Aspetos Profissionais e Sociais da Engenharia Informática

Networks.. on a different view…

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Today

- The Effect of networking
  - Social networks
  - Scalling
- The models
  - How networks work
  - What can be this be modelled.

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NETWORKING EFFECTS

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What is (Social) Networking?

- A community of people with a common interest
- A way to establish personal relationships
- Interact socially
  - school
  - clubs
  - sports teams
  - religion
  - hobbies
  - politics
  - workplace
  - **ONLINE**

ONLINE, SOCIAL NETWORKING IS A WEBSITE OR APPLICATION THAT ALLOWS USERS TO INTERACT WITH EACH OTHER.

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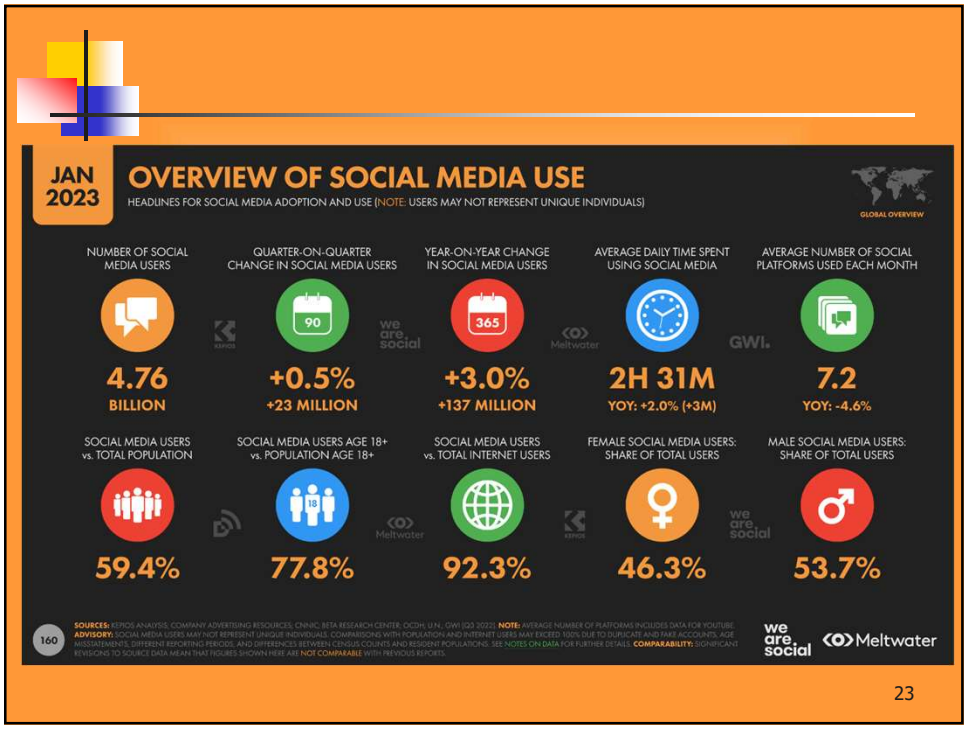

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We keep in touch with people through multiple platforms

INDICATE IF YOU CONNECT WITH PEOPLE TO YOUR RIGHT :

1. USING ONLY ONE SOCIAL PLATFORM
2. USING TWO SOCIAL PLATFORMS
3. USING THREE SOCIAL PLATFORMS
4. USING FOUR OR MORE SOCIAL PLATFORMS

Facebook	Instagram	Twitter	Pinterest	YouTube	reddit
67.48%	10.96%	10.32%	6.12%	3.9%	0.45%

