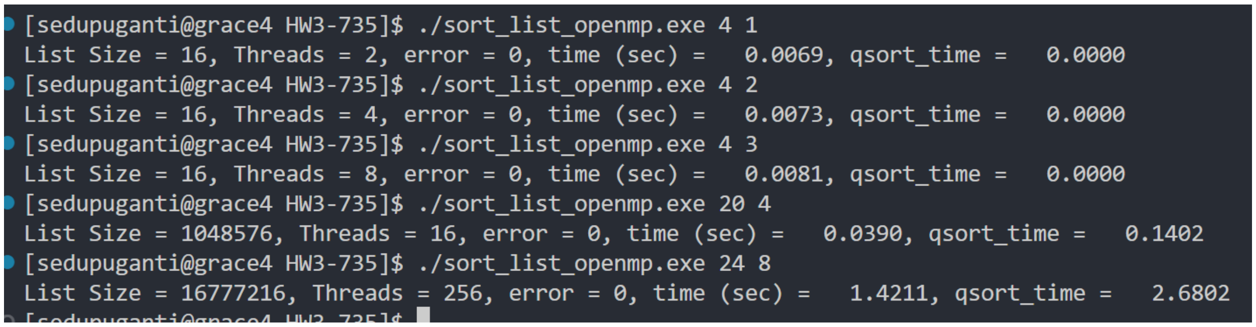
1:



```
[sedupuganti@grace4 HW3-735]$ ./sort_list_openmp.exe 4 1
List Size = 16, Threads = 2, error = 0, time (sec) =   0.0069, qsort_time =   0.0000
[sedupuganti@grace4 HW3-735]$ ./sort_list_openmp.exe 4 2
List Size = 16, Threads = 4, error = 0, time (sec) =   0.0073, qsort_time =   0.0000
[sedupuganti@grace4 HW3-735]$ ./sort_list_openmp.exe 4 3
List Size = 16, Threads = 8, error = 0, time (sec) =   0.0081, qsort_time =   0.0000
[sedupuganti@grace4 HW3-735]$ ./sort_list_openmp.exe 20 4
List Size = 1048576, Threads = 16, error = 0, time (sec) =   0.0390, qsort_time =   0.1402
[sedupuganti@grace4 HW3-735]$ ./sort_list_openmp.exe 24 8
List Size = 16777216, Threads = 256, error = 0, time (sec) =   1.4211, qsort_time =   2.6802
```

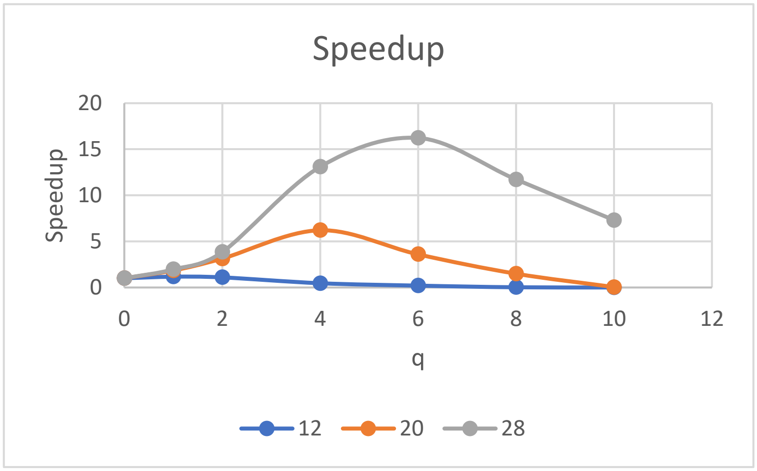
These results showcase that the code is working as expected and is reporting error=0.

