Open Source Resources for Teaching and Research in Mathematics

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Outline

- History
- Definition
- General Applications
- Open Source Mathematics
  - Applications
  - Environments
- Comments

In the Beginning ...

then there were Unix, GNU, and Linux

- 1969 UNIX was born,
  - Portable OS (PDP-7 to PDP-11) – in new “C”
    - Ken Thompson, Dennis Ritchie, and J.F. Ossanna
    - Mailed OS => Unix hackers
- Berkeley Unix - BSD
  - (Berkeley Systems Distribution) 1970-80's
- MIT Hackers
  - Public Domain projects => commercial
    - RMS – Richard M. Stallman
      - EMACS, GNU - **G**NU's **N**ot **U**nix, GPL

History

- Free Software Movement – 1983
  - RMS - GNU Project – 1983
    - GNU GPL – GNU General Public License
- Free Software Foundation (FSF) – 1985
  - Free = “free speech not free beer”
- Open Source Software (OSS) – 1998
  - Netscape released Mozilla source code
  - Open Source Initiative (OSI) – 1998
  - Eric S. Raymond and Bruce Perens
    - *The Cathedral and the Bazaar* 1997 - Raymond

The Cathedral and the Bazaar

- The Cathedral model,
  - source code is available with each software release,
  - code developed between releases is restricted to an exclusive group of software developers.
  - GNU Emacs and GCC are examples.
- The Bazaar model,
  - code is developed over the Internet in public view
  - Raymond credits Linus Torvalds, Linux leader, as the inventor of this process. http://en.wikipedia.org/wiki/The_Cathedral_and_the_Baz

Given Enough Eyeballs ...

- central thesis is that "given enough eyeballs, all bugs are shallow"
- the more widely available the source code is for public testing, scrutiny, and experimentation, the more rapidly all forms of bugs will be discovered.

- Example: Wikipedia

The Free Software Definition

Free software is a matter of liberty, not price. To understand the concept, you should think of free as in free speech, not as in free beer.

Free software is a matter of the users' freedom to run, copy, distribute, study, change and improve the software. More precisely, it refers to four kinds of freedom, for the users of the software:

* The freedom to run the program, for any purpose (freedom 0).
* The freedom to study how the program works, and adapt it to your needs (freedom 1). Access to the source code is a precondition for this.
* The freedom to redistribute copies so you can help your neighbor (freedom 2).
* The freedom to improve the program, and release your improvements to the public, so that the whole community benefits (freedom 3). Access to the source code is a precondition for this.

A program is free software if users have all of these freedoms. Thus, you should be free to redistribute copies, either with or without modifications, either gratis or charging a fee for distribution, to anyone anywhere. Being free to do these things means (among other things) that you do not have to ask or pay for permission.

http://www.gnu.org/philosophy/free-sw.html

The Open Source Definition

1. Free Redistribution: the software can be freely given away or sold. (This was intended to encourage sharing and use of the software on a legal basis.)

2. Source Code: the source code must either be included or freely obtainable. (Without source code, making changes or modifications can be impossible.)

3. Derived Works: redistribution of modifications must be allowed. (To allow legal sharing and to permit new features or repairs.)

4. Integrity of The Author's Source Code: licenses may require that modifications are redistributed only as patches.

5. No Discrimination Against Persons or Groups: no one can be locked out.

6. No Discrimination Against Fields of Endeavor: commercial users cannot be excluded.

7. Distribution of License: The rights attached to the program must apply to all to whom the program is redistributed without the need for execution of an additional license by those parties.

8. License Must Not Be Specific to a Product: the program cannot be licensed only as part of a larger distribution.

9. License Must Not Restrict Other Software: the license cannot insist that any other software it is distributed with must also be open source.

10. License Must Be Technology-Neutral: no click-wrap licenses or other medium-specific ways of accepting the license must be required.

http://opensource.org/docs/osd

Obituary – Netscape
Oct 13, 1994- Mar 1, 2008

- Oct 13 1994 Mosaic Netscape 0.9
  - Marc Andreessen, and others from Mosaic
- 1995 MS IE appeared in Windows 95 Plus Pack
- Jan 1998 Free Netscape Communicator 4.0
  - Under Netscape Public License
- Nov 24, 1998 To be purchased by AOL
- Nov 14, 2000 AOL released Netscape 6.0
- July 15, 2003 Time Warner disbanded Netscape
- Oct 2007 Last Release – Netscape Navigator 9.0
- Dec 28 2007, AOL announced pending death of Netscape

How not to do open source

"**Jamie Zawinski**, another of the key figures in opening up Netscape Navigator, and the person who had come up with the Mozilla name back in 1994 – a combination of the original "Mosaic" and Godzilla – wrote in his resignation letter when he left AOL, which had recently bought Netscape in November 1998:

Open source does work, but *it is most definitely not a panacea. If there's a cautionary tale here, it is that* ***you can't take a dying project, sprinkle it with the magic pixie dust of "open source," and have everything magically work out****. Software is hard. The issues aren't that simple."*

