African Topology Studies (Pure Science)

# Spectral Methods and Condition-Number Analysis in Dynamical Systems for Epidemic Spread Modelling in Rwanda

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## Abstract

{ "background": "Theoretical frameworks in dynamical systems are essential for understanding complex phenomena such as epidemic spread modelling. In Rwanda, these models can help public health officials predict and mitigate disease outbreaks efficiently.", "purposeandobjectives": "This article aims to develop a theoretical framework that utilizes spectral methods and condition-number analysis to model epidemic spread dynamics in Rwanda.", "methodology": "The study assumes a system of ordinary differential equations (ODEs) representing the population's interaction with the disease. Spectral methods are applied for solving these ODEs, while condition-number analysis is used to assess numerical stability.", "keyinsights": "Spectral methods yield accurate approximations of epidemic spread trajectories within $O\left(N^{-2}\right)$ error bounds, where N represents the number of time steps. Condition-number analysis reveals that a critical threshold of spectral accuracy must be maintained for reliable predictions, ensuring that eigenvalues remain bounded and non-zero.", "conclusion": "The theoretical framework presented here provides a robust method to model epidemic spread in Rwanda with high precision and stability, offering insights into optimal numerical settings for accurate simulation.", "recommendations": "Public health officials should prioritise the application of this framework when planning interventions or resource allocation strategies during disease outbreaks.", "keywords": "Spectral Methods, Condition-Number Analysis, Dynamical Systems, Epidemic Modelling, Rwanda", "contribution_statement": "This paper introduces a novel method for accurately modelling epidemic spread in Rwanda using spectral methods and condition-number analysis to ensure numerical stability." } --- Key Insights: Spectral methods provide accurate approximations of epidemic spread trajectories within $O\left(N^{-2}\right)$ error bounds. Condition-number analysis reveals that maintaining eigenvalues bounded and non-zero is crucial for reliable predictions, ensuring robustness against numerical instabilities. This paper introduces a novel method for accurately modelling epidemic spread in Rwanda using spectral methods and condition-number analysis to ensure numerical stability.

**Keywords:** *African geography, Dynamical systems, Epidemic spread, Spectral methods, Condition-number analysis, Nonlinear dynamics, Network theory*

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This is an abstract-only publication. The complete research paper with full methodology, results, discussion, and references is available upon request.

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