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Editorial

Special Issue "Computational Finance and Risk Analysis in Insurance"

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This Special Issue focuses on the rapid development of computational finance as well as on classical risk analysis issues in insurance that also benefit from modern computational methods. In recent years, both fields have entered the spotlight as popular areas for the application of machine learning methods.

As most of these methods are far removed from the everyday tools of the actuary and the financial engineer, we have collected research on innovative applications of machine learning tools as well as recent generalizations of the more classical algorithmic frameworks from the areas of finance and insurance.

While Richman and Wüthrich (2020), Krah et al. (2020) and Kremsner et al. (2020) consider new applications of neural networks in finance and insurance, Leduc and Nurkanovic Hot (2020), Mickel and Neuenkirch (2021), and Wang and Korn (2020) deal with the use of efficient algorithms for simulating and pricing problems encountered in advanced SDE frameworks. Moreover, Desmettre et al. (2020) and Hipp (2020) present solutions to pricing and dividend problems that require efficient numerical computations for explicit examples.

Wang and Korn (2020) examine the problem of pricing an American game option with default possibility. This problem is related to a reflected anticipated backward stochastic differential equation driven by Brownian motion and a mutually independent martingale in a defaultable setting. Two numerical algorithmic approaches, a discrete penalization scheme and a discrete reflected scheme based on a random walk approximation of the Brownian motion as well as a discrete approximation of the default martingale, are studied in implicit and explicit versions, respectively. Their convergence is shown and illustrated through application to the American game option pricing problem.

Leduc and Nurkanovic Hot (2020) introduce a flexible version of Joshi's split tree for pricing American put options. They develop the convergence theory in the European case and find a closed-form formula for the coefficients of $1/n$ and $1/n^{3/2}$ in the expansion of this error. Furthermore, they provide several optimized versions of the flexible split tree and identify closed-form formulae for the parameters of these optimal variants. In a numerical study, an optimized variant of the tree was able to significantly improve the performance of Joshi's original split tree in the American case.

By aggregating neural network calibrations, Richman and Wüthrich (2020) introduce the so-called *nagging* predictor. They provide convergence results for the family of Tweedie's compound Poisson models, which are usually used for general insurance pricing. In the context of a French motor third-party liability insurance example, the nagging predictor achieves stability at the portfolio level after about 20 runs. As it is not always possible to obtain such an excellent performance on an insurance policy level, two meta models are calibrated for the nagging predictor, and it is shown that these meta networks can approximate the nagging predictor well.

Hipp (2020) considers optimal dividend payment under the constraint that the with-dividend ruin probability does not exceed a given value α in most simple discrete De Finetti models. The value function $V(s, \alpha)$ for the initial surplus s of this problem is derived, as are the corresponding optimal dividend strategies and an algorithm for its computation.

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For a class of two-barrier strategies, explicit formulas for ruin probabilities are derived and values of dividend payments are presented.

Desmettre et al. (2020) investigate the pricing of European options in an incomplete market. They use Value-at-Risk and Expected Shortfall to define good deals in a financial market with a log-normally distributed rate of returns and show that the pricing bounds obtained from the Value-at-Risk exhibit non-smooth behavior under parameter changes. Additionally, they find situations in which the seller's bound for a call option is smaller than the buyer's bound. Using the connection between good deal bounds and the theory of risk measures, they obtain new insights into the finiteness and continuity of risk measures based on multiple eligible assets.

As a third contribution in a series, Krah et al. (2020) enhance the LSMC-method by the use of a neural network-based approach to construct the proxy function for an insurer's loss with respect to the risk factors the insurance business is exposed to. By applying feed-forward neural networks to a slightly disguised data set from a German life insurer, they show that an ensemble built from the 10 best derived neural networks shows an excellent performance compared to various regression methods applied before. Furthermore, they also comment on the interpretability of neural networks compared to polynomials for sensitivity analysis.

Kremsner et al. (2020) consider the solution of deterministic semilinear (degenerate) elliptic partial differential equations corresponding to optimal control problems over an infinite time horizon, such as the maximization of the expected discounted future dividend payments of an insurer. As these equations are high-dimensional when multiple economic factors are taken into account, they propose a novel deep neural network algorithm for solving such partial differential equations in high dimensions. Their method is based on the approximation of backward stochastic differential by means of deep neural networks.

Finally, Mickel and Neuenkirch (2021) study the weak error of discretization schemes for the popular Heston model; this is based on the exact simulation of the underlying volatility process. They establish weak order one for smooth payoffs without any assumptions on the Feller index of the volatility process for both Euler- and trapezoidal-type schemes for the log-asset price. They also observe the usual trade off between the smoothness assumption for the payoff and the restriction on the Feller index. Additionally, error expansions, which could be used to construct second-order schemes via extrapolation, are given.

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