Social Media Stats Worldwide - March 2023

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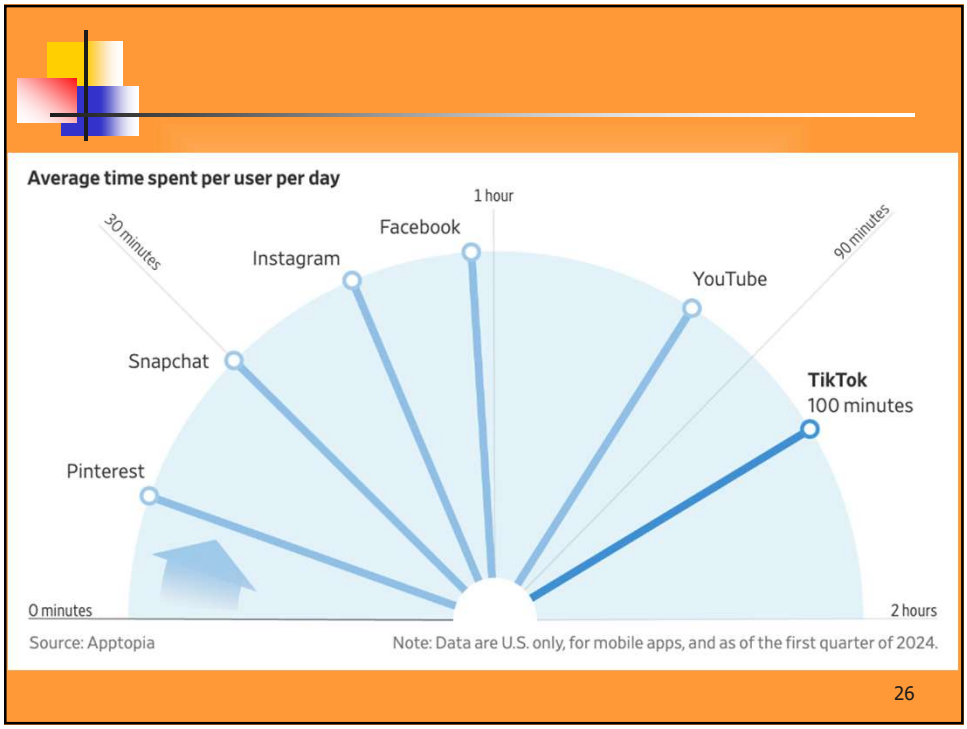
Average time spent per user per day
1 hour
30 minutes
90 minutes
Facebook
Instagram
YouTube
Snapchat
TikTok
100 minutes
Pinterest
0 minutes
2 hours
Source: Apptopia
Note: Data are U.S. only, for mobile apps, and as of the first quarter of 2024.
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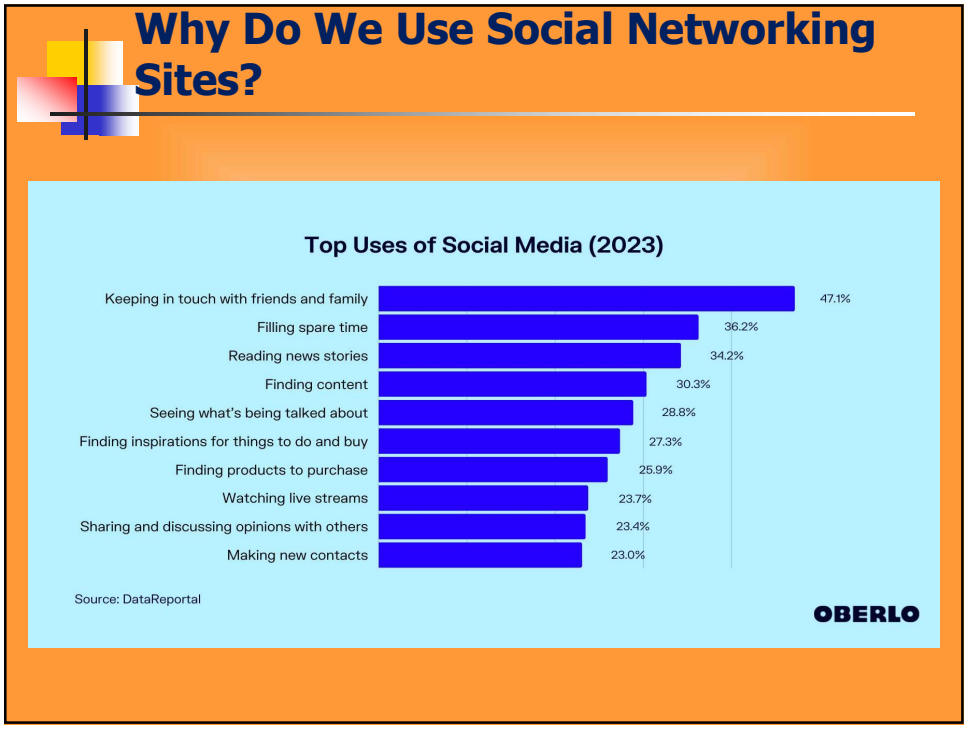
Why Do We Use Social Networking Sites?
Top Uses of Social Media (2023)
Keeping in touch with friends and family 47.1%
Filling spare time 36.2%
Reading news stories 34.2%
Finding content 30.3%
Seeing what's being talked about 28.8%
Finding inspirations for things to do and buy 27.3%
Finding products to purchase 25.9%
Watching live streams 23.7%
Sharing and discussing opinions with others 23.4%
Making new contacts 23.0%
Source: DataReportal
OBERLO

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What are some of the pros and cons of social networks?

