eLPA: An e-Learner's Personal Assistant

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Abstract. One of the most rapidly evolving e-services is e-Learning, that is, the creation of advanced educational resources that are accessible on-line and, potentially, offer numerous advantages over the traditional ones like intelligent access, interoperability between two or more educational resources and adaptation to the user ([1], [2]). The driving force behind the most advanced e-Learning services that are about to appear is the definition of the various standards about educational metadata, that is, data describing learning resources, the learner, assessment results, etc. The internal details of systems that utilize these metadata are still an open issue since these efforts are primarily dealing with "what" and not "how". In this position paper, and under the light of these emerging metadata standards, we outline eLPA, an intelligent agent that uses a conceptual graph (CG) binding of certain educational metadata together with CG rules, to serve primarily as a personal memory assistant.

1 Introduction

In the last years, we have witnessed a huge, ongoing effort towards an information society in which the various software tools will be able to understand the information behind accessed data, rather than only moving them around and displaying them. One of the key elements in most of these efforts is the definition and use of various metadata i.e. data describing the accessed data. One of the most ambitious efforts on metadata definition is in the e-Learning domain. Educational metadata describe educational resources (LOM [7]), the learner's profile [8], packaging information, etc. The internal details of systems that utilize these metadata are still an open issue since these efforts are primarily dealing with "what" and not "how". On the other hand, Conceptual Graphs ([13], [3]), are a proven solution for modeling knowledge repositories [5] and e-services [11].

Although in an early stage of development, these standardization efforts will enable the various educational resource developers to create autonomous, on-line educational material that will be used by multiple tutorials, will operate independently of any single tutorial, and will be adjusted to each learner's individual needs.

Under the light of these emerging efforts, we present eLPA, a client side, knowledge based agent that gathers metadata records from the learning objects the user accesses, encodes them in the Conceptual Graph (CG) notation and uses additional domain knowledge (CG-rules) to serve the user as a personal educational memory and assistant.

The rest of the paper is organized as follows: Section 2 outlines the Learning Object Metadata, Section 3 describes the current architecture of the eLPA agent and Section 4 gives some examples of its functionality, from the user point of view. Finally, Section 5 concludes the paper and gives some insight for future work.

2 Learning Object Metadata

The lack of widely adopted methods for searching the Web by content makes it difficult for an instructor or learner to find educational material on the Web that addresses particular learning and pedagogical goals. In addition, the lack of standards prevents the interoperability of educational resources. Toward this direction and under the aegis of the IEEE Learning Technology Standards Committee (LTSC) [6], several working groups are developing technical standards, recommended practices and guides for software components, tools, technologies, and design methods that facilitate the development, deployment, maintenance and interoperation of computer implementations of educational components and systems. One of the most important LTSC groups is the Learning Object Metadata (LOM) group [7].

```
<RECORD>
  <GENERAL>
    <TITLE>Systems of Linear Equations</TITLE>
    <IDENTIFIER>ID1</IDENTIFIER>
    <KEYWORDS>
      <LANGSTRING>keyword1</LANDSTRING>
      <LANGSTRING>keyword2</LANDSTRING>
    </KEYWORDS>
    <DESCRIPTION>  .....  </DESCRIPTION>
  </GENERAL>
  <RELATION>
    <KIND>Requires</KIND>
    <RESOURCE>
      <IDENTIFIER>id2</IDENTIFIER>
      <DESCRIPTION>  ...  </DESCRIPTION>
    </RESOURCE>
  <RELATION>
  <TECHNICAL>
    <LOCATION Type=URL>
        "http://my.e-school.gr"
    </LOCATION>
  </TECHNICAL>
</RECORD>
```

Fig. 1. A LOM record (partial) in XML binding

The LOM working group is dealing with the attributes required to adequately describe a learning object, that is, any digital or non-digital means, which can be used during technology-supported learning. Such attributes include type of object, author, owner, terms of distribution, format, requirements to operate, etc. Moreover, LOM may also include pedagogical attributes, such as teaching or interaction style, mastery level, grade level, and prerequisites. Since no information is included in these standards on how to represent metadata in a machine-readable format, the IMS Global

Learning Consortium has developed a representation of LOM in XML [9]. Recently, the LOM draft standard reached an almost stable state and now IMS is working towards the elaboration of a DTD and XML schema specification which will enable more automation over XML LOM records. A partial LOM record in XML binding is presented in Fig.1. Some detail has been removed to simplify the example.

