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Program Structures & Algorithms

Spring 2021

Assignment No. 3

- **Task**
  - **Implement height-weighted Quick Union with Path Compression.**
  - **Run related unit tests.**
  - **Create a client for the implementation of height-weighted Quick Union with Path Compression.**
  - **Determine the relationship between the number of objects (n) and the number of pairs (m) generated to accomplish this (i.e., to reduce the number of components from n to 1).**

Relationship

Connections will always be n-1

n	m1	m2	m3	m4	m5
128	294	251	390	317	256
256	865	624	647	687	741
512	1692	1522	1638	2503	1853
1024	2895	4426	3255	4782	5755
2048	9442	8087	9866	9452	10073

Change (x * 100)

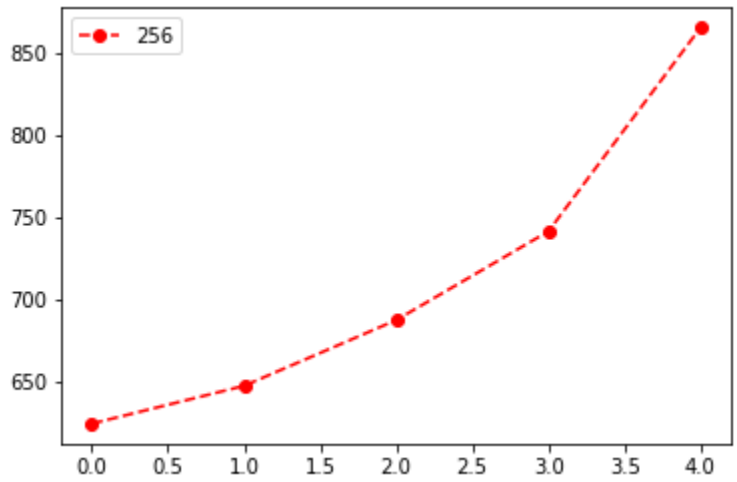
```
128
0    2.296875
1    1.960938
2    3.046875
3    2.476562
4    2.000000
256
0    3.378906
1    2.437500
2    2.527344
3    2.683594
4    2.894531
512
0    3.304688
1    2.972656
2    3.199219
3    4.888672
4    3.619141
1024
0    2.827148
1    4.322266
2    3.178711
3    4.669922
4    5.620117
2048
0    4.610352
1    3.948730
2    4.817383
3    4.615234
4    4.918457
```

As seen above as the size of (n) increases the number of pairs (m) to be generated to accomplish the reduction of component to 1 is exponential. For 2048 it is twice on average & for 2048 it is 4 times on average, if taking this a trend we can assume that 4096 should be 16times on average.

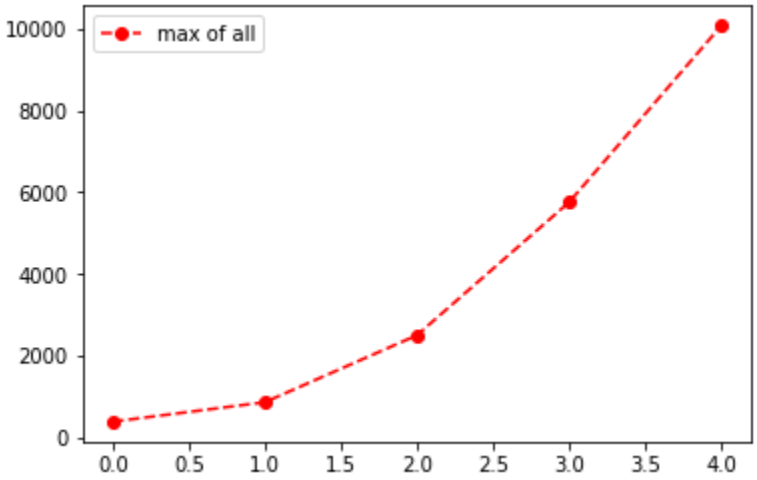
```
Total Iterations: 16158
Unions Performed: 4095
Total Iterations: 16572
Unions Performed: 4095
Total Iterations: 16892
```

