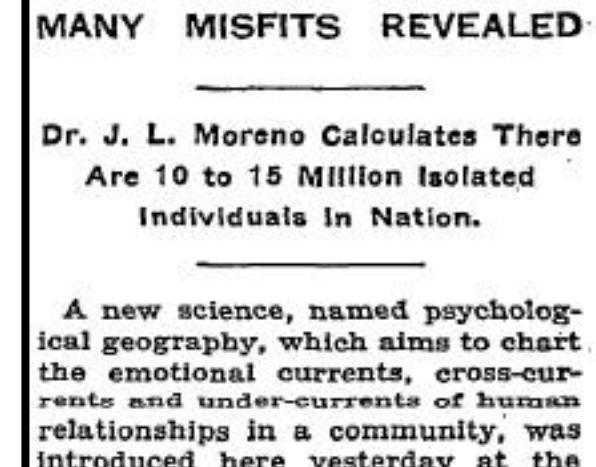
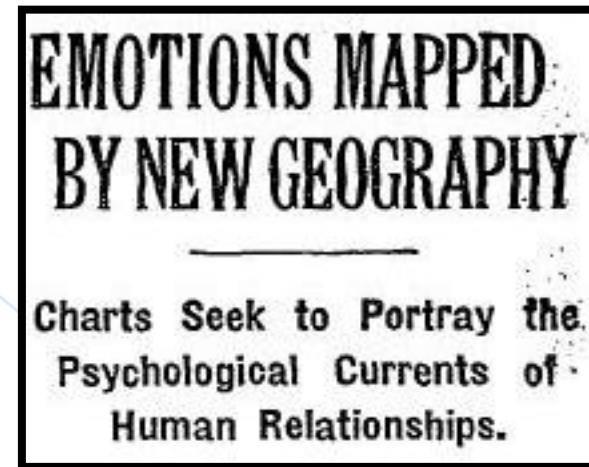
- Mapping and measurement of relationships and flows between entities that include people
- Views social relationships in terms of network theory consisting of **nodes** and **links**
 - **node**: actor on which relationships act
 - **link**: relationship connecting two nodes



Social Graph

Early Social Network Analysis

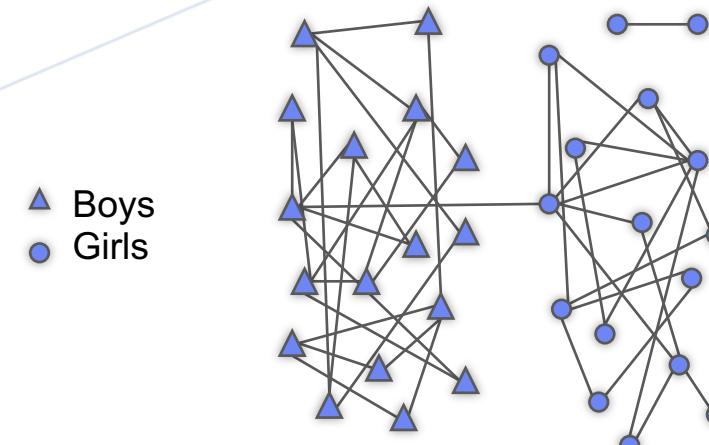
- In 1933 J.L. Moreno displays first **sociogram** at meeting of the Medical Society of the state of New York
 - article in NY Times
 - interests: effect of networks on e.g. disease propagation



Source:
The New York Times
(April 3, 1933, page 17)

Early Social Network Analysis

- School kids – favorite (and captive) subjects of study



Source:

An Attraction Network in a 4th Grade Class
(Moreno, 'Who shall survive?', 1934)

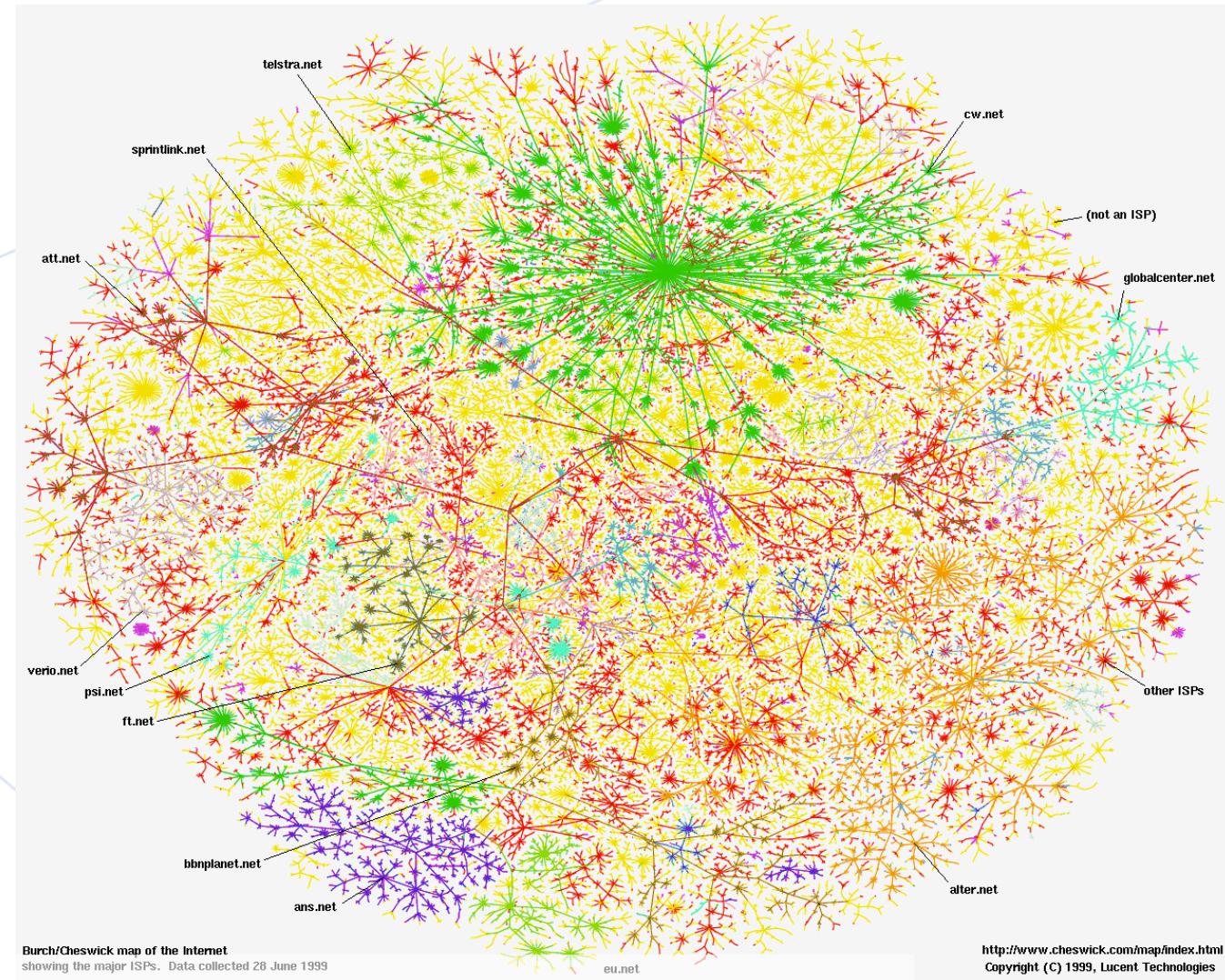
- These days much more difficult because need parental consent to gather social network data



Think LINKS:

Networks are everywhere!

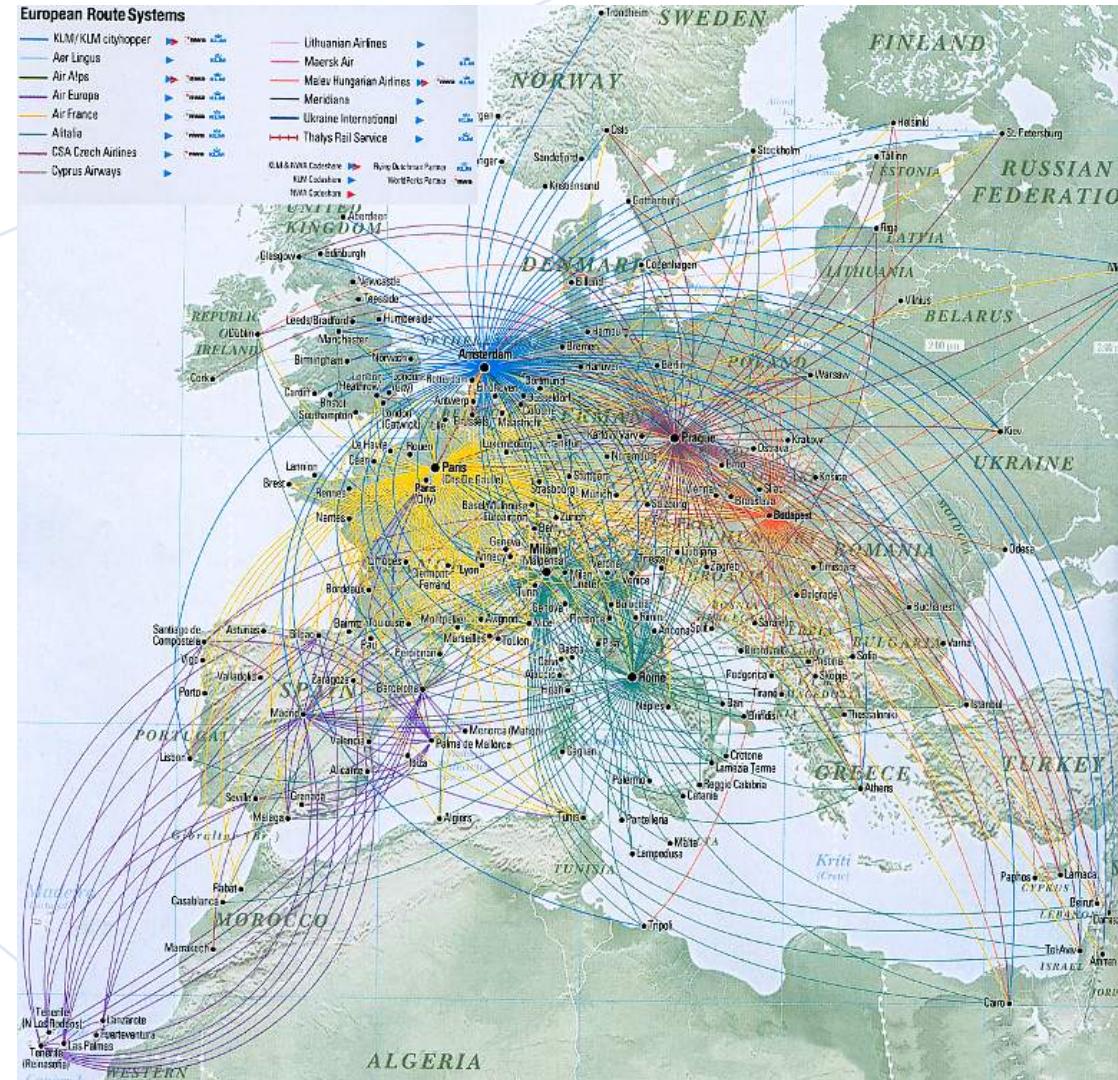
Internet Mapping Project (ISPs Network)



Source:

