

# › THE POWER OF SOCIAL NETWORK ANALYSIS

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**TNO** innovation  
for life



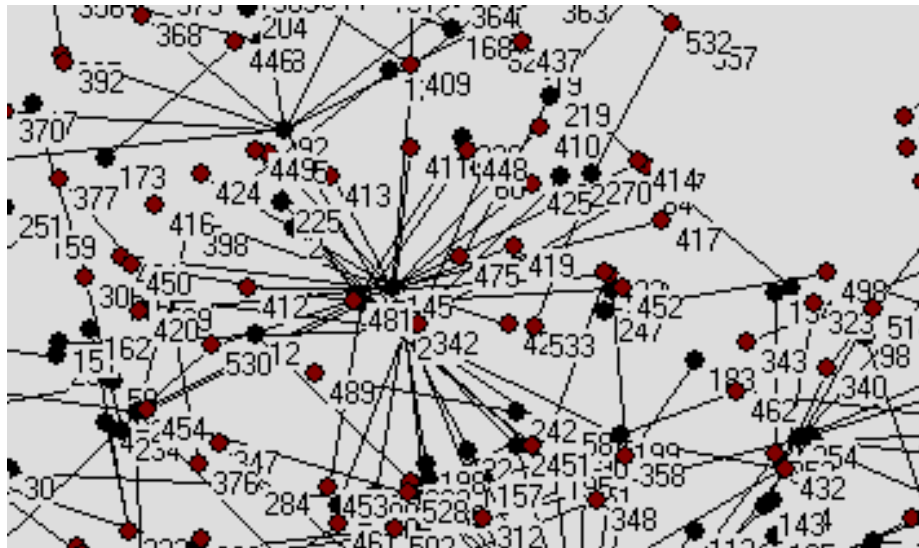
**POLITIE**  
• Politieacademie

# CONTENTS

- › Social Network Analysis (SNA) ?
- › SNA in practice
- › Conclusions

# SOCIAL NETWORK ANALYSIS ?

**Social network analysis** maps and analyses relationships between individuals in Social Networks (using Mathematical metrics for socio-structural attributes)



# WHEN DID IT START?

- › Father of SNA was psychoanalyst **J. L. Moreno** (1889-1974)
- › Moreno developed **sociometry**, the science and art of measuring relationships
- › Moreno also introduced the **sociogram**: graphic representation of individuals as points/nodes and the relationships between them as lines/arcs

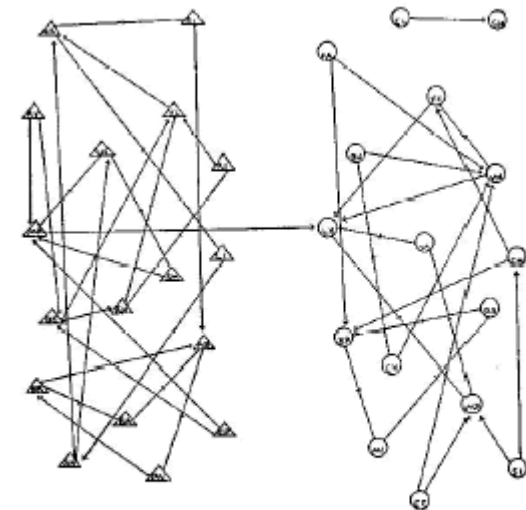
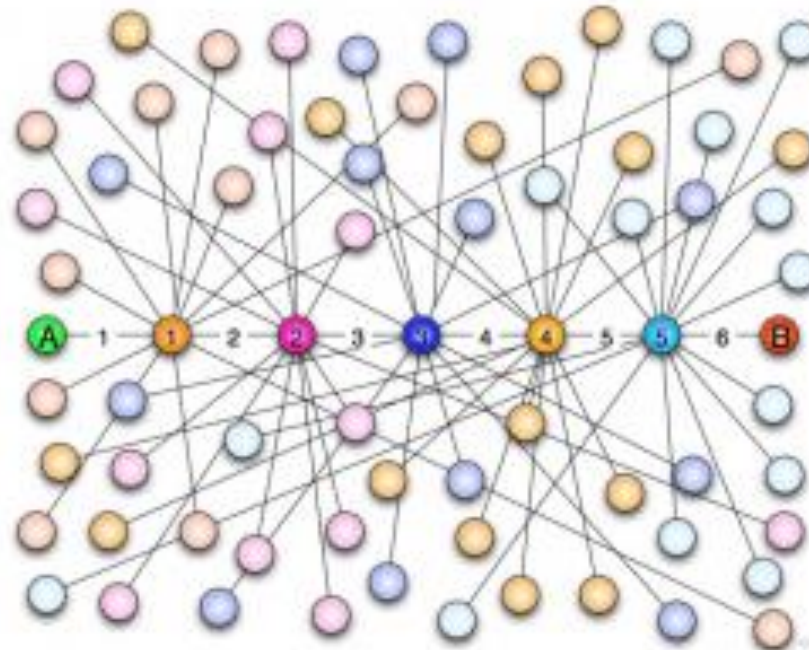


Figure 1. An Attraction Network in a Fourth Grade Class (from Moreno [19], p. 38).

