African Applied Mathematics (Pure Science)

Functional Spectral Analysis for Epidemic Spread Modelling in South Africa: Condition Numbers and Methods

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Abstract

Functional spectral analysis is a mathematical technique used to model epidemic spread in various regions, including South Africa. This approach involves analysing the eigenvalues and eigenvectors of matrices that represent the interactions between individuals within a population. A key assumption is that the population can be represented by a network where nodes correspond to individuals and edges represent interactions such as contact rates or infection probabilities. The methodology employs spectral methods for solving differential equations derived from compartmental models (e.g., SIR model). Condition numbers of these matrices are calculated to assess numerical stability. The analysis reveals that the condition number of the matrix representing interaction strengths in South Africa's population is significantly higher than in other regions, indicating greater sensitivity to input parameter variations. This finding suggests a need for more robust data collection and modelling techniques. This study provides insights into how functional spectral methods can be applied to epidemic spread models in specific geographical contexts, with implications for understanding disease dynamics and improving public health interventions. Future research should focus on validating these findings using real-world data from South Africa. Additionally, the robustness of the model should be tested under varying conditions such as different infection rates or population mobility patterns. epidemic spread, functional spectral analysis, condition numbers, SIR model, differential equations 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: *Functional Analysis, Spectral Methods, Condition Numbers, South Africa, Epidemiology, Matrix Theory, Dynamical Systems*

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