**Program Structures & Algorithms**

Assignment No. 2 - Benchmark

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**Task:**

* Step 1:

(a) Implement height-weighted Quick Union with Path Compression. For this, you will flesh out the class UF\_HWQUPC. All you must 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).

* 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).

* 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.

**Output Values:**

Graphical user interface, text

Description automatically generated

**Code:**

UF\_HWQUPC.java, UnionFindClient.java files attached.

**Observations:**

Plotting all the values of N (x-axis) and Number of connections (y-axis) along with plotting graph of N log(N) \* 1.2, we can clearly see it follows the same trend. Hence we can conclude that:

**Number of connections = N log (N) \* 1.2 ,** where N = number of sites

|  |  |  |
| --- | --- | --- |
| **Sites** | **Connections** | **N \* log(N) \*1.2** |
| 59 | 139.75 | 125.3763224 |
| 118 | 312.4 | 293.3784922 |
| 236 | 757.35 | 672.0086792 |
| 472 | 1579.5 | 1514.520748 |
| 944 | 3663.4 | 3370.048275 |
| 1888 | 7965 | 7422.110108 |
| 3776 | 15898.3 | 16208.24733 |
| 7552 | 35563.7 | 35144.5489 |
| 15104 | 72718.55 | 75745.20626 |
| 30208 | 162670.55 | 162402.6295 |
| 60416 | 360765.3 | 346629.6928 |
| 120832 | 769127.75 | 736908.2533 |
| 241664 | 1571876.6 | 1561114.242 |
| 483328 | 3427873.8 | 3296823.955 |
| 966656 | 6973199.05 | 6942838.852 |
| 1933312 | 1.50E+07 | 14584059.59 |
| 3866624 | 2.92E+07 | 30564882.94 |
| 7733248 | 6.52E+07 | 63923293.42 |
| 15466496 | 1.33E+08 | 133433641.9 |
| 30932992 | 2.67E+08 | 278041393.9 |

**Test Cases:**

Text

Description automatically generated