UNIVERSITY OF LONDON

THE LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE

Metropolis-Hastings algorithm

ST2195 - Programming for data science

Coursework Project 2023-24

Part 1 – Report

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(1 page – excluding table of contents and references)

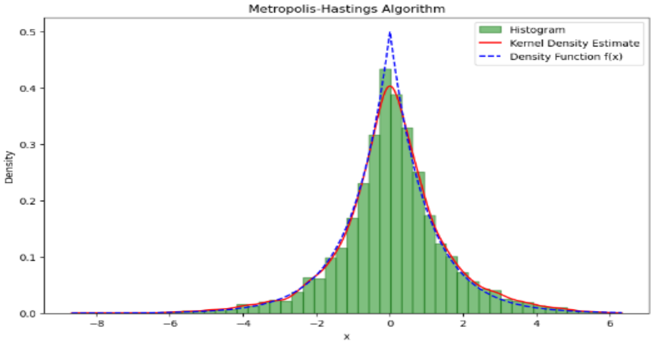
Contents

01. Introduction:

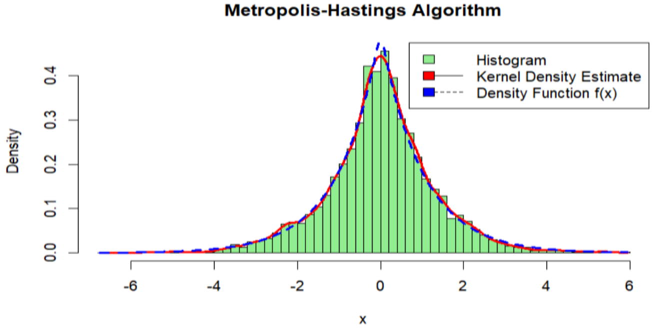
This report presents an extensive overview of the Metropolis-Hastings algorithm's use, illustrating the algorithm's accuracy and convergence when simulating random sequences of n samples from a given distribution.

02. Histogram and Kernel Density Plot:

Python



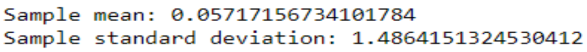
R



The distribution of the sequence of n samples is shown visually by the histogram and Kernel Density Estimate (KDE). We can assess how closely the samples generated fit the intended distribution function by overlaying the actual distribution. An intuitive comprehension of the simulation process's accuracy in capturing the underlying distribution is made possible by this comparison. This comparison helps us see how well the generated samples match the intended distribution.

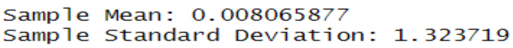
03. Monte Carlo Estimates:

Python



```
Sample mean: 0.05717156734101784
Sample standard deviation: 1.4864151324530412
```

R

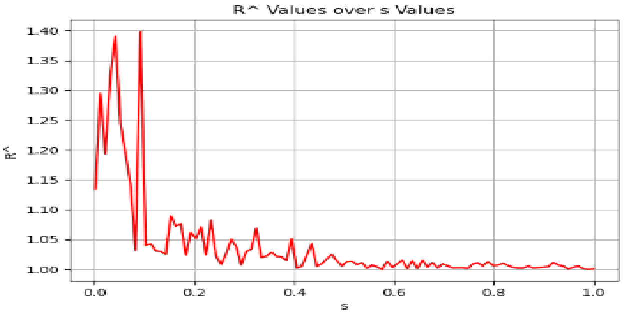


```
Sample Mean: 0.008065877
Sample Standard Deviation: 1.323719
```

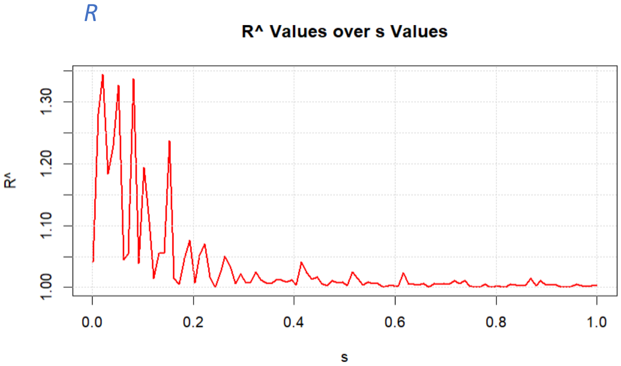
The sample mean represents average clustering of outcomes, estimating central tendency. The sample standard deviation reflects the dispersion from the mean, indicating variability; higher values imply more variability, lower values suggest consistency.

04. Convergence assessment plot with R^ values:

Python



R



The R^ figures reveals how well the Metropolis-Hastings algorithm converges across different s values. As R^ values decrease, it shows a higher level of convergence and this suggests that the algorithm is effective.

05. Conclusion:

The Metropolis-Hastings method generated samples that complied with the given probability density function, as demonstrated by the R^ value evaluation, which showed excellent results with the convergence to 1.

06. Recommendations:

We can try changing the step size *s* in the Metropolis-Hastings algorithm and see how it affects the results. This helps us see how the algorithm reacts to changes and if it converges smoothly. Additionally, to aid our results, use multiple other convergence tests like “Raftery-Lewis diagnostic, Gelman-Rubin diagnostic and autocorrelation plots”, etc.

07. References:

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  Other sub-links for the r codes taken:
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