GeoGebra Manual

The official manual of GeoGebra.

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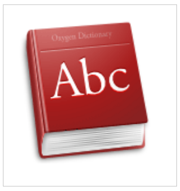
Tutorials

Step-by-step tutorials for GeoGebra both for beginners and experts

Forum [1]

Get quick answers to all your questions in our friendly GeoGebra User Forum [1]



GeoGebra Manual

The GeoGebra Manual describes all commands and tools of our software

Events [2]

Visit GeoGebra Events [3] near to you with workshops and presentations

Compatibility

GeoGebra is backward compatible in sense that files created with older version should open in later versions. Sometime we make changes which will cause files to behave differently.

Differences from GeoGebra 4.4 to 5.0

- The winding rule [1] for self-intersecting polygons has changed so they will look different.

Differences from GeoGebra 3.2 to 4.0

- lists of angles, integrals, barcharts, histograms etc. are now visible
- lists {Segment[A,B], Segment[B,C] } are now draggable
- circle with given radius (e.g. Circle[(1,1),2]) draggable
- Distance[Point, Segment] gives distance to the Segment (was to the extrapolated line in 3.2)
- Angle[A,B,C] now resizes if B is too close to A or C
- Integral[function f,function g,a,b] is now transcribed to IntegralBetween[function f,function g,a,b].
- Objects that are a translation by a free vector are now draggable, eg Translate[A, Vector[(1,1)]]
- Points on paths may behave differently when the path is changed, e.g. point on conic.

LaTeX Equations

The LaTeX rendering is now nicer, but some errors in LaTeX syntax which were ignored in 3.2 will cause missing texts in 4.0.

- Make sure that each `\left\{` has corresponding `\right.`.
- See here for more tips about getting LaTeX working: http://forum.geogebra.org/viewtopic.php?f=20&t=33449

Installation Guide

GeoGebra Installation

- Installation
- Mass Installation
- FAQ

Windows

GeoGebra can be installed for Windows in two ways:

- GeoGebra Installer for Windows [1] (recommended)
- GeoGebra Portable for Windows [2] (runs from USB memory sticks for example)

Please note that the Installer will automatically update to newer versions.

MacOS X

We provide GeoGebra in two ways for Mac OS X:

- GeoGebra in the Mac App Store [3] (recommended)
- GeoGebra Portable for OSX [4].

Please note that the Mac App Store will automatically update to newer versions.

Linux

The following GeoGebra Linux installers are available:

- 64 bit [5] / 32 bit [6] installers for **.deb** based systems (Debian, Ubuntu)
- 64 bit [7] / 32 bit [8] installers for **.rpm** based systems (Red Hat, openSUSE)
- Portable Linux [9] bundle for 64 and 32 bit Linux systems

Repository

The .deb and .rpm installers will automatically add the official GeoGebra repository to the package management system on the workstation. This will enable automatic update of GeoGebra every time a new version is released. Note that the portable version will not automatically update.

If you want to include GeoGebra in your custom Linux distribution with GeoGebra included, the best way is to add the official GeoGebra repository (http:// www. geogebra. net/ linux/) to your package management system. The GPG key of the repository is at http://www.geogebra.net/linux/office@geogebra.org.gpg.key.The name of the package is **geogebra5**. This will conflict with the earlier versions (4.0, 4.2 and 4.4), which are named **geogebra** (and **geogebra44** for 4.4) and should be deleted first.

All versions

Version	Windows	Mac OS X	Linux
4.4	Installer [10] Portable [11]	Portable [12]	Portable [13]
5.0	Installer [14] Portable [15]	Portable [16]	Portable [17]
latest	Installer [1] Portable [2]	Portable [4]	Portable [9]

Supported devices and Troubleshooting

Please check the Supported devices [18] page for further information about running GeoGebra on different devices, have a look at the FAQ [19] for more information and visit the forum [20] for support.

Objects

Free, Dependent and Auxiliary Objects

Geometric Objects

Points and Vectors

Lines and Axes

Conic sections

Functions

Curves

Inequalities

Intervals

General Objects

Numbers and Angles

Texts

Boolean values

Complex Numbers

Lists

Matrices

Action Objects

Selecting objects

Change Values

Naming Objects

Animation

Tracing

Object Properties

Labels and Captions

Advanced Features

Object Position

Conditional Visibility

Dynamic Colors

LaTeX

Layers

Scripting

Tooltips

Tools

Tools

GeoGebra's *Tools* enable you to produce new Objects using your pointing device. They can be activated by clicking on the corresponding buttons of the *Toolbar*.

Note: All *Tools* have their *Commands equivalents* which are suitable for more complicated constructions.

Different Toolbars for Different Views

Each *View* except the *Algebra View* has its own *Toolbar*, providing *Tools* specific for the *View* you are working with.

- *Graphics View Toolbar*
- *3D Graphics View Toolbar*
- *CAS View Toolbar*
- *Spreadsheet View Toolbar*

Once you start using another *View* within the GeoGebra window, the *Toolbar* changes automatically. If you open another *View* in a separate window, it will have its *Toolbar* attached.

Toolboxes

Each *Toolbar* is divided into *Toolboxes*, containing one or more related *Tools*. You may open a *Toolbox* by clicking

- on one of the default *Tools* in the *Toolbar* (GeoGebra Web and Tablet Apps)
- on the little arrow in the lower right corner of the default *Tools* (GeoGebra Desktop).

You can reorder these *Toolboxes* and save the setting in the GeoGebra Worksheet (*.ggb). See Customizing the Toolbar for details.

More Information about Tools

For more information please check our complete list of all available *Tools* as well as the general information about *Toolbars*, creating *Custom Tools* and Customizing the Toolbar.

Movement Tools

Movement tools are by default grouped under ↖ icon (the first from left) in the toolbar. Currently there are three movement tools:

- Move
- Rotate around Point
- Record to Spreadsheet

Move Tool

Move Tool in the Graphics View

Drag and drop Free Objects with the mouse. If you select an object by clicking on it in *Move* mode, you may…

- … delete the object by pressing the Delete key
- … move the object by using the arrow keys (see section Manual Animation)

> **Note:**You can quickly activate the Move Tool by pressing the Esc key of your keyboard.To move a Slider ToolSlider when Move Tool is selected, you need to drag it with your right mouse button.

Move Tool in the 3D Graphics View

Using the *Move Tool* in the *3D Graphics View* you may drag and drop free points. In order to move a point in the three-dimensional coordinate system, you can switch between two modes by clicking on the point:

- **Mode *x*-*y*-plane**: You may move the point parallel to the *x*-*y*-plane without changing the *z*-coordinate.
- **Mode *z*-axis**: You may move the point parallel to the *z*-axis without changing the *x*- and *y*-coordinates.

Record to Spreadsheet Tool

This tool allows you to move an object and to record a sequence of its values in the Spreadsheet View. This tool works for numbers, points, and vectors.

Note: GeoGebra will use the first two empty columns of the Spreadsheet View to record the values of the selected objects.

Rotate around Point Tool

Select the object you want to rotate. Then, click on a point to specify the center of rotation and enter the rotation angle into the text field of the appearing dialog window.

Note: See also Rotate command

.

Point Tools

Point tools are by default grouped under ●A icon (the second from the left) in the toolbar. Currently there are six point tools:

- Point
- Point on Object
- Intersect
- Midpoint or Centre
- Attach / Detach Point
- Complex Number

Point Tool

Click on the drawing pad in the Graphics View in order to create a new point. The coordinates of the point are fixed when the mouse button is released.

Note: By clicking on a segment (or interval), straight line, polygon, conic section, function, or curve you can create a point on this object (see also Point CommandPoint command). Clicking on the intersection of two objects creates this intersection point (see also Intersect ToolIntersect tool and Intersect CommandIntersect command).

Attach / Detach Point Tool

To **attach a point** to a path or region click a free point and the path or region. From now on, the point can still be moved via Move Tool, but only within the path or region.

To **detach a point** that is defined as point on path or region simply click the point. The point will become free.

Note: You can also use Point Command and PointIn Command for attaching a point. See also CopyFreeObject Command.

Complex Number Tool

Click in the the Graphics View in order to create a new complex number. The value of the complex number point is fixed when the mouse button is released.

Point on Object Tool

To create a point, which is fixed to an object, click on the tool button first and then on the object. This new point can be moved via Move Tool, but only within the object.

Note: To put a point in the interior of a Circle or Ellipse you will need to increase the Opacity from 0 first. If you click on the perimeter of an object (eg Circle, Ellipse, Polygon), then the point will be fixed to the perimeter rather than the interior.

Intersect Tool

Intersection points of two objects can be created in two ways (see also Intersect command).

- Selecting two objects creates all intersection points (if possible).
- Directly clicking on an intersection of the two objects creates only this *single intersection point*.

Note: Sometimes it's useful to display only the portions of the intersecating objects near the intersection point. To do so, right click on the intersection point, and check the option *Show trimmed intersection lines* in the *Basic* tab of the *Properties* dialog of the object, then hide the intersecting objects.

Outlying Intersections

For segments, rays, or arcs you may specify whether you want to *Allow outlying intersections* on tab *Basic* of the Properties Dialog. This can be used to get intersection points that lie on the extension of an object. For example, the extension of a segment or a ray is a straight line.

Midpoint or Center Tool

You may click on either two points or one segment to get its midpoint. You can also click on a conic section (circle or ellipse) in order to create its center point.

See also Center (🇬🇧 , 🇦🇺 : Centre) and Midpoint commands.

Line Tools

Line tools are by default grouped under icon (the third from left) in the toolbar. Currently there are seven line tools:

- Line
- Segment
- Segment with Given Length
- Ray
- Polyline
- Vector
- Vector from Point

Line Tool

Selecting two points *A* and *B* creates a straight line through *A* and *B*.

Notes: The line's direction vector is \overrightarrow{AB}, (B - A)See also Line CommandLine command.

Segment Tool

Select two points *A* and *B* in order to create a segment between *A* and *B* (see also Segment command).

Note: In the Algebra View, the segment's length is displayed.

Segment with Given Length Tool

Click on a point *A* that should be the starting point of the segment. Specify the desired length *a* of the segment in the appearing window (see also Segment command).

Note: This tool creates a segment with length *a* and endpoint *B* which may be rotated around the starting point *A* by using tool Move.

Ray Tool

Selecting two points *A* and *B* creates a ray starting at *A* through *B* (see also Ray command).

Note: In the Algebra View the equation of the corresponding line is displayed.

Vector from Point Tool

Select a point *A* and a vector *v* to create the new point $B = A + v$ as well as the vector from *A* to *B* (see also Vector command).

Vector Tool

Select the starting point and then the end point of the vector (see also Vector command).

Special Line Tools

Special line tools are by default grouped under icon (the fourth from the left) in the toolbar. Currently there are eight line tools:

- Perpendicular Line
- Parallel Line
- Perpendicular Bisector
- Angle Bisector
- Tangents
- Polar or Diameter Line
- Best Fit Line
- Locus

Best Fit Line Tool

Creates the best fit line for a set of points, chosen as follows :

- Creating a selection rectangle that contains all points.
- Selecting a list of points .

Note: See also FitLine command.

Parallel Line Tool

Selecting a line *g* and a point *A* defines a straight line through *A* parallel to *g* (see also Line command).

Note: The line's direction is the direction of line *g*.

Angle Bisector Tool

Angle bisectors can be defined in two ways:

- Selecting three points *A*, *B*, and *C* produces the angle bisector of the enclosed angle, where point *B* is the apex.
- Selecting two lines produces their two angle bisectors.

Notes: The direction vectors of all angle bisectors have length 1 See also AngleBisector CommandAngleBisector command.

Perpendicular Line Tool

Selecting a line (or a segment) *g* and a point *A* creates a straight line through *A* perpendicular to line (or segment) *g* (see also PerpendicularLine command).

Note: The line's direction is equivalent to the perpendicular vector of *g* (see also PerpendicularVector command).

Tangents Tool

Tangents to a conic section can be produced in several ways (see also Tangent command):

- Selecting a point *A* and a conic *c* produces all tangents through *A* to *c*.
- Selecting a line *g* and a conic *c* produces all tangents to *c* that are parallel to line *g*.
- Selecting a point *A* and a function *f* produces the tangent line to *f* in *x = x(A)*.
- Selecting two circles *c* and *d* produces the common tangents to the two circles (up to 4).

Note: *x(A)* represents the *x*-coordinate of point *A*. If point *A* lies on the function graph, the tangent runs through point *A*.

Note: Type rather than if you want a **conic** (parabola) rather than a **function**.

Polar or Diameter Line Tool

This tool creates the polar or diameter line of a conic section (see also Polar command).

- Select a point and a conic section to get the polar line.
- Select a line or a vector and a conic section to get the diameter line.

Perpendicular Bisector Tool

Click on either a segment (or interval) *s* or two points *A* and *B* in order to create a perpendicular bisector.

Notes: The bisector’s direction is equivalent to the perpendicular vector of segment (or interval) s or ABSee also PerpendicularVector CommandPerpendicularVector command See also PerpendicularBisector CommandPerpendicularBisector command.

Locus Tool

Select a point *B* that depends on another point *A* and whose locus should be drawn. Then, click on point *A* to create the locus of point *B* (see also Locus command).

Note: Point *A* has to be a point on an object (e. g. line, segment/interval, circle).

Example: Type f(x) = x^2 – 2 x – 1 into the Input Bar and press the Enter-key. Place a new point A on the x-axis (see Point ToolPoint tool; see Point CommandPoint command). Create point B = (x(A), f'(x(A))) that depends on point A. Select tool and successively click on point B and point A.Drag point A along the x-axis to see point B moving along its locus line.

Warning: Locus is undefined, if the dependent point depends on Point Command with two parameters or PathParameter Command.

Polygon Tools

Polygon tools are by default grouped under ▷ icon (the fifth from the left) in the toolbar. Currently there are four polygon tools:

- Polygon
- Regular Polygon
- Rigid Polygon
- Vector Polygon

Rigid Polygon Tool

Successively select at least three free points which will be the vertices of the polygon. Then, click the first point again in order to close the polygon. The resulting polygon will keep the shape: you can move it and rotate it by moving two vertices.

Holding down the Alt key when drawing a rigid polygon allows to get angles that are a multiple of 15°.

Notes: The polygon's area is displayed in the Algebra View. See also RigidPolygon CommandRigid Polygon command.

Polyline Tool

Successively select at least two points which will be the vertices of the polyline.

Holding down the Alt key when drawing a Polyline allows to get angles that are a multiple of 15°.

Note: In the Algebra View, the polyline length is displayed.

Regular Polygon Tool

Select two points *A* and *B* and specify the number *n* of vertices in the input field of the appearing dialog window. This gives you a regular polygon with *n* vertices including points *A* and *B*.

Note: See also Polygon command.

Polygon Tool

Successively select at least three points which will be the vertices of the polygon. Then, click the first point again in order to close the polygon.

Holding down the Alt key when drawing a Polygon allows to get angles that are a multiple of 15°.

Notes: The polygon area is displayed in the Algebra View. See also Polygon CommandPolygon command.

Circle & Arc Tools

Circle and arc tools are by default grouped under ⊙ icon (the sixth from the left) in the toolbar. Currently there are nine circle and arc tools:

- Circle with Centre through Point
- Circle with Centre and Radius
- Compasses
- Circle through 3 Points
- Semicircle through 2 Points
- Circular Arc
- Circumcircular Arc
- Circular Sector
- Circumcircular Sector

Circle with Center and Radius Tool

Select the center point *M* and enter the radius in the text field of the appearing dialog window.

Note: See also Circle command.

Circle through 3 Points Tool

Selecting three points *A*, *B*, and *C* defines a circle through these points (see also Circle command).

Note: If the three points lie on the same line, the circle degenerates to this line.

Circle with Center through Point Tool

Selecting a point *M* and a point *P* defines a circle with center *M* through *P*.

Circumcircular Arc Tool

Select three points *A*, *B*, and *C* to create a circular arc through these points. Thereby, point *A* is the starting point of the arc, point *B* lies on the arc, and point *C* is the endpoint of the arc.

Note: See also CircumcircularArc command.

Circumcircular Sector Tool

Select three points *A*, *B*, and *C* to create a circular sector through these points. Thereby, point *A* is the starting point of the sector's arc, point *B* lies on the arc, and point *C* is the endpoint of the sector's arc.

Note: See also CircumcircularSector command.

Compass Tool

Select a segment or two points to specify the radius. Then, click on a point that should be the center of the new circle.

Circular Sector Tool

First, select the center point *M* of the circular sector. Then, select the starting point *A* of the sector's arc, before you select a point *B* that specifies the length of the sector's arc.

Notes: While point A always lies on the sector's arc, point B does not have to lie on it.See also CircularSector CommandCircularSector command.

Semicircle through 2 Points Tool

Select two points *A* and *B* to create a semicircle above the segment (or interval) *AB*.

Note: See also Semicircle command.

Circular Arc Tool

First, select the center point *M* of the circular arc. Then, select the starting point *A* of the arc, before you select a point *B* that specifies the length of the arc.

Notes: While point A always lies on the circular arc, point B does not have to lie on it.See also CircularArc CommandCircularArc command.

Conic Section Tools

Conic section tools are by default grouped under icon (the sixth from the right) in the toolbar. Currently there are four conic section tools:

- Ellipse
- Hyperbola
- Parabola
- Conic through 5 Points

Ellipse Tool

Select the two foci of the ellipse. Then, specify a third point that lies on the ellipse.

Note: See also Ellipse command.

Hyperbola Tool

Select the two foci of the hyperbola. Then, specify a third point that lies on the hyperbola.

Note: See also Hyperbola command.

Conic through 5 Points Tool

Selecting five points produces a conic section through these points.

Notes: If four of these five points lie on a line, the conic section is not defined. See also Conic CommandConic command.

Parabola Tool

Select a point (focus) and the directrix of the parabola, in any order.

Note:

- If you select the directrix line first, a preview of the resulting parabola is shown.
- See also Parabola command.

Measurement Tools

Measurement tools are by default grouped under ∡ icon (the fifth from the right) in the toolbar. Currently there are six measurement tools:

- Angle
- Angle with Given Size
- Distance or Length
- Area
- Slope
- Create List

Distance or Length Tool

This tool returns the distance between two points, two lines, or a point and a line as a number, and shows a dynamic text in the Graphics View. It can also be used to measure the length of a segment (or interval), the circumference of a circle, or the perimeter of a polygon.

Note: See also Distance and Length commands.

Angle Tool

With this tool you can create angles in different ways:

- Click on three points to create an angle between these points. The second point selected is the vertex of the angle.
- Click on two segments to create the angle between them.
- Click on two lines to create the angle between them.
- Click on two vectors to create the angle between them.
- Click on a polygon to create all angles of this polygon.

Notes: If the polygon was created by selecting its vertices in counter clockwise orientation, the Angle tool gives you the interior angles of the polygonAngles are created in counter clockwise orientation. Therefore, the order of selecting these objects is relevant for the Angle tool. If you want to limit the maximum size of an angle to 180°, un-check Allow Reflex Angle on tab Basic of the Properties DialogSee also Angle CommandAngle command.

Slope Tool

This tool gives you the slope of a line and shows a slope triangle in the Graphics View, whose size may be changed using Properties Dialog (see also Slope command).

Area Tool

This tool gives you the area of a polygon, circle, or ellipse as a number and shows a dynamic text in the Graphics View.

Note: See also Area command.

Angle with Given Size Tool

Select two points *A* and *B* and type the angle's size into the text field of the appearing window.

Notes: This tool creates a point C and an angle α, where α is the angle ABCSee also Angle CommandAngle command

Transformation Tools

Transformation tools are by default grouped under icon (the fourth from the right) in the toolbar. Currently there are six transformation tools:

- Reflect about Line
- Reflect about Point
- Reflect about Circle
- Rotate around Point
- Translate by Vector
- Dilate from Point

Translate by Vector Tool

Select the object you want to translate. Then, click on the translation vector or click twice to make a vector (see also Translate command).

From version 4.0.15.0 you can also now just drag to clone an object with this tool.

Reflect about Line Tool

Select the object you want to reflect. Then, click on a line to specify the mirror/line of reflection (see also Reflect command).

Reflect about Point Tool

Select the object you want to reflect. Then, click on a point to specify the mirror/point of reflection (see also Reflect command).

Rotate around Point Tool

Select the object you want to rotate. Then, click on a point to specify the center of rotation and enter the rotation angle into the text field of the appearing dialog window.

Note: See also Rotate command

.

Reflect about Circle Tool

Inverts a geometric object about a circle. Select the object you want to invert. Then, click on a circle to specify the mirror/circle of inversion.

Note: See also Reflect command.

Dilate from Point Tool

Select the object to be dilated. Then, click on a point to specify the dilation center and enter the dilation factor into the text field of the appearing dialog window (see also Dilate command).

Special Object Tools

Special object tools are by default grouped under ABC icon (the third from the right) in the toolbar. Currently there are six special object tools:

- Text
- Image
- Pen Tool
- Relation
- Probability Calculator
- Function Inspector

Image Tool

This tool allows you to insert an image into the Graphics View.

First, specify the location of the image in one of the following two ways:

- Click in the Graphics View to specify the position of the image's lower left corner.
- Click on a point to specify this point as the lower left corner of the image.

Then, a file-open dialog appears that allows you to select the image file from the files saved on your computer.

Note: After selecting the tool Insert Image, you can use the keyboard shortcut Alt-click in order to paste an image directly from your computer's clipboard into the Graphics View.
Note: Transparent [GIF [1]] and [PNG [2]] files are supported, but for PNGs you may need to edit them first so that they have an alpha channel (for example using [IrfanView [3]], save using the PNGOUT plugin and choose **RGB+Alpha**)

Properties of Images

The position of an image may be absolute on screen or relative to the coordinate system. You can specify this on tab *Basic* of the Properties Dialog of the image.

You may specify up to three corner points of the image on tab *Position* of the Properties Dialog. This gives you the flexibility to scale, rotate, and even distort images (see also Corner command).

- Corner 1: position of the lower left corner of the image
- Corner 2: position of the lower right corner of the image

  Note: This corner may only be set if Corner 1 was set before. It controls the width of the image.

- Corner 4: position of the upper left corner of the image

  Note: This corner may only be set if Corner 1 was set before. It controls the height of the image.

Example: Create three points A, B, and C to explore the effects of the corner points.Set point A as the first and point B as the second corner of your image. By dragging points A and B in Move mode you can explore their influence.

Now, remove point B as the second corner of the image. Set point A as the first and point C as the fourth corner and explore how dragging the points now influences the image. Finally, you may set all three corner points and see how dragging the points distorts your image.

Example: In order to attach your image to a point A, and set its width to 3 and its height to 4 units, you could do the following:Set Corner 1 to A Set Corner 2 to A + (3, 0) Set Corner 4 to A + (0, 4)

Note: If you now drag point A in Move mode, the size of your image does not change.
You may specify an image as a *Background* image on tab *Basic* of the Properties Dialog. A background image lies behind the coordinate axes and cannot be selected with the mouse any more.

Note: In order to change the background setting of an image, you may open the Properties Dialog by selecting Properties… from the Edit Menu.

The *Transparency* of an image can be changed in order to see objects or axes that lie behind the image. You can set the transparency of an image by specifying a *Filling* value between 0 % and 100 % on tab *Style* of the Properties Dialog.

Pen Tool

The Pen Tool allows the user to add freehand notes and drawings to the Graphics View. This makes the Pen Tool particularly useful when using GeoGebra for presentations or with multimedia interactive whiteboards. To add a freehand note onto a region of the Graphics View, start drawing while keeping the left button of the mouse pressed. Release the mouse button to finish.

GeoGebra stores the notes you traced in the Graphic View as a polyline (assigning the name *stroke* to it), so you can apply to it any operation applicable to the related object (move, rotate, delete, etc.).

The default colour of the pen is black, but you can change the pen properties (colour, style, and thickness) using the Styling Bar, selecting the black triangle icon displayed on the Graphics View title bar.

Erasing

To erase a portion of your notes created in the Graphic View with the Pen Tool, press and hold the right mouse button while moving it on the notes you want to delete. Release the mouse button to finish.
In order to delete the *stroke* you previously created, erase it totally, or use the context menu of the object, or just delete the corresponding item in Algebra View.

Slider Tool

Click on any free place in the Graphics View to create a slider for a number or an angle. The appearing dialog window allows you to specify the *Name*, *Interval* [*min*, *max*], and *Increment* of the number or angle, as well as the *Alignment* and *Width* of the slider (in pixels), and its *Speed* and *Animation* modality.

Note: In the Slider dialog window you can enter a degree symbol ° or *pi (π)* for the interval and increment by using the following keyboard shortcuts:Alt-O (Mac OS: Ctrl-O) for the degree symbol ° Alt-P (Mac OS: Ctrl-P) for the pi symbol π

The position of a slider may be absolute in the Graphics View (this means that the slider is not affected by zooming, but always remains in the visible part of the Graphics View) or relative to the coordinate system (see Properties Dialog of the corresponding number or angle).

Note: In GeoGebra, a slider is the graphical representation of a Numbers and Angles#Free Numbers and Anglesfree number or free angle. You can easily create a slider for any existing Numbers and Angles#Free Numbers and Anglesfree number or angle by showing this object in the Graphics View (see Context Menu; see tool Show / Hide Object ToolShow/Hide Object).

Fixed sliders

Like other objects, sliders can be fixed. To translate a fixed slider when Move Tool is selected, you can drag it with your right mouse button. When Slider Tool is selected, you can use either left or right button. Sliders made with the Slider Tool are fixed by default (from GeoGebra 4.0). You can change value of fixed slider by simply clicking it. Preview of the new value appears next to your mouse pointer.

Relation Tool

Select two objects to get information about their relation in a pop-up window (see also Relation command) .

Function Inspector Tool

Enter the function you want to analyze. Then choose the tool.

- In the tab *Interval* you can specify the interval, where the tool will find minimum, maximum, root, etc. of the function.
- In the tab *Points* several points of the function are given (step can be changed). Slope etc. can be found at these points.

Text Tool

With this tool you can create static and dynamic text or LaTeX formulas in the Graphics View.

At first, you need to specify the location of the text in one of the following ways:

- Click in the Graphics View to create a new text at this location.
- Click on a point to create a new text that is attached to this point.

Note: You may specify the position of a text as absolute on screen or relative to the coordinate system on tab Basic of the Properties Dialog.

Then, a dialog appears where you may enter your text, which can be static, dynamic, or mixed.

The text you type directly in the *Edit* field is considered as static, i.e. it's not affected by the objects modifications. If you need to create a dynamic text, which displays the changing values of an object, select the related object from the *Objects* drop-down list. The corresponding name is shown, enclosed in a grey box, in the *Edit* field, and its value is displayed in the *Preview* box. Right-clicking on the grey box allows you to select "Definition" or "Value" for each dynamic object.

It is also possible to perform algebraic operations or apply specific commands to these objects, just clicking in the grey box and typing the algebraic operation or GeoGebra text command desired. The results of these operations will be dynamically shown in the resulting text, in the Graphics View.

Best visual results are obtained when using LaTex formatting for the formulas. Its use is simple and intuitive: just check the *LaTeX Formula* box, and select the desired formula template from the drop-down list. You can also select a variety of mathematical symbols and operators from the *Symbols* drop-down list.

Action Object Tools

These tools allow you to create Action Objects. They are by default grouped under a=2 icon (the second from the right) in the toolbar. Currently there are four action object tools:

- Slider
- Check Box
- Button
- Input Box

Check Box Tool

Clicking in the Graphics View creates a check box (see section Boolean values) that allows you to show and hide one or more objects. In the appearing dialog window you can specify which objects should be affected by the check box.

Note: You may select these objects from the list provided in the dialog window or select them with the mouse in any view.

Input Box Tool

Click in the Graphics View to insert an input box. In the appearing dialog you may set its caption and the linked object.

Note: See also InputBox command

Button Tool

Click in the Graphics View to insert a button. In the appearing dialog you may set its caption and OnClick script.

General Tools

General tools are by default grouped under ✥ icon (the first from the right) in the toolbar. Currently there are seven general tools:

- Move Graphics View
- Zoom In
- Zoom Out
- Show / Hide Object
- Show / Hide Label
- Copy Visual Style
- Delete

Custom Tools

GeoGebra allows you to create your own construction tools based on an existing construction. Once created, your custom tool can be used both with the mouse and as a command in the Input Bar. All tools are automatically saved in your GeoGebra file.

Note: Outputs of the tool are not movable (ie you can't drag them with the mouse), even if they are defined as `Point[<Path>]`. In case you need movable output, you can define a list of commands and use it with Execute Command.

Creating custom tools

To create a custom tool, use the option Create new tool from Tools Menu.

Saving custom tools

When you save the construction as GGB file, all custom tools are stored in it. To save the tools in separate file(s) use the Tool Manager Dialog (option Manage Tools from Tools Menu).

Accessing custom tools

If you open a new GeoGebra interface using item New from the File menu, after you created a custom tool, it will still be part of the GeoGebra Toolbar. However, if you open a new GeoGebra window (item New Window from the File Menu), or open GeoGebra on another day, your custom tools won’t be part of the Toolbar any more.

There are different ways of making sure that your user defined tools are displayed in the Toolbar of a new GeoGebra window:

After creating a new user defined tool you can save your settings using item Save Settings from the Options Menu. From now on, your customized tool will be part of the GeoGebra Toolbar.

Note: You can remove the custom tool from the Toolbar after opening item Customize Toolbar… from the Tools Menu. Then, select your custom tool from the list of tools on the left hand side of the appearing dialog window and click button Remove. Don’t forget to save your settings after removing the custom tool.

Importing custom tools

After saving your custom tool on your computer (as a GGT file), you can import it into a new GeoGebra window at any time. Just select item Open from the File Menu and open the file of your custom tool.

Note: Opening a GeoGebra tool file (GGT) in GeoGebra doesn’t affect your current construction. It only makes this tool part of the current GeoGebra Toolbar. You can also load GGT file by dragging it from file manager and droping into GeoGebra window.

Show / Hide Label Tool

Click on an object to show or hide its label.

Zoom Out Tool

Click on any place on the drawing pad to zoom out (see also Customizing the Graphics View section).

Notes: The position of your click determines the center of zoom See also ZoomOut CommandZoomOut command See also Zoom_In ToolZoom In tool.

Zoom In Tool

Click on any place on the drawing pad to zoom in (also see section Customizing the Graphics View).

Notes: The position of your click determines the center of zoom See also ZoomIn CommandZoomIn command See also Zoom_Out ToolZoom Out tool.

Delete Tool

Click on any object you want to delete.

> **Notes:**You can use the Edit Menu#UndoUndo button if you accidentally delete the wrong object See also Delete CommandDelete command.

Move Graphics View Tool

Move Graphics View Tool in the Graphics View

You may drag and drop the background of the Graphics View to change its visible area or scale each of the coordinate axes by dragging it with your pointing device.

Note: You can also move the background or scale each of the axes by pressing the Shift key (MS Windows: also Ctrl key) and dragging it with the mouse, no matter which Tool is selected.

Move Graphics View Tool in the 3D Graphics View

You may translate the three-dimensional coordinate system by dragging the background of the *3D Graphics View* with your pointing device. Thereby, you can switch between two modes by clicking on the background of the *3D Graphics View*:

- **Mode *x*-*y*-plane**: You may translate the scene parallel to the *x*-*y*-plane.
- **Mode *z*-axis**: You may translate the scene parallel to the *z*-axis.

Show / Hide Object Tool

Select the object you want to show or hide after activating this tool. Then, switch to another tool in order to apply the visibility changes to this object.

Note: When you activate this tool, all objects that should be hidden are displayed in the Graphics View highlighted. In this way, you can easily show hidden objects again by deselecting them before switching to another tool.

Copy Visual Style Tool

This tool allows you to copy visual properties (e. g., color, size, line style) from one object to one or more other objects. To do so, first select the object whose properties you want to copy. Then, click on all other objects that should adopt these properties.

Commands

Commands

Using commands you can produce new and modify existing objects. Please check the list displayed on the right, where commands have been categorized with respect to their field of application, or check the full commands list [1] for further details.

Note: A command's result may be named by entering a label followed by an equal sign (=). In the example below, the new point is named S.

Example: To get the intersection point of two lines g and h you can enter `S = Intersect[g, h]` (see Intersect Command).

Note: You can also use indices within the names of objects: A_1 is entered as `A_1` while S_{AB} is created using `S_{AB}`. This is part of LaTeX syntax.

Geometry Commands

- AffineRatio
- Angle
- AngleBisector
- Arc
- Area
- Centroid
- CircularArc
- CircularSector
- CircumcircularArc
- CircumcircularSector
- Circumference
- ClosestPoint
- CrossRatio
- Direction
- Distance
- Incircle
- Intersect
- IntersectRegion
- Length
- Line
- Locus
- Midpoint
- Perimeter
- PerpendicularBisector
- PerpendicularLine
- Point
- PointIn

- Polygon
- PolyLine
- Radius
- Ray
- RigidPolygon
- Sector
- Segment
- Slope
- Tangent
- Vertex

AffineRatio Command

AffineRatio[<Point A>, <Point B>, <Point C>]

Returns the affine ratio λ of three collinear points *A*, *B* and *C*, where $C = A + \lambda * AB$.

Example:

`AffineRatio[(-1, 1), (1, 1), (4, 1)]` yields *2.5*

Angle Command

Angle[<Object>]

- **Conic:** Returns the angle of twist of a conic section’s major axis (see command Axes).

  Example: `Angle[x²/4+y²/9=1]` yields *90°* or 1.57 if the default angle unit is *radians*.
- **Vector:** Returns the angle between the *x*-axis and given vector.

  Example: `Angle[Vector[(1, 1)]]` yields *45°* or the corresponding value in *radians*.
- **Point:** Returns the angle between the *x*-axis and the position vector of the given point.

  Example: `Angle[(1, 1)]` yields *45°* or the corresponding value in *radians*.
- **Number:** Converts the number into an angle (result in [0,360°] or [0,2π] depending on the default angle unit).

  Example: `Angle[20]` yields *65.92°* when the default unit for angles is *degrees*.
- **Polygon:** Creates all angles of a polygon in mathematically positive orientation (counter clockwise).

  Example: `Angle[Polygon[(4, 1), (2, 4), (1, 1)] ]` yields *56.31°*, *52.13°* and *71.57°* or the corresponding values in *radians*.

  Note: If the polygon was created in counter clockwise orientation, you get the interior angles. If the polygon was created in clockwise orientation, you get the exterior angles.

Angle[<Vector>, <Vector>]

Returns the angle between two vectors (result in [0,360°] or [0,2π] depending on the default angle unit).

Example:

`Angle[Vector[(1, 1)], Vector[(2, 5)]]` yields *23.2°* or the corresponding value in *radians*.

Angle[<Line>, <Line>]

Returns the angle between the direction vectors of two lines (result in [0,360°] or [0,2π] depending on the default angle unit).

Example:

`Angle[y = x + 2, y = 2x + 3]` yields *18.43°* or the corresponding value in *radians*.

Angle[<Line>, <Plane>]

Returns the angle between the line and the plane.

Example:

`Angle[Line[(1, 2, 3),(-2, -2, 0)], z = 0]` yields *30.96°* or the corresponding value in *radians*.

Angle[<Plane>, <Plane>]

Returns the angle between the two given planes.

Example:

`Angle[2x - y + z = 0, z = 0]` yields *114.09°* or the corresponding value in *radians*.

Angle[<Point>, <Apex>, <Point>]

Returns the angle defined by the given points (result in [0,360°] or [0,2π] depending on the default angle unit).

Example:

`Angle[(1, 1), (1, 4), (4, 2)]` yields *56.31°* or the corresponding value in *radians*.

Angle[<Point>, <Apex>, <Angle>]

Returns the angle of size *α* drawn from *point* with *apex*.

Example:

`Angle[(0, 0), (3, 3), 30°]` yields *(1.9, -1.1)*.

Note: The point *Rotate[<Point>, <Angle>, <Apex>]* is created as well.

Angle[<Point>, <Point>, <Point>, <Direction>]

Returns the angle defined by the points and the given *Direction*, that may be a line or a plane (result in [0,360°] or [0,2π] depending on the default angle unit).

Note: Using a *Direction* allows to bypass the standard display of angles in 3*D* which can be set as just [0,180°] or [180°,360°], so that given three points *A*, *B*, *C* in 3*D* the commands `Angle[A, B, C]` and `Angle[C, B, A]` return their real measure instead of the one restricted to the set intervals.

Example:

`Angle[(1, -1, 0),(0, 0, 0),(-1, -1, 0), zAxis]]` yields *270°* and `Angle[(-1, -1, 0),(0, 0, 0),(1, -1, 0), zAxis]]` yields *90°* or the corresponding values in *radians*.

Note: See also Angle and Angle with Given Size tools.

AngleBisector Command

AngleBisector[<Line>, <Line>]

Returns both angle bisectors of the lines.

Example:

`AngleBisector[x + y = 1, x - y = 2]` yields *a: x = 1.5* and *b: y = -0.5*.

AngleBisector[<Point>, <Point>, <Point>]

Returns the angle bisector of the angle defined by the three points.

Example:

`AngleBisector[(1, 1), (4, 4), (7, 1)]` yields *a: x = 4*.

Note: The second point is apex of this angle.

Note: See also Angle Bisector tool .

Arc Command

Arc[<Circle>, <Point M >, <Point N>]

Returns the directed arc (counterclockwise) of the given circle, with endpoints M and N.

Arc[<Ellipse>, <Point M>, <Point N>]

Returns the directed arc (counterclockwise) of the given ellipse, with endpoints M and N.

Arc[<Circle>, <Parameter Value>, <Parameter Value>]

Returns the circle arc of the given circle, whose endpoints are identified by the specified values of the parameter.

Note: Internally the following parametric forms are used:
Circle: (*r* cos(*t*), *r* sin(*t*)) where *r* is the circle's radius.

Arc[<Ellipse>, <Parameter Value>, <Parameter Value>]

Returns the circle arc of the given ellipse, whose endpoints are identified by the specified values of the parameter.

Note: Internally the following parametric forms are used:
Ellipse: (*a* cos(*t*), *b* sin(*t*)) where *a* and *b* are the lengths of the semimajor and semiminor axes.

Note: See also CircumcircularArc command.

Area Command

Area[<Point>, ..., <Point>]

Calculates the area of the polygon defined by the given points.

Example:

`Area[(0, 0), (3, 0), (3, 2), (0, 2)]` yields *6*.

Area[<Conic>]

Calculates the area of a conic section (circle or ellipse).

Example:

`Area[x^2 + y^2 = 2]` yields *6.28*.

Area[<Polygon>]

Calculates the area of the polygon.

Note: In order to calculate the area between two function graphs, you need to use the command IntegralBetween CommandIntegralBetween. See also the Area ToolArea tool.

Centroid Command

Centroid[<Polygon>]

Returns the centroid of the polygon.

Example:

Let `A = (1, 4)`, `B = (1, 1)`, `C = (5, 1)` and `D = (5, 4)` be the vertices of a polygon. `Polygon[ A, B, C, D ]` yields *poly1 = 12*. `Centroid[ poly1 ]` yields the centroid *E = (3, 2.5)*.

CircularArc Command

CircularArc[<Midpoint>, <Point A>, <Point B>]

Creates a circular arc with midpoint between the two points.

Note: Point *B* does not have to lie on the arc.

Note: See also Circular Arc tool.

CircularSector Command

CircularSector[<Midpoint>, <Point A>, <Point B>]

Creates a circular sector with midpoint between the two points.

Notes: Point B does not have to lie on the arc of the sector.See also Circular Sector ToolCircular Sector tool.

CircumcircularArc Command

CircumcircularArc[<Point>, <Point>, <Point>]

Creates a circular arc through three points, where the first point is the starting point and the third point is the endpoint of the circumcircular arc.

Note: See also Circumcircular Arc tool.

CircumcircularSector Command

CircumcircularSector[<Point>, <Point>, <Point>]

Creates a circular sector whose arc runs through the three points, where the first point is the starting point and the third point is the endpoint of the arc.

Note: See also Circumcircular Sector through Three Points tool.

Circumference Command

Circumference[Polygon]

Returns the circumference of a Polygon.

Circumference[Conic]

If the given conic is a circle or ellipse, this command returns its circumference. Otherwise the result is undefined.

ClosestPoint Command

ClosestPoint[<Path>, <Point>]

Returns a new point on a path which is the closest to a selected point.

Note: For Functions, this command now uses closest point (rather than vertical point). This works best for polynomials; for other functions the numerical algorithm is less stable.

ClosestPoint[<Line>, <Line>]

Returns a new point on the first line which is the closest to the second line.

CrossRatio Command

CrossRatio[<Point A>, <Point B>, <Point C>, <Point D>]

Calculates the cross ratio *λ* of four collinear points *A*, *B*, *C* and *D*, where:
λ = AffineRatio[B, C, D] / AffineRatio[A, C, D].

Example:

`CrossRatio[(-1, 1), (1, 1), (3, 1), (4, 1)]` yields *1.2*

Direction Command

Direction[<Line>]

Yields the direction vector of the line.

Example: `Direction[-2x + 3y + 1 = 0]` yields the vector $u = \begin{pmatrix}3\\2\end{pmatrix}$

Note: A line with equation *ax* + *by* = *c* has the direction vector *(b, - a)*.

Distance Command

Distance[<Point>, <Object>]

Yields the shortest distance between a point and an object.

Example:

`Distance[(2, 1), x^2 + (y - 1)^2 = 1]` yields *1*

Note: The command works for points, segments, lines, conics, functions and implicit curves. For functions it uses a numerical algorithm which works better for polynomials.

Distance[<Line>, <Line>]

Yields the distance between two lines.

Example:

- `Distance[y = x + 3, y = x + 1]` yields *1.41*
- `Distance[y = 3x + 1, y = x + 1]` yields *0*

Note: The distance between intersecting lines is *0*. Thus, this command is only interesting for parallel lines.

Note: See also Distance or Length tool .
Distance[<Point>, <Point>]

Yields the distance between the two points.

Example:

`Distance[(2, 1, 2), (1, 3, 0)]` yields *3*

Distance[<Line>, <Line>]

Yields the distance between two lines.

Example:

Let *a: X = (-4, 0, 0) + λ*(4, 3, 0)* and *b: X = (0, 0, 0) + λ*(0.8, 0.6, 0).*
`Distance[a, b]` yields *2.4*

Intersect Command

Intersect[<Object>, <Object>]

Yields the intersection points of two objects.

Example:

- Let `a: -3x + 7y = -10` be a line and `c: x^2 + 2y^2 = 8` be an ellipse. `Intersect[a, c]` yields the intersection points *E* = (-1.02, -1,87) and *F* = (2.81, -0.22) of the line and the ellipse.
- `Intersect[y = x + 3, Curve[t, 2t, t, 0, 10]]` yields *A*=(3,6).
- `Intersect[Curve[2s, 5s, s,-10, 10 ], Curve[t, 2t, t, -10, 10]]` yields *A*=(0,0).

Intersect[<Object>, <Object>, <Index of Intersection Point>]

Yields the n$^{\text{th}}$ intersection point of two objects.

Example:

Let `a(x) = x^3 + x^2 - x` be a function and `b: -3x + 5y = 4` be a line. `Intersect[a, b, 2]` yields the intersection point *C* = (-0.43, 0.54) of the function and the line.

Intersect[<Object>, <Object>, <Initial Point>]

Yields an intersection point of two objects by using a (numerical) iterative method with initial point.

Example:

Let `a(x) = x^3 + x^2 - x` be a function, `b: -3x + 5y = 4` be a line, and *C* = (0, 0.8) be the initial point. `Intersect[a, b, C]` yields the intersection point *D* = (-0.43, 0.54) of the function and the line by using a (numerical) iterative method.

Intersect[<Function>, <Function>, <Start x-Value>, <End x-Value>]

Yields the intersection points numerically for the two functions in the given interval.

Example:

Let `f(x) = x^3 + x^2 - x` and `g(x) = 4 / 5 + 3 / 5 x` be two functions. `Intersect[ f, g, -1, 2 ]` yields the intersection points *A* = (-0.43, 0.54) and *B* = (1.1, 1.46) of the two functions in the interval [-1, 2].

Intersect[<Curve 1>, <Curve 2>, <Parameter 1>, <Parameter 2>]

Finds one intersection point using an iterative method starting at the given parameters.

Example:

Let `a = Curve[cos(t), sin(t), t, 0, π]` and `b = Curve[cos(t) + 1, sin(t), t, 0, π]`.

`Intersect[a, b, 0, 2]` yields the intersection point *A = (0.5, 0.87).*

CAS Syntax

Intersect[<Function>, <Function>]

Yields a list containing the intersection points of two objects.

Example:

Let `f(x):= x^3 + x^2 - x` and `g(x):= x` be two functions. `Intersect[ f(x), g(x) ]` yields the intersection points list: *{(1, 1), (0, 0), (-2, -2)}* of the two functions.

Note: See also Intersect tool.

Intersect[<Object>, <Object>]

Example:

- `Intersect[ <Line> , <Object> ]` creates the intersection point(s) of a line and a plane, segment, polygon, conic, etc.
- `Intersect[ <Plane> , <Object> ]` creates the intersection point(s) of a plane and segment, polygon, conic, etc.
- `Intersect[ <Conic>, <Conic> ]` creates the intersection point(s) of two conics
- `Intersect[ <Plane>, <Plane> ]` creates the intersection line of two planes
- `Intersect[ <Plane>, <Polyhedron> ]` creates the polygon(s) intersection of a plane and a polyhedron.
- `Intersect[ <Sphere>, <Sphere> ]` creates the circle intersection of two spheres
- `Intersect[ <Plane>, <Quadric> ]` creates the conic intersection of the plane and the quadric (sphere, cone, cylinder, ...)

Note: See also IntersectConic and IntersectPath commands.

IntersectPath Command

IntersectPath[<Line>, <Polygon>]

Creates the intersection path between line and polygon.

Example:

`IntersectPath[ a, triangle ]` creates a segment between the first and second intersection point of line *a* and polygon *triangle*.

IntersectPath[<Polygon>, <Polygon>]

Creates the intersection polygon between two given polygons.

Example:

`IntersectPath[ quadrilateral, triangle ]` creates a new polygon as intersection of the two given polygons.

Note: The new polygon can either be a quadrilateral, a pentagon or a hexagon. This depends on the position of the vertices of the given polygons.

IntersectPath[<Plane>, <Polygon>]

Creates the intersection path between plane and polygon.

Example:

`IntersectPath[ a, triangle ]` creates a segment between the first and second intersection point of plane *a* and polygon *triangle* in the plane of the polygon.

IntersectPath[<Plane>, <Quadric>]

Creates the intersection path between plane and quadric.

Example:

`IntersectPath[ a, sphere ]` creates a circle as intersection between plane *a* and quadric *sphere*.

Note: See also Intersect and IntersectConic commands.

Length Command

Length[<Object>]

Yields the length of the object.

Examples:

- `Length[ <Vector> ]` yields the length of the vector.
- `Length[ <Point> ]` yields the length of the position vector of the given point.
- `Length[ <List> ]` yields the length of the list, which is the number of elements in the list.
- `Length[ <Text> ]` yields the number of characters in the text.
- `Length[ <Locus> ]` returns the number of points that the given locus is made up of. Use Perimeter[Locus] to get the length of the locus itself. For details see the article about First Command.
- `Length[ <Arc> ]` returns the *arc length* (i.e. just the length of the curved section) of an arc or sector.

Length[<Function>, <Start x-Value>, <End x-Value>]

Yields the length of the function graph in the given interval.

Example:

`Length[2x, 0, 1]` returns 2.23606797749979, about $\sqrt{5}$.

Length[<Function>, <Start Point>, <End Point>]

Yields the length of the function graph between the two points.

Note: If the given points do not lie on the function graph, their x-coordinates are used to determine the interval.

Length[<Curve>, <Start t-Value>, <End t-Value>]

Yields the length of the curve between the two values **of the parameter**.

Length[<Curve>, <Start Point>, <End Point>]

Yields the length of the curve between the two points that lie on the curve.

CAS Syntax

Length[<Function>, <x-start>, <x-end>]

Calculates the length of a function graph between the two points.

Example:

`Length[2 x, 0, 1]` yields $\sqrt{5}$.

Length[<Function>, <Variable>, <Start Point>, <End Point>]

Calculates the length of a function graph from *Start Point* to *End Point*.

Example:

`Length[2 a, a, 0, 1]` yields $\sqrt{5}$.

Note:

See also Distance or Length tool.

Line Command

Line[<Point>, <Point>]

Creates a line through two points *A* and *B*.

Line[<Point>, <Parallel Line>]

Creates a line through the given point parallel to the given line.

Line[<Point>, <Direction Vector>]

Creates a line through the given point with direction vector *v*.

Note: See also Line and Parallel Line tools.

PerpendicularBisector Command

PerpendicularBisector[<Segment>]

Yields the perpendicular bisector of a segment.

PerpendicularBisector[<Point>, <Point>]

Yields the perpendicular bisector of a line segment between two points.

Note: See also Perpendicular Bisector tool.

Locus Command

Locus[<Point Creating Locus Line Q>, <Point P>]

Returns the locus curve of the point *Q*, which depends on the point *P*.

Note: Point *P* needs to be a point on an object (e. g. line, segment, circle).

Locus[<Point Creating Locus Line Q>, <Slider t>]

Returns the locus curve of the point *Q*, which depends on the values assumed by the slider *t*.

Locus[<Slopefield>, <Point>]

Returns the locus curve which equates to the slopefield at the given point.

Locus[<f(x, y)>, <Point>]

Returns the locus curve which equates to the solution of the differential equation $\frac{dy}{dx} = f(x, y)$. The solution is calculated numerically.

Loci are specific object types, and appear as auxiliary objects. Besides Locus command, they are the result of some Discrete Math Commands and SolveODE Command. Loci are paths and can be used within path-related commands such as Point. Their properties depend on how they were obtained, see e.g. Perimeter Command and First Command.

Note: See also Locus tool.

Warning: A locus is undefined when the dependent point is the result of a Point Command with two parameters, or a PathParameter Command.

Midpoint Command

Midpoint[<Segment>]

Returns the midpoint of the segment.

Example:

Let `s = Segment[(1, 1), (1, 5)]`.

`Midpoint[s]` yields *(1, 3)*.

Midpoint[<Conic>]

Returns the center of the conic.

Example:

`Midpoint[x^2 + y^2 = 4]` yields *(0, 0)*.

Midpoint[<Interval>]

Returns the midpoint of the interval (as number).

Example:

`Midpoint[2 < x < 4]` yields *3*.

Midpoint[<Point>, <Point>]

Returns the midpoint of two points.

Example:

`Midpoint[(1, 1), (5, 1)]` yields *(3, 1)*.

Note: See also Midpoint or Center tool.

PerpendicularLine Command

PerpendicularLine[<Point>, <Line>]

Creates a line through the point perpendicular to the given line.

Example:

Let c: $-3x + 4y = -6$ be a line and $A = (-2, -3)$ a point. `PerpendicularLine[ A, c ]` yields the line d: $-4x - 3y = 17$.

PerpendicularLine[<Point>, <Segment>]

Creates a line through the point perpendicular to the given segment.

Example:

Let c be the segment between the two points $A = (-3, 3)$ and $B = (0, 1)$. `PerpendicularLine[ A, c ]` yields the line d: $-3x + 2y = 15$.

PerpendicularLine[<Point>, <Vector>]

Creates a line through the point perpendicular to the given vector.

Example:

Let u be a vector between two points: u = *Vector*[(5, 3), (1, 1)] and A = (-2, 0) a point. `PerpendicularLine[ A, u ]` yields the line c: $2x + y = -4$.

Note: See also Perpendicular Line tool.

PerpendicularLine[<Point>, <Line>]

Creates a line through the point perpendicular to the given line.

Note: This command yields *undefined* if the point is on the line in 3D.

