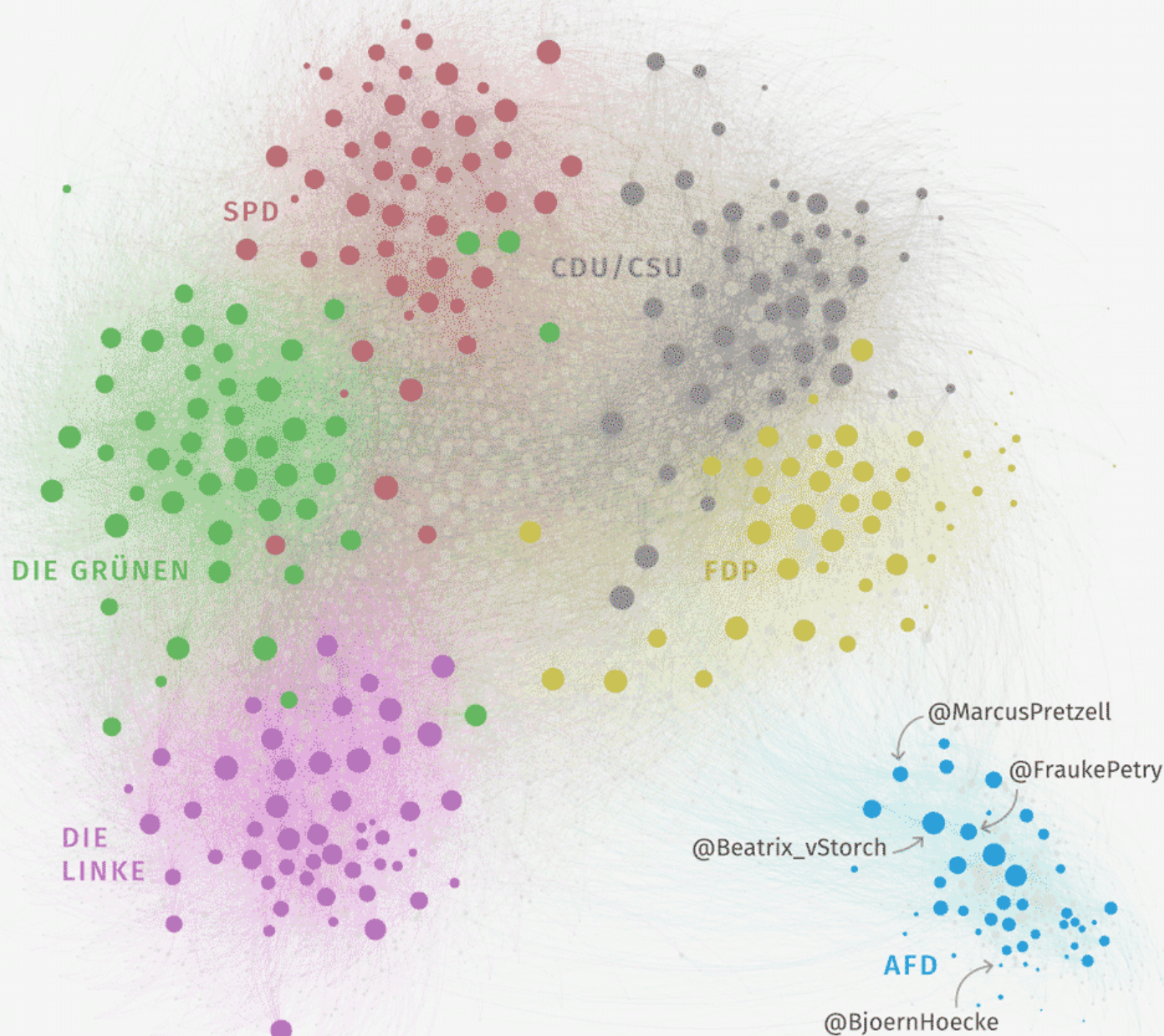


A network diagram with colorful pins representing nodes and lines representing connections. The pins are in various colors including red, green, yellow, blue, purple, and black. They are arranged on a white surface with a faint grid pattern. The text is overlaid on a semi-transparent white box in the center of the image.

# Social Network Analysis in Practice

Projektseminar WiSe 2018/19

Tim Repke, Dr. Ralf Krestel



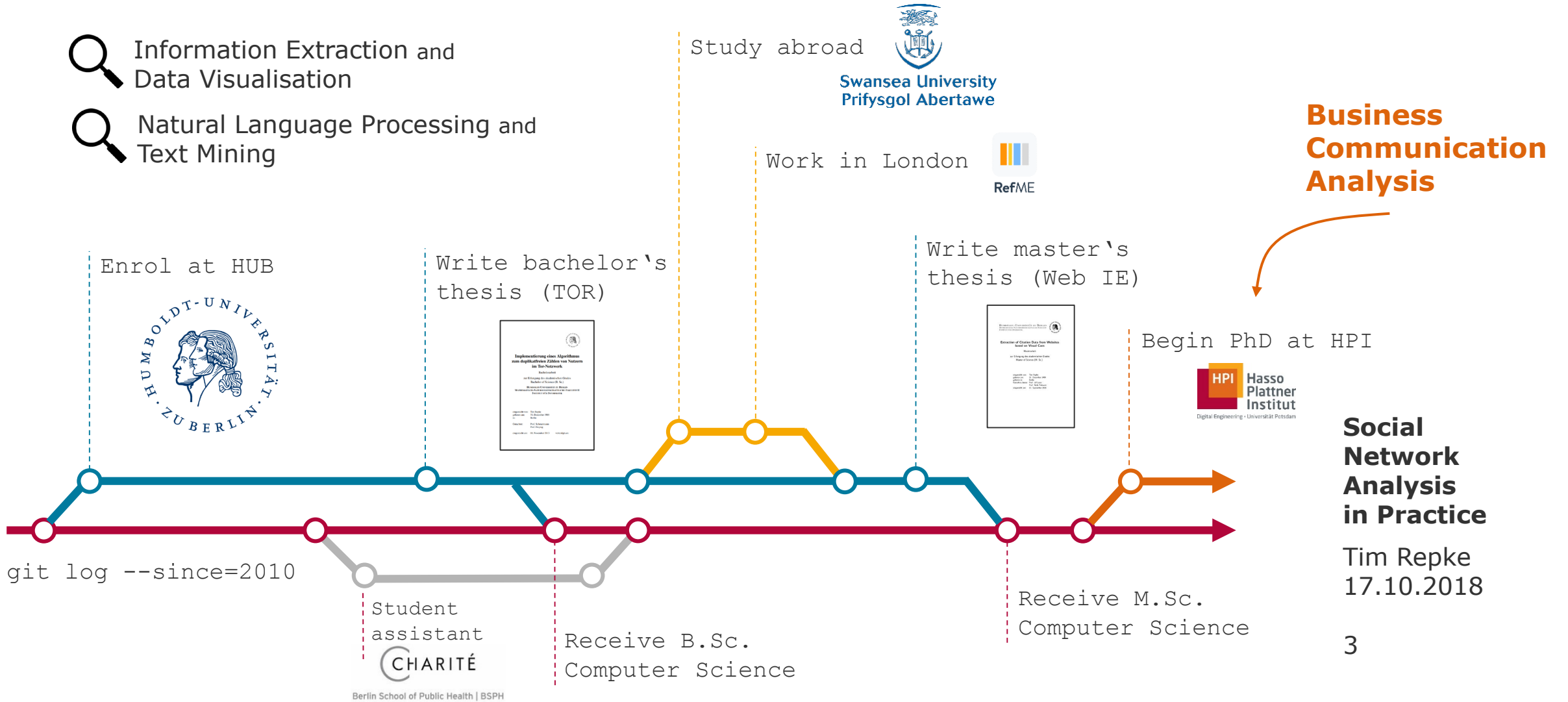
## Social Network Analysis in Practice

Tim Repke  
17.10.2018

# About Me



- Information Extraction and Data Visualisation
- Natural Language Processing and Text Mining



