# SOCIAL NETWORKS

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The person who built the modern social network theory was the Stanley Milgram [Was94]. He conducted the experiment in which he asked many people from Nebraska to forward a letter to his colleague in Boston. It should be done only by giving this letter to a person that these people knew on a first – name basis. After that he analyzed the results of the experiment and concluded that people in USA create the social network and they are connected to this network with "six degrees of separation". It means that a message in such a network would be delivered in average six steps.

Recently, social networks become more and more important. The social network is a map of the individuals, and the ways how they are related to each other. A single person is the node of the network while edges, that link nodes and are called also "connections", "links" or "ties", correspond to relationships between people.

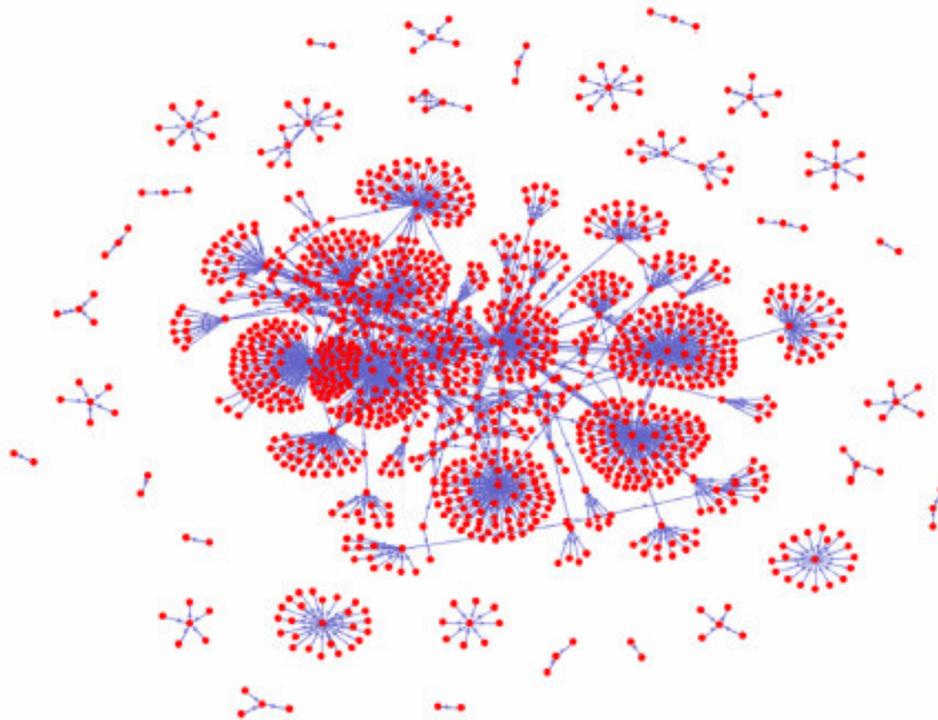Some graphical examples of social networks are presented in the figures 1, 2 and 3.



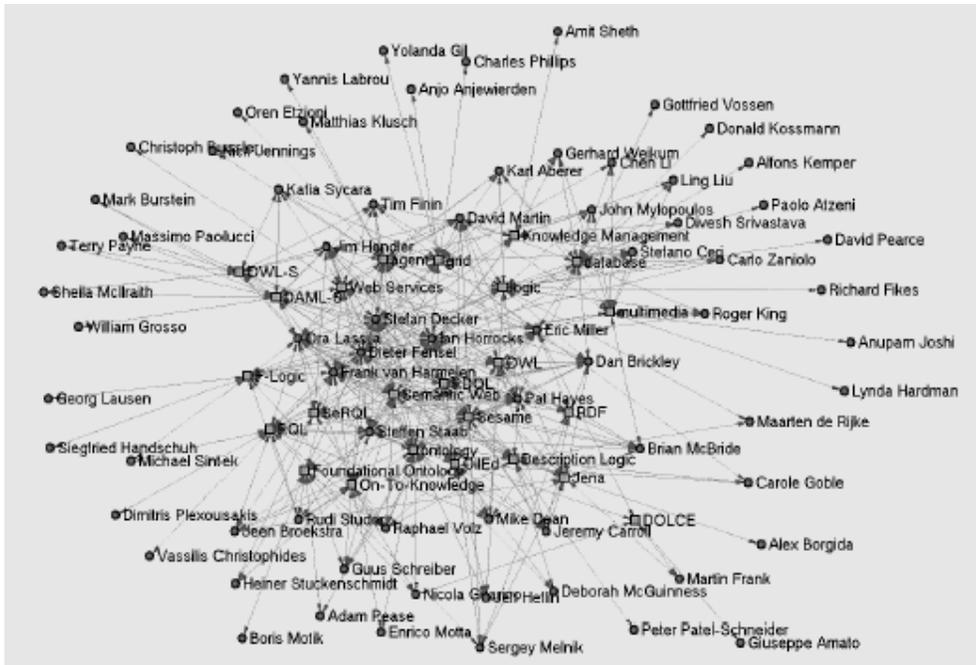Figure 1 The trust network developed at http://trust.mindswap.org [Gol04]