PerpendicularLine[<Point>, <Plane>]

Creates a perpendicular line to the plane through the given point.

PerpendicularLine[<Line> , <Line>]

Creates a perpendicular line to the given lines through the intersection point of the two lines.

PerpendicularLine[<Point>, <Direction>, <Direction>]

Creates a perpendicular line to the given directions (that can be lines or vectors) through the given point.

PerpendicularLine[<Point>, <Line>, <Context>]

Creates a perpendicular line to the line through the point and depending on the context.

Examples:

- `PerpendicularLine[ <Point>, <Line>, <Plane> ]` creates a perpendicular line to the given line through the point and parallel to the plane.

  Note: This command yields undefined if the point is on the line in 3D.

- `PerpendicularLine[ <Point>, <Line>, Space ]` creates a perpendicular line to the given line through the point. The two lines have an intersection point.

Perimeter Command

Perimeter[<Polygon>]

Returns the perimeter of the polygon.

Example:

`Perimeter[Polygon[(1, 2), (3, 2), (4, 3)]]` yields *6.58*.

Perimeter[<Conic>]

If the given conic is a circle or ellipse, this command returns its perimeter. Otherwise the result is undefined.

Example:

`Perimeter[x^2 + 2y^2 = 1]` yields *5.4*.

Perimeter[<Locus>]

If the given locus is finite, this command returns its approximate perimeter. Otherwise the result is undefined.

Point Command

Point[<Object>]

Returns a point on the geometric object. The resulting point can be moved along the path.

Point[<Object>, <Parameter>]

Returns a point on the geometric object with given path parameter.

Point[<Point>, <Vector>]

Creates a new point by adding the vector to the given point.

Point[<List>]

Converts a list containing two numbers into a Point.

Example: `Point[{1, 2}]` yields *(1, 2)*.

Note: See also ●A Point tool.

PointIn Command

PointIn[<Region>]

Returns a point restricted to given region.

Note: See also Attach / Detach Point Tool.

Polyline Command

Polyline[<List of Points>]

Creates an open polygonal chain (i.e. a connected series of segments) having the initial vertex in the first point of the list, and the final vertex in the last point of the list.

Note: The polygonal chain length is displayed in the Algebra View.

Polyline[<Point>, ..., <Point>]

Creates an open polygonal chain (i.e. a connected series of segments) having the initial vertex in the first entered point, and the final vertex in the last entered point.

Notes: The polygonal chain length is displayed in the Algebra View. It is also possible to create a discontinuous polygonal: Example: Polyline[(1, 3), (4, 3), (?,?), (6, 2), (4, -2), (2, -2)] yields the value 9.47 in Algebra view, and the corresponding polygonal in Graphics view.

Note: See also Polygon command.

Polygon Command

Polygon[<Point>, ..., <Point>]

Returns a polygon defined by the given points.

Example:

`Polygon[(1, 1), (3, 0), (3, 2), (0, 4)]` yields a quadrilateral.

Polygon[<Point>, <Point>, <Number of Vertices>]

Creates a regular polygon with *n* vertices.

Example:

`Polygon[(1, 1), (4, 1), 6]` yields a hexagon.

Polygon[<List of Points>]

Returns a polygon defined by the points in the list.

Example:

`Polygon[{(0, 0), (2, 1), (1, 3)}]` yields a triangle.

Note: See also Polygon and Regular Polygon tools.

Radius Command

Radius[<Conic>]

Returns the radius of a conic.

Example:

- Returns the radius of a circle c (e.g. c:$(x - 1)^2 + (y - 1)^2 = 9$) `Radius[c]` yields *a = 3*.
- Returns the radius of a circle formula `Radius[(x - 2)² + (y - 2)² = 16]` yields *a = 4*.

Ray Command

Ray[<Start Point>, <Point>]

Creates a ray starting at a point through a point.

Ray[<Start Point>, <Direction Vector>]

Creates a ray starting at the given point which has the direction vector.

Notes: When computing intersections with other objects, only intersections lying on the ray are considered. To change this, you can use Intersect Tool#Outlying_IntersectionsOutlying Intersections option. See also Ray ToolRay tool.

RigidPolygon Command

RigidPolygon[<Polygon>]

Creates a copy of any polygon that can only be translated by dragging its first vertex and rotated by dragging its second vertex.

RigidPolygon[<Polygon>, <Offset x>, <Offset y>]

Creates a copy of any polygon with the given offset that can only be translated by dragging its first vertex and rotated by dragging its second vertex.

RigidPolygon[<Free Point>, ..., <Free Point>]

Creates polygon whose shape cannot be changed. This polygon can be translated by dragging its first vertex and rotated by dragging its second vertex.

Note: The copy will join in every change of the original polygon.
If you want to change the shape of the copy, you have to change the original.

Sector Command

Sector[<Conic>, <Point>, <Point>]

Yields a conic sector between two points on the conic section.

Example:

- Let `c: x^2 + 2y^2 = 8` be an ellipse, `D = (-2.83, 0)` and `E = (0, -2)` two points on the ellipse. `Sector[ c, D, E ]` yields *d = 4.44*.
- Let `c: x^2 + y^2 = 9` be a circle, `A = (3, 0)` and `B = (0, 3)` two points on the circle. `Sector[ c, A, B ]` yields *d = 7.07*

Note: This works only for a circle or ellipse.

Sector[<Conic>, <Parameter Value>, <Parameter Value>]

Yields a conic sector between two parameter values between *0* and *2π* on the conic section.

Example:

Let `c: x^2 + y^2 = 9` be a circle. `Sector[ c, 0, 3/4 π ]` yields *d = 10.6*

Note: Internally the following parametric forms are used: Circle: (r cos(t), r sin(t)) where r is the circle's radius. Ellipse: (a cos(t), b sin(t)) where a and b are the lengths of the semimajor and semiminor axes.

Segment Command

Segment[<Point>, <Point>]

Creates a segment between two points.

Segment[<Point>, <Length>]

Creates a segment with the given length starting at the point.

Notes: When computing intersections with other objects, only intersections lying on the segment are considered. To change this, you can use Intersect Tool#Outlying_IntersectionsOutlying Intersections option. See also Segment_ToolSegment and Segment_with_Given_Length_ToolSegment_with_Given_Length tools.

Slope Command

Slope[<Line>]

Returns the slope of the given line.

Note: This command also draws the slope triangle whose size may be changed on tab Style of the Properties Dialog.

Note: See also Slope tool.

Tangent Command

Tangent[<Point>, <Conic>]

Creates (all) tangents through the point to the conic section.

Example:

`Tangent[(5, 4), 4x^2 - 5y^2 = 20]` yields $x - y = 1$.

Tangent[<Point>, <Function>]

Creates the tangent to the function at $x = x(A)$.

Note: $x(A)$ is the x-coordinate of the given point A.

Example:

`Tangent[(1, 0), x^2]` yields $y = 2x - 1$.

Tangent[<Point on Curve>, <Curve>]

Creates the tangent to the curve in the given point.

Example:

`Tangent[(0, 1), Curve[cos(t), sin(t), t, 0, π]]` yields $y = 1$.

Tangent[<x-Value>, <Function>]

Creates the tangent to the function at *x-Value*.

Example:

`Tangent[1, x^2]` yields $y = 2x - 1$.

Tangent[<Line>, <Conic>]

Creates (all) tangents to the conic section that are parallel to the given line.

Example:

`Tangent[y = 4, x^2 + y^2 = 4]` yields $y = 2$ and $y = -2$.

Tangent[<Circle>, <Circle>]

Creates the common tangents to the two Circles (up to 4).

Example:

`Tangent[x^2 + y^2 = 4, (x - 6)^2 + y^2 = 4]` yields $y = 2$, $y = -2$, $1.49x + 1.67y = 4.47$ and $-1.49x + 1.67y = -4.47$.

Note: See also Tangents tool.

Vertex Command

Vertex[<Conic>]

Returns (all) vertices of the conic section.

Vertex[<Inequality>]

Returns the points of intersection of the borders.

Example: Vertex[(x + y < 3) && (x - y > 1)] returns point A = (2, 1).{Vertex[(x + y < 3) ∧ (x - y > 1) && (y > - 2)]} returns list1 = {(2, 1), (5, -2), (-1, -2)}.Vertex[(y > x²) ∧ (y < x)] returns two points A = (0, 0) and B = (1, 1).{Vertex[(y > x²) ∧ (y < x)]} returns list1 = {(0, 0), (1, 1)}.

Vertex[<Polygon>]

Returns (all) vertices of the polygon.

Vertex[<Polygon>, <Index>]

Returns *n*-th vertex of the polygon.

Note: To get the vertices of the objects polygon / conic / inequality in a list, use `{Vertex[Object]}`.

Algebra Commands

- CommonDenominator
- CompleteSquare
- Div
- Division
- Divisors
- DivisorsList
- DivisorsSum
- Expand
- Factor
- FromBase
- GCD
- IsPrime
- LCM
- LeftSide
- Max
- Min
- Mod
- NextPrime
- PreviousPrime
- PrimeFactors
- RightSide
- Simplify
- ToBase

Div Command

Div[<Dividend Number>, <Divisor Number>]

Returns the quotient (integer part of the result) of the two numbers.

Example:

`Div[16, 3]` yields *5*.

Div[<Dividend Polynomial>, <Divisor Polynomial>]

Returns the quotient of the two polynomials.

Example:

`Div[x^2 + 3 x + 1, x - 1]` yields *f(x) = x + 4*.

CAS Syntax

Div[<Dividend Number>, <Divisor Number>]

Returns the quotient (integer part of the result) of the two numbers.

Example:

`Div[16, 3]` yields *5*.

Div[<Dividend Polynomial>, <Divisor Polynomial>]

Returns the quotient of the two polynomials.

Example:

`Div[x^2 + 3 x + 1, x - 1]` yields *x + 4*.

Expand Command

Expand[<Expression>]

Expands the expression.

Example: `Expand[(2 x - 1)^2 + 2 x + 3]` yields $4x^2 - 2x + 4$.

Note: This command needs to load the Computer Algebra System, so can be slow on some computers. Try using the Polynomial Command instead.

CAS Syntax

Expand[<Expression>]

Expands the expression.

Example: `Expand[(2 x - 1)^2 + 2 x + 3]` yields $4x^2 - 2x + 4$.

Factor Command

Factor[<Polynomial>]

Factors the polynomial.

Example:

`Factor[x^2 + x - 6]` yields *(x + 3) (x - 2)*.

Note: This command needs to load the Computer Algebra System, so can be slow on some computers.

CAS Syntax

Factor[<Polynomial>]

Factors the polynomial.

Example:

`Factor[x^2 - y^2]` yields *(x + y) (x - y)*.

Factor[<Expression>, <Variable>]

Factors an expression with respect to a given variable.

Example:

- `Factor[x^2 - y^2, x]` yields *(x + y) (x - y)*, the factorization of $x^2 - y^2$ with respect to *x*,
- `Factor[x^2 - y^2, y]` yields *(-x - y) (-x + y)*, the factorization of $x^2 - y^2$ with respect to *y*.

Note: This command factors expressions over the Rational Numbers. To factor over irrational real numbers, see the IFactor Command. To factor over complex numbers, see the CFactor Command and CIFactor Command.

GCD Command

GCD[<Number>, <Number>]

Calculates the greatest common divisor of the two numbers .

Example:

`GCD[12, 15]` yields *3*.

GCD[<List of Numbers>]

Calculates the greatest common divisor of the list of numbers.

Example:

`GCD[{12, 30, 18}]` yields *6*.

CAS Syntax

GCD[<Number> , <Number>]

Calculates the greatest common divisor of the two numbers .

Example:

`GCD[12, 15]` yields *3*.

GCD[<List of Numbers>]

Calculates the greatest common divisor of the list of numbers.

Example:

`GCD[{12, 30, 18}]` yields *6*.

GCD[<Polynomial>, <Polynomial>]

Calculates the greatest common divisor of the two polynomials.

Example:

`GCD[x^2 + 4 x + 4, x^2 - x - 6]` yields $x + 2$.

GCD[<List of Polynomials>]

Calculates the greatest common divisor of the list of polynomials.

Example:

`GCD[{x^2 + 4 x + 4, x^2 - x - 6, x^3 - 4 x^2 - 3 x + 18}]` yields $x + 2$.

LCM Command

UK English: LCM = lowest common multiple

LCM[<Number>, <Number>]

Calculates the least common multiple of two numbers.

Example:

`LCM[12, 15]` yields *60*.

LCM[<List of Numbers>]

Calculates the least common multiple of the elements in the list.

Example:

`LCM[{12, 30, 18}]` yields *180*.

CAS Syntax

LCM[<Number>, <Number>]

Calculates the least common multiple of two numbers.

Example:

`LCM[12, 15]` yields *60*.

LCM[<List of Numbers>]

Calculates the least common multiple of the list of numbers.

Example:

`LCM[{12, 30, 18}]` yields *180*.

LCM[<Polynomial>, <Polynomial>]

Calculates the least common multiple of the two polynomials.

Example:

`LCM[x^2 + 4 x + 4, x^2 - x - 6]` yields $x^3 + x^2 - 8x - 12$.

LCM[<List of Polynomials>]

Calculates the least common multiple of the polynomials in the list.

Example:

`LCM[{x^2 + 4 x + 4, x^2 - x - 6, x^3 - 4 x^2 - 3 x + 18}]` yields $x^4 - 2x^3 - 11x^2 + 12x + 36$.

Max Command

Max[<List>]

Returns the maximum of the numbers within the list.

Example: `Max[{-2, 12, -23, 17, 15}]` yields *17*.

Note: If the input consists of non-numeric objects, then this command considers the numbers associated with those objects. If you have a list of segments for example, the command *Max[<List>]* will yield the maximum segment length.

Max[<Interval>]

Returns the upper bound of the interval.

Example: `Max[2 < x < 3]` yields *3*.

Note: Open and closed intervals are treated the same.

Max[<Number>, <Number>]

Returns the maximum of the two given numbers.

Example: `Max[12, 15]` yields *15*.

Max[<Function>, <Start x-Value>, <End x-Value>]

Calculates the maximum point of the function in the given interval. The function should be continuous and have only one *local* maximum point in the interval.

Example: `Max[ x^3 + 2x^2 - 1, -2, 0]` creates the point (-1.33, 0.19).

Note: See also Extremum Command, Min Command and Function Inspector Tool.

Max[<List of Data>, <List of Frequencies>]

Returns the maximum of the list of data with corresponding frequencies.

Example: `Max[{1, 2, 3, 4, 5}, {5, 3, 4, 2, 0}]` yields 4.

CAS Syntax

Max[<List>]

Returns the maximum of the numbers within the list.

Example: `Max[{-2, 12, -23, 17, 15}]` yields *17*.

Note: See also Extremum Command and Min Command.

Max[<Number>, <Number>]

Returns the maximum of the two given numbers.

Example: `Max[12, 15]` yields *15*.

Min Command

Min[<List>]

Returns the minimum of the numbers within the list.

Example: `Min[{-2, 12, -23, 17, 15}]` yields *-23*.

Note: If the input consists of non-numeric objects, then this command considers the numbers associated with those objects. If you have a list of segments for example, the command Min[<List>] will yield the minimum segment length.

Min[<Interval>]

Returns the lower bound of the interval.

Example: `Min[2 < x < 3]` yields *2* .

Note: Opened and closed intervals are not distinguished.

Min[<Number>, <Number>]

Returns the minimum of the two given numbers.

Example: `Min[12, 15]` yields *12*.

Min[<Function>, <Start x-Value>, <End x-Value>]

Calculates (numerically) the minimum point for function in the given interval. Function should be continuous and have only one *local* minimum point in the interval.

Example: `Min[ x^3 + 2x^2 - 1, -2, 0]` creates the point (0, -1).

Min[<List of Data>, <List of Frequencies>]

Returns the minimum of the list of data with corresponding frequencies.

Example: `Min[{1, 2, 3, 4, 5}, {0, 3, 4, 2, 3}]` yields 2.

CAS Syntax

Min[<List>]

Returns the minimum of the numbers within the list.

Example: `Min[{-2, 12, -23, 17, 15}]` yields *-23*.

Min[<Number>, <Number>]

Returns the minimum of the two given numbers.

Example: `Min[12, 15]` yields *12*.

Note: See also Max Command, Extremum Command and Function Inspector Tool.

Mod Command

Mod[<Dividend Number>, <Divisor Number>]

Yields the remainder when dividend number is divided by divisor number.

Example: `Mod[9, 4]` yields *1*.

Mod[<Dividend Polynomial>, <Divisor Polynomial>]

Yields the remainder when the dividend polynomial is divided by the divisor polynomial.

Example: `Mod[x^3 + x^2 + x + 6, x^2 - 3]` yields *4 x + 9*.

CAS Syntax

Mod[<Dividend Number>, <Divisor Number>]

Yields the remainder when dividend number is divided by divisor number.

Example: `Mod[9, 4]` yields *1*.

Mod[<Dividend Polynomial>, <Divisor Polynomial>]

Yields the remainder when the dividend polynomial is divided by the divisor polynomial.

Example: `Mod[x^3 + x^2 + x + 6, x^2 - 3]` yields *4 x + 9*.

Note:

If you want a function to do this, you can define it yourself eg `mod(x, y) = y (x / y - floor(x / y))`

PrimeFactors Command

PrimeFactors[<Number>]

Returns the list of primes whose product equals to the given number.

Examples:

- `PrimeFactors[1024]` yields *{2, 2, 2, 2, 2, 2, 2, 2, 2, 2}*.
- `PrimeFactors[42]` yields *{2, 3, 7}*.

CAS Syntax

PrimeFactors[<Number>]

Returns the list of primes whose product equals to the given number.

Examples:

- `PrimeFactors[1024]` yields *{2, 2, 2, 2, 2, 2, 2, 2, 2, 2}*.
- `PrimeFactors[42]` yields *{2, 3, 7}*.

Note: See also Factors Command.

Simplify Command

Simplify[<Function>]

Simplifies the terms of the given function, if possible.

Example: `Simplify[x + x + x]` yields the function $f(x) = 3x$.

Simplify[<Text>]

Attempts to tidy up text expressions by removing repeated negatives etc.

Example: For $a = b = c = -1$ `Simplify["f(x) = " + a + "x² + " + b + "x + " + c]` yields the text *f(x) = -x^2 - x - 1*.

Note:

- The FormulaText Command normally produces better results and is simpler.
- This command needs to load the Computer Algebra System, so can be slow on some computers. Try using the Polynomial Command instead.

CAS Syntax

Simplify[<Function>]

Simplifies the terms of the given function, if possible. Undefined variables can be included in the terms.

Example: `Simplify[3 * x + 4 * x + a * x]` yields $xa + 7x$.

Note: See also Factor Command.

Text Commands

- ContinuedFraction
- FormulaText
- FractionText
- LetterToUnicode
- Ordinal
- RotateText
- StandardForm
- SurdText
- TableText
- Text
- TextToUnicode
- UnicodeToLetter
- UnicodeToText
- VerticalText

See also ABC Insert Text Tool.

FractionText Command

FractionText[<Number>]

Converts the number to a fraction, which is displayed as a (LaTeX) text object in the Graphics View.

Example: If *a: y = 1.5 x + 2* is a line, then `FractionText[Slope[a]]` gives you the fraction *3/2* as a text.

FractionText[<Point>]

Displays the coordinates of the point as fractions in the Graphics View.

Example: If *A=(1.33,0.8)* is a point, then `FractionText[A]` gives you the coordinates $\left(\frac{133}{100}, \frac{4}{5}\right)$as a text.

Note: See also SurdText command.

FormulaText Command

FormulaText[<Object>]

Returns the formula for the object as a LaTeX text.

Examples:

- Let $a = 2$ and $f(x) = a\ x^2$. `FormulaText[f]` returns $2\ x^2$ (as a LaTeX text).
- `LaTeX[$1]` returns the contents of the first row of the CAS View as a LaTeX text.

Note: By default, values are substituted for variables.

FormulaText[<Object>, <Boolean for Substitution of Variables>]

Returns the formula for the object as LaTeX text. The Boolean variable determines if values are substituted for variables (*true*) or if variable names are shown in the text (*false*).

Example:

Let $a = 2$ and $f(x) = a\ x^2$.

`FormulaText[f, true]` returns $2\ x^2$ (as a LaTeX text).

`FormulaText[f, false]` returns $a\ x^2$ (as a LaTeX text).

FormulaText[<Object>, <Boolean for Substitution of Variables>, <Boolean Show Name>]

Returns the formula for the object as LaTeX text. The first Boolean variable determines if values are substituted for variables (*true*) or if variable names are shown in the text (*false*), the second Boolean variable determines if the object name is shown in the text (*true*) or not (*false*).

Example:

Let $a = 2$ and $f(x) = a\ x^2$.

`FormulaText[f, true, true]` returns $f(x) = 2\ x^2$ (as a LaTeX text).

`FormulaText[f, false, false]` returns $a\ x^2$ (as a LaTeX text).

LetterToUnicode Command

LetterToUnicode["<Letter>"]

Turns a single letter into its Unicode number.

Example: `LetterToUnicode["a"]` returns the number 97.

Note: The letter needs to be in between a set of quotation marks.

Note: See also UnicodeToLetter Command and TextToUnicode Command.

Ordinal Command

Ordinal[<Integer>]

Turns a number into an ordinal (as a text).

Example: `Ordinal[5]` returns "5th".

RotateText Command

RotateText[<Text>, <Angle>]

Returns text rotated by given angle. LaTeX is used for rendering of the result.

Example:

```
RotateText["a = 5", 45°]
```

Notes: The text needs to be enclosed in double quotes ". The text is rotated around the top left corner (also known as corner 4) of the box containing the text. The angle is in radians unless you explicitly use the degree symbol °.

TableText Command

TableText[<List>, <List>, ...]

Creates a text that contains a table of the list objects.

Note: By default, each list is displayed in its own row of the table.

Examples: TableText[{x^2, 4}, {x^3, 8}, {x^4, 16}] creates a table as a text object with three rows and two columns. All items of the table are left aligned. TableText[Sequence[i^2, i, 1, 10]] creates a table as a text object with one row. All items of the table are left aligned.

TableText[<List>, <List>, ..., <Alignment of Text>]

Creates a text that contains a table of the list objects. The optional text “Alignment of text” controls the orientation and alignment of the table text.

Note: Possible values are "vl", "vc", "vr", "v", "h", "hl", "hc", "hr". Default is "hl"."v" = vertical, i. e. lists are columns "h" = horizontal, i. e. lists are rows "l" = left aligned "r" = right aligned "c" = centered

Examples: TableText[{1, 2, 3, 4}, {1, 4, 9, 16}, "v"] creates a text with two columns and four rows whose elements are left aligned. TableText[{1, 2, 3, 4}, {1, 4, 9, 16}, "h"] creates a text with two rows and four columns whose elements are left aligned. TableText[{11.2, 123.1, 32423.9, "234.0"}, "vr"] creates a text with one column whose elements are right aligned.

It's now possible to insert:

- different types of brackets, using the following symbols ||||, ||, {}, [] or ()
- line separators, using the symbol _
- column separators, using the symbol |
- different colourings

Examples: TableText[{1, 2}, {3, 4}, "c()"] creates the text \begin{pmatrix}{} 1 & 2 \\ 3 & 4 \\ \end{pmatrix} TableText[{1, 2}, {3, 4}, "c|_"] creates the text TableText[{1, 2}, {3, 4}, "||"] creates the text \begin{vmatrix}{} 1 & 2 \\ 3 & 4 \\ \end{vmatrix} TableText[{1, 2}, {3, 4}, "||||"] creates the text \begin{Vmatrix}{} 1 & 2 \\ 3 & 4 \\ \end{Vmatrix} TableText[{{"2x+3y=5","5x+8y=12"}},"{v"] creates the text \left\{\begin{matrix} 2x+3y=5\\ 5x+8y=12 \end{matrix}\right.TableText[{{1, 2, 3, 4}, {1, 2, 3, 4}, {1, 2, 3, 4}, {1, 2, 3, 4}, {1, 2, 3, 4}}, "-/|_v"] creates a table with border and no separation lines TableText[{{1, 2, 3, 4}, {1, 2, 3, 4}, {1, 2, 3, 4}, {1, 2, 3, 4}, {1, 2, 3, 4}}, "|11001 _110001 h"]creates a table with border and one separation line to the right of the first column and under the first row of contents. The value 1 in the syntax means that there is a separation line between the numbers and the value 0 means that there is no separation line or border. TableText[{{"\blue{0, 1, 2, 3, 4}", "\red{4, 3, 2, 1, 0}"}}, "v"] creates a table having the objects in the first row coloured in blue, the ones in the second row coloured in red.

Note: Clicking on a *TableText* object displays its style bar, which allows the user to customize the object's appearance, background and text colour, text and lines style.

Text Command

Text[<Object>]

Returns the formula for the object as a text object.

Note: By default, values are substituted for variables.

Example: If $a = 2$ and $c = a^2$, then `Text[c]` returns the text *"4"*.

Text[<Object>, <Boolean for Substitution of Variables>]

Returns the formula for the object as a text object. The Boolean variable determines if values are substituted for variables (*true*) or if variable names are shown in the text (*false*).

Example:

If $a = 2$ and $c = a^2$, then

- `Text[c, true]` returns the text *"4"* and
- `Text[c, false]` returns the text "a^2".

Text[<Object>, <Point>]

Returns the formula for the object as a text object at the position of the given point.

Example: `Text["hello", (2, 3)]` returns the text *hello* at the position *(2, 3)*.

Text[<Object>, <Point>, <Boolean for Substitution of Variables>]

Returns the formula for the object as a text object at the position of the given point. The Boolean variable determines if values are substituted for variables (*true*) or if variable names are shown in the text (*false*).

Example: If $a = 2$ and $c = a^2$, then `Text[c, (2, 1), true]` returns the text *"4"* at the position *(2, 1)*.

Text[<Object>, <Point>, <Boolean for Substitution of Variables>, <Boolean for LaTeX formula>]

Returns the formula for the object as a text object at the position of the given point. First Boolean variable determines if values are substituted for variables (*true*) or if variable names are shown in the text (*false*). If the second Boolean variable is *true*, the result is rendered using LaTeX.

Example: If $a = 2$ and $c = a^2$, then `Text[c, (2, 1), true, true]` returns the text *"4"* at the position *(2, 1)* using LaTeX.

Note: See also ABC Insert Text tool.

TextToUnicode Command

TextToUnicode["<Text>"]

Turns the text into a list of Unicode numbers, one for each character.

Examples: TextToUnicode["Some text"] gives you the list of Unicode numbers {83, 111, 109, 101, 32, 116, 101, 120, 116}.If text1 is "hello", then TextToUnicode[text1] gives you the list of Unicode numbers {104, 101, 108, 108, 111}.

Note: See also UnicodeToText Command and LetterToUnicode Command.

UnicodeToLetter Command

UnicodeToLetter[<Integer>]

Converts the integer Unicode number back into a letter which is displayed as a text object in the Graphics View.

Example: `UnicodeToLetter[97]` yields the text *"a"*.

Note: See also LetterToUnicode Command and UnicodeToText Command.

UnicodeToText Command

UnicodeToText[<List of Integers>]

Converts the integer Unicode numbers back into text.

Example: `UnicodeToText[{104, 101, 108, 108, 111}]` yields the text *"hello"*.

Note: See also TextToUnicode Command and UnicodeToLetter Command.

VerticalText Command

VerticalText[<Text>]

Returns text rotated by 90° counter-clockwise. LaTeX is used for rendering of the result.

VerticalText[<Text>, <Point>]

This allows the location of the Text to be specified.

Logic Commands

- CountIf
- If
- IsDefined
- IsInRegion
- IsInteger
- KeepIf
- Relation
- AreParallel
- AreEqual
- ArePerpendicular
- AreConcurrent
- AreConcyclic

CountIf Command

CountIf[<Condition>, <List>]

Counts the number of elements in the list satisfying the condition.

Example: CountIf[x < 3, {1, 2, 3, 4, 5}] gives you the number 2.CountIf[x < 3, A1:A10], where A1:A10 is a range of cells in the spreadsheet, counts all cells whose values are less than 3.

Note: For list of numbers arbitrary condition may be used. For list of other objects one can use only conditions of the form `x==constant` or `x!=constant`.

CountIf[<Condition>, <Variable>, <List>]

As above, using a more flexible syntax.

Example:

Given points *P*, *Q*, *R* `CountIf[x(A) < 3, A, {P, Q, R}]` will count only the points whose x-coordinate is less than *3*. The variable *A* is replaced in turn with *P* then *Q* then *R* for the check. Therefore `CountIf[x(A) < 3, A, {(0, 1), (4, 2), (2, 2)}]` yields the number *2*.

IsDefined Command

IsDefined[<Object>]

Returns *true* or *false* depending on whether the object is defined or not.

Example: `IsDefined[Circle[(1,1), -2]]` returns *false*.

If Command

If[<Condition>, <Then>]

Yields a copy of the object *Then* if the condition evaluates to *true*, and an undefined object if it evaluates to *false*.

Examples:

- Let $n = 3$. `If[n==3, x + y = 4]` yields line $x + y = 4$, because the condition on number n is met.
- Let $n = 4$. `If[n==3, x + y = 4]` creates an *undefined* object, because the condition on number n is not met .

If[<Condition>, <Then>, <Else>]

Yields a copy of object *Then* if the condition evaluates to *true*, and a copy of object *Else* if it evaluates to *false*. Both objects *must* be of the same type.

Example: Let n be a number. `If[n==3, x + y = 4, x - y = 4]` yields line $x + y = 4$ when $n = 3$, and line $x - y = 4$ for all n not equal to 3.

Conditional Functions

The *If* command can be used to create conditional functions. Such conditional functions may be used as arguments in any command that takes a function argument, such as Derivative, Integral, and Intersect.

Examples:

- `f(x) = If[x < 3, sin(x), x^2]` yields a piecewise function that equals *sin(x)* for $x < 3$ and x^2 for $x \geq 3$.
- `f(x) = If[0 <= x <= 3, sin(x)]` yields a function that equals *sin(x)* for x between 0 and 3 (and undefined otherwise).

Notes:

- Derivative of *If[condition, f(x), g(x)]* gives *If[condition, f'(x), g'(x)]*. It does not do any evaluation of limits at the critical points.
- See section: Boolean values for the symbols used in conditional statements.

If Command in Scripting

If command can be used in scripts to perform different actions under certain conditions.

Example: Let *n* be a number, and *A* a point. The command `If[Mod[n, 7] == 0, SetCoords[A, n, 0], SetCoords[A, n, 1]]` modifies the coordinates of point *A* according to the given condition. In this case it would be easier to use `SetCoords[A, n, If[Mod[n, 7] == 0,0,1]]`.

Note: Arguments of *If* must be Objects or Scripting Commands, not assignments. Syntax `b = If[a > 1, 2, 3]` is correct, but *b = 2* or *b = 3* would not be accepted as parameters of If.

IsInRegion Command

IsInRegion[<Point>, <Region>]

Returns *true* if the point is in given region and *false* otherwise.

Example: `IsInRegion[(1,2), Polygon[(0,0), (2,0), (1,3)]]` returns *true*.

IsInteger Command

IsInteger[<Number>]

Returns *true* or *false* depending whether the number is an integer or not.

Example: `IsInteger[972 / 9]` returns *true*.

KeepIf Command

KeepIf[<Condition>, <List>]

Creates a new list that only contains those elements of the initial list that fulfil the condition.

Example: `KeepIf[x<3, {1, 2, 3, 4, 1, 5, 6}]` returns the new list *{1, 2, 1}*.

Note: For list of numbers arbitrary condition may be used. For list of other objects one can use only conditions of the form `x==constant` or `x!=constant`.

KeepIf[<Condition>, <Variable>, <List>]

This syntax allows a more flexible condition.

Example: For Points *P, Q, R* `KeepIf[x(A) < 3, A, {P, Q, R}]` will filter the points whose *x*-coordinate is less than *3* out of the list. The variable *A* is replaced in turn with *P* then *Q* then *R* for the check.

Relation Command

Relation[<Object>, <Object>]

Shows a message box that gives you information about the relation between two objects.

This command allows you to find out whether

- two lines are perpendicular
- two lines are parallel
- two objects are equal
- a point lies on a line or conic
- a line is tangent or a passing line to a conic.

Note: See also Relation tool.

Functions & Calculus Commands

- Asymptote
- CompleteSquare
- Coefficients
- ComplexRoot
- Curvature
- CurvatureVector
- Curve
- Degree
- Denominator
- Derivative
- Extremum
- Factors
- Function
- ImplicitCurve
- InflectionPoint
- Integral
- IntegralBetween
- Intersect
- Iteration
- IterationList
- LeftSum
- Limit
- LimitAbove
- LimitBelow
- LowerSum
- Numerator
- OsculatingCircle
- PartialFractions
- PathParameter
- Polynomial
- RectangleSum

- Root
- RootList
- Roots
- SolveODE
- TaylorPolynomial
- TrapezoidalSum
- TrigCombine
- TrigExpand
- TrigSimplify
- UpperSum

Asymptote Command

Asymptote[<Conic>]

Yields both asymptotes of the conic.

Example: `Asymptote[x^2 - y^2 /4 = 1]` returns line *-2x + y = 0* and line *-2x - y = 0*.

Asymptote[<Function>]

GeoGebra will attempt to find the asymptotes of the function and return them in a list. It may not find them all, for example vertical asymptotes of non-rational functions such as ln(x).

Example: `Asymptote[(x^3 - 2x^2 - x + 4) / (2x^2 - 2)]` returns the list *{y = 0.5x - 1, x = 1, x = -1}*.

Asymptote[<Implicit Curve>]

Yields a list containing all the asymptotes of the Implicit Curve.

Example: `Asymptote[x^3 + y^3 + y^2 - 3 x = 0]` returns the list *{x + y = -0.33}*.

Coefficients Command

Coefficients[<Polynomial>]

Yields the list of all coefficients $a_k, a_{k-1}, \ldots, a_1, a_0$of the polynomial $a_k x^k + a_{k-1} x^{k-1} + \cdots + a_1 x + a_0$.

Example:

`Coefficients[x^3 - 3 x^2 + 3 x]` yields *{1, -3, 3, 0}*, the list of all coefficients of $x^3 - 3x^2 + 3x$.

Coefficients[<Conic>]

Returns the list of the coefficients *a*, *b*, *c*, *d*, *e*, *f* of a conic in standard form: $a \cdot x^2 + b \cdot y^2 + c + d \cdot x \cdot y + e \cdot x + f \cdot y = 0$

Note: For a line in implicit form *l*: *ax* + *by* + *c* = 0 it is possible to obtain the coefficients using the syntax *x*(*l*), *y*(*l*), *z*(*l*).Example: Given line: 3x + 2y - 2 = 0: x(line) returns 3, y(line) returns 2, and z(line) returns -2

CAS Syntax

Coefficients[<Polynomial>]

Yields the list of all coefficients of the polynomial in the main variable.

Example:

`Coefficients[x^3 - 3 x^2 + 3 x]` yields *{1, -3, 3, 0}*, the list of all coefficients of $x^3 - 3x^2 + 3x$.

Coefficients[<Polynomial>, <Variable>]

Yields the list of all coefficients of the polynomial in the given variable.

Example:

- `Coefficients[a^3 - 3 a^2 + 3 a, a]` yields *{1, -3, 3, 0}*, the list of all coefficients of $a^3 - 3a^2 + 3a$
- `Coefficients[a^3 - 3 a^2 + 3 a, x]` yields {a^3 - 3 a^2 + 3 *a*}.

CompleteSquare Command

CompleteSquare[<Quadratic Function>]

Returns the quadratic function in the form: $a(x-h)^2+k$.

Example:

`CompleteSquare[x^2 - 4x + 7]` yields *1 (x - 2)^2 + 3*.

CAS Syntax

CompleteSquare[<Quadratic Function>]

Returns the quadratic function in the form: $a(x-h)^2+k$.

Example:

`CompleteSquare[x^2 - 4x + 7]` yields *(x - 2)^2 + 3*.

ComplexRoot Command

ComplexRoot[<Polynomial>]

Finds the complex roots of a given polynomial in *x*. Points are created in Graphics View.

Example:

`ComplexRoot[x^2 + 4]` yields *(0 + 2 ί)* and *(0 - 2 ί)*

CAS Syntax

ComplexRoot[<Polynomial>]

Finds the complex roots of a given polynomial in *x*.

Example:

`ComplexRoot[x^2 + 4]` yields *{2 ί, - 2 ί}*

Note:

Use CSolve Command instead.

Curvature Command

Curvature[<Point>, <Function>]

Calculates the curvature of the function in the given point.

Example: `Curvature[(0 ,0), x^2]` yields *2*.

Curvature[<Point>, <Curve>]

Calculates the curvature of the curve in the given point.

Example: `Curvature[(0, 0), Curve[cos(t), sin(2t), t, 0, π]]` yields *0*.

CurvatureVector Command

CurvatureVector[<Point>, <Function>]

Yields the curvature vector of the function in the given point.

Example: `CurvatureVector[(0, 0), x^2]` yields vector *(0, 2)*.

CurvatureVector[<Point>, <Curve>]

Yields the curvature vector of the curve in the given point.

Example: `CurvatureVector[(0, 0), Curve[cos(t), sin(2t), t, 0, π]]` yields vector *(0, 0)*.

Curve Command

Curve[<Expression>, <Expression>, <Parameter Variable>, <Start Value>, <End Value>]

Yields the Cartesian parametric curve for the given *x*-expression (first <Expression>) and *y*-expression (second <Expression>) (using parameter variable) within the given interval [*Start Value*, *End Value*].

Example: `Curve[2 cos(t), 2 sin(t), t, 0, 2π]` creates a circle with radius *2* around the origin of the coordinate system.

Note:

- *End Value* must be greater than or equal to *Start Value* and both must be finite.
- *x* is not allowed as a parameter variable.

Note: See Curves for details, also see the Derivative Command and the Parametric Derivative Command.

Degree Command

Degree[<Polynomial>]

Gives the degree of a polynomial (in the main variable).

Example:

`Degree[x^4 + 2 x^2]` yields *4*

CAS Syntax

Degree[<Polynomial>]

Gives the degree of a polynomial (in the main variable or monomial).

Example:

- `Degree[x^4 + 2 x^2]` yields *4*
- `Degree[x^6 y^3 + 2 x^2 y^3]` yields *9*

Degree[<Polynomial>, <Variable>]

Gives the degree of a polynomial in the given variable.

Example:

- `Degree[x^4 y^3 + 2 x^2 y^3, x]` yields *4*
- `Degree[x^4 y^3 + 2 x^2 y^3, y]` yields *3*

Denominator Command

Denominator[<Function>]

Returns the denominator of a function.

Example:

`Denominator[5 / (x^2 + 2)]` yields $f(x)=(x^2 + 2)$.

Notes: For a fast numerical method (so long as the numbers aren't too big) you can use these in the Input Bar: CommonDenominator[a,a] for denominator and round(a*CommonDenominator[a,a]) for NumeratorSee also Numerator Command.

CAS Syntax

Denominator[<Expression>]

Returns the denominator of a rational number or expression.

Example:

`Denominator[2 / 3 + 1 / 15]` yields *15*.

Derivative Command

Derivative[<Function>]

Returns the derivative of the function with respect to the main variable.

Example: `Derivative[x^3 + x^2 + x]` yields *$3x^2 + 2x + 1$*.

Derivative[<Function>, <Number>]

Returns the *n*th derivative of the function with respect to the main variable.

Example: `Derivative[x^3 + x^2 + x, 2]` yields *$6x + 2$*.

Derivative[<Function>, <Variable>]

Returns the partial derivative of the function with respect to the given variable.

Example: `Derivative[x^3 y^2 + y^2 + xy, y]` yields *$2x^3y + x + 2y$*.

Derivative[<Function>, <Variable>, <Number>]

Returns the *n*th partial derivative of the function with respect to the given variable.

Example: `Derivative[x^3 + 3x y, x, 2]` yields *$6x$*.

Derivative[<Curve>]

Returns the derivative of the curve.

Example: `Derivative[Curve[cos(t), t sin(t), t, 0, π]]` yields curve *x = -sin(t), y = sin(t) + t cos(t).*

Note: It only works for parametric curves.

Derivative[<Curve>, <Number>]

Returns the *n*th derivative of the curve.

Example: `Derivative[Curve[cos(t), t sin(t), t, 0, π], 2]` yields curve *x = -cos(t), y = 2cos(t) - t sin(t).*

Note: It only works for parametric curves.

Note: You can use `f'(x)` instead of `Derivative[f]`, or `f''(x)` instead of `Derivative[f, 2]`, and so on.

CAS Syntax

Derivative[<Expression>]

Returns derivative of an expression with respect to the main variable.

Example: `Derivative[x^2]` yields *$2x$*.

Derivative[<Expression>, <Variable>]

Returns derivative of an expression with respect to the given variable.

Example: `Derivative[a x^3, a]` yields *x^3*.

Derivative[<Expression>, <Variable>, <Number>]

Returns the *n*th derivative of an expression with respect to the given variable.

Examples:

- `Derivative[y x^3, x, 2]` yields *$6xy$*.
- `Derivative[x³ + 3x y, x, 2]` yields *$6x$*.

Extremum Command

Extremum[<Polynomial>]

Yields all local extrema of the polynomial function as points on the function graph.

Example:

`Extremum[`$x^3 + 3x^2 - 2x + 1$`]` creates local extrema *(0.29, 0.70)* and *(-2.29, 9.30)* and shows them in the Graphics View.

Extremum[<Function>, <Start x-Value>, <End x-Value>]

Calculates (numerically) the extremum of the function in the open interval (<Start x-Value>, <End x-Value>).

Example:

`Extremum[(`$x^4 - 3x^3 - 4x^2 + 4$`) / 2, 0, 5]` creates local extremum *(2.93, -16.05)* in the given interval and shows it in the Graphics View.

Note: The function should be continuous in [<Start x-Value>, <End x-Value>], otherwise false extrema near discontinuity might be calculated.

Factors Command

Factors[<Polynomial>]

Gives a list of lists of the type *{factor, exponent}* such that the product of all these factors raised to the power of the corresponding exponents equals the given polynomial. The factors are sorted by degree in descending order.

Example:

`Factors[x^8 - 1]` yields *{{x^4 + 1, 1}, {x^2 + 1, 1}, {x + 1, 1}, {x - 1, 1}}*.

Note: Not all of the factors are irreducible over the reals.

Factors[<Number>]

Gives a list of lists of the type *{prime, exponent}* such that the product of all these primes raised to the power of the corresponding exponents equals the given number. The primes are sorted in ascending order.

Example:

- `Factors[1024]` yields *{{2, 10}}*, since $1024 = 2^{10}$.
- `Factors[42]` yields *{{2, 1}, {3, 1}, {7, 1}}*, since .

Note: See also PrimeFactors Command and Factor Command.

CAS Syntax

Factors[<Polynomial>]

Yields a matrix of the type *(factor, exponent)* such that the product of all these factors raised to the power of the corresponding exponents equals the given polynomial. The factors are sorted by degree in descending order.

Example: `Factors[x^8 - 1]` yields

Note: Not all of the factors are irreducible over the reals.

Factors[<Number>]

Yields a matrix of the type *{prime, exponent}* such that the product of all these primes raised to the power of the corresponding exponents equals the given number. The primes are sorted in ascending order.

Example:

- `Factors[1024]` yields , since $1024 = 2^{10}$.
- `Factors[42]` yields , since .

Note: See also PrimeFactors Command and Factor Command.

Function Command

Function[<List of Numbers>]

Yields the following function: The first two numbers determine the start *x*-value and the end *x*-value. The rest of the numbers are the *y*-values of the function in between in equal distances.

Example:

- `Function[{2, 4, 0, 1, 0, 1, 0}]` yields a triangular wave between *x = 2* and *x = 4*.
- `Function[{-3, 3, 0, 1, 2, 3, 4, 5}]` yields a linear equation with slope = *1* between *x = -3* and *x = 3*.

ImplicitCurve Command

ImplicitCurve[<List of Points>]

Creates implicit curve through given set of points. The length of the list must be $\frac{n(n+3)}{2}$for implicit curve of degree n.

ImplicitCurve[<f(x,y)>]

Creates the implicit curve f(x,y) = 0. Currently f(x,y) must be a polynomial in x and y.

Integral Command

Integral[<Function>]

Gives the indefinite integral with respect to the main variable.

Example:

`Integral[x^3]` yields $x^4 \cdot 0.25$.

Integral[<Function>, <Variable>]

Gives the partial integral with respect to the given variable.

Example: `Integral[x³+3x y, x]` gives $\frac{1}{4}x^4 + \frac{3}{2}x^2y$.

Integral[<Function>, <Start x-Value>, <End x-Value>]

Gives the definite integral over the interval *[Start x-Value , End x-Value]* with respect to the main variable.

Note: This command also shadows the area between the function graph of *f* and the *x*-axis.

Integral[<Function>, <Start x-Value>, <End x-Value>, <Boolean Evaluate>]

Gives the definite integral of the function over the interval *[Start x-Value , End x-Value]* with respect to the main variable and shadows the related area if *Evaluate* is *true*. In case *Evaluate* is *false* the related area is shaded but the integral value is not calculated.

CAS Syntax

Integral[<Function>]

Gives the indefinite integral with respect to the main variable.

Example:

`Integral[cos(x)]` yields $sin(x) + c_1$.

Integral[<Function>, <Variable>]

Gives the indefinite integral with respect to the given variable.

Example:

`Integral[cos(a t), t]` yields $\frac{sin(at)}{a} + c_1$.

Integral[<Function>, <Start x-Value>, <End x-Value>]

Gives the definite integral over the interval *[Start x-Value , End x-Value]* with respect to the main variable.

Example:

`Integral[cos(x), a, b]` yields $sin(b) - sin(a)$.

Integral[<Function>, <Variable>, <Start x-Value>, <End x-Value>]

Gives the definite integral over the interval *[Start x-Value , End x-Value]* with respect to the given variable.

Example:

`Integral[cos(t), t, a, b]` yields $sin(b) - sin(a)$.

IntegralBetween Command

IntegralBetween[<Function>, <Function>, <Number>, <Number>]

Gives the definite integral of the difference *f(x) - g(x)* of two function *f* and *g* over the interval *[a, b]*, where *a* is the first number and *b* the second, with respect to the main variable.

Note: This command also shades the area between the function graphs of *f* and *g*.

IntegralBetween[<Function>, <Function>, <Number>, <Number>, <Boolean Evaluate>]

Gives the definite integral of the difference *f(x) - g(x)* of two function *f* and *g* over the interval *[a, b]*, where *a* is the first number and *b* the second, with respect to the main variable and shadows the related area if *Evaluate* is *true*. In case *Evaluate* is *false* the related area is shaded but the integral value is not calculated.

CAS Syntax

IntegralBetween[<Function>, <Function>, <Number>, <Number>]

Gives the definite integral of the difference *f(x) - g(x)* of two function *f* and *g* over the interval *[a, b]*, where *a* is the first number and *b* the second, with respect to the main variable.

Example:

`IntegralBetween[sin(x), cos(x), π / 4, π * 5 / 4]` yields $2\sqrt{2}$.

IntegralBetween[<Function>, <Function>, <Variable>, <Number>, <Number>]

Gives the definite integral of a variable of the difference *f(x) - g(x)* of two function *f* and *g* over the interval *[a, b]*, where *a* is the first number and *b* the second, with respect to the given variable.

Example:

`IntegralBetween[a * sin(t), a * cos(t), t, π / 4, π * 5 / 4]` yields $2\sqrt{2}a$.

Intersect Command

Intersect[<Object>, <Object>]

Yields the intersection points of two objects.

Example:

- Let `a: -3x + 7y = -10` be a line and `c: x^2 + 2y^2 = 8` be an ellipse. `Intersect[a, c]` yields the intersection points *E* = (-1.02, -1,87) and *F* = (2.81, -0.22) of the line and the ellipse.
- `Intersect[y = x + 3, Curve[t, 2t, t, 0, 10]]` yields *A*=(3,6).
- `Intersect[Curve[2s, 5s, s,-10, 10 ], Curve[t, 2t, t, -10, 10]]` yields *A*=(0,0).

Intersect[<Object>, <Object>, <Index of Intersection Point>]

Yields the nth intersection point of two objects.

Example:

Let `a(x) = x^3 + x^2 - x` be a function and `b: -3x + 5y = 4` be a line. `Intersect[a, b, 2]` yields the intersection point *C* = (-0.43, 0.54) of the function and the line.

Intersect[<Object>, <Object>, <Initial Point>]

Yields an intersection point of two objects by using a (numerical) iterative method with initial point.

Example:

Let `a(x) = x^3 + x^2 - x` be a function, `b: -3x + 5y = 4` be a line, and *C* = (0, 0.8) be the initial point. `Intersect[a, b, C]` yields the intersection point *D* = (-0.43, 0.54) of the function and the line by using a (numerical) iterative method.

Intersect[<Function>, <Function>, <Start x-Value>, <End x-Value>]

Yields the intersection points numerically for the two functions in the given interval.

Example:

Let `f(x) = x^3 + x^2 - x` and `g(x) = 4 / 5 + 3 / 5 x` be two functions. `Intersect[ f, g, -1, 2 ]` yields the intersection points *A* = (-0.43, 0.54) and *B* = (1.1, 1.46) of the two functions in the interval [-1, 2].

Intersect[<Curve 1>, <Curve 2>, <Parameter 1>, <Parameter 2>]

Finds one intersection point using an iterative method starting at the given parameters.

Example:

Let `a = Curve[cos(t), sin(t), t, 0, π]` and `b = Curve[cos(t) + 1, sin(t), t, 0, π]`.
`Intersect[a, b, 0, 2]` yields the intersection point *A = (0.5, 0.87).*

CAS Syntax

Intersect[<Function>, <Function>]

Yields a list containing the intersection points of two objects.

Example:

Let `f(x):= x^3 + x^2 - x` and `g(x):= x` be two functions. `Intersect[ f(x), g(x) ]` yields the intersection points list: *{(1, 1), (0, 0), (-2, -2)}* of the two functions.

Note: See also Intersect tool.

Intersect[<Object>, <Object>]

Example:

- `Intersect[ <Line> , <Object> ]` creates the intersection point(s) of a line and a plane, segment, polygon, conic, etc.
- `Intersect[ <Plane> , <Object> ]` creates the intersection point(s) of a plane and segment, polygon, conic, etc.
- `Intersect[ <Conic>, <Conic> ]` creates the intersection point(s) of two conics
- `Intersect[ <Plane>, <Plane> ]` creates the intersection line of two planes
- `Intersect[ <Plane>, <Polyhedron> ]` creates the polygon(s) intersection of a plane and a polyhedron.
- `Intersect[ <Sphere>, <Sphere> ]` creates the circle intersection of two spheres
- `Intersect[ <Plane>, <Quadric> ]` creates the conic intersection of the plane and the quadric (sphere, cone, cylinder, ...)

Note: See also IntersectConic and IntersectPath commands.

Iteration Command

Iteration[<Function>, <Start Value>, <Number of Iterations>]

Iterates the function *n* times using the given start value.

Example:

After defining `f(x) = x^2` the command `Iteration[f, 3, 2]` gives you the result $(3^2)^2 = 81$.

Example: repeated addition

To obtain the repeated addition of 7 to the number 3:

Let `g(x) = x + 7`, then `Iteration[g, 3, 4]` yields $(((3+7) +7) +7) +7 = 31$.

IterationList Command

IterationList[<Function>, <Start Value>, <Number of Iterations n>]

Gives you a list of length *n+1* whose elements are iterations of the function starting with the start value.

Example: After defining `f(x) = x^2` the command `IterationList[f, 3, 2]` gives you the list *{3, 9, 81}*.

Note: See also Iteration_Command.

