SQL/SDA: A Query Language for Supporting Spatial Data Analysis and Its Web-Based Implementation

Written by:
Hui Lin
Bo Huang

IEEE Transaction of Knowledge and Data Engineering (TKDE),

Presented by Shan Huang (Group 2)

Slides Available at
http://www.users.cs.umn.edu/~joh/csci8715/HW-list.htm

Topics:

• Motivation
• Problem Statement
• Major Contribution
• Key Concept
• Validation Methodology
• Assumption
Motivation (contd.)

• Find a land parcels suitable for growing coffee in Jamaica.
  - Evaluation criteria: temperature, altitudes, area >1000, etc.

Motivation

• If we want to open a new store, which location should we choose?
  - Where are the customers mostly from?
Problem Statement

- **Given**
  - Spatial Data Type
  - Spatial Data Analysis Function
- **Find**
  - Extensions to SQL
  - Web-based Interface for Spatial Data Analysis
- **Constraints**
  - Relational Database
  - SQL with Geometry Types
- **Objective**
  - Easy to use
  - Efficient
  - Ease of Expressing Spatial Questions

Major Contribution

- **SQL/SDA**
  - Restructuring the FROM Clause
- **Visual Interface and Hybrid Model**
  - Takes advantage of the Web GIS Design in Client/Server Environment
    - Client - provides a query interface
    - Server - carry out query processing on spatial databases
Key Concepts

• Spatial Feature
  - Spatial attributes (e.g., coordinates and topological relationships)
  - Non-Spatial attributes (e.g., name and size)

• Spatial Data Type
  - Geometry: Point, Linestring, Polygon, Collection
    • Collection: Multipoint, Multilinestring, Multipolygon

Key Concepts (contd.)

• Spatial Analysis Functions

<table>
<thead>
<tr>
<th>Function</th>
<th>Purpose</th>
<th>Function Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Property</td>
<td>Access properties of spatial features</td>
<td>AREA, LENGTH, CENTROID</td>
</tr>
<tr>
<td>Spatial</td>
<td>Test spatial relationships</td>
<td>EQUALS, DISJOINT, TOUCH, WITHIN, OVERLAP, CROSS, INTERSECTS, CONTAINS</td>
</tr>
<tr>
<td>Relationship</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metric</td>
<td>Calculate distance and direction</td>
<td>DISTANCE, DIRECTION</td>
</tr>
<tr>
<td>Derivation</td>
<td>Create a new set of spatial features</td>
<td>VORONOI, BUFFER, CONVEXHULL, INTERSECTION, DIFFERENCE, UNION, FUSION</td>
</tr>
</tbody>
</table>
# OGIS vs. SQL/SDA

<table>
<thead>
<tr>
<th></th>
<th>OGIS</th>
<th>SQL/SDA</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Spatial datatypes</strong></td>
<td>Point, Curve, Surface, MultiPoint, MultiCurve, MultiSurface</td>
<td>Point, Curve, Surface, MultiPoint, MultiCurve, MultiSurface</td>
</tr>
<tr>
<td><strong>Spatial operations</strong></td>
<td>Basic topological and metric spatial relationships</td>
<td>Richer set of operations CENTROID, DIRECTION, VORONOI, FUSION</td>
</tr>
</tbody>
</table>

## FROM Clause

- **Structure and Syntax of SQL/SDA**
  - Align with the SQL design concept
    - SELECT - projection
    - FROM - Cartesian product
    - WHERE - selection
- **Restructured FROM Clause**
  - Employ a subquery
  - Create an intermediate relation as a new derived attributes
  - Append attributes to the Cartesian product
Key Concepts (contd.)

Example of SQL/SDA query

- Display the land parcels and their corresponding area on the condition that the landuse type of each parcels brush land and soil type is 'A' and area is between 700 hectares to 900 hectares

```
SELECT lu.ID, sl.ID, ILocation, areaval
FROM ( SELECT *
    OVERLAP ( lu.Location, sl.Location ) AS overlapval,
    INTERSECTION ( lu.location, sl.location ) AS iLocation,
    AREA (iLocation) AS areaval
    FROM landuse as lu, soil as sl
    )
WHERE lu.type = 'Brushland' AND sl.type = 'A'
AND overlapval = True AND areaval > 700
AND areaval < 900
```

- View.
- In SQL, this is called inline view.

Key Concepts (contd.)

- Solution

Fig.2. The intermediate relation of the FROM clause in query
Key Concepts (contd.)

• Solution (contd.)
  Fig. 3. The result of query

<table>
<thead>
<tr>
<th>ID</th>
<th>Location</th>
<th>areaVal</th>
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<tbody>
<tr>
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<td>800.5</td>
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</table>

Key Concepts (contd.)

Implementation of SQL/SDA on the Web

Client
• provides query interface

Server
• Query processor and Spatial Database Engine (SDE)
• carry out query processing
Validation Methodology

+ Examples of SQL/SDA queries
+ Case Study
  - Macro Languages of GIS
    • Difficult to learn
    • No optimization strategy
  - Previous Spatially Extended SQLs (SESOL)
    • spatial relationship and metric constrains, derivation functions are not accommodated
    • Spatial functions are applied in the main SELECT or WHERE clause
? Perform User Studies

Assumption

• Spatial indexing is already provided by Spatial Data Engine (SDE)
• Users
  - familiar with SQL and relational database
  - familiar with spatial datatypes and operations
Rewrite

- Perform user studies to evaluate the ease of expressing spatial queries
- Making the query interface more friendlier
- Query optimization.