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Program Structures & Algorithms

Fall 2021

Assignment No. 3

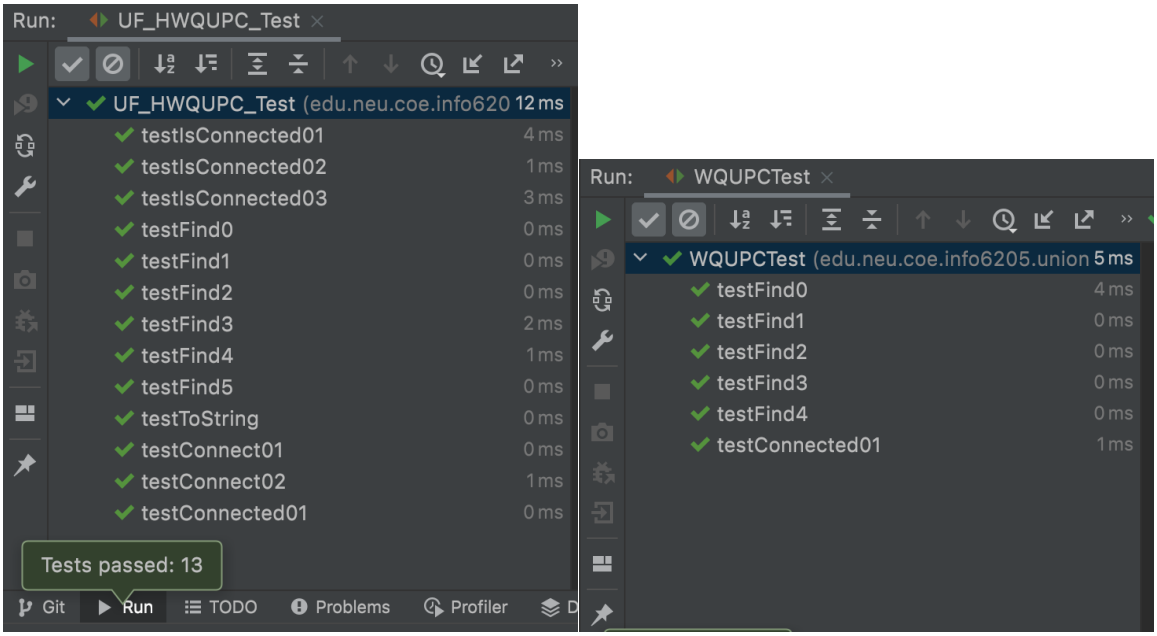
- ## Task

  ## Benchmark

- 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).

- Screen shot of unit test:

