Program Structures & Algorithms

Spring 2022

Assignment No. 3

WQUPC

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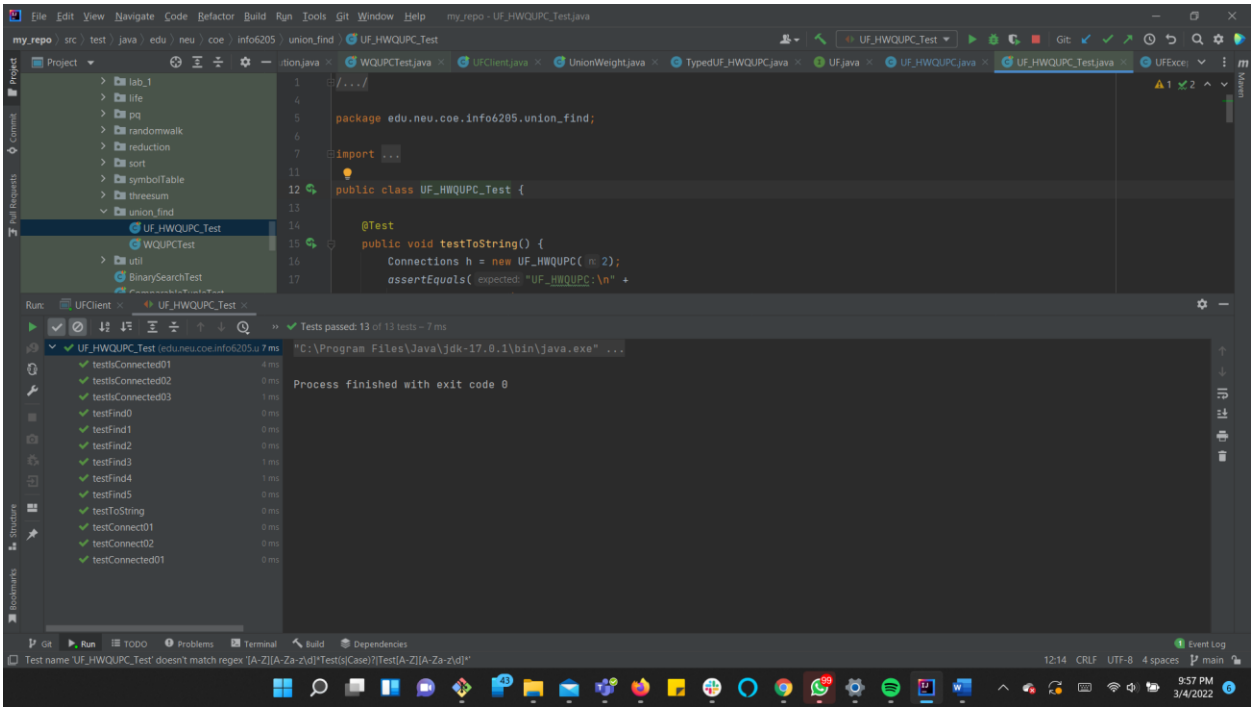
STEP 1

(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 (screenshot is OK).

