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# Program Structures & Algorithms

Fall 2021

## Assignment No. 3

- Task (List down the tasks performed in the Assignment)

WQUPC

- Relationship Conclusion:

$m = n \lg n$

- Evidence to support the conclusion:

The screenshot shows an IDE with a project named 'Assignment3'. The code file 'UF\_HWQUPC.java' contains the following Java code:

```
281 }
282
283 public int count(int n) {
284     int num_pair = 0;
285     Random random = new Random();
286     while(count < n){
287         int p = random.nextInt(n);
288         int q = random.nextInt(n);
289         if(!connected(p, q)){
290             union(p, q);
291             num_pair++;
292         }
293     }
294     return num_pair;
295 }
296
297 public static void main(String[] args) {
298     for (int i = 2; i <= 200000; i=i+2) {
299         UF_HWQUPC uh = new UF_HWQUPC(i, pathCompression: false);
300         System.out.println("n="+i+", number of pairs is: "+uh.count(i)+", number of connection generated is: "+(i-1));
301     }
302 }
```

The output window shows the following results:

```
n=2,number of pairs is:2,number of connection generated is:1
n=4,number of pairs is:5,number of connection generated is:3
n=8,number of pairs is:10,number of connection generated is:7
n=16,number of pairs is:27,number of connection generated is:15
n=32,number of pairs is:64,number of connection generated is:31
n=64,number of pairs is:136,number of connection generated is:63
n=128,number of pairs is:351,number of connection generated is:127
n=256,number of pairs is:825,number of connection generated is:255
n=512,number of pairs is:1537,number of connection generated is:511
n=1024,number of pairs is:3458,number of connection generated is:1023
n=2048,number of pairs is:7241,number of connection generated is:2047
n=4096,number of pairs is:15287,number of connection generated is:4095
n=8192,number of pairs is:35919,number of connection generated is:8191
n=16384,number of pairs is:78883,number of connection generated is:16383
n=32768,number of pairs is:156531,number of connection generated is:32767
n=65536,number of pairs is:429848,number of connection generated is:65535
n=131072,number of pairs is:792639,number of connection generated is:131071
Process finished with exit code 0
```

## ○ Unit tests result:(Snapshot of successful unit test run)

The screenshot displays an IDE window titled "Assignment3 - UF\_HWQUPC.java". The main editor shows the source code for `UF_HWQUPC.java` with the following methods:

```
68 public int components() { return count; }
69
70 /**
71  * Returns the component identifier for the component containing site (@code p).
72  *
73  * @param p the integer representing one site
74  * @return the component identifier for the component containing site (@code p)
75  * @throws IllegalArgumentException unless (@code 0 <= p < n)
76  */
77 public int find(int p) {
78     validate(p);
79     int root = p;
80     while (root != parent[root]) {
81         if (pathCompression == true) {
82             doPathCompression(root);
83         }
84         root = parent[root];
85     }
86     return root;
87 }
88
89 /**
90  * Returns true if the two sites are in the same component.
91  *
92  * @param p the integer representing one site
93  * @param q the integer representing the other site
94  * @return (@code true) if the two sites (@code p) and (@code q) are in the same component;
95  *         (@code false) otherwise
96  * @throws IllegalArgumentException unless both (@code 0 <= p < n) and (@code 0 <= q < n)
97  */
98 public boolean connected(int p, int q) { return find(p) == find(q); }
99
```

The bottom panel shows the "Run" tab with the following output:

```
Tests passed: 13 of 13 tests - 11ms
/Library/Java/JavaVirtualMachines/jdk1.8.0_142.jdk/Contents/Home/bin/java ...
Process finished with exit code 0
```

The "Test Results" panel below the output shows a list of 13 tests, all of which passed:

- testIsConnected01: 0ms
- testIsConnected02: 0ms
- testIsConnected03: 4ms
- testFind0: 0ms
- testFind1: 0ms
- testFind2: 0ms
- testFind3: 1ms
- testFind4: 0ms
- testFind5: 0ms
- testToBring: 0ms
- testConnect01: 0ms
- testConnect02: 0ms
- testConnected01: 0ms