# An Implementation of the CIDOC Conceptual Reference Model (CRM, ver. 4.2) in OWL-DL

Guenther Goerz, *University of Erlangen-Nuremberg, Germany*
Martin Oischinger, *University of Erlangen-Nuremberg, Germany*
Bernhard Schiemann, *University of Erlangen-Nuremberg, Germany*

CIDOC's CRM has been introduced as a formal reference ontology with particular focus on cultural heritage documentation. Meanwhile acknowledged as an ISO standard, one of its main goals is to facilitate interoperability betwenn data and database schemata for which impressive examples have been given. In order to take full advantage of the benefits offered by CRM, an implementation in a modern knowledge representation language has been a desideratum for quite a while.

Suitable candidates for very expressive knowledge representation languages are description logics. They are attractive as languages for formal ontologies not only due to specific language constructs designed for this porpose, but also because their inference problems are decidable and very efficient reasoners are available for them. A dialect of the Web Ontology Language, OWL-DL, based on XML and RDF/RDFS(FO) within the Semantic Web language hierarchy, is equivalent to a very expressive description logic. Furthermore, extensions to incorporate rules, e.g. SWRL, which further increase its expressive power, are currently under development.

To satisfy the needs arising from practical applications, we have developed an implementation of the most recent CRM version in OWL-DL. We describe our approach to formalize the definition of the CRM as given in the latest update of the standard document and demonstrate its functionality by means of an extended example. Nevertheless, a critical investigation of the scope notes in this document shows that the description of intricate semantic problems in common language is not only error-prone, but also in danger of vagueness and a certain degree of ambiguity - despite all effort in the precision of argumentation. Therefore, a clarification via translation into a logic-based language can be achieved; it also offers an opportunity to uncover methodological problems. In fact, with the exception of a few places which reach beyond the realm of standard logic, as e.g. defaults, most of the issues which cannot be covered in a formal way in general are related to semantic issues in the domains and applications to be modeled. We will discuss problems of formalization of the scope notes on the basis of some typical examples, and, furthermore, point out some problems in the design of the CRM which may lead to future improvements.

As a practical application example, a comprehensive XML database

containing documentation of sculptures up to 1800, as supplied by the German National Museum in Nuremberg (GNM), has been turned into a domain ontology for which CRM/OWL serves as a foundational reference ontology.

We have successfully achieved an implementation of the CRM in OWL-DL which covers the given specification as far as it can be formalized in logical terms, and given evidence of its usefulness in a practical application.  Further improvements and extensions, e.g. towards a meta-CRM to be able to deal with generics and simple cases of default reasoning, are already taken up.