ENGINE B

What's the difference between ontology and Knowledge Graphs?

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What's the difference between ontology and Knowledge Graphs?

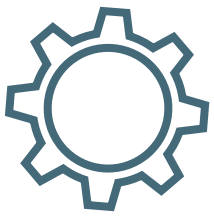
Domain knowledge is represented by the concept of ontology. The purpose of this paper is to explain what ontology is, how it's different from Knowledge Graphs, how it's related to a database, the way to connect ontology to databases by using queries (ontology to database and database to ontology), why it is important for business and ultimately, and to identify the gaps for improvement which remain to be explored in the future.

As previously explained in our recent article 'Deriving knowledge from Knowledge Graphs', a Knowledge Graph gives the user a much-needed context-driven view of complex data. It achieves this by acquiring and integrating nearby information using data relationships to derive new knowledge. This ability to connect data and define relationships adds great value to users, applications, and even machine learning models.

Now, having established a Knowledge Graph definition, we can deduce a clear link between data and knowledge. However, does this link still exist between data and domain knowledge too?

Let's answer this question in more detail.

What is Ontology?



Etymology: Ontology means the study of being and its history goes way back to when Pythagoras and Parmenides discussed the ontological categorisation of existence on 570BCE and 500BCE in respect. By analysing the components of the word, we understand ontology is about comprehending what exists in a particular domain and mapping it in detail.

Definition: By knowing the etymology of the word it is easier to agree with Gruber's definition as *"a representation of a shared, agreed and detailed model or set of concepts of a certain problem, domain"* (Gruber, 1993)

What's the difference between ontology and Knowledge Graphs?

What is the difference between ontology and a Knowledge Graph?

Very often these two concepts are mixed, as they both represent knowledge by displaying, in a similar way, how their components are connected. More specifically, in ontology, we have categories, properties and relationships between the concepts, data and entities. Similarly, in Knowledge Graphs, we have subgraphs, properties, relationships, data and vertices (nodes). However, there is a fundamental difference between them. A Knowledge Graph is a representation of knowledge in a graph form, which very often derives from a graph database (GDB) - a database that stores data by using a graph architecture. A Knowledge Graph and its database structure are focused on the applications we target to build. Therefore, they are defined by the task. On the other hand, ontology is defined from the domain knowledge, contains the definition of a concept and its relationships for a given domain as well as the domain rules.

From ontology to graph databases or from graph databases to ontology?

In both cases, we are using questions and queries to form ontology and GDB in respect. In the 'ontology to database' approach, business questions derive from ontology and are translated to queries which then form the graph database. In the 'database to ontology,' approach, database queries are translated to business questions which then form and update the ontological model. This is further clarified below:

Ontology-to-database approach

This approach is about formulating questions and queries (most of the query formulation systems are based on RDF structure) that support the specialisation or generalisation of the basic ontology concepts. These concepts can build database-specific queries, capable of designing a graph database that responds to the ontology and supports information retrieval for an application or a UI. Additionally, expert knowledge is stored in a form of questions to be answered. These questions expand ontology and add value to the relationships between the concepts.

What's the difference between ontology and Knowledge Graphs?

Common Data Model as a median

Then, a Common Data Model (CDM) is drafted, based on the defined ontology. A CDM presents what data entities, attributes and data types we need to answer the domain-business questions.

When the data is extracted and mapped into the CDM, we then translate the business questions to database queries. The necessity to answer these translated queries will give birth to the graph database structure.

Film production ontology example

With entities: Producer, Actor and Film, and Relationships: Producer_Invested_In_Film, Actor_Acted_In_Film.

A question could be; *Who is the most common producer in X actor's films?*

The relevant query should match and select all movies played by actor X, count the producers and return the one that appeared more often. Thus Producer, Actor and Film will be vertices (nodes) into the GDB with the following edges in respect; Producer_Invested_In_Film and Actor_Acted_In_Film.

