Abstract—Social networks are playing an important role in personal as well as corporate environments. However, perceived issues and evolving challenges may hinder further expansion of social networks to meet new opportunities. In this paper, we review inherent concepts and properties of social networks and highlight major analytical evaluation criteria, which are used to identify key findings that reveal degrees of benefits and shortcomings of social networks. We also discuss some proposed solutions related to decentralized social networks in the context of business implications as well as their effects on privacy, identity and trust issues. Future perspectives of social networks are also envisioned in this paper.

Keywords—Social networks, decentralization, privacy, trust, business models.

1. INTRODUCTION

During the past decade, social networks have increased dramatically along the rapid developments of Web 2.0 applications. Millions of people tend to participate in social networks such as Facebook, Twitter and MySpace. Facebook in particular, accumulated more than 400 million active user in 2010\(^1\). As the number of users increases, the complexity induced when evaluating social networks increases as well. Moreover, the bewildering tangle of options, which are continuously expanding the scope of these networks across social, business [5] and even governmental [6] spaces, sparked the need for criteria or measures to understand current and future trends of social networks [2].

Social networks are essentially built from group of people who share same interests, backgrounds and activities. In social networks, people can communicate with each other in many ways. They can share and upload profiles with images, video and texts. Social networks consist of nodes that are considered as the actors of the network. These nodes might represent a user, or a company, etc. The nodes are interlinked through connections, which represent the relationships between nodes as friendship, partnership, etc. The cardinality of nodes expands dynamically, especially on the Web, as new documents and profiles are created continuously while further populating additional nodes in the social Web [7]. Hubs are one of the social Web networks phenomena, simply defined by the nodes that have a large number of links [8]. An example for a hub would be a Facebook page with many incoming links. Figure 1 shows a graph view of a typical social network involving profiles and documents with a typical hub node.

Different users adopt different social media spaces for different purposes. This variety makes social networks an interesting environment for attracting companies to establish businesses and governments in gauging public endorsements. For example, companies can use social networks to increase customer base and build new business
relationships to promote new products or services in a targeted-marketing environment. One such example relates to Dell Corp., which generated a total of $6.5 million in revenue from promoting products through Twitter [10]. Governments can also involve their population in public safety procedures. For example, Boston in US is known for its tweeting police department, which uses Facebook and Twitter to fight crimes in the city. In one of such use cases, they established the Stolen Bikes Boston Community Alert to seek the general public cooperation in reporting and tracking stolen bikes. Other examples, involve social networks in promoting political campaigns. Many politicians have realized the power of social networks and used them in their election campaign, including President Obama whose campaign used Twitter and MySpace. He also held a Q&A session on YouTube, where he received many questions from the public.

The analysis of social networks can help identifying social behaviors that may promote or hinder future social and business developments based on these cyberspace communities. This analysis helps discovering real world phenomena such as “small world phenomenon” [1] that is also known by the “six degrees of separation”[1]. The idea behind “small world” is to find the shortest average path that connects any two nodes. The goal is to reach nodes in a small number of steps [3]. In real world contexts, this is observed when we meet strangers and discover later on that we have acquaintances in common [3]. This is typically observed in LinkedIn social network. High clustering degree is one property of small world networks, as the nodes connected to a specific node are likely to connect to each other too [4].

The huge use of social networks has led to new research problems such as: (1) interoperability and decentralized social networks, (2) business/government implications, (3) privacy and identity issues and, (4) building trust. In this paper, we discuss all of these challenges and reveal some current solutions as well as their
related technical implications to new business opportunities and accessibility issues. The lack of a comprehensive analysis of these issues in the literature and the potential opportunities raised by related insights prompted the development of the research presented in this paper. We focus on identifying salient criteria, by first reviewing the background of social networks to understand some perspectives and perceived developments in Section 2, which elaborates further on the background of social networks analysis and reveals some related works. Section 3, discusses and analyzes cornerstone analytics of social networks and identifies some related challenges. Section 4 provides solutions to the problems discussed in Section 3. Finally Section 5 concludes the paper with a summary of work and an outlook on some future perspectives.

2. BACKGROUND AND RELATED WORK

In this section, we unveil different concepts and properties that are related to social networks and reveal some related works done around analytical issues.

