DS-13/22 EU Session-2

DS-13 EU Statistics 2
Training Clarusway
Pear Deck - November 23, 2022 at 11:53AM

Part 1 - Summary

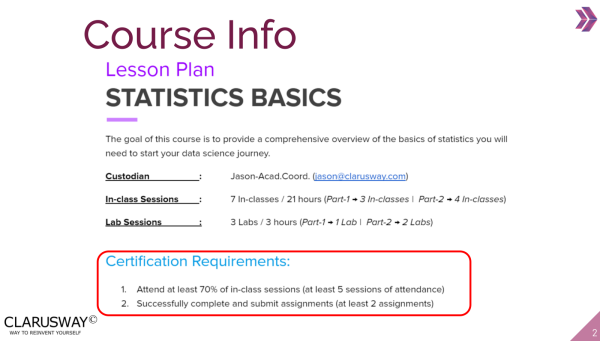
Use this space to summarize your thoughts on the lesson

Part 2 - Responses

Slide 1

Use this space to take notes:

Slide 2



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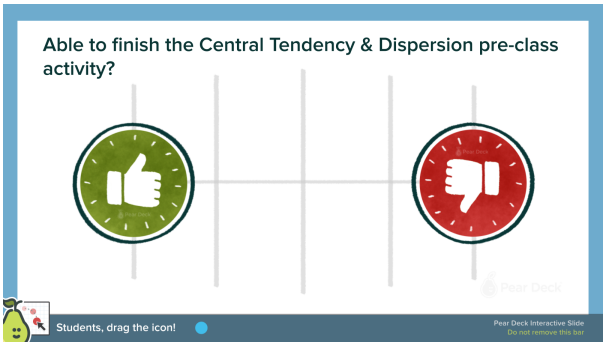

Your Response

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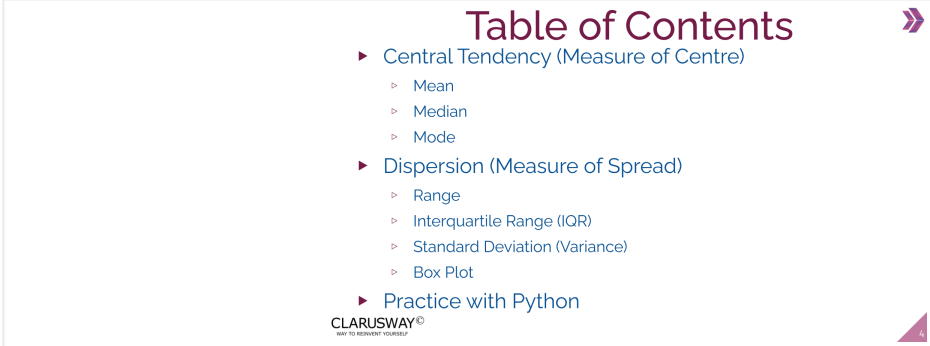

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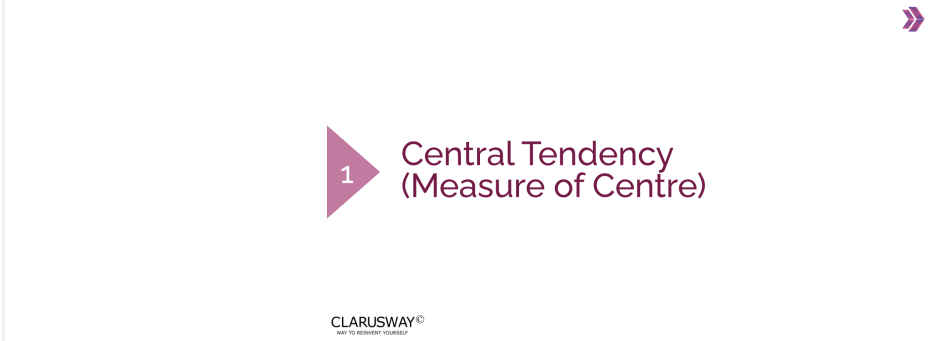

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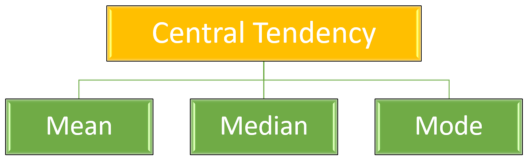
Central Tendency (Measure of Centre)

The central tendency concept is that one single value can best describe the data.



