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Services-Oriented Model for the Regulation of Learning

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Abstract**—**One of the major sources of learners' professional difficulties is their heterogeneity. Whether on cognitive, social, cultural or emotional level, learners being part of the same group have many differences. These differences do not allow to apply the same learning process at all learners. Thus, an optimal learning path for one, is not necessarily the same for the other. We present in this paper a model-oriented service to offer to each learner a personalized learning path to acquire the targeted skills.

Keywords**—**Service-oriented architecture, learning path, web service, personalization, trace analysis.

I. Introduction

THE quality of learning is the core of every educational theory. Therefore, improving the quality of learning was the main target of several works in e-learning. This improvement has targeted the contents, the knowledge and how they will be transmitted. However, in the most existing IT learning environments, the content and the order of operations are presented in a static way without worrying about the learner's characteristics. These present the differences in social, cultural, cognitive or emotional level. This heterogeneity acts as an obstacle to the process. Thus, providing an interactive environment adapted to the learners' needs is one of the most important goals of e-learning.

Our goal in this work is to propose a model to improve the education quality in e-learning by offering the learner an individualized learning path adapted to his skills and his needs. Our proposal consists to adapt learning path to a learner's capacities by implementing an orchestrated web component in a service-oriented architecture. These components are responsible for traces' collection and analysis. These traces are generated following the activities and learner's interactions and they will be exploited to make the educational process more responsive as possible to the learner profile.

II. The Learning Personalization

The concept of learning personalization is based on an approach that aims to improve the learning effectiveness and the educational process organizing by offering to learners an individualized path to progress at their own pace. This progress must consider learners' specificities and levels.

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The design of these adaptive learning systems was influenced by many theoretical researches in several fields like psychology, artificial intelligence, and education [7]. The comparative study of these systems will be based on a reference framework consisting of four views: "resources model", "learner model", "learning model", and "adaptation methods" [6].

A. The Learner Model

A learner model contains the learners' characteristics. These characteristics vary from a learner to another and may also vary in time and be different for the same learner. The technologies used and how these characteristics are used and refreshed by the adaptive learning systems can represent comparing indicators.

B. Educational Resources Model

Each adaptive learning system offers the learner a set of resources adapted to his/her profile. These resources have levels of abstractions and forms that can represent the classification criteria.

C. Learning Model

In the literature, we find several theoretical models of learning; we can quote the transmissive model, the behavioral model, and the constructivist model. Generally, the model of learning may differ from one learner to another depending on these capacities and his rhythm.

The learning methods generally are focused on resources or on an approach by objective. In this latter, the learning unit can be divided into fragments, and the sequence will be decided in a learning scenario [5].

D. Adaptation Model

The adaptation model represents methods and adaptation techniques that ensure the correspondence between learners' needs and the proposed path. Fig. 1 shows the main components of adaptive learning systems.

After a comparative study of different learning systems, we find that:

- The so-called "intelligent" systems are focusing on learning methods despite of the learner model.
- The hypermedia systems are based on resources model and learners' profiles without taking account of the learning processes.

Our proposal is to exploit the traces generated by learner's activities in a e-learning environment to enrich the learner profile and individualize the learning paths by taking into account the capacities of learners.

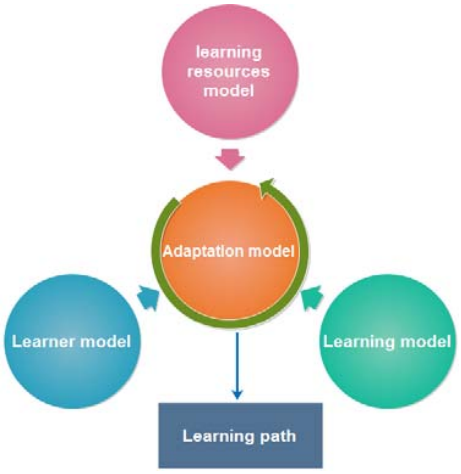

Fig. 1 Components of an adaptive learning system

III. Learning Traces

A. Concept and Traces Types

Within the framework of distance learning, the teacher is not in a traditional learning situation (face to face) to interpret the expressions of learners' faces and determine if they have assimilated the presented knowledge according to the asked questions. He/she is not able to know how to adapt the learning situation to the learner. He/she loses in this context the perception of learner's activity.

