

Overview of Programs that Provide An Interface to Maxima

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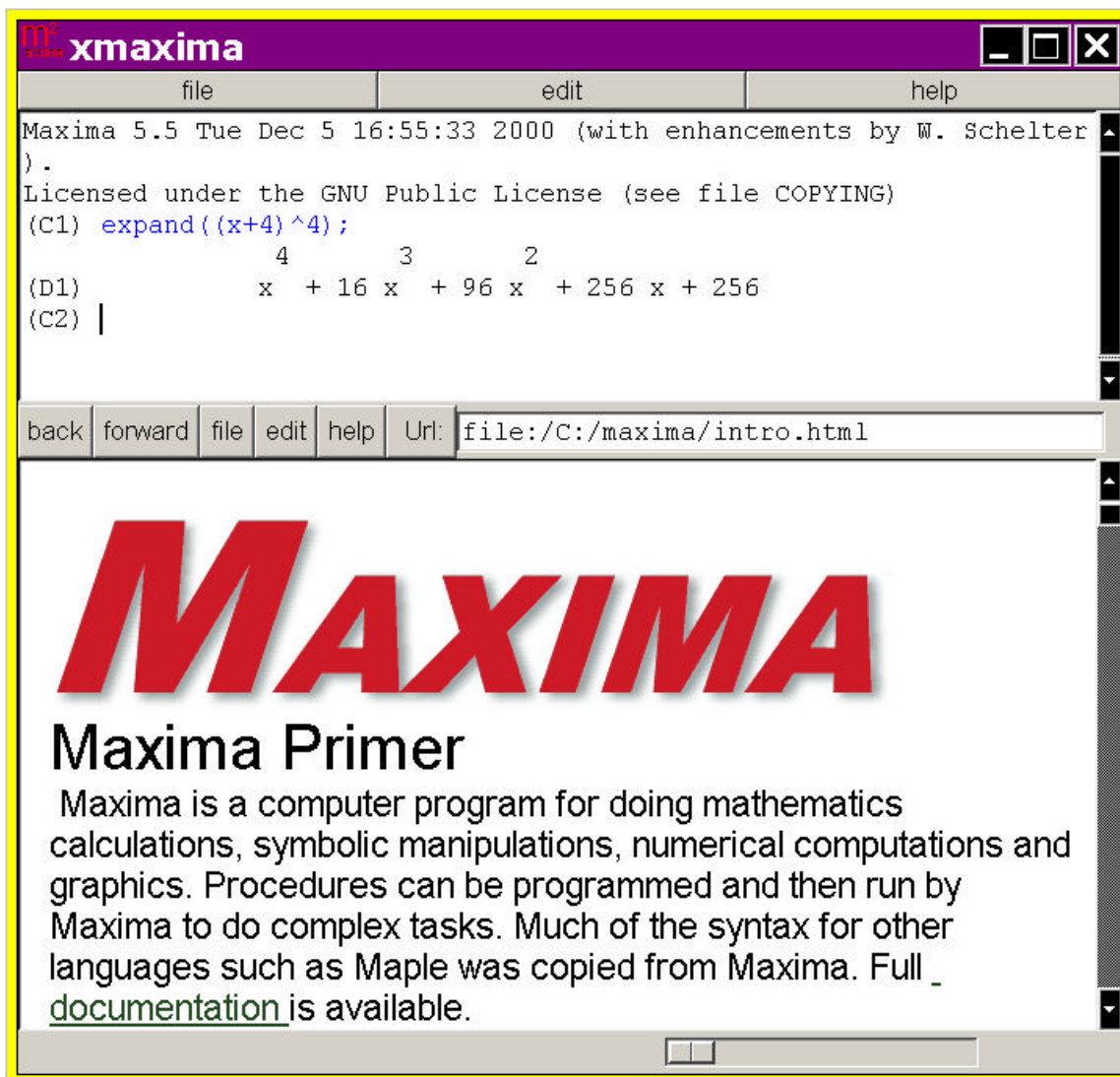
Introduction

Maxima is a free-source version of the Macsyma computer algebra system that has its origins in a research project at MIT in the late 1960's. A brief history of this system is given in an appendix. For our purposes here, we can assume that its "native" interface is an ascii script-like input and output stream, and that users prefer a fancier interface.

Xmaxima

This is the interface that Bill Schelter packaged up for users on a variety of platforms. Notably it works on Windows.

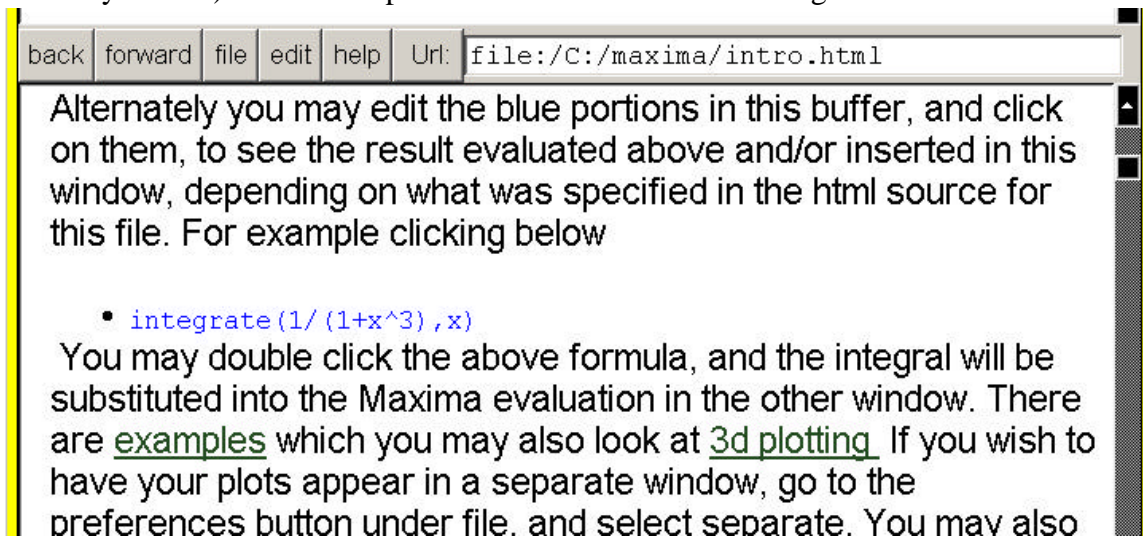
The system starts up in a resizable window split into resizable halves. The top half is a relatively simple script window typical of older interfaces to interactive programs. The bottom half of the window is a web browser.



In the top window there is a command prompt (c1) which invites you to type a command, here “expand((x+4)^4) which you must terminate by a “;” The result of the computation is displayed at a label (d1). Some editing capabilities are available, such as re-execution of a modified command, in which case the new command is placed at the end of the script and re-executed. Parenthesis matching assistance is provided: As you type a right parenthesis, the matching left parenthesis is highlighted in red. The treatment of interrupt characters needed to stop a run-away calculation is correct: they are passed immediately to the underlying Maxima program. Very long expressions are split over as many lines as necessary to fully display them, although only a fixed-width font is presented. It should be apparent that with multi-line text outputs, editing utilities such as copy and paste falters when there are superscripts or subscripts because they are printed on separate lines. Such as below, exponents are actually written on one line, and the coefficients and variables are typed on the next line.

$$(D5) \quad Y^{20} + 20 X Y^{19} + 190 X^2 Y^{18} + 1140 X^3 Y^{17} + 4845 X^4 Y^{16}$$

The bottom half of the Xmaxima window is open in a special web browser initially viewing an introductory document about Maxima. This (editable) document includes hyperlinks which, when clicked, are interpreted by the browser to evaluate sections in a program (for example maxima, but possibly other programs such as Octave or GP, similarly linked.) Here is a clip from the lower window showing an executable section:

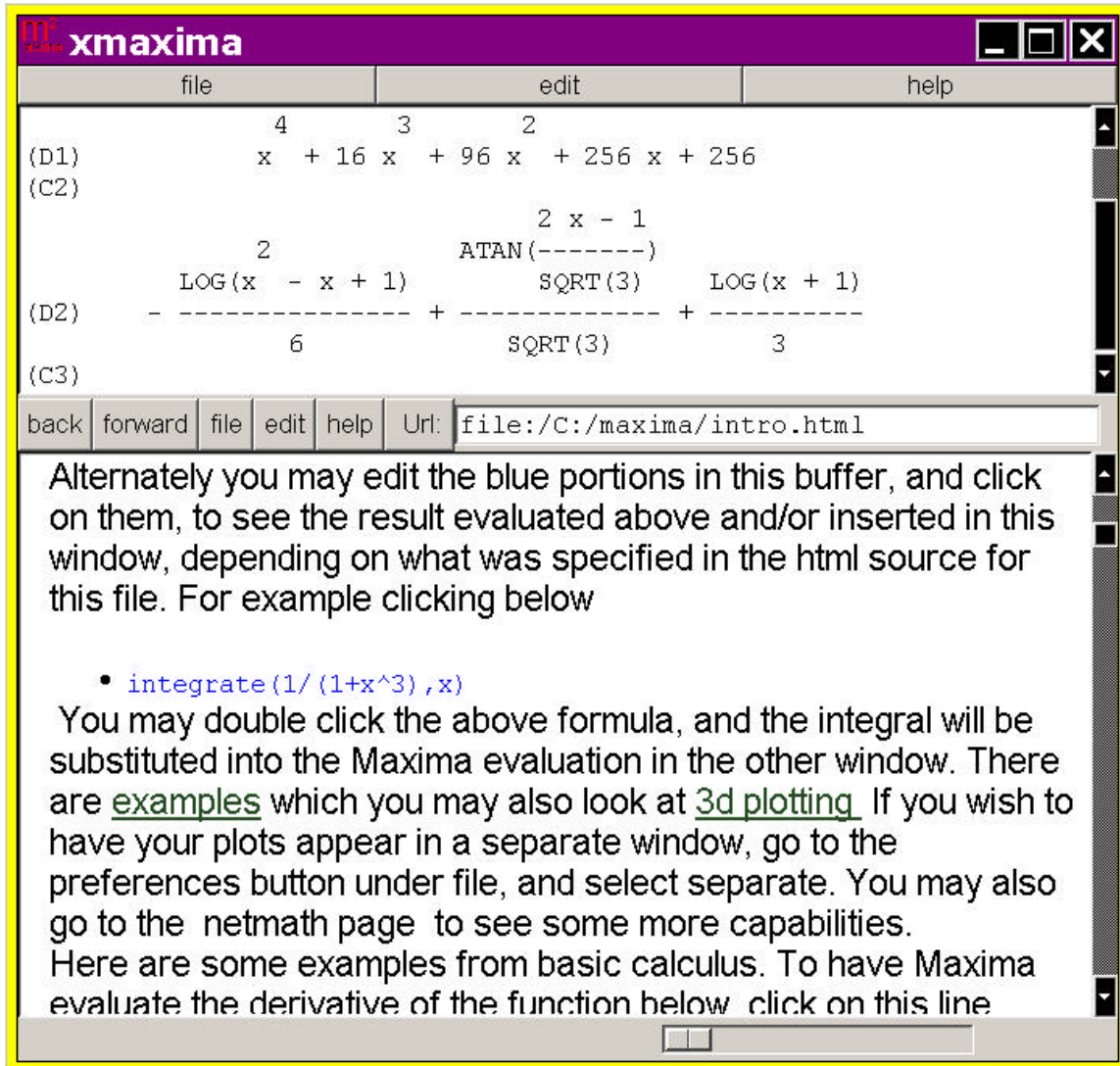


In the html for the file maxima/intro.html you can see the source text for the middle part of this window:

```
For example clicking below
<br>
<ul><li>
<eval program=maxima doinsert=0
>integrate(1/(1+x^3),x)</eval>
```


You may double click the above formula, and the integral will be substituted into the Maxima evaluation in the other window.

