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Program Structures & Algorithms

Fall 2021

Assignment No. 3 (WQUPC)

⊙ Tasks performed

i. Implemented below methods in UF_HWQUPC.java

- find(int p)
- mergeComponents(int i, int j)
- doPathCompression(int i)

ii. Ran unit tests and verified successful execution for

- UF_HWQUPC_Test.java

iii. Developed UF ("union-find") client to determine number of random pairs that are required to be generated to connect all the sites. Implemented a static count method to that takes number of sites as input and returns the number of random pairs required to be generated to connect all sites.

iv. The main method initially took an integer input n (number of "sites") from command line, however I modified the code further for benchmarking using doubling method to determine relation between in n and number of pairs.

v. Ran the Java code – HWQUPC_Solution for various values of n (number of "sites") and analyzed output.

vi. Plotted a graph to understand the and analyze results.

⊙ Relationship Conclusion:

A standard plot graph i.e. n (number of sites) vs number of pairs generated was plotted based on the evidences, below are the observations and conclusions:

1. The graph is a **linearithmic** graph and hence the relation between **N and number of pairs is linear.**

2. Based on the benchmarking evidences, below is the approximate relation that I could derive

N	No of pairs
16	34
32	62.4
64	158.5
128	354.8
256	830
512	1708.2
1024	3937.6
2048	8958.4
4096	19688.7
8192	38417.1
16384	83712.8
32768	190141
65536	378940.8
131072	815444.6
262144	1728704.3

From the graph and above observations, it is evident that as N doubles, the number of pairs also doubles. So, it is a direct proportion.
Considering above highlighted values to derivation

$N = 65536 = 2^{16}$ Number of pairs = 378940.8

$$Log_2 378940 = 18.5 \approx N + 2$$

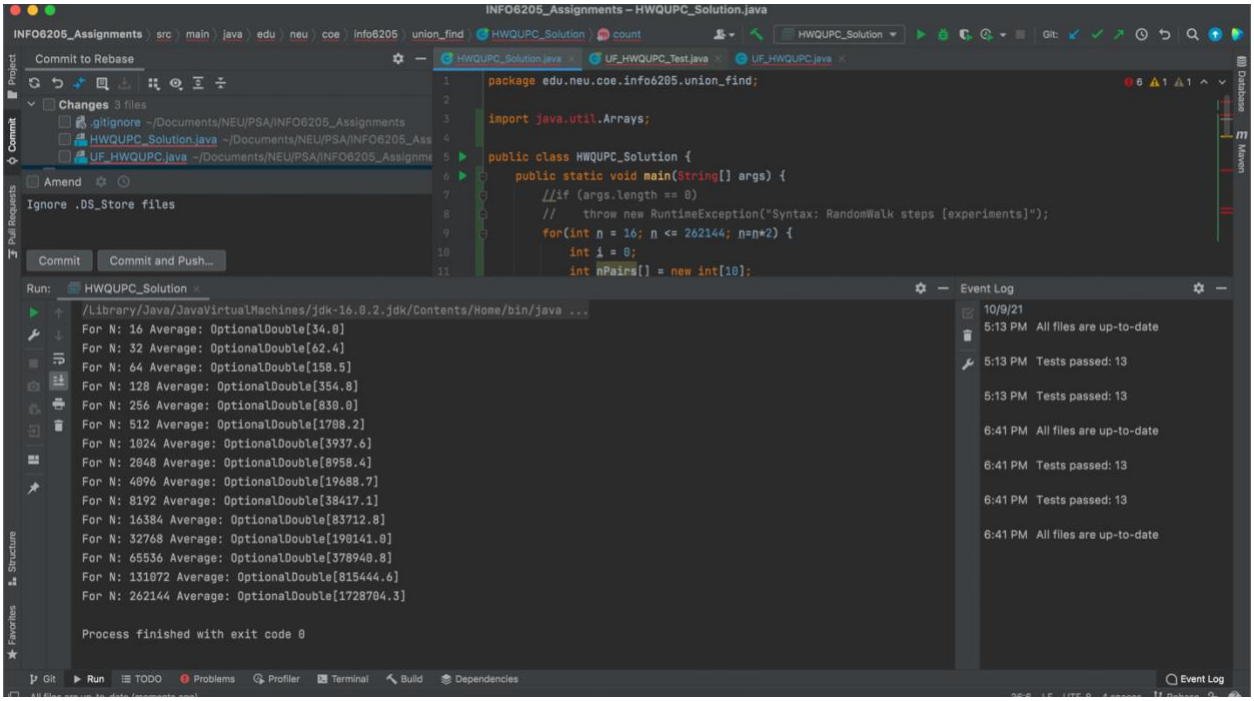
$N = 131072 = 2^{17}$ Number of pairs = 815444.6

