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# Quick guide



Welcome to GEUP 12, a software that will allow you to explore Geometry and Mathematics interactively through new ways and use it as a tool for calculation and visualization in Mathematics, Science and Engineering.

This new version includes many new functions, included the functionality requested by the users. All its power and stability together with its high quality interactive visualization has been preserved.

## Installation and System requirements

### Minimum requirements

- Microsoft Windows® 11, Windows 10, Windows 8, Windows 7, Windows Vista, Windows XP
- Pentium® Processor 133MHz (1GHz for Windows 11,10,8,7,Vista or 300 MHz for Windows XP)
- 1 Gb RAM for Windows 11,10,8,7,Vista or
  256 Mb RAM for Windows XP, 2003, 2000 and NT4 or
  64 Mb RAM for Windows ME, 98 and 95
- 16-bits 65536 colors video card - 800x600
- 8 Mb of free hard disk space for electronic distribution and
  25 Mb of free hard disk space for physical distribution.
- Mouse or compatible pointer
- CD-ROM/DVD-ROM drive (physical distribution)
- Adobe Acrobat Reader® 3.0 or higher (required to read the manuals in PDF format)

To install GEUP 12 Demo, download and run geup12i.exe and follow the instructions.

# Basic concepts

## Overview

GEUP is an interactive geometry software for math calculation and visualization. Designed to be easy to use, it is a powerful and versatile mathematical environment where the construction concept and the interactive visualization in real time is the heart of the program.
With GEUP you can study graphically a general problem and obtain dynamically its particular cases. This property together with its calculation capability, enables you to study problems of different areas of Mathematics like Calculus, Algebra, ...

The fundamental thing is that you can modify the position and other geometric properties of the elements of the construction. The established mathematical relationships between the elements through the construction tools will be preserved: when an element is moved, the construction will be reformed by maintaining these relationships.
This property is the most important feature of GEUP: you can obtain many particular cases of a construction quickly, being able to verify geometric properties about any construction.

## Selecting and Moving elements

 To move and/or edit the elements of the construction, activate the option [Edit][Move or edit element] or click on its button on the main toolbar.

- To move an element, detect it (if is possible to move it the cursor changes to  ), click and move it.)
- To edit an element, you must detect it and click with right button. The edit box of the detected element will be activated.
- To select elements, detect and 'click' with left button on each element. To select multiple elements you must define a rectangle on the plane starting on a position without elements.

  Press the [Shift] key to fix the selection of the previous selected elements.

Press the [Ctrl] key for not detecting the elements.

## Rotating elements

 To rotate constructed elements, activate the option [View][Rotate elements] or click on its button on the main toolbar.
To rotate an element or a group of previously selected elements:
1º choose the rotation center (a point in the construction plane('click' without detect) or a constructed point(detect and 'click' the point))
2º detect the element to rotate, 'click' and move to rotate, or press the key [Shift] and 'click' to enter the angle.

# Elements appearance

The appearance of the elements is defined by its color, shape (the names, text and numbers by its fonts), by its name and visibility.
**Visibility**: You can set each element of the construction as visible or hidden. To view the hidden elements activate the option [View][View hidden elements] or click on its button  on the main toolbar, the current hidden elements will be shown on screen with the color set on the General options. You can change the visibility of an element by activating the option [Edit][Hide/View] or click on its button  on the edit toolbar.

You can use this property, for example, for not seeing some intermediate elements of the construction.

**You can change the appearance of an element in two different ways:**

**a)** By activating the tools of change of color, shape and visibility (on the edit toolbar), and detecting and click on the element to modify.

**b)** Through the edit box of the element. If you want to add a name to an element, you must activate the edit box of the element to name.

# Eliminating elements

**You can eliminate an element in two different ways:**

**a)** Activate the option [Edit][Eliminate element] or click on its button  on the edit toolbar and detect and click on the element to eliminate.
Also You can select the elements to eliminate first and then activate the menu option [Edit][Delete].

**b)** Through the edit box of the element to eliminate.

If an element is eliminated, all the elements that depends on it will also be eliminated.

# Edit box

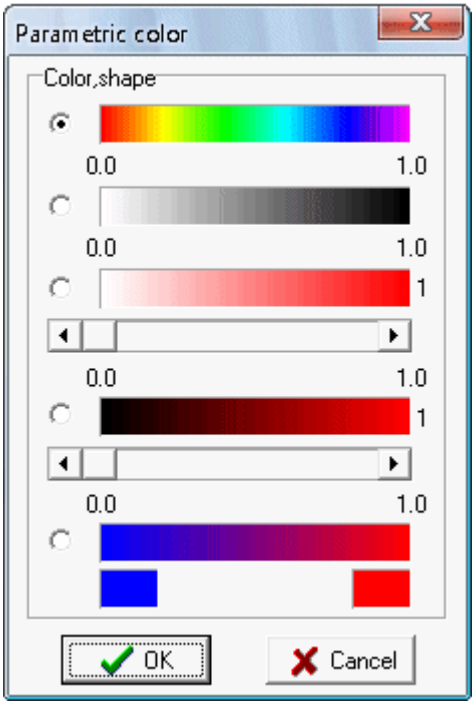
You can change the color and shape of an element, set its visibility, eliminate it and name it with the edit box. Also you can edit some exclusive options of some elements. 

**You can activate the edit box in two different ways:**

**a)** If the option [Move or edit elements] is activated, detect and click with right button on the element to edit.

**b)** Activate the option [Edit][Edit box] or click on its button on the edit toolbar or with the keyboard [ctrl][E], detect and click on the element to edit.

# Parametric color




It is possible to assign the color (or fill color) of an element using a number (parameter). This number represents a color defined by the following dialog box of the parametric color.

- variation - spectrum
- variation - grayscale
- variation - white → fixed color
- variation - black → fixed color
- variation – fixed color 1 → fixed color 2

The fractional part ( 0 <= P < 1 ) represents the color.

**We can begin the assignment of the parametric color of an element in two different ways:**

**a)** Opening the color box in the edit toolbar and selecting the button to edit the parametric color or the parametric fill color of the element.

**b)** Through the edit box of the element and selecting the button .

**To construct:**
**1º** Detect and 'click' on the element to assign the parametric color.
**2º** Detect and 'click' on the number (parameter).
**3º** Select the variation mode.

# Font

**To change the font of an element.**

**1º** Select the button on the toolbar.
**2º** Detect and 'click' on the element.
**3º** Select the font and 'click' on OK.

**To change the font of several elements.**
**1º** Select the elements.
**2º** Activate the button on the edit toolbar.
**3º** Select the font and 'click' on OK.

Also you can modify the font of an element through its edit box.

# Moving across the plane

**If you want to view all the defined plane or you need to select an element of the construction that is outside of the limits of the screen you have two possibilities:**

• To move the screen, click with right button on an unocuppied area and drag.

• You can activate the window 'Move the screen' with the menu option [View][Move the screen] or click on the button  on the toolbar or with the keyboard [shift][M]. The plane will be shown. You can change its size with the trackbar.

To move the screen detect and click on the rectangle that represent it, drag it to the required area and press [OK]. Press [Cancel] to return to the initial position.

# Viewer mode

Activate the menu option [View][Viewer mode].

The purpose of the viewer mode is to optimize the visualization and usage of constructions when its modification is not required. The viewer mode hides the construction and edition elements of the program interface to maximize the visible area.

If a document is saved with the viewer mode enabled then that document is activated with the viewer mode enabled when it is opened through a command line, this method is useful to publish documents in a web pages or to work with multiple documents by using a file manager.

# Zoom

Activate the button  or the menu option [View][Zoom].

click' on the plane (zoom center), move up the pointer to enlarge and down to reduce.

To move the screen use the right button.

# Redefinition of points

The redefinition of points is a powerful tool that allows to modify the construction quickly for obtain the particular cases of a general construction, it is not necessary to repeat intermediate steps.

**Redefine a point:**

**1º** Activate the button  on the main toolbar.

**2º** Detect and ‘click’ on the point.

**3º** Detect and 'click' on other point, other element to attach the point, an intersection or a free position on the plane.

# Traces of elements

Trace the path of elements when moving. Trace toggles on or off.

- Detect and 'click' on the elements to set on/off its trace. 
- To disable all the traces use the menu option [Edit][All traces (Off)].

To erase the traces use the menu option [Edit][Erase traces] or with the keyboard [ctrl][R].

# Animations

Enable/disable the animation of points on element, lines given 1 point, rays given 1 point, circles given 1 point and parameters. 

- Detect and 'click' on the elements to enable/disable its animation.

**Animation box**

You can control the pause, speed, direction of the elements and enable/disable its animation.

Also is possible to pause of all elements in the animation.

# Antialiasing

It is activated through the menu option [View][Antialiasing].
This document option allows to visualize the drawing of lines/curves of the construction with a "smooth" visual effect which can be useful to improve the visual appearance of some constructions, this option generally slows the representation of the construction.
Through the dialog box [File][Elements appearance] it is possible to modify the default option for the new documents.

# Text

Create a text on the construction plane (It is possible to change its font later).

**To create:**
**1º** Click on the place where to put the text.
**2º** Edit the text on the edit window.
You can change the window size. (drag the low right corner on the edit window)
You can maximize the window.
**3º** Click the button ('OK') to put the text on the plane.
**4º** Drag the text to the required position.
It is possible to modify its position and font later.

# Bitmap

Inserts an image (bitmap) in the construction. It is possible to split/merge this bitmap to a point.

There are two ways.
**Way 1**
**1º** Activate the button in the edit toolbar.
**2º** 'click' on a free area of the plane or on a point to split the bitmap.
**3º** Select a bitmap from a file and 'click' on OK.
**Way 2**
**1º** A bitmap must be loaded in the clipboard.
**2º** Unselect the elements in the construction or select a point to split the bitmap.
**3º** Activate the menu option [Edit][Paste image].

It is possible to change the position of a bitmap attached to a point through the edit box of the bitmap.

# Button Hide/View

Construct a button to assign the visibility of a group of elements.

There are two ways.
**Way 1**
**1º** Select the button  on the edit toolbar.
**2º** Select the elements.
**3º** 'click' on a free area of the plane to place the button.
**Way 2**
**1º** Select the elements.
**2º** Select the button  on the edit toolbar.
**3º** 'click' on a free area of the plane to place the button

# Button movement

Create a button to move a given point to other point (the points are independent).

**1º** Select the button  in the edit toolbar.
**2º** Select a set of points (pairs).
**3º** 'click' on a free area of the plane to place the button.

# Plot assistant

Its activated with its menu option [Measure - Calculate][Plot assistant...] or clicking on its button on the main toolbar.
The plot assistant allows to plot on the first constructed coordinate system (being created if not exist previously) a curve defined by their equations according to the following options, varying the independent variable between the given extreme values:
**y = f(x)** ; (rectangular coordinates), **x = f(y)** ; (rectangular coordinates)
**r = f(w)** ; (polar coordinates), **w = f(r)** ; (polar coordinates)
**x = f(t), y = f(t)** ; (rectangular coordinates),**r = f(t), w = f(t)** ; (polar coordinates)

The assistant facilitates the plot of each curve by automatically identifying for each function(equation) the possible constructed numeric values with a name assigned and creating the corresponding parameters that not exist previously.

# Step by step

Select the menu option [View][Step by step] to view the construction step by step (visible elements) or click on its button  on the toolbar or with the keyboard [F2].

- The element for each step is shown blinking. The element type is also named.
- Moving the included scrollbar on the dialog box it is possible to reproduce step by step the construction process quickly.

You can press the button [OK] to set the construction in the required step.

# List construction

To show the construction list, activate the button  or activate the menu option [View][Construction list] or with the keyboard with the key [F3].

- Using the mouse or with the nav.bar it is possible to go up/down on the list, the current element will be selected.
- It is possible to Hide/View the hidden elements with the button 'show hidden elements' of the nav.bar.
- To copy the construction to the clipboard, 'click' with the right button of the mouse on the list and activate the menu option [Copy].

# Printing the construction

- Activate the print window by selecting the option [File][Print] or with the keyboard [ctrl][p]. 
- Change the plane size with the trackbar 'Plane size' if the area to print is not visible.
- Select the number of copies.
- Finally, to print, click on the button 'Print'.

To choose the printer, the printer configuration and the type of the page, click the button 'Options'.

# Basic construction tools

## Point

Create a free point, a point on element, or an intersection point.

**Free point: To create**:
Move the pencil to an unocuppied area and click.
A free point can move to any position.
**Point on element: To create:** Detect the element (segment, line, ray, axis, circle, arc, polygon) that will contain to the point and click.
The created point will be linked to the detected element and will be able to move to any position on the element.
**Intersection point: To create:** Detect the intersection and click.

## Segment Construct a segment given two endpoints.

**To create**:
Detect the first point and click, detect the second point and click.
The segment will be able to move if both endpoints are free points

## Vector Construct a vector given two endpoints.

**To create**: Detect the first point (origin) and click, detect the second point and click.
The vector will be able to move if both endpoints are free points

## Vector sum Construct the vector sum of two given vectors.

**To create**: Detect and 'click' on the two vectors.
Detect and 'click' on the endpoint that defines the vector's tail.

## Polygon Create a polygon given its 'n' vertexes.

**To create:**
Detect and click the vertexes consecutively and double click on the last vertex.
The polygon will be able to move if all of its vertexes are free points.
Later You will be able to fill the polygon with a fixed or parametric color.

## Regular polygon

Construct a regular polygon(max.30 sides), defined by a center point and a radius points.

**To create:**
**1º** Detect and click on the center point..
**2º** Detect and click on a second point (vertex).
**3º** Move the pointer: clockwise (convex) or counter-clockwise (star) to specify the number of sides.
**4º** 'click' to complete the construction.

# Line

Create a line through one or two points.

**Line through one point:**
**To create**: Detect a point and click, move the pencil to an unocuppied area and click. You can change its slope.
**Line through two points:**
**To create:** Detect first point and click, detect second point and click.
The line will be able to move if both endpoints are free points.

# Ray

Create a ray through one or two points.

**Ray through one point:**
**To create:** Detect a point and click, move the pencil to an unocuppied area and click. You can change the ray slope.
**Ray through two points:**
**To create:** Detect first point and click, detect second point and click.
The ray will be able to move if both endpoints are free points.

# Conic defined by five points

Construct a conic defined by five points.

**To create:**
Detect and 'click' on five points.
The conic exists if two of its points are not in the same position and four of its points are not collinear.

# Circle

Create a circle given the centre or given the center and a point.

**Circle given the center:**
**To create:** Select a point(center), move the pencil to an unocuppied area and click. You can change the radius.
**Circle given the center and a point:**
**To create:** Detect first point(center) and click, detect the second point and click.
The circle will be able to move if both endpoints are free points.

# Circle given the center and a point

Create a circle given the radius(defined by two points or by a number) and the center.

**To create:**
**1º** Detect and click two points(radius endpoints) or a segment, vector or side of polygon or a number(radius).
**2º** Detect and click the center. **It works like a compass.**

# Arc

Create an arc given three points.

**To create:**
Detect and click three points, the first and the last points will be the endpoints.
The arc will be able to move if the three points are free points
It is possible to measure the arc length with the numeric tool [Length-Distance], you can attach this number to the arc.

# Angle

Define the angle defined by three points.

**To create:**
Detect and and click three points, the second point will be the vertex.
You can change the radius of the arc that represents the angle.
Later You can measure the angle with the numeric tool [Measure angle].

# Parallel line

Create the line through a point and parallel to a segment, line, ray, axis or side.

**To create:**
Detect and click a point and the element.

# Perpendicular line

Create the line through a point and perpendicular to a segment, line, ray, axis or side.

**To create:**
Detect and click a point and the element.

# Angle bisector

Create the angle bisector of an angle defined by three points.

**To create:**
Detect and click three points that defines the angle(the second point will be the vertex) or an angle.

# Perpendicular bisector

Create the perpendicular bisector of the segment defined by two points.

**To create:**
Detect and click the points that defines the segment or a segment, vector or side of a polygon.
The perpedicular bisector is the perpendicular line to a segment through the midpoint of the segment.

## Midpoint

Create the midpoint of two given points.

**To create:** Detect and click two points or a segment, vector or side of a polygon.

## Intersection point(s)

Create the intersection points of two given elements(segments, lines, rays, axes, circle, arcs or loci).

**To create:** Detect and click two elements.

## Locus

Create the locus (described by a point, segment, line, circle, arc, polygon, conic, locus) defined by the movement of a 'point on element' or defined by the variation of a 'parameter' between its maximum and minimum values. .

**To create:**
**1º** Detect and click the element that will describe the locus.
**2º** Detect and click the 'point on element' or the 'parameter'.
You can change the number of calculated samples by activating the edit box.
Using this tool you can plot functions on an axes.
Also it is possible to calculate loci defined by a [point on a grid].
Later you can create loci of loci and obtain its intersection points with other elements of the construction.

# *Numeric tools*

## Length - Distance

Calculate the following measures:

**Length of a segment, circle, arc or the perimeter of a polygon.**
**To create:**
Detect and click a segment, circle, arc or polygon.
Drag the number to an appropriate position.
If you edit the number you will be able to identify the measure through the blinking elements.

**Distance point-point, distance point-line.**
**To create:**
**1º** Detect and click a point.
**2º** Detect and click a point or a line.
Drag the number to an appropriate position.
If you edit the number you will be able to identify the measure through the blinking elements.

## Area Calculate the area of a circle or a polygon.

**To create:** Detect and click a circle or a polygon.
Drag the number to an appropriate position.

## Measure angle Calculate the measure of an angle given by 3 points or the measure of an arc central angle.

**Angle given by 3 points: To create:** Detect and click three points that defines the angle, the second point will be the vertex.
**Arc central angle: To create:** Detect and click the arc.
Drag the number to an appropriate position.
If you edit the number you will be able to identify the measure through the blinking elements.

## Slope Measure the slope of a line, ray, segment or side.

**To create:** Detect and 'click' on a line, ray, segment or side.
Drag the number to an appropriate position.
If you edit the number you will be able to identify the measure through the blinking elements.

## Ratio Calculate the ratio of two lengths of segments.

**To create:**
**Case a:** Detect and 'click' on two segments (a,b). (p = a / b)
**Case b:** Detect and 'click' on three aligned points (a,b,c) (p = ab / ac) (if a belongs to bc then p<0)

## Coordinate system

Create a coordinate system.

**To create:** Detect and click on a point (origin).
You can move the axes if the origin is a free point.
To change the scale of the axes drag the mark indicated by '1' on the x-axis.
To change the scale of the y-axis drag the mark indicated by '1' on the y-axis.

## Grid Define a grid on a coordinate system.

**To create:** Detect and 'click' on the coordinate system.
You can split and merge points on the grid with the tool Split/Merge point on element.

## Equation, coordinates

Create the coordinates of a point and the equations of lines and circles.

**To create:**
**1º** Detect and click on a point, a circle or a line.
**2º** Detect and click on the axes to calculate the coordinates or equation.

# Point given coordinates

Create a point given its coordinates on a give coordinate system.

**To create:**

**1º** Detect and click on the number that will be the x-coordinate or the r-coordinate when you work with polar coordinates.
**2º** Detect and click on the number that will be the y-coordinate or the theta-coordinate when you work with polar coordinates.
**3º** Detect and click on the axes to plot the point.

A set of axes will be created If there are not visible axes.

# Calculate

Calculate the result of a mathematical expression through numbers and functions. You will be able to use the result in other construction step.
If you have created a number by using variables and these variables changes, the created number will be calculated again.
Later You will be able to modify the calculation with a double 'click' when detecting it.

**It works like a calculator:**

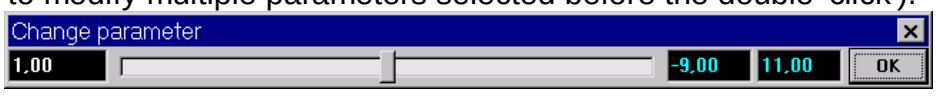
- Enter the numerical values with the keyboard.
- Detect and click on the variables (numbers(a,b,c,d,... (without a name assigned previously)) or functions(f1,f2,f3,f4,...)
- Enter the operations with the buttons or with the keyboard.
- To obtain the result of a calculation click on the [=] button.

To use the result on the construction, click the result and drag the number to an appropriate position.

# Parameter

Calculate the result of a mathematical expression as with the tool calculate. If we create the number(drag the result to the plane), it will be a parameter we can modify.

If you detect and double 'click' a parameter its edit box will be shown.
It is possible to modify directly the parameter or change its value with the track bar(allowing to modify multiple parameters selected before the double 'click').



# Function

We can create 'construction functions' to use them in a calculation, in the creation of parameters or in the creation of other 'construction functions'.
Also it is possible to plot them in a coordinate system in the following forms:
**cartesian coordinates**: y=f(x) or x=f(y)
**polar coordinates**: r=f(w) or w=f(r)

**To create:**
**1º** Enter the selected function f(x),f(y),f(w) o f(r) (it is possible use numbers and functions)
**2º** 'click' on the button [=].
**3º** To use the result in the construction, click the result and drag the number to an appropriate position.
You can modify the function (detect it and double 'click').
You can edit the function to add it a name or description.

# Plot function

Plot in a coordinate system a previously created 'construction function'.

**1º** Detect and 'click' on the function to plot.
**2º** Detect and 'click' on the coordinates system.
Edit the plotted function to modify the max. and min. values of the independent variable and to modify the number of calculated points.

# Plot points

Plot points on a coordinate system.

**To create:**
**1º** Detect and 'click' on the coordinate system.
**2º** (Choose between cartesian and polar coordinates). Enter the coordinates of the point and 'click' on the button [point].

# Table

Create a table of numerical values to represent the values of measurements or functions in the particular cases of a construction. Also adds the current values for a table.

**To create:**
**1º** Detect and click on the numbers to tabulate.
**2º** Detect and click on an unocuppied area.
The names of each number will be placed over the columns of each number on the table.

**Add current values:** To add the current values detect and click on the selected table.
**Delete last entry:**To delete the last entry detect and click on the selected table with the key[Shift] pressed.

# *Geometric transformations*

## Translated point given number

Create a point that is obtained moving a point on a path a given distance. 

**To create:**
**1º** Detect and click on the point to translate.
**2º** Select the path:
**On a line**:
(**case a**) Detect and click on a 2º point: [the first point will be translated on the ray(imaginary) through both points].
(**case b**) If the first point is an endpoint of a ray, detect and click on the ray: [the first point will be translated on the ray].
(**case c**) If the first point is the origin of an axis, detect and click on the axis: [the first point will be translated on the axis].
**On a circle**: The point to move should belong to the circle.Detect and click on the circle: [the first point will be tranlated on the circle].
**3º** Detect and click on the number that defines the distance to translate the first point.

## Symmetry

Create the symmetrical image of an element across a point (simmetry center). 

**To create:**
**1º** Detect and click on the element to transform (point, segment, line, ray, circle, arc or polygon).
**2º** Detect and click on a point (simmetry center).

## Reflection

Create the image of an element reflected across a simmetry axis. 

**To create:**
**1º** Detect and click on the element to transform (point, segment, line, ray, circle, arc or polygon).

**2º** Detect and click on the simmetry axis (segment, line, ray, axis or side of a polygon).

## Translation

Create the image of an element translated by a given vector. 

**To create:**
**1º** Detect and click on the element to transform (point, segment, line, ray, circle, arc or polygon).

**2º** Detect and click on two points that defines the vector.

## Rotation

Create the image of an element rotated around a point a given angular value.

**To create:**
**1º** Detect and click on the element to transform (point, segment, line, ray, circle, arc o polygon).
**2º** Detect and click on a point(rotation center).
**3º** Select the angular value:
**(case a)** Detect and click on a number (rotation angular value).
**(case b)** Detect and click three points that defines the angle, the second point will be the vertex.

## Dilation

Create the image of an element dilated from a point by a given factor.

**To create:**
**1º** Detect and click on the element to transform (point, segment, line, ray, circle, arc or polygon).
**2º** Detect and click on a point (dilation center).
**3º** Detect and click on a number (factor).

## Inversion

Create the inverse point(P') of a given point(P), given a circle(radius = r).
The center of the circle is the inversion center (O). OP x OP' = $r^2$.

**To create:**
**1º** Detect and click on the point to transform.
**2º** Detect and click on the circle.

# *Check property*

## Check property - Parallel

Verify whether or not two lines, rays, segments, axes, or sides are parallel.

## Check property - Perpendicular

Verify whether or not two lines, rays, segments, axes, or sides are perpendicular.

## Check property - Member

Verify whether or not a point lies on an element.

## Check property - Collinear

Verify whether or not three points lie on the same line.

## Check property - Equidistant

Verify whether or not one point is equidistant from two other points.

# Macros

## what is a macro ?

A macro creates final elements given initial elements, carrying out the steps automatically, avoiding that you have to make each step one by one.

Once designed, the macro works as any other construction tool.

When you activate a macro, once the initial elements are selected, the final elements and the necessary elements will be created.

## Apply a macro

To apply a macro, activate the menu option [Macros][Macro options] or click on its button  on the toolbar or with the keyboard [ctrl][M].

If there are not available macros, you will have to load them from the disk drive, from other document or create a new one.

When a macro is available, you can to activate it and enter the initial elements, (double click or click on its name and 'Start macro').

The last step is to select the initial elements. The following element type is shown in the status bar.

## Create a new macro

To create a new macro you will have to carry out a construction that contains the constructive process for the macro to create: the initial and the final elements.

**1º Select the Initial elements:**
• Activate the window('Macros') and click the button('Initial elements').
• Detect and click the initial elements.

**2º Select the Final elements:**
• Activate the window('Macros') and click the button ('Final elements').
• Detect and click the final elements.

An element can be a last element if can be constructed with the basic construction tools, starting from the initial elements that you have chosen.

**3º Complete macro:**
• Activate the window('Macros') and click the button ('Complete macro').
• Enter a name for the created macro.

To add a comment for the macro: select the macro, edit the text and save.
To save the macro: select the macro(click the name) and click the button('Save macro').

# *Iterations*

Through the tool 'Iteration' it is possible to iterate(repeat any number of steps(with recursion)) the construction created by 'initial elements'(points/numbers) starting with corresponding 'destination elements'(points/numbers), with each iteration step the construction is repeated using as initial elements the destination elements obtained in the previous step.

(When the iteration is created it draws the iteration of the visible geometric elements that depends on the 'initial elements').

Activate the menu option [Transform-Check][Iteration] or 'click' on its button in the main toolbar or press the keys [ctrl][I].

To create a new iteration you will have to carry out a construction that contains the constructive process for the iteration to create: the 'initial elements' and the 'destination elements'.

**Select elements:**
This option starts the selection of initial or destination elements (points/numbers).
The 'initial elements' are named as 1,2,3,... and the corresponding 'destination elements' as 1',2',3',... .

**Add destination elements:**
This option adds a new set of 'destination elements'.

**Remove:**
This option removes the set of initial or destination elements currently selected on the list.

**Number of iterations:**
It is possible to select a constructed number(detect and 'click') to assign the number of iterations of the iteration element or to assign a constant value('click' without detect) which can be changed later when the iteration is edited.

