COMPLEX NETWORKS

ASSIGNMENT 1 – Structural descriptors of complex networks

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2021-03-12

Introduction

In the achievement of this assignment, we following technologies have been used:

* Python, with its library networkx, specific to deal with networks (parts a) and b))
* …, for the calculations for part c).

In the next sections we will comment more specifically each exercise.

Part a

Python and networtx have been used for calculating the data of this exercise. For each specified metric, the following functions of networkx have been used:

|  |  |
| --- | --- |
| **METRIC** | **FUNCTION** |
| 1. Number of edges | number\_of\_nodes |
| 2. Number of nodes | number\_of\_edges |
| 3. Minimum, 4. maximum, 5. and average degree | degree |
| 6. Average clustering coefficient | average\_clustering |
| 7. Assortativity | degree\_assortativity\_coefficient |
| 8. Average path length | average\_shortest\_path\_length |
| 9. Diameter | diameter |

The code executed to get the results can be found in source code main.py. The results are stored in part1(stable).csv and can be shown in the next table:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **METRIC** | **1.** | **2.** | **3.** | **4.** | **5.** |
| **256\_4\_4\_2\_15\_18\_p** | 256 | 2274 | 15 | 23 | 17.765625 |
| **256\_4\_4\_4\_13\_18\_p** | 256 | 2299 | 10 | 25 | 17.9609375 |
| **BA1000** | 1000 | 3990 | 4 | 115 | 7.98 |
| **ER1000k8** | 1000 | 3956 | 1 | 17 | 7.912 |
| **ER5000k8** | 5000 | 19980 | 4 | 17 | 7.992 |
| **homorand\_N1000\_K4\_0** | 1000 | 2000 | 4 | 4 | 4 |
| **homorand\_N1000\_K6\_0** | 1000 | 2994 | 5 | 6 | 5.988 |
| **rb125** | 125 | 410 | 4 | 100 | 6.56 |
| **SF\_500\_g2.7** | 500 | 859 | 2 | 22 | 3.436 |
| **SF\_1000\_g2.5** | 1000 | 1905 | 2 | 30 | 3.81 |
| **SF\_1000\_g2.7** | 1000 | 1668 | 2 | 24 | 3.336 |
| **SF\_1000\_g3.0** | 1000 | 1517 | 2 | 26 | 3.034 |
| **ws1000** | 1000 | 3000 | 3 | 13 | 6 |
| **ws2000** | 2000 | 6000 | 3 | 13 | 6 |
| **airports\_UW** | 3618 | 14142 | 1 | 250 | 7.81757877 |
| **dolphins** | 62 | 159 | 1 | 12 | 5.12903225 |
| **PGP** | 10680 | 24316 | 1 | 205 | 4.55355805 |
| **zachary\_unwh** | 34 | 78 | 1 | 17 | 4.58823529 |
| **20x2+5x2** | 50 | 404 | 4 | 22 | 16.16 |
| **circle9** | 9 | 9 | 2 | 2 | 2 |
| **graph3+1+3** | 7 | 8 | 2 | 3 | 2.28571428 |
| **graph4+4** | 8 | 13 | 3 | 4 | 3.25 |
| **grid-p-6x6** | 36 | 72 | 4 | 4 | 4 |
| **rb25** | 25 | 66 | 4 | 20 | 5.28 |
| **star** | 9 | 8 | 1 | 8 | 1.77777777 |
| **wheel** | 9 | 16 | 3 | 8 | 3.55555555 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **METRIC** | **6.** | **7.** | **8.** | **9.** |
| **256\_4\_4\_2\_15\_18\_p** | 0.73306114 | 0.02862392 | 2.78210784 | 5 |
| **256\_4\_4\_4\_13\_18\_p** | 0.51129955 | 0.00069540 | 2.65110294 | 4 |
| **BA1000** | 0.03544876 | -0.05420735 | 3.18327927 | 5 |
| **ER1000k8** | 0.00804211 | -0.01683326 | 3.56977777 | 6 |
| **ER5000k8** | 0.00138889 | -0.05547627 | 4.37974106 | 6 |
| **homorand\_N1000\_K4\_0** | 0.002 |  | 5.64 | 9 |
| **homorand\_N1000\_K6\_0** | 0.0038 | 0.19190283 | 4.19129929 | 6 |
| **rb125** | 0.83729505 | -0.17298195 | 2.30322580 | 4 |
| **SF\_500\_g2.7** | 0.00777380 | -0.02558588 | 4.87593587 | 12 |
| **SF\_1000\_g2.5** | 0.00960504 | 0.01998152 | 4.61493293 | 10 |
| **SF\_1000\_g2.7** | 0.00665045 | -0.00196089 | 5.46882682 | 12 |
| **SF\_1000\_g3.0** | 0.00515919 | -0.00853880 | 5.96506306 | 13 |
| **ws1000** | 0.00436484 | -0.09992885 | 4.09130330 | 6 |
| **ws2000** | 0.00333015 | -0.07617895 | 4.51109304 | 7 |
| **airports\_UW** | 0.49574893 | 0.04622413 | 4.43959464 | 17 |
| **dolphins** | 0.25895824 | -0.04359402 | 3.35695399 | 8 |
| **PGP** | 0.26594522 | 0.23821137 | 7.48554005 | 24 |
| **zachary\_unwh** | 0.57063847 | -0.47561309 | 2.40819964 | 5 |
| **20x2+5x2** | 0.97155844 | 0.91864737 | 2.38775510 | 4 |
| **circle9** | 0 |  | 2.5 | 4 |
| **graph3+1+3** | 0.66666666 | -0.6 | 2.19047619 | 4 |
| **graph4+4** | 0.875 | -0.08333333 | 1.85714285 | 3 |
| **grid-p-6x6** | 0 |  | 3.08571428 | 6 |
| **rb25** | 0.90231578 | -0.16352583 | 2.03333333 | 4 |
| **star** | 0 | -1 | 1.77777777 | 2 |
| **wheel** | 0.62433862 | -0.33333333 | 1.55555555 | 2 |