$$Log_2 815444.6 = 19.6 \approx N + 2$$

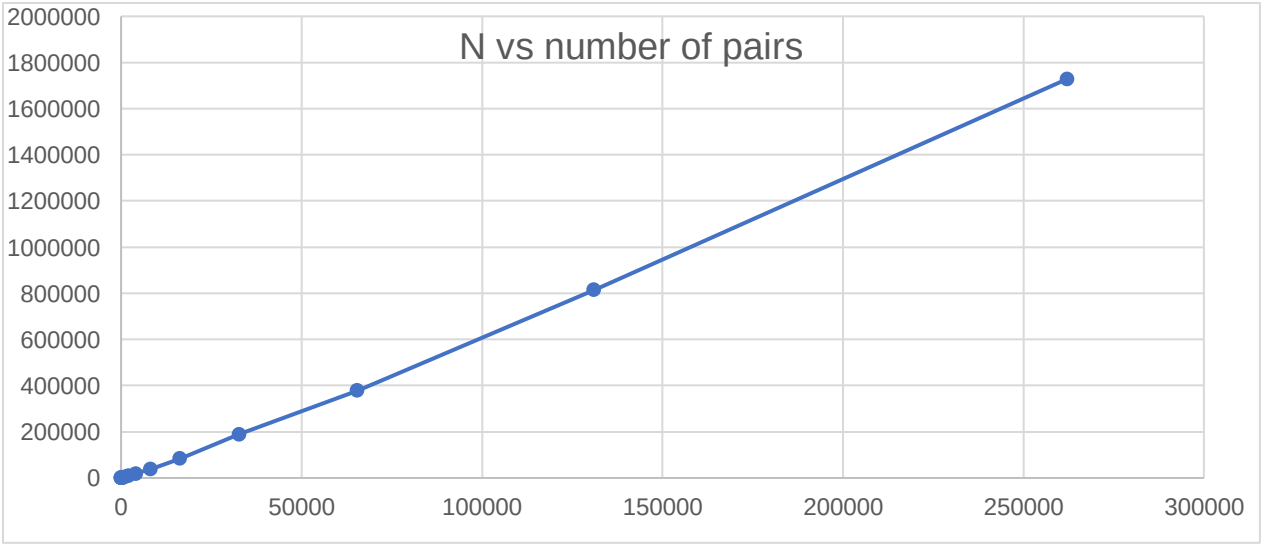
From above I can conclude logarithmic relation is definitely there however with some other factor. With some trial and errors and comparing with graphs of k*Nlog(N), I could come to the conclusion that this is a linearithmic relation.

