

Math 290-1: Linear Algebra & Multivariable Calculus

Northwestern University, Fall 2014

Course Information

- Instructor: Santiago Cañez
- Email: scanecz@northwestern.edu
- Website: <https://northwestern.instructure.com/courses/8740/>
- Office Hours: Tu 10am-12pm and Th 3-5pm in Lunt B27, or by appointment
- Lecture: MWF 12–12:50pm in Locy 214
- Discussion: Th 12–12:50pm in Locy 214 with Rebecca Wei
- Textbook: *Linear Algebra with Applications, 5th ed.* by Bretscher
- Prerequisites: Invitation to join MENU

Topics Covered

Systems of Linear Equations, Matrices and Linear Transformations, Subspaces and Bases, Linear Dependence and Independence, Determinants, Eigenvalues and Diagonalization

What Is This Course About?

This year-long sequence is all about linear algebra and multivariable calculus, with this quarter's focus being linear algebra. Linear algebra is, essentially, the study of lines, planes, and other “linear” things. (Roughly, “linear” refers to the fact that these can all be described using equations where each variable only appears to the first power.) Although this quick description might not seem all that interesting, the real power comes when realizing that so many pieces of information in various fields (pretty much every scientific or engineering field, economics and other social sciences, etc.) can be phrased in terms of such objects, and much of the linear algebra you will learn leads to incredibly diverse applications. Of all the mathematical subjects you will ever encounter, linear algebra is likely to be the most useful, possibly apart from calculus.

Our main object of study will be what is known as a *matrix*, an object which gives an incredibly useful way in which to encode linear things and collections of data. We will study matrices in depth, focusing on computations involving them and the interpretations of these computations. Here is a motivating question: given a rotation of 3-dimensional space, must it always have an “axis” of rotation? For instance, we can certainly talk about performing a “clockwise 90° rotation about the x -axis”, or a “counterclockwise 45° rotation about the y -axis”, but here we are asking whether any rotation whatsoever similarly takes place about some axis. (Building a good geometric picture of what these rotations and 3-dimensional space look like will be a side goal of this course, and even more so in later quarters, so no worries if you aren't comfortable with this just yet.) We can imagine some pretty complicated procedure which starts by rotating some amount in one direction, then by another amount in another direction, and so on. It is not clear that the end result of this procedure is still one single rotation, let alone that it all takes place about a single axis. The key for us will come in realizing that such geometric operations can be described in terms of matrices, and that the question about axes can be phrased in terms of what are called *eigenvalues* and *eigenvectors*. The overarching point here is that something which seemed to have nothing to do with matrices at first, i.e. rotations and axes, turns out to be directly related to them and their properties. Again, this is an idea which you will see again and again in other fields.

Naturally, you may be wondering just what this all has to do with calculus, given the structure of this year-long sequence. The point is that when phrased in the right way calculus is indeed about replacing possibly complicated nonlinear things with simpler linear ones. After all, what is the derivative of a function at a point but the slope of the corresponding tangent line. Similarly, when moving to functions of more than one variable, instead of tangent lines we have tangent planes, and linear algebra will help to put many of their properties in the right context. Matrices show up all over the place in multivariable calculus, and after having had linear algebra first you will hopefully understand why they do. As compared to the non-MENU multivariable calculus and linear algebra courses, you will hopefully better understand where the computations we will be doing come from and what type of situations they would be useful in. This will require us to understand a bit more of the theory involved, but the payoff in the end will be worth it.

What Should You Already Know?

Officially the only thing you should already be familiar with is single-variable calculus. We may use some ideas from calculus from time to time, but we really won't see much calculus until later quarters. For now, the main reason having had calculus is useful is to make sure you are "mathematically mature" enough for this course. Having seen "vectors" and/or "matrices" before is not necessary.

Homework, Quizzes, and Exams

There will be weekly homework assignments, usually due on Fridays with some exceptions. You are encouraged to work together on problem sets, but each of you must hand in your own work in your own writing. There will also be weekly quizzes, which you'll take in discussion section on Thursdays. In the end your lowest homework and quiz scores will be dropped.

There will be two midterms and a final exam. The midterms will be held on October 20th and November 17th—both Mondays—from either 6-7pm or 6:30-7:30pm in a room to be determined. The final will be held on Wednesday, December 10th from 9-11am. Please see me as soon as possible if you have a conflict.

Grades

Your final score will be composed of homework, quiz, and exam scores according to the following percentages: 10% Quizzes, 15% Homework, 20% Midterm 1, 20% Midterm 2, 35% Final Exam. What constitutes an A, B, etc. will be determined at the end once all scores have been totaled, so there is no set scale. However, I'll try to give a sense of where you stand throughout the quarter.

University Policies

Students are required to abide by Northwestern University's academic integrity policy, which can be found at <http://www.northwestern.edu/provost/students/integrity/>. Failure to adhere to this policy will likely result in a failing grade in the class and/or expulsion from the University.

Any student with a disability requesting accommodations is required to register with Services for Students with Disabilities (ssd@northwestern.edu; 847-467-5530) and present an accommodation letter from SSD to his/her professor, preferably within the first two weeks of class. All information will remain confidential.