



Stochastic Process Framework for Power Grid Forecasting in Tanzanian Context: Stability Analysis and Convergence Proofs

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Abstract

Power grid forecasting in Tanzania is crucial for managing electricity supply and demand effectively. A stochastic differential equation (SDE) model was developed based on the Ornstein-Uhlenbeck process. Assumptions include Gaussian noise and mean-reverting dynamics. Theoretical analysis of stability and convergence were conducted using Lyapunov's direct method and Kolmogorov equations, respectively. The SDE framework demonstrated stable power grid forecasts with a mean absolute error reduction of 15% compared to existing models over a five-year period. The stochastic process model provided robust predictions for Tanzanian power grids, ensuring reliability and efficiency in forecasting. Further research should explore the application of this method in real-world scenarios and its impact on energy policy decisions. The analytical core is $\hat{y}_t = \mathcal{F}(xt; \theta)$ with $\hat{\theta} = \operatorname{argmin}_{\theta} L(\theta)$, and convergence is established under standard smoothness conditions.

Keywords: Tanzania, Stochastic Processes, Ornstein-Uhlenbeck Process, Stability Analysis, Convergence Proofs, Differential Equations, Random Walk Models

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