[Shalfeeva, 2005] E.A. Shalfeeva. Classification of structural properties of ontology // Artificial intelligence – 2005. – № 3. – Pp. 67-77.

[Gladun, 2005] A.Ya. Gladun, Yu.V. Rogushina. Ontology how perspective direction of intellectualisation information retrieval in the multiagent systems E-commerce // In Proc. XI-th Int. Conf. "KDS-2005". – Varna.– Vol. 1. – Pp. 158-165.

[Gribova, 2005] V. Gribova. Implementation of various dialog types using an ontology-based arproach to user interface development // In Proc. XI-th Int. Conf. "KDS-2005". – Varna.– Vol. 1. – Pp. 153-158.

[Palagin, 2005] A. Palagin, V. Peretyatko. Development of procedures of objects recognition with usage multisensor ontology controlled instrumental complex // In Proc. XI-th Int. Conf. "KDS-2005". – Varna.– Vol. 1. – Pp. 140-147.

[Haken, 1985] H. Haken. Synergetycs. – M.: Science, 1985. – 320 p.

[Ivakhnenko, 1975] A.G. Ivakhnenko. Long-term prognostication and management by the difficult systems. – Kiev: Naukova dumka, 1975. – 311 p.

[Molchanov, 1988] A.A. Molchanov. Design and modeling of the difficult systems. – Kiev: Visha shkola, 1988. – 359 p.

[Luger, 2002] G.F. Luger. Artificial intelligence. Structures and strategies for complex problem solving. – Addison Wesley: Boston, 2002. – 864 p.

Information about an author

Elena Netavskaya – Cherkasy state technological university; Av. Shevchenko 460/501, Cherkasy, Ukraine; e-mail: neelena@list.ru

PROTOTYPING ADAPTIVE ONLINE LEARNING COURSES[1]

Tim Geleverya, Olga Malinovskaya,
Tatiana Gavrilova, Vladimir Golenkov

Abstract: This article describes the process of prototyping adaptive online learning using the authoring tool for developers, which is based on ontologies. The article also gives a brief overview of contemporary situation and describes modern trends of evolution e-learning courses and present standards in this area. It also describes architecture of system VITA II.

Keywords: E-learning, ontologies, user modeling, LOM.

ACM Classification Keywords: K.3.1 Computer Uses in Education – Distance learning, K.3.2 Computer and Information Science Education – Computer science education, E.1 Data Structures – Trees, I.2.6 Learning – Concept learning (Knowledge acquisition).

Introduction

Using new computer technologies modern teachers can easily create online-courses accessible through the Internet.

However there are a number of problems with the creation of e-learning courses. The first one is that not every teacher posses an equal good knowledge in computer technologies, which are necessary for creation and management of e-learning courses.

The second problem is that users of e-learning courses do not posses an equal knowledge level. They also have different psychological, social and other personal characteristics. (All these facts, defining personal characteristics of users, create so-called "user model"). That is why the data, assignable to different users, must be different. As a result, the e-learning system is needed of some measure to be adaptive for ensuring the best process of education, or in other words it must be slaved for exact user model.

[1] This work is supported by grant Bel-RFFI 06-01-81005.

In this connection, the main goal is to create universal authoring tool for developers of e-learning systems with user-friendly interface, which can help teacher with minimum set of knowledge in informational technological area develop adaptive e-learning course based on user model, suitable world standards in e-learning.

State-of-the-art standards of e-learning courses

Today there are plenty of organizations, developing standards for e-learning systems. Each of these organization popularizes its own standard. Some of the leading organizations with the most widely accepted standards are [Hage H., Aimeur E.]:

- IEEE Learning Technology Standards Committee [http://ltsc.ieee.org/];
- ADL Initiative (Advanced Distributed Leaning) [http://www.adlnet.org/];
- IMS Project (Instructional Management System) [http://www.imsproject.org/].

According to ADL (Advanced Distributed Learning) [http://www.adlnet.org/] standards materials, designed for e-learning must correspond to following requirements:

- *reuse* – materials must be easily designing and using with different tools;
- *accessibility* – materials must be easily assessable both for students and developers of curses;
- *interoperability (интерпорабельность)* – materials must posses an ability to share upon different programming basics;
- *extendibility* – materials mast be easily modified and tuned for new versions of software.

Today with the appearance and spreading of e-learning standards, learning materials and tests should correspond to some abilities: to be reusable and to be shared upon various e-learning basics (platforms).

Furthermore ADL introduces standard ADL SCORM (Shareable Content Object Reference Model) [SCORM]. SCORM is an XML-based scheme, which is used for describing and getting access to learning object. The SCORM meta-data application profiles defined in this section directly references the IEEE LTSC Learning Object Meta-data (LOM) standard [LOM].