- The Netscape Story: From Mosaic to Mozilla, Glyn Moody, 12/1/2007

Some Open Source Software

Web Browsing

Mozilla Firefox

Word Processing / Office Suites

OpenOffice.org

AbiWord

Sound Recording

Audacity

Graphics

GIMP

Paint.NET

Inkscape

Note Taking

Freemind

Keynote

Video Player

Miro

Podcasting

Juice

DVD Ripping

Handbrake

Utilities

7-Zip

Filezilla

Outer Space

Celestia

Stellarium

3D Graphics

Blender

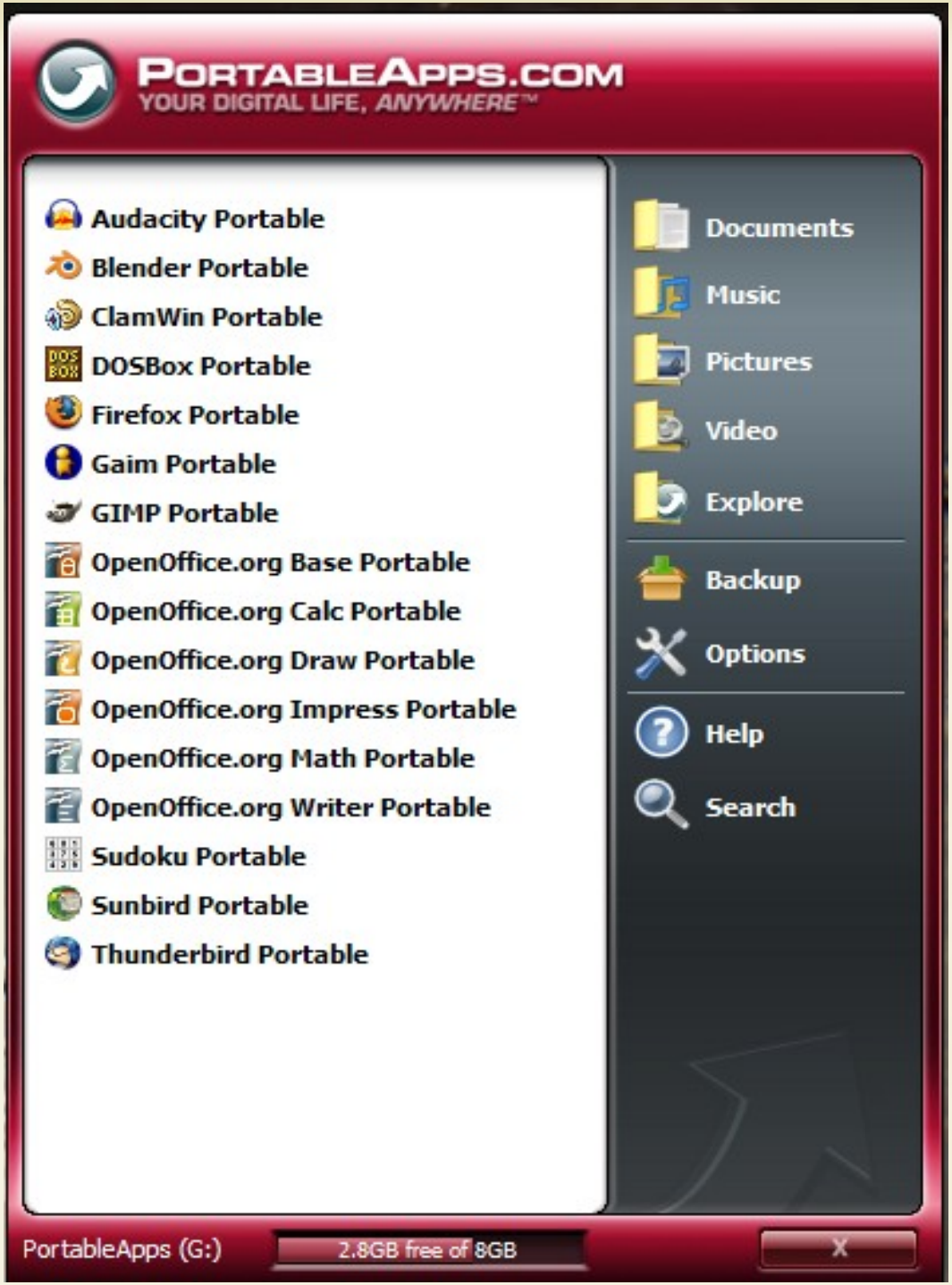
E-mail

Thunderbird

ClamWin

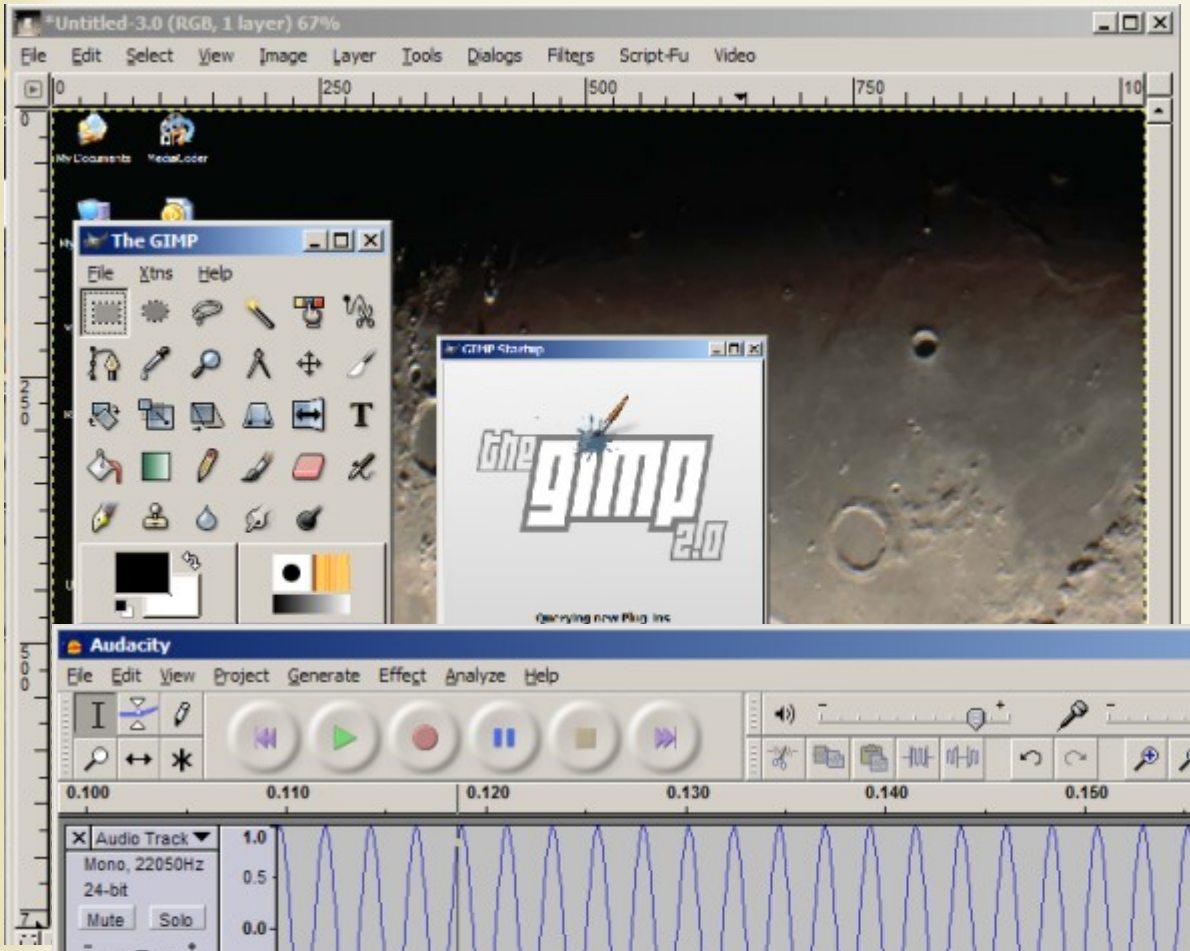
Portable Apps

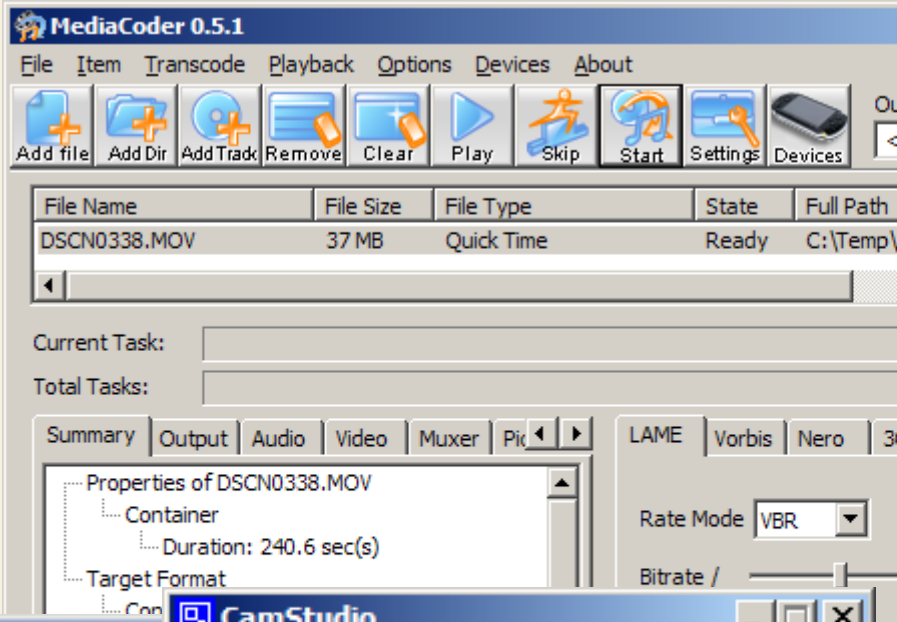
Carry your favorite applications and operating system on a (USB) stick

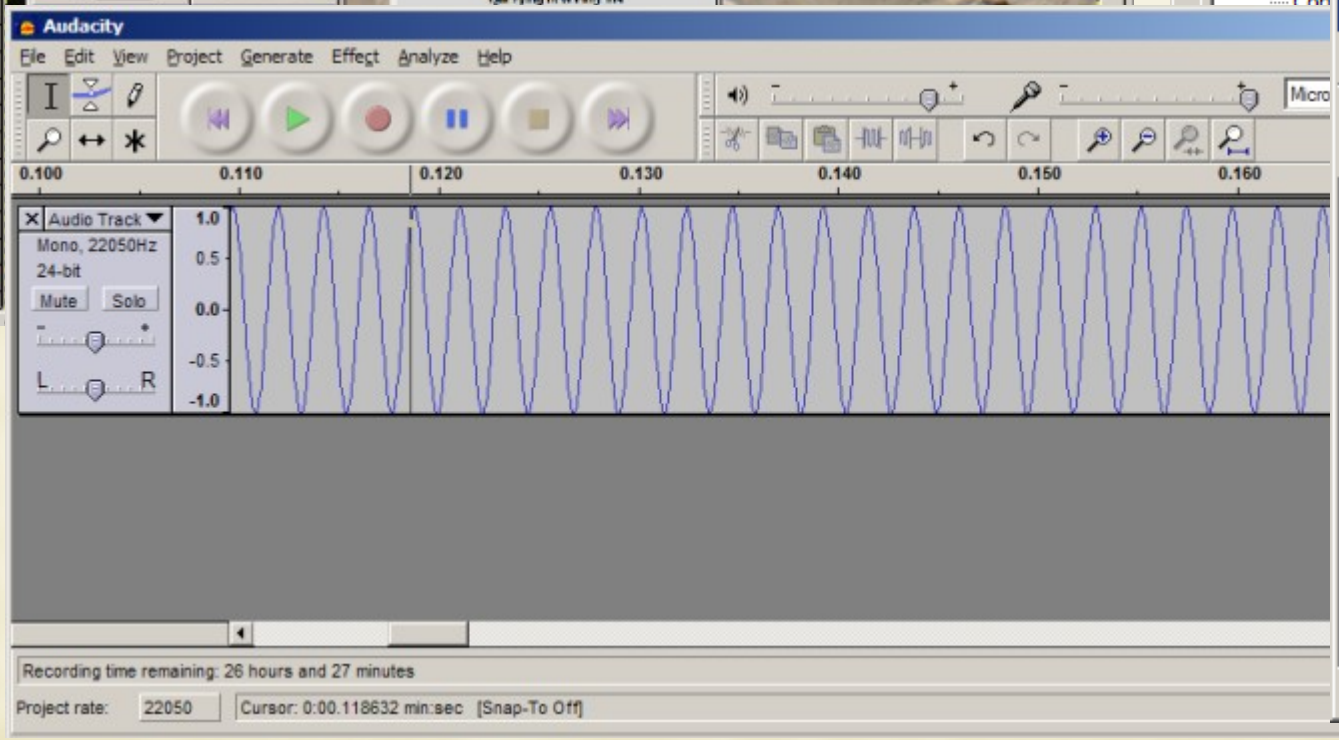


Multimedia-

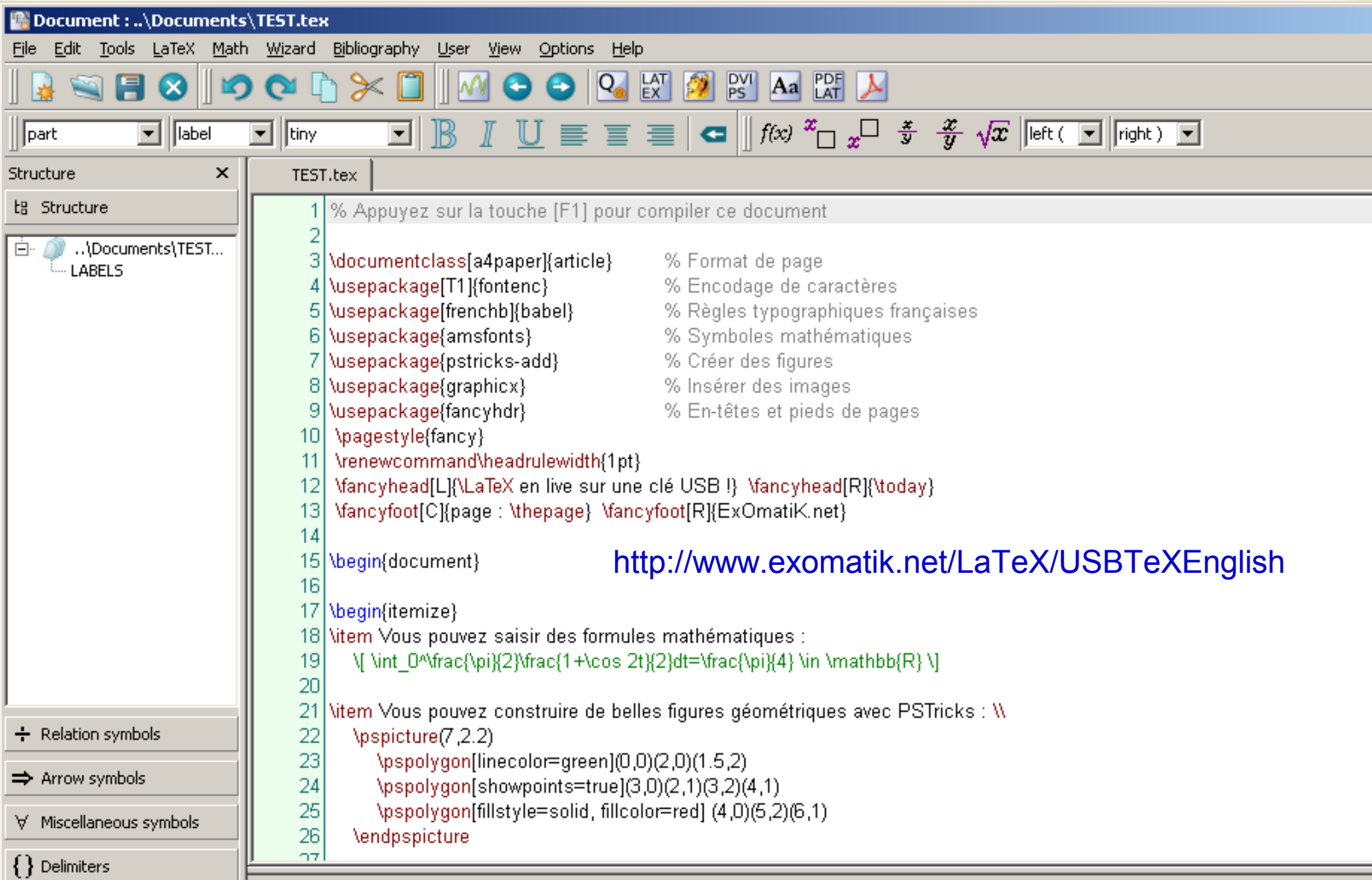
GIMP, Audacity, Mediacoder, CamStudio







USB TeX – on the go



Linux OS

Developed in response to proprietary UNIX

Users needed a complete Unix-compatible software system

"I'm doing a (free) operating system (just a hobby, won't be big and professional like gnu)..." - Linus Torvalds, 1991 (Torvalds)

Linux & GNU worked to provide fully functional and free operating system

Portable Operating Systems

http://www.pendrivelinux.com/

Mathematics Software - Survey

Reduce 1960s/1968

Macsyma 1968/1978
/Maxima 1998 (1982 version)

Axiom 1971/2002

MuMath 1970s/1980
/Derive 1988
/TI-Nspire 2006

MATLAB late 70's/1984

Maple 1979/1985

Cayley (1982-1993)
/Magma 1990/1993

MathCAD 1985

Mathematica 1986/1988
PARI/GP 1985

GAP 1986

MuPad 1989/92

Fermat 1985/1993

LiveMath – 1999
/Expressionist/Theorist
/Mathview & MathPlus

Python 1991, VPython 2000, IPython 2005, SymPy 2006, matplotlib, ...

