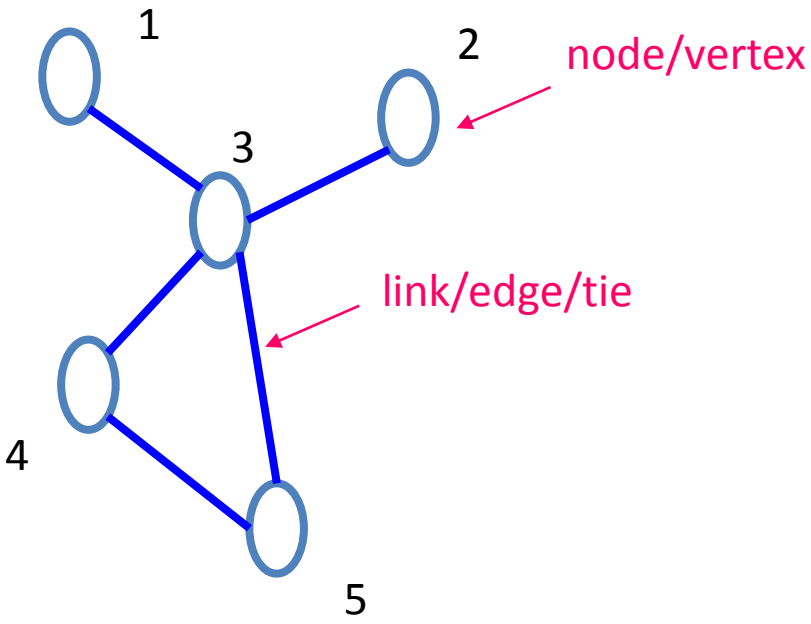
COMP9311 Advanced Topics: Social Network Analysis

INTRODUCTION – What are Networks

- **Networks** are collections of **points** joined by **lines.**



"Network" ≡ "Graph"

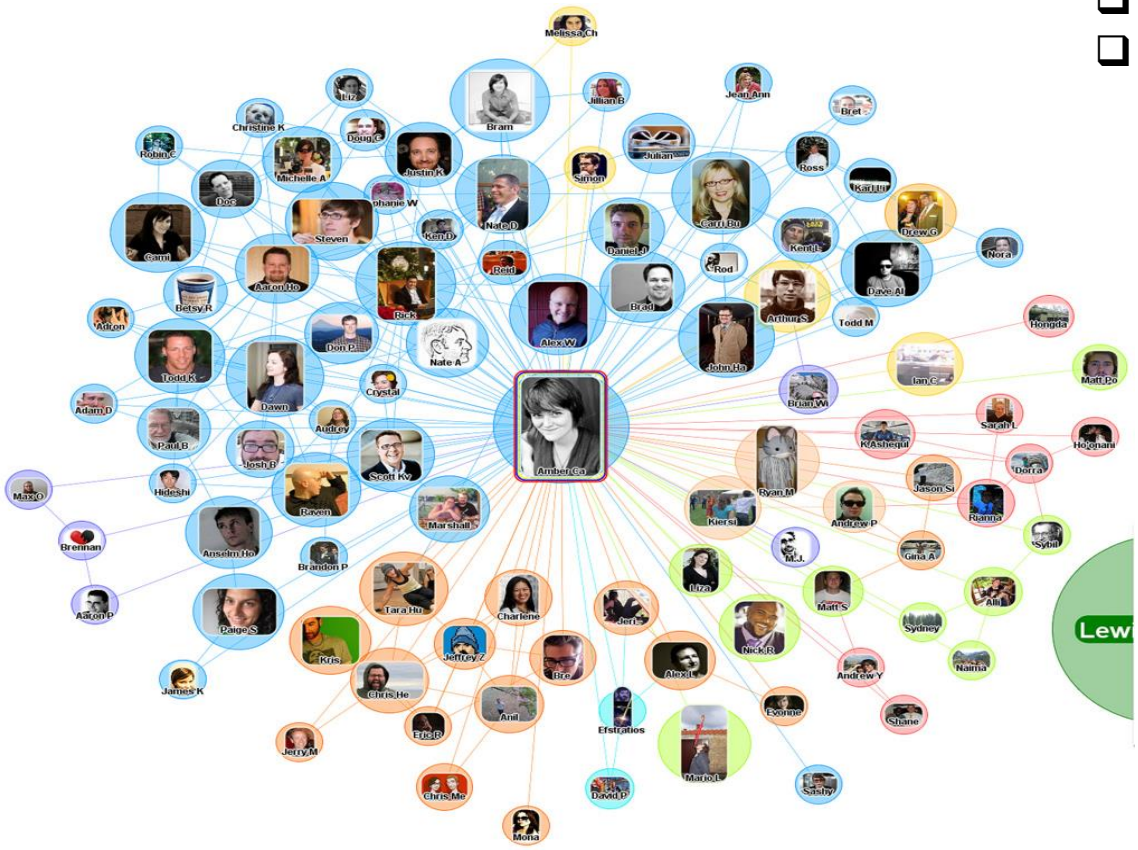
INTRODUCTION – Why we study networks

- **Networks** are everywhere, and we live in a highly-connected world.
- **Social Network**

*A **social network** is a **social structure** made up of a set of **social actors** (such as individuals or organizations), sets of dyadic ties, and other **social interactions** between actors.*

-- wikipedia

Social Networks – Facebook ego-network



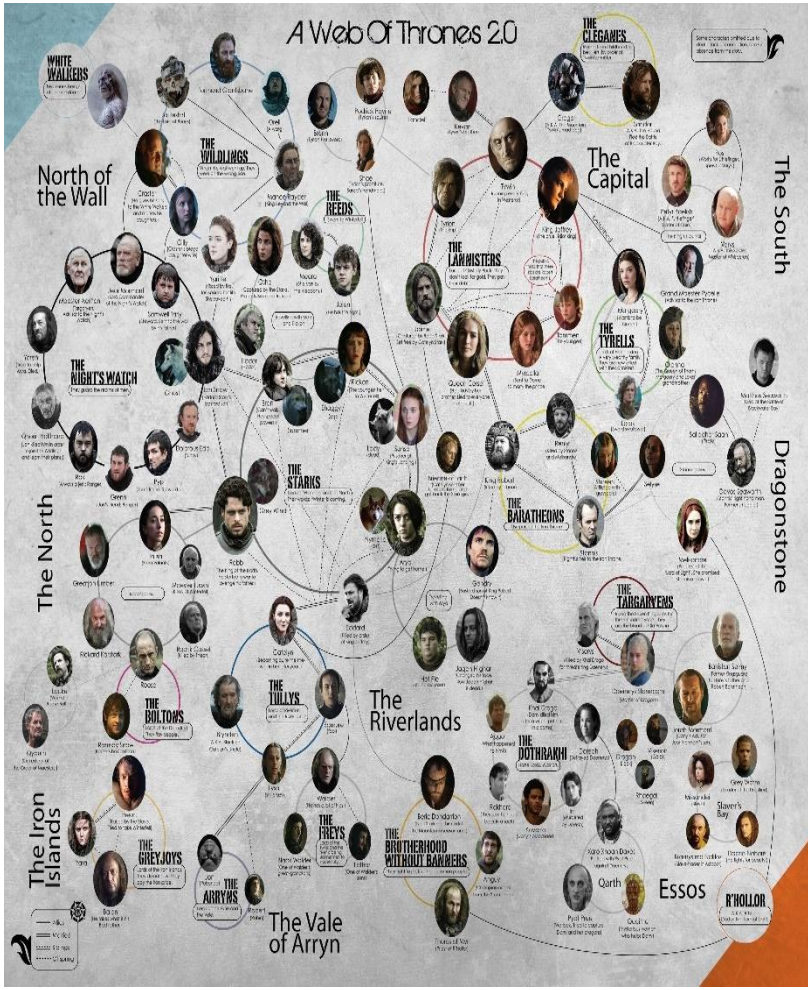
- Find your communities
- Know how to approach a person via Facebook.
  e.g., how to increase the chance of getting your friend invitation accepted?

