USER'S GUIDE TO LIDENBROCK

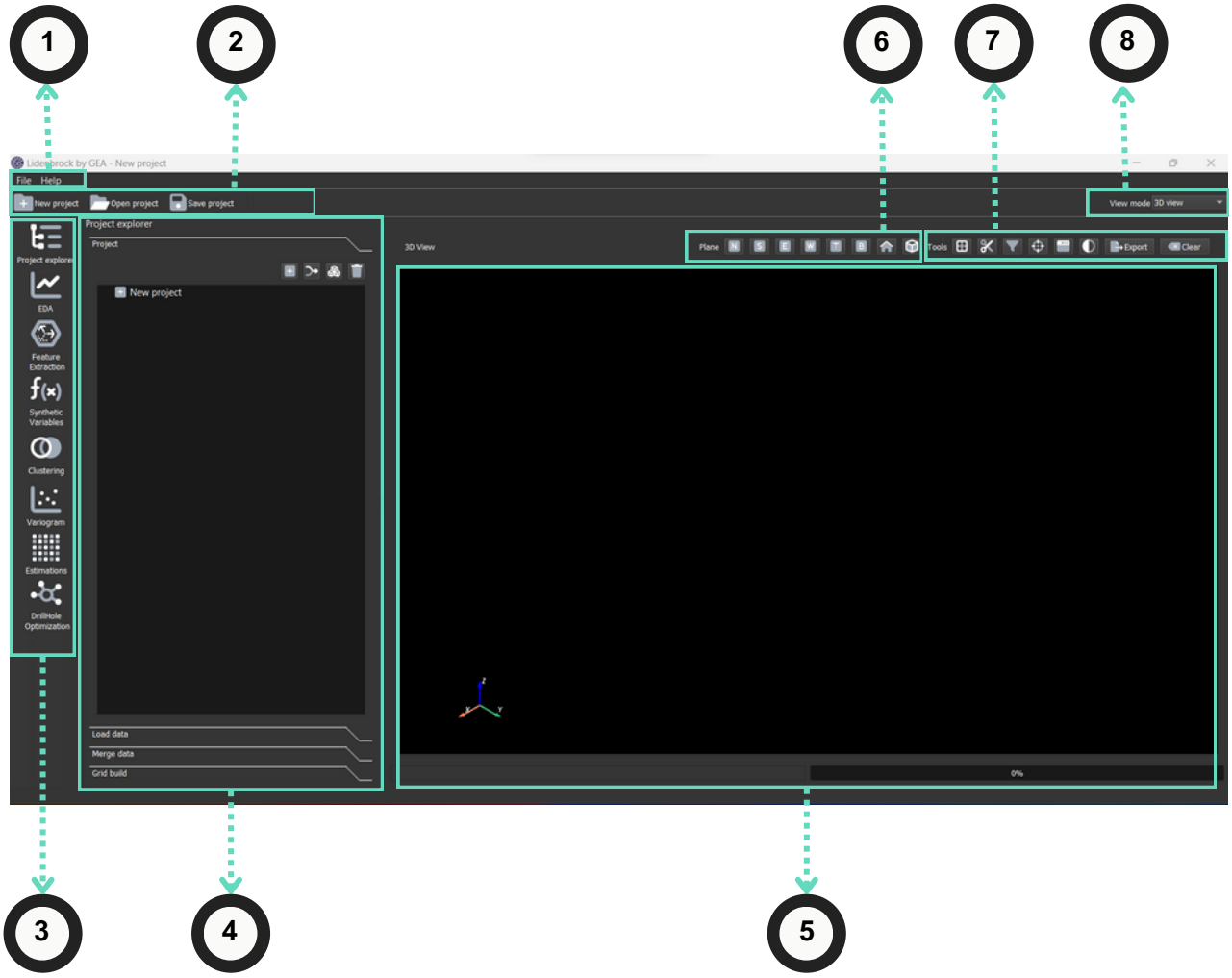
LIDENBROCK

TABLA DE CONTENIDOS

LIDENBROCK

TABLA DE CONTENIDOS

1. LIDENBROCK™ INTERFACE

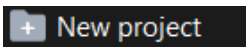


1. Main bar
2. Projects
3. Module bar
4. Tree view
5. Display panel
6. Visualization planes
7. Visualization tools
8. Display mode

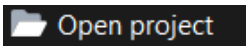
1. LIDENBROCK™ INTERFACE

1 Main bar

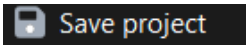
File: Manage your project files from this item.



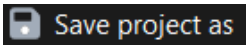
Create a project (Ctrl+N): Creates the destination folder from the file explorer.



Open a project (Ctrl+O): Selects the destination folder from the file explorer.



Save project (Ctrl+S): Saves a new project.

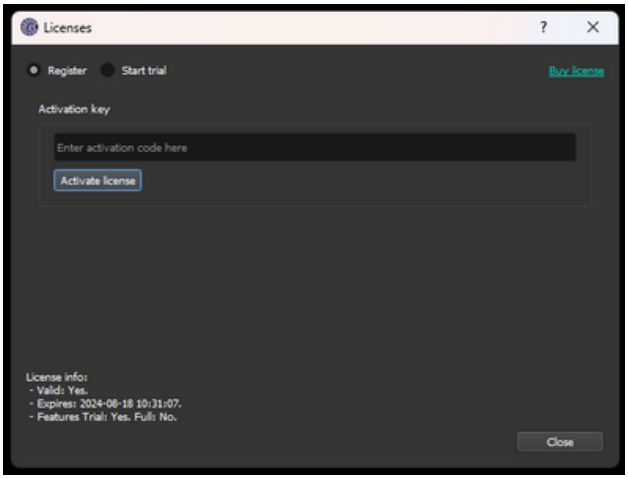


Save project as (Ctrl+Alt+S): Creates a new destination folder.

Exit: Closes LIDENBROCK™.

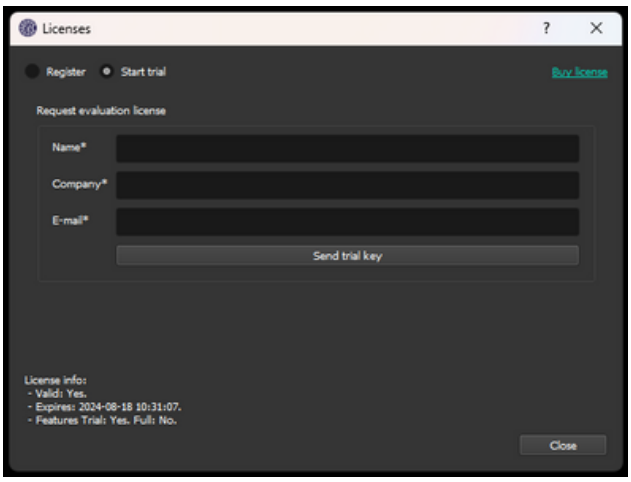
Help: Manage your project files from this item.

Register: Get information about your license status



*If you **already have your activation key**, please enter it to activate your Lidenbrock™ License.*

1. LIDENBROCK™ INTERFACE



*If you **don't have your activation key,** you can request one by entering your details.*
You will have 15 days to explore Lidenbrock™.

About

About us: Get information about your Lidenbrock license, terms and conditions of your license or contact us.

Check the availability of updates. Bug fixes are constantly being made and new modules and enhancements are being implemented. keep your version of LIDENBROCK™ up to date.

Report issues

Report problems: Fill out the form to report bugs. We will work to resolve it as soon as possible.

2 Projects

New project

Create a project: Create the target folder from the file explorer.

Open project

Open a project: Select the target folder from the file browser.

Save project

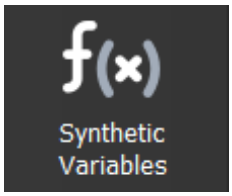
Save a project: Saves a new project.

3 Module bar

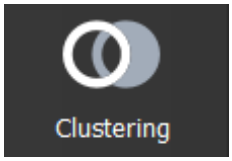
Project Explorer: In the project explorer you can manage your projects, display your data, create projects, load new data sets, join data sets and build grids for your block models.

EDA: In the exploratory data analysis module, you can choose up to 12 statistical models to analyze the quantity, quality and location of the available data, define the study area and/or divide it into sub-areas and anticipate difficulties due to outliers, which may arise in your local estimates. Get to know the main characteristics of your datasets to drive your next project through the different graphical visualization methods: Scatter Plot, Histogram, Boxplot, Violin Plot, QQ Plot, PP Plot, Correlation, Ternary Plot, 2D Density, Contact analysis, Drift Plot and PCA.

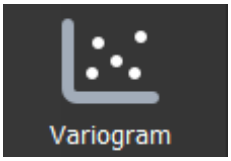
Feature Extraction: Principal component analysis allows to analyze large data sets containing a high number of dimensions/characteristics per observation, to increase the interpretability of the data while preserving the maximum amount of information and to allow the visualization of multidimensional data.



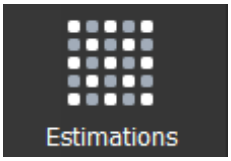
Synthetic Variables: This module focuses on improving database imbalance with variables from different assays (geochemical, metallurgical, geological interpretation, etc.) through a variable generated using the Variable Creation and Equation Finder tools.



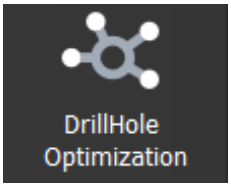
Clustering: Module to differentiate groups of data according to their behavior. With the K-means and Hierarchical clustering tools, you will find two statistical methods to group your data and simplify your searches.



Variogram: Know the directions of maximum continuity and anisotropies in a reservoir. Use this geostatistical module to describe the spatial geometry of regionalized variables and integrate geostatistics into the evaluation of a reservoir.



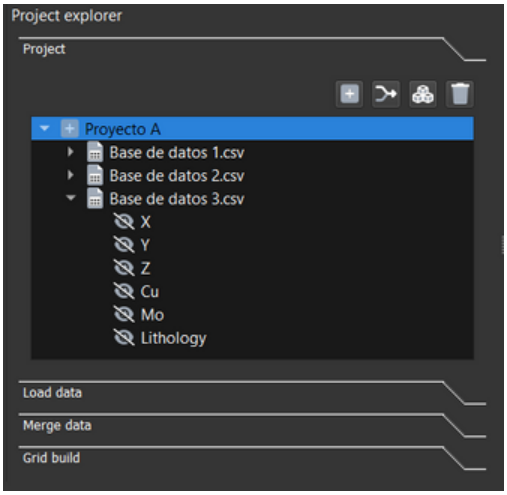
Estimations: In this module you have access to 4 different data estimation tools. Use Kriging estimation, do Kriging cross-validation, estimate by inverse distance weighted (IDW) or create swathplot analysis.



Drill Hole Optimization: Optimize your drilling campaigns with this module that uses machine learning to learn from your data. It finds an optimization algorithm and chooses the function that best fits your data.

4 Tree view

Through treeview you can interact with your projects and databases to test the different analyses and visualizations available in Lidenbrock.

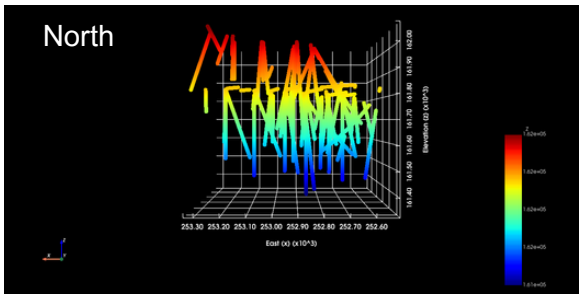


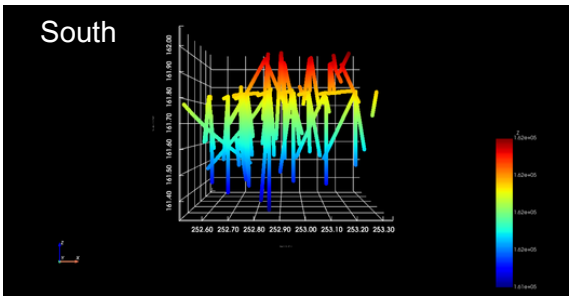
5 Display panel

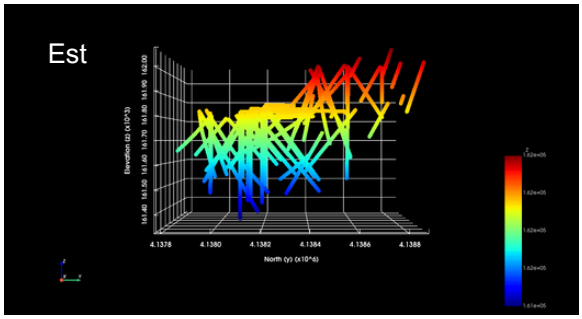
In the viewer your analyses will be displayed, you can use the 3D View Plane bar, to choose viewing planes. Or use the Tools bar to configure different visualization parameters of your data.

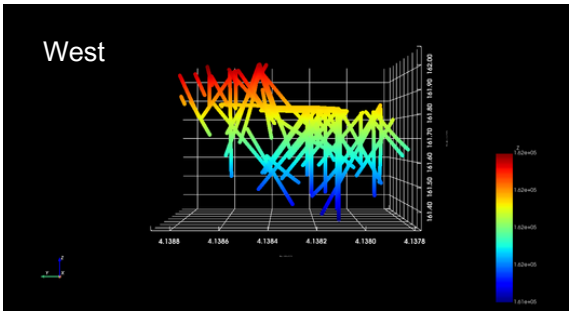
6 Visualization planes

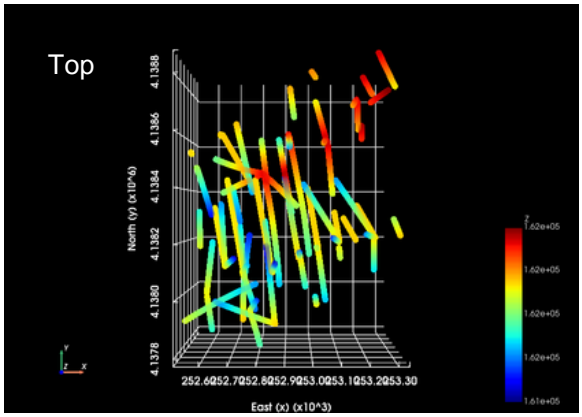
Configure the viewing plane that suits you best. Use the top panel to define the view in the North (N), South (S), East (E), West (W), Top (T) and Below (B) planes to understand the spatial distribution of the data in the 3D View Plane.

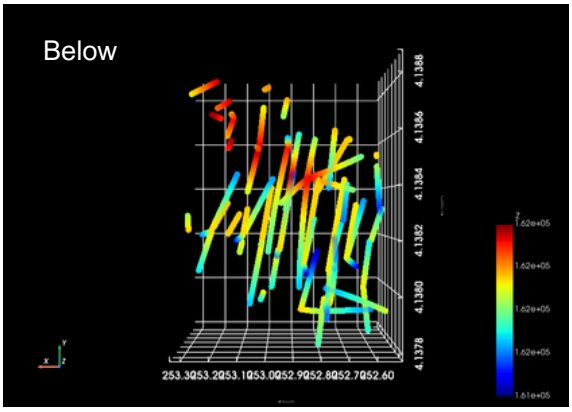


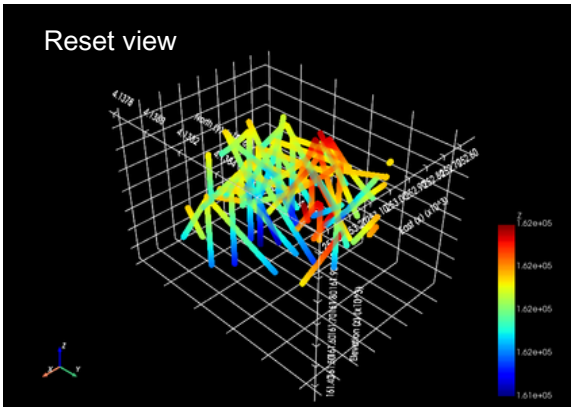


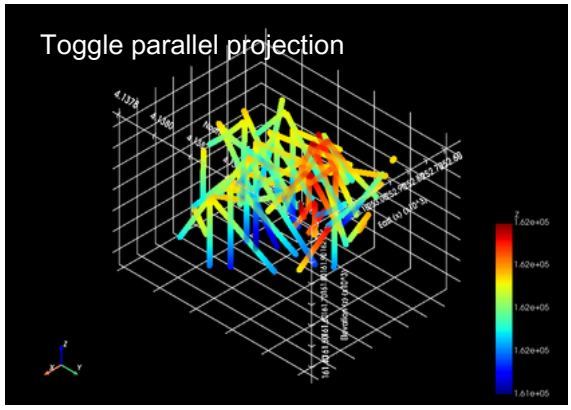








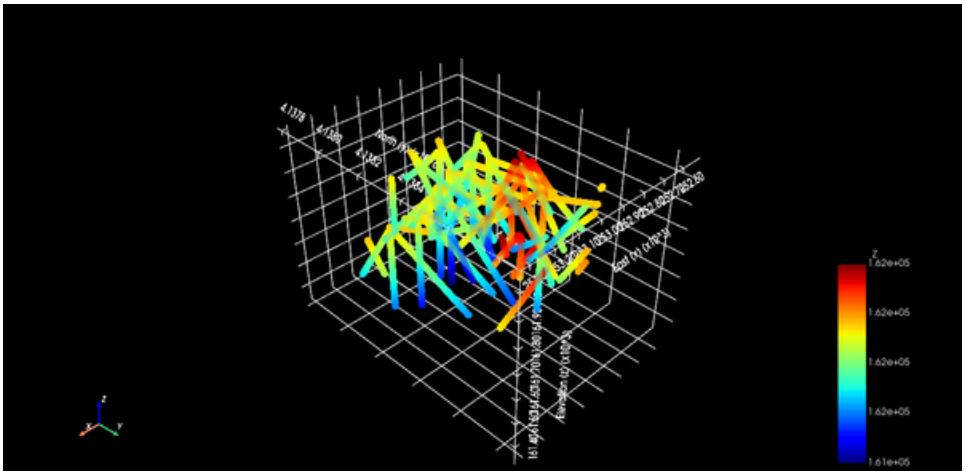




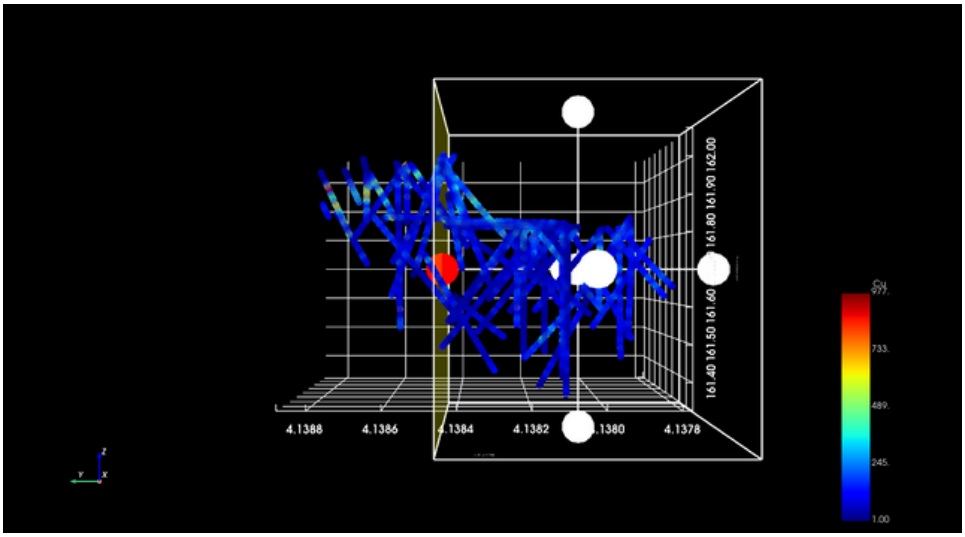
7 Visualization tools

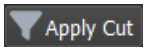
LIDENBROCK™ has 5 tools to configure your visualization.

