

Output and total time of problem requests

% java PercolationStats 200 100

mean: = 0.5932544999999998
stddev: = 0.010132043864827467
95% confidence interval = 0.5912686194024936, 0.595240380597506
The total time is: 0.411

% java PercolationStats 200 100

mean: = 0.591239
stddev: = 0.009900568369563639
95% confidence interval = 0.5892984885995655, 0.5931795114004345
The total time is: 0.391

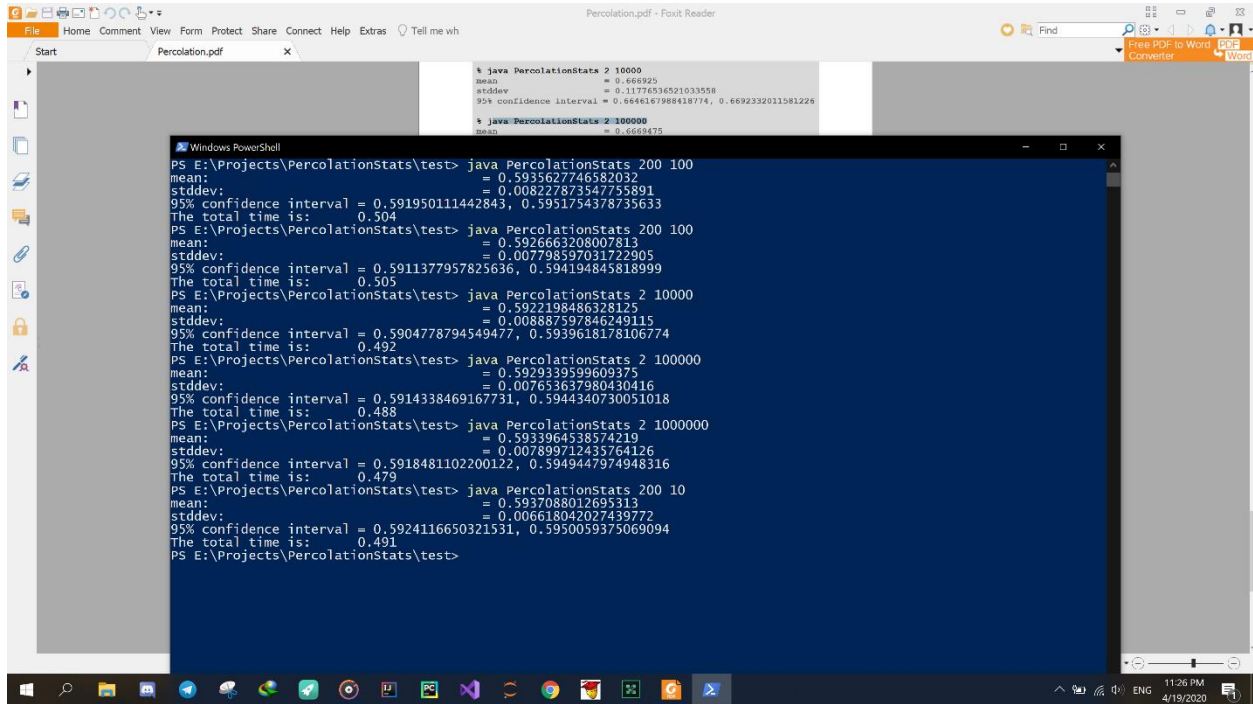
% java PercolationStats 2 10000

mean: = 0.6665
stddev: = 0.11791581918487896
95% confidence interval = 0.6641888499439763, 0.6688111500560237
The total time is: 0.058

