5.2

America's Next Top Polynomial Model

Modeling with Polynomials

LEARNING GOALS

In this lesson, you will:

- Determine the appropriate regression equation to model a problem situation.
- Predict outcomes using a regression equation.
- Sketch polynomial functions that appropriately model a problem situation.

KEY TERMS

- regression equation
- coefficient of determination

Transportation plans are an essential part of any large urban development project. Whether designing residential blocks, shopping districts, or stadiums, part of the planning process is determining how to move large groups of people in and out of an area quickly. Building new highways, bus stations, bike lanes, or railways may be necessary for some large-scale developments.

Part of urban development projects is monitoring existing conditions in a specific area. Planners must determine how well the current traffic infrastructure meets the community's needs before modeling and predicting what transportation processes may work best for a future project.

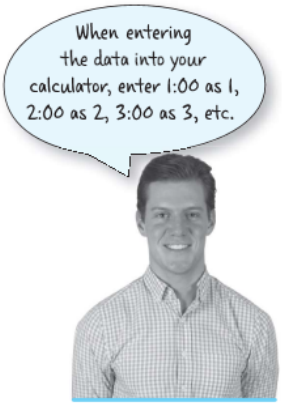
What things do you consider when planning projects? What type of predictions or considerations do you make when planning projects?

PROBLEM 1 Feeling a Little Congested

City planners consider building a new stadium on several acres of land close to the downtown of a large city. They monitored the number of cars entering and exiting downtown from a major highway between 1:00 PM and 7:00 PM to determine current traffic conditions.

1. Analyze the table of values that represent the average number of cars entering and exiting downtown during the given hours of a typical weekday. The value for time represents the start-time for the full hour over which the vehicles were monitored.

Time (PM)	Average Number of Vehicles on a Typical Weekday (thousands)
1:00	7.0
2:00	10.8
3:00	14.5
4:00	21.1
5:00	23.9
6:00	19.0
7:00	10.0



a. Describe any patterns you notice. Explain the patterns in the context of this problem situation.

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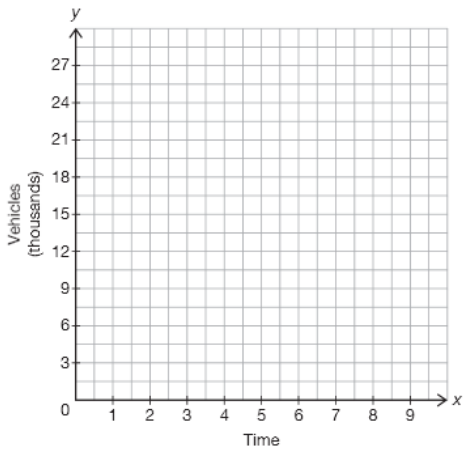
b. Predict the type of polynomial that best fits the data. Explain your reasoning.

2. Create a scatter plot of the data.



Recall that a **regression equation** is a function that models the relationship between two variables in a scatter plot. The regression equation can be used to make predictions about future events. Any degree polynomial can model a scatter plot, but data generally has one curve that best fits the data. You may also recall that the **coefficient of determination** (R^2) measures the "strength" of the relationship between the original data and its regression equation. The value ranges from 0 to 1 with a value of 1 indicating a perfect fit between the regression equation and the original data.

3. Use a graphing calculator to determine the regression equation for the average number of cars entering and exiting downtown on a typical weekday. Sketch the regression equation on the coordinate plane in Question 2. How well does the regression equation model the data? Was your prediction about the type of polynomial that best fits the data correct? Explain your reasoning.

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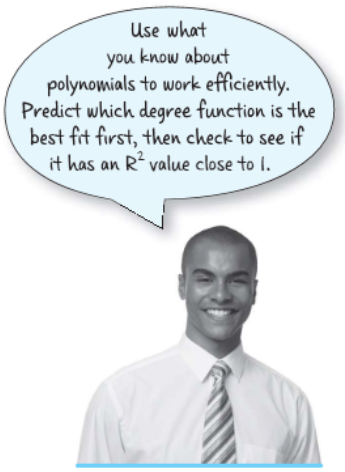
4. Use the regression equation that best models the data to make predictions.

   a. Downtown is congested when more than 20,000 cars are on the streets and highway. Predict when the downtown will be congested. Explain your reasoning.



   b. Predict the hours when the number of cars that enter and exit downtown is less than 10,000. Explain your reasoning.

   c. Predict the number of vehicles that enter or exit downtown during the hour starting at noon.

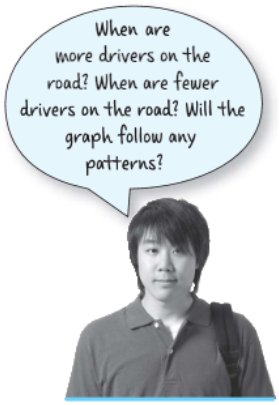
   d. Predict the number of vehicles that enter or exit downtown during the hour starting at 9 PM.

