Program Structures and Algorithms
Spring 2023(SEC –01)
Assignment-4

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Task:
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.

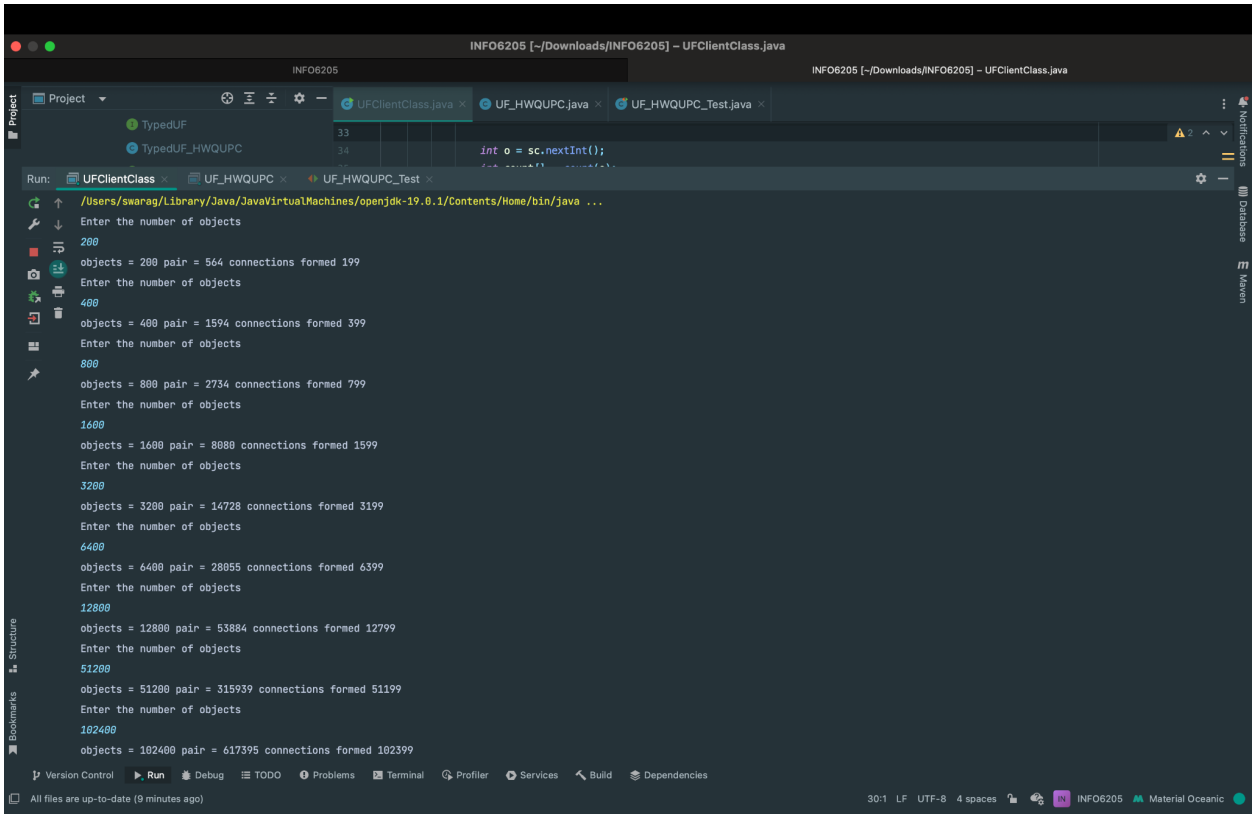
(b) Check that the unit tests for this class all work. You must show "green" test results in your submission.

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.

NOTE: although I'm not going to tell you in advance what the relationship is, I can assure you that it is a simple relationship.

Output:

