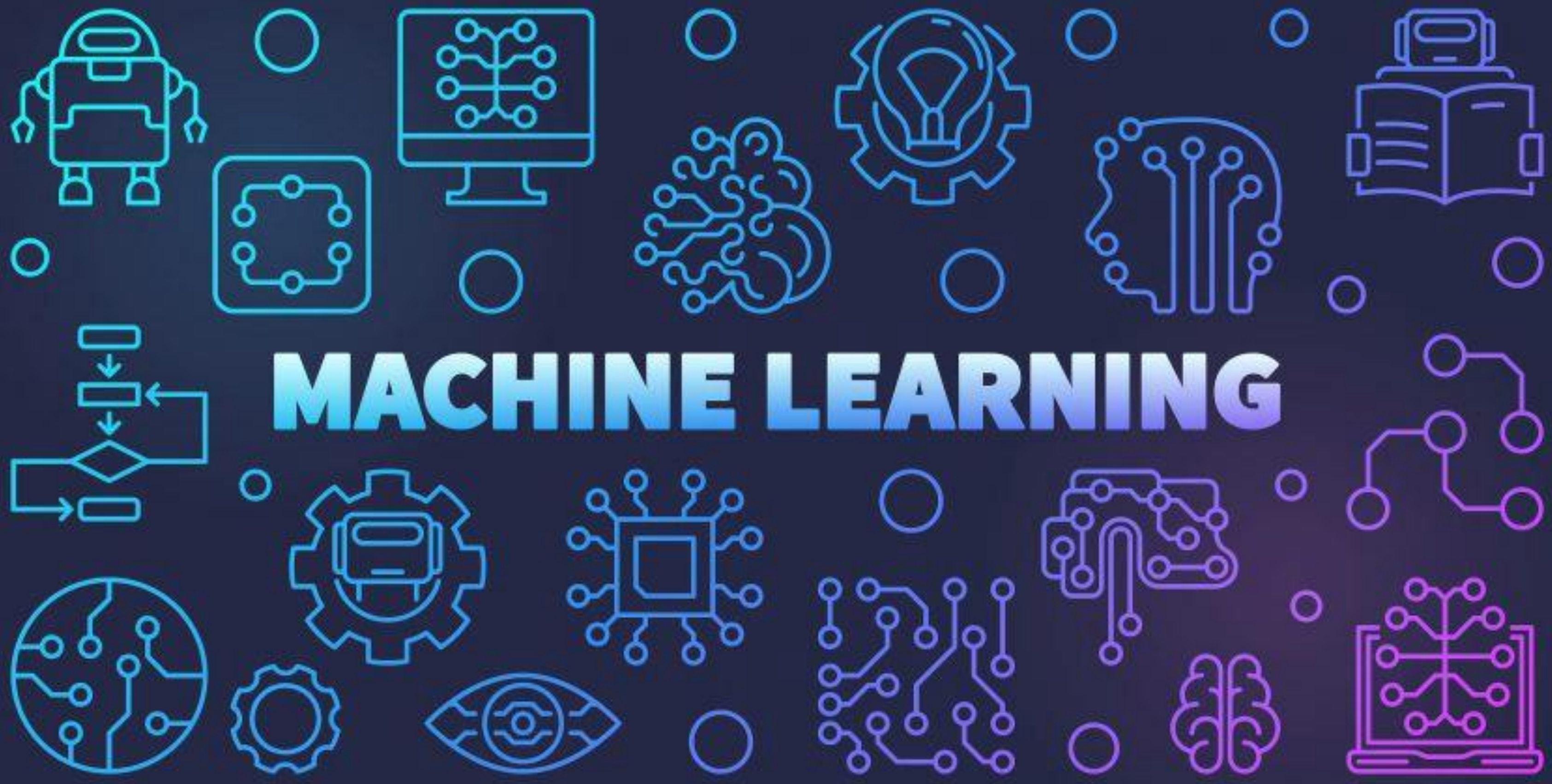
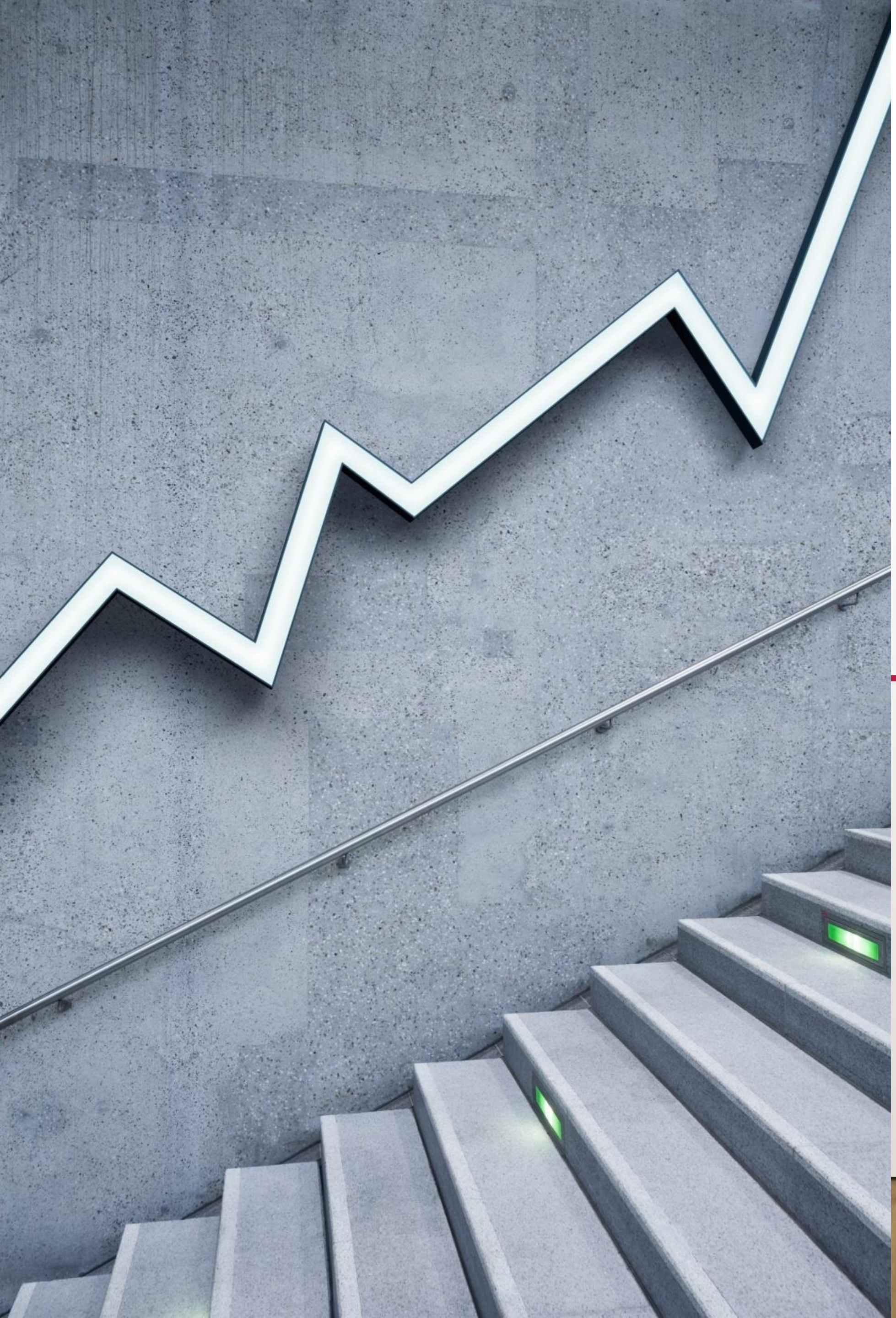


