

CIP- OSN

Online Social Networks as Graphs

Dr. Thanassis Tiropanis - tt2@ecs

[itv](#)
[Player](#)
[Shows](#)
[Guide](#)
[News](#)
[Sport](#)
[More ▾](#)
Search

[News](#) | [Regions ▾](#) | [Topics ▾](#) | [Entertainment](#) | [Meet the team](#) | [Top news](#)

Meridian

[Back to news home](#)

[Simon's weather for Thursday](#)

[Eastleigh by-election triggered](#)

[Missing sailor campaign latest](#)

[Footballers' assault trial latest](#)

['Give empty homes to homeless'](#)

[Man fractures baby's skull](#)

[Bobby sniffs out drug factory](#)

[Hotel evacuated after fire](#)

[HMV to close 66 stores](#)

[Giants clams' new home](#)


Do you have Facebook Fatigue?

Is Facebook finished? ITV News Meridian has been carrying out an investigation into the social media site's popularity - with some interesting results.

[+ Share](#)

6:21 PM, FRI 01 FEB 2013

Has Facebook's bubble burst?



It was a real novelty, being able to contact family and friends at a moment's notice, when and wherever you were. Social media sites on the internet have been all the rage for the past few years.

But as with many new crazes over the years, there are signs that we're getting fed up of Facebook and tired of tweeting.

Is it the end of an era, or the start of another one? Andrew Pate speaks to "Techno Gran" Brenda Meakin and Lisa Harris and Fiona Harvey from University of Southampton.

[+ Share](#)

[UK](#) • [Facebook](#) • [Social Media](#)

<http://vimeo.com/58729247>

Online Social Networks

An Interdisciplinary Course on Networks, Social Media, Society and You

[Home](#)[About the Course](#)[Video Channel](#)[Resources](#)[Wiki](#)

User menu

[> My account](#)[> Log out](#)

Welcome!

[View](#)[Edit](#)

Social Media is increasingly important in the modern world, impacting the way we socialise, do business and govern ourselves. But are digital social networks that different from our existing social structures, and what can existing network science tell us about the way we connect? This module aims to develop understanding of the emergent interdisciplinary area of online social network analysis by drawing upon technological, social, network science and organisational perspectives.

Having successfully completed the module, the students will be able to:

1. Discuss online social networks in a holistic manner, including the technological, social, network science, web science and organisational dimensions.
2. Evaluate key technological and social mechanisms of online social networking and network structures.
3. Analyse the impact of online social networks on their own lives, society and business.

The narrative

Web Evolution and
Online Social Networks

Web Evolution – Stage 1

- The Web of Documents
 - Web 1.0; Read-only Web
- The Web experienced as a technological artefact
 - A network where the nodes are documents and the edges are links and documents
 - Search engines enabled users to discover documents
 - E-commerce services

Web Evolution – Stage 2

- The Web of People
 - Web 2.0; Read-write Web
- The Web experienced as an artefact that includes people publishing and communicating on a large scale
 - A network where the nodes are people, documents, software and the edges are links between them
 - Recommender engines (and search engines) enabled people to discover people, documents and services

Web Evolution – Stage 3

- The Web of Data and Social Networks
 - Web 3.0; The Social Semantic Web
- The Web experienced as an artefact that includes people and documents and data linked together in social networks
 - A network where the nodes are people, datasets, documents, services and the edges are links between them
 - Enhanced discovery powered by online social networks
 - The Web as a resource of data analytics and research (Web Observatories)

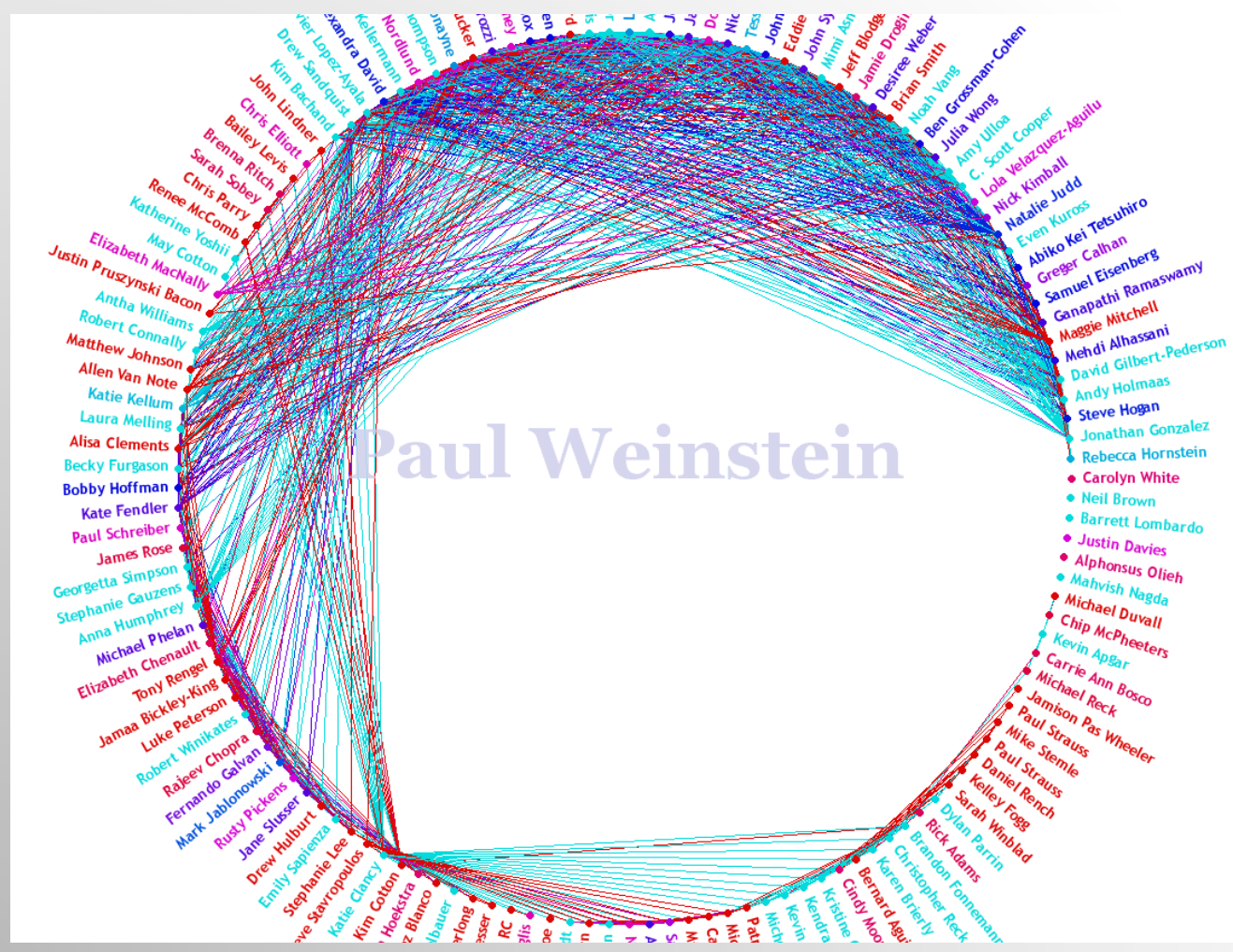
The narrative

Graphs representing social networks

Discussion

- How many of you have joined one or more online social networks?
- Have you used any tools/apps to show you your network?
- Do you find those tools/apps useful? Why?

