Edgenuity

Warm-Up | Regression Models

Lesson Question

How do you determine an appropriate nonlinear model to use for a scenario?

Lesson Goals

Model real-world scenarios using linear, quadratic, or exponential [regression].

- **Use** a model to make [predictions].
- **Identify** [limitations] to models.
- **Interpret** the graph of a model.
- **Determine** which type of [function] best models the data.

Words to Know

Fill in this table as you work through the lesson. You may also use the glossary to help you.

evaluate	to determine the [value] of
predict	to tell or state in [advance]
extrapolation	a prediction made [outside] the range of the values in the data set

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Words to Know

interpolation	a prediction made [within] the range of the values in the data set
scatterplot	a graph that has two sets of data plotted as points so that [relationships] between the data can be visualized

Linear Regression

Use the [regression] calculator to find a [linear] model for the data in the table.

x	y
–4	–13
–2	–6
0	–1
2	5
4	12

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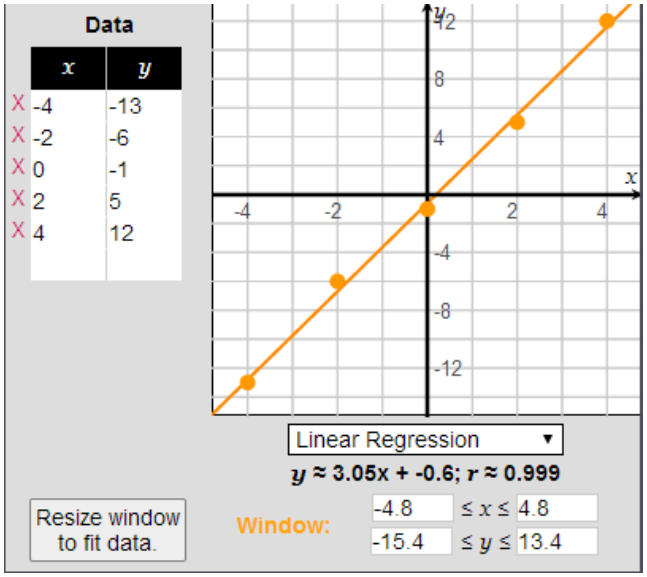
Using the Regression Calculator to Find a Linear Model

- Put each (x, y) pair into the calculator.
- Press “Resize window to fit data” in order to see all the points.
- Make sure that “Linear Regression” is highlighted in the drop down.
- Once we click that, we get a regression model and an equation for the model.

$$y = \boxed{3.05x} - 0.6$$



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Using the Regression Calculator to Find an Exponential Model

The number of bacteria colonies in a petri dish as a function of time, in hours, is shown in the table. Find an exponential function that models the data. Round numerical values to the nearest hundredth.

x $f(x)$ or y

Time (hour)	Number of Colonies
0	10
1	19
2	62
3	96
4	199
5	471

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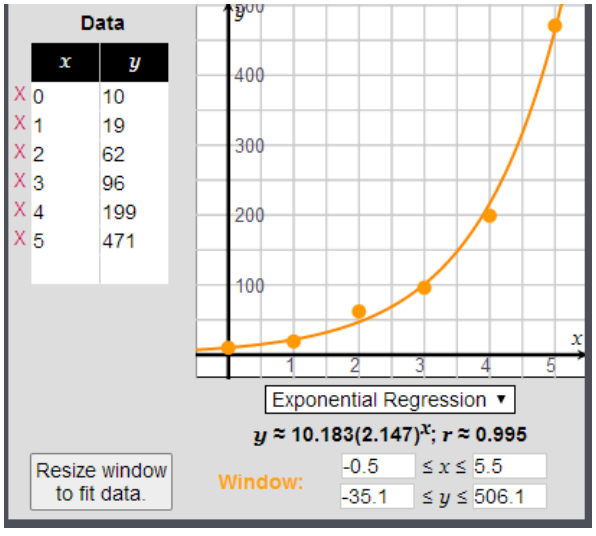
Using the Regression Calculator to Find an Exponential Model