DSC Program 2020-2021



STATISTICS

Statistics

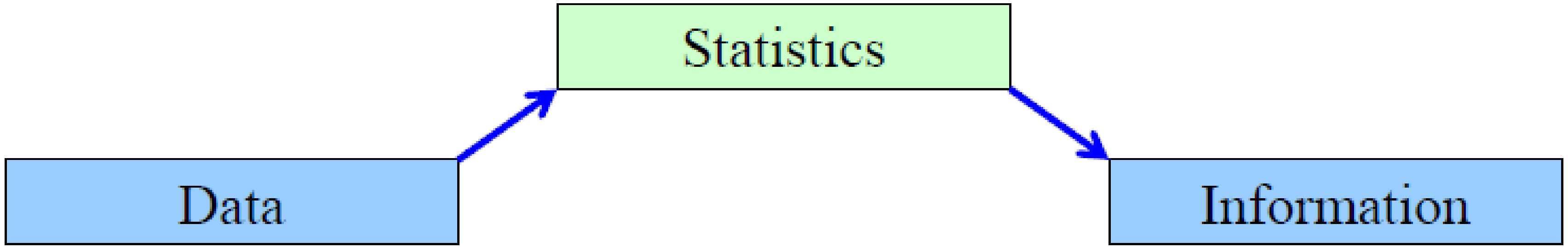
WHY STATISTICS

Statistics Limitations

“STATISTICS IS THE SCIENCE OF COLLECTING ,ORGANIZING PRESENTING, ANALYZING, AND INTERPRETING NUMERICAL DATA”

“STATISTICS IS A WAY TO GET INFORMATION FROM DATA.”

“Statistics is a way to get information from data”



<u>Data:</u> Facts, especially numerical facts, collected together for reference or information.

<u>Information:</u> Knowledge communicated concerning some particular fact.

Statistics is a ***tool*** for creating ***new understanding*** from a set of numbers.

Statistical Terms

Variable

A variable is a feature characteristic of any member of a population differing in quality or quantity from another member.

Statistical Data Type According to variable type

- **Qualitative**
  “Sex, Religion, GPA”
  - **Nominal Data**
    Sex, Religion
  - **Ordinal Data**
    GPA
- **Quantitative**
  “Age, High, Blood pressure, number of cars, family members”
  - **Discrete**
    number of cars, family members
  - **Continuous**
    Age, High, Blood pressure

Types of data

Categorical

Categorical data represents groups or categories.

