

# Empirical background on Social and Economic Networks

Rogayeh Dastranj Tabrizi

email: rda18@sfu.ca

Office: WMC 3607

Office Hours: Thursdays 12pm-2pm

Department of Economics

Simon Fraser University

16. Februar 2015

# Caveats And Cautions

Before we start studying some stylized facts from literature about social network, note that:

- Much of information we have about the structure of networks come from limited measurements of links that describes a static and discrete view of something that is inherently dynamic and volatile.
- How to define and measure links and relationships matter.
- Also, it might be impossible to find or contact all nodes in the network.
- Even when contacted, they may have reasons to hide relationships.
- There are biases and idiosyncrasies associated with each dataset.

# Diameter And Small Worlds

The term **Small Worlds** embodies the idea that large networks tend to have small **diameter** and small **average path length**. Some example:

- Milgram's clever experiment in which people had to route a letter to another person who was not directly known to them.
  - Roughly 25% of letters reached their targets. Median length of the path was 5, with maximum path length of 12.
- Watts and Strogatz report a mean distance of 3.7 in a network of actors in which a link indicates that two actors have been in a movie together.
- **Erdos Number**: Shortest path from mathematicians to Erdos!

# Clustering

Social networks tend to have **high clustering coefficients** relative to what would emerge if the links were simply determined by an **independent random process**.

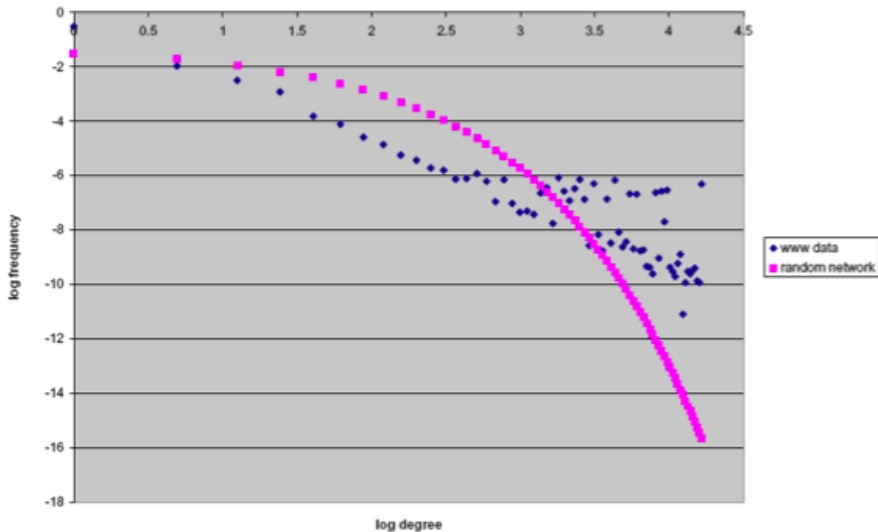
- Consider physics coauthor network with 52909 nodes, average degree of 9.3 and Clustering Value 0.45.
- A purely random network with this average degree would have a probability of link formation of  $\frac{9.3}{52908} = 0.00018$ .
- For a pure random network, the chance that link  $ik$  is present given that  $ij$  and  $jk$  are already present is simply the probability that  $ik$  is present : 0.00018.
- Thus value of clustering, 0.45, is 2500 times greater than what we would expect from a random network.

# Degree Distribution

**Average degree** of a network provides a rough feel for **network connectivity**, but we get a much richer feel for the structure of the network by examining the full **distribution of degrees**.

- There are **more high and low degree** nodes than predicted at random.
- **Citation Networks**: too many with 0 citations, too many with high numbers of citations to have citations drawn at random.
- **Fat tails** compared to random network.
- Next figure is the distribution of in-degree from the network of links among webpages on the Notre Dame domain in late 1990s (Albert, Jeong, Barabasi).

# Degree Distribution



# Correlations And Assortativity

- **Positive Assortativity**: The tendency for high-degree nodes to be connected to other high-degree nodes (positive correlation)
- But sometimes there is negative correlation between degrees of nodes:
  - Serrano & Boguna find negative correlation among degrees of countries that trade with one another.
  - This describes the network as **hub-and-spoke**, with small countries (spokes- with small # partners) trade with bigger countries (hubs) who have more partners.
- **Core-periphery** pattern: A core of highly connected and interconnected nodes and a periphery of less connected nodes.

# The Strength of Weak Ties

The role of social networks in finding jobs was at the heart of some of the most influential research in Social networks: Conducted by Granovetter.

- He interviewed people in Amherst, MA across a variety of professions to learn how they found their jobs.
- He measured the strength of social relationships by frequency of interactions.
- He found that a surprising proportion of jobs were found through weak links.
- Individuals with weak ties were less likely to have overlap in their neighbourhoods.
- Weak ties are more likely to form bridges across groups that have fewer connections to one another, thus play a critical role in dissemination of information.



# Structural Holes

Another important concept regarding the structure of the network is due to Burt:

- **Structural Hole** is a void in a social structure and refers to an absence of connections between groups.
- This absence doesn't mean that the groups are unaware of each other, but lack of links between groups can lead to failure of diffusion.
- Individuals who fill structural holes end up with power and control over flow of information and favours between groups.