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ADAPTIVE TRAINING SYSTEM FOR IT-COMPANIES PERSONNEL: DESIGN PRINCIPALS, ARCHITECTURAL MODELS AND IMPLEMENTATION TECHNOLOGY

Досліджені проблеми, пов'язані з корпоративним навчанням персоналу ІТ-компаній, вивчено актуальність та мету створення адаптивних систем тренінгів. Переглянуті існуючі системи для перегляду основних функціональних можливостей. Досліджені засоби визначення компетенції та навичок, зокрема, e-CF та SFIA. Переглянуті архітектури та моделі, які можуть бути використані для систем тренінгів. Запропонована онтологія та алгоритм створення тренінгу.

Ключові слова: адаптація, адаптивна система, корпоративне навчання, ІТ-компанія, e-CF, SFIA.

Исследованы проблемы, связанные с корпоративным обучением персонала ИТ-компаний, изучены актуальность и цель создания адаптивных систем тренингов. Рассмотрены существующие системы для анализа основных функциональных возможностей. Исследованы способы определения компетенции и навыков, в частности, e-CF и SFIA. Рассмотрены архитектуры и модели, которые могут быть использованы для систем тренингов. Предложена онтология и алгоритм создания тренинга.

Ключевые слова: адаптация, адаптивная система, корпоративное обучение, ИТ-компания, e-CF, SFIA.

Investigated problems and not resolved issues related to corporate training for IT-companies personnel, explored the actuality and goal of creating adaptive training and learning systems to improve the quality and speed of competence growth of IT-companies' personnel. Reviewed learning and training systems structures and main differences. Reviewed existing top learning and training systems and selected two of them – Explore Gate and Forma LMS – to be basically tested to explore the common requirements, functionality and not resolved issues. Investigated frameworks for IT competences and skills, exactly e-CF (European e-Competence Framework) and SFIA (Skills Framework for the Information Age). These frameworks are proposed to be used in training system for IT companies' personnel. Reviewed architectures and models that can be used for adaptive learning and training systems. Proposed ontology of adaptive training system for IT-companies personnel and algorithm to create the training track for employee according to the selected competence, current level of knowledge and skills, aim level of competence and preferences.

Keywords: Adaptation, adaptive system, corporate training, IT-company, e-CF, SFIA.

Introduction: Problem Actuality and Research Goal. The theory of adaptive systems arose due to the necessity to solve a large number of applied problems, for which it is impossible to use traditional methods that require knowledge of an adequate mathematical model of an object. The quality of traditional (non-adaptive) ways of managing depends on the amount of priory information about the object and its operating conditions. In practice, it is quite difficult to provide an exact mathematical description of the object of management. And for educational systems, adaptability provides such an important advantage as the individualization of the learning process. In the process of classical learning in the “person – person” format, an experienced teacher can identify the strengths and weaknesses of the student evaluate his overall erudition and level of knowledge of a particular discipline – and, based on these data, determine the volume and the optimal presentation of the material [1].

The main issue of the adaptive learning systems is the individual characteristics of each particular student highlighting and representing the data exactly according it. The construction of the training systems is also connected with the support of high reliability.

The idea of such systems is to create algorithms and tools for collecting information about the user in order to use this information for determining the learning track of the trainees. In addition, taking into account the student's knowledge of the course, the amount of submitted teaching material and the form of its presentation may be regulated: text format, hypermedia, presentation of the image, etc. [2].

Learning and training systems structure. Considering the problem of developing computer training

systems in general, distinguish two main processes: “studying as learning” and “studying as tutoring” [3]. The direction of *learning* (learning systems) implies self-education, mentoring, adaptation, self-organization, etc. Therefore, in the development of educational systems, models that demonstrate the ability to adapt to the environment through the accumulation of information are explored. The direction of *tutoring* (educational systems) is closely linked with the questions of “who to teach?” (model of learner), as well as “what to teach?” (model of learning) and even “how to teach” (model of explanation), that is here models of information and knowledge transfer from mentor through computer. The heuristic learning model is displayed on fig. 1.

Existing systems overview. Nowadays there are a lot of learning systems. Some of them were investigated deeply to get information about main functional areas of learning systems. Explore Gate [5] and Forma LMS [6] systems were reviewed (some features are summarized in table 1).

Table 1 – The main features existing learning systems [5–6]

	Explore Gate	Forma LMS
Learning with mentor	-	+
Training auto-generation	-	-
Career track constructor	+	-
Courses constructor	+	+

It is basically web-based corporate training systems that allow tailoring individual training plans for employees, clients and partners. Additionally, systems may include automated administration, evaluation, certification and no integration problems. System should provide correct knowledge sets according to competence.

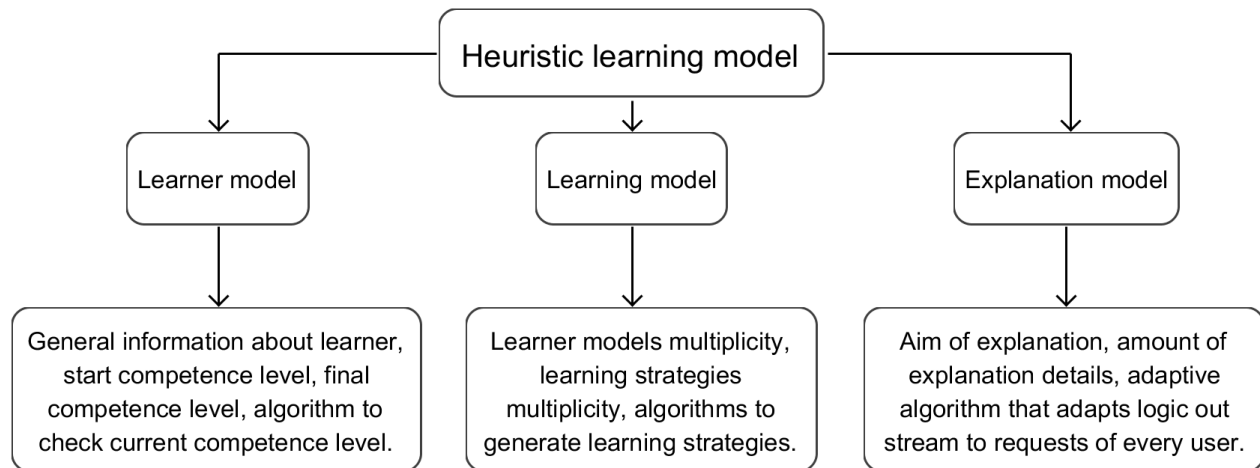


Figure 1 – Heuristic learning model [4]

But the main idea of adaptive training systems for IT companies personnel is to provide ability automatically build the learning track of every employee according to the current level of knowledge and to the expected level of knowledge (current competence and expected competence). This functionality does still not exist as the common approach.

Competences and skills frameworks. For the IT companies' personnel several documents are developed to combine information about competences and levels of competences and for IT skills. Such frameworks as e-CF ("The European e-Competence Framework") [7–9] and SFIA ("The Skills Framework for the Information Age") [10] can be used for the developing of training as the base proofed knowledge about IT competences and necessary skills.

Architectural models for adaptive solutions of training systems. In scope of work several architecture models were investigated [11]:

- (1) AHAM: A Reference Model to Support Adaptive Hypermedia Authoring [11].
- (2) LAOS: Layered AHS Authoring-Model and Operators [11].

AHAM model describes an adaptive hypermedia system consisting of several layers. AHAM focuses on Storage Levels that include the Domain Model, User Information Model, and Adaptation Model [11]. The domain model of the adaptive system consists of a set of concepts and concepts of relationships. Relationships can be used to create a hierarchy of concepts, which is used to represent the structure of small and large themes, perhaps small concepts, sections and chapters, the text of the course. Another common use of relationships is the notion of reason where hypermedia wants to provide as much navigation as the set of available links can be adapted or annotated with the user having previously visited. The prior requirements help the user avoid the following links to information that cannot (yet) be clear or help the system decide whether or not to include additional explanations [11].

The LAOS model [11] is a common basis for authoring adaptive hypermedia based on the AHAM model. Its main components are shown in Figure 2:

Domain Model (DM), Goal and Limit Model (GM), User Model (UM), Adaptation Model (AM), and Model Representation (PM). The structure defines the elements of each model based on conceptual map representations, except for the adaptive model based on the LAG adaptability model [11]. The main difference from AHAM (and other models) is the clear division of information about the primitive information (content) and the purpose of the presentation.

For example, since the preconditions are not leading in the domain model, the domain elements can be used in different settings and orders than originally intended. Thus, LAOS promotes a high degree of reuse of information by separating fragments information from a specific context. This division is expressed by the presence of two different models, rather than one: domain model (DM) and target model and limitations (GM). Separation can be easily understood if we use the metaphor of the encyclopedia: DM represents the book (book) on which the presentation is based (for example, PowerPoint presentation, represented by GM) [11].

DM contains knowledge resources. From DM different presentations can be built (in GM), depending on the purpose. The presentation does not contain the entire book, only part (limited) of it. In addition, the presentation may contain information from several books. Thus, the separation provides a high degree of flexibility, based on the multicomponent DM-GM dependency. Another important difference from AHAM is the notion of "concept" used in the domain model. In LAOS, concepts have different representations, defined through attributes, and are limited to representing semantic unity (as opposed to AHAM). This is provided if only stand-alone attributes are allowed (without direct or indirect dependencies). This option allows you to flexibly change the order of the attributes. Therefore, the links are external and can be dynamic [11].

The LAOS model for adaptive training purposes can be transformed and used for corporate training areas as presented on fig. 2. Architecture that can be used for system is presented on fig. 3.

Common ontology of adaptive training system. Basic concepts of the subject area:

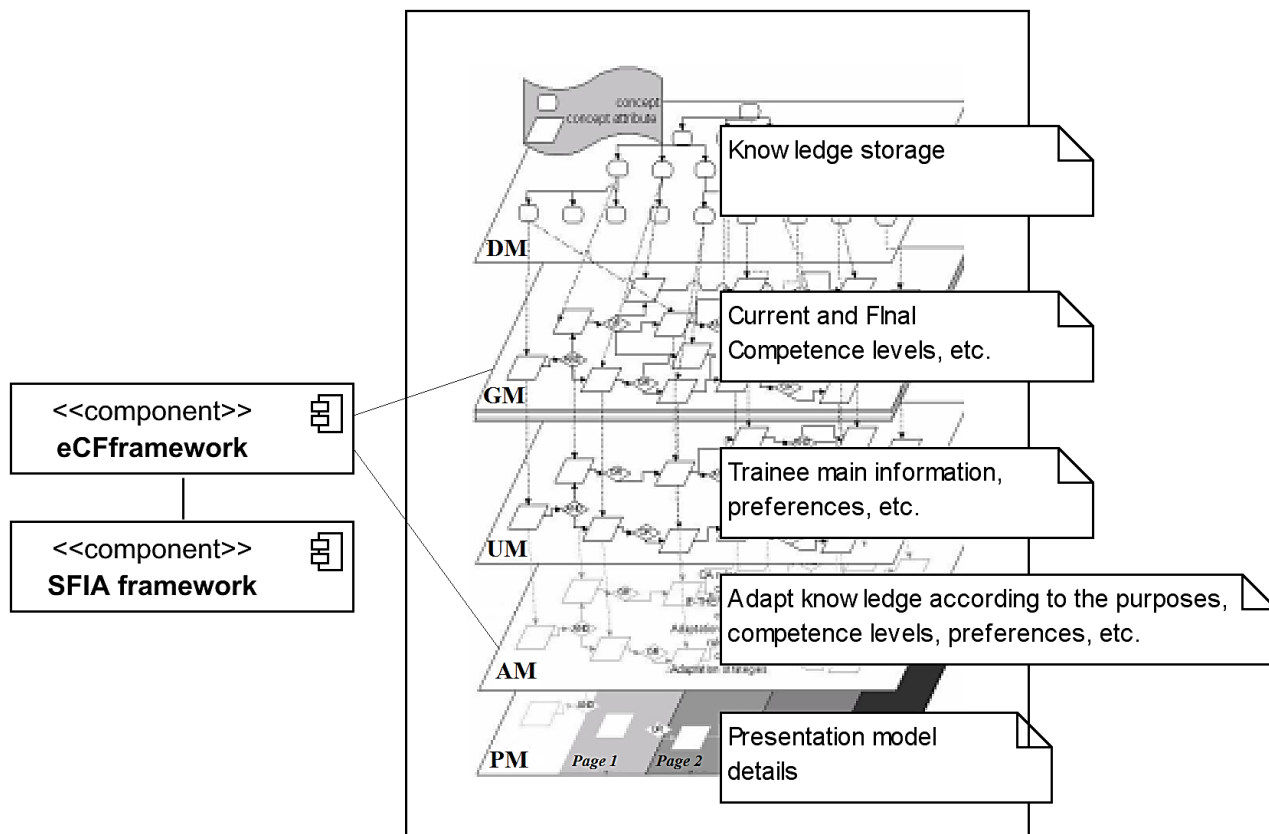


Figure 2 – LAOS model using for corporate training system (to compare with the scheme given in [11])

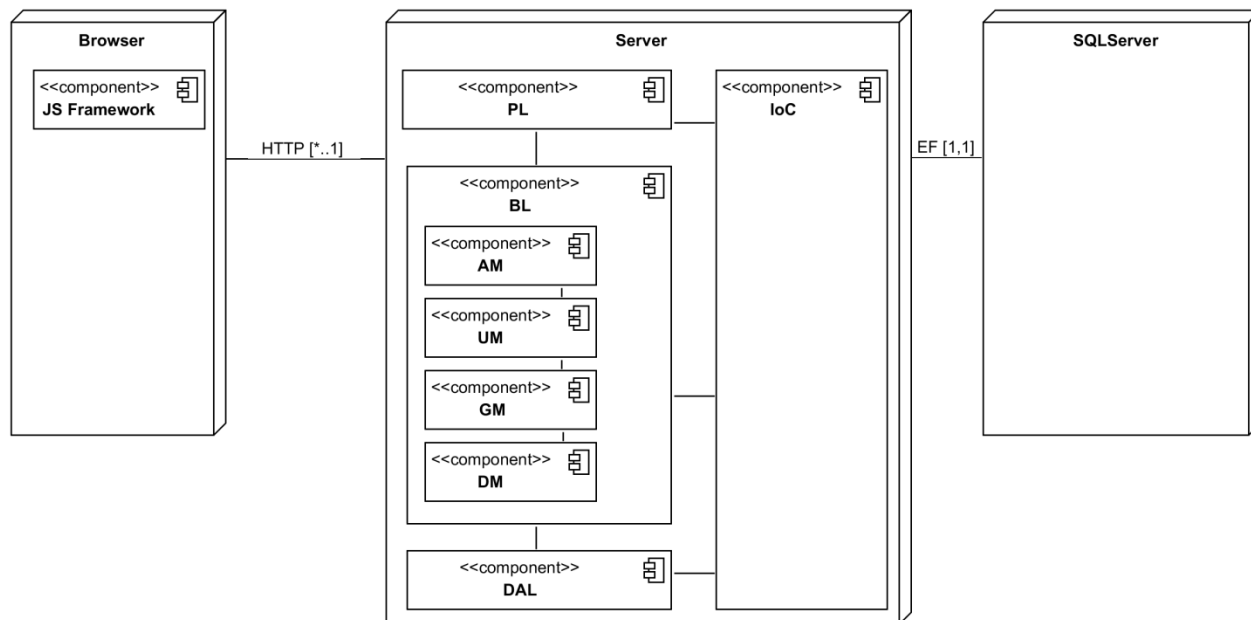


Figure 3 – Training system architecture based on LAOS model [11]

- (1) Competence.
- (2) Employee.
- (3) Form of presentation of the content.
- (4) Initial level of competence.
- (5) Final level of competence.
- (6) Training.
- (7) Skill.

Relationships in terms of hyponym/hyperonium, holonym/meronym:

- (1) “Competence” meronyms: “skill”, “initial level of competence”, “final level of competence”.
- (2) “Competence” is a holonym for “ability”, “initial level of knowledge of competence”, “the final level of competence”.

- (3) “Employee” meronyms: “initial level of compliance”, “final level of competence”, “skill”.
- (4) “Employee” is a holonym for “initial level of competence”, “final level of competence”, “ability”.
- (5) “Competence” hyponyms: “the initial level of competence”.
- (6) “Competence” is a hyperonium for “the initial level of competence”.
- (7) “Initial level of competence” is a holonym for “ability”.
- (8) “Initial level of competence” meronyms: “skill”.
- (9) “Competence” hyponyms: “the final level of competence”.
- (10) “Competence” is a hyperonium for “final level of competence”.
- (11) “Final level of competence” is a holonym for “ability”.
- (12) “Final level of competence” meronyms: “skill”.
- (13) “Training” meronyms: “skill”.

Also additional entities and relationships can be added in future work.

Proposed approach. The system should provide several levels of access: the administrator and the user (employee).

Each employee has his or her profile, which contains the basic information about it, as well as information about the current level of competence and the competence to be achieved. Then system creates a training, which contains a set of courses for necessary skills to achieve the selected competence level of each employee.

Also, for each user, system allows selecting a setting that will describe the user's priorities, for example: quick study, the most complete study, and more. In accordance with these priorities training is under way.

Each level of competence contains set of skills and set of knowledge. Thus, in order to acquire skills to achieve a certain level of competence, the employee is given a set of courses, compiled in a single training.

To analyze and track the progress of employee growth, there are reports that are available to users at the level of the administrator.

Summarized algorithm to create the training track from the Administrator view is presented on fig. 4 in the form of a sequence diagram.