Examples:

1. Car brands: Audi, BMW and Mercedes.

2. Answers to yes/no questions: yes and no

Numerical

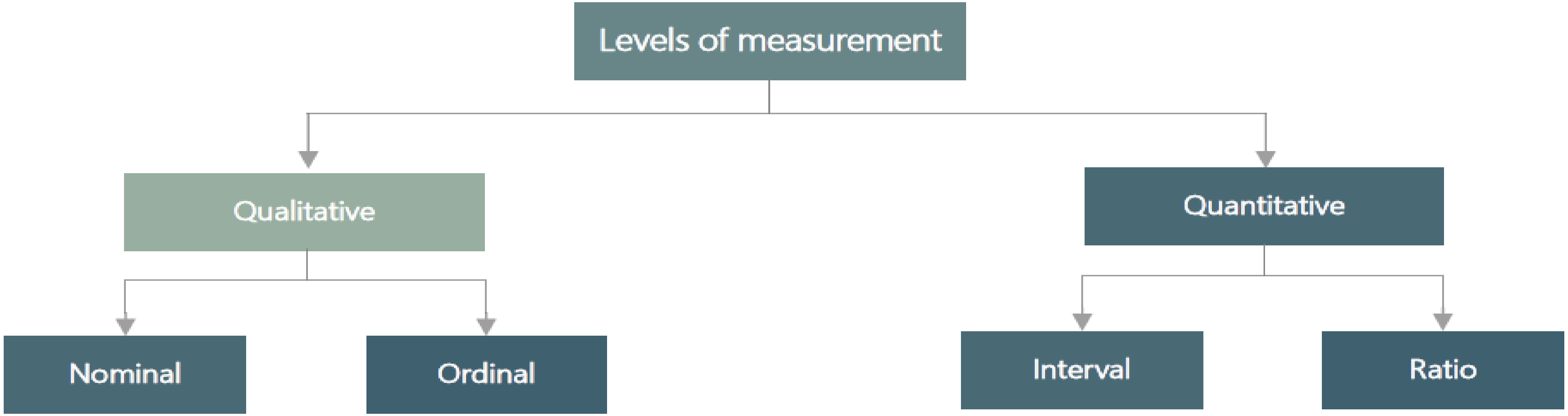
Discrete

Continuous

Numerical data represents numbers. It is divided into two groups: discrete and continuous. Discrete data can be usually counted in a finite matter, while continuous is infinite and impossible to count.

Examples:
Discrete: # children you want to have, SAT score
Continuous: weight, height

Levels of measurement



There are two qualitative levels: nominal and ordinal. The nominal level represents categories that cannot be put in any order, while ordinal represents categories that **can** be ordered.

Examples:
Nominal: four seasons (winter, spring, summer, autumn)
Ordinal: rating your meal (disgusting, unappetizing, neutral, tasty, and delicious)

There are two quantitative levels: interval and ratio. They both represent "numbers", however, ratios **have a true zero,** while intervals don't.

Examples:
Interval: degrees Celsius and Fahrenheit
Ratio: degrees Kelvin, length

Statistical Terms

Population

A population is the group from which data is to be collected.

ALL

Population

Sample

A sample is a subset of a population.

