→ Probability sampling :- is the method of selecting sample from a large population based on randomization

* simple random sampling :- Every person has equal chance of being selected

* cluster sampling :- The population is divided into clusters and a random sample of these clusters is selected. All member within the chosen clusters are included in the final sample

* stratified sampling :- The population is divided into homogenous, mutually exclusive subgroup called strata. Then random samples are taken from each strata.

→ Non- Probability sampling :-

- non- random method
- no guarantee that every individual will be include
- has higher risk of sampling bias

i) Volunter sampling :- Volunters make up the sample

ii) Purposive sampling :- a researcher use their best judgement to select a sample that they think is a best fit.

iii) quota sampling :- sampling is done until a specific number of units (quota) for various subpopulations have been selected

iv) Snowball sampling :- participants recruit other participants to join the sample

→ Tabular Data

→ Nominal data :- data with no inherent order
eg. gender

→ Ordinal data :- Data with ordered categories
eg: clothing size

→ Numerical data :- Data that consists of amounts or quantities
eg. Height, weight

→ Qualitative Data [Categorical data]

Nominal data
* has no inherent order

Ordinal data
* falls into ordered categories

→ Quantitive data (Numerical data) : uses histogram or scatter plot

Interval data :- continuous interval : Temp
Quasi - Interval Data :- special case of Interval
Ratio Data :- Height
Year of Experience

Statistical inference :- The process of using data analysis to deduce properties of an underlying probability distributionⁿ

Methods:
* hypothesis tests
  - null hypothesis
  - Alternative hypothesis
* Confidence Intervals

→ Classification :-
- Observation :- A situation where you want to make a prediction
- Each observation has certain aspects that describe the observation, and these are called attributes
- The attributes are known and each observation belongs to a specific category which is called a class, and the class is not know,
- In classificaⁿ, the goal is to correctly predict the classes of observations using the observations attributes
- In order to make predictions, you need training data
- Training data consists of ~~see~~ observations that have already been correctly classied, analyze the training data and then build something called a classifier

- A classifier is a algorithm that helps classify future observations whose classes you do not already know

Binary classificaⁿ :- include two classes

Multiclass " :- inclued multiple classe,

K - nearest neighbour algorithm (K-NN algorithm)

The algorithm finds the most similar data points to a new, unclassified point and uses their properties to make the decision

---

- Mean
- Median
- Mode
- Range
- SD : How far data points are from each other
- Normally distributed dataset

  68% 95% 99.7%

- Sample : Subset of entire population
- Random sample each sample has some probability
- Sample size : Number of units drawn.
- Central Limit theorem : states that as more and more samples are collected, the average of all the individual samples will result in a normal distribution
- standard error : measure how big the diff might be b/w your sample average and the actual average of the entire population
- confidence interval :- will have both upper and lower limit

- Hypothesis tests :-
- bias :- Sample must be unbiased
- independence : data must be independent from other
- Systematic Sampling
- Opportunity Sampling
- Stratified Sampling
- Cluster Sampling :- all units in one cluster are homogen
- Standard error :

$$\sigma_p = \sqrt{\frac{P(1-p)}{n}}$$ standard deviation

Q 80% of customer pay with a debit or credit card, 25 customers are chosen at random each day. 68% of samples would have p-hats between:"

P = 0.80

n = 25

confidence interval = 68

- Population : entire group ; complete data set
- Sample : Subset of population
- μ - population mean
- $\bar{x}$ - Sample mean
- σ - Standard deviation (population)
  (how spread out the data in the dataset from it's mean.

$$\sqrt{\frac{(x_i - \bar{x})^2}{n}}$$

- s - Sample standard deviation $\sqrt{\frac{(x_i - \bar{x})^2}{n-1}}$
- Variance - square of S.D
- Quartiles are the values that divide a set into four equal parts
  Q_1 - first quartile
  Q_2 - Second " - Median
  Q_3 - Third "

$IQR = Q_3 - Q1$

Upper limit = $Q_1 - 1.5 * I.QR$

Lower limit = $Q_3 + 1.5 * I.Q.R$

- Covariance : These measures how two variables change together ; positive covariance and negative covariance
- Correlation : How strong is the relation b/w -1 to 1

→ using numpy and scipy

→ statistics module has mean, median, mode, stdev, variance

→ numpy.quantile()

→ numpy.percentile()

→ Hypothesis : The basic idea is to formulate a statement, or hypothesis and then use statistical tests to determine whether the evidence from your data supports or refutes it

