GeoGebra

Quickstart for Web and Tablet App

What is GeoGebra?

- Dynamic Mathematic Software in one easy-to-use package
- For learning and teaching at all levels of education
- Joins interactive 2D and 3D **geo**metry, al**gebra**, tables, 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

After starting the Web or Tablet App of GeoGebra you will first see the *Perspectives Start Screen*.
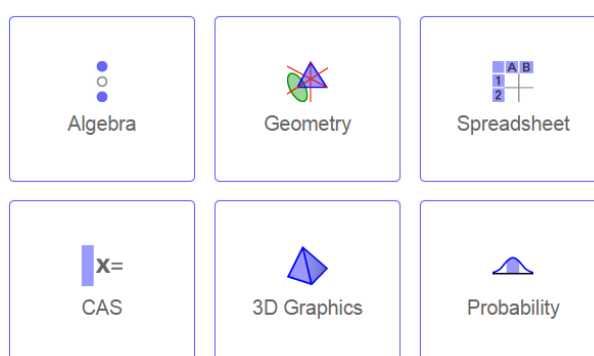
Select the GeoGebra *Perspective* that best fits the mathematical topic you want to work with (e.g. Geometry, Algebra, Statistics). Please note that you can switch between *Perspectives* at any time using the *Perspectives* menu.
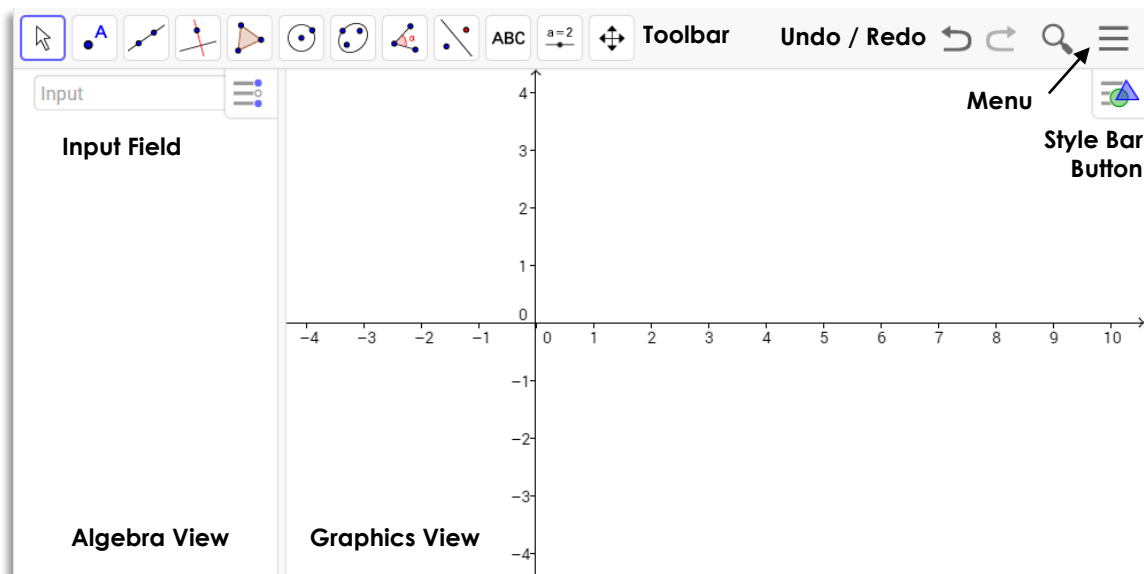
The image above shows the default screen of the *Algebra Perspective* of GeoGebra's Web or Tablet App. It displays the **Algebra View** and the **Graphics View** in the GeoGebra window.

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 / your finger. 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 Field** in the *Algebra View* 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 or 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.

Please note that this document provides information about both the Web and Tablet App of GeoGebra. Depending on your input device (mouse or finger) you will need to either click or tap on the screen while working through the following examples. In order to keep the instructions simple, we are only using the term 'tap' which is equivalent to 'click'.

