Columbia University
Computational Methods in Derivatives Pricing
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Course Overview

This course introduces and applies various computational techniques useful in quantitative/computational finance. Among them are transform techniques for pricing derivatives, finite difference methods for partial differential equations (PDE), and partial integro-differential equations (PIDE), Monte Carlo simulation techniques and its applications, calibration techniques, filtering and model parameter estimation techniques.

The computational platform will be C++/Java/Python. The primary application focus will be the pricing of financial derivatives. These techniques are useful for various other problems in financial modeling/engineering and practical implementations from the theory of mathematical finance.

Required Textbook:

Computational Methods in Finance (Chapman & Hall/CRC Financial Mathematics Series) by Ali Hirsa

Required Work and Grading Policy:

Assignment: 3/4 case studies (C++/Java/Python programming)

In-Class Examination

Grading is based the following weighting schemes:

60% Case Studies, 40% In-class Examination

Teaching Assistant:

Helen Chien

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Office Hours:

Ali Hirsa on Tuesdays 12:00pm-1:10pm Room #318

Helen Chien by appointment
Class Schedule (subject to change):

Lecture 01. – Overview; option pricing using transform techniques (e.g. FFT) (Chapter 2 - Pages 35–47)

Lecture 02. – Option pricing using transform techniques (Cont’d) (Chapter 2 - Pages 47–63)

Lecture 03. – Introduction to finite differences; discussing various schemes; stability analysis of the schemes (Chapter 3 - Pages 83-105)

Lecture 04. – Pricing various options in diffusion framework; issues in implementation; nonuniform grids; coordinate transformation (Chapter 4 - Pages 115–146)

Lecture 05. – Finite differences in higher dimensional; numerical solution of the partial-integro differential equations (Chapter 4 - Pages 146–158, Chapter 5 - Pages 171–180)

Lecture 06. – Numerical solution of the partial-integro differential equations (Cont’d) (Chapter 5 - Pages 180–199)

Lecture 07. – Introduction to Simulation; Sampling from various distributions (Chapter 6 - Pages 203–210)

Lecture 08. – Simulation in finance; integration via simulation; simulation of diffusion and pure jump processes (Chapter 6 - Pages 211–239)

Lecture 09. – Variance reduction techniques in simulation (Chapter 6 - Pages 240–254)

Lecture 10. – Pricing of financial derivatives via simulation (Chapter 6 - Pages 240–254)

Lecture 11. – Calibration formulation and techniques (Chapter 7 - TBD)

Lecture 12. – Calibration examples; model risk (Chapter 7 - TBD)

Lecture 13. – Parameter estimation via likelihood (Chapter 8 - TBD)

Lecture 14. – Various filtering techniques (Chapter 8 - TBD)

Lecture 15. – Parameter estimation using filtering (Chapter 8 - TBD)