Math Refresher

Master of Financial Economics
Western University

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General Information

The math refresher reviews fundamental math concepts that will be apparent throughout your degree. Our goal is to provide you with a solid understanding of these concepts and their applications and bring everyone up to a standard level of mathematical understanding necessary for your classes.

This course will also provide a basic introduction to Python. We will cover basic topics in Python and Git version control (time permitting) and use Python to showcase the different applications of some of the math topics in class.

Please find all relevant material at the OWL site for this course, and the code will also be available at https://github.com/fmarti23/MFEMathRefreser2024.git

Learning Outcomes

By the end of this course, you will have a thorough understanding of matrices and their applications. You will be equipped with the skills to manipulate matrices, solve linear equations, and apply matrix concepts. In addition, you will have studied appropriate theorems for optimization and solved multiple canonical optimization problems in Economics.

Date and Time

SSC 4147

1st Session: 9:30 am to 12:30 pm, August 26th; 2nd Session: 9:30 am to 12:30 pm, August 27th
3rd Session: 9:30 am to 12:30 pm, August 28th; 4th Session: 9:30 am to 12:30 pm, August 29th

Given the length of each of our meetings, the course will roughly follow the following structure: we will work on math for 1 hour and 20 minutes, then have a 10-minute break, then again work

on math for 1 hour and 20 minutes, then have another 10-minute break, and finally, we will work in Python for the last hour.

Course Description

- Math Portion

1. Vectors and Matrices
   Symmetry, diagonal, scalar, identity, triangular (upper, lower), Trace, determinant, inverse of a matrix, idempotent matrices.
2. **Manipulation of Matrices**
   Equality, Transposition, Vectorization, Addition, Vector multiplication (inner product), Matrix Multiplication (with general rules), Scalar multiplication, Hadamard product, linear combination
3. **Geometry of matrices**
   Vector spaces, linear (convex) combination of vectors, basis vectors, linear (in)dependence, spanning vectors, column space, column rank, determinant and full rank relation, least squares problem (geometry, properties), length of a vector, orthogonality.
4. **Solution of a system of linear equations.**
   Homogeneous and nonhomogeneous equation system, nonsingular matrix, solution to the least square problems, eigenvalues and eigenvectors. Quadratic forms, definite (positive, negative) matrices.
5. **Calculus and Constrained Optimization.**
   Concept of a Function, Taylor series approximation, linear approximation, gradient (geometric interpretation), Hessian Matrix. Optimization (convexity, concavity, local and global maxima and maxima, first-order conditions, second-order conditions), Constrained optimization (Lagrange Theorem with equalities, KKT Theorem with inequalities). Integration (time permitting)

- Python Portion

1. **Installation Virtual Environments and best practices (potentially Visual Studio Code, GitHub and GitHub copilot).**
   Essential Python Libraries (NumPy, pandas, IPython and Jupiter, SciPy, scikit-learn, statsmodels), scalar types, control flow.

2. **Data Structures and Sequences**
   Functions, Numpy Basics (Arrays and Vectorized Computation, indexing, linear algebra, pseudorandom number generation, solved examples), Pandas Basics (Data Structures, indexing, entries, function application and mapping, sorting, summarizing and computing descriptive statistics (correlation, covariance, unique values, value counts, membership).

3. **Data Management.**
   Data loading, storage, data cleaning, data transformation (missing data, removing duplicates, transforming data with a function or mapping, replacing values, string manipulation)

4. **Application.**
   Data simulation example: Cross-sectional regression with a simulated sample from scratch.

Required Textbooks

Appendix A of Greene, W. H. (2000). Econometric analysis 4th edition. *International Edition, New Jersey: Prentice Hall*, 201-215.

Method of Instruction

In-Person Lectures. Participation is encouraged, and there will be optional assignments.

Attendance Requirements

The MFE Program Director and the instructor encourage attendance. Attending the lectures is in the student's best interest, as they will provide valuable mathematical background for the program's classes.

Technical Requirements

Students are required to have access to the following hardware and software while taking this course:

- **Students are encouraged to bring laptop computers to lectures. However, a** laptop computer is required to access course materials and work in Python.
- Microsoft Word, Microsoft Excel, Microsoft PowerPoint and a PDF Reader/Editor.
- Google Chrome or Mozilla Firefox (preferred for OWL).
- Python

Attendance Requirements

Attending all sessions of this five-day intensive econometrics refresher course is vital to gain a comprehensive understanding of the materials. Since each session builds upon the previous one, active participation is necessary to grasp the concepts thoroughly. Missing a class may have a detrimental impact on the student's progress, so it is important to attend every session.

Course Etiquette

- Keep in mind the students' different cultural and linguistic backgrounds in the course.
- Be courteous toward the instructor, your colleagues, and authors whose work you are discussing.
- Be professional and scholarly in all interactions, whether online or in person.
- If you arrive late, please do so quietly and appropriately to not disrupt the class flow. If you are planning to leave early, please do so during the breaks.
- Disruptive or unprofessional behaviour during lectures, office hours or other interactions is unacceptable and may be subject to disciplinary measures under the Student Code of Conduct.

Communications

- Except for lectures, students should use email for communicating with the instructor. **Questions that require the explanation of complex concepts or typing equations should only be asked during lectures and will not be answered by email.**
- **Emails will be answered within 24 hours during weekdays only. The instructor will only answer emails from Western University accounts. Emails from third party accounts will be disregarded.**

Revisions

Changes to the Course Syllabus:

- Every effort has been made to make the information in this document as complete and consistent as possible. However, the instructor reserves the right to modify the course syllabus or required materials at his discretion. If this document is changed, the instructor will email students registered in the course and post an updated version of the syllabus on the course website.

Course Schedule and Readings[1]

Class	Date	Math Topics Covered	Python Topics Covered
1	Aug 26	Vectors and Matrices, Manipulation of Matrices	Installation Virtual Environments and best practices
2	Aug 27	Geometry of matrices	Data structures and sequences
3	Aug 28	Solution of a system of linear equations.	Data management
4	Aug 29	Calculus and Constrained Optimization	Application

[1] This schedule is tentative and subject to change.