African Probability and Statistics (Pure Science)

Monte Carlo Estimation Variance Reduction in Dynamical Systems for Traffic Flow Optimization in Egypt

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Abstract

Theoretical investigation of Monte Carlo estimation variance reduction techniques in dynamical systems to optimise traffic flow in Egypt. This work proposes the use of stochastic differential equations (SDEs) to model traffic dynamics, integrating Monte Carlo simulations to estimate mean travel times and variance reductions across different road networks. The framework assumes a Markovian process for vehicle movements and incorporates an assumption that traffic densities follow a Poisson distribution. This theoretical framework provides a robust method for optimising traffic flow using Monte Carlo estimation with variance reduction techniques, offering significant improvements over existing approaches. Future research should validate these models through real-world simulations and evaluate their scalability across various urban settings in Egypt. Policy makers could then implement optimised traffic management strategies based on this theoretical framework. Model selection is formalised as $\hat{\{}\theta\} = argmin_{\theta in\theta} ¿ L(\theta) + \lambda ¿ \omega(\theta) ¿$ with consistency under mild identifiability assumptions.

Keywords: *Egypt, Monte Carlo method, Dynamical systems, Stochastic processes, Variance reduction, Traffic flow optimization, Differential equations*

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