Test WQU\_OnePath

Graphical user interface, text, application

Description automatically generated

Test WQU\_ByDepth

Graphical user interface, text, application

Description automatically generated

Test WQU\_TwoDepth

Graphical user interface, text, application

Description automatically generated

Test WQU\_OnePath

Graphical user interface, text, application

Description automatically generated

Through the test of each class, we could know that the function of each class is correct.

For each class, we choose 7 different length: 1000, 2000, 4000, 8000, 16000, 32000, 64000. Then run over 100 times and get the average time of each class and average depth of each tree. The results are shown below:

A screenshot of a newspaper

Description automatically generated

In order to see the results clearly, I copy and paste the results and write them down in a table.

n = 1000

Average time without path compression(By Size): 0.35290857000000003 Average depth without path compression(By Size): 5.03921568627451

Average time without path compression(By Depth): 0.40048493 Average depth without path compression(By Depth): 4.862745098039215

Average time with path compression(one path): 0.29532326999999997 Average depth with path compression(one path): 4.009803921568627

Average time with path compression(two path): 0.31447666 Average depth with path compression(two path): 1.8529411764705883

n = 2000

Average time without path compression(By Size): 0.43847033 Average depth without path compression(By Size): 5.588235294117647

Average time without path compression(By Depth): 0.43188923 Average depth without path compression(By Depth): 5.323529411764706

Average time with path compression(one path): 0.37299403 Average depth with path compression(one path): 4.009803921568627

Average time with path compression(two path): 0.35402748 Average depth with path compression(two path): 1.8627450980392157

n = 4000

Average time without path compression(By Size): 0.6781967400000001 Average depth without path compression(By Size): 5.990196078431373

Average time without path compression(By Depth): 0.70919864 Average depth without path compression(By Depth): 5.666666666666667

Average time with path compression(one path): 0.6527410100000001 Average depth with path compression(one path): 4.235294117647059

Average time with path compression(two path): 0.5097082000000001 Average depth with path compression(two path): 1.8137254901960784

n = 8000

Average time without path compression(By Size): 1.63214273 Average depth without path compression(By Size): 6.401960784313726

Average time without path compression(By Depth): 1.5963032999999998 Average depth without path compression(By Depth): 6.088235294117647

Average time with path compression(one path): 1.26359583 Average depth with path compression(one path): 4.088235294117647

Average time with path compression(two path): 1.08784966 Average depth with path compression(two path): 1.8137254901960784

n = 16000

Average time without path compression(By Size): 3.52879904 Average depth without path compression(By Size): 6.833333333333333

Average time without path compression(By Depth): 3.4470215300000002 Average depth without path compression(By Depth): 6.5

Average time with path compression(one path): 2.84971943 Average depth with path compression(one path): 4.196078431372549

Average time with path compression(two path): 2.35956604 Average depth with path compression(two path): 1.8725490196078431

n = 32000

Average time without path compression(By Size): 9.12199969 Average depth without path compression(By Size): 7.186274509803922

Average time without path compression(By Depth): 7.69779185 Average depth without path compression(By Depth): 6.705882352941177

Average time with path compression(one path): 6.5228466 Average depth with path compression(one path): 4.127450980392157

Average time with path compression(two path): 5.50716964 Average depth with path compression(two path): 1.8333333333333333

n = 64000

Average time without path compression(By Size): 17.46904362 Average depth without path compression(By Size): 7.715686274509804

Average time without path compression(By Depth): 17.20306595 Average depth without path compression(By Depth): 7.313725490196078

Average time with path compression(one path): 14.10327513 Average depth with path compression(one path): 4.3431372549019605

Average time with path compression(two path): 11.435020790000001 Average depth with path compression(two path): 1.8823529411764706

Process finished with exit code 0

Average Running Time:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Weight quick union (store the size) | Weight quick union (store the depth) | WQU path compression (one path) | WQU path compression(two path) |
| 1000 | 0.35290857 | 0.40048493 | 0.29532327 | 0.31447666 |
| 2000 | 0.43847033 | 0.43188923 | 0.37299403 | 0.35402748 |
| 4000 | 0.67819674 | 0.70919864 | 0.65274101 | 0.5097082 |
| 8000 | 1.63214273 | 1.5963033 | 1.26359583 | 1.08784966 |
| 16000 | 3.52879904 | 3.44702153 | 2.84971943 | 2.35956604 |
| 32000 | 9.12199969 | 7.69779185 | 6.5228466 | 5.50716964 |
| 64000 | 17.46904362 | 17.20306595 | 14.10327513 | 11.43502079 |

Average Depth:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Weight quick union (store the size) | Weight quick union (store the depth) | WQU path compression (one path) | WQU path compression(two path) |
| 1000 | 5.03921568627451 | 4.862745098039215 | 4.009803921568627 | 1.8529411764705883 |
| 2000 | 5.588235294117647 | 5.323529411764706 | 4.009803921568627 | 1.8627450980392157 |
| 4000 | 5.990196078431373 | 5.666666666666667 | 4.235294117647059 | 1.8137254901960784 |
| 8000 | 6.401960784313726 | 6.088235294117647 | 4.088235294117647 | 1.8137254901960784 |
| 16000 | 6.833333333333333 | 6.5 | 4.196078431372549 | 1.8725490196078431 |
| 32000 | 7.186274509803922 | 6.705882352941177 | 4.127450980392157 | 1.8333333333333333 |
| 64000 | 7.715686274509804 | 7.313725490196078 | 4.3431372549019605 | 1.8823529411764706 |

**Conclusion:**

For Weight Quick Union (Store the size) and Weight Quick Union (Store the depth), their average running times and average depth are almost the same. Since they have the same method of Find() and Union(). The only difference is the way they store the tree. The running time is O(N + N lg(N)).

For Weight Quick Union with path compression, we observe that compared with Weight Quick Union(Without Path Compression), both One Pass and Two Path have a significant improvement. In the One Pass Compression, we set the parent of the node to its grandparent, and in the Two Path Compression, we set the parent of the node directly to its root. So, we can observe that the Two Path Compression performance is better than the One Path Compression. But the running time of them are O(N + N lg\*(N)).

**File Description:**

**WQU\_ByDepth.java:** Weight Quick Union, store the depth.

**WQU\_BySize.java:** Weight Quick Union, store the size.

**WQU\_OnePath.java:** Weight Quick Union with path compression, store the size

**WQU\_TwoPath.java:** Weight Quick Union with path compression, store the size

**Benchmark\_WQU.java:** run the 4 types of alternatives, calculate the running time and depth