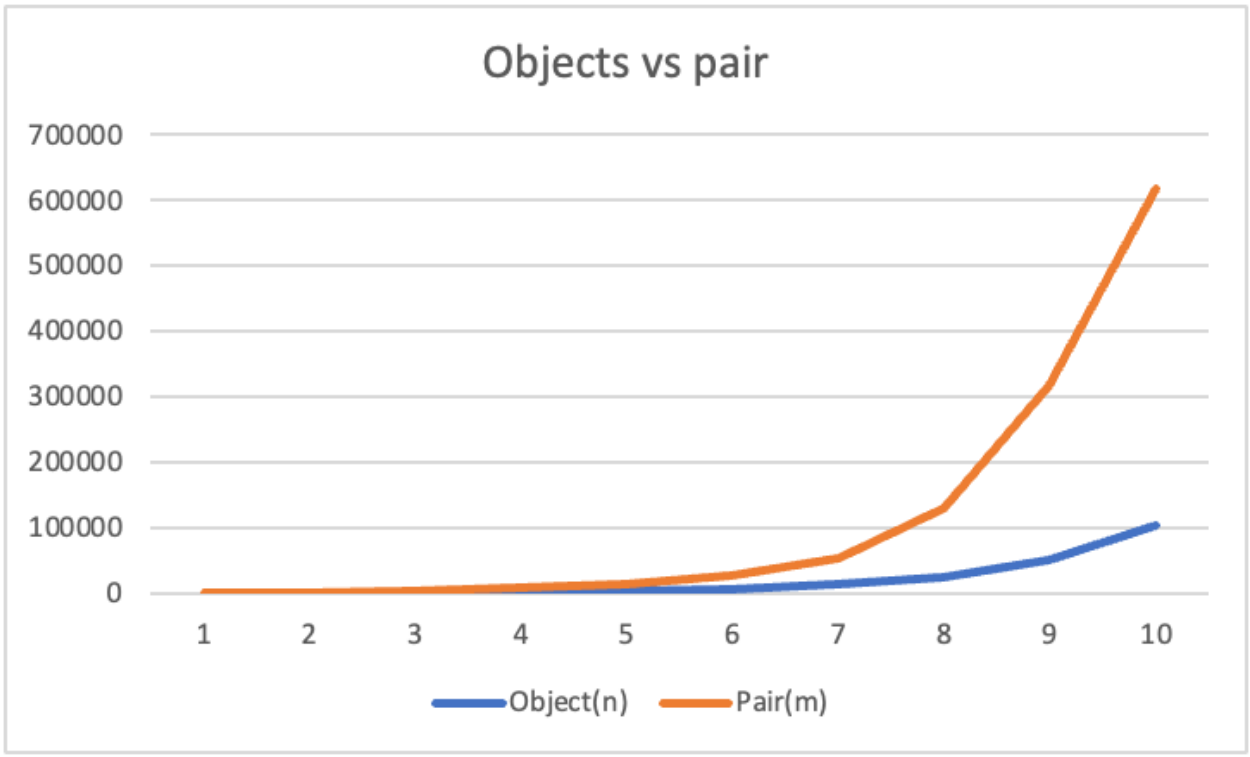


Relationship Conclusion/ Evidence Graph:

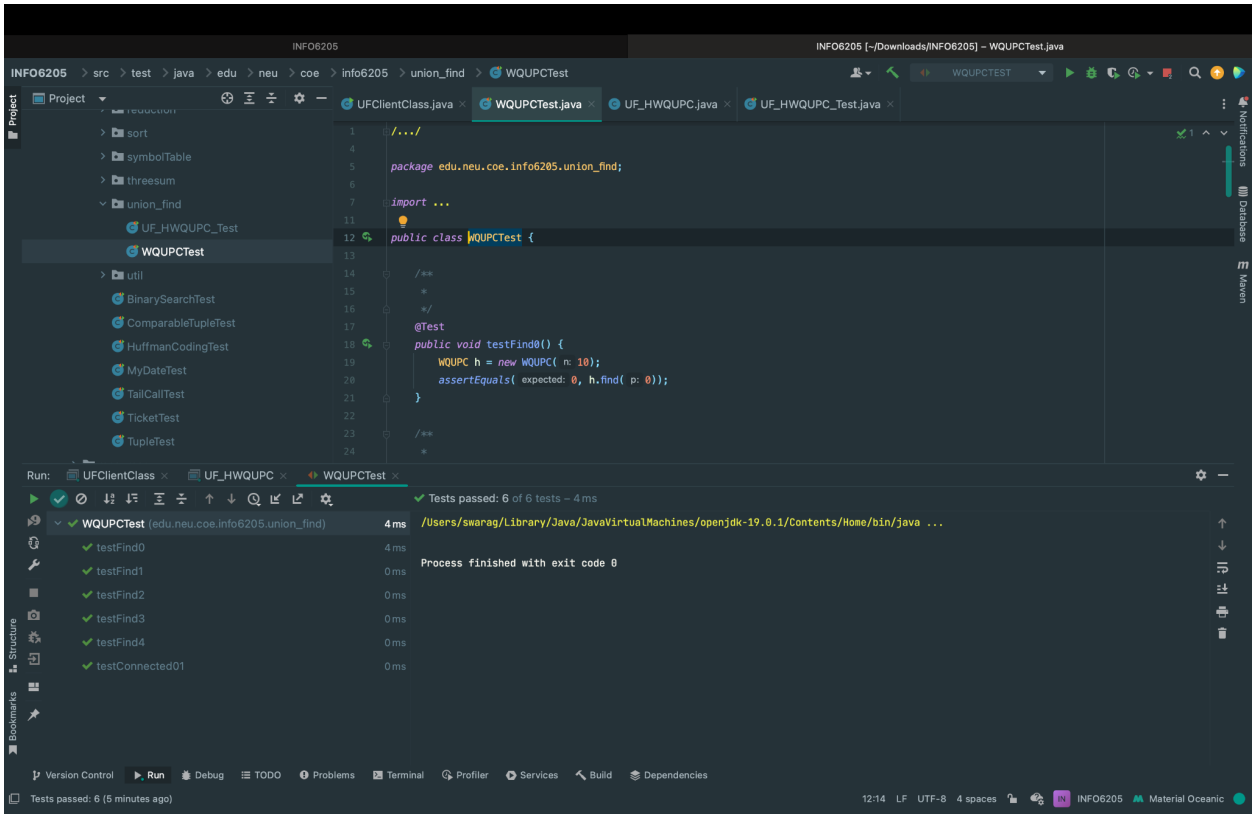
Object(n)	Pair(m)
200	564
400	1594
800	2734
1600	8080
3200	14728
6400	28055
12800	53884
25600	129780
51200	315939
102400	617395