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Mean

The mean is equal to the sum of the values in the dataset divided by the number of values.

1 Find the sum of all values in a group of values

2 Divide the sum by the number of values in the group.

$$Mean = \frac{Sum\ of\ all\ values}{Number\ of\ values}$$

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Mean *Notation*

Population Mean

$\sum X = Sum\ of\ all\ X\ values$
$N = Number\ of\ X\ values$
$\mu = Population\ mean$

$$\mu = \frac{\sum X}{N}$$

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Mean *Notation*

Population Mean

$\sum X = Sum\ of\ all\ X\ values$
$N = Number\ of\ X\ values$
$\mu = Population\ mean$

$$\mu = \frac{\sum X}{N}$$

Sample Mean

$\sum x = Sum\ of\ all\ x\ values$
$n = Number\ of\ x\ values$
$\bar{x} = Sample\ mean$

$$\bar{x} = \frac{\sum x}{n}$$

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Mean *Example*

Compute the mean age.

Name	Age
Elon Musk	49
Bill Gates	64
Mark Zuckerberg	36
G. van Rossum	64
Martha L. Fox	47

$$\mu = \frac{\sum X}{N}$$

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Mean *Example*

Compute the mean age.

Name	Age
Elon Musk	49
Bill Gates	64
Mark Zuckerberg	36
G. van Rossum	64
Martha L. Fox	47

$$\mu = \frac{\sum X}{N}$$

$$\sum X = 49 + 64 + 36 + 64 + 47 = 260$$

$$N = 5$$

$$\mu = \frac{260}{5} = 52$$

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Median

The median is the middle score for a dataset that has been sorted from small to large.

1. List scores from smallest to largest
2. With an odd number of scores, the median is the middle score.
3. With an even number of scores, the median is the sum of the middle two scores divided by 2.

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Median *Example 1*

Find the median age, given an odd number of scores.

Name	Age
Elon Musk	49
Bill Gates	64
Mark Zuckerberg	36
G. van Rossum	64
Martha L. Fox	47

1. List scores in ascending order.
   36 47 49 64 64

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Median *Example 1*

Find the median age, given an odd number of scores.

Name	Age
Elon Musk	49
Bill Gates	64
Mark Zuckerberg	36
G. van Rossum	64
Martha L. Fox	47

1. List scores in ascending order.
   36 47 49 64 64
2. With an odd number of scores, the median is the middle score.
   36 47 49 64 64
   Median age

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Median *Example 2*

Find the median age, given an even number of scores.

Name	Age
Elon Musk	49
Bill Gates	64
Mark Zuckerberg	36
Martha L. Fox	47

1. List scores in ascending order.
   36 47 49 64

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Median *Example 2*

Find the median age, given an even number of scores.

Name	Age
Elon Musk	49
Bill Gates	64
Mark Zuckerberg	36
Martha L. Fox	47

1. List scores in ascending order.
   36 47 49 64
2. With an even number of scores, the median is the sum of the middle two scores divided by 2.

$$Median = \frac{47 + 49}{2} = 48$$

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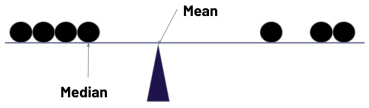
Mean vs. Median

- The median is better if a small set of scores has an outlier.
- The mean is better if a large set of scores does not have an outlier.



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Selection of Imputation Method for Missing Values

	col1	col2	col3	col4	col5
0	2	5.0	3.0	6	NaN
1	9	NaN	9.0	0	7.0
2	19	17.0	NaN	9	NaN

	col1	col2	col3	col4	col5
0	2.0	5.0	3.0	6.0	7.0
1	9.0	11.0	9.0	0.0	7.0
2	19.0	17.0	6.0	9.0	7.0

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Selection of Imputation Method for Missing Values

	First Name	Gender	Salary	Bonus %	Senior Management	Team
0	Douglas	Male	97308.0	6.945	True	Marketing
1	Thomas	Male	61933.0	NaN	True	NaN
2	Jerry	Male	NaN	9.340	True	Finance
3	Dennis	n.a.	115163.0	10.125	False	Legal
4	NaN	Female	NaN	11.598	NaN	Finance
5	Angela	NaN	NaN	18.523	True	Engineering
6	Shawn	Male	111737.0	6.414	False	NaN
7	Rachel	Female	142032.0	12.599	False	Business Development
8	Linda	Female	57427.0	9.557	True	Client Services
9	Stephanie	Female	36844.0	5.574	True	Business Development
10	NaN	NaN	NaN	NaN	NaN	NaN

