

Web-based system for distant learning support on special courses (BSc thesis summary)

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INTRODUCTION

The industrial growth of recent years increases the need for high-qualified personnel, able to learn new technologies quickly. This fact puts the requirements to education system to higher level. One of the best solutions is distant learning (DL). It can be used when and as long as needed, anytime, anywhere. And even more – it is more cost-effective than traditional education. The advantages of distant learning make it very perspective branch of education progress.

Despite the variety of distant courses offered by universities, there are some badly covered and even uncovered at all fields of knowledge. Particularly, this concerns special courses, such as, for example, artificial neural networks (ANNs).

There are a lot of Internet-books about ANN, but most of them are straightforward representation of traditional courses and make absolutely no use of enhanced interactive capabilities of new technologies. Simultaneously, there are materials that contain multimedia and interactive elements, but they generally relate to one specific field of ANN application, are uncoordinated and cannot represent whole conception of diversity and universality of neural technologies.

The aim of this work was to develop existing methods and tools for (distant) learning, which are to raise the quality of education by means of active usage of modern informational technologies.

In order to reach this aim, the following tasks were set up:

- Develop and implement a universal informational reference system for support of DL, which would allow to use new technologies in learning process more intensively.
- Adapt and improve existing materials of “Neural Networks” lection course for use in distant learning.

The first chapter of this paper gives a short introduction to distant learning and its advantages compared to traditional one. The second chapter is dedicated to development process of the system and used methods and technologies. The third chapter describes the developed system itself, its features and its current content – course on neural networks.

1. DISTANT LEARNING

Distant learning is such an organization of educational process, when tutors and students may be physically distant from each other. Distant learning implements best traditional and new methods, means and forms of education, based on computer and telecommunication technologies [1]. There are a number of DL advantages:

- Flexibility. Everybody may learn as much as one personally needs.
- Compound. Modularity principle lies in the base of distant learning. This allows forming of individual study plan from the set of independent courses.
- Parallelism. Learning may be easily combined with main professional activity, so one can learn and work simultaneously.
- Remoteness. The distance between student and its educational establishment does not hinder from effective educational process.
- Operative control of quality of received knowledge.

- Asynchronous. Teacher and student may rely on their own timetable and own rate, which is convenient for each of them.
- Range. Student count is not a critical parameter for distant learning.
- Cost. Average estimate of distant educational systems shows that they are 10...50% cheaper than traditional ones [1].

There are factors that enforce one to use distant learning:

- Limitations of acquirement of professional education (e.g., limited accessibility, high cost of education, time limitations, etc);
- Limited “transfer rate” of educational establishments;
- Increasing amount of people who want to acquire professional education, caused by raising prestige of education and the need of staff re-training;
- Creation and development of new informational technologies and obvious process of telecommunication technologies computerization [1].

Any complete DL system contains two main components: informational subsystem (electronic textbook) and knowledge testing subsystem. The development of any of these is complex independent task and requires the solutions for questions that are unresolved yet. But, surprisingly, most developers do pay much of their attention to knowledge testing subsystem, while informational part is often left quite primitive, as it often has bad material layout, inconvenient navigation and even more – no search functionality (!) [2,3].

2. USED METHODOLOGIES

The main task of the work was to create a system that is free of described problems. It should contain and provide access to systematized material. The system supposed to provide its users with comprehensive information, fast search, convenient interface and navigation.

It is possible that user requirements to the system may change after it is complete, as educational methods are permanently in progress. These changes demand corresponding changes and enhancement of the system’s functionality. That is, the system has to be flexible and scalable.

It is obvious, that the development of such a system is rather complicated task. It is impossible to implement such a complex system “from nothing”.

2.1. RATIONAL UNIFIED PROCESS

Rational Unified Process (RUP) is one of the best software development methodologies. Having the experience of many successful projects in its basis, RUP allows to create complex program systems, using industrial development methods [4].

One of the main foundations of RUP is creation of models with Unified Modelling Language (UML). Modelling helps to determine both problem and its possible solutions. UML is standard de-facto for description of complex systems, it allows developers to determine, visualize, construct and document parts of a system. Thus, it makes possible to go through the whole process – from general bird's-eye view to creation of specific objects.

Models allow to see the future system, its objects and their cooperation before its creation; to see the system from the point of view of future users and developers even when not a single line of source code is written. Most models are presented as UML diagrams.

The main idea of object-oriented analysis and design (OOA & OOD) is to consider the domain and to solve the task in respect to objects. During OOA the main attention is paid to object definition and description in the terms of data domain. In the process of OOD, logical program objects are created, which are to be implemented by means of OO–

programming language. At least, developed components and classes are implemented with OOP.

Lets consider main stages of RUP.

