European Virtual Laboratory of Mathematics

Teachers' guide
Computer Algebra Systems

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Some information about CAS-s

The expression used for the computer algebra tools is the Computer Algebra Systems, CAS, because beside numerical and symbolic computation, they can be used to edit mathematical text, to visualize by models the mathematics behind, to create own programs etc.

The most known general CAS-s are MAPLE and MATHEMATICA.

We will present the examples using MAPLE 9, but due to the rapid changes in computer software the latest available MAPLE version is 11, as well as for Mathematica 11.

Some other CAS

Beside the two systems already mentioned there are many general and a large variety of special CA tools.

General tools: MUPAD, DERIVE, MATLAB, MATHCAD work more or less with the same philosophy, all can handle numerical and symbolic computations, and there are some advantages for each.

Special tools are: ODE, DELiA for solving ordinary differential equations, SPSS for Statistics in economy and social sciences, CAYLEY, LiE and GAP for algebra, CAMAL, SCHONSCHIP and STENSOR for Physics, any many others like MACSYMA, REDUCE etc.
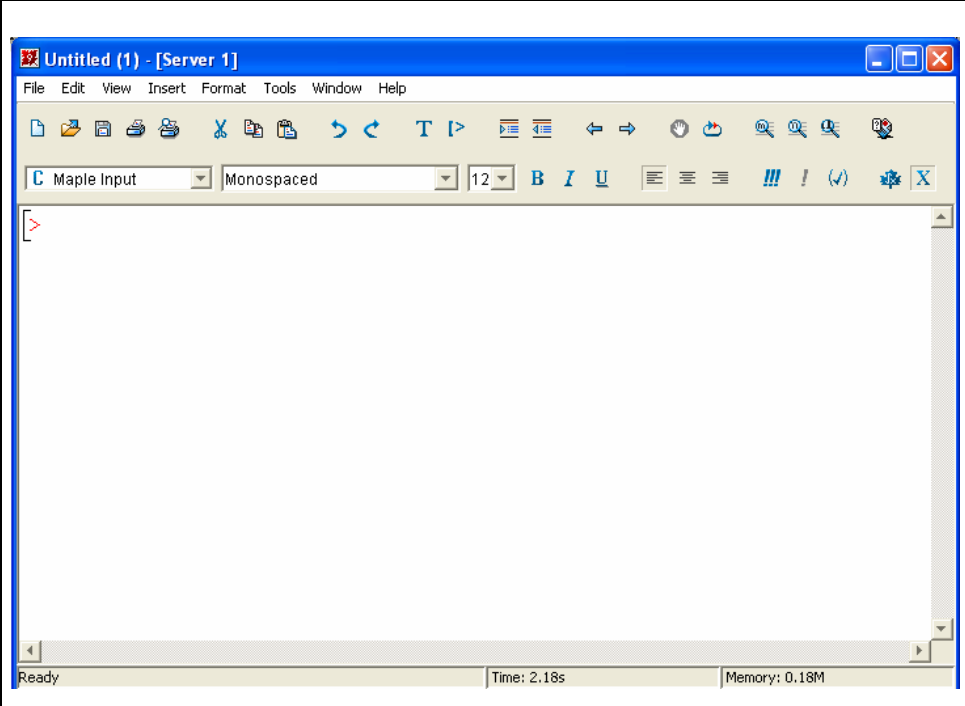
Let us start with MAPLE

You will start the MAPLE program, usually with its maple leave logo:

The MAPLE program will let you open several worksheets, the first one opens automatically, when opening the program You will be able to save your worksheets on your