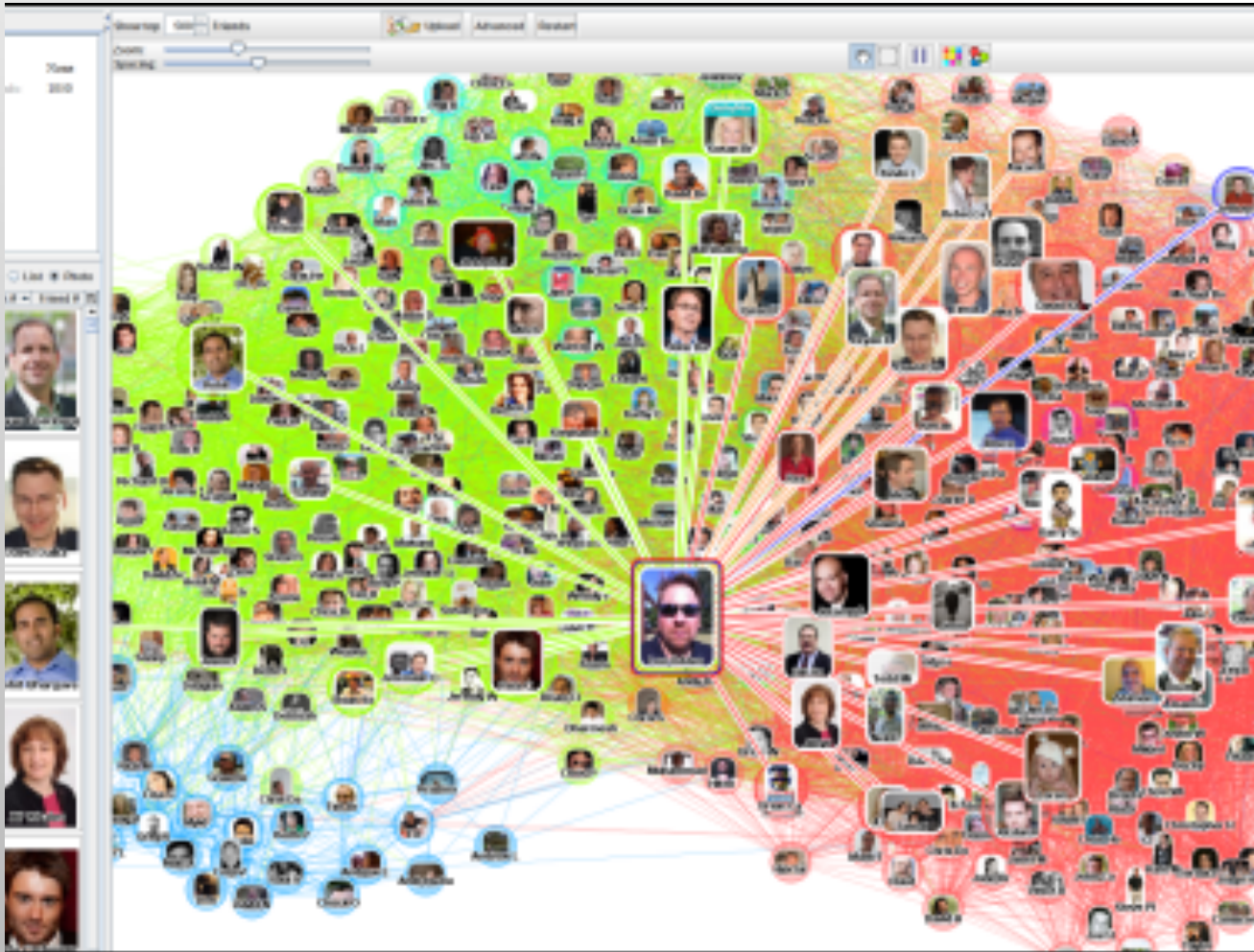
A Facebook Network



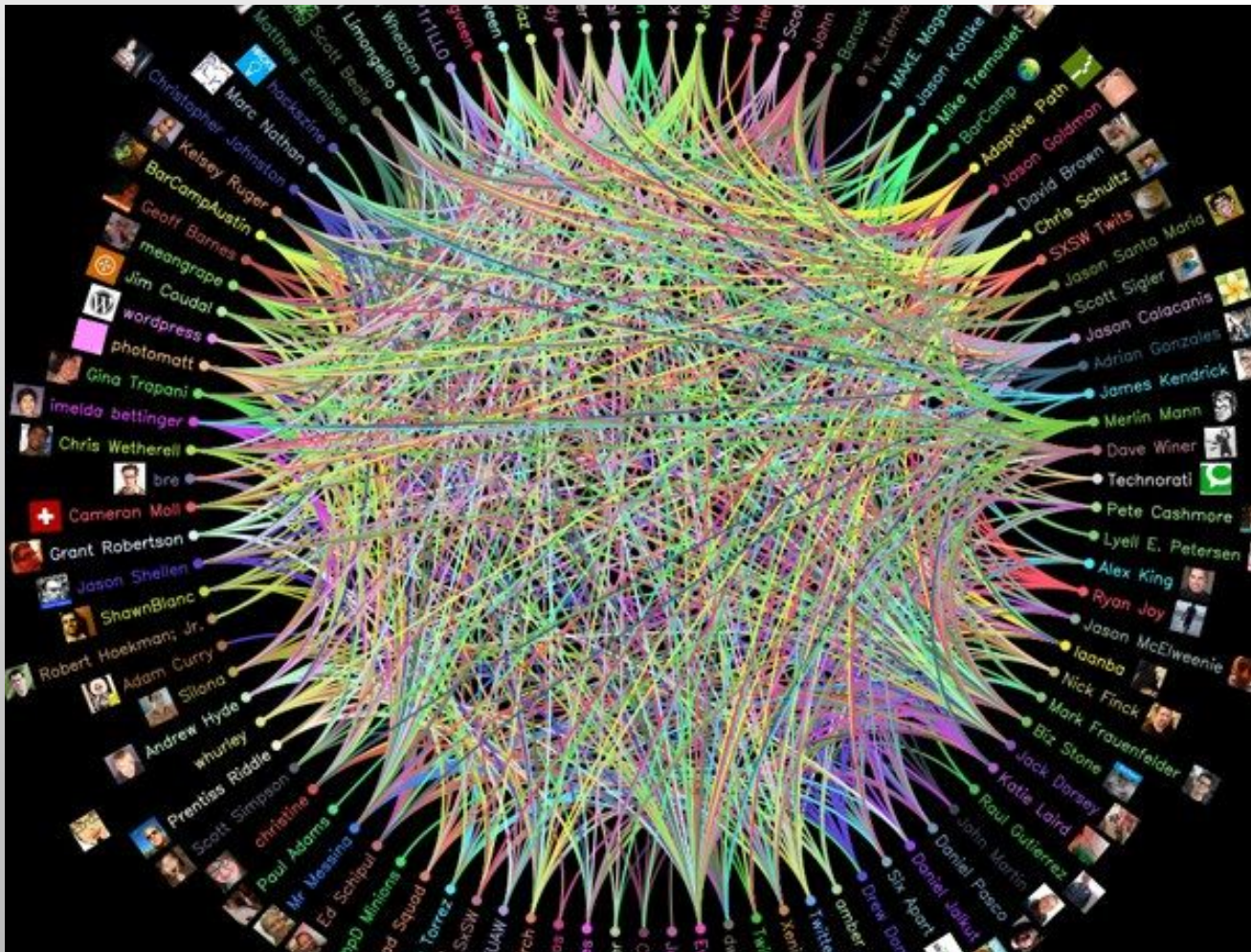
A Facebook Network



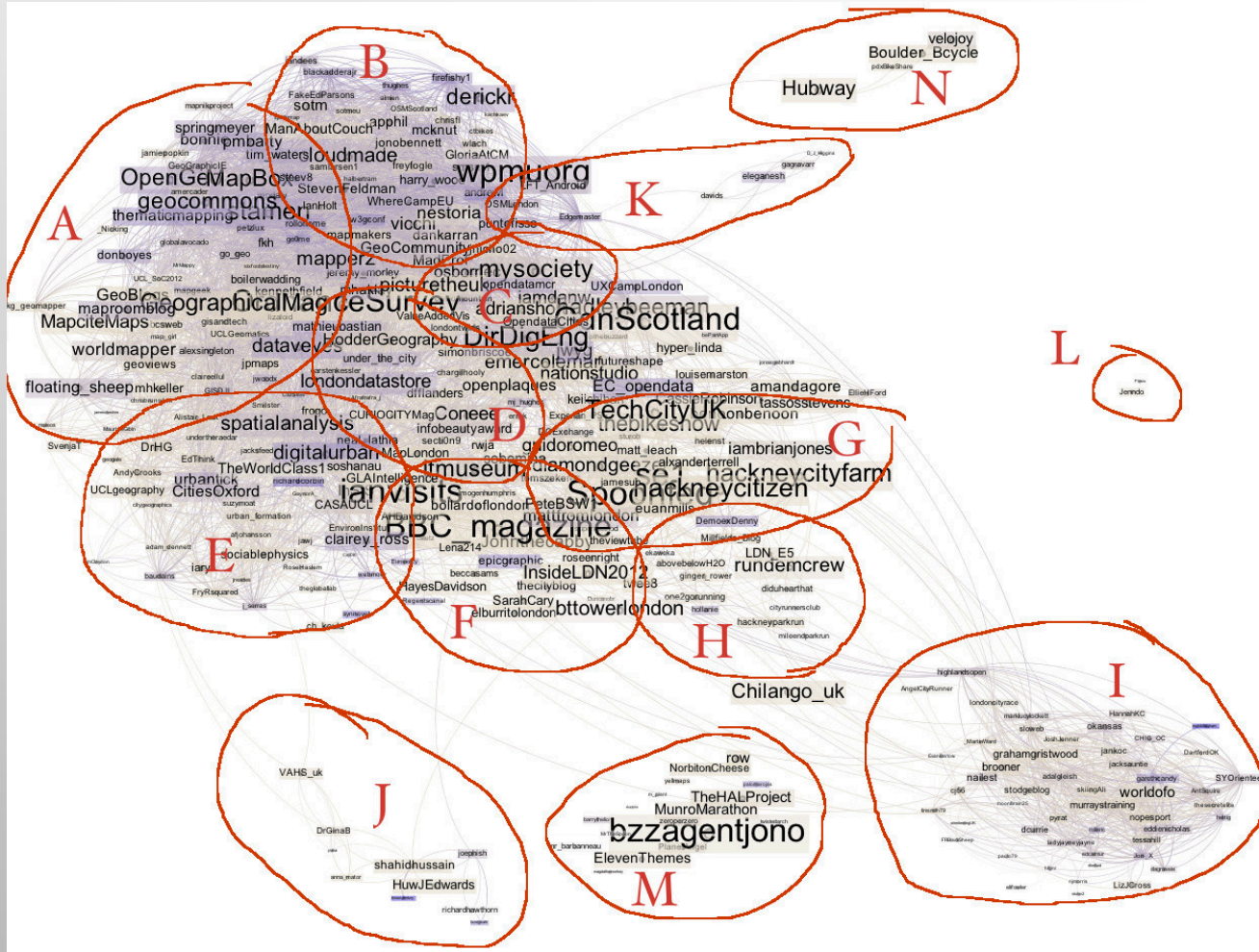
A Facebook Network



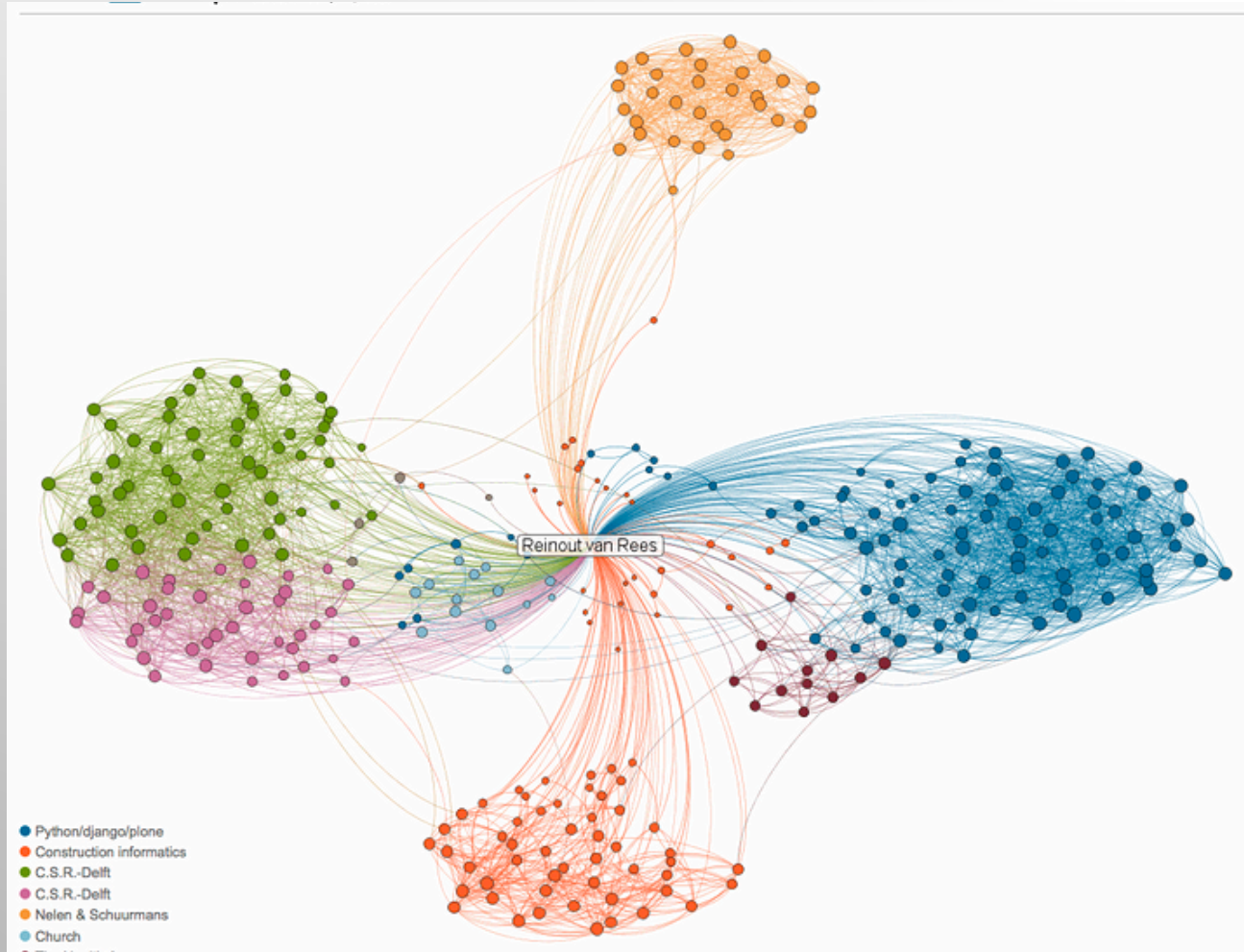
A Twitter Network



A Twitter Network



A LinkedIn Network



Discussion

- What do those illustrations of my network tell me about my connections?
- What do they tell me about myself?
- Are there different ways to visualise my network to gain further insights?

Real World Networks/Graphs

- Collaboration Graphs
- Who-Talks-to-Whom Graphs
- Information Linkage Graphs
- Technological Networks
- Networks in the Natural World

Easley and Kleinberg (2010)

