AN ONTOLOGICAL APPROACH TO COMPETENCY MANAGEMENT

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Abstract

Competency management is a very important part of a well-functioning organisation especially when considering individual long-term development planning and organisational learning. Unfortunately competency descriptions are not uniformly specified nor defined across boarders: National, sectorial or organisational, leading to an opaque competency description market with a multitude of competency frameworks and competency benchmarks. The aim of the Leonardo sponsored project TRACE (TRAnsparent Competence in Europe) is to enable transparency between European competency frameworks that will include the use of an individualised common description language. This description will be based on a ontological competency description which will add semantic value to any description which has references to or bindings with it.

An ontology in computer science is a formalised description of a domain. It is usually described in a description logics language where the individuals of a domain together with all the classes and their attribute and interrelations between individuals, classes and attributes are defined. This allows automated reasoning engines to be built which by utilising the interrelations between entities can make "intelligent" choices in different situations within the domain.

Therefore with formalised competency ontologies automated tools could be developed, which compare and contrast different competency descriptions on the semantic level. Tools such as skill gap analysis, training suggestion generation, job search and recruitment could be envisaged all based on individual semantically specified competency descriptions, hence empowered to align the results with the actual meaning of the competencies, which would provide better results for the users.

The major problem with defining a common ontology for competencies is that there are so many viewpoints of competencies and competency frameworks. Initial work within the TRACE project has focused on finding common trends within different competency frameworks in order to allow an intermediate competency description to be made, which other frameworks can make references to. Initially this research has shown that competencies usually can be divided up into "knowledge", "skills" and what we call "others". In the European Qualification Framework (EQF) for instance that would be called "Wider Competency", in the American Occupational Information Network (O*NET) it is called "Abilities" and "Others". An initial ontology has been created based on this with a simple structure of different "kinds" of "knowledges" and "skills" using semantic interrelations to define the basic semantic structure of the ontology.

A prototype tool for analysing a skill gap analysis has been developed.. The tool is based on the initial ontology from the TRACE project together with a domain specific ontology defining particular competencies needed in the eLearning domain. Several personal profiles are produced and a skill gap analysis is performed on a desired competency profile by using an ontologically based inference engine, which is able to list closest fit and possible proficiency gaps.

This shows how an ontological approach can enrich competency tools by utilising the semantic knowledge held in the competency descriptions; moreover it will highlight how this approach can provide a feasible technique for cross domain, sector and framework competency tools enabling transparency.

1. Introduction

Competency management is a very important part of a well-functioning organisation especially when considering individual long-term development planning and organisational learning. Many different stakeholders are addressing this need for competency management. Numerous competency frameworks have been developed both on national levels (e.g. CNCP [1] in France), sectorial level (e.g. SFIA [2] in the IT sector) and even on a Meta level (i.e. EQF [3]). Unfortunately these competency descriptions are not uniformly specified, leading to an opaque competency description market with a multitude of competency frameworks and competency benchmarks.

The members of the Leonardo sponsored project TRACE (TRAnsparent Competence in Europe) are the University of Reading, Menon, EIFEL, Scienter, Scienter España, SkillsNet Europe, HUT Dipoli, BitMedia, Junta de Andalucia and Andras. The aim is to enable transparency between European competency frameworks, to do this it has been recognized that an intermediate competency language is needed to provide a platform for comparison between different competency descriptions and profiles, which can provide a way to capture and reference the semantic knowledge contained with the individual competency definitions. This competency language is based on an ontology [4] based competency description which will add semantic value to any description which has references to or bindings with it.

This work-in-progress paper is a description of a comparison tool which has been developed within TRACE that utilises the first prototype ontology while performing fully automated comparisons of different competency profiles.

2. Transparency and Automation

Automation and transparency are two important concepts within the TRACE project. The potential of automating competency tasks, such as job search, skill gap analysis and training plan preparation across cultural barriers is enormous, and would be extremely valuable in the European knowledge society. Three levels of transparency have been examined in the context of the automation we are investigating:

- Viewing
- Reading
- Understanding

The first level (viewing) is the level that this project is least concerned with. The Internet is the medium which enables stakeholders to share their information with others and provides a means of automation between computers. Protocols (http, ftp etc.) and standards (html, xml etc.) are well established at this level and these can be used with competency descriptions. Some tools on this level will be needed in the future, such as privacy control; however this is out of the scope of TRACE.

At the reading level the concern is on the syntax of the competency descriptions, so that computers can read the descriptions in a consistent way across different computer platforms and applications. The IEEE has created a standard for defining competencies (Reusable Competency Definition – RCD) [5] which is intended to enable users to define competencies in a structured and consistent manner. This standard enables applications to share competencies and display the definitions consistently; however the applications do not have any semantic knowledge about what they display, because the definitions are in natural language. Therefore the only automated processes which are possible are transportation and unique identification of different RCDs. However two RCDs with different identifiers can be semantically equivalent, but such a comparison is not possible without semantic understanding.

