ACTIVITY 3

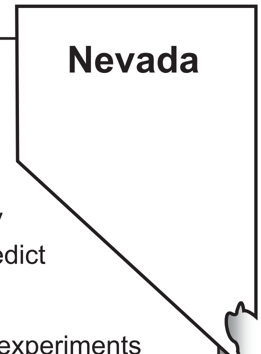
Nevada's Population

Math Objectives:

- Graph scatter plots
- Graph and analyze exponential functions
- Interpreting, estimating, and predicting data

Materials:

- TI-83/TI-84 Plus Family



Year	Population
1900	42,335
1910	81,875
1920	77,407
1930	91,058
1940	110,247
1950	160,083
1960	285,278
1970	488,738
1980	800,493
1990	1,201,833
2000	1,998,257

OVERVIEW

It is common to think of a mathematics problem as having one and only one right answer. However, mathematics is also used to study patterns and those patterns are used to try to predict different aspects of an event.

This type of prediction is easily applied to science experiments that involve distance and time, temperature and time, rate of growth of plants, etc. This sample deals with the statistics of the population of Nevada. The 2000 Census found that Nevada is the fastest growing state in the country. It is helpful if state planners can estimate how many people will be in Nevada in the years to come so that they can plan ahead for needs such as schools, hospitals, firemen, police, and roads.

Given this table of information, create two lists of data. Plot the points using the Year list as the **X**-values and the Population list as the **Y**-values. Identify a regression equation that closely fits the data and use it to predict what the population of Nevada will be in the year 2010.

SETUP

1. Press [MODE] key and make sure all the choices on the left are selected (with the exception of the **SET CLOCK** line). To do this, use the arrow keys to position the cursor on your choice and then press [ENTER]. **See Figure 1.**

2. Press [Y=] and delete any equations that remain from previous graphs. Position the cursor on the first character beside the equal sign and press [CLEAR]. Turn off any of the **STAT PLOTS** that are highlighted. Use the up arrow key to position the cursor on the name of the **Plot** and press [ENTER]. The highlighting will disappear and the plot will not appear on the graph screen. **See Figure 2.**

★ **NOTE** *For more help with resetting the [Y=] screen, see Appendix A.*

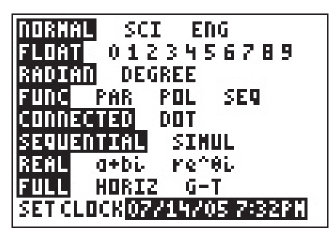


Figure 1

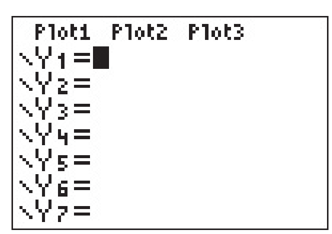


Figure 2

3. Press [STAT] key and [ENTER] and be sure **L1** and **L2** are displayed and cleared. **See Figure 3.**

★ **NOTE** *If you do not see **L1** and **L2** refer to Appendix B.*

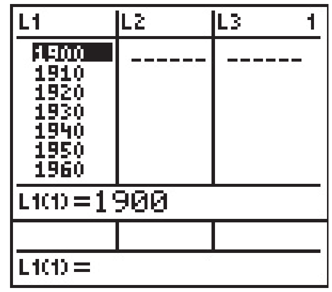


Figure 3

DATA COLLECTION

1. In this example, put the year data in **L1** and the population data in **L2**. Begin by inputting the data from the **Year** list in **L1**. These numbers can be entered individually, but since the numbers for **L1** are in a sequence, the calculator can enter the years for you. To save time, type a command for the entire list rather than entering one year at a time.

2. Use the up arrow key to highlight **L1**. **See Figure 4.**

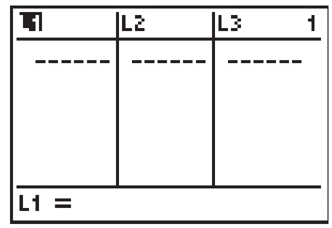


Figure 4

3. Press [2nd] [STAT] to access the [LIST] menu; scroll over so **OPS** is highlighted, and choose **5:seq(** by either pressing [5] or by scrolling down until **5:seq(** is selected and then press [ENTER]. **See Figure 5.**

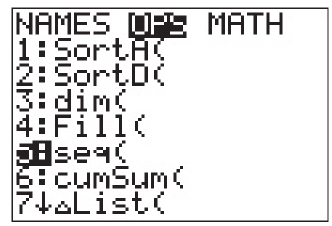


Figure 5

4. There are several ways to generate this sequence. One way is to type **seq(X,X,1900,2000,10)** with no spaces between the commas and numbers. **See Figure 6.** Encourage students to explore other ways to generate this sequence.