As is noted in the figure, the integrate command shown in blue can be edited in place in the browser window before submitting it to Maxima (by double clicking). Clicking on the integrate command will change the screen to this:



Thus it is possible to consider Xmaxima as a combination tool for computation and display of information in html. The computed information is not embedded back in the html, but in the top window. While the Tcl-based browser embedded in Xmaxima is not as full of features as some of the competition, a browser which could be taught to run <eval program=maxima> sections would be plausible.

Other features: 2d and 3d plotting is shown in-line in the upper window.

Downsides: no mathematical typesetting (using variable width fonts). No selection by mouse from display.

Implementation: The Xmaxima system was written by Bill Schelter in a combination of Tcl/Tk and Lisp, with additional parts written in C. The Lisp system used here, GCL, is itself written in C. Xmaxima runs on Windows and various Unix operating systems.

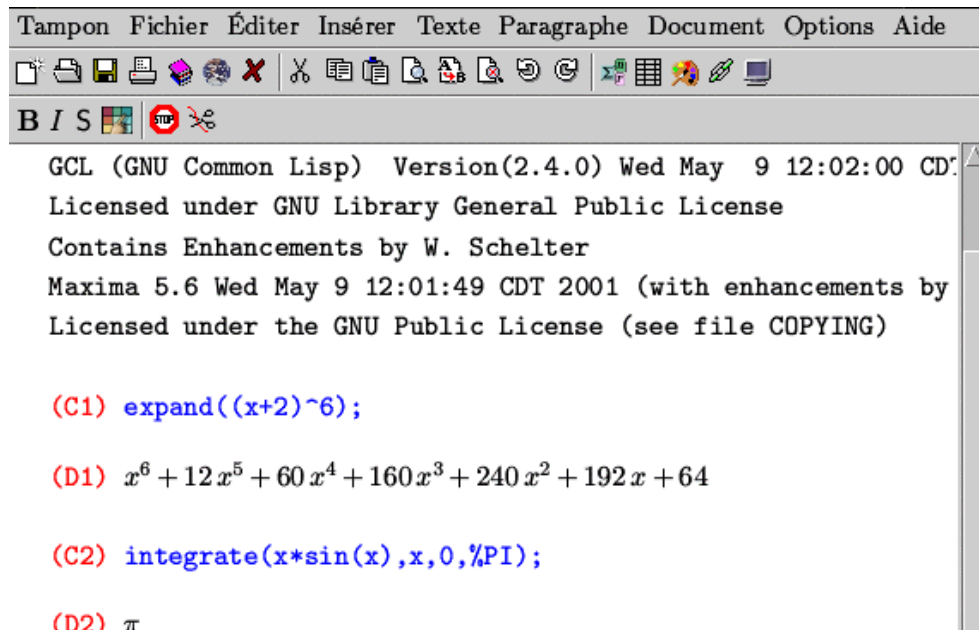
TeXmacs

TeXmacs is a “what you see is what your get “(wyswig) text editor which supports mathematical typesetting using commands that are reminiscent of LaTeX, a popular scientific typesetting program but which is usually considered a “batch only” system. TeXmacs is not LaTeX, but an interactive version of an editor capable of producing similar results. While the result of TeXmacs editing is an internal source form, it can generally be translated into a valid LaTeX file. Conversely, a sufficiently simple hand-written LaTeX file can be read in to TeXmacs, where it is converted to the internal form in TeXmacs. This form is oriented toward wysiwyg editing. This conversion may represent some compromises to the hard-line sophisticated LaTeX user.

