Chapter 11
Organizing Contextual Data in Context Aware Systems: A Review

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ABSTRACT

Context aware systems strive to facilitate better usability through advanced devices, interfaces and systems in day to day activities. These systems offer smart service discovery, delivery and adaptation all based on the current context. A context aware system must gather the context prior to context inference. This gathered context is then stored in a tagged, platform independent format using Extensible Markup Language (XML) or Web Ontology Language (OWL). The hierarchy is enforced for fast lookup and contextual data organization. Researchers have proposed and implemented different contextual data organizations a large number of which has been reviewed in this chapter. The chapter also identifies the tactics of contextual data organizations as evident in the literature. A qualitative comparison of these structures is also carried out to provide reference to future research.

INTRODUCTION

Context aware systems aim at smart service discovery, delivery and adaptation based on a person or a group’s context. The context is considered as the set of attributes that describe an activity among participant persons and applications (Mahmud & Malik, 2014; Mahmud, 2015). The context requires a four stage process where in the contextual data is gathered, is represented and stored, is subsequently recognized and activity identified using machine learning techniques and finally the services are adjusted based on the recognition outcome (Mahmud & Javed, 2014). The complete system is set within the physical bounds of the environment that encompasses sensors, users and services. Context Aware Systems constitute mobile platforms and facilitate mobile computing (Musumba & Nyongesa, 2013; Hong, Suh, & Kim, 2009; Kiani, Anjum, Knappmeyer, Bessis, & Antonopoulos, 2013).

DOI: 10.4018/978-1-5225-0435-1.ch011

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The context is gathered from the sensors present on the environment. This context can also be acquired through user devices as well as interaction with the users present in the environment. Gathering the context requires a representation technique that maintains the diverse data acquired from the environment thus conforming to heterogeneity across multiple platforms. The collected data is consistently represented and stored in the system. Two research questions are highlighted in context gathering phase. First: What is the suitable technique for context data representation? And second: How is the data organized? Feng et al have raised the question of organization of contextual data as well. (Feng, Apers, & Jonker, 2004).

The theme of this chapter is the organization of contextual data and the survey of published evidences. HCI is the branch of computer science that strives to improve the interactions between humans and machines. It is a cross discipline encompassing computer science, cognition and psychology. HCI includes smart interfaces that recognize gestures to control applications (Schmidt, Context-Awareness, Context-Aware User Interfaces, and Implicit Interaction, 2014). HCI bridges the gap between human factors and the computing world to provide better interfaces based on the user’s preference, mood and state. User preferences are observed by monitoring the user’s activity (Malik, Mahmud, & Javed, 2009). The early computers could only be used by trained professionals who used keyboards and stared at black screens with white text all day.

Software Requirements Engineering (SRE) is the study of the end user to gather refined software requirements (Sommerville, 2015). The user being naïve is unable to explicitly provide requirements in a design and development friendly manner. Observing the users facilitates design and development with reduced risk in a Software Development Life Cycle (SDLC). SRE focuses on the daily activities and interaction of a user with his machine. With the advent of HCI the usage has become global where old and young both can use computing devices easily (Carroll, 2014). The core concept of HCI is increase in usability. Usability being a nonfunctional requirement as part of SDLC has now evolved into enhanced experience, entertaining, ease of learning with ease of using developer tools, gesture and mood recognition and context awareness (Dix, Finlay, Abowd, & Beale, 2003).

The actions performed by humans consciously or unconsciously follow some context. This context is acquired explicitly through sensors present in the environment or implicitly deduced though simple cognition mechanisms, traditionally (Grudin, 2001). The HCI aspect allows us to improve the usability of applications through which we can provide better, effective and efficient services. A simple application that switches the orientation of a tablet based on the holding style of the user is an example of context awareness in HCI (Schmidt, 2014).

This chapter serves as a probe into the context awareness research work and enlists the evidences of proposed organizations of contextual data. The list is not exhaustive and is populated using common keyword like “context-awareness”, “context-aware systems”, “context structure”, “context organization”, “context gathering and acquisition”, “context aware applications”, “contextual data”, “context organization”, “context structure” and “context representation”, etc. The search is carried out for published works as research papers in conferences and journals.

Researchers working on contextual data organization have proposed different context structures based on their approach and focus. These structures can be categorized into loose tactics which is presented in this chapter. The characteristics of contextual data are also outlined and a comparison of published contextual organizations is also presented.