

London Graduate School in Mathematical Finance

MF2: Computational Finance - 2010-11

Prof William T. Shaw, King's College London

Registration

Please fill out the form using BLOCK CAPITAL LETTERS - pass it round the class please. I will need this information for various purposes, including setting up login access to the machines in this room.

Course Dates

Tuesdays, normally 3-5 in Oct, Nov and Dec, starting 12 October 2010.

There will be break-out sessions in parallel computation in the KCL cluster room, with the precise arrangements TBD in light of numbers.

WTS E-mail and contact

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020 7848 1119 (but PLEASE use e-mail)

Office Hours: 1pm to 3pm Wednesdays (preference to PT students from 1-2).

My Web Page

www.mth.kcl.ac.uk/staff/w_shaw.html

MF2 Web Page (Public)

www.mth.kcl.ac.uk/~shaww/web_page/lgs/

Resources

We have this room, equipped with C++ development environment and *Mathematica 7*. The hardware has just been "upgraded" and things are bedding down. I will do a lot of theoretical presentation using *Mathematica* notebooks, but these will be available in PDF form as well as *Mathematica* notebook form. I will try to do examples in as generic a way as possible.

For people with an interest in serious computational research, we have the Apple Cluster. This consists of (as of October 2009) six 8-core 64-bit Mac Pro workstations and two 8-core Xserves. Some of the Mac Pros are also equipped with Nvidia GPU Quadro and other boards for explorations of CUDA and OpenCL. We will do some projects in that room, mostly based on GridMathematica.

KCL Grid Computing Centre (Public)

http://www.mth.kcl.ac.uk/~shaww/web_page/grid/

Course Notes (Private Information)

www.mth.kcl.ac.uk/~shaww/web_page/lgs/notes/

This is a secure area and there are also no public links to it. Please DO NOT publicise it. Your login in is lgsstudent2010

and your password is *****. DO NOT pass this on! This will contain lots of notes, some of which are bits of drafts of chapters of the second ed. of my book. I will tell you when you need to take notes if there is something NOT on this site.

Topic Summary

These will be a mixture of theory and computation, and will include (this is being revised so I include more detail for the earlier topics). There will also be quick-start introductions to *Mathematica* and C++.

Quantiles: Importance to Monte Carlo simulation, non-linear differential equations and approximation methods. Gaussian vs non-Gaussian issues, Parallel and GPU optimization issues.

Copula and their simulation: 2D special cases and Laplace methods for Archimedean. Combining copulas and quantiles.

Finite Difference Methods: Summaries of truncation, stability and coding methods.

Implied Volatility problems

Fourier transforms done properly via complex analysis and the Heston model theory and computation in that setting.

Grid programming in *Mathematica* and basic CUDA work.

If time: Monte Carlo portfolio optimization and other topics.

Journals

You might find it useful to figure out now if and how you can get access to some journals I will refer to:

Journal of Computational Finance

Applied Mathematical Finance

International Journal of Computer Mathematics

(check out institutional subs, db access).

Statistics

(AMF and Statistics are Taylor and Frances; JCF is Incisive (formerly RISK) and they want money if you are not a subscriber, so good idea to get this sorted through your home institution). Good catalyst for sorting out journal access anyway.

C++ Environment

This room has the C++ environment from Bloodshed Software

www.bloodshed.net

that the KCL physics dept already uses, and I will be demonstrating some material for this setup. This is a good environment for beginners as you do not have to develop project structures to get going - you can work in "compile and run" mode with no difficulty.

Mathematica

Please check your own departmental licensing arrangements first to see if you already have access to a full working version, or a licensing deal that allows you to get a cheap personal copy. Otherwise you can get this from

www.wolfram.com

in two forms.

A free reader that just allows you to read my notebooks is available at

www.wolfram.com/products/mathreader

Also, for student versions:

<http://www.wolfram.co.uk/products/student/mathforstudents/licenses.html>

lists various versions that allows calculations to be done. Full student is about (prices last year) £92, one year £34.50, 6 months £23. (Win, Mac, Linux).

In the later sessions we will work on GridMathematica on both local 8-core machines and in a cluster.

CUDA/OpenCL

This is an environment for programming GPUs. CUDA environment is specific to Nvidia GPUs, while OpenCL is a new open standard for programming GPUs more generally, including ATI 5000 series, and also "traditional" CPUs. I will give some exposure to this. If you want to explore yourselves at

http://www.nvidia.co.uk/object/cuda_what_is_uk.html

and in particular you can download it at:

http://www.nvidia.co.uk/object/cuda_get_uk.html

I strongly advise you to get version 3.2 or later resources, as this has modulated into a GPU computing toolkit with BOTH CUDA and OpenCL resources. You will need to have a computer with a compatible GPU. An old 8800GT is fine for getting going and will not cost much, but is limited to single precision arithmetic. Newer 200 and 400 series do double precision well. An old GTX 260 is probably the cheapest way in to that level, though 285s with 2GB of memory are affordable with serious computation levels. If your dept or univ has Teslas or recent Quados all the better. Our lab has Quadro 4800 with the odd 8800/200. These are Nvidia solutions. 200 series do DP work as well as Tesla 10xx series, but Tesla 20xx and Quadro 4000, 5000, 6000 have much better DP than 4xx games cards.

University Challenge - if possible...

William Shaw pretends to be Jeremy Paxman?

Team Working

A team effort is a lot of people doing what I say,

Michael Winner, Movie Producer

And a joke told to me by Lane Hughston:

Q: What is the difference between an introvert mathematician and an extrovert mathematician?

A: When he is speaking to you, an introvert mathematician will look at his feet. An extrovert looks at *your* feet.

When we talk to financial institutions they tell us that they do not need many mathematical primadonnas. One or two might be useful to lead innovation. Greatest demand is for flexible team players who will turn their hand to many things, and leave their egos at the door. So we are going to try to have some team-based projects. These will not be formally assessed, but we will have groups present to each other. Suggest grouping according to institution in first case - at least that way easier to get together. Open to ideas, else I will suggest something, for early Dec.

Note that there is no formal or informal programming prerequisite for this course. Those of you with no programming experience should team up with those who do, and perhaps do something about comparing exact solutions with numerical results, or do technology transfer - converting some maths or complicated numerical analysis into an algorithm.

King's College Financial Mathematics and Applied Probability Seminars

In addition to the proposed PhD seminars, we have the KCL Financial Maths Series. These will normally begin shortly after these lectures finish, at 5.30 p.m. (tea from 5 to 5.30, so you can get some refreshment after two hours with me!). The next talk is this evening, October 12th, and is Dr McCloud from Nomura.

I will let you know of other dates, but the programme for the rest of the semester and shortly to include some of 2010 is at

<http://www.mth.kcl.ac.uk/research/finmath/seminars.html>

The talks are normally in lecture theatre K2.31 (also known as 2C) down the big stairs from here).

These, especially given our location, are well attended by practitioners as well as academics, and are an opportunity to keep up with what "quants" are doing in the markets as well as seeing more theoretical work.