Part b

Analogous to first exercise, each metric of nodes have been calculated using a function or algorithm implemented in network. The next table shown the metric-function relation:

|  |  |
| --- | --- |
| **METRIC** | **FUNCTION** |
| Degree | degree |
| Strength | degree – with weighted graph |
| Clustering coefficient | clustering |
| Average path length | single\_source\_shortest\_path\_length |
| Maximum path length | single\_source\_shortest\_path\_length |
| Betweenness | betweenness\_centrality |
| Eigenvector centrality | eigenvector\_centrality |
| PageRank | pagerank |

All nodes data appear in part2(stable).csv file. The required airports data are reflected in the following table:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Metric:** | **1.** | **2.** | **3.** | **4.** |
| **PAR** | 250 | 1023424.5 | 0.08915662 | 2.68767274 |
| **LON** | 242 | 1464828 | 0.11234182 | 2.63515754 |
| **FRA** | 237 | 697513.5 | 0.11696345 | 2.68214483 |
| **AMS** | 192 | 481335 | 0.14283376 | 2.73134328 |
| **MOW** | 186 | 217145 | 0.09584423 | 2.87755666 |
| **NYC** | 179 | 1524349 | 0.15755445 | 2.70840243 |
| **ATL** | 172 | 1129605 | 0.13783489 | 2.91542288 |
| **BCN** | 80 | 289105 | 0.32848101 | 3.27307904 |
| **WAW** | 55 | 86836 | 0.45858585 | 3.24350469 |
| **CHC** | 20 | 64158 | 0.25263157 | 3.56522940 |
| **DJE** | 20 | 10198 | 0.7 | 3.57822001 |
| **ADA** | 7 | 10704 | 0.71428571 | 3.63239358 |
| **AGU** | 7 | 7678 | 0.76190476 | 3.66445550 |
| **TBO** | 2 | 234 | 1 | 4.58319513 |
| **ZVA** | 1 | 19 | 0 | 7.57517965 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Metric:** | **5.** | **6.** | **7.** | **8.** |
| **PAR** | 10 | 0 | 1.04881472458e-08 | 0.00019511 |
| **LON** | 10 | 0 | 0.00094308 | 7.53557562288e-05 |
| **FRA** | 10 | 0.00073728 | 0.00024356 | 0.00144771 |
| **AMS** | 10 | 0 | 0.00011871 | 7.73265505999e-05 |
| **MOW** | 10 | 0 | 0.00010368 | 0.00020128 |
| **NYC** | 11 | 6.22222680485e-07 | 0.16058354 | 0.01247061 |
| **ATL** | 11 | 0.01649081 | 2.17515155149e-05 | 0.00013048 |
| **BCN** | 11 | 0 | 3.03230550635e-05 | 5.58477660009e-05 |
| **WAW** | 11 | 0 | 0.00153226 | 0.00033084 |
| **CHC** | 10 | 0 | 3.39281927263e-05 | 0.00056948 |
| **DJE** | 11 | 1.75003921447e-07 | 0.00022992 | 4.78239897404e-05 |
| **ADA** | 11 | 0.00259273 | 2.66889335119e-05 | 0.00011621 |
| **AGU** | 11 | 0.06928349 | 0.00513411 | 0.00011932 |
| **TBO** | 12 | 3.50559432593e-06 | 0.00053789 | 0.00022523 |
| **ZVA** | 15 | 1.52916047866e-07 | 8.85270982091e-05 | 8.35141328324e-05 |