As you can see in the below table, information about the entities' attributes can be retrieved from the CDM.

Entities	Attributes	Type
Producer	Name	Character
	Surname	Character
	Net worth	Numeric
	Film ID	Character
Actor	Name	Character
	Surname	Character
	Years of experience	Numeric
	Film ID	Character

Table 1.1

Entities	Attributes	Type
Film	Title	Character
	Release date	Date time (US)
	Budget	Numeric
	Profit	Numeric
	Film ID	Character

Table 1.1

Database-to-ontology approach

This approach formulates queries from a data perspective by storing all data from a data source as part of the ontology, the ontological instances or linking the data directly to ontology concepts (Hoang, et al., 2006).

Following this approach and to specify a domain ontology from a database query, it is required to represent the domain metadata (what we expect to see) along with the relationships of the underlying graph database schema, into the ontology schema.

Common Data Model as a median

Once we have the GDB schema, the CDM is used as a median in which the collected data is categorised into entities and able to form an ontological model. When the data is extracted and mapped into the CDM, we translate the queries to business questions, which gives birth to the ontological schema.

It is important to note that directly linking all database instances to associated ontological concepts may become both a complicated and time-consuming activity.

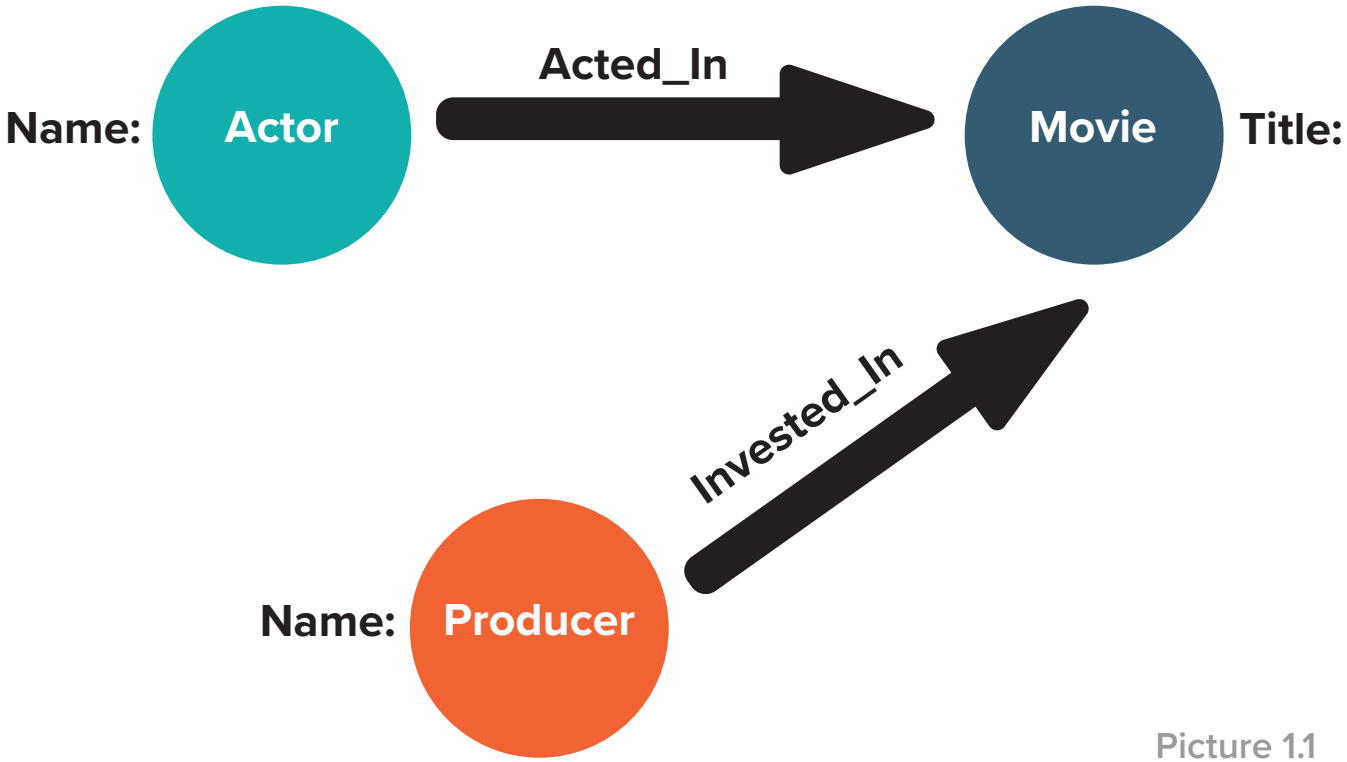
Film production ontology example

For example, an application or a user interface (UI) target returns information about who is the most common film producer per actor.

The match/select query(ies) needs to extract data such as actor names, producer

names and movie titles and how this data is connected. This forms a graph database schema that presents the requested data and how they are connected (Picture 1.1).

Under what entity and with what properties the data is populated with, is displayed in the CDM (See Table 1.1). The final step is to form ontological models based on the CDM information.



Picture 1.1

Why do we need ontology for effective business decision-making?

Ontology-based information retrieval acts as a communication medium, aiming to close the gap between database/query infrastructure and business questions. Writing structured queries is a powerful method to access data since it allows end-users to formulate complex database queries by learning specialised query languages. However, query formulation remains difficult for the various levels of systems users. Thus, a gap is created between domain knowledge experts and database knowledge experts. Ontology acts as a communication medium between different people, including users and developers, across different

enterprises but also between different implemented computational systems (including modules of the enterprise toolset, DBMS, spreadsheets etc.)

