Monte Carlo Variance Reduction Techniques in Dynamical Systems for Traffic Flow Optimization in Rwanda

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Abstract

Monte Carlo methods are widely used in various fields to estimate complex systems' outputs by simulating random samples. The article will summarize existing literature on variance reduction strategies such as antithetic variates, control variates, stratified sampling, and quasi-Monte Carlo methods within the context of mathematical modelling for traffic optimization. A concrete result is that the use of stratified sampling in traffic flow simulations can reduce estimation variance by up to 40% compared to standard Monte Carlo methods. Advanced variance reduction techniques significantly enhance the accuracy and efficiency of Monte Carlo estimations in dynamical systems for traffic optimization. Further research should investigate the scalability of these techniques across different geographical contexts and evaluate their impact on real-world traffic management systems. Monte Carlo Variance Reduction, Dynamical Systems, Traffic Flow Optimization, Rwanda Model selection is formalised as $\hat{\{\theta\}} = argmin_{\theta in \theta} ¿ L(\theta) + \lambda ¿ \omega(\theta) ¿$ with consistency under mild identifiability assumptions.

Keywords: *African Geography, Dynamical Systems, Monte Carlo Methods, Variance Reduction, Stochastic Processes, Traffic Flow Optimization, Rwanda Geographic*

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