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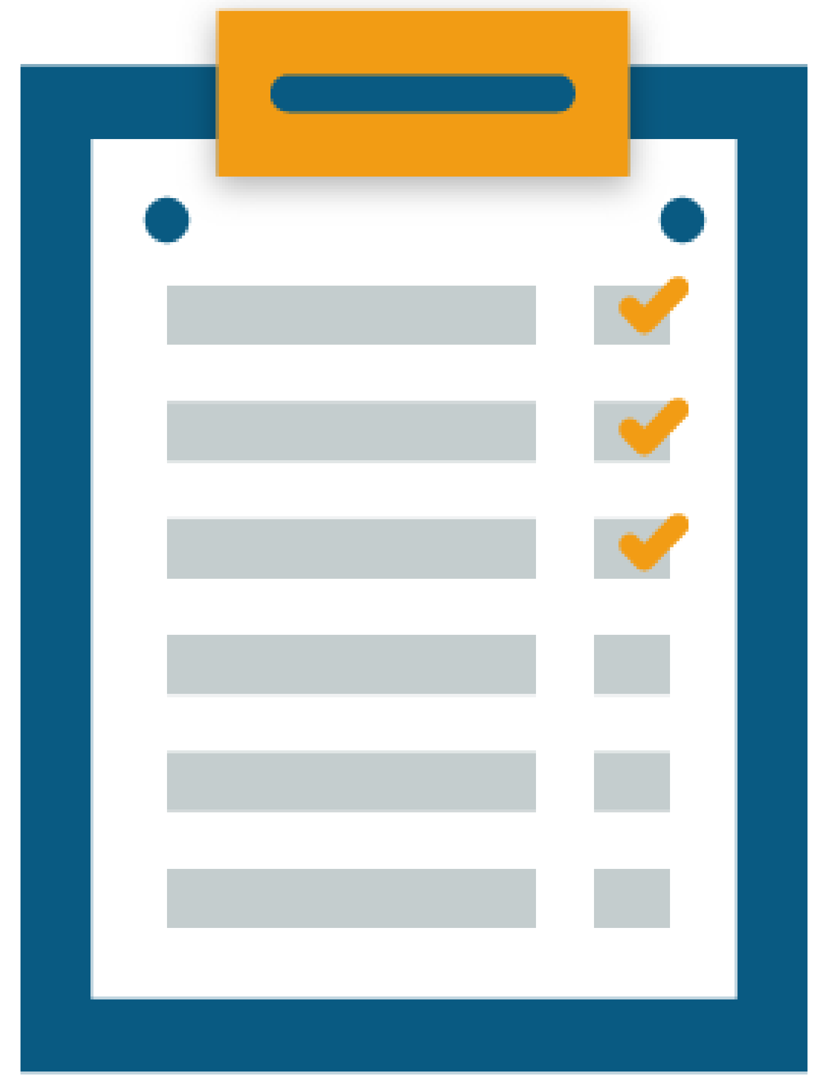
Predictive Analytics

COURSE OUTLINE
MODULE 02

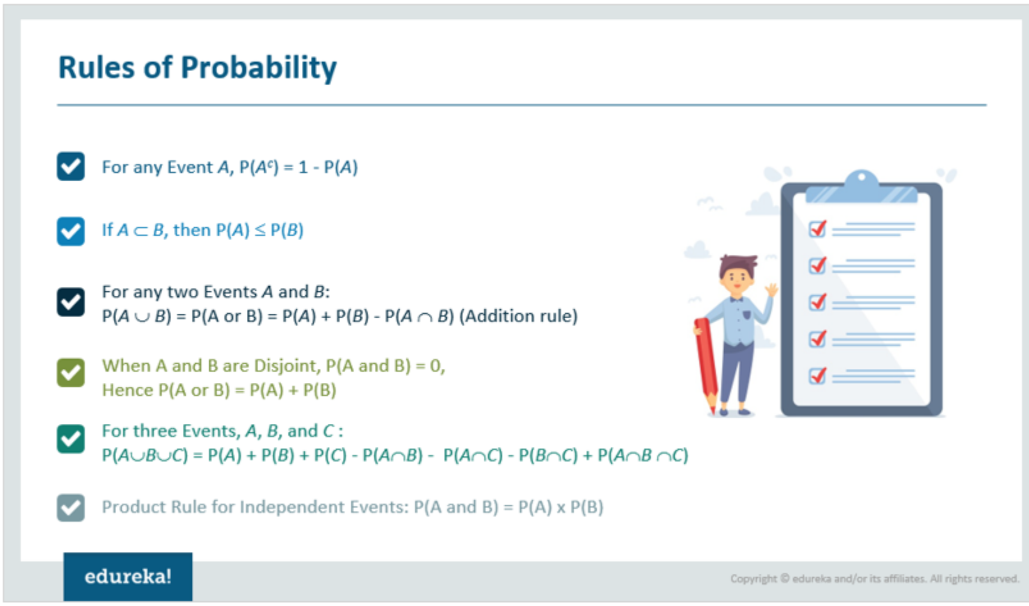
1. Statistical Foundations
2. Probability
3. Inferential Statistics
4. Regression