3 Architecture Outline

Fig.2 gives an outline of the eLPA's architecture and usage model. It is built around CoGITaNT [4], a library of C++ classes allowing the development of applications based on the CG knowledge representation scheme. CoGITaNT allows the handling of CGs using an object oriented approach and offers a great number of functionalities on CGs such as creation, modification, projection, rules, inputs/outputs, etc. In addition, we have implemented the forward and backward chaining inference module proposed in [12], which acts upon the CGs and CG rules of the knowledge base.

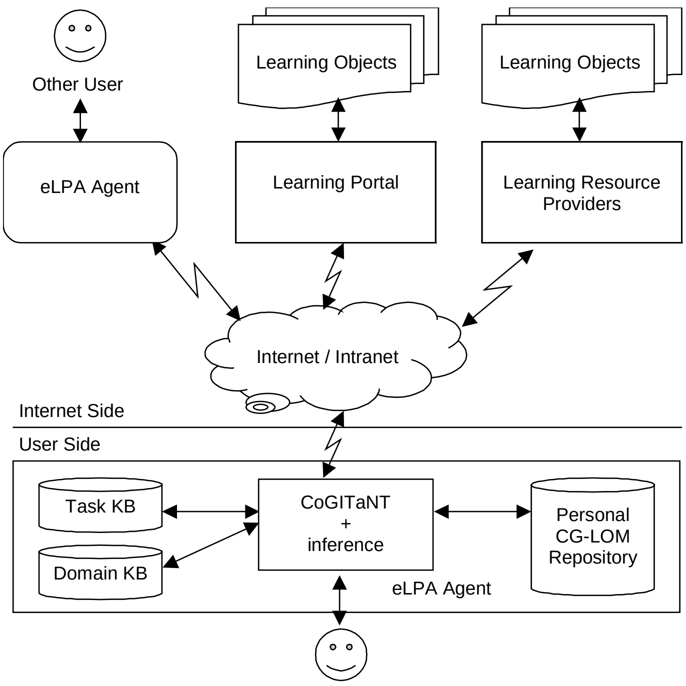

Fig. 2. eLPA's architecture and usage outline

The knowledge base of the eLPA agent consists of three parts. The first one is a *CG-LOM repository* created from the various LOM records that accompanies any LOM compliant learning object. This is an automated task that transforms the XML expressed LOM records into a semantically superior CG-LOM binding (Fig.2) [10].

Apart from the more compact representation of the CG-LOM binding, the resulting CGs have, in some cases, better semantics. This is because some elements of the LOM record do not refer to the learning object itself but to some other entity like the intended learning object user. In another case, while a typical LOM record describes the difficulty of a learning object with a number in the scale of 1 to 5 ("very easy" to "very difficult", respectively), the CG-LOM allows the derivation of an internal, user adapted, difficulty factor that can take into account other metadata, like the age of the learner or his/her familiarization to other prerequisite learning objects. This is possible by using certain CG rules that form the *domain knowledge base* of the agent (Fig.2). Other knowledge included into the domain KB is the definition of courses. A *course* is described as a graph of related, simple and autonomous tutorial items that someone who wants to study this course, should study.

```
CG-LOM
(reqs [LOM: id1 *lom] [LOM: id2 *lom2])  (fdescr ?lom2 [LANGSTR: "…"])
(title ?lom [LANGSTR: "Systems of Linear ..."])
(keyword ?lom [LANGSTR: keyword1])
(keyword ?lom [LANGSTR: keyword2])
(descry ?lom [LANGSTR: "…"])
(phys_loc ?lom [URL: "http://my.e-school.gr"])
```

Fig. 3. The LOM record of Fig.1 in the CG-LOM binding

Finally, there exists the *task knowledge base* (Fig.2), which materializes the services the agent is able to offer to the user and its internal operations. Such services include, without limitation, the generation of dynamic hyperlinks for a user to traverse and communication between an agent with other agents to seek for help. Two such rules are presented in Fig.4. Rule R1 augments a learning object *x* that has as prerequisite the learning object *y* physically located at URL *z*, with a dynamic hyperlink to that URL. Rule R2 is similar to R1 in the first part but it creates a system event that forces the agent to communicate with peer agents, instead.

```
R1
[If: (requires [LOM: *x] [LOM: *y]) (phys_loc ?y [URL: *z])

[Then: (d_link ?x ?z) ]
```

```
R2
[If: (requires [LOM: *x] [LOM: *y]) (phys_loc ?y [URL: *z])

[Then: (q_params [SYS_EVENT: p2pquery]
                 [QCG: (phys-loc [LOM: id2] [URL]) ]) ]
```

