Social Network for Elderly

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Abstract: Elderly's health is closely related to their level of social activity. Maintaining an active social life contributes to peoples' ability to live at home longer and enjoy an active and healthy life. Yet, as age progresses maintaining and expanding a social network can be challenging. The work presented here demonstrates a design and implementation of a social network system for elderly, including a recommender system, which will recommend relevant cultural and social events, and friends and acquaintances to enjoy these events with.

1 Introduction

The expected development in demographics in the western world, "... can be characterized as a gradual shift from a society with quantitatively dominant younger cohorts to a society in which the elderly form a solid majority" [Mue07, p. 5]. The current projected scenario estimates that the median age of the population in the European Union will have risen to 48 years, up from 38.5 in 2005. The ratio between the older and the younger population is expected to change from 100 people in the working age range 15–65 to 25 people of age 65 and up in 2005 towards 100 younger people to 51 older in 2050.

Gaymu et al. examine issues of care needs of dependent older adults for nine European countries based on projections for future development until 2030 [GEB07]. They expect that the proportion in the ageing population requiring professional care will grow slower than those with at least the potential of being supported by family. These trends will make the need for children to care for their parents more pronounced. Consolvo et al. classify caretakers based on the impact that carers allow care giving to have on their own lives: the drastic life changer will often sacrifice career or hobbies, the significant contributor will see a profound impact, but with his own life still in focus, and the peripherally involved will provide sporadic care [CRS04].

The field ambient assisted living attempts to counter this fast growing need for care personnel by augmenting the living environment with computerised artefact enabling elderly to live healthy and good life at home. Ambient assisted living applications range from smart home scenarios (see e.g. [SML^{+}09]) to mobile wellness applications (see e.g. [TH07]). Recently, there has been a growing interest in stimulating social connections.

Living alone and isolated is a common problem among the elderly part of the population, in particular in the western world [DW96, RP03]. Tackling this isolation and loneliness among elderly is increasingly being recognised as an important aspect of improving elderly's wellbeing and health. Loneliness is often associated with being disconnected from society, lacking social relations, such as "...nobody asking for me and nobody to ask for...", and not being appreciated [HK10].

Preventing social isolation and maintaining elderly's health and functional capabilities are critical premises for realising the ageing-at-home vision. While social media can play a key role in helping people feel connected to the outside world, conventional solutions are typically not designed to cater for the elderly population. Solutions such as Facebook or Google+ are designed without the specific focus that is required when working with elderly. Thus, only certain types of individuals might benefit from these types of services [MFM08].

The work presented here describes the development of a personalised mobile social recommender system to help promote active living among elderly, both in a physical and social sense. The Social Network for Elderly (SNE) system focuses on developing a system specifically for the elderly population. SNE will inform the elderly about various events and engage them in joining social activities through smart phones. The system was designed and implemented as a student project as part of a project course for 4^{th} year engineering students in the cooperation with the ongoing AAL project *co-living*[1].

The rest of the paper is organised as follows: Section 2 describes the design and implementation of SNE along with some of the design considerations; Section 3 details the functional testing, the limited acceptance tests carried out and the preliminary results obtained; Finally, Section 4 ends the paper with a summary, a brief overview of ongoing testing and and outlook on future work.

2 System Design and Implementation

The SNE system is based on the Service Oriented Architecture (SOA) principle. The architecture consists of three main parts: the content provider, in this case the municipality; the end-users, who are primarily using an Android client; and the SNE server (see Figure: 1). The SNE server consists of the *content data base*, the *user data base*, the *user model*, the *social graph* and at the core the *recommender*.

The content provider's interface is a straight forward web-interface that allows users to add events along with classification information, such as the type of event, when and where,

