Numerical Methods in Economics
Syllabus - Spring 2021
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Introduction

In this course, students will learn about the fundamentals of numerical analysis with an emphasis on applying them to economic models. The course is intended for practitioners. As a result, we will be heavily using python programming language and its vast array of scientific and data analysis packages as well packages that will help us collect data from the internet. The field of numerical analysis is vast and it is evolving fast. This will be an introductory course. Hope is students will gain enough knowledge and practice to be able to study their own interests in greater depth. The syllabus is a roadmap on what we intend to cover. We might skip some topics or go into more details in other topics depending on how the class will progress.

Class Schedule

We will have classes each Monday and Wednesday 2-3:20. Before each class, I will upload class slides online. Participation is not mandatory. I will record each class. At the end of the class, I will remove student comments and update the slides and the video recording accordingly and upload it on compass. Since participation is not mandatory I will be conducting surveys on each class. Your feedback is essential to me. Please take the time and do the surveys. Consider them as my class participation rule.
For office hours, I will be asking for your feedback about the appropriate time. Many of you are in different time zones and we might end up having to set up multiple office hours.

References

For python, there are many free books and resources that are available online or in electronic form through the library. The first source that you should check out is **QuantEcon.org**. The website, which is run by the leading economist Tom Sargent, has an exhaustive list of lecture notes and examples of economics and econometrics problems that are solved with python. The material will add up to more than 1000 pages. We will definitely be using many of these examples from this source in our exercises. Also, two book references that I found well written and I think would benefit you most are:

1. Python for Data Analysis, A Complete Guide for Beginners, Including Statistics and Big Data
2. Intro to Python for Computer Science and Data Science, Learning to Program with AI, Big Data and the Cloud

For the theoretical part of the class, two main references are listed below. Our main reference is number one, but those of you who want to dig deeper should also consider looking at the second book:

1. Applied Computational Economics and Finance by Miranda and Feckler

2. Numerical Methods in Economics by Kenneth Judd

Unfortunately the first book is not freely available through the library, but it is an invaluable source and the paperback is around $30. This is a very good investment, you will be coming back to the materials covered in this book many years into the future. Let me know if you have a problem getting the book, we will try to figure out a way. If you are more theoretically inclined, you should also try to study the second book. Judd is the leading economist in the field of numerical methods. I believe you can also find the book and some of his lectures online.

Throughout the course, I will mention further references for each particular topic. Nevertheless, what we will cover in this course is by no means comprehensive. Those of you who have special interests, say in graphical models, or directed acyclic graphs, etc, should come and talk to me about it. I will try to lead you to proper places where you can learn more, or conversely, I can learn something from you.

Syllabus

1. Learning Python: In the first one or two weeks of the class, we will go over the python programming language and some of its accompanying packages. The intention is that every student should be able to use python to solve the homework and exercises of the forthcoming chapters. There will be numerous homework exercises at the end of this section. The goal is give the students a feedback on their abilities to code.
2. Introduction to Numerical Analysis and Linear Algebra: We will cover the basic concepts of linear algebra, error propagation, matrix factorization, solving linear equations directly and using iterative methods. We will then employ these techniques in later sections to solve more complicated nonlinear problems. The homework at the end of this section will be a combination of questions about the theory of linear algebra as well as programming exercises to apply the said theory. The theoretical part of the homework will be again used in the midterm.
3. Introduction to Solving Nonlinear Equations and Complementarity Problems. We will study a variety of techniques, fixed point methods, newton and quasi newton methods, Nadler-Meade etc, to solve the problems in this section. Every method will be motivated with examples from economics and machine learning. There will be programming exercises that use these techniques as well as theoretical questions for the students to evaluate their understanding of the underlying theory. Students' theoretical knowledge will again be tested in the midterm.
4. Introduction to Optimization and Mathematical Programming. We will review solution techniques for unconstrained and constrained optimization problems with heavy emphasis on problems that the students will encounter in economics and machine learning. We will cover lots of examples and the references contain many more examples to help you practice and learn better. Once again, there will be coding exercises as well as theoretical homework to evaluate students' understanding of the subject.

5. Midterm: The first 4 sections of the course should take between 5 to 8 weeks depending on the progression of the class. The midterm will be on the theoretical aspects of parts 2-4. I have not yet decided whether to hold a two hour midterm online or a 24 hour take home exam. We will discuss this in class.
6. The week after midterm will be learning about some online databases and how to collect data from them using Python. At this time, the students will choose their course project which will count towards their final grade. We will break down and embed some of the steps of the final project in the homework. By the end of this section each student should have their dataset for their final projects downloaded and ready to use.
7. We will take a deeper look at the data analysis and scientific packages accompanying python. That includes Scipy, Scikit-learn and Pandas. Individual students might need to learn other packages like TensorFlow. Those will be covered in office hours and in the extra material that will be provided to the students.
8. The final projects are due in the final week of the class. I am not inclined to have in class presentations as many of you have expressed your preference to have individual projects. If that changes we might decide on each group presenting their work in the final week.

Grading

Finally we get to the point you have been all waiting for. Total point is out of 100. Here is the break down of the grading in the class:

1. 33 points for homework
2. 33 points for midterm
3. 33 points for final project
4. 1 point to everyone.

As for the letter grades. I want everyone to succeed. This is a 490 course, which means if you are taking the class you feel the need to learn the topic and that is my sole intention, to help you become proficient in numerical analysis. Alas, we have to set a grading guideline. For the time being I intend to use the following break down:

1. A: 80-100
2. B: 70-80
3. C: 60-70
4. D: 50-60
5. F: 1-49

I might end up changing these bounds, which is basically the same as putting your numerical grades on the curve.