Geospatial Problem Solving

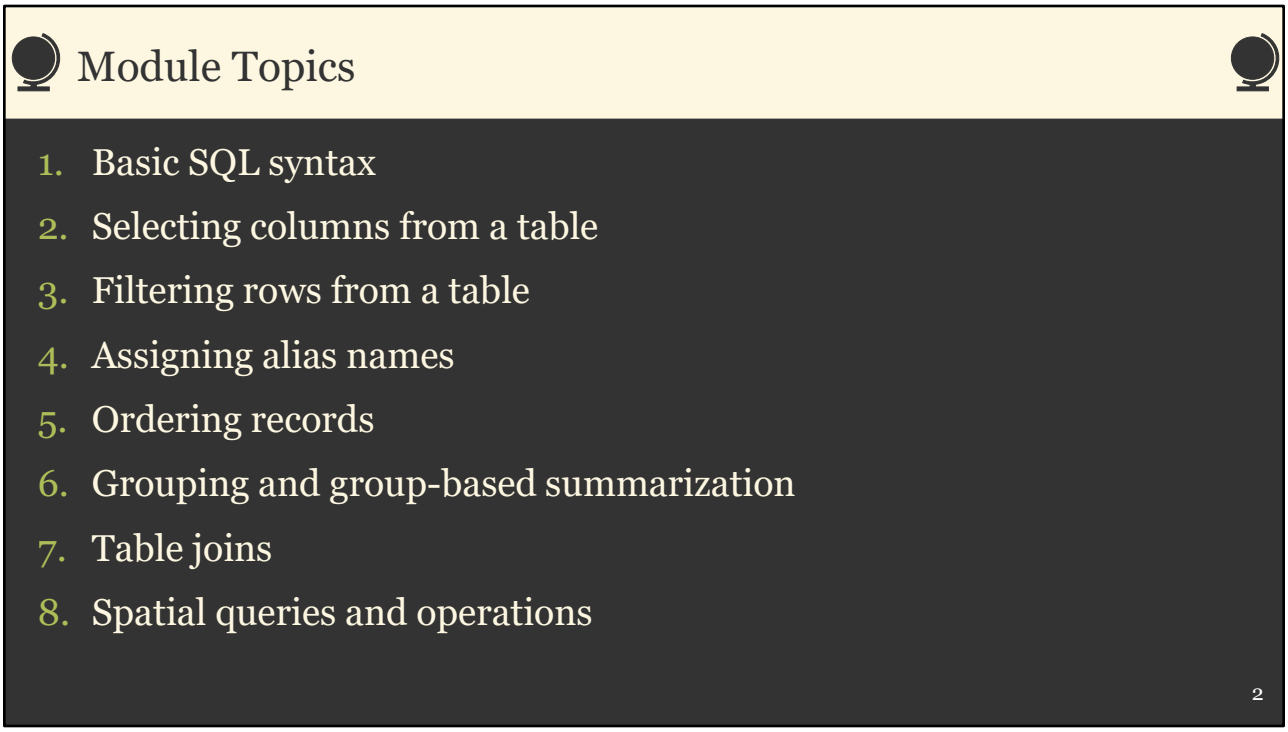
Structured Query Language

Image from NASA: https://commons.wikimedia.org/wiki/File:Earth_Western_Hemisphere_transparent_background.png#filelinks

WV VIEW

AmericaView
Empowering Earth Observation Education
AmericaView.org - Est. 2003

In this module, I will provide an introduction to Structured Query Language (SQL).



These are the topics covered in this module.

SQL

What can you do with SQL?

- Structured Query Language
- Access, manipulate, and query databases
- ANSI/ISO standard
- Different versions of SQL are available

