# Higher Education Qualification Evaluation

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***Abstract*— Qualification developed by the requirements of labor market is more competitive than the other ones. In Hungary, this issue constitutes one of the central elements of the higher education reform taking place nowadays. In this paper, a system in progress is presented, which aims at evaluating the learning outcomes of Business Informatics Bachelor's degree program at Corvinus University of Budapest versus the competences needed by the labor market, as appeared on a job recruitment portal. Ontology-based learning and matching domains are touched in the course of the development, so it is necessary to choose their appropriate tools to integrate them into a system. The tools written in Java constitute the base of the development.**

***Keywords-competence; ontology learning; ontology matching***

## I. INTRODUCTION

The higher education reform is a long-term process in Hungary. One of the objectives of the government is to rationalize qualification obtained in the higher education in the light of requirements of the world of labor [10]. The research focus of the Ph.D. thesis is to examine in what measure the learning outcomes of *Business Informatics* Bachelor's degree program at Corvinus University of Budapest are matched to the requirements given by ICT job roles (job requirements).

The competences are the descriptors of learning outcomes and they serve as an appropriate tool to describe a job role, so the question is what the missing and surplus competences of this training program are. But, this concept has no universal definition, so the ontology approach serves as an appropriate method by providing an explicit, formal specification about this domain and it is capable of comparing the competences semantically and by considering the structure of related concepts too. The ontology learning approach is an appropriate method to build ontology dynamically and the ontology matching approach provides this semantic and structural comparison.

Two projects – OntoHR [12] and SAKE [13] – have already dealt with this problem. They aimed to identify the shortcomings of higher and vocational education learning outcome through matching a job role ontology based on competences retrieved from job role descriptions and a learning outcome ontology based on competences claimed and/or extracted from descriptions of a given training program. SAKE project concerned several ICT job profiles and Business Informatics degree program, whilst the goal of OntoHR was to build an ontology-based selection and training system based on Information System Analyst (ISA) job role. One module of this system deals with the evaluation of the ICT degree programs. In these projects, the job role ontology reflected only a static moment of requirements of the labor market. In SAKE project, the job advertising documents were downloaded and tagged manually. In OntoHR, the ontology elements were extracted from the detailed descriptions of ISA job profile given by public organizations (e.g., O*Net) or by projects concerned job analysis (e.g., EUQuaSIT). In the current research, a system is under development, which aims at formalizing the job requirements derived from IT/Telecommunication category of a popular job recruitment portal (Profession.hu) into the Job Role Ontology and matching this ontology to the Learning Outcome Ontology, which is created by the learning outcomes, and materials of Business Informatics Bachelor's degree program [17].

In Section 2, it is presented why the competence as a phenomenon gives the basis of this comparison. In Section 3, an incremental software development process is depicted, creating a prototype because there are not enough resources to implement all learning materials. Finally, conclusion and future work are shown.

## II. COMPARISON THROUGH COMPETENCES

In the previous work [17], it was shown that competence concept has several definitions in the literature due to contextual discrepancies of its usage, cultural traditions of the authors, and different epistemological foundations [19]; but, according to the presented definitions, common content elements (skills, knowledge and attitudes) were revealed. On the demand side of labor market (job demand), the importance of this concept was shown by the advantages of switching from job-based to competency-based organizational approach [8], by its strategic importance presented by Schoonover and Andersen [14], and by the role of updating competency models and job descriptions in talent specific succession planning [4].

On the supply side of labor market (education side), qualification frameworks based on competences (like European Qualifications Framework [5], Framework for

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Qualifications of the European Higher Education Area [2]) give a guideline to develop the national framework like OKKR in Hungary [20].

Therefore, competence seems to be an appropriate base to achieve the comparison between the two sides of the labor market. (In English the competence and competency concept are distinguished. This paper follows the guideline of Hungarian public education that uses the first interpretation.)

## III. THE SYSTEM DEVELOPMENT

The learning outcomes of the above-mentioned degree program have not been changed since 2005, so the fundamental requirements related to the system are to adopt the changes occurred in job demand and to achieve the matching process with minimal human intervention. The system is capable of:

- collecting job requirements from the Internet in an automatic manner, extracting knowledge elements of them and forming these elements into the Job Role Ontology in a semi-automatic manner; formalizing the actual status into the Learning Outcome Ontology;
- achieving the matching process between Competence classes or its subclasses of both ontologies and evaluating the results.

We state that these requirements delineate into two development phases, the incremental system development methodology seems to be usable. Ontology learning is touched in the first stage and ontology matching in the second stage.

### A. *First development phase: Ontology building and learning*

The objective of ontology learning is "to generate domain ontologies from various kinds of resources by applying natural language processing and machine learning techniques" [6]. The input of this phase is a collection of job requirements from the above-mentioned portal. A crawler was written in Java, to be responsible for ensuring this input - at given intervals.

