

# MA 323 - Monte Carlo Simulation Assignment - 10

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## 1 TABULAR DATA:

| M      | $I_M$              | 95% confidence level for $I_M$ (Length = a) | $\hat{I}_M$        | 95% confidence level for $\hat{I}_M$ (Length = b) | Ratio of length of both intervals (a/b) |
|--------|--------------------|---|--------------------|---|---|
| $10^2$ | 1.9530628367840035 | [1.863981446763257, 2.04214422680475]       | 1.9986463476134089 | [1.992488264044228, 2.0048044311825897]           | 14.4658                                 |
| $10^3$ | 1.9847265706875816 | [1.9570516696541143, 2.012401471721049]     | 1.9995305635503724 | [1.9975513498703716, 2.0015097772303734]          | 13.9828                                 |
| $10^4$ | 1.9914061973071622 | [1.9827862602887094, 2.0000261343256147]    | 2.000289999955245  | [1.9996547521285561, 2.0009252477819337]          | 13.5694                                 |
| $10^5$ | 1.9992837551561167 | [1.9965529966352606, 2.0020145136769725]    | 2.000121925755008  | [1.9999198410156243, 2.000324010494391]           | 13.5129                                 |

## 2 OBSERVATIONS:

| M      | Variance of I using Monte Carlo Estimator | Variance of I using Antithetic Estimator |
|--------|---|--|
| $10^2$ | 0.20657501273421114                       | 0.000987176877719643                     |
| $10^3$ | 0.19937741961107822                       | 0.001019739368283723                     |
| $10^4$ | 0.19342473177589758                       | 0.0010504858184052792                    |
| $10^5$ | 0.19412005821996686                       | 0.0010630920126407884                    |

1. The  $I_M$  converges to the value of 2 as M increases. Similar nature is observed for the value of  $\hat{I}_M$ .
2. Both  $I_M$  and  $\hat{I}_M$  values are almost same and the absolute difference between them decreases as M increases.
3. The variance is greatly reduced when the Antithetic Estimator is used, which is quite evident from the table above.