Activity

8-5 Linear, Exponential, and Quadratic Models

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MODEL & DISCUSS

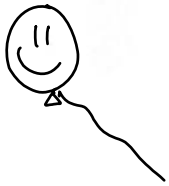
Jacy and Emma use different functions to model the value of a bike x years after it is purchased. Each function models the data in the table.

Jacy's function: $f(x) = -14.20x + 500$

Emma's function: $f(x) = 500(0.85)^x$

Time (yr)	Value ($)
0	500.00
1	485.20
2	472.13
3	461.00
4	452.10

A. **Make Sense and Persevere** Why did Jacy and Emma not choose a quadratic function to model the data? MP.1



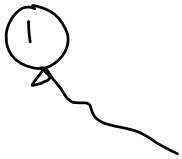
B. Whose function do you think is a better model? Explain.

C. Do you agree with this statement? Explain why or why not.

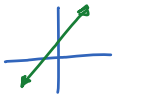
To ensure that you are finding the best model for a table of data, you need to find the values of the functions for the same values of x.

HABITS OF MIND

Communicate Precisely How is finding the best model for data in a real-world situation similar to finding the best model in a mathematical situation? How is it different? MP.6



Linear, Exponential, & Quadratic



Notes

Assess

EXAMPLE 1 **Try It! Determine Which Function Type Represents Data**

1. Does a linear, quadratic, or exponential function best model the data? Explain.

d: current − previous

a.

x	0	1	2	3	4
y	−2	−5	−14	−29	−50

1st: −3 −9 −15 −21

2nd: −6 −6 −6

→ quadratic

b.

x	−2	−1	0	1	2
y	4	12	36	108	324

1st: +8 +24 +72 +216

2nd: +16 +48 + ...

y-ratios: $\frac{12}{4} \rightarrow \frac{36}{12} \rightarrow \frac{108}{36} \rightarrow \frac{324}{108}$ → mult 3

→ exponential

EXAMPLE 2 **Try It! Choose a Function Type for Real-World Data**

2. Determine whether a linear, quadratic, or exponential function best models the data. Then, use regression to find the function that models the data.

x	0	1	2	3	4
y	~~100~~	~~89.5~~	~~78.9~~	~~68.4~~	~~57.8~~

3 9 19 33 51

1st: +6 +10 +14 +18

2nd: +4 +4 +4

→ quadratic

HABITS OF MIND

Reason If a table of data does not have common differences or a common ratio, can you still make predictions about other data points in the data set? Explain. MP.2

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Notes

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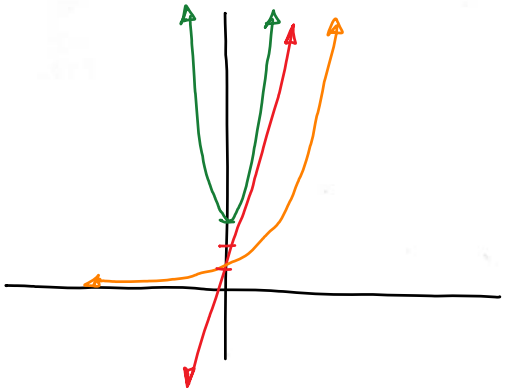
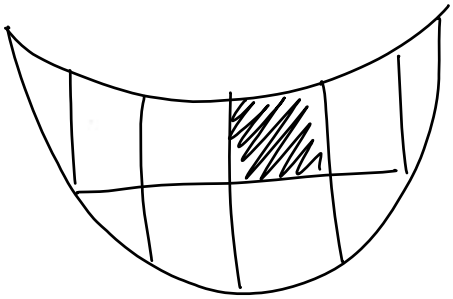
EXAMPLE 3 **Try It! Compare Linear, Exponential, and Quadratic Growth**

3. Compare the functions $f(x) = 3x + 2$, $g(x) = 2x^2 + 3$, and $h(x) = 2^x$. Show that as x increases, $h(x)$ will eventually exceed $f(x)$ and $g(x)$.





HABITS OF MIND

Generalize How can the rate of change help determine the type of function that best fits the data? MP.8

Do You UNDERSTAND?

1. **ESSENTIAL QUESTION** How can you determine whether a linear, exponential, or quadratic function best models data?

2. **Reason** The growth of a function is less from $x = 1$ to $x = 4$ than from $x = 5$ to $x = 8$. What type of function could it be? Explain. MP.2

3. **Error Analysis** Kiyo used a quadratic function to model data with constant first differences. Explain the error Kiyo made. MP.3

Do You KNOW HOW?

Determine whether the data are best modeled by a linear, quadratic, or exponential function.

4.

x	0	1	2	3	4
y	−2	1	10	25	46

1st: +3 +9 +15 +21

2nd: +6 +6 +6

→ quadratic

5.

x	−2	−1	0	1	2
y	2	7	12	17	22

1st: +5 +5 +5 +5

→ linear

6. A company's profit from a certain product is represented by $P(x) = -5x^2 + 1{,}125x - 5{,}000$, where x is the price of the product. Compare the growth in profits from $x = 120$ to $x = 140$ and from $x = 140$ to $x = 160$. What do you notice?