DC2AP Metadata Editor: A Metadata Editor for an Analysis Pattern Reuse Infrastructure

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Abstract. The software development process often encounters obstacles to reuse analysis patterns. Many designers do not have access to these computational artifacts by the difficulty in finding them, since the ways in which analysis patterns are documented are often precarious. The lack of both a computational tool which supports the analysis patterns documentation process and a digital repository to store these patterns affect their reuse. This paper presents the tool DC2AP Metadata Editor. This tool is a metadata editor for analysis patterns based on the Dublin Core Application Profile for Analysis Patterns (DC2AP). To support the patterns retrieval, the DC2AP Metadata Editor provides analysis patterns documented in RDF files, thus allowing the knowledge stored in these artifacts to be shared and automatically interpreted by software.

Keywords: analysis pattern, reuse, Dublin Core, semantic web, linked data, cloud computing, software as a service, web service.

1 Introduction

Analysis patterns are reusable computational artifacts aimed at the analysis stage of the software development process. These artifacts support software designers during the system domain analysis, reducing in this way the time spent on the software design and especially allowing interoperability between systems. Although the analysis patterns provide gains in the software development process through knowledge reuse, designers can still find difficulties in reuse them due to inefficiency in the way which these patterns are documented. This complicates to search for these artifacts by computational tools or even by search engines on the Internet.

The analysis patterns documentation is an important task in order to enable software designers to effectively share these artifacts. To date there is no template to document patterns of analysis that is widely accepted, so each set of patterns is specified according to its author's preferences. Although this is a common practice, a consensus on the use of a single documentation standard by the authors can facilitate the processes of search, manipulation and dissemination of these patterns.

Aiming to solve the problem of the lack of both standardization and detail in the analysis patterns documentation, a specific metadata profile to document analysis patterns, called DC2AP, was proposed [12].

The following paper presents the tool DC2AP Metadata Editor. This tool allows the creation and editing of metadata about analysis patterns by using the DC2AP profile. The metadata documented with this tool can be exported to RDF format and consequently became Linked Data that reduces barriers to reuse analysis patterns.

The DC2AP Metadata Editor is a free software that is available on the Software as a Service (SaaS) model. Thus, it can be accessed from any location via the Internet regardless of technological details in your terminal access, requiring only a Web browser and Internet access [15]. Some of the functionalities of this metadata editor are also available via Web services, allowing other systems to make use of them.

The remainder of this paper is organized as follows: Section 2 describes the related works with documentation of analysis patterns; semantic Web and Linked Data; cloud computing and Web services. The tool DC2AP Metadata Editor proposed in this paper is presented in Section 3, while Section 4 presents conclusions and future works.

2 Related Work

2.1 Analysis Pattern Documentation

Analysis patterns can be documented from the use of predefined models and sketches. The absence of use of models in the analysis pattern documentation reduces the usability of these patterns [4]. It happens due to a bigger difficulty in retrieving knowledge in unstructured documentation. Some analysis patterns documented by means of models can be found in [7]. A model for documenting analysis patterns is presented in [8], which is composed of the topics: name, problem, context, motivation, solution, participants and related patterns. This model was applied by [7] to document an analysis pattern focused on defining an urban streets mesh.

This analysis pattern, originally documented in [7], will be presented later documented with DC2AP using the DC2AP Metadata Editor.

APRI – Analysis Patterns Reuse Infrastructure.

The access to analysis patterns is still very deficient due to the format used for documentation and availability of them [4]. These patterns are usually presented in means of access not machine-processable, such as books and scientific papers, thus hindering the retrieval of information from these reusable computational artifacts.

In order to minimize these problems concerning the documentation and availability of analysis patterns, thus increasing the possibilities for reuse of these artifacts, in [10] was proposed the architecture of an Analysis Pattern Reuse Infrastructure (APRI). In the following infrastructure, which is shown in Fig. 1, the analysis patterns are documented using metadata and can be retrieved by Web services.

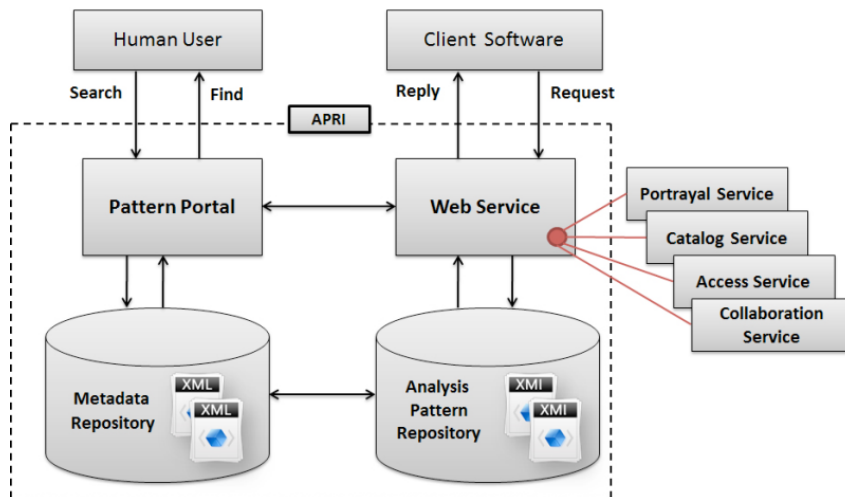The DC2AP Metadata Editor presented here was designed and developed as a tool of the Pattern Portal.

