Modeling Sinusoidal Temperature Fluctuations

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1 Abstract

My project will consist of a JavaScript RTICA for visualizing data animated in 3 dimensions. The program will demonstrate how temperature fluctuations over the course of a year changes over time similar to a sinusoidal curve. The purpose of the project will be to depict a visual representation of climate change as it varies over time.

2 Introduction

Local climate data can be visually represented using oscillating sine curves that are modeled to fit real world data. I will be creating trigonometric functions that represent the yearly fluctuations. I will be modeling the temperature fluctuations of Denver, CO, Washington DC, Chicago, IL, and San Francisco, CA.

I will be using the mean monthly temperatures over a range of the past 20 years to model the average yearly fluctuations. Typically the amount of variation in local weather for a single year does not fit a sinusoidal model due to random climate variability. The long-term average reduces the impact of very extreme events. Alongside the temperature fluctuation I will also be modeling changes in humidity and precipitation levels.

3 Math

For each US city I will be creating a separate sinusoidal equation that will be used to model the temperature fluctuation. I will be using real world data to create a sinusoidal interpolation that displays the average temperature, humidity, and precipitation level for each month varying throughout the sample year.

A sinusoidal curve is given by the general form equation of $y = Acos(Bx + C) + D$ Where A is the amplitude, B is the frequency of the function, C is the phase shift, and D is the vertical translation.

3.1 Deriving sinusoidal equation from data

Step 1: Determine the amplitude A of the function.
A = (maximum temperature - minimum temperature)/2

Step 2: Determine the vertical translation B of the function.
B = (maximum temperature + minimum temperature)/2

Step 3: Determine the period C of the function.
In this case the period is 12 months for a yearly representation. Using the expression $2\pi/12$ we get C = $\pi/6$

Step 4: Determine the phase shift by observing that in the parent cosine function the high point happens when t=0. Therefore, when modeling with the cosine, the phase shift (or delay) is the length of time between t=0 and the first time the function reaches its maximum value. This will be calculated separately for each city since the maximum will occur during different months due to regional variations.

4 Project Details

I will be using JavaScript and HTML to create an RTICA. I will be using three.js which is a library for creating three dimensional objects. My application will utilize a counter method which will call the rendered frame. The graphs will be modeled using cosine curves and the resulting animation will be smooth to the viewer. The render function will be called approximately sixty times per second and time will increment for each rendered frame.

References

[1] "Western Regional Climate Center" *National Weather Service.* (n.d.). Retrieved October 31, 2016, from http://www.wrcc.dri.edu/CLIMATEDATA.html

[2] "NOAA" *National Centers for Environmental Information.* (n.d.). Retrieved October 31, 2016, from https://www.ncdc.noaa.gov/

[3] Leiserowitz, Anthony. "Americans' Knowledge of Climate Change." *Americans' Knowledge of Climate Change.* Yale University, n.d. Web. 8 Nov. 2016.