E-Learning System

THE E-LEARNING SYSTEM WITH EMBEDDED NEURAL NETWORK

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Abstract: *Perhaps the most efficient of modern didactic policies is e-learning course. E-education shapes the culture of life-long learning and teaching and enables contemporary learners to meet the requirements of the outward reality. Learning is a daunting and time-consuming task. Its final success depends on many factors, so it's crucial to choose the proper enhancing software, able to adapt the teaching process to an individual learner and able to verify and assess his improvement in learning. According to the Ebbinghausen forgetting curves, reasonably frequent revisions give student both the knowledge and methods of its consolidation: as a result he learns more efficiently. Hence, the salient part of our e-learning system is the neural network able to establish the best possible timetable of revisions. The e-learning system we provide pertains to the knowledge of the Polish orthography. By means of it we have proved, that e-learning is didactically effective only if the educational software is interactive and flexible enough to adjust itself to the user's needs, requirements and perceptional skills.*

Keywords*: e-learning, neural network, forgetting curve*

ACM Classification Keywords: *I.2.6 Artificial Intelligence- Learning*

Introduction

Among various solutions, the e-learning course is one of the most effective teaching strategies, but intrinsic motivation, self-discipline and method are required from the learner. It obliges the learner to independently plan his/her learning process, promotes initiative, engagement and energetic action. The e-learning course uses those methods which are suited to the needs of the learner. They are organised when they are needed and allow satisfactory mastery of the material. The suggested teaching methods increase the effectiveness of teaching through the positive impact on the learner's motivation and thanks to adapting to his/her perceptive and intellectual abilities.

E-learning is an innovative method of knowledge transfer which uses IT tools; however, what is most important in this method is the learner and methods of solidifying the learning material. Effective knowledge acquirement, selection of important information and its use require regular repetitions, thus mnemonic techniques are crucial.

There is no universal learning method which would guarantee to every learner knowledge on a suitable level. Everyone prefers different learning methods and that is why systems which support the learning process and the process of solidifying knowledge use various techniques which speed up the process of memorising and facilitate recalling the memorised material [Szewczyk, 2005].

Human memory is the most important factor in mnemonic techniques. Numerous research and medical and scientific experiments concerning the construction and functioning of the brain clearly prove the existence of potential, though still not discovered, possibilities of memory processes.

The suggested application of learning orthography of the Polish language refers to the above-mentioned recommendations, emphasising above all the interactivity and virtuality of the learning reality.

Methods of memorising the learning material through e-learning courses

The standards of an e-learning course regarding the design of the learning material concern establishing and describing training aims, defining the conditions of the course distribution and using the prototypes of the projected system. The learning content should be subordinated to educational needs in the first place. Hierarchization of the content, legibility and cohesion of the transfer strengthen the content answer to the user's needs, making it possible for him/her to gain new competences and skills. It is necessary to remember about the well-thought out layout of the course, cohesive navigation and equipment limitations of the users.

To learn better one should not forget about the crucial role of the memory, for which the brain is responsible. When a person eats a heavy meal, he or she gets lazy. Before a bigger mental effort one should avoid heavy meals and sugars, which increase the level of insulin in blood; however, it is important not to starve either, because the brain needs fuel to operate.

We remember better the things we read at the beginning and at the end, worse the middle part of the material. Breaks have a beneficial effect on the process of learning, because thanks to them we have more beginnings and endings. For a learning process to be effective, the material which is supposed to be memorised should be divided into smaller fragments, i.e. lesson units. Portioning the material is a significant element, because we better learn smaller fragments than big portions. A kind and method of division also influences the quality of the learning process [Hyla, 2005].

Methods of planning repetitions

An important element of the learning process is repetition. Repetitions are very important because learning means creating new tracks in one's mind. The more often they are used, the better are formed connections between neurons. Revising the material is a necessity so it needs to be carefully planned. Thanks to repetitions, knowledge is not only systematically solidified but above all it stays longer in memory. The optimum time after which a material should be revised varies for different people, it depends on individual predispositions of a learner. To be able to remember the memorised material for a longer time, repetitions should be organised not accidentally but with suitable breaks. Subsequent revisions can be planned in the following way:

- after about ten minutes from studying
- the same day before going to sleep
- in the morning of the next day
- after a week
- after a month
- right before using the gained knowledge, e.g. before the exam

The forgetting curve

A German psychologist, professor Hermann von Ebbinghaus, in his research on the memory observed regularity in the learning and forgetting process whose reflection is the forgetting curve, known also as Ebbinghaus curve. It shows the dependence between the memory retention and time which from the moment of studying. In the beginning the curve descends very rapidly, to become almost a horizontal line (figure 1).