Bill Cheswick <http://www.cheswick.com/ches/map/gallery/index.html>

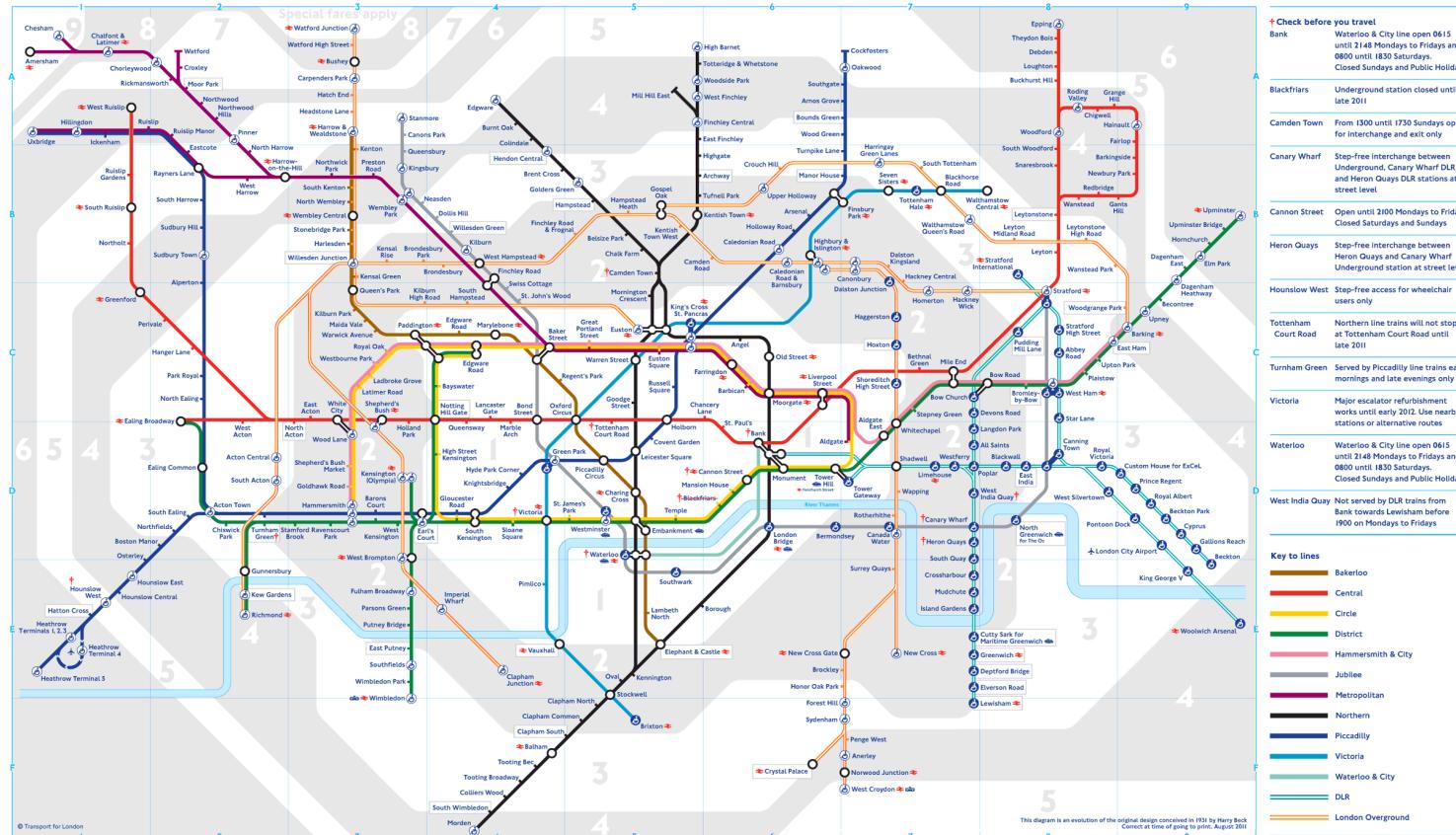
Airline Networks



Source: Northwest Airlines World Traveler Magazine

Metro Networks

Tube map



MAYOR OF LONDON

Websit
tfl.gov.uk

24 hour travel information
0843 222 1234*

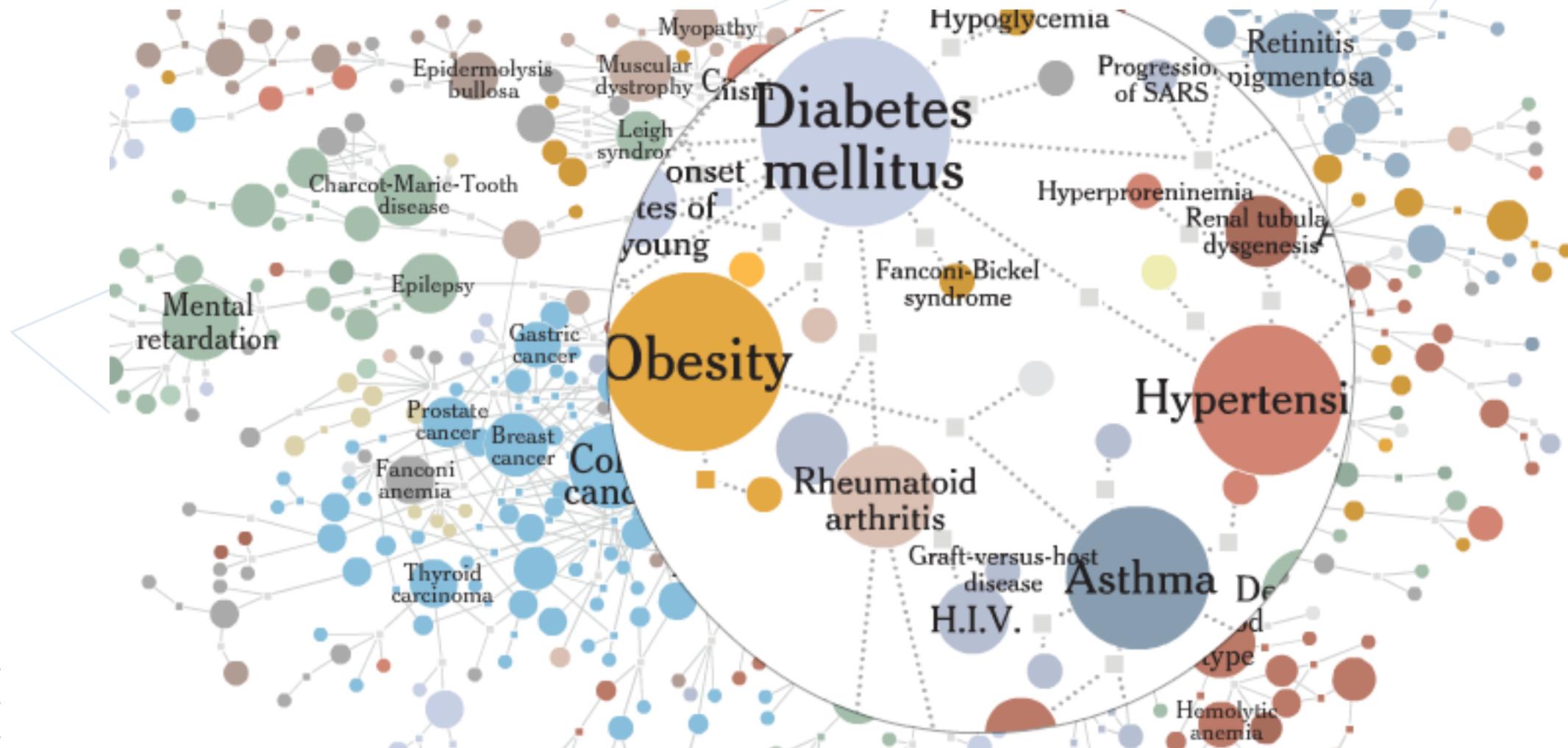
*You pay no more than 5p per minute if calling from a BT landline. There may be a connection charge. Charges from mobiles or other landline providers may vary.

Travel information at stations
Help points

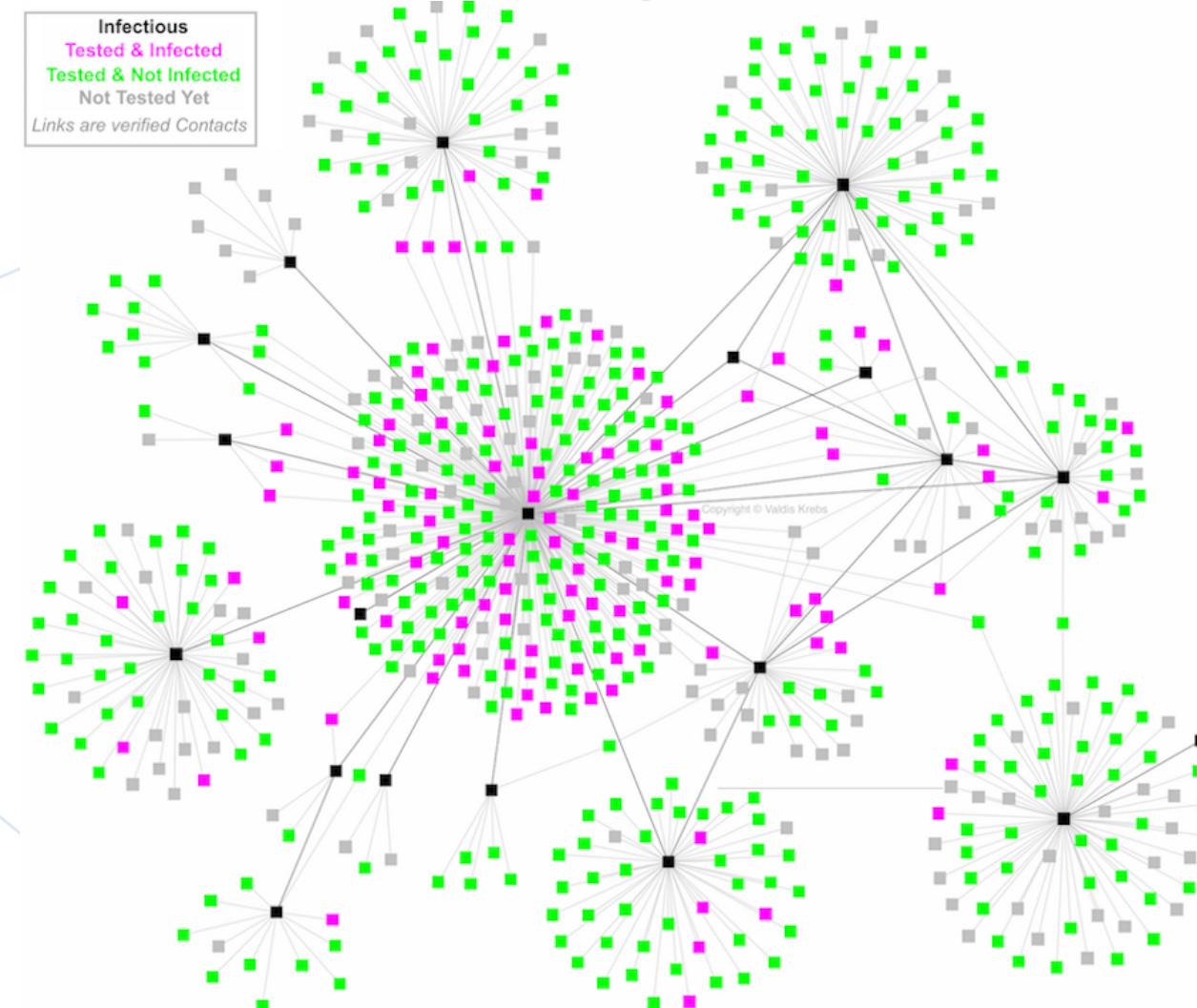
Transport for London



Human Disease Network (Diseasome)

