An Overview of the NMOF Package

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1 The book and the package

1.1 The book

'Numerical Methods and Optimization in Finance' (NMOF, Gilli et al., 2019) is about tools for computational finance, with emphasis on simulation and optimisation. Many chapters are organised as case studies, covering topics such as portfolio insurance or the valuation of financial derivatives. In particular, several chapters explain optimisation heuristics and show in detail how to use these methods for portfolio selection or the calibration of option pricing models. Some highlights:

- Simulation: how to create random variates under specified marginal distributions; how to induce cross-sectional correlation (beyond Cholesky for Gaussian variates) and serial dependencies; examples for copulæ; resampling, bootstrapping data sets.

- Option pricing: binomial trees, finite differences and Monte Carlo simulation; but also integration methods for pricing with the characteristic function (eg, Heston, Bates, Variance-Gamma). Calibration of surfaces under such models.

- Portfolio optimisation: methods to optimise portfolio under any objective function (eg, drawdown, partial moments) and constraints (eg, cardinality constraints). Sample programs for classical mean-variance analysis are also included.

- Backtesting: testing trading and investment strategies: overfitting, data preparation, and the effects of randomness. Software for backtesting; running backtests in parallel; sensitivity and robustness checks.

- Yield-curve calibration: various strategies how to calibrate a yield-curve model: through fitting to bootstrapped yields, to bond prices or to yields-to-maturity.

1.2 The package

The NMOF package provides many of the code examples and data sets used in Gilli et al. [2019]; it also contains several functions that have not been described in the book. Notably, the package provides implementations of a number of optimisation heuristics, among them Differential Evolution and Genetic Algorithms. There are also functions for valuing financial instruments, such as bonds and options, and helper functions for stochastic simulations.

2 What's in the package

2.1 Optimisation

There are functions for Differential Evolution (`DEopt`), Genetic Algorithms (`GAopt`), (Stochastic) Local Search (`LSopt`), Particle Swarm (`PSopt`), Simulated Annealing (`SAopt`), Threshold Accepting (`TAopt`) and grid search (`gridSearch`).

2.2 Pricing financial instruments

For options, see `vanillaOptionEuropean`, `vanillaOptionAmerican`, `putCallParity`. For pricing methods that use the characteristic function, see `callCF`. For bond/bond-futures pricing, see `vanillaBond`, `bundFuture` and `xtContractValue`.

2.3 Simulation

See `resampleC`, `mc` and `repairMatrix`.

2.4 Datasets

See `bundData`, `fundData` and `optionData`.

2.5 Code examples from the book

All R code examples in the book can be displayed (and used) via the function `showExample`. Call it without any argument to see all examples.

```
> showExample()
                                        Chapter                        File
1                               01_Introduction              Introduction.R
2   03_Linear_equations_and_Least_Squares_problems  Appendix_linear_systems.R
3                              05_Binomial_trees            Binomial_Trees.R
4                        07_Modeling_dependencies               Gaussian2.R
5                        07_Modeling_dependencies                Spearman.R
6                        07_Modeling_dependencies                   randn.R
7                        07_Modeling_dependencies                    tria.R
8              12_Heuristic_methods_in_a_nutshell  Appendix_NMOF_heuristics.R
9              12_Heuristic_methods_in_a_nutshell               Heuristics.R
10                 13_Heuristics_-_a_tutorial       Heuristics_tutorial.R
 [ reached 'max' / getOption("max.print") -- omitted 8 rows ]
```

2.6 Vignettes

The package comes with a number of tutorials, written as vignettes. See `?vignette` for how to extract the code from these documents.

```
> vignette(package = "NMOF")   ## display vignette titles
```

3 Other resources

3.1 Websites

The book's website: `http://nmof.net`

The package's website: `http://enricoschumann.net/NMOF`

The stable version is available from CRAN. The development version is available from
    `http://enricoschumann.net/R/packages/NMOF/index.htm`

To install the development version from an R session, type:

```
> install.packages("NMOF",
                   repos = c("http://enricoschumann.net/R",
                             getOption("repos")))
```

The package source code is also available in the GitHub repository
`https://github.com/enricoschumann/NMOF`.

The book's source code examples are available from GitLab:
`https://gitlab.com/NMOF`.

3.2 Manual

A manual is available from `http://enricoschumann.net/NMOF.htm#NMOFmanual`, though it is still work in process. The code examples from the manual are also available from that site.

3.3 Tests

A goal for the NMOF package is to provide reliable code. Thus, a large number of test cases is included.

```
Package version  2.1-0
Number of tests: 2476
```

These tests are stored in subdirectory `unitTests`.

3.4 News, feedback and discussion

New package releases and other news related to the book or the package are announced on the `NMOF-news` mailing list:

`https://lists.r-forge.r-project.org/cgi-bin/mailman/listinfo/nmof-news`

An RSS feed of the package NEWS file is available at

`http://enricoschumann.net/R/packages/NMOF/NMOF_news.xml`.

Applications, as long as they are finance-related, should be discussed on the `R-SIG-Finance` mailing list:

`https://stat.ethz.ch/mailman/listinfo/r-sig-finance`

Please send bug reports or suggestions directly to the package maintainer, for instance by using `bug.report`.

```
> library("utils")
> bug.report("[NMOF] Unexpected behaviour in function XXX",
             maintainer("NMOF"), package = "NMOF")
```

References

Manfred Gilli, Dietmar Maringer, and Enrico Schumann. *Numerical Methods and Optimization in Finance*. Elsevier/Academic Press, 2nd edition, 2019. URL `http://enricoschumann.net/NMOF`.