Syllabus: Introduction to Quantitative Methods

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1 Course Description

This short course is aimed to introduce the PhD students to numerical methods. The course will cover an introduction standard numerical solution and function approximation techniques as well as an overview of most common model solution methods. This is intended to be an interactive class where part of the time will be allocated to coding in class.
While this will be done in the context of Julia programming language, it will not be a class on Julia. However, an overview of Julia specifics and a comparison to other programming languages will be provided.

2 Prerequisites

No prior knowledge of Julia is required, but knowledge of the first-year PhD material, especially dynamic programming will be helpful.

Students should install Julia before the class. For that you will need to download the compiler and the integrated development environment (IDE). Julia compiler can be downloaded here from https://julialang.org/downloads. For the IDE I recommend using VS Code, which can be downloaded from https://code.visualstudio.com. Once installed, you will need to add a Julia language extension. Just follow the steps in section 1.4 in this tutorial

https://julia.quantecon.org/getting_started_julia/getting_started.html.

3 References

- https://julia.quantecon.org/intro.html
- https://docs.julialang.org/en/v1
- Numerical Methods in Economics , Kenneth L. Judd, 1998 MIT Press
- Applied Computational Economics and Finance, Mario J. Miranda and Paul L. Fackler, 2004 MIT Press

4 Assignments

There will be two assignments. Assignment 1 is due on the day before Class 3. It is there so that students start familiarizing with the software. Assignment 2 will ask to implement the value function iteration algorithm. It is due by the end of the term and there will be an opportunity to work on it during the lectures. Students are encouraged to work on assignments together but should submit it separately.

5 Schedule

- Class 1: Introduction to Julia, numerical optimization
  - Variable types, manipulating arrays, functions, loops.
  - Overview of numerical optimization algorithms (Newton, Golden-section, Nelder-Mead etc.), application to static optimization problems.
- Class 2: Function approximation, numerical integration.
  - Introduction to global function approximation (splines, polynomials) and integration (quadrature, Monte Carlo).
- Class 3: Dynamic Programming.

  - Implementing value function iteration algorithm using material from classes 1-3.

- Class 4: The Need for Speed.
  - Methods for VFI speedup.
  - Overview of main parallelization approaches: multi-threading, distributed computing, GPU parallelization.

- Class 5: Writing efficient code, working with data, parallelization.
  - Introduction to Julia's DataFrame package.
  - Multiple dispatch, efficient data handling , memory management.
  - Other tips for writing an efficient code.