What's My Model?

By Pat Flynn

Time required
45 minutes

ACTIVITIES eXCHANGE **ID: 8518**

Activity Overview

Students will investigate several different regression models and determine which of the models makes the most sense, based upon a real-world situation (cooling a cup of hot chocolate).

Concepts

- *Mathematical modeling using regression curves*
- *Forecasting*

Teacher Preparation

This investigation illustrates to students how to strategically choose an appropriate regression model instead of blindly choosing.

- *The activity pages that follow provide a brief overview of the steps students will complete as the activity progresses. The student worksheet provides more detailed instructions as to how to use TI-Nspire learning technology to complete each step.*
- *The screenshots on pages 78–80 demonstrate expected student results. Refer to the screenshots on page 81 for a preview of the student TI-Nspire document (.tns file).*
- ***To download the student .tns file and student worksheet, go to education.ti.com/exchange and enter "8518" in the quick search box.***

Classroom Management

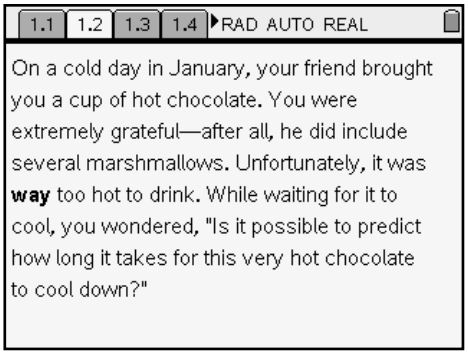
- *This activity is intended to be **teacher-led**, with breaks for independent student practice. You may use the following pages to present the material to the class and encourage discussion. Students will follow along using their handhelds. The majority of the ideas and concepts are only presented in **this** document; so be sure to cover all material necessary for students' total comprehension.*
- *The student worksheet StatAct01_WhatsMyModel_worksheet_EN is intended to guide students through the main ideas of the activity while providing more detailed instruction on how to perform specific actions using the tools of the TI-Nspire handhelds. It also serves as a place for students to record their answers. Alternatively, you may wish to have the class record their answers on separate sheets of paper, or just use the questions posed to engage a class discussion.*

TI-Nspire™ Applications

Calculator, Graphs & Geometry, Lists & Spreadsheet, Notes

Introduction

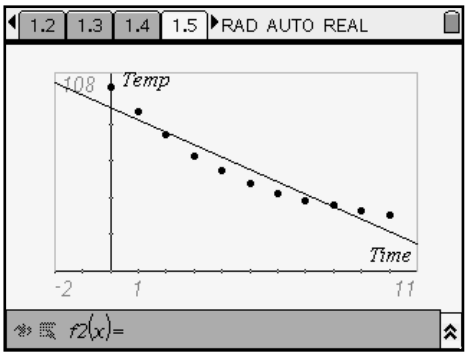
Many students incorrectly assume that, for any scatter plot, they must perform a *linear* regression to find an equation that models the points. This activity attempts to dispel this notion and get the students thinking about other possible regression models.



Refer to the student worksheet for this activity for more detailed instructions as to how to use TI-Nspire learning technology to complete the steps outlined below.

A Linear Model

The linear regression equation for this data is **f1**(x) = –6.74x + 88.70 and gives a prediction of –315.64°C after 60 minutes. This should be an immediate clue to students that the linear model is not the best model for the data.

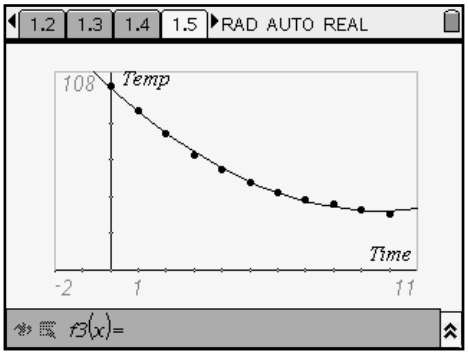


This should lead to a discussion about the linear model and its problems with describing these data. One of the topics the students should bring up is that the linear model assumes a constantly decreasing temperature (slope). When the data table is examined, this is seen to not be the case.

Note that the linear regression line over predicts for the 3rd–8th data points and under predicts elsewhere. When a model is a good fit, you cannot make such statements that generalize a pattern in over/under predicting. Another constraint that needs to be mentioned is the assumption that the temperature of the hot chocolate will continue to decrease forever, which is obviously not true.

