

Design of Distributed Algorithms in Highly Congested Networks

In traditional models of distributed computing, many devices (computers) cooperate in order to solve an algorithmic problem and communicate through physical network of direct connections. Appropriate algorithms allow for coordination of nodes of the network to accelerate computation. This poses nontrivial problems of appropriate synchronization, load balancing and data transmission over communication links. Ubiquitous contemporary applications of information technologies go beyond this traditional models of distributed computations.

In particular, several devices have to share the same communication medium (*channel*) in wireless communication. Applications of wireless tools in sensor networks, Internet of Things or emerging 5G networks add more factors which are not taken into account in classic models of distributed computing, e.g. limited capabilities of devices, energy consumption, interferences and others.

Contemporary fast communication channels allow for efficient virtual direct connections, even if physical direct connections are not available (overlay networks). Similarly, computers in data centers can quickly exchange information (of limited size). The key challenge in such scenarios is not in finding paths for data delivery in communication networks, but appropriate techniques of sketching huge data stored in nodes and exchange information to provide efficient load balancing.

The main objective of the project is to design fast algorithms for described above scenarios, adjusted to limitations of particular models and applications. Our results will address challenges which appear in ad hoc wireless communication as well as in highly congested dense networks. Our algorithmic techniques will complement progress in hardware design.

Apart from research on distributed algorithms for particular networked environments, we will develop mathematical structures which turned out to be (and still are) important tools for design of distributed algorithms. In particular, we will consider generalizations of broadly applicable group testing framework, introduced in 1940s as a tool for identifying a group of ill individuals with small number of laboratory tests.

Research direction and problems considered in the project are intensively studied in leading academic IT research centers, potential solutions will require new algorithmic methods with prospective broad applicability in computer science. At the same time, the problems are scientifically challenging and intriguing.

Our research is mainly located in algorithmic research, where properties of all algorithms should be confirmed by precise mathematical proofs. Similarly, the interest is also in formal impossibility results showing limitations of certain technologies or difficulty of problems.