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

Joel Carbonera, Mara Abel, Tiago Agnes, Thais Almeida Empinotti, Luan Fonseca Garcia, Alcides Lopes Jr.
{joel.carbonera, marabel,luan.garcia,alcides.lopes@inf.ufrgs.br,tiagoagne, thaisealmeida@petrobras.com.br}

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 (McHargue, Pyrcz et al. 2011, Beucher, Bourges et al. 2013, Cullis, Colombera et al. 2018, Cullis, Patacci et al. 2019, Qu 2020, Tek, McArthur et al. 2022).

GeoReservoir project (2021-2004) has the goal of evolving and applying a Geology descriptive ontology for turbidite deposits developed by Cicconeto (Cicconeto 2021) and colleagues (Cicconeto, Vieira et al. 2020, Cicconeto, Vieira et al. 2021) based on GeoCore ontology of Luan Garcia (Garcia, Abel et al. 2020, Garcia 2021) and BFO (Arp, Smith et al. 2015). Geological entities with distinct ontological identities and temporal stability were identified and labeled to form the ontology's core structure that supports our developments.

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) :

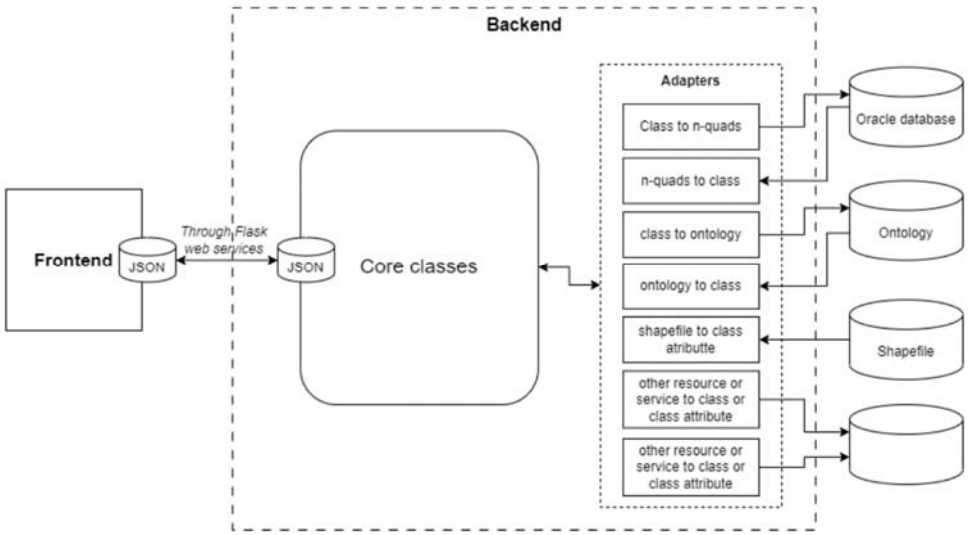
- Geological site description: the data source may be a field study, a scientific paper, a previous research report, or a seismic study in a new block.
- Graphical simulation: this functionality allows geologists to create scenarios with hypothetical parameters to compare the geometrical distribution with some deposit of interest (Bechlin 2021). 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 (Nadareishvili, Mitra et al. 2016), 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. 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.

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)

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



The GeoReservoir project is being developed through a cooperation contract with the Institute of Informatics of Federal University of Rio Grande do Sul (UFRGS) and the Research Center of PETROBRAS (CENPES), with the financial support of PETROBRAS. The SAGA application was tested, refined, and validated by users inside the corporate IT environment. The GitHub repository of the Intelligent Database Group[1] shares the ontology artifacts in Portuguese and English. The SAGA is not openly available for testing due to confidentiality issues of the cooperation term.

[1] https://github.com/BDI-UFRGS

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