Sawyer Cowan
CSCE 435

Homework 5 - Results
(Problem 1 Evidence)

```
[scowan818@ada6 HW5]$ mpiicpc -o qsort_hypercube.exe qsort_hypercube.cpp
icpc: command line warning #10006: ignoring unknown option '-cc=icpc'
[scowan818@ada6 HW5]$ mpirun -np 2 ./qsort_hypercube.exe 4 -1
[Proc: 0] number of processes = 2, initial local list size = 4, hypercube quicksort time = 0.000539
[Proc: 0] Congratulations. The list has been sorted correctly.
[scowan818@ada6 HW5]$
```

```
[scowan818@ada6 HW5]$ mpirun -np 4 ./qsort_hypercube.exe 4 -2
[Proc: 0] number of processes = 4, initial local list size = 4, hypercube quicksort time = 0.000318
[Proc: 0] Congratulations. The list has been sorted correctly.
[scowan818@ada6 HW5]$
```

```
[scowan818@ada6 HW5]$ mpirun -np 8 ./qsort_hypercube.exe 4 -1
[Proc: 0] number of processes = 8, initial local list size = 4, hypercube quicksort time = 0.001841
[Proc: 0] Congratulations. The list has been sorted correctly.
[scowan818@ada6 HW5]$
```

```
[scowan818@ada6 HW5]$ mpirun -np 16 ./qsort_hypercube.exe 4 0
[Proc: 0] number of processes = 16, initial local list size = 4, hypercube quicksort time = 0.001786
[Proc: 0] Congratulations. The list has been sorted correctly.
[scowan818@ada6 HW5]$
```

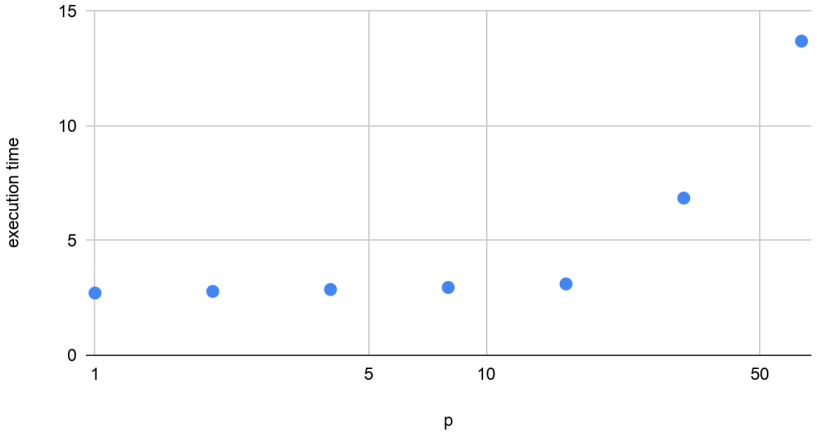
```
[scowan818@ada6 HW5]$ mpirun -np 16 ./qsort_hypercube.exe 20480000 0
[Proc: 0] number of processes = 16, initial local list size = 20480000, hypercube quicksort time = 3.078181
[Proc: 0] Congratulations. The list has been sorted correctly.
[scowan818@ada6 HW5]$
```

(Problem 2 and 3)

