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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:

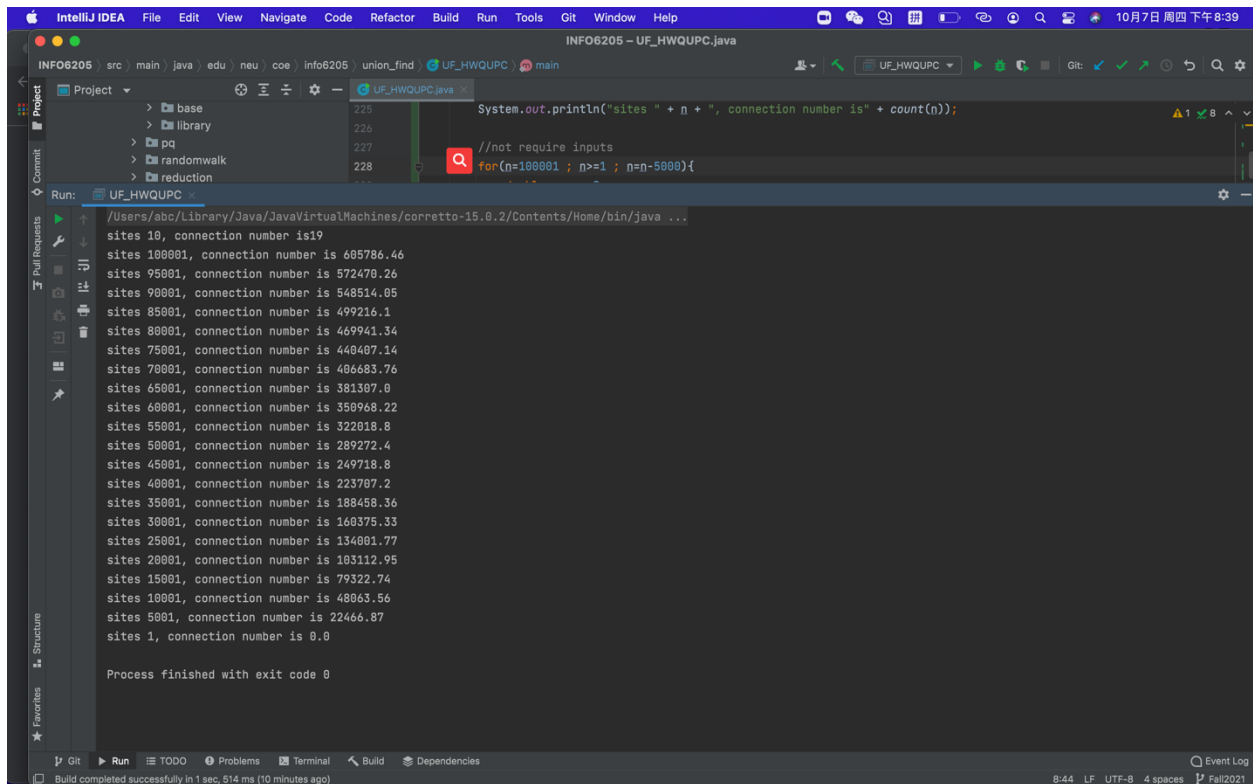
Determine the relationship between the number of objects (n) and the number of pairs (m) generated to accomplish this (i.e. to reduce the number of components from n to 1). Justify your conclusion in terms of your observations and what you think might be going on.

