Leveraging Social Networks for Information Sharing

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ABSTRACT
Saori is a computation infrastructure that enables users and end-user applications to leverage social networks to mediate information dissemination. Saori provides users with awareness of and control over the information dissemination process within social networks; Saori enables users to employ both technological and social methods to manage information sharing. Saori users can create policies that mediate sharing by exploiting social network structures. Saori also provides social data to users; this data encourages users to be accountable for how they share information. We integrated Saori into a Wiki Wiki Web to demonstrate a concrete use of the infrastructure.

Categories and Subject Descriptors
H.5.3 [**Information Interfaces and Presentation**]: Group and Organizational Interfaces – *collaborative computing, computer-supported cooperative work, organizational design.*

General Terms
Design, Human Factors.

Keywords
Social networks, information sharing, privacy.

1. INTRODUCTION
Social networks are a foundation of human society. An individual's personal social network is the people that he interacts with regularly: his friends, family, colleagues, and acquaintances. Within a community or organization, personal social networks overlap and merge to form extended social networks that span the entire community.

It is difficult to overestimate the importance of social networks in the processes of disseminating and receiving information. Contact and availability information is often closely guarded and shared only with the people in one's personal social network. Friends talk about books that they've recently read and share photos of their children. Colleagues share ideas, data, and references when collaborating.

Disseminating information in social networks is a complex and nuanced process that is the sum of many individual actions. Based on the information itself and on contextual factors, a person may choose to share the information as is to selected people in his social network or may modify the information (e.g. remove details) before disseminating it. Frequently people are put in a position to disseminate information that belongs to someone else in their social network; hence, they act on behalf of the owner as best they can. Receiving information is a similarly nuanced process. Oftentimes the source of the information is as valuable as the information itself.

Despite the prevalence with which information is disseminated and received via social networks, current user interfaces and end-user applications provide only limited support for doing so. Current applications often do not enable users to manage and maintain awareness of how information they have shared with others moves through a social network. Without such support, users sometimes have difficultly sharing information with the "right" people and frequently have privacy concerns because it is difficult to determine who has access to particular information.

We posit that there is a need for an infrastructure that enables users to leverage their personal and extended social network to mediate information sharing. We are particularly interested in supporting opportunistic, peer-to-peer sharing of semi-public information, such as work products or one's current location, across a relatively small number of people. To this end, we have developed the Saori infrastructure. In this paper, we describe Saori and demonstrate a concrete use of Saori in an end-user application.

2. SAORI
Saori (Figure 1) is a computational infrastructure that enables users and applications to leverage social networks to manage information dissemination. Saori provides users with awareness of and control over the information dissemination process within social networks. In Saori, all information dissemination occurs along ties between individuals connected in a social network. Users can leverage both their personal network and the extended networks that they belong to share information.

Saori maintain a database of information that can be shared. Saori makes a number of assumptions about information and its attributes. Saori presumes that information is in the form of a pointer or a URL and that each instance of information is owned.

The owner of an instance of information designates a type and a sharing policy for the instance. An instance can be either typed as 'mostly public' or 'mostly private.' These types reflect our belief that the majority of information is intended to be treated as either largely public or largely private (but not both) and shared accordingly. An instance's policy determines how it can be shared; Saori enforces instances' policies.

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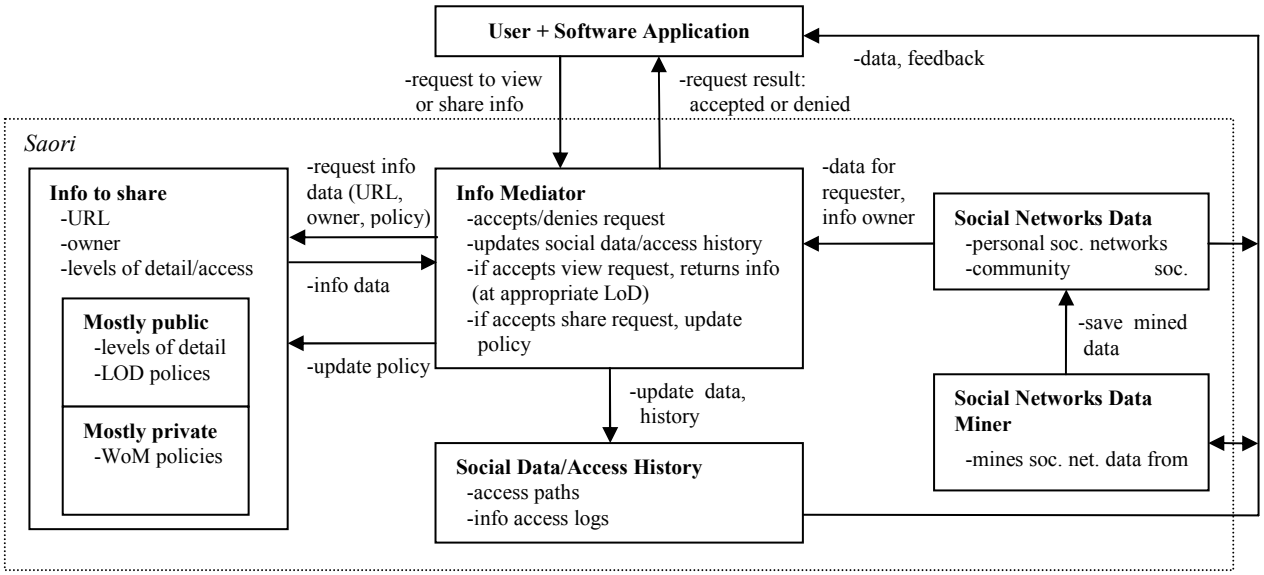

