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**Program Structures & Algorithms**  
**Fall 2021**  
**Assignment No. 3**

- **Task (List down the tasks performed in the Assignment)**

1. Completed the implementation of methods in the `UF_HWQUPC` class.
2. Created new test class `UF_HWQUPC_TestRandomPair` to test `UF_HWQUPC` class with custom inputs and recorded it in the screenshot
3. Ran unit tests successfully under `src/test/java/edu/neu/coe/info6205/union_find/UF_HWQUPC_Test.java` and recorded in the screenshot
4. With the output from custom inputs, plotted the chart and found the relationship between number of sites and the number of connections

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

- Considering the values of number of sites and number of connections. It is very clear that the relationship is

$$\text{number of sites} = N \log N / 2$$

- When considered with concurrent and increasing values of number of sites, it is evident that this relationship holds good.
  - Since the  $N * \log$  of no of steps is not exactly equal to mean no of pairs obtained, it can be justified as an approximated value rather than exact value.

○ These values are calculated for the series of experiments and for each step value. Hence it can be concluded that this mathematical expression holds mostly good with all the experiments provided the given constraints remaining the same.

- **Evidence to support the conclusion:**

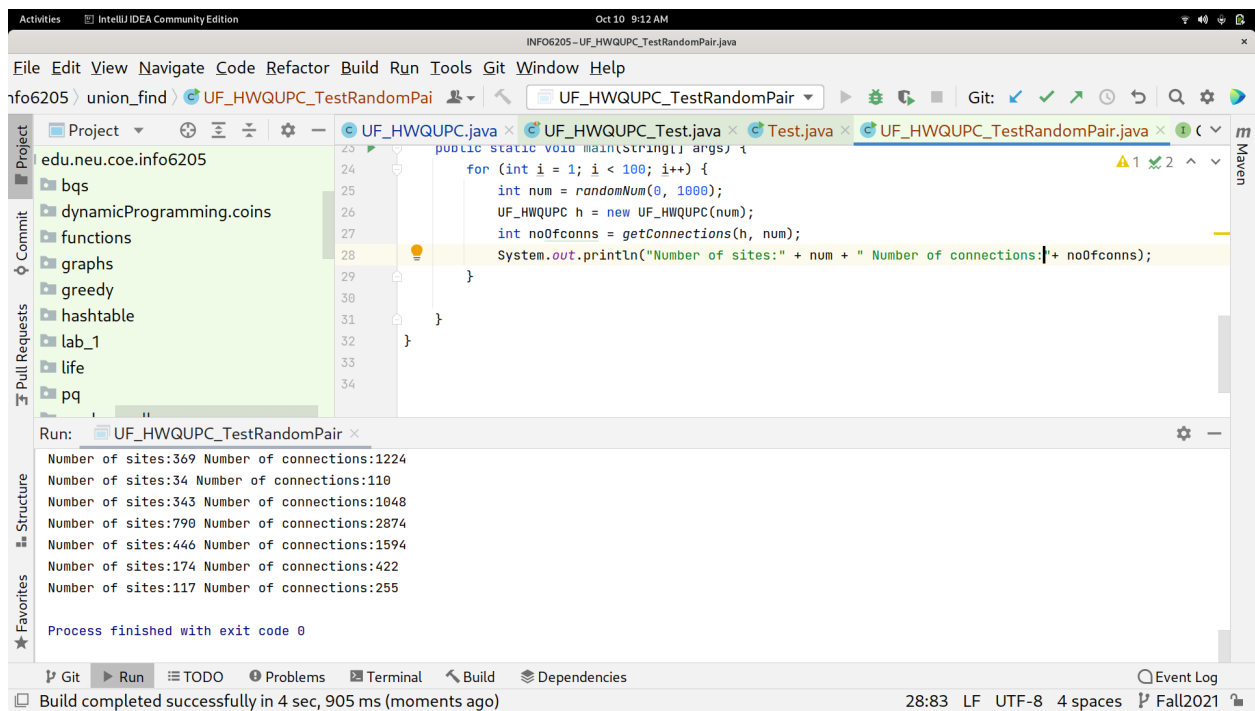
1. **Unit tests (Snapshot of Code output in the terminal)**

The screenshot shows the IntelliJ IDEA interface with the 'Run' tool window open. The 'Run' tab displays the test results for 'UF\_HWQUPC\_Test' (edu.neu.coe.info6205.union\_find). The test suite passed 13 of 13 tests in 49 ms. The individual test results are as follows:

Test Name	Duration
testIsConnected01	10 ms
testIsConnected02	1 ms
testIsConnected03	32 ms
testFind0	0 ms
testFind1	0 ms
testFind2	0 ms
testFind3	1 ms

The 'Test Results' section shows 'Tests passed: 13'. The 'Process finished with exit code 0' message is visible in the terminal output.

## 2. Test UF\_HWQUPC\_TestRandomPair to find number of sites and the number of connections



The screenshot shows the IntelliJ IDEA interface with the following components:

- Project View:** A tree view on the left showing the project structure under 'edu.neu.coe.info6205', including folders like 'bqs', 'dynamicProgramming.coins', 'functions', 'graphs', 'greedy', 'hashtable', 'lab\_1', 'life', and 'pq'.
- Code Editor:** The main window displays the code for 'UF\_HWQUPC\_TestRandomPair.java'. The code is as follows:

```
public static void main(String[] args) {  
    for (int i = 1; i < 100; i++) {  
        int num = randomNum(0, 1000);  
        UF_HWQUPC h = new UF_HWQUPC(num);  
        int noOfconns = getConnections(h, num);  
        System.out.println("Number of sites:" + num + " Number of connections:" + noOfconns);  
    }  
}
```
- Run Console:** The bottom panel shows the output of the program execution:

```
Run: UF_HWQUPC_TestRandomPair  
Number of sites:369 Number of connections:1224  
Number of sites:34 Number of connections:110  
Number of sites:343 Number of connections:1048  
Number of sites:790 Number of connections:2874  
Number of sites:446 Number of connections:1594  
Number of sites:174 Number of connections:422  
Number of sites:117 Number of connections:255  
  
Process finished with exit code 0
```
- Status Bar:** The bottom of the window shows 'Build completed successfully in 4 sec, 905 ms (moments ago)' and '28:83 LF UTF-8 4 spaces'.

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