2.1. Social Networks Concepts

a) User Profile:

Most of social networks provide their functionalities for free to the users. Though some social networks need the users to register in order to gain access to full facilities. Personal information about each user is stored in his/her profile, where a profile is a collection of user information that shapes the user identity and other personal attributes such as interests, on the Internet [28].

b) User Connections:
The main goal of social networks is to connect people, thus each user in a social network can establish a link with other users in the network. Figure 2 shows the types of relationships that occur in social networks. An example would be the concept of “follow-me”, in Twitter where a user (creator) can follow other users (targets). A full connection between the creator and the target is established if both are following each other. In the case of Twitter example, the full connection will allow additional functionalities such as the ability of sending private messages between users. Users establish these connections in order to follow each other contributions, especially if they share similar interests.

c) Profile Privacy:

Many social networks allow any user to view other users’ profiles, though some social networks such as Facebook provide users with privacy levels that allow them to access only a group of people profiles.
2.2. Social networks properties

a) Network Diameter:

The diameter of a network is the length of the longest path between two nodes. In social networks, the diameter is small and averaged by the number six as in the small world phenomenon[11]. This will affect the processes that take place in the network. For example there would be a fast spread of information such as “rumors” [30].

b) Network Clustering:

The idea of cliques is very common in social networks. The cliques are groups of friends who know each other. This is related to the idea of “friend of your friend is likely to be your friend” [30]. The degree to which nodes are able to cluster together can be measured by the clustering coefficient. In general the clustering coefficient \( C \) is based on the number of closed triples in a network (a set of three nodes connected to each other “triangles”) and it can be calculated by the following equation:

\[
C = \frac{3 \times \text{number of triangles}}{\text{number of connected triples of vertices}} \quad [32]
\]

For example the clustering coefficient \( C \) for the network below can be measured as follows:

\[
C = \frac{3 \times 1}{5} = \frac{3}{5}
\]

c) Degree Distribution:

Figure 3 Histogram of degree distribution of nodes
The degree of a node represents the number of edges connected to that node [29]. A distribution function \( P(K) \) gives the probability that a selected node at random has degree \( K \) [29]. Plotting the \( P(K) \) function for a network, generates a histogram of degree distribution of nodes similar to the one shown in Figure 3. Note that the distribution has a long right tail as shown in Figure 3. The long right tail indicates that in social networks, most nodes have a low degree, whereas a small number of nodes known as “hubs” have a high degree. And this is fairly true for social networks.

\[ d) \textit{Reputation and Trust:} \]

In social networks, trust relationship between acquaintances and friends is paramount. Amazon for example, has a recommender system that we trust. Another example would be eBay as it uses the sellers rating system in order to allow sellers and buyers to build reputation. Digg is an example for rating the web content, where people “digg” articles they like from all over the web and the highest articles are promoted to be in the front page of the website so million of people can view it. Much research has been done in the area of social networks trust but in order to build a robust reputation and trust, a deeper understanding of social topology is required [2]. Understanding the social network topology will help in identifying some properties about the different members of the network. For example, the location of the member can be used to infer the power and reputation of that member. These members could be identified easily through the number of connection they have with other nodes in the network. This information could support an automatic reputation system in the future, instead of using a manual rating system provided by the users.

\[ e) \textit{Users’ interests:} \]

Users in social networks tend to navigate their neighbors’ profiles because they may find things of interest there. Systems like Delicious (social bookmarking) allow users to bookmark web links of interests and share them with their friends or explore
bookmarks of other users. StumbleUpon also helps users to discover and rate web pages, photos and videos based on their interests. The discovered content is recommended by users’ friends or other people who share the same interest [9]. It gives them the choice to “like” or “not-like” the recommended content which also increases the quality of content recommendation.

Thus, understanding the structure of social networks will help evaluating the strength, weaknesses, opportunities and threats associated with them. Many such works have been done in the field of social networks analytics. One of the most popular papers is by Milgram "The Small-World Problem"[11] Where the earliest experiment about the “six degrees of separation” was investigated. Milgram studied the average path length for social networks in the United States and suggested that we live in a small world. Watts also studied the mathematical analyses of the small world structure [12] as he examined the small world systems and discussed the problem of measuring the distances in social world and he studied examples of real small-world networks.

