What does randomness tell us about risk?

Randomness is used to explain the risk in financial systems. In any real market, the future prices are uncertain due to many unpredictable factors and randomness is a way to address this uncertainty formally.

Risk can be seen when we look at how widely outcomes can differ. The more randomness a system has, the more spread there is between best-case and worst-case scenarios. A highly predictable asset has low randomness and therefore low risk, whereas an asset with large randomness has high risk.

Risk cannot be eliminated by forecasting hence we implement some kind of randomness in simulation too representing the volatility of the system. When we simulate GBM price paths, the random term represents all the unpredictable events that move markets day to day. Even if we start at the same price and use the same parameters, each path ends up different. This variation across outcomes is what we mean by risk.

By modeling randomness and running simulations, we can estimate probabilities of loss, expected ranges of outcomes, and potential extremes. This turns uncertainty into something we can reason about and make decisions around.