CARNEGIE LEARNING

More Than Meets the “Line”

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#longlivemath
#NCTMannual

Session Objectives

- Discuss the meaning of ordered pairs on a scatter plot.
- Use informal methods to determine a line of best fit.
- Interpret slopes and *y*-intercepts of lines of best fit.
- Use lines of best fit to interpret data and make predictions, including interpolation and extrapolation.
- Consider ways to teach with a focus on interpretation rather than computation.

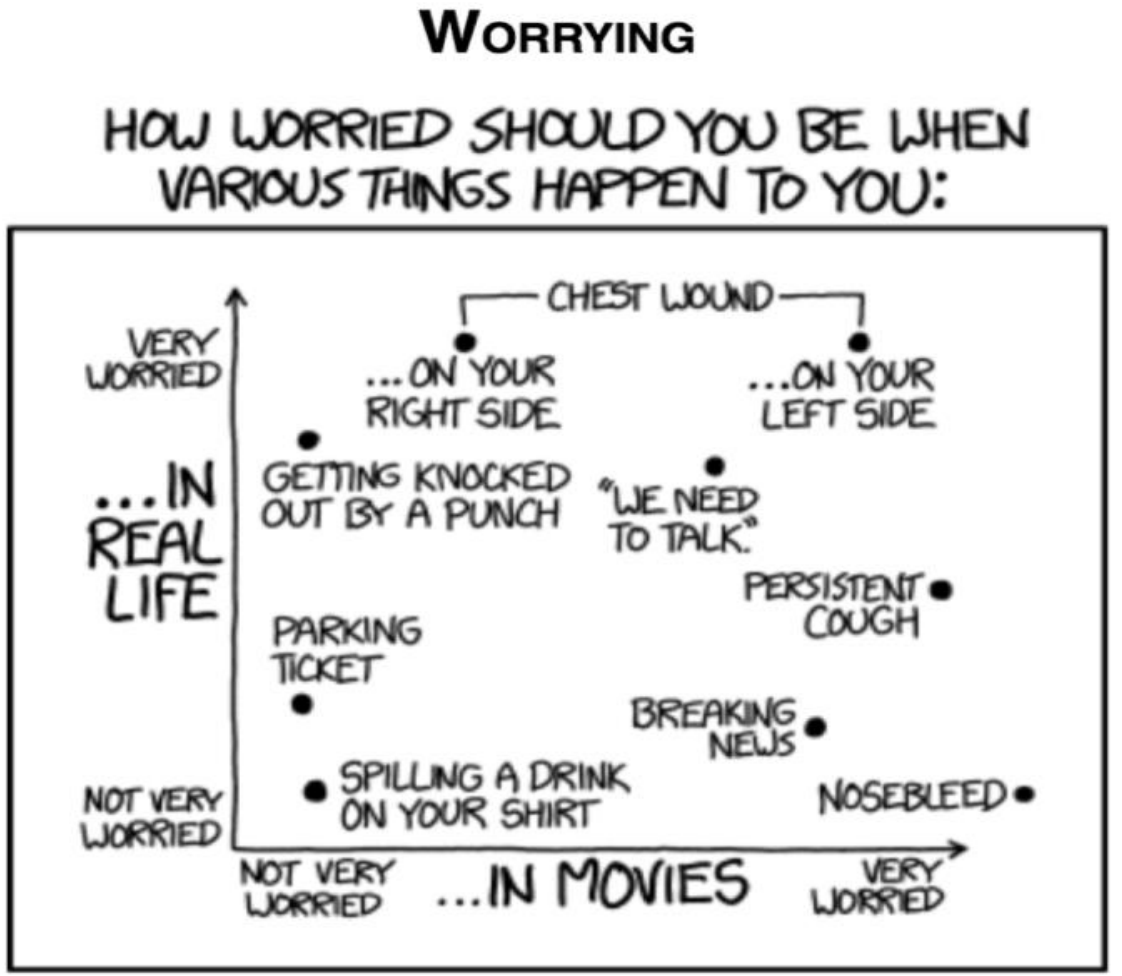
Standards Related of Lines of Best Fit

- Grade 8
  - Construct and interpret scatter plots
  - Informally fit a straight line and assess the fit, when the data is approximately linear
  - Use the equation of a linear model to solve problems and interpret the meaning of the parameters of the line
- High School (Grade 9, typically)
  - Fit functions to data
  - Informally assess the fit by plotting and analyzing residuals
  - Interpret parameters of the model in terms of context
  - Use technology to compute correlation coefficient for a linear fit

Scatter Plots

Making Sense of Data Points

Why Worry about Data?



Interpreting Data Points

- Locate a bag of graphs.
- Each participant should:
  - reach in and randomly select a scatter plot,
  - circle 1 point on the scatter plot, and
  - write what that point **specifically** represents on the back of the plot.
- You have 1 minute and 45 seconds.

Interpreting Data Points

- Pass your paper to the person on your right.
  - Is their description correct?
  - Does it make sense?
  - Could their description be more specific?

- You have 1 minute and 45 seconds.

Scatter Plot Sort

- With the participants around you,
  - Sort the scatter plots in the bag into any number of groups.
  - Be able to identify the characteristics that led you to form your groups.