Grid: You can enhance the viewing experience of your graphics by applying a grid over your 3D graphic models. Click to apply or discard.

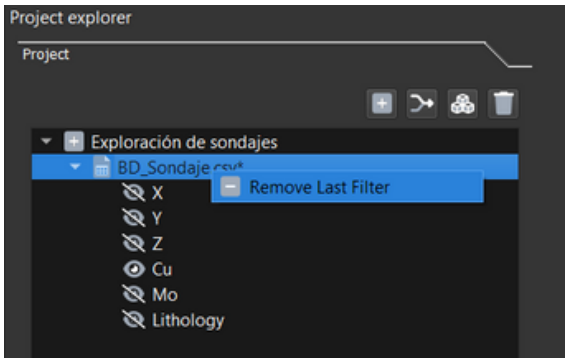


Plane Clip: Filter your data according to the manually selected box. Drag the edges of the box to define the volume of data you want to work with.

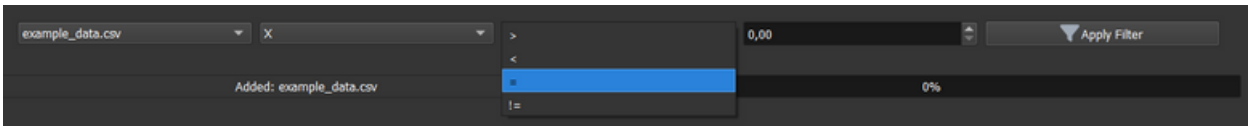


Select  to cut your database according to the selected box.

Automatically LIDENBROCK™ will apply the clipping and the new clipped database will be displayed in green with an asterisk, indicating that the previous database was modified. Go back to your initial database by right clicking on the trimmed database and select "Remove Last Filter".

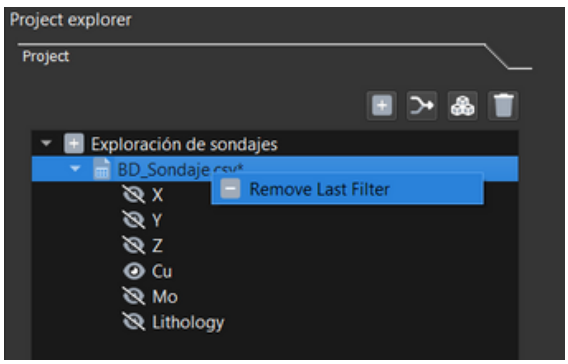


Data Filter: Filter your data by categorical or numeric variables using logical operators such as >, <, = or != relative to a manually set value. Select Apply Filter to apply the desired filter.



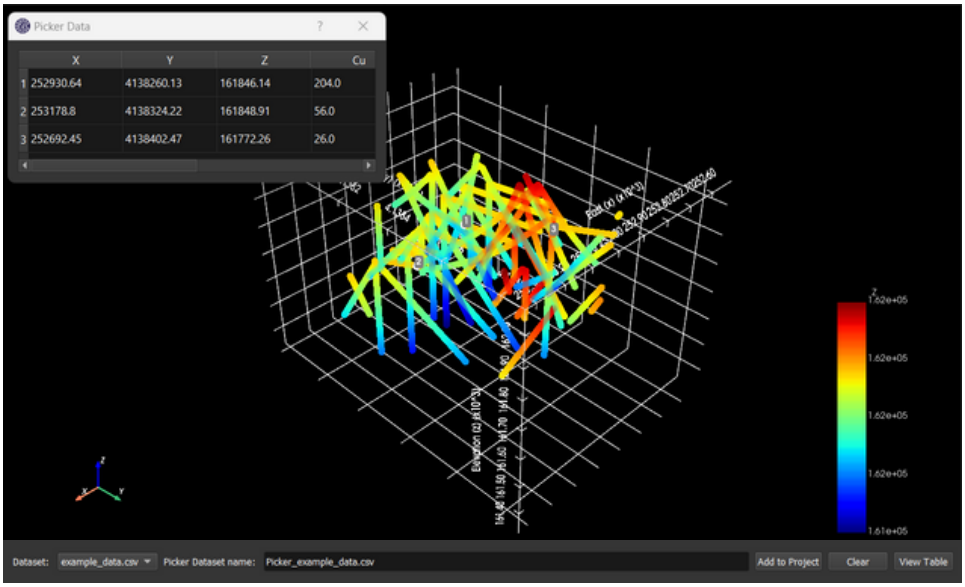
Select Apply Filter to trim your database according to the chosen filter. LIDENBROCK™ will automatically apply the filter and the new trimmed database will be displayed in green with an asterisk, indicating that the previous database was modified.

Remove the filter from your initial database by right-clicking on the filtered database and selecting "Remove Last Filter".

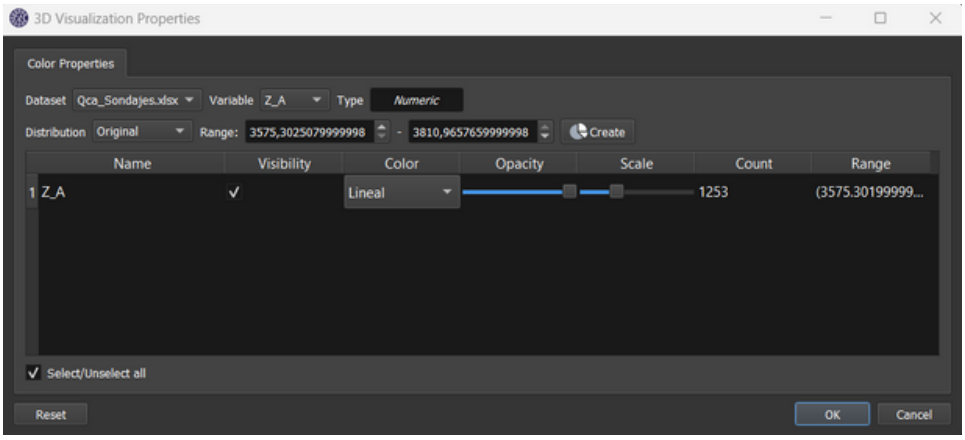


1. LIDENBROCK™ INTERFACE

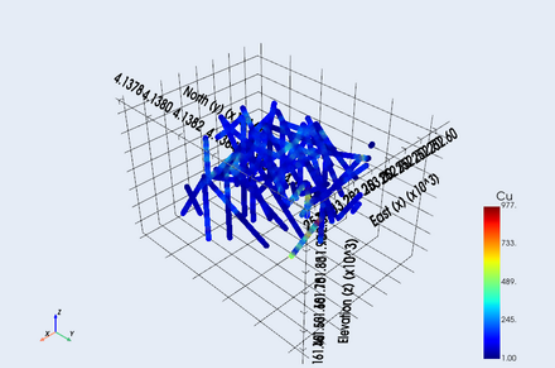
Point Picker: Select and get information from one or several points in the database. Select Add to Project from the bottom bar to add to the treeview of your project. Click View table or Hide table to display a table with the information of the selected points.

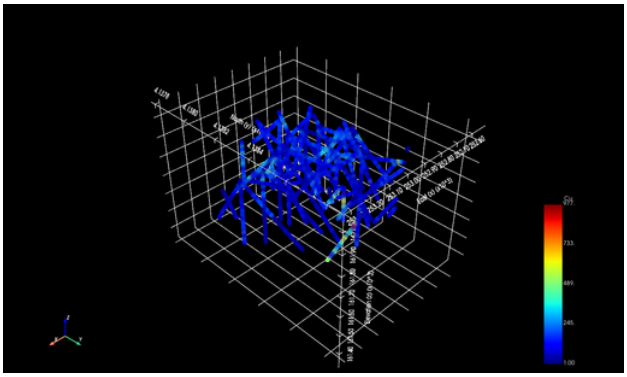


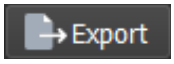
Attributes: Configure the 3D visualization properties of your variables by displaying the 3D visualization properties. Here you can create categories by distribution, choose display ranges, choose the variables to display, adjust color, opacity and size.



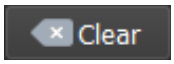
Background: Choose a white or black background to display using the Display button.







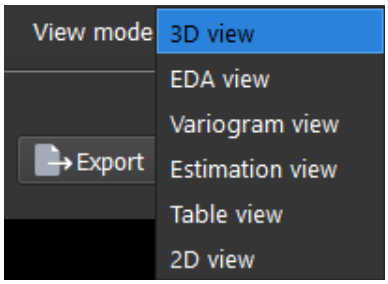
Export: Use this icon to export files, choose your file format.



Clear: Removes the display from the panel, clicking on "Clear" to create a new display.

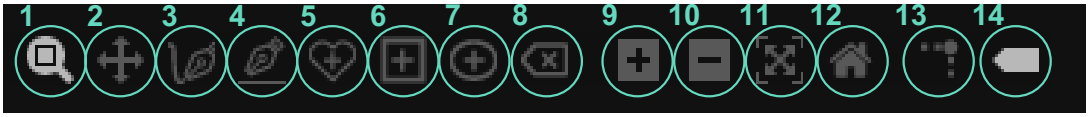
8 Display modes

Choose the visualization from "View mode" in the upper right corner of the interface. From there you can quickly access the last visualization created in each of the different modules that LIDENBROCK has: 3D, EDA, Variogram, Estimation, Table and 2D.



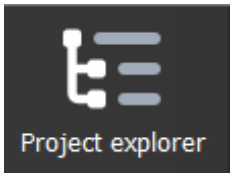
1.1 | 2D Display Panel Tools

LIDENBROCK™ knows your needs and uses Phyton's Plotty library with a suite of tools to highlight the most relevant part of your data. Activate the toggle bar by clicking on the icon  .



1. **Zoom:** You can zoom in and out on the group of data you want to display in your chart.
2. **Pan:** Move the chart area to put the most relevant part of your data in the center.
3. **Draw open freeform:** Draw a shape of your choice.
4. **Draw line:** Draw a line
5. **Draw closed freeform:** Draw a polygon.
6. **Draw rectangle:** Draw a rectangle of your choice.
7. **Draw circle:** Draw a circle.
8. **Erase active shape:** Erase the selected shape.
9. **Zoom in:** Zoom in to your data.
10. **Zoom out:** Zoom out to integrate more data into the plot area.
11. **Autoscale:** Return to the original scale of your chart area.
12. **Reset axes:** Return to the previous scale of the chart axes.
13. **Toggle spike lines:** Add coordinates to a sample, to know the value of a sample on the X and Y axes.
14. **Show closest data on hover:** Shows the closest data point when hovering over a plot point.

2. PROJECT EXPLORER

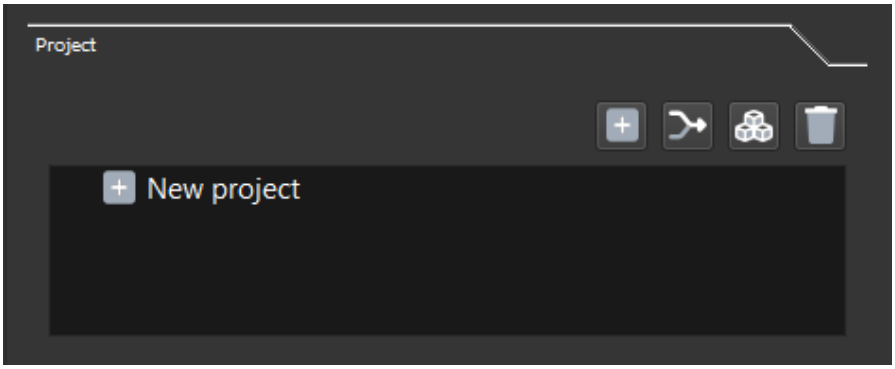


In **project explorer** you can manage your projects, display your data, create projects, load new data sets, join data sets and build grids for your block models.

2.1 Project: To manage your data sets, join databases, delete and view variables with a double click.

Using the toolbar, you can quickly access:

- Load dataset
- Merge datasets
- Create Grid
- Delete Dataset

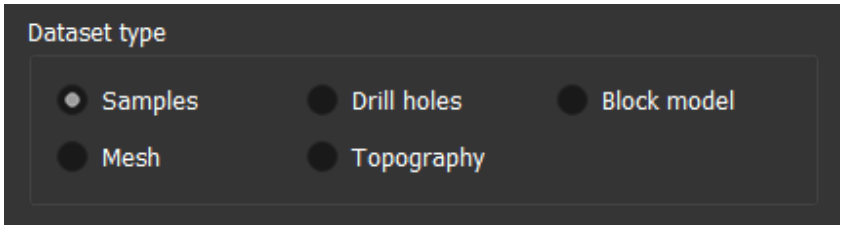


2.2 *Load dataset* :

a) Click Load data to open a file browser on your computer. Select the file containing the data you will be working with.

b) Select the type of data you want to import into LIDENBROCK™ under Dataset type.
The data types that LIDENBROCK™ can load are:

- Samples
- Drill holes
- Block model
- Mesh
- Topography

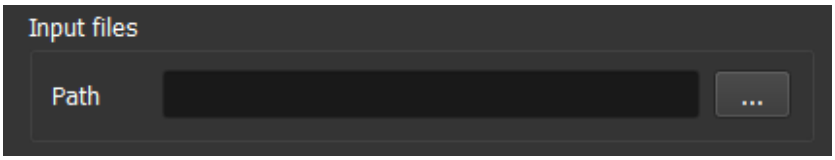


c) Once you have selected the data type, select in File format the format of the file containing your database. LIDENBROCK™ supports the following file types:

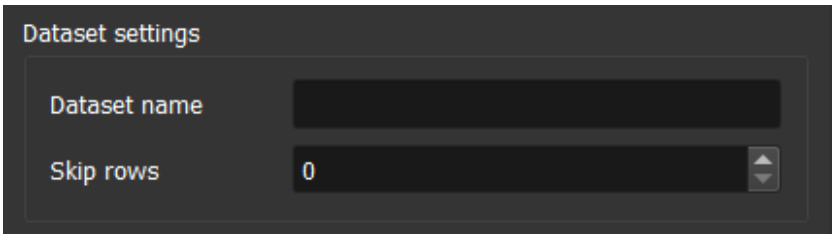
- Comma delimited texts (.csv files).
- Excel (.xls, .xlsx files)
- Geostatistical Software Library (.gslib files)}Labeled Image File Format (.tiff files)
- Drawing Exchange Format (.dxf files)

- Data structures: point samples; block models; soundings in survey, collar, assay format; topographies; solids.

d) Select ... Input files to choose a file from your computer. Make sure that the file format you selected matches the file type you specified previously.



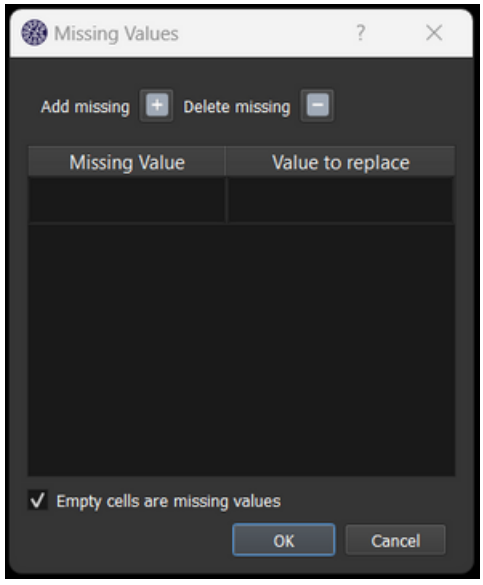
e) Configure your database by assigning the name in **Dataset name** or by deleting the first rows of your data set in **Skip rows.** Each numeric or categorical variable will have the name of the first cell in each column.

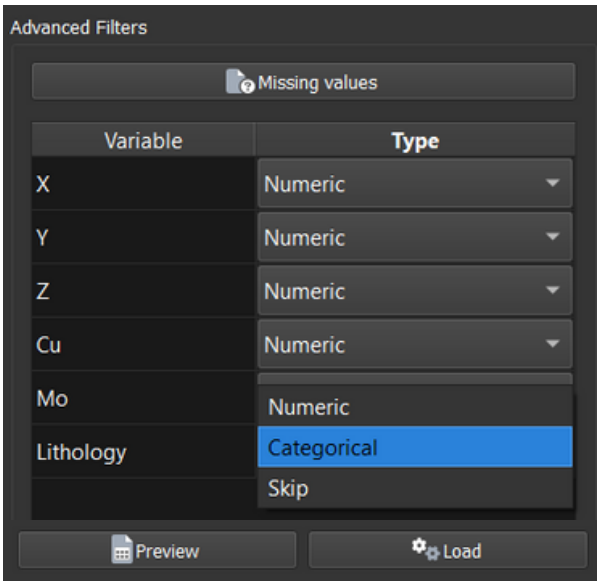


f) LIDENBROCK™ will automatically recognize the coordinates East (x), North (y) and Elevation (z) of the file. Verify that the coordinates are correctly assigned to the corresponding columns and modify if necessary.

g) In **Advanced Filters**, you will find "Missing values", by clicking on it, you will be able to display a window. Use "Add missing" and type the value of a numeric variable you want to replace.
You can use logical parameters > or < plus the value you need, to replace with a more suitable value for your workflow.