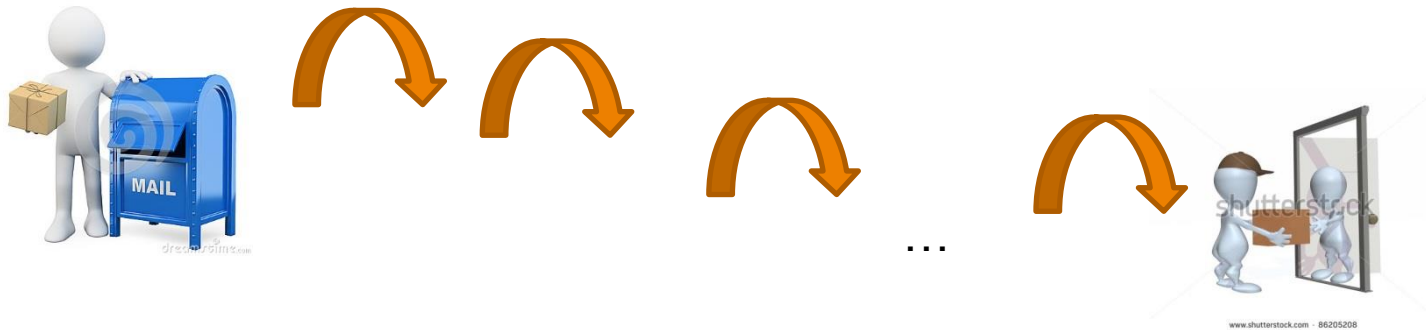
## AND THEN ...

- › **Frigyes Karinthy** (1887–1938), Hungarian author
- › Introduced in 1929, the “Six degrees of separation concept”, in his short story, *Chains (Láncszemek)*.



# SMALL WORLD PHENOMENON

- › Everybody in the world can be reached through a short chain of social acquaintances.
- › 1967: **Stanley Milgram's** experiment showed that the concept “six degrees of separation” works in practice
  - › Experiment



<http://www.stanleymilgram.com/milgram.php>

# KEVIN BACON'S SIX DEGREES

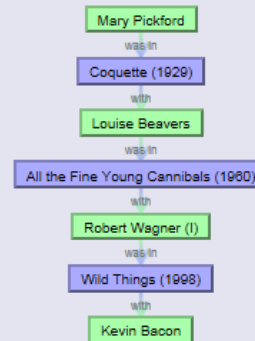


## THE ORACLE OF BACON

- Welcome
- Credits
- How it Works
- Contact Us
- Other stuff »

### About the Oracle of Bacon

This is the most comprehensive version of the Kevin Bacon game on the web. The object of the game is to start with any actor or actress who has been in a movie and connect them to Kevin Bacon in the smallest number of links possible. Two people are linked if they've been in a movie together. We do not consider links through television shows, made-for-tv movies, writers, producers, directors, etc. For example, you might wonder how Mary Pickford can be connected to Kevin Bacon. One answer is that:



Then we can count how many links were necessary and assign the actor or actress a **Bacon number**. Bacon numbers higher than 4 are very rare. In the example above, Mary Pickford has a Bacon number of 3. The Oracle uses the data from the [Internet Movie Database](#) and can give you the shortest path from every actor and actress that can be connected to Kevin Bacon.

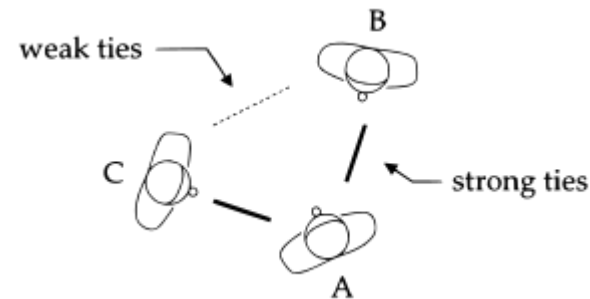
24  
 Tweet  
 +

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# AND ...

