

ISA

Geographic Information Systems 2026/2027

Lesson 08 - Revision of Hands-on Exercises 2 and 3,
- Resolution of Exercise 04
- Introduction to Model Builder/ Graphical Modeler

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Exercise 2

Knowledge Check:

- To prepare the working environment (create a project/working folder, DataIn, DataOut)
- QGIS and/or ArcGIS Interfaces (panels, standard and customized toolbars, zooming and panning)
- Geopackage and geodatabase files
- Add a map, data, and explore attribute data
- Change symbology and add labels
- Change base maps adding external data

Exercise 3

Knowledge Check:

- QGIS and/or ArcGIS Interfaces and Documentation
- How to create geographic data sets (gds) that follow specific requirements
- How to use some Geoprocessing Tools (clip, buffer, intersect, dissolve)
- How to conduct non-spatial operations (select features using logical expression/condition, join)
- How to add and edit attribute fields (calculate geometry, calculate field, delete field)
- How to update the symbology combining values from multiple fields (expression builder/dialog)

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Exercise 4

Knowledge Check:

- Organise a dataset according to the rules of the Normal Forms (NF)
- Create joins between geographic datasets and tables and visualize them in GIS

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Revisiting Normal Forms

- 1NF**
- No duplicate rows (**unique** rows)
 - No repeating columns
 - Each cell only contains a single value
 - Values in a cell must be non-divisible
 - Attribute values must be in the same domain
- 2NF**
- Table must be in 1NF
 - No partial dependencies: every **non-key attribute** must be fully functionally dependent on the **entire candidate key**, not just a part of it. **Candidate keys** are minimal sets of attributes that can uniquely identify a row. One candidate key is selected as the primary key. A **partial dependency** happens when a non-key attribute depends only on part of a **composite primary key** (a candidate key made up of two or more attributes).
- 3NF**
- Table must be in 2NF
 - No transitive dependencies: meaning non-key attributes should not depend on other non-key attributes.

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Exercise 4- Resolution

Task 01. Analyse the data columns and identify possible duplications and dependencies to be solved via data normalization

Map Fields: Ambiente_DMG..._XYTableToPrint X										
Current Layer: Ambiente_DMGVAE_en_XYTableTo										
Visible	Read Only	Field Name	Alias	Data Type	Allow NULL	Highlight	Number Format	Domain	Default	Length
☒	☒	OBJECTID	OBJECTID	Object ID	☐	☐	Numeric			
☒	☐	Shape	Shape	Geometry	☒	☐				
☒	☐	X	X	Double	☒	☐	Numeric			
☒	☐	Y	Y	Double	☒	☐	Numeric			
☒	☐	OBJECTID_1	OBJECTID	Long	☒	☐	Numeric			
☒	☐	COD_SIG_NEW	COD_SIG_NEW	Long	☒	☐	Numeric			
☒	☐	MORADA	MORADA	Text	☒	☐				8000
☒	☐	ESPECIE_VA	ESPECIE_VA	Text	☒	☐				8000
☒	☐	PAP	PAP	Long	☒	☐	Numeric			
☒	☐	MANUTENCAO	MANUTENCAO	Text	☒	☐				8000
☒	☐	OCUPACAO	OCUPACAO	Text	☒	☐				8000
☒	☐	LOCAL	LOCAL	Text	☒	☐				8000
☒	☐	TIPOLOGIA	TIPOLOGIA	Text	☒	☐				8000
☒	☐	FREG_2012	FREG_2012	Text	☒	☐				8000
☒	☐	NOME_VULGA	NOME_VULGA	Text	☒	☐				8000
☒	☐	GlobalID	GlobalID	Text	☒	☐				8000

Column	Description
OBJECTID	Unique identifier of the geographic feature
COD_SIG_NEW	Other unique identifier of the geographic feature
MORADA	Address of the location of the tree
ESPECIE_VA	Scientific name of the tree species
PAP	circumference at chest height
MANUTENCAO	Entity responsible for the maintenance
OCUPACAO	type of occupation
LOCAL	type of place
TIPOLOGIA	type of implantation of the tree
FREG_2012	Name of the freguesia
NOME_VULGA	common name of the tree
GlobalID	global unique identifier

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Exercise 4- Resolution

Task 02. Transform the dataset to a normalised format, according to the 3rd Normal Form

Double underline: *foreign key* single underline: *primary key*

```
ARVOREDO_NORM(X,Y,OBJECTID,COD_SIG_NEW,morada_ID,especie_ID,PAP,manutencao_ID,ocupacao_ID,local_tipo_ID,tipologia_ID,GlobalID)
ESPECIE_VA(especie_ID,ESPECIE_VA,NOME_VULGAR)
MORADA(morada_ID,MORADA,FREG_2012)
LOCAL_TIPO(local_tipo_ID,LOCAL)
MANUTENCAO(manutencao_ID,MANUTENCAO)
TIPOLOGIA(tipologia_ID,TIPOLOGIA)
```