★ **NOTE** *For more help with filling a list with a sequence, see Appendix D.*

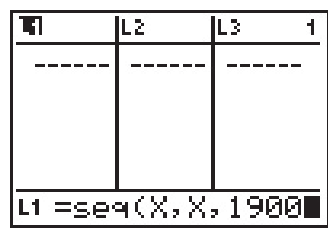


Figure 6

5. You will see the entry you type appear across the bottom of the List Editor screen. **See Figure 7.**

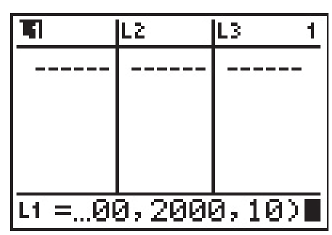


Figure 7

6. Press [ENTER] when finished and **L1** will be filled in with the desired sequence. **See Figure 8.**

7. Refer to the list at the beginning of this activity and enter the population data into **L2**. Be sure to line up each population with its corresponding year. There is no pattern to this data, so each element must be individually entered. When using paper and pencil, commas are used to write large numbers. The calculator does not need commas. Do **NOT** enter commas when entering this data. **See Figure 8.**

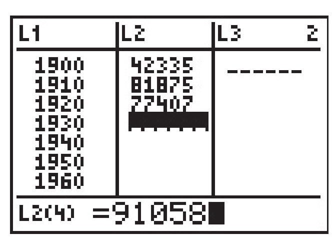


Figure 8

8. The calculator can only display 6 characters in a list, so when a number is entered that is one million or more, the calculator appears to round the number and use its own form of scientific notation. The display is written in the calculator's shortcut version, but if you highlight one of these elements, the full value listed will appear at the bottom of the screen. The calculator stores the full value in its memory and uses the full value for calculations. **See Figure 9.**

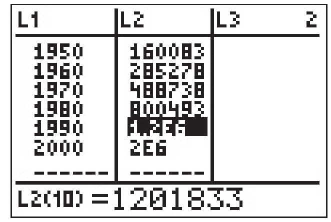


Figure 9

DATA ANALYSIS

1. Next, press [2nd] [Y=] to access [STAT PLOT] and create a scatter plot. Use **L1** for the **Xlist** and **L2** for the **Ylist.** This will graph the population as a function of the year. **See Figure 10.**

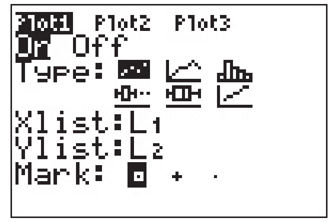


Figure 10

★ **NOTE** *For help with creating a scatter plot, see Appendix F.*

2. Press the [ZOOM] key and then press [9], or scroll to highlight **9:ZoomStat** and then press [ENTER]. The data points will be displayed. Press [TRACE] and scroll right and left to see the **X**-and **Y**-values of the data points. Notice the **P1** in the upper left corner. This indicates that it is tracing the points from **Plot:1** and displays the lists that make up the coordinates. **See Figure 11.**

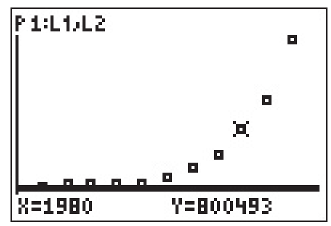


Figure 11

NOTE Most of the menus on the calculator are "wrap around" menus. **9:ZoomStat** is the last entry in the [ZOOM] menu. Instead of starting at the top of the list and pressing the down arrow multiple times, press the up arrow once and you will be taken to the bottom of the list where **9:ZoomStat** will be highlighted.

3. Ask your students to try to identify an equation type that would generate this shape. Their predictions will most likely depend on whether or not they have been taught exponentials. The shape should be identified as generating from an exponential equation, but do not discard the answer of "half a parabola." Try to encourage the students to analyze the graph by asking for other ideas from the class.