- Pros
  - keep in touch with friends
  - meet new people
  - share links, photos, videos, news
  - practise English
  - educational purposes

- Cons
  - people post too often
  - people post photos or videos of you without permission
  - malicious gossip or bullying
  - misunderstandings can easily arise
  - unknown friends may not be who they seem
  - spam and viruses

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Network effects

Network effects: as usage of a product grows, its value to each user also grows.

- Network effects can start to weaken after certain point in the growth of the network.
- Growth in an asymptotic network, after a certain size, no longer benefits the existing users.

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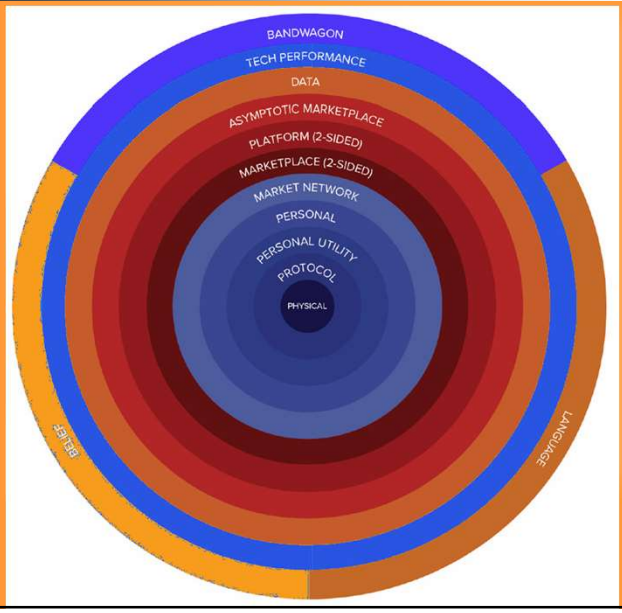
Network effects map



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Network Effects?

- Same-side effects
  - direct network effects that occur on the same side of a multi-sided (2-sided or N-sided) network
- Cross-side effects
- Indirect
- Critical Mass
- Assymptotic returns
  - network effects with diminishing returns
- Negative network effects

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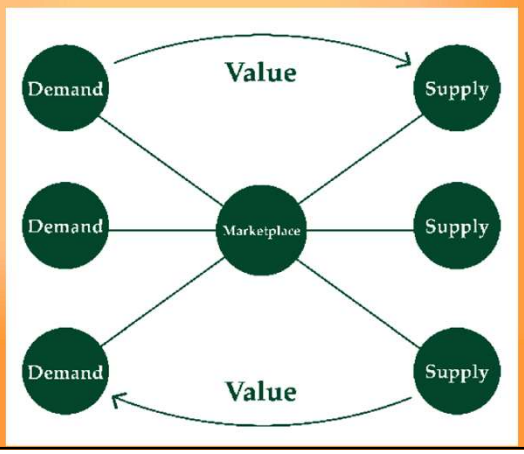
Cross-side network effects

- Direct network effects that arise from complementary goods or services in a network with more than one side



