

## CSC443 Assignment 1 2017: Performance Report

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# PART ONE

## 3.1 Experiment 1: Optimal Block Size

### *System Disk Block Size*

Filesystem	Type	Size	Used	Avail	Use%	Mounted on
/dev/sda1	ext4	20G	14G	5.2G	72%	/

### *Write Blocks Sequential Data*

#### First Experiment

Data rate: 11.919 MBPS  
Data rate: 10.420 MBPS  
Data rate: 9.208 MBPS  
Data rate: 7.818 MBPS  
Data rate: 9.642 MBPS  
Data rate: 10.770 MBPS  
Data rate: 11.291 MBPS  
Data rate: 9.995 MBPS  
Data rate: 11.752 MBPS

#### Second Experiment

Data rate: 13.102 MBPS  
Data rate: 11.649 MBPS  
Data rate: 11.892 MBPS  
Data rate: 14.470 MBPS  
Data rate: 11.999 MBPS  
Data rate: 14.792 MBPS  
Data rate: 15.771 MBPS  
Data rate: 15.325 MBPS  
Data rate: 15.347 MBPS

#### Third Experiment

Data rate: 14.872 MBPS  
Data rate: 14.941 MBPS  
Data rate: 13.836 MBPS  
Data rate: 14.627 MBPS  
Data rate: 15.222 MBPS  
Data rate: 14.125 MBPS  
Data rate: 15.046 MBPS  
Data rate: 13.195 MBPS  
Data rate: 14.289 MBPS

#### Fourth Experiment

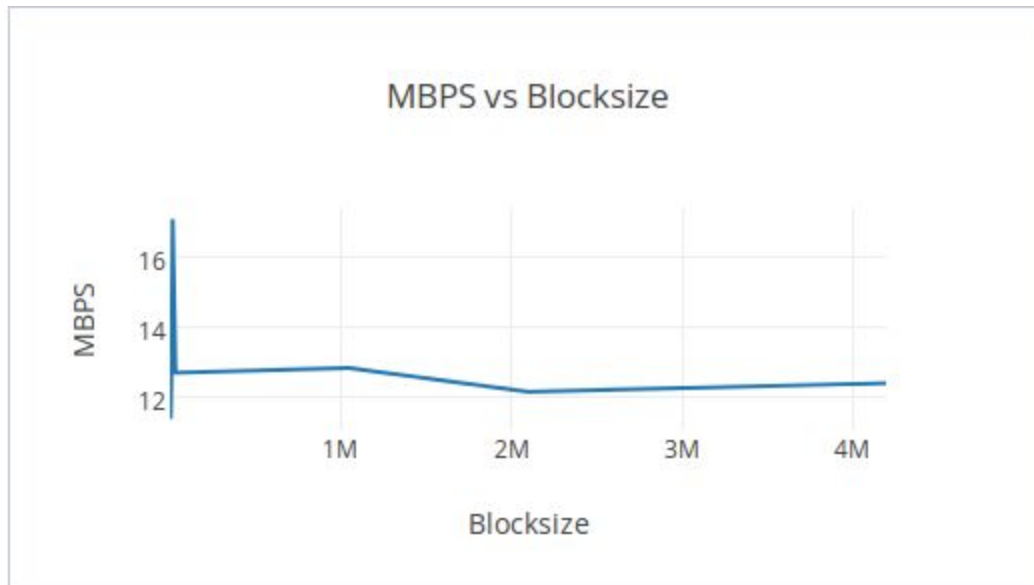
Data rate: 11.648 MBPS  
Data rate: 11.020 MBPS  
Data rate: 11.245 MBPS  
Data rate: 12.349 MBPS  
Data rate: 11.091 MBPS  
Data rate: 11.230 MBPS  
Data rate: 13.579 MBPS  
Data rate: 12.664 MBPS  
Data rate: 13.973 MBPS

#### Fifth Experiment

Data rate: 11.485 MBPS  
Data rate: 11.739 MBPS  
Data rate: 10.695 MBPS  
Data rate: 12.541 MBPS  
Data rate: 12.586 MBPS  
Data rate: 12.567 MBPS  
Data rate: 8.464 MBPS  
Data rate: 9.583 MBPS  
Data rate: 6.612 MBPS

#### Block Sizes Used

Blocksize 1: 512  
Blocksize 2: 1024  
Blocksize 3: 4096  
Blocksize 4: 8192  
Blocksize 5: 16384  
Blocksize 6: 32768  
Blocksize 7: 1048576  
Blocksize 8: 2097152  
Blocksize 9: 4194304



Blocksize Average 1: 12.605 MBPS

Blocksize Average 2: 11.954 MBPS

Blocksize Average 3: 11.375 MBPS

Blocksize Average 4: 12.361 MBPS

Blocksize Average 5: 17.096 MBPS

Blocksize Average 6: 12.697 MBPS

Blocksize Average 7: 12.830 MBPS

Blocksize Average 8: 12.152 MBPS

Blocksize Average 9: 12.395 MBPS

(512, 12.605), (1024, 11.954), (4096, 11.375), (8192, 12.361), (16384, 17.096), (32768, 12.697),  
(1048576, 12.83), (2097152, 12.152), (4194304, 12.395)

