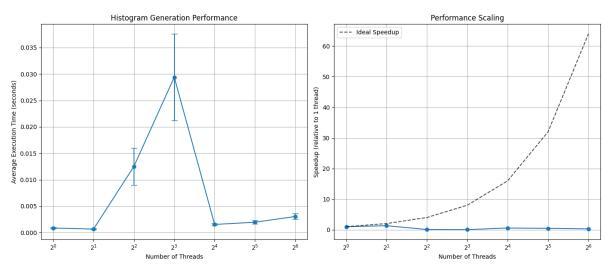
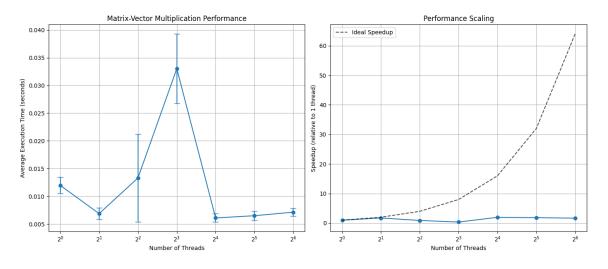
Question1:

```
tolgahan@DESKTOP-64PO879:/mnt/d/projects/COMP482/hw1/question1$ make
                                                                     Thread count, Run, Time
gcc question1.c -o question1.o -fopenmp -03
                                                                     1,1,0.000980
./question1.o generate input.txt 1000000
                                                                     1,2,0.000769
Generating input file...
Input file 'input.txt' generated with 1000000 samples.
                                                                     1,3,0.000947
Running with 1 threads (run 1 of 5)...
                                                                     1,4,0.000789
Running with 1 threads (run 2 of 5)...
                                                                     1,5,0.000787
Running with 1 threads (run 3 of 5)...
                                                                     2,1,0.000672
Running with 1 threads (run 4 of 5)...
                                                                     2,2,0.000708
Running with 1 threads (run 5 of 5)...
                                                                     2,3,0.000475
Running with 2 threads (run 1 of 5)...
                                                                     2,4,0.000713
Running with 2 threads (run 2 of 5)...
Running with 2 threads (run 3 of 5)...
                                                                     2,5,0.000696
Running with 2 threads (run 4 of 5)...
                                                                     4,1,0.007021
Running with 2 threads (run 5 of 5)...
                                                                     4,2,0.012587
Running with 4 threads (run 1 of 5)...
                                                                     4,3,0.011766
Running with 4 threads (run 2 of 5)...
                                                                     4,4,0.016018
Running with 4 threads (run 3 of 5)...
                                                                     4,5,0.015119
Running with 4 threads (run 4 of 5)...
                                                                     8,1,0.034383
Running with 4 threads (run 5 of 5)...
                                                                     8,2,0.014906
Running with 8 threads (run 1 of 5)...
Running with 8 threads (run 2 of 5)...
                                                                     8,3,0.031375
Running with 8 threads (run 3 of 5)...
                                                                     8,4,0.032345
Running with 8 threads (run 4 of 5)...
                                                                     8,5,0.033992
Running with 8 threads (run 5 of 5)...
                                                                     16,1,0.001718
Running with 16 threads (run 1 of 5)...
                                                                     16,2,0.001648
Running with 16 threads (run 2 of 5)...
                                                                     16,3,0.001330
Running with 16 threads (run 3 of 5)...
                                                                     16,4,0.001689
Running with 16 threads (run 4 of 5)...
Running with 16 threads (run 5 of 5)...
                                                                     16,5,0.001259
Running with 32 threads (run 1 of 5)...
                                                                     32,1,0.001889
Running with 32 threads (run 2 of 5)...
                                                                     32,2,0.002130
Running with 32 threads (run 3 of 5)...
                                                                     32,3,0.001904
Running with 32 threads (run 4 of 5)...
                                                                     32,4,0.001449
Running with 32 threads (run 5 of 5)...
                                                                     32,5,0.002394
Running with 64 threads (run 1 of 5)...
                                                                     64,1,0.002732
Running with 64 threads (run 2 of 5)...
                                                                     64,2,0.003637
Running with 64 threads (run 3 of 5)...
Running with 64 threads (run 4 of 5)...
                                                                     64,3,0.003599
Running with 64 threads (run 5 of 5)...
                                                                     64,4,0.002778
Benchmark results saved to benchmark results.csv
                                                                     64,5,0.002474
Plot saved to benchmark_plot.png
```



Question2:

```
tolgahan@DESKTOP-64P0879:/mnt/d/projects/COMP482/hw1/question2$ make
                                                                 Thread count,Run,Time
gcc question2.c -o question2.o -fopenmp -03
question2.c: In function 'read file':
                                                                 1,1,0.011536
question2.c:76:5: warning: ignoring return value of 'fscanf' declared
                                                                 1,2,0.010803
ed_result' [-Wunused-result]
           fscanf(file, "%d %d", rows, cols);
                                                                 1,3,0.014228
question2.c:87:13: warning: ignoring return value of 'fscanf' declare 1,4,0.012511
                                                                 1,5,0.010749
sed_result' [-Wunused-result]
                   fscanf(file, "%lf", &(*matrix)[i][j]);
                                                                 2,1,0.006774
./question2.o generate 4000 4000 a.txt b.txt
                                                                 2,2,0.008692
Generating matrix file: a.txt
                                                                 2,3,0.006534
Generating vector file: b.txt
Rows: 4000, Cols: 4000
                                                                 2,4,0.006120
Random matrix and vector files generated successfully.
                                                                 2,5,0.006237
Running with 1 threads (run 1 of 5)...
Running with 1 threads (run 2 of 5)...
                                                                 4,1,0.004305
Running with 1 threads (run 3 of 5)...
                                                                 4,2,0.020730
Running with 1 threads (run 4 of 5)...
                                                                 4,3,0.005290
Running with 1 threads (run 5 of 5)...
Running with 2 threads (run 1 of 5)...
                                                                 4,4,0.016344
Running with 2 threads (run 2 of 5)...
                                                                 4,5,0.019872
Running with 2 threads (run 3 of 5)...
Running with 2 threads (run 4 of 5)...
                                                                 8,1,0.027883
Running with 2 threads (run 5 of 5)...
                                                                 8,2,0.034708
Running with 4 threads (run 1 of 5)...
Running with 4 threads (run 2 of 5)...
                                                                8,3,0.025088
Running with 4 threads (run 3 of 5)...
                                                                8,4,0.039214
Running with 4 threads (run 4 of 5)...
Running with 4 threads (run 5 of 5)...
                                                                 8,5,0.038217
Running with 8 threads (run 1 of 5)...
                                                                 16,1,0.005004
Running with 8 threads (run 2 of 5)...
Running with 8 threads (run 3 of 5)...
                                                                 16,2,0.006026
Running with 8 threads (run 4 of 5)...
                                                                 16,3,0.007094
Running with 8 threads (run 5 of 5)...
                                                                16,4,0.006115
Running with 16 threads (run 1 of 5)...
Running with 16 threads (run 2 of 5)...
                                                                 16,5,0.006231
Running with 16 threads (run 3 of 5)...
                                                                 32,1,0.006771
Running with 16 threads (run 4 of 5)...
Running with 16 threads (run 5 of 5)...
                                                                 32,2,0.005988
Running with 32 threads (run 1 of 5)...
                                                                 32,3,0.007691
Running with 32 threads (run 2 of 5)...
Running with 32 threads (run 3 of 5)...
                                                                 32,4,0.005624
Running with 32 threads (run 4 of 5)...
                                                                 32,5,0.006399
Running with 32 threads (run 5 of 5)...
Running with 64 threads (run 1 of 5)...
                                                                 64,1,0.005865
Running with 64 threads (run 2 of 5)...
                                                                 64,2,0.007316
Running with 64 threads (run 3 of 5)...
Running with 64 threads (run 4 of 5)...
                                                                 64,3,0.007553
Running with 64 threads (run 5 of 5)...
                                                                 64,4,0.007633
Benchmark results saved to benchmark_results.csv
Plot saved to benchmark_plot.png
                                                                 64,5,0.007292
```



Question3:

tolgahan@DESKTOP-64P0879:/mnt/d/projects/COMP482/hw1/question3\$ make	
gcc question3.c -o question3.o -fopenmp -lm -03	Thread count,Run,Time
Running with 1 threads (run 1 of 5)	1,1,0.018769
Running with 1 threads (run 2 of 5)	1,2,0.018027
Running with 1 threads (run 3 of 5)	1,3,0.016900
Running with 1 threads (run 4 of 5)	1,4,0.017291
Running with 1 threads (run 5 of 5)	1,5,0.017134
Running with 2 threads (run 1 of 5)	2,1,0.009171
Running with 2 threads (run 2 of 5)	2,2,0.009778
Running with 2 threads (run 3 of 5)	2,3,0.009130
Running with 2 threads (run 4 of 5)	2,4,0.009035
Running with 2 threads (run 5 of 5)	2,5,0.009226
Running with 4 threads (run 1 of 5)	4,1,0.007337
Running with 4 threads (run 2 of 5)	4,2,0.006551
Running with 4 threads (run 3 of 5) Running with 4 threads (run 4 of 5)	4,3,0.006500
Running with 4 threads (run 5 of 5)	4,4,0.005577
Running with 8 threads (run 1 of 5)	4,5,0.005411
Running with 8 threads (run 2 of 5)	8,1,0.008530
Running with 8 threads (run 3 of 5)	8,2,0.006268
Running with 8 threads (run 4 of 5)	8,3,0.005213
Running with 8 threads (run 5 of 5)	8,4,0.010668
Running with 16 threads (run 1 of 5)	8,5,0.005311
Running with 16 threads (run 2 of 5)	16,1,0.004717
Running with 16 threads (run 3 of 5)	16,2,0.004077
Running with 16 threads (run 4 of 5)	16,3,0.004676
Running with 16 threads (run 5 of 5)	
Running with 32 threads (run 1 of 5)	16,4,0.004416
Running with 32 threads (run 2 of 5)	16,5,0.004655
Running with 32 threads (run 3 of 5) Running with 32 threads (run 4 of 5)	32,1,0.005143
Running with 32 threads (run 5 of 5)	32,2,0.005094
Running with 64 threads (run 1 of 5)	32,3,0.004958
Running with 64 threads (run 2 of 5)	32,4,0.005096
Running with 64 threads (run 3 of 5)	32,5,0.004845
Running with 64 threads (run 4 of 5)	64,1,0.005967
Running with 64 threads (run 5 of 5)	64,2,0.006416
Benchmark results saved to benchmark results.csv	64,3,0.006363
make: Warning: File 'benchmark_results.csv' has modification time 0.6	64,4,0.006086
Plot saved to benchmark_plot.png	64,5,0.006277

