Grounding Crisp and Fuzzy Ontological Concepts in Artificial Cognitive Agents

Radosław Piotr Katarzyniak

Institute of Information Science and Engineering, Wrocław University of Technology,
Wybrzeże Wyspiańskiego 27, 50-350 Wrocław
radoslaw.katarzyniak@pwr.wroc.pl

Abstract. The grounding of crisp and fuzzy concepts is defined for the class of artificial cognitive agents equipped with means for recognizing states of external objects and language signs. Each concept is created in the internal cognitive space of the agent in the context of social communication. This communication makes it possible to correlate cognitive agent's perceptions with language signs generated by other members of the same population of agents. Related processes yield the so called semiotic relation consisting of recognized instances of semiotic triangles. A simple measure between concepts is suggested and used to define higher level relations of semantic synonymy, similarity, generalization and contradiction. In consequence an approach to modeling ontology creation for a particular class of agents and a particular language is defined.

1 Introduction

In the field of information systems and artificial intelligence ontologies are understood as formal specifications of domain conceptualizations. One of the main features of the majority of these definitions is that they do not refer ontologies to their underlying idea of knowledge subjects [2] and grounding [4]. The relation between ontology, which is a specification of knowledge, and any agent of this knowledge is fundamental due to the fact that conceptualizations are always created by particular cognitive minds [2].

In this paper an approach to modelling crisp and fuzzy conceptualizations of external world is discussed for a case of artificial cognitive agents introduced in other works [6]. This way ontologies that capture these concepts are grounded in actual empirical experiences of agents. All considered concepts are labelled by assigned language signs which are called language symbols due to their reference to particular meaning [1], [7], [8]. All theoretical notions introduced in this paper are given for an example case of a world, an artificial cognitive agent, and a simple language for communication. The higher ontological relations are defined on the basis of lower level notions of fuzzy and crisp concepts, and the additional idea of conceptual similarity.

The approach to grounding lower level concepts and higher ontological relations is similar to the process of social semiosis suggested in [7], [8] and applied to a class

B. Gabrys, R.J. Howlett, and L.C. Jain (Eds.): KES 2006, Part III, LNAI 4253, pp. 1027 – 1034, 2006.

of simple "agents" equipped with dedicated data structures for storing external worlds' reflections [7], [8]. In that approach the authors assumed that language grounding would be a complex process carried out within an existing artificial population. Main steps proposed and assumptions made for the process of semiosis given in [7], [8] are:

- Artificial cognitive agents are assumed to be able to conceptualize externally originated data streams into internal mental representations. These data are collected through dedicated sensors which analyze incoming material and distribute it over dedicated knowledge representation structures. In natural cognitive agents this process is carried out on the basis of biological neural networks [3].
- All internal representations that are stored by cognitive agents induce higher level models of external world, provided that their strength is grounded by multiple instantiation of the same recognized shapes and order of observed objects.
- The above mentioned process of collecting reflections of external world is correlated with additional processing of language recognition. Additionally, artificial cognitive agents are assumed to be able to recognize and store correlations between particular instantiations of external worlds' perceptions and accompanying language signs produced by other agents of the same population.
- Artificial cognitive agents learn the underlying correlation between all stored perceptions and language labels produced by other parties of the discourse and recognized simultaneously to certain observations (classes of observations). The output of such process of semiosis is the creation of internally grounded fundamental meaning of language signs that can be further process in order to create higher level representations.

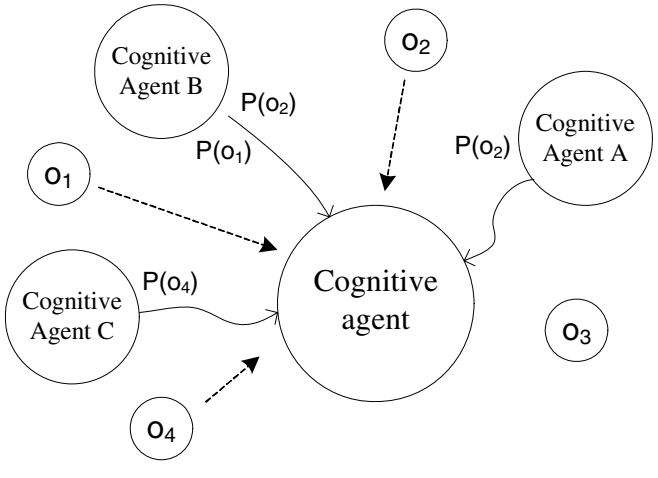

Fig. 1. The general organization of environment for the process of semiosis