

Nimish Sharma (001598648)

Program Structures & Algorithms

Fall 2021

Assignment No. 3

- **Tasks performed in the assignment:**

Task 1:

- A. Implemented “Height-Weighted Quick Union with path compression”.
- B. Checked & passed all of the 13 test cases.

Task 2: Developed Union-find client in the

UF_Client.java file with two methods, i.e Count, Main.

- 1. Count: A static method that returns the number of pairs in the implemented height weighted Quick union find.
- 2. Main: For a given set of values of N, calls Count method to calculate the number of pairs for each value of N and prints to the console.

Task 3:

Plotted the graph with the output values generated by the main function for N values and derived the relationship between “Number of Objects” & “Number of Pairs”.

- **Relationship Conclusion:**
The relationship between number of objects(n) and number of pairs (m) appears to be " $m \propto n \log n$ ".

- **Evidence to support conclusion:**

The screenshot shows an IDE with the following code in `UF_Client.java`:

```
package edu.neu.coe.info6205.union_find;
import java.util.Scanner;
import java.util.Random;

public final class UF_Client {

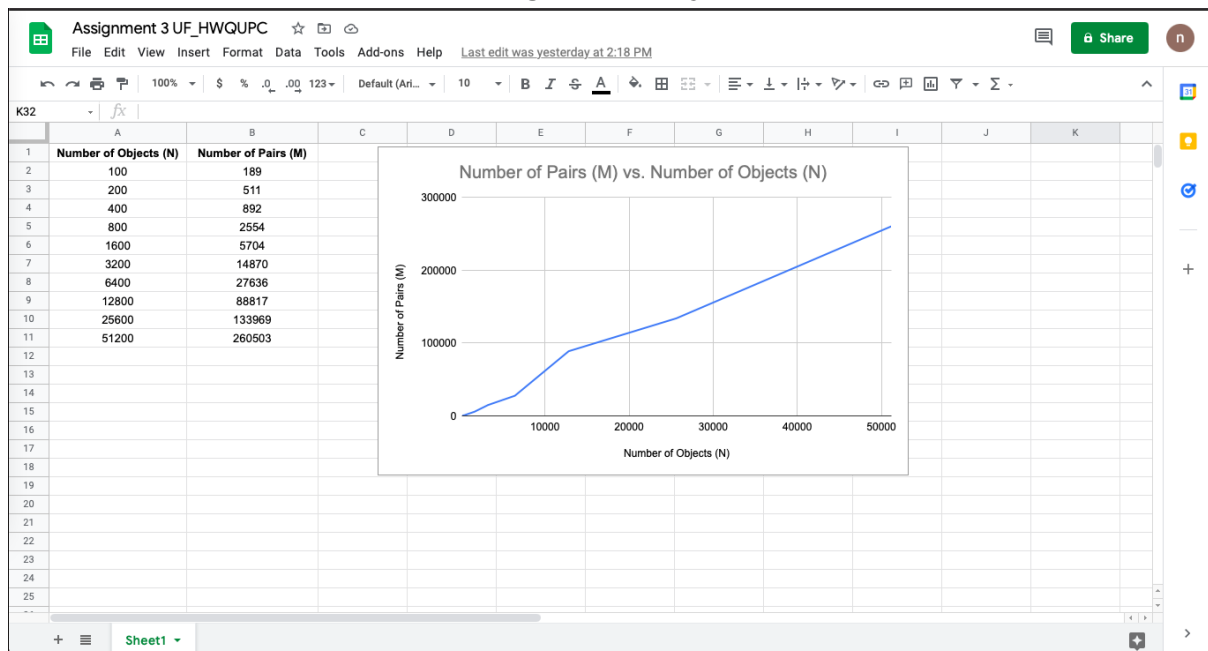
    public static int count(int n) {
        UF_HWQUPC uf = new UF_HWQUPC(n);
        int count = 0;
        while (uf.components() != 1) {
            int p = new Random().nextInt(n);
            int q = new Random().nextInt(n);
            if (!uf.isConnected(p, q)) {
                uf.union(p, q);
            }
            count++;
        }
        return count;
    }

    public static void main(String[] args) {
```

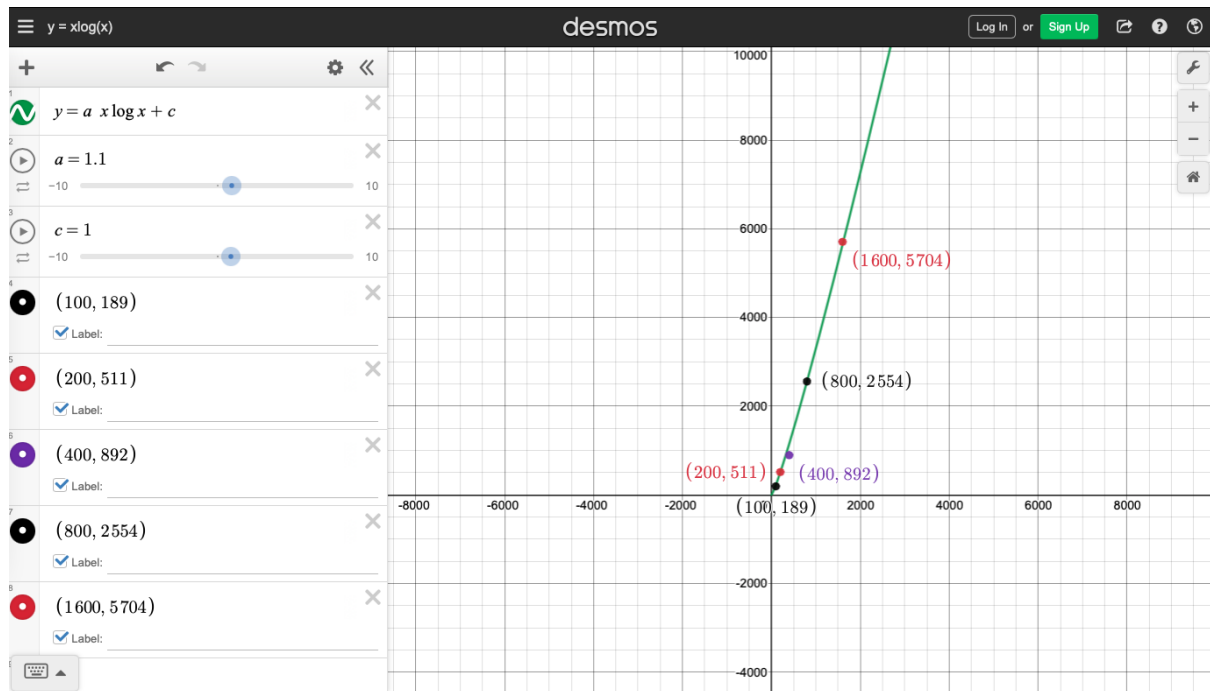
The Run console output shows the following results:

