# Context-Aware User Modeling and Semantic Interoperability in Smart Home Environments

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## ABSTRACT

*The current paper provides an overview on how user modeling, context awareness and content adaptation in Smart Home environments may be handled formally in order to capture the semantics that emerge from a newly introduced user experience: SandS is in fact a complete ecosystem of users within a social network, creating and exchanging content in the form of so-called recipes and developing a collective intelligence which adapts its operation through appropriate feedback provided by the user. The authors will approach SandS from the user's perspective and illustrate how users and their relationships can be modeled through a number of fuzzy stereotypical profiles. Additionally, context modeling in pervasive computing systems and especially in the Smart Home paradigm will be examined through appropriate representation of context cues in the overall interaction. Finally, the authors will investigate how users and system services although using languages of different semantic expressiveness can inter-operate successfully thanks to appropriate knowledge-based expert mappings.*

*Keywords:   Content Adaptation, Context Awareness, Personalization, Semantic Interoperability, Smart Homes, Social Network, User Modeling*

# 1. INTRODUCTION

Although in their initial definition and development stages pervasive computing practices did not necessarily rely on the use of Internet, current trends show the emergence of many convergence points with the Internet of Things (IoT) paradigm, where objects are identified as Internet resources and can be accessed and utilized as such. Smart Homes that follow the IoT approach emerge the users in environments where data is continuously produced by appliances, sensors and humans, while data processing, knowledge assessment and decision making can be performed remotely. Following a pragmatic approach, the FP7

European Project and FIRE framework "Social & Smart" (SandS) aims to highlight the potential of IoT technologies in a concrete user-centric framework. The aim is for the user ("eahouker" in SandS) to collectively, via the SNS (Social Network Service), and intelligently, via the adaptive social network intelligence, interface and finally control his household appliances. The overall data transfer is orchestrated through a domestic infrastructure. The central role of the user is reflected on all aspects of the ecosystem, from the family of Things, which is socially governed to the household appliances that affect our everyday life, to the parameters of the domestic and network intelligence. This entire procedure is devised so as to optimally carry out ordinary housekeeping tasks with a minimal low level intervention from the part of the user, while preserving acquired knowledge through an inter-operable manner.

The main content medium inside the SandS framework are "recipes", i.e., messages containing a series of instructions in near natural, user friendly, language for controlling the appliances in order to perform a specific task. Recipes are exchanged between the users of the social network and are in turn adapted to each household. Eahoukers are considered definitely as pro-active users: they participate actively in content creation, modification and sharing but also produce additional qualitative content through feedback and recommendations about the recipes effectiveness. Moreover, by giving the means to the eahouker to intelligently control his domestic appliances and by placing him inside the ESN (Eahoukers Social Network), SandS follows clearly a human and user centric approach. User Modeling (UM) and adaptation emerges as an important research direction inside the framework; more precisely, UM not in a general sense, but relatively to the user's activity inside the ESN and with respect to the task on hand, the efficient orchestration of his household appliances (context). We are considering in particular a context-aware UM of eahoukers, taking into account all contextual information that could characterize the situation and condition of the system's entities. In SandS' case, this could be context information about the eahouker (distance to his house, communication device used, time of the day, weather, etc.), usage information (recipes used, feedback provided by user, frequency of use,..), information about the homes (geo-localization, proximity to other homes, surface area, number of rooms, etc.), about the appliances (location inside house, energy consumption levels, etc.) and information specific to the social network itself (friendship statements, content exchanged between users, graph structure, communities formation, etc.). Eahoukers are recorded and Computational Intelligence algorithms extract knowledge about groups of similar users and eventually construct for these groups stereotypical users (Personas).

Current paper investigates how each individual eahouker could be modeled with a simple user model, consisting of a fuzzy representation of extracted Personas. The main goal is to capture the semantics of the relationships between the user and the various entities of the ecosystem (recipes, other users, houses, appliances and manufacturers), in order to exploit them and improve the overall user experience. Finally, an important interoperability issue will be tackled in the process, namely how to bridge the gap between the expressively rich natural language vocabulary used in the recipes and the low-level machine-readable instructions with very precise and restricted semantic content.

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