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HUMAN EFFECTS OF ENHANCED PRIVACY MANAGEMENT MODELS

Author Name: Abuthahir.S1UG/CSE, Maheswari.A2 UG/CSE, Pavithara.S3 UG/CSE, D.KIRUTHIKA AP/CSE
Computer Science Engineering, Surya Engineering College,
Mettukadai, Erode, Tamilnadu.
abucse22@gmail.com*, maheshmahi0551@gmail.com, pavitharagayu9596.pg@gmail.com

Abstract— We enhance existing and introduce new social network privacy management models and we measure their human effects. First, we introduce a mechanism using proven clustering techniques that assists users in grouping their friends for traditional group-based policy management approaches. We found measurable agreement between clusters and user-defined relationship groups.Second, we introduce a new privacy management model that leverages users' memory and opinion of their friends (called examplefriends) to set policies for other similar friends. Finally, we explore different techniques that aid users in selecting example friends. Wefound that by associating policy temples with example friends (versus group labels), users author policies more efficiently and haveimproved perceptions over traditional group-based policy management approaches. In addition, our results show that privacymanagement models can be further enhanced by utilizing user privacy sentiment for mass customization. By detecting user privacysentiment (i.e., an unconcerned user, a pragmatist or a fundamentalist), privacy management models can be automatically tailoredspecific to the privacy sentiment and needs of the user.

INTRODUCTION

SOCIAL networking sites are experiencing tremendous adoption and growth. The Internet and online socialnetworks, in particular, are a part of most people's lives.eMarketer.com reports that in 2011, nearly 150 million USInternet users will interface with at least one socialnetworking site per month. eMarketer.com also reportsthat in 2011, 90 percent of Internet users ages 18-24 and82 percent of Internet users ages 25-34 will interact with atleast one social networking site per month. This trend isincreasing for all age groups. As the young population ages, they will continue to leverage social media in their dailylives. In addition, new generations will come to adopt theInternet and online social networks. These technologieshave become and will continue to be a vital component ofour social fabric, which we depend on to communicate,interact, and socialize Not only are there a tremendous amount of users online,there is also a tremendous amount of user profile data andcontent online. For example, on Facebook, there are over30

billion pieces of content shared each month. Newcontent is being added every day; an average Facebookuser generates over 90 pieces of content each month. Thislarge amount of content coupled with the significantnumber of users online makes maintain appropriatelevelsprivacyvery challenging.There have been numerous studies concerning privacy inthe online world A number of conclusions can be drawn from these studies. First, there are varying levels.of privacy controls, depending on the online site. For example, some sites make available user profile data to the Internet with no ability to restrict access. While other sites limit user profile viewing to just trusted friends. Other studies introduce the notion of the privacy paradox, the relationship between individual privacy intentions to disclose their personal information and their actual beha- vior. Individuals voice concerns over the lack of adequate controls around their privacy information while freely providing their personal data. Other research con- cludes that individuals lack appropriate information to make informed privacy decisions [3]. Moreover, when there is adequate information, short-term benefits are often opted over long-term privacy. However, contrary to common belief, people are concerned about privacy [2], [13]. But managing ones privacy can be challenging. This can be attributed to many things, for example, the lack of privacy controls available to the user, the complexity of using the controls [36], and the burden associated with managing these controls for large sets of users. We enhance existing and introduce new privacy management models for online social networks.

1.In addition, we measure the human effects of our improve- ments. We introduce three new improvements to privacy management models Assisted Friend Grouping—an incremental improve- ment to traditional group-based policy management.

2.Same-As Policy Management—a new paradigm im- provement over traditional group-based policy management

3. Example Friend Selection—an incremental improvenment to Same-As Policy Management We leverage traditional group-based policy management as our baseline and progressively improve upon this privacy management model. With each new enhancement,

we measure their human effects including cluster/user defined relationship group alignment, user privacy sentiment, efficiencies and user perceptions. Our contributions are as follows: We introduce a user-assisted friend grouping me chanism that enhances traditional group-based policy management approaches. Assisted Friend Grouping leverages proven clustering techniques to aid users in grouping their friends more effectively and efficiently. We found measurable agreemen between clusters and user-defined relationshi groups. In addition, user perceptions of our improvements are encouraging . We introduce a new privacy management model that is an improvement over traditional group- based policy management approaches. Our new paradigm leverages a user's memory and opinion of their friends to set policies for