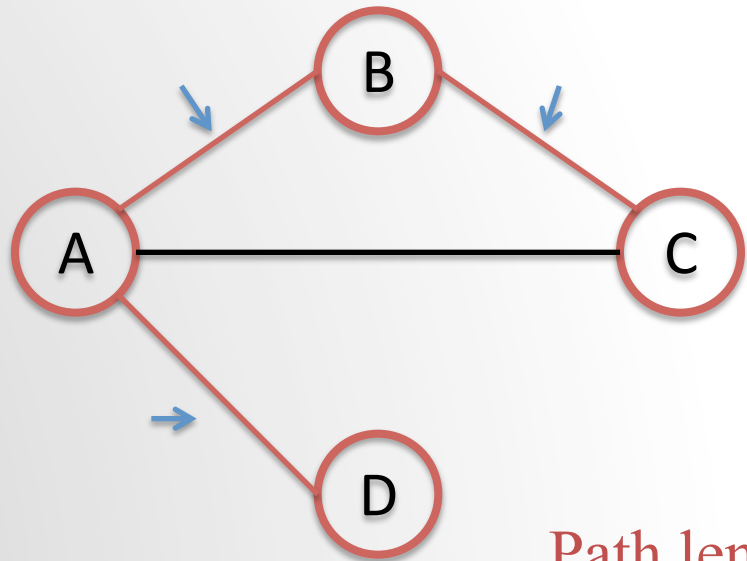
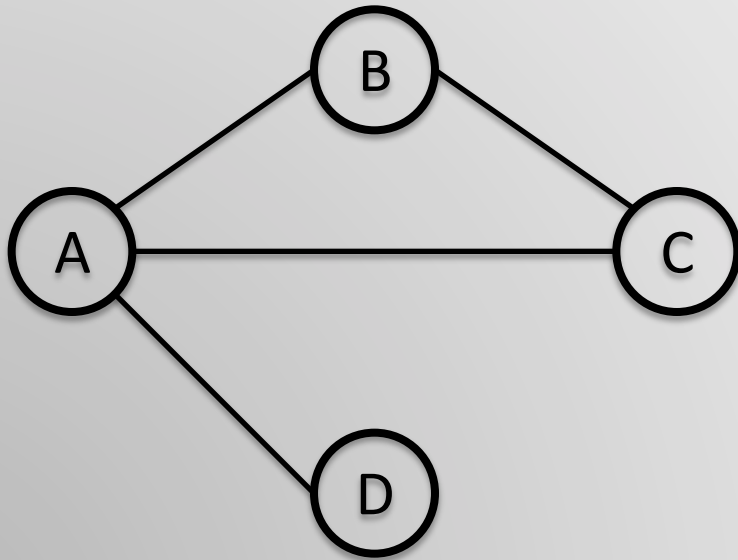
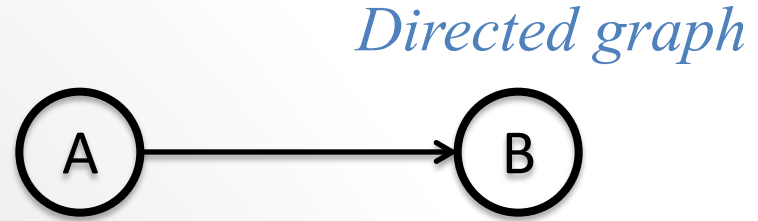
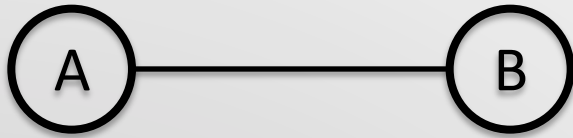
The narrative

Graphs on an abstract level

Graphs

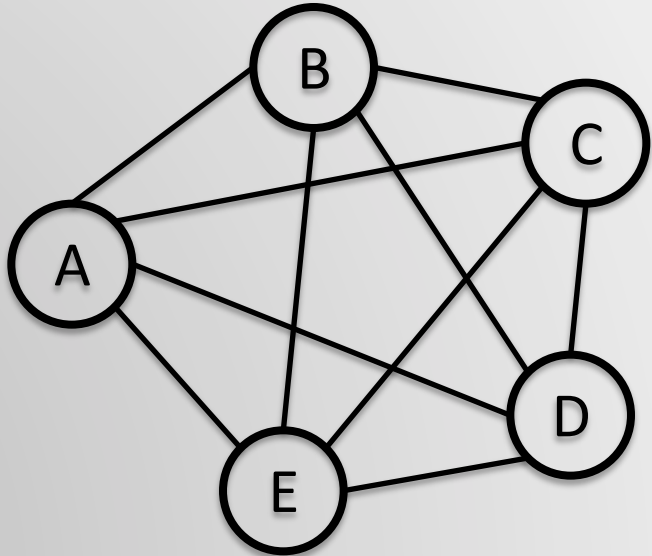
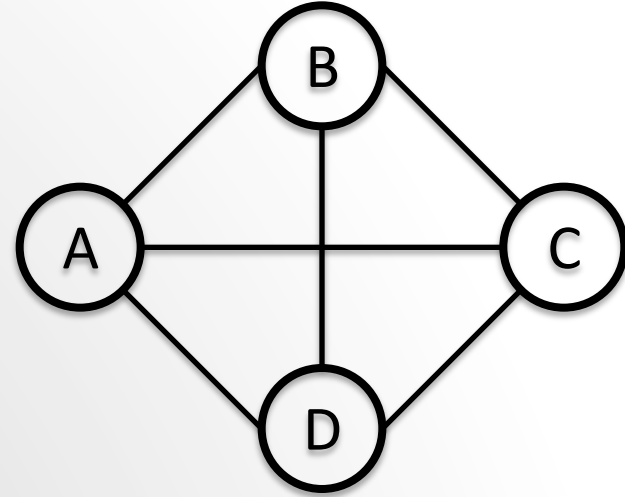
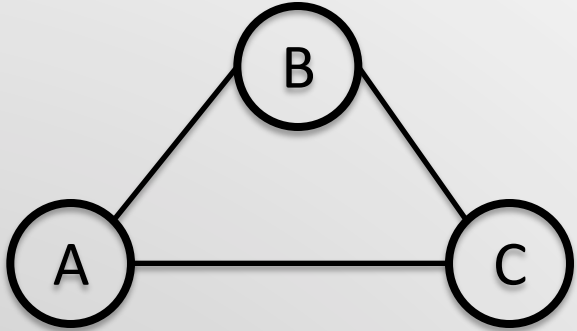
- Representing relationships among items
 - Nodes (vertices)
 - Edges
 - Symmetric (undirected)
 - Asymmetric (directed)
 - Paths
 - Connected graph (a path for every pair of nodes)
 - Components (connected graph component)

Graphs, Edges, Paths

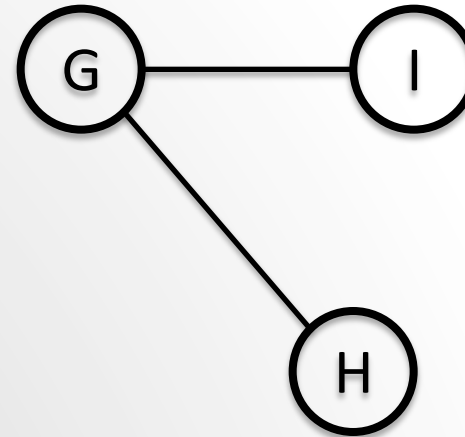
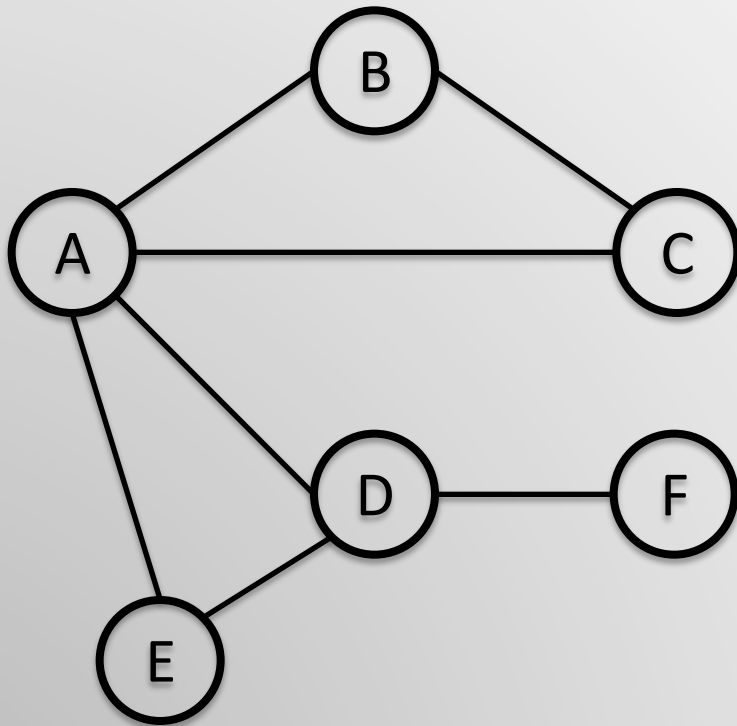


