

Conclusion:  $m \approx 0.37 * n * \lg(n)$  ( $\lg$  stands for log base of 2)  
Unit tests:

The screenshot shows an IDE with a project named 'INFO6205-Assignments'. The left sidebar shows a file tree with a folder 'union\_find' containing files like 'Connections', 'HWQUPC\_Solution', 'TypedUF', 'TypedUF\_HWQUPC', 'UF', 'UF\_HWQUPC', 'UFException', and 'WQUPC'. The main editor displays the code for 'UF\_HWQUPC\_Test.java'. The code includes two test methods: 'testToString()' and 'testIsConnected01()'. The 'testToString()' method creates a 'Connections' object 'h' and asserts its string representation. The 'testIsConnected01()' method creates a 'Connections' object 'h' and asserts that it is not connected. The bottom panel shows the test results for 'UF\_HWQUPC\_Test', indicating that 13 out of 13 tests passed in 8 ms. The test results list includes 'testIsConnected01', 'testIsConnected02', 'testIsConnected03', 'testFind0', 'testFind1', 'testFind2', 'testFind3', 'testFind4', 'testFind5', 'testToString', 'testConnect01', 'testConnect02', and 'testConnect03'.

```
public class UF_HWQUPC_Test {  
    @Test  
    public void testToString() {  
        Connections h = new UF_HWQUPC(10, 2);  
        assertEquals("expected: 'UF_HWQUPC: 10 2'\n",  
            "count: 2\n" +  
            "path compression? true\n" +  
            "parents: [0, 1]\n" +  
            "heights: [1, 1]", h.toString());  
    }  
  
    /**  
     *  
     */  
    @Test  
    public void testIsConnected01() {  
        Connections h = new UF_HWQUPC(10, 2);  
        assertFalse(h.isConnected(0, 0, 1));  
    }  
  
    /**  
     *  
     */  
}
```

Run: UF\_HWQUPC\_Test  
Tests passed: 13 of 13 tests - 8 ms  
Process finished with exit code 0

UF client run output:

n	m(Average per run)	$0.37 * n * \lg(n)$
1	0	0
256	779	757
512	1783	1704
1024	3846	3788
2048	8462	8335
4096	18261	18186
8192	39263	39403
16384	84655	84869
32768	179069	181862
65536	383215	387973