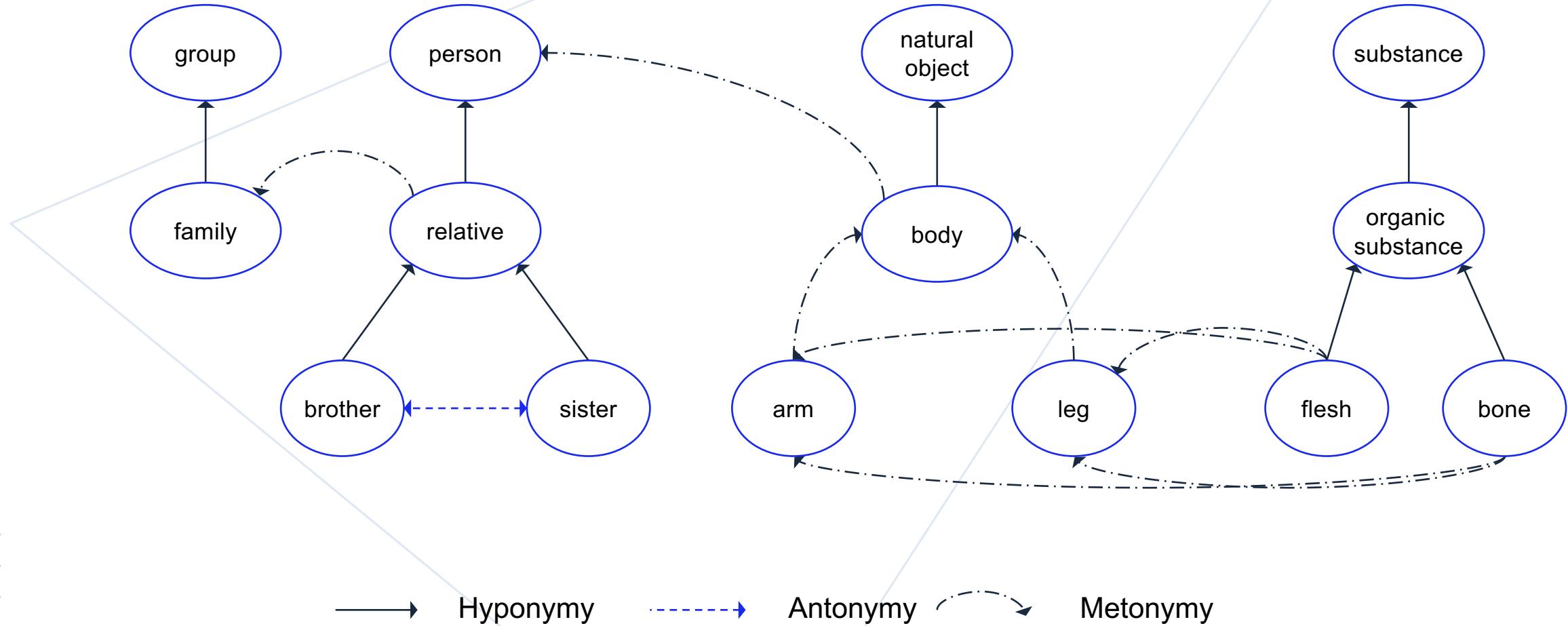


Virus Spread Networks

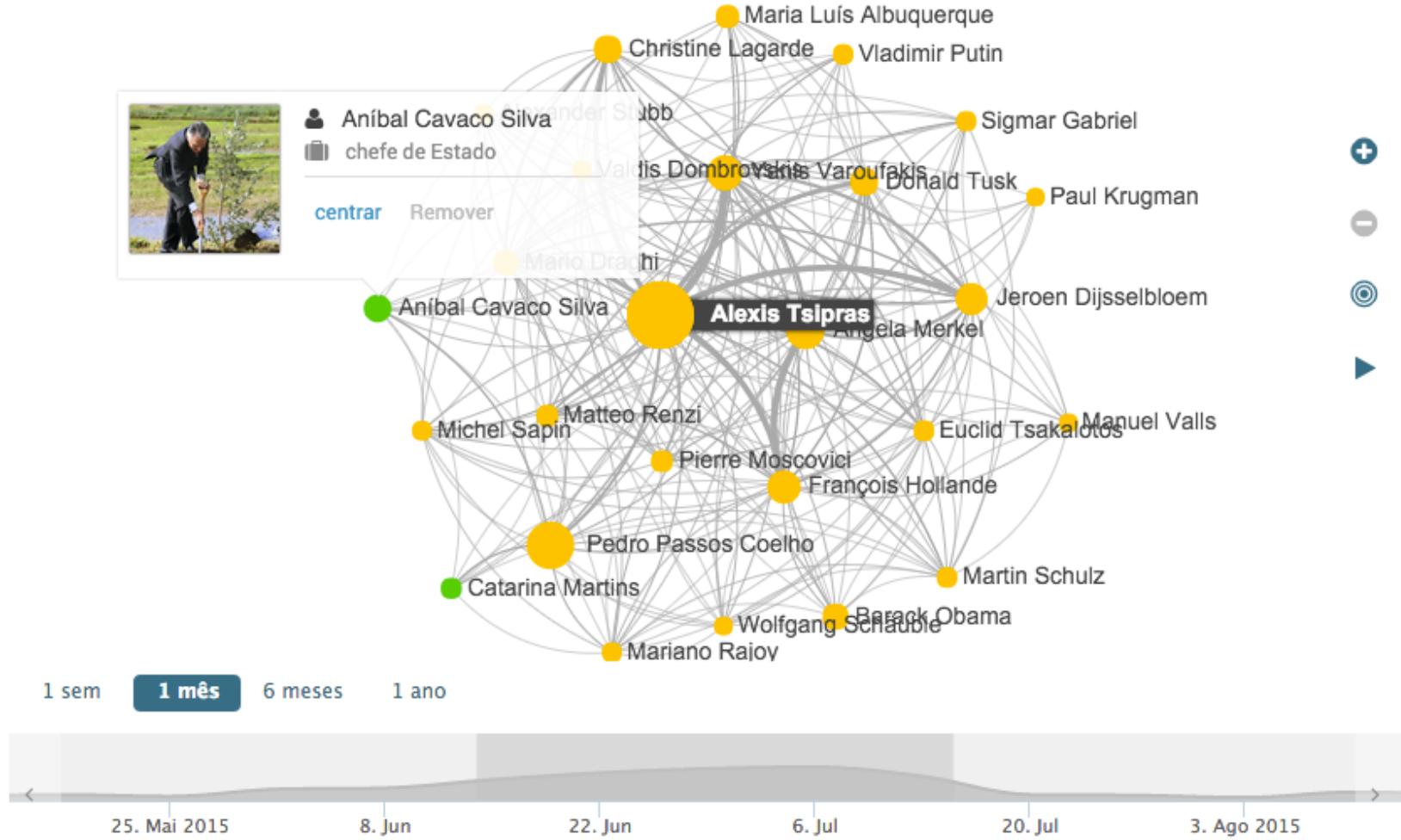


Source: <http://www.orgnet.com/contagion.html>

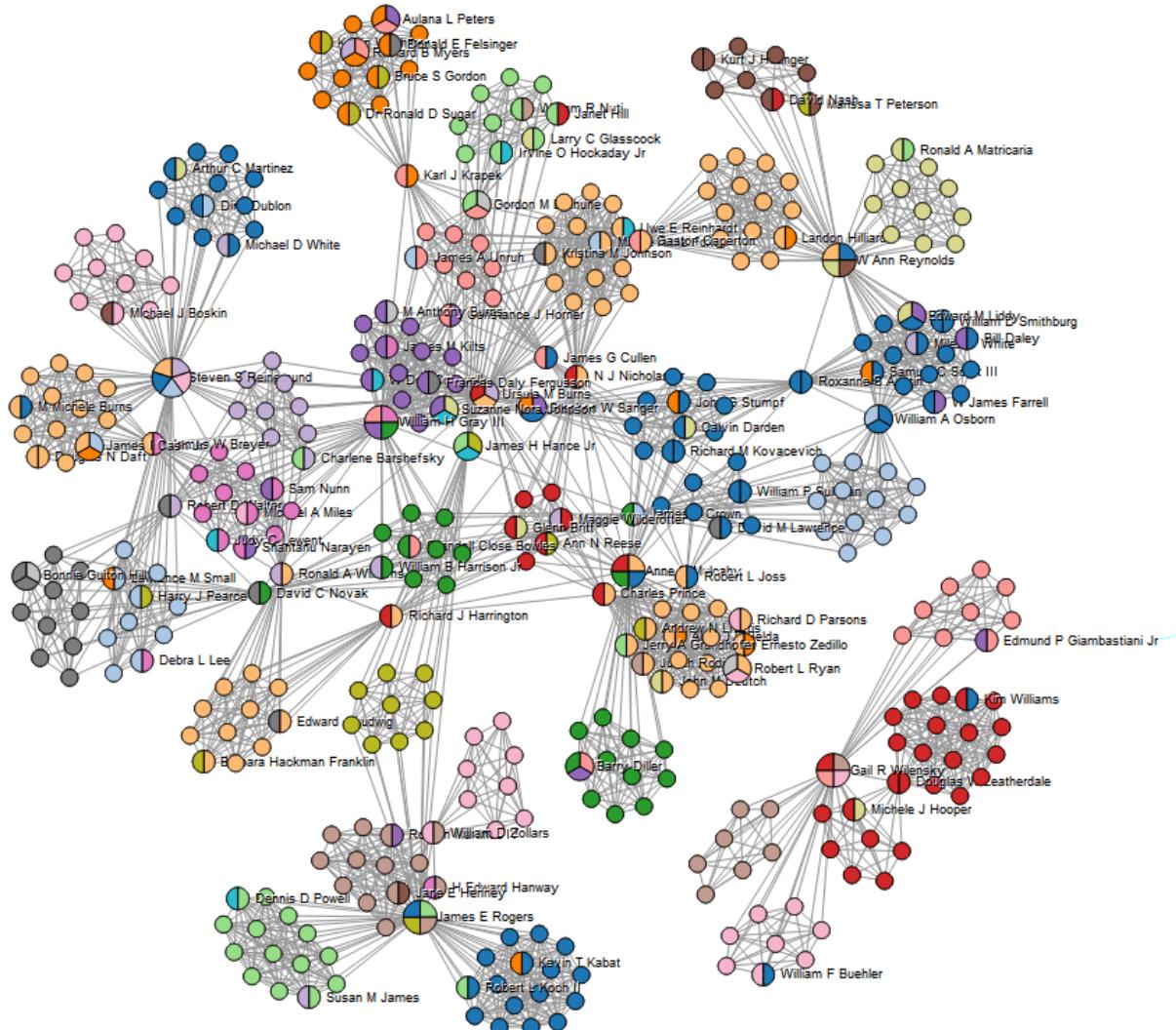
Semantic Networks (Wordnet)



