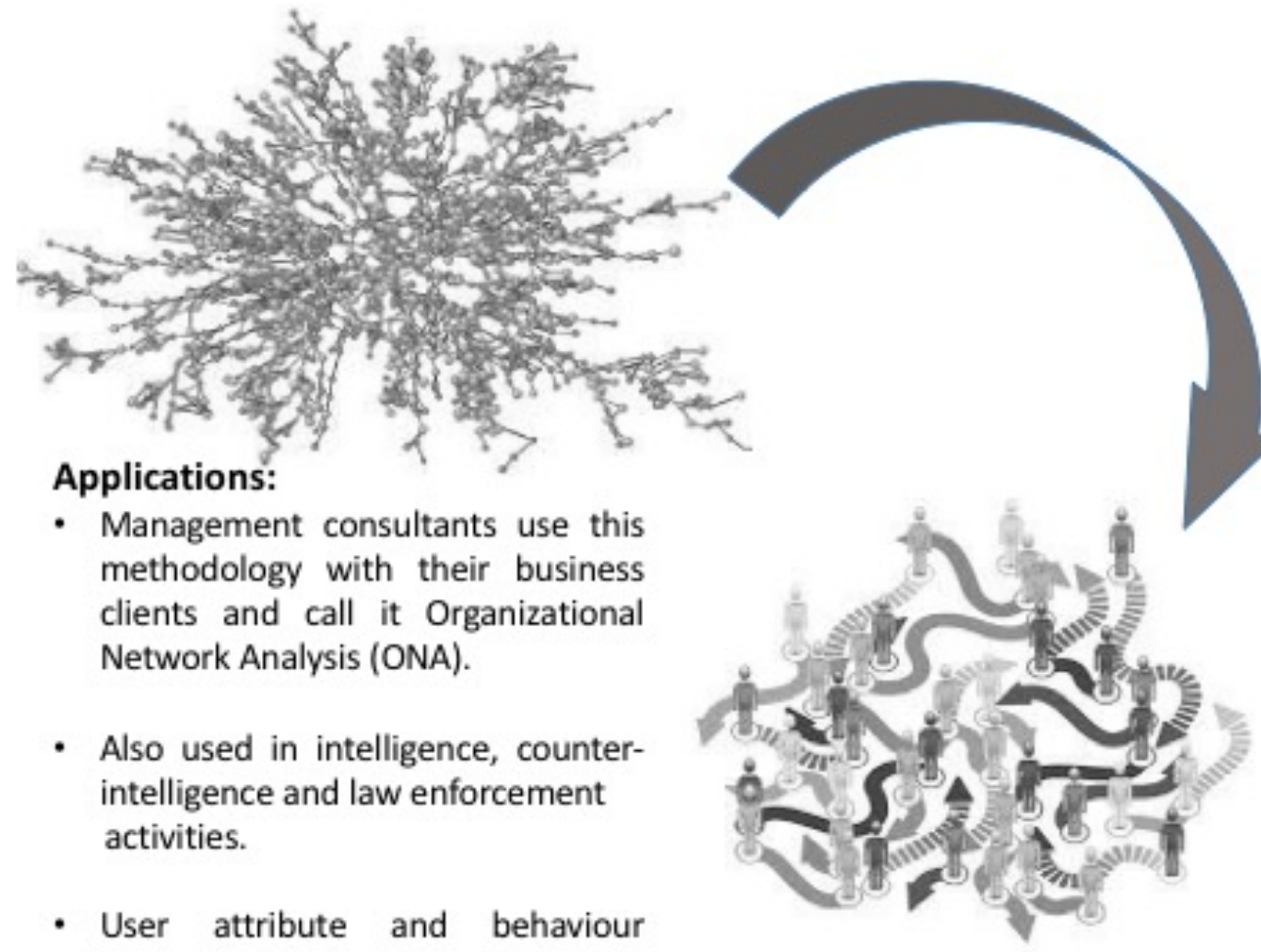


QUANTITATIVE METHODS

Social Network Analysis (SNA)

