CPS 5310 Spring 2019 Mathematical and Computer Modeling
NSS, Instructor

Introduction to Maxima with Examples

One of the software packages we will use to do mathematical modeling in this course is Maxima.
Maxima is a computer program for doing mathematical calculations, symbolic manipulations, numerical computations and graphics. It is based on the 1982 version of the Computer Algebra System MacSyMa. Please go to the course website
http://www.math.utep.edu/Faculty/nsharma/public_html/sp19_5310.html
and download the zipped folder Maxima_Intro.zip.

Example Problem 1. What volumes of fluids A and B should be mixed to obtain 150 *units* of a fluid C that contains 70 *units* of a substance, if A and B contain 50 and 80, respectively.
2a. Determine the unknowns.
2b. Give precise definitions of the unknowns.
2c. Translate the information in the problem description into mathematical statements.
2d. Please look at the Maxima code Mix.mac to see how this problem is solved using Maxima.

Example Problem 2. Consider the problem of minimizing the metal used to construct a cylindrical tin having a volume of 1 liter.
Formulate the mathematical model can be used to solve the problem.

1a. Explain how to use calculus to solve the problem.
1b. Examine the file Tin.mac to see how it solves the problem.
1c. Use Maxima to run the batch file Tin.mac to obtain the solution to the problem. Explain the results.

Example Problem 3. Suppose the fluids A, B, C and D contain substances S1, S2, S3 (concentration in grams per liter) as shown in the table below.

	A	B	C	D
S1	2.5	8.2	6.4	12.7
S2	3.2	15.1	13.2	0.4
S3	1.1	0.9	2.2	3.1

What is the concentration of S3 in a mixture of these fluids that contains 75% (percent by volume) of fluids A and B and which contains 4 and 5 of the substances and , respectively?

3a. Determine and give a precise definition of the unknown(s).
3b. Translate the problem description into a mathematical model consisting of a system of linear equations. (Hint: To do this, you will need to introduce some auxiliary variables).
3c. Examine the file Mix1.mac to see how it solves the problem.
3d. Run the batch file Mix1.mac in Maxima to obtain the solution to the problem.

Example Problem 4. Suppose a farmer has a piece of farm land *A* square kilometers large to be planted with either wheat or barley or some combination of the two. Furthermore, suppose the farmer has a limited permissible amount of fertilizer and of insecticide that can be used, each of which is required in different amounts per unit area for wheat and barley . Let be the selling price of wheat, and the selling priceof barley. How many square kilometers should be planted of wheat versus barley to maximize the revenue?

4a. Determine and give a precise definition of the unknowns.
4b. Formulate the problem as a mathematical model in the form of a linear programming problem.
4c. Examine the file Farm.mac to see how it solves the problem.
4d. Run the batch file Farm.mac from Maxima to obtain the solution to the problem.

Example Problem 5. Work through the Tank Labeling Problem in Section 1.5.4.2 of the textbook, including running the file Label.mac in Maxima to obtain the solution.
Tank Labeling Problem: When fluids are stored horizontally in cylindrical tanks, one is interested in labeling on the front side of the tank with labels indicating for example the 1000 liters, 2000 liters etc. The challenge is if the fluid is not visible from outside the tank then one needs to experimentally obtain the level. These experimental techniques prove to be expensive hence we would like to use some mathematical modeling to help answer this problem.