DS 09/21 Statistics Session-4

DS Statistics Session-4
Training Clarusway
Pear Deck - September 29, 2021 at 0:59PM

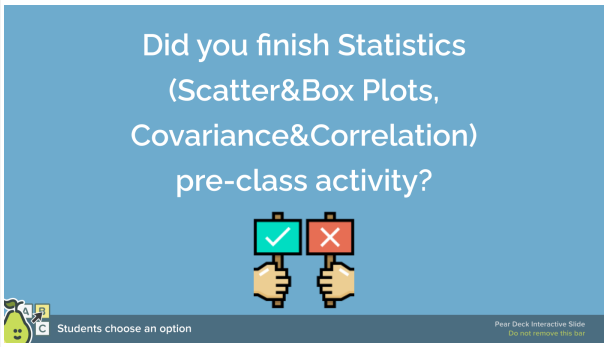
Part 1 - Summary

Use this space to summarize your thoughts on the lesson

Part 2 - Responses

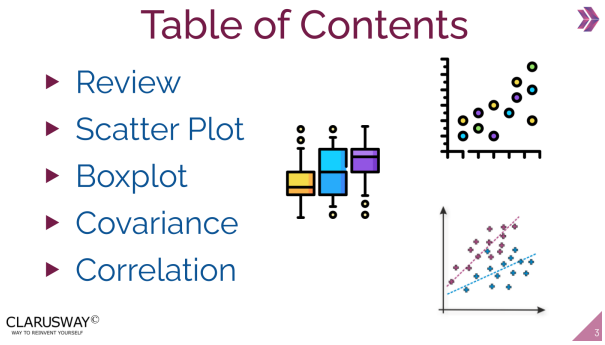
Slide 1

Use this space to take notes:

Slide 2	Your Response
	You Chose • **I finished partially.** Other Choices • I finished completely. • No, I didn't finish.

Use this space to take notes:

Slide 3



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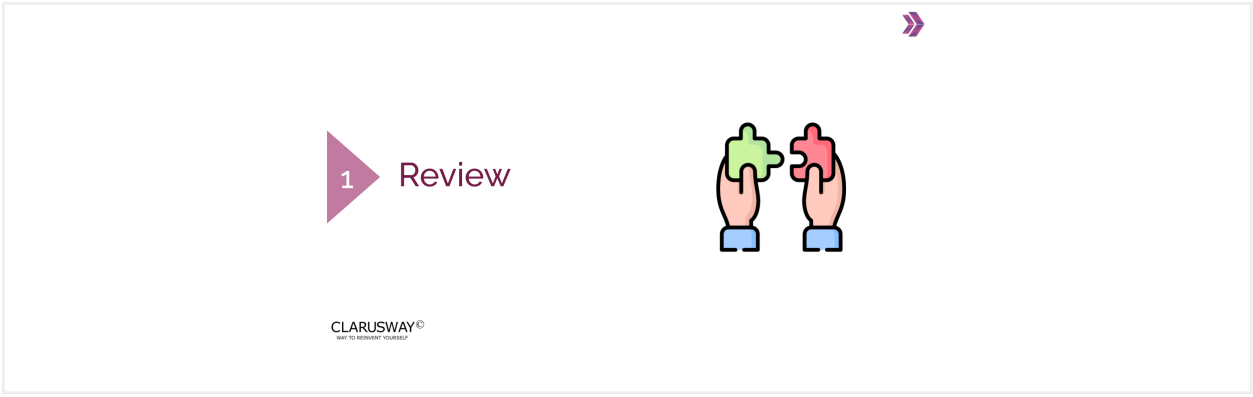
Slide 4



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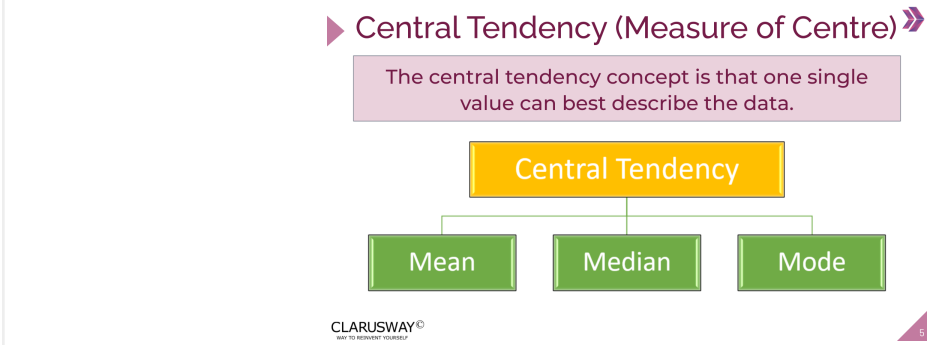
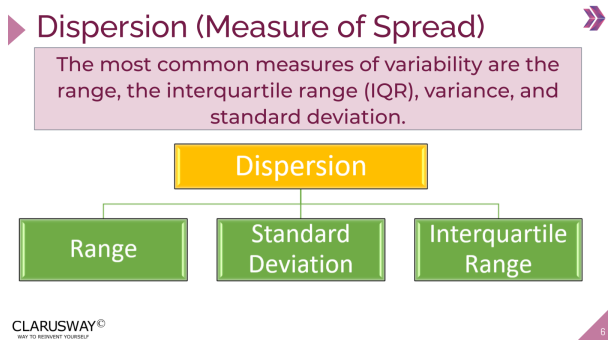
Slide 5



Use this space to take notes:

Slide 6



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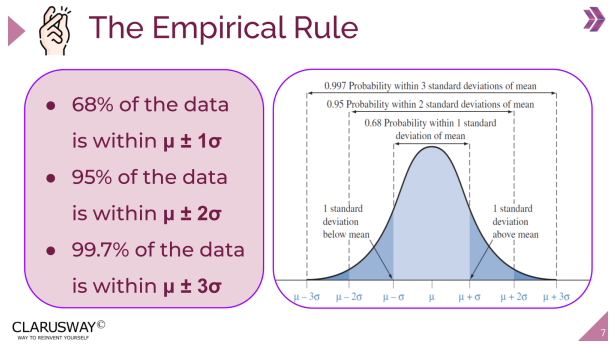
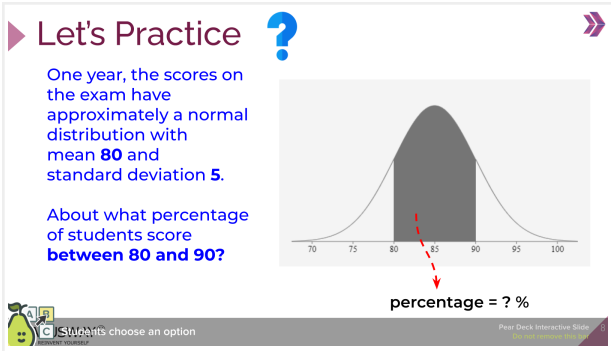
Slide 7



Use this space to take notes:

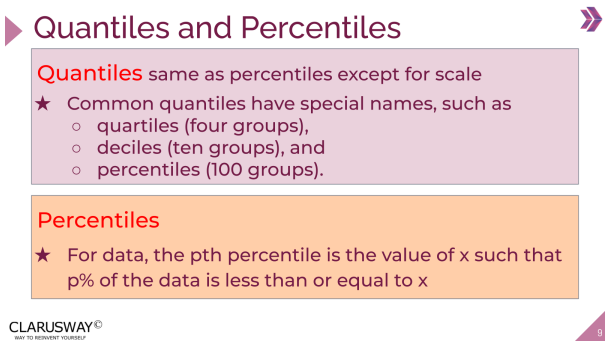
Slide 8	Your Response
	You Chose • **68** Other Choices



- 95
- 99.7
- Don't know

Use this space to take notes:

Slide 9

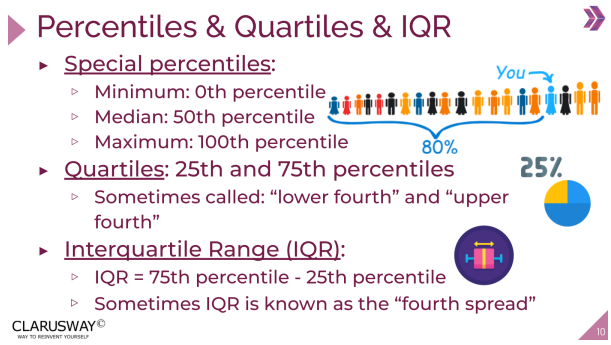


Link(s) on this slide:

- https://en.wikipedia.org/wiki/Quartile
- https://en.wikipedia.org/wiki/Decile
- https://en.wikipedia.org/wiki/Percentile

Use this space to take notes:

Slide 10



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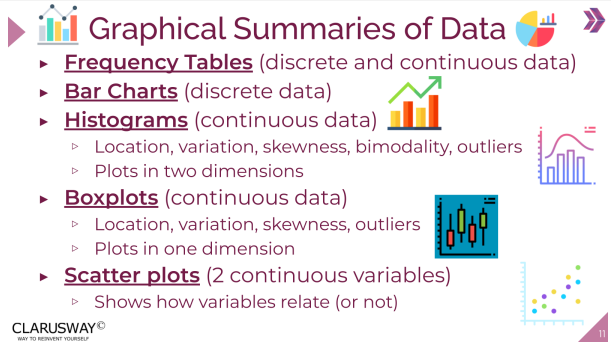
Slide 11



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Slide 12

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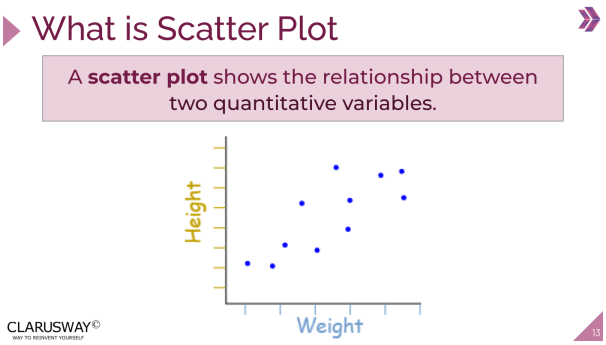

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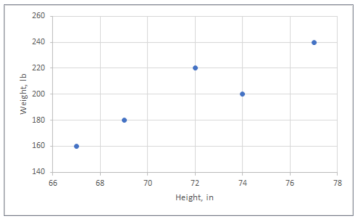
Slide 14

How to make a Scatter Plot

Height, in	Weight, lb
67	160
72	220
77	240
74	200
69	180



Scatter plots reveal patterns in bivariate data.

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Use this space to take notes:

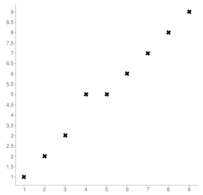
Slide 15

Patterns of Data in Scatter Plot

Linearity | Slope | Strength | Unusual Features

Linearity refers to whether a data pattern is linear (straight) or nonlinear (curved).

Linear



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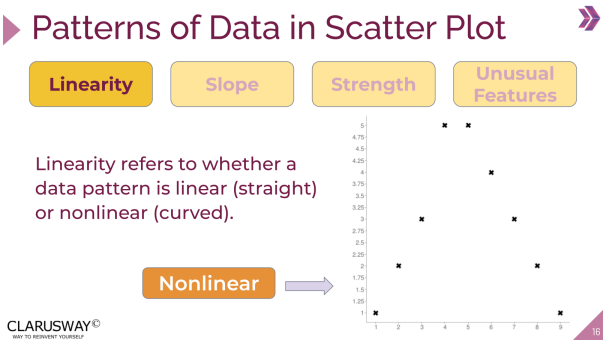
Slide 16



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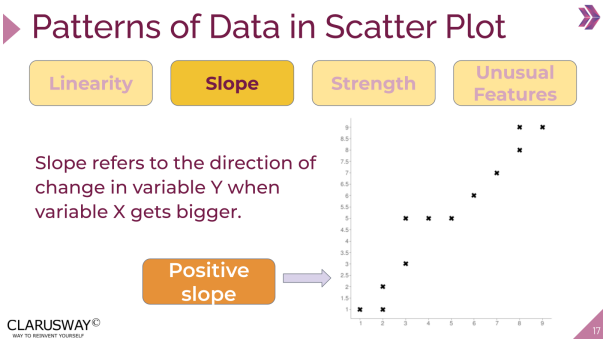
Slide 17



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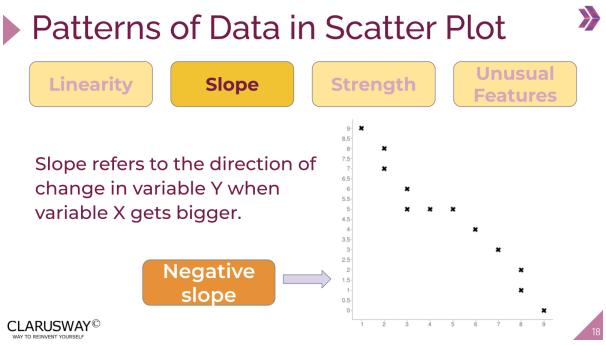

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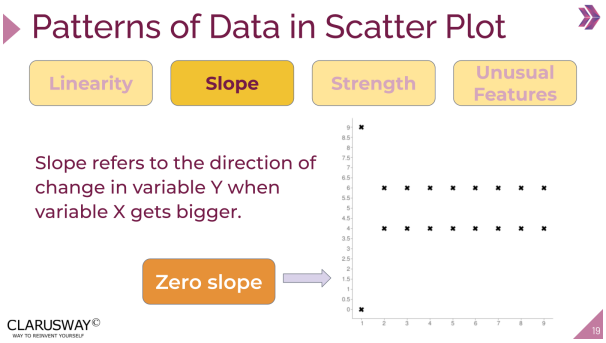
Slide 19



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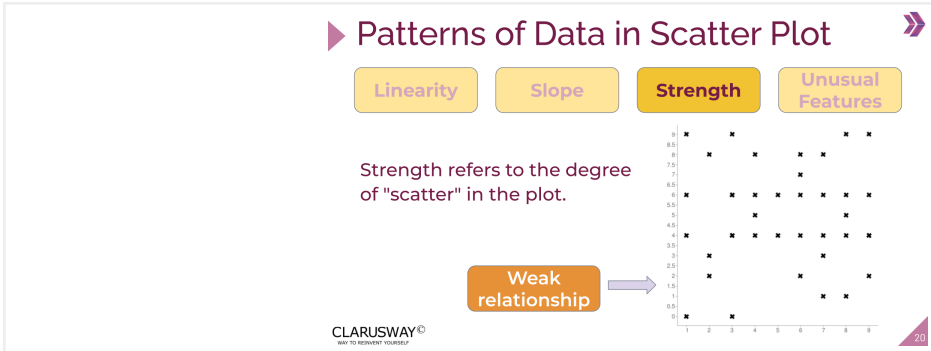
Slide 20



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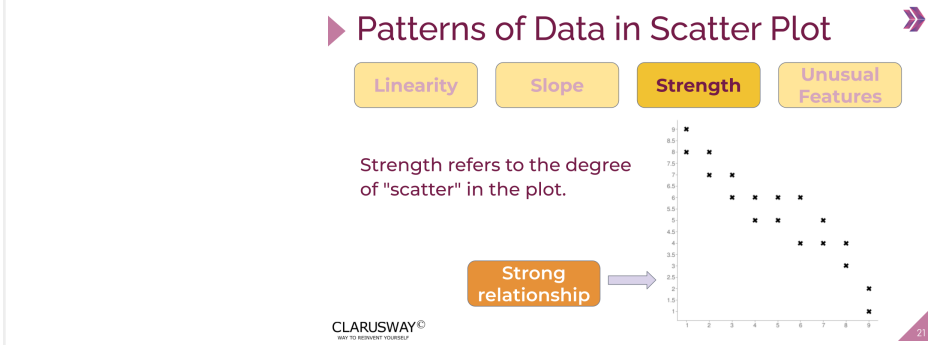

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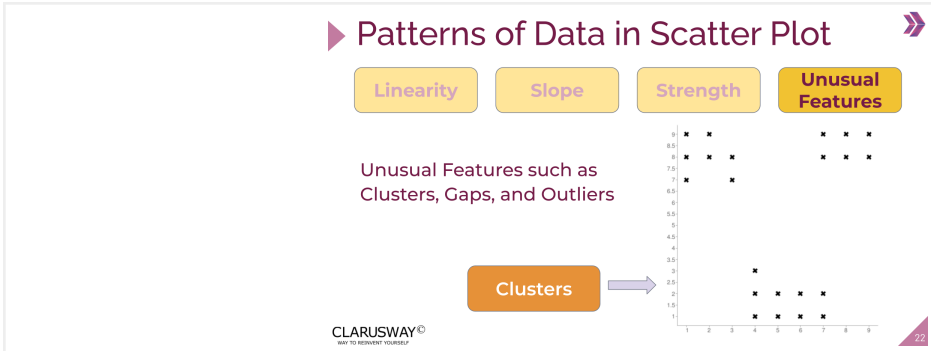

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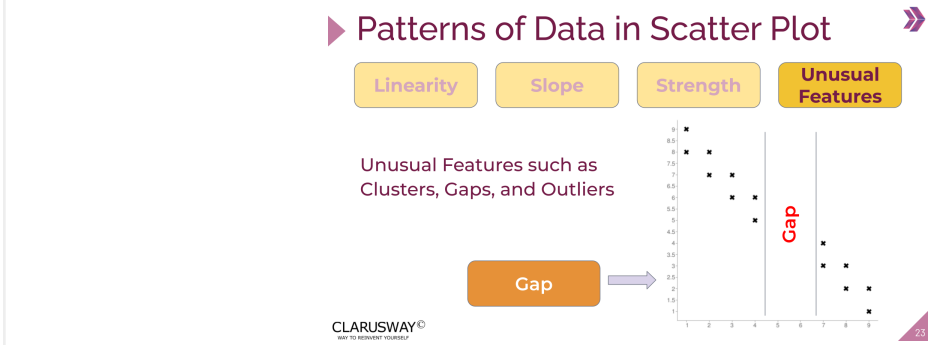

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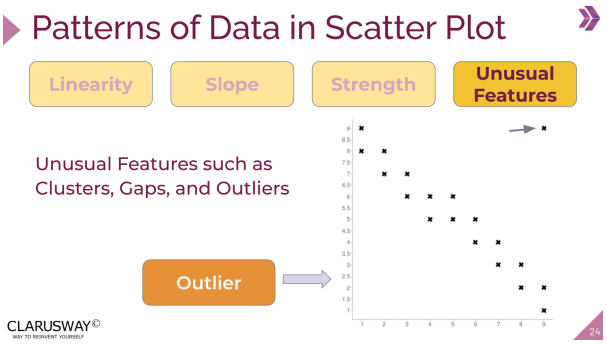
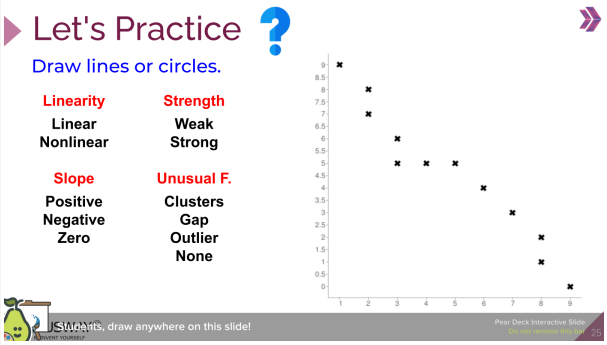
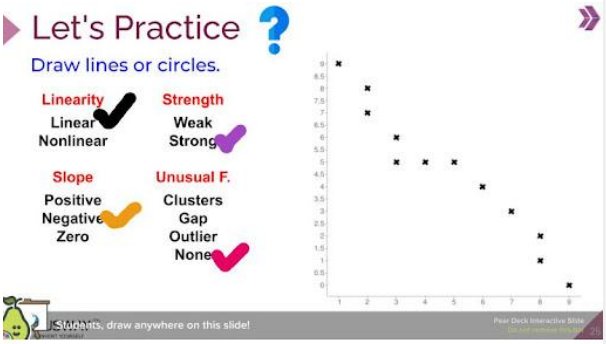


Use this space to take notes:

Slide 25	Your Response
	

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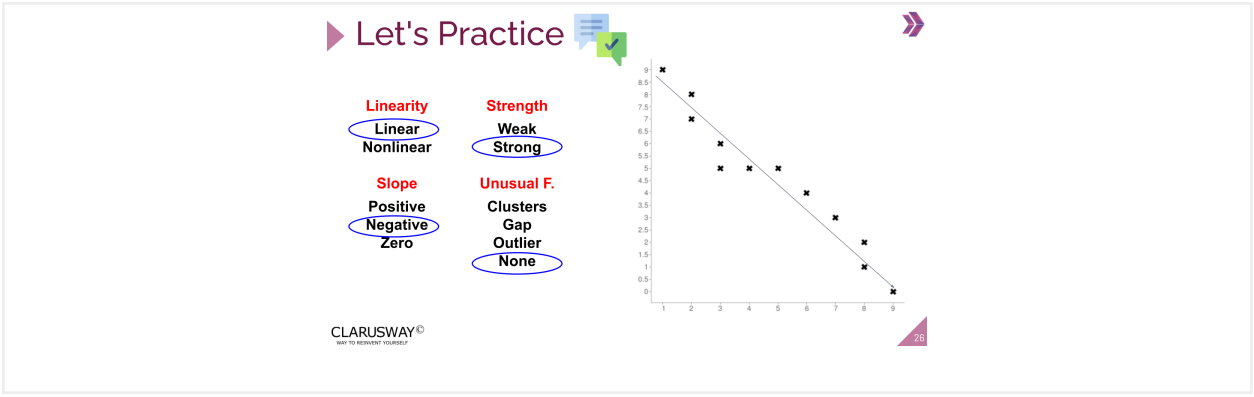
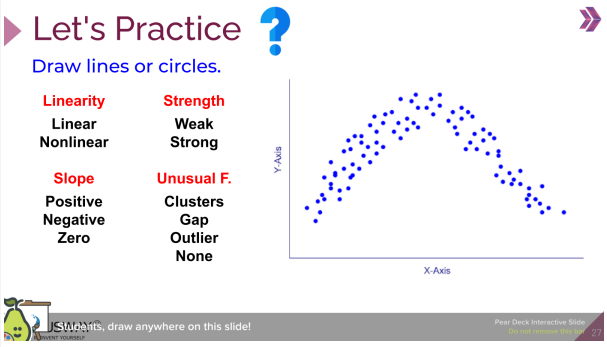
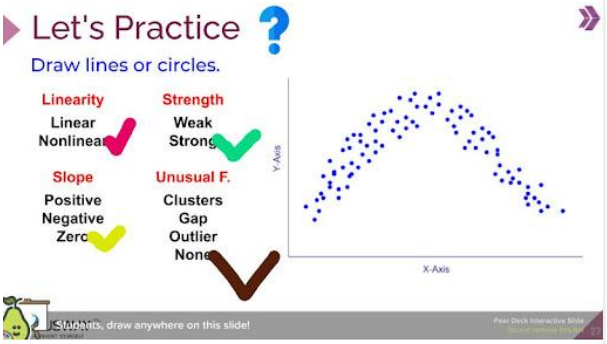
Slide 26



Use this space to take notes:

Slide 27	Your Response
	

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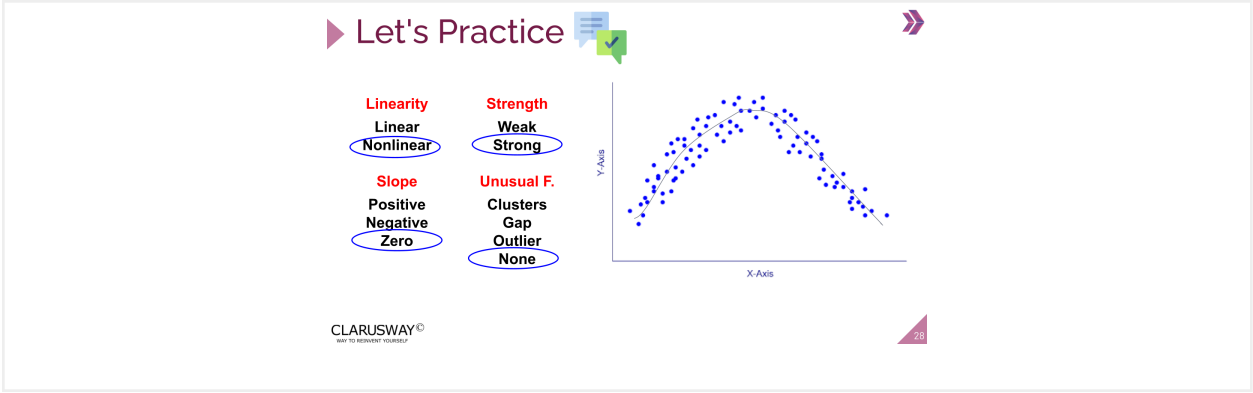

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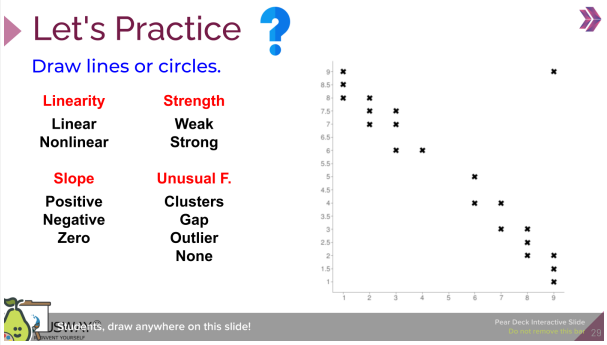
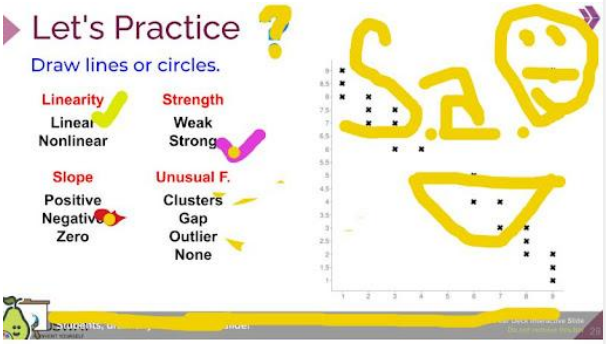
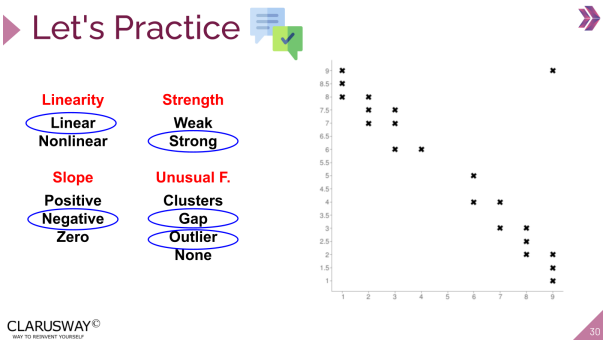
Slide 29	Your Response
	

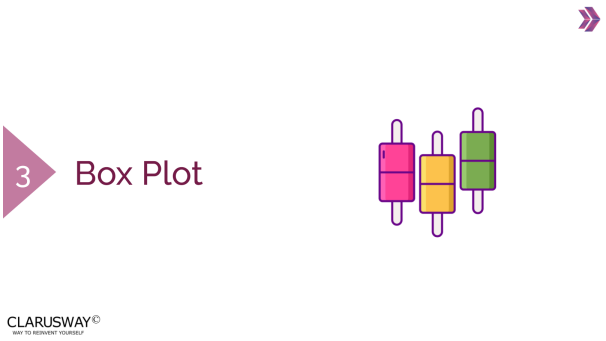
Use this space to take notes:

Slide 30



Use this space to take notes:

Slide 31



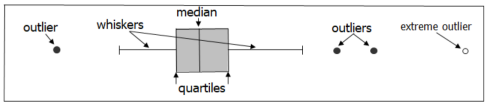
Use this space to take notes:

Slide 32

What is Box Plot

A **box plot** is a method for graphically depicting groups of numerical data through their *quartiles*.