https://www.w3schools.com/sql/default.asp

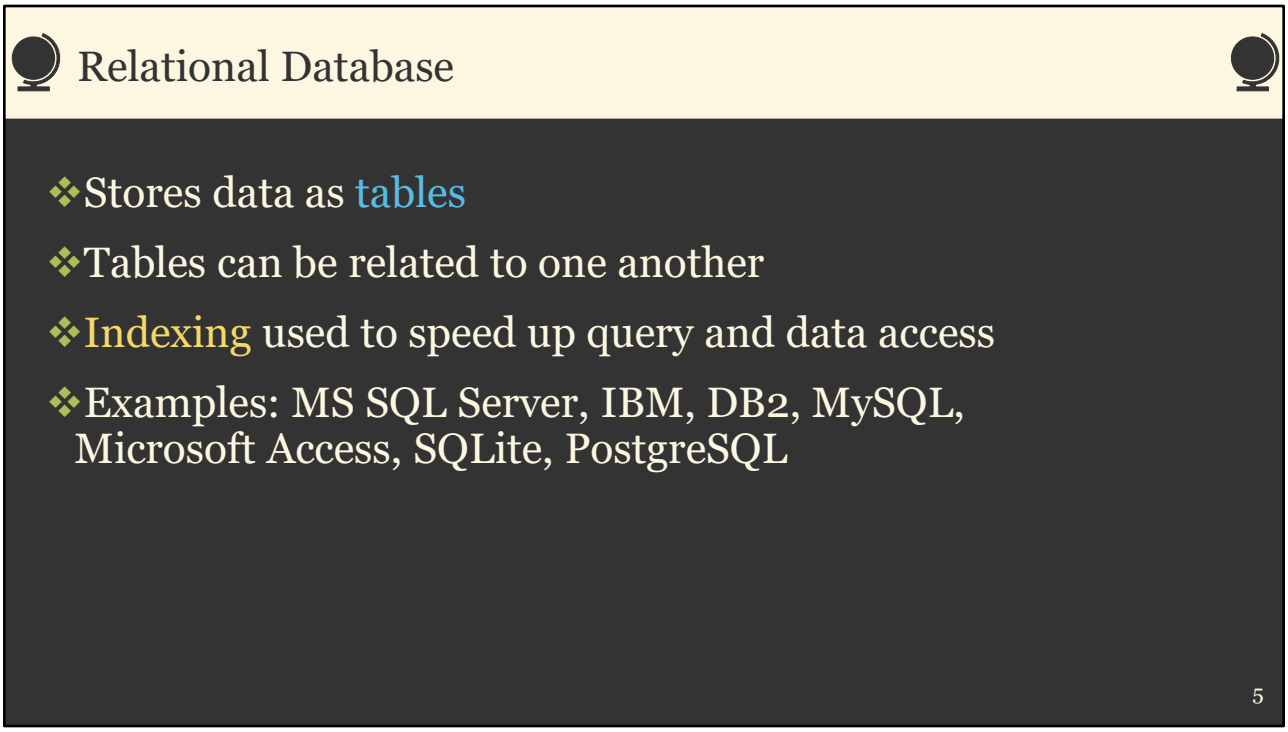
4

SQL stands for Structured Query Language. It is the primary language for working with relational databases and querying data.

Generally, SQL allows you to access, manipulate, and query data stored in a relational database.

SQL syntax can vary between different relational database systems. SQL is an ANSI/ISO standard, and, in order to be compliant, a specific version of SQL must adhere to some common rules and include the same major commands. In this course, we will focus on SQL as implemented with SQLite, which is open-source, free, and ANSI/ISO compliant.

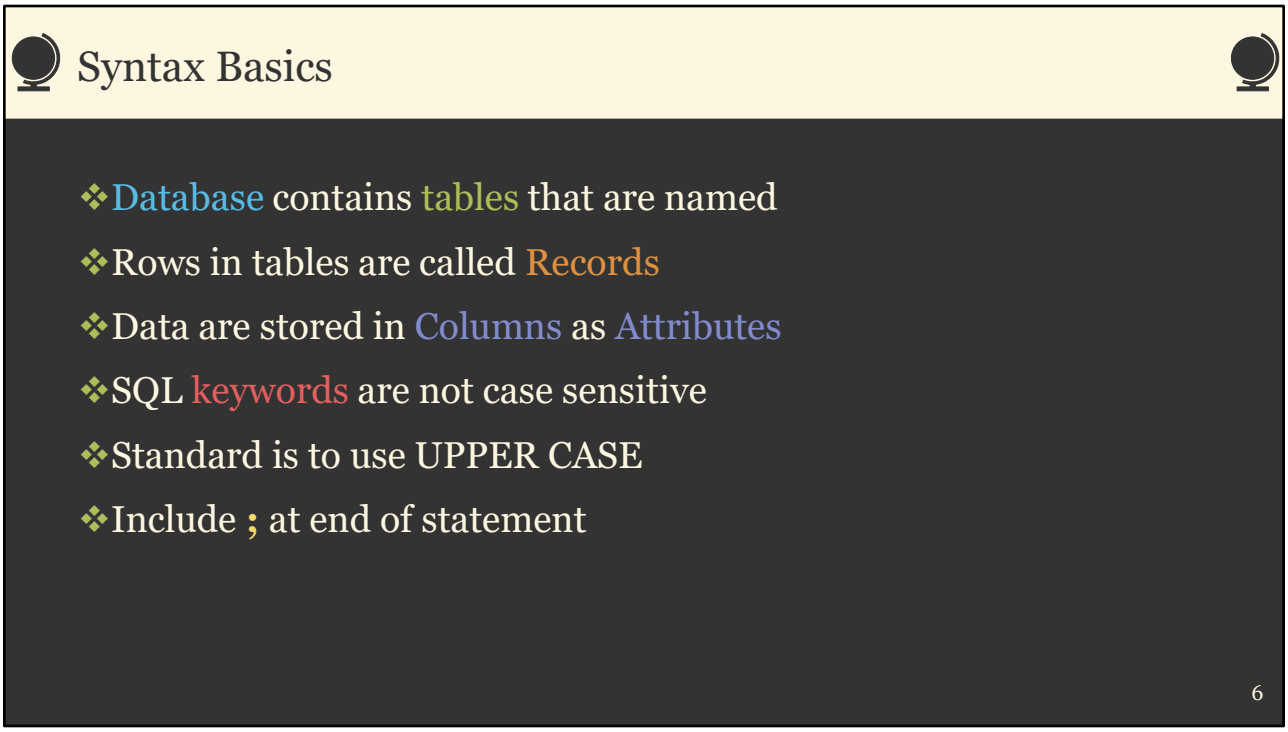
w3schools.com, which is referenced on this slide, is a great resources for learning and working with SQL. It was used extensively in the production of this module.



A relational database is a data structure in which multiple datasets, represented as tables, can be stored collectively and related to one another.

In order to speed up data query and access, data can be indexed.

There are a variety of relational database management systems.



As with all computer languages, SQL has some standards and best practices.

