Computer Assignment # 1

# Question 1:

• Identify the top 20 most trusted individuals in the network.

|  |  |
| --- | --- |
| Rank | User ID |
| 1 | 18 |
| 2 | 143 |
| 3 | 737 |
| 4 | 790 |
| 5 | 136 |
| 6 | 1179 |
| 7 | 1719 |
| 8 | 118 |
| 9 | 4416 |
| 10 | 780 |
| 11 | 27 |
| 12 | 128 |
| 13 | 34 |
| 14 | 1516 |
| 15 | 40 |
| 16 | 1 |
| 17 | 791 |
| 18 | 28 |
| 19 | 1619 |
| 20 | 1621 |

Time: 0.49 seconds

# Question 2:

• How many (and which) members should the company contact in order to achieve its “50% coverage” goal? Assume that any individual who is provided this incentive will definitely review the product.

3390 reviewers. The chosen IDs are listed in the Appendix.

• Formulate the problem as an optimization model.

Let be a binary variable indicating whether a person is selected, i.e. =1 if person is selected; =0 otherwise. Let be a binary variable indicating whether person is informed, i.e. =1 if person is informed; =0 otherwise. Let be the total number of people in the network and let be the number of people trusted by person Let represent the set of users that are trusted by user . Then the optimization problem can be formulated as follows:

Subject to

• Provide a pseudo-code and explanation for the method you used (it should be a reasonable method, but need not necessarily guarantee finding the “optimal” solution)

unselected = 75879.0 #Number of nodes not selected to review

informed = dict() #List of informed users

selected = dict() #List of selected reviewers

while len(informed) < unselected/2: # < half of unselected users are informed

chosen = leaders.get() #Pick next most influential individual

selected[chosen] = True

count = 0

for arc in arcs[chosen]: #Each person that trusts this user

if arc.i not in selected and arc.i not in informed:

#If they are not selected or already informed

informed[arc.i] = True #They become informed

count += 1

if count > 0:

if chosen in informed: #Informed by a more influential user

del informed[chosen] #Remove them from the informed list

unselected -= 1 #One fewer person can be informed

else:

del selected[chosen] #don't actually select this user

return selected

Time: 0.47 seconds

# Question 3:

• How many days does it take to inform 40% of the members?

Two days.

• How long (days) does it take for the process to terminate?

Eight days.

• At the end of the process (termination), what fraction of members are “informed”?

74.99% of members are “informed” after eight days.

• Discuss how we can use a Maximum Flow model to address the above question.

We will use the most trusted individual as the source node and create a dummy sink node. There are arcs from people who are trusted to people that trust them with zero cost and unlimited capacity. Except for the source node, every node has an arc pointing to the dummy sink node with cost and capacity . There is an arc from the dummy sink node to the source node with zero cost and unlimited capacity. Then the minimum cost flow solution maximizes the flow from source to sink.

Time: 0.77 seconds

# Question 4:

• What are the top 5 nodes with the highest local clustering coefficients?

Nodes 218, 477, 1043, 1208, and 1326 all have a clustering coefficient of 1.

• What is the (average) clustering coefficient of the whole network?

The average clustering coefficient on the network is 0.1294.

Time: 1576.28 seconds

A node-node adjacency matrix makes this problem much easier given that it can provide information on neighbor status without requiring inspecting arcs.

# Question 5

Other questions and additional data needed

1. Data on the cost to motivate different persons. Motivating a celebrity is usually more expensive than motivating a normal person. With the cost to motivate different people, we can answer the question of what the cheapest way is to achieve 50% of coverage, instead of the least number of people.
2. Data of level of the trust. There are different levels of trust: strongly trust, somewhat trust, etc.. If the level of trust can be collected, it can help to further define the level of coverage.
3. Data on the time to pass the information. The time taken to obtain information from people you trust can be different depending on how often you check their status etc. Knowing this data can further answer the question of achieving coverage in a certain time frame.

Some other applications:

1. It can be used in the online advertising. Find the targeted customers and focus on them.
2. It can be used in the warehouse/hospital/cell tower location problem. Suppose we have the data of the coverage of each possible location, we can use similar methods to determine the best locations.
3. It can be used in a political campaign when the candidates want to find the best person to endorse them.