The data model “Learning Object Metadata” is described with the «IEEE 1484.12.1 – 2002, Learning Object Metadata. Standard» from 15/07/2002. This standard is developed by IEEE Review Committee.

The 1484.12.1-2002 Information Model is broken up into nine categories. These categories are based on the definitions found in the 1484.12.1-2002. The nine categories of meta-data elements are [LOM]:

- The *General* category groups the general information that describes the resource as a whole.
- The *Lifecycle* category groups the features related to the history and current state of this resource and those who have affected this resource during its evolution.
- The *Meta-metadata* category groups information about the meta-data record itself (rather than the resource that the record describes).
- The *Technical* category groups the technical requirements and characteristics of the resource.
- The *Educational* category groups the educational and pedagogic characteristics of the resource.
- The *Rights* category groups the intellectual property rights and conditions of use for the resource.
- The *Relation* category groups features that define the relationship between this resource and other targeted resources.
- The *Annotation* category provides comments on the educational use of the resource and information on when and by whom the comments were created.
- The *Classification* category describes where this resource falls within a particular classification system

The LOM data model is an hierarchy of data elements, including aggregate data elements and simple data elements (leaf nodes of the hierarchy).

For each data element, the LOMv1.0 Base Schema defines:

- *name:* the name by which the data element is referenced;
- *explanation:* the definition of the data element;
- *size:* the number of values allowed;
- *order:* whether the order of the values is significant (only applicable for data elements with list values);
- *example*: an illustrative example.

For simple data elements, the LOMv1.0 Base Schema also defines:

- *value space:* the set of allowed values for the data element – typically in the form of a vocabulary or a reference to another standard;
- *datatype:* indicates whether the values are LangString, DateTime, Duration, Vocabulary, CharacterString or Undefined.

Both the size and datatype information may include smallest permitted maximum values.

Authoring tool VITA II

Describing authoring tool for fast prototyping is based on existing authoring tool VITA, designed and described in [Gavrilova, Geleverya, 2002].

While the designing authoring tool VITA two types of learning were taken into account:

- Learning from course content (learning on basis of content). The idea is to learn material in series. This type of learning is most widely distributed. The content of the material is set by the teacher. (The trainee is given a framework of field of knowledge of e-learning course).
- Learning from conceptual definition of knowledge domain given as ontologies and links of concepts with learning materials describing these concepts. The idea is to localize student on tight terms of knowledge domain and to give more detailed information about this terms. In this way it is possible to change the way of navigation for different users. In other words different user models can be compared with own navigation style in hypertext environment. This style is shown by the way of traveling through the given ontologies and reviewing those hypertext pages that they really needs and not all pages one after another as in first case.

In authoring tool «VITA» Groups are entered to realize the first type of learning. *Group* is a course, consisting of paragraphs, which puts together basis[2]. These groups are necessary for student with different levels of training.

The Ontologies are entered to reale the second type of learning. *Ontology* is a coupled concepts of knowledge domain with which the paragraphs consisting basis are associated.

The authoring tool gives the author of e-learning course following base opportunities [Gavrilova, Geleverya, 2002]:

1. Building course on basis of prepared source material – giving a link between paragraph of basis and source file, consisting information.
2. Storing information in united depository.
3. Managing course with the repository (content of course).
4. Editing and review of paragraphs.
5. Editing of course structure.

The language HTML is used for creating e-learning course. The HTML provides:

- Multilogical features for creating and work with the course;
- Presence of Web Browser;
- Opportunities of creating local and remote courses.

The tool haves following features [Gavrilova, Geleverya, 2002]:

- Simple and user-friendly interface;
- Visual tools;
- Feature of introduction of extension modules.

Learning course consist of paragraphs. Paragraph is an indivisible element of course. Relations of paragraphs organize pseudo tree-like structure of course and define its content.

Attribute content of paragraph contains:

- Name – defines name of paragraph;
- Identification of element in paragraph space, including in course;

[2]Basis is a source structure on course's content.

- Name of the file, containing information about this paragraph;
- List of child elements (paragraphs).

