Green Applications in Beginning and Intermediate Algebra

Mark Clark and Cindy Anfinson
Palomar College
mclark@palomar.edu, canfinson@palomar.edu

Mark Clark - Biography

- BA and MS in Mathematics, California State University, Long Beach
- Associate Professor of Mathematics, Palomar College, San Marcos, CA
- Co-author, with Cindy Anfinson, of a Beginning and Intermediate Algebra textbook series, published by Cengage Learning

Cindy Anfinson - Biography

- BA Mathematics, UC San Diego
- MSc Applied Mathematics, Cornell University

- Associate Professor of Mathematics, Palomar College, San Marcos, CA

- Co-author, with Mark Clark, of a Beginning and Intermediate Algebra textbook series, published by Cengage Learning

Green Across the Curriculum

Prealgebra	Vegetable Seed Purchases	Hybrid Car Sales	
Beginning Algebra	Recycling (Linear)	Smog in Los Angeles (Linear)	
Intermediate Algebra	Solar (Quadratic)	Wind Power (Exponential)	Population Growth/Decay (Exponential)

Green Across the Curriculum

Prealgebra	
Vegetable Seed Purchases	Hybrid Car Sales

Vegetable Seed Sales

- The table gives the number of US homes buying vegetable seeds.

Year	Number of US Homes buying Vegetable Seeds (in millions)
2007	16.4
2008	20
2009	23

Source: http://www.usatoday.com/money/industries/food/2009-02-19-recession-vegetable-seeds_N.htm

Vegetable Seeds (continued)

- Questions:
- How many US homes purchased vegetable seeds in 2007? Answer with a complete sentence, including units.
- Draw a bar chart for this data.
- What is the percent increase in the number of US homes buying vegetable seeds from the year 2008 to the year 2009?

Hybrid Car Sales

- In August 2011, U.S. new car sales were 1,069,227. Hybrid sales in that month totaled 21,177.

Source: http://www.hybridcars.com/hybrid-clean-diesel-sales-dashboard/august-2011.html

- Question: What percent of total U.S. new car sales were hybrid vehicles in August 2011?

Green Across the Curriculum

Beginning Algebra	
Recycling (Linear)	**Smog in Los Angeles (Linear)**

Recycling in the United States

Year	Percent of Municipal Solid Waste Recycled
1989	8.0
1990	11.5
1991	14.0
1992	17.0
1993	19.0
1994	23.0
1995	27.0
1996	28.0
1997	30.0
1998	31.0
1999	33.0

Source: www.zerowasteamerica.org/statistics

Recycling in the United States

- What can instructors do with data like this?
- Prealgebra: reading tables. Paying attention to the units of measurement.
- Prealgebra and beginning algebra: creating a bar chart
- Beginning algebra: creating a scatterplot with the data. Scaling axes. Adjusting data.
- Beginning and intermediate algebra: creating a linear model.

Creating a Linear Model

- The “eyeball best-fit” line can be determined by students as follows:

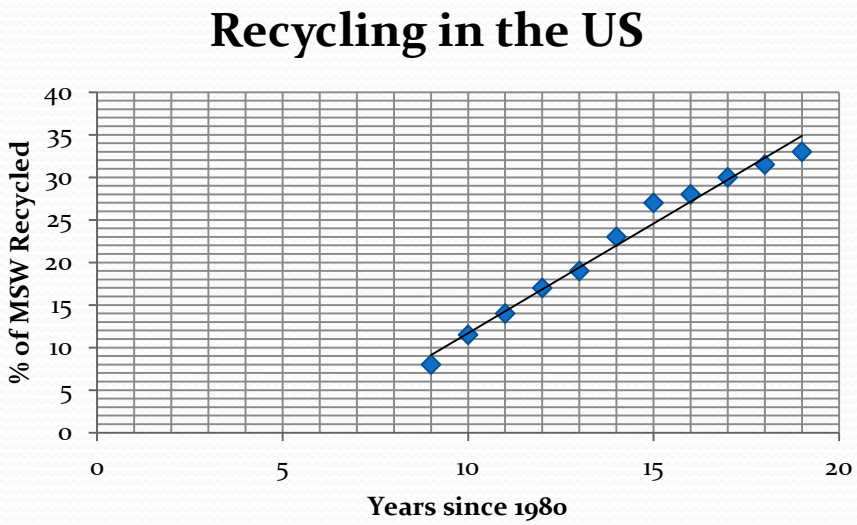
1. Adjust the data if necessary. Define the variables.
2. Create a scatter plot. Determine if it is linear.
3. Pick two points the eyeball best-fit line passes through.
4. Use these two points to find the equation of the line passing through them.
5. Write the equation of the model.
6. Check the model by graphing it on the scatter plot.