A box plot generally shows
- ★ median
- ★ 1st quartile (Q1)
- ★ 3rd quartile (Q3)
- ★ outliers



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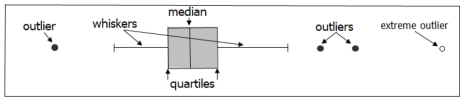
Use this space to take notes:

Slide 33

Box Plot

Boxplots show distribution in one dimension
- ★ Only useful for continuous variables
- ★ Good for comparing distributions of a continuous variable between categorical groups
- ★ Will not show multiple modes

Box plots are also known as **box and whisker plots**.



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Box Plot

- Different variants exist, some do whiskers to min and max, others go to the lowest data that is at most 1.5*IQR from the edges of the rectangle.
- More outlying observations are identified as “outliers” or “extreme outliers” if greater than 3*IQR from the edges of the rectangle.

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Use this space to take notes:

Slide 35

How to make a Box Plot (Min & Max)

Weight, kg
38
25
37
28
35
29
35
29
34
30

Step 1: Order the data from smallest to largest.

25 28 29 29 30 34 35 35 37 38

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Slide 36

How to make a Box Plot (Min & Max)

Weight, kg
38
25
37
28
35
29
35
29
34
30

Step 1: Order the data from smallest to largest.

25 28 29 29 30 34 35 35 37 38

Step 2: Find the median.

25 28 29 29 30 34 35 35 37 38

Median = 32

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Slide 37

How to make a Box Plot (Min & Max)

Weight, kg
38
25
37
28
35
29
35
29
34
30

Step 1: Order the data from smallest to largest.

25 28 29 29 30 34 35 35 37 38

Step 2: Find the median.

25 28 29 29 30 34 35 35 37 38

Median = 32

Step 3: Find the quartiles.

25 28 29 29 30 34 35 35 37 38

Q1 = 29 *Q2 = 35*

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Use this space to take notes:

Slide 38

How to make a Box Plot (Min & Max)

Weight, kg
38
25
37
28
35
29
35
29
34
30

Step 1: Order the data from smallest to largest.

25 28 29 29 30 34 35 35 37 38

Step 2: Find the median.

25 28 29 29 30 34 35 35 37 38

Median = 32

Step 3: Find the quartiles.

25 28 29 29 30 34 35 35 37 38

Q1 = 29 *Q2 = 35*

Step 4: Find the min and the max.

Min = 25 *Max = 38*

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Use this space to take notes:

Slide 39

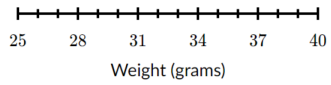
How to make a Box Plot (Min & Max)

Min	25
Q1	29
Median	32
Q3	35
Max	38

Step 1: Scale / label an axis that fits the five-number.

25 28 29 29 30 34 35 35 37 38

Min = 25 *Max = 38*



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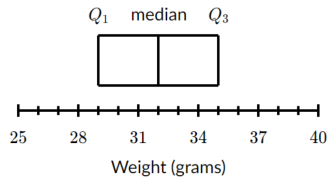
Slide 40

How to make a Box Plot (Min & Max)

Min	25
Q1	29
Median	32
Q3	35
Max	38

Step 2: Draw a box from *Q1* to *Q3* with a vertical line through the *median*.

25 28 29 29 30 34 35 35 37 38



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Use this space to take notes:

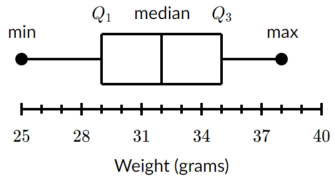
Slide 41

How to make a Box Plot (Min & Max)

Min	25
Q1	29
Median	32
Q3	35
Max	38

Step 3: Draw a whisker from *Q1* to the *min* and from *Q3* to the *max*.

25 28 29 29 30 34 35 35 37 38



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Use this space to take notes:

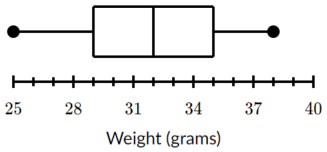
Slide 42

How to make a Box Plot (Min & Max)

Min	25
Q1	29
Median	32
Q3	35
Max	38

We don't need the labels on the final product:

25 28 29 29 30 34 35 35 37 38



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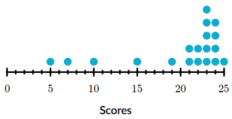
Use this space to take notes:

Slide 43	Your Response
## Identifying Outliers An **outlier** is a data point that lies outside the overall pattern in a distribution.  **Question:** How many outliers do you see? Students, enter a number! Pear Deck Interactive Slide Do not remove this bar 43	• 4

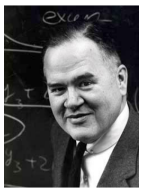
Use this space to take notes:

Slide 44

Identifying Outliers (1.5xIQR Rule)

1.5 IQR Rule: If an observation falls more than 1.5 IQRs above Q3 or below Q1, it is an outlier.

According to John Tukey,
1 IQR seemed like too little and
2 IQRs seemed like too much.



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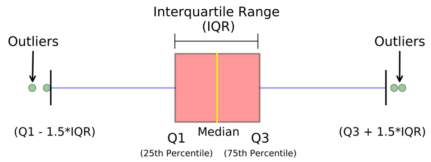
Slide 45

Boxplot with 1.5xIQR Rule

1.5 IQR Rule: If an observation falls more than 1.5 IQRs above Q3 or below Q1, it is an outlier.



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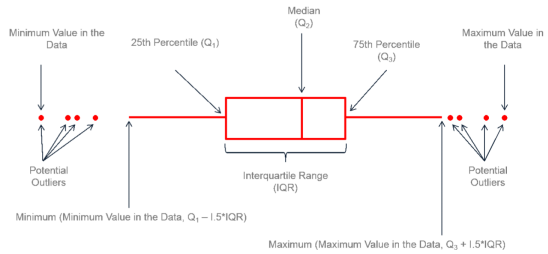
Boxplot with 1.5xIQR Rule



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How to make a Box Plot (1.5xIQR Rule)

5, 7, 10, 15, 19, 21, 21, 22, 22, 23, 23, 23, 23, 23, 24, 24, 24, 24, 25

Step 1: Find the median, quartiles, and interquartile range.