Social Networks – Facebook

Monthly active users: around **1 billion** in **2012** and now around **1.86 billion** **(Google+ : 440 million)**

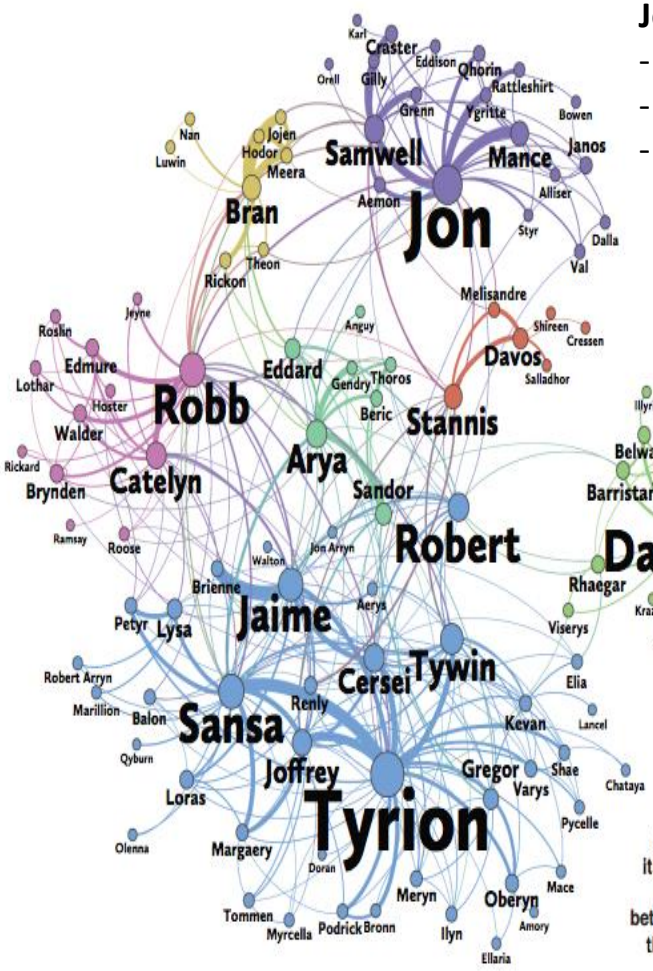
Facebook social graph, ***4-degrees of separation*** *[Backstrom-Boldi-Rosa-Ugander-Vigna,* ***2011****]*

Social Networks – Network of thrones



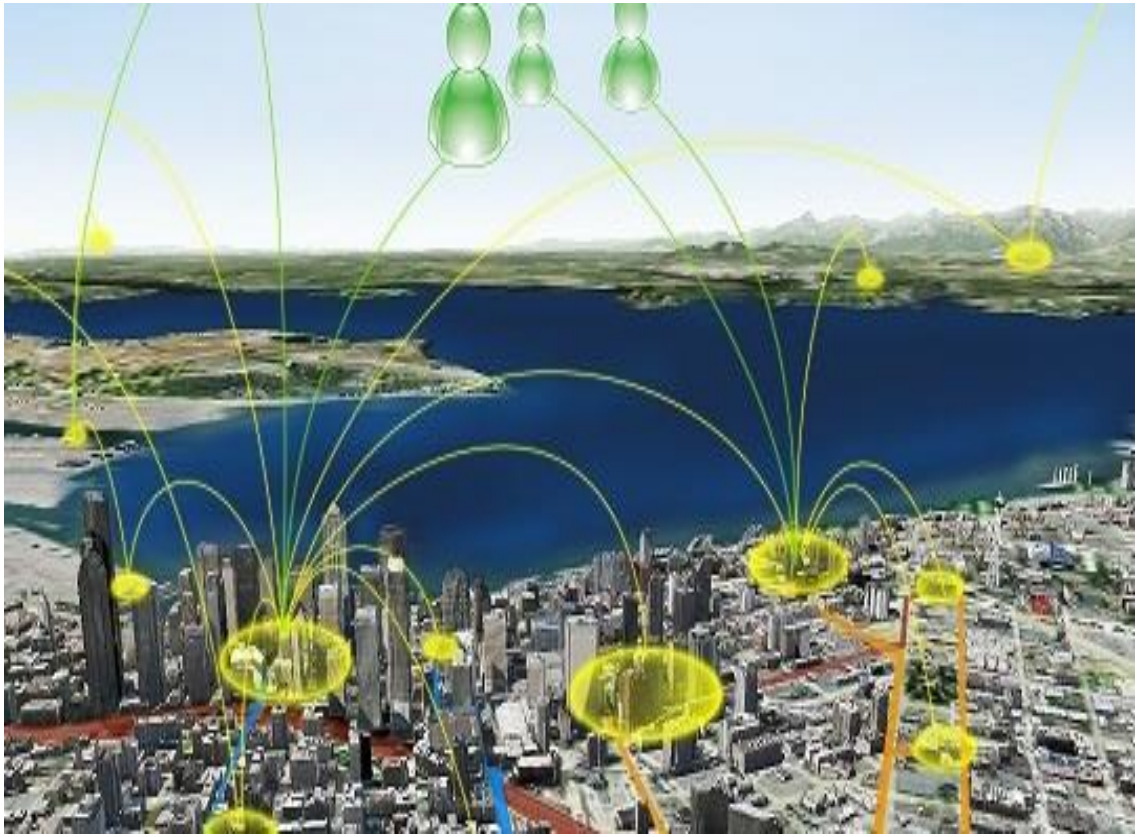
http://www.chartgeek.com/game-of-thrones-family-tree/

Jon snow
- Stark family
- Night watch
- Savage Wildlings



http://www.maa.org/sites/default/files/pdf/Mathhorizons/NetworkofThrones%20%281%29.pdf

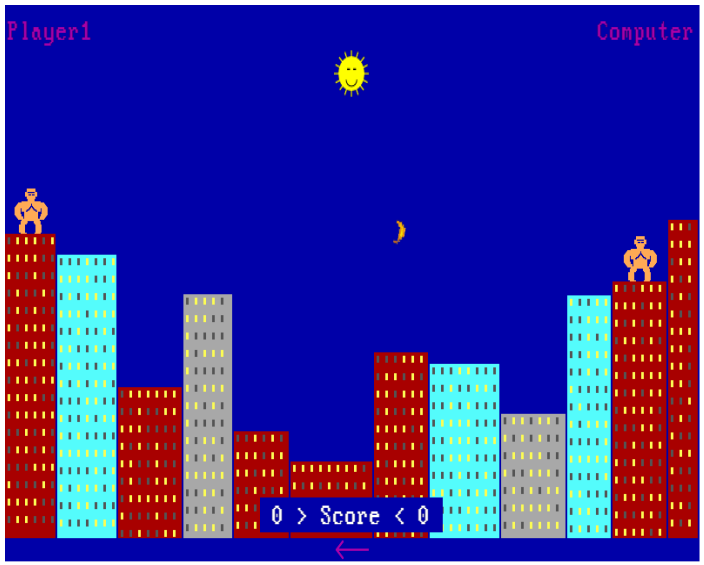
Social Networks – Location Based Social Network (LBSN)



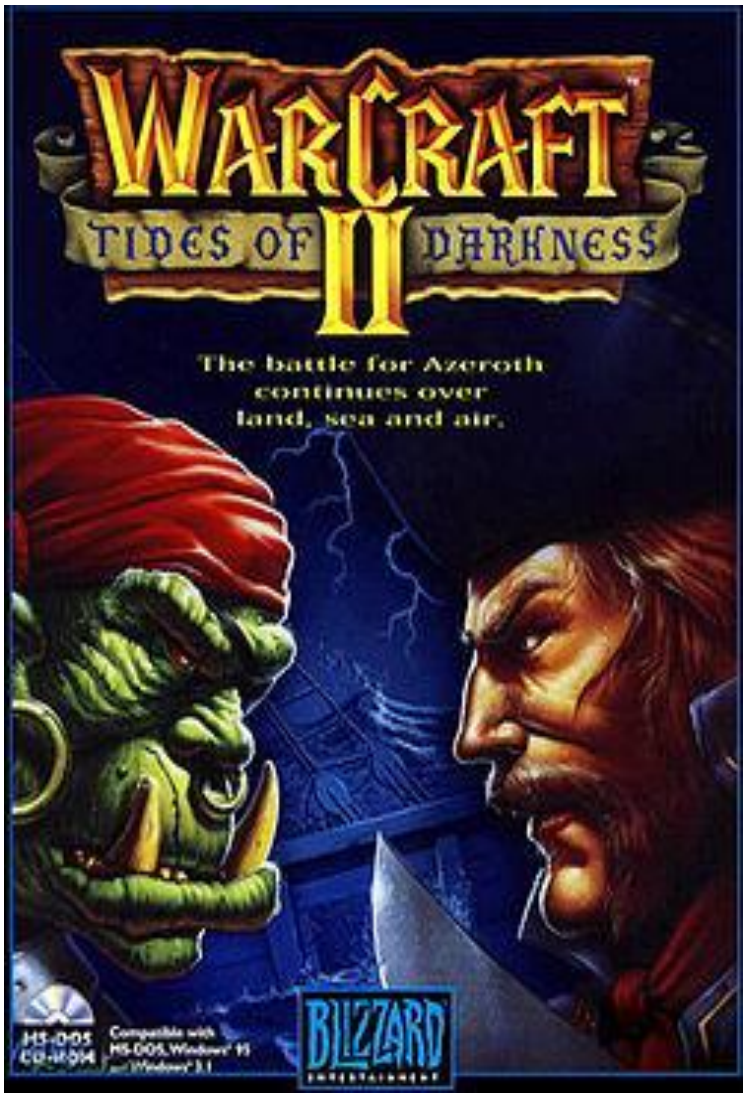
https://www.microsoft.com/en-us/research/project/location-based-social-networks

Yelp data challenge !

