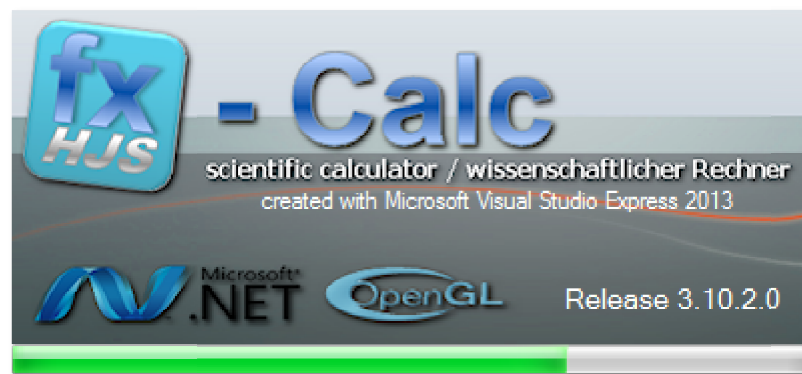


# fx-Calc How-To

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## Fx-Calc – universal desktop calculator for Windows

***fx-Calc*** is actually one of the most advanced desktop calculators for Windows. Starting with a simple calculator window, it allows already calculating self defined functions, sums and product's. It takes for instance just a few clicks to run the Leibnitz iteration to calculate Pi.

***fx-Calc*** let's you define, analyze, visualize and calculate scientific functions and is a full featured replacement and/or enhancement of the old fashioned Windows calculator. Additional to calculation and visualization you can analyze and solve scientific functions and perform linear regression. Even if the Window concept may not look advanced, it provides the big advantage to open similar windows multiple times and compare the results as needed. This application requires less than 750kbyte memory and is smaller than the windows integrated calc.exe.

To use the interpreter DLL in your own projects, you can obtain a copy and documentation of this DLL directly from the [author](#).

### Unique features:

- definition and immediate calculation of functions with up to 5 variables
- solves equations
- function analysis combined with graphic result presentation
- parametric sum and product calculation
- integrated function library
- integrated library for scientific constants
- 2D function plots including complex graphs
- OpenGL accelerated 3D function plots
- multiple plot and analysis windows to compare different function characteristics
- interactive linear regression module
- automated history
- displays current memory value in separate field
- integrated examples
- is handling complex numbers

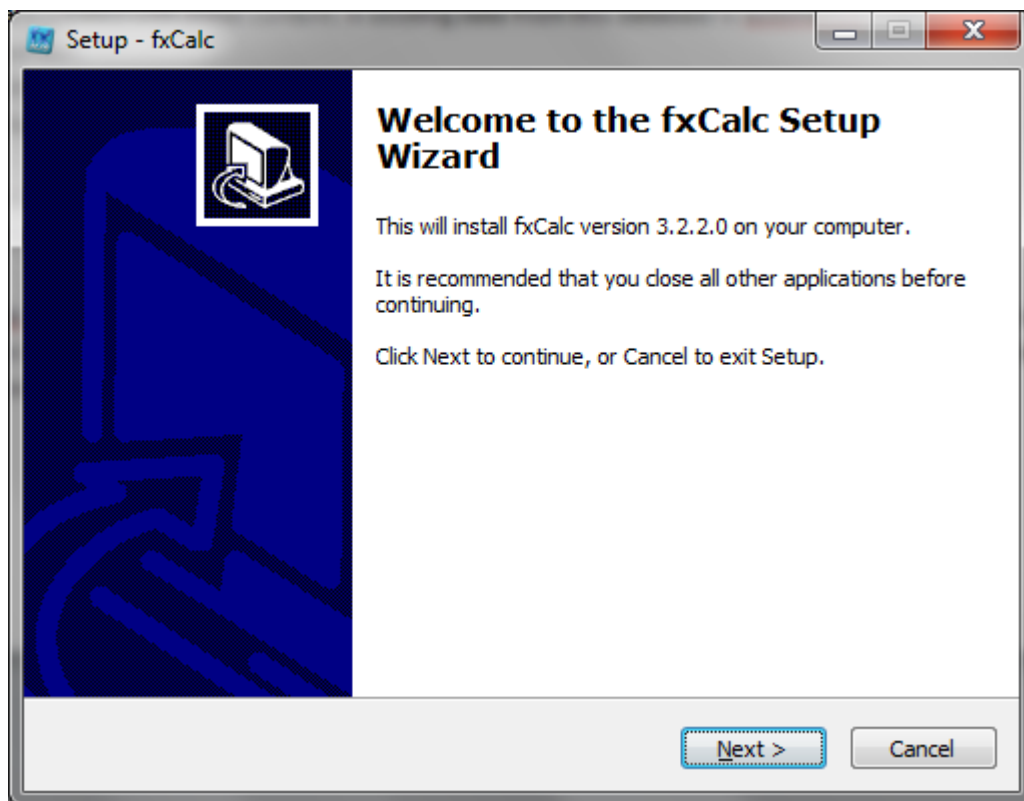
## Installation

System requirements:

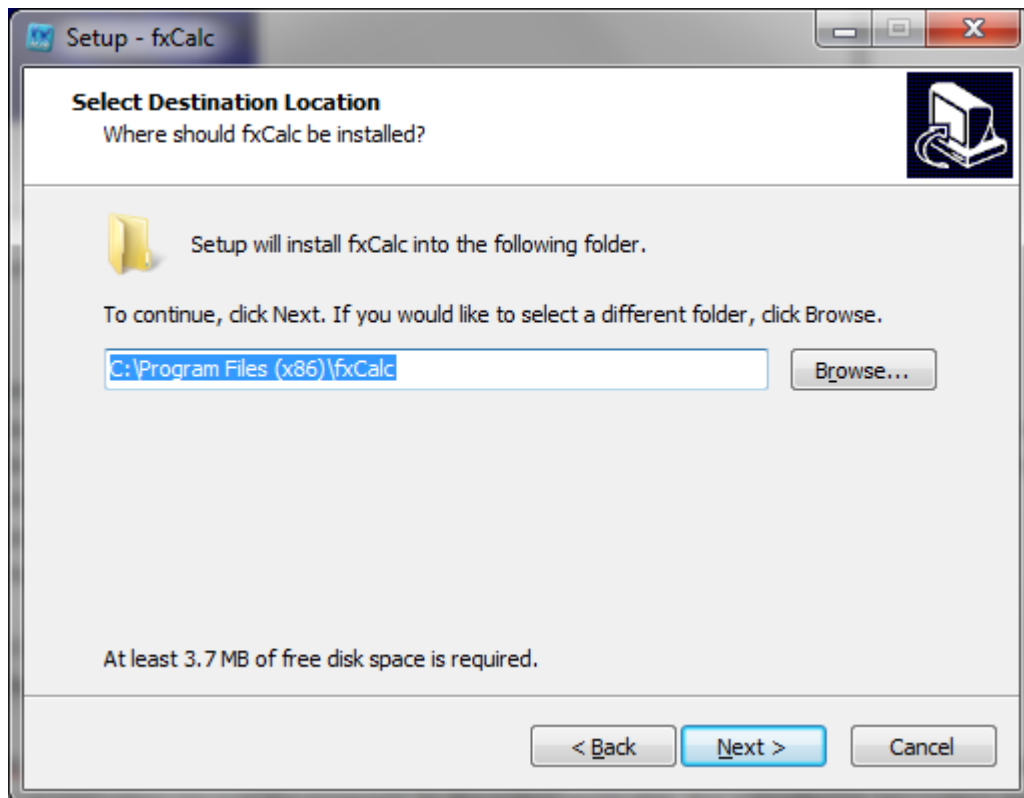
CPU	X86 Dual Core starting from 1,6 GHz
Memory (RAM)	512 MB
HDD	3 MB
Graphics Card	OpenGL 2.0 support required
Operating Systems	Windows Vista, Windows 7, Windows 8 (64 und 32 Bit) (XP very limited, but working)

Fx-Calc requires Microsoft dotNET version 4.0 and above.



The installation is very simple and is done by an automatic setup routine.



This only requires an adjustment of the location - if at all:



The setup creates an entry in the start menu and offers the optional creation of a desktop icon. In addition, the uninstaller is being integrated in the programs section of the system control menu. If no files for your own functions and constants exist, they will be created with initial content. Existing data from previous versions will be migrated to the new version automatically. In addition to the shortcut to the program a further shortcut will point to this documentation, which therefore is offline available:

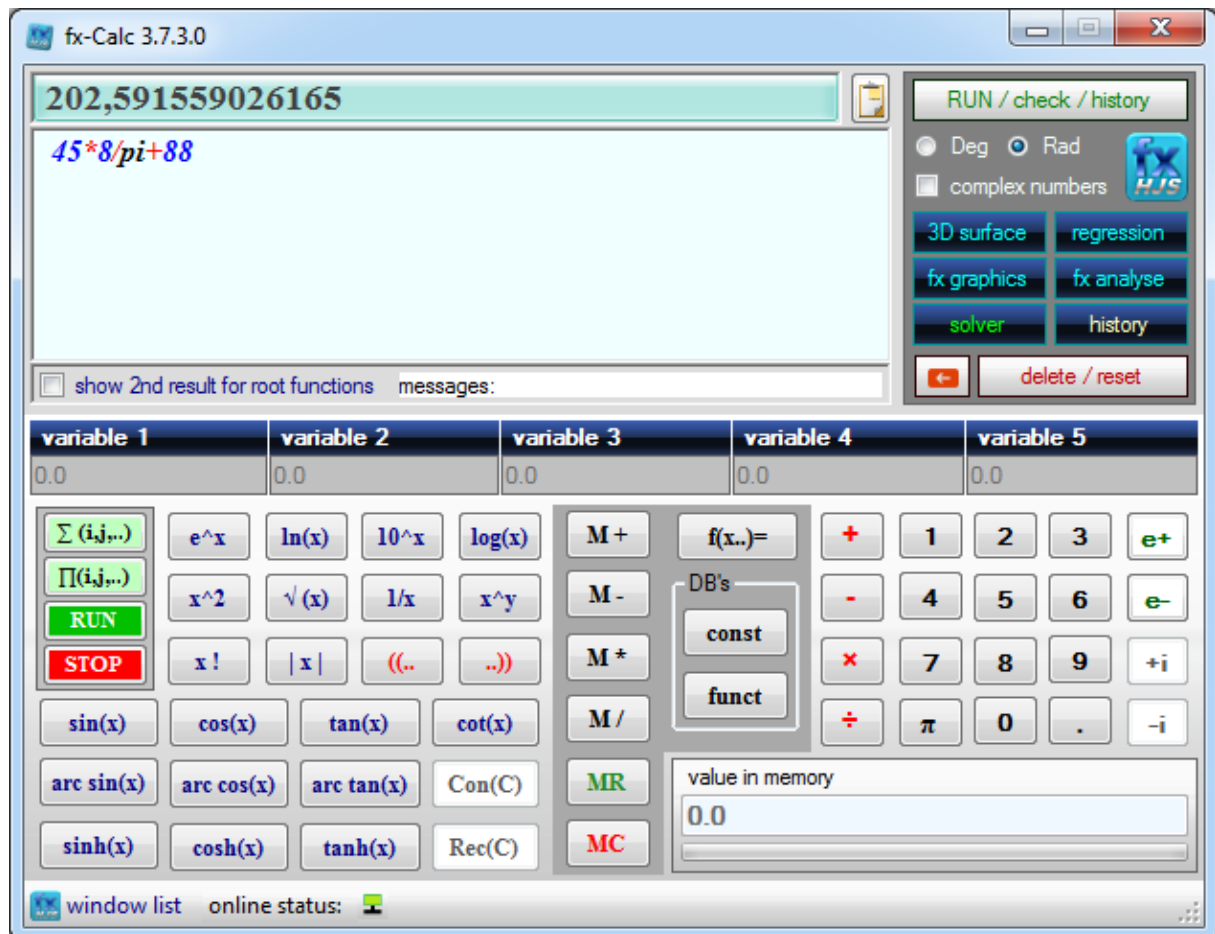
 fxCalc	06.06.2014 17:00	Shortcut
 Short Documentation	06.06.2014 17:00	Shortcut

Fx-Calc contains a function for automatic update checking. If a new version is available this functionality will offer a shortcut to download the new version at application closing. This kind of internet communication is read only, which means fx-Calc isn't sending any data from your pc to the internet.

## Basic concept

Every calculation needs to be typed into the editor field. fx-Calc calculates your results immediately while you type. The format of mathematical expressions is similar to BASIC and the keys do help to insert functions in correct writing.

In case of any errors in your mathematical expression an additional text box becomes visible and a more specific error message will be displayed. It disappears automatically as soon as the expression isn't containing anymore errors.



The interpreter is case - sensitive!

By using the keypad you can insert the correct function names into the editor field - so this is just an input help for the mathematical expressions in the text field.

## Short reference table

The following table provides an overview of input elements:

topic	sub topic	examples	comments
numbers	simple numbers	1; 2,579; 3.14256; -0,0015	. and , are both used as decimal separator
	scientific number format	4e-4 6,623e-23	e is followed by the power, basis is 10
	complex numbers	1+1i; 0-4i; 6e-12+i8e3; (12-i3e-5)	complex number in expressions must always contain both elements, real and imaginary - if real or imaginary is 0 then write 0.
operators	+	5+3,14; 546+3+6	any */ operation will be performed prior to this
	-	5-3,14; 546-3-6	any */ operation will be performed prior to this
	*	5*3,14; 546*3*6	<p>this operation has priority over +/-</p> <p>In the following cases the multiplication operator is not required::</p> <p>multiplication of two variables: x*y is the same as xy</p> <p>a number and</p> <p>an opening bracket 2,5*(... is the same as 2,5(</p> <p>a function 2,5*sin(30) .. is the same as 2,4sin(30)</p> <p>a variable 2,5*x is the same as 2,5x</p> <p>an closing and opening bracket ..) * ( .. ist the same as )( ..</p>
	/	5/3,14; 546/3/6	this operation has priority over +/-
	priority example	4+3*6 = 40 7+1/2 = 7.5	3*6 is calculated first, before 4 is being added. division is performed prior to add 7
	^	x^n 4^3 = 64 5,23^2,77 = 97.77	for raising a number x to the power of n (x and n can be integer, double or even complex)
functions	using functions	sin(30); f(x)=sin(x); 3^(1/2); 4^2	The both examples show how functions have to be used. Usually it starts with the function identifier followed by the argument in brackets. This is very similar to BASIC syntax. Exceptions for this concept are the power functions, which can make use of the power operator "^".
	In-build functions	all in-build functions	ln(x), exp(x), log(x), x^y, sqrt(x), abs(x), fac(x) (facult), sin(x), cos(x), tan(x), cotan(x), pi, arcsin(x), arccos(x), arctan(x), sinh(x), cosh(x), tanh(x), Con(i); Rec(i);

	degree and radian	trigonometric functions	for trigonometric functions you can chose the type of arguments, degree or radian, by using the radio button in the upper right corner
	self defined	$f(x)=\sin(x);$ $f(\text{hight})=\text{sqrt}(\text{hight}*9,91)$	<p>Any self defined function starts with f( followed by up to 5 parameters, separator is "," and finally again a closing bracket, followed by "=" and the expression, which is making use of the parameters.</p> <p><math>f(\text{argument1},\dots, \text{argument5}) = \text{expression with argument1}...\text{argument5}</math></p> <p>fx-Calc is recognising the arguments and activates the corresponding input fields automatically.</p>

Things to consider:

- A general rule is, if you are uncertain about the need of operators and brackets, use brackets and operators where it makes your expression clear.
- - / \* hierarchy
- Input is case sensitive
- Complex values must always contain both, real and imaginary part – brackets can help to let you consider this, but they are not required)
- This calculator is very tolerant for missing multiplication operators, but using it is reducing the chance of wrong calculation

## Simple calculations

For simple calculations, enter the desired task in the text field - the calculation is happening while you type. fx-Calc is processing expressions using dash-dot hierarchy.

Example:





Or



You can use the scientific number format, example: 5e-5 is equal to 0.00005.  
Furthermore fx-Calc is supporting complex numbers using the following format:

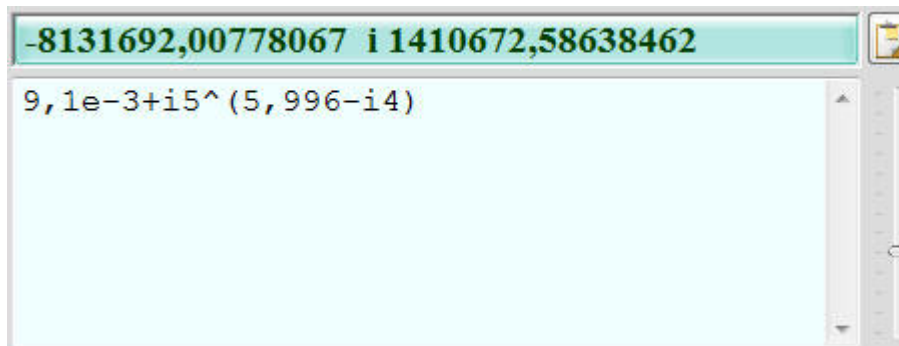
$r \pm i z$

r is the real part

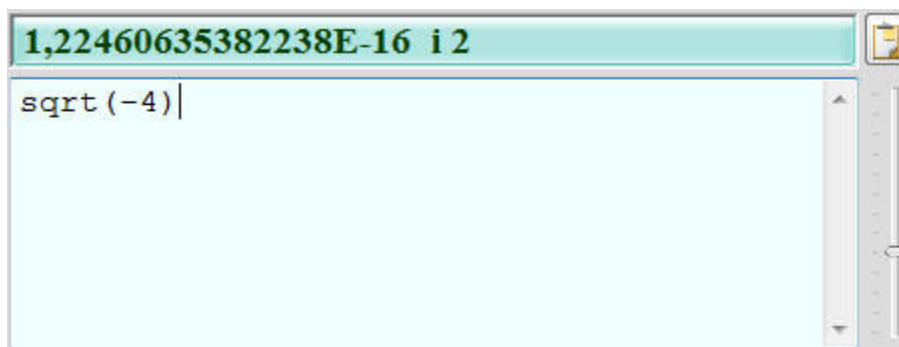
z is the imaginary part, plus or minus in front of i defines the sign of z

Examples: 4-i1e-3 or 0+2i

Following you have examples for complex number calculation:



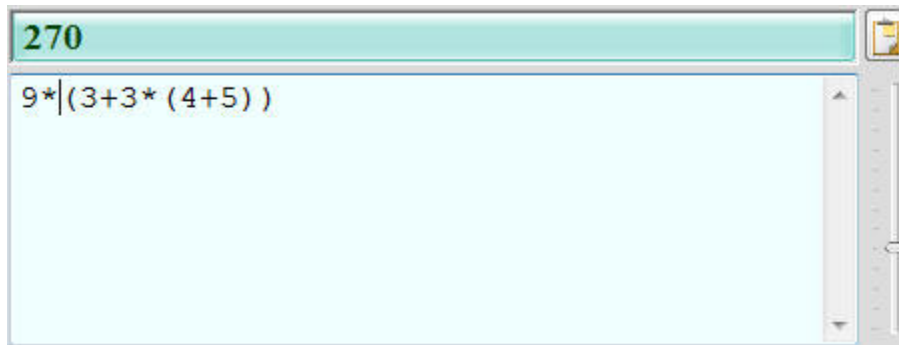
For doing complex number calculation fx-Calc provides functions to conjugate a complex number and to calculate the reciproc value of a complex number. A typical example is to calculate the square root of a negative number:



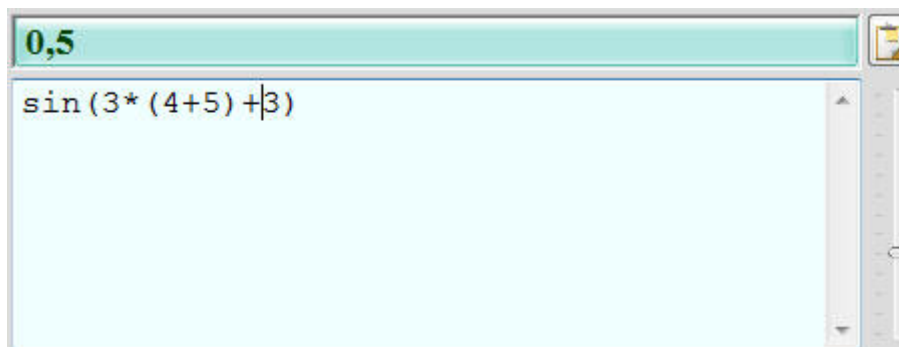
## Calculation with functions and brackets

The principle is also compared to simple arithmetic operations nothing complicated or otherwise. The functions including required brackets will be inserted in the text box when using the corresponding buttons. The dynamic memory allows theoretically unlimited levels of parentheses in mathematical expression - with today's memory sizes, so this shouldn't become a limiting factor in your work with fx-Calc. Again the integrated expression testing is monitoring whether the number of opening and closing brackets are identical.