LeftSum Command

LeftSum[<Function>, <Start x-Value>, <End x-Value>, <Number of Rectangles>]

Calculates the left sum of the function in the interval using *n* rectangles.

Example: `LeftSum[x^2 + 1, 0, 2, 4]` yields *a* = 3.75

Notes: This command draws the rectangles of the left sum as well. See also the commands: RectangleSum CommandRectangleSum, TrapezoidalSum CommandTrapezoidalSum, LowerSum CommandLowerSum and UpperSum CommandUpperSum

Limit Command

Limit[<Function>, <Value>]

Computes the limit of the function for the given value of the main function variable.

Example:

`Limit[(x^2 + x) / x^2, +∞]` yields *1*.

Note: Not all limits can be calculated by GeoGebra, so *undefined* will be returned in those cases (as well as when the correct result is undefined).

CAS Syntax

Limit[<Expression>, <Value>]

Computes the limit of the expression for the given value of the main function variable.

Example:

`Limit[a sin(x) / x, 0]` yields *a*.

Limit[<Expression>, <Variable>, <Value>]

Computes the limit of the expression for the given value of the given function variable.

Example:

`Limit[a sin(v) / v, v, 0]` yields *a*.

Note:

- Not all limits can be calculated by GeoGebra, so *?* will be returned in those cases (as well as when the correct result is undefined).
- If you want the limit of a piecewise-defined function you need to use LimitAbove or LimitBelow, for example `LimitAbove[If[x>1, x^2, -2x], 1]`

- See also Asymptote Command, LimitAbove Command and LimitBelow Command.

LimitAbove Command

LimitAbove[<Function>, <Value>]

Computes the right one-sided limit of the function for the given value of the main function variable.

Example:

`LimitAbove[1 / x, 0]` yields ∞.

Note: Not all limits can be calculated by GeoGebra, so *undefined* will be returned in those cases (as well as when the correct result is undefined).

CAS Syntax

LimitAbove[<Expression>, <Value>]

Computes the right one-sided limit of the function for the given value of the main function variable.

Example:

`LimitAbove[1 / x, 0]` yields ∞.

LimitAbove[<Expression>, <Variable>, <Value>]

Computes the right one-sided limit of the multivariate function for the given value of the given function variable.

Example:

`LimitAbove[1 / a, a, 0]` yields ∞.

Note: Not all limits can be calculated by GeoGebra, so *?* will be returned in those cases (as well as when the correct result is undefined).

Note: See also Limit Command and LimitBelow Command.

LimitBelow Command

LimitBelow[<Function>, <Value>]

Computes the left one-sided limit of the function for the given value of the main function variable.

Example:

`LimitBelow[1 / x, 0]` yields $-\infty$.

Note: Not all limits can be calculated by GeoGebra, so *undefined* will be returned in those cases (as well as when the correct result is undefined).

CAS Syntax

LimitBelow[<Expression>, <Value>]

Computes the left one-sided limit of the function for the given value of the main function variable.

Example:

`LimitBelow[1 / x, 0]` yields $-\infty$.

LimitBelow[<Expression>, <Variable>, <Value>]

Computes the left one-sided limit of the multivariate function for the given value of the given function variable.

Example:

`LimitBelow[1 / a, a, 0]` yields $-\infty$.

Note: Not all limits can be calculated by GeoGebra, so *?* will be returned in those cases (as well as when the correct result is undefined).

Note: See also Limit Command and LimitAbove Command.

LowerSum Command

LowerSum[<Function>, <Start x-Value>, <End x-Value>, <Number of Rectangles>]

Calculates the *lower sum* of the given function on the interval [*Start x-Value, End x-Value*], using *n* rectangles.

Example: `LowerSum[x^2, -2, 4, 6]` yields *15*.

Note: This command draws the rectangles for the lower sum as well.See also the commands: UpperSum CommandUpperSum, LeftSum CommandLeftSum, RectangleSum CommandRectangleSum, and TrapezoidalSum CommandTrapezoidalSum.

Numerator Command

Numerator[<Function>]

Returns the numerator of the function.

Example:

`Numerator[(3x² + 1) / (2x - 1)]` yields $f(x) = 3x^2 + 1$.

Notes: For a fast numerical method (so long as the numbers aren't too big) you can use these in the Input Bar: CommonDenominator[a,a] for denominator and round(a*CommonDenominator[a,a]) for NumeratorSee also Denominator Command.

CAS Syntax

Numerator[<Expression>]

Returns the numerator of a rational number or expression.

Examples:

- `Numerator[2/3 + 1/15]` yields *11*.
- If variables *a, b* and *c* haven't been previously defined in GeoGebra, then `Numerator[a/b]` yields *a* and `Numerator[a + b/c]` yields $a\,c + b$

OsculatingCircle Command

OsculatingCircle[<Point>, <Function>]

Yields the osculating circle of the function in the given point.

Example: `OsculatingCircle[(0, 0), x^2]` yields $x^2 + y^2 - y = 0$.

OsculatingCircle[<Point>, <Curve>]

Yields the osculating circle of the curve in the given point.

Example: `OsculatingCircle[(1, 0), Curve[cos(t), sin(2t), t, 0, 2π]]` yields $x^2 + y^2 + 6x = 7$.

PartialFractions Command

PartialFractions[<Function>]

Yields, if possible, the partial fraction of the given function for the main function variable. The graph of the function is plotted in Graphics View.

Example:

`PartialFractions[x^2 / (x^2 - 2x + 1)]` yields $1 + \frac{2}{x - 1} +$.

CAS Syntax

PartialFractions[<Function>]

Yields, if possible, the partial fraction of the given function for the main function variable.

Example:

`PartialFractions[x^2 / (x^2 - 2 x + 1)]` yields $1 + \frac{2}{x - 1} +$.

PartialFractions[<Function>, <Variable>]

Yields, if possible, the partial fraction of the given function for the given function variable.

Example:

`PartialFractions[a^2 / (a^2 - 2a + 1), a]` yields $1 + \frac{2}{a - 1} +$.

PathParameter Command

PathParameter[<Point On Path>]

Returns the parameter (i.e. a number ranging from *0* to *1*) of the point that belongs to a path.

Example:

Let `f(x) = x² + x - 1` and `A = (1, 1)` is a point on the function.
`PathParameter[A]` yields $a = 0.47$.

Polynomial Command

Polynomial[<Function>]

Yields the expanded polynomial function.

Example: `Polynomial[(x - 3)^2]` yields $x^2 - 6x + 9$.

Polynomial[<List of Points>]

Creates the interpolation polynomial of degree *n-1* through the given *n* points.

Example: `Polynomial[{(1, 1), (2, 3), (3, 6)}]` yields $0.5\, x^2 + 0.5\, x$.

CAS Syntax

Polynomial[<Function>]

Expands the function and writes it as a polynomial in x (grouping the coefficients).

Example: `Polynomial[(x - 3)^2 + (a + x)^2]` yields $2\, x^2 + (2a - 6)\, x + a^2 + 9$.

Polynomial[<Function>, <Variable>]

Expands the function and writes it as a polynomial in the variable (grouping the coefficients).

Example: `Polynomial[(x - 3)^2 + (a + x)^2, a]` yields $a^2 + 2\, x\, a + 2\, x^2 - 6\, x + 9$.

RectangleSum Command

RectangleSum[<Function>, <Start x-Value>, <End x-Value>, <Number of Rectangles>, <Position for rectangle start>]

Calculates the sum of rectangles with left height starting at a fraction *d* (0 ≤ *d* ≤ 1) of each interval, using *n* rectangles.

When *d* = 0 it is equivalent to the LeftSum command, and when *d* = 1 it computes the right sum of the given function.

Note: This command draws the rectangles of the left sum as well.See also the commands: UpperSum CommandUpperSum, LowerSum CommandLowerSum, LeftSum CommandLeftSum , TrapezoidalSum CommandTrapezoidalSum

Root Command

Root[<Polynomial>]

Yields all roots of the polynomial as intersection points of the function graph and the *x*-axis.

Example:

`Root[0.1*x^2 - 1.5*x + 5 ]` yields *A = (5, 0)* and *B = (10, 0)*.

Root[<Function>, <Initial x-Value>]

Yields one root of the function using the initial value *a* for a numerical iterative method.

Example:

`Root[0.1*x^2 - 1.5*x + 5, 6 ]` yields *A = (5, 0)*.

Root[<Function>, <Start x-Value>, <End x-Value>]

Let *a* be the *Start x-Value* and *b* the *End x-Value* . This command yields one root of the function in the interval [*a, b*] using a numerical iterative method.

Example:

`Root[0.1x² - 1.5x + 5, 8, 13]` yields *A = (10, 0)*.

CAS Syntax

Root[<Polynomial>]

Yields all roots of the polynomial as intersection points of the function graph and the *x*-axis.

Example:

`Root[x^3 - 3 * x^2 - 4 * x + 12]` yields *{x = 3, x = 2, x = -2}*.

Note:

In the CAS View, this command is only a special variant of Solve Command.

RootList Command

RootList[<List>]

Converts a given list of numbers $\{a_1,a_2,...,a_n\}$ to a list of points $\{(a_1,0),(a_2,0),...,(a_n,0)\}$.

Example:

Command `RootList[{3, 4, 5, 2, 1, 3}]` returns the list of points `list1={(3,0), (4,0), (5,0), (2,0), (1,0), (3,0)}`

Roots Command

Roots[<Function>, <Start x-Value>, <End x-Value>]

Calculates the roots for function in the given interval. The function must be continuous on that interval. Because this algorithm is numeric, it may not find all the roots in some cases.

Example:

`Roots[f, -2, 1]` with the function `f(x) = 3x³ + 3x² - x` yields `A = (-1.264, 0), B = (0, 0), C = (0.264, 0)`

Note: See also Root command

SolveODE Command

SolveODE[<f'(x, y)>]

Attempts to find the exact solution of the first order ordinary differential equation (ODE) $\frac{dy}{dx}(x) = f(x, y(x))$.

Example:

`SolveODE[2x / y]` yields $-2x^2 + y^2 = 0$.

SolveODE[<f'(x, y)>, <Point on f>]

Attempts to find the exact solution of the first order ODE $\frac{dy}{dx}(x) = f(x, y(x))$and use the solution which goes through the given point.

Example:

`SolveODE[y / x, (1, 2)]` yields $y = 2x$.

SolveODE[<f'(x, y)>, <Start x>, <Start y>, <End x>, <Step>]

Solves first order ODE $\frac{dy}{dx} = f(x, y)$numerically with given start point, end and step for x.

Example:

`SolveODE[-x*y, x(A), y(A), 5, 0.1]` solves $\frac{dy}{dx} = -xy$using previously defined A as a starting point.

Note: Length CommandLength[<Locus>] allows you to find out how many points are in the computed locus. First CommandFirst[<Locus>, <Number>] allows you to extract the points as a list. To find the "reverse" solution, just enter a negative value for End x, for example SolveODE[-x*y, x(A), y(A), -5, 0.1]

SolveODE[<y'>, <x'>, <Start x>, <Start y>, <End t>, <Step>]

Solves first order ODE $\frac{dy}{dx}=\frac{f(x,y)}{g(x,y)}$ with given start point, maximal value of an internal parameter *t* and step for *t*. This version of the command may work where the first one fails e.g. when the solution curve has vertical points.

Example:

`SolveODE[-x, y, x(A), y(A), 5, 0.1]` solves $\frac{dy}{dx}=-\frac{x}{y}$ using previously defined *A* as a starting point.

Note: To find the "reverse" solution, just enter a negative value for *End t*, for example `SolveODE[-x, y, x(A), y(A), -5, 0.1]`.

SolveODE[<b(x)>, <c(x)>, <f(x)>, <Start x>, <Start y>, <Start y'>, <End x>, <Step>]

Solves second order ODE $y''+b(x)y'+c(x)y=f(x)$.

Example:

`SolveODE[x^2, 2x, 2x^2 + x, x(A), y(A), 0, 5, 0.1]` solves the second order ODE using previously defined *A* as a starting point.

Note: Always returns the result as locus. The algorithms are currently based on Runge-Kutta numeric methods.

Note: See also SlopeField command.

CAS Syntax

SolveODE[<Equation>]

Attempts to find the exact solution of the first or second order ODE. For first and second derivative of *y* you can use *y'* and *y''* respectively.

Example:

`SolveODE[y' = y / x]` yields $y = c_1 x$.

SolveODE[<Equation>, <Point(s) on f>]

Attempts to find the exact solution of the given first or second order ODE which goes through the given point(s).

Example:

`SolveODE[y' = y / x, (1, 2)]` yields *y = 2x*.

SolveODE[<Equation>, <Point(s) on f>, <Point(s) on f'>]

Attempts to find the exact solution of the given first or second order ODE and goes through the given *point(s) on f* and *f'* goes through the given *point(s) on f'* .

Example:

`SolveODE[y'' - 3y' + 2 = x, (2, 3), (1, 2)]` yields $y=\frac{-9x^2e^3+30xe^3-32(e^3)^2+138e^3+32e^{3x}}{54e^3}$.

SolveODE[<Equation>, <Dependent Variable>, <Independent Variable>, <Point(s) on f>]

Attempts to find the exact solution of the given first or second order ODE which goes through the given point(s).

Example:

`SolveODE[v' = v / w, v, w, (1, 2)]` yields *v = 2w*.

SolveODE[<Equation>, <Dependent Variable>, <Independent Variable>, <Point(s) on f>, <Point(s) on f'>]

Attempts to find the exact solution of the given first or second order ODE which goes through the given *point(s) on f* and *f'* goes through the given *point(s) on f'* .

Example:

`SolveODE[v' = v / w, v, w, (1, 2), (0, 2)]` yields *v = 2w*.

Note: For compatibility with input bar, if the first parameter is just an expression without *y'* or *y''*, it is supposed to be right hand side of ODE with left hand side *y'*.

TaylorPolynomial Command

TaylorPolynomial[<Function>, <x-Value>, <Order Number>]

Creates the power series expansion for the given function at the point *x-Value* to the given order.

Example:

`TaylorPolynomial[x^2, 3, 1]` gives *9 + 6 (x - 3)*, the power series expansion of x^2 at *x = 3* to order *1*.

CAS Syntax

TaylorPolynomial[<Expression>, <x-Value>, <Order Number>]

Creates the power series expansion for the given expression at the point *x-Value* to the given order.

Example:

`TaylorPolynomial[x^2, a, 1]` gives $a^2 + 2a (x - a)$, the power series expansion of x^2 at *x = a* to order *1*.

TaylorPolynomial[<Expression>, <Variable>, <Variable Value>, <Order Number>]

Creates the power series expansion for the given expression with respect to the given variable at the point *Variable Value* to the given order.

Examples:

- `TaylorPolynomial[x^3 sin(y), x, 3, 2]` gives $27 \sin(y) + 27 \sin(y) (x - 3) + 9 \sin(y) (x - 3)^2$, the power series expansion with respect to *x* of $x^3 \sin(y)$ at *x = 3* to order *2*.
- `TaylorPolynomial[x^3 sin(y), y, 3, 2]` gives $\sin(3) x^3 + \cos(3) x^3 (y - 3) - (y - 3)^2$, the power series expansion with respect to *y* of $x^3 \sin(y)$ at *y = 3* to order *2*.

Note: The order has got to be an integer greater or equal to zero.

TrapezoidalSum Command

TrapezoidalSum[<Function>, <Start x-Value>, <End x-Value>, <Number of Trapezoids>]

Calculates the trapezoidal sum of the function in the interval [*Start x-Value, End x-Value*] using *n* trapezoids.

Example:

`TrapezoidalSum[x^2, -2, 3, 5]` yields *12.5*.

Notes: This command draws the trapezoids of the trapezoidal sum as well. See also the commands: LowerSum CommandLowerSum, LeftSum CommandLeftSum, RectangleSum CommandRectangleSum and UpperSum CommandUpperSum.

InflectionPoint Command

InflectionPoint[<Polynomial>]

Yields all inflection points of the polynomial as points on the function graph.

Example:

`InflectionPoint[x^3]` yields *(0, 0)*.

UpperSum Command

UpperSum[<Function>, <Start x-Value>, <End x-Value>, <Number of Rectangles>]

Calculates the *upper sum* of the function on the interval [*Start x-Value, End x-Value*] using *n* rectangles.

Example: `UpperSum[x^2, -2, 4, 6]` yields *35*.

Notes: This command draws the rectangles of the upper sum as well.See also the commands: LowerSum CommandLowerSum, LeftSum CommandLeftSum, RectangleSum CommandRectangleSum, and TrapezoidalSum CommandTrapezoidalSum

Conic Commands

- Asymptote
- Axes
- Center
- Circle
- Conic
- ConjugateDiameter
- Directrix
- Eccentricity
- Ellipse
- Focus
- Hyperbola
- LinearEccentricity
- MajorAxis
- MinorAxis
- Parabola
- Parameter
- Polar
- Semicircle
- SemiMajorAxisLength
- SemiMinorAxisLength

See also Conic section tools.

Asymptote Command

Asymptote[<Conic>]

Yields both asymptotes of the conic.

Example: `Asymptote[x^2 - y^2 /4 = 1]` returns line *-2x + y = 0* and line *-2x - y = 0*.

Asymptote[<Function>]

GeoGebra will attempt to find the asymptotes of the function and return them in a list. It may not find them all, for example vertical asymptotes of non-rational functions such as ln(x).

Example: `Asymptote[(x^3 - 2x^2 - x + 4) / (2x^2 - 2)]` returns the list *{y = 0.5x - 1, x = 1, x = -1}*.

Asymptote[<Implicit Curve>]

Yields a list containing all the asymptotes of the Implicit Curve.

Example: `Asymptote[x^3 + y^3 + y^2 - 3 x = 0]` returns the list *{x + y = -0.33}*.

Axes Command

Axes[<Conic>]

Returns the equations of the major and minor axes of a conic section.

Note: See also MajorAxis and MinorAxis commands.

Axes[<Quadric>]

Creates the 3 axes of the given quadric.

Example:

`Axes[x^2 + y^2 = 3]` returns the three lines

a: $X = (0, 0, 0) + \lambda\ (1, 0, 0)$, b: $X = (0, 0, 0) + \lambda\ (0, 1, 0)$ and c: $X = (0, 0, 0) + \lambda\ (0, 0, 1)$

Notes: Specifically:if the given quadric is a cylinder, the command yields the two axes of the bottom circle and the rotation axisif the given quadric is a sphere, the command yields the three axes parallel to the coordinate system axes.

Center Command

Center[<Conic>]

Returns the center of a circle, ellipse, or hyperbola.

Example: `Center[x^2 + 4 y^2 + 2x - 8y + 1 = 0]`
(🇬🇧, 🇦🇺: `Centre[x^2 + 4 y^2 + 2x - 8y + 1 = 0]`)
returns point *A = (-1, 1)*

Note: See also Midpoint or Center (🇬🇧, 🇦🇺: Midpoint or Centre) tool .

Center[<Quadric>]

Creates the center of a quadric (e.g. sphere, cone, etc.).

Example:

`Center[x^2 + (y-1)^2 + (z-2)^2 = 1]` yields *(0, 1, 2)*

Circle Command

Circle[<Point>, <Radius Number>]

Yields a circle with given center and radius.

Circle[<Point>, <Segment>]

Yields a circle with given center and radius equal to the length of the given segment.

Circle[<Point>, <Point>]

Yields a circle with given center through a given point.

Circle[<Point>, <Point>, <Point>]

Yields a circle through the three given points (if they do not lie on the same line).

Note: See also Compass, Circle with Center through Point, Circle with Center and Radius, and Circle through 3 Points tools.

Circle[<Line>, <Point>]

Creates a circle with line as axis and through the point.

Circle[<Point>, <Radius>, <Direction>]

Creates a circle with center, radius, and axis parallel to direction, which can be a line, vector or plane.

Example:

`Circle[ <Point>, <Radius>, <Plane> ]` yields a circle parallel to the plane and with perpendicular vector of the plane as axis.

Circle[<Point>, <Point>, <Direction>]

Creates a circle with center, through a point, and axis parallel to direction.

Conic Command

Conic[<Point>, <Point>, <Point>, <Point>, <Point>]

Returns a conic section through the five given points.

Example: `Conic[(0, -4), (2, 4), (3,1), (-2,3), (-3,-1)]` yields $151x^2 - 37x\,y + 72y^2 + 14x - 42y = 1320$.

Note: If four of the points lie on one line the conic section is not defined.

Conic[<Number a>, <Number b>, <Number c>, <Number d>, <Number e>, <Number f>]

Returns a conic section $a \cdot x^2 + d \cdot xy + b \cdot y^2 + e \cdot x + f \cdot y = -c$.

Example: `Conic[2, 3, -1, 4, 2, -3]` yields $2x^2 + 4x\,y + 3y^2 + 2x - 3y = 1$.

Note: See also Conic through 5 Points tool and Coefficients command.

ConjugateDiameter Command

ConjugateDiameter[<Line>, <Conic>]

Returns the diameter of the conic section being its conjugate diameter parallel to the line.

Example: `ConjugateDiameter[-4x + 5y = -2, x^2 + 4 y^2 + 2x - 8y + 1 = 0]` yields line $5x + 16y = 11$

ConjugateDiameter[<Vector>, <Conic>]

Returns the conjugate diameter of the diameter that is parallel to the vector (relative to the conic section).

Example: Let $u = (4,1)$ be a vector. Then `ConjugateDiameter[u, x^2 + 4 y^2 + 2x - 8y + 1 = 0]` yields line $x + y = 0$

Directrix Command

Directrix[<Conic>]

Yields the directrix of the conic.

Example: `Directrix[x^2 - 3x + 3y = 9]` yields the line $y = 4.5$

Note: See also the Focus command.

Eccentricity Command

Eccentricity[<Conic>]

Calculates the eccentricity of the conic section.

Example: `Eccentricity[x^2/9 + y^2/4 = 1]` returns $a = 0.75$

Ellipse Command

Ellipse[<Focus>, <Focus>, <Semimajor Axis Length>]

Creates an ellipse with two focal points and semimajor axis length.

Example: `Ellipse[(0, 1), (1, 1), 1]` yields $12x^2 + 16y^2 - 12x - 32y = -7$.

Note: If the condition: *2*semimajor axis length > Distance between the focus points* isn't met, you will get an hyperbola.

Ellipse[<Focus>, <Focus>, <Segment>]

Creates an ellipse with two focal points, where the length of the semimajor axis equals the length of the given segment.

Example: Let *s = Segment[(0,1), (2,1)]* : `Ellipse[(0, 1), (2, 1), s]` yields $3x^2 + 4y^2 - 6x - 8y = 5$.

Ellipse[<Focus>, <Focus>, <Point>]

Creates an ellipse with two focal points passing through a given point.

Example: `Ellipse[(0, 1), (2, 1), (1,2)]` yields $1x^2 + 2y^2 - 2x - 4y = -1$.

Note: See also Ellipse tool .

LinearEccentricity Command

LinearEccentricity[<Conic>]

Calculates the linear eccentricity of the conic section, i.e. the distance between the conic center and its focus (or one of its two foci).

Example: `LinearEccentricity[4x^2 - y^2 + 16x + 20 = 0]` returns 2.24

MajorAxis Command

MajorAxis[<Conic>]

Returns the equation of the major axis of the conic section.

Example: `MajorAxis[x^2 / 9 + y^2 / 4 = 1]` returns $y = 0$

Note: See also MinorAxis command.

SemiMajorAxisLength Command

SemiMajorAxisLength[<Conic>]

Returns the length of the semimajor axis (half of the major axis) of the conic section.

Example:

`SemiMajorAxisLength[(x - 1)^2 + (y - 2)^2 = 4]` yields *2*.

Note: See also SemiMinorAxisLength command.

Focus Command

Focus[<Conic>]

Yields (all) foci of the conic section.

Example: `Focus[4x^2 - y^2 + 16x + 20 = 0]` returns the two foci of the given hyperbola: *A*=(-2, -2.24) and *B*=(-2, 2.24).

Note: See also the Directrix command.

Hyperbola Command

Hyperbola[<Focus>, <Focus>, <Semimajor Axis Length>]

Creates a hyperbola with given focus points and semimajor axis length.

Example: `Hyperbola[(0, -4), (2, 4), 1]` yields $-8xy - 15y^2 + 8y = -16$.

Note: If the condition: *0 < 2*semimajor axis length < Distance between the focus points* isn't met, you will get an ellipse.

Hyperbola[<Focus>, <Focus>, <Segment>]

Creates a hyperbola with given focus points where the length of the semimajor axis equals the length of the segment.

Example: Let a = Segment[(0,1), (2,1)]. `Hyperbola[(4, 1), (-2, 1), a]` yields $-5x^2 + 4y^2 + 10x - 8y = -19$.

Hyperbola[<Focus>, <Focus>, <Point>]

Creates a hyperbola with given focus points passing through a given point.

Example: `Hyperbola[(1, 1), (2, 1), (-2,-4)]` yields $-2.69x^2 + 1.30y^2 + 8.07x - 2.62y = 4.52$.

Note: See also Hyperbola tool .

Incircle Command

Incircle[<Point>, <Point>, <Point>]

Returns Incircle of the triangle formed by the three Points.

Parabola Command

Parabola[<Point>, <Line>]

Returns a parabola with focal point *F* and directrix *g*.

Example: Let a = Line[(0,1), (2,1)]. `Parabola[(3, 3), a]` yields $x^2 - 6x - 4y = -17$.

Note: See also Parabola tool .

Parameter Command

Parameter[<Parabola>]

Returns the parameter of the parabola, which is the distance between the directrix and the focus.

Example: `Parameter[y = x^2 - 3x + 5]` returns 0.5

Polar Command

Polar[<Point>, <Conic>]

Creates the polar line of the given point relative to the conic section.

Example: `Polar[(0,2), y = x^2 - 3x + 5]` creates the line $1.5x + 0.5y = 4$

Note: See also Polar or Diameter Line tool.

MinorAxis Command

MinorAxis[<Conic>]

Returns the equation of the minor axis of the conic section.

Example: `MinorAxis[x^2 / 9 + y^2 / 4 = 1]` returns $x = 0$

Note: See also MajorAxis command.

SemiMinorAxisLength Command

SemiMinorAxisLength[<Conic>]

Returns the length of the semiminor axis (half of the minor axis) of the conic section.

Example:

`SemiMinorAxisLength[x^2 + 2y^2 - 2x - 4y = 5]` yields *2*.

Note: See also SemiMajorAxisLength command.

Semicircle Command

Semicircle[<Point>, <Point>]

Creates a semicircle above the segment between the two points.

Note: See also Semicircle tool.

List Commands

- Append
- Classes
- Element
- First
- Frequency
- IndexOf
- Insert
- Intersection
- IterationList
- Join
- Last
- OrdinalRank
- PointList
- Product
- RandomElement
- RemoveUndefined
- Reverse
- RootList
- SelectedElement
- SelectedIndex
- Sequence
- Sort
- Take
- TiedRank
- Union
- Unique
- Zip

Append Command

Append[<List>, >Object>]

Appends the object to the list and yields the results in a new list.

Example: `Append[{1, 2, 3}, 4]` creates the list *{1, 2, 3, 4}*.

Append[<Object>, <List>]

Appends the list to the object and yields the results in a new list.

Example: `Append[4, {1, 2, 3}]` creates he list *{4, 1, 2, 3}*.

Classes Command

Classes[<List of Data>, <Start>, <Width of Classes>]

Gives a list of class boundaries. The first boundary (min) is equal to *Start*, the last boundary (max) will be at least the maximum of the *List* and the boundaries will be equally spaced between min and max.

Example: `Classes[{0.1, 0.2, 0.4, 1.1}, 0, 1]` gives {0, 1, 2}

Classes[<List of Data>, <Number of Classes>]

Gives a list of class boundaries. The first boundary (min) is equal to the minimum of the *List*, the last boundary (max) will be the maximum of the *List* and the boundaries will be equally spaced between min and max.

Example: `Classes[{1, 3, 5, 7, 8, 9, 10}, 3]` gives {1, 4, 7, 10}

Note: By convention this uses the $a \leq x < b$ rule for each class except for the last class which is $a \leq x \leq b$

Element Command

Element[<List>, <Position of Element n>]

Yields the n^{th} element of the list.

Example:

`Element[{1, 3, 2}, 2]` yields *3*, the second element of *{1, 3, 2}*.

Element[<Matrix>, <Row>, <Column>]

Yields the element of the matrix in the given row and column.

Example:

`Element[{{1, 3, 2}, {0, 3, -2}}, 2, 3]` yields *-2*, the third element of the second row of $\begin{pmatrix} 1 & 3 & 2 \\ 0 & 3 & -2 \end{pmatrix}$.

Element[<List>, <Index1>, <Index2>, ...]

Provided list is *n*-dimensional list, one can specify up to *n* indices to obtain an element (or list of elements) at given coordinates.

Example:

Let *L = {{{1, 2}, {3, 4}}, {{5, 6}, {7, 8}}}*.

Then `Element[L, 1, 2, 1]` yields *3*, `Element[L, 2, 2]` yields *{7, 8}*.

Note: This command only works, if the list or matrix contains elements of one object type (e. g. only numbers or only points).

CAS Syntax

Element[<List>, <Position of Element n>]

Yields the n^{th} element of the list.

Example:

`Element[{a, b, c}, 2]` yields *b*, the second element of *{a, b, c}*.

Element[<Matrix>, <Row>, <Column>]

Yields the element of the matrix in the given row and column.

Example:

`Element[{{a, b, c}, {d, e, f}}, 2, 3]` yields *f*, the third element of the second row of $\begin{pmatrix} a & b & c \\ d & e & f \end{pmatrix}$.

Note:

See also First Command, Last Command and RandomElement Command.

First Command

First[<List>]

Gives a new list that contains the first element of the given list.

Example:

`First[{1, 4, 3}]` yields *{1}*.

Note: To get the first element use `Element[{1, 4, 3}, 1]`.

First[<List>, <Number n of elements>]

Gives a new list that contains just the first *n* elements of the given list.

Example:

`First[{1, 4, 3}, 2]` yields *{1, 4}*.

First[<Text>]

Gives first character of the text.

Example:

`First["Hello"]` yields *"H"*.

First[<Text> , <Number n of elements>]

Gives the first *n* characters of the text.

Example:

`First["Hello",2]` yields *"He"*.

First[<Locus>, <Number n of elements>]

This command is useful for

- loci generated by SolveODE Command - It returns list points that were created in the first *n* steps of the numeric ODE-solving algorithm.
- loci generated using ShortestDistance Command, TravelingSalesman Command, Voronoi Command, MinimumSpanningTree Command, ConvexHull Command and Hull Command Commands - It returns vertices of the graph.

CAS Syntax

First[<List>]

Gives a new list that contains the first element of the given list.

Example:

`First[{1, 4, 3}]` yields *{1}*.

Note: To get the first element use `Element[{1, 4, 3}, 1]`.

First[<List>, <Number n of elements>]

Gives a new list that contains just the first *n* elements of the given list.

Example:

`First[{1, 4, 3}, 2]` yields *{1, 4}*.

Note:

See also Last Command.

Frequency Command

Frequency[<List of Raw Data>]

Returns a list with a count of the occurrences of each unique value in the given list of data. This input list can be numbers or text. The list is sorted in ascending order of the unique values. To get a list of the corresponding unique values use the Unique Command.

Example: Enter `list1 = { "a", "a", "x", "x", "x", "b" }`. `Frequency[list1]` returns the list *{ 2, 1, 3 }*. `Unique[list1]` returns the list *{ "a", "b", "x" }*.

Frequency[<Boolean Cumulative>, <List of Raw Data>]

If *Cumulative = false*, returns the same list as Frequency[<List of Raw Data>]

If *Cumulative = true*, returns a list of cumulative frequencies for Frequency[<List of Raw Data>] .

Example: Enter `list1 = { 0, 0, 0, 1, 1, 2 }`. `Frequency[true, list1]` returns the list *{ 3, 5, 6 }*. `Frequency[false, list1]` returns the list *{ 3, 2, 1}*. `Unique[list1]` returns the list *{ 0, 1, 2 }*.

Frequency[<List of Class Boundaries>, <List of Raw Data>]

Returns a list of the counts of values from the given data list that lie within intervals of the form [a, b), where *a* and *b* are all the couples of consecutive numbers in the given class boundaries list. The highest interval has the form [a, b].

Example: `Frequency[{1, 2, 3}, {1, 1, 2, 3}]` returns the list *{ 2, 2 }*.

Frequency[<Boolean Cumulative>, <List of Class Boundaries>,<List of Raw Data>]

If *Cumulative = false*, returns the same list as Frequency[<List of Class Boundaries>, <List of Raw Data>]

If *Cumulative = true*, returns a list of cumulative frequencies for Frequency[<List of Class Boundaries>, <List of Raw Data>]

Frequency[<List of Class Boundaries>, <List of Raw Data>, <Use Density> , <Density Scale Factor> (optional)]

Returns a list of frequencies for the corresponding Histogram Command.

If *Use density = false*, returns the same list as Frequency[<List of Class Boundaries>, <List of Raw Data>]

If *Use density = true*, returns the list of frequencies of each class.

Example: Let `data = {1, 2, 2, 2, 3, 3, 4, 4, 4, 4}` be the list of raw data and `classes={0, 2, 5}` the list of class boundaries. Then `Frequency[classes, data, false]` and `Frequency[classes, data]` both return the list *{1, 9}*, while `Frequency[classes, data, true]` returns the list *{0.5, 3}*.

Frequency[<Boolean Cumulative>, <List of Class Boundaries>, <List of Raw Data>, <Use Density> , <Density Scale Factor> (optional)]

Returns a list of frequencies for the corresponding Histogram Command.

Frequency[<List of Text>, <List of Text>]

Returns a contingency matrix containing counts of paired values from the two lists. The rows of the matrix correspond to the unique values in the first list, and the columns correspond to the unique values in the second list. To get a list of the unique values for each list use the command Unique Command.

Example: Let `list1 = {"a", "b", "b", "c", "c", "c", "c"}` and `list2 = {"a", "b", "a", "a", "c", "c", "d"}`. Then `Frequency[ list1, list2 ]` returns the matrix

$$\begin{pmatrix}1 & 0 & 0 & 0\\1 & 1 & 0 & 0\\1 & 0 & 2 & 1\end{pmatrix}$$

Note: See also the ContingencyTable command.

IndexOf Command

IndexOf[<Object>, <List>]

Returns position of first occurrence of Object in List.

Examples: `IndexOf[5, {1, 3, 5, 2, 5, 4}]` returns *3*.

Note: When the object is not found, result is *undefined*.

IndexOf[<Object>, <List>, <Start Index>]

Same as above, but the search starts at given index.

Examples:

- `IndexOf[5, {1, 3, 5, 2, 5, 4}, 3]` returns *3*.
- `IndexOf[5, {1, 3, 5, 2, 5, 4}, 4]` returns *5*.
- `IndexOf[5, {1, 3, 5, 2, 5, 4}, 6]` returns *undefined*.

IndexOf[<Text>, <Text>]

Specifies the position at which the short text appears for the first time in the whole text.

Example: `IndexOf["Ge", "GeoGebra"]` returns *1*.

IndexOf[<Text>, <Text>, <Start Index>]

Same as above, but the search starts at given index.

Example: `IndexOf["Ge", "GeoGebra",2]` returns *4*.

Insert Command

Insert[<Object>, <List>, <Position>]

Inserts the object in the list at the given position.

Example:

`Insert[x^2, {1, 2, 3, 4, 5}, 3]` places x^2 at the third position and creates the list *{1, 2,* x^2*, 3, 4, 5}*.

Note: If the position is a negative number, then the position is counted from the right.

Example:

`Insert[x^2, {1, 2, 3, 4, 5}, -1]` places x^2 at the end of the list and creates the list *{1, 2, 3, 4, 5,* x^2*}*.

Insert[<List>, <List>, <Position>]

Inserts all elements of the first list in the second list at the given position.

Example:

`Insert[{11, 12}, {1, 2, 3, 4, 5}, 3]` places the elements of the first list at the third (and following) position(s) of the second list and creates the list *{1, 2, 11, 12, 3, 4, 5}*.

Note: If the position is a negative number, then the position is counted from the right.

Example:

`Insert[{11, 12}, {1, 2, 3, 4, 5}, -2]` places the elements of the first list at the end of the second list before its last element and creates the list *{1, 2, 3, 4, 11, 12, 5}*.

Intersect Command

Intersect[<Object>, <Object>]

Yields the intersection points of two objects.

Example:

- Let `a: -3x + 7y = -10` be a line and `c: x^2 + 2y^2 = 8` be an ellipse. `Intersect[a, c]` yields the intersection points *E* = (-1.02, -1,87) and *F* = (2.81, -0.22) of the line and the ellipse.
- `Intersect[y = x + 3, Curve[t, 2t, t, 0, 10]]` yields *A*=(3,6).
- `Intersect[Curve[2s, 5s, s,-10, 10 ], Curve[t, 2t, t, -10, 10]]` yields *A*=(0,0).

Intersect[<Object>, <Object>, <Index of Intersection Point>]

Yields the nth intersection point of two objects.

Example:

Let `a(x) = x^3 + x^2 - x` be a function and `b: -3x + 5y = 4` be a line. `Intersect[a, b, 2]` yields the intersection point *C* = (-0.43, 0.54) of the function and the line.

Intersect[<Object>, <Object>, <Initial Point>]

Yields an intersection point of two objects by using a (numerical) iterative method with initial point.

Example:

Let `a(x) = x^3 + x^2 - x` be a function, `b: -3x + 5y = 4` be a line, and *C* = (0, 0.8) be the initial point. `Intersect[a, b, C]` yields the intersection point *D* = (-0.43, 0.54) of the function and the line by using a (numerical) iterative method.

Intersect[<Function>, <Function>, <Start x-Value>, <End x-Value>]

Yields the intersection points numerically for the two functions in the given interval.

Example:

Let `f(x) = x^3 + x^2 - x` and `g(x) = 4 / 5 + 3 / 5 x` be two functions. `Intersect[ f, g, -1, 2 ]` yields the intersection points *A* = (-0.43, 0.54) and *B* = (1.1, 1.46) of the two functions in the interval [-1, 2].

Intersect[<Curve 1>, <Curve 2>, <Parameter 1>, <Parameter 2>]

Finds one intersection point using an iterative method starting at the given parameters.

Example:

Let `a = Curve[cos(t), sin(t), t, 0, π]` and `b = Curve[cos(t) + 1, sin(t), t, 0, π]`.
`Intersect[a, b, 0, 2]` yields the intersection point *A = (0.5, 0.87)*.

CAS Syntax

Intersect[<Function>, <Function>]

Yields a list containing the intersection points of two objects.

Example:

Let `f(x):= x^3 + x^2 - x` and `g(x):= x` be two functions. `Intersect[ f(x), g(x) ]` yields the intersection points list: *{(1, 1), (0, 0), (-2, -2)}* of the two functions.

Note: See also Intersect tool.

Intersect[<Object>, <Object>]

Example:

- `Intersect[ <Line> , <Object> ]` creates the intersection point(s) of a line and a plane, segment, polygon, conic, etc.
- `Intersect[ <Plane> , <Object> ]` creates the intersection point(s) of a plane and segment, polygon, conic, etc.
- `Intersect[ <Conic>, <Conic> ]` creates the intersection point(s) of two conics
- `Intersect[ <Plane>, <Plane> ]` creates the intersection line of two planes
- `Intersect[ <Plane>, <Polyhedron> ]` creates the polygon(s) intersection of a plane and a polyhedron.
- `Intersect[ <Sphere>, <Sphere> ]` creates the circle intersection of two spheres
- `Intersect[ <Plane>, <Quadric> ]` creates the conic intersection of the plane and the quadric (sphere, cone, cylinder, ...)

Note: See also IntersectConic and IntersectPath commands.

Intersection Command

Intersection[<List>, <List>]

Gives you a new list containing all elements that are part of both lists.

Example:

Let `list = {1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15}` and `list1 = {2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30}` be two lists. `Intersection[ list, list1 ]` yields a new list *list2 = {2, 4, 6, 8, 10, 12, 14}*.

IterationList Command

IterationList[<Function>, <Start Value>, <Number of Iterations n>]

Gives you a list of length *n+1* whose elements are iterations of the function starting with the start value.

Example: After defining `f(x) = x^2` the command `IterationList[f, 3, 2]` gives you the list *{3, 9, 81}*.

Note: See also Iteration_Command.

Join Command

Join[<List>, <List>, ...]

Joins the two (or more) lists.

Note: The new list contains all elements of the initial lists even if they are the same. The elements of the new list are not re-ordered.

Example:

`Join[{5, 4, 3}, {1, 2, 3}]` creates the list *{5, 4, 3, 1, 2, 3}*.

Join[<List of Lists>]

Joins the sub-lists into one longer list.

Note: The new list contains all elements of the initial lists even if they are the same. The elements of the new list are not re-ordered.

Examples: Join[{{1, 2}}] creates the list {1, 2}.Join[{{1, 2, 3}, {3, 4}, {8, 7}}] creates the list {1, 2, 3, 3, 4, 8, 7}.

Last Command

Last[<List>]

Gives a new list that contains the last element of the initial list.

Example:

`Last[{1, 4, 3}]` yields *{3}*.

Note: To get the last element use `Element[{1, 4, 3}, 3]`.

Last[<List>, <Number of elements>]

Gives a new list that contains just the last *n* elements of the initial list.

Example:

`Last[{1, 4, 3}, 2]` yields *{4, 3}*.

Last[<Text>]

Gives last character of the text.

Example:

`Last["Hello"]` yields *"o"*.

Last[<Text> , <Number of elements>]

Gives the last *n* characters of the text.

Example:

`Last["Hello", 2]` yields *"lo"*.

CAS Syntax

Last[<List>]

Gives a new list that contains the last element of the initial list.

Example:

`Last[{1, 4, 3}]` yields *{3}*.

Note: To get the last element use `Element[{1, 4, 3}, 3]`.

Last[<List>, <Number of elements>]

Gives a new list that contains just the last *n* elements of the initial list.

Example:

`Last[{1, 4, 3}, 2]` yields *{4, 3}*.

Note:

See also First Command.

OrdinalRank Command

OrdinalRank[<List>]

Returns a list, whose *i*-th element is the rank of *i*-th element of list *L* (rank of element is its position in Sort[L]). If there are more equal elements in *L* which occupy positions from *k* to *l* in Sort[L], ranks from *k* to *l* are associated with these elements.

Example:

- `OrdinalRank[{4, 1, 2, 3, 4, 2}]` returns *{5, 1, 2, 4, 6, 3}*
- `OrdinalRank[{3, 2, 2, 1}]` returns *{4, 2, 3, 1}*

Note: Also see command: TiedRank

PointList Command

PointList[<List>]

Creates list of points from a list of two-element lists.

Example: `PointList[{{1,2},{3,4}}]` returns {(1,2),(3,4)}.

Product Command

Product[<List of Raw Data>]

Calculates the product of all numbers in the list.

Example:

`Product[{2, 5, 8}]` yields *80*.

Product[<List of Numbers>, <Number of Elements>]

Calculates the product of the first *n* elements in the list.

Example:

`Product[{1, 2, 3, 4}, 3]` yields *6*.

Product[<List of Numbers>, <List of Frequencies>]

Calculates the product of all elements in the *list of numbers* raised to the value given in the *list of frequencies* for each one of them.

Examples:

`Product[ {20, 40, 50, 60}, {4, 3, 2, 1} ]` yields *1536000000000000*

`Product[ {sqrt(2), cbrt(3), sqrt(5), cbrt(-7)}, {4, 3, 2, 3} ]` yields *-420*

Note: The two lists must have the same length.

CAS Syntax

Product[<List of Expressions>]

Calculates the product of all elements in the list.

Example:

`Product[{1, 2, x}]` yields *2x*.

Product[<Expression>, <Variable>, <Start Index>, <End Index>]

Calculates the product of the expressions that are obtained by replacing the given variable with every integer from *start* to *end*.

Example:

`Product[x + 1, x, 2, 3]` yields *12*.

RandomElement Command

RandomElement[<List>]

Returns randomly chosen element from the list (with uniform probability). All elements in the list must be of the same type.

Example:

`RandomElement[{3, 2, -4, 7}]` yields one of *{-4, 2, 3, 7}*.

Note:

See also Element Command.

CAS Syntax

RandomElement[<List>]

Returns randomly chosen element from the list (with uniform probability). All elements in the list must be of the same type.

Example:

`RandomElement[{3, 2, -4, 7}]` yields one of *{-4, 2, 3, 7}*.

Note:

See also Element Command.

Note: See also SetSeed command, RandomBetween command, RandomBinomial command, RandomNormal command, RandomPoisson command, RandomUniform command.

RemoveUndefined Command

RemoveUndefined[<List>]

Removes undefined objects from a list.

Example:

`RemoveUndefined[Sequence[(-1)^i, i, -3, -1, 0.5]]` removes the second and fourth element of the sequence since expressions $(-1)^{1.5}$and $(-1)^{2.5}$are undefined and yields list *{-1, 1, -1}*.

Note:

See also Remove Command.

Reverse Command

Reverse[<List>]

Reverses the order of a list.

Example:

`Reverse[list1]` reverses `list1 = {(1, 2), (3, 4), (5, 6)}` to create *list2 = {(5, 6), (3, 4), (1, 2)}*

CAS Syntax

Reverse[<List>]

Reverses the order of a list.

Example:

`Reverse[{1, 2, 3, 4}]` reverses the list to create *{4, 3, 2, 1}*

RootList Command

RootList[<List>]

Converts a given list of numbers {a_1,a_2,...,a_n} to a list of points {(a_1,0),(a_2,0),...,(a_n,0)}.

Example:

Command `RootList[{3, 4, 5, 2, 1, 3}]` returns the list of points `list1={(3,0), (4,0), (5,0), (2,0), (1,0), (3,0)}`

SelectedElement Command

SelectedElement[<List>]

Returns the selected element in a drop-down list.

Note: See also SelectedIndex command

SelectedIndex Command

SelectedIndex[<List>]

Returns the index of the selected element of a drop-down list.

Note: See also SelectedElement command

Sequence Command

Sequence[<Expression>, <Variable i>, <Start Value a>, <End Value b>]

Yields a list of objects created using the given expression and the index *i* that ranges from start value *a* to end value *b*.

Example:

`Sequence[(2, i), i, 1, 5]` creates a list of points whose *y*-coordinates range from 1 to 5: *{(2, 1), (2, 2), (2, 3), (2, 4), (2, 5)}*.

Sequence[<Expression>, <Variable i>, <Start Value a>, <End Value b>, <Increment>]

Yields a list of objects created using the given expression and the index *i* that ranges from start value *a* to end value *b* with given increment.

Example:

`Sequence[(2, i), i, 1, 3, 0.5]` creates a list of points whose *y*-coordinates range from 1 to 3 with an increment of *0.5*: *{(2, 1), (2, 1.5), (2, 2), (2, 2.5), (2, 3)}*.

Note: Since the parameters *a* and *b* are dynamic you could use slider variables in both cases above as well.

Sequence[<End Value b>]

Creates list of numbers from 1 to end value *b*.

Example:

- `Sequence[4]` creates list *{1, 2, 3, 4}*.
- `2^Sequence[4]` creates list *{2, 4, 8, 16}*.

Note: See Lists for more information on list operations.

CAS Syntax

Sequence[<Expression>, <Variable i>, <Start Value a>, <End Value b>]

Yields a list of objects created using the given expression and the index *i* that ranges from start value *a* to end value *b*.

Example:

`Sequence[x^i, i, 1, 10]` generates the sequence $\{x, x^2, x^3, x^4, x^5, x^6, x^7, x^8, x^9, x^{10}\}$.

Sequence[<Expression>, <Variable i>, <Start Value a>, <End Value b>, <Increment>]

Yields a list of objects created using the given expression and the index *i* that ranges from start value *a* to end value *b* with given increment.

Example:

`Sequence[x^i, i, 1, 10, 2]` generates the sequence $\{x, x^3, x^5, x^7, x^9\}$.

Note: Since the parameters *a* and *b* are dynamic you could use slider variables in both cases above as well.

Sequence[<End Value b>]

Creates list of numbers 1 to end value *b*.

Example:

`Sequence[5]` generates the sequence *{1, 2, 3, 4, 5}*.

Note: See Lists for more information on list operations.

Sort Command

Sort[<List>]

Sorts a list of numbers, text objects, or points.

Note: Lists of points are sorted by *x*-coordinates.

Examples:

- `Sort[{3, 2, 1}]` gives you the list *{1, 2, 3}*.
- `Sort[{"pears", "apples", "figs"}]` gives you the list elements in alphabetical order.
- `Sort[{(3, 2), (2, 5), (4, 1)}]` gives you *{(2, 5), (3, 2), (4, 1)}*.

Sort[<Values>, <Keys>]

Sorts the first list *Values* according to the corresponding second list *Keys*.

Examples:

- In order to sort a list of polynomials `list1 = {x^3, x^2, x^6}` according to degree, create the dependent list of degrees `list2 = Zip[Degree[a], a, list1]`. After that, `Sort[list1, list2]` yields the requested *list3 = {x^2, x^3, x^6}*.
- In order to draw the polygon having as vertices the complex roots of $x^{10} - 1$, sorted by their arguments, create `list1 = {ComplexRoot[x^10-1]}`, then use the command `Polygon[Sort[list1, arg(list1)]]`. This command yields *poly1 = 2.94*.

Note: There is a workaround to sort lists of arbitrary objects which is explained in the Tutorial:Advanced List Sorting.

Take Command

Take[<List>, <Start Position>]

Returns a list containing the elements from *Start Position* to the end of the initial list.

Example:

`Take[{2, 4, 3, 7, 4}, 3]` yields *{3, 7, 4}*.

Take[<Text>, <Start Position>]

Returns a text containing the elements from *Start Position* to the end of the initial text.

Example:

`Take["GeoGebra", 3]` yields the text *oGebra*.

Take[<List>, <Start Position>, <End Position>]

Returns a list containing the elements from *Start Position* to *End Position* of the initial list.

Example:

`Take[{2, 4, 3, 7, 4}, 3, 4]` yields *{3, 7}*.

Take[<Text>, <Start Position>, <End Position>]

Returns a text containing the elements from *Start Position* to *End Position* of the initial text.

Example:

`Take["GeoGebra", 3, 6]` yields the text *oGeb*.

CAS Syntax

Take[<List>, <Start Position>, <End Position>]

Returns a list containing the elements from *Start Position* to *End Position* of the initial list.

Example:

`Take[{1, 2, a, 4, 5}, 2, 4]` yields *{2, a, 4}*.

TiedRank Command

TiedRank[<List>]

Returns a list, whose *i*-th element is the rank of *i*-th element of the given list *L* (rank of element is its position in Sort[L]). If there are more equal elements in *L* which occupy positions from *k* to *l* in Sort[L], the mean of the ranks from *k* to *l* are associated with these elements.

Examples:

- `TiedRank[{4, 1, 2, 3, 4, 2}]` returns {5.5, 1, 2.5, 4, 5.5, 2.5}.
- `TiedRank[{3, 2, 2, 1}]` returns {4, 2.5, 2.5, 1}.

Note: Also see OrdinalRank Command

Union Command

Union[<List>, <List>]

Joins the two lists and removes elements that appear multiple times.

Example:

`Union[ {1, 2, 3, 4, 5}, {3, 2, 1, 7} ]` yields `{1, 2, 3, 4, 5, 7}`.

Union[<Polygon>, <Polygon>]

Finds the union of the two polygons. Works only for where the polygons are not self-intersecting, and where the union is a single polygon.

Unique Command

Unique[<List>]

Returns list of elements of the given list in ascending order, repetitive elements are included only once. Works for both a list of numbers and a list of text.

Examples:

- `Unique[{1, 2, 4, 1, 4}]` yields *{1, 2, 4}*.
- `Unique[{"a", "b", "Hello", "Hello"}]` yields *{"Hello", "a", "b"}*.