Figure 1. Saori system diagram.

A level of detail (LoD) policy governs how mostly public information can be shared. A LoD policy makes information public, but users further from the owner of the information, as defined by social network metrics, see fewer details of the information. A word of mouth (WoM) policy governs how mostly private information can be shared. If a WoM policy is applied to an instance of information, the instance is initially completely private (i.e. only the owner has access to it). Users can, however, share the instance from person to person in a word-of-mouth manner. A WoM policy specifies what restrictions there are on this process.

To enforce these polices, Saori must have access to users' attributes and their social networks. Saori maintains a database of this information. Users, their attributes, and personal social networks are stored in the database; Saori creates community social networks when necessary and does so by merging personal social networks. Saori obtains user attributes and personal social networks by mining users' email messages. After mining a user's email messages, Saori provides a tentative personal social network for the user; he can then adjust his network as desired.

Saori acts as a protective layer over information, mediating requests to view and share information. When Saori receives a request to view or share a particular piece of information, it uses its social network data and the information's policy to determine whether to grant the request. These policies are Saori's technological method of managing information sharing.

Saori also provides scaffolding so that users can employ social methods to control information dissemination. This scaffolding is in the form of social data. Saori keeps a record of how each user gained access to an instance of information (the access path) and a history of the user's accesses of the information. Together, these records of users' activities comprise Saori's social data. Saori personalizes this data and makes it available to users. For example, the owner of an instance can determine who has access to the instance, and other users can determine how their sharing activities enabled others to gain access to the instance.

Making these records available to users has two consequences. First, it encourages users to be accountable for how they share information. This accountability motivates users to share an instance of information in ways that others would find acceptable. Second, an owner can, if desired, modify an instance's policy based on the feedback he receives about who has access to an instance and how often particular users have accessed the instance. Thus, by making social information available, Saori enables users to employ social methods to shape how information is shared.

2.1 Sociology of Social Networks

Saori's design draws from a large body of sociological research on social networks. In this section, we discuss features of social networks that significantly influence information sharing.

2.1.1 Strong and weak ties

Granovetter first made the distinction between strong ties and weak ties in social networks [3][4]. *Strong ties* often exist between family members, close friends, and colleagues that are also friends. *Weak ties* exist between acquaintances, colleagues that are not seen outside work, and people in shared interest groups (e.g. sports leagues).

There is a fundamental difference between information dissemination via strong ties and via weak ties. A strong tie often connects an individual to someone within the groups he is closely affiliated with. In contrast, a weak tie frequently acts as a *local bridge*, connecting the individual to someone outside the groups that he is most closely affiliated with. Thus, information shared via a strong tie often stays within a group, while information shared via a weak tie is often shared outside a group. Information shared via weak ties, then, moves conceptually further on average than does information shared via strong ties.

2.1.2 Boundary crossing ties

Social networks have long been known to cross formal, recognized boundaries [7]. Many organizations employ a hierarchical structure that emphasizes vertical information flow. In contrast, social networks are largely horizontal structures, and

information moves through the network accordingly. Hence, social networks afford opportunities for information to move across established boundaries in a hierarchical structure.

Ties that extend across organizational boundaries are similar to weak ties. In both cases, such ties enable information to be disseminated to a new group. This is in contrast to strong ties and ties that do not cross organizational boundaries; information disseminated via these ties stays within a group.

