Multi-Dimensional Context-Aware Adaptation for Web Applications

Jean Vanderdonckt, Vivian Genaro Motti

Louvain Interaction Laboratory, Louvain School of Management
Université catholique de Louvain, Place des Doyens 1,
1348 Louvain la Neuve, Belgium +32 10478525
{jean.vanderdonckt,vivian.genaromotti}@uclouvain.be

Abstract. This tutorial presents the state-of-the-art of adaptation for web interfaces concerning multi-dimensionality and context-awareness. The specific goals include: (i) the presentation of fundamental concepts, as: what is adaptation, relevant context information for adaptation and how to consider it to implement context aware adaptive applications for web, multi-dimensions for adaptation; (ii) the presentation of techniques currently used to adapt web applications, as methods, models and user-interface technologies for this domain; (iii) the presentation of adaptive web applications to illustrate: the context-awareness and multi-dimension adaptation in practice, in both: scientific and commercial domains.
Keywords: Web Interface adaptation, Context-awareness, Multi-dimensions

1 Context-aware Adaptation

Web applications are often developed for a pre-defined context of use: an able-bodied user, in a stable environment, with a conventional desktop PC. But web users have heterogeneous backgrounds, knowledge and goals. They interact via different devices, means, and from distinct environments. Thus, considering a pre-defined context of use may difficult the interaction. Context is information relevant for the interaction, as: the user, the place, and the available devices [5]. Context of use is also mapped as a formal model defined by the triple (U,P,E), where U characterizes the user, P the platform (hardware and software) and E the environment (social and physical) [3]. The 'Future Internet' aims at presenting the right information to the users, in the right time and in the right format, which requires high-level adaptations considering multiple, dynamic and on-demand contexts of use [2]. This tutorial presents the state-of-the-art of Multi-Dimension Context-Aware Adaptation, and it is organized in 3 parts; fundamental concepts, as important dimensions for adaptation of interfaces, the definition of context information and adaptation. Then, the concepts will be detailed with: methodologies, techniques, technologies that are used in this domain. And the tutorial will be concluded with examples of adaptive web applications.

2 Content

This tutorial is organized in: ***Fundamental Concepts***, ***Methods***, and ***Applications***.
The ***Fundamental Concepts*** are information in the domain of adaptive web applications. Adaptation transforms in different levels different dimensions of an application to improve the users' interaction. The context involves mainly user profile, platform and available devices. And the dimensions are aspects of the application that can be subject to adaptation in different levels, like: interaction modality, interactors, and technological space.
Methods are the main techniques, models, technologies and languages. Such as:

- The *context-aware design space* (CADS), a graphic representation to define dimensions for adaptation, as: adaptation means (redistribution and remolding), UI component granularity (total, dialog space and interactor), state recovery granularity (session, task, action), UI deployment (static and dynamic), context of use (user, platform, environment), technological space (intra, inter and multi) and the existence of a meta-UI (absence, meta-UI without negotiation, meta-UI with negotiation and plastic meta-UI). The CADS is: descriptive (the dimensions are well-defined as well as its different adaptation levels), exploratory (each application can be analyzed in a CADS in order to identify its strengths and weakness) and comparative (applications can be compared to find under-explored and potential dimensions for adaptation).
- The *context-aware reference framework* (CARF): a diagram to list context information. It defines adaptation concerning: what, who, where, when, how, to what and why. For instance, an adaptation technique for images, can be initiated by the system, it can be performed in the client side, at run time, considering the device, and to improve the accessibility level.
- Different technologies can be used to implement adaptive web applications, but preferably, to accommodate different use scenarios, the architecture of the system must be organized in different layers, such as: content (XML), presentation (XSLT, CSS) and processing (JavaScript). As User-Interface Description Languages, developers can adopt UsiXML, UIML, IDEAL2.

• A three layers model considers distinct levels for adaptation rules. First-order rules define direct commands, as: R1="if it is a mobile platform, then replace all radio boxes by drop-down lists" or R2="if it is a mobile platform and the entries are limited, then replace radio boxes by edit fields with codes"; a second-order rule defines strategies by prioritizing rules: "if the user is an expert, then prefer R1 than R2"; and third-order rules are adaptation strategies that consider sets of second-order rules, and the context in a more structured, and intelligent way: "if user is an expert, then reverse the preference order of R1 and R2 ". Parsers analyze the context and evolutive models capture its dynamic aspects, to analyzing changes and learning from the user feedback to perform adaptation efficiently.

The tutorial will be concluded with the presentation of Adaptive **Applications**. For instance:

• Rekimoto's pre-distributed pick and drop exemplifies a static UI deployment [10]. Pick and drop is an interaction paradigm that extends the drag-and-drop. The user selects a resource (like a video-file) by selecting its icon, and then, drags it to another device, to copy and share it.

• Sedan-Bouillon is a plastic website that can be distributed by the user [1], by specifying platform screens in which the workspaces of the website will be accessed. Sedan-Bouillon exemplifies re-molding and re-distribution: techniques that are performed at the workspace level: the title, content, and the navigation bar are the smallest units for re-molding and re-distribution.

• Meta-user interfaces are functions to help users to control and evaluate the state of interactive ambient spaces. A dimension space is presented to classify, compare and contrast research efforts in the meta-UI domain. Models and mechanisms are being developed for re-molding and re-distribution under the umbrella of plastic UI's and context-aware adaptive UI's. A prototype for meta-UI was designed to support the discovery and coupling of mixed-by-design objects (PDA's and PC), and UI re-distribution [4].

• Interfaces can be distributed in different levels. A toolkit partitionates the GUI of applications over the display processes [9]. A single display process can, thus, combine parts of the GUI of each application, in one or more windows. The goal was to show that a complex application (with toolbars and buttons) could be distributed over many devices and users. An interface can be decomposed in components, and a workspace can be divided into migratable regions. One of the specific goals was to distribute atomic elements of the interface. Buttons on the drawing toolbar were detachable and distributable as well as paragraphs or lines of the text.

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