Lines of Best Fit

Determining Lines of Best Fit

What's the Question?

- The Statistical Process
  - Pose a question
  - Collect data
  - Analyze the data
  - Interpret the result

- Find the scatter plots that seem to be linear.
  - Why might this data have been collected?
  - What question might the data collector might want to answer?
  - What is the purpose of the data?
  - What additional or follow-up questions might you ask?

Determining Lines of Best Fit

- Using the scatter plot showing distance run and calories burned,
  - What conclusions can you draw from the scatter plot?
  - Using the plot, predict the number of calories burned if you run
    - 1.5 miles
    - 6.5 miles
    - 15 miles
- Work/compare with those around you.

We have additional copies of this graph for you.

Determining Lines of Best Fit

- Use the provide pasta noodle and tape to estimate a line that ‘best fits’ the data.
  - What does it mean for a line to best fit the data?
  - Did everyone around you place their line in the same place?
  - How are your lines vary? How are they similar?

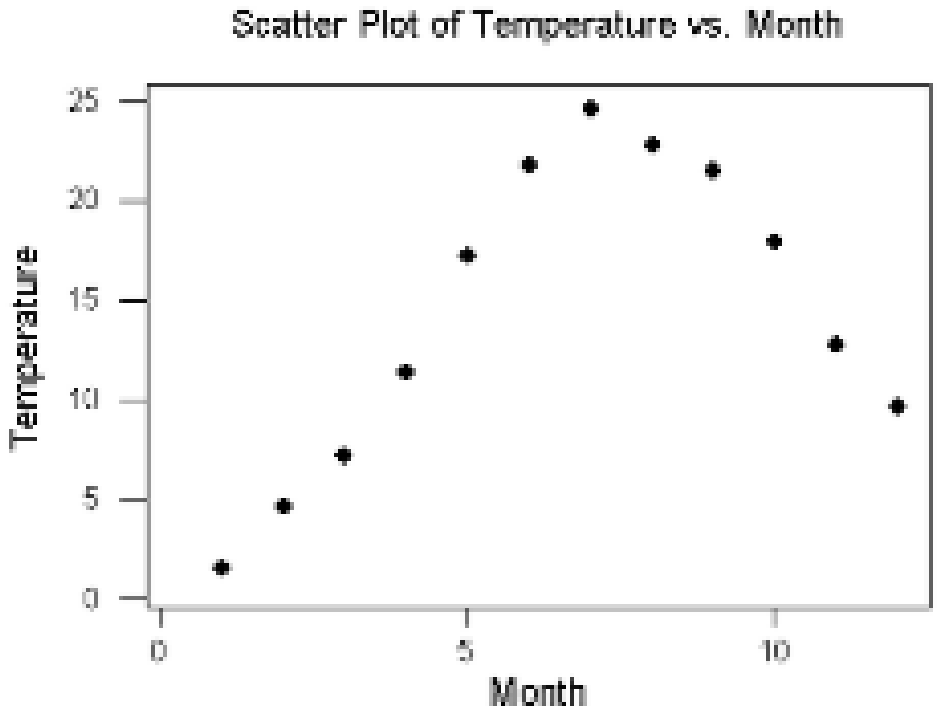
We have plenty of pasta and tape if you need more!

Determining Lines of Best Fit

- Determine the equation for your pasta line.
  - How did you determine your equation? What information did you need?
  - What is the meaning of the line? What does the *x* represent? What does the *y* represent?
  - What is the meaning of the *y*-intercept in terms of the scenario?
  - What is the meaning of the slope in terms of the scenario?

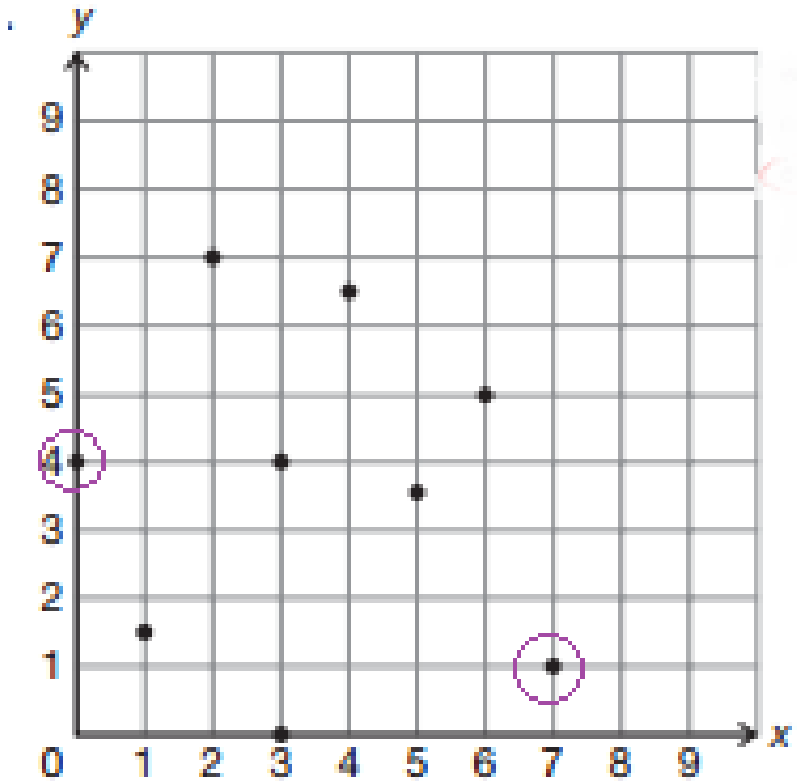
Does everyone have the same equation?