SELECTED

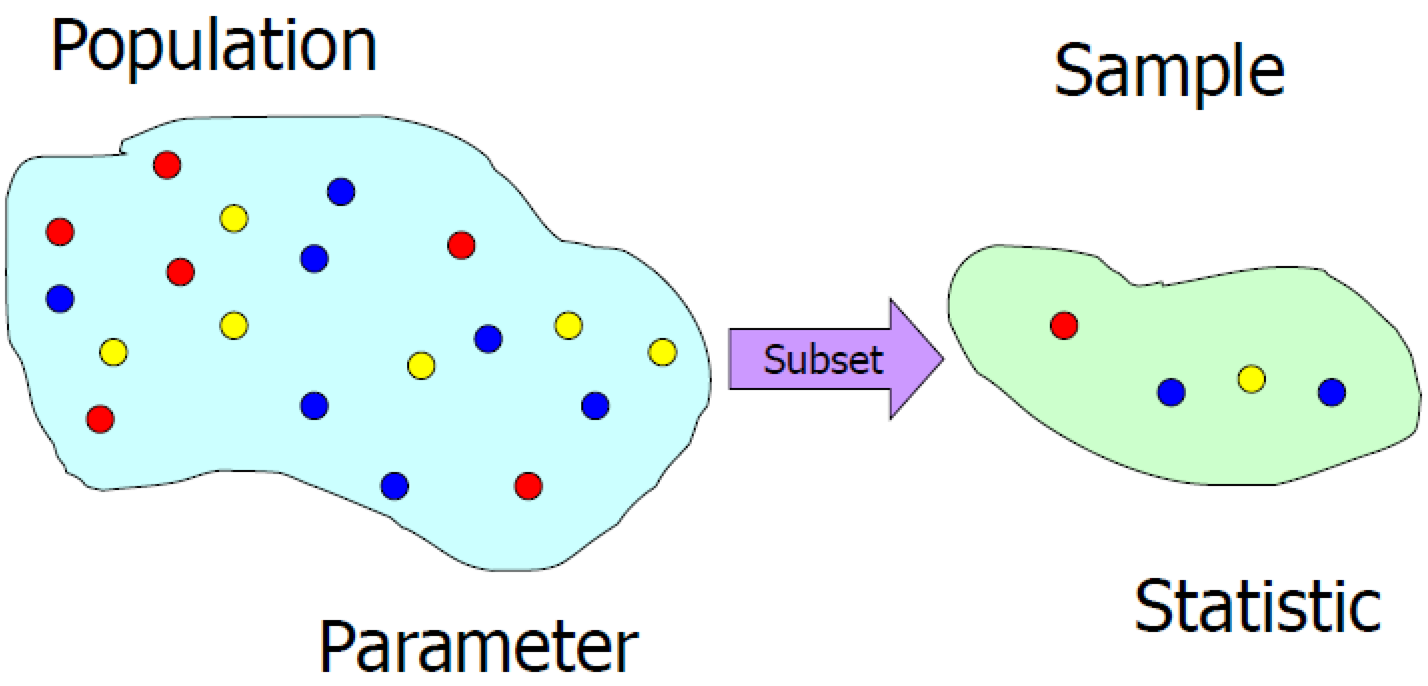
Population Sample

Parameter

A descriptive measure of a ***population.***

Statistic

A descriptive measure of a ***sample.***



Populations have Parameters,

Samples have Statistics.

Measures of Central Tendency

Statistic that represents the center point or typical value of a dataset. These measures indicate where most values in a distribution fall and are also referred to as the central location of a distribution.

DEFINITION

HOW TO COMPUTE

PROPERTIES

DEFINITIONS

Mean	• **The sum of values divided by the number of data points.**
Median	• **The middle value when the data arranged.**
Mode	• **The value that occurs most frequency**

HOW TO COMPUTE

Ungrouped Data

height
130
100
90
115
105
120
80
70

Height (in cm)	No of students
159-162	1
163-166	4
167-170	11
171-174	12
175-178	6
179-182	4
183-186	2

Grouped Data

Ungrouped Data

Mean

Ungrouped data

$$\text{Arithmetic Mean} \quad \bar{x} = \frac{\sum x_i}{n}$$

	Height
1	130
2	100
3	90
4	115
5	105
6	120
7	80
8	70
Total	810

n=8

mean=810/8= 101.25

median

Ungrouped data

**Put the observation in ascending order(lowest first to highest last)

	Height
1	130
2	100
3	90
4	115
5	105
6	120
7	80
8	70

1-Ascending order

n=8

	Height
1	70
2	80
3	90
4	100
5	105
6	115
7	120
8	130

When the number of observations (n) is even:

1. Find the value at position $\left(\frac{n}{2}\right)$
2. Find the value at position $\left(\frac{n}{2}+1\right)$

n/2= 4 v1= 100

(n/2)+1= 5 v2= 105

median=(v1+v2)/2= (100+105)/2 102.5

	Weight
1	62
2	55
3	48
4	90
5	52
6	60
7	40
8	50
9	60

1-Ascending order

n=9

	Weight
1	40
2	48
3	50
4	52
5	55
6	60
7	60
8	62
9	90

When the number of observations (n) is odd: the median is the value at position

$$\left(\frac{n+1}{2}\right)$$

(n+1)/2= 5

median=55

The value that occurs most frequency

Mode

Grouped data

	Height	Weight
1	130	62
2	100	55
3	90	48
4	115	90
5	105	52
6	120	60
7	80	40
8	70	50
9		60

height mode=	nan
weight mode=	60

Grouped Data

Mean, median and mode

Grouped data

Class	frequency(f)
16-	4
24-	8
32-	9
40-	13
48-	10
56-	5
64-72	1
Total	50.00

Mean

Grouped data

$$\text{Arithmetic Mean} = \frac{\sum (f_i * x_i)}{\sum f_i}$$

Class	frequency(f)	Mid-Point(x)	f * x
16-	4	20	80
24-	8	28	224
32-	9	36	324
40-	13	44	572
48-	10	52	520
56-	5	60	300
64-72	1	68	68
Total	50.00		2088

$$\bar{X} = \frac{\sum fx}{\sum f} = \frac{2088}{50} = 41.76$$

Median

Grouped data

Class	frequency(f)
16-	4
24-	8
32-	9
40-	13
48-	10
56-	5
64-72	1
Total	50.00

1-Ascending cumulative frequency distribution table

Upper limits	CF
Less than 24	4
Less than 32	=4+8=12
Less than 40	=12+9=21
Less than 48	34
Less than 56	44
Less than 64	49
Less than 72	50

2-Find the position of median= $\frac{\sum f}{2} = \frac{50}{2} = 25$

3-Median class = (40-48)

Lower limit of median class (M_o)=40

Width of median class (l)=8

$f_1 = 21$

$f_2 = 34$

$$median = M_o + \frac{pos. - f_1}{f_2 - f_1} * l$$

$$= 40 + \frac{25 - 21}{34 - 21} * 8 = 42.46$$

Mode

Grouped data

l=8 equal width

Class	frequency(f)
16-	4
24-	8
32-	9
40-	13
48-	10
56-	5
64-72	1
Total	50.00

M_o=40

Δ_1=13-9=4

Δ_2=13-10=3

$$mode = M_o + \frac{\Delta_1}{\Delta_1 + \Delta_2} * l$$

$$mode = 40 + \frac{4}{4+3} * 8$$

$$mode = 42.46$$

Mode

Grouped data

unequal width

Class	frequency (f)	The length of the class	modified frequency
0-	3	5	3/5=0.60
5-	8	7	8/7=1.14
12-	16	8	2.00
20-	11	10	1.10
30-	7	15	0.47
45-50	5	5	1.00
total	50		

M_o=12

l=8

Δ_1=2-1.143=0.857

Δ_2=2-1.1=0.9

$$mode = M_o + \frac{\Delta_1}{\Delta_1 + \Delta_2} * l$$

$$mode = 12 + \frac{0.857}{0.857 + 0.9} * 8$$

$$mode = 15.9$$

Which measure is best?

