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A Comparative Analysis of Traditional and Structured Allometry Growth Models with Machine Learning Intergration

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This study presents a comparative analysis of traditional growth models with proposed models based on a structured allometry parameter theta, conditioned on the intrinsic rate of increase. Solutions to these proposed models were derived by solving their respective ordinary differential equations to model population size and predict demographic processes in Nigeria, with machine learning approaches employed to enhance predictive accuracy. By evaluating existing models against newly proposed frameworks, this research identifies the most effective approaches for capturing Nigeria's complex demographic dynamics. The exponential growth equation was modified through the introduction of a structured allometry parameter. Through a combination of visual representations and statistical metrics, a detailed picture of population trends and modeling effectiveness was established. The findings demonstrate varying applicability of mathematical growth models to Nigeria's demographic reality, with the proposed model 3 emerging as the most effective framework despite acknowledging persistent limitations common to all models. The application of machine learning approaches through systematic data partitioning and validation enhances methodological rigor in demographic modeling, moving beyond simple curve fitting to assess genuine predictive capability. Results suggest that future advances in demographic modeling will require interdisciplinary approaches integrating mathematical modeling with deeper understanding of socioeconomic factors, policy impacts, and migration patterns.

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