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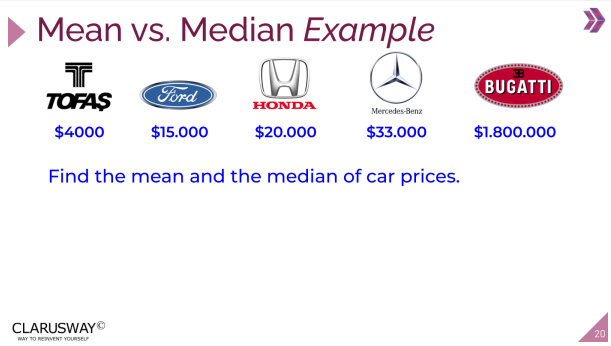

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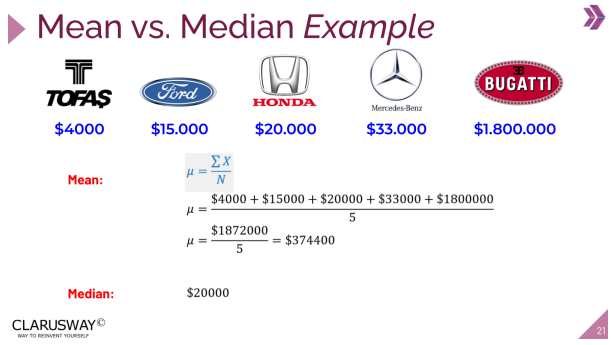

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Slide 22	Your Response

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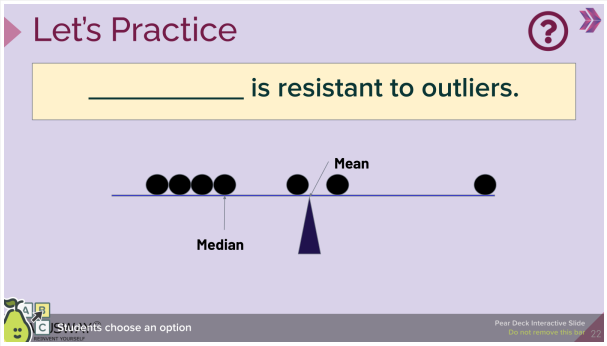	

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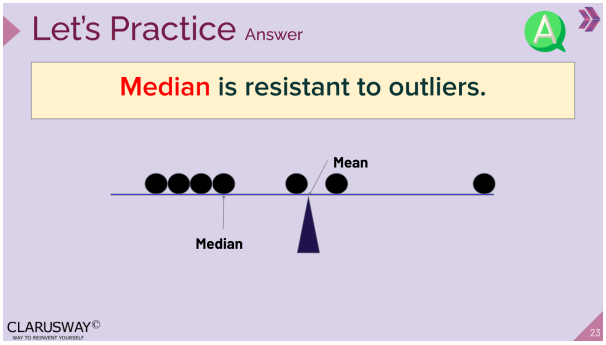

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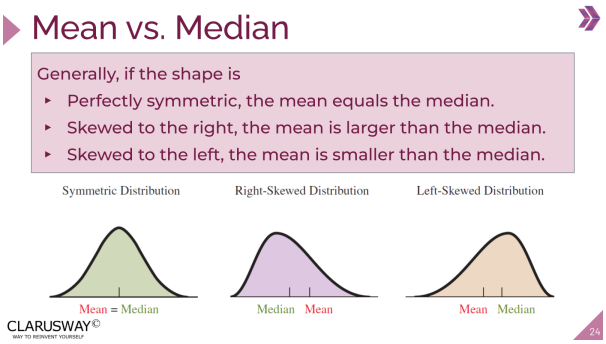

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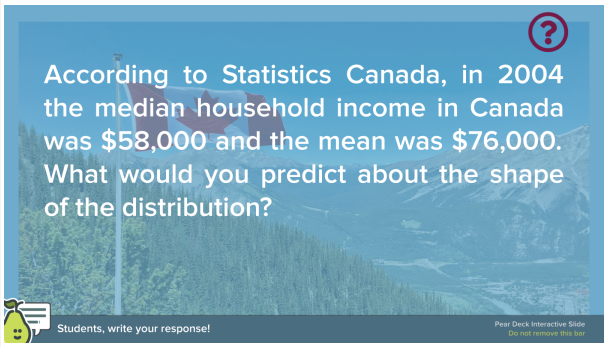

