S12 - HS Regression Labs Workshop

Regression Types: Needed for Math B

Linear

Quadratic (not required)

Logarithmic

Exponential

Power

You can calculate the least-square fit to altered set of data for five types of curves. They are the line (LinReg), the quadratic (QuadReg), the exponential curve (ExpReg), and the power curve (PwrReg).

\[ y = a + bx \quad y = ax^2 + bx + c \quad y = a + b \ln x \quad y = ab^x \]

Warning! These curve regressions work by fitting a line to logarithm of the x-data set, the y-data set, or both. If you have zero or negative values in the data, you may get an error.
Statistics Steps

Directions:

(a) **Statistics Menu**: press **STAT** key.

1. Press 1: Edit (You will see columns labeled , etc.)
2. Type in some paired data point(s) followed by **ENTER** key.

   For example enter 2, 2.25, 2.60 etc.
   For example enter 1.06, 2, 1.80, etc.

(b) **Graphing data using Stat Plot Menu**

1. Press **2nd** **Y =** keys.
2. Choose 1: Plot 1
   (a) In Plot 1, choose **ON**
   (b) Type: **SCATTERPLOT** (choice 1)
   (c) Xlist:
   (d) Ylist
   (e) Mark:
3. **Zoom**: Press **Zoom** key and Choose 9: **ZoomStat**
4. Press **Graph** key.
5. Start with step b again and choose this time
   Type: **SCATTERPLOT** (choice 2) and Make a scatter plot of the data.

(c) **Finding a Linear regression, Quadratic regression, etc.**

*(Look at the sheet for what type reg.)*
The TI 83 OR TI 84 calculator has a built-in feature that allows it to compute best-fitting line through a set of data. This procedure is called a **linear regression**. To perform a linear regression on the data you have collected,

1. Press **STAT** key and move the cursor to **Calc**
2. Select Linear regression: now you end up at your home screen.
(3) On your home screen ????
Type in

(4) Press enter
(5) \( r^2 \) and \( r \) give us the information how good of fit the equation is to the data.
The closer \( r \) is to \( +1 \) and \( -1 \) the better fit. \( r^2 \) is also determines the best fit.

**Correlation Coefficient/Coefficient of Determination**

The TI 83 or TI 84 will compute both the correlation coefficient and the coefficient of determination. However, these are not shown on the screen unless the Diagnostic is turned on. With **Diagnostic On**, the values of \( r \) and \( r^2 \) will be displayed when ????Reg is executed.

One way to turn Diagnostic On: 2nd CATALOG ▶ ALPHA D and mouse down to Diagnostic On

Another way to turn **Diagnostic On**: VARS ▶ 5: Statistics ▶ EQ ▶ 7: \( r \) and 8: \( r^2 \)

The **coefficient of determination** \( (r^2) \) gives a measure of the strength of the linear association between \( x \) and \( y \).

The square root of the coefficient of determination, \( r \), is called the **correlation coefficient**. It is a measure of linear association, or the way the data points cluster around the least squares regression line.

The least square line is the line that minimizes the sum of squared residuals. The \( r^2 \) formula uses the sum of squares residuals from the regression line. Therefore, it is a measure of how strongly the data points follow a linear relationship. If all data points fall on a line, the \( x \)-variable predicts the \( y \)-variable perfectly. In that case, \( r^2 = 1 \) and \( r = \pm 1 \). The value of \( r^2 \) must always satisfy and the value of \( r \) must satisfy .
Conclusions:
Survivor Lab

You are on a desert island and you have come in contact with a rare disease. You are exposed to the disease by the people on the island with you. Only one of you on the island will survive this disease because of the immunity that is already in your system. Which one of you will survive this disease and be on the island alone? To simulate the spread of the disease you will do the following:

**Materials:** One die per person
Graphing Calculator

**Activity:** Everyone gets a die. All those still “living” will get to roll their die at the next “exposure.” You escape the disease if they roll a 1 through 5. You get the disease and “die” if you roll a 6. Once you are dead, you cannot roll the die again.