As ontology means the study of being or existing, we can realise ontological model's necessity to build a digital representation of a real-time (existing) physical object or process (digital twin).

In other words, ontology's representation can be used as a blueprint for a digital replication.

Ontology also intends to assist in the acquisition, representation, and manipulation of enterprise knowledge. Such assistance will be achieved via the provision of a consistent core of basic concepts and language constructs, structuring and organising libraries of knowledge, the explanation of the rationale, the transition of research knowledge and systems into operational prototypes, the analysis of the internal structures, algorithms, and inputs and outputs of implemented systems, in theoretical and conceptual terms (Uschold, et al., 1996).

As already mentioned, an important benefit of ontology is the interaction between data held in different formats which could potentially be used as the basis to guide and validate models of domains. According to (El-Ghalayini, et al., n.d.), a domain ontology can be mapped to a domain CDM. In other words, the transformation from a given domain ontology to a corresponding conceptual schema.

Finally, the idea of how computers and terminals can be used in business and society is changing from single isolated devices to entry points into a world wide network of information exchange and business transactions. The web converts personal computers from a data transformation machine to an artificial "body-cell" that ceaselessly shares information within the network. All data, information and knowledge are always stored inside the network and the only way for an application or system to retrieve them is by asking the right queries. However, asking the right question is subject to knowing the right set of concepts. These concepts are defined in ontology which provides a shared and common understanding of a domain that can be communicated between people and across application systems.

What's the difference between ontology and Knowledge Graphs?

Limitations and future work

Ontology of a specific domain varies across different areas, as with each ontological construction, new terms are developed that represent an ever-changing language (Tower of the Babel problem). For instance, in the legal field, the same concepts could have different legal ontological interpretation across different countries or different companies. Therefore, under this context, there is room for improvement, as further research towards a universal representation of the ontological concept in business culture and business law would hopefully solve this issue. Until then, a formulation of a Common Data Model dictionary can temporarily be a solution.