## Mark Granovetter

### › "The Strength of Weak Ties" (1973)



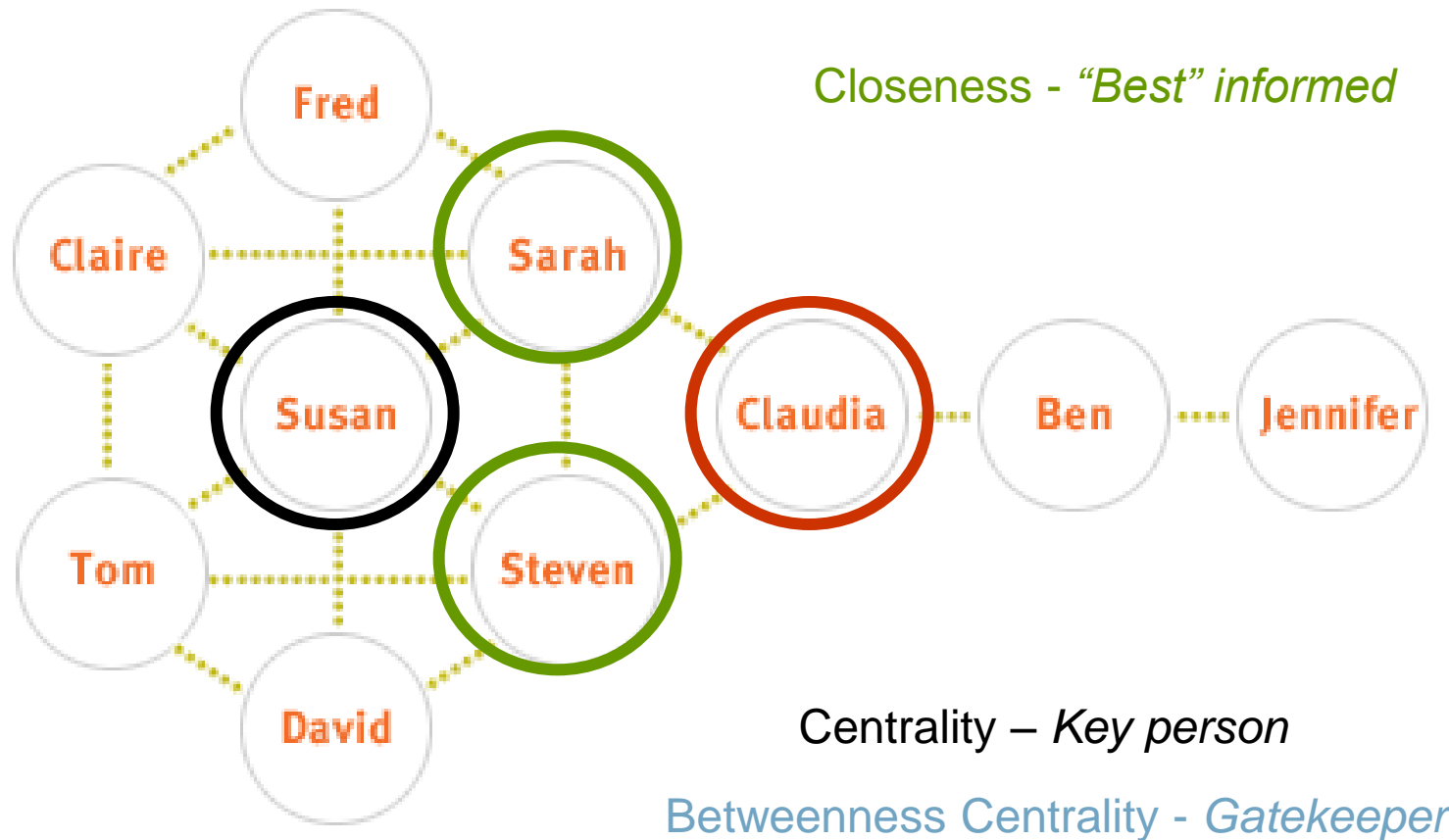
- › Weak links are connections to different & "fresh" knowledge locations !
- › "Getting a Job" (1974)
  - › "How do people get information about job opportunities?"
  - › Research method: interviews and questionnaires:
    - › how often contact person were seen during the period of the job transition (often, occasionally, rarely)?





