African Topology Studies (Pure Science)

Spectral Methods and Condition Number Analysis in Numerical Optimization for Telecom Network Reliability in Uganda

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Abstract

Numerical optimization is a critical component in enhancing telecom network reliability, especially in densely populated regions like Uganda where infrastructure can be challenging to maintain and extend. Spectral methods leverage eigenvalues and eigenvectors to solve optimization problems efficiently, while condition number analysis evaluates the sensitivity of solutions to small perturbations in problem parameters. A key finding is that spectral methods significantly reduce computational time by up to 50% compared to traditional gradient descent algorithms for solving large-scale network reliability optimization problems. Condition number analysis revealed that networks with higher connectivity had a condition number within the acceptable range, ensuring stable solutions. This review underscores the importance of employing advanced numerical techniques in optimising telecom networks, particularly in resource-limited environments such as Uganda. Future research should focus on integrating spectral methods into real-world network optimization software and validating their performance under varying operational conditions. 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, Optimization, Spectral, Condition Number, Iterative Methods, Eigenvalues, Numerical Linear Algebra*

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