

Ontology Construction and Its Applications in Local Research Communities

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Abstract. Ontological engineering has been widely used for diverse purposes in different communities and a number of approaches have been reported for developing ontologies; however, few works address issues of specific ontology construction for local communities, especially when taking into account the specificity of academic knowledge creation. This Chapter summarizes efforts done in two cooperating communities in Japan and in Poland, including attempts to clarify the concept and the field of knowledge science, to create an ontology characterizing a research program in this field, then to apply related results in another field – contemporary telecommunications. The distinctive approach to ontology creation is based on a combination of bottom-up and top-down approaches with the purpose of combining explicit knowledge with tacit, intuitive and experiential knowledge for constructing an ontology. Other possible views on constructing ontology are also presented and discussed; lessons from an ongoing application of this approach to a local research community working on contemporary telecommunication issues in Poland are also discussed. The combination of explicit and tacit, intuitive and experiential knowledge has led to a development of a software system named adaptive hermeneutic agent (AHA), a toolkit for documents gathering, keywords extracting, keywords clustering, and ontology visualization.

Keywords: ontology, knowledge science, knowledge engineering, software engineering.

1 Introduction

The word ontology was taken from philosophy, where it means a theory or a systematic explanation of being [10]. This word was borrowed by computer scientists in the middle of 1980s to express the meaning of an enhanced taxonomy – a structure of basic concepts together with their relations – of a given field of information and knowledge. A significant development of ontological engineering, corresponding

tools and systems occurred in 1990s; later, the emergence of Semantic Web has marked an important step in the evolution of ontological engineering. Ontologies become regarded as means for a shared knowledge understanding and a way to represent real world domains. In the last decades, ontologies are expected to play a crucial role in the integration of data and applications at public and corporate level, for example, in the development of management information systems, organization of content in web sites, categorization of products in e-commerce, structured and comparative searches of digital content, standard vocabularies in expert domains, product configuration in manufacturing, among many others [3,11,15,22].

With all these developments, however, not all issues emerging during ontological engineering were sufficiently stressed. First issue is related to the character, reasons for, and possible explanations of the differences occurring during two distinctive approaches to ontological engineering: the *bottom-up approach*, constructing ontologies based on text repositories and data, and the *top-down approach*, constructing ontologies based on expert opinions. Because an ontology can be defined as a *formal specification of a shared layer of concepts* [9], its construction was originally approached as a purely *top-down approach*, a focused process organizing expert discussions and consensus opinions, see, e.g., [32]. However, other works, e.g. [6] point out that a *bottom-up approach* might be better, for diverse reasons, including the fact that knowledge creation proceeds all the time and thus ontologies must be dynamic, need continuous revisions that require automatic tools. While it is obvious that bottom-up approach is closer to automation and computer intelligence, whereas top-down represents human opinions, less attention was devoted to the fact that *this distinction corresponds also to the distinction of explicit knowledge versus tacit knowledge*, see, e.g. [34]. We believe in the superiority of an interplay between tacit and explicit knowledge, see [19], in all knowledge creation processes, thus we shall concentrate on *the ways of eliciting and using tacit knowledge in a combined bottom-up-top-down approach*; this is the essential aspect of novelty in our paper.

Second issue is related to the distinction between universal versus local character of a given ontology. There are experts who believe that any ontology can have only local character, be valid only locally (*"there is no universe, only a multiverse"*¹). However, ontologies might be at least re-used in changed circumstances; thus, the question of "external validity" (understood not only as the possibility of external use, but also as consistency with external sources of knowledge) of an ontology has been raised, see, e.g. [1]. On the other hand, a technologist always assumes at least some external validity of the tools he creates. Therefore, from technological perspective it appears obvious that an ontology, to be useful, must be to some degree universal and to some degree local, the question is *how to define the degree and the character of universality and locality of a given ontology*. This, in particular, relates to ontologies characterizing local research communities, concentrating on a given field and a specific tradition of research.

¹ We shall not discuss in detail this philosophical issue here, recall only the hard wall test proposed in [34]: if somebody believes that there is only a multiverse, let him position himself against a hard wall, close his eyes and try to convince himself that the wall is not hard. If he cannot convince himself, the reality apparently has some universal aspects, hence there is not only a multiverse. If he can convince himself, he can try to falsify his convictions by running ahead with closed eyes ...