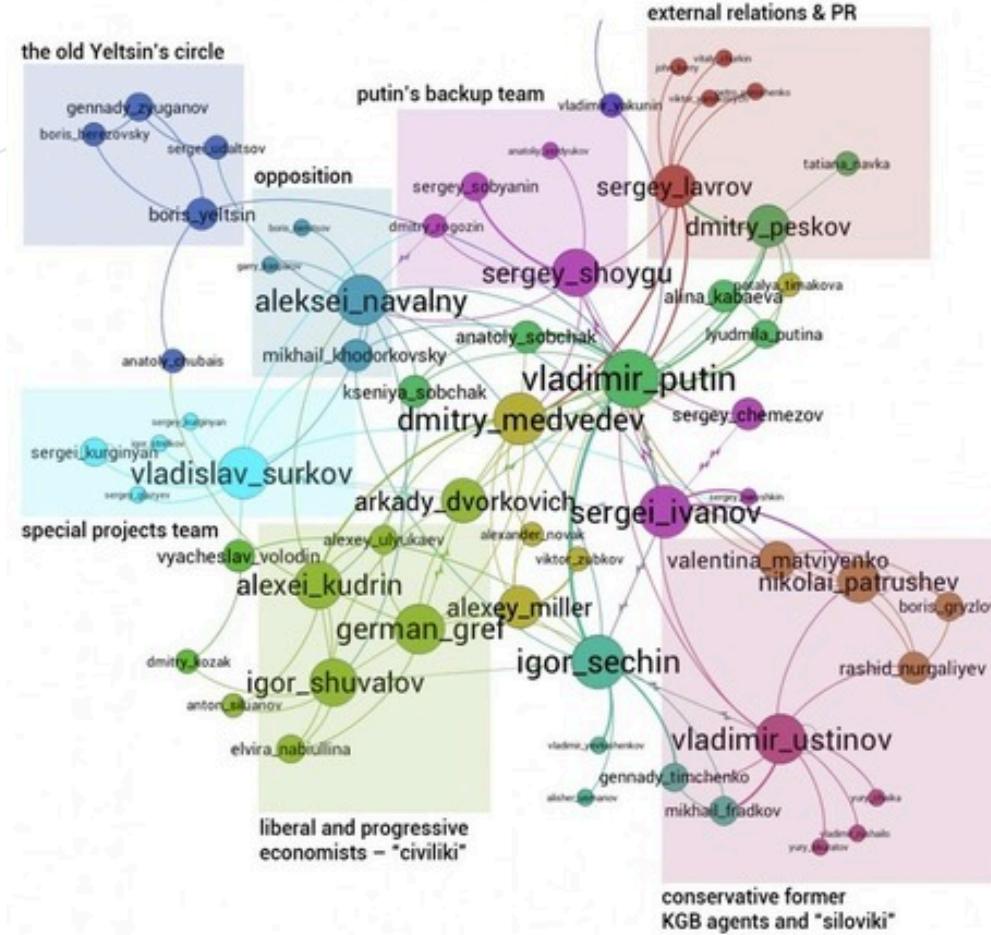
News Entity Networks



US Board of Directors Network



Political Networks



Source:

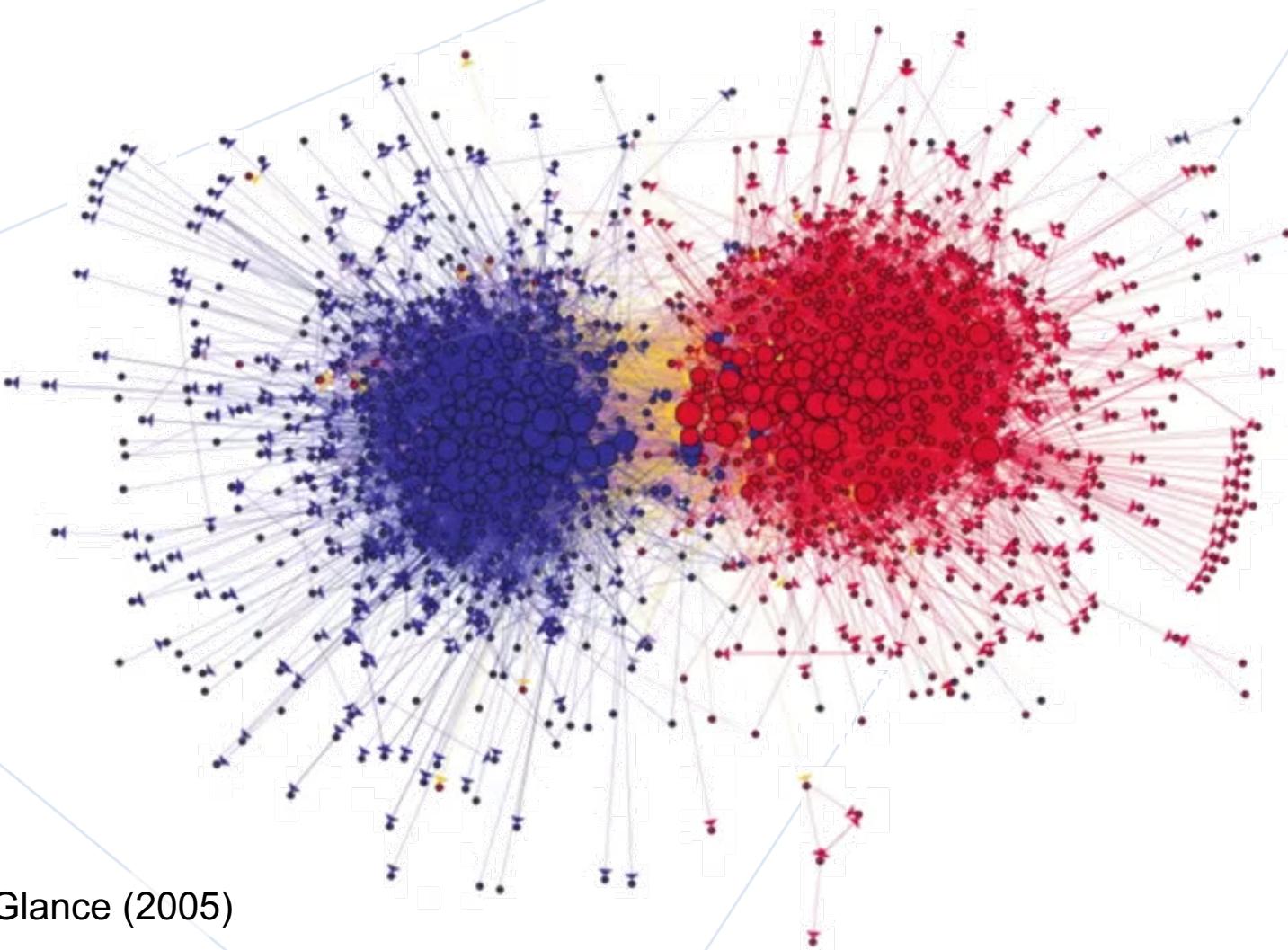
<http://noduslabs.com/research/knowledge-graphs-type-document/>

Social Media Networks: Facebook Friendship



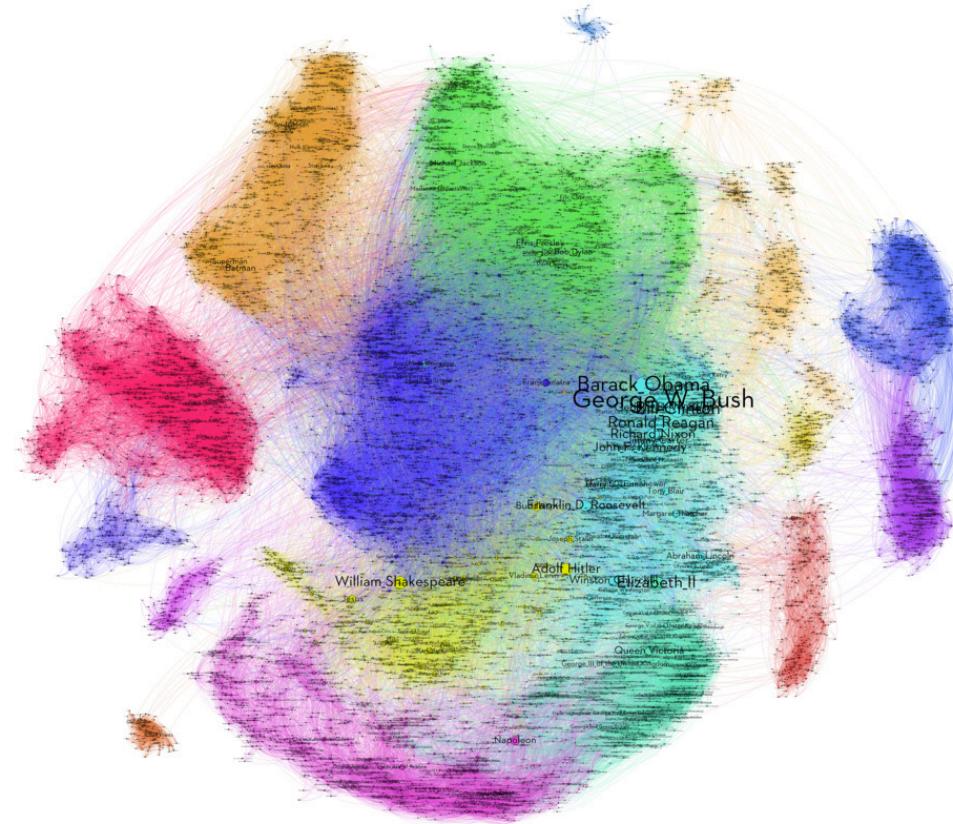
facebook

Social Media Networks: Blogosphere Citations (US Election 2004)



Source: Adamic and Glance (2005)