Recycling in the United States

- Adjusted Data: original source: www.zerowasteamerica.org/statistics

Years since 1980	Percent of Municipal Solid Waste Recycled
9	8.0
10	11.5
11	14.0
12	17.0
13	19.0
14	23.0
15	27.0
16	28.0
17	30.0
18	31.0
19	33.0

- Graph with Regression Line



Recycling (continued)

- An "eyeball best fit" line is $P=2.64t-14.9$, where t is the number of years since 1980 and P is the percent of MSW (Municipal Solid Waste) recycled for that year.

- The regression line is $P=2.57t-14.02$, where t is the number of years since 1980 and P is the percent of MSW recycled for that year.

Recycling (continued)

- Questions:

1. If *t* represents the number of years since 1980, what is *t* for the year 2000?
2. What is the percent of MSW recycled predicted to be in the year 2000?
3. What is the slope of this line? What does it mean in the context of this problem?
4. What is the vertical intercept of this line? What does it mean in the context of this problem?

Smog in Los Angeles

- **Data:** source: http://www.arb.ca.gov/adam/trends/trendsdisplay.php

Year	Number of Days Over the National Standard
2001	53
2003	51.6
2004	37.5
2005	22.6
2006	11.7
2008	12
2009	7
2010	2.2

Smog in Los Angeles (continued)

- Smog in Los Angeles, CA, while still a problem, has been getting better in the past twenty years.
- According to the California Air Resources Board, particulate matter and ozone are the biggest contributors of smog in the state of California.
- Small particulate matter is also known as PM 2.5. The table reports the number of days in the Los Angeles-North Main Street area PM 2.5 is above the national standard.

Smog in Los Angeles (continued)

- **Data:** source: http://www.arb.ca.gov/adam/trends/trendsdisplay.php

Year	Number of Days Over the National Standard
2001	53
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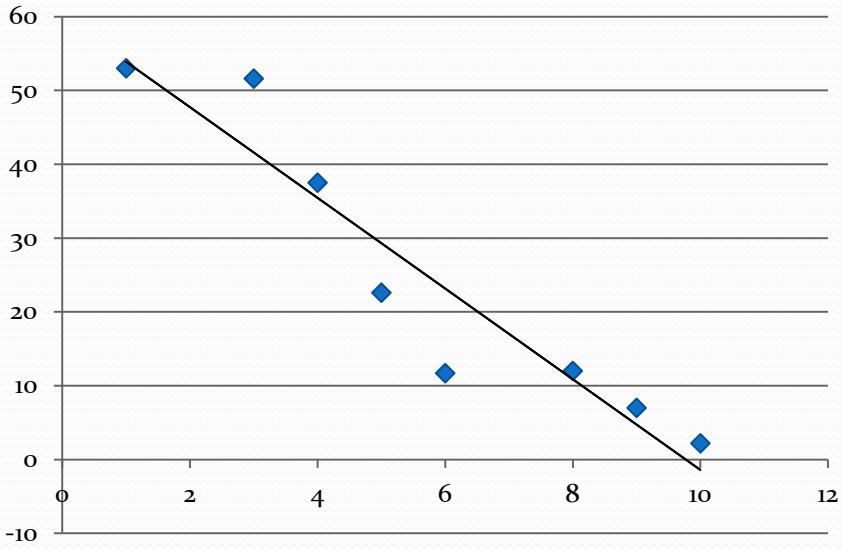
- Graph with Regression Line



