

Program Structures & Algorithms

Fall 2021

Assignment NO. 3

- Tasks:
 - Implemented four methods (find, union, mergeComponents and doPathCompression) of the class UF_HWQUPC and passed TimerTest and UF_HWQUPC_Test
 - Created a class UF_CLIENT with a static method count() and a main()
 - Run count() with 13 different n values (using doubling method), each with 20 trials. The number of connections is determined by the average count of 20 trials.
- Conclusion:
 - The number of pairs needed to reduce number of component to 1 is approximately $1/2 * n \ln n$
 - If we think of union find operation as a special case of ordering (instead of order a list to be in order, we order it to be “connected”), we need $n \ln n$ operations. A pair of nodes can have two operations, therefore we need $1/2 * n \ln n$ pairs
- Evidence to Support the Conclusion:

N	m	$1/2 * n \lg n$
500	1556.35	1553.65202460555
1000	3987.95	3453.87763949107
2000	8578.3	7600.90245954208
4000	17480.8	16588.0992802041
8000	41587.1	35948.7872826479
16000	81460.9	77442.7520097753
32000	170190.66	165975.85890851
64000	366966.56	354132.427594938
128000	775387.9	752626.274745712
256000	1731800.4	1593975.3886031
512000	3470226.8	3365396.45542954
1024000	7258505.5	7085684.26730577
2048000	1.4720859E+07	14881151.2475049

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Please enter the number of sites: 500
TRIAL 1: 1431, TRIAL 2: 1245, TRIAL 3: 1435, TRIAL 4: 1375, TRIAL 5: 1354, TRIAL 6: 1233, TRIAL 7: 1520, TRIAL 8: 1389, TRIAL 9: 1976, TRIAL 10: 1443,
TRIAL 11: 1759, TRIAL 12: 1708, TRIAL 13: 1840, TRIAL 14: 1623, TRIAL 15: 1481, TRIAL 16: 1369, TRIAL 17: 1925, TRIAL 18: 1367, TRIAL 19: 1917, TRIAL 20: 1737,
Average of connections generated: 1556.35

Process finished with exit code 0

Please enter the number of sites: 1000
TRIAL 1: 4674, TRIAL 2: 3865, TRIAL 3: 3023, TRIAL 4: 3930, TRIAL 5: 3652, TRIAL 6: 3748, TRIAL 7: 3611, TRIAL 8: 3964, TRIAL 9: 4513, TRIAL 10: 3848,
TRIAL 11: 3407, TRIAL 12: 4336, TRIAL 13: 3984, TRIAL 14: 4991, TRIAL 15: 4181, TRIAL 16: 3693, TRIAL 17: 3281, TRIAL 18: 5222, TRIAL 19: 3953, TRIAL 20: 3883,
Average of connections generated: 3987.95

Please enter the number of sites: 2000
TRIAL 1: 7497, TRIAL 2: 8464, TRIAL 3: 9919, TRIAL 4: 9639, TRIAL 5: 11428, TRIAL 6: 6541, TRIAL 7: 7697, TRIAL 8: 7261, TRIAL 9: 8285, TRIAL 10: 8202,
TRIAL 11: 7840, TRIAL 12: 7509, TRIAL 13: 8822, TRIAL 14: 11075, TRIAL 15: 8109, TRIAL 16: 9823, TRIAL 17: 8488, TRIAL 18: 7846, TRIAL 19: 8689, TRIAL 20: 8432,
Average of connections generated: 8578.3

Please enter the number of sites: 4000
TRIAL 1: 22753, TRIAL 2: 20761, TRIAL 3: 15237, TRIAL 4: 18480, TRIAL 5: 19770, TRIAL 6: 15969, TRIAL 7: 16898, TRIAL 8: 18396, TRIAL 9: 16151, TRIAL 10: 16887,
TRIAL 11: 21069, TRIAL 12: 17003, TRIAL 13: 15134, TRIAL 14: 16261, TRIAL 15: 15287, TRIAL 16: 13941, TRIAL 17: 15019, TRIAL 18: 20149, TRIAL 19: 18613, TRIAL 20: 15838,
Average of connections generated: 17480.8
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Please enter the number of sites: 8000
TRIAL 1: 34591, TRIAL 2: 41556, TRIAL 3: 40046, TRIAL 4: 42619, TRIAL 5: 43397, TRIAL 6: 33577, TRIAL 7: 37495, TRIAL 8: 45076, TRIAL 9: 48444, TRIAL 10: 39082,
TRIAL 11: 42349, TRIAL 12: 34807, TRIAL 13: 48851, TRIAL 14: 55542, TRIAL 15: 32049, TRIAL 16: 48382, TRIAL 17: 40681, TRIAL 18: 38693, TRIAL 19: 40115, TRIAL 20: 44390,
Average of connections generated: 41587.1

Please enter the number of sites: 14000
TRIAL 1: 79394, TRIAL 2: 71356, TRIAL 3: 87188, TRIAL 4: 88737, TRIAL 5: 76496, TRIAL 6: 71167, TRIAL 7: 82444, TRIAL 8: 75993, TRIAL 9: 76823, TRIAL 10: 97022,
TRIAL 11: 68745, TRIAL 12: 70526, TRIAL 13: 85602, TRIAL 14: 71095, TRIAL 15: 92102, TRIAL 16: 97474, TRIAL 17: 82624, TRIAL 18: 99802, TRIAL 19: 80309, TRIAL 20: 74319,
Average of connections generated: 81460.9

