INFO 6205 - Program Structure & Algorithms

– Assignment 3

Disjoint Sets Algorithms

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Contents

Introduction

Disjoint sets are n sets whose union yields an empty set. Our goal is to model a connection so that we can reduce all the sets into 1 superset.

Two points x and y justify the “is connected to” equivalence relation if they are:

1. Reflexive: p is connected to p.
2. Symmetric: if q is connected to p, then p is connected to q.
3. Transitive: if p is connected to q and q is connected to r, then p is connected to r.

We have 3 main methods for this:

1. Quick Union
2. Quick Find
3. Weighted Quick Union

Implementation:

1. Find query: Check if 2 objects are in the same component.
2. Union Command: Replace components containing two objects with their union.

Connection Counts

Here are the plots for number of random pairs generated for union of disjoint sets consisting of n elements each. The below table shows the count of the number of successfully generated random pairs that are then used to invoke union find algorithm.

Input Set Size:

1. 100

Successful Union	99	99	99	99	99	99	99	99	99
Redundant Pair	121	153	208	199	231	209	246	176	207
Total Pairs Generated	220	252	207	298	330	308	345	275	306

Average Pairs Generated = 282

2. 200

Successful Union	199	199	199	199	199	199	199	199	199
Redundant Pair	411	576	496	457	441	386	399	456	357
Total Pairs Generated	610	775	695	656	640	585	598	655	556

Average Pairs Generated = 641

3. 400

Successful Union	399	399	399	399	399	399	399	399	399
Redundant Pair	1550	1094	1396	1172	1122	1231	1091	1180	1038
Total Pairs Generated	1949	1493	1795	1571	1521	1630	1490	1579	1437

Average Pairs Generated = 1607

4. 800

Successful Union	799	799	799	799	799	799	799	799	799
Redundant Pair	3821	2355	2299	2931	2604	3575	2267	2475	2398
Total Pairs Generated	4620	3154	3098	3730	3403	4374	3066	3274	3197

Average Pairs Generated = 3546

5. 1600

Successful Union	1599	1599	1599	1599	1599	1599	1599	1599	1599
Redundant Pair	5316	5528	6214	6206	5398	6923	6888	5169	5843
Total Pairs Generated	6915	7127	7813	7805	6997	8522	8487	6768	7442

