

## Summer School on Operational Research and Applications

### **Network clustering: from models to methods**

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Networks are a basic and versatile tool for the study of complex systems in a variety of domains. This includes modeling of social networks, telecommunication networks, transportation networks, and many more. The mathematical representation is based on graphs, where typically vertices are associated with the entities of the system under study, and edges express whether a relation defined on all pairs of vertices holds or not for each such pair.

A modular structure characterizes many complex systems, meaning that they contain subgroups of entities sharing some common properties. A topic of particular interest in the study of complex networks is therefore the identification of modules, also called clusters or communities. Intuitively, a cluster of a graph is a subset of vertices such that there are more edges within the cluster than edges joining it to the outside. This concept has been refined in many ways, leading to the introduction of various definitions of network community and clustering criteria, as well as algorithms to find partitions of networks.

In this context, we will discuss

- basics of networks theory
- examples
- measures and criteria for the identification of communities
- fundamentals of network clustering algorithms
- mathematical programming and optimization in network clustering