# Appendix – Question 2 Chosen User IDs

18, 143, 737, 790, 136, 1179, 1719, 118, 4416, 780, 27, 128, 34, 1516, 40, 1, 791, 28, 1619, 1621, 401, 4415, 77, 725, 1753, 44, 125, 550, 2512, 0, 135, 735, 849, 1398, 1440, 726, 1191, 31, 418, 2239, 1029, 4969, 1623, 738, 1401, 49, 59, 438, 1756, 74, 1164, 433, 385, 64, 918, 717, 2120, 549, 90, 1909, 449, 19, 1178, 1247, 103, 715, 398, 1432, 1606, 295, 301, 4282, 1620, 1617, 30, 329, 546, 2066, 102, 776, 1749, 681, 1172, 2969, 66, 645, 395, 388, 104, 1075, 555, 3281, 1894, 563, 5038, 443, 1399, 854, 12, 46, 81, 3655, 35, 3540, 210, 634, 1274, 1429, 786, 130, 1405, 1014, 1577, 29, 2227, 1409, 843, 576, 723, 141, 883, 1023, 722, 1173, 107, 663, 689, 1903, 85, 1396, 5958, 13, 187, 2118, 5952, 2144, 83, 374, 879, 2228, 3685, 127, 733, 112, 169, 1712, 2656, 860, 1613, 382, 138, 1918, 65, 1177, 92, 586, 402, 4161, 72, 551, 1111, 101, 1390, 48, 2236, 51, 2113, 2115, 2464, 1024, 45, 664, 4045, 728, 850, 381, 1190, 440, 639, 43, 93, 429, 447, 2643, 3505, 100, 763, 1304, 299, 431, 1323, 1635, 96, 426, 1129, 22, 789, 61, 556, 1288, 1935, 4170, 783, 165, 105, 63, 1283, 1815, 3899, 53, 1471, 1751, 2375, 195, 637, 8363, 973, 55, 452, 684, 235, 793, 413, 650, 1438, 69, 71, 427, 1576, 4162, 1020, 1892, 2059, 9412, 1754, 4412, 4454, 1207, 2636, 4037, 10, 54, 590, 697, 2995, 446, 2174, 58, 24, 766, 225, 686, 1400, 2528, 79, 368, 140, 1776, 5144, 421, 369, 21, 394, 1574, 1895, 1975, 2, 223, 4061, 2444, 233, 408, 4040, 1411, 2650, 6, 2244, 2694, 6871, 120, 1397, 3420, 1908, 2652, 20, 751, 1642, 50, 68, 1268, 853, 1476, 2063, 2161, 26, 2062, 289, 1163, 1716, 4168, 37, 390, 665, 3410, 2052, 3065, 3502, 2685, 78, 333, 997, 3428, 18955, 993, 588, 1392, 4931, 67, 848, 110, 1437, 3138, 4414, 975, 1181, 4055, 3174, 844, 2028, 4123, 117, 888, 1224, 1857, 39, 923, 1910, 2215, 3264, 7310, 354, 699, 965, 312, 2637, 4120, 6653, 7579, 2696, 11240, 33, 1256, 2956, 3892, 3984, 1108, 1817, 1912, 2218, 2864, 3499, 1596, 3249, 319, 1778, 122, 282, 1521, 1905, 14, 76, 383, 559, 1561, 2169, 5250, 97, 557, 1315, 729, 3866, 172, 5177, 123, 415, 453, 2498, 3932, 5199, 824, 1255, 1755, 5972, 198, 1276, 2065, 2687, 696, 1312, 2714, 4946, 3879, 133, 863, 2775, 999, 558, 3534, 5142, 116, 236, 320, 410, 2991, 4046, 1436, 1629, 2025, 2234, 71388, 1572, 88, 719, 5934, 1906, 4041, 5, 2644, 4978, 976, 1403, 73, 1171, 5951, 119, 124, 432, 913, 3284, 5953, 2713, 1540, 2037, 7928, 115, 640, 724, 1911, 126, 445, 1747, 2201, 2226, 4354, 1460, 2230, 2435, 4039, 1738, 10498, 436, 1185, 1748, 5831, 1028, 