

COLLABORATION GRAPHS

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1 INTRODUCTION

In class we learned a lot about how to interpret graphs by using different theorems and definitions. We can apply graph theory not only in mathematics but in social settings and science as well. This is used to compare relationships and to have a visual representation of how many “connections” a vertex has. We can use this for several things including knowing who to go to for information or who you should collaborate with for a project whether it’s educational or work related. Today, I am going to discuss why collaboration graphs are important, and what it can be used for.

1.1 BACKGROUND

According to *Graph Theory: A Problem Oriented Approach* by Daniel A. Marcus states, “A graph consists of points which are called vertices and connections which are called edges which are indicated by line segments or curves joining certain pairs of vertices” (9).

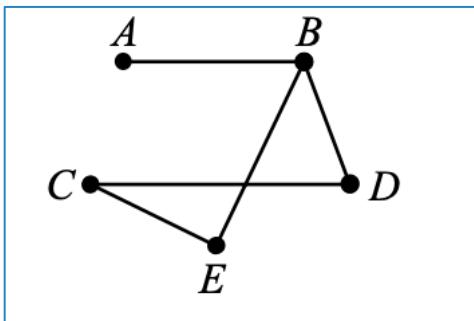


FIGURE 1-1 GRAPH WITH 5 VERTICES AND 5 EDGES

According to the textbook *Networks: An Introduction* by M.E.J Newman defines a network as “... a collection of points joined together in pairs by a line... the points are referred to as vertices... and the lines are referred to as edges... Many objects of interest in the physical, biological, and social sciences can be thought of as networks... There are many systems of interest to scientist that are composed of individual parts or components

link together in some way. Examples include the Internet, collection of computers linked by data connections, and human societies which are collections of people linked by acquaintances or social interactions” (Newman 1).

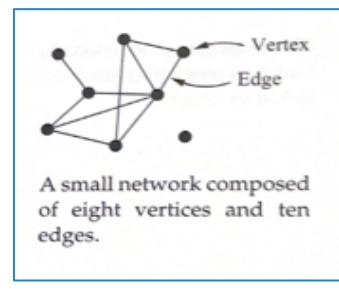


FIGURE 1-2 SHOWN IN NEWMAN PG1

1.2 WHAT ARE COLLABORATION GRAPHS

Collaboration graphs takes a deeper look into a social network. It uses vertices to represent people or a place and if two vertices share a relationship, it will be connected by an edge. According to *Collaboration Graph as a New Graph Definition Approach*, by Kenan Ince and Ali Karci, describes how collaboration graphs are made "...collaborative works is not as simple as saying a hello from social media or following someone you never met. It requires working together for some time and requires having some information in common. Secondly, people collaborate in scientific networks have similar education level and informal background or at least have similar purposes" (Karci and Ince 1).

Some well-known collaboration graphs are...

1. There is a collaboration graph of mathematicians called The Erdős Number Project, which was first started by a man called Paul Erdős (1913 – 1996). "He was an expert in the mathematics of networks" (1). He traveled the world and collaborated with other "mathematicians on problems and proofs he found interesting". Then he would move on to the next. During his lifetime he had 507 co – authors and some collaborated with each other. "These collaborations became so famous that soon mathematicians were keeping track of their Erdős Numbers. If you co-authored an article with Erdős you have a number of 1, if you co-authored a paper with one of his direct collaborators you have an Erdős Number of 2, and so on." Figure 2.1-1 shows Erdős collaboration graphs.

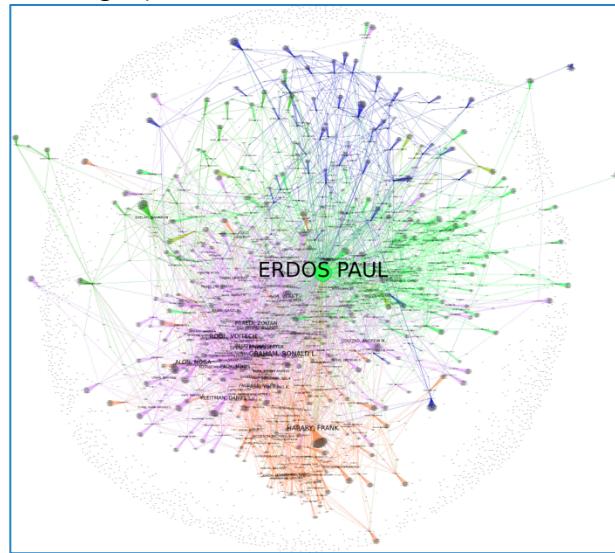


FIGURE 1.1-1-1 ERDOS PAUL COLLABORATION GRAPH

2. The Hollywood graph is a collaboration graph of actors and actresses and shows who worked together in movie and tv-shows. This can also be done for music artist, sports, and anything in entertainment.

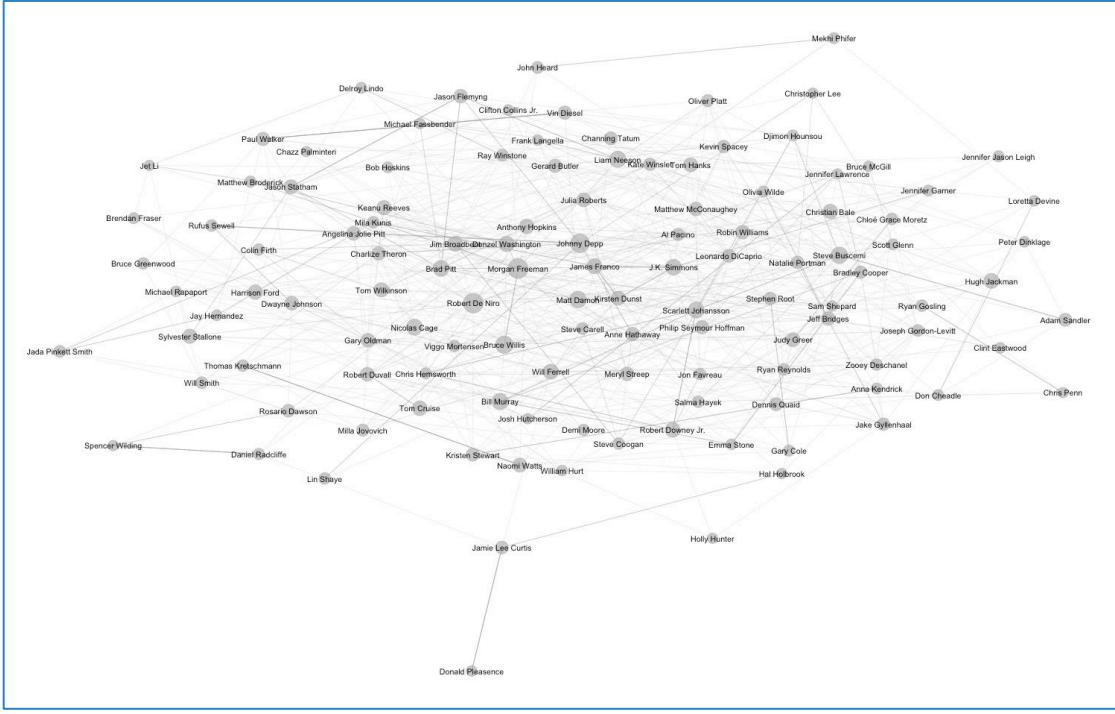


FIGURE 1.1-1-2 SHOWS THE HOLLYWOOD GRAPH

3. Friendship graph is a set of people, and an edge is present if the two people are friends/know each other.

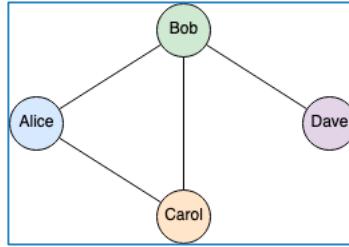


FIGURE 1.1-1-3 SIMPLE FRIENDSHIP GRAPH

1.3 COLLABORATION GRAPHS VS NETWORKS

Social network analysis is used to study social structures by using networks and graph theory. One way is using collaboration graphs to better see the relationships in a social network. Why...? Networks are very vague and shows a more visual representation of the relationship like an overview using data. It gives you more of a summary of what is being looked at because you can tell which vertices are more connected. While collaboration graphs label every vertex so that you can count many connections each vertex has and compare which vertex has the most connections. Below are some networks.