Click on the YouTube icon next to an example heading in order to open and watch the corresponding Quickstart video tutorial.

Example 1: Circumcircle of a Triangle

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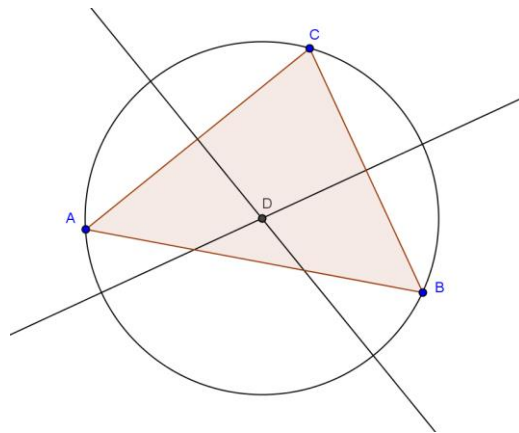
Preparations

- Open the GeoGebra Web or Tablet App and select the *Geometry Perspective* from the *Perspectives Start Screen*.

- Familiarize yourself with the tools provided in the *Graphics View Toolbar*. <u>Hint</u>: You can open a toolbox by tapping on one of the default tools.

Construction Steps

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

Hints

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

Use the ⦿ *Show / Hide Object* tool from the *Graphics View Toolbar* in order to **hide an object**. Using this tool, select all objects you would like to hide. Then, switch to another tool in order to apply your changes.

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 tap the ◮ *Style Bar Button* in the upper right corner of the *Graphics View* in order to open the ■ ● ᴬᴬ ⚙ ⋮ ◮ *Style Bar*.
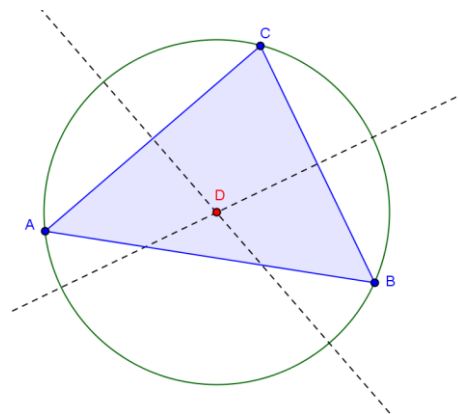
You can also show / hide ∟ **axes** and a ▦ **grid** using the *Style Bar*. Tap on the white background of the *Graphics View* to make sure that no object is selected. Then, tap the ◮ *Style Bar Button* in the upper right corner of the *Graphics View* in order to open the ■ ● ᴬᴬ ⚙ ⋮ ◮ *Style Bar*.
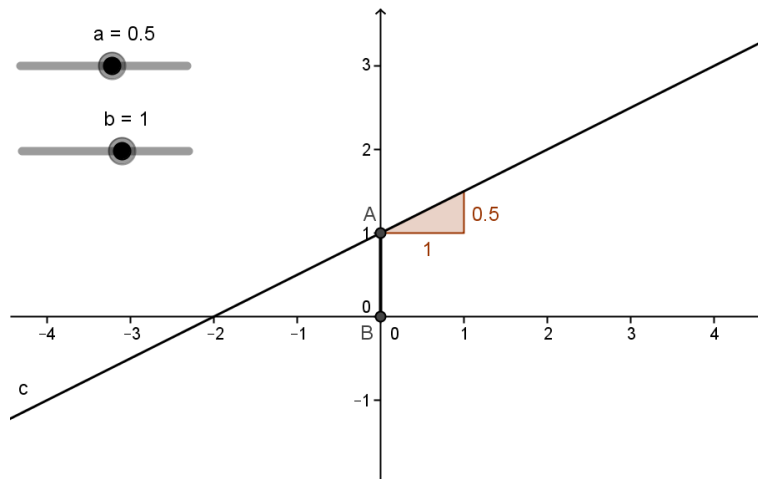
Example 2: Parameters of a Linear Equation

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

Preparations

- Open the GeoGebra Web or Tablet App and select the ⋮ *Algebra Perspective* from the *Perspectives Start Screen*.

OR

- Tap on the ≡ *Menu* button on the top right corner of the GeoGebra window and select ╋ *New* from the ⬡ *File* menu. Then select the ⋮ *Algebra Perspective* from the *Perspectives Start Screen*.

Construction Steps

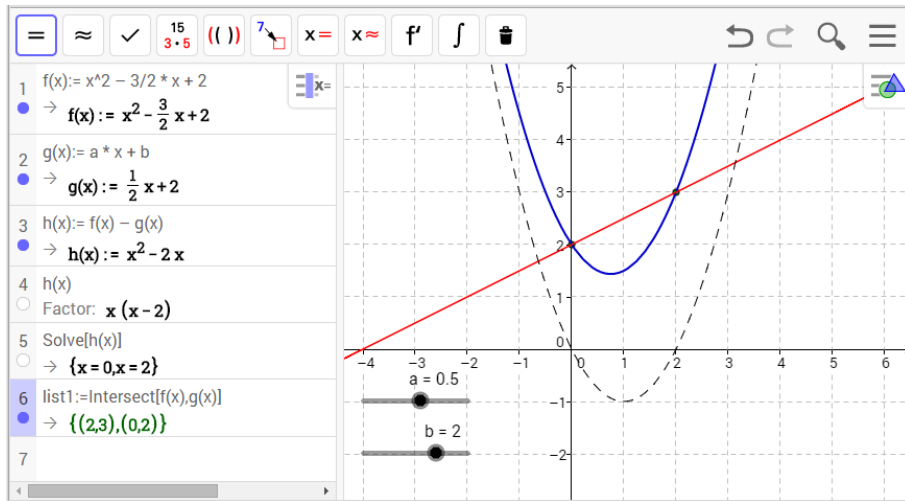|		
1		Enter `y = 0.8 * x + 3.2` into the *Input Field* in the *Algebra View* and hit the *Enter* key.
2		<u>Exploration</u>: Which parameters can be changed when you modify the line in the *Graphics View* by using your finger to drag the line?
3		In the *Graphics View*, use the *Delete* tool in order to delete the line. <u>Hint</u>: You need to open a toolbox in order to select this tool.
4	a=2	Use the *Slider* tool in order to create two sliders *a* and *b* using the default settings of sliders. <u>Hint</u>: After tapping on the *Graphics View*, a window appears allowing you to specify the parameters of your slider. Tap *Apply* in order to close the window and create a slider.
5		Enter `y = a * x + b` in the *Algebra View* and hit the *Enter* key.
6		Select tool *Intersect* from the *Graphics View Toolbar* in order to create the intersection point *A* between the line and the *y*-axis.
7		Use the *Point on Object* tool in order to create a point *B* at the origin.
8		Use the *Segment* tool in order to create a segment between points *A* and *B*.
9		Use the *Slope* 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 tap on the 🔺 *Style Bar Button* in the upper right corner of the *Graphics View* in order to open the ■ ● ᴬᴬ ⚙ ⁝ 🔺 *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 the GeoGebra Web or Tablet App and select the ᵡ⁼ *CAS Perspective* from the *Perspectives Start Screen*.

  OR

- Tap on the ☰ *Menu* button on the top right corner of the GeoGebra window and select ✛ *New* from the ✿ *File* menu. Then select the ᵡ⁼ *CAS Perspective* from the *Perspectives Start Screen*.