computer or a pendrive, in the FILENAME.ms format. For simplicity we will name the worksheets we create EVLM-nr.ms.
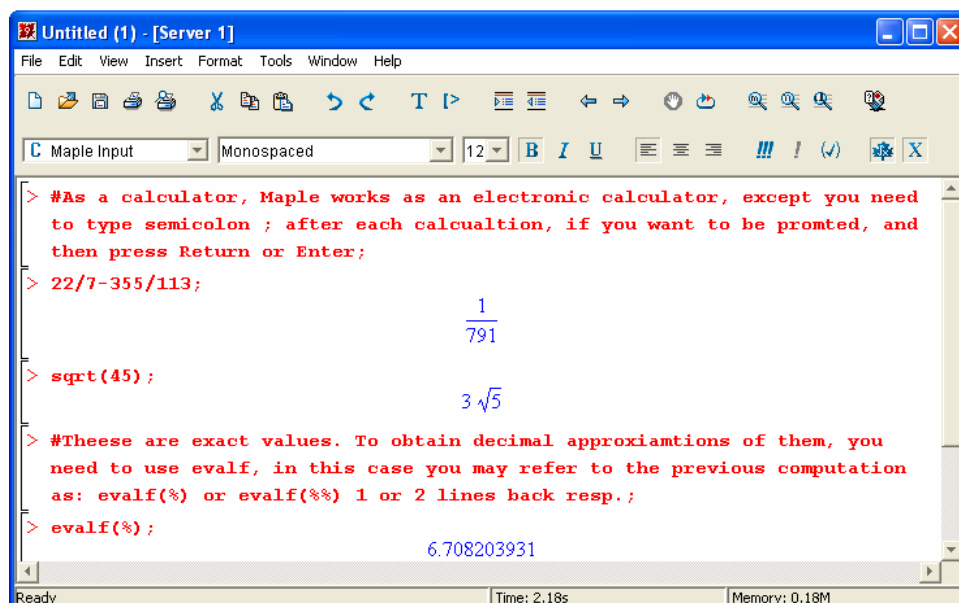
Maple working surface

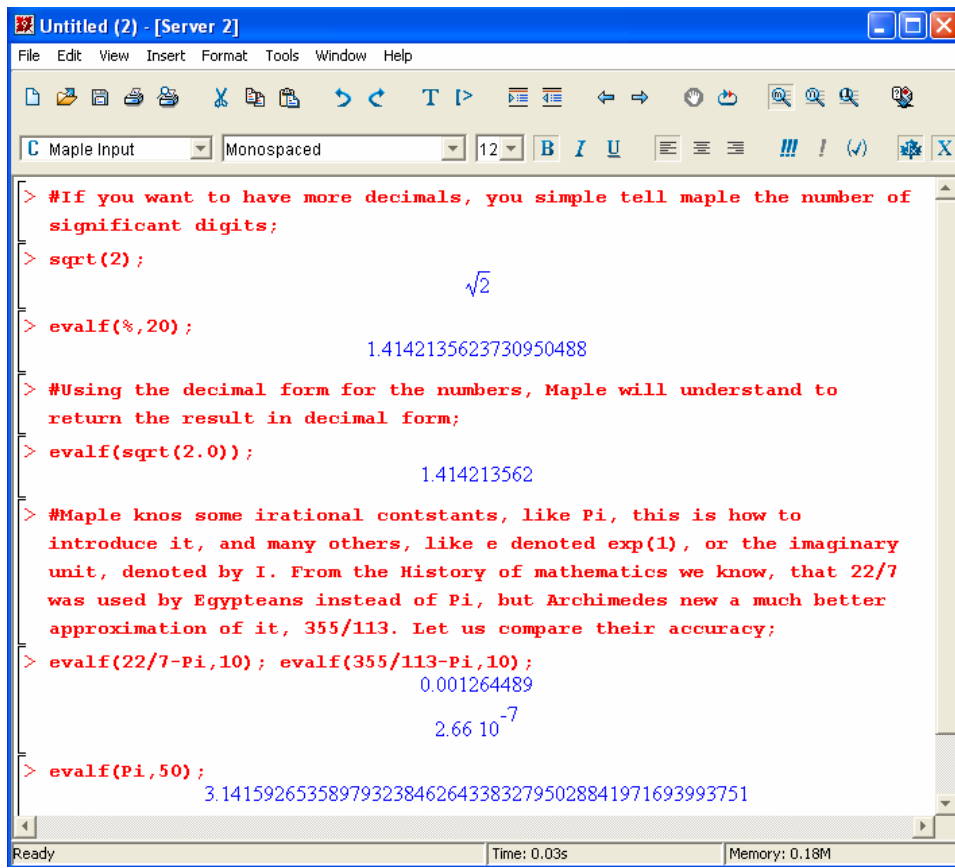|	
Contains a general window and also it opens a worksheet, named Untitled (1).	
Most of the menu points are similar to Word, and there are some Mathematical ones as well, but you will use the most - maybe - the Help menu	
You can open the same time several worksheets, they will pop up as Untitled (2), etc. but only one will be active, the one you click on.	

