African Geometry and Topology (Pure Science)

Regularization and Cross-Validation in Numerical Optimization for Epidemic Spread Modelling in South Africa

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Abstract

Numerical optimization techniques are crucial for modelling epidemic spread by balancing model complexity with data fidelity. A hybrid method combining least squares regression with L1 regularization was employed. Cross-validation was used to optimise hyperparameters and prevent overfitting. The model selection process involved comparing multiple parameter configurations using metrics such as Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC). The findings indicate that the cross-validated models were able to predict epidemic dynamics with high accuracy, achieving an average prediction error of 12% across different regions in South Africa. The regularization parameter had a significant impact on model complexity and predictive performance. This study demonstrates the efficacy of regularization and cross-validation in optimising epidemic spread models, providing a robust framework for future research and policy-making. The proposed method should be further validated with additional datasets from various regions within South Africa to enhance its generalizability. Future work could explore ensemble methods combining different model configurations. 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, Least Squares, Lasso, Cross-Validation, Regularization, Optimization, Epidemiology*

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