LOT4KG: A Methodology for the Knowledge Graph Lifecycle

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Abstract. The current state of the art of knowledge engineering lacks proper methodologies to deal with the ever-changing nature of knowledge. In this short paper, we present LOT4KG: a first step towards including the changing nature of knowledge in the knowledge graph lifecycle. LOT4KG extends the LOT ontology engineering methodology to include activities associated with KG construction, better reflecting how KGs are engineered in the real world. Further, we analyse how these lifecycles compare to ontology evolution frameworks and what work is there to be done in the future to step from engineering towards full KG evolution.

Keywords: KG construction, KG lifecycle, methodology

1 Introduction

The constantly evolving nature of knowledge has become a major problem in the way we engineer and publish data on the Web in the form of knowledge graphs (KGs)[5] [5]. We lack methodologies that accurately capture the problem of evolving KGs and at the same time propose how to deal with changing KGs over time. This problem is aggravated by the fact that today we have methodologies for the engineering of ontologies [6,4,2], and KGs [8,1] separately.

Although Ontology 101 [4] specifically includes the activity "creation of individuals" and does not consider today's technologies such as RML, SHACL, ShEx, which are involved in the engineering of KGs. Even LOT [6], one of the newest ontology engineering methodologies, focusses only on the engineering of the schema, or what we refer to as ontology, and does not consider the population with large amounts of data. Works such as those by Radulovic et al. [7], Chaves-Fraga et al. [1] and Simsek et al. [8] have abstracted the process to different levels and varying focus. Radulovic et al. [7] merely provide guidelines on

[5] We consider a KG to consist of a Tbox (terminology, schema) and Abox (assertions).

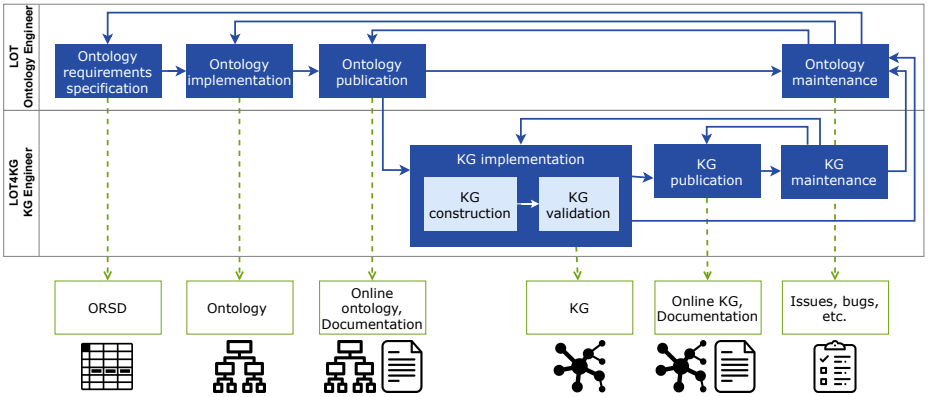

Fig. 1. High-level LOT4KG methodology overview with the LOT methodology [6] (top), and knowledge graph (KG) lifecycle (bottom).

what steps to take, and Chaves-Fraga et al. [1] describe the process they used when engineering a KG for research-performing organisations. Simsek et al. [8] abstract the process, which is where we take our inspiration for the proposed methodology.

Therefore, in this short work, we propose LOT4KG, which integrates the engineering of the schema as captured by LOT [6] and adds the engineering of KG into a joint methodology. Then, we discuss LOT4KG in the context of knowledge evolution and propose future research on integrating it into LOT4KG.

2 LOT4KG Methodology

The original LOT methodology [6] details the process of *ontology requirements specification*, *ontology implementation*, *ontology publication* and *ontology maintenance*, shown in the upper lane of Figure 1. Our extensions, the KG lifecycle (bottom lane), is described in detail further below.

We identify three high-level activities: *KG implementation*, *KG publication*, and *KG maintenance*, mirroring the LOT ontology lifecycle. The KG lifecycle starts after the publication of the ontology, so there is an activity flow from *ontology publication* to *KG implementation*. Unlike the ontology engineering process, no requirement specification activity is required: the ontology imposes requirements on the KG. *KG implementation* is analogous to the ontology implementation activity and describes the steps taken to construct the KG. We also distinguish lower-level activities: KG construction and KG validation, similar to [8]. During KG construction, we generate relationships between heterogeneous data sources and ontology terms using mapping languages (e.g., RML or SPARQL-Anything). In a separate step, SHACL shapes are generated, which impose constraints on the shape of the KG and are thus used for KG validation. The output of the validation activity may generate a refined version of the KG. These two activities may be divided into more fine-grained activities such as the generation of mapping rules, the transformation of input sources into

RDF and debugging. *KG publication* includes the publication of the KG and its corresponding documentation in human-readable format. The publication also includes not only documentation of the actual KG but also of the associated assets (e.g. documentation of RML mappings or SHACL) Lastly, *KG maintenance* is analogous to that of ontology maintenance. Issues and bugs are collected during a certain period of time, which, in turn, can trigger the implementation and publication of KG.

3 LOT4KG in the Context of Knowledge Evolution

In ontology and, consequently, in KG evolution, the need for change can come from different sources [11] other than from the process of fixing issues and bugs. These needs for change can be divided into two categories: (i) changes in business requirements, therefore, changes to ontology requirements, and (ii) changes to the underlying application domain, which needs to be represented by the ontology/KG [9]. Further discussion and deliberation are needed, as changes can also come from input sources, affecting the KG construction, depending on the changes and possibly the ontology. Such changes and update activities are not captured with LOT and not in LOT4KG at this point, although the methodologies are circular.

Therefore, as a research community, we need to evaluate how KG maintenance is done today and how it compares with known ontology evolution frameworks [11,10]. The activities that need to be discussed are distinct from ontology and KG implementation activities to the extent that the engineers are updating the already existing artefact rather than creating a new one. Hence, at the ontology level, we will be able to produce a list of changes [11,3] according to which the KG can be updated. In a KG update, not all mapping rules and validation shapes need to be regenerated. Those that are affected by the ontology change need to be adjusted, either automatically or with some expert input, and then the KG does not need to be regenerated from scratch, potentially saving resources and, in turn, being more sustainable.

4 Conclusions and Future Work

In this short article, we give a high-level overview of the LOT4KG methodology. We present a first-of-its-kind theoretical methodology, which is based on previous work for dealing with the KG lifecycle as a whole. LOT4KG presents an extension to the LOT framework [6]: the inclusion of the KG lifecycle, describing the general steps that are followed when creating a KG from a given ontology or schema. In the future, we plan to make a lower-level definition of activities available, similar to what is already published for LOT. Furthermore, we discussed how ontology and KG evolution compare to LOT4KG and how we plan to continue to extend LOT4KG to make the lifecycle firmly encompass the maintenance of the artefacts as well. This will lead to the definition of evolution activities on both levels, the ontology and KG. Implementations of the

KG lifecycle are also of interest; however, these can be highly dependent on the available infrastructure. More interesting is the investigation into the evolution activities, as tool support is, to the best of our knowledge, still scarce.

This methodology is the first of its kind to combine the lifecycles of ontology and KG. With the formalisation of such a methodology, we open up discussion on how ontologies and KGs are engineered today. LOT4KG also fosters further methodological research, as the Semantic Web community has to some extent mastered the engineering of ontologies and KGs but still needs to work on maintaining them over time.

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