Problem 1

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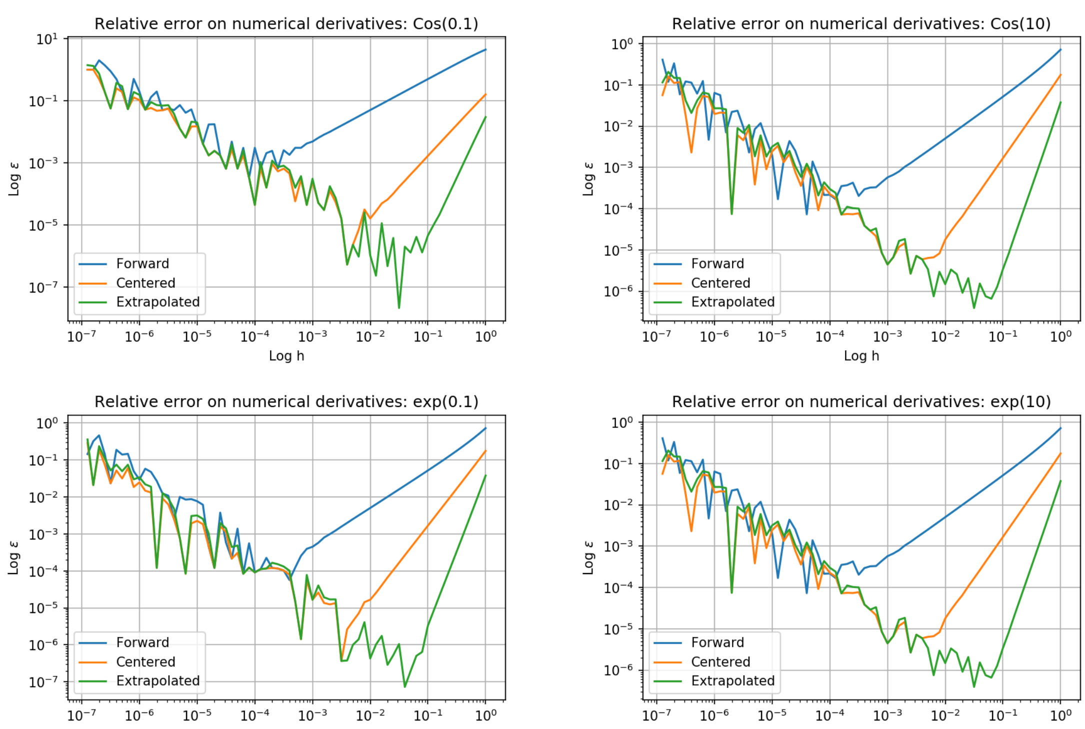
b)Since we are using single precision here and single precision is only accurate up to 10^{-7}, corresponding to 7 significant/decimal digits, it makes sense that our graph fits and scales with relative error up to 10^{-7}.

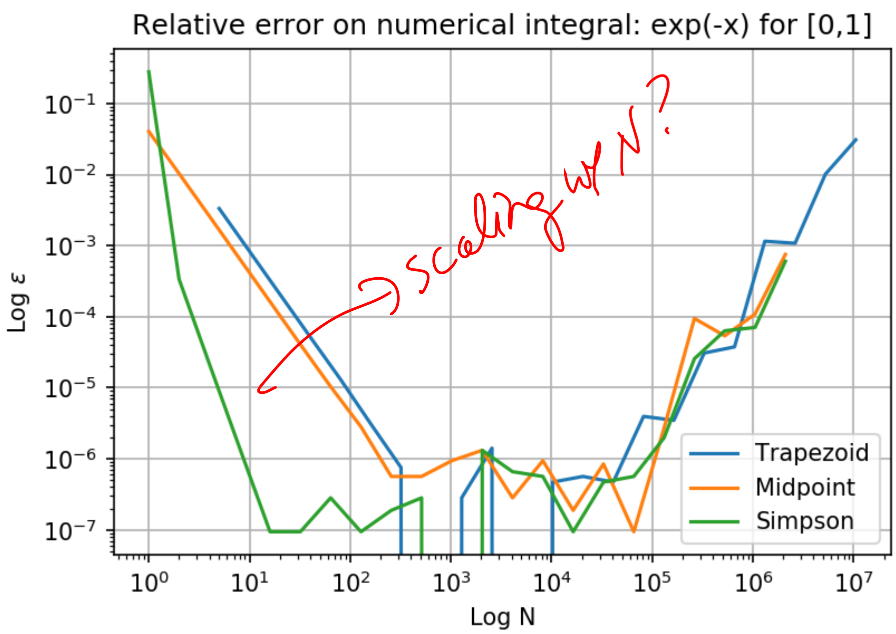
c) On the left hand side of the graph, we see that the round-off error is dominant because we are taking relatively small values of h, resulting in larger and larger relative errors. In that regime, all three methods result in close relative errors with the extrapolated difference and centred difference being almost identical and better than the forward difference. On the right hand side of the graph, as we make h larger, we are able to minimize the effect of roundoff error but the truncation error becomes more pronounced. Also, with larger values of h the derivative itself becomes less accurate, resulting in larger errors. In that case, the extrapolated difference is the most accurate, followed by the centered difference then forward difference. For the forward difference, we can only get half of the usual numerical precision for our derivatives. Since our precision is 10^{-7}-10^{-8} we should see about 3-4 digit precision on the derivatives, which is represented in the plots. The central difference is usually 100 times better than forward difference, but this is only obvious at large values of h. This is also indicated in the graph. The optimal value of h seems to be around 10^{-3}-10^{-4} for forward difference, around 10^{-3}-10^{-2} for centered difference and around 10^{-2}-10^{-1} for extrapolated difference.



good

Problem 2

c) For a relatively small amount of bins, Simpson's method gives significantly more accurate results than the Trapezoid and Midpoint rule which produce very similar results. In this regime, the accuracy depends more on the numerical integration method being used. As we take more number of bins, we see that this difference between the three integration methods becomes less and less pronounced. For large number of bins, starting around 10^5, we can see the effects of roundoff error, since large numbers of bins correspond to small values of h. In that case, all three methods have very close accuracies.



Problem 3

Towards the right hand side of the graph, at larger scales of r, we see a bump in the correlation function. This bump corresponds to the BAO bump and occurs at around 100-110 Mpc.

More details please.