#### *Write Lines Data*

Data rate: 14.423 MBPS

Data rate: 14.695 MBPS

Data rate: 15.146 MBPS

Data rate: 13.936 MBPS

Data rate: 14.045 MBPS

### **3.2 Experiment 2: Sequential vs. Random Read rate**

#### *Read Blocks Sequential Data*

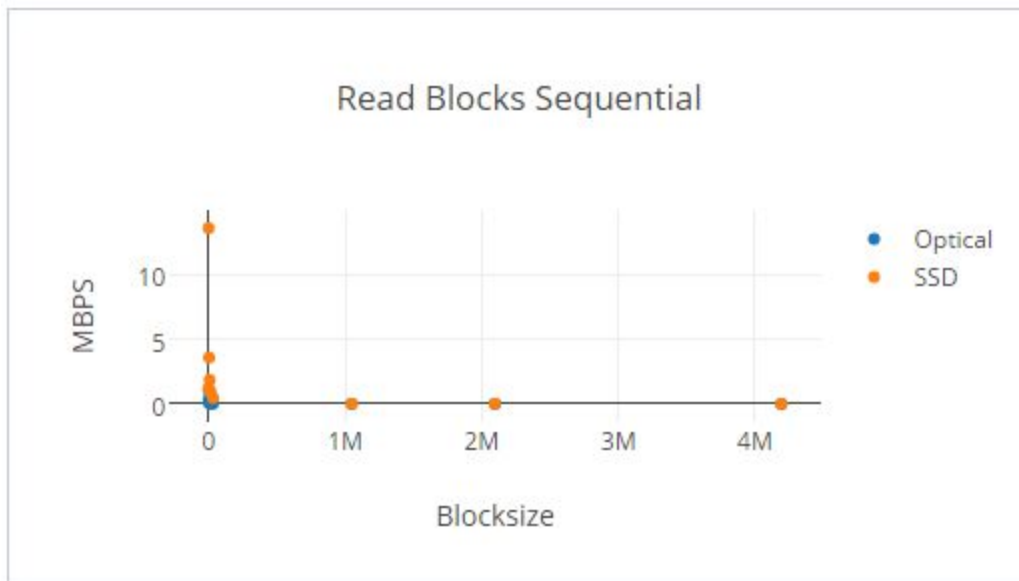
##### *Optical Hard Drive Data*

./read_blocks_seq big.dat 512 Total Records: 255870600 Unique Users: 26297226	./read_blocks_seq big.dat 1024 Total Records: 255870600 Unique Users: 26297226	./read_blocks_seq big.dat 4096 Total Records: 255870600 Unique Users: 26297226
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Average: 9 Max Followers: 214276 Data rate: 1.075 MBPS	Average: 9 Max Followers: 214276 Data rate: 0.333 MBPS	Average: 9 Max Followers: 214276 Data rate: 0.111 MBPS
./read_blocks_seq big.dat 8192 Total Records: 255870600 Unique Users: 26297226 Average: 9 Max Followers: 214276 Data rate: 0.037 MBPS	./read_blocks_seq big.dat 16384 Total Records: 255870600 Unique Users: 26297226 Average: 9 Max Followers: 214276 Data rate: 0.019 MBPS	./read_blocks_seq big.dat 32768 Total Records: 255870600 Unique Users: 26297226 Average: 9 Max Followers: 214276 Data rate: 0.018 MBPS
./read_blocks_seq big.dat 1048576 Total Records: 255870600 Unique Users: 26297226 Average: 9 Max Followers: 214276 Data rate: 0.001 MBPS	./read_blocks_seq big.dat 2097152 Total Records: 255870600 Unique Users: 26297226 Average: 9 Max Followers: 214276 Data rate: 0.000 MBPS	./read_blocks_seq big.dat 4194304 Total Records: 255870600 Unique Users: 26297226 Average: 9 Max Followers: 214276 Data rate: 0.000 MBPS

#### SSD Data

./read_blocks_seq big.dat 512 Total Records: 255933054 Unique Users: 26301626 Average: 9 Max Followers: 214329 Data rate: 1.210 MBPS	./read_blocks_seq big.dat 1024 Total Records: 255933054 Unique Users: 26301626 Average: 9 Max Followers: 214329 Data rate: 13.584 MBPS	./read_blocks_seq big.dat 4096 Total Records: 255933054 Unique Users: 26301626 Average: 9 Max Followers: 214329 Data rate: 3.578 MBPS
./read_blocks_seq big.dat 8192 Total Records: 255933054 Unique Users: 26301626 Average: 9 Max Followers: 214329 Data rate: 1.860 MBPS	./read_blocks_seq big.dat 16384 Total Records: 255933054 Unique Users: 26301626 Average: 9 Max Followers: 214329 Data rate: 0.923 MBPS	./read_blocks_seq big.dat 32768 Total Records: 255933054 Unique Users: 26301626 Average: 9 Max Followers: 214329 Data rate: 0.470 MBPS
./read_blocks_seq big.dat 1048576 Total Records: 255933054 Unique Users: 26301626 Average: 9 Max Followers: 214329 Data rate: 0.016 MBPS	./read_blocks_seq big.dat 2097152 Total Records: 255933054 Unique Users: 26301626 Average: 9 Max Followers: 214329 Data rate: 0.008 MBPS	./read_blocks_seq big.dat 4194304 Total Records: 255933054 Unique Users: 26301626 Average: 9 Max Followers: 214329 Data rate: 0.003 MBPS



### Read Ram Sequential Data

#### Optical Hard Drive Data

./read_ram_seq big.dat 512 Total Records: 64 Unique Users: 3 Average: 21 Max Followers: 51 Data rate: inf MBPS	./read_ram_seq big.dat 1024 Total Records: 128 Unique Users: 4 Average: 32 Max Followers: 64 Data rate: inf MBPS	./read_ram_seq big.dat 4096 Total Records: 512 Unique Users: 4 Average: 128 Max Followers: 64 Data rate: inf MBPS
./read_ram_seq big.dat 8192 Total Records: 1024 Unique Users: 4 Average: 256 Max Followers: 64 Data rate: inf MBPS	./read_ram_seq big.dat 16384 Total Records: 2048 Unique Users: 4 Average: 512 Max Followers: 64 Data rate: inf MBPS	./read_ram_seq big.dat 32768 Total Records: 4096 Unique Users: 10 Average: 409 Max Followers: 1996 Data rate: inf MBPS
./read_ram_seq big.dat 1048576 Total Records: 131072 Unique Users: 404 Average: 324 Max Followers: 8566 Data rate: inf MBPS	./read_ram_seq big.dat 2097152 Total Records: 262144 Unique Users: 865 Average: 303 Max Followers: 8566 Data rate: inf MBPS	./read_ram_seq big.dat 4194304 Total Records: 524288 Unique Users: 1723 Average: 304 Max Followers: 8566 Data rate: 3999.992 MBPS

