Open Source Software for Higher Mathematics

An Overview of Available Tools

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http://www.CJFearnley.com/higher.math.and.open.source.pdf

Notable Quotable

Dare to be Naïve!

— Buckminster Fuller

Statement of the Problem

Finding The Open Source "Mathematica" or "Maple" for Linux

My Requirements

- Numeric calculator
- Symbolic calculator (can do algebra)
- Solve systems of equations, differential equations, and differentiate and integrate functions
- Matrices, modular arithmetic, fractions, number theory, etc.
- Facility for defining groups, rings, fields and other abstract mathematical objects
- Graph functions
- Interactive, but with a programming capability (like the shell)

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A Litany of Choices

- Inadequate: bash, bc, dc, calc (apcalc in Debian), aribas
- Too Specialized

regina	3-manifold topology
snappea	hyperbolic 3-manifolds
geomview	interactive geometry viewing program
magnus	Computational group theory
r-base	GNU R statistical computing language and environment

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The Also Rans

Good enough for many things

mathomatic	portable computer algebra system
euler	portable computer algebra system
octave	GNU Octave language for numerical computations (mostly Matlab (R) compatible)
scilab	Matrix-based scientific software (resembles Matlab)

These are Good

These meet my needs, but we can do better

gap Groups, Algorithms, and Programming (focus: group theory)

pari-gp PARI/GP Computer Algebra System (focus: number theory)

yacas Yet Another Computer Algebra System (focus: flexible, modern infrastructure)

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Maxima
Sophisticated Computer Algebra System

Maxima

- Derived from DOE Macsyma, which had its origins in the late 1960s at MIT
- William Schelter (deceased) got DOE permission to release under the GNU GPL in 1998
- excellent graphics
- Seems to have the best community of all systems
- The acronym Maxima is the corruption of the main project name MACSYMA, which stands for Project MAC's SYmbolic MAnipulation System. MAC itself is an acronym, usually cited as meaning Man and Computer or Machine Aided Cognition. The name MACSYMA is now trademarked by Macsyma Inc.
- Commercial derivatives of MACSYMA in the 1980s were one of Richard Stahlman's motivations for creating project GNU.

Axiom
A fairly complete computer algebra system

Axiom

- Initiated in 1971 as "Scratchpad" at IBM under Richard D. Jenks (deceased)
- September 3, 2002 Axiom was released as free software by NAG (Numerical Algorithms Group) which purchased it from IBM in the 1990s
- "The crucial strength of Axiom lies in its excellent structural features and unlimited expandability—it is open, modular system designed to support an ever growing number of facilities with minimal increase in structural complexity." — From the Forward to the Axiom Book
- Huge library of functions
- Graphics are broken in Debian package (and upstream)
- Other little annoyances from its newness as Open Source
- 1140 page manual

Axiom Example

```
-- run in axiom(1) with the command
-- )read fermat.little.axiom.input

)clear all

topprimetotest: Integer := 341
topintegerbasetotest: Integer := 10
n: Integer := 340
x: Any
repeat
  if n = topprimetotest then break
  a: Integer :=2
  n := n+1
  repeat
    if (a >= n) or (a > topintegerbasetotest) then break
    -- If the 2nd and 4th fields are unequal, n is composite.
    --   By Fermat's little theorem: n prime, then n divides a^n - a
    -- Carmichael numbers are composite but pass this prime test
    --   e.g., 561, 1105, 1729
    x := a^n
    output [n,a,x,x:: IntegerMod(n)]
    if a ~= x:: IntegerMod(n) then break
    a := a+1
factor(341)
```

Axiom Output

```
   [341, 2,

    44794894843556084211148845611368885562432909944692990697999782019275837423_
     60321890761754986543214231552
     ,
    2]
   [341, 3,

    49928424197694444115757141151258800743557279941572028730327028529918288938_
     73287975661182639605572486502613841657002635137622031360394139015053716 64_
     3508803196884403
     ,
    168]
                                                                    Type: Void
factor(341)


   (6)  11 31
                                                        Type: Factored Integer
```

Thank You

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Any Questions?

http://www.CJFearnley.com/higher.math.and.open.source.pdf