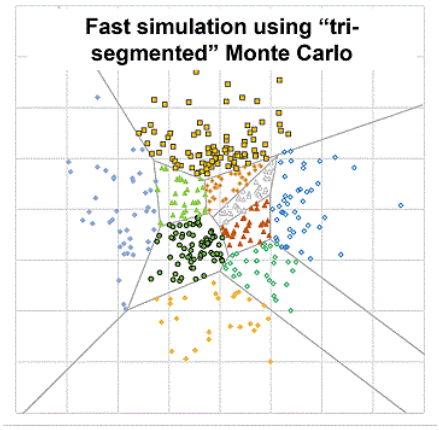
Tri-Segmented Monte Carlo Simulation

[Nematrian website page: TriSegmentedMonteCarlo, © Nematrian 2022]



Monte Carlo simulation

Financial firms and others who advise or regulate them often need estimates of the value of portfolios of assets and/or liabilities or of risk measures quantifying the risks to which such portfolios are exposed. Common risk measures used to quantify risk for such portfolios include value-at-risk (VaR), expected shortfall and tail value-at-risk (TVaR). For portfolios involving sufficiently simple payoffs, the relevant valuation and risk metrics may be expressible using just analytical formulae and the runtimes needed to calculate them may be quite low. However, for more complicated portfolios it is typically necessary to use simulation techniques. Simulation techniques are also used extensively in non-financial fields.

The traditional workhorse for this purpose is *Monte Carlo simulation*. In its most basic form, simulations are drawn randomly from the relevant probability distribution(s) characterising the economic drivers impacting the (present) value of the portfolio payoff. The payoff present values arising from each simulation are then calculated. The portfolio value is estimated as the average of these values. The portfolio VaR can be estimated by identifying the outcome below which only a specified fraction of losses arising from such simulations lie, in other words, from the relevant percentile (quantile) of the observed distribution of these simulated losses.

Unfortunately, the accuracy of results derived from (basic) Monte Carlo simulation exercises typically improves only in proportion to the square root of the number of simulations used. To improve accuracy 10-fold we thus need to use 100 times as many simulations. If the portfolio includes many more complicated assets or liabilities or if nested calculations are involved (in which quantification of the value of a payoff for a given simulation itself requires a simulation exercise) runtimes can easily become excessive. Firms may then use *proxy models*, approximating full book simulations, for day-to-day decision-making and monitoring. But proxy modelling comes with other complications such as a need to select a suitable proxy model and to justify why that model should be a suitable approximation to a full book simulation for the purpose in question.

Tri-segmented Monte Carlo (TSMC)

Nematrian has developed an approach, called tri-segmented Monte Carlo, that for many relevant problems seems capable of materially improved runtimes. Instead of applying all simulations to the portfolio, the simulations are split into 3 subsets, (1) an "underlying", (2) an "added" and (3) an

"extended" simulation set. The extended set is usually by far the largest of these three sets. Only the underlying and added sets are actually applied to the portfolio; the extended set is instead applied to only to a fast to evaluate approximation derived principally from the underlying simulation set. The added simulation set helps to correct for inaccuracies in this approximation.

A presentation summarising tri-segmented (trisegmented) Monte Carlo is available here: Efficient Monte Carlo simulation of portfolio value, value-at-risk and other portfolio metrics.

Demonstration tool

To help organisations unfamiliar with tri-segmented Monte Carlo (TSMC) understand better how it might help them, Nematrian has included on its website several Nematrian web service tools:

(a) MnDemoTSMC. This tool provides a cut-down demonstration version of Nematrian's full TSMC engine. Users can enter simulation data and other parameters that are similar in form to a subset of those needed by the full engine but with size limits on datasets and parameters to limit the CPU resources required to run the demonstration version.
(b) MnDemoTSMCSimGen. This tool allows users to create a simulation set of the sort needed for MnDemoTSMC.
(c) MnDemoTSMCValueSim. This tool allows users to apply simulations from MnDemoTSMCSimGen to a simplified portfolio which MnDemoTSMC uses to illustrate TSMC. The strikes, terms and underlyings of each of the instruments in this portfolio are available through MnDemoTSMCStrikes, MnDemoTSMCTerms and MnDemoTSMCUnderlyings.

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