#### SSD Data

./read_ram_seq big.dat 512 Total Records: 64 Unique Users: 5 Average: 12 Max Followers: 42 Data rate: inf MBPS	./read_ram_seq big.dat 1024 Total Records: 128 Unique Users: 8 Average: 16 Max Followers: 64 Data rate: inf MBPS	./read_ram_seq big.dat 4096 Total Records: 512 Unique Users: 24 Average: 21 Max Followers: 171 Data rate: inf MBPS
./read_ram_seq big.dat 8192 Total Records: 1024 Unique Users: 48 Average: 21 Max Followers: 171 Data rate: inf MBPS	./read_ram_seq big.dat 16384 Total Records: 2048 Unique Users: 98 Average: 20 Max Followers: 171 Data rate: inf MBPS	./read_ram_seq big.dat 32768 Total Records: 4096 Unique Users: 201 Average: 20 Max Followers: 234 Data rate: 31.242 MBPS
./read_ram_seq big.dat 1048576 Total Records: 131072 Unique Users: 595 Average: 220 Max Followers: 8569 Data rate: 999.992 MBPS	./read_ram_seq big.dat 2097152 Total Records: 262144 Unique Users: 1056 Average: 248 Max Followers: 8569 Data rate: inf MBPS	./read_ram_seq big.dat 4194304 Total Records: 524288 Unique Users: 1914 Average: 273 Max Followers: 8569 Data rate: 3999.992 MBPS



#### Read Blocks Random Data

##### Optical Hard Drive Data

Blocksize 1: 512 Blocksize 2: 1024 Blocksize 3: 4096 Blocksize 4: 8192	1. Data rate: 0.001 MBPS 2. Data rate: 0.001 MBPS 3. Data rate: 0.001 MBPS 4. Data rate: 0.001 MBPS
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Blocksize 5: 16384 Blocksize 6: 32768 Blocksize 7: 1048576 Blocksize 8: 2097152 Blocksize 9: 4194304	5. Data rate: 0.000 MBPS 6. Data rate: 0.001 MBPS 7. Data rate: 0.000 MBPS 8. Data rate: 0.000 MBPS 9. Data rate: 0.000 MBPS
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#### *SSD Data*

Blocksize 1: 512 Blocksize 2: 1024 Blocksize 3: 4096 Blocksize 4: 8192 Blocksize 5: 16384 Blocksize 6: 32768 Blocksize 7: 1048576 Blocksize 8: 2097152 Blocksize 9: 4194304	1. Data rate: 0.031 MBPS 2. Data rate: 0.025 MBPS 3. Data rate: 0.032 MBPS 4. Data rate: 0.032 MBPS 5. Data rate: 0.031 MBPS 6. Data rate: 0.029 MBPS 7. Data rate: 0.010 MBPS 8. Data rate: 0.006 MBPS 9. Data rate: 0.003 MBPS
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#### *Read Ram Random Data*

