

# Program Structures & Algorithms

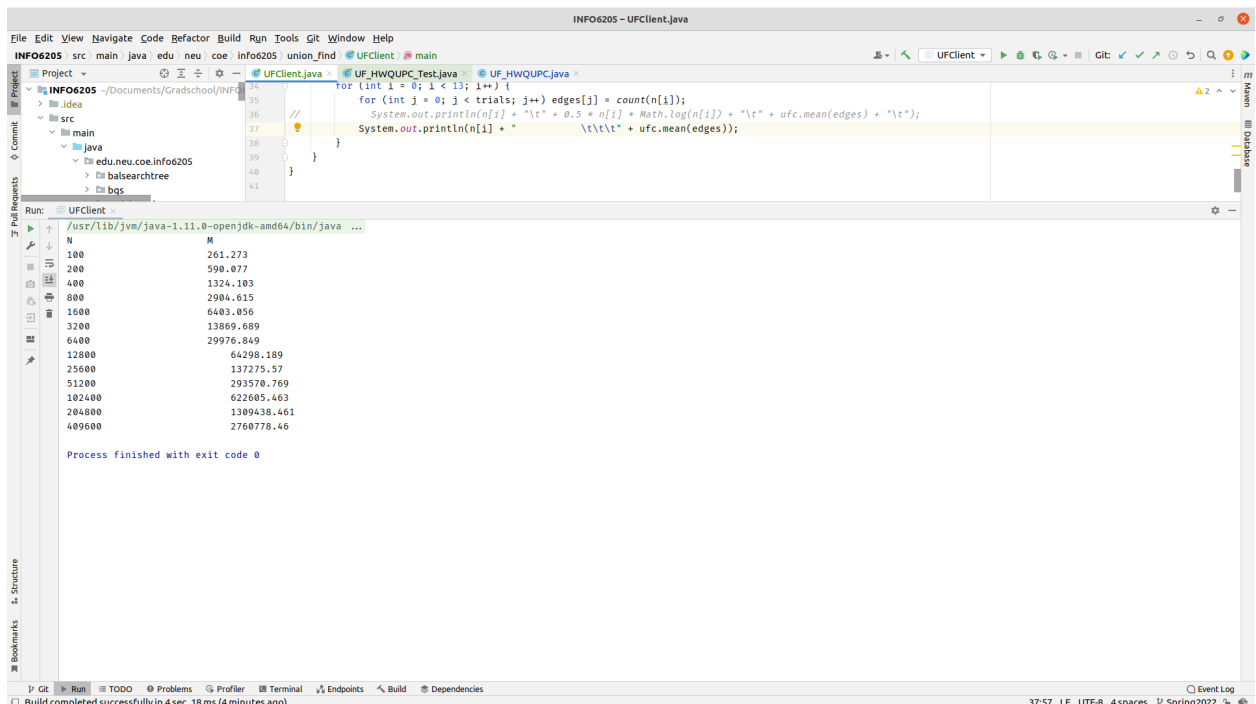
Spring 2022

## Assignment No. 3

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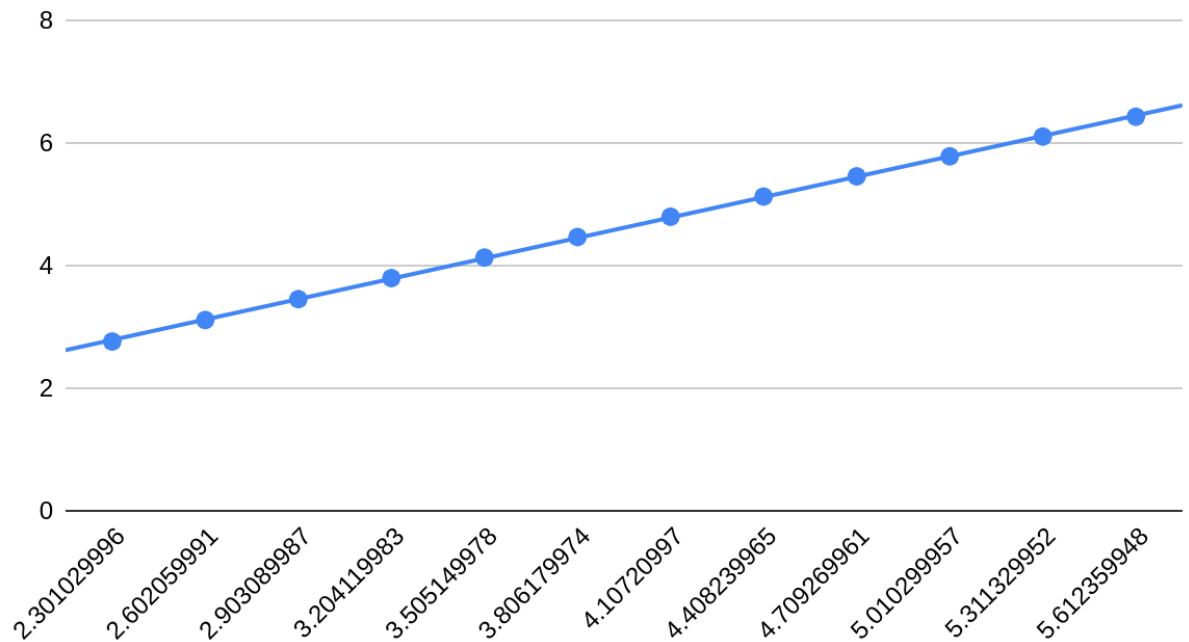
- **Task:**
  - Implement height weighted quick union with path compression
  - Create a client to perform height weighted quick union with path compression
  - Find the relation between the number of objects (N) and the number of pairs(M)
- **Output screenshot**



```
INFO6205 - UFClient.java
File Edit View Navigate Code Refactor Build Run Tools Git Window Help
INFO6205 src main java edu neu coe info6205 union_find UFClient main
INFO6205 - /Documents/Gradschool/Info6205
Project
  > info6205
    > src
      > java
        > edu.neu.coe.info6205
          > bsearchtree
            > bqs
Run: UFClient
/usr/lib/jvm/java-1.11.0-openjdk-amd64/bin/java ...
N      M
100    261.273
200    590.077
400    1324.103
800    2904.615
1600   6403.056
3200   13809.689
6400   29976.849
12800  64298.189
25600  137275.57
51200  293570.769
102400 622605.463
204800 1309438.461
409600 2760778.46
Process finished with exit code 0
Build completed successfully in 4 sec, 18 ms (4 minutes ago)
37:57 LF UTF-8 4spaces l? Spring2022
```

