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Program Structures & Algorithms
Spring 2021
Assignment No. 3

- **Task –**

- Step 1:
    (a) Implement height-weighted Quick Union with Path Compression. For this, you will flesh out the class UF_HWQUPC. All you have to do is to fill in the sections marked with // TO BE IMPLEMENTED ... // ...END IMPLEMENTATION.

- (b) Check that the unit tests for this class all work. You must show "green" test results in your submission (screenshot is OK).

- Step 2:
    Using your implementation of UF_HWQUPC, develop a UF ("union-find") client that takes an integer value n from the command line to determine the number of "sites." Then generates random pairs of integers between 0 and n-1, calling connected () to determine if they are connected and union () if not. Loop until all sites are connected then print the number of connections generated. Package your program as a static method count () that takes n as the argument and returns the number of connections; and a main () that takes n from the command line, calls count() and prints the returned value. If you prefer, you can create a main program that doesn't require any input and runs the experiment for a fixed set of n values. Show evidence of your run(s).
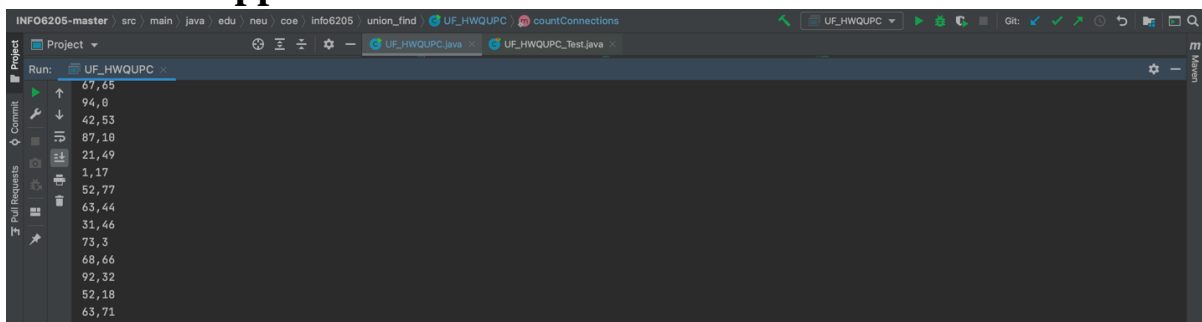
- Step 3:
    Determine the relationship between the number of objects (n) and the number of pairs (m) generated to accomplish this (i.e., to reduce the number of components from n to 1). Justify your conclusion.

- **Relationship Conclusion:**
    Number of components can be calculated by "**n − m**".

