Syllabus

FIN 285a : Computer Simulations and Risk Assessment, Fall 2017

Key information

Instructor

- Blake LeBaron
- blebaron@brandeis.edu
- http://www.brandeis.edu/~blebaron
- Sachar 204, 736-2258
- Office hours: Monday 3:30-4:30, Tuesday 2:00–3:00 (Office hours subject to change during the first two weeks.)

TA

- TA
  - Mohammed AlMehdar
  - email: mmehdar@brandeis.edu
  - office hours: TBA

Times:

Class Times: Mon/Wed, 2:00–3:20, Lee Hall

Detailed information

Course Description

Measuring and managing financial risk has been a critical task for institutions, regulators, and investors. Over the last half century, as markets have become more complex, this task has become more important. Modern technology has changed the playing field in risk measurement. Computers allow for measurement of risk across the enterprise at near up to the minute frequencies, which has led to demands for processing and interpreting this information. Computational tools have provided a key component in this mission. Analyses based on monte-carlo, or computer simulation methods allow us to produce future scenarios from which we can judge the overall risks we are currently exposed to. This course will introduce the computational tools and show how they can be used in various forms of
financial risk assessment. We will look at classic statistical methods such as bootstrapping, and also other modern methods such as extreme value theory and copulas. We will apply these in different financial settings involving both market and credit risk. Finally, we will look at these computational tools from the perspective of the recent crisis and global financial policy going forward.

**Learning Goals**

1. Ability to apply computational statistical methods such as bootstrapping, and monte-carlo to questions of risk measurement in financial settings.
2. Understand how to implement small programs in the Python programming language for use in financial analysis.
3. Assess the confidence of various risk measures given available data sets.
4. Learn how to quantify the impact of tail risk in many situations.
5. This course can be a rough preparation (with some more reading) for taking the financial risk manager (FRM) exam from the Global Association of Risk Professionals (GARP).

**Prerequisites:**

1. FIN 201a, or a basic knowledge of finance is essential.
2. Econ213a or Econ184a: A basic working knowledge of mathematical statistics is important too. You need to know about random variables, probability distributions and densities. Also, a little knowledge of linear regression will be useful too. A standard one semester course in math stats with calculus will cover this.
3. Fin 270a (Options and derivatives) would also be useful, but it is not required.
4. Although all computer skills will be taught in the course, some enthusiasm for programming will be useful. No programming skills are assumed. However, some knowledge of excel will be useful, but not necessary.
5. The course also assumes basic calculus equivalent to about 1 semester of calculus at the undergraduate level.

This course is designed for 2nd year IBS masters students (MA, MSF, MBA). PhD students may also find some of the content useful as well.

**Required Readings:**

1. Lecture notes (many)

**Recommended books:**

6. Efron/Hastie, Computer Age Statistical Inference, Cambridge University Press, 2016. (This book is very optional, but it is a very nice, complete view of how computer simulation is currently being used in many parts of statistics. Many more than we will talk about.)

Websites

• Quant finance site
• Datacamp
• Statistical ideas

Required Software

The Python programming language, and tools in the Anaconda download will be assumed. This is an open source package. You will be able to run this on your own laptop.

Grading

Grades will be based on:

• Problem sets (15%)
• Two midterm exams (20% each)
  ◦ Midterm exams will only be 45 minutes. We will also have about 30 minutes of lecture too.
  ◦ Wednesday, October 18
  ◦ Wednesday, November 15
• Group project (15%), Due Wednesday, December 6th.
• Final exam (30%), K-Block, Thursday, December 14th, 1:30pm–4:30pm
Rules and responsibilities

Communications
You are responsible for all announcements and materials in class. Also, much of the information in class will be sent over Latte and the class website.

Rules specific to Fin285

- Exams
  - Your own work.
  - Closed book (no notes).
  - No laptops, no cell phones, no pda’s.

- Problem sets
  - Hand in your own work.
  - Can talk and assist each other.
  - Use all resources.

- Group projects
  - Own work for the group.
  - Hand in one writeup per group.

- Laptops: Please bring to class if you want to.

Academic Integrity
You are expected to be honest in all of your academic work. Please consult Brandeis University Rights and Responsibilities for all policies and procedures related to academic integrity. Students may be required to submit work to TurnItIn.com software to verify originality. Allegations of alleged academic dishonesty will be forwarded to the Director of Academic Integrity. Sanctions for academic dishonesty can include failing grades and/or suspension from the university. Citation and research assistance can be found at LTS – Library guides.

Workload
Success in this four-credit course is based on the expectation that students will spend a minimum of 9 hours of study time per week in preparation for class (readings, papers, discussion sections, preparation for exams, etc.)
Disability Statement

If you are a student with a documented disability on record at Brandeis University and wish to have a reasonable accommodation made for you in this class, please see me immediately.

Fall calendar dates

- First day of classes: August 30
- Last day of classes: Dec 8
- No class:
  - Sept 4
  - Sept 21–22
  - Oct 5
  - Oct 12
  - Nov 22–24

- Brandeis days
  - Tuesday, Oct 3: Thursday schedule
  - Wednesday, Oct 11: Thursday schedule

Course Outline

Syllabus refers to pages in core textbook, Hilpisch. Most sections are now covered by lecture notes only, and Python code examples. All available on website, or Latte. Some data sets are on Latte since they are proprietary, and should NOT be shared outside of the Brandeis community.

1. Introduction
2. Tools
   1. Probability basics (this is assumed to be review)
   2. The Python computer language
      1. Basics (H, pp 79–94)
      2. Numpy (H, pp 95–107)
      3. Matplotlib (H, pp 109–131)
      4. Pandas (H, 137–156 skim)
   3. Computational statistics (see Efron/Hastie)
1. Sampling, monte-carlo, and bootstrapping
   Cosma Salizi, The Bootstrap, American Scientist

2. Hypothesis tests/Confidence intervals

4. Time series basics

3. Financial data review
   1. Financial data reminder/review
   2. Stylized facts of financial data

4. VaR analytics
   1. Basics and interpretations
   2. VaR issues
   3. Expected shortfall

   1. Parametric methods
   3. VaR precision, confidence intervals, and the bootstrap
      1. VaR confidence intervals
      2. The antithetic bootstrap
      3. Monte-carlo tests of the bootstrap
   4. Method comparisons

6. Extending VaR
   1. Time aggregation and longer horizons
   2. Extreme value theory

7. Volatility forecasting
   1. Modeling volatility
   2. Using volatility forecasts
      1. Basic empirical conditional volatility
      2. Implied volatility and VIX
      3. Realized volatility
      4. Time series models, and volatility forecasting
3. *Option:* The volatility term structure Chistoffersen, chapter 8

8. Correlations and portfolios
   1. Correlations and portfolios
   2. Simple multivariate models with changing correlations
      Chistoffersen, chapter 7.1–7.3
   3. *Option:* Copulas, Chistoffersen 9

9. Options and monte-carlo measures
   1. Option pricing with simulation (H, pp 290–294)
   2. Options and partial risk hedges
   3. Exotic options (Barriers and Asian)
   4. Convergence trades and pairs trading (Funding risk)
   5. Evaluating dynamic trading strategies
   6. *Option:* Retirement portfolios
   7. *Option:* Volatility pumping

10. Backtesting/stress testing Chistoffersen 13
    1. Backtests and VaR evaluation
    2. Capital requirements and VaR Hull, chapter 12(skim), 13.1/13.2
    3. Stress tests Hull, chapter 19
    4. Model risk