Note of Study

Ontologies and some Applications

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Chapitre 1

Understanding of related concepts

1.1 Ontology

Definition : Using a formal, explicit and structured pattern to define, represent the basic terms and relations in a specific domain.

Components : Instances, Functions, Relations and Concepts.

Language and Development environment : Using Web Ontology language (OWL) to transfer an ontology into a text file that are easily computer-processable, the required format is called the RDF/XML format. For the authoring of an ontology, there are ontology development environments (ODEs) that render the ontology graphically, textually, or with a logic view. (One of such tool, is called Protégé).

Evaluate :

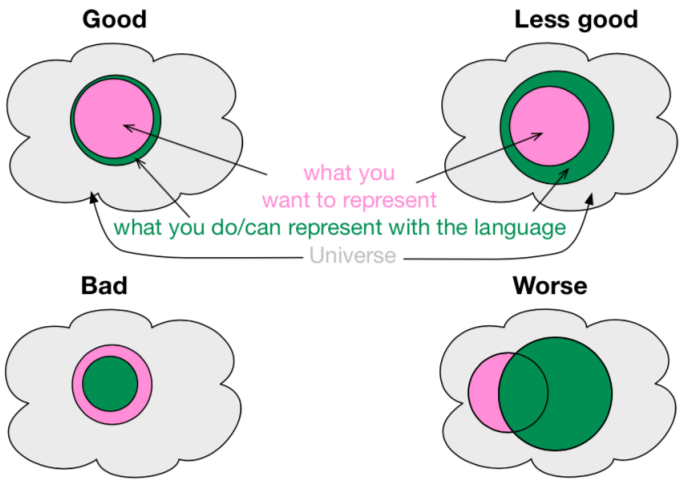

FIGURE 1.1 – **Good, less good, bad, and even worse ontologies** The pink circle denotes what you would like to represent, the green circle denotes what's in the ontology.

1.2 Semantic Web

Definition : The Semantic Web is an extension of the current web in which information is given well-defined meaning, better enabling computers and people to work in cooperation. It is based on the idea of having data on the Web defined and linked such that it can be used for more effective disovery, automation, integration and reuse across various applications.

Differences : Current Web uses the formats (URL, HTTP, HTML), while Semantic Web (RDF, RDFS, OWL).

Semantic Web in job domain : Using Semantic Web technologies in the domain of online recruitment and skill management can substantially increase market transparency, lower the transaction costs for employers and speed up the procurement process.

1.3 Description Logics (DLs)

DLs are a family of logic formalisms whose basic syntax elements are **concept** names, e.g., person, degree, specialization, and **role** names, such as workingIn, requiredAS. Intuitively, concepts stand for sets of objects, and roles link objects in different concepts, e.g., $Graduate \sqcap \exists hasDegree.Engineering$, which describes the set of graduates with an engineering degree.

1.4 Web Ontology Language OWL

As we mentioned in Section 1.1, the language that we use to serialise the ontology is the most widely used ontology language for computational purposes, being the Web Ontology Language OWL.

1.5 Ontology Development Environments, Protégé

Protégé is a free, open source ontology editor and a knowledge management system. Protégé provides a graphic user interface to define ontologies. It also includes deductive classifiers to validate that models are consistent and to infer new information based on the analysis of an ontology.

Chapitre 2

Ontologies existing

Chapitre 3

Job Ontologies

3.1 SEEMP Reference Ontology [1]

The Reference Ontology described acts as a common "language" in the form of a set of controlled vocabularies to describe the details of a job posting and the CV of a job seeker. This Ontology is composed of thirteen modular ontologies : **Competence, Compensation, Driving License, Economic Activity, Education, Geography, Job Offer, Job Seeker, Labour Regulatory, Language, Occupation, Skill and Time**.

