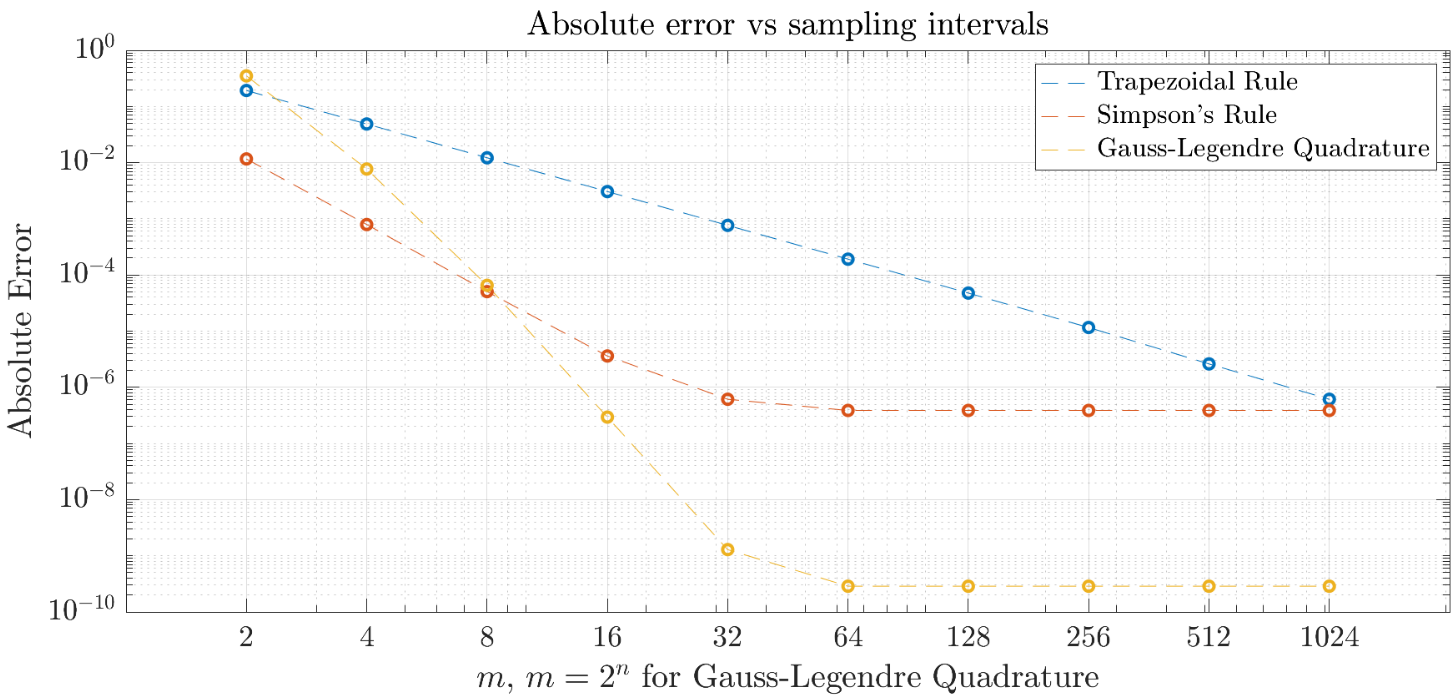
NE-591 OutLab 03: Analysis

Arjun Earthperson

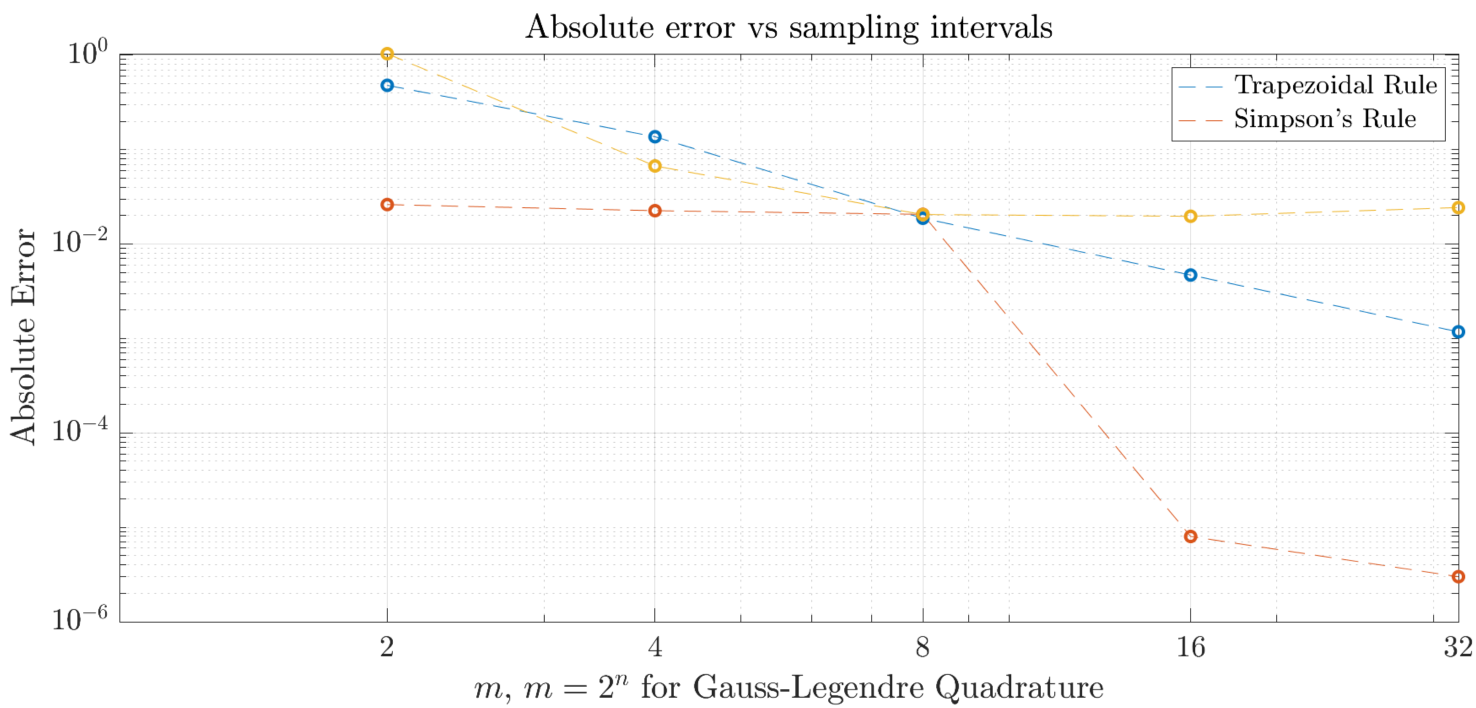
For f(x) = exp(x) for m = [2,4,8,16,32], the absolute error is plotted below on a log-log scale. For the Simpson's and Gauss-Legendre Quadrature rules, the error trend decreases exponentially from m = 2 through m=32, (n=5), but then slows down and becomes flat from m = 64 onwards. In our experiment, we test this until m=1024, n=10 (we implemented Newton-Raphson's root finding method to compute Gauss-Legendre polynomials for an arbitrary n). For the trapezoidal rule, the error decreases steadily, but never goes below than the Simpson's and Gauss-Legendre methods. At some point after m = 8, Gauss Legendre starts outperforming Simpson's method in terms of error.