When discussing databases, files stored in the database are commonly called tables. Rows are called records and columns are called columns or attributes.

For example, a table of student information could have one row or record for each student with each column holding information or a specific attribute about that student, such as academic year, hometown, major, or GPA.

When typing SQL, keywords are not case sensitive. For example, SELECT, Select, and select are all acceptable. However, it is considered best practice to use upper case for all keywords (e.g., SELECT).

It is also recommended to end each SQL statement with a semicolon.

Query Basics

7

In this section we will discuss querying data from tables stored in a database.

SELECT

- SELECT records from a table
- FROM used to specify table
- * indicates to select all columns/attributes
- Can also select subset of columns/attributes

```
SELECT * FROM county_summary;
SELECT NAME, GEOID, elev_median  FROM county_summary;
```

8

A query is initiated with the SELECT keyword, and FROM is used to specify what table you want to query.

In the first example, I am selecting all columns from the “county_summary” table. The asterisks indicate to select all columns.

If you want to select just a subset of the columns, you can list the column names, separated by commas.

Note that both queries end with a semicolon.

WHERE

- Used to subset data based on a condition

```
SELECT NAME, elev_median
FROM county_summary
WHERE elev_median > 1200;
```

9

Using SELECT and FROM will allow you to select all records in a table and all or a subset of columns.

WHERE is used to define a subset of the records. Data that meet the condition defined by the WHERE clause will be selected, and all other records will not be selected.

Here, I am selecting all counties that have a median elevation larger than 1200 meters from the "county_summary" table. The query will only return the "NAME" and "elev_median" attributes for the records that satisfy the WHERE clause.

With the addition of WHERE, you can now query or subset your data/records based on criteria.

LIMIT

- Some DBs use SELECT TOP
- LIMIT number of records returned

```
SELECT  NAME, elev_median
FROM county_summary
WHERE elev_median > 1200
LIMIT 10;
```

10

LIMIT is used to limit the number of records returned. In this example, only the first 10 records that meet the condition are returned.

Aliases

- Tables and columns can be assigned alias names using AS

```
SELECT  NAME AS County, elev_median AS Elevation
FROM county_summary
WHERE elev_median > 1200;
```

11

You may want to define a different name for a column or table for use in the query and output.

The AS keyword can be used to define an alias name. In this case, the “NAME” field is assigned the alias “County” and “elev_median” is assigned the alias “Elevation”. These will be the new column headings in the query result.

Operators

Comparison Operator	Description
=	Equal
>	Greater Than
<	Less Than
>=	Greater Than Or Equal To
<=	Less Than or Equal To
<>	Not Equal To

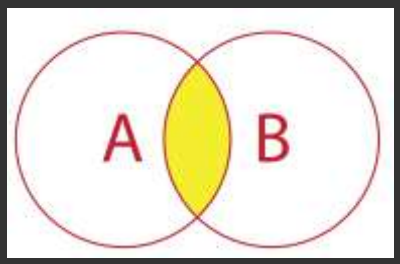
12

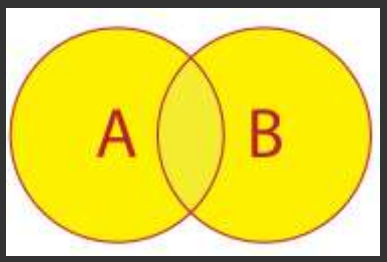
These are the comparison operators available for use in a WHERE clause.

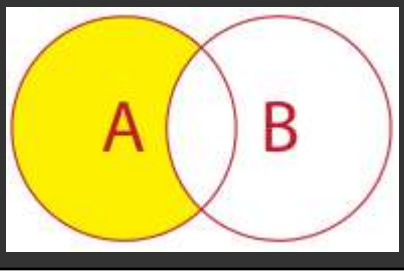
AND, OR, NOT

```
SELECT  NAME AS County, elev_median AS Elevation
FROM county_summary
WHERE elev_median > 1200 OR elev_median <300;
```

Logical Operator	Description
AND	A AND B
OR	A OR B
NOT	A NOT B







13

In order to query based on multiple conditions or criteria, you can use logical operators.

AND means that both criteria must be satisfied,

OR means at least one of the two criteria must be satisfied (including both criteria), while NOT indicates that one criteria but not the other must be satisfied.

In the example, only records that have an elevation greater than 1200 meters or less than 300 meters will be selected. If OR was replaced with AND, no results would be returned because the median elevation cannot be both greater than 1200 and less than 300.

BETWEEN

- Return records **BETWEEN** two values in a column

```
SELECT  NAME AS County, elev_median AS Elevation
FROM county_summary
WHERE elev_median BETWEEN 1000 AND 2000;
```

14

BETWEEN can be used in a WHERE clause to denote values between two end members.

IN

- Return records that match an element **IN** a list
- Can use **NOT IN** to reverse the selection

```
SELECT  * FROM geology
WHERE MAJOR1 IN ("Limestone", "Dolostone");

SELECT  * FROM geology
WHERE MAJOR1 NOT IN ("Limestone", "Dolostone");
```

15

IN allows you to select based on whether a value for an attribute matches one of the records in a list. In the example, a record will be returned if its rock type attribute (“MAJOR1” column) is either “limestone” or “dolostone”.

NOT IN is used to invert IN: records with a value for a specific attribute or column not in the list will be returned.

