Special Problems in Financial Engineering
FE 800 Section A, Spring 2013

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Class Schedule: Tuesdays 3:00 p.m. to 5:30 p.m., Hanlon Lab

Course Objectives and Description:

This course deals with students undertaking a research or analytical project either individually or as a group.

The projects can either be:

1) **Research** Oriented in the field of Mathematical Financial Engineering such as

- Optimal Hedging Monte Carlo
- Asset Replication through Kalman Filtering
- Statistical Modeling of Trading Strategies
- Dynamic Portfolio Allocation Methods
- Regulatory Research (Basel III, CVA, etc.)
- Credit Derivative Arbitrage
- Volatility trading strategies
- Any project proposed by a faculty member

2) **Analytics** or Software Design and Implementation

- CUDA parallel programming methods
- Derivative Pricing and Hedging Software Design and Implementation
- Regulatory (Basel III, CVA) Software Design and Implementation
- News Analytics
- Any project proposed by a faculty member

Grading Scheme:

Abstract (due Jan 29th)	**10%**
Phase One (due Feb 26th)	**10%**
Phase Two (due Mar 26th)	**20%**
Phase Three (due Apr 23th)	**20%**
Written Report (due May 7th)	**20%**
Oral Presentation (due May 7th)	**20%**

Below are two ***brief*** abstract schematics: Your abstract will have to be somewhat more detailed.

Example Abstract: Research Project (difficult!):

Topic: OPTIMAL DYNAMIC HEDGING OF CLIQUETS

There exists a pre-print on DefaultRisk.com entitled "***Optimal Dynamic Hedging of Cliquets",***

by Petrelli, A, J. Zhang, O. Siu, R. Chatterjee, & V. Kapoor, May 2008.

This paper can be extended and then published. The phases are as follows:

Phase One

1) Understand **OHMC (Optimal Hedging Monte Carlo).** I briefly taught this at the end of FE 535 and continued it in FE 635. The concepts in OHMC are becoming critical to hedging analysis, gap risk, etc.

2) Understand how to simulate **GARCH(1,1).** Students who took (my) FE 535 should know how to do this.

3) Understand the structure of a **Cliquet**-style derivative. Students who took (my) FE 535 should know this.

4) Read the paper "***Optimal Dynamic Hedging of Cliquets".***

Phase Two

Code the above using C++ ***and*** NVIDIA CUDA technology found in a GPU card within a Z820 machine in the **Hanlon Lab**,. Parallel computing for MC simulations via GPU is the next big thing. It is much cheaper than using GRID computing (blade servers sitting in some warehouse) and much of Wall Street is looking into this technology.

Phase Three

Extend the simulation to a form of **Asymmetric GARCH (possibly APARCH).** The paper uses GARCH (1,1) which has fat tails (kurtosis) but is a symmetric process (skewness = 0) . Cliquet pricing is mostly used for downside risk (gap risk) so an asymmetric simulation should provide more accurate pricing.

For group work, you must indicate who will do which part of these phases.

Example Abstract: Analytics Project:

Topic: Regulatory (Basel III, CVA) Software Design and Implementation

Phase One

Understand:

1. **Counter-party Credit Risk (CCR) Risk Weighted Assets(RWA)**
2. **Market-Risk RWA**
3. **Operational-Risk RWA**

This should include all necessary equations needed to calculate the above numbers, i.e.

VaR of Regulatory CVA (RCVA)

$$RCVA = LGD_{mkt} \sum \frac{EE_i Z_i + EE_{i+1} Z_{i+1}}{2} \cdot PD_{i,i+1}$$

$$PD_{i,i+1} = \exp\left(-\frac{s_i t_i}{LGD_{mkt}} \right) - \exp\left(-\frac{s_{i+1} t_{i+1}}{LGD_{mkt}} \right)$$

$$RCS01_i = 10^{-4} \cdot t_i \cdot \exp\left(-\frac{s_i t_i}{LGD_{mkt}} \right) \cdot \frac{EE_{i-1} Z_{i-1} - EE_{i+1} Z_{i+1}}{2}$$

Phase Two

Code the above using C++/Java/CUDA/OpenCL (no Matlab!). This includes a detailed schematic of the different parts of the analytics libraries including all base classes. There will be periodic **code reviews! Your code must be structured and understandable by the Professor of this course!**

Phase Three

Test and debug the above analytics on portfolios of financial instruments and demonstrate that these numbers make sense. **The analytics must be provided to the Professor of this course for testing purposes.**

For group work, you must indicate who will do which part of these phases.

Each class will consist in student presentations and discussions of what you have accomplished to date for each phase.