# Web-based system for distant learning on neural networks and distributed systems

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## ABSTRACT

In this paper we present our system for distant learning support, and its current content – neural networks and distributed systems courses. The system provides users with remote access to learning materials, features dynamic glossary of terms and supports inline multimedia.

Keywords: distant learning, neural networks, distributed systems, Java technologies.

## INTRODUCTION

The industrial growth of recent years increases the need for high-qualified personnel, able to learn new technologies quickly. These factors put requirements to education system to higher level. One of the best solutions is distant learning. 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.

In this paper we present the web-based "Edia" system for distant learning support and its actual content: courses on artificial neural networks (ANNs) and distributed systems. The "Edia" system was designed using modern OOA&OOD methodologies and implemented with use of Java technologies (Servlets & JSP). The main feature of the system is that it contains and provides access to systematized information for remote and local users. Information is provided as html-formatted articles with inline multimedia. The system also features keywords assignment for articles, search functionality and dynamic glossary (index of keywords).

The ANN course available for students provides them comprehensive information of practical solutions in ANN data processing (function approximation, time-rows prediction, pattern recognition etc.) The demonstration applets, introduced into articles, give students a visual aid to clarify their knowledge by self-conducted experiments.

In the first chapter of this paper we give a short introduction to distant learning and its advantages compared to traditional one. The second chapter is dedicated to Edia system and its features. The third chapter describes neural networks and distributed systems courses that the system currently provides.

## 1. DISTANT LEARNING

Distant learning (DL) is such an organization of educational process, when tutors and students may be physically distant from each other. Historically, distant learning meant correspondence courses. But now it is a kind of education that makes extensive use of audio, video and computer systems connected via network. Distant learning implements best traditional and new methods, means and forms of education, based on computer and telecommunication technologies [1]. It is possible to select such advantages of distant learning, as:

- Flexibility. Everybody may learn as mush as one personally needs to master the course and receive required knowledge of chosen specialty. Moreover, more time is given for self-work, and thus knowledge and experience being received are mastered better.
- 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 right after material learning (online tests).
- Asynchronous. Teacher and student may take part in the study process relying on their own timetable and own rate, that 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 stuff 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 involves need of solution of yet unresolved questions. But, surprisingly, most developers do pay much of their attention to knowledge testing subsystem, while informational part is often left quite primitive, as it has bad material layout, inconvenient navigation and even more – no search functionality [2,3].

## 2. THE EDIA PROJECT

Our aim was to create a system that is free of described problems. It should contain and provide access to systematized information. The system must provide its users with comprehensive information, fast search and convenient interface and navigation.

There are four groups of users. Every group has own set of rights. Detailed descriptions of users rights 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. |

## 2.1. MAIN AND CONTEXT MENU

Menus are the one of the means of interaction between the user and the system, they provide quick access to system features. User interface provides two kinds of menu: main menu and the context one.

The main menu is placed at the top of page. Its content depends only on the group that current user belongs to (i.e. on his/her rights) and does not depend on current system state.
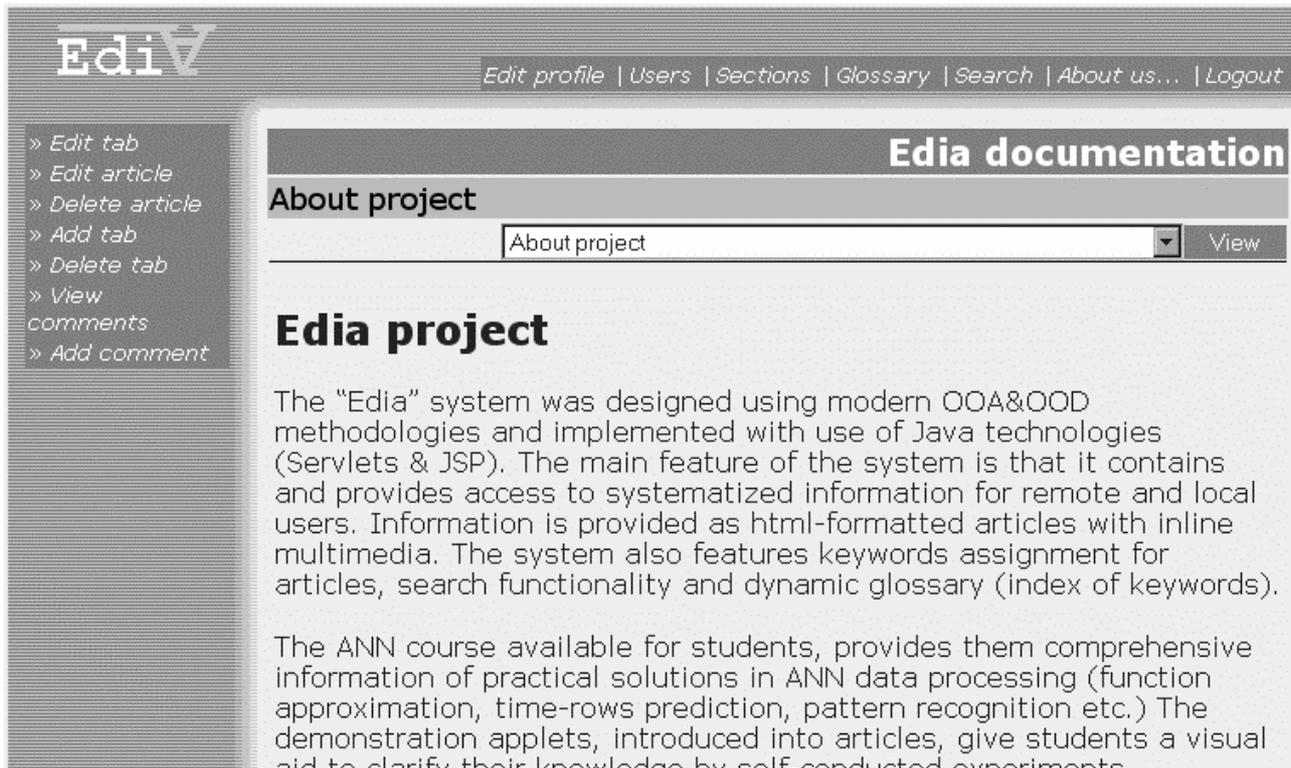
*Figure 1.* Controls layout in the system's user interface.

