Social Network Analysis using Graph Metrics of Web-based Social Networks

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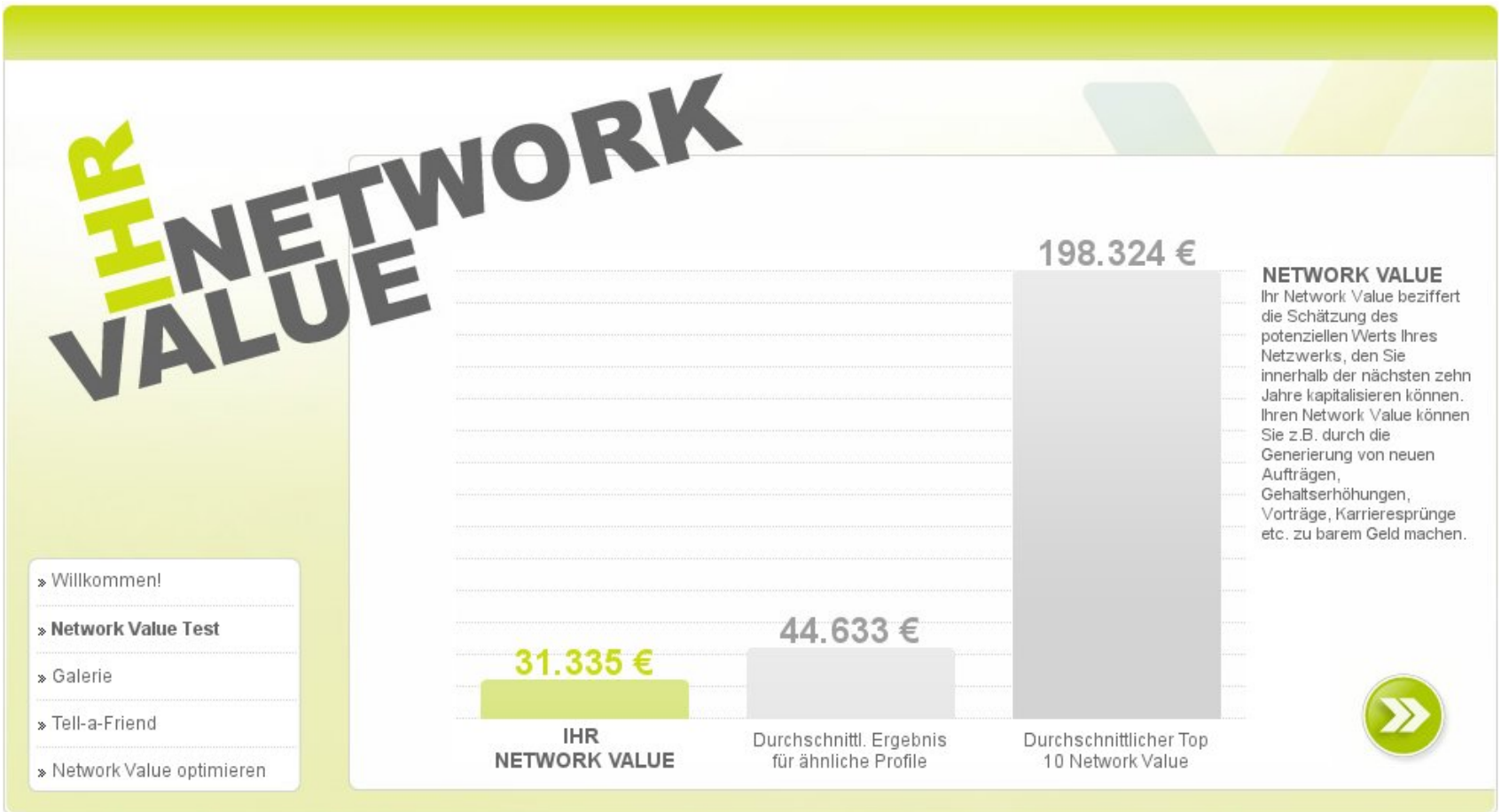
. . . taken from `http://mynetworkvalue.com/` (XING AG)

. . . and here my results:



How do they know that?

Research Area called Social Network Analysis (SNA)

. . . is a key technique in modern sociology, anthropology, sociolinguistics, geography, social psychology, communication studies, information science, organizational studies, economics, and biology as well as a popular topic of speculation and study.

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Goal

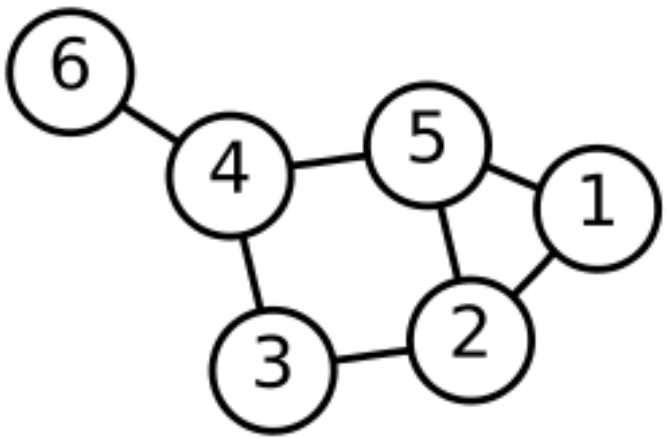
Analyze the structure of a social network to infer knowledge about an individual or a group.

Agenda

Graphs & Metrics

A graphical way to express relations.

What are Graphs?

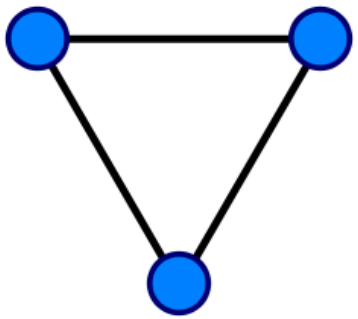


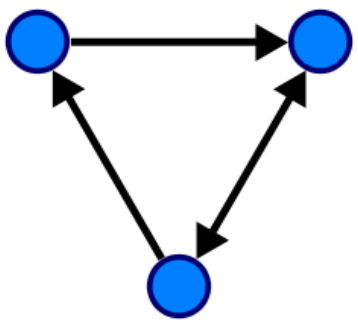
Graphs are ...

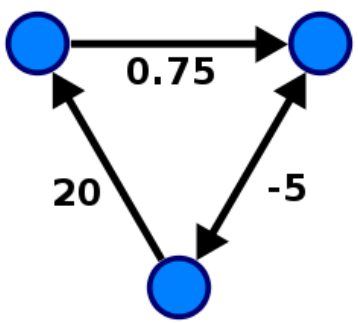
mathematical structures used to model pairwise relations between objects.

- nodes to represent objects ($\rightarrow$ *actors*)
- edges to express relations ($\rightarrow$ *communication paths*)

Graphs can be ...