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Exercise 4- Resolution

QUESTION 2: Include in the report screenshots of the first 10 rows of each table you created. The names of the columns should be visible and correspond to the text schema included in Question 1.

arvoredo_norm

1	X	Y	OBJECTID	COD_SIG_NEW	morada_ID	especie_ID	PAP	manutencao_ID	ocupacao_ID	local_tipo_ID	tipologia_ID	GlobalID
2	-9.112291113	38.76492639	1	2190	1	206	0	12	6	6	7	77fc6764-3d02-4810-a7b3-96a4e6c5f716
3	-9.111319844	38.76459284	2	2194	1	206	0	12	6	6	7	418f1611-ab67-4912-ae7a-0baec564f7f9
4	-9.111828981	38.76481876	3	2195	1	206	0	12	6	6	7	49faa812-065d-4e7a-a32b-724c44456f53
5	-9.111744782	38.76641835	4	2200	1	206	0	12	6	6	7	03dbae2c-728f-4262-ba78-fcb386b54651
6	-9.111535672	38.76477776	5	2202	1	206	0	12	6	6	7	8ecfab9b-c0ac-4264-0865-faadfcf62b5b
7	-9.112781359	38.75979928	6	2238	2	206	0	12	8	8	1	e082f3e9-62fe-4520-9a7b-1b73d2657f6d
8	-9.112203923	38.76487827	7	2261	1	206	0	12	6	6	7	b3822e9b-bd19-4c33-9045-57d7af68786c
9	-9.111833446	38.7651392	8	2263	1	206	0	12	6	6	7	bb393497-70bf-4f9a-b826-7f14fd1a6129
10	-9.111589912	38.76478435	9	2265	1	206	0	12	6	6	7	9e788f5e-bd51-476e-b966-ac3262586eb4

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Exercise 4- Resolution

especie_va

1	especie_ID	ESPECIE_VA	NOME_VULGAR
2	1	Abies pinsapo	abeto-espanhol
3	2	Acacia dealbata	acácia-mimosa
4	3	Acacia longifolia	acácia-de-espigas
5	4	Acacia melanoxylon	acácia-da-Austrália
6	5	Acacia retinodes	acácia-virilda
7	6	Acacia sp.	acácia
8	7	Acca sellowiana	Feijoa
9	8	Acer campestre	bordo-comum
10	9	Acer monspessulanum	zelha

morada

1	morada_ID	MORADA	FREG_2012
2	1	Rua Cidade de Benguela	Olivais
3	2	Rua Cidade da Praia	Olivais
4	3	Rua Cidade de Bissau	Olivais
5	4	Rua Almada Negreiros	Olivais
6	5	Não identificada	Campolide
7	6	Rua Rodrigues Sampaio	Santo António
8	7	Rua Camilo Castelo Branco	Santo António
9	8	Acesso IP7	Campolide
10	9	Não identificada	Alvalade

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Exercise 4- Resolution

local_tipo

1	local_tipo_ID	LOCAL
2	1	Cemitério
3	2	Em atualização
4	3	Escola
5	4	Espaço verde
6	5	Mata
7	6	Não identificado
8	7	Privado
9	8	Via pública
10	9	Viveiro

manutencao

1	manutencao_ID	MANUTENCAO
2	1	Administração Central
3	2	APL
4	3	CML
5	4	Condomínio
6	5	DJ
7	6	DMREV
8	7	EDIFÍCIO PORTUGAL TELECOM
9	8	EGEAC
10	9	Em atualização

ocupacao

1	ocupacao_ID	OCUPACAO
2	1	Arvore
3	2	Arvore seca
4	3	Cepo
5	4	Eliminada
6	5	Em atualização
7	6	Não identificada
8	7	Pavimentada
9	8	Vazia

tipologia

1	tipologia_ID	TIPOLOGIA
2	1	Caldeira
3	2	Canteiro
4	3	Em atualização
5	4	Espaço verde
6	5	Floreira
7	6	Floreira Amovível
8	7	Não identificada
9	8	Outra
10	9	Sem caldeira

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Exercise 4- Resolution

QUESTION 3: How many trees with the type of implantation Canteiro exist in freguesia ALCÂNTARA? Describe how did you determine it.

There are 133 trees in freguesia Alcântara with the implantation of type canteiro.

