What's Going On?

Checking In

Minds on Pen and Paper Analysis

Action! One Question to Bind Them

Consolidation The Hardest Part?

Learning Goal - I will be able to determine appropriate mathematical models to fit real world data and use the models to predict past and future behaviour.

Minds on

Pen and Paper Analysis

For each table:

1. Identify the independent and dependent variables.
2. Identify units for the rate of change.
3. Describe the trend.
4. Determine whether it shows a linear trend, quadratic trend or exponential trend.

ind. var. dep. var. FD SD Ratios

Year	Goose Population
1	1190
2	1250
3	1310
4	1380
5	1455
6	1530

60 → 1.05
60 → 0 → 1.05
70 → 10 → 1.05
75 → 5
75 → 0

rate of change: # of geese / year

trend: the population increases over time, the rate of change appears to be increasing.

ratios are constant, therefore an exponential model would be the best fit.

ind dep FD SD

Year	New Teacher Hires
0	45
1	44
2	41
3	36
4	29

-1 -3 -5 -7

-2 -2 -2

RoC: # of hires / year

trend: decreasing over time, the rate of decrease is accelerating over time

second differences constant . . . quadratic

ind dep FD SD Ratios

Week	Volume of Sand (m^3)
0	2000
1	1922
2	1836
3	1755
4	1682
5	1598
6	1520
7	1442
8	1338

-78
-86
-81
-73
-84
-78
-78
-104

0.96

RoC: volume of sand/week

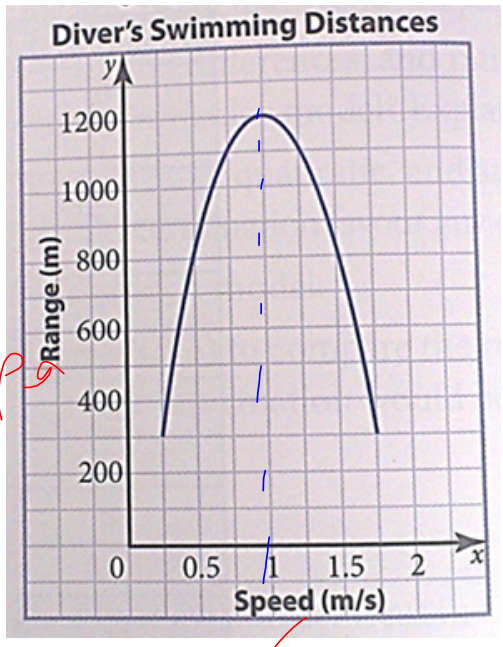
trend: volume of sand decreases each week, exponential trend, percent decrease is 4% per week

Minds on

Pen and Paper Analysis

For each graph:

1. Identify the independent and dependent variables.
2. Identify units for the rate of change.
3. Describe the trend.
4. Determine whether it shows a linear trend, quadratic trend or exponential trend.



