

Advanced mathematical environments

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Mathematical software

Mathematical software is software used to model, analyze, or calculate numeric, symbolic, or geometric data.(wikipedia)

Application areas:

- ▶ Symbolic mathematics – computer algebra systems
- ▶ Statistics
- ▶ Geometry
- ▶ Numerical analysis

Categories of software:

- ▶ applications, e.g. GeoGebra
- ▶ interactive platforms, e.g. Scilab, Sage
- ▶ problems solving environments (PSE), e.g. Diffpack
- ▶ software libraries, e.g. GNU Scientific Library, Trilinos

Selected software packages

Alphabetical list:

- ▶ Diffpack
- ▶ Maple
- ▶ MathCad
- ▶ Mathematica
- ▶ Matlab
- ▶ Maxima <http://maxima.sourceforge.net/>
- ▶ Octave <http://www.gnu.org/software/octave/>
- ▶ R <http://www.r-project.org/>
- ▶ Sage <http://www.r-project.org/>
- ▶ Scilab <http://www.scilab.org/>

Software taxonomies

Licensing:

- ▶ Open Source
- ▶ Proprietary

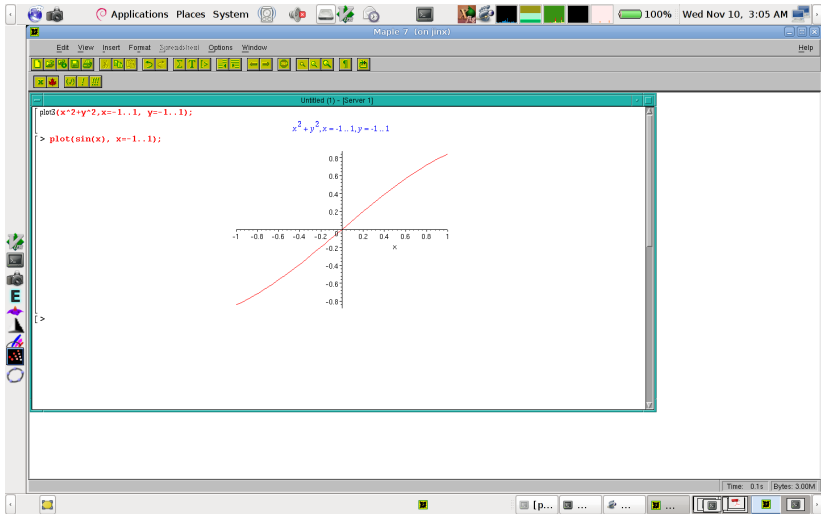
Scope:

- ▶ Symbolic computations
- ▶ Numerical computations

Operating mode:

- ▶ WYSWIG, GUI
- ▶ traditional programming, CLI

Maple



Maxima + wx = wxMaxima

Applications Places System wxMaxima 0.8.5 [wxMaxima_wxplot_Tutorial.wxmx*]

File Edit Cell Maxima Equations Algebra Calculus Simplify Plot Numeric Help

The plot below is generated by selecting Plot/Plot 2d from the menu or by clicking on the Plot2D button at the bottom of the screen. Alternatively, the command can be entered directly into the cell.

To execute any command below, use "Ctrl-Enter" or "Shift-Enter".

```
(i2) wxplot2d([x*sin(x)], [x,-5,5])$
```

Note: At any time, a graph may be saved to a file. Click on the image to be saved. Then select the menu item Edit/Selection to image and save the graph.

We now add labels to the horizontal and vertical axes. Notice wxMaxima's use of lists. Each new set of instructions consists of a list of items.

```
(i3) wxplot2d([x*sin(x)], [x,-5,5], [xlabel, "x(m)"], [ylabel, "Displacement (m)"])$
```

Welcome to wxMaxima

Ready for user input

Scilab

The screenshot displays the Scilab software environment with three main windows:

- atomsAutoload.sci - Scilab text editor:** Shows the source code for the `atomsAutoload` function. The code includes comments about the CeCILL license and a function definition that loads toolboxes and the `atomsAutoload` function.


```

1 // Scilab ( http://www.scilab.org/ ) - This file is part of Scilab
2 // Copyright (C) 2009 - DIGITEO - Pierre MARECHAL <pierre.marechal@scilab.org>
3
4 // This file must be used under the terms of the CeCILL.
5 // This source file is licensed as described in the file COPYING, which
6 // you should have received as part of this distribution. The terms
7 // are also available at
8 // http://www.cecill.info/licences/Licence_CeCILL_V2-en.txt
9
10 // End user function
11
12 // Load the toolboxes that are marked 'autoload'
13
14 function result = atomsAutoload()
15
16     result = [];
17
18     // Load Atoms Internals Lib if it's not already loaded
19
      
```
- Scilab Console:** Displays the execution output, showing a warning about a missing shared archive and an error message:


```

-->// unlink previous function with same name
-->[bOK,ilib] = c_link('rpend');if (bOK) then unlink(ilib),end
-->[bOK,ilib] = c_link('rp');if (bOK) then unlink(ilib),end
-->[bOK,ilib] = c_link('ener');if (bOK) then unlink(ilib),end
-->link(npnd_path+'libnpnd'+getdynlibext(),['rpend','rp','ener'],'f');
Link failed for dynamic library '/tmp/SD_7459/_libnpnd.so'.
An error occurred: /tmp/SD_7459/_libnpnd.so: undefined symbol: s_wafe
link(npnd_path+'libnpnd'+getdynlibext(),['rpend','rp','ener'],'f');
l--error 236
link: The shared archive was not loaded: (null)
at line 11 of exec file called by :
at line 17 of function npnd_build_and_load called by :
at line 5 of function demo_pendulum called by :
demo_pendulum()
at line 13 of exec file called by :
no_gui_update();exec(script_path,1);if exists('%oldgcb%' then gcb0 = %old
while executing a callback
      
```
- Help Browser:** Shows the Scilab manual for the `bvode` function, which is used for solving boundary value problems for ODE using collocation method.