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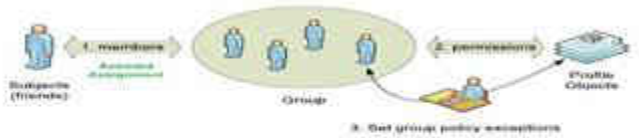
other similar friends which we refer to as Same-As Policy Management.Users associate the policy with an example friend and in doing so have this friend in the forefront of their mind. This allows users to be more selective and careful in assigning permissions. Users are thinking of people, not groups. Using a visua policy editor that takes advantage of friend recognition and minimal task interruptions, Same-As Policy Management demonstrated improved performance and user perceptions over traditional group-based policy management approaches We further enhance Same-As Policy Management by introducing Example Friend Selection—two techniques for aiding users in selecting their example friends that are used in developing policy templates. Both techniques reduced policy authoring times and were positively perceived by users . We detect user privacy sentiment that can be leveraged to further enhance privacy management models. For example,



Unconcerned Users who author more open policies may leverage a les flexible coarse-grained privacy management ap- proach. Whereas a Fundamentalist, who authors more conservative policies, will find a fine-grained approach better suited for meeting their privacy needs. Privacy management models can be further refined and enhanced by detecting and leveraging user privacy sentiment in managing access to user privacy information.The rest of the paper is organized as follows: In Section 2, we provide a brief background of role/group based access control. Section 3 details our improvements to privacy management models. Our user study design is described in Section 4 with the results/human effects and discussion detailed in Sections 5 and 6, respectively. Finally, we wrap up the paper with related work,conclusions, and future work to specify policies for their profile objects. For example, my work colleague is restricted from seeing my photos. But my trusted best friend from school may access all my information. Facebook provides an optional mechanism that allows users to create custom lists to organize friends and set privacy restrictions. Similarly, Google+ allows users to create Circles of friends, such as family, acquaintances,and so on, where the user can apply policies based on these Circles. Facebook also has smart lists that automatically group friends who live nearby or attend the same school.However, managing access for hundreds of friends is still a very difficult and burdensome task .In addition,security unaware users typically follow an open and permissive default policy.

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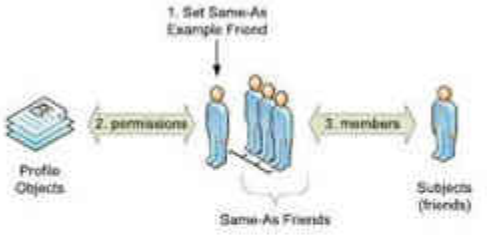
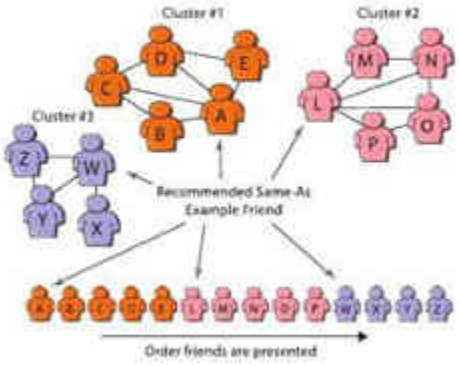
As a result, the potential for unwanted information leakage is great .One approach that has been taken to alleviate the burden of managing access permissions for large sets of friends is the implementation of a role-based access control model (RBA. Role-based access control provides a level of abstraction with the introduction of a role between the subject and the object permission. A role is a container with a functional meaning, for example, a specific job within an enterprise. Permissions to objects are assigned to roles and subjects are assigned to roles. Role members are granted object permissions associated with the role(s) in which they belong. See Fig. 1. This level of abstraction alleviates the burden of managing large numbers of subjects to object permissions assignments. For the purposes of discussion, we will use the term group to be synonymous with the term role, with the understanding that traditionally roles have subject to object permissions assignments and groups traditionally only have subject assignments. Traditional RBAC can be leveraged within social networks. Often,





people's relationships drive privacy decisions. People like to specify groups for their friend relationships, in which they then can set privacy policies]. We refer to this approach as a group-based policy management. However, populating relationship groups can be very time consuming

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and burdensome touser.We enhance traditional group-based policy management by introducing a mechanism that assists users in placing their subjects (or friends) into relationship groups. Our approach leverages proven clustering techniques, which have measurable agreement with user-defined relationship groups,to aid users in grouping their friends more efficiently. Our model is referred to as Assisted