Construction Steps

1		In the *CAS View*, create a quadratic polynomial by entering `f(x):= x^2 - 3/2 * x + 2` into the first row and hitting the *Enter* key.
2	a = 2	Select the *Slider* tool from the *Graphics View Toolbar* and create two sliders *a* and *b* using the default settings of sliders. Hint: After tapping on the *Graphics View*, a window appears allowing you to specify the parameters of your slider. Tap *Apply* 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 *Enter* key.
4	▷	In the *Graphics View*, use the *Move* 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	$\frac{15}{3 \cdot 5}$	Enter `h(x)`, then select the tool *Factor* from the *CAS View Toolbar* in order to factorize the polynomial. Hint: You can now use these factors to determine the roots of *h(x)*.

7 ● ○	Enter `Solve[h(x)]` in order to confirm the roots. Hint: GeoGebra creates a list of points which can be displayed in the *Graphics View* by tapping on the *Show / Hide Object* icon below the corresponding row number of the *CAS View*.
8 ● ○	Enter `Intersect[f(x), g(x)]` in order to create the intersection points of functions *f(x)* and *g(x)*. Hint: You might want to display the intersection points in the *Graphics View* as well.
9	Exploration: 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). Hint: Use the *Move* 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 may include variables that have not already been defined).

Input and automatic completion

=	Enter `y = 2 x + 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:

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=	'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 and then tapping 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.
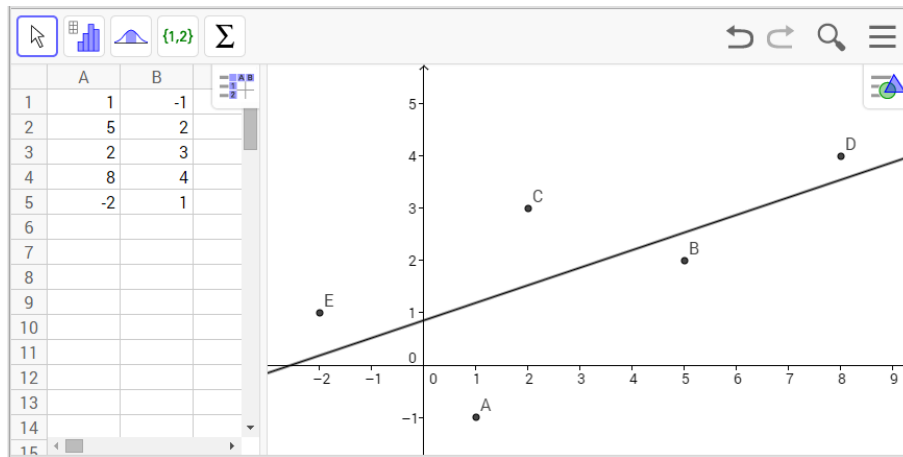
Preparations

*   Open the GeoGebra Web or Tablet App and select the ⊞ *Spreadsheet Perspective* from the *Perspectives Start Screen*.

    OR

*   Tap on the ≡ *Menu* button on the top right corner of the GeoGebra window and select ＋ *New* from the ⚙ *File* menu. Then select the ⊞ *Spreadsheet Perspective* from the *Perspectives Start Screen*.

Construction Steps

1		In the *Spreadsheet View*, enter the following data values into the cells of column *A*: *A1:* 1 *A2:* 5 *A3:* 2 *A4:* 8 *A5:* −2 Hint: Always evaluate your input by tapping the *Enter* key.
2		Enter the following numbers into the spreadsheet cells of column *B*: *B1:* −1 *B2:* 2 *B3:* 3 *B4:* 4 *B5:* 1
3	{•••} ✛	Create a Scatter Plot from this data: Highlight all cells of columns *A* and *B* that contain data. Then, select the tool *Create List of Points* from the *Spreadsheet View Toolbar* and tap *Create* in order to create points from your data set. Note: The values in column *A* determine the x-coordinates and the values in column *B* specify the y-coordinates of the plotted points. Hint: You might want to use tool *Move Graphics View* if not all five points are visible in the *Graphics View*.

