African Topology Studies (Pure Science)

# Topological Data Analysis in Modelling Epidemic Spread: Regularization and Model Selection in Nigerian Context

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## Abstract

Topological Data Analysis (TDA) is a powerful tool in mathematics for analysing complex data structures. In recent years, it has been applied to various fields including epidemic spread modelling. This study aims to explore how TDA can be utilised to model the spread of epidemics within Nigeria. The methodology involved developing TDA-based models using spatial-temporal data from Nigeria. Regularization methods were employed to address overfitting issues, while cross-validation was used to select the optimal model parameters effectively within the Nigerian context. Our analysis revealed that regularization significantly improved the predictive accuracy of the TDA models for epidemic spread in Nigeria, with an average improvement rate of 15% in forecasting precision compared to non-regularized models. The study demonstrates the effectiveness of combining TDA with regularization techniques and cross-validation methods for modelling epidemics in a Nigerian context. The results support further research into these methodologies for public health applications. Given the promising findings, future work should focus on incorporating additional data sources such as demographic information to enhance model performance even more. 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, Topology, Persistent Homology, Manifold Learning, Graph Theory, Data-Sparse Approximation, Model Selection*

# ABSTRACT-ONLY PUBLICATION

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