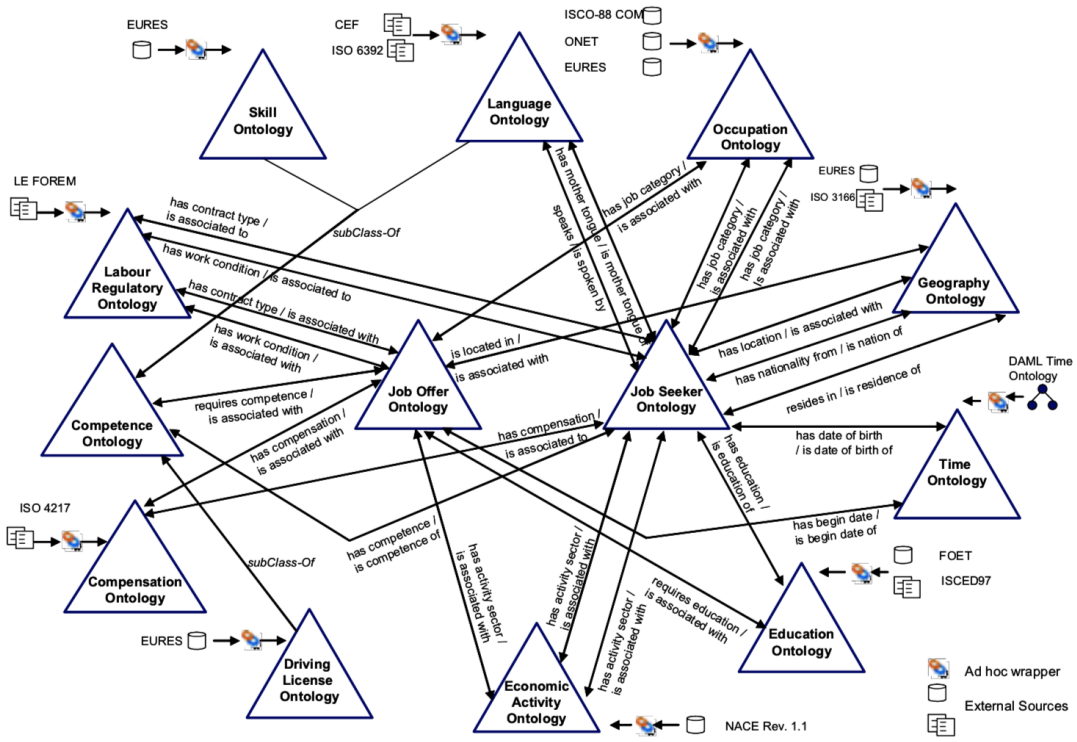

FIGURE 3.1 – **Main ad-hoc relationships between the modular ontologies**

3.2 A Formal Approach to Ontology-Based Semantic Match of Skills Descriptions [2]

In this paper, their approach, based on Description Logics formalization and reasoning, is oriented to finding the best individual for a given task or project (*one to one*), based on profile descriptions sharing a common ontology. Formally, *one to one* means that we have one job profile to match with one individual ; offered and requested profile descriptions may be relative to more than one skill. The scenario is typical of temporary work agencies or counseling companies, in which one person is employed if s/he is able to attend one task.

3.2.1 Skills ontology

Their ontology currently is endowed of approximately seventy concepts and is still being expanded. The methodology they used to generate the ontology based on the one proposed in [3]. A portion of the ontology hierarchy is pictured in Figure 3.2.