f(x) = exp(x)

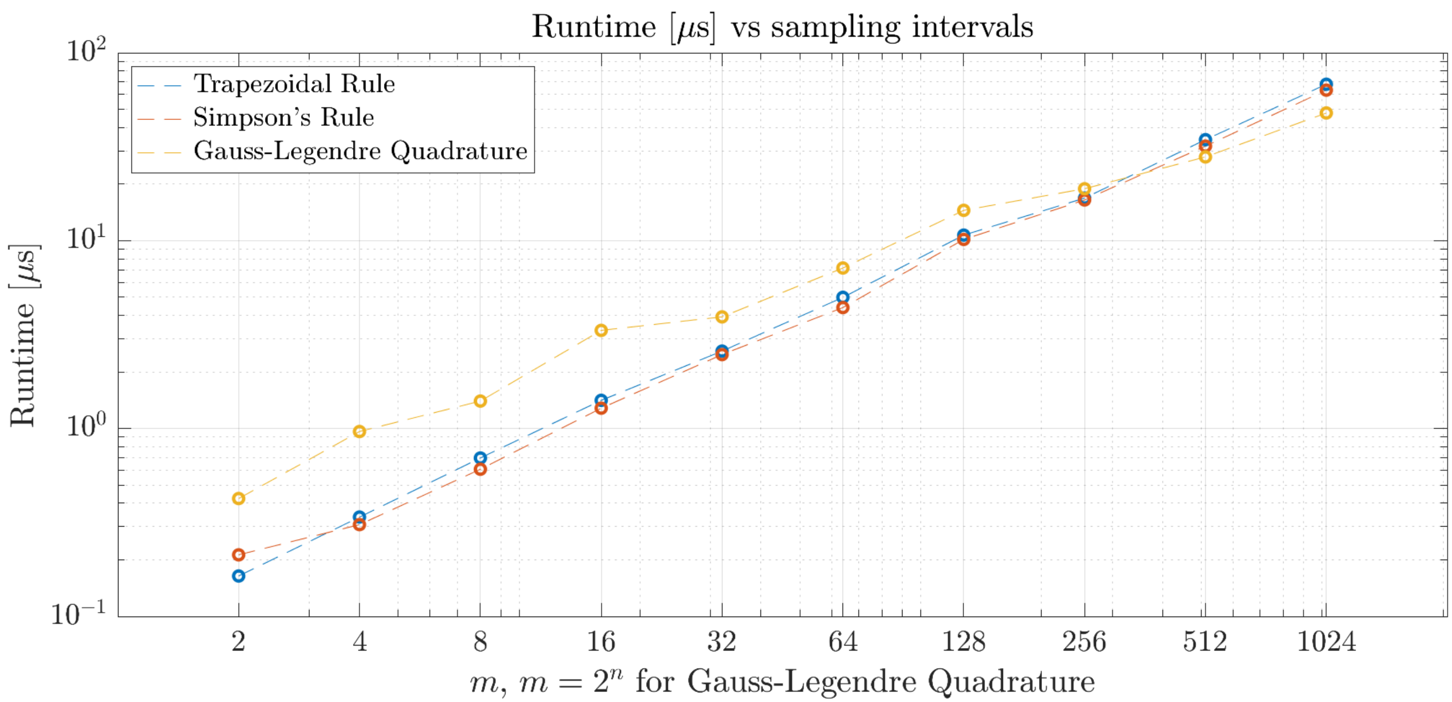


For this case, the error is higher.

$$\begin{cases} e^{-x+\frac{1}{4}}, -1 \leq x < 1/4 \\ e^{x-\frac{1}{4}}, 1/4 \leq x \leq 1 \end{cases}$$



f(x) = exp(x)



Runtime [μs] vs sampling intervals
Trapezoidal Rule
Simpson's Rule
Gauss-Legendre Quadrature
Runtime [μs]
10^2
10^1
10^0
10^{-1}
2
4
8
16
32
64
128
256
512
1024
m, $m = 2^n$ for Gauss-Legendre Quadrature