GIS Exercise 29-11-2019

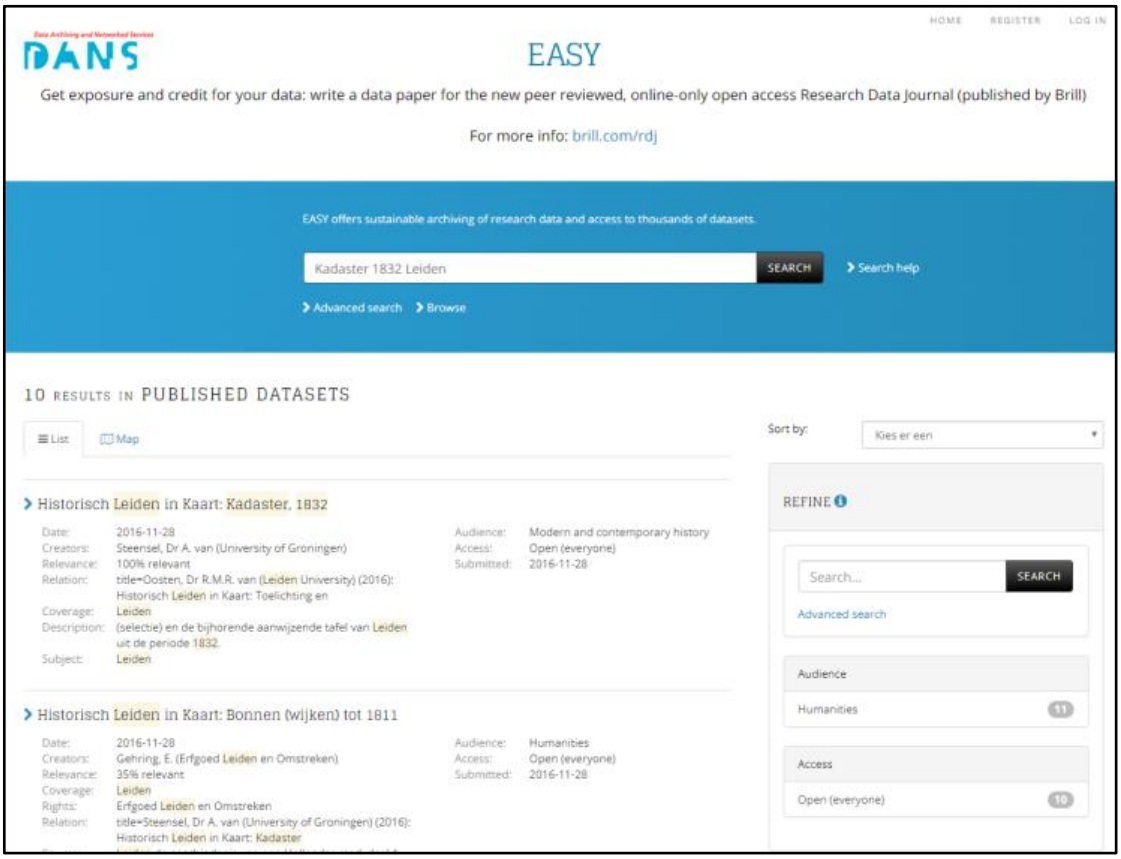
General remarks:

- Be careful when scrolling in QGIS. Within many menus in the program you change a setting that you have previously clicked by scrolling. Try to work through the menus in a more relaxed way and click more instead of scrolling.
- Words with a > and a bold marking **(> example)** refer to the index at the end.
- **Bold words** refer to a button or an action in QGIS.
- Always check where you save your files. Both files that you download, files that you make yourself, or even converted files, always give QGIS a location to save them.