1520, 1558, 2511, 4544, 451, 730, 1035, 1167, 2032, 4047, 360, 409, 2049, 644, 652, 994, 2501, 9479, 547, 1036, 5227, 5277, 434, 597, 2046, 5206, 14552, 307, 340, 727, 1016, 1412, 2030, 2371, 4558, 7806, 132, 297, 411, 1309, 1407, 1718, 2640, 4451, 5423, 5829, 685, 779, 1406, 2303, 4342, 113, 548, 2035, 2040, 2638, 2867, 1258, 2047, 2248, 4278, 6175, 7172, 108, 375, 420, 649, 1254, 1314, 3398, 12307, 89, 386, 2151, 2561, 4165, 5386, 71383, 111, 407, 3875, 7843, 345, 2232, 2318, 2558, 4089, 60, 365, 1814, 3276, 5208, 5209, 646, 720, 996, 1472, 3189, 414, 765, 1272, 1783, 2008, 2034, 2649, 4313, 852, 2033, 2497, 3684, 3979, 4565, 552, 629, 1483, 3514, 3585, 4010, 4976, 5412, 5636, 693, 1301, 7687, 1618, 1849, 2043, 2635, 2710, 3520, 109, 909, 1033, 2654, 3014, 6285, 9397, 11519, 350, 680, 954, 2639, 2896, 3277, 7040, 565, 826, 2197, 2647, 4118, 8183, 9294, 10314, 315, 357, 400, 534, 1259, 1498, 2373, 2424, 2704, 4187, 4423, 8754, 1439, 1532, 2630, 4260, 3173, 3510, 4062, 4955, 792, 1503, 1509, 4051, 4081, 6557, 154, 745, 2479, 2651, 4862, 11, 318, 417, 450, 1533, 38, 98, 405, 1206, 1424, 1434, 1512, 1615, 2160, 2478, 2678, 4096, 1763, 1898, 2229, 3280, 3282, 4341, 87, 331, 1174, 2027, 2446, 3703, 25, 139, 376, 442, 1324, 2290, 6420, 370, 625, 746, 1428, 1655, 1885, 3352, 3659, 3859, 3901, 4183, 4573, 6636, 134, 661, 972, 2042, 3457, 3523, 3718, 5308, 8769, 4, 335, 403, 564, 773, 1899, 2980, 4177, 620, 683, 794, 1083, 1813, 2067, 2641, 2893, 5957, 7301, 10505, 11968, 32, 917, 952, 2757, 2861, 10250, 12269, 237, 349, 916, 955, 1346, 1580, 1658, 1933, 4325, 5140, 296, 1037, 1316, 1433, 1446, 2563, 2821, 4974, 10424, 787, 851, 4867, 11201, 342, 721, 828, 1514, 1636, 2146, 3092, 3483, 3966, 4357, 5273, 7104, 17, 222, 249, 782, 979, 1008, 1021, 2061, 3830, 4411, 4561, 5032, 6669, 7608, 7881, 1004, 2288, 3069, 3783, 4186, 6168, 13123, 2147, 3120, 3687, 3864, 6171, 6320, 71399, 2712, 2865, 4757, 5205, 6864, 7437, 8784, 9087, 71389, 545, 1027, 1646, 2051, 3321, 3852, 4115, 4788, 4967, 6431, 6631, 15653, 1152, 1463, 3841, 4098, 4422, 5941, 6565, 6624, 7047, 75, 191, 927, 942, 1902, 2084, 3462, 217, 989, 2195, 3501, 10109, 71403, 215, 378, 428, 1305, 1546, 1665, 2217, 2255, 2565, 2634, 2688, 2800, 3533, 4687, 6865, 303, 330, 669, 1507, 1581, 5947, 7191, 193, 516, 702, 1368, 1896, 2060, 2285, 2631, 2984, 4950, 4964, 5813, 1435, 2064, 3431, 3836, 3881, 4338, 5969, 5980, 11225, 19519, 1025, 1622, 1979, 2690, 3143, 3306, 4163, 5098, 7394, 57, 647, 1530, 2183, 4963, 6990, 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1299, 