Automatic treatment of the learner's productions

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Summary

An adjustable hypermedium is supposed to post a pedagogic behaviour close to actual teaching. Among other things, it must be able to adjust the learning to the learner.
In order to fulfil this individualization, such a system must possess a set of information about its user, usually called "learner's pattern".
Our article is concerned with the learner's patterning problematic in an adjustable hypermedium. The described information in the pattern must be reliable enough reflecting the real cognitive and psychological state of the learner too.
We suggest here the use of conceptual maps to treat and evaluate the learner's knowledge automatically.

Key words:
Adjustable hypermedium, learner's pattern, learner's cognitive state, conceptual maps.

1. Introduction

The conception of the adjustable hypermedia represents an important part in the field of research about the new technologies of information and communication "NTIC".
Introducing such a system in the field of education aims at two different purposes:

- To facilitate the teacher's task,
- To improve the learning process for the learner.

These learning environments, which must be satisfactory both on the level of the informatics development and that of the educational aspects, require the cooperation of different fields (education sciences, didactics, cognitive psychology, artificial intelligence, human and social sciences, informatics …)
The adjustable hypermedia must have the closest behavior to that of an actual teaching, which involves the gathering of information concerning points of various kinds (the lesson content, the pedagogic strategy carried out, the learner's pre-requisites and knowledge …).
To fulfill the adjustable of the content to the learner, an hypermedium must possess a set of information about its user, mainly his present knowledge concerning the field taught.
So an advanced diagnosis of the learner's knowledge is necessary in order to adjust the hypermedium. We have to implement a diagnosis evaluation method instead of a simple summing-up method.

2. Design of an adjustable hypermedium

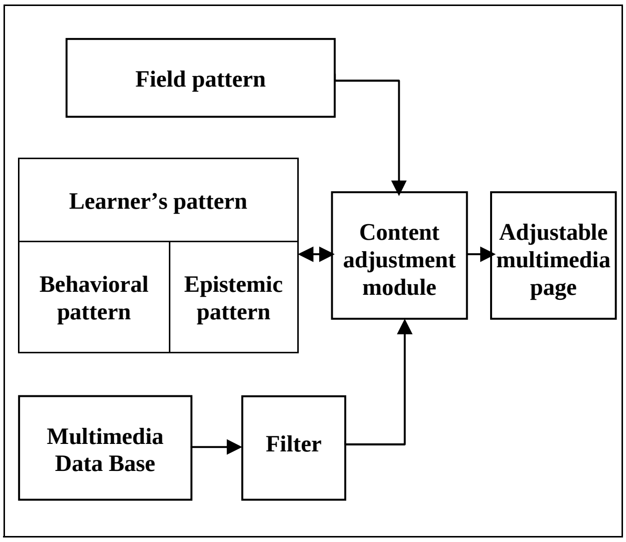

Fig. 1 Design of an adjustable hypermedium

The system includes:

- A pattern of the field containing the teacher's knowledge.
- A pattern of the learner which allows to know the learner, it is made of two sub-patterns (the behavioral and epistemic patterns).
- Multimedia data base which will contain elementary components to formulate the teacher's knowledge.
- A content adjuster which permits to set up multimedia pages adjusted to the learner's pattern.

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3. Learner's pattern

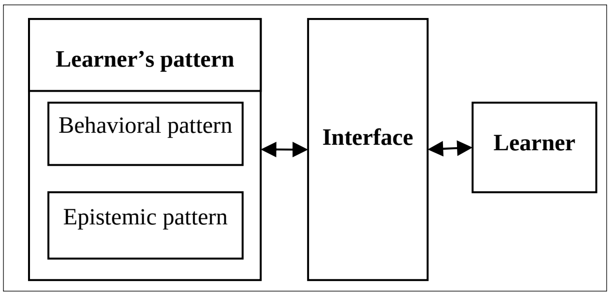

Fig.2 Learner's pattern

Nicolas Balatcheff [1] distinguishes between two components within a learner's pattern, as is shown at Fig.2.

- The learner's behavioral pattern,
- The epistemic pattern,

The behavioral pattern is a representation of the learner's behavior, i.e. how he interacts with the environment.

The epistemic pattern is an interpretation of the first pattern, it's supposed to represent the learner's concepts which originate from his behavior.

4. Learner's patterning

The learner's patterning has to contain information reflecting the cognitive and psychological status and psychological features of the learner's. Hence, these are difficult not only to define but also to advance during the interaction and to be used so as to improve the learning. For this, the psychological attributes are rarely present in the learner's pattern.
So we are interested in the information related to the learner's cognitive status. It's possible to describe this status according to many approaches (perturbations, primitives, overlay …).

4.1. Overlay patterning

The learner's status of knowledge , as it is shown in fig.3, is represented as a sub-set of knowledge of field's pattern [2]. The aim of the learning hypermidium is to ensure that the learner's pattern gets close to that of field to the maximum.