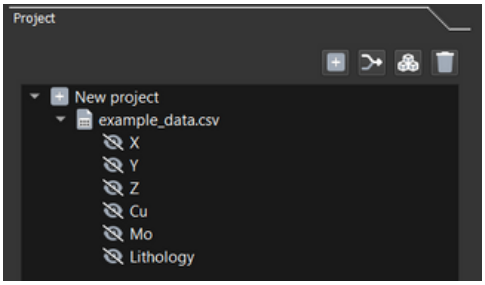
- *For example <1 laws, you can replace them by a single law of 0.5, so that all values meeting this condition will be replaced by the value 0.5. In case you do not add any value, LIDENBROCK™ will assume it as a NaN.*





h) In **Advanced Filters**, the variables identified by LIDENBROCK™ will appear. Set the type of variable to numeric or categorical, as appropriate.

i) Scroll down to select **Preview** if you need to display your database in a table or select **Load** to load the database into the LIDENBROCK™ treeview.

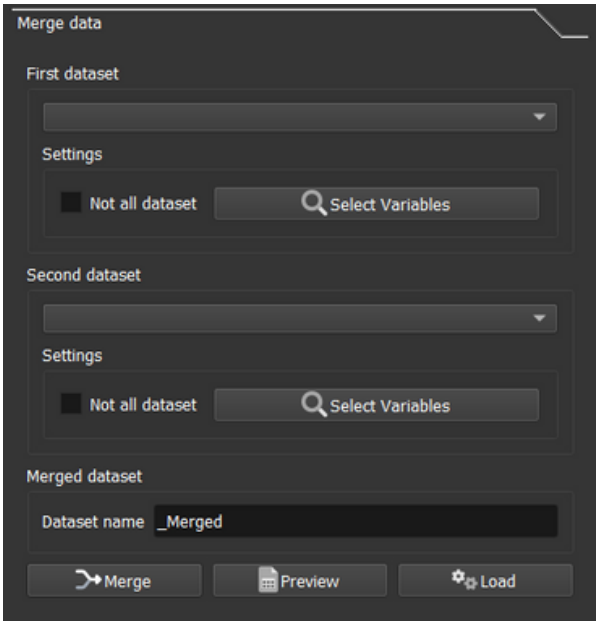


- *After loading the data into LIDENBROCK™, all variables will appear in the treeview in **Project**. You can double-click on the element you want to visualize and it will automatically be displayed in 3D in the visualization panel.*

2.3 *Merge dataset (Join data):*

Create databases based on your data sets and your variables of interest.

To merge databases, you must first load them in "Load data", then you can concatenate your databases.



To join your data in LIDENBROCK™ you must:

a) Select the first database you want to join. Configure the variables you are interested in concatenating.

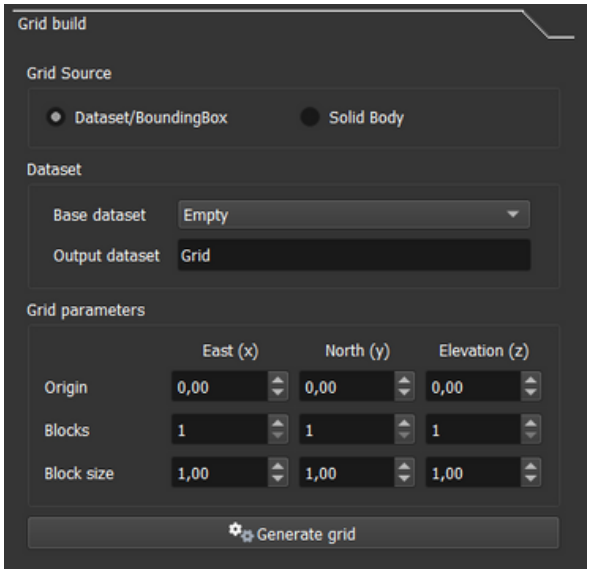
b) Select the second database you want to join to the first one. Configure the variables you want to concatenate.

c) Write the name of your new database.

d) Select **"Merge"** to merge, **"Preview"** to view the first 20 rows, modify again or load your new database by pressing Load.

2.4 Grid build:

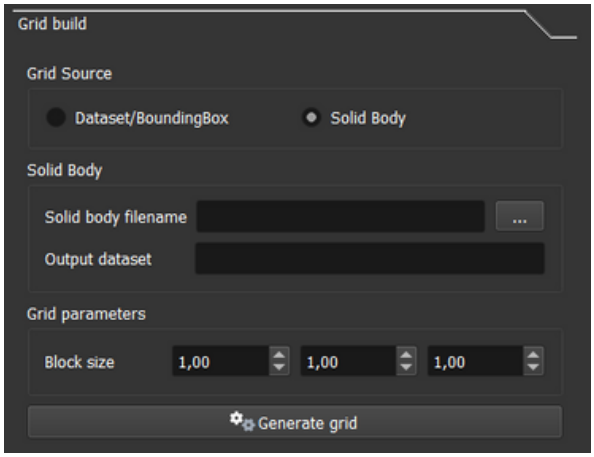
Build a grid of your project to create block models, define the parameters of your grid, according to your project. To do so, choose the source of your grid.



- **2.4.1 Create grid: I**f you want to create a grid with your database, from LIDENBROCK™ choose Dataset/ BoundingBox, then:

a) Select the loaded database, with which you want to build your block model, from Base dataset.
b) Write the name that will be displayed in the treeview in Output dataset.
c) Set the centroid of your block model, in **Origin,** if required. Otherwise, LIDENBROCK™ will search for the most appropriate centroid for your work.
d) In **Blocks,** set the number of blocks you want for each dimension (East, North and/or elevation). LIDENBROCK™ will calculate the size that fits the number of blocks of your preference.
e) Under **Block Size**, set the size of blocks you want for each dimension (East, North and/or elevation). LIDENBROCK™ will calculate the number that fits your preferred block size.
f) Generate your grid by clicking on **Generate grid**. You will be able to visualize the block model in your Project explorer treeview.

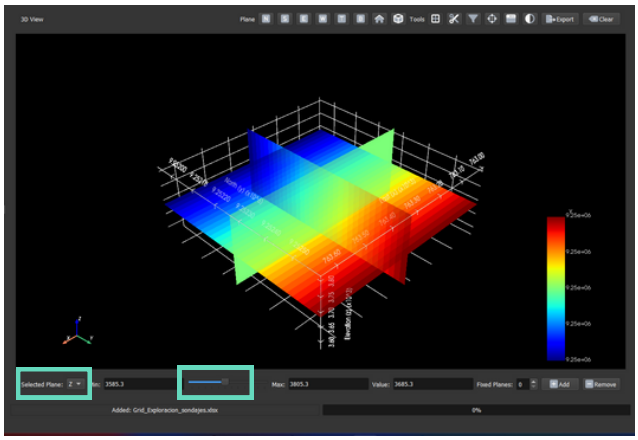
- ***2.4.2* Load Block Model:** If you want to load a block model with LIDENBROCK™ choose **Solid Body**, then:

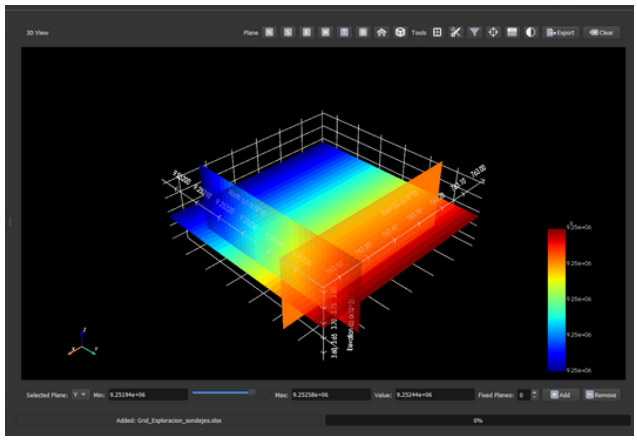


a) Select the .dxf file from the file explorer.
b) Type the name to be displayed in the treeview in **Output dataset**.
c) Set the size of your blocks in **Block size**.
d) Generate your grid by clicking on **Generate grid**.

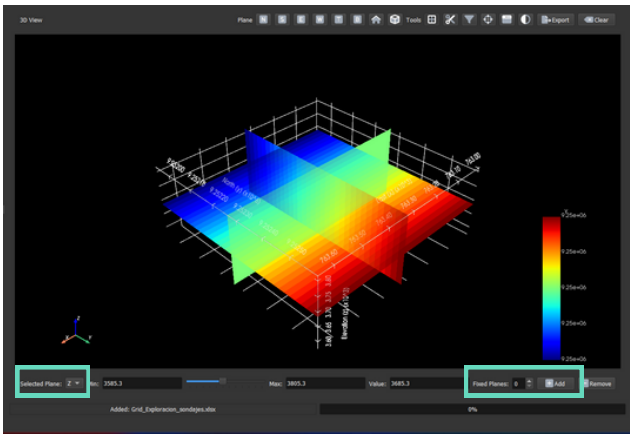
2.4.3. **Visualize Block Model:** To visualize your model from the treeview, access **Project** and click on the loaded or created grid. The visualization panel will display 3 planes of your block model.

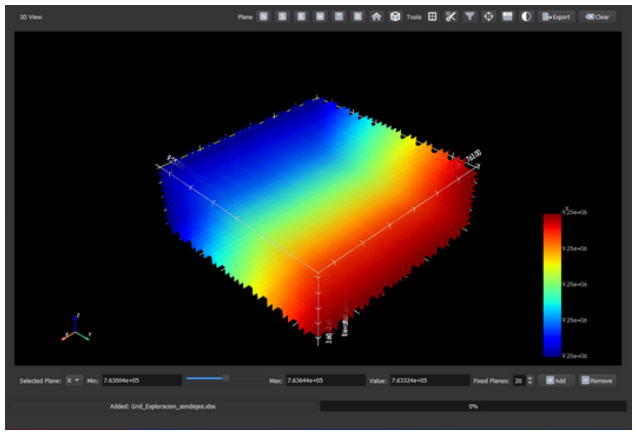
To view other areas of your block model, you can change the position of the main planes by selecting the plane of interest in **Selected Plane:** (x, y, z), then slide the button across the bar and place the plane at the position of interest.





To visualize your model more densely, access the lower panel. Select an axis (x, y or z) in **Selected Plane:** and add the number of planes you want to add in each axis by pressing "Add". You can remove the planes by pressing "Remove", the 3 main planes of your block model will be displayed again.





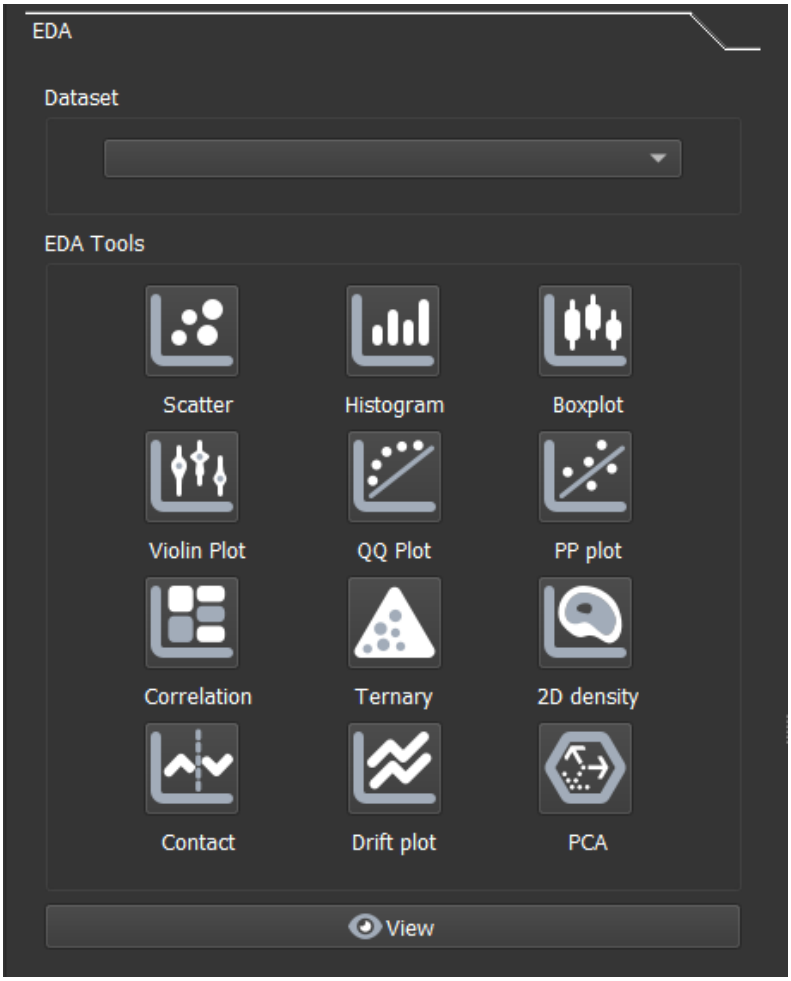
3. EXPLORATORY DATA ANALYSIS

In **Exploratory Data Analysis** module of LIDENBROCK™ you can choose up to 12 statistical models **to analyze the quantity, quality and location of the available data, define the study area and/or divide it into sub-areas and anticipate difficulties due to outliers**, **which may arise in your local estimates.** Get to know the main characteristics of your datasets to drive your next project through the different graphical visualization methods: **Scatter Plot**, **Histogram**, **Boxplot**, **Violin Plot**, **QQ Plot**, **PP Plot**, **Correlation**, **Ternary Plot**, **2D Density**, **Contact analysis**, **Drift Plot** and **PCA**.

1. Choose your dataset

2. Choose your statistical method

3. Display

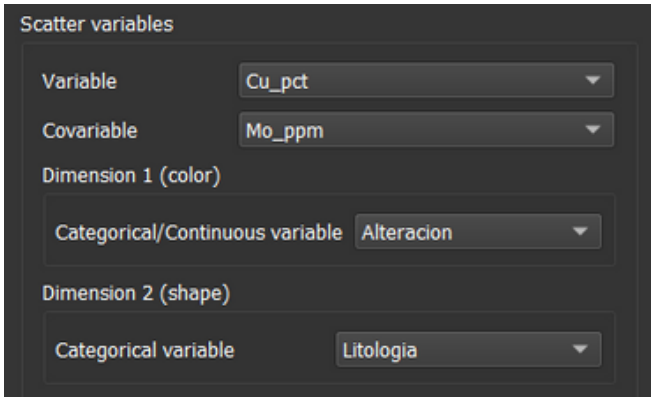


3. EXPLORATORY DATA ANALYSIS : SCATTER

3.1 *Scatter*: It shows **the relationship between one variable with respect to another** (covariate), this correlation of two variables allows to visualize a scatter cloud of variables in 2 dimensions.

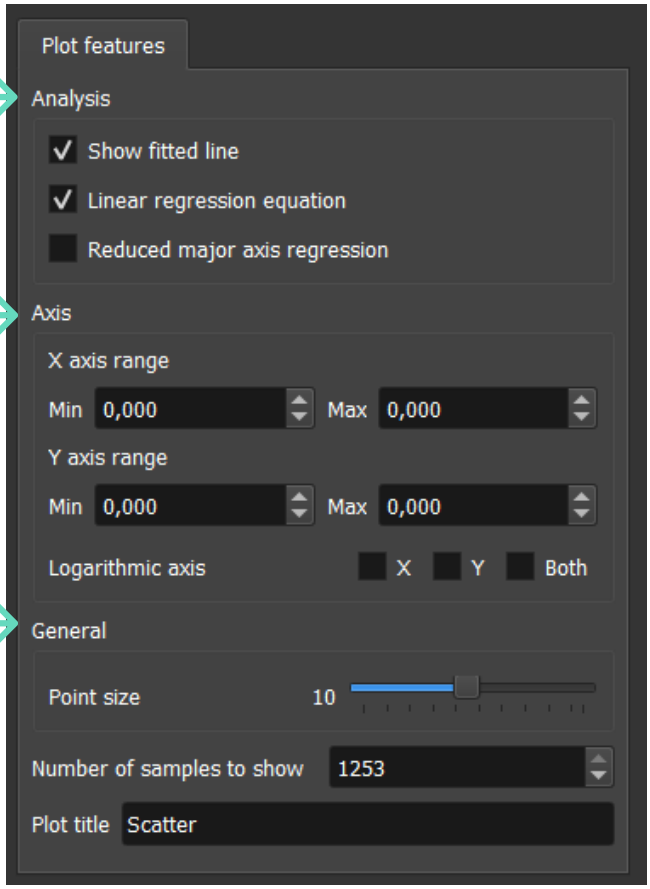
To create a scatter diagram in LIDENBROCK™:

a) Select the **Scatter** icon in the EDA module.
b) Interact with the form displayed on the left side of the interface.
c) Select the variable (y) and the covariate (x) you want to relate.
d) Add a continuous or categorical variable to separate data sets by color.
e) Add a second continuous or categorical variable to subdivide your data set by shape.
f) Configure your plot features in **Plot features.**



*You can hide or display each category in the plot generated by LIDENBROCK™ using the legend on the right of the display panel. You can add a **linear regression** line, display the equation and **adjust the logarithmic scale on the axes**, as well as modify the size of the plot points, from the form in **Plot features**.*

- **Analyze the distribution of your data**
- **Configure the axes of your chart**
- **Choose the visualization properties of your data**

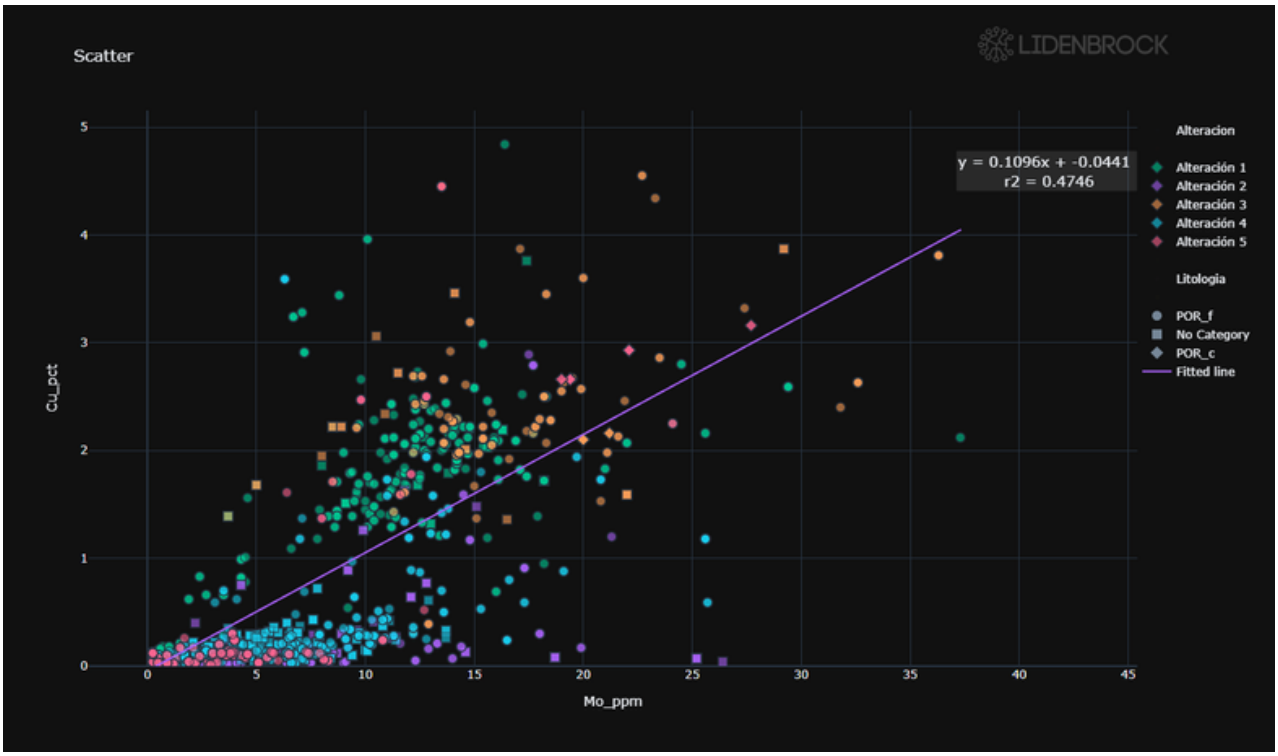


3. EXPLORATORY DATA ANALYSIS : SCATTER

Once you have configured the characteristics of your chart:

g) Press **View** to create the chart, which will be displayed in the display panel on the right side of the interface.