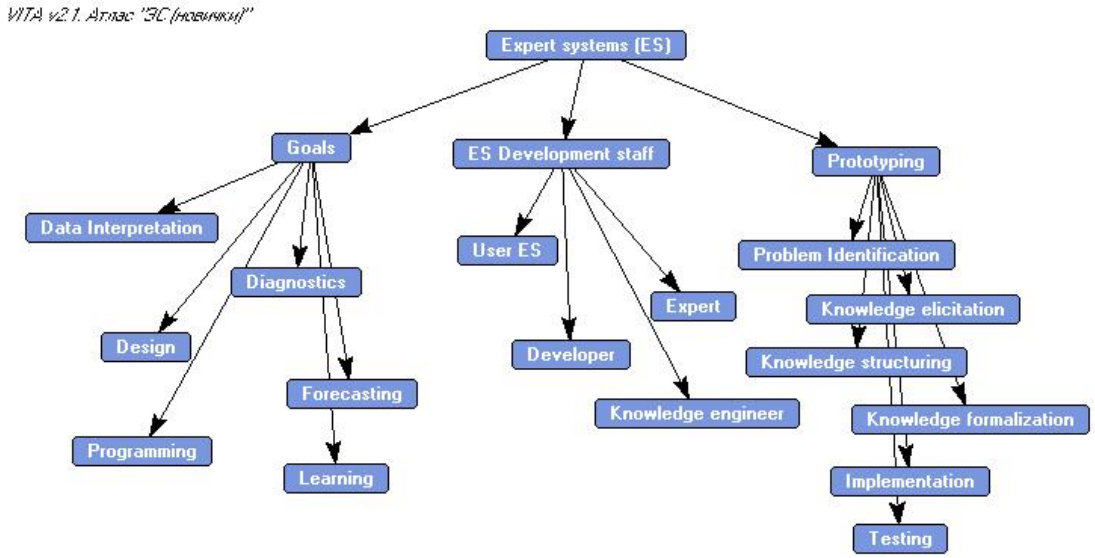
Based on listed above it can be said that using of this authoring tool helps the course' developer quickly atomize the creating and support process of learning course, and to facilitate debugging and searching errors.

Authoring tool VITA was learned in detail and on its base adaptive learning course based on ontologies was created.

Adaptive online course of artificial intelligence

Adaptive learning course was built upon the textbook «Base of knowledge of intellectual systems" [Gavrilova, Khoroshevskiy, 2001].

The three main concepts of knowledge domain were extracted from course "Base of knowledge of intellectual systems": artificial intelligence, expert system, knowledge engineering. The three models of users were defined: beginner, developer, knowledge engineer. The ontology was built both for each user mode and each main concept of course, so nine ontologies were built. The example of this ontology is given in Picture 1.



Picture 1. Ontology of concept «Expert system» for user model «Beginner»

The process of ontology development was divided into several subtasks. At first, the detailed glossary of used in course terms was built (Glossary of Terms), The next, concept classification trees were built.

As one can see on Picture 1, the main drawback of such ontology is that it is very bulky. So some troubles may cause during work with it.

Every element of ontology can be open as hypertext page for more detailed examining of presented information. Moreover every concept has brief description.

The following drawbacks were revealed during work with authoring tool VITA:

- necessity of availability specific software for setup authoring tool (authoring tool VITA is developed on language Python);
- absence of automatic test generator;
- absence of possibility to give user models and links them with ontologies;
- uncomfortable ontology editor;
- absence of possibility of viewing ontologies in Web;
- absence of possibility of creating multi-level ontologies (desiring ontologies are huge and the work with them is very uncomfortable).

In connection with listed above drawbacks the requirements to developing authoring tool (preliminary named VITA II) were revealed:

- availability of automatic test generator;

- availability of possibility links user models and ontologies;
- possibility of creating learning course without programming;
- user-friendly visualization of ontologies;
- support of multilevel ontologies;
- absence of necessity of additional software for setup authoring tool;
- support of graphic templates, corresponding to contemporary requirements of Web-usability;
- capability of loading Web-pages, created in another editors.

Besides, corresponding to standards of learning systems, the requirements to learning materials, using in developing tool, were picked out:

- possibility of reusing learning materials;
- accessibility of materials to users of other systems and learning courses;
- data generality (compliance Learning Object Metadata and Shareable Content Object Reference Model);
- extensibility (availability of features of downloading of Learning objects from other programs and systems);
- application of international standards of e-learning;
- using contemporary semantic markup languages (RDFS, OWL).

Architecture of system

System VITA II inherits base advantages of tool VITA, particularly availability of presentation data in two views – in form of groups and ontologies.

As was stated above, one of the main drawbacks of tool VITA is that ontologies, giving learning resources to end user, are very bulky and hard to percept. That is why in system VITA II introduce the support of multilevel ontologies.

The next scheme offers the division of multi-lavel ontologies:

1. Content fragment (CF) [Jovanovic' J., Gasevic' D, 2005] – elements of lower level that can't be opened as ontologies (content units in their most basic form, like text, audio, video, images, tables);
2. Content Object (CO) [Jovanovic' J., Gasevic' D, 2005] – ontologies of middle level (contains set of CF, CO and navigation between them);
3. Learning object (LO) [Jovanovic' J., Gasevic' D, 2005] – ontologies of higher level (collections of CO and links between them).

