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Program Structures & Algorithms
# Summer 2021
Assignment No. 3

Task 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).
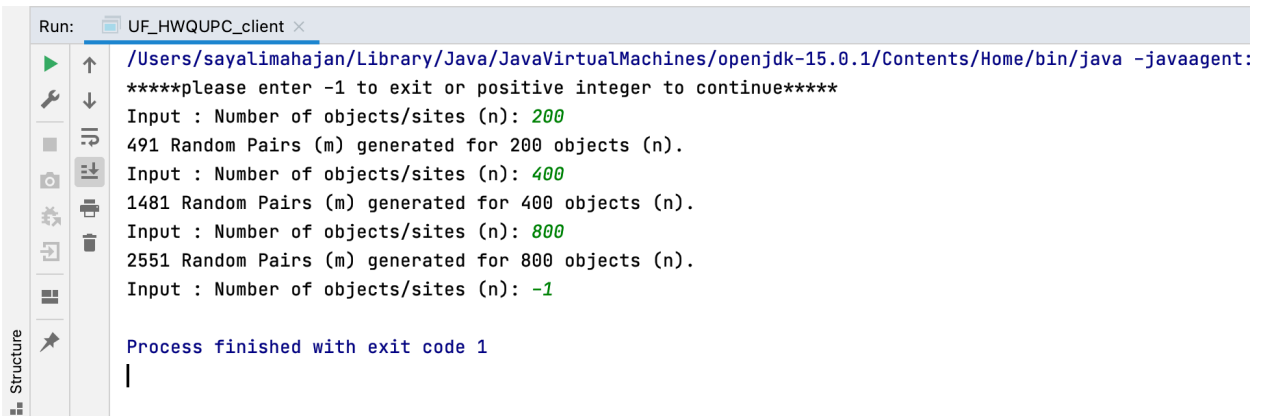
Output

UF_HWQUPC_Test
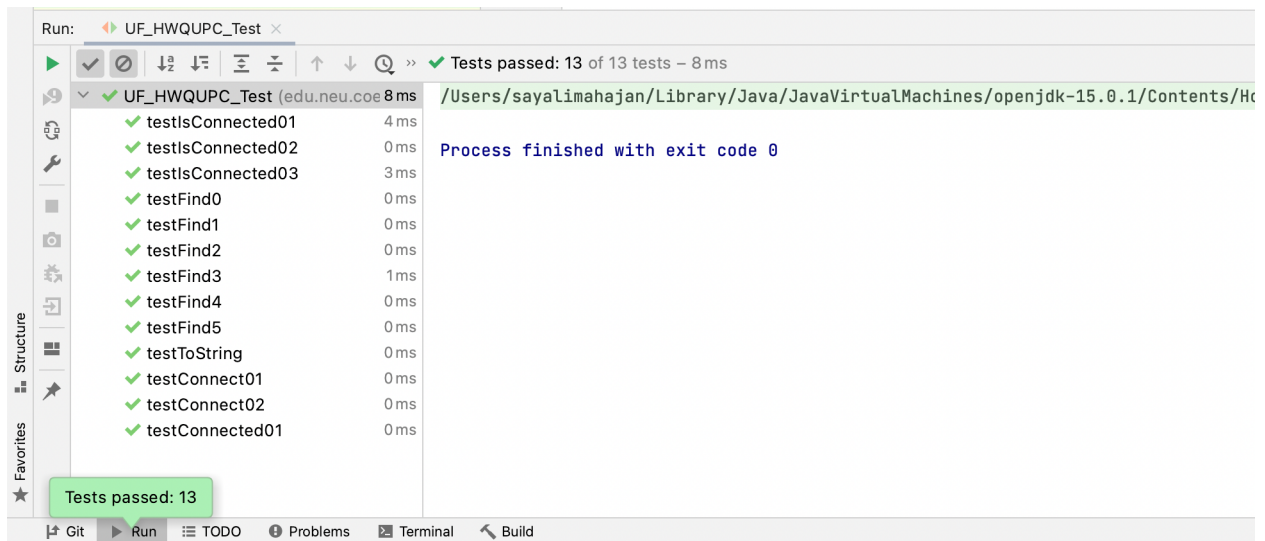
Task 2

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

UF_HWQUPC_Client

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Run:    UF_HWQUPC_client ×
  ▶  ↑   /Users/sayalimahajan/Library/Java/JavaVirtualMachines/openjdk-15.0.1/Contents/Home/bin/java -javaagent:
  ⚲  ↓   *****please enter -1 to exit or positive integer to continue*****
  ▣  ⇥   Input : Number of objects/sites (n): 200
  ▣  ↧   491 Random Pairs (m) generated for 200 objects (n).
  ▣  ▤   Input : Number of objects/sites (n): 400
  ⇲  🖶   1481 Random Pairs (m) generated for 400 objects (n).
  ⇲  ▣   Input : Number of objects/sites (n): 800
         2551 Random Pairs (m) generated for 800 objects (n).
  ▣      Input : Number of objects/sites (n): -1
  ☆
         Process finished with exit code 1
```

Task 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

Column1	Column 2	Column 3
number of Objects (n)	Number of connections (m)	Approx to n* ln(n)/2
50	115	97.8
100	259	230
200	491	529
400	1348	1198
800	2551	2673
1600	6456	5902
3200	14791	12913
6400	29248	28044
12800	64884	60526

Graphical Representation

Number of connections(m) Vs Number
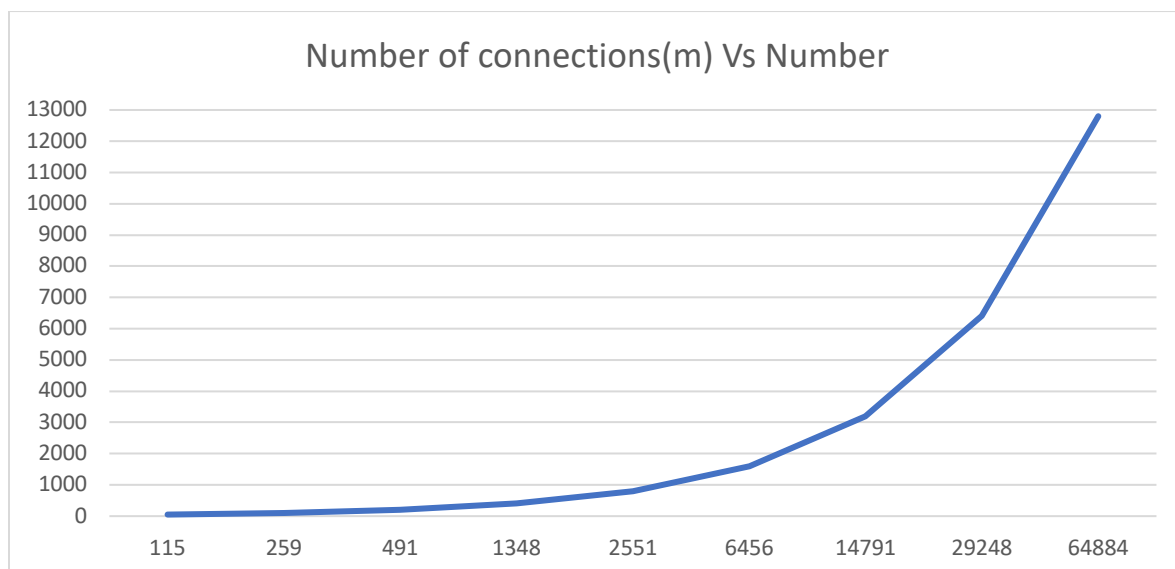
Conclusion

1. From the number of experiments carried out It is observed that, relationship between the number of objects (n) and the number of pairs (m) is m is equivalent to $n * ln(n)/2$. Evidence provided above clearly shows that, cloumn2 and column 3 are equivalent.
2. In theory, Weight Quick-Union with Path Compression is not quite linear.
3. In practice, Weight Quick-Union with Path Compression is linear.