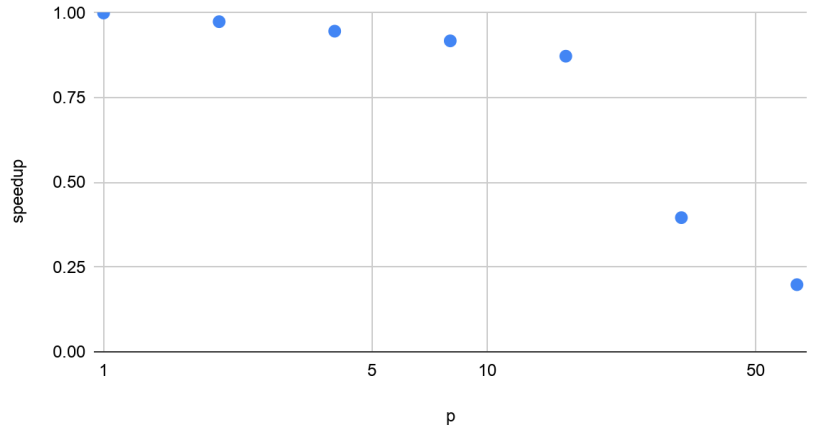
```
------------------------------------------------------------
# LSBATCH: User input
#BSUB -J compute_pi       # job name
#BSUB -L /bin/bash        # job's execution environment
#BSUB -W 0:10             # wall clock runtime limit
#BSUB -n 20               # number of cores
#BSUB -R "span[ptile=20]"       # number of cores per node
#BSUB -R "rusage[mem=2560]"     # memory per process (CPU) for the job
#BSUB -o output.%J        # file name for the job's standard output
##
# <--- at this point the current working directory is the one you submitted the job from.
#
module load intel/2017A         # load Intel software stack
#
mpirun -np 1 ./qsort_hypercube.exe 20480000 0
mpirun -np 2 ./qsort_hypercube.exe 20480000 0
mpirun -np 4 ./qsort_hypercube.exe 20480000 0
mpirun -np 8 ./qsort_hypercube.exe 20480000 0
mpirun -np 16 ./qsort_hypercube.exe 20480000 0
mpirun -np 32 ./qsort_hypercube.exe 20480000 0
mpirun -np 64 ./qsort_hypercube.exe 20480000 0
##
------------------------------------------------------------

Successfully completed.

Resource usage summary:

    CPU time :                                   648.66 sec.
    Max Memory :                                 11464 MB
    Average Memory :                             3203.50 MB
    Total Requested Memory :                     51200.00 MB
    Delta Memory :                               39736.00 MB
    Max Processes :                              7
    Max Threads :                                9

The output (if any) is above this job summary.

[scowan818@ada6 HW5]$ clear
[scowan818@ada6 HW5]$ more output.15016216
[Proc: 0] number of processes = 1, initial local list size = 20480000, hypercube quicksort time = 2.715013
[Proc: 0] Congratulations. The list has been sorted correctly.
[Proc: 0] number of processes = 2, initial local list size = 20480000, hypercube quicksort time = 2.786338
[Proc: 0] Congratulations. The list has been sorted correctly.
[Proc: 0] number of processes = 4, initial local list size = 20480000, hypercube quicksort time = 2.868887
[Proc: 0] Congratulations. The list has been sorted correctly.
[Proc: 0] number of processes = 8, initial local list size = 20480000, hypercube quicksort time = 2.958215
[Proc: 0] Congratulations. The list has been sorted correctly.
[Proc: 0] number of processes = 16, initial local list size = 20480000, hypercube quicksort time = 3.111695
[Proc: 0] Congratulations. The list has been sorted correctly.
[Proc: 0] number of processes = 32, initial local list size = 20480000, hypercube quicksort time = 6.855926
[Proc: 0] Congratulations. The list has been sorted correctly.
[Proc: 0] number of processes = 64, initial local list size = 20480000, hypercube quicksort time = 13.700741
[Proc: 0] Congratulations. The list has been sorted correctly.

------------------------------------------------------------
Sender: LSF System <lsfadmin@nxt1366>
Subject: Job 15016216: <compute_pi> in cluster <Main_Compute> Done
```

p	execution time	speedup	efficiency
1	2.697093	1	1
2	1.343346	2.007742607	1.003871303
4	0.678009	3.97796047	0.9944901174
8	0.339184	7.951710576	0.993963822
16	0.181344	14.87279976	0.9295499851
32	0.254061	10.61592688	0.3317477151
64	0.269201	10.0188818	0.1565450282

