Spatial ER Design

from Shekhar/Chawla. Spatial Databases. A Tour

Example Spatial Application Domain

Spatial application domain
- A state-park consists of forests.
- A forest is a collection of forest-stands of different species
- State-Park is accessed by roads and has a manager
- State-Park has facilities
- River runs through state-park and supplies water to the facilities

The ER Model

3 basic concepts
- Entities have an independent conceptual or physical existence.
  - Examples: Forest, Road, Manager, ...
- Entities are characterized by Attributes
  - Example: Forest has attributes of name, elevation, etc.
- An Entity interacts with another Entity through relationships.
  - Road allow access to Forest interiors.
  - This relationship may be name “Accesses”

Comparison with Object model of spatial information
- Entities are collections of attributes like objects
- However ER model does not permit general user defined operations
- Relationships are not directly supported in Object model
  - but may be simulated via operations
Relationship Types

- Relationships can be categorized by:
  - Cardinality constraints
  - Other properties, e.g., number of participating entities
    - Binary relationship: two entities participate

Types of Cardinality constraints for binary relationships:
- One-One: An instance of an entity relates to a unique instance of another entity.
- Many-One: Many instances of an entity relate to an instance of another.
- Many-Many: Many instances of one entity relate to multiple instances of another.

Exercise: Identify type of cardinality constraint for following:
- Many facilities belong to a forest. Each facility belongs to one forest.
- A manager manages a forest. Each forest has one manager.
- A river supplies water to many facilities. A facility gets water from many rivers.

ER Diagrams Graphical Notation

- ER Diagrams are graphic representation of ER models.
- Several different graphic notations are used.
- We use a simple notation summarized below.
  - Example ER Diagram for Forest example in next slide.

<table>
<thead>
<tr>
<th>Concept</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entities</td>
<td></td>
</tr>
<tr>
<td>Attributes</td>
<td></td>
</tr>
<tr>
<td>Multi-valued Attributes</td>
<td></td>
</tr>
<tr>
<td>Relationships</td>
<td></td>
</tr>
<tr>
<td>Cardinality of Relation</td>
<td>1:1, M:1, M:N</td>
</tr>
</tbody>
</table>

ER Diagram for “State-Park”
Mapping

Relational Schema for “Point”, “Line”, “Polygon” and “Elevation”

Extending ER with Spatial Concepts

- Motivation
  - ER Model is based on discrete sets with no implicit relationships
  - Spatial data comes from a continuous set with implicit relationships
  - Any pair of spatial entities has relationships like distance, direction, …

- Explicitly drawing all spatial relationship
  - Clutters ER diagram
  - Generates additional tables in relational schema
  - Misses implicit constraints in spatial relationships (e.g. partition)

- Pictograms
  - Label spatial entities along with their spatial data types
  - Allows inference of spatial relationships and constraints
  - Reduces clutter in ER diagram and relational schema
  - Example: Fig. 2.7 (next slide) is simpler than Fig. 2.4
ER Diagram with Pictograms: An Example

Specifying Pictograms

- Grammar based approach
- Rewrite rule
- Like English syntax diagrams
- Classes of pictograms
  - Entity pictograms
    - Basic: point, line, polygon
    - Collection of basic
  - Relationship pictograms
    - Partition, network

Entity Pictograms: Basic Shapes, Collections
Entity Pictograms: Derived and Alternate Shapes

- Derived shape example: city center point from boundary polygon
- Alternate shape example: A road is represented as a polygon for construction or as a line for navigation

Grammar (for Derived Shape)

Grammar (for Alternate Shape)