

Shunqing Li (001539980)
Program Structures & Algorithms
Spring 2021
Assignment 3

Task:

- 1a: Implement height-weighted Quick Union with Path Compression.
- 1b: Check that the unit tests for this class all work.
- 2: 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.
- 3: Determine the relationship between the number of objects (n) and the number of pairs (m) generated to accomplish this.

Output:

```
"C:\Program Files\Java\jdk1.8.0_111\bin\java.exe" ...
```

```
Number of objects(n): 20
```

```
Number of pairs(m): 27
```

```
Process finished with exit code 0
```

```
"C:\Program Files\Java\jdk1.8.0_111\bin\java.exe" ...
```

```
Number of objects(n): 60
```

```
Number of pairs(m): 159
```

```
Process finished with exit code 0
```

```
"C:\Program Files\Java\jdk1.8.0_111\bin\java.exe" ...
```

```
Number of objects(n): 180
```

```
Number of pairs(m): 582
```

```
Process finished with exit code 0
```

```
"C:\Program Files\Java\jdk1.8.0_111\bin\java.exe" ...
```

```
Number of objects(n): 540
```

```
Number of pairs(m): 2439
```

```
Process finished with exit code 0
```

```
"C:\Program Files\Java\jdk1.8.0_111\bin\java.exe" ...
```

```
Number of objects(n): 1620
```

```
Number of pairs(m): 7115
```

```
Process finished with exit code 0
```

```
"C:\Program Files\Java\jdk1.8.0_111\bin\java.exe" ...
```

```
Number of objects(n): 4860
```

```
Number of pairs(m): 21816
```

```
Process finished with exit code 0
```

Conclusion:

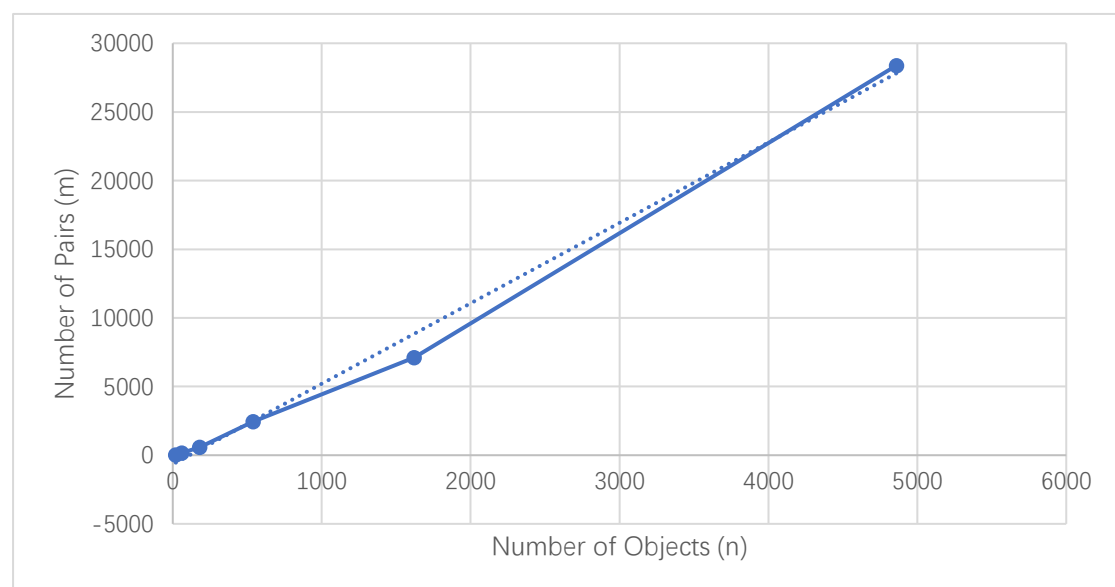
The relationship between number of objects(n) and number of pairs(m) is

$$m = 1/2n * \ln(n).$$

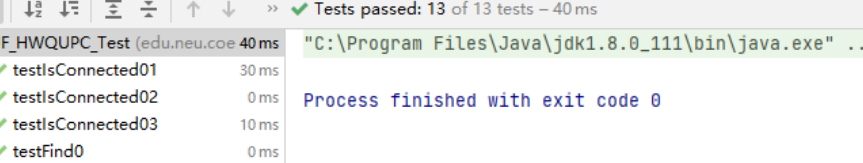
With 6 runs with different values of n resulted in the corresponding values of m. Applied the same values of n to the relationship resulted in 6 values of M. Comparing the two linear relationship in the line graph confirmed the conclusion.

Evidence:

n	m	M:	$m = 0.5n * \ln(n)$
20	27	30	
60	159	123	
180	582	467	
540	2439	1699	
1620	7115	5986	
4860	28382	20628	



Unit Test Result:



The screenshot shows the Run console of an IDE. At the top, the tab is labeled "Run: UF_HWQUPC_Test". Below the tab bar, there is a status bar indicating "Tests passed: 13 of 13 tests - 40 ms". The main area of the console displays a list of test results for the class "UF_HWQUPC_Test" from the package "edu.neu.coe". The tests and their durations are as follows:

Test Name	Duration
testIsConnected01	30 ms
testIsConnected02	0 ms
testIsConnected03	10 ms
testFind0	0 ms
testFind1	0 ms
testFind2	0 ms
testFind3	0 ms
testFind4	0 ms
testFind5	0 ms
testToString	0 ms
testConnect01	0 ms
testConnect02	0 ms
testConnected01	0 ms

Below the test results, the command executed is shown: "C:\Program Files\Java\jdk1.8.0_111\bin\java.exe" ...

At the bottom, the message "Process finished with exit code 0" is displayed.