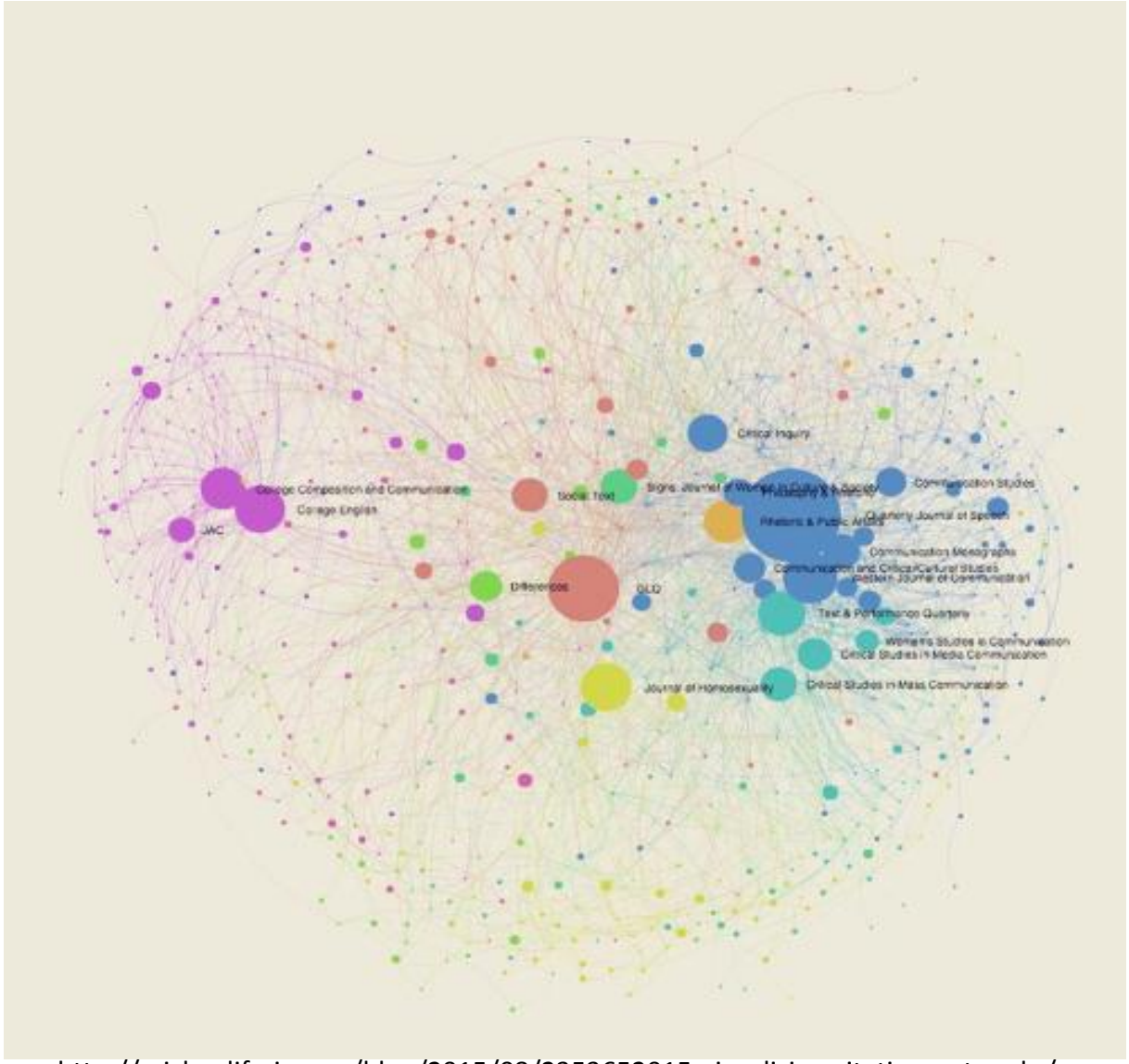
Social Networks – Social Games



Hit your opponent with an exploding banana.



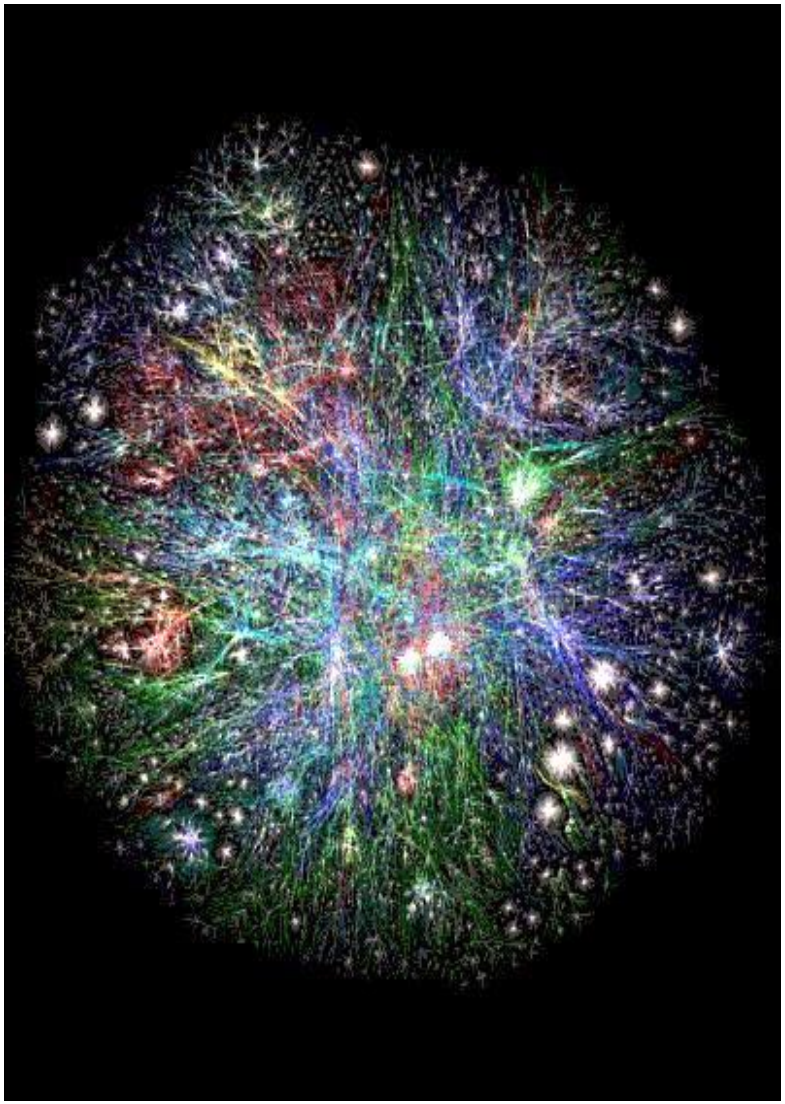
Social Networks – Citation network



Citation Network is a social network which contains paper sources and linked by co-citation relationships