Having examined the resulted collection, some problems were revealed. These problems and the related solutions are depicted in the next table:

TABLE I. PROBLEMS WITH THE JOB ADVERTISING COLLECTION

| Problem | Solution |
|---|---|
| In one month approximately 500 advertisements usually bear. Among them, there are several identical documents or documents showing few discrepancies (for example the contact person's name). | DOS Batch program find the same files, leave one file of them and delete the others. |
| HTML tags do not refer to its content. (For example: <h3>Requirement(s):</h3>) | Searching another patterns. For example: blocks assigned by colon. |
| The "requirement:" block is missing of certain job advertisements. If they exist, they contain only little information about competences. | The most job advertisements contain task description block, so competences have to be assigned to tasks (e.g. based on the knowledge elements of The Open Group Architecture Framework [18], an Open Group standard). |
| The documents are in XHTML formats, which are unstructured and customized by advertisers. It is ambiguous to process them. | After identifying the task: block it is necessary to create XML files from simple text. Java SAXparser() and DefaultHandler() classes can process XML files. |

After these steps, a bouquet of XML files is created.

The first version of the Job Role Ontology is built on a collection derived from the first quarter of 2011. The meta-model of the ontologies is presented by Figure 1.

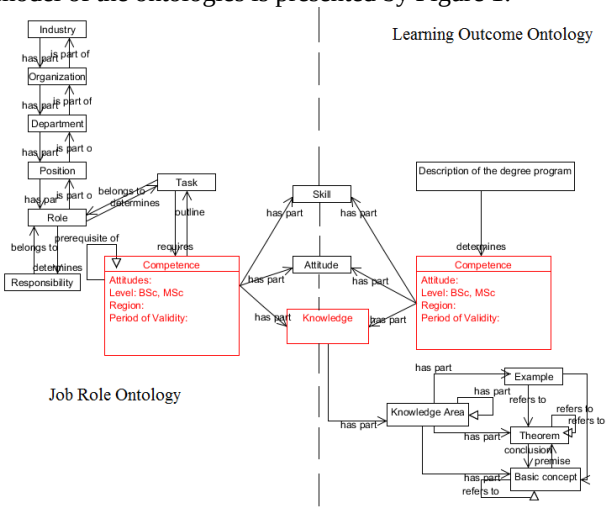


Figure 1. The meta-model of the Job Role Ontology and the Learning Outcome Ontology

In the meta-model of the *Job Role Ontology*, *the Industry*, *Organization*, *Department* and *Position* classes put the competences into an organizational context. Within an organization, the business processes consist of tasks that

roles and responsibilities belong to. In the backward direction, the *Role* as the parts of the *Position* class determines the entities of the *Task* and the *Responsibility* class. *Competence(s)* are required to execute a *Task*. The attitudes of the *Competence* class facilitate to execute the comparison at the appropriate Level, in the Period of Validity and in a given Region.

The meta-model of the Learning Outcome Ontology is an extended version of the OntoHR project's Educational Ontology [7] by the *Description of the Degree Program*, as sources of the competences, and by the attitudes of the *Competence* class.

The elements of competences mentioned in Section 2 (like *Skill*, *Attitude* and *Knowledge*) represent the basis of the comparison, but in the prototype we use only the *Knowledge* class to execute the comparison as we will see in the next section.

The Task class plays an important role in the construction of the Job Role Ontology. But too many positions and related tasks appear in the job advertisement collection, so we had to choose a position (like Software Developer position), its roles (Developer role and Contact Person role) and its related tasks (Designing the software development process, Preparing specification, Program coding, Program testing, Bug fixing and Communicating) to create the first version of the ontology. The knowledge extraction algorithm collects the concrete appearance of these tasks from the appropriate job advertisements and fitting them into this ontology. The steps of this algorithm are the following ones:

- To define a process whose tasks will be in the center of interest and formalize them into a first version of the ontology;
- To filter the job advertisements by their relevancy related to this process and the existence of tasks: block in order to cut this text block from the advertisements;
- To search expressions as patterns to describe a task (for example task – Communicating, expression: relation with customers or task – Designing the software development process, expression: design of an embedded software);
- To use these expressions like open sentences (for example (relation with; who) or (design of, something));
- To search the given words of the open sentences (e.g. relation, design) in the job advertisements and the nouns forming an expression with its preposition (e.g., with or of). Based on the position of these words in the text, we decide about that these nouns may be appropriate or not;
- To put the found expressions (e.g. relation with customers, or design of application), as subclass of the Task subclass related to the given expression, and its original texts, as comments, into the ontology.

Having executed this algorithm, the first version of the Job Role Ontology is implemented in Protégé 4.2 [16] ontology development tool by a Protégé API written in JAVA. It is presented by Figure 2.