Note: See also Frequency command.

CAS Syntax

Unique[<List>]

Returns a list where each element of the given list occurs only once.

Example:

`Unique[{1, x, x, 1, a}]` yields *{1, x, a}*.

Zip Command

Zip[<Expression>, <Var1>, <List1>, <Var2>, <List2>, ...]

Creates list of objects obtained by substitution of variables in the expression by elements of corresponding lists. Length of the resulting list is minimum of lengths of input lists.

Example: Let P, Q, R, S be some points. `Zip[Midpoint[A, B], A, {P, Q}, B, {R, S}]` returns a list containing midpoints of segments *PR* and *QS*.

Example: Let *list1={x^2, x^3, x^6}* be a list of polynomials. `Zip[Degree[a], a, list1]` returns the list *{2, 3, 6}*.

Note: In each list the elements must be of the same type.

Vector & Matrix Commands

- ApplyMatrix
- CurvatureVector
- Determinant
- Identity
- Invert
- PerpendicularVector
- ReducedRowEchelonForm
- Transpose
- UnitPerpendicularVector
- UnitVector
- Vector

ApplyMatrix Command

ApplyMatrix[<Matrix>, <Object>]

Transforms the object *O* so that point *P* of *O* is mapped to:

- point *M*P*, if *P* is a *2D* point and *M* is a 2 x 2 matrix

  Example: Let `M={{cos(π/2),-sin(π/2)}, {sin(π/2), cos(π/2)}}` be the transformation matrix and `u = (2,1)` a given vector (object). `ApplyMatrix[M,u]` yields the vector *u'=(-1,2)*, i.e. the result of a mathematically positive rotation by 90° of vector *u*.

- point *project(M*(x(P), y(P), 1))*, if *P* is a *2D* point and *M* a 3 x 3 matrix: *project* is a projection, mapping point *(x, y, z)* to *(x/z, y/z)*.

  Example: Let `M={{1,1,0},{0,1,1},{1,0,1}}` be a matrix and `u=(2,1)` a given vector. `ApplyMatrix[M,u]` yields vector *u'=(1,0.67)*. In effect $\begin{pmatrix}1 & 1 & 0\\ 0 & 1 & 1\\ 1 & 0 & 1\end{pmatrix}\begin{pmatrix}2\\ 1\\ 1\end{pmatrix}=\begin{pmatrix}3\\ 2\\ 3\end{pmatrix}$, and (3/3 = 1, 2/3 ≈ 0.67) (rounding to 2 decimal places)

  - point *M*P*, if *P* is a *3D* point and *M* a 3 x 3 matrix
  - point *N*P*, if *P* is a *3D* point and *M* a 2 x 2 matrix: the matrix *N* is the *completion or order 3* of *M*: given *M* = $\begin{pmatrix}a & b\\ c & d\end{pmatrix}$then *N* = $\begin{pmatrix}a & b & 0\\ c & d & 0\\ 0 & 0 & 1\end{pmatrix}$

  Note: This command also works for images.

CurvatureVector Command

CurvatureVector[<Point>, <Function>]

Yields the curvature vector of the function in the given point.

Example: `CurvatureVector[(0, 0), x^2]` yields vector *(0, 2)*.

CurvatureVector[<Point>, <Curve>]

Yields the curvature vector of the curve in the given point.

Example: `CurvatureVector[(0, 0), Curve[cos(t), sin(2t), t, 0, π]]` yields vector *(0, 0)*.

Determinant Command

Determinant[<Matrix>]

Gives the determinant of the matrix.

Example:

`Determinant[{{1, 2}, {3, 4}}]` yields *a* = *-2*.

CAS Syntax

Determinant[<Matrix>]

Gives the determinant of the matrix. If the matrix contains undefined variables, it yields a formula for the determinant.

Example:

`Determinant[{{1, a}, {b, 4}}]` yields *-a b + 4*.

Identity Command

Identity[<Number>]

Gives the identity matrix of the given order.

Example:

`Identity[3]` yields the matrix $\begin{pmatrix}1 & 0 & 0\\ 0 & 1 & 0\\ 0 & 0 & 1\end{pmatrix}$.

Note: If *A* is a square matrix of order *n*, `A^0` yields the same as `Identity[n]`.

CAS Syntax

Identity[<Number>]

Gives the identity matrix of the given order.

Example:

`Identity[3]` yields the matrix $\begin{pmatrix}1 & 0 & 0\\ 0 & 1 & 0\\ 0 & 0 & 1\end{pmatrix}$.

Note: If *A* is a square matrix of order *n*, `A^0` yields the same as `Identity[n]`.

Invert Command

Invert[<Matrix>]

Inverts the given matrix.

Example: `Invert[{{1, 2}, {3, 4}}]` yields $\begin{pmatrix}-2 & 1\\ 1.5 & -0.5\end{pmatrix}$, the inverse matrix of $\begin{pmatrix}1 & 2\\ 3 & 4\end{pmatrix}$.

Invert[<Function>]

Gives the inverse of the function.

Example:

`Invert[sin(x)]` yields *asin(x)*.

Note:

The function must contain just one *x* and no account is taken of domain or range, for example for f(x) = x^2 or f(x) = sin(x).

If there is more than one *x* in the function another command might help you:

Example:

Both `Invert[PartialFractions[(x + 1) / (x + 2)]]` and `Invert[CompleteSquare[x^2 + 2 x + 1]]` yield the inverse functions.

CAS Syntax

Invert[<Matrix>]

Inverts the given matrix.

Example:

`Invert[{{a, b}, {c, d}}]` yields $\begin{pmatrix}\frac{d}{ad-bc} & \frac{-b}{ad-bc}\\ \frac{-c}{ad-bc} & \frac{a}{ad-bc}\end{pmatrix}$, the inverse matrix of $\begin{pmatrix}a & b\\ c & d\end{pmatrix}$.

Invert[<Function>]

Gives the inverse of the function.

Examples:

- `Invert[(x + 1) / (x + 2)]` yields $\frac{-2x+1}{x-1}$.
- `Invert[x^2 + 2 x + 1]` yields $\sqrt{x} - 1$.

Note: In the CAS View, the command also works if the function contains more than one *x*.

PerpendicularVector Command

PerpendicularVector[<Line>]

Returns the perpendicular vector of the line.

Example:

Let `Line[ (1, 4), (5, -3) ]` be the line *j*. `PerpendicularVector[ j ]` yields the perpendicular vector *u=(7, 4)* of the line *j*.

Note: A line with equation *ax* + *by* = *c* has the perpendicular vector *(a, b)*.

PerpendicularVector[<Segment>]

Returns the perpendicular vector of the segment with the same length.

Example:

Let `Segment[ (3, 2), (14, 5) ]` be the segment *k*. `PerpendicularVector[ k ]` yields the perpendicular vector *u=(-3, 11)* of the segment *k*.

PerpendicularVector[<Vector>]

Returns the perpendicular vector of the given vector.

Example:

Let `Vector[ (-12, 8) ]` be the vector *u*. `PerpendicularVector[ u ]` yields the perpendicular vector *v=(-8, -12)* of the vector *u*.

Note: A vector with coordinates *(a, b)* has the perpendicular vector *(-b, a)*.

CAS Syntax

PerpendicularVector[<Vector>]

Returns the perpendicular vector of the given vector.

Example:

- `PerpendicularVector[(3, 2)]` yields the vector *{-2, 3}*.
- `PerpendicularVector[(a, b)]` yields the vector *{-b, a}*.

Note:

See also UnitPerpendicularVector Command.

ReducedRowEchelonForm Command

ReducedRowEchelonForm[<Matrix>]

Returns the reduced echelon form of the matrix.

Example:

`ReducedRowEchelonForm[{{1, 6, 4}, {2, 8, 9}, {4, 5, 6}}]` yields the matrix $\begin{pmatrix}1 & 0 & 0\\0 & 1 & 0\\0 & 0 & 1\end{pmatrix}$.

CAS Syntax

ReducedRowEchelonForm[<Matrix>]

Returns the reduced echelon form of the matrix.

Example:

`ReducedRowEchelonForm[{{1, 6, 4}, {2, 8, 9}, {4, 5, 6}}]` yields the matrix $\begin{pmatrix}1 & 0 & 0\\0 & 1 & 0\\0 & 0 & 1\end{pmatrix}$.

Transpose Command

Transpose[<Matrix>]

Transposes the matrix.

Example:

`Transpose[{{1, 2, 3}, {4, 5, 6}, {7, 8, 9}}]` yields the matrix $\begin{pmatrix}1 & 4 & 7\\2 & 5 & 8\\3 & 6 & 9\end{pmatrix}$.

CAS Syntax

Transpose[<Matrix>]

Transposes the matrix.

Example:

`Transpose[{{a, b}, {c, d}}]` yields the matrix $\begin{pmatrix}a & c\\b & d\end{pmatrix}$.

UnitPerpendicularVector Command

UnitPerpendicularVector[<Line>]

Returns the perpendicular vector with length 1 of the given line.

Example:

`UnitPerpendicularVector[3x + 4y = 5]` yields $\begin{pmatrix}0.6\\0.8\end{pmatrix}$.

UnitPerpendicularVector[<Segment>]

Returns the perpendicular vector with length 1 of the given segment.

Example:

Let `s = Segment[(1,1), (4,5)].`

`UnitPerpendicularVector[s]` yields $\begin{pmatrix}-0.8\\0.6\end{pmatrix}$.

UnitPerpendicularVector[<Vector>]

Returns the perpendicular vector with length 1 of the given vector. The vector must be defined first.

Example:

Let v=$\begin{pmatrix}3\\4\end{pmatrix}$. `UnitPerpendicularVector[v]` yields $\begin{pmatrix}-0.8\\0.6\end{pmatrix}$.

CAS Syntax

UnitPerpendicularVector[<Vector>]

Yields a perpendicular vector with length 1 of the given vector.

Example:

`UnitPerpendicularVector[(a, b)]` yields (,).

Note:

See also PerpendicularVector Command.

UnitVector Command

UnitVector[<Vector>]

Yields a vector with length 1, which has the same direction and orientation as the given vector. The vector must be defined first.

Example:

Let *v*= $\begin{pmatrix}3\\4\end{pmatrix}$. `UnitVector[v]` yields $\begin{pmatrix}0.6\\0.8\end{pmatrix}$.

UnitVector[<Line>]

Yields the direction vector of the given line with length 1.

Example:

`UnitVector[3x + 4y = 5]` yields $\begin{pmatrix}0.8\\-0.6\end{pmatrix}$.

UnitVector[<Segment>]

Yields the direction vector of the given segment with length 1.

Example:

Let `s = Segment[(1,1),(4,5)]`.

`UnitVector[s]` yields $\begin{pmatrix}0.6\\0.8\end{pmatrix}$.

CAS Syntax

UnitVector[<Vector>]

Yields a vector with length 1, which has the same direction and orientation as the given vector.

Example:

`UnitVector[(a, b)]` yields *(,)*.

Example:

`UnitVector[(2, 4, 4)]` yields $(\frac{1}{3}, \frac{2}{3}, \frac{2}{3})$.

Vector Command

Vector[<Start Point>, <End Point>]

Creates a vector from *Start Point* to *End Point*.

Example:

`Vector[(1, 1), (3, 4)]` yields $u = \begin{pmatrix}2\\3\end{pmatrix}$.

Vector[<Point>]

Returns the position vector of the given point.

Example:

`Vector[(3, 2)]` yields $u = \begin{pmatrix}3\\2\end{pmatrix}$.

Note: See also Vector tool.

Transformation Commands

- Dilate (Enlarge)
- Reflect
- Rotate
- Shear
- Stretch
- Translate

See also Transformation tools

Dilate Command

Dilate[<Object>, <Dilation Factor>]

Dilates the object from a point of origin using the given factor.

Dilate[<Object>, <Dilation Factor>, <Dilation Center Point>]

Dilates the object from a point, which is the dilation center point, using the given factor.

Note: When dilating polygons, GeoGebra creates also all the transformed vertices and segments.

Note: See also Dilate from Point by Factor tool.

Reflect Command

Reflect[<Object>, <Point>]

Reflects the geometric object through a given point.

Note: When reflecting polygons through a point, the transformed vertices and segments are created as well.

Reflect[<Object>, <Line>]

Reflects an object (e.g. an image) across a given line.

Note: When reflecting polygons across a line, the transformed vertices and segments are created as well.

Reflect[<Object>, <Circle>]

Inverts the geometric object with respect to a circle.

Note: See also Reflect about Point, Reflect about Line , and Reflect about Circle tools.

Rotate Command

Rotate[<Object>, <Angle>]

Rotates the geometric object by the angle around the axis origin.

Rotate[<Object>, <Angle>, <Point>]

Rotates the geometric object by the angle around the given point.

Note: Vectors are not rotated around axis origin, but around their initial point. When a polygon, segment or arc are rotated, also images of the vertices / endpoints and sides (in case of polygon) are created. This command also rotates images. For text rotation use RotateText Command. See also Rotate around Point ToolRotate around Point tool.

Shear Command

Shear[<Object>, <Line>, <Ratio>]

Shears the object so that

- points on the line stay fixed.
- points at distance *d* from the line are shifted by *d* ·*ratio* in direction of the line (direction of the shift is different for halfplanes with respect to the line).

A sheared plane figure maintains its original area.

Stretch Command

Stretch[<Object>, <Vector>]

The object is stretched **parallel** to the given vector by the ratio given by the **magnitude** of the vector (i.e. points on the line perpendicular to the vector (through its startpoint) stay on their place and distance of other points from the line is multiplied by given ratio.)

Stretch[<Object>, <Line>, <Ratio>]

The object is stretched **perpendicular** to the line by the given ratio (i.e. points on the line aren't moved and the distance of other points from the line is multiplied by given ratio.)

Translate Command

Translate[<Object>, <Vector>]

Translates the geometric object by the vector.

Note: When translating a polygon, the transformed new vertices and segments are created as well.

Translate[<Vector>, <Start Point>]

Translates the vector to the start point.

Note: See also Translate by Vector tool.

Chart Commands

- BarChart
- BoxPlot
- DotPlot
- FrequencyPolygon
- Histogram
- HistogramRight
- NormalQuantilePlot
- ResidualPlot
- StemPlot

BarChart Command

BarChart[<List of Data>, <List of Frequencies>]

Creates a bar chart using the list of data with corresponding frequencies.

Note: The numbers in the list of raw data need to be arranged in increasing order.

Example:

- `BarChart[{10, 11, 12, 13, 14}, {5, 8, 12, 0, 1}]`
- `BarChart[{5, 6, 7, 8, 9}, {1, 0, 12, 43, 3}]`
- `BarChart[{0.3, 0.4, 0.5, 0.6}, {12, 33, 13, 4}]`

BarChart[<List of Raw Data>, <Width of Bars>]

Creates a bar chart using the given raw data; the bars have the given width.

Example: `BarChart[ {1, 1, 1, 2, 2, 2, 2, 2, 3, 3, 3, 5, 5, 5, 5}, 1]`

BarChart[<List of Data> , <List of Frequencies>, <Width of Bars>]

Creates a bar chart using the list of data and corresponding frequencies; the bars have width *w*.

Example:

- `BarChart[{10, 11, 12, 13, 14}, {5, 8, 12, 0, 1}, 0.5]` leaves gaps between bars.
- `BarChart[{10, 11, 12, 13, 14}, {5, 8, 12, 0, 1}, 0]` produces a line graph.

BarChart[<Start Value>, <End Value>, <List of Heights>]

Creates a bar chart over the given interval: the number of bars is determined by the length of the list, whose elements are the heights of the bars.

Example: `BarChart[10, 20, {1, 2, 3, 4, 5} ]` gives you a bar chart with five bars of specified height in the interval [10, 20].

BarChart[<Start Value>, <End Value> , <Expression>, <Variable>, <From Number>, <To Number>]

Creates a bar chart over the given interval [Start Value, End Value], that calculates the bars’ heights using the expression whose variable *k* varies from number *c* to number *d*.

Example: If *p = 0.1*, *q = 0.9*, and *n = 10* are numbers, then `BarChart[ -0.5, n + 0.5, BinomialCoefficient[n,k] * p^k * q^(n-k), k, 0, n ]` gives you a bar chart in the interval [*-0.5, n+0.5*]. The heights of the bars depend on the probabilities calculated using the given expression.

BarChart[<Start Value>, <End Value>, <Expression>, <Variable>, <From Number>, <To Number>, <Step Width>]

Creates a bar chart over the given interval [Start Value, End Value], the bars’ heights are calculated using the given expression in which the variable *k* varies from number *c* to number *d* using step width *s*.

BoxPlot Command

BoxPlot[yOffset, yScale, List of Raw Data]

Creates a box plot using the given raw data and whose vertical position in the coordinate system is controlled by variable *yOffset* and whose height is influenced by factor *yScale*.

Example: `BoxPlot[0, 1, {2, 2, 3, 4, 5, 5, 6, 7, 7, 8, 8, 8, 9}]`

BoxPlot[yOffset, yScale, Start Value, Q1, Median, Q3, End Value]

Creates a box plot for the given statistical data in interval [*Start Value, End Value*].

BoxPlot[<yOffset>, <yScale>, <List of Raw Data>, <Boolean Outliers>]

This allows outliers to be plotted as "X"s rather than included in the boxplot. For this command, outliers are data lying below Q1 - 1.5 * IQR or above Q3 + 1.5 * IQR.

BoxPlot[<yOffset>, <yScale>, <List of Data>, <List of Frequencies>, <Boolean Outliers>]

This allows data from a frequency table to be easily plotted as a boxplot.

DotPlot Command

DotPlot[<List of Raw Data>]

Returns a dot plot for the given list of numbers, as well as the list of the dot plot points. If a number *n* appears in the list of raw data *k* times, the returned list contains points *(n, 1), (n, 2), ..., (n, k)*.

Example:

`DotPlot[{2, 5, 3, 4, 3, 5, 3}]` yields *{(2, 1), (3, 1), (3, 2), (3, 3), (4, 1), (5, 1), (5, 2)}*.

FrequencyPolygon Command

Note: Frequency polygon is a line graph drawn by joining all the midpoints of the top of the bars of a histogram. Therefore usage of this command is the same as usage of Histogram Command.

FrequencyPolygon[<List of Class Boundaries>, <List of Heights>]

Creates a frequency polygon with vertices in given heights. The class boundaries determine the x-coordinate of each vertex.

FrequencyPolygon[<List of Class Boundaries>, <List of Raw Data>, <Boolean Use Density>, <Density Scale Factor (optional)>]

Creates a frequency polygon using the raw data. The class boundaries determine the x-coordinates of vertices and are used to determine how many data elements lie in each class. The y-coordinate of a vertex is determined as follows

- If *Use Density = true*, height = (Density Scale Factor) * (class frequency) / (class width)
- If *Use Density = false*, height = class frequency

By default, Use Density = true and Density Scale Factor = 1.

FrequencyPolygon[<Boolean Cumulative>, <List of Class Boundaries>, <List of Raw Data>, <Boolean Use Density> , <Density Scale Factor (optional)>]

If Cumulative is true this creates a frequency polygon where each vertex y-coordinate equals the frequency of the class plus the sum of all previous frequencies.

Note: For examples see Histogram Command.

Histogram Command

Histogram[<List of Class Boundaries>, <List of Heights>]

Creates a histogram with bars of the given heights. The class boundaries determine the width and position of each bar of the histogram.

Example: `Histogram[{0, 1, 2, 3, 4, 5}, {2, 6, 8, 3, 1}]` creates a histogram with 5 bars of the given heights. The first bar is positioned at the interval [*0, 1*], the second bar is positioned at the interval [*1, 2*], and so on.

Histogram[<List of Class Boundaries>, <List of Raw Data>, <Boolean Use Density>, <Density Scale Factor>(optional)]

Creates a histogram using the raw data. The class boundaries determine the width and position of each bar of the histogram and are used to determine how many data elements lie in each class. Bar height is determined as follows

- If *Use Density = true*, height = (Density Scale Factor) * (class frequency) / (class width)
- If *Use Density = false*, height = class frequency

By default, Use Density = true and Density Scale Factor = 1. This creates a histogram with total area = n, the number of data values.

Note: All elements of Raw Data must be within the interval of the class boundaries or the histogram will return "undefined".

Note: By convention this uses the a ≤ x < b rule for each class except for the last class which is a ≤ x ≤ b

Example: (*Default Histogram*)Histogram[{10, 20, 30, 40}, {10, 11, 11, 12, 18, 20, 25, 40}, true] creates a histogram with 3 bars, with the heights 0.5 (first bar), 0.2 (second bar), and 0.1 (third bar). This histogram has total area = 0.5*10 + 0.2*10 + 0.1*10 = 8.

Example: (*Count Histogram*)Histogram[{10, 20, 30, 40}, {10, 11, 11, 12, 18, 20, 25, 40}, false] creates a histogram with 3 bars, with the heights 5 (first bar), 2 (second bar), and 1 (third bar). This histogram does not use density scaling and gives bar heights that equal the count of values in each class.

Example: (*Relative Frequency Histogram*)Histogram[{10, 20, 30, 40}, {10, 11, 11, 12, 18, 20, 25, 40}, true, 10/ 8] creates a histogram with 3 bars, with the heights 0.625 (first bar), 0.25 (second bar), and 0.125 (third bar). This histogram uses density scaling to give bar heights that equal the proportion of values in each class. If n is the number of data values, and the classes have constant width w, then Density Scale Factor = w/n creates a relative histogram.

Example: (*Normalized Histogram*)Histogram[{10, 20, 30, 40}, {10, 11, 11, 12, 18, 20, 25, 40}, true, 1/8] creates a histogram with 3 bars, with the heights .0625 (first bar), .025 (second bar), and .0125 (third bar). This histogram has total area = .0625*10 + .025*10 + .0125*10 = 1. If n is the number of data values, then Density Scale Factor = 1/n creates a normalized histogram with total area = 1. This is useful for fitting a histogram with a density curve.

Histogram[<Boolean Cumulative>, <List of Class Boundaries>, <List of Raw Data>, <Boolean Use Density> , <Density Scale Factor> (optional)]

If Cumulative is true this creates a histogram where each bar height equals the frequency of the class plus the sum of all previous frequencies.

Example: :`Histogram[true, {10, 20, 30, 40}, {10, 11, 11, 12, 18, 20, 25, 40}, true]` creates a histogram with 3 bars, with the heights 0.5 (first bar), 0.7 (second bar), and 0.8 (third bar).

HistogramRight Command

HistogramRight[<List of Class Boundaries>, <List of Heights>]

> Same as `Histogram[<List of Class Boundaries>, <List of Heights>]`

HistogramRight[<List of Class Boundaries>, <List of Raw Data>, <Boolean Use Density> , <Density Scale Factor> (optional)]

> Same as `Histogram[<List of Class Boundaries>, <List of Raw Data>, <Boolean Use Density>, <Density Scale Factor>]`, except that if a datum is equal to the right border of a class, it is counted in this class and not in the next one.

HistogramRight[<Boolean Cumulative>, <List of Class Boundaries>, <List of Raw Data>, <Boolean Use Density> , <Density Scale Factor> (optional)]

> Same as `Histogram[<Boolean Cumulative>, <List of Class Boundaries>, <List of Raw Data>, <Boolean Use Density>, <Density Scale Factor>]`, except that if a datum is equal to the right border of a class, it is counted in this class and not in the next one.

Note: By convention this uses the a < x ≤ b rule for each class except for the first class which is a ≤ x ≤ b

NormalQuantilePlot Command

NormalQuantilePlot[<List of Raw Data>]

> Creates a normal quantile plot from the given list of data and draws a line through the points showing the ideal plot for exactly normal data. Points are formed by plotting data values on the x axis against their expected normal score (Z-score) on the y axis.

ResidualPlot Command

ResidualPlot[<List of Points>, <Function>]

Returns a list of points whose x-coordinates are equal to the x-coordinates of the elements of the given list, and y-coordinates are the residuals with respect to *f*.

If the *i*-th element of the given list is a point *(a,b)* then *i*-th element of the result is *(a,b-f(a))*.

Example:

Let `list = {(-1, 1), (-0.51, 2), (0, 0.61), (0.51, -1.41), (0.54, 1.97), (1.11, 0.42), (1.21, 2.53), (-0.8, -0.12)}` be the list of points and `f(x) = x^5 + x^4 - x - 1` the function. The `ResidualPlot[ list, f ]` command yields *list1 = {(-1, 1), (-0.51, 2.46), (0, 1.61), (0.51, 0), (0.54, 3.38), (1.11, -0.66), (1.21, 0), (-0.8, 0)}* and creates the corresponding points in *Graphics* view.

StemPlot Command

StemPlot[<List>]

Returns a stem plot of the given list of numbers. Outliers are removed from the plot and listed separately.

An outlier is defined as a value outside the interval [Q1 - 1.5 (Q3 - Q1) , Q3 + 1.5 (Q3 - Q1)].

StemPlot[<List>, <Adjustment -1|0|1>]

Returns a stem plot of the given list of numbers.

If *Adjustment* = -1 the default stem unit is divided by 10

If *Adjustment* = 0 nothing is changed

If *Adjustment* = 1 the default stem unit is multiplied by 10

Statistics Commands

- ANOVA
- Classes
- CorrelationCoefficient
- Covariance
- Fit
- FitExp
- FitGrowth
- FitLine
- FitLineX
- FitLog
- FitLogistic
- FitPoly
- FitPow
- FitSin
- Frequency
- FrequencyTable
- GeometricMean
- HarmonicMean
- Mean
- MeanX
- MeanY
- Median
- Mode
- Percentile
- Q1
- Q3
- RootMeanSquare
- RSquare
- Sample
- SampleSD
- SampleSDX
- SampleSDY
- SampleVariance
- SD
- SDX
- SDY
- Shuffle
- SigmaXX
- SigmaXY
- SigmaYY
- Spearman
- Sum
- SumSquaredErrors
- Sxx
- Sxy

- Syy
- TMeanEstimate
- TMean2Estimate
- TTest
- TTest2
- TTestPaired
- Variance

See also Probability Calculator.

ANOVA Command

ANOVA[<List>, <List>, ...]

Performs a one-way ANOVA test on the given lists of numbers.

Results are returned in list form as {P value, F test statistic}.

Classes Command

Classes[<List of Data>, <Start>, <Width of Classes>]

Gives a list of class boundaries. The first boundary (min) is equal to *Start*, the last boundary (max) will be at least the maximum of the *List* and the boundaries will be equally spaced between min and max.

Example: `Classes[{0.1, 0.2, 0.4, 1.1}, 0, 1]` gives {0, 1, 2}

Classes[<List of Data>, <Number of Classes>]

Gives a list of class boundaries. The first boundary (min) is equal to the minimum of the *List*, the last boundary (max) will be the maximum of the *List* and the boundaries will be equally spaced between min and max.

Example: `Classes[{1, 3, 5, 7, 8, 9, 10}, 3]` gives {1, 4, 7, 10}

Note: By convention this uses the a ≤ x < b rule for each class except for the last class which is a ≤ x ≤ b

Covariance Command

Covariance[<List of Numbers>, <List of Numbers>]

Calculates the covariance between the elements of the specified lists.

Example:

`Covariance[{1, 2, 3}, {1, 3, 7}]` yields *2*, the covariance of *{1, 2, 3}* and *{1, 3, 7}*.

Covariance[<List of Points>]

Calculates the covariance between the *x* and *y* coordinates of the specified points.

Example:

`Covariance[{(1, 1), (2, 3), (3, 7)}]` yields *2*, the covariance of *{1, 2, 3}* and *{1, 3, 7}*.

CAS Syntax

Covariance[<List of Numbers>, <List of Numbers>]

Calculates the covariance between the elements of the specified lists.

Example:

`Covariance[{1, 2, 3}, {1, 3, 7}]` yields *2*, the covariance of *{1, 2, 3}* and *{1, 3, 7}*.

Covariance[<List of Points>]

Calculates the covariance between the *x* and *y* coordinates of the specified points.

Example:

`Covariance[{(1, 1), (2, 3), (3, 7)}]` yields *2*, the covariance of *{1, 2, 3}* and *{1, 3, 7}*.

Fit Command

Fit[<List of Points>, <List of Functions>]

Calculates a linear combination of the *functions* that best fit the *points* in the list.

Example:

- `Fit[{(-2, 3), (0, 1), (2, 1), (2, 3)}, {x^2, x}]` yields *0.625 x^2 - 0.25x*.
- Let *L = {A, B, C, ...}*, *f(x) = 1*, *g(x) = x*, *h(x) = e^x*, *F = {f, g, h}*.
  `Fit[L, F]` calculates a function of the form *a + b x + c e^x* that fits the points in the list.

Fit[<List of points>, <Function>]

Calculates a minimum squared error function to the points in the list. The *function* must depend on one or more sliders, that are taken as start values of parameters to be optimized. The non-linear iteration might not converge, but adjusting the sliders to a better starting point might help.

Example:

Let *a* be slider with interval from *-5* to *5* and increment 1.

`Fit[{(-2, 3), (0, 1), (2, 1), (2, 3)}, a + x^2]` yields *-1* + *x^2*.

Note: Other point fitting commands are FitExp, FitGrowth, FitLine, FitLineX, FitLog, FitLogistic, FitPoly, FitPow and FitSin.

FitExp Command

FitExp[<List of Points>]

Calculates the exponential regression curve in the form *a*□^{bx}.

Example:

`FitExp[{(0, 1), (2, 4)}]` yields □$^{0.69x}$.

CAS Syntax

FitExp[<List of Points>]

Calculates the exponential regression curve.

Example:

`FitExp[{(0, 1), (2, 4)}]` yields □$^{0.69x}$.

Note:

- If you want the answer in the form ab^x then use the FitGrowth Command.
- Euler's number *e* can be obtained by pressing ALT + e.
- See also Fit, FitGrowth, FitLine, FitLineX, FitLog, FitLogistic, FitPoly, FitPow and FitSin.

FitGrowth Command

FitGrowth[<List of Points>]

Calculates a function of the form ab^x to the points in the list. (Just like FitExp[<List of Points>], for users who do not know the meaning of exponential growth).

Example:

`FitGrowth[{(0, 1), (2, 3), (4, 3), (6, 4)}]` yields $1.31 \cdot 1.23^x$.

CAS Syntax

FitGrowth[<List of Points>]

Calculates a function of the form ab^x to the points in the list.

Example:

`FitGrowth[{(0, 1), (2, 3), (4, 3), (6, 4)}]` yields $1.31 \cdot 1.23^x$.

Note: See also Fit, FitExp, FitLine, FitLineX, FitLog, FitLogistic, FitPoly, FitPow and FitSin.

FitLineX Command

FitLineX[<List of Points>]

Calculates the *x* on *y* regression line of the points.

Example:

`FitLineX[{(-1, 3), (2, 1), (3, 4), (5, 3), (6, 5)}]` yields $1.1x - 0.1$.

CAS Syntax

FitLineX[<List of Points>]

Calculates the *x* on *y* regression line of the points.

Example:

`FitLineX[{(-1, 3), (2, 1), (3, 4), (5, 3), (6, 5)}]` yields $1.1x - 0.1$.

Note: See also Best Fit Line tool and FitLine Command.

FitLine Command

FitLine[<List of Points>]

Calculates the *y* on *x* regression line of the points.

Example:

`FitLine[{(-2, 1), (1, 2), (2, 4), (4, 3), (5, 4)}]` yields *0.4x* + *2*.

CAS Syntax

FitLine[<List of Points>]

Calculates the *y* on *x* regression line of the points.

Example:

`FitLine[{(-2, 1), (1, 2), (2, 4), (4, 3), (5, 4)}]` yields *0.4x* + *2*.

Note: See also Best Fit Line tool and FitLineX Command.

FitLog Command

FitLog[<List of Points>]

Calculates the logarithmic regression curve.

Example:

`FitLog[{(e, 1), (e^2, 4)}]` yields *-2* + *3 ln(x)*.

CAS Syntax

FitLog[<List of Points>]

Calculates the logarithmic regression curve.

Example:

`FitLog[{(e, 1), (e^2, 4)}]` yields *3 ln(x)* - *2*.

Note:

- Euler's number *e* can be obtained by pressing ALT + e.
- See also FitExp Command, FitPoly Command, FitPow Command and FitSin Command.

FitLogistic Command

FitLogistic[<List of Points>]

Calculates the regression curve in the form a/(1 + b e^(-kx)).

Example:

`FitLogistic[{(-6, 2), (0, 2), (3, 4), (3.4, 8)}]` yields $\frac{1.98}{1 - 0.03e^{x}}$.

CAS Syntax

FitLogistic[<List of Points>]

Calculates the regression curve in the form a/(1 + b e^(-kx)).

Example:

`FitLogistic[{(-6, 2), (0, 2), (3, 4), (3.4, 8)}]` yields $\frac{1.98}{1 - 0.03e^{x}}$.

Note:

- The first and last data points should be fairly close to the curve. The list should have at least 3 points, preferably more.
- See also Fit, FitExp, FitGrowth, FitLine, FitLineX, FitLog, FitPoly, FitPow and FitSin.

FitPoly Command

FitPoly[<List of Points>, <Degree of Polynomial>]

Calculates the regression polynomial of degree *n*.

Example:

`FitPoly[{(-1, -1), (0, 1), (1, 1), (2, 5)}, 3]` yields $f(x) = x^3 - x^2 + 1$.

CAS Syntax

FitPoly[<List of Points>, <Degree of Polynomial>]

Calculates the regression polynomial of degree *n*.

Example:

`FitPoly[{(-1, -1), (0, 1), (1, 1), (2, 5)}, 3]` yields $x^3 - x^2 + 1$.

Note:

- For order *n* there must be at least $n + 1$ Points in the list.
- See also FitExp Command, FitLog Command, FitPow Command and FitSin Command.

FitPow Command

FitPow[<List of Points>]

Calculates the regression curve in the form *a x^b*.

Example:

`FitPow[{(1, 1), (3, 2), (7, 4)}]` creates the regression curve *f(x) = 0.97 x^{0.71}*.

CAS Syntax

FitPow[<List of Points>]

Calculates the regression curve in the form *a x^b*.

Example:

`FitPow[{(1, 1), (3, 2), (7, 4)}]` yields *0.97 x^{0.71}*.

Note:

- All points used need to be in the first quadrant of the coordinate system.
- See also FitExp Command, FitLog Command, FitPoly Command, and FitSin Command.

FitSin Command

FitSin[<List of Points>]

Calculates the regression curve in the form *a + b sin (c x + d)*.

Example:

`FitSin[{(1, 1), (2, 2), (3, 1), (4, 0), (5, 1), (6, 2)}]` yields *f(x) = 1 + 1 sin (1.5708 x - 1.5708)*.

CAS Syntax

FitSin[<List of Points>]

Calculates the regression curve in the form *a + b sin (c x + d)*.

Example:

`FitSin[{(1, 1), (2, 2), (3, 1), (4, 0), (5, 1), (6, 2)}]` yields *1 + 1 sin (1.5708 x - 1.5708)*.

Note:

- The list should have at least four points, preferably more. The list should cover at least two extremal points. The first two local extremal points should not be too different from the absolute extremal points of the curve.
- See also FitExp Command, FitLog Command, FitPoly Command and FitPow Command.

Frequency Command

Frequency[<List of Raw Data>]

Returns a list with a count of the occurrences of each unique value in the given list of data. This input list can be numbers or text. The list is sorted in ascending order of the unique values. To get a list of the corresponding unique values use the Unique Command.

Example: Enter `list1 = { "a", "a", "x", "x", "x", "b" }`. `Frequency[list1]` returns the list *{ 2, 1, 3 }*. `Unique[list1]` returns the list *{ "a", "b", "x" }*.

Frequency[<Boolean Cumulative>, <List of Raw Data>]

If *Cumulative* = *false*, returns the same list as Frequency[<List of Raw Data>]

If *Cumulative* = *true*, returns a list of cumulative frequencies for Frequency[<List of Raw Data>] .

Example: Enter `list1 = { 0, 0, 0, 1, 1, 2 }`. `Frequency[true, list1]` returns the list *{ 3, 5, 6 }*. `Frequency[false, list1]` returns the list *{ 3, 2, 1}*. `Unique[list1]` returns the list *{ 0, 1, 2 }*.

Frequency[<List of Class Boundaries>, <List of Raw Data>]

Returns a list of the counts of values from the given data list that lie within intervals of the form [a, b), where *a* and *b* are all the couples of consecutive numbers in the given class boundaries list. The highest interval has the form [a, b].

Example: `Frequency[{1, 2, 3}, {1, 1, 2, 3}]` returns the list *{ 2, 2 }*.

Frequency[<Boolean Cumulative>, <List of Class Boundaries>,<List of Raw Data>]

If *Cumulative* = *false*, returns the same list as Frequency[<List of Class Boundaries>, <List of Raw Data>]

If *Cumulative* = *true*, returns a list of cumulative frequencies for Frequency[<List of Class Boundaries>, <List of Raw Data>]

Frequency[<List of Class Boundaries>, <List of Raw Data>, <Use Density> , <Density Scale Factor> (optional)]

Returns a list of frequencies for the corresponding Histogram Command.

If *Use density* = *false*, returns the same list as Frequency[<List of Class Boundaries>, <List of Raw Data>]

If *Use density* = *true*, returns the list of frequencies of each class.

Example: Let `data = {1, 2, 2, 2, 3, 3, 4, 4, 4, 4}` be the list of raw data and `classes={0, 2, 5}` the list of class boundaries. Then `Frequency[classes, data, false]` and `Frequency[classes, data]` both return the list *{1, 9}*, while `Frequency[classes, data, true]` returns the list *{0.5, 3}*.

Frequency[<Boolean Cumulative>, <List of Class Boundaries>, <List of Raw Data>, <Use Density> , <Density Scale Factor> (optional)]

Returns a list of frequencies for the corresponding Histogram Command.

Frequency[<List of Text>, <List of Text>]

Returns a contingency matrix containing counts of paired values from the two lists. The rows of the matrix correspond to the unique values in the first list, and the columns correspond to the unique values in the second list. To get a list of the unique values for each list use the command Unique Command.

Example: Let `list1 = {"a", "b", "b", "c", "c", "c", "c"}` and `list2 = {"a", "b", "a", "a", "c", "c", "d"}`. Then `Frequency[ list1, list2 ]` returns the matrix

$$\begin{pmatrix}1 & 0 & 0 & 0\\1 & 1 & 0 & 0\\1 & 0 & 2 & 1\end{pmatrix}$$

Note: See also the ContingencyTable command.

FrequencyTable Command

FrequencyTable[<List of Raw Data>]

Returns a table (as text) whose first column contains sorted list of unique elements of list *L* and second column contains the count of the occurrences of value in the first column. List *L* can be numbers or text.

FrequencyTable[<Boolean Cumulative>, <List of Raw Data>]

If *Cumulative* = *false*, returns the same table as Frequency[<List of Raw Data>]

If *Cumulative* = *true*, returns a table whose first column is the same as in FrequencyTable[<List of Raw Data>] and the second contains cumulative frequencies of values in the first column.

FrequencyTable[<List of Class Boundaries>, <List of Raw Data>]

Returns a table (as text) whose first column contains intervals (classes) and second column contains the count of numbers in *List of Raw Data*, which belong to the interval in the first column. All intervals except the highest interval are of the form [a, b). The highest interval has the form [a, b].

FrequencyTable[<Boolean Cumulative>, <List of Class Boundaries>, <List of Raw Data>]

If *Cumulative* = *false*, returns the same table as FrequencyTable[<List of Class Boundaries>, <List of Raw Data>]

If *Cumulative* = *true*, returns a table whose first column is the same as in FrequencyTable[<List of Raw Data>] and the second contains cumulative frequencies of values in the first column.

FrequencyTable[<List of Class Boundaries>, <List of Raw Data>, <Use Density> , <Density Scale Factor (optional)>]

Returns a table (as text) whose first column contains intervals (classes) and second contains frequencies for the corresponding Histogram Command.

FrequencyTable[<Boolean Cumulative>, <List of Class Boundaries>, <List of Raw Data>, <Use Density> , <Density Scale Factor (optional)>]

Returns a table (as text) whose first column contains intervals (classes) and second contains frequencies for the corresponding Histogram Command.

Note: This command is similar to Frequency Command and Histogram Command. Articles about these commands contain some related examples.

GeometricMean Command

GeometricMean[List of Numbers]

Returns the geometric mean of given list of numbers.

Example: `GeometricMean[{13, 7, 26, 5, 19}]` yields 11.76.

HarmonicMean Command

HarmonicMean[<List of Numbers>]

Returns the harmonic mean of given list of numbers.

Example: `HarmonicMean[{13, 7, 26, 5, 19}]` yields 9.79.

Mean Command

Mean[<List of Raw Data>]

Calculates the arithmetic mean of list elements.

Example:

- `Mean[{1, 2, 3, 2, 4, 1, 3, 2}]` yields *a = 2.25* and
- `Mean[{1, 3, 5, 9, 13}]` yields *a = 6.2*.

Mean[<List of Numbers>, <List of Frequencies>]

Calculates the weighted mean of the list elements.

Example:

- `Mean[{1, 2, 3, 4}, {6, 1, 3, 6}]` yields *a = 2.56* and
- `Mean[{1, 2, 3, 4}, {1, 1, 3, 6}]` yields *a = 3.27*.

CAS Syntax

Mean[<List of Numbers>]

Calculates the arithmetic mean of the list elements.

Example:

`Mean[{1, 2, 3, 5, 44}]` yields *a = 11*.

Note:

See also MeanX, MeanY, and SD commands.

MeanX Command

MeanX[<List of Points>]

Calculates the mean of the *x*-coordinates of the points in the list.

Example: `MeanX[{(0,0), (3,2), (5,1), (2,1), (2,4)}]` yields *2.4*

MeanY Command

MeanY[<List of Points>]

Calculates the mean of the *y*-coordinates of the points in the list.

Example: `MeanY[{(0,0), (3,2), (5,1), (2,1), (2,4)}]` yields *1.6*

Median Command

Median[<List of Raw Data>]

Determines the median of the list elements.

Examples:

- `Median[{1, 2, 3}]` yields *2*.
- `Median[{1, 1, 8, 8}]` yields *4.5*.

Median[<List of Numbers>, <List of Frequencies>]

Calculates the weighted median of the list elements.

Example:

- `Median[{1, 2, 3}, {4, 1, 3}]` yields *1.5*.
- `Median[{1, 2, 3}, {4, 1, 6}]` yields *3*.

CAS Syntax

Median[<List of Numbers>]

Determines the median of the list elements.

Examples:

- `Median[{1, 2, 3}]` yields *2*.
- `Median[{1, 1, 8, 8}]` yields 4.5

Note:

- If the length of the given list is even, the arithmetic mean of the two center elements is returned.
- See also Mean command.

Mode Command

Mode[<List of Numbers>]

Determines the mode(s) of the list elements.

Examples: Mode[{1, 2, 3, 4}] returns an empty list {}.Mode[{1, 1, 1, 2, 3, 4}] returns the list {1} .Mode[{1, 1, 2, 2, 3, 3, 4}] returns the list {1, 2, 3}.

CorrelationCoefficient Command

CorrelationCoefficient[<List of x-coordinates>, <List of y-coordinates>]

Calculates the product moment correlation coefficient using the given *x*- and *y*-coordinates.

Example:

`CorrelationCoefficient[{1, 3, 2, 1, 5, 2}, {1, 6, 4, 3, 3, 2}]` yields *0.36*.

CorrelationCoefficient[<List of Points>]

Calculates the product moment correlation coefficient using the coordinates of the given points.

Example:

`CorrelationCoefficient[{(1, 1), (3, 6), (2, 4), (1, 3), (5, 3), (2, 2)}]` yields *0.36*.

Percentile Command

Percentile[<List of Numbers>, <Percent>]

Let *P* equal the given *Percent*.

Returns the value that cuts off the first *P* percent of the *list of numbers*, when the list is sorted in ascending order. *Percent* must be a number in the interval $0 < P \leq 1$.

Example:

`Percentile[{1, 2, 3, 4}, 0.25]` yields *1.25*.

Note: The commands Quartile and Percentile use different rules and do not always return matching results.Example:Q1[{1, 2, 3, 4}] yields 1.5.Percentile[{1, 2, 3, 4}, 0.25] yields 1.25.

Q1 Command

Q1[<List of Raw Data>]

Determines the lower quartile of the list elements.

Example:

`Q1[{1, 2, 3, 4}]` yields *1.5*.

Q1[<List of Numbers>, <List of Frequencies>]

Determines the lower quartile of the list elements considering the frequencies.

Example:

`Q1[{1, 2, 3, 4}, {3, 2, 4, 2}]` yields *1*.

Note:

GeoGebra uses the **Moore & McCabe (2002)** method to calculate quartiles, see http://mathworld.wolfram.com/Quartile.html

Q3 Command

Q3[<List of Raw Data>]

Determines the upper quartile of the list elements.

Example:

`Q3[{1, 2, 3, 4}]` yields *3.5*.

Q3[<List of Numbers>, <List of Frequencies>]

Determines the upper quartile of the list elements considering the frequencies.

Example:

`Q3[{1, 2, 3, 4}, {3, 2, 4, 2}]` yields *3*.

Note:

GeoGebra uses the **Moore & McCabe (2002)** method to calculate quartiles, see http://mathworld.wolfram.com/Quartile.html

RSquare Command

RSquare[<List of Points>, <Function>]

Calculates the coefficient of determination R^2 = *1-SSE/Syy*, between the *y*-values of the points in the list and the function values of the *x*-values in the list.

Example:

`RSquare[{(-3, 2), (-2, 1), (-1, 3), (0, 4), (1, 2), (2, 4), (3, 3), (4, 5), (6, 4)}, 0.5x + 2.5]` yields *0.28*.

RootMeanSquare Command

RootMeanSquare[<List of Numbers>]

Returns the root mean square of given list of numbers.

Example:

`RootMeanSquare[{3, 4, 5, 3, 2, 3, 4}]` yields *3.5456*.

SD Command

SD[<List of Numbers>]

Calculates the standard deviation of the numbers in the list.

Example: `SD[{1, 2, 3, 4, 5}]` yields *1.41*

SD[<List of Numbers>, <List of Frequencies>]

Calculates the weighted standard deviation of the given numbers.

Example: `SD[{20, 40, 41, 42, 40, 54}, {20, 6, 4, 5, 2} ]` yields *5.96*

CAS Syntax

SD[<List of Numbers>]

Calculates the standard deviation of the numbers in the list.

Example:

- `SD[{1, 2, 3, 4, 5}]` yields $\sqrt{2}$.
- `SD[{-3 + 2 x, -1- 4 x, -2 + 5 x^2}]` is evaluated as = $\frac{\sqrt{25x⁴ + 10x³ + 28x² - 18x + 3} \; \sqrt{2} } { \; 3 \; }$.

Note:

See also Mean Command.

SDX Command

SDX[<List of Points>]

Returns standard deviation of x-coordinates of points from the given list.

Example: `SDX[{(1, 1), (2, 2), (3, 1), (3, 3), (4, 2), (3, -1)}]` yields *a = 0.97*.

SDY Command

SDY[<List of Points>]

Returns standard deviation of y-coordinates of points from the given list.

Example: `SDY[{(1, 1), (2, 2), (3, 1), (3, 3), (4, 2), (3, -1)}]` yields *a = 1.25*.

Sxx Command

Sxx[<List of Numbers>]

Calculates the statistic $\sum x^2 - \frac{(\sum x)^2}{n}$.

Sxx[<List of Points>]

Calculates the statistic $\sum x^2 - \frac{(\sum x)^2}{n}$using the *x*-coordinates of the given points.

Sxy Command

Sxy[<List of Points>]

Calculates the statistic $\sum xy - \frac{(\sum x)(\sum y)}{n}$using the coordinates of the given points.

Sxy[<List of Numbers>, <List of Numbers>]

Calculates the statistic $\sum xy - \frac{(\sum x)(\sum y)}{n}$, where *x* are the values in the first list, and *y* are the values in the second given list.

Syy Command

Syy[<List of Points>]

Calculates the statistic $\sum y^2 - \frac{(\sum y)^2}{n}$ using the *y*-coordinates of the given points.

Sample Command

Sample[<List>, <Size>]

Returns list of *n* randomly chosen elements of a list; elements can be chosen several times.

Example:

`Sample[{1, 2, 3, 4, 5}, 5]` yields for example *list1 = {1, 2, 1, 5, 4}*.

Sample[<List>, <Size>, <With Replacement>]

Returns list of *n* randomly chosen elements of a list. Elements can be chosen several times if and only if the last parameter is true.

Example:

`Sample[{1, 2, 3, 4, 5}, 5, true]` yields for example *list1 = {2, 3, 3, 4, 5}*.

CAS Syntax

Sample[<List>, <Size>]

Returns list of *n* randomly chosen elements of a list; elements can be chosen several times.

Example:

`Sample[{-5, 2, a, 7, c}, 3]` yields for example *{a, 7, -5}*.

Sample[<List>, <Size>, <With Replacement>]

Returns list of *n* randomly chosen elements of a list. Elements can be chosen several times if and only if the last parameter is true.

Example:

The list can include lists as well: Let *List1* be *{1, 2, 3}*.

`Sample[{List1, 4, 5, 6, 7, 8}, 3, false]` yields for example *{6, {1, 2, 3}, 4}*.

SampleSD Command

SampleSD[<List of Numbers>]

Returns sample standard deviation of given list of numbers.

Example:

`SampleSD[{1, 2, 3}]` yields *1*.

SampleSD[<List of Numbers>, <List of Frequencies>]

Returns the standard deviation of the sample of numbers having the given frequencies.

Example:

`SampleSD[{1, 2, 3, 4, 4},{1, 1, 1, 2}]` yields *1.08*.

CAS Syntax

SampleSD[<List of Numbers>]

Returns sample standard deviation of given list of numbers. If the list contains undefined variables, it yields a formula for the sample standard deviation.

Example:

`SampleSD[{1, 2, a}]` yields .

SampleSDX Command

SampleSDX[<List of Points>]

Returns sample standard deviation of x-coordinates of points from the given list.

Example:

`SampleSDX[ {(2, 3), (1, 5), (3, 6), (4, 2), (1, 1), (2, 5)} ]` yields *a* = *1.17*.

SampleSDY Command

SampleSDY[<List of Points>]

Returns sample standard deviation of y-coordinates of points from the given list.

Example:

`SampleSDY[ {(2, 3), (1, 5), (3, 6), (4, 2), (1, 1), (2, 5)} ]` yields *a = 1.97*.

SampleVariance Command

SampleVariance[<List of Raw Data>]

Returns the sample variance of given list of numbers.

Example:

`SampleVariance[ {1, 2, 3, 4, 5} ]` yields *a = 2.5*.

SampleVariance[<List of Numbers>, <List of Frequencies>]

Returns the sample variance of given list of numbers considering the frequencies.

Example:

`SampleVariance[ {1, 2, 3, 4, 5}, {3, 2, 4, 4, 1} ]` yields *a = 1.29*.

CAS Syntax

SampleVariance[<List of Numbers>]

Returns the sample variance of given list of numbers. If the list contains undefined variables, it yields a formula for the sample variance.

Example:

`SampleVariance[ {x, y, z} ]` yields .

Shuffle Command

Shuffle[<List>]

Returns list with same elements, but in random order.

Note: You can recompute the list via *Recompute all objects* in View Menu (or pressing F9).

See also RandomElement Command and RandomBetween Command.

CAS Syntax

Shuffle[<List>]

Returns list with same elements, but in random order.

Examples: Shuffle[{3, 5, 1, 7, 3}] yields for example {5, 1, 3, 3, 7}.Shuffle[Sequence[20]] gives the first 20 whole numbers in a random order.

SigmaXX Command

SigmaXX[<List of Points>]

Calculates the sum of squares of the *x*-coordinates of the given points.

