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# Addition Laws:

If $A$ and $B$ are any two events defined in a Sample Space, then

$$P(A \cup B) = P(A) + P(B) - P(A \cap B).$$

**Proof:**

The event $A \cup B$ may be written as the union of two mutually exclusive events $A$ and $B \cap \bar{A}$. that is:

$$A \cup B = A \cup (B \cap \bar{A}).$$

Apply Probability on both Side

$$P(A \cup B) = P(A) + P(B \cap \bar{A}) \longrightarrow eq\ (i)$$

$P(B \cap \bar{A})$

Again event $B$ may be decomposed into Two mutually exclusive events.

$$B = (A \cap B) \cup (B \cap \bar{A})$$

Apply probability

$$P(B) = P(A \cap B) + P(B \cap \bar{A}) \rightarrow eq\ (ii)$$

$$P(A \cup B) - P(B) = P(A) + P(B \cap \bar{A}) - P(A \cap B)$$

$$P(A \cup B) = P(A) + P(B) - P(A \cap B).$$

1 head occur?

The SS for this exp is

$S = \{HHH, HHT, HTH, THH, HTT, THT, TTH, TTT\}$.

$n(S) = 8$

let A represent event that at least one head occurs.

$\bar{A}$ is the event that no head occur.

$\bar{A} = \{TTT\}$

$n(\bar{A}) = 1$

$P(A) = 1 - P(\bar{A})$

$1 - \boxed{\frac{1}{8}} = \frac{7}{8}$.

**Question:**

17 one card is selected at random from a deck a 52 playing card, what is the probability that card is club or a face card or both

The SS for this exp is

$S = \binom{52}{1} = 52$

$n(S) = 52$

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$S = \{(1,1), (1,2), (1,3), (1,4), (1,5), (1,6)$
$(2,1), (2,2), (2,3), (2,4), (2,5), (2,6)$
$(3,1), (3,2), (3,3), (3,4), (3,5), (3,6)$
$(4,1), (4,2), (4,3), (4,4), (4,5), (4,6)$
$(5,1), (5,2), (5,3), (5,4), (5,5), (5,6).$
$(6,1), (6,2)$ ... $(6,6)\}.$

let A be the event

$A = \{(1,4), (2,3), (3,2), (4,1)\}$

$n(A) = 4.$

let B be the event

$B = \{(6,5), (5,6)\}$

$n(B) = 2$

$P(A \cup B) = P(A) + P(B) - P(A \cap B)$

$= \frac{4}{36} + \frac{2}{36} - 0$

$= \frac{6}{36}$

$P(A \cup B) = \frac{1}{6}.$

Question:

$(3,1), (3,2), (3,3), (3,4), (3,5), (3,6)$

$(4,1), (4,2), (4,3), (4,4), (4,5), (4,6)$

$(5,1), (5,2), (5,3), (5,4), (5,5), (5,6).$

$(6,1), (6,2)$ ---------- $(6,6)\}.$

let A be the event

$A = \{(1,4), (2,3), (3,2), (4,1)\}$

$n(A) = 4.$

let B be the event

$B = \{(6,5), (5,6)\}$

$n(B) = 2$

$P(A \cup B) = P(A) + P(B) - P(A \cap B)$

$= \frac{4}{36} + \frac{2}{36} - 6$

$= \frac{6}{36}$

$P(A \cup B) = \frac{1}{6}.$

**Question:**

A class contain 10 men and 20 women's of which half women's have brown eyes Find the probability that a person choose at random is a men has brown eyes?

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**Question:** Two coin are Toss. Find the Probability of (i) both are heads (ii) Both faces are Same (iii) only 1 is head. (iv) atleast one is head on the first coin.

| | H | T |
|---|---|---|
| H | HH | HT |
| T | TH | TT |

$S = \{HH, HT, TH, TT\}$.