[1] http://www.project-coliving.eu/

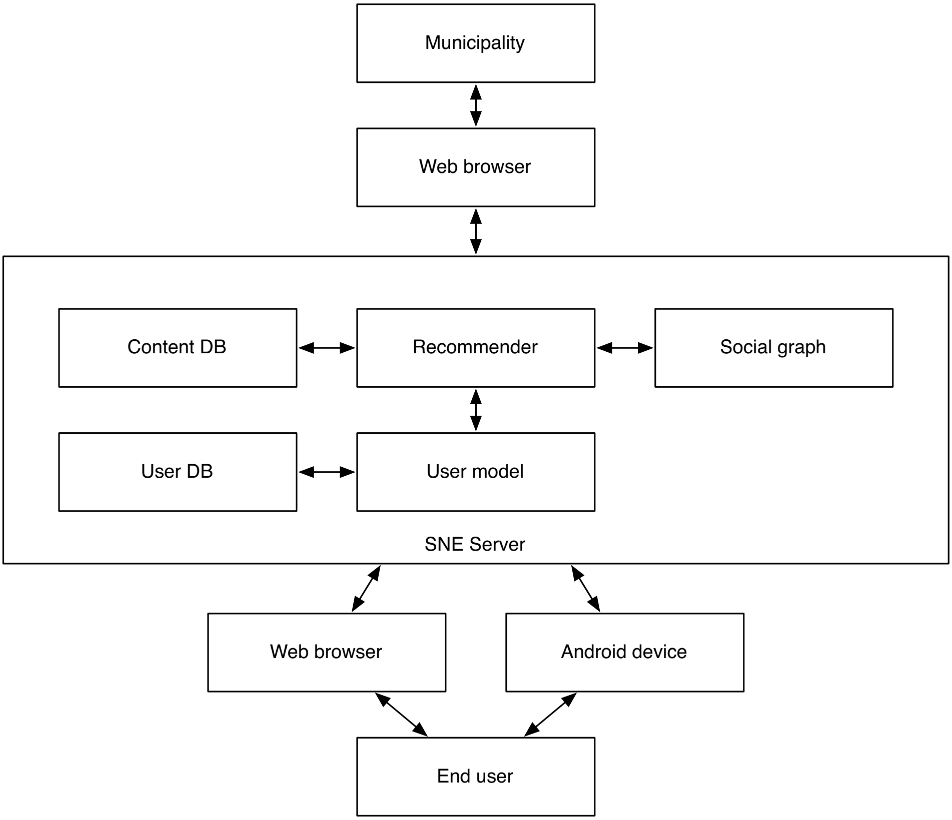

Figure 1: SNE architecture

and price. The content and the user data bases are persistent storages for content and user information, respectively. These parts are more or less run-of-the-mill implementations and will not be detailed further. The remaining parts of this section will describe the user and event modelling, how this is used in the recommender; the social graph and its affect on the system and the end-user application and interface.

2.1 User and Event Modelling

When choosing a specific way of modelling users for adaptive systems some considerations as to the nature of the users and system in question are required. The three most important aspects to consider are: i) if users are homogenous or heterogeneous; ii) whether users are permanent or not; and iii) if their interests are persistent [Lie95].

When working in domains where users are a homogeneous group it is likely that canonical

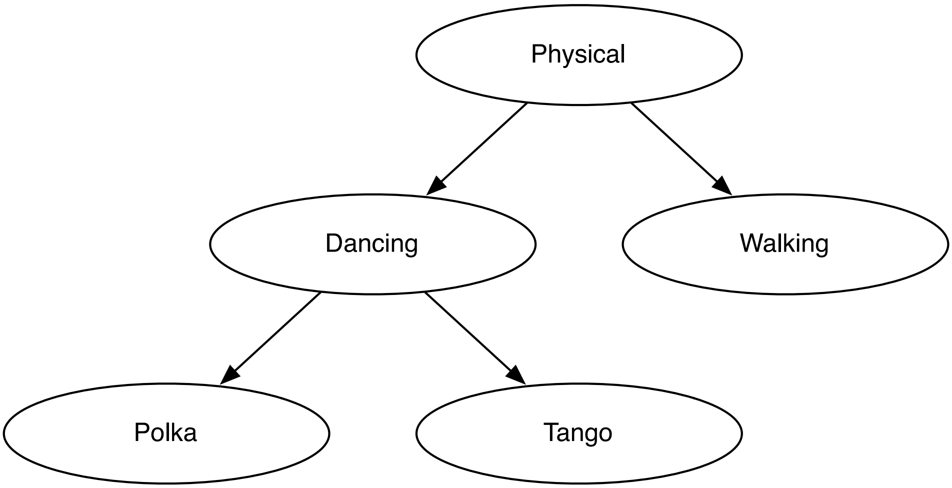

Figure 2: Example of tag taxonomy

user models are to be preferred. Whilst in domains consisting of heterogeneous users special user models would be the preferred option. In domains where user are permanent the system has the option to learn specific user models over time. Whereas, in domains with non-permanent users, canonical models are most useful.

In general, systems with homogeneous and non-permanent users will use very limited and standardised user models. Compared to systems with heterogeneous and permanent users, where very personalised user models will be used. Systems like SNE will typically contain permanent and heterogeneous users; one can also assume that users' interests are persistent. Thus, the option of learning user models exist. However, boot strapping recommender systems with new items and/or new users is a well known problem even in these types of domains. Not having sufficient information is know as the *cold start* problem.