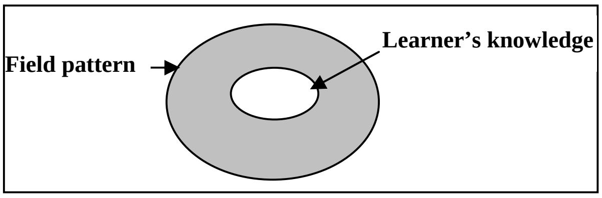

Fig.3 Overlay Patterning

In order that the recovery pattern can be up to date, many sources of information are relied on:

- Implicit information which are derived from the comparison between the learner's behavior and that of the field.
- Explicit information obtained by a direct questioning of the learner.

4.2. Patterning by perturbations

It permits to represent the misrules frequently observed about the learner, in addition to the correct rules he has (see Fig.4). The errors are regarded as perturbations for the field pattern.
So, this kind of patterning requires the conception of an error catalogue [3].

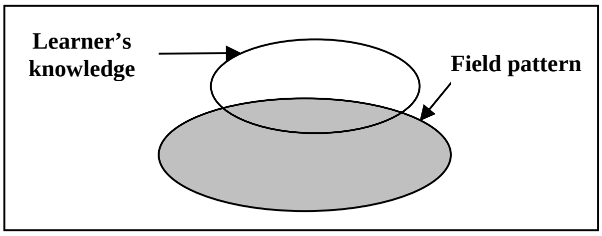

Fig.4 Patterning by perturbations

4.3. Patterning by primitives

This technique, as it is shown at in Fig.5, consists in determining a set of primitives components [4] whose gathering allows to represent the knowledge in the field's pattern and the learner's errors.

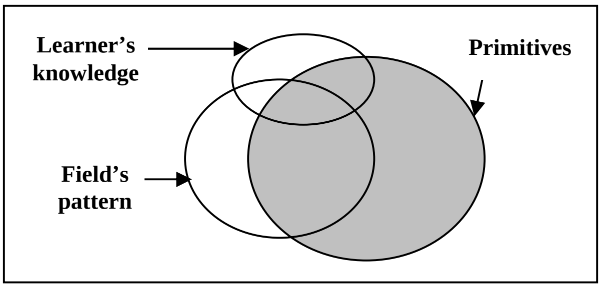

Fig.5 Patterning by primitives

There are different means to initiate the learner's pattern. Either to consider the learner as a neophyte (beginner) as far as the field taught is concerned, or to consider the learner as an expert in the field by creating a pattern which is initially equal to the field's pattern.
Another possibility of initiation is probably by using the pre-knowledge about the learner (Multiple Choice Questions before the first session).

5. Represenation approch of the learner knowledge by using the conceptual maps

5.1. Defining a concept by means of a conceptual map

The conceptual maps permit to represent the knowledge in any field, particularly in the informatics systems of learning. The main advantage of conceptual map is being a formalism which is limp enough to be employed by a learner or a tutor, still remaining quite more structured than a natural language text. So the analysis of the learner's production is becoming easier, not only by a human reader, but mainly by an informatics system.

Barth [5] assumes to pattern the raised knowledge by following a certain methodology. For him a concept is an entity made of three interdependent elements: the concept's tag which is the term used by a tutor or the learner; its attributes, which are a set of conditions which are necessary and sufficient so that a certain phenomenon relays from this concept and set of concrete examples which are several phenomena used to check all the attributes associated with the concept.
Once the teacher's definition is determined and the first step of the teaching takes place, the tutor can require from the learner to define the studied notion. It terms of the learners answer, many situations can be determined (Exact definition, Error definition, others …). The teacher reaction will depend on the way the learner's answer is classified. Such classification is the one which will have the role of the epistemic pattern of the learner.

An informatics system has to analyze the definition suggested by the learner and react so, evaluating it in comparison with the one given by the tutor.
A conceptual map is a graphic representation which presents a set of concepts linked together according to quite formal rules. So, it concerns a tool which permits to seize the relationship between the different concepts raised by the teacher in a better way, by presenting a global view in the form of a diagram.
The teacher is urged to pattern the notions that he wishes to raise, by means of a conceptual map to evaluate the learner's one. The conceptual map will be then used as a tool allowing to define a certain notion, it will be centered around a knot representing the notion to be defined. Once this card is set up, the tutor may ask the learner, after a certain learning step, to set up his own map. We suggest to compel the learner to choose concepts and linking types which he can use in his map among a list already determined by the tutor.

