Residuals
TI-NSPIRE™ CX/CXII

Math Objectives

- Students will explore the validation of a model constructed from a data set.

- Students will be able to determine a regression equation.

- Students will understand that a pattern in the graph of the residuals indicates that the model is not appropriate for the data set.

- Students will look for and express regularity in repeated reasoning (CCSS Mathematical Practice).

- Students will look for and make use of structure (CCSS Mathematical Practice).

Vocabulary

- data set
- residual
- linear
- exponential

About the Lesson

- This lesson includes modeling a data set using linear and exponential regressions.

- As a result students will:

  - Observe a residual plot as well as a scatter plot of the data.

  - Understand that a residual is the actual value of the data minus the predicted value from the regression equation.

  - Conjecture and draw conclusions about the appropriateness of the model based on the residual plot.

TI-Nspire™ Navigator™

- Send the TI-Nspire document to students.
- Use Class Capture to view and discuss the scatter plots and residual plots.
- Use Quick Poll questions to adjust the pace of the lesson according to student understanding.

Activity Materials

- Compatible TI Technologies: TI-Nspire™ CX Handhelds, TI-Nspire™ Apps for iPad®, TI-Nspire™ Software
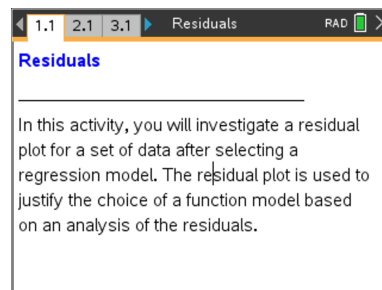
Tech Tips:

- This activity includes screen captures taken from the TI-Nspire CX handheld. It is also appropriate for use with the TI-Nspire family of products including TI-Nspire software and TI-Nspire App. Slight variations to these directions may be required if using other technologies besides the handheld.

- Watch for additional Tech Tips throughout the activity for the specific technology you are using.

- Access free tutorials at http://education.ti.com/calculators/pd/US/Online-Learning/Tutorials

Lesson Files:
Student Activity
- Residuals_Student.pdf
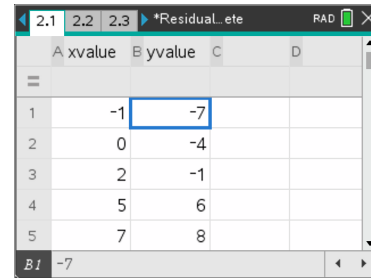- Residuals_Student.doc

TI-Nspire document
- Residuals.tns

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Part 1

Use the following data set in Part 1.

x	−1	0	2	5	7	10
y	−7	−4	−1	6	8	16

1. Enter the *x* values in the column labeled *xvalue.* Enter the *y* values in the column labeled *yvalue.*

Tech Tip: Students must press enter or the down arrow after the last value is entered.

Add a page by pressing [ctrl] [doc▾]. Select>Add Calculator. Press [menu] . Select> Statistics> Stat Calculations, then Linear Regression (mx + b). For X List: select xvalue and for Y List: select yvalue. Press enter for OK..
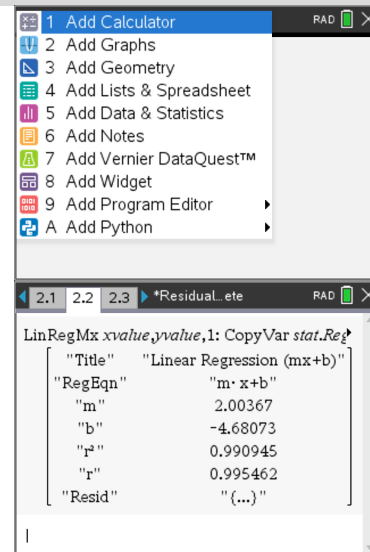
What is your linear regression equation?

**Answer:** The linear regression equation is

$y = mx + b$

$m = 2.00367$

$b = -4.68073$

2. Add a page by pressing [ctrl] [doc▾]. Select> Add Data & Statistics. Click in the lower gray region to select xvalue and click in the left gray region to select yvalue.

    Note: To show the graph of the linear regression equation, press [menu]. Select > Analyze> Regression, and Show Linear (mx + b). To hide the graph of the linear regression equation, press [menu]. Select 4>Analyze>Regression, and Hide Linear (mx + b).
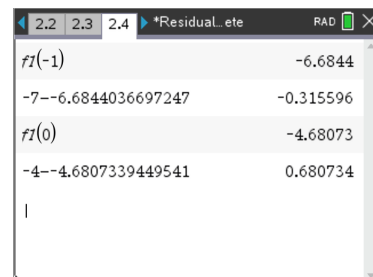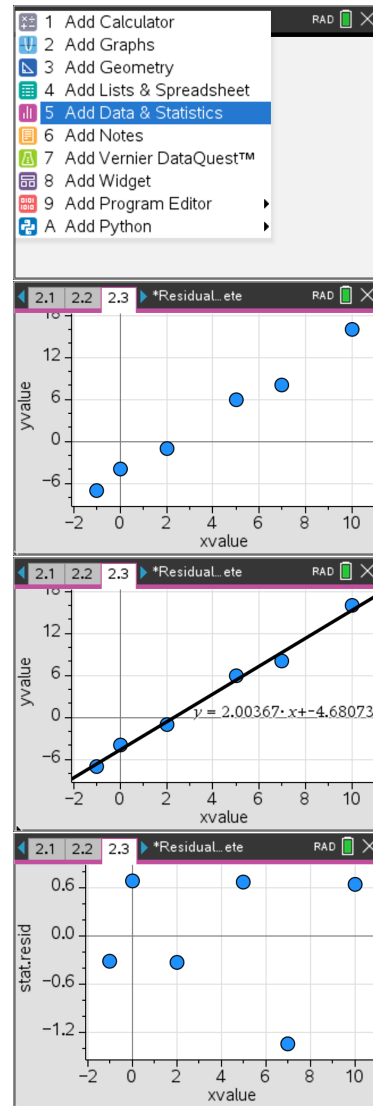
    The residual is the actual value minus the predicated value. A regression model is justified as appropriate for a data set if the residuals of a regression, the residual plot, appear without pattern. To view the residual plot, click in the left gray region and select stat.resid.