- The first stage is requirements analysis, which allows to distinguish main processes of the system and to formalize them in the form of precedents. Precedent (use case) is a textual description of processes in the domain.
- Stage two, object-oriented domain analysis. This step is to determine all possible activities of process actors and to create a conceptual model, which reflects different categories of domain elements.
- Stage three. The attention is concentrated at responsibility assignment. This is object-oriented design itself. Responsibility assignment means definition of tasks and duties of different program objects.

The most important moment of OOA & OOD is qualified assignment of responsibility. It is the only obligatory stage. More over, it influences the quality of the system, its scalability and flexibility.

What concerns the distant learning system, the complete requirements analysis has been done. The result of this step was a list of detailed use cases descriptions, which was of much help during implementation.

There are four groups of users. Each group has own set of rights; their descriptions are shown in the table.

User group	Description
Guest	Unregistered user. Can register him/herself as a student and/or logon into the system (identify him/herself).
Student	Registered user. Can edit own personal profile data, search and view articles, place comments on articles etc.
Tutor	Registered user. Can edit own articles and add new ones.
Admin	System administrator. Performs system support, user management, registers new tutors. Controls all sections, articles and comments.

Also, the sequence diagram of general workflow and class diagram were created.

2.2. TECHNOLOGIES OF IMPLEMENTATION

For implementation, modern Java technologies such as Java Servlets and Java Server Pages (JSP) were chosen. Java is powerful object-oriented language, which allows to create a platform-independent applications and has built-in security functionality. These factors make Java one of the best languages for Internet applications. Moreover, servlets and JSPs allow to separate data processing and data representation modules, thus easing future support.

Database structure was created in ErWin 4.0 and free MySQL 3.23 database is used as data storage. These technologies ensure easy porting to various operating systems and reduce installation and deployment time of the created system.

3. RESULTS

As the result of the work, a universal web-based informational system for support of distant learning was created. Its current content is a distant course on artificial neural networks. These are described below.

3.1. INFORMATIONAL SYSTEM

Main informational elements of the system are articles. Depending on their topic, articles are arranged in sections that make up a multilevel hierarchical structure. Every article has one additional internal level of hierarchy – so called tabs. This allows to represent article's structure in the best way, consequently improving its comprehensibility. Text portion of the material is stored in HTML format, so authors can use the full potential of HTML to present information in the best way.

The system supports attachment to tabs of various types of files. Thus, a tutor can upload not only textual material, but also a set of images, audio or video data, flash-animation, java applets or files of any other type. Attached files can be referred in tags of html-content of a tab. So articles can be displayed with inline multimedia and active elements, which significantly improve perception of the article.

All registered users can view and put their own comments on articles. This allows to establish a communication between tutor and students, and hence allows tutors to adapt their articles according to audience's needs. User comments subsystem can also be considered as the mean of organization of "question-answer" discussion, related to the concerned article.

Keywords support is a distinctive feature of the created system. Keywords allow indexing of textual materials, thus simplifying searching of articles significantly.

The glossary is a convenient way to find articles with certain topic. It contains all keywords of all tabs of all articles in DB, sorted alphabetically. When some tab is changed (or the new one is added), all concerned keywords changes result in automatic glossary update. Thus, dynamic glossary update guaranties that it always contains up-to-date information.

To find required information, user clicks on appropriate keyword in the glossary. The system displays list of all tabs that contain this keyword, as well as full path to each tab (i.e. article's name, and all parent sections, up to the root). Then user can select the tab (article, section) needed. Thus, the glossary search can be performed via two mouse clicks only.

The system also provides following functionality for information search:

- Search by section name;
- Search by article name;
- Search by tab name;
- Search by author name;
- Search by keywords.

Users may use any combination of items above.

An example of the system's interface is presented on figure 1.

