Ride the Rollercoaster

ID: 11854

Time Required
15–20 minutes

Activity Overview

In this activity, students will use polynomial regression to develop and assess the fit of equations modeling data. The equation models are then evaluated for reasonableness in their use for extrapolating beyond the given data sets.

Topic: Polynomial Regression

- *Cubic and Quartic Regression*
- *R^2 (Coefficient of Determination)*
- *Evaluating Functions*

Teacher Preparation and Notes

- *Problem 1 may be done in class, and Problems 2 and 3 could either be done in class or assigned as homework.*
- *As an extension, the teacher could include relative and absolute maxima and minima.*
- *The data for Problems 1 and 2 are not actual data values, but have been generalized from visual references.*
- ***To download the student and solution TI-Nspire documents (.tns files) and student worksheet, go to education.ti.com/exchange and enter "11854" in the keyword search box.***

Associated Materials

- *RideTheRollercoaster_Student.doc*
- *RideTheRollercoaster.tns*
- *RideTheRollercoaster_Soln.tns*

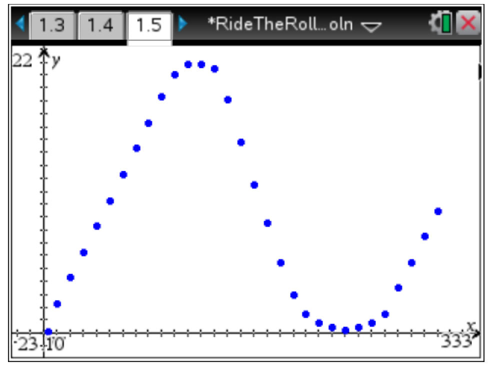
Suggested Related Activities

To download any activity listed, go to education.ti.com/exchange and enter the number in the keyword search box.

- *Graphs of Polynomial Functions (TI-Nspire technology) — 10222*
- *Building Curves (TI-Nspire technology) — 8962*

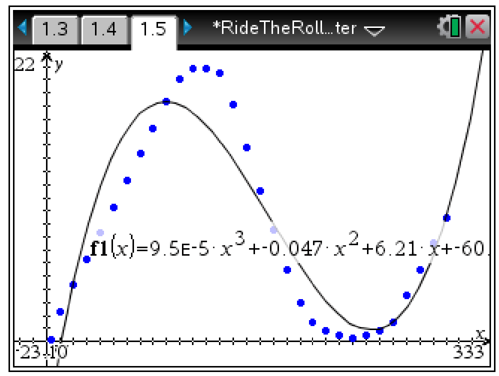
Problem 1 – Introduction

Problem 1 involves developing a regression equation to model a section of track for a steel rollercoaster. Using the given data, students are given a scatter plot and, using their observations of the graph shape, choose a regression method and graph the resulting equation on the scatter plot.

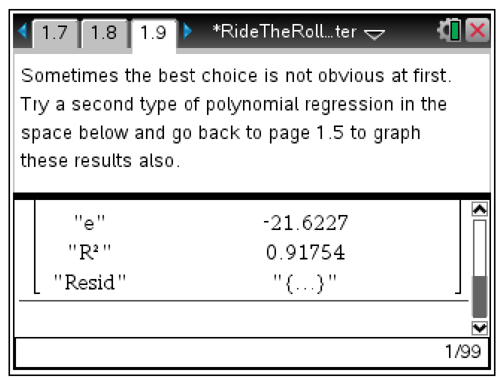


Following the regression, to enter the function graph on the scatter plot page, students are to press ctrl + G. The function will already be entered in f1. It will be necessary to arrow up when at the bottom of the screen to move to f1, then press enter to enable the graph of the equation to be displayed.

Press ctrl + G to toggle the Entry Line on and off at the bottom of the *Graphs* application age.

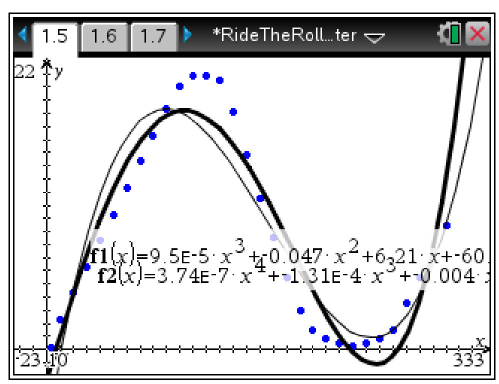


Students are next asked to try another regression model and to graph it also on the scatter plot.



Based on the "N" shape of the graph, students will likely be drawn to perform a cubic regression. If students do not have experience with general polynomial graph shapes, it will be helpful to direct the students to use cubic regression for the first graph. Students may choose to use a cubic model, but may need guidance on why the cubic is not the most accurate model.