Null hypothesis (H_0) : states that there is no effect, no diff or no relationship

Alternative hypothesis (H_1) : contradicts the null hypothesis

If $p \leq \alpha$, you reject the null hypothesis

$p > \alpha$, you ~~accept~~ fail to reject the null hypothesis ;

[not accept, lack evidence to reject it]

Percentile & Quartiles

- Using percentiles, you may estimate the percentage of the data that should fall above and below a certain value

- 1st quartile - 25th percentile
  2nd quartile, median - 50 %
  3rd Quartile - 75th percentile

  # Quartile is a type of quantile

Measures of Variability

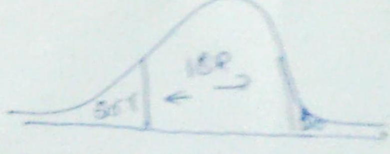
- Variability describes how far apart data points lie from each other and from the centre of distribution

- Variability is also referred to as spread, scatter or dispersion

  * Range :- the diff b/w the highest and lowest values
  * Interquartile range :- the range of the middle half of a distribution
  * Standard deviation : average dist from the mean
  * Variance : average of squared dist from the mean

Interquartile range :

* It gives you the spread of the middle of your distribution
* contains half of the values



Basic Bivariate Analysis

The analysis using two variables is referred to as Bivariate Analysis

Pearson Correlation

- Correlation is a statistical measure that expresses the extent to which two variables are linearly related
- correlation coefficient -1 to 1
  - closer to zero, the weaker relationship
  - positive value indicates a positive correlation, where the values of both variables tend to increase together
  - Negative value indicate a neg correlation, where the value of one variable tend to increase when the values of the other variable decrease

$$r = \frac{\Sigma (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\Sigma (x_i - \bar{x})^2 \, \Sigma (y_i - \bar{y})^2}}$$

Covariance

$$cov(x,y) = \frac{\Sigma (x_i - \bar{x})(y_i - \bar{y})}{n}$$

Correlation

$$\rho(x,y) = \frac{cov(x,y)}{\sigma_x \sigma_y}$$

→ Covariance measures how two variables change together. It indicates the direction of the linear relationship b/w variables

→ Correlation is a standardized version of covariance. It measures both the direction and strength of the linear relationship

→ The Central Limit Theorem (CLT) is a foundational concept states that the sampling distribution of the mean of any independent, rv will be normal or nearly normal, if the sample size is large enough

Estimation & Hypothesis Testing

-> Estimation :-

When we try to conclude about the values of statistics

-> Type of Estimate:

* Point Estimate
* Interval Estimate

-> H_0 : null hypothesis

H_1 : Alternative hypothesis

To accept H_0 we need evidance

-> Degree of Freedom

* The number of values in a statistic's final calculat that are liable to vary is known as the degree of freedom or "df"

* The entire number of measure -
  Total number of measurement limitations
  = number of degree of freedom

* $(n-1)$

The hypothesis we test or validate is called "Null hypothesis". Alternate hypothesis is the hypothesis that negates or challenges the null hypothesis

-> Different Types of Error

	Null hypothesis is True	Null hypothesis is false
Reject H_0	Type 1 Error (FP)	Correct outcome
fail to Reject H_0	Correct Outcome	Type II Error (FN)

-> Significance level and P-value

- The level where we want to fix the probability of Type-1 error is known as the level of significance or simply significance level of the test

  P(Type 1 error) = Level of Significance = alpha

- Generally, we fix the value of alpha at a very low value like 0.05 or 0.01

-> P. value:

- P value indicates given a dataset, probability is that the null hypothesis is True

- If P value is lower than significance level, then we reject the null hypothesis. Else we accept the null hypothesis

Applied Statistical Tests

- To validate some of the ideas

1, One tailed Vs Two tailed tests

2, Z tests

3, t-test

4, ANOVA

5 Chi-Square test

6 Parametric Vs Non Parametric test

One tailed Vs Two tailed tests

- One tailed & two tailed tests in hypothesis testing are alternate ways of computing the statistical significance of a parameter inferred from a dataset

- Two tailed is used when we want to know the difference b/w two things, don't have specific direction

- One tail specific ~~sp~~ direction

Z-test

- when sample size is greater than 30

1, State the null and alternative hypothesis

- compute Z statistics

- H_0 :- state there is no significant difference

  H_1 :- Opp of H_0

2, Set the significance level (α)