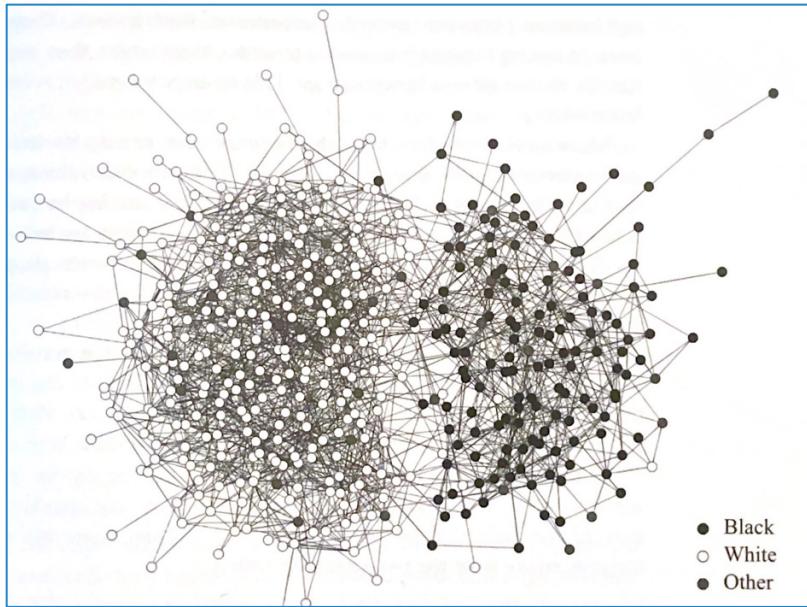


FIGURE 1-4 FRIENDSHIP NETWORK AT A US HIGH SCHOOL VERTICES= 470 HIGH SCHOOL STUDENTS VERTICES ARE COLOR CODED BASED ON RACE