(i) Both are heads.

let A be the event that both are head

$n(A) = 1$

$P(A) = \frac{n(A)}{n(S)} = \frac{1}{4}$

(ii) Both faces are Same.

let B are the event that both faces are Same.

$P(B) = \frac{n(B)}{n(S)} = \frac{2}{4} = 2.$

(iii) Only one is head.

let C is the event that only one is head.

$P(C) = \frac{n(C)}{n(S)}$

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$= \frac{2}{4} = 2.$

(iv) Atleast one is head.

let D is the event that atleast one is head.
$\{HH, HT, TH\}$.

$$P(D) = \frac{n(D)}{n(S)} = \frac{3}{4}.$$

(v) head on the first coin.

let E be the event that head on the first coin.

$$n(E) = \frac{n(E)}{n(S)}$$

$$= \frac{4}{2} = 2.$$

**Question:**

A card is selected from a deck of 52 playing card. Find the probability.

(i) The card is red.
(ii) The card is king.
(iii) The card is of diamond.
(iv) The card is king or queen.
(v) It is a face card.

The SS for this exp is

$$S = \binom{30}{1} = 30$$

let A represent the Person chosen, is a man.

$n(A) = 10$ men

$$P(A) = \frac{10}{30}$$

let B be the event that Person has brown eyes.

$$P(B) = \frac{15}{30}$$

$B = \{(6,5), (5,6)\}$

$n(B) = 2$

$$P(A \cup B) = P(A) + P(B) - P(A \cap B)$$

$$= \frac{10}{30} + \frac{15}{30} - \frac{5}{30}$$

$$P(A \cup B) = \frac{2}{3}.$$

Question:

Let A represent the event that card is club

$$P(A) = \frac{n(A)}{n(S)}$$

$$P(A) = \frac{13}{52} = \boxed{0.25}$$

let B represent the event that card is face card.

$$P(B) = \frac{n(B)}{n(S)} = \frac{12}{52}$$

$$\boxed{= 0.2}$$

$$n(A \cap B) = 3$$

$$P(A \cup B) = P(A) + P(B) + P(B) - P(A \cap B)$$

$$= \frac{13}{52} + \frac{12}{52} = \frac{3}{52}.$$

**Question:**

A Pair of dice thrown find the Probability of getting a total of either 5 or 11.

The SS for this exp is

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## Question:

A coin is Toss 3 Times in Succession what is the Probability that atleast 1 head occur?

The SS for this exp is:

$S = \{HHH, HHT, HTH, THH, HTT, THT, TTH, TTT\}$.

$n(S) = 8$

let A represent event that at least one head occurs.

$\bar{A}$ is the event that no head occur.

$\bar{A} = \{TTT\}$

$n(\bar{A}) = 1$

$P(A) = 1 - P(\bar{A})$

$1 - \boxed{\frac{1}{8}} = \frac{7}{8}$.

## Question:

17 one card is selected at random from a deck a 52 playing card, what is the Probability that card is club or a face card or both

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The SS is for the experiment.

$$S = \binom{52}{1} = 52.$$

$$n(S) = 52.$$

(i) The card is red.

let A be the event that card is red.

$$A = \binom{13}{52} \quad P(A) = \frac{26}{52}$$

$$\frac{n(A)}{n(S)} = 0.25.$$

(ii) The card is King.

let B be the event that card is king.

$$P(B) = \binom{4}{52} = 0.076$$

(iii) The card is of diamond.

let C be the event that card is diamond.

$$n(C) = 13$$

$$P(C) = \frac{n(C)}{n(S)} = \frac{13}{52} = 4.$$

# Conditional Probability:

The likely hood of an event or outcome occuring, based on the occurance of a previous event or outcome. is called conditional probability

## Example:

we assume that today is 40%. chance of raining but this fact condition on many things, Such as the Probability of.

i) A cold front coming to your area

ii) Rain clouds fooming.

Another front pushing the rain clouds a way.