http://michaeljfaris.com/blog/2015/08/2353652015-visualizing-citation-networks/

Information Networks – WWW

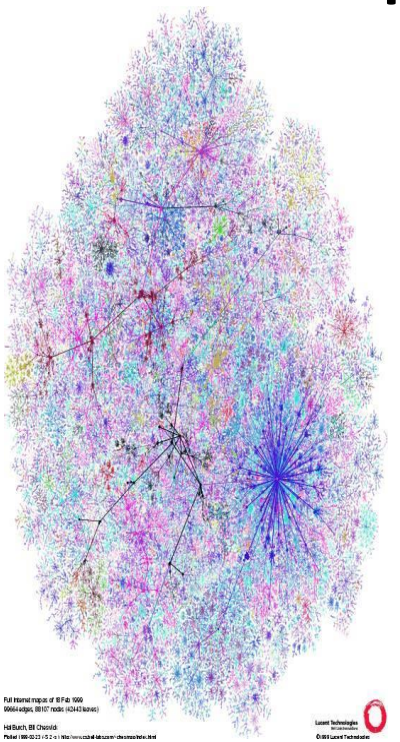


http://www.vlib.us/web/worldwideweb3d.html

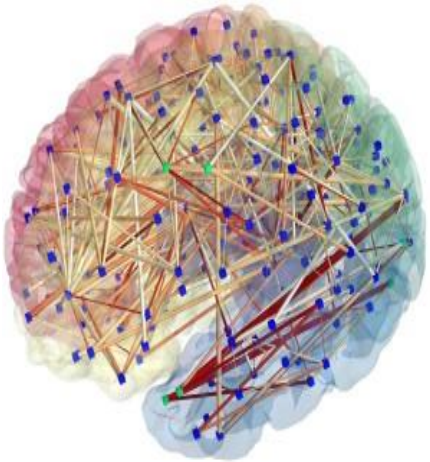
3D Map of the World Wide Web

This illustrates in 3-D the actual domains and connections of the world wide web. **Colors** have been added to represent .edu, .gov, .com, etc. domains.

Many other Networks



Internet

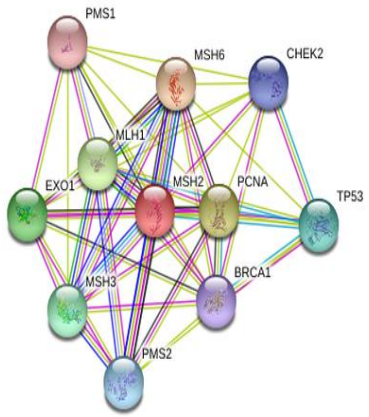


Human Brain Network (10-100 billion neurons)

http://blog.myesr.org/mri-reveals-the-human-connectome

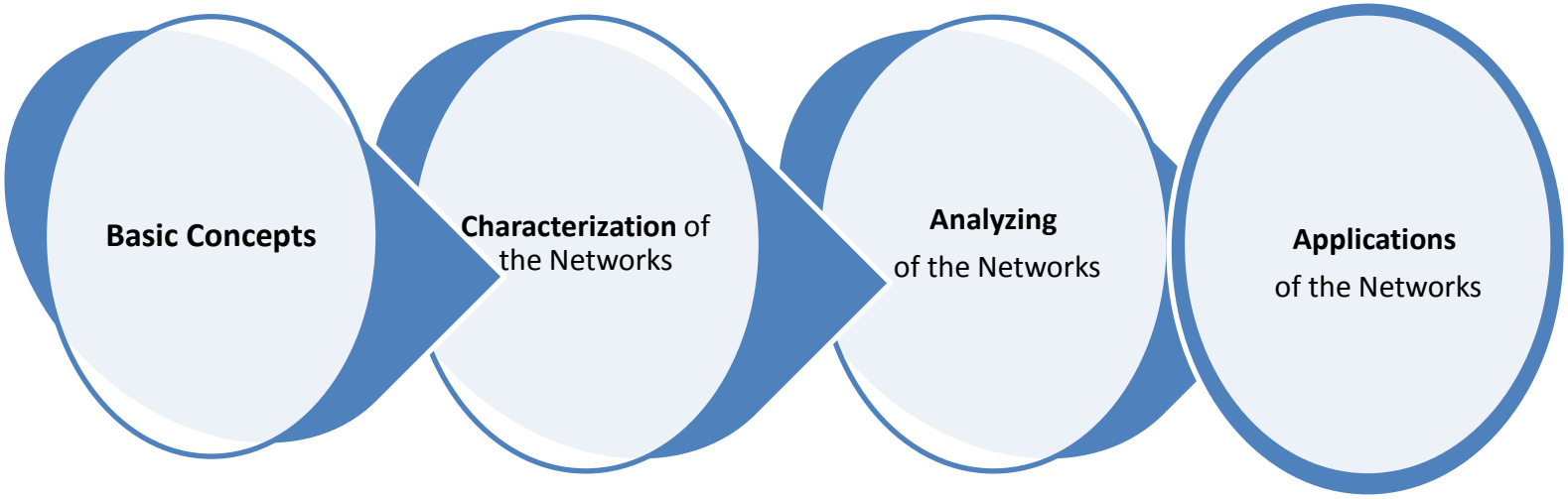
Sydney Road Network

http://www.brt.cl/opinion-pieces-i-tolled-you-so



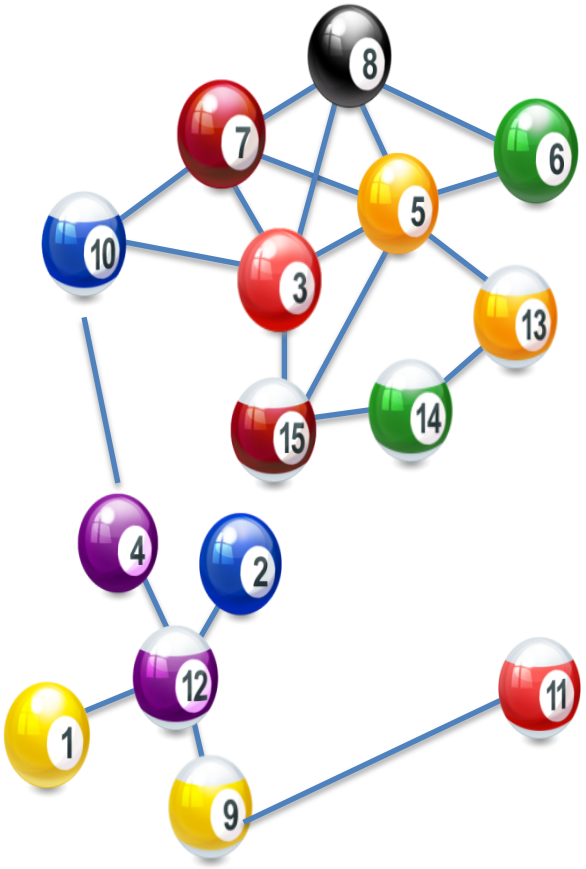
Protein interaction network

Social Network Analysis



- What are networks? **Basic concepts**
- How to **characterize** networks?
- How to **analyse** social and information network data?
  – Methods and tools;
- **Applications** of social and information network analysis

CHARACTERIZATION



- **Degree**: how many friends do I have?
- **Weights**: how strong are the ties?
- **Path**: how far am I from another vertex?
- **Connectivity**: can I reach all other vertices?
- **Diameter**: how dense are they?
- **Centrality** (e.g., betweenness, closeness): Am I in the center of everyone?

Average shortest path

How close is everyone from everyone?

Six degree of separation: only six hops separate any two people in the world

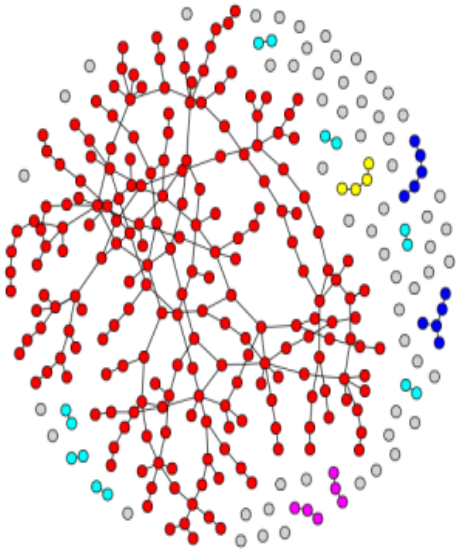
"**Three and a half degrees of separation**" recently reported by Facebook research
https://research.fb.com/three-and-a-half-degrees-of-separation/

Mark Zuckerberg
3.17 degrees of separation

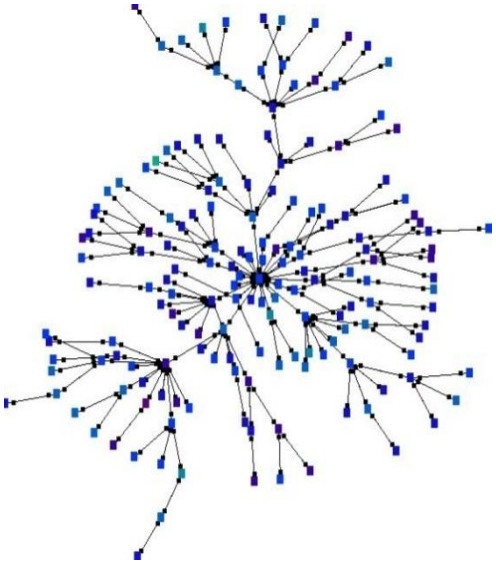
Graph Modelling

Network modelling is to find the **right generative process** of networks that **explains the observations** of network properties.

