PSA Assignment 4|Padma Anaokar |
Github: https://github.com/padmaanaokar/002727445_PSA

Part A:

Code Changes in **UF_HWQUPC.java:**

Find method

```
public int find(int p) {
    validate(p);
int root = p;
// FIXME
while (p != parent[p])
    p = parent[p];
if (this.pathCompression) {
    doPathCompression(root);
}
return p;
// END
}
```

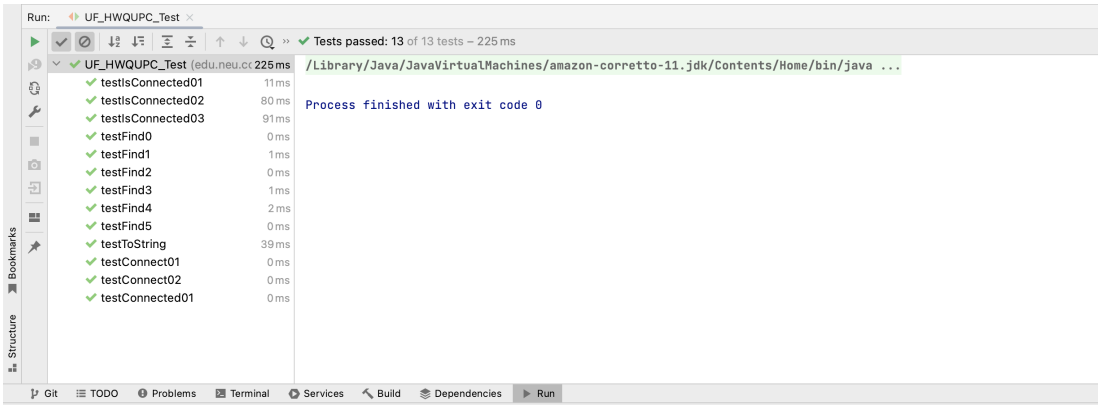
mergeComponents method:

```
private void mergeComponents(int i, int j) {
    // FIXME make shorter root point to taller one
    // END
    int rootX = find(i);
    int rootY = find(j);

    if (height[rootX] < height[rootY]) {
        parent[rootX] = rootY;
        height[rootY] += height[rootX];
    } else if (height[rootX] > height[rootY]) {
        parent[rootY] = rootX;
        height[rootX] += height[rootY];
    } else {
        parent[rootY] = rootX;
        height[rootX]++;
    }

}
```

doPathCompression Method:

```
private void doPathCompression(int i) {
    // FIXME update parent to value of grandparent
    // END
    while (i != parent[i]) {
    parent[i] = parent[parent[i]];
    i = parent[i];

}
}
```

Test Cases:

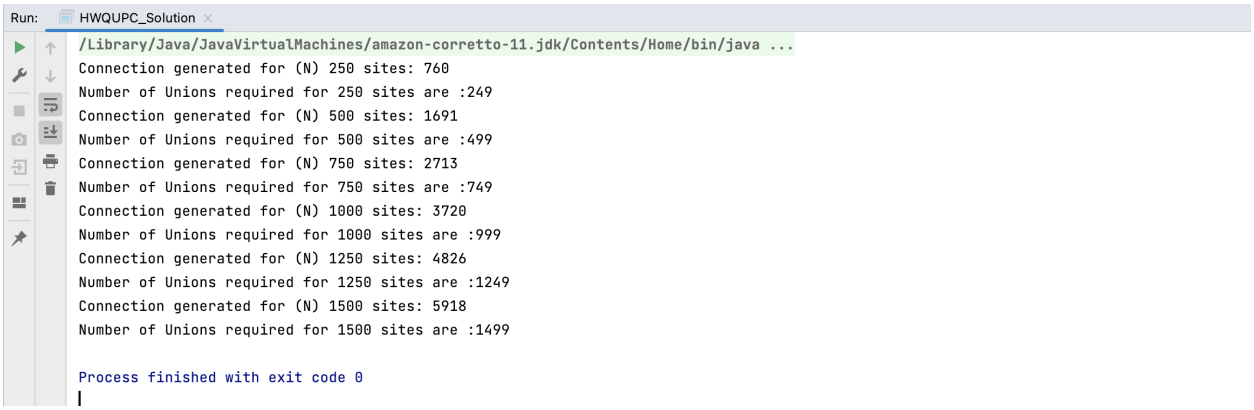


Part B:

Writing a main function for running a fixed set of n values. HWQUPC_Solution.java

```
static int union=0;
 public static void main(String[] arg) {
     findConnections(1000, 250, 1500);
 }
 public static void findConnections(int runs, int low, int high) {
     for (int i = low; i <= high; i = i+low) {
         int totalConn = 0;
         for (int j = 0; j < runs; j++) {
             totalConn+=count(i);
         }
         System.out.println("Connection generated for (N) " + i + " sites: " + totalConn/runs);
         System.out.println("Number of Unions required for "+i+" sites are :"+union/runs);
         union=0;
     }
 }
 public static int count(int n) {
     int pairs = 0;
     UF_HWQUPC unionFind = new UF_HWQUPC(n);
     Random r = new Random();
     while(unionFind.components() > 1) {
         int p = r.nextInt(n);
         int q = r.nextInt(n);
         pairs++;
         if (!unionFind.isConnected(p, q)) {
             unionFind.connect(p, q);
             union++;
         }
     }
     return pairs;
 }
```

Output:

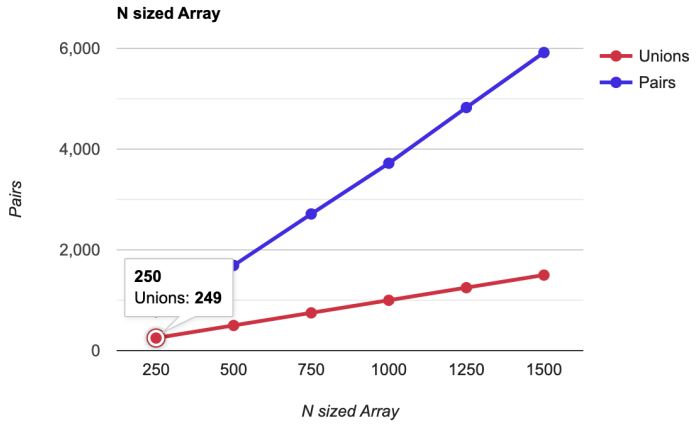


Part C:

Graph:

Unions Vs Pairs

N	Union	Pairs
250	249	760
500	499	1691
750	749	2713
1000	999	3720
1250	1249	4826
1500	1499	5918



Conclusion:

Here we tried to average the number of pairs generated value by taking an average of 1000 runs for any given N value and we have plotted a graph for the same.

We can observe that the relationship between number of objects (n) and the number of pairs (m) generated is

M = (N*log(N))/2

Also, the number of connections formed in union find to connect n objects is (n-1) because any connection after n-1 will result in a cycle.