Smog in Los Angeles (continued)

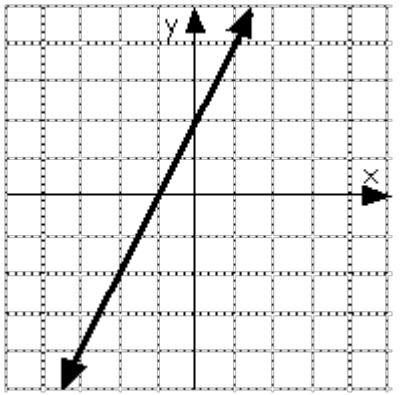
- The "eyeball best-fit" line is $N=-5.86t+58.86$, where t is the number of years since 2000 and N is the number of days small particulate matter was over the national standard for that year.
- The regression line is $N=-6.14t+59.98$, where t is the number of years since 2000 and N is the number of days small particulate matter was over the national standard for that year.

Smog in Los Angeles (continued)

- Questions:

1. If t represents the number of years since 2000, what is t for the year 2003?
2. What are the estimated number of days for small particulate matter to be over the national standard for the year 2003 in Los Angeles?
3. What is the slope of this line? What does it mean in the context of this problem?
4. What is the horizontal intercept of this line? What does it mean in the context of this problem?

An Activity for Lines

(0,2) y-intercept	y=2x+2
2 slope	

Green Across the Curriculum

Intermediate Algebra		
Solar (Quadratic)	**Wind Power (Exponential)**	**Population Growth/Decay (Exponential)**

Delta College Solar Energy

Source: http://www3.delta.edu/solar/index.html

Date	Time	Total AC Power
3/28/11	7.00	216.42
3/28/11	8.00	2634.03
3/28/11	9.00	5283.92
3/28/11	10.00	7402.2
3/28/11	11.00	8765.43
3/28/11	12.00	9477.43
3/28/11	13.00	9595.11

Date	Time	Total AC Power
03/28/11	14.00	9196.83
03/28/11	15.00	8405.89
03/28/11	16.00	6770.13
03/28/11	17.00	4389.79
03/28/11	18.00	1472.96

Creating a Quadratic Model

- A quadratic model can be generated by students using the vertex form of a quadratic function:

$$y = a(x - h)^2 + k$$

where (h, k) are the coordinates of the vertex.

1. Adjust the data if necessary. Define the variables.
2. Create a scatter plot. Determine if the data follows a parabolic pattern.
3. Select a vertex and substitute it in for (h, k) in $y = a(x - h)^2 + k$
4. Pick another point, substitute it into $y = a(x - h)^2 + k$ and solve for a.
5. Write the equation of the model.
6. Check the model by graphing it on the scatter plot.

Delta College Solar Energy (continued)

- The data is available at http://www3.delta.edu/solar/solarArchive.html.
- The original data was sampled every 15 minutes (quarter hour) beginning at 6:45 am and ending at 6:45 pm.
- $P(t)$ is the solar power production in watts on March 28, 2011, and t is the number of hours since midnight.
- In order to reduce the amount of data students need to enter in their calculator, the data was simplified to be sampled every hour.

Delta College Solar Energy (continued)

- Find an equation for a model of this data.
- *P(t)* is the solar power production in watts on March 28, 2011, and *t* is the number of hours since midnight.
- Using the Quadratic Modeling Process:

$$P(t) = -\ 278.44(t - 13)^2 + 9595.11$$

- Using the Quadratic Regression feature of the calculator:

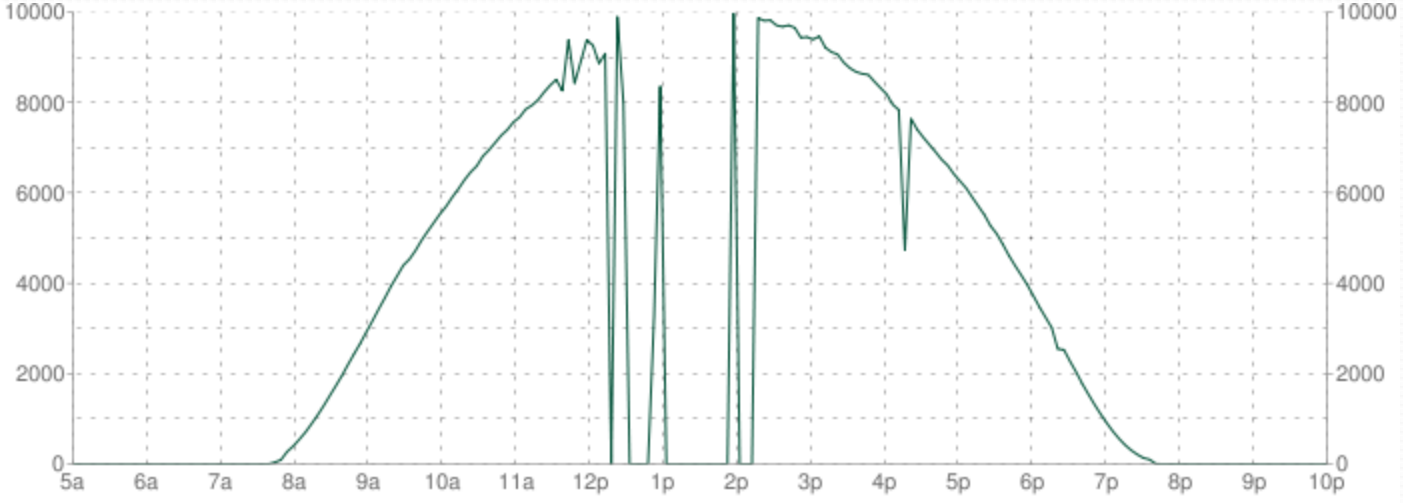
$$P(t) = -\ 288.9t^2 + 7{,}398.4t - 37{,}733$$

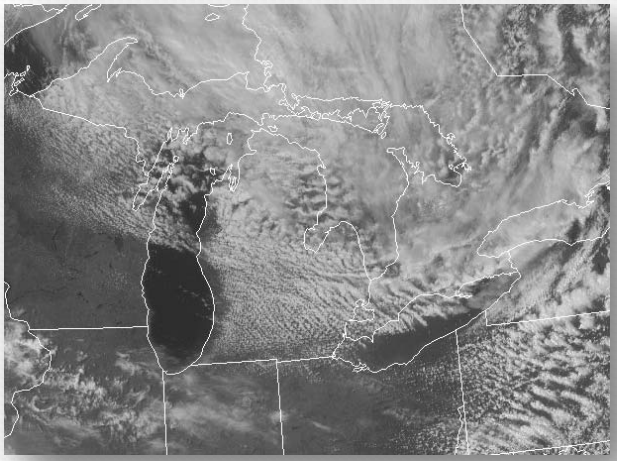
Delta College Solar Energy (continued)

- Questions for a quadratic model:

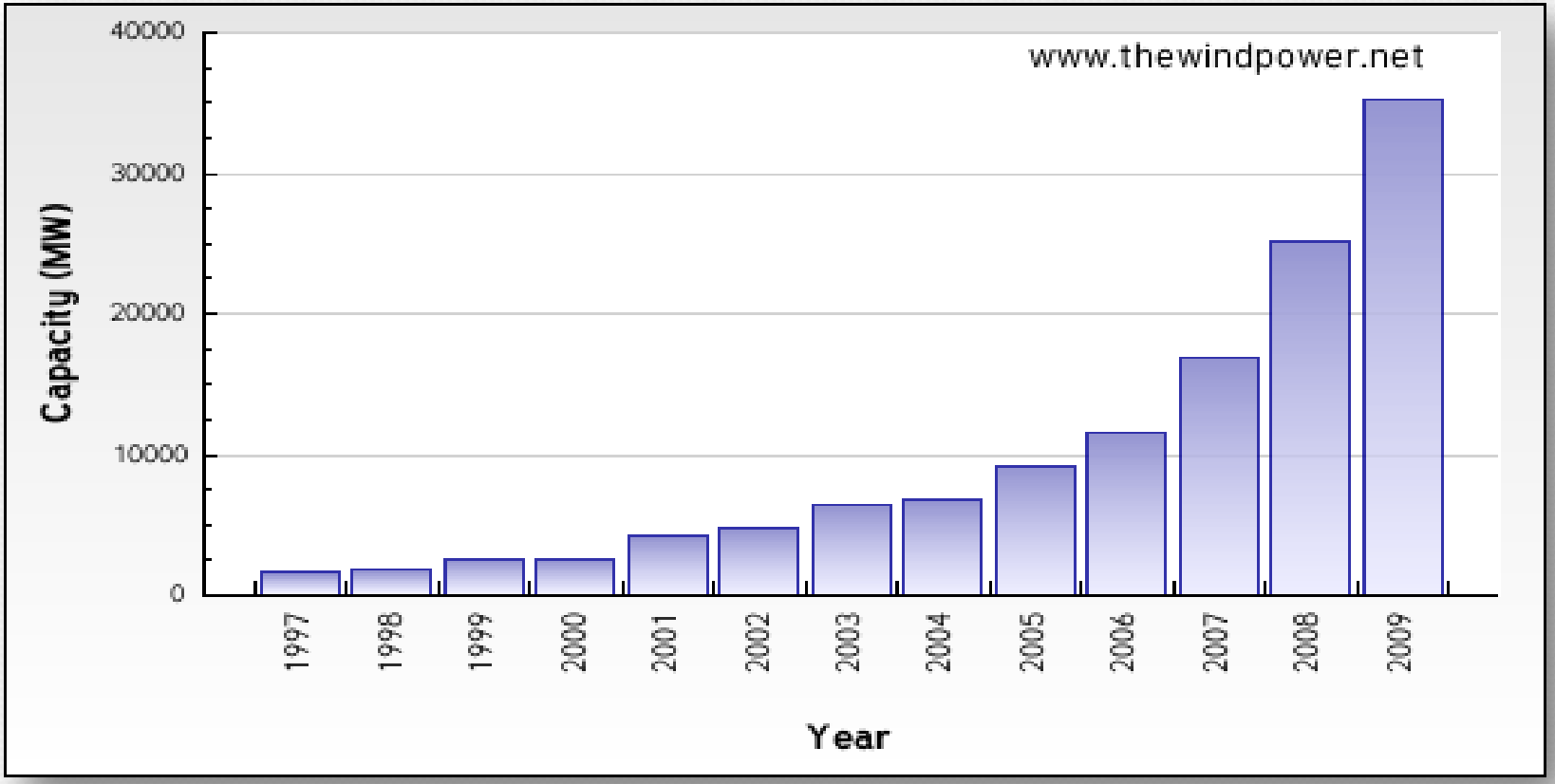
1. Find the vertex. What does the vertex represent in the context of this situation? Does the vertex represent a maximum or minimum value?
2. Find the horizontal intercepts of this model. Explain their meaning in terms of the problem situation.
3. What is a reasonable domain and range for this model?

How does weather affect the data?





U.S. Wind Power Capacity



Source: http://www.thewindpower.net

Creating an Exponential Model

- An exponential model can be generated by students using the form of an exponential function:

$$y = a \times b^x$$

- Select two points to write two equations using the form: $y = a \times b^x$
- Divide the two equations and eliminate *a*. Solve for *b*.
- Substitute the value of *b* into the general form $y = a \times b^x$
- Substitute one of the points and solve for *a*.
- Write the equation of the model.
- Check the model by graphing it on the scatterplot.

U.S. Wind Power Capacity (continued)

- Find an equation that models the data.
- Let $C(t)$ represent the U.S. wind power capacity in MW (megawatts) t years since 1990.