There in no best, but what separates to determine which is better is the data?

Mean

Good with normal distributed data

Too bad with outlier because it's affected by all the data

Mode

Good with significantly duplicated data

Also bad with the outlier

Median

Measure of central is one of the best to deal with outlier

Measures of *Dispersion*

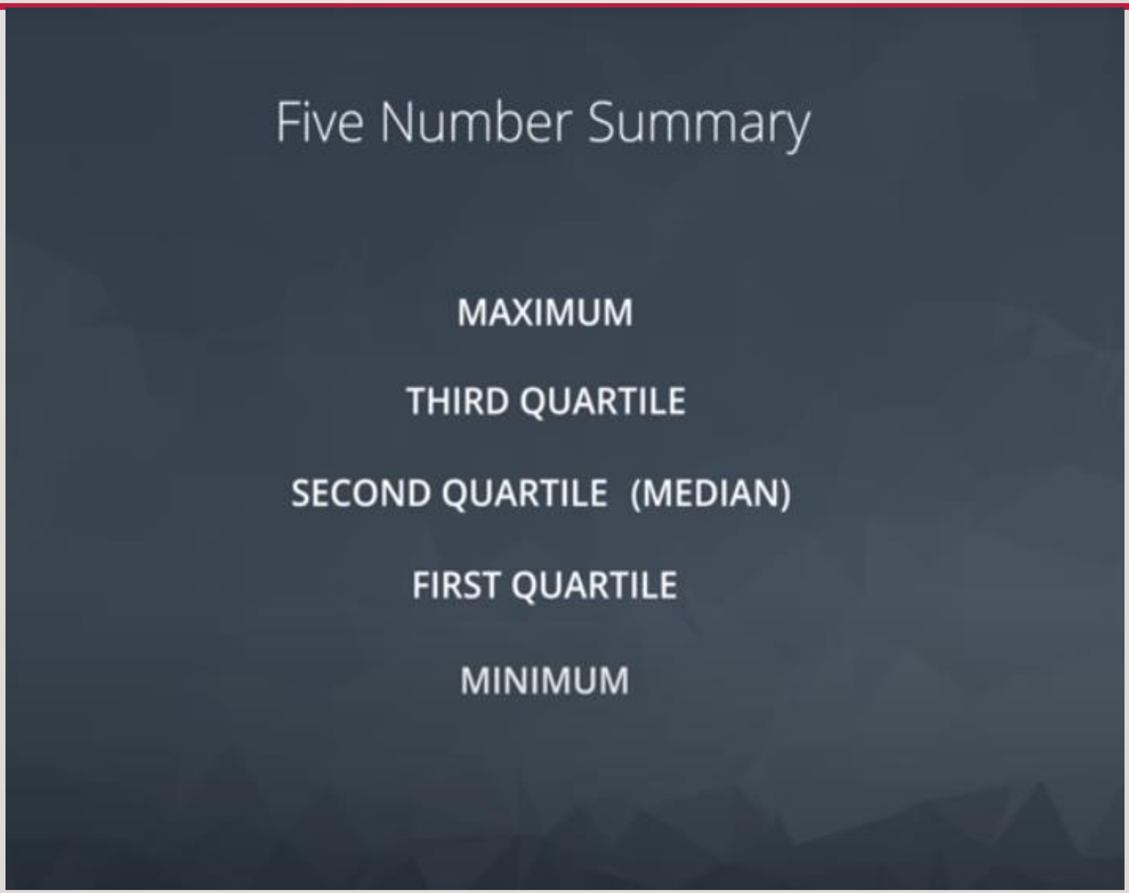
Dispersion refers to measures of how spread out our data is. Typically they're statistics for which values near zero signify *not spread out at all* and for which large values (whatever that means) signify *very spread out*.

