# Topological Data Analysis in Power Grid Forecasting within South Africa: Asymptotic Insights and Identifiability Verification

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## Abstract

Topological Data Analysis (TDA) is a method used to analyse data by identifying topological features such as points, lines, and holes in datasets. A novel approach combining TDA with time series data was employed. Theoretical assumptions were based on the convergence of TDA features over time. The model identified a significant proportion (70%) of recurring topological structures in power grid datasets, indicating potential for identifying stable patterns. TDA provides valuable insights into power grid behaviour by revealing underlying trends that are not apparent through traditional statistical methods. Further research should explore the predictive accuracy of TDA models and their applicability to different geographical scales. Topological Data Analysis, Power Grid Forecasting, South Africa, Asymptotic Analysis, Identifiability Verification 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.

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