Graph Theory for Representing the Connection among Users of Social Networks : Facebook, Twitter and Plurk

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Abstract—**This paper is about the graph theory which is used in analyzing and describing connection among users of social networks. Basic theories which is used is the types of graph that consist of simple and unsimple graph, then directed and undirected graph. We discuss several social networks, they are Facebook, Twitter, and Plurk. The connection among Facebook users can be represented as undirected graph, while among Twitter users as directed graph, and among Plurk users we use both, directed and undirected graph.**

Index Terms—**Facebook, graph, Plurk, Twitter**

I. INTRODUCTION

A. Graph Definition

1. Vertex,vertices

A vertex of a graph is a connection point. A graph has a set of vertices, usually shown as V = {v1, v2, ..., vn}, V = {A, B, C} or V = {1, 2, ... N}. The number of vertices in a graph is |V|, but is sometimes written in equations as just V. A vertex may have no connections, one connection or many connections. A vertex may have any number of properties such as a name or a color.

2. Edge

An edge in a graph is a connection between vertices. Given vertices v1 and v2 in a graph, the edge between them may be written as (v1,v2) or sometimes [v1,v2]. A graph has a set of edges usually denoted E, E = {(v1,v2), (v2,v3)}. The number of edges in a graph is |E| but is sometimes written in equations as just E.

3. Graph

A graph is a set of vertices and a set of edges. G = (V, E).

B. Types of Graph

Based on the presence of loops or double edges, graph is differentiated into two types, simple and unsimple graph.

1. Simple Graph

A simple graph is a graph that has no loops and no more than one edge between any two different vertices. In a simple graph the edges of the graph form a set (rather than a multiset) and each edge is a distinct pair of vertices. In a simple graph with n vertices every vertex has a degree that is less than n (the converse, however, is not true — there exist non-simple graphs with n vertices in which every vertex has a degree smaller than n).

2. Unsimple Graph

A graph that has loops or more than one edge between any two different vertices is called unsimple graph.
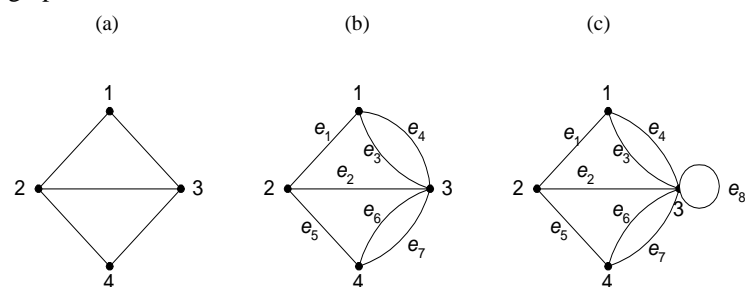
Source: Rinaldi Munir's Graph Slide Presentation

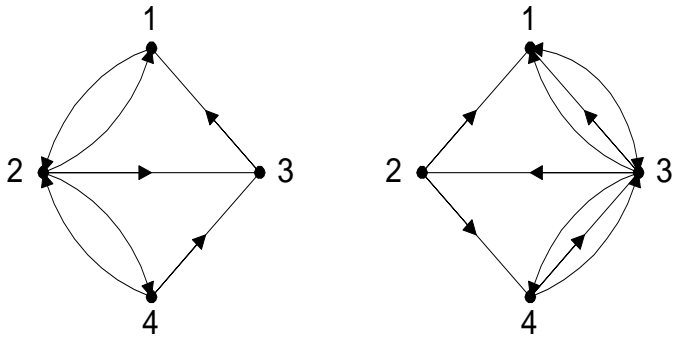**Image1.** (a) simple graph, (b) and (c) unsimple graph

Based on edge's direction, graph is differentiated into two types, undirected and directed graph.

1. Undirected Graph

An undirected graph is a graph in which edges have no orientation.

2. Directed Graph

A directed graph is a graph in which the edges have a direction, usually drawn with an arrow head at one end.