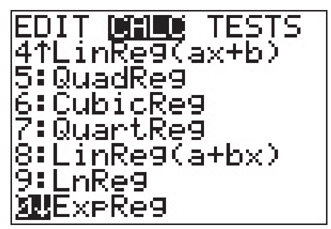


Figure 12

4. Find the regression equation and paste it in **Y1.** Press [STAT] and scroll right to **CALC** and down (or up) to highlight **0:ExpReg**. Press [ENTER].
See Figure 12.

★ **NOTE** *For more help with finding the regression equation, see Appendix G.*

5. When **0:ExpReg** appears on the home screen type **L1**, **L2**, **Y1** after it. This directs the calculator to which lists to use for the **X**- and **Y**-values of the function and where to paste the regression equation. The keystroke sequence is as follows: [2nd] [1] [,] [2nd] [2] [,] [VARS] [▸]. Choose **1:Function** and then **1:Y1**. Press [ENTER]. ([2nd] [1] is used to access **L1** and [2nd] [2] will access **L2.**) **See Figure 13.**

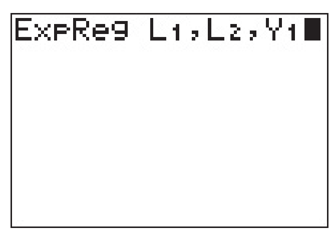


Figure 13

6. Press [ENTER] to execute the command. The regression equation will be displayed on the home screen and also pasted in the [Y=] window as **Y1**. **See Figure 14.**

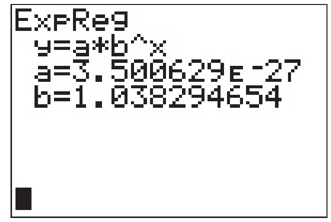


Figure 14

7. Press the [GRAPH] key to view the graph of both the plot and the regression equation. **See Figure 15.**

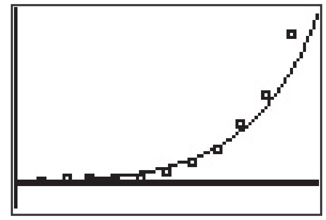


Figure 15

8. Press [TRACE] and use the right and left arrow keys to see the cursor go back and forth across the data points. Notice the **P1: L1**, **L2** in the upper left corner. This confirms that the cursor is tracing the individual data points from the lists entered in the [STAT PLOT] menu. **See Figure 16.**

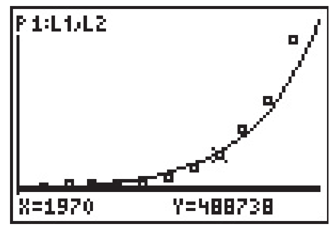


Figure 16

9. Press the down arrow key and notice that the **P1** in the upper left-hand corner has changed to display **Y1**. This indicates that the cursor will now be tracing the points on the regression curve that is stored in **Y1**. **See Figure 17.**

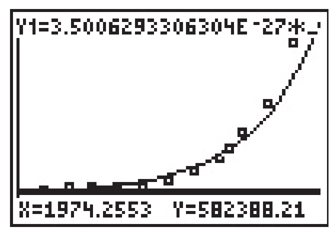


Figure 17

10. If you press the [WINDOW] key, you will see the domain and range for the part of the graph that is being displayed. **See Figure 18.**

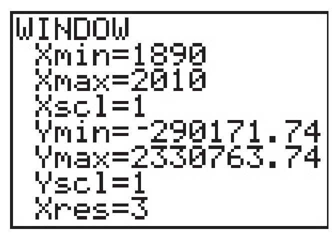


Figure 18

11. If you want to use the graph to predict the population in future years for Nevada, adjust the window settings so the **Xmax = 2015** and **Ymax = 2500000**. Adjust the **Xscl** and **Yscl** as shown. This will position the tick marks on the axes so that they are easier to read. **See Figure 19.**

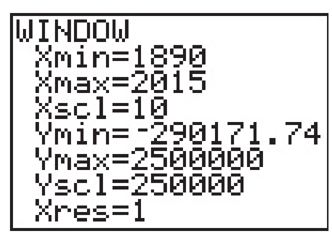


Figure 19

12. Next, press [GRAPH] and [TRACE]. Press the down arrow key to see the points on the graph of the equation. Scroll to the right to see the values. These stand for the population in years for the future of Nevada's population. The calculator typically does not use "friendly" **X**-values when you trace the graph. Encourage your students to round these values. **See Figure 20.**

