Stochastic Model Report: General Brownian Motion on Clinical Data

BSc Operations Research 4.1

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Introduction

This report explores the application of a General Brownian Motion (GBM) model to a clinical dataset titled `COLORECTALCANCERCLIN_DATA_2023-06-06`. The dataset contains 17 records and 147 variables, including clinical and demographic data. The analysis focused on the `age` variable to simulate its stochastic progression over time. GBM is widely used in fields such as finance and biology to model random processes with drift and volatility, making it a suitable choice for this scenario.

Model

The GBM is defined by the formula:

$$X(t) = X(0)e^{(\mu - \frac{1}{2}\sigma^2)t + \sigma W(t)},$$

where $X(t)$ represents the value at time t, $X(0)$ the initial value, μ the drift rate, σ the volatility, and $W(t)$ the Wiener process. The parameters were set as $\mu = 0.01$, $\sigma = 0.05$, and $\Delta t = 1$. Using SAS, the model simulated 100 time steps for each record in the dataset. The starting value was derived from the `age` column.

Results

The simulation produced stochastic paths for `age`, illustrating possible future scenarios. Drift caused a consistent upward trend, while volatility introduced randomness. A time-series plot revealed these paths, showcasing variability across individuals. Such results highlight the potential for stochastic models to represent uncertainty in clinical data.

Conclusion

This study demonstrates the utility of GBM in modeling clinical variables. While preliminary, it provides a framework for analyzing time-dependent processes under uncertainty. The approach has applications in predictive modeling, scenario analysis, and decision support. Future work could expand the analysis to include additional variables, refine assumptions, and increase dataset size to improve accuracy and applicability.