For each exposure, record the number of the exposure and the number of people still living. Enter the number of the exposure into L₁ and the number of people into L₂. Adjust the window and look at the points. You can record the points into a table and then plot the points onto graph paper using an appropriate scale.

Collect the data: Graph the data in the box below.
Be sure to axes, window and scale.

<table>
<thead>
<tr>
<th>Exposure</th>
<th>Living</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>16</td>
</tr>
<tr>
<td>2</td>
<td>17</td>
</tr>
<tr>
<td>3</td>
<td>18</td>
</tr>
<tr>
<td>4</td>
<td>19</td>
</tr>
<tr>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td>6</td>
<td>21</td>
</tr>
<tr>
<td>7</td>
<td>22</td>
</tr>
<tr>
<td>8</td>
<td>23</td>
</tr>
<tr>
<td>9</td>
<td>24</td>
</tr>
<tr>
<td>10</td>
<td>25</td>
</tr>
<tr>
<td>11</td>
<td>26</td>
</tr>
<tr>
<td>12</td>
<td>27</td>
</tr>
<tr>
<td>13</td>
<td>28</td>
</tr>
<tr>
<td>14</td>
<td>29</td>
</tr>
<tr>
<td>15</td>
<td>30</td>
</tr>
</tbody>
</table>
Follow-up questions:

1. What mathematical model appears to emulate the data

2. Write an equation for the model

3. What is the correlation coefficient that corresponds with your model?

4. If there were 10 people alive, what day corresponds to the number alive

5. Based on your model, on day 2, how many people were still alive

6. Describe the behavior of the graph in mathematical terms

7. Why must one person survive the disease on the island
Bridge Building
Linear Regression

Most bridges are built with frames of steel beams. Steel is very strong, but if you put enough weight on the beam, it will bend or break. The amount of weight a beam can support is related to its thickness and design. To design a bridge, engineers need to understand these relationships thoroughly. Engineers often use scale models to test the strength of their bridge designs.

Testing Paper Bridges:
You will do an experiment to test some of the principles involved in building bridges.

Equipment:
Four 11 inch by 4-inch strips of paper
two books of the same thickness
a small paper cup
about 100 pennies.

Directions:
Make a paper bridge by folding up 1 inch on each long side of one of the paper strips. See diagram below. Cup must be placed in the center of the paper bridge. Books must be placed at each end of the paper. Paper may not be used as braces.
In groups of 4 collect data by taking one sheet of paper and add enough pennies to make the bridge bow. The books should be 7 inches apart. Fill in the chart below.

**Group Data:**

<table>
<thead>
<tr>
<th>Layers of paper (strength of steel)</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of pennies (breaking weight)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Each student must do the following questions:

- Make a scatter plot of the data and the linear regression line of your group data.

![Graph](image)

Label your axis and mark the axis & tell your window

- Find the equation that fit the group data plot. What is that equation?

- Is the equation a good model for the data represented? Explain_______

- What is the slope of the linear regression? Verify your answer by calculating the slope to two points of the group data. Show your calculations. Show your work here:

  Points: __________________________

  Slope class data____________________

  How accurate is your slope of your group data to the actual slope of the equation? ________________________________
When you have 10 sheets of paper, predict the number of pennies. Use table.

When you have 500 pennies, find the number of sheets of paper you would need.
Rope Lab  Linear Regression

Objective:  To find an equation that fits a set of real world data.

Materials:  Piece of rope of varying lengths for each group.
            Ruler in mm measurement
            Graphing Calculator

Procedure:  Each group should measure the length of the rope and record the
            measurement in the chart below.  Then the group will put one knot in the
            rope and take a subsequent measurement.  The procedure will be repeated
            until 5 knots or more are placed on the length of the rope.

            Plot your data and draw your regression line.  Label your axis

<table>
<thead>
<tr>
<th>Knots</th>
<th>Length (cm) to the nearest tenth</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

Questions:
1) What type of regression equation does the data appear to fit?

2) Based on your data, how many knots are you able to construct with your piece of rope?

3) What is your equation that fits this data?

