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# INFO 6205 Program Structure & Algorithms
# Summer Full 2018
# Assignment 2 - Union-Find

**Files Description:**

+- PinHo_Wang_assignment2
    +- Report
    +- src
        +- main
        |  +- edu.neu.coe.info6205.union_find
        |      +-Client.java: *Including static count() and main() method.*
        |      +-UF.java (default)
        |      +- Connections.java (default)
        |      +- UF_HWQUPC.java: *Completed pathCompression and mergeComponents methods.*
        |      +- WQUPC.java (default)
        +- test
            +- edu.neu.coe.info6205.union_find
                +- UF_HWQUPC_Test.java (default)
                +- WQUPCTest.java (default)

**Experiments:**

As the request, I create a class file named Client.java, which contains static method count(), randomPairGen(), and main(). In main(), I set the initial sites 100, 200 util it reaches 204800 to count() as arguments. In each model of unions, I using the model of WQUPC calculate 100 times, 1000 times, and get the mean of every number of connections output, which I call edges

here. The 1/2 n * ln(n) also shows in the result in order to compare with mean of connections. The 100 times and 1000 times of experiment figures show below.

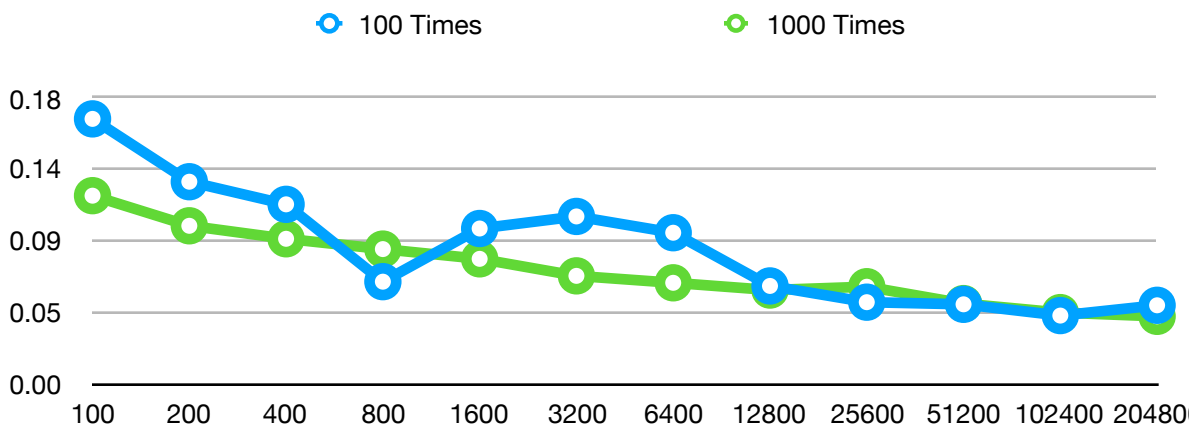
**100 times:**

```
<terminated> Client [Java Application] /Library/Java/JavaVirtualMachines/jdk1.8.0_91.jdk/Contents/Home/bin/java (Oct 2, 2018, 2:58:15 PM)
n         mean # edges      1/2 n ln n
100       268.61            230.26
200       597.23            529.83
400       1333.76           1198.29
800       2846.66           2673.84
1600      6480.16           5902.21
3200      14275.53          12913.45
6400      30716.95          28044.97
12800     64276.73          60526.08
25600     136653.55         129924.45
51200     291601.64         277593.47
102400    616314.46         590676.07
204800    1314752.23        1252330.41

Elapsed Time is: 35.333
```

**1000 times:**

```
<terminated> Client [Java Application] /Library/Java/JavaVirtualMachines/jdk1.8.0_91.jdk/Contents/Home/bin/java (Oct 2, 2018, 3:18:14 PM)
n         mean # edges      1/2 n ln n
100       257.54            230.26
200       582.61            529.83
400       1307.91           1198.29
800       2901.20           2673.84
1600      6368.06           5902.21
3200      13795.06          12913.45
6400      29837.70          28044.97
12800     64120.86          60526.08
25600     137912.07         129924.45
51200     291726.00         277593.47
102400    617413.36         590676.07
204800    1306100.10        1252330.41

Elapsed Time is: 362.443
```

As the experiment, the values of mean # edges are similar to the formula. Compare the differences between 100 times experiment and 1000 times one, as the plot below, 1000 times experiments seem have less differences., but it also spent longer time. It is worthy to mention that as the sites number become larger, the differences become smaller. We can assume that while n is approaching to infinite, the differences will approximate to zero.



Then I change the model to UF_HWQUPC model, which run 100 experiments and calculate the mean value. The result shows below.

```
<terminated> Client [Java Application] /Library/Java/JavaVirtualMachines/jdk1.8.0_91.jdk/Contents/Home/bin/java (Oct 2, 2018, 4:20:12 PM)
n          mean # edges      1/2 n ln n
100        267.43            230.26
200        582.69            529.83
400        1352.84           1198.29
800        2891.70           2673.84
1600       6206.91           5902.21
3200       14196.20          12913.45
6400       29424.65          28044.97
12800      63531.37          60526.08
25600      138622.67         129924.45
51200      288649.95         277593.47
102400     612604.61         590676.07
204800     1311548.56        1252330.41

Elapsed Time is: 30.45
```

The elapsed time is  30.45 sec, which is slight less than WQUPC.

**Test cases:**

Then, the WQUPC and UF_HWQUPC cases testing figures show below.