**New iteration:**
This option is enabled when a new iteration can be created.

Once an iteration is created it is possible to modify the next options through its edit box:

• View/Hide the iterated points.
• View all the iterations(steps) (the 'Number of iterations(n)' assigned when the iteration element was created)/View only the last iteration(step).
• Own color (assign a common color for all the iterated elements) or keep the initial color for the iterated elements.
• Continuous fill(equals the color of circumferences/polygons with its fill color).
• Number of iterations.
(The keys [PageDown],[PageUp],[Home],[End] allow to identify the elements that define the iteration)

# *Scripting*

The scripting functionality allows to create a GEUP construction through a script(a program in text mode which contains a sequence of instructions(logical/mathematical) which define an algorithm). The creation of constructions through scripts allows to automate complex constructive processes and apply them systematically, conditionally and repetitively.

To create a new script activate the menu option [Edit][Script] or 'click' its button  in the document toolbar or press the keys [shift][S].
· The 'RUN' button in the dialog box executes the script, creating the construction.
· It is possible to load scripts previously saved in disk and save the current script.

(Scripts allow to create fractals by creating in the construction(construct) all the individual elements that form the fractal(points,segments,etc.), for example it is possible to intersect these elements with the other geometric elements of the construction. If the access to the individual elements that form the fractal is not required, it is possible to create the fractal with the tool 'Iteration', which has the advantage of using less system resources)

## Structure

GEUP uses an interpreter with a similar syntax to the C programming language to create the scripts, the interpreter includes a set of built-in functions to apply the construction tools of GEUP.

- A GEUP script consist of a main body and functions.
- When the script is executed(RUN), the instructions(statements) in the main body are executed sequentially
- The statements end with a semicolon (;)
- Blocks of statements enclosed in braces ({) and (})
- Identifiers can include alphabetic characters(a-z,A-Z), digits(0-9), underscore(_) and must start with an alphabetic character
- Comments between (//) and carriage return(new line)

## Variables, constants and arrays

- Variables can be assigned to the following types:
  **integer** ex. [a=1;]
  **real** ex. [a=1.0;]
  **string** ex. [a="N1";]
  **element**(GEUP element) ex. [a=point(0.0,0.0);]
- Variables omits its declaration(its type is assigned at execution time)
- Automatic type conversion of the value of variables in expressions
- Variables defined inside functions are local variables and the variables defined inside the main body are global variables
- Definition of scope for local variables: (access to global variables) **name:global;** and (by default) **name:local;**
- A definition of scope of a local variable is not limited to a block of statements
- Constants: false (0 (integer)),  true (1 (integer)),  pi (3.1415... (real)),  e (2.7182... (real)),  nullext (null (element))

# Arrays

Array definition:
name[expression-dim1][expression-dim2]...,expression-ini;

- The array type is declared(defined) by the type of the value of expression-ini (ex.'a[2],nullext;')
- The value of expression-ini is assigned to all the elements of the array when the array is defined(declared)
- Multidimensional arrays can be defined: expression-dim1,expression-dim2,...(integer) are the size of each dimension
- An array can be redefined
- An array of strings can't be defined
- Examples of definition and access(refer to any particular element) of arrays(ex.'a[2],1; a[0]=3;','i=0; b[3][2],i+2; n=b[2][i+1];')

# Operators

assignment operators:
=
+=
-=
*=
/=

arithmetic operators:
+
-
*
/
^

relational operators:
<
>
<=
>=
==
!=

logical operators:
&&
||
!

**Operators precedence**

(highest priority) (Expressions inside parenthesis() are evaluated first)
(1) +(unary), -(unary), !, ^ (2) *, / (3) +, -
(4) <, >, <=, >=, ==, != (5) &&, || (6) =, +=, -=, *=, /=
(lowest priority)

# Loops and execution control statements

## if, else

if (expression) [statements1]
[else] [statements2]

if executes [statements1] if (expression) is true (not 0); if (expression) is false (0), it executes [statements2].

## for

for (expression-init; expression-condition; expression-loop)
[statements]
for executes [statements] repeatedly. First expression-init is evaluated. Then, while expression-condition evaluates to a nonzero value, [statements] is executed and expression-loop is evaluated. When expression-condition becomes 0, the statement following the for loop is executed.

## while
while (expression)
[statements]
while executes [statements] repeatedly until (expression) becomes 0

## do, while
do [statements]
while (expression);
do executes [statements] repeatedly until (expression) becomes 0
The statement [break;] terminates the loops 'for', 'while', 'do, while'

## Functions
Function definition
name([par1,par2,...])
{
  [statements]
  [return [expression];]
}
A function definition can be included anywhere in the program
A function definition can't be included inside another function definition or statement(ex.'while, if')

Function call
name([expression1, expression2,...])
In a function call the variables argument can be passed by value or reference
To pass a variable by reference the character '&' must be added before its name in the function call (ex.'f1(a,&b);','f3(&c[2]);')
An array always is passed by reference
A function call returns the evaluated value of expression

## Built-in functions
element abisector(point,point,point);
real abs(real);
real acos(real);
element angle(point,point,point);
integer angleunit(integer);
integer antialiasing(integer);
element arc(point,point,point);
element area(element);
real asin(real);
integer assignlength(real,point,point);
real atan(real);
integer backgroundcolor(real,real,real);
element calculate(string,array:number,integer);
real ceil(real);
element circle(point,point);

```
integer color(element,real,real,real);
element conic5p(point,point,point,point,point);
real cos(real);
real cosec(real);
real cosh(real);
real cotg(real);
element dilation(element,point,number);
element distance(point,element);
integer einfinity(integer);
real exp(real);
integer fill(element,real,real,real);
real floor(real);
element getelem(string);
integer getelems(array:element);
real getvalue(number);
integer hidelemcolor(real,real,real);
integer int(real);
real integer(real);
element intersect(element,element);
element intersecti(element,element,integer);
element inversion(point,circle);
element length(element);
integer lengthunit(integer);
element line(point,point);
real ln(real);
element locus(element,element);
real log(real);
element midpoint(point,point);
element parameter(real,real,real);
element parline(element,point);
element pbisector(point,point);
element perpline(element,point);
integer pixelscm(real);
element point(real,real);
element pointelem(element,real);
element polygon(array:point,integer);
integer postxt(element,integer,integer);
real pow(real,real);
real rand();
element ratio(point,point,point);
element ray(point,point);
element reflection(element,element);
element rotation(element,point,number);
real round(real);
integer samplesL(element,integer);
```

real sec(real);
element segment(point,point);
integer selelemcolor(real,real,real);
integer setname(element,string);
integer setparam(parameter,real);
real sgn(real);
integer shape(element,integer);
integer show(element,integer);
integer showname(element,integer);
real sin(real);
real sinh(real);
element slope(element);
real sqr(real);
element symmetry(element,point);
real tan(real);
real tanh(real);
element translation(element,vector);
element trpointn(point,element,number);
element vector(point,point);

Notes: In the previous table, the types: point,vector,circle,parameter,number are GEUP elements(element type).

# *Configuration*

## General options It is activated with the menu option [File][General options].

### Environment

**Maximun detection distance(pixels)**: If you usually work with few elements increase this number and you will detect them easily.
**Plane Height/Width (píxels):** You can also change this value through the window 'Move the screen'.
**Adapt cursor message color:** Choose this option if you are going to change frequently the background color.
**Background color:** If you change the background color, change the color of each element type with the option Elements appearance, the color of the hidden elements and the color of the selected elements to make sure that they are visible on the screen.
**Hidden elements color:** It is advisable to choose a different color to the select for each one of the non hidden elements to be able to distinguish them.
**Selected elements color:** It is necessary to choose a different color to the select for each one of the rest of the elements.
**Size of buttons:** Buttons of the interface small, normal or big.
**Recent files: (0-10)**
**Save options on exit**

## Construction

**Max. name-element distance(pixels):** It allows to distance more the names of its elements.
**Number of points in a new locus:** A locus will have this number of points when it is created.
**Hide intermediate elements when a macro is created:** Choose this option if you are not going to work with the intermediate elements of a macro.
**Elements at infinity**
**Begin step by step with last element**
**Horizontal direction for new tables**
**Default increment of parameters with keys +-**
**Number of iterations in a new iteration**
**Save as Bitmap scale**

## Numbers

**Pixels / (distance unit):**
You can adapt the distance unit to the screen resolution and to the monitor size.
**Assign length:** Automatically assign 'Pixels / (distance unit)' to equal a given constructed length measure with a given value.
**1º** enter the value(length), **2º** press the button'Assign length', **3º** select the distance(length) by selecting 2 points in the construction
**Keep length measures with Zoom:** Automatically modifies 'Pixels / (distance unit)' to keep the measures when zooming the construction.
**Number of decimal places:**
The numbers will show this number of decimal places on the screen.
**Length unit:** You can choose mm, cm, m, km.
**Angle unit:** You can choose radian(RAD), grad(GRA), degree(DEG).
**Coordinate system:** You can choose between rectangular and polar coordinates to calculate the coordinates of points and plot them with the tool [point given coordinates].

## Script

**Background color:** Background color for the text of the script.
**Font:** Font for the text of the script.
**Syntax coloring:** Swap the option for the syntax coloring.
**Syntax colors:** Allows to assign different colors for the Text base, Keywords, Comments, Strings and Built-in functions.
**Automatic indent:** Swap the option for the automatic indent.
**Tabs:** Assign the number of spaces for the positions of the cursor each time you press the key [Tab].

# Elements appearance and font settings

**Elements appearance** The elements will have this color and shape when are created.
**Font settings**The font types and its size are parameters of configuration of the program that each user adapts to his preferences, affecting to all the elements that are displayed with text. You can modify the color of each element of text.