

# Statistical Network Analysis

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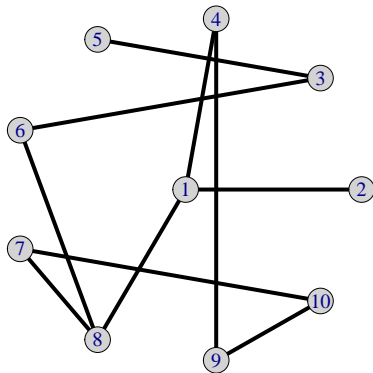
# What is a network?

A network (also called graph) is a purely formal representation consisting of a collection of **nodes** and associated **links**.

**Example of nodes:** persons, places, firms, countries, web pages, email addresses, electrical power stations, molecules,...

**Example of links:** trades, marriages, citations, letters sent, contiguity, group memberships, airline connections, friendships,...

# Visualization



**Figure:** Example of a simple statistical network

# Examples of networks

- Technological applications
  - ▶ Transportation networks
  - ▶ Energy networks
- Social networks
  - ▶ friendships
  - ▶ memberships of people in clubs or companies
  - ▶ contacts between people
- Biological networks
  - ▶ regularity behaviour among genes
  - ▶ bindings among proteins
  - ▶ epidemiological networks

# Typical Questions

- What are the structural characteristics of the network?
- How much traffic is flowing across the network?
- Which nodes are the most influential ones in the network?
- Is the graph clustered (i.e. are there groups/cliques in the network)?
- Is the network behaviour as expected?
- How can we measure the network dynamics?
- How can the relationships be modeled?

## Some topics that will be discussed

- Concepts for representing networks
- Components and families of (sub)graphs
- Measuring network characteristics
- Incidence matrix and Graph Laplacian
- Cohesiveness and clustering over networks
- Centrality measures
- Network models

# Literature

- Kolaczyk, E. & Csardi, G. (2014): *Statistical Analysis of Network Data with R*, Springer.
- Newman, N. (2018): *Networks*, Oxford University Press.
- Salter-Townshend, M., White, A., Gollini, I., & Murphy, T. B. (2012): *Review of statistical network analysis: models, algorithms, and software*, *Statistical Analysis and Data Mining*, 5(4), 243-264.