Misconceptions and Pitfalls



- "Pick the first and last data points"
  - $y = \frac{8}{11}x + \frac{14}{11}$
  - $y = 0.73x + 1.27$
- What is wrong with this strategy?

Misconceptions and Pitfalls



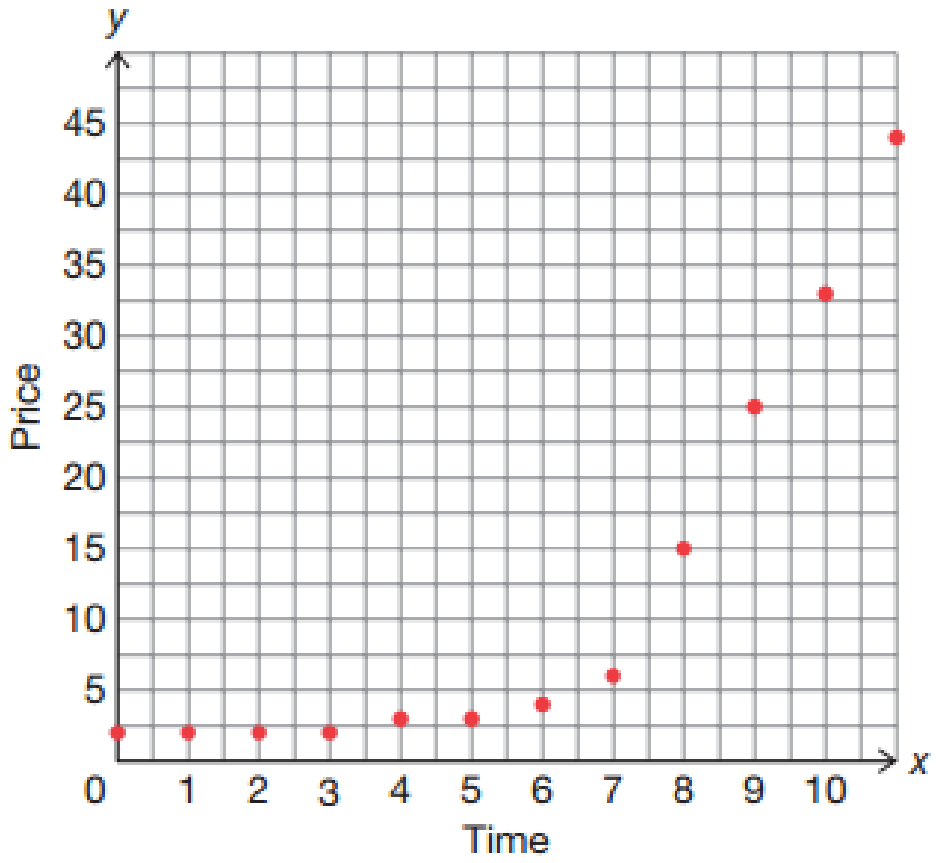
- “Pick the first and last data points”
  - $y = -\frac{3}{7}x + 4$
- What is wrong with this strategy?

Misconceptions and Pitfalls

- Computation without plotting or thoroughly examining the data.
- What is wrong with this strategy?

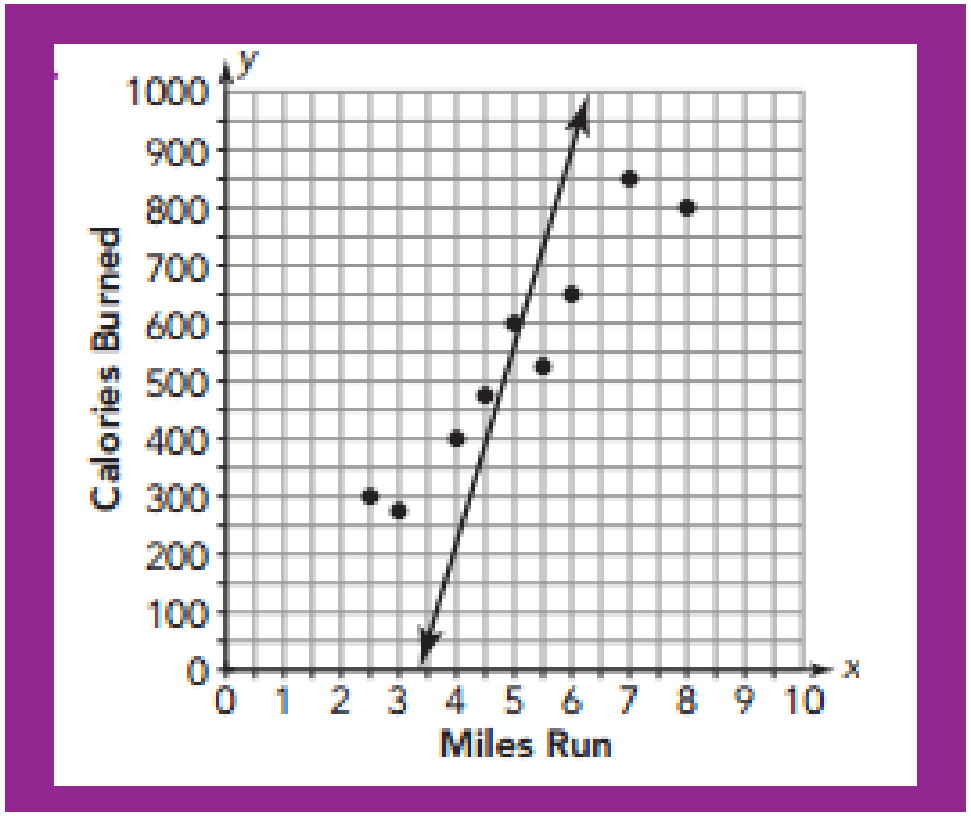
Year	Price (cents)
1900	2
1910	2
1920	2
1930	2
1940	3
1950	3
1960	4
1970	6
1980	15
1990	25
2000	33
2010	44

