BATCH: 223

DT/NT : DATA SCIENCE
LESSON : STATISTICS -2
SUBJECT: SCATTER PLOT
COVARIANCE
CORRELATION

techproeducation.com +1 (585) 304 29 59

TECHPRO EDUCATION

STATISTICS - 2

Data Science Program
Session -3

Part-1

- The meaning of Statistics
  - Eisenhower Matrix
  - Characterization
    - Collection
    - Analyzing
    - Visualization
    - Inference
    - Presentation
  - Why Statistics
  - Importance of Statistics
    - Data Science vs Statistics
  - How much Statistics for us
  - Statistic Types
    - Descriptive
    - Inferential
  - Data Types
  - Parameters and Statistics
  - Probability vs Statistics
  - Level of Measurement
    - Nominal
    - Ordinal
    - Interval
    - Ordinal

Part-2

- Data Visualization - Graphical Represent
- Patterns
  Center
  - Spread
  - Shape
    - Symmetric
    - Number of peaks
    - Skewness
    - Uniform
  - Unusual Features
    - Gaps
    - Outliers
  - Frequency Table
    - Relative Frequency
    - Cumulative Frequency
  - Bar Chart
  - Pie Chart
  - Histogram
- Populations & Samples
  - Parameters & Statistics
- Central Tendency (Measure of Centre)
  - Mean
  - Median
  - Mode
- Dispersion (Measure of Spread)
  - Range
  - IQR
  - Standard Deviation
    - Empirical Rule
  - Variation

Part-3

- Scatter Plot
  - Linearity
  - Slope
  - Strength
  - Unusual Features
    - Clusters
    - Gaps
    - Outliers
- Box Plot
  - Min & Max Values
  - 1.5*IQR (John Tukey)
- Covariance
- Correlation
  - Pearson Correlation Coefficient
  - Correlation – Linear Relationship

Part-4

- Linear Regression
  - Dependent & Independent Variables
  - Regression Equation
    - Pearson's r Calculation
    - Residual term (e)
  - Coefficient of Determination – R^2

Part-5

- Probability
  - Law of Large Estimates
  - Sample Space – Event
  - Independent – Dependent Event
  - Probability of 2 Independent Event
  - Intersection, Union, Complement
  - Permutation
  - Combination
  - Conditional Probability
    - Independency check
- Bayes Theorem

Part-6

- Random Variables
- Probability Distributions
  - Discrete Probability Distributions
    - Probability Mass Function (PMF)
    - Cumulative Distribution Function (CDF)
    - Binomial Distribution
    - Bernoulli Distribution
    - Poisson Distribution
    - *Geometric, Hypergeometric, Negative Binominal*
  - Continuous Probability Distributions
    - Uniform Distribution
    - Normal Distribution
      - Z Table
    - Standard Distribution
    - T Distribution (aka, Student's Test, T-Distribution)
    - *Exponential, Gamma, Chi-square, F*

Part-7

- Sample Distribution
  - Simple Random Sampling (SRS)
  - Standard Error of the Mean
  - Central Limit Theorem
    - Normal Distribution Advantages
  - Confidence Interval

Part-8

- Hypothesis (Significance) Test
  - Hypothesis Test Steps
    - Assumptions
    - Hypotheses
      - Null Hypotheses
      - Alternative Hypotheses
    - Test Statistic
    - P – Value
    - Conclusions
  - Significance Level (α – alpha)
  - Type I – II Error
  - One – Two Tail Tests
    - Left Tail Test
    - Right Tail Test
    - Two Side (Two Tail) Test
  - T Test
  - Z Test

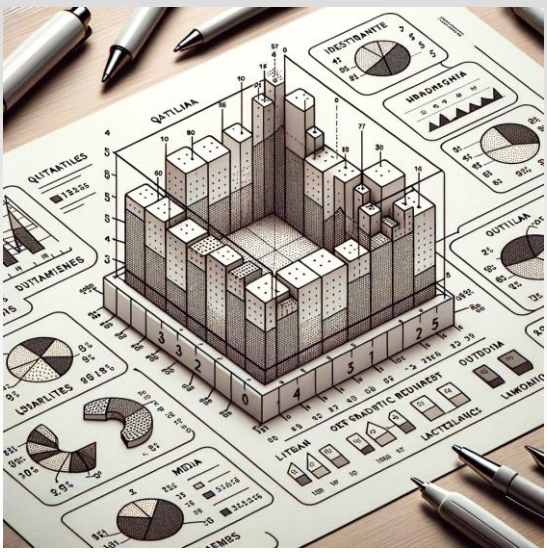
Part-9

- Independent Samples T Test
- Dependent T test – (Paired T Test)
- One Way ANOVA
  - Test Statistics – ANOVA Table
    - SSR: Regression Sum of Squares
    - SSE: Error Sum of Squares
    - SST: Total Sum of Squares
    - MSR: Regression Mean Squares
    - MSE: Mean Squares Error
    - F Statistic
- Categorical Data Analysis
- Chi-Square Test

Session - 3 Content

Content

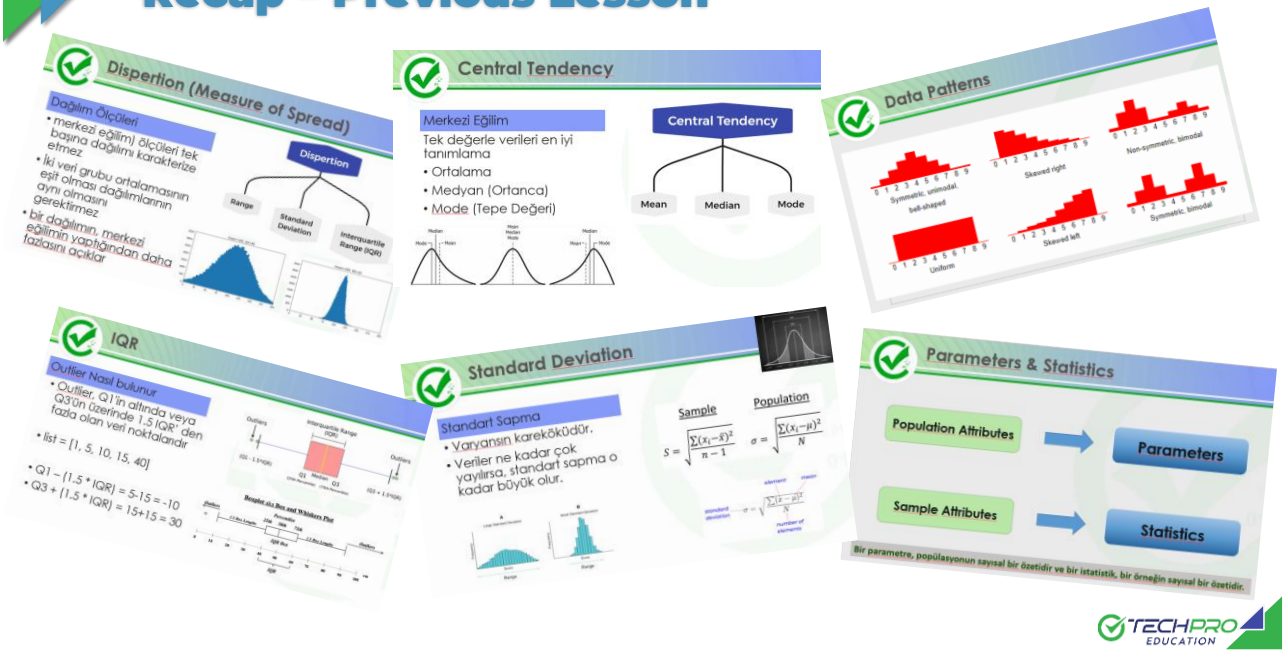
- Scatter Plot
- Box Plot
- Covariance
- Correlation



RECAP

Herkes önceki dersten hatırladığı 1 cümle yazabilir mi?

Recap – Previous Lesson

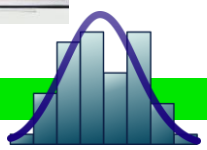


Graphical Summarization for Data

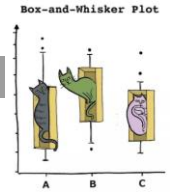
Frequency Tables — Discrete and continous data

Bar Charts — Discrete data

Histograms — Continous data; Variation, skewnes, outliers,



Box Plots — Continous data; Variation, skewnes, outliers,

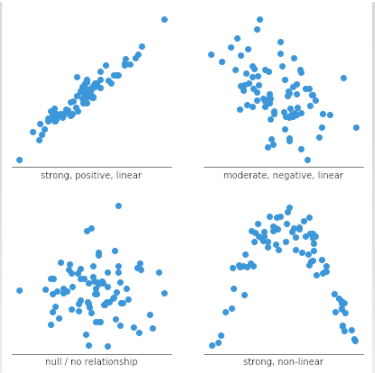


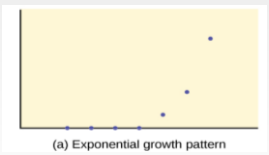
Scatter Plots — Two Continous variable

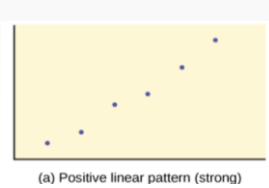
Scatter Plot

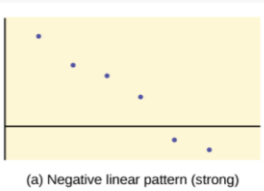
Saçılım Grafiği – Serpilme Diyagramı

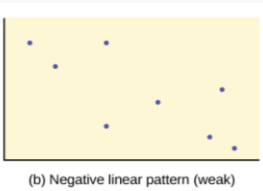
- İki değişkenli bir scatter plot, Y eksenindeki bir değişkenin değerlerini ve X eksenindeki diğer değişkenin değerlerini gösterir.
- Değişkenler arasındaki ilişkinin yönünü ve büyüklüğünü gösterir

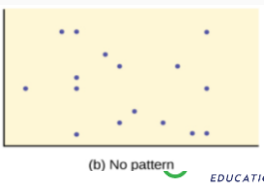




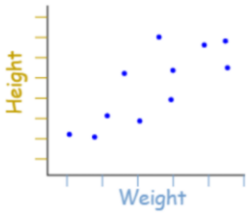




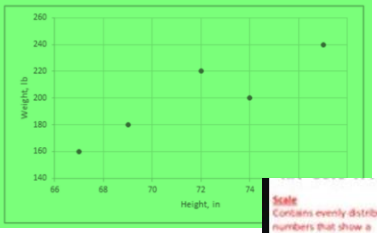


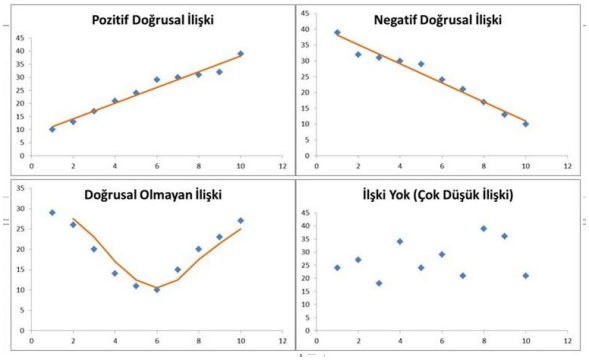


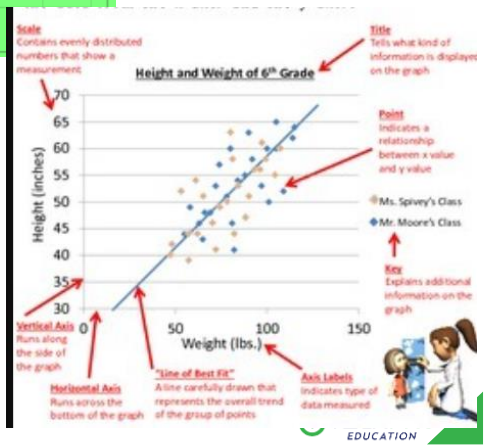
Scatter Plot



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







Scatter Plot Pattern

Linearity

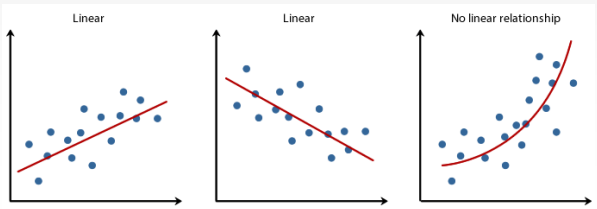
- Lineerlik, bir veri modelinin lineer - doğrusal (düz) veya non-lineer -doğrusal olmayan (curve -eğri) olup olmadığını ifade eder.

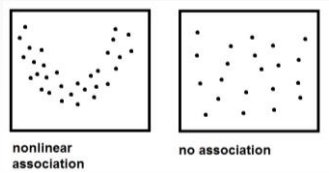
Linearity

Slope

Strength

Unusual Features



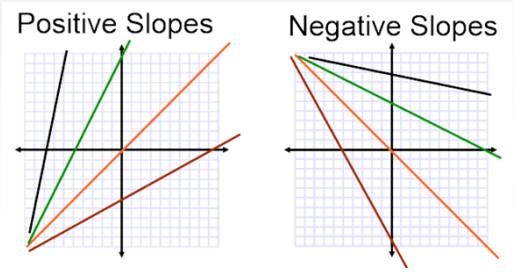


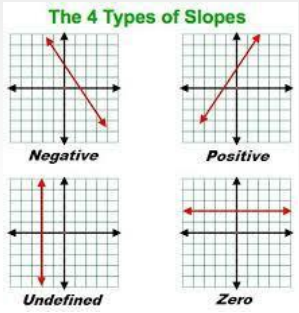
TECHPRO EDUCATION

Scatter Plot Pattern

Slope

- Slope yani eğim, X değişkeni büyüdüğünde Y değişkenindeki değişimin yönünü ifade eder.





Linearity

Slope

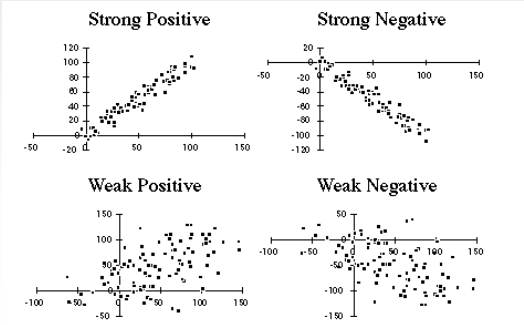
Strength

Unusual Features

Scatter Plot Pattern

Strength

- Strength, grafikteki dağılmanın veya saçılmanın derecesini -gücünü ifade eder



Linearity

Slope

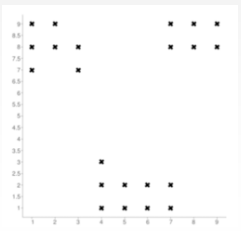
Strength

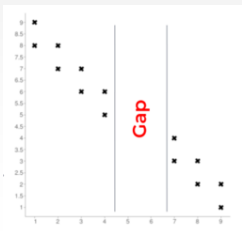
Unusual Features

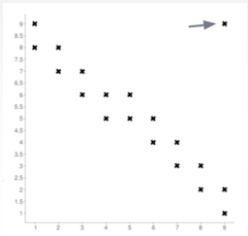
Scatter Plot Pattern

Unusual Features

- Clusters (Kümelenme)
- Gaps (Boşluklar)
- Outliers (Aykırı Değerler)







Linearity

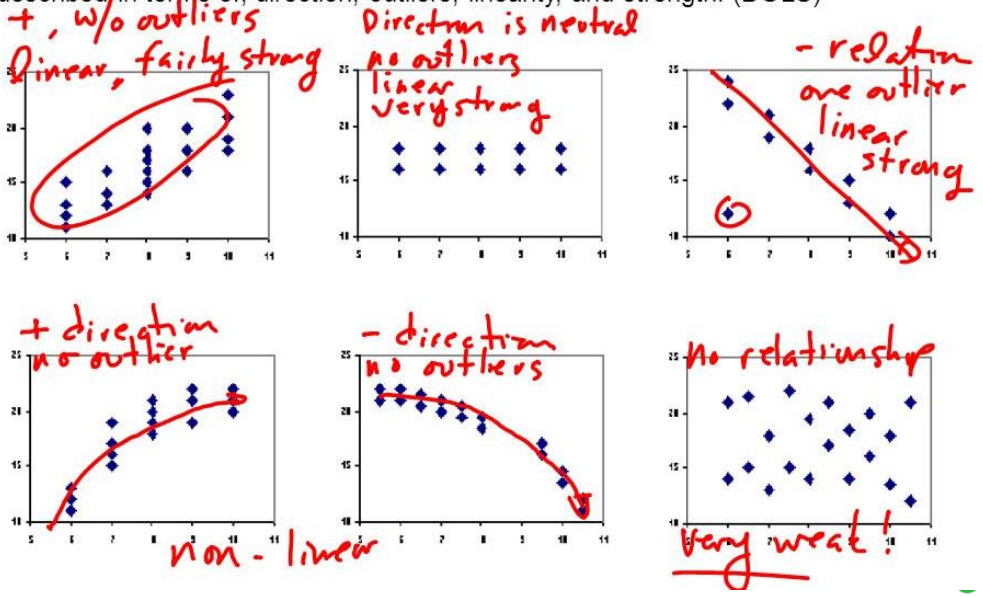
Slope

Strength

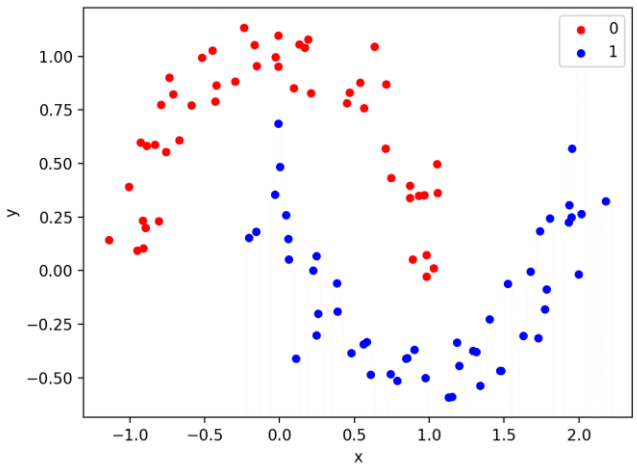
Unusual Features

Pattern of Data in Scatterplot

described in terms of, direction, outliers, linearity, and strength. (DOLS)



Peardeck Question



- ***Linearity***

Linear Nonlinear

- ***Slope***

Positive Negative Zero

- ***Strength***

Weak Strong

- ***Unusual Features***

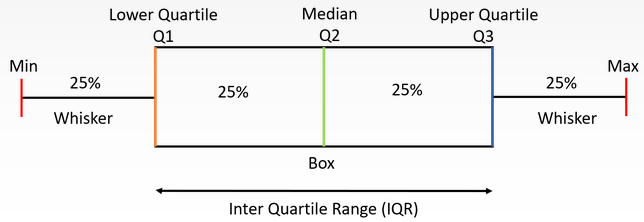
Cluster Gap Outlier None

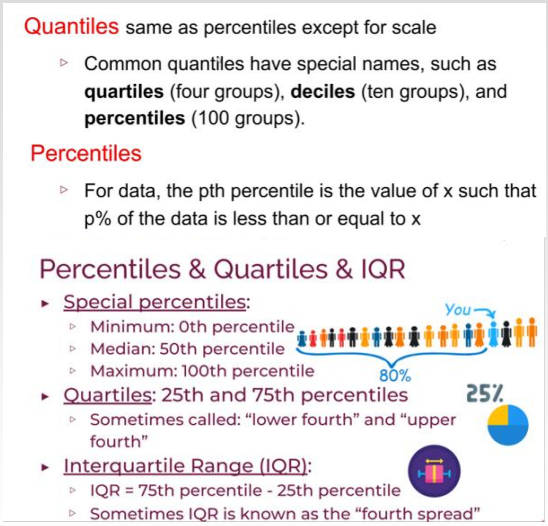
Box Plot

Box Plot

Box Plot – Kutu Grafiği

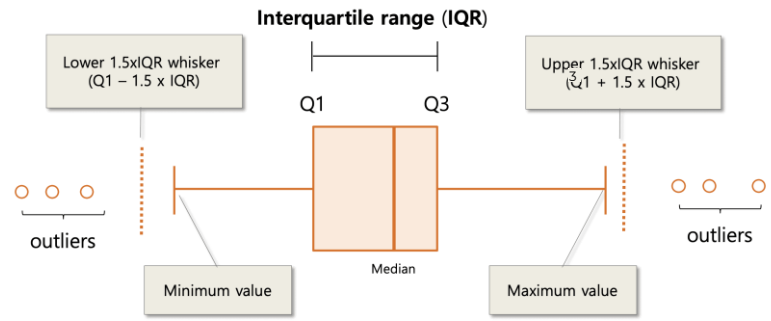
- Bir veri kümesinin en etkili grafik özetlerinden biri olan box plot genellikle ortalama, medyan, 25. ve 75. yüzdelikler ve outlier'ları gösterir.

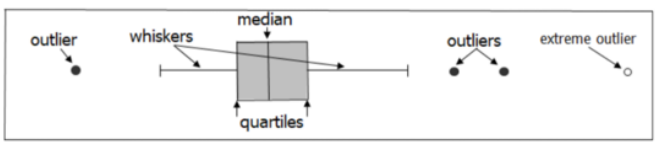


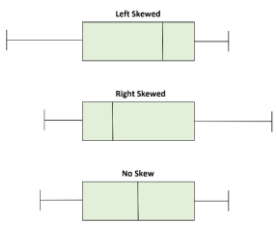


Box Plot

- Ortadaki quartiles denen kısım benim datamın tamamının %50'si
- Q3+**1.5** IQR sonrası outlier, Q3+**3** IQR extreme outlier.

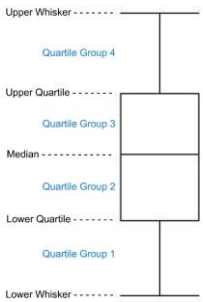






Box Plot

- Box-and-whisker plot bir veri setinin önemli özelliklerini vurgulayan bir EDA keşif veri analizi aracıdır
- Beş tane değer, grafiği çizmek için kullanılır:
  - minimum veri
  - Q1
  - Q2 (medyan)
  - Q3
  - maximum veri

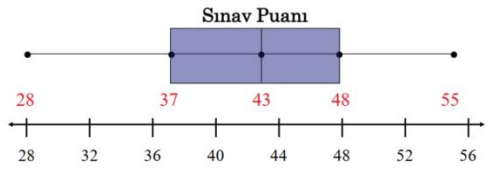


- Örnek
- Box-and-whisker plot çizmek için 15 sınav puanından verileri kullanın

28 30 33 37 37 38 42 43 43 44 45 48 48 51 55

5 tane değer

minimum veri	28
Q_1	37
Q_2 (median)	43
Q_3	48
maximum veri	55



Box Plot – Min & Max Values

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*

Step 4: Find the min and the max.

Min = 25 *Max = 38*

Min	25
Q1	29
Median	32
Q3	35
Max	38

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

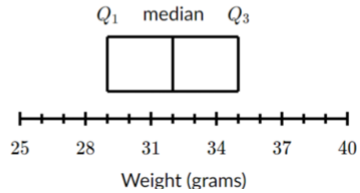
25 28 29 29 30 34 35 35 37 38

Min = 25 *Max = 38*

Min	25
Q1	29
Median	32
Q3	35
Max	38

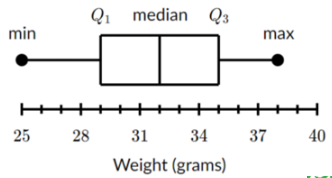
Step 2: Draw a box from *Q1* to *Q3* with a vertical line through the *median*.

25 28 29 29 30 34 35 35 37 38



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

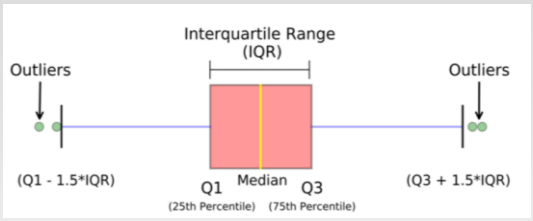


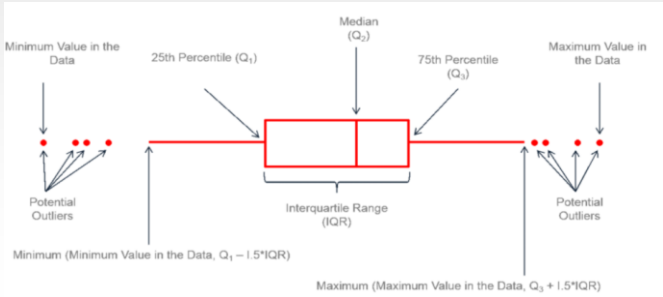
Outliers Detection

1.5*IQR Kuralı

İstatistikçi John Tukey'e göre,

- Eğer gözlem değeri Q1'in altında ve Q3'ün üzerinde 1.5*IQR dan daha fazla düşerse bu değer outlier'dır.





Box Plot – IQR

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
```

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 = 20 - 1.5 x 3.5
= 14.75

Low Outliers: 5 7 10

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

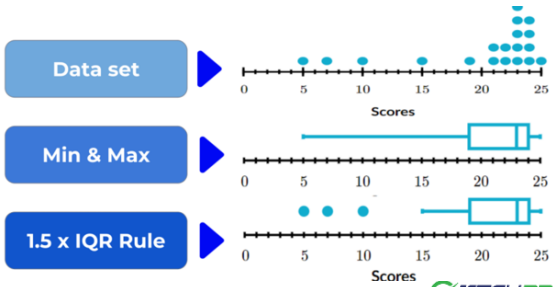
Step 1: Find the median, quartiles, and interquartile range.

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

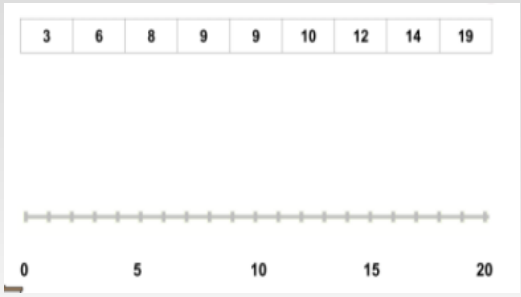
Step 3: Calculate 1.5 x IQR above the third quartile and check for high outliers.

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

High Outliers: None



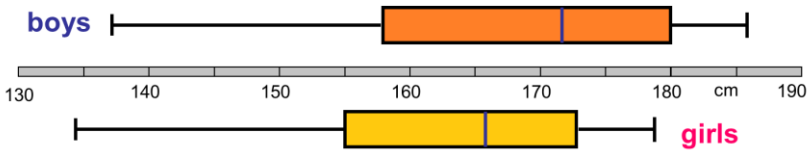
PRACTICE



Box Plot'u çiziniz.

Box Plot Comments ??

boxplot of student's heights:



which are true and why?

1. the girls are taller on average
2. the boys are taller on average
3. the girls show less spread in height
4. the boys show less spread in height
5. the shortest person is a girl
6. the tallest person is a boy
7. both data sets are skewed to the left
8. half the boys are over 172 cm tall
9. half the girls are under 165cm tall

Covariance & Correlation

Covariance

Kovaryans

- İki veri arasındaki değişimin yönünü gösterir
- Değişkenlerin birlikte nasıl değiştiğini görmek önemlidir

Covariance Formula

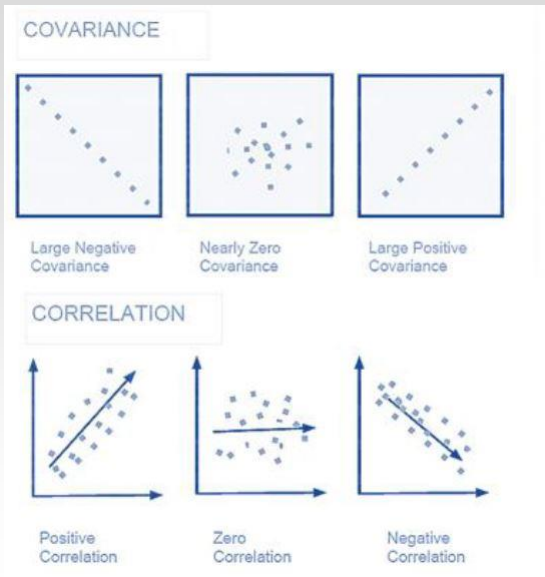
For Population

$$Cov(x,y) = \frac{\Sigma (x_i - \bar{x}) * (y_i - \bar{y})}{N}$$

For Sample

$$Cov(x,y) = \frac{\Sigma (x_i - \bar{x}) * (y_i - \bar{y})}{(N-1)}$$

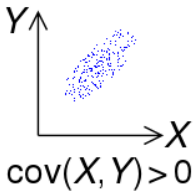
$$Cov(x,y) = \sigma_{xy} = \frac{\sum_{i=1}^{N} (x_i - \mu_x)(y_i - \mu_y)}{N}$$



Covariance

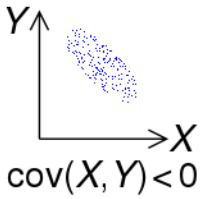
Cov (x,y) > 0

- İlişki pozitiftir.
- X artarken Y de artar



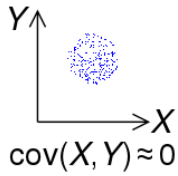
Cov (x,y) < 0

- İlişki negatiftir.
- X artarken Y azalır



Cov (x,y) = 0

- İki değişkenin arasında ilişki yoktur, birbirinden bağımısızlar.

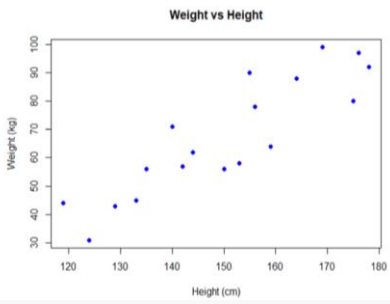


Correlation

Korelasyon

- iki değişken arasındaki ilişkinin derecesini verir.
- Bu değer -1 ile 1 arasındadır.
- -1 mutlak strong negative ilişkinin varlığını, +1 mutlak strong pozitif ilişkinin varlığını söyler

Height	Weight	Height	Weight
119	44	153	58
124	31	155	90
129	43	156	78
133	45	159	64
135	56	164	88
140	71	169	99
142	57	175	80
144	62	176	97
150	56	178	92



Correlation doesn't imply causation

Correlation

- Correlation (r): measures the direction and strength of the **linear** relationship between two quantitative variables

r = correlation

r < 0 Negative association

r > 0 Positive association

r = 0 No correlation

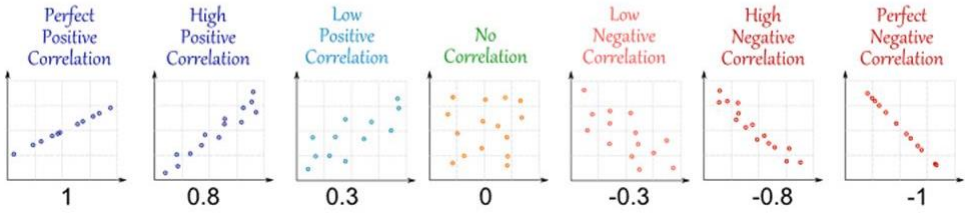
Correlation does NOT equal slope!

Sample Correlation

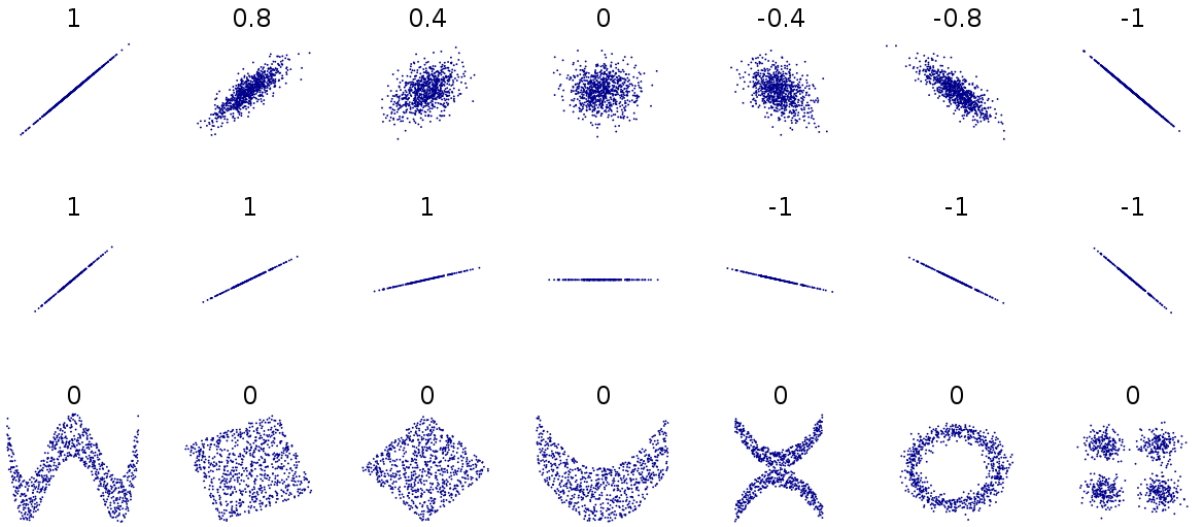
$$r = \frac{Cov(x,y)}{s_X s_Y}$$

Population Correlation

$$\rho = \frac{Cov(x,y)}{\sigma_X \sigma_Y}$$



Correlation

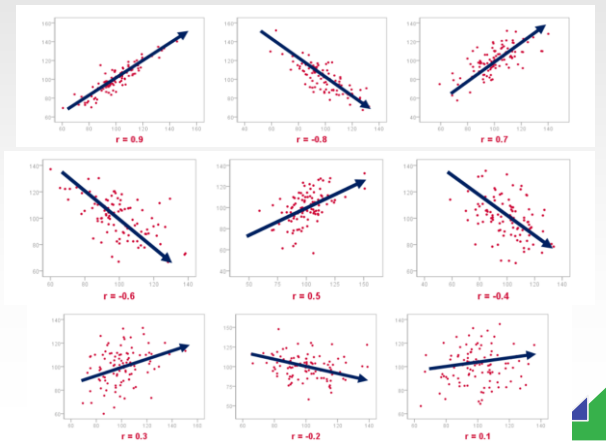


Pearson Correlation Coefficient

Pearson Katsayısı

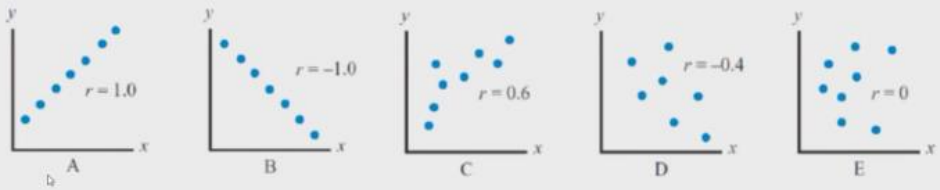
- İki değişken arasındaki korelasyon katsayısını hesaplamak için farklı yöntemler vardır. En ünlüsü Pearson Korelasyon Katsayısı. **Sample için r ile, Populasyon için R (veya ρ) ile gösterilir**
- İlişkinin gücünü gösteren -1 ile 1 arasında bir sayıdır.

$$r = \frac{\sum(x-\mu_x)(y-\mu_y)}{\sqrt{\sum(x-\mu_x)^2 \sum(y-\mu_y)^2}}$$



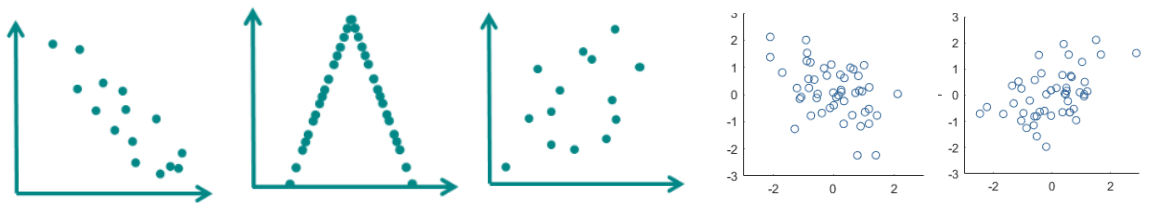
Correlation – Linear Relationship

Examples of Approximate r Value



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

r değerlerini plot'lar ile eşleştiriniz



r = - 0,5 | r = - 0,8 | r = 0 | r = +0,2 | r = +0,4

Correlation - r Calculation

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

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

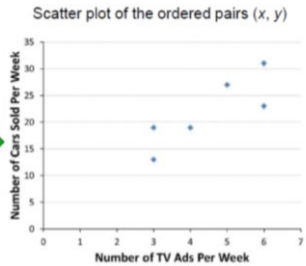
$$r_{xy} = \frac{(5)(1585) - (50)(180)}{\sqrt{\left[(5)(750) - 50^2\right]\left[(5)(6680) - 180^2\right]}}$$

$$= \frac{7925 - 9000}{\sqrt{(3750 - 2500)(33400 - 32400)}}$$

$$= \frac{-1075}{\sqrt{(1250)(1000)}} = -.9615$$

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
	$\Sigma x = 27$	$\Sigma y = 132$	$\Sigma xy = 631$	$\Sigma x^2 = 131$	$\Sigma y^2 = 3110$

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



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

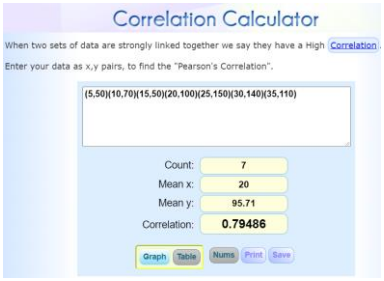
$$r = \frac{n\sum xy - (\sum x)(\sum y)}{\sqrt{\left[n\sum x^2 - (\sum x)^2\right]\left[n\sum y^2 - (\sum y)^2\right]}} = \frac{(6)(631) - (27)(132)}{\sqrt{\left[(6)(131) - (27)^2\right]\left[(6)(3110) - (132)^2\right]}}$$

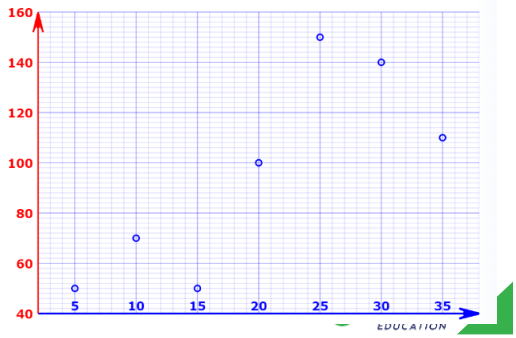
$$= \frac{222}{\sqrt{[57]\,[1236]}} = \frac{222}{265.43} = 0.836$$

Online Calculator

Variable 1	Variable 2
5	50
10	70
15	100
20	100
25	150
30	140
35	110

Online Calculator link

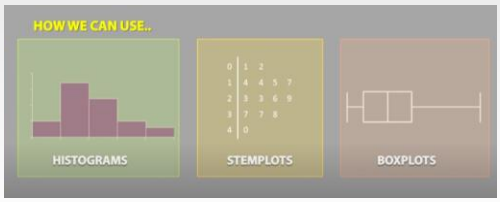




YOUTUBE VIDEO ONERI

https://www.youtube.com/watch?v=DAH8DyLXdjM

- Explanatory and Response Variables, Correlation (2.1)



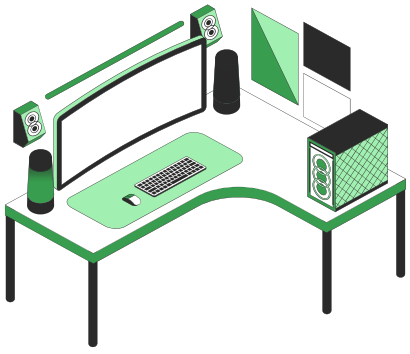
Python Calculation

input :

```
import numpy as np

temp=[93,84,82,78,98,70]

number_of_people=[13,10, 11, 8, 15, 9]

print("covariance: ", np.cov(temp, number_of_people))

print("correlation: ", np.corrcoef(temp, number_of_people))
```

output :

```
covariance:  [[102.56666667  24.        ]
              [ 24.           6.8       ]]

correlation:  [[1.         0.90876934]
               [0.90876934 1.        ]]
```



Do you have any questions?

Send it to us! We hope you learned something new.