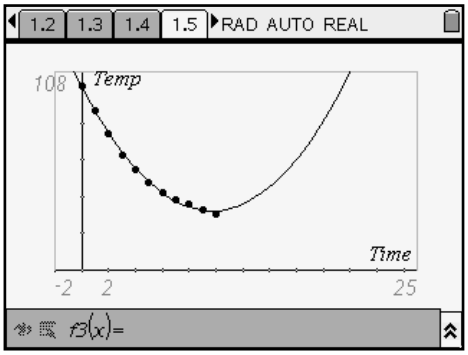
A Quadratic Model

Students might then believe the function to be quadratic, as the data points seem to follow a curve. The quadratic regression equation for the data is **f2**(x) = $0.71x^2 - 13.89x + 99.43$ and gives a prediction of 1839.49°C after 60 minutes. Additionally, this model over predicts for all values after the 11th data point. This indicates that the quadratic model, like the linear model, is not the correct model for the data.



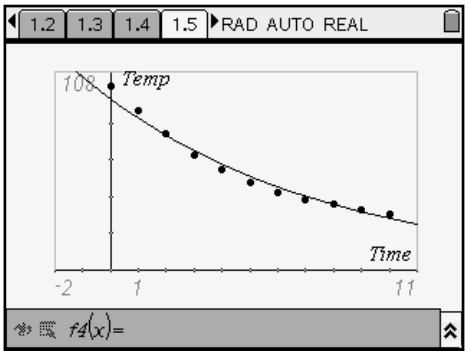
The discussion about why this model isn't a correct choice for the data should revolve around the shape of a parabola. Have students adjust the window settings to those in the screenshot at the right to show the parabola. According to this model, the temperature of the hot chocolate decreases at first and then increases without bound.

Other polynomial regressions (cubic and quartic) will also not be good fits as their curves either decrease or increase beyond absolute temperatures.

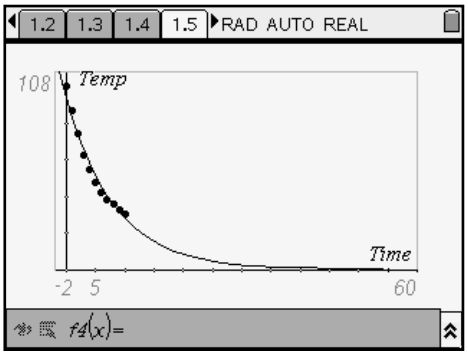


An Exponential Model

The exponential regression equation for the data is **f3**(x) = $93.24(0.89)^x$ and gives a prediction of 0.07°C after 60 minutes. Encourage students to think about how cooling works: the temperature of a liquid sitting in a room usually approaches the room temperature. Looking at the scatter plot, they can see that, once again, the exponential model will under predict for all values past the 10th data point. Again, the model is not appropriate for the data.

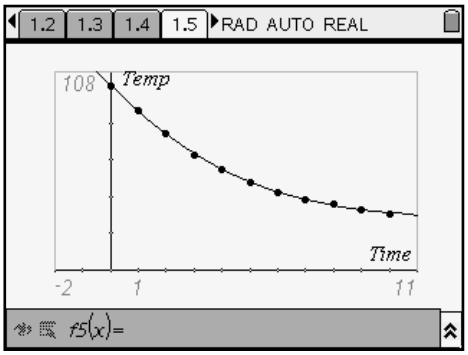


Students might think that the exponential regression would be an appropriate model because it has a horizontal asymptote. However, as time continues, the temperature of the hot chocolate according to this model approaches 0°C. You might as well be outside if the room temperature is that cold! To properly view this model's horizontal asymptote, change the window settings to those in the screenshot to the right.



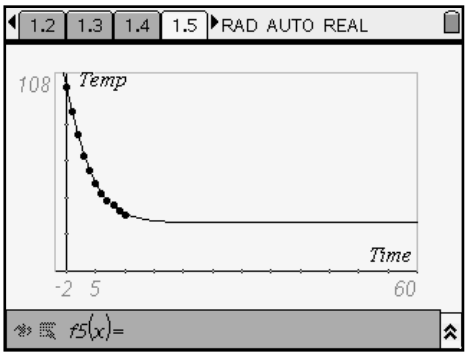
A Logistic Model

The logistic regression equation for the data is $\mathbf{f4}(x) = \frac{195.29}{1 + 1.63e^{0.321x}} + 26.25$ and gives a prediction of 26.25°C after 60 minutes.



This is the correct model, since the hot chocolate's temperature in this case approaches a temperature that is reasonable for a room temperature. This can be verified in the graph using different window settings as shown below to the right. Note also that the logistic model does not seem to over or under predict in any set pattern.

When students are detecting a good model for a given situation, they should consider these factors: the context of the problem and the existence of a pattern in predictions made from the model.



Visit education.ti.com/exchange to download activity files, including the student .tns file StatAct01_WhatsMyModel_EN.tns. Enter "8518" in the quick search box.