2.1.3 Horizon of observability

Central to the question of disseminating information via social network ties is how far away the information must go before an individual can no longer maintain control of it. Social control is manifested largely as accountability; accountability is made possible through the combination of observability and social norms or expectations. If an individual can observe how another person is using a particular piece of information, social norms are often enough to ensure that the information is used judiciously.

Friedkin found that an individual can observe and thus exert a measure of social control only over people that are at most two ties away from him [2]. This feature is the network's *horizon of observability*. Friedkin's quantification of the network's horizon yields an important design criterion for computational systems that attempt to augment information sharing processes. A system should attempt to extend the horizon of observability beyond two ties, enabling social norms to continue to influence how information is shared well beyond two ties.

2.2 Information Sharing Policies

2.2.1 Public information policies

Public information is broadcast, and an effort is made to make some form of the information available to all. An example of owned information that is often made public is one's availability data (e.g. instant messaging status, a shared calendar).

Saori offers an information sharing policy for public information that couples the social network characteristics discussed above with a general feature of information: levels of detail. Saori's policy for sharing public data is based on the observation that the closer a person is to an individual, the more detail the individual is likely be comfortable sharing with that person.

The policies that Saori supports are based on the number of ties, or path length, between two individuals in a social network. When creating a policy for a piece of information, an owner assigns a maximum path length to each level of detail; people with a path to the owner that is less than or equal to the path length can view that level of detail. An owner can also choose to decrease the level of detail if there are weak ties or boundary ties in the path. We call this policy a *level of details* (LoD) policy.

An example LoD policy for a shared calendar would enable people one tie away from the user (i.e. people in his personal social network) see the full text of all entries; people two or three ties away would see the calendar as free/busy blocks, and people more than three ties away would not have access to the calendar. The policy might also decrease the level of detail for each weak tie or boundary crossing tie in the path to a user.

2.2.2 Private information policies

Private information is markedly different than public information. It is not meant to be generally available to a significant number of people, and it is shared via word-of-mouth. Examples of private information include work products, online family photo albums, and personal contact data.

Saori's policies for private information enable dissemination via controlled word-of-mouth sharing. Word-of-mouth sharing is a distributed, collaborative process; the owner of a piece of information shares it with someone, who then shares it with someone else, and so on. Thus, a policy that mediates word-of-mouth sharing must strike a balance between controlling the information and allowing others to reshare it when appropriate.

Saori's *word-of-mouth* (WoM) policy enables users to strike this balance. A WoM policy enables a user to reshare an instance of information with those in his personal social network, but such resharing is limited by the policy. A WoM policy can limit sharing to a maximum distance (i.e. number of ties) from the owner; it can also prevent the instance from being shared across weak ties or outside of particular organizations. When an instance is shared, the existing policy can be used or a new policy can be created and applied to the user with which the information is being shared; however, the new policy cannot be less restrictive than the current policy.

Consider managing access to online family photo albums using a WoM policy. Such albums are becoming increasingly common, but many families are not comfortable making their album publicly available on the Internet. Instead, they would like to be able to provide access only to those people that "should" have access to the album; however, determining who should have access to the album is often not easy. This problem can be solved by using a WoM policy that enables sharing along strong ties; any family member can then easily share the album with people they have strong ties to, such as their friends and close colleagues, without making the album public.

2.3 Mining Social Network Data

One the most difficult challenges that Saori must address is obtaining user attributes and social network data. We cannot rely on users to provide this information for two reasons. First, there is a large volume of needed information, and users would find it difficult and tedious to enter it all. More importantly, though, Saori relies on the integrity of data about users and social networks to control information dissemination; if users can modify this data, they can easily circumvent Saori's policies.

Saori obtains user attributes and social network data by using existing mining techniques that extract social networking data from email messages [1][6]. Saori also extends this work in multiple ways. Saori uses email addresses to identify organizations that a user belongs to. If a user's email addresses are joe@cc.gatech.edu and joe@wisc.edu, Saori places the user in the 'cc.gatech.edu' and the 'wisc.edu' organizations. (Organizations can be renamed.) Saori also creates organizations based on mailing list memberships; mailing lists often reflect real-world organizational structures. Lastly, Saori automatically computes the strength of a tie between two users; a tie's strength is the overlap in two users' personal social networks [4].

Ultimately, Saori will likely be most effective if users have some control over their personal social networks. More work is needed to examine how best to combine automated social network discovery and user-specified networks.

