African Geometry and Topology (Pure Science)

Regularity Constraints and Model Selection in Nonlinear Differential Equations for Epidemic Spread in South Africa: A Replication Study

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Abstract

This study focuses on the application of nonlinear differential equations to model epidemic spread in South Africa, with a particular emphasis on regularization techniques and cross-validated model selection. The study employs nonlinear differential equations to describe the dynamics of an epidemic in South Africa. Regularization constraints are applied to ensure model stability, and cross-validation is used to select the best-performing model based on predictive performance metrics. A key finding was that regularization significantly improved the accuracy of the models when compared to unregularized versions, reducing overfitting issues observed in previous studies. Cross-validation revealed a clear trend towards selecting simpler models with fewer parameters for better generalization. The replication study confirms the effectiveness of regularization and cross-validated model selection in epidemic modelling within South Africa's context. Future research should explore the impact of different regularization strategies on various types of data to further refine these methods. 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, Nonlinear, Differential, Equations, Epidemic, Model, Selection*

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