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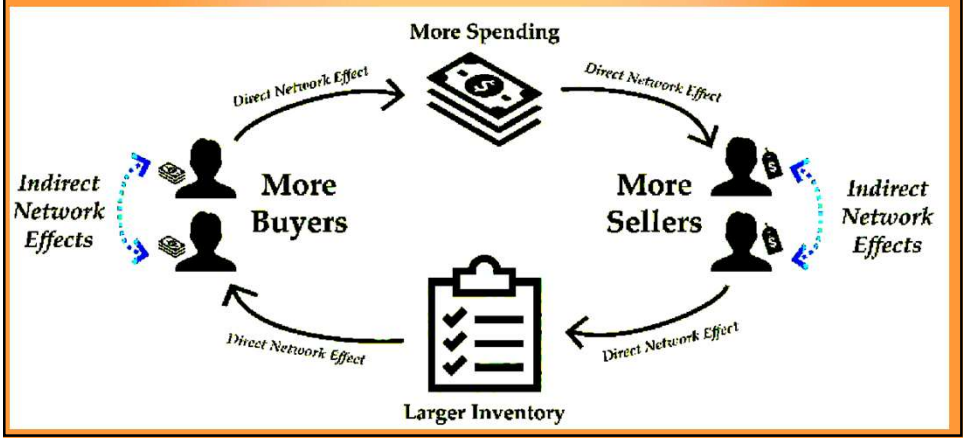
Indirect Network effects

- When the value of a network increases as a result of one type of node benefitting another type of node directly, but not directly benefiting the other nodes of its same type



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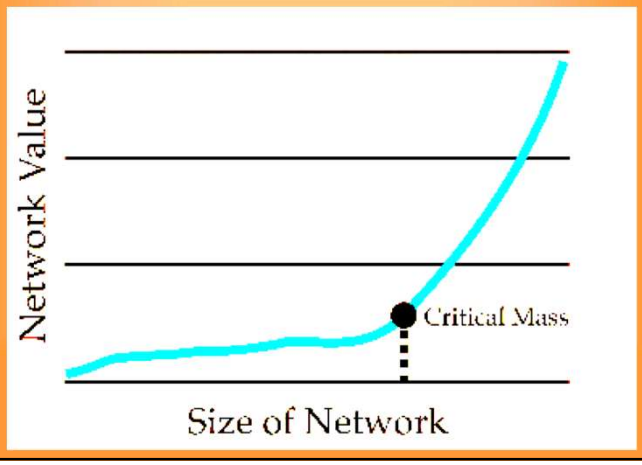
Why social networking: Critical mass

The critical mass of a network refers to the point at which the value produced by the network exceeds the value of the product itself and of competing products.



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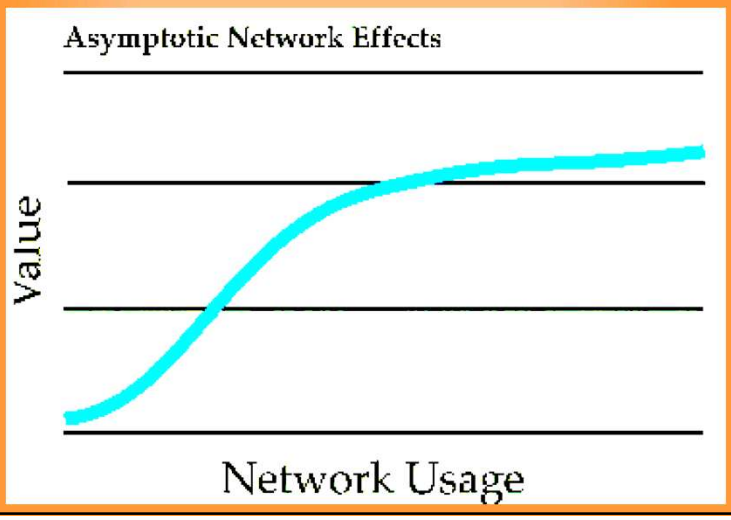
Asymptotic Effects

- Law of diminuishing returns



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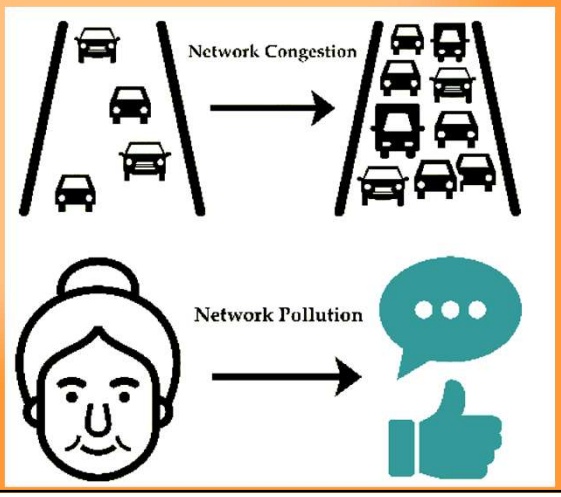
Negative effects

More network usage or greater network size can actually decrease the value of the network



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Is this of any relevance?