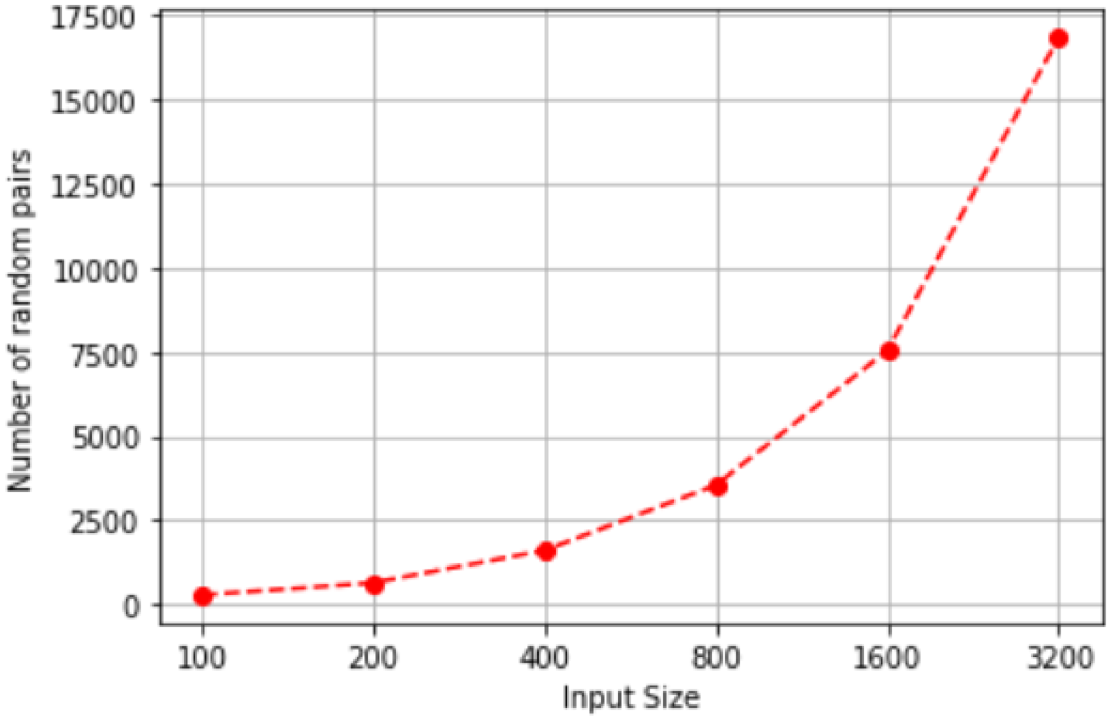
Average Pairs Generated = 7542

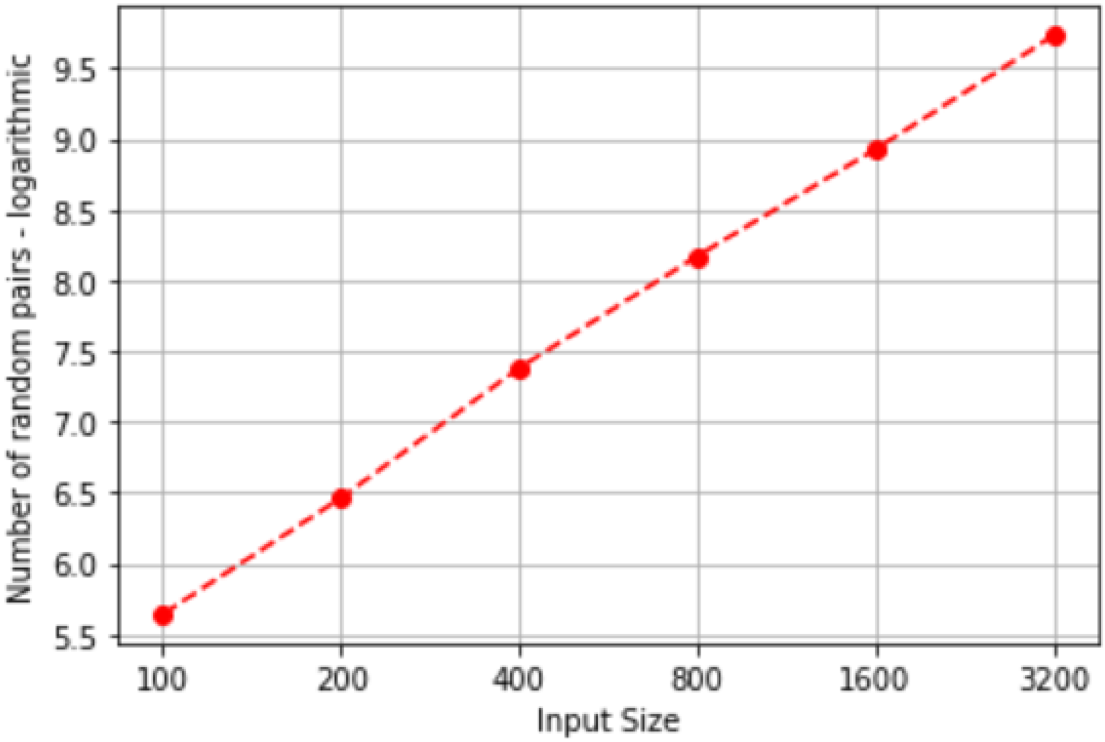
6. 3200

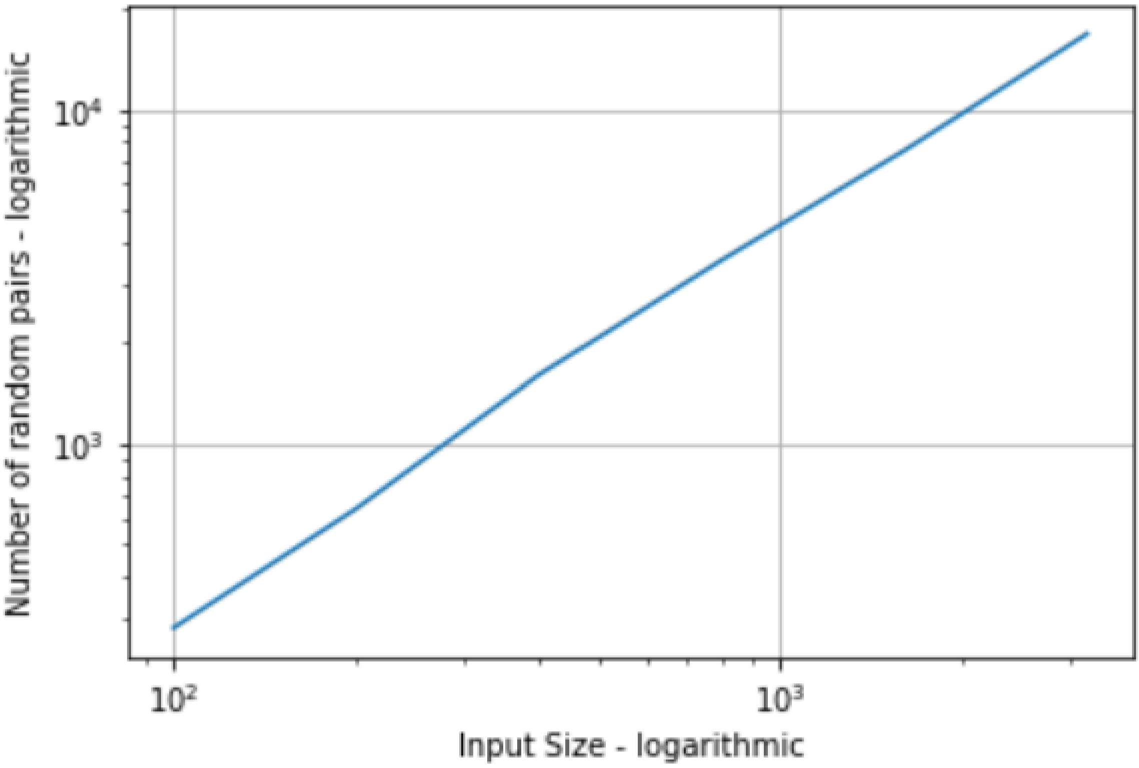
Successful Union	3199	3199	3199	3199	3199	3199	3199	3199	3199
Redundant Pair	13970	13231	15441	12986	11627	13178	16605	12250	13499
Total Pairs Generated	17169	16430	18640	16185	14826	16377	19804	15449	16698

