CloudLab *Curve Fit Feature* Preview: *Inverse Square Law of Light*

Introduction

The ability to quickly match empirical data to well-known mathematical models is an essential feature in the analysis of experiments. This technique is generally referred to as ***curve-fitting***. The up-and-coming, but not yet leased, ***CloudLab*** software from PocketLab provides an easy way to fit data to models including linear, quadratic, power, exponential, and logarithmic. This curve-fitting can be done for any *selected* region of PocketLab data. This lesson provides a sneak preview of this ***CloudLab*** feature, allowing students to study the inverse square law of light.

The Experiment

Figure 1 shows the set-up for the experiment. Voyager has been mounted to a cart that *travels at constant speed*. Any such cart will do, but the author elected to use a cart made from Lego® parts, power supply, and motor. The light sensor on Voyager faces a clear incandescent light, and data collection and the cart are ***simultaneously started*** when the cart is *as close as possible* to the light. At this close position the light sensor data will be out-of-range, but it will quickly get back into range as the cart moves away from the light.

The unit of distance will be what the author refers to as a ***cart-second***. This is defined as the *distance that the cart travels in one second* (analogous to a light-year, which is the distance that light travels in one year). By using a cart traveling at a constant speed, there is no need to measure distance between the light and cart with a meter stick. Our distance will simply be measured in cart-seconds. In other words, we can think of PocketLab's light intensity vs. time data to be light intensity vs. distance. To put it another way, since $d = vt$ and velocity is constant for our cart, d and t are proportional—meaning we can use time as a measure of distance. *No need for a meter stick in our experiment!*

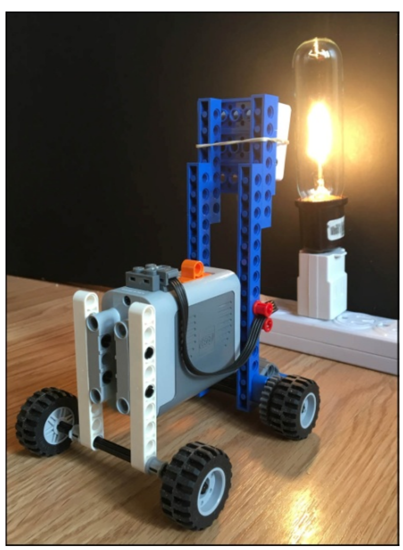

Figure 1

A combined data/video accompanies this lesson. It was obtained from the PocketLab app running on an iPhone. A snapshot from this video, showing the inverse nature of light intensity as it relates to distance (in cart-seconds) from the light source, appears in Figure 2.

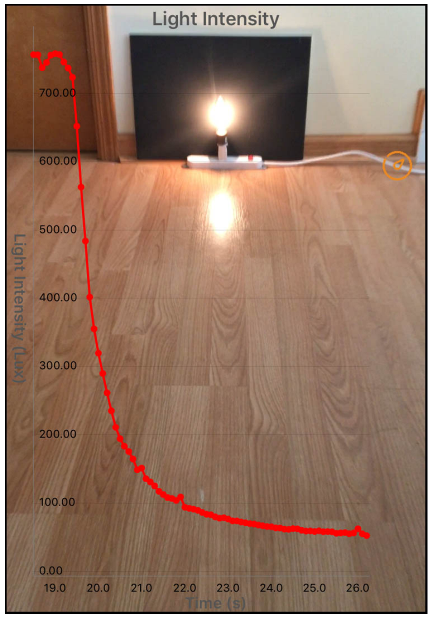

Figure 2

Experiment Results

Figure 3, captured from ***CloudLab***, shows a graph of light intensity vs. distance in cart-seconds. At a distance of 0.6 cart-s, the light intensity is within the light sensor's allowed range. From a distance of 0.7 cart-s and beyond, one might be misled into believing that the light intensity is constant—but this is due to the large scale of the light intensity axis. Figure 4 was obtained by selecting a range from 0.8 cart-s to 4.0 cart-s. There is clearly some kind of an inverse relationship between light intensity and distance.