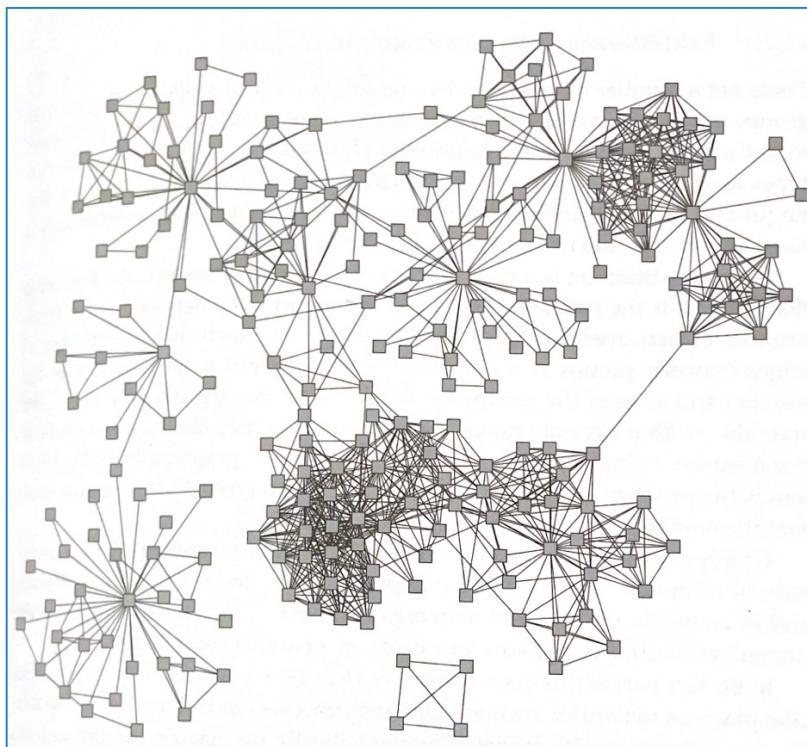


FIGURE 1-5 NETWORK OF COAUTHORSHIPS IN A UNIVERSITY DEPARTMENT VERTICES ARE SCIENTIST IN A UNIVERSITY DEPARTMENT AND EDGES LINKED PAIRS OF SCIENTIST WHO HAVE COAUTHOR SCIENTIFIC PAPER

2 MATHEMATICAL IDEAS

Power Quality: Scientific Collaboration Networks and Research Trends, published in 2018 is a scientific paper about using collaboration graphs to better understand the trends in power quality. The paper explains that "Power quality is a research field related to the proper operation of devices and

technological equipment in industry, service, and domestic activities...Several studies...related to power quality can be found in the literature. However, none of them have addressed in detail the topics in power quality that attract more attention and the characteristics of the collaboration networks among researchers in this field" (Montoya 1). To create the collaboration networks, they used information from the papers to find the co-authors. The article describes "the bot applies an iterative process for each of the authors that have published papers including typical power quality keywords in their publications, then obtains information such as the number of authors, co-author collaborations, the name of the institution, city, country, and current affiliation of these collaborators, etc. This information is later used to construct a graph where nodes represent the researchers and edges the existence of collaboration between them, respectively" (Montoya 4). They found a lot of patterns about how researchers collaborated in this field.

Such as in Figure 2-1, this is a collaboration graph that shows different publications and how they cite from other articles, but it shows what publication company that paper cited "It can be noticed that articles from a given journal tend to include citations to others published in the same journal" (Montoya 7).

