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ATTITUDE TREATMENT TRAINING BY ADAPTIVE INSTRUCTION (A.T.T.A.IN)

By
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Abstract

A.T.T.A.I.N is a research project proposing certain guidelines and principles that outline the design of a flexible interactive and adaptive learning environment. Flexibility, interactivity and adaptivity are three of the many crucial properties that define the right learning environment. So far A.T.T.A.I.N focuses on this three properties aiming to test their applicability. Later on, A.T.T.A.I.N will examine more of the properties that define optimum relations in an ideal learning environment. Therefore, A.T.T.A.I.N has to simulate learner's ability diagnosis procedure. As it is known, learner's ability to adapt the interaction to the situation at hand is strongly connected either to their behavior in the educational environment (learning style) or to their learning type. It is also known that learner's type is strongly connected to learner's cognitive control and style. Looking at the diagnosis of problem solving behavior that describes learning style, K.de Köning at al, introduce a sophisticated direct answer to this extremely difficult issue of artificial intelligence in education. DeKöning's method allows the flexibility of the educational environment in terms of **learner's behavior** to the purpose of adaptation. The learner's ability diagnosis, we are dealing with, can be considered as a technique that classifies learners into certain groups. This technique allows the flexibility of the educational environment in terms of **learner's ability**. Learner's classification in terms of their ability to accept the learning material is allowed by a sequence of diagnostic tests having as output a final mark. Therefore, it would be of great importance to introduce the learner's ability scale. In order to do so, we consider the Kolb's classification.

Using learner's ability diagnosis results, A.T.T.A.I.N introduces a non-hierarchical learning flow, which is a dynamically adjustable learning flow. To this end a robust large scale system has been established, which governs the system and composes the foundation of the A.T.T.A.I.N architecture and a three agent system ensures the systems functionality.

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INTRODUCTION

This paper presents the up to date progress on the development of the Attitude Treatment Training by Adaptive Instruction (A.T.T.A.IN) architecture. As it will be clear to the reader, A.T.T.A.IN can be used as a basic tool for developing an asynchronous distance learning course in any educational subject, provided that those who would make use of it, will provide the course material which would exploit A.T.T.A.IN's features. The project aims to design a self driven dynamical (or non autonomous) architectural model that would be capable of behaving as the "optimum virtual teacher". The parameters of such a model are time dependant in order to have the crucial abilities a good tutor has, like the ability to redesign a module having a continuous feedback from their students. At the same time A.T.T.A.IN takes under consideration certain characteristics of the student. The chosen characteristics are also time dependant and influence the learning flow progress as well. To the best of the author's knowledge, similar attempts have been implemented by Tom Murray [M1] and Maria Pantano-Rokou [PR1]. They both aim to design software that imitates the "best possible teacher". A.T.T.A.IN introduces a number of innovative ideas that finally create a new computer implemented learning environment. At this point, it should be mentioned that efforts for having even better such computer implemented learning environments, should be made in the near future. Obviously, A.T.T.A.IN is subject to continuous improvement.

A.T.T.A.IN aims to the individualization of learning. Therefore, it is flexible and adaptive to the learner's abilities and at the same time adaptive in the sense of controllability. As a matter of the adaptation to learner abilities, A.T.T.A.IN collects a number of learner qualitative characteristics, using appropriate scale systems thanks to which it finally gets a quantified learner's profile. Learner's classification in terms of their ability to accept the learning material is possible by a sequence of diagnostic tests resulting to a final mark. Therefore, it would be of great importance to introduce the learner's ability scale. In order to do so, we consider the Kolb's classification [K1]. Looking at the diagnosis of problem solving behaviour that describes learning style, K. de Köning at al [dK1] introduce a sophisticated direct answer to this extremely difficult question in artificial intelligence in education. Köning's method allows the flexibility of the educational environment in terms of learner's behaviour to the purpose of adaptation. The learner's ability diagnosis, A.T.T.A.IN uses, can also be considered also as a technique that classifies learners into certain groups. This technique allows the flexibility of the educational environment in terms of learner's ability. The design and in-the-program implementation of suitable diagnostic tests in combination with the multilevel evaluation of the results, support A.T.T.A.IN's capability to recognize learner's styles, following R. Danielson's techniques [D1] . Evaluation concerns both the student and the module efficiency to learners. Since there is a variety of student characteristics which have been chosen to be evaluate and two basic characteristics of the program efficiency (degree of influence to the set of users ever used the module and the average rate of variance in students progress), A.T.T.A.IN uses multilevel evaluation and consequently multivariable statistical analysis.