FriendGrouping. A shortcoming of the group-based policy management approach is that the user's attention is focused in multiple areas. For example, a user must first focus on the friend's relationship to group them appropriately. Next, the user must change focus to the group to set the group-level policy.Finally, the user must switch focus back to the friend to set

2.BACKGROUND Many current social networking platforms offer a simple policy management approach. Security aware users are able any friend-level exceptions for each group policy. We introduce a new privacy management paradigm that over comes this weakness. Our model leverages a user's memory and opinion of their friends to set policies for other similar friends. Studies have shown that users perform more efficiently using recognition-based approaches that have minimal task interruptions [11], [20]. Using our visual policy editor, a user selects a representative friend (same-as example friend), assigns appropriate object permissions to this friend and then associates other similar friends to the same policy. Our model is called Same-As

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Policy Management. We further enhance Same-As Policy Management by introducing two techniques for selecting representative friends (same-as example friends) used in the development of policies. Our model is called Example Friend Selection

3.ENHANCED PRIVACY MANAGEMENT MODELS We enhance existing and introduce new social network privacy management models, in addition to measuring the humaneffects of these models. First, we improve upon traditional group-based policy management with Assisted Friend Grouping. Next, we introduce a new approach for privacy management called Same-As Policy Management. We further improve upon Same-As Policy Management by introducing techniques for selecting friends used in developing policies, called Example Friend Selection. The details of which are discussed in the following sections.

3.1 Group-Based Policy Management with Assisted Friend Grouping Group-based policy management allows users to populate groups based on relationship and assign object permissions to the groups, Assisted Friend Grouping extends this model in two areas: 1) provides the user with assistance in grouping their friends, and 2) provides the user the ability to set friend-level exceptions within the group policy. For the purposes of our prototype Facebook application,we predefined 10 relationship groups: family, close friends,graduate school, under graduate school, high school, work,acquaintances, friends of friend, community, and other.These groups were carefully selected, in part, from the work of Jones and O'Neil . They postulate that usersgroup their friends, for controlling privacy, based on six criteria: social circles, tie strength, temporal episodes,geographical locations, functional roles, and organizational boundaries. Our friend relationship groups were selected to reflect these criteria. Within our prototype, each friend is presented to the user in the center of a friend grouping page.

3.2 Same-As Policy Management In group-based policy management, the user must first group their friends. After which, they must select grouppermissions (setting the group policy). Finally, friend-levelexceptions to the group policy are set. A user's attention(mental model) is focused in multiple areas. Whereas in Same-As Policy Management, the user's attention is focused on a specific friend. Users leverage their memory andopinion of a friend to set policies for otherlike friends. In essence, we use a friend recognition approach, with minimal task interruptions, to aid the user in setting policies. A representative friend is selected (same-as example friend), profile object permissions are assigned to this example friend and other similar friends (same-as friends) are associated with the same set of object permisillustrates our model; the same-as example friend is depicted in front of the user's other similar friends who have been assigned the same set of object permissions. First, the user selects a friend (same-as example friend) that is representative of a subset of their friend set. The notion is that we all have subsets of friends that have similar levels of trust. The user selects one easy to remember friend from each subset as its respective representative.Second, using our visual policy editor, the user assigns appropriate

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object level permissions for each object for this same-as example friend. For the purposes of our prototype Facebook application, we presented three profile object categories: Albums, About Me, and Education and Work. Within each profile object category, objects of the same family are presented. For example, About Me includes Birthday, Status, Current City, email, and so on, as indicated in The user can allow or deny access to any object or object category by simply clicking on the object or object category. For example, if the user does not want the same-as example friend to have access to their college information, they merely click on College, and the object permission is set to deny and the object will begrayed out. Or, for example, if the user does not want to allow access to any of their education and work information, they click on Deny for the object category Education and Work, and the entire object category will be grayed out, thus effectively setting the permissions to deny for each profile object within that category. Any permutation of permissions is allowed. Third, after the permissions are set for the same-as example friend, other like or similar friends (same-as friends)are assigned to the policy. The visual policy editor presents to the user their friend set, where the user can associate a friend to an already defined same-as example friend. Or, the usercan designate a friend as a new same-as example friend, thereby setting a new policy which would be assigned to other similar friends. This process repeats itself for the user's entire friend set. As new content is created (e.g., new pictures are taken), the user can set access rights (e.g., view) for this new content by associating them with existing same-as example friends. Or the user may establish a new policy by repeating the process outlined above.