Path length: 3

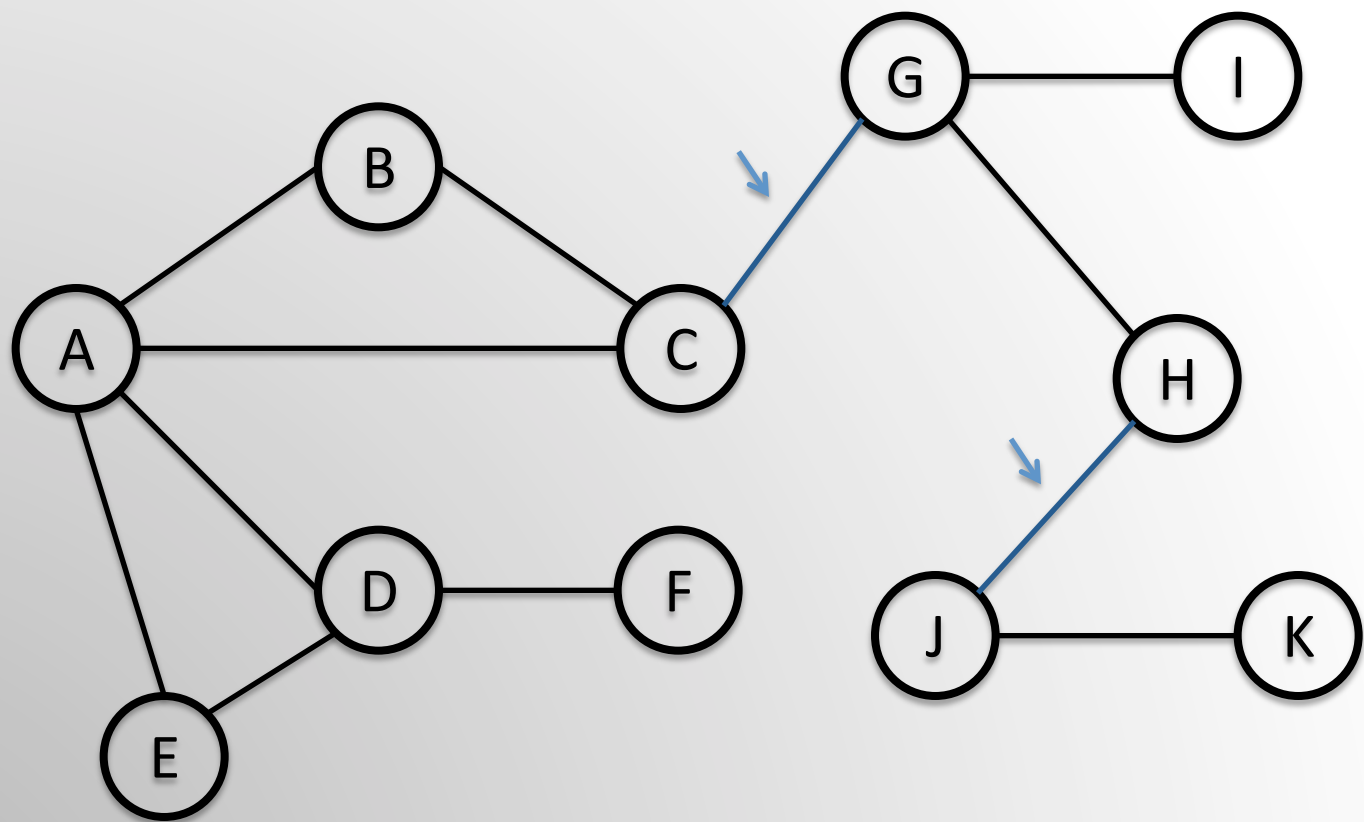
Complete Graphs



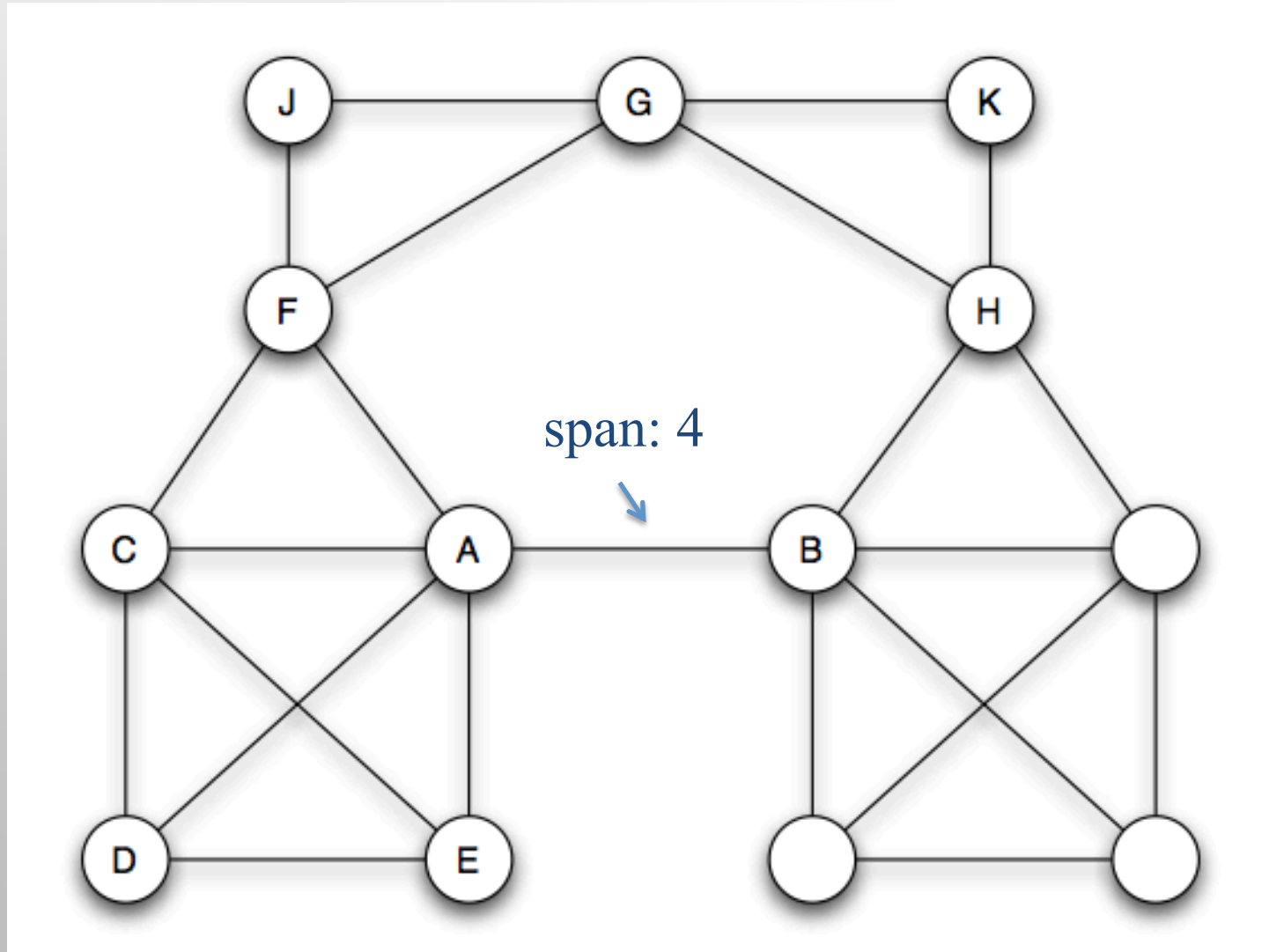
Components



Bridges

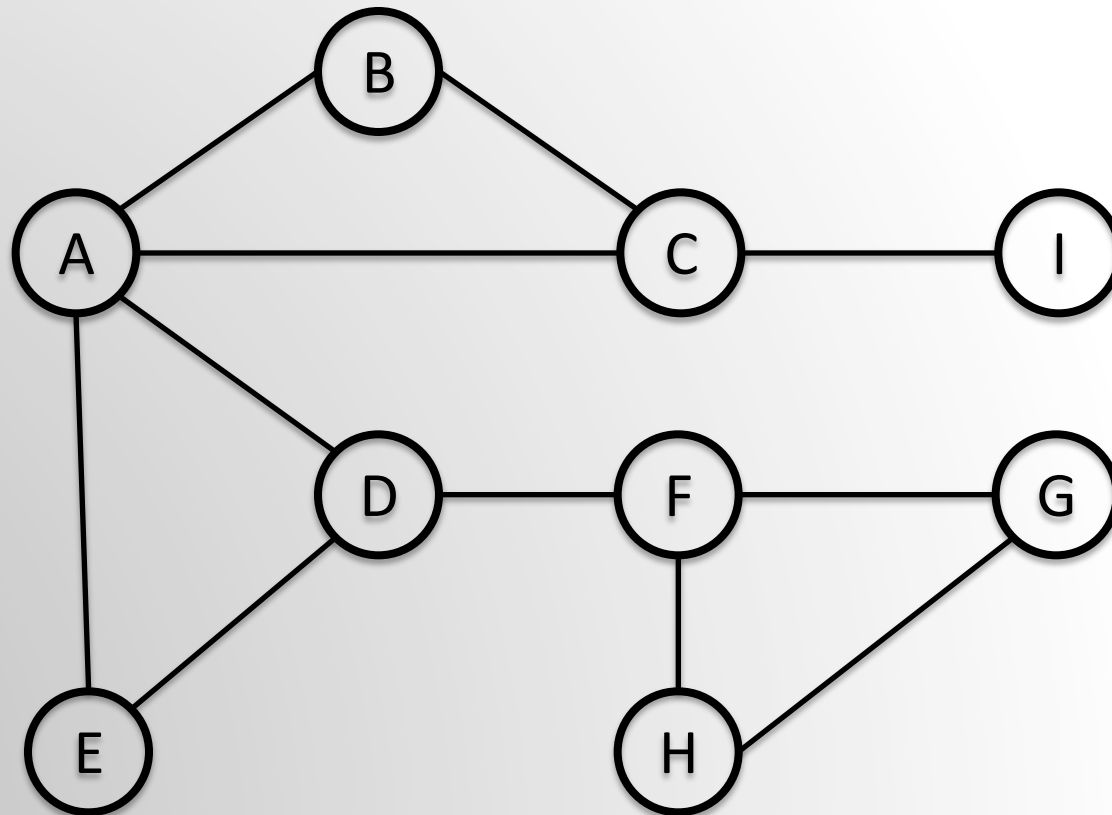


Local Bridges



Path Length

- How long is the shortest path from A to G?
- What is the distance between A and any other node?



Clustering and Graph Partitioning

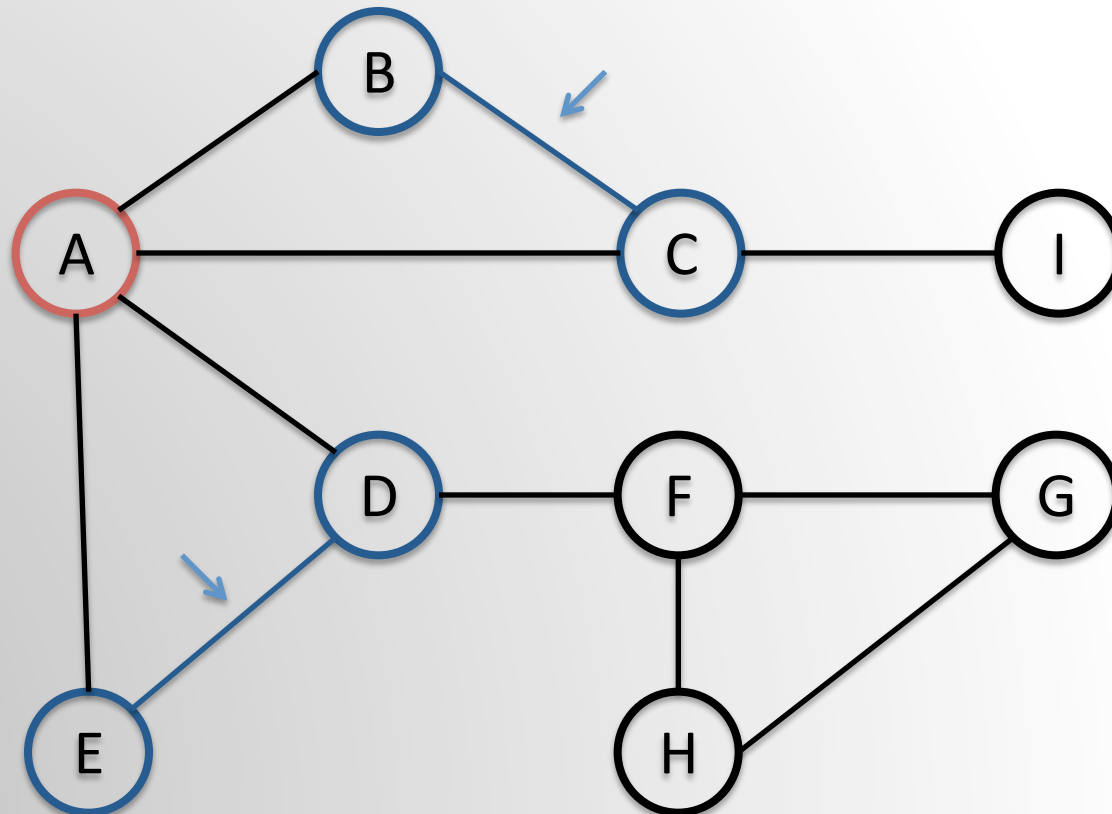
- Can you observe clusters on this graph?
- How many?



SOURCE: YAHOO RESEARCH

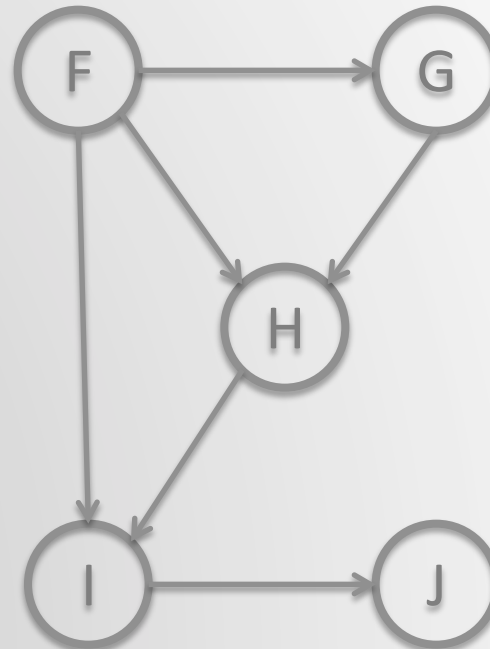
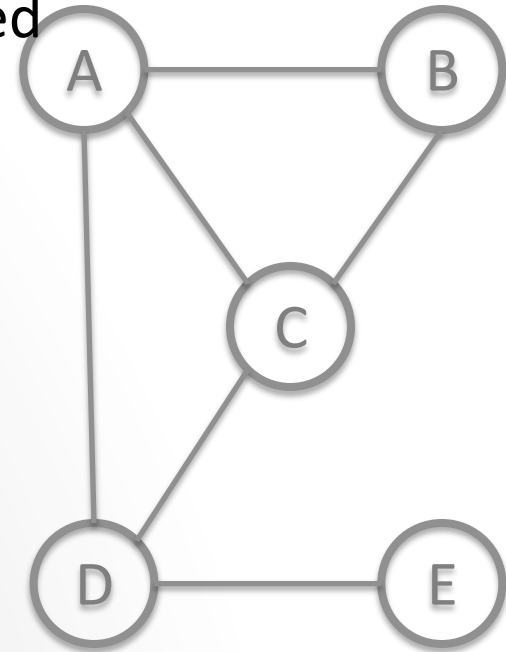
Local Clustering Coefficient

- The probability that two randomly selected friends of a node are friends with each other (for undirected graphs)
- What is the clustering coefficient of node A?



Degree of a node

- The number of nodes to which a node is connected
 - *Degree of Node C: 3*
 - *Degree of Node E: 1*
- In directed graphs we distinguish between outdegree and indegree
 - *Outdegree of Node H: 1*
 - *Indegree of Node H: 2*



What can a high degree of a node in a graph representing a social network mean?

