GeoGebra
Quickstart

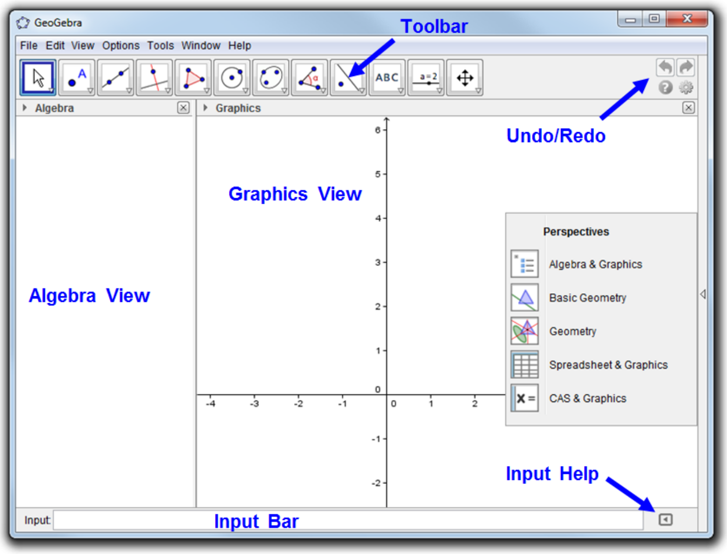
What is GeoGebra?

- Dynamic Mathematics Software in one easy-to-use package
- For learning and teaching at all levels of education
- Joins interactive **geo**metry, al**gebra**, tables, graphing, calculus and statistics
- Open source software, freely available from www.geogebra.org

Quick Facts

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

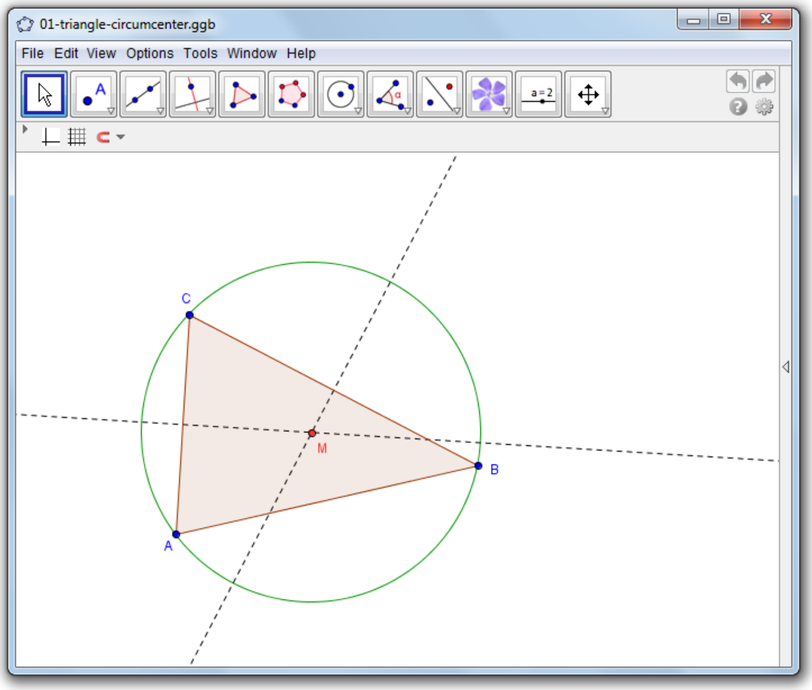
After starting GeoGebra, the following window appears:



Using the tools in the **Toolbar** you can do constructions in the **Graphics View** with your mouse. At the same time the corresponding coordinates and equations are displayed in the **Algebra View**. The **Input Bar** is used to enter coordinates, equations, commands and functions directly; these are displayed in the Graphics View and in the Algebra View immediately after pressing the Enter key. In GeoGebra, geometry and algebra work side by side.

Example 1: Circumcircle of a Triangle

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

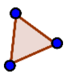
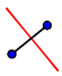
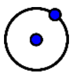


Construction Using the Mouse

Preparations

- Click on the arrow on the right side of the Graphics View and select  *Basic Geometry* from the *Perspectives* sidebar.