Your Response

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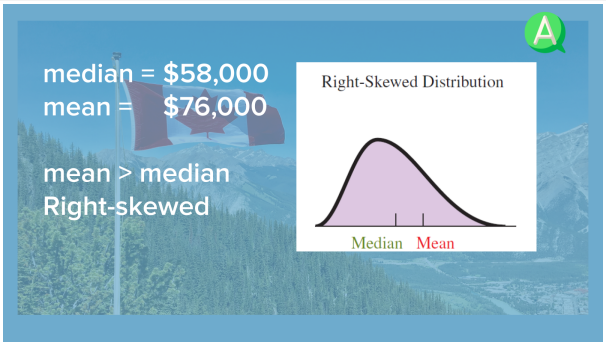

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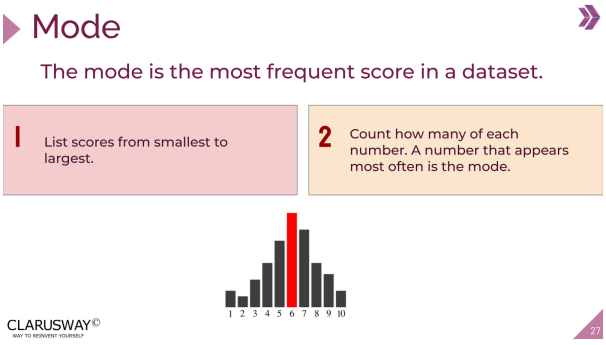

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Mode *Example*

Find the mode.

Name	Age
Elon Musk	49
Bill Gates	64
Mark Zuckerberg	36
G. van Rossum	64
Martha L. Fox	47
Tim Berners-Lee	64

1. List scores from smallest to largest.

36 47 49 64 64 64

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Mode *Example*

Find the mode.

Name	Age
Elon Musk	49
Bill Gates	64
Mark Zuckerberg	36
G. van Rossum	64
Martha L. Fox	47
Tim Berners-Lee	64

1. List scores from smallest to largest.

36 47 49 64 64 64

2. Count how many of each number.

1 1 1 3

36 47 49 64 64 64

Mode

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Pro's and Con's of Mode

Advantages:

- The mode is easy to understand and calculate.
- The mode is not affected by extreme values.
- The mode is useful for categorical data.

Disadvantages:

- The mode is not defined when there are no repeats in a data set.
- The mode is not based on all values.
- The mode is unstable when the data consist of a small number of values.
- Sometimes data have one mode, more than one mode, or no mode at all.

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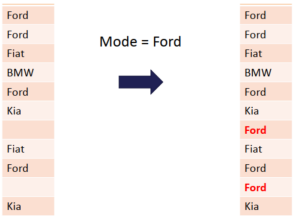
Selection of Imputation Method for Missing Values



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Selection of Imputation Method for Missing Values

	id	A	B	C	D
0	0	10.0	A	NaN	NaN
1	1	9.0	B	BB	20.0
2	2	8.0	A	CC	18.0
3	3	7.0	A	BB	22.0
4	4	NaN	NaN	BB	18.0
5	5	NaN	B	CC	17.0
6	6	20.0	A	AA	19.0
7	7	15.0	B	BB	NaN
8	8	12.0	NaN	NaN	17.0
9	9	NaN	A	AA	23.0

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2 Dispersion (Measure of Spread)

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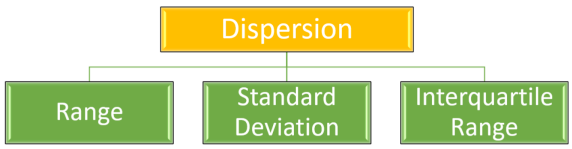
Dispersion (Measure of Spread)

The most common measures of variability are the range, the interquartile range (IQR), variance, and standard deviation.



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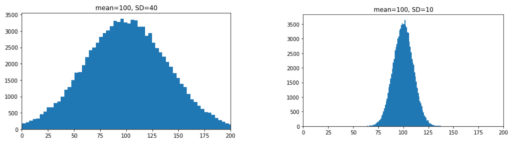
Dispersion vs Central Tendency



Means are the same but standard deviations are quite different because distributions are different. Dispersion gives idea about distributions.