Following Carrol's theory of minimalization [VdM&C1], attention has been given to any possible diminization of the passive role the student can have. For this, the student is involved into certain activities from the very beginning . Every activity aims to educational scopes, which are discrete and independent from each other . Each student has to deliver projects in which characteristics from every day life are easily recognizable. The learning flow encourages autonomous thinking and improvisation. At the same time A.T.T.A.IN's learning environment, supports the possibility of error indication and presents a help menu that is helpful to the error correction. In a way, Caroll's minimalization theory implementation into A.T.T.A.IN gives some characteristics of constructivism [A et al]. Moreover, the design of the learning material is based on additional principles like the learning by acting principle, which underline the emphasis given on its constructivistic characteristics.

Therefore, A.T.T.A.IN creates, maintains and makes use of a student model and of the current knowledge state of the student. This dynamically updated model contains the ATTAIN's inferred estimation of the mastery level of important concepts and procedures.

Student's interest stimulation has also been taken under consideration. Following instructions given by certain devices, A.T.T.A.IN uses a variety of means thanks to which stimulates the students interest.

THE PARAMETERS

Since learning is an individualized process, ATTAIN takes under consideration the student's learning style and prior and recent knowledge that affect the choice of the learning path. Evaluation of the student learning progress and the course efficiency also determine the choice of the learning path. Regarding the student's learning style [D1], ATTAIN focuses on two variables - learning ability (*LA*) and learning behaviour (*LB*) - which describe the two dimensional learning profile of a student. On the other hand, prior and recent knowledge evaluations are expressed through two parameters (*PK*) and (*RK*) respectively. The parameters are multidimensional vectors which take values in certain ranges defined in relation to the scaling of the property which defines each of them. A.T.T.A.IN stores the values of all of the variables and parameters in a database and updates it continuously during the progress of the course.

An additional parameter describes statistics (*S*) on the time response of the student to certain learning activities. Parameter *S* eventually becomes a reliable indicator of the student concentration and interest shown to the learning material. Thus, helps to self-evaluation of the program (see [B1]) giving information at the points which might need redesign.

THE DESIGN

A.T.T.A.IN uses three main data bases to deposit to store data for students, learning material and statistics. Each one of them is capable to store a number of characteristics. Thus, the student's data base keeps for each student separately information related to its *LA, LB, PK* and *S.* The learning material data base keeps the learning elements, i.e. theorems, examples, exercises, laboratory demonstrations and experiments as well. Every item in the learning material data base is classified in terms of its position at the A.T.T.A.IN's large scale system and has additional labels indicating its learning goals. Every single activity, a student has to do throughout the completion of the learning flow, have in advance being characterized by the tutor who follows the instructions. Characterizations refer to the learning goals of the learning level following the Gagne classification of instructional goals [G1], [G2]. Both *PK* and *RK* contain evaluation marks for each of the learning goals separately. The third data base stores statistical results concerning among others, the impact factor of each learning unit to the student, the index of the progress shown by groups of a certain learning style students, distributions of student evaluation in every learning unit.

For a learning module of ***n*** sequential lectures or learning units, each one of which refers to a certain learning subject, the architecture of A.T.T.A.IN has been designed on an n-partite oriented and connected pseudograph of m vertices, where vertices represent teaching learning units. Each of the ***n*** groups of ***m*** vertices refers to the same learning subject which can be considered as a learning level in the graph. Each vertex of such group represents an alternative presentation of the same lecture's material. We call learning path a path in A.T.T.A.IN's pseudograph, which is the selection and sequencing of instructional content's which responds to the student profile and abilities. As we consider that the recognition of student characteristics is subject to change continuously, data are adjustable at every vertex of the learning path. The choice of the adjoint vertex is made by the system coordinator at every level, following the late modulation of student profile. Therefore, suitable methods for student profile recognition function repeatedly at every vertex of the learning path and so, A.T.T.A.IN as an adaptive learning tool is capable ensuring the optimum learning path which can be adapted to a learner's special needs.

The whole structure is functioning as a large scale system of learning units. The A.T.T.A.IN's system coordinator navigates the user through the pseudograph, using up to date data. System coordinator is a synchronous optimum controller which reacts according to predescribed list of instructions and aims to find the best (to the student) fitting learning path.

