

ISA

Geographic Information Systems 2026/2027

Lesson 05 – Structured Query Language

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Structured Query Language (SQL)

SQL is a standard programming language (ANSI - 1986) for managing data held in a relational DBMS, allowing:

- data insert
- update and delete
- schema creation and modification
- data access control
- **data query**

SQL is one of the major advantages of the relational database model

- SQL is a standard used by all relational DBMS
- Relational DBMS usually include an interface to SQL
- SQL is application-independent (although the SQL interfaces can exhibit slight differences)

The SELECT statement

- The most common operation in SQL is the **query**, which is performed with the `SELECT` statement
- `SELECT` retrieves data from one (or more) tables/layers
 - in order to be processed by other functions/statements
 - in GIS, in order to be visualized (on maps) as well
- Standard `SELECT` statements have **no persistent effects** on the database
 - the `SELECT` statement can have persistent effects when an output table is also mentioned to store the `SELECT` statement result
- `SELECT` statement retrieves a subset of a given table/layer according to a given logical condition
 - a **logical condition** is an expression that returns either `TRUE` or `FALSE`
 - the `SELECT` statement retrieves the table/layer rows/objects verifying a given logical condition (those for which the condition returns the logical value `TRUE`)

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SELECT by Attributes (ArcGIS or QGIS)

```
SELECT * FROM <table> WHERE <condition>
```

- the `*` represents all attributes (the default)
- `<table>` is the activated layer
- `<condition>` involves at least one attribute of the table, one or more values (consistent with the attribute datatype) and operators returning either `True` or `False`
- Relational operators: `<`, `<=`, `>`, `>=`, `=`, `<>`
- Logical operators: `NOT`, `AND`, `OR`
- Other operators: `IS`, `IN`
- Conditions can also include arithmetic operators (`+`, `-`, `*`, `/`, `^`, `%`) and string operators (`LIKE`, `||` - concatenation: joins two values together into a string)

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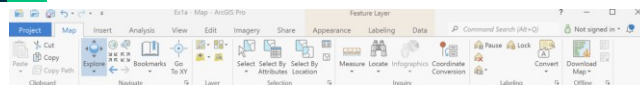
SELECT by Attributes (ArcGIS)

```
SELECT * FROM <table> WHERE <condition>
```

- <condition> involves at least one attribute of the table, one or more values (consistent with the attribute datatype) and operators returning either `True` or `False`
- Examples:
 - `CLC2code = 51`
 - `CLC2descr = 'Inland waters'`
 - `CLC2code = 11 OR CLC2code = 12 OR CLC2code = 13`
 - `CLC2code IN (11, 12, 13)`
 - `CLC2descr IN ('Arable land', 'Forests')`
 - `CLC2code = 21 AND areaM2 >= 10000`
 - `CLC2descr LIKE 'A%'`
 - `TIPO IS NULL`

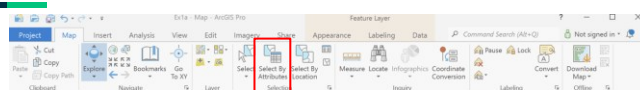
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SELECT by Attributes (ArcGIS)



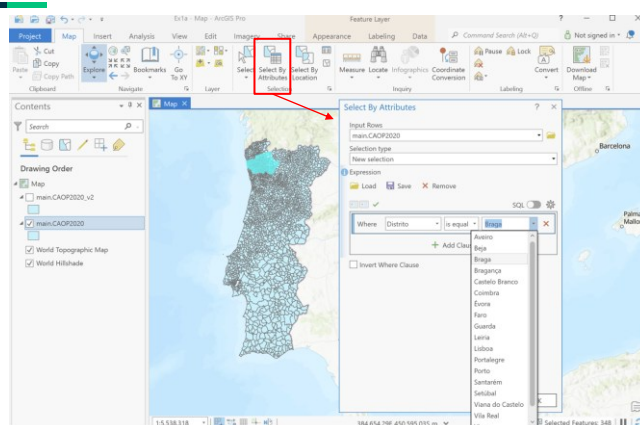
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SELECT by Attributes (ArcGIS)



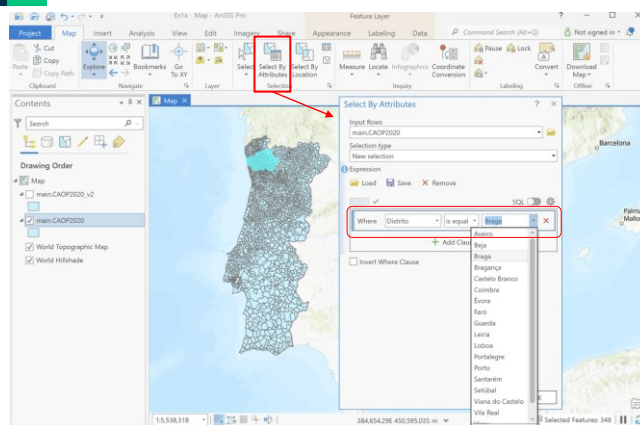
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SELECT by Attributes (ArcGIS)