Fig. 1. Analysis Patterns Reuse Infrastructure (APRI) [10]

− *Pattern Portal:* Contains a set of tools and services focused on discovery, obtaining, cataloging and reuse of analysis patterns.
− *Metadata Repository:* Are repositories that contain metadata in XML for the documentation of analysis patterns and services contained in an APRI.
− *Analysis Pattern Repository:* Are repositories that contain the solutions proposed by analysis patterns represented by means of diagrams in the XMI format. These diagrams can be used by portrayal and collaboration services.
− *Portrayal Service:* Are services that support the visualization of diagrams contained in analysis patterns of an APRI.
− *Catalog Service:* Are services that enable the cataloging, discovery and use of analysis patterns and services of an APRI, based on their metadata.
− *Access Service:* Are services that allow to obtain analysis patterns.
− *Collaboration Service:* Are services that allow analysts and designers to share their use experiences to improve analysis patterns in an APRI.

DC2AP - Dublin Core Application Profile for Analysis Pattern.
To assist authors and users of analysis patterns in documentation task, [11] [12] presented the Dublin Core Application Profile for Analysis Patterns (DC2AP). The DC2AP was developed based on the model for the specification of analysis patterns proposed by [9] and the Dublin Core metadata standard [16]. The main goals of the DC2AP are to standardize the analysis patterns documentation in APRI metadata repositories and then improve the reuse of analysis patterns through documentation that allow a better knowledge retrieval made by computers and therefore provide specific information that could not be previously retrieved by search engines.

In contrast to the Dublin Core metadata standard, which is generic and therefore intended to document resources from multiple domains, the model proposed in DC2AP was specially developed to document analysis patterns, thus rich in details of this specific domain. The DC2AP is composed by twenty-one major elements and forty-one elements refiners, all of them are specific for analysis patterns documentation. Each of the main and refiners elements of DC2AP are controlled by rules regarding to obligation, occurrence and value type of each field. These rules seek to standardize the use of this application profile and analysis pattern documentation.

Due to its level of detail, this model was chosen to be used in the DC2AP Metadata Editor to document analysis patterns.

2.2 Semantic Web and Linked Data

The Semantic Web is seen as a layer of the Web where is possible to publish, retrieve and use data that can be processed by machines [2]. Linked Data provides the means to make this possible, because these are structured and machine-processable data published on the Web. These data are well defined and connected to other data from different sources through semantic relationships [3].

Linked Data uses three technologies to support the Semantic Web. Uniform Resource Identifiers (URIs) are used to identify the data, the HTTP (Hypertext Transfer Protocol) on the other hand is used as a mechanism for data retrieval and finally the RDF (Resource Description Framework) is used to describe machine-processable data on the Web and creating semantic relationships among them [6].

In order to provide Linked Data from analysis patterns is important that a tool for cataloging intends to export the metadata of these artifacts to RDF files and assign an URI to each of these documents. The objectives of the tool DC2AP Metadata Editor, presented in Section 3, comply with such tasks.

2.3 Cloud Computing and Web Services

Cloud computing is provided through different types of services, and the main one is the Software as a Service (SaaS) [14]. This service type provides various software resources over the internet and they can be used via web browsers by end users [1]. The DC2AP Metadata Editor presented here is an example of SaaS.

The main reasons for developing the DC2AP Metadata Editor as a SaaS are the democratization of the access to this tool and its facilitated coupling to an APRI. Other tools as CatMDEdit [5] and xMET Metadata Editor [13] were evaluated during this work. Although these tools are metadata editors based on Dublin Core, they are not specific for analysis patterns documentation and were not developed using Web technology, which prevents them for being used as SaaS in an APRI.

Besides of the DC2AP Metadata Editor was developed as a SaaS, this tool provides some of its resources by means of Web services, so other applications can understand and reuse these resources without the need to use its GUI, regardless of the programming language used to create them.

3   DC2AP Metadata Editor

DC2AP Metadata Editor is a SaaS that enables analysis patterns users to create, edit and store metadata of these patterns according to rules described in the DC2AP. This tool provides Linked Data when exports these metadata to RDF files.