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4		Select the *Best Fit Line* tool from the *Graphics View Toolbar*. Create the line that best fits your data points by using a selection rectangle that contains all data points plotted. Hint: Create a selection rectangle by tapping in the upper left corner of the *Graphics View* and steadily sliding your finger to the lower right corner of the *Graphics View*. Make sure that all data points lie within the selection rectangle.
5		Exploration: Using this construction you can easily demonstrate how outliers affect the best fit line of a data set. Select the *Move* tool and drag one of the points in order to create an outlier. Hint: You can also change the initial data directly in the *Spreadsheet View*.

Hint

You may **change the style** (e.g. color, thickness) of the line and points. Select the object you want to enhance and then tap the ⊿ *Style Bar Button* in the upper right corner of the *Graphics View* in order to open the ◼ ● ᴬᴬ ⚙ ⋮ ⊿ *Style Bar*.

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.
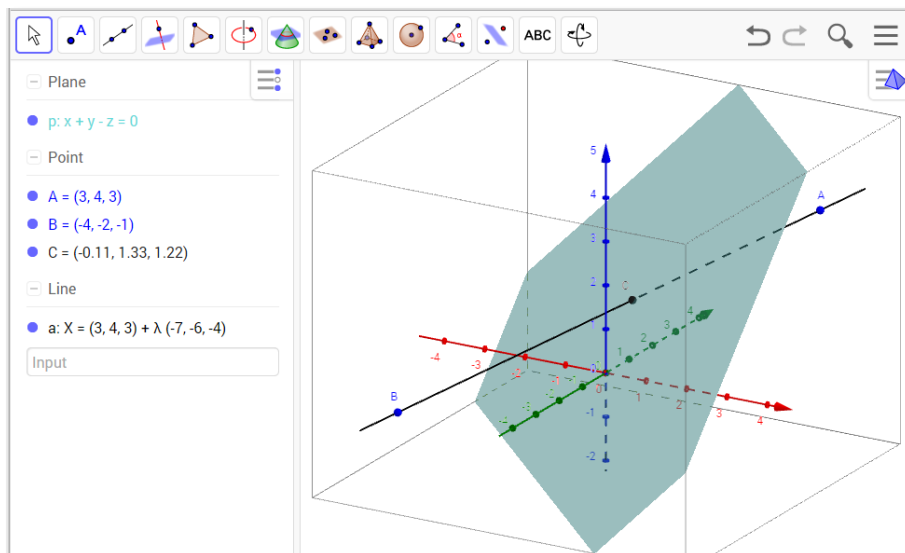
Preparations

- Open the GeoGebra Web or Tablet App and select the ◢ *3D Graphics Perspective* from the *Perspectives Start Screen*.

OR

- Tap on the ☰ *Menu* button on the top right corner of the GeoGebra window and select ＋ *New* from the ⬠ *File* menu. Then select the ◢ *3D Graphics Perspective* from the *Perspectives Start Screen*.

Construction Steps

1	Enter `p: x + y = z` into the Input Field in the *Algebra View* and tap the *Enter* 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 *Algebra View* and tapping the *Enter* key after each input.
3	Select the *Line* tool from the *3D Graphics Toolbar* and tap on the points *A* and *B* respectively to create the line *a* through both points.
4	Select the *Intersect* tool. Then, tap on the plane and the line in order to create the intersection point *C*.
5	<u>Exploration</u>: Use the *Move* 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? <u>Hint</u>: By clicking on a point you may switch between moving the point parallel to the *x-y-plane* or parallel to the *z-axis*.

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 tap the ⬙ *Style Bar Button* in the upper right corner of the *Graphics View* in order to open the ▣ ● ᴬᴬ ⚙ ⋮ ⬙ *Style Bar*.

You can also **hide** the ▪ **x-y-plane** or the └ **coordinate axes** using the *Style Bar*. Tap on the white background of the *Graphics View* to make sure that no object is selected before you open the └▦⌂ C ◷ ◻ ✳ ◻ ⋮ ◢ *Style Bar*.

Further Information

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