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Range

The range is the difference between the largest and smallest values in a set of values.

Example:

2 4 9 5 7 3

Range = Largest - Smallest = 9 - 2 = 7

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The Interquartile Range (IQR)

The interquartile range (IQR) is a measure of variability, based on dividing a data set into quartiles.

- Quartiles divide a rank-ordered data set into four equal parts.
- The values that divide each part are called the first, second, and third quartiles.
- First, second, and third quartiles are denoted by Q1, Q2, and Q3, respectively.

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The Interquartile Range (IQR)

The interquartile range (IQR) is a measure of variability, based on dividing a data set into quartiles.

- Q2 is the median of the entire data set.
- Q1 is the median of the data below Q2.
- Q3 is the median of the data above Q2.

Interquartile Range = Q3 - Q1

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IQR *Example*

Ordered data set.

0 1 2 3 4 5 6 7 8 9 10

Q2 = 5

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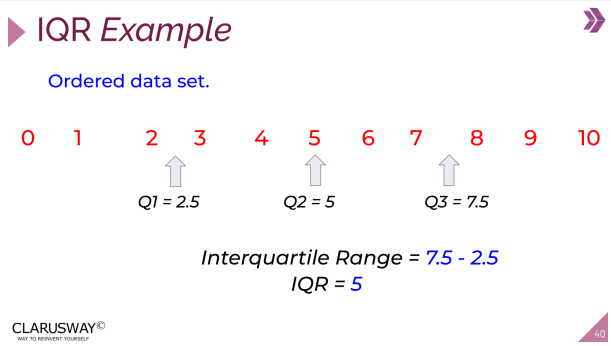

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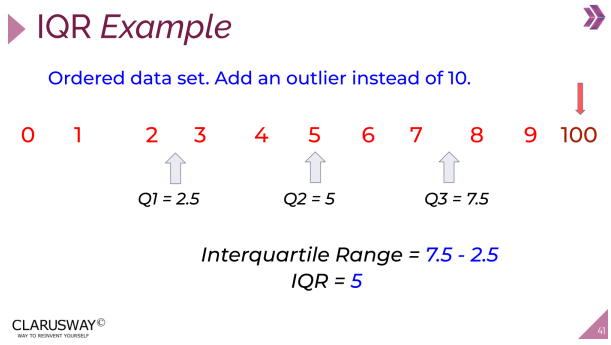

Use this space to take notes:

Slide 42	Your Response

Slide 42	Your Response
IQR *Practice* **Question**: What is the interquartile range of these numbers? 8 9 10 10 12 13 14 15 16 Students, enter a number!	

Use this space to take notes:

Slide 43
IQR Practice Answer **Question**: What is the interquartile range of these numbers? 8 9 (10) 10 12 13 (14) 15 16 IQR = Q3 - Q1 IQR = 14 - 10 IQR = 4 CLARUSWAY©

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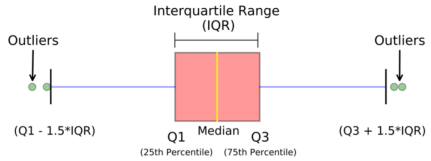
1.5xIQR Rule for Outliers

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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Outlier Practice

Question:

Are there any outliers?

8 9 (10) 10 12 13 (14) 15 22

IQR = Q3 - Q1
IQR = 14 - 10
IQR = 4

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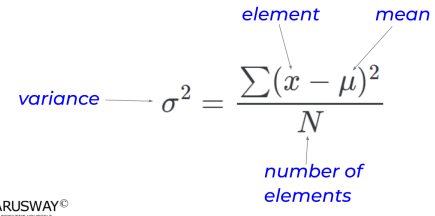
Variance (Population)

Variance is the average squared deviation from the mean.



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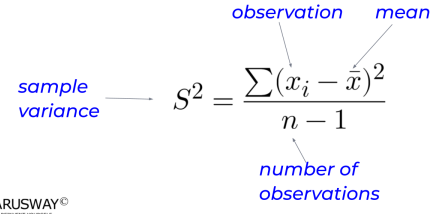
Variance (Sample)

Variance is the average squared deviation from the mean.



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Variance *Example*

Find the Variance.

0 1 5 6

$$\sigma^2 = \frac{\sum(x-\mu)^2}{N}$$

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Variance *Example*

Find the Variance.