At the same time ontologies of higher level (learning objects) should be described according to standard IEEE 1484.12.1 – 2002 и ADL SCORM Version 1.3, i.e. should be simple extended, accessible for other learning systems and independent from software platform.

Developing software tool supposes a possibility of user's work with different types of information, for example like text, html-pages, images, tables, diagrams, ontologies, multimedia and etc. At the time, to different resource type corresponds own software module, realizing work with exact resource.

As system VITA II is directed on learning that is why source course basis, designing with html-language facilities, is paramount. Hence all material, existing in system, can be divided on:

- initial learning data (course basis, representing group of paragraphs),
- resources (html-pages, images, tables, diagrams, presentations, multimedia and etc.)

Materials, representing in course basis, should be structured in a view of tree, namely broken in accordance with structure of learning course, the recourses should be divided in accordance of data types.

Learning data is supreme aspect and should be linked with the resources by associating every recourse with an element of learning material. The final data representing for the course user is a number of multilevel ontologies, described according to the LOM and SCORM standards.

Basic constructive elements (modules) of system, which quickly prototype learning courses, are:

- information recourse manager,
- tools of examination and editing of each type of information data,
- the LOM description module (generating and recognizing).

The system is realized upon the NET platform.

Information recourse manager.

Information recourse manager is a tree-like structure, where the “root” elements are the courses parts. This structure of data presentation helps to achieve clear and exact results. Each manager’s element is an offspring of basic class, in which main parts and elements are given.

For each type of recourse means and methodology of examination and operation of its elements are also determined.

The LOM description module.

The LOM description module is used to describe different information recourses according with international LOM and SCORM standards. These standards are realized in filling in fixed number of fields.

The main functions of this module are

- generating of meta-description of information resources,
- recornizing of resource’s type according to it meta-description.

Organization of work in system.

The basic problem while the organization of work process is an operation of learning material elements, because it consists of a number of html-pages with different recourses (texts, multimedia, images). System does not create the course’ design, so it is necessary to give an opportunity to course user to chouse his own strategy of data’s editing. System only represents to the user the necessary course part, which contains elements of learning data. Then user himself decides how to design this material.

Conclusion

As a result of operation with designed system, the developer of on-line courses possesses an adaptive learning course, which contains sum of ontologies. The lowest ontologies level is informational data of different types (text, images, multimedia, etc.). These materials correspond to international standards and can be borrowed from existing learning courses of others developers. So developers can simply generate there own courses. The adopting process under the needs of certain user occurs throe the correlation of each ontology to the certain user’s model, which is given in meta-description.

Bibliography

[Гаврилова, Хорошевский, 2001] Гаврилова Т.А., Хорошевский В.Ф. Базы знаний интеллектуальных систем: учебник. СПб.: Питер, 2001.

[Gavrilova, Geleverya, 2002]. Гаврилова Т.А., Гелеверя Т.Е. Программный инструментарий Vita. Версия 2.1. Техническая документация, 2002.

[Brusilovsky, Sosnovsky, 2005] Brusilovsky P., Sosnovsky S., etc. Interactive Authoring Support for Adaptive Educational Systems, 2005.

[Clarebout, Elen, 2005] Clarebout G., Elen J. The Effects of Pedagogical Agent in an Open Learning Environment, 2005.

[Hage, Aimeur, 2005] Hage H., Aimeur E. Exam Question Recommender System, 2005.

[Jovanovic’, Gasevic’, 2005] Jovanovic’ J., Gasevic’ D. Ontology of Learning Object Content Structure, 2005.

[LOM] LOM v1.0 Base Schema Draft Standard for Learning Object Metadata, IEEE 1484.12.1-2002, 15 July 2002.

[SCORM] ADL SCORM Version 1.3 WORKING DRAFT 0.9, November 27, 2002.

http://ltsc.ieee.org/

http://www.adlnet.org/

http://www.imsproject.org/

Authors' Information

Olga Malinovskaya – graduate student of Saint-Petersburg State Polytechnical University, Politechnicheskaya 29, 195251, St. Petersburg, Russia, e-mail: malinol@mail.ru

Tim Geleverya – senior developer, ”GRANIT” company; e-mail: gt@csa.ru

Tatiana Gavrilova – Professor Saint-Petersburg State Polytechnical University, Politechnicheskaya 29, 195251, St. Petersburg, Russia, e-mail: gavr_csa@rambler.ru

Vladimir Golenkov – Head of AI Department of Belorussian University of Informatics and Radio-electronics, 220027, Brovki str.,6, Minsk,Belorussia, e-mail: golen@bsuir.unibel.by