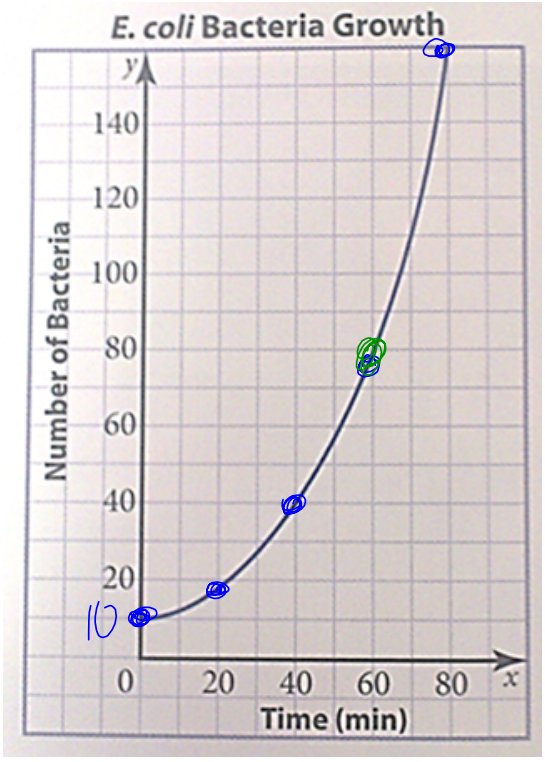
dep

ind

RoC: m / m/s

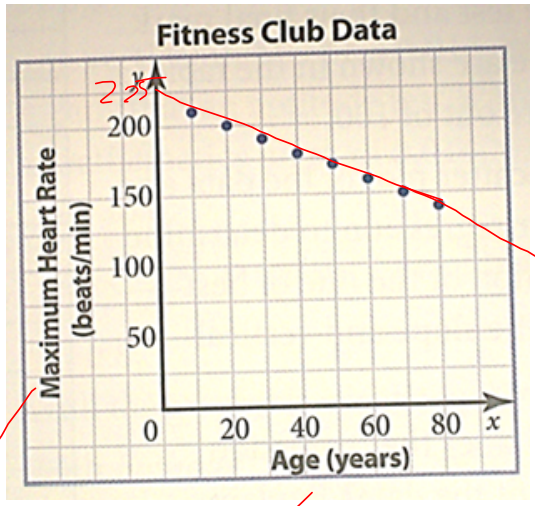
Trend: distance diver can swim increases as their speed increases to a maximum, and then decreases.

*quadratic



t	#	ratios
0	10	
20	20	2
40	40	2
60	80	2
80	160	2

ratios are constant . . . exponential



R.C

bpm/year

dep

ind

linear

Action!

One Question to Bind Them

Mark is considering starting his own Web design business. There are already several similar companies and he is concerned that there might not be enough business in the future. He conducted some research and determined the number of business with web sites in the town seems to be growing.

a. Independent Variable: Year

Dependent Variable: # of businesses w/ websites

b. Units for Rate of Change: websites/year

Action!

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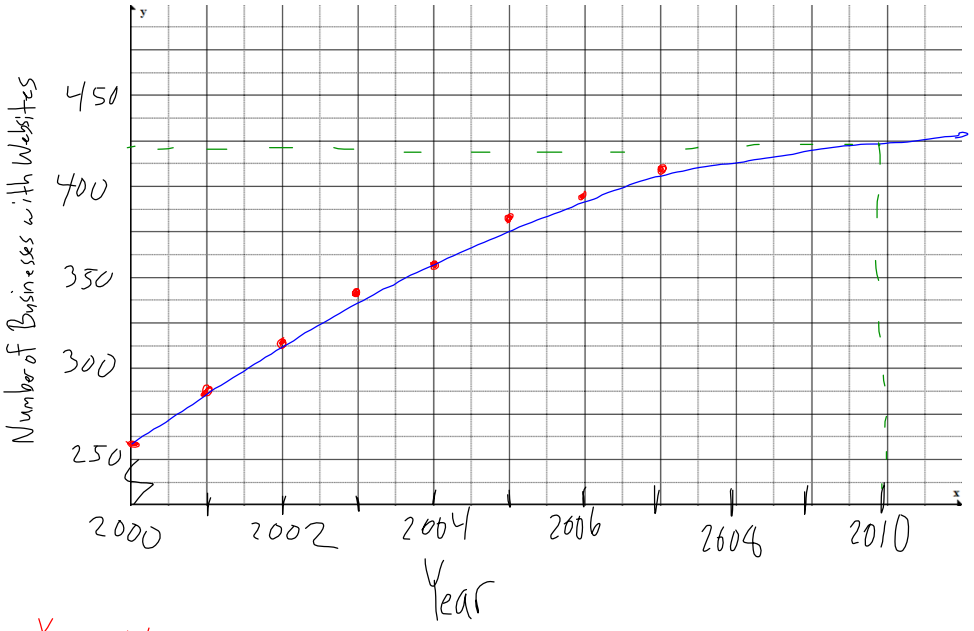
c. Scatter Plot



* provide room for future predictions

d. Estimate for 2010: 475

e. Best model based on graph:

The rate of change seems to be slowing down. It appears that the number of businesses with websites will reach a maximum (makes sense as eventually most or all will have one). Therefore, I would say a quadratic model fits best.