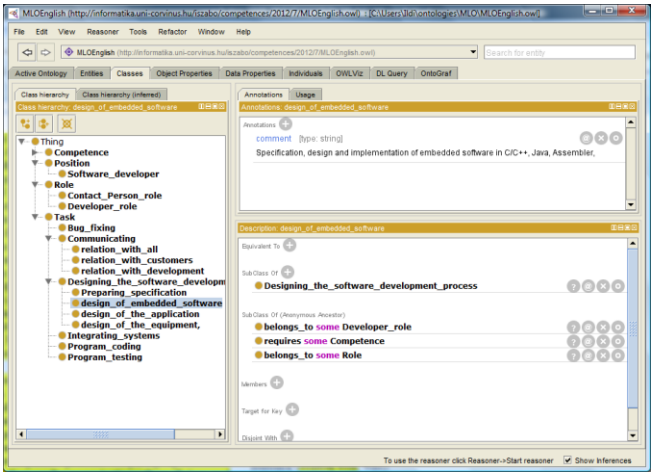


Figure 2. The implementation of the first version of the Job Role Ontology

As this figure illustrates, the first ontology version contains the main tasks of the determined process (software development process) that are expanded by the results of its open sentences. For example, the task is "communicating", and it is expanded by the expression "relation with customer" or "relation with development" etc. due to the indirect object found in the open sentence (relation with; who).

After this step, the competence elements (mainly the knowledge elements) of TOGAF will be assigned to the appropriate Task subclasses in manual or semi-automatic manner. Based on the requirements appeared in the job advertisements (for example Generic knowledge in Unix / Linux, AIX or Windows), an algorithm will validate or complete these competence elements and determines the attitudes of the competences. The development of these algorithms is under way.

In this phase, we plan to evaluate the results given by these algorithms by the measure of needed human intervention.

Having constructed the Job Role Ontology by this approach and formalized the actual knowledge elements into the Learning Outcome Ontology, we can pass into the next stage.

### *B. Second development phase: Ontology matching*

Alasoud, Haarslev and Shiri [1] define Ontology matching problem as follows: "given ontologies O1 and O2, each describing a collection of discrete entities such as classes, properties, individuals, etc., we want to identify

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semantic correspondences between the components of these entities."

In the first version of the prototype, the comparison between both sides will be executed through the Knowledge class, because the knowledge elements can be measured and can be assigned to the tasks more unambiguously than the other elements. This research concerns on finding the semantic and/or structural correspondences between the individuals of the Knowledge class of both ontologies.

In the research, ontology matching systems proposed by Choi [3] (Glue, Mafra, Lom, Qom, Onion, Omen) and offered by Noy [11] (Prompt, IF-Map) were investigated according to the following features:

- ontology matching is achieved in dynamic manner:
    - automatic, semi-automatic or non automatic working
    - the handling of changes occurred in the ontology
- reusability:
    - usage of different ontology format in matching process
    - type of matching method
    - modularity, integration with other systems
    - adaptability in Hungarian language environment.

Based on these characteristics MAFRA [9] and PROMPT [15] (or its built-in version into Protégé 4.2) ontology matching tools seem to be most suitable to achieve matching process. They are free downloadable, to execute from command prompt or a Java program automatically, to support RDF(S) or OWL languages and to handle changes occurred in the ontology through the usage of a semantic bridge or Protégé ontology editor. These are the most advantages of these programs compared to the others. However, they need human intervention as against IF-MAP. Nevertheless, the usage of algorithms from other systems (e.g., the one developed in OntoHR) can be taken into consideration.

In this phase, we plan to evaluate the results versus the results given by a human comparison.

## IV. CONCLUSIONS AND FUTURE WORK

This two-phased incremental software development process creates a prototype, which is capable of building the Job Role Ontology from the actual job requirements and executing a matching algorithm to reveal same and different elements between this ontology and the Learning Outcome Ontology. In this prototype, only one position is implemented but it is extendable with others in same way.

Considering carefully the system's requirements, detailed in the previous section, programming in Java seemed to be the most appropriate tool to develop the system. The main arguments are, that it provides a simply way to download contents from websites, it can be capable of running external commands (batch files) to create XML files, in order to put knowledge elements extracted from these files into ontology format (like RDF or OWL 2.0 format in Protégé). MAFRA, PROMPT and Protégé 4.2 open source programs are written in Java, too.

The XML creator program, the Learning Outcome Ontology, the algorithm for extracting tasks from the job requirements and putting them into the first version of the Job Role Ontology are ready to use. The future work is to develop an algorithm to assign the TOGAF knowledge elements to the relevant tasks and to find an appropriate tool or algorithm to achieve the matching process. These features must be integrated into one system in order to achieve the same-time process execution.

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