

Combining Ontologies and Machine Learning to Capture Tacit Knowledge in Complex Decision Making

Yiannis Gatsoulis, Owais Mehmood, Vania Dimitrova, Anthony G. Cohn
School of Computing, University of Leeds

Complex decision making in domains with high impact, such as infrastructure management, is a challenging task that requires the consideration of a large number of parameters and their dependencies. For example, in the case of tunnel management, accurate pathology diagnosis and early risk assessment are critical for making cost effective maintenance plans. The common practice is that such decisions are made by a small number of domain experts, who follow their intuitions and apply tacit knowledge gained over many years of experience. This results in unsustainable subjective decision models, where knowledge can be lost when experts leave.

We tackle these issues in the context of tunnel management within the EU project NETTUN (nettun.org). Following ontology engineering methodologies, we have engaged domain experts with extensive experience in tunnel management in a knowledge elicitation process to identify the concepts they investigate and the rules they apply when diagnosing a tunnel. Our tunnel diagnosis ontology, which is the first of its kind in this domain, was presented at UKON2015 and ESWC2015.

We will present a follow on of this work. Ontological models can have some limitations. Firstly, they may not be able to capture the true complexity of the decision process. Then, the process of validating these models is an important one, but laborious and slow. It is hard to identify missing or inaccurate rules, and some rules are 'more reliable' than others, but experts typically cannot articulate this information. Furthermore, there are aspects of the decision process, such as risk assessment and potential for further degradation of tunnel portions, which take into account a number of parameters so that experts are unable to elucidate.

To address these challenges, we adopt supervised machine learning models, taking advantage of the existence of provenance data with past observations and expert decisions. We use the ontology to enrich the feature space for machine learning methods that derive risk assessment rules and extend the knowledge model. We are also adopting machine learning to learn rules that may be applied to assess the pathologies, so that to facilitate ontology validation.