# What You Learn in this Seminar

---



- Overview of topics in Social Network Analysis
- Deep understanding of one aspect
- Explore heterogeneous data
- How to find, implement, and reproduce research papers
- How to write a research abstract

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# Schedule

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Overview Talks  
*October & June*

Seminar

Exploration

"Data Science"  
*December*

Date	Topics
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SNA in Practice  
*January & February*

Project

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30.01.2019	
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Write and  
Review Paper  
*February & March*

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# Schedule (pt. 1)

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# Schedule (pt. 1)

## Overview Talks - Topic Assignment

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- Topics will be assigned ASAP!
- Please send email to [tim.repke@hpi.de](mailto:tim.repke@hpi.de)
  - Subject: [SNAiP] Topic preferences
  - Data Engineering students preferred
  - First-come-first-serve, but please cancel if you change your mind
  - Please send top 3 topics ordered by preference
  - Registration deadline: **Friday, 19.10., 18:00**

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# Schedule (pt. 1)

## Overview Talks - Presentation Specs

---



- Length: 25 mins interactive lecture<sup>1</sup>
- Presentation should cover all aspects of the topic
- Highlight pros/cons/applications of presented methods
- For general (network) algorithms: make it SNA specific
- Students should get overview of what can be done, not how one specific thing works
- Please coordinate, so that talks in each lecture fit together
- We'll meet to discuss slides the week before your presentation, please send finished slides to [tim.repke@hpi.de](mailto:tim.repke@hpi.de) the day before
  - Feel free to send me a selection of topics/methods you want to cover earlier on!

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<sup>1</sup> On 21.11., we have to fit four presentations, so we will begin earlier

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SNA in Practice  
*January & February*

Project

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# Schedule (pt. 2) Exploration



Date	Topics
05.12.2018	Lecture Enron Dataset, practical tips working with network data
12.12.2018	
19.12.2018	Presentations Findings of Data Exploration

- Datasets, project topics, tools/libraries will be presented on 05.12.
- Get acquainted with data and tools and prepare small, informal presentation with #datascience stuff
- More on that then...

**Note:** I will choose and prepare project topics based on **your intetestests!**  
Your requests are very welcome!

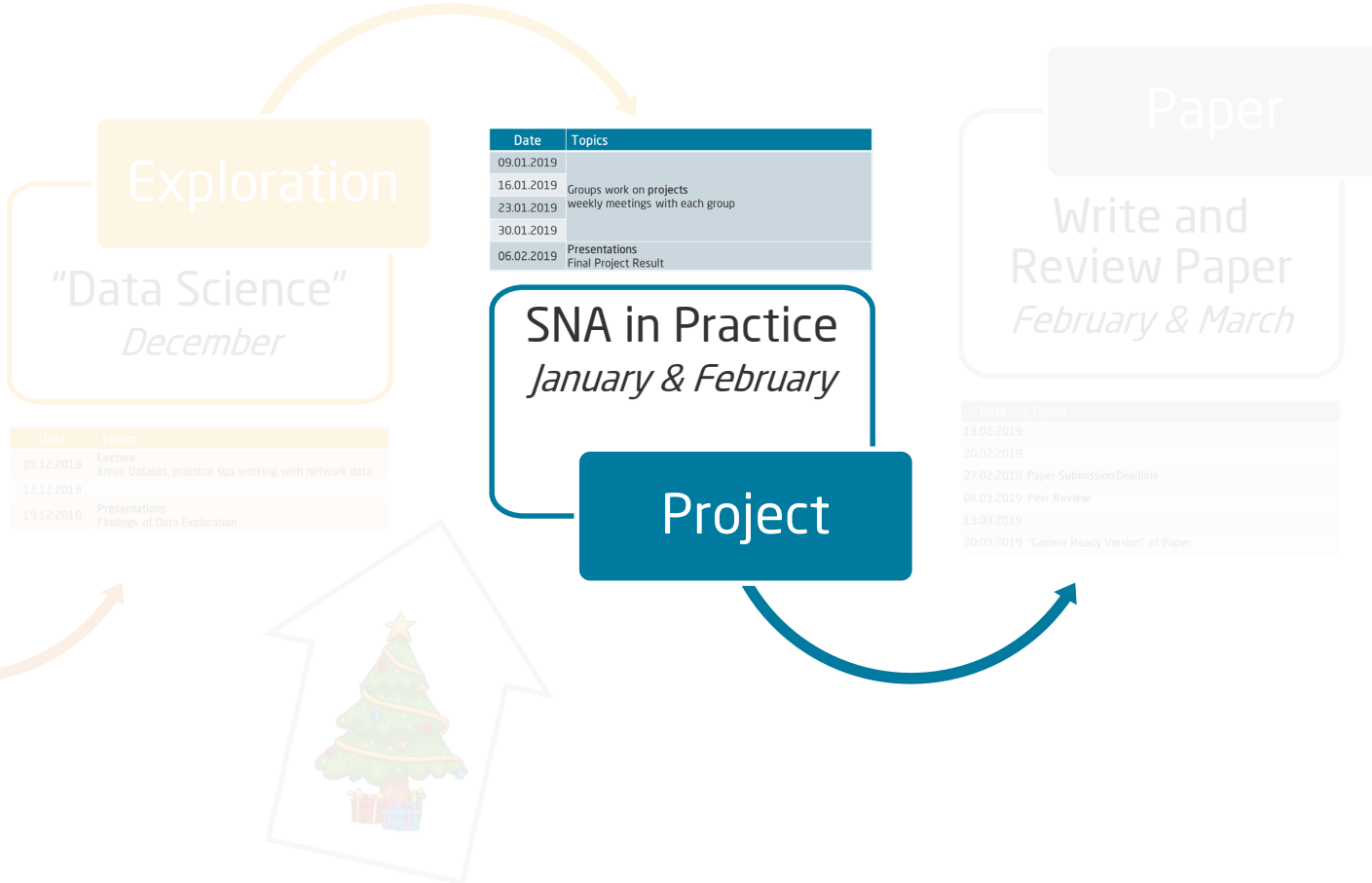
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# Schedule

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16.01.2019	Groups work on projects
23.01.2019	weekly meetings with each group
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06.02.2019	Presentations Final Project Result



Overview Talks  
*October & June*

“Data Science”  
*December*

SNA in Practice  
*January & February*

Paper  
Write and Review Paper  
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# Schedule (pt. 3) Project



Date	Topics
09.01.2019	Groups work on <b>projects</b> weekly meetings with each group
16.01.2019	
23.01.2019	
30.01.2019	
06.02.2019	<b>Presentations</b> Final Project Result

- Groups of 2-3 students
- Implement a paper, method, idea you like with real-world data
- I'll meet with each group once a week for feedback
- More on that in December!

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# Schedule

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Overview Talks  
*October & June*

Seminar

Exploration

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SNA in Practice  
*January & February*

Project

Paper

Write and  
Review Paper  
*February & March*

Date	Topics
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20.02.2019	
27.02.2019	Paper Submission Deadline
06.03.2019	Peer Review
13.03.2019	
20.03.2019	"Camera Ready Version" of Paper

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# Schedule (pt. 4) Paper



Date	Topics
13.02.2019	
20.02.2019	
27.02.2019	Paper <b>Submission</b> Deadline
06.03.2019	Peer <b>Review</b>
13.03.2019	
20.03.2019	"Camera Ready Version" of Paper

- Single-blind review
- 2 pages (+ references)
  - ACM proceedings template<sup>1</sup>
  - Each student writes about one aspect of the group project
    - Either individual papers or one longer paper