Example: Let `list1 = { (-3, 4), (-1, 4), (-2, 3), (1, 3), (2, 2), (1, 5) }` be a list of points. `SigmaXX[ list1 ]` yields the value *20*.

SigmaXX[<List of Raw Data>]

Calculates the sum of squares of the given numbers.

Example: In order to work out the variance of a list you may use `SigmaXX[list] / Length[list] - Mean[list]^2`.

SigmaXX[<List of Numbers>, <List of Frequencies>]

Calculates the weighted sum of squares of the given numbers.

Example: Let `list1 = {3, 2, 4, 3, 3, 2, 1, 1, 2, 3, 3, 4, 5, 3, 2, 1, 1, 2, 3}` be a list of numbers. `Unique[ list1 ]` yields *list2 = {1, 2, 3, 4, 5}* and `Frequency[ list1 ]` yields *list3 = {4, 5, 7, 2, 1}*. Command `SigmaXX[ list2, list3 ]` yields the value *144*.

SigmaXY Command

SigmaXY[<List of Points>]

Calculates the sum of the products of the *x*- and *y*-coordinates.

Example: You can work out the covariance of a list of points using `SigmaXY[list]/Length[list] - MeanX[list] * MeanY[list]`.

SigmaXY[<List of x-coordinates>, <List of y-coordinates>]

Calculates the sum of the products of the *x*- and *y*-coordinates.

Example: Let `A = (-3, 4)`, `B = (-1, 4)`, `C = (-2, 3)` and `D = (1, 3)` be points. `{x(A), x(B), x(C), x(D)}` yields the x-coordinates of the points in a list *list1 = {-3, -1, -2, 1}* and `{y(A), y(B), y(C), y(D)}` yields the y-coordinates of the points in a list *list2 = {4, 4, 3, 3}*. Command `SigmaXY[ list1, list2 ]` yields *a = -19*.

SigmaYY Command

SigmaYY[<List of Points>]

Calculates the sum of squares of *y*-coordinates of the given points.

Example: Let `list = { (-3, 4), (-1, 4), (-2, 3), (1, 3), (2, 2), (1, 5) }` be a list of points. `SigmaYY[ list ]` yields *a = 79*.

Spearman Command

Spearman[<List of Points>]

Returns Spearman's rank correlation coefficient of x-coordinates and y-coordinates of points of a list.

Example: Let `list = { (-3, 4), (-1, 4), (-2, 3), (1, 3), (2, 2), (1, 5) }` be a list of points. `Spearman[ list ]` yields *a = -0.37*.

Spearman[<List of Numbers>, <List of Numbers>]

Returns Spearman's rank correlation coefficient of two lists.

Example: Let `list1 = {3, 2, 4, 5, 1, 6, 8, 9}` and `list2 = {5, 6, 8, 2, 1, 3, 4, 7}` be two lists. `Spearman[ list1, list2 ]` yields *a = 0.24*.

Sum Command

Sum[<List>]

Calculates the sum of all list elements.

Examples:

- `Sum[{1, 2, 3}]` yields the number *a = 6*.
- `Sum[{x^2, x^3}]` yields $f(x) = x^2 + x^3$.
- `Sum[Sequence[ i, i, 1, 100 ]]` yields the number *a = 5050*.
- `Sum[{(1, 2), (2, 3)}]` yields the point *A = (3, 5)*.
- `Sum[{(1, 2), 3}]` yields the point *B = (4, 5)*.
- `Sum[{"a", "b", "c"}]` yields the text *"abc"*.

Sum[<List>, <Number of Elements>]

Calculates the sum of the first *n* list elements.

Example:

`Sum[{1, 2, 3, 4, 5, 6}, 4]` yields the number *a = 10*.

Sum[<List>, <List of Frequencies>]

Returns the sum of given list of numbers considering the frequencies.

Example:

`Sum[{1, 2, 3, 4, 5}, {3, 2, 4, 4, 1}]` yields *a = 40*.

Note: This command works for numbers, points, vectors, text, and functions.

CAS Syntax

Sum[<List>]

Calculates the sum of all list elements.

Examples:

- `Sum[{1, 2, 3}]` yields *6*.
- `Sum[{a, b, c}]` yields *a + b + c*.

Sum[<Expression>, <Variable>, <Start Value>, <End Value>]

Computes sum $\sum_{t=StartValue}^{EndValue} f(t)$. End value might be infinity.

Examples:

- `Sum[i^2, i, 1, 3]` yields *14*.
- `Sum[r^i, i, 0, n]` yields $\frac{r^{n+1}}{r-1} - \frac{1}{r-1}$.
- `Sum[(1/3)^i, i, 0, Infinity]` yields $\frac{3}{2}$.

SumSquaredErrors Command

SumSquaredErrors[<List of Points>, <Function>]

Calculates the sum of squared errors, SSE, between the y-values of the points in the list and the function values of the x-values in the list.

Example: If we have a list of points: L={A,B,C,D,E} and have calculated for example: `f(x)=FitPoly[L,1]` and `g(x)=FitPoly[L,2]`, then it is possible to decide which of the two functions offers the best fit, in the sense of the least sum of squared errors (Gauss), by comparing: `sse_f=SumSquaredErrors[L,f]` and `sse_g=SumSquaredErrors[L,g]`.

TMean2Estimate Command

TMean2Estimate[<List of Sample Data 1>, <List of Sample Data 2>, <Level>, <Boolean Pooled>]

Calculates a t confidence interval estimate of the difference between two population means using the given sample data sets and confidence *Level*.

If *Pooled* = true, then population variances are assumed equal and sample standard deviations are combined in calculation.

If *Pooled* = false, then population variances are not assumed equal and sample standard deviations are not combined.

Results are returned in list form as *{lower confidence limit, upper confidence limit}*.

TMean2Estimate[<Sample Mean 1>, <Sample Standard Deviation 1>, <Sample Size 1>, <Sample Mean 2>, <Sample Standard Deviation 2>, <Sample Size 2>, <Level>, <Boolean Pooled>]

Calculates a t confidence interval estimate of the difference between two population means using the given sample statistics and confidence *Level*. *Pooled* is defined as above. Results are returned in list form as *{lower confidence limit, upper confidence limit}*.

TMeanEstimate Command

TMeanEstimate[<List of Sample Data>, <Level>]

Calculates a t confidence interval estimate of a population mean using the given sample data and confidence *Level*. Results are returned in list form as *{lower confidence limit, upper confidence limit}*.

TMeanEstimate[<Sample Mean>, <Sample Standard Deviation>, <Sample Size>, <Level>]

Calculates a t confidence interval estimate of a population mean using the given sample statistics and confidence level. Results are returned in list form as *{lower confidence limit, upper confidence limit}*.

TTest Command

TTest[<List of Sample Data>, <Hypothesized Mean>, <Tail>]

Performs a one-sample t-test of a population mean using the given list of sample data. *Hypothesized Mean* is the population mean assumed in the null hypothesis. *Tail* has possible values "<", ">" , "≠". These specify the alternative hypothesis as follows.

"<" = population mean < *Hypothesized Mean*

">" = population mean > *Hypothesized Mean*

"≠" = population mean ≠ *Hypothesized Mean*

Results are returned in list form as *{Probability value, t-test statistic}*.

Example:

`TTest[{1, 2, 3, 4, 5}, 3, "<"]` yields *{0.5, 0}*.

TTest[<Sample Mean>, <Sample Standard Deviation>, <Sample Size>, <Hypothesized Mean>, <Tail>]

Performs a one-sample t-test of a population mean using the given sample statistics. *Hypothesized Mean* and *Tail* are defined as above. Results are returned in list form as *{Probability value, t-test statistic}*.

Example:

`TTest[4, 1, 12, 4, "≠"]` yields *{1, 0}*.

TTest2 Command

TTest2[<List of Sample Data 1>, <List of Sample Data 2>, <Tail>, <Boolean Pooled>]

Performs a t-test of the difference between two population means using the given lists of sample data. Tail has possible values "<", ">" , "≠" that determine the following alternative hypotheses:

"<" = difference in population means < 0

">" = difference in population means > 0

"≠" = difference in population means ≠ 0

If *Pooled* = true, then population variances are assumed equal and sample standard deviations are combined in calculation.

If *Pooled* = false, then population variances are not assumed equal and sample standard deviations are not combined.

Results are returned in list form as *{Probabilty value, t-test statistic}*.

TTest2[<Sample Mean 1>, <Sample Standard Deviation 1>, <Sample Size 1>, <Sample Mean 2>, <Sample Standard Deviation 2>, <Sample Size 2>, <Tail>, <Boolean Pooled>]

Performs a t-test of the difference between two population means using the given sample statistics. *Tail* and *Pooled* are defined as above. Results are returned in list form as *{Probabilty value, t-test statistic}*.

TTestPaired Command

TTestPaired[<List of Sample Data 1>, <List of Sample Data 2>, <Tail>]

Performs a paired t-test using the given lists of paired sample data. *Tail* has possible values "<", ">" , "≠" that determine the following alternative hypotheses:

"<" = μ < 0

">" = μ > 0

"≠" = μ ≠ 0

(μ is the mean paired difference of the population)

Results are returned in list form as *{Probabilty value, t-test statistic}*.

Example:

`TTestPaired[{1, 2, 3, 4, 5}, {1, 1, 3, 5, 5}, "<"]` yields *{0.5, 0}*.

Variance Command

Variance[<List of Raw Data>]

Calculates the variance of list elements.

Example:

`Variance[{1, 2, 3}]` yields *0.67*.

Variance[<List of Numbers>, <List of Frequencies>]

Calculates the variance of list elements, considering the frequencies.

Example:

`Variance[{1, 2, 3} , {1, 2, 1}]` yields *0.5*.

CAS Syntax

Variance[<List of Numbers>]

Calculates the variance of list elements. If the list contains undefined variables, it yields a formula for the variance.

Examples: Variance[{1, 2, a}] yields \frac{2 a^{2} - 6 a + 6}{9}.Variance[{1, 2, a} {20, 3, 1}] yields \frac{2 a² - 52 a + 632}{9}.

Probability Commands

- Bernoulli
- BinomialDist
- BinomialCoefficient
- Cauchy
- ChiSquared
- Erlang
- Exponential
- FDistribution
- Gamma
- HyperGeometric
- InverseBinomial
- InverseCauchy
- InverseChiSquared
- InverseExponential
- InverseFDistribution
- InverseGamma
- InverseHyperGeometric
- InverseNormal
- InversePascal
- InversePoisson
- InverseTDistribution
- InverseWeibull
- InverseZipf

- Logistic
- LogNormal
- Normal
- Pascal
- Poisson
- RandomBetween
- RandomBinomial
- RandomNormal
- RandomPoisson
- RandomUniform
- TDistribution
- Triangular
- Uniform
- Weibull
- Zipf

Bernoulli Command

Bernoulli[<Probability p>, <Boolean Cumulative>]

For *Cumulative = false* returns the bar graph of Bernoulli distribution where probability of success is equal to *p*.

For *Cumulative = true* returns the bar graph of cumulative Bernoulli distribution.

BinomialCoefficient Command

BinomialCoefficient[<Number>, <Number>]

Calculates the binomial coefficient $\binom{n}{r}$. The first Number represents all elements *n* and the second Number represents the selected elements *r*.

Example:

`BinomialCoefficient[5, 3]` yields *10*.

CAS Syntax

BinomialCoefficient[<Number>, <Number>]

Calculates the binomial coefficient $\binom{n}{r}$. The first Number represents all elements *n* and the second Number represents the selected elements *r*. If you type undefined variables instead of numbers it yields a formula for the binomial coefficient.

Example:

`BinomialCoefficient[n, 3]` yields $\frac{n^3 - 3n^2 + 2n}{6}$.

Note: See also nPr command.

BinomialDist Command

BinomialDist[<Number of Trials>, <Probability of Success>]

Returns a bar graph of a Binomial distribution.

The parameter *Number of Trials* specifies the number of independent Bernoulli trials and the parameter *Probability of Success* specifies the probability of success in one trial.

BinomialDist[<Number of Trials>, <Probability of Success>, <Boolean Cumulative>]

Returns a bar graph of a Binomial distribution when *Cumulative* = false.

Returns a graph of a cumulative Binomial distribution when *Cumulative* = true.

First two parameters are same as above.

BinomialDist[<Number of Trials>, <Probability of Success>, <Variable Value>, <Boolean Cumulative>]

Let X be a Binomial random variable and let v be the variable value.

Returns P(X = *v*) when *Cumulative* = false.

Returns P(X ≤ *v*) when *Cumulative* = true.

First two parameters are same as above.

CAS Specific Syntax

In CAS View only one syntax is allowed:

BinomialDist[<Number of Trials>, <Probability of Success>, <Variable Value>, <Boolean Cumulative>]

Let X be a Binomial random variable and let v be the variable value.

Returns P(X = *v*) when *Cumulative* = false.

Returns P(X ≤ *v*) when *Cumulative* = true.

Example:

Assume transfering three packets of data over a faulty line. The chance an arbitrary packet transfered over this line becomes corrupted is $\frac{1}{10}$, hence the propability of transfering an arbitrary packet successfully is $\frac{9}{10}$.

- `BinomialDist[3, 0.9, 0, false]` yields $\frac{1}{1000}$, the probability of none of the three packets being transferred successfully,
- `BinomialDist[3, 0.9, 1, false]` yields $\frac{27}{1000}$, the probability of exactly one of three packets being transferred successfully,
- `BinomialDist[3, 0.9, 2, false]` yields $\frac{243}{1000}$, the probability of exactly two of three packets being transferred successfully,
- `BinomialDist[3, 0.9, 3, false]` yields $\frac{729}{1000}$, the probability of all three packets being transferred successfully.
- `BinomialDist[3, 0.9, 0, true]` yields $\frac{1}{1000}$, the probability of none of the three packets being transferred successfully,
- `BinomialDist[3, 0.9, 1, true]` yields $\frac{7}{250}$, the probability of at most one of three packets being transferred successfully,

- `BinomialDist[3, 0.9, 2, true]` yields $\frac{271}{1000}$, the probability of at most two of three packets being transferred successfully,
- `BinomialDist[3, 0.9, 3, true]` yields *1*, the probability of at most three of three packets being transferred successfully.
- `BinomialDist[3, 0.9, 4, false]` yields *0*, the probability of exactly four of three packets being transferred successfully,
- `BinomialDist[3, 0.9, 4, true]` yields *1*, the probability of at most four of three packets being transferred successfully.

Cauchy Command

Cauchy[<Median>, <Scale>, x]

Creates probability density function (pdf) of Cauchy distribution.

Cauchy[<Median>, <Scale>, x, <Boolean Cumulative>]

If *Cumulative* is true, creates cumulative distribution function of Cauchy distribution, otherwise creates pdf of Cauchy distribution.

Cauchy[<Median>, <Scale>, <Variable Value>]

Calculates the value of cumulative distribution function of Cauchy distribution at *Variable Value v*, i.e. the probability *P(X ≤ v)* where *X* is a random variable with Cauchy given by parameters *Median* and *Scale*.

Note: Returns the probability for a given *x*-coordinate's value (or area under the Cauchy distribution curve to the left of the given *x*-coordinate).

CAS Syntax

Cauchy[<Median>, <Scale>, <Variable Value>]

Calculates the value of cumulative distribution function of Cauchy distribution at *Variable Value v*, i.e. the probability *P(X ≤ v)* where *X* is a random variable with Cauchy given by parameters *Median* and *Scale*.

Example:

`Cauchy[1, 2, 3]` yields $\frac{3}{4}$.

ChiSquared Command

ChiSquared[<Degrees of Freedom>, x]

Creates probability density function (pdf) of Chi squared distribution with the appropriate degrees of freedom.

ChiSquared[<Degrees of Freedom>, <Variable Value>]

Calculates the value of cumulative distribution function of Chi squared distribution at *Variable Value v*, i.e. the probability *P(X ≤ v)* where *X* is a random variable with Chi squared distribution with the appropriate degrees of freedom.

Note: Returns the probability for a given *x*-coordinate's value (or area under the Chi squared distribution curve to the left of the given *x*-coordinate).

ChiSquared[<Degrees of Freedom>, x, <Boolean Cumulative>]

If the logical value is *true*, creates cumulative distribution function of Chi squared distribution, otherwise creates pdf of Chi squared distribution.

CAS Syntax

ChiSquared[<Degrees of Freedom>, <Variable Value>]

Calculates the value of cumulative distribution function (cdf) of Chi squared distribution at *Variable Value v*, i.e. the probability *P(X ≤ v)* where *X* is a random variable with Chi squared distribution with the appropriate degrees of freedom.

Example:

`ChiSquared[4, 3]` yields $\gamma(2, \frac{3}{2})$, which is approximately *0.44*.

Erlang Command

Erlang[<Shape>, <Rate>, x]

Creates probability density function (pdf) of Erlang distribution with parameters shape *k* and rate *λ*.

Erlang[<Shape>, <Rate>, x, <Boolean Cumulative>]

If *Cumulative* is true, creates cumulative distribution function of Erlang distribution, otherwise creates pdf of Erlang distribution.

Erlang[<Shape>, <Rate>, <Variable Value>]

Calculates the value of cumulative distribution function of Erlang distribution at variable value *v*, i.e. the probability *P(X ≤ v)* where *X* is a random variable with Erlang distribution given by parameters shape *k* and rate *λ*.

Note: Returns the probability for a given *x*-coordinate's value (or area under the Erlang distribution curve to the left of the given *x*-coordinate).

CAS Syntax

Erlang[<Shape>, <Rate>, x]

Creates probability density function (pdf) of Erlang distribution with parameters shape *k* and rate *λ*.

Erlang[<Shape>, <Rate>, x, <Boolean Cumulative>]

If *Cumulative* is true, creates cumulative distribution function of Erlang distribution, otherwise creates pdf of Erlang distribution.

Erlang[<Shape>, <Rate>, <Variable Value>]

Calculates the value of cumulative distribution function of Erlang distribution at variable value *v*, i.e. the probability *P(X ≤ v)* where *X* is a random variable with Erlang distribution given by parameters shape *k* and rate *λ*.

Note: Returns the probability for a given *x*-coordinate's value (or area under the Erlang distribution curve to the left of the given *x*-coordinate).

Exponential Command

Exponential[<Lambda>, x]

Creates probability density function (pdf) of exponential distribution with parameter *lambda*.

Exponential[<Lambda>, x, <Boolean Cumulative>]

If *Cumulative* is true, creates cumulative distribution function (cdf) of exponential distribution, otherwise creates pdf of Exponential distribution.

Exponential[<Lambda>, <Variable Value>]

Calculates the value of cumulative distribution function of Exponential distribution at variable value *v*, i.e. the probability *P(X ≤ v)* where *X* is a random variable with Exponential distribution with parameter *lambda*.

Note: Returns the probability for a given *x*-coordinate's value (or area under the Exponential distribution curve to the left of the given *x*-coordinate).

CAS Syntax

Exponential[<Lambda>, <Variable Value>]

Calculates the value of cumulative distribution function of exponential distribution at variable value *v*, i.e. the probability *P(X ≤ v)* where *X* is a random variable with Exponential distribution with parameter *lambda*.

Example:

`Exponential[2, 1]` yields $\frac{e^2 - 1}{e^2}$, which is approximately *0.86*.

FDistribution Command

FDistribution[<Numerator Degrees of Freedom>, <Denominator Degrees of Freedom>, x]

Creates probability density function (pdf) of F-distribution with parameters *n, d* (*n* for *Numerator Degrees of Freedom*, *d* for *Denominator Degrees of Freedom*).

FDistribution[<Numerator Degrees of Freedom>, <Denominator Degrees of Freedom>, x, <Boolean Cumulative>]

If *Cumulative* is true, creates cumulative distribution function of F-distribution, otherwise creates pdf of F-distribution.

FDistribution[<Numerator Degrees of Freedom>, <Denominator Degrees of Freedom>, <Variable Value>]

Calculates the value of cumulative distribution function of F-distribution at *Variable Value v*, i.e. the probability *P(X≤v)* where *X* is a random variable with F-distribution given by parameters *n, d* (*n* for *Numerator Degrees of Freedom*, *d* for *Denominator Degrees of Freedom*).

Note: Returns the probability for a given *x*-coordinate's value (or area under the F-distribution curve to the left of the given *x*-coordinate).

CAS Syntax

FDistribution[<Numerator Degrees of Freedom>, <Denominator Degrees of Freedom>, <Variable Value>]

Calculates the value of cumulative distribution function of F-distribution at *Variable Value v*, i.e. the probability *P(X≤v)* where *X* is a random variable with F-distribution given by parameters *n, d* (*n* for *Numerator Degrees of Freedom*, *d* for *Denominator Degrees of Freedom*).

Gamma Command

Gamma[<Number α>, <Number β>, x]

Creates probability density function (pdf) of gamma distribution with parameters *α, β*.

Gamma[<Number α>, <Number β>, x, <Boolean Cumulative>]

If *Cumulative* is true, creates cumulative distribution function of gamma distribution, otherwise creates pdf of gamma distribution.

Gamma[<Number α>, <Number β>, <Variable Value v>]

Calculates the value of cumulative distribution function of gamma distribution at *v*, i.e. the probability *P(X≤v)* where *X* is a random variable with gamma distribution given by parameters *α, β*.

Note:

Returns the probability for a given *x*-coordinate's value (or area under the gamma distribution curve to the left of the given *x*-coordinate).

CAS Syntax

Gamma[<Number α>, <Number β>, <Variable Value v>]

Calculates the value of cumulative distribution function of gamma distribution at *v*, i.e. the probability *P(X≤v)* where *X* is a random variable with gamma distribution given by parameters *α, β*.

HyperGeometric Command

HyperGeometric[<Population Size>, <Number of Successes>, <Sample Size>]

Returns a bar graph of a Hypergeometric distribution.

Parameters:

Population size: number of balls in the urn

Number of Successes: number of white balls in the urn

Sample Size: number of balls drawn from the urn

The bar graph shows the probability function of the number of white balls in the sample.

HyperGeometric[<Population Size>, <Number of Successes>, <Sample Size>, <Boolean Cumulative>]

Returns a bar graph of a Hypergeometric distribution when *Cumulative* = false.

Returns the graph of a cumulative Hypergeometric distribution when *Cumulative* = true.

First three parameters are same as above.

HyperGeometric[<Population Size>, <Number of Successes>, <Sample Size>, <Variable Value>, <Boolean Cumulative>]

Let X be a Hypergeometric random variable and v the variable value.

Returns P(X = *v*) when *Cumulative* = false.

Returns P(X ≤ *v*) when *Cumulative* = true.

First three parameters are same as above.

CAS Syntax

HyperGeometric[<Population Size>, <Number of Successes>, <Sample Size>, <Variable Value>, <Boolean Cumulative>]

Let X be a Hypergeometric random variable and v the variable value.

Returns P(X = *v*) when *Cumulative* = false.

Returns P(X ≤ *v*) when *Cumulative* = true.

The first three parameters are the same as above.

Example:

Assume you select two balls out of ten balls, two of which are white, without putting any back.

- `HyperGeometric[10, 2, 2, 0, false]` yields $\frac{28}{45}$, the probability of selecting zero white balls,
- `HyperGeometric[10, 2, 2, 1, false]` yields $\frac{16}{45}$, the probability of selecting one white ball,
- `HyperGeometric[10, 2, 2, 2, false]` yields $\frac{1}{45}$, the probability of selecting both white balls,
- `HyperGeometric[10, 2, 2, 3, false]` yields *0*, the probability of selecting three white balls.
- `HyperGeometric[10, 2, 2, 0, true]` yields $\frac{28}{45}$, the probability of selecting zero (or less) white balls,
- `HyperGeometric[10, 2, 2, 1, true]` yields $\frac{44}{45}$, the probability of selecting one or less white balls,

- `HyperGeometric[10, 2, 2, 2, true]` yields *1*, the probability of selecting two or less white balls and
- `HyperGeometric[10, 2, 2, 3, true]` yields *1*, the probability of selecting three or less white balls.

InverseBinomial Command

InverseBinomial[<Number of Trials>, <Probability of Success>, <Probability>]

Returns least integer *n* such that *P(X ≤ n) ≥ p*, where *p* is the probability and *X* is binomial random variable given by *Number of Trials* and *Probability of Success*.

Note: See also BinomialDist Command.

InverseCauchy Command

InverseCauchy[<Median>, <Scale>, <Probability>]

Computes the inverse of cumulative distribution function of Cauchy distribution at probability *p*, where the Cauchy distribution is given by median *m* and scale *s*.

In other words, finds *t* such that *P(X ≤ t) = p*, where *X* is Cauchy random variable.

Probability *p* must be from [0,1].

InverseChiSquared Command

InverseChiSquared[<Degrees of Freedom>, <Probability>]

Computes the inverse of cumulative distribution function of Chi squared distribution at probability *p*, where the Chi squared distribution has given *d* degrees of freedom.

In other words, finds *t* such that *P(X ≤ t) = p*, where *X* is Chi squared random variable.

Probability *p* must be from [0,1].

InverseExponential Command

InverseExponential[<Lambda>, <Probability>]

Computes the inverse of cumulative distribution function of exponential distribution at probability *p*, where the exponential distribution is given by Lambda.

In other words, finds *t* such that *P(X ≤ t) = p*, where *X* is exponential random variable.

Probability *p* must be from [0,1].

InverseFDistribution Command

InverseFDistribution[<Numerator Degrees of Freedom>, <Denominator Degrees of Freedom>, <Probability>]

Computes the inverse of cumulative distribution function of F-distribution at probability *p*, where the F-distribution is given by the degrees of freedom.

In other words, finds *t* such that *P(X ≤ t) = p*, where *X* is random variable with F-distribution.

Probability *p* must be from [0,1].

InverseGamma Command

InverseGamma[<Alpha>, <Beta>, <Probability>]

Computes the inverse of cumulative distribution function of gamma distribution at probability *p*, where the gamma distribution is given by parameters *Alpha* and *Beta*.

In other words, finds *t* such that *P(X ≤ t) = p*, where *X* is random variable with gamma distribution.

Probability *p* must be from [0,1].

InverseHyperGeometric Command

InverseHyperGeometric[<Population Size>, <Number of Successes>, <Sample Size>, <Probability>]

Returns least integer *n* such that *P(X ≤ n) ≥ p*, where *p* is the probability and *X* is hypergeometric random variable given by *Population Size*, *Number of Successes* and *Sample Size*.

Note: See also HyperGeometric Command.

InverseNormal Command

InverseNormal[<Mean>, <Standard Deviation>, <Probability>]

Calculates the function $\Phi^{-1}(P) \cdot \sigma + \mu$with given probability *P*, mean *μ* and standard deviation *σ*, where $\Phi^{-1}$is the inverse of the cumulative distribution function *Φ* for *N(0,1)*.

Note: Returns the *x*-coordinate with the given probability to the left under the normal distribution curve.

InversePascal Command

InversePascal[<Number of Successes>, <Probability of Success>, <Probability>]

Returns least integer *n* such that *P(X≤n) ≥ p*, where p is the probability and *X* is Pascal random variable [1] given by *Number of Successes* and *Probability of Success*.

Note: See also Pascal Command.

InversePoisson Command

InversePoisson[<Mean>, <Probability>]

Returns least integer *n* such that *P(X≤n) ≥ p*, where *p* is the probability and *X* is Poisson random variable with mean *λ*.

Note: See also Poisson Command.

InverseTDistribution Command

InverseTDistribution[<Degrees of Freedom>, <Probability>]

Computes the inverse of cumulative distribution function of t-distribution at *p*, where the t-distribution has *d* degrees of freedom. In other words, finds *r* such that *P(X≤r)=p*, where X is random variable with t-distribution. Probability *p* must be from [0,1].

InverseWeibull Command

InverseWeibull[<Shape>, <Scale>, <Probability>]

Computes the inverse of cumulative distribution function of Weibull distribution at *p*, where the Weibull distribution is given by shape parameter *k* and scale parameter *λ*. In other words, finds *t* such that *P(X ≤ t) = p*, where *X* is random variable with Weibull distribution. Probability *p* must be from [0,1].

InverseZipf Command

InverseZipf[<Number of Elements>, <Exponent>, <Probability>]

Returns least integer *n* such that *P(X≤n) ≥ p*, where X is Zipf random variable given by *Number of Elements* and *Exponent* and *p* is the probability.

Note: See also Zipf Command.

LogNormal Command

LogNormal[<Mean>, <Standard Deviation>, x]

Creates probability density function (pdf) of log-normal distribution with parameters mean μ and standard deviation σ.

LogNormal[<Mean>, <Standard Deviation>, x, <Boolean Cumulative>]

If *Cumulative* is true, creates cumulative density function of log-normal distribution, otherwise creates pdf of log-normal distribution.

LogNormal[<Mean>, <Standard Deviation>, <Variable Value>]

Calculates the value of cumulative distribution function of log-normal distribution at variable value v, i.e. the probability $P(X \le v)$ where X is a random variable with log-normal distribution given by parameters mean μ and standard deviation σ.

Note: Returns the probability for a given x-coordinate's value (or area under the log-normal distribution curve to the left of the given x-coordinate).

CAS Syntax

LogNormal[<Mean>, <Standard Deviation>, x]

Creates probability density function (pdf) of log-normal distribution with parameters mean μ and standard deviation σ.

LogNormal[<Mean>, <Standard Deviation>, x, <Boolean Cumulative>]

If *Cumulative* is true, creates cumulative density function of log-normal distribution, otherwise creates pdf of log-normal distribution.

LogNormal[<Mean>, <Standard Deviation>, <Variable Value>]

Calculates the value of cumulative distribution function of log-normal distribution at variable value v, i.e. the probability $P(X \le v)$ where X is a random variable with log-normal distribution given by parameters mean μ and standard deviation σ.

Note: Returns the probability for a given x-coordinate's value (or area under the log-normal distribution curve to the left of the given x-coordinate).

Logistic Command

Logistic[<Mean>, <Scale>, x]

Creates probability density function (pdf) of logistic distribution with parameters mean μ and scale *s*.

Logistic[<Mean>, <Scale>, x, <Boolean Cumulative>]

If *Cumulative* is true, creates cumulative distribution function of logistic distribution, otherwise creates pdf of logistic distribution.

Logistic[<Mean>, <Scale>, <Variable Value>]

Calculates the value of cumulative distribution function of logistic distribution at variable value *v*, i.e. the probability $P(X \leq v)$ where *X* is a random variable with logistic distribution given by parameters mean μ and scale *s*.

Note: Returns the probability for a given *x*-coordinate's value (or area under the logistic distribution curve to the left of the given *x*-coordinate).

CAS Syntax

Logistic[<Mean>, <Scale>, x]

Creates probability density function (pdf) of logistic distribution with parameters mean μ and scale *s*.

Logistic[<Mean>, <Scale>, x, <Boolean Cumulative>]

If *Cumulative* is true, creates cumulative distribution function of logistic distribution, otherwise creates pdf of logistic distribution.

Logistic[<Mean>, <Scale>, <Variable Value>]

Calculates the value of cumulative distribution function of logistic distribution at variable value *v*, i.e. the probability $P(X \leq v)$ where *X* is a random variable with logistic distribution given by parameters mean μ and scale *s*.

Note: Returns the probability for a given *x*-coordinate's value (or area under the logistic distribution curve to the left of the given *x*-coordinate).

Normal Command

Normal[<Mean>, <Standard Deviation>, x]

Creates probability density function (pdf) of normal distribution.

Normal[<Mean>, <Standard Deviation>, x, <Boolean Cumulative>]

If *Cumulative* is true, creates cumulative distribution function of normal distribution with mean μ and standard deviation σ, otherwise creates pdf of normal distribution.

Normal[<Mean μ>, <Standard Deviation σ>, <Variable Value v>]

Calculates the function $\Phi\left(\frac{x-\mu}{\sigma}\right)$at *v* where *Φ* is the cumulative distribution function for *N(0,1)* with mean μ and standard deviation σ.
Note: Returns the probability for a given *x*-coordinate's value (or area under the normal distribution curve to the left of the given *x*-coordinate).

CAS Syntax

Normal[<Mean>, <Standard Deviation>, <Variable Value>]

Calculates the function $\Phi\left(\frac{x-\mu}{\sigma}\right)$where *Φ* is the cumulative distribution function for *N(0,1)* with mean μ and standard deviation σ.
Example:

`Normal[2, 0.5, 1]` yields $\frac{-erf(2/\sqrt{2})+1}{2}$.

Pascal Command

Pascal[<Number of Successes>, <Probability of Success>]

Returns a bar graph of a Pascal distribution [1].

Parameters:

Number of Successes: number of independent Bernoulli trials that must be successful

Probability of Success: probability of success in one trial

Pascal[<Number of Successes>, <Probability of Success>, <Boolean Cumulative>]

Returns a bar graph of a Pascal distribution when *Cumulative* = false.

Returns a graph of a cumulative Pascal distribution when *Cumulative* = true.

First two parameters are same as above.

Pascal[<Number of Successes>, <Probability of Success>, <Variable Value>, <Boolean Cumulative>]

Let X be a Pascal random variable and *v* the variable value.

Returns P(X = *v*) when *Cumulative* = false.

Returns P(X ≤ *v*) when *Cumulative* = true.

First two parameters are same as above.

CAS Syntax

Pascal[<Number of Successes>, <Probability of Success>, <Variable Value>, <Boolean Cumulative>]

Let X be a Pascal random variable.

Returns P(X = *v*) when *Cumulative* = false.

Returns P(X ≤ *v*) when *Cumulative* = true.

Example:

The number of independent Bernoulli trials that must be successful is n = 1, the probability of success in one trial is p = $\frac{1}{6}$, the variable value is v = 2 and "Cumulative" = false.

`Pascal[ n, p, v, false]` yields $\frac{25}{216}$

Poisson Command

Poisson[<Mean>]

Returns a bar graph of a Poisson distribution with given mean λ.

Poisson[<Mean>, <Boolean Cumulative>]

Returns a bar graph of a Poisson distribution when *Cumulative = false*.

Returns a graph of a cumulative Poisson distribution when *Cumulative = true*.

The first parameter is same as above.

Poisson[<Mean>, <Variable Value v>, <Boolean Cumulative>]

Let X be a Poisson random variable.

Returns P(X = *v*) when *Cumulative* = false.

Returns P(X ≤ *v*) when *Cumulative* = true.

First parameter is same as above.

CAS Syntax

Poisson[<Mean>, <Variable Value v>, <Boolean Cumulative>]

Let X be a Poisson random variable.

Returns P(X = *v*) when *Cumulative* = false.

Returns P(X ≤ *v*) when *Cumulative* = true.

First parameter is same as above.

Examples:

- `Poisson[3, 1, true]` yields .
- `Poisson[3, 1, false]` yields .

RandomBetween Command

RandomBetween[<Minimum Integer> , <Maximum Integer>]

Generates a random integer between *minimum* and *maximum* (inclusive).

Example:

`RandomBetween[0, 10]` yields a number between *0* and *10* (inclusive)

RandomBetween[<Minimum Integer> , <Maximum Integer> , <Boolean Fixed>]

If *Boolean Fixed* = "true", it generates a random integer between *minimum* and *maximum* (inclusive), which is updated just once (when file is loaded and also on undo/redo).

Example:

`RandomBetween[0, 10, true]` yields a number between *0* and *10* (inclusive)

Note: Press F9 to see the difference between those two syntaxes.

CAS Syntax

RandomBetween[<Minimum Integer> , <Maximum Integer>]

Generates a random integer between *minimum* and *maximum* (inclusive).

Example:

`RandomBetween[0, 10]` yields a number between *0* and *10* (inclusive)

Note: See also SetSeed command, RandomElement command, RandomBinomial command, RandomNormal command, RandomPoisson command, RandomUniform command.

RandomBinomial Command

RandomBinomial[<Number of Trials>, <Probability>]

Generates a random number from a binomial distribution with *n* trials and probability *p*.

Example:

`RandomBinomial[3, 0.1]` gives $j \in \{0, 1, 2, 3\}$, where the probability of getting *j* is the probability of an event with probability *0.1* occuring *j* times in three tries.

CAS Syntax

RandomBinomial[<Number of Trials>, <Probability>]

Generates a random number from a binomial distribution with *n* trials and probability *p*.

Example:

`RandomBinomial[3, 0.1]` gives $j \in \{0, 1, 2, 3\}$, where the probability of getting *j* is the probability of an event with probability *0.1* occuring *j* times in three tries.

Note: See also SetSeed command, RandomBetween command, RandomElement command, RandomNormal command, RandomPoisson command, RandomUniform command.

RandomNormal Command

RandomNormal[<Mean>, <Standard Deviation>]

Generates a random number from a normal distribution with given mean and standard deviation.

Example:

`RandomNormal[3, 0.1]` yields a random value from a normal distribution with a mean of *3* and standard deviation of *0.1*.

CAS Syntax

RandomNormal[<Mean>, <Standard Deviation>]

Generates a random number from a normal distribution with given mean and standard deviation.

Example:

`RandomNormal[3, 0.1]` yields a random value from a normal distribution with a mean of *3* and standard deviation of *0.1*.

Note: See also SetSeed command, RandomBetween command, RandomElement command, RandomBinomial command, RandomPoisson command, RandomUniform command.

RandomPoisson Command

RandomPoisson[<Mean>]

Generates a random number from a Poisson distribution with given mean.

Example:

`RandomPoisson[3]` yields a random value from a Poisson distribution with a mean of *3*.

CAS Syntax

RandomPoisson[<Mean>]

Generates a random number from a Poisson distribution with given mean.

Example:

`RandomPoisson[3]` yields a random value from a Poisson distribution with a mean of *3*.

Note: See also SetSeed command, RandomBetween command, RandomElement command, RandomBinomial command, RandomNormal command, RandomUniform command.

RandomUniform Command

RandomUniform[<Min>, <Max>]

Returns random real number from uniform distribution on interval [*min*, *max*].

Example:

`RandomUniform[0, 1]` returns a random number between *0* and *1*

RandomUniform[<Min>, <Max>, <Number of Samples n>]

Returns a list of *n* random real numbers from uniform distribution on interval [*min*, *max*].

Example:

`RandomUniform[0, 1, 3]` returns a list of three random numbers between *0* and *1*

CAS Syntax

RandomUniform[<Min>, <Max>]

Returns random real number from uniform distribution on interval [*min*, *max*].

Example:

`RandomUniform[0, 1]` returns a random number between *0* and *1*

Note: `RandomUniform[0,1]` is equivalent to `random()` (see Predefined Functions and Operators).

Note: See also SetSeed, RandomBetween, RandomElement, RandomBinomial, RandomNormal , RandomPoisson commands.

TDistribution Command

TDistribution[<Degrees of Freedom>, x]

Creates probability density function (pdf) of t-distribution with given degrees of freedom.

TDistribution[<Degrees of Freedom>, x, <Boolean Cumulative>]

If *Cumulative* is true, creates cumulative distribution function of t-distribution, otherwise creates pdf of t-distribution.

TDistribution[<Degrees of Freedom>, <Variable Value>]

Calculates the value of cumulative distribution function of t-distribution at *variable value v*, i.e. the probability *P(X ≤ v)* where *X* is a random variable with t-distribution with given degrees of freedom.

Example:

`TDistribution[10, 0]` yields *0.5*.

Note: Returns the probability for a given *x*-coordinate's value (or area under the t-distribution curve to the left of the given *x*-coordinate).

CAS Syntax

TDistribution[<Degrees of Freedom>, <Variable Value>]

Calculates the value of cumulative distribution function of t-distribution at *variable value v*, i.e. the probability *P(X ≤ v)* where *X* is a random variable with t-distribution with given degrees of freedom.

Example:

`TDistribution[10, 0]` yields $\frac{1}{2}$.

Triangular Command

Triangular[<Lower Bound>, <Upper Bound>, <Mode>, x]

Creates probability density function of triangular distribution with parameters *min, max, mod*.

Triangular[<Lower Bound>, <Upper Bound>, <Mode>, x, <Boolean Cumulative>]

If *Cumulative* is true, creates cumulative distribution function of triangular distribution, otherwise creates probability density function of triangular distribution.

Triangular[<Lower Bound>, <Upper Bound>, <Mode>, <Variable Value>]

Calculates the value of cumulative distribution function of triangular distribution at *Variable Value v*, i.e. the probability *P(X≤v)* where *X* is a random variable with triangular distribution given by parameters *min, max, mod*.

Note: Returns the probability for a given *x*-coordinate's value (or area under the triangular distribution curve to the left of the given *x*-coordinate).

CAS Syntax

Triangular[<Lower Bound>, <Upper Bound>, <Mode>, <Variable Value>]

Calculates the value of cumulative distribution function of triangular distribution at *Variable Value v*, i.e. the probability *P(X≤v)* where *X* is a random variable with triangular distribution given by parameters *min, max, mod*.

Example:

`Triangular[ 0, 5, 2, 2 ]` yields *0.4*.

Uniform Command

Uniform[<Lower Bound min>, <Upper Bound max>, x]

Returns the probability density function of uniform distribution on interval *[min,max]*.

Uniform[<Lower Bound min>, <Upper Bound max>, x, <Boolean Cumulative b>]

For *b=false* returns the probability density function of uniform distribution on interval *[min,max]*.

For *b=true* returns the cumulative distribution function of the same distribution.

Uniform[<Lower Bound min>, <Upper Bound max>, <Variable Value v>]

Returns the value of cumulative distribution function at *v* (i.e. P(X<v)) for uniform distribution on interval *[min,max]*

Weibull Command

Weibull[<Shape>, <Scale>, x]

Creates probability density function (pdf) of Weibull distribution with parameters shape *k* and scale *λ*

Weibull[<Shape>, <Scale>, x, <Boolean Cumulative>]

If *Cumulative* is true, creates cumulative distribution function of Weibull distribution, otherwise creates pdf of Weibull distribution.

Weibull[<Shape>, <Scale>, <Variable Value>]

Calculates the value of cumulative distribution function of Weibull distribution at variable value *v*, i.e. the probability *P(X ≤ v)* where *X* is a random variable with Weibull distribution given by parameters shape *k* and scale *λ*.

Note: Returns the probability for a given *x*-coordinate's value (or area under the Weibull distribution curve to the left of the given *x*-coordinate).

CAS Syntax

Weibull[<Shape>, <Scale>, <Variable Value>]

Calculates the value of cumulative distribution function of Weibull distribution at variable value *v*, i.e. the probability *P(X ≤ v)* where *X* is a random variable with Weibull distribution given by parameters shape *k* and scale *λ*.

Examples:

- `Weibull[ 0.5, 1, 0]` yields *0*.
- `Weibull[ 0.5, 1, 1]` yields $\frac{e-1}{e}$.

Zipf Command

Zipf[<Number of Elements>, <Exponent>]

Returns a bar graph of a Zipf distribution.

Parameters:

- *Number of Elements*: number of elements whose rank we study
- *Exponent*: exponent characterizing the distribution

Zipf[<Number of Elements>, <Exponent> , <Boolean Cumulative>]

Returns a bar graph of a Zipf distribution when *Cumulative* = false.

Returns a graph of a cumulative Zipf distribution when *Cumulative* = true.

First two parameters are same as above.

Zipf[<Number of Elements>, <Exponent> , <Variable Value v>, <Boolean Cumulative>]

Let X be a Zipf random variable.

Returns P(X = *v*) when *Cumulative* = false.

Returns P(X ≤ *v*) when *Cumulative* = true.

First two parameters are same as above.

CAS Syntax

Zipf[<Number of Elements>, <Exponent> , <Variable Value v>, <Boolean Cumulative>]

Let X be a Zipf random variable.

Returns P(X = *v*) when *Cumulative* = false.

Returns P(X ≤ *v*) when *Cumulative* = true.

Example:

`Zipf[ 10, 1 , 5, false]` yields $\frac{504}{7381}$.

Spreadsheet Commands

These commands are designed for referencing data from Spreadsheet View and copying data into it.

- Cell
- CellRange
- Column
- ColumnName
- FillCells
- FillColumn
- FillRow
- Row

Cell Command

Cell[<Column>, <Row>]

Returns copy of spreadsheet cell in given column and row.

Example: `Cell[2, 1]` returns copy of B1.

Note:

- By default the cells in spreadsheet cells are auxiliary and in such case this command returns auxiliary object as well.
- You must make sure that the cells you refer to are **earlier** in the Construction Protocol than this command.

CellRange Command

CellRange[<Start Cell>, <End Cell>]

Creates a list containing the cell values in this cell range.

Example:

Let `A1 = 1`, `A2 = 4`, `A3 = 9` be spreadsheet cells values.Then `CellRange[A1, A3]` returns the list {1, 4, 9}.

Note: `A1:A3` is a shorter syntax.

Column Command

Column[<Spreadsheet Cell>]

Returns the column of the cell as a number (starting at 1).

Example: `q = Column[B3]` returns *q = 2* since column *B* is the second column of the spreadsheet.

ColumnName Command

ColumnName[<Spreadsheet Cell>]

Returns the column name of the cell as a text.

Example: `r = ColumnName[A1]` creates *r* = *A* and shows such text - A - in the Graphics View.

FillCells Command

FillCells[<CellRange>, <Object>]

Copies the value/equation etc. of the object to the given cellrange. Resulting cells are free objects, i.e. independent of object.

Notes: CellRange has to be entered like this: e.g.: B2:D5.Object can be anything, e.g.: 3, RandomBetween[0, 10], Circle[A, B].Cells are labelled by column and row, e.g.: B2

FillCells[<Cell>, <List>]

Copies values from the list to the first cells on the right of the given cell. Resulting cells are free objects, i.e. independent of the list.

FillCells[<Cell>, <Matrix>]

Copies values from the matrix. The upper left corner of the matrix is matched to the given cell. Resulting cells are free objects, i.e. independent of the matrix.

Note: See also FillRow and FillColumn commands.

FillColumn Command

FillColumn[<Column>, <List>]

Copies values from the list to the first cells of the column given by number (1 for A, 2 for B, etc.). Resulting cells are free objects, i.e. independent of the list.

Note: See also the FillRow and FillCells commands.

FillRow Command

FillRow[<Row>, <List>]

Copies values from the list to the first cells of the row given by number. Resulting cells are free objects, i.e. independent of the list.

Note: See also the FillColumn and FillCells commands.

Row Command

Row[<Spreadsheet Cell>]

Returns the row number of the spreadsheet cell (starting at 1).

Example: `r = Row[B3]` yields *r = 3*.

Scripting Commands

These commands are substitutes for features accessible e.g. via Properties Dialog and are meant to simplify scripting in GeoGebra.

Note: These commands don't return any object, therefore cannot be nested in other commands.

- AttachCopyToView
- Button
- CenterView
- Checkbox
- CopyFreeObject
- Delete
- Execute
- GetTime
- HideLayer
- InputBox
- Pan
- ParseToFunction
- ParseToNumber
- PlaySound
- Rename
- SelectObjects
- SetActiveView
- SetAxesRatio
- SetBackgroundColor
- SetCaption
- SetColor
- SetConditionToShowObject
- SetCoords
- SetDynamicColor
- SetFilling
- SetFixed

- SetLabelMode
- SetLayer
- SetLineStyle
- SetLineThickness
- SetPointSize
- SetPointStyle
- SetSeed
- SetTooltipMode
- SetTrace
- SetValue
- SetVisibleInView
- ShowAxes
- ShowGrid
- ShowLabel
- ShowLayer
- Slider
- StartAnimation
- UpdateConstruction
- ZoomIn
- ZoomOut

Button Command

Button[ ]

Creates a new button.

Button[<Caption>]

Creates a new button with given caption.

Checkbox Command

Checkbox[ ]

Creates a checkbox.

Checkbox[<Caption>]

Creates a checkbox with given caption.

Checkbox[<List>]

Creates a checkbox which, when unchecked, hides listed objects.

Example: Let *A* and *B* be points. `c = Checkbox[{A,B}]` creates checkbox *c*. When *c* is checked, *A* and *B* are visible, otherwise they are hidden.

Checkbox[<Caption>, <List>]

Creates checkbox with given caption which, when unchecked, hides listed objects.

CopyFreeObject Command

CopyFreeObject[<Object>]

Creates a free copy of the object. Preserves all basic Object Properties and copy of Auxiliary Object is auxiliary as well.

Delete Command

Delete[<Object>]

Deletes the object and all its dependent objects.

Example: `Delete[a]` clears *a*.

CAS Syntax

Delete[<Object>]

Deletes the object and all its dependent objects in GeoGebra and removes any value assigned to the object in the CAS.

Example: `Delete[a]` clears *a*.

Note: See also 🗑 Delete tool.

Execute Command

Execute[<List of Texts>]

Executes list of commands entered as texts.

Note: Please note that you always need to use English commands within this list of texts, no matter which language option you selected for GeoGebra.

Examples: Execute[{"A=(1,1)","B=(3,3)","C = Midpoint[A, B]"}] creates points A, B and their midpoint C.Execute[Join[{"f_{1} = 1", "f_{2} = 1"}, Sequence["f_{"+(i + 2) + "} = f_{" + (i+1) + "} + f_{"+ i +"}", i, 1, 10]]] creates first 10 elements of Fibonacci sequence.

Execute[<List of Texts>, <Parameter>, ... , <Parameter>]

Replaces %1 for the first parameter, %2 for the second parameter and so on in each text in list. Up to 9 parameters can be specified. After the replacement, resulting scripts are executed.

Example:

`Execute[{"Midpoint[%1,%2]"},A,B]` creates midpoint of segment *AB*.

Note: Command names **must be in English** in the texts for this command to work.

GetTime Command

GetTime[]

Returns a list with the current time and date in this order:

milliseconds, seconds, minutes, hours (0-23), date, month (1-12), year, month (as text), day (as text), day (1 = Sunday, 2 = Monday, etc)

Example: `GetTime[]` returns a list such as *{647, 59, 39, 23, 28, 2, 2011, "February", "Monday", 2}*

GetTime["<Format>"]

where *Format* is a Text, replaces any of the following characters when prefixed by a backslash (\):

d, D, j, l, N, S, w, z, W, F, m, M, n, t, L, Y, y, a, A, g, G, h, H, i, s, U - the explanation to these characters are here http://php.net/manual/en/function.date.php

Example: `GetTime["The date is \l the \j\S of \F \Y"]` might give *The date is Thursday the 5th of July 2012*

HideLayer Command

HideLayer[<Number>]

Makes all objects in given layer invisible. Does not override Conditional Visibility.

Pan Command

Pan[<x>, <y>]

Shifts the current view by *x* pixels to the left and *y* pixels upwards.

Pan[<x>, <y>, <z>]

Shifts the current view by (x, y, z) if it's a 3D View, or just by (x,y) for a 2D View

Notes: If multiple Graphics ViewGraphics Views are present, the active one is used See also ZoomIn CommandZoomIn, ZoomOut CommandZoomOut, SetActiveView CommandSetActiveView commands.

ParseToFunction Command

ParseToFunction[<Function>, <String>]

Parses the string and stores the result to a function *f*, which must be defined and free before the command is used.

Example: Define `f(x) = 3x² + 2` and `text1 = "f(x) = 3x + 1"`. `ParseToFunction[f, text1]` returns *f(x) = 3x + 1*.

Note: See also ParseToNumber command.

ParseToNumber Command

ParseToNumber[<Number>, <String>]

Parses the string and stores the result to a number *a*, which must be defined and free before the command is used.

Example: Define `a = 3` and `text1 = "6"`. `ParseToNumber[a, text1]` returns *a* = *6*.

Note: See also ParseToFunction command.

Plane Command

Plane[<Polygon>]

Creates a plane through the polygon.

Plane[<Conic>]

Creates a plane through the conic.

Plane[<Point>, <Plane>]

Creates a plane through the given point, parallel to the given plane.

Plane[<Point>, <Line>]

Creates a plane through the given point and line.

Plane[<Line> , <Line>]

Creates the plane through the lines (if the lines are in the same plane).

Plane[<Point>, <Point>, <Point>]

Creates a plane through three points.