Action!

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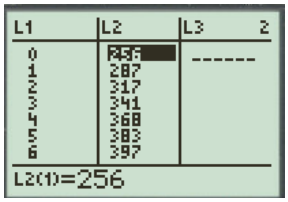
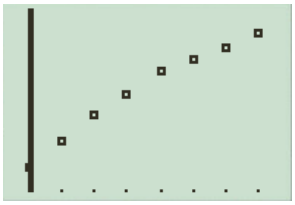
f. Regression Equations





Linear:

```
LinReg
 y=ax+b
 a=22.39285714
 b=267
 r²=.9785616794
 r=.9892227653
```

$y = 22.393x + 267$

$r^2 = 0.979$

Quadratic:

```
QuadReg
 y=ax²+bx+c
 a=-1.613095238
 b=33.68452381
 c=255.7083333
 R²=.998873516
```

$y = -1.613x^2 + 33.685x + 255.708$

$r^2 = 0.999$

Exponential:

```
ExpReg
 y=a*b^x
 a=269.901863
 b=1.069329723
 r²=.9565492414
 r=.9780333539
```

$y = 269.902(1.069)^x$

$r^2 = 0.957$

g. Best fit:

based on analysis, quadratic is best fit
99.9% confidence

To change the window to see the years 1980 to 2020, we need to change the x-values of our window to -20 (min) and +20 (max)

Action!

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h. Best past predictions: The exponential model seems to do the best job at predicting into the past. The other two (linear and quadratic) show the number of websites bottoming out to zero fairly quickly.

i. Best future predictions: None of the models seem to do a great job into the future. Over the short term, the quadratic seems to be the best as we expect the number of businesses with websites to reach a max (all of them). However, the quadratic model then shows the number decreasing, this is unlikely.

The exponential shows the rate of change continuing to increase (not the trend shown by the actual data)

The linear shows a constant increase over time (again, not the trend shown by the data)

Action!

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j. Predictions for 1990, 2010:

* 2000 is year 0

(x = -10) 1990 (x = 10) 2010

Linear:

$y = 22.393x + 267$

43 491

Quadratic:

$y = -1.613x^2 + 33.645x + 255.708$

makes no sense!

-242 431

Exponential:

$y = 269.902(1.069)^x$

138 526

Action!

One Question to Bind Them

Mark is considering starting his own Web design business. There are already several similar companies and he is concerned that there might not be enough business in the future. He conducted some research and determined the number of business with web sites in the town seems to be growing.

Based on your analysis. What should he do?

Because the rate of change seems to be decreasing, this is probably not a great area to get into.

As the number of NEW businesses with websites per year decreases, the existing web design companies will compete more and more for limited business.

Consolidation

The Hardest Part?

The following equations are the result of regression analyses on data of the number of fatal collisions per year from 1992 to 2011.

Linear $y = -50.832x + 3012.457$

Quadratic $y = -0.704x^2 - 37.465x + 2972.356$

Exponential $y = 3052.329*0.980^x$

What do x and y represent?

x represents the number of years since 1992

y represents the number of fatal collisions per year

Consolidation

The Hardest Part?

The following equations are the result of regression analyses on data of the number of fatal collisions per year from 1992 to 2011.

Linear $y = -50.832x + 3012.457$

Quadratic $y = -0.704x^2 - 37.465x + 2972.356$

Exponential $y = 3052.329*0.980^x$

If we want to use each model to predict the number of fatal collisions in 1975 what do we do? Do it!

We would need to plug x = -17 into each equation and solve. (1975 - 1992 = -17)

*17 years in the **past** (NEGATIVE)

Consolidation

The Hardest Part?

The following equations are the result of regression analyses on data of the number of fatal collisions per year from 1992 to 2011.

Linear $y = -50.832x + 3012.457$

Quadratic $y = -0.704x^2 - 37.465x + 2972.356$

Exponential $y = 3052.329*0.980^x$

If we want to use each model to predict the number of fatal collisions in 2025, what do we do? Do it!

We would need to plug x = 33 into each equation and solve. (2025 - 1992 = 33)

*33 years in the **future** (POSITIVE)