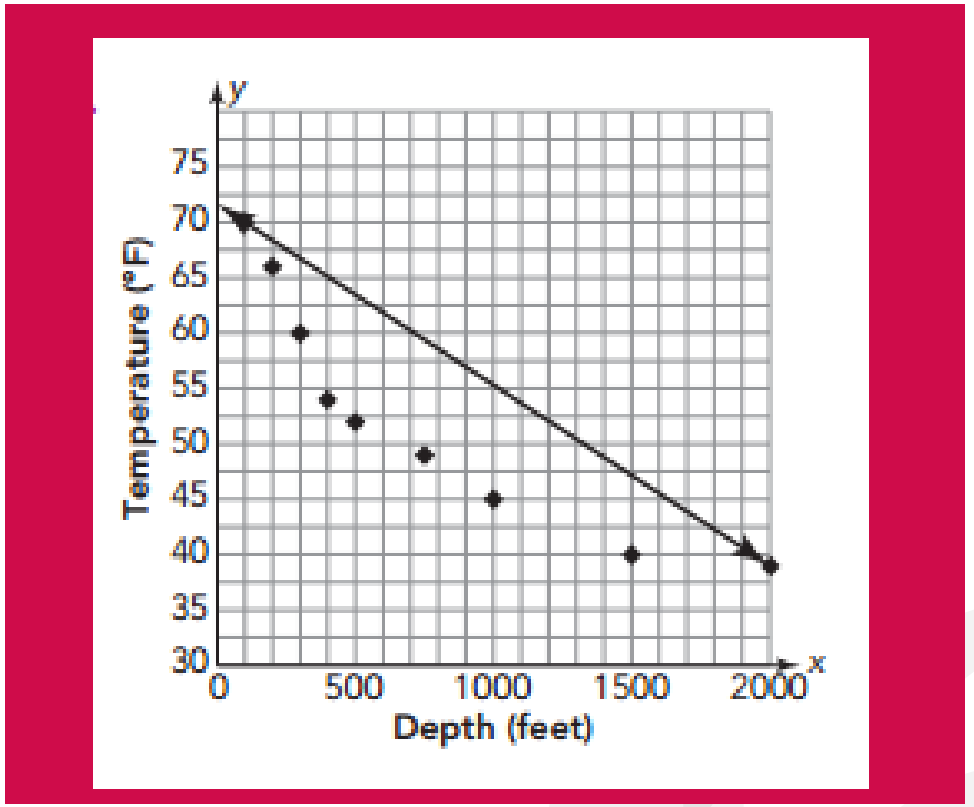
Misconceptions and Pitfalls



- Misconceptions in interpretation with adjusted scales or data values.

Misconceptions: What is the Reasoning Error?

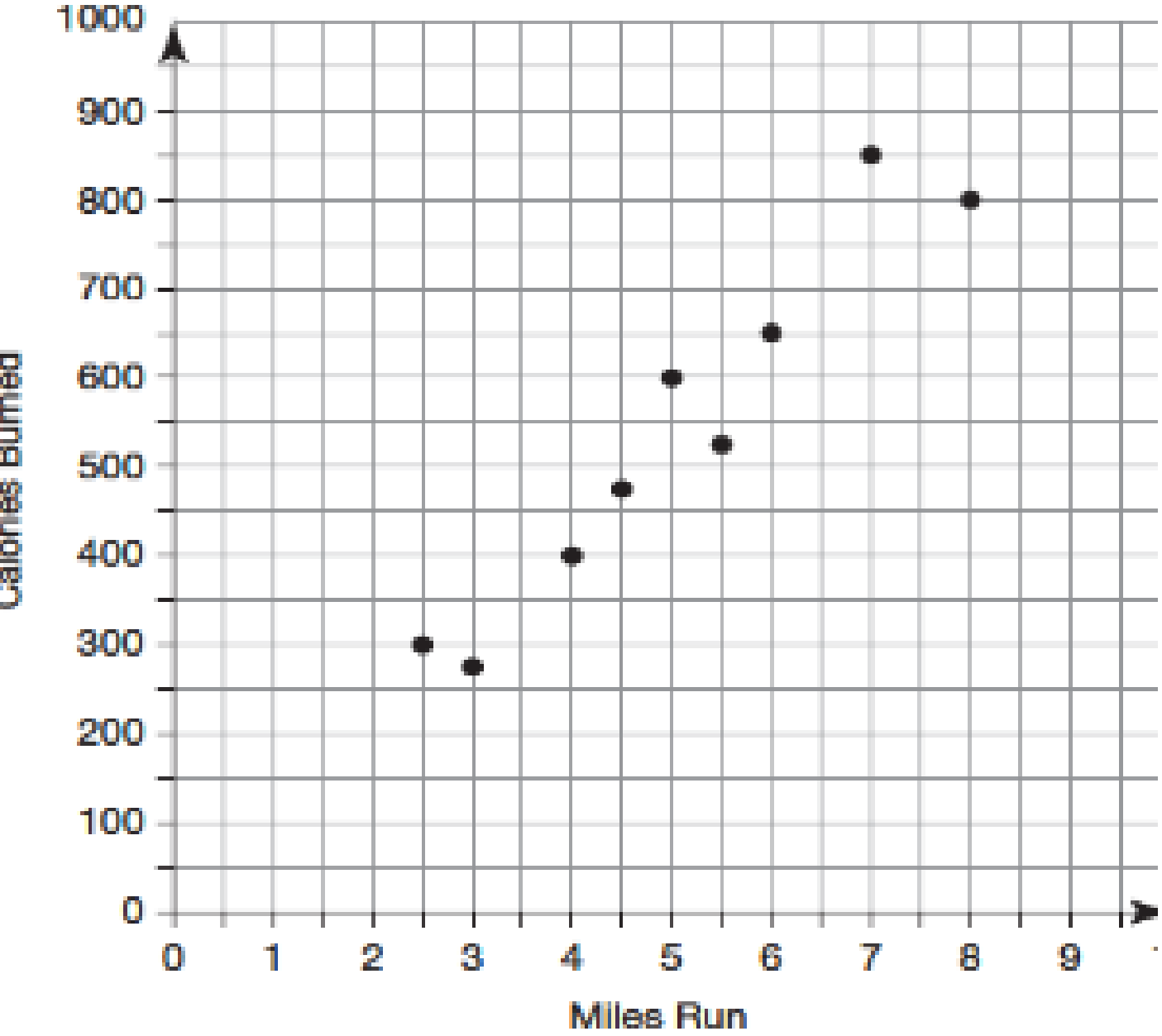




Using Lines of Best Fit

Prediction: Extrapolation and Interpolation

Assessing Fit of the Linear Model

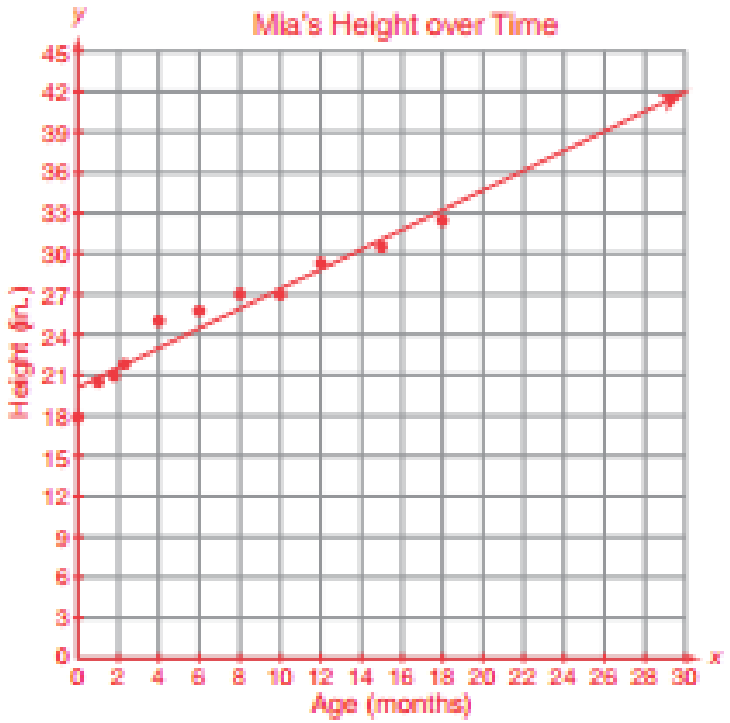


You Have an Equation. Now What?