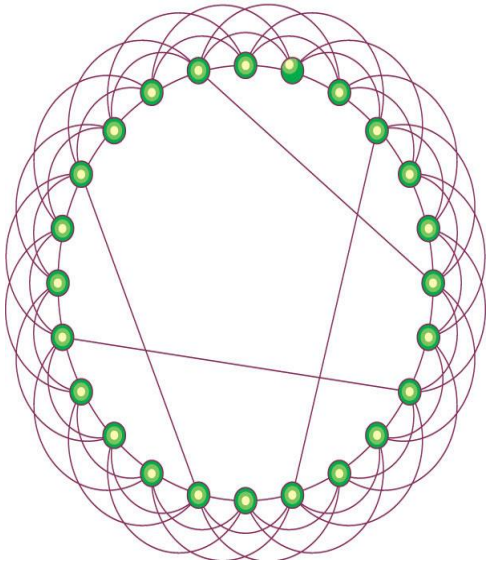
- Degree distribution, average shortest path, community structure, etc.



Random graph



Scale-free graph



Small world graph

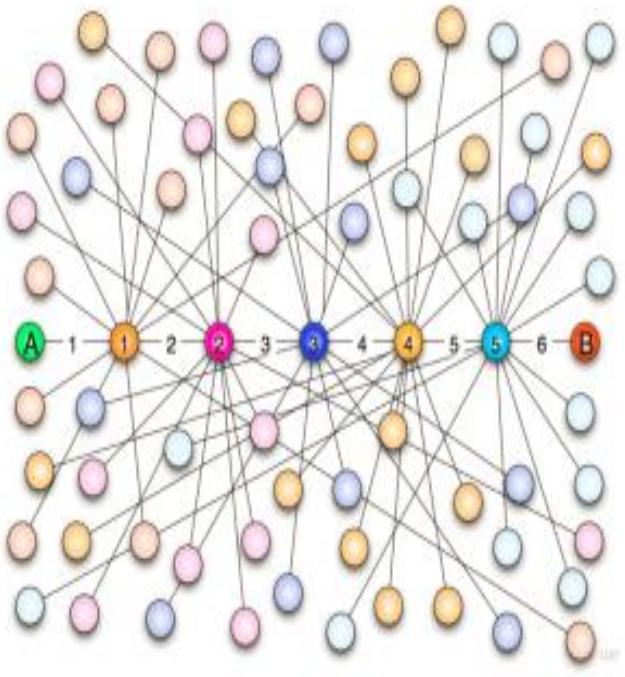
Search

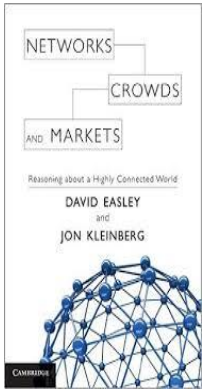
- Find the (shortest) path between two people.

Wenjie Zhang

Ming Hua
(manager at Facebook)

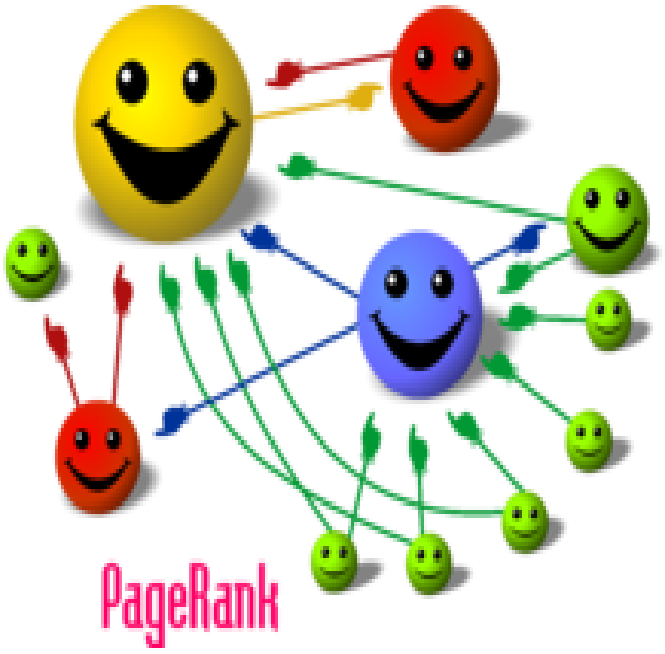
Mark Zuckerberg



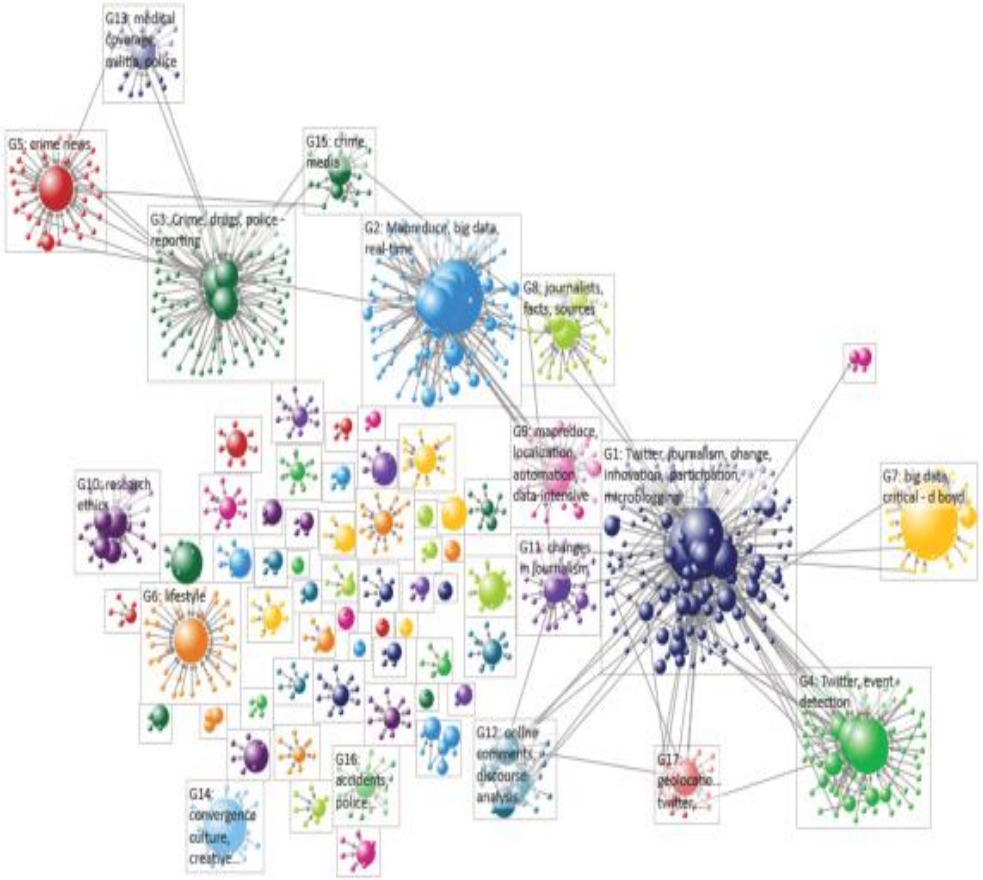


Ranking

- Importance of the vertices. E.g., which is the most influential paper in a co-citation network