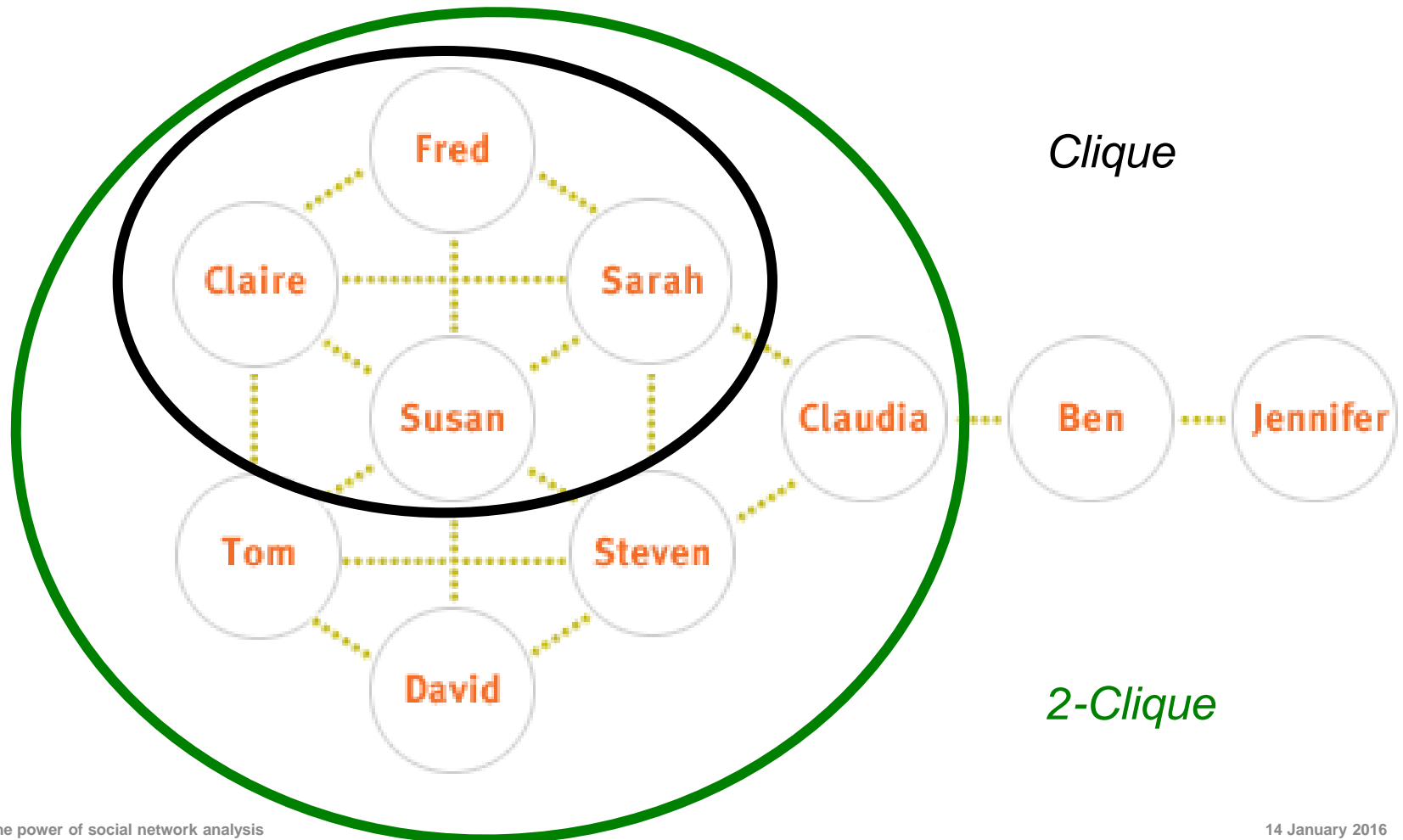
# BUT HOW DOES IT WORK?

Based on Krackhardt & Krebs



# BUT HOW DOES IT WORK?

Based on Krackhardt & Krebs





# SNA ANALYSIS AND OR?

Social Closeness Terms	Flow Model Properties
People or groups	Nodes (sinks, sources, or transshipment)
Connectivity or affinity	Capacitated arcs (or edges) between nodes
Social Closeness	Capacity
Influence	Commodity
Potential Influence	Magnitude of flow
People or groups initiating influence in the network	Source(s)
Target people or groups to be influenced	Sink(s)
People or groups involved in influencing	Transshipment node(s)
.....	....
.....	.....

# INTERPRETING SNA RESULTS?

1. **Core groups / Hubs**

Network with high clique-ness figures: High degree of local clusters

2. **Key central figures**

High centrality metrics

3. **Sub-groups**

Presence of cliques or n-cliques

4. **Mid-level individuals**

Lower centrality scores than key central figures but higher than the rest. High betweenness

5. **Isolated individuals**

Low closeness, located at periphery of network.

6. ....

