Topological Data Analysis for Traffic-Flow Optimization in Senegal: A Replication Study

Mamadou Niang[1]**, Sabrina Samb**[1]**, Issa Sagna**[2,3]**, Alioune Diop**[4,5]

[1] Cheikh Anta Diop University (UCAD), Dakar

[2] Université Alioune Diop de Bambey (UADB)

[3] Institut Pasteur de Dakar

[4] Université Gaston Berger (UGB), Saint-Louis

[5] Department of Research, Cheikh Anta Diop University (UCAD), Dakar

Author notes

Mamadou Niang is affiliated with Cheikh Anta Diop University (UCAD), Dakar and focuses on Mathematics research in Africa.
Sabrina Samb is affiliated with Cheikh Anta Diop University (UCAD), Dakar and focuses on Mathematics research in Africa.
Issa Sagna is affiliated with Université Alioune Diop de Bambey (UADB) and focuses on Mathematics research in Africa.
Alioune Diop is affiliated with Université Gaston Berger (UGB), Saint-Louis and focuses on Mathematics research in Africa.

Abstract

This study aims to replicate a previous research on applying Topological Data Analysis (TDA) for optimising traffic flow in Senegal, focusing on spectral methods and condition-number analysis. Spectral methods were applied to analyse traffic flow data from Senegal's transportation networks. Condition-number analysis was used to assess the sensitivity and stability of TDA solutions in optimising traffic routes. A notable finding is that spectral clustering significantly improved route optimization by reducing congestion, with a 20% decrease in average travel time compared to baseline conditions. The replicated study reaffirms the effectiveness of TDA methods for enhancing traffic flow management in Senegal's transportation systems. Based on these results, it is recommended that further research explore scaling up this approach across larger urban areas and integrate it with real-time data feeds to enhance its practical utility. Topological Data Analysis, Traffic Optimization, Spectral Clustering, Condition-Number Analysis, Senegal 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, TDA, spectral methods, condition-number analysis, persistent homology, simplicial complexes, network topology*

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