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

$$P(A \cap B) \frac{n(A \cap B)}{n(S)} \Rightarrow P(A) = \frac{n(A)}{n(S)}.$$

## Question:

Two coins are Toss? what is conditional Probability that Two heads result, given

The likely hood of an event or outcome occuring, based on the occurance of a previous event or outcome. is called Conditional Probability

**Example:**

we assume that today is 40% chance of raining but this fact condition on many things, Such as the Probability of.

i) A cold front coming to your area
ii) rain clouds forming.
Another front Pushing the rain clouds a way.

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

$$P(A \cap B) \; \frac{n(A \cap B)}{n(S)} \quad \Rightarrow \quad P(A) = \frac{n(A)}{n(S)}.$$

**Question:**

Two coins are toss? what is conditional Probability that Two heads result, given that their is atleast one head.?

that (i) the Sum is odd.

(ii) the Sum is greater than six.

(iii) the Two dice had the Same outcomes

The SS experiment is

$S = \{(1,1), (1,2), (1,3), (1,4), (1,5), (1,6)$

$(2,1), (2,2), (2,3), (2,4), (2,5), (2,6)$

$(3,1), (3,2), (3,3), (3,4), (3,5), (3,6)$

$(4,1), (4,2), (4,3), (4,4), (4,5), (4,6)$

$(5,1), (5,2), (5,3), (5,4), (5,5), (5,6)$

$(6,1), (6,2), (6,3), (6,4), (6,5), (6,6)\}.$

$n(S) = 36.$

let A be the event that the Sum is 7.

$n(A) = \{(1,6), (2,5), (3,4), (4,3), (5,2), (6,1)$

$n(A) = 6.$

let B be the event that Sum is odd.

sum is odd.

(ii) the sum is greater than six.

(iii) the two dice had the same outcomes.

The SS experiment is

$S = \{(1,1), (1,2), (1,3), (1,4), (1,5), (1,6)$
$(2,1), (2,2), (2,3), (2,4), (2,5), (2,6)$
$(3,1), (3,2), (3,3), (3,4), (3,5), (3,6)$
$(4,1), (4,2), (4,3), (4,4), (4,5), (4,6)$
$(5,1), (5,2), (5,3), (5,4), (5,5), (5,6)$
$(6,1), (6,2), (6,3), (6,4), (6,5), (6,6)\}.$

$n(S) = 36.$

let A be the event that the sum is 7.

$n(A) = \{(1,6), (2,5), (3,4), (4,3), (5,2), (6,1)\}$

$n(A) = 6.$

let B be the event that sum is odd.

$n(B) = 18.$

let C be the event that sum is greater than six.

$C \{(1,6), (2,5), (2,6), (3,4)\ (3,5), (3,6)$
$(4,3), (4,4), (4,5), (4,6)\ (5,2)\ (5,3)\ (5,4)$
$(5,5), (5,6), (6,1)\ (6,2)\ (6,3)(6,4), (6,5)(6,6)$

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Question:

what is the Probability that a random Selected a ~~Focal Land~~. Poker ~~Copper~~ hand contain ~~atleast~~ exactly 3 aces given that it contain atleast 2 aces.

$N = 52$

$k = 4$

$n = 5$

$$p(x=n) \; \frac{\binom{k}{x}\binom{N-k}{n-x}}{\binom{N}{n}}$$

$$P(A) = P(x=3) \; \frac{\binom{4}{3}\binom{52-4}{5-3}}{\binom{52}{5}}$$

$$P(A) = \frac{\binom{4}{3}\binom{48}{2}}{\binom{52}{5}}$$

let B be the event that at least 2 aces are Selected.

$$P(B) = \frac{\binom{4}{2}\binom{48}{3}}{\binom{52}{5}} + \frac{\binom{4}{3}\binom{48}{2}}{\binom{52}{5}} + \frac{\binom{4}{4}\binom{48}{1}}{\binom{52}{5}}$$

$$P(A \cap B) \; \frac{\binom{4}{3}\binom{48}{2}}{\binom{52}{5}}$$

# TESTING hypothesis of Independence (categorical data)

## General Procedure:

Null hypothesis: $H_0$: The Two variable of classification are independent

Alternative hypo: $H_1$: The two variables of classification are not independent

level of Significance:

$\alpha = 5\%, 1\%$ or etc.