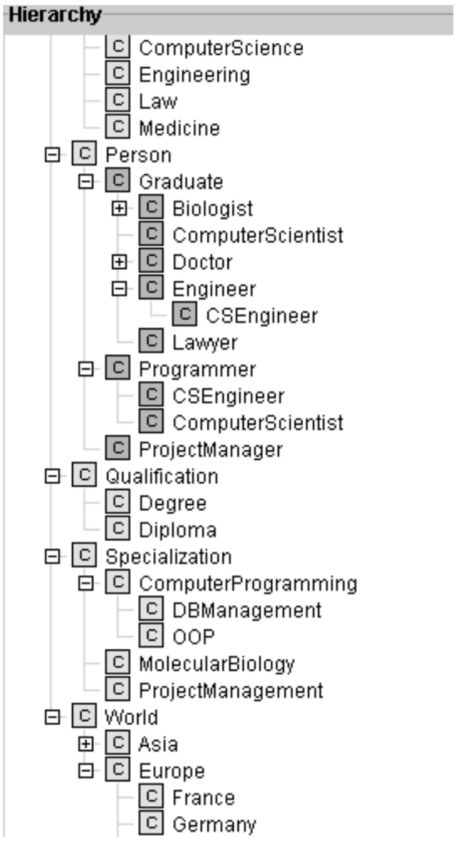

FIGURE 3.2 – **Hierarchy of concepts in the skills ontology**

3.2.2 Result

An example was showed in this paper, suppose to have the Demand profile description *Looking for an engineer, living in Europe, required as OOP programmer for a work in Europe*. Also suppose that a set of possible profiles, shown in Figure 3.3 is to be analyzed with respect to the Demand.

```
demand LOOKING FOR AN ENGINEER, LIVING IN EUROPE, REQUIRED AS OOP
PROGRAMMER TO WORK IN EUROPE. (createIndividual demand (and
Engineer (at-least 1 livingIn)(all livingIn Europe)(at-least 1
requiredAs) (all requiredAs Programmer)(at-least 1
specializedIn)(all specializedIn OOP)))

supply1 COMPUTER SCIENCE ENGINEER, LIVING IN ITALY, REQUIRED AS
PROGRAMMER SPECIALIZED IN DB MANAGEMENT (createIndividual supply1
(and  CSEngineer (at-least 1 livingIn)(all livingIn
Italy)(at-least 1 requiredAs) (all requiredAs Programmer)(at-least
1 specializedIn)(all specializedIn DBmanagement)))

supply2 GRADUATE WITH A DEGREE IN ENGINEERING, LIVING IN ITALY,
WORKING IN EUROPE AS OOP PROGRAMMER (createIndividual supply2 (and
Graduate (all hasDegree Engineering)(at-least 1 workingIn) (all
workingIn Italy)(at-least 1 livingIn)(all livingIn Italy)(at-least
1 requiredAs) (all requiredAs Programmer)(at-least 1
specializedIn)(all specializedIn OOP)))

supply3 GRADUATE WITH A DEGREE IN LAW, WORKING IN ITALY AS
COMPUTER PROGRAMMER (createIndividual supply3 (and  Graduate (all
hasDegree Law)(all workingIn Italy)(at-least 1 requiredAs) (all
requiredAs Programmer)(at-least 1 specializedIn)(all specializedIn
ComputerProgramming)))

supply4 ENGINEER LIVING AND WORKING IN JAPAN AS COMPUTER
PROGRAMMER (createIndividual supply4 (and  Engineer (at-least 1
workingIn)(all workingIn Japan)(at-least 1 livingIn) (all livingIn
Japan)(at-least 1 requiredAs)(all requiredAs Programmer)(at-least
1 specializedIn) (all specializedIn ComputerProgramming)))

supply5 DOCTOR WORKING AND LIVING IN GERMANY (createIndividual
supply5 (and  Doctor (all workingIn Germany)(all livingIn
Germany)))

supply6 MOLECULAR BIOLOGIST LIVING IN GERMANY (createIndividual
supply6 (and  MolecularBiologist (all livingIn Germany)))
```

FIGURE 3.3 – **Sample demand and supplies together with their Classic description**

Using their system w.r.t. the reference ontology they have the following ranked list $R = \{S_2, S_1, S_3, S_5, S_4 - S_6\}$ in which S_2, S_1, S_3, S_5 potentially match the demand and S_4, S_6 partially.