The following steps were followed to achieve the solution:

1. From CAOP select by attribute all freguesias that belong to the Município (municipality) Lisboa, and create a new layer Lisbon_freg
2. Add all csv tables to GIS project.
3. Table arvoredo_norm is added as a csv file with point geometry, where x are longitudes and y latitudes.
4. Create table joins between arvoredo_norm and each of the tables, setting the primary key and foreign key of each table as defined in question 01
5. Make a spatial join/ join by location operation between arvoredo_norm and Lisbon_freg, to add the name of freguesia to the attribute table of the first table. This is necessary to avoid possible errors in the naming of the freguesia in the original table.
6. Select by attribute/select by expression using the field Tipologia and selecting "Canteiro" and summarize/select by category counting the number of trees

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Model Builder- ArcGIS Pro

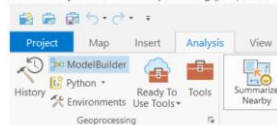
ModelBuilder allows users to create, automate, and execute geoprocessing workflows by connecting different tools and datasets in a flowchart-like model.

1. Visual Workflow Creation (drag- and drop-interface)
2. Automation of Tasks (Repetitive geoprocessing tasks can be automated, reducing manual effort and errors)
3. Logical Flow of Processes (outputs of one tool become inputs of the next tool to be used)
4. Parameterization (Users can set model parameters, allowing flexibility when running the model with different inputs)
5. Integration with Python (ArcPy) (Models can be converted into Python scripts for further customization)
6. Reusability & Sharing (Once created, models can be saved, shared, and reused by other users)

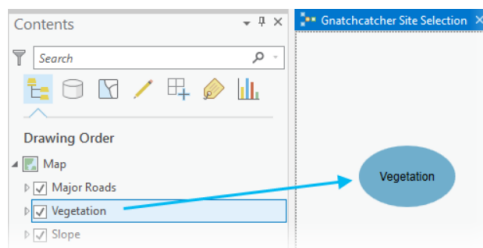
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Model Builder- ArcGIS Pro

On the **Analysis** tab, in the **Geoprocessing** group, click **ModelBuilder**.



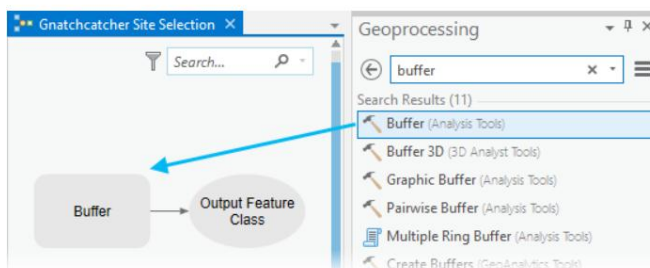
To add data, drag layers from Contents, and datasets from the Project into the model. The layers and datasets are added to the model and display as input data variables.



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Model Builder- ArcGIS Pro

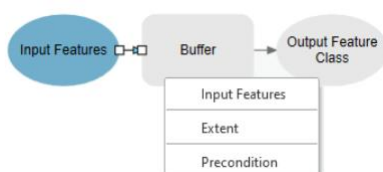
To add geoprocessing tools to your model, make sure the model view is active, then start typing to search for a tool. Alternatively, drag a geoprocessing tool into the model from the Geoprocessing pane or Catalog pane.



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Model Builder- ArcGIS Pro

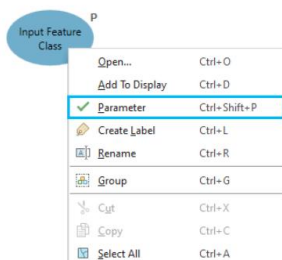
To connect the data variables directly to a tool by **drawing a connection between them**, then choose the tool parameter to which to connect the variable. You can connect the output of one tool as input to another tool.



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Model Builder- ArcGIS Pro

Set model parameters: Variables that are set as model parameters show as tool parameters when the model is run as a geoprocessing tool, allowing you to specify different data or values for your model to process than what was specified when the model was created.



Examples of Model Parameters (P) Usage

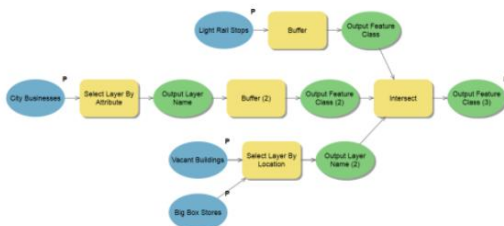
- User selects an input feature class before running the model
- Specify a buffer distance dynamically
- Choose an output location instead of using a fixed path

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Model Builder- ArcGIS Pro

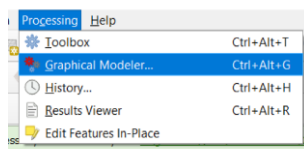
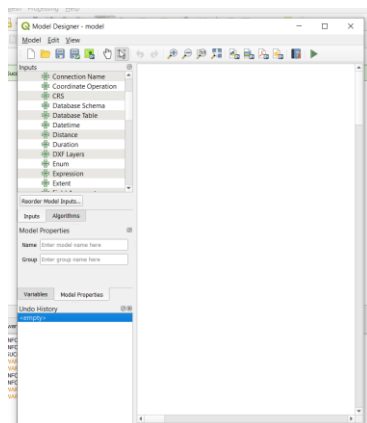
Click the **Run** button  on the **ModelBuilder** tab to run the entire model.