- **Evidence to support the conclusion:**

```
73,3
68,66
92,32
52,18
63,71
7,85
56,88
14,16
90,10
72,89
96,1
28,15
71,24
91,28
18,80
85,33
79,22
89,26
55,43
78,59
76,63
11,58
The number of nodes are : 100
Number of connections are : 85
The number of components are : 15

Process finished with exit code 0
```
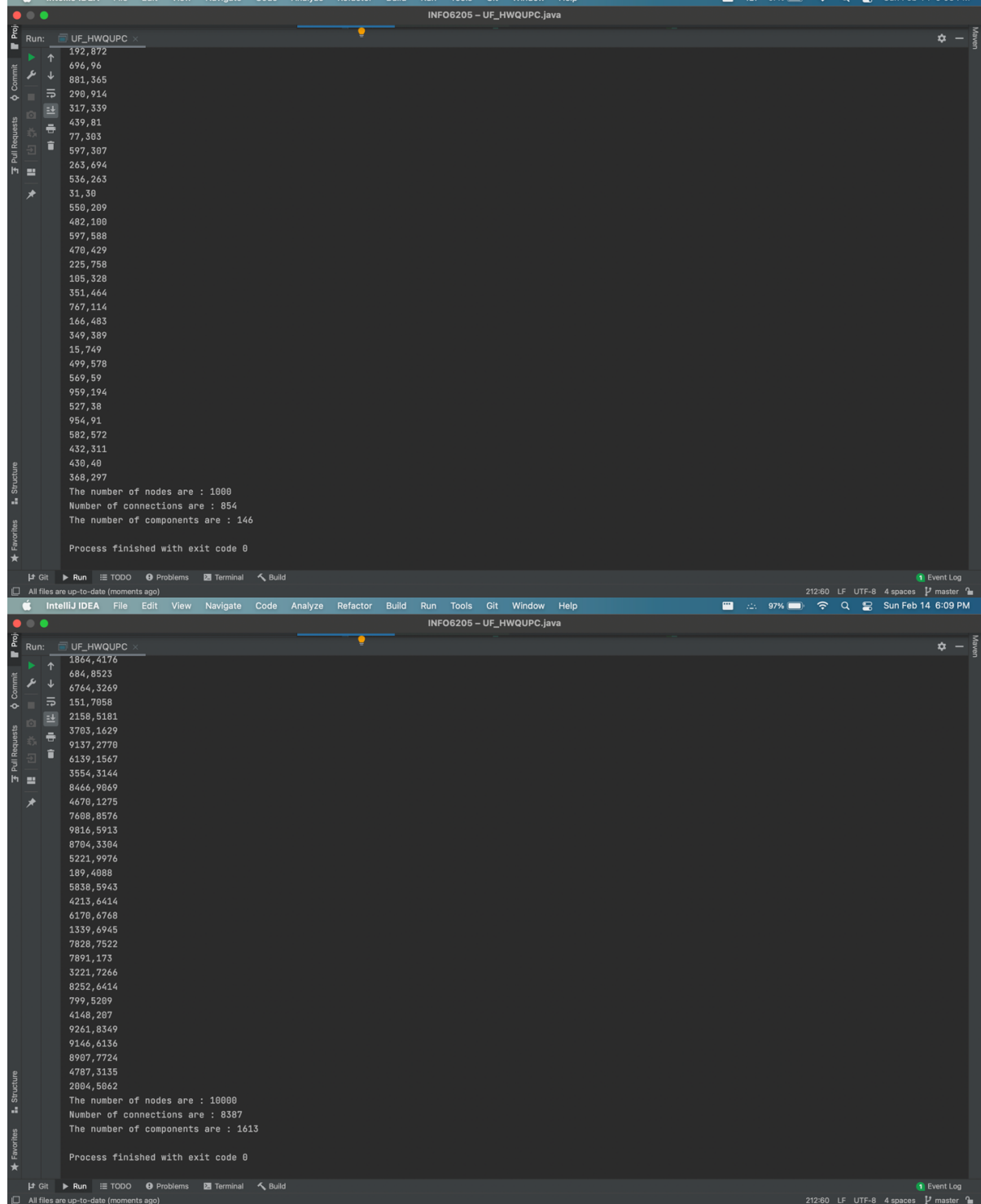
Build completed successfully in 2 sec, 202 ms (moments ago)
INFO6205-master) src) main) java) edu) neu) coe) info6205) union_find) UF_HWQUPC) countConnections