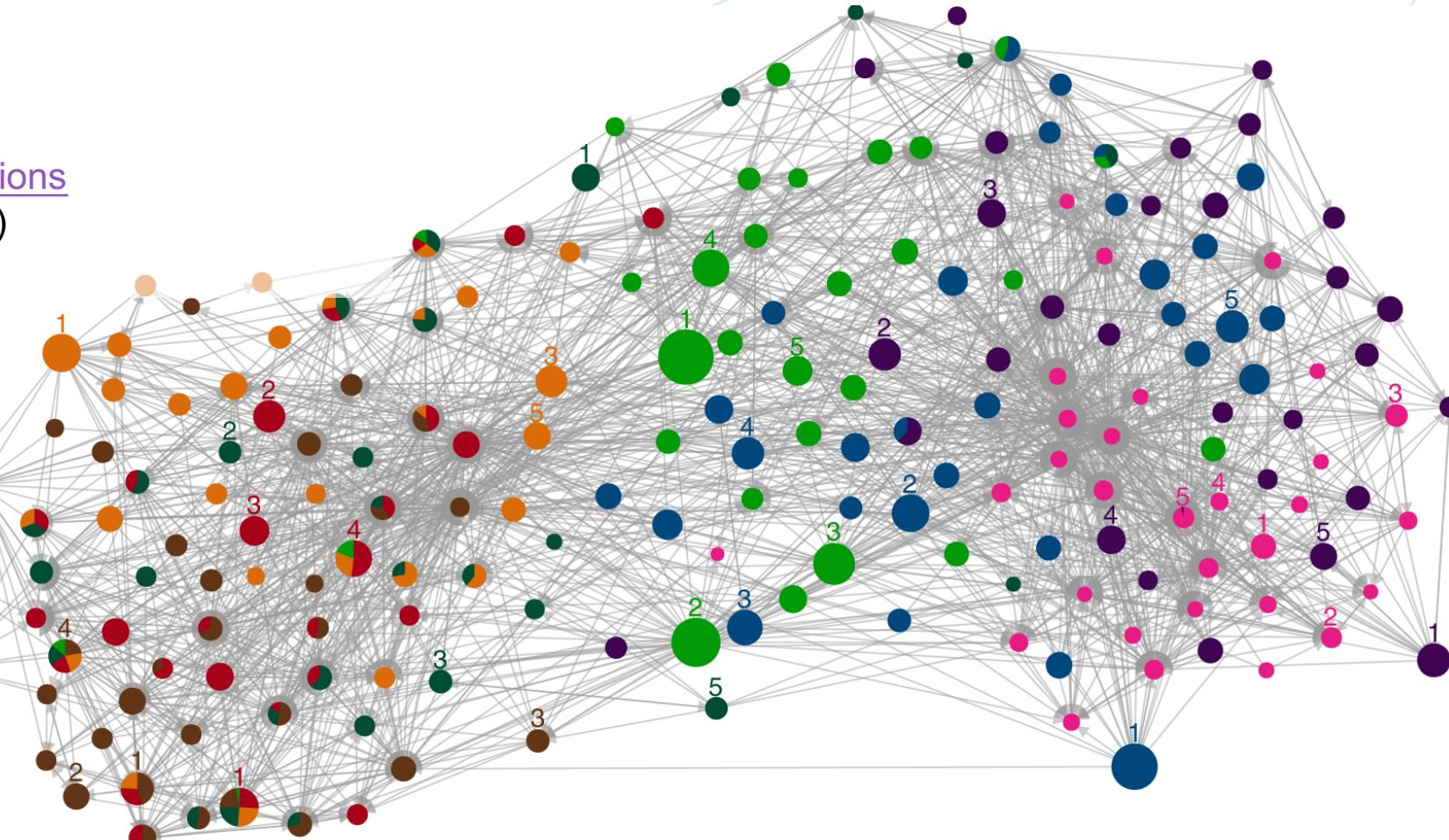
Social Media Networks: Wikipedia Related People



Source: <http://www.hackdiary.com/>

Social Media Networks: Twitter re-tweets

Source:
Nature Communications
 No. 10, 1ol. 7 (2019)



Fake news
 1 @PrisonPlanet
 2 @RealAlexJones
 3 @zerohedge
 4 @DRUDGE_REPORT^{4,5}
 5 @realDonaldTrump^{1,2,4}

Extreme bias (right)
 1 @realDonaldTrump^{2,4,5}
 2 @DailyCaller
 3 @BreitbartNews
 4 @wikileaks
 5 @DRUDGE_REPORT^{4,4}

Right
 1 @FoxNews
 2 @realDonaldTrump^{1,4,5}
 3 @dce examiner
 4 @DRUDGE_REPORT^{4,5}
 5 @nypost

Right leaning
 1 @WSJ
 2 @WashTimes
 3 @RT_com
 4 @realDonaldTrump^{1,2,5}
 5 @RT_America

Center
 1 @CNN
 2 @thehill
 3 @politico
 4 @CNNPolitics
 5 @Reuters

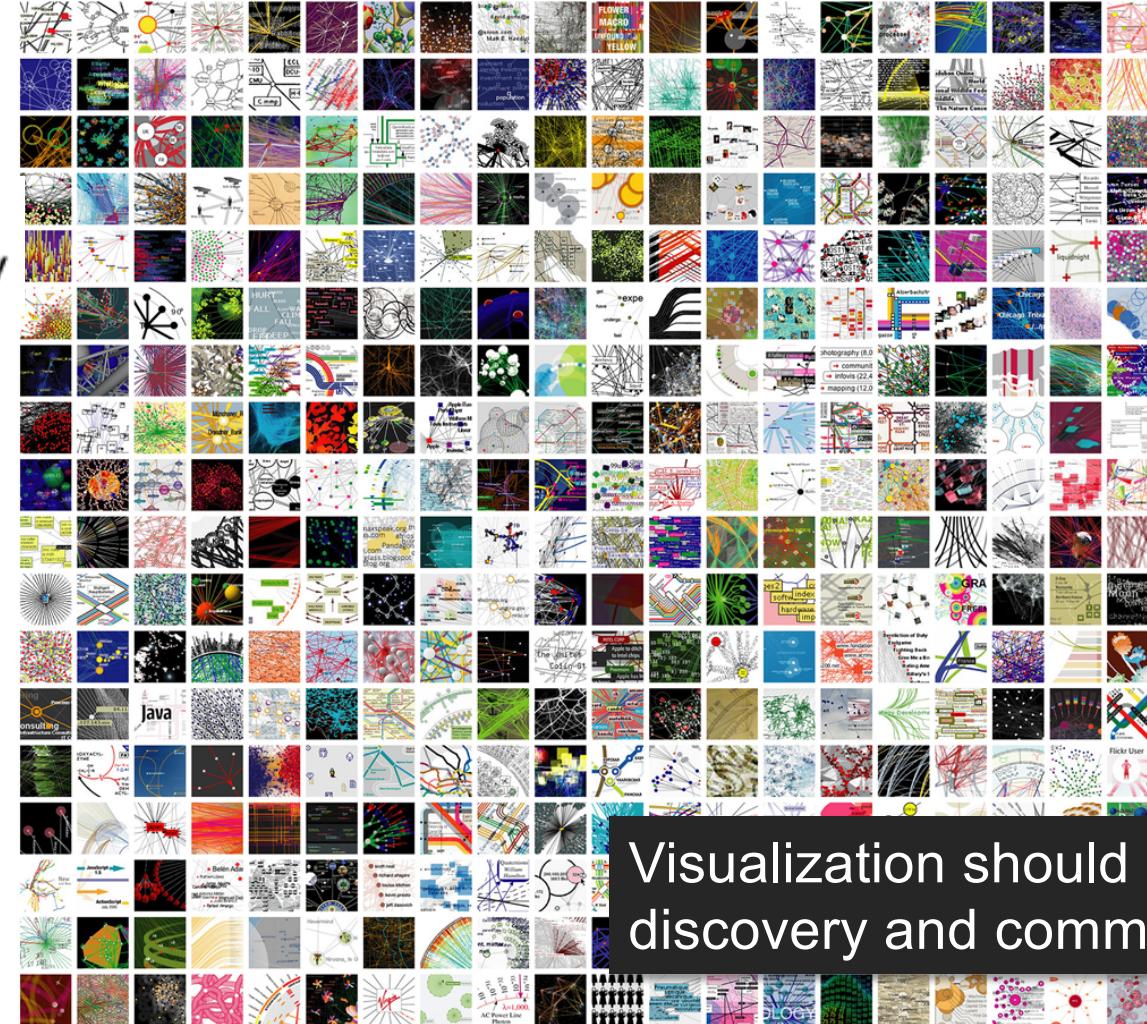
Left leaning
 1 @nytimes
 2 @washingtonpost
 3 @ABC
 4 @NBCNews
 5 @Slate

Left
 1 @HuffPost
 2 @TIME
 3 @thedailybeast
 4 @RawStory
 5 @HuffPostPol

Extreme bias (left)
 1 @Bipartisanism
 2 @PalmerReport
 3 @peterdaou
 4 @crooksandliars
 5 @BoldBlueWave

Networks, networks, networks...

visual complexity



Visualization should support knowledge discovery and communication

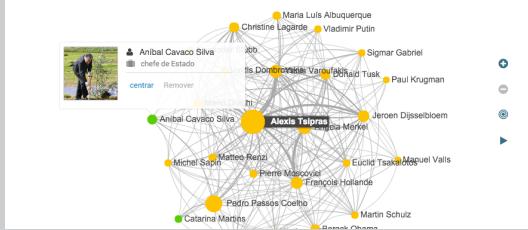
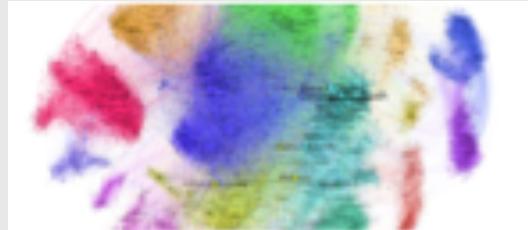
Types of Networks



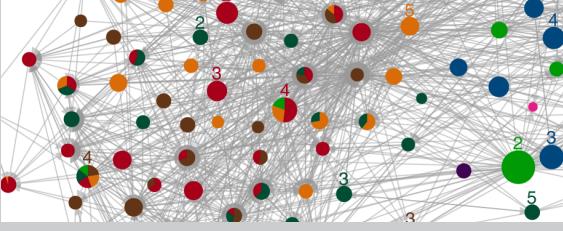
Characterization of Network Types

Network	Entities	Relations	Type of Network
 Board of Directors	<ul style="list-style-type: none"> • Directors • Companies 	<ul style="list-style-type: none"> • Board co-membership 	<ul style="list-style-type: none"> • Implicit • Undirected
 Facebook	<ul style="list-style-type: none"> • People 	<ul style="list-style-type: none"> • Friendship 	<ul style="list-style-type: none"> • Explicit • Undirected 

Characterization of Network Types

Network	Entities	Relations	Type of Network
 News Networks	<ul style="list-style-type: none"> Public figures 	<ul style="list-style-type: none"> Co-occurrence 	<ul style="list-style-type: none"> Implicit  Undirected Weighted 
 Wikipedia	<ul style="list-style-type: none"> Person's wiki page 	<ul style="list-style-type: none"> Hyperlink 	<ul style="list-style-type: none"> Explicit  Directed (Un)weighted

Characterization of Network Types

Network	Entities	Relations	Type of Network
 Twitter Networks	<ul style="list-style-type: none"> • Users • Hashtags • Tweets 	<ul style="list-style-type: none"> • Follows • Retweets • Replies • Tagged 	<ul style="list-style-type: none"> • Implicit, Explicit • Directed • (Un)weighted • Multi-relational



Exercise: Pick other networks (from the examples or elsewhere) and try to identify the **entities, relations and type of network**

Think SOCIAL MEDIA:

Interaction networks
User-generated content

People interact through social media...



...patterns are left behind!

Social Media Interaction Networks

Forums / Online Discussion Groups

- Threaded conversations where people exchange messages asynchronously to share ideas and information
- Shape of the threads captures social interactions, which can be of various types:
 - Q&A, social support, debate a topic, verbal attack, etc.

how fast of a connection?

steve	11/5/2008
Doug Jacobs	11/6/2008
shawn	1/23/2009
JBDragon	1/23/2009
shawn	1/26/2009

Subject: Re: how fast of a connection? 1/23/2009 11:18 PM PST
By: JBDragon In: microsoft.public.xbox

That's because it would be Impossible for him to play games with Dial-Up, way to SLOW, he would get booted. Sure you can connect your Xbox to your PC and use the PC's Modem to connect. I guess if you have no choice, life out in the boonies where there is no Broadband, if you need to get a Update, you do whatever it takes. I don't think you could even play a simple Multiplayer game of UNO over dial-up.