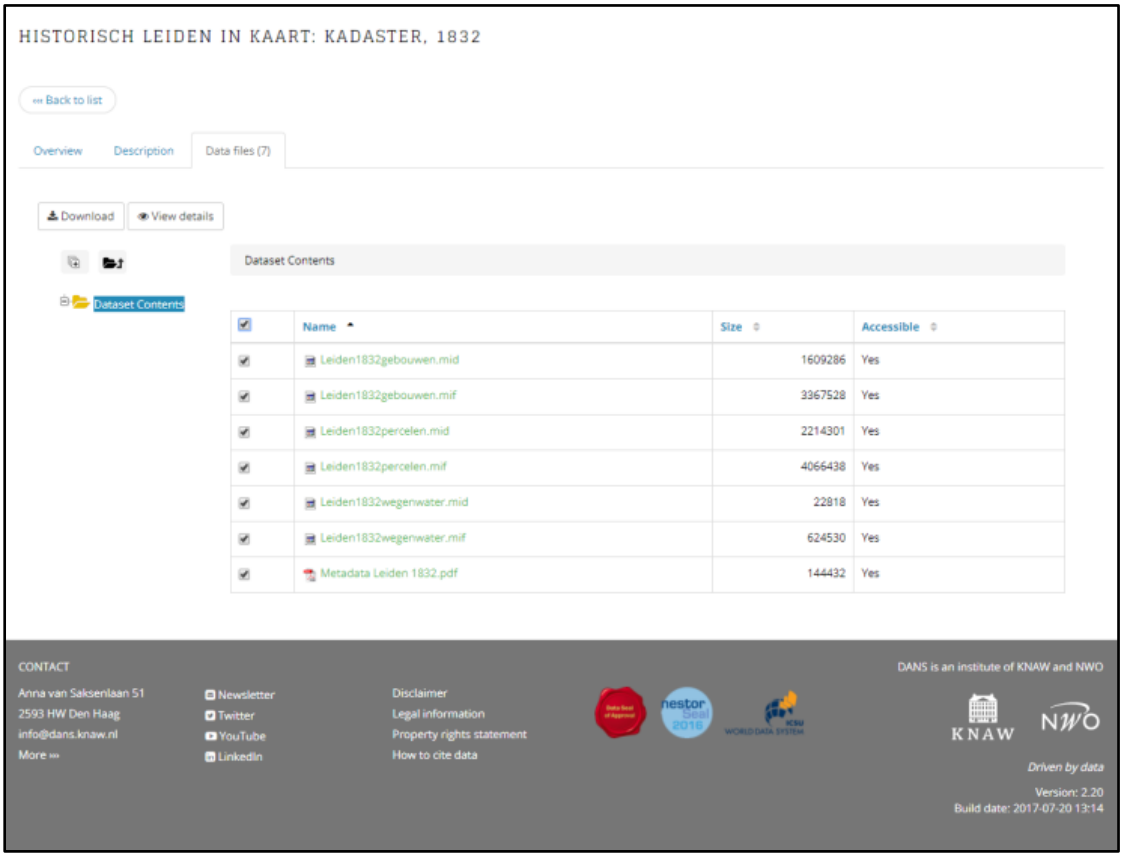
EXERCISE 1: FIRST STEPS WITHIN GIS

For this first exercise we get our data from the DANS website (Data Archiving and Networked Services). This is the Dutch institute for permanent access to digital research data. DANS encourages researchers to make their digital research data findable, accessible, interoperable and reusable. You can find the EASY platform on the DANS website. Here scientists can put their datasets online, so that their research can be checked or used by others. In this exercise you will work on a local topic: the city of Leiden.

- Go to the EASY website: https://easy.dans.knaw.nl/ui/home
- Search for the dataset with the Land Registry of Leiden, in the search bar type: Kadaster 1832 Leiden
- The first result is called: *Historisch Leiden in Kaart: Kadaster, 1832*. Click on this result. (See Figuur 2)
- You now have the option to view different parts of the dataset. At Overview you see a short description, the relationship with other research and the correct way of citing. At Description you will find the detailed description and the metadata **(> metadata)**. With Data Files you can download the actual dataset in various parts. Go to Data Files, check all options and download the entire data set. (Figure 1)



FIGUUR 2



FIGUUR 1

You have now downloaded a .zip file containing the dataset. It is good practice to create a folder with every GIS project containing your files, so that they are not scattered across your computer.

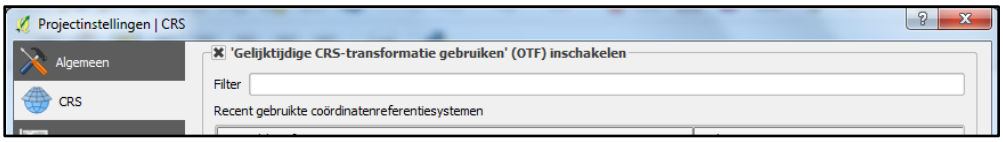
- Go to your Documents folder and create a folder with the name GIS Exercises. Make another folder in that folder called Exercise 1. Copy your .zip file to this folder and extract the file from there. (Right-click on the file, with 7-ZIP you click on extract (here))

Without QGIS you can't do that much with the .mip and .mif files. The PDF file *Metadata Leiden 1832* is very useful for learning more about the data file itself.