Construction Steps

1		Choose the tool *Polygon* from the Toolbar. Now click on the Graphics View three times to create the vertices *A*, *B*, and *C*. Close the triangle by clicking on point *A* again.
2		Next, choose the tool *Perpendicular Bisector* (click on the small arrow at the fourth icon from the left) and construct two line bisectors by clicking on two sides of the triangle.
3		Using the tool *Intersect Two Objects* you can click on the intersection of both line bisectors to get the center of your triangle's circumcircle. To name it *"M"*, just type "*M*" to open the *Rename* dialog.
4		To finish your construction, choose the tool *Circle with Center through Point* and click first on the center, then on any vertex of the triangle.
5		Using the *Move* tool you can now use the mouse to drag the triangle vertices around - your construction will change dynamically with them.

Some Tips

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

To **hide an object**, right click on it (Mac OS: ctrl-click) and uncheck *Show Object*.

You can change the **appearance of objects** (color, type of line, ...) easily using the Style Bar: just click the arrow at the top of the Graphics View to show or hide it. For more options, please click on the *GeoGebra Properties* icon and choose *Objects* from the appearing context menu.

Axes and **grid** may be hidden or shown using the Style Bar.

You can show different views like the **Algebra**, **Graphics, Spreadsheet** and **CAS** View using the *View* menu or the *Perspective* sidebar (to the right of *Graphics View)*.

In order to **move your construction** in the Graphics View, choose the tool *Move Graphics View* and simply use the mouse to drag it.

The **Construction Protocol** (see *View* menu) provides a table with all the steps of your construction. Using buttons you can step through the construction steps again. Furthermore, you can drag rows up or down to change the construction order.

Construction using the Input Bar

Preparations

- We are now going to do the same circumcircle construction as above using the Input Bar, so we will start from scratch by using *New* in the *File* menu.
- Click on the arrow on the right side of the Graphics View and select *Algebra & Graphics* from the *Perspectives* sidebar.

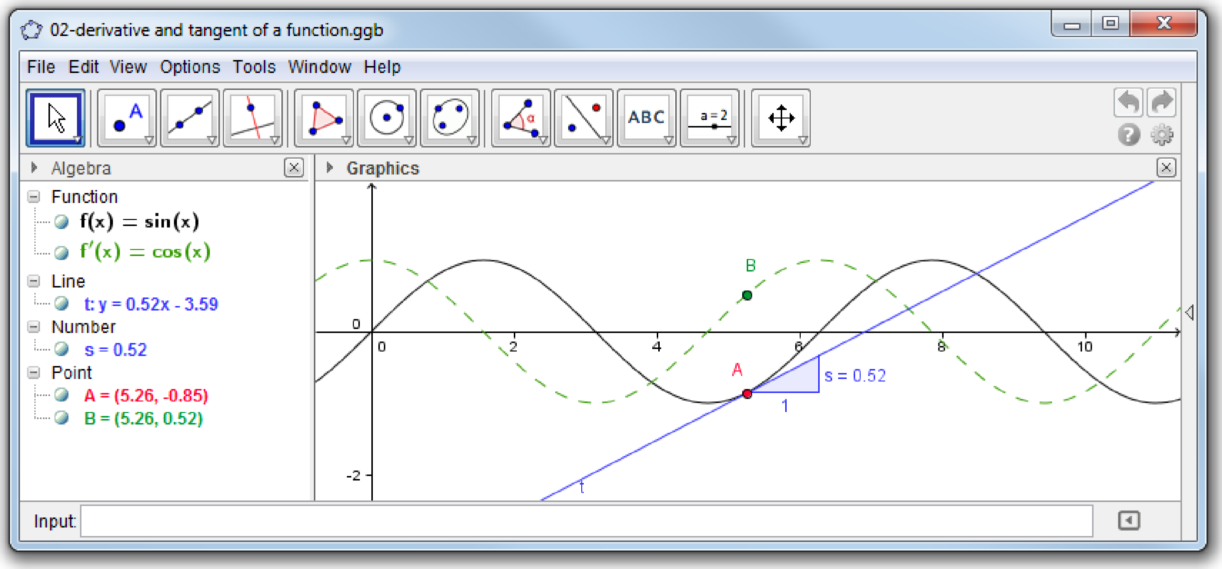
Construction Steps

Type the following commands into the Input Bar at the bottom of the screen and press the Enter key after each line.


```
A=(2,1)
B=(12,5)
C=(8,11)
Polygon[A,B,C]
s=PerpendicularBisector[a]
t=PerpendicularBisector[b]
M=Intersect[s,t]
Circle[M,A]
```