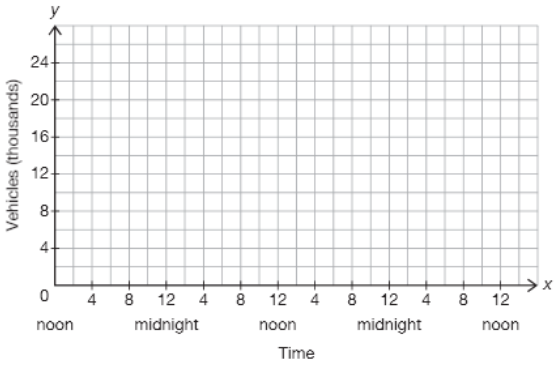
   e. Predict the number of cars that enter or exit downtown during the hour starting at midnight the previous evening.

5. Consider the data and your regression equation.

   a. For what intervals is the model appropriate for this problem situation? For what intervals is the model inappropriate? Explain your reasoning.

   b. Sketch a curve that you believe accurately predicts the number of vehicles on the road over a 2-day period. Explain your reasoning.





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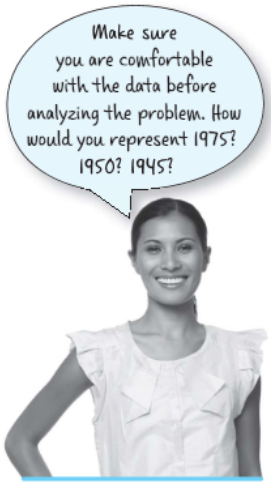
6. Do you think a polynomial function could accurately model this problem situation over the next 2 months before the next planning phase? Explain your reasoning.

PROBLEM 2 Keep It to a Minimum

Although the minimum wage may vary from state to state, the U.S. federal government sets an absolute minimum wage for the nation every few years.

1. Analyze the table of values that shows the absolute minimum wage, and the years they were enacted by Congress.

Time Since 1950 (years)	Absolute Minimum Wage (dollars)
5	0.75
6	1.00
11	1.15
13	1.25
17	1.40
18	1.60
24	2.00
25	2.10
28	2.65
29	2.90
30	3.10
31	3.35
40	3.80
41	4.25
46	4.75
47	5.15
57	5.85
58	6.55
59	7.25



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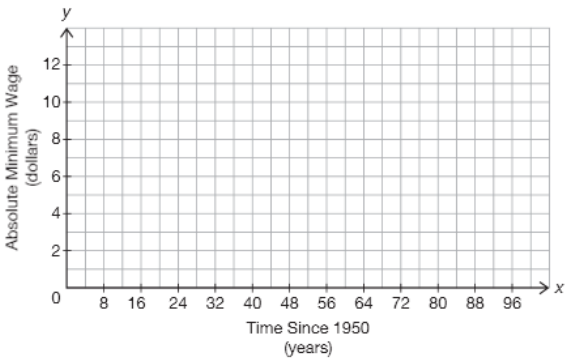
a. Describe any patterns you notice.

b. Predict the type of polynomial that best fits this data. Explain your reasoning.

2. Analyze the data graphically.

a. Use a graphing calculator to determine the best regression function $f(x)$ to model the changes in the minimum wage over the years since 1950. Sketch the regression equation on the coordinate plane.



b. How well does the regression function model this data? Explain your reasoning.

3. Use the regression equation that best models the data to make predictions.

a. Predict the absolute minimum wage in 2020. Explain your reasoning.

b. Predict the minimum wage in 1945. Explain your reasoning.

c. Predict when the minimum wage is greater than $12.50. Explain your reasoning.

4. Use the regression function to make predictions about events in the distant past and distant future.

   a. According to the regression equation, what was the minimum wage when the Civil War ended in 1865? Explain your reasoning.

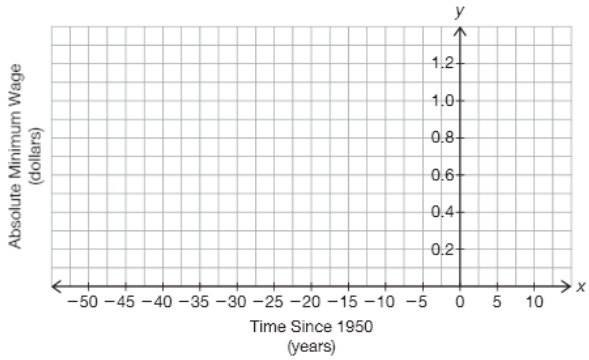
   b. Predict the years when the minimum wage will be greater than $15.00. Explain your reasoning.

   c. Do you think that a cubic model is appropriate to predict minimum wages in the distant past and future? Explain your reasoning.

Let's take a closer look at the minimum wage in the early part of the 20th Century. A minimum wage did not exist until 1938 under the Fair Labor Standards Act. Before this time, employers could pay employees any hourly wage that employees were willing to accept. The initial hourly minimum wage in 1938 was \$0.25 per hour. The wage increased steadily before reaching \$0.75 in 1955.

5. Consider the minimum wage from 1900 to 1955.

a. Sketch a graph that you believe accurately models the minimum wage for the time interval (1900, 1955). Explain your reasoning.



b. Do you think a polynomial function can accurately model the changes in minimum wage in the 20th Century? Explain your reasoning.

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Be prepared to share your solutions and methods.