A Fast and Accurate Numerical Method for the Left Tail of Sums of Independent Random Variables

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Special session: Variance reduction techniques for rare events

We present a flexible, deterministic numerical method for computing left-tail rare events of sums of non-negative, independent random variables. The method is based on iterative numerical integration of linear convolutions by means of Newtons–Cotes rules. The periodicity properties of convoluted densities combined with the Trapezoidal rule are exploited to produce a robust and efficient method, and the method is flexible in the sense that it can be applied to all kinds of non-negative continuous RVs. We present an error analysis and study the benefits of utilizing Newton–Cotes rules versus the fast Fourier transform (FFT) for numerical integration, showing that although there can be efficiency-benefits to using FFT, Newton–Cotes rules tend to preserve the relative error better, and indeed do so at an acceptable computational cost. Numerical studies on problems with both known and unknown rare-event probabilities showcase the method's performance and support our theoretical findings.