Multi-representation in spatial databases using the MADS conceptual model

Christelle Vangenot
EPFL
Database laboratory

ICA Workshop on Generalisation and Multiple representation – 20-21 August 2004 – Leicester
MADS is a conceptual model ...

- ER conceptual

ER model

conceptual schema

logical schema

OO DB

relational DB
A diagram illustrating the concept of spatial and temporal attributes in the context of river flows and reservoirs. The diagram includes:

- **Spatial attributes**:
  - Spatial object type: River
  - Space varying attribute: Temperature $f(\sim)$
  - Time varying attribute: Quality $f()$
  - Synchronisation semantics: Small, Big

- **Topological semantics**: Flows

- **Life cycle**

The diagram shows relationships between different river segments, including main, tributary, name, and reservoir, with associated attributes and semantics.
Objectives

- Add Multi-representation facilities in the MADS conceptual model

- Considering the following facets:
  - Resolution
    - level of detail for spatial and thematic data
  - Viewpoint
    - user perception of real world
Multi-Representation Modeling

- Two strategies:
  - Multi-representation strategy
    - Integrate representations in a single data structure
  - Inter-representation strategy
    - Link representations with a link with an inter-representation semantics

- Stamping
  - (Builder, 10)
  - (Risk manager, 50)
### Multi-representation strategy

<table>
<thead>
<tr>
<th>Road</th>
<th>Road</th>
</tr>
</thead>
<tbody>
<tr>
<td>number: (1:1), integer</td>
<td></td>
</tr>
<tr>
<td>name: (1:1), string</td>
<td></td>
</tr>
<tr>
<td>adm.class.: (1:1), integer</td>
<td></td>
</tr>
<tr>
<td>type: (1:1), string</td>
<td></td>
</tr>
</tbody>
</table>

**Stamps**
- (Builder, 10)
- (Risk manager, 50)

**Route Napoléon RN17**
Multi-perception relationship

- Multi-perception relationship “Adjacent”:
  - Adjacency of buildings and roads is described for red and blue stamps
  - *Adjacent* relationship may contain different sets of attributes according to stamps
Multi-perception relationship (2)

- Mono-perception relationship “Adjacent”:
  - Adjacency of buildings and roads is described only for instances of Building are linked to which instances of Road
  - Transactions having only the stamp do not see which instances of Building are linked to which instances of Road
Multi-perception hierarchy

Tourist Site
- Name: (1,1) Str
- District: (1,1) Str
- District: (1,n) Int

Museum
- Entrance: (1,1) •
- Exhibition: (0,n) Str f(◯)
- OpenTime: (1,n) ◯
- Description: (1,1) Str

Monument

Private
- Owner: (1,1) Str

Public
Multi-perception hierarchy

TouristSite

- Name: (1,1) Str
- District: (1,1) Str
- District: (1,n) Int

Museum

- Entrance: (1,1)
- Exhibition: (0,n) Str f(⊙)
- OpenTime: (1,n)
- Description: (1,1) Str

Monument

Private

- Owner: (1,1) Str

Public
Multi-perception hierarchy

TouristSite
- Name: (1,1) Str
- District: (1,1) Str
- District: (1,n) Int

Museum
- Entrance: (1,1) •
- Exhibition: (0,n) Str f(囱)
- OpenTime: (1,n) 〇
- Description: (1,1) Str

Private
- Owner: (1,1) Str

Monument
Inter-representation strategy

Number: (1:1), integer
Name: (1:1), string
Adm. class.: (1:1), integer
Type: (1:1), integer

Road

Relationship with inter-representation semantics

Number: (1:1), integer
Name: (1:1), string
Dpt: (1:1), integer
Type: (1:1), string
Inter-representation strategy

- Several kinds of correspondences:
  - Binary relationship 1:1
  - Aggregation 1:n
  - Multi-associations n:m

- Adding a inter-representation semantics on relationships:
  - Binary relationship 1:1
  - Aggregation 1:n
  - Multi-associations n:m
1:1 correspondence

- Binary relationship with inter-representation semantics
- Links 2 objects representing the same phenomenon in different perceptions
1:n correspondence

- Aggregation (intrinsic inter-representation semantics)
n:m correspondence

- Multi-Association with inter-representation semantics

\[(\{b_1, b_2, b_3, b_4, b_5\}, \{b_a, b_b, b_c\})\]

Linked Instances are two perceptions of the same real world phenomenon
Implementation

- MurMur Project (ULB, IGN, Cemagref, Star)
  - Software on top of a GIS (Oracle)
    - Schema editor MADS with multi-representation capabilities
    - Query editor multi-representation
    - Viewer

```
conceptual level

| schema editor | query editor | viewer |

logical level

DB
```
Future work

- Consistency, derivation between representations
  - Stating constraints between multiple-representations
  - Derivation rules

- Multi-representation in the continuous view of space
  - Space-varying attribute referring to a spatial attribute defined at various spatial resolutions
  - Space varying attribute for which the same value may be defined at different semantic resolution

- Describing the correspondences between the continuous and discrete representation of space.
Thank you