Computing and Markets

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Abstract. The seminar Computing and Markets facilitated a very fruitful interaction between economists and computer scientists, which intensified the understanding of the other disciplines' tool sets. The seminar helped to pave the way to a unified theory of markets that takes into account both the economic and the computational issues—and their deep interaction.

Keywords: algorithms, complexity, game theory, social choice, auctions, equilibrium.

Markets are institutions used by economic agents to trade goods. Progress in information and communication technologies, in particular the development of the Internet, have changed the way information is shared amongst market participants, how market clearing is organized, and last but not least, who is aware of and has access to a particular market. Internet auctions, like eBay, provide a prominent example. Industrial applications like supply chain management and procurement auctions challenge computer scientists by their need for complex negotiation and clearing protocols. In recent years this has stimulated a plethora of computer science research in market design, in particular for combinatorial auctions.

The infrastructure underlying this development, the Internet with its services for communication and content, becomes itself a huge market with millions of agents sharing resources like bandwidth, server CPU cycles, memory, and content. The performance of such systems depends not only on their implementation, but more and more on the behavior of its users. Therefore, analysis and design of information systems need to incorporate a game-theoretic analysis in order to accurately predict system performance. Central to such analysis is the notion of independent agents which act selfishly in order to maximize their own utility. The implementation of the system defines the rules of a game. Game

theory provides us with the tools to analyze the behavior of agents in such environments. Agents themselves can again be computerized in the form of adaptive software agents, using learning techniques developed in AI to outperform other agents.

The Dagstuhl seminar *Markets and Computing* brought together researchers from Economic Theory, Game Theory, Artificial Intelligence, Theoretical Computer Science and Operations Research to present and discuss their approaches towards understanding the interrelation between advances in computing and the design of markets. The main threads of the seminar were the following.

A couple of sessions dealt with algorithmic issues arising in combinatorial auctions. We had sessions on the topics pricing in auctions and iterative auctions, analyzing the (pricing) information that can be efficiently provided during and after an auction, and the convergence of iterative auctions towards a pricing equilibrium. A session on discrete convexity presented the relation between this notion from discrete mathematics and the existence of particular pricing equilibria in combinatorial auctions.

Related to these topics were sessions on bidding and simulation. Important issues here were the implementation and experimental evaluation of bidding strategies, and experimental evaluation of efficiency and other market objectives under such bidding strategies.

A third thread of sessions dealt with mechanism design for particular market situations. One of these sessions investigated designs for online situations, in which bidders arrive over time, or supply of items changes over time. Other papers in this thread dealt with specific domains, approximate mechanism design, and automated mechanism design.

There was a thread of sessions with an emphasis on game-theoretic issues. A prominent topic there was the impact of selfish agents on system performance with respect to various performance measures. Finally we had sessions on social choice, dealing with the possibility of the design of mechanism with specific desirable properties.

Similar to previous Dagstuhl seminars on related topics, this seminar facilitated a very fruitful interaction between economists and computer scientists, which intensified the understanding of the other disciplines' tool sets, and which is likely to lead to joint research projects across the disciplinary borders. This seminar helped to pave the way to a unified theory of markets that takes into account both the economic and the computational issues—and their deep interaction.