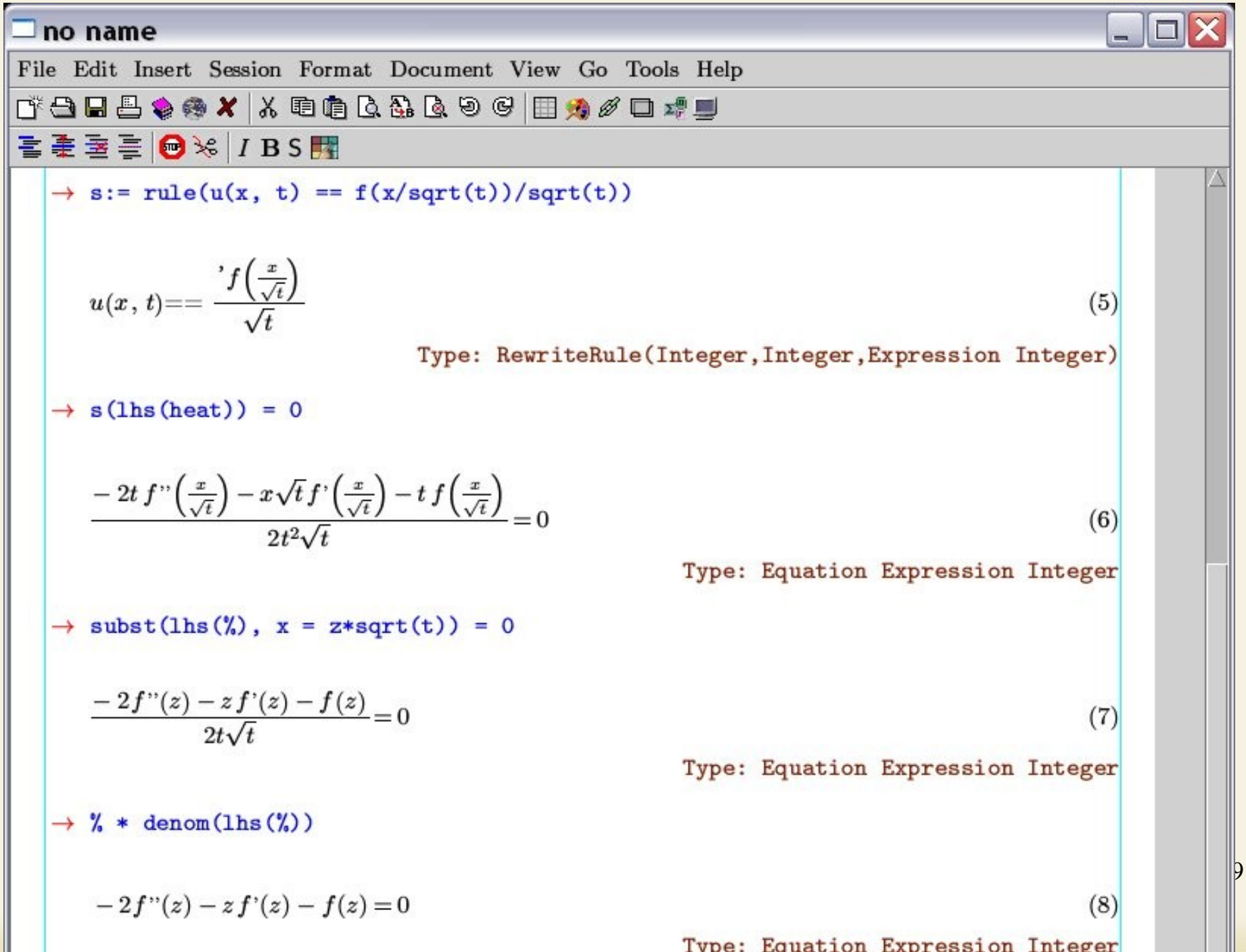
SAGE Feb 24, 2005

http://en.wikipedia.org/wiki/Comparison_of_computer_algebra_systems

Open Source Mathematics

- Computer Algebra Systems
- Numerical Computing
- Programming
- Geometry
- Number Theory
- Graphics
- Mathematics Environments

Axiom


no name
File Edit Insert Session Format Document View Go Tools Help
I B S
→ s:= rule(u(x, t) == f(x/sqrt(t))/sqrt(t))
$$u(x,t) == \frac{'f\left(\frac{x}{\sqrt{t}}\right)}{\sqrt{t}} \quad (5)$$
Type: RewriteRule(Integer,Integer,Expression Integer)
→ s(lhs(heat)) = 0
$$\frac{-2t\,f''\left(\frac{x}{\sqrt{t}}\right) - x\sqrt{t}\,f'\left(\frac{x}{\sqrt{t}}\right) - t\,f\left(\frac{x}{\sqrt{t}}\right)}{2t^2\sqrt{t}} = 0 \quad (6)$$
Type: Equation Expression Integer
→ subst(lhs(%), x = z*sqrt(t)) = 0
$$\frac{-2f''(z) - z\,f'(z) - f(z)}{2t\sqrt{t}} = 0 \quad (7)$$
Type: Equation Expression Integer
→ % * denom(lhs(%))
$$-2f''(z) - z\,f'(z) - f(z) = 0 \quad (8)$$
Type: Equation Expression Integer

Maxima

Maxima Manual - Matrices and Linear Algebra

File Edit Options Maxima Help

```
A:matrix([1,2],[3,4]);
                                  [ 1  2 ]
(D1)                              [      ]
                                  [ 3  4 ]

(C2)
DETERMINANT(A);
(D2)                                 - 2
(C3)
B:matrix([1,5.3,7],[5,4,0],[1,0,0]);
                                 [ 1  5.3  7 ]
                                 [           ]
(D3)                             [ 5   4   0 ]
                                 [           ]
                                 [ 1   0   0 ]
(C4)
ECHELON(D3);

RAT replaced 5.3 by 53//10 = 5.3
                                  [ 1  0  0 ]
                                  [         ]
(D4)                              [ 0  1  0 ]
                                  [         ]
                                  [ 0  0  1 ]
(C5)
```

File Back Forward Edit Options Url: file:/C:/PROGRA~1/Maxima/share/maxima/592E9D~1.0/doc/html/maxima_26.html

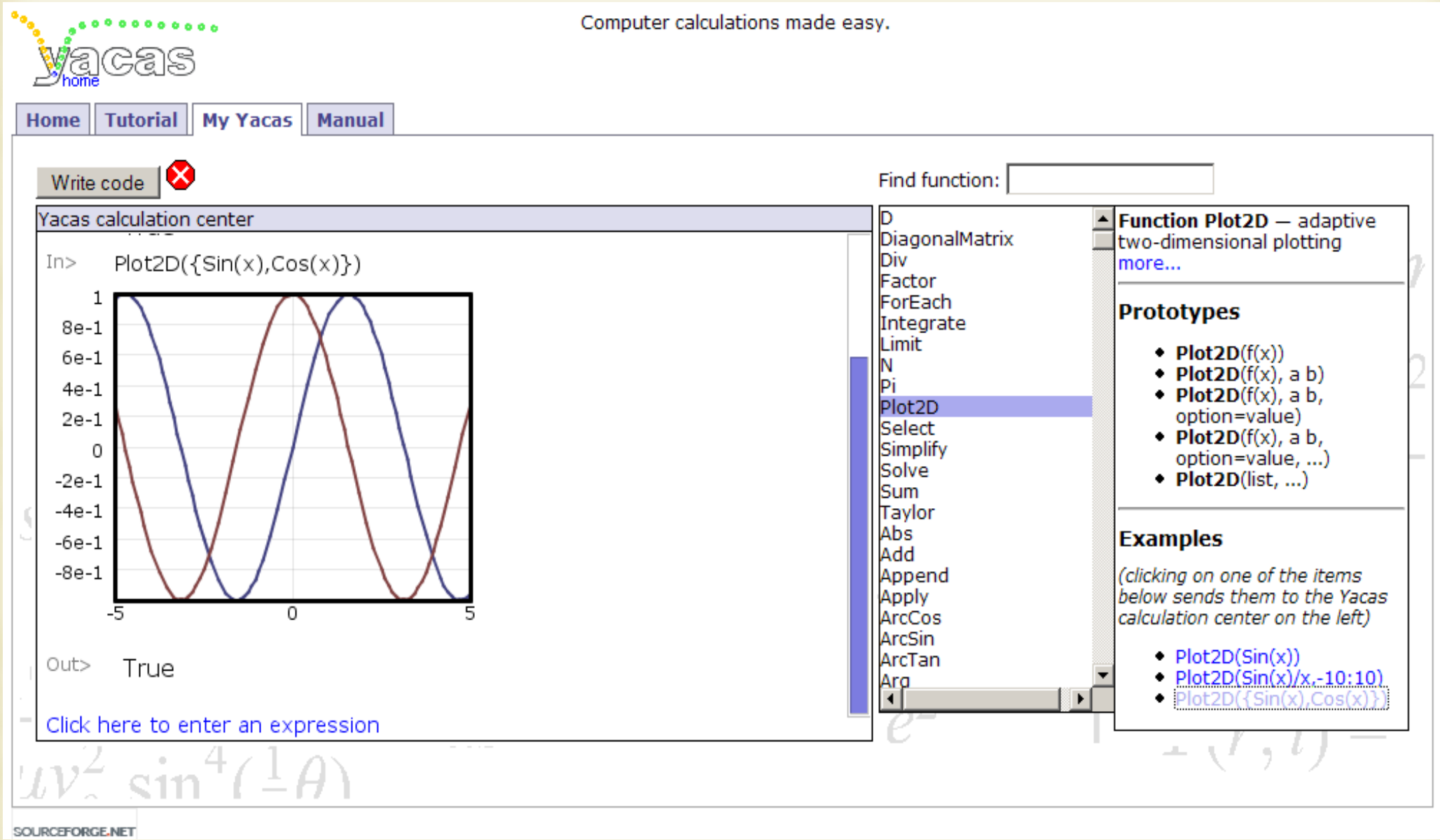
Variable: **DOTIDENT**
default: [1] The value to be returned by X^^0.