The following main menu items are available to any registered user:

- Edit profile (edit personal info);
- Sections (view sections);
- Glossary (search via glossary);
- Search;
- About us (info about system and its developers);
- Logout (finish work with the system).

The context menu is at the left side of the page. Its items' set depends not only on current user's rights, but on current execution context as well. For example, while tutor browsing section, the context menu contains link to "AddArticle" process; while viewing an article – to edit it, to view comments, etc. (Figure 1).

When user chooses (click) some menu item, the main servlet receives only the name of requested action, without any additional parameters. All the necessary for correct processing parameters are restored from the history of previous requests, thus context influence is taken into account.

For example, let's consider the situation when administrator while browsing section clicks on "Delete section" item of the context menu. The system receives request to delete section, but without any instructions which one. So it recalls the history of user's actions and finds the id of the currently viewed section. As a result, the system asks the user to confirm current section removal.

## 2.2. SECTIONS, ARTICLES AND TABS

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 more, internal level of hierarchy – so called tabs. This allow to represent article's structure in the best way, hence improving its perception by readers. For example, the first tab may contain general information, the second– demonstration materials (applets), the third – proofs of complex theorems, the fourth one – literature references and web links to associated materials on article's topic.

Only user who belongs to administrators group can create and edit sections. When editing a section, it is required to define its name and parent section.

Tutors can place new articles in any existing section. Only article's author or system administrator can delete or edit the article. For every article it is required to designate its name and the section it must be put in.

Every article has one or more tabs associated with it. The tutor can change the order of tabs appearance in the list, by means of "upper/lower" buttons (⬆⬇).

When adding/changing a tab, the tutor defines its caption, content (html-text) and provides a set of keywords, that describe tab's content. The user can set the tab's content either by typing it directly in corresponding field of form, or by pointing to appropriate .html file. The maximum size of this file is defined in system's configuration (1 Mb by default). If file size exceeds this limit, the file is not uploaded and the user gets appropriate warning message.

Keywords, associated with the tab, are automatically added to the glossary (see below).

It is possible to attach a number of files to every tab, and these files are then accessible from the html-tags of tab's text content.

## 2.3. FILE ATTACHMENTS

The developed system supports inclusion of multimedia and active content into html-text of tabs. These can be pictures, audio and video clips, flash-animation, java applets or other kinds of files.

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

All attached files are stred in DB and may be accessed via special servlet (FileServlet). Jackarta Tomcat server can be configured to redirect requests of certain addresses to servlet. In this case, all requests from client to address like "files/*" are redirected to FileServlet, which loads requested file from DB and sends it to client. Thus, all links to attached files have common unified format "files/subdirectories/file_name".

While processing client's request, FileServlet retrieves from execution context information about what tab is requested file is attached to. It also performs security check on whether user is allowed to get this file.

Lets consider an example. Assume, that in some tab's content there is a link like "files/somefile.jpg", and in the content of second tab – same link, but the attached file has different content. Nevertheless links (i.e. file names) are identical, each tab will have proper file loaded. In this case, the main role is played by request history saving mechanism – it allows to use unified format of links, without explicit association with certain tab.

To attach one or more files to tab, user must click "Add files" in the context menu while in tab edit mode. By means of appeared form it is possible to upload up to five files simultaneously. (That number is defined by system configuration and may be easily changed). Summary size of simultaneously uploading files must not exceed some limit, defined by system configuration (by default, it is 1 Mb).