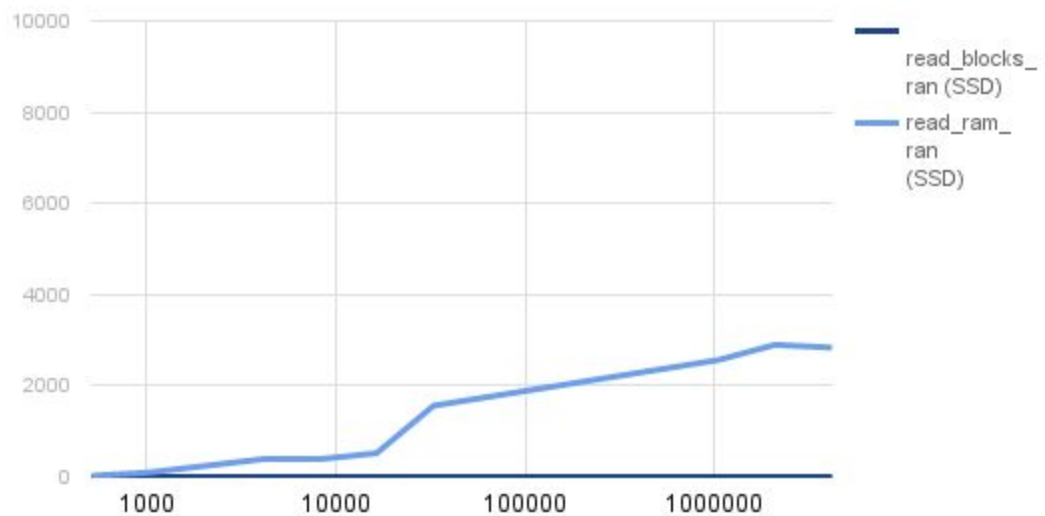
#### *Optical Hard Drive Data*

Blocksize 1: 512 Blocksize 2: 1024 Blocksize 3: 4096 Blocksize 4: 8192 Blocksize 5: 16384 Blocksize 6: 32768 Blocksize 7: 1048576 Blocksize 8: 2097152 Blocksize 9: 4194304	1. Data rate: 48.828 MBPS 2. Data rate: 97.656 MBPS 3. Data rate: 390.625 MBPS 4. Data rate: 3.488 MBPS 5. Data rate: 97.656 MBPS 6. Data rate: 781.250 MBPS 7. Data rate: 2222.222 MBPS 8. Data rate: 2127.660 MBPS 9. Data rate: 3076.923 MBPS
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#### *SSD Data*

Blocksize 1: 512 Blocksize 2: 1024 Blocksize 3: 4096 Blocksize 4: 8192 Blocksize 5: 16384 Blocksize 6: 32768 Blocksize 7: 1048576 Blocksize 8: 2097152 Blocksize 9: 4194304	1. Data rate: 24.414 MBPS 2. Data rate: 97.656 MBPS 3. Data rate: 390.625 MBPS 4. Data rate: 390.625 MBPS 5. Data rate: 520.833 MBPS 6. Data rate: 1562.500 MBPS 7. Data rate: 2564.103 MBPS 8. Data rate: 2898.551 MBPS 9. Data rate: 2836.879 MBPS
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### Random Read Compared



### 3.3. Experiment 3: Sequential vs. Random Write Rate

*Write Blocks Random Data*

*Optical Hard Drive Data*

Blocksize 1: 512  
 Blocksize 2: 1024  
 Blocksize 3: 4096  
 Blocksize 4: 8192

1. Data rate: 0.042 MBPS
2. Data rate: inf MBPS
3. Data rate: inf MBPS
4. Data rate: inf MBPS

Blocksize 5: 16384 Blocksize 6: 32768 Blocksize 7: 1048576 Blocksize 8: 2097152 Blocksize 9: 4194304	5. Data rate: inf MBPS 6. Data rate: inf MBPS 7. Data rate: 0.007 MBPS 8. Data rate: 0.005 MBPS 9. Data rate: 0.006 MBPS
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#### *SSD Data*

Blocksize 1: 512 Blocksize 2: 1024 Blocksize 3: 4096 Blocksize 4: 8192 Blocksize 5: 16384 Blocksize 6: 32768 Blocksize 7: 1048576 Blocksize 8: 2097152 Blocksize 9: 4194304	1. Data rate: 0.191 MBPS 2. Data rate: inf MBPS 3. Data rate: 0.763 MBPS 4. Data rate: inf MBPS 5. Data rate: 0.254 MBPS 6. Data rate: 0.254 MBPS 7. Data rate: 0.005 MBPS 8. Data rate: 0.019 MBPS 9. Data rate: 0.006 MBPS
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#### *Write Ram Random Data*

