A Non Monotonic Reasoning framework for Goal-Oriented Knowledge Adaptation

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Introduction

In this paper we present a framework for the dynamic and automatic generation of novel knowledge obtained through a process of commonsense reasoning based on typicality-based concept combination. We exploit a recently introduced extension of a Description Logic of typicality able to combine prototypical descriptions of concepts in order to generate new prototypical concepts and deal with problem like the PET FISH (Osherson and Smith, 1981; Lieto & Pozzato, 2019). Intuitively, in the context of our application of this logic, the overall pipeline of our system works as follows: given a goal expressed as a set of properties, if the knowledge base does not contain a concept able to fulfill all these properties, then our system looks for two concepts to recombine in order to extend the original knowledge based satisfy the goal. Our system has been tested in the task of object composition of compound tools and its results are compared with both human and artificial responses (Lieto et al 2019).

In particular, by following (Olteleanu and Falomir, 2016) we asked our system to combine objects in order to obtain the following goals:

G1={Object,Cutting,Graspable}
G2={Object,Graspable,LaunchingObjectsAtDistance}
G3={Object,Support,LiftingFromTheGround}

For what concerns the first goal, i.e. where the purpose of our intelligent system consisted is looking for a graspable object able to cut,the system was not able to find a unique object satisfyingall the properties and, therefore, proposed the combination Stone AND Branch a solution, thus suggesting a combined concept having the characteristics resembling a rudimentary Knife with a handle. For what concerns the second goal, where the system was asked to look for a graspable object able to launch objects at distance, the systems combined the concepts Branch AND RubberBand, being those with the highest rank with respect to G2. For what concerns the third goal, the system provides a solution by combining Shelf AND Stump. The last two obtained compounds correspond, roughly to the object of a Rubber Band and Table. We also proposed to 36 human users to solve the same goals (with the same objects of our system Knowledge base) and the obtained results show how the top proposed combination are the same proposed by our system. On the other hand, human users show a much more creative attitude by proposing also alternative combinations.
The system has been integrated with the SOAR cognitive architecture, by showing how it is possibile to extend the knowledge processing capabilities of such general systems (Lieto, Lebiere & Oltramari, 2018).

References

Osherson, D.N., Smith, E.E. (1981) . On the adequacy of prototype theory as a theory of concepts. *Cognition* 9(1) 35–58.

Lieto, A., & Pozzato, G. L. (2019). A Description Logic Framework for Commonsense Conceptual Combination Integrating Typicality, Probabilities and Cognitive Heuristics. to appear in *Journal of Experimental & Theoretical Artificial Intelligence,* arXiv preprint arXiv:1811.02366.

Lieto, A., Perrone, F., Pozzato, G. L., & Chiodino, E. (2019). Beyond subgoaling: a dynamic knowledge generation framework for creative problem solving in cognitive architectures. *Cognitive Systems Research,* 58, 305-316

Olteţeanu, A. M., & Falomir, Z. (2016). Object replacement and object composition in a creative cognitive system. Towards a computational solver of the Alternative Uses Test. Cognitive Systems Research, 39, 15-32.

Lieto, A., Lebiere, C., Oltramari, A. (2018). The knowledge level in cognitive architectures: Current limitations and possibile developments. *Cognitive Systems Research*, 48, 39-55.