# Towards Life-long Personalization Across Multiple Devices: The Case of Personal Career Management

Rainer Wasinger[1], Anthony Collins[1], Michael Fry[1], Judy Kay[1], Tsvi Kuflik[2], Robert Kummerfeld[1]
[1] CHAI Group, School of IT, Sydney University, 2006, NSW, Australia
{rainer.wasinger, anthony.collins, michael.fry, judy.kay, bob.kummerfeld}@sydney.edu.au
[2] University of Haifa, Haifa, Israel
tsvikak@is.haifa.ac.il

## 1 Illustrative Scenario

Consider the following scenario. Sammy is a professional software developer, and although content with his current job, is also keen to keep his skills up to date and to keep a look out for new career opportunities in both his current field of work (i.e. as a software developer) as well as potential new fields of work (e.g. as either a developer specialising in user-models and mobile applications; or as a project manager).

Sammy has undergone many years of education, having completed 6 years of primary school, another 6 years of high school, 4 years at a University, and a number of speciality post-graduate short-term courses. He has much of these 16+ years of education (as well as details on his past job positions and his possessed skills) condensed into a 2 page curriculum-vitae. Sammy has an inkling that having 16+ years of education and experience, condensed into 2 pages of curriculum-vitae might be missing something, but he can't quite put his finger on what (or just how much).

Now consider the following vision: Sammy has a life-long user model containing details of his past education and employment, and at a granularity that contains individual course names and all the topics covered within each course, according to a given curriculum (be that a national school curriculum, a university-specific curriculum, or other), as well as details of past work experiences (types of systems, programming languages etc). He has just registered to an online career web service and installed a career management application onto his favourite mobile device and is keen to look at what career prospects might exist for him both now and in 5 years time. Using data contained within his life-long user model, the system is able to quickly configure an application-specific persona that is used to filter thousands of job listings from a 3rd-party server. He then commences to browse these personalised listings on his mobile device whenever he has a few spare minutes of time (e.g. during his bus trip to and from work) and notes to himself the importance of being able to efficiently consume information on small screen devices and in busy mobile contexts, as well as the ability to easily pause and resume tasks when the user is mobile. He also appreciates how a number of different and diverse data sets (e.g. his own life-long user model and the 3rd-party job listings) are being used to create him a personalised list of easily browsed career opportunities within his organisation, the city he lives in, as well as more globally; and the way that educational opportunities also link back to current weaknesses in his career management profile.

## 2 Discussion

The above described scenario is not too fictitious. It demonstrates one of the aspects where lifelong user modelling is needed for supporting a personalized service for a user on a daily basis. There are many similar activities in a user's life that will benefit from being able to harness information contained within a life-long user model; career management - which we feel has strong ties to education as well as work experience and other contextual aspects - is one such task. The research community is still a long way off from solving all the issues surrounding the use of life-long user models. [1] describes some of these issues as being: data capture, user profiling, reasoning, and recommendation, and [2] describes the issues of interoperability, scrutability, control, and user privacy. This position paper presents some of the technical and social implications and possible solutions for integrating multiple data sources with a life-long user model, to be used with small-screen devices in pervasive computing. Following are some suggested solutions for challenges implicitly suggested by the above scenario.

From a **user modelling** point of view we need to consider what user-modelling data will look like for educational and career-management domains and how it may be maintained over time. As representations and terminology tends to evolve, simple evidence-based user models will require considerable reasoning efforts for combining relevant pieces (as well as considerable storage). One possibility may be to rely on domain ontologies that are flourishing nowadays and represent users' skills as an overlay over domain ontologies, where the user model contains a link to the ontology as well as a list of abstract terms and a definition of levels of knowledge and/or interests. This option solves the need for detailed domain ontologies or relying on reasoning about personal definitions. Still, reasoning will be needed for integrating data from different ontologies (different institutions will probably use different ontologies), but this will be largely resolved by future ontology matching research. Periodic maintenance will take care of ontologies evolvement over time.

**Place of storage** of user modelling data is another challenge. Users should have control over their personal information, hence the lifelong user model should reside in the possession of the user (e.g. on the personal device and/or on a personal computer or on a secure server). This approach, combined with the previous suggestion relies heavily on internet access (overlay model over remote ontologies), however, nowadays it is reasonable to assume that ongoing communication is possible whether by using a mobile service provider or WiFi. When considering the home environment, profiles may reside on the home-server and be synchronized with the mobile version every time the user enters/leaves the house. Having a personal profile stored over a secure server may be a possibility as well. The key concept is that the lifelong user model will be in the possession of the user and information will be revealed to service provider following user-defined privacy policies.

For a life-long user model to be useful, relevant communication protocols for information sharing are essential. An **API** needs to exist through which applications can contribute and retrieve data. Additional to such an API, a supporting framework to control access to (and to monitor and record) the data that is and has been provided over time to individual applications should also exist. Such communication can be based on extensions to the already suggested UserML.

In addition to the actual user model data, it is conceivable that **reasoning and inference** layers will exist on top of the data and rules be applied to the data, in order to increase the relevance of that data to the user's current context. For example, consider the concept of "forgetting" learned material and how this might apply to both technical skills and social skills that a user has acquired over time. The effect of forgetting might for example be modelled as a rule based on elapsed time, though perhaps also using information in a forgetfulness layer so that each user model attribute can be treated uniquely. The notion of privacy and access control may also be modelled using a layer approach in which users indicate by privacy policies, which attributes can be used for which purposes (e.g. not to be used at all, only for intermediary purposes, or only by certain applications).

**Visualisation of user-modelling** data and user interface design will be particularly important considering for example, on top of the limited display space provided by current mobile devices, that the user model data is likely to be quite exhaustive, and viewed at different levels of granularity (e.g. consider sensor data), and on different time scales (e.g. data now and as it was in the past), and may (depending on the intelligence intertwined in the user model) be a result of multiple intermediary calculations on other attribute values. User alerts and user explanations will also need to be carefully crafted, e.g. to explain the type of data, the quantity of data, past requested-data, and expected future data requests by 3rd-party applications. Similarly, the formulation of reasons as to why an application requires a particular user model attribute, and consequences (for the application) in the user denying one or more of the attribute values would need careful consideration, as too features for a supporting framework to help prevent a user (e.g. in the form of user alerts or data locks) from providing 3rd-party applications with too much information (or even their complete user model) at the expense of a short-term gain (e.g. "give me all your data and I'll let you download this file now"). One solution for dealing with these UI design issues and interaction flow sequences will be to conduct careful user evaluations to determine what works best for users of small-screen devices in pervasive computing settings.

We discussed a wide range of challenges posed by applying lifelong user modelling in practice, in a pervasive scenario and suggested what seems to be initial feasible scenarios, however, we are sure that there are additional challenges, as well as solutions that we look forward to discuss.

## References


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