Game theory and machine learning offer better bidding strategies

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(PhysOrg.com) -- By combining techniques from game theory and artificial intelligence, computer scientists at the University of Michigan have developed a better way to find the best bidding strategy in a simulated auction modeled after commodity and financial securities markets.

Michael Wellman, a professor in the Division of Computer Science and Engineering; and L. Julian Schvartzman, a doctoral student, will present their findings May 15 at the International Joint Conference on Autonomous Agents and Multiagent Systems in Budapest, Hungary.

The researchers say they've conducted the most comprehensive continuous double auction strategy study ever published. A continuous double auction is an ever-changing market in which bidders exchange offers to both buy and sell, and transactions occur as soon as participants agree on a price. This dynamic behavior is characteristic of the stock market, for example. And it makes such markets difficult for researchers to study and solve.

Analysts trying to "solve" such problems are seeking an equilibrium for the market. An equilibrium is a configuration of bidding strategies under which each participant uses the best strategy he or she can, taking into consideration the other participants' strategies.

Schvartzman and Wellman evaluated and tested all prior proposals for the best strategies, which include waiting until the last minute to bid,

randomly bidding, and taking into account the history of the bids of all participants.

To this evaluation they added a layer of artificial intelligence, or machine learning. The "reinforcement learning" technique they used enables a computer to, in essence, learn from experimenting with actions in a variety of situations to determine what overall strategy would work best.

"Nobody has put these techniques together before," Schvartzman said.

"One could take these techniques and apply them to real markets, not to predict specific price movements, but to determine the best bidding strategy, given your objectives," Wellman said.

This new combined method generated a more stable equilibrium candidate comprising stronger bidding strategies than any previously identified, the researchers say. The method would produce different strategies in different situations.

"My goal is to make a contribution to the automation of markets," Schvartzman said, "not just financial markets, but in other scenarios, such as web advertising or even nurses bidding for their shifts in hospitals. Eventually, any resource allocation problem in which there is uncertainty about what something is worth could use a dynamic market instead of a fixed price."

The paper is called, "Stronger CDA strategies through empirical game-theoretic analysis and reinforcement learning."

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