Project   UF_HWQUPC.java   UF_HWQUPC_Test.java

Run: UF_HWQUPC

```
26,56
71,18
99,54
78,6
37,14
46,22
59,88
91,42
27,7
99,27
39,36
46,21
68,48
70,68
94,90
84,93
58,28
83,37
35,39
54,38
81,78
85,63
32,55
5,2
40,81
13,62
96,18
72,57
11,96
51,17
91,88
The number of nodes are : 100
Number of connections are : 81
The number of components are : 19

Process finished with exit code 0
```
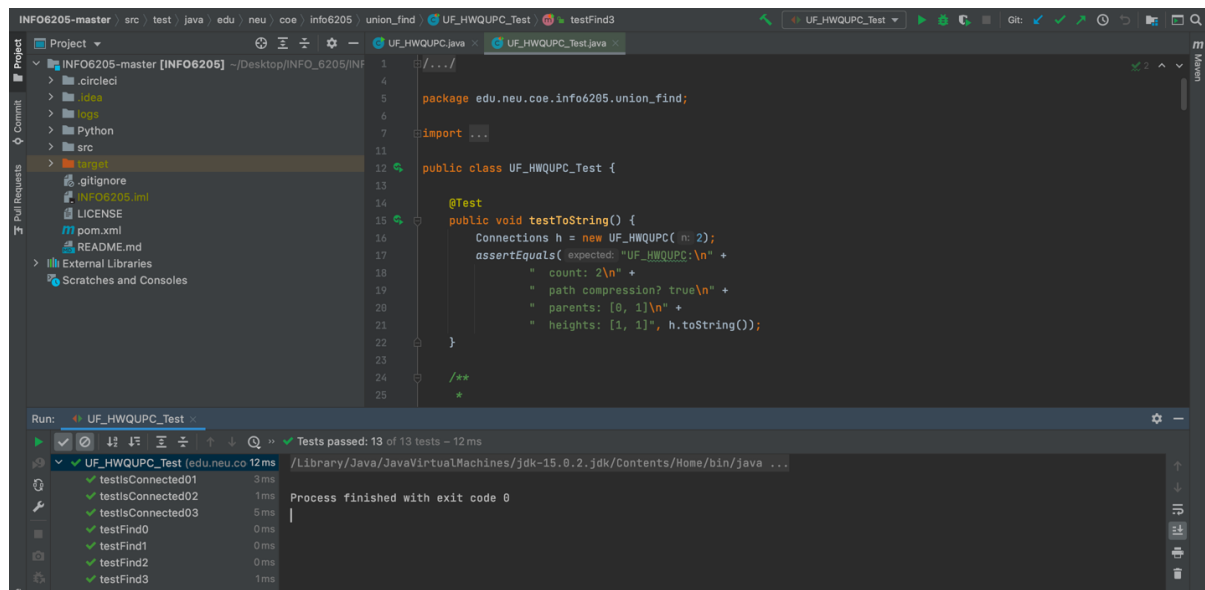
All files are up-to-date (moments ago)
INFO6205-master) src) main) java) edu) neu) coe) info6205) union_find) UF_HWQUPC) countConnections

Project   UF_HWQUPC.java   UF_HWQUPC_Test.java

Run: UF_HWQUPC

```
36,62
87,60
52,25
69,20
27,89
22,82
43,17
64,86
54,35
30,62
29,86
49,0
10,22
71,78
35,31
68,91
98,39
85,30
29,65
26,41
32,86
29,99
30,47
55,98
70,35
55,76
45,66
29,34
88,26
81,3
23,1
The number of nodes are : 100
Number of connections are : 79
The number of components are : 21

Process finished with exit code 0
```

All files are up-to-date (moments ago)

INFO6205 – UF_HWQUPC.java

Run: UF_HWQUPC
```
192,872
696,96
```

```
Run:    UF_HWQUPC

    192,872
    696,96
    881,365
    290,914
    317,339
    439,81
    77,303
    597,307
    263,694
    536,263
    31,30
    550,209
    482,100
    597,588
    470,429
    225,758
    105,328
    351,464
    767,114
    166,483
    349,389
    15,749
    499,578
    569,59
    959,194
    527,38
    954,91
    582,572
    432,311
    430,40
    368,297
    The number of nodes are : 1000
    Number of connections are : 854
    The number of components are : 146

    Process finished with exit code 0
```

```
Run:    UF_HWQUPC

    1864,4176
    684,8523
    6764,3269
    151,7058
    2158,5181
    3703,1629
    9137,2770
    6139,1567
    3554,3144
    8466,9069
    4670,1275
    7608,8576
    9816,5913
    8704,3304
    5221,9976
    189,4088
    5838,5943
    4213,6414
    6170,6768
    1339,6945
    7828,7522
    7891,173
    3221,7266
    8252,6414
    799,5209
    4148,207
    9261,8349
    9146,6136
    8907,7724
    4787,3135
    2004,5062
    The number of nodes are : 10000
    Number of connections are : 8387
    The number of components are : 1613

    Process finished with exit code 0
```

• **Unit tests result:**