THE APPLICATION OF NEURAL NETWORKS TO THE PROCESS OF GAINING AND CONSOLIDATING THE KNOWLEDGE

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ABSTRACT

The e-learning course is one of the most efficient and promising didactic policies. It must be grounded on the revision because it was proved that it enhances the long-term memory. However, human mind is not a uniform phenomenon. Each man memorizes and learn in a different manner. Hence, the intelligent e-learning system purposed to teach orthography was provided which is based on the multi-layer neural network. Such structure enables a learner to adjust the crucial period between revisions to his personal learning habits and policy.

INTRODUCTION

Owing to the modern information and communication technologies in education (ICT) a teacher is given a great opportunity to prepare his students to deliberate and controlled dealing with the available information. So, if we offer professional courses, instead of postponing the proved capabilities of ICT we should apply it to the modernization of the didactic process to meet the requirements of the learners.

According to the conducted research the youth are heavily affected by the virtual reality grounded on the information technology (IT). For a member of so called AC – generation (After Computers) learning by means of the Internet is the preferred way of self-education. Hence, the application of modern technologies and systems enhancing the learning processes is helpful in the fast and efficient gaining the knowledge as well as in shaping and nurturing the lifelong learning habit.

The E-learning Course

The e-learning course is one of the most efficient didactic policies because the e-education affects the culture of learning and teaching (which is the culture of sharing the knowledge with the others). However, the mentality of e-learners should be reshaped as e-teaching and e-learning requires the self-motivation, self-discipline and being conscientious. The e-learner must arrange the study on his own, and his commitment is praised as well as active participation. The results would be developed abilities, broaden knowledge and new competences acquired.

The functioning educational policy, grounded on so called 'just in case learning', is not efficient enough. It helps to gain knowledge, but the extent of the practical application of that knowledge is limited. Learners are aware of this fact and lack commitment to learning, which worsens the entire didactic process. Hence, according to e-learning the 'just in case learning' should be replaced with methods and policies which:

- are adjusted to suit the learner's needs ('just for me' policy)
- are provided exactly when they are necessary ('just in time' policy)
- enable a learner to acquire enough knowledge ('just enough' policy)

Three above-mentioned policies (also abbreviated as 3J) affect the learning process and enhance its efficiency because:

- they increase the learners' motivation – a user is taught only these abilities which are currently needed or required, so it is less time-consuming
- owing to them it is the knowledge and not the learner which is mobile
- owing to them teaching might be more individual, adjusted to the knowledge profile and perceptive and intellectual capability of a learner
- they enhance the knowledge acquisition and motivate to the lifelong learning

E-learning is a very innovative method of sharing the knowledge by means of IT tools. But every educational process must, primarily, focus on the learner and the ways of consolidation of the didactic material. To acquire the knowledge efficiently and to select and use the crucial data one should revise the material regularly. The available programs managing the knowledge are helpful in organizing the educational process and in planning the revision of the particular parts of the syllabus.

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Memorizing Via Revising

There is no universal learning policy which would guarantee gaining the high level of knowledge. Each learner prefers one policy to the other and thus the system enhancing the process of learning and consolidation of the knowledge uses various techniques which accelerate the memorizing and make the consolidated knowledge easier to be reminded.

Human memory is crucial for the mnemonic techniques. According to the various researches and experiments concerning the anatomy and functioning of the brain, processes of memorizing could be enhanced. In this respect brain has still a great unlocked potential.

Revision is very important for learning. Due to revisions the knowledge is systematically consolidated and it lasts longer within the memory. The learning material should be also fragmented as we acquire rather small than large parts of knowledge. We should carefully choose and divide the material as it affects the quality of the whole learning process.

Determining The Best Possible Time of Revision

The optimal time for revision is different for various learners. I will concern the e-learning system intended to teach the orthography. I used the neural network and forgetting curve to set the optimal time for the revision.

German psychologist Hermann von Ebbinghaus was conducting a research on human memory. Consequently, he drew the forgetting curve, also known as the Ebbinghaus curve, which reflects the observed regularities in the process of learning and forgetting. It illustrates the relationship between the amount of acquired information and the time which passed since the moment of learning. At the very beginning the curve is falling rapidly but then it turn almost flat (figure 1).

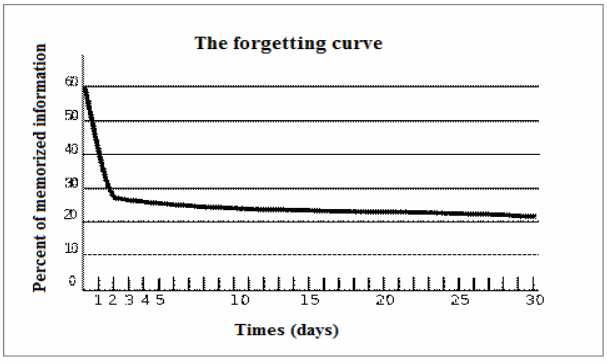

Figure 1: The forgetting curve

Once the learning is finished the amount of memorized information decreases rapidly. Half of the material is forgotten in an hour. Two days later the forgetting process is remarkably less rapid. Thanks to the revision of the acquired material the pace of forgetting is slower and slower. The Ebbinghaus curve can be approximately projected by means of the following functions:

- Exponential: $m = (a - c)e^{-bt} + c$

where:
m - stands for the amount of memorized information,
b - stands for the coefficient of forgetting,
a - stands for the coefficient of memorizing,
c - stands for the asymptote,
t - stands for the time.

- Power: $m = g(1 + bt)^{-i}$

where:
m - stands for the amount of memorized information,
g - stands for the level of the long-term memory,
t - stands for the time,
i - stands for the coefficient of forgetting.

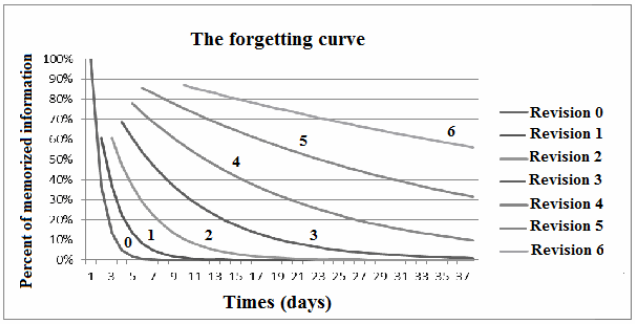

Figure 2: Forgetting curves projected when the learning material is revised

According to the forgetting curve, ten minutes after the termination of the learning process a man holds on 90 percent of the information he has gained. If we repeat that information we will enhance the relative power of memorizing and thus lengthen the period when it can't be forgotten.

The system use the projection of the forgetting curve in the power form, namely in the form of the following equation: $R = e^{-t/s}$

where:

R - stands for the amount of easily-recalled information
t - stands for the number of days measured from the revision
s - stands for the relative power of the memory

Now, what we seek is the proper value of the time between two revisions. Hence, we transform the equation to the form: $t = -s * \log(R)$

where:

s - stands for the coefficient of the stability of facts. (It is equal to 2^n where n represents the number of revisions).

for the sake of convenience we assumed that R=70%. It is the threshold value for the system, which means that the revision takes place whenever the level of the memorized information reaches 70% . The chart 2 illustrates how the revisions affect the shape of the curve. We should notice that the time of the revision is calculated by means of the universal methods. Hence, the system of revisions should be deprived of any personalization.

Determining The Following Revision by Means of The Neural Network

Concept of the artificial neural network is derived from the research on human mind and the interrelationship between the artificial neurons. Nowadays, artificial neurons are interconnected variously, either in the software or within the integrated circuits. The e-learning system is grounded on the Multi-layer perceptron neural network.

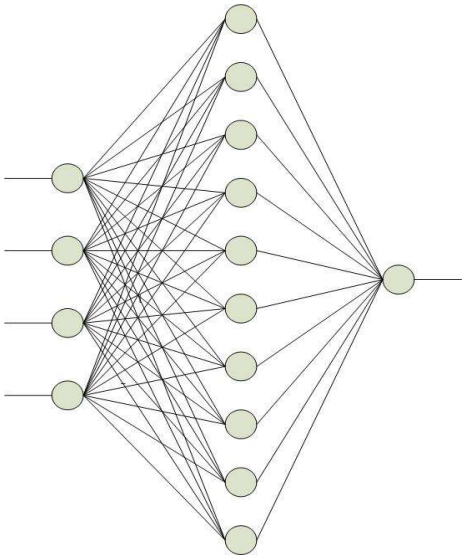

Figure 3: Neural network provided for the purpose of the e-learning system

The provided network is taught by means of backward propagation of error (abbr. to back propagation) method which belongs to supervised methods. The artificial neural network was taught by means of the experimental set including the values of data for each of the 4 inputs and expected output values. As the initial arguments we set:

- time which has passed since the last revision,
- the number of conducted revisions,
- the mean value of the user's notes (we take account of all the revisions),
- the note of the last revision.

The artificial neural network estimates how strong has the student remembered the given material (which level he has gained), because it precises the value of the s coefficient at the forgetting curve (the relative memory strength). Thus, it is able to be taught, and is able to adjust itself to the way the student's memory functions. The student is provided with the pre-taught network which enables him to use the system. The adjusting process has global character because it appertains to the entire set of questions related to the particular orthographic rule (and not to a single question)

The network is taught again whenever:

- the student was graded very well; it could be up to 5^{th} revision and the period between revisions exceeded 10 days,
- the student was graded very well; it was more than 10^{th} revision and the period between revisions exceeded 1 year.

The network is protected from over-learning by the threshold value which sets the maximal number of teaching cycles e.g., 10000.

During the revision the system displays the following questions appertaining to the particular orthographic rule. The student answers, verifies his answer comparing it with the correct one, and decides whether his answer was correct. There are six possible levels of correctness (0-5). Owing to the revision system it is possible to maintain he high level of memorizing the rules of polish orthography. Owing to neural network, which adjusts to the particular student's skills, the next revision is set more and more precisely, in the given interval.

Tests were conducted in two 15-person groups. Students from the first group were provided with e-learning course without the support of scheduling the term of revision, whereas the second group of students were provided with the system where the optimal time of revision was scheduled by the neural network built-in the system. Among students using the system with neural network the efficiency of memorizing the training material has increased by 15%.

Experiment results have been shown in the following diagrams.
Evaluation used in the experiment:
A – very good
B – good
C – fair
D – failed

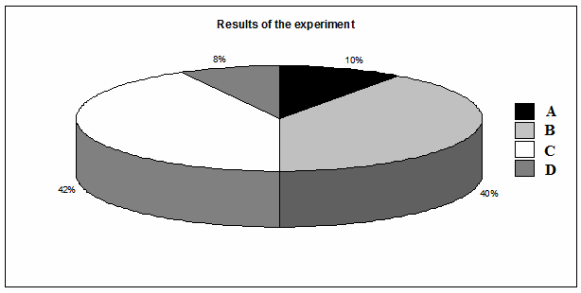

Figure 4: Results of the experiment for I group

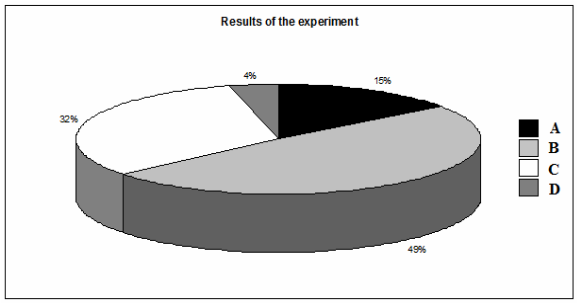

Figure 5: Results of the experiment for II group

SUMMARY

The e-learning system enhancing the process of learning the orthography in school has also the additional module. It manages the gained knowledge, enabling the revisions to be planned. Similar systems leads the education to its future.

So far, one could set the conditions under which the time of revision may come, but they apply to every orthographic rule. Perhaps we should enable the users to set a distinct conditions for each orthographic issue. Transferring the coefficients of the artificial neural network, so that they accommodate to the conditions of the particular rule, would make the following revisions for the particular sets of questions more correct. The questions concerning the particular orthographic rules could be more or less difficult, so it will affect the process of memorizing the information.

Apart from that, the system may be expanded with the statistics providing the fixed dates and results of the revisions. Owing to them the student would be aware of his current state of knowledge and of particular difficulties. He would know if his learning policy is efficient or to be changed.

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