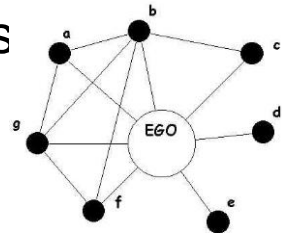
# SOFTWARE

- › Lots of social network analysis software has been developed and improved allowing to collect, analyse and visualise data in real-time
- › Some of the most known SNA packages are
  - › UCINET
  - › Pajek
  - › NodeXL (Excel)
  - › .....
- › A list of software with a short description is available at:  
<http://www.gmw.rug.nl/~huisman/sna/software.html>

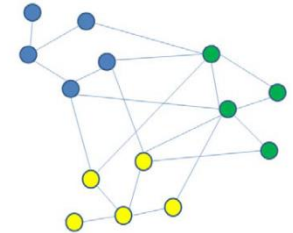
# USING SNA IN PRACTICE

1. Determine the analysis goal, and define the context

› Egocentric Analysis



Sociocentric Analysis



2. Choose the data collection and modelling strategy
3. Analysis
4. Interpreting and validating results

# SNA DATA

- › Social network data = relational data
  - › data about contacts, ties and connections
  
- › Relational data can be obtained in many ways
  1. Qualitative
    - › Survey research (questionnaire, interviews...)
    - › Ethnographic studies
  
  2. Quantitative
    - › Document analysis
    - › Electronic logs
    - › ...





# DOES IT WORK IN PRACTICE?

- › Biology
- › Business and organisation
- › Marketing
- › Defence and security
- › .....










# RISSO'S DOLPHIN

- › Can SNA
  - › Provide insight in the social structure Risso's dolphins?
  - › Uncover dominance and hierarchy ?



# SOCIAL STRUCTURE

## › Which dolphins ?

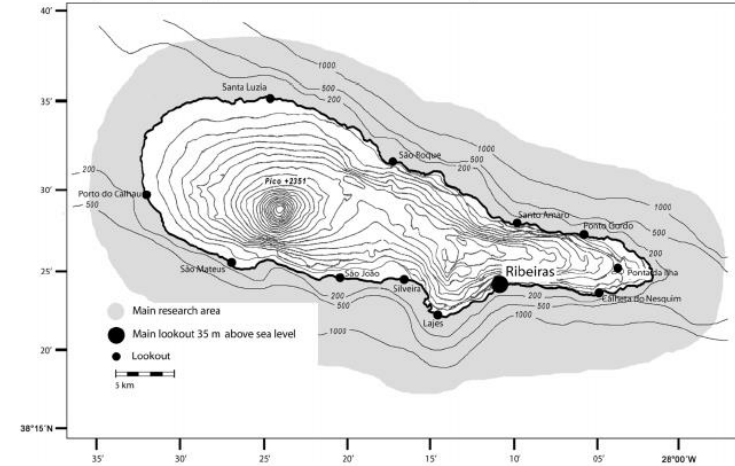
Group: S1		
Individual: S1a Name: Hook 	Individual: S1b Name: Pointer 	Individual: S1c Name: Racoon 
Individual: S1d Name: Hooper 	Individual: S1e Name: Nr.5 	Individual: S1f Name: Slammer 
Individual: S1g Name: Bull 	Individual: S1h Name: Spot 	Individual: Name: 

## › Interaction between dolphins?

## › How often/many interactions?



Fig. 1. The island of Pico, Azores, showing the main research area and 12 lookout posts.