Closeness of two nodes

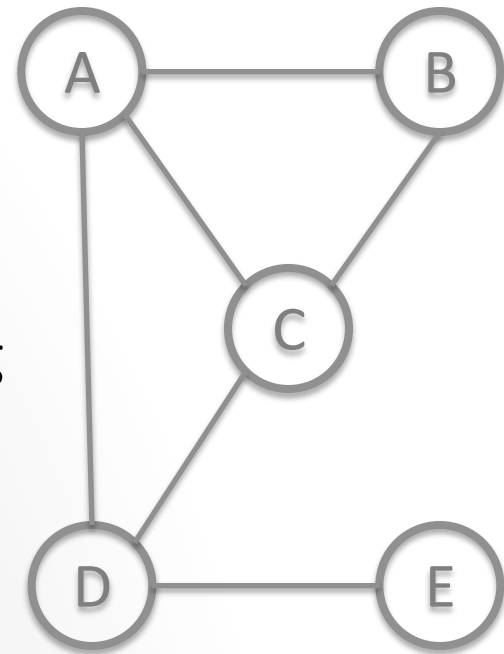
- The mean distance from a node to all the other nodes
 - *Distance between nodes is the shortest path between them.*

Which node is closer to the other nodes in this network?



Edge Betweenness

- Let's take any two nodes of a graph and find the shortest path between them (if there is one)
 - There can be more than one shortest paths
- For each edge in the path we allocate one unit of 'traffic'; this traffic is divided equally to *flow* along all possible shortest paths with every other node
- When this is completed for all pairs of nodes, we will have a measure of the 'traffic' that each edge carries
- This measure is the betweenness of an edge



Discussion

- What do the different types of centrality mean in graphs representing social networks such as Facebook, Twitter or collaboration networks?
 - Degree centrality
 - Closeness centrality
 - (Edge) betweenness centrality

Kevin Bacon Distance

<http://oracleofbacon.org/>



THE ORACLE OF BACON



Welcome
Credits
How it Works
Contact Us
Other stuff »

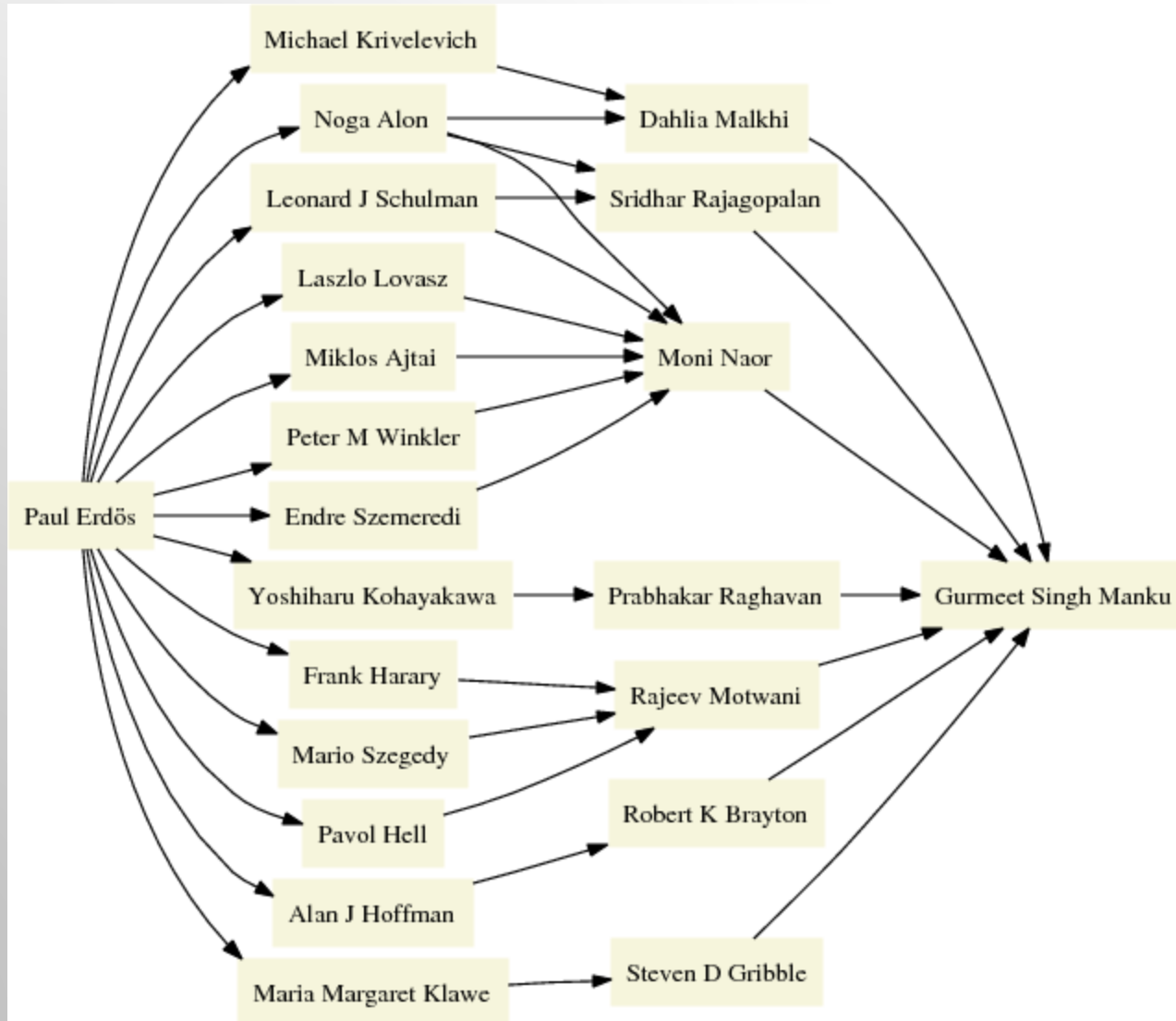
[Richard Stilgoe](#) has a [Kevin Bacon](#) number of infinity.

[Richard Stilgoe](#) cannot be linked to [Kevin Bacon](#) using only feature films. Do you want to include [documentaries](#) or [TV shows](#)?

About 12% of all actors cannot be linked to the rest of the movie universe, either because they have appeared only in video games or straight-to-video releases that the Oracle doesn't count, or because they have not appeared in any films with actors from the Hollywood mainstream.

to

Erdős Distance



Erdős distance

<http://www.oakland.edu/enp/>

Oakland University

[OU Home](#) | [Ask OU](#) | [Add This To...](#) | [SAIL](#) | [Print](#)

Search OU

Go

[Future Students](#)[Current Students](#)[Alumni](#)[Visitors & Friends](#)[Faculty & Staff](#)

The Erdős Number Project

[The Erdős Number Project](#)[Information about the Erdős Number Project](#)[The Erdős Number Project Data Files](#)[Facts about Erdős Numbers and the Collaboration Graph](#)[Some Famous People with Finite Erdős Numbers](#)[Computing Your Erdős Number](#)[Research on Collaboration in Research](#)[Information about Paul Erdős \(1913–1996\)](#)[Publications of Paul Erdős](#)[Items of Interest Related to Erdős Numbers](#)

The Erdős Number Project

This is the website for the Erdős Number Project, which studies research collaboration among mathematicians.

This site is maintained by **Jerry Grossman** at **Oakland University**, with the collaboration of **Patrick Ion** (ion@ams.org) at **Mathematical Reviews** and **Rodrigo De Castro** (rdcastro@matematicas.unal.edu.co) at the **Universidad Nacional de Colombia, Bogota**. Please address all comments, additions, and corrections to Jerry at grossman@oakland.edu.

Erdős numbers have been a part of the **folklore of mathematicians** throughout the world for many years. For an introduction to our project, a description of what Erdős numbers are, what they can be used for, who cares, and so on, choose the "What's It All About?" link below. To find out who **Paul Erdős** is, look at this **biography** at the MacTutor History of Mathematics Archive, or choose the "Information about Paul Erdős" link

SPECIAL NOTES:

We have finished updating the lists of Erdős coauthors.