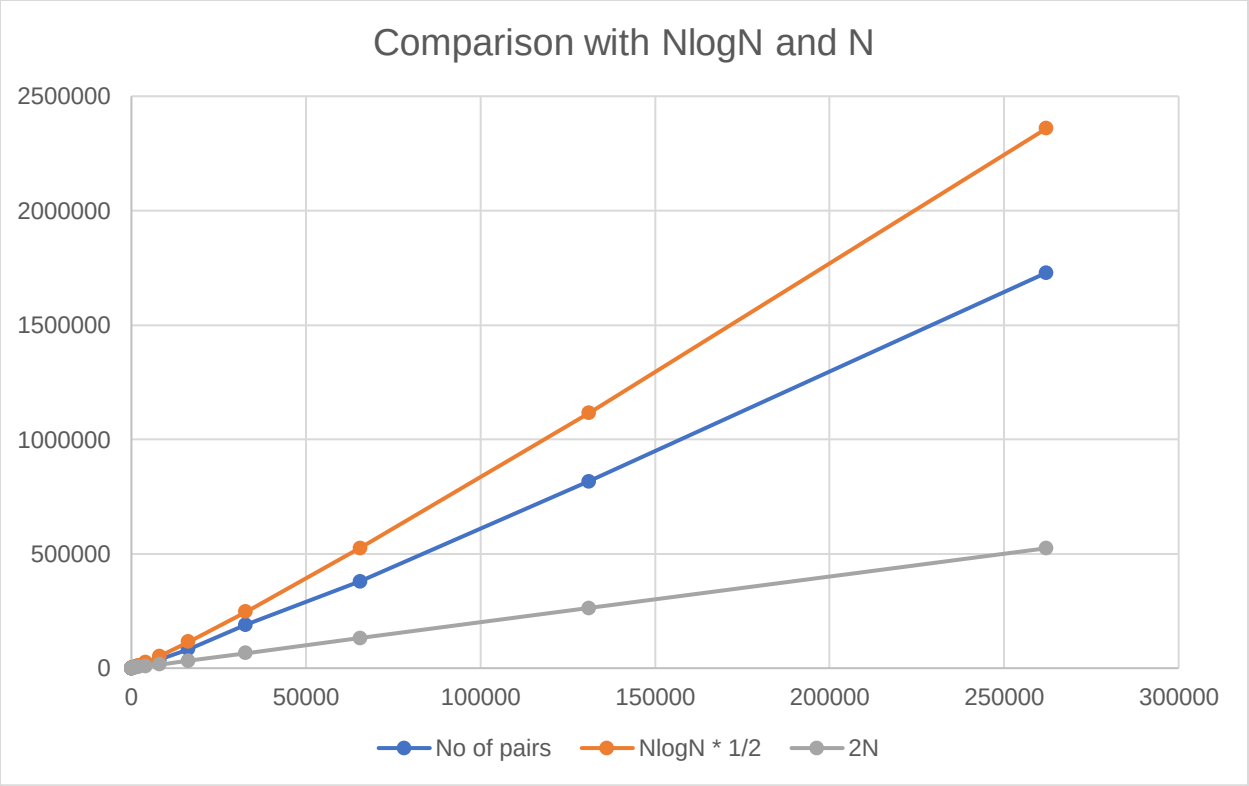
- **Evidence to support the conclusion:**