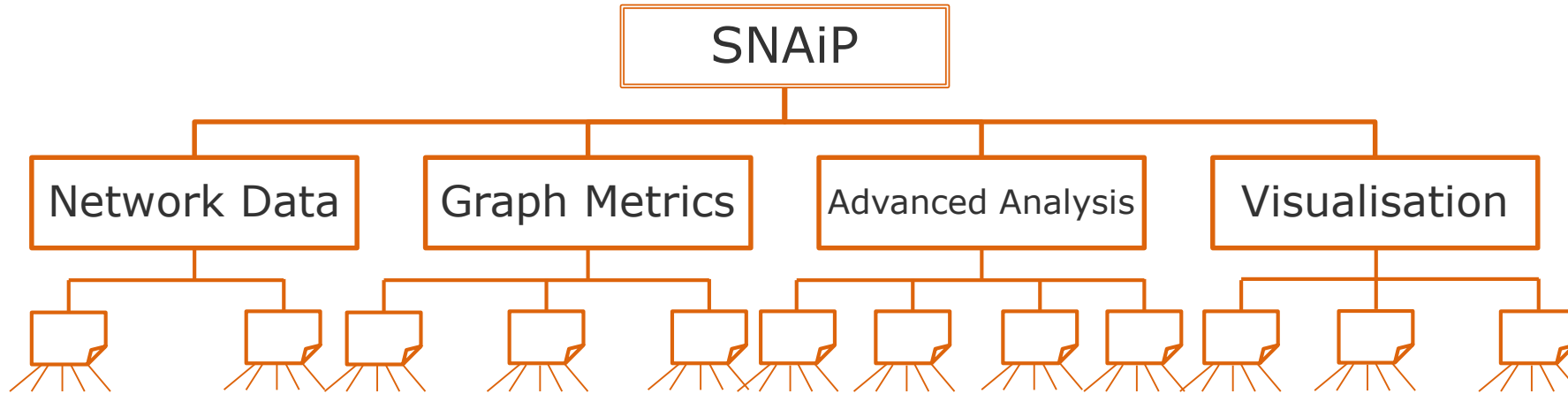
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<sup>1</sup><https://www.acm.org/publications/proceedings-template>

# Seminar Philosophy

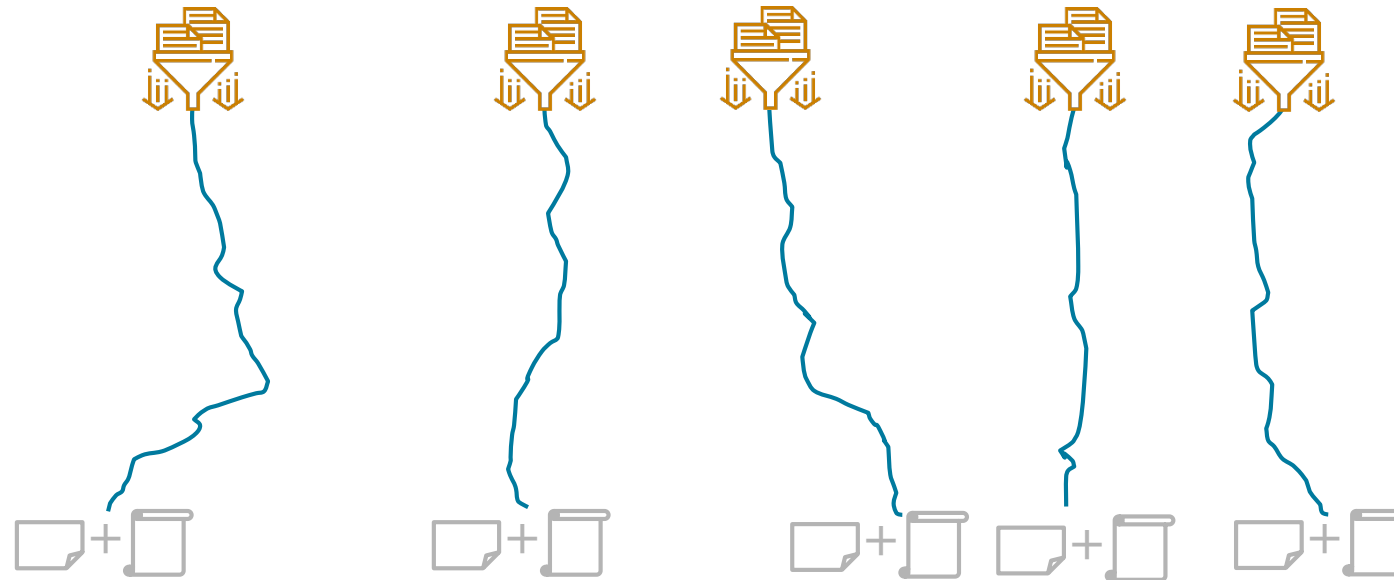


**Talks**  
(breadth first)

**Exploration**

**Projects**  
(depth first)

**Talks & Papers**  
(bringing things together)



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- 30% „Chapters of SNA“ presentation (individual)
- 70% Project
  - 40% Project result (group<sup>1</sup>)
  - 15% Final presentation (group<sup>1</sup>)
  - 15% Paper (individual)

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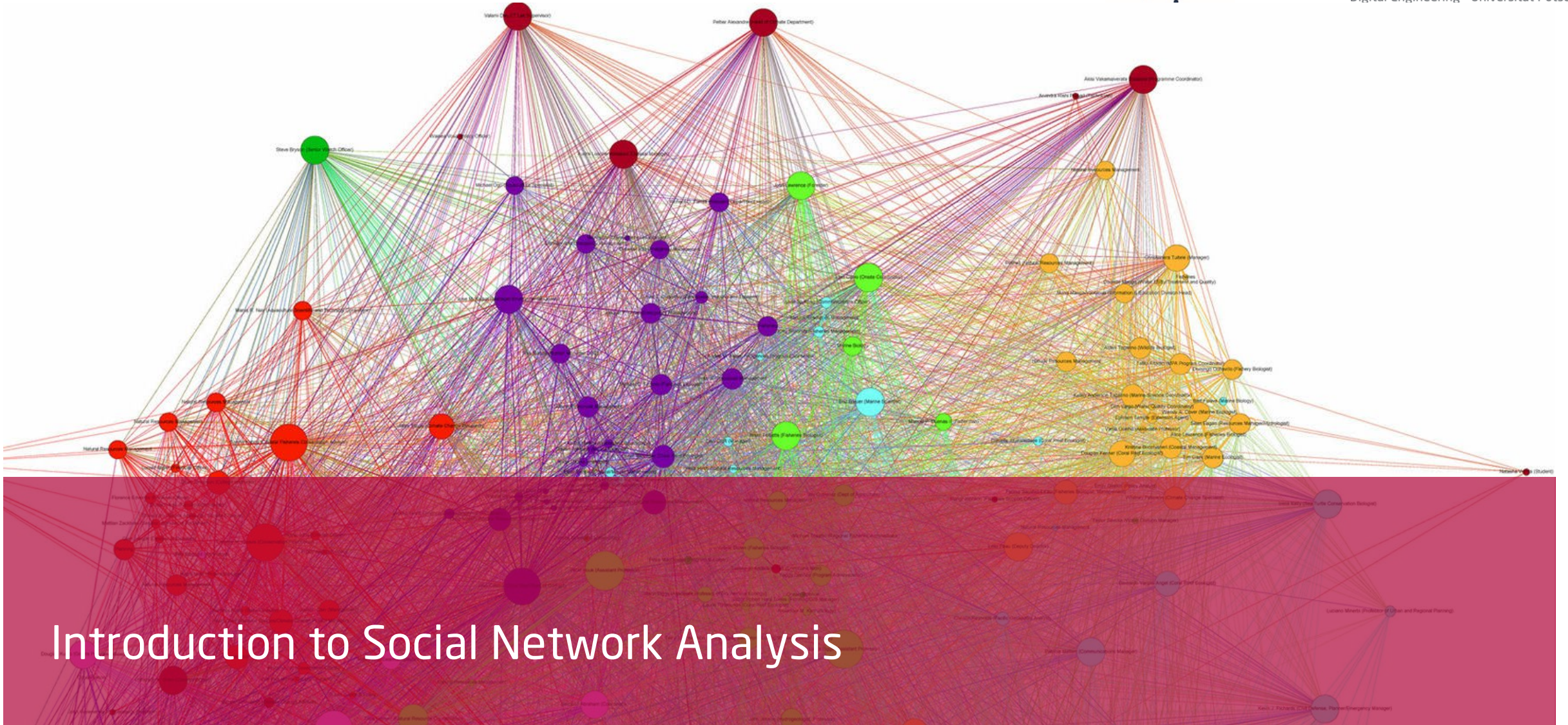
<sup>1</sup>Everyone in the group gets the same grade