- Open the PDF file and start QGIS.
- When the program is loaded you will see a message with tips, which you can click away. Then create a new file in QGIS.

A first important step in every new project is to set up the Coordinate Reference System (CRS) **(> CRS)** or Spatial Reference System (SRS) **(> SRS)**. A CRS contains all kinds of information about the projection of the earth, which is a sphere, to a flat surface. It contains information about the location, references and distortions of a projection. A CRS therefore indicates how the real world is represented on a two-dimensional map. Locating on the basis of coordinates and measurements has been done by people for centuries. Since every country or area makes its own calculation in its own way, due to all kinds of local differences, there are also many different coordinate systems. Since we work with a data set that has already been compiled, it is useful to copy the CRS from this data set.

- Search in the PDF file *Metadata Leiden 1832* which CRS it is using. Hint: the Dutch word is "referentiesysteem".
- Set this CRS for your project. You do this at **Project > Project settings > CRS**. If necessary, check the box above with the text "Use simultaneous CRS Transformation". In the **Filter** function you can search for the name or number. (Figure 3).
- Fill in the number you found and select the correct CRS. Click **Apply** and after that **OK**.



FIGUUR 3

The worksheet in QGIS is now completely empty, but the CRS is already set. You are now going to load the downloaded data set into QGIS.

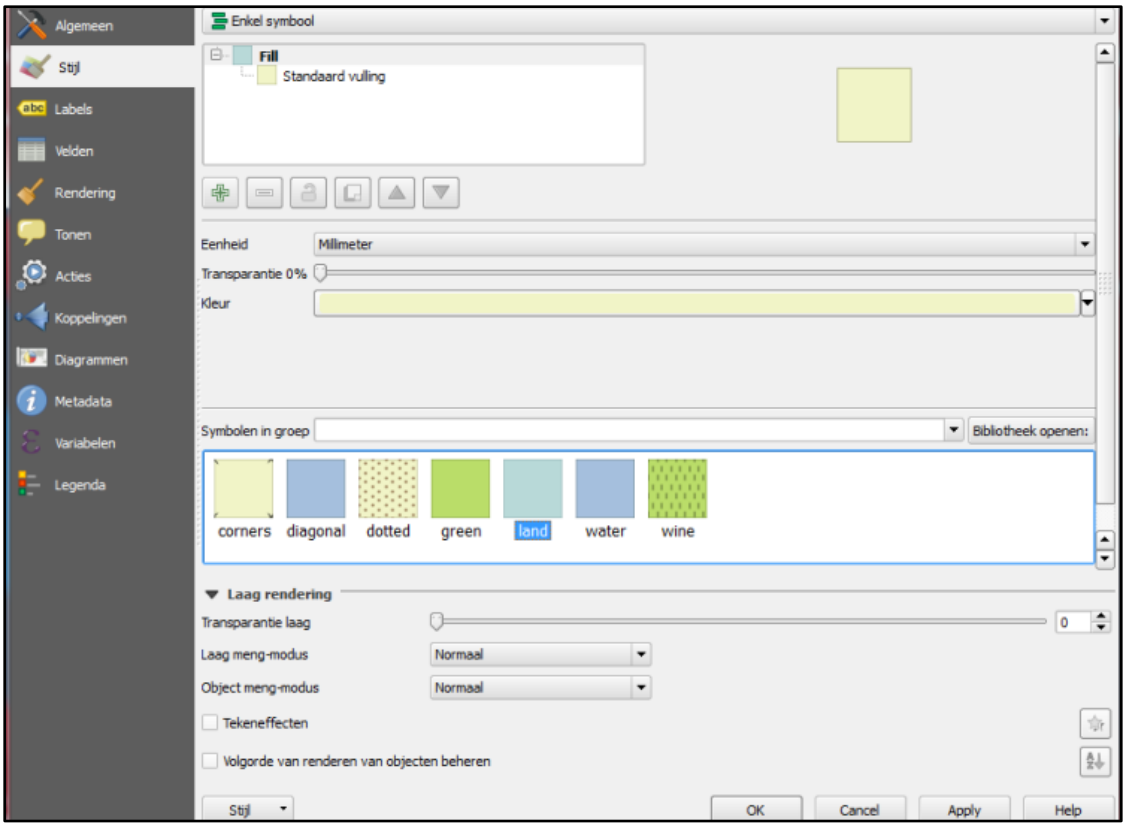
- In the left menu, click **Add Vector Layer**. This is also possible via the top menu via **Map Layers> Add Layer> Add Vector Layer**.
- The dataset Kadaster Leiden 1832 consists of three layers, load these three layers in QGIS. It is the files with the .mid extension. You can select all three at once when loading.
- Save your file in the Exercise 1 folder. You can do this via **Project > Save as**. Name your file Exercise 1. By default, a working file in QGIS has the extension .qgs, just as a Word file has .doc as an extension.

