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INFO 6205

Program Structures & Algorithms

Fall 2020

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:

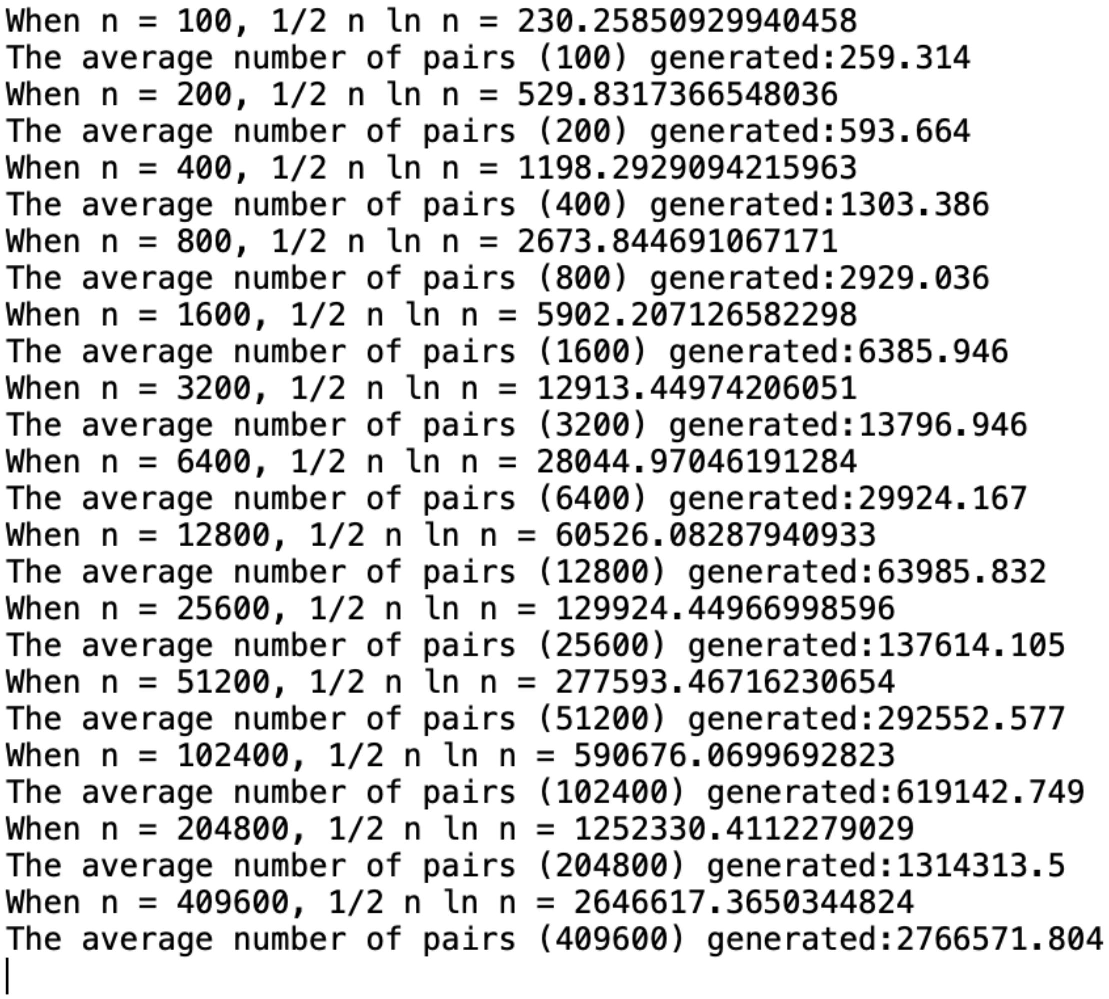
Using your implementation of UF_HWQUPC, develop a UF ("union-find") client that takes an integer value n from the command line to determine the number of "sites." Then generates random pairs of integers between 0 and n-1, calling connected() to determine if they are connected and union() if not. Loop 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.

- **Output** (few outputs to prove relationship)

Every n value with 1000 runs.



