User-driven visual composition of service-based interactive spaces

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ABSTRACT

Objective: The overall objective of the research work presented in this paper is to investigate models, methods and architectures to replace fixed, pre-packaged applications with flexible composition environments that make interactive environments "emerge" at run-time, based on composition actions performed by non-technical users. The approach aims at the lightweight construction of integrated, situational workspaces pervasively accessible and sharable through a variety of devices.

Methods: Based on a meta-design approach, we designed and implemented a platform that allows end users, not necessarily experts of technologies, to extract contents from heterogeneous sources and compose Personal Information Spaces (PISs) that satisfy their information needs. Specific emphasis is posed on the adoption of a composition paradigm that abstracts from technical details and can thus be used by non-technical users.

Results: The platform for service composition that supports the activity of the different involved stakeholders is described in details. Thanks to the separation of concerns on which the composition paradigm is based, the overall approach and its enabling platform are also amenable to customization with respect to the requirements of specific domains.

Conclusion: We present an approach where a composition platform enables the extraction of content from heterogeneous services and its integration into situational applications where content presentation is flexibly managed through different visual templates. We also discuss the advantages offered by this approach to the stakeholders of a specific community of users in the Cultural Heritage domain.

Practice: The developed prototypes were evaluated in laboratories and field studies: the former aimed at investigating the ease of use and the users satisfaction of the functionality and the user interface of the environment for domain customization, the latter aimed instead at observing real users (e.g., guides of an archeological park) in action, to assess the validity of the proposed composition paradigm as an EUD practice.

Implications: The user studies described in this paper provided hints for refining the prototypes, and laid the basis for future work related to the identification of design principles that can make service-based composition technologies in general more useful and usable for end users.

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1. Introduction

Different work contexts and every-day life situations are nowadays characterized by activities where single users or groups of people, through different devices, browse heterogeneous content, capture, synthesize and annotate it to highlight insights and compose it in various ways, in order to create new content and applications. The huge amount of resources available on the Web provide a valuable source of content; but to enable an increasing number of people to make sense of such resources it is necessary to open up the construction of service-based software to non-programmers. Technologies for Web service composition have been proposed since the 1990s in the context of the Service Oriented Architecture (SOA) [1]. More recently, we have seen the proposal of platforms, based on mashup technologies, which claim to be more oriented towards end users [2]. However, this claim has proved to be unrealistic because of the inadequacy, for non-technical people, of the composition languages on which such platforms are based [3–5].

The overall goal of the research presented in this article is to investigate models, methods and architectures for supporting people, who are not software developers and have diverse needs, to co-create Personal Information Spaces (PISs), by integrating heterogeneous contents and artifacts. By PIS we mean an interactive space personalized by its creator that can facilitate access to and manipulation of contents and functionality, since it provides integrated views over disparate, distributed resources. Our goal is in line with the interest, growing both in academia and in industry, in *elastic systems*, able to support paradigms in which applications can be flexibly shaped up at different layers (data, functions and presentation) at use time, based on users' actions in specific usage contexts. One important ingredient to achieve such a flexibility is separation of concerns: "contents, applications, and devices need to be decoupled as much as possible to allow users to focus on information without being confined to a particular pre-packaged application context" [6].

This article discusses the above issues and shows how we addressed them by developing a platform where a visual paradigm enables the lightweight construction of multi-device applications, through which users can easily access, integrate and manipulate information to satisfy their situational needs. We illustrate composition environments where users, by means of "content-exploratory" actions, seamlessly create applications, without the need for distinguishing among what design and execution are (which is typical of professional software design and programming), and are not forced to master technicalities to invoke and integrate data and services (which is typical of service management).

Empowering people, who may not have technical skills, with the possibility of composing content and services is a very critical challenge. The approach presented in this paper builds on recent experience in investigating paradigms for mashup composition [7,8] and on the lessons learnt on End-User Development (EUD) [9–11], and tries to combine the advantages of both fields. This work is the result of an iterative set of experiences, which led us to identify some key points. One is about specializing a platform for mashup composition to a specific domain, thus capitalizing on the knowledge of people working in the domain, in order to offer a composition process that makes sense for a community of users [4]. In [12], we discussed the need for composition approaches to foster EUD and we reported some preliminary studies conducted to assess the adequacy of a composition platform in a specific domain, namely Cultural Heritage by better understanding how the envisioned platform could bring practical value to different stakeholders in the context of visits to sites of cultural interest. Based on these studies, we identified in particular the need for *domain-specific resources*, providing sensible, non-generic content, and for *user interface* (*UI*) *templates*, able to guide the composition, thanks to some basic visual elements that can be easily manipulated by non-technical people to create and modify their PIS. Thus, the significant, new contribution of this paper is a comprehensive methodology for service and data composition by end users, based on a meta-design approach and a novel "stratification" of the composition platform into layers, so that:

- In accordance with *meta-design*, the overall approach enables the involvement of different stakeholders: the first phase (the meta-design phase) consists of designing software environments that allow some stakeholders to create templates, basic elements, and software environments appropriate for end users in the specific application domain; in the second phase, using such environments, end users are able to compose and manipulate their PIS.
- In accordance with the need for *domain-specific approaches*, it enhances customization processes, easing the adoption of the approach by specific communities of end users.
- In accordance with the need for *elastic systems*, it offers an "un-packaged" environment, where end users have the freedom to select the most adequate source of contents, visual templates and execution devices, and the logic to integrate contents deriving from different sources.

The article is organized as follows. Section 2 illustrates the motivations of the overall research work and Section 3 reports related work on service composition. Section 4 illustrates the meta-design approach to PIS composition. Section 5 describes the platform developed, addressing its main components and showing, with examples taken from the case study referring to visits to sites of cultural interest, the adopted visual interaction paradigms and how the platform is customizable to specific application domains. Sections 6 and 7 report some formative studies we have performed to evaluate the platform components devoted to non-technical users. In particular, the study described in Section 7 involved professional guides and visitors of an archeological park. Section 8 finally outlines our conclusions.

2. Motivation

The emerging need for making software systems flexible, so as to increase their ability to support a large variety