LIKE

- Search for a pattern
- % = 0, 1, or multiple characters
- _ = a single character
- \ is escape character
- NOT LIKE is also available

```
SELECT  * FROM geology
WHERE MAJOR1 LIKE '%stone';
```

16

LIKE allows you to find records based on a pattern.

In the example, any unit with a rock type ending with “stone” will be returned.

NOT LIKE can be used to invert LIKE. So, rock types not ending in “stone” will be returned.

% before “stone” indicates that this is the end of the string. In contrast, ‘stone%’ would indicate the beginning of the string and ‘%stone%’ would indicate at the beginning, middle, or end. _ is used to denote a single character.

\ can be used as an escape character to avoid characters that have special meaning in SQL being misinterpreted, such as quotes.

MIN, MAX, COUNT, AVG, SUM

- Return summary or statistical measure for records in rows that meet query criteria

```
SELECT NAME as County, AVG(elev_median) AS Elevation
From county_summary;

SELECT NAME as County, MAX(elev_median) AS Elevation
From county_summary

SELECT COUNT(NAME) AS County
From county_summary
WHERE temp_median > 20;
```

17

Numeric data can be summarized using different summary methods.

In the first example, the average of all median county elevations will be returned.

In the second example, the maximum of all median county elevations will be returned.

In the last example, the number of counties with a median mean annual temperature greater than 20 degrees Celsius will be returned.

You will see more examples of this when we investigate grouping.

ORDER BY

- Sort results ascending or descending based on strings or numbers
- ASC = Ascending
- DESC = Descending
- Can use multiple columns/attributes

```
SELECT NAME AS Counties, elev_median AS
Elevation, temp_median AS Temp
From county_summary
ORDER BY Elevation DESC, Temp ASC;
```

18

ORDER BY can be used to sort the results in ascending (ASC) or descending (DESC) order relative to a column.

When used on character or text data, this will sort alphabetically. When used on numeric data, it will sort increasing/decreasing.

It is also possible to order using multiple fields. In the example, the results are ordered based on decreasing elevation and increasing temperature.

CASE

- Return different results to new column based on a condition
- Like If…Else statement

```
SELECT NAME AS Counties, elev_median AS Elevation,
        CASE
                WHEN county_summary.elev_median < 1000 THEN 'Low Elevation'
                WHEN county_summary.elev_median >= 1000 AND
                        county_summary.elev_median < 2000 THEN 'Medium Elevation'
                ELSE 'High Elevation' END
                AS ElevationClass
FROM county_summary
ORDER BY Elevation DESC;
```

19

CASE is used to return different results based on a case and is similar to If…Else statements used in most programming languages, such as Python or R.

Here, CASE is being used to create a new column in which to return the query results. The string stored in the query will vary based on a condition.

CASE initiates the clause. WHEN is used to define a specific case while THEN is used to denote what to return if that specific case is true. ELSE denotes the default case and does not require a condition. END is used to end the CASE clause, and AS is used to name the output column.

In the example, CASE is used to return different text depending on the elevation of the county. The result is written to a column called "ElevationClass".

NULL VALUES

- NULL = missing data (not the same as zero)
- IS NULL = use in WHERE statement to find NULL records
- IS NOT NULL = use in WHERE statement to find not NULL records

```
SELECT NAME AS County
From county_summary
WHERE temp_median IS NOT NULL;
```

20

NULL indicates missing data. IS NULL can be used in a WHERE clause to find records with missing data in a specific column while IS NOT NULL is used to find records without missing data in a column.

Summary of Key Points: Query Basics

- A variety of methods are available to query data tables using SQL.
- You can select subsets of columns with the SELECT clause and rename the columns in the output.
- You can use a WHERE clause to subset records or rows based on a criteria.
- It is possible to reorder the records in the output.
- Summary statistics can be calculated as part of the output.

Grouping

GROUP BY

- Group data based on a nominal or ordinal variables
- Use summary measures to obtain group statistics: COUNT, MIN, MAX,AVG, SUM, etc.

```
SELECT UNIT_AGE AS Age,
COUNT(UNIT_NAME) AS Unit_Count
FROM carbonates
GROUP BY Age
ORDER BY Unit_Count DESC;
```

23

You may want to group the results based on a nominal or ordinal variable or attribute. This can be accomplished using GROUP BY. In the example, the result is being grouped based on the geologic age, which is an ordinal variable.

So, each age will be returned to a column called “Age”. The number of units in the age will be returned to a column called “Unit_Count”, and the results will be sorted in descending order based on the number of units in the age group.

It is common to use summary keywords with GROUP BY. Here, I am using COUNT.

HAVING

- Replaces WHERE when data are grouped
- Cannot use WHERE with GROUP BY

```
SELECT UNIT_AGE AS Age,
COUNT(UNIT_NAME) AS Unit_Count
FROM carbonates
GROUP BY Age
HAVING Unit_COUNT > 1500
ORDER BY Unit_Count DESC;
```

24

WHERE cannot be used once data are grouped. So, HAVING serves a similar purpose for grouped data; it allows you to subset the groups based on a query.

So, in this example, only geologic ages with more than 1,500 carbonate records will be returned.

Summary of Key Points: Grouping

- It is possible to calculate summary statistics by group suing the GROUP BY clause.
- WHERE cannot be used on grouped data. Instead, HAVING is used.

