Towards Knowledge Structuring of Sensor Data Based on FCA and Ontology

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Abstract

With the rapid development of sensor technology, sensor web is increasingly found in all kinds of fields. Modeling the sensor web is a key issue if one wants to achieve efficient sensors network interconnection, sensors resources access, sensors maintenance, etc. Such a model requires various stages: first, ontologies must be defined to represent knowledge of the application domain; then, modeling techniques such as semantics and data mining can be used to predict sensor defects, access, etc. These stages exploit the observed sensor data, which may be very large. Automating the ontology extraction process is key in the face of data volumes and domains variability.

In this paper, we focus on the first stage of designing the sensor equipment ontology, by using the Formal Concept Analysis approach. This ontology will allow sharing knowledge on the sensor equipment, reasoning on its spatial, temporal, and thematic characteristics and constraining further models for better performances (this last point will not be described in this paper and is left for further research). FCA allows extracting the ontology on the basis of observed sensors data: this ontology will directly model concepts and concept hierarchy, through their properties rather than the designer. We illustrate the approach through a small dataset from a drilling platform scenario. First, we initialize an empty set of concepts and properties; we can also get some sensor observations and properties. Second, we create a concept table and add concepts and properties to that table. Third, we use FCA to visualize the lattice of concepts with their properties. Finally, based on the visualization, the designer can assess the ontology or its parts: he can modify it by adding or removing a concept or a property, assigning a property to a concept or removing a property from a concept, until the ontology matches his knowledge domain and fulfills its objective.

By using FCA to design sensor equipment ontology in the drilling platform domain, we show that more implicit concepts and their relationships can be represented for a web sensor network. We believe that this approach can lead to better ontology than previous methods of building semantic sensor web. This preliminary work will be further extended to include the other three ontologies (sensor network, sensor data and sensors), based on a larger data set from a real-world drilling platform.

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