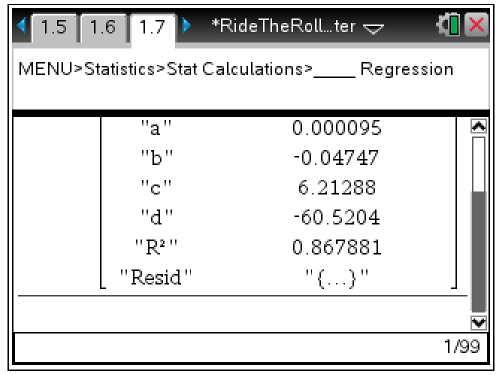
For the second model attempt, students may explore models, or the instructor may prefer to direct the students to use a quartic model. This model is graphed with the thicker line at the right.



Students may modify line thickness by pressing **MENU > Actions > Attributes** and then selecting the curve by clicking on it. (Alternatively, move the cursor to the graph, press ctrl menu, and select **Attributes**.) This will result in a thickness choice slider being displayed. Choose the desired thickness and press enter to exit the **Attributes** tool and save changes made.

Students are to make a visual comparison of the results to assess visually which equation model appears to best fit the data.

Then they are directed back to the pages with the calculated regression to compare the values of R^2 to assess the fit.

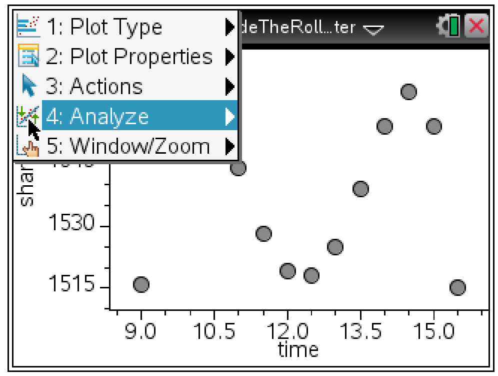


Problem 2 – The Financial "Rollercoaster"

Students explore NASDAQ index data for a one day period and choose an appropriate polynomial regression model to fit the data.

It may be helpful to discuss indices such as NASDAQ, S&P 500, and the Dow Jones to assess economic health.

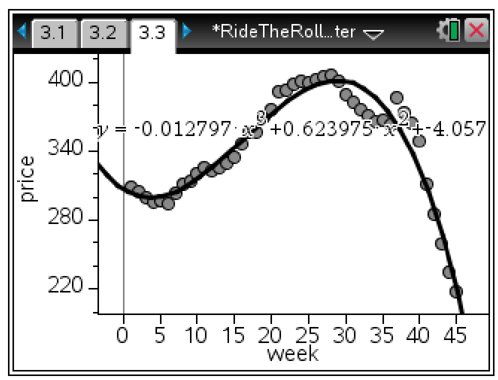
Students will explore problem 2 with the Data & Statistics application.



Problem 3 – The Gas Prices "Rollercoaster"

Students explore the changes in regular gasoline prices given average weekly prices for gasoline beginning with the first week of January 2008, and choose an appropriate polynomial regression model to fit the data.

This data could interest students in looking at other interesting current economic trends. Students could explore trends such as SUV sales, fuel-efficient car purchases, food prices, and unemployment data for the current year.



Student Solutions

1. Cubic would be expected based on shape.
2. $f(x) = 0.000095x^3 - 0.04747x^2 + 6.21288x - 60.5204$
3. $f(x) = 3.74298\text{E}{-7}x^4 - 0.000131x^3 - 0.00393x^2 + 3.36177x - 21.6227$
4. The quartic equation fits the data points slightly better than the cubic equation.
5. The R^2 value for the quartic equation is closer to 1, indicating a better fit.

   (quartic $R^2 = 0.91754$, cubic $R^2 = 0.867881$)
6. About 182 ft.
7. About 7703 ft. No, this doesn't make sense because it is far too high.
8. About –89 feet; No, this doesn't make sense because you would be 89 feet underground.
9. Quartic
10. $f(x) = -1.7406x^4 + 85.5041x^3 - 1556.8463x^2 + 12446.6333x - 35311.9226$
11. at about 10 a.m., 1567.49
12. One would expect negative index values for both the day before and the next day if the pattern was extended. The NASDAQ index values are positive, so this does not make sense.
13. Cubic
14. $f(x) = -0.0128x^3 + 0.624x^2 - 4.0572x + 306.7042$
15. about -16 cents
16. about $40.04
17. The graph and the equation give the impression that as weeks go on, the price will continue to drop to the point where it will be free and when the price is negative, it would imply that the customer would be given money to take the gas. While this would be nice, it is not realistic. Similarly, if we look back to weeks prior to January of 2007, the impression is given that the price of gas would become infinitely high, which is not historically accurate. In the 1980's, gas was around a dollar a gallon.

    Stress with students that the models used in this activity work for the given data and extrapolation is often problematic, so the application of such equations modeling real situations typically involves a restricted domain.

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