Variable: **DOTSCRULES**
default: [FALSE] when TRUE will cause A.SC or SC.A to simplify to SC*A and A.(SC*B) to simplify to SC*(A.B)

Function: **ECHELON** *(M)*
produces the echelon form of the matrix M. That is, M with elementary row operations performed on it such that the first non-zero element in each row in the resulting matrix is
column elements under the first one in each row are all zero.

```
                          [2  1 - A  -5 B ]
```

Yacas


yacas home
Computer calculations made easy.
Home
Tutorial
My Yacas
Manual
Write code
Find function:
Yacas calculation center
In> Plot2D({Sin(x),Cos(x)})
1
8e-1
6e-1
4e-1
2e-1
0
-2e-1
-4e-1
-6e-1
-8e-1
-5
0
5
Out> True
Click here to enter an expression
D
DiagonalMatrix
Div
Factor
ForEach
Integrate
Limit
N
Pi
Plot2D
Select
Simplify
Solve
Sum
Taylor
Abs
Add
Append
Apply
ArcCos
ArcSin
ArcTan
Arg
Function Plot2D — adaptive two-dimensional plotting
more...
Prototypes
Plot2D(f(x))
Plot2D(f(x), a b)
Plot2D(f(x), a b, option=value)
Plot2D(f(x), a b, option=value, ...)
Plot2D(list, ...)
Examples
(clicking on one of the items below sends them to the Yacas calculation center on the left)
Plot2D(Sin(x))
Plot2D(Sin(x)/x,-10:10)
Plot2D({Sin(x),Cos(x)})
SOURCEFORGE.NET

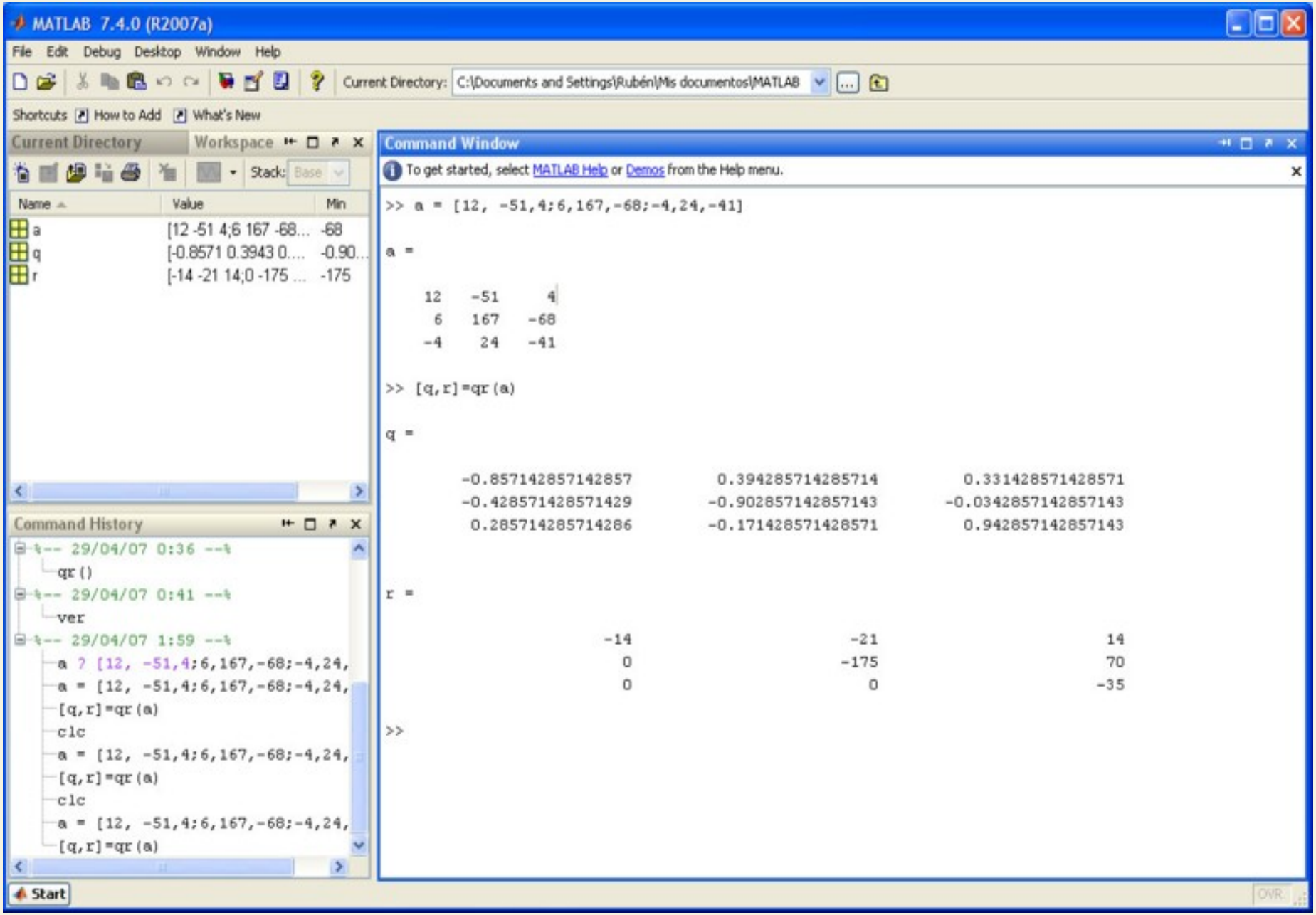
Mathomatic

xterm

```
1-> ; This is the famous Bailey-Borwein-Plouffe (BBP) algorithm.
1-> ; Sum this n = 0 to infinity to compute pi.
1-> ; This is especially useful for calculating pi in hexadecimal.
1-> ; One hexadecimal digit of pi is generated with each iteration.
1->
1-> ((4/((8*n) + 1)) - (2/((8*n) + 4)) - (1/((8*n) + 5)) - (1/((8*n) + 6)))/(16^n)

          4             2             1             1
     (---------- - ---------- - ---------- - ----------)
      ((8*n) + 1)   ((8*n) + 4)   ((8*n) + 5)   ((8*n) + 6)
#1: ------------------------------------------------------
                            (16^n)

1-> simplify

                       ((120*(n^2)) + (151*n) + 47)
#1: ------------------------------------------------------------------
    ((16^n)*((512*(n^4)) + (1024*(n^3)) + (712*(n^2)) + (194*n) + 15))

1-> sum n 0 10 ; Sum as n goes from 0 to 10.

#2: 3.1415926535898

1-> pi ; Verify that the digits are the same.
 answer = 3.1415926535898

1-> x^n/n! ; Sum this n = 0 to infinity to compute (e^x).

    (x^n)
#3: -----
    (n!)

3-> replace x with 1 ; Sum this n = 0 to infinity to compute e:

     1
#3: ----
```

