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Project of Complex Networks

Abstract

In this research project, we will judiciously examine the social network formed by the students of AIMS Senegal promotion 2019 in order to be able to answer the questions above and to draw possible conclusions using methods and techniques of Complex Network.

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1. Introduction

Social networks are more and more widespread. Internet users, market interactions are a few examples. AIMS Senegal brings together students from several African countries each year. They therefore find themselves in community with diverse habits and preferences. At meal times, they form a wonderful crowd moving towards the restaurant.

But how does each student behave after being served? Do they gather randomly during these moments around a table in order to eat? Does the country of origin or the language spoken influence the choice of the person to eat with? So there are as many questions as we can ask ourselves when we attend these meal times.

In this research project, we will judiciously examine the social network formed by the students of AIMS Senegal promotion 2019 in order to be able to answer the questions above and to draw possible conclusions using methods and techniques of Complex Network. We will also try to make some proposals if necessary in order to strengthen the relations between these students for not only the good of the community they constitute but also for a prosperous Africa.

Plan of the work

This thesis document will be divided in 4 chapters. The Chapter 1 is the introduction, Chapter 2 provides some basic concepts related to social networks and social network analysis. This chapter is intended to ease the reading of the rest of the document. Chapter 3 describes the methodology and data used results of our experimentation are explained in Finally, in chapter 6 contains our conclusions and comments about future work.

2. DEFINITION AND RECALL OF SOME PROPERTIES

2.1 Basic concepts related to social networks

This thesis uses tools and measures emerging social network analysis:

2.1.1 Distance matrix.

In an undirected connected network the distance matrix D is such the entries are the distance between any pair of node in the network. The distance matrix is square and the distances between a node v and any other node in the network are given at the vth row or column of D. In the case of a directed network, the distance matrix is not necessarily symmetric and can contain entries equal to infnite.

2.1.2 Eccentricity.

The maximum entry for a given row/column of the distance matrix of an undirected (strongly connected directed) network is known as the eccentricity e(u) of the node u and given by: $e(u) = \sum_{v \in V(G)} d(u,v)$

2.1.3 Diameter.

The maximum eccentricity among the nodes of a network is known as the diameter of the network, which is given by: $diam(G) = \max_{u,v \in V(G)} d(u,v)$

2.1.4 Radius, Central, Centre.

The radius of the network is the minimum eccentricity of the nodes, and a node is called central if its eccentricity is equal to the radius of the network. the centre of the graph C(G) is the set of all central nodes. $r(G) = \min_{u,v \in V(G)} d(u,v)$ $\mathbf{C}(G) = u \in V(G) | uiscentralnode$

2.1.5 Weiner index.

This index is de

ned as the semi-sum of all entries of the distance matrix and was introduced by Weiner in 1947 to to account for the variations of molecular branching in hydro carbons and is given by: $W(G) = \frac{1}{2} \sum_u \sum_v d(u,v) = \frac{1}{2} 1^T D 1$

2.1.6 Average path length.

An important characteristic descriptor of the topology of a network is its average path length which can be expressed in terms of the Wiener index and given by:

$\bar{I} = \frac{2W(G)}{n(n-1)}$

where the average is taken by considering only those pairs of nodes for which a path connecting them exists.

2.1.7 Connected network.

A network is connected if all pairs of nodes in the network are connected.

2.2 Network indicators

2.2.1 Clustering Coeffcient: Global and Local.

ci measures the network's local link density: The more densely interconnected the neighborhood of node i , the higher is its local clustering coeffcient.

The global version was designed to give an overall indication of the clustering in the network, whereas the local gives an indication of the embeddedness of single nodes

2.2.2 Betweenness.

Betweenness and closeness centrality assume that all communication in the network takes place via shortest paths, but this is often not the case.

2.2.3 Community.

In network science we call a community a group of nodes that have a higher likelihood of connecting to each other than to nodes from other communities.

3. METHODOLOGY AND NETWORK ANALYSIS

Our study relates to the restaurant network formed by the students of AIMS-SN 2019 (See fig). Here, the nodes are the students of this promotion and the link is such that two people are linked when one of them likes to eat with the second person. Our network consists of 58 nodes and by the fig 1, we can see that there are a lot of relationships between each component. The relationship or link between two nodes is not directional, which means that the relation is not necessarily mutual.

Graphs provide powerful tools to analyse and visualise some issues of the network. The size of the networks is 58. So, in order to find relevant information about this network, we need to go deeper and study the structure of the network from an individual point of view and as a whole. There are many metrics for analysing social networks. Here we are going to use **Distance** and **Density**.

The graphic above shows the network that we want to study. It includes 58 nodes and we can see that it is connected. So, neither a person nor a communauty of students is isolated. That means they are linked each other by this relationship.

We find two triangles. One of it is:

Christian NGNIE FOKOUA $\longrightarrow$ Cedric LONTSI SAADIO $\longrightarrow$ Rigobert TSOUAPI $\longrightarrow$ Christian NGNIE FOKOUA.

That implies they have a reciprocal relationship.

Bellow is the summary of some properties of this network:

It's clear that Nokeme MEITE is the center of this network. That means she is the most closest to the others.

The global clustering G1 is: 0.14754098360655737 So, there is therefore a 14 % chance that a student will eat with another of his classmates

The average path lengh of the graph is: 4.05. It measure the efficiency of information or mass transport on a network.

We can see that we have 8 communities. We see all the communites bellow:

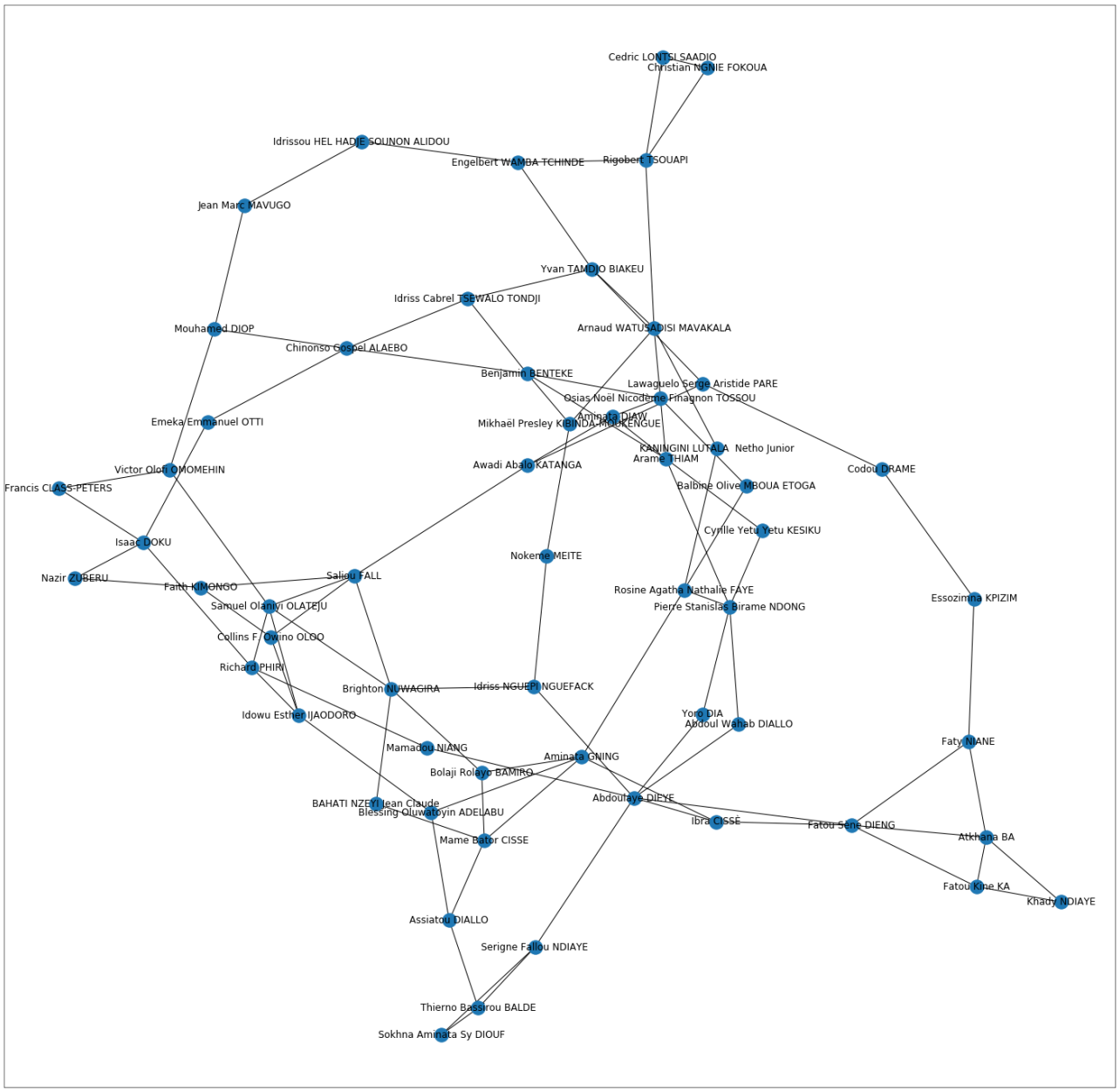

Figure 3.1: AIMS-SN 2019 Restaurant network

Caracteristic	Number of nodes	Number of edges	Wiener index	Radius	Diameter	Center	Shortest path length	Global clustering	Number of community
Value	58	93	6703	5	9	Nokeme MEITE	4.05	0.14	8

Figure 3.2: Summary of some properties of this network

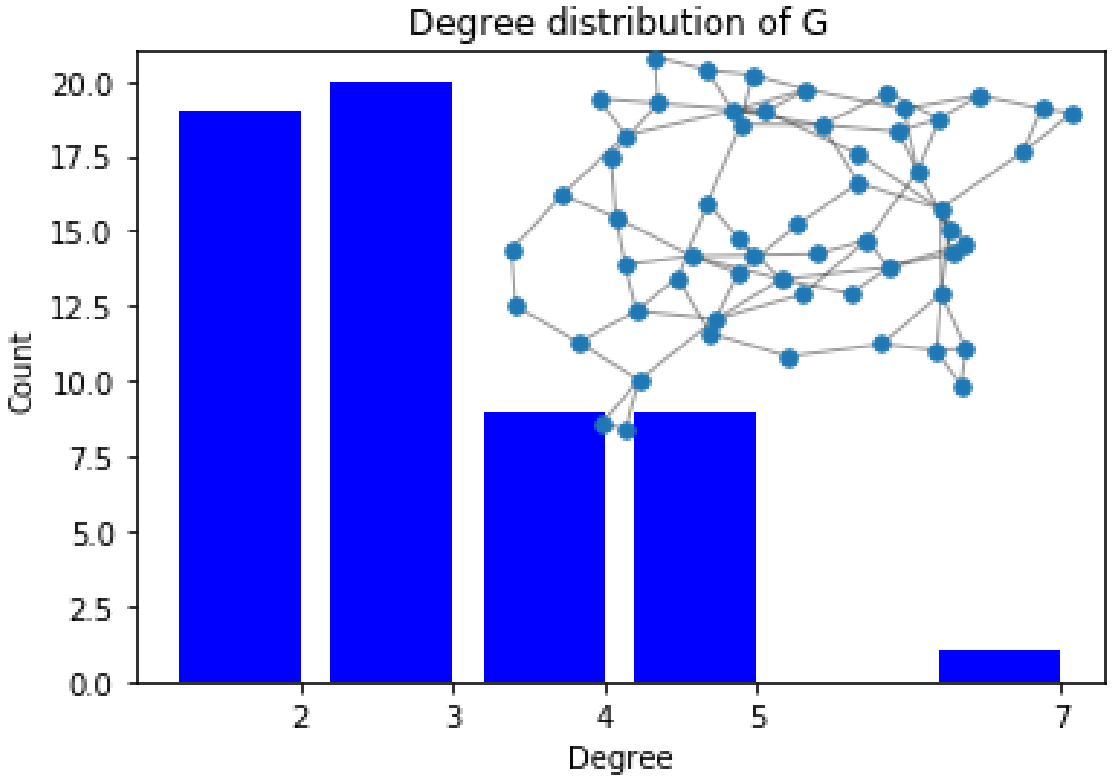

Figure 3.3: Degree distribution of the network

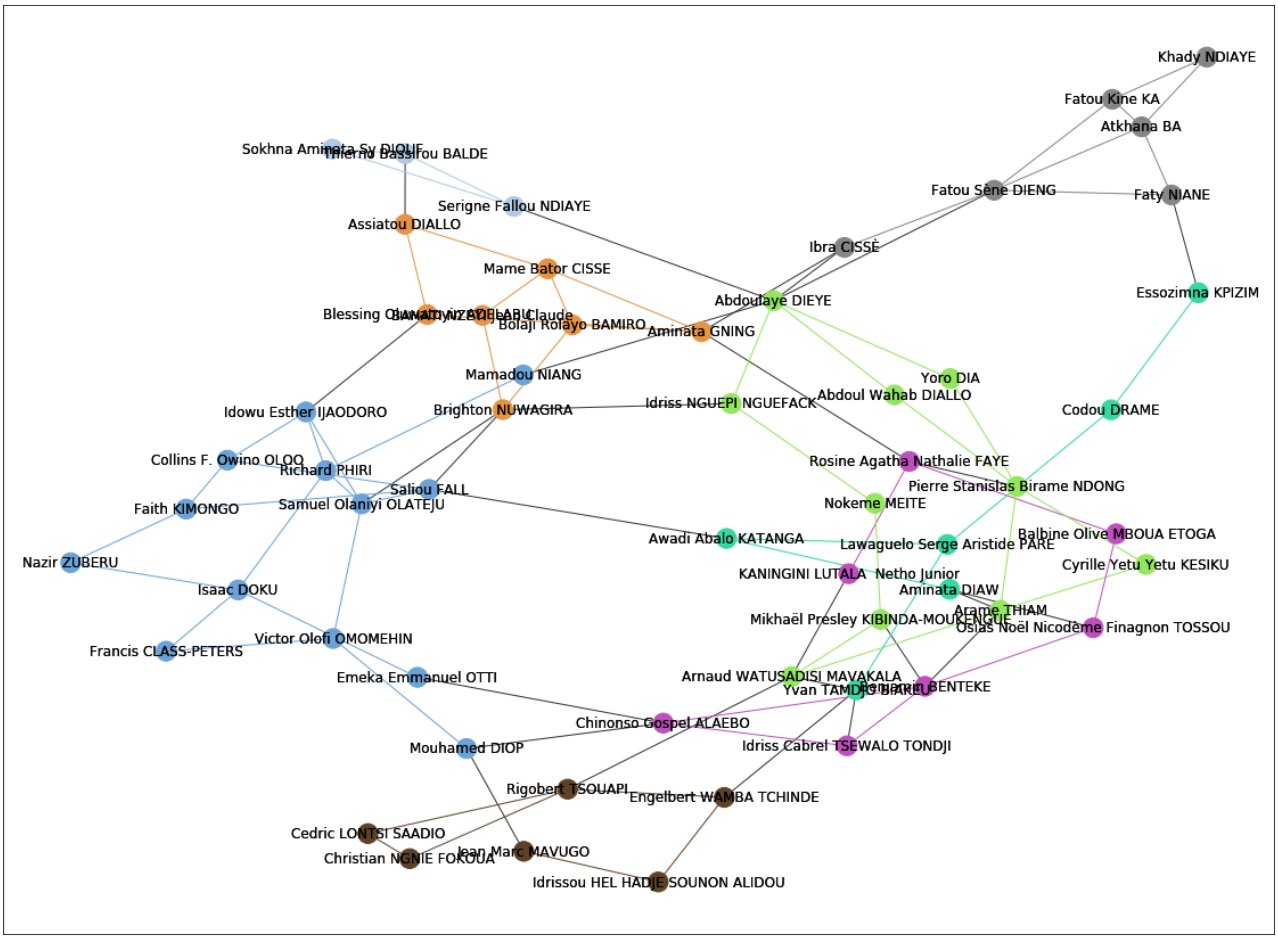

Figure 3.4: Communities of the network

4. CONCLUSION

After our AIMS-SN Network Restaurant 2019, we found that it was divided into 8 communities. Assuming that students from the same community are included in the friendship network, these students can therefore work together in a more pleasant way. Also, it is easier for one of them to ask for help from others in his community and they are more likely to receive help from him when they are in need.

This is normal because these students have left different backgrounds and therefore develop a certain number of behaviors that some agree with and which at the same time are regretted by others. It is therefore pleasant to call each of them to the culture of virtue and to watch over this since the development and the happiness of Africa and its peoples depend on it.

Acknowledgements

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