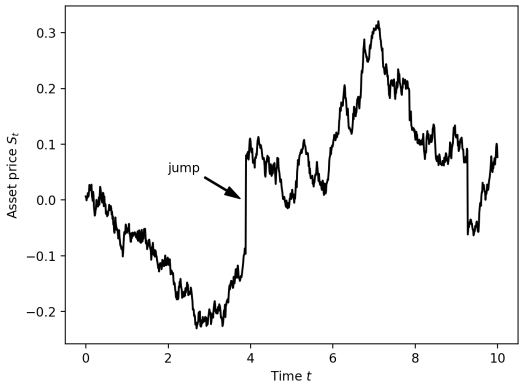
Background

In quantitative finance, the Black-Scholes equation was an important step in understanding how to price options. However, an obvious problem with the Black-Scholes model is that the equation is only valid if the price of the underlying asset S_t follows a Brownian motion, aka. a stochastic process W_t (that mathematicians refer to as Wiener process) such that $\forall u, t \leq 0, W_{t+u} - W_t \sim \mathcal{N}(0, u)$ (in addition to some technicalities).

It is widely known that in reality the prices of assets seldom behave like a Brownian motion - they have **jumps** of different sizes and with different frequencies, and they tend to be **skewed** favouring either going up or down. A more accurate assumption is to model the price of an asset as something called a Lévy process.

A Lévy process (technically speaking a sub-class of Lévy processes) can be though of as a combination of a Brownian motion (or possibly a stochastic process based on a stable distribution) with variance σ^2 and a compound Poisson process with intensity λ and jump sizes given by some probability measure $\nu(dx)$, and possibly a drift μ. The image on the right shows an example path of a Lévy process with $\nu(x) \sim \mathcal{N}(0, \sigma^2_{\text{jumps}})$ and no drift.



Project Idea

Estimating the parameters of a stochastic process underlying the price of a real asset is a well-studied problem in quantitative finance. I would like to train a neural network (or possibly several versions) to either:

- estimate the characteristic parameters (σ^2, μ, λ, $\nu(\cdot)$) (This would 'hard-code' the structure of a Lévy process into the NN)
- or use the NN itself as approximation of the probability distribution underlying the jump-diffusion

As training data, I could start with generated realizations of Lévy process with known parameters. Later, I would like to tests the so trained model on data of real asset prices. In this case I would have to use some other statistical method to estimate the Lévy process parameters of these real assets and compare those to the results of the NN.

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