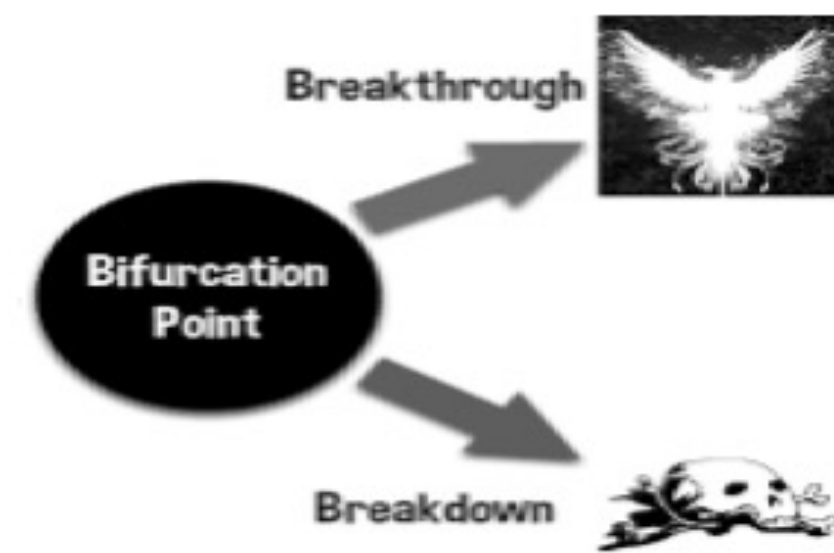
- A network is characterized in terms of nodes (individual actors, people, or things within the network) and the ties or edges (relationships or interactions) that connect them.
- SNA investigates the relationships between entities of a structured network and information flows within a network.
- It provides both a visual and a mathematical analysis of human relationships.



Applications:

- Management consultants use this methodology with their business clients and call it Organizational Network Analysis (ONA).
- Also used in intelligence, counter-intelligence and law enforcement activities.
- User attribute and behaviour analysis.

Bifurcation Analysis



- Bifurcation occurs when a slight change in parameter values causes a drastic, qualitative change in the system's behaviour, with the structure of its phase space topologically altered.
- Parameter values that cause a bifurcation are called the critical thresholds.
- Bifurcations occur in both continuous systems and discrete systems. However, for bifurcation analysis, continuous-time models are actually simpler than discrete-time models.
- Bifurcation analysis has proven to be a powerful method for understanding the qualitative behaviour of gene regulatory networks.

QUALITATIVE METHODS

method

result



- Comparative Analysis**
relation between systems or between parts of the same system, similarities and differences
- Ethnographical Methods**
description of complex system based on observation (of a group - behavior, relations, interactions) providing "shortest message" to describe essence of complex phenomena
- In-depth Interview + Phenomenological Analysis**
interactions, relations, structures, meanings, context
- Documents and Text Analysis**
divergent results of many aspects of a complex issue
- Visual Analysis**

Understanding Social Complexity

Complexity in social context can be approached from various view points. Here we have collected methods we would use in our research.

Peter, Tiia, Beenish, Mikko and Enrique

DATA DRIVEN METHODS

Web scraping gives you data that you can put into models to achieve understanding of social complexity.

The purpose of web scraping is to gather data from web pages.



This is done by creating a program in which the researcher (or his/her nerdy assistant) defines where, what and how the data is gathered and stored.

The result: massive amounts of data, possibly continuously changing itself.