- Write the known…
  - Search engine (2)
  - Operating system (2)
  - Cellular operating system (2)
  - E-market
  - Router brand
  - Cloud hosting company
  - Social network
  - Social dissemination tool
  - Google, bing
  - windows, linux, macOs
  - Android, IoS
  - amazon, aliexpres
  - cisco
  - amazon
  - insta, facebook
  - X

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Is this of any relevance?

- Write the next known…
  - Search engine
  - Operating system
  - Cellular operating system
  - E-market
  - Router brand
  - Cloud hosting company
  - Social network
  - Social dissemination tool

Overall, only the top ones are well-known

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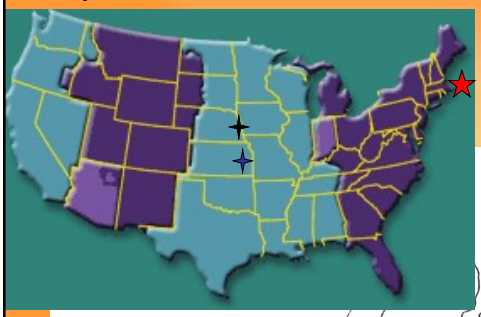
Social networks: Milgram's experiment



Milgram, *Psych Today* **2**, 60 (1967)

Dodds et al., *Science* **301**, 827 (2003)

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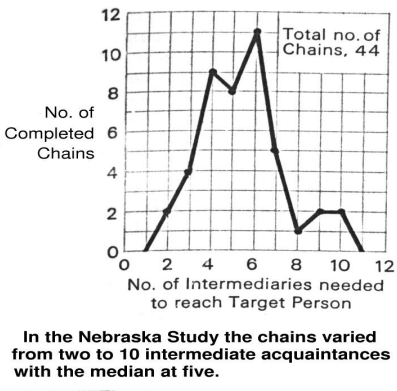
Social networks: Milgram's experiment

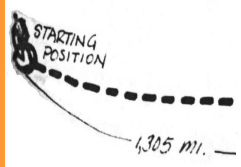
"Six degrees of separation"

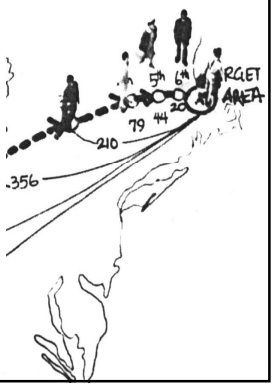
am, *Psych Today* **2**, 60 (1967)

ls et al., *Science* **301**, 827 (2003)



In the Nebraska Study the chains varied from two to 10 intermediate acquaintances with the median at five.





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Market: people create connections

The more connections the larger the value of those connections

The winner takes it all

Scale is all that matters

- Start-ups buy scale per profit…
- During how many years until there profits in…
  - Twitter…Amazon…

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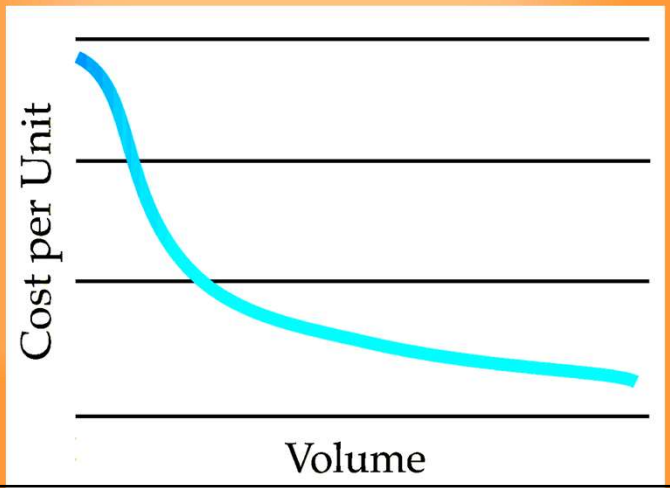
Scale effects

- Production and operation costs decrease with numbers!



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Can we analyse these effects?

- Consider a social network as a graph, where the vertices are the users in the network, and the edges are friendship links between those users.
- Each node has a finite subset of detail types (hometown, birthdate, groups, books, etc.)
- Each detail type has a finite number of detail values (books = The Bible, Harry Potter, etc.)

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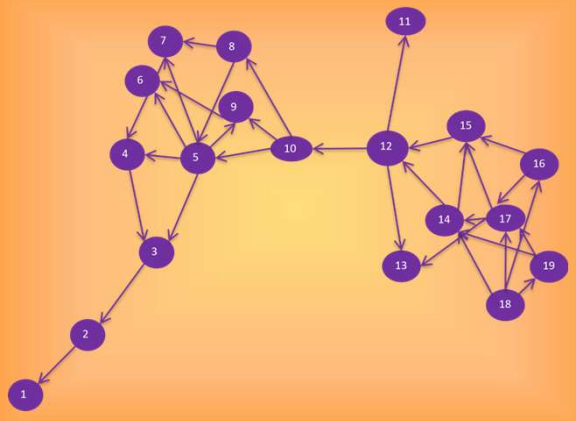
Can we analyse these effects



Graph theory

- Applies to people, market, technology

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Network Centrality metrics

- How do we know if a node is more or less importante?
  - What is the influence of an actor?

    actor = node = person, institution, group
  - How do we measure this?
- Metrics:

• characterize aspects of a node's positions in a network
• useful in identifying most influential actor (node)

- Number of relationships?
- Speed of influence?
- Ability to connect others?

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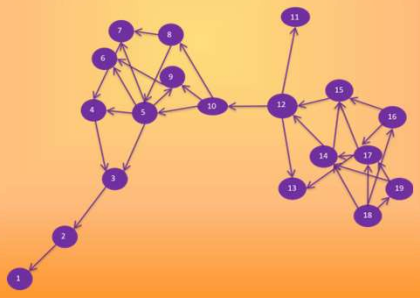
Centrality metrics

node degree
node linked to the most other nodes
(reflects # of relationships)

closeness
has shortest average mean distance to all other nodes
(reflects ability to influence others "quickly")

betweenness
falls on the shortest paths the most times
(reflects bridging between parts of network)



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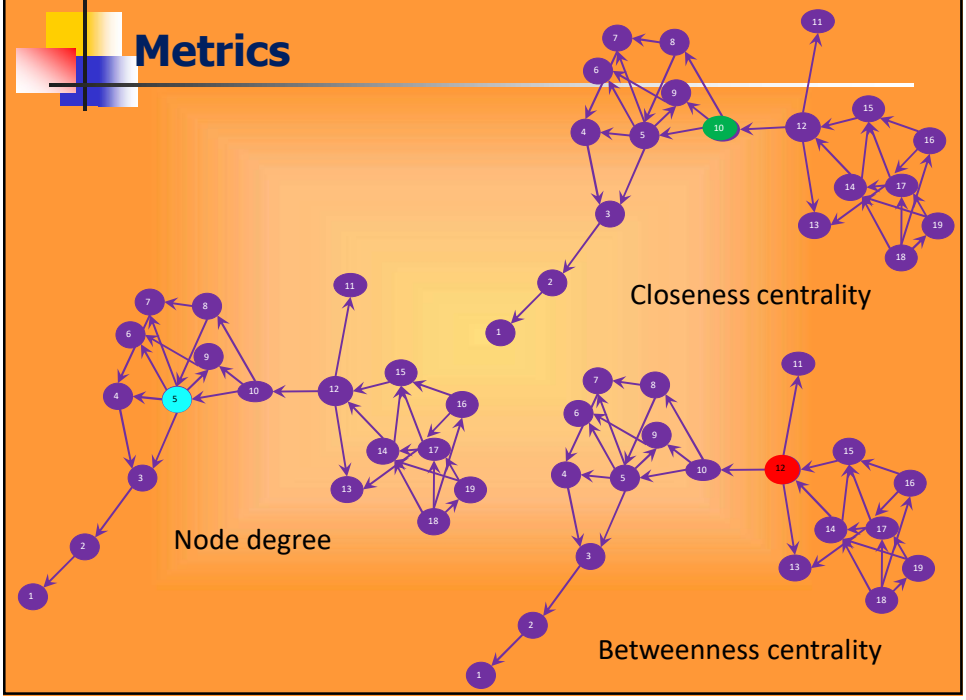
Metrics



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E.g. Definiting formally Betweenness