DC2AP Metadata Editor was developed using the framework Google Web Toolkit (GWT) [18]. GWT uses Java as standard programming language, and converts the source code produced in this language to JavaScript code compatible with different browsers. This technology allows to create dynamic Web systems and has a high level of portability, allowing the DC2AP Metadata Editor run on all major Web browsers.

Fig. 2 shows the initial window of the DC2AP Metadata Editor. This tool is hosted on a server that provides access to its facilities and Web Services. It can be accessed by the URI: `www.purl.org/dc2ap/editor`.

Fig. 2. DC2AP Metadata Editor

By accessing the tool, the user has access to all the elements described in DC2AP. For each element, there are two icons showing details of them. The icon shown in Fig. 2(a) shows the rules for filling an element regarding to obligatoriness, occurrence and value type. On the other hand, the icon displayed in Fig. 2(b) provides access to detailed information of the element.

The DC2AP Metadata Editor also provides fields for the multivalued elements of the DC2AP. This tool allows the manipulation and sorting the list of values of these

fields using the icons on the right side of multivalued fields. The element *2.1 Alternative Title* shown in Fig. 2 is an example of a multivalued element.

3.1 Functionalities

To date, the DC2AP Metadata Editor has two major functionalities: 1) metadata validation and 2) generation of documentation in the RDF format, accessible by the buttons Validate and RDF respectively as presented in Fig. 2.

The Validate functionality verifies if the metadata is in accordance with the obligatoriness rules of the DC2AP profile. If there are required elements that were not reported, the tool will then report this information to user by means of a window that contains a list of the errors found. After the validation of the metadata, it can be exported to RDF files by means of the function Generate RDF. The use of DC2AP to document analysis patterns in RDF files makes the metadata repository proposed by APRI (Fig. 1) a specific domain linked data source.

3.2 Example

Part of the RDF code equivalent to the analysis pattern originally documented in [7] is shown in Fig. 3. This code was generated by the DC2AP Metadata Editor after validation of the metadata registered for the pattern. After generating this code, the same could be exported to a RDF file and stored in a metadata repository of an APRI.

The full version of the RDF file shown in Fig. 3 can be accessed by URI `http://purl.org/apri/metadata/UrbanStreetMesh-v1`.

To create the URI present in the RDF files generated by the DC2AP Metadata Editor, this tool has been integrated into the PURL toolkit [17], which is an environment for creating permanent identifiers for documents on the Web.

Fig. 3. Script RDF for the analysis pattern Urban Street Mesh.

3.3 DC2AP Web Service

The DC2AP Metadata Editor provides some of its functionalities by means of a web service (DC2APWebService), in which the exchange of messages with the external environment is via SOAP protocol. The goal of the DC2APWebService is to allow developers of applications related to the domain of analysis patterns reuse the DC2AP Metadata Editor functionalities without the need to access the system GUI or redeploy them into their applications. This approach allows developers be free to create their own application using resources provided by the DC2AP Metadata Editor using languages and technologies of their choice, since the protocol SOAP is based on XML and HTTP, universal technologies for messaging.

The access to the DC2APWebService can be done via the URL: `http://www.ide.ufv.br/dc2ap/webservices/`, where is possible to have access to the following methods:

– *generateRdfScript()* - Creating RDF script for the input metadata.
– *validateResource()* - Validate metadata according to the DC2AP rules.

The method *generateRdfScript()* takes as parameters all the elements of the DC2AP. This method then converts this input to a script RDF, similar to the script shown in Fig. 3. The method *validateResource()* takes as parameters only the Mandatory and Conditional DC2AP elements. It checks if the input conforms to the validation rules of DC2AP and then returns a list of messages containing validation errors, or an empty list if no error has been found.

4 Conclusions and Future Work

The DC2AP Metadata Editor aims to improve the analysis patterns documentation process by applying the DC2AP profile. Due to its functionality to export the metadata to the RDF format, the DC2AP Metadata Editor allows the creation of digital collections of machine-processable analysis patterns. Thus, this tool enables to document analysis patterns in a better structured way. So, these patterns can be retrieved more quickly and efficiently in APRI's repositories distributed on the Web.

Creating documentation in the RDF format also aims to provide Linked Data. When analysis patterns are described as Linked Data they have the reuse potential expanded and can be better integrated with other data of heterogeneous sources [3].

This tool provides some of its functionality through Web services, allowing application developers in the field of analysis patterns to use the resources of the DC2AP Metadata Editor, regardless of the technology used for development and thus enabling the reuse of computational resources in another scale.

As future work is intend to provide new functionalities in the DC2AP Metadata Editor and make them available as new Web services, as for example, version control functionality for RDF files that are generated by the tool, thus allowing the user to have a history of changes and improvements made in the documentation and also manage its different versions. Furthermore, the aim is to adapt this tool to also behave as a generic Dublin Core metadata editor, thereby allowing this new extension to be

used not only for analysis patterns documentation but for document any resource which the Dublin Core may be applied.

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