# Questions so far?



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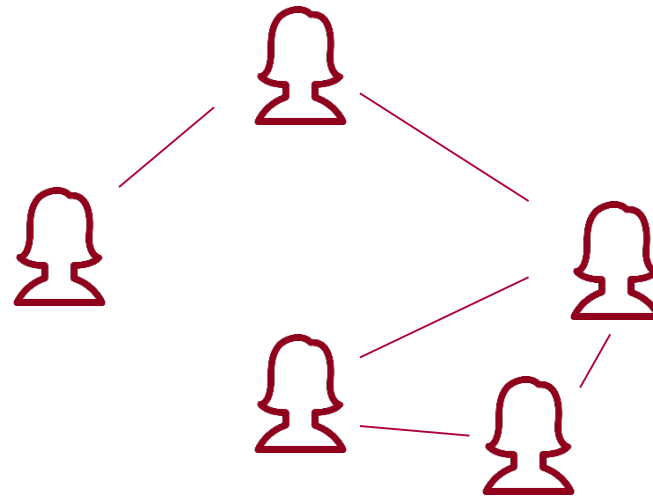
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# Introduction to Social Network Analysis

# What is a Social Network?

- Set of actors
  - E.g. people
- Set of ties
  - Friendships
  - Follows, likes,...
- Research in sociology, economics, maths, computer science
  - Detect salient structures
  - Extract knowledge, reduce data
  - Analyse social behaviour



## What is a Social Network? (cont.)

---

- Nodes can be individuals or collectives (or both)
  
- Relations can be
  - Similarities
    - Same location, same time
    - Same attribute (e.g. gender or association)
  - Roles (mother of, friend of, ...)
  - Cognition (knows, likes, ...)
  - Interaction/events (emails, posts, retweets,...)
  
- Heterogeneous data
  - Attributes at nodes or edges (text, time, location,...)

# Why Social Network Analysis?

---

- Actors affect each other
- Analyse diffusion
  - Epidemiology (patterns of disease transmission)
  - Information (social influencer, ...)
- Business
  - Marketing, Opportunities, Market segmentation
  - Optimise internal operations
- Investigation
  - Uncover crime and corruption
  - Data-journalism, audit, ...

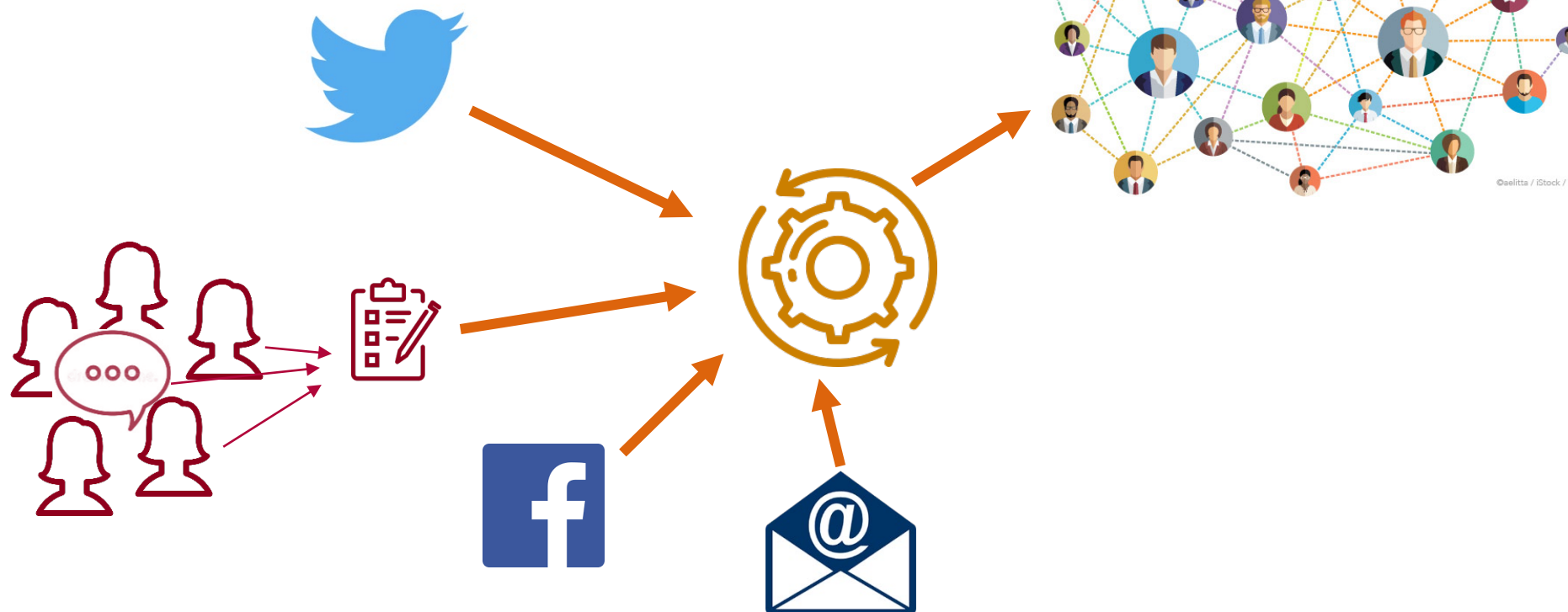
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# General

## - Data acquisition and preparation

- Where does data come from?
- What data to collect?
- How to form hypotheses?
- How to limit the collected data?



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# General

## - Data interpretation

- How to deal with boundaries of collected data?
- How to interpret non-existing links?
- Where do errors come from?
- How to filter data for analysis?
- How to measure the error of filtering and selecting?



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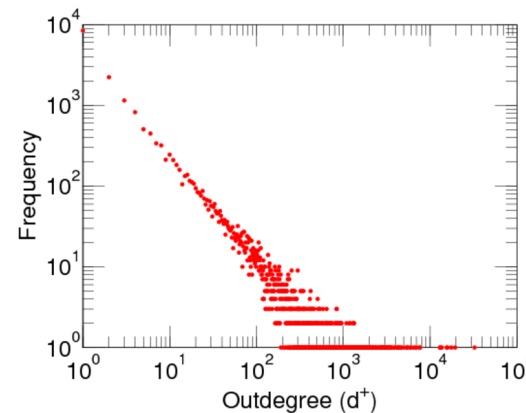
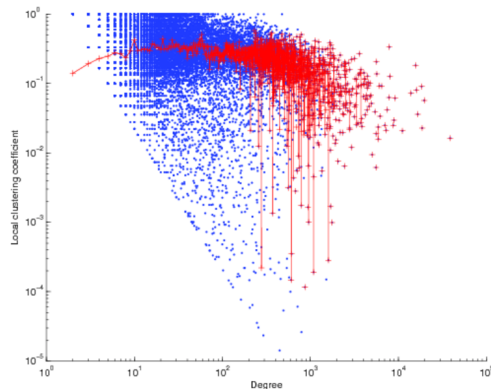
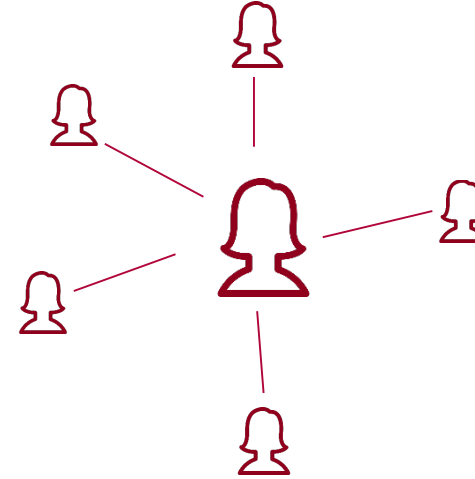
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# Measuring Graphs