WHA

There are about 1100 new people with Erdős number 2, compared to three years ago.

The narrative

How do real online social networks
develop over time?
Small-world networks

Discussion

- Do all your social friends have more or less the same number of connections (degree centrality)?
 - If so, what is the average number of friends for each of person?
- Do some have more connections than others?
 - If so, what percentage?

Small World Phenomenon

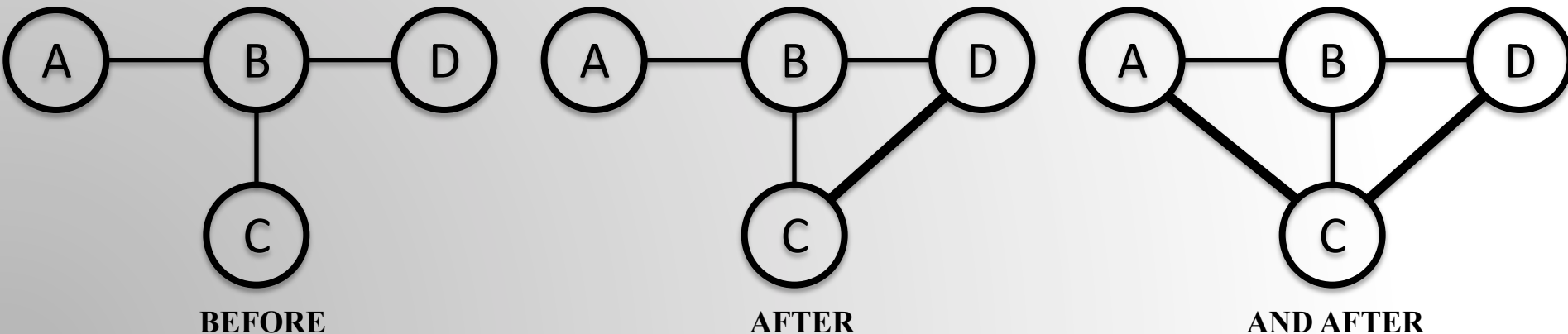
- We can think about the world as a big graph where nodes are people and edges represent acquaintance, collaboration, communication, etc.
- We can devise mechanisms to measure path length between nodes (people)
 - E.g. how short is the average path between any two nodes
- A number of experiments indicate that the world can appear very small this way
 - E.g. Milgram's six degrees of separation

Characteristics of small-world networks

- They tend to contain clusters of densely inter-connected nodes
- The mean shortest path between any two nodes can be short
- They tend to grow denser
 - Triadic closure

Triadic Closure

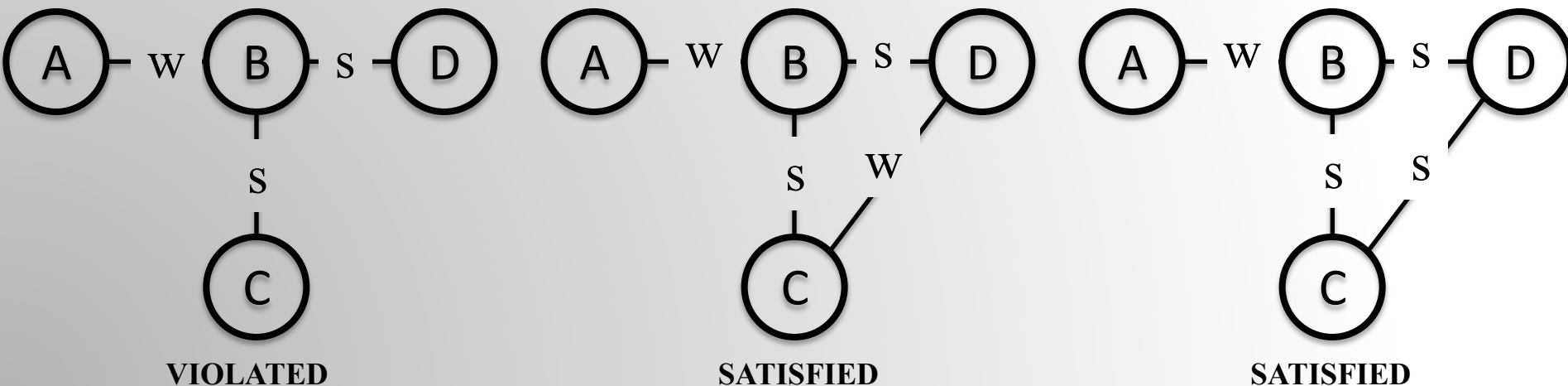
- Is the world getting even smaller?
 - Are the paths connecting individuals getting shorter?
- Triadic closure
 - *If two people in a social network have a friend in common, then there is an increased likelihood that they will become friends themselves at some point in the future (Rapoport, 1953)*



Strong Triadic Closure

- “If a node A has edges to nodes B and C, then the B-C edge is especially likely to form if A’s edges to B and C are both strong ties”
- A node A violates the strong triadic closure property if it has strong ties to two other nodes between which there is no edge at all (strong or weak)
- Strong triadic closure is satisfied if it is not violated

(Easley and Kleinberg 2010)



Discussion

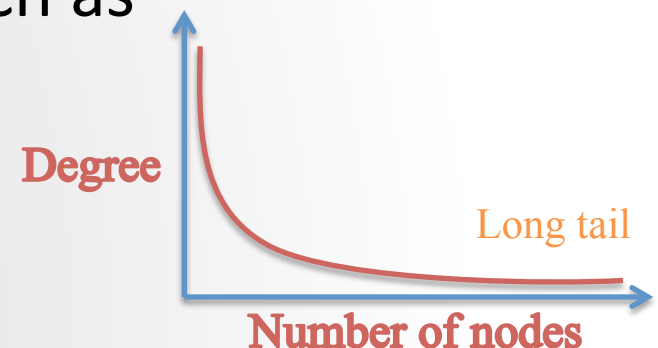
- Which types of social networks do you consider to present small-world network properties?

The narrative

How do real online social networks
develop over time?
Scale-free networks

Scale-free networks

- There are networks in which the degree distribution among nodes is a 'power-law' distribution; a smaller number of nodes have the most links
- Examples:
 - The WWW, Social networks such as Twitter



Characteristics of scale-free networks

- Preferential attachment
- Emergence of new nodes
- Upper limits on the degree of a node

- *E.g. on the Web*
 - *Websites with many links get even more*
 - *New websites keep emerging every moment*
 - *There appears to be a limit on the number of links from a website*

Discussion

- Which types of social networks do you consider to present scale-free network properties?
- Consider a number of networks in the discussion

Facebook



Twitter



Studying online social networks

- On generated models
- On samples
- On the whole network, online

- Quantitative and Qualitative research

Lessons learned

- Familiarity with how networks can be represented as graphs, the local clustering co-efficient metric, the different types of centrality (degree, closeness, betweenness) and what those types of centrality can indicate for graphs representing social networks.
- Familiarity with the triadic closure and the strong triadic closure property and what its presence can signify in an online social network.
- Hall, Wendy and Tiropanis, Thanassis (2012) Web evolution and Web Science. [in special issue: The WEB we live in] *Computer Networks*, 56, (18), 3859-3865. (doi:10.1016/j.comnet.2012.10.004).
<http://eprints.soton.ac.uk/343770/>
- Wang, X. F., & Guanrong Chen *Circuits and Systems Magazine*, 1. (n.d.). Complex networks: small-world, scale-free and beyond. *Circuits and Systems Magazine, IEEE*, 3(1).
<http://www.ee.cityu.edu.hk/~gchen/pdf/CW-CASM03-overview.pdf>
- Easley, D. and Kleinberg, J. *Networks Crowds and Markets*. Cambridge University Press, 2010.
<http://www.cs.cornell.edu/home/kleinber/networks-book>
- Hein, O., Schwind, M., & König, W. (2006). Scale-free networks. *Wirtschaftsinformatik*, 48(4), 267–275.
<http://eaton.math.rpi.edu/csums/papers/ScaleFree/Scale-Free%20Networks.pdf>