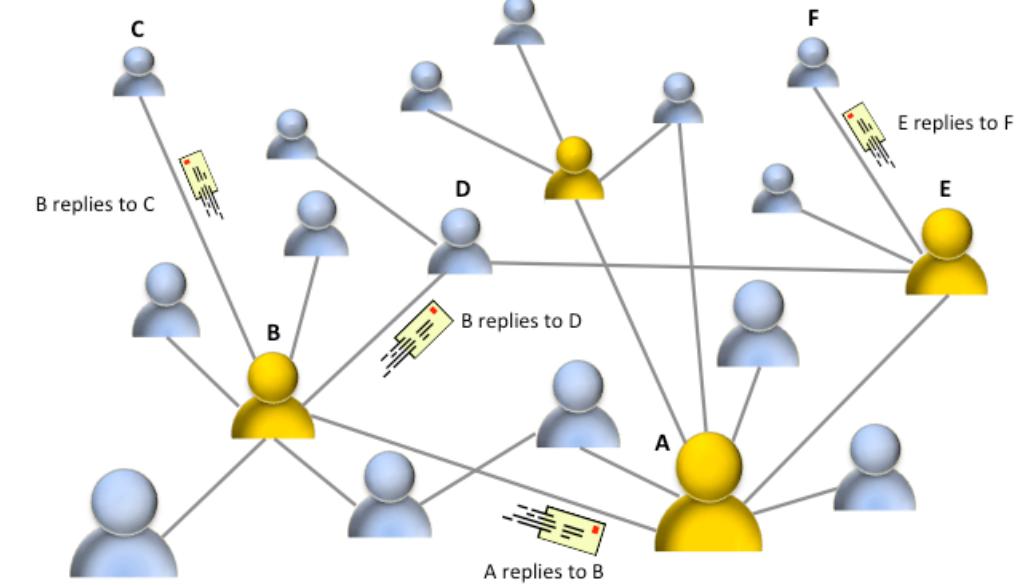
The FASTER the connection the better of course, but 1.5 Mbps is OK. Your not going to want to host any games yourself, and streaming Netflix SD Movies at that speed if your interested in that might not be fast enough. HD movies, No way. I remember not all that long ago where I used to think that was pretty fast. Then Again I remember back in the day using my 300 Baud Dial-Up modem connecting to Bulletin Board Systems(BBS) where you could easily read the type and it scrolled onto the screen. How fast do Dial Up modems connect these days in the real world, like 26.8K, or 26,800 Baud. Quite a bit faster!!! 1.5mbit Broadband is a whole lot faster on top of that so called fast Dial-Up speed.

```
"shawn" <yuppicide138@optonline.net> wrote in message
news:uTtRtpYfJHA.4368@TK2MSFTNGP04.phx.gbl...
>I know someone that connects to live on DIALUP. Took him hours to download
>the stupid NXE update. I'm not saying he plays games with it though,
>probably just downloads stuff.
>
> "steve" <steveeerree@yahoo.com> wrote in message
> news:ulvcgP%23PJHA.4992@TK2MSFTNGP05.phx.gbl...
>> How many Mbps do I need for Xbox Live? Is up to 1.5 Mbps enough?
```

Social Media Interaction Networks

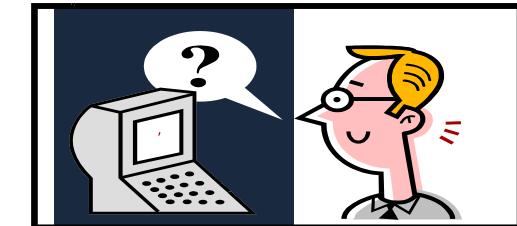
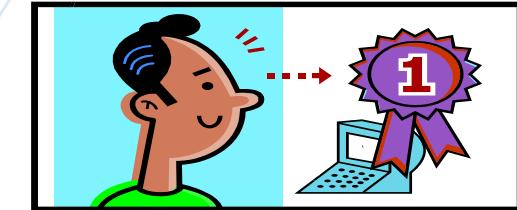
Forums / Online Discussion Groups

- Online discussions are extremely valuable sources of information
- Identifying the **polarity of people's opinions** about certain topics may be useful for business intelligence
- People seeking information through discussion groups search may want to be pointed at **answers to their questions**



Types of Participants in Online Communities

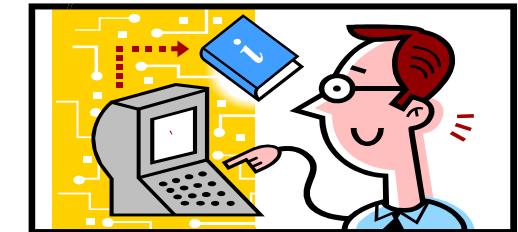
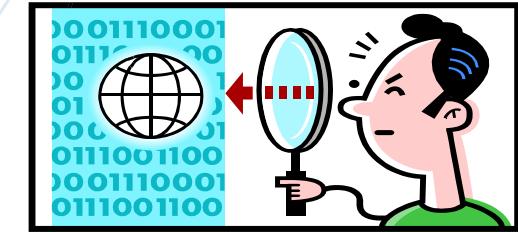
- Leaders
 - Provide answers, social support, institutional memory, and police the space
 - Want visibility and recognition for their efforts
- Questioners / Curious
 - Go to the community for help, expecting quick and accurate answers and have various levels of expertise
 - Want to be guided in their community interaction



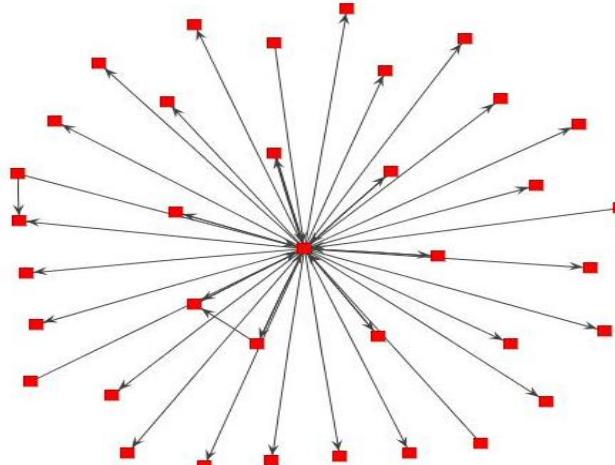
Social Media Interaction Networks

Types of Participants in Online Communities

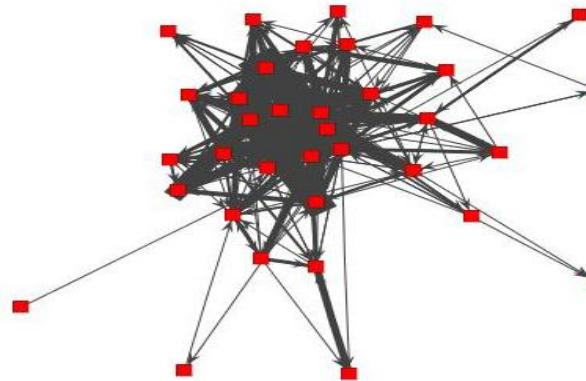
- Silent searchers / **Lurkers**
 - Do not actively participate in the community
 - Just consume the product of the interaction of the leaders and questioners, searching for previous answers to similar problems
- Content contributors
 - Spend a significant amount of their personal and work time contributing content for the community
 - Write FAQ, how-to articles, share code, etc.