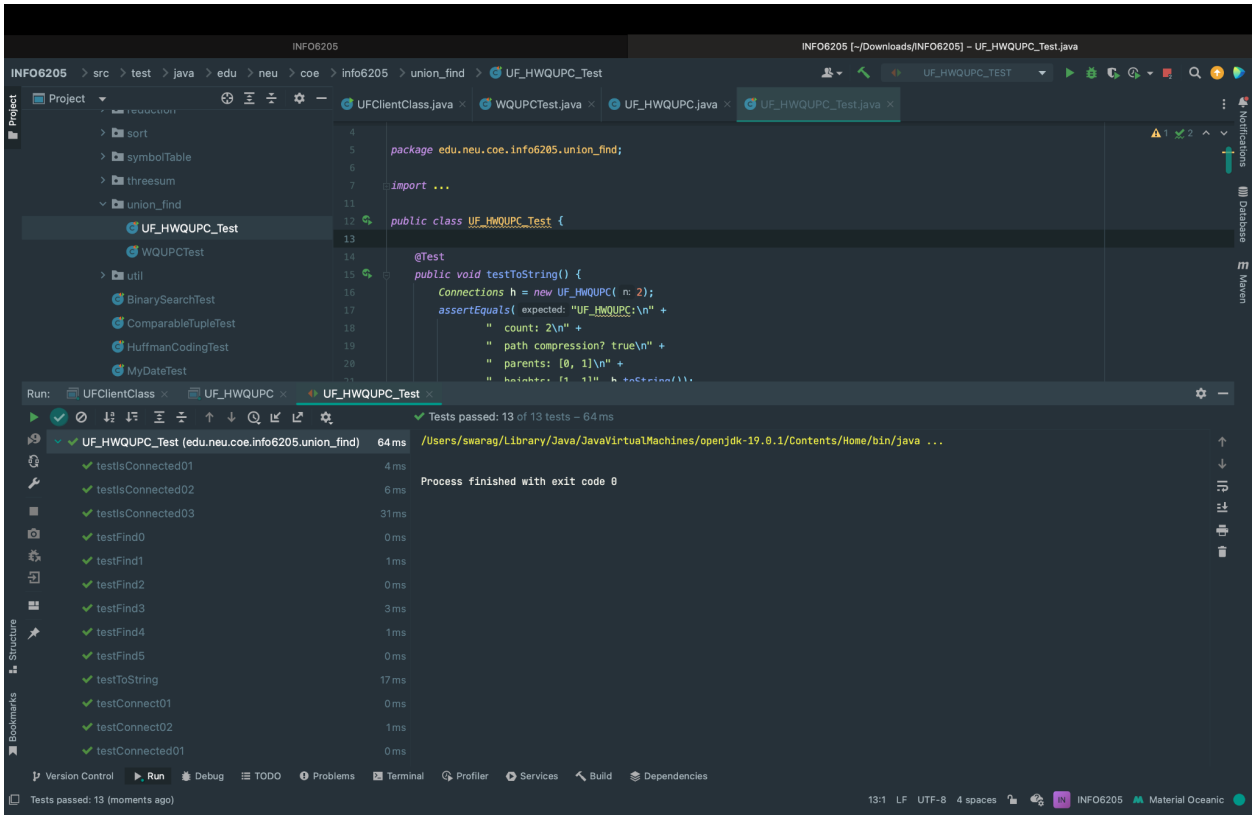
Conclusion:
The relationship between the number of objects and the number of pairs can be expressed as a logarithmic function with the number of objects, n, as the input and the number of pairs, m, as the output. In other words, the number of pairs is logarithmically proportional to the number of objects, with certain constants involved. M~nlogn