Example 2: Derivative and Tangent of a Function

Task: *Create the function f(x) = sin(x), its derivative and its tangent to a point on f including its slope triangle.*



First Way: Point on Function Graph

Preparations

- Open a new window using *New Window* from the *File* menu.

Construction Steps

1		Type the function `f(x) = sin(x)` into the Input Bar and press the Enter key.
2		Choose the tool *New Point* and click on the function graph of *f*. This creates point *A* attached to the function *f*.
3		Now choose the tool *Tangents* and click on point *A* and function *f*. Rename the tangent by typing "*t*" in order to open the *Rename* dialog.
4		Type the command `s = Slope[t]`.
5		Using the *Move* tool, drag point *A* with your mouse and observe the movement of the tangent.
6		Type `B = (x(A), s)` Hint: *x(A)* gives the x-coordinate of point *A*.
		Turn on the *trace* of point *B* by right-clicking on *B* (Mac OS: ctrl-click) and choosing *Trace On*.
7		Using the *Move* tool, drag point *A* with the mouse – point *B* will now leave a trace of the "slope function".
8		Enter the command `Derivative[f(x)]` to get its equation too.

Some Tips

Type a different function, e. g. `f(x)=x^3-2x^2`, into the Input Bar. Immediately, its derivate and tangent will be shown. Also try out the command `Integral[f(x)]`.

Choose the *Move* tool and drag the function's graph with the mouse. Observe the changing equations of the function and its derivative.

Automatic completion of commands: after entering the first two letters of a command, it will be completed automatically. If you want to adopt the suggestion, press the Enter key, otherwise just continue typing.

The **input help** is found on the right next to the Input Bar and gives you a list of all available commands in GeoGebra.

Second Way: Point with x-coordinate 'a'

Preparations

- We are now going to do another version of the previous construction using the *Inputbar*. Please, choose *File – New* to get a fresh window.

Construction Steps

Type the following commands into the Input Bar and press Enter after every line.

```
f(x)=sin(x)
a=2
T=(a,f(a))
t=Tangent[a,f]
s=Slope[t]
B=(x(T),s)
Derivative[f]
```

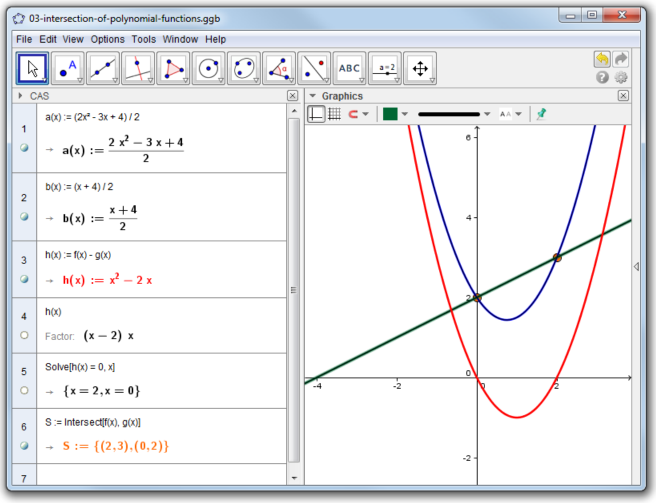
Some Tips

Choose the *Move* tool and click on the number *a*. You can change *a* by pressing the arrow keys. At the same time, point T and the tangent will move along the function f.

You can also change the number *a* by creating a **slider**: just click on the symbol ○ left of *a* in the Algebra View. Change the slider value by dragging the appearing point on the line with the mouse.