Median = 23
Q1 = 19
Q3 = 24
IQR = Q3 - Q1 = 24 - 19 = 5

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How to make a Box Plot (1.5xIQR Rule)

5, 7, 10, 15, 19, 21, 21, 22, 22, 23, 23, 23, 23, 23, 24, 24, 24, 24, 25

Step 1: Find the median, quartiles, and interquartile range.

Step 2: Calculate 1.5 x IQR below the first quartile and check for low outliers.

Q1 - 1.5 x IQR = 19 - 1.5 x 5
= 11.5

Low Outliers: 5 7 10

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How to make a Box Plot (1.5xIQR Rule)

5, 7, 10, 15, 19, 21, 21, 22, 22, 23, 23, 23, 23, 23, 24, 24, 24, 24, 25

Step 1: Find the median, quartiles, and interquartile range.

Step 2: Calculate 1.5 x IQR below the first quartile and check for low outliers.

Step 3: Calculate 1.5 x IQR above the third quartile and check for high outliers.

Q3 + 1.5 x IQR = 24 + 1.5 x 5
= 31.5

High Outliers: None

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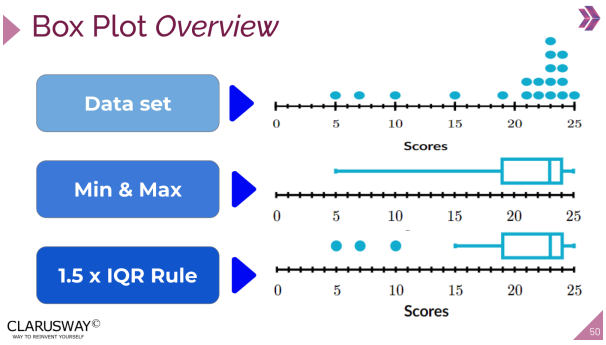
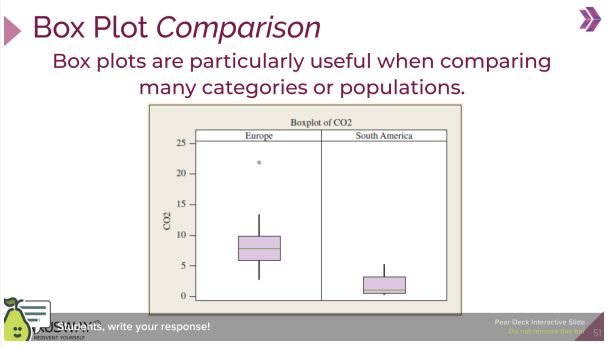
Slide 50



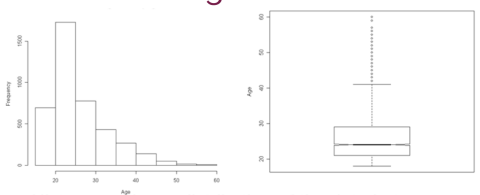
Use this space to take notes:

Slide 51	Your Response
	**Answer 1:** Yorumsuz :)

Use this space to take notes:

Slide 52

Box Plot vs. Histogram



- Histogram shows distribution of the data in two dimensions – the boxplot is in one dimension
  - Histogram shows frequency of observations within ranges
  - Boxplot only shows summary statistics

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Slide 53	Your Response

Let's Practice *Draw Box Plot*

3	6	8	9	9	10	12	14	19

0 5 10 15 20

Students, draw anywhere on this slide!

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Let's Practice *Draw Box Plot*

3 6 8 9 9 10 12 14 19

0 5 10 15 20

Students, draw anywhere on this slide!

Use this space to take notes:

Slide 54

4 Covariance

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Intro

- ★ We are interested in how variables behave together.
- ★ For example, suppose we want to investigate the relationship between smoking and lung capacity.
- ★ We might ask a group of people about their smoking habits, and measure their lung capacities.

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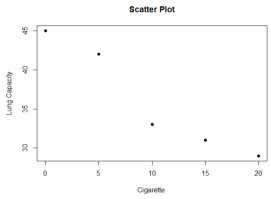
Scatter Plot

Cigarette (X)	Lung Capacity (Y)
0	45
5	42
10	33
15	31
20	29



Scatter plots reveal patterns in bivariate data.

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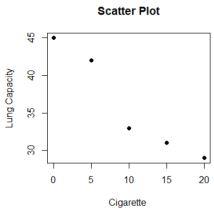
Slide 57

Scatter Plot

- We can see easily from the graph that as smoking goes up, lung capacity tends to go down.
- The two variables covary in opposite directions.



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Covariance

- ★ **Covariance** is a measure of how much two random variables change together.
- ★ The covariance gives info on the strength of the linear relationship between two variables. Since it is not a scaled metric, it is not useful to compare two different values of covariances.

$$Cov(x,y) = \sigma_{xy} = \frac{\sum_{i=1}^{N}(x_i - \mu_x)(y_i - \mu_y)}{N}$$

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Covariance Interpretation

x and y tend to move in the same direction	Cov(x,y) > 0
x and y tend to move in opposite directions	Cov(x,y) < 0
x and y are independent	Cov(x,y) = 0

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Covariance *Example*

Table shows years of education (S) and hourly earnings in dollars (Y).

Observation	*S*	*Y*	*Observation*	*S*	*Y*
1	15	17.24	11	17	15.38
2	16	15.00	12	12	12.70
3	8	14.91	13	12	26.00
4	6	4.50	14	9	7.50
5	15	18.00	15	15	5.00
6	12	6.29	16	12	21.63
7	12	19.23	17	16	12.10
8	18	18.69	18	12	5.55
9	12	7.21	19	12	7.50
10	20	42.06	20	14	8.00

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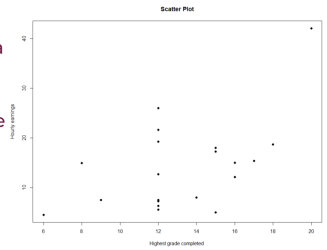
Covariance *Example*

- Figure shows the data plotted as a scatter plot.
- You can see that there is a weak positive association between the two variables.



