Exploring Weather Patterns
An Investigation of Sine Waves

Introduction

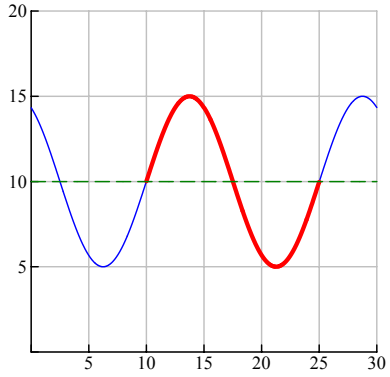
In this lab activity you will explore the weather patterns of your community. Generally speaking, average temperatures of a given location follow an oscillating pattern from year to year. That repetitive pattern can be modeled with a sinusoidal function, or simply a sine wave function. You might recall from trigonometry that such a function can be modeled by the equation

$$y = a \cdot \sin\left(b \cdot \left(x - c\right)\right) + d$$

where $|a|$ is the amplitude of the wave, $2\pi/b$ is the period, c is the phase shift, and d is the vertical shift. The value of d is also the equilibrium value.

If you observe the graph below in Fig 1, the equilibrium value appears to be $y = 10$. That helps indentify the amplitude of 5. If you arbitrarily choose $x = 10$ as a starting point (which helps identify the phase shift), you can see that the period of the wave is 15 units.

Fig 1



Use the information given to write a function to represent the graph in Fig 1.

(6pts)

By now, you know that you can use the derivative of the sinusoidal model to describe the change in the wave pattern. In this lab, you will use it to describe the changes in the observed weather patterns.

Using the Chain Rule, find the derivative of the function described in Fig 1.

(3pts)

Collecting the Data

Data for this activity will be collected from the Weatherbase website found at http://www.weatherbase.com.

A. Click the link above to go to the Weatherbase website. Select United States for the Region, then choose Georgia, and finally choose Acworth (Kennesaw is not on the list).

B. Locate the Average Temperature data and record it into the List Editor (let January be 1, February 2, etc.).

Recording the Data

1. Rename the appropriate lists as *time* and *temperature*.

2. Create a scatter plot that represents the temperature data with respect to the time data.

(3pts)

3. Using the scatter plot in step 2, *verbally* describe the temperature pattern throughout the year.

(3pts)

Analyzing the Data

4. The data can obviously be described as sinusoidal. Approximate the amplitude, period, phase shift, and displacement.

(12pts)

5. Use the information in step 4 to define a model called "temp". Be sure to use appropriate variables.

(6pts)

6. Use the statistical features of TI-InterActive! to perform a sinusoidal regression analysis of the temperature and time data. Name the function "temp_reg". Show the calculations, and write the resulting model equation using appropriate variables.

(6pts)

7. How do the values of a, b, c, and d in the two models compare to each other? Hint: you may have to rewrite the TI-InterActive model to compare values.

(12pts)

8. Create a graph of the two model equations along with the scatter plot.

(6pts)

9. How does the graph of each model equation compare to the scatter plot? Which model seems to be a closer fit?

(6pts)

10. Calculate the derivative of the function found in step 6, temp_reg. What does this function represent?

(9pts)

11. Describe how one can use the derivative in step 10 to determine where does the greatest change in the average temperature occurs (March, June, November, etc.)? Where is that greatest change?

(6pts)

12. You should recall that the second derivative can be used to determine where the greatest change in the average temperature occurs as well. What should the second derivative be at this time?

(4pts)

13. Calculate the second derivative of the function in step 6, then enter your time value from step 11 into this function. Did you get the value you expected in step 12?

(6pts)

14. Use the CAS features to set the second derivative function equal to zero and solve. How close is this value to the one in step 11?

(9pts)

15. You answer in step 14 should have given you two values, one in the spring and one in the fall. Explain why you get two solutions in this application?

(3pts)