DEFINITION

HOW TO COMPUTE

PROPERTIES

RANGE & IQR


Five Number Summary
MAXIMUM
THIRD QUARTILE
SECOND QUARTILE (MEDIAN)
FIRST QUARTILE
MINIMUM

RANGE & IQR

Finding the 5 number summary

8,1,3,5,10,2,3

1- data sort

1, 2, 3, 3, 5, 8, 10

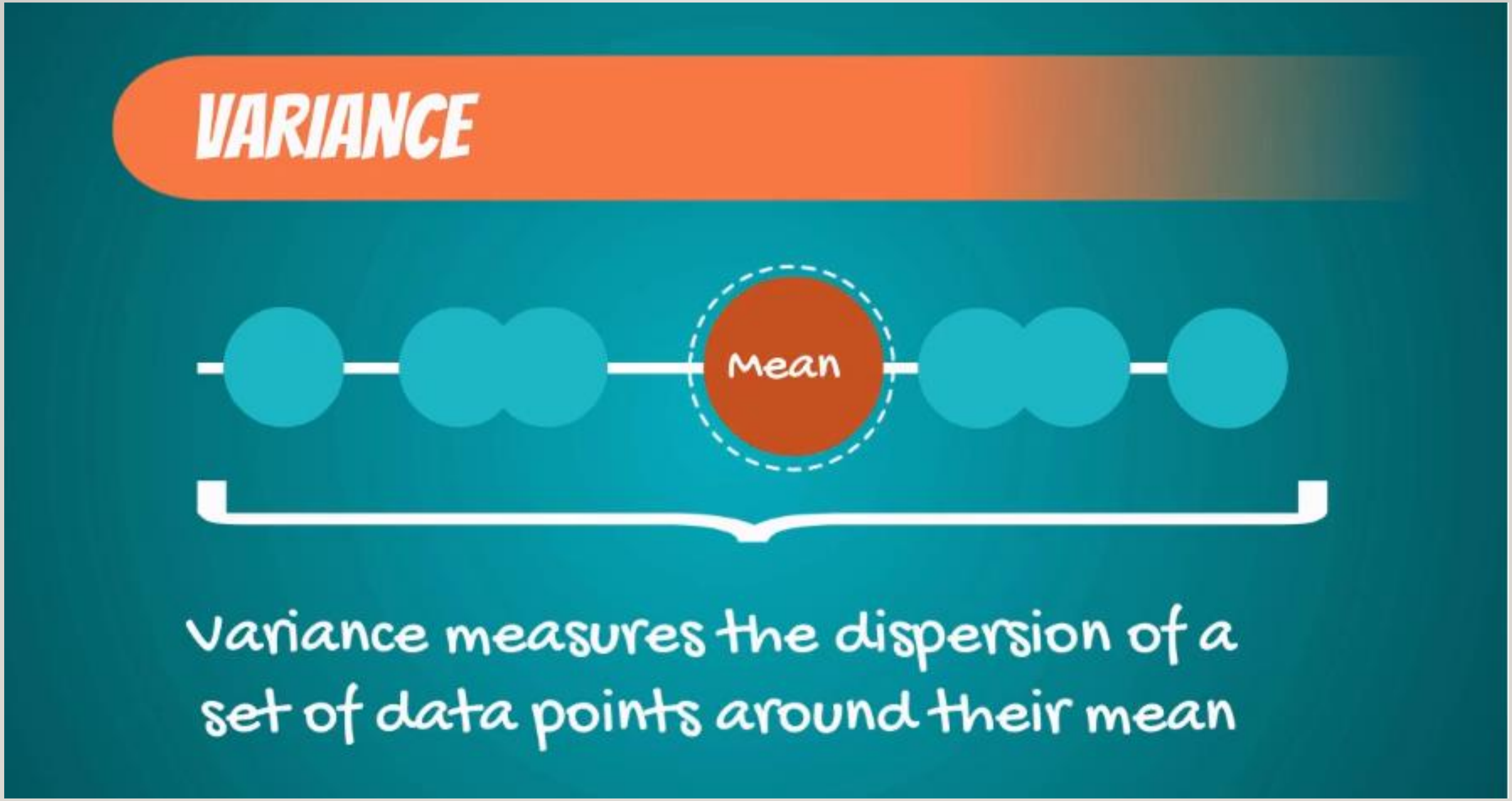
2- Range= max - min

=10 - 1 = 9

3- Interquartile Range

= Q3 - Q1=8 - 2=6

MINIMUM	Q1	Q2 (MEDIAN)	Q3	MAXIMUM
1	2	3	8	10


VARIANCE
Mean
Variance measures the dispersion of a set of data points around their mean

