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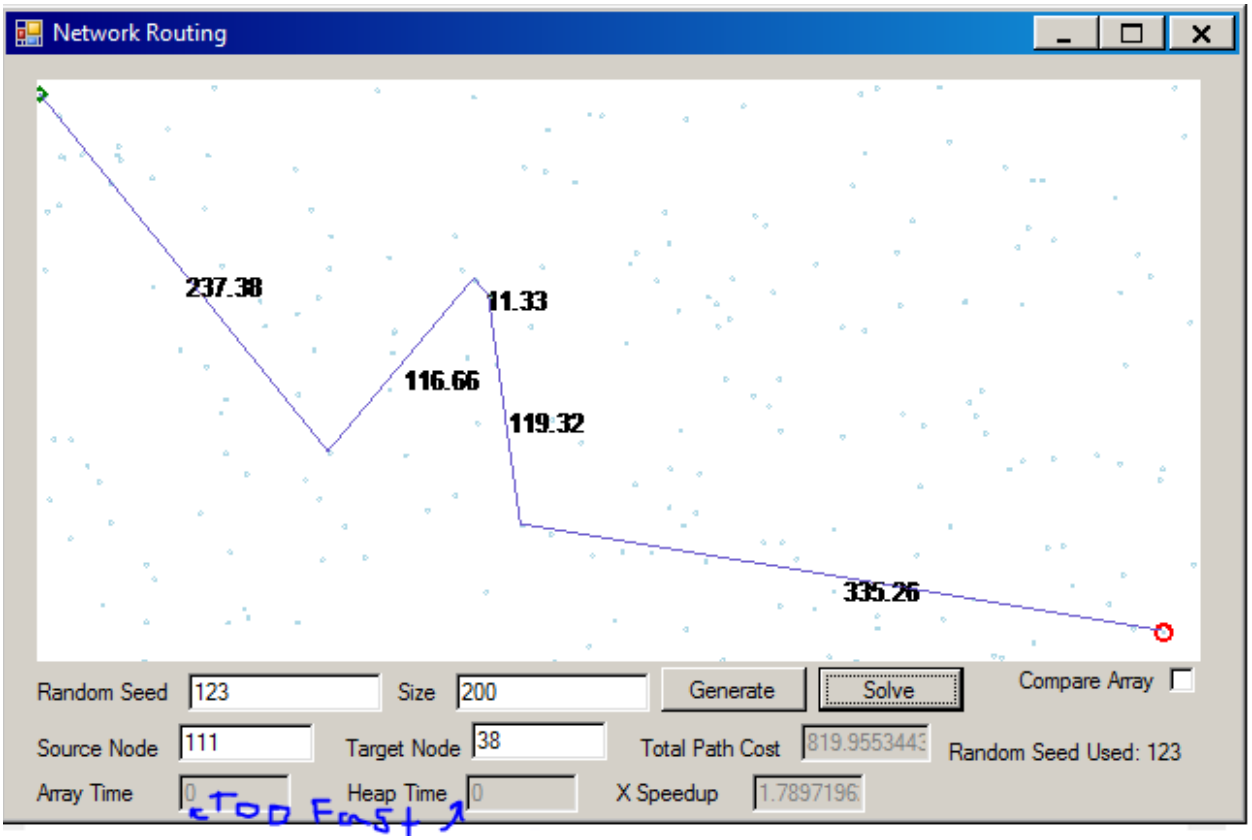
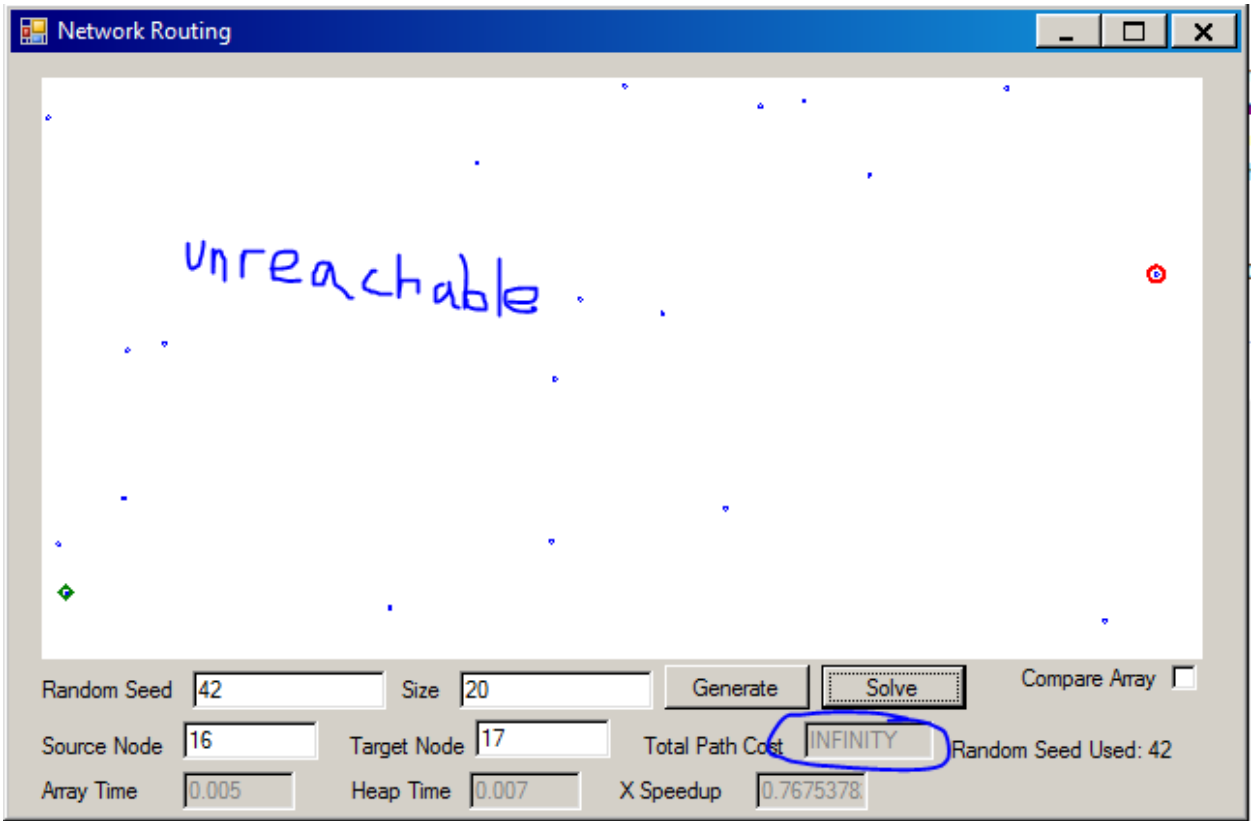
CS 312
Project 3: Dijkstra's Algorithm