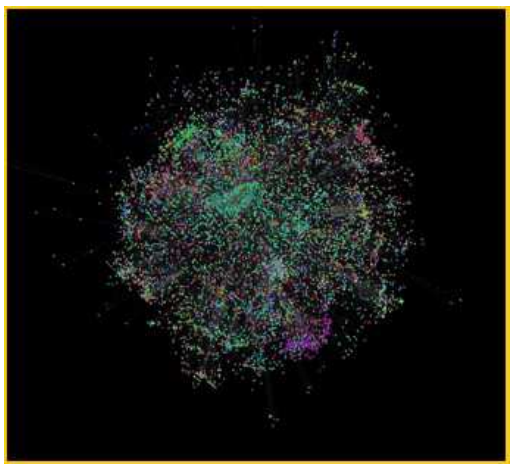






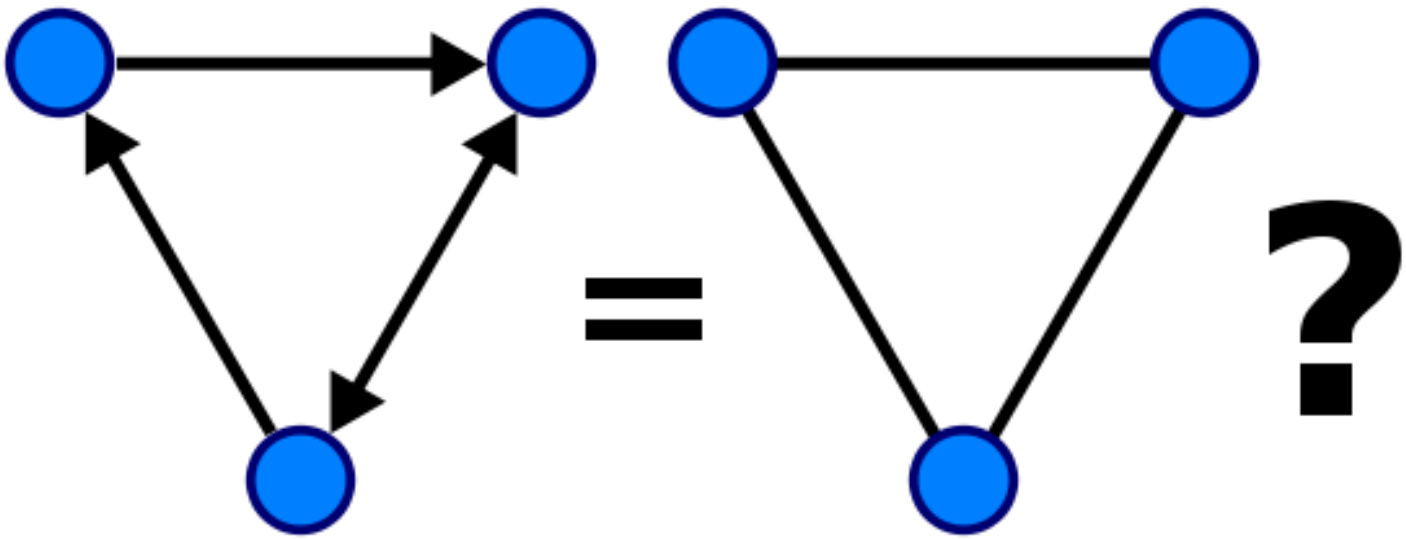
- undirected
  to represent (only) symmetric relations
- directed
  to represent asymmetric ($\rightarrow$ directed) and symmetric relations
- weighted
  to represent intensities, distances or costs of relations

Examples



- `http://mit.edu/networks`
  Research with a 250 million node graph (call logs)
- Vizster - Visualizing Online Social Networks
  "... exploration of the community structure of friendster, tribe, ..."
  `http://www.cs.berkeley.edu/~jheer/vizster/early_design/`
- ...

What are Graphs Metrics?



In SNA, we need to compare Graphs with other Graphs

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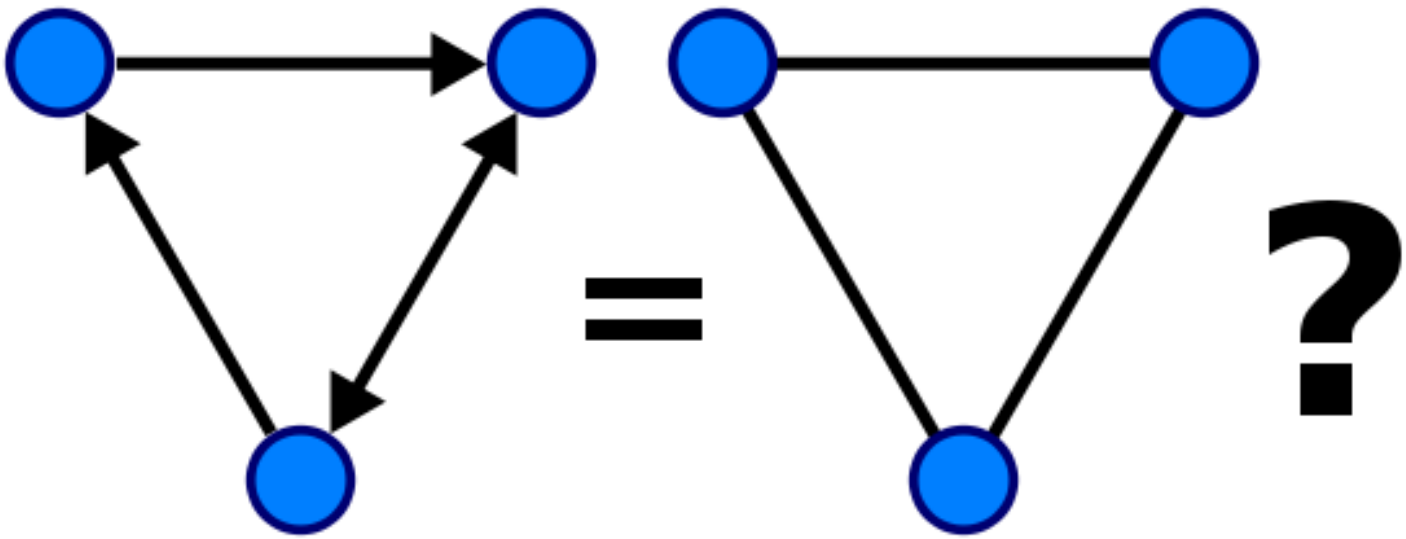

