SUPPORTING MULTIPLE REPRESENTATIONS WITH SPATIAL DATABASES VIEW MANAGEMENT AND THE CONCEPT OF "VUEL"

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ABSTRACT

Fulfilling the needs of spatial database users may require the capability to describe a same reality according to different points of view as well as different abstraction levels. This is the case for example of web-based systems that supports "maps-on-demand" (MOD) and systems built for the interactive exploration of spatial data (SOLAP: Spatial On-line Analytical Processing). Such systems, if they are built from a unique spatial database, must offer different geometric representations for a same real-life feature, different cartographic semiologies for a same geometry, different semantics for a same map element, etc. The challenge is even higher when the system must support multiple map scales and the semantic generalizations/aggregations that are part of its database conceptual schema. Doing so requires a flexible database view engine that supports simultaneously geometric multiplicity, semantic multiplicity and graphical multiplicity (i.e. supports different combinations of geometry, semantic and graphical semiology). This DB view engine must support such multiplicities at the class and occurrence levels in order to add extra flexibility for the user. Additionally, as the user navigates from one database or map view to the next (eg. views at different abstraction levels and epochs), it may become very useful to keep a trace of the database navigation operations in order to facilitate backward navigation. This is especially needed for the SOLAP applications used for geographic knowledge discovery.

The proposed paper will present the requirements specific to MOD and SOLAP with regards to their impact on multiple representations. In particular, fundamental concepts about geometric, semantic and graphical multiplicities are defined. Then, we will introduce an innovative concept aimed at solving these requirements: the VUEL (View Element). Vuels are defined as the primitives of spatial database views similarly to the way pixels (picture elements) are defined as the primitives of digital images. The application of vuels to maps, tabular reports, statistical charts, images and other viewing mechanism is discussed with special emphasis on maps in a multiscale SOLAP context. In particular, we will present a metamodel that is central to the vuel concept. This metamodel is built with the Unified Modeling Language (UML) and based on a multidimensional database paradigm. In this metamodel, the vuel is presented as a fact table linking three dimensions: semantic, geometric and graphical. According to this metamodel, the vuel becomes a way to record all types of multiple representations and the metamodel itself becomes the structure of a spatial database view engine supporting multiple representations. Accordingly, a spatial database view (eg. a map) becomes an aggregation of vuels.

We believe this new solution is a step towards very flexible systems that can offer different representations at different levels of abstraction, such as SOLAP and the ideal MOD. The vuel concepts allows a system to go further than taking into account only the geometric aspect of the data without considering their graphic or semantic aspects. For instance, at a small scale, an element can be represented with a simple geometry (point) and defined with a general description (construction). But, for a larger scale, the same element can be represented with a more complex geometry (polygon) and associated with a more precise semantic (house). Moreover, some applications have their own semiology rules that govern the way that objects must be displayed. So, the ability to store these rules and display the same object according to different semiologies results in a database that is more adapted to the user's needs. Furthermore, unlike several of the existing solutions, the proposed structure is not only based on multiscale aspects but also takes into account the possible multiplicities for a same scale. A spatial database used by different applications or in different contexts may offer different geometries with the same level of details (which can or cannot be derived from each other). For example, some organizations make analysis about houses according to their roofing while others use them according to their foundations.

Finally, we will present how we tested these theoretical concepts to support multiple representations at the occurrence level and at the class level, and to support geometric as well as semantic and graphical multiplicities. A working prototype, developed during the MSc research of the second co-author and using real data coming for the Quebec Topographic Database, will be presented live.

KEYWORDS: GIS, VUEL, multiple representations, multidimensional database, SOLAP, spatial database view

BIOGRAPHICAL SKETCH

Dr Yvan Bédard is professor in GIS and Spatial Databases at Laval University since 1986. He was the founding director of the Centre for Research in Geomatics and is an active member of the Canadian network of centers of excellence GEOIDE. His research in automatic generalization and multiple representations stemmed from his research in spatial database, Spatial On-Line Analytical Processing and Map-on-Demand where on-the-fly generalization can be achieved mostly by proper utilization of multiple representations. Dr Bédard also chairs the WG-IV/1 of the ISPRS.

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