Test Statistic:

$$\chi^2 = \frac{(ad-bc)^2(a+b+c+d)}{(a+c)(b+d)(a+b)(c+d)} \text{ with } 1 \text{ d.f}$$

Critical Region:

Reject $H_0$ if $\chi^2_{(cal)} \geq \chi^2_{\alpha(1)}$

Calculation:

Conclusion:

Question: A random Sample of 250 men

5. Calculation:

$$\chi^2 = \frac{[(80)(130)-(120)(170)]^2(80+120+170+130)}{(250)(250)(200)(300)}$$

$$\chi^2 = 13.33$$

: The two variable of classif[illegible]
not independent.

**level of Significance:**

$$\alpha = 0.05$$

**Test Statistic:**

$$\chi^2 = \frac{(ad - bc)^2 (a+b+c+[illegible]}{(a+c)(b+d)(a+b)(c[illegible]}$$

**Critical Region:**

Reject Ho if

$$\chi^2_{(cal)} \geq \chi^2_{(0.05)(1)}$$

$$\chi^2_{(cal)} \geq 3.84.$$

| Classification | Men | women | Total |
|---|---|---|---|
| want television | 80 | 120 | 200 |
| Don't want television | 170 | 130 | 300 |
| Total | 250 | 250 | 500. |

Test the hypothesis that desire to own a Television set in independent of sex at th

5% level of

Null $H_0$: The two variables of classification are independent.

$H_1$: The two variable of classification are not independent.

level of significance:

$$\alpha = 0.05$$

Test Statistic:

$$\chi^2 = \frac{(ad - bc)^2 (a+b+c+d)}{(a+c)(b+d)(a+b)(c+d)}$$

## General Procedure:

Null hypothesis: $H_0$: The Two variable of classification are independent

Alternative hypo: $H_1$: The two variables of classification are not independent.

level of Significance:

$\alpha = 5\%, 1\%$ or etc.

Test Statistic:

$$\chi^2 = \frac{(ad-bc)^2 (a+b+c+d)}{(a+c)(b+d)(a+b)(c+d)} \text{ with } 1 \text{ d.f}$$

Critical Region:

Reject $H_0$ if $\chi^2_{(cal)} \geq \chi^2_{\alpha(1)}$

calculation:

Conclusion:

Question: A random Sample of 250 men and 250 women were Polled as to their desire concerning the ownership of television sets. The following data resulted

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

$$= \frac{\binom{4}{3}\binom{48}{2} \Big/ \cancel{\binom{52}{5}}}{\dfrac{\binom{4}{2}\binom{48}{3} + \binom{4}{3}\binom{48}{2} + \binom{4}{4}\binom{48}{0}}{\cancel{\binom{52}{5}}}}$$

$$= \frac{4512}{108336} \Rightarrow 0.0416.$$

estion:

$n(C) = 21.$

let D be the event the outcomes have Same.

$D = \{(1,1), (2,2), (3,3), (4,4), (5,5), (6,6)\}$

$n(D) - 6.$

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

$$= \frac{6/36}{18/36} = \frac{1}{3}$$

$$P(A|C) = \frac{P(A \cap C)}{P(C)} = \frac{6/36}{21/36} = \frac{6}{21}.$$

$$P(A|D) = \frac{0}{6/36} = 0$$

$n(A \cap D) = 0.$

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The SS of this experiment is:

$S = \{HH, HT, TH, TT\}$.

Let A be the event that Two head occur:

$A = \{HH\}$

$n(A) = 1$

Let B be the event that atleast one head occur.