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Covariance *Example*

Observation	S	Y	$(S - \bar{S})$	$(Y - \bar{Y})$	$(S - \bar{S})(Y - \bar{Y})$
1	15	17.24	1.75	3.016	5.277
2	16	15.00	2.75	0.775	2.133
3	8	14.91	-5.25	0.685	-3.599
4	6	4.5	-7.25	-9.725	70.503
5	15	18.00	1.75	3.776	6.607
6	12	6.29	-1.25	-7.935	9.918
7	12	19.23	-1.25	5.006	-6.257
8	18	18.69	4.75	4.466	21.211
9	12	7.21	-1.25	-7.015	8.768
10	20	42.06	6.75	27.836	187.890
11	17	15.38	3.75	1.156	4.333
12	12	12.70	-1.25	-1.525	1.906
13	12	26.00	-1.25	11.776	-14.719
14	9	7.50	-4.25	-6.725	28.579
15	15	5.00	1.75	-9.225	-16.143
16	12	21.63	-1.25	7.406	-9.257
17	16	12.10	2.75	-2.125	-5.842
18	12	5.55	-1.25	-8.675	10.843
19	12	7.50	-1.25	-6.725	8.406
20	14	8.00	0.75	-6.225	-4.668

$$\text{Cov}(x, y) = \frac{1}{n}[(x_1 - \bar{x})(y_1 - \bar{y}) + \ldots + (x_n - \bar{x})(y_n - \bar{y})]$$
$$= \frac{1}{n}\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})$$

Therefore, covariance is calculated as

305.888 / 19 = 16.0993

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5 Correlation

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Correlation

The **correlation** summarizes the direction of the association between two quantitative variables and the strength of its linear (straight-line) trend.

Direction

- Positive : Move in same direction
- Negative : Move in opposite directions

Strength

- Weak : Widely spread
- Strong : Concentrated around a line

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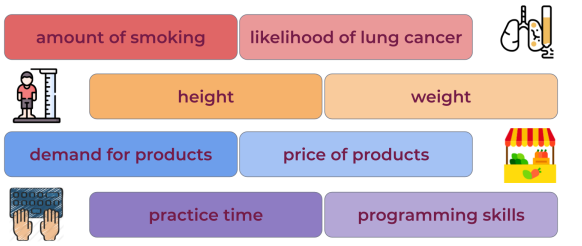
Examples



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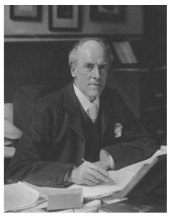
Correlation *Coefficient*

The correlation coefficient, ***r***, developed by *Karl Pearson* in the early 1900s.

$$r = \frac{n\Sigma(xy) - (\Sigma x)(\Sigma y)}{\sqrt{\left[n\Sigma x^2 - (\Sigma x)^2\right]\left[n\Sigma y^2 - (\Sigma y)^2\right]}}$$

n = the number of data points.



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Correlation *Coefficient*

Denoted by *r*, it takes values between *-1* and *+1*.

Strength

- Greater absolute value, stronger relationship
- Strongest relationship is correlation of -1 or 1
- Weakest relationship is correlation of zero.

Direction

- Sign of coefficient describes direction
- Positive sign: Variables move in same direction
- Negative sign: Move in opposite directions

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Correlation *Notation*

Sample Correlation	r
Population Correlation	ρ or R

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Correlation *Coefficient Formula*

Sample Correlation	$r = \frac{Cov(x,y)}{s_X s_Y}$
Population Correlation	$\rho = \frac{Cov(x,y)}{\sigma_X \sigma_Y}$

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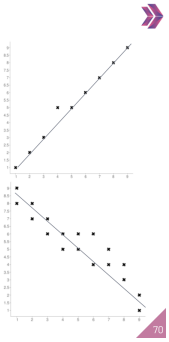
Linear Relationship

When the data points follow a roughly straight-line trend, the variables are said to have an approximately **linear relationship**.

On the line

Around the line



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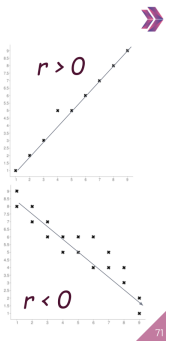
Direction

Slope determines the sign of the correlation coefficient.

When the slope of the line in the plot is negative, the correlation is negative; and vice versa.

Positive

Negative



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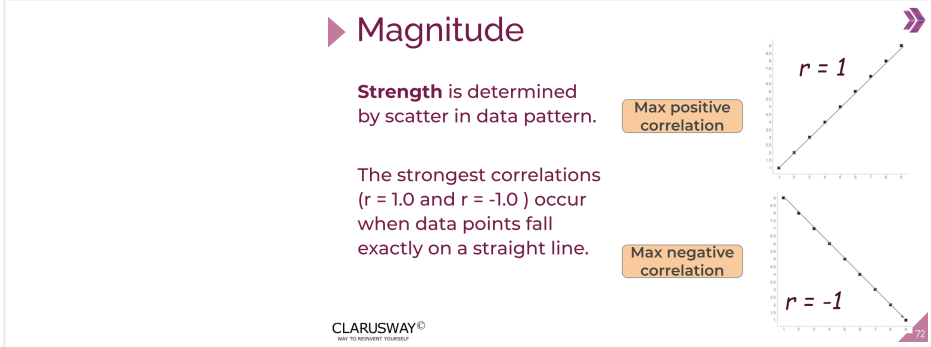

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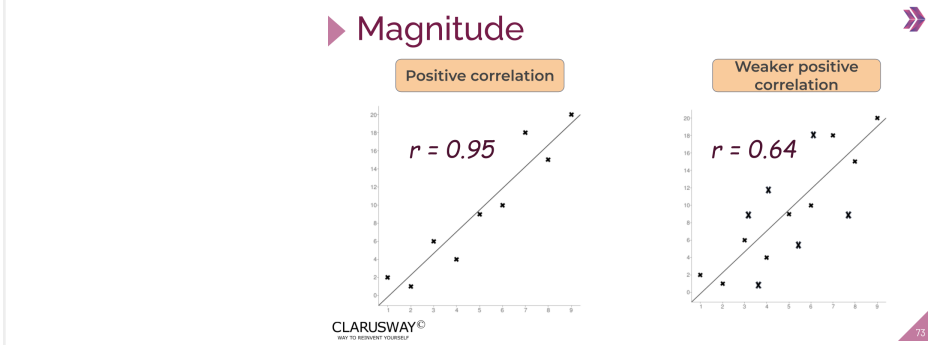

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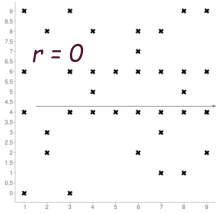
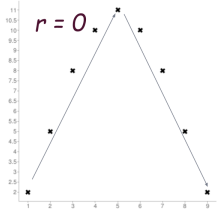
Zero Correlation

Random pattern



Curvilinear pattern



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Use this space to take notes:

Slide 75	Your Response

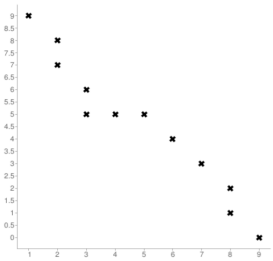
Patterns of Data in Scatter Plot

Draw lines or circles.

Linearity
Linear
Nonlinear

Strength
Weak
Strong

Slope
Positive
Negative
Zero



Students, draw anywhere on this slide!