## - Node/dyad-level metrics

- How can **nodes** be described?
  - Distance to one another
  - „Importance“ of a node
    - Connectivity
    - Centrality
- Rank, filter, compare nodes



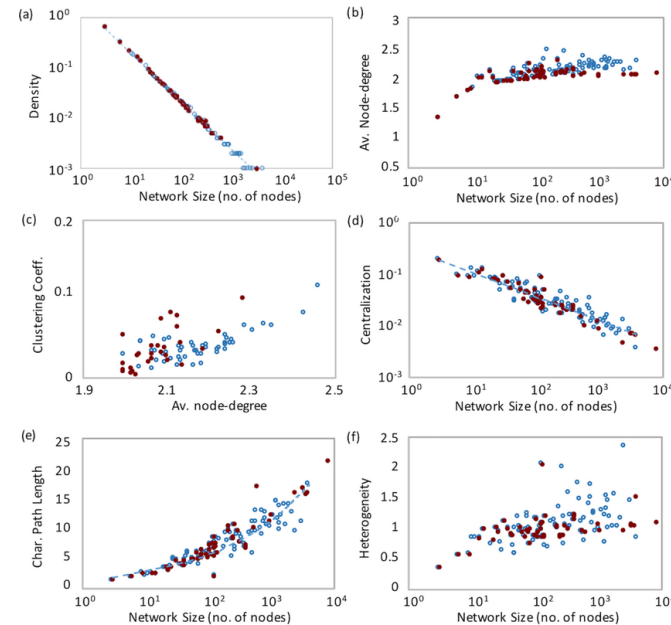
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# Measuring Graphs

## - Dyad/group-level metrics

- How can **relations** or the **entire graph** be described?
  - Within-group connectivity
  - Clustering coefficient
  - Effective aggregation of node measures
- Higher level of analysis
- General insights



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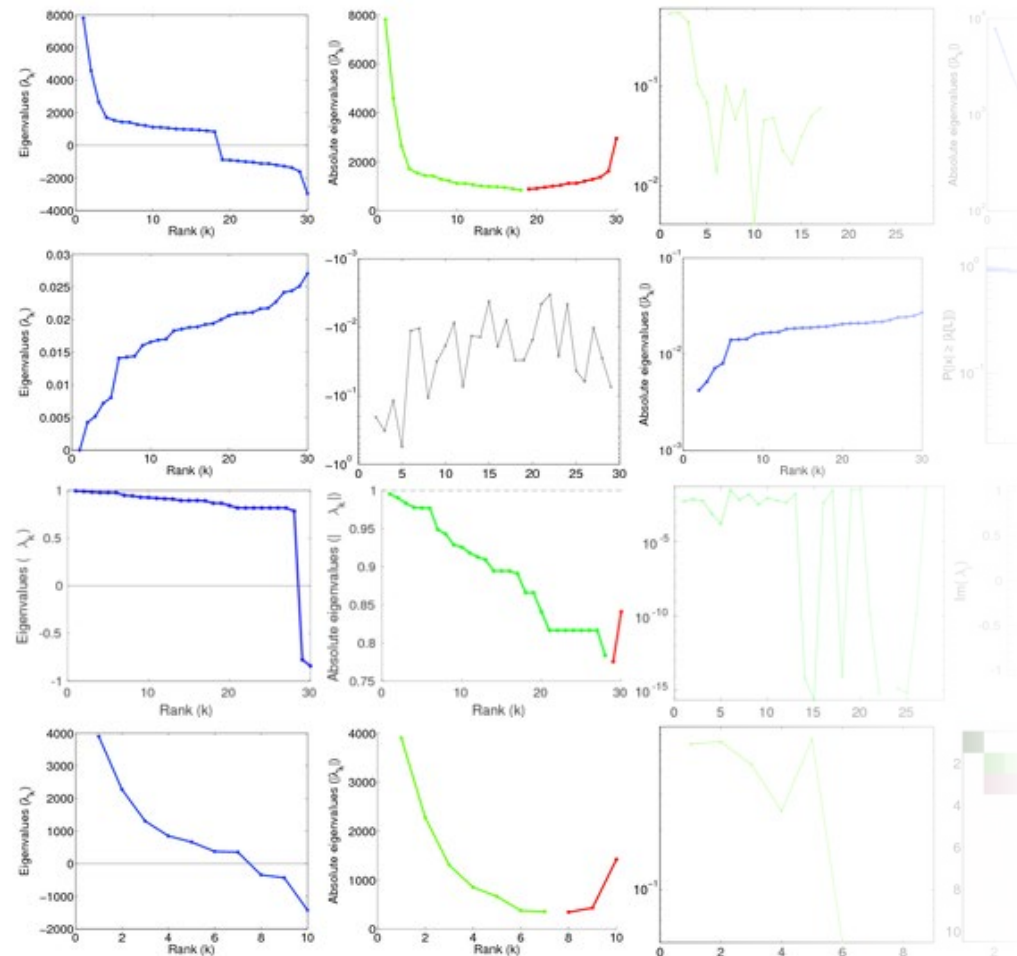
# Measuring Graphs

## - Interpreting metrics

### Statistics

[Size](#)  
[Volume](#)  
[Unique edge count](#)  
[Loop count](#)  
[Wedge count](#)  
[Claw count](#)  
[Cross count](#)  
[Triangle count](#)  
[Square count](#)  
[4-Tour count](#)  
[Maximum degree](#)  
[Maximum outdegree](#)  
[Maximum indegree](#)  
[Average degree](#)  
[Fill](#)  
[Average edge multiplicity](#)  
[Size of LCC](#)  
[Size of LSCC](#)  
[Relative size of LSCC](#)  
[Diameter](#)  
[50-Percentile effective diameter](#)  
[90-Percentile effective diameter](#)  
[Median distance](#)  
[Mean distance](#)  
[Gini coefficient](#)  
[Reference: konect.cc/enron-rm/](#)

$n = 87,273$   
 $m = 1,147,126$   
 $\bar{m} = 321,288$   
 $l = 13,080$   
 $s = 49,130,407$   
 $z = 13,799,850,890$   
 $x = 3,784,732,758,298$   
 $t = 1,178,289$   
 $q = 92,655,137$   
 $T_4 = 938,356,410$   
 $d_{\max} = 38,778$   
 $d_{\max}^+ = 32,613$   
 $d_{\max}^- = 6,165$   
 $d = 26.2882$   
 $p = 4.23495 \times 10^{-5}$   
 $\bar{m} = 3.57040$   
 $N = 84,220$   
 $N_s = 9,160$   
 $N_s^r = 0.104958$   
 $\bar{\delta} = 14$   
 $\bar{\delta}_{0.5} = 4.38396$   
 $\bar{\delta}_{0.9} = 5.79471$   
 $\bar{\delta}_M = 5$   
 $\bar{\delta}_m = 4.89080$   
 $G = 0.907479$   
 $D = 0.400885$



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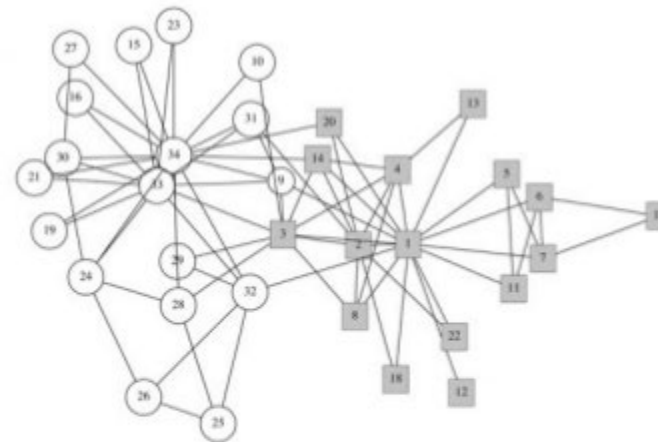
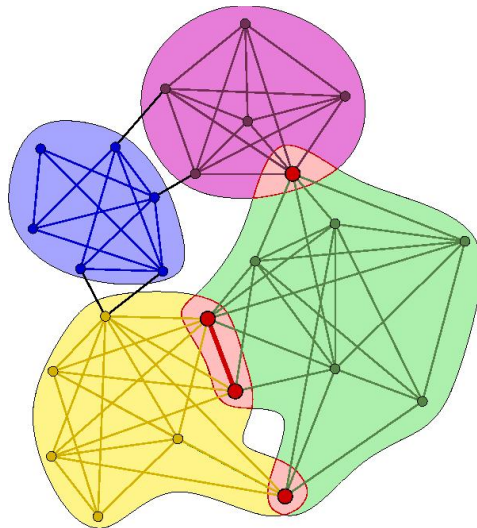
<sup>1</sup><http://konect.cc/networks/enron-rm/>