After the end of studying a fast decrease in the amount of the remembered information can be observed. Half of the material gets forgotten within the first hour. After the second day the process of forgetting slows down distinctly.

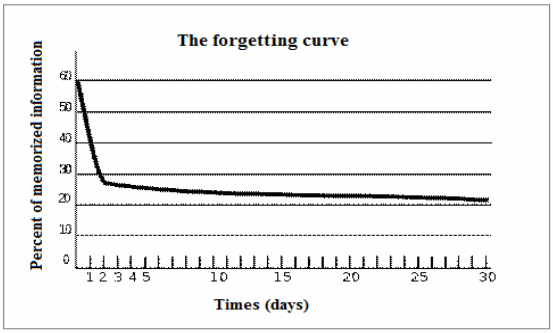

Fig.1: The forgetting curve

Thanks to repetitions of the material, every time the tilt of the remembered information is slower. The curve can be approximately presented by the:

- exponential function:

$$m = (a - c) * e^{bt} + c \tag{1}$$

where

m is memory retention,

b is forgetting factor,

a – remembering factor,

c – asymptote ,

t – time.

- power function:

$$m = g(1 + bt)^{-t} \tag{2}$$

where

m is memory retention,

g level of the non-volatile memory,

t is time,

i is forgetting factor.

Thanks to revising the material, a high level of remembered information is maintained. The main problem to be solved is defining the time when the learnt material is to be revised so that it gets solidified. To do this, the forgetting curve can be used; it shows interrelation between the memory retention and time passed from gaining the knowledge. According to the forgetting curve, after ten minutes from the end of studying, the learner remembers 90% of the information which he/she has been studying. The system uses the transfer of the forgetting curve in the power shape, to be more exact the formula: $R=e^{-t/s}$, where R is the amount of information easily recalled from the memory, t time in days that passed from the revision and s is relative strength of memory. The value wanted in the calculation process of the time for the next revision is time after which it should take place. The formula should be changed into: t=-s*log(R).

s is the factor of stability of facts calculated as 2^n, where n is the number of repetitions. To make it easier, it has been assumed that R equals 70%. It is at the same time the boundary value for the system, which means that the repetition should take place when the level of the remembered information reaches 70%. The diagram showed in picture 2 illustrates what influence on the shape of the curve repetitions have.

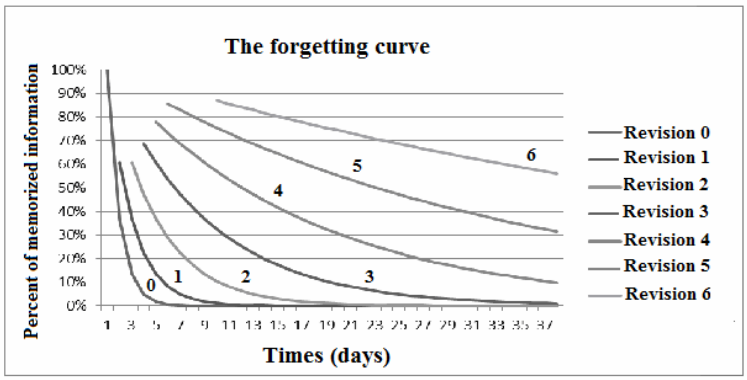

Fig.2: Forgetting curves projected when the learning material is revised

When a piece of information is repeated, relative strength with which it is remembered gets strengthened, thanks to which it is remembered longer. It should be noted that when deciding on the time of the repetition using the forgetting curve, the time of the repetition is calculated using universal methods, so individual characteristics of a learner are not taken into account [Lindsay, Norman, 1991].

The proposed e-learning system to indicate the next repetition uses the neural network of the Multilayer perceptron type. The concept of an artificial neural network comes from the human brain research and connections between the artificial neurons. The proposed network is taught by using the method with a teacher. It is a method of reverse mistake propagation, it consists of giving a set of input signals along with the expected output signals during the learning process. The learning of the network consists of such a neuron weights correction that in the final effect the mistake made by the network is smaller than the given. To achieve a better effect, a number of learning cycles is established, which allow the decrease of the value of the made mistake. The picture 3 shows the used neural network, whose task is predicting on the basis of the signals given on the input what the value of the output function should be [Tadeusiewicz, 1993].

