Project: Monte Carlo Option Pricing

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Date: October 2025

Objective

Price a European call option via Monte Carlo simulation under Geometric Brownian Motion (GBM), and compare the estimate to the Black–Scholes closed-form solution.

Setup & Parameters

S0 = 100.0, K = 105.0, r = 0.02, sigma = 0.2, T = 1.0 year(s), steps = 252, paths = 20000.

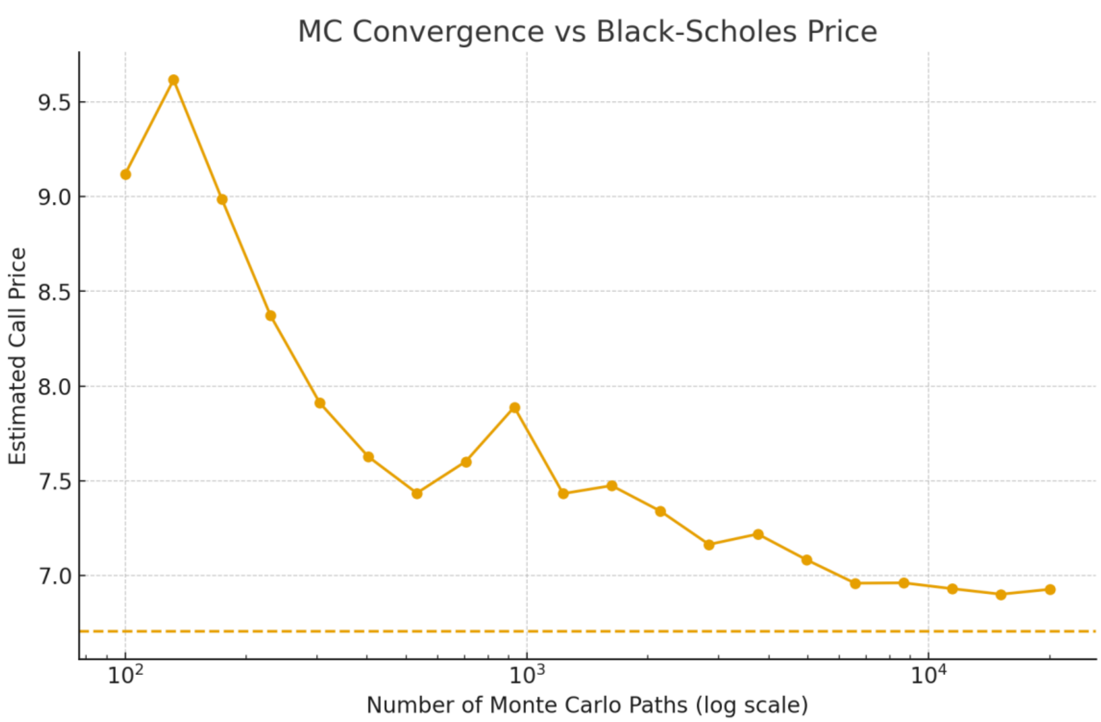
Methodology

- Simulate GBM paths using daily steps and risk-neutral drift.
- Compute terminal payoff max(S_T − K, 0) and discount at r to present value.
- Estimate price as the average discounted payoff; report standard error.
- Compare the Monte Carlo estimate with the Black–Scholes price.

