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Program Structures & Algorithms

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Union-Find alternatives

- **Task**

We mentioned two alternatives for implementing Union-Find:

For weighted quick union, store the depth rather than the size;

For weighted quick union with path compression, do two loops, so that all intermediate nodes point to the root, not just the alternates.

For both of these, code the alternative and benchmark it against the implementation in the repository. You have all of that available from a previous assignment.

If you can explain why alternative #1 is unnecessary to be benchmarked, you may skip benchmarking that one.

- **Output**

Output1(WQU):

```
2021-02-23 00:27:29 INFO Benchmark_Timer - Begin run: WQU with 10 runs
The time cost for connecting 10 nodes with WQU is: 0.01512
```

```
2021-02-23 00:27:29 INFO Benchmark_Timer - Begin run: WQU with 10 runs
The time cost for connecting 100 nodes with WQU is: 0.03549
```

```
2021-02-23 00:27:29 INFO Benchmark_Timer - Begin run: WQU with 10 runs
The time cost for connecting 1000 nodes with WQU is: 0.33787
```

```
2021-02-23 00:27:29 INFO Benchmark_Timer - Begin run: WQU with 10 runs
The time cost for connecting 10000 nodes with WQU is: 2.33245
```

```
2021-02-23 00:27:29 INFO Benchmark_Timer - Begin run: WQU with 10 runs
The time cost for connecting 100000 nodes with WQU is: 23.89996
```

```
2021-02-23 00:27:29 INFO Benchmark_Timer - Begin run: WQU with 10 runs
The time cost for connecting 1000000 nodes with WQU is: 393.22185
```

Output2(WQU which stores depth instead of size):

```
2021-02-23 00:27:34 INFO Benchmark_Timer - Begin run: WQU_Depth with 10 runs
The time cost for connecting 10 nodes with WQU which stores depth instead of size is: 0.03286
```

```
2021-02-23 00:27:34 INFO Benchmark_Timer - Begin run: WQU_Depth with 10 runs
The time cost for connecting 100 nodes with WQU which stores depth instead of size is: 0.03798
```

```
2021-02-23 00:27:34 INFO Benchmark_Timer - Begin run: WQU_Depth with 10 runs
The time cost for connecting 1000 nodes with WQU which stores depth instead of size is: 0.31357
```

```
2021-02-23 00:27:34 INFO Benchmark_Timer - Begin run: WQU_Depth with 10 runs
The time cost for connecting 10000 nodes with WQU which stores depth instead of size is: 1.7782399999999998
```

```
2021-02-23 00:27:34 INFO Benchmark_Timer - Begin run: WQU_Depth with 10 runs
The time cost for connecting 100000 nodes with WQU which stores depth instead of size is: 25.3305
```

```
2021-02-23 00:27:35 INFO Benchmark_Timer - Begin run: WQU_Depth with 10 runs
The time cost for connecting 1000000 nodes with WQU which stores depth instead of size is: 415.64646000000005
```

Output3(WQUUPC):

```

2021-02-23 00:27:40 INFO Benchmark_Timer - Begin run: WQUPC with 10 runs
The time cost for connecting 10 nodes with WQUPC is: 0.00507

2021-02-23 00:27:40 INFO Benchmark_Timer - Begin run: WQUPC with 10 runs
The time cost for connecting 100 nodes with WQUPC is: 0.03296

2021-02-23 00:27:40 INFO Benchmark_Timer - Begin run: WQUPC with 10 runs
The time cost for connecting 1000 nodes with WQUPC is: 0.28490000000000004

2021-02-23 00:27:40 INFO Benchmark_Timer - Begin run: WQUPC with 10 runs
The time cost for connecting 10000 nodes with WQUPC is: 1.2921200000000002

2021-02-23 00:27:40 INFO Benchmark_Timer - Begin run: WQUPC with 10 runs
The time cost for connecting 100000 nodes with WQUPC is: 16.15983

2021-02-23 00:27:40 INFO Benchmark_Timer - Begin run: WQUPC with 10 runs
The time cost for connecting 1000000 nodes with WQUPC is: 299.2586

```

- **Relationship Conclusion:**

WQU cost nearly the same time whether it stores depth or size.
But WQUPC cost obviously less time than the former 2 ways.

Evidence to support the conclusion:

- **Graphical representation:**