0 1 5 6

Mean: $\mu = \frac{\sum X}{N} = \frac{0+1+5+6}{4} = \frac{12}{4} = 3$

Dev Sum of Squares: $SS = \sum(X-\mu)^2$

$SS = (0-3)^2 + (1-3)^2 + (5-3)^2 + (6-3)^2$

$SS = 9 + 4 + 4 + 9 = 26$

Variance: $\sigma^2 = \frac{\sum(X-\mu)^2}{N}$

$\sigma^2 = \frac{26}{4} = 6.5$

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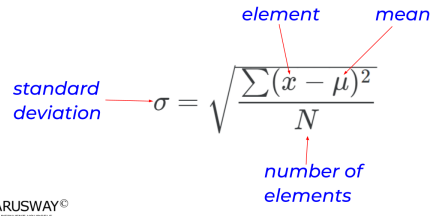
Standard Deviation

Standard deviation is the square root of the variance.



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Standard Deviation *Example*

Students in a class were asked on a questionnaire at the beginning of the course,
"How many children do you think is ideal for a family?"
The observations, classified by student's gender, were

Men	:	0	0	0	2	4	4	4
Women	:	0	2	2	2	2	2	4

Both men and women have a mean of 2 and a range of 4.

Do the distributions of data have the same amount of variability around the mean?

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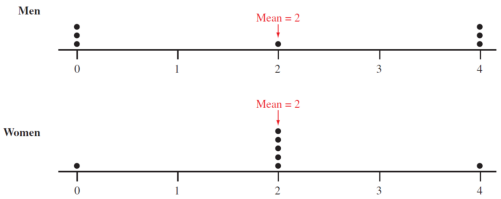
Standard Deviation *Example*

Men : 0 0 0 2 4 4 4
Women : 0 2 2 2 2 2 4



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Standard Deviation *Example*

Men : 0 0 0 2 4 4 4
Women : 0 2 2 2 2 2 4

Men: $s = \sqrt{\frac{\Sigma(x - \bar{x})^2}{n - 1}} = \sqrt{\frac{24}{6}} = \sqrt{4} = 2.0$

Women: $s = 1.2$

The observations for males tend to be farther from the mean than those for females, as indicated by $s = 2.0 > s = 1.2$. In summary, the men's observations vary more around the mean.

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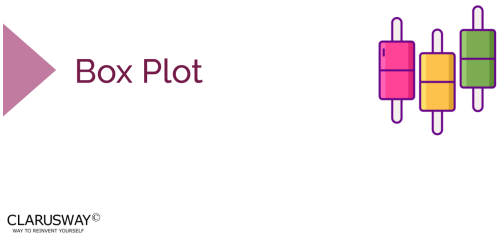

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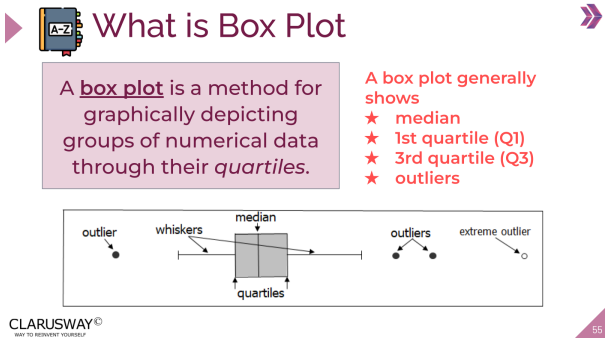

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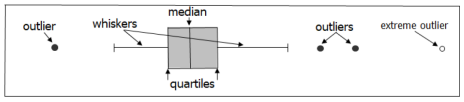
Box Plot

Boxplots show distribution in one dimension

- ★ Only useful for continuous variables
- ★ Good for comparing distributions of a continuous variable between categorical groups

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



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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 58

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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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 *Q3 = 35*

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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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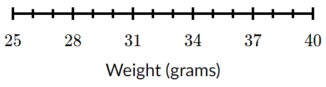
How to make a Box Plot (Min & Max)

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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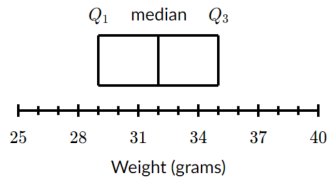
How to make a Box Plot (Min & Max)

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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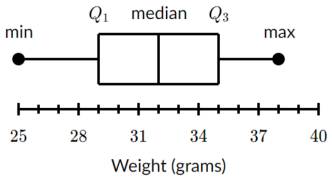
How to make a Box Plot (Min & Max)

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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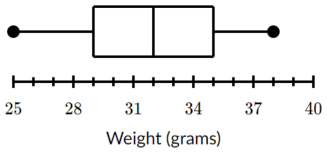
How to make a Box Plot (Min & Max)

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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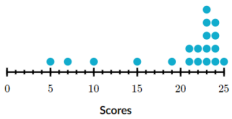
Identifying Outliers

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!