Joins

Joins

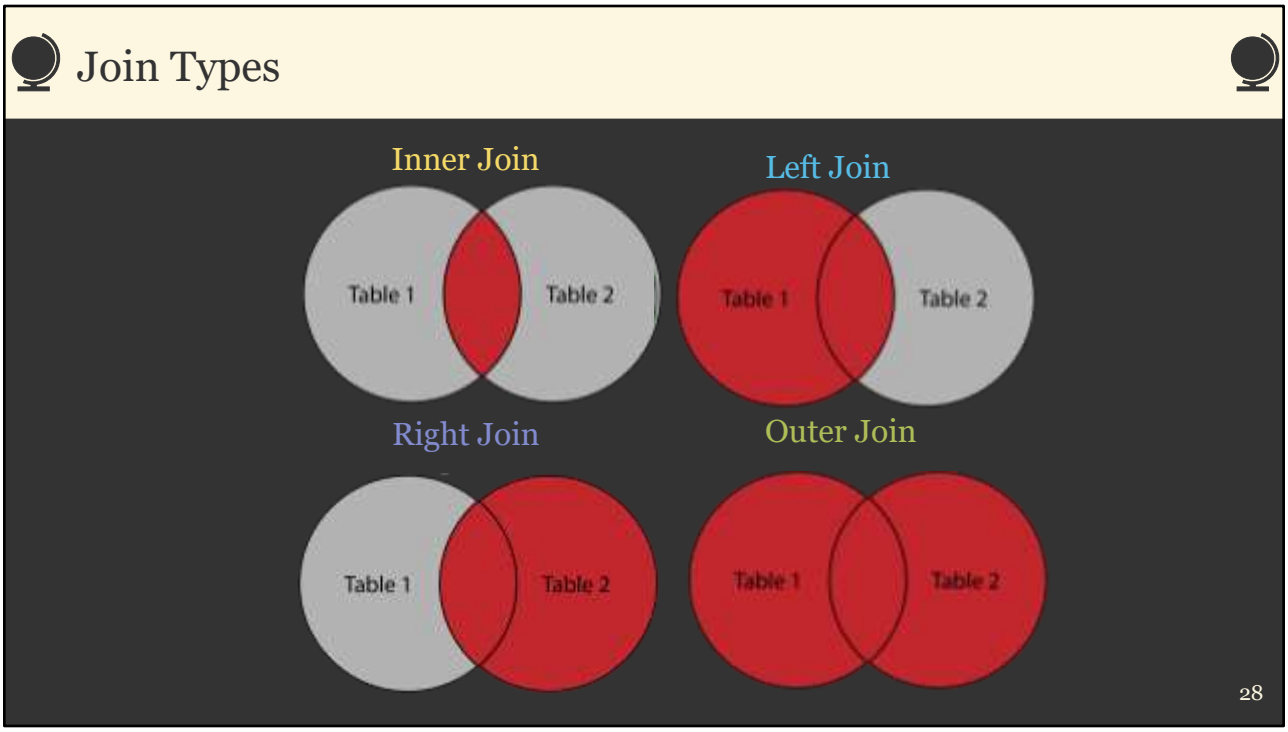
- Allow you to relate tables in a database
- Relationship established using a common field/attribute or unique identifier
- Primary Key = unique identifier in table
- Foreign Key = unique identifier in table being associated

27

Joins allow you to relate or associate two tables in a database based on a shared or common field.

In the case of a table join, a unique ID in one table, the primary key, is used to associate the data to another table based on the shared ID, which is called the foreign key in the second table.

So, table joins require that a relationship be established based on shared IDs or a common column.



Different types of joins are possible.

An inner join will return only records that occur in both tables or only records where a match is found between the primary and foreign keys.

A left join will return all records from the first table even if no match is found in the second table.

A right join will return all records in the second table even if there is no match in the first.

Lastly, a full join will return all records from both tables, regardless of whether there are matches.

I find that I use inner and left joins most often.

Join Example

```
SELECT cnty.NAME AS CountyName, st.NAME AS StateName
FROM county_summary AS cnty
INNER JOIN state_fips AS st
ON cnty.STATEFP = st.FIPS;
```

29

In this example, state names are being associated with each county based on the state FIPS (Federal Information Processing Standard) code, which is unique for each county. The FIPS code occurs in both datasets. So, it is used to relate the data.

So, a table will be returned that includes the county name and state name. To simplify the syntax, I am using alias names for both tables. An inner join is used and is specified using the INNER JOIN keywords. The ON keyword is used to define the primary/foreign key relationship.

Join Example

```
SELECT st.NAME AS StateName, AVG(cnty.elev_median)
AS Elevation
FROM county_summary AS cnty
INNER JOIN state_fips AS st
ON cnty.STATEFP = st.FIPS
GROUP BY  StateName
HAVING Elevation > 1000;
```

30

In this example, I am grouping using the state name to return an average county-level median elevation by state. So, a join field is used to define the subsequent grouping. Also, I am only returning states that have an average median county elevation greater than 1,000 meters. Note the use of HAVING as opposed to WHERE since the data have been grouped.

Summary of Key Points: Joins

- Different types of joins exist to relate tables.
- Joins make use of shared or common attributes.

Database Manipulation

32

Manipulate Databases

- CREATE DATABASE https://www.postgresql.org/docs/12/sql-createdatabase.html
- DROP DATABASE https://www.postgresql.org/docs/12/sql-dropdatabase.html

https://www.postgresql.org/docs/

33

We will not focus on database, table, and record manipulation in this module. Instead, we focus on data queries, subsetting, and summarization. However, I did want to mention some of the techniques that are available to manipulate databases and their content.

