Introduction

Most practitioners in finance care very little about mathematical formulae and theorems. What they care about is numbers. Ideally positive ones. The aim of this course is to find out how to turn all the mathematical theory you have learned in the rest of the programme into numbers.

The fact that you will almost certainly need some numerical skills in your job is probably pretty persuasive in itself. But you will also need some numerical skills to complete this MSc. Everyone on this programme has to complete an MSc project and that will definitely require you to perform some numerical computations. This is the course that prepares you for the programming needed for your dissertation.

Let me give you another motivation for studying numerical methods. Its fun. You will be able to produce beautiful looking charts and graphs very easily by the end of this course and you will be able to experiment rapidly with different ideas. For example, suppose you come up with an idea for a trading strategy, you will be able to back test your strategy with historical data; you'll see how well it would have performed in the past and you'll be able to simulate how well it might perform in the future. By doing this you'll gain real insights into financial mathematics that you would never get from the formulae alone.

That's the sales pitch for the course. But what will you actually learn?

MATLAB Programming

First of all you are going to learn how to program a computer. We're going to use the MATLAB programming language throughout this course. The reasons we will be using MATLAB are:

- It is easy to learn.
- It is designed specifically for scientific computation (rather than say for writing games or word processors).
- Employer's expect you to know MATLAB. It is often listed as a required skill in job advertisements.

We won't dwell too much on computer programming in the course however, what we want to focus on is numerical methods. In the first few lectures I will

explicitly teach you the basics of MATLAB, but from then on the focus will be on the ideas and the algorithms rather than on the specific programming language.

Numerical Methods

So what are the ideas and algorithms that we will cover?

One central idea will be Monte Carlo methods. The idea behind Monte Carlo methods is simple: one randomly generates possible scenarios and then uses these scenarios to simulate trading strategies, compute risk figures, and also to price options. One recurring theme will be the difference between the risk neutral measure and the real world measure. As you know already, for pricing one computes expectations in the risk neutral measure for risk management and simulation one must use the real world measure. Thus this course will reinforce the messages you have learned in your risk neutral pricing course.

We will also examine other numerical approaches to risk neutral option pricing. There is a well established theory of how to numerically solve partial differential equations numerically. If option prices obey the Black Scholes partial differential equation, we should be able to use these methods to price options. A closely related approach which we will examine is the method of pricing using binomial and trinomial trees.

One other subject that we will study is the application of numerical optimization methods to problems in financial mathematics. For example we will consider problems such as portfolio optimization and model calibration.

From a mathematical point of view, I hope many of these ideas already sound familiar. For example you should already know the idea of risk neutral pricing and you have perhaps already come across Markowitz's theory of Portfolio optimization. By revisiting topics that you have already studied in theory and implementing them in practice, this course should give you a much stronger understanding of the core ideas of this MSc programme.