1 Conclusion

As shown in this paper the sample size and Mandelbrot function iterations applied can have significant effect on the results obtained for the estimate of the Mandelbrot area. It was shown that while not having a statistically significant impact on the mean value increasing the sample size for any method drastically decreases the variance resulting in a higher level of confidence in the answer. Conversely, increasing the number of Mandelbrot iterations did not show a relevant impact on the variance but it could be shown that the mean area estimate approached the *true area* of the Mandelbrot set. It could additionally be observed that increasing the sample size and Mandelbrot iterations indefinitely did not necessarily yield better results. Instead the combination of parameters as well as the sampling method used determines up to which point statistically relevant differences could be observed.

It was shown that above a small threshold of sample size, orthogonal sampling produced significant difference, in terms of average area estimate, for a larger range of increasing Mandelbrot iterations than the other methods. While latin hypercube sampling out performed pure monte carlo sampling in the aspect, the difference between these methods was smaller than the gap to orthogonal sampling. Furthermore the gap to orthogonal sampling increased as the sample size was increased while the gap between monte carlo and latin hypercube sampling seemed to shrink.

Furthermore it was shown that increasing the sample size lead to more significant differences between latin hypercube and orthognal sampling in terms of variance, but reduced the relevant difference between latin hypercube and monte carlo sampling. It can therefore be concluded that from the tested sampling methods orthogonal sampling performs the best as it produces significantly lower variances while increasing the accuracy of its average estimate for a larger range of Mandelbrot function iterations. Additionally latin hypercube sampling outperformed pure monte carlo sampling. Lastly the gap between the latter two methods shrunk while increasing the experiment pararmeters while the gap from both of them to orthogonal sampling grew. However, this effect is expected to be offset past a specific threshold of sample size as such a large proportion of the sample space will be sampled by any method.

While using control variates to lower the variance of the individual sampling techniques could not been proven to have a significant statistical impact, it seems plausible that a different choice of variable, having a larger covariance with the estimated area of the Mandelbrot set could produce the desired results.

This paper has shown that significant differences both between experiment parameters and sampling methods exist. For future research more variance reduction techniques can be explored and other potentially simple changes like exploiting the symmetry of the Mandelbrot set about the real axis could yield more accurate results.