# Advanced Analysis

## - Community detection & clustering

Keywords:

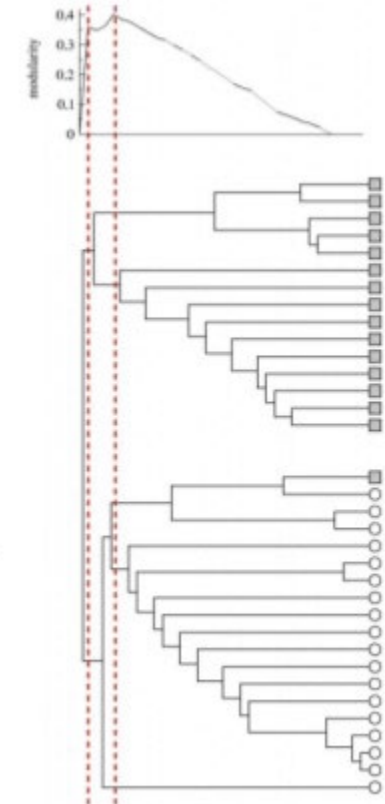
- Community Detection
- Node Clustering
- Graph Segmentation



Optimal community structure for Zachary's karate club.



Modularity without recalculating



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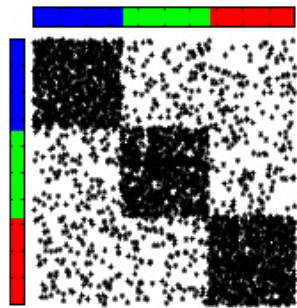
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- Grivan and Newman. *Community structure in social and biological networks*. PNAS 2002

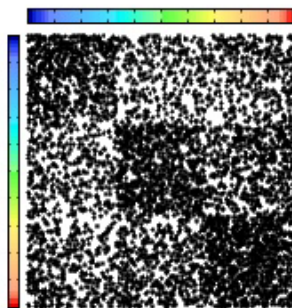
# Advanced Analysis

## - Mixed membership models

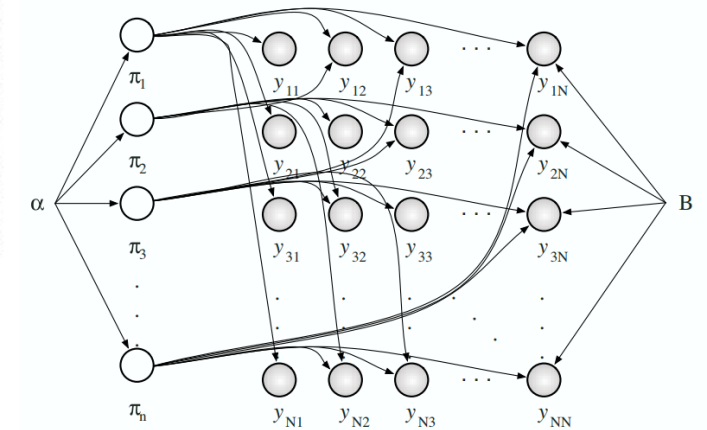
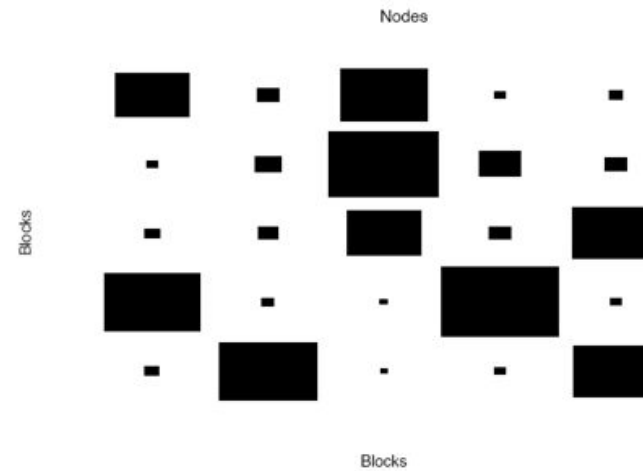
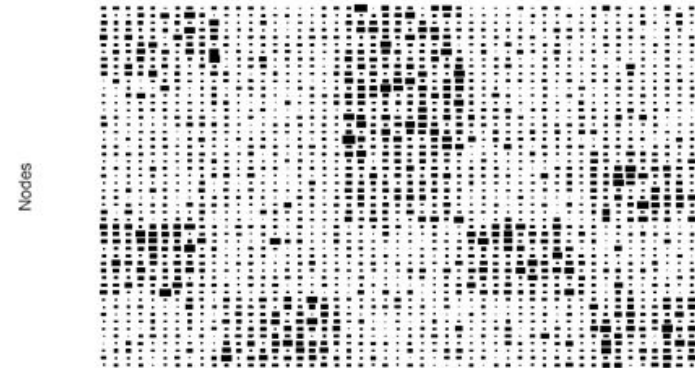
- Stochastic Block Models
- Mixed Membership Models



Non-overlapping



Overlapping



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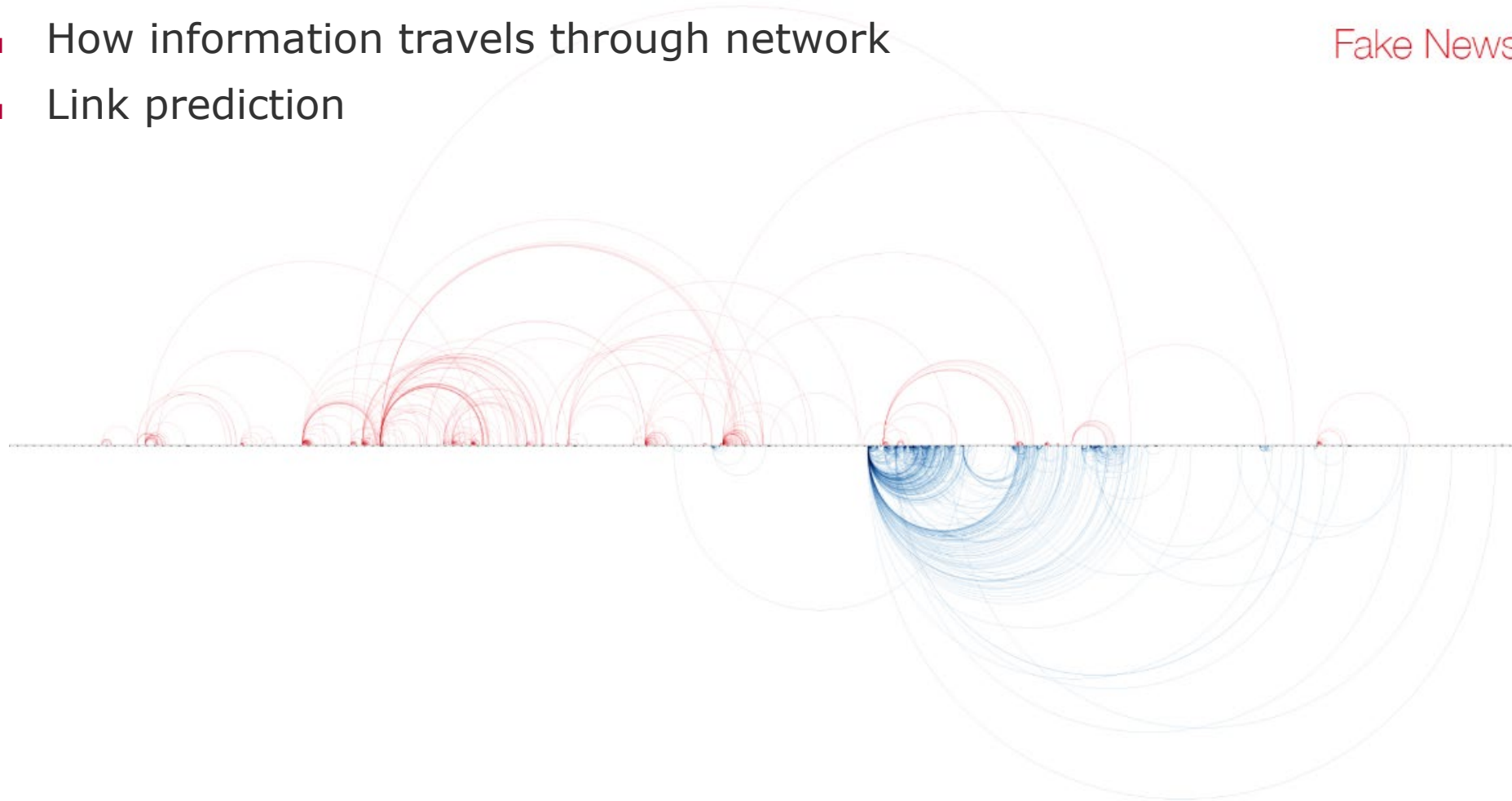
- Blei et al. *Mixed Membership Stochastic Blockmodels*. JMLR 2008
- Williams et al. *Mixed Method Social Network Analysis*. ORM 2015

