Towards an Upper-Level Ontology for Information Exchange in ePortfolios

Brokenshire, D., Bogyo, B. and Kumar, V
Simon Fraser University, Surrey, BC, Canada
{brokenshire,bbogyo,vive}@sfu.ca

Abstract

Portfolios are lifelong projects which help people In their learning and job seeking. Unfortunately ePortfolio systems are neither universal nor eternal and eventually users must switch or use multiple systems. Information exchange allows users to change easily between systems without losing their data. Ontologies enable information exchange by formalizing and standardizing vocabulary and relationships. In this paper we discuss our approach to creating an upper-level ontology for the ePortfolio domain to facilitate information exchange between ePortfolio systems in the context of the SPARC ePortfolio system (SPARC 2004).

Keywords: Ontology, Interoperability

1. Introduction

Portfolios are inherently lifelong projects which are continually repurposed for educational assessment, job applications, reflection and learning. In contrast, particular tools tend to focus on a single use and are unable to share content that a user has entered, sometimes forcing the user to completely recreate their portfolio for each purpose.

ePortfolios cover such a wide area there are no widely adopted standards for their creation and use. There are specific technological approaches such as IMS LIP and IEEE PAPI Learner both currently under consideration as ISO standards. Unfortunately no one standard met the needs of SPARC's diverse clientele.

Inspired by the progress of the Semantic Web movement with formal vocabularies (ontologies) the SPARC team decided to create an ePortfolio ontology for the SPARC project that could be used to adapt the project to multiple clientele. The team created a formal ontology for one application only to discover that their ontology was extremely specific to government guidelines and limited the possible uses. The team created multiple ontologies based on specific tools and needs and an upper level ontology abstracted from these specific ontologies to be used in information exchange between different tools.

Herein we give a brief introduction to SPARC ePortfolios, ontologies, and information exchange. We then discuss our process in creating the ontologies. Finally we go through our upper level ePortfolio ontology and discuss future work to be done.

1.1 SPARC ePortfolios

The SPARC ePortfolio project was first created to serve the specific needs of British Columbia high school students and teachers as they implemented an ambitious program to have all high school students graduate with a portfolio. The BC Ministry of Education created specialized requirements for topic coverage, assessment, and teaching of portfolios which the SPARC team adapted to create the software. As interest in the project grew the team was asked to create a version for use by first year students in the cohort based TechOne program at Simon Fraser University Surrey and to be used on a ongoing basis by those students after their first year, but no longer in a formal setting. Finally SPARC is attempting to make the system available to and usable by the general public, a domain in which needs vary widely and no specifications are present.

1.2 Need for information exchange

Information exchange is necessary between systems because a user will use many systems as they produce ePortfolios for different aspects of their life and at different times. Being able to transfer information between them is important for the user, so they don't have to re-enter the information, and for possible assessors, to evaluate the accuracy of statements in different portfolios.

Information exchange is also useful for transferring information to and from user models derived from the ePortfolio and other interested systems. The authors are developing user models which represent the user based on their ePortfolios. These user models allow us to do automated reasoning and inference on the data gathered and to incorporate other information that wouldn't be in an ePortfolio such as specific habits, marks, and learning styles.

1.3 Ontologies

In computer science ontology has many definitions loosely derived from the original philosophical definition. Ontology is commonly defined as a formalization of a specification. (Sowa 2000) defines ontology as "a catalog of the types of things that are assumed to exist in a domain of interest D from the perspective of a person who uses a language L for the purpose of talking about D." To paraphrase, an ontology combines a vocabulary, the relationships between terms in the vocabulary, and axioms over the vocabulary all from a specific perspective. Some researchers also include a means of performing inference such as first order logic in their definition.

Creating a single ontology for all things has been tried but found to be extremely difficult (Lenat 1995). The opposite approach, creating many very specific ontologies for particular tasks and domains, makes it challenging to exchange information because the ontologies must be manually translated, a time consuming and error prone process. Upper ontologies form the most abstract level of either approach, providing the basic vocabulary and relationships on which the rest of the ontology is based.