To help teachers to resolve this problem and establish such assistance, it is necessary to analyze and interpret learners' activities during their interactions with the learning environment.

In the literature [3], [8], there are several names to describe the monitoring of online learners. Among them, we find the term "tracking" and "trace". The trace definition differs according to its context, the research area, its role, and its use. We define a track as a result of data exchange observations and interaction between the actor and the system.

The traces are grouped into three types [4]: social traces, activity traces, and cognitive traces.

B. Analysis and Organization Traces

The learning traces analysis is a set of actions that aim to manipulate the data produced of the learning environments to extract useful results. The actions can be materialized by a system having as input raw data, and relevant results as output (Fig. 2).

These traces are from a variety of sources such as databases, log-files, XML files, video, and so on. The traces organization and management can be done by adopting different models (traces' generic UML [1], UTL language [2], etc.), but the means to visualize vary between Chernoff figures, links, bubbles, shadows bars, balls, histograms, and so on.

Fig. 2 Trace analysis system

The trace analysis goes through three stages: data collection, processing, and interpretation of results (Fig. 3).

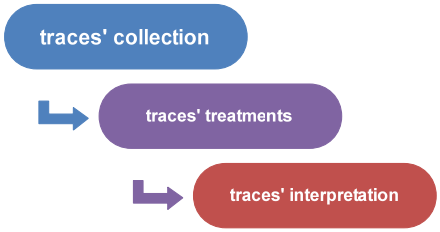

Fig. 3 Traces analysis steps

TABLE I
Comparative Study of Adaptive Learning Systems [5]

SYSTEMS / COMPONENTS		AHA	ALFANET	ANATOM TUTOR	ELM ART	Inspire	Metadyne
Learner Model	Contents	Profile, level of knowledge	Level of knowledge	Profile	Prerequisite, level of knowledge	Profile, level of knowledge	Objectives, level of knowledge, profile
	technology	Concepts based	IMS-LIP				
	Refresh	dynamically by the system	static	dynamically by the system	static	dynamic	dynamic
Resources Model		Domain model	IMS-QTI, IEEE-LOM	Domain model	Domain model	metadata	Domain model
Learning Model		Oriented content using fragments	Oriented activities	Oriented activities	Oriented activities	Oriented activities	Resources oriented
Adaptation	Type	Presentation and navigation	Contents, Presentation	Navigation, presentation	navigation	navigation	Navigation, presentation
	Technical aspect	Link annotation, link hiding using user model values	Feedback to author + learning paths for user profiles	Predefined sequence and stereotype knowledge	Rules of methods' selection	Rules of methods' selection	Rules of learning unit selection
	scope	contents	Learning paths	Test activities	contents	Learning paths	contents

