

## **Analysing the Outcome of a Learning Process Conducted Within the System ALS\_CORR[LP]**

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**Abstract**—This paper presents the results of an experiment, conducted on a sample of computer science students, using the adaptive learning system called ALS\_CORR[LP]<sup>1</sup>. Indeed, unlike the traditional LMS, adaptive learning systems provide a personalized learning experience based on specific objectives, prerequisites and learning styles, generating thereby a specific learning path. However, the main issue resides in the fact that they assume that the generated learning path is supposedly the leading one, which is far from being true, as we can always detect some failure cases during the evaluation phase. In this paper we will conduct a learning experiment using the system ALS\_CORR[LP], which has the ability to correct the generated learning path by recommending the most relevant learning objects, and update the learner model based on a calculation of similarity in behavior between the struggling learner and the succeeding ones. We will later analyze the results of behavior tracking within the system.

**Keywords**—Learning style, Learning path, Experiment, Adaptive learning system.

### **1 Introduction**

Adaptive learning systems make content dynamic and interactive, placing the learner at the centre of the learning experience. The techniques used to provide adaptability have been summarized by [1] into several techniques and methods. The authors of [2] made it clear that those systems operate according to two strategies:

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<sup>1</sup> Adaptive Learning System with a CORRection of Learning Path

We will use some explicit methods, [3], [4], [5] and [6], to gather information about the learner's preferences, learning-wise, using mainly e-questionnaires, where they can express their tendencies. We will use implicit methods, [7], [8] and [9], to monitor how the student interacts with the learning system, grouping data on the interaction of the learner with the learning objects. Despite the adaptation provided in both cases, failure is an undeniable reality in the learning process. In the case of adaptive learning systems, failure amounts to a detection of error in the learner's preferences, or sometimes in the relevance of the learning objects.

In this paper, we will present the results of an experiment conducted on bachelor of computer science students, using the current MERISE method as a subject of learning on the adaptive learning platform called ALS\_CORR[LP] [10]. The rest of this paper is organized as follows:

In Section 2, we will begin with a presentation of the characteristics of the ALS\_CORR [LP] system, exposing its learning scenario and architecture. Later, in Section 3, we will focus on the implementation of the experiment. In Section 4, we will analyze the outcome of the experiment and provide some comparisons, using graphical representations of the results. Then, in Section 5, we will provide a graphical representation of the learning style combination of the related students. In Section 6, we will display some statistics about the versions of the learning objects. Finally, some conclusions will be drawn in the last section.

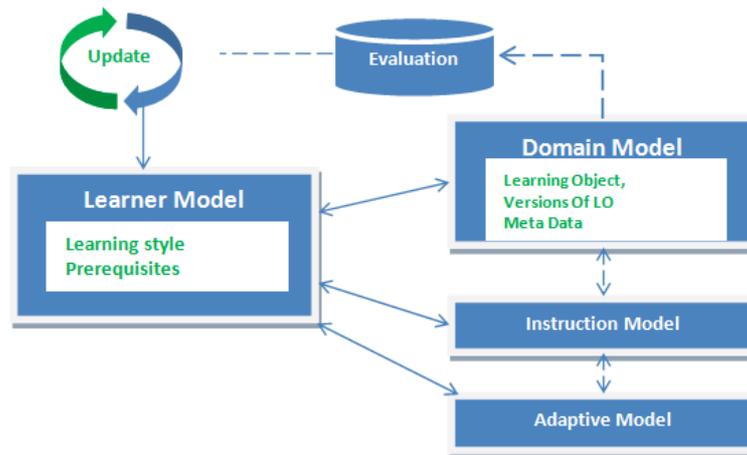
## **2 The Style Adaptive Learning System**

With the runaway success of e-learning systems in their abilities to meet specific needs, a new kind of system is booming, namely the adaptive learning system. We are currently witnessing a transition from the one-size-fits-all systems [11] to new ones, which are more interested in a personalization of the learning process. In fact, adaptive learning systems are an important class of the e-learning systems; they usually customize the learning process according to the needs, prerequisites, objectives, etc... of each learner, creating thereby a specific learning path. The problem with these systems is that they assume the generated learning path as systematically the leading one, which is not necessarily the case, as we can still detect several negative results during the evaluation phase.