Source: Rinaldi Munir's Graph Slide Presentation

Image2. directed graph

C. Social Network Sites

Social network sites are web-based services that allow individuals to (1) construct a public or semi-public profile within a bounded system, (2) articulate a list of other users with whom they share a connection, and (3) view and traverse their list of connections and those made by others within the system. The nature and nomenclature of these connections may vary from site to site. There are hundreds of social network sites, with various technological affordances, supporting a wide range of interests and practices. Some of them are:

1. Facebook

Source: http://upload.wikimedia.org/wikipedia/commons/thumb/0/06 /Facebook.svg/2000px-Facebook.svg.png

Facebook is a social networking service launched in February 2004, owned and operated by Facebook, Inc. As of September 2012, Facebook has over one billion active users, more than half of them using Facebook on a mobile device. Users must register before using the site, after which they may create a personal profile, add other users as friends, and exchange messages, including automatic notifications when they update their profile. Additionally, users may join common-interest user groups, organized by workplace, school or college, or other characteristics, and categorize their friends into lists such as "People From Work" or "Close Friends".

Facebook was founded by Mark Zuckerberg with his college roommates and fellow Harvard University students Eduardo Saverin, Andrew McCollum, Dustin Moskovitz and Chris Hughes. The website's membership was initially limited by the founders to Harvard students, but was expanded to other colleges in the Boston area, the Ivy League, and Stanford University. It gradually added support for students at various other universities before opening to high school students, and eventually to anyone aged 13 and over.

Some of Facebook's features:
- Posting
- Group
- Game
- Comment and like
- etc.

2. Twitter

Source: http://upload.wikimedia.org/wikipedia/en/thumb/9/9f/Twitter_bird_logo_2012.svg/200px-Twitter_bird_logo_2012.svg.png

Twitter is an online social networking service and microblogging service that enables its users to send and read text-based messages of up to 140 characters, known as "tweets". It was created in March 2006 by Jack Dorsey and launched that July. The service rapidly gained worldwide popularity, with over 500 million active users as of 2012, generating over 340 million tweets daily and handling over 1.6 billion search queries per day. Since its launch, Twitter has become one of the ten most visited websites on the Internet, and has been described as "the SMS of the Internet". Unregistered users can read tweets, while registered users can post tweets through the website interface, SMS, or a range of apps for mobile devices.

Some of Twitter's features:
- Posting
- Follower and following system
- etc.

3. Plurk

Source: http://upload.wikimedia.org/wikipedia/commons/4/43/Plurk.png

Plurk is a free social networking and micro-blogging service that allows users to send updates (otherwise known as plurks) through short messages or links, which can be up to 140 text characters in length.

Updates are then shown on the user's home page using a timeline which lists all the updates received

in chronological order, and delivered to other users who have signed up to receive them. Users can respond to other users's updates from their timeline through the Plurk.com website, by instant messaging, or by text messaging.

Plurk was developed by and envisioned as a communication medium meant to form a balance between blogs and social networks, and between e-mail messaging and instant messaging. After months of development, Plurk was launched on May 12, 2008.

Some of Plurk's features:
- Posting
- Lists of Posts
- Emoticon at post
- Changing theme using CSS Template
- Karma, grade of user's activity
- etc.

II. GRAPH FOR EACH SOCIAL NETWORK

There are some differences between Facebook, Twitter, and Plurk. One of the difference is based on the connection between each individual of that three social networks.

We now are about to see that difference using graph theory, so before that, we will make some definition to make it easier to analyze.

