PercolationDFS

Grid Size (N by N)	Num of Trials (T)	Time	Mean	Standard Deviation	95% Conf. Interval
100	10	0.546890	0.593440	0.018743	[0.581823, 0.605057]
200	10	6.358221	0.590292	0.009209	[0.584585, 0.596000]
400	10	82.6047819	0.590939	0.002731	[0.589247, 0.592632
100	20	1.163771	0.592645	0.014201	[0.586421, 0.598869]
200	20	13.506909	0.591840	0.010227	[0.587358, 0.596322]
400	20	162.939465	0.590832	0.004670	[0.588785, 0.592878]

1. How does doubling the grid-size, N, affect the running time?
    a. Doubling the grid size increases the run time by a factor of approximately 12
2. How does doubling the number of experiments, T, performed affect the running time?
    a. Doubling the number of experiments performed increases the runtime by a factor of two (thus, it's linear)
3. Try to provide a formula for the running time in terms of N and T, use big-Oh.
    a. N affects runtime linearly (by factor of 12 when doubling) and T affects runtime linearly as well. The runtime has time complexity of approximately O(N*kT) = O(NT)
4. Estimate the largest grid-size you can run in a day for 100 trials (assume time is the only limit here, not memory).
    a. The number of trials increases by 10, thus increasing the runtime by a factor of 10 as well. Thus, for a grid size of 100 by 100, the run time will be about 60 seconds or a minute. A day has 1440 minutes (60 min / hour * 24 hours = 1440 minutes), and we need the grid size to increase by a factor of X such that the runtime increases by a factor of 1440. Since doubling the grid size increases run time by approx 12, and since 12^3 is approximately 1440 minutes, we can double the grid size 2^3 times, or the largest grid-size is approximately 800 by 800 to run in a day with 100 trials.

5. Give estimate for how much memory is used in terms of N, the grid-size. Provide your estimate in bytes and use four bytes for an int, one byte for a boolean, and eight bytes for a double. For example, an array of N integers uses 4N bytes in this model, there's no overhead for the array other than storing the integer values.
    a. Each cell in the N by N grid stores an int or 4 bytes, so the array of N^2 integers uses 4N^2 bytes, which is in O(N^2)

PercolationDFSFast

Grid Size (N by N)	Num of Trials (T)	Time	Mean	Standard Deviation	95% Conf. Interval
100	10	0.114917	0.593440	0.018743	[0.581823, 0.605057]
200	10	0.253476	0.590292	0.009209	[0.584585, 0.596000]
400	10	0.504194	0.590939	0.002731	[0.589247, 0.592632]
100	20	0.168339	0.592645	0.014201	[0.586421, 0.598869]
200	20	0.374967	0.591840	0.010227	[0.587358, 0.596322]
400	20	0.844927	0.590320	0.012327	[0.587101, 0.598927]

1. How does doubling the grid-size, N, affect the running time?
    a. It approximately doubles the running time
2. How does doubling the number of experiments, T, performed affect the running time?
    a. It approximately doubles the running time
3. Try to provide a formula for the running time in terms of N and T, use big-Oh.
    a. O(NT)
4. Estimate the largest grid-size you can run in a day for 100 trials (assume time is the only limit here, not memory).
    a. With 100 trials, we need to multiple the runtime of 0.115 by 10, because of the tenfold increase in T, thus getting 1.15 seconds for N = 100 and T = 100. A day has 86400 seconds, so 86400/1.15 is approximately 75000

seconds, so we can increase N by a factor of approximately log_2(75000) = 16, or 16*100 = 1600

5. Give estimate for how much memory is used in terms of N, the grid-size. Provide your estimate in bytes and use four bytes for an int, one byte for a boolean, and eight bytes for a double. For example, an array of N integers uses 4N bytes in this model, there's no overhead for the array other than storing the integer values.
    a. Each cell in the N by N grid stores an int (4 bytes), so approximately 4N^2 bytes are used, which is in O(N^2)

PercolationUF-QuickFind

Grid Size (N by N)	Num of Trials (T)	Time	Mean	Standard Deviation	95% Conf. Interval
100	10	0.357217	0.593440	0.018743	[0.581823, 0.605057]
200	10	4.094621	0.590292	0.009209	[0.584585, 0.596000]
400	10	88.737023	0.590939	0.002731	[0.589247, 0.592632]
100	20	0.748193	0.592645	0.014201	[0.586421, 0.598869]
200	20	8.616876	0.591840	0.010227	[0.587358, 0.596322]
400	20	195.039239	0.592031	0.011329	[0.585458, 0.593218]

1. How does doubling the grid-size, N, affect the running time?
    a. It increases it exponentially by 2^N
2. How does doubling the number of experiments, T, performed affect the running time?
    a. It doubles the runtime as well
3. Try to provide a formula for the running time in terms of N and T, use big-Oh.
    a. N affects runtime exponentially, and T increases it linearly, for a big Oh time of O(2^N*T)

4. Estimate the largest grid-size you can run in a day for 100 trials (assume time is the only limit here, not memory).
    a. For 100 trials and N = 100, we get runtime is approximately 4 seconds. 86400 seconds in a day, and log _2 (86400) = ~16.4 so we can the largest grid size is 16.4*100 trials = 1640.
5. Give estimate for how much memory is used in terms of N, the grid-size. Provide your estimate in bytes and use four bytes for an int, one byte for a boolean, and eight bytes for a double. For example, an array of N integers uses 4N bytes in this model, there's no overhead for the array other than storing the integer values.
    a. QuickFind uses an int array of size N^2+2, or 4(N^2+2) bytes, and PercolationUF uses a boolean array of size N^2, or a total of 5N^2+8 bytes, which is in O(N^2)

PercolationUF-QuickUWPC

Grid Size (N by N)	Num of Trials (T)	Time	Mean	Standard Deviation	95% Conf. Interval
100	10	0.131078	0.593440	0.018743	[0.581823, 0.605057]
200	10	0.596107	0.590292	0.009209	[0.584585, 0.596000]
400	10	0.617702	0.590939	0.002731	[0.589247, 0.592632]
100	20	0.166709	0.592645	0.014201	[0.586421, 0.598869]
200	20	0.331767	0.591840	0.010227	[0.587358, 0.596322]
400	20	0.760565	0.590832	0.004670	[0.588785, 0.592878]

1. How does doubling the grid-size, N, affect the running time?
    a. It similarly roughly doubles the runtime
2. How does doubling the number of experiments, T, performed affect the running time?
    a. It increases T by log T
3. Try to provide a formula for the running time in terms of N and T, use big-Oh.

    a. For T, it is O(log T), and for N it's O(N), so the run time is roughly O(N log T)
4. Estimate the largest grid-size you can run in a day for 100 trials (assume time is the only limit here, not memory).
    a. Because trials affect run time by log T, if N = 100, we get for T = 100, run time is 0.26. Doubling N doubles run time, and there are 86400 seconds in a day. At N = 400, run time is approx 1 sec. log_2(86400) = 16.4. Thus the largest grid size is approximately 16.4*400 = 6560.
5. Give estimate for how much memory is used in terms of N, the grid-size. Provide your estimate in bytes and use four bytes for an int, one byte for a boolean, and eight bytes for a double. For example, an array of N integers uses 4N bytes in this model, there's no overhead for the array other than storing the integer values.
    a. PercolationUF uses a boolean array of size N^2, or using N^2 bytes. QuickUWPC uses two int arrays of size 8N^2 + 2 bytes total, for a total of 6N^2+8 bytes which is O(N^2)