Another specification (Simple Reusable Competency Mappings – SRCM [6]) has been proposed, which adds logical relationships between different RCDs, this enables different profiles of competency to be created, and does add semantic knowledge to competency profiles (the understanding level), however this proposed standard does not solve the semantic problem at the RCD level, and therefore

to ensure, that automation is possible there is a need to develop semantic knowledge about RCDs. This semantic need can be satisfied by ontologies.

3. Ontology

An ontology is a formal specification of a domain. It defines and specifies the different classes of individuals that form the domain, the actual individuals and the properties (relationships) of the individuals [7] [8]. One of the benefits of developing an ontology is that multiple applications can use the same domain consistently to perform different automated tasks, including tasks that involve reasoning based on the different relationships that are specified.

A prototype competency ontology has been developed in the web ontology language OWL [7], with the aim of becoming the unifying reference point between miscellaneous competency frameworks and descriptions. The prototype ontology defines three groups of competencies:

- Knowledge
- Skill
- Others

These are mainly inspired by the EQF meta-qualification framework [9] and the American occupational framework O*NET [10]. Both of these significant frameworks have Knowledge, Skills and something else as different kinds of competencies. The initial analysis of diverse competency frameworks showed that this is a common trend among competency frameworks. The top level knowledges and skills have been taken from O*NET, as this is a very well established framework, and the 8 level measures [11] from EQF have been incorporated into the system and provides a measurement of proficiency of the different skills and knowledges. The reason for this is that these are well defined and designed to be used in many dissimilar competency frameworks. The semantic relationships that exist between the different competencies are adapted from linguistics, especially with reference to the linguistic ontology WordNet [12], because of the natural language that defines the competencies. Figure 1 is a screenshot of the ontology taken from the ontology building tool Protégé [13]. It is outside the scope of this paper to explain Protégé; however the different types of competencies (knowledge, skill and other) are listed in the left “box”. A subset of the skills from O*NET are listed in the middle “box”, and some of the definition and label of the skill “Active Learning” are viewable in the right “box”.

