Towards a Description and Definition of the Perceived-Entity Linking Problem

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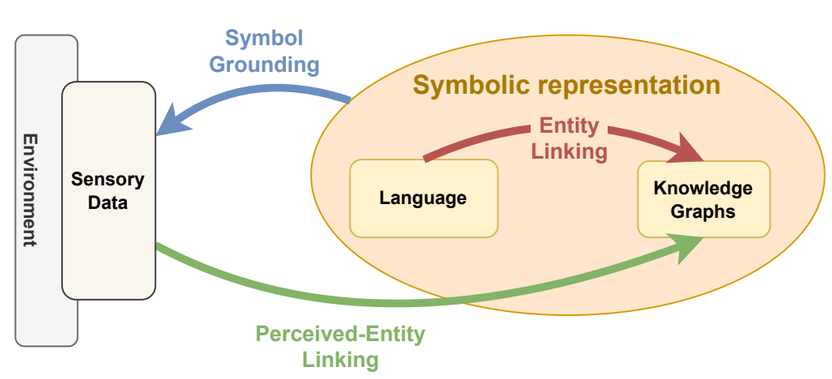
KCAI Knowledge in Artificial Intelligence

Abstract

In this paper we present an initial conceptualization of the problem of Perceived-Entity Linking (PEL), which is inspired by the entity linking task used in the Natural Language Processing domain. The task was adopted to represent a problem knowledge-driven embodied systems face, which concerns the linking of the representations of perceived entities to a target knowledge graph. We provide an initial description of the problem, demonstrated with a motivating example, and followed by a preliminary case study, where we identify some of the challenges and opportunities PEL presents both to the engineers of knowledge-driven autonomous agents and to the knowledge engineers of the Semantic Web community.

Introduction

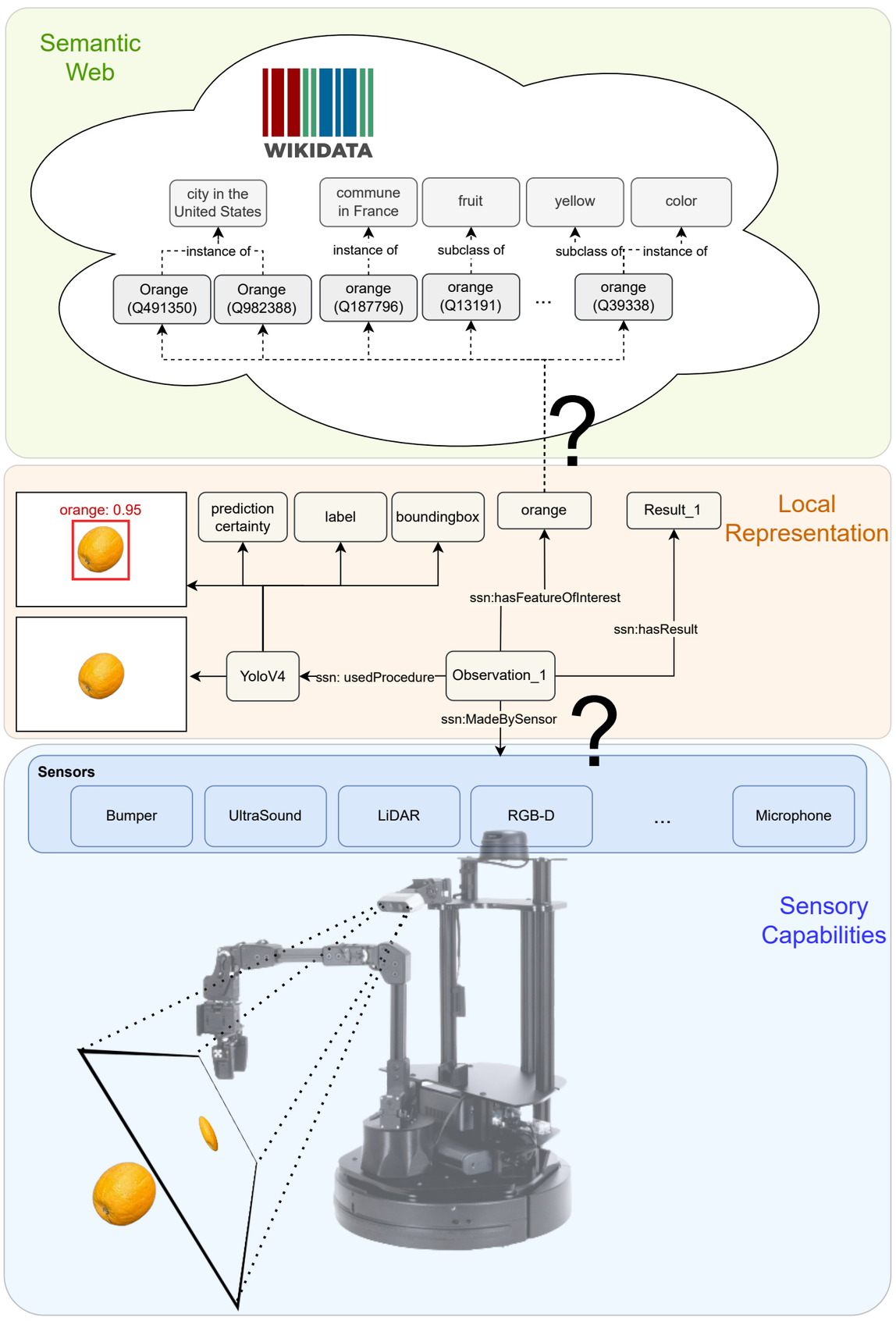
Autonomous agents, such as robotic systems, base their operation on the sensory information extracted from the environment. In order to be able to operate in an autonomous manner, these systems need to perceive different aspects of the often dynamically changing environment, often in the form of symbolic knowledge. Within the field of robotics, one of the most popular methods to represent symbolic knowledge is in the form of ontologies.
In this paper, we present a first attempt to conceptualize the problem that we call Perceived-Entity Linking (PEL), which is the process of linking perceptual data to a corresponding entity in a target knowledge graph.