The three layers of the dataset are now in a random (and perhaps wrong) order. On the left side of your screen you will see the **Panel Layers (> Panel Layers)**, there are the three layers that you have just loaded. This panel is like a table of contents for your QGIS project. You can change the order by dragging the different layers. The most logical order of these three layers would be the layer with roads and water at the bottom, above the parcels (percelen) and finally the buildings on these plots. However, the roads and canals appear twice in the dataset, also in the layer with plots. To keep the whole thing usable, we'll use a slightly different order.

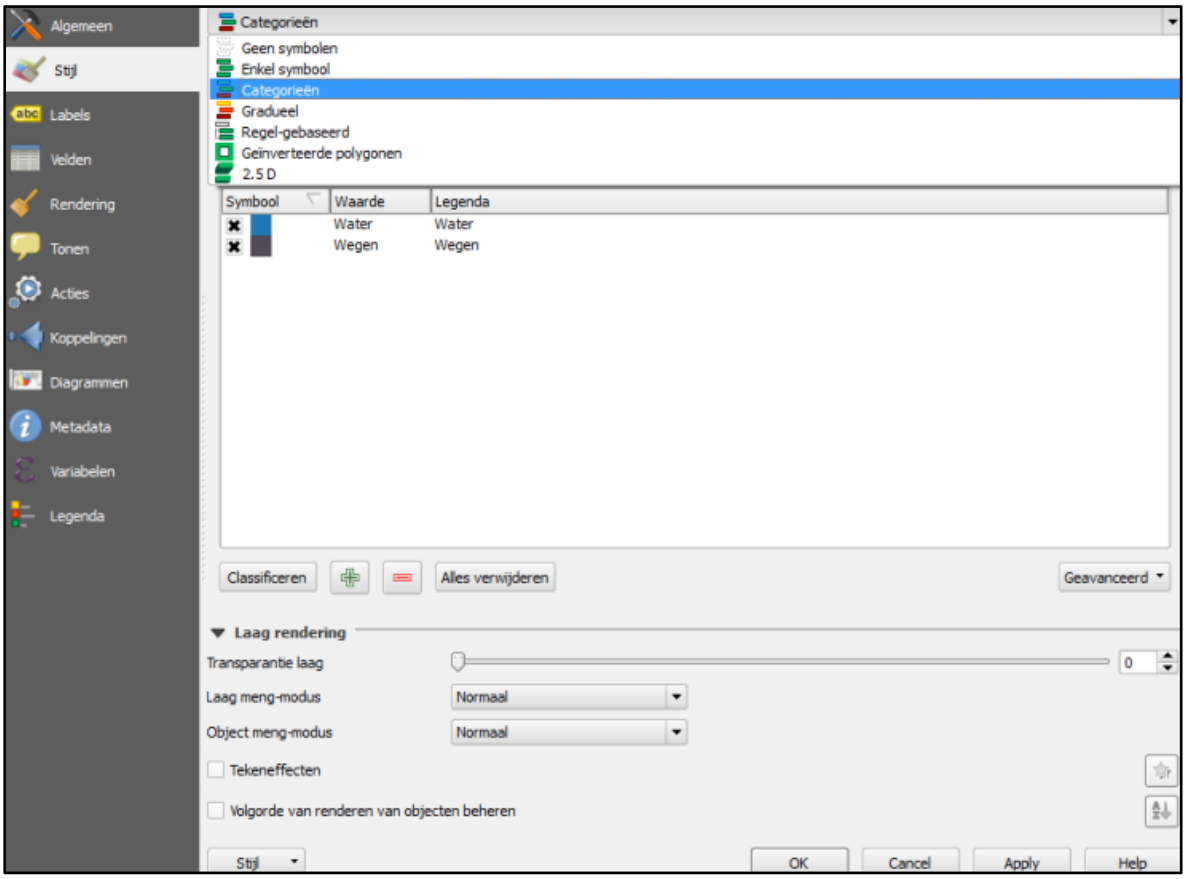
- Drag the layers from the dataset in the most useful order:
    1. Wegen en water (roads and water)
    2. Gebouwen (buildings)
    3. Percelen (parcels)

