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Ontology-based reasoning applications for mineral exploration and hazard mapping

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Many artificial intelligence (AI) applications in the geosciences are constrained by interoperability problems. The use by researchers of different complex non-standard earth science taxonomies constitutes one of these problems. Different ways in which these taxonomies can be combined to build problem-domain ontologies, necessary for AI reasoning, constitutes another. Data interoperability standards for earth sciences established by the EU's INSPIRE directive address the problem of non-standard taxonomies. Standardising ontologies for the earth sciences is, however, still in its infancy. Consequently we report here the building of our own problem-domain ontologies to enable problem-solving based on large earth science datasets.
In this study we demonstrate software that mimics the reasoning of human experts solving problems in minerals exploration and hazard mapping by comparing data (instances) to theories (models), both described in semantic networks. Four types of comparison can be made, each being appropriate for different kinds of problem solving: instance to instances, instance to models, model to models, and model to instances. In mining industry applications we work with mineral deposits, mineral occurrences or arbitrary locations (instances), and ore deposit models (models). In the field of natural hazards we work with points, lines or polygons (instances) which may be susceptible to different landslide types (models). The software reasoning includes probabilistic qualifiers (always, sometimes, etc...) for model properties and true-false statements for instance properties. It is able to explain its reasoning, and provide advice in certain contexts.
It is concluded that ontological standardisation of instances and models can significantly increase the speed, reliability and explainability of AI applications in minerals exploration and hazard mapping. By embedding these applications in a user-friendly interface, ontologically-based AI applications can also improve the understanding of these complex geological problems by minerals exploration decision makers, hazard insurance companies and other, possibly non-specialized, interested parties.