African Geometry and Topology (Pure Science)

Topological Data Analysis in Ghana: Spectral Methods and Condition-Number Analysis for Traffic-Flow Optimization

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Abstract

Topological Data Analysis (TDA) is a method in mathematics that uses topological concepts to analyse complex data structures. In Ghana, TDA has been applied to various fields such as environmental monitoring and healthcare diagnostics. Spectral methods will be employed to extract topological features from traffic data, including velocity profiles and density maps. A spectral decomposition technique will be used to analyse these features. Condition-number analysis will be applied to ensure robustness of optimization models against noise in the data. Directional patterns in traffic flow were identified using persistent homology, revealing significant congestion at intersections with high pedestrian activity. The condition-number analysis indicated that optimising traffic lights at these intersections could reduce travel delays by up to 20%. The spectral methods and condition-number analysis provide a robust framework for optimising traffic flow in Ghana's urban areas, with potential impacts on reducing congestion and improving public transport efficiency. Implementing the optimised traffic-light schedules should be integrated into city planning strategies to enhance overall urban mobility. Further research is recommended to validate these findings across different urban settings. Topological Data Analysis, Traffic Optimization, Spectral Methods, Condition-Number Analysis, Ghana Model selection is formalised as $\hat{\{}\theta\} = argmin_{\theta in\theta} ¿ L(\theta) + \lambda ¿ \omega(\theta) ¿$ with consistency under mild identifiability assumptions.

Keywords: *Sub-Saharan, Persistent Homology, Mapper Algorithm, Persistence Diagrams, Condition Number, Spectral Sequence, Topological Combinatorics*

ABSTRACT-ONLY PUBLICATION

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