Finance 6320 - Computational Methods

- **Instructor:** Tyler J. Brough
- **Email:** tyler.brough@aggiemail.usu.edu
- **Office:** BUS 605
- **Course Dates:** January 7 - May 1, 2015
- **Course Room:** Engineering Laboratory 248
- **Course Time:** TR 12:00 - 1:15 PM
- **Office hours:** TBD

Course Description

This course is an introduction to scientific computing in the `Python` programming language for modern financial economics. This is a very applied course by nature. Although there will often be class lectures that focus on theory, they will always be followed by computational exercises that focus on implementation. The computational tools that we refer to consist of two dimensions: 1) the mathematical tools that form *numerical analysis* that are helpful in solving problems in finance, and 2) the actual implementation of said tools in a programming language. The programming language that we will focus on is `Python`, which has become a de facto standard in the scientific computing community. Again, the focus will be applied, that is will be problem-solving oriented rather than theoretical. I expect that upon completion of this course you will have developed a set of real-world skills that will allow you to implement theories from modern finance in an industry setting or to assist you in carrying out research in a doctoral program.

Course Objectives

- Developing specific skills, competencies and points of view needed by professionals in the finance industry and in academic finance
  - Learn the basics of the Python programming language for purposes of scientific computation.
  - Develop computational skills necessary to implement theories from modern financial economics in practice.
- Learning fundamental principles and theories.
  - Learn theories of advanced derivatives pricing.
  - Learn the concepts of numerical methods useful in computational finance.
  - Learn theories of advanced econometric methods.
  - Learn the basics of Monte Carlo methods for use in financial economics and econometrics.

- Learning to apply course materials.
  - Learn to implement derivative pricing models for applications in trading and hedging.
  - Learn to apply theories of advanced econometrics to estimate volatility and to measure transactions costs.

Huntsman School Pillars

This course aligns with the Huntsman School Pillars along the dimension of analytical rigor.

Textbook

There are two *required* textbooks for the course:

- The first is *Python for Data Analysis*. You may wish to purchase the text in PDF form from the publisher, O'Reilly.

- The second is *Derivatives Markets, 3rd Edition*.

Grading

The grade that you will earn will be determined by your ranking in the class based on the weighted total points accumulated on class preparation and participation, a class project, and a final exam. There is no predetermined percentage of the class that will earn an A, or that will fail. If you all do excellent work, you will all earn high grades. The weights given to each part of the class are as follows:

- Class preparation, participation, and homework (30%) - I expect each student to come to class prepared for each class session. Preparation includes completing the assigned readings, writing down questions for sections of the reading that were not fully understood or internalized, and completing homework assignments. Class participation is crucial for understanding. I will call on students in class. There are two good answers when called upon. The first correct response is an informed answer based on your preparation. The second correct response is a question that shows that you have wrestled with the material in your preparations. A good question often lays the foundation for a more complete understanding. One important aspect of class participation is the professionalism with which you conduct yourself. I will drop your lowest homework assignment and replace it with the average of the others, BUT only if I deem it of sufficient quality and effort.

- Final project (45%) - The class project consists of a computational exercise in implementing a derivatives pricing model or econometric technique in Python. Further details will be given regarding project topics. I may choose to carefully control the topics allowed. You may work in teams of two, and you must inform me by the end of the first week of class of your chosen team. At that point if you are part of a team, but would like to be I will do my best to facilitate matching individuals. Please inform me privately if this applies to you.

- Final exam (25%) - The final exam will consist of a timed take-home computational exercise similar to homework assignments. Any day during finals week you can check out the exam from me by email or in person. You will then be required to email me the completed problems with the accompanying Python source code before the time limit expires.

Python Programming

We will be mainly using two different tools for Python:

- The Sage Math Cloud, which I will refer to as SMC. This is a free computing service offered by the University of Washington in partnership with Google. Please create an account as soon as possible.

- The Anaconda edition of Python by Continuum Analytics. This will have every thing that we will need preinstalled. Please install the version that comes with Python 3. It is completely free.

Python is a very good choice for a programming language for this course. As a programming language, Python is fairly easy to learn and can be put to productive use very quickly. Python has become the de facto standard scripting language for scientific computing, and is widely usd in the finance industry.

Topics (Subject to Change)

Lecture Topic	Readings
SMC & Anaconda Python	
Unix Vim & Git	Handouts & Online Material
IPython & IPython Notebooks	Appendix (PFDA)
Python types variables & Simple IO	Appendix (PFDA)
Branching & Looping	Appendix (PFDA)
Data Structures	Appendix (PFDA)
Functions	Appendix (PFDA)
Classes Objects & OOP	Appendix (PFDA)

NumPy SciPy Pandas & Matplotlib	Chps. 3 4 5 & 12 (PFDA)
Binomial Model	Chps. 10 - 11 (DM)
Black-Scholes Model	Chps. 12 - 13
Implied Volatility	Handout
Econometric Volatility Estimation	Handout
Monte Carlo Methods	Chp. 19 (DM)
Exotic Options	Chps. 14 & 23 (DM)
American Options	Handout
Stochastic Volatility & Jumps	Chp. 24 (DM)
Numerical PDF Methods	Handout
The Sampling Distribution	Handout
Monte Carlo Studies	Handout
The Bayesian Algorithm	Chp. 1 (AIMBE)
Bayesian Linear Regression	Chp. 3 (AIMBE)
Markov Chain Monte Carlo Methods	Chp. 4 (AIMBE)
Multivariate Time Series	Handouts
Cython	Handout
IPython Paralles	Handout
GPU Computing	Handout

Important Dates:

- **Feb 17** - Monday Schedule
- **Mar 9 - 13** - Spring Break
- **Apr 24** - Last Day of Classes
- **Apr 28** - Final Exam