# RISSO'S DOLPHIN DATA

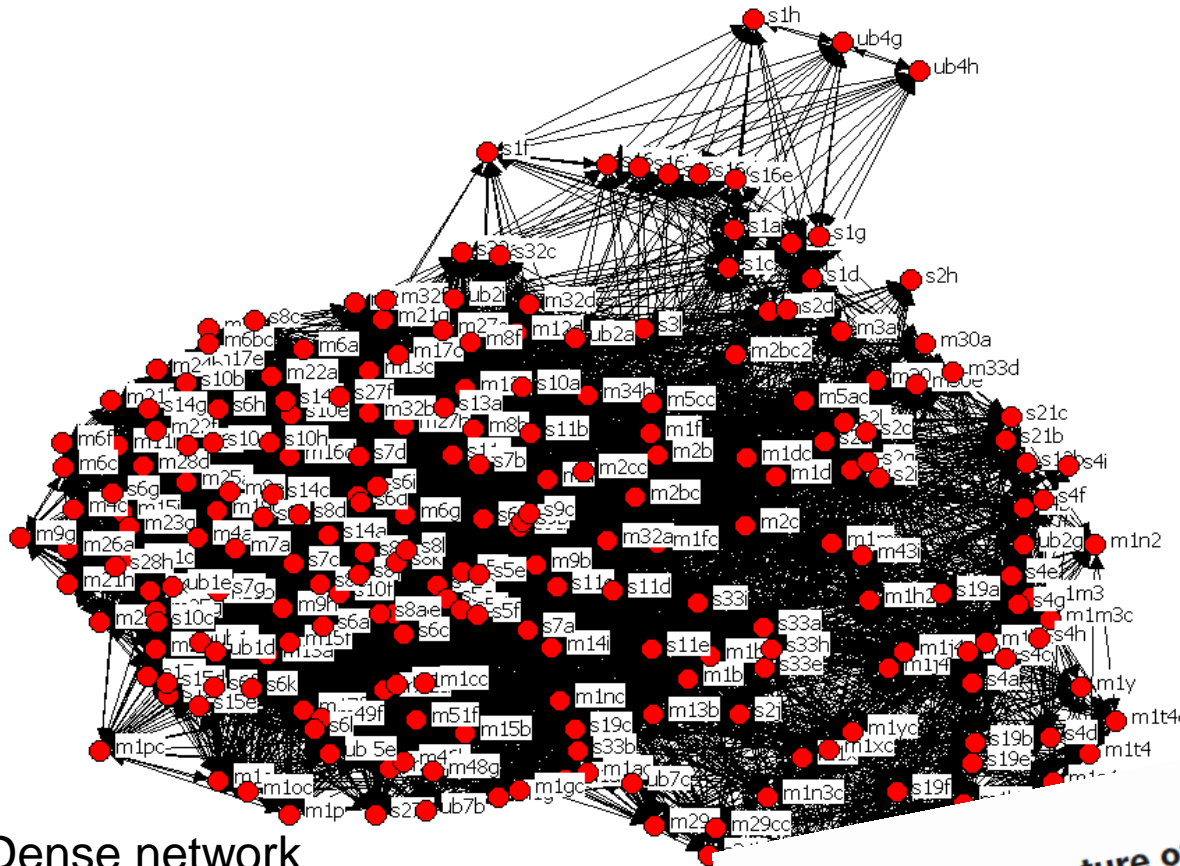
## › Source Sightings (period 2004-2006)

Date	Observarion code	Grp(d ag)	Grsiz	Code individuen
03-05-04	OGg03-05-2004a3	1	3	m11b
03-05-04	OGg03-05-2004a3	1	3	m24c
03-05-04	OGg03-05-2004a3	1	3	m43a
04-05-04	OGg04-05-2004a	1	2	m43b
04-05-04	OGg04-05-2004a	1	2	m43c

› 6511 sightings, about 1010 individuals

› Network with 239 individuals (minimal of 8 sightings)

# POWER OF SNA



- › Dense network
- › Young risso's have higher centrality metrics

294  
**Social structure of Risso's dolphins (*Grampus griseus*) at the Azores: a stratified community based on highly associated social units**

K.L. Hartman, F. Visser, and A.J.E. Hendriks

# POWER OF SNA

## Teamwork in the operating room arena

- › Case study in paediatric cardiac surgery
- › SNA is able to characterize team processes at a fine-grained level
- › SNA provides a solid basis for improving team communication processes and, ultimately, clinical performance



# POWER OF SNA



- › Often not only positive opinions about the products, but also negative opinions may emerge and propagate over the social network.

## Analyzing Discussions on Twitter: Case Study on HPV Vaccinations

Rianne Kaptein, Erik Boertjes, and David Langley

TNO, Delft, The Netherlands



# POWER OF SNA

CUSTOMER  
ANALYSIS  
ADVERTISING  
MARKET  
SALES  
PROMOTION  
PRICE  
INTERNET  
TARGET



Increasing popularity of online social networks requires exploiting social connectivity patterns of users to propagate product awareness— **Viral Marketing**

- › Strategy: Give free products to certain set of influential individuals
- › How to choose, within a given budget €, the initial seeds for viral marketing of products?

**SNA Key player 2: find a key player-set of order € that is maximally connected to all other nodes**

- › How to choose, within a certain budget €, the initial seeds for viral marketing of products in *specific target groups*?
- › ....



# SNA AND COVERT NETWORKS

Who belongs to  
network?

Modus  
operandi?

Leader ? Potential  
sources of  
information / victims?

How to disrupt  
the network?

# POWER OF SNA

Social Network Analysis  
of the 9-11 terrorism  
network,

*Valdis Krebs*



# POWER OF SNA

## U.S. 'Connects The Dots' To Catch Roadside Bombers

by TOM GJELTEN



Enlarge

David Gilkey/NPR

Marines on patrol in Afghanistan's Helmand province walk near a blast crater from a homemade explosive device. Roadside bombs are the leading killer of U.S. troops in Iraq and Afghanistan. The American military has turned to mathematics and social network analysis to help identify bombers and their supporters.

December 3, 2010

text size AAA

With his doctorate from Princeton, Army Gen. David Petraeus, the U.S. commander in Afghanistan, became the prime example of a special breed of soldier: the warrior-scholar, trained in history and politics as well as how to fight wars.



**Slate**

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Comfortabel oversteken  
naar Engeland, Ierland en Scandinavië

Ste  
Maki

HOME / SEARCHING FOR SADDAM : THE SOCIAL NETWORK THAT CAUGHT A DICTATOR.

## Searching for Saddam

A five-part series on how the U.S. military used social networking to capture the Iraqi dictator.

By Chris Wilson | Updated Monday, Feb. 22, 2010, at 8:06 AM ET



01:14 05:02  
 PAUSE E-MAIL LINK CODE WATCH MORE VIDEO ON  
 Searching for Saddam



# POWER OF SNA



## Studies in Conflict & Terrorism

Publication details, including instructions for authors and subscription information:

<http://www.tandfonline.com/loi/uter20>

## Tweeting the Jihad: Social Media Networks of Western Foreign Fighters in Syria and Iraq

Jytte Klausen<sup>a</sup>

<sup>a</sup> Lawrence A. Wien Professor of International Cooperation, Brandeis University

Accepted author version posted online: 17 Oct 2014.

PERSPECTIVES ON TERRORISM

Volume 6, Issue 1

## The YouTube Jihadists: A Social Network Analysis of Al-Muhajiroun's Propaganda Campaign

by Jytte Klausen, Eliane Tschaen Barbieri, Aaron Reichlin-Melnick, and Aaron Y. Zelin

# POWER OF SNA

SNA helps identifying

- › Offenders
- › Offenders-victims relation
- › Potential victims

Input for *focused deterrence*



## NEWS RELEASE

### Chicago Police Department

Jody P. Weis  
Superintendent of Police

Lt. Maureen C. Biggane  
Commanding Officer

For Immediate Release  
February 13, 2011

Contact: Office of News Affairs  
312-745-6110

### Chicago Police Target Most Violent Gang in Harrison District *Social Network Analysis Aids Efforts to Dismantle Gang Network*

Superintendent Weis emphasized the utility of Social Network Analysis for identifying perpetrators of violence so that gang factions may be dismantled. The analysis also reveals the relationships between victims and offenders in shooting and homicide incidents, highlighting that both parties often are known to each other through personal disputes, and that violence is not random but intentional. Although the community as a whole is not at risk, the misconception and ongoing gang conflicts devastate neighborhoods and demand resources.

Social Network Analysis effectively enables law enforcement to identify at-risk individuals and make appropriate outreach. The call-in strategy involves offering social service aid to gang members, as well as job training and continuing education. Comprehensive enforcement action only is the result of gang members continuing to engage in illegal activities.

# POWER OF SNA

J Quant Criminol (2014) 30:113–139  
DOI 10.1007/s10940-013-9198-x

ORIGINAL PAPER

## Deterring Gang-Involved Gun Violence: Measuring the Impact of Boston’s Operation Ceasefire on Street Gang Behavior

Anthony A. Braga · David M. Hureau · Andrew V. Papachristos

The available research on Ceasefire and its replications has thus far provided scant empirical evidence on the ways *individuals* nested within targeted groups and social networks may change their criminal decision making processes. The Ceasefire mechanism of putting gangs “on notice” is designed to increase the certainty of punishment for the group as a whole, but it does so through (a) the diffusion of the message among individual group members and (b) reliance on the group members, as a collective, to modify behavior accordingly.

# POWER OF SNA

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Kennedy et al. (1997, p. 240) describe how social network analysis concepts were used to assist the diffusion of the deterrence message across Boston's gang landscape:

We used structural network analysis in pursuit of support for an effective communications strategy. Here, [social network analysis software] was employed to identify naturally existing subgroups, or “cliques,” such that talking to one member would effectively be talking to all members [of that clique] ... for clique identification, conflict and alliance networks were combined and analyzed.

# DYNAMICS OF COVERT NETWORKS

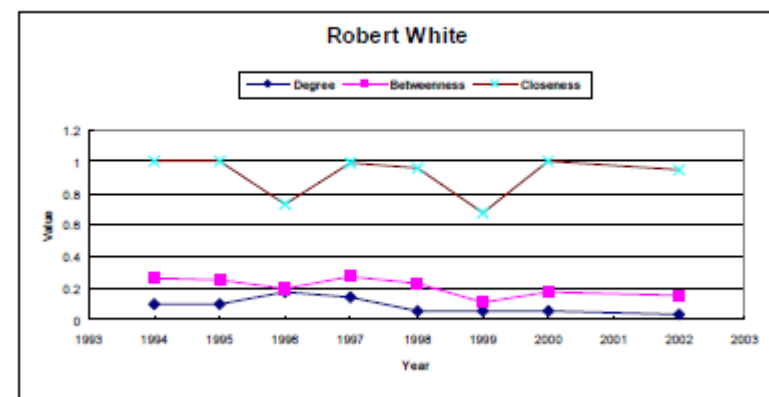
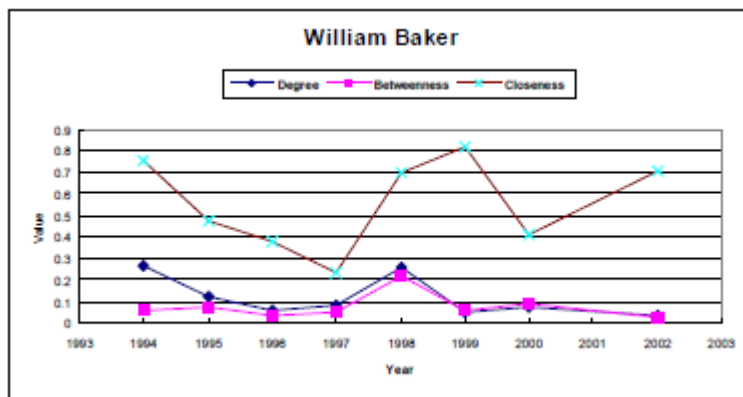
- › Most applications of SNA are based on static analysis in which data is collected at a single point in time and the snapshot of a criminal network is generated and studied.
- › What about the dynamics ?
  - › How does an individual acquire a central position in a network and gain more power over time?
  - › Do relations between individuals become stronger or weaker?
  - › How does a group's membership or structure change?
  - › What do these changes imply about the future of the network?
    - › Can we use this knowledge to define counter-strategies ?





# KEEPING TRACK OF DYNAMICS

- › Case study based on a list of 103 major criminals in the Meth World from the Gang Unit Sergeant at the Tucson Police Department
- › A network consisting of 924 criminals surrounding these major offenders. These offenders committed 11,074 crimes ranging from theft and aggravated assault to drug offences from 1983 to 2002.



Analyzing and Visualizing Criminal Network Dynamics: A Case Study

# POWER OF SNA

## Potential Affiliation to criminal group?

- › Node importance evaluation: focus on the links between network members to identify likely crime suspects.
- › Social Network Criminal Suspect Evaluator:
  - › New approach that incorporates members' individual criminal propensities (Criminal group human capital)
  - › Success application for 2 cases
    - › data from an USA youth gang prevention program
    - › real police data on petty drug offenders (Chile)

A Social Network Approach to Identifying Key Police Suspects

Fredy Troncoso · Richard Weber



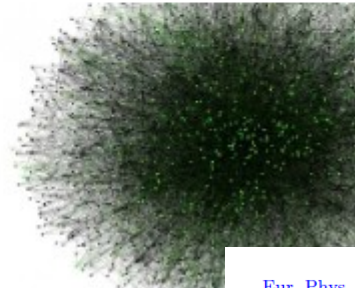
# POWER OF SNA

## WHAT IS THE BEST WAY TO TACKLE CRIMINAL NETWORKS?

05 March 2014

How are criminal networks organised, and what is the best way to tackle them? UvA professor Peter Sloot has used computer models to study the complexity of criminal network structures. His work has been carried out in partnership with Russian computer scientists, the Dutch police and criminologist Paul Duijn. Their findings are published this week in the academic journal 'Nature Scientific Reports'.

The research team's key finding is that targeting random criminal entrepreneurs in the organised cannabis cultivation sector can be entirely counterproductive. Using computer models, the research team has shown that a more effective way of destabilising the network is an alternative intervention aimed at removing very specialised players rather than the most high-profile and seemingly influential criminals.



Eur. Phys. J. Special Topics **222**, 1413–1439 (2013)  
© EDP Sciences, Springer-Verlag 2013  
DOI: [10.1140/epjst/e2013-01935-7](https://doi.org/10.1140/epjst/e2013-01935-7)

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**The importance of centralities in dark network value chains**

# CONCLUSIONS

- › SNA provides insight in the dynamics of organisations
- › SNA helps devising new business/marketing/security strategies



Social network analysis