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



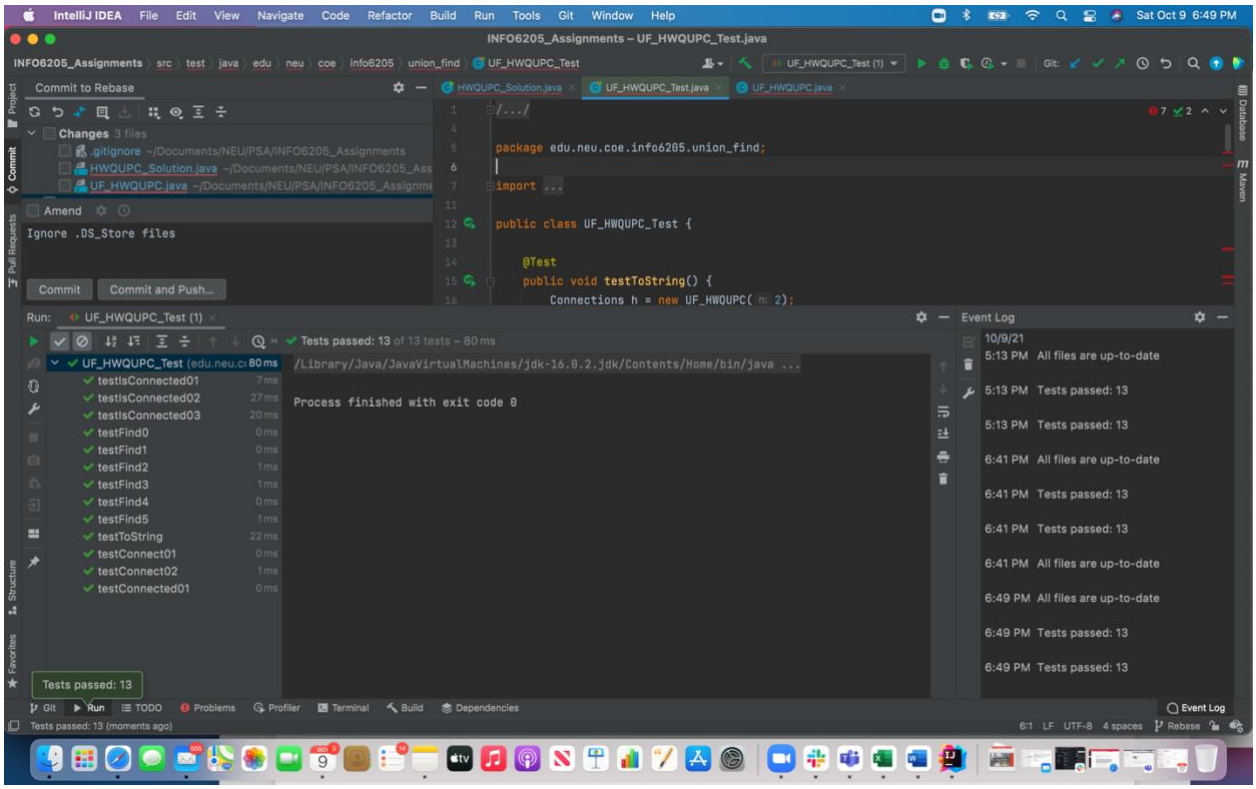
2. **Graphical Representation(Observations from experiments should be tabulated and analyzed by plotting graphs(usually in excel) to arrive on the relationship conclusion)**





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

UF_HWQUPC_Test.java


IntelliJ IDEA File Edit View Navigate Code Refactor Build Run Tools Git Window Help
Sat Oct 9 6:49 PM
INFO6205_Assignments – UF_HWQUPC_Test.java
Commit to Rebase
Changes 3 files
.gitignore ~/Documents/NEU/PSA/INFO6205_Assignments
HWQUPC_Solution.java ~/Documents/NEU/PSA/INFO6205_Ass
UF_HWQUPC.java ~/Documents/NEU/PSA/INFO6205_Assignme
Amend
Ignore .DS_Store files
Commit
Commit and Push...
HWQUPC_Solution.java
UF_HWQUPC_Test.java
UF_HWQUPC.java
/.../
package edu.neu.coe.info6205.union_find;
import ...
public class UF_HWQUPC_Test {
@Test
public void testToString() {
Connections h = new UF_HWQUPC(n: 2);
Run: UF_HWQUPC_Test (1)
Tests passed: 13 of 13 tests – 80 ms
UF_HWQUPC_Test (edu.neu.c 80 ms
testIsConnected01 7 ms
testIsConnected02 27 ms
testIsConnected03 20 ms
testFind0 0 ms
testFind1 0 ms
testFind2 1 ms
testFind3 1 ms
testFind4 0 ms
testFind5 1 ms
testToString 22 ms
testConnect01 0 ms
testConnect02 1 ms
testConnected01 0 ms
/Library/Java/JavaVirtualMachines/jdk-16.0.2.jdk/Contents/Home/bin/java ...
Process finished with exit code 0
Event Log
10/9/21
5:13 PM All files are up-to-date
5:13 PM Tests passed: 13
5:13 PM Tests passed: 13
6:41 PM All files are up-to-date
6:41 PM Tests passed: 13
6:41 PM Tests passed: 13
6:41 PM All files are up-to-date
6:49 PM All files are up-to-date
6:49 PM Tests passed: 13
6:49 PM Tests passed: 13
Tests passed: 13
Git Run TODO Problems Profiler Terminal Build Dependencies
Event Log
Tests passed: 13 (moments ago)
6:1 LF UTF-8 4 spaces Rebase