# Advanced Analysis

## - Information diffusion

- How information travels through network
- Link prediction

Fake News



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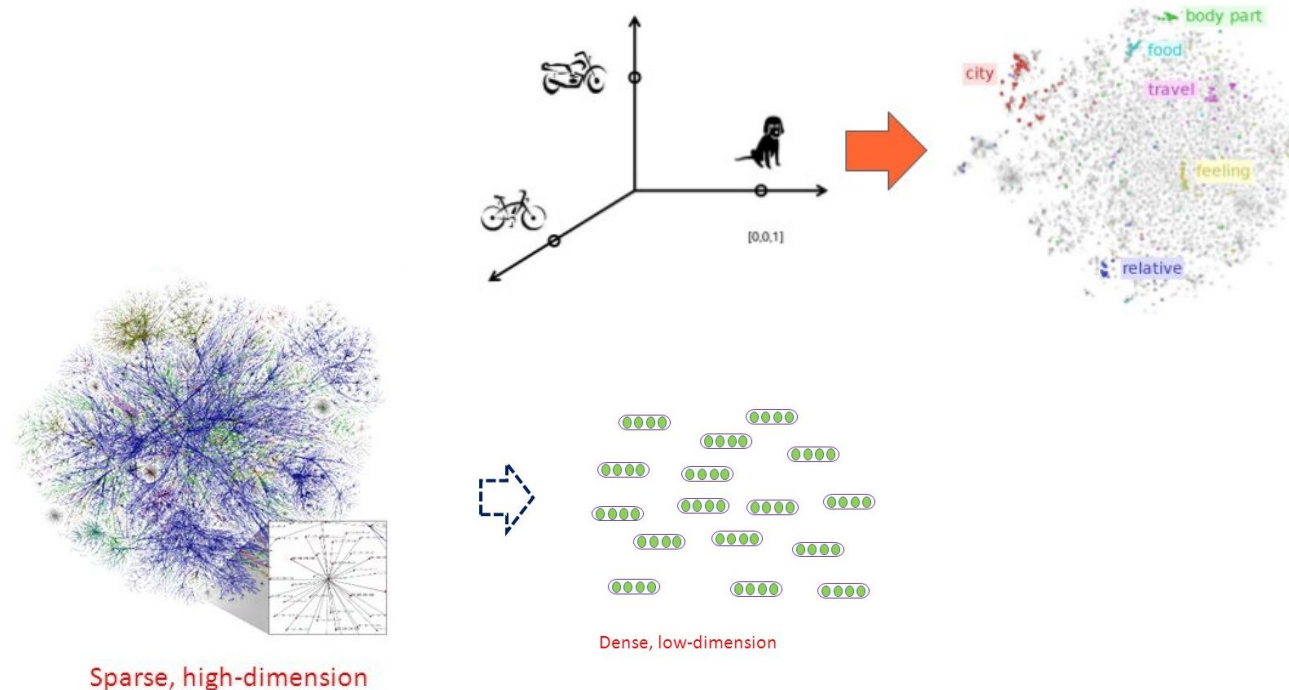
30

Gegendarstellung

# Advanced Analysis

## - Graph/node embeddings

- Node similarity
- Node classification
- Community embedding
- Graph embedding



- Tsitsulin et al. *VERSE: Versatile Graph Embeddings from Similarity Measures*. WWW 2018
- Anton Tsitsulin et al. *NetLSD: Hearing the Shape of a Graph*. KDD 2018
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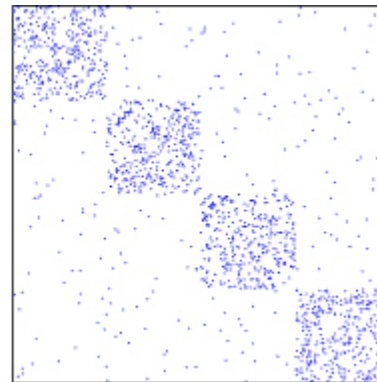
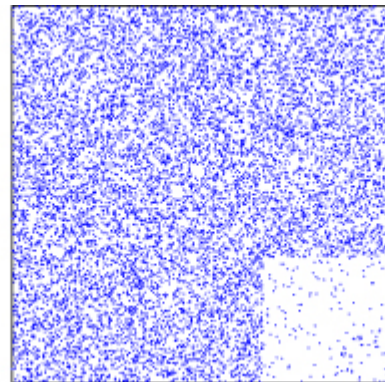
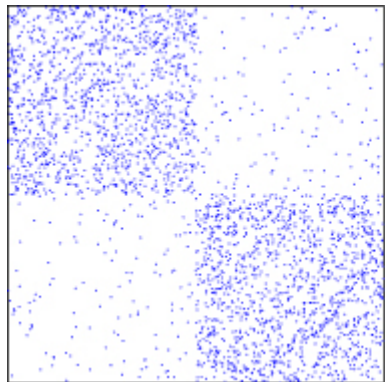
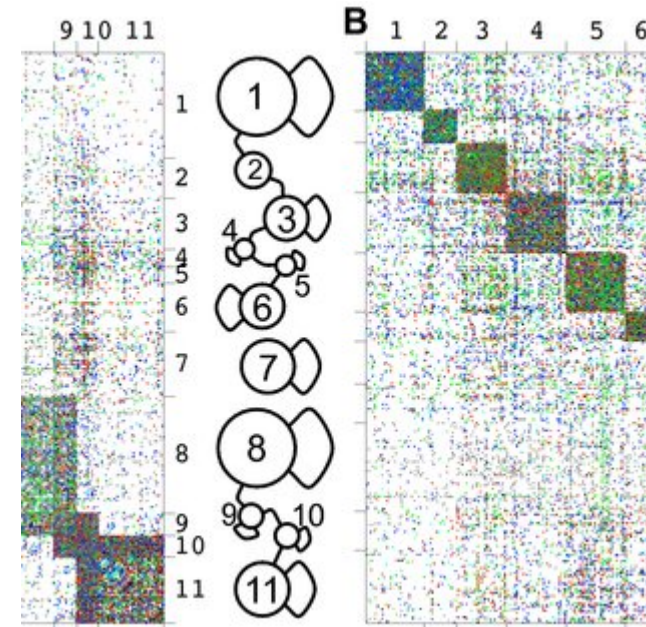
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# Network visualisation

