



Social Networks

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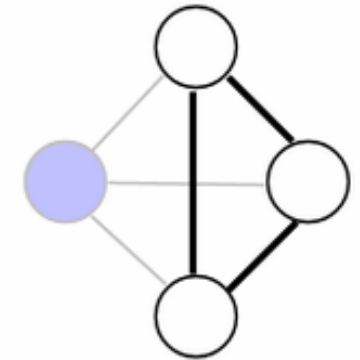
- Definition
- Topological properties
- Social Network Examples
- Social Network Models



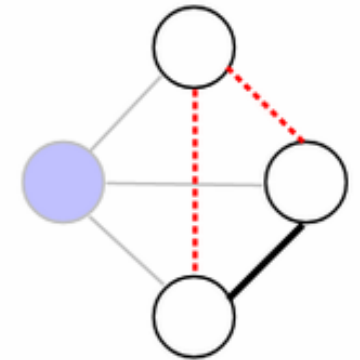
What is a Social Network?

- Network defined by people interactions
 - Friendship
 - Business
 - Sexual
- Built from simple local interactions
- Show interesting global properties

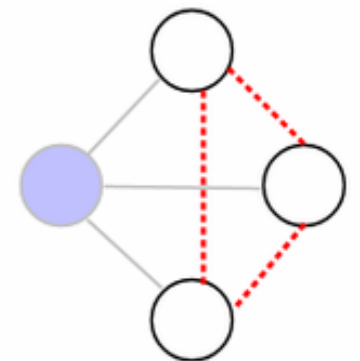
- CC for node i : proportion between
 - Links between vertexes in i neighborhood
 - All the possible links in i neighborhood
 - $k_i(k_i-1)$ with k_i =degree of node i
- Network CC
 - Average of every node CC



$c = 1$



$c = 1/3$



$c = 0$



- Path length between nodes i and j
 - Minimum number of hops needed to go from i to j
 - Equal 1 if j is i 's neighbor
- Average path length
 - Average of path lengths between any possible pair of nodes



- Many different kinds of social networks
- Small World networks family
- Common topological features
 - High clustering coefficient (CC)
 - My friends are often friends to one another
 - Low average path length (APL)
 - I am linked to anyone by a small sequence of “friend’s friend”
- Interesting *functional* properties
 - Information diffusion speed and reliability



The Milgram Experiment

- Six degrees of separation
- In 1960 Milgram asked people throughout the USA to try to reach via mail a person in Boston
 - Only one mail could have been sent
 - Mail sent to someone likely to know the target person
- Each mail has been sent on average 6 times
- Conjecture: on average people are separated by chains of friend of length 6 on average



- Paul Erdos
 - Popular and very prolific mathematician
- Erdos number
- Distance of co-authorship from Paul Erdos
 - Paul Erdos' himself has Erdos number 0
 - Erdos number of people who wrote a paper with Erdos is 1
 - Erdos number of people who wrote a paper with somebody who wrote a paper with Erdos is 2
 - ...
- Scientific publication co-authorship network



- Movies database used (imdb)
 - Network of actors collaboration
 - Average distance from Kevin Bacon: 2.946

Kevin Bacon Number	# of People
0	1
1	1952
2	169274
3	477226
4	113032
5	7968
6	735
7	68
8	13



The Bacon Oracle: Some (Amazing) Examples



The Oracle says: [diego abatantuono](#) has a Chaplin, Charles number of 3.

[Diego Abatantuono](#) was in [Ultimo minuto \(1987\)](#) with [Antonio Prester](#)
[Antonio Prester](#) was in [Tatowierte Herz, Das \(1991\)](#) with [Ernst Josef Lauscher](#)
[Ernst Josef Lauscher](#) was in [Wien-Film \(1976\)](#) with [Charles Chaplin](#)



The Oracle says: [scarlett johansson](#) has a Valentino, Rudolph number of 3.