The cold start problem can, to a certain degree, be mitigated by employing user models. Yet, building these models require sufficient knowledge about the specific users. Acquiring this knowledge suffers from the *knowledge bottleneck* problem. That is, it is time consuming (for the user) and not necessarily easily accessible.

The work presented here uses stereotype modelling, in the tradition of Rich [Ric83], to mitigate both the cold start and the knowledge bottleneck problem. Using stereotypes is a quick and efficient way of building user models. A stereotype contains characteristics about a user that fits particular stereotypes. The main advantages of using stereotypes are that they are easy to build and quick to use (mitigating the bottleneck problem).

Stereotypes contain information about stereotypical characteristics, which are known as facets. A facet will traditionally be represented by a value ranging from -5 to 5. Further, each facet has a certainty assigned to it, ranging from 0 to 1000. The rating gives an estimate on how certain the system is about the value assigned. Thus, a high facet value tells us that the users is very interested in the particular facets, while a high certainty rating tells us that we are very certain of the rating.

Stereotypes are organised as a directed acyclic graph (DAG), where the root node, *any-person*, contains all the facets with average values, and more descriptive values for the facets are given for the more specialist stereotypes. When a user first registers to SNE, a series of questions are asked that will match the user to a set of stereotypes. Whenever possible the most specific stereotype will be chosen. The sum of matched stereotypes is know as the *user synopsis*. This model is fed into the recommender whenever a recommendation is required, and based on the result of the recommendation the user synopsis can be adapted over time to the user's own idiosyncrasies.

Events are tagged with facets that correspond to the ones used in the user model. These tags are also ordered in a DAG, or more specifically a taxonomy. Figure 2 gives an example of the facets related to physical activity. As depicted, *dancing* and *walking* are both types of physical activity; and *Polka* and *Tango* are both types of dances.

The specific user's model describes, by giving a value to, the relationship between the facets ascribed to the user and the tags available to the system. Using these values the recommender is capable of estimate the fit between a specific user and a specific event.

2.2 Social Graph

The main purpose of the SNE system is not to be yet another event recommender, rather to recommend not only events that are to the user's liking but also people to attend these events with. Thereby (hopefully) increase sociability of the elderly users. The social graph follows much the same approach as the one by e.g. Facebook[2].

The users are organised in the graph (see Figure 3 for an example) and when recommending events to a user the system can traverse the graph in several dimensions. For an example, finding other users in user's neighbourhood, in the graph or physically, who has similar preferences and suggesting that these two participates in an event together. Alternatively, suggesting users with similar preferences, but outside the user's graph neighbourhood to expand the user's social network.

2.3 Recommender

Recommender systems are designed to help users cope with vast amounts of information, and they do so by presenting only a certain subset of items that is believed to be relevant for the user. Traditionally, these systems recommend items like books (`amazon.com`) or films (`movielens.com`), but may just as well recommend events relevant to users.

Recommender systems are usually grouped into two categories: *Content-based* systems and *collaborative filtering*. Content-based systems make recommendations based on a

[2] It could actually be preferable to use Facebook as the supplier of the graph in future incarnations

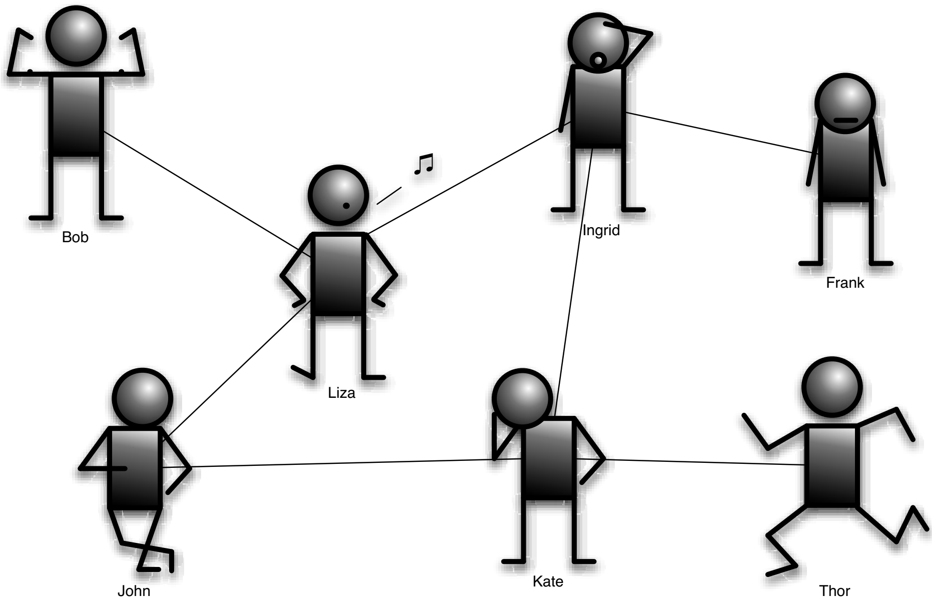

Figure 3: Example of social graph

user preference model that combines the user's ratings with, e.g., content information and structured descriptions of events. On the other hand, collaborative filtering uses the "ratings" of like-minded users to make recommendations for the user in question. Ratings can be explicit (e.g., a number of stars given to an event), or implicit (e.g., the amount of time attended an event that was recommended).

Over the last decade recommender systems based on collaborative filtering have enjoyed a great deal of interest. Collaborative filtering systems are often characterised as either being *model-based* or *memory-based* [BHK98], although hybrid systems have also been developed [PHLG00]. Roughly speaking, memory-based algorithms use the whole database of user ratings and rely on a distance function to measure user similarity. On the other hand, model-based algorithms learn a model for user preferences, which is subsequently used to predict a user's rating for a particular item that he or she has not seen before.

The work presented here approaches the idea of recommending events through a content and model-based approach. Currently the recommender calculates the distance between a user's preferences and the corresponding tags. The collaborative filtering algorithm starts by calculating the ÓPrefValueÓ for each tag, and then traverses the graph from the bottom, since the bottom-most tags are estimated to describe the event best. The ÓPrefValueÓ of the bottom-most tags are multiplied by a factor of 1.0, then their parents 0.5, and grandparents 0.25. Then all these values are added together for a combined preference value, if there are multiple paths of tags in the graph, then the combined preference value is the mean of these paths.

Figure 4: Initial user interface

2.4 End-user Interface and Universal Design

When designing applications for elderly or people with disabilities, the rules of universal design must be adhered to. Universal design is a set of concepts and ideas to use when designing (universally) accessible solutions. The term *universal design* was coined by Ronald L. Mace[3]. Selwyn Glodsmith pioneered the concept of free access for disabled people [Gol97, Gol00].

In the context of computer systems, universal design is used to ensure that web-pages are accessible and usable for all people, regardless of life situation, abilities or disabilities, age and education. Disabilities might include impaired vision, light sensitivity, physically being unable to handle equipment of certain kinds or learning difficulties. Since June 2011 all new IT solutions for the public in Norway has to comply with universal design standards. The most important reference for this work in the Web Content Accessibility Guidelines (WCAG) from W3C [CCRC08].

The implementation of SNE conforms with the main principles of WCAG:

Perceivable Information and user interface components must be presentable to users in ways they can perceive.

Operable Information and the operations of the user interface must be understandable.

Robust The content must be robust enough to be interpreted reliably by a wide variety of user agents and assistance tools.

The user interface on the Android device is designed and implemented following the universal design philosophy. This means that there are large buttons, large font sizes and good

[3] `http://www.udinstitute.org/`

Figure 5: Android interface for specific event

colour contrast to improve the usability for the end users. Further, the system also has a clean and simple layout, which the elderly users are able to handle. Figure 4 shows the initial user interface on an Android device. The buttons lists five categories of events that the user can choose from.

3 Testing and Results

Testing of the SNE system has been done, and indeed is being done, continuously. Testing can be divided into two main parts: *verification*, the code actually works the way it is supposed to do; and *validation*, the program actually fulfils the requirements. The SNE system was designed, implemented and tested during the autumn of 2011. The process was carried out through nine sprints following the Scrum approach.

The verification tests covered 20 different test cases relating to the components for the content providers and end-users, as well as functionality testing of the databases. With respect to the validation testing, the user interface and functionality was tested by two employes at the municipality and two elderly subject.

For the municipality, the test persons were satisfied with the system and it lived up to the requirements put on it. The system was fairly simple and easy to use, something that they liked. They suggested some additional features like the ability to add groups of people with companion and have a printable version of the list of participants.