/Library/Java/JavaVirtualMachines/jdk1.8.0_301.jdk/Contents/Home/bin/java ...
Please enter the number of sites: 32000
TRIAL 1: 179293, TRIAL 2: 143428, TRIAL 3: 182395, TRIAL 4: 155128, TRIAL 5: 169212, TRIAL 6: 199150, TRIAL 7: 159843, TRIAL 8: 172250, TRIAL 9: 163414, TRIAL 10: 188278,
TRIAL 11: 170297, TRIAL 12: 171261, TRIAL 13: 211105, TRIAL 14: 164080, TRIAL 15: 154022, TRIAL 16: 181406, TRIAL 17: 146422, TRIAL 18: 168538, TRIAL 19: 163774, TRIAL 20:
Average of connections generated: 170190.66

Please enter the number of sites: 64000
TRIAL 1: 325916, TRIAL 2: 346996, TRIAL 3: 369454, TRIAL 4: 358484, TRIAL 5: 325975, TRIAL 6: 376704, TRIAL 7: 315193, TRIAL 8: 382182, TRIAL 9: 516420, TRIAL 10: 372731,
TRIAL 11: 383174, TRIAL 12: 325629, TRIAL 13: 386633, TRIAL 14: 362190, TRIAL 15: 360094, TRIAL 16: 383195, TRIAL 17: 398309, TRIAL 18: 311972, TRIAL 19: 418443, TRIAL 20:
Average of connections generated: 366966.56

Please enter the number of sites: 128000
TRIAL 1: 754984, TRIAL 2: 721800, TRIAL 3: 681815, TRIAL 4: 713364, TRIAL 5: 895924, TRIAL 6: 751559, TRIAL 7: 681362, TRIAL 8: 783542, TRIAL 9: 716770, TRIAL 10: 707068,
TRIAL 11: 760602, TRIAL 12: 853332, TRIAL 13: 858905, TRIAL 14: 762866, TRIAL 15: 965048, TRIAL 16: 826262, TRIAL 17: 713392, TRIAL 18: 993730, TRIAL 19: 655433, TRIAL 20:
Average of connections generated: 775387.9

Please enter the number of sites: 256000
TRIAL 1: 1575213, TRIAL 2: 1925530, TRIAL 3: 1875141, TRIAL 4: 1570980, TRIAL 5: 1845828, TRIAL 6: 2026992, TRIAL 7: 1848968, TRIAL 8: 1826298, TRIAL 9: 1495605, TRIAL 10:
TRIAL 11: 1575544, TRIAL 12: 1461467, TRIAL 13: 1569595, TRIAL 14: 1834259, TRIAL 15: 1748959, TRIAL 16: 2085526, TRIAL 17: 1726504, TRIAL 18: 1612444, TRIAL 19: 1648345,
Average of connections generated: 1731800.4

Please enter the number of sites: 512000
TRIAL 1: 3979764, TRIAL 2: 3709183, TRIAL 3: 3329130, TRIAL 4: 3637107, TRIAL 5: 3467731, TRIAL 6: 3404377, TRIAL 7: 3145519, TRIAL 8: 3641544, TRIAL 9: 3580605, TRIAL 10:
TRIAL 11: 3226055, TRIAL 12: 3395097, TRIAL 13: 3764278, TRIAL 14: 3197696, TRIAL 15: 3236854, TRIAL 16: 3537915, TRIAL 17: 3497355, TRIAL 18: 3140891, TRIAL 19: 3409505,
Average of connections generated: 3470226.8

Please enter the number of sites: 1024000
TRIAL 1: 8493392, TRIAL 2: 6551516, TRIAL 3: 7371109, TRIAL 4: 6978142, TRIAL 5: 7254883, TRIAL 6: 7280206, TRIAL 7: 6984983, TRIAL 8: 6478246, TRIAL 9: 6480855, TRIAL 10:
TRIAL 11: 6995063, TRIAL 12: 6861635, TRIAL 13: 7563322, TRIAL 14: 7420187, TRIAL 15: 8082758, TRIAL 16: 6941858, TRIAL 17: 7704701, TRIAL 18: 8045535, TRIAL 19: 7386345,
Average of connections generated: 7258505.5

Please enter the number of sites: 2048000
TRIAL 1: 14926145, TRIAL 2: 14982889, TRIAL 3: 15511351, TRIAL 4: 15017372, TRIAL 5: 14443239, TRIAL 6: 14353906, TRIAL 7: 13259915, TRIAL 8: 14340584, TRIAL 9: 14009676,
TRIAL 11: 16755953, TRIAL 12: 14836806, TRIAL 13: 14979049, TRIAL 14: 15011399, TRIAL 15: 14479930, TRIAL 16: 14407299, TRIAL 17: 15128600, TRIAL 18: 14176981, TRIAL 19:
Average of connections generated: 1.4720859E7

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• Unit Tests Result:

Run: **UF_HWQUPC_Test** x

Tests passed: 13 of 13 tests - 10 ms

UF_HWQUPC_Test (edu.neu.co 10ms) /Library/Java/JavaVirtualMachines/jdk1.8.0_301.jdk/Contents/Home/bin/java ...

- testIsConnected01 4 ms
- testIsConnected02 0 ms
- testIsConnected03 2 ms
- testFind0 0 ms
- testFind1 0 ms
- testFind2 0 ms
- testFind3 4 ms
- testFind4 0 ms
- testFind5 0 ms
- testToString 0 ms
- testConnect01 0 ms
- testConnect02 0 ms
- testConnected01 0 ms

Process finished with exit code 0

Tests passed: 13

Git | TODO | Problems | Terminal | Build | Dependencies | Run