In SNA, we need to compare Graphs with other Graphs
Need measures for Graphs $\longrightarrow$ Graph Metrics!

Graph Metrics

Graph Metrics

. . . are of properties of graphs to compare

- Graphs with other Graphs
- Nodes with other Nodes

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Simple examples

- # of nodes per graph
- # of edges per node

Graph Metrics in SNA

Social Network Analysis (SNA) needs/deserves special metrics.

Using SNA metrics in . . .

- static graphs
  graph properties at a given point in time ($\rightarrow$ snapshot)
- dynamic graphs
  graph properties observed over a period of time ($\rightarrow$ evolution)

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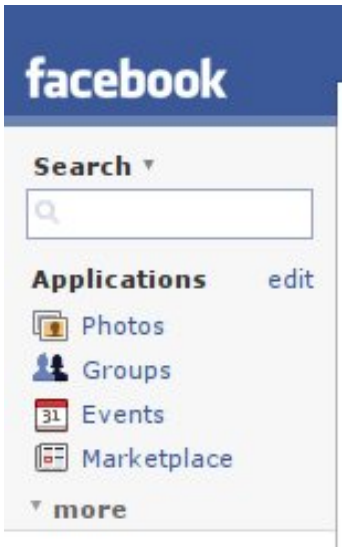
Some popular SNA metrics

- *Density*: $\frac{\#\text{ of edges}}{\#\text{ of possible edges}}$
- *Characteristic Path Length (CPL)*:
  relative connectedness of a social network
- . . .

Graphs for Social Networks

Modelling a web-based social network using graphs

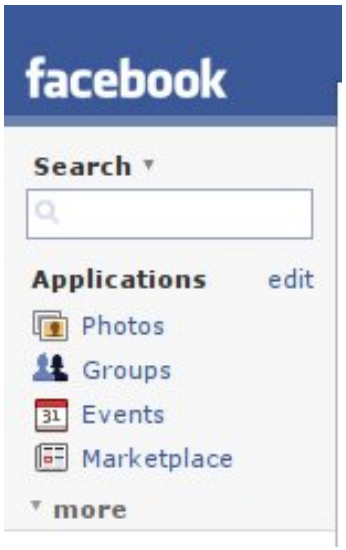
Modelling a Social Network



Now you got all the tools

- to build a model ($\rightarrow$ graphs) and
- analyze it ($\rightarrow$ graph metrics)

Modelling a Social Network



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Questions

What can you infer about real life from these models?
To what extent do your metrics reflect real life?

Critical Remarks

Example

Intuitive metric: Popularity of a node $\rightsquigarrow$ # edges per node

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How about "A. Schmidt" with 192 344 friends in XING?
What if "A. Schmidt" also had a Gold Account at StayFriends?

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Critical Comments

- web-based social networks reflect an *artificial* social network
- being part of a social network attaches a *label* (Facebook vs. XING)
- joining a community may have *purpose* or *strategy* behind it

Application Areas

Who is using graphs and metrics of social networks?

static models: Reputation management

...taken from `http://amazon.com`

main idea: reciprocity

"the more other people value my opinions, the more weight has my opinion on other topics."

dynamic models: Find terrorist activity

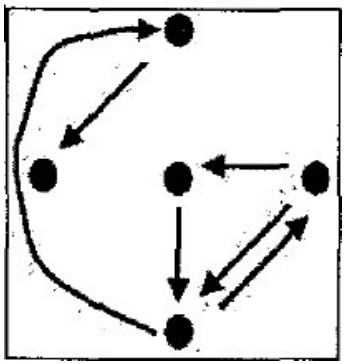
Idea

- Given a directed graph representing communication paths
- Goal: Find secretive / terrorist activity in cells in the graph
- Method: Find *communication patterns* that uncommon for human social networks

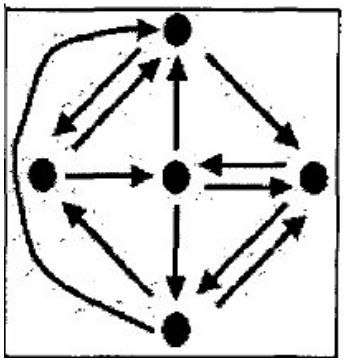
. . . DOD / DARPA sponsored research (!!)

Evolution of *Human Social Networks* vs. *Secretive Activity*

Human Social Networks



$t = t_0$



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- no central mediator
- geodesic assumption
- redundancy assumption

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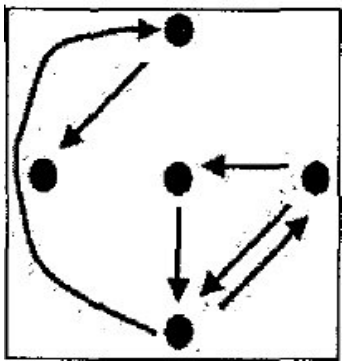

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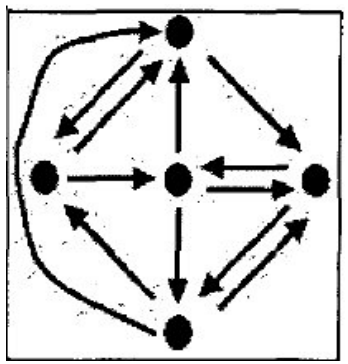

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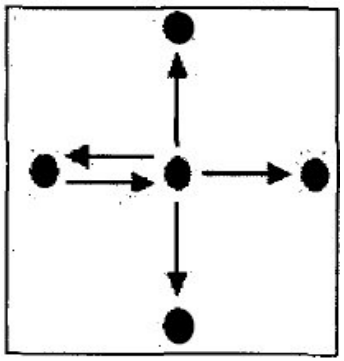
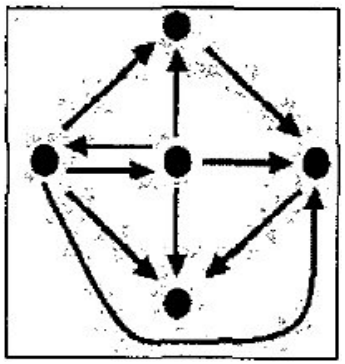
Secretive Activity



$t = t_0$ (*sleeping*)



$t = t_1$ (*active*)

- *sleeping*: central mediator to reduce risk for leaks
- *active*: efficiency needs direct communication

Find secretive activity

Which metrics are used?

- mediated communication $\longrightarrow$ Characteristic Path Length$\uparrow$
- Density is lower compared to real live
  (reduce # possible leaks $\Rightarrow$ reduce # communication paths)

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Experiments

- on a generated graph do *pattern-search* for metrics
- Result: accuracy rate of 96%

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Remarks ...

- Found a pattern = Found Terror Cell?
- Pattern based on Leninist Cell-Communication Model
- However: AT&T develops similar approach to detect fraud!

Keynote

What should you take home?

Keynote

Should we use graph metrics?

Keynote

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Yes, because . . .

- AT&T, DOD(DARPA), . . .
- Data-Mining
  (fast, simple, cheap)
- Only need the Graph
- High accuracy rate

Keynote

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No, because ...

- Based on Models
  $\longrightarrow$ Model Errors?
- Observation noise
  $\longrightarrow$ effect on metrics?
- False interpretations possible!
- How to build a complete Social Network?

Further Plans for the Paper

1. Further analysis of terror papers to show *weak spots and false assumptions*

2. Learn more about *Reputation Management*
3. Start it soon :)

Bibliography (. . . more on the WIKI)


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Questions or Comments?