Total connections, for n =	are
100	189
200	511
400	892
800	2554
1600	5784
3200	14878
6400	27636
12800	88817
25600	133969
51200	260503

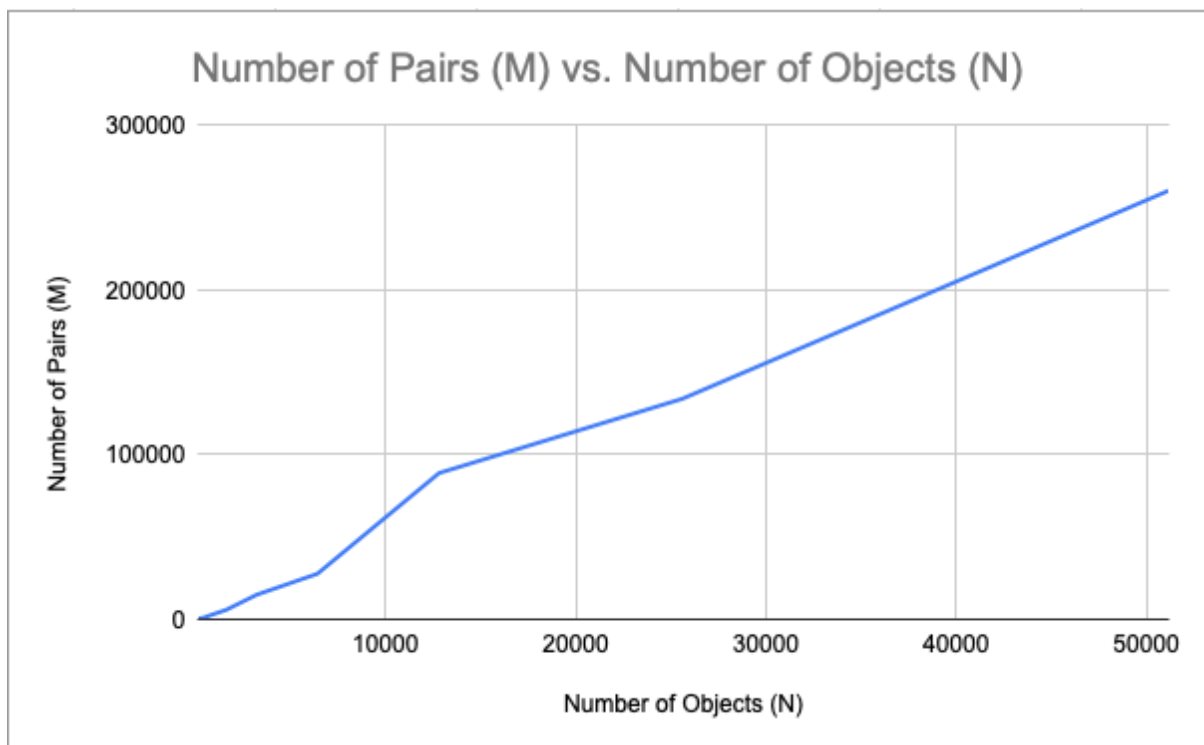
1. Graph Output from the values generated by main():



2. Graph Output validation by plotting 'm' and 'n' values in $y = a * x \log x + c$ equation:



● Graphical Representation:



● Unit Test Result:

The screenshot displays an IDE window titled "INFO6205 - UF_HWQUPC_Test.java". The main editor shows the source code for the `UF_HWQUPC_Test` class, which includes a `testToString()` method. The left sidebar shows the project structure, including a `test` directory. The bottom panel shows the "Run" output, indicating that 13 of 13 tests passed in 224ms. The test results are as follows:

Test Name	Duration
testIsConnected01	79 ms
testIsConnected02	1 ms
testIsConnected03	109 ms
testFind0	1 ms
testFind1	0 ms
testFind2	1 ms
testFind3	2 ms
testFind4	15 ms
testFind5	1 ms
testToString	2 ms
testConnect01	12 ms
testConnect02	0 ms
testConnect01	1 ms

The "Run" output also shows the command used to execute the tests: `/Users/nimishsharma/Library/Java/JavaVirtualMachines/openjdk-16.0.2/Contents/Home/bin/java ...` and the message "Process finished with exit code 0".