4) What is the correlation for this equation?

5) Predict what the length of the rope will be at 10 knots.
Name______________________________  Exponential Regression

Exponential Growth & Decay

Materials:  Bag of M & M's
           Paper Cup
           Napkin

Part 1
Experiment # 1 Growth

1. Start this experiment with 4 M & M's in a cup.  Shake the cup and pour the M & M's on a napkin. Count the number of M & M's that have the M showing (be careful with the yellow M & M's .. it's a little hard to see the M.. check both sides).  Add a new M & M for each one with an M showing.  Record the total number of M & M's in the table below.  Using the new total of M & M's each time, repeat the procedure five more times or until you run out of M & M's.

<table>
<thead>
<tr>
<th>Trials</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
</tr>
</tbody>
</table>

2. Create a scatterplot include the # 0 ExpReg equation in the graph above.

3. Write the exponential growth equation: (4 decimal places)

4. Predict the number of M & M's on trial # 9 (look at your table): ________________

5. Predict the number of trials needed to have 300 M & M's (use table): ____________
Experiment #2 Decay

Materials: Bag of M & M's
          Paper Cup
          Napkin

6. Start this experiment with all the M & M's in a cup from the experiment #1 Growth. Shake the cup and pour the M & M's onto the napkin. Count the number of M & M's that have the M showing (be careful with the yellow M & M's... it's a little hard to see the M... check both sides). Then remove all M & M's that have the M showing. Record the total number of M & M's left on the table below. Using the new total of M & M's each time, repeat the procedure five more times. Note: If the number of M & M's reaches zero at any trial, then the experiment is over at that time and you should not use the zero results as part of your data.

<table>
<thead>
<tr>
<th>Trials</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
</tr>
</tbody>
</table>

7. Create a scatterplot include the #0 Exp Reg equation in the graph above.

8. Write the exponential decay equation: (4 decimal places)

9. Predict the number of M & M's on trial #1 if it could exist (use your table): ________

10. Predict the number of trials needed to have 900 M & M's: ___________________
Thirst Dilemma

Modified from an activity by: Wallace Brewer, Marcelline Carr, Aimee Evans, Allen Henderson, Ellen Johnston, and Tony Timms

Introduction
You are a scientist flying across the desert. The plane develops engine trouble and crashes. Because you had the forethought to bring your cell phone, a rescue chopper will come for you eventually. All you were able to recover from the wreckage was on bottle of water. A human being can go several days without food, but not water. The water must last until the rescue chopper comes for you. You can only have one drink of water at a time. How long will the water last?

Procedure:
The experiment will investigate the relationship between the water removed by the scientist’s drinks and the height of the water left in the bottle. You will record the original height of the water. One student, designated as the survivor, will take one drink. Another student will measure the new height. Repeat this process until the liquid is gone or until the rescue chopper arrives.

Materials
A cylindrical glass of soft drink about \(\frac{1}{2}\) a can
A centimeter ruler

Questions:

1. The independent variable, \(x\), is__________________________

   The dependent variable, \(y\), is__________________________

   Our prediction for the number of drinks needed to empty the bottle is____
Group Data:

<table>
<thead>
<tr>
<th>Independent variable</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Dependent variable</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Each student must do the following questions:

🔍 **Make a scatter plot of the data and the linear regression line** of your **group data**. Select a scale for each axis that will allow you to make predictions on the Liquid level after 3 hours (One drink is taken every 15 minutes.)

Label your axis and mark the axis & tell your window

🔍 Describe any pattern you see in your data.

🔍 **Find the equation that fit the group data plot.** What is that equation?

🔍 Is the equation a good model for the data represented? Explain_______
What is the slope of the linear regression? Verify your answer by calculating the slope to two points of the class data. Show your calculations.

Show your work here:

Points: __________________________
Slope: __________________________
Y intercept: ______________________

If one drink is taken every 15 minutes, how many hours will it take before all the liquid is gone?

__________________________________________________________________________

How would your graph change if you used a narrower glass with the same amount of liquid and the same sized drinks? __________________________

__________________________________________________________________________