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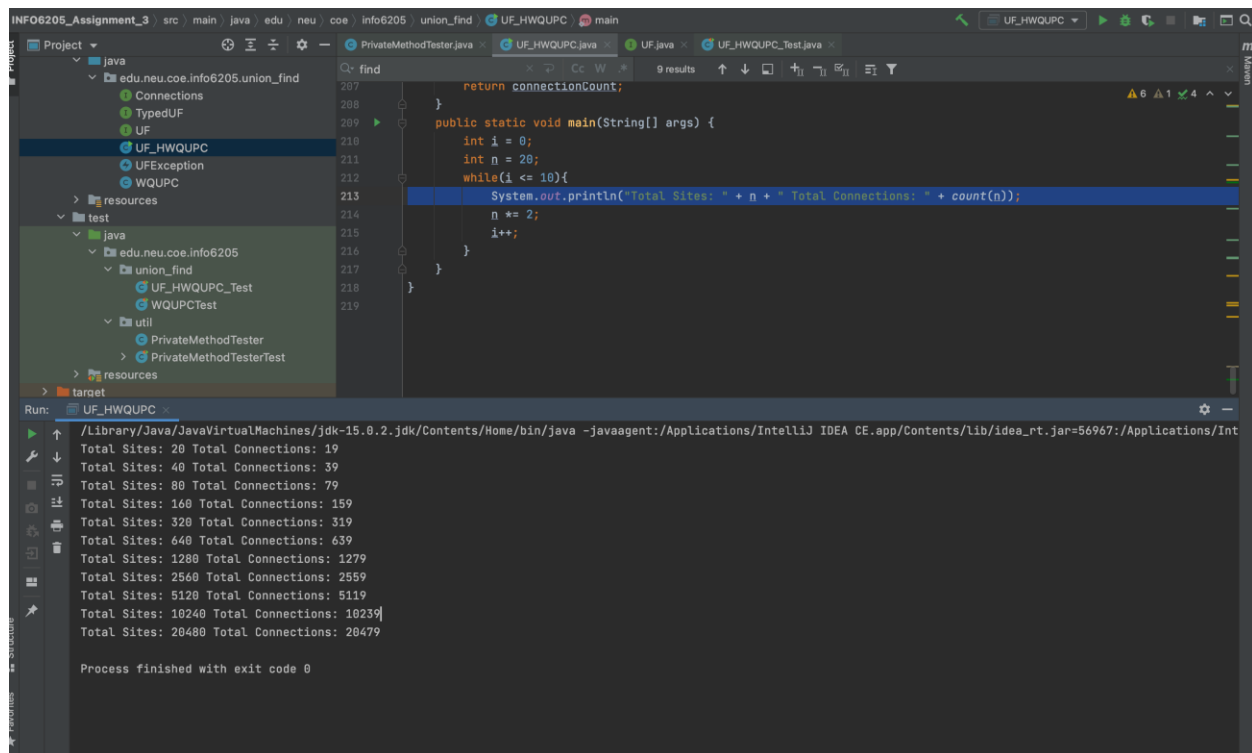
Program Structures & Algorithms

Spring 2021

Assignment No. 3

Task: Quick Union with path compression

Output:



```
INFO6205_Assignment_3 src main java edu neu coe info6205 union_find UF_HWQUPC main
Project
  java
    edu.neu.coe.info6205.union_find
      Connections
      TypedUF
      UF
      UF_HWQUPC
      UFException
      WQUPC
      resources
      test
        java
          edu.neu.coe.info6205
            union_find
              UF_HWQUPC_Test
              WQUPCTest
            util
              PrivateMethodTester
              PrivateMethodTesterTest
            resources
      target
Run: UF_HWQUPC
/Library/Java/JavaVirtualMachines/jdk-15.0.2.jdk/Contents/Home/bin/java -javaagent:/Applications/IntelliJ IDEA CE.app/Contents/Lib/idea_rt.jar=56967:/Applications/Int
Total Sites: 20 Total Connections: 19
Total Sites: 40 Total Connections: 39
Total Sites: 80 Total Connections: 79
Total Sites: 160 Total Connections: 159
Total Sites: 320 Total Connections: 319
Total Sites: 640 Total Connections: 639
Total Sites: 1280 Total Connections: 1279
Total Sites: 2560 Total Connections: 2559
Total Sites: 5120 Total Connections: 5119
Total Sites: 10240 Total Connections: 10239
Total Sites: 20480 Total Connections: 20479
Process finished with exit code 0
```

Relationship Conclusion: Connections function $f(n)$: $f(n) = n - 1$

Evidence to support the conclusion:

As we can see above the relationship between n (number of sites) and connections needed to connect all of them is $\text{connections} = n - 1$.

