Design of Ontological Data for Data Navigation and Media-Rich Document Display Application

Tatiana Malyuta, Insook Choi, and Robin Bargar
New York City College of Technology of the City University of New York
tmalyuta@citytech.cuny.edu

The initiative of the Downtown Brooklyn project is to prototype a media-rich interactive navigation system in a media-rich document environment. To assume an urban environment such as Downtown Brooklyn as a content base, the system must support documents of different types that can be stored and reproduced in digital formats, such as photographs, moving images, drawings, architectural plans, text documents and sounds. The main objectives of this project include:

- Implementation of a navigation system guided by ontological data.
- Interactive media-assisted query and documents display in a multimodal environment.
- Extensible data model that affords efficient incorporation of rapidly-developing urban data.

System Description

The prototype system differs in several respects from mainstream map-based information systems. The primary mode of accessing documents is through semantic coordinates rather than map coordinates, and the user interface is anchored by a visualization tool for navigating semantic space. Documents and visualizations are displayed dynamically on multiple screens by a digital media signal processing system that schedules the timing, sampling and sequencing of images and sounds based upon semantic relevance. Ontological data design increases the capacity for prioritization of signal processing resources, facilitating the implementation of a concept that requires time-critical parallel access to multiple documents of multiple types.

In terms of data representation for users of the system, two approaches benefit directly from the data design methodology:

- Visualization of semantic space and its correspondence with map-based coordinates of individual documents; and
- Representation of the semantic interests of multiple users traversing a shared virtual model of a complex urban environment.

These representations are assisted by the application of ontological data design for modeling the profiles of the users, the semantic interests in the document resources, and the metadata of the documents about the urban environment.

Data Design

Design of meta and ontological data (see Figure 1) is provided based on the following approach. The system supports documents of different types. We consider documents *data*. Documents are modeled with the help of the class <`Document`> and subclasses of this class that represent documents of specific types, e.g. <`PhotoDocument`> and <`ArchitecturalDrawing`>.

Except for several basic features, different features of interest (attributes) of documents are modeled not as properties of the document classes but as separate classes. The general class <`Attribute`> has subclasses: subclass <`Common`> of attributes relevant for documents of each type and the subclasses of attributes relevant for documents of different types, e.g. subclasses <`PhotoSpecificAttribute`> and <`ArchitectureSpecificAttribute`>. Within each subclass of attributes we may define additional superclass-subclass hierarchies of attributes, e.g. common attributes contain as a subclass <`Location`>, which in turn contains subclasses <`Street`>, <`CrossStreet`>, and <`District`>.

All documents share a few basic properties e.g. <DateOfDocument>, and they can be related to the leaf <Common> attributes. Documents of each type are related to their leaf <Specific> attributes. We consider documents' attributes *metadata.*

Documents of different types also are made related to each other with the help of various relationships between attributes. We call such various relationships of interest between attributes *ontologies* because these relationships define meaningful associations between documents. These relationships are asserted as separate knowledge. Each ontology is based on one or more conditions involving attributes; such conditions constitute the *ontology contents*. Ontologies define additional classifications of documents. For example, a user may want to see documents of different types related to the 'Business district' of Downtown, where the concept of 'business' district is defined based on the values 'Downtown' and "Metrotech' of the metadata attribute <District>.

Profiles and Invariants

To enforce documents search, the system supports several user *profiles* that reflect different users' interests. The system defines several *invariants* that participate in building the profiles; each profile is defined by invariant ontologies. For example, for the 'District' invariant, the profile 'Architecture Preservationist' is related to the ontology 'Historical district', while the profile 'Real Estate Developer' is related to the ontology 'Business district'. Document navigation and search are performed from profiles to invariant ontologies, then to other ontologies and metadata, and from there to the documents.

We consider hierarchies of attributes, ontologies, profiles, and invariants *ontological data*. Such design of meta and ontological data has several advantages: integrity of metadata, flexibility of modifications and expansion of meta and ontological data, and better utilization of OWL features by the reasoning mechanism.

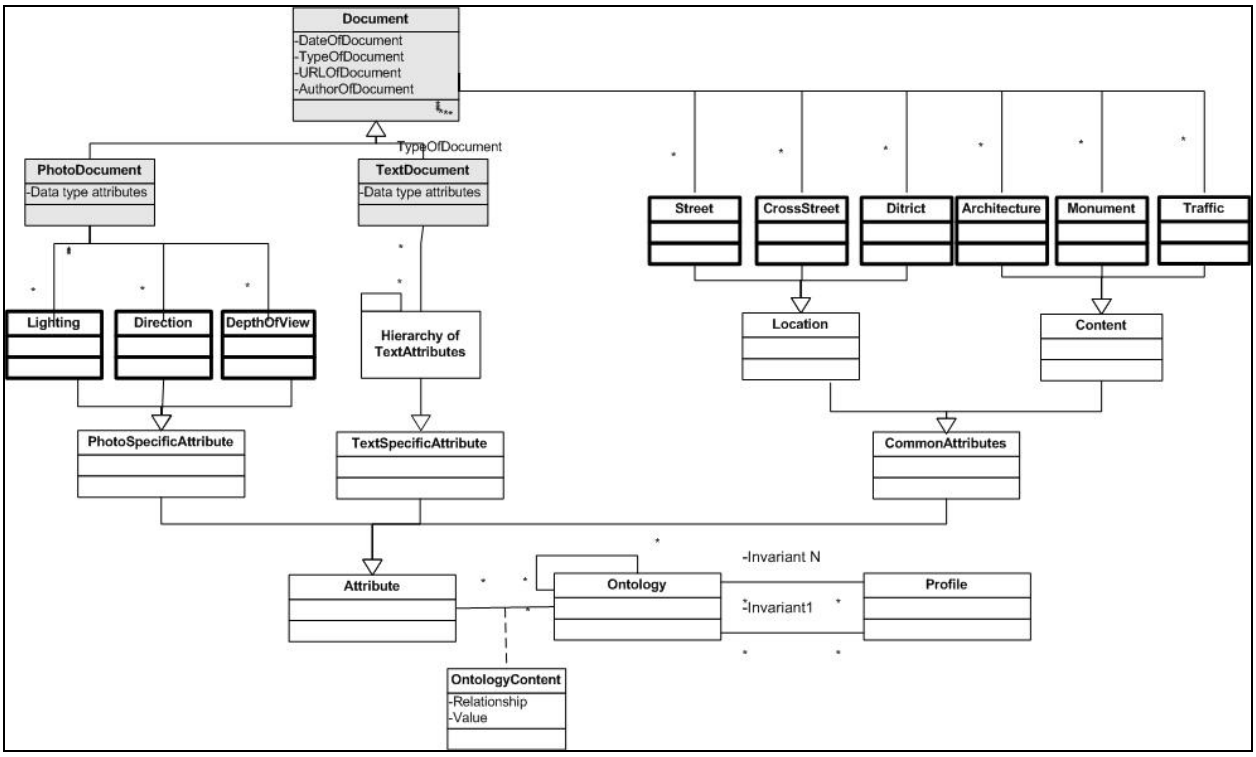

Figure 1. Design of meta and ontological data.