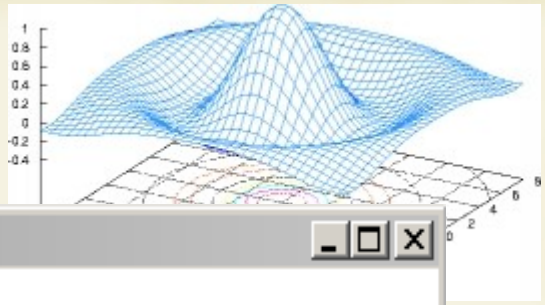
http://mathomatic.org/math/

MATLAB Wanna Be's

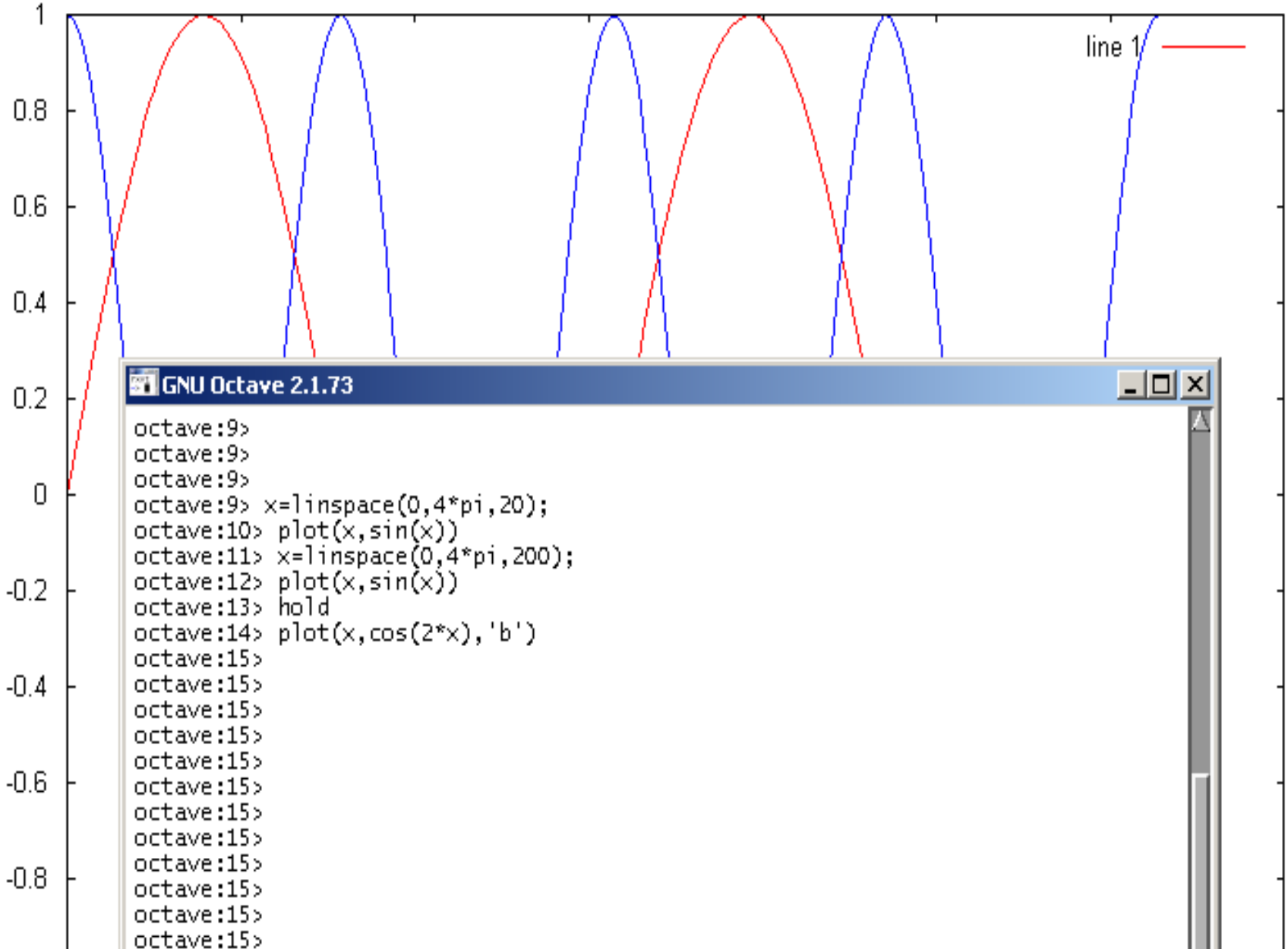


GNU Octave

http://www.gnu.org/software/octave/



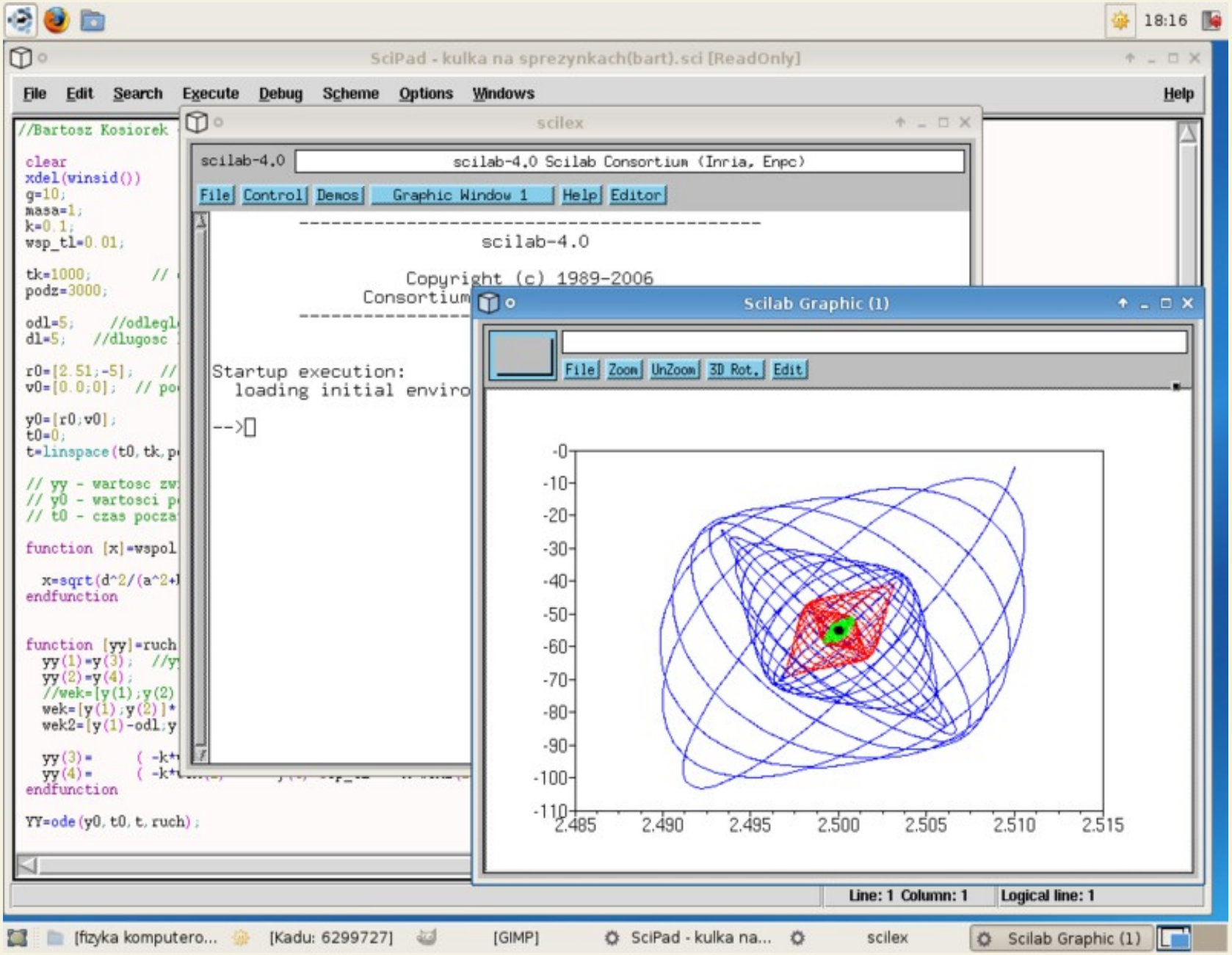
gnuplot graph



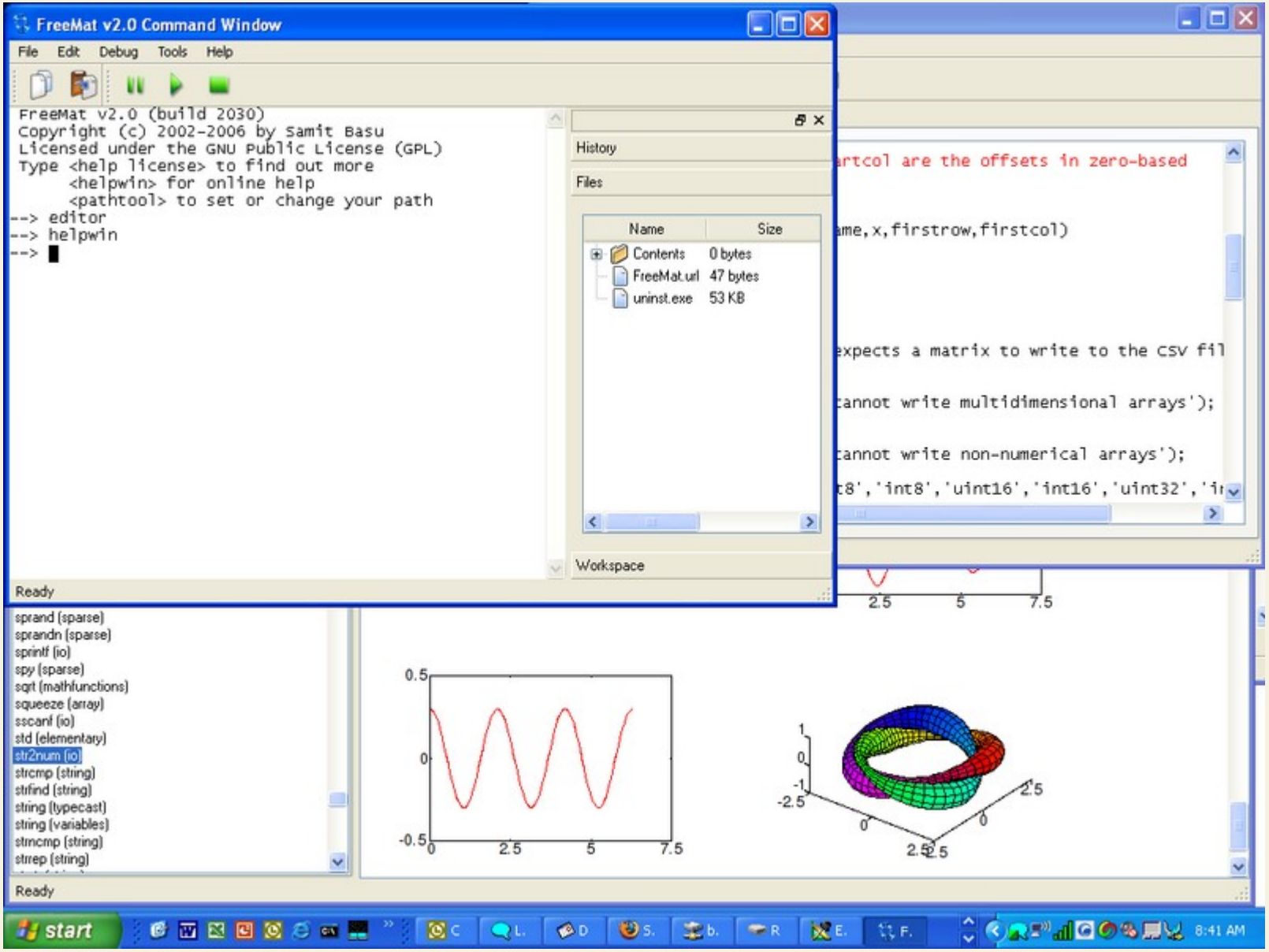
GNU Octave 2.1.73

```
octave:9>
octave:9>
octave:9>
octave:9> x=linspace(0,4*pi,20);
octave:10> plot(x,sin(x))
octave:11> x=linspace(0,4*pi,200);
octave:12> plot(x,sin(x))
octave:13> hold
octave:14> plot(x,cos(2*x),'b')
octave:15>
octave:15>
octave:15>
octave:15>
octave:15>
octave:15>
octave:15>
octave:15>
octave:15>
octave:15>
octave:15>
octave:15>
```

Scilab

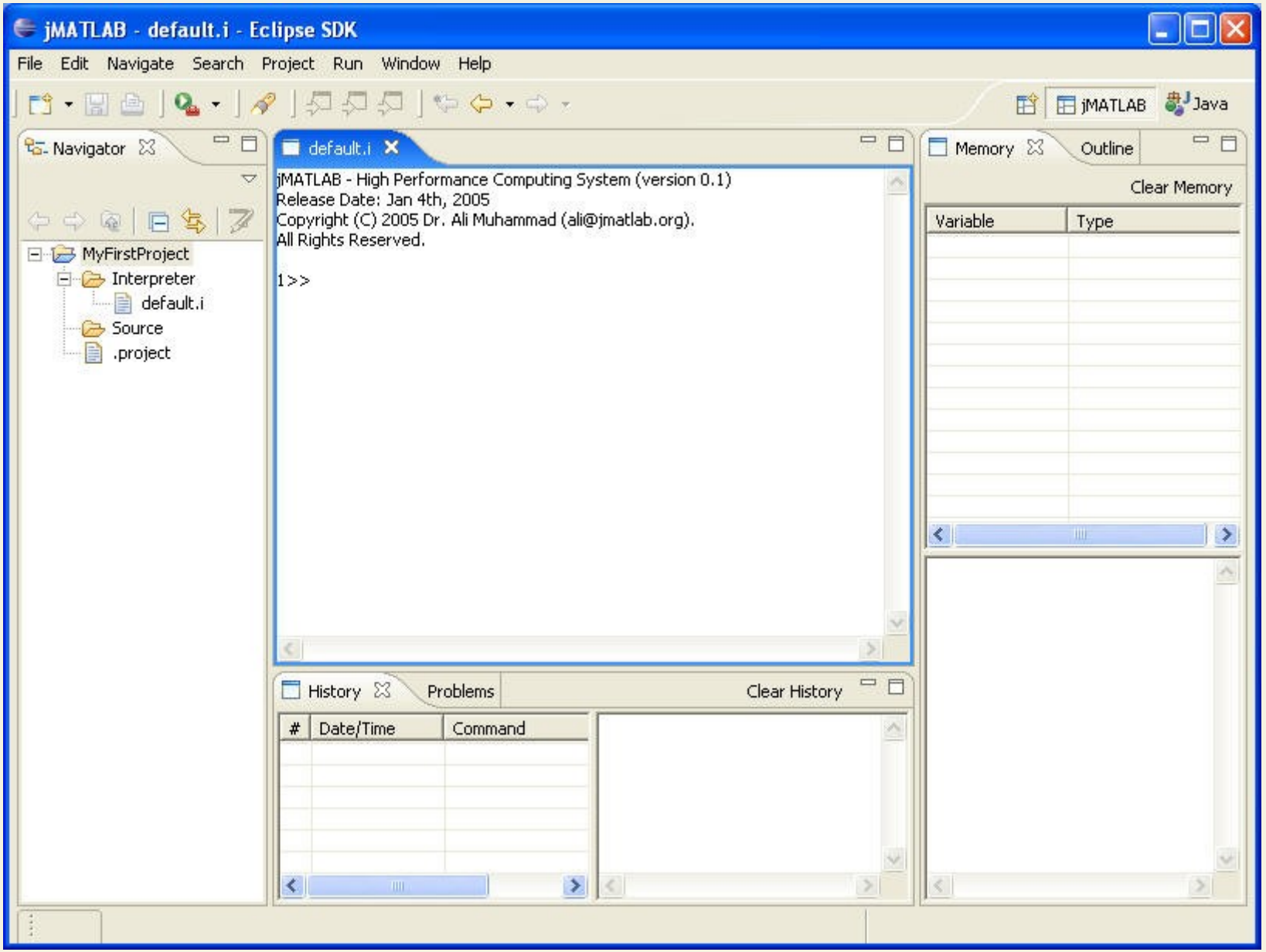

SciPad - kulka na sprezynkach(bart).sci [ReadOnly]
File Edit Search Execute Debug Scheme Options Windows Help
scilex
scilab-4.0
scilab-4.0 Scilab Consortium (Inria, Enpc)
File Control Demos Graphic Window 1 Help Editor
scilab-4.0
Copyright (c) 1989-2006
Consortium
Startup execution:
loading initial enviro
-->
Scilab Graphic (1)
File Zoom UnZoom 3D Rot. Edit
Line: 1 Column: 1
Logical line: 1

