GeoReservoir Project – An ontology-driven standard for parametric similarity measurements of deep-marine sedimentary deposits

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Abstract
Integrating data for legacy repositories brings a complex task for professionals who must analyze a large amount of legacy data. Ontology is increasely becoming a useful tool to bring all data to a common semantic rule. Domain ontology allows petroleum geologists to bring the meaning of the terminology and clarify the common misunderstandings in data alignment. The GeoReservoir project intends to apply well-founded domain ontology to bring together a large collection of legacy geological data with a common analysis framework. A cooperation term between the Institute of Informatics of UFRGS and the PETROBRAS research center expands a previously existent framework of ontologies to support the application development of a turbidite deposit description and analytic system (SAGA). The domain ontology plays a central role in connecting user queries and back-end services, in a microservice architecture that keeps the independency of the database and the ontology resource for further evolution. The 4-year project is in the last year, allowing the corporate user to feed the system to support data analytics.

Keywords
Ontology-based system, data analytics, petroleum reservoir analysis

1. Introduction

Sand deposits in deep marine water – the turbidite deposits - represent the predominant type of petroleum reservoirs globally and have demanded strong exploration efforts to understand these bodies' spatial shape and distribution. The difficulty in understanding turbidite reservoirs is related to the depth in which the productive deposits occur, usually more than 1,000 meters deep, which prevents direct access or data collection. The alternative for learning about these geological deposits is studying analogous deposits in outcrops, despite these sand bodies having no potential for economic exploration.

Geology is still immature as a descriptive science compared to other Natural Sciences, and geological studies are mostly nonsystematic hypothesis-driven data collection that reflects the geologist's interpretation. The long-term result of this strategy is a large collection of studies and data produced by academics, researchers, and companies that describe turbidite sites worldwide under very distinct views of analysis. In the last decade, the industry and academy applied a large effort to bring this data to a reference model that allows uniform manipulation, as discussed in the studies of [1-6].

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GeoReservoir project (2021-2004) has the goal of evolving and applying a Geology descriptive ontology for turbidite deposits developed by Cicconeto [7] and colleagues [8, 9] based on GeoCore ontology of Luan Garcia [10, 11] and BFO [12]. Geological entities with distinct ontological identities and temporal stability were identified and labeled to form the ontology's core structure that supports our developments.

2. The ontology-based system SAGA

The ontology framework builds the core of a system that allows us to create a template for description and data analytics covering all aspects of sedimentation, geometry, and architecture of turbidite deposits. These resources allowed us to develop the software application SAGA (Geometry and Architecture Analog System) that guides the geologist in systematically describing sedimentary bodies in turbidite systems. The software supports capturing, storing, and analyzing empirical data from geological sites stemming from outcrop studies, seismic survey interpretation, and well data, with minimal loss of the geological meaning of the collected information. The captured data offers richer possibilities for queries, extraction of deposition patterns, or comparison between distinct occurrences.

Our software application offers three main functionalities (Figure 1):

- Geological site description: the data source may be a field study, a scientific paper, a previous research report, or a seismic study in a new block.
- Graphical simulation: this functionality allows geologists to create scenarios with hypothetical parameters to compare the geometrical distribution with some deposit of interest [13]. The graphical and mathematical simulation considers physical dynamic properties to generate near-real sedimentation.
- Data analysis: supports selecting and grouping records based on any ontology entity, property, relation, and associated values. The dynamically produced description cluster can be statistically compared.

SAGA follows the microservices architecture [14], where loosely coupled, independently deployable services that communicate over well-defined APIs compose the application. The architecture encompasses the front-end, back-end, microservices, and additional resources such as the Oracle database, domain ontology, shapefile files, etc., as Figure 2 shows.

Figure 1: Initial page of SAGA after user identification. The user can select a description by its geolocation (Left), input a new description (middle), or parametrize a new simulation (right).

The architecture keeps the independence of the front end, which receives user requests, and the back-end, which runs the microservices that deal with data and ontology. The architecture grants the evolution of the ontology to support more detailed geological descriptions or to expand covering other types of sedimentary deposits without missing the semantic enrichment or logical consistency. The SAGA application was tested, refined, and validated by users inside the corporate IT environment.

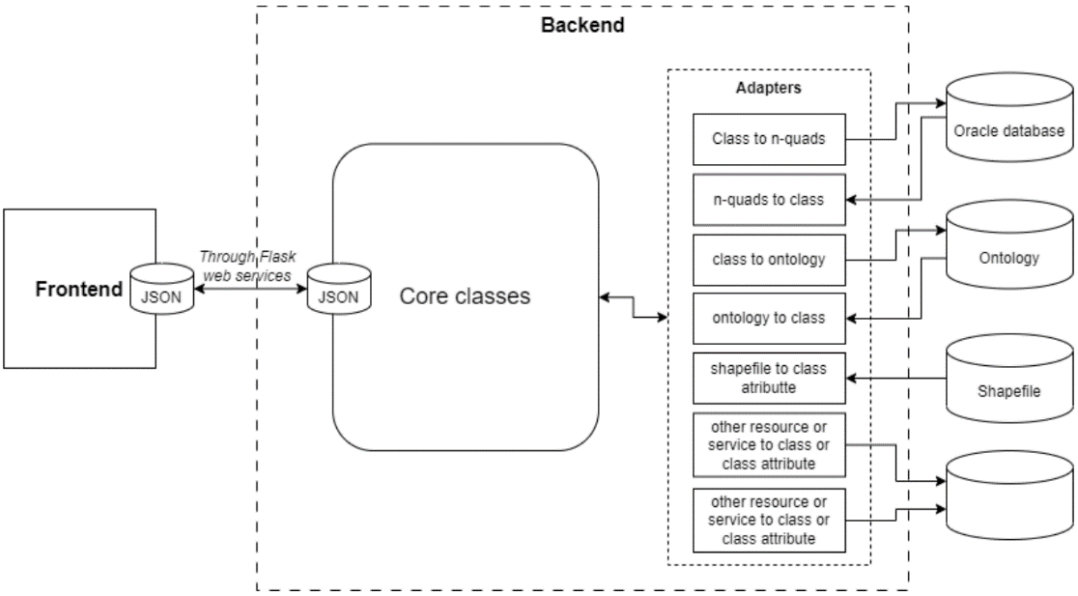

Figure 2: Schema presenting the communication architecture containing the back-end resources.

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A. Online Resources

The GitHub repository of the Intelligent Database Group shares the ontology artifacts in Portuguese and English.

https://github.com/BDI-UFRGS

The SAGA is not openly available for testing due to confidentiality issues of the cooperation term.