PhD Thesis of Sergio Miranda

Abstract

The main theme of this PhD thesis is IWT – Intelligent Web Teacher – an innovative e-learning and knowledge management platform coming from experiences in national and international research project leaded by the Excellence Pole in Learning & Knowledge of the University of Salerno.

As a distinctive feature, IWT offers the ability to create and deliver personalized courses by taking into account user profiles and guarantying flexibility in terms of content and learning models. These kind of courses are more efficient and effective than classic and static e-learning courses.

The ability in delivering personalized courses is based on a sophisticated modelling of the knowledge of domain and content as well, by using ontologies and metadata, acquired competencies and learning preferences of the user by means of user profiles and their continuous adaptation.

The validity of this IWT approach has been confirmed by benchmarking solutions, methodologies, models at the state of the art and results coming from many experimentation activities leaded in both educational university and enterprise contexts and described in the following papers:

- N.Capuano, M.Gaeta, S.Miranda, F.Orciuoli and P.Ritrovato "*LIA: an Intelligent Advisor for e-Learning*", M. Lytras, J. Carroll, E. Damiani, R. Tennyson (Eds.), Emerging Technologies and Information Systems for the Knowledge Society - Proceedings of the World Summit on the Knowledge Society (WSKS 2008), September 24-26, 2008, Athens, Greece, Lecture Notes in Computer Science Series, vol. 5288, pp. 187-196, Springer-Verlag, 2008 – 2nd Best Paper Award
- N.Capuano, S.Miranda and F.Orciuoli "*IWT: A Semantic Web-based Educational System*", G. Adorni, M. Coccoli (Eds.) Proceedings of the IV Workshop of the AI*IA Working Group on Artificial Intelligence & e-Learning held in conjunction with the XI International Conference of the Italian Association for Artificial Intelligence (AI*IA 2009), December 12, 2009, Reggio Emilia, Italy, pp. 11-16, AI*IA, 2009
- M.Gaeta, S.Miranda, F.Orciuoli, S.Paolozzi, A.Poce "*An Approach To Personalized e-Learning*", submitted to Informatics Education Europe V Rome, Italy, November 3-5, 2010

The main result is linked to the matching between performances of simple and personalized courses measured in terms of user competencies.

Interesting considerations have been made on the experimentation. The IWT approach based on personalized courses seems to gain results better than typical e-learning approaches based on simple static courses. Through the personalization it is possible to involve in learning processes also people having yet high level competences on treated themes and usually unwilling to accept an e-learning engagement.

On the other hand, this approach, even if totally automated, needs a start-up effort for defining right user profiles, designing domain ontologies intended as a right semantic representation of concepts and relationships among them, defining metadata for learning objects, indexing them end describing them in a way as complete as possible for using them in the courses.

Research activities aimed at the study of the state of the art, at the study of the existing models, at the looking for solutions, at the definition of possible methodologies able to create improvements on these key aspects related to knowledge representation in terms of ontologies and metadata and to user profiles representation in terms of competencies on learning domain and preferences on the way to use content.

The approach, of course, has not been just applicative, but it has been oriented to the wide literature of this scientific sector in order to study problems and existing solutions and to define something (also in terms of algorithms) that is valid and interesting for the scientific community. Some idea has been reported in the following papers:

- N.Capuano, L.Dell'Angelo, S.Miranda, F.Orciuoli and F.Zurolo "*Ontology extraction from existing educational content to improve personalized e-Learning experiences*", Proceedings of the III IEEE International Conference on Semantic Computing (ICSC 2009), September 14-16, 2009, Berkeley, CA, USA, pp. 577-582, IEEE Computer Society, 2009
- G.Gianforme, S.Miranda, F.Orciuoli and S.Paolozzi "*From Classic User Modeling to Scrutable User Modeling*" on the 1st International Workshop on Ontology for e-Technologies 2009 (ICEIS 2009)
- F.Colace, S.Miranda, R.Piscopo, P.Ritrovato "*Applicazione di aritmetica degli intervalli per la verifica dei contenuti in una piattaforma di e-learning*", Proceedings of VI Congresso della SIE-L, Società Italiana di e-Learning, Salerno, 16-18 settembre 2009

To summarize, after having found models to describe and make up to date the user profiles, computationally efficient methodologies to understand if content for a matter are enough for a set of students, this work have been turned to two fundamental aspects that are the automatic extraction of ontologies directly from content and the automatic definition of metadata for content.

In fact, it usually happens that the material is available and, to take advantage of personalization, it is necessary to create ontologies and metadata a posteriori (... and manually).

In order to automate these operations, we have defined methods to extract ontologies from learning objects and contextually define metadata in terms of technical and pedagogical parameters.

In literature there are many approaches able to extract technical features (format, size, requirements, ...) but there are rare and incomplete approaches able to describe pedagogical aspects as used in standard IMS learning Object Metadata (learning resource type, semantic density, difficulty, time to spend, interactivity, ...). By getting together information theory fundamentals and learning models we have proposed a solution to this kind of problem. This approach, by now, seems to be very good. It has been experimented on a database of more than 2000 learning objects on Mathematics and Computer Science and the results may suggest to apply it in other contexts by following the trend of new information publishing and Linked Data. In other word, a new way to automate the cataloguing of documents: a hot spot for IEEE, BBC, USA Government and many other organizations.