VARIANCE

$$\sigma^2 = \frac{\sum_{i=1}^{N}(x_i - \mu)^2}{N}$$

population variance

$$s^2 = \frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}$$

sample variance

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STANDARD DEVIATION FORMULAS

$$\sigma = \sqrt{\sigma^2}$$

population standard deviation

sample standard deviation

$$S = \sqrt{S^2}$$

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COEFFICIENT OF VARIATION (CV)
/relative standard deviation/
standard deviation
mean
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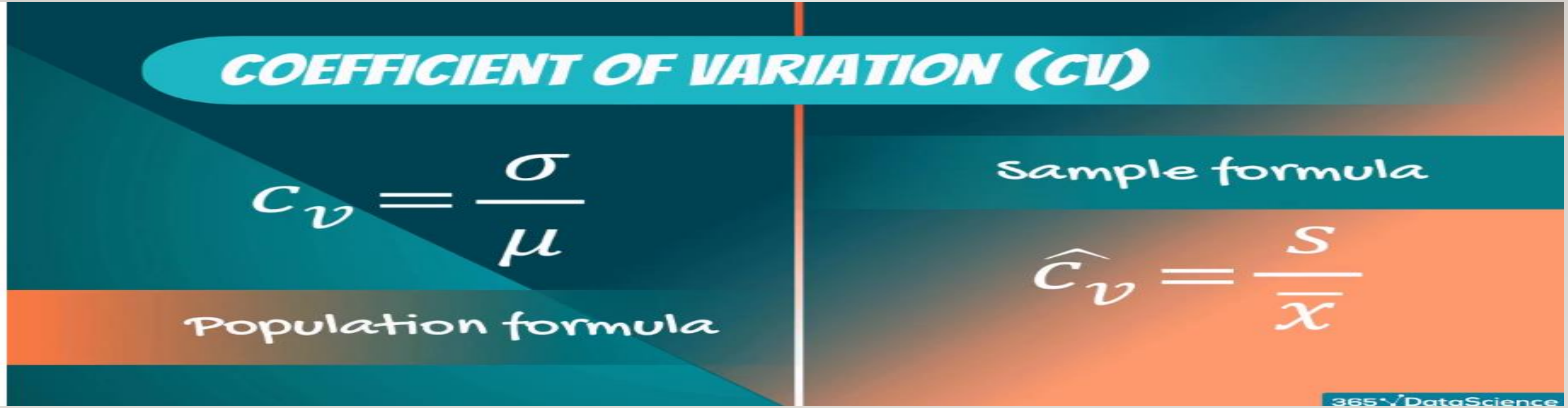
COEFFICIENT OF VARIATION (CV)
$c_v = \frac{\sigma}{\mu}$
Population formula
Sample formula
$\hat{c}_v = \frac{s}{\bar{x}}$
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σ
Standard deviation is the most common measure of variability for a SINGLE DATASET
Comparing TWO OR MORE datasets
C_v
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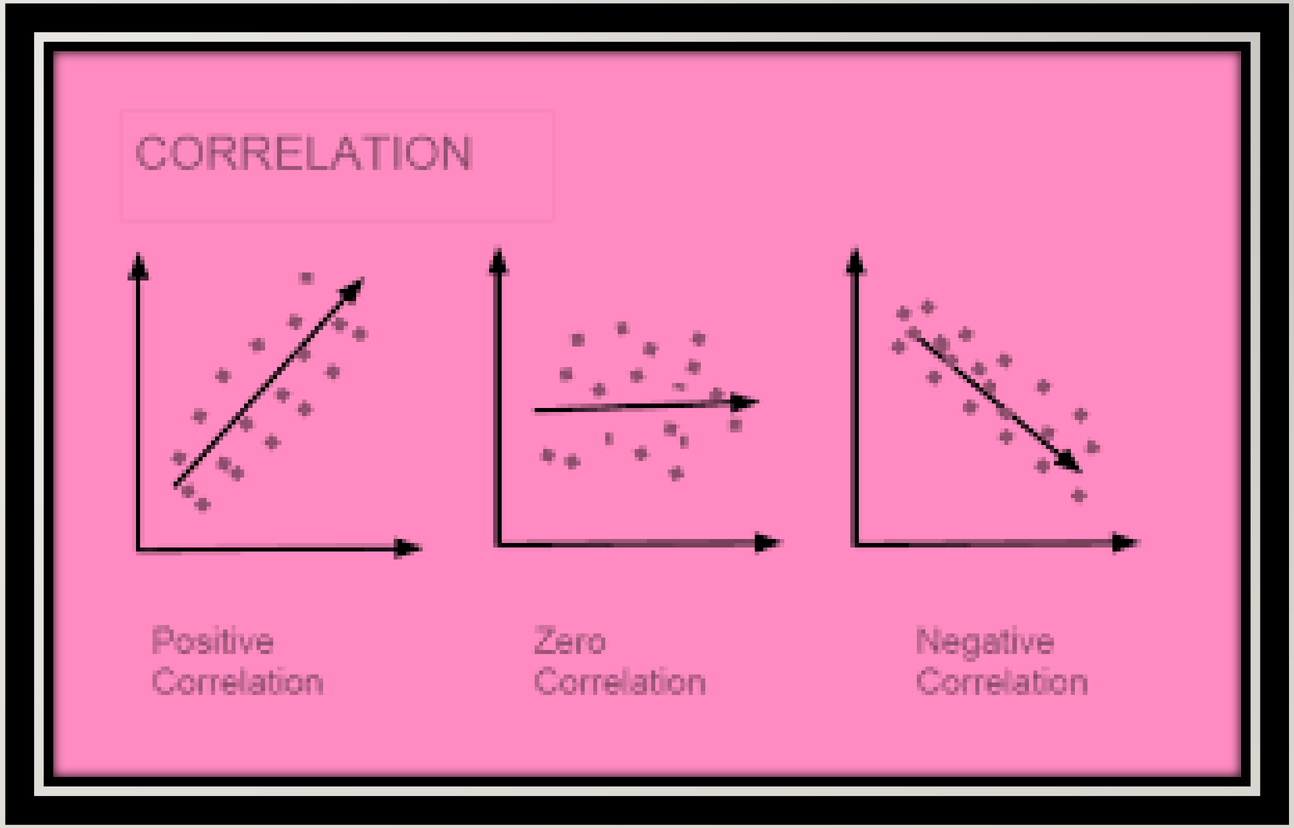
Covariance VS Correlation



Skewness

Positive (right)

Dataset 1
1
1
1
1
2
2
2
2
2
2
3
3
3
3
4
4
5
5
7

Interval	Frequency
0 to 1	4
1 to 2	6
2 to 3	4
3 to 4	2
4 to 5	2
5 to 6	0
6 to 7	1

Mean	Median	Mode
2.79	2.00	2.00

Zero (no skew)

Dataset 2
1
1
2
2
3
3
3
4
4
4
4
4
5
5
5
6
6
7
7

Interval	Frequency
0 to 1	2
1 to 2	2
2 to 3	3
3 to 4	5
4 to 5	3
5 to 6	2
6 to 7	2