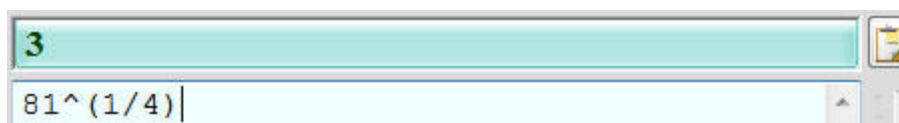
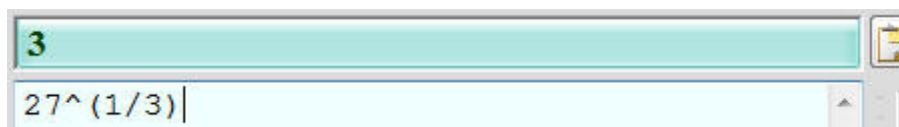
Example:



and using the sinus function:



All implemented functions can be found on most scientific calculators and by moving your mouse pointer over the function buttons you get hints on the specific function. A special case is to calculate other roots than just square root. The following both examples are showing how this can be simply achieved using the power function,  $y^x$ . (examples for 3rd and 4th root)



## Self defined Functions

Simply speaking a function defines how a specific result can be derived based on certain parameters or variables. These variables can have own names and fx-Calc can manage user-defined functions in it's own small database. fx-Calc allows the use of up to five of these variables.

Each variable name must start with a letter and must be different from integrated function names, just like "sin" or "ln". The variables are automatically detected as you type their function into the text field and the corresponding input fields are activated accordingly and provided with the variable name.

Bearing all this in mind, a function definition starts always with

**f(**

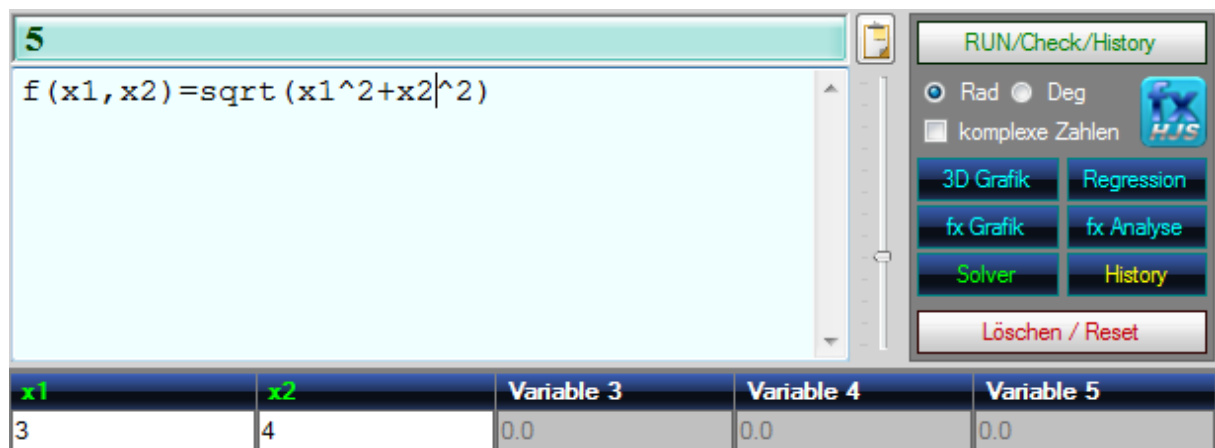
followed by your variable names, separated by "," like this

**f(a1,b2,c3, ...**

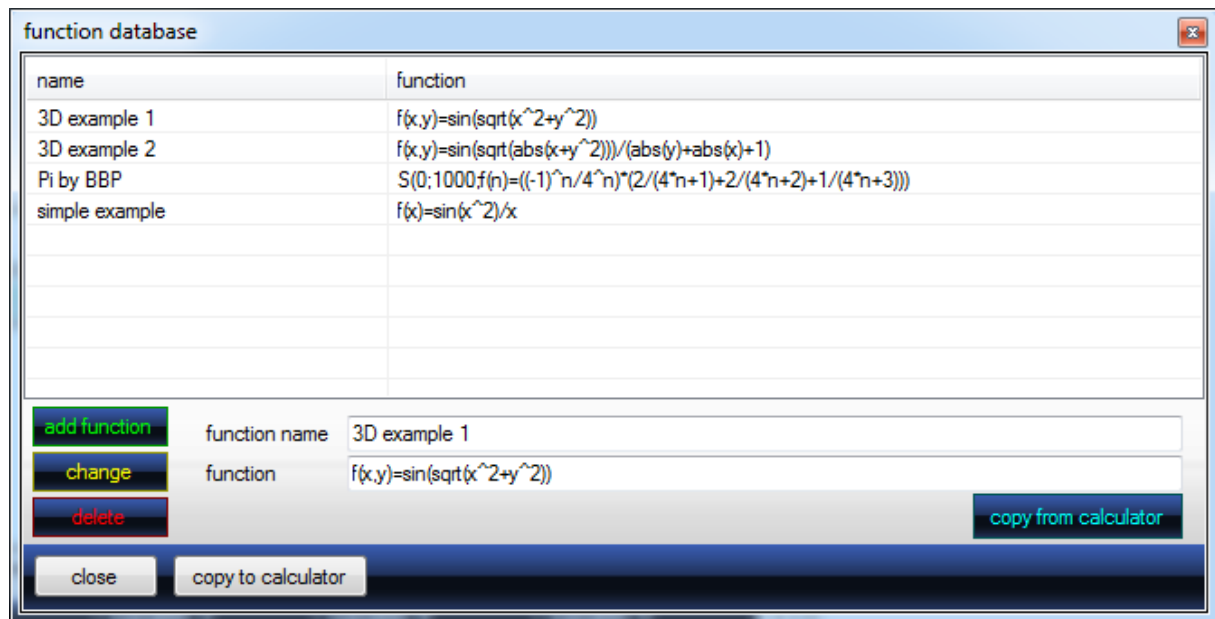
and of course a closing bracket and the formula itself:

**f(a1,b2,c3) = a1 \* b2 \* c3** (very simple example)

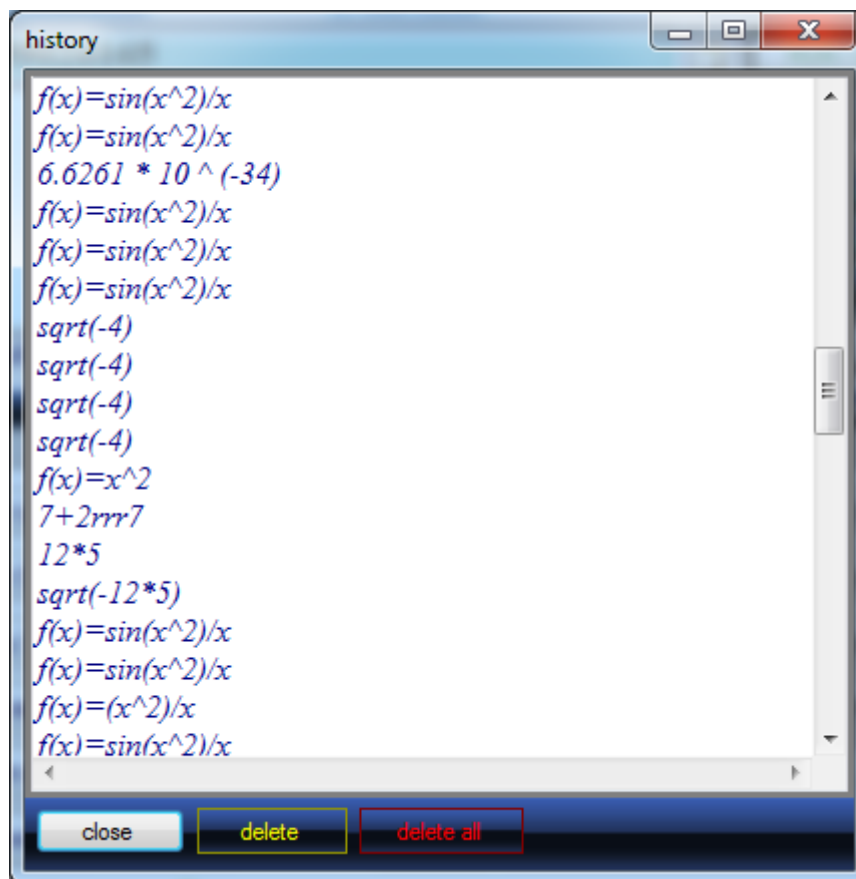
The easiest way to get familiar with this capability is to use some examples:



All variable values (in our example x1 and x2) can be changed to calculate new function results. Every Function can be stored in the function database, which allows recalling a function by simply double clicking the desired entry.