While the tools in the model are running, a progress window appears to indicate which tool is running and any messages. As a model is running, the actively running tool is highlighted in red.



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Graphical Modeler-QGIS



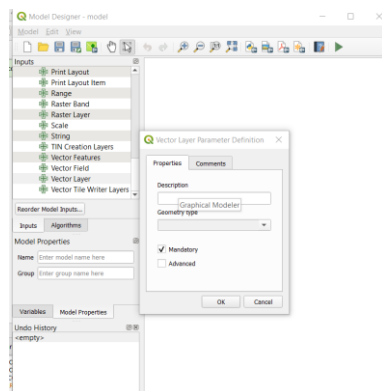
The Modeler window opens with:

- **Inputs Panel** (to define user inputs)
- **Algorithms Panel** (to add geoprocessing tools)
- **Canvas Area** (to build the model visually)

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Graphical Modeler-QGIS

The first step is to define the inputs for the model.

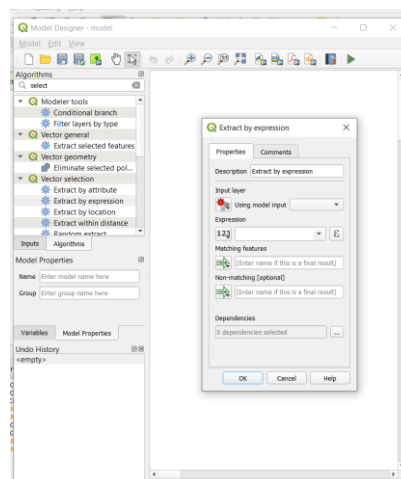


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Graphical Modeler-QGIS

The next step is to define the algorithms of the model.

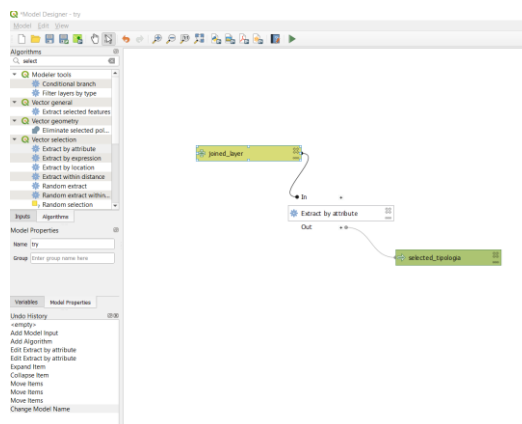
Algorithms are grouped in the same way as they are in the Processing toolbox.



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Graphical Modeler-QGIS

Once all the parameters have been assigned valid values, and the algorithm will be added to the canvas the connections between the elements will appear automatically.

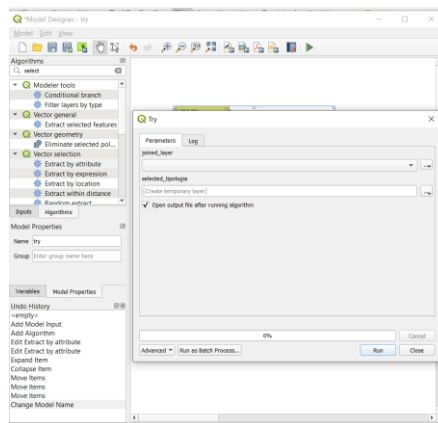


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Graphical Modeler-QGIS

Save Validate and Run the model

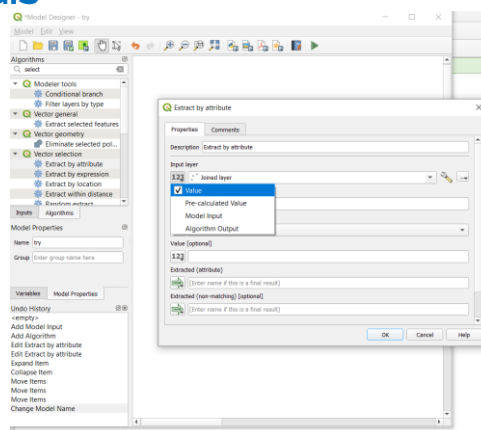
When we use model inputs rather than defining specific layers, this message will appear for the user to set the layers for each model input



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Graphical Modeler-QGIS

When you set the algorithms, you can use value instead of model input and select the layers from the layer contents.



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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) and Angeliki Peponi (SIG_2024_2025)

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