Problem Analysis

Accessing knowledge requires the autonomous agent to establish a connection between the context and the target knowledge graph.The agent first needs to represent the context through its sensory capabilities. Among the examined knowledge-based robotic systems, this connection is commonly established by one of the two ways:
1. Hand-crafting the system with the links to an online knowledge-graph .
2. Not utilizing general, external knowledge graphs, but instead creating an separate knowledge framework, In both cases, first a local representation is created, which then is linked to an external knowledge graph by the systems engineers.

This suggests that the problem of PEL could be conceptualized with two levels, where the first level is concerned with using the sensory data and the second level is concerned with aligning these representations with external knowledge graphs.



Case Study

we use a preliminary proof-of-concept case study to compare how some of the knowledge-based robotic systems, namely PMK[1] and RoboSherlock[2] could represent an orange on the two levels of the PEL task using their currently available ontologies to create an instance of an orange. In this manually created example an ideal object detection algorithm is assumed, that can provide all the information the ontologies afford.
To investigate the second level, three target knowledge graphs containing common-sense knowledge are considered, namely ConceptNet, DBPedia and WikiData. Upon examining all the three resources a perceived instance of orange could be linked to, WikiData and DBpedia presented more structured information. While several pieces of information that is characteristic of the concept orange fruit is represented, such as the color and the parent classes (DBpedia and WikiData), there is no information about the material, shape, or the average sizes or weights of the fruits that could be used for the PEL task.
This preliminary investigation has revealed some weaknesses and opportunities in both the Semantic Web resources and ontology-based approaches

Conclusion and Future Work

In this paper we introduced the task of Perceived-Entity Linking, and after briefly describing some of recent knowledge-driven robotic systems we present a case-study, which served as a motivating example, and as an investigation of the problem domain. The results of this investigation indicated that all of the systems examined could be extended with a more complete and precise object representation method. Furthermore we discovered that all of the large, "common-sense" knowledge graphs investigated lack some common-sense qualities of an orange, such as shape, weight, and size. Future work will focus on a formal definition of a problem, and a comprehensive evaluation of the systems we discussed

References

[1] Diab, Mohammed, et al. "PMK—A knowledge processing framework for autonomous robotics perception and manipulation." *Sensors* 19.5 (2019): 1166.
[2] Beetz, Michael, et al. "Robosherlock: Unstructured information processing for robot perception." *2015 IEEE International Conference on Robotics and Automation (ICRA)*. IEEE, 2015.