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Stefano M. Iacus · Nakahiro Yoshida

Simulation and Inference for Stochastic Processes with YUIMA

A Comprehensive R Framework for SDEs and Other Stochastic Processes

Springer

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To Maite, Lucy and Ludo,
to whom I wish to find what gives
their life true meaning and purpose

and to Tizy,
whose heart I met late in my life,
but, thanks God, not too late!

Stefano M. Iacus

Preface

Statistics for stochastic processes is rapidly developing. It forms a branch of mathematical sciences, spreading over theoretical statistics, probability theory, software development and real data analysis. Since a general theoretical framework of statistical inference for stochastic processes was recently established, statistical inference has been applicable to various stochastic systems and its scope is expanding more and more from ergodic to nonergodic processes, from low-frequency regular to high-frequency irregular sampling schemes, from linear to nonlinear models, and so on.

The formulas provided by the theory are often fairly complicated, and it makes it difficult for nonexperts to use them in their own fields. For example, an asymptotic expansion formula derived by the Malliavin calculus involves hundreds of terms, the Bayesian estimator theoretically validated recently needs modern MCMC methods for computation in practice, and some random number generators for simulation of Lévy-driven stochastic differential equations use quite sophisticated algorithms. Software implementation is an issue in such circumstances.

YUIMA is a computational framework for statistical analysis and simulation for stochastic processes, especially objects described in terms of the stochastic analysis. YUIMA is designed to realize a circle of data analysis, modelling, fitting, simulation, and prediction. Through YUIMA, the user enjoys easily, without depending on his/her expertise, the latest developments in theoretical statistics for stochastic processes.

The YUIMA Project was launched by Stefano Maria Iacus and Nakahiro Yoshida, respectively, an R guru and a dreamer, after a three-person discussion around 2005 set by Masayuki Uchida. Supported by Japan Science and Technology Agency PRESTO (2007–2011), the project implemented a basic structure on R and extended by inviting Hideitsu Hino, Hiroki Masuda, Yasutaka Shimuzu, Kengo Kamatani, Alexandre Brouste, Masaaki Fukasawa and Teppei Ogihara. Hino with the Waseda University team was quite active in programming many YUIMA functions. Collaboration with Kenji Kashiwakura and Kentaro Hoshi with their NS Solutions team in 2012–2016 is acknowledged. The YUIMA Project got new members Yuta Koike, Ryosuke Nomura, Lorenzo Mercuri, Yusuke Shimizu,

Shoichi Eguchi, Yuma Uehara, Yuto Yoshida, Emanuele Guidotti and many other young people. Most of them are mathematical statisticians, and this is the reason why the functions of YUIMA are structurally designed with rigorous mathematical backing. Presently, the YUIMA Project (YUIMA III) is supported by Japan Science and Technology Agency CREST led by Prof. Takashi Tsuboi. Special thanks go to Prof. Shigeo Kusuoka for his great support for statistics in mathematics. The authors also thank Mrs. Sayako Takehara and Miss Homare Yoshihira for their help as the secretaries of the laboratory.

We also need to thank MIUR—Ministero dell'Istruzione, dell'Università e della Ricerca, Grant: PRIN 2009JW2STY, for supporting the early work of Lorenzo Mercuri, Emanuele Guidotti and the first author on this project.

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Nakahiro Yoshida

Contents

Part I The YUIMA Framework