    Does your residual plot have a pattern? Would a linear regression be appropriate for this data set?

    <u>**Answer:**</u> The residual plot does not have a pattern. A linear regression is appropriate for this data set.

3. Add a page by pressing [ctrl] [doc▾]. Select> Add Calculator. To evaluate the predicted values, type $f1(-1)$ and then calculate the residual when x is –1. Calculate $f1(0)$ and then calculate the residual when x is 0. Notice that one residual value is negative and one is positive. What does this tell us about the predicted value as being an underestimate or an overestimate?

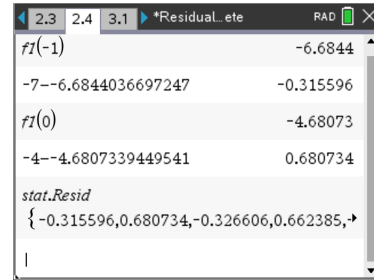### Answer:

f1(−1) = −6.68440367; Residual = −0.31559633

f1(0) = −4.680733945; Residual = 0.680733945

If the residual is positive, the predicted value is an underestimate. If the residual is negative, the predicted value is an overestimate.

Note: To view the residual list for all of the data points, press [var] and select stat.Resid. Scroll to the right to see more values.

Teacher Note: The graph of the scatter plot with the regression equation may be helpful to visualize the overestimate or underestimate.


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Part 2

Use the following data set in Part 2.

| x	−1	0	1	2	4	5
y	0.2	0.6	0.9	2.1	7.9	16.2

4. Follow the steps in Part 1. Enter the *x* values in the column labeled *xvalue.* Enter the *y* values in the column labeled *yvalue.* Compute a linear regression, view the scatter plot, and view the residual plot. Does your residual plot have a pattern? Would a linear regression be appropriate for this data set?
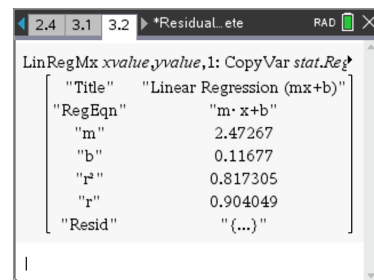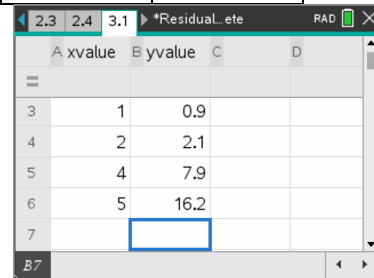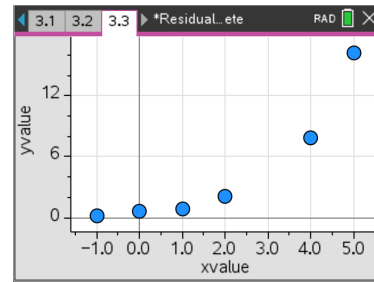
Answer: The residual plot appears to have a pattern. A linear regression is not appropriate for this data set.

5. Now compute an exponential regression. Add a page by pressing `ctrl` `doc▾`. Select > Add Calculator. Press `menu` . > Statistics, >Stat Calculations, then \ Exponential Regression. View the residual plot. Does your residual plot have a pattern? Would an exponential regression be appropriate for this data set?
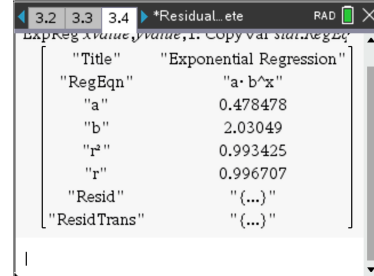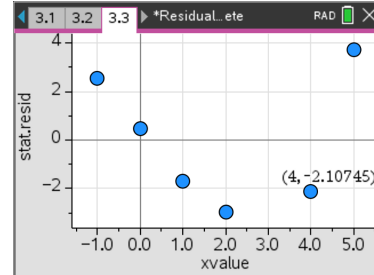
Answer: The residual plot does not appear to have a pattern. An exponential regression is appropriate for this data set.
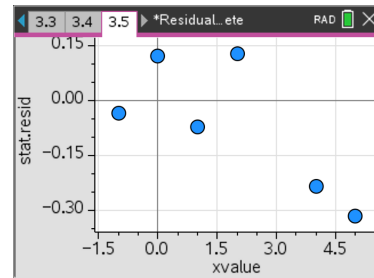
Extensions

1. Find a data set that models a quadratic and ask the students to follow the steps for a quadratic regression. Observe the scatter plot and the residual plot.

Wrap Up

Upon completion of the lesson, the teacher should ensure that students are able to understand:

- How to input data and view scatter plots.
- How to compute linear, quadratic, and exponential regressions.
- How to plot residuals and determine if the residual plot has a pattern.