Let's start MAPLE

Each line will start automatically by the prompt sign [> after which you can type your text, or commands. In the Maple window you can introduce any non-mathematical text, comments, if started by the sign double cross #, and finished by semicolon ;

After each command line, which you can fill in without taking care of the length of the line, you need to press return or enter, to validate it.
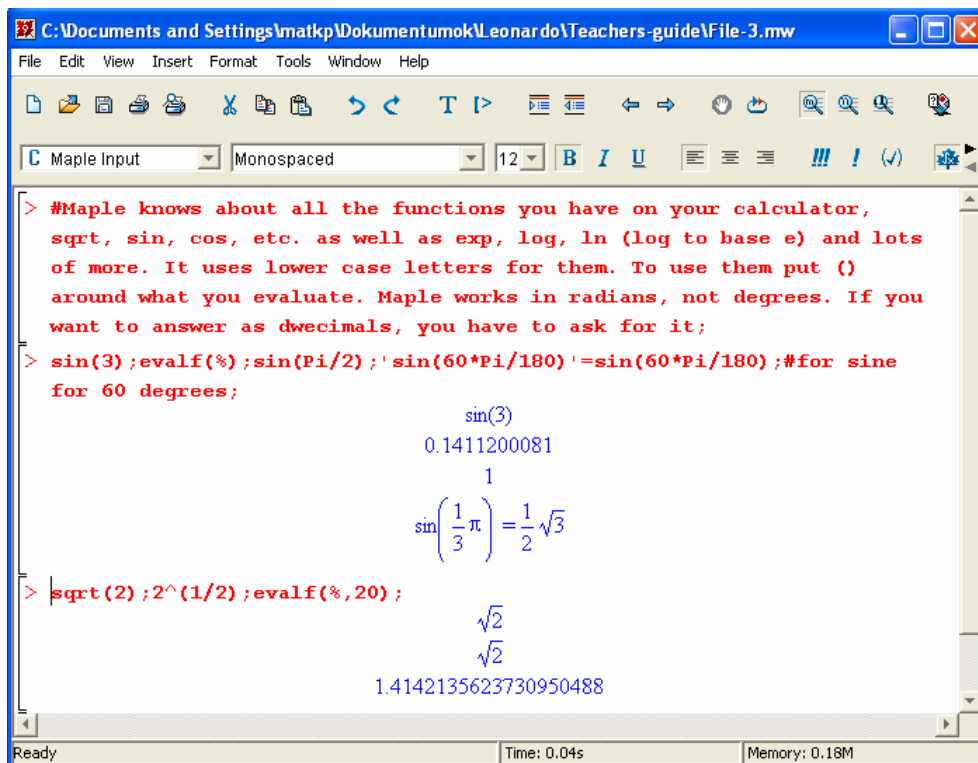
More decimals and constants in Maple

```
> #If you want to have more decimals, you simple tell maple the number of
  significant digits;
> sqrt(2);
                              √2

> evalf(%,20);
                    1.4142135623730950488
> #Using the decimal form for the numbers, Maple will understand to
  return the result in decimal form;
> evalf(sqrt(2.0));
                       1.414213562

> #Maple knos some irational contstants, like Pi, this is how to
  introduce it, and many others, like e denoted exp(1), or the imaginary
  unit, denoted by I. From the History of mathematics we know, that 22/7
  was used by Egypteans instead of Pi, but Archimedes new a much better
  approximation of it, 355/113. Let us compare their accuracy;
> evalf(22/7-Pi,10); evalf(355/113-Pi,10);
                       0.001264489

                      2.66 10⁻⁷

> evalf(Pi,50);
          3.1415926535897932384626433832795028841971693993751
```