3.3 Same-As Policy Management with Example Friend Selection The visual policy uses three approaches for assisting users in selecting their same-as example friend: Random, CNM Order, and Sample CNM Order. Random presents friends to the user in random order. Both the CNM Order and Sample CNM Order approaches leverage the CNM network clustering algorithm. Our prototype clusters the user's social network graph creating CNM clusters of friends. In CNM Order, we present the user's friends in CNM cluster order, i.e., all the friends in Cluster #1 are presented to the user followed by all the friends in Cluster#2, and so on. The first friend presented for each cluster is the friend with the highest degree (friend with the highest number of friend connections) in that cluster. This friend is the same-as example friend for that cluster. The premise is the highly connected friends are potentially more well known and thus easier to remember making them good candidates for same- as example friends. For example, Fig. 6 illustrates a user's social network graph that has three CNM clusters of friends. Friend A has the highest degree in Cluster #1 and, therefore, Friend A is presented to the user first as a recommendation for a same-as example friend. After Friend A is presented to the user, the remaining friends of Cluster #1 are presented for association with an already defined same-as example friend or for assignment as a new same-as example friend. After all of Cluster #1 friends are presented, Cluster #2 friends are presented in a similar fashion, i.e., Friend L has the

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highest degree in Cluster #2 and thus is presented to the user as a possible candidate for a same-as example friend followed by the remainder of the friends in Cluster #2. This same process is repeated for all clusters.The premise is by presenting the friends in CNM cluster order, the user can set the policy for the Same-As Example Friend and then associate all other similar friends with this Same-As Example Friend. The user's mental model is focused on one Same-As Example Friend at a time. After the policy is set for the Same-As Example Friend, the user can quickly ascertain that the stream of friends that follow may potentially be associated with this Same-As Example Friend. In our second approach for assisting users in selecting their Same-As Example Friend, called Sample CNM Order, we present all of the friends with the highest degree within their cluster first. These friends are highly connected and are potentially more well known and, thus, easier to remember making them good candidates for Same-As Example Friends. Using the example social network graph depicted in Fig. 7, Sample CNM Order will present Friends A, L, and W first followed by the remainder of the friends from Cluster #1, followed by the reminder of the friends from Cluster #2, and then the remainder of the friends from Cluster #3. In Sample CNM Order, users enable their policies globally followed by policy assignment for each of their friends. The premise of this approach is that the user will set all their policies for all their Same-As Example Friends first and then quickly associate the stream of friends that follow with their respective Same-As Example Friend.

4.USER STUDY

In designing our user study [Approved IRB Protocol #11-08-01], we set out to answer the following research questions: Q1. Do proven clustering techniques align with user-defined relationship groups? Q2. Can proven clustering techniques assist users in grouping their friends more efficiently? Q3. What are users' perceptions of Assisted Friend Grouping techniques? Q4. Will a policy management approach based on leveraging a user's memory and perception of their friends outperform traditional group-based policy management approaches? Q5. Do different policy management approaches impact the conservativeness of a user's policy? Q6. Will users' perceptions of a policy management approach based on leveraging a user's memory and perception of their friends be higher than traditional group-based policy management approaches? Q7. Can different friend selection techniques effec- tively aid users in picking example friends that are used in developing policy templates?

4.1 Design

To answer these research questions, we built four tasks and two surveys into our two prototype Facebook applications. The first three tasks and the first survey were designed to evaluate traditional group-based policy management and our Assisted Friend Grouping Model. The fourth task and the second survey were designed to evaluate our Same-As Policy

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Management Model and Example Friend Selection.In the first task (Task 1), the user is instructed to place 50 of their randomly selected friends into the 10 predefined groups. We divided the user participants into two groups, namely Not Assisted and Assisted. For the Not Assisted population, the 50 friends were presented to the user for available and visible to the user, but it also must be readable. Policies that are complex and difficult to under-stand are more likely to be misconfigured resulting in unintended consequences, for example, data leakage. Flexibility. Policy management mechanisms must be flexible to accommodate the user's needs and intentions. Effective policy management must create a balance between coarse-grained and fine-grained access control. Traditionally, coarse-grained access control provides few options to the end user. On the other hand, fine-grained access control, although extremely flexible in that it provides lots of options and capabilities, is traditionally overwhelming and complex. A balance between too little flexibility and an overly burdensome policy management mechanism is needed. The second prototype Facebook application includes the fourth task and second survey. This task was

