EVALUATION OF TRAINING EXECUTED BY WEB USING MULTILAYER PERCEPTRON BASED SYSTEMS

Liliane dos Santos Machado[1] and Ronei Marcos de Moraes[2]

Abstract *— This paper presents a new methodology of evaluation of training executed by Web. To evaluate the user's performance it is necessary collect data from training. Dedicated plug-ins are used to collect information about the different variables of user's training. Some automatic evaluators use expert systems to perform evaluation using as input statistical models and statistical tests. However, in some applications, it is difficult to obtain knowledge from an expert and the data collected from user's interaction cannot be adequate to classical statistical distributions. To solve these problems we propose an intelligent evaluation procedure that allows classifying a trainee learning using a Multi-Layer Perceptron neural network based system. The user can be classified into classes of learning giving him a real position about his performance, through the reports of performance. That reports can help user to improve your performance in execution of real procedure.*

Index Terms — Multi-Layer Perceptron Neural Networks, Training Evaluation, Web-based Simulation.

INTRODUCTION

The form of evaluation is a big problem in distance training or distance learning. Several discussions point out advantages and disadvantages of methodologies and suggestions about how to introduce evaluation components [6] in distance learning [7]. However, it is a consensus that evaluation is necessary to assess the training quality and provide some feedback about the user performance.

There are automatic and semi-automatic evaluation systems for analysis of students log files and creation of a profile for evaluation [30]. In this category we can find systems, which trace student's actions over specific topics or utilized resources. Other systems [21] do the evaluation using tests, exercises, quizes and questionnaires. Brusilovsky and Miller [2] used local tests and a system with some intelligence to do not repeat tests applied before or to evaluate answers. Unfortunately, these methodologies are incipient because they use short pre-defined evaluations. Even when the questions are presented randomly or use some intelligence they are finite. Other limitation is that the student cannot execute effectively the procedure for what he is been trained.

Recently, Moraes and Machado [20] presented an approach that uses an automatic evaluation system for training executed at distance. Several measures from user interaction in training executed by Web are used as input for a fuzzy rule based expert system [20]. However, to develop an expert system we need to obtain the knowledge from an expert. Sometimes, that task is not easy.

In this paper, we introduce a new approach for an automatic evaluation system for training executed by Web. Several measures from user interaction in training executed by Web are used as input for an evaluation system based on Multi-Layer Perceptron neural network [13, 25]. The evaluation system can construct a profile for a trainee and emit relevant information about his performance in some pre-defined categories of training.

BACKGROUND

There are many examples of training systems by Web. Some of them are informative systems with several web pages with a lot of information about a specific subject as, for example, the website *Electronic Music Interactive* at University of Oregon [28]. In several cases, informative systems do not present any form of evaluation. Their function is simply to transmit knowledge using massive multimedia resources [16]. Others are realistic-based training using high-resolution graphics and permit direct interaction simulating pseudo-real actions over mechanisms [22]. Some of those systems have an evaluation system close to the training system. The evaluation system collects relevant variables during user interaction by Web.

Some methodologies have been proposed for evaluation in simulated training. McBeth et al. [14] proposed a methodology to evaluate medical procedures using basic statistics. Pucel and Anderson [22] developed a computational ophthalmic simulation to test a person's ability to perform psychomotor tasks using basic statistics too. Recently, Machado and Moraes [9][11], Machado, Moraes e Zuffo [12] e Moraes e Machado [17][19] proposed advanced statistical techniques or tools based on fuzzy logic to evaluate training based on virtual reality simulators [3]. Those systems are capable to collect specific data from training execution and to compare them to pre-defined models (statistical or logic) that are called classes of performance. For example, five models can correspond to

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five classes of performance in training: *you need much more training, you need more training, you need training, your training is good* or *your training is excellent* [12].

In several of those works, it is showed that with modifications some techniques can be generalized for applications in training executed at distance. For those cases, Moraes and Machado proposed an evaluation technique using a fuzzy expert system. A fuzzy rule based expert system uses statistical measures and models, fuzzy sets and expert systems. The first one is a set of statistical measures commonly used for general purposes as mean, median, mode, standard deviation, etc [26]. Besides, we also use statistical models based on regression analysis to modeling linear [4] and non-linear [23] sequences of performance in task execution. In some cases is interesting to use statistical time series analysis to perform better statistical models using the time as a variable [1]. Statistical measures and statistical parameters of models can be compared using appropriate statistical testing of hypothesis: nonparametric [8] or parametric [15]. As results of these comparisons, we have statistical decisions about equality or difference between parameters and a measure of probability of significance.

Because it is possible that some variables in virtual world do not present an exactly correspondence to the real world, some measures cannot be exact. Then we must use fuzzy sets to measure those variables [5]. These fuzzy variables are measures based on membership functions previously defined by experts.

