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Program Structures & Algorithms

Spring 2022

Assignment No. 3

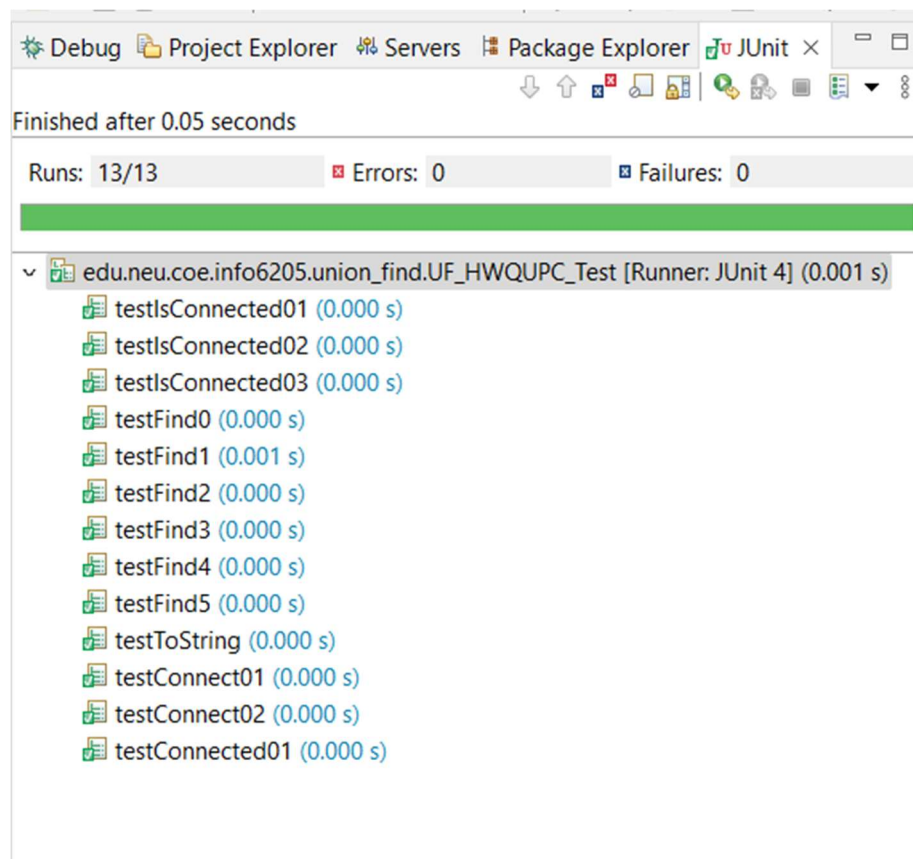
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TASK 1

- ❖ (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 Screenshot:

➤ 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).

```
Console x Debug Shell Search
<terminated> UF_HWQUPC_client [Java Application] C:\Program Files\Java\jdk-17\bin\javaw.exe (Mar 4, 2022, 8:07:53 PM – 8:09:02 PM)
****please enter -1 to exit or positive integer to continue****
Input : Number of objects/sites (n): 50
113 Random Pairs (m) generated for 50 objects (n).
Input : Number of objects/sites (n): 100
257 Random Pairs (m) generated for 100 objects (n).
Input : Number of objects/sites (n): 200
591 Random Pairs (m) generated for 200 objects (n).
Input : Number of objects/sites (n): 300
964 Random Pairs (m) generated for 300 objects (n).
Input : Number of objects/sites (n): 400
1301 Random Pairs (m) generated for 400 objects (n).
Input : Number of objects/sites (n): 500
1682 Random Pairs (m) generated for 500 objects (n).
Input : Number of objects/sites (n): 600
2100 Random Pairs (m) generated for 600 objects (n).
Input : Number of objects/sites (n): -1
```

TASK 3

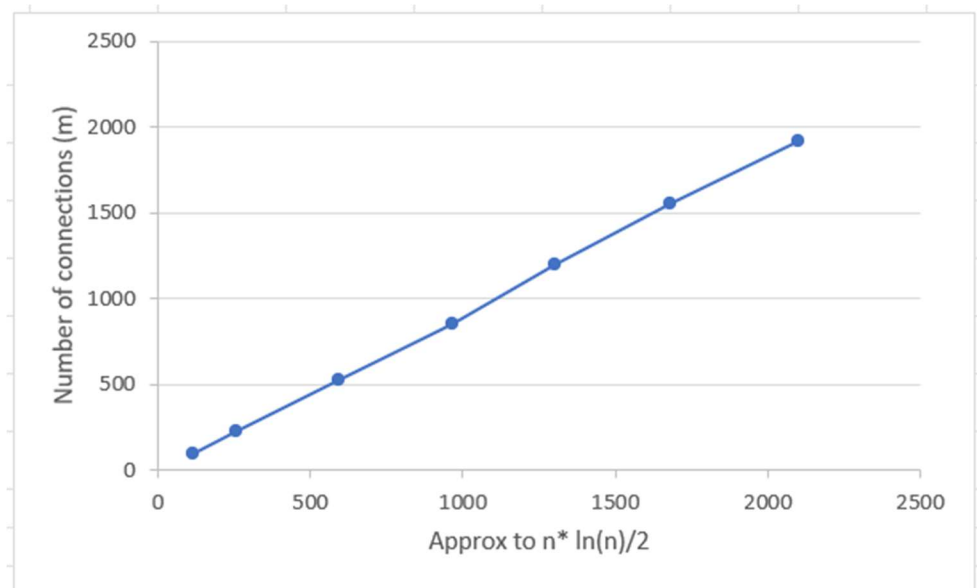
Determine the relationship between the number of objects (n) and the number of pairs (m) generated to accomplish this (i.e. to reduce the number of components from n to 1). Justify your conclusion in terms of your observations and what you think might be going on.

- EVIDENCE

Column 1	Column 2	Column 3
number of Objects (n)	Number of connections (m)	Approx to $n * \ln(n)/2$
50	113	97
100	257	230
200	591	529
300	964	855

400	1301	1198
500	1682	1553
600	2100	1919

Graphical Representation



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, column2 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.