CREATE DATABASE and DROP DATABASE can be used to create and delete databases, respectively.

When a database is created, some parameters can be defined. For example, you can define the database owner, a template to use, and a character set encoding.

If you use SQL to manipulate tables, it is important that you use caution. You don't want to accidentally delete records, tables, or entire databases, for example.

Manipulate Tables

- CREATE TABLE https://www.postgresql.org/docs/12/sql-createtable.html
- DROP TABLE https://www.postgresql.org/docs/12/sql-droptable.html
- ALTER TABLE https://www.postgresql.org/docs/12/sql-altertable.html

https://www.postgresql.org/docs/

34

This slide shows examples for manipulating tables.

CREATE TABLE allows you to create a new table to store in an existing database while DROP TABLE can be used to delete a table from a DATABASE.

ALTER TABLE allows you to change the definition of the table once it is created. For example, you can add or delete columns, change data types for columns, set or change default column values, or change the name of the table or the names assigned to specific columns in the table.

Manipulate Records

- INSERT https://www.postgresql.org/docs/12/sql-insert.html
- UPDATE https://www.postgresql.org/docs/12/sql-update.html
- DELETE https://www.postgresql.org/docs/12/sql-delete.html

https://www.postgresql.org/docs/

35

It is also possible to manipulate individual records in a table using INSERT, UPDATE, and DELETE.

INSERT allows you to add records while DELETE will remove them. UPDATE can be used to edit an existing record, such as change the values in certain columns for that record.

Summary of Key Points

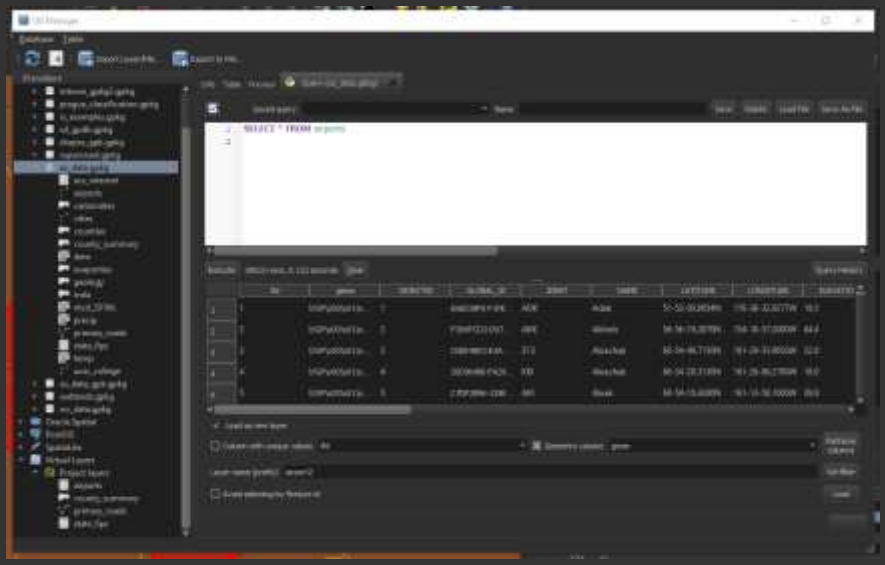
- Some uses of SQL:
  - Manipulate databases, including creating and deleting databases
  - Creating, deleting, or altering tables in a database
  - Inserting, updating, and deleting records within a specific table in a database
  - And more!

Spatial Queries

37

This section discusses spatial queries as implemented using GeoPackages or PostGIS.

QGIS DB Manager

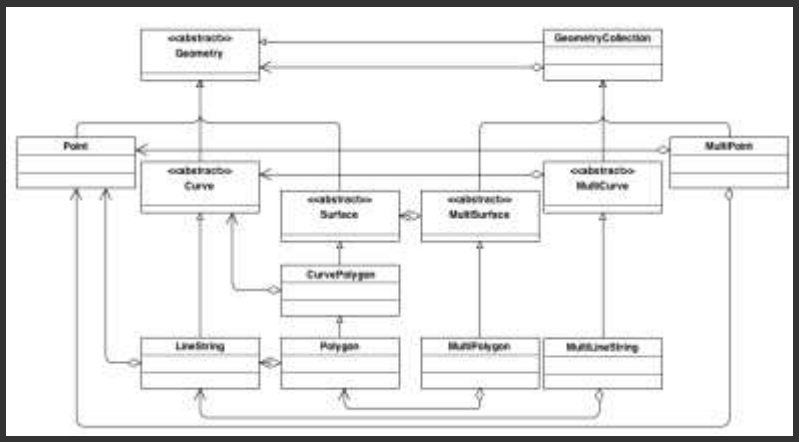


38

The examples in this section were produced in QGIS using the DB Manager plugin. Queries can produce aspatial/table output or spatial output, depending on whether or not the geometric information is included in the output.

Geometry Types

- Point
- LineString
- Polygon
- MultiPoint
- MultiLineString
- MultiPolygon
- GeometryCollection



http://www.geopackage.org/spec/

39

If using SQL for spatial queries on GeoPackages or PostGIS tables, it is useful to at least have a basic understanding of the geometry types available.