1761, 1816, 2088, 2116, 2180, 2189, 2440, 2827, 2866, 3560, 3946, 4070, 4553, 4703, 5241, 6401, 6490, 7983, 8217, 437, 1003, 1250, 1893, 1897, 3054, 3878, 4017, 5131, 5499, 6368, 7929, 14580, 19665, 254, 768, 1246, 2153, 2220, 2254, 2316, 2655, 3234, 4042, 4164, 4259, 4698, 5215, 6489, 8296, 9426, 10703, 11763, 20568, 28527, 62, 1554, 2231, 2633, 2708, 2960, 3835, 6491, 8777, 9638, 19733, 20434, 439, 654, 1479, 1614, 2224, 2386, 2646, 2648, 2810, 3155, 3275, 5064, 5117, 5259, 5414, 6812, 9320, 11161, 145, 1262, 2152, 3118, 3593, 3599, 3999, 4030, 12604, 185, 283, 1589, 1806, 2157, 3278, 4231, 6787, 11884, 12571, 20072, 20552, 659, 688, 2164, 2265, 2653, 5776, 5942, 6478, 6497, 7959, 8182, 8712, 19742, 24191, 277, 454, 679, 837, 1450, 1717, 2123, 2933, 2990, 3178, 3346, 3374, 3903, 5128, 5145, 5474, 5760, 6326, 6810, 7066, 7693, 8773, 11092, 14879, 16832, 23991, 353, 1059, 1370, 1539, 1699, 1845, 3107, 3463, 4064, 5417, 8164, 8786, 12346, 12823, 15798, 17200, 19731, 367, 372, 492, 540, 617, 1112, 2070, 2156, 2264, 3415, 3554, 3934, 4546, 5248, 5719, 6870, 8154, 8273, 10422, 15205, 15945, 731, 777, 1709, 1750, 2425, 2499, 2557, 2605, 4122, 4853, 6670, 6732, 7757, 8156, 8270, 8280, 8734, 15226, 15802, 18346, 19157, 19993, 42, 359, 630, 839, 938, 1648, 1690, 1779, 1863, 1883, 2281, 2362, 2906, 3168, 3368, 3440, 3850, 4954, 5387, 6166, 9166, 9645, 9845, 10550, 12249, 18765, 22359, 24577, 343, 2276, 2369, 2872, 3106, 3185, 3434, 3920, 3929, 4320, 4920, 7067, 7505, 7932, 8771, 9340, 10698, 11756, 16362, 16571, 16850, 23977, 327, 387, 575, 1157, 1184, 1552, 1752, 2050, 2053, 2939, 3076, 3167, 3204, 3391, 4054, 4511, 4940, 5278, 5444, 5905, 5964, 7392, 7512, 7944, 7961, 8789, 9503, 11190, 11224, 17012, 21821, 302, 581, 584, 705, 718, 1170, 1176, 1319, 1481, 1522, 1677, 1818, 2344, 2559, 2560, 2814, 3180, 3186, 3506, 3716, 4620, 5216, 5503, 6500, 6588, 6765, 6792, 8002, 8158, 10403, 10416, 781, 1022, 1445, 2602, 2792, 3116, 4413, 5428, 5679, 9362, 9753, 10434, 10442, 17240, 20561, 22371, 22689, 156, 541, 829, 926, 1515, 2287, 2535, 2672, 3124, 3827, 4166, 4274, 4360, 4397, 6393, 6586, 6623, 6686, 7178, 7522, 7618, 8153, 13000, 19809, 22947, 24224, 399, 703, 805, 1030, 1249, 1457, 2504, 2950, 3220, 3720, 3868, 3874, 3885, 4501, 5818, 6014, 7154, 8783, 10413, 10606, 12551, 306, 544, 1524, 1630, 1840, 1900, 1901, 2145, 2162, 2237, 2256, 2324, 2728, 2786, 2958, 2977, 3631, 4549, 4615, 5036, 6322, 6470, 10937, 12591, 17007, 18502, 1189, 1227, 2366, 2476, 2509, 3064, 3473, 3564, 