- Put each (x, y) pair into the calculator.
- Press “Resize window to fit data” in order to see all the points.
- Go to the dropdown menu and select “Exponential Regression.”
- The equation shown is:

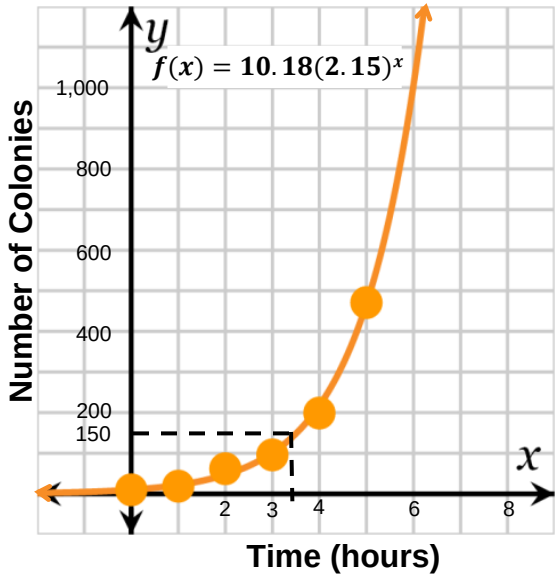
$$y = 10.18(\boxed{2.15})^x$$

Making Predictions with the Graph of a Model

Interpolation is a prediction made [within] the range of values in a data set.

Predict the approximate number of bacteria colonies after 3.5 hours by **evaluating** $f(3.5)$. $(x = 3.5)$

[150] bacteria colonies



Making Predictions with the Equation of a Regression Model

The number of bacteria colonies in a petri dish as a function of time, in x hours, can be modeled with the function $f(x) = 10.18(2.15)^x$.

Extrapolation is a prediction made [outside] the range of values in the data set.

Evaluate the number of bacteria colonies there will be after 6 hours.

$$f(6) = 10.18(2.15)6$$

$$= 1005.4918 \ldots \approx$$ [1,005] bacterial colonies

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Using the Regression Calculator to Find a Quadratic Model

A company manufactures cardboard boxes. The company's profit, in dollars, as a function of the number of units sold is shown in the table. Find a [quadratic] function that models the data.

Use the model to predict how many units sold will produce the [maximum] profit.

x Number Sold	y Profit (thousands of $)
0	–600
100	–15
200	500
300	645
400	705
500	540

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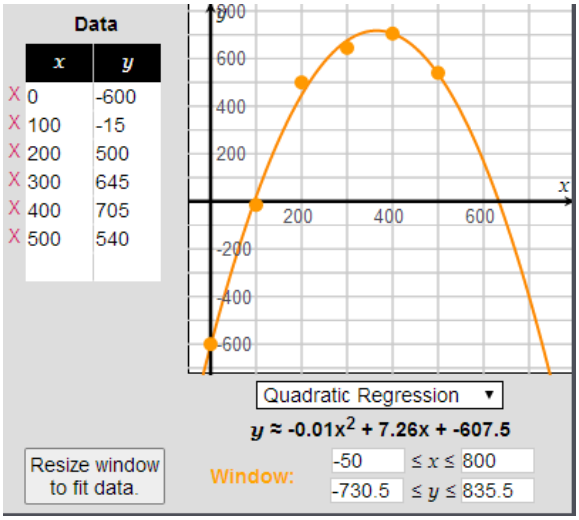
Using the Regression Calculator to Find a Quadratic Model



Select "Quadratic Regression" from the dropdown menu.

max profit

Vertex appears to be at about (360, 710).