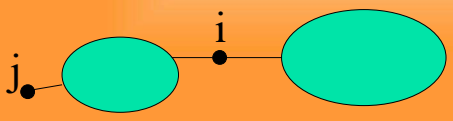
⇒ measures the "centrality" of a node i:

for each pair of nodes (l,m) in the graph, there are

σ^{lm} shortest paths between l and m

σ_i^{lm} shortest paths going through i

b_i is the sum of $\sigma_i^{lm} / \sigma^{lm}$ over all pairs (l,m)



b_i is large

b_j is small

For large numbers... computationally expensive

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Network "laws"

Sarnoff's Law

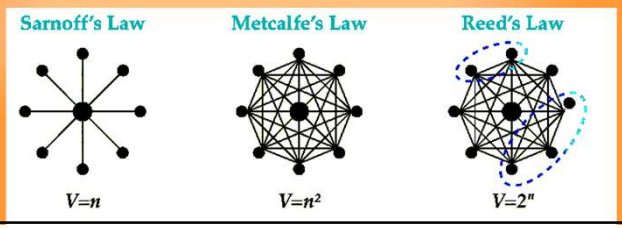
- value of network increase in direct proportion to the size of the network — proportional to N, where N is the total number of users on the network

Metcalfe's Law

- value of network grows in proportion to the square of the number of users on the network (N^2 where N is the total number of users on the network).

Reed's Law

- "group-forming networks" that allow for the formation of clusters (as described above) scale value even faster than other networks.



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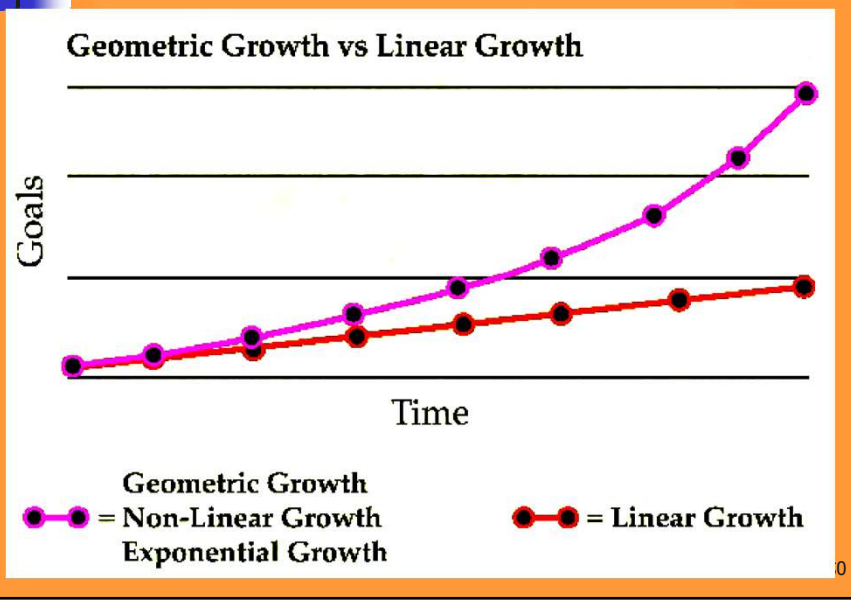
Network outcomes



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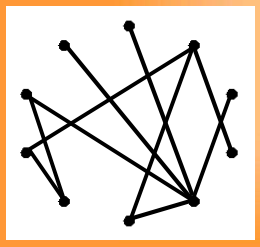
Usual random graphs: Erdös-Renyi model (1960)

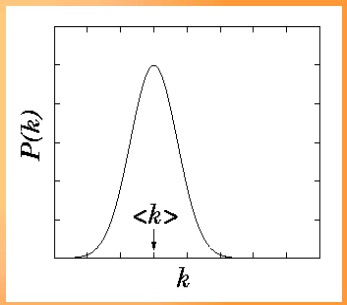
N points, links with probability p:

static random graphs

(p=O(1/N))



Poisson distribution



Distances: short(log N)

Simple, BUT NOT REAL LIFE

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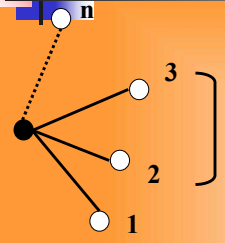
Clustering coefficient: node degree

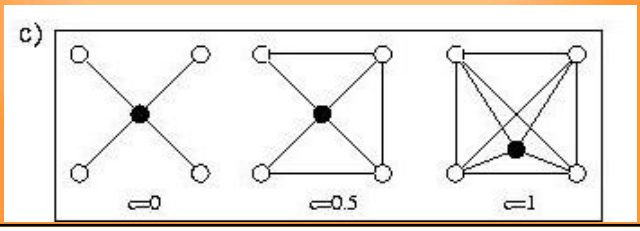


Higher probability to be connected

$$C = \frac{\text{\# of links between 1,2,\ldots n neighbors}}{n(n-1)/2}$$

Clustering: Typical example: social networks

My friends will know each other with high probability



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Expected Asymptotic behavior in graphs

Lattice

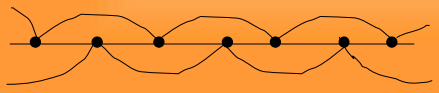
$$L(N) = N^{1/d}$$

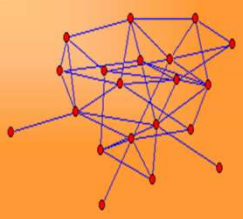
$$C(N) \approx const$$

Random graph

$$L(N) = \log N$$

$$C(N) \approx N^{-1}$$





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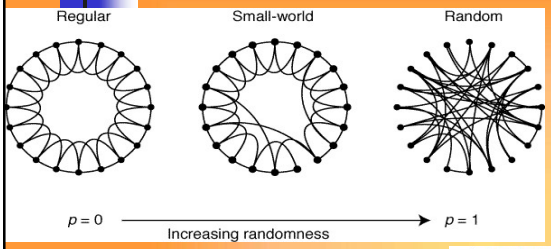
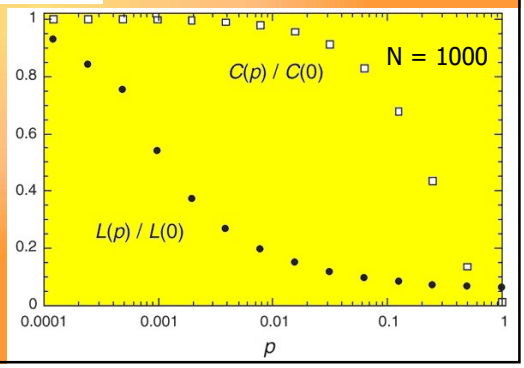
Reality In-between: Small-world networks



N nodes forms a regular lattice.
With probability p,
each edge is rewired randomly

=>Shortcuts

- Large clustering coeff.
- Short typical path



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However….

(1) The number of nodes (N) is **NOT** fixed.

Networks continuously expand by the addition of new nodes

Examples:
WWW : addition of new documents
Citation : publication of new papers

(2) The attachment of nodes is **NOT** uniform.

A node is linked with higher probability to a node that already has a large number of links.

Examples :
WWW : new documents link to well known sites
Citation : well cited papers are more likely to be cited again

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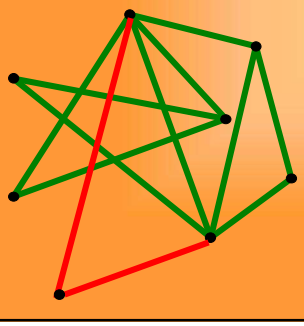
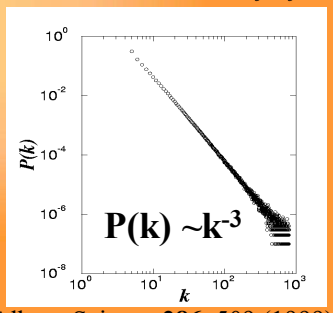
Scale-free models (BA model)

(1) GROWTH : At every timestep we add a new node with *m* edges (connected to the nodes already present in the system).

(2) PREFERENTIAL ATTACHMENT :
The probability Π that a new node will be connected to node *i* depends on the connectivity *ki* of that node

$$\Pi(k_i) = \frac{k_i}{\Sigma_j k_j}$$





A.-L.Barabási, R. Albert, Science **286,** 509 (1999)

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Why have I mentioned graph theory

- There are ways of looking into the networking effects
- We can model them!
  - And derive what to do to be sucessful
  - Social networks explore these

Any succesfull technology in our field explores network effects in some way

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