$B = \{HH, HT, TH\}$.

$n(B) = 3$

$A \cap B = \{HH\}$

$(A \cap B) = 1$

$$P(A \cap B) = \frac{1}{4} = \frac{n(A \cap B)}{n(S)}$$

$$P(B) = \frac{3}{4} = \frac{n(B)}{n(S)}$$

$$P(A|B) = \frac{1/4}{3/4} = 1/3.$$

Question:

A man Toss Two fair dice. what is the conditional Probability that the sum of dice will be 7. will be given

The SS of this experiment is:

$S = \{HH, HT, TH, TT\}$.

Let A be the event that Two head occur:

$A = \{HH\}$

$n(A) = 1$

Let B be the event that atleast one head occur.

$B = \{HH, HT, TH\}$.

$n(B) = 3$

$A \cap B = \{HH\}$

$(A \cap B) = 1$

$$P(A \cap B) = \frac{1}{4} = \frac{n(A \cap B)}{n(S)}$$

$$P(B) = \frac{3}{4} = \frac{n(B)}{n(S)}$$

$$P(A|B) = \frac{1/4}{3/4} = 1/3.$$

# #12: DEFINITIONS

## Point Estimate:

A Point estimate is a number representing an estimate of the population parameter based on a Sample.

## Interval Estimate:

An Interval estimate is the range of values within which the value of the parameter is expected to lie.

## Error of estimation:

The distance between an estimate and the estimated parameter is called error of estimation.

## Unbiased Estimation:

An estimator is unbiased if its expected value is equal to the Population Parameter being estimated.

called confidence limits.

## Level of Confidence:

The probability that the population parameter is included within the confidence interval is called the level of confidence.

## Degree of Freedom:

Degree of freedom is the number of values that are free to vary after we have placed certain restricitions upon the data.

## Statistical Inference:

The process in which we make conclusion about a population based on sample information collected from the population.

## Estimation:

Estimation is the process by which we attempt to determine the value of a population parameter from sample informat

## Estimate:

## Confidence Interval:

A confidence interval is a range of value within which the population parameter is expected to occur.

## Confidence Limits:

The two endpoints of a confidence interval are called confidence limits.

The distance between an estimate and the estimated parameter is called error of estimation.

## Unbiased Estimation:

An estimator is unbiased if its expected value is equal to the population parameter being estimated.

## Biased Estimator:

If the mean of the estimator is not equal to the population parameter. the estimator is said to be biased.

a population parameter from sample information

## Estimate:

An estimate is the numerical value of the estimator.

## Estimator:

An estimator is a statistic that specifies how to use the sample data to estimate an unknown parameter of the population.

is a normal distribution with a mean of zero and standard deviation of 1.

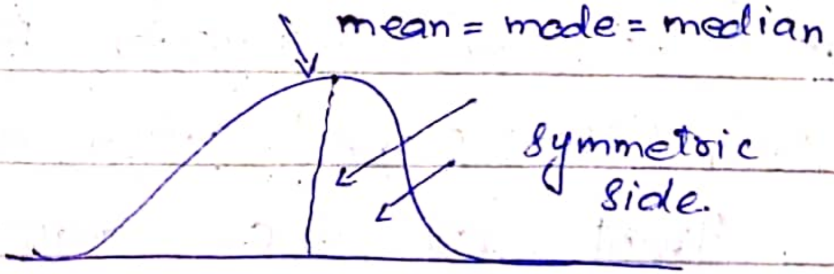
## Properties of Normal ------

=> The mean, median, and mode are exactly the same.

=> It is symmetric A normal distribution comes with a perfectly shape.

## Normal Distribution:

is a probability distribution that is Symmetric about the mean, Showing that data near the mean are more frequent in occurrence than data far from the mean.




## Standard Normal distribution:

The Standard normal distribution is a normal distribution with a mean of zero and Standard deviation of 1.