Note: See also Plane through 3 Points and Plane tools.

PlaySound Command

PlaySound[<Note>, <Duration>, <Instrument>]

Plays a MIDI note.

Note is an integer from 0 to 127 that represents a musical note given by the table below. When note = 60 a Middle C is played.

Duration is the time to play the note in seconds.

Instrument is an integer that represents the synthesized instrument used to play the note. See technical specifications [1] for possible instruments.

Most instruments are supported, but there are differences between computer platforms.

MIDI Notes

PlaySound[<Note Sequence>, <Instrument>]

Plays a sequence of MIDI notes and commands using a JFugue [2] music string.

Note Sequence is a text string that uses JFugue character commands.

Instrument is the default MIDI instrument used when the string is played.

The basic commands are given below. The full command set is described in

The Complete Guide to JFugue [3] (English).

Basic JFugue Commands

Character	+	A-G	+	[number]	+	+	+	R	+	w, h, q, i, s	+	/n	+	I[number]	+	V	+	Space	Play the previous note, combination of notes or rest.

Example: `PlaySound["C+E+G Rw Ai Bi Ci A4i B4i C4i ", 0]` Plays a quarter note chord CEG; rests for a whole note; plays the eighth notes A, B, C; plays them again one octave lower. Piano instrument is used.

Example: `PlaySound["I[56] C5q D5q I[71] G5q F5q", 0]` Plays notes with different instruments. Trumpet = 56 and Clarinet = 71.

Example: `PlaySound["V0 A3q B3q C3q B3q V1 A2h C2h", 0]` Plays notes in harmony with different voices.

PlaySound[<File>]

Plays a MIDI file (*.mid) or a text file (* .txt) containing a JFugue string.

"File" is the directory path to this file, e.g. PlaySound["path/to/myFile.mid"]

PlaySound[<Function>, <Min Value>, <Max Value>]

Plays a sound generated by Function, a time-valued function with range [-1,1]. The time units are seconds and the sound is played from time Min Value to Max Value. Sound is generated by 8-bit samples taken at a rate of 8000 samples per second.

Example: `PlaySound[sin(440 2Pi x), 0, 1]`This plays a pure sine wave tone at 440 Hz (musical note A) for one second.

PlaySound[<Function>, <Min Value>, <Max Value>, <Sample Rate>, <Sample Depth>]

Plays a sound generated by Function, a time-valued function with range [-1,1]. The time units are seconds and the sound is played from time Min Value to Max Value. The sampling method is specified by "Sample Depth" and "Sample Rate".

"Sample Rate" is the number of sample function values taken each second. Allowable values are 8000, 11025, 16000, 22050, or 44100

"Sample Depth" is the data size of a sample in bits. Allowable values are 8 and 16.

PlaySound[<Boolean Play>]

Pause or resume play.

PlaySound[true] = play, PlaySound[false] = pause.

Rename Command

Rename[<Object>, <Name>]

Sets the label of given object to the given name.

Example:

Let `c: x^2 + 2y^2 = 2`.

`Rename[c, ell]` sets the label to *ell*.

SelectObjects Command

SelectObjects[ ]

Deselects all selected objects.

SelectObjects[<Object>, <Object>, ...]

Deselects all objects and selects objects passed as parameters. All parameters must be labeled objects.

Examples:

- Let *A*, *B* and *C* be points. `SelectObjects[A, B, C]` selects points *A*, *B* and *C*.
- The command `SelectObjects[Midpoint[A, B]]` has no effect.

Note: This command now cancels any drag that is in progress (useful in scripts).

SetActiveView Command

SetActiveView[<View>]

Makes given Graphics View active.

Notes: See also ZoomIn CommandZoomIn, ZoomOut CommandZoomOut, Pan CommandPan, SetPerspective CommandSetPerspective commands.

SetAxesRatio Command

SetAxesRatio[<Number>, <Number>]

Changes the axes ratio of active Graphics View so that X units on x-axis correspond to the same number of pixels as Y units on y-axis and point (0,0) stays on its coordinates.

SetBackgroundColor Command

SetBackgroundColor[<Object>, <Red>, <Green>, <Blue>]

Changes the background color of given object. This is used for Texts and for objects in the Spreadsheet. The red, green and blue represent amount of corresponding color component, 0 being minimum and 1 maximum. Number *t* exceeding this interval is mapped to it using function $2\left|\frac{t}{2} - round\left(\frac{t}{2}\right)\right|$.

SetBackgroundColor[<Object>, <"Color">]

Changes the background color of given object. This is used for Texts and for objects in the Spreadsheet. The color is entered as text. The command accepts more than a hundred English color names (see Reference:Colors). Some of them can be also used in national languages and are listed below.

Note: If you use this command in a GeoGebraScript, you must use the English color names

- **Black**
- **Dark Gray**
- **Gray**
- **Dark Blue**
- **Blue**
- **Dark Green**
- **Green**
- **Maroon**
- **Crimson**
- **Red**
- **Magenta**
- **Indigo**
- **Purple**
- **Brown**
- **Orange**
- **Gold**
- **Lime**
- **Cyan**

- Turquoise
- Light Blue
- Aqua
- Silver
- Light Gray
- Pink
- Violet
- Yellow
- Light Yellow
- Light Orange
- Light Violet
- Light Purple
- Light Green
- White

SetCaption Command

SetCaption[<Object>, <Text>]

Changes the caption of the given object. *Text* must be enclosed in double quotes ".

SetColor Command

SetColor[<Object>, <Red>, <Green>, <Blue>]

Changes the color of given object. The red, green and blue represent amount of corresponding color component, 0 being minimum and 1 maximum. Number t exceeding this interval is mapped to it using function $2\left|\frac{t}{2} - round\left(\frac{t}{2}\right)\right|$.

SetColor[<Object>, <"Color">]

Changes the color of given object. The color is entered as text. The command accepts more than a hundred English color names (see Reference:Colors). Some of them can be also used in national languages and are listed below.

Note: If you use this command in a GeoGebraScript, you must use the English color names

- **Black**
- **Dark Gray**
- **Gray**
- **Dark Blue**
- **Blue**
- **Dark Green**
- **Green**
- **Maroon**
- **Crimson**
- **Red**
- **Magenta**
- **Indigo**

- **Purple**
- **Brown**
- **Orange**
- **Gold**

- **Lime**
- **Cyan**
- **Turquoise**
- **Light Blue**
- **Aqua**
- **Silver**
- **Light Gray**
- **Pink**
- **Violet**
- **Yellow**
- **Light Yellow**
- **Light Orange**
- **Light Violet**
- **Light Purple**
- **Light Green**
- **White**

SetConditionToShowObject Command

SetConditionToShowObject[<Object>, <Condition>]

Sets the condition to show given object.

SetCoords Command

SetCoords[<Object>, <x>, <y>]

Changes cartesian coordinates of free objects. This command uses values of the coordinates, not their definitions, therefore the object stays free.

Note: This command now works for Sliders, Buttons, Checkboxes, Input Boxes, Images. If "Absolute Screen Position" is selected then *x*, *y* are in screen pixels.

SetDynamicColor Command

SetDynamicColor[<Object>, <Red>, <Green>, <Blue>]

Sets the dynamic color of the object.

SetDynamicColor[<Object>, <Red>, <Green>, <Blue>, <Opacity>]

Sets the dynamic color and opacity of the object.

Note: All numbers are on a scale from 0 (off/transparent) to 1 (on/opaque)

SetFilling Command

SetFilling[<Object>, <Number>]

Changes the opacity of given object. Number must be from interval [0,1], where 0 means transparent and 1 means 100% opaque. Other numbers are ignored.

SetFixed Command

SetFixed[<Object>, <true | false>]

Makes the object fixed (for true) or not fixed (for false).

SetLabelMode Command

SetLabelMode[<Object>, <Number>]

Changes the label mode of given object according to the table below. Integers distinct from the ones listed in table are treated as 0.

Number	Mode
0	Name
1	Name + Value
2	Value
3	Caption

SetLayer Command

SetLayer[<Object>, <Layer>]

Sets the layer for given object, where number of the layer must be an integer from {0, 1, ..., 9}.

SetLineStyle Command

SetLineStyle[<Line>, <Number>]

Changes the line style of given object according to following table (numbers out of range [0,4] are not valid).

Number	Style
0	Full
1	Dashed long
2	Dashed short
3	Dotted
4	Dash-dot

SetLineThickness Command

SetLineThickness[<Object>, <Number>]

Let *N* be the <*Number*>. The command SetLineThickness sets the line thickness for the given object to $\frac{N}{2}$ pixels.

Notes: From GeoGebra 5 this command can be used to set the line thickness for Polygons and Polyhedra Only numbers in the range 0 to 13 are supported

SetPointSize Command

SetPointSize[<Point>, <Number>]

Changes the size of the point.

SetPointSize[<Polygon>, <Number>]

Changes the size of a polygon's points.

SetPointSize[<Polyhedron>, <Number>]

Changes the size of a polyhedron's points.

SetPointSize[<Net>, <Number>]

Changes the size of a net's points.

Notes: From GeoGebra 5 this command can be used to set the Point Size (including size 0 to hide the Points) for Polygons, Nets and Polyhedra Only numbers in the range 0 to 9 are supported

SetPointStyle Command

SetPointStyle[<Point>, <Number>]

Changes the point style of given point according to following table (numbers out of range [0,9] are not valid).

Number	Style	Symbol
0	Full dot	●
1	Cross	▯
2	Empty dot	○
3	Plus sign	+
4	Full diamond	◆
5	Empty diamond	◇
6	Triangle north	▲
7	Triangle south	▼
8	Triangle east	▶
9	Triangle west	◀

SetTooltipMode Command

SetTooltipMode[<Object>, <Number>]

Changes the tooltip mode for given object according to following table (values out of range [0,4] are treated as 0):

Number	Mode
0	Automatic
1	On
2	Off
3	Caption
4	Next cell

SetValue Command

SetValue[<Boolean>, <0|1>]

Sets the state of a boolean / check box : 1 = true, 0 = false

Example: If *b* is a boolean, `SetValue[b,1]` sets the boolean *b* as *true*.

SetValue[<Object>, <Object>]

Let*A* be the first and *B* the second object. If *A* is a free object or a Point restricted to Path or Region, its value is set to current value of *B* (i.e. *A* doesn't change value if *B* is changed afterwards).

Example: If *f* is a function, `SetValue[f, RandomElement[{cos(x), 3x+2, ln(x)}]]` defines, at random, f as being one of the functions proposed in the list.

SetValue[<List>, <Number>, <Object>]

Let *n* be the <*Number*>. The command SetValue sets the n-th element of a free list to the current value of the object. Number *n* can be at most 1 + length of L.

SetVisibleInView Command

SetVisibleInView[<Object>, <View Number 1|2>, <Boolean>]

Makes object visible or hidden in given Graphics View.

ShowLabel Command

ShowLabel[<Object>, <Boolean>]

Shows or hides the label in the Graphics View for the given object.

Example:

Let `f(x) = x^2`.

`ShowLabel[f, true]` shows the label of the function.

ShowLayer Command

ShowLayer[<Number>]

Makes all objects in given layer visible. Does not override Conditional Visibility.

Example:

`ShowLayer[2]` makes all objects in the second layer visible.

Slider Command

Slider[<Min>, <Max>, <Increment>, <Speed>, <Width>,<Is Angle>, <Horizontal>, <Animating>, <Boolean Random>]

Creates a slider. The parameters settings can be as follows:

- *Min*, *Max*: set the range of the slider - These parameters are compulsory.
- *Increment*: set the increment of the slider's value - default: 0.1
- *Speed*: set the slider speed during animations - default: 1
- *Width*: sets the slider width in pixels - default: 100
- *Is Angle*: sets if the slider is related to an angle. This parameter can be *true* or *false* - default: *false*
- *Horizontal*: sets whether the slider is shown as an horizontal (*true*) or vertical (*false*) segment - default: *true*
- *Animating*: sets the automatic animation of the slider - default: *false*
- *Random*: sets if the slider assumes continuous values in the [Min, Max] range (*false*), or random values in the same interval (*true*) - default: *false*

StartAnimation Command

StartAnimation[ ]

Resumes all animations if they are paused.

StartAnimation[<Boolean>]

When the boolean is false, pauses all animations, otherwise resumes them.

StartAnimation[<Point or Slider>, <Point or Slider>, ...]

Starts animating given points and sliders, the points must be on paths.

StartAnimation[<Point or Slider>, <Point or Slider>, ..., <Boolean>]

Starts (for boolean = true) or permanently stops (for boolean = false) animating given points and sliders, the points must be on paths.

Note: See also Animation.

InputBox Command

InputBox[]

Create a new Input Box.

InputBox[<Linked Object>]

Create a new Input Box and associate a Linked Object with it.

Note: See also a = 1 Input Box Tool.

UpdateConstruction Command

UpdateConstruction[ ]

Recomputes all objects (random numbers are regenerated). Same as F9 or Ctrl + R.

Note: If you want to refresh the view (e.g to remove traces from Graphics View) you can use `ZoomIn[1]` instead, which is the same as Ctrl + F. You may also need SetActiveView[1] or SetActiveView[2] first if you are using two Graphics Views.

ZoomIn Command

ZoomIn[<Scale Factor>]

Zooms the Graphics View in by given factor with respect to current zoom, center of the screen is used as center point for the zoom.

Example:

`ZoomIn[1]` doesn't do anything

`ZoomIn[2]` zooms the view in

`ZoomIn[0.5]` is equivalent to `ZoomOut[2]`, i.e. it zooms the view out.

ZoomIn[<Scale Factor>, <Center Point>]

Zooms the Graphics View in by given factor with respect to current zoom, second parameter specifies center point for the zoom.

Example:

`ZoomIn[2, (0, 0)]`

ZoomIn[<Min x>, <Min y>, <Max x>, <Max y>]

Zooms the graphics view to the rectangle given by vertices (Min x, Min y), (Max x, Max y).

Example:

`ZoomIn[0, 1, 5, 6]`

Note: If any of these parameters are dependent or has label set, the bounds of the view become dynamic. To avoid this behaviour, use CopyFreeObject Command.

Example:

If *a* is a slider, `ZoomIn[-a, -a, a, a]` makes the zoom of the view dependent on slider *a*.

Notes: If multiple Graphics ViewGraphics Views are present, the active one is used See also ZoomOut CommandZoomOut, SetActiveView CommandSetActiveView, Pan CommandPan commands.

ZoomOut Command

ZoomOut[<Scale Factor>]

Zooms the Graphics View out by given factor with respect to current zoom, center of the screen is used as center point for the zoom.

Example:

`ZoomOut[2]` zooms the view out.

ZoomOut[<Scale Factor>, <Center Point>]

Zooms the Graphics View out by given factor with respect to current zoom, second parameter specifies center point for the zoom.

Example:

```
ZoomOut[2, (0, 0)]
```

Notes: ZoomOut[t] and ZoomOut[t, A] are equivalent to ZoomIn[1/t] and ZoomIn[1/t, A] respectively. If multiple Graphics ViewGraphics Views are present, the active one is used See also ZoomIn CommandZoomIn, SetActiveView CommandSetActiveView, Pan CommandPan commands.

Discrete Math Commands

- Convex hull
- DelaunayTriangulation
- Hull
- MinimumSpanningTree
- ShortestDistance
- Travelling Salesman
- Voronoi

ConvexHull Command

ConvexHull[<List of Points>]

Creates convex hull of given set of points. Returned object is a locus, so it is auxiliary.

DelaunayTriangulation Command

DelaunayTriangulation[<List of Points>]

Creates a Delaunay Triangulation of the list of points. Returned object is a locus, so it is auxiliary.

Hull Command

Hull[<List of Points> , <Percentage>]

Creates a characteristic hull of the points as described in Efficient generation of simple polygons for characterizing the shape of a set of points in the plane [1]. For percentage *p=1*, result is the same as the result of ConvexHull Command. The lower percentage, the lower area of the hull. For *p=0* the area of resulting shape is not necessarily minimal.

Returned object is a locus, so it is auxiliary.

Note: Values of *p* greater than 1 are treated as 1, values less than 0 are treated as 0.

MinimumSpanningTree Command

MinimumSpanningTree[<List of Points>]

Returns the minimum spanning tree of a complete graph on given vertices in which weight of edge *(u,v)* is the Euclidian distance between *u* and *v*. The resulting object is a locus.

ShortestDistance Command

ShortestDistance[<List of Segments>, <Start Point>, <End Point>, <Boolean Weighted>]

Finds shortest path between start point and endpoint in a graph given by list of segments. If weighted is false, weight of each edge is supposed to be 1 (i.e. we are looking for the path with least number of edges), otherwise it is the length of given segment (we are looking for the geometrically shortest path).

TravelingSalesman Command

TravelingSalesman[<List of Points>]

Returns the shortest closed path which goes through each point exactly once. Returned object is a locus, so it is auxiliary.

Voronoi Command

Voronoi[<List of Points>]

Draws the Voronoi diagram for given list of points. Returned object is a locus, so it is auxiliary.

GeoGebra Commands

- AxisStepX
- AxisStepY
- ClosestPoint
- ConstructionStep
- Corner
- DynamicCoordinates
- Name
- Object
- SlowPlot
- ToolImage

AxisStepX Command

AxisStepX[ ]

Returns the current step width for the *x*-axis.

Note: Together with the Corner and Sequence commands, the AxisStepX and AxisStepY commands allow you to create custom axes (also see section Customizing Coordinate Axes and Grid).

AxisStepY Command

AxisStepY[ ]

Returns the current step width for the *y*-axis.

Note: Together with the Corner and Sequence commands, the AxisStepX and AxisStepY commands allow you to create custom axes (also see section Customizing Coordinate Axes and Grid).

ClosestPoint Command

ClosestPoint[<Path>, <Point>]

Returns a new point on a path which is the closest to a selected point.

Note: For Functions, this command now uses closest point (rather than vertical point). This works best for polynomials; for other functions the numerical algorithm is less stable.

ClosestPoint[<Line>, <Line>]

Returns a new point on the first line which is the closest to the second line.

ConstructionStep Command

ConstructionStep[]

Returns the current Construction Protocol step as a number.

ConstructionStep[<Object>]

Returns the Construction Protocol step for the given object as a number.

Corner Command

Corner[<Number of Corner>]

For number *n = 1, 2, 3, 4* creates a point at the corner of the Graphics View, for *n = 5* returns point *(w, h)*, where *w* and *h* are width and height of the graphics view in pixels. Always uses first graphics view, even if second is active.

Corner[<Graphics View>, <Number of Corner>]

Creates a point at the corner of Graphics View (1, 2) which is never visible in that view. Supported values of number *n* are *1, 2, 3, 4* and *5* as above.

Corner[-1, <Number>]

Creates a point at one of the 3D view's corners (available values for *Number*: from 1 to 8); for *n = 9* returns point *(w, h, 0)*, where *w* and *h* are width and height of the graphics view in pixels; for *n = 10* returns point *(w, h, 0)*, where *w* and *h* are width and height of the main window in pixels; for *n = 11* returns view direction (for parallel projections) or eye position (for e.g. perspective projection).

Corner[<Image>, <Number of Corner>]

Creates a point at the corner of the image (number *n = 1, 2, 3, 4*).

Corner[<Text>, <Number of Corner>]

Creates a point at the corner of the text (number *n = 1, 2, 3, 4*).

Notes:

- Corner[<Text>, <Number of Corner>] won't work inside the Sequence or Zip commands.
- The numbering of the corners is counter-clockwise and starts at the lower left corner.

DynamicCoordinates Command

DynamicCoordinates[<Point A>, <Number X>, <Number Y>]

> Creates a point with coords (X, Y). This point is dependent, but can be moved. Whenever you try to move the new point to coordinates (x, y), point *A* is moved there and coordinates for the new point are calculated. Works best if point *A* is not visible and dragging is done with the mouse. At least one of *X* and *Y* should depend on *A*.

Example:

- Let *A* be a point and `B = DynamicCoordinates[A, round(x(A)), round(y(A))]`. When you try to move *B* to (1.3, 2.1) using the Move Tool, point *A* becomes (1.3, 2.1) and *B* appears at (1,2).
- `B = DynamicCoordinates[A, x(A), min(y(A), sin(x(A)))]` creates a point under sin(x).

  Note: `PointIn[y < sin(x)]` is the easier solution in this case.

The following examples show other ways to restrain the positions of a point *C*:

- Let `A = Point[xAxis]` and `B = Point[xAxis]`.

  Now type in the Input Bar:

  `DynamicCoordinates[B, Min[x(B), x(A)], 0]` and press Enter

  `SetVisibleInView[B, 1, false]` and press Enter

  `SetLayer[C, 1]` and press Enter

  Now, *C* cannot be moved to the right of *A*.
- Define `A=(1, 2)`.

  Now, type in the Input Bar:

  `SetVisibleInView[A, 1, false]` and press Enter

  `B = DynamicCoordinates[A, If[x(A) > 3, 3, If[x(A) < -3, -3, If[x(A) < 0, round(x(A)), x(A)]]], If[x(A) < 0, 0.5, If[y(A) > 2, 2, If[y(A) < 0, 0, y(A)]]]]` and press Enter
- This example makes *A* a sticky point when a point *C* is dragged near it. Define `A = (1, 2)` and `B = (2, 3)`.

  Now, type in the Input Bar:

  `SetVisibleInView[B, 1, false]` and press Enter

  `C = DynamicCoordinates[B, If[Distance[A, B] < 1, x(A), x(B)], If[Distance[A, B] < 1, y(A), y(B)]].`

Name Command

Name[<Object>]

Returns the name of an object as a text in the Graphics View.

Notes:

This command works properly only in dynamic text for objects (so that they work after objects are renamed).

The **Name** command is the opposite of the Object command.

Object Command

Object[<Name of Object as Text>]

Returns the object for a given name. The result is always a dependent object.

Note: The **Object** command is the opposite of the Name command.

Example: If points *A1*, *A2*, ... , *A20* exist and also a slider *n = 2*, then `Object["A" + n]` creates a copy of point *A2*.

Note: You must make sure that the objects you refer to are **earlier** in the Construction_Protocol than this command

Warning: Object command cannot be used in Custom Tools

SlowPlot Command

SlowPlot[<Function>]

Creates animated graph of given function: the function is plotted from left to right. The animation is controlled by a slider, which is also created by this command.

ToolImage Command

ToolImage[<Number>]

Creates image of tool icon with given number sized 32x32 pixels. See Reference:Toolbar for the numbering, or ToolsEN.

Optimization Commands

- Maximize
- Minimize

Maximize Command

Maximize[<Dependent number>, <Free number>]

Calculates the free number which gives the maximal value of the dependent number. The free number must be a slider and the slider interval will be used as the search interval. If the construction is complicated, this command might fail or quit to avoid using too much processor time.

Note: See also Minimize command.

Minimize Command

Minimize[<Dependent number>, <Free number>]

Calculates the free number which gives the minimal value of the dependent number. The free number must be a slider and the slider interval will be used as the search interval. If the construction is complicated, this command might fail or quit to avoid using too much processor time.

Note: See also Maximize command.

CAS Specific Commands

All of the following commands can be used in the CAS View.

- BinomialCoefficient
- BinomialDist
- CFactor
- CSolutions
- CSolve
- Cauchy
- ChiSquared
- Coefficients
- CommonDenominator
- Covariance
- Cross
- Degree
- Delete
- Denominator
- Derivative
- Determinant
- Dimension
- Div
- Division
- Divisors
- DivisorsList
- DivisorsSum
- Dot
- Element
- Expand
- Exponential
- FDistribution
- Factor
- Factors
- First
- FitExp
- FitLog
- FitPoly
- FitPow
- FitSin
- GCD
- Gamma
- HyperGeometric
- Identity
- ImplicitDerivative
- Integral
- IntegralBetween
- Intersect

- Invert
- IsPrime
- Last
- LCM
- LeftSide
- Length
- Limit
- LimitAbove
- LimitBelow
- Max
- Mean
- Median
- Min
- MixedNumber
- Mod
- NIntegral
- nPr
- NSolutions
- NSolve
- NextPrime
- Normal
- Numerator
- Numeric
- PartialFractions
- Pascal
- PerpendicularVector
- Poisson
- PreviousPrime
- PrimeFactors
- Product
- RandomBetween
- RandomBinomial
- RandomElement
- RandomNormal
- RandomPoisson
- RandomPolynomial
- Rationalize
- ReducedRowEchelonForm
- RightSide
- Root
- SD
- Sample
- SampleSD
- SampleVariance
- Sequence
- Shuffle
- Simplify

- Solutions
- Solve
- SolveODE
- Substitute
- Sum
- TDistribution
- Take
- TaylorPolynomial
- ToComplex
- ToExponential
- ToPoint
- ToPolar
- Transpose
- Unique
- UnitPerpendicularVector
- UnitVector
- Variance
- Weibull
- Zipf

CFactor Command

CAS Syntax

CFactor[<Expression>]

Factorizes a given expression, allowing for complex factors.

Example:

`CFactor[x^2 + 4]` yields *(x + 2 ί) (x - 2 ί)*, the factorization of $x^2 + 4$.

CFactor[<Expression>, <Variable>]

Factorizes an expression with respect to a given variable, allowing for complex factors.

Examples:

`CFactor[a^2 + x^2, a]` yields *(ί x + a) (- ί x + a)*, the factorization of $a^2 + x^2$ with respect to *a*.

`CFactor[a^2 + x^2, x]` yields *(x + ί a) (x - ί a)*, the factorization of $a^2 + x^2$ with respect to *x*.

Note:

This command factors expressions over the Complex Rational Numbers. To factor over rational numbers, see the Factor Command.

CSolutions Command

CAS Syntax

CSolutions[<Equation>]

Solves a given equation for the main variable and returns a list of all solutions, allowing for complex solutions.

Example:

`CSolutions[x^2 = -1]` yields *{ί, -ί}*, the complex solutions of x^2 = *-1*.

CSolutions[<Equation>, <Variable>]

Solves an equation for a given unknown variable and returns a list of all solutions, allowing for complex solutions.

Example:

`CSolutions[a^2 = -1, a]` yields *{ί, -ί}*, the complex solutions of a^2 = *-1*.

CSolutions[<List of Equations>, <List of Variables>]

Solves a set of equations for a given set of unknown variables and returns a list of all solutions, allowing for complex solutions.

Example:

`CSolutions[{y^2 = x - 1, x = 2 * y - 1}, {x, y}]` yields ,
the complex solutions of $y^2 = x - 1$and $x = 2 * y - 1$.

Note:

- The complex ί is obtained by pressing ALT + i.
- See also CSolve Command and Solutions Command.

CSolve Command

CAS Syntax

CSolve[<Equation>]

Solves a given equation for the main variable and returns a list of all solutions, allowing for complex solutions.

Example:

`CSolve[x^2 = -1]` yields *{x = ί, x = -ί}*, the complex solutions of $x^2 = -1$.

CSolve[<Equation>, <Variable>]

Solves an equation for a given unknown variable and returns a list of all solutions, allowing for complex solutions.

Example:

`CSolve[a^2 = -1, a]` yields *{a = ί, a = -ί}*, the complex solutions of $a^2 = -1$.

CSolve[<List of Equations>, <List of Variables>]

Solves a set of equations for a given set of unknown variables and returns a list of all solutions, allowing for complex solutions.

Example:

`CSolve[{y^2 = x - 1, x = 2 * y - 1}, {x, y}]` yields *{{x = 1 + 2 ί, y = 1 + ί}, {x = 1 - 2 ί, y = 1 - ί}}*, the complex solutions of $y^2 = x$ and $x = 2 * y - 1$.

Note:

- The complex ί is obtained by pressing ALT + i.
- See also CSolutions Command and Solve Command.

CommonDenominator Command

CommonDenominator[<Expression>, <Expression>]

Returns the function having as equation the lowest common denominator of the two expressions.

Example: `CommonDenominator[3 / (2 x + 1), 3 / (4 x^2 + 4 x + 1)]` yields $f(x) = 4 x^2 + 4 x + 1$.

CAS Syntax

CommonDenominator[<Expression>, <Expression>]

Returns the lowest common denominator of the two expressions.

Example: `CommonDenominator[3 / (2 x + 1), 3 / (4 x^2 + 4 x + 1)]` yields $4 x^2 + 4 x + 1$.

Cross Command

Cross[<Vector u> , <Vector v>]

Calculates the cross product of *u* and *v*.

Example:

`Cross[{1, 3, 2}, {0, 3, -2}]` yields *{-12, 2, 3}*.

Note: In the Input Bar you can also use `u ⊗ v`.

CAS Syntax

Cross[<Vector u> , <Vector v>]

Calculates the cross product of *u* and *v*.

Example:

`Cross[{1, 3, 2}, {0, 3, -2}]` yields *{-12, 2, 3}*.

If a vector contains undefined variables, it yields a formula for the cross product.

Example:

`Cross[{a, b, c}, {d, e, f}]` yields *{b f - c e, -a f + c d, a e - b d}*.

Note:

See also Dot Command.

Dimension Command

Dimension[<Object>]

Gives the dimension of a vector or a Matrix.

Example:

`Dimension[{1, 2, 0, -4, 3}]` yields *5*.

Example:

`Dimension[{{1, 2}, {3, 4}, {5, 6}}]` yields *{3, 2}*.

CAS Syntax

Dimension[<Object>]

Gives the dimension of a vector or matrix.

Example:

`Dimension[{1, 2, 0, -4, 3}]` yields *5*.

Example:

`Dimension[{{a, b}, {c, d}, {e, f}}]` yields *{3, 2}*.

Division Command

Division[<Dividend Number>, <Divisor Number>]

Gives the quotient (integer part of the result) and the remainder of the division of the two numbers.

Example:

`Division[16, 3]` yields *{5, 1}*.

Division[<Dividend Polynomial>, <Divisor Polynomial>]

Gives the quotient and the remainder of the division of the two polynomials.

Example:

`Division[x^2 + 3 x + 1, x - 1]` yields *{x + 4, 5}*.

CAS Syntax

Division[<Dividend Number>, <Divisor Number>]

Gives the quotient (integer part of the result) and the remainder of the division of the two numbers.

Example:

`Division[16, 3]` yields *{5, 1}*.

Division[<Dividend Polynomial>, <Divisor Polynomial>]

Gives the quotient and the remainder of the division of the two polynomials.

Example:

`Division[x^2 + 3 x + 1, x - 1]` yields *{x + 4, 5}*.

Divisors Command

Divisors[<Number>]

Calculates the number of all the positive divisors, including the number itself.

Example: `Divisors[15]` yields *4*, the number of all positive divisors of *15*, including *15*.

CAS Syntax

Divisors[<Number>]

Calculates the number of all the positive divisors, including the number itself.

Example: `Divisors[15]` yields *4*, the number of all positive divisors of *15*, including *15*.

Note: See also DivisorsList Command and DivisorsSum Command.

DivisorsList Command

DivisorsList[<Number>]

Gives the list of all the positive divisors, including the number itself.

Example: `DivisorsList[15]` yields *{1, 3, 5, 15}*, the list of all positive divisors of *15*, including *15*.

CAS Syntax

DivisorsList[<Number>]

Gives the list of all the positive divisors, including the number itself.

Example: `DivisorsList[15]` yields *{1, 3, 5, 15}*, the list of all positive divisors of *15*, including *15*.

Note: See also Divisors Command and DivisorsSum Command.

DivisorsSum Command

DivisorsSum[<Number>]

> Calculates the sum of all the positive divisors, including the number itself.
>
> **Example:** `DivisorsSum[15]` yields *24*, the sum *1* + *3* + *5* + *15*.

CAS Syntax

DivisorsSum[<Number>]

> Calculates the sum of all the positive divisors, including the number itself.
>
> **Example:** `DivisorsSum[15]` yields *24*, the sum *1* + *3* + *5* + *15*.

Note: See also Divisors Command and DivisorsList Command.

Dot Command

CAS Syntax

Dot[<Vector>, <Vector>]

> Returns the dot product (scalar product) of the two vectors.
>
> **Example:**
>
> `Dot[{1, 3, 2}, {0, 3, -2}]` yields *5*, the scalar product of *{1, 3, 2}* and *{0, 3, -2}*.

Note:

See also Cross Command.

ImplicitDerivative Command

ImplicitDerivative[<f(x, y)>]

Gives the implicit derivative of the given expression.

Example:

`ImplicitDerivative[x + 2 y]` yields *-0.5*.

CAS Syntax

ImplicitDerivative[<f(x, y)>]

Gives the implicit derivative of the given expression.

Example:

`ImplicitDerivative[x + 2 y]` yields $-\frac{1}{2}$.

ImplicitDerivative[<Expression>, <Dependent Variable>, <Independent Variable>]

Gives the implicit derivative of the given expression.

Example:

`ImplicitDerivative[x^2 + y^2, y, x]` yields $-\frac{x}{y}$.

Note:

See also Derivative Command.

IsPrime Command

IsPrime[<Number>]

Gives *true* or *false* depending on whether the number is prime or not.

Example:

- `IsPrime[10]` yields *false*,
- `IsPrime[11]` yields *true*.

CAS Syntax

IsPrime[<Number>]

Gives *true* or *false* depending on whether the number is prime or not.

Example:

- `IsPrime[10]` yields *false*,
- `IsPrime[11]` yields *true*.

LeftSide Command

LeftSide[<Equation>]

Gives the left-hand side of the simplified equation.

Example:

`LeftSide[x + 2 = 3 x + 1]` yields *x*.

CAS Syntax

LeftSide[<Equation>]

Gives the left-hand side of the equation.

Example:

`LeftSide[x + 3 = 3 x + 1]` yields *x + 3*.

LeftSide[<List of Equations>]

Gives the list of the left-hand sides of the equations.

Example:

`LeftSide[{a^2 + b^2 = c^2, x + 2 = 3 x + 1}]` yields $\left\{a^2 + b^2, x + 2\right\}$.

LeftSide[<List of Equations>, <Index>]

Gives the left-hand sides of the equation specified by the index.

Example:

`LeftSide[{a^2 + b^2 = c^2, x + 2 = 3 x + 1}, 1]` yields $a^2 + b^2$.

Note:

See also RightSide Command.

MatrixRank Command

MatrixRank[<Matrix>]

Returns the rank of given matrix.

Examples:

- `MatrixRank[{{2, 2}, {1, 1}}]` yields *1*,
- `MatrixRank[{{1, 2}, {3, 4}}]` yields *2*,
- let `A = {{1, 2, 3}, {1, 1, 1}, {2, 2, 2}}` be a 3x3-matrix, `MatrixRank[A]` yields *2*.

CAS Syntax

MatrixRank[<Matrix>]

Returns the rank of given matrix.

Examples:

- `MatrixRank[{{2, 2}, {1, 1}}]` yields *1*,
- `MatrixRank[{{1, 2}, {3, 4}}]` yields *2*,
- `MatrixRank[{{1, 2}, {k*1, k*2}}]` yields *1*.

MixedNumber Command

CAS Syntax

MixedNumber[<Number>]

Converts the given number to a mixed number.

Example:

- `MixedNumber[3.5]` yields $3 + \frac{1}{2}$.
- `MixedNumber[12 / 3]` yields *4*.
- `MixedNumber[12 / 14]` yields $\frac{6}{7}$.

Note:

See also Rationalize Command.

NIntegral Command

CAS Syntax

NIntegral[<Function>, <Start x-Value>, <End x-Value>]

Let *a* be the *Start x-Value*, *b* be the *End x-Value* and *f* the *Function*. NIntegral-command computes the definite integral $\int_a^b f(x)\mathrm{d}x$numerically.

Example:

`NIntegral[e^(-x^2), 0, 1]` yields *0.746824132812427*.

NIntegral[<Function>, <Variable>, <Start Value>, <End Value>]

Let *a* be the *Start x-Value*, *b* be the *End x-Value*, *f* the *Function* and *t* the *Variable* to integrate. NIntegral-command computes the definite integral $\int_a^b f(t)\mathrm{d}t$numerically.

Example:

`NIntegral[e^(-a^2), a, 0, 1]` yields *0.746824132812427*.

NSolutions Command

CAS Syntax

NSolutions[<Equation>]

Attempts (numerically) to find a solution for the equation for the main variable. For non-polynomials you should always specify a starting value (see below)

Example:

`NSolutions[x^6 - 2x + 1 = 0]` yields *{0.51, 1}* or *{0.508660391642, 1}* (the number of decimals depends on the choosen in global rounding)

NSolutions[<Equation>, <Variable>]

Attempts (numerically) to find a solution of the equation for the given unknown variable. For non-polynomials you should always specify a starting value (see below)

Example:

`NSolutions[a^4 + 34a^3 = 34, a]` yields *{a = -34.00086498588374, a = 0.9904738885574178}*.

NSolutions[<Equation>, <Variable = starting value>]

Finds numerically the list of solutions to the given equation for the given unknown variable with its starting value.

Examples:

- `NSolutions[cos(x) = x, x = 0]` yields *{0.74}*
- `NSolutions[a^4 + 34a^3 = 34, a = 3]` yields the list *{-34, 0.99}*.

NSolutions[<List of Equations>, <List of Variables>]

Attempts (numerically) to find a solution of the set of equations for the given set of unknown variables.

Example:

`NSolutions[{π / x = cos(x - 2y), 2 y - π = sin(x)}, {x = 3, y = 1.5}]` yields the list *{3.14, 1.57}*

Note: If you don't give a starting point like a=3 or {x = 3, y = 1.5} the numerical algorithm may find it hard to find a solution (and giving a starting point doesn't guarantee that a solution will be found)The number of decimals depends on the choosen in Options Menu#Roundingglobal rounding. π is obtaind by pressing Alt + p. See also Solutions Command and NSolve Command.

NSolve Command

NSolve[<Equation>]

Attempts (numerically) to find a solution for the equation for the main variable. For non-polynomials you should always specify a starting value (see below).

Example:

`NSolve[x^6 - 2x + 1 = 0]` yields *{x = 0.51, x = 1}*.

NSolve[<Equation>, <Variable>]

Attempts (numerically) to find a solution of the equation for the given unknown variable. For non-polynomials you should always specify a starting value (see below).

Example:

`NSolve[a^4 + 34a^3 = 34, a]` yields *{a = -34.00086498588374, a = 0.9904738885574178}*.

NSolve[<Equation>, <Variable = starting value>]

Finds numerically the list of solutions to the given equation for the given unknown variable with its starting value.

Examples:

- `NSolve[cos(x) = x, x = 0]` yields *{0.74}*
- `NSolve[a^4 + 34a^3 = 34, a = 3]` yields the list *{-34, 0.99}*.

NSolve[<List of Equations>, <List of Variables>]

Attempts (numerically) to find a solution of the set of equations for the given set of unknown variables.

Example:

`NSolve[{π / x = cos(x - 2y), 2 y - π = sin(x)}, {x = 3, y = 1.5}]` yields *{x = 3.141592651686591, y = 1.570796327746508}*.

Note:

- If you don't give a starting point like *a=3* or *{x = 3, y = 1.5}* the numerical algorithm may find it hard to find a solution (and giving a starting point doesn't guarantee that a solution will be found)
- The number of decimals depends on the choosen in global rounding.
- π is obtaind by pressing Alt + p.
- See also Solve Command and NSolutions Command.

NextPrime Command

NextPrime[<Number>]

Returns the smallest prime greater than the entered number.

Example:

`NextPrime[10000]` yields *10007*.

Note:

See also PreviousPrime Command.

Numeric Command

CAS Syntax

Numeric[<Expression>]

Tries to determine a numerical approximation of the given expression. The number of decimals depends on the global rounding you choose in the Options Menu.

Example:

`Numeric[3 / 2]` yields *1.5*.

Numeric[<Expression>, <Significant Figures>]

Tries to determine a numerical approximation of the given expression, using the entered number of significant figures.

Example:

`Numeric[sin(1), 20]` yields *0.84147098480789650665*.

Note: If you don't specify enough digits then you can get an apparently wrong answer due to floating point cancelation [1] for example

```
Numeric[-500000000/785398163*sin(785398163/500000000)*1258025227.19^2+500000000/78539
```

will give 0 but

```
Numeric[-500000000/785398163*sin(785398163/500000000)*1258025227.19^2+500000000/78539
```

will give 0.318309886345536696694580314215

PreviousPrime Command

PreviousPrime[<Number>]

Returns the greatest prime smaller than the entered number.

Example:

`PreviousPrime[10000]` yields *9973*.

Note:

See also NextPrime Command.

RandomPolynomial Command

RandomPolynomial[<Degree> , <Minimum for Coefficients>, <Maximum for Coefficients>]

Returns a randomly generated polynomial in *x* of degree *d*, whose (integer) coefficients are in the range from *minimum* to *maximum*, both included.

Examples:

- `RandomPolynomial[0, 1, 2]` yields either *1* or *2* and
- `RandomPolynomial[2, 1, 2]` yields a random polynomial with a degree of two and only *1* and *2* as coefficients, for example $2x^2 + x + 1$.

CAS Syntax

RandomPolynomial[<Degree> , <Minimum for Coefficients>, <Maximum for Coefficients>]

Returns a randomly generated polynomial in *x* of degree *d*, whose (integer) coefficients are in the range from *minimum* to *maximum*, both included.

Examples:

- `RandomPolynomial[0, 1, 2]` yields either *1* or *2* and
- `RandomPolynomial[2, 1, 2]` yields a random polynomial with a degree of two and only *1* and *2* as coefficients, for example $2x^2 + x + 1$.

RandomPolynomial[<Variable>, <Degree> , <Minimum for Coefficients>, <Maximum for Coefficients>]

Returns a randomly generated polynomial in *Variable* of degree *d*, whose (integer) coefficients are in the range from *minimum* to *maximum*, both included.

Examples:

- `RandomPolynomial[a, 0, 1, 2]` yields either *1* or *2* and
- `RandomPolynomial[a, 2, 1, 2]` yields a random polynomial with a degree of two and only *1* and *2* as coefficients, for example $2a^2 + a + 1$.

Note: In both cases if *minimum* or *maximum* are not integers, *round(minimum)* and *round(maximum)* are used instead.

Rationalize Command

CAS Syntax

Rationalize[<Number>]

Creates the fraction of the given *Number*, and rationalizes the denominator if appropriate.

Examples:

`Rationalize[3.5]` yields $\frac{7}{2}$.

`Rationalize[1/sqrt(2)]` yields $\frac{\sqrt{2}}{2}$.

Note:

See also MixedNumber Command.

RightSide Command

RightSide[<Equation>]

Gives the right-hand side of the simplified equation.

Example:

`RightSide[x + 2 = 3x + 1]` yields *0.5*

CAS Syntax

RightSide[<Equation>]

Gives the right-hand side of the equation.

Example:

`RightSide[x + 3 = 3 x + 1]` yields *3 x + 1*.

RightSide[<List of Equations>]

Gives the list of the right-hand sides of the equations.

Example:

`RightSide[{a^2 + b^2 = c^2, x + 2 = 3x + 1}]` yields *{c^2, 3x + 1}*.

RightSide[<List of Equations>, <Index>]

Gives the right-hand sides of the equation specified by the index.

Example:

`RightSide[{a^2 + b^2 = c^2, x + 2 = 3 x + 1}, 1]` yields c^2.

Note:

See also LeftSide Command.

Solutions Command

CAS Syntax

Solutions[<Equation>]

Solves a given equation for the main variable and returns a list of all solutions.

Example:

`Solutions[x^2 = 4x]` yields *{4, 0}*, the solutions of $x^2 = 4x$.

Solutions[<Equation>, <Variable>]

Solves an equation for a given unknown variable and returns a list of all solutions.

Example:

`Solutions[x * a^2 = 4a, a]` yields $\{\frac{4}{x}, 0\}$, the solutions of $xa^2 = 4a$.

Solutions[<List of Equations>, <List of Variables>]

Solves a set of equations for a given set of unknown variables and returns a list of all solutions.

Examples:

- `Solutions[{x = 4 x + y , y + x = 2}, {x, y}]` yields *{{-1, 3}}*, the sole solution of $x = 4x + y$ and $y + x = 2$, displayed as $\begin{pmatrix} -1 & 3 \end{pmatrix}$.
- `Solutions[{2a^2 + 5a + 3 = b, a + b = 3}, {a, b}]` yields *{{0, 3}, {-3, 6}}*, displayed as $\begin{pmatrix} 0 & 3 \\ -3 & 6 \end{pmatrix}$.

Note: Sometimes you need to do some manipulation to allow the automatic solver to work, for example Solutions[TrigExpand[sin(5/4 π + x) - cos(x - 3/4 π) = sqrt(6) * cos(x) - sqrt(2)]] See also Solve Command.

Solve Command

CAS Syntax

Solve[<Equation in x>]

Solves a given equation for the main variable and returns a list of all solutions.

Example:

`Solve[x^2 = 4x]` yields *{x = 4, x = 0}*, the solutions of $x^2 = 4x$.

Solve[<Equation>, <Variable>]

Solves an equation for a given unknown variable and returns a list of all solutions.

Example:

`Solve[x * a^2 = 4a, a]` yields $\{a = \frac{4}{x}, a = 0\}$, the solutions of $xa^2 = 4a$.

Solve[<List of Equations>, <List of Variables>]

Solves a set of equations for a given set of unknown variables and returns a list of all solutions.

Examples:

- `Solve[{x = 4 x + y , y + x = 2}, {x, y}]` yields *(x = -1, y = 3)*, the sole solution of $x = 4x + y$ and $y + x = 2$
- `Solve[{2a^2 + 5a + 3 = b, a + b = 3}, {a, b}]` yields *{{a = 0, b = 3}, {a = -3, b = 6}}*.

Note: The right hand side of equations (in any of the above syntaxes) can be omitted. If the right hand side is missing, it is treated as 0. Sometimes you need to do some manipulation to allow the automatic solver to work, for example Solve[TrigExpand[sin(5/4 π + x) - cos(x - 3/4 π) = sqrt(6) * cos(x) - sqrt(2)]] .

Solve[<List of Parametric Equations>, <List of Variables>]

Solves a set of parametric equations for a given set of unknown variables and returns a list of all solutions.

Example:

- `Solve[{(x, y) = (3, 2) + t (5, 1), (x, y) = (4, 1) + s (1, −1)}, {x, y, t, s}]` yields *{{x = 3, y = 2, t = 0, s = -1}}.*

Note: Solving parametric equations is available from GeoGebra 4.4 For piecewise-defined functions, you will need to use NSolve CommandNSolveSee also Solutions CommandSolutions, NSolve CommandNSolve and CSolve CommandCSolve commands.

Substitute Command

CAS Syntax

Substitute[<Expression>, <from>, <to>]

Substitutes *from* in *expression* with *to*.

Examples:

- `Substitute[(x^2 / (4x + 6))^2 + 6(x^2 / (4x + 6)) + 8, x^2, a*(4x + 6)]` yields $a^2 + 6 a + 8$.
- `Substitute[(3 m - 3)^2 - (m + 3)^2, m, a]` yields $8 a^2 - 24 a$.

Substitute[<Expression>, <Substitution List>]

Substitutes in *expression* every variable of the list with the variable or number you choose for it.

Example: `Substitute[2x + 3y - z, {x = a, y = 2, z = b}]` yields $2a - b + 6$.

ToComplex Command

ToComplex[<Vector>]

Transforms a vector or point to a complex number in algebraic form.

Example:

`ToComplex[(3, 2)]` yields *3 + 2ί*.

CAS Syntax

ToComplex[<Vector>]

Transforms a vector or point to a complex number in algebraic form.

Example:

`ToComplex[(3, 2)]` yields *2ί + 3*.

Note:

- The complex ί is obtained by pressing ALT + i.
- See also ToExponential Command, ToPoint Command and ToPolar Command.

ToExponential Command

CAS Syntax

ToExponential[<Complex Number>]

Transforms a complex number into its exponential form.

Example: `ToExponential[1 + ί]` yields .

Note:

- The complex ί is obtained by pressing ALT + i.
- See also ToPoint Command, ToComplex Command and ToPolar Command.

ToPoint Command

CAS Syntax

ToPoint[<Complex Number>]

Creates a point from the complex number.

Example: `ToPoint[3 + 2ί]` creates a point with coordinates *(3, 2)*.

Notes:

- The complex ί is obtained by pressing ALT + i.
- See also the following commands: ToComplex, ToExponential and ToPolar.

ToPolar Command

ToPolar[<Vector>]

Transforms a vector into its polar coordinates.

Example: `ToPolar[{1, sqrt(3)}]` yields *(2; 60°)*, the polar coordinates of *(1,* $\sqrt{3}$*)*.

ToPolar[<Complex Number>]

Transforms a complex number into its polar coordinates.

Example: `ToPolar[1 + sqrt(3) * ί]` yields *(2; 60°)*, the polar coordinates of *1 +* $\sqrt{3}$** ί*.

CAS Syntax

ToPolar[<Vector>]

Transforms a vector into its polar coordinates.

Example: `ToPolar[(1, sqrt(3))]` yields *(2;* $\frac{\pi}{3}$*)*, the polar coordinates of *(1,* $\sqrt{3}$*)*.

ToPolar[<Complex Number>]

Transforms a complex number into its polar coordinates.

Example: `ToPolar[1 + sqrt(3) * ί]` yields *(2;* $\frac{\pi}{3}$*)*, the polar coordinates of *1 +* $\sqrt{3}$** ί*.

Note:

- The complex ί is obtained by pressing ALT + i.
- See also ToComplex Command, ToExponential Command and ToPoint Command.

nPr Command

nPr [<Number n>, <Number r>]

Returns the number of possible permutations without repetition of *r* elements out of a list of *n* elements.

Example:

`nPr[10, 2]` yields *90*.

CAS Syntax

nPr [<Number n>, <Number r>]

Returns the number of possible permutations without repetition of *r* elements out of a list of *n* elements.

Example:

`nPr[10, 2]` yields *90*.

Example:

`nPr[n, 3]` yields $n^3 - 3n^2 + 2n$.

Note: See also BinomialCoefficient command.

Predefined Functions and Operators

To create numbers, coordinates, or equations using the Input Bar you may also use the following pre-defined functions and operations. Logic operators and functions are listed in article about Boolean values.

Note: The predefined functions need to be entered using parentheses. You must not put a space between the function name and the parentheses.

Operation / Function	Input
e (Euler's number)	Alt + e
ί (Imaginary unit)	Alt + i
π	Alt + p or pi
° (Degree symbol)	Alt + o
Addition	+
Subtraction	-
Multiplication	* or Space key
Scalar product	* or Space key
Vector product(see Points and Vectors)	⊗
Division	/
Exponentiation	^ or superscript (`x^2` or x^2)
Factorial	!
Parentheses	( )
x-coordinate	x( )
y-coordinate	y( )
Argument	arg( )
Conjugate	conjugate( )
Absolute value	abs( )
Sign	sgn( ) or sign()
Square root	sqrt( )
Cubic root	cbrt( )
Random number between 0 and 1	random( )
Exponential function	exp( ) or e^x
Logarithm (natural, to base e)	ln( ) or log( )
Logarithm to base 2	ld( )
Logarithm to base 10	lg( )
Logarithm of *x* to base *b*	log(b, x)
Cosine	cos( )
Sine	sin( )
Tangent	tan( )
Secant	sec()

Cosecant	cosec()
Cotangent	cot()
Arc cosine	acos( ) or arccos( )
Arc sine	asin( ) or arcsin( )
Arc tangent (returns answer between -π/2 and π/2)	atan( ) or arctan( )
Arc tangent (returns answer between -π and π) [1]	atan2(y, x)
Hyperbolic cosine	cosh( )
Hyperbolic sine	sinh( )
Hyperbolic tangent	tanh( )
Hyperbolic secant	sech( )
Hyperbolic cosecant	cosech( )
Hyperbolic cotangent	coth( )
Antihyperbolic cosine	acosh( ) or arccosh( )
Antihyperbolic sine	asinh( ) or arcsinh( )
Antihyperbolic tangent	atanh( ) or arctanh( )
Greatest integer less than or equal	floor( )
Least integer greater than or equal	ceil( )
Round	round( )
Beta function [2] B(a, b)	beta(a, b)
Incomplete beta function [3] B(x;a, b)	beta(a, b, x)
Incomplete regularized beta function [4] I(x; a, b)	betaRegularized(a, b, x)
Gamma function Γ(x)	gamma(x)
(Lower) incomplete gamma function [5] γ(a, x)	gamma(a, x)
(Lower) incomplete regularized gamma function P(a,x) = γ(a, x) / Γ(a) [6]	gammaRegularized(a, x)
Gaussian Error Function	erf(x)
Real	real( )
Imaginary	imaginary( )
Digamma function	psi(x)
The Polygamma function [7] is the (m+1)th derivative of the natural logarithm of the Gamma function, gamma(x) [8] (m=0,1)	polygamma(m, x)
The Sine Integral [9] function	sinIntegral(x)
The Cosine Integral [10] function	cosIntegral(x)
The Exponential Integral [11] function	expIntegral(x)
The Reimann-Zeta [12] function ζ(x)	zeta(x)

Example:

`Conjugate(17 + 3 * ί)` gives *-3 ί + 17*, the conjugated complex number of *17 + 3 ί*.

