

Towards a Well-Founded Domain Ontology for Offshore Petroleum Production Plants

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Abstract

The petroleum industry has many challenges to address when it comes to data handling. The vast number of companies that perform specialized services and use their proprietary software creates a challenging environment for managing whole chain field data. Thus, a significant effort has been made to provide a semantic framework for interoperability in the oil and gas industry, such as the ontology provided by ISO 15926, the integrated data platform from the Open Subsurface Data Universe Forum (OSDU), and standard glossaries such as the Professional Petroleum Data Management (PPDM) *What is a Well?*. Despite such an effort, accessing integrated data and reasoning over it remains an issue in the offshore environment. Service companies, operators, and platform leasing companies usually work together, each with its own siloed systems. Besides several interoperability problems, the lack of a uniform vocabulary for entities involved in the production process shows a problematic issue. Our work aims to build a domain ontology of offshore petroleum production plants to address this issue. The initial scope is material entities and their inhering properties, connecting the subsurface reservoir and topside equipment. By building the ontology, we intend to help solve modeling challenges common to ontologies in the industrial domain.

The development of the domain ontology is following the NeOn Methodology. In this proposal, we consider a collection of requirements defined in the format of competence questions. The ontology uses BFO as a top-level ontology and employs the core ontology produced by the Industry Ontology Foundry (IOF) and GeoCore as middle-level ontologies. We build the ontology after textual definitions for the terms of the domain provided by ISO 15926-4 and other publications or glossaries from the oil and gas industry (e.g., Petrowiki, SPE, API, PPDM). The ontology will provide first-order logic definitions of concepts from the domain and enables query answering related to production and injection data from wells. We intend the ontology to rule the tag definitions on monitoring systems, provide labels for annotating databases from different providers, allow unified queries over various sources, and expand the semantics involved in machine learning applications.

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Up to now, we have performed a meta-property analysis following OntoClean methodology to guide the initial taxonomy construction. The author acquired 59 competence questions (at present) and 26 initial modeling terms after eight initial one-and-a-half-hour interviews with professionals from the partner industry. Formal definitions for the terms are in development. The author started classifying each of the acquired terms following BFO guidelines and associating the terms with possible specializations of GeoCore and IOF-Core.

This research is part of a joint industry-university project to develop a digital twin for production optimization for the petroleum industry. The ontology is under the process of formalization and logical consistency validation. We have scheduled a new round of interviews with stakeholder groups to validate the definitions. The further validation step corresponds to applying the developed ontology to a use case from a production facility plant located offshore of Southeast Brazil.

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