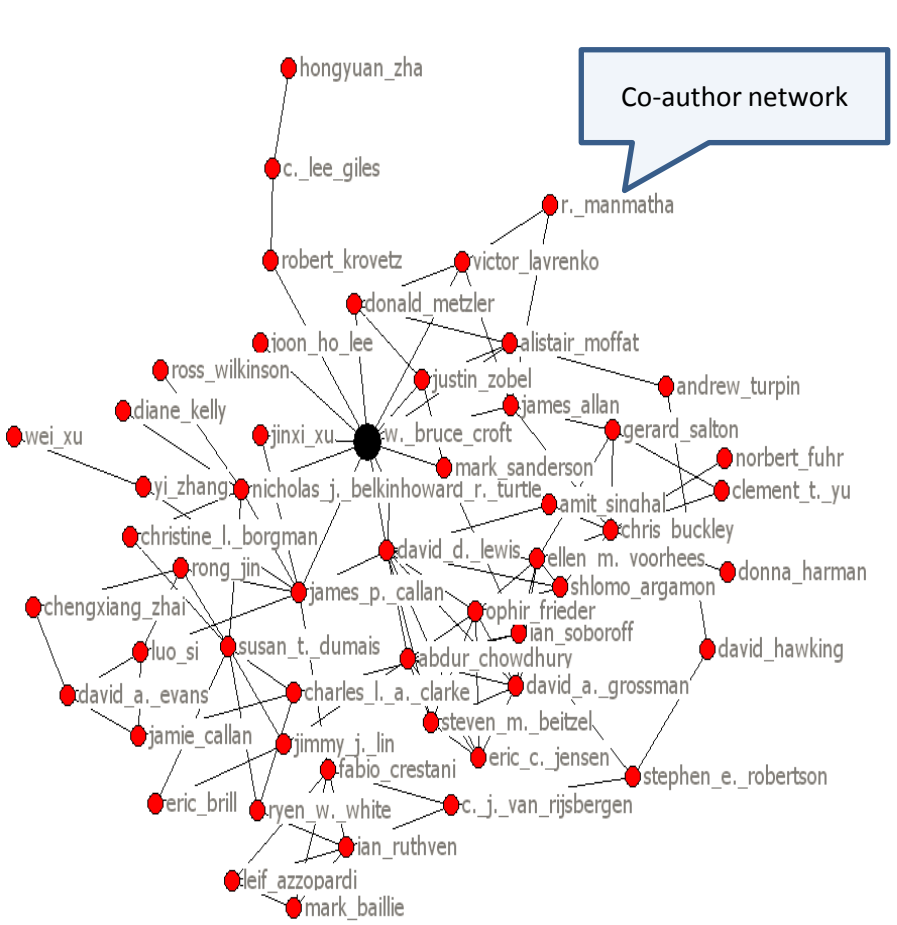
https://en.wikipedia.org/wiki/PageRank

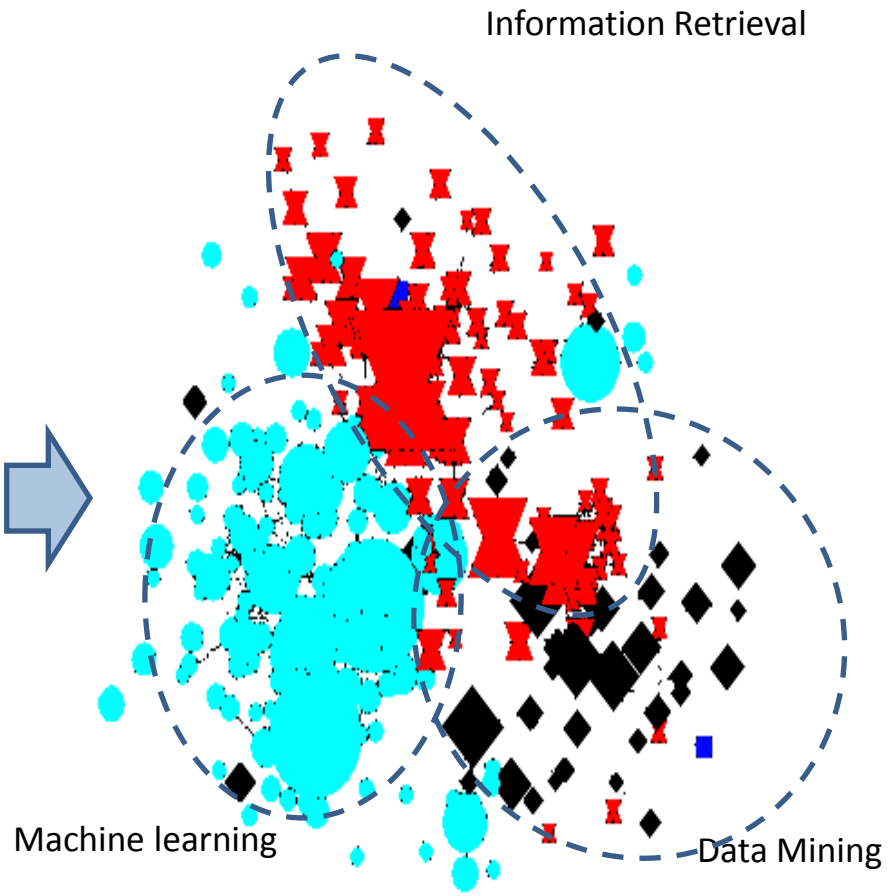


https://www.researchgate.net/

Finding Communities

- Who tend to work together



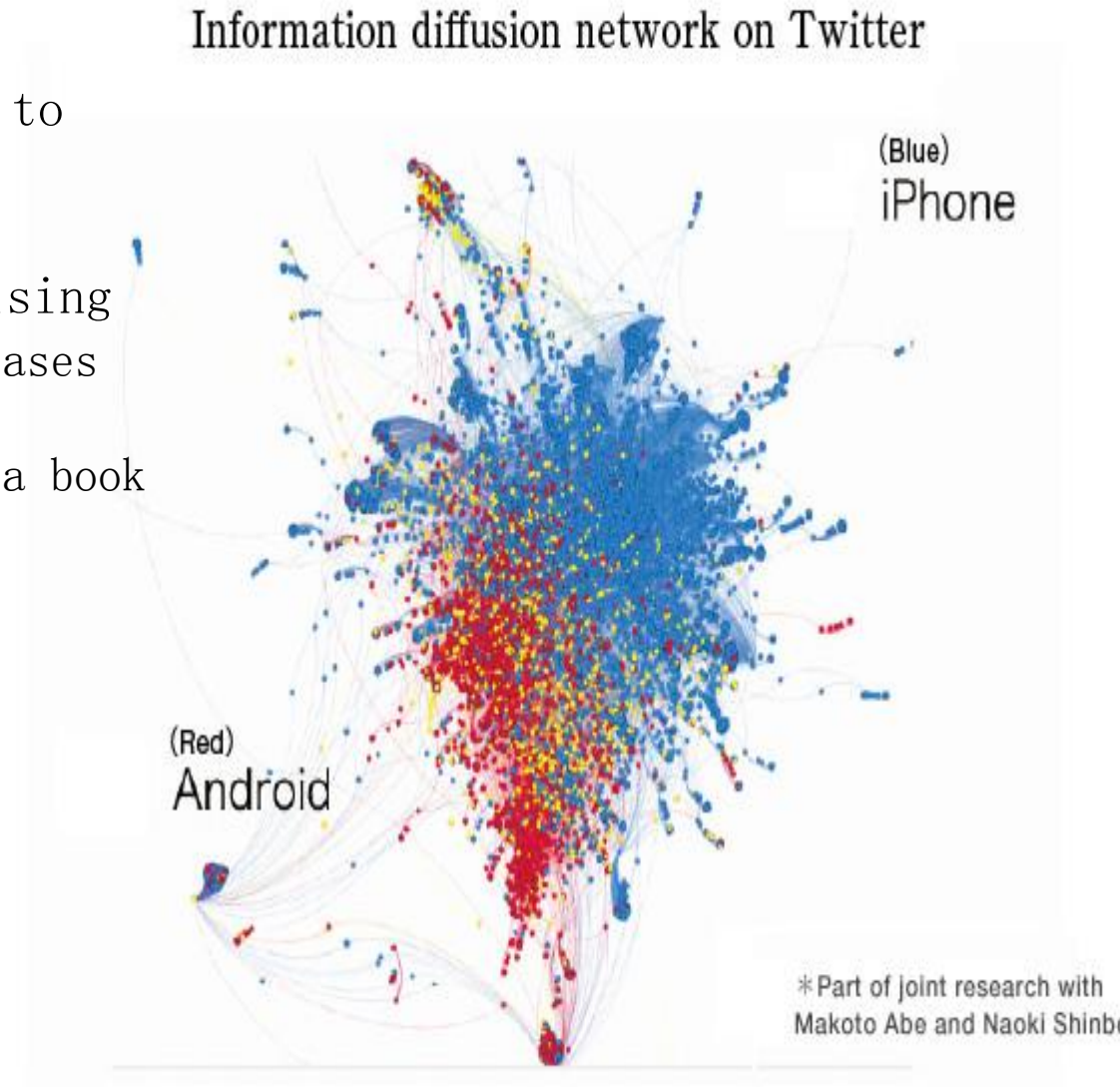


Network Dynamic Analysis

Cascade behaviour from node to node like an epidemic

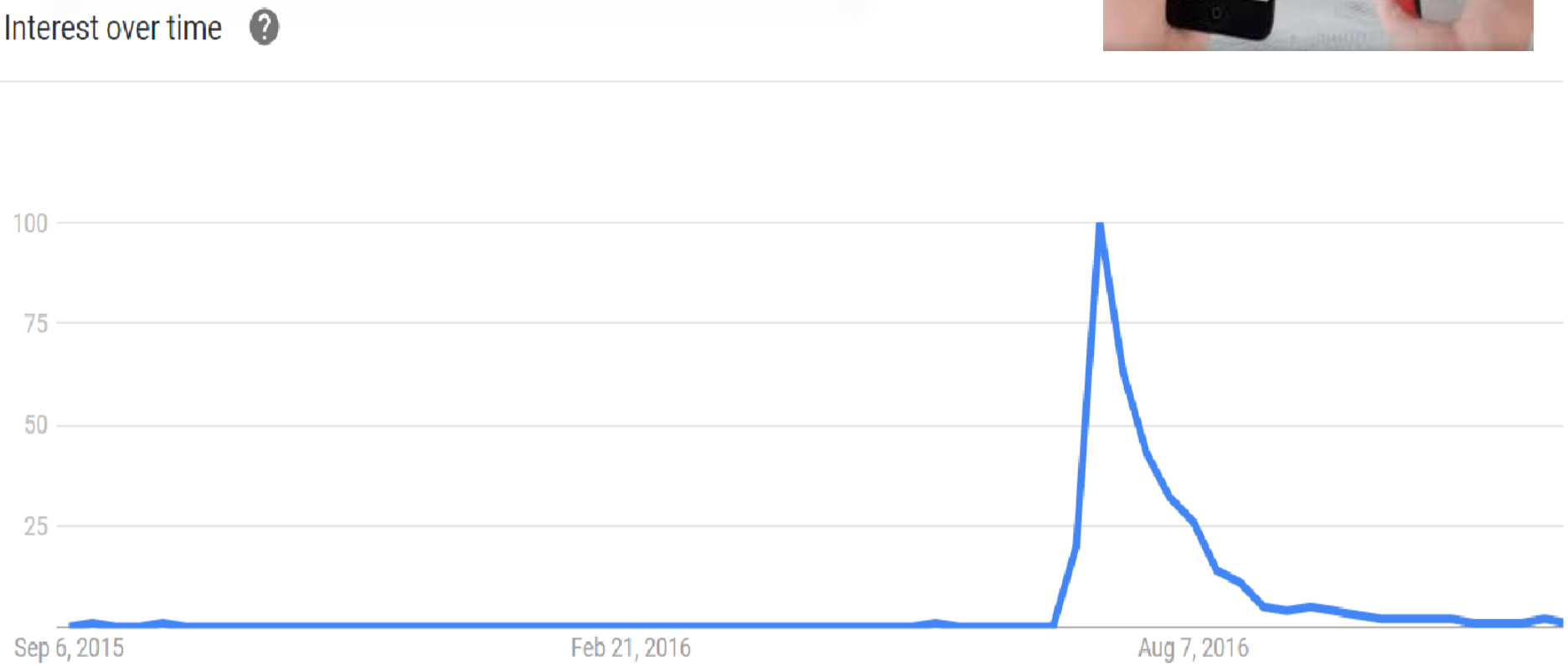
E.g.,

- Marketing, online advertising
- News, opinions, rumors, diseases
- Adoption of innovation;
- Joining a community, buying a book



