Program Structures and Algorithms
Spring 2023(SEC –03)

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Task:
Assignment 4 (WQUPC)

Relationship Conclusion:
y – connections
n – sites
m – pairs
y = n – 1
m = 2.5*n^1.08

Proof:
Connections vs Sites
Because every node is connected and has no cycle, the final graph is a tree. A tree with n vertices can have at most n-1 edges. So, the connections we generate must be less than the sites we have. (y<n)
Every time we make a connection, we can reduce the total components by 0 or 1. Finally, we will only have 1 component. So, the connections we generate must be at least n-1. (y >= n-1)
So, we will exactly generate n-1 connections.
Pairs vs Sites
Some pairs cannot generate connections because those 2 sites are already connected. So, we need to have almost 2.5 times to connect all sites.

Evidence to support that conclusion:

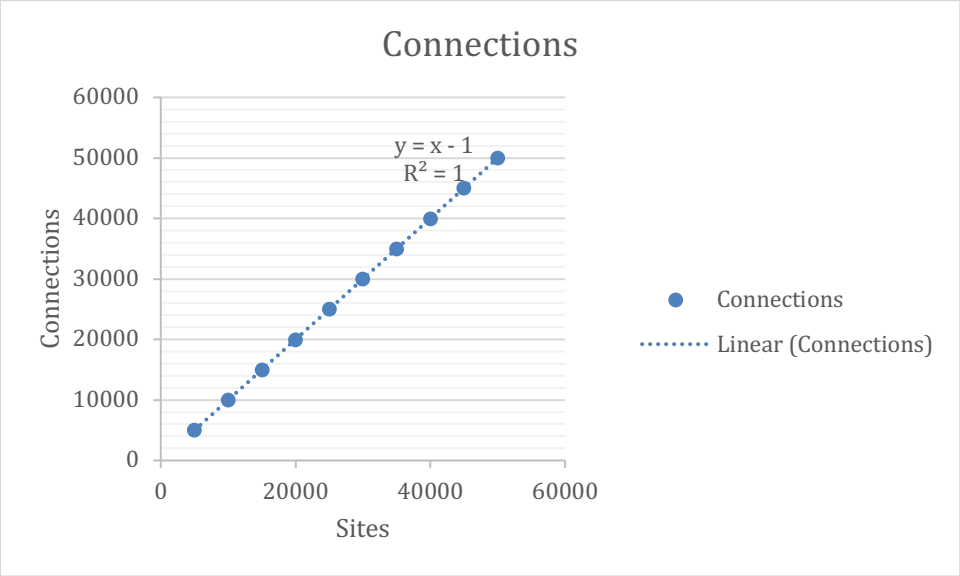
```
5000 sites, generate 4999connections, generate 23945 pairs.
10000 sites, generate 9999connections, generate 48454 pairs.
15000 sites, generate 14999connections, generate 77790 pairs.
20000 sites, generate 19999connections, generate 105466 pairs.
25000 sites, generate 24999connections, generate 127937 pairs.
30000 sites, generate 29999connections, generate 167400 pairs.
35000 sites, generate 34999connections, generate 184983 pairs.
40000 sites, generate 39999connections, generate 230878 pairs.
45000 sites, generate 44999connections, generate 267794 pairs.
50000 sites, generate 49999connections, generate 292338 pairs.
```

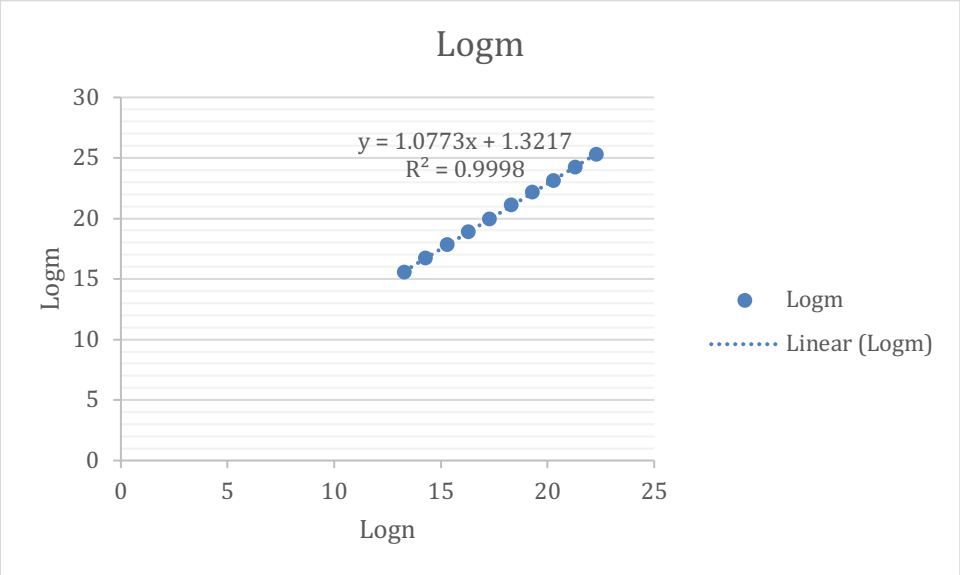
```
10000 sites, generate 9999connections, generate 48231 pairs.
20000 sites, generate 19999connections, generate 106699 pairs.
40000 sites, generate 39999connections, generate 232824 pairs.
80000 sites, generate 79999connections, generate 479267 pairs.
160000 sites, generate 159999connections, generate 1030229 pairs.
320000 sites, generate 319999connections, generate 2248000 pairs.
640000 sites, generate 639999connections, generate 4705477 pairs.
1280000 sites, generate 1279999connections, generate 9228736 pairs.
2560000 sites, generate 2559999connections, generate 19509331 pairs.
5120000 sites, generate 5119999connections, generate 41052673 pairs.
```

Sites	Connections	Pairs
5000	4999	23945
10000	9999	48454
15000	14999	77790
20000	19999	105466
25000	24999	127937
30000	29999	167400
35000	34999	184983
40000	39999	230878
45000	44999	267794
50000	49999	292338

Sites	Pairs	Logn	Logm
10000	48231	13.2877124	15.5576731
20000	106699	14.2877124	16.7031871
40000	232824	15.2877124	17.8288803
80000	479267	16.2877124	18.8704701
160000	1030229	17.2877124	19.9745336
320000	2248000	18.2877124	21.1002106
640000	4705477	19.2877124	22.1659095
1280000	9228736	20.2877124	23.1377016
2560000	19509331	21.2877124	24.217661
5120000	41052673	22.2877124	25.2909728

Graphical Representation:





Unit Test Screenshots: