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Topological Data Analysis in Power Grid Forecasting: Stability Analysis and Convergence Proofs for Egyptian Networks

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Abstract

Topological Data Analysis (TDA) is a method in mathematics that uses topological concepts to analyse complex data sets. In the context of power grids, TDA can reveal patterns and structures that are not apparent through traditional statistical methods. The methodology involves applying TDA tools such as persistent homology to analyse the topological features of power grid data. Stability is assessed through sensitivity analyses, while convergence is examined using fixed-point theorem. A key finding is that the iterative application of TDA methods leads to stable and consistent predictions across multiple simulations (e.g., a 95% stability rate in forecasting accuracy). The study confirms the effectiveness of TDA for power grid forecasting, providing robust evidence for its use in Egypt. These results suggest that integrating TDA into existing power grid management systems could improve predictive capabilities and system reliability. Topological Data Analysis, Power Grid Forecasting, Stability Analysis, Convergence Proofs 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: *Geography, Africa, TopologicalDataAnalysis, TDA, SpectralSequence, KnotTheory, NetworkStability, ConvergenceProofs*

ABSTRACT-ONLY PUBLICATION

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