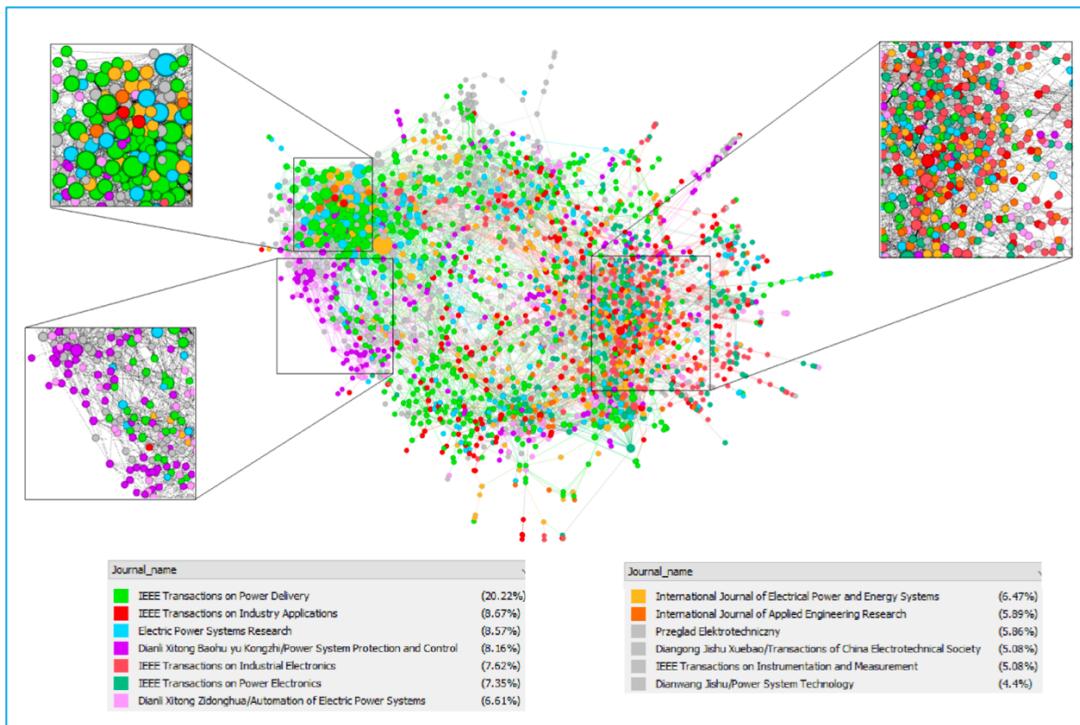


FIGURE 2-1 SHOWS A GRAPH OF PUBLICATIONS WHICH ARE REPSENDED BY VERTICES, WHERE EDGES INDICATE CITATION FROM ONE ARTICLE TO ANOTHER.

Figure 2-2 shows the collaboration network of how researchers work together. The center of the network is shown to have a lot of edges which shows that a lot of collaborations happened which means there were many co-authors named in the paper. The outer region of the network it had less edges with states that this research didn't collaborate with that many co-authors or if they did it was a small number of co-authors. As you can see from the enlarged section on Figure 2-2.

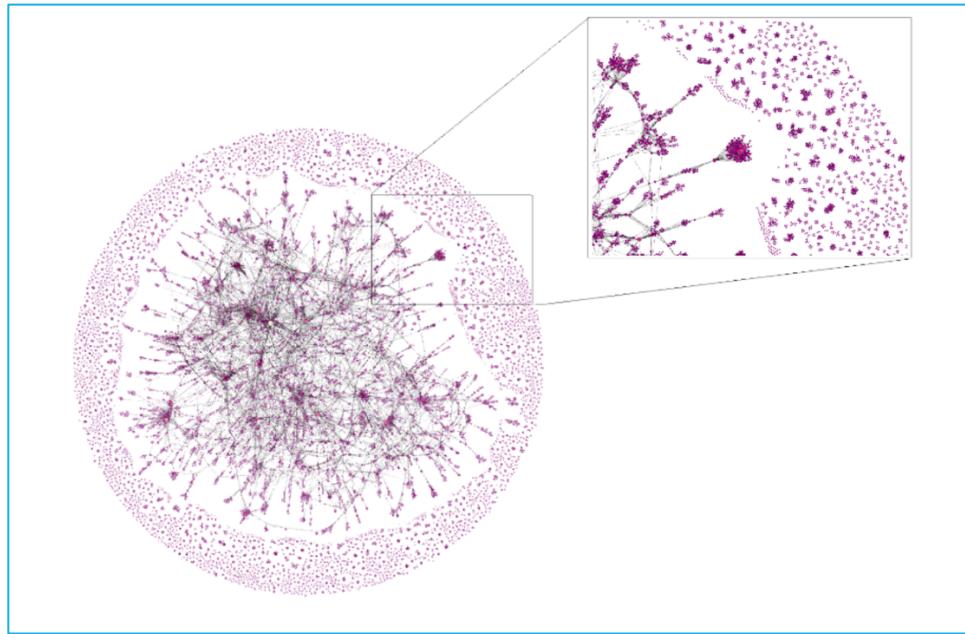


FIGURE 2-2 COLLABORATION NETWORK OF RESEARCHERS IN POWER QUALITY VERTICES REPRESENTING INDIVIDUAL RESEARCHERS, AND EDGES REPRESENTING CO-AUTHORING RELATIONS OF AT LEAST ONE ARTICLE RELATED TO POWER QUALITY.

Figure 2-3 and Figure 2-4(b) is a collaboration graph of countries that have worked together regarding power quality. As shown, we see that China has the highest percentage of collaboration with other countries. "The countries having more contributors related to power quality are China (26.04%, orange vertices), India (11.25%, blue vertices), USA (10.2%, pink vertices), Brazil (4.68%, green vertices), Iran (3.07%), Italy (2.66%), Spain (2.51%), South Korea (2.18%), United Kingdom (2.17%), and Japan (2.15%). Furthermore, most researchers mainly collaborate with peers from their own country" (Montoya 9-10). All these figures are important to find out what research in each country reach out to people around the world. Even though the USA is not the top country when it comes amount of research in this field. We can see the USA has the most collaboration with other countries.

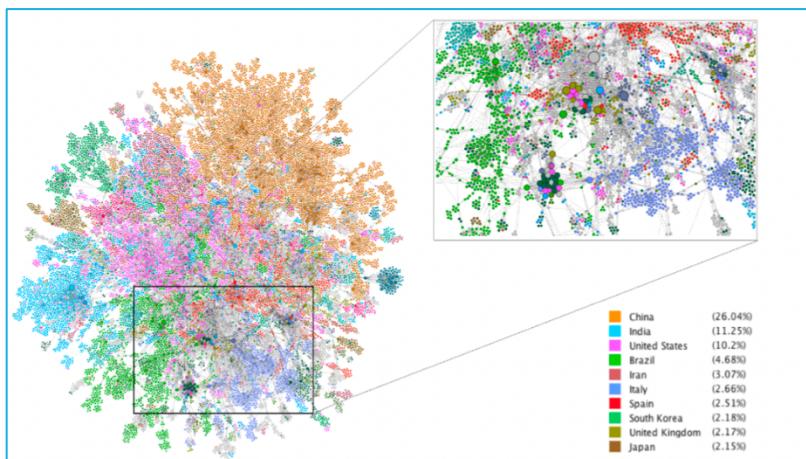


FIGURE 2-3 COLLABORATIONS IN POWER QUALITY BY COUNTRY. VERTICES REPRESENTS RESEARCHES FROM THAT COUNTRY. EDGES REPRESENT THAT A RESEARCHER FROM THAT COUNTRY COLLABORATED WITH ANOTHER

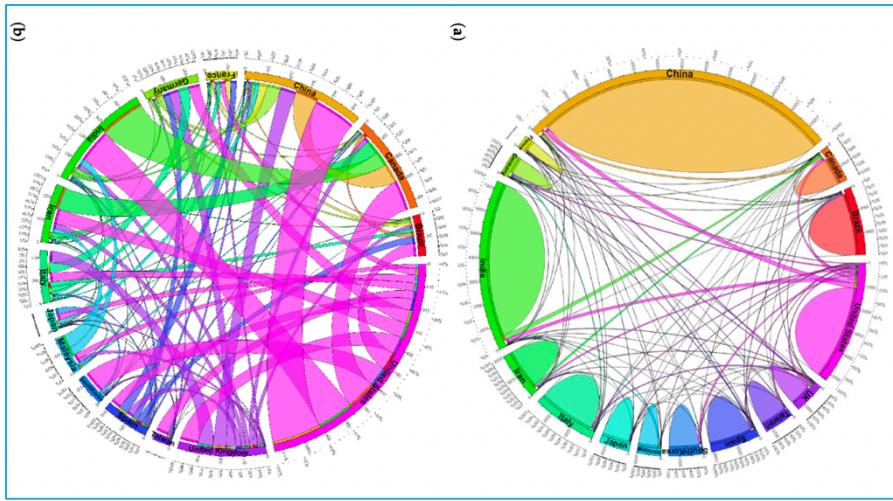


FIGURE 2-4 (A) LOCAL AND INTERNATIONAL COLLABORATIONS IN POWER QUALITY, (B) INTERNATIONAL COLLABORATIONS IN POWER QUALITY

3 CONCLUSION

This paper showed how collaboration graphs and networks can be used to see relationships between things that you couldn't have seen in writing. Montoya explains, "This paper aims to cover a gap in the literature by analyzing the trending topics and scientific collaborations in the field of power quality, based on information about related publications" (Montoya 13). Instead of using a table or numbers to show a relationship. We can use collaboration graphs to better understand the point you are trying to prove. By labeling your vertices and using the edges to show a relationship. As you can see from the figures above your graph can look like anything. There is a world of possibilities when it comes to collaboration graphs.

Citations

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