FreeMat



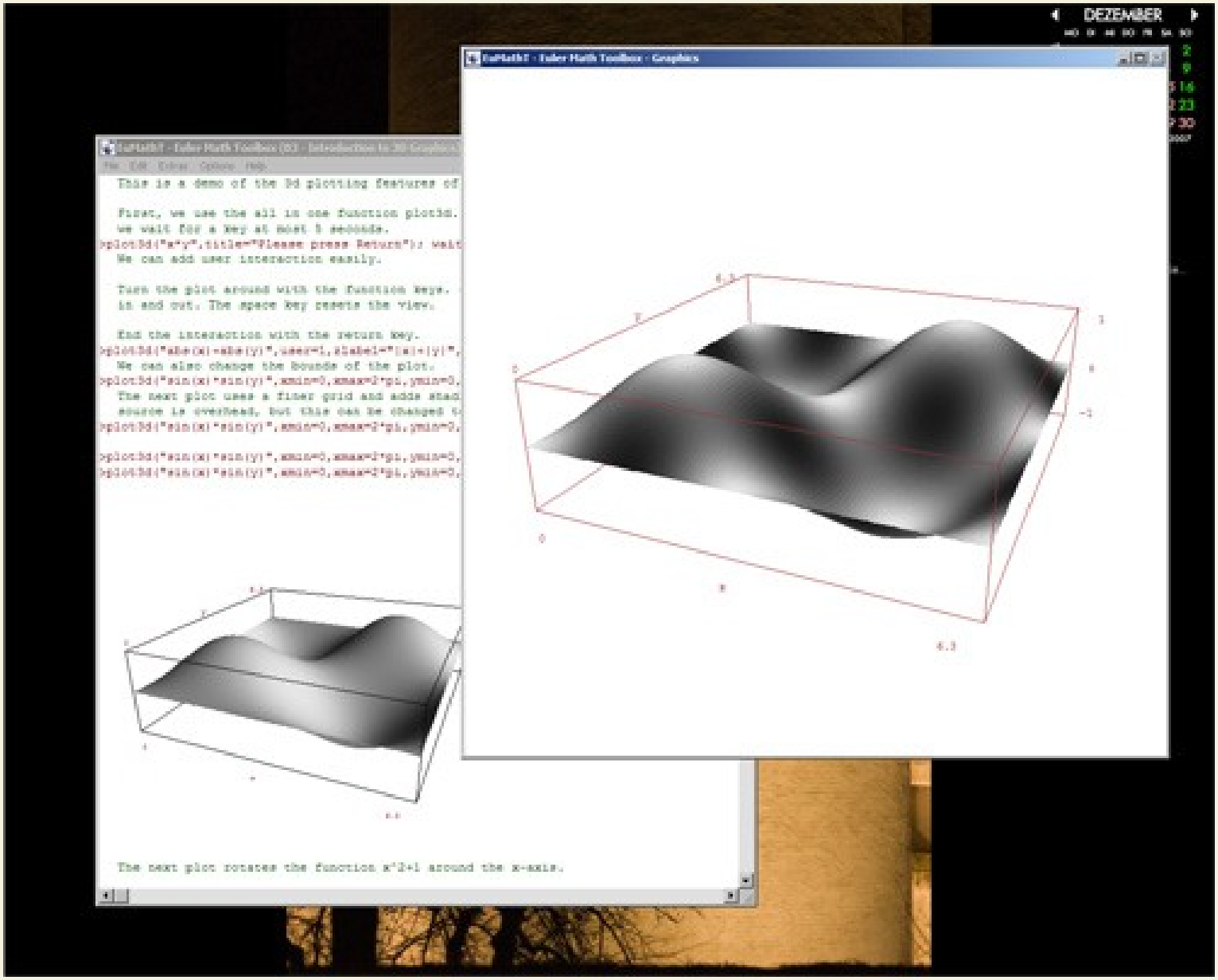
http://freemat.sourceforge.net/wiki/index.php/Main_Page