Experimental Evidence:

n(Total Sites)	Connections	Difference(n - connections)
20	19	1
40	39	1
80	79	1
160	159	1
320	319	1
640	639	1
1280	1279	1
2560	2559	1
5120	5119	1
10240	10239	1
20480	20479	1

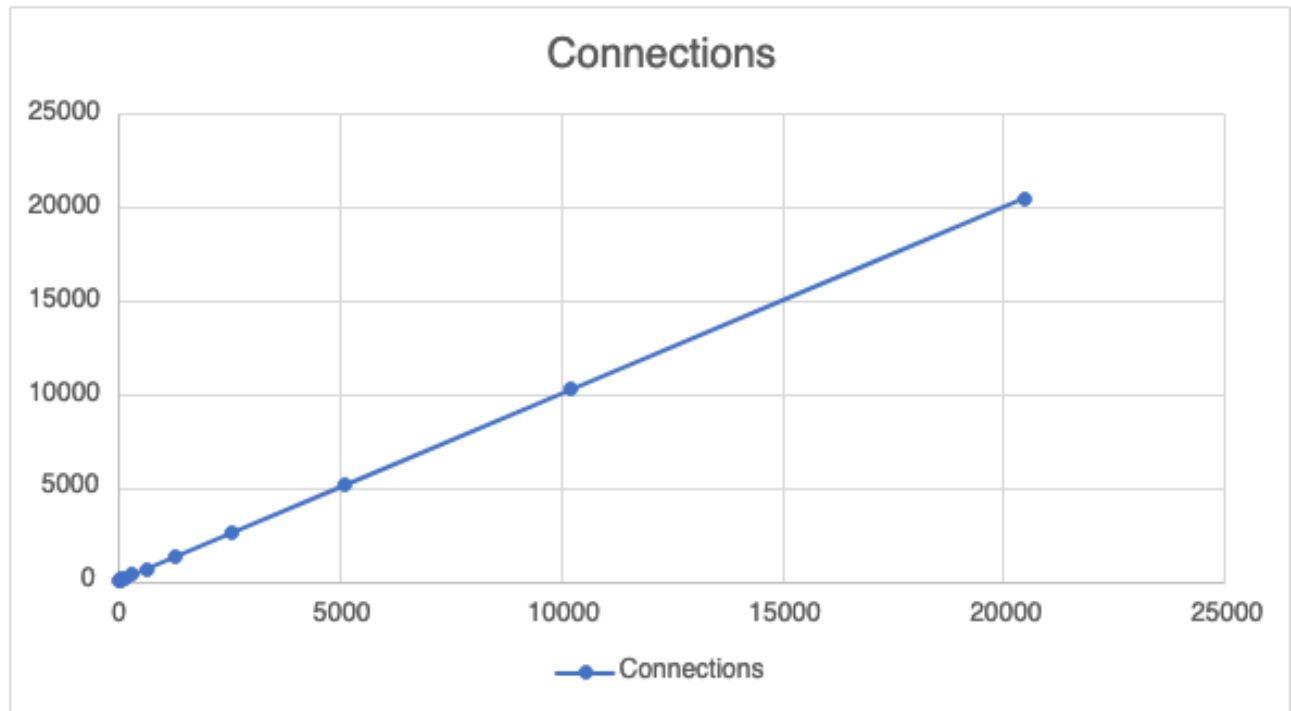
From the above data we can easily conclude the above relationship.

Reasoning:

When we are connecting n sites using **weighted path compression union find** what we are essentially doing is combining them into a single tree data structure with 1 root.

Simplifying this idea further, we are basically connecting $n-1$ sites/nodes to the root element either directly or indirectly. So, one connection each for connecting $n-1$ sites to the root node. Hence connections equation $f(n)$ is: **$f(n) = n-1$**

Graphical representation:



Unit tests result:

The screenshot displays an IDE interface with the following components:

- Project Explorer:** Shows the project structure with packages like `edu.neu.coe.info6205.union_find` and `edu.neu.coe.info6205.util`. The `UF_HWQUPC_Test` class is highlighted under the `test` directory.
- Code Editor:** Displays the source code of `UF_HWQUPC_Test.java`. It includes imports for `edu.neu.coe.info6205.util.PrivateMethodTester` and `org.junit.Test`, and a test method `testToString()` that uses `assertEquals` to verify the output of `UF_HWQUPC`.
- Run Console:** Shows the execution results of the tests. It indicates that 13 out of 13 tests passed in 5 ms. The tests listed are:
 - `testIsConnected01` (2 ms)
 - `testIsConnected02` (0 ms)
 - `testIsConnected03` (1 ms)
 - `testFind0` (0 ms)
 - `testFind1` (1 ms)
 - `testFind2` (0 ms)
 - `testFind3` (0 ms)
 - `testFind4` (1 ms)
 - `testFind5` (0 ms)
 - `testToString` (0 ms)
 - `testConnect01` (0 ms)
 - `testConnect02` (0 ms)
 - `testConnected01` (0 ms)
- Terminal:** Shows the message "Process finished with exit code 0".