Computational Finance: Pricing and valuation

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Option pricing

- An option gives the holder right (but not the obligation) to buy or sell a risky asset at a pre-specified fixed price within a specified period.
- Underlying asset: stock, currency, commodity...
- Question – how can we compute the price of the option?
What is this course about?

- Mathematical models (stochastic differential equation, partial differential equation, Itô calculus, Feynman-Kac, Black-Scholes…) given.
- This course is about how to compute the option price given the mathematical formulation.
- Focus on numerical algorithms (Monte Carlo methods and finite differences).
- Implementation of algorithms in MATLAB.
Computational Finance, 5 credits

**Content:** The course contains areas which are essential when practically dealing with computational finance in engineering and research. The content include Monte Carlo and Monte Carlo-like methods, finite difference methods and the use of advanced software in the field. The course contains general parts, which all participants take, as well as a number of eligible modules. Thus, the course can partly be individually adjusted.
After the course, the student should be able to:

- describe solution methodologies based on Finite differences, Monte Carlo methods and Lattice methods;
- implement solvers based on Monte Carlo and Finite differences for European financial derivatives in one space dimension;
- describe similarities and differences in efficiency, convergence rate and complexity for the methods in previous item;
- describe how solvers for more complex types of financial derivatives can be developed, and for higher grades implement these solvers;
- use advanced software for pricing of financial derivatives;
- appraise, interpret and discuss computational results both orally and in a written report;
- read and summarize a scientific paper in the computational finance area.
Pedagogical model

- Flipped classroom
- Online lectures + regular seminars
- Active learning
- Maximize time for student teacher interaction
Evaluation

- Previous evaluations were mainly positive (14, 21, 12, 23, 16, 13 answering students):
  - What is your general feeling about the course? (4.21, 4.30, 4.42, 4.5, 4.2, 4.3)
  - What was the degree of difficulty? (3.64, 3.61, 3.92, 3.4, 3.3, 3.6)
  - How did the total amount of work on the course relate to the credits? (3.93, 3.83, 4.00, 3.8, 3.4, 3.8)
  - Is the course relevant to your education? (4.43, 4.57, 4.83, 4.6, 4.1, 4.9)
  - Has the course been stimulating and interesting? (4.14, 4.48, 4.58, 4.4, 4.1, 4.7)
  - Did you have enough prerequisites for this course? (4.36, 4.00, 4.25, 4.4, 3.8, 4.0)
Evaluation cont.

I think assignments are way better than a written exam. In real life you are supposed to construct solvers etc. like in the assignments, and not answer questions like at a written exam.

I particularly liked the practical approach of the course, learning by doing.

Good assignments that helped you learn the course content while implementing solvers etc. The "hands on" approach is great.

Always good to get a feel for how the very theoretical knowledge we're taught is actually applied.

The course was more autodidactic, the teacher was clear about the things we should do and learn.
Examination

- 5 assignments:
  - Monte-Carlo methods
  - Finite differences
  - Monte-Carlo/Finite differences
  - Exotic options
  - American options

- 2 assignments (computer labs):
  - FIS Front Arena
Examination cont.

- Examination both orally and written reports.
- Work in groups of 2-3 students in some assignments, individually in some.
- Tutoring will be given by Lina and Slobodan
- Each assignment is followed by a short questionnaire in "Studentportalen" that should be answered individually.
Grade on course (3, 4 or 5) depends on choice of level of assignment.

<table>
<thead>
<tr>
<th>Assignment 4/5</th>
<th>Basic</th>
<th>Higher level</th>
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<tbody>
<tr>
<td>Basic</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Higher level</td>
<td>4</td>
<td>5</td>
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Literature

Computational Methods in Finance

Ali Hirsa
Additonal literature

Tools for Computational Finance
Fourth Edition
Rüdiger U. Seydel
The course on the web

- All material is available through the Student Portal.
- All information will be announced in the Student Portal.
  - Link to schedule
  - Syllabus
  - Assignments
  - Bulletin board
  - ...


FIS’s Front Arena

- In this course you will use "Front Arena", one of FIS’s softwares.
- Guest lecturer from FIS.
Course layout

The teaching consists of

- Lectures (L)
- Seminars (S)
- Tutoring (T)
- Computer Labs (Lab)
Course layout cont.

- L1 Introduction to course (today).
- L2 Overview of different types of financial derivatives and financial pricing problems (web lecture).
- L3 Overview of solution methods - lattice methods, Monte Carlo methods and finite differences (web lecture).
- L4 Monte Carlo-methods (web lecture).
- S1 Monte Carlo-methods. Introduction to assignment 1.
Course layout cont.

- T1 Assignment 1.
- L5 Finite difference methods (web lecture).
- S2 Finite difference methods. Introduction to assignment 2.
- T2 Assignment 2.
- S3
  - Review of assignment 1 and 2.
  - Monte Carlo methods vs finite differences - Introduction to assignment 3.
  - Exotic options - Introduction to assignment 4.
Course layout cont.

- T3+4 Assignment 3 + 4.
- S4 Exotic options, presentations by students. Introduction to assignment 5 – American options.
- Guest lecture + Lab1 Front Arena
- T5 Assignment 5
- Guest lecture + Lab2 Front Arena
- S6 Summary of course (not scheduled yet)
Reading instructions for today

- Seydel: A1 - Investment and Risk
- Seydel: A2 - Financial derivatives
- MATLAB:
  - Basics of Matlab
    http://www.it.uu.se/edu/course/homepage/bridging/lab/matlab/
  - Suggested literature:
Practical details

- Computer access
  Make sure that you have a valid Unix account or bring your own laptop with Matlab.

- Entry card
  Make sure that you have a valid entry card to Polacksbacken.
Computational Finance-
Calibration and Estimation

- Content: The course contains areas which are essential when practically dealing with computational methods in finance in engineering and research. The content includes
- methods for calibration of stochastic models for financial applications, optimization methods for calibration, filtering,
- maximum likelihood-estimation and Kalman-filter. The course contains general parts, which all participants take, as well as a number of eligible modules. Thus, the course can partly be individually adjusted. The software that is used is Front Arena and Matlab
Next period

- Project in Scientific Computing, 15 hp.
- Project work in groups of 2-3 students.
- We will try to set up at least one project in Computational Finance/Computational Financial Statistics.

Master thesis

- Possibility to do your Master thesis project in Computational Finance/Computational Financial Statistics.