It is possible to define a "pseudo directory" for each file. Then the file will be accessible in this directory. This allows to arrange access to different types of files from tab's text (e.g., images – in "files/images", applets – in "files/applets", etc).

## 2.4. USER COMMENTS

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.

To view comments for the current article, user chooses "View comments" item of context menu. To put own comment, there is an "Add comment" item in context menu.

## 2.5. THE GLOSSARY

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 (figure 2).

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). User selects the tab (article, section) needed.

Thus, the glossary search can be performed via two mouse clicks only.



*Figure 2*. The glossary

**2.6.     SEARCH FUNCTION**

The system 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.

The user may use any combination of items above.

Search results are displayed just like glossary search results: section(s) / article(if any) / tab(if any).

For string comparison, build-in functions of SQL language are used. This allows to minimize search time, as DB-level search is optimized by its developers.

Particularly, we use LIKE operator of SQL language for string comparison. Special symbols supported by this operator make the search more flexible. With LIKE it is possible to use the following two wildcard characters in the pattern:

Char     Description

%        Matches any number of characters, even zero characters;

_        Matches exactly one character [4]

Search is not case sensitive. The search request must be at least three characters long (defined by system configuration and can be changed).

**2.7.     USED TECHNOLOGIES**

The system was developed with use of Rational unified Process methodology [5]. The system was designed in Rational Rose 2000 using modern object-oriented technologies. For implementation, we used up-to-date Java technologies such as Java Servlets 2.3 and Java Server Pages 1.2. Database structure was created in ErWin 4.0 and MySQL 3.23 database is used as data storage. These technologies provide easy porting to various operating systems and reduce installation and deployment time of the created system.

## 3. NEURAL NETWORKS AND DISTRIBUTED SYSTEMS COURSES

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 [6].

We used existing traditional course of lections "Neural networks" which has been reading at the Radio Physics and Electronics faculty of Belarusian State University for some years. 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 [7]. 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 modeling;
  4. Data analysis.

*Figure 3.* Neural networks course

- The structure, learning algorithms and applications of NNs 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-modeling was created [8]. It is written in C++ and allows modeling of single neuron, single- and multi-layer neural network.

Our distant learning course also contains demonstrational Java-applets for most of the topics. They are provided together with lectures and allow modeling 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 improves material perception significantly and positively influence on 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 and adapt them for own tasks. At the current time course contains following applets [9-14].

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

The system currently also provides basic information about distributed systems and parallel computing. There are a number of articles that describe the theory and applications of distributed systems:

- Parallel computing overview;
- Cluster technologies;
- OpenMP standard;
- MPI and MPICH standards.

## CONCLUSION

In result of this work the universal informational system for distant learning support was created. Also, 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 created system, in contrast to the most of analogs, 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.

Every complete distant learning system must provide some way for users to estimate their knowledge, acquired from informational articles and other studying materials. Thus, our current task is to create a knowledge testing subsystem and incorporate it into Edia system. Currently such system is under construction. We also consider the possibility of enhancement the discussed system with an expert one based on semantic networks [15].

## REFERENCES

1. General concepts of distant learning system. (http://cdo.bseu.by/about/DA.htm)
2. Distant learning system "Prometeus". (http://www.prometeus.ru)
3. Distant learning system "e-University". (http://www.iba.by)
4. MySQL Reference Manual. (http://www.mysql.com/documentation/)
5. Rational Unified Process. (http://www.rational.com/products/rup/index.jsp)
6. Ringwood J. V., Galvin G. Computer-aided learning in artificial neural networks. //IEEE Trans on Education. Vol. 45, No. 4, 2002. PP. 380–387.
7. Lutkovski V. Neural networks. Lectures. Minsk, BSU. 2003.
8. Asaula R., Yautsiukhin A., Makovetski A., Papliatseyeu A., Lutkovski V. Package for neural network modeling. //Proceedings of International scientific-methodological conference «High technical education: problems and ways of development», BSUIR, Minsk, 2004. P. 158.
9. Corbett F. (http://home.cc.umanitoba.ca/~umcorbe9/)
10. Michel O. (http://diwww.epfl.ch/lami/team/michel/)
11. Watta P., Hassoun M., Dannug N. (http://neuron.eng.wayne.edu/bpFunctionApprox/bpFunctionApprox.html)
12. Tiscione J. (http://www.geocities.com/SiliconValley/2548/ochre.html)
13. Wong J. W. (http://exodus.mit.edu/~jesse/)
14. Loos H. S., Fritzke B. (http://www.neuroinformatik.ruhr-uni-bochum.de/ini/VDM/research/gsn/DemoGNG/GNG.html)
15. Sowa J.F. Semantic Networks. (http://www.jfsowa.com/pubs/semnet.htm)