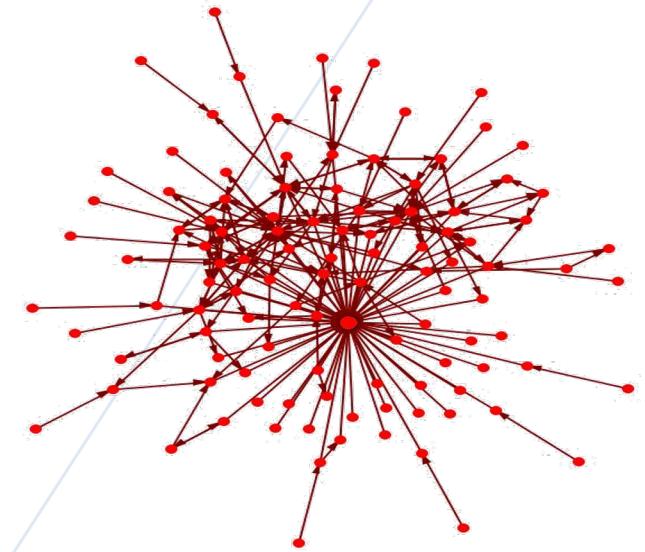
Distinguishing Social Roles



Answer Person



Discussion Person



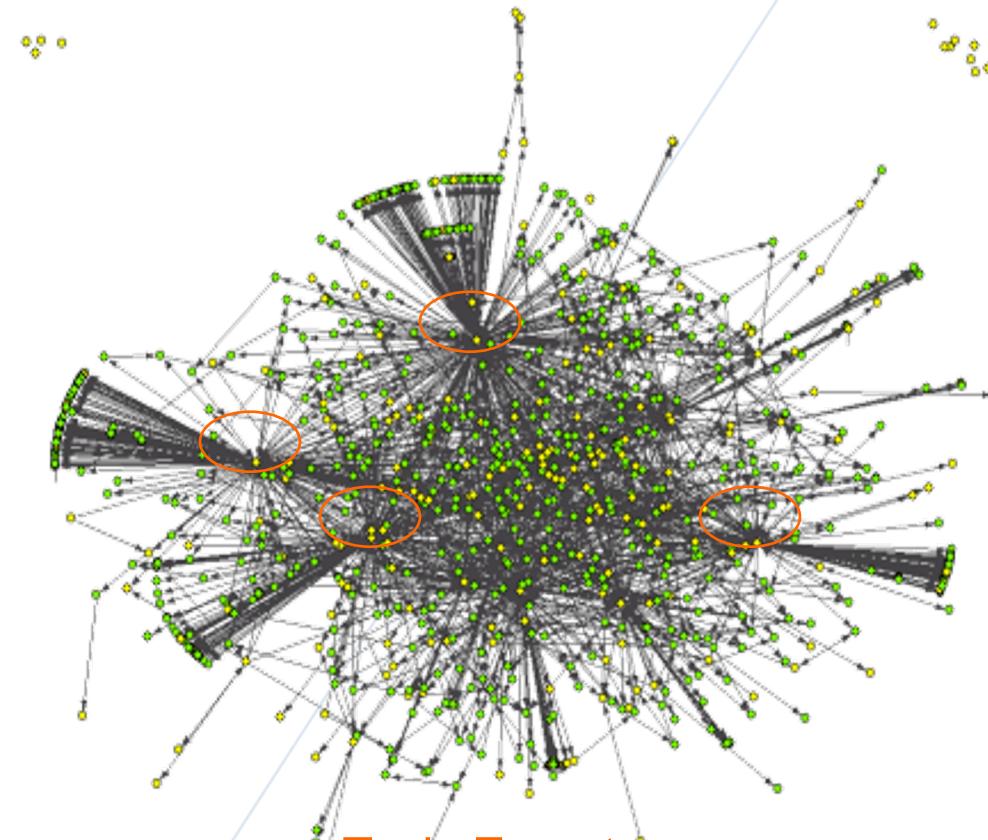
Reply Magnet

Source: Welser et al. 2007

Distinguishing Social Roles

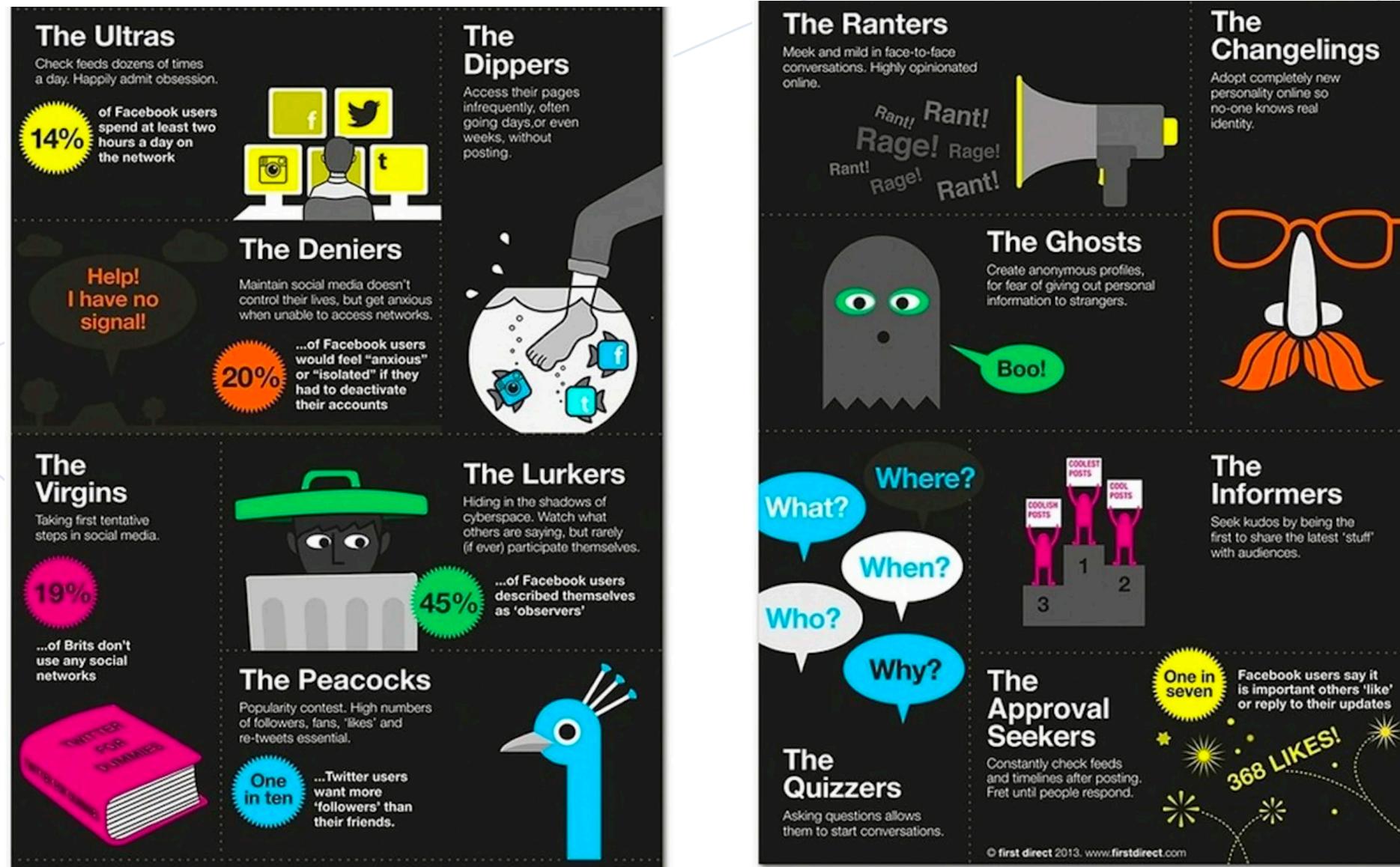


Political Discussion



Technical Discussion

Types of Behaviours in Social Media



Why Analysis of Social Media Networks?

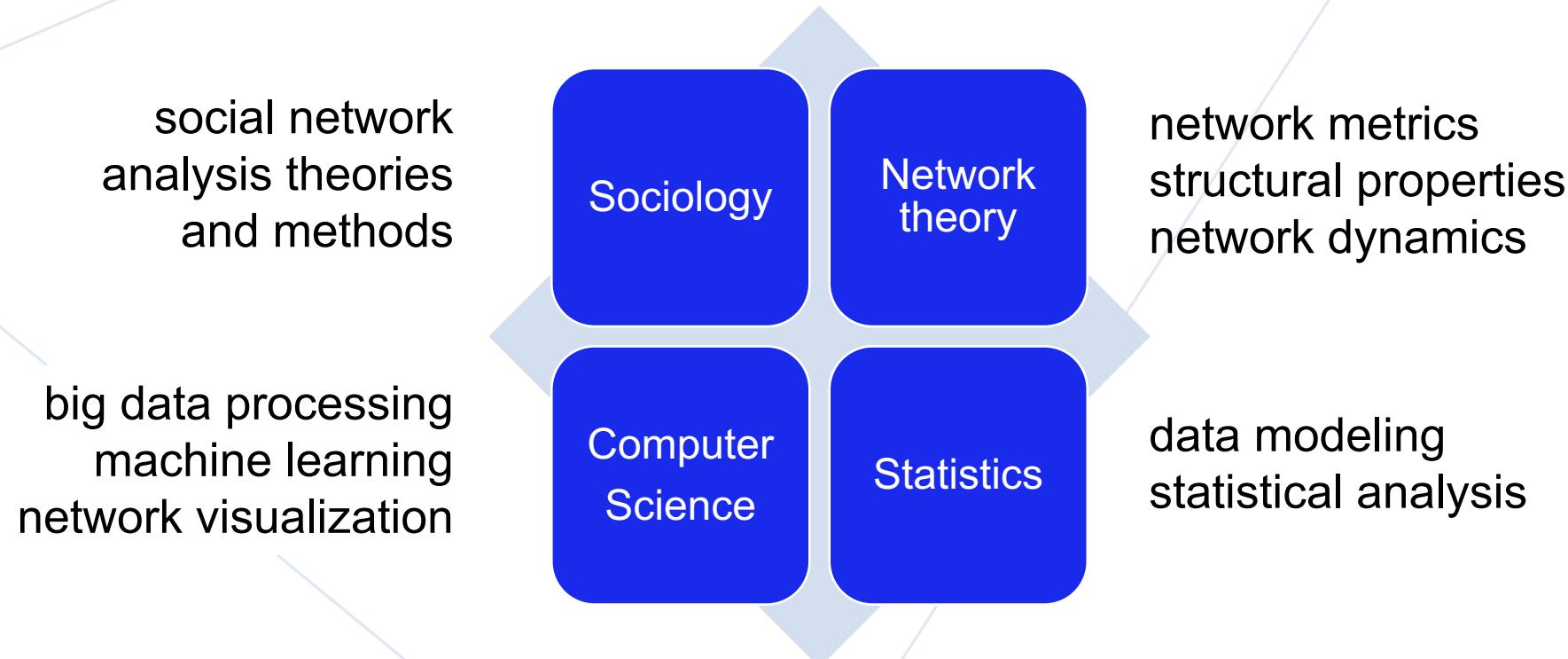
- From **SMALL** scale to **WORLD** scale **social science**
- Emergence of the Social Web
 - Variety of services with different purposes and functionalities
 - Availability of data through web crawling and / or APIs
- Scalable computation technologies
 - Big data / streaming technologies, NoSQL databases, Machine Learning GPU libraries, etc.

Traditional Social Science

- Social science
 - aims to isolate, analyse and understand the causes of individual and collective behaviour
 - aims to understand how social forces shape behaviour, by studying groups rather than individuals
- Social behaviour is studied by sociologists
 - Identifying facts about how and why people behave as they do
 - Systematic observations (comparative and observational studies, etc.)
 - Quantitative methods (questionnaires, interviews, etc.)
- Social network analysis
 - Social science methodology that models social interaction as a network

Computational Social Science

- Leverages the capacity to collect and analyze data with an unprecedented breadth, depth and scale

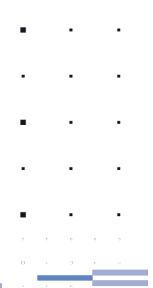


Social Media Content Analysis



“Flavours” of Social Media Content Analysis

- Text Mining for **analysis of content** (information)
 - topic classification
 - sentiment analysis
 - trend analytics
- Relation extraction for **analysis of structure** (behaviour)
 - natural language processing



Sentiment Analysis

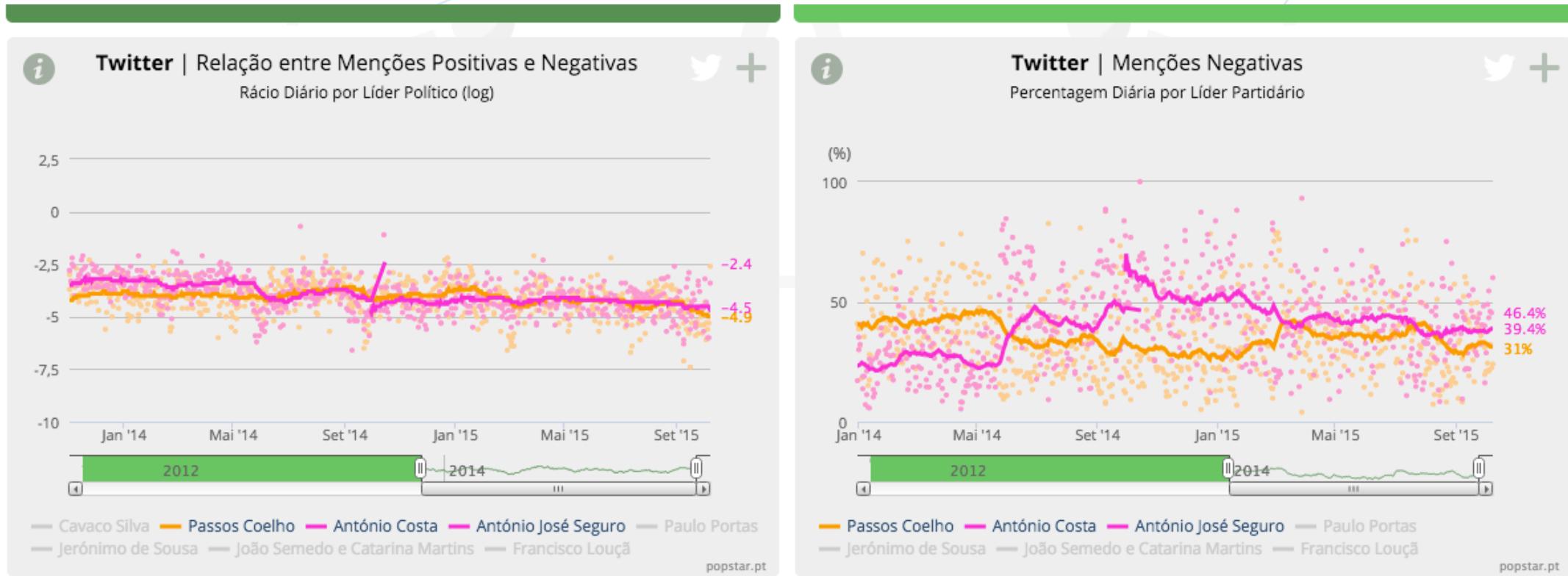
- Sentiment
 - A view or opinion that is held and expressed in verbal, non-verbal or written form
- Sentiment Analysis (a.k.a. Opinion Mining)
 - Use of natural language processing / computational linguistic techniques to infer sentiment from unstructured text

Why sentiment analysis?