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Slide 76

Examples of Approximate r Values

Graph A (r = 1.0): perfect positive correlation between x and y

Graph B (r = -1.0): perfect negative correlation between x and y

Graph C (r = 0.6): a moderately positive relationship: y tends to increase as x increases, but not necessarily at the steady rate we observed in Graph A

Graph D (r = -0.4): a relatively weak negative relationship: the correlation coefficient is closer to zero, negative r value so y tends to decrease as x increases

Graph E (r = 0): no relationship between x and y

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Use this space to take notes:

Slide 77	Your Response
## Let's Practice Which pair of variables exhibits the strongest linear relationship? Which pair of variables exhibits the weakest linear relationship?	You Chose ● **Strongest: B | Weakest: E** Other Choices ● Strongest: C | Weakest: E ● Strongest: E | Weakest: B

Pair	Variable 1	Variable 2	Correlation
A	Internet Users	Facebook Users	0.507
B	Internet Users	Broadband Subscribers	0.949
C	Internet Users	Population	0.744
D	Facebook Users	Broadband Subscribers	0.619
E	Facebook Users	Population	0.097
F	Broadband Subscribers	Population	0.533

Students choose an option

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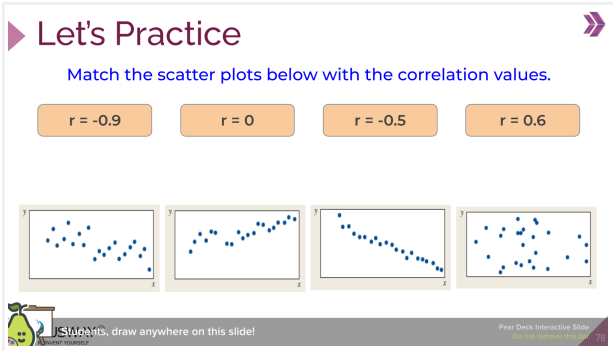
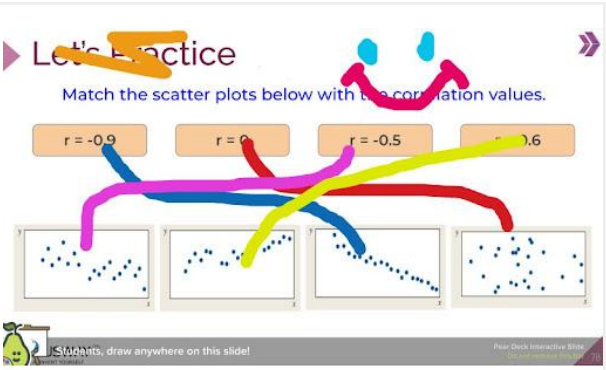
Slide 78	Your Response





Use this space to take notes:

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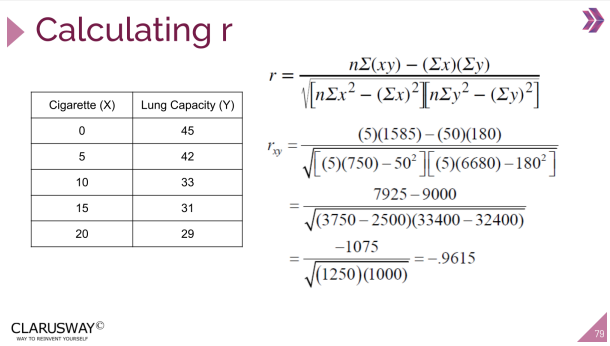
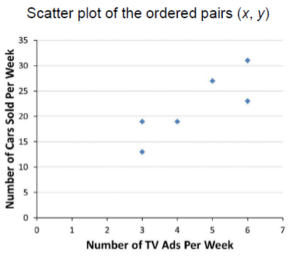


Use this space to take notes:

Slide 80

Calculating r

Week	Number of TV Ads x	Number of Cars Sold y
1	3	13
2	6	31
3	4	19
4	5	27
5	6	23
6	3	19



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Slide 81

Calculating r

Week	Number of TV Ads x	Number of Cars Sold y	xy	x^2	y^2
1	3	13	39	9	169
2	6	31	186	36	961
3	4	19	76	16	361
4	5	27	135	25	729
5	6	23	138	36	529
6	3	19	57	9	361
	$\Sigma x = 27$	$\Sigma y = 132$	$\Sigma xy = 631$	$\Sigma x^2 = 131$	$\Sigma y^2 = 3110$

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Slide 82

Calculating r

$$r = \frac{n\sum xy - (\sum x)(\sum y)}{\sqrt{\left[n\sum x^2 - (\sum x)^2\right]\left[n\sum y^2 - (\sum y)^2\right]}}$$

$$r = \frac{n\sum xy - (\sum x)(\sum y)}{\sqrt{\left[n\sum x^2 - (\sum x)^2\right]\left[n\sum y^2 - (\sum y)^2\right]}} = \frac{(6)(631) - (27)(132)}{\sqrt{\left[(6)(131) - (27)^2\right]\left[(6)(3110) - (132)^2\right]}}$$

$$= \frac{222}{\sqrt{[57]\,[1236]}} = \frac{222}{265.43} = 0.836$$

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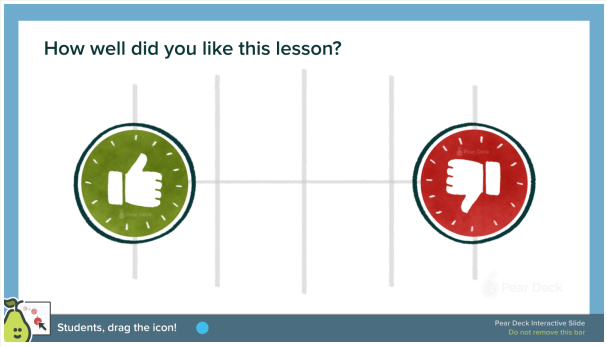
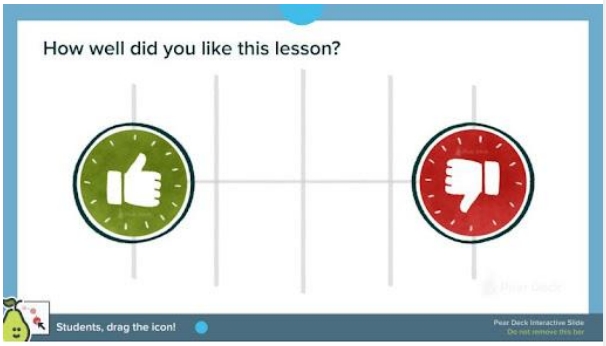
Use this space to take notes:

Slide 83	Your Response
## Let's Practice If one y value is changed, the correlation for the five pairs equals 1. Identify the y value and how it must be changed for this to happen. **Variable 1** / **Variable 2** 3 / 8 4 / 13 5 / 12 6 / 14 7 / 16 Students, write your response! Pear Deck Interactive Slide Do not remove this bar 83	

Use this space to take notes:

Slide 84	Your Response





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Use this space to take notes: