

## MULTI-AGENT SYSTEM FOR COMPETENCE MODELING

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**ABSTRACT.** Modeling competences is a real challenge for the people working in a lot of domains like Human Resource (HR), companies, e-Learning related activities, universities and not only. Universities and e-Learning organizations define the prerequisites that must be fulfilled before joining and the competences that will be acquired after successful completion. Based on these are stated the curricula or training programmes. The future students and companies mainly HR departments try to define their own competences and these are compared with those offered by the applicants and universities respectively. The proposed model will be included in the project Cex 05-D8-66/2005. It will offers to the universities, companies and students to define and to present the competencies, making comparisons between them with appropriate scores and evaluations in order to use in an efficient way.

### 1. INTRODUCTION

Due to the IT evolution the people mobility has increased and also the managers and Human Resource departments have more difficulties in deciding the most appropriate qualifications (the right qualifications) to join a job in company or in a project. Some of the major problems that appear most currently for the universities and e-Learning companies is that the competences can be well stated and valuated from simplest ones to the complex ones. From the following examples:

- an applicant needs to possess a Bachelor degree to apply for Master studies. This is the prerequisite;
- in both Bachelor degree and Master studies there is the course of Software engineering but on different levels. The name of the course is the same but their content is different. In order to attend an expert course on a topic, a certification on a basic level may be required;
- for the Human resource departments the need is that to match the applicant experience with the requirements of a job offer, including the mandatory requirements and the desired ones.

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we can conclude that for representation of competences in a large variety and sufficiently expressive and necessary formats:

- matching the competences (profiles, requirements);
- expressing the inheritance;
- expressing the part of;
- mechanisms for increasing the reusability;
- the relationships between competences.

In [4] and [3] focus on reusable competency definitions. The basic idea is to define the repositories that concentrate the competencies defined for certain communities. These can be referenced by external data structures, allowing the interoperability and reusability.

## 2. RELATED WORK

Concerning the competence were done some standardization efforts on modeling competences. The efforts focused on aspects related on competency: profiles and relationships among competencies. The IMS Reusable Definition of Competencies or Educational Objective [4] focus on reusable competency definitions. It lacks information on context and proficiency level and does not allow relations or recursive dependencies among competencies. HR-XML focuses on the modeling of information related to human resource tasks. It tries to define profiles in order to use such competency definitions. Here data sets are specified:

- as job requirement profiles - the competencies that a person is required to possess;
- personal competency profiles - that describes the competencies that a person has.

This model does not make a clear distinction between the required and acquired profiles. In [5] the relationships between competencies are modeled. The map can contain information about dependencies or equivalencies among competencies. The capability of composing complex competencies for simpler ones is also taken under consideration. The basic representation is a directed acyclic graph. Due to the fact that the relationships are different meanings i.e., composition, equivalence or order dependency, the model can lead to some confusions.

In [1] the competence (plural competences) is defined as effective performance within a domain context at different levels of proficiency. The competency (plural competencies), is defined in [3] and [4] as any form of knowledge, skill, attitude, ability or learning objective that can be described in a context of learning, education or training. In [2] these definitions are considered to be insufficiently expressive for gap analysis. The context information and the proficiency level scale is not included in the models given in [3], [4]. The model given in [2] competency proficiency level and context are three different dimensions that must be modeled separately in order to maximize their reuse. As an example the same

competencies may be used in different contexts, or the same proficiency level scales may be reused among different certifications. The same can be applied to the contexts (domain models) that in many situations already exist and therefore may be reused by competences. As a consequence in [2] is modeled the competence (plural competences) as a three dimensional variable: competency (plural competencies), a proficiency level and a context.

As example for illustrating the [2] model given in Figure 1 for *Fluent Business English* that is composed by competency *English* the proficiency *Fluent* and the context *Business*. Also [2] in order to avoid the confusion between the terms competence and competency they propose that competency and skill as being interchangeable but skill is not a synonymous for competency as it covers a part of its scope.

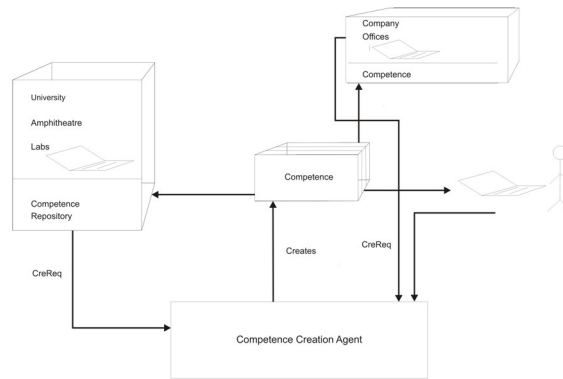


FIGURE 1

### 3. REQUIREMENTS FOR MODELING A COMPETENCE

The IEEE Reusable Competency Definitions provide a model for the representation of competencies, the objective being referencing and cataloging an competency not classifying it. The model does not provide any means to specify the relationships between the competencies. The relationships must be taken into account that the competences are composed from competency proficiency level and context.

Different scales qualitative and quantitative may be used in order to represent proficiency levels. As an example a computer science curricula want to specify whether a student has acquired a competence or not whereas an English certification institution may want to classify the students into intermediate, advanced or proficient. Many different scales may be used but it should be possible to reuse them within and across the borders of the institution.

Among elements of one scale of proficiency levels there are implicit relationships. For example a proficiency level may be subsumed by another: *proficient* subsumes *advanced* which subsumes *intermediate*. Such relationships must be modeled due to the fact that these are needed for competence matching. For instance a job requiring someone with intermediate English skill typically has implicit quantifier *at least*, it means that anyone with advanced English will be accepted (being even preferred). One of the possibilities is that to represent as an ordered list the proficiency level scale. In such a list the minimum value (subsumed by any other in the list) is given by the first element and the maximum is given by the last one. Therefore the order in the list represent subsumption relationships, that is, the first element is subsumed by the second one and so on.

In order to improve the interoperability and matching among scales, an optional field is included for mapping to the universal scale (e.g.,  $[0,1]$ ). The reason why this mapping field is optional is that even though it would be useful to include it, in some contexts it may not be possible to find a suitable mapping or it may not even be necessary.

Competence descriptions can refer to specific items of these scales in order to represent the proficiency level required/acquired. Algorithms could take relationships among proficiency levels into account in order to find out how much training/learning is required to reach a determined employee/learner proficiency level.

The context can be defined:

- interrelated conditions in which something exists or occurs (Webster on line dictionary, <http://webster.com> [6]) or
- the circumstances and conditions which surround it (Wikipedia, <http://en.wikipedia.org> [7]).

Regarding to competences, context may refer to different concepts like:

- the specific occupation in which a competence is required;
- a set of topics within a domain;
- even the personal settings related to the student.

And these are contexts which may be part of a competence. Context descriptions can not be defined in general but these depends on the scope and the purpose of the competence descriptions to which they are attached. Also the context definitions may be reused.

Modeling contexts is a complex task, it may coincide with modeling the whole domain knowledge of an institution. Ontologies can capture such knowledge and use arbitrary complex structures from simple sets or tree structures to directed acyclic graphs. The existing relationships between context elements (regarding their use within competences) do not show the need for providing a graph representation or multiple inheritance.

Competences generally can be described as reusable domain knowledge. Any model representing competences describes what a competence is and how it is composed of sub-competences. Due to the fact that the competences are referenced in different situations like:

- certifications;
- job descriptions;
- personalizing relevant competences for their business that are included in job offers projects descriptions.

Based on these the competence must be adequate represented and described in order to:

- how a competence may be achieved (ex: by acquiring some sub-competences);
- to which level each competence should be acquired;
- whether sub-competences must be all achieved or simply a subset of them;
- if the sub-competences must be acquired in a specific order.

As an other significant problem is that the capability of the model to represent aggregate and alternative structures of the competence. The aggregation allows that the competence is composed from several sub-competences all of them required. Alternative competence can be viewed as a set of competences and there can be possible to specify by a numeric interval what is the number of alternatives that must be acquired.

Due to the multiple usages of the model it is also important that the equivalence relationships between the competences to be well defined, understood and used by all users.

#### 4. PROBLEM STATEMENT

There are many domains where the competences are used. Our intention is to define a model that can be used by the:

- universities in order to:
  - define the competences acquired by the students after a undergraduate or graduate profile;
  - evaluate the competence in academic media;
  - give the details concerning the conditions and modalities for gaining a competence;
- a student in order to define its own competences and own conditions for:
  - finding the appropriate university that satisfies its beliefs and desires;
  - offering their own competences for companies or/and universities;
  - compare their competences with those of companies or/and universities;

- companies that can:
  - define their own requirements concerning the competences for job offers;
  - compare their competences with those of the universities and students for stages or persons who are searching a job.

Our model will have tools that will allow:

- defining the competences and use them under specific needs;
- searching the universities/companies for required competences;
- matching the own competences with those that were find (offered by universities/companies);
- valuating and ordering the competences after some criteria.

## 5. PROPOSED MODEL

The competences are frequently used in the relations between the universities and the future students, between the companies and the future employees. Our model intend to allow to the universities, students, employees and companies to:

- construct and maintain their own competences;
- evaluate their competences;
- match their own competences with the other competences;
- search the desired competences in appropriate domains.

Comparing the competences In order for an efficient usage it is intended to offer a tool that make an exhaustive analysis concerning the competences. It will mainly based on the details that are given for a competence: -the components of the competence. Here the specific agent will compare the occurrence of the competence components scoring the matching between the two competences also the order of components will be taken into the account; -the resources used for gaining a competence. -the effort that must be fulfilled by the student in order to gain certain competence. The students that intend to obtain some qualification (and some competences) can make some suppositions concerning the financial effort and their own effort and time and it will be offered in an adequate manner.

The model is based on a multi-agent system that is constituted from appropriate agents that will fulfill these objectives. The agents are:

- Competence Creation Agent (CCA);
- Evaluator Agent (EvA);
- Broker Agent (BrA);

The user can be either a university, a company, a student or an employee. He (the user) can submit to the CCA requirements to create competences from basic sub-competences. The CCA creates and furnish the competences to the user that can place them into a Competence Repository or use immediately in new requirements.

The competence creation can be:

- the simplest one when the competence is defined from sub-competences;
  - the medium one when is given the competence and the details that specify the conditions that must be fulfilled in order that the requester obtain the competence;
  - the complex one when we have all details that are needed with the quantification of required conditions and the quality of obtained competence.
- All these will be valued after an evaluation.

Every user can construct its own Competence Repository. When a user (student, employee, company) want to find some competence that is placed in an university or company he must furnish the generic competence and eventually the sub-competences, the conditions that allow to acquire the competence and other own requirements concerning the competence. In the Figure 2 is presented the proposed model.

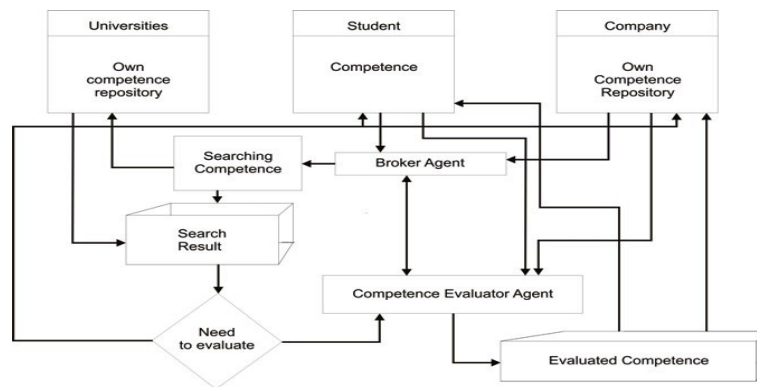


FIGURE 2

All these requirements are taken by the BrA that search (usually on the Internet) and tries to match the user requirement with those that were found. The matching can be in a wide range, starting from a simple matching (the competence name) thur a complex one where a lot of actions are executed by the EvA:

- matching of competences with appropriate scores;
- matching the sub-competences and scoring the matching;
- matching of conditions and giving the scores in some order (preferred by the user or a predefined system order).

The system work as follows. The companies and universities have their Competence Repositories that are posted as web pages. The users: students, employees, applicants, the universities and companies can define the requirements that are

addressed to the system. The system agents try to satisfy the requirements in different levels of details and complexity, as was stated above. The paper purpose is to give some fundamentals for the proposed system that will allow to use agents in order to create, find and compare the competences. Based on this paper in future work and future papers will be stated the specific agent technology will be used in the proposed system.

## 6. FUTURE WORKS

The model suppose that the users are able accessing a tool that allows to develop their own competences, dispose them in a Competence Repository form the others can access interpret and compare them. As an immediate activity the modules that allow to create and access the competences will be developed. The next step will allow to refine the search and comparison between the competences will be defined and developed.

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