SL PORTFOLIO TYPE II

“Body Mass Index”

BODY MASS INDEX

Throughout this portfolio, various functions will be evaluated, applying the given data.
A model function will be determined and extrapolated as it relates to the following real-world example:

Body mass index (BMI) is a measure of one's body fat. It is calculated by taking one's weight (kg) and dividing it by the square of one's height (m).

The table below provides the median BMI for females of varying ages in the US in the year 2000.

Age	BMI
2	16.40
3	15.70
4	15.30
5	15.20
6	15.21
7	15.40
8	15.80
9	16.30
10	16.80
11	17.50
12	18.18
13	18.70
14	19.36
15	19.88
16	20.40
17	20.85
18	21.22
19	21.60
20	21.65

(Source: http://www.cdc.gov)

When graphed:

(The independent variable being the age of the women studied <x>, and the dependent being the BMI of these women <y>. Both values must always be greater than zero.)

This graph's behavior is most nearly modeled by the cosine function, $f(x) = \cos(x)$, because it is undulating and periodic: it repeats a pattern as it rises and falls. However, due to the limitations presented by the nature of the given information itself, only the portion of the graph in the first quadrant that is positive applies, as both the age of the women and their respective body mass index values are real world examples and could never be negative. Other functions I experimented with, with the exception of the sine function, could not be used, because no portion of their graphs reflected the data provided. (The sine function was another possible choice, but I found the cosine function to be adequate.) Below is a graph of the chosen function type, $f(x) = \cos(x)$.

Once I had deduced which function type best fit the provided data, I used a GDC to test different forms of $f(x) = \cos(x)$ through trial-and-error, and decided that the function ***f(x) =3cos(.2x-4)+18*** most closely modeled the data, though certain values did not perfectly correlate. Below is a graph showing both the given BMI data and this model cosine function, for comparative purposes. It can be seen that the actual raw data very nearly coincides with the model: they curve in a relatively similar fashion, for example. The graphs are not, however, identical. Certain points do not exactly line up with this model. The first few, for instance, before age five, have slightly higher x-values than the cosine model, as do the last few, after age sixteen. Other values also do not correlate perfectly. Nonetheless, the model illustrates the provided BMI statistics with relative accuracy.

In order to discover a different function that models the given information, I used technology. I downloaded Graph 4.3, and saved the given data, the cosine function, and the model function into the program. When I compared the graph of the BMI statistics with my own model, I noticed that they did not look as similar as they had on my calculator, because I was able to view them more closely and in greater detail. I decided to refine my function slightly to more accurately model the data. Through trial-and-error, I found the function $f(x)= 3.3\cos(.21x-4.2)+18.3$ to better reflect the information. Both this function and the original model function, $f(x) =3\cos(.2x-4)+18$, are graphed below.

These functions are very similar, it can be seen, despite the original model function beginning with a lower x-value. The new model is a bit more accurate, and falls slightly higher on the y-axis. The two functions become increasingly similar at the bottom of the first curve, as they begin to rise. (It is logical that the two would be similar, because I only altered certain values very slightly in order to refine the function. For instance, I changed the period of the function from one-fifth, or .2, to .21, differing only by .01.)

The model function can be applied in order to ascertain certain values not included in the data. It can, in other words, be extrapolated. For example, the model can be used to estimate the BMI value of a 30 year-old woman in the US at that time. Using Graph 4.3, doing this is simple. I needed only to drag the cursor on my computer to the point on the function where the x value equals 30, and it gave me the y-coordinate. Thus, the BMI value of a 30 year-old US woman, assuming the trend in the statistics would continue to correspond with the model function, would be an estimated 16.6. In order to check this, I went to the table function under the CALC tab, and found the y value for to equal 16.63 for an x value of 30. This value is a bit low; a BMI less than 18.5 is considered to be underweight.[1] For a 30 year-old woman, this is not altogether reasonable: most women actually undergo weight *gain* around this age, as their metabolism is beginning to slow.[2] The model function would not thus accurately reflect the data, had the statistics been extended to include older women. The real life data would no longer follow the same pattern at that point.

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1 http://www.cdc.gov/healthyweight/assessing/bmi/adult_bmi/index.html

2 http://www.hughston.com/hha/a_15_2_4.htm

The model function, or at least a similar one, could perhaps also be applied to body mass index statistics for women in other countries.

The table below provides the median BMI for females of varying ages in Guatemala.

Age	**BMI**
2	16.0
3	16.0
4	16.0
5	15.6
6	15.3
7	15.3
8	-
9	-
10	-
11	16.7
12	17.2
13	18.9
14	19.2
15	20.5
16	21.7
17	22.1
18	22.3

(Source: http://www.unu.edu/unupress/food2/uid02e/uid02e0e.htm)

When graphed:

The model function $f(x) = 3.3\cos(.21x - 4.2) + 18.3$ does not exactly carry over to this data. Below is this data graphed with the model function for comparative purposes.

In order to make the model fit with this data, it would need to be refined in order to better reflect the trend in the statistics. Much as I adjusted my original function through trial-and-error using Graph 4.3, one could modify certain values (amplitude and period, for instance) in order to make it fit. Through manipulation I found the function **$3.1\cos(.21x-4)+18.36$** to be a bit of a closer match. Below is the data graphed with this new model function, for comparative purposes.

It can be observed that this model does not perfectly correlate with the data, but does reflect its trends with relative accuracy. Because the data for Guatemalan women was more sporadic than the data for American women, it was much more difficult to discover a model that fit. In other words, the data did not always follow a consistent undulating pattern, while the first set did, making it harder for a function to correspond. There was also less data present, as there is a gap between ages seven and eleven and it stops at age eighteen, which also made it difficult to view any trends. The data often shows slightly higher x-values than the model, and at some points, they are lower. Because I used a trial-and-error method (on both a GDC and the program Graph 4.3) to discover it, the model function I found may have somewhat limited accuracy, though it does illustrate the trends this data presents pretty closely. The function, while not a perfect match, is appropriate considering the limitations presented by the data itself.