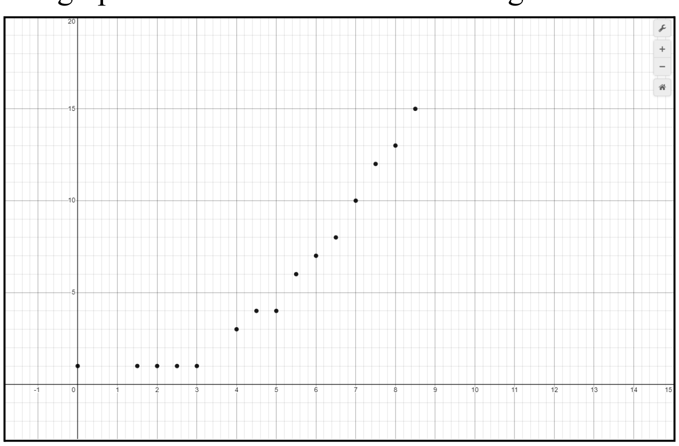
Azeem Ahmed

Determining Regression Lines to Determine Equitable Trends in Data Using Desmos

1. Open a new graph on desmos
2. At the top left, select the plus icon and insert a table in Line 1
3. Insert the following data and set the data points to color black:

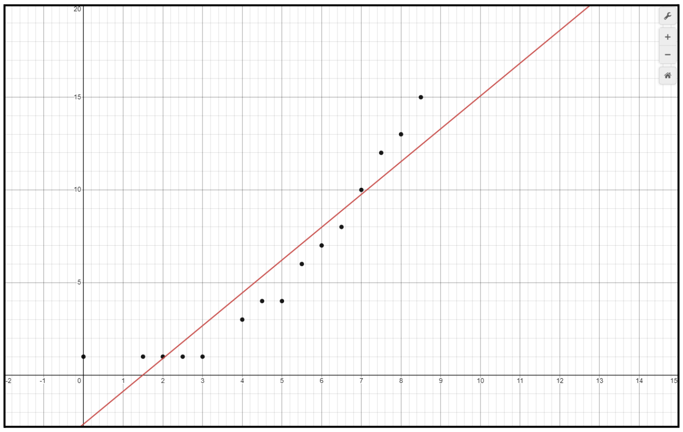
x_1	y_1
0	1
1.5	1
2	1
2.5	1
3	1
4	3
4.5	4
5	4
5.5	6
6	7
6.5	8
7	10
7.5	12
8	13
8.5	15

4. At the top left, select the wrench icon and change the following settings
   a. X - Axis: $-2 \leq x \geq 15$
   b. Y - Axis: $-3 \leq y \geq 20$
5. The graph should look like the following:

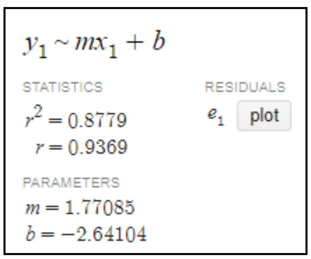


6. Looking at this data, It is difficult to summarize this data, one may argue that it is a linear model while others can argue that it is a quadratic or exponential model
7. We will start with exploring a linear model:

a. Select the plus at the top left and insert an expression
b. Type in the following: $y_1 \sim mx_1 + b$
c. Change the color to red inorder to differentiate it from the data
d. The graph should look like the following:

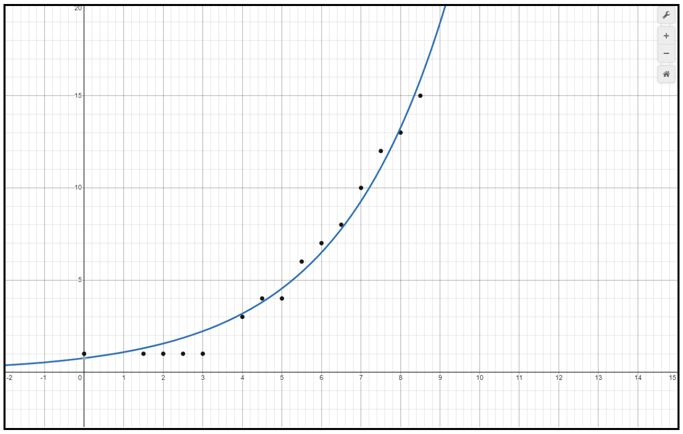


e. The values under the expression should also look like the following:

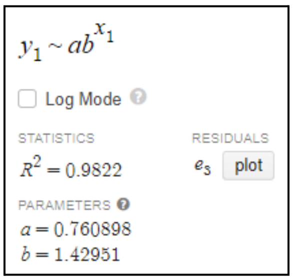


f. The *m* and *b* parameters at the bottom replace the *m* and *b* variables in the equation at the top: $y = 1.77x - 2.64$
g. This has a correlation coefficient (r^2) of 0.8779

8. Explore exponential model:
   a. Select the plus at the top left and insert an expression
   b. Type in the following: $y_1 \sim ab^{x_1}$
   c. Change the color to blue inorder to differentiate it from the data and linear regression line
   d. The graph should look like the following:



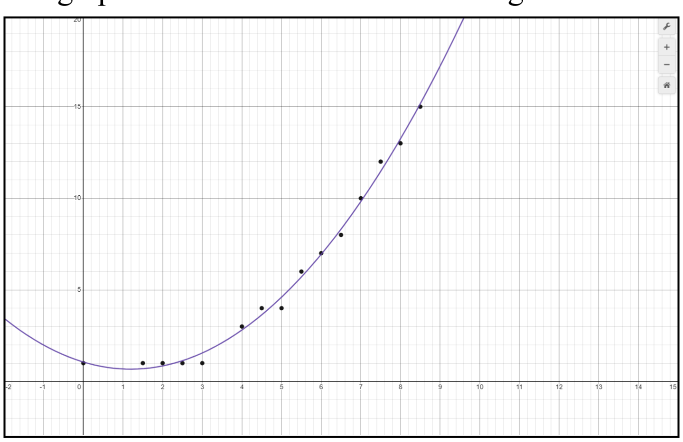
e. The values under the expression should also look like the following:



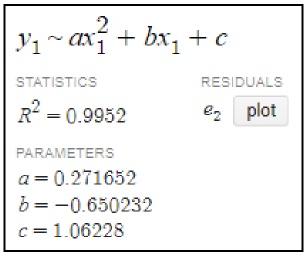
f. The *m* and *b* parameters at the bottom replace the *m* and *b* variables in the equation at the top: $y = (0.76)(1.43)^x$

g. This has a correlation coefficient (r^2) of 0.9822

9. Explore quadratic model:
   a. Hide the exponential regression line by selecting the line icon on the left on line 2
   b. On line 3, insert the following equation: $y_1 \sim ax_1^2 + bx_1 + c$
   c. Change the color to purple inorder to differentiate it from the data, linear and exponential regression lines
   d. The graph should look like the following:



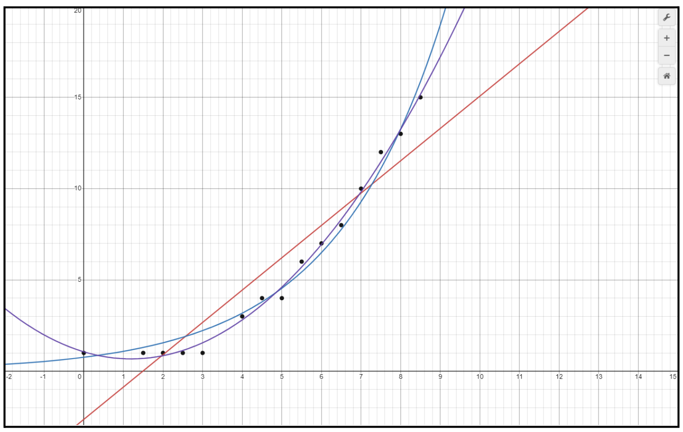
   e. The values under the expression should also look like the following:



f. The *a, b* and *c* parameters at the bottom replace the *a, b* and *c* variables in the equation at the top: $y = 0.27x^2 - 0.65x + 1.06$

g. This has a correlation coefficient (r^2) of 0.9952

10. Using the show feature, show all 3 regression lines, the graph should look like the following:



11. As the following graph shows, the data follows a quadratic regression best
12. The correlation coefficient also follows the graph and shows that there it is closest to 1
13. Go back to line one where the data is and hold the icon next to y_1 and toggle drag
    a. This allows the data points to be manipulated freely and allows you to explore what changes will affect the regression lines in real time
14. In any data set, the following base equations can be used to determine what kind of regression best fits the data:

Linear	$y_1 \sim mx^1 + b$
Quadratic	$y_1 \sim ax_1^2 + bx_1 + c$
Cubic	$y_1 \sim ax_1^3 + bx_1^2 + cx_1 + d$
Exponential	$y_1 \sim ab^{x_1}$
Square Root	$y_1 \sim a\sqrt{x_1} + b$

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