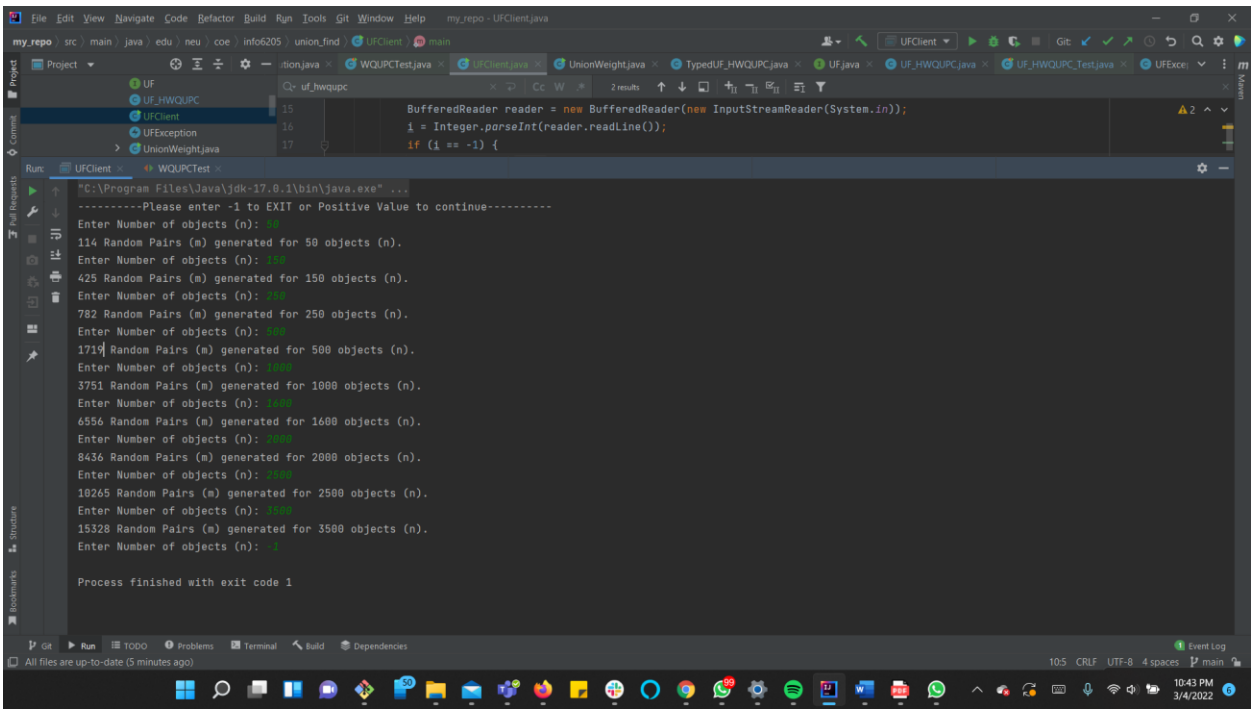
- **Output Screenshot**
  1. **UF_HWQUPC_Test**



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).

- **Output Screenshot**
  1. **UFClient**



STEP 3

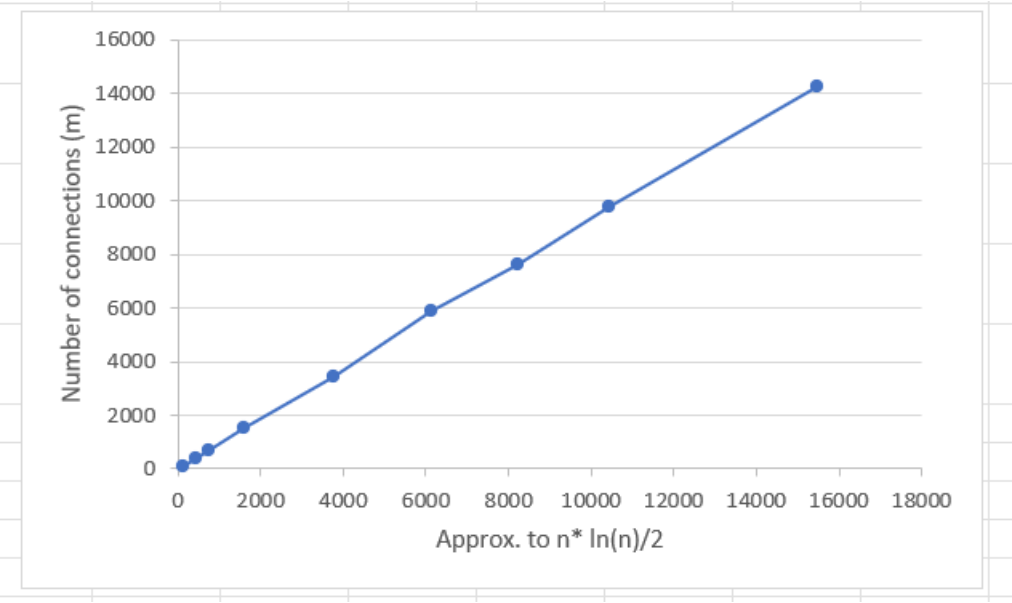
Determine the relationship between the number of objects (*n*) and the number of pairs (*m*) generated to accomplish this (i.e. to reduce the number of components from *n* to 1). Justify your conclusion in terms of your observations and what you think might be going on.

Evidence to support the conclusion

- **Table**

Number of Objects (n)	Number of connections (m)	Approx. to n* ln(n)/2
50	114	97
150	425	375
250	782	690
500	1719	1553
1000	3751	3453
1600	6556	5902
2000	8436	7600
2500	10265	9780
3500	15328	14280

- **Graphical Representation**



Conclusion

1. Based on the number of tests conducted, The relationship between the number of objects (n) and the number of pairs (m) is m = n *ln(n)/2, as the observed Number of objects column and Number of connections column are definitely equivalent, as evidenced by the evidence supplied above.
2. Weight Quick-Union with Path Compression is a linear process in practice.
3. Weight Quick-Union with Path Compression isn't exactly linear in principle.