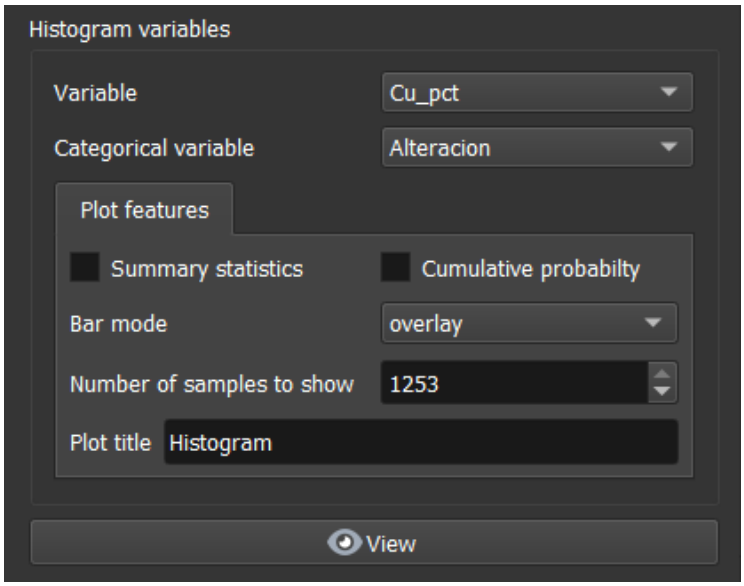
h) Use the toolbar located in the upper right area to adjust the display characteristics of your chart. Activate or deactivate it by pressing  .



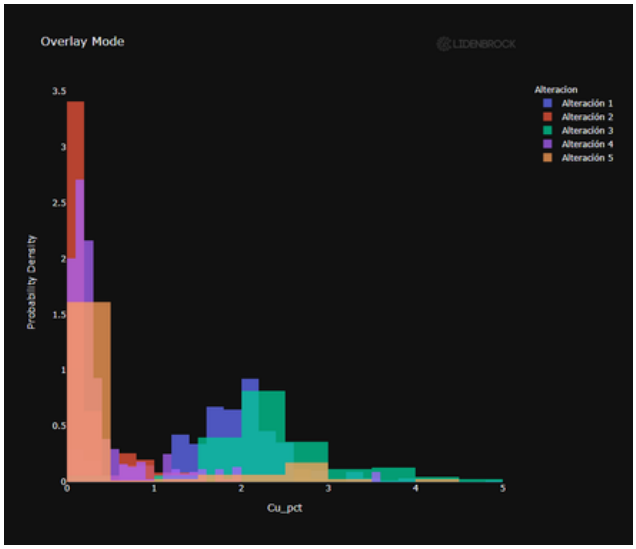
3.2 Histogram: Graphically represents the **frequency distribution of a variable**. The range values of your data are divided into several intervals and with a histogram you can visualize the number of points that belong to each of these sub-range garbage cans.

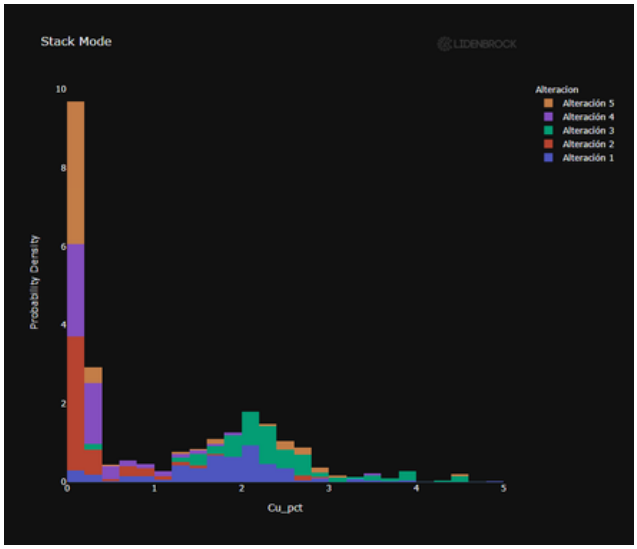
To draw a histogram in LIDENBROCK™:

a) Select the **Histogram** icon in the EDA module.
b) Interact on the form displayed on the left side of the interface.
c) Select the variable of interest and/or the categorical variable you want to relate.
d) Configure the characteristics of your plot in **Plot features**.
e) In **Bar mode** you can choose histogram with overlay or stacked bars.
f) Click on **View** to create the graph that will be displayed in he display



panel on the right side of the interface.
g) Use the toolbar located in the upper right area to adjust the display characteristics of your chart. Activate or deactivate it by pressing  .



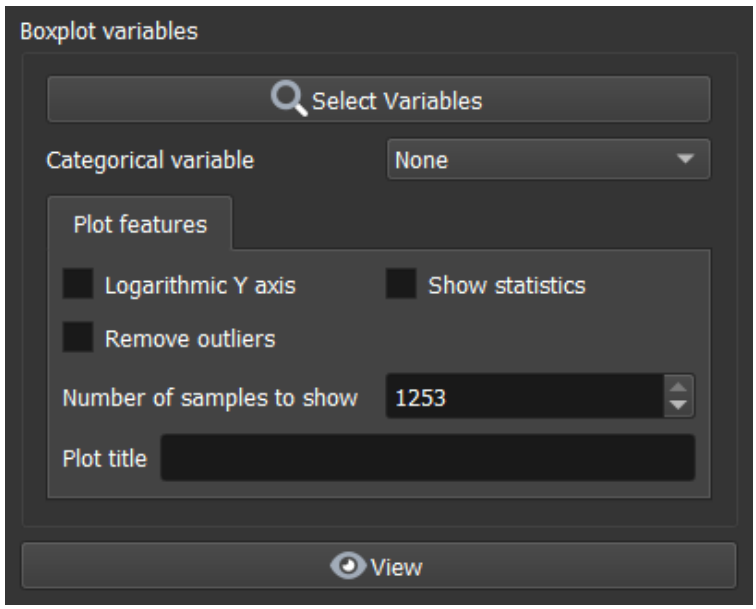


3. EXPLORATORY DATA ANALYSIS : BOX PLOT

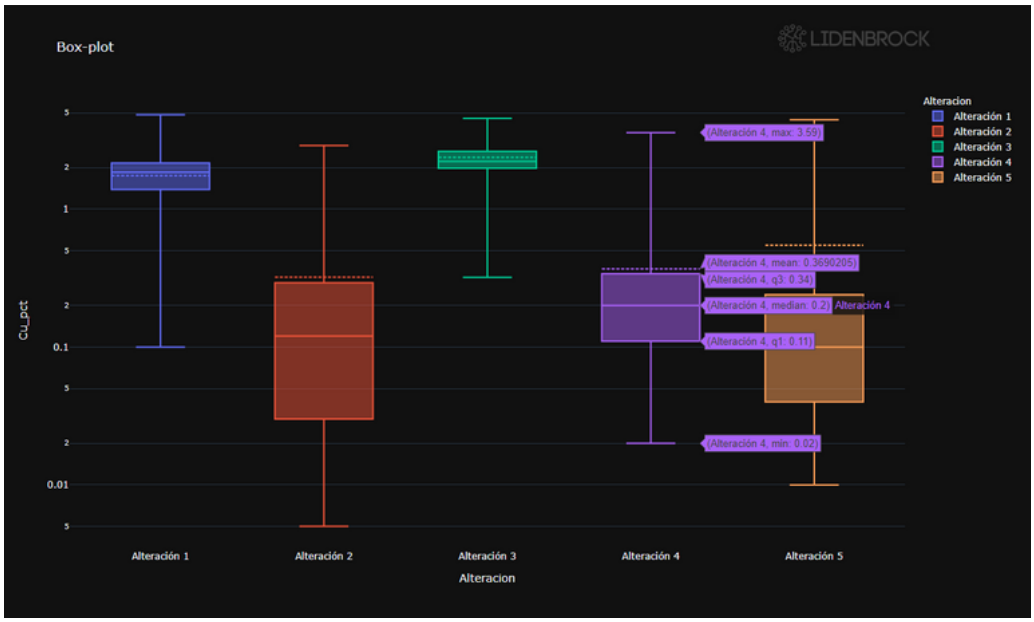
3.3 *Box Plot*: Allows you to summarize some characteristics of the distribution of your data, such as its **symmetry** and **dispersion**. **It compares one or several variables in your data set.** One axis per variable represents minimum, maximum, first quantile (q1: 25%), third quantile (q3:75%), median and average value per categorical variable.

To create a Box Plot in LIDENBROCK™:

a) Select the **Box Plo**t icon in the EDA module.
b) Interact on the form displayed on the left side of the interface.
c) Select the variable of interest and/or the categorical variable you wish to relate.
d) Configure the characteristics of your plot in **Plot features**.
e) Press **View** to create the plot that will be displayed in the display panel on the right side of the interface.
f) Use the toolbar button located in the upper right area to adjust the display characteristics of your chart. Activate or deactivate it by pressing  .



Place the cursor over one of the boxes to view the category statistics.

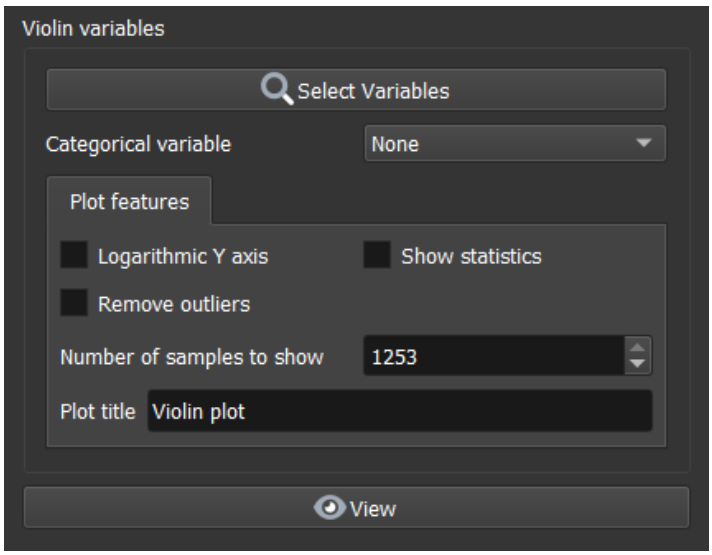


3. EXPLORATORY DATA ANALYSIS : VIOLIN PLOT

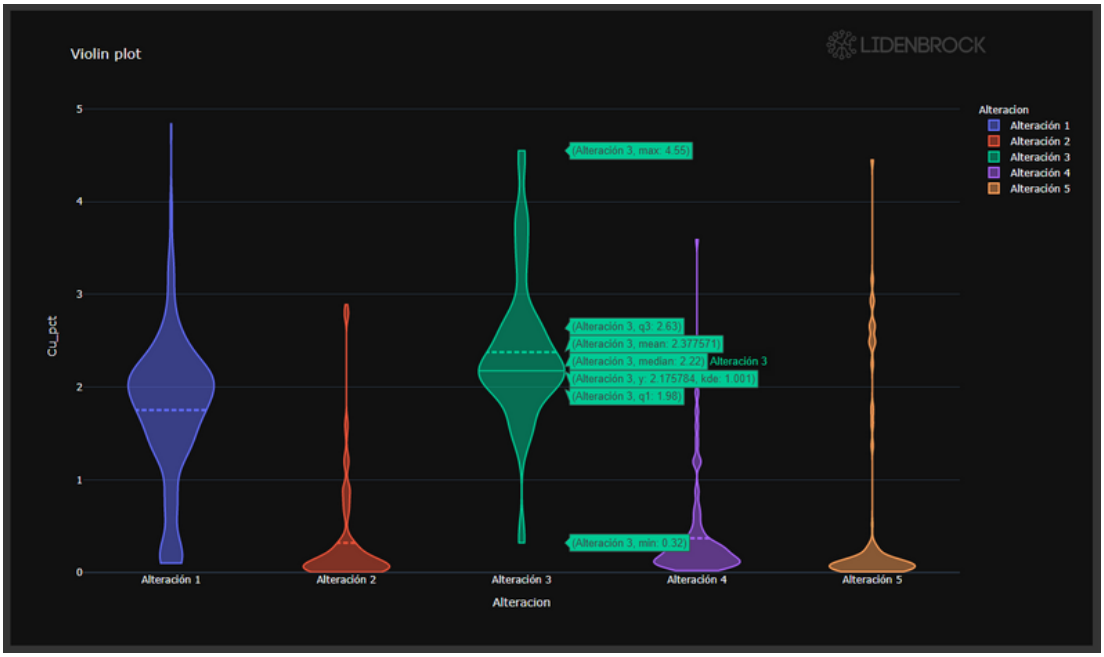
3.4 *Violin Plot*: Violin plots are similar to box plots, except that they also **show the probability density of the data at different values**, usually smoothed by a Kernel density estimator. With a violin plot you can also have information about the **minimum and maximum values, first quantile (q1:25%), third quantile (q3:75%), median and average of your data**.

To make a Violin Plot in LIDENBROCK™:

a) Select **Violin Plot** icon in the EDA module.
b) Interact on the form displayed on the left side of the interface.
c) Select the variable of interest and/or the categorical variable you want to relate.
d) Configure the characteristics of your plot in **Plot features.**
g) Press **View** to create the plot that will be displayed in the visualization panel on the right side of the interface.



Place the cursor over a category to view general statistics.

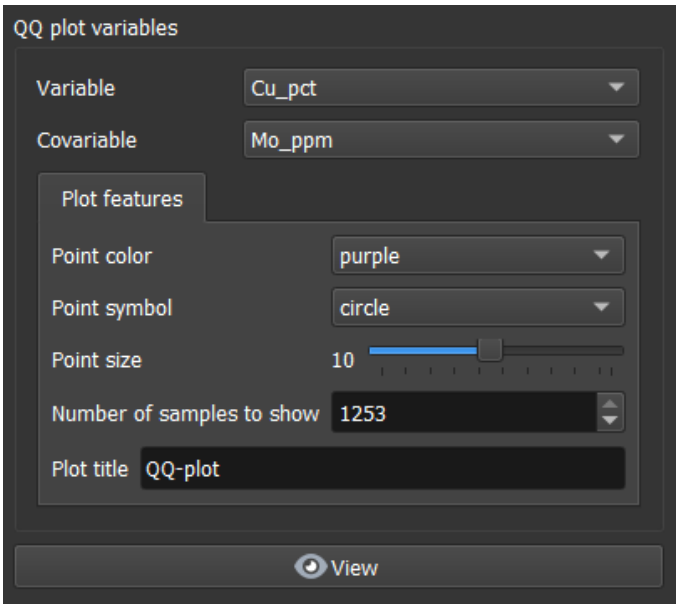


3. EXPLORATORY DATA ANALYSIS : QQ PLOT

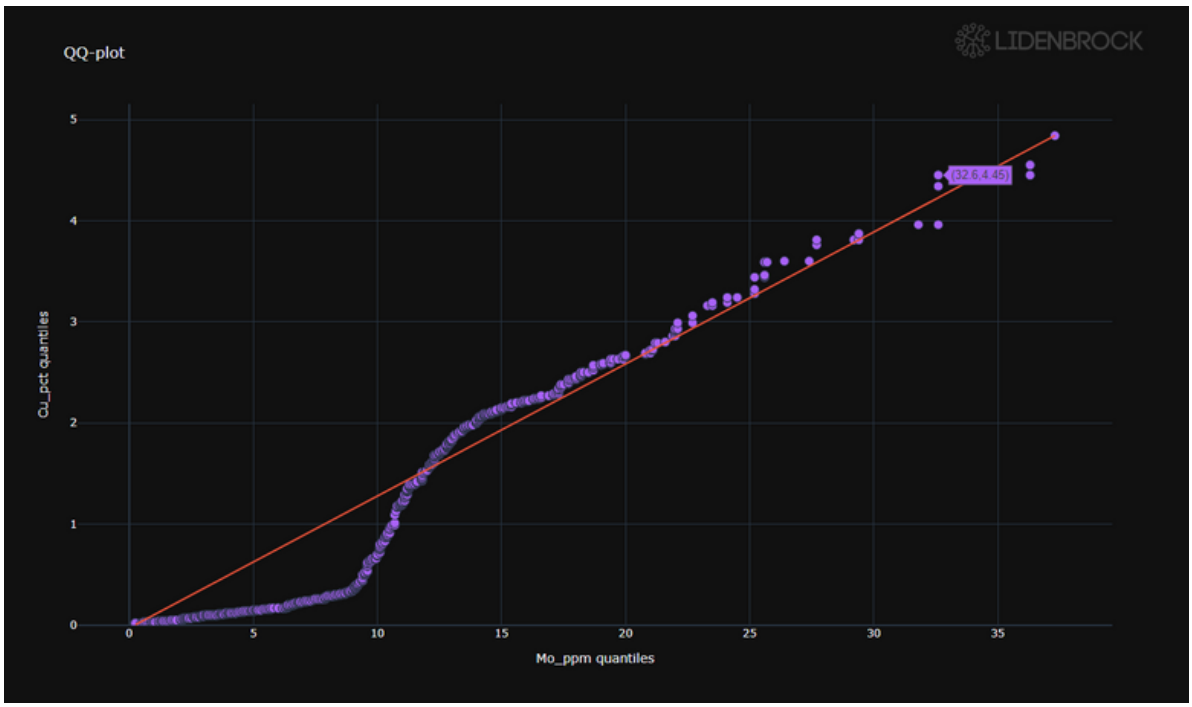
3.5 *QQ Plot*: Produces a quantile-quantile plot **to compare two distributions with each other**, which can be associated with different variables or with the same variable in different categories. A point (x, y) on the plot corresponds to one of the quantiles of the second distribution (y-coordinate) plotted against the same quantile of the first distribution (x-coordinate). In the latter case, the comparison **is used to decide whether the two sets of data have an identical distribution** and therefore come from the same population.

To elaborate a QQ Plot in LIDENBROCK™:

a) Select **QQ Plot** icon in the EDA module.
b) Interact on the form displayed on the left side of the interface.
c) Select the variable of interest and/or the categorical variable you wish to relate.
d) Configure the characteristics of your plot in **Plot features.**
e) Press **View** to create the plot that will be displayed in the visualization panel on the right side of the interface.



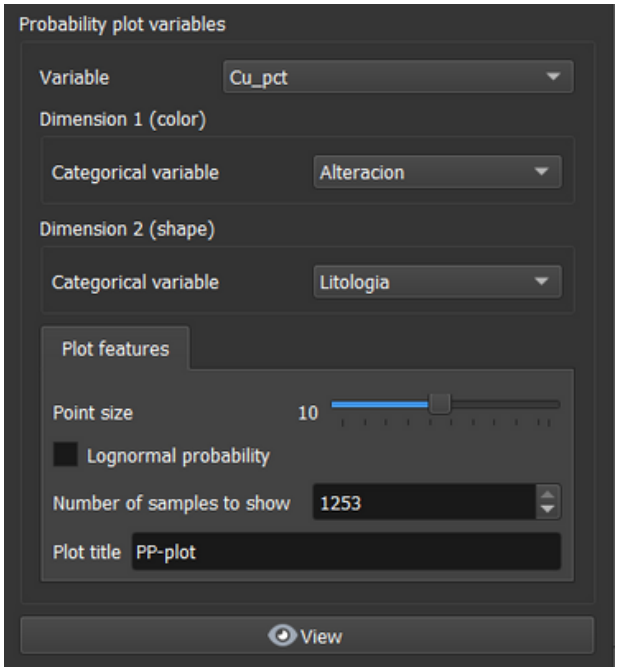
By placing the cursor over a plotted point, you can see the X and Y value.



3. EXPLORATORY DATA ANALYSIS : PP PLOT

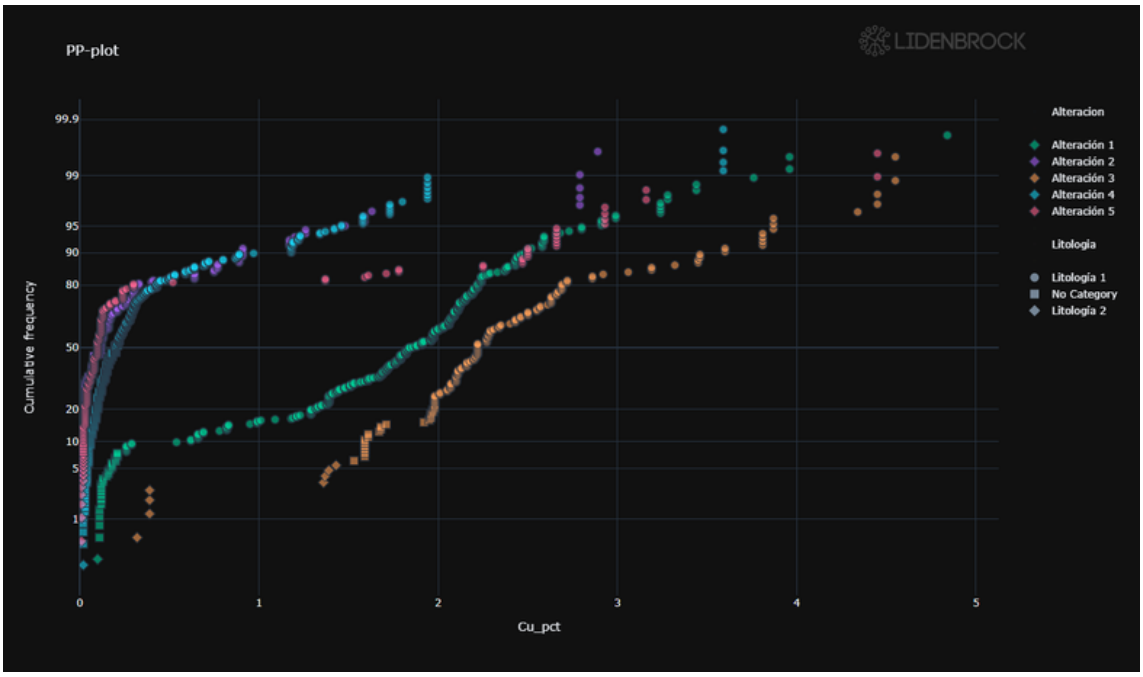
3.6 PP Plot: Make a **P-P plot to assess the extent to which two data sets match,** or to assess the extent to which a data set fits a particular model. It works by plotting the two cumulative distribution functions against each other; if they are similar, the data will look almost like a straight line.

To produce a PP Plot in LIDENBROCK™:



a) Select **PP Plot** icon in the EDA module.
b) Interact on the form displayed on the left side of the interface.
c) Select the variable of interest.
d) Choose one or two categorical variables to which you want to relate your variable of interest.
e) Configure the characteristics of your plot in **Plot features.**
f) Press **View** to create the plot that will be displayed in the visualization panel on the right side of the interface.

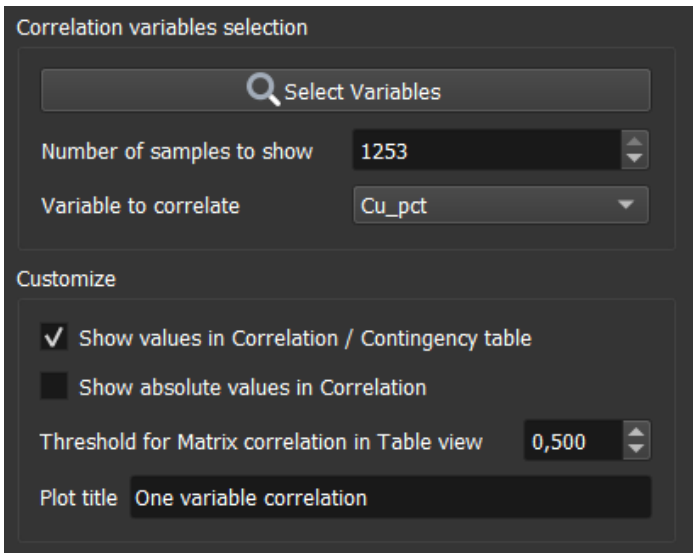
By placing the cursor over a plotted point, you can see the X and Y value.



3.7 *Correlation*: Measures **the statistical relationship between two variables.** The result will show how the change in one parameter would affect the other parameter. A very useful tool **to perform predictive analysis** and build a model about the relationship between variables.

To build a correlation in LIDENBROCK™:

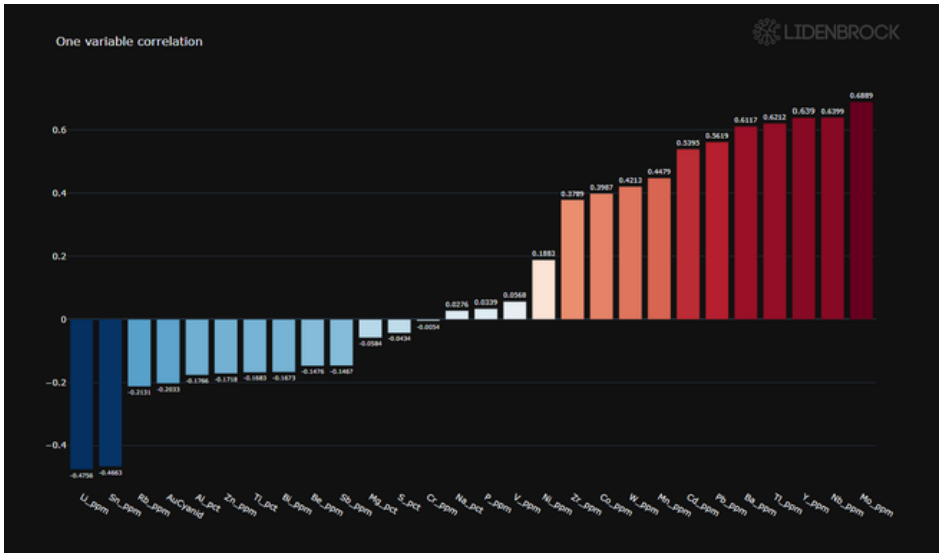
a) Select **Correlation** icon in the EDA module.
b) Interact on the form displayed on the left side of the interface.
c) Select the variable of interest.
d) Choose the variable for which you want to correlate your variables.
e) Configure the characteristics of your graph in **Customize.**
g) Choose the type of visualization you want to create.
h) Press **View** to create the graph that will be displayed in the visualization panel on the right side of the interface.



LIDENBROCK™ has 3 types of visualizations, you can choose them according to your project.

One variable correlation

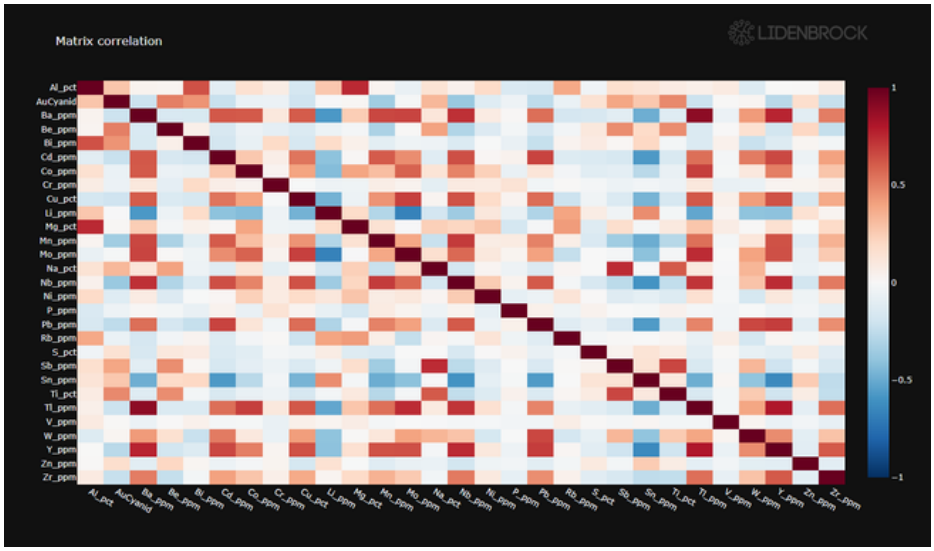
With this visualization you will be able to correlate your numerical variables with respect to a variable of interest.



3. EXPLORATORY DATA ANALYSIS : CORRELATION

Matrix correlation

With this visualization you will be able to correlate your numerical variables with each other.



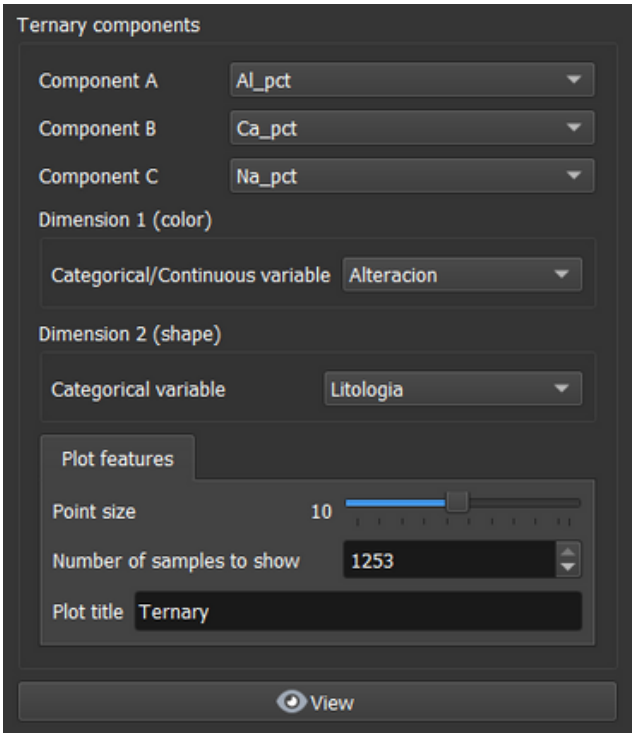
Contingency Table

With this visualization you will be able to correlate your categorical variables with each other.

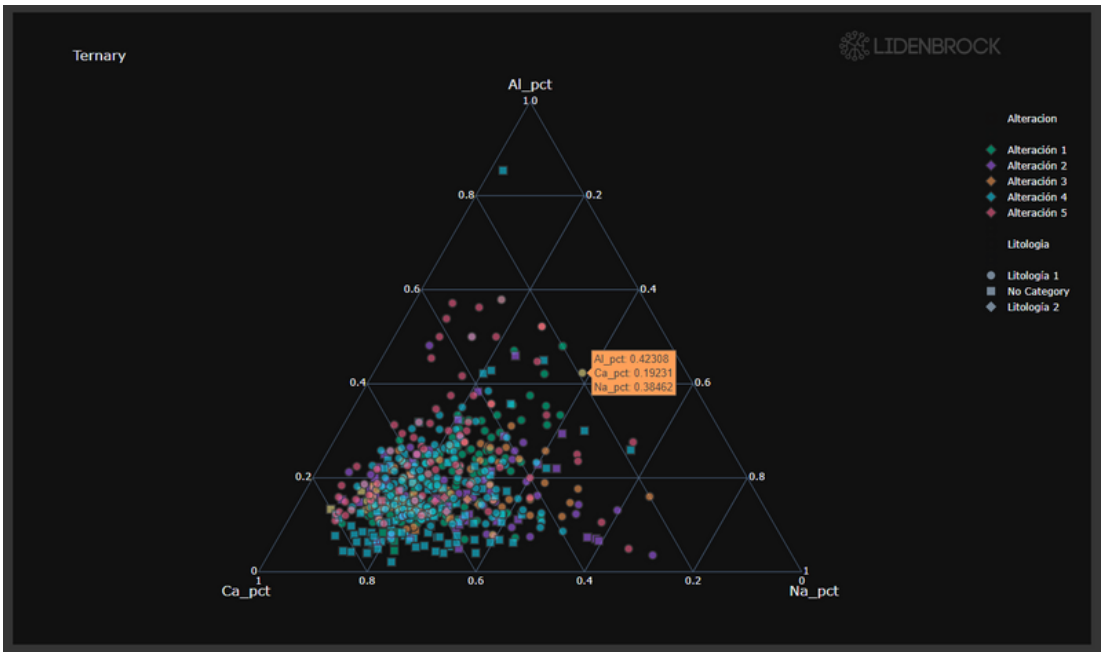
3.8 *Ternary:* It graphically represents the relationship of three variables as positions in an equilateral triangle. A ternary graph is a barycentric diagram of three variables summing to a constant. Use this tool to analyze compositional data in a three-dimensional case.

To elaborate a Ternary Diagram in LIDENBROCK™:

a) Select the Ternary icon in the EDA module.
b) Interact on the form displayed on the left side of the interface.
c) Select the variables of interest.
d) You can add categorical variables.
e) Configure the characteristics of your plot i**n Plot features.**
f) Press **View** to create the plot that will be displayed in the visualization panel on the right side of the interface.



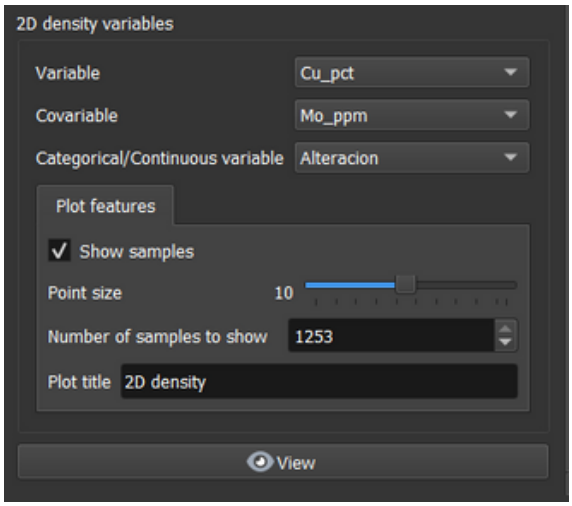
By placing the cursor over a plotted point, you can see the X, Y and Z value.



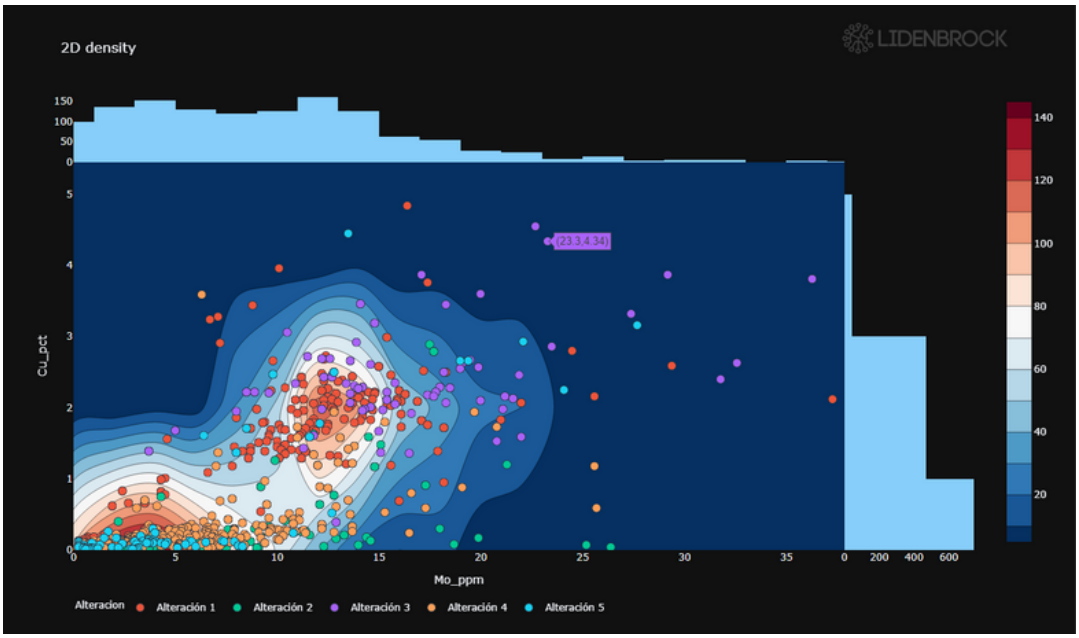
3.9 *2D Density:* It uses 2d distributions, **to avoid overplots in a scatter plot**. A 2D density plot **shows the relationship between 2 numerical variables**, where one variable is represented on the X-axis and the other on the Y-axis, as in a scatter plot. The number of observations within a given area of 2D space is counted and represented by a color gradient to indicate the differences in the distribution of data in one region with respect to the other.

To produce a 2D Density Plot in LIDENBROCK™:

a) Select the **2D density** icon in the EDA module.
b) Interact on the form displayed on the left side of the interface.
c) Select the variables of interest.
d) Configure the characteristics of your plot in **Plot features.**
e) Click **View** to create the plot that will be displayed in the visualization panel on the right side of the interface.

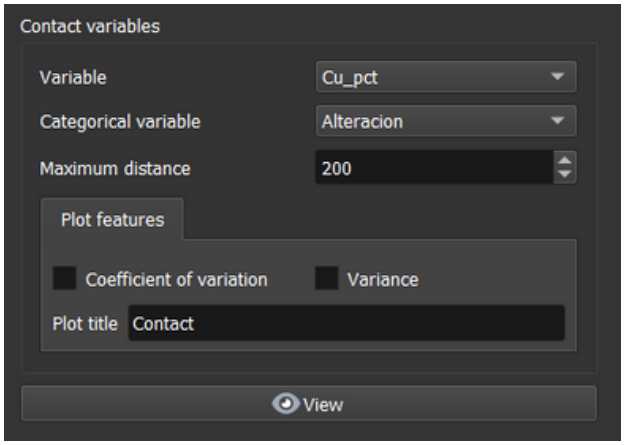


By placing the cursor over a plotted point, you can see the X and Y value.

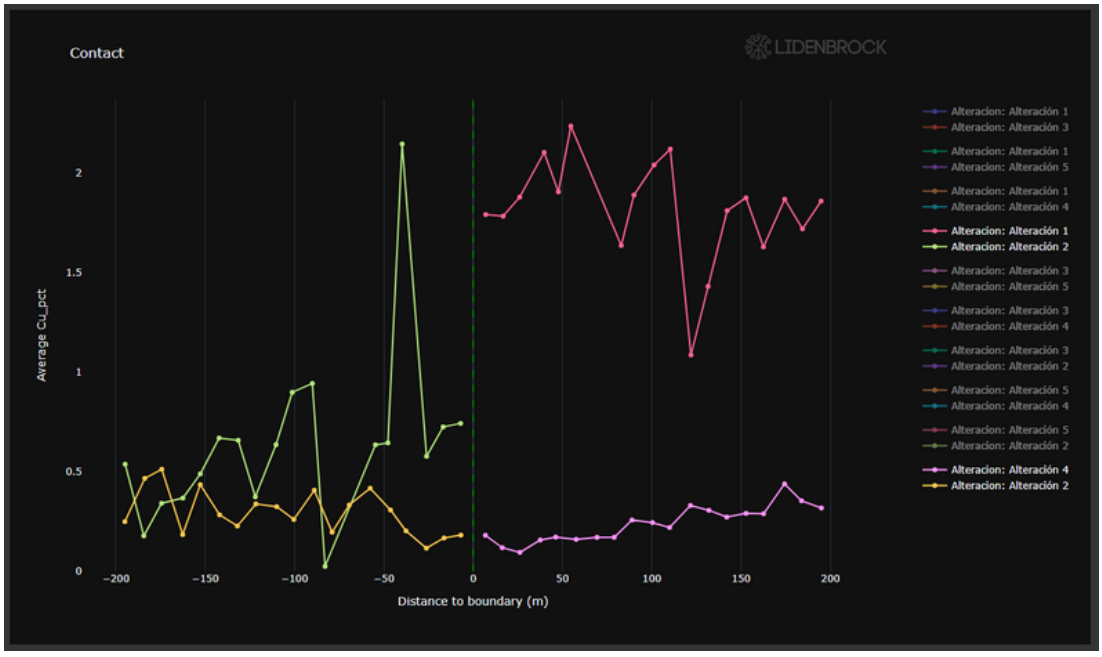


3.10 *Contact*: This statistical model allows you **to interpret the continuity of a numerical variable at the boundary between units of a categorical variable and to observe whether a contact is statistically soft or abrupt.** In LIDENBROCK™ you can visualize the average of a variable of your choice, at the boundary between two categories, at a maximum average distance to the contact between the two categories.

To analyze a contact in LIDENBROCK™:



a) Select **Contact** icon in the EDA module**.**
b) Interact in the form displayed on the left side of the interface.
c) Select the variable of interest.
d) Define the maximum distance to the contact or boundary you want to analyze.
e) Configure the characteristics of your plot in **Plot features.**
f) Press **View** to create the plot that will be displayed in the visualization panel on the right side of the interface.



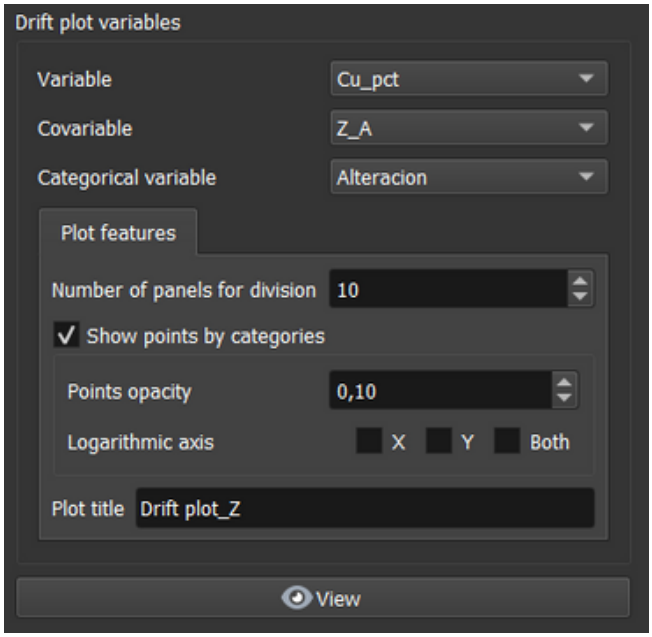
Example shows an abrupt contact between Alteration 1 and Alteration 2, and a soft contact between Alteration 4 and 2.
In the right side area, you can click on the categories you want to compare.

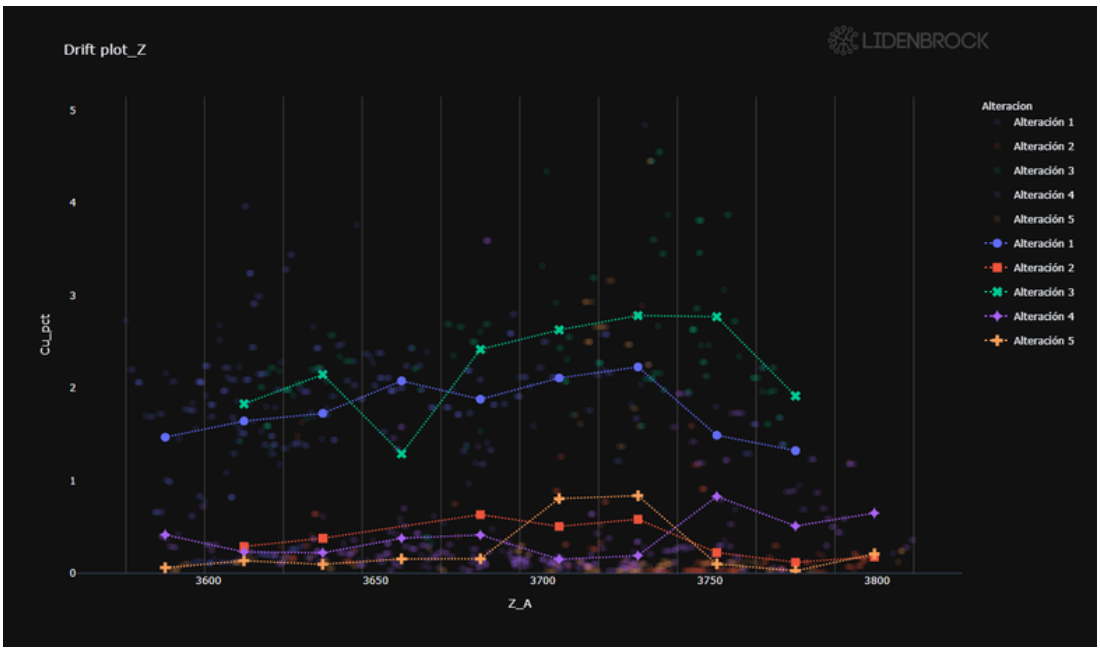
3.11 *Drift*: You can **visualize the behavior of an element or numerical variable, with respect to the axes of the reservoir or project (X, Y or Z).** It is also possible to add categorical variables **to know the distribution of a variable, a co-variable and/or a categorical variable** according to a spatial dimension.

To elaborate a LIDENBROCK™ drift graph:

(a) Select the **Drift** icon in the EDA module**.**
b) Interact on the form displayed on the left side of the interface.
c) Select the variables of interest.
d) Configure the characteristics of your plot in **Plot features.**
e) Press **View** to create the plot that will be displayed in the visualization panel on the right side of the interface.

By placing the cursor over a plotted point, you can see the X and Y value.

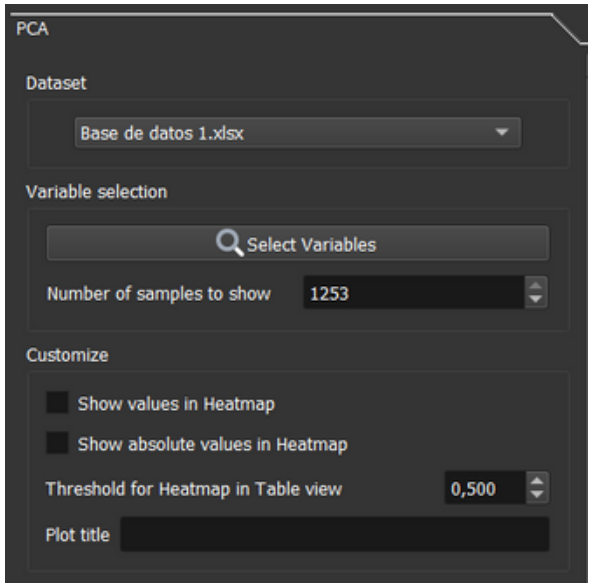




4. FEATURE EXTRACTION

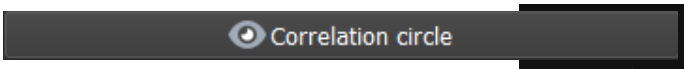
4.1 *Principal Component Analysis* (PCA): Principal component analysis allows to analyze large data sets containing a high number of dimensions/characteristics per observation, **to increase the interpretability of the data while preserving the maximum amount of information and to allow the visualization of multidimensional data.** PCA is a statistical technique to reduce the dimensionality of a data set. This is achieved by linearly transforming the data into a new coordinate system in which (most of) the variation in the data can be described in fewer dimensions than the initial data. **Use the first two principal components to represent your data** in two dimensions and visually identify groups of closely related data points.

To analyze a PCA in LIDENBROCK™:

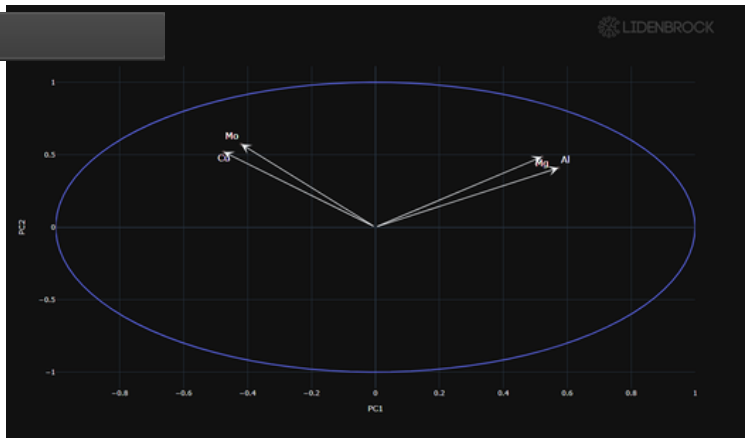


a) Select the **PCA** icon from the module bar.
b) Interact on the form displayed on the left side of the interface.
c) Select the variables of interest.
d) Configure the characteristics of your graph in **Customize.**
e) Set the correlation threshold between the principal components using a value between 0 and 1 in Treshold for Heatmap in Table view.
f) Choose the type of visualization in **Visualizations** to analyze your variables.

Visualizations:

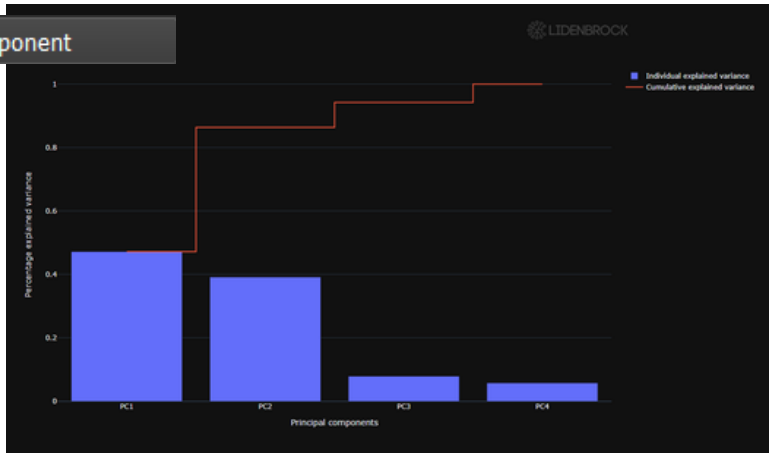


Elaborate a 2D correlation circle to project observations from a space composed of n variables to one of 2 variables to facilitate the interpretation of events.



Explained Variance for each component

Display the variance of principal components computed with LIDENBROCK to improve your interpretations

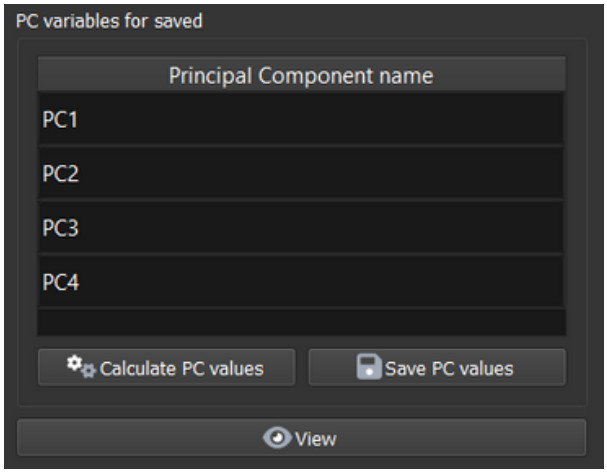


Heatmap Variables and Explained Variance

Obtain a correlation table to know in detail the relationship between principal components and related variables.

In LIDENBROCK™ ***you can also download a heatmap in excel format,*** *exporting from view mode: Table view, located in the upper right area of the interface.*

g) Calculate the Principal Components on your database by pressing Calculate PC values, save to display each component as a new variable in the treeview, which you can visualize in 3D by double clicking.



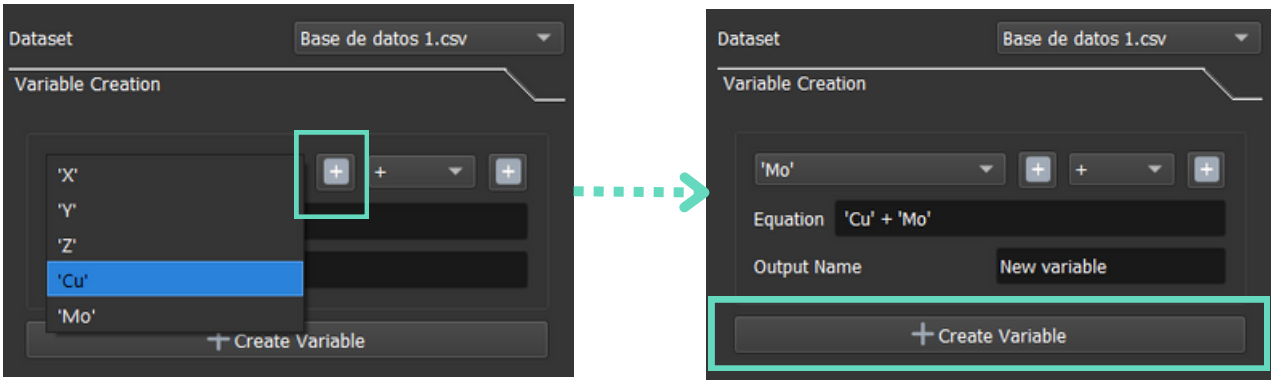
5. SYNTHETIC VARIABLES

In LIDENBROCK™ you will have a module **to support Data Imputation.** This module focuses on **improving the imbalance of databases with variables coming from different assays** (geochemical, metallurgical, geological interpretation, etc.) through a variable generated using LIDENBROCK™ **Variable Creation** and **Equation Finder** tools.

5.1 ***Variable Creation:*** *LIDENBROCK™ allows you* ***to create synthetic variables.*** *By selecting your variable of interest,* ***add operators to create an equation that defines your new variable.***

To create a new variable in LIDENBROCK™:

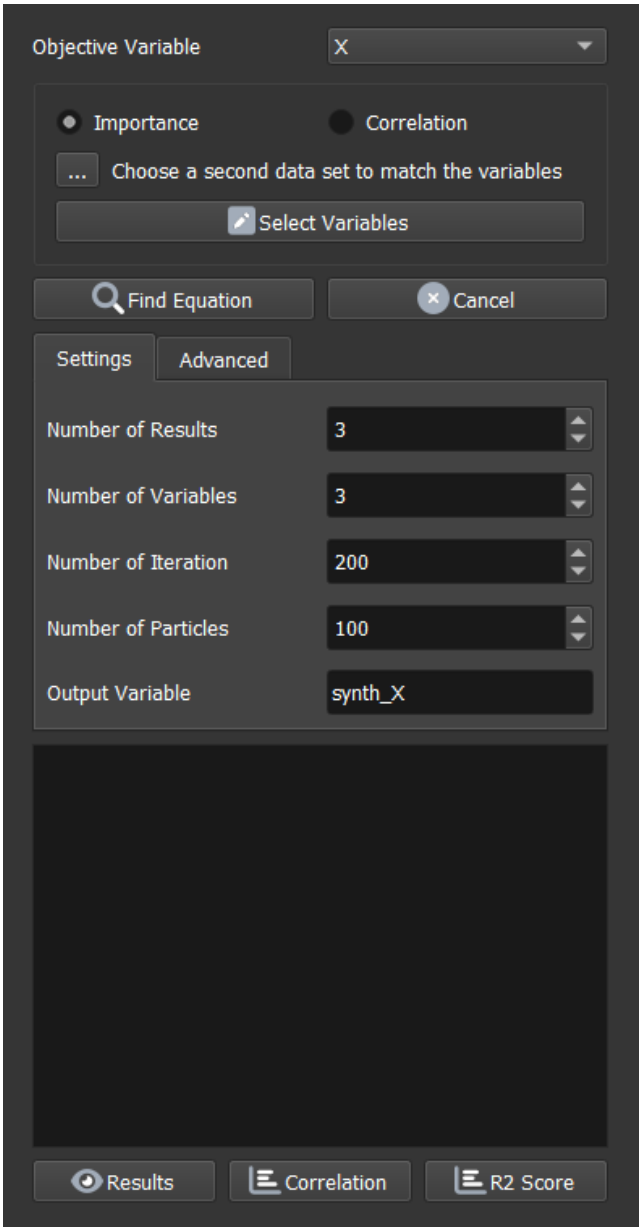
a) Choose the database that contains the variables you will use to create your new variable from Dataset.
b) Select the variable and click on  to Add it to the equation.
c) Add logical operators to the equation that will give rise to your new variable, use the icon  on the right to add to Equation.



d) Define the name of the variable in **Output Name**
e) Create your new variable by clicking on the **Create Variable** button**.**

Once created, your new variable will appear as another variable in the treeview of the ***Project Explorer*** *module. Work with your new variable like any other variable in your database, use all the modules that LIDENBROCK™ has available for your project.*

5.2 *Equation Finder*: This tool searches for an equation **to impute data by learning from your variables**. This tool has two methods to associate variables with your variable of interest, Feature importance based on random forest and correlation index, choose the most appropriate one to impute data.



To find an equation to impute data in LIDENBROCK™:

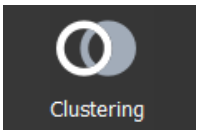
a) Select a target variable.
b) Choose the method to associate variables to your target variable.
c) Configure the search for correlations.

> ***Number of results*** *you want LIDENBROCK™ to search for,*
> ***Number of variables*** *in the equation,*
> ***Number of iteration***
> ***Number of Particles*** *or solutions*
> ***Output Variable:*** *Name of the synthetic variable you will create.*

d) Click **Find equation** to search.
e) Use the **Results, Correlation** or **R2 Score buttons** to visualize the behavior of the equations with your data in the visualization panel.

With this tool you can obtain a linear equation, a correlation parameter and the associated error of the target equation compared to the modeling. Use the most appropriate equation to create a new variable in the ***Variable Creation*** *module.*

6. CLUSTERING

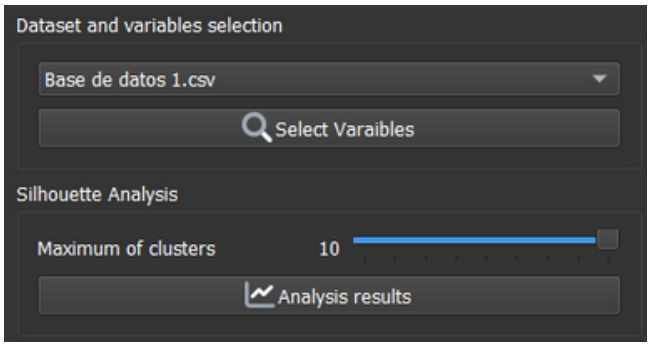


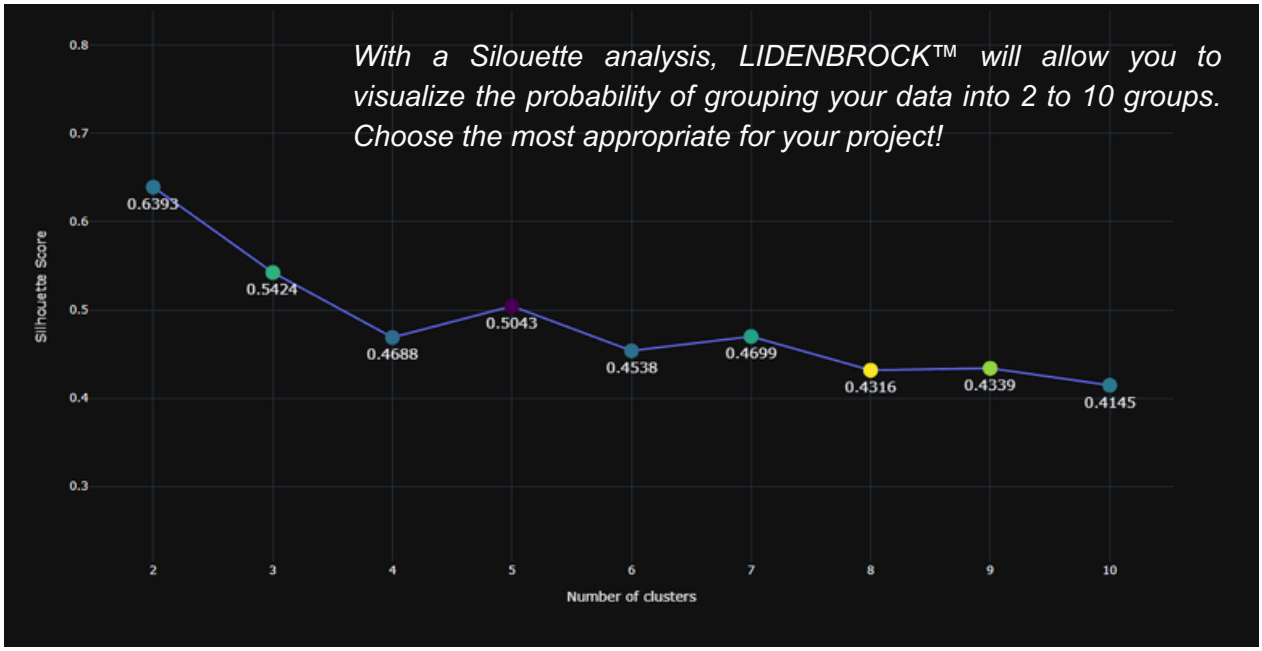
In LIDENBROCK™ you will have a module **to differentiate groups of data according to their behavior.** With the **K-means** and **Hierarchical clustering** tools, you will find **two statistical methods to group your data and simplify your searches.**

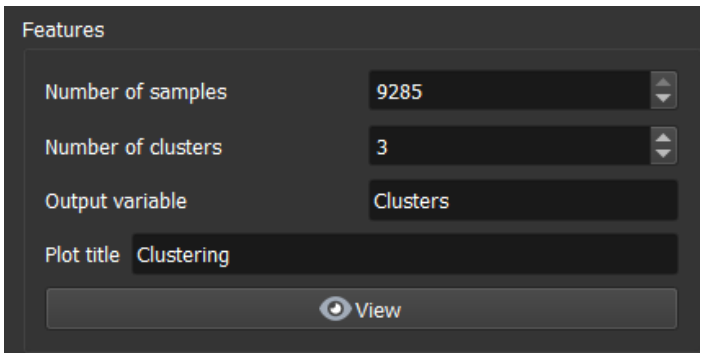
6.1 K means: k-means clustering **is a vector quantization method**, which helps you **to partition n observations into k clusters** in which each observation belongs to the cluster with the nearest mean (cluster centers), serving as a cluster prototype. This results in a partitioning of the data space. With this LIDENBROCK™ clustering tool you will be able **to cluster by minimizing variances within clusters.**

For clustering with the K-means method in LIDENBROCK™:

a) Choose a previously loaded database.
b) Select the data you want to analyze
c) Perform a silhouette analysis and choose the maximum number of clusters you want to evaluate in your data.
d) Click **Analysis results** to find the probability of grouping your data into "n" groups (clusters).

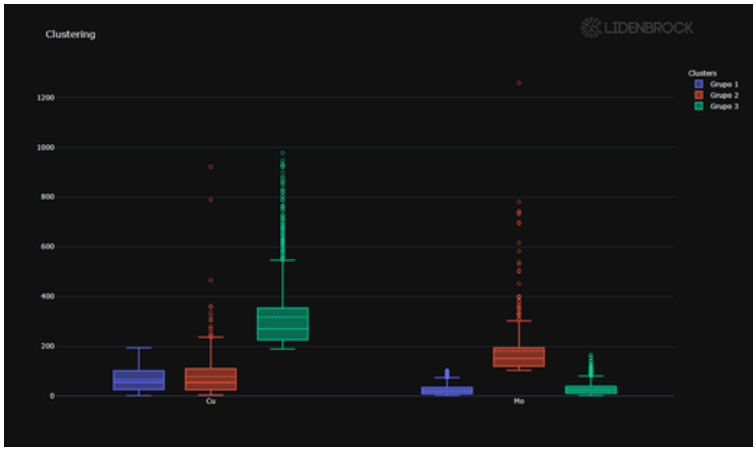






e) Decide, with the previous result, the number of clusters with which you want to group your data, by setting in **Features, Number of cluster**s.
f) Add a name to the new variable created by clustering.
g) Add a title to your graph and
h) Visualize the clusters in a **Box Plot** to know the distribution of the variables according to the group by pressing **View**.
i) Add a name to each label group by clicking on each cluster and modifying with your keyboard. To update the legend in the box plot, click on **Update labels**.

j) Save the box plot as an image from Export or
k) Save the generated cluster as a new variable by pressing Save clusters. You will be able to visualize in 3D from your dataset, by double clicking on the treeview from Project explorer.

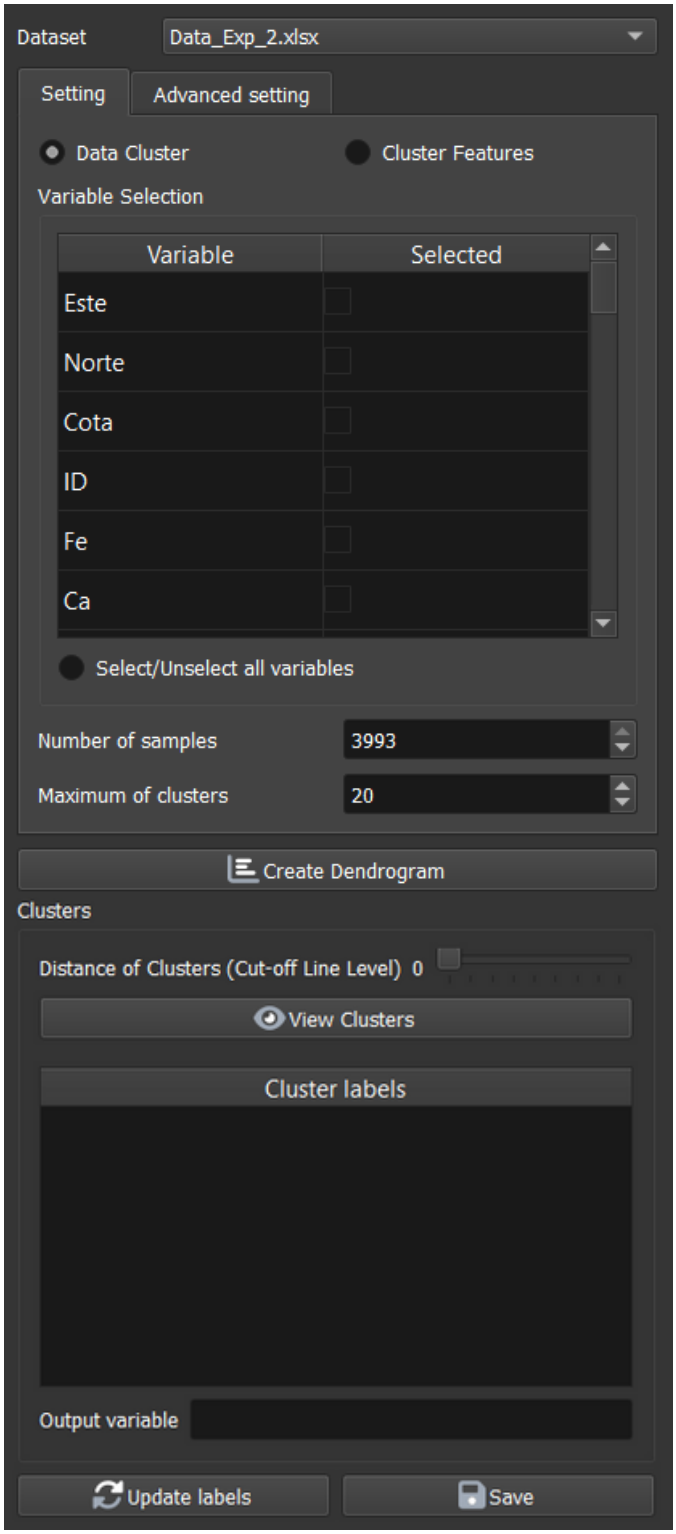


Zoom in to see more statistics. The solid line represents the median, the segmented line corresponds to the arithmetic mean, while circles show outliers. Complement your analysis from the EDA module to better understand the distribution of your data.

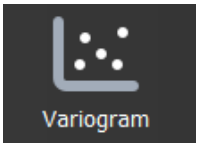
6.2 ***Hierarchical clusters*****:** Hierarchical clustering analysis is **a method of cluster analysis that seeks to build a hierarchy of groupings.** LIDENBROCK™ performs this **agglomerative type of analysis.** Each category creates its own cluster and each pair of clusters are merged as one moves up in hierarchy. The results of this clustering are presented in a dendrogram. Hierarchical clustering has the distinct **advantage that any valid measure of distance can be used.**

To perform hierarchical grouping in LIDENBROCK™:

a) Choose your data in **Settings.**
b) Create a dendogram.
c) Decide with the previous result, the grouping of your choice. Visualize the clusters by pressing **View Clusters.**
d) You can add labels by editing each one and pressing **Update labels.**
e) You can save the generated clusters by pressing **Save clusters.**
f) You can visualize your clustered dataset in 3D by double clicking on the treeview of the **Project explorer module.**

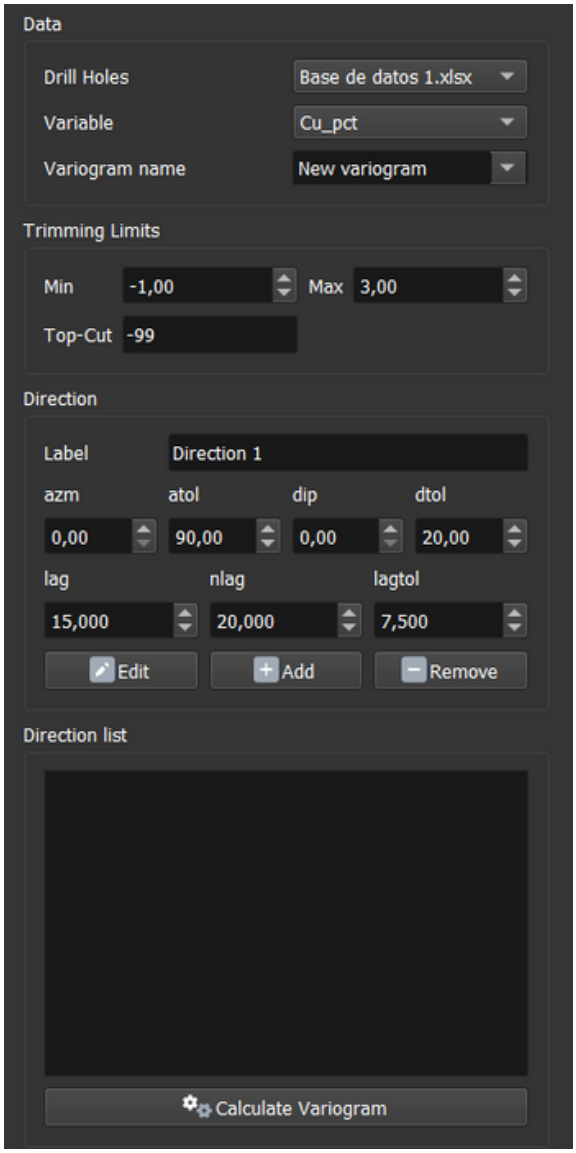


7. VARIOGRAM



In the LIDENBROCK™ **Variogram** module **you can learn the directions of maximum continuity and anisotropies** present in a reservoir. Use this geostatistical module **to describe the spatial geometry of regionalized variables** and integrate geostatistics into the evaluation of a reservoir. By statistically calculating the scale and regularity of different reservoir properties, reservoirs in unknown zones can be evaluated and predicted using the variogram tool. In this way qualitative geological study and quantitative statistical prediction are organically combined in the evaluation of your reservoir.