Ease of Use	
Question 1	It was simple to use this system.
Question 2	Overall, I am satisfied with the ease of completing the tasks.
Question 3	It was easy to learn to use this system.
Readability	
Question 4	I easily understood who had access to what in my profile.
Question 5	The information was effective in helping me complete the tasks and scenarios.
Question 6	I could understand what my friends could access in my profile.
Flexibility	
Question 7	The system had enough flexibility in allowing me to set what my friends could access in my profile.
Question 8	This system has all the functions and capabilities I expect it to have.
Question 9	I could easily set what my friends could access in my profile.
Westin Privacy Sentiment	
Question 10	Users have lost all control over how personal information is collected and used by companies.
Question 11	Most businesses handle the personal information they collect about users in a proper and confidential way.
Question 12	Existing laws and organizational practices provide a reasonable level of protection for user privacy today.

designed to evaluate our Same-As Policy Management Model, as described in Section 3.2. The user was instructed, for a subset of their friends (50 randomly chosen ones), to select a Same-As Example Friend. We divided the user participants into three groups, namely Random, CNM

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Order, and Sample CNM Order. For the Random population, the 50 friends were presented to the user in random order. For the CNM Order and Sample CNM Order populations, the 50 friends were presented to the user in CNM Order and Sample CNM Order, respectively, as described in Section 3.3 After the user selected their Same-As Example Friend, they then set appropriate profile object permissions for this example friend and assigned the policy to appropriate like or similar friends. This step was repeated as necessary, i.e., for as many unique policies the user would like to assign for their friend set. We measured the total time to complete Task 4. After completing Task 4, the user completed a second survey identical to the first survey.grouping in random order. For the Assisted population, the 50 friends were presented to the user for grouping in CNM group order, as described in Section 3.1. Friends were presented to the user for grouping based on clustering the user's social graph using the CNM algorithm. We measured the grouping time for both populations. After the user placed their friends into groups, they were asked to select access permissions for each group (Task 2). Allow/Deny permissions were selected for each profile object and/or profile object category. Finally in Task 3, the user was asked to review and possibly select friend-level exceptions to the group policy that was set in Task 2.Upon completion of Tasks 1, 2, and 3, the user was asked to complete the first survey. The initial part of the survey collected basic demographic information summarized in Section 4.2. In the remaining portion of the survey, the user responded to questions designed to capture their perceptions of group-based policy management, both the Not Assisted and Assisted Friend Grouping approaches. Table 2 provides a sampling of the questions, which were presented to the user in a different order than they actually appear in the table. The question responses are on a Likert-scale of 1 (strongly disagree) to 7 (strongly agree). Each question is designed to capture the user's perceptions in the following areas: Ease of use. The user needs to be able to manage their policies in an easy, intuitive, and effective way such that they have a consistent experience. Complex and laborious policy management mechanisms can lead to ineffective policies. Readability. Not only does a policy management solution have to be easy to use, it must be decipherable. The core component of any access control mechanism is the policy that governs the access.

CONCLUSION AND FUTURE WORK

In this paper, we enhance existing and introduce new privacy management models, in addition to measuring their human effects. First, we present an enhancement to traditional group-based policy management, which assists users in grouping their friends more efficiently. With Assisted Friend Grouping, we found measurable agreement between clusters and user-defined relationship groups. Second, we introduce Same-As Policy Management, which leverages users' memory and opinion of their example friends to set policies for other similar friends. Finally, we introduce two techniques for aiding users in selecting their example friends. By associating policy

templates with friends versus group labels, Same-As Policy Management allowed users to author policies more efficiently and was more positively perceived over traditional group-based policy management. In addition, by leveraging our user study results, privacy management models can be further enhanced by detecting and leveraging user privacy sentiment. Based on a user's privacy sentiment, the privacy management model can be tailored. For example, for unconcerned users, a more coarse-grained privacy manage- ment model could be leveraged and for Fundamentalists, a more fine-grained approach could be used. Our future work plans include running additional studies and comparing the two CNM-based policy management model enhancements (Assisted Friend Grouping and Example Friend Selection) in terms of policy definition, openness, and their human effects. In addition, we plan to further investigate patterns in alignment of clusters and user-defined relationship groups. We also plan to develop a prototype that leverages user privacy sentiment for the mass customization of a privacy management model.

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