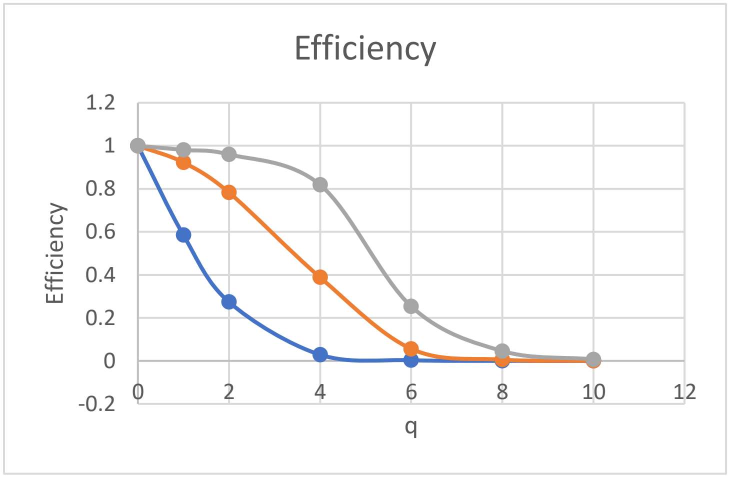
2:

K = 12	**q**	**threads**	**time**	**speedup**	**efficiency**
12	0	1	0.0069	1	1
12	1	2	0.0059	1.169492	0.584746
12	2	4	0.0063	1.095238	0.27381
12	4	16	0.015	0.46	0.02875
12	6	64	0.0343	0.201166	0.003143
12	8	256	0.2981	0.023147	9.04E-05
12	10	1024	3.8213	0.001806	1.76E-06

K = 20	**q**	**threads**	**time**	**speedup**	**efficiency**
20	0	1	0.1851	1	1
20	1	2	0.1003	1.845464	0.922732
20	2	4	0.0591	3.13198	0.782995
20	4	16	0.0298	6.211409	0.388213
20	6	64	0.0515	3.594175	0.056159
20	8	256	0.1239	1.493947	0.005836
20	10	1024	4.0279	0.045954	4.49E-05

K = 28	q	threads	time	speedup	efficiency
28	0	1	62.9315	1	1
28	1	2	32.0775	1.961858	0.980929
28	2	4	16.3897	3.839698	0.959925
28	4	16	4.8041	13.09954	0.818721
28	6	64	3.8781	16.22741	0.253553
28	8	256	5.3666	11.72651	0.045807
28	10	1024	8.6057	7.312769	0.007141





The results of this experiment do align with the typical behavior of parallel programming. The whole idea of parallel programming is that multiple tasks are running concurrently to cut down on runtime of a process. This type of behavior is being displayed here within the graphs. As larger list sizes increase (, the there is an increase in speed up, especially when q = 6. However, after it reaches this point the speedup decreases. This may be due to the number of threads that have increased; however the efficiency of each thread decreases as q increases. Therefore, the efficiency decreases despite there being an increase in speedup. The threads are being underutilized. Due to the increase in threads, they are not all able to stay efficient. This also results in some overhead, hence the extra time, which is shown from the data tables. These graphs do align with the principles of parallel programming. These results are very similar to the outputs to the previous assignment, which is another indication that the results are correct because OpenMP allows for a much easier to way to be able to create and joining threads by creating parallel regions, which is better than creating and joining multiple threads.

3: Execution Time with different Affinity and Places

	threads	**cores**	**sockets**
master	67.6812	67.4923	5.1998
close	3.1174	3.1167	3.116
spread	3.1273	3.0906	3.1071

There are a plethora of observations that can be made from these results. We can see that when the OMP_PROC_BIND = spread, the 3 abstract names are relatively same. With OMP_PROC_BIND = master, the results are vastly different, where when OMP_PLACES = threads, and cores, the runtime is roughly 67, as seen from the table above. This is because when the bind is set to master, all threads are assigned to the same place as the master thread, which causes more overhead. When OMP_PLACES = sockets, the runtime decreases greatly under master. This is due to sockets being composed of cores, which is composed of threads. The sockets are a culmination of both threads and cores, so despite being placed in the same area as the master thread, the runtime will be lower than threads, or cores. For all other values, the runtime is relatively low, around 3 seconds, despite the binding being set to close or spread.