3, Calculate the Z-Test statistics

$$Z = \frac{\bar{x} - M}{\sigma/\sqrt{n}}$$

$\bar{x}$ - sample mean

M - population mean

σ - population s.D

n - sample-size

4, Determine the Critical Value(s) or p value

Find the critical z-value from a standard normal distribution table that corresponds to your chosen α. If your calculated z-test statistic falls into the rejection region (the tails beyond the critical value), you reject the null hypothesis

5. Compare your z-test statistic to the critical values(s) or p-value to the significance level (α).

If pvalue $\leq \alpha$, reject the null hypothesis

pvalue $> \alpha$, fail to reject the null hypothesis

t-test

- when standard deviation is not known
- we replace the population mean by sample mean
- follows a t-distribution with degree of freedom $(n-1)$
- compare the means of two group.

1. State the hypothesis

H_0 : assumes there is no significant diff b/w the group

H_1 : states that a significant diff exists

2. Choose the Right T-Test

There are three main types of t-tests

- One sample :- Compares the mean of a single sample to a known or hypothesized mean
- Independent Sample T test: Compares the means of two separate, independent groups
- Paired Sample T-Test: Compares the means from the same group at two different time (before and after)

3. Calculate The T statistic

one sample :- $T = \frac{\bar{x} - \mu}{s/\sqrt{n}}$

Two-Sample Independent :-

$$t = \frac{\bar{x}_1 - \bar{x}_2}{S_p \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

$\bar{x}_1, \bar{x}_2$ - Mean of two samples

n_1, n_2 - sizes of two samples

S_p - pooled standard deviation of the two sample

$$S_p = \sqrt{\frac{(n_1-1)s_1^2 + (n_2-1)s_2^2}{n_1+n_2-2}}$$

Paired Sample :-

$$t = \frac{\bar{d} - \mu_d}{\frac{s_d}{\sqrt{n}}}$$

$\bar{d}$ - mean of the paired difference

μ_d - Hypothesized population mean of diff (usually 0)

s_d - Standard deviation of the diff

n - Number of paired observations

4. Determine the Degrees of freedom (df)

$df = n_1 + n_2 - 2$

5. Find the Critical Value or P value

Using your degree of freedom and a chosen significance level find the critical t-value from a t-table

If your calculated t-statistic is larger than the critical t-value you reject the null hypothesis.

$$\text{Calculated}_t > \text{critical}_t \therefore \text{reject null}$$

F distribution

→ To compare two variance

1. State hypothesis

H_0 : Variances are equal

H_1 : Variances are not equal

2 Set the significance level (α)

3 Calculate the F-test statistic

$$F = \frac{S_1^2}{S_2^2}$$

S_1^2 - larger sample variance

S_2^2 - The smaller sample variance

4 Determine the Degree of freedom

Numerator degree of freedom (df_1) : $n_1 - 1$

Denominator degree of freedom (df_2) = $n_2 - 1$

5, Find the critical value or p-value

- If your calculated F-statistic is greater than the critical F-value from the table, you reject the null hypothesis

$$F_{calculated} > F_{critical} : \text{reject } H_0$$

Parametric Test	Non-Parametric Test
Z-test	Chi-square test
t-test	
ANOVA	

- Matrix

$$\begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix}_{m \times n}$$

m: rows
n: column

- rectangular matrix
- square matrix
- diagonal matrix
- symmetrical matrix $a_{ij} = a_{ji}$
- identity matrix - I $\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$ $\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$

$$D = \begin{bmatrix} 6 & 3 \\ 9 & 4 \\ 0 & 7 \end{bmatrix} \quad C = \begin{bmatrix} 1 & 2 \\ 3 & 4 \\ 11 & 31 \end{bmatrix}$$

$$D + C = \begin{bmatrix} 7 & 5 \\ 12 & 8 \\ 11 & 38 \end{bmatrix}$$

- Matrix multiplication
- Scalar multiplication

$$\underset{m \times n}{M} \times \underset{n \times r}{A} = \underset{m \times r}{D}$$

$$\underset{M}{\begin{bmatrix} -5 & -1 \\ -6 & 0 \\ 11 & 24 \end{bmatrix}} \underset{A}{\begin{bmatrix} 15 & 6 & 4 \\ 1 & 2 & 3 \end{bmatrix}} = \begin{bmatrix} (-75-1) & (-30-2) & (-20-3) \\ (-90+0) & -36 & -24 \\ 165+24 & 66+48 & 44+72 \end{bmatrix}$$

$$= \begin{bmatrix} -76 & -32 & -23 \\ -90 & -36 & -24 \\ 189 & 114 & 116 \end{bmatrix}$$