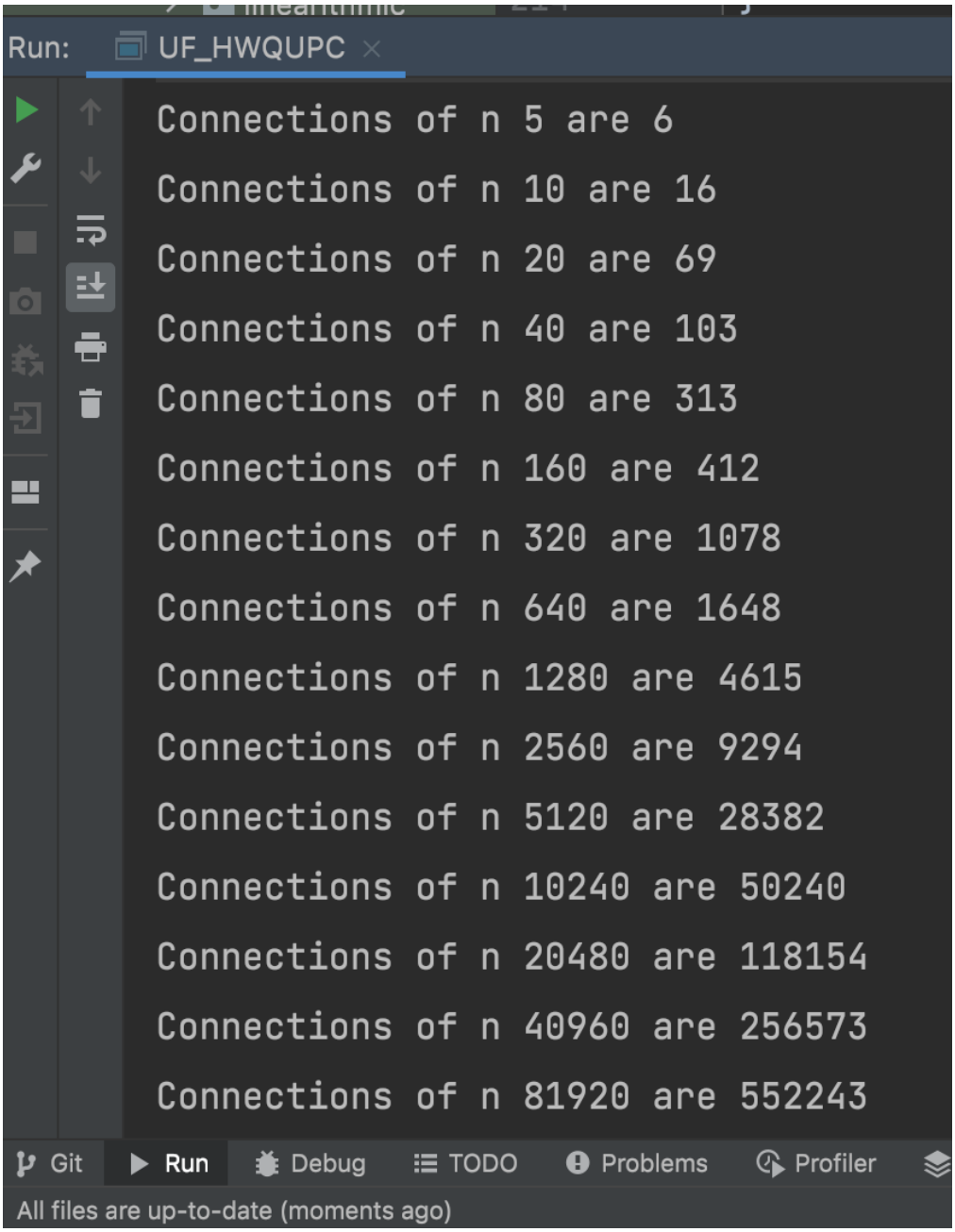


- Step 2:
  Using your implementation of UF_HWQUPC, develop a UF ("union-find") client that takes an integer value n from the command line to determine the number of "sites." Then

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).

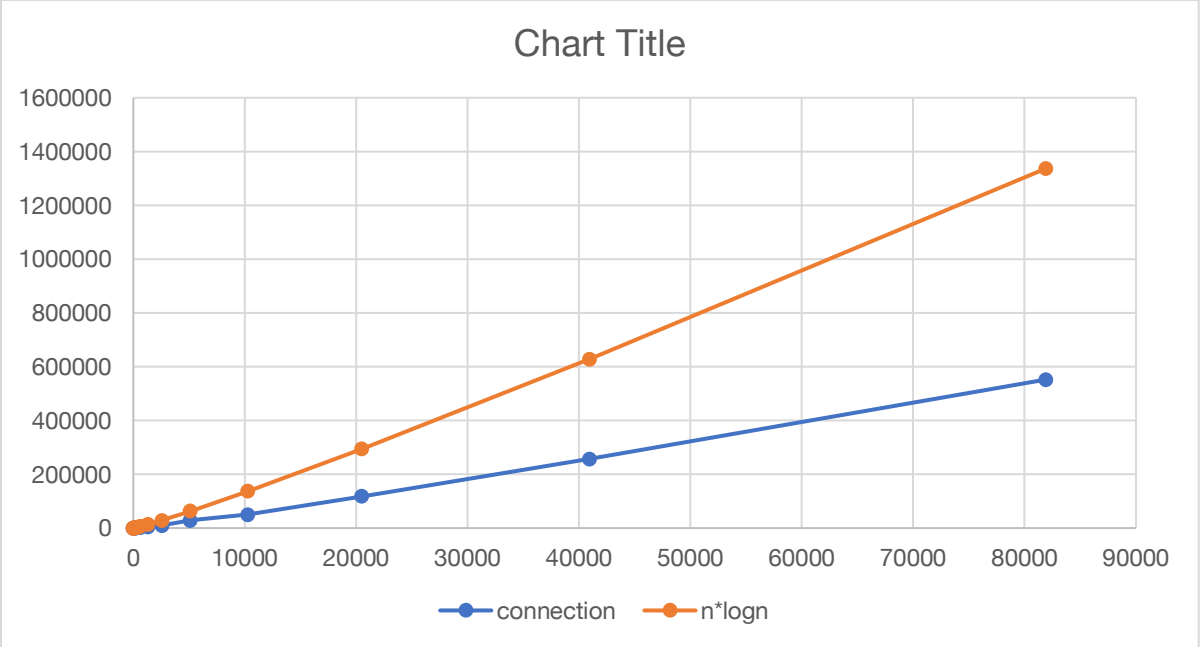
Screen shot of evidence:

Each n is run for 20 times and get the average of the 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.

	A	B	C	D
1	n	connection	n*logn	ratio
2	5	6	11.6096405	0.51681187
3	10	16	33.2192809	0.48164799
4	20	69	86.4385619	0.79825484
5	40	103	212.877124	0.4838472
6	80	313	505.754248	0.61887765
7	160	412	1171.5085	0.35168332
8	320	1078	2663.01699	0.40480403
9	640	1648	5966.03398	0.27623041
10	1280	4615	13212.068	0.34930187
11	2560	9294	28984.1359	0.32065817
12	5120	28382	63088.2718	0.44987759
13	10240	50240	136416.544	0.36828378
14	20480	118154	293313.087	0.40282553
15	40960	256573	627586.175	0.40882513
16	81920	552243	1337092.35	0.41301784
17			average	0.44299648



In that case, the relationship between the sites and connections is : $f(n) = 0.442 * n * log_2{}^{n}$.