Overview

This course will introduce the basic concepts of data analysis and practical techniques for implementing them incorporating methods of scientific computation. Half of the course will emphasize the theoretical foundation of data analysis with lectures and homework assignments, while the other half will focus on the practical application of analyzing data acquired as part of lab assignments. Development of programming techniques for performing data analysis and
data visualization will also be stressed using MATLAB or python (your choice). The following topics will be covered:

- Measurement Uncertainty and Error Propagation
- Statistical Inference
- Scientific Programming for data import, plotting, analysis and interpretation
- Gaussian Distribution and Confidence Levels
- Least Squares and Linear Regression
- Binomial/Poisson Distributions
- Astronomical Image Data Processing and Analysis
- Time Series Acquisition and Fourier Transforms
- Analysis of Arctic Sea Ice Data

Grading

Course grades will be based on five bi-weekly homework assignments, the first involving programming to import and analyze data, then 3 from Taylor (40%), and a final assignment involving programming and using Fourier transforms. Five bi-weekly lab assignments (60%) complete the assigned work. There will be no examinations (midterm or final) for this course, so it is important for students to turn in all assigned work when it is due. Late assignments will either be significantly penalized or not accepted at the instructors discretion. The final lab assignment will be due during finals week in place of a final examination.

In order to pass the course, you must complete all of the labs! It is also noteworthy that not completing all homework assignments will reduce your point total, resulting very likely in a significantly lower grade.

Grades will be awarded based on the departmental grading policy. Modifiers (+/-). I may adjust the grade boundaries depending upon the final distribution so that students with similar scores will receive similar grades.

Syllabus

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
<th>Lab (due following Tuesday)</th>
<th>Homework (due following Tuesday)</th>
<th>Reading</th>
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<tr>
<td>Week 1</td>
<td>Measurement Uncertainties, Intro do</td>
<td>Lab 1: Coding to read, plot and analyze data</td>
<td>HW1</td>
<td>Taylor Ch. 1-3</td>
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<tr>
<td>1/5 - 1/9</td>
<td>Scientific Programming Tasks</td>
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(data file link here)
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<thead>
<tr>
<th>Week</th>
<th>Dates</th>
<th>Topics</th>
<th>Textbook Chapters</th>
<th>Notes</th>
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<td>2</td>
<td>1/12 - 1/16</td>
<td>More on 'Error,' more about Scientific Programming</td>
<td>Lab 2: Brownian</td>
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<td>Motion</td>
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<td>1/26 - 1/30</td>
<td>Weighted Average</td>
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<td>2/2 - 2/6</td>
<td>Linear Regression</td>
<td>Lab 3: Astronomical</td>
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<td>Binomial Distribution and Random Walks</td>
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<td>2/16 - 2/20</td>
<td>Fourier Transforms</td>
<td>Lab 4: Fourier</td>
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<td>Transforms</td>
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<td>2/23 - 2/27</td>
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<td>Climate Change Data</td>
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<td>Arctic Sea Ice</td>
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<td>Coverage</td>
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<td>3/9 - 3/13</td>
<td>'Features' in Data Sets</td>
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<td>Final Lab Due Weds 3/18 at 5 PM</td>
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This syllabus is tentative, and is subject to change as the quarter progresses.

**MATLAB or python**

One of the goals of this course is for you to develop the skills to properly undertake non-trivial data analysis of large data samples. There are many different tools available to do this, including the programming 'language du jour' python. You can learn scientific programming and complete assignments for this course using either MATLAB or python. MATLAB is relatively easy to learn, very powerful, and widely used in Science and Engineering disciplines, but does cost money to install on your computer (student version is ~$100). Python and MATLAB are somewhat similar, though python's environment takes more effort to set up. Python's main
advantage is that it is free to install on your computer. There are also many 'packages' of
pre-programmed functions and scripts available for use with python, a few of which are
emphasized in this course (for example, in Lab 3). MATLAB and python are also good examples
of 'procedural programming', and the general techniques learned in this course can easily be
transferred to the language or tool of your choice later. MATLAB is widely (and freely) available
at the University of Oregon on UO-owned computers, including those in our lab. We have also
loaded python on those computers. Some possibilities are listed on the MATLAB Information
page. You will need to use either python or MATLAB extensively in this course, so you should
invest some time in the first two weeks to make sure you have a working computing
environment which you can use and you are happy with.

