Lab D: Mathematical Modeling

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Overview
The term "Mathematical Modeling" is used to describe many different types of problems. One common use is the process of developing equations to describe a real-world situation based on accepted properties of the system. The objectives of this lab are:

- learn to input a table of values and
- use Maple to find a formula $y = f(x)$ that best describes the data.

Maple Essentials

- The *Curve Fitting* maplet is started from the Maple 9.5 user interface under the **Tools** menu:
  - **Tools → Assistants → Curve Fitting** ...

  The *Curve Fitting* maplet returns an expression to the Maple worksheet.

Preparation
Review the Lab B on lines and plots. Review the seven basic functions given in Lab C.

Maple Syntax
In Maple, an ordered list must be enclosed in square brackets [ ]. So $[x_1, y_1]$ is an ordered pair, or point, while $[[x_1, y_1], [x_2, y_2], [x_3, y_3]]$ is an ordered list of points.

Activities

(1) Log in and Start a Maple session.
(2) Type **with(plots):** at the top of your worksheet. This will allow us to plot points and a function on the same graph.
(3) Example 1: Consider the data points given in the table below:

x	1	2	3	4	5	6	7
y	2.2	3.7	5.5	5.9	5.6	4.2	3.1

Find a parabola which best fits the data. Then graph the parabola and the points in the same plot.
   (a) First assign the set of points to a variable, say *mydata*.
   > mydata:= $[[1, 2.2], [2, 3.7], [3, 5.5], [4, 5.9], [5, 5.6], [6, 4.2], [7, 3.1]]$
   (b) Next, launch the *Curve Fitting* maplet, but click **Cancel** instead of inputing the points again. You should see the following:
   > CurveFitting[Interactive]();
   (c) Change this line to read:
   > CurveFitting[Interactive](mydata);
   This will launch the *Curve Fitting* maplet with our data.
   (d) Under "enter an expression in x" type: a*x^2+b*x+c.
   (e) Click **Plot** to see the parabola that most closely resembles our data points.

(f) Click **Done** and the *Curve Fitting* maplet will return the expression that describes the parabola.

(g) Assign this expression to a variable, say f.

(h) Next, we assign our desired plots to the variables P1 and P2 as follows:
(Remember to use : for these not ;)
> P1:=plot(mydata,style=point,symbolsize=10,color=blue):
The **style** command tells Maple not to connect the dots. The **symbolsize** command makes the points large enough to see. The **color** command changes the color of the points.
> P2:=plot(f,x=0..8):

(i) We can then view our plot and give it a title with the **display** command.
> display([P1,P2],title="My Parabola");

(4) Example 2: Consider the population data given in the table below:

Date	1900	1910	1920	1930	1940	1950	1960	1970	1980	1990
Pop. (billions)	1.65	1.75	1.86	2.07	2.3	2.52	3.02	3.7	4.45	5.3

Enter this data into Maple. (You should input your time values in decades since 1900.) Find a cubic which best fits the data. Then graph the cubic and the points in the same plot.

(5) Example 3: Consider the temperature/pressure data given in the table below:

Temperature ($°C$)	0	50	100	150	200
Pressure (atm)	2.54	3.06	3.46	4.00	4.41

Enter this data into Maple. Find the least squares line, the line which best fits the data.

(6) Remember to logout.

Assignment

Your assignment for this week is to complete Project 1. You should prepare a neat and complete project report. Your TA will provide details about the format of your project. All projects are due at the *beginning* of next week's lab.