A fuzzy rule based expert system combines logically all information about fuzzy and non-fuzzy variables to making decisions about complex conjectures [27]. That expert system could classify the trainee into classes of training [20].

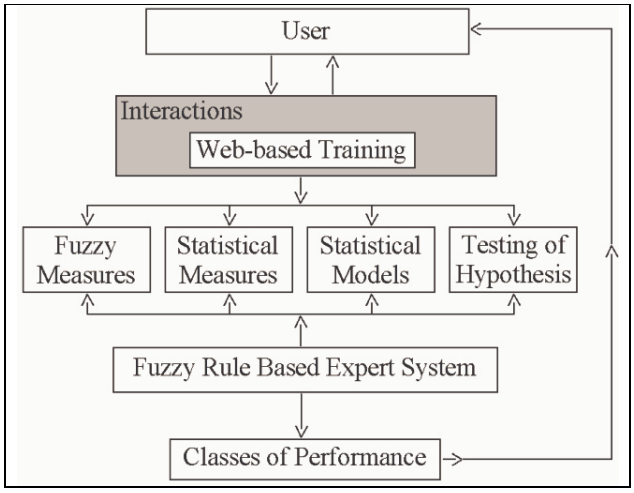

FIGURE. 1
DIAGRAM OF THE EVALUATION SYSTEM PROPOSED BY [20].

Figure 1 shows the blocks diagram of the evaluation system. User executes a realistic training by Web interacting with the system. The interactions are monitored by modules, which can make measures, modeling and testing of hypothesis. A fuzzy rule based expert system receives that information and it can classify the training in predefined classes of performance. The final classification is returned to the user.

However, it is not easy to obtain the knowledge from an expert. Besides, data collected from user's interaction cannot be adequate to classical statistical distributions, which can compromise statistical decisions based on that data. To solve these two problems, we propose the use of Neural Networks for evaluation of procedures in Web-based simulation.

NEURAL NETWORKS

This section presents the Multi-Layer Perceptron (MLP) neural network method for training evaluation. Basically, a neural network is a computational system using artificial neurons, which are totally connected with others (synapses). The main capabilities of neural networks are:

- To learn by examples;
- Self-adapt for other problems
- Organization
- Generalization
- Robustness to the noise and
- Fail tolerance

Several applications for MLP with good results in statistical pattern recognition can be found in literature [24, 29].

There are several kinds of neural network, but some of them are based of Perceptron concept [25]. Figure 2 shows this concept and we can observe the linear combination of inputs *X* by weights *W* that results the output *Y*.

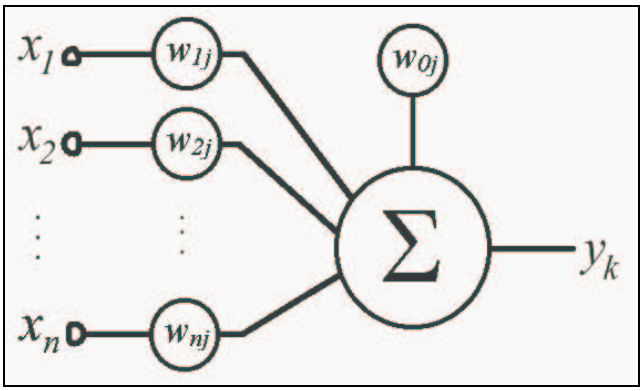

FIGURE. 2
CONCEPT OF PERCEPTRON.

The output y_k is done by:

$$y_k = w_{0j} + \Sigma^{n}_{j=1} x_i w_{ij} \qquad (1)$$

The activation function or threshold function maps a Perceptron to a pre-specified range. Four activation functions are commonly used: linear, ramp, step and sigmoid. The family of sigmoid functions is large, but the function

$$S(x) = (1+e^{-x})^{-1} \qquad (2)$$

is known as logistic function and it is observed in statistics as the Gaussian distribution function.

In this paper, we use the Multi-Layer Perceptron (MLP) [25]. The Figure 3 shows the concept of MLP. We have an input layer X, with $x_1, x_2, ..., x_n$ inputs. We can have one or more hidden layers Z and an output layer Y, with $y_1, y_2, ..., y_k$ outputs.

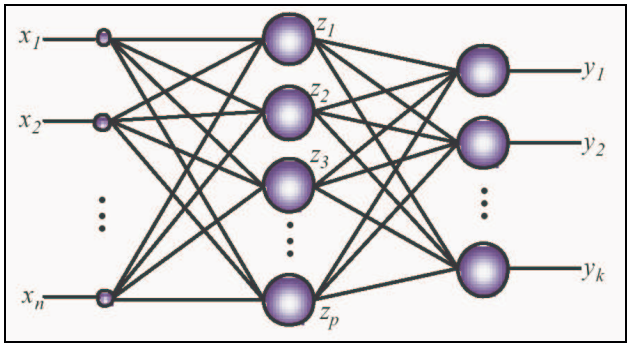

FIGURE. 3
CONCEPT OF MULTI-LAYER PERCEPTRON.

