Syllabus

Each week of the course consists of several **video lectures** and **Homework** and **Lab** assignments. Typically there will be one Homework and one Lab, but there are a few weeks that deviate slightly from this pattern. We will also provide optional **review questions** and other reflectionsperiodically as the course progresses.

You'll notice that throughout this course we use the convention of numbering weeks and assignments starting with 0. This means that while this is an eight-week course the final week of material is labeled "Week 7" because the first is "Week 0". This numbering convention reflects the fact that Week 0 covers preliminary material; coverage of linear algebra starts in Week 1.

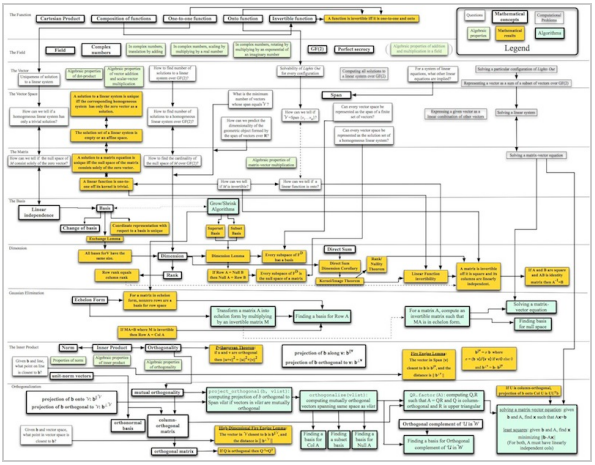
Weekly Schedule at a Glance

The following grid provides a quick overview of the lectures and assignments you'll be responsible for each week.

Week	Lectures	Homework	Labs	Assignments Due
Week 0 July 1 - 7	The Function The Field	Homework 0	Python Inverse Index	**July 21 at 11:59 p.m. (EDT)**
Week 1 July 8 - 14	The Vector	Homework 1 Vector Class Homework	Politics Lab	**July 28 at 11:59 p.m. (EDT)**
Week 2 July 15 - 21	The Vector Space	Homework 2		**Aug. 4 at 11:59 p.m. (EDT)**
Week 3 July 22 - 28	The Matrix	Homework 3 Matrix Class Homework	Error-correcting Code Lab	**Aug. 11 at 11:59 p.m. (EDT)**
Week 4 July 29 - Aug. 4	The Basis	Homework 4	Geometry Lab	**Aug. 18 at 11:59 p.m. (EDT)**
Week 5 Aug. 5 - 11	Dimension	Homework 5	Perspective Rectification Lab	**Aug. 25 at 11:59 p.m. (EDT)**

Week	Lectures	Homework	Labs	Assignments Due
Week 6 Aug. 12 - 18	Gaussian Elimination The Inner Product	Homework 6	Secret Sharing Lab Integer Factoring Lab	**Sept. 1 at 11:59 p.m. (EDT)**
Week 7 Aug. 19 - 25	Orthogonalization	Homework 7	Machine Learning Lab	**Sept. 8 at 11:59 p.m. (EDT)**

A (Rough) Map of the Course



You may recognize this map from the Course Introduction video. We've made it available for download. This isn't a precise outline of everything covered in the course, but you can use it as a general guide to help situate yourself conceptually as we proceed through the weeks.

Week 0: The Function and The Field

July 1 - 7, 2013

There are two labs assigned this week, both designed to acquaint you with programming in Python. The first is an atypical lab in that it consists of many, many small tasks without one overall goal other than learning Python features such as sets, lists, dictionaries, and comprehensions. The second provides practice in Python and in particular in multi-line procedures, in reading from files, and in using dictionaries.

The labs have no dependence on the lectures; you can start them in parallel with watching the lectures.

The first lectures (The Function) review some basic notation, terminology and concepts that you'll be using throughout the course, including notation for sets and functions. The highlight of this part is the concept of *invertible function*.

After that, we'll look at The Field. A field is a collection of values with a *plus* operation and a *times* operation. You will already be familiar with the field of *real numbers* but perhaps not with the field of *complex numbers* or the field *GF(2)*, which consist just of zero and one. We will discuss these fields and give examples of applications.

Assignments

- Python Lab
- Inverse Index Lab
- Homework 0

All assignments for this week are **due July 21 at 11:59 p.m. (EDT)**.