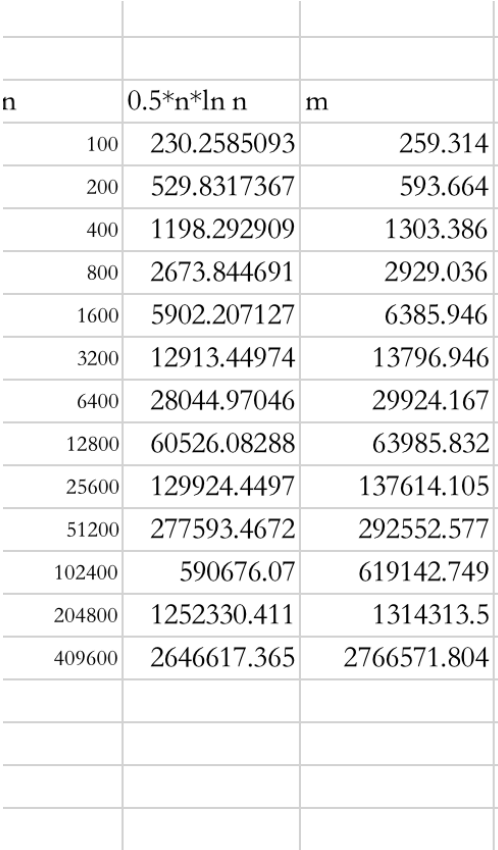
```
When n = 100, 1/2 n ln n = 230.25850929940458
The average number of pairs (100) generated:259.314
When n = 200, 1/2 n ln n = 529.8317366548036
The average number of pairs (200) generated:593.664
When n = 400, 1/2 n ln n = 1198.2929094215963
The average number of pairs (400) generated:1303.386
When n = 800, 1/2 n ln n = 2673.844691067171
The average number of pairs (800) generated:2929.036
When n = 1600, 1/2 n ln n = 5902.207126582298
The average number of pairs (1600) generated:6385.946
When n = 3200, 1/2 n ln n = 12913.44974206051
The average number of pairs (3200) generated:13796.946
When n = 6400, 1/2 n ln n = 28044.97046191284
The average number of pairs (6400) generated:29924.167
When n = 12800, 1/2 n ln n = 60526.08287940933
The average number of pairs (12800) generated:63985.832
When n = 25600, 1/2 n ln n = 129924.44966998596
The average number of pairs (25600) generated:137614.105
When n = 51200, 1/2 n ln n = 277593.46716230654
The average number of pairs (51200) generated:292552.577
When n = 102400, 1/2 n ln n = 590676.0699692823
The average number of pairs (102400) generated:619142.749
When n = 204800, 1/2 n ln n = 1252330.4112279029
The average number of pairs (204800) generated:1314313.5
When n = 409600, 1/2 n ln n = 2646617.3650344824
The average number of pairs (409600) generated:2766571.804
```

- **Relationship conclusion**

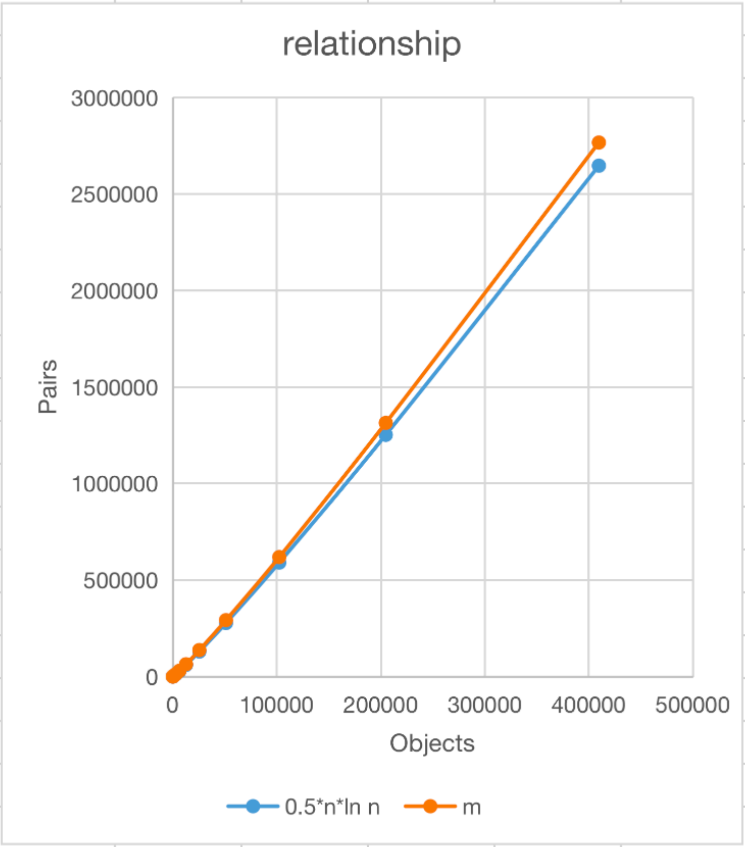
the relationship between the number of objects (n) and the number of pairs (m) generated:

m $\sim 0.5 * n * lnn$

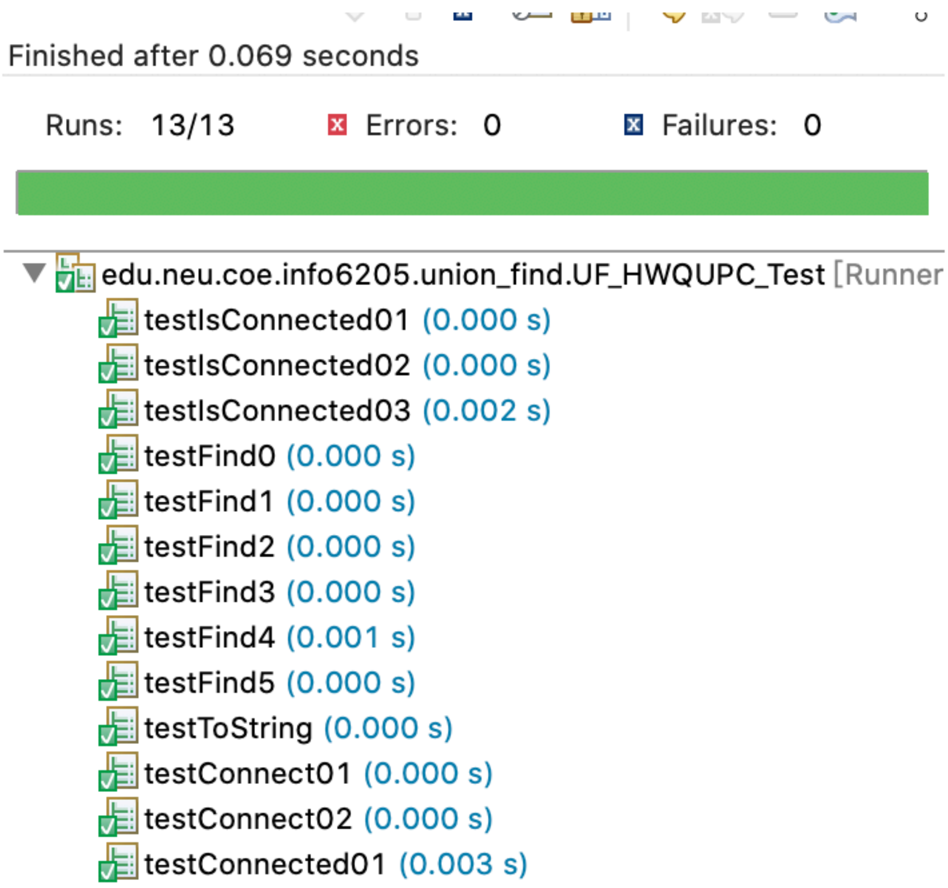
- **Evidence to support relationship** (screen shot and/or graph and/or spreadsheet)



n	0.5*n*ln n	m
100	230.2585093	259.314
200	529.8317367	593.664
400	1198.292909	1303.386
800	2673.844691	2929.036
1600	5902.207127	6385.946
3200	12913.44974	13796.946
6400	28044.97046	29924.167
12800	60526.08288	63985.832
25600	129924.4497	137614.105
51200	277593.4672	292552.577
102400	590676.07	619142.749
204800	1252330.411	1314313.5
409600	2646617.365	2766571.804



- **Screenshot of Unit test passing**



Finished after 0.069 seconds

Runs: 13/13 ☒ Errors: 0 ☒ Failures: 0

```
edu.neu.coe.info6205.union_find.UF_HWQUPC_Test [Runner
    testIsConnected01 (0.000 s)
    testIsConnected02 (0.000 s)
    testIsConnected03 (0.002 s)
    testFind0 (0.000 s)
    testFind1 (0.000 s)
    testFind2 (0.000 s)
    testFind3 (0.000 s)
    testFind4 (0.001 s)
    testFind5 (0.000 s)
    testToString (0.000 s)
    testConnect01 (0.000 s)
    testConnect02 (0.000 s)
    testConnected01 (0.003 s)
```