



# Spectral Methods and Condition Number Analysis in Numerical Optimization for Epidemic Spread Modelling in Nigeria: A Theoretical Framework

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### Abstract

Theoretical frameworks in numerical optimization are essential for understanding the dynamics of disease spread models, particularly in regions with varying healthcare resources and population densities. Spectral methods are employed to analyse the eigenvalues of matrices representing epidemiological models, while condition-number analysis provides insights into the sensitivity of these models under perturbations. A key assumption is that the model's parameters follow a normal distribution for simplicity in analysis. The theoretical framework presented here offers a robust method for optimising epidemic models in Nigeria. This approach can help policymakers better understand and mitigate disease outbreaks by providing more accurate and reliable predictions. Policymakers should consider incorporating the insights from this framework into their decision-making processes, especially when dealing with limited data or resource constraints. Model selection is formalised as  $\hat{\theta} = \operatorname{argmin}_{\theta \in \Theta} L(\theta) + \lambda \omega(\theta)$  with consistency under mild identifiability assumptions.

**Keywords:** Sub-Saharan, Optimization, Spectral, Condition Number, Epidemic, Nigeria, Modelling

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