- Politics: “listen” to voters’ opinions, understand politicians’ stances on specific topics
- Social media: find like-minded individuals or communities
- Consumer information: product reviews, trends
- Marketing: consumer behaviour, brand management

Sentiment Analysis

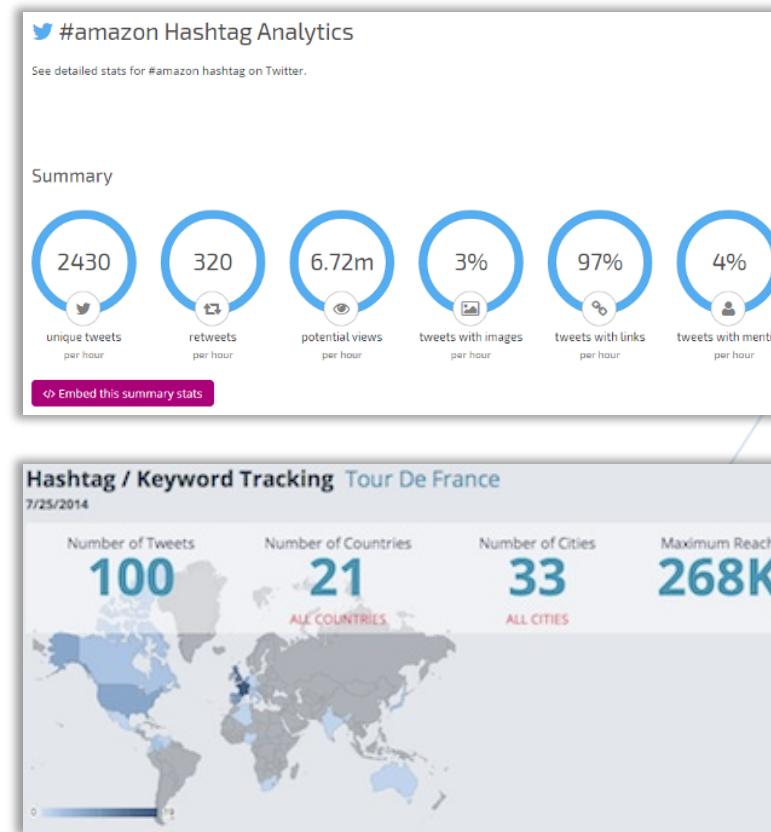
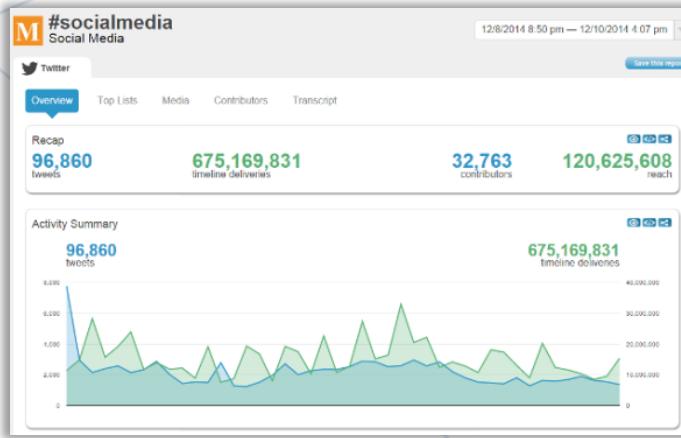
- Public Opinion and Sentiment Tracking, Analysis & Research



Source: <http://popstar.pt>

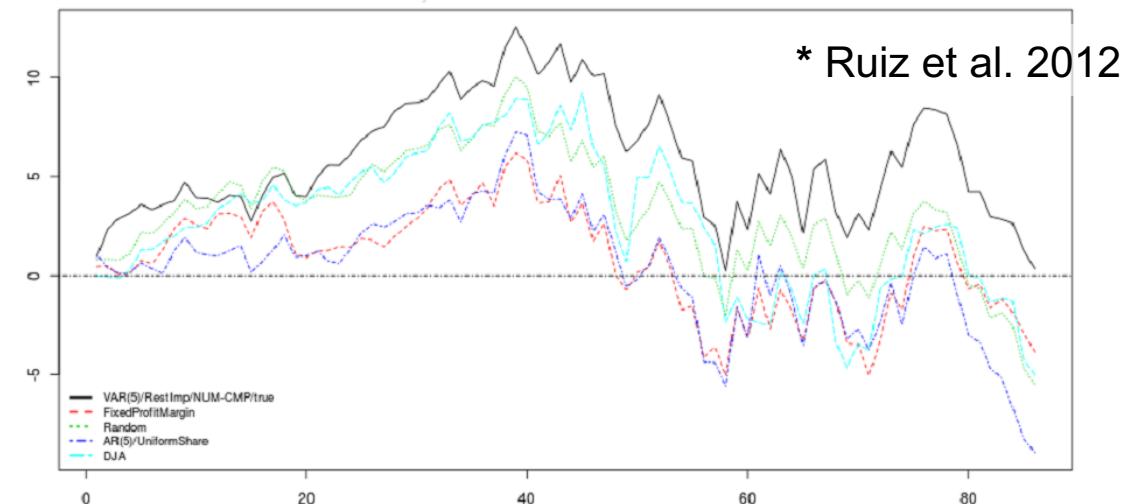
Trend Analytics

- Trends per hashtag, influencers, lots of visual dashboards,...



- Financial Analysis, Stock Prediction

- **Twitter-Augmented Regression** [*] can improve financial predictive analysis
- Both Twitter and financial features are used in the regression model
- Tested performance in simulated stock market
- Predict price change based on regression model and buy/sell accordingly



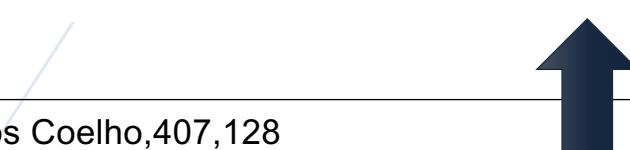
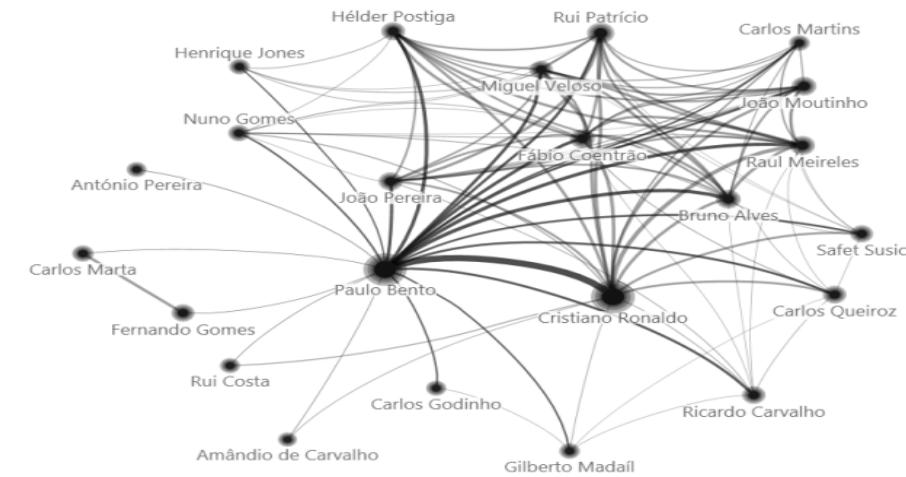
Relation Extraction

- Natural Language Processing (NLP) techniques apply knowledge about the structure of language to extract information from unstructured text
 - named-entity recognition (NER), part-of-speech tagging (POS), etc.
- NLP is used to extract names of entities, such as **people, organisations, products, locations, dates**, etc.
- It is also used to extract **relations between entities** and characteristics of those entities (metadata)

Relation Extraction with NLP

Visualizing News Networks

- Information extraction from thousands of news articles
- SAPO Labs / UPorto developed NLP technology for Named Entity Recognition
- Relation extraction based on entity co-occurrence



Pedro Passos Coelho, 407,128
Silvio Berlusconi, 271,106
Aníbal Cavaco Silva, 234,98

...
'Paulo Bento' e 'Cristiano Ronaldo' co-ocorreram em 72 notícias
'Paulo Bento' e 'Bruno Alves' co-ocorreram em 39 notícias
'Paulo Bento' e 'Raul Meireles' co-ocorreram em 37 notícias

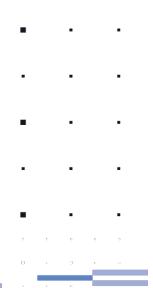
...

Challenges in Social Media Content Analysis

- Social media content is more informal and rather more noisy than other information sources, such as web pages, news, reviews, etc.
 - Use of abbreviations, mixed languages, URLs, etc.
 - Typos (“helo wold”), joined terms (e.g. “helloworld”), etc.
 - Symbols (e.g. ==>, :-S, (<._.<)), emoticons, etc.
 - Lack of context may lead to ambiguity (e.g. Tweets are limited to 140 characters)
 - Subtlety of sentiment expression: irony, use of neutral words

Challenges in Social Media Content Analysis

- Identifying credible information vs. rumors and hearsay
- Distinguishing user-generated content vs. machine-generated content (e.g. news bots, spam)
- Self-declared geo-localisation is not reliable (“Location: planet Mars”) and not everyone enables location services on their devices
- **Text mining techniques** need to be tailored to cope with all these challenges!



Social Network Analysis for Business Intelligence



Social Media Analytics for BI

- Social media analytics tools are widely used for business intelligent applications
- They support decision making across the spectrum, including
 - Sales, marketing
 - Human resources management
 - Product development
 - Consumer behaviour
 - Customer service
 - etc.

Social Media Analytics for BI

- Objectives, Requirements & Outcomes (1/2)

Source: U. Ruhí 2014

Common Use Cases for Social Media Analytics	Required Business Insight	Enabling Analytics Techniques	Pertinent Performance Metrics
Audience Segmentation	<ul style="list-style-type: none"> Which segments to target for acquisition, growth or retention? Who are the advocates and influencers for brand or product? 	SNA	<ul style="list-style-type: none"> Active advocates Advocate Influence
Information Discovery	<ul style="list-style-type: none"> What are the new or emerging business relevant topics or themes? Are new communities of influence emerging? 	NLP, CEP	<ul style="list-style-type: none"> Topic trends Sentiment trends

Social Media Analytics for BI

- Objectives, Requirements & Outcomes (2/2)

Source: U. Ruhí 2014

Common Use Cases for Social Media Analytics	Required Business Insight	Enabling Analytics Techniques	Pertinent Performance Metrics
Exposure & Impact	<ul style="list-style-type: none"> What are the brand perception? How does brand compare against competitors? Which social media channels are being used for discussion? 	SNA, NLP	<ul style="list-style-type: none"> Conversation reach Velocity Share of voice Audience engagement
Behaviour Inferences	<ul style="list-style-type: none"> What is the relationship among business relevant topics & issues? What are the causes for user intent (buy, churn, etc.)? 	NLP, Clustering	<ul style="list-style-type: none"> Interests or preferences Correlations Topic Affinity

References

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Make change happen



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UNICON
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