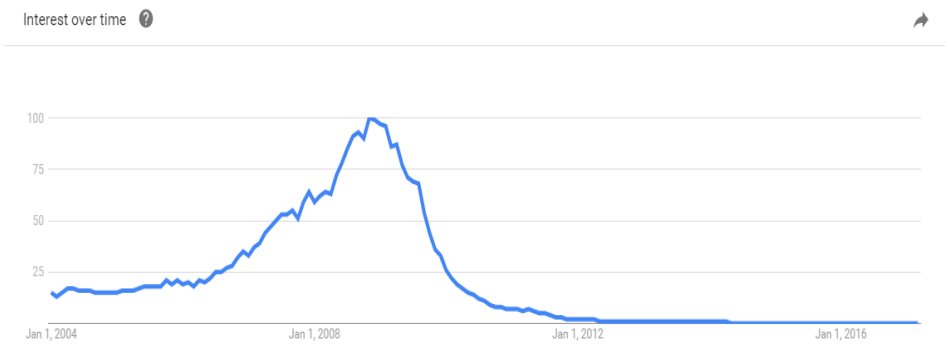
Network Dynamic Analysis

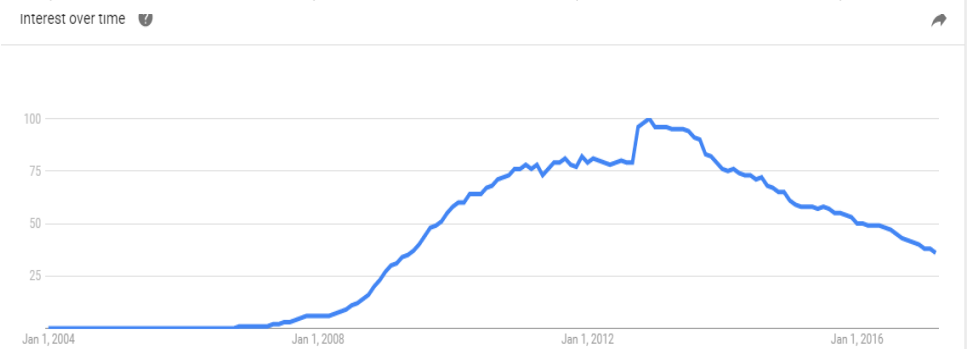
Our survey: around 50% used to play, now no active user any more

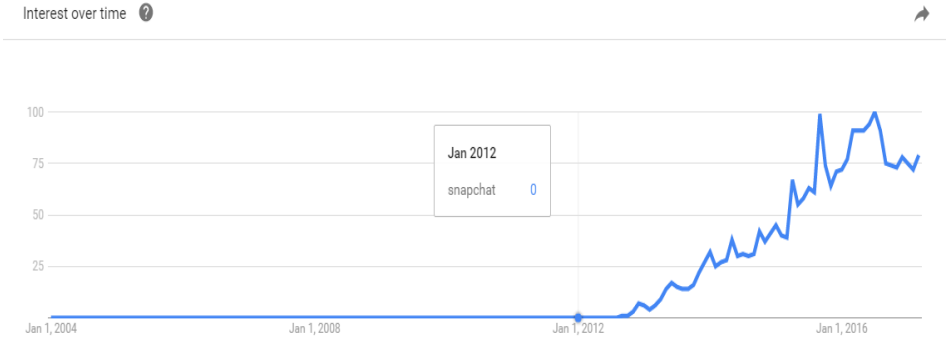


Google Trend “Pokémon Go”

Network Dynamic Analysis





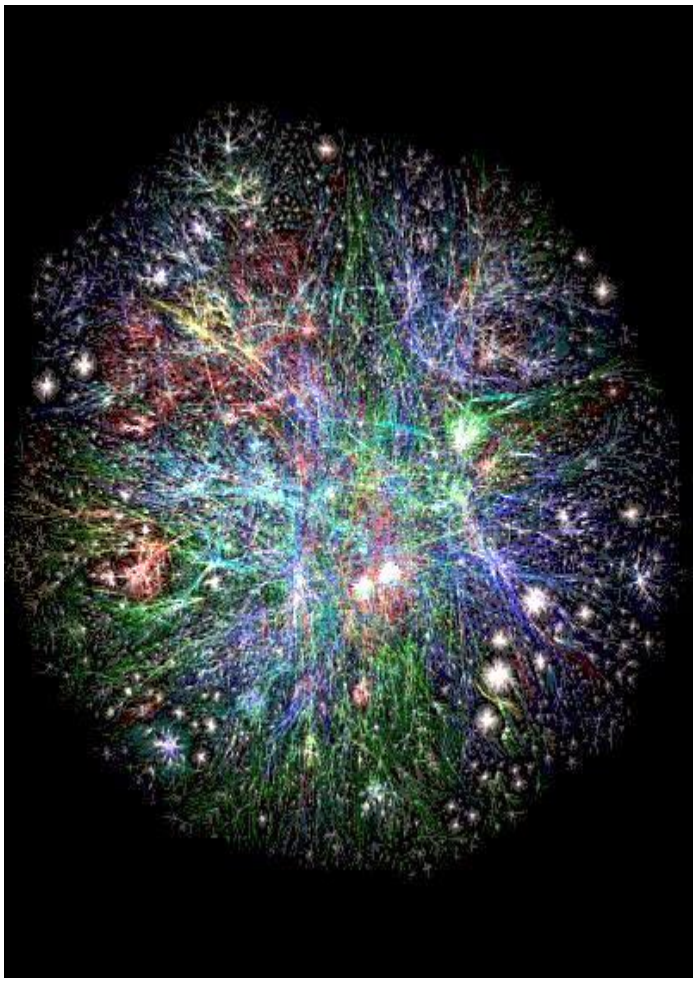


Google trend for

Friendster,
Facebook and
Snapchat

Since 2004

Web search



- Understand the user **intent**

"Please translate these roman numerals mcmxcviii thank you."