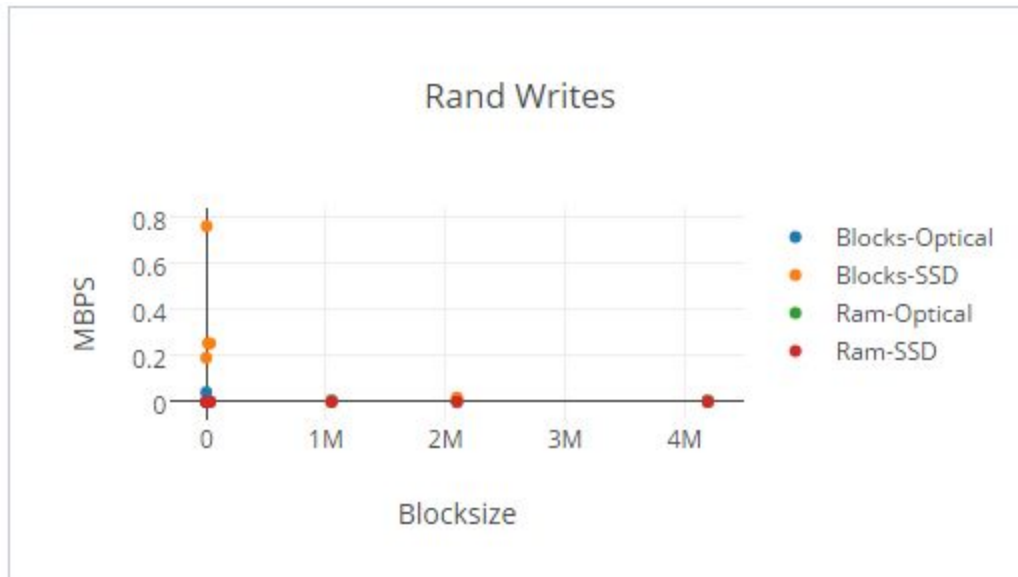
#### *Optical Hard Drive Data*

Blocksize 1: 512 Blocksize 2: 1024 Blocksize 3: 4096 Blocksize 4: 8192 Blocksize 5: 16384 Blocksize 6: 32768 Blocksize 7: 1048576 Blocksize 8: 2097152 Blocksize 9: 4194304	1. Data rate: inf MBPS 2. Data rate: inf MBPS 3. Data rate: inf MBPS 4. Data rate: inf MBPS 5. Data rate: inf MBPS 6. Data rate: inf MBPS 7. Data rate: inf MBPS 8. Data rate: inf MBPS 9. Data rate: inf MBPS
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#### *SSD Data*

Blocksize 1: 512 Blocksize 2: 1024 Blocksize 3: 4096 Blocksize 4: 8192 Blocksize 5: 16384 Blocksize 6: 32768 Blocksize 7: 1048576 Blocksize 8: 2097152 Blocksize 9: 4194304	1. Data rate: inf MBPS 2. Data rate: inf MBPS 3. Data rate: inf MBPS 4. Data rate: inf MBPS 5. Data rate: inf MBPS 6. Data rate: inf MBPS 7. Data rate: inf MBPS 8. Data rate: inf MBPS 9. Data rate: inf MBPS
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## PART TWO

### 2 Performance Experiments

#### 2.1 Timing

Using timing command:

```
$ /usr/bin/time -v disk_sort records.dat 209715200 16384
```

#### Results:

Command being timed: "main\_merge records.dat 209715200 16384"

Command being timed: "main\_merge records.dat 209715200 16384"