Figure 2 Members of the semantic web community and their association to research interests. [Sta05]

The relationships between network members are created based on individual experience, knowledge and trust of human beings which are external with reference to the social network itself. Trust and the mutual relative interpersonal interest similarity appears to be crucial in most social networks [Gol04, Gol05, Zie05]. Since the links from the network, their maintenance and quality, reflect social behaviors of individuals, the research on them can be helpful at the quantitative, and qualitative assessment of human relationships in the age of information society.

In social networks some typical phenomena may be observed such as the small world effect, clustering, and the strength of weak ties what has been proved by the research conducted on Club Nexus, an online community at Stanford University [Ada03b]. Moreover, various human features, extracted from user profiles, can have more or less significant influence on the process of formation of a friendship and even the distance within a pair of people in the network [Ada03b].

Typical social networks like Friendster [boy04] or LinkedIn are created and maintained by commercial companies but some informal social networks also exist within almost all communication services in the internet. If we consider address books from email agents, bookmarks to home pages from web browsers, contact lists from communicators, etc as kind of links between people, then we obtain a complicated network. Yet another social network example is the structure of the web, especially the network of hyperlinks between home pages – figure 3 [Ada03a].
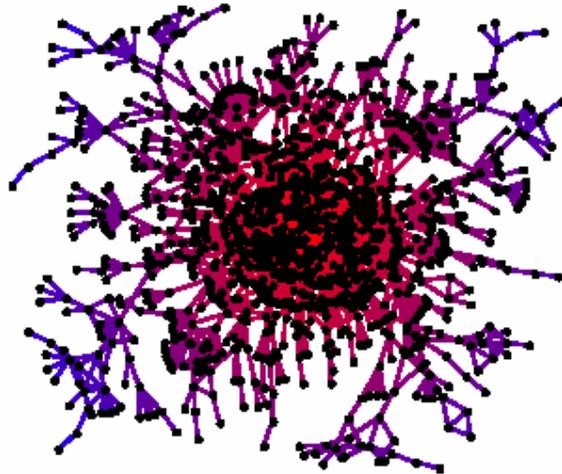
Figure 3 The social network based on hyperlinks that connect home pages at Stanford Univeristy [Ada03a]

Research in a number of scientific fields have demonstrated that social networks operate on many levels, from families up to the level of nations, and play a critical role in determining the way problems are solved, organizations are run, and the degree to which individuals succeed in achieving their goals.

There are many techniques how to collect the measurements about the social networks, e.g. full network method, sowball method, and both ego – centric methods, "with alter connections" and "ego only" [Han05].

The full network method is the most complex one, because all members of the network and all their possible connections are taken into consideration. To achieve this goal, the complete list of connections between people is created. However, the biggest advantage of this approach is that it provides one full and integrated view of all ties within the network. On the other hand, it is really hard to create such description, because it is resources as well as time consuming and there is always the possibility that some of the connections will be missed, especially in case of an extensive network with many ties.

The next strategy, which is less complex, is the snowball method. Firstly, we define the group of actors (nodes) who describe their connections to other people. Next the same task – identification of all outgoing connections – is done for the actors that have been identified in the first step. This recurrency is executed until all ties have been defined or we have decided to stop creating new ties due to time limits. The most important shortcomings of this method is the possibility that not all connections and not all actors, particularly isolated ones, will be identified.

If there is no need to identify all connections in the network, the ego-centric method can be used. It focuses on a single individual rather than on groups or pairs. In the first step, one "ego" is chosen. The information about this ego connections is retrieved, together with their target actors and relationships among them. As a result, a sub-network is created that helps to understand the possibilities and constraints of the given individual. In this approach, we consider the "ego" and their alter direct connections, however we can also exploit the "ego only" approach. In this case, we are not interested in the connections between the various alters but we only concentrate on a single ego and their first level connections.

We can use the social network to present the collaborative relationship between individuals. In this case people represent nodes of the social network and the relationships are described as the directed ties [Pal04]. Thus, we can model a social network with a directed graph and the graph theory appears to be an important element of social network analysis.

**Social Networks for Knowledge Management**

We can use the relationships – links between people to gather and manage the knowledge. Social network operates on many levels. The social network analysis helps to define the level to which individuals succeed in achieving their goals. The social networks are used to solve the problems within the organizations. Moreover, they determine how the company runs.

This reference between the social network and knowledge management is made explicit in the interactive system ReferralWeb [Kau97]. It is used to reconstruct, search, and visualizing the social networks on the web. The system was built to cope with the problems that occur at manual searching for the appropriate information. "One is faced with the trade-off of contacting a large number of individuals at each step, and thus straining both the time and goodwill of the possible respondents, or of contacting a smaller, more focused set, and being more likely to fail to locate an appropriate expert." [Kau97]
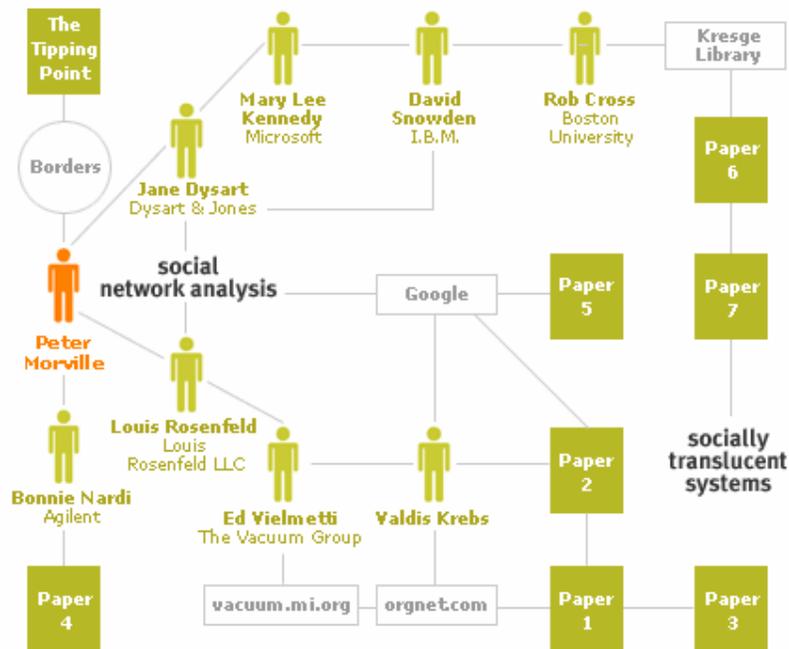


Figure 4 Interactive story map of social network analysis learning process by Peter Morville
[http://semanticstudios.com/publications/semantics/000006.php]

The system can provide the rich knowledge management by analyzing the social networks and providing recommendations (e.g. products or companies), building the communities that gather people with similar interests, helping to exchange the experience within the team, and localizing experts, i.e. persons most appropriate to perform the specific task. Moreover, the knowledge management can be support by the interpersonal link prediction or the entire community recommendations like in Orkut Social Network [Spe05]. In all these cases the crucial problem is the similarity or distance measure between considered objects [Ada03a, Ada05, Lib04, Han05, Spe05, Zie05].

Kumar *et al.* observed great correspondence between the nature of social networks and the structure and content of the web what can result in more precise web search mechanisms and better understanding of the sociological aspects of the web content management [Kum02, Kum03].

The Problem Solver Markup Language – PSML can be used to gather the knowledge from the web in the form of a social network and incorporate this knowledge to the local operational databases to enhance the enterprise or community, adaptable web intelligence services [Zho03]. PSML is the language that is sufficient for the Wisdom Web Agents. The automatic reasoning can be done.

Each network changes over the course of time and we should be aware what influence has the time on the development of the network [Aue01]. Fortunately, this evolution process can be supported by link prediction mechanisms that help to envisage the future outlook of the

network [Lib04]. The conducted experiments proved that it is possible to extract the future relationships among users based on the present network topology. Additionally, some other methods known from recommendation systems [Kaz05] can be adapted to link prediction in social networks.

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