jMatlab



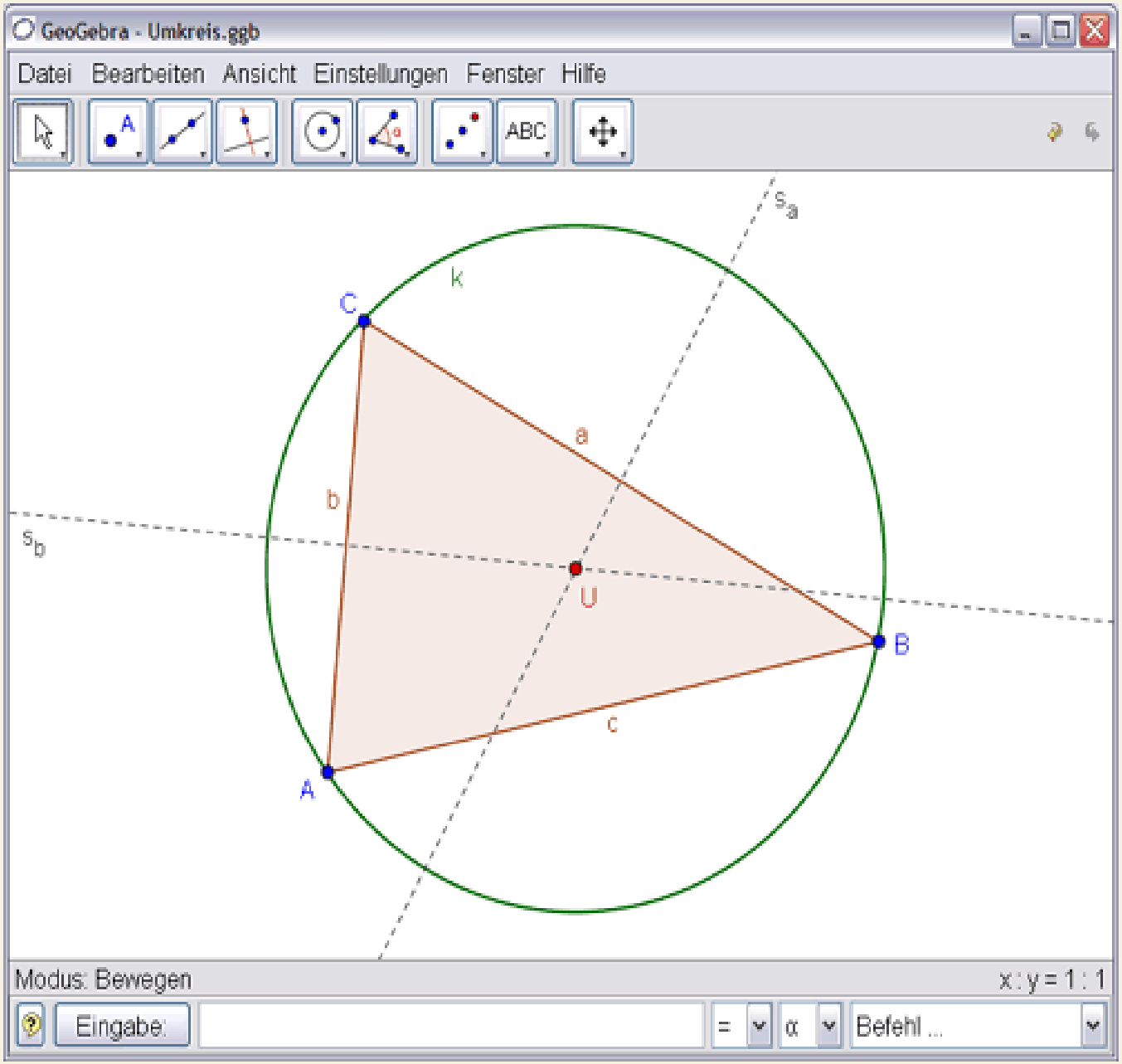
http://www.jmatlab.org/

Euler

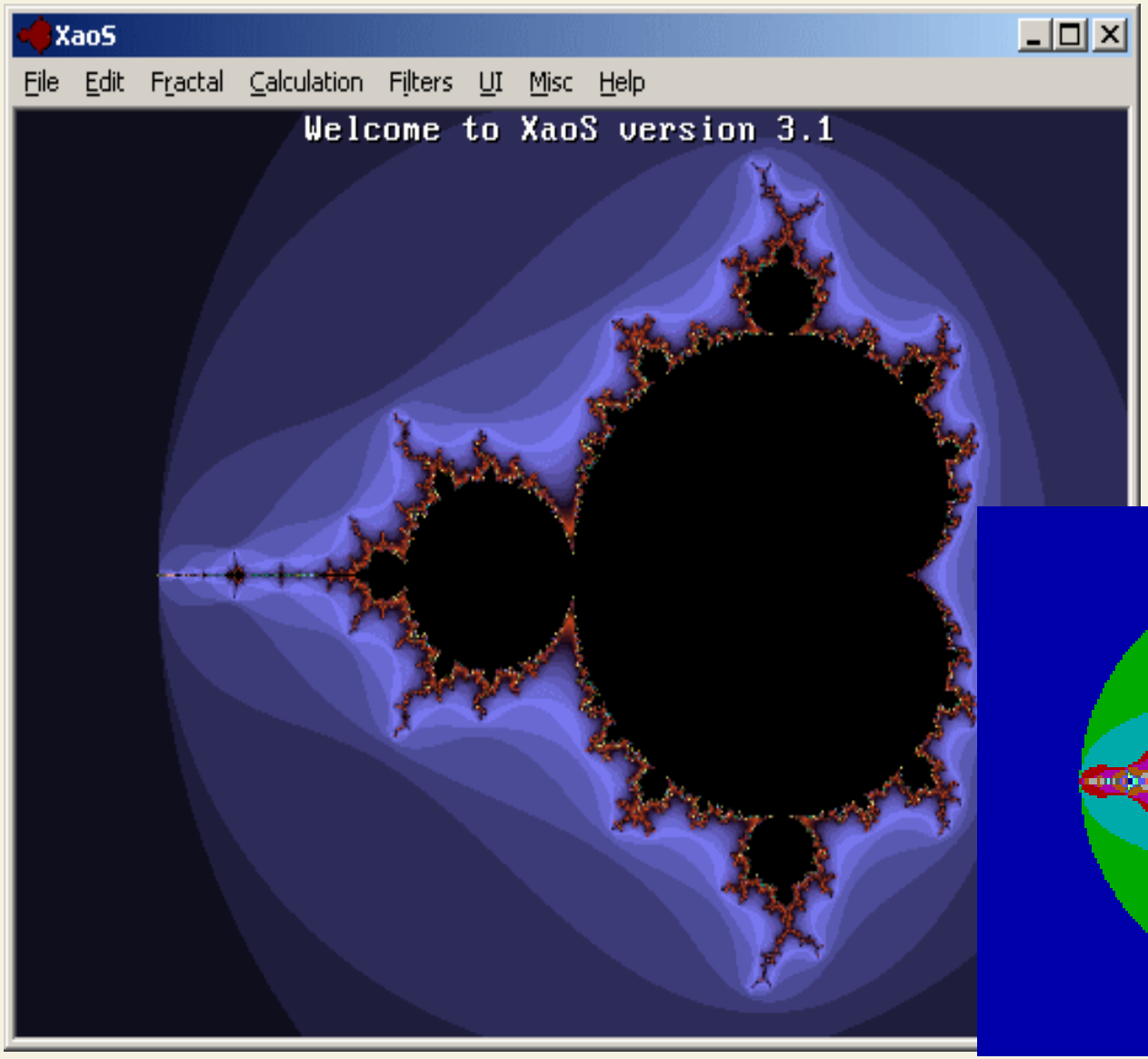


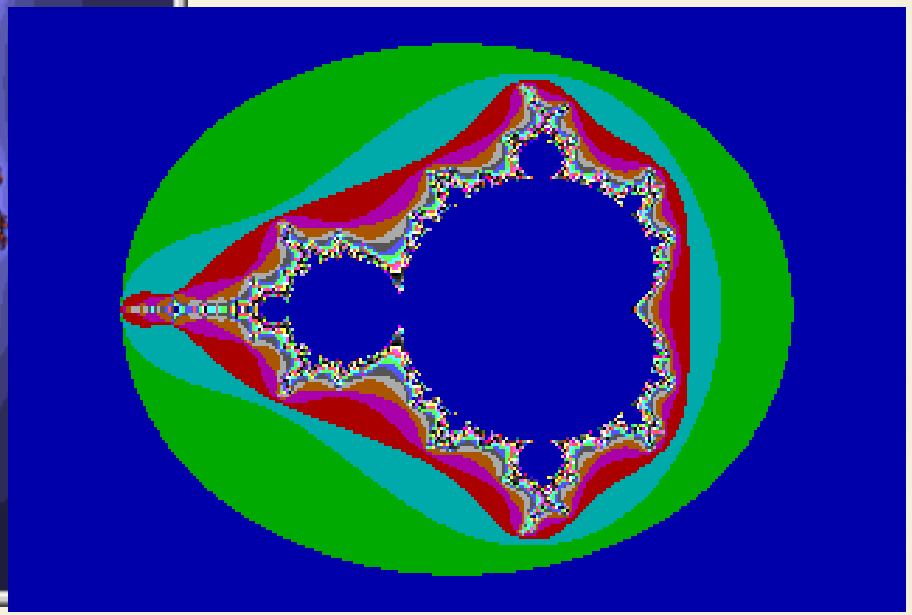
http://mathsrv.ku-eichstaett.de/MGF/homes/grothmann/euler/index.html

GeoGebra


GeoGebra - Umkreis.ggb
Datei Bearbeiten Ansicht Einstellungen Fenster Hilfe
ABC
s_a
k
C
a
b
s_b
U
B
c
A
Modus: Bewegen
x : y = 1 : 1
Eingabe:
=
α
Befehl ...

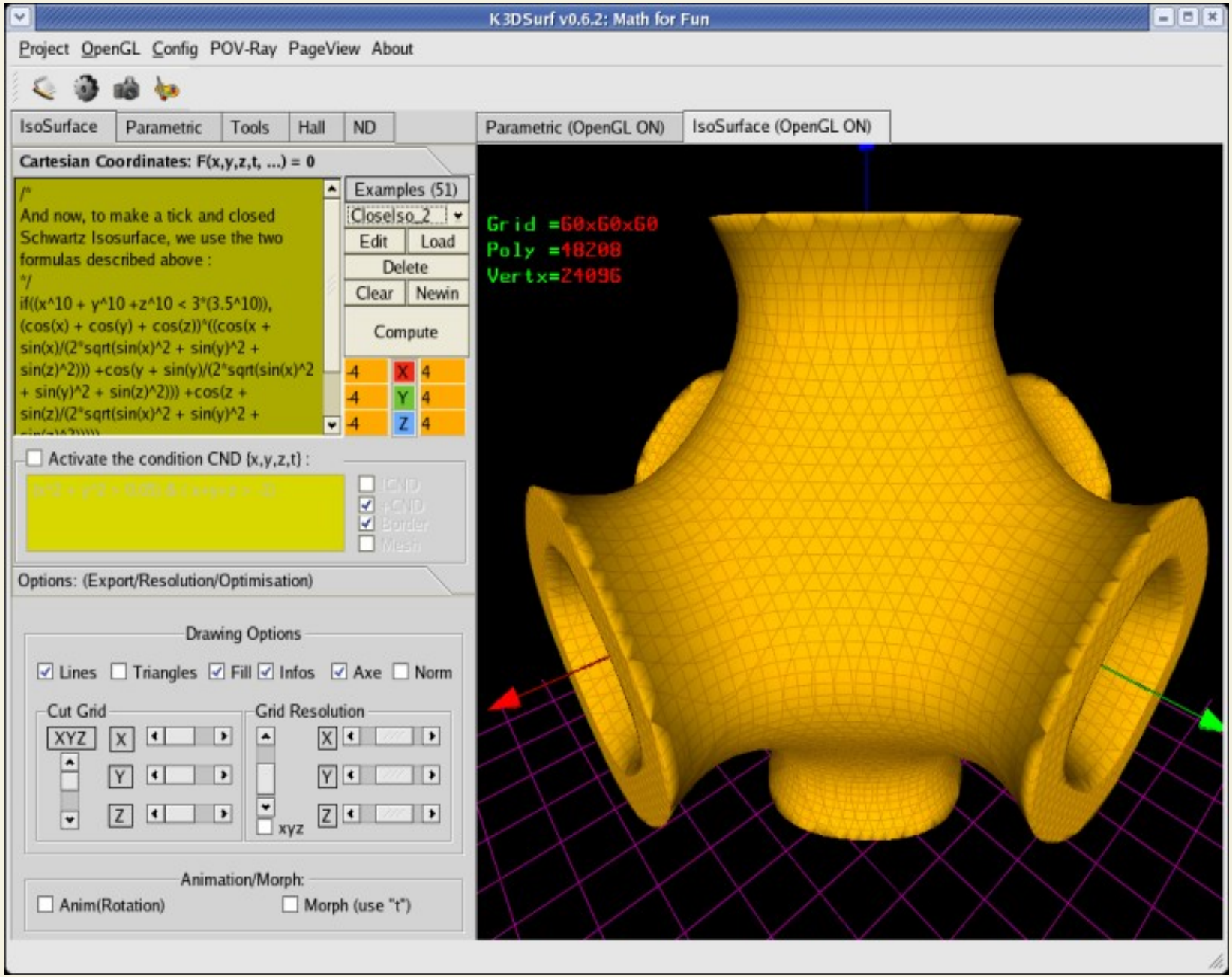
Fractint and Xaos





http://wmi.math.u-szeged.hu/xaos/doku.php http://spanky.triumf.ca/www/fractint/fractint.html

K3DSurf



http://k3dsurf.sourceforge.net/

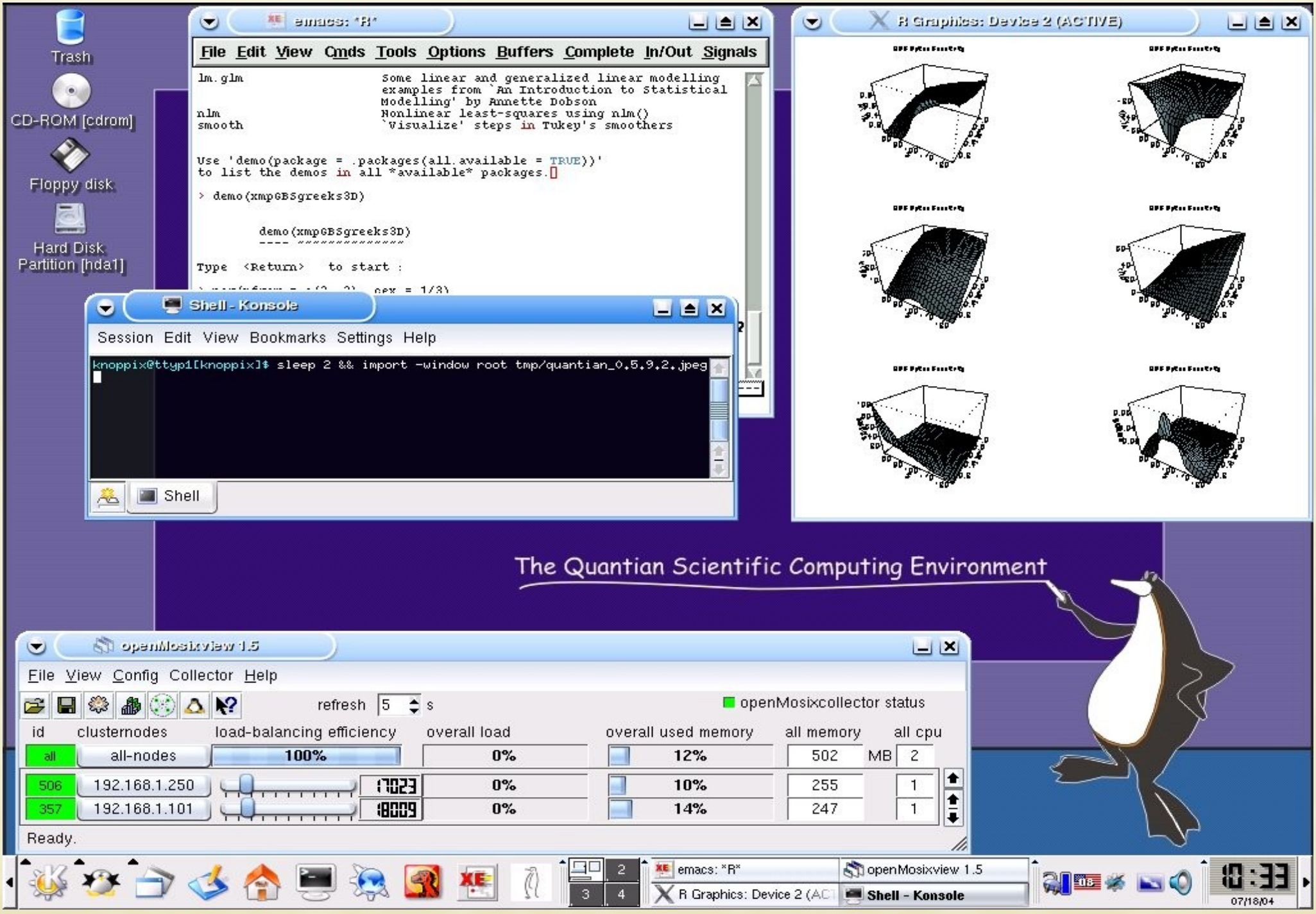
And more ...