Usual (calculator type) functions in Maple

```
> #Maple knows about all the functions you have on your calculator,
  sqrt, sin, cos, etc. as well as exp, log, ln (log to base e) and lots
  of more. It uses lower case letters for them. To use them put ()
  around what you evaluate. Maple works in radians, not degrees. If you
  want to answer as dwecimals, you have to ask for it;
> sin(3);evalf(%);sin(Pi/2);'sin(60*Pi/180)'=sin(60*Pi/180);#for sine
  for 60 degrees;
                            sin(3)
                        0.1411200081
                             1
```
$$\sin\left(\frac{1}{3}\pi\right) = \frac{1}{2}\sqrt{3}$$

```
> sqrt(2);2^(1/2);evalf(%,20);
                             √2
                             √2
                    1.4142135623730950488
```

Other functions

Help in Maple

To see the help files on a Maple command, type the command and highlight it. Then go to the Help menu and you will see an entry for the command. Alternatively, type? and then the command. (e.g. ? print, You don't even need a semi-colon!)

You can also use or help(command); (and you do need the semi-colon!) > help(sin); At the bottom of a help file, you will find some examples of how to use the command. (This is the most useful bit!) You can copy and paste these lines into your worksheet and look at what happens. Then you can change them to do what *you* want.

Each help file has a list of examples, for which you can use can paste and copy in the worksheet, to practise its use. There are links to related topics at the bottom of the file, which may let you hunt down exactly what you want.

The Help menu also has a "Full text search" facility, which will point you in the direction of any help files where the word or phrase you enter is mentioned. This tends to produce too much output be very useful!

Getting help for the use of evalf – Description

In the help window you have the topic tree, and the help file itself, as hypertext to enhance rapid search within the help menu.

Window 1

File   Edit   View   Help

Contents | Topic | Search | History

- Discrete Mathematics
- Evaluation
  - allvalues
  - assume
  - cost
  - eval
  - Eval
  - evala
  - evalb
  - evalc
  - evalf
  - evalhf
  - evalindets
  - evalm
  - evaln
  - evalpow
  - evalr
  - evalrC
  - hfarray
  - last name evaluation
  - special evaluation
  - value
- Factorization and Solving Equations
- Financial Functions
- FunctionAdvisor
- General Information
- Geometry

evalf - evaluate using floating-point arithmetic

Calling Sequence

evalf(**expr**)

evalf[**n**](**expr**)

Parameters

expr – any expression

n   – (optional) integer; specifies number of digits

Description

- The **evalf** function evaluates to floating-point or complex floating-point numbers, expressions (or subexpressions) involving constants such as **Pi**, **exp(1)**, **gamma**, and functions such as **exp**, **ln**, **sin**, **arctan**, **cosh**, **GAMMA**, and **erf**. For the complete list of known constants, see inlnames. For the complete list of known functions, see inlfcns.

- The accuracy of the result is determined by the value of the environment variable **Digits**. By default the results will be computed using 10-digit floating-point arithmetic, since the initial value of **Digits** is **10**. A user can change the value of **Digits** to any positive integer that does not exceed the value given by **kernelopts(maxdigits)**.

evaluate using floating-point arithmetic

Window 2

File   Edit   View   Help

Contents | Topic | Search | History

- Discrete Mathematics
- Evaluation
  - allvalues
  - assume
  - cost
  - eval
  - Eval
  - evala
  - evalb
  - evalc
  - evalf
  - evalhf
  - evalindets
  - evalm
  - evaln
  - evalpow
  - evalr
  - evalrC
  - hfarray
  - last name evaluation
  - special evaluation
  - value
- Factorization and Solving Equations
- Financial Functions
- FunctionAdvisor
- General Information
- Geometry
- Group Theory
- Inert Functions

Examples

```
> evalf(Pi);
```

$$3.141592654$$

```
> evalf[15](5/3*exp(-2+3*I)*sin(Pi/4));
```

$$-0.157898022493763 + 0.0225078172647505\,I$$

```
> evalf(cos(1) + sin(1)*I);
```

$$0.5403023059 + 0.8414709848\,I$$

```
> evalf(3/4*x^2+1/3*x-sqrt(2));
```

$$0.7500000000\,x^2 + 0.3333333333\,x - 1.414213562$$

```
> sin(3.5+4.5*I);
```

$$-15.79019836 - 42.14337074\,I$$

```
> int(exp(x^3), x=0..1);
```

$$\int_0^1 e^{(x^3)}\,dx$$

```
> evalf(%);
```

evaluate using floating-point arithmetic