See Complex Numbers for details.

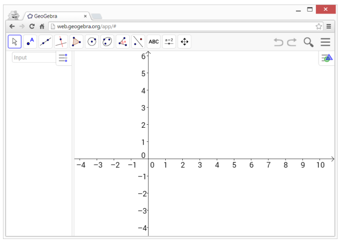
User interface

Views

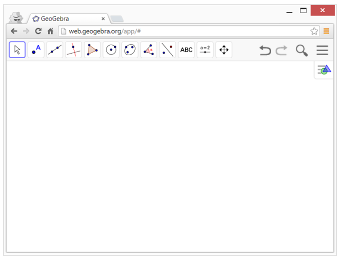
What are Views

GeoGebra provides different *Views* for mathematical objects, which are displayed in different representations (e.g. algebraic and graphical) and are linked dynamically. This means that if you modify an object in any of the *Views*, its representations in the other *Views* automatically adapt to these changes if possible.

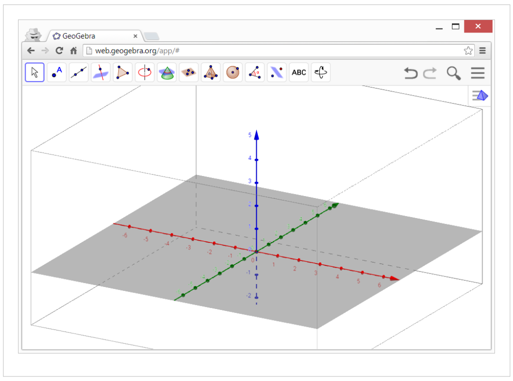
Main Views



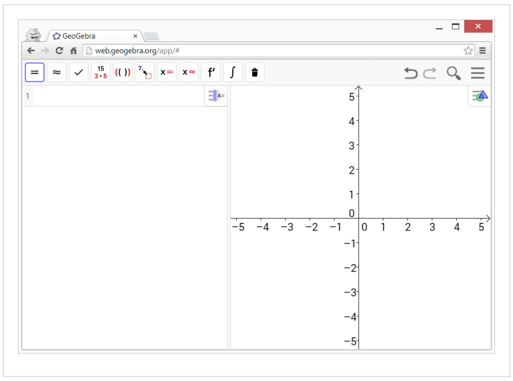
Algebra View:
Algebraic representations of objects are displayed and can be entered directly using the (virtual) keyboard (e.g. coordinates of points, equations).



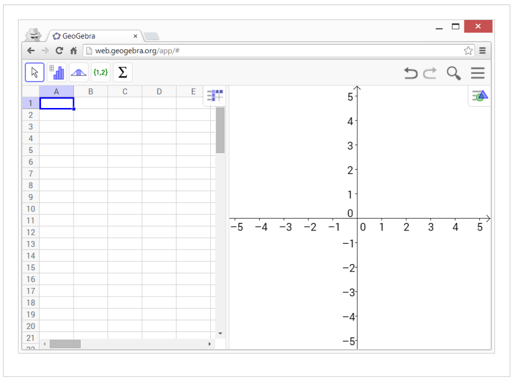
Graphics View:
Mathematical objects can be constructed with your mouse and changed dynamically afterwards.



3D Graphics View:
Three dimensional mathematical objects can be constructed and changed dynamically.



X= ***CAS View***:
GeoGebra's Computer Algebra System can be used for numerical and symbolic computations.



Spreadsheet View:
You can work with data and explore statistical concepts.

Other Display Features

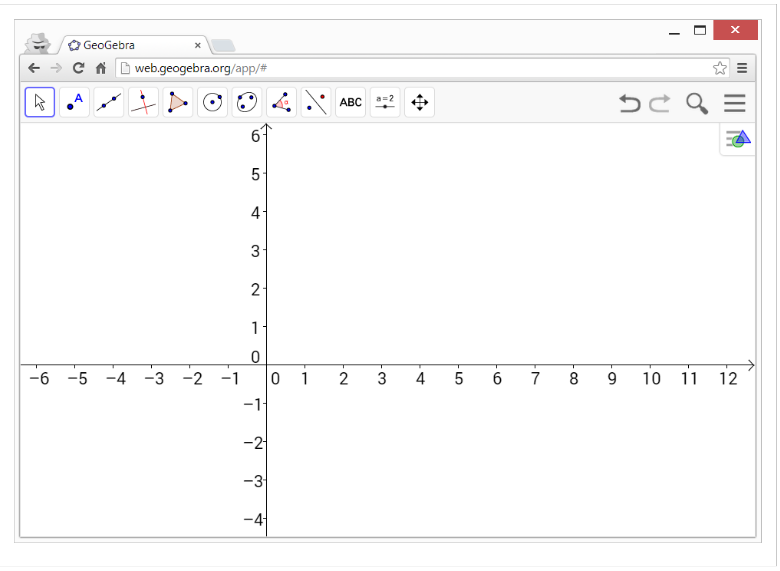
Construction Protocol: This interactive list of your construction steps allows you to redo your construction step by step.

Probability Calculator: Allows you to easily calculate and graph probability distributions.

Graphics View

Graphics View User Interface

The *Graphics View* is part of almost all *Perspectives* and always displays the graphical representation of objects created in GeoGebra. In addition, the *Graphics View Toolbar* is displayed at the top of the GeoGebra window, with the *Undo / Redo* buttons in the top right corner.



Graphics View

Customizing the Graphics View

The *Graphics View* may include various types of grids and axes. For more information see Customizing the Graphics View. You may also change the layout of GeoGebra's user interface according to your needs.

Displaying a Second Graphics View

A second *Graphics View* may be opened using the *View Menu*. If two *Graphics Views* are opened, one of them is always active (either it's being worked with and it has bold caption, or it is the last *View* that has been worked with). All visible objects created by *Commands* appear in the active *Graphics View*. For each object you can specify in which *Graphic View(s)* it will be visible using the *Advanced* tab of the *Properties Dialog*.

Creating Mathematical Objects

Constructions with the Mouse

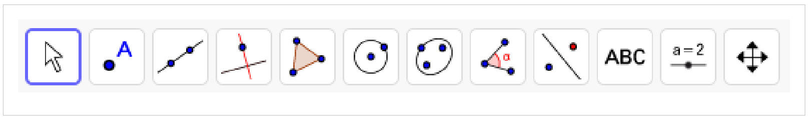
Using the construction *Tools* available in the *Graphics View Toolbar* you can create geometric constructions in the *Graphics View* with the mouse. Select any construction tool from the *Graphics View Toolbar* and read the tooltip provided in the *Graphics View* in order to find out how to use the selected *Tool*.

Note: Any object you create in the *Graphics View* also has an algebraic representation in the *Algebra View*.

Example: Select the *Circle with Center through Point Tool* and click in the *Graphics View* twice. The first click creates the center point while the second click creates a circle and a point on the circle.

Graphics View Toolbar

The *Graphics View Toolbar* provides a wide range of *Tools* that can be operated with the mouse and allow you to create the graphical representations of objects directly in the *Graphics View*. Every icon in the *Toolbar* represents a *Toolbox* that contains a selection of related construction *Tools*. In order to open a *Toolbox*, you need to click on the corresponding default *Tool* shown in the *Graphics View Toolbar* (GeoGebra Web and Tablet Apps) or on the small arrow in the lower right corner of the *Toolbar* icon (GeoGebra Desktop).



Note: The *Tools* of the *Graphics View Toolbar* are organized by the nature of resulting objects or the functionality of the *Tools*. You will find *Tools* that create different types of points in the *Points Toolbox* (default icon) and *Tools* that allow you to apply geometric transformations in the *Transformations Toolbox* (default icon).

Direct Input using the Input Bar

You can also create objects in the *Graphics View* by entering their algebraic representation or corresponding *Commands* into the *Input Bar*.

Hint: The *Input Bar* can be shown using the *View Menu*.

Modifying Mathematical Objects

The Move Tool

After activating the *Move Tool* you are able to move objects in the *Graphics View* by dragging them with the mouse.

Note: At the same time, their algebraic representations are dynamically updated in the *Algebra View*.

Copy & Paste

Via Keybord Shortcut Ctrl + C and Ctrl + V (Mac OS:Ctrl + C and Ctrl + V) you can *Copy and Paste* selected objects (except if they depend on the coordinate axes) into either the same or into another window.

Note: *Copy and Paste* will copy every ancestor of the selected objects but makes the non-selected objects invisible.

Example: If you copy objects depending on sliders into a new window, it will copy the slider (invisible) into the window, too.

The pasted object is fixed when you click on the *Graphics View*. If the copied object depends on at least one point then it can snap onto existing points when pasted (but only the point following the mouse pointer will do this).

Display of Mathematical Objects

Graphics View Style Bar

The *Graphics View Style Bar* contains buttons to

- show / hide the coordinate axes and a grid (different kinds of grids in the GeoGebra Web and Tablet Apps)
- go back to default view
- change the *Point Capturing* settings
- open the *Properties Dialog* (GeoGebra Web and Tablet Apps)
- display additional *Views* in the GeoGebra window (GeoGebra Web and Tablet Apps)

Style Bar for Tools and Objects

Depending on the *Tool* or object you select, the buttons in the *Style Bar* adapt to your selection. Please see Style Bar Options for Tools and Objects for more information.

Hiding Mathematical Objects in the Graphics View

You may hide objects in the *Graphics View* by either

- using the *Show / Hide Object Tool*
- opening the *Context Menu* and unchecking *Show Object*

Customizing the Graphics View

In order to adjust the visible part of the drawing pad in the Graphics View, you can drag the drawing pad by using tool Move Graphics View Tool and use the following ways of zooming:

- You may use the Zoom In Tool and Zoom Out Tool in order to zoom in the Graphics View. **Note:** The position of your click determines the center of zoom.
- You may use the scroll wheel of your mouse in order to zoom in the Graphics View.
- You may use keyboard shortcuts to zoom in Ctrl + + and to zoom out Ctrl + -.
- After right clicking (Mac OS: Ctrl-click) on an empty spot on the drawing pad a Context Menu appears which allows you to Zoom.
- You may specify a zoom rectangle by right clicking (Mac OS: Cmd - click) on an empty spot in the Graphics View and dragging the mouse to the opposite corner of your desired zoom rectangle. Release the mouse button in order to finish the zoom rectangle, which will then automatically adjust to fill all the space in the Graphics View.
- You may also specify range of *x*- and *y*-axis in the Properties Dialog for Graphics view (see below).

Showing and hiding objects

In the Algebra View, the icon to the left of every object shows its current visibility state (shown or hidden). You may directly click on the little marble icon in order to change the visibility status of an object. For more information see visibility.

Properties of Graphics View (Properties Dialog)

Coordinate axes, grid and some other properties can be customized using the Properties Dialog of the Graphics View. After right clicking (Mac OS: Ctrl-click) on the drawing pad, you can open this dialog window by selecting Graphics... from the appearing Context Menu of the Graphics View.

Customizing Coordinate Axes and Grid

To show or hide the axes and the grid, right click (Mac OS: Ctrl-click) on the drawing pad and select the corresponding items ∟ *Axes* or ▦ *Grid* from the appearing Context Menu. For further setting you need to open the Properties Dialog.

- On tab *Basic*, you can, for example, change the line style and color of the coordinate axes, and set the the ratio between the axes . To make sure the axes ratio cannot be changed by any command or user action, you may lock it using the lock icon.
- Clicking on tabs *xAxis* and *yAxis* allows you to customize the axes individually, set the distance of the tickmarks, labeling, axes visibility, units and more. If you want the cross of the axes to be at point *(a,b)*, you can set *Cross at* parameter for *xAxis* to *b* and for *yAxis* to *a*. Option *Stick to edge* means that the line remains close to the bottom or left border of the screen. To draw only the part of the axis to the right or to the top of the axes intersection, you can select *Positive direction only*.
- On tab *Grid*, you can change the color and line style of the coordinate grid, set the distance and ratio for grid lines to a certain value, and the grid visibility. Three types of grid are available: Cartesian, polar and isometric.

Note: Axes scaling is possible in every mode by pressing and holding the Shift-key (PC: also Ctrl-key) while dragging the axis. Range of the axes may be given dynamically, e.g. in Basic tab you can set X Min to x(A) and Y Min to y(A) to ensure the lower left corner of the view remains in point A. In such setting, the view cannot be zoomed.

Showing Navigation Bar

You can add Navigation Bar for Construction Steps to the Graphics View by enabling it in Basic Tab of Properties Dialog. You can also add the Play button to allow animating the construction steps and a button to show the Construction Protocol.

Miscellaneous settings

These settings are located in the last part of the *Basic* tab of *Properties Dialog*.

Background color

Allows you to change background color of the Graphics View.

Tooltips

Allows you to set the behavior of tooltips in the Graphics View. See article on Tooltips for details.

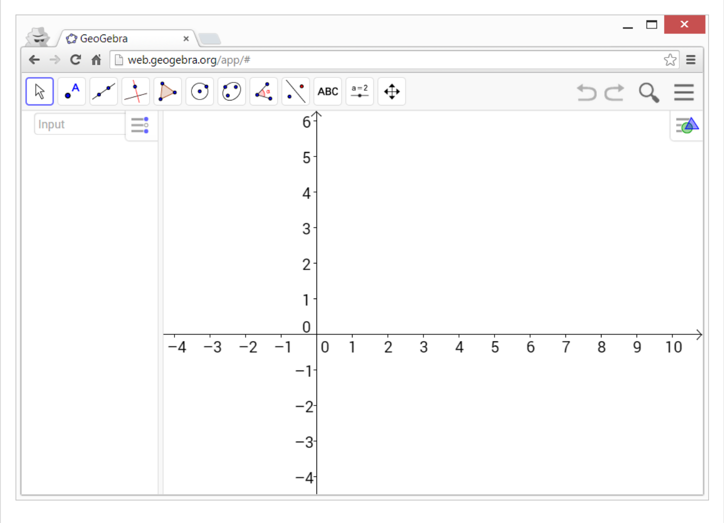
Show mouse coordinates

Enables display of mouse coordinates next to the mouse pointer.

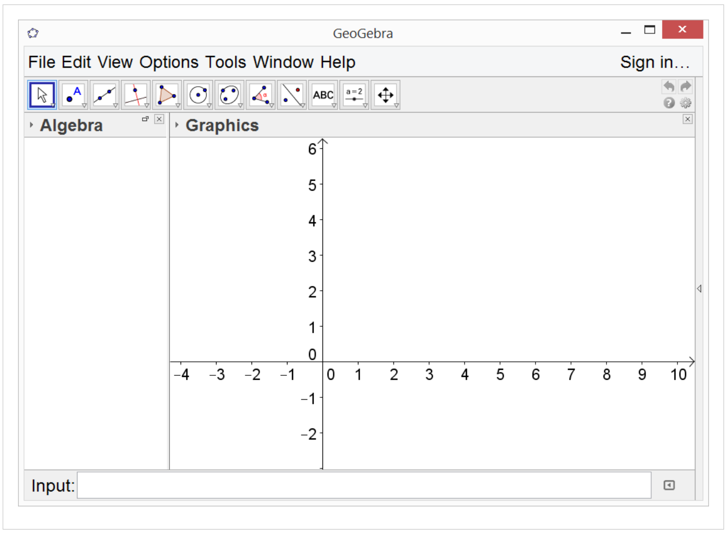
Algebra View

Algebra View User Interface

By default, the *Algebra View* is opened next to the *Graphics View*. In addition, either the *Input Bar* is displayed at the bottom of the GeoGebra window (GeoGebra Desktop), or an *Input Field* is integrated directly in the *Algebra View* (GeoGebra Web and Tablet Apps). The *Graphics View Toolbar* is displayed at the top of the GeoGebra window, with the *Undo / Redo* buttons in the top right corner.



GeoGebra Web and Tablet Apps



GeoGebra Desktop

The *Algebra View* is part of the *Algebra Perspective*, although you may change the layout of GeoGebra's user interface according to your needs.

Creating Mathematical Objects

Direct Input

In the *Algebra View* you can directly enter algebraic expressions using the integrated *Input Field* (GeoGebra Web and Tablet Apps) or the *Input Bar* at the bottom of the GeoGebra window (GeoGebra Desktop). After hitting the Enter key your algebraic input appears in the *Algebra View* while its graphical representation is automatically displayed in the *Graphics View*.

Example: The input `y = 2 x + 3` gives you the linear equation in the *Algebra View* and the corresponding line in the *Graphics View*.

Commands

GeoGebra also offers a wide range of *Commands* that can be used to create objects in the *Algebra View*. Just start typing the name of a *Command* into the *Input Bar* or *Input Field* and GeoGebra will offer you a list of *Commands* that match your input.

Tools

Although the *Algebra View* doesn't have it's own *Toolbar*, you can create *Dependent Objects* with the mouse. Select a tool from the *Graphics View Toolbar* and click on any appropriate object in the *Algebra View* in order to create a new *Dependent Object*.

Example: Create two points *A* and *B*, whose coordinates are displayed in the *Algebra View*. Select the *Line Tool* from the *Graphics View Toolbar* and click on both points in the *Algebra View* in order to create a line through points *A* and *B*.

Modifying Mathematical Objects

You can modify the algebraic representation of mathematical objects directly in the *Algebra View*.

Activate the *Move* tool and double click a *Free Object* in the *Algebra View*. In the appearing text box you can directly modify its algebraic representation. After hitting the Enter key, both the algebraic representation in the *Algebra View* and the graphical representation of the object in the *Graphics View* will automatically adapt to your changes.

If you double click on a *Dependent Object* in the *Algebra View*, a dialog window appears allowing you to Redefine the object.

Display of Mathematical Objects

By default, mathematical objects are organized by *Object Types* in the *Algebra View*. In GeoGebra Desktop, you may use the *Style Bar* option *Sort by* in order to re-sort the objects by *Dependency*, *Layer* or *Construction Order*.

Hint: You can collapse or expand each group of objects individually (e.g. all points, all free objects, all objects on a specific layer) by clicking on the plus or minus symbol in front of the group's name.

Algebra View Style Bar

The *Algebra View Style Bar* provides buttons to

- show / hide *Auxiliary Objects*
- sort the list of objects by different criteria

- display additional *Views* in the GeoGebra window (GeoGebra Web and Tablet Apps)

Hiding Mathematical Objects in the *Algebra View*

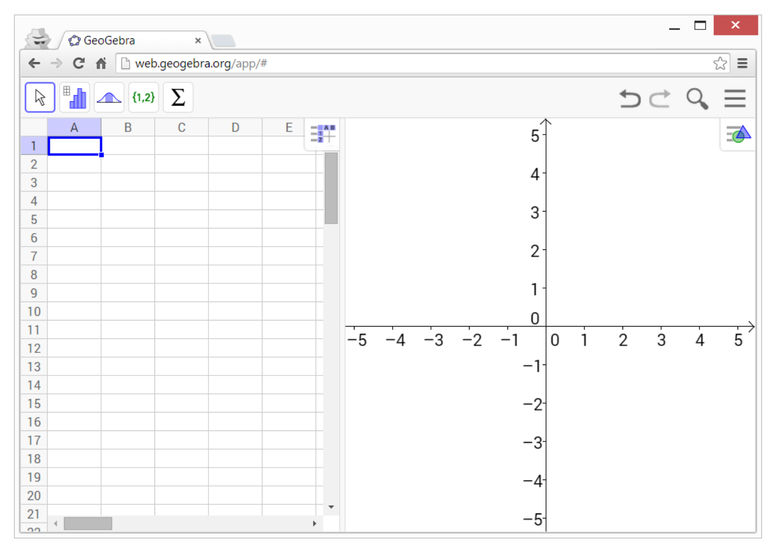
If you want to hide the algebraic representation of an object in the *Algebra View*, you may specify the object as an *Auxiliary Object*. Open the tab *Basic* of the *Properties Dialog* and check *Auxiliary Object*.

By default, *Auxiliary Objects* are not shown in the *Algebra View*. You can change this setting by selecting *Auxiliary Objects* from the *Context Menu* (right-click or Mac OS Ctrl-click), or by clicking on the appropriate icon in the *Algebra View Style Bar*.

Spreadsheet View

Spreadsheet View User Interface

By default, the *Spreadsheet View* is opened next to the *Graphics View*. The *Spreadsheet View Toolbar* is displayed at the top of the GeoGebra window, with the *Undo / Redo* buttons in the top right corner.



Spreadsheet View

The *Spreadsheet View* is part of the *Spreadsheet Perspective*, although you may change the layout of GeoGebra's user interface according to your needs.

Customizing the Spreadsheet View

The *Spreadsheet View* can be customized according to your preferences by

- opening the *Preferences Dialog* and selecting the option *Spreadsheet* (GeoGebra Desktop)
- opening the *Spreadsheet View Style Bar* and selecting *Preferences* (GeoGebra Web and Tablet Apps)

In the appearing dialog window you may change the layout by choosing whether to

- Show the *Input Bar*
- Show *Gridlines*
- Show the *Column* or *Row Header*
- Show *Vertical* or *Horizontal Scrollbars*

In addition, you may change the behavior of the *Spreadsheet View* by

- allowing *Use of Buttons and Checkboxes* or *Tooltips*
- requiring *"=" before Commands*
- using *Auto-complete*

Creating Mathematical Objects

In GeoGebra's *Spreadsheet View* every cell has a specific name that allows you to directly address each cell.

Example: The cell in column *A* and row *1* is named *A1*.

Note: These cell names can be used in expressions and *Commands* in order to address the content of the corresponding cell.

Direct Input and Commands

In the *Spreadsheet Cells* you can enter not only numbers, but all types of General Objects and Geometrical Objects that are supported by GeoGebra (e. g., coordinates of points, Functions, *Commands*).

Relative Cell Names

If you copy content from one cell to another, by default all references are changed accordingly to the target position.

Example: Let `A1=1`, `A2=2`. In *B1* put `(A1, A1)`. By copying *B1* to *B2* (either via Ctrl + C, Ctrl + V or by dragging the cell corner) you get *(A2, A2)* in *B2*.

To prevent this behavior, you can insert `$` before the column and/or row of the referenced cell.

Note: On Mac OS the Copy & Paste shortcuts are Cmd + C and Cmd + V

Input Data into the Spreadsheet View

Manual Entry, Commands, and Tracing

Besides manually adding entries into the *Spreadsheet View* cells, you may use the commands *FillColumn*, *FillRow* or *FillCells*. You can also enter data by using the feature *Tracing to Spreadsheet*.

Copy Data from the Algebra View

With a simple drag and drop operation it is also possible to copy objects from the *Algebra View* to the *Spreadsheet View*. If you drag a list, its elements will be pasted horizontally, starting from the cell in which you release the left mouse button. Pressing the Shift key while dragging opens a dialog window when the mouse button is released, allowing you to choose whether the pasted objects will be Free or Dependent, as well as to choose the vertical placement of the copied objects (check option *Transpose*).

Copy Data from Other Spreadsheet Software

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

- Select and copy the data you want to import. For example, you may use the keyboard shortcut Ctrl + C (Mac OS: Cmd + 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*. For example, you may select a cell and use the keyboard shortcut Ctrl + V (Mac OS: Cmd + V) in order to paste the data into the highlighted spreadsheet cell.

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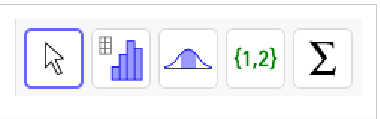
Import Data Files from other Applications

You can also import data from other applications, if stored using *.txt*, *.csv* and *.dat* formats. Simply right click on a free cell of the *Spreadsheet View*, then choose the *Import Data File...* option.

Note: GeoGebra uses the dot . as decimal separator, and the comma , as field separator. Ensure to check if your data file matches these settings before importing.

Spreadsheet View Toolbar

The *Spreadsheet View Toolbar* provides a range of *Tools* that can be operated with the mouse and allow you to create objects in the *Spreadsheet View*. Every icon in the *Toolbar* represents a *Toolbox* that contains a selection of related *Tools*. In order to open a *Toolbox*, you need to click on the corresponding default *Tool* shown in the *Spreadsheet View Toolbar* (GeoGebra Web and Tablet Apps) or on the small arrow in the lower right corner of the *Toolbar* icon (GeoGebra Desktop).



Note: The *Tools* of the *Spreadsheet View Toolbar* are organized by the nature of resulting objects or their functionality. For example, you will find *Tools* that analyze data in the *Data Analysis Toolbox*.

Display of Mathematical Objects

Display of Spreadsheet Objects in other Views

If possible, GeoGebra immediately displays the graphical representation of the object you entered in a *Spreadsheet Cell* in the *Graphics View* as well. Thereby, the name of the object matches the name of the *Spreadsheet Cell* used to initially create it (e. g., *A5*, *C1*).

Note: By default, *Spreadsheet Objects* are classified as *Auxiliary Objects* in the *Algebra View*. You can show or hide these *Auxiliary Objects* by selecting *Auxiliary Objects* from the *Context Menu* or by clicking on the icon in the *Algebra View Style Bar*

Using Spreadsheet Data in other *Views*

You may process the *Spreadsheet Data* by selecting multiple cells and right-clicking (Mac OS: Cmd-clicking) on the selection. In the appearing *Context Menu*, choose the submenu *Create* and select the appropriate option (*List*, *List of points*, *Matrix*, *Table*, *Polyline* and *Operation table*).

Operation Table

For a function with two parameters you can create an *Operation Table* with values of the first parameter written in the top row and values of second parameter written in the left column. The function itself must be entered in the top left cell.

After entering the function and the parameter values in the appropriate cells, select the rectangular area of the desired *Operation Table* with the mouse. Then, right click (Mac OS: Cmd-click) on the selection and choose option *Create* > *Operation Table* of the appearing *Context Menu*.

Example: Let `A1 = x y`, `A2 = 1`, `A3 = 2`, `A4 = 3`, `B1 = 1`, `C1 = 2` and `D1 = 3`. Select cells *A1:D4* with the mouse. Then, right click (Mac OS: Cmd-click) on the selection and choose *Create* > *Operation Table* in the *Context Menu* to create a table containing the results of substitution of the inserted values in the given function.

Spreadsheet View Style Bar

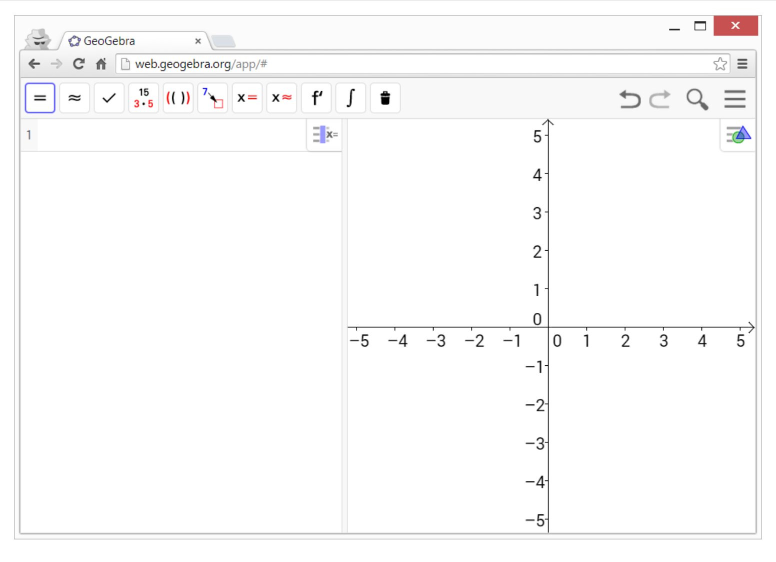
The *Spreadsheed View Style Bar* provides buttons to

- show / hide the *Input Bar* (GeoGebra Desktop)
- change the text style to B **bold** or *I* *italic*
- set the text alignment to ≡ *left*, ≡ *center*, or ≡ *right*
- change the □ background color of a cell
- change the cell borders (GeoGebra Desktop)
- open the ⚙ *Properties Dialog* (GeoGebra Web and Tablet Apps)
- display additional ⋮ *Views* in the GeoGebra window (GeoGebra Web and Tablet Apps)

CAS View

x= CAS View User Interface

By default, the x= *CAS View* is opened next to the △ *Graphics View*. Depending on which one of these two *Views* is active, either the *CAS View Toolbar* or the *Graphics View Toolbar* is displayed at the top of the GeoGebra window, with the *Undo / Redo* buttons in the top right corner.



CAS View

The x= *CAS View* is part of the *CAS Perspective*, although you may change the layout of GeoGebra's user interface according to your needs.

Creating Mathematical Objects

Direct Input

The *CAS View* allows you to use GeoGebra's CAS (Computer Algebra System) for symbolic computations. It consists of cells with an *Input Field* at the top and output display at the bottom. You can use these *Input Fields* in the same way as the normal *Input Bar*, with the following differences:

- You can use variables that were not assigned any value. **Example:** Enter `(a+b)^2` into an *Input Field* and hit the Enter key. You will get the output $a^2+2ab+b^2$.
- `=` is used for equations and `:=` for assignments. This means that the input `a=2` will not assign value 2 to *a*. See the section about assignments for details.
- Multiplication needs to be marked explicitly. While in the *Input Bar* you can use both `a(b+c)` and `a*(b+c)` for multiplication, in the x= *CAS View* only `a*(b+c)` is valid.

Keyboard Shortcuts for Direct Input

In the *CAS View* the following keyboard shortcuts help you to evaluate or check your input.

Note: Instead of using these keyboard shortcuts, you may also use the corresponding *Tools* of the *CAS View Toolbar*.

- Enter: Evaluates you input
- Ctrl + Enter: Evaluates your input numerically **Example:** `sqrt(2)` yields *1.41*
- Alt + Enter: Checks your input but does not evaluate it. **Example:** `b + b` stays as *b* + *b*.

Note: Assignments are always evaluated, e.g. `a := 5`

In the *CAS View* the following keyboard shortcuts help you to reuse previous input or output in a new row if you enter them into an empty *Input Field*:

- Space bar: Inserts the previous output into the new row.
- `)` : Inserts the previous output in parentheses.
- =: Inserts the previous input into the new row.

Note: You may suppress any output with a semicolon at the end of your input, e.g. `a := 5;`.

Variable Assignments and Connection with other Views

You may use the `:=` notation for assignments, e.g. `b := 5`, `a(n) := 2n + 3`.

- *Free up a name*: Use `Delete[b]` in order to free up a variable name again.
- *Redefine a variable or function*: You may redefine a variable or function, but you must do so **in the same cell**, otherwise it will be treated as a new variable and automatically renamed.

Variables and functions are always shared between the *CAS View* and the other *Views* if possible. For example:

- If you define `b:=5` in the *CAS View*, then you can use *b* in all the other *Views* of GeoGebra.
- If you define a function `f(x)=x^2` in another *View*, you can also use this function in the *CAS View*.

Note:

The output will always be just the expression **after** the `:=`, e.g. if you type `b:=5` the output will be *5*. Please also note, that for clarification actually *b := 5* will be displayed.

Equations

- You may write equations using the simple *Equals* sign, e.g. `3x + 5 = 7`.
- *Arithmetic operations*: You can perform arithmetic operations on equations, which is useful for manual equation solving. **Example:** `(3x + 5 = 7) - 5` subtracts 5 from both sides of the equation.
- *Extracting one Side*: You may extract either the left or right side of an equation by using the commands `LeftSide[]` and `RightSide[]`. **Example:** `LeftSide[3x + 5 = 7]` returns *3 x + 5* and `RightSide[3x + 5 = 7]` returns *7*

Row References

You can refer to other rows in the *CAS View* in two ways:

- **Static row references** copy the output and **won't be updated** if the *referenced* row is subsequently changed
  - `#`: Copies the previous output.
  - `#5`: Copies the output of row 5.
- **Dynamic row references** insert a reference to another row instead of the actual output and therefore **will be updated** if the *referenced* row is subsequently changed
  - `$`: Inserts a reference to the previous output.
  - `$5`: Inserts a reference to the output of row 5

CAS Commands

GeoGebra also offers a wide range of *CAS Commands* that can be used to create objects in the *CAS View*. Just start typing the name of a *Command* into the *Input Field* and GeoGebra will offer you a list of *Commands* that match your input.

Note: For a complete list of *Commands* see section CAS Commands.

Note: From GeoGebra 4.9.170.0 on, the *CAS View* supports exact versions of some *Geometry Commands*

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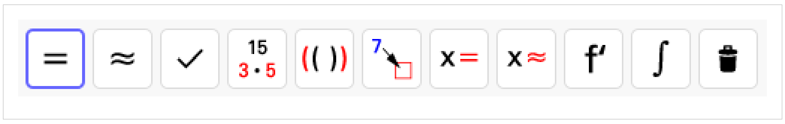
CAS View Toolbar

The *CAS View Toolbar* provides a range of *CAS Tools* that can be operated with the mouse and allow you to evaluate input and perform calculations. Just enter your input and use the mouse to click on the corresponding *CAS Tool* afterwards in order to apply it to your input.



Hint: You may select part of the input text to only apply the operation to this selected part.

Note: For a complete list of *Tools* see *CAS Tools*.

Context Menus

Row Header Context Menu

Right click (MacOS: Ctrl-click) on a row header in order to show a *Context Menu* with the following options:

- **Insert Above**: Inserts an empty row above the current one.
- **Insert Below**: Inserts an empty row below the current one.
- **Delete Row**: Deletes the contents of the current row.
- **Text**: Toggles between the current result and a text showing the current result contained in the row, which allows the user to insert comments.
- **Copy as LaTeX** (GeoGebra Desktop): Copies the contents of the current row to your computer's clipboard, allowing you to paste the contents e.g. in a Text object.

  Note: To copy the contents of more than one CAS row as LaTeX, select the rows you want with Ctrl-click (MacOS: Cmd-click), then right-click (MacOS: Ctrl-click) on the row header and select *Copy as LaTeX*.

Cell Context Menu

In GeoGebra Desktop, right click (MacOS: Ctrl-click) on a CAS output cell in order to show a *Context Menu* with the following options:

- **Copy**: Copies the cell contents to the your computer's clipboard. Then, right click on a new cell in order to show the **Paste** option.
- **Copy as LaTeX**: Copies the cell contents in LaTeX format to the your computer's clipboard, so it can be pasted into a Text object or a LaTeX editor.
- **Copy as LibreOffice Formula**: Copies the cell contents in LibreOffice formula format to your computer's clipboard, so it can be pasted in a word processing document.
- **Copy as Image**: Copies the cell contents in PNG format to your computer's clipboard, so it can be pasted into an Image object or in a word processing document.

Display of Mathematical Objects

CAS View Style Bar

The *CAS View Style Bar* provides buttons to

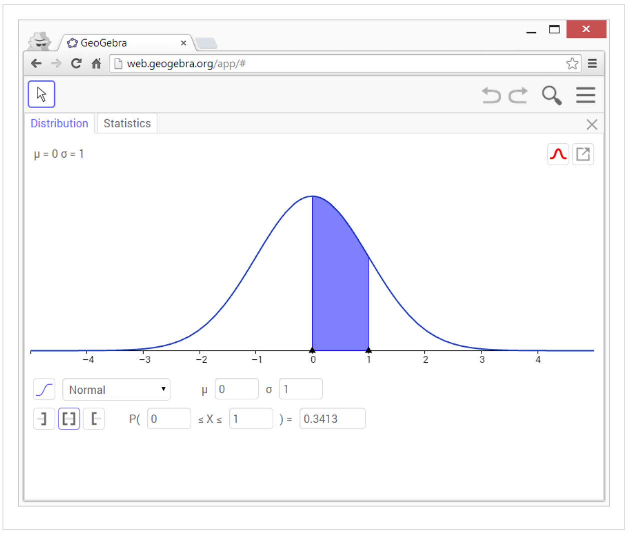
- T change the text style (**B** **bold** and *I* *italics*) and □ color
- display a virtual keyboard (GeoGebra Desktop)
- display additional ⋮ *Views* in the GeoGebra window (GeoGebra Web and Tablet Apps)

Showing CAS Objects in the *Graphics View*

In the *CAS View*, the icon to the left of every row shows the current visibility state (shown or hidden) of the object defined in it (when possible). You may directly click on the little *Show / Hide Object* icon in order to change the visibility status of the object in the *Graphics View*.

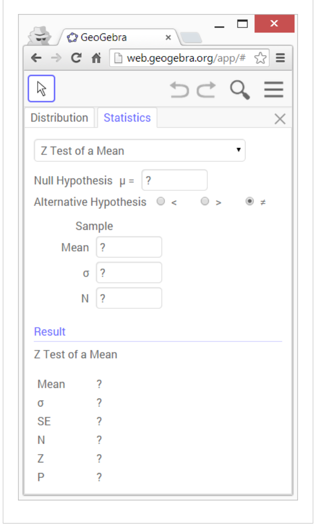
Probability Calculator

The *Probability Calculator* is one of GeoGebra's main perspectives. You may use it in order to calculate and graph probability distributions, as well as to conduct statistical tests.



Normal μ 0 σ 1

P(0 ≤ X ≤ 1) = 0.3413



Z Test of a Mean

Null Hypothesis μ = ?

Alternative Hypothesis ○ < ○ > ● ≠

Sample

Mean ?

σ ?

N ?

Result

Z Test of a Mean

Mean ?

σ ?

SE ?

N ?

Z ?

P ?

Probability Calculator: Tab *Distribution*

Tab *Statistics*

Distributions

Tab *Distribution* allows you to graph a variety of probability distributions. Just select the distribution you want to work with from the list available in the drop down menu (e.g. Normal, Binomial) and GeoGebra will graph it for you. Then, you may adjust the parameters of the distribution in the adjacent text boxes.

You may also use the buttons provided in order to change the appearance of the distribution:

- Toggle between the probability density function and the cumulative distribution function of the distribution
- Modify your graph in order calculate a cumulative probability (e.g. *P(x ≤ X)*, *P(x ≥ X)*). To calculate a probability select the interval type using the buttons provided. Then adjust the interval in the adjacent text boxes or drag the corresponding markers along the *x*-axis in the graph.

Statistics

Tab *Statistics* allows you to conduct a variety of statistical tests. Just select the test you want to work with from the list available in the drop down menu (e.g. *Z Test of a Mean*) and specify your *Null Hypothesis*, as well as your *Alternative Hypothesis*. Then, adjust the parameters of your test in the provided text boxes and GeoGebra will automatically provide the results of your statistical test.

Probability Calculator Style Bar

The *Probability Calculator Stylebar* provides options to overlay your distribution with the *Normal Curve* and to export the graph.

Note: You may export your distribution as a picture file (.png), copy it to your computer's clipboard (GeoGebra Desktop) or copy it to the *Graphics View* (GeoGebra Desktop).

Drag and Drop: In GeoGebra Desktop, you may use *Drag and Drop* in order to transfer the plot of your distribution either to the *Graphics View* or to another application that will accept images. Just position the mouse at the top of the

Probability Calculator screen and the cursor will change to a hand cursor. This new cursor allows you to drag the plot into *Graphics View* 1 or 2 to create a new plot or to drag an image of the plot into another application.

Construction Protocol

You can access the interactive Construction Protocol by selecting the *Construction Protocol* option in the *View* menu. The Construction Protocol is a table that shows all construction steps, allowing you to redo a construction step by step. To show the Navigation Bar at the bottom of the GeoGebra window, right click in the *Graphics View*, then select the *Navigation bar* option in the context menu displayed.

Navigating and Modifying the Construction Protocol

You may use the keyboard to navigate in the Construction Protocol:

- Press the ↑ up arrow of your keyboard to go to the previous construction step.
- Press the ↓ down arrow of you keyboard to go to the next construction step.
- Press the Home key to return to the beginning of the Construction Protocol.
- Press the End key to move to the end of the Construction Protocol.
- Press the Delete key to delete the selected construction step.

  Note: This may also affect other objects that depend on the selected object/construction step.

You may also use the mouse in order to navigate in the Construction Protocol:

- Double click a row to select a construction step.
- Double click the header of any column to go to the beginning of the Construction Protocol.
- Drag and drop a row to move a construction step to another position in the Construction Protocol.

  Note: This is not always possible due to the dependencies between different objects.
- Right click on a row to open the context menu related to the currently selected object.

Note: You can insert construction steps at any position. Select the construction step below the one you would like to insert a new construction step. Leave the Construction Protocol window open while you create a new object. This new construction step is immediately inserted into the selected position of the Construction Protocol.

Select the options listed when you click the first icon of the Construction Protocol toolbar, to decide which informations related to the construction will be shown. The *Breakpoint* option allows you to define certain construction steps as breakpoints, i.e. group several objects together. When navigating through your construction using the Navigation Bar, selected groups of objects are shown at the same time.

Exporting the Construction Protocol as a Webpage

GeoGebra allows you to export the *Construction Protocol* as a Webpage. Open the *Construction Protocol* using the related option in the *View* menu, then click the third icon of the *Contruction Protocol*'s toolbar (*Export as Webpage*).

In the export window of the *Construction Protocol* you can enter *Title*, *Author*, and a *Date* for the construction and choose whether or not you want to include a picture of the Graphics View and the Algebra View. In addition, you can also choose to export a *Colorful Construction Protocol*. This means that objects in the *Construction Protocol* will match the color of the corresponding objects in the construction.

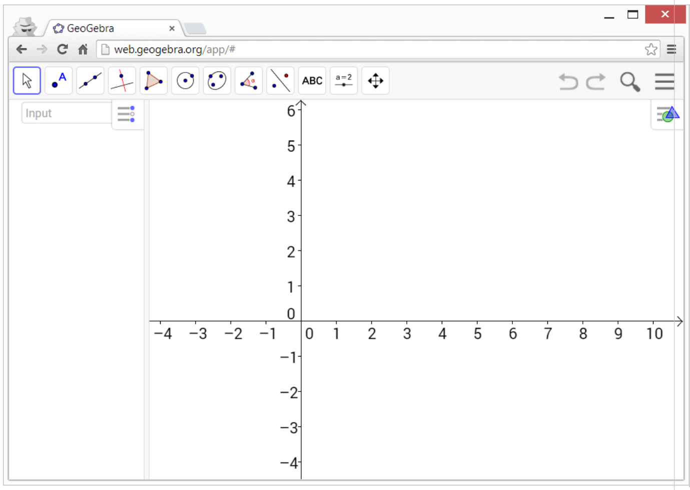
> **Note:** The exported HTML file can be viewed with any Internet browser (e. g. Firefox, Internet Explorer) and edited with many text processing systems (e. g. OpenOffice Writer).

Input Bar

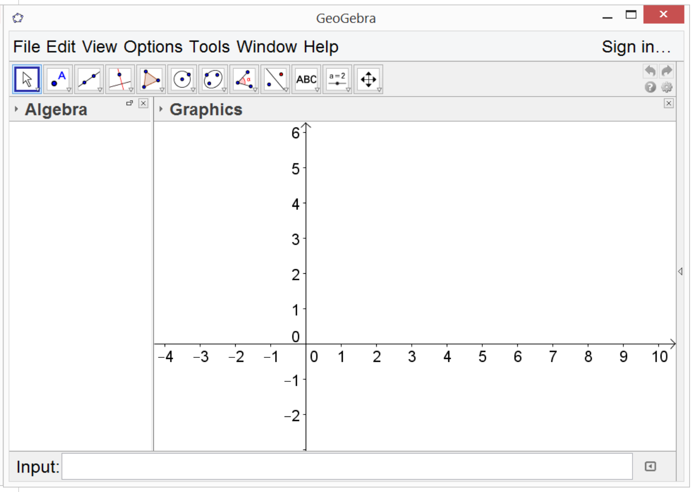
Input Bar and Input Field

In GeoGebra Desktop, the *Input Bar* is by default located in the bottom of GeoGebra window. You can show it or hide it using the *View Menu* or can change it's position within the GeoGebra window.

In the GeoGebra Web and Tablet Apps an *Input Field* is integrated directly into the *Algebra View*. Therefore, the *Input Bar* is not displayed by default if the *Algebra View* is part of the GeoGebra window. However, the *Input Bar* can be shown using the *View Menu*, replacing the *Input Field*. Both, the *Input Bar* and *Input Field* are providing the same functionalities in GeoGebra.



GeoGebra Web and Tablet Apps



GeoGebra Desktop

Algebraic Input and Commands

The *Input Bar* allows you to directly create and redefine mathematical objects in the *Algebra View* by entering or modifying their algebraic representations (e. g., values, coordinates, equations).

Example: The input `f(x) = x^2` gives you the function *f* in the *Algebra View* and its function graph in the *Graphics View*.

Note: Always press Enter after typing algebraic input into the *Input Bar*.

Additionally, you may input *Commands* in order to easily create new or work with existing objects. For more information, please see Geometric Objects and General Objects.

Example: Typing `A=(1,1)` and hitting the Enter key creates a free point *A* with coordinates (1, 1). Create another free point `B=(3,4)` in the same way. Then, type in `Line[A, B]` in order to create a dependent line through both points *A* and *B*.

You can toggle the focus between the *Input Bar* and the *Graphics View* at any time by pressing the Enter key. This allows you to enter expressions and commands into the *Input Bar* without having to click on it with the mouse first.

Displaying Input History

After placing the cursor in the *Input Bar* you can use the ↑ up and ↓ down arrow keys of your keyboard in order to navigate through prior input step by step. Hit the Enter key in order to transfer the selected prior input back into the *Input Bar*.

Insert Name, Value, or Definition of an Object into the Input Bar

Insert the name of an object: Activate the *Move Tool* and select the object whose name you want to insert into the *Input Bar*. Then, press F5 on your keyboard.

Note: The name of the object is appended to any expression you typed into the *Input Bar* before pressing F5.

Insert the value of an object: To insert an object's value (e. g., coordinates of a point `(1, 3)`, equation `3x − 5y = 12`) into the *Input Bar*, select the *Move Tool* and click on the object whose value you want to insert into the *Input Bar*. Then, press F4 on your keyboard.

Note: The value of the object is appended to any expression you typed into the *Input Bar* before pressing F4.

Insert the definition of an object: There are two ways of inserting an object's definition (e. g., `A = (4, 2)`, `c = Circle[A, B]`) into the *Input Bar*.

- Alt + click on the object to insert the object's definition and delete whatever input might have been in the *Input Bar* before.
- Activate the *Move Tool* and select the object whose definition you want to insert into the *Input Bar*. Then, press F3 on your keyboard.

Note: The definition of the object replaces any expression you typed into the *Input Bar* before pressing F3.

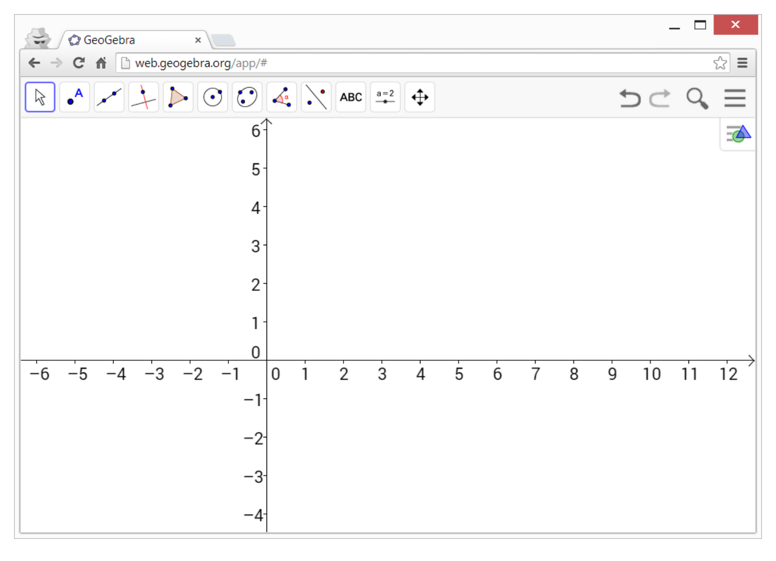
Menubar

The Menubar is always situated in the top part of GeoGebra window. For applets it can be switched on and off during export. It contains following menus:

- File Menu
- Edit Menu
- View Menu
- Options Menu
- Tools Menu
- Window Menu
- Help Menu

Toolbar

By default the *Toolbar* is located at the top of the GeoGebra window or right below the *Menubar* (GeoGebra Desktop). The *Toolbar* is divided into *Toolboxes*, containing one or more related *Tools*.



Graphics View Toolbar

Tool Help

If you select a *Tool*, a tooltip appears explaining how to use this *Tool*.

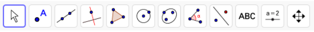
Note: When you click on the tooltip in the GeoGebra Web and Tablet Apps, a web page providing help for the selected tool opens in your browser.

If you are using GeoGebra Desktop, click on the *Help* button in the upper right corner of the GeoGebra window in order to show the *Tool Help Dialog* and get more information about how to use the selected *Tool*. Furthermore, you can access the online help by clicking on the button *Show Online Help* provided in the *Tool Help Dialog*. In addition, you can display the *Toolbar Help* to the right of the *Toolbar* by using the *Layout* option in the *View Menu* and checking *Show Toolbar Help*.

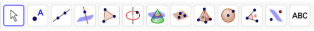
Different Toolbars for Different Views

Each *View* except the *Algebra View* has its own *Toolbar*, providing *Tools* specific for the *View* you are working with.

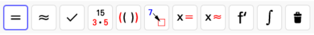
Graphics View Toolbar



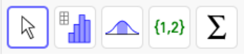
3D Graphics View Toolbar



CAS View Toolbar



Spreadsheet View Toolbar



Once you start using another *View* within the GeoGebra window, the *Toolbar* changes automatically. If you open another *View* in a separate window, it will have its *Toolbar* attached.

Customizing the Toolbar

Creating a Custom Toolbar

The different *Toolbars* can be customized by selecting *Customize Toolbar…* from the *Tools Menu*.

- From the drop-down list select the *Toolbar* of the *View* you want to edit.
- To **remove a *Tool* or entire *Toolbox*** from the custom *Toolbar*, select it in the list on the left hand side of the appearing dialog window and click the button *Remove >*.
- To **add a Tool** to your custom Toolbar, select it in the right list and click the button < *Insert*.
- To **add a *Tool* to a new Toolbox**, select a *Toolbox* in the left list and the *Tool* you want to insert in the right list. Then, click < *Insert*. Your *Tool* is inserted as part of a new *Toolbox* below the selected *Toolbox*.
- To **add a *Tool* to an existing *Toolbox***, open the *Toolbox* in the left list and select the *Tool* above the desired position of the new *Tool*. Then, select the *Tool* from the right list and click < *Insert*.
- To **move a *Tool* from one *Toolbox* to another**, you need to remove the *Tool* first and then add it to the other *Toolbox*.

Note: You can restore the default *Toolbar* by clicking on the button *Restore Default Toolbar* in the left lower corner of the dialog window.