Week 1: The Vector

July 8 - 14, 2013

Here's where we really get started. You might think a vector is just a list of numbers but you'll find out otherwise. We'll also see by example the wide variety of things a vector can represent. We'll then learn about the three basic vector operations and see some example applications that use them. Here is where we first encounter linear equations and linear systems.

As part of your work for this week, you will complete an implementation of vectors, `Vec`. You will use this implementation throughout the rest of the course, so make sure your implementation is correct and complete!

The lab this week uses vectors, but does not use your `Vec` implementation, so you don't have to complete `Vec` before starting the lab.

Assignments

- Homework 1
- Vector Class Homework
- Politics Lab

All assignments for this week are **due July 28 at 11:59 p.m. (EDT)**.

Week 2: The Vector Space

July 15 - 21, 2013

Vectors are perfectly fine as individuals but when they get together in large sets, they have great power. One way to specify a large set of vectors is as the span of a few vectors; another way is as the set of solutions to certain equations. The concept of *vector space* unifies these two.

Assignments

- Homework 2

The homework for this week are **due August 4 at 11:59 p.m. (EDT)**. This is the only assignment for

this week—there is no Lab. Use your free time to make sure your *Vec* class is perfect!

Week 3: The Matrix

July 22 - 28, 2013

What is the Matrix? It's not just a big grid of numbers. Here we learn the mechanics of matrix operations and, crucially, several different interpretations of these operations. We study functions defined by matrix-vector multiplication; these provide important examples of the more abstract concept *linear function*. We start our study of what makes a linear function invertible, a question with implications for several of our applications. We also encounter the related concept of a *matrix inverse*.

We also begin using the `solver` module, which provides a procedure for solving a matrix-vector equation. So far this module is a black box; in the next two weeks, we will see how it can be used, and in the final two weeks, we will learn how it is implemented.

This week you will complete an implementation of matrices, `Mat`. You will use this implementation throughout the rest of the course, so make sure your implementation is correct and complete!

This week's lab assignment makes use of your `Mat` class.

Assignments

- Homework 3
- Matrix Class Homework
- Error-correcting Code Lab

All assignments for this week are **due August 11 at 11:59 p.m. (EDT)**.

Week 4: The Basis

July 29 - August 4, 2013

In this chapter, the concepts come fast and furious: coordinate representation, linear independence, and, most important, the basis. We will also learn some *gedanken* algorithms for selecting bases, and see the connection to forests in graphs.

Assignments

- Homework 4
- Geometry Lab

All assignments for this week are **due August 18 at 11:59 p.m. (EDT)**. This week's Lab can be completed before viewing the lectures if you choose.

Week 5: Dimension

August 5 - 11, 2013

The concept of dimension is simple but very powerful, and we use it to obtain the most fundamental results in the course. We can finally answer most of the mathematical questions that have arisen so far. The computational questions, on the other hand, are answered in the last two weeks.

The lab does not depend on this week's material, and you can do it before viewing the lectures.

Assignments

- Perspective Rectification Lab
- Homework 5

All assignments for this week are **due August 25 at 11:59 p.m. (EDT)**.

Week 6: Gaussian Elimination and The Inner Product

August 12 - 18, 2013

You might have seen Gaussian elimination before, but perhaps not this formulation. Gaussian elimination is used in the `solver` module for solving matrix-vector equations over *GF(2)*. We see how it can be used to address other computational problems as well.

For some fields (not *GF(2)* but the reals and the complex numbers), we can define an inner product, which is closely related to the idea of distance. Building on the notion of inner product, we explore the notions of orthogonality and orthogonal projection. These ideas enable us, for example, to find the point on a given line closest to a given point.

The labs build on the material on Gaussian elimination.

Assignments

- Homework 6
- Secret Sharing Lab
- Integer Factoring Lab

All assignments for this week are **due September 1 at 11:59 p.m. (EDT)**.

Week 7: Orthogonalization

August 19 - 25, 2013

We generalize the notion of orthogonal projection, enabling us, for example, to find the point on a given plane closest to a given point. The techniques are used in the `solver` module for solving matrix-vector equations over the reals, and also give us solutions for other computational problems that have arisen in the course.

The lab does not depend on on this material and you can do it before viewing the lectures.

Assignments

- Machine Learning Lab
- Homework 7

All assignments for this week are **due September 8 at 11:59 p.m. (EDT)**.

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