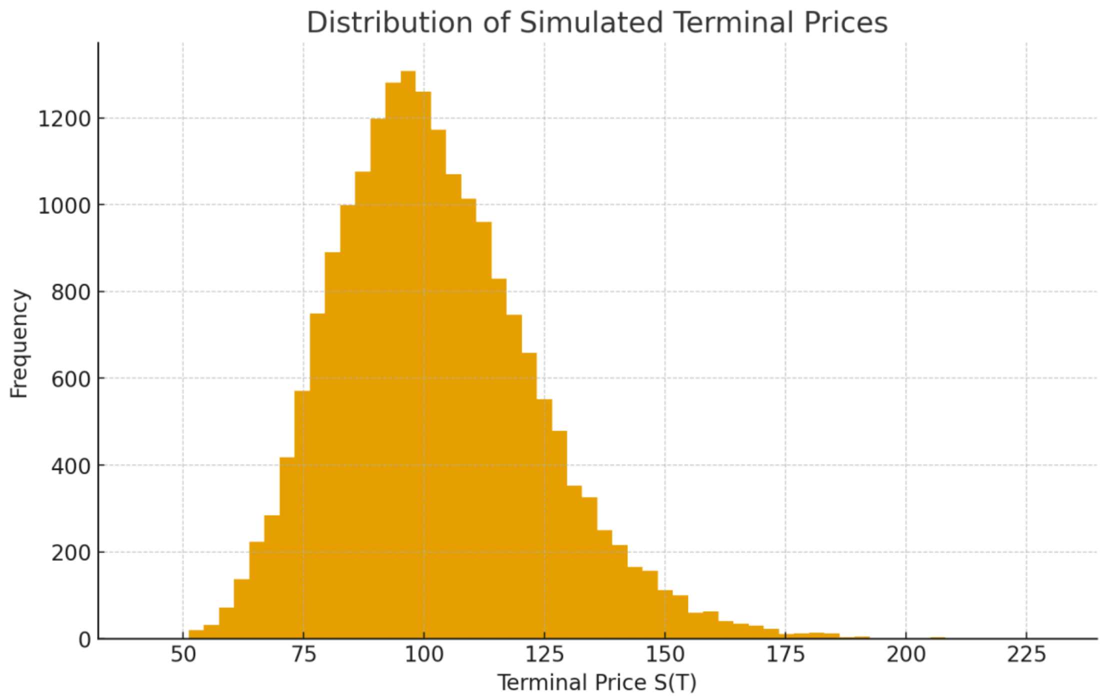
Results

Monte Carlo price (±SE): 6.9277 ± 0.0884
Black–Scholes price: 6.7048

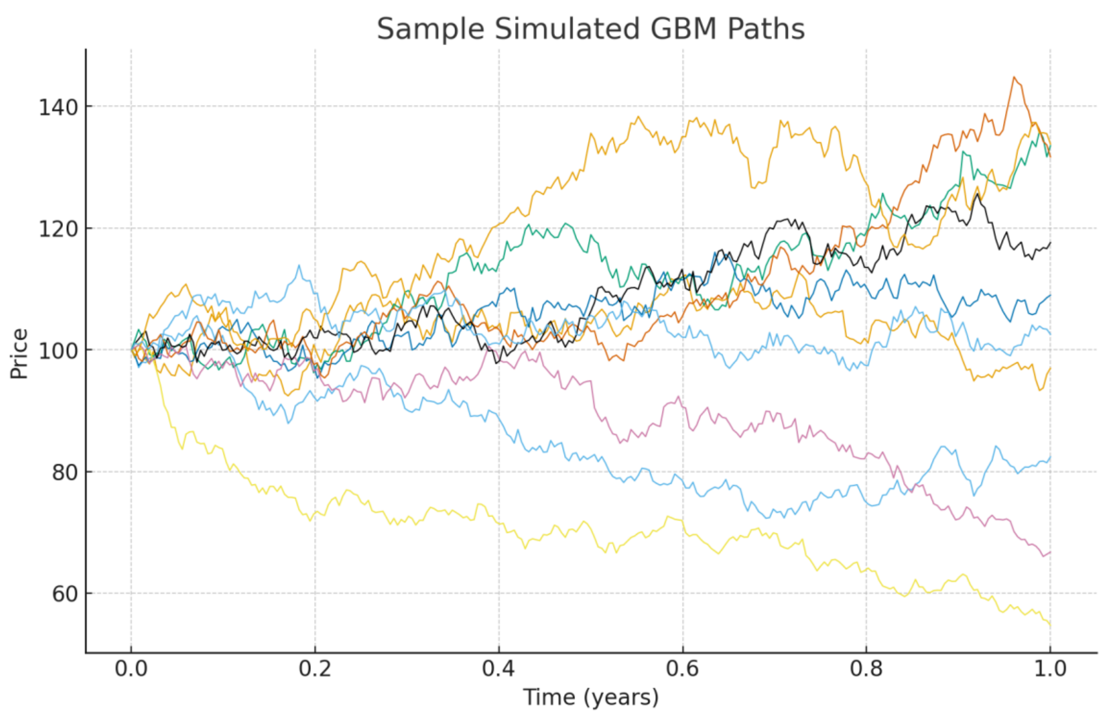
Convergence of Monte Carlo estimate to Black–Scholes as the number of paths increases:



Distribution of simulated terminal prices S(T):



Sample of simulated GBM price paths:



Discussion & Notes

The Monte Carlo estimate converges toward the Black–Scholes price as the number of paths grows. Increasing path count lowers the standard error at the cost of computation time. Extensions include variance reduction (antithetic variates, control variates) and pricing path-dependent options (Asian, Barrier).