Numerical Methods in Finance with C++

Driven by concrete computational problems in quantitative finance, this book provides aspiring quant developers with the numerical techniques and programming skills they need.

The authors start from scratch, so the reader does not need any previous experience of C++. Beginning with straightforward option pricing on binomial trees, the book gradually progresses towards more advanced topics, including non-linear solvers, Monte Carlo techniques for path-dependent derivative securities, finite difference methods for partial differential equations, and American option pricing by solving a linear complementarity problem. Further material, including solutions to all exercises and C++ code, is available online.

The book is ideal preparation for work as an entry-level quant programmer, and it gives readers the confidence to progress to more advanced skill sets involving C++ design patterns as applied in finance.

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Mastering Mathematical Finance

Mastering Mathematical Finance is a series of short books that cover all core topics and the most common electives offered in Master's programmes in mathematical or quantitative finance. The books are closely coordinated and largely self-contained, and can be used efficiently in combination but also individually.

The MMF books start financially from scratch and mathematically assume only undergraduate calculus, linear algebra and elementary probability theory. The necessary mathematics is developed rigorously, with emphasis on a natural development of mathematical ideas and financial intuition, and the readers quickly see real-life financial applications, both for motivation and as the ultimate end for the theory. All books are written for both teaching and self-study, with worked examples, exercises and solutions.

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[PF] *Probability for Finance*,
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[SCF] *Stochastic Calculus for Finance*,
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[BSM] *The Black–Scholes Model*,
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[PTRM] *Portfolio Theory and Risk Management*,
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[NMFC] *Numerical Methods in Finance with C++*,
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[SIR] *Stochastic Interest Rates*,
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[FE] *Financial Econometrics*,
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[SCAF] *Stochastic Control Applied to Finance*,
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To Monika and Nina

Contents

Preface

This volume of the 'Mastering Mathematical Finance' series is all about numerical methods combined with C++ programming skills, driven by concrete computational problems in quantitative finance. It begins with straightforward option pricing on binomial trees, and gradually progresses towards more advanced topics, including non-linear solvers, Monte Carlo techniques for path-dependent derivative securities, finite difference methods for partial differential equations, and American option pricing by solving a linear complementarity problem.

Familiarity with C++ is not a prerequisite. The exposition starts from scratch in that respect. Nonetheless, the learning curve is steep, and some, if only limited, experience of computer programming, in any language, might be helpful. In terms of quantitative finance background, working knowledge of the binomial and Black–Scholes models of the market is sufficient. Prior knowledge of numerical methods is not necessary, though it would give some advantage.

This book takes an accelerated route through C++, picking and choosing whatever programming language tools are required to tackle the job in hand. It is not a substitute for a systematic C++ manual. We recommend that the reader should frequently consult such a manual (or Internet resources) for reference about the finer points of the various C++ constructs.

The emphasis is on solving and implementing numerical problems of increasing complexity that arise in finance. Of equal importance is code design that reflects the structure of such problems, facilitates future extensions and encourages collaboration between programmers. This provides motivation to master both the numerical techniques and programming language at the same time.

One of the aims of this course is to prepare the reader for work as an entry-level quant programmer. It can also be used as a springboard to embark on more advanced texts, for example, the brilliant book by Mark Joshi.[1]

The material has been tried and tested at the University of York, as part of an MSc in Mathematical Finance, both campus-based and by online

[1] M. Joshi, *C++ Design Patterns and Derivatives Pricing*, Cambridge University Press 2004.

distance learning, and it has also been taught to final-year undergraduates. We are indebted to our students for their feedback and enthusiasm, constructive criticism and creative ideas, which resulted in many improvements both in the code and the text.

The accompanying C++ code is available on the linked website

`www.cambridge.org/9781107003712`

which also contains solutions to all exercises. Errata and some bonus material will be posted on this website in due course.