Towards an Open Translation Environment for Supporting Translators in the Materials Domain

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Abstract

In this paper, we report on the current state of the development of the Open Translation Environment (OTE), which is based on the Elementary Multiperspective Material Ontology (EMMO) – a top-level ontology for applied science, to support Translators in the Materials domain. We describe the conceptual architecture of the OTE, as well as some of its main components.

Keywords

Open Translation Environment, EMMO, Materials domain

1. Introduction

Industry 5.0 is set up around human-centric approaches for directing innovation with a focus on sustainability and resilience. Shared value is created for globally distributed stakeholders who are involved in highly cooperative, interactive and interdisciplinary processes comprising innovative products and services. In the framework of such global and holistic value networks, the granularity of the Translator role is being shaped [1] for profiting from the expertise of persons who provide kind of a communication-based glue between the involved stakeholders [2]. Innovation challenges for manufactured products are launched by needs that are expressed by users and are of relevance to the entire product lifecycle in the global ecosystem (cf. Figure 1 - left). Translators, especially in the materials domain, are experts who address the translation of an industrial need into a solution by identifying missing data required to solve the challenge. They utilize their expertise and knowledge to process input data provided by product creators

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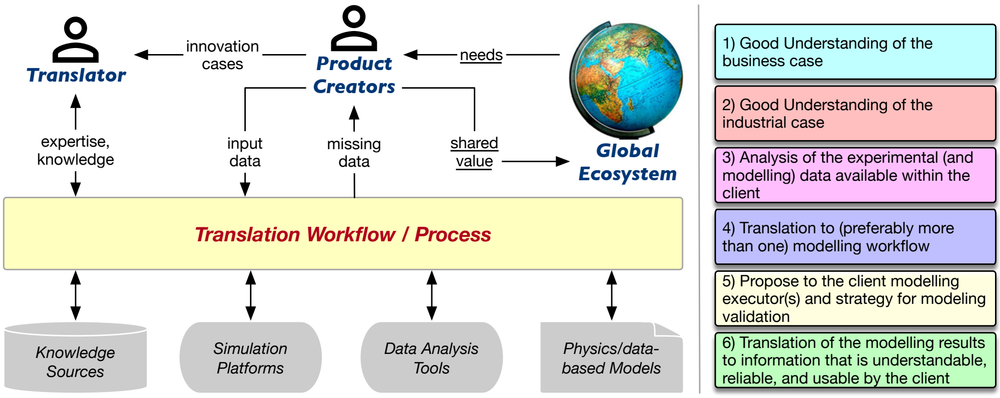

Figure 1: Translator contributions in industrial value creations (left); and the six universal steps of the translation process in materials modeling (right)

into the required information. In the process, they typically utilize state-of-the-art knowledge, models, and tools (e.g., open simulation platforms - OSPs).

Partners in the EU H2020 project OntoTrans develop an Open Translation Environment (OTE) to support Translators in the identification and collection of missing data, in building up knowledge for boosting innovation. We aim to assist *OntoTranslators* (i.e., Translators empowered by OTE) to conceptualise and ontologise the specific innovation case profiting from support by semantic technologies along all the six steps of materials modeling (cf. Figure 1 - right) following a workflow that is fine-tuned for each innovation case. OntoTranslators activities are greatly supported by the EMMO (Elementary Multiperspective Material Ontology) [3] and dedicated domain and application ontologies; safeguarding semantic interoperability in such way yields product innovation based on FAIR (Findable, Accessible, Interoperable, Reusable) principles for all data (and notably metadata) and knowledge involved. The tools provided by the OTE expose interfaces towards an overarching innovation ecosystem that comprises European Materials Modelling Marketplaces (MMM; e.g., VIMMP, MarketPlace, DOME 4.0) and Open Innovation Platforms (OIP; e.g., OpenModel, VIPCOAT and MUSICODE) [4].

2. An Architectural View of OTE

For providing the required assistance to the OntoTranslators, the OTE consists of several interconnected key components as shown in Figure 2: (i) *OntoKB and OntoREC*, RDF-based solutions for storing, inferring, and accessing relevant knowledge and its context information; (ii) *the OTEAPI framework*, an interoperability solution for facilitating information exchange between OTE internal and external components; and (iii) *the Exploratory Search System (ESS)* that provide a graphical intuitive access to relevant information for the involved stakeholders.

These components are semantically connected via a common ontological framework built on top of EMMO [5]. EMMO is a top level ontology designed to meet the needs of applied sciences and provides a solid theoretical basis for the ontological framework of the OTE. EMMO allows to describe the world according to different perspectives. This flexibility is essential because the OTE targets applied sciences in general, with all its different scientific communities that have their own way to describe the physical real-world system of interest.