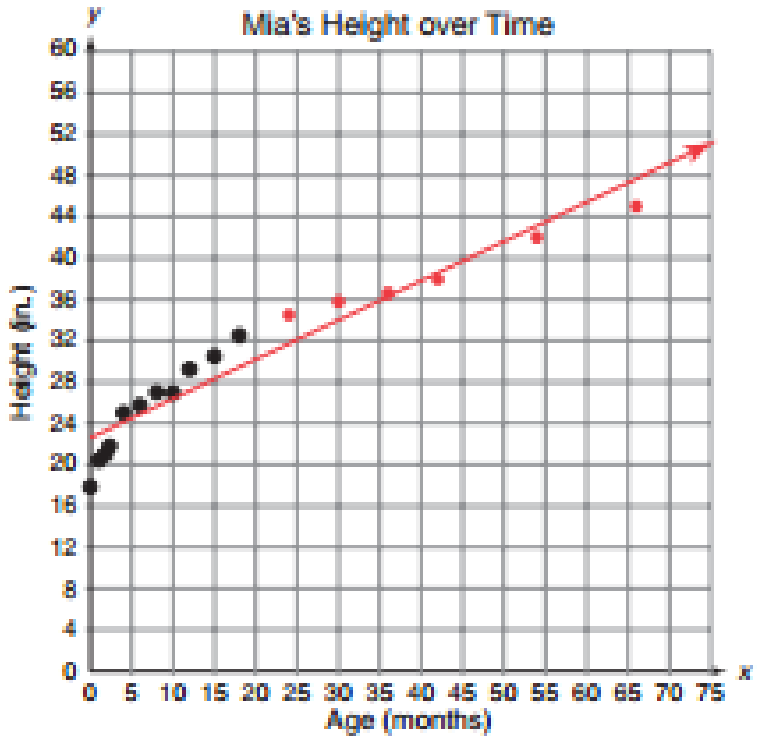
- Do your earlier predictions fall on your line?
- Are any of the predictions more accurate than others?
- What is the difference between interpolation and extrapolation?
- Which type of prediction is more reliable?

Prediction Pitfalls

$y = 0.73x + 20.08$



$y = 0.38x + 22.66$



Beware of Context

Line 1 predicts a height of 117.8 inches when Mia is 18 years old.

Line 2 predicts a height of 104.74 inches when Mia is 18 years old.

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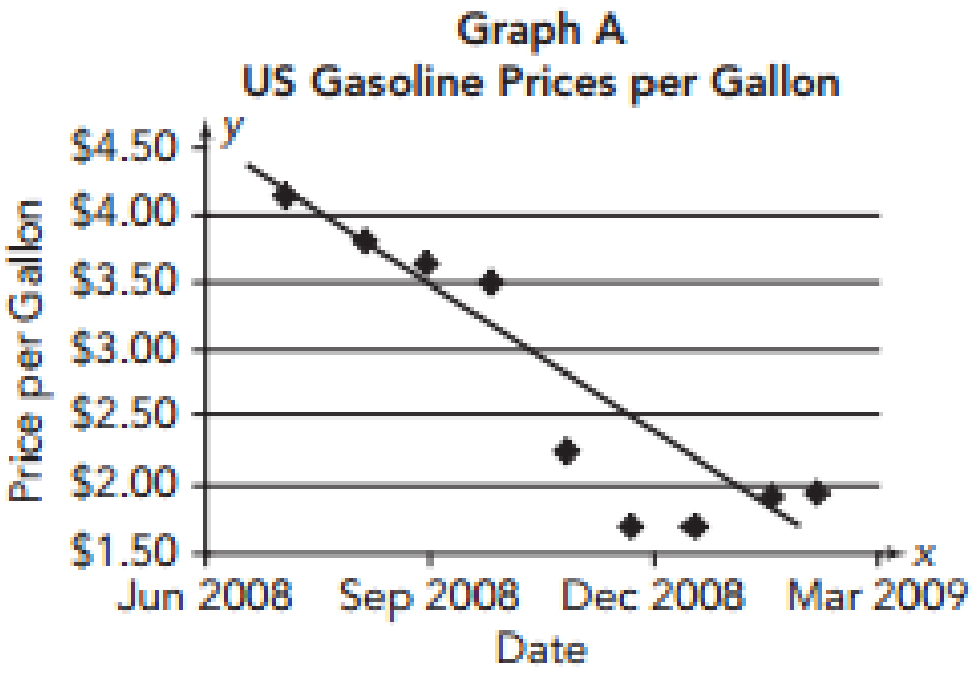
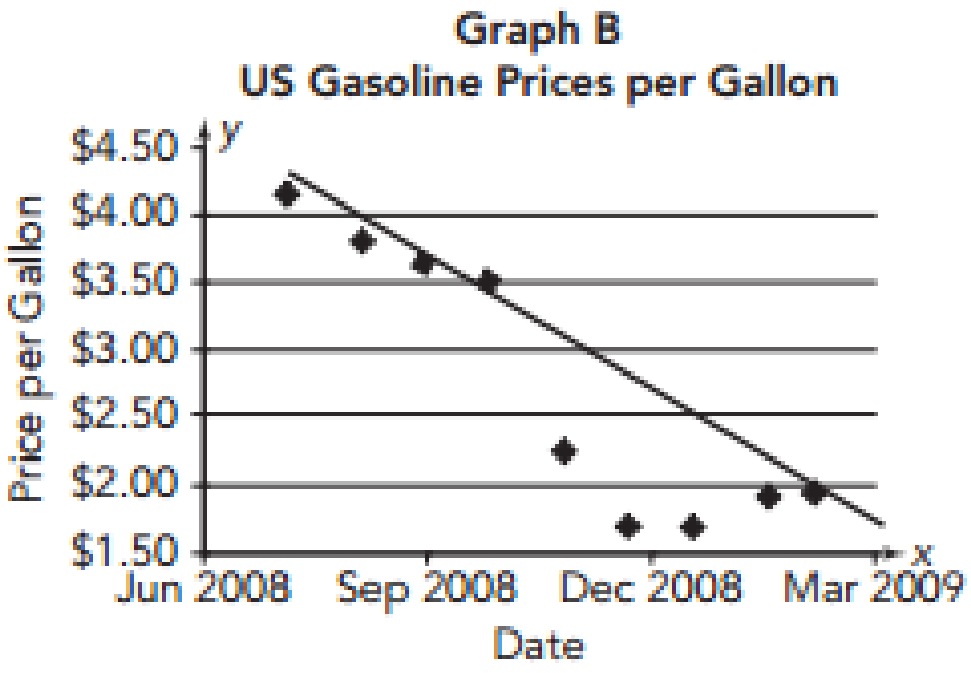
Learning Targets

If analysis and interpretation are the primary learning targets, how do we engage students in this work efficiently?

Which Line is a Better Fit?





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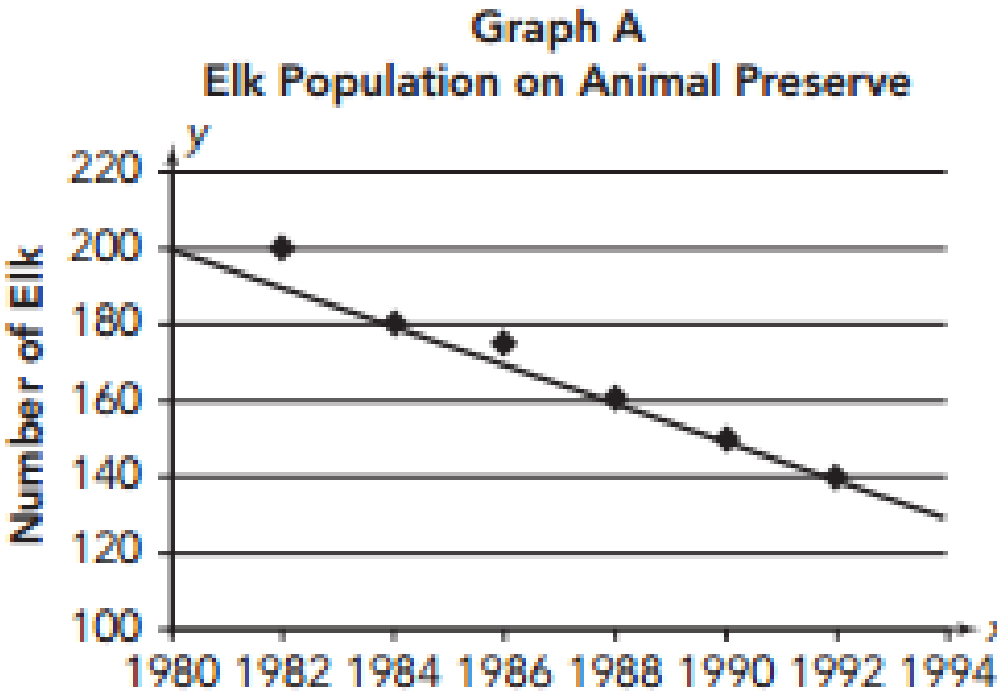

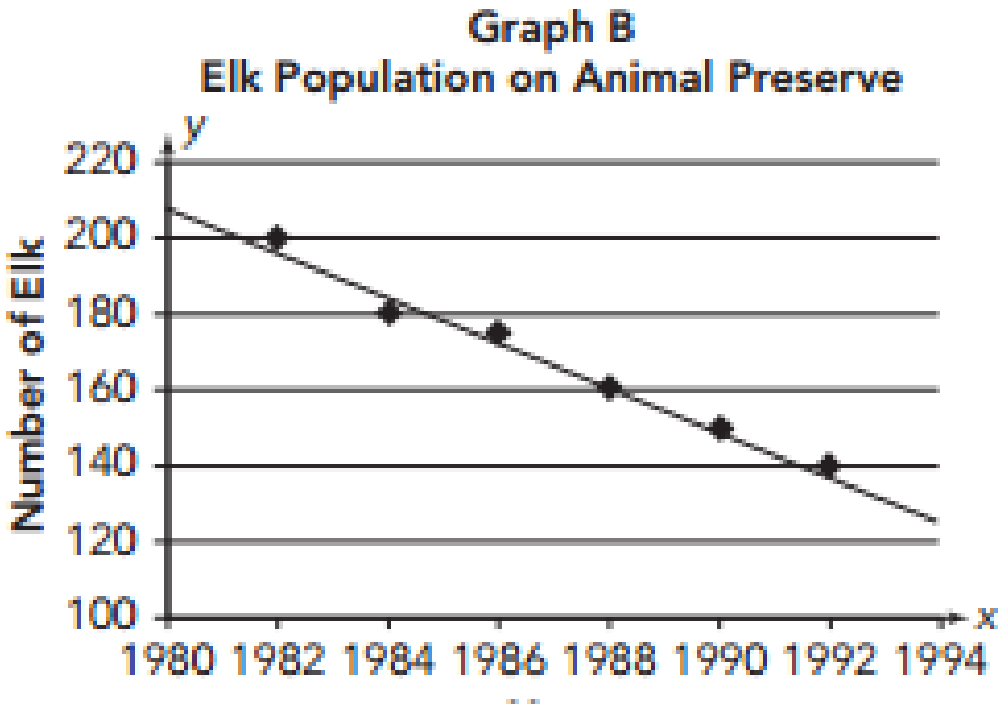

Additional Ideas?

- How might you use the scatter plots from our original scatter plot sort?
- How could you use technology?

Untitled Graph

desmos

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x_1	y_1
2	300
3	275
4	400
4.5	475
5	600
5.5	525
6	650
7	850
8	800

$y_1 \sim mx_1 + b$

STATISTICS

$r^2 = 0.906$

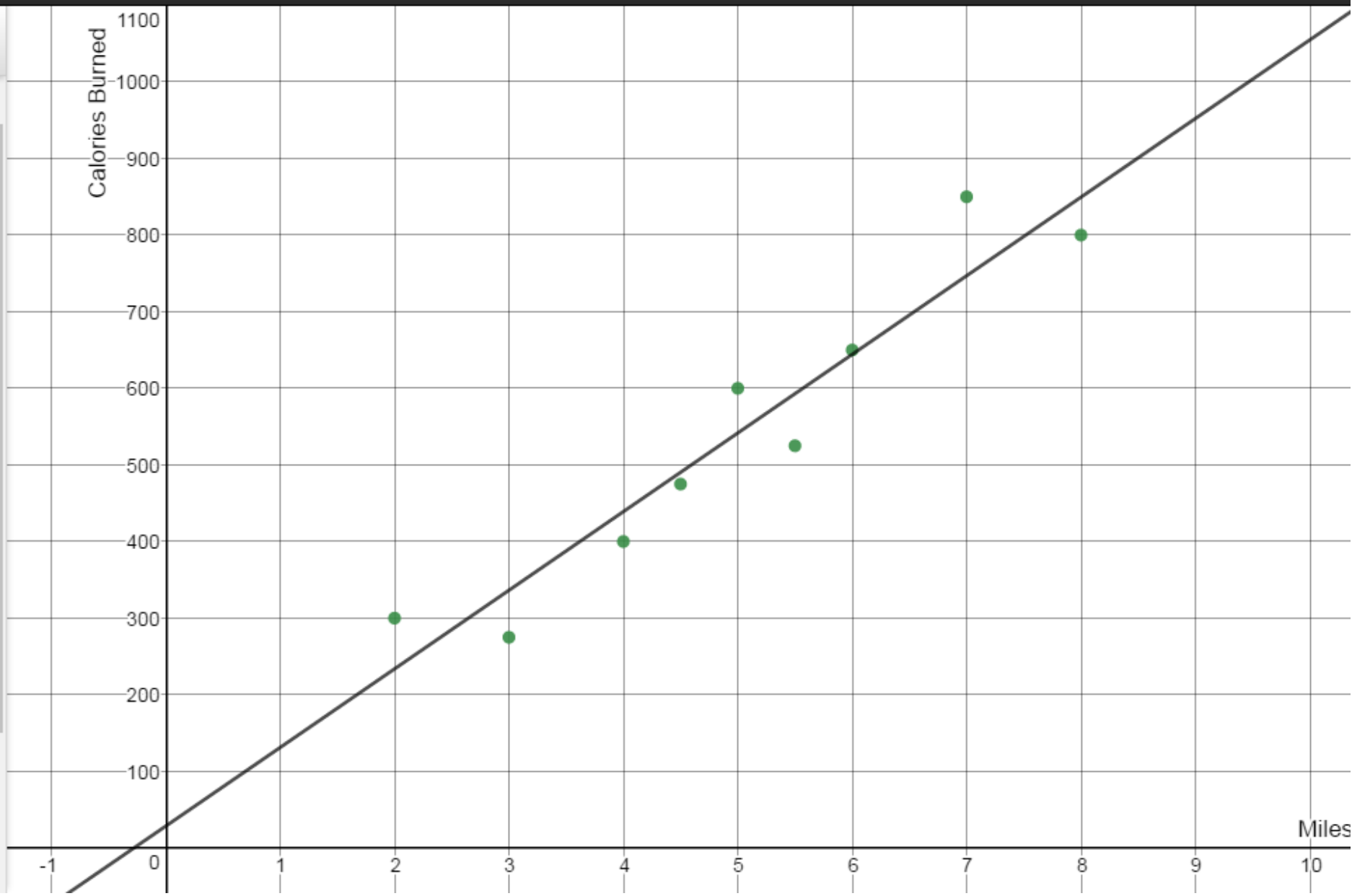
$r = 0.952$

RESIDUALS

e_1 plot

PARAMETERS

$m = 102.63$ $b = 28.509$



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Thank you!

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