Lectures

Lecture 4 - Link to Matlab linear/quadratic fitting demonstrated in class and to zip file with my
fitting functions (will be posted)

Homework

Homework will typically be assigned every other week on Tuesday and due on the following
Tuesday at the start of class. The homework will mostly be problems from Taylor forcing you to
work through a particular concept 'by hand' at least once. Supplimental problems to exercise
your MATLAB skills may also be assigned.

- HW 1 - Coding a physics simulation (due Jan 20, assignment related directly to Lab 1)
- HW 2 - Statistical Inference (due Jan 26)
- HW 3 - Linear Regression (due Feb 10)
- HW 4 - Binomial and Poisson Distributions (due Feb 24)
- HW 5 - Fourier Transforms (due March 10)

Labs

Lab assignments will be made every two weeks and will be due on Tuesday during weeks when
homework is not due. It is expected that you will work on your labs during the two weeks before
they are due. Assigned lab times will be available when TAs or I will be in room 17 to provide
support and advice, although you are free to work on the labs whenever you have time
available. You will be expected to work with a partner, although each member of the lab group is
expected to turn in their own material including the data analysis and any associated code.

Formal write-ups will not be required, although I do expect you to keep a lab notebook which
clearly shows the work you have done. I really want to see proof that you did the lab and
understood the material. Neatly organized notes taken during the lab itself, answers to the
questions posed in the lab writeup, plus a short summary giving the main quantitative results in
your notebook is perfectly adequate. If you are very sloppy in your notes, you may also turn in a
longer printed write up, but please get into the habit of taking neat legible lab notes. Either way,
please turn in your lab notebook (legible or not) on Tuesday in class. For labs with significant computer work, your M-files and supplemental material should be emailed to me directly as well.

For an upper-division course, the university expects students to spend one hour in class and two hours out of class for each credit. While each student will vary, you should expect on average to put this much time into this course. In particular, you should not expect to complete all of the lab work during the scheduled lab times each week, although you certainly should be able to collect all of the necessary data during that time. Make sure you do not try to start your lab assignments at the last minute. Most students who struggle in this course simply don't invest enough time in completing the labs.

- **Lab 1 - Data upload, plotting, and analysis (programmin) lab** (due Jan 20) ([Here's a direct link to Elsa's data file](#))
- **Lab 2 - Brownian Motion** (due Feb 3)
- **Lab 3 - Astronomical Signals from Noisy Data** (due Feb 17) (see [this web site](#) for more information)
- **Lab 4 - Fourier Transforms** (due March 3)
- **Lab 5 - Analysis of Climate Change Data** ([here is more about noisy data](#)) (due Finals Week on 3/18 by 5pm)

**Academic Honesty**

There is arguably a grey area between working together collaboratively on a homework assignment or lab, and just copying somebody else's work. In general, however, it is usually very apparent to the people involved whether a student is really contributing to a result, or just copying from others. Copying answers and passing them off as your own work, either from another student or from any other source is no different from plagiarism and will be dealt with according to the UO rules and procedures for academic misconduct.

You are responsible for all the work you turn in for this course. You are encouraged to work with others to help your understanding, but anything you write down on your homework or you lab assignments needs to be your own work. You can certainly collect data with your lab partner and discuss the methods for analyzing the data and even compare your results, but all written and code work must be your own. Please note that THIS MEANS EACH STUDENT SHOULD TURN IN THEIR OWN CODE ASSIGNMENTS TO THE INSTRUCTOR, I WON'T ACCEPT 'GROUP' CODE ASSIGNMENTS.

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