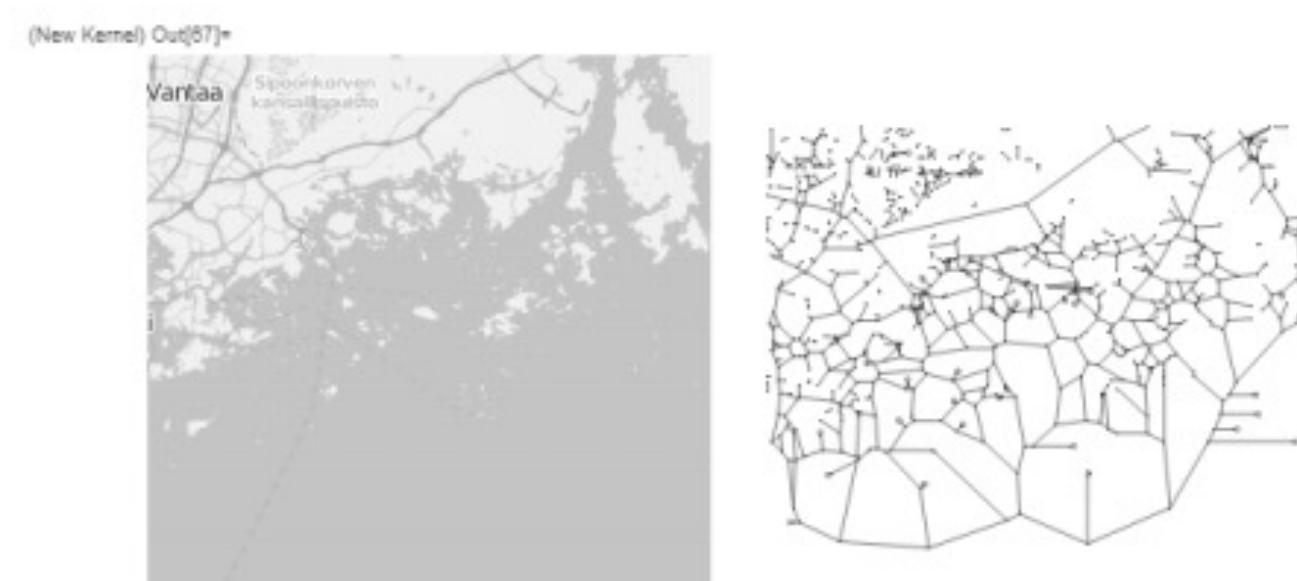
Examples of usage for the data

- Live research:** Feed a model of the number of posts relating to a given topic on twitter timelines around the world with real-time streaming data
- Topic modeling:** Collect news articles for a year and see what the most common topics have been in different months
- Price development:** Follow the stickiness of prices of online retailers' products
- Creativity is the limit!**

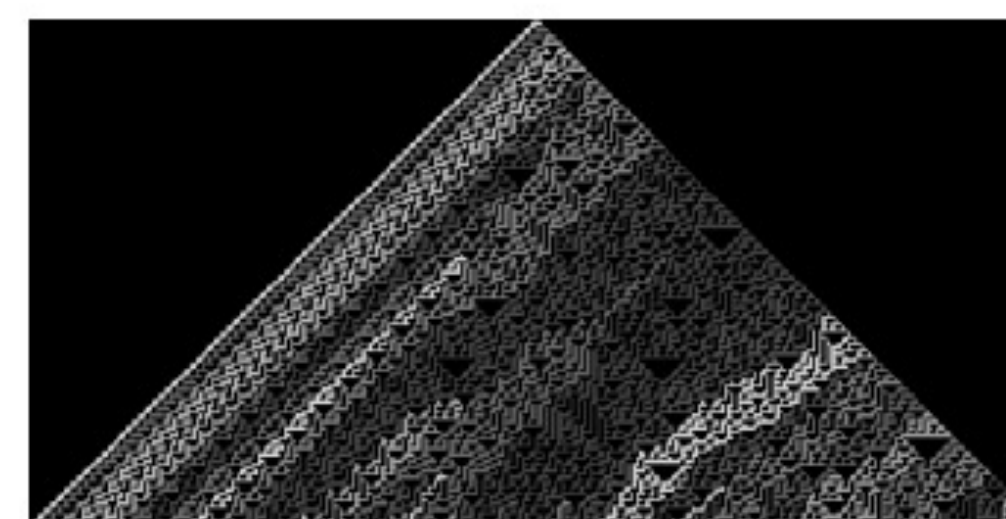
Mathematical methods in complex systems

- Scaling laws (fractals, trees, renormalization, multigrid)
- Nonlinear feedback iteration maps, chaos theory, amplification, dissipation
- Mathematics of pattern formation: local activation and long range inhibition
- Mathematics of multiple stable sets: random frustration, spin glass, random Boolean nets, attractor networks
- Algorithmic complexity, description complexity: Kolmogorov complexity
- Response complexity

Urban road network analysis (Mathematica example – Helsinki – 5 km across)



A cellular automaton with colored complex components



AGENT-BASED MODELLING TOOLS

- For entry-level**
 - Excel + VBA: Available, relatively easy, for initial testing
- Next Steps**
 - NetLogo - Simple Integrated Development Environment (IDE)
 - Eclipse - IDE with scalability
 - Swarm, RePast, MASON – Library-based tools
 - AnyLogic, Repast Syphony, etc. - Combination of IDE & Libraries
- Computational Mathematics**
 - Matlab, Mathematica
- Languages**
 - C, C++, Java, Python

SELECTING A MODELLING TOOL

- How to specify the model?
- How to specify agents?
- How to input data to the model?
- How to execute the model?
- How to store the results?
- How to analyze and visualize results?
- How to distribute and share you model?

The more complicated model, the more advanced tools are needed