7.1 *Variogram*: Use this tool **to analyze the spatial behavior of a variable over a defined area**. With LIDENBROCK™ you can create an experimental variogram that reflects the maximum distance and how a point influences another point at different distances.



To create an experimental variogram in LIDENBROCK™:

a) Select **Variogram** in the Variogram Tools module.
b) Interact on the form displayed on the left side of the interface.
c) Select your database and the variable of interest.
d) Configure your data limits.
e) Choose the direction of the analysis and add (Add) to your Direction list.

> ***OMNI DIRECTIONAL:***
> *Azm 0, atol 90, dip 0, dtol 90*
> ***HORIZONTAL:***
> *Azm 0, atol 90, dip 0, dtol 20*
> ***VERTICAL:***
> *Azm 0, atol 90, dip 9, dtol 20*

f) Set the most appropriate lag according to your dataset.
g) Press ***Calculate Variogram*** to create your experimental variogram.

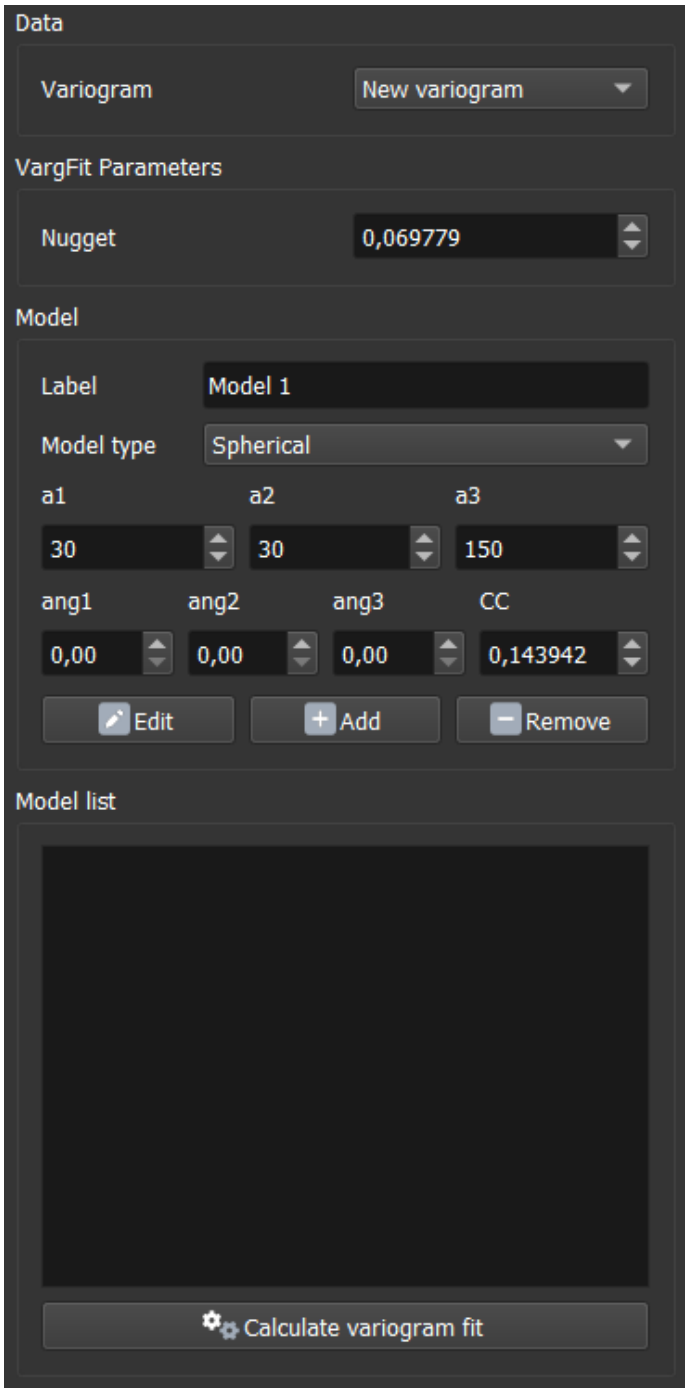
7.2 *Variogram Fit*: With this tool **you can recognize which structures best represent an experimental variogram**. With LIDENBROCK™ you can **check the fit of your experimental variogram in 4 models**: Spherical, exponential, cubic or Gaussian.

To create a variogram model in LIDENBROCK™:

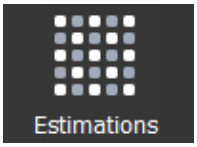
a) Select **Variogram Fit** in the **Variogram Tools** module.
b) Interact on the form displayed on the left side of the interface.
c) Configure the nugget effect by setting the minimum separation between two variables.
d) Choose and configure the model you want to apply.

If your variogram has a different behavior depending on the distance, you can add a model that fits each span. LIDENBROCK™ has spherical, exponential, cubic and Gaussian models.

e) Add, Edit or **Remove** your models to the list.
f) Press **Calculate Variogram Fit** to elaborate the analysis.



8. ESTIMATIONS



In the **Estimation Tools** module of LIDENBROCK™ you can access **4 different data estimation tools**. Use Kriging estimation, do Kriging cross-validation, estimate by inverse distance weighted (IDW) or create swathplot analysis.

8.1 *Kriging*: Use the spatial kriging inference method **to spatially interpolate your data with a variogram model** with which to assign weights to each benchmark**.** With LIDENBROCK™ you can perform a local estimation with the best unbiased linear estimator of an unknown characteristic or variable you study. With this method **you will obtain the best weighted linear moving average of a block.** You will be able to obtain **an estimate of your data through a regression analysis between the samples and blocks of your dataset.**

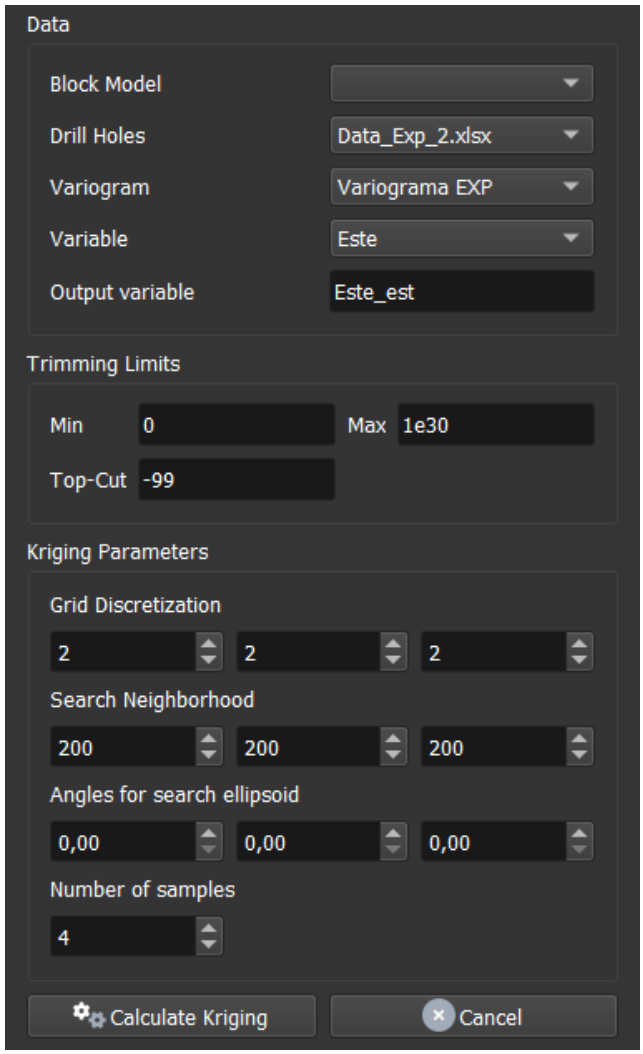
To make an estimate by Kriging in LIDENBROCK™:

1. Select your data →

2. Set the limits →

3. Choose the estimation parameters →

4. Estimate →



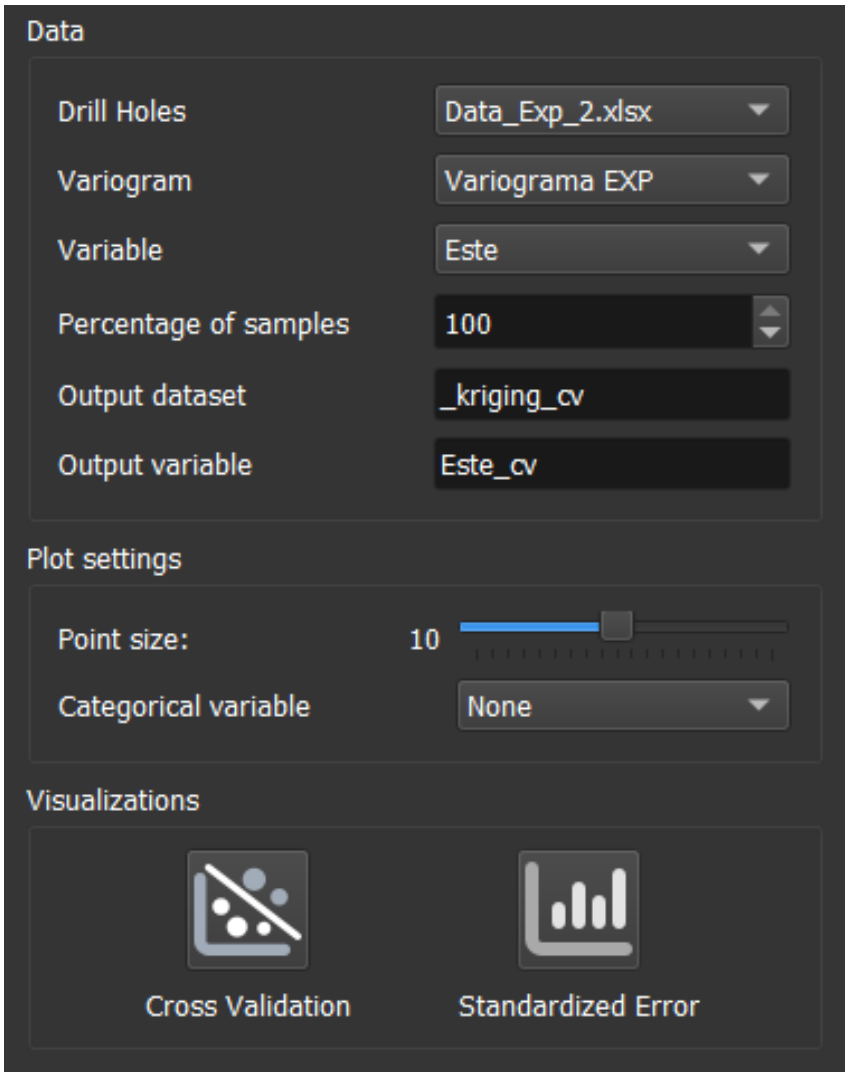
8.2 *Kriging Cross Validation*: You can perform cross-validation in LIDENBROCK™ **to test your "moving neighborhood" kriging models.** With this tool, you will be able **to predict each unknown value from a small number of surrounding data.** While in "single neighborhood" kriging algorithms, each estimate uses all available data, with this method your validation method.

To do a Kriging cross validation in LIDENBROCK™:

1. Select your data

2. Configure your chart

3. Visualize



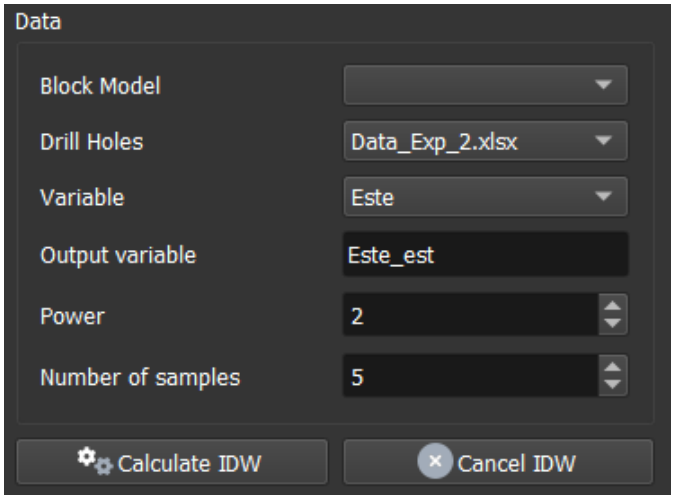
8.3 *Inverse distance weighting:* IDW is a type of deterministic estimation method for multivariate interpolation with a set of known sparse points. It uses LIDENBROCK™ **to assign values at unknown points are estimated with a weighted average of the available values at the known points.** This method can also be used to create spatial weight matrices in spatial autocorrelation analysis. This applied weighted average uses the inverse of the distance to each known point ("proximity quantity") when assigning weights.

To make an estimate with IDW on LIDENBROCK™:

1. Select your data →

2. Configure your chart →

3. Estimate →



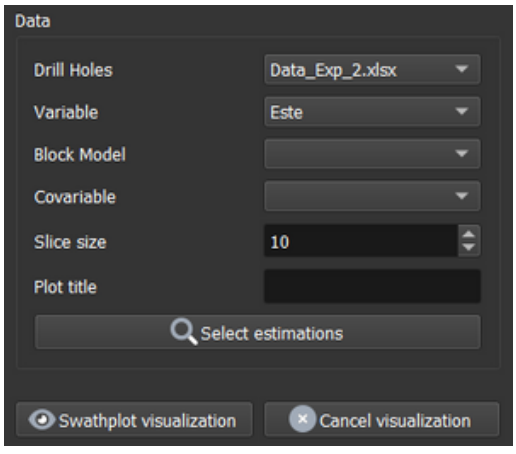
8.4 *Swathplot analysis*: With this validation tool **you can compare the sample points and the estimated values to detect any under- or overestimation bias or any smoothing of the results.** The swath plot is a one-dimensional plot in a specific direction of interest. A swath is a sectional cut through the block model with a specific thickness. The swath plot **shows the average grade of the blocks in the swath,** along with the average values of the samples in the swath.

To make an estimate with a fringe analysis in LIDENBROCK™:

1. Select your data →

2. Configure your chart →

3. Visualize →



9. DRILL HOLE OPTIMIZATION

At LIDENBROCK™ we know how to optimize your drilling campaigns. The ***Drill Hole Optimization*** module uses machine learning to learn from your data. With artificial intelligence, it helps you **search for an optimization algorithm,** choose a function that best fits your data model and LIDENBROCK™ **will help you optimize**.

To perform drillhole optimization with LIDENBROCK™:

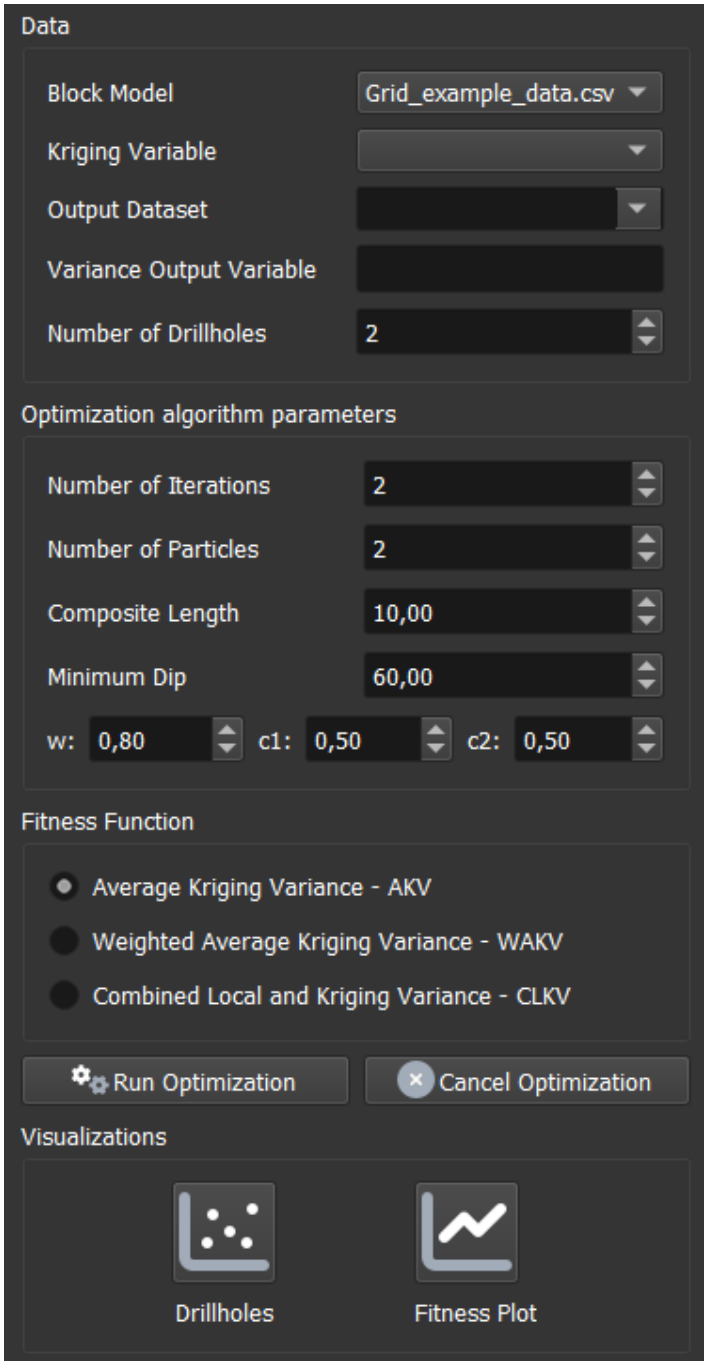
1. Select your data

2. Configure the search parameters of optimization algorithms with your data.

3. Choose the setting function

4. Search for the optimization algorithm

5. Visualize



Congratulations! You are part of the LIDENBROCK™ community.

If you experience any problems using LIDENBROCK™
feel free to contact us to report them.

We are continuously improving.

Send your comments and suggestions, or request technical support at:

Enjoy using LIDENBROCK™ for your geological analyses!