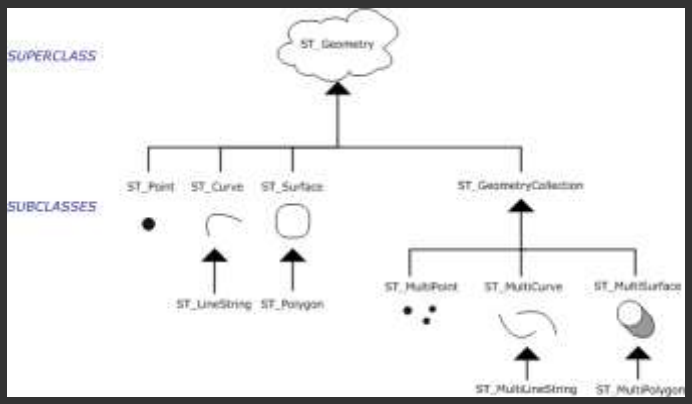
Individual coordinates are stored as Points; 1-dimensional, line features are stored as LineStrings; and polygon features are stored as Polygons.

If you want to treat multiple points, lines, or polygons as a single record or feature, you can use MultiPoint, MultiLineString, or MultiPolygon. For example, all the islands of Hawaii could be stored as a single record as a MultiPolygon.

The GeometryCollection type allows for multiple geometry types to be store in the same table. In other words, different records in the same table can have different geometries.

Geometry Types

- Point
- LineString
- Polygon
- MultiPoint
- MultiLineString
- MultiPolygon
- GeometryCollection



https://desktop.arcgis.com/en/arcmap/10.3/manage-data/gdbs-in-postgresql/data-types-postgresql.htm

40

PostGIS has similar data types as those available in GeoPackages or SpatiaLite databases.

Coordinate Reference Systems

- ST_SRID returns EPSG code
- Get EPSG code
- ST_TRANFORM used to transform the data to a different spatial reference system

```
SELECT ST_SRID(geom)
FROM county_summary
LIMIT 1;
```

41

ST_SRID can be used to obtain the spatial reference information for a table as an EPSG code while ST_TRANSFORM can be used to transform the data to a different spatial reference system.

When transforming the coordinate system, the new, desired projection can be defined with an EPSG code or a PROJ string.

Geometric Data

- ST_ASTEXT returns geometry info as text
- ST_GEOMETRYTYPE returns the geometry type
- ST_X and ST_Y return point X and Y coordinates

```
SELECT ST_ASTEXT(geom)
FROM county_summary
```

42

In order to return the geometric information in a text format (Well-Known Text), ST_ASTEXT can be used. It is also possible to limit the number of decimal places.

Well-Known Text is a text markup language for representing vector geospatial data. This format is supported by the Open Geospatial Consortium.

ST_GEOMETRYTYPE will return the geometry type, as defined in the prior slides, while ST_X and ST_Y will return coordinates for point features.

ST_AREA

- Calculate area of polygon features

```
SELECT NAME AS County,
ST_AREA(county_summary.geom)/10000
AS hectares
FROM county_summary
ORDER BY hectares desc
LIMIT 1;
```

43

ST_AREA will return the area of a polygon relative to the map units and coordinate system.

In the example, I am calculating the area of each county in hectares and returning the first record after sorting the data descending. So, the largest county by land area will be returned.

ST_LENGTH

- Calculate length of line features

```
SELECT SUM(ST_LENGTH(primary_roads.geom))/1000
AS total_km FROM primary_roads;

SELECT RTTYP AS Rd_Type,
SUM(ST_LENGTH(primary_roads.geom))/1000 AS
total_km FROM primary_roads
GROUP BY RTTYP;
```

44

ST_LENGTH calculates the length of line features relative to the map units, meters in the example, and coordinate reference system.

In the first example, I am calculating the length of each line segment in a roads data set. I divide by 1000 to obtain the length in kilometers as opposed to meters.

In the second example, I am summing the lengths by group. The grouping is defined by the "RTTYP" field, which represents different road types.

ST_LENGTH should not be used on polygon features. To obtain the perimeter of a polygon, use ST_PERIMETER.

ST_CENTROID

- Calculate centroid of polygons

```
SELECT
ST_ASTEXT(ST_CENTROID(county_summary.geom
)) AS Centroid
FROM county_summary
WHERE STATEFP = '54';
```

45

ST_CENTROID will return the X and Y coordinates of the centroid for each polygon record in a data set.

In the example, I am using ST_ASTEXT to return Well-Known Text. I also only obtain results for counties in West Virginia, as defined the WV FIPS code.

Geometry vs. Geography

- **Geometry** = Cartesian (length units)
- **Geographies** = Earth surface (degrees lat/long)

46

In PostGIS, geospatial data can be referenced based on a geometry, in which it is assumed the data are mapped to a Cartesian or planar surface, such as a map projection. Alternatively, geographies can be used to map features relative to the curved surface of the Earth as latitude and longitude coordinates.

In this brief introduction, I am only discussing geometries.

ST_WITHIN

- Find feature(s) that spatially occur within other feature(s)

```
SELECT a.NAME AS Airport, a.IDENT AS ID
FROM airports AS a, county_summary AS c
WHERE ST_WITHIN(a.geom, c.geom) AND
c.GEOID = '42003';
```

47

ST_WITHIN returns True or False based on whether the first geometry is or is not completely inside of the second geometry.