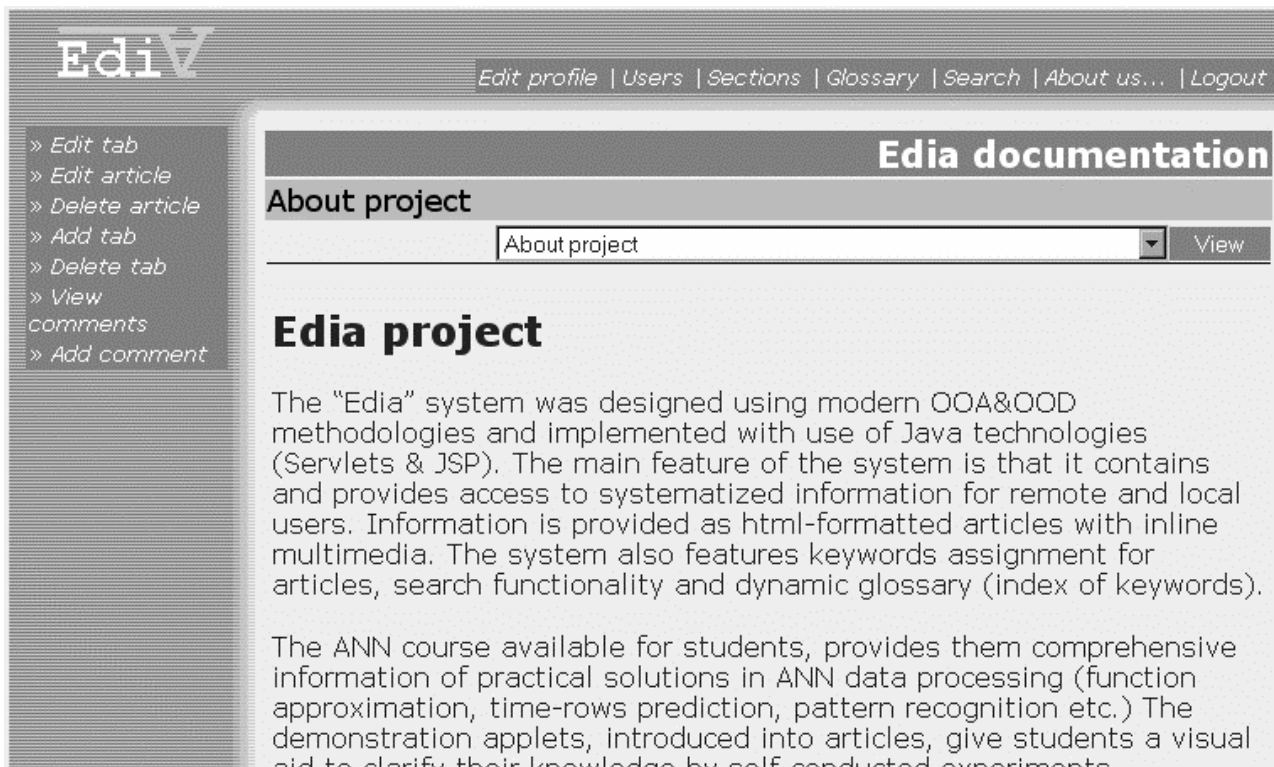


Figure 1. User interface of the system.

3.2. ANN DISTANT LEARNING COURSE

Artificial neural networks (ANNs) are one of the most interesting tools for data analysis and processing. That is why corresponding study courses are often included in universities programs [5].

An existing traditional course of lectures “Neural networks” which has been reading at the Radio Physics and Electronics faculty of Belarusian State University for some years has been used. The main characteristic of the course is its orientation to raising of students’ practical skills of application and usage of neural networks for data processing [6]. The course contains three modules with four lectures in each:

- Biological prototype and theoretical basis of neural networks.
 1. Biological and artificial neurons;
 2. Single-layer neural networks;
 3. Multi-layer perceptron;
 4. Supervised learning of neural networks.
- Typical applications of feed-forward neural networks.
 1. Classification tasks;
 2. Pattern recognition;
 3. Neural approximation and modelling;
 4. Data analysis.
- The structure, learning algorithms and applications of ANNs with feedback and lateral connections.
 1. Neural networks with feedback and their training algorithms;
 2. Neural networks with lateral connections and their training algorithms;
 3. Stochastic networks and their training algorithms;
 4. Complex neural networks and their applications.

One of the problems arising with course is the high cost of ANN-simulation software that is required to conduct laboratory works. To overcome this obstacle, the class library for NN-modelling was created [7]. It is written in C++ and allows modelling of single neuron, single- and multi-layer neural network.

The course also contains demonstrational Java-applets for all of important topics. They are provided along with lectures and allow modelling of different aspects of NN-functionality in real-time mode. Thus, students may conduct their own online experiments with different kinds of neural networks. Obviously, this fact positively influence on material perception and the quality of acquired knowledge.

All of the applets are freeware and most of them are provided as open-source. This fact solves the licensing problem and allows the students to develop these applets on their own and adapt them for own tasks. At the current time the course contains following applets:

- Artificial neuron;
- Perceptron learning;
- Multilayer perceptron;
- Function approximation;
- Prediction with multilayer perceptrons;
- Character recognition;
- Approximation with Radial-Basis network;
- Self-organizing networks;
- Associative memory.

CONCLUSION

In result of this work a universal informational system for distant learning support has been created. Also, the existing traditional course “Neural networks” was adapted for use in distant learning.

Created system can be used in local and global networks (Intranet/Internet); it provides users with wide functional abilities for materials placement and search. The system supports keywords search; it features the dynamic glossary that eases search process appreciably. It also supports insertion of interactive elements into text of articles. These elements increase material perception, allow students to conduct their own experiments. All these factors obviously have positive influence on education effectiveness and knowledge quality.

It must be noted that the system, in contrast to the most of analogues, has lower cost and does not require users to purchase any special equipment or software. To use all the features of the system, users need only Internet browser (e.g., Internet Explorer or Opera), which is supplied by default with all modern operating systems.

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