User time (seconds): 10.17

System time (seconds): 1.71

Percent of CPU this job got: 25%

Elapsed (wall clock) time (h:mm:ss or m:ss): 0:46.40

Average shared text size (kbytes): 0

Average unshared data size (kbytes): 0

Average stack size (kbytes): 0

Average total size (kbytes): 0

Maximum resident set size (kbytes): 312032

Average resident set size (kbytes): 0

Major (requiring I/O) page faults: 0

Minor (reclaiming a frame) page faults: 328456

Voluntary context switches: 31286

Involuntary context switches: 89559

Swaps: 0

File system inputs: 0

File system outputs: 2072720

Socket messages sent: 0  
Socket messages received: 0  
Signals delivered: 0  
Page size (bytes): 4096  
Exit status: 00  
Page size (bytes):

## 2.2 Buffer Size

1/2 of 209715200

Command being timed: "main\_merge records2.dat 104857600 16384"

User time (seconds): 9.96  
System time (seconds): 1.19  
Percent of CPU this job got: 23%  
Elapsed (wall clock) time (h:mm:ss or m:ss): 0:47.65  
Average shared text size (kbytes): 0  
Average unshared data size (kbytes): 0  
Average stack size (kbytes): 0  
Average total size (kbytes): 0  
Maximum resident set size (kbytes): 180444  
Average resident set size (kbytes): 0  
Major (requiring I/O) page faults: 0  
Minor (reclaiming a frame) page faults: 7423  
Voluntary context switches: 35705  
Involuntary context switches: 100952  
Swaps: 0  
File system inputs: 36240  
File system outputs: 1804032  
Socket messages sent: 0  
Socket messages received: 0  
Signals delivered: 0  
Page size (bytes): 4096  
Exit status: 0

1/4 of 209715200

Command being timed: "main\_merge records3.dat 52428800 16384"

User time (seconds): 8.56  
System time (seconds): 1.07  
Percent of CPU this job got: 22%  
Elapsed (wall clock) time (h:mm:ss or m:ss): 0:42.91

Average shared text size (kbytes): 0  
Average unshared data size (kbytes): 0  
Average stack size (kbytes): 0  
Average total size (kbytes): 0  
Maximum resident set size (kbytes): 97728  
Average resident set size (kbytes): 0  
Major (requiring I/O) page faults: 0  
Minor (reclaiming a frame) page faults: 18938  
Voluntary context switches: 74365  
Involuntary context switches: 179898  
Swaps: 0  
File system inputs: 1240896  
File system outputs: 1650496  
Socket messages sent: 0  
Socket messages received: 0  
Signals delivered: 0  
Page size (bytes): 4096  
Exit status: 0

1/16 of 209715200

Command being timed: "main\_merge records4.dat 13107200 16384"

User time (seconds): 8.61  
System time (seconds): 0.83  
Percent of CPU this job got: 26%  
Elapsed (wall clock) time (h:mm:ss or m:ss): 0:35.48  
Average shared text size (kbytes): 0  
Average unshared data size (kbytes): 0  
Average stack size (kbytes): 0  
Average total size (kbytes): 0  
Maximum resident set size (kbytes): 28304  
Average resident set size (kbytes): 0  
Major (requiring I/O) page faults: 0  
Minor (reclaiming a frame) page faults: 19527  
Voluntary context switches: 25910  
Involuntary context switches: 76664  
Swaps: 0  
File system inputs: 5280  
File system outputs: 1392000  
Socket messages sent: 0  
Socket messages received: 0  
Signals delivered: 0  
Page size (bytes): 4096

Exit status: 0

1/32 of 209715200

Command being timed: "main\_merge records5.dat 6553600 16384"