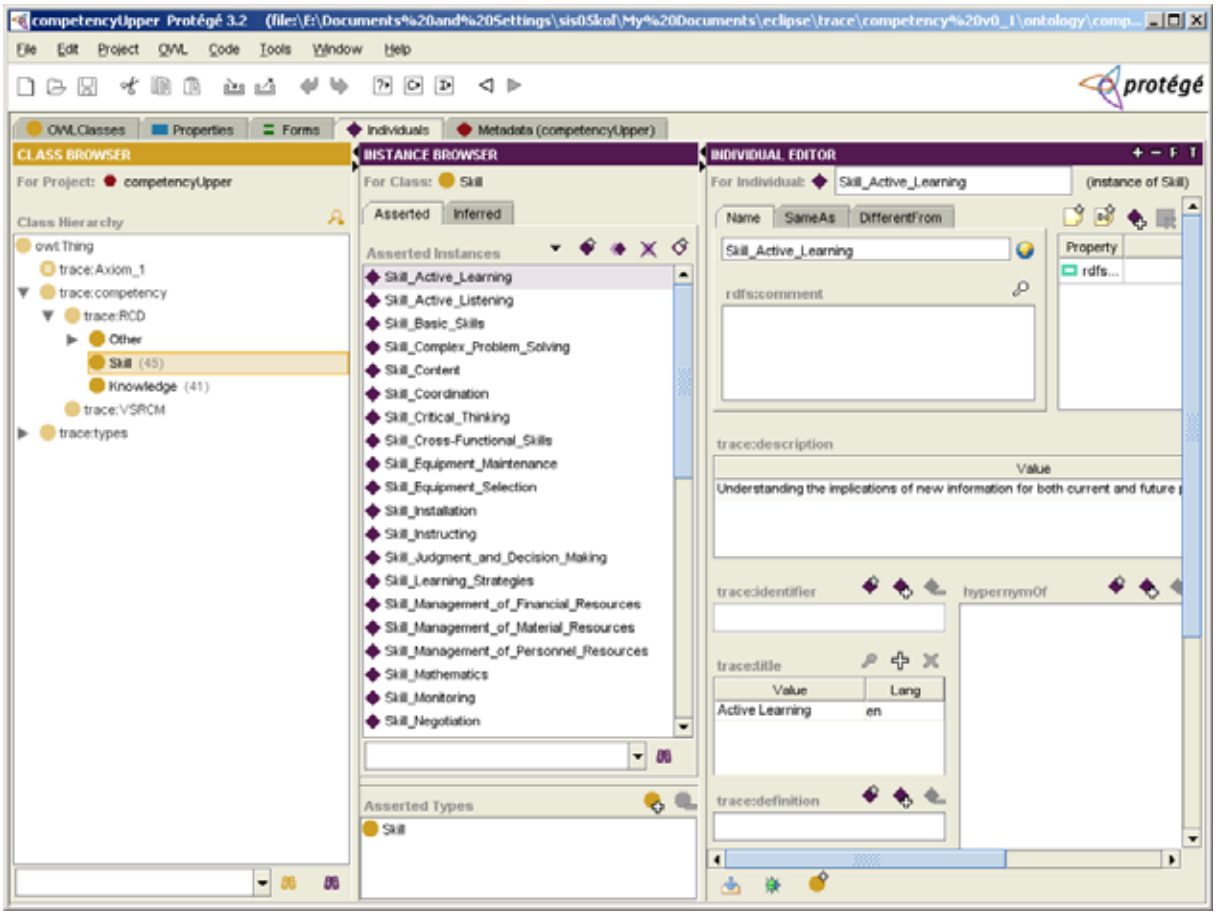

Figure 1: The prototype ontology.

4. Proof of Concept

To show the benefits of ontological reasoning, especially connected to competency maps, it was decided to create a comparison tool between a job profile and a personal profile, where the profiles would be purely described using competency maps. Apart from being a valuable proof of concept exercise comparison is also the basic logical assessment in most logical systems, hence being the natural first step towards many other tools. For instance skill gap analysis tools where many different profiles are matched with a desired profile and the closest matches are specified with their different skill gaps. Training suggestion tools could also be devised that can match profile skill gaps with eLearning material “target” end result competency profiles, hence provide users with training material that could take them from their current competency profile to a desired competency profile.

The comparison tool we have developed as part of this work has been implemented in Java [14] using the semantic web framework Jena [15]. It starts out by loading the prototype ontology described in section 3, thereafter it loads a prototype computer science domain ontology with bindings into the prototype ontology containing additional definitions of knowledge, skills, technologies and techniques and their relationships that exist in the computer domain. Thereafter the desired competency profile is loaded, which is described using a bespoke version of the proposed “Simple Reusable Competency Mapping” (SRCM). The modified version of SRCM is used to increase the readability of the XML for testing purposes and doesn’t change it’s interpretation significantly. The only significant change made was to tailor the relationship so that a personal profile can contain a proficiency level rather than a required or a desired proficiency level. This is an important relationship when looking at the competency “owners” such as individuals and groups of individuals, but this relationship is not presently included.

In the examples we have chosen a typical job advertisement for an entry level eLearning Web Producer as might be found on www.monster.com. Taking this as the starting point the desired competency profile was manually prepared using assessments based on the experience of the authors whilst making the mappings. Profiles were allocated to hypothetical graduates to be used in the comparison process. Then the comparison tool starts out by comparing the desired job profile with each of the given personal profiles and establishes which competencies are satisfied, which are close matches or those which are not contained in the personal profiles. This is carried out using the semantic relationships contained in the ontology to make automated inferences. In figure 2 we illustrate two examples of the result of such an inference procedure. In the first case the personal profile does not include the competency of Software Requirement Analysis (SRA); however it does contains Computer Software Development, which, in the domain of computer science, is a holonym of SRA (meaning SRA is part of computer software development), hence the system reasoning process is able to make the inference that the competency is matched. In the diagram this is indicated by the 'green' fill to the SRA node. In the second example we seek to check if the profile contains a proficiency using the technology XSLT. In this case we find it is only closely matched, because the personal profile only has XML proficiency which is a hypernym of XSLT (XML is the base of XSLT). In this case the system can assess that it might be relatively easy for the profile to match the desired profile and this is indicated by the 'yellow' fill in the XSLT node.

Figure 2: Inference examples

5. Conclusions and Future work

This exercise has shown that a comparison tool is possible between different competency mappings and that ontologies can be used to enhance the comparison by utilising ontological semantic inference. This is an important conclusion because it enables a lot of future work on automated tools which otherwise would not be possible to automate. The most immediate tool that is needed is a tool for creation of competency maps with support for easy integration of competency frameworks. After this further comparison tools should be built for comparison of other kinds of competency maps, for instance enabling comparisons of different levels of two different competency frameworks.

The effectiveness of the inferences is relying on the quality and size of the ontologies, and much work is needed on the ontologies. Although anybody can modify and add to the ontologies depending on their needs, it is obvious that the bigger and extensive the main ontologies are the more value there would be in using them, hence attracting more users of the system, which again would assist refining the ontologies even further.

Many tools, such as skill gap, ePortfolio and training solution tools that would build on the comparison tools can be envisaged, however these are tools which extent the transparency that the TRACE project tools bring and as such lies outside the scope of the TRACE project.

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