There are different levels of abstraction even in upper level ontologies. The highest level deals with general concepts such as objects, space, and time common to all applications (Sowa 2000). Upper-level ontologies can also define the general concepts used in a domain (i.e. education, physics, music, portfolios) and allow more specific ontologies to be built from there (Niles 2000). We follow the latter approach.

2. Knowledge Engineering

Initially we created a very specific ontology reflecting the software as implemented to the government guidelines (BC 2004). It was so specific as to be useless outside of the SPARC project. We set out to create a more general upper level ontology which could be extended to the various targets SPARC serves and also for other ePortfolio projects.

2.1 Creating an Initial Ontology

To create out initial ontology we followed the process described in (Noy 2001) step by step. This process is similar to object oriented analysis, picking out the relevant terms and then creating their relationships and properties. As shown in Figure 1 it was complicated and overly specific to the BC Ministry of Education requirements, even though the SPARC software was more flexible.

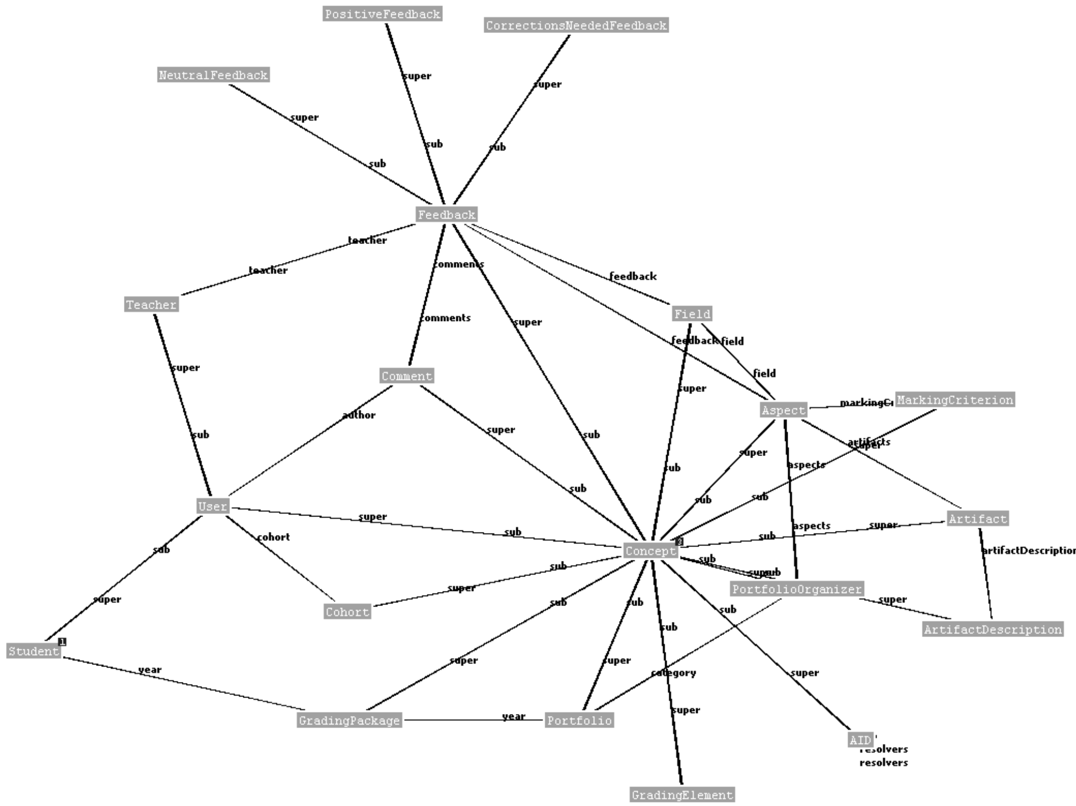

Figure 1: Specialized SPARC Secondary School Ontology

2.2 Generalization

Recognizing the need to generalize our ontology we developed a more general ontology by gathering information on what terms were commonly used and how in a variety of ePortfolio projects. After reviewing the terminology of a variety of projects, we investigated the OSPI project repeating the process to create a specific ontology. Necessarily our attempts were somewhat more general as we did not have direct access to experts involved in the creation of OSPI.