1. See attached code.
2. Code complexity
    a. For the Array,
        i. insert is O(1) because we just put it at the end of the array
        ii. delete-min is O(1) because we just throw away the first index of the array
        iii. decrease-key is O(n) because we bubble-sort the single key to its proper location
    b. For the Heap,
        i. Insert is O(1) because when we insert, we just dump things at the end. (when you insert, the distance is infinity)
        ii. Delete-min is O(logV) because we need to do the whole heap delete-min, where we take out the min, put the last element at the start, then bubble-down.
        iii. Decrease-key is also O(logV) because after the key is decreased, it bubbles-up to its correct location
3. In each case, we might need to cycle through each vector. For each of these cycles, we
    a. Decrease-key the distances at 3 edges – O(1) for array and O(logV) for heap
    b. Delete-min to get the next node- O(V) for array and O(logV) for heap

    Making the final complexity O(V^2) for the array and O(V(logV + logV)) ~ O(VlogV) for the heap
4. Screenshots! For 200 at seed 123, it calculated too quickly to really get times. For 20 at seed 42, it is not reachable, so the distance is INFINITY.





5. It looks like our complexity calculation is correct- the array time goes up squared relative to the number of nodes, and the heap time goes up by VlogV. It is too bad we ran out of memory; I was hoping for a nicer curve on the heap timing. There are some runs (such as seed 1476 with 100,000 points) that went a lot faster than the others. I expect this means there was an improbably short path between the nodes, and our algorithm found it really fast.

Data table						
Seed	**Size**	**Source**	**Target**	**Array Time**	**Heap Time**	**X Speedup**
1456	100	39	83	0.004	0.084	0.04792
1457	100	59	14	0	0	1.06422
1458	100	95	71	0.005	0.008	0.634
1459	100	82	84	0	0	1.1571
1460	100	3	95	0	0	1.0483
Average				0	0	0.790308
1461	1000	224	259	0.005	0	7.08498
1462	1000	960	439	0.001	0	4.95111
1463	1000	721	972	0.005	0	6.20113
1464	1000	54	805	0.005	0.002	2.48097
1465	1000	905	499	0.006	0.001	5.53367
Average				0.0044	0.0006	5.250372
1466	10,000	9072	3662	0.39	0.011	34.5241

1477	10,000	7164	5481	0.398	0.009	40.9654
1468	10,000	1836	646	0.288	0.005	48.476641
1469	10,000	485	7146	0.365	0.008	43.4262
1470	10,000	4586	1417	0.456	0.013	33.3696
Average				0.3794	0.0092	40.152388
1472	100,000	12752	47962	32.058	0.11	289
1473	100,000	10236	84628	33.272	0.104	317
1474	100,000	62807	70160	35.691	0.177	201
1475	100,000	14029	13496	36.306	0.186	194
1476	100,000	9546	19592	7.614	0.034	220
Average				28.9882	0.1222	244.2
1477	1,000,000	504705	53686	-	2.571	-
1478	1,000,000	396618	860359	-	2.312	-
1479	1,000,000	428806	521130	-	2.16	-
1480	1,000,000	557796	587158	-	2.541	-
1481	1,000,000	887379	192927	-	1.697	-
1482	1,000,000	23816	668763	-	2.424	-
Average				?? 300	2.284166	-
1483	10,000,000	“System.OutOfMemoryException”