DS-12/22 EU Session-3

DS 12/22 Statistics Session-3
Training Clarusway
Pear Deck - July 28, 2022 at 0:55PM

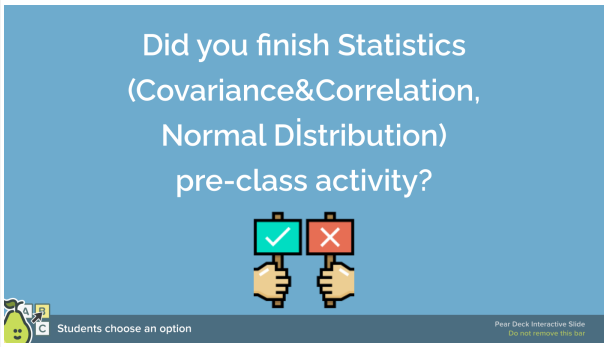
Part 1 - Summary

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
	

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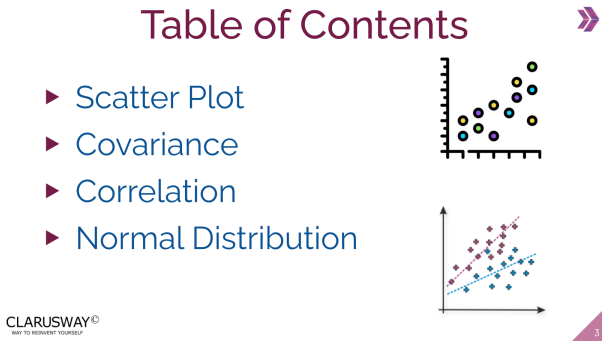

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Slide 4

1 Scatter Plot

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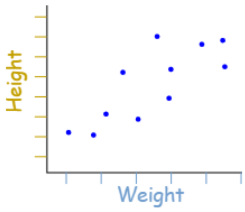
What is Scatter Plot

A **scatter plot** shows the relationship between two numerical variables.



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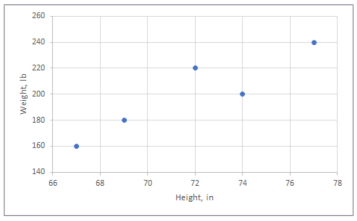
How to make a Scatter Plot

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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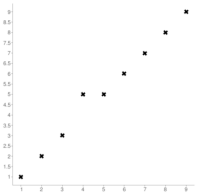
Patterns of Data in Scatter Plot

Linearity | Slope | Strength | Unusual Features

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

Linear



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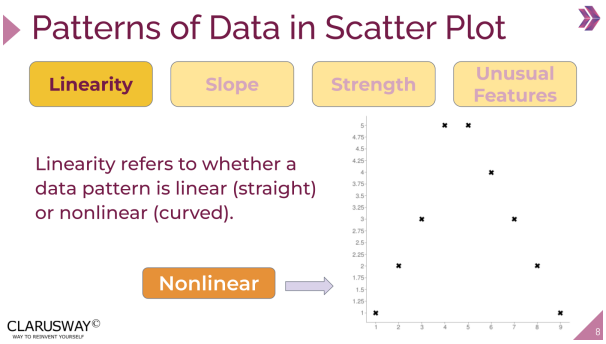

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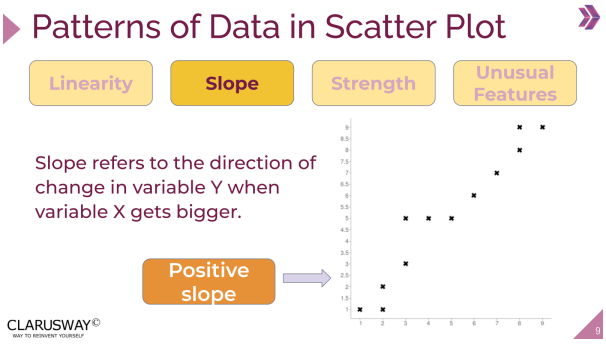

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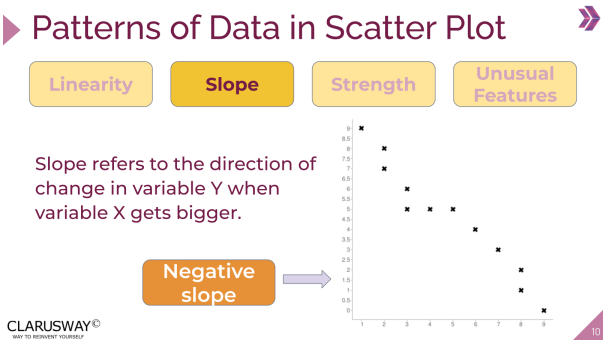

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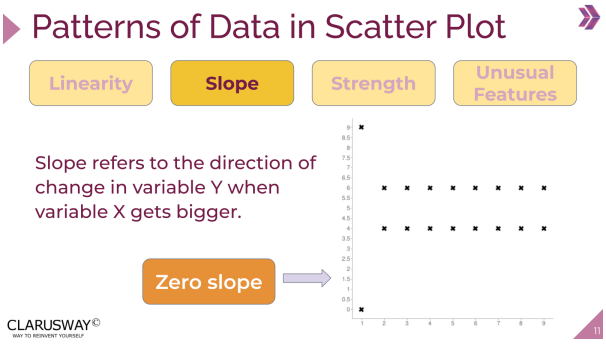

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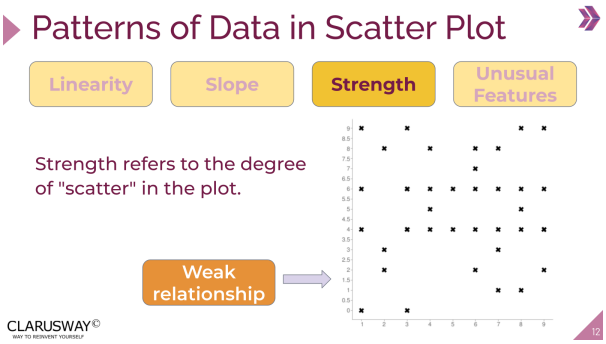

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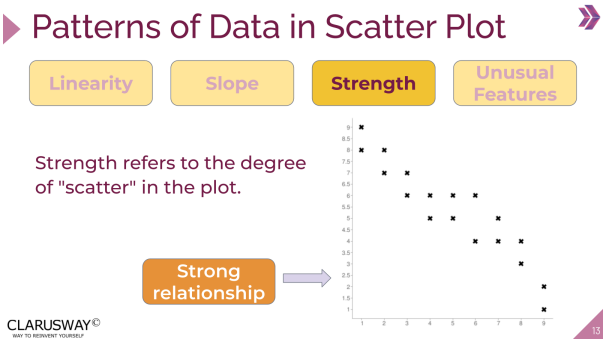

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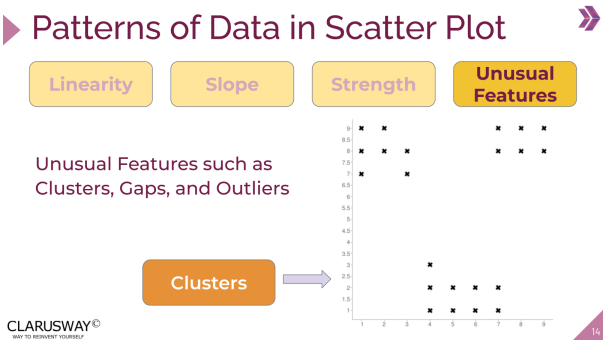

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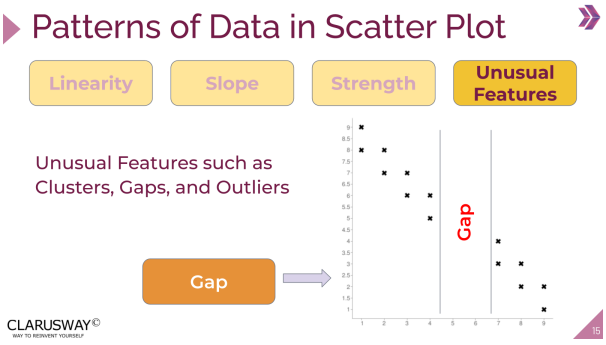

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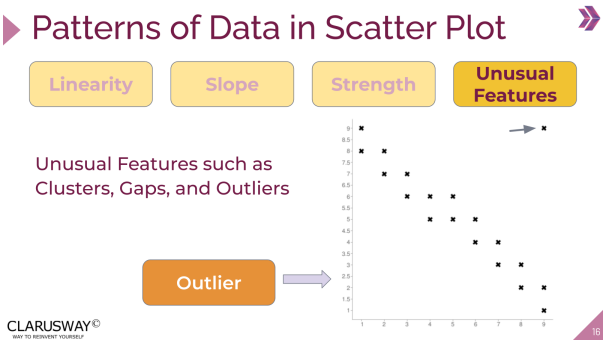

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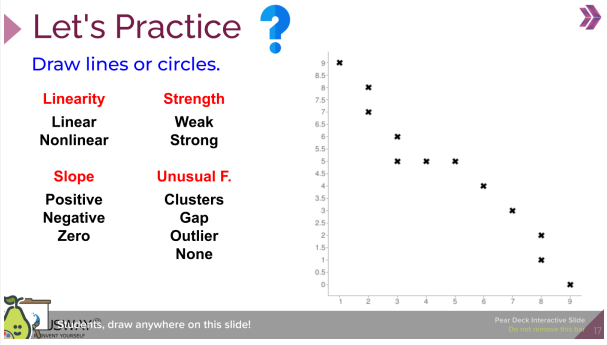

Your Response

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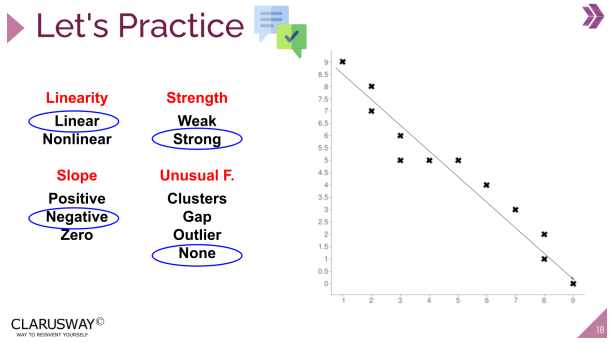

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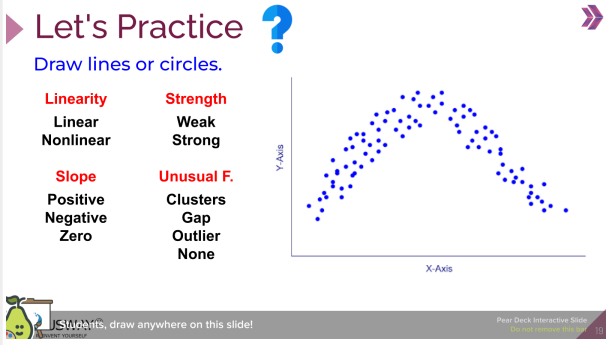

Your Response

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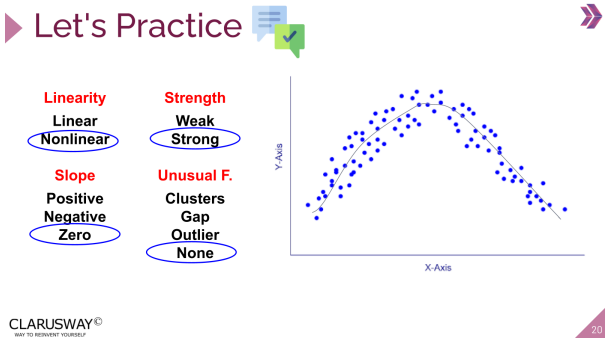

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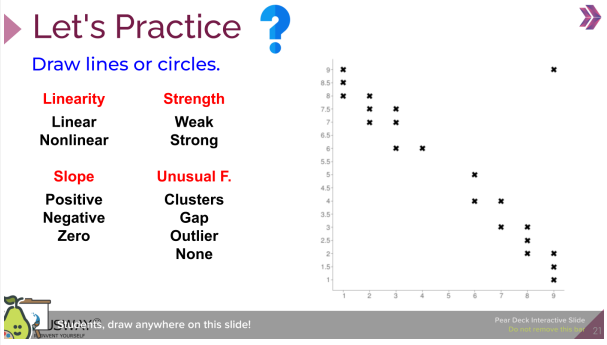

Your Response

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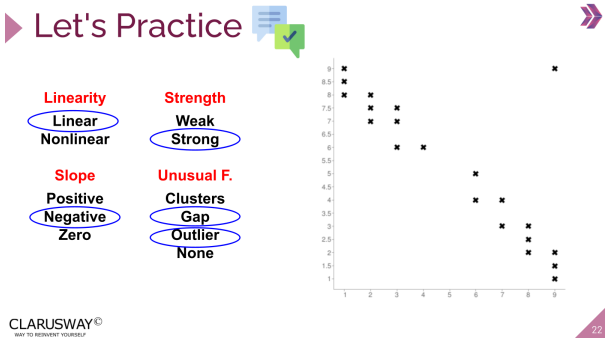

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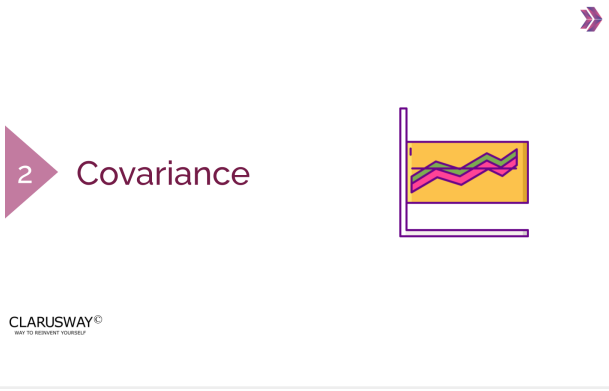

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Intro

- ★ 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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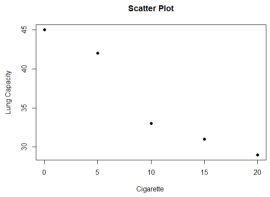
Scatter Plot

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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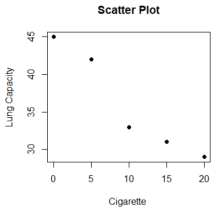
Scatter Plot

- 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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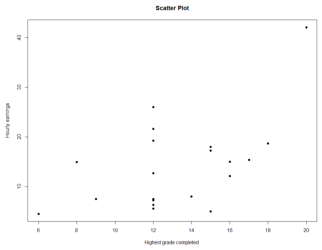
Covariance *Example*

- 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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3 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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Correlation *Notation*

Sample Correlation	r
Population Correlation	ρ or R

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Correlation *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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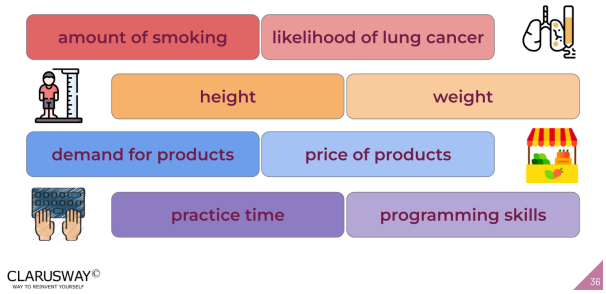
Examples



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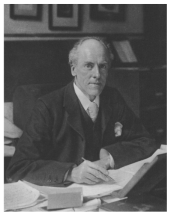
Correlation *Coefficient*

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



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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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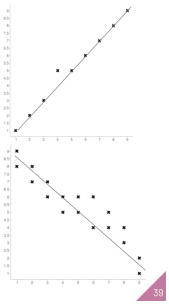
Linear Relationship

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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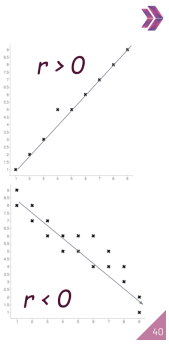
Direction

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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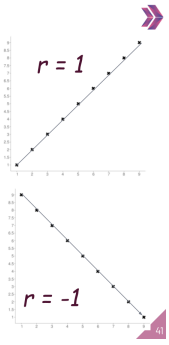
Strength

Strength is determined by scatter in data pattern.

The strongest correlations (r = 1.0 and r = -1.0) occur when data points fall exactly on a straight line.

Max positive correlation

Max negative correlation



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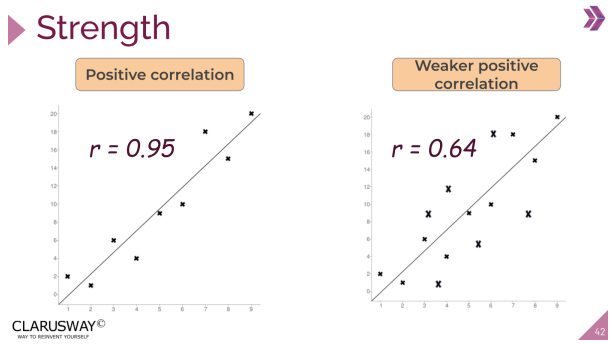

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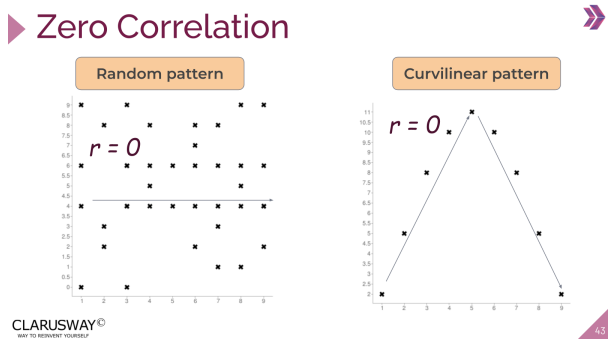


Use this space to take notes:

Slide 44	Your Response

Slide 44

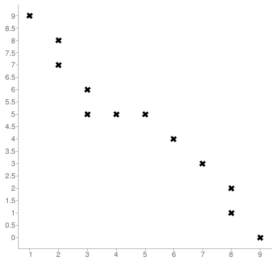
Patterns of Data in Scatter Plot

Draw lines or circles.

Linearity
Linear
Nonlinear

Strength
Weak
Strong

Slope
Positive
Negative
Zero



Students, draw anywhere on this slide!

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Do not remove this bar 44

Your Response

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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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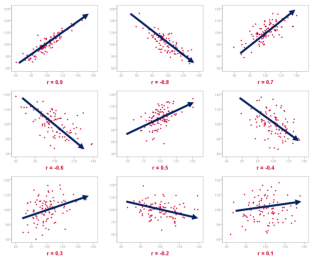
Examples of Approximate r Values



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Let's Practice

Which pair of variables exhibits the strongest linear relationship?
Which pair of variables exhibits the weakest linear relationship?

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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Your Response

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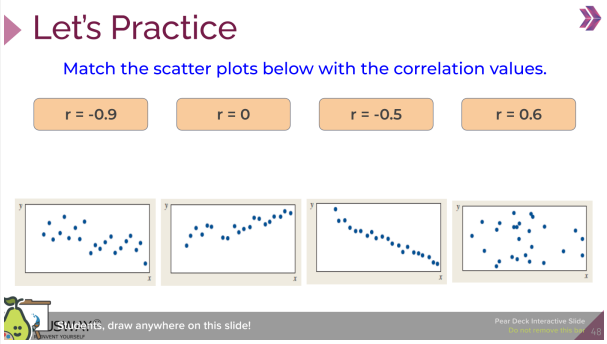
Your Response

Slide 48	Your Response
	

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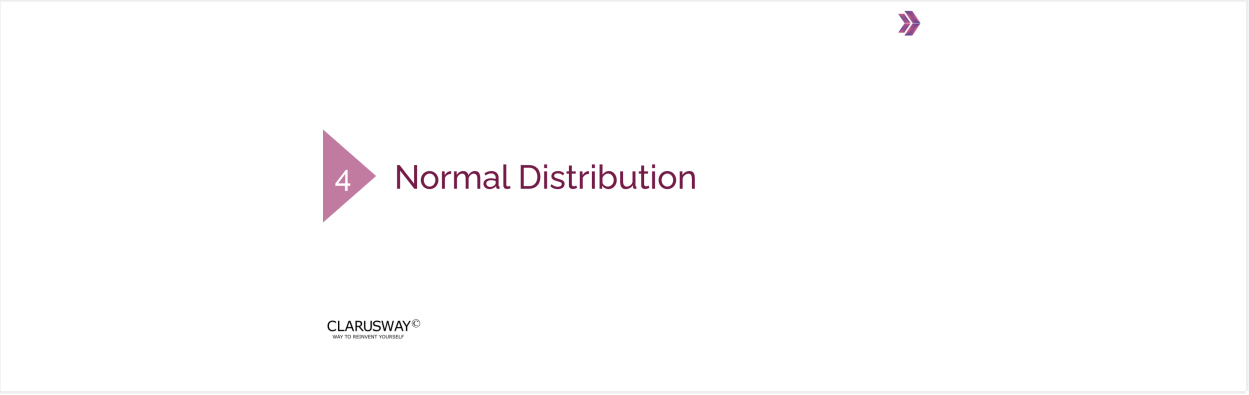

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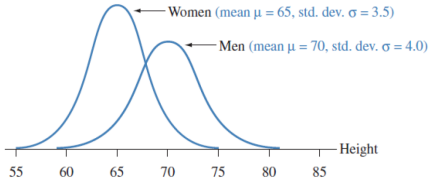
Normal Distribution

The normal distribution is symmetric, bell-shaped, and characterized by its mean **μ** and standard deviation **σ**.



Normal Distributions for Women's Height and Men's Height.

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Normal Distribution

- ★ Symmetric around their mean.
- ★ The mean, median, and mode are equal.
- ★ The area under the normal curve is equal to 1.0.
- ★ Denser in the center and less dense in the tails.
- ★ Defined by two parameters: μ and σ. $\mathcal{N}(\mu, \sigma^2)$
- ★ Bell-shaped curve or Gaussian curve.

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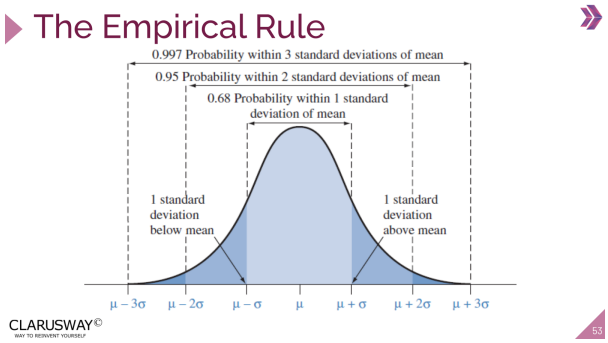
Use this space to take notes:

Slide 52	Your Response

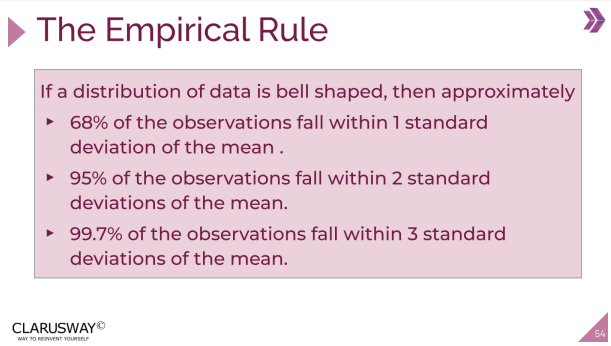
Slide 52	Your Response
	

Use this space to take notes:

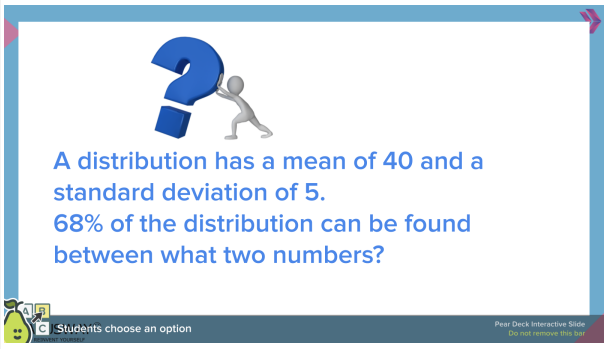
Slide 53



Use this space to take notes:

Slide 54


Use this space to take notes:

Slide 55	Your Response
	

Use this space to take notes:

Slide 56	Your Response

Slide 56

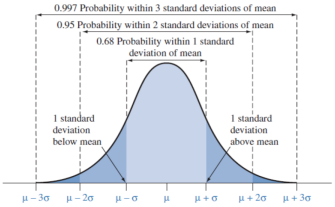
Your Response

The Empirical Rule

Question:

About what percentage (%) would fall more than 2 standard deviations from the mean?

Enter a number between 0-100



Students, enter a number!

Pear Deck Interactive Slide

55

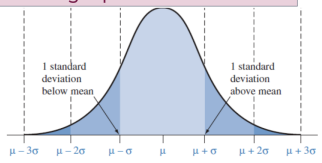
Use this space to take notes:

Slide 57

Finding Standard Score (z-score)

- The normal random variable of a standard normal distribution is called a standard score or a z-score.
- Every normal random variable x can be transformed into a z score via the following equation:

$$z = \frac{x - \text{mean}}{\text{standard deviation}}$$



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Use this space to take notes:

Slide 58

Finding z-score

- SAT scores are approximately normally distributed with mean μ = 500 and standard deviation σ = 100.
- If your SAT score from one of the three components was x = 650, how many standard deviations from the mean was it?

$$z = \frac{x - \mu}{\sigma} = \frac{650 - 500}{100} = 1.50$$

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Use this space to take notes:

Slide 59

Finding z-score

- SAT scores are approximately normally distributed with mean μ = 500 and standard deviation σ = 100.
- What percentage of SAT scores was higher than yours?

Table 4 Normal Curve Areas
Standard normal probability in right-hand tail
(for negative values of z, areas are found by symmetry)

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
	Second decimal place of z									
0.0	.5000	.4960	.4920	.4880	.4840	.4801	.4761	.4721	.4681	.4641
0.1	.4602	.4562	.4522	.4483	.4443	.4404	.4364	.4325	.4286	.4247
0.2	.4207	.4168	.4129	.4090	.4052	.4013	.3974	.3936	.3897	.3859
0.3	.3821	.3783	.3745	.3707	.3669	.3632	.3594	.3557	.3520	.3483
0.4	.3446	.3409	.3372	.3336	.3300	.3264	.3228	.3192	.3156	.3121
0.5	.3085	.3050	.3015	.2981	.2946	.2912	.2877	.2843	.2810	.2776
0.6	.2743	.2709	.2676	.2643	.2611	.2578	.2546	.2514	.2483	.2451
0.7	.2420	.2389	.2358	.2327	.2296	.2266	.2236	.2206	.2177	.2148
0.8	.2119	.2090	.2061	.2033	.2005	.1977	.1949	.1922	.1894	.1867
0.9	.1841	.1814	.1788	.1762	.1736	.1711	.1685	.1660	.1635	.1611
1.0	.1587	.1562	.1539	.1515	.1492	.1469	.1446	.1423	.1401	.1379
1.1	.1357	.1335	.1314	.1292	.1271	.1251	.1230	.1210	.1190	.1170
1.2	.1151	.1131	.1112	.1093	.1075	.1056	.1038	.1020	.1003	.0985
1.3	.0968	.0951	.0934	.0918	.0901	.0885	.0869	.0853	.0838	.0823
1.4	.0808	.0793	.0778	.0764	.0749	.0735	.0722	.0708	.0694	.0681
1.5	.0668	.0655	.0643	.0630	.0618	.0606	.0594	.0582	.0571	.0559
1.6	.0548	.0537	.0526	.0516	.0505	.0495	.0485	.0475	.0465	.0455
1.7	.0446	.0436	.0427	.0418	.0409	.0401	.0392	.0384	.0375	.0367
1.8	.0359	.0352	.0344	.0336	.0329	.0322	.0314	.0307	.0301	.0294
1.9	.0287	.0281	.0274	.0268	.0262	.0256	.0250	.0244	.0239	.0233

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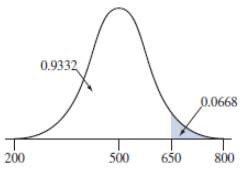
Use this space to take notes:

Slide 60

Finding z-score

- SAT scores are approximately normally distributed with mean μ = 500 and standard deviation σ = 100.
- What percentage of SAT scores was higher than yours?



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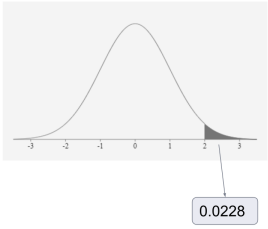
Use this space to take notes:

Slide 61

Normal Distribution - *Example*

- Let Z denote a normal random variable with mean 0 and standard deviation 1.
- Find
  - P(Z>2)



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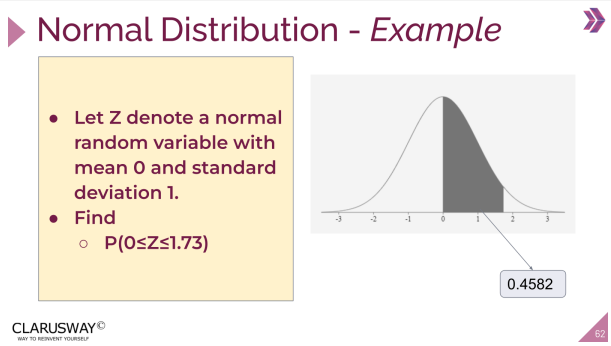
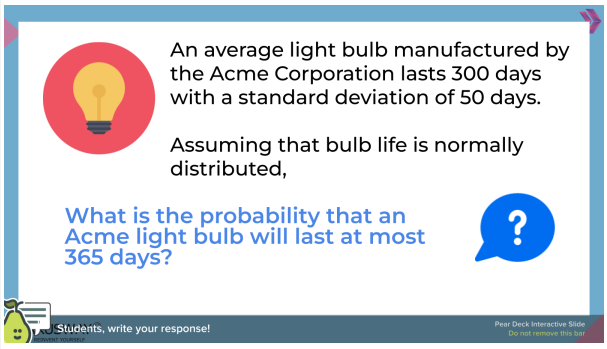
Use this space to take notes:

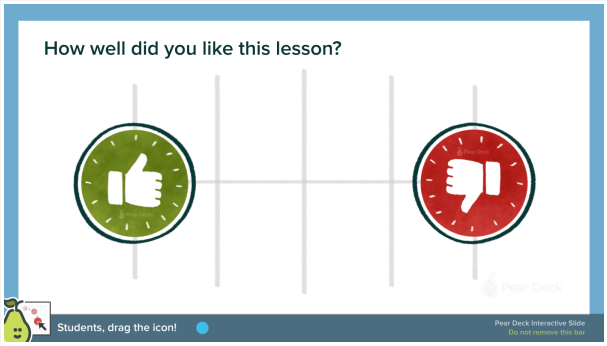
Slide 62


Use this space to take notes:

Slide 63	Your Response
	

Use this space to take notes:

Slide 64	Your Response

Slide 64	Your Response
	

Use this space to take notes:

Slide 65


Use this space to take notes: