

GeoGebra

Quickstart for Desktop Version

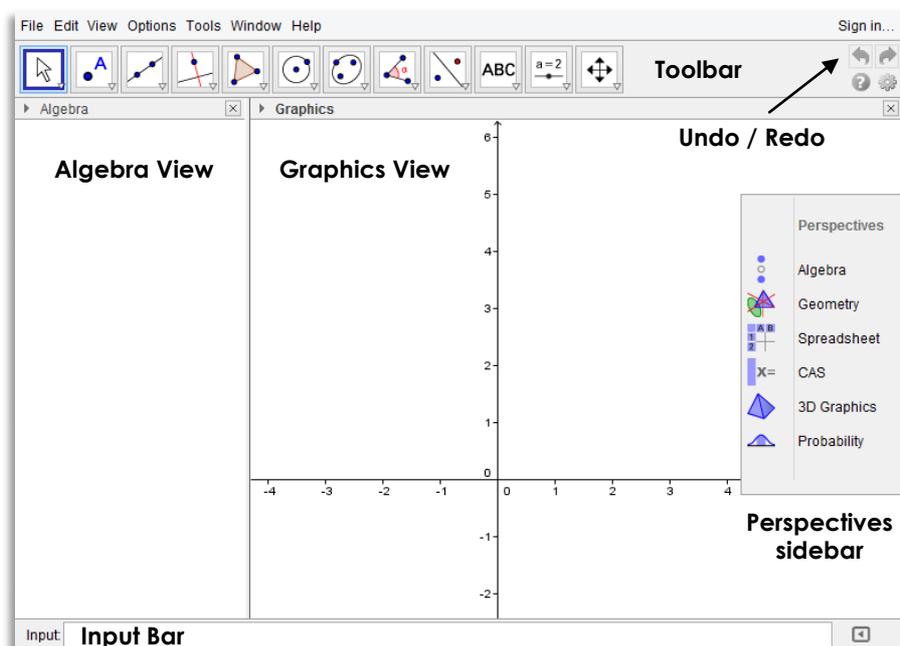
What is GeoGebra?

- Dynamic Mathematics Software in one easy-to-use package
- For learning and teaching at all levels of education
- Joins interactive 2D and 3D **geometry**, **algebra**, tablets, graphing, calculus, and statistics
- Open source software, freely available from www.geogebra.org

Quick Facts

- GeoGebra facilitates the creation of mathematical constructions and models by students. It allows interactive explorations by dragging objects and changing parameters.
- GeoGebra is also an authoring tool for teachers to create interactive worksheets. Find free classroom materials and share your own on www.geogbratube.org.

Getting Started



The image above shows the default screen of GeoGebra's desktop version. Depending on what you would like to use GeoGebra for (e.g. Geometry, Algebra, Statistics), you may choose the corresponding *Perspective* from the *Perspectives* menu. By default, the **Algebra View** and **Graphics View** are displayed in the GeoGebra window.

The **Toolbar** consists of a series of toolboxes containing a collection of related tools. Using these tools you can create constructions in the *Graphics View* with your mouse. At the same time the corresponding coordinates and equations are displayed in the *Algebra View*. Please note that each *View* has its own *Toolbar* and therefore, gives access to a different set of tools.

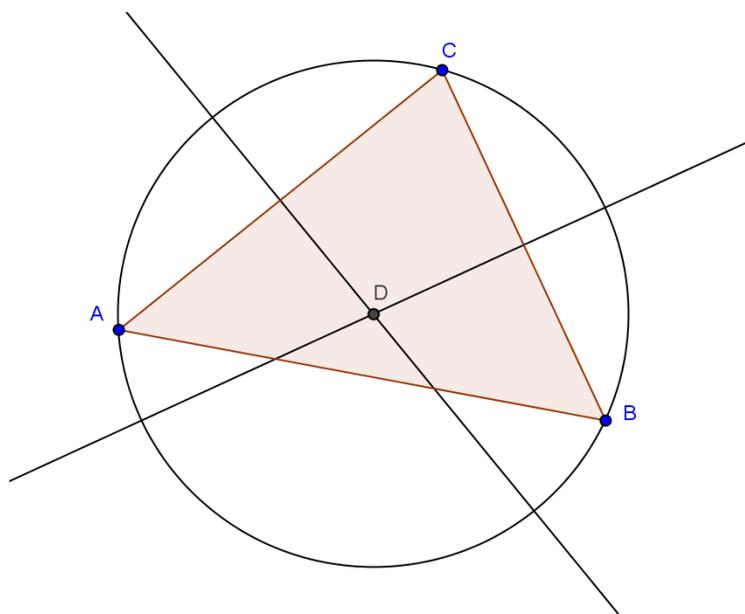
The **Input Bar** at the bottom of the GeoGebra window is used to directly enter coordinates, equations, commands, or functions. After pressing the *Enter* key, the algebraic representation of these objects is shown in the *Algebra View* while their graphical representation is displayed in the *Graphics View*.

In addition, GeoGebra offers a **3D Graphics View**, a **CAS View** to use GeoGebra's Computer Algebra System for symbolic computations, a **Spreadsheet View** to work with data and statistical concepts, as well as a **Probability Calculator** to calculate and graph probability distributions.

All *Views* of GeoGebra are linked dynamically, meaning that if you modify an object in one of the *Views*, its representations in the other *Views* automatically adapt to these changes if possible.

Example 1: Circumcircle of a Triangle

Task: Construct a triangle A, B, C and its circumcircle using GeoGebra.



Preparations

- Open a new GeoGebra window.
- Click on the arrow on the right side of the *Graphics View* in order to open the *Perspectives* sidebar and select the  *Geometry Perspective*.
- Familiarize yourself with the tools provided in the *Graphics View Toolbar*.
Hint: You can open a toolbox by clicking on the small arrow in the lower right corner of the default tools.

Construction Steps

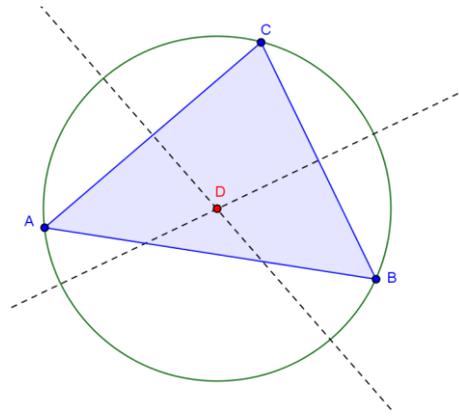
1		Choose the tool <i>Polygon</i> from the <i>Toolbar</i> . Now counter-clockwisely click on the <i>Graphics View</i> three times to create the vertices <i>A</i> , <i>B</i> , and <i>C</i> . Close the triangle by clicking on point <i>A</i> again.
2		Select the tool <i>Perpendicular Bisector</i> and construct two line bisectors by consecutively clicking on two sides of the triangle. <u>Hint</u> : If a tool is not displayed in the <i>Toolbar</i> by default, you may want to look for it in the toolboxes.
3		Using the tool <i>Intersect</i> you can successively click on the line bisectors to create the center of the triangle's circumcircle. <u>Hint</u> : By default, the intersection point is named <i>D</i> .
4		Select the tool <i>Circle with Center through Point</i> . Click first on the center point <i>D</i> , then on any vertex of the triangle to create the circumcircle.
5	 	Using the <i>Move</i> tool you can now use your mouse to drag the triangle vertices - your construction will change dynamically while you move them. <u>Hint</u> : In order to move the whole construction within the <i>Graphics View</i> , select the tool <i>Move Graphics View</i> and simply drag it around.

Hints

Try the  **Undo** /  **Redo** buttons on the right side of the *Toolbar*.

To **hide an object**, Right-click (Mac OS: Ctrl-click) on it and uncheck  *Show Object* in the appearing context menu.

You can change the **appearance of objects** (e.g. change color or line style, show / hide labels) easily using the *Style Bar*. Select the object you want to enhance and click on the little arrow in the upper left corner of the *Graphics View* in order to open the  *Style Bar*.

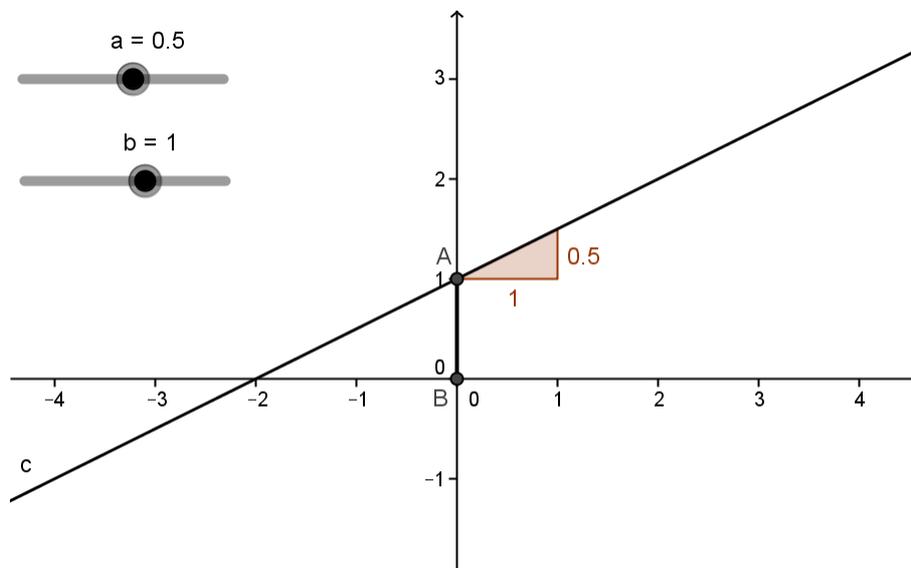


You can also show / hide  **axes** and a  **grid** using the *Style Bar*. Click on the white background of the *Graphics View* to make sure that no object is selected. Then, click on the little arrow in the upper left corner of the *Graphics View* in order to open the  *Style Bar*.

The  **Construction Protocol** (see *View* menu) provides a table listing all the construction steps. Using your arrow keys you can go through the construction steps again. Furthermore, you can change the order of construction steps by dragging rows up or down.

Example 2: Parameters of a Linear Equation

Task: Use sliders to dynamically change the parameters of a linear equation.



Preparations

- Open a new GeoGebra window using the *File* menu.
- Click on the arrow on the right side of the *Graphics View* in order to open the *Perspectives* sidebar and select the  *Algebra & Graphics Perspective*.

Construction Steps

1		Enter $y = 0.8 * x + 3.2$ into the <i>Input Bar</i> and hit the <i>Enter</i> key.
2		<u>Exploration</u> : Which parameters can be changed when you modify the equation of the line in the <i>Algebra View</i> (use the arrow keys) or the line in the <i>Graphics View</i> (use the mouse)? <u>Hint</u> : Make sure the equation/line is selected before you try to modify it.
3		In the <i>Graphics View</i> , use the <i>Delete</i> tool in order to delete the line. <u>Hint</u> : You need to open a toolbox in order to select this tool.
4		Use the <i>Slider</i> tool in order to create two sliders a and b using the default settings of sliders. <u>Hint</u> : After clicking on the <i>Graphics View</i> , a window appears allowing you to specify the parameters of your slider. Click <i>Apply</i> in order to close the window and create a slider.
5		Enter $y = a * x + b$ in the <i>Input Bar</i> and hit the <i>Enter</i> key.
6		Select tool <i>Intersect</i> from the <i>Graphics View Toolbar</i> in order to create the intersection point A between the line and the y -axis.
7		Use the <i>Point on Object</i> tool in order to create a point B at the origin.
8		Use the <i>Segment</i> tool in order to create a segment between points A and B .
9		Use the <i>Slope</i> tool in order to create a slope (triangle) of the line.

Hint

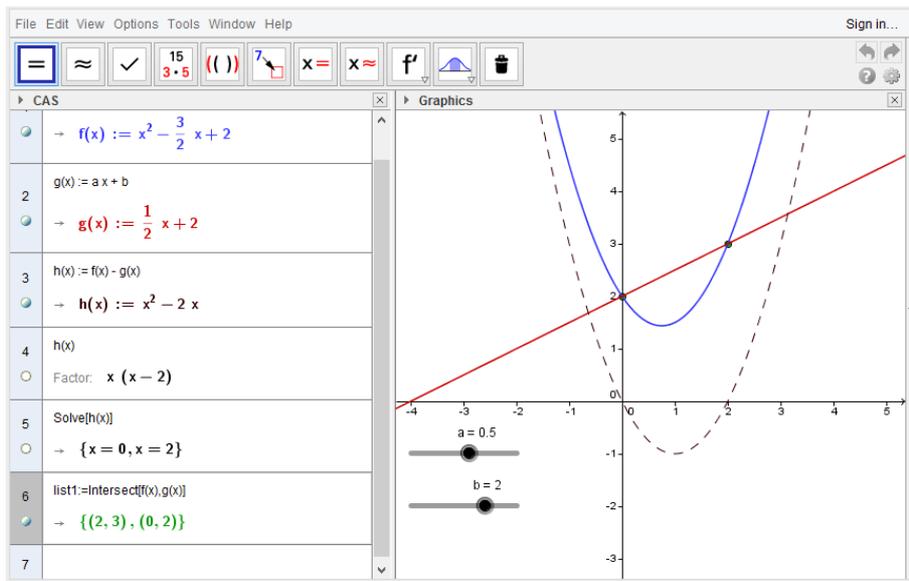
You might want to **enhance the appearance** of your construction using the *Style Bar* (e.g. increase the line thickness of the segment to make it visible on top of the y -axis, show the slope's value instead of its name). Select the object you want to enhance and then click on the little arrow in the upper left corner of the *Graphics View* in order to open the  *Style Bar*.

Example 3: Intersection of Polynomial Functions

Task: Explore how a parabola can be intersected with a linear function by determining the roots of their difference function.

Preparations

- Open a new GeoGebra window using the *File* menu.
- Click on the arrow on the right side of the *Graphics View* in order to open the *Perspectives* sidebar and select the  *CAS Perspective*.



Construction Steps

1		In the CAS View, create a quadratic polynomial by entering $f(x) := x^2 - \frac{3}{2} * x + 2$ into the first row and hitting the <i>Enter</i> key.
2		Select the <i>Slider</i> tool from the <i>Graphics View Toolbar</i> and create two sliders a and b using the default settings of sliders. <u>Hint:</u> After clicking on the <i>Graphics View</i> , a window appears allowing you to specify the parameters of your slider. Click <i>Apply</i> in order to close the window and create a slider.
3		In the CAS View, create a linear function by entering $g(x) := a * x + b$ into the next row and hitting the <i>Enter</i> key.
4		In the <i>Graphics View</i> , use the <i>Move</i> tool in order to change the value of slider a to 0.5 and the value of slider b to 2.
5		In the CAS View, enter $h(x) := f(x) - g(x)$ in order to determine the difference between those functions.
6		Enter $h(x)$, then select the tool <i>Factor</i> from the <i>CAS View Toolbar</i> in order to factorize the polynomial. <u>Hint:</u> You can now use these factors to determine the roots of $h(x)$.
7		Enter $Solve[h(x)]$ in order to confirm the roots.
8		Enter $Intersect[f(x), g(x)]$ in order to create the intersection points of functions $f(x)$ and $g(x)$.
9		<u>Exploration:</u> Try to find out what the intersection points of $f(x)$ and $g(x)$ have in common with the roots of the difference function $h(x)$. Change the parameters of the linear function to find out for which values of a and b there are two, one, or no intersection point(s). <u>Hint:</u> Use the <i>Move</i> tool in order to change the values of the sliders and create new functions to explore.

Hints

The CAS View allows you to work with fractions, equations and formulas that include **undefined variables**.

Input and automatic completion

= Enter $y = 2x + 1$ in order to **define** an **equation**.

:= Enter $f(x) := 2x + 1$ in order to **assign the name** f to the function.

() [] If you enter opening **parentheses** or **brackets**, GeoGebra will automatically insert the corresponding closing counterpart.

While entering a command in the CAS View, GeoGebra tries to **automatically complete your command** in order to help you with the syntax.

Hint: Select the command you want from the appearing list and hit *Enter* in order to accept the suggestion.

The CAS Toolbar offers three **different tools to evaluate your input** with:

= 'Evaluate' calculates and simplifies the input in a symbolic way.

≈ 'Numeric' calculates the input numerically and yields the result in decimal notation.

✓ 'Keep Input' keeps and checks the input. This is very useful if you don't want your input to be simplified automatically, for example when introducing the manipulation of expressions.

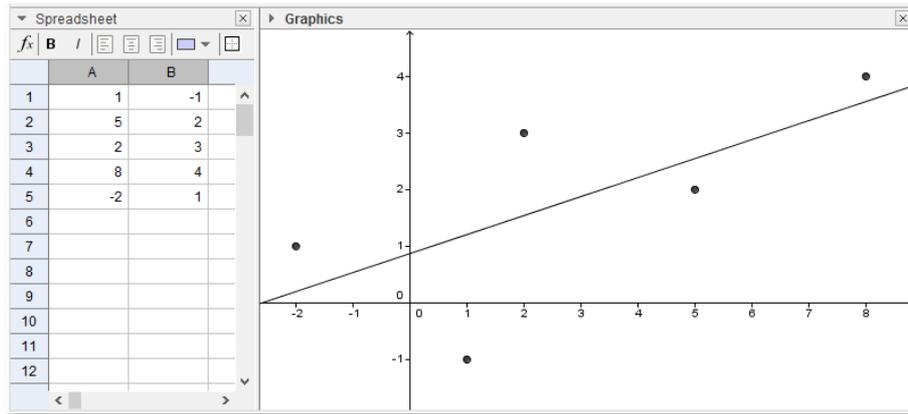
You can also **manipulate only part of an expression** by selecting it with the mouse and then clicking on a tool like $\frac{15}{3 \cdot 5}$ Factor.

Example 4: Scatter Plot and Best Fit Line

Task: Create a Scatter Plot and conduct a Two Variable Regression Analysis for a given data set. Explore how outliers affect the best fit line.

Preparations

- Open a new GeoGebra window using the *File* menu.
- Click on the arrow on the right side of the *Graphics View* in order to open the *Perspectives* sidebar and select the  *Spreadsheet Perspective*.



Construction Steps

1	<p>In the <i>Spreadsheet View</i>, enter the following data values into the cells of column A: A1: 1 A2: 5 A3: 2 A4: 8 A5: -2 <u>Hint:</u> Always evaluate your input by pressing the <i>Enter</i> key.</p>
2	<p>Enter the following numbers into the spreadsheet cells of column B: B1: -1 B2: 2 B3: 3 B4: 4 B5: 1</p>
3	<p>Create a Scatter Plot from this data: Highlight all cells of columns A and B that contain data. Then, select the tool <i>Create List of Points</i> from the <i>Spreadsheet View Toolbar</i> and click <i>Create</i> in order to create points from your data set. <u>Note:</u> The values in column A determine the x-coordinates and the values in column B specify the y-coordinates of the plotted points. <u>Hint:</u> You might want to use tool <i>Move Graphics View</i> if not all five points are visible in the <i>Graphics View</i>.</p>
4	<p>Select the <i>Best Fit Line</i> tool from the <i>Graphics View Toolbar</i>. Create the line that best fits your data points by using a selection rectangle that contains all data points plotted. <u>Hint:</u> Create a selection rectangle by clicking in the upper left corner of the <i>Graphics View</i> and steadily sliding your mouse to the lower right corner of the <i>Graphics View</i>. Make sure that all data points lie within the selection rectangle.</p>
5	<p><u>Exploration:</u> Using this construction you can easily demonstrate how outliers affect the best fit line of a data set. Select the <i>Move</i> tool and drag one of the points in order to create an outlier. <u>Hint:</u> You can also change the initial data directly in the <i>Spreadsheet View</i>.</p>

Hints

You may **change the style** (e.g. color, thickness) of the line and points. Select the object you want to enhance and then click on the little arrow in the upper left corner of the *Graphics View* in order to open the  Style Bar.