A.M

$$\begin{bmatrix} 15 & 6 & 4 \\ 1 & 2 & 3 \end{bmatrix} \begin{bmatrix} -5 & -1 \\ -6 & 0 \\ 11 & 24 \end{bmatrix}$$

$$= \begin{bmatrix} -75-36+44 & -15+0+96 \\ -5-12+33 & -1+0+72 \end{bmatrix}$$

$$= \begin{bmatrix} -67 & 81 \\ 16 & 71 \end{bmatrix}$$

- Transpose (A^T)

$$A = \begin{bmatrix} 1 & 2 & 3 & 4 \\ 7 & 8 & 9 & 10 \end{bmatrix}_{2 \times 4}$$

$$A^T = \begin{bmatrix} 1 & 7 \\ 2 & 8 \\ 3 & 9 \\ 4 & 10 \end{bmatrix}_{4 \times 2}$$

- $M = M^T$; then it's a symmetric matrix
- Determinant : only applicable only for square matrix

$$M = \begin{bmatrix} 10 & 12 \\ 9 & 7 \end{bmatrix}$$

$$= [70 - 108]$$

$$|M| = -38$$

- Invease of matrix

$MM^{-1} = I$

- M^{-1} doesnot exist when $|M| = 0$

- $A = \begin{bmatrix} 2 & 0 \\ 0 & 3 \end{bmatrix}$ $\quad V = \begin{bmatrix} 2 \\ 0 \end{bmatrix}$ $\quad u = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$ $\quad w = \begin{bmatrix} 1 \\ 1 \end{bmatrix}$

$$A.V = \begin{bmatrix} 2 \\ 0 \end{bmatrix}$$

$$A.u = \begin{bmatrix} 0 \\ 3 \end{bmatrix}$$

$$A.w = \begin{bmatrix} 2 \\ 3 \end{bmatrix}$$

- Eigen vector
- Eigen value

$AV = 2V$

2 - eigenvalue

$AV = \lambda . V$

λ = eigen value

V - eigen vector

$A v = \lambda . v$

$(A . v) - (\lambda . v) = 0$

$(A - \lambda I) V = 0$

$A - \lambda I = 0$ and V is non-zero

$|(A - \lambda I)| = 0$

Q find eigen value of $\begin{bmatrix} 1 & 4 \\ 3 & 2 \end{bmatrix}$

$$\begin{bmatrix} 1 & 4 \\ 3 & 2 \end{bmatrix} - \lambda \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} 1 & 4 \\ 3 & 2 \end{bmatrix} - \begin{bmatrix} \lambda & 0 \\ 0 & \lambda \end{bmatrix}$$

$$= \begin{matrix} 1-\lambda & 4 \\ 2 & 2-\lambda \end{matrix}$$

[illegible]

$$\begin{vmatrix} -\lambda & 1 \\ 1 & -\lambda \end{vmatrix} = 0$$

$(-\lambda)^2 - 1 = 0$

$\lambda^2 - 1 = 0$

$\lambda = \pm 1$

eigen values are +1 and -1

$(A - \lambda I)v = 0$

when $\lambda = 1$

$$\begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix} - \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \times \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = 0$$

$$\begin{bmatrix} -1 & 1 \\ 1 & -1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = 0$$

$-x_1 + x_2 = 0$

$x_1 - x_2 = 0$

$x_1 = x_2$

$\cancel{x_1 \begin{bmatrix} 1 \\ 0 \end{bmatrix} + x_2 \begin{bmatrix} 0 \\ 1 \end{bmatrix}}$

$x_1 \begin{bmatrix} 1 \\ 1 \end{bmatrix}$

$\lambda = -1$

$$\begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix} - \begin{bmatrix} -1 & 0 \\ 0 & -1 \end{bmatrix} \times \begin{bmatrix} y_1 \\ y_2 \end{bmatrix} = 0$$

$$\cancel{\begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}} \begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix} \begin{bmatrix} y_1 \\ y_2 \end{bmatrix} = 0$$

$y_1 + y_2 = 0$

$y_1 + y_2 = 0$

$y_1 = -y_2$

$\cancel{y_1 \begin{bmatrix} 1 \\ 0 \end{bmatrix} + y_2 \begin{bmatrix} 0 \\ +1 \end{bmatrix}}$

$y_1 \begin{bmatrix} 1 \\ -1 \end{bmatrix}$

2 $M = \begin{bmatrix} 2 & 1 \\ 0 & 2 \end{bmatrix}$

$$\begin{bmatrix} 2 & 1 \\ 0 & 2 \end{bmatrix} - \lambda \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} 2 & 1 \\ 0 & 2 \end{bmatrix} - \begin{bmatrix} \lambda & 0 \\ 0 & \lambda \end{bmatrix}$$

$$= \left| \begin{bmatrix} 2-\lambda & 1 \\ 0 & 2-\lambda \end{bmatrix} \right| = 0$$

$= (2-\lambda)(2-\lambda) - 0 = 0$

$4 - 2\lambda - 2\lambda + \lambda^2 - \cancel{1} = 0$

$\lambda^2 - 4\lambda + 4 = 0$

$\lambda = 2$

eigen value = 2

when $\lambda = 2$

$$\begin{bmatrix} 2 & 1 \\ 0 & 2 \end{bmatrix} - \begin{bmatrix} 2 & 0 \\ 0 & 2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = 0$$

$$= \begin{bmatrix} 0 & 1 \\ 0 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = 0$$

$x_2 = 0$

$\cancel{\begin{bmatrix} x_1 \\ 1 \end{bmatrix}} \begin{bmatrix} 1 \\ 0 \end{bmatrix}$

Pillar of D.S

1. Lin. of algebra
2. Prob of statistics
3. Calculus
4. Comp. Science

Probability

- Sample space:
- Event ⇒ get an outcome from sample space
- Probability ⇒ chance of occurence of event

$$= \frac{(\text{Event})\text{ count}}{\text{Sample count}}$$

Event
- Dependent
- Independent

- Joint Probability ; Marginal probability ; Conditional probability

$p(c) = \frac{15}{32}$ $p(T) = \frac{17}{32}$

$P(m) = \frac{2}{32}$ $p(n) = \frac{30}{32}$

	M	N	
C	$\frac{30}{(32)^2}$	$\frac{450}{(32)^2}$	$\frac{480}{(32)^2}$
T	$\frac{34}{(32)^2}$	$\frac{(17)30}{(32)^2}$	$\frac{17(32)}{32 \times 32}$
	$64/(32)^2$	$960/(32)^2$	

$P(T) = P(T,M) + P(T,N)$

$= \frac{34}{32^2} + \frac{17(30)}{(32)^2}$

Spec = 9 WS = 23

girls = 15 B = 17

	S	WS
G	$\frac{9}{32} \times \frac{15}{32}$	$\frac{23}{32} \times \frac{15}{32}$
B	$\frac{9}{32} \times \frac{17}{32}$	$\frac{23}{32} \times \frac{17}{32}$
	$\frac{135}{(32)^2} + \frac{153}{(32)^2}$	$\frac{345}{(32)^2} + \frac{391}{(32)^2}$

$P(G, Sp) = \frac{135}{(32)^2}$

$P(G, WS) = \frac{345}{(32)^2}$

$P(B, S) = \frac{153}{(32)^2}$

$P(B, WS) = \frac{391}{(32)^2}$

Conditional probability:-

$$P(R/C) = \frac{P(R \cap C)}{P(C)}$$

$$P(C/R) = \frac{P(C \cap R)}{P(R)}$$

$P(R \cap C) = P(R|C) \times P(C)$

$P(C \cap R) = P(C|R) \times P(R)$

$P(R|C) \times P(C) = P(C|R) \times P(R)$

$$P(R|C) = \frac{P(C|R) \times P(R)}{P(C)}$$

Baye's theorem | Baye's rule

$$P(A|B) = \frac{P(B|A) \times P(A)}{P(B)}$$

$P(B)$ - Prior

$P(B|A)$ - Likelihood

$P(A|B)$ - posterior

$P(B)$ - evidence.

$P(R) = 0.75$

$P(R') = 0.25$

Rainy	not raining
$P(C/R) = 0.6$	$P(C/R') = 0.1$
$P(C'/R) = 0.4$	$P(C'/R') = 0.9$

