

Implementing QuantLib

Luigi Ballabio

© 2005, 2006, 2007, 2008, 2009, 2010, 2011 Luigi Ballabio.

This work is licensed under the Creative Commons Attribution-NonCommercial-NoDerivs 3.0 License. To view a copy of this license, visit

<http://creativecommons.org/licenses/by-nc-nd/3.0/>

or send a letter to Creative Commons, 559 Nathan Abbott Way, Stanford, California 94305, USA.

The author has taken care in preparation of this book, but makes no expressed or implied warranty of any kind and assumes no responsibility for errors or omissions. No liability is assumed for incidental or consequential damages in connection with or arising out of the use of the information or programs contained herein.

Draft



Attribution-NonCommercial-NoDerivs 3.0 Unported

You are free:



to Share — to copy, distribute, and transmit the work

Under the following conditions:



Attribution. You must attribute the work in the manner specified by the author or licensor (but not in any way that suggests that they endorse you or your use of the work).



Noncommercial. You may not use this work for commercial purposes.



No Derivative Works. You may not alter, transform, or build upon this work.

- For any reuse or distribution, you must make clear to others the license terms of this work. The best way to do this is with a link to <http://creativecommons.org/licenses/by-nc-nd/3.0/>

- Any of these conditions can be waived if you get permission from the copyright holder.

- Nothing in this license impairs or restricts the author’s moral rights.

Your fair dealing and other rights are in no way affected by the above.

This is a human-readable summary of the Legal Code (the full license).

The Legal Code is available at

<http://creativecommons.org/licenses/by-nc-nd/3.0/legalcode>.

Draft

Contents


Contents	i
List of Listings	v
List of Asides	ix
List of Figures	xi
Acknowledgments	xiii
❖	
1 Introduction	1
2 Financial instruments and pricing engines	5
2.1 The Instrument class	5
<i>Interface and requirements, 5 • Implementation, 7 • Example: interest-rate swap, 10 • Further developments, 15</i>	
2.2 Pricing engines	16
<i>Example: plain-vanilla option, 22</i>	
3 Term structures	29
3.1 The TermStructure class	29
<i>Interface and requirements, 29 • Implementation, 31</i>	
3.2 Yield term structures	35
<i>Interface and implementation, 35 • Discount, forward-rate, and zero-rate curves, 37 • Example: bootstrapping an interpolated yield curve, 41 • Example: adding z-spread to a yield curve, 52</i>	
3.3 Other term structures	54
<i>Default-probability term structures, 54 • Inflation term structures, 57 • Volatility term structures, 60 • Equity volatility structures, 60 • Cap and caplet volatility structures, 60 • Swaption volatility structures, 60</i>	

4	Cash flows and coupons	61
4.1	The CashFlow class	61
4.2	Interest-rate coupons	62
	<i>Fixed-rate coupons, 65 • Floating-rate coupons, 66 • Example: LIBOR coupons, 72 • Example: capped/floored coupons, 76 • Generating cash-flow sequences, 82 • Other coupons and further developments, 84</i>	
4.3	Cash-flow analysis	87
	<i>Example: fixed-rate bonds, 90</i>	
5	Parameterized models and calibration	97
6	The Monte Carlo framework	99
6.1	Path generation	99
	<i>Random-number generation, 99 • Stochastic processes, 103 • Random path generators, 115</i>	
6.2	Pricing on a path	120
6.3	Putting it all together	122
	<i>Monte Carlo traits, 122 • The Monte Carlo model, 125 • Monte Carlo simulations, 128 • Example: basket option, 132</i>	
7	The tree framework	141
7.1	The Lattice and DiscretizedAsset classes	141
	<i>Example: discretized bonds, 147 • Example: discretized option, 152</i>	
7.2	Trees and tree-based lattices	155
	<i>The Tree class template, 155 • Binomial and trinomial trees, 159 • The TreeLattice class template, 170</i>	
7.3	Tree-based engines	176
	<i>Example: callable fixed-rate bonds, 176</i>	
8	The finite-differences framework	183
9	Conclusion	185



Appendices

A	Odds and ends	189
A.1	Basic types	189
A.2	Date calculations	190
	<i>Dates and periods, 190 • Calendars, 190 • Day-count conventions, 192 • Schedules, 192</i>	
A.3	Error reporting	194
A.4	Finance-related classes	195

	<i>Market quotes, 196 • Interest rates, 199 • Indexes, 200 • Exercises and payoffs, 206</i>	
A.5	Math-related classes	206
	<i>Interpolations, 206 • One-dimensional solvers, 206 • Statistics, 206</i>	
A.6	Global settings	206
A.7	Utility classes	208
	<i>Smart pointers and handles, 208</i>	
A.8	Design patterns	211
	<i>The Observer pattern, 212 • The Singleton pattern, 213 • The Visitor pattern, 213</i>	
B	Code conventions	215
		
	QuantLib license	219
	Bibliography	223