The authors also analyzed the requirements of the TechOne program to derive a second ontology which was not dependent on the ministry guidelines. This gave us three ontologies with many similar terms and some identical ones. We then took all of the ontologies and extracted the common elements to form the core of an upper level ontology. For the similar terms we added the most general ones to the ontology as synonyms of or specializations of other terms. Having defined the relationships between the terms we were left with the upper level ontology described in the next section.

3. The Upper-Level Ontology

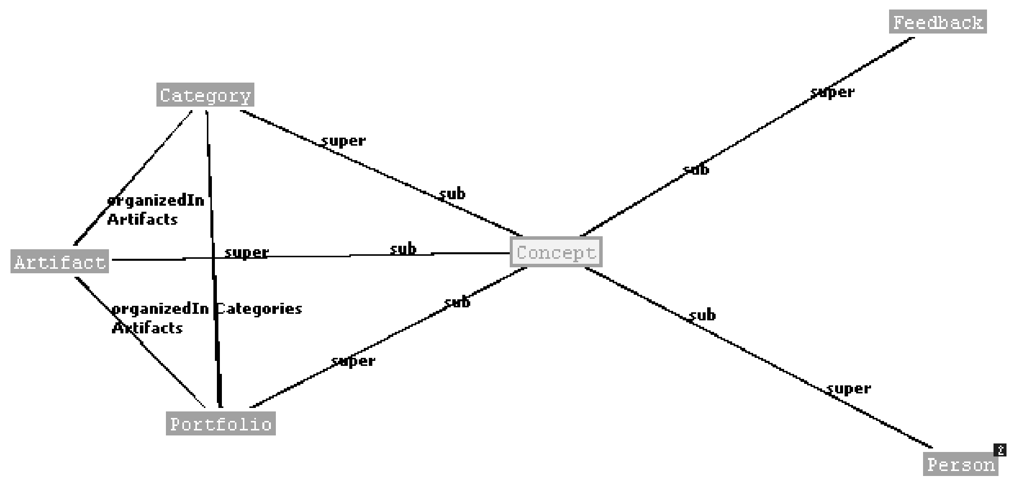

Figure 2: Upper-level Ontology

Figure 2 shows the upper ontology we created. Only the classes and their relationships are represented in the figure. Slots (also known as fields or parameters) are omitted for clarity. The Portfolio class and its slots are displayed in Figure 3. For the complete ontology please visit our website. Clearly the upper level ontology uses more general concepts than the original ontology. This simplicity is partly due to the reduced number of concepts present in the ontology; lower level material such as grading is not present because it is not general to ePortfolios.

In order to be useful an upper level ontology must support extensions for particular purposes. The upper level ontology offers starting points for all of the lower level concepts. Assessment and grading have a specialization relationship with Feedback. Different organization schemes can be built off the portfolio and categories. The authors evaluated the success of the upper-level ontology (ULO) by extending it for each of the domains from which we generated it. We were successful in building back from the ULO to each of the specific domains, though it requires more effort for those using unusual terminology such as the BC Ministry guidelines.

