Computational Markets: Econ 496/895
This class is offered Online

Instructor: Professor Kevin McCabe, kmccabe@gmu.edu,
All EMAIL correspondence should have as its subject ECON 496 or 895

Virtual Hours: By Mutual Agreement

Course Description: This course examines the algorithms used to run markets. We will use Python to implement and study these algorithms. See the Course Requirements below. The basic premise of this course is that market algorithms evolve to lower the transaction costs of exchange. Note economists define institutions as the rules that govern participant interactions. Thus the study of market algorithms is the study of the computational nature of institutions. To study market computations, we will build computer models of different exchange systems.

In Part I of the course, we will review Python and other computational skills needed to program market algorithms. We will build and study a continuous Double Auction institution during the review while reading and discussing some of the core papers on computational markets. In particular, we will extend the microeconomic system's framework, introduced by Leonid Hurwicz (1960), to study market algorithms' evolution.

In Part II of the course, we will look at various Call Market alternatives to the Double Auction using sealed bids and price clocks. We will build models to better understand the evolution of one-sided and two-sided auctions to specific economic niches.

In Part III of the course, we will look at the evolution of decentralized exchange algorithms, including the emergent roles of property-rights, money, contracts, and record-keeping. (accounting), and various forms of regulatory governance. We will build agent-based models to study how institutions adapt to changing market characteristics and improvements in computational and communication technologies.

Course Requirements: This course assumes you know how to program in Python at the level of my class: Computational Methods for Economists, or any equivalent class. There are many online (and free) classes you can also take in Python to meet this prerequisite. You should know how to use Jupyter Notebooks and Visual Studio Code or any other code editor. Python topics you should know include expressions and assignments, conditionals, while and for loops, functions, file-handling, exception-handling, modules, built-in data structures, i.e., strings, lists, tuples, and dictionaries. Additional Python topics you should be familiar with are object-oriented programming, and the Python scientific stack, i.e., NumPy, matplotlib, SciPy, SymPy, and Pandas.

Course Materials:

We will use different recommended textbooks to inform our market design choices. None of these books is required. All books are available on Amazon or online.

John Holland, Hidden Order, Addison-Wesley, New York, 1995.

John Holland, Signals and Boundaries. MIT Press, Cambridge, Massachusetts, 2012.

Martin Bichler, Market Design, Cambridge University Press, Cambridge U.K., 2018.

We will also use Python 3.7 or later. Download Python 3.X and many useful libraries using the Anaconda Distribution (https://www.anaconda.com/products/individual). You should also install Visual Studio Code (https://code.visualstudio.com/) and git (https://git-scm.com/) and set up a GitHub Account (https://github.com/). See the blackboard welcome page for more details.

Grading: Grading will be,

- 1/3 participation. Prepare for and participate in a weekly group meeting for lectures and discussions.
- 1/3 group development. Build Python code for group projects on Github.
- 1/3 final project. Build a simulation using a Jupyter Notebook and the code developed in class.

Students with Disabilities: If you have a learning or physical difference that may affect your academic work, you will need to furnish appropriate documentation to the Office of Disability Services. If you qualify for accommodation, the ODS staff will give you a form detailing appropriate accommodations for your instructor. In addition to providing your professors with the appropriate form, please take the initiative to discuss accommodation with them at the beginning of the semester and as needed during the term. Because of the range of learning differences, faculty members need to learn from you the most effective ways to assist you. If you have contacted the Office of Disability Services and are waiting to hear from a counselor, please tell me.

Honor Code: George Mason University is an Honor Code university; please see the Office for Academic Integrity for a full description of the code and the honor committee process. What does academic integrity mean in this course? Essentially this:

(1) When you are responsible for a report, presentation, or paper, you will perform that task to the best of your ability. Quizzes are to be done completely independently. Any interaction with others during these times is in violation of the honor code.

(2) When you rely on someone else's work in your reports, presentations, or paper, you will give full credit in the proper, accepted form.

(3) Another aspect of academic integrity is the free play of ideas. Vigorous discussion and debate are encouraged in this course. The university and your peers expect that all aspects of the class be conducted with civility and respect for differing ideas, perspectives, and traditions.

Weekly Schedule: This schedule might undergo some further revision.
See on Blackboard for details.

Part I: Review Python Development Practice and work on Double Auction Tournament

Week 1: Building a quasi-linear independent value model of Supply and Demand.
Week 2: Building a Continuous Double Auction Institution
Week 3: Running the Double Auction with Zero-Intelligence Traders
Week 4: Building and running Market Tournaments with Advanced Traders

Part II. Double Auction Call Markets – Understanding Price Discovery

Week 5: The Sealed-Bid-Offer Auction
Week 6: Clock Auctions
Week 7: Uniform Price Double Auctions

Part III: Decentralized Markets – An Agent-Based Approach

Week 8: The Basic Contract/Exchange Model
Week 9: Matching - Network Models
Week 10: Matching - Intermediaries
Week 11: Negotiation – Threat Points
Week 12: Negotiation – Dynamic Pricing
Week 13: Fulfillment and Restitution – Record Keeping
Week 14: Fulfillment and Restitution - Reputation Systems
Week 15: Governance – Rule of Law