

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 conditions 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 an existing numerical method I have developed for computing equilibrium bidding strategies in first-price auctions. The method solves the nonlinear system of ODEs using an iterative method. Although the method is quite robust, the choice of iterations requires some manual configuration at times and therefore the method can be further improved. *This is an open research question.* The project includes analysis of the iterations, first in rather simple cases, using numerical and analytical tools in aim of developing improved iterations.

Prerequisites:

- Numerical analysis course similar to Technion course 104283
- Some experience in MATLAB

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