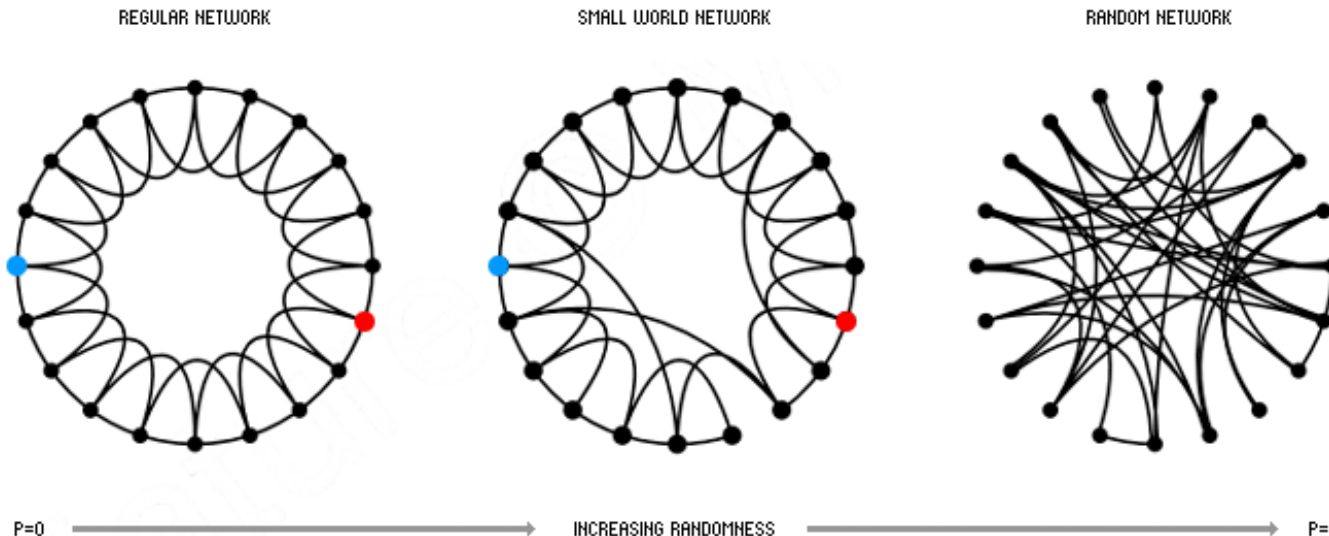
[Scarlett Johansson](#) was in [Ghost World \(2001\)](#) with [Teri Garr](#)
[Teri Garr](#) was in [Escape Artist, The \(1982\)](#) with [Jackie Coogan](#)
[Jackie Coogan](#) was in [Character Studies \(1927\)](#) with [Rudolph Valentino](#)





- Simple algorithm to build a network with small world properties
- Start from ring topology
 - High clustering
 - BUT high average path length
- Introduce some source of randomness
 - Network composed by clusters linked by “bridges”

- Starting from a ring lattice
 - Nodes placed in a ring
 - Each node linked to its nearest neighbors
 - $n=20$ $k=4$ in the example
- Random rewiring
 - Rewire each edge to a randomly chosen node with probability p
- The highest the p the more random-like the network





Everything is Small World!!!!

- Many different kind of system show Small World network properties
 - People acquaintances
 - Internet
 - Routers
 - Autonomous systems
 - Food web
 - ...

- Social network
 - Formed by human relations
- Small World properties
 - Typical of social networks
 - Found in many different kinds of network
 - Interesting properties
- More detailed social network analysis is possible
 - Degree distribution
 - ...



- Stanley Milgram, "The Small World Problem", *Psychology Today*, May 1967. pp 60 - 67.
- Watts, D. J., and Strogatz, S. H. Collective dynamics of 'small-world' networks. *Nature* 393, 6684 (June 1998), 440–442.
- Erdos number: <http://www.oakland.edu/enp/>
- Bacon oracle: <http://www.cs.virginia.edu/oracle/>