Fig. 4. CG rules of the agent's system knowledge base

4 Functionality

As the user/learner accesses learning objects from Learning Portals or Learning Resource Providers, the eLPA agent gathers educational metadata records and stores them into the Personal CG-LOM Repository. This information can be used either as a traditional bookmark or as the source for the generation of dynamic links. For example, consider a user dealing with a system of linear equations in some educational material. If that user has used related material in the past (say Linear Algebra and/or Matrix Calculations), then the agent would be able to create dynamic hyperlinks to that material, based on the domain knowledge and the metadata the agent had gathered at that time. For efficiency purposes this functionality is provided on demand.

Furthermore, the agent is able to communicate with peer agents that belong to different users. In case its own CG-LOM repository has produced poor results, the agent can ask its peers for related dynamic links. Currently, each agent is aware of the existence of its peers and can ask for help on a restricted set of tasks. Finally, if the owner of another agent has made his/her e-mail address public and has studied similar education material, the agent would be able to contact that user through e-mail and ask for assistance.

Finally, the agent can augment the course description graph according to the user's progress, being able in that way to suggest to the user the next tutorial item he/she should study.

5 Conclusions and Future Work

In this position paper, we have outlined a CG-based assistant agent that serves its user as a personal memory for e-Learning content. The agent is able to understand and handle certain educational metadata describing learning objects. These metadata are gathered automatically as the user accesses learning objects and are kept internally in a proprietary CG-based binding (CG-LOM) of educational metadata. Finally, the eLPA agent has a limited ability to communicate with other similar agents in a peer to peer manner.

We plan to extend the ability of the eLPA agent to handle more types of educational metadata and enrich its domain and task knowledge to provide more functionality. Our priority is to incorporate the learner's metadata [8], creating in that way a more formal knowledge model for the learner (user). The Learner Model Group of LTSC is dealing with the specification of the syntax and semantics of attributes that will characterize a learner and his/her knowledge abilities. These will include elements such as knowledge, skills, abilities, learning styles, records, and personal information.

Finally, we plan to better formulate the cooperation abilities of the eLPA agent with peer agents.

References

1. Bassiliades, N., Kokkoras, F., Vlahavas, I., Sampson, D.: An Intelligent Educational Metadata Repository. Accepted for publication at Intelligent Systems, Techniques and Applications, C.T. Leondes (ed.), CRC Press, (2002)
2. Brusilovsky, P.: Adaptive and Intelligent Technologies for Web-based Education. In: Rollinger, C., Peylo, C. (eds.): Kunstliche Intelligenz. Special Issue on Intelligent Systems and Technology, (1999)
3. Conceptual Graphs Standard Working Draft, http://www.jfsowa.com/cg/cgstand.htm
4. Genest, D., Salvat, E.: A Platform Allowing Typed Nested Graphs: How CoGITo Became CoGITaNT. In: Proceedings of the ICCS '98, LNAI 1453, Springer Verlag, (1998), 154-161
5. Gerbe, O.: Conceptual Graphs for Corporate Knowledge Repositories. In: Proceedings of the ICCS '97, Springer Verlag, (1997)
6. IEEE Learning Technology Standards Committee (LTSC), http://ltsc.ieee.org/
7. IEEE P1484.12/D6.3a, Draft Standard for Learning Object Metadata
8. IEEE P1484.2/D7, Draft Standard for Learning Technology - Public and Private Information (PAPI) for Learners (PAPI Learner)
9. IMS Global Learning Consortium, Learning Resource Meta-data (LOM) Specification, Version 1.2, May 2001, http://www.imsglobal.org/metadata/index.html.
10. Kokkoras, F., Sampson, D., Vlahavas, I.: CG-PerLS: Conceptual Graphs for Personalized Learning Systems. In: Proceedings of the 8th Panhellenic Conference in Informatics, Vol.2, Livanis Press, (2001), 531-540.
11. Puder, A., Markwitz, S., Gudermann, F.: Service Trading Using Conceptual Graphs. In: Proceedings of the ICCS '95, LNAI 954, Springer Verlag, (1995)
12. Salvat, E., Mugnier, M.L.: Sound and Complete Forward and Backward Chaining of Graph Rules. In: Proceedings of the ICCS '96, LNAI 1115, Springer Verlag, (1996), 248-262
13. Sowa, J., Conceptual Structures: Information Processing in Mind and Machine. Addison-Wesley Publishing Company, (1984)