Mathematical Models, Spring 2003

Project #3

Guess your weight?

DUE DATE: Friday, March 21st, in class.

The goal of this project is for you to use the tools we have developed in the course thus far to come up with a model relating the weight of a person to their height. Factors such as size and gender should be included in your model. After starting with a few warm-up exercises, you should collect data on people's heights and weights. Since we want to aim for a more generic model (not just Holy Cross students) you should gather information from people of differing ages and sizes. You then will build a linear model for females and males using the method of least squares and compare this to a standard rule of thumb given in the text (Exercise #6, Section 3.3). Your goal is to derive a good model based on your data and to get a glimpse of the work involved in modeling a real-world problem.

It is **required** that you work in a group of two or three people. Any help you receive from a source other than your lab partner(s) should be acknowledged in your report. For example, a textbook, web site, another student, etc. should all be appropriately referenced at the end of your report. The project should be typed although you do not have to typeset your mathematical notation. For example, you can leave space for a graph, computations, tables, etc. and then write it in by hand later. You can also include graphs or computations in an appendix at the end of your report. Your presentation is important and I should be able to clearly read and understand what you are saying. Spelling mistakes and sentence fragments, for example, should not occur. Only one project per group need be submitted.

Read all of the directions carefully. You do not have to include an introduction in your report, although a **conclusion** which states what you learned from the project and further questions you might like to investigate are expected. Remember: A well-written report with a few tables and graphs to illustrate key points is far better than a sloppy report with too many figures.

Warm-up: Fitting data to a curve

1. Consider the data given in Problem #2(c) in the exercise set for Section 3.3 (p. 118). Use MAPLE to find the best fit using Chebyshev's method. Use Linear Algebra to find the best Least Squares fit. Compute the absolute deviations in each example and compare $c_{\max}$ and $d_{\max}$. Also compare the sum of the squares of the deviations in each case. Plot both fits and the data on the same graph. Which method approximates the most number of data points the best? Comment on which method you would choose and why.

2. Recall the Bass Fishing Derby model from Section 2.3. Do problems #7 and #8 from the exercise set for Section 3.4 (p. 125). Use a Least Squares fit in each case. The goal is for you to determine which of the four models is best. Be sure to justify your answer.

Relating Height to Weight

Consider the following rule for estimating a person's weight (in lbs.) based on their height (in inches):

- For a female, multiply the height (in inches) by 3.5 and subtract 108.
- For a male, multiply the height (in inches) by 4.0 and subtract 128.
- If the person is small bone-structured, adjust by subtracting off 10% of the result.
- If the person is large bone-structured, adjust by adding 10% of the result.
- No adjustment is made for an average size person.

So for example, a 6 foot, male football guard (large bone-structured) would have an estimated weight of $1.1(72 \cdot 4.0 - 128) = 176$ lbs.

Gather the heights and weights of at least 25 people of differing age, gender and size. Be creative here, don't just stick to your friends. Using the method of least squares, fit your data for females to a line. How do your results compare with the rule above? Repeat the same process for males.

Comment on the effectiveness of your models. How "bad" are your deviations from the data? Is there an easy way to improve them? Is one gender easier to model than another? How does your model change if you incorporate whether a person is small, average or large bone-structured? Is their a better model than a straight-line fit? If you include geometric similarity in your model, what model would you obtain? Does this lead to a better model? Explain. Remember, there is no single correct answer here. Two groups may come up with totally different models, both of which fit their data well. The process, the exploration and justification, are the key aspects I will be looking for.