$$P(R|C) = \frac{P(C|R) \times P(R)}{P(C)}$$

$$= \frac{0.6 \times 0.75}{P(C)}$$

$P(C|R) = 0.6$

$P(C/R') = 0.1$

$P(C) = ?$

$$P(C/R) = \frac{P(C \cap R)}{P(R)}$$

$$P(C/R') = \frac{P(C \cap R')}{P(R')}$$

$P(C \cap R)$

	R	R'
C	$P(C \cap R)$	$P(C \cap R')$
C'	$P(C' \cap R)$	$P(C' \cap R')$

$P(C \cap R) + P(C \cap R') = P(C)$

$$P(C/R) = \frac{P(C \cap R)}{P(R)}$$

$$P(C/R') = \frac{P(C \cap R')}{P(R')}$$

$P(C) = P(C/R) \cdot P(R) + P(C/R') P(R')$

$= 0.6 \times 0.75 + 0.1 \times 0.25$

$= 0.475$

$$P(R|C) = \frac{0.6 \times 0.75}{0.475} = 0.947$$

LINEAR ALGEBRA

→ Algebra is a branch of mathematics in which arithmetical operations and formal manipulⁿ are applied to abstract symbols rather than specific numbers

→ Linear Algebra is a branch of mathematics that lets you concisely describe coordinates and interactions of planes in higher dimensions and perform operaⁿ on them

→ study of vectors and linear functions

→ main building blocks are linear equⁿ,
vectors and matrices
linear transformⁿ,
determinents and vector spaces

Imp Applications:
1) Data set and Data files
2) Images and Photographs
3) Data Preparation ; One hot Encoding

The process of converting catagorical data into a numerical format that machine learning algorithm can understand

4) Linear Regression
5) Regularization
6) Principal Component Analysis
7) Latent Semantic Analysis
8) Recommender Systems
9) Deep Learning

Vectors :- is a one-dimensional array of numbers
* dimensionality: the no: of elements in the vector
* orientation: column orientation or row orientation

$$x = \begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix} \qquad y = \begin{bmatrix} 1 & 2 & 3 \end{bmatrix}$$

3D column vector   3D row vector

```
vectorAsList = [1,2,3,4,5]
vectorAsArray = np.array([1,2,3,4,5])
rowVector = np.array([[1,2,3,4,5]])
columnVector = np.array([[1]])
               np.array([[1],[2],[3],[4],[5]])
```

Dot multiplication

$a \cdot b = b \cdot c$

$a \cdot (b+c) = a \cdot b + a \cdot c$

$$a \cdot b = \sum_{i=1}^{n} a_i b_i$$

$\vec{a} = [1, 2, 3, 4, 5]$

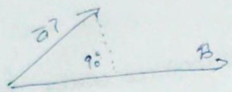
$\vec{b} = [6, 7, 8, 9, 10]$

$a \cdot b = 1 \cdot 6 + 2 \cdot 7 + 3 \cdot 8 + 4 \cdot 9 + 5 \cdot 10$

$= 130$

Magnitude = np.norm(a)

Vector projection of a vector a onto a vector b



formula: $proj_b a = \frac{a.b}{||b||^2} b$

Vector projection is the process of finding how much of one vector, a, is in the direction of another vector b. You can think of it as the shadow that vector a cast onto a line defined by vector b. The result of a vector projection is another vector that points in the same direction of b, but with a length equal to the shadow

Basic vectors

-> e_1 and e_2 are called unit vectors along the x-axis and y-axis (1, 0) (0, 1)

-> any vector can be represented uniquely as a combination of ~~unique~~ basic. unit vector

-> Unit vectors or basics vectors form a basis for space

-> Any vector in space can be written as linear combin of these two vectors.

-> If dot product are zero, then orthogonal

$e_1 = [1, 0]$

$e_2 = [0, 1]$

$v = [2, 3]$

$\cdot\ 2[1, 0] \quad 3[0, 1]$

new basis

$b_1 = [1, 1]$ $\quad [2, 3]$

$b_2 = [-1, 1]$

find new coordinates of vector v in this new basis

Projection v onto b_1

$$Proj_{b_1} v = \frac{v.b_1}{||b_1||^2}$$

$v.b_1 = (2)(1) + 3(1) = 5$

$||b_1||^2 = 1^2 + 1^2 = 2$

$c_1 = 5/2 = 2.5$

$$Proj_{b_2} v = \frac{v.b_2}{||b_2||^2} =$$

$v \cdot b_2 = (2)(-1) + (3)(1) = 1$

$||b_2||^2 = (-1)^2 + 1^2 = 2$

$c_2 = 1/2 = 0.5$

$V_{new} = [c_1, c_2] = [2, 5, 0.5]$

Spanning Set:

Types of matrix transformation:-

Scaling

Inversion $\begin{bmatrix} -1 & 0 \\ 0 & -1 \end{bmatrix}$

Rotation $\begin{bmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{bmatrix}$ } rotation matrix