Matrix Decompositions for Power Grid Forecasting in Uganda: A Spectral Analysis and Condition Number Examination

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Abstract

Matrix decompositions are fundamental techniques in linear algebra used to simplify matrix operations, enhancing computational efficiency for various applications including power grid forecasting. A series of experiments were conducted using historical power grid data from Uganda's electric utility company. Spectral methods were employed to analyse the eigenvalues and singular values, while condition number analysis was used to evaluate matrix stability and sensitivity. A notable finding is that Singular Value Decomposition outperformed other methods in terms of reducing the condition number, indicating improved numerical stability for power grid forecasting models. The study concludes that matrix decomposition techniques can significantly enhance the accuracy and reliability of power grid forecasts in Uganda, particularly when using SVD. Power grid operators are encouraged to implement these methods as a routine part of their data analysis workflows to improve predictive modelling and resource allocation efficiency. The analytical core is $\hat{\{y\}}t = mathcal\{F\}(xt;\theta)$ with $\hat{\{\theta\}} = argmin_\theta L(\theta)$, and convergence is established under standard smoothness conditions.

Keywords: *Matrix Decomposition, Power Grid Forecasting, Uganda, Spectral Analysis, Condition Number, Linear Algebra, Eigenvalues*

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