3.3 Improving the accuracy of job search with semantic techniques[4]

The first step towards the realization of the Semantic Web e-Recruitment scenario was the creation of a human resources ontology (HR-ontology). In the process of ontology building they first identified the sub-domains of the application setting (skills, types of professions, etc.) and several useful knowledge sources covering them.

As candidate ontologies they selected some of the most relevant classifications in the area, deployed by federal agencies or statistic organizations : German Profession Reference Number Classification (BKZ), Standard Occupational Classification (SOC), German Classification of Industrial Sector (WZ2003), North American Industry Classification System (NAISC), German version of the Human Resources XML (HR-BA-XML) and Skill Ontology developed by the KOWIEN Project (in German).
Their HR ontology can be found in [5] [6]. They decided to reuse the following resources[5] :

- HR-BA-XML : official German extension of Human Resource XML, the most widely used standard for process documents. HR-XML is a library of more than 75 interdependent XML schemes defining particular process transactions, as well as options and constraints regulating the correct usage of the XML elements.
- SOC-Standard Occupational Classification : classifies employees into occupational categories (23 major groups, 96 minor groups, and 449 occupations). The 2018 Standard Occupational Classification (SOC) system is used by federal statistical agencies to classify workers and jobs into occupational categories for the purpose of collecting, calculating, analyzing, or disseminating data, see `https://www.bls.gov/soc/2018/soc_2018_manual.pdf`. Another one National Occupational Classification Matrix 2016 `http://noc.esdc.gc.ca/English/NOC/Matrix2016.aspx?ver=16`
- BKZ : German version of the SOC, classifying employees into 5597 occupational categories according to occupational definitions.
- WZ2003 : German standard classification of economic activities.
- NAICS-North American Industry Classification System : provides industry sector definitions for Canada, Mexico, and the United States to facilitate uniform economic studies across the boarders of these countries.
- KOWIEN : a skill ontology which defines concepts representing competencies required to describe job position requirements and job applicant skills.

3.3.1 Semantic Web-based job portal

The planned architecture for the Semantic Web-based job portal implies three basic roles information providers, aggregators and consumers. Note that there are two different approaches for Information Providers to publish annotated job postings depending on their existing software infrastructure. If they use database standard software in the back-end, they can export related data directly into RDF using mapping tools like D2RQ[7]. If they do not use any enterprize software to manage open positions, they can annotate existing HTML versions of their postings using annotation tools and

publish RDF version of their postings using, for example the RDF NetAPI or RAP.

Bibliographie

[1] Gómez-Pérez.A, Jaime.R, and Boris Villazón-T. "An ontology for modelling human resources management based on standards." International Conference on Knowledge-Based and Intelligent Information and Engineering Systems. Springer, Berlin, Heidelberg, 2007.

[2] Colucci.S, Di Noia.T, Di Sciascio.E, et al. "A formal approach to ontology-based semantic match of skills descriptions". J. UCS, 2003, 9(12) : 1437-1454.

[3] Uschold, M. and Gruninger, M. (1996) : "Ontologies : Principles, methods and applications" ; Knowledge Engineering Review, 11(2) : 93- 113.

[4] Mochol.M, Holger.W, and Lyndon.N. "Improving the accuracy of job search with semantic techniques." International Conference on Business Information Systems. Springer, Berlin, Heidelberg, 2007.

[5] Mochol.M and Paslaru Bontas.E. "Practical Guidelines for Building Semantic eRecruitment Applications." In International Conference on Knowledge Management, Special Track : Advanced Semantic Technologies (AST' 06), 2006.

[6] Paslaru Bontas.E, Mochol.M, and Tolksdorf.R. "Case Studies on Ontology Reuse." In Proc. of the 5th International Conference on Knowledge Management(iKnow05), 2005.

[7] Bizer.C and Seaborne.A. "D2RQ - Treating Non-RDF Databases as Virtual RDF Graphs." In Proc. of the 3rd International Semantic Web Conference, 2004.