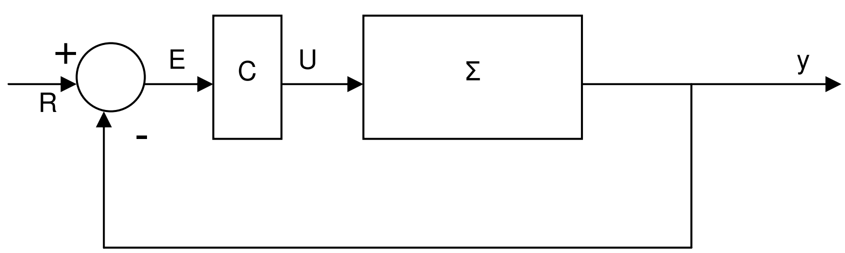

Figure 1: Control System of a Learning Unit at a vertex of ATTAIN pseudograph

Let us now focus on a single vertex of A.T.T.A.IN's pseudograph. In there, the control system with feedback is easily recognizable by the observer.

As it is shown above, R contains a set of demands related to instructional goals and to RK of the student. The output y should reach R in order to minimize E (error). For the model at hand E is an increasing function. Theoretically speaking a control system with feedback, aims eventually to diminish E, or $\lim_{t \to \infty} E(t) = 0$

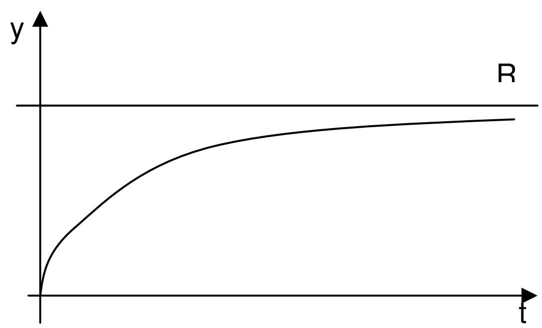

Figure 2: The output y expected to reach the predescribed learner's profile R.

Practically speaking, minimization of E means that student's recent knowledge meets the standards (tutorial goals). The controller C combines Information carried mainly by PK, LA, LB and S. Additional information in reference to statistical results. stored in the statistics data base, make controller more efficient. The controller influent to the state variable Σ emphasizing on certain learning goals and choosing suitable learning material from the learning material data base. It also uses data concerning timing and evaluation and results, other students succeeded before, in order to create a more collaborating learning environment [W1]. The state variable Σ in this case is a system of difference equations of the form:

$$PK_{n+1} = f_{PK}(PK_n, RK_n, LA_n, LB_n, S_n, n)$$

$$RK_{n+1} = f_{RK}(PK_n, RK_n, LA_n, LB_n, S_n, n)$$

$$LA_{n+1} = f_{LA}(PK_n, RK_n, LA_n, LB_n, S_n, n)$$

$$LB_{n+1} = f_{LB}(PK_n, RK_n, LA_n, LB_n, S_n, n)$$

$$S_{n+1} = f_S(PK_n, RK_n, LA_n, LB_n, S_n, n)$$

The functions f_i , i Є { *PK, RK, LA, LB, S*}, have been designed for the purposes of a fixed learning unit. Therefore, A.T.T.A.IN is consisted by nxm such systems. The output *y* of a single learning unit, the student has been work with, carries out pieces of information on student evaluation, (variables *PK* and *RK*), student profile (parameters *LA* and *LB*). If the value of the variable *RK* is below a given previously threshold, then the student stays at this learning unit to reinforce his knowledge. A.T.T.A.IN has been planed in such a way that student doesn't get information in terms of his progress. Moreover, y provides information to both the system coordinator who navigates to the next learning unit and to the controller of the next control system.

System coordinators are functioning at the output of every single learning unit. According to the tutoring strategy at hand, the system coordinator decides the direction of the flow. Therefore, a system coordinator has to choose between 2*n* learning units, located at the previous and the next learning level. Backward flow of the program increases the total length of the module, but reinforces the knowledge by correcting evaluation errors or misleading procedures.

THE FUNCTION

The A.T.T.A.IN will adapt the teaching style dynamically to respond to the student, according to his/her learning style, in the best-fitted way. Multiple tutoring strategies will be implemented and used to achieve this instructional flexibility.

In order to select the best tutoring strategy for a given situation the acting system coordinator at a learning unit, decides if the path will move the learner forward to the next learning unit or to return at a learning unit backward. If the latest is the case, either the learning unit is the previously given, or another one at the same level which fits better to the student recent recognized needs. Even in the case the system coordinator drives backward or the controller C does not allow the exit of a learning unit, student will not be able to feel repetitions, since the learning material will be quite different. As by the evaluation techniques the level of student success are easily recognizable by A.T.T.A.IN , related information transferred by the output to the system coordinator results on the optimum navigation through A.T.T.A.IN's large scale system.

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