360 units → $ [710,000]

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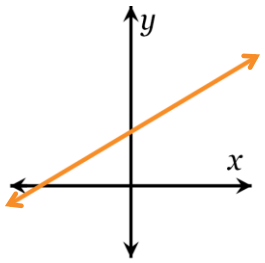
Different Function Types

To choose whether a linear, exponential, or quadratic model is the best fit, consider the general shape and properties of the graphs of these functions.

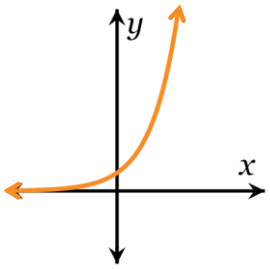
straight line

turning point

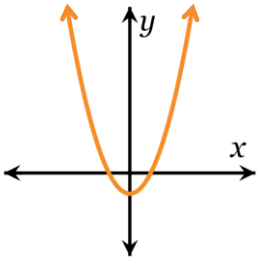
Linear Function



Exponential Function



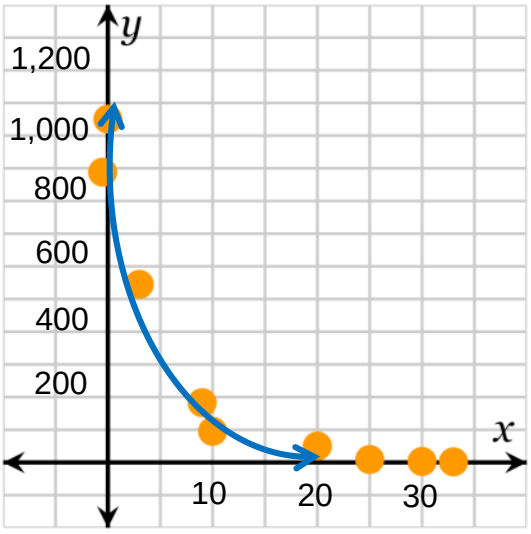
Quadratic Function



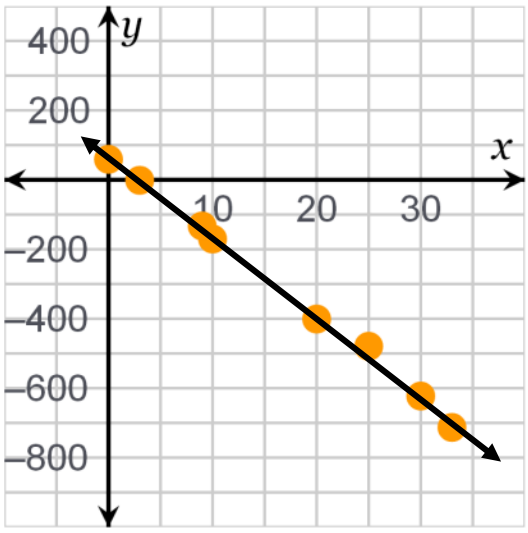
Choosing a Function to Model Data

Which kind of function **best** models the data shown in each **scatterplot**?

exponential



linear



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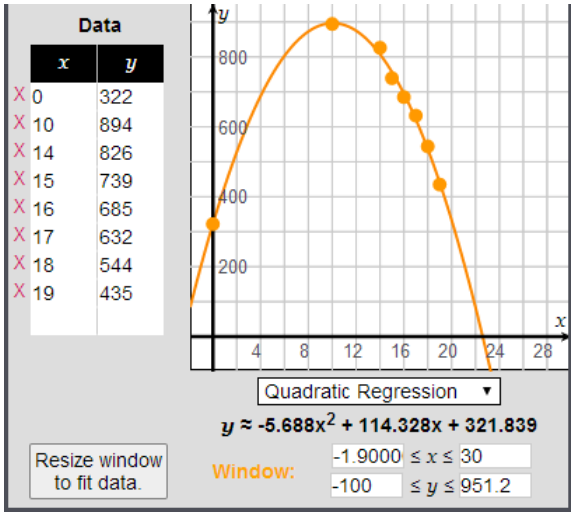
Finding a Regression Model