16892/4095 = 16.49

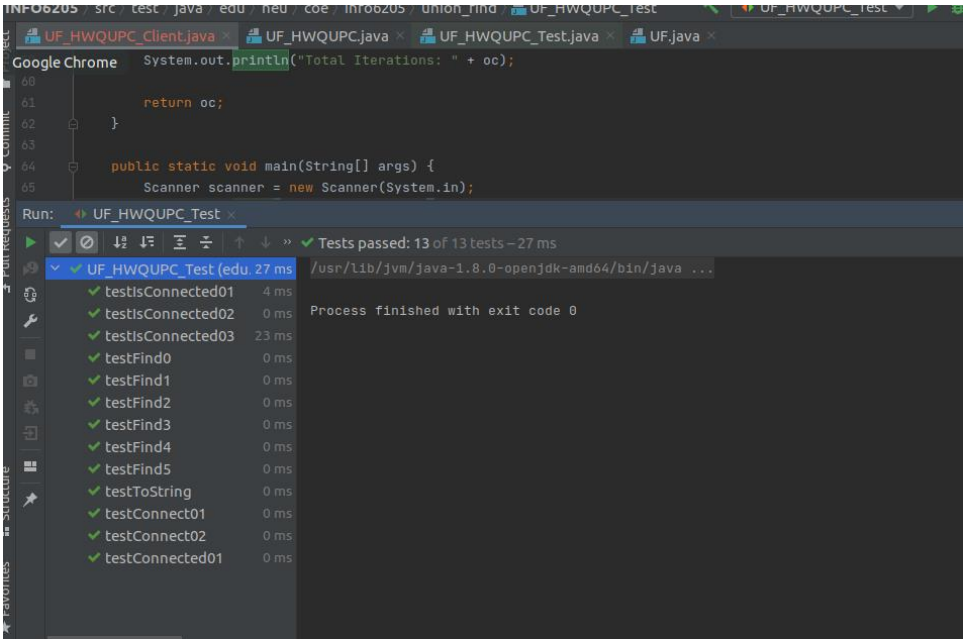
The following plot is of n= 256



The next graph plots all the max(m) i.e., max of 128,256,512... and so on



Unit Tests



Sample Run Output

Number of sites:10

Generated: 6, 1

Connecting

Generated: 1, 9

Connecting

Generated: 6, 7

Connecting

Generated: 9, 4

Connecting

Generated: 8, 1

Connecting

Generated: 3, 7

Connecting

Generated: 8, 1

Already connected!

Generated: 1, 2

Connecting

Generated: 2, 0

Connecting

Generated: 7, 3

Already connected!

Generated: 3, 1

Already connected!

Generated: 3, 0

Already connected!

Generated: 6, 9

Already connected!

Generated: 7, 8

Already connected!

Generated: 1, 2

Already connected!

Generated: 6, 7

Already connected!

Generated: 7, 1

Already connected!

Generated: 9, 6

Already connected!

Generated: 8, 3

Already connected!

Generated: 7, 9

Already connected!

Generated: 2, 9

Already connected!

Generated: 5, 8

Connecting

Unions Performed: 9

Total Iterations: 22

Generated: 3, 7

Connecting

Generated: 7, 9

Connecting

Generated: 0, 5

Connecting

Generated: 0, 8

Connecting

Generated: 4, 1

Connecting

Generated: 9, 4

Connecting

Generated: 6, 4

Connecting

Generated: 3, 4

Already connected!

Generated: 2, 8

Connecting

Generated: 5, 0

Already connected!

Generated: 7, 6

Already connected!

Generated: 8, 6

Connecting

Unions Performed: 9

Total Iterations: 12

Generated: 3, 5

Connecting

Generated: 8, 3

Connecting

Generated: 6, 5

Connecting

Generated: 5, 8

Already connected!

Generated: 2, 5

Connecting

Generated: 4, 9

Connecting

Generated: 7, 8

Connecting

Generated: 7, 9

Connecting

Generated: 5, 9

Already connected!

Generated: 9, 8

Already connected!

Generated: 3, 5

Already connected!

Generated: 0, 9

Connecting

Generated: 2, 1

Connecting

Unions Performed: 9

Total Iterations: 13

Generated: 8, 1

Connecting

Generated: 6, 0

Connecting

Generated: 1, 7

Connecting

Generated: 0, 6

Already connected!

Generated: 3, 7

Connecting

Generated: 4, 9

Connecting

Generated: 4, 0

Connecting

Generated: 9, 3

Connecting

Generated: 8, 9

Already connected!

Generated: 1, 2

Connecting

Generated: 9, 0

Already connected!

Generated: 1, 8

Already connected!

Generated: 8, 3

Already connected!

Generated: 1, 4

Already connected!

Generated: 6, 1

Already connected!

Generated: 8, 2

Already connected!

Generated: 9, 8

Already connected!

Generated: 6, 2

Already connected!

Generated: 5, 8

Connecting

Unions Performed: 9

Total Iterations: 19

Generated: 3, 0

Connecting

Generated: 7, 6

Connecting

Generated: 2, 3

Connecting

Generated: 0, 6

Connecting

Generated: 6, 8

Connecting

Generated: 4, 0

Connecting

Generated: 8, 9

Connecting

Generated: 8, 6

Already connected!

Generated: 5, 7

Connecting

Generated: 3, 0

Already connected!

Generated: 3, 9

Already connected!

Generated: 5, 8

Already connected!

Generated: 0, 6

Already connected!

Generated: 7, 2

Already connected!

Generated: 0, 9

Already connected!

Generated: 9, 1

Connecting

Unions Performed: 9

Total Iterations: 16