

COMPUTER ALGEBRA SYSTEM

A SYMBOLIC APPROACH USING MAXIMA

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Abstract: The introduction of mathematical software package into the field of math education has brought about many benefits, chief among them the ability to obtain more accurate and sometimes precise results more quickly. In a sense, these programs are designed to deliver help with the more mechanical parts of doing mathematics. Thus, with this technology, one needs less time for the traditional skills and can focus on problem-solving skills, which allows both instructors and students to focus on the formulation and interpretation phases of the mathematical modeling process. The aim of this article is to introduce the readers to the open source computer algebra system called Maxima which is released and distributed under the GNU Public License and apparently has the capabilities to challenge the top retail software that lies in the same category such as Maple, Mathematica and MathCAD.

The Information Technology (IT) revolution has boldly stepped in the new millennium, since when it has effectively manifested itself in different areas such as Engineering, Medicine, Economics and Education, and has become indispensable for their growth and development. As a math instructor, my main concern is to present the benefits of using Mathematical Software Packages in education as a part of the IT expansion, which has been penetrating steadily into our daily life since the appearance of the term IT in 1958. However, a great deal of math software is available in the market nowadays in contrast with the past years, giving us a wide variety to choose from. But, one faces a couple of problems: first, when you start working with a certain math program, you spend a lot of time becoming familiar with its interface and commands, adjusting it to your preferences and writing your own functions, routines and sub-routines. Because of this, you are automatically trapped into using one and only one program for most purposes, and with time it becomes increasingly difficult to switch to another. Therefore, the choice, the decision about which software you would "go for" should be taken only after due consideration. Second, most major mathematical software companies are too greedy, their products are very expensive and beyond our reach, in addition to which they charge you "much" for later updates boosting their revenues rather than helping individuals who seek knowledge. In fact, this selfish desire for wealth is intolerable, so I turned to the net googling until I came across an interesting "computer algebra system" called Maxima which is distributed freely and seemingly has many aspects and functionalities that are ready to be used.

What is a Computer Algebra System?

A Computer Algebra System (CAS) is a particular type of mathematical software package that is used in handling and manipulating mathematical expressions with abstract variables. The primary goal of a CAS is to automate dull and sometimes

difficult algebraic tasks. The principal difference between a Computer Algebra System (CAS) and an ordinary calculator is the ability to deal with equations symbolically rather than numerically. The specific uses and capabilities of these systems vary greatly from one system to another, yet the purpose remains the same: manipulation of symbolic expressions. Computer Algebra systems often include facilities for graphing different types of equations and provide a programming language for the users to define their own routines and procedures.

Example 1.

As a simple example on types of calculations, the numerical result of $1-2/3=0.333\dots$ while the symbolic one $1-2/3=1/3$.

Maxima

Maxima is a CAS (Computer Algebra System) similar to systems such as Mathematica and Maple. Maxima is a system for the manipulation of symbolic and numerical expressions, including differentiation, integration, Taylor series, Laplace transforms, ordinary differential equations, systems of linear equations, polynomials, and sets, lists, vectors, matrices, statistics and tensors. Maxima yields high precision numeric results by using exact fractions, arbitrary precision integers, and variable precision floating point numbers. It can plot functions and data in two and three dimensions. It also has a programming language that you can use to extend Maxima's capabilities.

Example 2.

The first 32 rows of Pascal's triangle (beginning with row zero) may be calculated with:

```
makelist(makelist(binomial(n, i), i, 0, n), n, 0, 31);
```

In many cases problems which would take years by hand can be reduced to seconds by powerful mainframe computers.

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A Brief Historical Overview²

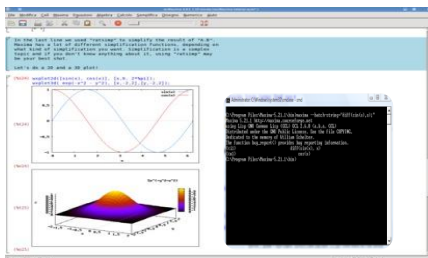
Maxima is based on a 1982 version of Macsyma, which was developed at MIT with funding from the United States Department of Energy and other government agencies. A version of Macsyma was maintained by Bill Schelter from 1982 until his death in 2001. In 1998 Schelter obtained permission from the Department of Energy to release his version under the GPL. That version, now called Maxima, is maintained by an independent group of users and developers. Maxima does not include any of the many modifications and enhancements made to the commercial version of Macsyma during 1982–1999. Though the core functionality remains similar, code depending on these enhancements may not work on Maxima, and bugs which were fixed in Macsyma may still be present in Maxima, and vice-versa.

Maxima is written in the powerful and popular Lisp programming language that was originally specified in 1958 and the mathematics-oriented programming language that Maxima makes available to users is an extension and a continuation of lisp.



Graphical User Interface (GUI)

Maxima *per se*, is a command-line application that runs under DOS platform, which makes it a bit harder to use. However a GUI (Graphical User Interface) frontend called wxMaxima made using Maxima simpler and more user-friendly.



GUI and Command-line of Maxima

wxMaxima combines various software packages (Gnuplot, MikTeX Ghostscript and Maxima) and seamlessly integrates their functionality into a common experience; it is designed to supplant proprietary mathematical analysis programs such as Maple, MATLAB, and Mathematica. It is well suited for education, studying and research.

Example 3.

Find the derivative of: $y = e^{2x} \sin(x)$

```
diff((%e^(2*x))*sin(x),x);
```

Platform

Maxima runs on all POSIX platforms such as Mac OS X, Unix, BSD, and GNU/Linux as well under Microsoft Windows.

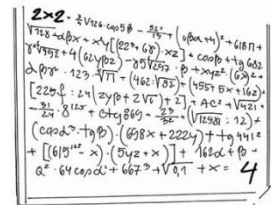
No other infrastructure is required. Just install and it is ready to do your work.



Benefits of Maxima

Have you ever wondered about the existence of a freeware program capable of performing the tedious and dull operations ranging from simplifying expressions to carrying out complex calculations?

Maxima is a versatile math tool available on the net free of charge and offers the user symbolic and numeric manipulation and



solution capabilities in algebra and calculus and numerical analysis; 2D and 3D reports quality graphics, interactive scientific notebooks and a user programming environment. Thus, it serves us in different ways through –

- Decreasing time demand on calculations,
- Enhancing the user's algorithmic skills,
- Preventing overlapping during modeling process,
- Making multi-disciplinary research possible, and
- sharing information and ideas.

Limitations

One must bear in mind the limitations inherent in any such tools. Those considering the use of computers to do maths, particularly students, must be warned that these systems are no substitute for hands-on work with equations and struggling with concepts. These systems do not build your mathematical intuition, nor will they strengthen your core skills.

So, kindly use it responsibly as a complementary tool for the hand-paper work and not as a replacement for the basic education.

Downloads

Maxima is available:

Binaries: <http://maxima.sourceforge.net/download.html>

Documentations:

<http://maxima.sourceforge.net/documentation.html>

Front end: <http://wxmaxima.sourceforge.net/>