MAXIMA FOR UNIVERSITY STUDENTS: POLYNOMIALS AND PLOTTING APPLICATIONS

Prof. Niyazi Ari, ***Hochschule für Technik Zürich***
Zürich, Switzerland
Jyldyzbek Jakshylykov,
International Ataturk Alatoo University
Bishkek, Kyrgyzstan

ABSTRACT

This paper's objectives are to give a brief information about a computer algebra system "Maxima", to explain that why we decided to facilitate "Maxima" for university students, to show the polynomial and plotting applications, and to indicate the benefits of the stated study.

INTRODUCTION

What is "Maxima"? 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, and tensors. Maxima yields high precision numeric results by using exact fractions, arbitrary precision integers, and variable precision floating point numbers. Maxima can plot functions and data in two and three dimensions.

Maxima derived from Macsyma, the legendary computer algebra system developed in the late 1960s at the Massachusetts Institute of Technology. It is the only system based on that effort still publicly available and with an active user community, and open source nature. Macsyma was revolutionary in its day, and many later systems, such as Maple and Mathematica, were inspired by it. Because of its open source advantage, we intended to make a contributions to this formation. After some studies we recognized that the program Maxima is very essential for university students and it needs to be summarized and presented in organized manner. Only then, the university students can easily understand important topics and use the program efficiently. Also, one of the incomplete sides of the Maxima program is that there are not corresponding examples and applications for many functions. So, we want to complete this part of program by applying the functions.

In this paper, we are going to present polynomials and plotting applications with three examples for each. Firstly, we will learn about functions of polynomial category. There are short and easy understandable definitions of functions besides their examples.

APPLICATION

This part gives us opportunity to understand and separate the differences between functions (e.g. factor-eliminate). Beside it, the following tables allow to learn the functions systematically and effectively. After coming examples facilitate our understanding of subject.

Table-1: Corresponding Functions for Polynomials

#	Function	Short Definition
1	bezout	Determinant of the returned matrix is the resultant
2	bothcoef	Gets a list of coefficient and remaining part of expression
3	coeff	Returns the coefficient of x^n
4	combine	Simplifies the sum expression
5	divide	Computes the quotient and remainder
6	eliminate	Eliminates variables from equations
7	ezgcd	Returns a list whose first element is g.c.d.
8	facexpand	Controls whether the irreducible factors are in expanded or recursive form
9	factcomb	Combines the coefficients of factorials in expression with the factorials themselves
10	factor	Factors the expression, into factors irreducible over the integers
11	factorout	Rearranges the sum expression into a sum of terms
12	fasttimes	Returns the product of the polynomials by using a special algorithm for multiplication
13	gcd	Gets the greatest common divisor

Examples with solutions

1. gcd(x^2-4,x-2,x)

   x-2

2. remainder(x^3-27,x^2-9,x)

   9*x-27

3. factor(y^2-y^3)

   -(y-1)*y^2

Table-2: Corresponding Functions for Plotting

Maxima uses external package programs (as Gnuplot and Xmaxima) for plotting. There are again short and easy understandable definitions of functions.

#	Function	Short Definition
1	contour_plot	Plots the contours (curves of equal value) of *expr* over the region *x_range* by *y_range*.
2	plot2d	Plots one or more expressions as a functions of one variable
3	xgraph_curves	Graphs the list of `point sets' given in list by using the program xgraph.
4	plot3d	Displays a plot of one or three expressions as functions of two variables
5	make_transform	Returns a function suitable for the transform function in plot3d.
6	set_plot_option	Assigns one of the global variables for plotting
7	gnuplot_start	Opens the pipe to gnuplot used for plotting with the gnuplot_pipes format
8	gnuplot_close	Closes the pipe to gnuplot
9	gnuplot_restart	Closes the pipe which is used with the gnuplot_pipes format and opens a new pipe
10	gnuplot_replot	Updates the gnuplot window
11	gnuplot_reset	For updating the gnuplot window call gnuplot_replot after gnuplot_reset

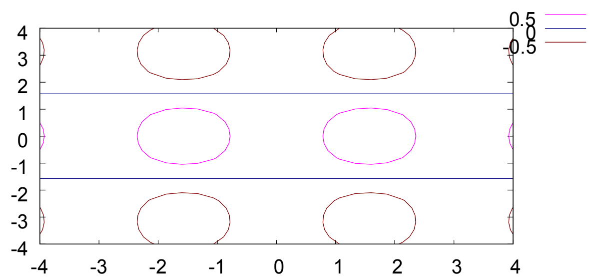
Additionally, there is a table of options for plotting functions.

Table-2-a: Options for Plotting

#	Option	Short Definition
1	plot_format	Determines which graphic interface is used by plot2d and plot3d
2	run_viewer	Controls whether or not the appropriate viewer for the plot format should be run
3	y	The vertical range of the plot
4	plot_realpart	When plot_realpart is true, the real part of a complex value x is plotted
5	nticks	Gives the initial number of points used by the adaptive plotting routine
6	adapt_depth	The maximum number of splittings used by the adaptive plotting routine

Examples with solutions

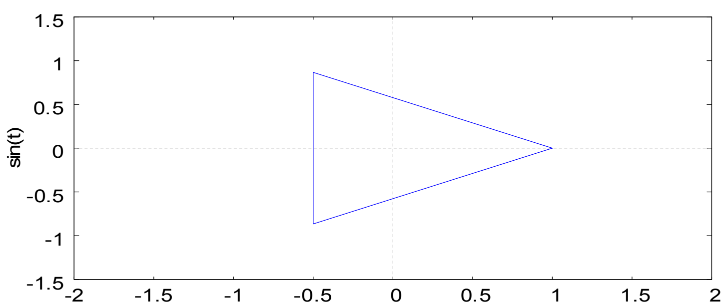
1. contour_plot (cos(y) * sin(x)^2, [x, -4, 4], [y, -4, 4])



*function only works when the plot format is gnuplot or gnuplot_pipes.

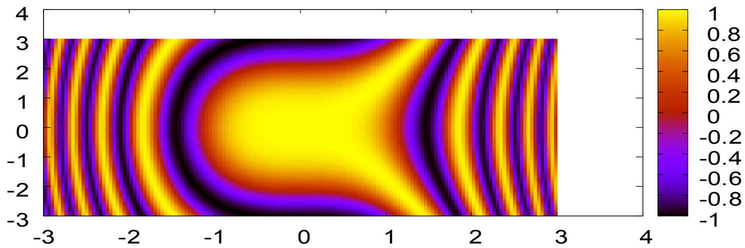
2. plot2d (two dimensional plotting)

   - plot2d ([parametric, cos(t), sin(t), [t, -%pi*2, %pi*2], [nticks, 4]], [x, -2, 2], [y, -1.5, 1.5])$



3. Plotting examples for three dimensions

- plot3d (cos(-x^3+y^2/3),[x,-3,3],[y,-3,3],[gnuplot_preamble, "set view map; unset surface"],[gnuplot_pm3d, true], [grid, 150,50])$



CONCLUSION

As a result, we can easily indicate that the computer algebra system Maxima always requires improvement and development by its computer language researchers. Every study will be extra contribution for both mathematics and informatics. In addition, we hope that, university students take advantages of this implementation which is only one part of my large-scale Maxima for University Students Project.

REFERENCES

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