Ontology-driven Geographic Information System and `dlvhex` Reasoning for Material Culture Analysis

Alessandro Mosca, Diego Bernini

Department of Computer Science, Systems and Communication (DISCo)
University of Milan - Bicocca, Viale Sarca 336, 20126 Milano, Italy
{alessandro.mosca, diego.bernini}@disco.unimib.it

Abstract. The problem of performing specific reasoning tasks on large ontological knowledge bases is a challenging issue both for the Semantic Web and the KR&R community. One way to meet the challenge is to try to design and implement systems that are able to exploit the descriptive capabilities offered by Semantic Web languages, in conjunction with the reasoning power of logic programming systems.
The present work is about the design of a system that integrates an ontology-driven Geographic Information System (GIS) with a `dlvhex` classification system, in the archaeological research domain of the material culture analysis. 'Material culture' is a generic term used to describe objects produced by human beings, including buildings, dwellings, tools, weapons, utensils, and artistic creations. Material culture is the main source of information about the past, and the artefacts classification represents the inescapable starting point for studying archaeological cultures and chronological aspects of settlement dynamics in specific spatio-temporal contexts.
The ontological counterpart of the Geographic Information System (GIS) is devoted to supply the logic-based classification system with a unitary well structured view of all the (domain dependent) information that come from a number of distributed and heterogeneous sources (e.g. university departments and labs, scientific articles, scholars' web homesites, museum repositories and archives). Instances of the introduced ontology represent ceramic artefacts, characterized by having explicit geospatial coordinates, a GIS is able to visualize and exploit for further quantitative analyses (e.g. buffering, overlaying, networking).
The paper also discusses the representational issues related to the design and the implementation of the classification system, whose main components are: (i) a meta-model, concerning the set of the epistemic dimensions by means of which the ceramic entities are studied; (ii) a mereological theory, devoted to the representation of the ceramic artefacts internal structure; (iii) a classification module, containing a set of classification heuristics that depend on the domain of interest and on the involved research community.
The system has been designed with the help of the Department of Archaeology of the University of Bologna (Italy) and tested, with encouraging results, on a large dataset of ceramic findings of the Bronze Age Northern Italy.