T-79.192 Seminar on Distributed Algorithmics (Autumn 2002)

The network computing and communication models underlying distributed systems give rise to new opportunities and challenges also in the fields of algorithm design and analysis.

Modern algorithmics has developed a sophisticated set of tools for tasks such as approximate solution of hard combinatorial optimisation problems [6, 12], efficient computation of network flows and other digraph characteristics [3], speeding up algorithms by randomisation [8], and the design and analysis of computational methods in an "online" setting where the input stream unfolds as the computation proceeds [2, 5].

While traditional sequential algorithm design is already a rather mature discipline, the novel requirements of the distributed environment — especially in systems such as mobile ad hoc networks [10] — place heavy emphasis on many design parameters that have only recently begun to be addressed in the literature. Firstly, the computation and communication substrata change in this setting from the traditional centralised, stable, and reliable models to being decentralised, mobile, and susceptible to faults. Secondly, new system design objectives and constraints arise from the properties of the participating nodes, when e.g. their mobility, or the limitations on their battery life and signal strength need to be taken into account. In addition to the response time and throughput of a system one now needs to consider also its fault-tolerance, energy-intensity and signal-locality characteristics. Furthermore, the computation nodes may be noncollaborative and distrustful of each other.

Despite all these differences, the fundamental models and techniques of algorithm design can be adapted to provide a solid methodology also in the distributed setting, and this area of research is currently the focus of intense attention in the theoretical computer science community. For instance, Rajaraman [11] surveys some recent analytic work in the topology control and routing in ad hoc networks, while Meyer auf der Heide et al. [7] perform a geometric graph-theoretic analysis of the congestion-energy-delay tradeoff in a simplified network model, and Dolev et al. [4] design randomised self-stabilising algorithms for establishing group communication services even in the case where the agents can be mobile and faulty. Papadimitriou [9] discusses game-theoretical approaches to bringing a collection of selfish nodes to collaborate on a networked computation or communication task. The study of such analytically well-founded algorithmic work is the goal of our seminar.

References

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