The graph that is used here is defined as a set of vertices U and a set of edges C, $G = (U, C)$ that in this case, U represents users while C acts as connection between a pair of users.
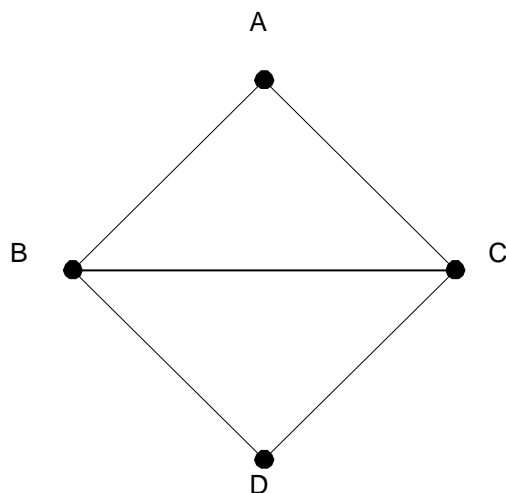
From the graph above, based on our definition we can see that A, B, C, and D are the users, then (A,B), (A,C), (B,C), (B,D), (C,D) are the connections between 2 users, the connections are friends connections.

Then this is the representation of connection among users for each of that three social network.

A. Facebook

Friendship on Facebok can be modeled using undirected graph. It is because there is the equivalent connection between two people on this site, if A is connected or friend of B, for sure B will also be connected or friend of A (commutative). So, Facebook users that have become friends can receive status update from each user. And also her/his own status will be sent to each her/his friend. This social connection that happens on Facebook can be represented as figure below.

From the figure, we can see:
- Aulia Zahwa is friends with Dyah Rahmawati and Eki Sulistiani Dewi
- Eki Sulistiani Dewi is friends with Dyah Rahmawati, Aulia Zahwa, and Maulidina Dwi Mega
- Maulidina Dwi Mega is friends with Dyah Rahmawati and Eki Sulistiani Dewi
- Dyah Rahmawati is friends with Aulia Zahwa, Maulidina Dwi Mega and Eki Sulistiani Dewi

B. Twitter

Different with Facebook, Twitter uses *following-follower* system. Following someone on Twitter means:
- You are subscribing to their Tweets as a follower.
- Their updates will appear in your Home tab.
- That person is able send you direct messages.

While followers are people who receive your Tweets. If someone follows you:
- They'll show up in your followers list.

- They'll see your Tweets in their home timeline whenever they log in to Twitter.
- You can send them direct messages.

In short, we can say that following are people that we follow, so their status updates will appear on our home page, while followers are people that follow our status updates. In this system, if A follows B, then B doesn't always have to follow A. B can choose whoever he/she wants to follow by his/herself.

So, the social connection here in Twitter can be represented as directed graph. First, we assume that direction on the edge means information flow or status update from one account to another account. It means that if A follows B, then A will get status information from B, so there will be edge from A to B (the direction is from A to B, usually drawn with an arrow head at B). Figure below will show how it works.

From the figure above, we can see:
- @dyrablablabla follows @putriisnaeni13 or it can be said that @dyrablablabla is @putriisnaeni13 's follower
- @gisnaaa is @dyrablablabla 's follower
- @Eki_dewi is follower of @gisnaaa and @dyrablablabla
- The edge that connects @dyrablablabla and @Eki_dewi has two direction. It shows that @dyrablablabla is @Eki_dewi 's follower and @Eki_dewi is also @dyrablablabla 's follower.

C. Plurk

On Plurk, social connection is based on *fans* and *friends* system, that is the combination of Facebook and Twitter system. A fan is someone who follows your Plurk. While a friend is someone who follows your plurk, and at the same time you also follow his/her plurk.

A fan in Plurk is like follow term on Twitter, so becoming fan will automatically make you follow his/her status update. If A is a fan of B, then B doesn't always have to be a fan of A. B by his/herself can choose whoever he/she wants to be fan of.

Friend here on Plurk is like friend on Facebook. If A is a friend of B, automatically B is also a friend of A.

Maybe by using two categories of social connections, Plurk wants to make the difference that friends are special for our nearest people that we know, while fans are for other people that we don't really know and just want to follow our status.

