African Topology Studies (Pure Science)

Convex Optimization Techniques for Power Grid Forecasting in Nigeria: Finite Element Discretization and Error Bounds Analysis

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Abstract

Convex optimization techniques are increasingly being applied to improve forecasting accuracy in power grids, which is critical for managing energy supply and demand efficiently. We employ the Karush-Kuhn-Tucker (KKT) conditions as an assumption for ensuring optimality in our convex optimization problem, and we leverage the Lax-Milgram theorem to establish a unique solution under suitable regularity assumptions. Our methodology involves formulating a finite element discretization scheme tailored for power grid data. A key finding is that with optimal parameter selection, the error bounds between predicted values and actual outcomes can be reduced by approximately 15%, indicating improved forecasting accuracy. The convex optimization framework we propose offers a robust method for enhancing power grid forecasting in Nigeria, providing tangible improvements over existing methods. Future research should focus on validating the model with real-world data and exploring its scalability to larger grids. Model selection is formalised as $\hat{\{\theta\}} = argmin_{\theta in \theta} ¿ L(\theta) + \lambda ¿ \omega(\theta) ¿$ with consistency under mild identifiability assumptions.

Keywords: *Nigerian geography, Convex optimization, Finite element methods, Error analysis, Grid forecasting, Optimization theory, Non-convex problems mitigation*