

Maharshi Jinandra - SEC01(NUID 001546653)

# **Program Structures & Algorithms**

**Spring 2021**

**Assignment No. 4**

## **TASK**

- 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.

## Union by size OR Union by Depth

- When we union by size or height growth of the tree is **logarithmic**.
- The height of the tree increases only when both trees are of the same height.
- In union by size, consider  $n=1,2,3..k$  nodes. Initially height is 0. When a tree is merged it produces tree with nodes  $k+1$ . Resulting in height of the trees  $(T1,T2)$  whose height is  $(h1,h2)$  as  $\max(h1+1, h2)$ .
- Both have worst case complexity of  $O(\lg(n))$ .

## Benchmark results for 250,000 nodes

- **Weighted Union**
  - Time is in ms
  - Average with 100 runs pre run

5k	10k	20k	40k	80k	160k	320k	640k	128k	256k
1.56	2.91	7.19	12.8	28.6	69.2	163	459	1422	3600

- **Weighted Union with Path Compression**
  - Time is in ms
  - Average with 100 runs per run

5k	10k	20k	40k	80k	160k	320k	640k	128k	256k
.56	1.32	3.25	5.71	12.2	27.4	65.7	206	640	1534

## Benchmark Results for 55,00,000 nodes

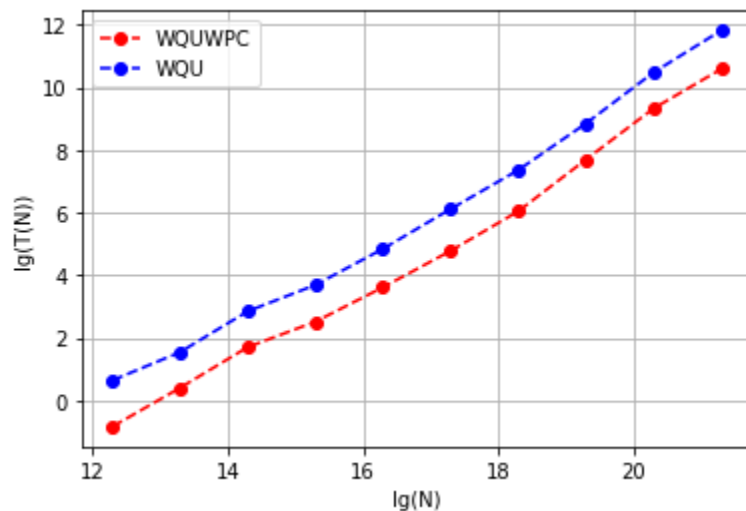
- Weighted Union: 10818ms
- Weighted Union with Path Compression: 3964ms

m - union and find operations

n - nodes

Complexity with only weighted union find is  $O((m + n) \lg(n))$  & complexity with only path compression is  $O((m + n) \lg(n))$ .

Weighted unions with path compression gives an amortized complexity of  $O((m+n) \lg^*(n))$ .



## **Sample Output:**

### Weighted Union

2021-03-01 19:26:49 INFO Benchmark\_Timer - Begin run: Union Find with 100 runs

2021-03-01 19:27:03 INFO TimeLogger - Raw time per run (mSec): 123.39

2021-03-01 19:27:03 INFO Benchmark\_Timer - Begin run: Union Find with 100 runs

2021-03-01 19:27:19 INFO TimeLogger - Raw time per run (mSec): 140.96

2021-03-01 19:27:19 INFO Benchmark\_Timer - Begin run: Union Find with 100 runs

2021-03-01 19:27:34 INFO TimeLogger - Raw time per run (mSec): 142.78

### Weighted Union with Path Compression

2021-03-01 19:27:34 INFO Benchmark\_Timer - Begin run: Union Find with 100 runs

2021-03-01 19:27:40 INFO TimeLogger - Raw time per run (mSec): 56.58

2021-03-01 19:27:40 INFO Benchmark\_Timer - Begin run: Union Find with 100 runs

2021-03-01 19:27:47 INFO TimeLogger - Raw time per run (mSec): 61.32

2021-03-01 19:27:47 INFO Benchmark\_Timer - Begin run: Union Find with 100 runs

2021-03-01 19:27:54 INFO TimeLogger - Raw time per run (mSec): 58.09

Process finished with exit code 0