This program can be used as a front-end to other programs and in particular Maxima. Properly hooked up to the Maxima TeX code generator, Maxima is provided a superior appearance as a notebook where each computation is entered and the answer is displayed in alternate sections. Each input and output line is numbered, so the user can refer to previous inputs or outputs with the line number.

Whereas the Maxima program can only present outputs in fixed-width 2-d mathematical text with simulated super/sub scripts, TeXmacs can generate and display output that looks like it has gone through LaTeX, and has full mathematical size/font/placement flexibility.

The input of commands to Maxima via TeXmacs would presumably be the same conventional command syntax, as displayed below.



TeXmacs provides users editing facilities such as select, copy, and paste. The user can highlight a part of a previous input with a red box, copy the selection, edit it, and paste it into a new input.

It's especially nice to be able to select a formula that consists of elements at different levels of a line. Whether it's the numerator of a fraction or exponent of a variable, TeXmacs allows you to highlight them.

Downsides: Although TeXmacs displays pleasant looking math, as it is initially set up, there are pauses for the generation of fonts the first time they are used, and this can slow down the interaction. These activities can be monitored in the shell startup-window of TeXmacs, notably when loading files, typing mathematics, or processing outputs in the TeXmacs buffer. If you are on a slow computer, some process in TeXmacs may take some time.

Even though TeXmacs claims it is partly inspired by GNU Emacs, there are differences in the some basic Emacs functions such as buffer manipulation and keyboard shortcuts. There is no option to split the window. Also, even though TeXmacs provide a variety of keyboard shortcuts for inserting symbols (i.e. A-a for alpha), changing fonts (i.e. E-C-b for bold), it lacks the complete emulation of Emacs key commands. You will not find keyboard shortcuts for all the possible commands; this editor requires the use of a mouse-less editor.

TeXmacs is that it requires loads of other packages pre-installed, so the installation can be lots of work.ⁱⁱ

Also, it can only be installed on Linux and Sun machines at this time because a Windows version is currently unavailable.

TeXmacs is able to split long lines at a top-level operator like + or *, but is not capable of massive rearrangement that might be necessary for quotients or built-up exponents.

What about plotting?

Other features: can be used as a front end to other programs.

TeXmacs : how implemented? Who worked on it?

Emaxima

There are two parts to this package: the Emaxima mode, and the Maxima.el mode.

The maxima.el mode is a command/response mode that supports the script-like interaction with Maxima, allowing you to skip back to previous commands, and similar tasks. Similar modes for Maple or Mathematica are available, but in each case the interaction result must be simple text.

```
Buffers Files Tools Edit Search Mule Complete In/Out Signals Help
(C4) integrate(a+b*x+c*x^2,x);
(D4)
      3      2
      c x   b x
      --- + --- + a x
      3      2
(C5) █
--:** *maxima* (Inferior Maxima: run)--L34 iii
```

Emaxima is a text-editing construction mode in Emacs 21.1 with extra features to allow you to embed active mathematics in a document. In particular, it is set up such that a two character command to emacs can copy a command or sequences of commands to a maxima system, collect the results and return back to the emacs. The result most likely will be incorporated back in the document. There are two forms for this: as 2-d fixed-font math, or more attractively set out as LaTeX and then typeset.

In Emaxima interaction, computation is not necessarily strictly linear where you have to go from one command line to the next. Instead, command lines are enclosed in text cells, which are blocks of Maxima code written in between delimiters `\beginmaxima` and `\endmaxima`.

Users can have several cells of Maxima code in a document and can select and execute them in any order. Returning to a cell and re-executing it deletes the former output (if any) and computes a new output. Each cell in Emaxima can include other cells by reference to their labels. When a cell is updated, its dependent cells are updated as well. So even though Emaxima has a linear textual layout, it allows a non-linear fluid information flow among computations.