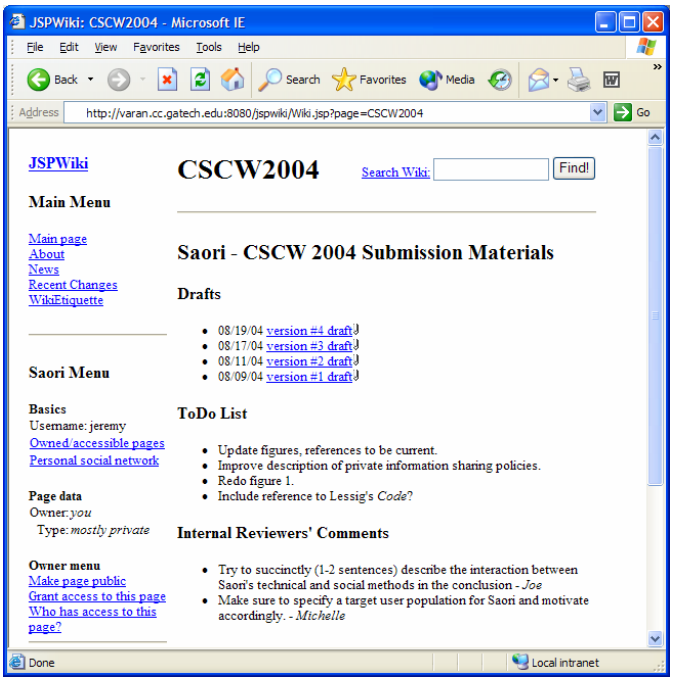

Figure 2. Wiki web augmented with Saori.

3. APPLICATION

To explore a concrete use of Saori, we integrated Saori into a Wiki Wiki Web (or Wiki). A Wiki is a collaborative website; any user can create, edit, or remove web pages [8]. Wikis have proven to be a valuable and interesting collaborative tool [5]. Wikis, though, are not suitable if the collaborative process or information used in the process is not completely public. Integrating Saori into a Wiki enables users to take advantage of the open and informal nature of Wikis and also keep the content and activities on the Wiki somewhat private.

Saori treats each Wiki page as an instance of information, and thus users can employ Saori to mediate access to any Wiki page. When a user creates a page, he is designated the owner of the page. The owner can set the page's type (private or public) and its sharing policy to mediate access to the page as desired. Owners can use Saori's policies to control who can edit and view Wiki pages that they own. The levels of detail for mostly public pages are (1) view and edit; (2) view; and (3) no access.

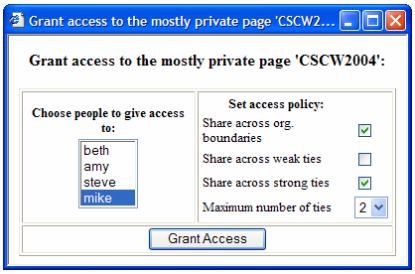

Figure 3. Granting access to a page.

We modified the Wiki's interface to include a menu that enables users to perform actions using Saori and to view Saori's social data. The Wiki page itself is on the right, and the Saori menu is on the left (Figures 2). We also provide a very simple interface for users to grant access to pages (Figure 3) and to manage their personal social network (not shown).

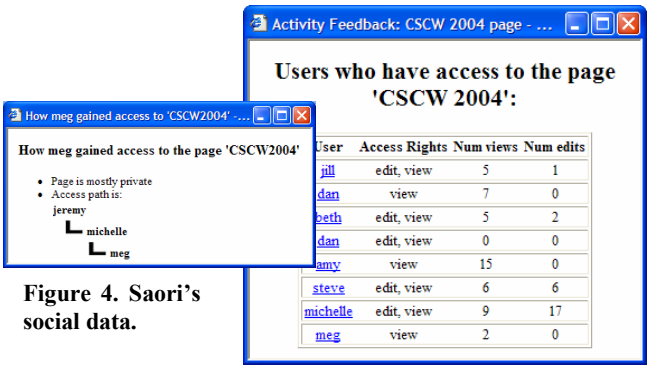

Figure 4. Saori's social data.

Saori maintains two types of social data for a Wiki: (a) a record of how each user gained access to a Wiki page (the access path) and (b) user access logs for all pages. Saori selectively makes this data available to users. A page's owner can see all users that have access to a page, how often each user has edited or viewed the page, and the access path for each user (Figure 4). For pages governed by a WoM policy, users who have access to a page but who do not own it can see which other users have access to the page as a result of their sharing activities.

4. CONCLUSION

Social networks play a large role in information dissemination. Saori leverages social networks to provide tools for users to view, understand, and control semi-public, informal information dissemination. Saori enables users to employ both technological and social methods to mediate information sharing. We anticipate that Saori users will distribute information more widely than they would otherwise because Saori provides awareness and control over the information distribution process.

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