3774, 4616, 5628, 7530, 8096, 8775, 10060, 12754, 14560, 627, 700, 707, 1541, 1654, 1890, 2006, 2024, 2041, 2055, 2100, 2272, 2541, 3077, 3117, 3921, 3935, 3994, 4458, 4523, 4957, 5299, 5758, 6553, 6613, 6941, 6966, 7070, 7138, 7661, 8292, 8512, 10624, 10939, 14107, 20559, 287, 676, 1404, 1551, 1907, 2869, 3274, 3509, 4391, 4455, 6503, 8269, 8795, 11243, 14111, 18513, 22421, 84, 560, 970, 985, 987, 1166, 1495, 1564, 1727, 1882, 2516, 2553, 2625, 3033, 4939, 5930, 6112, 6167, 6477, 7035, 8288, 8370, 8790, 10964, 12229, 12910, 14493, 14586, 15114, 19734, 16, 334, 1253, 1423, 1465, 1529, 1766, 1851, 1915, 2556, 2632, 2938, 3286, 3780, 3876, 3972, 4418, 4918, 6169, 6183, 6591, 6625, 6878, 6952, 7796, 7804, 8072, 9997, 10721, 12022, 13265, 16248, 20563, 20851, 406, 448, 599, 660, 896, 2112, 2252, 2430, 2496, 3184, 3550, 3948, 4315, 5061, 6044, 6795, 8271, 8680, 8745, 8782, 9330, 10726, 15522, 21638, 269, 396, 582, 592, 611, 643, 982, 1102, 1506, 1535, 1694, 1855, 2104, 2221, 2343, 2507, 3256, 3266, 3292, 3433, 3559, 3873, 3976, 4456, 4560, 4692, 4958, 6036, 8749, 8989, 10064, 13686, 20676, 99, 131, 279, 808, 1218, 1394, 1632, 1663, 1702, 2279, 2419, 2963, 3692, 4343, 4419, 4618, 5939, 6006, 6173, 8261, 9312, 10313, 13706, 14897, 16360, 19358, 19743, 129, 294, 358, 1517, 1526, 1528, 1934, 2096, 2163, 2414, 2949, 3004, 3119, 3261, 3772, 3973, 3990, 4367, 4559, 4949, 5070, 5519, 5659, 6505, 6509, 6522, 6558, 6697, 6962, 7346, 7395, 7872, 8281, 10002, 11574, 12263, 13036, 50956, 610, 840, 1233, 1780, 1846, 2069, 2083, 2342, 2433, 2448, 2754, 2796, 3177, 3432, 3828, 3938, 4340, 4374, 4527, 4564, 4795, 5778, 6245, 6523, 6611, 6900, 7427, 9051, 11695, 12556, 13136, 16811, 17429, 241, 325, 336, 425, 953, 1180, 1447, 1523, 1652, 1730, 2629, 2988, 3752, 3883, 4005, 4276, 4356, 4486, 4706, 4941, 5542, 5961, 5982, 8326, 8433, 8532, 10370, 11246, 14122, 18773, 332, 709, 1006, 1126, 1165, 1313, 1490, 1527, 1673, 1674, 1725, 1775, 2205, 2246, 2367, 2379, 3075, 3485, 3555, 3854, 4330, 4538, 4945, 4970, 5055, 5143, 5722, 6023, 7187, 7837, 8163, 9182, 9333, 9974, 10675, 11777, 11834, 12572, 12905, 12919, 16199, 20194, 192, 257, 424, 830, 832, 1026, 1158, 1544, 2101, 2105, 2219, 2463, 2500, 2645, 2751, 2909, 3379, 3392, 3865, 4003, 4052, 4121, 4921, 5076, 5612, 5847, 6017, 6321, 6383, 7408, 8003, 8020, 8514, 8727, 13269, 29616, 323, 655, 691, 822, 974, 1720, 1971, 2128, 2547, 2642, 2692, 2946, 2978, 3439, 3464, 3678, 4426, 4547, 4603, 4913, 5139, 5580, 6455, 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