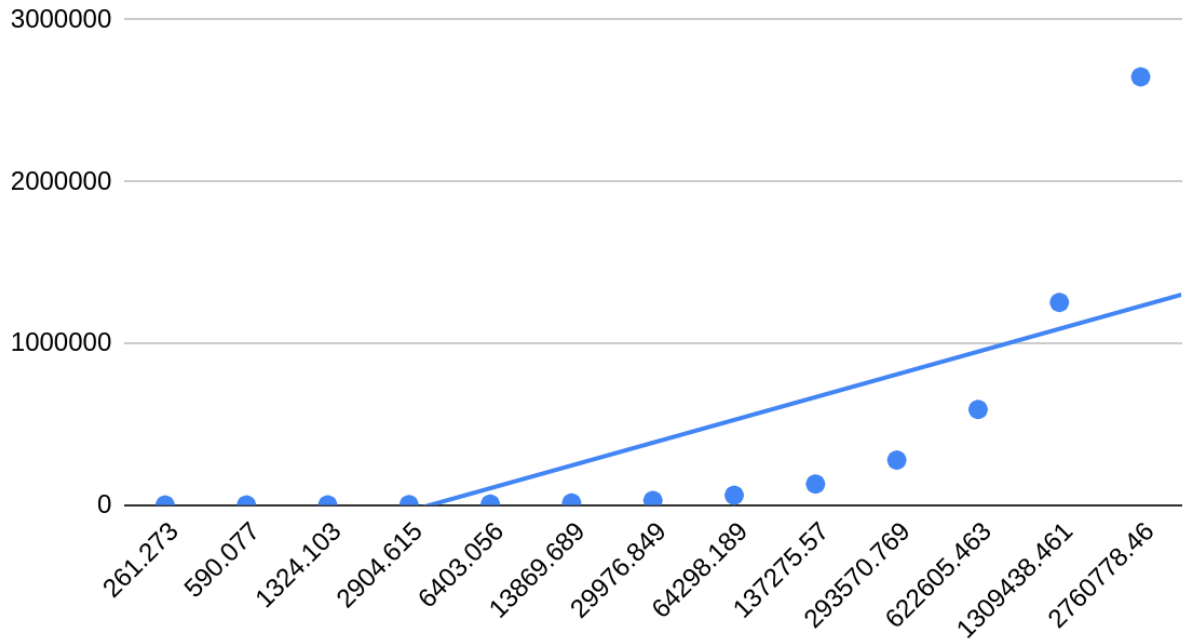
- **Relationship Conclusion**
  - Number of Pairs (M) =  $1 / 2 N \ln(N)$
- **Evidence / Graph**

ln(N) vs log(M)



After looking at the regression lines and calculating the coefficient another term must be combined with N. natural log seems like the obvious choice. Since the  $N * \ln(N)$  seems like a huge value. Its been divided by 2 and thus gives us the equation  $\frac{1}{2} N \ln(N)$ , which is approximately equal to M. This is identified from the graph below.

## M vs $1/2N \lg(N)$



## ● Unit tests result

The screenshot shows an IDE window titled "INFO6205 - UF\_HWQUPC\_Test.java". The editor displays the source code for the `UF_HWQUPC_Test` class, which includes a `testToString()` method. The Run window shows the test results for the `UF_HWQUPC_Test` class, indicating that all 13 tests passed. The test results are as follows:

Test Name	Duration	Result
testisConnected01	22 ms	Pass
testisConnected02	0 ms	Pass
testisConnected03	0 ms	Pass
testFind0	0 ms	Pass
testFind1	0 ms	Pass
testFind2	0 ms	Pass
testFind3	1 ms	Pass
testFind4	1 ms	Pass
testFind5	0 ms	Pass
testToString	0 ms	Pass
testConnect01	0 ms	Pass
testConnect02	0 ms	Pass
testConnect01	0 ms	Pass

The Run window also shows the following output:

```
Tests passed: 13 of 13 tests - 30 ms
UF_HWQUPC_Test (edu.neu.coe.info6205.union_find) 30 ms / jvm/java-1.11.0-openjdk-amd64/bin/java ...
Process finished with exit code 0
```