In this example, I use ST_WITHIN to perform a spatial query within a WHERE clause to find which airports are within a county with a specific "GEOID", which in this case represents Allegheny County, Pennsylvania.

The result of this query will be a table of the airport name and ID for each airport in the county.

ST_CONTAINS

- Find feature(s) contained in another feature(s)

```
SELECT c.NAME AS County, COUNT(a.fid) As
Num_Airports
FROM wv_pa AS c, wv_pa_air AS a
WHERE ST_CONTAINS(c.geom, a.geom)
GROUP BY County
ORDER BY Num_Airports DESC;
```

48

ST_CONTAINS is the reverse of ST_WITHIN. Here, we are trying to select all counties that contain an airport.

Using a COUNT summary and GROUP BY, we obtain a count of airports by county.

ST_INTERSECTS/ST_INTERSECTION

- Intersect geometries
- Clip geometries
- Perform spatial joins
- ST_INTERSECTS = True or False
- ST_INTERSECTION = return geometry

```
SELECT c.NAME AS County,
SUM(ST_LENGTH(rd.geom)/1000) AS
Length, ST_INTERSECTION(c.geom,
rd.geom)
FROM wv_pa_rd AS rd
JOIN wv_pa AS c
ON ST_INTERSECTS(rd.geom, c.geom)
GROUP BY Name
```

49

ST_INTERSECTION is used to perform a spatial intersection, which can be used as a clip operation, intersection overlay, or spatial join. The resulting, intersected geometric information will be returned. In contrast, ST_INTERSECTS can be used in a WHERE clause to test whether two geometries share any land area, or overlap, and will return True or False.

In the example, I am summing the length of roads by county using a combination of ST_INTERSECTION and ST_INTERSECTS. All road segments in each county, which have been split along county lines using ST_INTERSECTION, are summed using SUM and GROUP BY.

Note also the use of a JOIN where the join is based on the spatial intersection as opposed to a common attribute.

ST_DISTANCE

- Calculate distance between geometries
- Query based on distance

```
SELECT wv_pa_air.* FROM wv_pa_air, wv_pa_rd
WHERE ST_DISTANCE(wv_pa_rd.geom,
wv_pa_air.geom) < 2000;
```

50

ST_DISTANCE can be used to query based on distance between features. It will return True or False based on whether or not the spatial distance criteria is met.

In the example, I am selecting all airports that are within 2 kilometers of a road. Remember that measurements will be relative to the spatial reference system and use the units of the coordinate system, meters in this case.

When multiple tables are included in the query, * become ambiguous. In the example, “wv_pa_air.*” indicates to include all columns form that specific table.

ST_BUFFER

- Buffer geometries
- Query based on proximity

```
SELECT c.Name AS County FROM
county_summary AS c, preston AS P
WHERE ST_INTERSECTS( ST_BUFFER(p.geom,
50000), c.geom);
```

51

ST_BUFFER can be used to perform a proximity analysis. In the example, I am finding all counties that are within 50 kilometers of Preston County, West Virginia. Since ST_INTERSECTS is used, only a portion of the county has to be within the buffer distance, not the entire county.

ST_TOUCHES

- Query feature(s) that touch or share a boundary with other feature(s)

```
SELECT c.Name AS County FROM
county_summary AS c, preston AS P
Where ST_TOUCHES(p.geom, c.geom);
```

52

ST_TOUCHES can be used to find all features that touch or share a boundary with another feature. Here, I am finding all the counties that share a boundary with Preston County, West Virginia.

Other Useful Functions

- ST_COVERS: test whether geometry A completely covers or is inside of geometry B (True or False)
- ST_CROSSES: test whether geometries cross (True or False)
- ST_EQUALS: test whether geometries are identical (True or False)
- ST_OVERLAPS: like ST_INTERSECTS, accept does not include completely contains (True or False)
- ST_ISEMPTY: test if geometry is empty (True or False)
- ST_COLLECT: aggregate to geometry collection
- ST_ENDPOINT: return last point of line
- ST_STARTPOINT: return first point of line

https://postgis.net/docs/reference.html

53

There are a wide variety of additional commands and functions available to work with GeoPackage or PostGIS data using SQL. The following slides provide some additional examples and links to the PostGIS documentation.

This is a powerful set of tools. An entire class could be devoted to this topic. I hope that this brief introduction is enough to get you started.

Other Useful Functions

- ST_CONCAVEHULL: return concave hull for set of geometries
- ST_CONVEXHULL: return convex hull for set of geometries
- ST_MINIMUMBOUNDINGCIRCLE: return minimal bounding circle for set of geometries
- ST_SIMPLIFY: return simplified geometries using Douglas-Peucker algorithm
- ST_SYMDIFFERENCE: spatial XOR
- ST_UNION: spatial OR
- ST_DIFFERENCE: spatial NOT
- ST_VORONOIPOLYGONS: Thiessen or Voronoi polygons from geometries

https://postgis.net/docs/reference.html

Other Useful Functions

- ST_SNAP: snap geometries to a reference geometry based on a tolerance
- ST_ISVALID: test whether geometries are valid
- ST_SETSRID: define spatial reference system as EPSG code
- ST_EXTENT: returns bounding box for a set of geometries

https://postgis.net/docs/reference.html

This is the end of this lecture module.

Please return to the West Virginia View Webpage for additional content.

Thanks! Hope you found this useful.