Graph:



Passed Test cases:


INFO6205
INFO6205 [~/Downloads/INFO6205] – WQUPCTest.java
INFO6205 > src > test > java > edu > neu > coe > info6205 > union_find > WQUPCTest
WQUPCTEST
Project
UFClientClass.java
WQUPCTest.java
UF_HWQUPC.java
UF_HWQUPC_Test.java
sort
symbolTable
threesum
union_find
UF_HWQUPC_Test
WQUPCTest
util
BinarySearchTest
ComparableTupleTest
HuffmanCodingTest
MyDateTest
TailCallTest
TicketTest
TupleTest
/.../
package edu.neu.coe.info6205.union_find;
import ...
public class WQUPCTest {
/**
*
*/
@Test
public void testFind0() {
WQUPC h = new WQUPC(n: 10);
assertEquals(expected: 0, h.find(p: 0));
}
/**
*
Run:
UFClientClass
UF_HWQUPC
WQUPCTest
Tests passed: 6 of 6 tests – 4 ms
WQUPCTest (edu.neu.coe.info6205.union_find) 4 ms
testFind0 4 ms
testFind1 0 ms
testFind2 0 ms
testFind3 0 ms
testFind4 0 ms
testConnected01 0 ms
/Users/swarag/Library/Java/JavaVirtualMachines/openjdk-19.0.1/Contents/Home/bin/java ...
Process finished with exit code 0
Version Control
Run
Debug
TODO
Problems
Terminal
Profiler
Services
Build
Dependencies
Tests passed: 6 (5 minutes ago)
12:14 LF UTF-8 4 spaces
INFO6205
Material Oceanic


INFO6205
INFO6205 [~/Downloads/INFO6205] – UF_HWQUPC_Test.java
INFO6205 > src > test > java > edu > neu > coe > info6205 > union_find > UF_HWQUPC_Test
UF_HWQUPC_TEST
Project
UFClientClass.java
WQUPCTest.java
UF_HWQUPC.java
UF_HWQUPC_Test.java
sort
symbolTable
threesum
union_find
UF_HWQUPC_Test
WQUPCTest
util
BinarySearchTest
ComparableTupleTest
HuffmanCodingTest
MyDateTest
package edu.neu.coe.info6205.union_find;
import ...
public class UF_HWQUPC_Test {
@Test
public void testToString() {
Connections h = new UF_HWQUPC(n: 2);
assertEquals(expected: "UF_HWQUPC:\n" +
" count: 2\n" +
" path compression? true\n" +
" parents: [0, 1]\n" +
Run:
UFClientClass
UF_HWQUPC
UF_HWQUPC_Test
Tests passed: 13 of 13 tests – 64 ms
UF_HWQUPC_Test (edu.neu.coe.info6205.union_find) 64 ms
testIsConnected01 4 ms
testIsConnected02 6 ms
testIsConnected03 31 ms
testFind0 0 ms
testFind1 1 ms
testFind2 0 ms
testFind3 3 ms
testFind4 1 ms
testFind5 0 ms
testToString 17 ms
testConnect01 0 ms
testConnect02 1 ms
testConnected01 0 ms
/Users/swarag/Library/Java/JavaVirtualMachines/openjdk-19.0.1/Contents/Home/bin/java ...
Process finished with exit code 0
Version Control
Run
Debug
TODO
Problems
Terminal
Profiler
Services
Build
Dependencies
Tests passed: 13 (moments ago)
13:1 LF UTF-8 4 spaces
INFO6205
Material Oceanic