CareBook: Assisting elderly people by social networking

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1 Introduction

In Belgium (and many other European countries), the avarage age of individuals is increasing significantly. Many governmental as well as commercial initiatives aim at supporting elderly people in daily tasks. Examples are cooking services, cleaning services and health related services (such as washing, pedicure ...). However, society can no longer sustain the huge costs of these services. Moreover, some tasks can easily be performed by relatives (i.e. people in the social network around a person that needs assistance). For instance, a neighbour can cook frequently or a daughter can clean the house. Although relatives can reduce the increasing work load and costs, many elderly people are reluctant to rely on their social network for two main reasons. First, unfair task allocations may put a burden on certain relatives. Second, the execution of certain tasks (such as meal services) must be guaranteed daily. Many relatives may in fact be willing to offer health care support to patients although they do not want to give a commitment to offer it daily and for a long period. A fair digital platform for building and maintaining a social network around elderly persons may overcome these barriers. Sites, such as LinkedIn[4], FaceBook[3] and Twitter[7], show that maintaining social networks is nowadays an important part of people's activities in the virtual world of the internet. Contacts with friends and relatives on social network sites are seen as easier to maintain, but equally relevant, as real-life contacts. Our platform is inspired by the ease-of-use and potential of social network sites. Clearly, the requirements for our platform differ greatly from those of social network sites. For instance, our platform requires the support of more advanced services than only generic communication services, and we need to devote even more attention to advanced security and privacy issues[5][6]. These requirements are driven by the high sensitivity of data that must

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often be released to/by caregivers.

This paper presents CareBook, a digital platform that assists elderly people by social networking. The rest of this paper is structured as follows. Section 2 gives a general overview of the architecture. Section 3 describes the security design. Section 4 focuses on the allocation of tasks. This paper ends with conclusions and points to future research (see section 5).

2 Architecture

The CareBook application enables *patients* (i.e. individuals that need care) to manage a set of *caregivers* (i.e. the social network). The rest of this paper focuses on one service that is implemented in the CareBook application, namely the *allocation of tasks* to caregivers requested by a patient. Each task type has a name (f.i. `washing`, `cooking`, `financial_support`, `medical_organisation`), a set of required skills, a duration, and two sets of personal information that must be released by the caregiver and patient respectively, depending on the allocated task. For instance, a patient needs to release the pin code for her medical cabinet to the caregiver that is responsible for `medical_organisation` whereas he needs to release the access code to his bank account to the one responsible for `financial_support`. The architecture consists of 4 modules:

- A *client module* is available to registered inviduals (i.e. caregivers and patients). Each individual can add other members to his social network. Moreover, she can build a *profile*. A profile consists of identifying information, a set of skills and personal data that must be released to a caregiver (or patient) to perform a task (such a `pin_code` of the medical cabinet, bank account info ...). Moreover, she can define *availability preferences* and *privacy preferences*. The latter restricts the types of data a user is willing to release to another individual or a subset of users in the network. Finally, a patient can submit task requests to members in her social network.
- The *communication and storage module* stores information that is submitted by members in the network (i.e. it mediates interactions between members). This module can be run by a commmercial organisation. If task requests are submitted by a patient, the module forwards the requests and relevant information about the patient and other members in her social network (such as preferences, skills ...) to the *allocation module*.
- The *allocation module* assigns tasks to caregivers. Of course, caregivers and patients need to commit to the proposal of the allocation module before the task is actually allocated.
- The *registration module* issues pseudonym certificates to members (after identification). These certificates are used to enforce certain security and privacy requirements. We list these requirements in the following section.

3 Security and privacy

The security and privacy requirements are listed below. Next, the security design is discussed. The advanced requirements result in a more advanced security design than is currently adopted by social networking applications (such as Facebook):

- R_1: Strong authentication is required to access the CareBook application, to access personal data and to join the social network of patients.
- R_2: Personal data may not be revealed to the company. Users can define privacy preferences (i.e. users can define which personal data may be revealed to other entities in the network).
- R_3: Personal information is revealed to other members only if necessary to perform a certain task and after explicit consent of the owner.

Users receive a pseudonym certificate at registration (after identification). An assymmetric key pair (PK_U, SK_U) is generated by the user. The public key is certified by a certificate authority (CA). Individuals can use the pseudonym certificate to create an account and to build a profile. After activation, the company keeps a list of registered pseudonyms. Personal data is encrypted with the public key PK_U embedded in the certificate. Thereafter, the encrypted data are submitted and stored at the company. Hence, the company never knows the actual value of personal data. If personal data needs to be revealed to other members (i.e. if a task is assigned), the user needs to agree explicitly. If so, she pulls the encrypted data from the server at the company and decrypts them with her private key. Next, the required data are encrypted with the public key PK_C of the caregiver and submitted to the company. The caregiver can now retrieve a encrypted subset of personal data of the patient and decrypt it with her private key SK_C.

4 Allocation of tasks

The task assignment algorithm suited for the CareBook application is concerned with the fair allocation of tasks among the social network of the patient. The interest for developing algorithms that fairly divide or allocate goods amongst two or more persons mainly originates from research within Economics. However, recently the fields of computer science and artificial intelligence got highly interested in the topic of fairness while developing automated multi-agent systems that should interact with humans [**?**]. Centralized and distributed mechanisms such as voting, trading and negotiation have been developed to guarantee some specific fairness criteria. In this first iteration of the CareBook application, the Top Trading Cycle algorithm that reduces the amount of envy between agents, is implemented [1]. In an envy-free environment no agent wants to exchange its good or allocation. Complete envy-freeness is generally impossible to be achieved, but any reduction in envy between agents is useful to increase the probability of agents agreeing with the proposed allocation.

5 Conclusion and future work

This paper presented the results of the first iteration of a social care networking application. The application integrates advanced technologies and recent research in multiple domains (i.e. architectural design, security/privacy and artificial intelligence). Moreover, it opens up huge opportunities for future research. First, including care organisations (voluntarily services) and companies (meal service providers) as caregivers bootstraps research on optimisation. Second, the performance of a system that combines AI blocks and security/privacy blocks can be evaluated. Third, trust levels and

policies can be extended. Finally, adding new services may improve the attractiveness of the system.

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