Changing the Position of the Toolbar

In GeoGebra Desktop, you can change the position of the *Toolbar* using the *Layout* option in the *View Menu*.

Changing the Toolbar in a GeoGebra Applet

The appearance of the *Toolbar* in a Dynamic Worksheets can be set using the *customToolBar* parameter.

Navigation Bar

GeoGebra offers a **Navigation Bar** that allows you to navigate through the construction steps of your GeoGebra file. The *Navigation Bar* is shown at the bottom of the Graphics View.

To display it: Right click (Mac OS: Ctrl-click) on an empty spot on the drawing pad, then select the option *Navigation Bar* in the appearing context menu .

The *Navigation Bar* provides a set of navigation buttons, and displays the number of construction steps (e. g. 2 / 7 means that the second step of a total of 7 construction steps is currently displayed):

- ⏮ button: go back to step 1
- ⏪ button: go back step by step
- ⏩ button: go forward step by step
- ⏭ button: go to the last step
- ▷ Play: automatically play the construction, step by step

  Note: You may change the speed of this automatic play feature using the text box to the right of the ▷ Play button.

- ⏸ Pause: pause the automatic play feature

  Note: This button only appears after clicking on the Play button.

- ▤ button: This button opens the Construction Protocol

  Note: This button only appears if option 'Button to open construction protocol' is enabled.

File Menu

New Window

Keyboard shortcut: Ctrl + N (MacOS: Cmd + N)

This menu item opens a new GeoGebra window that uses the default settings of the GeoGebra user interface.

Note: If you change and save some of these settings, the new GeoGebra window will open using your customized settings.

New

This menu item opens a new and empty user interface in the same GeoGebra window. You are asked if you would like to save the existing construction before opening the new user interface.

Note: The new user interface adopts the settings used for the prior construction. For example, if the coordinate axes were hidden before selecting the menu item New, the axes will be hidden in the new user interface as well.

Open...

Keyboard shortcut: Ctrl + O (MacOS: Cmd + O)

This menu item allows you to open a GeoGebra worksheet (file name extension GGB), Style Template File (file name extension GGB), GeoGebra tool (file name extension GGT) or dynamic worksheet (HTM or HTML file produced by GeoGebra) that is saved on your computer.

It also allows you to open and insert a GeoGebra file in another one.

Note: In order to open a GeoGebra file you can also drag it with the mouse to the GeoGebra window and drop it there.

Open Webpage...

This menu item allows you to open a Webpage containing a GeoGebra applet, just entering the Webpage address in the appearing dialog.

Open Recent (submenu)

Lists up to eight recently opened files.

Save

Keyboard shortcut: Ctrl + S (MacOS: Cmd + S)

This menu item allows you to save your current construction as a GeoGebra file (file name extension GGB) on your computer.

Note: If the file was saved before, this menu item overwrites the old file by using the same file name.

Save as...

This menu item allows you to save your current construction as a GeoGebra file (file name extension GGB). You will be asked to enter a new name for your GeoGebra file before it is saved on your computer.

Share

Lets you upload your worksheet directly to GeoGebraTube [1], see also Dynamic Worksheet as Webpage (html)... .

Export (submenu)

Offers several export possibilities:

- Dynamic Worksheet as Webpage (html)...
- Graphics View as Picture (png, eps)…
- Graphics View to Clipboard
- ...and others

Print Preview

Keyboard shortcut: Ctrl + P (MacOS: Cmd + P)

This menu item opens the Print Preview window for the Graphics View. You may specify Title, Author, Date and the Scale of your printout (in cm).

Note: Press the Enter-key after you made a change in order to update the preview of your printout.

Close

Keyboard shortcut: Alt + F4 (MacOS: Cmd + W)

This menu item closes the GeoGebra window. If you didn't save your construction prior to selecting Close, you are asked if you would like to do so.

Edit Menu

Undo

Keyboard shortcut: Ctrl + Z (MacOS: Cmd + Z)

This menu item allows you to undo your activities step by step.

Note: You can also use the Undo button to the right of the Toolbar.

Redo

Keyboard shortcut: Ctrl + Y (MacOS: Cmd + Shift + Z)

This menu item allows you to redo your activities step by step.

Note: You can also use the Redo button to the right of the Toolbar.

Copy

Keyboard shortcut: Ctrl + C (MacOS: Cmd + C)

Copies the currently selected objects to GeoGebra's internal clipboard

Paste

Keyboard shortcut: Ctrl + V (MacOS: Cmd + V)

Pastes the objects from GeoGebra's internal clipboard into the currently selected Graphics View. You must then click the mouse where you would like to put them (if you move the mouse near an existing point it will "lock" onto it).

Object Properties…

Keyboard shortcut: Ctrl + E (MacOS: Cmd + E)

This menu item opens the Properties Dialog which allows you to modify the properties of all objects used in the GeoGebra file.

Select All

Keyboard shortcut: Ctrl + A (MacOS: Cmd + A)

This menu item allows you to select all objects used in your construction.

Select Current Layer

Keyboard shortcut: Ctrl + L (MacOS: Cmd + L)

This menu item allows you to select all objects that are on the same layer as a selected object.

Note: You need to select one object that lies on the desired layer prior to using this menu item.

Select Descendants

Keyboard shortcut: Ctrl + Shift + J (MacOS: Cmd + Shift + J)

This menu item allows you to select all objects that depend on the selected object.

Note: You need to select the parent object prior to using this menu item.

Select Ancestors

Keyboard shortcut: Ctrl + J (MacOS: Cmd + J)

This menu item allows you to select all objects that are ancestors of the selected object, meaning all objects the selected one depends on.

Note: You need to select the dependent object prior to using this menu item.

Invert Selection

Keyboard shortcut: Ctrl + I (MacOS: Cmd + I)

Deselects selected objects and vice versa.

Show / Hide Objects

Keyboard shortcut: Ctrl + G (MacOS: Cmd + G)

Toggles the visibity of selected objects.

Show / Hide Labels

Keyboard shortcut: Ctrl + Shift + G (MacOS: Cmd + Shift + G)

Shows hidden labels for selected objects and hides the shown ones.

Graphics View to Clipboard

Keyboard shortcut: Ctrl + Shift + C (MacOS: Cmd + Shift + C)

This menu item copies the Graphics View to your computer's clipboard. Afterwards, you can easily paste this picture into other documents (e. g., word processing document).

Delete

Keyboard shortcut: Delete

This menu items allows you to delete selected objects and their dependent objects.

Note: You need to select the objects you want to delete first (e. g., use a selection rectangle).

View Menu

Algebra

Keyboard shortcut: Ctrl + Shift + A (MacOS: Cmd + Shift + A)

This menu item allows you to show or hide the Algebra View.

Spreadsheet

Keyboard shortcut: Ctrl + Shift + S (MacOS: Cmd + Shift + S)

This menu item allows you to show or hide the Spreadsheet View.

CAS

Keyboard shortcut: Ctrl + Shift + K (MacOS: Cmd + Shift + K)

This menu item allows you to show or hide the CAS View.

Graphics

Keyboard shortcut: Ctrl + Shift + 1 (MacOS: Cmd + Shift + 1)

This menu item allows you to show or hide the Graphics View.

Graphics 2

Keyboard shortcut: Ctrl + Shift + 2 (MacOS: Cmd + Shift + 2)

This menu item allows you to show or hide a second Graphic View.

Graphique 3D

Keyboard shortcut: Ctrl + Maj + 2 (MacOS: Cmd + Maj + 3)

This menu item allows you to show or hide a second Graphic View 3D.

Construction Protocol…

This menu item opens the Construction Protocol dialog.

Keyboard

This menu item allows you to show or hide the Virtual Keyboard, that you can use with a mouse, and contains the standard keyboard characters, as well as the most used mathematical symbols and operators.

Input Bar

This menu item allows you to show or hide the Input Bar and the Command List at the bottom of the GeoGebra window.

Layout...

This menu opens the dialog in which you can configure:

Input Bar and the list of commands

The toolbar

The menu and style bars

The sidebar

Refresh Views

Keyboard shortcut: Ctrl + F (MacOS: Cmd + F)

This menu item allows you to repaint all views on screen.

> **Note:** You can use this menu item to delete any traces of points or lines in the Graphics View.

Recompute all objects

Keyboard shortcut: Ctrl + R (MacOS: Cmd + R)

or F9

This menu item recomputes all objects used in your GeoGebra file.

> **Note:** You can use this menu item to create new random numbers if you used any in your GeoGebra file.

Perspectives

Standard Perspectives

Algebra *Geometry* *Spreadsheet*

CAS *3D Graphics* *Probability*

GeoGebra provides a set of standard *Perspectives*. You can easily switch between *Perspectives* using the *Perspectives Sidebar* (GeoGebra Desktop) or the *Perspectives Menu* (GeoGebra Web and Tablet Apps). For more information please check out Selecting a *Perspective*.

Algebra Perspective

The *Algebra Perspective* consists of the *Algebra View* and the *Graphics View*. By default, the coordinate axes are shown in the *Graphics View*. Furthermore, the *Graphics View Toolbar* is displayed at the top of the GeoGebra window. Please note that in *GeoGebra 5.0 Desktop* the *Input Bar* is displayed as well at the bottom of the GeoGebra window while in the *GeoGebra 5.0 Web and Tablet Apps* an *Input Field* is integrated into the *Algebra View* (see Input Bar and Input Field).

Geometry Perspective

The *Geometry Perspective* displays the *Graphics View* without the coordinate axes, as well as the *Graphics View Toolbar*.

Spreadsheet Perspective

The *Spreadsheet Perspective* consists of the *Spreadsheet View* and the *Graphics View*. By default, the coordinate axes are shown in the *Graphics View*. Depending on which of these *Views* is activated, either the *Graphics View Toolbar* or the *Spreadsheet View Toolbar* are shown at the top of the GeoGebra window.

CAS Perspective

The *CAS Perspective* consists of the *CAS View* and the *Graphics View*. By default, the coordinate axes are shown in the *Graphics View*. Depending on which of these *Views* is activated, either the *Graphics View Toolbar* or the *CAS View Toolbar* are shown at the top of the GeoGebra window.

3D Graphics Perspective

The *3D Graphics Perspective* consists of the *3D Graphics View* and the *Algebra View*. By default, the coordinate axes and the *xOy*-plane are shown in the *3D Graphics View*. Furthermore, the *3D Graphics View Toolbar* is displayed at the top of the GeoGebra window. Please note that in *GeoGebra 5.0 Desktop* the *Input Bar* is displayed as well at the bottom of the GeoGebra window while in the *GeoGebra 5.0 Web and Tablet App* an *Input Field* is integrated into the *Algebra View* (see Input Bar and Input Field).

Probability Perspective

The *Probability Perspective* shows the *Probability Calculator*, which allows you to easily calculate and graph probability distributions.

Customized Perspectives

GeoGebra allows you to customize its user interface according to the mathematical topic you want to work with. You can add additional *Views* or other user interface components (e.g. *Input Bar*, second *Graphics View*) to the standard *Perspectives* by using the *View Menu* or the corresponding *Views Button* in the *Style Bar* (GeoGebra Web and Tablet Apps). Furthermore, you can change the position of some of these elements using the *Layout* option in the *Preferences Dialog* in GeoGebra Desktop or the *Drag View Button* in the GeoGebraWeb App. For more information please see Customizing the Layout of the User Interface.

Options Menu

Global options may be changed in the menu Options.

Note: To change object settings, please use the Context Menu and Properties Dialog.

Algebra Descriptions

You can set how will objects be represented in Algebra View with this item. There are three possibilities:

- *Value*: show current value of the object.
- *Definition*: show user-friendly description of the object, e.g. "Intersection of *a* and *b*."
- *Command*: show the command that was used to create the object, e.g. "Intersect[a,b]".

Rounding

This menu item allows you to set the number of decimal places or significant figures displayed on screen.

Labeling

You can specify whether the label of a newly created object should be shown or not. You can choose between the settings *All New Objects*, *No New Objects*, *New Points Only*, and *Automatic*.

Note: The setting Automatic shows the labels of newly created objects if the *Algebra View* is shown.

Font Size

This menu item determines the font size for labels and text in points (pt).

Note: If you are using GeoGebra as a presentation tool, increasing the font size makes it easier for your audience to read text, labels, and algebraic input you are using.

Language

GeoGebra is multilingual and allows you to change the current language setting. This affects all input including command names and all output.

Note: No matter which language was selected, the globe icon will lead you back to the *Language* menu. All language names are always displayed in English.

Advanced

This menu item opens the *Advanced* section of the Preferences Dialog.

Note: You can also open this dialog window by right clicking (Mac OS: Ctrl-click) on the Graphics View or Spreadsheet View and selecting *Graphics* ... and *Spreadsheet Options* respectively.

Save Settings

GeoGebra remembers your favorite settings (e. g., settings in the *Options* menu, current *Toolbar* and *Graphics View* settings) if you select Save settings in the Options menu.

Restore Default Settings

You can restore the default settings of GeoGebra using this menu item.

Tools Menu

Create New Tool…

Based on an existing construction you can create your own tools in GeoGebra. After preparing the construction of your tool, choose Create new tool in the Tools Menu. In the appearing dialog you can specify the output and input objects of your tool and choose names for the Toolbar icon and corresponding command.

Note: Your tool can be used both with the mouse and as a command in the Input Bar. All tools are automatically saved in your GGB construction file.

Manage Tools…

Using the Manage tools dialog you can delete a tool or modify its name and icon. You can also save selected tools to a GeoGebra Tools File (GGT). This file can be used later on (File menu, Open) to load the tools into another construction.

Note: Opening a GGT file doesn't change your current construction, but opening a GGB file does.

Customize Toolbar…

Opens Customize Toolbar Dialog.

Window Menu

New Window

Keyboard shortcut: Ctrl + N (MacOS: Cmd + N)

See File Menu > New Window.

List of GeoGebra windows

If you have more than one GeoGebra window open, this menu item allows you to switch between these different windows.

Note: This might be helpful when you are using GeoGebra as a presentation tool and want to have several GeoGebra files open at the same time as well as to toggle between them.

Help Menu

WARNING: Article could not be rendered - ouputting plain text.
Potential causes of the problem are: (a) a bug in the pdf-writer software (b) problematic Mediawiki markup (c) table is too wide

Note: Following four menu items work only provided you have access to the internet. If you want to access help on a computer that is not connected, please download the PDF version . Instead of reading tutorials you might download the GeoGebra Introductory Book. HelpThis menu item opens the HTML-version of the GeoGebra help (the Manual part of GeoGebraWiki) in your browser. TutorialsThis menu item opens the tutorial part of GeoGebraWiki in your browser. GeoGebraTubeThis menu item opens the GeoGebraTube webpage in your default web browser. Report BugThis menu item opens the GeoGebra User Forum in your default web browser. You can post and answer GeoGebra-related questions and problems in the GeoGebra User Forum. About / LicenseThis menu item opens a dialog window that gives you information about the license of GeoGebra and gives credit to people who support the GeoGebra project by contributing in many different ways (e. g., programming, translations).

Context Menu

WARNING: Article could not be rendered - ouputting plain text.
Potential causes of the problem are: (a) a bug in the pdf-writer software (b) problematic Mediawiki markup (c) table is too wide

The Context Menu provides a quick way to change the behavior or advanced properties of an object. Right click (Mac OS: Ctrl-click) on an object in order to open its Context Menu. For example, it allows you to change the object's algebraic notation (e. g., polar or Cartesian coordinates, implicit or explicit equation) and to directly access features like Rename, Delete, Trace On, Animation On. Note: If you open the Context Menu for a point in the Graphics View, it gives you the option Record to Spreadsheet (only if the Spreadsheet View is active). Once selected, this feature allows you to record the coordinates of the point in the Spreadsheet View if it is moved. Note: Selecting Properties… in the Context Menu opens the Properties Dialog, where you can change the properties of all objects used.

Customize the Settings

GeoGebra allows you to change and save settings using the Options Menu. For example, you may change the Angle Unit from Degree to Radians, or change the Point Style, Checkbox Size, and Right Angle Style. In addition, you may change how Coordinates are displayed on screen and which objects are labeled (Labeling).

Please see the section about the Options menu for more information.

You can save your customized settings by selecting item Save Settings from the Options menu. After doing so, GeoGebra will remember your customized settings and use them for every new GeoGebra file you create.

Note: You may restore the default settings by selecting Restore Default Settings from the Options menu.

Note: If you use GeoGebra as a presentation tool, you might want to increase the Font Size (Options menu) so your audience can easily read text and labels of objects.

Export Graphics Dialog

This dialog is accessible via Export submenu of File Menu (item Graphics View as Picture (png, eps)….)

Keyboard shortcut: Ctrl + Shift + P (Mac OS: Cmd + Shift + P)

This dialog allows you to save GeoGebra Graphics View as a picture file on your computer. In the appearing dialog window, you can select the picture file Format, change the Scale (in cm) and Resolution (in dpi) of the picture, and set the image as Transparent.

Note: If you create Points called Export_1 and Export_2 then these will define the rectangle that is exported, otherwise just the visible Graphics View is exported

When exporting the Graphics View as a picture you can choose out of the following formats:

PNG – Portable Network Graphics

> This is a pixel graphics format. The higher the resolution (dpi), the better the quality (300dpi will usually suffice). PNG graphics should not be scaled subsequently to avoid a loss of quality.
>
> PNG graphic files are well suited for the use on web pages (HTML) and in word processing documents.
>
> **Note:** Whenever you insert a PNG graphic file into a word processing document (menu Insert, Image from file) make sure that the size is set to 100 %. Otherwise the given scale (in cm) would be changed.

EPS – Encapsulated Postscript

> This is a vector graphics format. EPS pictures may be scaled without loss of quality. EPS graphic files are well suited for the use with vector graphics programs (e. g., Corel Draw) and professional text processing systems (e. g., LaTeX).
>
> The resolution of an EPS graphic is always 72dpi. This value is only used to calculate the true size of an image in centimeters and has no effect on the image's quality.
>
> **Note:** The transparency effect with filled polygons or conic sections is not possible with EPS.

PDF – Portable Document Format

> (see EPS format above)
>
> **Note:** In SVG and PDF export you have the option to export text as editable text or shapes. This stores the text either as text (this lets you edit the text in e. g., InkScape) or as Bézier curves (this guarantees that the text looks the same even if the correct font is not installed).

SVG – Scalable Vector Graphic

> (see EPS format above)

EMF – Enhanced Metafile

> (see EPS format above)

Export Worksheet Dialog

GeoGebra allows you to create interactive webpages, so called Dynamic Worksheets, from your files. In the File Menu, you need to select item *Export*, then click on item *Dynamic Worksheet as Webpage (html)*. This opens the export dialog window for Dynamic Worksheets.

Upload to GeoGebraTube

Under this tab you can enter a title for your construction, a text above and below the construction (e. g. a description of the construction and some tasks), and then Upload it to GeoGebraTube [1].

Note: When you upload a file to GeoGebraTube, you will be asked to create an account and/or login first.

Properties Dialog

The Properties Dialog allows you to modify properties of objects (e. g., size, color, filling, line style, line thickness, visibility) as well as automate some object actions using Javascript or GeoGebra Script.

How to Open the Properties Dialog

You can open the Properties Dialog in several ways:

- Select item *Object Properties* from the *Edit Menu*.
- Right-click (Mac OS: Ctrl-click) on an object and select *Object Properties* from the appearing *Context Menu*.
- Select the *Properties* button from the *Style Bar* (GeoGebra Web and Tablet Apps).
- Select item *Properties* in the upper right corner of the GeoGebra window (GeoGebra Desktop).
- Select the *Move Tool* and double click on an object in the *Graphics View*. In the appearing *Redefine Dialog* window, click on the button *Object Properties*.

Organization of Objects

In the *Properties Dialog* objects are organized by types (e. g., points, lines, circles) in the list on the left hand side, which makes it easier to handle large numbers of objects. You need to select one or more objects from this list in order to change their properties.

Note: By clicking on a heading in the list of objects (e. g., *Point*, *Line*) you can select all objects of this type and then quickly change the properties for all these objects.

Modifying Object Properties

You can modify the *Properties* of selected objects using the tabs on the right hand side of the *Properties Dialog* window.

- *Basic*
- *Text*
- *Color*
- *Position*
- *Style*
- *Algebra*
- *Advanced*
- *Scripting*

Note: Depending on the selection of objects in the list, a different set of tabs may be available.

Close the *Properties Dialog* when you are done with changing properties of objects.

Redefine Dialog

Redefining objects is a very versatile way to change a construction. Please note that this may also change the order of the construction steps in the Construction Protocol.

Note: The redefined element can only depend on elements defined earlier in the construction order -- you may need to change order of the elements in Construction Protocol.

In GeoGebra, an object may be redefined in different ways:

- Select Move Tool and double click on any object in the Algebra View.
  - For free objects an editing field is opened allowing you to directly change the algebraic representation of the object. Hit the Enter-key in order to apply these changes.
  - For dependent objects the Redefine dialog is opened allowing you to redefine the object.
- Select Move Tool and double click on any object in the Graphics View. This opens the Redefine dialog and allows you to redefine the object.
  - Change any object by entering its name and the new definition into the Input Bar.
  - Open the Properties Dialog and change the definition of an object on tab Basic.
- From GeoGebra 4.2, the Redefine dialog of an object, which was just created, is immediately opened by typing any letter on the keyboard.

Note:

Fixed objects cannot be redefined. In order to redefine a fixed object, you need to free it first using tab Basic of the Properties Dialog.

Note:

You can also redefine existing objects in the Input Bar. For example type `a:Segment[A, B]` to redefine `a` to be a segment.

Examples

Example: In order to place an existing free point A onto an existing line h, you first need to double click on the point A to open the Redefine dialog window. Then change the definition to `Point[h]` in the appearing text field and press Enter. To remove point A from this line and make it free again, you need to redefine it to some free coordinates, eg (1, 2).

Example: Another example is the conversion of a line h through two points A and B into a segment. Open the Redefine dialog for line h and change `Line[A, B]` into `Segment[A, B]`

Tool Creation Dialog

First, create the construction your tool should be able to create later on. In the Tools menu, click on Create New Tool in order to open the corresponding dialog box. Now you need to fill in the three tabs Output Objects, Input Objects, and Name and Icon in order to create your custom tool.

Example: Create a Square-tool that creates a square whenever you click on two existing points or on two empty spots in the Graphics View.

- Construct a square starting with two points A and B. Construct the other vertices and connect them with the tool Polygon to get the square poly1.
- Select Create New Tool in the Tools menu.
- Specify the Output Objects: Click on the square or select it from the drop down menu. Also, specify the edges of the square as Output Objects.
- Specify the Input Objects: GeoGebra automatically specifies the Input Objects for you (here: points A and B). You can also modify the selection of input objects using the drop down menu or by clicking on them in your construction.
- Specify the Tool Name and Command Name for your new tool.

Note: The Tool Name will appear in GeoGebra Toolbar, while the Command Name can be used in GeoGebra Input Bar.

- You may also enter text to be shown in the Toolbar Help.
- You can also choose an image from you computer for the Toolbar icon. GeoGebra resizes your image automatically to fit on a Toolbar button.

Note: Outputs of the tool are not moveable, even if they are defined as `Point[<Path>]`. In case you need moveable output, you can define a list of commands and use it with Execute Command.

Keyboard Shortcuts

Key	Shortcut(Windows)	Shortcut(Mac OS X)	Action
A	Ctrl + A	Cmd + A	Select All
A	Ctrl + Shift + A	Cmd + Shift + A	View/Hide Algebra Window
A	Alt + A	Option + A	alpha α (Press Shift for upper-case: Α)
B	Alt + B	Option + B	beta β (Press Shift for upper-case: Β)
B	Ctrl + Shift + B	Cmd + Shift + B	Export ggbBase64 string to clipboard
C	Ctrl + C	Cmd + C	Copy
C	Ctrl + Alt + C	Cmd + Option + C	Copies values (spreadsheet)
C	Ctrl + Shift + C	Cmd + Shift + C	Copy Graphics View to clipboard
D	Ctrl + D	Cmd + D	Toggle value/definition/command
D	Ctrl + Shift + D	Cmd + Shift_D	Toggle toggle *Selection Allowed* for all "non-essential" geos
D	Alt + D	Option + D	delta δ (Press Shift for upper-case: Δ)
E	Ctrl + E	Cmd + E	Open Object Properties View
E	Ctrl + Shift + E	Cmd + Shift + E	Open/Close Object Properties View
E	Alt + E	Option + E	Euler *e*
F	Ctrl + F	Cmd + F	Refresh Views
F	Alt + F	Option + F	phi φ (Press Shift for upper-case: Φ)
G	Ctrl + G	Cmd + G	Show/Hide selected objects
G	Ctrl + Shift + G	Cmd + Shift + G	Show/Hide labels of selected objects
G	Alt + G	Option + G	gamma γ (Press Shift for upper-case: Γ)
I	Alt + I	Option + I	imaginary unit ί = √-1
J	Ctrl + J	Cmd + J	Select ancestors
J	Ctrl + Shift + J	Cmd + Shift + J	Select descendants
K	Ctrl + Shift + K	Cmd + Shift + K	View/Hide CAS View
L	Ctrl + L	Cmd + L	Select current layer
L	Alt + L	Option + L	lambda λ (Press Shift for upper-case: Λ)
L	Ctrl + Shift + L	Cmd + Shift + L	View/Hide Construction Protocol
M	Ctrl + Shift + M	Cmd + Shift + M	Export ggbBase64 string to clipboard
M	Alt + M	Option + M	mu μ (Press Shift for upper-case: Μ)
N	Ctrl + N	Cmd + N	New Window
N	Ctrl + Shift + N	Cmd + Shift + N	Open next window (or next ggb file in folder)
N	Ctrl + Shift + Alt + N	Cmd + Shift + Option + N	Open previous window
O	Ctrl + O	Cmd + O	Open New File
O	Alt + O	Option + O	degree symbol °
P	Ctrl + P	Cmd + P	Print Preview
P	Ctrl + Shift + P	Cmd + Shift + P	Open Probability Calculator
P	Alt + P	Option + P	pi π (Press Shift for upper-case: Π)

Q	Ctrl + Q		Select descendants (deprecated)
Q	Ctrl + Shift + Q		Select ancestors (deprecated)
Q		Cmd + Q	Quit GeoGebra
R	Ctrl + R	Cmd + R	Recompute all objects (including random numbers)
R	Alt + R	Option + R	Square-root symbol: √
S	Ctrl + S	Cmd + S	Save
S	Ctrl + Shift + S	Cmd + Shift + S	View spreadsheet
S	Alt + S	Option + S	sigma σ (Press Shift for upper-case: Σ)
T	Ctrl + Shift + T	Cmd + Shift + T	Export as PSTricks
T	Alt + T	Option + T	theta θ (Press Shift for upper-case: Θ)
U	Alt + U	Option + U	infinity ∞
U	Ctrl + Shift + U	Cmd + Shift + U	Open Graphic Export Dialog
V	Ctrl + V	Cmd + V	Paste
W		Cmd + W	Quit GeoGebra
W	Ctrl + Shift + W	Cmd + Shift + W	Export Dynamic Worksheet
W	Alt + W	Option + W	omega ω (Press Shift for upper-case: Ω)
Y	Ctrl + Y	Cmd + Y	Redo
Z	Ctrl + Z	Cmd + Z	Undo
Z	Ctrl + Shift + Z	Cmd + Shift + Z	Redo
0	Alt + 0	Option + 0	to the power of 0
1	Ctrl + 1		Standard font size, line thickness, and point size
1	Alt + 1	Option + 1	to the power of 1
1	Ctrl + Shift + 1	Cmd + Shift + 1	View/Hide Graphics View 1
2	Ctrl + 2		Increase font size, line thickness, and point size
2	Alt + 2	Option + 2	to the power of 2
2	Ctrl + Shift + 2	Cmd + Shift + 2	View/Hide Graphics View 2
3	Ctrl + 3		Black/white mode
3	Alt + 3	Option + 3	to the power of 3
4	Alt + 4	Option + 4	to the power of 4
5	Alt + 5	Option + 5	to the power of 5
6	Alt + 6	Option + 6	to the power of 6
7	Alt + 7	Option + 7	to the power of 7
8	Alt + 8	Option + 8	to the power of 8
9	Alt + 9	Option + 9	to the power of 9
-	-	-	Decrease selected slider/number Move selected point along path/curve
-	Ctrl + -	Ctrl + -	Zoom out(hold Alt as well for accelerated zoom)
-	Alt + -	Option + -	superscript minus
+	+	+	Increase selected slider/number Move selected point along path/curve

+	Ctrl + +	Ctrl + +	Zoom in (hold Alt as well for accelerated zoom)
+	Alt + +	Option + +	plus-or-minus ±
=	=	=	Increase selected slider/number Move selected point along curve
=	Ctrl + =	Cmd + =	Zoom in (hold Alt as well for accelerated zoom)
=	Alt + =	Option + =	not-equal-to ≠
<	Alt + <	Option + <	less-than-or-equal-to ≤
, (comma)	Alt + ,	Option + ,	less-than-or-equal-to ≤
>	Alt + >	Option + >	greater-than-or-equal-to ≥
. (period)	Alt + .	Option + .	greater-than-or-equal-to ≥
F1	F1	F1	Help
F2	F2	F2	Start editing selected object
F3	F3	F3	Copy definition of selected object to the Input Bar
F4	F4	F4	Copy value of selected object to the Input Bar
F4	Alt + F4		Quit GeoGebra
F5	F5	F5	copy name of selected object to the Input Bar
F9	F9	F9	Recompute all objects (including random numbers)
Enter	Enter	Enter	Toggle input between Graphics View and Input Bar
Tab	Ctrl + Tab	Cmd + Tab	Cycle the focus round the open views
Left Click	Left Click	Left Click	(current mode)
Left Click	Alt+Left Click	Option+Left Click	copy definition to input bar
Left Click	Alt+Left Drag	Option+Left Drag	create list of selected objects in input bar
Right Click	Right click in Graphics View		Fast drag mode (drag on object) Zoom (drag not on object) Open menu (click on object) Open Axes and Grid menu (click not on object)
Right Click	Shift+ Right Drag		Zooms without preserving the aspect ratio
Scroll Wheel	Scroll Wheel	Scroll Wheel	Zoom in / out (Application)
Scroll Wheel	Shift+Scroll Wheel		Zoom in / out (Applet)
Scroll Wheel	Alt+Scroll Wheel	Option+Scroll Wheel	Accelerated zoom in / out
Delete	Delete		Delete current selection
Backspace	Backspace	Backspace	Delete current selection
Up arrow ↑	↑	↑	Increase selected slider/number Move selected point up **3D Graphics** Increase y-coordinate of selected point Go to older entry in Input Bar history Go up in construction protocol
Up arrow ↑	Ctrl + ↑		x10 speed multiplier Spreadsheet: go to top of current block of cells (or go up to next defined cell)
Up arrow ↑	Shift + ↑	Shift + ↑	x0.1 speed multiplier, or rescale y-axis if no objects selected
Up arrow ↑	Alt + ↑	Option + ↑	x100 multiplier

Right arrow →	→	→	Increase selected slider/number Move selected point right **3D Graphics** Increase x-coordinate of selected point Go up in construction protocol
Right arrow →	Ctrl + →		x10 speed multiplier Spreadsheet: go to right of current block of cells (or go right to next defined cell)
Right arrow →	Shift + →	Shift + →	x0.1 speed multiplier, or rescale x-axis if no objects selected
Right arrow →	Alt + →	Option + →	x100 multiplier
Left arrow ←	←	←	Decrease selected slider/number Move selected point left **3D Graphics** Decrease x-coordinate of selected point Go down in construction protocol
Left arrow ←	Ctrl + ←		x10 speed multiplier Spreadsheet: go to left of current block of cells (or go left to next defined cell)
Left arrow ←	Shift + ←	Shift + ←	x0.1 speed multiplier, or rescale x-axis if no objects selected
Left arrow ←	Alt + ←	Option + ←	x100 multiplier
Down arrow ↓	↓	↓	Decrease selected slider/number Move selected point down **3D Graphics** Decrease y-coordinate of selected point Go to newer entry in Input Bar history Go down in construction protocol
Down arrow ↓	Ctrl + ↓		x10 speed multiplier Spreadsheet: go to bottom of current block of cells (or go down to next defined cell)
Down arrow ↓	Shift + ↓	Shift + ↓	x0.1 speed multiplier, or rescale y-axis if no objects selected
Down arrow ↓	Alt + ↓	Option + ↓	x100 multiplier
Home	Home		Go to first item in construction protocol Spreadsheet: go to top left
PgUp ↑	▯		Go to first item in construction protocol **3D Graphics** Increase z-coordinate of selected point
End	End		Go to last item in construction protocol Spreadsheet: go to bottom right
PgDn↓	▯		Go to last item in construction protocol **3D Graphics** Decrease z-coordinate of selected point

In addition, use Alt + Shift (Mac OS X Ctrl + Shift) to get upper-case Greek characters.

Settings Dialog

This dialog is available by selecting the *Advanced* item in Options Menu, or by clicking the *Preferences* icon on the toolbar. It is divided into different sections, which are shown depending on active objects and Views: *Properties*, *Graphics*, *CAS*, *Spreadsheet*, *Layout*, *Defaults*, and *Advanced*.

Properties

This section is displayed only if an object is currently selected in the construction. Clicking on the related icon displays the Properties Dialog of the object.

Graphics

This section is displayed only if the *Graphics View* is active, and allows you to define its settings, e.g. background colour, axes and grid. See Customizing the Graphics View for further details.

CAS

This section is displayed only if the *CAS View* is active, and allows you to:

- set a timeout for the CAS calculations, in seconds
- set how to show rational exponents

Spreadsheet

This section is displayed only if the *Spreadsheet View* is active, and contains two tabs.

- The *Layout* tab allows you fully customize the spreadsheet, setting preferences for the input bar, grid lines, column/row headers and scrollbars. You can also enable using buttons, checkboxes and tooltips.
- The *Browser* tab allows you to show the files browser, and set the file system directories, as well as a remote URL for your files.

Layout

This section allows you to customize the layout of the main components of your GeoGebra window, setting the position of the input bar, the toolbar, and the sidebar, as well as the style bar and title bar visibility.

Defaults

This section allows you to customize the appearance and style of all the mathematical objects in GeoGebra. The list of all available objects is shown on the left of the dialog window, while on the right the Properties Dialog tabs are shown, where you can set visibility, colour, style and algebraic settings for all your mathematical objects.

Advanced

This section contains the following advanced global settings:

- *Angle Unit*: switch between *Degree* and *Radians*
- *Right Angle Style*: choose the symbol for a right angle.
- *Coordinates*: define how coordinates are displayed algebraically.
- *Continuity*: if Continuity is *On*, GeoGebra tries to set new calculated points near the original ones.
- *Use Path and region Parameters*: you can turn On and Off this option
- *Virtual Keyboard*: options to set the *virtual keyboard language*, its width,height and opacity.
- *Checkbox Size*: switch between *regular* and *large* checkboxes.
- *Fonts Size*: set the Menu font size
- *Tooltips*: set the *tooltip language* and a timeout for tooltips.
- *Language*: use digits and point names specified for your language.
- *Perspectives*: manage the perspectives of GeoGebra.
- *Miscellaneous*: enable scripting, enable the use of Java fonts, set inverse trig functions values as angles and reverse the mouse wheel zooming features.

Virtual Keyboard

The Virtual Keyboard is a semi-transparent keyboard that is displayed on the screen when the corresponding menu item is selected.

It contains the standard keyboard characters, as well as the most used mathematical symbols and operators, and can be used with a mouse or other pointing devices.

This makes the Virtual Keyboard particularly useful when using GeoGebra for presentations or with multimedia interactive whiteboards.

Tool Manager Dialog

You can save your custom tools so you can reuse them in other GeoGebra constructions. In the Tools Menu, select Manage Tools to open this dialog. Then, select the custom tool you want to save from the appearing list. Click on button Save As… in order to save your custom tool on your computer.

Note: User defined tools are saved as files with the file name extension GGT so you can distinguish custom tool files from usual GeoGebra files (GGB).

This dialog also allows you to remove or modify tools. If you decide to modify a tool, new GeoGebra window appears. The input objects are listed as free objects in it. If you have done finishing your changes, you can save the tool via option Create new tool in Tools Menu. Keep the old name to overwrite the tool. To overwrite a tool which was already used, the types of input and output objects must stay the same.

Accessibility

Mouse control

GeoGebra has an embedded virtual keyboard that allows the user to interact with the software using the mouse. Select *View* → *Keyboard* to open the virtual keyboard and start using it with the mouse.

Note: Besides the standard layout, the virtual keyboard also contains a selection of mathematical symbols. Further characters are available by pressing the AltG button.The virtual keyboard can also be resized, by dragging its edges.

Keyboard control

To open menus using keyboard only, press Alt and arrows (on Windows). On Mac you have to enable *full keyboard access* first. Press Ctrl + F1 to activate it. Now you are able to select menus by using Ctrl + F2 or on some keyboards Fn + Ctrl + F2. For more keyboard options see the Keyboard Shortcuts section. Moreover, all features of the Properties Dialog are accessible via Scripting Commands.

Publishing

Creating Pictures of the Graphics View

You can either save a picture of the Graphics View in a file or copy it to clipboard.

Saving as File

Note: The full Graphics View will be saved as a picture, unless points Export_1 and Export_2 are defined (see below).

If your construction does not use all the available space in the Graphics View, you might want to…

- …use tools Move Graphics View Tool, Zoom In Tool and/or Zoom Out Tool in order to place your construction in the upper left corner of the Graphics View. Afterwards, you may reduce the size of the GeoGebra window by dragging one of its corners with the mouse.
- … use the selection rectangle in order to specify which part of the Graphics View should be exported and saved as a picture.

You create points called Export_1 and Export_2, which will be used to define diagonally opposite corners of the export rectangle.

Note: Points Export1 and Export2 must be within the visible area of the Graphics View.

In the File Menu, select item Export before clicking on item Graphics View as Picture. In the appearing dialog window you may specify the Format, Scale (in cm), and the Resolution (in dpi) of the output picture file.

Note: The true size of the exported image is shown at the bottom of the export window just above the buttons, both in centimeters and pixel.

Please find more information about the different picture files available in section Export Graphics Dialog.

Copying the Graphics View to Clipboard

You can also copy the Graphics View to the Clipboard of your computer: just select *File – Export – Graphics View as Picture (png, eps)…*, then click the *Clipboard* button.

This feature copies a screenshot of the *Graphics View* to your system's clipboard as a PNG picture. This picture can be pasted into other documents (e. g. a word processing document).

Notes: The File – Export – Graphics View as Picture (png, eps)… option allows you to define the dimension (scale or pixels) of the exported image.The copy to Clipboard feature is not available for Mac Os.

Upload to GeoGebraTube

There are two ways to upload a file to GeoGebraTube [1] directly from GeoGebra. First one is using the Export Worksheet Dialog, second one is using the *Share...* option in File Menu.

Note: This feature requires an active internet connection to work correctly.

In the first step GeoGebra is going to prepare your worksheet for upload to GeoGebraTube, afterwards your browser should open up and load a website which leads you through the process of publishing your worksheet on GeoGebraTube. More information about GeoGebraTube and its usage can be found in the wiki section [1].

Note: You can cancel the uploading process at any time by closing the browser window.

Export as html Webpage

To create a webpage including interactive GeoGebra construction, you have to upload the construction to GeoGebraTube and use the Embed button in the teacher page.

You can then paste the resulting code into your online content management system or you can save it as .html file using a text editor like Notepad and add texts above and below the construction.

Advanced settings

The Advanced Settings button allows you to change the functionality of the dynamic construction (e. g., show a reset icon and browser features) as well as to modify the user interface shown in the interactive applet (e. g., show the Toolbar, modify height and width, enabling saving and printing, and others).

Note: If the size of your applet is too big to fit on a computer screen with standard resolution (1024 x 768), you may want to resize it before the actual export as a Dynamic Worksheet.

Functionality:

- *Enable right click, zooming and keyboard editing features*: By selecting this feature you will be able to right click objects or the drawing pad in order to access the features of the context menu (e.g. show / hide object or label, trace on / off, Properties dialog). It is also possible to use the common keyboard shortcuts.
- *Enable dragging of labels*: By selecting this feature you are able to drag labels of points or objects.
- *Show icon to reset construction*: A reset icon is displayed in the upper right corner of the interactive applet allowing your students to reset the interactive figure to its initial state.

User interface:

- *Show menubar*: The menubar is displayed within the interactive applet.
- *Show toolbar*: The toolbar is displayed within the interactive applet allowing to use the geometry tools.
- *Show inputbar*: The input field is displayed at the bottom of the interactive applet allowing to use algebraic input and commands for explorations.

Note: If you reduce the size of the applet important parts of the dynamic worksheets might be invisible for users.

Hint: If you include the menubar, toolbar, or input field you might want to adjust the height of the interactive applet.

Embedding to CMS, VLE (Moodle) and Wiki

To create a webpage including interactive GeoGebra construction, you have to upload the construction to GeoGebraTube and use the Embed button in the teacher page.

You can then paste the resulting code into your online content management system or you can save it as .html file using a text editor like Notepad and add texts above and below the construction.

Advanced settings

The Advanced Settings button allows you to change the functionality of the dynamic construction (e. g., show a reset icon and browser features) as well as to modify the user interface shown in the interactive applet (e. g., show the Toolbar, modify height and width, enabling saving and printing, and others).

Note: If the size of your applet is too big to fit on a computer screen with standard resolution (1024 x 768), you may want to resize it before the actual export as a Dynamic Worksheet.

Functionality:

- *Enable right click, zooming and keyboard editing features*: By selecting this feature you will be able to right click objects or the drawing pad in order to access the features of the context menu (e.g. show / hide object or label, trace on / off, Properties dialog). It is also possible to use the common keyboard shortcuts.
- *Enable dragging of labels*: By selecting this feature you are able to drag labels of points or objects.
- *Show icon to reset construction*: A reset icon is displayed in the upper right corner of the interactive applet allowing your students to reset the interactive figure to its initial state.

User interface:

- *Show menubar*: The menubar is displayed within the interactive applet.
- *Show toolbar*: The toolbar is displayed within the interactive applet allowing to use the geometry tools.
- *Show inputbar*: The input field is displayed at the bottom of the interactive applet allowing to use algebraic input and commands for explorations.

Note: If you reduce the size of the applet important parts of the dynamic worksheets might be invisible for users.

💡 **Hint:** If you include the menubar, toolbar, or input field you might want to adjust the height of the interactive applet.

Export to LaTeX (PGF, PSTricks) and Asymptote

Export - Graphics View as Animated GIF...

When the dynamic construction depends on a slider, this menu item allows you to save the Graphics View as an Animated GIF. Just drag a selection rectangle around the portion of the construction you need to export (or resize the GeoGebra window), then select File -> Export -> Graphics View as Animated GIF. A dialog will let you choose the animating slider name, as well as the timing between frames and the option to display the animation as loop.

Export - Graphics View as PSTricks…

Keyboard shortcut: Ctrl + Shift + T (MacOS: Cmd + Shift + T)

This menu item allows you to save the Graphics View as a PSTricks [1] picture file, which is a LaTeX picture format.

Export - Graphics View as PGF/TiKZ…

This menu item allows you to save the Graphics View as a PGF [2] picture file, which is a LaTeX picture format.

Export - Graphics View as Asymptote…

This menu item allows you to save the Graphics View as a Asymptote [3] picture file.

Limits of these export functions

Apart from Animated GIF export, these exports work only for the 2D View and the following object types can't be exported

- implicit curves
- loci

Printing Options

Printing the Graphics View

GeoGebra allows you to print the Graphics View of your constructions. You can find the corresponding item Print Preview in the File Menu. In the appearing *Print Preview Dialog* window, you can specify the Title, Author, and a Date for the construction. In addition, you can set the Scale of your printout (in cm) and change the Orientation of the paper used (portrait or landscape).

Note: In order to update the Print Preview after you made changes to the text or layout of the printout, you need to press Enter.

Printing the Construction Protocol

If you want to print the Construction Protocol, you first need to open the Construction Protocol dialog window by using the View menu. Then, select Print... from the File menu of this new window.

The Print dialog window allows you to enter the Author or change the paper Margins and Orientation before printing the Construction Protocol.

Note: You may switch the different columns Name, Definition, Command, Algebra, and Breakpoint of the Construction Protocol on and off by using the View menu of the Construction Protocol dialog window.

Article Sources and Contributors

Introduction *Source*: http://wiki.geogebra.org/s/en/index.php?oldid=43173 *Contributors*: Administrator, Christina.biermair, Florian Sonner, Jhohen, Markus, MediaWiki default, Murkle, Noel Lambert, Spam cleanup script, Spanish1, Zbynek

Compatibility *Source*: http://wiki.geogebra.org/s/en/index.php?oldid=43233 *Contributors*: Markus, Murkle, Zbynek

Installation Guide *Source*: http://wiki.geogebra.org/s/en/index.php?oldid=44049 *Contributors*: Kovács Zoltán, Mathmum, Murkle, Spanish1, Wkuellinger, davidfruelund

Free, Dependent and Auxiliary Objects *Source*: http://wiki.geogebra.org/s/en/index.php?oldid=42065 *Contributors*: Andrea.duringer, Jhohen, Mathmum, Zbynek

Geometric Objects *Source*: http://wiki.geogebra.org/s/en/index.php?oldid=43713 *Contributors*: Jhohen, Mathmum, Zbynek

Points and Vectors *Source*: http://wiki.geogebra.org/s/en/index.php?oldid=38481 *Contributors*: Andrea.duringer, Mathmum, Murkle, Zbynek

Lines and Axes *Source*: http://wiki.geogebra.org/s/en/index.php?oldid=34184 *Contributors*: Andrea.duringer, Mathmum, Murkle, Zbynek

Conic sections *Source*: http://wiki.geogebra.org/s/en/index.php?oldid=34122 *Contributors*: Mathmum, Zbynek

Functions *Source*: http://wiki.geogebra.org/s/en/index.php?oldid=39053 *Contributors*: Mathmum, Zbynek

Curves *Source*: http://wiki.geogebra.org/s/en/index.php?oldid=39425 *Contributors*: Andrea.duringer, Mathmum, Murkle, Zbynek

Inequalities *Source*: http://wiki.geogebra.org/s/en/index.php?oldid=34430 *Contributors*: Birgit Lachner, Mathmum, Zbynek

Intervals *Source*: http://wiki.geogebra.org/s/en/index.php?oldid=34165 *Contributors*: Mathmum, Zbynek

General Objects *Source*: http://wiki.geogebra.org/s/en/index.php?oldid=34419 *Contributors*: Mathmum, Zbynek

Numbers and Angles *Source*: http://wiki.geogebra.org/s/en/index.php?oldid=34499 *Contributors*: Mathmum, Zbynek

Texts *Source*: http://wiki.geogebra.org/s/en/index.php?oldid=34599 *Contributors*: Andrea.duringer, Mathmum, Murkle, Zbynek

Boolean values *Source*: http://wiki.geogebra.org/s/en/index.php?oldid=38389 *Contributors*: Mathmum, Zbynek

Complex Numbers *Source*: http://wiki.geogebra.org/s/en/index.php?oldid=42043 *Contributors*: Andrea.duringer, Mathmum, Zbynek

Lists *Source*: http://wiki.geogebra.org/s/en/index.php?oldid=34469 *Contributors*: Andrea.duringer, Mathmum, Murkle, Noel Lambert, Zbynek

Matrices *Source*: http://wiki.geogebra.org/s/en/index.php?oldid=41244 *Contributors*: Mathmum, Zbynek

Action Objects *Source*: http://wiki.geogebra.org/s/en/index.php?oldid=38421 *Contributors*: Mathmum, Zbynek

Selecting objects *Source*: http://wiki.geogebra.org/s/en/index.php?oldid=38861 *Contributors*: Mathmum, Zbynek

Change Values *Source*: http://wiki.geogebra.org/s/en/index.php?oldid=38860 *Contributors*: Mathmum, Zbynek

Naming Objects *Source*: http://wiki.geogebra.org/s/en/index.php?oldid=42041 *Contributors*: Andrea.duringer, Markus, Mathmum, Murkle, Zbynek

Animation *Source*: http://wiki.geogebra.org/s/en/index.php?oldid=34311 *Contributors*: Florian Sonner, Mathmum, Zbynek

Tracing *Source*: http://wiki.geogebra.org/s/en/index.php?oldid=34604 *Contributors*: Mathmum, Zbynek

Object Properties *Source*: http://wiki.geogebra.org/s/en/index.php?oldid=39025 *Contributors*: Andrea.duringer, Mathmum, Zbynek

Labels and Captions *Source*: http://wiki.geogebra.org/s/en/index.php?oldid=34805 *Contributors*: Birgit Lachner, Mathmum, Murkle, Spanish1, Zbynek

Advanced Features *Source*: http://wiki.geogebra.org/s/en/index.php?oldid=34308 *Contributors*: Mathmum, Zbynek

Object Position *Source*: http://wiki.geogebra.org/s/en/index.php?oldid=34196 *Contributors*: Andrea.duringer, Zbynek

Conditional Visibility *Source*: http://wiki.geogebra.org/s/en/index.php?oldid=38390 *Contributors*: Mathmum, Zbynek

Dynamic Colors *Source*: http://wiki.geogebra.org/s/en/index.php?oldid=39811 *Contributors*: Mathmum, Zbynek

LaTeX *Source*: http://wiki.geogebra.org/s/en/index.php?oldid=41241 *Contributors*: Birgit Lachner, Mathmum, Murkle, Zbynek

Layers *Source*: http://wiki.geogebra.org/s/en/index.php?oldid=34461 *Contributors*: Andrea.duringer, Mathmum, Zbynek

Scripting *Source*: http://wiki.geogebra.org/s/en/index.php?oldid=39475 *Contributors*: Birgit Lachner, Corinna, Mathmum, Murkle, Zbynek

Tooltips *Source*: http://wiki.geogebra.org/s/en/index.php?oldid=34289 *Contributors*: Zbynek

Tools *Source*: http://wiki.geogebra.org/s/en/index.php?oldid=43379 *Contributors*: Jhohen, Mathmum, Zbynek

Movement Tools *Source*: http://wiki.geogebra.org/s/en/index.php?oldid=34492 *Contributors*: Mathmum, Zbynek

Move Tool *Source*: http://wiki.geogebra.org/s/en/index.php?oldid=42039 *Contributors*: Florian Sonner, Jhohen, K Voss, Mathmum, Zbynek

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Point Tools *Source*: http://wiki.geogebra.org/s/en/index.php?oldid=41887 *Contributors*: Jhohen, Mathmum, Zbynek

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Intersect Command *Source*: http://wiki.geogebra.org/s/en/index.php?oldid=41235 *Contributors*: Andrea.duringer, Johanna, JohannaZ, K Voss, MagdalenaSophieF, Mathmum, Murkle, Noel Lambert, Sabsi, Sarah., SarahSt, Zbynek

IntersectPath Command *Source*: http://wiki.geogebra.org/s/en/index.php?oldid=41291 *Contributors*: Mathmum, Sabsi, Sarah.

Length Command *Source*: http://wiki.geogebra.org/s/en/index.php?oldid=40529 *Contributors*: Alexander Hartl, Andrea.duringer, Christina.biermair, Johanna, JohannaZ, K Voss, Mathieu, Mathmum, Murkle, UnTom, Zbynek

Line Command *Source*: http://wiki.geogebra.org/s/en/index.php?oldid=38504 *Contributors*: K Voss, Kimeswenger, Mathmum, Murkle, Spanish1, Zbynek

PerpendicularBisector Command *Source*: http://wiki.geogebra.org/s/en/index.php?oldid=41274 *Contributors*: Andrea.duringer, Gabriela Ferenczy, K Voss, MagdalenaSophieF, Mathmum, Sabsi, Sarah., Zbynek

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