MATH 245, Spring 2016
Homework 2
due 10:45am on Wednesday, March 9.

Background reading: Section 1.3 to page 25 and Section 1.4, as well as **Mathematica** Tutorials 1–3.

Follow the posted homework guidelines when completing this assignment.
In particular, remember that you must **fully justify** any calculations or assertions you make.

Only consult with your classmates or professor to discuss the problem set.

Don't forget to include acknowledgments for those who helped you with the assignment!

2-1. (7 pts) Here is some data that represents an independent variable x and a dependent variable y.

x	1	2	4	6	7	9	10	11	13	15	16
y	1	20	78	138	134	219	346	380	434	585	684

It is thought that y satisfies a function of type (a) $y = Cx^k$ or type (b) $y = Ck^x$, but it is not known which one is more likely.

- Use the method of **transforming the data using logarithms** combined with **visual fitting** to determine the curve of best fit. Either use graph paper to plot the transformed data by hand, or use *Mathematica* to plot the transformed data using a computer. Then use your judgment to determine the line of best fit. Use this line of best fit to determine the curve of best fit to the original data. Do this twice—once for a curve of type (a) and once for a curve of type (b).
- Now compare and contrast your two curves of best fit. Create the residual plot for each fit. In a paragraph or two, discuss which one you think gives a better fit and why.

  [*Important: Residual graphs are* **always** *plotted with respect to the original dataset, not the transformed dataset.*]

2-2. (6 pts) Here is some data related to the growth of a plant after grafting:

Months after grafting	1	2	3	4	5	6
Height, in inches	0.8	2.4	4.0	5.1	7.3	9.4

(a) Do a **linear regression** manually to determine the least-squares best fit line for height as a function of time. Work under the assumption that the height (h) is **proportional** to the time (t).

(You will need to write down your calculations that you perform. You may use a computer to help you with the algebra, but make sure you mention where you used a computer when you write up your work. You may not use a computer to do the linear regression for you.)

(b) Use the model from part (a) to predict the height of the graft at four and one-half **months** and again the height of the graft at 5 **years**. Which prediction is more reliable? Give specific reasons why one might be more reliable than the other.

The following question involves *Mathematica* and is worth 7 points. You may use online resources to learn more about Mathematica to solve these questions. **Do not handwrite any answers.** Create one *Mathematica* notebook for the entire homework question. Every part should be **answered completely** and must include **text cells** that explain what you are doing and why. Print out your notebook and turn it in on 3/9/16.

2-3. (a) Watch the first two videos at the following link:

`http://www.wolfram.com/broadcast/screencasts/handsonstart/`

These videos are for helping to get started with Mathematica. It is highly suggested that you follow along with Mathematica open alongside to try out the presented commands yourself. The first video is about 7 minutes long and it introduces you to how to add sections and text into your notebooks. The second video is about 19 minutes long and discusses how Mathematica allows you to use "free-form input" and how else to input information.

[*It is important to realize that free-form input is nice, but to use Mathematica's full capability, you will need to understand its language.*]

(b) Create a new *Mathematica* notebook that satisfies the following properties.

- Your notebook must have a Title (with relevant title), Subtitle (Your name, date, class). Choose a stylesheet (Format > Stylesheet) of your liking.
- Name a first Section "List Questions" and create two subsections, named as you wish. The two subsections should answer the following two questions.
  - Use the `Range` command to create a list of the numbers from 0 to 200 that are three more than multiples of seven. [*Your output will start* `{3,10,17,...}`]
    Next, use the `Table` command to create the list of the square numbers that are between 100 and 1000 and the list of the cube numbers that are between 100 and 1000.
  - Define variables `list1` and `list2`, each with 20 entries (You choose!). Have *Mathematica* count the number of entries in each list and also find the sum of the entries in each list. Then have Mathematica generate a new list named `list3` that combines the two lists into a set of twenty ordered pairs. For example, if `list1` starts off `{1,2,3,...`, and `list2` starts off `{4,5,6,...`, then `pairs` should start off `{{1,4},{2,5},{3,6},...`. Last, use remove all the extra braces from the list `pairs`; in the example, the output would start `{1,4,2,5,3,6,...`.
- Name a second Section "Plotting Questions" and create subsections as necessary to answer the following question. Generate three individual plots and combine them in a fourth plot, as follows.

  - First, plot $4\sin(x/2)$ from 0 to 2π using a thick blue line.
  - Second, plot $3\cos(3x)$ from 0 to 2π using a thin dashed line that is not blue.
  - Third, plot ten to twenty large bright fluorescent points of the form $\left(x, \frac{1}{20}x^3 - x\right)$ with x values between 0 and 6.
  - Last, combine all three graphs on one set of axes.
- Name a third Section "Neat Mathematica things"
  - Find two neat things that you have seen that *Mathematica* is able to do. Copy the code into your notebook and describe what it does. Discuss where you found this code and explain why they are interesting. **Further discuss** in what ways it would be interesting for you or someone else to modify these things in a new and innovative way.