3. RESEARCH CHALLENGES

Social networks are facing many issues in different fields. In this section, we discuss four main problems: the decentralization of social networks, business implications, privacy and identity issues, and trust construction.

3.1. Decentralized Social Networks

Current social networks are centralized sites where users do not have the rights to control and share their data over multiple social networks. Users need to register in every social network they are interested to join. This process is getting cumbersome for people, as new social networks appear everyday. They don’t have enough control on what information to show in their profiles. They can decide who can see their
profiles, but cannot filter out parts of that profile. Moreover they do not have control on how the social networks’ sites will use their data later on. For example, in Facebook one cannot be sure that private data will be fully erased in case of account deactivation [14]. Many social networks sites use this information in target advertisements and gain revenues from it. Another problem is that users cannot move their assets from one social network to another. In other words, there are difficulties in identifying users on multiple social networks. Moreover centralized social networks do not have a secure connection between the client and the server, which means that users’ data are susceptible to privacy and security breaches.

All of the above problems led researchers to suggest the use of a decentralized social network, where there is no specific authority that controls users’ data and preferences. These decentralized social networks need to provide users with traditional functionalities that are available in social networks. With decentralized social networks, a user will not need to register in sites like Facebook and MySpace. Instead, they will need to use one service that is trustful to host the user data. Facebook actually tried to extend itself beyond its domain using the service of Facebook Connect, which allows Facebook users to connect from other websites and update their Facebook board news through these external websites. Many semantic web tools have also been suggested by researchers, to promote the use of distributed social networks, such as OpenID, OAuth protocols and other technologies such as FOFA and RDF [15]. These approaches provide a decentralized digital identity to allow users to login into multiple services using the same digital identity [17]. They are used in many popular social networks such as Facebook, MySpace and LiveJournal. The problem with these approaches is the need for an OpenID-Provider (the entity that hosts the OpenID URI [18]). Users’ information stays unencrypted on the provider’s server, and these providers get access to private data and can collect
critical information about users’ behaviors and activities. OAuth allows social networks to provide their services to users without forcing the users to reveal their credentials. It asks the users if they would allow Facebook to get their details from the provider. The great thing about these approaches is that they allow other applications to access or stream the social data without actually exposing the data outside the server. Tim Berners-Lee et al., suggested the use of FOAF (Friend-Of-A-Friend) in their framework [15]. FOAF is becoming very popular as a machine-readable way of describing people relationships [16] and their activities on the web [17]. FOAF provides each user with and identity and a URI, that is referred to as “Web ID” [15]. People need to use the user’s URI in order to access his profile, check his activities or even post in his message board. Evolving social network projects feature novel approaches to distributed identity. Appleseed project proposed by Michael Chisari [19] is a distributed social networking platform that supports multiple identities and languages. HelloWorld project, proposed by Markus Ackermann et al. is a free secure distributed social network, which is based on the idea of OpenID that uses URI to identify users. But instead of hosting it with one provider, it can be used in any domain. The HTML page that the URI point to contains a Meta link to the XML-representation of the owners’ RSA-public key. This key proves authenticity without the need for a third party.

3.2. Business Implications

Many business models have been deployed in social networks. Some sites create business in social network environment through advertisements, while others allow users to access a premium content with more facilitates, and others have subscription fees to allow users to participate.

Most of the current business models are about increasing the size of the network [20], not building a robust business model. Researchers suggested some alternative
business models such as micro-payments for exchange of goods and services [20]. This approach allows easy sharing of money between friends in social networks. Facebook announced the integration of micropayments using PayPal to buy real gifts, Facebook credits and Facebook Ads. As the Facebook mania has swept the web and many people now login to different websites through Facebook Connect and maybe in the near future they will also prefer to make on-line payments through Facebook to different websites too [21].