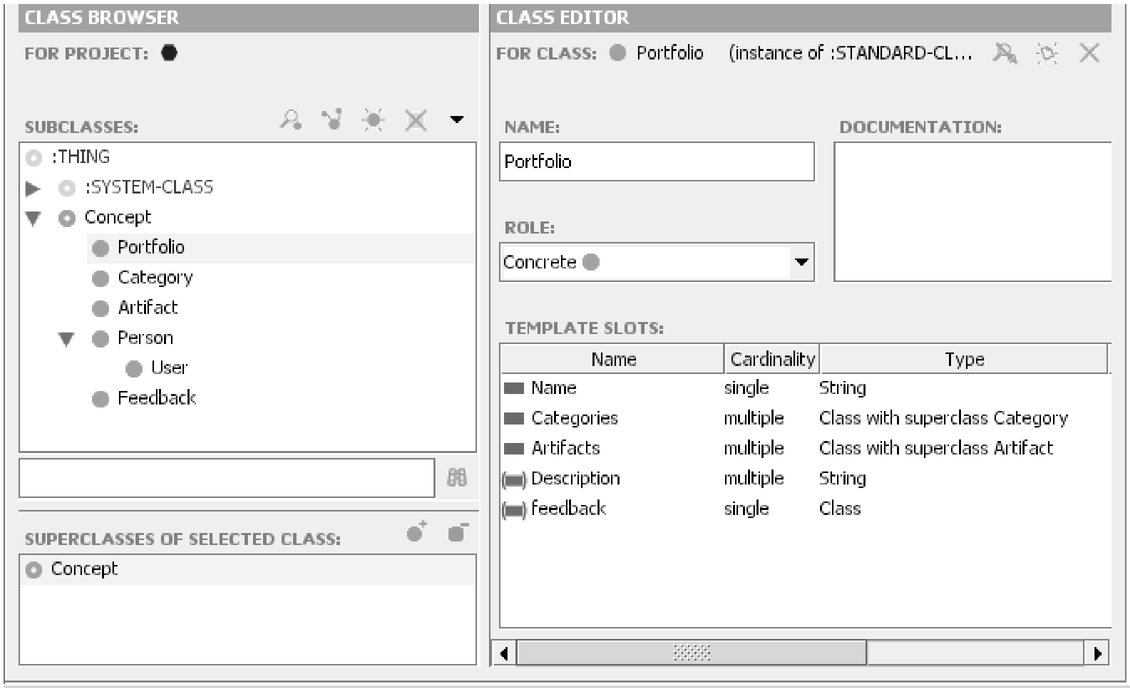

Figure 3: Portfolio Term of Upper Level Ontology

4. Discussion and Future Work

The process of creating the ontology has been useful in understanding the limitations of our existing system. Comparing our SPARC ontology to ontologies based on other ePortfolio systems allowed us to approach standards in our own work. Current versions of SPARC are much simpler internally reflecting the coherence of the new ontology.

The authors are continuing to evaluate and improve the upper level ontology by evaluating more ePortfolio systems and standards for compatibility with the ontology. The authors are currently evaluating the utility of the created upper level ontology in information exchange. They are also creating several user models to support users and working on translating information between those models, and between models and ePortfolios.

No ontology is ever a finished product, especially in dynamic environments such as the web (Klein 2002), and developing domains such as ePortfolios. The upper level ontology must be tested with more ePortfolio systems, a task our group is currently undertaking. It must also be used to create knowledge bases and transfer information among them before we can rely upon it.

5. Acknowledgements

The authors would like to thank LORNet Theme 1 and NSERC for their financial support of this research.

6. References

Klein, M., et al. (2002). Ontology Versioning and Change Detection on the Web. *in 13th International Conference on Knowledge Engineering and Knowledge Management (EKAW02).* Siguenza, Spain

Lenat, D. B. (1995) Cyc: A Large-Scale Investment in Knowledge Infrastructure. *Communications of the ACM 38, no. 11.*

Niles, I., & Pease, A., (2001), Toward a Standard Upper Ontology, *in Proceedings of the 2nd International Conference on Formal Ontology in Information Systems (FOIS-2001), Chris Welty and Barry Smith, eds.*

Noy, F., McGuinness, D. (2001) *Ontology Development 101: A Guide to Creating Your First Ontology* Stanford University

Norvig, S. & Russell, P. (2003) *Artificial Intelligence: A Modern Approach,* Prentice Hall, New Jersey.

Pinto, H., Prez, A., & Martins, J. (1999) Some Issues on Ontology Integration *in Proceedings of the IJCAI-99 workshop on Ontologies and Problem-Solving Methods (KRR5), V.R. Benjamins et al. eds.*

Protégé (2004) The Protégé Project. http://protege.stanford.edu

Sowa, John (2000) *Knowledge Representation - Logical, Philosophical, and Computational Foundations,* Thomson Learning, Boston

SPARC (2004) SPARC ePortfolios http://eportfolio.research.iat.sfu.ca/