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**PSA Assignment 4**

**Code:** <https://github.com/RipanHalder/INFO6205>

**Results**: <https://github.com/RipanHalder/INFO6205/tree/master/results/union_find>

**Submission PDF**: <https://github.com/RipanHalder/INFO6205> -> PSA Assignment 4 – Ripan Halder.pdf

**Observations:**

1. Quick Union Find for DEPTH vs SIZE
   1. DEPTH:

When we are merging by depth/height, longer tree will always be a parent of a shorter tree. If the depth of two trees are same, then it is arbitrarily merged and only then the height is increased by 1.

So, height of the tree will only increase when nodes count is doubled. So, we will get height which will be always less than or equal to log(N), where N is the number of nodes.

* 1. SIZE:

When we are merging by size, size of parent is increased with the size of child. Smaller node is attached to the larger node. So, the size of tree is always greater than or equal to 2h where h is the height of the tree.

So for DEPTH: h <= log2(N)

And for SIZE: N >= 2h  which implies to log2(N) >= h

So, time complexity either by DEPTH or SIZE, will always be same. So we don’t need to benchmark and test difference between them.

1. Comparing Path Compression vs No Compression on Pairs Generated:

|  |  |  |
| --- | --- | --- |
| **N** | **Pairs by no** **path compression** | **Pairs by path compression** |
| 10 | 16.115 | 16.885 |
| 20 | 38.84 | 40.105 |
| 40 | 89.03 | 85.265 |
| 80 | 205.45 | 193.6 |
| 160 | 456.1 | 464.8 |
| 320 | 1019.595 | 992.23 |
| 640 | 2214.385 | 2292.59 |

Benchmarking these results, we get the following Time (in ms) for random pairs generated through path compression or no path compression:

|  |  |  |
| --- | --- | --- |
| **N** | **Time in ms**  **(No Path Compression)** | **Time in ms**  **(Path Compression)** |
| 10 | 0.000762832 | 0.01115321 |
| 20 | 0.001834399 | 0.002413665 |
| 40 | 0.005050571 | 0.00382086 |
| 80 | 0.018420168 | 0.008785985 |
| 160 | 0.067016609 | 0.019016515 |
| 320 | 0.278660571 | 0.04297637 |
| 640 | 1.128474538 | 0.09351898 |
| 1280 | 1.215267839 | 0.934821415 |
| 2560 | 2.623784728 | 2.018295945 |
| 5120 | 3.262748327 | 2.509806406 |
| 10240 | 6.21572638 | 4.781327985 |
| 20480 | 13.26378234 | 10.20290949 |
| 40960 | 31.26372345 | 24.04901804 |
| 81920 | 70.76361283 | 54.43354833 |

**Unit Tests Screenshots:**

1. **UF\_HWQUPC Test:**

**Table

Description automatically generated**

1. **WQUPC Test:**

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**Conclusion:**

* *Random pairs generated during both union find using path compression or not is always almost similar.*
* *After, benchmarking we conclude that the algorithm works ~1.25 times faster when path compression is used versus when path compression is not used.*
* *Time complexity for is same for both depth versus size for this algorithm. Using any of them is fine but coding in size is bit easier rather than using approach of depth.*