The end-users appeared to have a bit more technical knowledge that what could be expected on average. One of the users were quite happy with the system, whereas the other one was sceptical; he thought that elderly would rather call their friends than having the system do it for them. In general, the idea of social graphs and not having total control of friends appeared to be a bit intimidating. The result of the graphical user interface testing was that some of the layout should be changed. It was mostly a problem with the buttons name and layout, that made some choices not seem intuitive (Figure 5 shows the user interface as it looks after the initial testing).

4 Summary and further work

This is work in progress. So far the SNE system has been implemented in a working prototype. Functional verification of the core functionality has been carried out. Initial validation has also been carried out on a limited number of persons. Parts of the SNE system has been implemented in the Co-living system.

There are currently some limitations compared to the original envisioned functionality, The social graph has rather a limited functionality. Currently the recommender does not offer social recommendations. This is currently under implementation.

As part of the ongoing Co-living project, long term and extensive test and validation is currently being carried out. We are currently recruiting and training end-users in the municipality of Trondheim.

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References

[BHK98] John S. Breese, David Heckerman, and Carl Kadie. Empirical Analysis of Predicitive Algorithms for Collaborate Filtering. Technical Report MSR-TR-98-12, Microsoft Research, 1998.

[CCRC08] Ben Caldwell, Michael Cooper, Loretta Guarino Reid, and Gregg Canderheiden, editors. *Web Content Accessibility Guidelines (WCAG) 2.0.* W3C, 2008. http://www.w3.org/TR/WCAG/ [last accessed 2012-03-01].

[CRS04] Sunny Consolvo, Peter Roessler, and Brett E. Shelton. The CareNet Display: Lessons Learned from an In Home Evaluation of an Ambient Display. In *Ubicomp*, pages 1–17, 2004.

[DW96] J. M. Donaldsom and R. Watson. Loneliness in elderly people: an important area for nursing research. *Journal of Advanced Nursing*, 25(5):952–959, November 1996.

[GEB07] Joëlle Gaymu, Peter Ekamper, and Gijs Beets. Who will be caring for Europe's dependent elders in 2030? *Population (english edition)*, 62(4):675–706, 2007.

[Gol97] Selwyn Goldsmith. *Designing for the Disabled: The New Paradigm*. Architectural Press, 1997.

[Gol00] Selwyn Goldsmith. *Universal Design*. Architectural Press, 2000.

[HK10] Solveig Hauge and Marit Kirkevold. Older Norwegians' understanding of loneliness. *International Journal Qualitative Studies on Health and Well-being*, 5(1), February 2010.

[Lie95] Henry Lieberman. Letizia: An Agent That Assists Web Browsing. pages 924–929, Montreal, Quebec, Canada, 1995. kaufmann.

[MFM08] David Mellor, Lucy Firth, and Kathleen Moore. Can the Internet improve the well-being of the elderly? *Aging International*, 3(1):25–42, March 2008.

[Mue07] Rainer Muenz. *Aging and Demographic Change in European Societies: Main Trends and Alternative Policy Options*. Number 0703 in SP Discussion Paper. Social Protection Advisory Service– The World Bank, Washington, DC, USA, 2007.

[PHLG00] David M. Pennock, Eric Horvitz, Steve Lawrence, and C. Lee Giles. Collaborative Filtering by Personality Diagnosis: A Hybrid Memory- and Model-Based Approach. In *Proceedings of the Sixteenth Conference on Uncertainty in Artificial Intelligence*, pages 473–480. Kaufmann, 2000.

[Ric83] Elaine Rich. Users are Individuals: Individualizing User Models. *International Journal of Man-Machine Stuides*, 18:199–214, 1983.

[RP03] Pirkko Routasalo and Kaisu H. Pitkala. Loneliness among older people. *Reviews in Clinical Gerontology*, 13(4):303–311, August 2003.

[SML+09] Andrew Sixsmith, Sonja Meuller, Felicitas Lull, Michael Klein, Ilse Bierhoff, Sarah Delaney, and Robert Savage. SOPRANO âĂŞ An Ambient Assisted Living System for Supporting Older People at Home. In Mounir Mokhtari, Ismail Khalil, JÃľrÃľmy Bauchet, Daqing Zhang, and Chris Nugent, editors, *Ambient Assistive Health and Wellness Management in the Heart of the City*, volume 5597 of *Lecture Notes in Computer Science*, pages 233–236. Springer Berlin / Heidelberg, 2009.

[TH07] Barnabás Takács and Dávid Hanák. A Mobile System for Ambient Assisted Living with Ambient Facial Interfaces. *IADIS International Journal on Computer Science and Information Systems*, 2(2):33–50, 2007.