The ALS\_CORR [LP] system presented in this paper has the ability to correct the learning path, using a recommendation system operating in two modes: to recommend the most relevant versions of each learning object by calculating the similarities in behavior between the struggling learner and those who have achieved positive results, provided they have the same initial profile, and recommending later their learning objects. The second mode is to update the initial profile in case the behavior observed in the system does not correspond to the original profile generated initially.

## 2.1 System architecture

The ALS\_CORR[LP] architecture [12] operates using the components displayed in the following figure:



**Fig. 1.** System Architecture

According to the figure, there are five major components that run the system, namely: the Learner model, the Domain model, the Instruction model, the Adaptive model and the Evaluation phase.

- The Learner model: it is based on Felder-Silverman's test to detect the learning style of each learner and on the prerequisite test.
- The Domain model: it is composed of the learning objects, designed according to the SCORM Standards [13], multiple versions of the same learning object and finally the Content Metadata as defined by IEEE Learning object Metadata.
- The Instruction model: it is the pedagogical model, responsible for designing the learning object.
- The Adaptive model: it enables the system to assign the learning objects according to the characteristics of the learner's profile.
- The Evaluation: it represents a critical part [14] in this adaptive learning system, as it remains the only way to correct the learning path in case it appears not to be the leading one.

## 2.2 Learning scenario

For a first-timer, the learner must respond to a prerequisite test and fill in the test of Felder-Silverman's learning style model known as FLSLM [15], in order to determine the initial profile. The system then assigns an appropriate version [16] of the specific course, based on the preferences expressed in the early profile. In case where the

generated learning path is not the leading one, which is translated, assessment-wise, by a negative result during the evaluation phase, the system recommends the most relevant versions of the same course based on the calculation of similarity in behavior between the struggling learner and those who have succeeded during the evaluation phase.

### 3 Conducting the experiment

The aim is to use the system ALS\_CORR [LP] to conduct an experiment on a sample of bachelor of computer science students, in order to study their behavior inside the adaptive learning system, and more particularly to check the relevance adaptation performed in the system, by comparing the learning model and the observed behavior.

As part of the Design Method module, where the MERISE method of learning takes place, an experiment was conducted on a sample of 53 students of computer engineering degree at the Faculty of Science and Technology of Tangier. To ensure students' engagement with regard to the process, the final score for each learner was calculated, including the results of the evaluation conducted within the system. In the next section, we will present the results relating to the calculation of Felder-Silverman learning styles within the system.

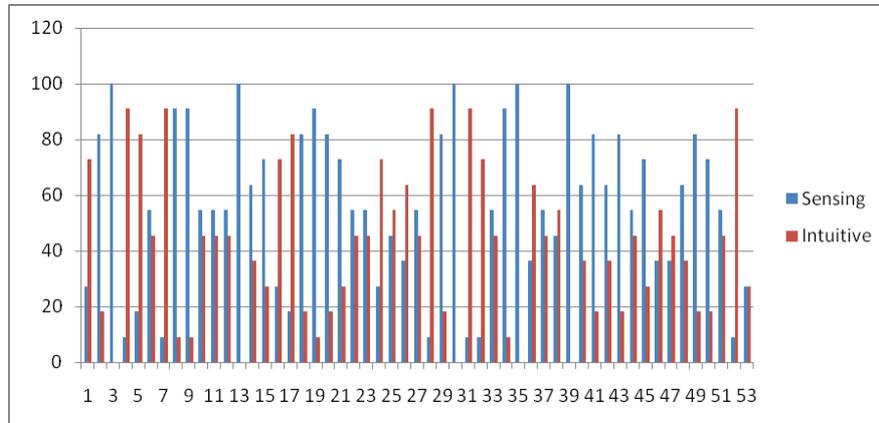
A first analysis of the results registered in the system reveals the following distribution of profiles according to the Felder-Silverman test:

**Table 1.** Felder-Silverman test result within the system ALS\_CORR[LP]

Learner's Number	Sensing	Intuitive	Visual	Verbal	Test Duration (Sec)
1	27,27	72,73	45,45	54,55	36
2	81,82	18,18	90,91	9,09	28
3	100,00	0,00	90,91	9,09	11
4	9,09	90,91	9,09	90,91	10
5	18,18	81,82	18,18	81,82	21
6	54,55	45,45	63,64	36,36	261
7	9,09	90,91	72,73	27,27	130
8	90,91	9,09	54,55	45,45	471
9	90,91	9,09	63,64	36,36	447
10	54,55	45,45	54,55	45,45	173
11	54,55	45,45	72,73	27,27	89176
12	54,55	45,45	81,82	18,18	2669
13	100,00	0,00	100,00	0,00	25
14	63,64	36,36	54,55	45,45	124
15	72,73	27,27	27,27	72,73	105
16	27,27	72,73	90,91	9,09	503
17	18,18	81,82	90,91	9,09	537
18	81,82	18,18	54,55	45,45	253

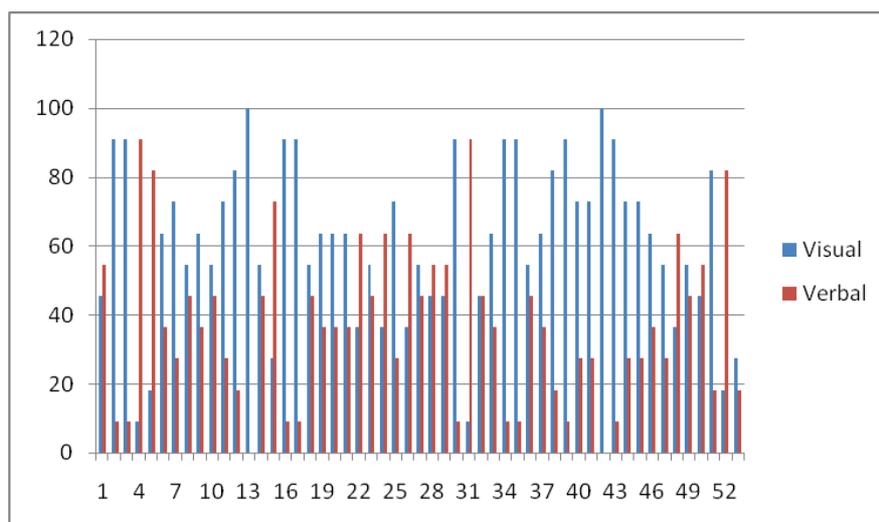
Learner's Number	Sensing	Intuitive	Visual	Verbal	Test Duration (Sec)
19	90,91	9,09	63,64	36,36	121
20	81,82	18,18	63,64	36,36	81
21	72,73	27,27	63,64	36,36	123
22	54,55	45,45	36,36	63,64	594
23	54,55	45,45	54,55	45,45	340
24	27,27	72,73	36,36	63,64	1129
25	45,45	54,55	72,73	27,27	275
26	36,36	63,64	36,36	63,64	156
27	54,55	45,45	54,55	45,45	126
28	9,09	90,91	45,45	54,55	246
29	81,82	18,18	45,45	54,55	84
30	100,00	0,00	90,91	9,09	10
31	9,09	90,91	9,09	90,91	7
32	9,09	72,73	45,45	45,45	1122
33	54,55	45,45	63,64	36,36	175
34	90,91	9,09	90,91	9,09	160
35	100,00	0,00	90,91	9,09	13
36	36,36	63,64	54,55	45,45	155
37	54,55	45,45	63,64	36,36	128
38	45,45	54,55	81,82	18,18	110
39	100,00	0,00	90,91	9,09	86
40	63,64	36,36	72,73	27,27	201
41	81,82	18,18	72,73	27,27	298
42	63,64	36,36	100,00	0,00	136
43	81,82	18,18	90,91	9,09	263
44	54,55	45,45	72,73	27,27	211
45	72,73	27,27	72,73	27,27	217
46	36,36	54,55	63,64	36,36	435
47	36,36	45,45	54,55	27,27	168
48	63,64	36,36	36,36	63,64	133
49	81,82	18,18	54,55	45,45	69
50	72,73	18,18	45,45	54,55	113
51	54,55	45,45	81,82	18,18	168
52	9,09	90,91	18,18	81,82	3
53	27,27	27,27	27,27	18,18	7

Let us start with an analysis of each dimension of Felder-Silverman's profile used in the system. The following graph shows a comparison of the perception dimension.



**Fig. 2.** "Perception" dimension analysis

The following graph relates to the analysis of the "input" dimension of Felder-Silverman's profile.



**Fig. 3.** "Input" dimension analysis

According to the two preceding paragraphs, "Sensing" and "Visual" styles are the most dominant among students' learning preferences. Thus, we can point out that there are four possible combinations, depending on Felder-Silverman's profiles:

- {Sensing, Visual}
- {Sensing, Verbal}
- {Intuitive, Visual}
- {Intuitive, Verbal}

Here are the results regarding the styles {Sensing, Visual}; in other words, these students prefer to work with examples and facts of visual kind (videos, diagrams, images, illustrations).

**Table 2.** {Sensing, Visual} Combination

Learner's Number	Sensing	Intuitive	Visual	Verbal	Test Duration (Sec)
2	81,82	18,18	90,91	9,09	28
3	100,00	0,00	90,91	9,09	11
6	54,55	45,45	63,64	36,36	261
8	90,91	9,09	54,55	45,45	471
9	90,91	9,09	63,64	36,36	447
10	54,55	45,45	54,55	45,45	173
11	54,55	45,45	72,73	27,27	89176
12	54,55	45,45	81,82	18,18	2669
13	100,00	0,00	100,00	0,00	25
14	63,64	36,36	54,55	45,45	124
18	81,82	18,18	54,55	45,45	253
19	90,91	9,09	63,64	36,36	121
20	81,82	18,18	63,64	36,36	81
21	72,73	27,27	63,64	36,36	123
23	54,55	45,45	54,55	45,45	340
27	54,55	45,45	54,55	45,45	126
30	100,00	0,00	90,91	9,09	10
33	54,55	45,45	63,64	36,36	175
34	90,91	9,09	90,91	9,09	160
35	100,00	0,00	90,91	9,09	13
37	54,55	45,45	63,64	36,36	128
39	100,00	0,00	90,91	9,09	86
40	63,64	36,36	72,73	27,27	201
41	81,82	18,18	72,73	27,27	298
42	63,64	36,36	100,00	0,00	136
43	81,82	18,18	90,91	9,09	263
44	54,55	45,45	72,73	27,27	211
45	72,73	27,27	72,73	27,27	217
49	81,82	18,18	54,55	45,45	69
51	54,55	45,45	81,82	18,18	168
52	9,09	90,91	18,18	81,82	3

Here is the second combination of possible learning styles, in which there are learners who tend to favor learning with examples and facts, but of textual nature.

**Table 3.** {Sensing, Verbal} Combination

Learner's Number	Sensing	Intuitive	Visual	Verbal	Test Duration (Sec)
15	72,73	27,27	27,27	72,73	105
22	54,55	45,45	36,36	63,64	594
29	81,82	18,18	45,45	54,55	84
48	63,64	36,36	36,36	63,64	133
50	72,73	18,18	45,45	54,55	113

This category of learners prefers learning through definitions and algorithms, presented as videos, images, illustrations, etc.

**Table 4.** {Intuitive, Visual} Combination

Learner Number	Sensing	Intuitive	Visual	Verbal	Test Duration Sec
7	9,09	90,91	72,73	27,27	130
8	90,91	9,09	54,55	45,45	471
16	27,27	72,73	90,91	9,09	503
17	18,18	81,82	90,91	9,09	537
25	45,45	54,55	72,73	27,27	275
36	36,36	63,64	54,55	45,45	155
38	45,45	54,55	81,82	18,18	110
46	36,36	54,55	63,64	36,36	435

The latest combination of learning styles focuses on learners who enjoy learning with definitions and algorithms of a textual nature.

**Table 5.** {Intuitive, Verbal} Combination

Learner's Number	Sensing	Intuitive	Visual	Verbal	Test Duration (Sec)
1	27,27	72,73	45,45	54,55	36
4	9,09	90,91	9,09	90,91	10
5	18,18	81,82	18,18	81,82	21
24	27,27	72,73	36,36	63,64	1129
26	36,36	63,64	36,36	63,64	156
28	9,09	90,91	45,45	54,55	246
31	9,09	90,91	9,09	90,91	7
8	90,91	9,09	54,55	45,45	471

#### 4 Graphical representation of the learning style combination

It is obvious that the combination of learning styles {Sensing, Visual} is the dominant combination in the system. In fact, students in this class promote learning with visual resources (videos, images, illustrations...) while learning objects are in the form of examples and explanations.