Another possibility in fx-Calc is to recall a history entry:

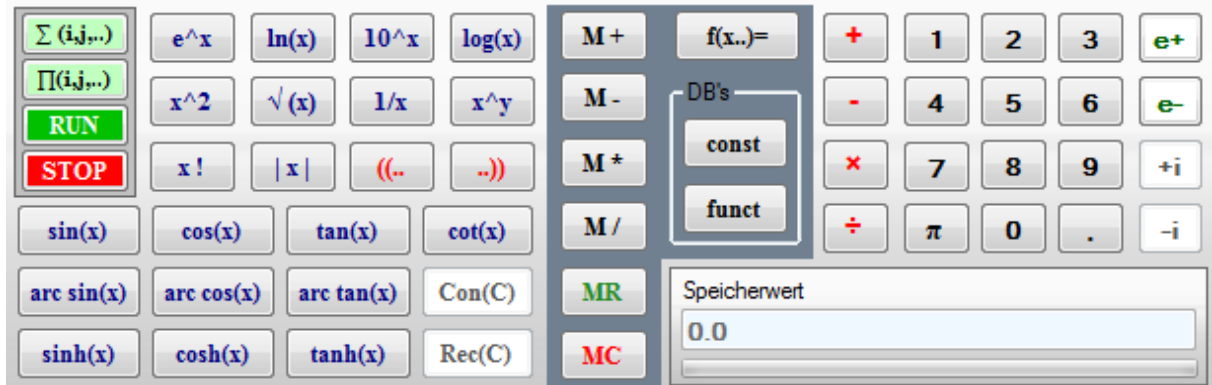


Important: By double clicking the selected item this will be pasted into the calculator immediately. This applies to all three database windows.

## Calculation with memory

fx-Calc supports the extended manipulation of the current value in memory based on all four basic calculation operations. The current memory value is displayed in the lower right corner of the main window. Initially the value is 0 and first thing this can be changed by using M+ or M- button.

MR recalls the value and inserts it in the editor window and MC is clearing the value to 0.



fx-Calc is performing the following memory based calculations:

- M+ is adding the result to memory
- M- memory minus result
- M\* memory times result
- M/ memory divided by result

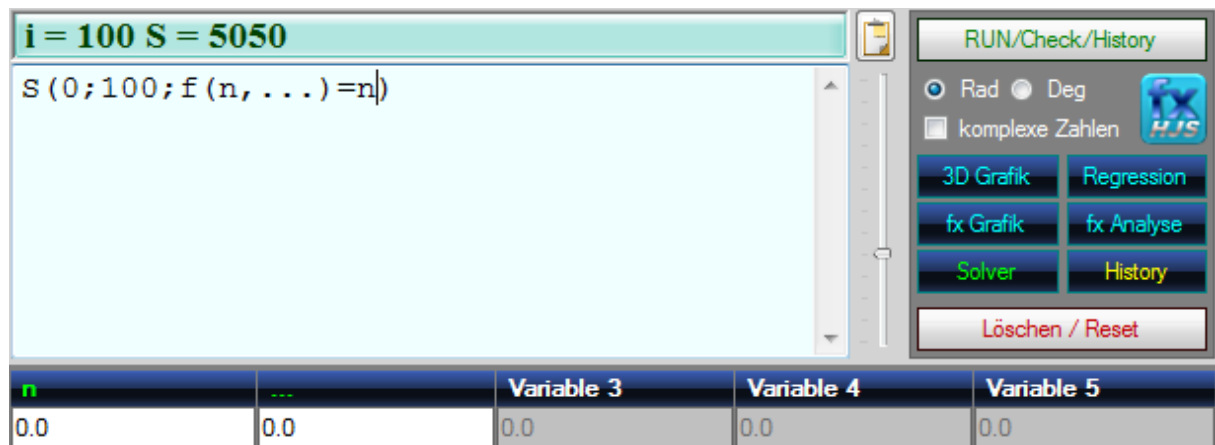
## Sum and Product

Sum and Product are just slightly more complicated than function definitions.

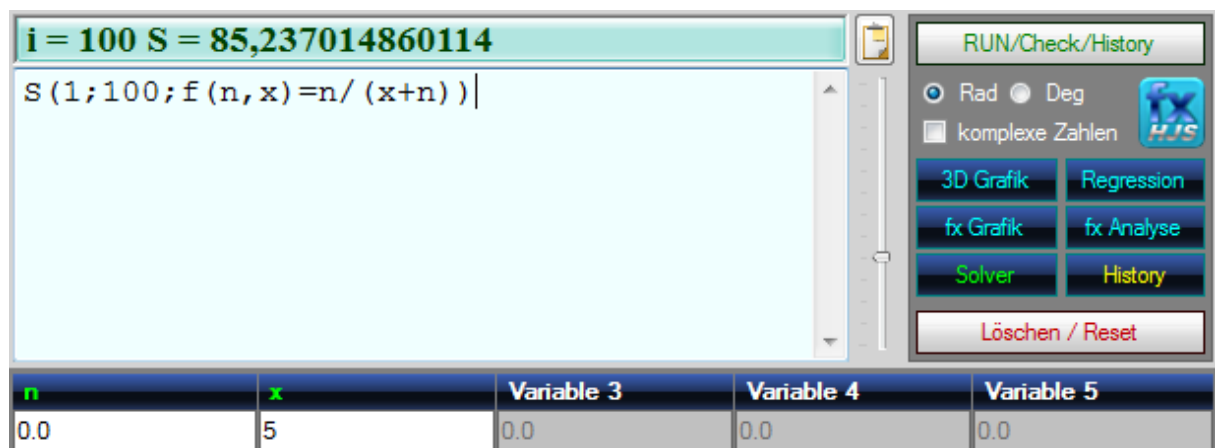
Apart from a function expression sum and products require a start point and the desired number of iterations. While this is almost easy for sum, it needs to be considered that a starting point = 0 might not be very reasonable for a product.

Another interesting point is to observe how a specific expression behaves and this would require the possibility to let fx-Calc do endless iterations, til this is stopped by the user. This can be achieved by setting the number of iterations to 0 and pressing the STOP button whenever the iteration should be stopped. Again we should look at examples to understand this in more detail:

To sum up all number from 0 to 100 you simply need the following expression:



The following example illustrates the use of a function expression:



X can be set via the corresponding variable field, which again is automatically activated.

Even if as well n is recognised and offered as variable field, any value in this field will be ignored and overwritten by the values from the expression.

`S(0;100;f(n,x)=n/(x+n))` contains the following elements:

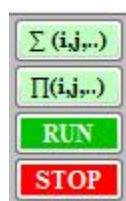
- S stand for sum (P for product)
- start with n from 0
- to 100
- use the following expression  $f(n,X)=n/(X+n)$

As mentioned, this is exactly the same for products - just use "P" instead of "S".

If the second parameter in our example is set to 0 fx-Calc will run the sum or the product until the STOP button was pressed by the user.

( of course a mathematical exception would stop this process as well )

All four buttons for sum and product can be found on the left upper corner of the fx-Calc keypad.



While this calculator is performing all calculations while you type, this isn't happening for sum and

product. The reason is obvious: the number of required iterations.

Therefore you need to click the green RUN button to get your calculation launched.

Prominent examples for sum calculations are Pi and a formula for Panini stickers:

Pi:  $S(0;1000;f(n)=((-1)^n/4^n)(2/(4n+1)+2/(4n+2)+1/(4n+3)))$

Panini:  $S(1;640;f(n)=640/n)$  ... for a total number of 640 different stickers

## Further functionalities

fx-Calc provides extended capabilities to:

- plot functions in 2D and 3D
- solve and analyse functions
- perform linear regression



Each of those modules starts with an integrated example, which illustrates the parameters and input formats per module. All examples can be easily changed and applied to your specific demand.

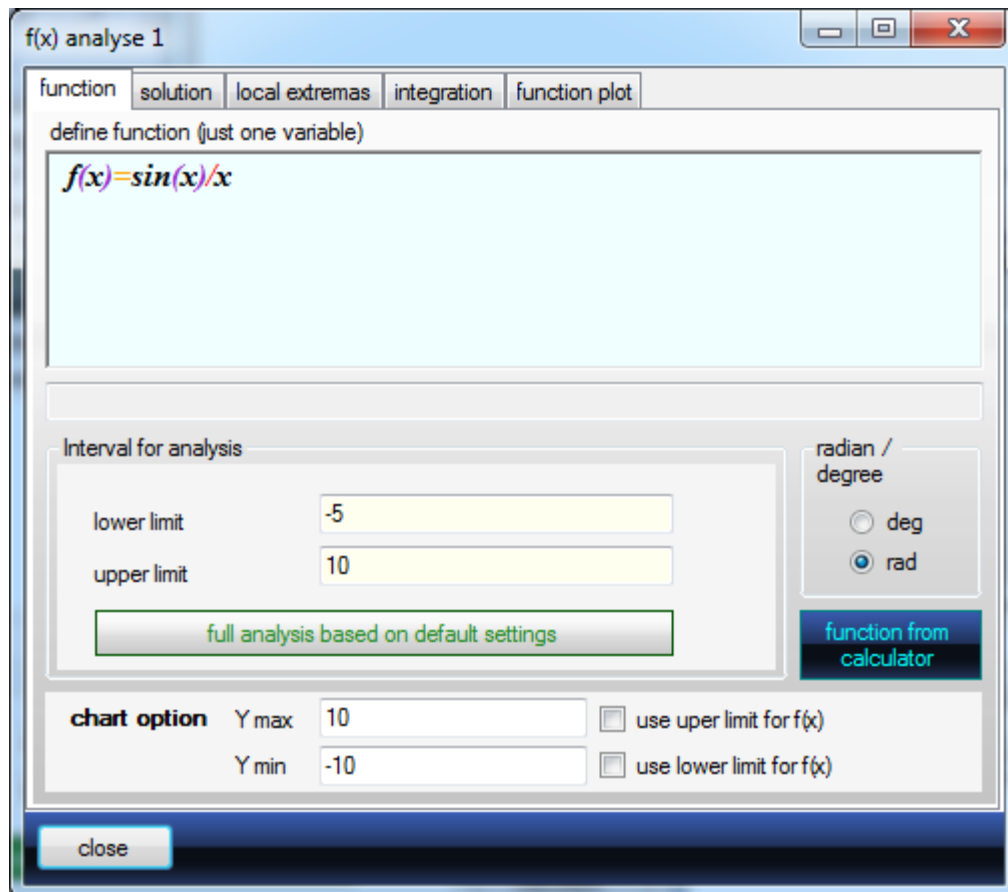
### Important hint:

All extended modules contain integrated methods to validate all input fields on a form. If the form should contain invalid input content, it disables all calculation capabilities and enables them again as soon as all errors are corrected. Errors are indicated by:

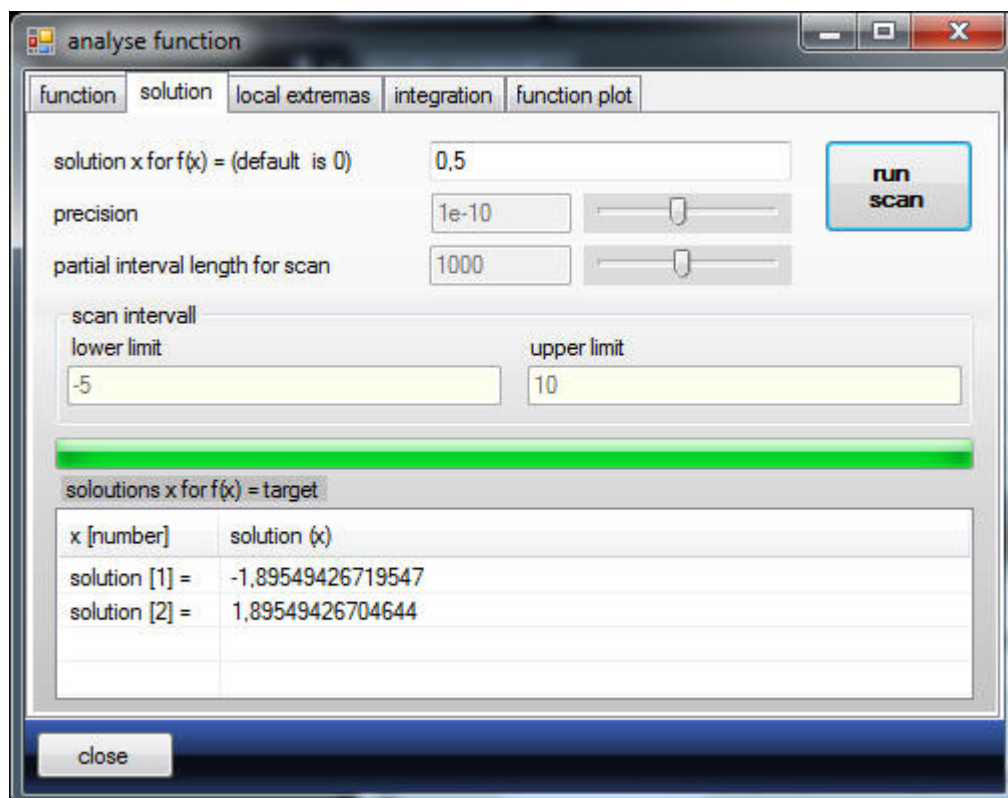
- red text colour in text boxes
- an information text in a separate textbox underneath the function editor field

## Analyse functions

Analysing functions can be time consuming, specifically for more complex expressions. fx-Calc provides capabilities to look for multiple zero points and local extreme values. All this is based on numeric algorithms, making use of scanning a given interval for sign changes for a function or a derivation of it. This is very flexible and stable - but has on the other hand limitations. So using reasonable interval boundaries and parameters is often very important. Furthermore you should use the function plot to verify the solution.

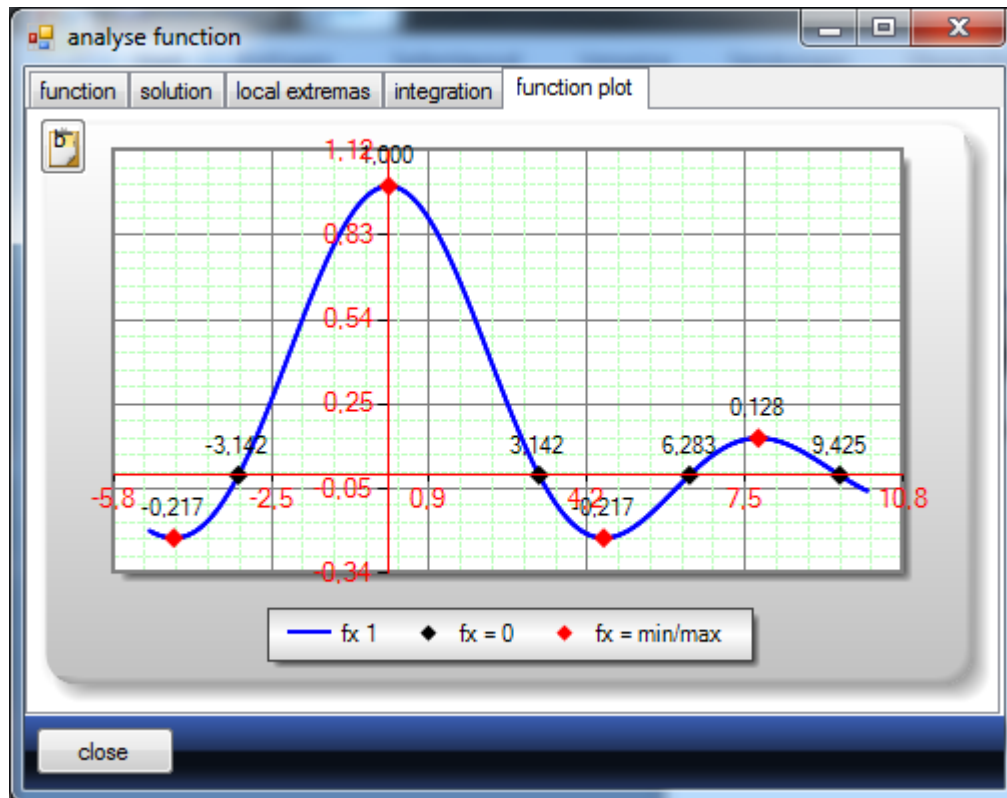


Solving equations is very simple by just changing the target value in the solution tab:





By using the function plot tab all results can be easily verified:

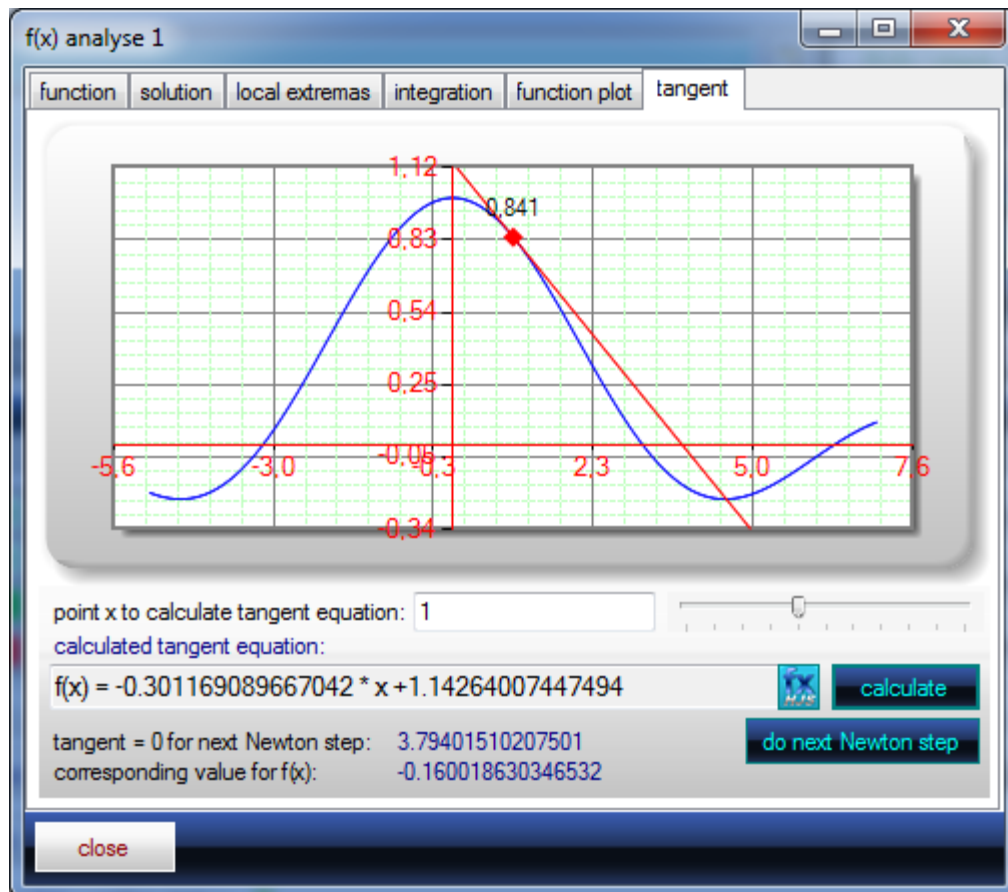


Finally this module allows to calculate the definite integral of an function.