5.2. The algorithm of the k closest neighbors

Supposing that we know, in a certain space with n dimensions, certain number of labeled points, i.e., associated to some know classes.
Suppose a p points whose coordinates are known and that we want to classify. The research algorithm of the k closest neighbors is a classical tool of classification which in ranking a p points by means of it's the k nearest neighbors.
If we search among the already known points which one is the nearest to p, and by observing its class, we will deduce that p relays from the same class. In order to determine which point is the closest, a calculation of the Euclidian distance is enough. If p is very far from all the referred points, we will reject it and indicate that we're unable to rank it.
In a two-dimension space, as it is shown in Fig.6 below , the classes and coordinates of the points: A, B and C are known. So, we fix k=1.
We'd like to rank the points P_1, P_2 and P_3, whose coordinates are the only thing we know. The closest point to P_1 is C, so P_1 will be attributed to the C class. The nearest neighbor of P2 is B. So, it will be attributed to the class B. Concerning P_3, although its nearest neighbor is A, it is rejected.

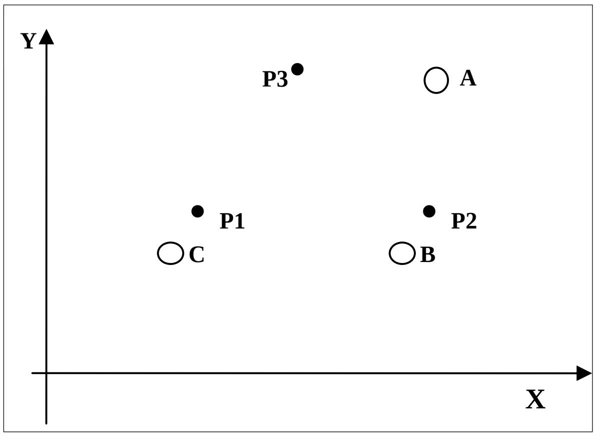

Fig.6 Principle of algorithm of the k closest neighbors

To calculate the distance between two points P1 and P2, we just need to deduce the Euclidian distance between these two points:

$$d(p_1, p_2) = \|p_1 - p_2\|^2$$

This algorithm can be used to rank data of any type, some learner's productions, as it is the case here, provided that we are able to represent the data in a type of a vector with numerical characteristics.

5.3. Transformation of a conceptual map to a vector

In order to implement the algorithm of the k nearest neighbors for the ranking of the conceptual maps, we must determine a method enabling us to represent a conceptual map in the type of a vector. Formally speaking, a conceptual map is a set of attributing $r(c_1,c_2,\ldots,c_n)$ of n dimension , and c_i a concept contributing to the relationship.

Hence, when learners set up their map, they have to respect certain restraints: they must be pleased with the types of links and concepts already determined by the teacher, and the knot which is the origin of a relationship is necessarily the one representing the concept to be defined.

So, the number of the different attributes that the learners can produce is limited [6], but also minimized as the original knot is fixed for all the attributes.

It is possible then to represent a map based on this set of relationships and concepts as a vector $\vec{v}$ with v_i=1 if the attribute i appears on the map, otherwise v_i=0.

Once the learner's map is transformed, we just need to calculate the distance which separates it from each one of the reference maps suggested by the tutor and to decide which one is the nearest [7].

5.4. Level-heading factors of the concepts

The level-heading factors that we would like to introduce in the treatment and ranking of the learner's productions represent the level of importance the tutor gives to an attribute that participates in any relationship during learning. This importance is expressed by a factor α_i for each attribute c_i.

Then, the teacher can rank the attributes contributing to the relationship in order of importance by defining a vector α(n, n-1, …, 1) which n the number of attributes participating in the relationship.

In order that the level-heading factor would have an effect on the distance calculation as it was seen in the previous paragraphs, we must make a change originating from the binary vector representing the learner's production (conceptual map). For this, we suggest the following translation vector:

T (1,1,…, 1) of n dimensions.

The calculation of the distance which separates the learner's map from those of the tutor is conveyed in the following relationship:

$$d(P, R) = \alpha^2 \|P - R\|^2$$

With α : Level-heading vector,
P : Leaner's production,
R : Teacher's reference.

6. Conclusion

A conceptual map enables the teacher to determine precisely the knowledge structure as he hopes to raise it with learners, and possibly to elaborate a progressing schema. It also enables the learners to be aware of the field structure they will study.

The adjustable hypermedia has opened a new research axis in the field of distance learning systems. The adjustable educational hypermedia tends to be open on the web to share and reuse the pedagogic resources.

On the other hand, the learner's patterning problem is far from being solved. The patterning of the affective and cognitive knowledge is very complex because the learner progress with time and modifies his preferences concerning the pedagogic strategies. The learner's patterning is meaningless unless the pattern is up-to-date as the learning takes place.

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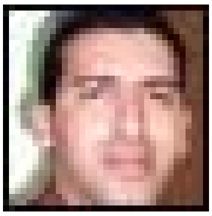

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