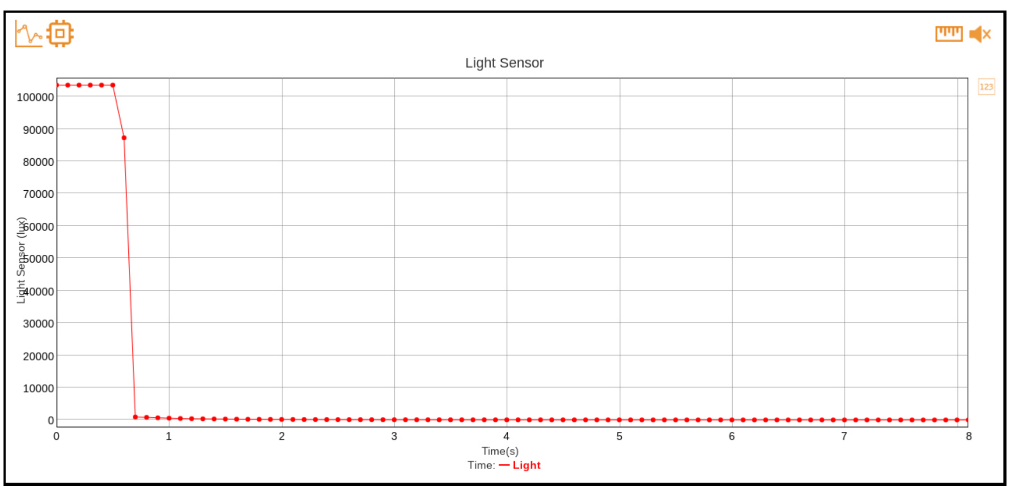

Figure 3

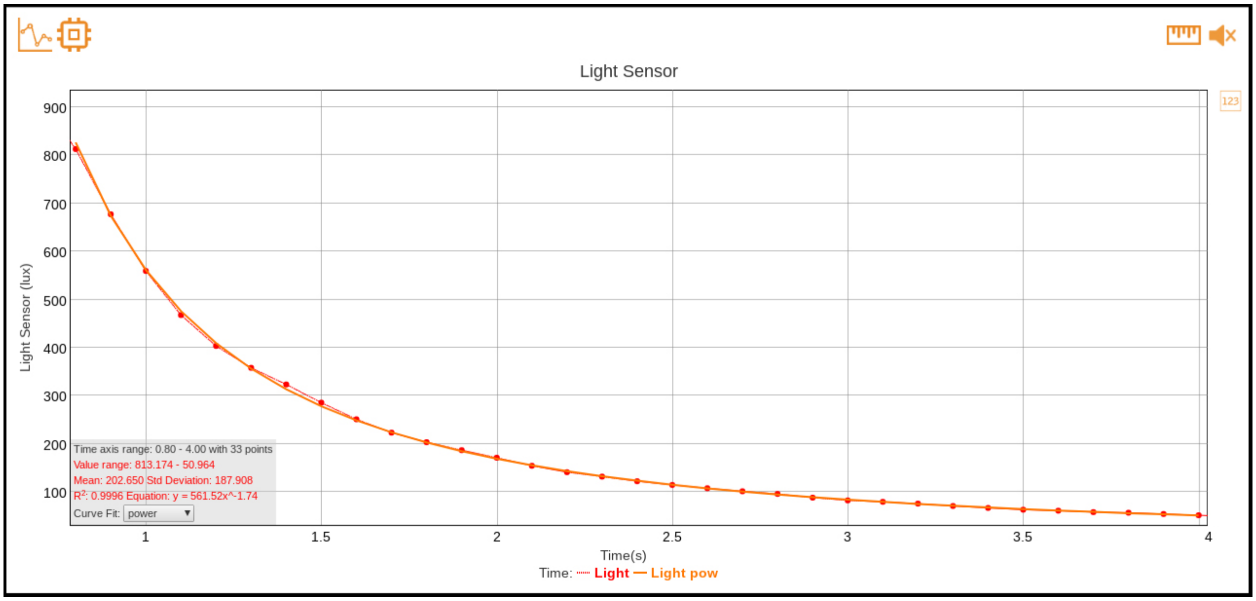

Figure 4

Upon zooming in on the selected range, ***CloudLab*** provides statistics including mean and standard deviation, shown in the lower left corner of the graph. Our interest here, however, is to do a curve fit--we select ***power***. The curve is shown in orange in the graph. ***CloudLab*** then shows us the R^2 value and the power equation of best fit to the data:

R^2: 0.9996 Equation: y = 561.52x^-1.74

We obtain a power -1.74, somewhat shy of the inverse square power of -2 that we were expecting. It is well worth students' time to come up with some reasonable explanations for this difference.

It should be noted that the ***CloudLab*** screen prints are from a prelease version and are therefore subject to possible future modification. Never-the-less, we can see that CloudLab provides a variety of useful curve-fitting models for analyzing PocketLab experiments.