CPS 5310 Spring 2015 Mathematical and Computer Modeling
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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. You should install Maxima on your own computer and bring it to class. See the Maxima homepage at http://maxima.sourceforge.net/ for more information. See also Ted Woollett's Maxima by Example available at http://www.csulb.edu/~woollett/ .

Next let's try some of the simple modeling examples from Chapter 1 in the textbook. Before starting, you'll need to download and unpack the book software file MMS-V2.zip from https://sites.google.com/site/booksoftwaremms/ .

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

$$M = \{\pi r^2 h = 1, A = 2\pi r^2 + 2\pi rh \to \min\}$$

where r and h denote the radius and height of the cylinder, respectively. The first mathematical statement expresses the fact that the volume of the tin is 1 liter. The second statement requires the surface area of the tin to be minimized.
1a. Substitute the first equation into the second to obtain a function $A(r)$ to be minimized.
1b. Explain how to use calculus to solve the problem.
1c. Examine the file Tin.mac from the Principles subfolder in the mms book software folder to see how it solves the problem.
1d. Use Maxima to run the batch file Tin.mac to obtain the solution to the problem. Explain the results.

Example Problem 2. What volumes of fluids A and B should be mixed to obtain 150 *l* of a fluid C that contains 70 gl^{-1} of a substance, if A and B contain 50 gl^{-1} and 80 gl^{-1}, respectively.
2a. Determine the unknowns.
2b. Give precise definitions of the unknowns, including units.
2c. Translate the information in the problem description into mathematical statements.
2d. Examine the file Mix.mac to see how it solves the problem.
2e. Run the batch file Mix.mac in Maxima to obtain the solution to the problem.

Example Problem 3. Suppose the fluids A, B, C, and D contain concentration (in grams per liter) of the substances S_1, S_2, and S_3 as shown in the table below. What is the concentration of S_3 in a mixture of these fluids that contains 75% (percent by volume) of fluids A an dB and that contains 4 gl^{-1} and 5 gl^{-1} of the substances S_1 and S_2, respectively.

	A	B	C	D
S_1	2.5	8.2	6.4	12.7
S_2	3.2	15.1	13.2	0.4
S_3	1.1	0.9	2.2	3.1

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 F of fertilizer and P of insecticide that can be used, each of which is required in different amounts per unit area for wheat (F_1, P_1) and barley (F_2, P_2). Let S_1 be the selling price of wheat, and S_2 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.

Preparation for next class: Work through the Tank Labeling Problem in section 1.5.4.2, including running the file Label.mac in Maxima to obtain the solution.