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

$$F(n)=1.2*n*\log_{10}(n)$$

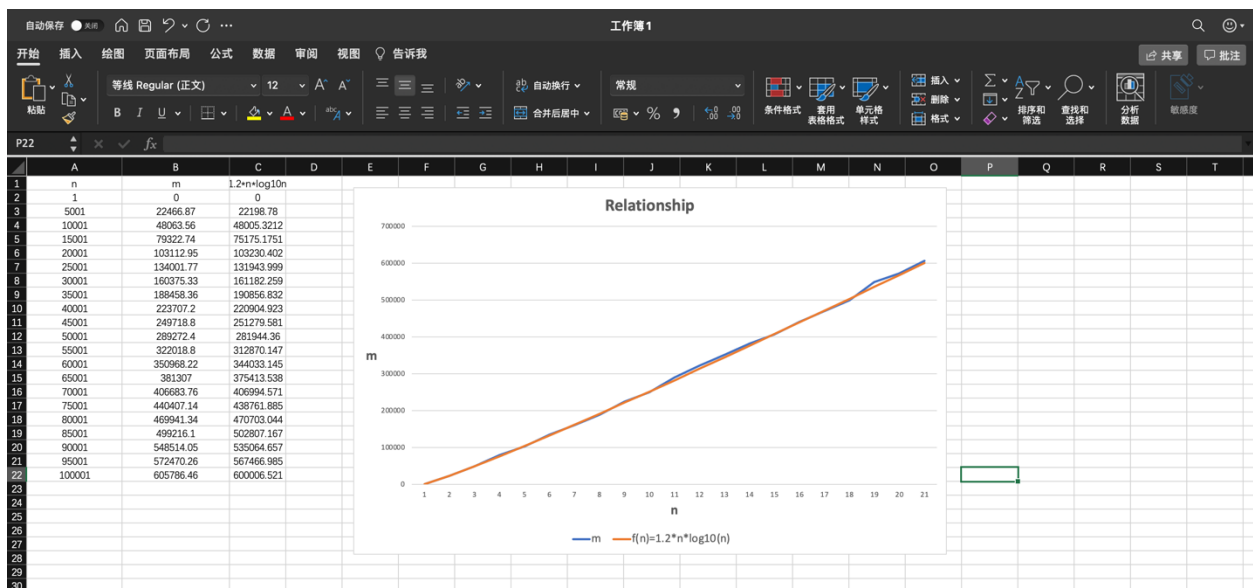
○ Evidence to support the conclusion:

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



```
System.out.println("sites " + n + ", connection number is" + count(n));  
//not require inputs  
for(n=100001; n>=1; n=n-5000){  
    sites 10, connection number is 19  
    sites 100001, connection number is 605786.46  
    sites 95001, connection number is 572470.26  
    sites 90001, connection number is 548514.05  
    sites 85001, connection number is 499216.1  
    sites 80001, connection number is 469941.34  
    sites 75001, connection number is 440407.14  
    sites 70001, connection number is 406683.76  
    sites 65001, connection number is 381307.0  
    sites 60001, connection number is 350968.22  
    sites 55001, connection number is 322018.8  
    sites 50001, connection number is 289272.4  
    sites 45001, connection number is 249718.8  
    sites 40001, connection number is 223707.2  
    sites 35001, connection number is 188458.36  
    sites 30001, connection number is 160375.33  
    sites 25001, connection number is 134001.77  
    sites 20001, connection number is 103112.95  
    sites 15001, connection number is 79322.74  
    sites 10001, connection number is 48063.56  
    sites 5001, connection number is 22466.87  
    sites 1, connection number is 0.0  
    Process finished with exit code 0
```

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



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

Step1 unit test

The screenshot displays an IDE interface with the following components:

- Project Explorer:** Shows a project structure with folders like 'resources', 'test', and 'java'. The 'test' folder is expanded, showing a list of test classes including 'UF_HWQUPC_Test'.
- Code Editor:** Displays the source code for 'UF_HWQUPC_Test.java'. The code includes a method 'doPathCompression' and a comment: ** This implements the single-pass path-halving mechanism of path compression*.
- Run Console:** Shows the execution results of the unit tests. The output indicates that all tests passed successfully.
- Test Results Table:** A table listing the individual test cases and their execution times.

Test Case	Execution Time
testisConnected01	4 ms
testisConnected02	0 ms
testisConnected03	3 ms
testFind0	0 ms
testFind1	0 ms
testFind2	0 ms
testFind3	0 ms
testFind4	1 ms
testFind5	0 ms
testToString	0 ms
testConnect01	1 ms
testConnect02	0 ms
testConnected01	0 ms

Overall Test Results: Tests passed: 13 of 13 tests - 9ms

Process finished with exit code 0