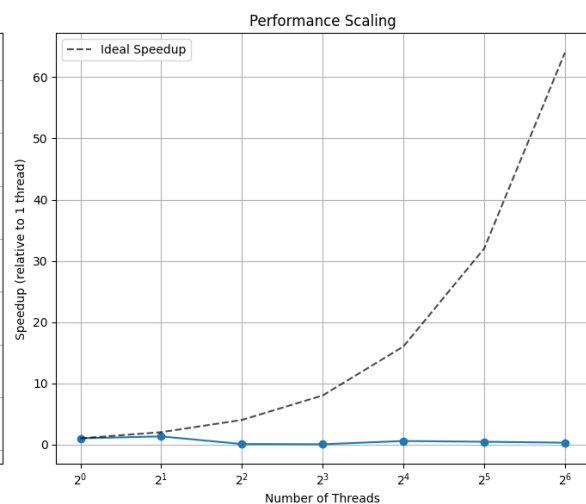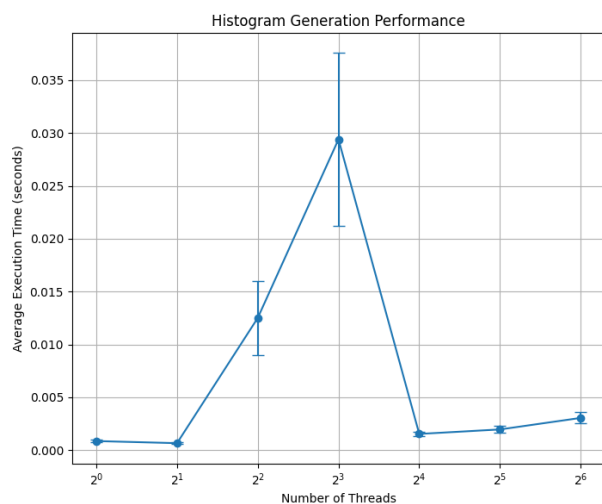## Question1:

```
tolgahan@DESKTOP-64PO879:/mnt/d/projects/COMP482/hw1/question1$ make
gcc question1.c -o question1.o -fopenmp -O3
./question1.o generate input.txt 1000000
Generating input file...
Input file 'input.txt' generated with 1000000 samples.
Running with 1 threads (run 1 of 5)...
Running with 1 threads (run 2 of 5)...
Running with 1 threads (run 3 of 5)...
Running with 1 threads (run 4 of 5)...
Running with 1 threads (run 5 of 5)...
Running with 2 threads (run 1 of 5)...
Running with 2 threads (run 2 of 5)...
Running with 2 threads (run 3 of 5)...
Running with 2 threads (run 4 of 5)...
Running with 2 threads (run 5 of 5)...
Running with 4 threads (run 1 of 5)...
Running with 4 threads (run 2 of 5)...
Running with 4 threads (run 3 of 5)...
Running with 4 threads (run 4 of 5)...
Running with 4 threads (run 5 of 5)...
Running with 8 threads (run 1 of 5)...
Running with 8 threads (run 2 of 5)...
Running with 8 threads (run 3 of 5)...
Running with 8 threads (run 4 of 5)...
Running with 8 threads (run 5 of 5)...
Running with 16 threads (run 1 of 5)...
Running with 16 threads (run 2 of 5)...
Running with 16 threads (run 3 of 5)...
Running with 16 threads (run 4 of 5)...
Running with 16 threads (run 5 of 5)...
Running with 32 threads (run 1 of 5)...
Running with 32 threads (run 2 of 5)...
Running with 32 threads (run 3 of 5)...
Running with 32 threads (run 4 of 5)...
Running with 32 threads (run 5 of 5)...
Running with 64 threads (run 1 of 5)...
Running with 64 threads (run 2 of 5)...
Running with 64 threads (run 3 of 5)...
Running with 64 threads (run 4 of 5)...
Running with 64 threads (run 5 of 5)...
Benchmark results saved to benchmark_results.csv
Plot saved to benchmark_plot.png
```

```
Thread count,Run,Time
1,1,0.000980
1,2,0.000769
1,3,0.000947
1,4,0.000789
1,5,0.000787
2,1,0.000672
2,2,0.000708
2,3,0.000475
2,4,0.000713
2,5,0.000696
4,1,0.007021
4,2,0.012587
4,3,0.011766
4,4,0.016018
4,5,0.015119
8,1,0.034383
8,2,0.014906
8,3,0.031375
8,4,0.032345
8,5,0.033992
16,1,0.001718
16,2,0.001648
16,3,0.001330
16,4,0.001689
16,5,0.001259
32,1,0.001889
32,2,0.002130
32,3,0.001904
32,4,0.001449
32,5,0.002394
64,1,0.002732
64,2,0.003637
64,3,0.003599
64,4,0.002778
64,5,0.002474
```
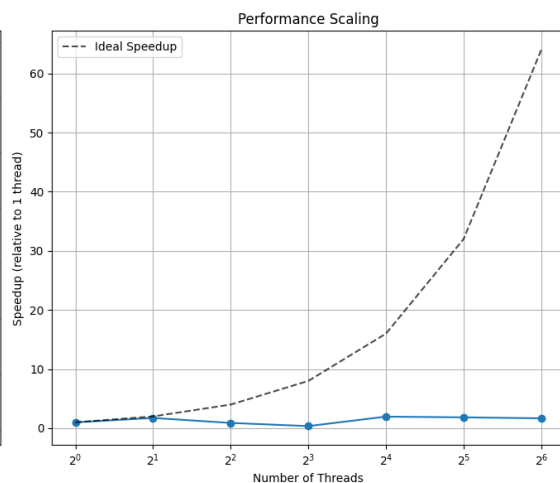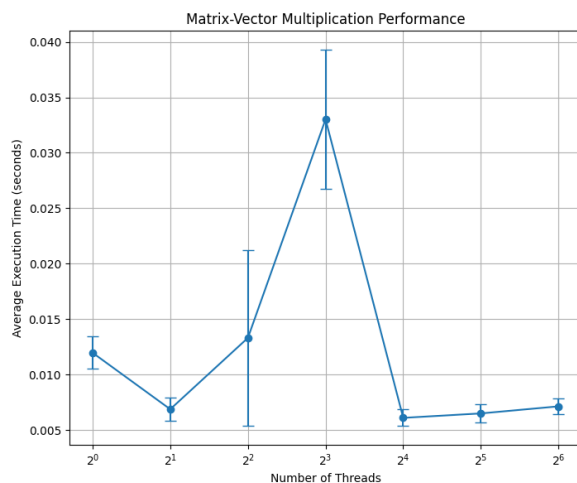
Question2:

```
tolgahan@DESKTOP-64PO879:/mnt/d/projects/COMP482/hw1/question2$ make
gcc question2.c -o question2.o -fopenmp -O3
question2.c: In function 'read_file':
question2.c:76:5: warning: ignoring return value of 'fscanf' declared
ed_result' [-Wunused-result]
   76 |     fscanf(file, "%d %d", rows, cols);
      |     ^~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
question2.c:87:13: warning: ignoring return value of 'fscanf' declare
sed_result' [-Wunused-result]
   87 |             fscanf(file, "%lf", &(*matrix)[i][j]);
      |             ^~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
./question2.o generate 4000 4000 a.txt b.txt
Generating matrix file: a.txt
Generating vector file: b.txt
Rows: 4000, Cols: 4000
Random matrix and vector files generated successfully.
Running with 1 threads (run 1 of 5)...
Running with 1 threads (run 2 of 5)...
Running with 1 threads (run 3 of 5)...
Running with 1 threads (run 4 of 5)...
Running with 1 threads (run 5 of 5)...
Running with 2 threads (run 1 of 5)...
Running with 2 threads (run 2 of 5)...
Running with 2 threads (run 3 of 5)...
Running with 2 threads (run 4 of 5)...
Running with 2 threads (run 5 of 5)...
Running with 4 threads (run 1 of 5)...
Running with 4 threads (run 2 of 5)...
Running with 4 threads (run 3 of 5)...
Running with 4 threads (run 4 of 5)...
Running with 4 threads (run 5 of 5)...
Running with 8 threads (run 1 of 5)...
Running with 8 threads (run 2 of 5)...
Running with 8 threads (run 3 of 5)...
Running with 8 threads (run 4 of 5)...
Running with 8 threads (run 5 of 5)...
Running with 16 threads (run 1 of 5)...
Running with 16 threads (run 2 of 5)...
Running with 16 threads (run 3 of 5)...
Running with 16 threads (run 4 of 5)...
Running with 16 threads (run 5 of 5)...
Running with 32 threads (run 1 of 5)...
Running with 32 threads (run 2 of 5)...
Running with 32 threads (run 3 of 5)...
Running with 32 threads (run 4 of 5)...
Running with 32 threads (run 5 of 5)...
Running with 64 threads (run 1 of 5)...
Running with 64 threads (run 2 of 5)...
Running with 64 threads (run 3 of 5)...
Running with 64 threads (run 4 of 5)...
Running with 64 threads (run 5 of 5)...
Benchmark results saved to benchmark_results.csv
Plot saved to benchmark_plot.png
```

```
Thread count,Run,Time
1,1,0.011536
1,2,0.010803
1,3,0.014228
1,4,0.012511
1,5,0.010749
2,1,0.006774
2,2,0.008692
2,3,0.006534
2,4,0.006120
2,5,0.006237
4,1,0.004305
4,2,0.020730
4,3,0.005290
4,4,0.016344
4,5,0.019872
8,1,0.027883
8,2,0.034708
8,3,0.025088
8,4,0.039214
8,5,0.038217
16,1,0.005004
16,2,0.006026
16,3,0.007094
16,4,0.006115
16,5,0.006231
32,1,0.006771
32,2,0.005988
32,3,0.007691
32,4,0.005624
32,5,0.006399
64,1,0.005865
64,2,0.007316
64,3,0.007553
64,4,0.007633
64,5,0.007292
```

Question3:

```
tolgahan@DESKTOP-64PO879:/mnt/d/projects/COMP482/hw1/question3$ make
gcc question3.c -o question3.o -fopenmp -lm -O3
Running with 1 threads (run 1 of 5)...
Running with 1 threads (run 2 of 5)...
Running with 1 threads (run 3 of 5)...
Running with 1 threads (run 4 of 5)...
Running with 1 threads (run 5 of 5)...
Running with 2 threads (run 1 of 5)...
Running with 2 threads (run 2 of 5)...
Running with 2 threads (run 3 of 5)...
Running with 2 threads (run 4 of 5)...
Running with 2 threads (run 5 of 5)...
Running with 4 threads (run 1 of 5)...
Running with 4 threads (run 2 of 5)...
Running with 4 threads (run 3 of 5)...
Running with 4 threads (run 4 of 5)...
Running with 4 threads (run 5 of 5)...
Running with 8 threads (run 1 of 5)...
Running with 8 threads (run 2 of 5)...
Running with 8 threads (run 3 of 5)...
Running with 8 threads (run 4 of 5)...
Running with 8 threads (run 5 of 5)...
Running with 16 threads (run 1 of 5)...
Running with 16 threads (run 2 of 5)...
Running with 16 threads (run 3 of 5)...
Running with 16 threads (run 4 of 5)...
Running with 16 threads (run 5 of 5)...
Running with 32 threads (run 1 of 5)...
Running with 32 threads (run 2 of 5)...
Running with 32 threads (run 3 of 5)...
Running with 32 threads (run 4 of 5)...
Running with 32 threads (run 5 of 5)...
Running with 64 threads (run 1 of 5)...
Running with 64 threads (run 2 of 5)...
Running with 64 threads (run 3 of 5)...
Running with 64 threads (run 4 of 5)...
Running with 64 threads (run 5 of 5)...
Benchmark results saved to benchmark_results.csv
make: Warning: File 'benchmark_results.csv' has modification time 0.(
Plot saved to benchmark_plot.png
```

```
Thread count,Run,Time
1,1,0.018769
1,2,0.018027
1,3,0.016900
1,4,0.017291
1,5,0.017134
2,1,0.009171
2,2,0.009778
2,3,0.009130
2,4,0.009035
2,5,0.009226
4,1,0.007337
4,2,0.006551
4,3,0.006500
4,4,0.005577
4,5,0.005411
8,1,0.008530
8,2,0.006268
8,3,0.005213
8,4,0.010668
8,5,0.005311
16,1,0.004717
16,2,0.004077
16,3,0.004676
16,4,0.004416
16,5,0.004655
32,1,0.005143
32,2,0.005094
32,3,0.004958
32,4,0.005096
32,5,0.004845
64,1,0.005967
64,2,0.006416
64,3,0.006363
64,4,0.006086
64,5,0.006277
```