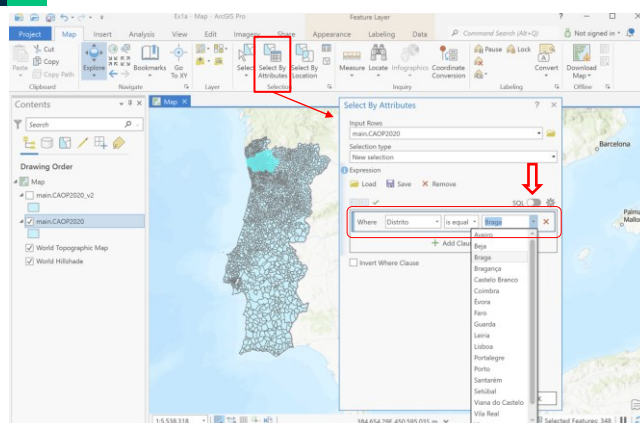
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SELECT by Attributes (ArcGIS)



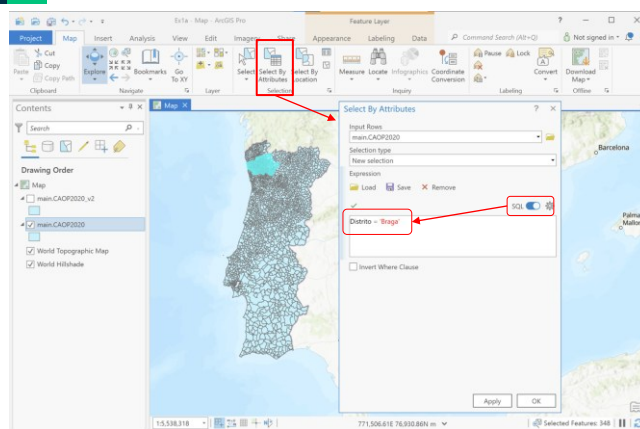
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SELECT by Attributes (ArcGIS)



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SELECT by Attributes (ArcGIS)



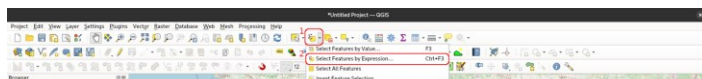
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SELECT by Attributes (QGIS)



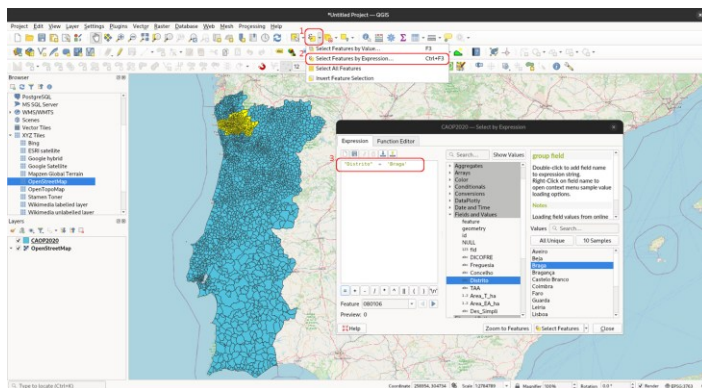
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SELECT by Attributes (QGIS)



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SELECT by Attributes (QGIS)



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Select by location



- Basically this command performs as the `SELECT` by Expression

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Select by location



- Basically this command performs as the `SELECT` by Expression
- But the condition uses spatial relationships among geographic objects from 2 layers, such as:
 - intersect
 - contain
 - within
 - are identical
 - ...

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Select by location

- Basically this command performs as the `SELECT` by Expression
- But the condition uses spatial relationships among geographic objects from 2 layers, such as:
 - intersect
 - contain
 - within
 - are identical
 - ...
- The meaning of the spatial relationship depends on the geometries of the 2 involved layers (both polygons, polygon and line, polygon and point, ...) and on the order used to refer to each layer

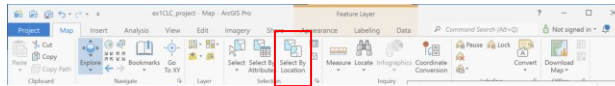
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Select by location