U.S. Wind Power Capacity (continued)

- Letting students select two points and finding the exponential model by hand:

$$C(t) = 209(1.30)^t$$

- Using the regression feature of the graphing calculator:

$$C(t) = 247.63(1.28)^t$$

U.S. Wind Power Capacity (continued)

- Questions for an exponential model:

1. What is the growth rate for this model? Explain the meaning of the growth rate in terms of the problem situation.
2. Find the vertical intercept of this model. Explain its meaning in terms of the problem situation.
3. What is a reasonable domain and range for this model?

Exponential growth in recovering wildlife populations

- The Cornell Lab of Ornithology estimates the population of the whooping crane has a growth rate of approximately 4.0% per year. In 2004, the estimated population was 468 birds.

Image: http://www.allaboutbirds.org/guide/Whooping_Crane/lifehistory

Growth/Decay Rates for Exponential Models

- The percentage change in a quantity per one unit of time is called the growth or decay rate r.

$$b = 1 + r$$

$$r = b - 1$$

- Here r is a percentage written as a decimal and b is the base of the exponential function.

Whooping Cranes (continued)

- The Cornell Lab of Ornithology estimates the population of the whooping crane has a growth rate of approximately 4.0% per year. In 2004, the estimated population was 468 birds.
- Questions to ask:

1. Define variables.
2. Assuming this growth rate continues, find an equation for the model of the whooping crane population.
3. Estimate the population in the year 2008.

Whooping Cranes (continued)

- The Cornell Lab of Ornithology estimates the population of the whooping crane has a growth rate of approximately 4.0% per year. In 2004, the estimated population was 468 birds.
- t = years since 2000 we get the model

$$P(t) = 400(1.04)^t$$

- t = years since 2004 we get the model

$$P(t) = 468(1.04)^t$$

Global Mobile App Store Rankings

- Year over year growth.
- Apple app store: 131.9%
- Google Android market: 861.5%
- Who had the largest revenue growth?

Global Mobile Applications Store Ranking in 2010 and 2009
(Ranking by Revenue in Millions of U.S. Dollars)

2010 Rank	Store	2009 Revenue	2009 Share	2010 Revenue	2010 Share	Year-Over-Year Growth
1	Apple App Store	$769	92.8%	$1,782	82.7%	131.9%
2	BlackBerry App World	$36	4.3%	$165	7.7%	360.3%
3	Noka Ovi Store	$13	1.5%	$105	4.9%	719.4%
4	Google Android Market	$11	1.3%	$102	4.7%	861.5%
	Total	**$828**	**100.0%**	**$2,155**	**100.0%**	**160.2%**

Source: IHS Screen Digest February 2011

Green Applications

- Green applications are all around us.
- Students in prealgebra or beginning algebra can: read a table, discuss units, work with percentages, and draw a bar chart.
- Students in beginning algebra can answer questions given a model. Units are important here, as are the meaning of the variables.
- Students in beginning algebra and intermediate algebra can develop models for green applications and use their algebra skills to analyze the models in real-world contexts.

Sources

- Green applications are all around us! Here are the sources I used in this presentation.

1. **Vegetable Seeds Sales**: http://www.usatoday.com/money/industries/food/2009-02-19-recession-vegetable-seeds_N.htm
2. **Hybrid Car Sales**: http://www.hybridcars.com/hybrid-clean-diesel-sales-dashboard/august-2011.html
3. **Recycling**: www.zerowasteamerica.org/statistics
4. **Smog in Los Angeles**: http://www.arb.ca.gov/adam/trends/trendsdisplay.php
5. **Delta College Solar Power**: http://www3.delta.edu/solar/solarArchive.html
6. **Wind Power**: http://www.thewindpower.net
7. **Growth/Decay Rates**: Clark/Anfinson, Intermediate Algebra: Connecting Concepts through Applications, published by Cengage Learning
8. **Whooping Cranes**: http://www.allaboutbirds.org/guide/Whooping_Crane/lifehistory
9. **Global Mobile App Store Rankings**: IHS Screen Digest February 2011