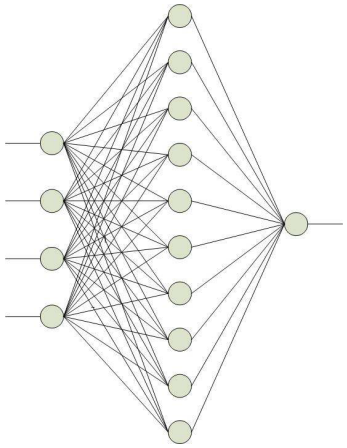

Fig. 3: Neural network provided for the purpose of the e-learning system

The suggested network has four inputs and one output. The network has been shaped and suited to the needs of the designed system. It is responsible for indicating the optimum value of the forgetting factor. Input arguments have been assumed:

- the time from the last repetition
- the number of repetitions
- the average calculated from the grades
- the last grade

In the proposed system, the learner gets a provisionally learnt network, which helps him use the system, in which the time for repetitions has been carefully planned. Thanks to the used neural network it is possible to indicate the optimum time for the next repetition, because it is set to the method of working of the learner's memory. Setting the network does not apply to one question only but the whole set of questions concerning a specific spelling rule – therefore the setting has a global character. The neural network can be coached, but only to some threshold value, which defines the maximum number of coachings of the network, it is a kind of a protection so that it is not over-coached [Plichta, 2011].

E-learning course to learn Polish orthography

In the proposed e-learning system the learner has a possibility to get to know the theoretical knowledge about the principles and rules of the Polish spelling and its practical application by completing a series of exercises illustrating the correct spelling within the specific rule. The learner checks the answer and verifies his/her mistakes. The system makes use of the navigation between the websites to move around. Such a way of moving is clear and easy to use. Text on the buttons precisely shows their destination, limiting wandering through the application's sites. Searching the electronic content allows learners to get to know the course's content and choose the suitable exercise from the module fast. Cohesion makes everything very simple – placing navigation elements in the same place on all the screens, using the same symbols and colours, the same fonts used for the same content elements, using the same rules while designing the layout of every screen. This solution makes it easier for learners and teachers to use the e-learning course.

The course's visual attractiveness is increased by the dynamically changing graphic signs placed in every module of the course, which have a high educational value. Graphic signs change with the change of a spelling rule, which makes it easy for learners to associate the picture with the rule. Correlations between the graphic and textual elements and also proper composition of those elements on the screen have been taken care of.

As text is the most common form of transfer in the e-learning course, its proper preparation is crucial, so that reading is easy and effective. The important information, which is a spelling rule, is repeated during every exercise concerned, and in different places of the course. It is shown on the user's demand.

Aesthetic rules are obeyed, also visual legibility of the screen has been taken care of, i.e. appropriate margins, spaces, light on the screen and appropriate font size. The size of the monitor and its resolution also influences the legibility of some of the course's elements.

Thanks to the data base of the questions, the system is able to organise repetitions. Repetitions involve showing subsequent questions by the system on the main panel of the application, to which the learner answers. The answer is then verified by comparing it with the correct one. The system enables also course and user's accounts administration, their rights to get to specific functions and platform's resources. It allows adding a new course or adding new information to the existing ones. The important element is communication between the individual members of the course and the teacher in a synchronous way (chat) and asynchronous one (forum, email) and creating virtual groups of members and teachers. The valuable source of information about the effectiveness of

the proposed course is the ability to examine the activity of the learners, surveying the members and teachers and checking the learning progress.

Conclusion

The e-learning system supporting learning spelling at school offers additionally a module managing the gained knowledge, making it possible to plan repetitions. These kinds of systems are the future of the modern education.

Nowadays, the choice of the repetition times in the programme concerns all spelling rules. A solution worth thinking about is transferring such decisions onto the specific rules. The change, concerning transferring the artificial neural network factors so that it adapts to the conditions of the specific spelling rule, will make it possible to increase the correctness of indicating the next repetitions for a chosen group of questions. As the questions concerning a specific spelling rule can be easier or more difficult, it will influence the process of remembering the information.

The system might be extended by adding statistics, on which the terms and effects of subsequent repetitions could be presented for a specific spelling rule.

The system I have designed uses the .NET platform by Microsoft because it provides tools which facilitate designing process. This platform is still developed by many experienced programmers. The artificial neural network is executed by the software.

On the basis of the statistics, the learner will have such information as the improvement of his knowledge and which spelling rules are the most problematic for him, which material is difficult for him and whether he needs to change his learning method.

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