## - Matrix-based visualisation

- Visualise network adjacency matrix
- How to utilise block models
- Incorporate time aspects
- Colouring points effectively



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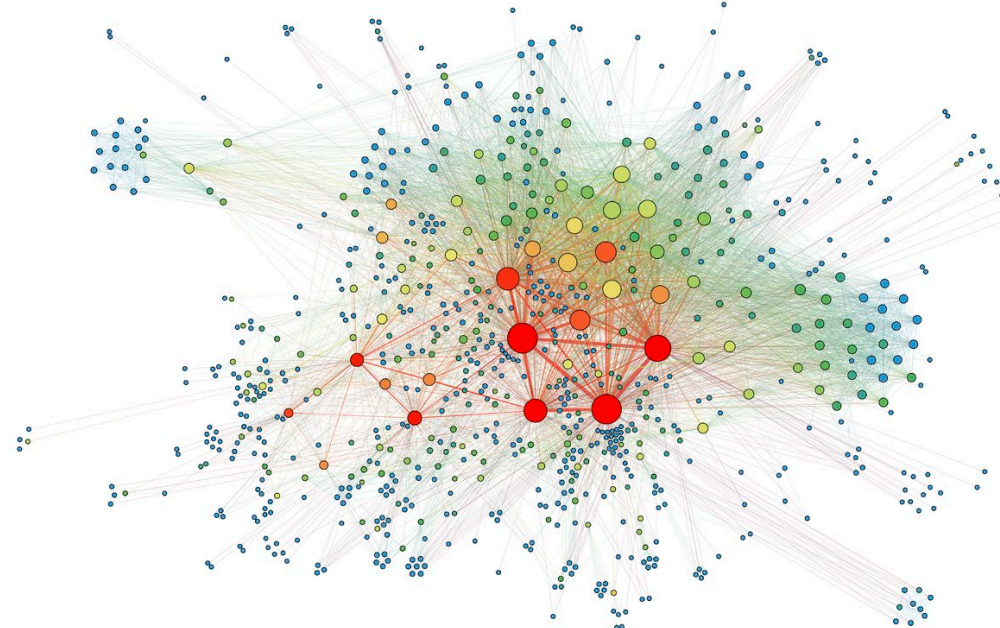
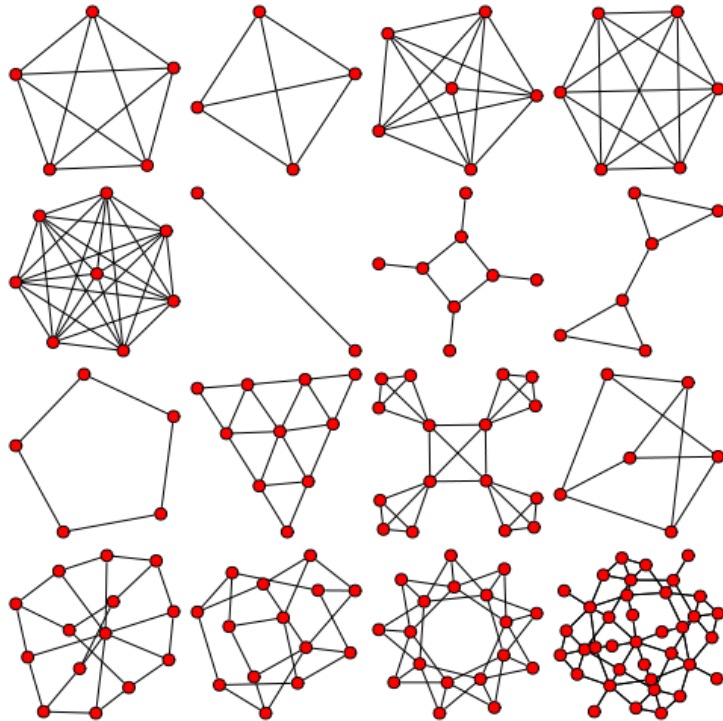
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# Network visualisation

## - Traditional visualisation/graph layout

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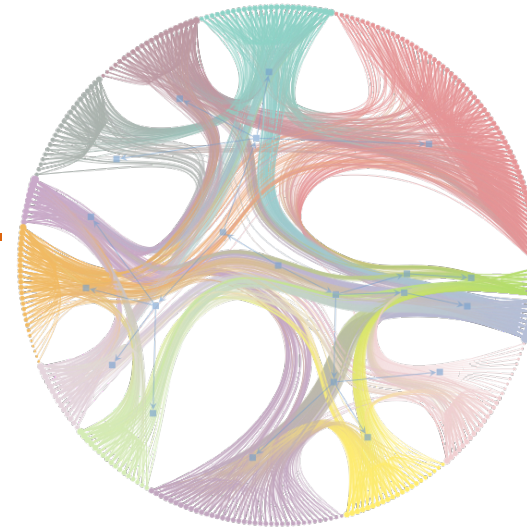


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# Network visualisation

## - Dynamic and advanced visualisation



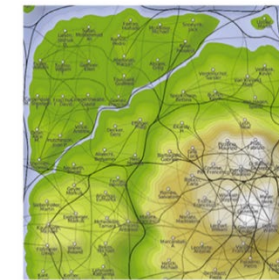
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- Efrat et al. *MapSets: Visualizing Embedded and Clustered Graphs*. JGAA 2014
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(a) Skupin, 2004b

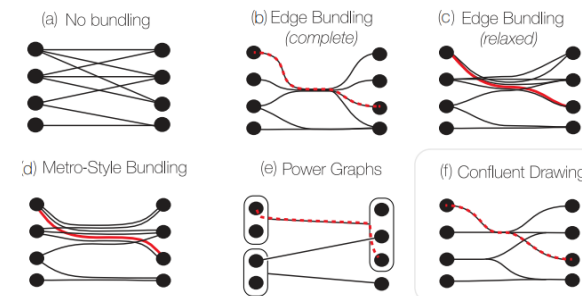


(b) Mashima et al., 2012

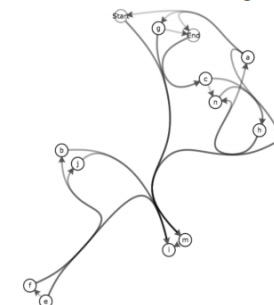


(c) Gronemann and Jünger, 2013

### Edge Bundling Methods



### Confluent Drawing



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# I'm here to help!

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- Don't hesitate to email or visit me if you need help!
- If something bothers you – take action!
  - *Constructive* criticism warmly welcome
  - Tell me (*explicitly!* I don't understand indirect feedback...)
  - If you don't want to talk to me personally, please communicate anonymously through the FSR

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Slides and Material online<sup>1</sup>



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<sup>1</sup><https://hpi.de/naumann/teaching/teaching/ws-1819/social-network-analysis-in-practice-ps-master.html>

# Fin

## - Remember to send preferences



Date	Topics
17.10.2018	Introduction
24.10.2018	
31.10.2018	
07.11.2018	<b>Introduction to Social Network Data</b> <ul style="list-style-type: none"><li>Data acquisition and preparation</li><li>Data interpretation</li></ul>
14.11.2018	<b>Introduction to Measuring Graphs</b> <ul style="list-style-type: none"><li>Node/dyad-level metrics</li><li>Dyad/group-level metrics</li><li>Interpreting metrics</li></ul>
21.11.2018	<b>Introduction to Advanced Analysis</b> <ul style="list-style-type: none"><li>Community detection and clustering</li><li>Mixed membership models</li><li>Information diffusion</li><li>Graph/node embeddings</li></ul>
28.11.2018	<b>Introduction to Network Visualisation</b> <ul style="list-style-type: none"><li>Matrix-based visualisation</li><li>Traditional visualisation/graph layout</li><li>Dynamic and advanced visualisation</li></ul>

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- <https://onlinelibrary.wiley.com/doi/abs/10.1002/spe.4380211102>
- <http://faculty.ucr.edu/~hanneman/nettext/>
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- <http://www.thenetworkthinkers.com/>
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