Example 3: Intersection of Polynomial Functions

Task: *Intersect a parabola with a linear function by determining the roots of their difference.*



Preparations

- Click on the arrow on the right side of the Graphics View and select  *CAS & Graphics* (CAS = computer algebra system) from the *Perspectives* sidebar.
- Please note that the CAS View is available from GeoGebra 4.2 onwards.

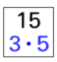
Construction Steps

Type following commands into the rows of the CAS View. Always evaluate your input.

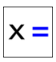
1		Enter `f(x):=x^2-3/2*x+2` into the first row to define *f(x).* Evaluate by pressing the Enter key. <u>Hint:</u> `:=` is used for assignments.
2		Enter `g(x):=x/2+2` into the second row.
3		Define h(x) as `h(x):=f(x)-g(x)` in the third row.
4		Enter `h(x)` in the fourth row and factor by choosing the tool *Factor*. The roots can be read off immediately.
5		Use `Solve[h(x)=0,x]` to confirm your solutions.
6		Create the intersection points by typing `S:=Intersect[f(x),g(x)]`.

Some Tips

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



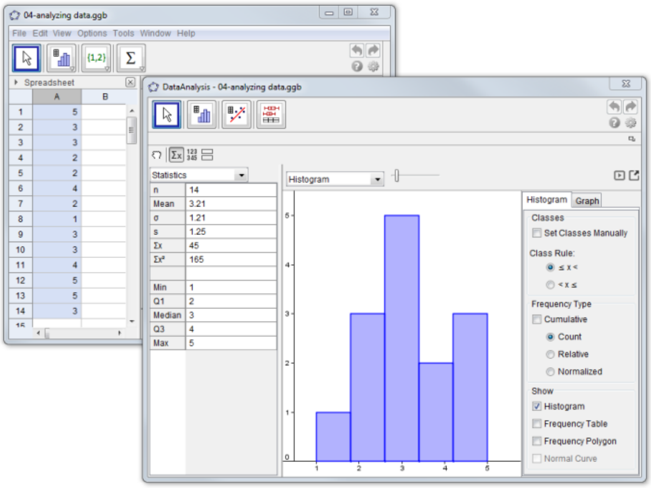
You can also manipulate only part of an expression by selecting it with the mouse and then clicking on a tool like *Factor*.



The solution could have also been determined immediately by defining *f(x)* and *g(x)* as above, selecting both rows and applying the *Solve* tool.

Example 4: Analyzing Data

Task: *Create a histogram and evaluate mean, median, min and max of a number of values.*



Preparations

- Click on the arrow on the right side of the Graphics View and select  *Spreadsheet & Graphics* from the *Perspectives* sidebar.

Construction Steps

1		Enter some data into the cells of column A of the spreadsheet, e.g. fill A1 to A14 with values like 5, 3, 3, 2, 2, 4, 2, 1, 3, 3, 4, 5, 5, 3.
2		Highlight the appropriate cells and select the tool *One Variable Analysis.* Hint: In this example: Highlight the cells A1 till A14 and click the tool *One Variable Analysis.* After clicking *Analyze* in the *Data Source* Dialog, the *Data Analysis* dialog appears.
3		Select the appropriate *Classes* at the top of the pop-up window. Hint: For the numbers in this example 5 *Classes* were used, because there are five different values.
4		Choose the *Show Statistics* icon from the Stylebar to open the *Statistics* panel. Find the mean, the median, the maximum and the minimum of the data.
5		Click the arrow button at the top right and select *Set Classes Manually* in the right *Histogram* menu. Hint: Press Enter after specifying the *Start* value 0.5 and the *Width* 1 (values of this example).

Some Tips

Change some values in column *A* and see how this influences the histogram and the statistical values like mean, median, maximum and minimum.

Change the diagram type from *Histogram* to *Box Plot* in the list box above the histogram.

Further Information

You can find further information, materials and help on our web pages:

Software	www.geogebra.org
Manual & Tutorials	wiki.geogebra.org
Worksheets & Materials	www.geogebratube.org
User Forum	www.geogebra.org/forum