SQL, SSQL, and GIS Data Architecture

IT4GIS
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Today's Road Map

- We will be making some connections and tying up some loose threads…
- This presentation/discussion focuses on Spatial SQL or SSQL
- In this week's exercise you will revisit some GIS fundamentals
  - Data Structure (vector and raster)
  - Objects in a Geodatabase
  - Topology

Definitions to get started

- SQL = Structured Query Language
- SSQL = Spatial SQL
- GPL = Graphical Presentation Language

SQL- A Review

- SQL is a simple language used to query (question) an ODBC-compliant database and retrieve data.
  - **S**QL is *not* simple or standard
  - **S** = structured

Structure

- The most basic SQL statement is:
  - SELECT * from *database.table*
- Let's dissect this statement
  - SELECT is the command
  - * is a wildcard = i.e., everything and anything
  - Database.table is the target of the query

A Little More…

- The previous SQL statement selected everything from a table
- But, how do we select only a portion of a table?
  - The WHERE CLAUSE

WHERE CLAUSE

- WHERE *conditional operator*
- For example:
  - SELECT * from database.table WHERE CITY_NAME = 'Pocatello'

Types of Conditional Ops

- **Simple** (as in the previous example)
- **Compound**
  - Let's say we want to select and work with all records describing *Pocatello and Blackfoot*
- We could select and work with them individually using two discrete **Simple** statements or use **Conditional** operators in a **Compound Expression**

Combining Statements using Conditional Operator Expressions

- Instead of:
  - SELECT * from database.table WHERE CITY_NAME = 'Pocatello'
  - …do some work, and then
  - SELECT * from database.table WHERE CITY_NAME = 'Blackfoot'
  - …do some more work

We Can Use…

- A **Compound** expression combining two or more simple expressions using either:
  - AND
  - OR
- In our example, which shall we use?

OR

- SELECT * from database.table WHERE
  CITY_NAME = 'Pocatello'
  OR
  CITY_NAME = 'Blackfoot'

Why OR?

- Before a record (entity) is returned as a result of a query, the record must satisfy EACH WHERE clause if AND is used.
- When OR is used, a record must satisfy only one of the WHERE clauses.

This is SQL

- What is **SSQL**?
  - **Spatial** Structured Query Language
  - Or SQL for Spatially-enabled relational databases (i.e., object-relational databases)
    - Informix
    - Oracle
    - IBM DB2
    - MS SQL Server
    - PostGreSQL
    - SQLite (GeoPackage)

An Example

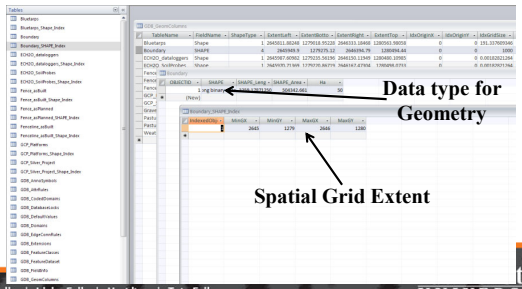
- SELECT *residence.geometry*
  FROM residence
  WHERE Type = 'single family'

What is different about this expression?
residence.*geometry*

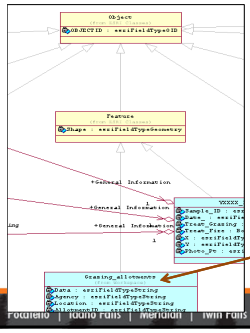
Why is **.geometry* important?

- Until now, we have been returning all fields
  - (SELECT * FROM…)
- *.geometry returns the *geographic feature(s)* as objects
- SSQL is used to select the geometry (*.geometry*) of the TABLE of interest (residence) from a spatially-enabled object-relational database

GIS Layers are Tables?



Object Relational



- OBJECTID inherited from Object class
- SHAPE inherited from a class called Feature

This could be "Boundary"

Geometry Data Type

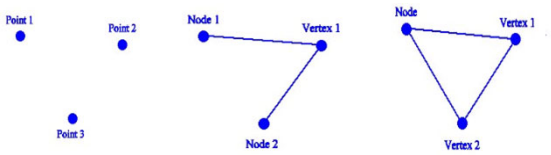
- We have talked a lot about the data types used to store traditional attributes (e.g., long integer, text, etc.)
- Recall, an ORDBMS can store OBJECTS natively
- What data type is used to store OBJECTS?

Speaking of Geometry

- GIS data is all about geometry
  - Vector data is based on Cartesian Coordinates (named for René Descartes)
  - However, GIS is not Geometric Information Systems, but Geographic
  - Vector data are points, lines, and polygons

Points, Lines, and Polygons

- Understanding the fundamentals of data architecture is critical to being an effective GIS Analyst



How Are These Different?

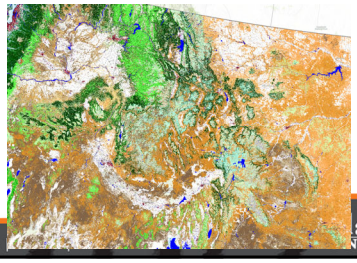
- Besides names used to describe these (points, lines, polygons, node, vertex), how does point layer **fundamentally** differ from a polygon layer?
  - Think about topology
  - Think about code/instruction to draw these geometries

Raster Data (AKA, imagery)

- Based on picture (**pix**) **el**ements (pixels)
  - All pixels (cells) have the exact same dimension (X Y)
- Each pixel is discrete and identified by a single numeric value (no text)
- Raster data can be:
  - Boolean (true (1), false (0))
  - Categorical (1 = water, 2 = grassland, 3 = forest)
  - Continuous (e.g., satellite imagery, elevation data)
- All raster layers are rectangular in shape

No Topology

- We can see patches of pixels in the same land cover class
- GIS "sees" individual pixels



NoData Pixels

- Mathematically, **NoData** values are important to understand

1	0	1		ND	ND	1		ND		
0	1	1	*	1	1	1	=			
0	0	1		ND	1	1				

Any Image Can Be *Georectified*

- How?
- Create a **World File**
  - TFW = TIFF World File
- Raster layers are always drawn beginning in the upper left corner of the image

```
10.0000000000
   0.0000000000
   0.0000000000
-10.0000000000
-2354936.2630753890
 3165585.7730424833
```

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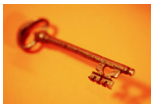

Key Concepts

- SQL is highly structured
- **Spatial SQL** builds upon SQL but remains within the same general framework
- SSQL requires an object relational, spatially-enabled database
- The *.geometry field is queried to return features…
  - Objects are stored in the table as LOB data (along with other attributes)
- Data architecture is important!

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Professional Hints and Tips

- Work Smarter not Harder
  - Open DIR.txt in Excel and extract a list of file names

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Questions?