We use the *Feedforward* topology [25] that allows flow of information in one direction. However, this topology has an inconvenient: we do not know about hidden layers errors. The solution for this problem is use *Error Backpropagation* supervised training method [25] to estimate weights of perceptron.

EVALUATION IN TRAINING PERFORMED BY WEB

From a realistic-based training by Web we can collect several information about user interaction. Sequence of executions, measures, etc., can be relevant information for an evaluation system. In web-server all interactions can be recorded in specific log-files. From these files, statistical measures and parameters can be obtained.

In this paper, we propose a new conception for an evaluation system of training executed by web using MLP. This system uses information from log-files, statistical measures and statistical parameters as input for a MLP based system.

For the evaluation an expert executes several times the procedure for each one of classes of training. In this work, we use five classes of training, according to [12]:

- *your training is excellent* – trainee is qualified to execute a real procedure .
- *your training is good* – trainee is almost qualified to execute a real procedure. Performance is good, but it can be better.
- *you need training* – trainee needs training to be qualified. Performance is regular.
- *you need more training* – trainee needs more training to be qualified. Performance is bad.
- *you need much more training – trainee is a beginner*. Performance is very poor.

So, the information of variability about these procedures is acquired using Backpropagation trained MLP neural network and using activation function done by (2).

The y_k outputs from Backpropagation trained MLP neural network are normalized and converted in scores of performance of each class of performance y_{ko} and $y_{ko} \in [0,1]$.

$$y_{ko} = y_k / \{\Sigma^{K}_{i=1} y_i\}, \quad k = \{1, 2, ..., K\} \qquad (3)$$

The trainee executes a realistic-based training by web interacting with the system. His interactions are monitored by modules, which can collect information and make measures from log-files. The evaluation system receives that information and it can classify the training in predefined classes of performance. The final classification is returned to the user with his respective score of performance, according (3).

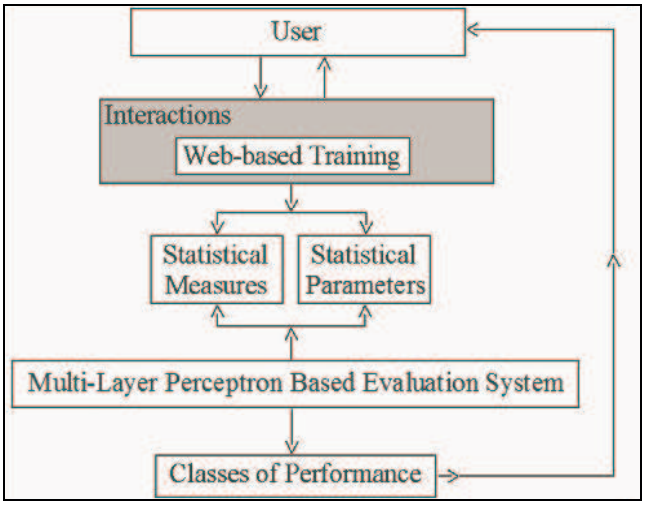

FIGURE. 4
DIAGRAM OF THE NEW EVALUATION SYSTEM BASED ON MULTI-LAYER PERCEPTRON FOR TRAINING EXECUTED BY WEB.

Figure 4 shows the blocks diagram of the new evaluation system. User executes a realistic training by Web interacting with the system. The interactions are monitored

by modules, which can collect statistical measures and parameters. A multi-layer perceptron based evaluation system receives that information and it can classify the training in predefined classes of performance. The final classification is returned to the user.

CONCLUSIONS AND FUTURE WORKS

In this paper, we introduced a new approach of evaluation for training executed at distance by Web using an automatic evaluation system. The data is collected from user interaction data collected over training executed by Web and save to log-files. This methodology uses that information, statistical measures and parameters as input for a Multi-Layer Perceptron based evaluation system. The evaluation system can classify a trainee into pre-defined categories of training.

This approach using Multi-Layer Perceptron based evaluation system can solve two problems in evaluation systems by Web: 1) it is not easy to obtain the knowledge from an expert and 2) data collected from user's interaction cannot be adequate to classical statistical distributions, which can compromise statistical decisions based on that data.

However, this approach cannot be used in any kind of training system by Web. To apply correctly this methodology it must be used over a realistic-based training. In this kind of training system, it is possible to collect information about user interaction.

As future work, we intend to test and to make a statistical comparison between others kinds of neural networks for improve accuracy of the evaluator.

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