1. Using the approaches described in Lesson 6, analyze the expected performance of your algorithm, and discuss how big N has to be for this kind of parallelization to be worthwhile. Time the runtime of the code and compare with your analysis.

Stage 0 – each process has N values that need to be sorted

Stage 1 – sort N values, quicksort. O(NlogN)

Stage 2 - separate values and insert them into an array for sendoff. O(pN)

Stage 3 – send sorted array of values to corresponding processes. $O((p - 1) * t_{comm})$

$T_s = N \log N + N$

$T_p = N \log N + Np + (p - 1) * t_{comm}$

$S = (N \log N + N)/ (N \log N + Np + (p - 1) * t_{comm})$

$E = 1 / 1 + ((Np + (p - 1) * t_{comm}) / (N \log N + N))$

$K = E / 1 - E$

$N \log N + N = K(Np + (p - 1) * t_{comm})$

p = 8 with k = 9 for 90% efficiency.

$N\log N + N = 72N + 63t_{comm}$

$N\log N - 71N = 0$

$N = 10^{71} + 63t_{comm}$

N must be at least 10^{71} to reach 90% efficiency. As we can see this algorithm is not practical for parallelization. It takes about N size 200000 for 30 seconds worth of computing.

2. Analyze and compare the performance of the three codes as the array size increases.

I had to perform these code algorithms locally on my machine as they did not work on the school server.

The serial version of the code (part a) was the most efficient as parallelization is not necessary for this algorithm. When N increased from 250 to 500, the time technically does increase but was barely noticeable on my system, on average it completed within 0ms computation time. The worst algorithm performed was the parallelization of each sum (part b), which is to be expected. With N size at 250, it took 9 seconds to complete. With part b being in comparison with part c, parallelization for part c only took 131ms when N was 250. When N increased for part b to 500, the time exponentially increased as well, it took 30sec to complete. That is 3x longer to complete when N only increased by x2. However, part c when N doubled in size from 250 to 500, it took less than a second to complete, and completed within ~950ms.