Mean	Median	Mode
4.00	4.00	4.00

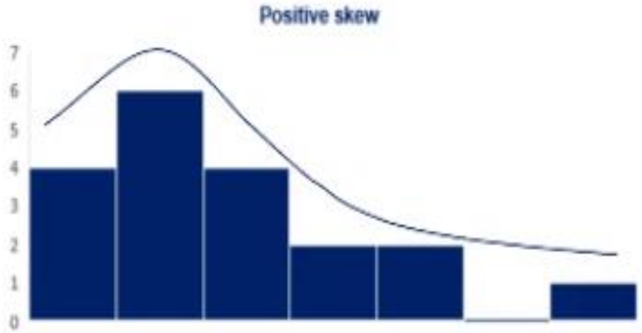
Negative (left)

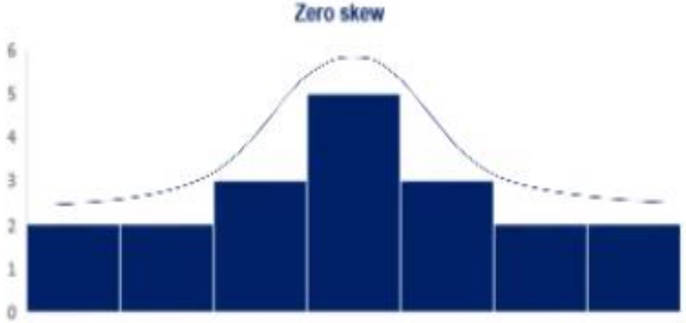
Dataset 3
1
2
3
3
4
4
4
5
5
5
5
6
6
6
6
6
6
7
7
7

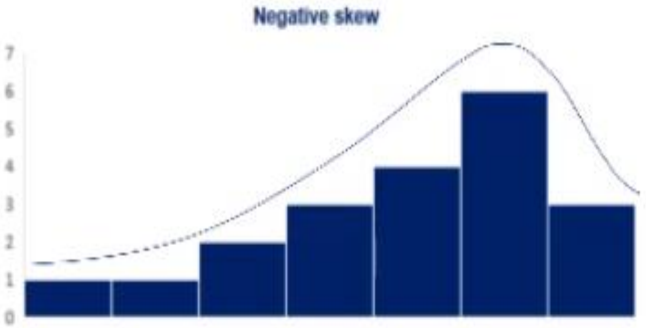
Interval	Frequency
0 to 1	1
1 to 2	1
2 to 3	2
3 to 4	3
4 to 5	4
5 to 6	6
6 to 7	3

Mean	Median	Mode
4.90	5.00	6.00

mean < median

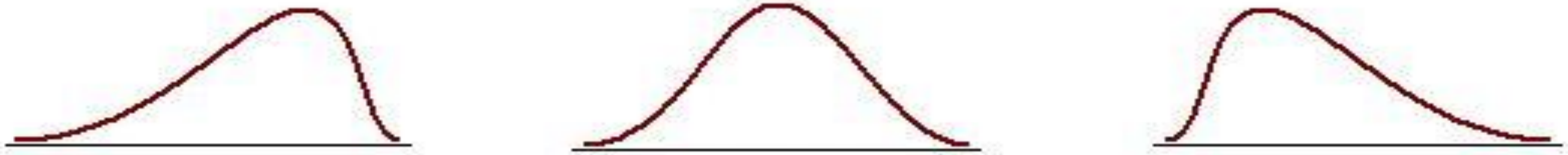






Skewness

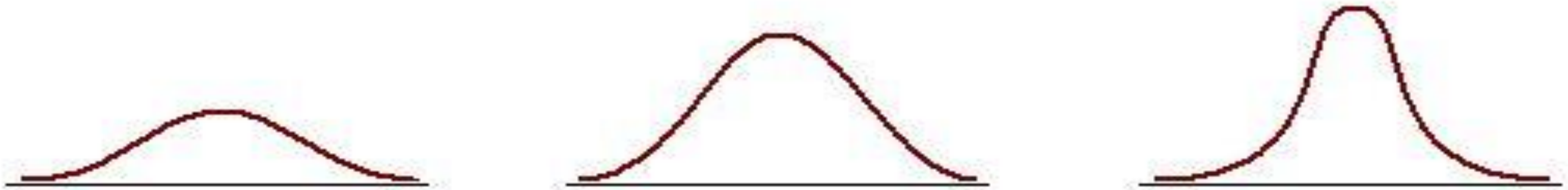
The coefficient of Skewness is a measure for the degree of symmetry in the variable distribution.



Negatively skewed distribution or Skewed to the left Skewness <0	Normal distribution Symmetrical Skewness = 0	Positively skewed distribution or Skewed to the right Skewness > 0

Kurtosis

The coefficient of Kurtosis is a measure for the degree of peakedness/flatness in the variable distribution.



Platykurtic distribution Low degree of peakedness Kurtosis <0	Normal distribution Mesokurtic distribution Kurtosis = 0	Leptokurtic distribution High degree of peakedness Kurtosis > 0

Feature Scaling

Standardization Vs Normalization

Normalization rescales the values into a range of [0,1]. This might be useful in some cases where all parameters need to have the same positive scale. However, the outliers from the data set are lost.

$$X_{changed} = \frac{X - X_{min}}{X_{max} - X_{min}}$$

Standardization rescales data to have a mean (μ) of 0 and standard deviation (σ) of 1 (unit variance).

$$X_{changed} = \frac{X - \mu}{\sigma}$$

For most applications standardization is recommended.