COMP 510 – Computational Finance
Fall 2008

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Office Hours: after class and by appointment.
Course Time: 9:00-10:20AM Tuesday-Thursday **Place:** 1511 Academic Bldg.
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Textbook: The official textbook for the course, covering most (but not all) of the material is:

- J. Hull, *Options, Futures, and Other Derivatives*, Pearson International Education, seventh edition, 2009.

Other recommended references include:

- P. Wilmott, *Paul Wilmott Introduces Quantitative Finance*, Wiley, second edition, 2007. (friendly general overview)
- R. Tsay, *Analysis of Financial Time Series*, Wiley-Interscience, second edition, 2005. ISBN 978-0471690740. (time series analysis)
- A. Borodin and R. El-Yaniv, *Online Computation and Competitive Analysis*, Cambridge University Press, 2005. ISBN 978-0521619462. (online algorithms)
- S. Skiena *Calculated Bets*: *Computers, Gambling, and Mathematical Modeling to Win*, Cambridge University Press, 2001. (fun read about how we built a program trading system)

Overview: The financial industry is a tremendous consumer of advanced computing technologies and mathematical modeling techniques, and a primary employer of computer science graduates. In this course, we will present the principles of computational finance and financial data analysis, focusing on research problems of algorithmic interest.

There will be divided roughly equally into three major topics:

- *Derivatives* – financial markets, arbitrage arguments, options, and other financial instruments, options pricing, numerical methods.
- *Time Series Analysis* – financial data, linear and non-linear time series analysis, clustering and pattern recognition.
- *Trading / Investment Strategies* – CAPM, Kelly criteria, online algorithms, order execution, technical analysis.

We may have occasional guest lecturers from the financial services industry.

- **Homeworks:** There will be two programming-oriented homework assignments which are intended to be done individually. The first will concern implementing algorithms to price options. The second will involve financial data analysis / trading strategies. My hope is that these will have relatively modest requirements but be open enough to facilitate individual explorations.

- **Research Project / Presentation:** This is your opportunity to study some aspect of computational finance in depth. Students will be required to do either a group research project or class presentation. A list of presentation topics are given below. Research project topics will be distributed a few weeks into into the semester, although you are encouraged to devise your own.

  Projects will emphasize programming/experimentation, while presentations (typically 20 minutes or so) will emphasize specific databases / software and what they do. Each group will be responsible to create a webpage with all presentation slides / project reports, as well as links to appropriate systems, resources, and supplemental material.

- **Exam:** There will be a final exam focusing on material from the lectures and assigned readings, mostly the lectures.

- **Grading:** Grades will be assigned based on the following formula, with cut-offs determined by my opinion of students on the boundary.

  Class Participation = 10%

  Homework (two programming assignments) = 35%

  Project/Presentation = 20 %

  Final Exam = 35 %

My grade distribution will confirm with standard departmental practices, typically half As and half Bs with (hopefully) few students below B-.

Rules of the Game:

1. As a visiting professor here at HKUST, I am unfamiliar with local rules, customs, and practices. Please inform me of any mistakes I make, as they are due to ignorance rather than malice. Corrections and changes to course policy will be made as appropriate.
2. The WWW page for the course is http://www.cse.ust.edu/~ skiena/510/. All course handouts and notes are available there, along with the latest announcements. Please check it out.
3. I have taught a previous version of this course as CSE 691 at Stony Brook in Spring 2007. This version will be somewhat similar, although it is morphing from a seminar course to a standard graduate course. Lecture notes and audio from my previous edition are available on my Stony Brook webpage at *www.cs.sunysb.edu/~skiena/691*.
4. I strongly value student interaction in class. The class participation portion of the grading is more designed to reward interaction / activity than attendance.
5. We live in interesting times. I encourage discussion about current events in the financial world at the beginning of each class.
6. I encourage interest from students who have a business/finance background. Talk to me about your particular situation.
7. Because a primary goal of the course is to teach professionalism, any academic dishonesty will be viewed as evidence that this goal has not been achieved, and will be grounded for receiving a grade of F.

Presentation Topics:

Certain groups will give (as their course project) presentations to provide practical information about available databases, software, and other resources. Each group presentation will last from 20 to maybe 30 minutes (including questions) and require the construction of a webpage with additional reference / tutorial material.

These presentations will be scheduled appropriately in the course material, and provide an excellent way for students to complete the course project prior to the end of the term.

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Prediction Markets: Iowa Electronic Market, Hollywood Stock Exchange, Trade Sports, ???
-- What securities do they trade?
-- What is the volume and degree of reality?
-- How efficient are they?
-- What interfaces are available for human and program trading?
-- What data is available for research purposes?

Options Pricing Software
-- What are the most popular open/commercial programs for pricing options?
-- What instruments can they price?   How fast/accurate are they?
-- How do they do it (i.e. what algorithms)?
-- Give examples of the input and output of these programs in action.

Options Markets:
-- What markets (US and international) allow you to trade options?
-- What contracts are available, how what equities/currencies/commodities?
-- Where can you obtain data on current prices?
-- How quickly does it change?

The R Statistics Library:
-- What statistical routines of financial interest are there?
-- What time series analysis routines are there?
-- What clustering, pattern recognition, and spectral decomposition  routines are there?
-- What is the user interface?
-- Give some examples of time series computations.

Backtesting and Trading Simulations:
-- Can you identify trading contests/competitions to participate in?
-- Find open/commercial systems for backtesting/simulating trading strategies
-- What languages are to specify trading rules?
-- Give examples of simple trading rules and how they perform

CRSP
-- Describe what type of data is available in the CRSP database.
-- What software interface in C provides access to this data?
-- Give examples of programs to extract data and do something interesting
-- How does one get local access?

RiskMetrics
-- Describe what type of data is available in the RiskMetrics database
-- What is it used for?  How is it computed?
-- What software interface in C provides access to this data?
-- Give examples of programs to extract data and do something interesting
-- How does one get local access?

Reuters 3000 Xtra
-- Describe what type of data is available in Reuters database.
-- What software interface in C provides access to this data?
-- Give examples of programs to extract data and do something interesting
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Tentative Lecture Schedule: Computational Finance (COMP 510)

OPTION THEORY

9/2 Course overview
9/4 Markets

9/9 Derivatives
9/11 Pricing Futures

9/16 Properties of Stock Options
9/18 Random Walk Models

9/23 Binomial Trees
9/25 The Black Scholes Model

9/30 Finite Difference Methods
10/2 Exotic Options

10/7 No class (Chung Yeung Festival)
10/9 Catch up / presentations (1)

DATA ANALYSIS

10/14 Financial Time Series Data
10/16 Linear Time Series Analysis

10/21 Garch Models
10/23 Regression Analysis

10/28 Clustering and Pattern Recognition
10/30 Fractal Analysis

11/4 Spectral Analysis
11/6 Catch up / Presentations (2)

TRADING STRATEGIES

11/11 The Capital Assets Pricing Model
11/13 Order Execution and Leverage

11/18 Introduction to Online Algorithms
11/20 Competitive analysis for finance

11/25 Money management and the Kelly criteria
11/27 Technical analysis

12/2 Pairs trading and other strategies
12/4 Catch-up / presentations / final thoughts (3)