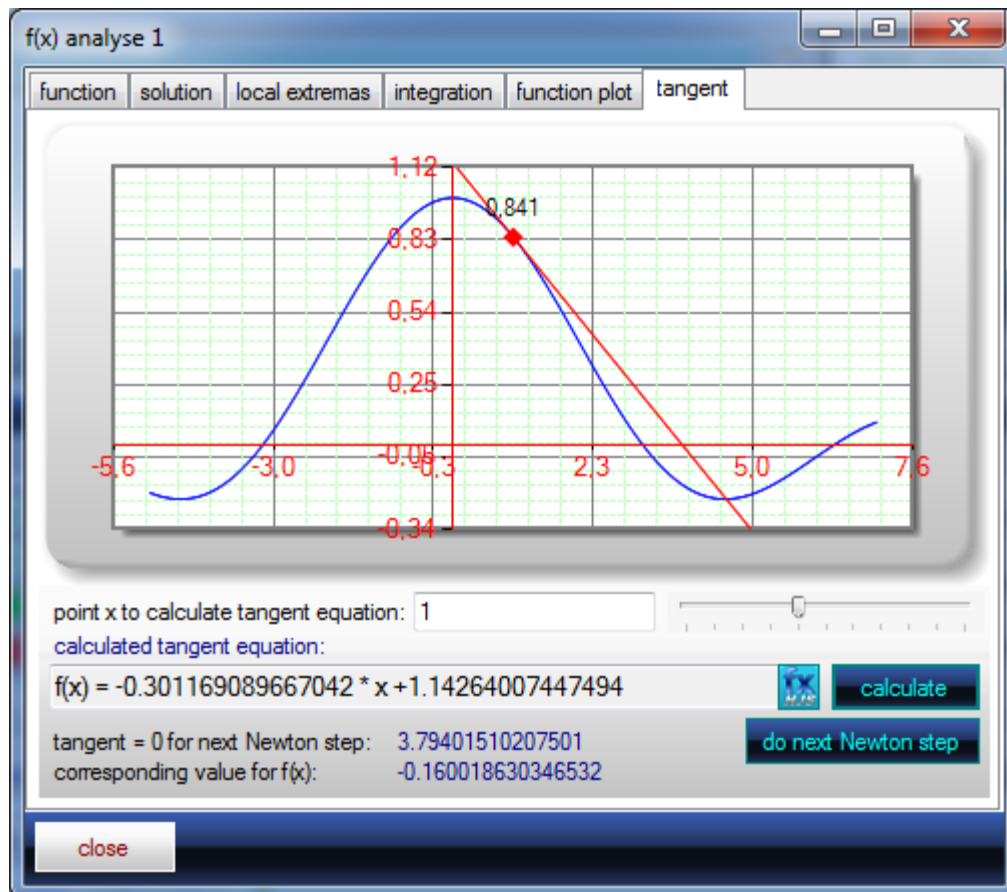
fx-Calc allows to open multiple instances of this window at the same time to compare different scenarios.

## Tangent calculation

Calculating tangent equations is based on the numerical calculation of the first derivate of given function  $f(x)$  at a specific point  $x$ . The starting point  $x$  is usually the average of the interval for the function analysis and can be easily changed by adjusting the value in the first text box. For reasonable results the function needs to be differentiable.



Fx-Calc calculates the tangent equation and provides the possibility to transfer the equation directly to the calculator window to use it for further purpose. On top of this you can use the "do next Newton step" button to perform step wise Newton iteration. While doing so, you can observe how the tangent is getting closer to the next solution for the given function. In most cases the procedure is fairly quick and in this example it took only 5 steps to get to a close result.

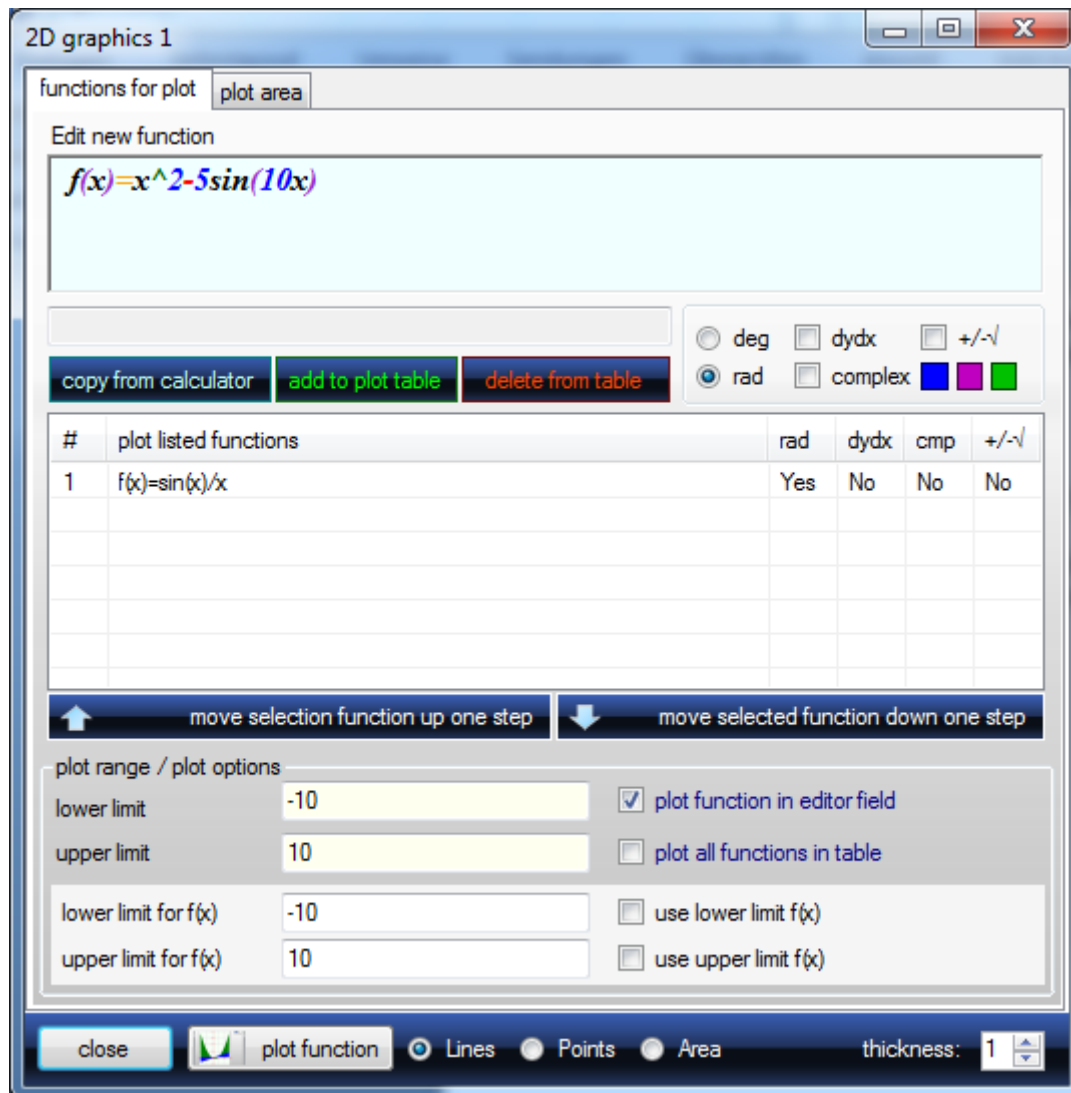


## 2D function plots

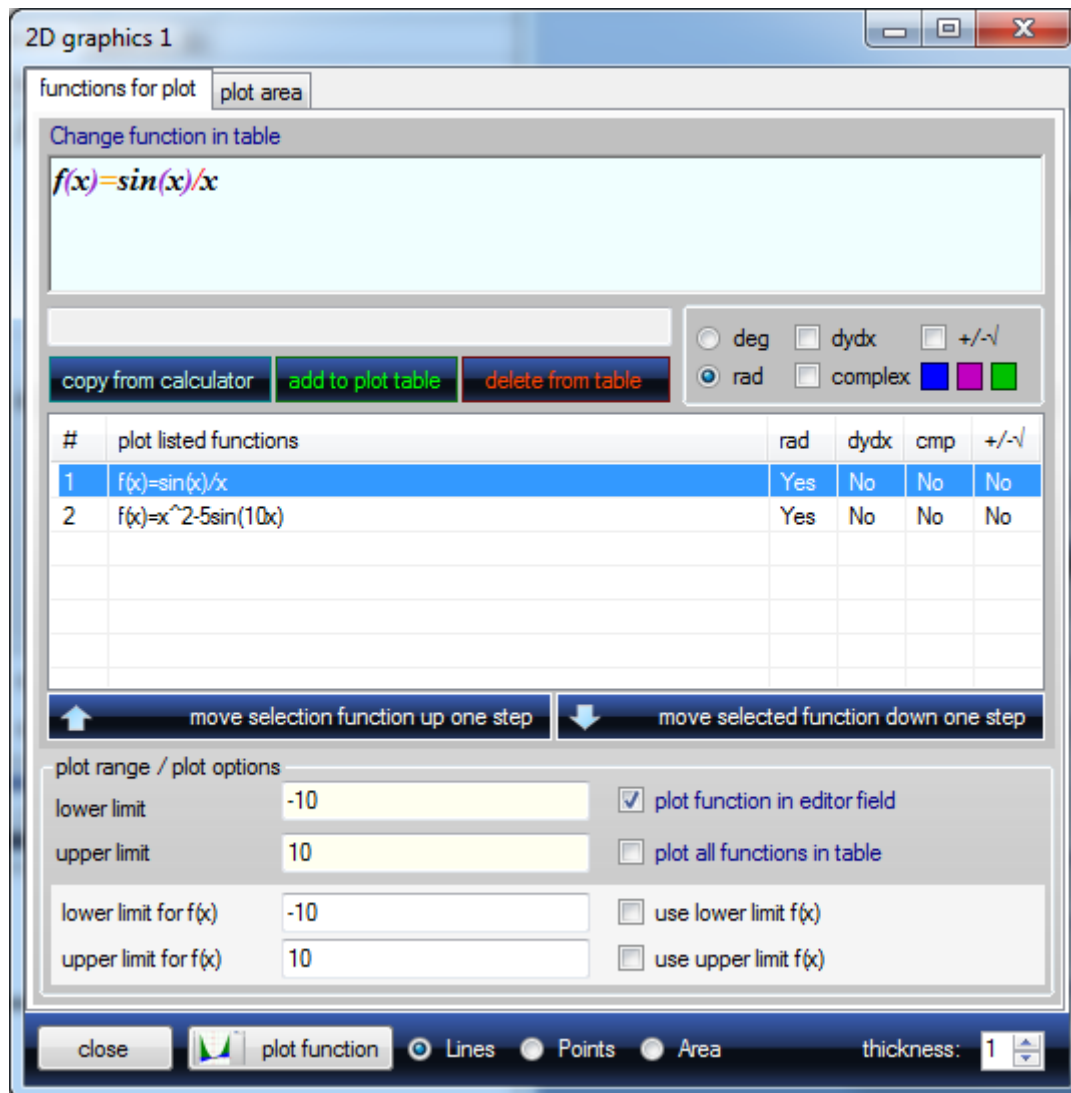
Function plots allow plotting one or multiple functions in one plot area. fx-Calc is plotting the table content and the editor field content. By using the checkboxes on the bottom of the input window it allows to select the following options:

- plot just the editor function (default)
- plot just all functions in table
- plot both, editor and table function

Using upper and lower limits for  $f(x)$  might help to visualise functions with significant differences for  $f(x)$ .

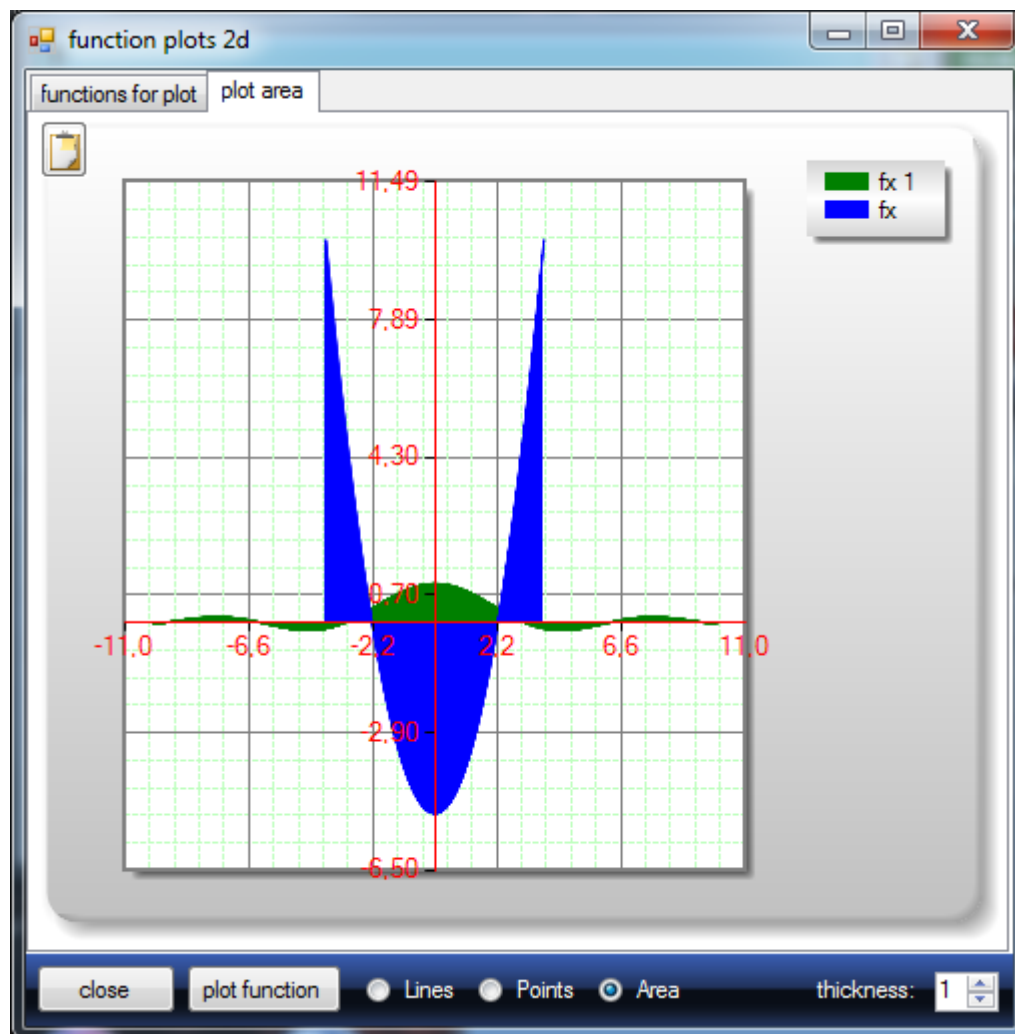


To change a function or its options click on the function in the table and the input dialog is automatically connected to the current selection. Any function change or adjustment of options changes the corresponding table field immediately. This modus is indicated by a changing background colour and the changing headline on top of the editor field:



In order to leave this modus click on an empty row in the table.

Another new and unique option is to plot functions using complex numbers. In this case Fx-Calc is plotting two function graphs, one for the real - and another one for the imaginary part of the complex function result.



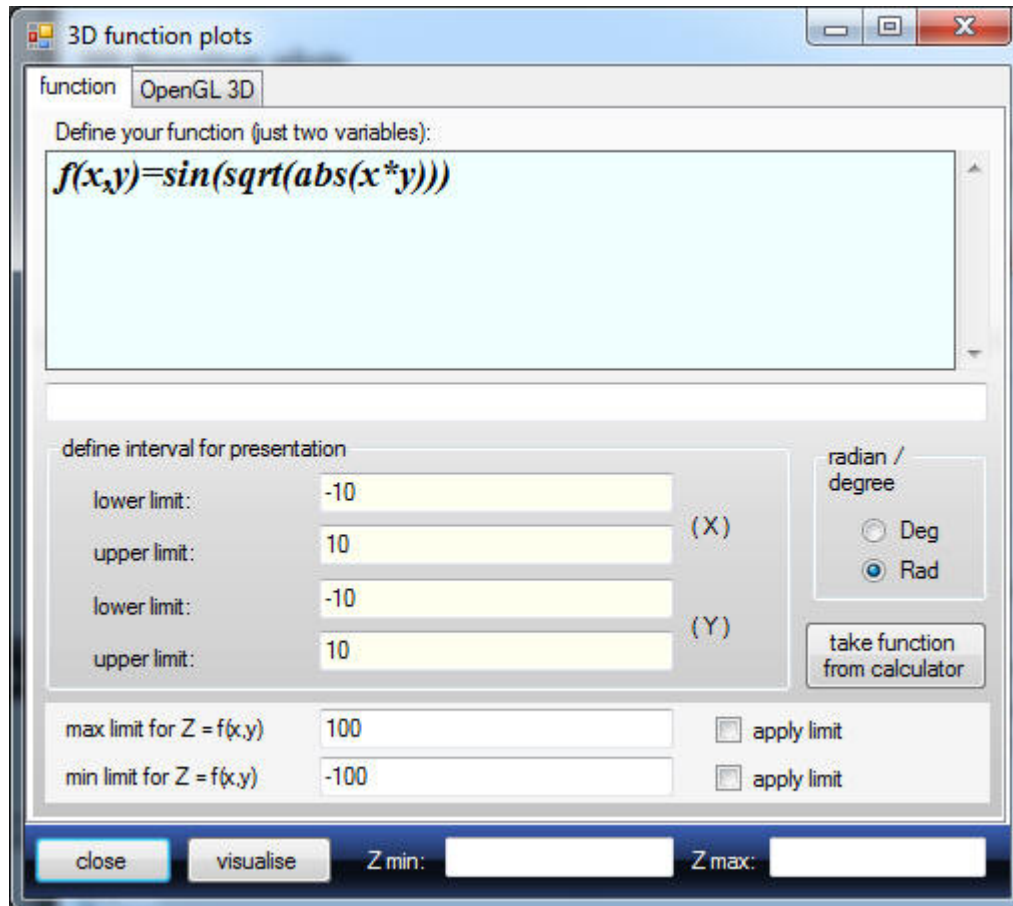
fx-Calc allows to open multiple instances of this window at the same time to compare different scenarios.

## 3D function plots

Within this module you can visualise 3D function plots for  $Z = f(x,y)$ .

