Siddhartha (001084614) | Program Structures & Algorithms
Spring 2021 Assignment No. 4

TASK: To benchmark Weighted Union Find based on storing size, storing height, one-pass and two-pass.

OUTPUT:

1) Storing Depth

```
<terminated> Benchmark_Timer [Java Application] /Library/Internet Plug-Ins/JavaAppletPlugin.plugin/Contents/Home/bin/java  (Mar 1, 2021, 12:05:06 AM
2021-03-01 00:05:07 INFO   Benchmark_Timer - Begin run: Union Find with 5 runs
2021-03-01 00:05:07 INFO   Benchmark_Timer - Number of sites: 1000 Time to Execute: 5 runs :0.38861 ms
2021-03-01 00:05:07 INFO   Benchmark_Timer - Begin run: Union Find with 5 runs
2021-03-01 00:05:07 INFO   Benchmark_Timer - Number of sites: 10000 Time to Execute: 5 runs :1.93300 ms
2021-03-01 00:05:07 INFO   Benchmark_Timer - Begin run: Union Find with 5 runs
2021-03-01 00:05:07 INFO   Benchmark_Timer - Number of sites: 100000 Time to Execute: 5 runs :18.36468 ms
2021-03-01 00:05:07 INFO   Benchmark_Timer - Begin run: Union Find with 5 runs
2021-03-01 00:05:09 INFO   Benchmark_Timer - Number of sites: 1000000 Time to Execute: 5 runs :251.97126 ms
2021-03-01 00:05:09 INFO   Benchmark_Timer - Begin run: Union Find with 5 runs
2021-03-01 00:06:28 INFO   Benchmark_Timer - Number of sites: 10000000 Time to Execute: 5 runs :11154.37960 ms
```

2) Storing Height

```
<terminated> Benchmark_Timer [Java Application] /Library/Internet Plug-Ins/JavaAppletPlugin.plugin/Contents/Home/bin/java  (Mar 1, 2021, 12:01:39 AM
2021-03-01 00:01:39 INFO   Benchmark_Timer - Begin run: Union Find with 5 runs
2021-03-01 00:01:39 INFO   Benchmark_Timer - Number of sites: 1000 Time to Execute: 5 runs :0.46580 ms
2021-03-01 00:01:39 INFO   Benchmark_Timer - Begin run: Union Find with 5 runs
2021-03-01 00:01:39 INFO   Benchmark_Timer - Number of sites: 10000 Time to Execute: 5 runs :1.94765 ms
2021-03-01 00:01:39 INFO   Benchmark_Timer - Begin run: Union Find with 5 runs
2021-03-01 00:01:39 INFO   Benchmark_Timer - Number of sites: 100000 Time to Execute: 5 runs :19.15392 ms
2021-03-01 00:01:39 INFO   Benchmark_Timer - Begin run: Union Find with 5 runs
2021-03-01 00:01:41 INFO   Benchmark_Timer - Number of sites: 1000000 Time to Execute: 5 runs :241.66115 ms
2021-03-01 00:01:41 INFO   Benchmark_Timer - Begin run: Union Find with 5 runs
2021-03-01 00:03:00 INFO   Benchmark_Timer - Number of sites: 10000000 Time to Execute: 5 runs :11244.44434 ms
```

3) Two Pass

```
<terminated> Benchmark_Timer [Java Application] /Library/Internet Plug-Ins/JavaAppletPlugin.plugin/Contents/Home/bin/java  (Mar 1, 2021, 12:05:06 AM
2021-03-01 00:05:07 INFO   Benchmark_Timer - Begin run: Union Find with 5 runs
2021-03-01 00:05:07 INFO   Benchmark_Timer - Number of sites: 1000 Time to Execute: 5 runs :0.38861 ms
2021-03-01 00:05:07 INFO   Benchmark_Timer - Begin run: Union Find with 5 runs
2021-03-01 00:05:07 INFO   Benchmark_Timer - Number of sites: 10000 Time to Execute: 5 runs :1.93300 ms
2021-03-01 00:05:07 INFO   Benchmark_Timer - Begin run: Union Find with 5 runs
2021-03-01 00:05:07 INFO   Benchmark_Timer - Number of sites: 100000 Time to Execute: 5 runs :18.36468 ms
2021-03-01 00:05:07 INFO   Benchmark_Timer - Begin run: Union Find with 5 runs
2021-03-01 00:05:09 INFO   Benchmark_Timer - Number of sites: 1000000 Time to Execute: 5 runs :251.97126 ms
2021-03-01 00:05:09 INFO   Benchmark_Timer - Begin run: Union Find with 5 runs
2021-03-01 00:06:28 INFO   Benchmark_Timer - Number of sites: 10000000 Time to Execute: 5 runs :11154.37960 ms
```

4) One Pass

```
<terminated> Benchmark_Timer [Java Application] /Library/Internet Plug-Ins/JavaAppletPlugin.plugin/Contents/Home/bin/java  (Feb 28, 2021, 11:13:08 PM
2021-02-28 23:13:09 INFO   Benchmark_Timer - Begin run: Union Find with 5 runs
2021-02-28 23:13:09 INFO   Benchmark_Timer - Number of sites: 1000 Time to Execute: 5 runs :0.44622 ms
2021-02-28 23:13:09 INFO   Benchmark_Timer - Begin run: Union Find with 5 runs
2021-02-28 23:13:09 INFO   Benchmark_Timer - Number of sites: 10000 Time to Execute: 5 runs :1.88809 ms
2021-02-28 23:13:09 INFO   Benchmark_Timer - Begin run: Union Find with 5 runs
2021-02-28 23:13:09 INFO   Benchmark_Timer - Number of sites: 100000 Time to Execute: 5 runs :22.17308 ms
2021-02-28 23:13:09 INFO   Benchmark_Timer - Begin run: Union Find with 5 runs
2021-02-28 23:13:11 INFO   Benchmark_Timer - Number of sites: 1000000 Time to Execute: 5 runs :387.75699 ms
2021-02-28 23:13:11 INFO   Benchmark_Timer - Begin run: Union Find with 5 runs
2021-02-28 23:14:47 INFO   Benchmark_Timer - Number of sites: 10000000 Time to Execute: 5 runs :12817.61841 ms
```

Relationship Conclusion:

1) Storing depth vs storing height: The execution time between both is similar as the depth of the tree formed during weighted quick union is at most logN

2) One pass vs Two Pass: From data it could be interpreted that performance for the one pass is slightly slower than two pass implementations for a bigger value of N

Evidence to support the conclusion:

Data collected from the execution with different values of sites and tested 5times

1) Storing size

No of Sites	Execution Time(ms)
1000	0.38861
10000	1.933
100000	18.36468
1000000	251.97126
10000000	11154.3796

2) Storing height

No of Sites	Execution Time(ms)
1000	0.4658
10000	1.94765
100000	19.15392
1000000	241.66115
10000000	11244.44434

3) Two Pass

No of Sites	Execution Time(ms)
1000	0.38861
10000	1.933
100000	18.36468
1000000	251.97126
10000000	11154.3796

4) One Pass

No of Sites	Execution Time(m)
1000	0.44622
10000	1.88809
100000	22.17308
1000000	387.75699
10000000	12817.61841

Graphical Representation

Storing Size vs Storing Height

One Pass vs Two Pass