Name
bvode — boundary value problems for ODE using collocation method

bvodeS — Simplified call to bvode

Calling Sequence
`zu=bvode(xpoints,N,n,x_low,x_up,zeta,ipar,lto1,tol,fixpnt,fsub,dfsub,q`
`zu=bvodeS(xpoints,m,N,x_low,x_up,fsub,gsub,zeta, <optional_args>)`

At the bottom, a 3D surface plot titled `plot3d : z=sin(x)*cos(y)` is displayed, showing a wave-like surface over a grid of x and y values.

Octave

```

function_plotting...ve/plotting) - GVIM1
File Edit Tools Syntax Buffers Window DrChip Tags Help
N = 200;
x = linspace(-5,5,N);
y = 1./(1 + (x .* sin(x)).^2);
axis([-5,5,0,1.5]);
plot(x,y,"-";T);
grid();
set(gca(), "defaultlinecolor", "red");
l1=line([-pi,-1.8],[1.05,1.28])
l2=line([pi,1.8],[1.05,1.28])
xlabel("X coordinate [m]")
ylabel("temperature T [K]")
title("Temperature distribution")
text(0, 1.3, "Characteristic points", "fontsize"
, 12, "horizontalalignment", "center")
replot
print("temp_dist.fig", "-color", "-F:20");
print("temp_dist.png", "-color", "-r0");
pause()
    
```

-plotting/function_plotting.m 1,1 All

```

putanow@atom: ~/programming/octave/plotting
File Edit View Terminal Help

Report bugs to <bug@octave.org> (but first, please read
http://www.octave.org/bugs.html to learn how to write a helpful report).

For information about changes from previous versions, type `news'.

octave:1> function_plotting
l1 = -7.4774
l2 = -8.6289
octave:2> A = [1,2;2,3]
A =
     1     2
     2     3
octave:3>
    
```

Figure 1
Temperature distribution

Octave + Qt = QtOctave

The screenshot displays the QtOctave application window. The main window contains several panels:

- Octave Terminal:** Shows the execution of Octave commands:


```

      0.11000  0.24000  0.37000  0.50000  0.63000  0.76000
      0.00000  0.13000  0.28000  0.45000  0.64000  0.83000
      -0.13000  0.00000  0.15000  0.32000  0.51000  0.70000
      -0.28000 -0.15000  0.00000  0.17000  0.34000  0.52000
      -0.45000 -0.32000 -0.17000  0.00000  0.18000  0.35000
      -0.64000 -0.51000 -0.36000 -0.19000  0.00000  0.20000

      >>> surface(x,y,z)
      >>>
      
```
- Figure 1:** A 3D surface plot of the function $z = x^2 - y^2$, showing a saddle shape. The plot is titled "Figure 1" and includes a coordinate system with axes ranging from -1 to 1. The surface is colored with a gradient from blue (low values) to red (high values).
- Command Line:** Shows the current command prompt: `Command line>>`
- Variables' List:** Displays a table of variables:

Name	Size	Bytes
loc...		
n...	1x1	8
ins	1x30	30
irlist	1x2	11
	1x1	8
	21x21	352
	21x21	352
- Commands' List:** Shows the executed commands:


```

      [x,y] = meshgrid(-1:0.1:1);
      z = x.^2 - y.^2;
      z = x.^2 - y.^2;
      surface(x,y,z)
      
```
- Navigator:** Two instances are visible, showing the file system structure under `/home/putanowr` with filters set to `*.m`. The file list includes:

Name	Size	Type
Zus10...	65 KB	pdf File
Zaocz...	22 KB	pdf File
ZAOC...	48 KB	pdf File
ZAOC...	1.9 MB	xls File
zaksp...	36 KB	pdf File
zaksp...	24 KB	odt File
zaken...	26 KB	doc File

Sage

From Sage web page: "Sage is built out of nearly 100 open-source packages and features a unified interface".

References

1. Maxima <http://maxima.sourceforge.net/>
2. R <http://www.r-project.org/>
3. Sage <http://www.r-project.org/>
4. Scilab <http://www.scilab.org/>
5. GNU Octave <http://www.gnu.org>
6. GNU Octave. A high-level interactive language for numerical computations, by John W. Eaton, David Bateman, Søren Hauberg, edition 3 for Octave version 3.0.2, Network Theory Ltd, 2008
7. Python <http://www.python.org/>
8. Own materials

Thank you for your attention

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