Programming and Advanced Numerical Methods

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- Education
  - An engineer
  - A finance specialist
- Career
  - ExxonMobil
  - Enron
  - BP
  - Calyon
  - Merrill Lynch
  - Standard Chartered

What Will I Teach You?

- A practitioner
  - not a mathematician
  - not a computer scientist
  - not an academic researcher
  - a user for over 25 years
  - pragmatic rather than theoretical
  - still will cover some theory, where needed to better understand concepts, issues and limitations

Objectives

- give you an overview of numerical methods
- understand applicability and limitation of some commonly used techniques
- be able to experiment with your own idea and test your result
- be able to compare effectiveness of different methods
- research solutions for your own problem

Objectives

- Most of the topics we will cover would deserve a course by itself.
- This course as just an introductory overview.
- This is not a programming course. Programming is covered to a bare minimum, to be able to understand numerical methods.

Marks

- 60% Exam
- 40% Assignments or Project

Assignments?Project

- Deadline for submission will be specified each time
- Late submissions will receive zero mark
- Incorrect submission (see rules in next page) will receive zero mark
- Individually or team of 5 maximum

Submission

- Submission are to be done via LuminusThe filename needs to have a filename in the format:
- Example Ex2.zip, project.zip

The zip file must contain a text file (group.txt) with the name of the participants

A123456, Fabio Cannizzo

A657890, John White

- Please only submit DOC, XLS, M. If your submission includes multiple files, please bundle them in a single ZIP file (other compression format, e.g. rar, are not accepted)

Course Organization

The course as divided in 2 sections

1. Fundamental Numerical Methods (50%)
2. Financial Numerical Methods (50%)

Syllabus - Introduction

- The course starts with a brief and practical introduction to some basic and general concept of imperative programming and its typical flow control structures. Programming is a very wide topic which would require several courses on its own. Here it is covered only to a minimal extent merely as a necessary tool to illustrate the numerical algorithms covered in the remainder of the course. The programming language of choice is Matlab, a high-level language primarily intended for numerical computations.
- A minimum of pre-acquired familiarity with Matlab programming language is beneficial, therefore it is recommended that students install Matlab (any version) and go through its user guide before the begin of the course.

Syllabus – Part 1

- After an introduction to topics like numerical errors, algorithm's stability, floating point representation and computer arithmetic, the first half of the course is devoted to general purpose numerical methods frequently encountered in financial applications. This includes linear algebra, interpolation, root search, integration and differentiation.

Syllabus – Part 2

- In the second half of the course, the focus shifts to the most common integration techniques used for pricing in Financial Engineering. Topics like Monte Carlo simulation, trees and partial differential equations are covered with equal weight. Theoretical foundation and practical applications, including aspects like efficiency and convergence, are discussed for each of them. The connection of the various methods and their strengths and weaknesses are also discussed.

Programming

- Brief Introduction to Concepts
  - General discussion on a fundamental topics related to programming
- Matlab
  - Introduction to Matlab syntax
  - Some examples
  - Will learn more later, as-we-go

Numerical Methods

- Introduction to Numerical Analysis
- Differentiation via Finite Differences
- Root Search
- Interpolation
- Quadrature
- Linear Algebra
- ODE integration

Financial Numerical Methods

- Main Methods:
  - Trees
  - Monte Carlo
  - PDE
- Theoretical foundation and practical applications, including aspects like efficiency and convergence, are discussed
- The connection of the various methods and their strengths and weaknesses are also discussed.

Material

- Will cover topics drawn from different sources
- Will not follow a single text book. Recommended books cover some of the topics
- Hand outs will be given
- Some references will be given
- Code samples:

https://bitbucket.org/fabiocannizzo/nummethods/src/master/

Required Knowledge

- Although we will do a brief math review, it is assumed that you are well familiar with these topics
  - Probability Theory
  - Calculus
  - Stochastic Calculus
- No knowledge of programming or numerical methods is assumed