Being connected to a network becomes more and more basic requirement for people as well as for even simple devices. Examples of networks include: telecommunication networks, electricity networks, water supply, and road systems. When deciding about the actual connections in a network, one typically looks for solutions that provide sufficient connectivity at the minimal possible cost. An additional challenge is to handle dynamically changing demand for connectivity services or to provide resiliance against failures of network elements. In this project we will study algorithms that can help to design a network by suggesting for which pairs of objects there should be a direct connection.

The real world scenarios of network design can be mathematically modeled in terms of graphs, in which vertices correspond to physical locations (of clients, servers, etc.) and edges represent the possibility of establishing a direct connection between pairs of locations. A typical setting boils down to selecting a proper subset of edges of the input graph. We analyze the mathematical models capturing all possible instances of the studied optimization setting rather than dealing with individual instances from a specific application. The main challenge to cope with is the combinatorial complexity, i.e., there are exponentially many subsets of edges constituting potential solutions. A common research question of our interest is: how good solution can be found with a computation that takes only polynomial time?

In parallel, we will focus on two settings notivated by handling uncertainty in network desigh: 1) Providing sufficient connectivity that guarantees robustness agains a failure of a small number of elements. 2) Providing solutions that handle dynamic demand for connectivity.