Numerical analysis in auction theory

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Auctions are commonly related to electronic trading sites like Ebay or auctions for selling art masterpieces. It is less commonly recognized that auctions are central to the backbone of economy with wide use in electricity markets, treasury auctions, foreign exchanges, mineral rights and more. For example, in 2013 the US Treasury used auctions to issue approximately 7.9 trillion dollars in securities to finance the public debt of the US.

Most of auction theory concerns the case where all bidders are symmetric (identical). This is not because bidders are believed to be symmetric, but rather because the analysis of asymmetric auctions is considerably harder. For example, in the case of the common first-price auction (i.e., the winner pays his bid), the symmetric case is governed by a single ODE, which is easy to solve explicitly. In contrast, the model for asymmetric first-price auction consists of n first-order nonlinearly coupled ODES with 2n boundary condition and an unknown location of the right boundary, where n is the number of bidders. This nonstandard boundary value problem is challenging to analyze, or even to solve numerically. Therefore, very little is known about its solutions.

This project focuses on the development and analysis of numerical methods for computing equilibrium bidding strategies in first-price auctions. As one studies such a problem, it quickly becomes apparent that brut force computations lead to failure, and rather fine understanding the ODE behavior is required. Currently, there exist a numerical method for this problem, which is quite robust, but nevertheless requires some manual configuration at times. Analysis of this method even in simple cases and its further development *is an open research question.*

Prerequisites:
* Numerical analysis course similar to Technion course 104283
* Some experience in MATLAB
* First ODE course

Additional information can be found at my website, http://ngavish.net.technion.ac.il/, including
* Recent tutorial on the computation of equilibrium bidding strategies
* Publication in GEB, 2011 presenting the numerical method
* Examples of current codes