Average Pairs Generated = 16842

Graphical Representation:



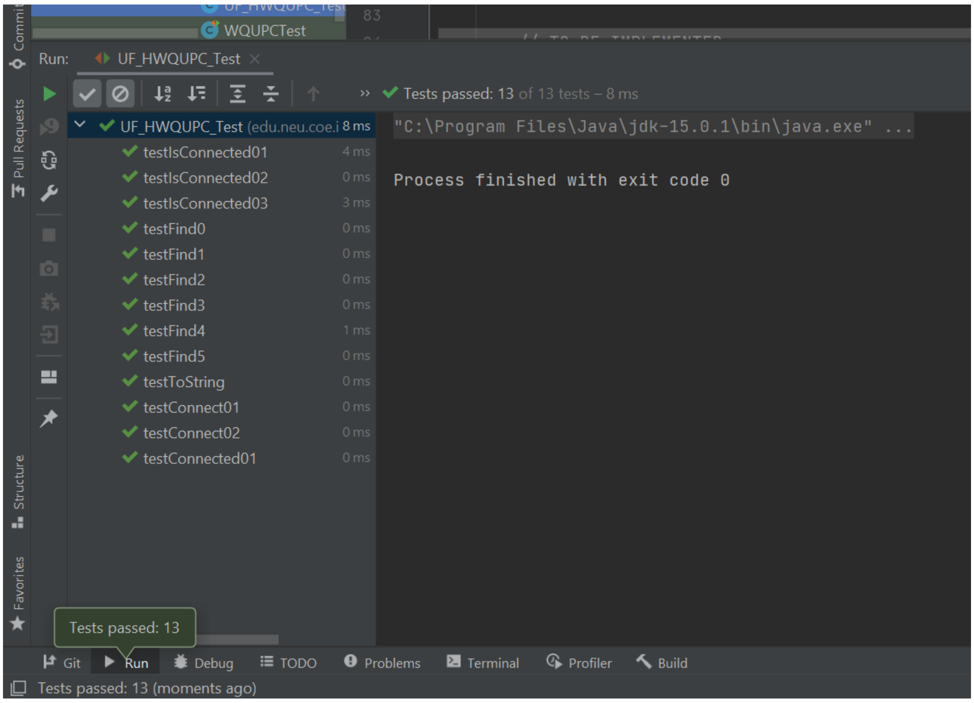




We see when we plot the number of random numbers required for generation shows an exponential growth.

For every n sized input, we will need n-1 successful unions to form a loop.

Test Cases



```
✓ Tests passed: 13 of 13 tests – 8 ms

✓ UF_HWQUPC_Test (edu.neu.coe.i 8 ms
    ✓ testIsConnected01   4 ms
    ✓ testIsConnected02   0 ms
    ✓ testIsConnected03   3 ms
    ✓ testFind0           0 ms
    ✓ testFind1           0 ms
    ✓ testFind2           0 ms
    ✓ testFind3           0 ms
    ✓ testFind4           1 ms
    ✓ testFind5           0 ms
    ✓ testToString        0 ms
    ✓ testConnect01       0 ms
    ✓ testConnect02       0 ms
    ✓ testConnected01     0 ms
```

```
"C:\Program Files\Java\jdk-15.0.1\bin\java.exe" ...

Process finished with exit code 0
```

Tests passed: 13

Tests passed: 13 (moments ago)

Direction to Run

Run GraphTemp.java file under the package edu.neu.coe.info6205.union_find