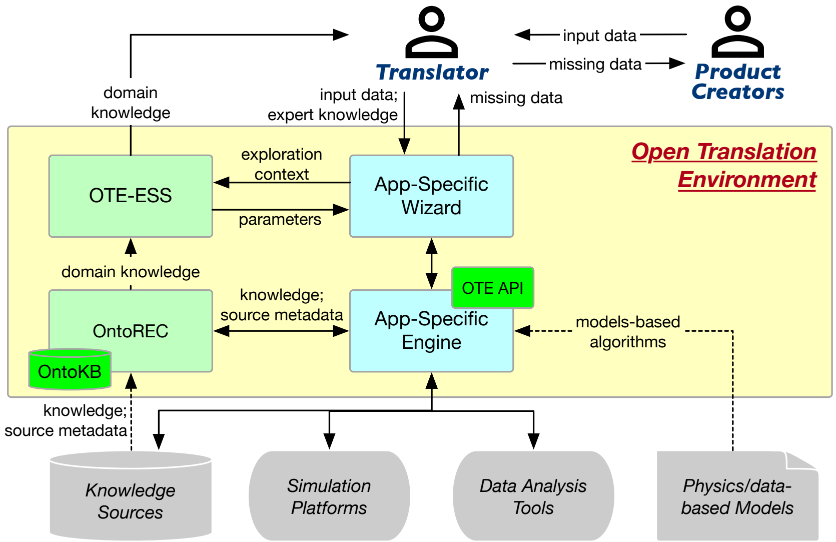

Figure 2: An architectural view of OTE and its components; Green boxes represent key elements of OTE while blue boxes are user application (app-) specific components

OntoKB is responsible for storing and querying ontologies. Differently from classical databases, OntoKB enables the inference of new information through an internal reasoning engine that currently supports several levels up to OWL2 DL; to this, it hosts an RDF triplestore as knowledge storage. Presenting itself as an interoperability layer, OntoKB does not store any raw data, but data models and mappings associated to raw data. Each data model defines the structure of the raw data (e.g., which property refers to which real data point set) and provides a binding for retrieving values from versatile remote datasources. **OntoREC**, as a proxy for OntoKB, provides a controlled access point to main features of the OntoKB triplestore, enables reasoning recommendation and is implemented as a containerized Web service exposing REST APIs. Each endpoint interacts with OntoKB's SPARQL endpoint through the HTTP protocol and we implemented it agnostical to the specific triplestore vendor: this limits the effort required to update OntoREC modules in the event of changes in the underlying triplestore technology.

OTEAPI[1] provides a set of interfaces enabling the OTE to perform a two-way exchange of knowledge between resources, both external and OTE internal resources. OTEAPI is a RESTful Web API for connecting data consumers to data resources through pipelines of sequentially connected, small, modular components (or filters) that allow to download, parse, map, filter, convert and process data from a source. The filters can be reused and combined into new pipelines for other data resources or needs. The pipelines themselves are also reusable and can, at a next level, be combined into workflows. For this to work, OTEAPI relies on an underlying interoperability framework. By itself, OTEAPI is agnostic to the choice of interoperability framework; we make use of SOFT/DLite [6], which is a lightweight interoperability framework based on simplistic data models. For Translators and Product Creators, the combination of OTEAPI and SOFT/DLite lowers the threshold of onboarding new data resources by a clear

[1]https://github.com/EMMC-ASBL/otelib/

separation of data models that are easy for data engineers to work with, and ontological mappings expressed as simple RDF triples. The use of ontologies provides very powerful transparent conversion between data models as well as semantic data discovery.

An **Exploratory Search System (ESS)** enables users to find information or learn about a topic in an interactive style. Integrated with an OTE-like system, the ESS actively helps Translators with expertise about the business and industrial use cases to discover information satisfying their requirements. There are three main components of OTE-ESS, which is adapted from the original ESS approach [7]: (i) **Knowledge Graph (KG) Access,** providing three well-defined interfaces: (a) SPARQL for read and update queries, (b) full-text search for keyword searches, and (c) a Gremlin interface for KG traversals; (ii) **Exploratory Search Microservice** operates on a KG via the three interfaces mentioned above, providing an API exposing exploratory search and analytic services over HTTP, which can serve general information retrieval tasks, or questions about the semantic structure of the KG such as centrality or similarity metrics; and (iii) **Exploratory Search Interface,** the web interface consumes the microservice's API and is highly configurable. The layout and Graphical User Interface (GUI) components employed when exploring resources are fully adjustable. This adaptive architecture makes it possible to support multiple use cases and domain models without additional (re-)engineering efforts.

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