Program Structures and Algorithms
Spring 2023(SEC –8)
Assignment 4 (WQUPC)

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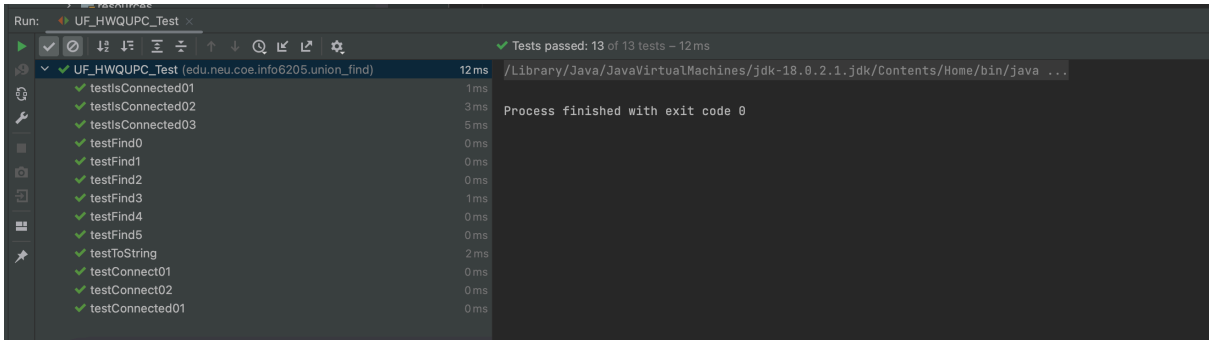
Task:

Step 1:
(a) Implement height-weighted Quick Union with Path Compression.
(b) Check that the unit tests for this class all work.
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.

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.

Unit Test Screenshots:



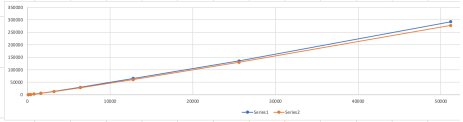
Relationship Conclusion:

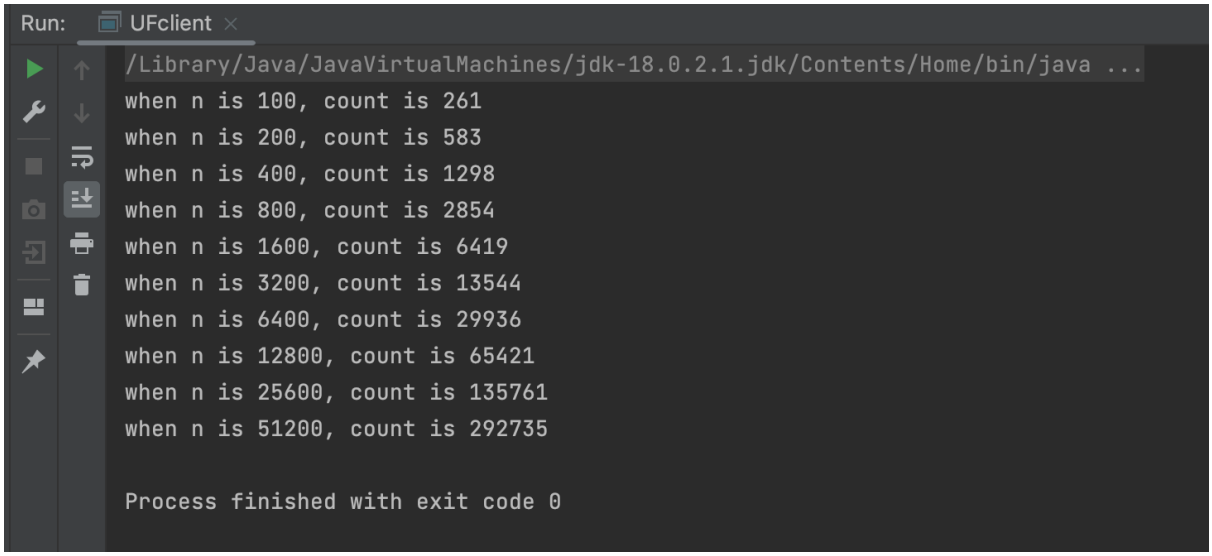
M=0.5*n*ln(n)

By random function, I generate random pairs with 10 different n values. And each of them I run 100 times and get the average of the connection counts. And then put the data into a Excel chart, and generate the graph. Based on it, I guess the relationship of them is M=0.5*n*ln(n).

Evidence to support that conclusion:

n	connection	0.5n*ln(n)
100	261	230.2585093
200	583	529.8317367
400	1298	1198.292909
800	2854	2673.844691
1600	6419	5902.207127
3200	13544	12913.44974
6400	29936	28044.97046
12800	65421	60526.08288
25600	135761	129924.4497
51200	292735	277593.4672




Run:
UFclient
/Library/Java/JavaVirtualMachines/jdk-18.0.2.1.jdk/Contents/Home/bin/java ...
when n is 100, count is 261
when n is 200, count is 583
when n is 400, count is 1298
when n is 800, count is 2854
when n is 1600, count is 6419
when n is 3200, count is 13544
when n is 6400, count is 29936
when n is 12800, count is 65421
when n is 25600, count is 135761
when n is 51200, count is 292735
Process finished with exit code 0