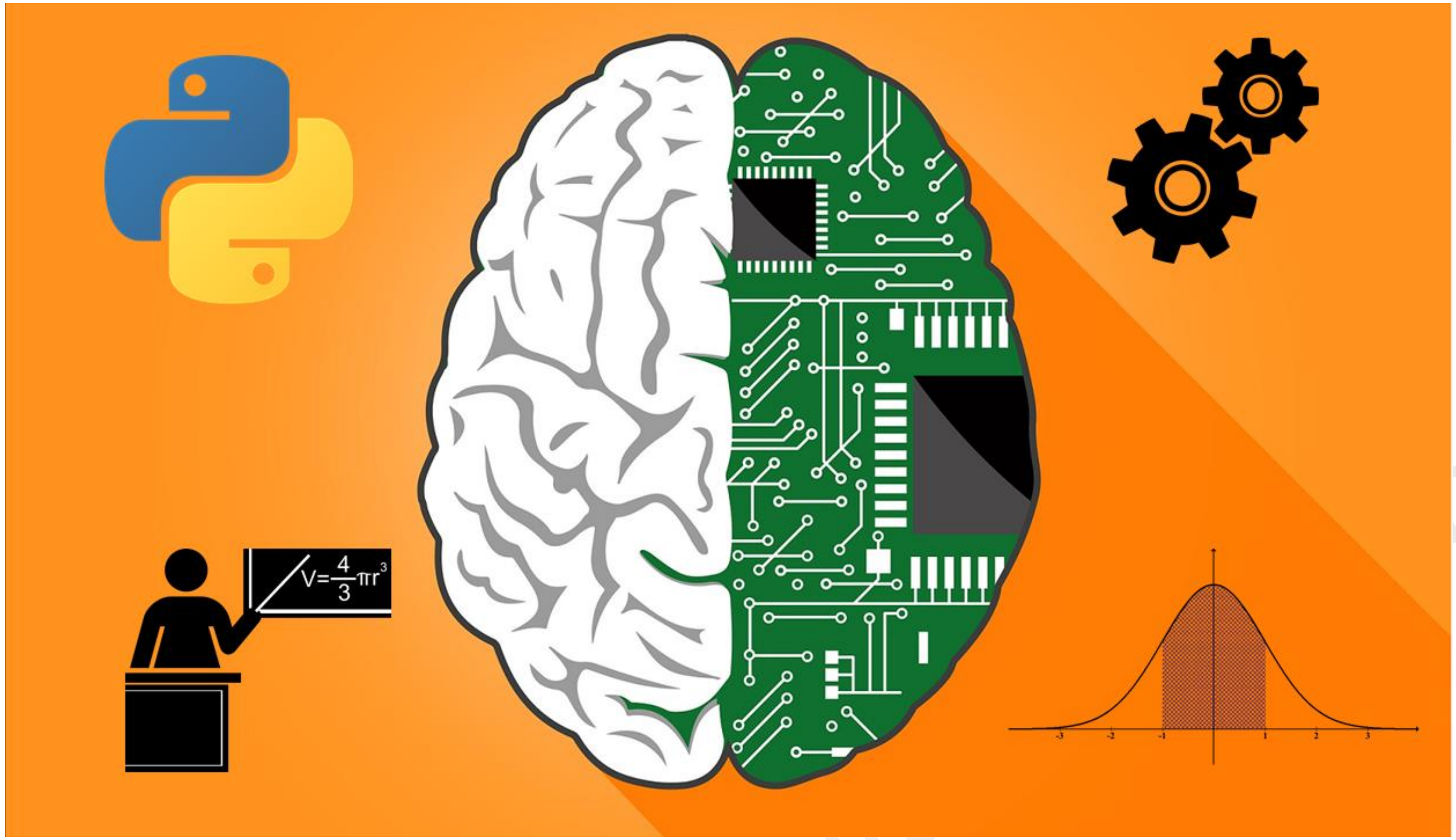

Complete Data Science and Machine Learning Using Python

By
Jitesh Khurkhuriya

Understanding Data, Variables/Features

Understanding The Variables Using a Dataset

Loan_ID	Gender	Married	Dependents	Self_Employed	Income	LoanAmt	Term	CreditHistory	Property_Area	Status
LP001002	Male	No	0	No	$5,849.00		60	1	Urban	Y
LP001003	Male	Yes	1	No	$4,583.00	$128.00	120	1	Rural	N
LP001005	Male	Yes	0	Yes	$3,000.00	$66.00	60	1	Urban	Y
LP001006	Male	Yes	2	No	$2,583.00	$120.00	60	1	Urban	Y

- Qualitative
  - Nominal
    - Gender
    - Married
    - Self employed
    - Property Area
    - Status
  - Ordinal
    - Credit History
    - Dependents
- Quantitative
  - Discrete
    - Term
  - Continuous
    - Income
    - LoanAmt

Understanding The Variables Using a Dataset

Loan_ID	Gender	Married	Dependents	Self_Employed	Income	LoanAmt	Term	CreditHistory	Property_Area	Status
LP001002	Male	No	0	No	$5,849.00		60	1	Urban	Y
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LP001006	Male	Yes	2	No	$2,583.00	$120.00	60	1	Urban	Y

Types of Variables

- **Predictor/Independent**
  - Gender
  - Married
  - Dependents
  - Self_Employed
  - Income
  - LoanAmt
  - Term
  - CreditHistory
  - PropertyArea
- **Target/Dependent**
  - Status

Data Type

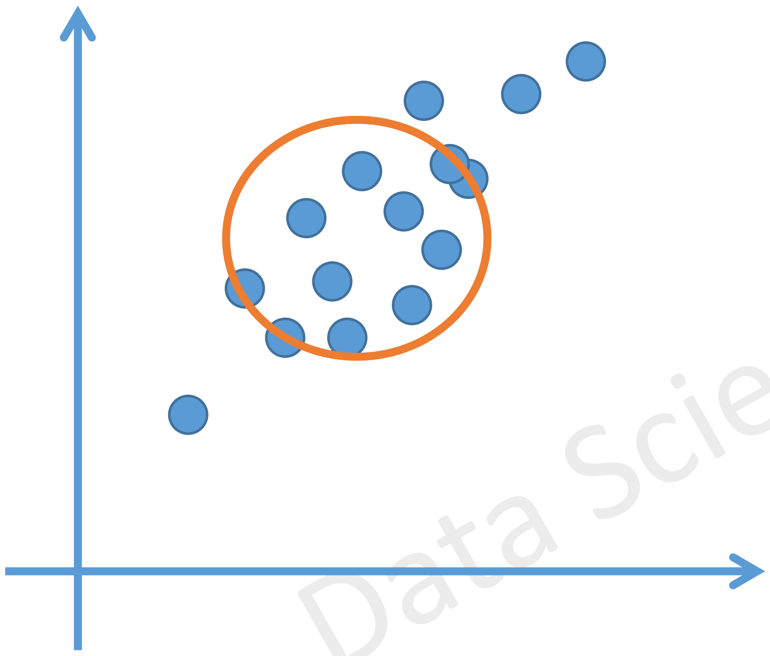
- **Character/String**
  - Gender
  - Married
  - Self_Employed
  - Property_Area
  - Status
- **Numeric**
  - Dependents
  - Income
  - LoanAmt
  - Term
  - CreditHistory

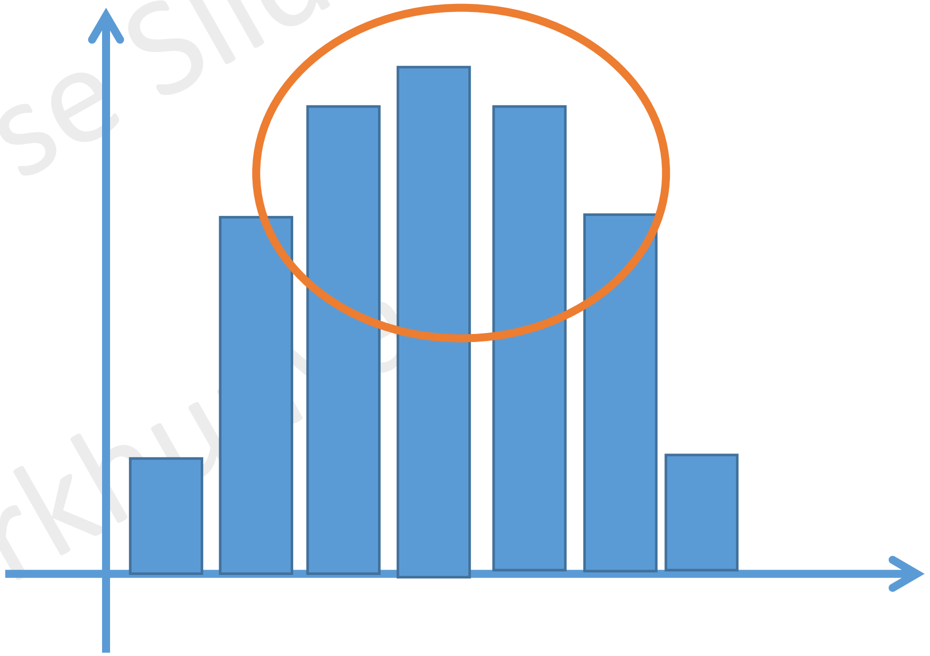
Central Tendency of Data

Central Tendency

Single value that attempts to describe the whole data using a central point or central location of the data.

Central Tendency of Data





Central Tendency

- Mean
- Median
- Mode
- Others – Geometric mean, Harmonic Mean, Weighted Arithmetic Mean

Mean

Applicant	Loan Amount
Jitesh	$ 24,000
John	$ 18,000
Frans	$ 34, 000
Danny	$ 40,000
Cecile	$ 24,000
Scott	$ 16,000
Alex	$ 29,000

$$\text{Mean} = \frac{24000 + 18000 + 34000 + 40000 + 24000 + 16000 + 29000}{7}$$

$$= \frac{151000}{7}$$

$$\text{Mean} = \$25{,}167$$

Median

Applicant	Loan Amount
Jitesh	$ 24,000
John	$ 18,000
Frans	$ 34, 000
Danny	$ 40,000
Cecile	$ 24,000
Scott	$ 16,000
Alex	$ 29,000

$24,000 $18,000 $34,000 $40,000 $24,000 $16,000 $29,000

$16,000 $18,000 $24,000 $24,000 $29,000 $34,000 $40,000

1 2 3 4 5 6 7

Median

Median = $24,000

Mode

Applicant	Loan Amount
Jitesh	$ 24,000
John	$ 18,000
Frans	$ 34, 000
Danny	$ 40,000
Cecile	$ 24,000
Scott	$ 16,000
Alex	$ 29,000

$$\text{Mode} = \$24{,}000$$

Outliers

Experience	Salary
1	$ 3,725
2	$ 4,155
3	$ 4,627
4	$ 5,147
5	$ 5,718
6	$ 6,347
7	$ 7,039
8	$ 7,210
9	$ 7,423
10	$ 19,000
11	$ 8,369
12	$ 8,810
13	$ 8,940
14	$ 9,200
15	$ 9,458

Effect of Outliers

Experience	Salary
1	$ 3,725
2	$ 4,155
3	$ 4,627
4	$ 5,147
5	$ 5,718
6	$ 6,347
7	$ 7,039
8	$ 7,210
9	$ 7,423
10	$ 7,556
11	$ 8,369
12	$ 8,810
13	$ 8,940
14	$ 9,200
15	$ 9,458

$ 6,915 ← Mean → $ 7,678

$ 7,200 ← Median → $ 7,200

Experience	Salary
1	$ 3,725
2	$ 4,155
3	$ 4,627
4	$ 5,147
5	$ 5,718
6	$ 6,347
7	$ 7,039
8	$ 7,210
9	$ 7,423
10	$ 19,000
11	$ 8,369
12	$ 8,810
13	$ 8,940
14	$ 9,200
15	$ 9,458

Measure of Dispersion

Central Tendency

Spread in Data

Spread in Data

Day	Temperature
1	20
2	21
3	19
4	20
5	21
6	19
7	20
Total	**140**

$$\text{Mean} = 20$$
$$\text{Median} = 20$$

Day	Temperature
1	22
2	23
3	21
4	18
5	19
6	17
7	20
Total	**140**

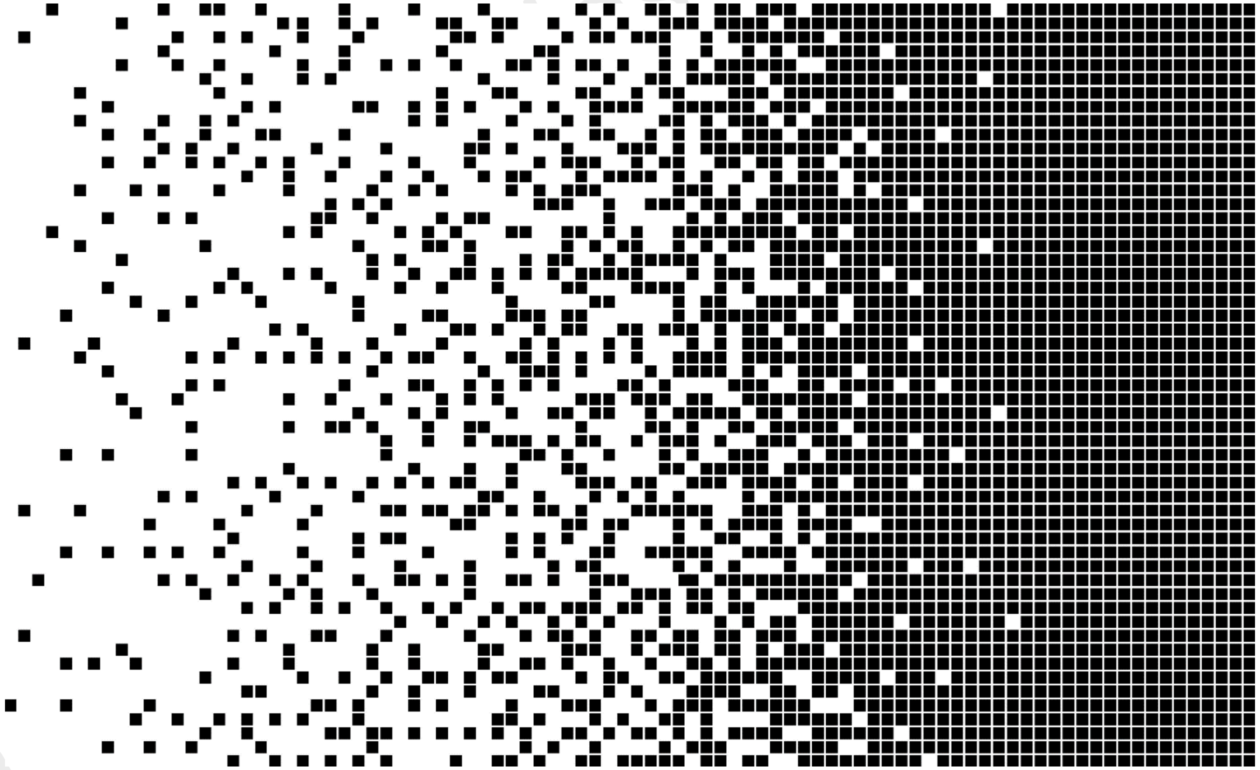
$$\text{Mean} = 20$$
$$\text{Median} = 20$$

Day	Temperature
1	12
2	11
3	13
4	20
5	24
6	29
7	31
Total	**140**

$$\text{Mean} = 20$$
$$\text{Median} = 20$$

Measure of Dispersion

- Variance
- Standard Deviation
- Percentile
- Range
- Interquartile range



Variance and Standard Deviation

Day	X	$X - \bar{X}$	$(X - \bar{X})^2$
1	20	0	0
2	21	1	1
3	19	-1	1
4	20	0	0
5	21	1	1
6	19	-1	1
7	20	0	0

$$\text{Average} = 4/7 = 0.57$$

$$\text{Variance, } \sigma^2 = 0.57$$

$$\sigma = 0.7559$$

$$\text{Mean} = \bar{X} = 20$$

Variance and Standard Deviation

Day	Temperature
1	20
2	21
3	19
4	20
5	21
6	19
7	20

$$\sigma = 0.7559$$

$$\text{Mean} = \overline{X} = 20$$

Day	Temperature
1	12
2	11
3	13
4	20
5	24
6	29
7	31

$$\sigma = 7.67$$

$$\text{Mean} = \overline{X} = 20$$

What is Percentile?

The value below which a given percentage of observations in a group of observations falls…

– Wikipedia

Percentile

- Arrange the data in an order

- Calculate the percentage of observations or data points below a particular value.

What is the 80th Percentile Observation?

Total Observations * 0.8

15 * 0.8 = 12

Row Number	Salary
1	$ 3,725
2	$ 4,155
3	$ 4,627
4	$ 5,147
5	$ 5,718
6	$ 6,347
7	$ 7,039
8	$ 7,210
9	$ 7,423
10	$ 7,556
11	$ 8,369
12	$ 8,810
13	$ 8,940
14	$ 9,200
15	$ 9,458

Range

Difference between the highest and lowest value…

Range

Day	Temperature
1	20
2	21
3	19
4	20
5	21
6	19
7	20

Mean = 20
Range = 2

Day	Temperature
1	22
2	23
3	21
4	18
5	19
6	17
7	20

Mean = 20
Range = 6

Day	Temperature
1	12
2	11
3	13
4	20
5	24
6	29
7	31

Mean = 20
Range = 20

Inter Quartile Range (IQR)

Row Number	Salary
1	$ 3,725
2	$ 4,155
3	$ 4,627
4	$ 5,147
5	$ 5,718
6	$ 6,347
7	$ 7,039
8	$ 7,210
9	$ 7,423
10	$ 7,556
11	$ 8,369
12	$ 8,810
13	$ 8,940
14	$ 9,200
15	$ 9,458

1st Quartile

Median

3rd Quartile

Q3 – Q1

Inter Quartile Range

IQR

$8,810 – $5,147 = $3,663

How to Show Numerical Data?

Visualize Numerical Data

- Frequency Table
- Histogram
- Bar Chart
- Boxplot

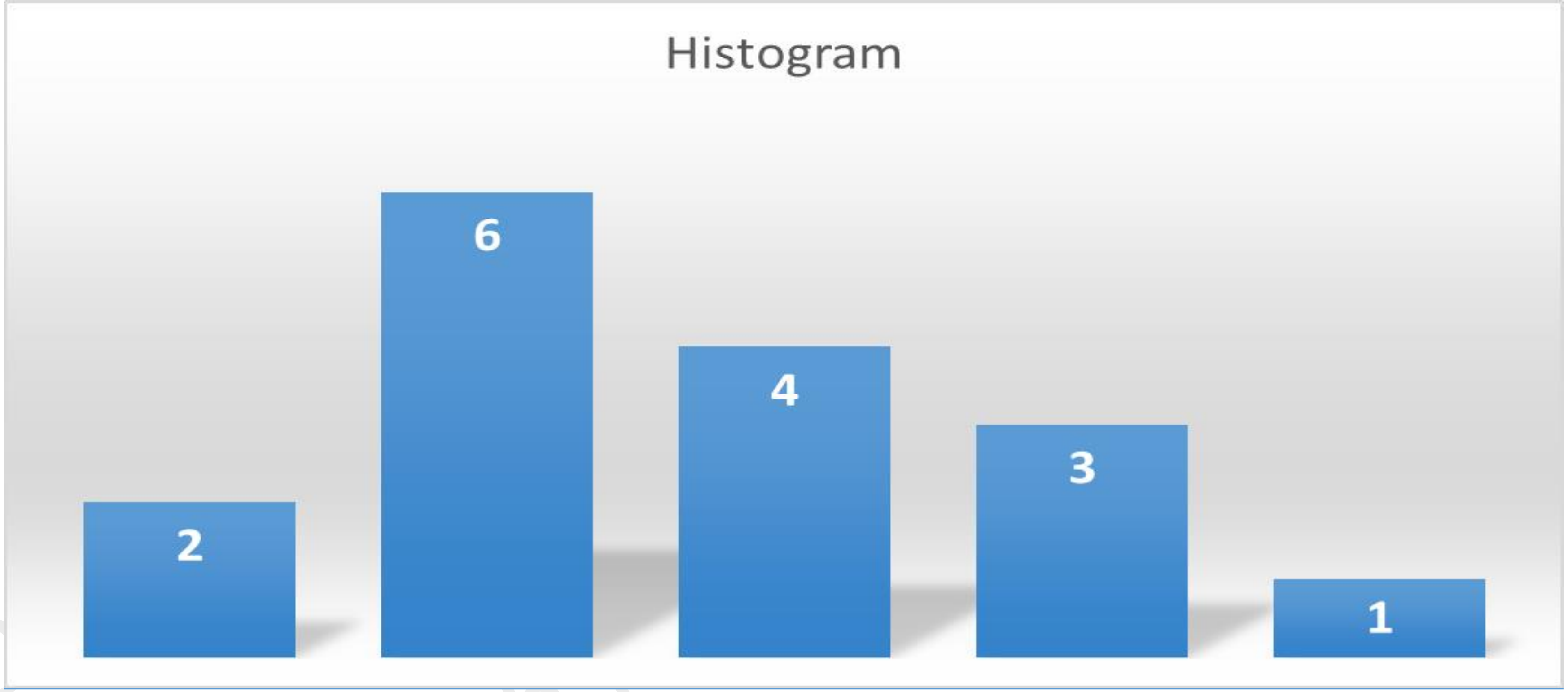
Frequency Table

1223
3434
4545
6798
2311
4321
5600
10345
900
2687
3450
6700
2340
3600
5632
7900

0-2000	2-4000	4-6000	6-8000	> 8000
1223	3434	4545	6798	10345
900	2311	4321	6700	
	2687	5600	7900	
	3450	5632		
	2340			
	3600			
2	**6**	**4**	**3**	**1**

Histogram

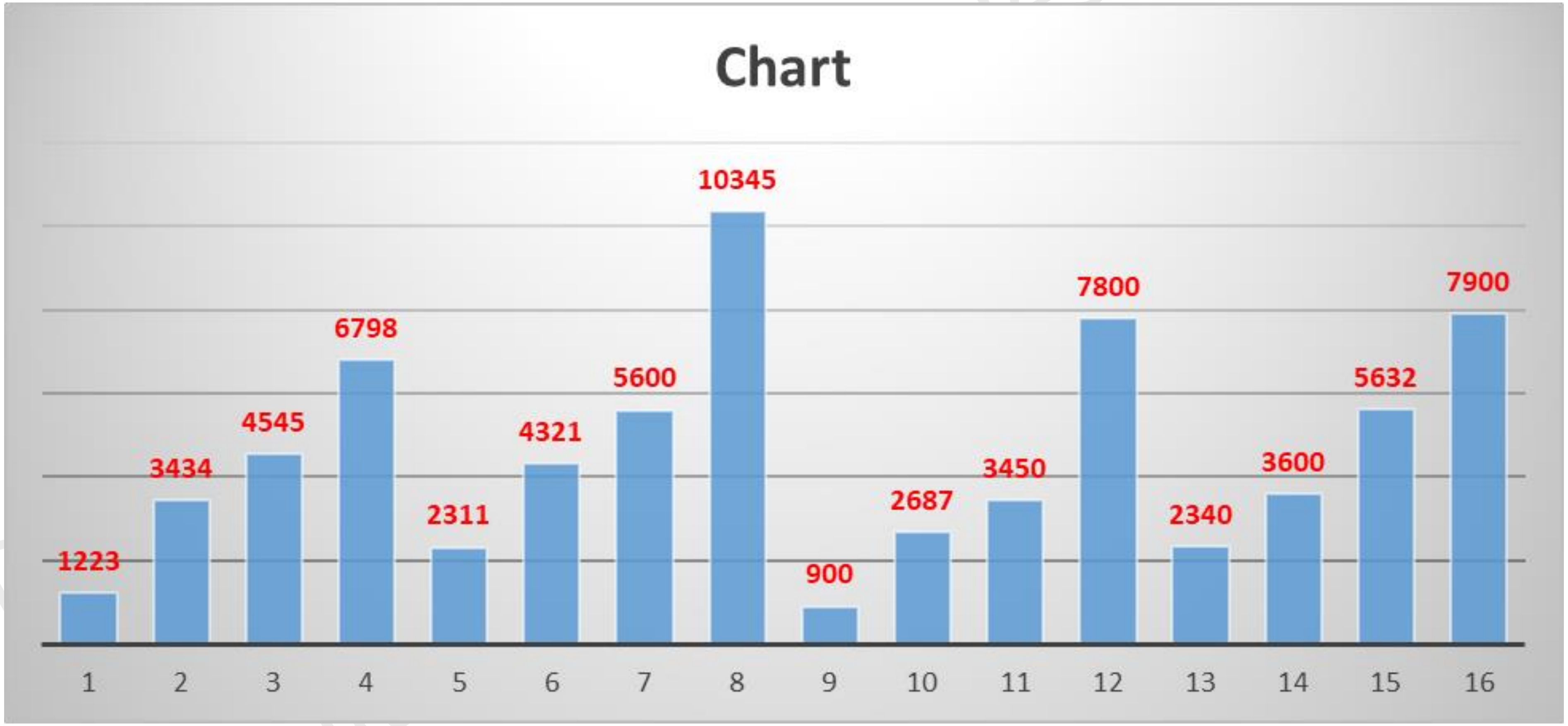
1223
3434
4545
6798
2311
4321
5600
10345
900
2687
3450
6700
2340
3600
5632
7900



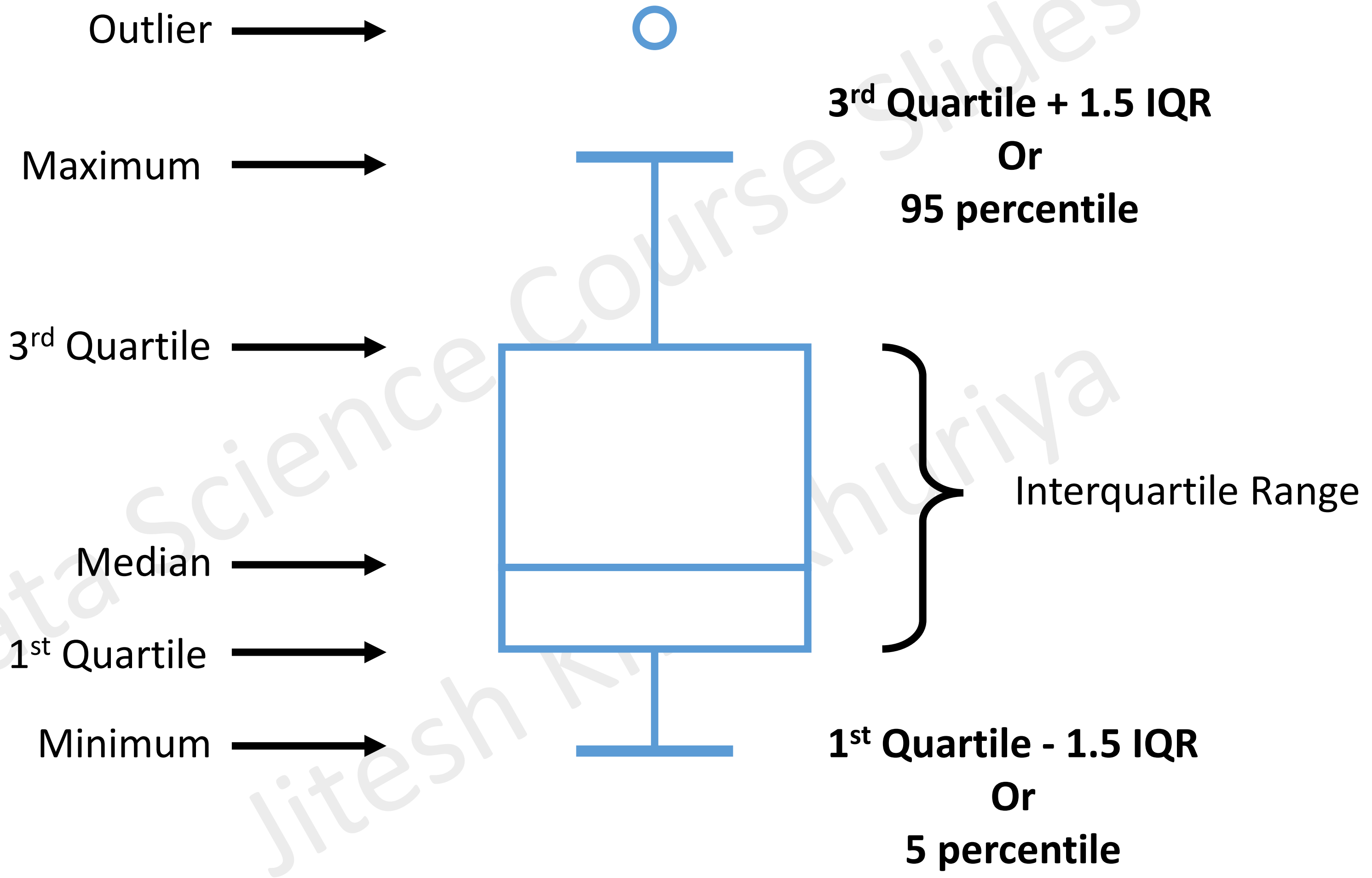
0-2000	2-4000	4-6000	6-8000	> 8000
2	6	4	3	1

Bar Chart

1223
3434
4545
6798
2311
4321
5600
10345
900
2687
3450
6700
2340
3600
5632
7900



Box Plot



Outlier
Maximum
3rd Quartile
Median
1st Quartile
Minimum
3rd Quartile + 1.5 IQR
Or
95 percentile
Interquartile Range
1st Quartile - 1.5 IQR
Or
5 percentile

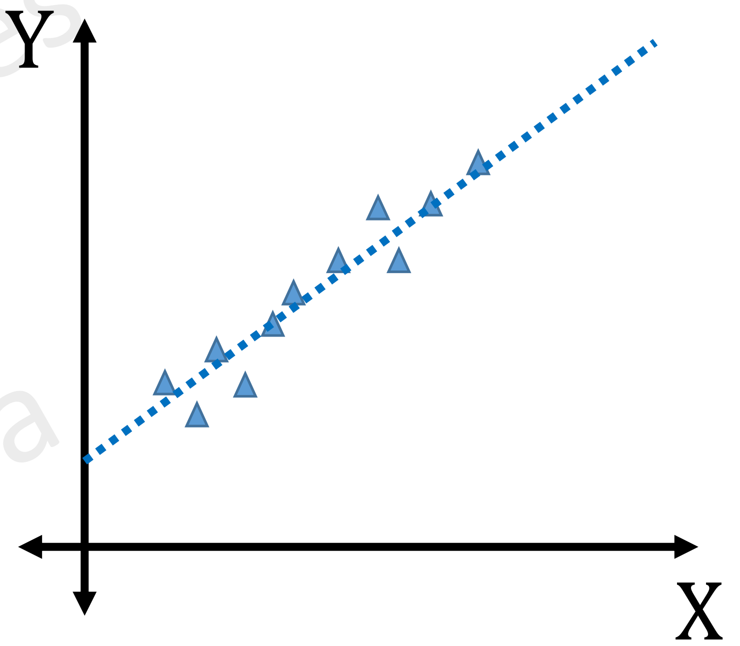
Correlation

Number of cigarettes smoked

Stress Level

Statistically Correlated

- Strength of the correlation – Coefficient of Correlation
- Direction of correlation – Sign of the Coefficient



Pearson Correlation Coefficient

$$r = \frac{\sum (x - \bar{x}) * (y - \bar{y})}{(N - 1) * \sigma_x * \sigma_y}$$

Correlation Coefficient

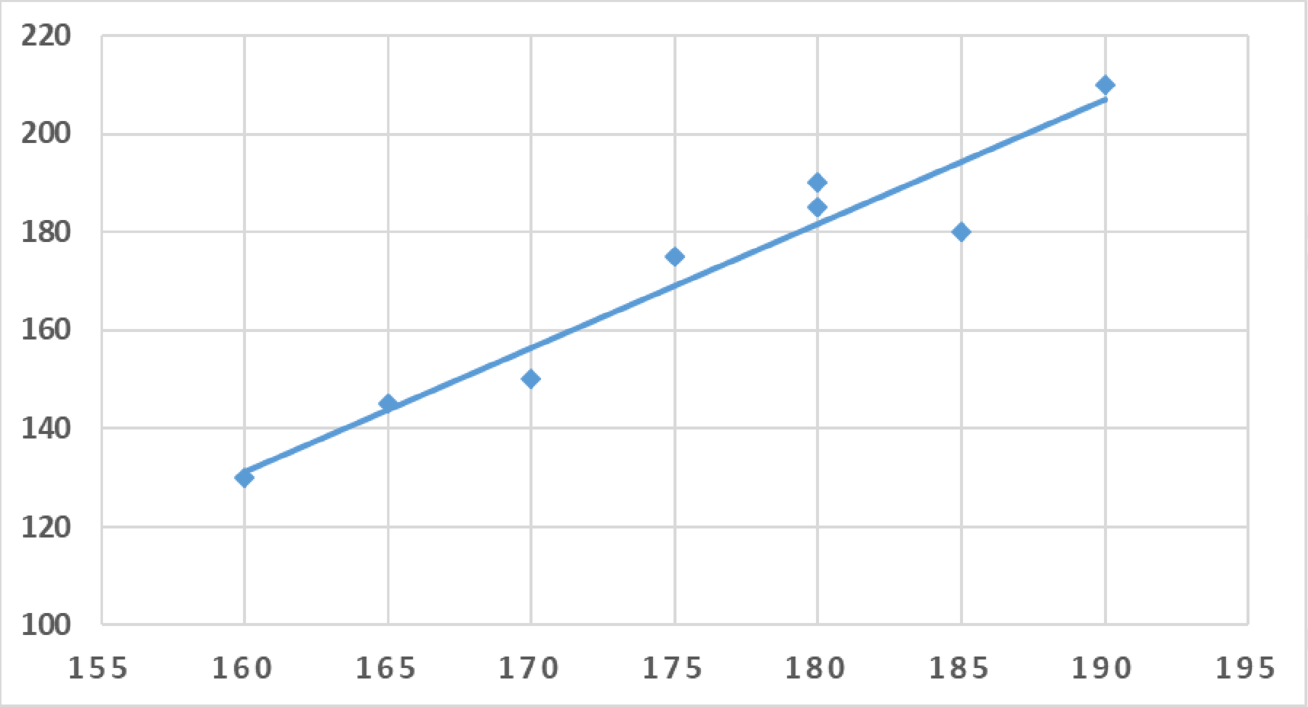
	Height X	Weight Y	$X - \bar{X}$	$Y - \bar{Y}$	$(X - \bar{X}) * (Y - \bar{Y})$
	160	130	-15.625	-40.625	634.7656
	170	150	-5.625	-20.625	116.0156
	165	145	-10.625	-25.625	272.2656
	180	190	4.375	19.375	84.76563
	175	175	-0.625	4.375	-2.73438
	190	210	14.375	39.375	566.0156
	185	180	9.375	9.375	87.89063
	180	185	4.375	14.375	62.89063
Mean	**175.625**	**170.625**			**1821.875**
Std Dev	**10.155**	**25.651**			

$$r = \frac{\sum (x - \bar{x}) * (y - \bar{y})}{(N - 1) * \sigma_x * \sigma_y}$$

$$r = \frac{1821.875}{(8\text{-}1) * 10.155 * 25.651}$$

$$r = 0.96$$

Correlation Coefficient

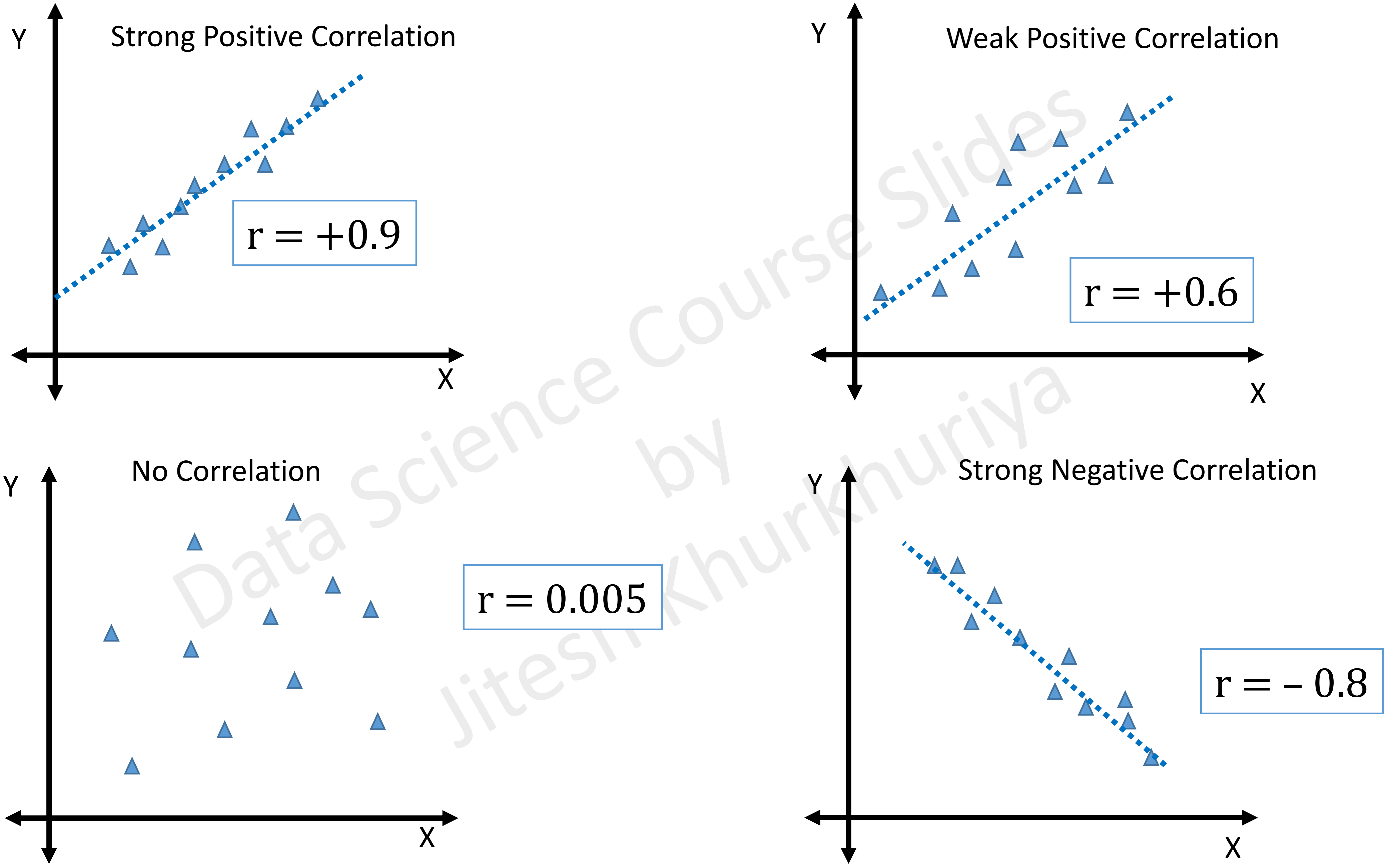


Scatter Plot

$$r = \frac{\sum (x - \overline{x}) * (y - \overline{y})}{(N - 1) * \sigma_x * \sigma_y}$$

$$r = \frac{1821.875}{(8\text{-}1) * 10.155 * 25.651}$$

$$r = 0.96$$


Y
Strong Positive Correlation
r = +0.9
X
Y
Weak Positive Correlation
r = +0.6
X
Y
No Correlation
r = 0.005
X
Y
Strong Negative Correlation
r = – 0.8
X

Covariance

Variance

Average of the squared difference of the data from the Mean.

$$\text{Variance}, S_x^2 = \frac{\sum (x - \bar{x}) * (x - \bar{x})}{(N - 1)}$$

Variance of X with respect to X.

Covariance

$$\text{Covariance, } S_{xy}^{2} = \frac{\sum (x - \overline{x}) * (y - \overline{y})}{(N - 1)}$$

Variance of X with respect to Y.

Covariance

Pearson Correlation Coefficient

$$r = \frac{\sum (x - \bar{x}) * (y - \bar{y})}{(N - 1) * \sigma_x * \sigma_y} = \frac{\text{Covar}(x, y)}{\sigma_x * \sigma_y}$$

$$\text{Covariance, } S_{xy}^2 = \frac{\sum (x - \bar{x}) * (y - \bar{y})}{(N - 1)}$$

Variance of X with respect to Y.

Covariance

	Height X	Weight Y	$X - \bar{X}$	$Y - \bar{Y}$	$(X - \bar{X}) * (Y - \bar{Y})$
	160	130	-15.625	-40.625	634.7656
	170	150	-5.625	-20.625	116.0156
	165	145	-10.625	-25.625	272.2656
	180	190	4.375	19.375	84.76563
	175	175	-0.625	4.375	-2.73438
	190	210	14.375	39.375	566.0156
	185	180	9.375	9.375	87.89063
	180	185	4.375	14.375	62.89063
Mean	**175.625**	**170.625**			**1821.875**
Std Dev	**10.155**	**25.651**			

$$\text{Covariance, } S_{xy}^2 = \frac{\sum (x - \bar{x}) * (y - \bar{y})}{(N - 1)}$$

$$\text{Covar}(x, y) = \frac{1821.875}{(8-1)}$$

$$\text{Covar}(x, y) = 260.27$$

Covariance

- Non-Standardised method of correlation
- Can be positive or negative

$$\text{Covariance, } S^2_{xy} = \frac{\sum (x - \overline{x}) * (y - \overline{y})}{(N - 1)}$$

$$\text{Covar (x, y)} = \frac{1821.875}{(8\text{-}1)}$$

$$\text{Covar (x, y)} = 260.27$$

Covariance Matrix

	Height X	Weight Y	$X - \bar{X}$	$Y - \bar{Y}$	$(X - \bar{X}) * (Y - \bar{Y})$
	160	130	-15.625	-40.625	634.7656
	170	150	-5.625	-20.625	116.0156
	165	145	-10.625	-25.625	272.2656
	180	190	4.375	19.375	84.76563
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	180	185	4.375	14.375	62.89063
Mean	**175.625**	**170.625**			**1821.875**
Std Dev	**10.155**	**25.651**			

	x	y
x	Covariance (x, x)	Covariance(x, y)
y	Covariance (y, x)	Covariance (y, y)

Covariance Matrix

	Height X	Weight Y	$X - \bar{X}$	$Y - \bar{Y}$	$(X - \bar{X}) * (Y - \bar{Y})$
	160	130	-15.625	-40.625	634.7656
	170	150	-5.625	-20.625	116.0156
	165	145	-10.625	-25.625	272.2656
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	180	185	4.375	14.375	62.89063
Mean	**175.625**	**170.625**			**1821.875**
Std Dev	**10.155**	**25.651**			

	x	y
x	Variance(x)	Covariance(x, y)
y	Covariance (y, x)	Variance (y)

Variance – Covariance Matrix

$$\text{Covariance, } S_{xy}^2 = \frac{\sum (x - \bar{x}) * (y - \bar{y})}{(N - 1)}$$

Covariance Matrix

	Height X	Weight Y	$X - \bar{X}$	$Y - \bar{Y}$	$(X - \bar{X}) * (Y - \bar{Y})$
	160	130	-15.625	-40.625	634.7656
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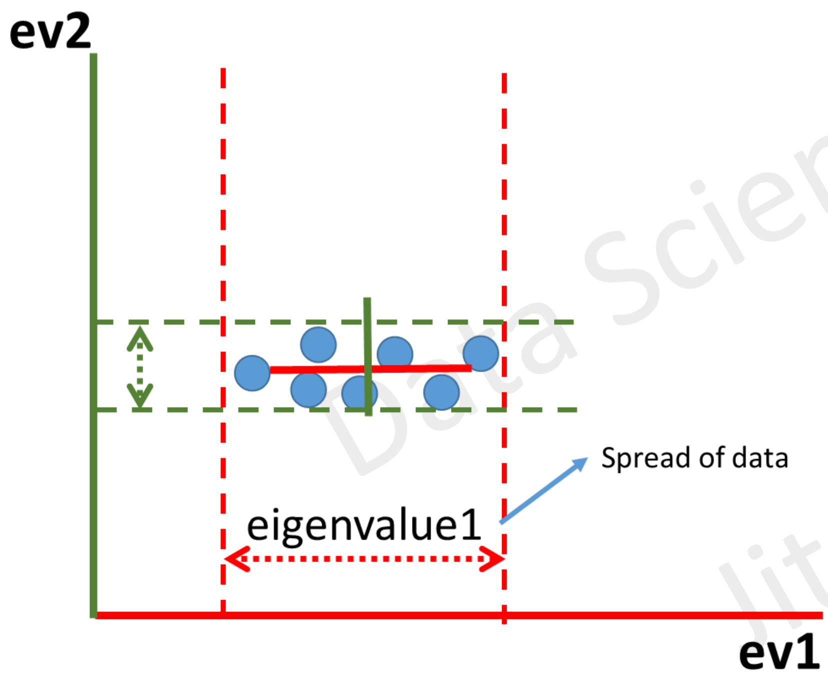
	180	185	4.375	14.375	62.89063
Mean	**175.625**	**170.625**			**1821.875**
Std Dev	**10.155**	**25.651**			

	x	y
x	103.125	260.27
y	260.27	710.26

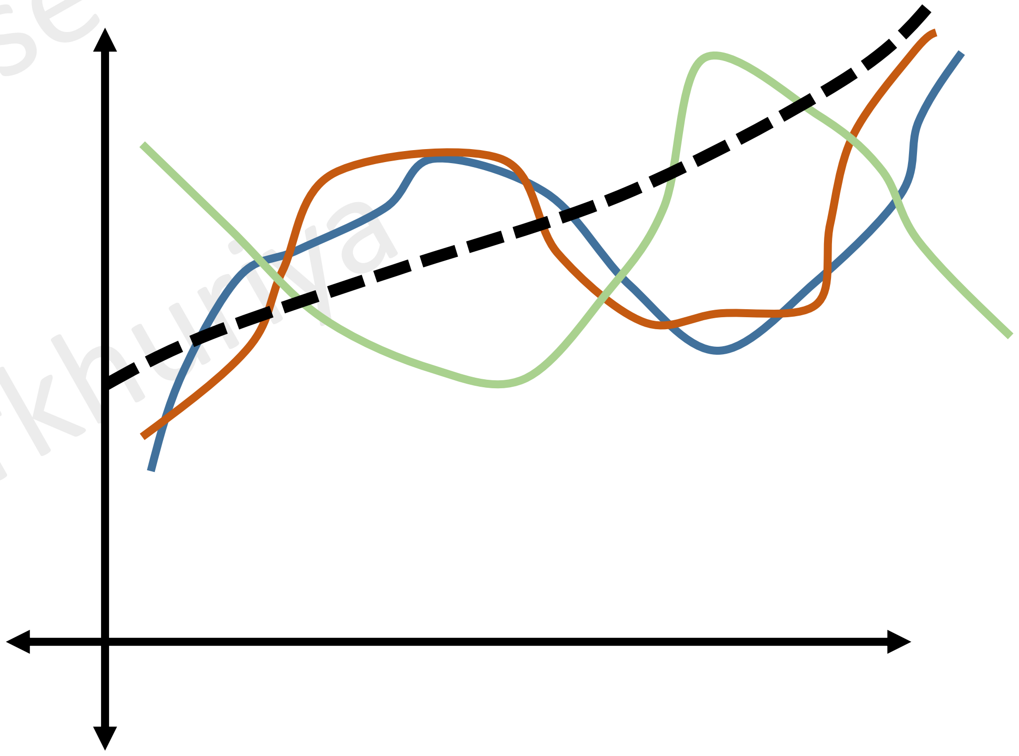
Variance – Covariance Matrix

Covariance Applications

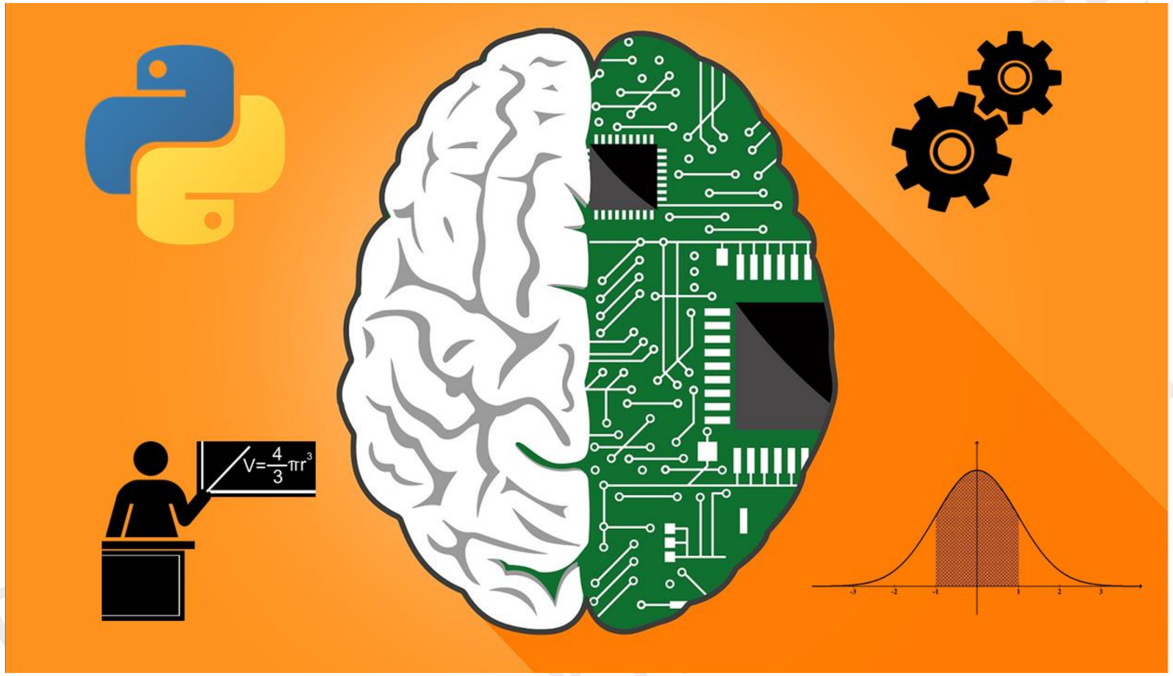
- Using Covariance matrix as Transformation Matrix to get Eigenvectors and EigenValues



- Financial Portfolio Management



Complete Data Science and Machine Learning Using Python



Thank You!