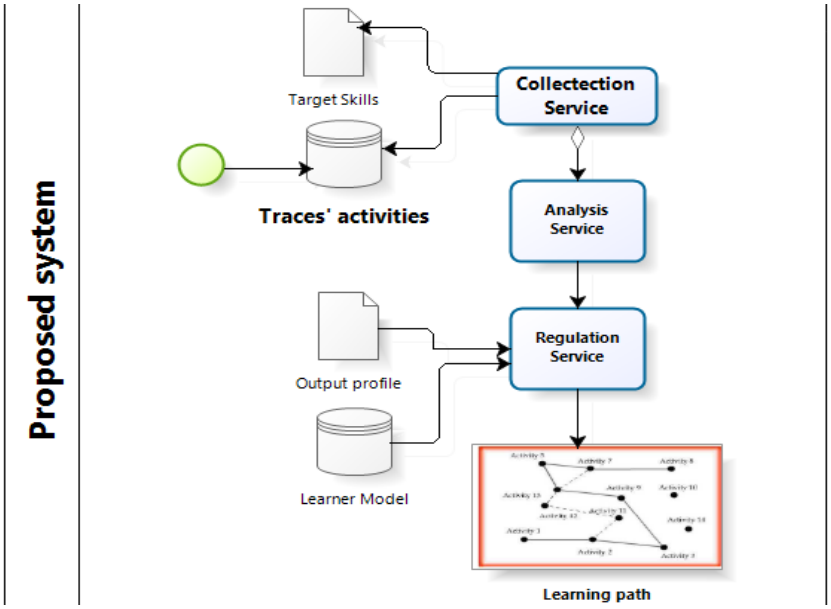

Fig. 4 The proposed system approach

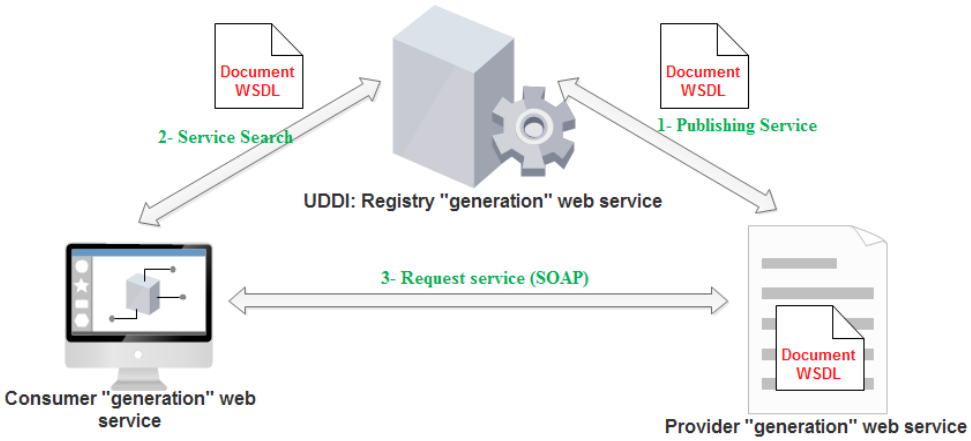

Fig 5 «Generation» web service

IV. Proposed Approach

Our idea is to exploit the traces generated by learner's activities and their interaction with the learning environment to individualize the learning path based on each learner's characteristics.

For this, we opted for a model based on a service oriented architecture (SOA). The goal is to decompose the functionality of our web services model. We propose three orchestrated components in a SOA. These services are responsible for collection, analysis, and exploitation of collected traces. Fig. 4 shows the various stages of the proposed approach.

Our system takes as input the target skills set by the engineer. These goals to be achieved at the end of the learning process will be decomposed into criteria.

The "collection" service is responsible for traces' research corresponding to the criteria established by the designer.

The "Analysis" service is responsible for structuring, analyzing, and studying the traces collected by considering output profile and learner's model. The result of this analysis will be sent to the "regulation" service that is responsible for the learning paths' adaptation and customization.

Regulation service adapts and individualizes the learning path according to the indicators proposed by the analysis service. The learning path regulation can be done by changing learning activities' order according to the learner's needs and pace.

V. Implementation

Service-oriented architecture is an architecture in which business processes are modeled and consumed as independent services. These services are autonomous and reusable. This is why we opted for the implementation of service-oriented architecture: web services.

Fig. 5 explains the operating principle of the "generation" web service based on three points:

- Simple Object Access Protocol (SOAP) that enables communication between web services.
- Web Services Description Language (WSDL) that provides a readable description web services.
- The Universal Description, Discovery and Integration (UDDI) that represents a registry of Web service descriptions.

VI. Conclusion

Giving the learner an adapted learning path depending on his needs is one of the most important objectives in e-learning. Several studies have focused on pedagogical personalization according to several angles. Our proposal is different and it is based on web services' independence and reusability to implement four components which are responsible for traces' generation, collection, analysis and exploitation resulting from learner's activities.

In this perspective, we expect experimentation and results' analysis to judge the suitability of our proposal.

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