A Source-agnostic Platform for Finding and Exploring Ontologies at Bosch

Lavdim Halilaj[1], Stefan Schmid[1], Khushboo Goutham Chand[2], Santhosh Kumar Arumugam[2], and Sahu Sajita Kumari[2]

[1] Bosch Center for Artificial Intelligence, Renningen, Germany
{lavdim.halilaj,stefan.schmid5}@de.bosch.com
[2] Bosch Global Software Technologies Private Limited, Bangalore, India
{khushboo.gouthamchand,santhoshkumar.arumugam,sajitakumari.sahu}@in.bosch.com

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1 Introduction

The usage of semantic technologies for purposes like data integration, information retrieval, search, and decision-making is steadily on the rise [10,2]. Bosch is leveraging these technologies to enhance the ability to represent, integrate, and query various data sources [7]. The main objectives are enabling data understanding, interlinking, and analysis [15]. To achieve this, a number of ontologies for various domains are developed over time, i.e. autonomous driving [9,14,7,5,6], manufacturing [8,13,3], smart home and IoT[3] [1,11,12]. These ontologies result from research and development activities carried out across several projects, groups, and departments. Subsequently, various stakeholders with diverse backgrounds and expertise are utilizing and repurposing the ontologies for their specific use cases and scenarios. Therefore, it is crucial that these ontologies, which may be hosted on different platforms, are easily discoverable and explorable by both humans and intelligent agents. This paper discusses how we at Bosch tackle the obstacles and barriers of finding and exploring ontologies by providing a source-agnostic solution. We underscore the ability to access and explore ontologies using user-friendly interfaces enhances comprehension, particularly for domain experts, thus facilitates the adoption of semantic technologies.

2 Approach

The objective of our platform is to serve as a centralized point for ontology finding and exploration and facilitate easy discovery, exploration, and reuse. For this purpose we designed the architecture illustrated in Figure 1 which is inspired by the approach presented in [4]. We extended it with the mechanisms to incorporate any SPARQL-based ontology repository, either hosted internally within Bosch or externally. Our approach enables users to search for relevant ontologies

[3] https://www.boschbuildingsolutions.com/xc/en/news-and-stories/building-ontologies

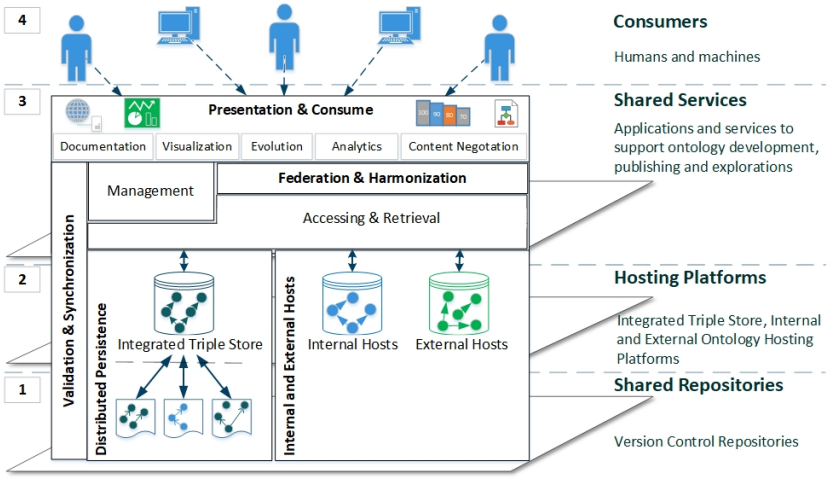

Fig. 1: Our solution comprises various layers: 1) *Shared Repositories* - git-based repositories for ontologies; 2) *Hosting Platforms* - triple-based repositories for ontologies; and 3) *Shared Services* - providing different services for management and exploration.

through various criteria, including domain, format, and language. Additionally, via dedicated views it is possible to check further how ontologies are interconnected to each other, thus supporting tasks for ontology mapping and alignment.

The architecture comprises three layers with a clear separation of concerns: 1) *Shared Repositories* - at the bottom layer various version control systems such as *git* can be plugged in. These systems are used to manage ontology development activities; 2) *Hosting Platforms* - contains internal and external hosted triple-stores where the ontologies are maintained or developed. Access to these stores is achieved through the standard SPARQL interface; and 3) *Shared Services* - offers a number of different functionalities related to the ontology finding, exploration, and analysis. Further, a separate module enables the administration of the system, including adding, configuring, or deleting hosting repositories. A simultaneous access to all sources of ontologies is realized via the distributed query processing mechanism. It sends queries, including user-provided values, to the selected sources and clusters the retrieved results into joint sets. These sets are then shown to the user as unified views, where additional filtering criteria can be applied. The functionalities are decoupled into two main components: back-end and front-end, allowing for an independent development and easier maintenance. To ensure the scalability and resilience of the platform, the following characteristics are implemented:

- Templated queries - enabling standardization and reusability of queries, thus saving integration time and reducing the risk of errors. They offer various placeholders for variables that are dynamically filled in at run-time according to the storage and representation characteristics of ontologies in the respec-

tive hosting repositories. Therefore, regardless of the underlying repository, each component can consume ontologies via a common interface.
- Configurable hosts - provide flexibility in deployment, and customization of features to be provided by each individual repository. This enables the platform to scale up by adding new repositories, thus facilitating the reusability and interoperability of ontologies for different domains.
- Extensible architecture - internally or of-the-shelf developed components can be easily integrated. This allows for extending its base functionalities with new features, such as ontology evaluation or evolution. As a result, users are able to have a more comprehensive view while deciding on the reuse of the ontologies for their applications.

3 Conclusion

At Bosch, we are utilizing semantic technologies to enhance the representation, integration, and querying of heterogeneous data sources. To facilitate ontology exploration, a source-agnostic platform is implemented serving as a centralized point for finding and exploring ontologies. At the moment, our platform serves more than 500 ontologies that are built inside Bosch. It also provides access to public external SPARQL endpoints, which serve more than 700 ontologies. At any time, new SPARQL endpoints can be added by simply specifying the connection details and defining a few SPARQL-based templates that resemble the way how ontologies can be accessed in the given source. On a daily basis, more than 100 users are accessing our platform to explore ontologies and the defined concepts.

Our ultimate objective is to simplify the process of ontology development and adoption by making it more efficient, cooperative, and accessible. A crucial aspect of this objective is to enable domain experts to have a better comprehension of ontologies. We support this through our platform by providing various views, such as visualization, documentation, hierarchical navigation, and connectivity.

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