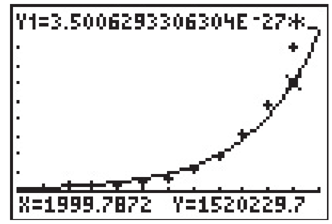


Figure 20

13. Set up a table of values to control the **X**-values. Press [2nd] [WINDOW] to access [TBLSET] to set up the table. Enter the year 1990 in TblStart and enter 1 beside ∆ Tbl to allow the table to count by intervals of one year. **See Figure 21.** Next, press [2nd] [GRAPH] to access [TABLE] and view the predictions for future years. **See Figure 21.**

Figure 21

14. You can scroll down this list indefinitely. The numbers are too big for the space provided, so the calculator automatically switches to its version of scientific notation for the display. Recall that 1.27E6 means 1.27 X 10^6. **See Figure 22.**

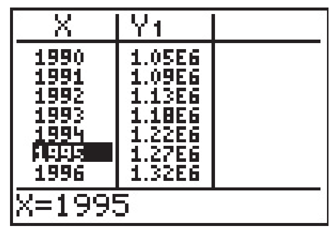


Figure 22

15. Scroll over to the **Y1** column and view each entry's full value that is displayed at the bottom of the screen. Scroll to find an estimate of the population in 2010. **See Figure 23.**

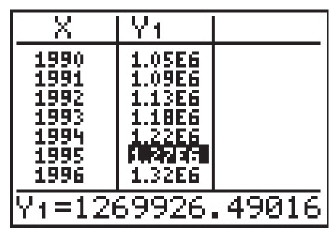


Figure 23

NOTE Similar population data can be found for your state on the Web at the Census Bureau's site. http://www.census.gov/population/www/censusdata/cencounts.html

EXTENSION

1. The calculator has a feature that was not activated in the previous displays. The calculator can be set to display the regression and correlation coefficients for the regression equations. This feature will allow you to use the calculator to determine how closely the chosen equation fits the data. Even if students are not studying statistics, they can easily tell which correlation coefficient is closest to the value of 1. They can also visually decide which equation is a "best fit."

NOTE The default mode of the calculator is set so that it does not display the correlation coefficients.

2. Turn on the **DiagnosticOn** feature. Press [2nd] [0] to access the **CATALOG.** Scroll to highlight **DiagnosticOn** and press [ENTER] to bring the command to the home screen. Press [ENTER] again to execute the command. You will see the word **Done** as verification. **See Figure 24.**

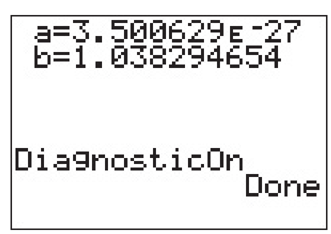


Figure 24

NOTE *For more help with the DiagnosticOn feature, see Appendix I.*

3. Re-enter the command to find the regression equation and notice how the display differs from the first time. The regression equation can also be accessed by pressing [2nd] [ENTER] to recall it. Pressing [2nd] [ENTER] the first time will recall the last command that was typed which was the **DiagnosticOn** command. **See Figure 25.**

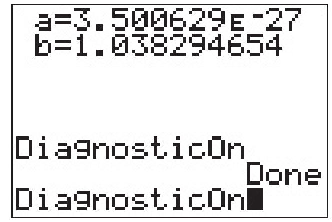


Figure 25

4. Press [2nd] [ENTER] again and the calculator will recall the desired command, ExpReg **L1**, **L2**, **Y1**. This command was the second to last command typed, so it requires two attempts to access it. **See Figure 26.**

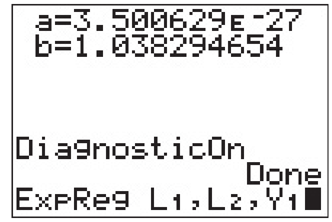


Figure 26

5. When you see the command for the regression equation on the screen, press [ENTER] to execute the command. This time the calculator gives you the regression equation along with the correlation coefficient. The closer the absolute value of **r** is to 1, the better the equation fits the data. **See Figure 27.**

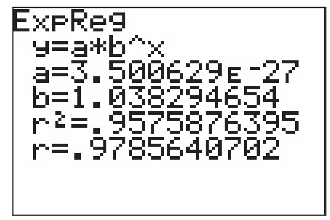


Figure 27

6. Explore other regression equations to see if a better fit can be found. Does this shape look like half of a parabola? Do you think it matters if the left side of the parabola does not line up to any points in this problem? Remember, mathematics does not always produce or require EXACT answers. An exploration of this data and quadratic equations is beneficial. Have students do a quadratic regression and paste it in **Y2.** **See Figure 28.**