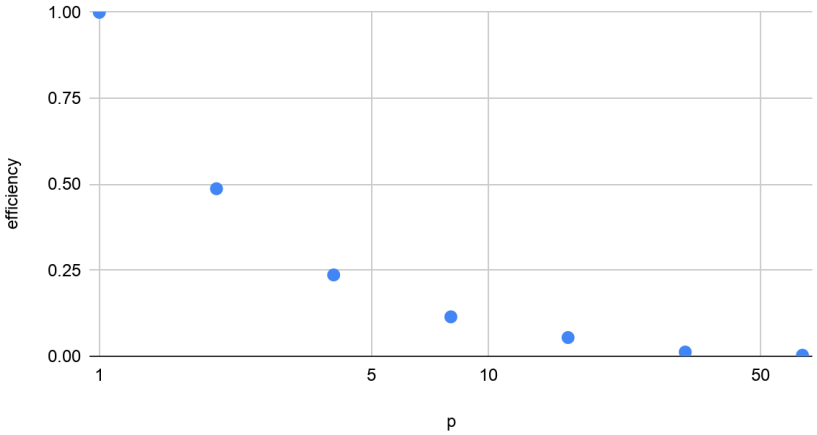
execution time vs. p



speedup vs p



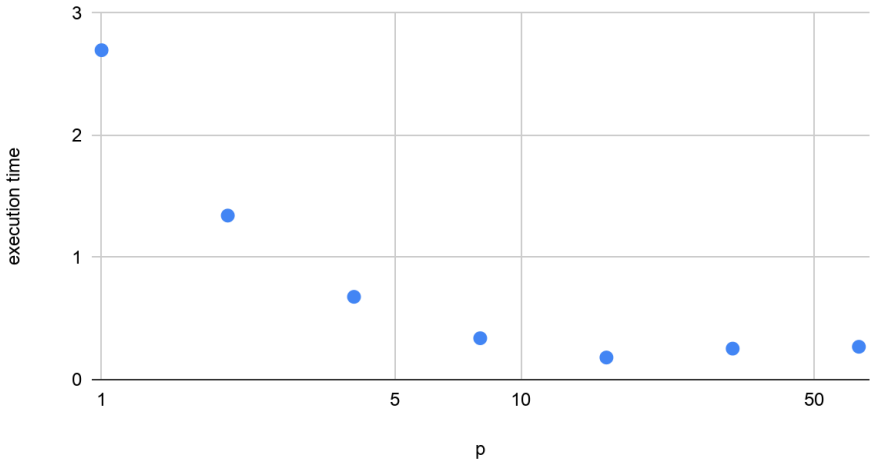
efficiency vs. p



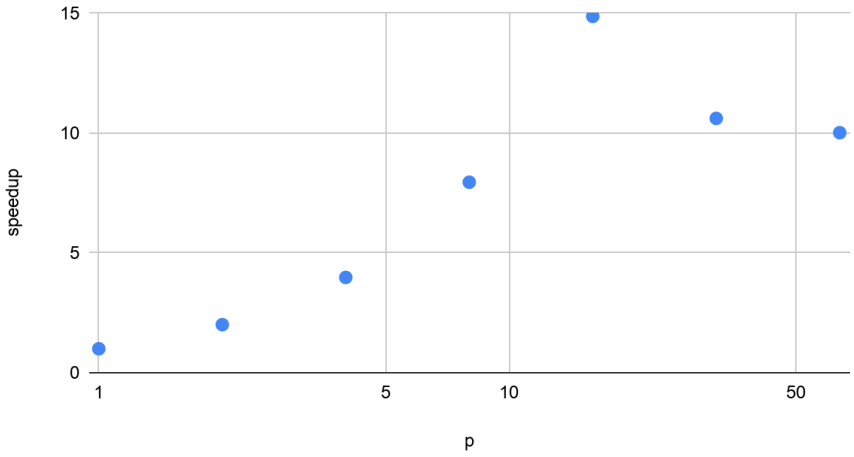
```
[scowan818@ada6 HW5]$ more output.15016490
[Proc: 0] number of processes = 1, initial local list size = 20480000, hypercube quicksort time = 2.697093
[Proc: 0] Congratulations. The list has been sorted correctly.
[Proc: 0] number of processes = 2, initial local list size = 10240000, hypercube quicksort time = 1.343346
[Proc: 0] Congratulations. The list has been sorted correctly.
[Proc: 0] number of processes = 4, initial local list size = 5120000, hypercube quicksort time = 0.678009
[Proc: 0] Congratulations. The list has been sorted correctly.
[Proc: 0] number of processes = 8, initial local list size = 2560000, hypercube quicksort time = 0.339184
[Proc: 0] Congratulations. The list has been sorted correctly.
[Proc: 0] number of processes = 16, initial local list size = 1280000, hypercube quicksort time = 0.181344
[Proc: 0] Congratulations. The list has been sorted correctly.
[Proc: 0] number of processes = 32, initial local list size = 640000, hypercube quicksort time = 0.254061
[Proc: 0] Congratulations. The list has been sorted correctly.
[Proc: 0] number of processes = 64, initial local list size = 320000, hypercube quicksort time = 0.269201
[Proc: 0] Congratulations. The list has been sorted correctly.

------------------------------------------------------------
Sender: LSF System <lsfadmin@nxt1726>
Subject: Job 15016490: <strongscaling> in cluster <Main_Compute> Done

Job <strongscaling> was submitted from host <login6> by user <scowan818> in cluster <Main_Compute>.
Job was executed on host(s) <20*nxt1726>, in queue <sn_short>, as user <scowan818> in cluster <Main_Compute>.
</home/scowan818> was used as the home directory.
</home/scowan818/Github/CSCE435/HW5> was used as the working directory.
Started at Thu Apr 15 22:35:29 2021
Results reported on Thu Apr 15 22:35:55 2021

Your job looked like:

------------------------------------------------------------
# LSBATCH: User input
#BSUB -J strongscaling       # job name
#BSUB -L /bin/bash          # job's execution environment
#BSUB -W 0:10               # wall clock runtime limit
#BSUB -n 20                 # number of cores
#BSUB -R "span[ptile=20]"       # number of cores per node
#BSUB -R "rusage[mem=2560]"     # memory per process (CPU) for the job
#BSUB -o output.%J          # file name for the job's standard output
##
# <--- at this point the current working directory is the one you submitted the job from.
#
module load intel/2017A         # load Intel software stack
#
mpirun -np 1 ./qsort_hypercube.exe 20480000 0
mpirun -np 2 ./qsort_hypercube.exe 10240000 0
mpirun -np 4 ./qsort_hypercube.exe 5120000 0
mpirun -np 8 ./qsort_hypercube.exe 2560000 0
mpirun -np 16 ./qsort_hypercube.exe 1280000 0
mpirun -np 32 ./qsort_hypercube.exe 640000 0
mpirun -np 64 ./qsort_hypercube.exe 320000 0
##
------------------------------------------------------------

Successfully completed.
```