The total sales, in millions of dollars, for snowmobiles is given for the years shown in the table. Find a regression model that best models the data. Round numerical values to the nearest tenth.

	x	y
	Year	**Total Sales (millions of $)**
	1990	322
	2000	894
	2004	826
	2005	739
	2006	685
	2007	632
	2008	544
	2009	435

Finding a Regression Model



x	Year	y Total Sales (millions of $)
0	1990	322
10	2000	894
14	2004	826
15	2005	739
16	2006	685
17	2007	632
18	2008	544
19	2009	435

- The input, x, represents years after 1990.
- Try several different types of regressions until you find one that looks like a good fit.
- In this case, a quadratic model is a good fit.

$$y = -5.7x^2 + 114.3x + 321.8$$

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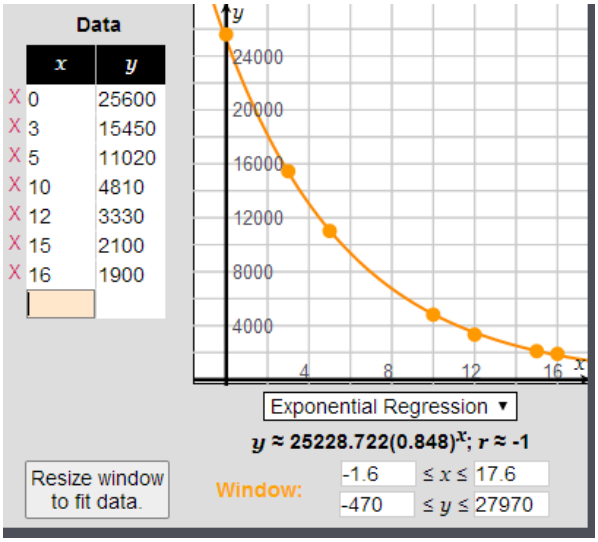
Finding and Using a Regression Model

The value of a car since its purchase is given in the table. Find a regression model that best models the data. Round numerical values to the nearest tenth. (Find)

Use the model to predict the value of the car after 18 years. (Use)

	x	y
	Years since Purchase	**Car Value ($)**
	0	25,600
	3	15,450
	5	11,020
	10	4,810
	12	3,330
	15	2,100
	16	1,900

Finding a Regression Model



Years since Purchase	Car Value ($)
0	25,600
3	15,450
5	11,020
10	4,810
12	3,330
15	2,100
16	1,900

- You can see that the Linear Regression is default. Notice that all the points on the scatter plot are far from the line. A linear model is not a good fit. Let's try a Quadratic Regression.
- Now this is a better fit than linear, however there is no indication of a turning point. So this may not be the best. Let's see if exponential is better.
- The graph of the exponential model appears to go through all the points. So, this is the best choice.
- Rewrite the function running the values to the nearest hundredth.

$$f(x) = 25228.72(0.85)^x$$

$$f(18) = 25228.72(0.85)^{18}$$

$$= 1353.43 \approx \$\ 1{,}353$$

Summary | Regression Models

Lesson Question

How do you determine an appropriate nonlinear model to use for a scenario?

Answer

(Sample answer) To determine an appropriate nonlinear model to use for a scenario, first plot the data points. Then, using visual clues and a regression calculator, determine which general shape and properties best fit the data points. Once the best fit is determined, the regression calculator can be used to determine the equation, which can then be used to predict values.

Slide 2

Review: Key Concepts

- Use the regression calculator to find a model for a set of data.
  - Linear functions have a constant [additive] rate of change.
  - Exponential functions have a constant [multiplicative] rate of change.
  - Quadratic functions do not have a constant rate of change, but have a [turning] point.
- Consider limitations when making predictions using regression models.

Summary | Regression Models

Use this space to write any questions or thoughts about this lesson.