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Monte Carlo Estimation with Variance Reduction for Numerical Optimization in Senegal's Water-Resource Allocation: A Replication Study

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Abstract

Monte Carlo estimation is a statistical method used for numerical optimization in complex systems such as water-resource allocation. Variance reduction techniques are employed to enhance the efficiency and accuracy of Monte Carlo simulations. A Monte Carlo simulation with variance reduction techniques was applied to a simplified model representing Senegal's water resources. The process involved generating random samples and applying variance reduction methods such as control variates and importance sampling. The findings indicated that the variance reduction techniques significantly reduced the standard deviation of the estimated allocations, leading to more precise results with fewer iterations. This study confirmed the efficacy of variance reduction in enhancing Monte Carlo estimation for numerical optimization problems in water-resource allocation. Future research could explore the application of these methods in real-world scenarios and investigate their scalability under different conditions. 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, Monte Carlo Method, Variance Reduction, Numerical Optimization, Stochastic Processes, Simulation Studies, Water Resource Management*

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