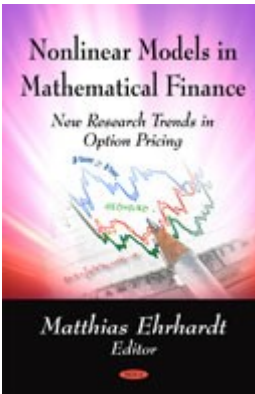


Novel Methods in Computational Finance

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In this lecture series, we will discuss a wide variety of modern numerical methods in computational finance. Parts of the lecture are based on our textbook “Nonlinear Models in Mathematical Finance: New Research Trends in Option Pricing”, 2008 and our book “Novel Methods in Computational Finance”, Vol. 25 of the Springer series Mathematics in Industry, 2017. We will give a broad overview on recent trends in computational finance.

Outline:

Lecture 1-2, Day 1: Negative interest rates: The SABR Model and its numerical solution.

Lecture 3-4, Day 2: Nonlinear Black-Scholes Equations, High-order compact Schemes

Lecture 5-6, Day 3: Stochastic Correlation Approaches in Finance

Lecture 7-8, Day 4: Sparse Grid Methods and the Combination Technique

Lecture 9-10, Day 5: WENO Methods in finance (and their enhancement by Machine Learning)

In case there is time left we may add spontaneously topics like

- Hybridisation with Pseudo-Spectral methods
- Extrapolation, Parallel-in-time approach
- Solving Forward-Backward SDEs with GPUs

- Lie Group integrator in Computational Finance
- Model order reduction approaches in Finance
- Valuation of Basket Credit Default Swaps
- Pricing Swing options in electricity markets with partial-integro differential equations
- Tree Methods for Hamilton-Jacobi-Bellman Equations

Some recent References:

- [1] M. Muniz, M. Ehrhardt and M. Günther, *Approximating correlation matrices using stochastic Lie group methods*, Mathematics 2021, 9(1), 94. DOI: 10.3390/math9010094
- [2] A. Clevenhaus, M. Ehrhardt, M. Günther and D. Sevcovic, *Pricing American Options with a Non-constant Penalty Parameter*, J. Risk Financial Manag. 13(6) (2020), 124. DOI: 10.3390/jrfm13060124
- [3] L. Teng, X. Wu, M. Günther and M. Ehrhardt, *A new methodology to create valid time-dependent correlation matrices via isospectral flows*, ESAIM: Mathematical Modelling and Numerical Analysis (M2AN), Volume 54, Number 2, (March-April 2020), 361-371. DOI:10.1051/m2an/2019064
- [4] M.C. Calvo-Garrido, M. Ehrhardt and C. Vázquez, *Jump-diffusion models with two stochastic factors for pricing swing options in electricity markets with partial-integro differential equations*, Appl. Numer. Math. Vol. 139 (May 2019), 77-92. DOI:10.1016/j.apnum.2019.01.001
- [5] L. Teng, M. Ehrhardt and M. Günther, *Quanto Pricing in Stochastic Correlation Models*, Intl. J. of Theoret. & Appl. Finance Vol. 21, No. 05, 1850038 (2018).
- [6] I. Kossaczký, M. Ehrhardt and M. Günther, *A new convergent explicit Tree-Grid Method for HJB equations in one space dimension*, Numer. Math. Theor. Meth. Appl. Vol. 11, No. 1, Feb. 2018. DOI: 10.4208/nmtma.OA-2017-0066
- [7] C. Hendricks, M. Ehrhardt and M. Günther, *Hybrid finite difference / pseudospectral methods for the Heston and Heston-Hull-White PDE*, J. Comput. Finance Vol. 21, No. 5 (April 2018), 1-33. DOI: 10.21314/JCF.2018.342

Short Bio

Prof. Dr. **Matthias Ehrhardt** is full professor at the Chair of Applied Mathematics and Numerical Analysis at the University of Wuppertal. He is the editor of different international journals and since 2020 he is one editor of the *SeMA Journal Bulletin of the Spanish Society of Applied Mathematics*. Also, since 2020 he is the representative of Germany in the Council of the European Consortium for Mathematics in Industry (ECMI) and organizes the forthcoming (virtual) ECMI 2021 conference as well as the postponed *International Conference of Computational Finance*, June 6-10, 2022. He has also been the coordinator of the EU Marie Curie network ITN STRIKE *Novel Methods in Computational Finance*, from 2013-2017. His research focus is on developing and analysing novel numerical methods for the solution in different application fields, including computational finance. He has written 9 books, 23 Chapters and 80 peer-reviewed research articles.