Conclusion

> **"Ontology closes the gap between concepts connected in a business area and how data is connected into a database."**

Ontology refers to the study of 'being' or 'existence' and an ontological model is a set of concepts of a certain domain. Based on their analytical value, ontological models can be used in business in many ways, from a communication tool to a domain's blueprint. As a communication medium, ontology aims to essentially close the gap between how data is connected into the database (data knowledge) and how concepts are connected in a business area (domain knowledge). As a "blueprint", ontology is used for processes' digital replication. It is easy for someone to confuse ontology with a Knowledge Graph because both are using similar components to be built but they are two fundamentally different concepts. Knowledge Graphs and graph databases derive from the task or the application, as opposed to ontology that is defined from the domain knowledge, contains the definition of a concept and its relationships for a given domain as well as the domain rules. This article mentioned two ontology formation approaches, both using queries as a tool. These are ontology-to-database and database-to-ontology. In both cases, a Common Data Model is used as a median between ontology and database communication. Finally, it is crucial to understand that since we are yet to construct a universal representation of the ontological concept, this issue can be temporarily bypassed by creating Common Data Model lexicons.

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Bibliography

Damljanovic, D., Agatonovic, M. & Cunningham, H., n.d. FREyA: an Interactive Way of Querying Linked Data using Natural Language, s.l.: s.n.

El-Ghalayini, H., Odeh, M., McClatchey, R. & Solomonides, T., n.d. REVERSE ENGINEERING ONTOLOGY TO CONCEPTUAL DATA MODELS, Bristol: Centre for Complex Cooperative Systems, CEMS Faculty.

Fensel, D. et al., 2000. The Ontology Inference Layer OIL, UK: Department of the Computer Science University of Manchester, UK, Vrije Universiteit Amsterdam, Holland, AIdministrator Nederland B.V.,AIFB, University of Karlsruhe, D-76128, Germany, Knowledge Media Institute, The Open University, UK.

Gruber, T. R., 1993. A Translation Approach to Portable Ontology Specifications. Knowledge Systems Laboratory, Volume 5(2), pp. 199-220.

Hoang, H. H., Nguyen, T. M., Andjomshoaa, A. & Tjoa, M. A., 2006. A FRONT-END APPROACH FOR USER QUERY GENERATION AND INFORMATION RETRIEVAL IN THE SEMANTICLIFE FRAMEWORK. Yogyakarta, Indonesia, DBLP.

Koepsell, D. R., 2000. The Ontology of Cyberspace: Law, Philosophy and the future of Intellectual Proeperty. Harvard Journal of law & Technology, 14(Chicago).
Mitra, P., Wiederhold, G. & Kersten, M., n.d. A Graph-Oriented Model for Articulation of Ontology Interdependencies, s.l.: Stanford University, INS CWI.

Munir, K. & Anjum, S. M., 2018. he use of ontologies for effective knowledge modelling and information retrieval. Applied Computing and Informatics, 14(07/08/2017), pp. 116-126.

Saha, D. et al., n.d. ATHENA: An Ontology-Driven System for Natural Language Querying over Relational Data Stores, s.l.: IBM.

Smith, B., 2003. Ontology. In: L. Floridi, ed. Guide to the Philosophy of Computing and Information. Oxford:: Bkackwell, pp. 155-166.

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Stojanovic, N., 2005. Ontology-based Information Retrieval: Methods and Tools for Cooperative Query Answering, Karlsruhe: Universitaet Karlsruhe.

Uschold, M., King,, M., Moralee, S. & Zorgios, Y., 1996. The Enterprise Ontology, Edinburg: AIAI, IBM, Loyd's, Logica UK Limited, Unilever.

Uschold, M. & King, M., 1995. Towards a Methodology for Building Ontologies, Edinburgh: Artificial Intelligence Applications Institute.

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Symeon Vasileiadis is a Knowledge Engineer at Engine B. An experienced data expert with an MSc in data analytics, Symeon's primary focus at Engine B is to design graph databases to optimise knowledge storage, information retrieval and data-pattern finding.

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