QGIS displays each vector layer with a random color. This is not always the most ideal or attractive color. It is worth remembering that making maps also involves an important visual aspect. For now it is important that you know how to adjust the colors of each layer. Start with the layer containing the roads and water.

- Right-click on the name of the layer in the table of contents, and then click **Properties**. With **Style** you can adjust the color of the layer. As you can see, you have several options: Single symbol, Categories, Gradual, etc. Since the vector layer *Wegen en water* displays both roads and water, one color for the entire layer is not sufficient.
- Change the layer from **Single symbol** to **Categories**. You now indicate that you want the colors to be determined in a different way, namely no longer by a single color. With a GIS you can let the software communicate with your dataset. This is exactly what we are going to do now. (Figure 5)
- Under **Categories**, click the arrow next to **Column**. You can now indicate which column from the dataset shows what water and what a road is. Select Soort_eige (Type of Property). Click on Classify.
- QGIS now shows the types of property that appear in this column. In this case there are only two: water and "wegen" (roads). QGIS also automatically adds a third class without name or value. This extra empty class is useful when creating your own layers and displaying those elements which have no value. For now, remove this third class by selecting it and then clicking the red minus sign.
- You can change the colors of a layer by double clicking on the box with the color. Add the color menu you can select another color in the triangle with the arrow, or choose one of the standard colors. Change the symbol of the water value to a color blue and the symbol of roads to a dark gray color (Figure 5). Click **Apply** and then **Ok**.
- The other two layers also have different classes, but for now we will display them with a **single symbol**. Make sure that the layer *Percelen* (parcels) has a yellow color. Color the layer *Gebouwen* (buildings) red.



FIGUUR 4



FIGUUR 5

Perhaps the map does not yet look exactly as you would like it to be. QGIS automatically adds a colored border to each layer. You can change this by clicking on Standard Fill under Style under the word Fill. You get all kinds of options for the layer fill and border.x

- Give the stroke (edge) of the Parcel layer a beige color. Make the **stroke width**0.1 mm.
- Give the stroke of the Buildings layer a dark red color. Make the **stroke width** 0.1 mm
- Make the strokes of the layer *Wegenwater* transparent.

If all went well your map should look something like this:

FIGUUR 6

Every building and plot in your work file in QGIS is connected to a row in the data set. In a GIS this is also called the Attribute table **(> Attribute table)**.

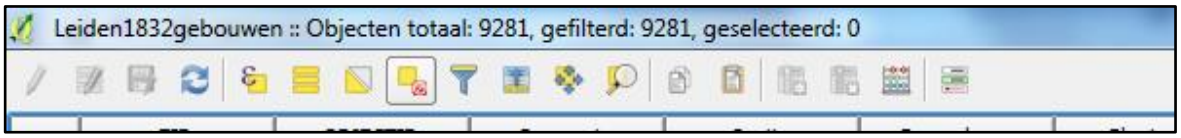
- Open the Attributes Table of the layer *gebouwen*: Right-click on the layer in the **layers panel> Open attributes table.**

QGIS opens the attribute table in a new window: you now see a properly filled table in front of you. Every row is an object, in this case a building in the city of Leiden. Each column represents information about this object. You can select a line in the attribute table and immediately see what it is in the map.

- Scroll to the building with the OBJECTID (the second column) 13186. Select the row by clicking on the left box, the boxes are to the left of the FID column.
- Go back to the map with Alt + Tab.
- You can see that you have just selected the Pieterskerk in the attribute table. QGIS has marked this with yellow. When you zoom in on the building, you can see how detailed the edges are.

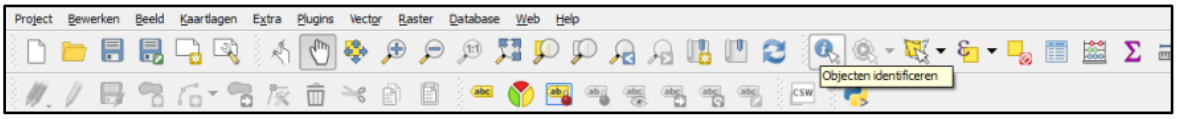
You can also perform a manual selection the other way round: via the map and not via the attribute table.

Go back to the attribute table (Alt + Tab) and click on the **Deselect Features from All Layers** icon at the top .



FIGUUR 7

- Go back to the map.
- At the top of the menu you can select different 'pointers', these pointers decide what happens when you click somewhere in the map.
- Click the **Identify Features** icon.



FIGUUR 8

- Next, click on the Pieterskerk on the map. Make sure that the layer *gebouwen* is selected in Layers on your left. You will now see a screen with **Identify Results** on the right. Here, the same results of the attribute table appear, but in a list.

When working with QGIS you sometimes want to give extra attention to special matters in a dataset. This is possible, for example, by giving the objects a different color.

- **Select** the layer with buildings and go to the **properties** of this layer. Then go to **Symbology** . A few steps back you have already adjusted the color of all layers. You can also do this based on information in the Attribute Table.
- At the top, select the drop-down menu that now shows Single Symbol. Select Categorized. Next, at the row with Column, select the column that shows the type of property: *Soort_eige*. Click **Classify**. QGIS then creates a list of unique values that appear in this column. Click **Apply** and see the result on your map: Leiden has turned into a colorful collection of buildings.

This result is nice, but not well-arranged. There are too many different types of buildings in the column. Leiden is known for its old architecture, among other things. Churches are part of this image. Let's try to make them stand out on the map. You could, of course, adjust features in the database itself, but you could also highlight certain buildings in a different way.

- Again, go to the **Symbology** of the layer *Buildings*. Make the layer Single Symbol again and color the buildings red.
- Then select **Rule-based** in the drop-down menu. We are now going to use a little bit of logical programming, or rather, come up with a logical rule as an exception to the symbology of the *Buildings* layer.

- **Click the green plus symbol** in the lower left area of the menu. A menu called **Edit Rule** appears . Name the label: Church Buildings. Subsequently click the icon with the Epsilon (ε). In this menu, the *Expression String Builder*, you can formulate an expression. In programming, this is a combination of all kinds of values and variables that yield a certain value themselves. In this case we are going to tell QGIS that we want to give certain buildings a different color.
- In the middle is a box with all kinds of terms, Arrays, Conditionals, Conversions, and so on. **Select Fields and Values**. You can see the names of all columns in the attribute table of the *Buildings* layer. **Double-click** *Soort_Eige* . This appears in the left box between quotation marks. Press the = sign. In the right-most box, **click All Unique**. It will show every unique term that is featured in this column. **Double-click** the Dutch word for Church ('kerk') in this box.

You will have now typed: "Soort_eige" = 'kerk'. But there is a problem, which is very common when using GIS: there is a flaw in your data. If you would apply this rule, not every church will show up with a different color, because some have a different name in this column. Try to keep this in mind when working with data sets in the future. Let's extend this current rule in the Symbology.

- Type the word OR in the left box, after the text you just created. This will tell the String Builder that you want to add another condition to this rule.
- Repeat the previous step, but instead select 'kerk en gebouwen' (church and buildings). If all went well you should have created this rule: "Soort_eige" = 'kerk' OR "Soort_eige" = 'kerk en gebouwen' **Click OK**.
- In the Edit Rule menu, **select a color** for the church buildings, one that stands out among the red buildings. Then **click OK** . You can see that a row for church buildings has been added under the red box. **Click Apply**. View the result of your work on the map.

Making your own data

Another important part of using GIS within your own research is creating your own data sets. For now, it is not that important what kind of information we use, but that you learn how to make these kinds of layers. We will make three different layers within Leiden: points, lines and polygons.

- Go to **Layer > Create Layer > New Shapefile Layer**.

This is your standard interaction menu when creating a new layer. The next step is the most important: save your file!

- Type in a **File Name**, "Points Test", and select a location to **save** your file using the symbol with the dots next to that line.
- **Select** the **Geometry type**: Point.
- **Select** the correct **CRS**, as you want your layer to be in the same projection as your project.

The rest of the menu is made up of the New Field part. Here you can choose to add columns to the database that is behind this layer.

- Add three Fields to this layer. One named "Name", which is of the **Text data type**, with a length of 99. One named "Height", which is an **Whole Number type** with a length of 1. And last but not least, a field named "Value", also a **Whole Number type** with a length of 3**.**
- **Click OK** to create the layer.

You will now see a new layer, under the Layers menu to the left, remember that it is a kind of table of contents. This new point layer is still empty and needs to be filled.

- Go to the **Toggle Editing** mode, the symbol with the pencil and click on it. Make sure that the layer you want to edit, in this case the layer “Points”, is selected in the Layers to the left.
- Next to the pencil you will see a symbol depicting points. This is called **Add Point Feature.** You use this tool to add new points to the layer.
- Try to add ten points to the layer. Fill in a name: this can be “one”, “two”, etc. Fill in a random number as height between 1-9. Also add a random value between 1 and 99.

We are now going to do the same thing, but with lines and polygons.

- Make a new layer called “Lines”. Instead of height, call the field width, and add a random number when adding the lines. Make 5 different lines (or paths) through Leiden, using the streets.
- Make a new layer called “Polygons”. Again, add the fields “Name”, “Height”, and “Value”. Make the polygons cover some of the neighborhoods of Leiden. It is up to you how many polygons you make.

There are few things you could have noticed while making new layers. Each type requires a different way of creating new features. Creating a point is simply one click, but adding polygons or lines requires some more work.

We will now decide with the class what to do next. If you worked on this exercise yourself, please talk to the instructor.

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Metadata: the information about a file or dataset, for example the author or the date. Sometimes this is crucial information about how you can use the file in question.

CRS / SRS: coordinate reference system or spatial reference system. The system used to locate geographical entities. It defines the map projection and surface transformation.

Layers: the contents of your QGIS project. Located at the bottom left of the screen. Every layer that is in your project is featured here.

Vector mode: a way in which objects are visualized in a GIS. A vector model consists of points, lines or polygons. Each object has a link to a database, where the attributes of each object are described. This database is called the attribute table in QGIS.

Raster model: a way in which objects are visualized in a GIS. A grid model consists of rows and columns (a matrix) of pixels. A raster file and a normal image (such as a .jpg) are more or less the same in GIS, both are raster models.

Attribute Table: every vector model is associated with an attribute table. This is the data set of each layer. Each line is connected to an object (a point, line or polygon). Each column contains a variable that has been added by the creator of the data set, or by the user himself.

Query (builder): several tools in QGIS use a query. It is a way to select or calculate something within a database. You write a question, also called an expression, in a language that the computer understands, for example SQL (Structured Query Language).

Plugin: an application or addition in QGIS designed by a user. A plugin usually has a specific function such as creating a heat map or georeferencing a map.

Layer properties: within the layer properties menu you will find the most important information about the layer. This is the place where you adjust how the layer is displayed.

Georeferencing: the process of making an image or old map "geographic". Multiple points are placed on an old map and subsequently as precisely as possible on the same location on a modern map. A coordinate is added to the points. An application or plugin in which you can georeference (a georeferencer) can then add the map as a layer to a GIS with various calculations. This will always be in the form of a raster data model, as it is a picture.

Strings: a series of characters, or string. In short, a piece of text. A string is also called a data type. This is mainly used for programming. A computer or program must know whether a piece of information consists of numbers or text.

Integer : a number without decimals. A data type. Remember that QGIS is able to do “more” with the integer data type, for example, calculate something.

Float : a number with decimals. A data type.

Polygon: a flat plane with at least three corners. A closed system of different lines that together form a (flat) surface. This is a display type within the vector data model.

North arrow: the arrow in a map that indicates the north.

Digitizing or vectorising: tracing a georeferenced map or parts of a georeferenced map. This is what makes a map interactive and how an old map can be converted to a vector model.