- Pari/GP http://pari.math.u-bordeaux.fr/
- GAP http://www.gap-system.org/
- Macaulay 2 http://www.math.uiuc.edu/Macaulay2/
- Singular http://www.singular.uni-kl.de/
- The R Project http://www.r-project.org/

Can projects be bundled together?

Quantian - Linux

http://dirk.eddelbuettel.com/quantian.html



SAGE

http://www.sagemath.org/

Shell - sage dev

Session Edit View Bookmarks Settings Help

```
|  SAGE Version 0.9.26, Build Date: 2005-12-23-0959                |
|  Distributed under the terms of the GNU General Public License   |
|  For help type <object>?, <object>??, %magic, or help            |
--------------------------------------------------------------------

sage: E = EllipticCurve(GF(5),[0,0,1,-1,0])
sage: maxima_console()
Maxima 5.9.2 http://maxima.sourceforge.net
Using Lisp GNU Common Lisp (GCL) GCL 2.6.7 (aka GCL)
Distributed under the GNU Public License. See the file COPYING.
Dedicated to the memory of William Schelter.
This is a development version of Maxima. The function bug_report()
provides bug reporting information.
(%i1) laplace(sin(a*t),t,s);

                                    a
(%o1)                          -------
                                2    2
                               s  + a
(%i2) plot2d (sec(x), [x, -2, 2], [y, -20, 20], [nticks, 200]);

(%o2)
sage: E.abelian_group()
(Abelian Group with invariants [8], ((4 : 0 : 1),))
sage: singular_console()
                     SINGULAR                             /  Development
 A Computer Algebra System for Polynomial Computations   /   version 3-0-1
                                                       0<
     by: G.-M. Greuel, G. Pfister, H. Schoenemann        \   October 2005
FB Mathematik der Universitaet, D-67653 Kaiserslautern    \
> ring r = 0,(x,y),dp; poly f = 9x16-18x13y2; factorize(f);
[1]:
   _[1]=-9
   _[2]=x
   _[3]=-x3+2y2
[2]:
   1,13,1
> Auf Wiedersehen.
sage: E.points()

[(0 : 1 : 0),
 (0 : 0 : 1),
 (0 : 4 : 1),
 (1 : 0 : 1),
 (1 : 4 : 1),
 (2 : 2 : 1),
 (4 : 0 : 1),
 (4 : 4 : 1)]
sage: gap_console()
GAP4, Version: 4.4.6 of 02-Sep-2005, x86_64-unknown-linux-gnu-gcc
gap> G:=SpecialUnitaryGroup(4,2); Size(G);
SU(4,2)
```

SAGE: Software for Algebra and Geometry Experimentation - Mozilla

File Edit View Go Bookmarks Tools Window Help

http://modular.ucsd.edu/ Search

Home Bookmarks MIDS Google gpwise GAP-dev GUAVA2.5

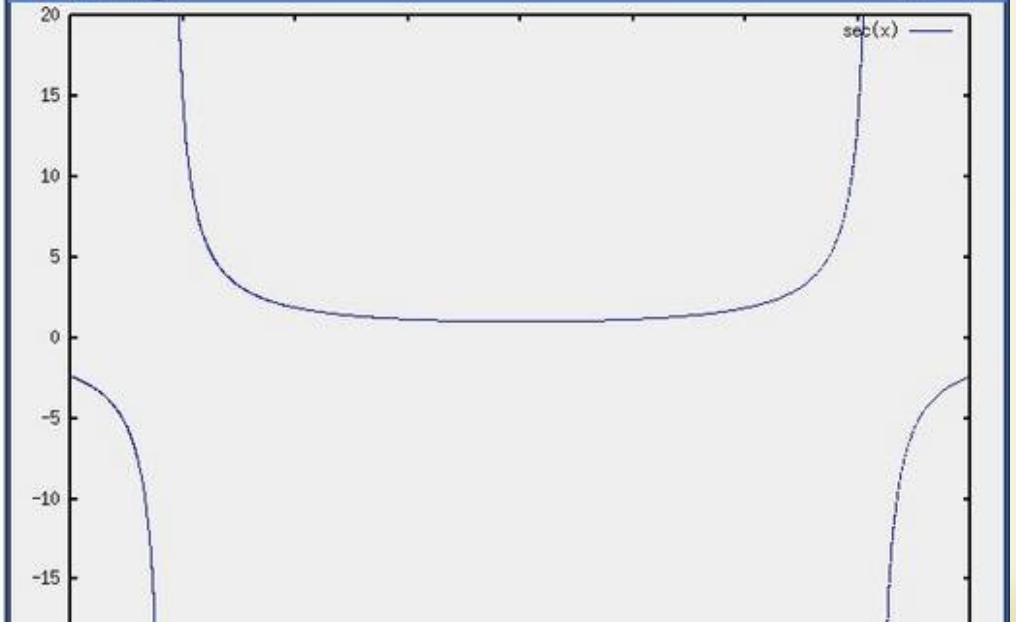
SAGE: So... Maxima ... Index of ... Singular ... SourceFo...

SAGE

Software for Algebra and Geometry Experimentation

By William Stein and MANY CONTRIBUTORS

Gnuplot



From the SAGE Page

"... for studying a huge range of mathematics, including **algebra, calculus, elementary to very advanced number theory, cryptography, numerical computation, commutative algebra, group theory, combinatorics, graph theory, and exact linear algebra**."

"... support a viable open source **alternative to Magma, Maple, Mathematica, and MATLAB**. SAGE includes many high-quality open source math packages."

"... use most mathematics software together. SAGE includes **interfaces to Magma, Maple, Mathematica, MATLAB, and MuPAD**, and the free programs **Axiom, GAP, GP/PARI, Macaulay2, Maxima, Octave, and Singular**."

Use Online- https://www.sagenb.org/

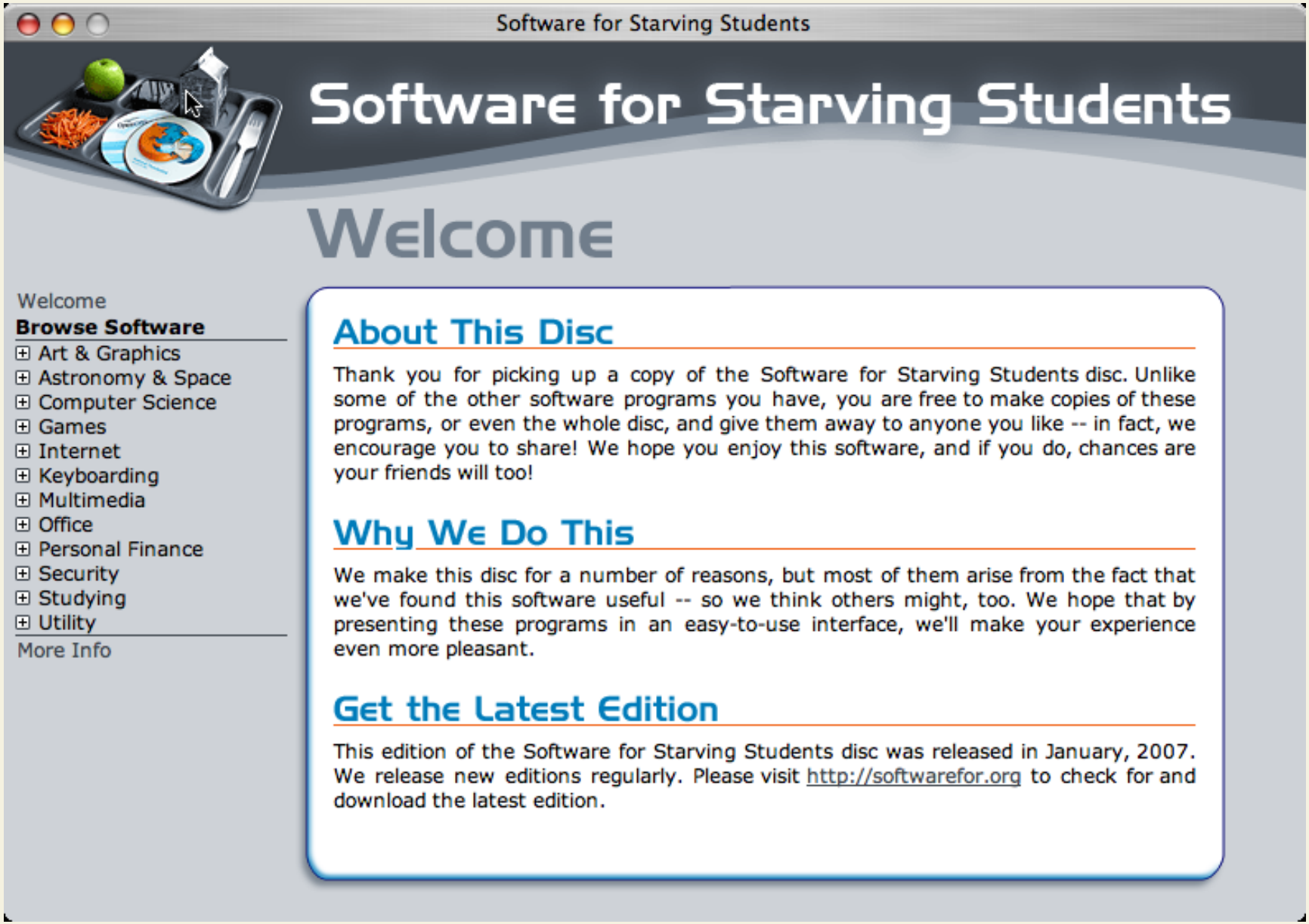
Advantages of Open Source

- Less Expensive
- Smaller in size
- Quick bug fixes
- Transparency allows quick security updates

Disadvantages of Open Source

- Stability
- Security
- Installation
- Poor Interactivity – important in education
- Poor integration with Microsoft
- No customer service
- No warranty

Software for Starving Students



Thank You!

Dr. Russell Herman

Dr. Gabriel Lugo

UNC Wilmington

PDF of this talk and links:
http://russherman.com/Talks/OpenSource.pdf
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Links

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