A cell in emaxima has an appearance similar to this below:

```
\beginmaximasession
diff(sin(x^2),x);
\maximatexsession
\C1. diff(sin(x),x); \\
\D1. $$ 2\*x\*\cos x^{2} $$ \\
\endmaximasession
```

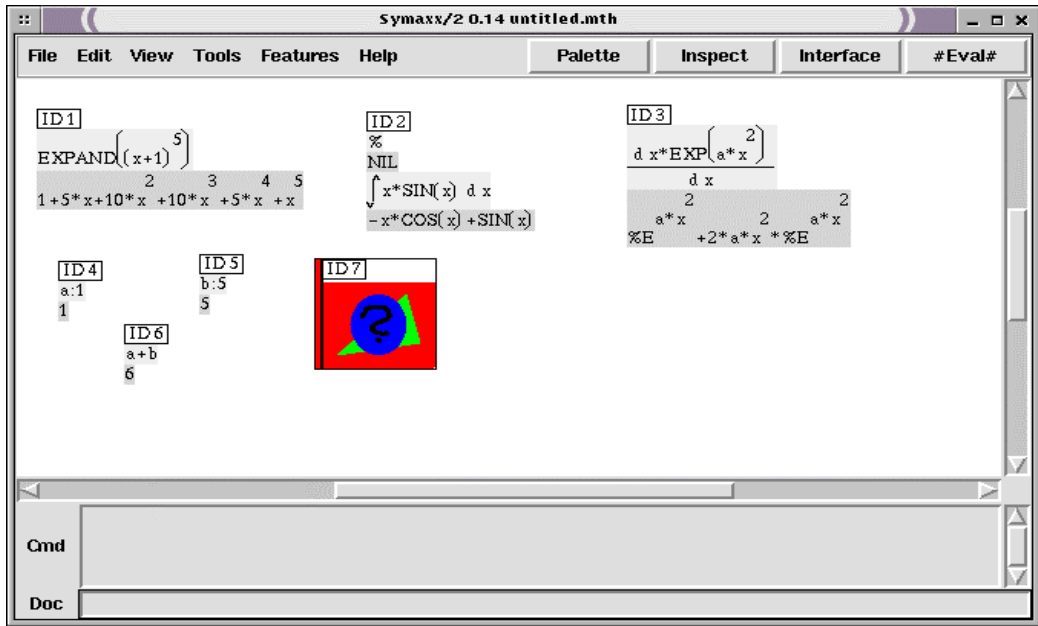
For the time being, I haven't figured out how to convert TeX form to typeset math in Emacs so I don't know if selection, copy, and paste works for typeset outputs. Also, for long lines of output, if the user is in a session cell, everything between the command `\D_` and `\\` will be typeset, but the output will need to be broken up by hand.

For navigation through the program, the user can utilize complete Emacs key commands. There is also a wide range of keyboard shortcuts for Maxima mode commands, Emaxima mode commands, AuxTeX commands, and commands for running TeX.^{iv}

Questions: Plotting? Long Lines?
Presumably Maxima.el does interrupts right.
Runs on Windows? Linux? Sun?
Implementers:

Symaxx

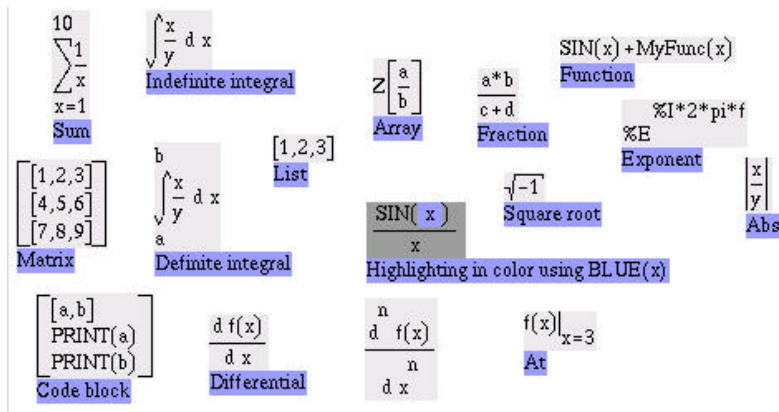
Symaxx is Perl/Tk based graphical frontend for the Maxima Computer Algebra System. It is unlike TeXmacs and Emaxima in that it uses a graphical flow model of interaction (Seen below). Instead of having one command listed one after another in a linear fashion, Symaxx displays the computations like nodes in a flow-chart. It sketches out the 'data flow' of the calculation with arrows. So when a computation refer to a previous output an arrow is drawn to show the relationship.



In Symaxx, each expression is an object uniquely identified by the ID# and each object starts a new Maxima session. Objects linked by an arrow are dependent on each other, so if one equation changes, all the dependent expressions will be marked red. It does similar interactions as Emaxima, but this provides a visual guide for the user, whereas with a model like TeXmacs nothing keeps track of interlinking information.

Symaxx has other features which go beyond just processing computation such as adding documentation text to each calculation and each variable. It also has a 'Variable Manager' which lists all variable names and associated properties (real, complex, integer, etc.). These functionalities may be useful when working on big projects involving a large amount of data and calculations.

Outputs in Symaxx are in text. There is no typesetting, although it has graphical representation for some mathematical functions such as summation, integral, square root, etc. (seen below)



(I am unsure of the selection, copy, and paste functionality of Symaxx and how it handles multiple line output displays at the moment because I haven't been able to install Symaxx. But I've emailed the Author about these issues.)

Symaxx runs on Linux and SunOS operating systems, but not on Windows. Also, due to its interactive and graphical user interface which uses dialog boxes, buttons, check boxes, Symaxx requires a mouse to navigate through the program.

(To my way of thinking, Symaxx is not a front-end to maxima so much as an implementation of another idea of how computation could be done symbolically. The model is, I think, similar to Tksolver or MathCAD, and not really supportive of the conventional notebook interface that has become familiar to Maple/Mathematica/Macsyma users).

Appendix: Relevant History of Macsyma/Maxima

Macsyma was developed as an academic project from about 1968 to about 1982 when commercial rights were transferred to Symbolics Inc. At the same time a version was secured as a potentially public version by the US Department of Energy.

Given the apparent demise of the commercial version in 2001, we have seen a re-awakening of interest in the 1982 DOE version. Prof. William Schelter at Univ. of Texas at Austin was a major contributor to this "Maxima" version (name changed to avoid trademark problems), especially in bringing this system up to compatibility with Common Lisp, and most particularly the GCL free version of common lisp that Schelter also was maintaining.

Schelter's untimely death in the summer of 2001 led to the opening of a free-source "sourceforge" site for the Maxima code, at about the same time that a number of projects were begun to enhance the appearance of Maxima to prospective users. The hope was to make a rival to Mathematica, Maple, and the commercial (but no longer available) Macsyma, with an attractive user interface, while continuing to be free of licensing restrictions. This version would ideally be available on common platforms (generally linux, unix [sun solaris], Mac-OS, and windows).

The enthusiasm of free software programmers is highest on platforms that are themselves free-software based, and so some solutions are basically unix or linux only.

References:

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ⁱ Image from <http://michel.gosse.free.fr/interfaces/>

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- ii Personal experience and shared opinion of Ayal from Yahoo Groups, Yacas.
 - iii Image from <http://symaxx.sourceforge.net/index.html>
 - iv List of commands at <ftp://vh213601.truman.edu/pub/Maxima/EMIntro.ps>
 - v Image from <http://michel.gosse.free.fr/interfaces/>
 - vi Image from <http://symaxx.sourceforge.net/index.html>