3.3. Privacy and Identity Issues

Many concerns surround privacy in social networks environment. Privacy is “the ability of an individual or group to seclude themselves or information about themselves and thereby reveal themselves selectively” [22]. For example, when a user posts his mobile number in his profile there might be a possibility that someone use it to harass the user. Other might regard the purchase information history and personal preferences and use them in marketing without the user’s awareness [23].

a) Privacy Levels:

To achieve privacy, many social networks provide privacy options for the users as in Facebook. The website provides the users with different levels of privacy and provide special privacy policy consideration for young-age users. Facebook allows users to specify the type of individuals who can view certain parts of a profile. It provides people with a way to control who can view their profiles, or various details of profile and who can view their contact information [24]. But the dramatic increase of social networks call for the need of further solid privacy solutions. Users need more control over their profiles and personal information.

b) Privacy Awareness:

Studies of privacy on social networks attracted many researchers because of the great impact of social networks on people especially young users. People lack the
awareness about privacy issues in social networks, but even if they got that awareness, studies show they do not use the available privacy tools [23]. In [24] Tabreez Govani and Harriet Pashley made a survey regarding the students’ awareness of privacy on Facebook. The survey showed that few students changed their privacy filtering options after taking the survey. Pablo Álvarez et al. states three levels of risks involving social networks: (1) Violating user’s data-protection rights. This is related to users’ personal information once published on the network where anyone can view them, search them and use them for different purposes, including as generating statistics and surveys. In such context, users do not have the ability to alleviate the privacy issues of such activities. (2) Identity fraud raised when users’ data are personified by unauthorized third parties and (3) the lack of global uniform standards for using social networks. Self-discipline measures that should be followed by users and providers in order to build a healthy social environment were also proposed [25] to face these risks.

3.4. Trust Construction

Trust in social network is related to relationships with strangers. Usually in the Internet trust is related to problems in privacy and security. That’s why the current solutions for trust are related to privacy and security such as certificates and data transfer security [26] There is a need to figure ways of applying real world behaviors in social networks such as building trust between users. There is a need for a trust network where users can evaluate new relationships and have different levels for these relationships. There are many researches done in the field of trust. Will Holcomb describes in his paper [26] a way for creating trustable digital identifiers using XML signature, unique identifiers and trusted signers. Alexandre Passant et al. also discussed trust and privacy in their paper [27] and they believe in using semantic web techniques to deal with trust and privacy such as FOAF, OpenID and SPARQL.
4. Future Perspectives

In this section we will discuss the future of social networking. There are many directions for future works in this area. One would be the difficulty of sharing users’ assets over social networks there are many protocols and formats introduced in the area of decentralization, but there is still a missing part that needs to be identified which makes decentralized social networks a possible area for future works to be done [31]. This is particularly appealing in today’s ubiquitous environment, which would allow future users to even share physical assets in the evolving *Internet of Things*.

In business, the lack of micropayments protocols is one of the gaps that prevent businesses from rapid development over social networks. Also allowing users to move their assets across different social networks is poised to create a bigger market for even business users [30]. In that context, Ping, the lately introduced social network by Apple as part of its ITunes application (which hits 2 million users in just two days) includes a tool for small business users to leverage social networking.

Privacy and trust are important factors to investigate, especially when building decentralized social networks. People need to be aware of privacy-implications of their behaviors on social networks. The use of P3P extension will enable social network websites to express their privacy practices in a format that would be automatically retrieved and interpreted by the user agents (in Semantic Web context). User agents inform the user of the social network practices and allow decision-making based on these practices [28]. In this case the users will not need to consult the privacy policy statements of each website they visit.

5. Conclusion

Social networks are very popular and they provide users with many facilities that
changed the type of interaction with the web. Their future is very bright as all and everyone will be available anywhere and anytime (friends, family, people you like, etc) in social networks where they will tend to share their knowledge and even assets. For example, when buying things from Amazon people will be able to view reviews from their friends or family members or get an advice from a social-network based friend regarding buying an item.

This paper addressed important issues related to social networks and provided alternative solutions. We are currently extending this research to include the exploration trends to software agents, which may plan, react, learn and cooperate with other agents, just like human users do on contemporary social networks. Another trends we are currently exploring aims at aggregating several social media sources to produce mashups based on social networks.

6. REFERENCES


[29] David Newth, "The Structure of Social Networks", Complex Science for a Complex World, chapter 5

