ALEXEY KUZNETSOV, York University, Toronto, Canada

Numerical computation of certain functionals of a Levy process using a combination of Wiener–Hopf and PIDE methods

A Levy process is a process with independent increments (a generalization of a random walk). Due to the rich structure and computational efficiency, these processes are being successfully applied to model various phenomena in Mathematical Finance and other areas of Science. In this talk we will discuss the problem of computing numerically the function $p(x\,;t,y)$—the joint density of the first passage time and the overshoot of a Levy process. This function can be used to price barrier and lookback options, it is also the main building block in various structural models in Credit Risk. It is known that $p(x\,;t,y)$ satisfies a linear partial integro-differential equation; moreover, using the Wiener–Hopf theory it can be expressed as a five-dimensional integral transform of known quantities. We will discuss the drawbacks associated with each of these approaches, and then we will introduce a new method, based on the combination of the above two. The PIDE method is used to obtain local information about $p(x\,;t,y)$ at $t=0$, while the Wiener–Hopf methods provide us with the global information in the form of the moments of this function. As the numerical example we will discuss the Normal Inverse Gaussian process.