GeoGebra allows you to **import data from other spreadsheet software** into the *Spreadsheet View*:

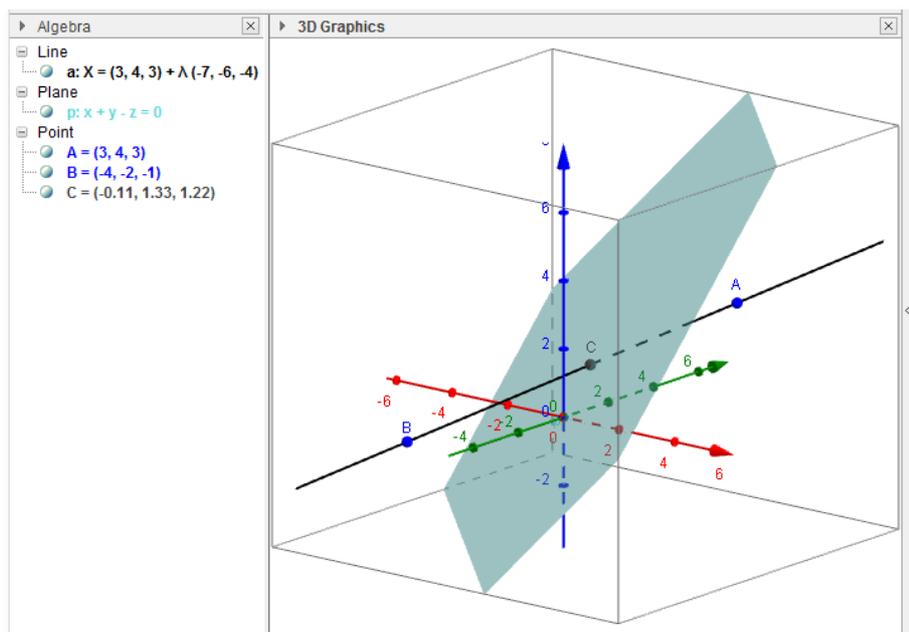
- Select and copy the data you want to import.
Hint: For example, use the keyboard shortcut Ctrl - C (Mac OS: Ctrl - C) in order to copy the data to your computer's clipboard.
- Open a GeoGebra window and show the *Spreadsheet View*.
- Click on the spreadsheet cell that should contain the first data value (e.g. cell A1).
- Paste the data from your computer's clipboard into GeoGebra's *Spreadsheet View*.
Hint: For example, right - click (Mac OS: Ctrl - click) on the highlighted cell and select  Paste.

Example 5: Intersection of a Plane and a Line

Task: Find out how you can intersect a plane and a line in the *3D Graphics View* of GeoGebra.

Preparations

- Open a new GeoGebra window using the *File* menu.
- Click on the arrow on the right side of the *Graphics View* in order to open the *Perspectives* sidebar and select the  *3D Graphics Perspective*.



Construction Steps

1		Enter $p: x + y = z$ into the <i>Input Bar</i> and hit the <i>Enter</i> key in order to define a plane p .
2		Create two points A and B by entering $A = (3, 4, 3)$ and $B = (-4, -2, -1)$ in the <i>Input Bar</i> , hitting the <i>Enter</i> key after each input.
3		Select the <i>Line</i> tool from the <i>3D Graphics Toolbar</i> and click on the points A and B respectively to create the line a through both points.
4		Select the <i>Intersect</i> tool. Then, click on the plane and the line in order to create the intersection point C .
5		<u>Exploration</u> : Use the <i>Move</i> tool in order to change the position of the points A and B . What happens to the intersection point if the line is parallel to the plane, or if both points lie within the plane?

Hints

You might want to use the tool  *Rotate 3D Graphics View* to get different views on your construction.

You might want to **enhance the appearance** of your construction by using the *Style Bar*. Select the object you want to enhance and then click on the little arrow in the upper left corner of the *3D Graphics View* in order to open the  *Style Bar*.

You can also  **hide** the **x-y-plane** or the  **coordinate axes** using the *Style Bar*. Click on the white background of the *Graphics View* to make sure that no object is selected. Then, click on the little arrow in the upper left corner of the *Graphics View* in order to open the  *Style Bar*.

Further Information

You can find further information, materials, and help on our web pages at www.geogebra.org.