- Find the **relevant** webpages (relevance)

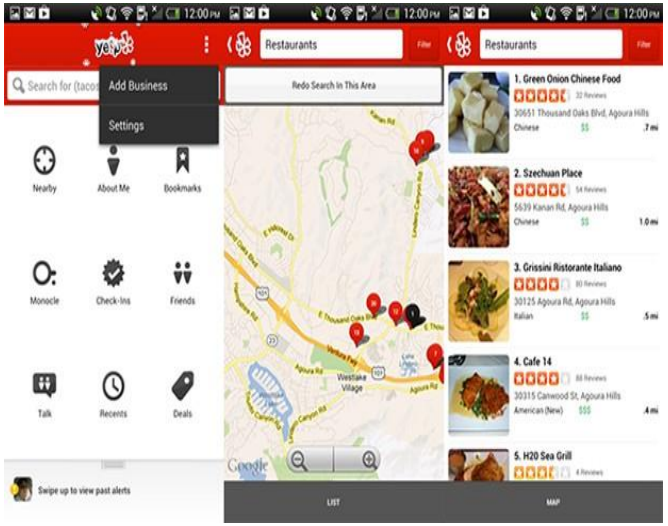
- **Rank** the search results (by importance)

Social search

Social Search is **an enhanced version of web search,** also takes into account **social relationships** between the results and the searcher, such as *work for the same companies*, *belong to the same social groups* etc.

Facebook graph search

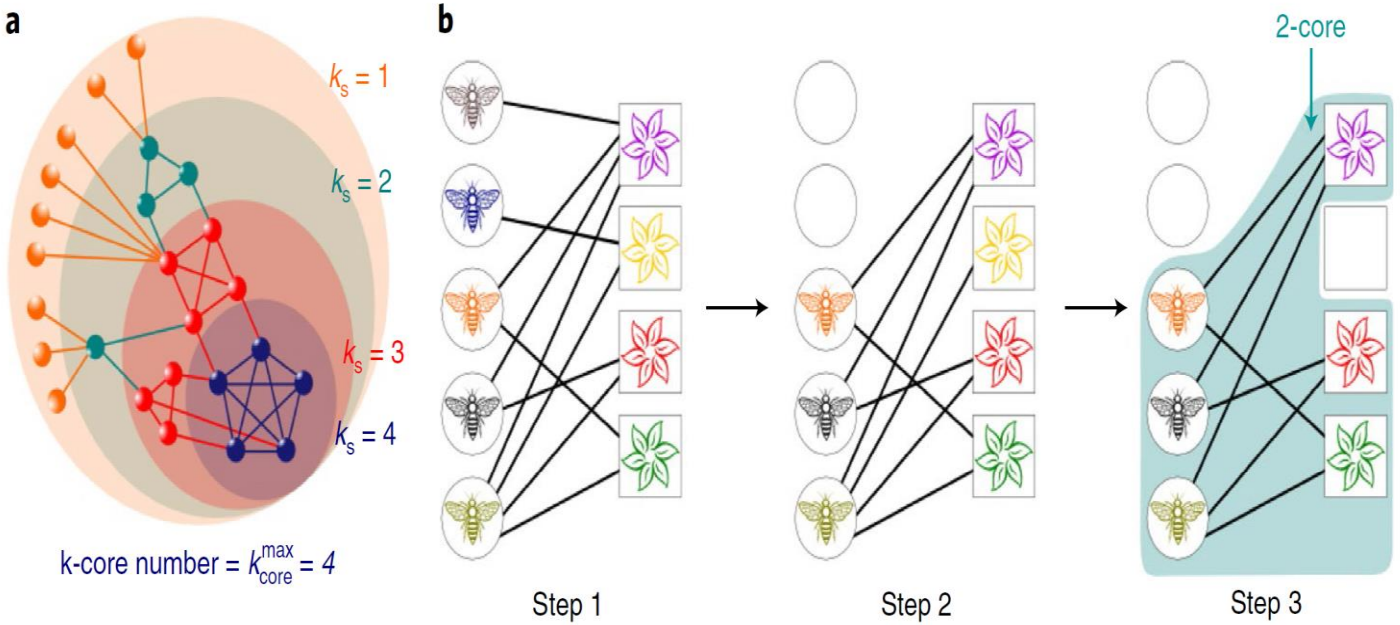
Recommendation



http://www.kis.kansai-u.ac.jp/res_music_e.html

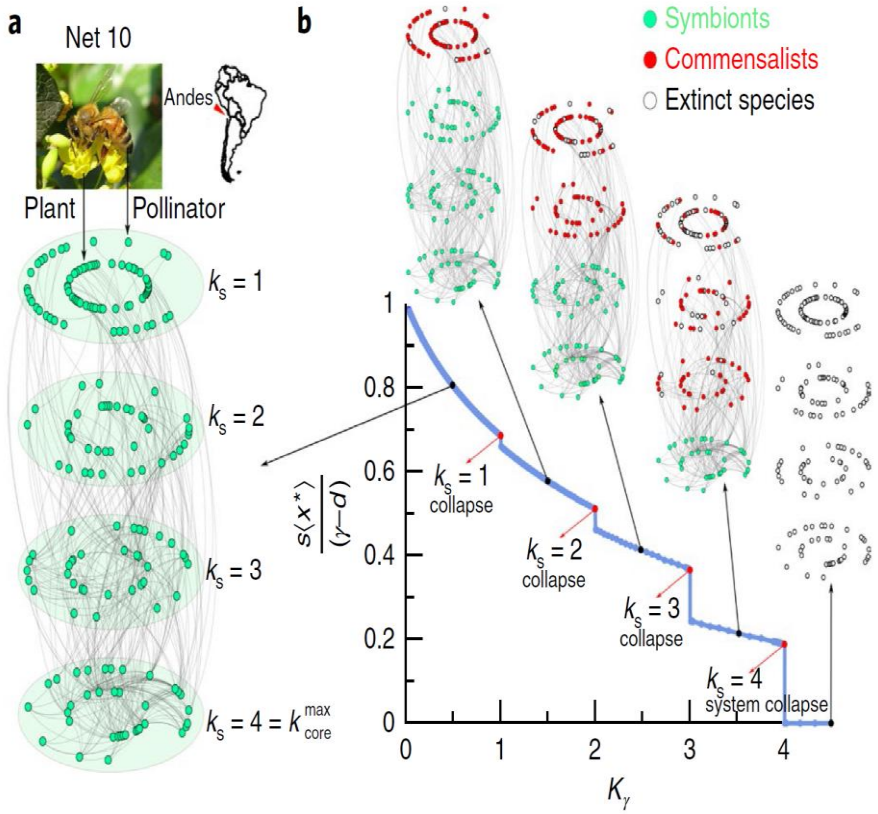
Biology Social Network

Biology: a cohesive subgraph as a predictor of structural collapse in mutualistic ecosystems [Nature Physics 2018]



Biology Social Network

Biology: the hierarchical decomposition reveals the tipping points of structural collapse in mutualistic ecosystems [Nature Physics 2018]



Many other applications

- Sentiment analysis (e.g., US presidential election prediction)
- Social behaviour (pattern) analysis
- Rumour detection and source detection (Facebook and Twitter)
- Social network privacy
- Viral marketing
- Sponsored search
- Etc.

George Fletcher

This part will not be covered in assessment or final exam