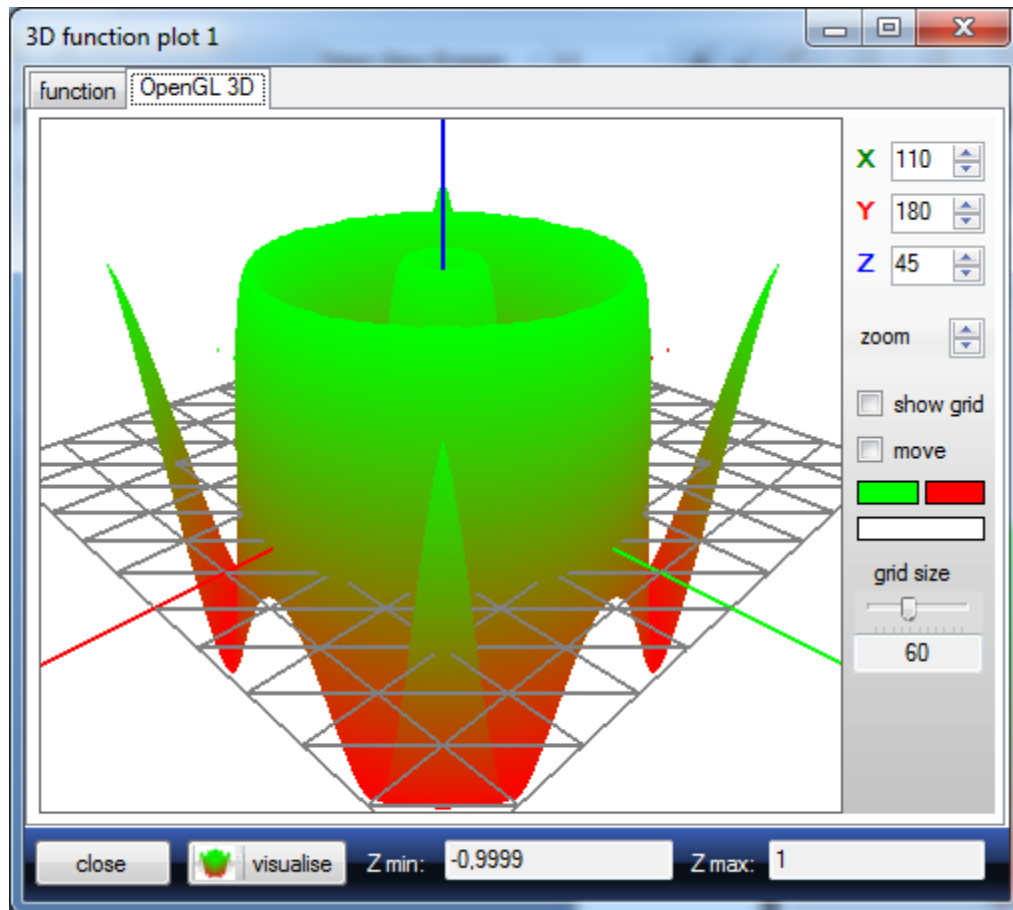
OpenGL provides real time manipulation by using the hardware accelerated graphics interface of your PC.

(This will not work on PC's without an OpenGL driver installed on your hardware.)



Similar to 2D plots 3D plot provides the possibility to set limits for your Z - values.

fx-Calc allows to open multiple instances of this window at the same time to compare different scenarios.



Within this window you can:

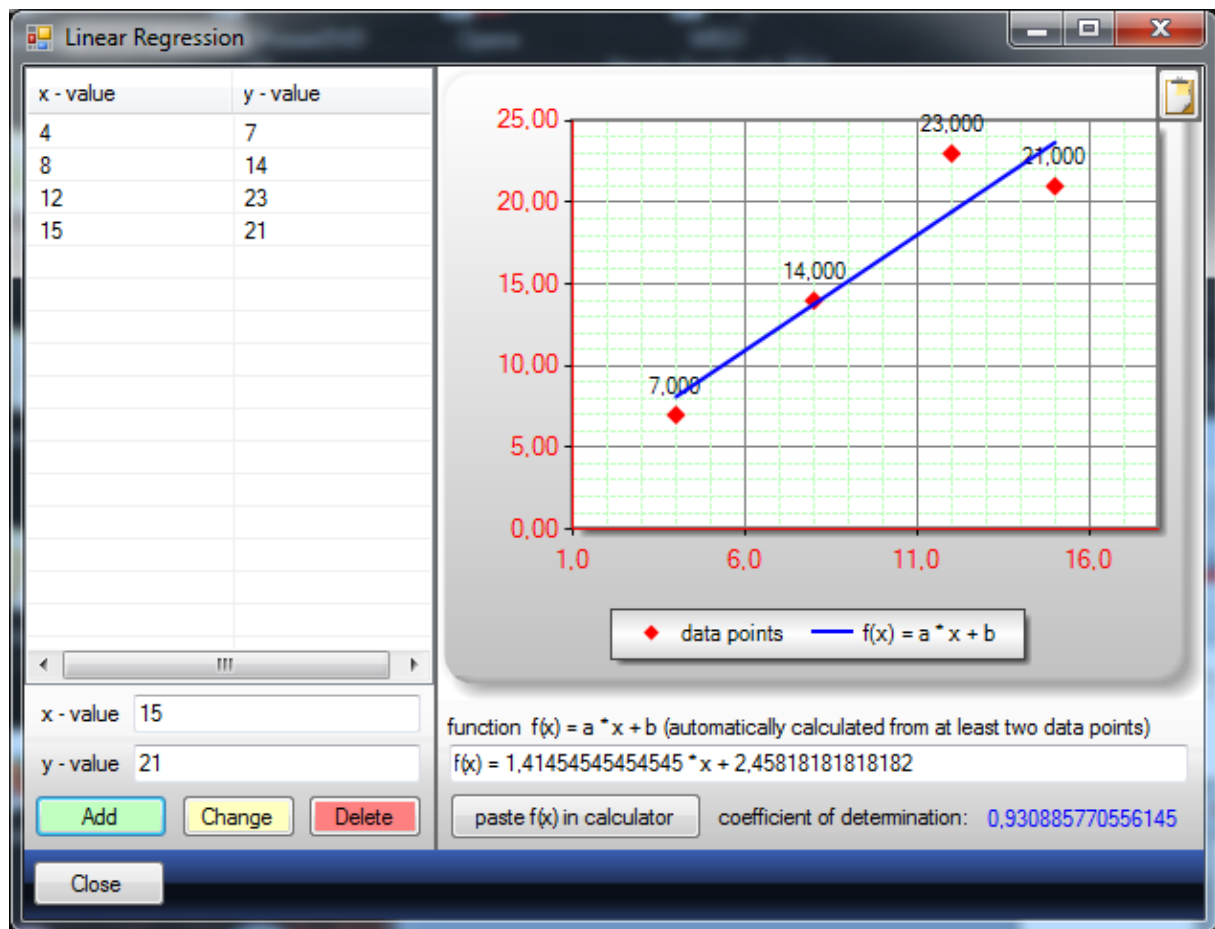
- turn the 3D plot with your mouse by keeping the left mouse button pushed
- show this as grid instead of the collard surface
- zoom in and out
- switch on auto rotation (move)

## Linear regression

In statistics, simple linear regression is the least squares estimator of a linear regression model with a single explanatory variable. In other words, simple linear regression fits a straight line through the set of  $n$  points in such a way that makes the sum of squared residuals of the model (that is, vertical distances between the points of the data set and the fitted line) as small as possible.

As soon as the table contains two pairs of values, fx-Calc calculates the linear function and is plotting the result. By using the copy button you can transfer the new function to the calculators editor field to use it for calculations.

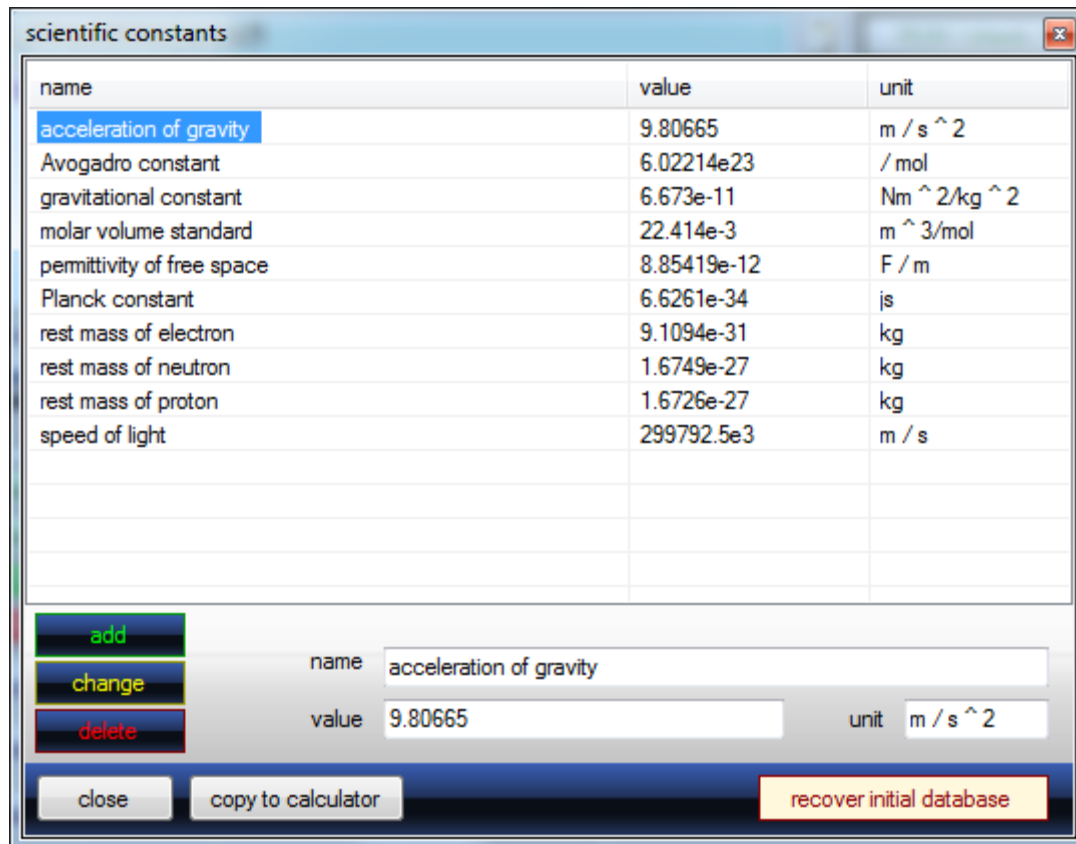




fx-Calc allows to open multiple instances of this window at the same time to compare different scenarios.

## Constant values DB

A small database allows storing of scientific constants. By double clicking a selected entry the corresponding value will be transferred to the editor field and the database window will be closed.



This is a modal window and must be closed to follow up with fx-Calc.

## Few last words...

First of all, I'm coming from Germany and must hope my translation is sufficient - otherwise let me know ;-)

I'd like to ask for your feedback, specifically if you think something could be better or is going wrong, this will help me to improve the application for you.

*Have fun with fx-Calc,  
Hans Jörg ;-)*