

Math 2270-2  
Solution Template, part A  
**A Power Law For Human Heights and Weights**

Type in your name here:

### Body Mass Index

In this part of your project you will use the method of least squares to find a power law which (approximately) relates human weights to heights. Within the past few years you might have noticed a series of newspaper and magazine articles about the so-called body mass index, and its use in determining risk factors for overweight (and underweight) people. If you search the internet for "body mass index" you will find many sites which let you compute your B.M.I., and which tell you a little bit about it.

A person's body mass index (B.M.I.) is computed by dividing their weight by the square of their height, and then multiplying by a universal constant. (If you measure weight in kilograms, and height in meters, this constant is the number one.) Thus, the proponents of the B.M.I. index seem to be assuming, or claiming, that for adults at equal risk levels (but different heights), weight should be proportional to the square of height. It is easy to deduce that if people were to scale equally in all directions when they grew, weight would scale as the cube of height. That particular power law seems a little high, since adults don't look like uniformly expanded versions of babies; we seem to get relatively stretched out when we grow taller. One would expect the best predictive power to be somewhere between 2 and 3. If the power is much larger than 2 then one could argue that the body mass index might need to be modified to reflect this fact. Of course, the sample heights and weights which we have collected may or may not be representative of a healthy population, but let's proceed anyway. (In previous years our experimental power has come out between 2.35 and 2.65.)

Here is the height- weight data which you have provided to me. Thanks to all who contributed, especially Travis. After I tried out your data, I noticed a big hole between 30 and 50 inches, so I took all data points between those heights from last year's class. (We also had a teacher in that class, only she must have had smaller students.) The first number of each pair is a height, in inches, the second number is a weight, in pounds. Heights vary from baby (19 inches) to tall person (78 inches). Weights vary from 6 to 250 pounds. .

```
[ > restart:with(linalg):with(plots):  
> S:=[[60,116],[63,132],[71,181],[63,118],[61,115],  
      [20,6.0+10/16], [20,7.0+1/16],[19,6.0+6/16],  
      [20,7.0+5/16],[19,6.0+2/16],[19.5,8.0+1/16],  
      [21,8.0+13/16],[20,7.0+11/16],[20,8.0+8/16],  
      [70,150],[68,135],[64,135],[69,132],[68,137],  
      [54,70],[73,142],[72,154],[74,170],[63,113],  
      [72,165],[30,30],[77,230],[73,180],[72,145],  
      [66,132],[75,250],[72,220],[78,185],[71,165],  
      [72,210],[73,180],[67,160],[64,110],[63,112],  
      [66,120],[76,230],[75,190],[43,41],[27,18],  
      [67,120],[73,182],[68,120],[69,154],[66,118],  
      [75,185],[67,145],[60,98],[64,93],[59,84],  
      [60,82],[48,82],[65,90],[49,64],[48,79],[59,84],
```

```

[ 60,92],[59,95],[57,61],[61,90],[53,58],[54,69],
[50,51],[54,77],[54,60],[52,63],[67,130],[63,135],
[60,105],[66,110],[61,110],[72,189],[60,100],
[64,156],[64,140],[69.5,145],[75,180],[67,138],
[73,132],[66,187],[74,240],[64,140],[72,187],
[55,79],[67,126],[40,37.5],[42,41.5],[43,41],
[43,43],[44,42.5],[44,38.5],[44,40.5],[45,55],
[45,46.5],[47,54.5],[48,70.5],[48,43.5],[49,49]]:
[ > A1:=convert(S,matrix):
[ >

```

- 1) **As in the worked example, find a least squares line fit to the ln-ln data which you obtain from A1. Show your work!**
  
- 2) **Create a plot display which shows the ln-ln data and your least squares line fit.**
  
- 3) **Deduce a power law for our class height-weight data. Create a plot display which shows the graph of the power function and the pointplot of our original data.**
  
- 4) **What does your power law predict for the weights of "average" people, at heights of 5 feet, 51/2 feet, 6 feet, and 61/2 feet?**
  
- 5) **Compare the power law you obtained with the one which I obtained from national data. (It's posted on our Maple page.) Are the two power laws close? How do they compare to the BMI index? Does this tell you anything about whether one should use the BMI index (without adjustment) on both children and adults?**