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65

Your Response

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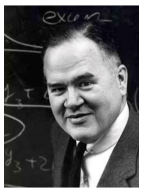
Identifying Outliers (1.5xIQR Rule)

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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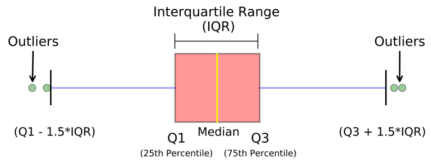
Boxplot with 1.5xIQR Rule

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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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 = 20
Q3 = 23.5
IQR = Q3 - Q1 = 23.5 - 20 = 3.5

```
[33] np.median(a)
     23.0

[34] np.percentile(a, 25)
     20.0

[35] np.percentile(a, 75)
     23.5
```

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

Q1 - 1.5 x IQR = 20 - (1.5 x 3.5)
= 14.75

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

Q3 + 1.5 x IQR = 23.5 + (1.5 x 5)
= 28.75

High Outliers: None

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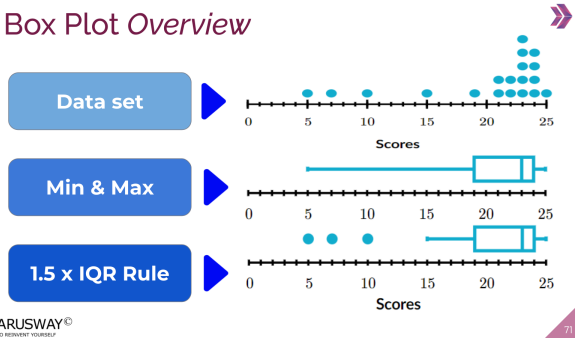
Box Plot *Overview*



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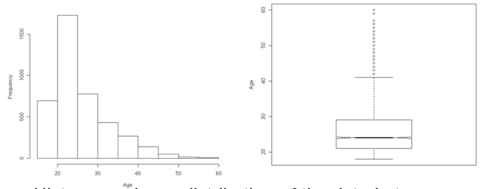
Box Plot vs. Histogram



- 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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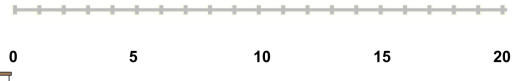
Let's Practice *Draw Box Plot*

3	6	8	9	9	10	12	14	19



Students, draw anywhere on this slide!

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Do not remove this bar 73

Your Response

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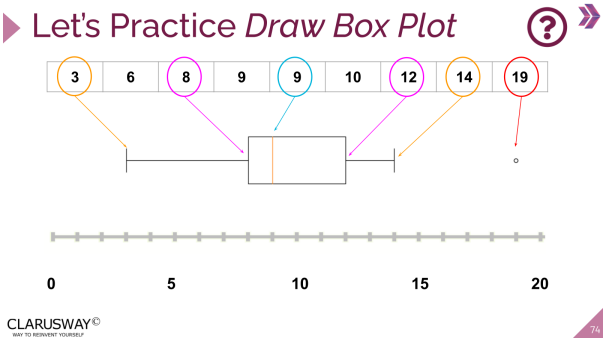

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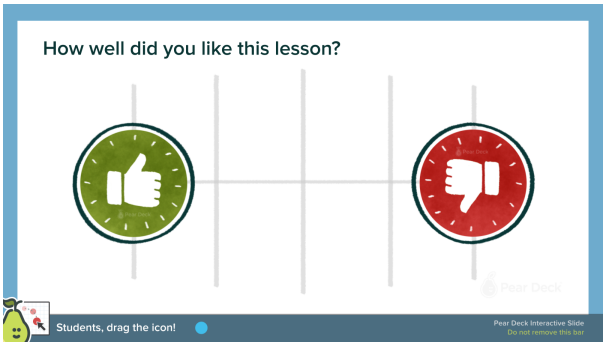

Your Response

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THANKS!

Any questions?

You can find us at:

- richard@clarusway.com
- jason@clarusway.com

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