Cheng Yan (001090569)

Program Structures & Algorithms

Fall 2021

Assignment No. 3

⊙ Task (List down the tasks performed in the Assignment)

- 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).

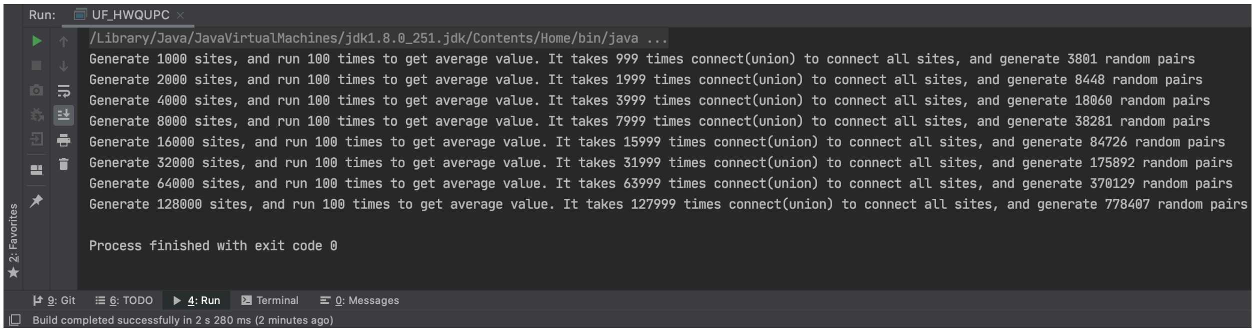
- Step 3: Determine the relationship between the number of objects (n) and the number of pairs (m) generated to accomplish this (i.e. to reduce the number of components from n to 1). Justify your conclusion in terms of your observations and what you think might be going on.

- **Relationship Conclusion: (For ex : z = a * b)**

$$M \sim O(N)$$

- **Evidence to support the conclusion:**

1. **Output (Snapshot of Code output in the terminal)**



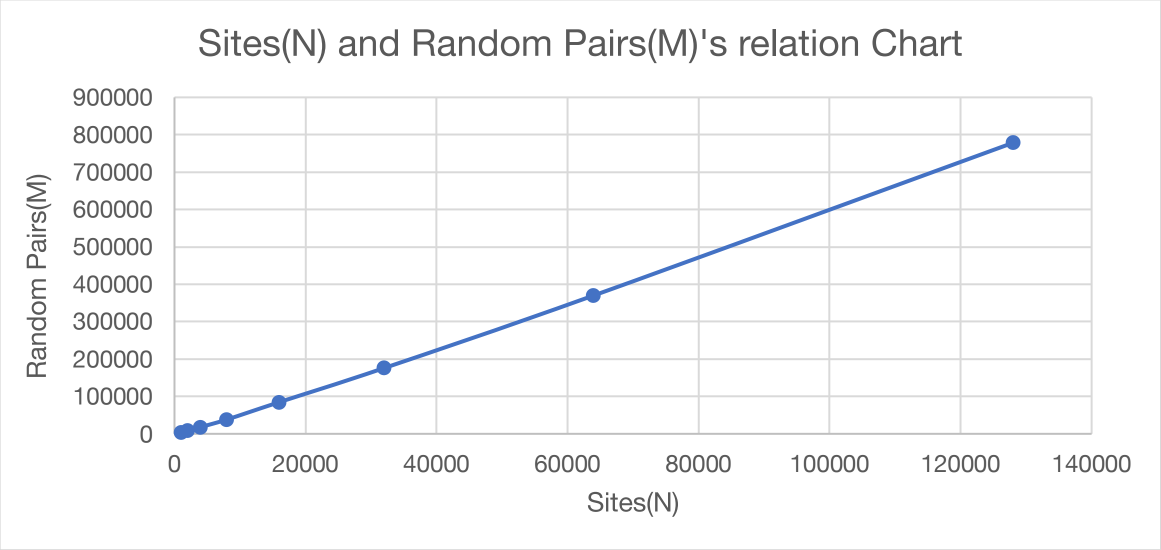
```
/Library/Java/JavaVirtualMachines/jdk1.8.0_251.jdk/Contents/Home/bin/java ...
Generate 1000 sites, and run 100 times to get average value. It takes 999 times connect(union) to connect all sites, and generate 3801 random pairs
Generate 2000 sites, and run 100 times to get average value. It takes 1999 times connect(union) to connect all sites, and generate 8448 random pairs
Generate 4000 sites, and run 100 times to get average value. It takes 3999 times connect(union) to connect all sites, and generate 18060 random pairs
Generate 8000 sites, and run 100 times to get average value. It takes 7999 times connect(union) to connect all sites, and generate 38281 random pairs
Generate 16000 sites, and run 100 times to get average value. It takes 15999 times connect(union) to connect all sites, and generate 84726 random pairs
Generate 32000 sites, and run 100 times to get average value. It takes 31999 times connect(union) to connect all sites, and generate 175892 random pairs
Generate 64000 sites, and run 100 times to get average value. It takes 63999 times connect(union) to connect all sites, and generate 370129 random pairs
Generate 128000 sites, and run 100 times to get average value. It takes 127999 times connect(union) to connect all sites, and generate 778407 random pairs

Process finished with exit code 0
```

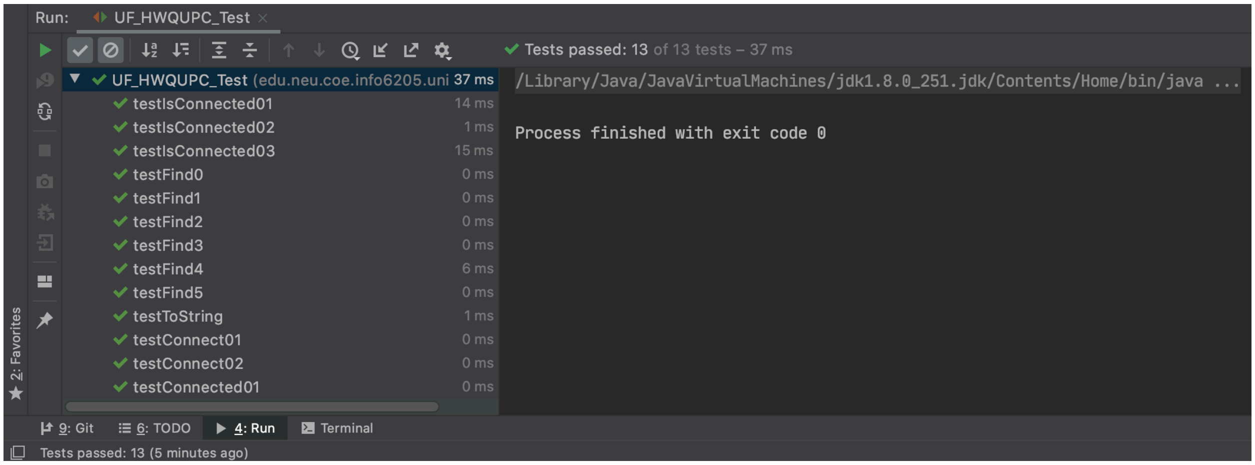
Build completed successfully in 2 s 280 ms (2 minutes ago)

2. **Graphical Representation(Observations from experiments should be tabulated and analyzed by plotting graphs(usually in excel) to arrive on the relationship conclusion)**

Sites(N) and Random Pairs(M)'s relation table		
sites(N)	connect times	random pairs(M)
1000	999	3881
2000	1999	8448
4000	3999	18060
8000	7999	38281
16000	15999	84726
32000	31999	175892
64000	63999	370129
128000	127999	778407



- **Unit tests result:(Snapshot of successful unit test run)**



```
✓ Tests passed: 13 of 13 tests – 37 ms

✓ UF_HWQUPC_Test (edu.neu.coe.info6205.uni 37 ms
    ✓ testIsConnected01       14 ms
    ✓ testIsConnected02        1 ms
    ✓ testIsConnected03       15 ms
    ✓ testFind0                0 ms
    ✓ testFind1                0 ms
    ✓ testFind2                0 ms
    ✓ testFind3                0 ms
    ✓ testFind4                6 ms
    ✓ testFind5                0 ms
    ✓ testToString             1 ms
    ✓ testConnect01            0 ms
    ✓ testConnect02            0 ms
    ✓ testConnected01          0 ms
```

```
/Library/Java/JavaVirtualMachines/jdk1.8.0_251.jdk/Contents/Home/bin/java ...

Process finished with exit code 0
```

Tests passed: 13 (5 minutes ago)