User time (seconds): 7.85  
System time (seconds): 0.98  
Percent of CPU this job got: 21%  
Elapsed (wall clock) time (h:mm:ss or m:ss): 0:41.51  
Average shared text size (kbytes): 0  
Average unshared data size (kbytes): 0  
Average stack size (kbytes): 0  
Average total size (kbytes): 0  
Maximum resident set size (kbytes): 16372  
Average resident set size (kbytes): 0  
Major (requiring I/O) page faults: 0  
Minor (reclaiming a frame) page faults: 49544  
Voluntary context switches: 79289  
Involuntary context switches: 160950  
Swaps: 0  
File system inputs: 1240896  
File system outputs: 1328520  
Socket messages sent: 0  
Socket messages received: 0  
Signals delivered: 0  
Page size (bytes): 4096  
Exit status: 0

1/64 of 209715200

Command being timed: "main\_merge records6.dat 3276800 16384"

User time (seconds): 8.34  
System time (seconds): 0.96  
Percent of CPU this job got: 13%  
Elapsed (wall clock) time (h:mm:ss or m:ss): 1:06.87  
Average shared text size (kbytes): 0  
Average unshared data size (kbytes): 0  
Average stack size (kbytes): 0  
Average total size (kbytes): 0  
Maximum resident set size (kbytes): 30604  
Average resident set size (kbytes): 0  
Major (requiring I/O) page faults: 0  
Minor (reclaiming a frame) page faults: 2387  
Voluntary context switches: 90032

Involuntary context switches: 157926  
Swaps: 0  
File system inputs: 1241424  
File system outputs: 1291280  
Socket messages sent: 0  
Socket messages received: 0  
Signals delivered: 0  
Page size (bytes): 4096  
Exit status: 0

At 1/128, cannot be sorted.

### 2.3. Comparing to Unix sort

Command being timed: "sort -t, -n -k2 edges.csv"  
User time (seconds): 200.82  
System time (seconds): 5.33  
Percent of CPU this job got: 69%  
Elapsed (wall clock) time (h:mm:ss or m:ss): 4:56.06  
Average shared text size (kbytes): 0  
Average unshared data size (kbytes): 0  
Average stack size (kbytes): 0  
Average total size (kbytes): 0  
Maximum resident set size (kbytes): 730632  
Average resident set size (kbytes): 0  
Major (requiring I/O) page faults: 2  
Minor (reclaiming a frame) page faults: 73500  
Voluntary context switches: 5723  
Involuntary context switches: 20531  
Swaps: 0  
File system inputs: 4960408  
File system outputs: 5153480  
Socket messages sent: 0  
Socket messages received: 0  
Signals delivered: 0  
Page size (bytes): 4096  
Exit status: 0

Command being timed: "sort -t, -n -k2 /s/csc443/habiberf/edges.csv"  
User time (seconds): 105.68  
System time (seconds): 2.60  
Percent of CPU this job got: 107%  
Elapsed (wall clock) time (h:mm:ss or m:ss): 1:40.37

Average shared text size (kbytes): 0  
Average unshared data size (kbytes): 0  
Average stack size (kbytes): 0  
Average total size (kbytes): 0  
Maximum resident set size (kbytes): 2376520  
Average resident set size (kbytes): 0  
Major (requiring I/O) page faults: 0  
Minor (reclaiming a frame) page faults: 167336  
Voluntary context switches: 1427  
Involuntary context switches: 3287  
Swaps: 0  
File system inputs: 357912  
File system outputs: 5153472  
Socket messages sent: 0  
Socket messages received: 0  
Signals delivered: 0  
Page size (bytes): 4096  
Exit status: 0

## PART THREE

**Time your programs and compare the running time to the running time of the equivalent database queries which you executed in Step 1. Also do not forget to mention which database system you are comparing to.**

For the Twitter edges.csv database:

Sqlite

Results of True Friends:

Run Time: real 423.320 user 324.396000 sys 88.640000

Count: 21776094

Results of Celebrities:

5994113,564220

7496,344850

1349110,340491

1629776,170111

8121005,155933

2041453,152069

797152,118752

6623784,115819

645019,107639

3403,97931

Run Time: real 363.833 user 220.109375 sys 12.093750

## Implementation

True Friends

Celebrities

Total time:166