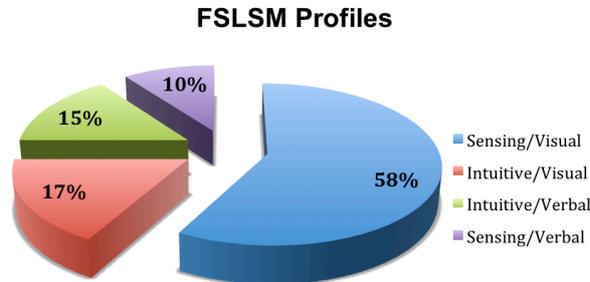


Fig. 4. Distribution of learning style combinations

Indeed, the graph showing the distribution obtained about learning styles based on combinations shows that approximately two thirds of students have the combination { Sensing, Visual }, while the remaining third is divided almost equally among the other combinations of learning styles.

## 5 Statistics About the Learning Object Versions

ALS\_CORR [LP] system allows for several statistics about the learning objects and their versions, depending especially on their nature, type and resources. It also allows pointing out the most visited versions of the course.

Below, we will present an overview of the statistics obtained by the system regarding the learning of the MERISE design method.

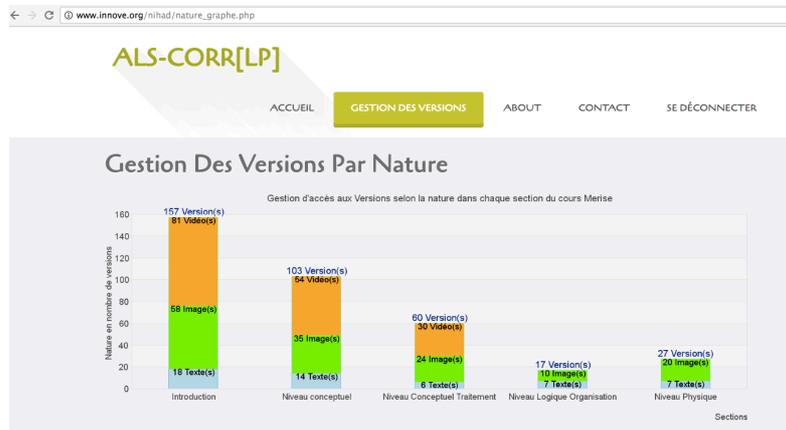


Fig. 5. Statistics related to the nature of the versions of the learning objects

The graph above shows that the video version of the course introduction is the most viewed of all sections. It is also noteworthy that the video versions of the other sections are the most visited too.

Here is an example of statistics on the most visited versions in seconds.



Fig. 6. Statistics about the most visited versions (s)

## 6 Evaluation Results

The main objective of the evaluation is to make sure that learners did achieve the educational goals set at the start, and to get a summary of, or judgment on, the teaching strategies adopted. This phase is crucial in the system because it provides it with the necessary information, on which it can rely to reassess the relevance of the calculation made in the Domain model.

Here is the result of the assessment regarding the learning of MERISE method by the computer science students.

### Evaluation result

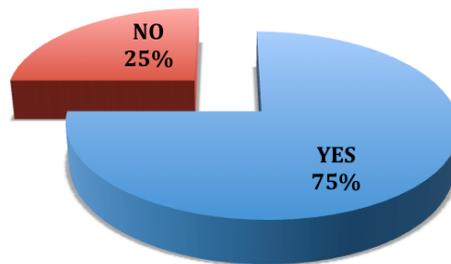


Fig. 7. Evaluation results

The figure above shows that 75% were able to overcome this phase successfully, against 25% who experienced difficulties during this phase. The former high percentage could certainly be explained by the adaptation that took place within the system. Nevertheless, we can still see cases of failure during the evaluation phase. Therefore, we will put the focus on how the system has performed during this phase.

## 7 Learning Path Correction

We will look at the case of students with negative results during the evaluation phase. We take as an example the case of a student "C-L". Here is the result of the similarity analysis by Bravais Pearson Formula, based on the behavior of other students who have passed this stage successfully.