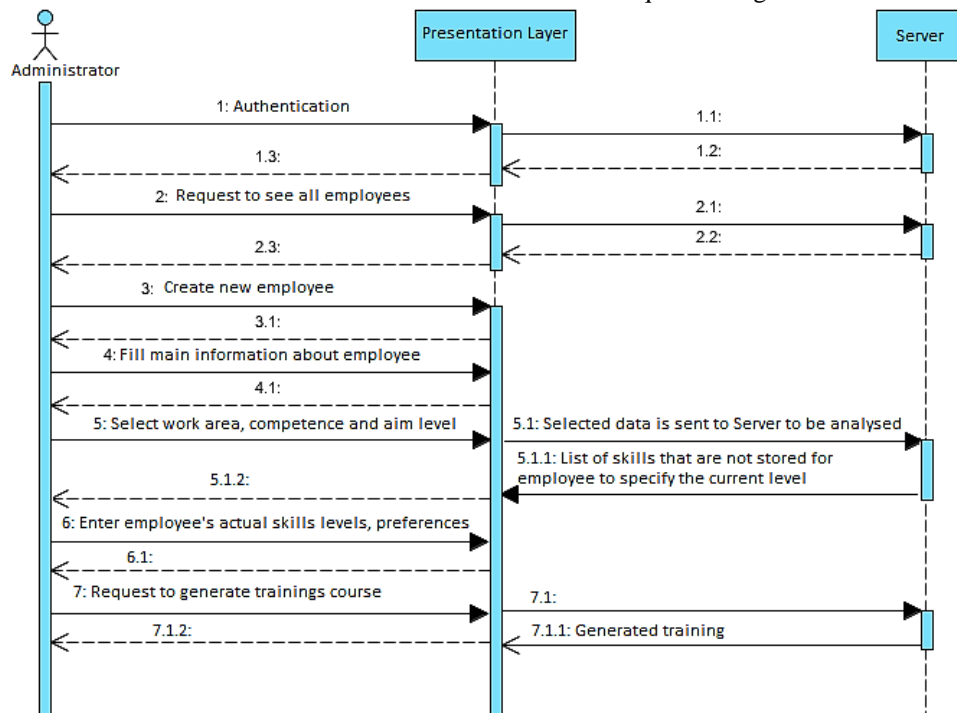


Figure 4 – Summarized algorithm from the Administrator view

Algorithm to create training for employee:

- (1) Select area and competence to improve level from the list of e-CF [7–9] competences.
- (2) Set final competence level that should be achieved. Competence levels are taken from e-CF [7–9].
- (3) Select current level of skills that needed for the selected competence (levels are got from the e-CF framework [7–9]). Only knowledge and skills levels with no information for the current employee should be configured/selected in this step.

- (4) Select preferences: quick learning, only main data, deep learning.
- (5) System checks the necessary levels of all skills for the selected competence and final level of competence.
- (6) System checks user preferences and select corresponding courses. There are such proposed preferences to be selected: *quick learning* – there are only courses that have time frames less than 1 (system has 3 levels of time: 1 – minimum time, 3 – maximum time) and with importance level more than 2 (system has 5 levels of importance: 1 – minimum importance, 5 –

maximum importance); *deep learning* – all courses that user don't have knowledge and experience; *only main data* – all courses with importance more than 2.

- (7) System gives the user a list of courses (generated according to preferences) that are necessary for the selected competence and selected level of competence, current level of knowledge and skills.
- (8) After running the course by user system updates the levels of knowledge and the statistics about ran courses are saved into database. Then for the future quizzes (when new competence is selected to improve knowledge and skills) user will not be asked about levels of knowledge and skills that are already stored in database. So the system will know about what user has already known and what he should learn additionally.

Quality metrics. A designed adaptive learning system should provide such benefits as minimizing time to support the training of each employee (by avoiding extra time of mentors' support), improving the content provided to a particular user according to the employee preferences, matching employees' competencies to European standards (e-CF [7–9] and SFIA [10]).

Also, according to business statistics [12], automation of training and training systems should increase such indicators as employee satisfaction, productivity and performance of work commitments [12].

Conclusions and Future Work. In this paper some existing approaches for training systems were described and main functionality of such systems was analyzed.

The proposed approach is based on the combined usage of the competence framework e-CF [7–9], skills framework SFIA [10] and LAOS model [11] as the base of architectural structure.

The proposed algorithm allows creating of adaptive training for every employee based on selected competence, current levels of knowledge and skills, the start and the aim competence levels. Also the adaptation algorithm should be configurable by preferences that give opportunity to manipulate the time of achieving the aim competence level, the depth of knowledge. Owing to the fact of using recognized frameworks as e-CF [7–9] and SFIA [10] training track for every person should be built with all necessary skills and knowledge courses.

Future work concerns final implementation of prototype of the proposed tool, as well as creating improved adaptive algorithm to achieve necessary levels of competence skills and knowledge. This tool should be tested to meet quality levels that are necessary for such types of systems.

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