Talk: Extending the Knowledge Level of Cognitive Architectures with a Hybrid Semantic System: the case of DUAL-PECCS

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Abstract

Two of the main current limitations of the knowledge level of the artificial Cognitive Architectures (CAs) are represented by the limited size and the homogeneous typology of the encoded and processed knowledge (Lieto, Lebiere, and Oltramari 2017). While the size problem corresponds to the fact that CAs usually operate with very limited and ad-hoc built knowledge bases, the problem concerning the homogeneity issue concerns the fact that usually the type of knowledge represented and manipulated by most CAs mainly covers the so called classical part of conceptual information (i.e. that one representing concepts in terms of necessary and sufficient conditions, see (Frixione and Lieto 2012) on these aspects). On the other hand, the so called common-sense knowledge components (i.e. those that, based on the results from the cognitive science, allow to characterize concepts in terms of prototypes, exemplars etc.) is largely absent in such computational frameworks. Common-sense conceptual knowledge, however, represents a necessary aspect to be integrated in human-like artificial CAs (Chella, Frixione and Lieto, 2017).

Some initial efforts have been done to deal with these problems. The works by Salvucci and Ball and colleagues (Salvucci 2014; Ball et al., 2008), for example, extend the knowledge model of the Declarative Memory (DM) of the ACT-R architecture (Anderson et al 2004) with world level knowledge bases such as DBpedia (i.e. the ontological version of Wikipedia), and the CYC ontology respectively (one of the widest ontological resources currently available).

Such solutions, however, are not completely satisfactory. In particular: the integrations with huge world-level ontological knowledge bases can be considered a necessary solution for solving the size problem. It is, however, insufficient for dealing with the knowledge homogeneity issue and with the integration of the common-sense conceptual mechanisms in CAs.

In this talk we present an alternative solution able to deal with both the size and the knowledge homogeneity issues. Such solution has been employed in a conceptual categorisation system for linguistic descriptions called DUAL-PECCS (Lieto, Radicioni, Rho, 2017). Such system has been integrated with the Declarative Memories and the knowledge processing mechanisms of different CAs (i.e. ACT-R and CLARION) by extending, de facto, their knowledge processing capabilities. In DUAL-PECCS (http://www.dualpeccs.di.unito.it/), the problem concerning the knowledge homogeneity is resolved "by design", since this system explicitly relies on a heterogeneous representational assumption and is built upon a hybrid conceptual structure coupling Conceptual Spaces (Gardenfors, 2000) and Ontological representations and reasoning. The size problem, on the other hand, is dealt with in a twofold way: trough the integration of Conceptual Spaces representation with world-level ontological knowledge (CyC) and with the automatic encoding of wide-coverage Conceptual Spaces knowledge bases by starting from encyclopedic linguistic resources such as BabelNet (http://babelnet.org/) and ConceptNet (http://conceptnet5.media.mit.edu/) (Lieto, Mensa, Radicioni, 2016) .

We will present the results obtained by the system in tasks of common-sense conceptual categorization (with an overlap close to the 80% compared to human performances) and will discuss the lessons learned and the future research directions.

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