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- But the condition uses spatial relationships among geographic objects from 2 layers, such as:
 - intersect
 - contain
 - within
 - are identical
 - ...
- The meaning of the spatial relationship depends on the geometries of the 2 involved layers (both polygons, polygon and line, polygon and point, ...) and on the order used to refer to each layer
- This command is in menu Map → **Select By Location**

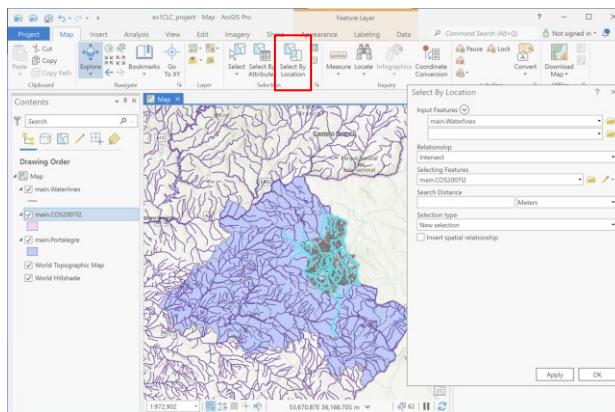
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Select by location



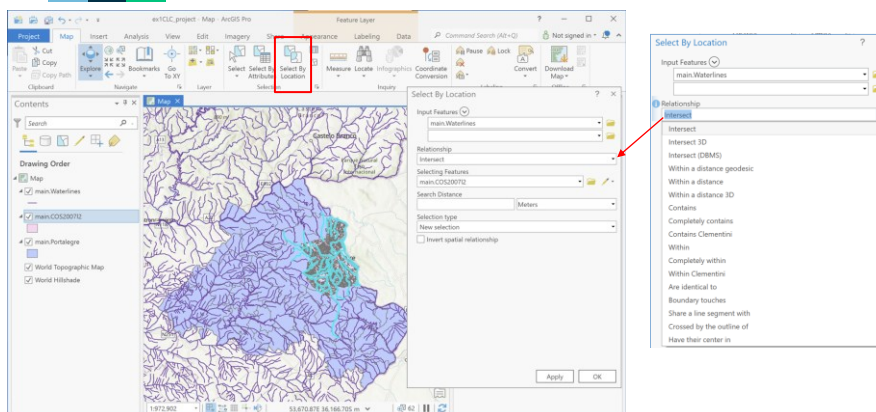
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Select by location



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Select by location



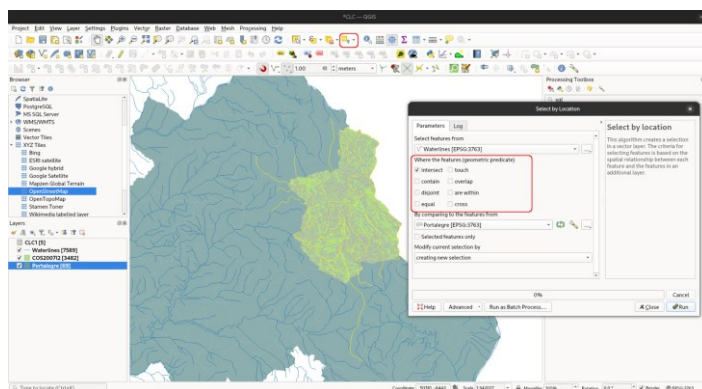
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Select by location



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Select by location



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Joining (Table Join and Relate, Spatial Join)

- The **Join** operation appends columns (attributes) from a second table based on a common value of two given attributes (**primary key** ↔ **foreign key**)
 - **best suited for 1:1 relationships**
 - usually the matching attributes are the foreign key of the table which rows are going to be appended and the (corresponding) primary key of the second table
 - the Join operation can be reversed (erased/deleted)
 - usually updates in joined tables are not allowed (at least for virtual attributes)
- The **Relate** operation defines a relationship between two tables
 - **best suited to 1:M or M:N relationships**
 - data isn't appended
 - a virtual table is created
- A **Spatial Join** uses location or proximity to join fields
 - Suited for tables that do not have a common field

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Relational DBMS (some more information)

- Relational DBMS are based on a set of theoretical concepts introduced on 1970 by **E. F. Codd**.
- Advantages of relational DBMS:
 - **simplicity** of concepts
 - the concepts have **formal definitions** based on the Set Theory
 - quick learning
 - generally adopted by different software development companies
 - they **support adequately** the representation of most characteristics of reality
 - entities, objects, phenomena
 - relationships among them

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Exercise

- Exercise 4 - Organizing geographic data
 - to be submitted by **28th September 2026 at 6 PM**

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Credits



The structure and content of the course, including most of the slides and exercises was developed by Professor Graça Abrantes (SIG 2021_2022) and Professor Rui Figueira (SIG 2023_2024)

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