Because of the two different social connection systems on Plurk, there will also be two types of graph to represent each social connection.

Friend connection can be said that if A is friend of B, then for sure B is also a friend of A. So, A will receive status timeline from B as well as B that will also receive status timeline from A. Figure below is the representation
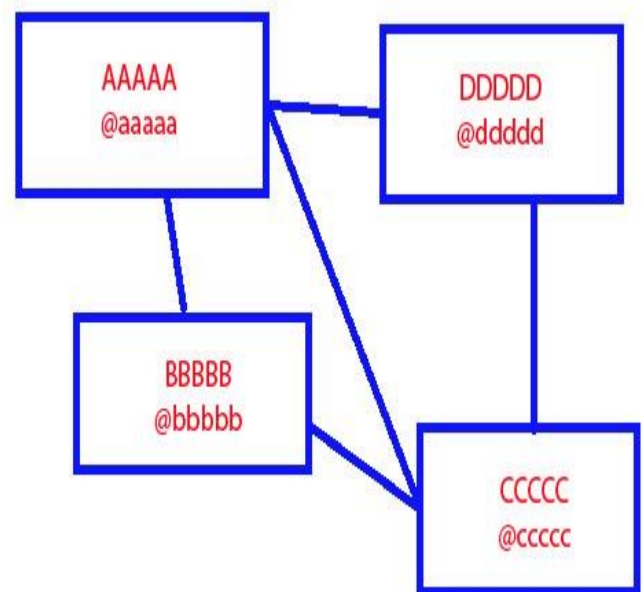
From the figure above, we can see:
- @aaaaa is friends with @bbbbb, @ccccc and @ddddd. It means that @aaaaa follows their status timeline.
- @ddddd is friends with @aaaaa and @ccccc. It means that @ddddd follows their status timeline.
- @ccccc is friends with @aaaaa, @bbbbb and @ddddd. It means that @ccccc follows their status timeline.
- @bbbbb is friends with @aaaaa and @ccccc. It means that @bbbbb follows their status timeline.

Becoming a fan of someone here in Plurk will automatically make us follow his/her status timeline. If A is a fan of B, A will follow B's status timeline while not always as well as B. So, graph below will represent it.
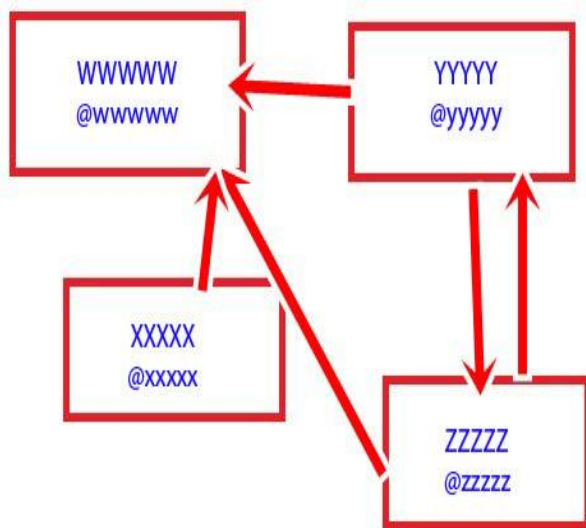
From the figure above, we can see:

- @xxxxx, @yyyyy and @zzzzz are fans of @wwwww. It means they follow status timeline from @wwwww
- @yyyyy is a fan of @zzzzz, as well as @zzzzz is a fan of @yyyyy. It means they are following each other's status timeline

III. CONCLUSION

Graph Theory can be used for representing the connection among users of social networks in this case Facebook, Twitter, and Plurk. Basic theories which is used is the types of graph that consist of simple and unsimple graph, then directed and undirected graph.

Using that theory, the connection among Facebook users can be represented as undirected graph, while among Twitter users as directed graph, and among Plurk users we use both, directed and undirected graph. Directed graph is used to represent fan connection, while undirected graph is used to represent friend connection.

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