Fig. 8. Similarity calculation based on Bravais-Pearson formula between the learner named "{C-L}" and the other learners having the same learning style

The maximum similarity in behavior is up to 0.896257856337. The system recommends the learner to follow the same course, but with versions of the learner with whom this similarity has proved to be at maximum. He can have access to these new versions as shown in the following figure:

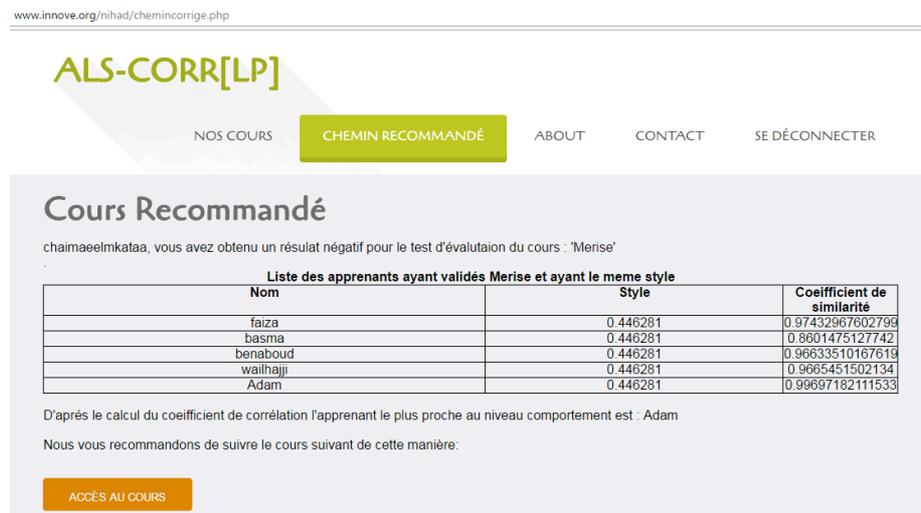


Fig. 9. Recommendation of new versions of courses based on the similarity results

Access to the course is possible once again, but this time while offering the versions that match the behavior observed in the learner "C-L" in the system. Here is an example of the displayed versions:

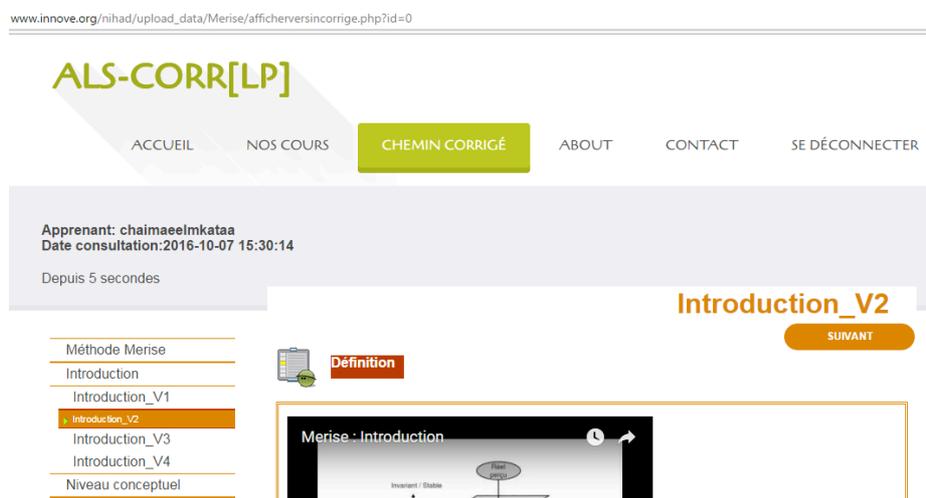


Fig. 10. Access to the new versions of the MERISE method course

## 8 Conclusion and Perspectives

The current paper presents the results of a learning process that took place within the system ALS\_CORR[LP]. 53 students took a course in the MERISE method. The results obtained during the evaluation phase were very encouraging, to the extent that they showed that 75% were able to validate the learning process, while the remaining 25% have been experiencing some difficulties during the evaluation phase. Students who had difficulties during the learning phase could follow the same course, but with new versions whose relevance has been deduced through the calculation of similarity in behavior between learners in difficulties and other learners with the same original learning style, and who managed to overcome successfully the evaluation phase.

The next step is to adapt our adaptive learning system AIS\_CORR[LP] to mobile learning, by studying the constraints of the latter which has experienced a very important development.

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