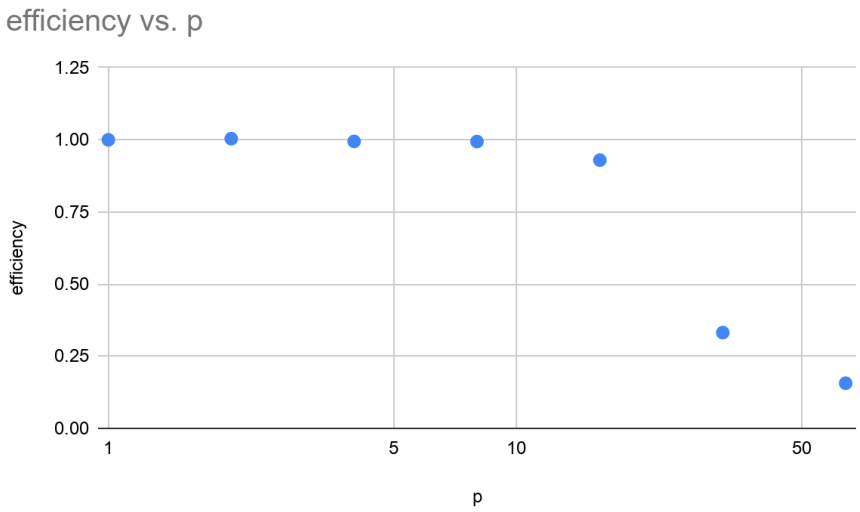
p	n	execution time	speedup	efficiency
1	20480000	2.697093	1	1
2	10240000	1.343346	2.007742607	1.003871303
4	5120000	0.678009	3.97796047	0.9944901174
8	2560000	0.339184	7.951710576	0.993963822
16	1280000	0.181344	14.87279976	0.9295499851
32	640000	0.254061	10.61592688	0.3317477151
64	320000	0.269201	10.0188818	0.1565450282

execution time vs. p



speedup vs p




efficiency vs. p
1.25
1.00
0.75
0.50
0.25
0.00
efficiency
1
5
10
50
p