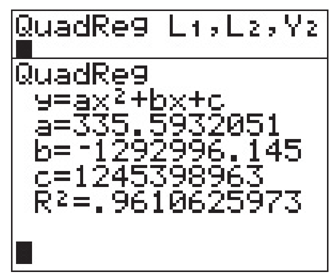


Figure 28

7. In the [Y=] window, position the cursor on the slash icon in front of **Y2** and press [ENTER] to change the thickness of the curve that will be displayed in the graph window. This will make it easier to distinguish **Y1** from **Y2**. **See Figure 29.**

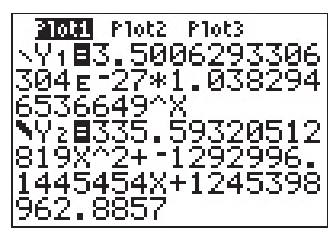


Figure 29

8. Press [GRAPH]. Compare and discuss which curve appears to be a better estimate. Although younger students will not understand the upper level mathematics involved, they can easily compare the ***r*** or ***r***² values of different regression equations to find the one closest to 1. **See Figure 30.**

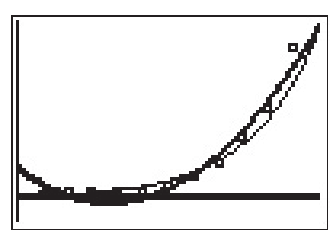


Figure 30

9. Consider changing the window again for a different perspective.
   See Figure 31.

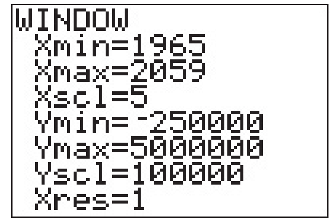


Figure 31

10. Encourage your students to discuss not only which is the "best fit," but also which appears to be going in the "right direction" for a future prediction. **See Figure 32.**

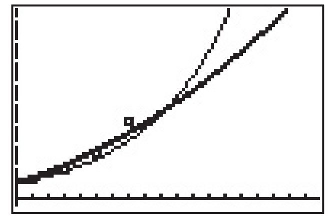


Figure 32

WORKSHEET ANSWERS

1. Y=(3.500629*10^-27)*(1.038294654)^x
2. Graph is shown above. See the chart.
3. Answers will vary. Encourage students to think about unexpected events that would cause data to deviate from the usual. Hurricane Katrina caused some states to lose population while others gained population.

X	Y1
2001	1,591,118
2002	1,652,049
2003	1,715,314
2004	1,781,001
2005	1,849,204
2006	1,920,018
2007	1,993,545
2008	2,069,887
2009	2,149,152
2010	2,231,454

ACTIVITY 3

Name: ______________________________

Nevada's Population

Math Objectives:

- Graph scatter plots
- Graph and analyze exponential functions
- Interpreting, estimating, and predicting data

Materials:

- TI-83/TI-84 Plus Family

Year	Population
1900	42,335
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The 2000 Census found that Nevada is the fastest growing state in the country. It is helpful if state planners can estimate how many people will be in Nevada in the years to come so they can plan ahead for needs such as schools, hospitals, firemen, police, and roads.

Given this table of information, create two lists of data. Plot the points using the **Year** list as the **X**-values and the **Population** list as the **Y**-values. Identify a regression equation that closely fits the data and use it to predict what the population of Nevada will be in the year 2010.

(Report all numbers rounded to the nearest hundredth.)

1. Enter the exponential regression equation you found. ____________

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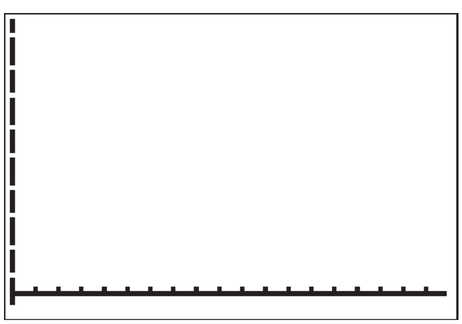
2. Sketch your graph in the window below and use the Table feature on your calculator to fill in the chart.



X	Y1
2001	
2002	
2003	
2004	
2005	
2006	
2007	
2008	
2009	
2010	

3. Discuss the process used in this activity. Is it guaranteed that the value you found for the population in 2010 will be accurate? What factors could affect the accuracy of this prediction.

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