% java PercolationStats 2 100000

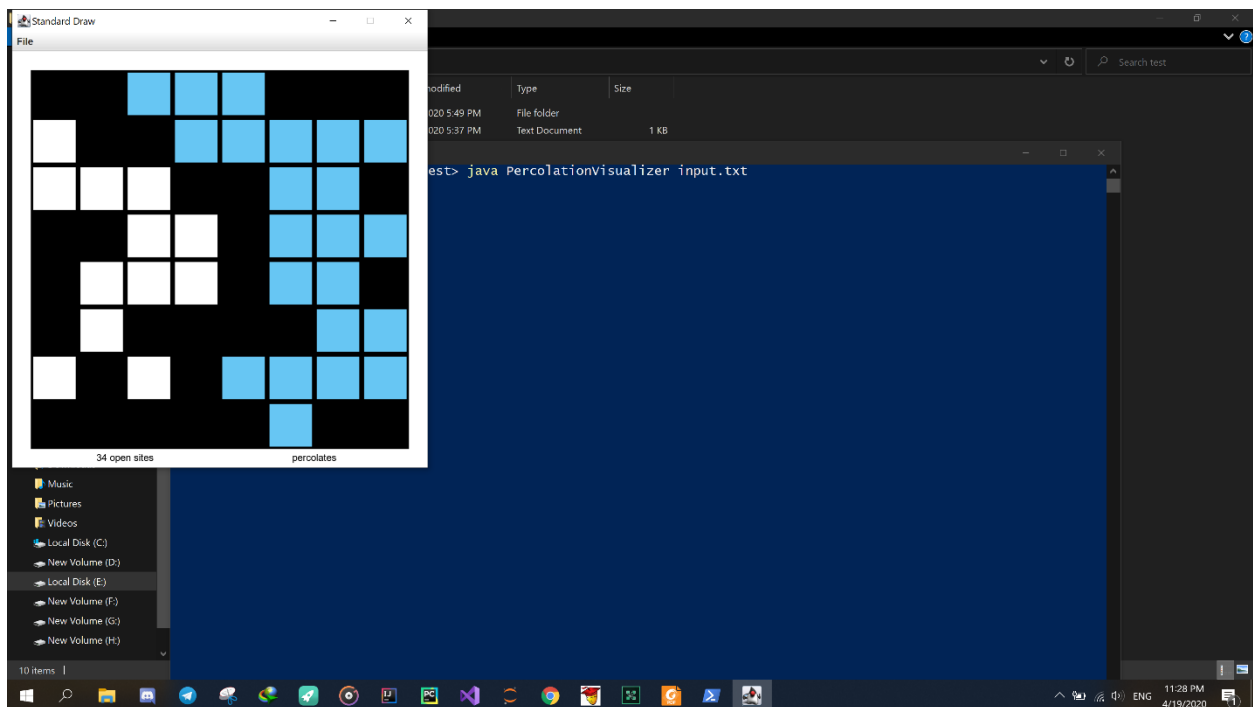
mean: = 0.6670625
stddev: = 0.11771102179742576
95% confidence interval = 0.6663329195282123, 0.6677920804717877
The total time is: 0.14

Screenshots of compiling project:



The screenshot shows a Windows desktop environment. In the background, a Foxit Reader window is open, displaying a PDF document titled 'Percolation.pdf'. In the foreground, a Windows PowerShell terminal window is open, showing the execution of several Java commands. The commands are: `java PercolationStats 2 10000`, `java PercolationStats 200 100`, `java PercolationStats 200 1000`, `java PercolationStats 2 100000`, and `java PercolationStats 2 1000000`. The output for each command shows the mean, stddev, 95% confidence interval, and the total time taken for the execution.

```
PS E:\Projects\PercolationStats\test> java PercolationStats 2 10000
mean: = 0.5935627746582032
stddev: = 0.008227873547755891
95% confidence interval = 0.591950111442843, 0.5951754378735633
The total time is: 0.504
PS E:\Projects\PercolationStats\test> java PercolationStats 200 100
mean: = 0.5926663208007813
stddev: = 0.007798597031722905
95% confidence interval = 0.5911377957825636, 0.594194845818999
The total time is: 0.505
PS E:\Projects\PercolationStats\test> java PercolationStats 2 100000
mean: = 0.5922198486328125
stddev: = 0.008887597846249115
95% confidence interval = 0.5904778794549477, 0.5939618178106774
The total time is: 0.492
PS E:\Projects\PercolationStats\test> java PercolationStats 2 1000000
mean: = 0.5929339599609375
stddev: = 0.007653637980430416
95% confidence interval = 0.5914338469167731, 0.5944340730051018
The total time is: 0.488
PS E:\Projects\PercolationStats\test> java PercolationStats 2 10000000
mean: = 0.5933964538574219
stddev: = 0.007899712435764126
95% confidence interval = 0.5918481102200122, 0.5949447974948316
The total time is: 0.479
PS E:\Projects\PercolationStats\test> java PercolationStats 200 10
mean: = 0.5937088012695313
stddev: = 0.006618042027439772
95% confidence interval = 0.5924116650321531, 0.5950059375069094
The total time is: 0.491
PS E:\Projects\PercolationStats\test>
```



Runtime analysis

% java PercolationStats 1 100

mean: = 1.0
stddev: = 0.0
95% confidence interval = 1.0, 1.0
The total time is: 0.037

% java PercolationStats 2 100

mean: = 0.6675
stddev: = 0.11814539065631512
95% confidence interval = 0.6443435034313623, 0.6906564965686377
The total time is: 0.042

% java PercolationStats 4 100

mean: = 0.600625
stddev: = 0.10948362210897576
95% confidence interval = 0.5791662100666407, 0.6220837899333592
The total time is: 0.042

% java PercolationStats 8 100

mean: = 0.59515625
stddev: = 0.08847465712976679
95% confidence interval = 0.5778152172025658, 0.6124972827974343
The total time is: 0.044

% java PercolationStats 16 100

mean: = 0.5917578125
stddev: = 0.05516312996747516
95% confidence interval = 0.5809458390263749, 0.6025697859736252
The total time is: 0.054

% java PercolationStats 32 100

mean: = 0.586201171875
stddev: = 0.038827232789562585
95% confidence interval = 0.5785910342482458, 0.5938113095017542
The total time is: 0.077

% java PercolationStats 64 100

mean: = 0.59226318359375
stddev: = 0.02218114837699032
95% confidence interval = 0.5879156785118599, 0.59661068867564
The total time is: 0.147

% java PercolationStats 128 100

mean: = 0.593360595703125
stddev: = 0.014485886922634118
95% confidence interval = 0.5905213618662888, 0.5961998295399613
The total time is: 0.215

% java PercolationStats 256 100

mean: = 0.5927090454101562
stddev: = 0.008122833003222073
95% confidence interval = 0.5911169701415248, 0.5943011206787877
The total time is: 0.584

% java PercolationStats 512 100

mean: = 0.5925073623657227
stddev: = 0.0050026776854162165

95% confidence interval = 0.5915268375393811, 0.5934878871920642
The total time is: 3.93

% java PercolationStats 1024 100

mean: = 0.5928369235992431
stddev: = 0.003038666333773182
95% confidence interval = 0.5922413449978235, 0.5934325022006627
The total time is: 19.23

% java PercolationStats 2048 100

mean: = 0.5925393152236939
stddev: = 0.001748037720134768
95% confidence interval = 0.5921966998305475, 0.5928819306168402
The total time is: 97.186

% java PercolationStats 4096 100

mean: = 0.5929054927825927
stddev: = 0.0012065776967578469
95% confidence interval = 0.5926690035540282, 0.5931419820111573
The total time is: 468.832

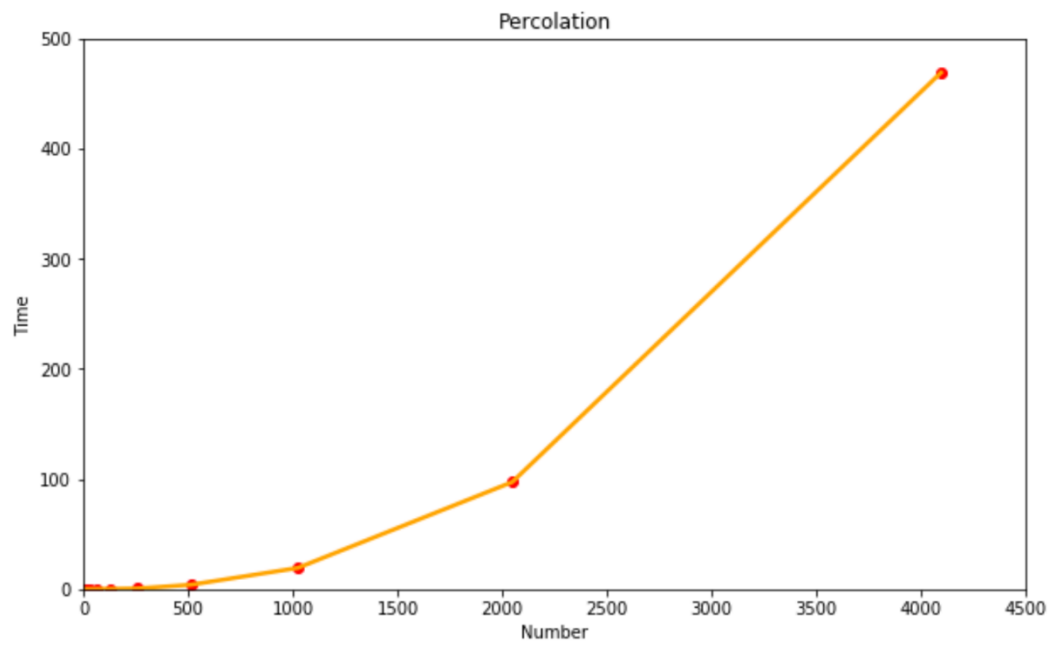
As can be seen from the above numbers, doubling the numbers (N) increases the execution time. That $T(n)$ is analyzed through the following relationships. Of course, due to random selection, the numbers are approximate and inaccurate, but we take almost the same values calculated by Stopwatch to analyze the same algorithm.

Experimental observation:

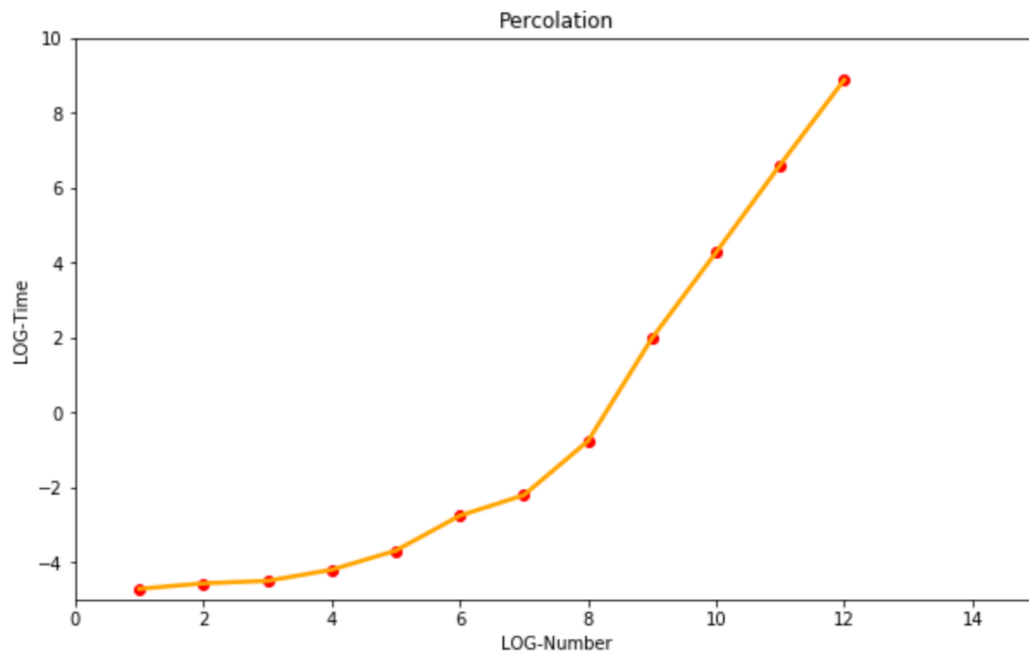
N	Time(seconds)
2	0.038
4	0.042
8	0.044
16	0.054
32	0.077
64	0.147
128	0.215
256	0.584
512	3.93
1024	19.23
2048	97.186
4096	468.832

In the figure below, we see the diagrams drawn in the Jupyter Notebook environment by matplotlib.

Standard diagram:



Log-Log chart:



Time(seconds)	N	LOG-TIME	LOG-N
0.038	2	-4.7179	1.0000
0.042	4	-4.5735	2.0000
0.044	8	-4.5064	3.0000
0.054	16	-4.2109	4.0000
0.077	32	-3.6990	5.0000
0.147	64	-2.7661	6.0000
0.215	128	-2.2176	7.0000
0.584	256	-0.7760	8.0000
3.93	512	1.9745	9.0000
19.23	1024	4.2653	10.0000
97.186	2048	6.6027	11.0000
468.832	4096	8.8729	12.0000

Due to the high error rate of low data, we use high-value data to analyze the algorithm and find the slope of the graph.

$$Lg(T(n)) = blgN + c$$

$$b = \frac{8.8729 - (-0.7760)}{12.0 - 8.0} = 2.412225$$

$$1.9745 = b * 9.0 + c, \quad c = -19.73575$$

$$T(n) = aN^b, \quad a = 2^c$$

$$T(n) = 1.46 * 10^{-6} N^{2.412}$$