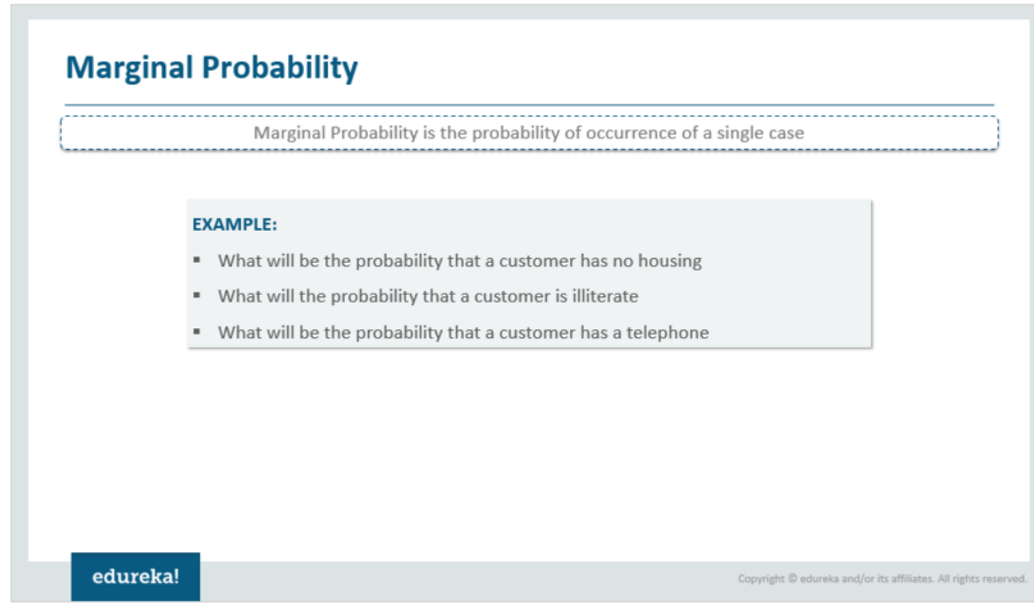
Topics

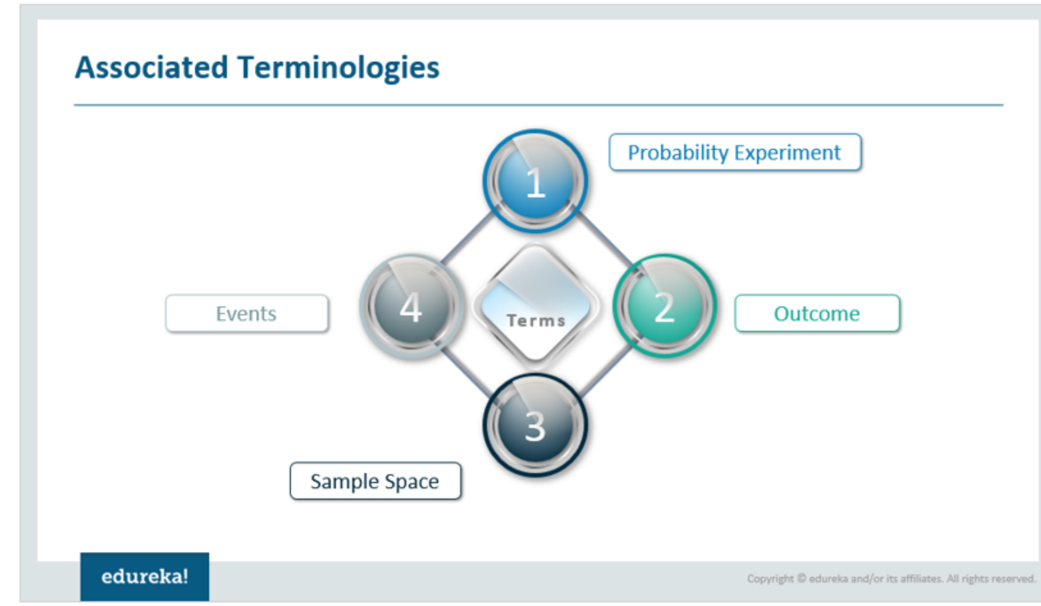
- Conditional Probability
- Random Variables
- Probability Distribution Functions
- Types of Probability Distribution Functions

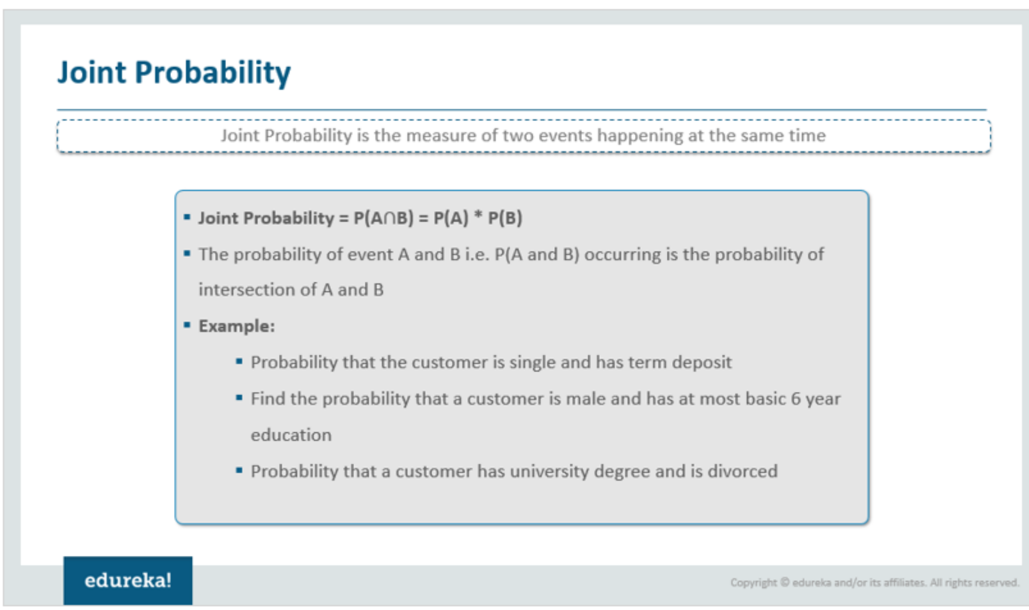


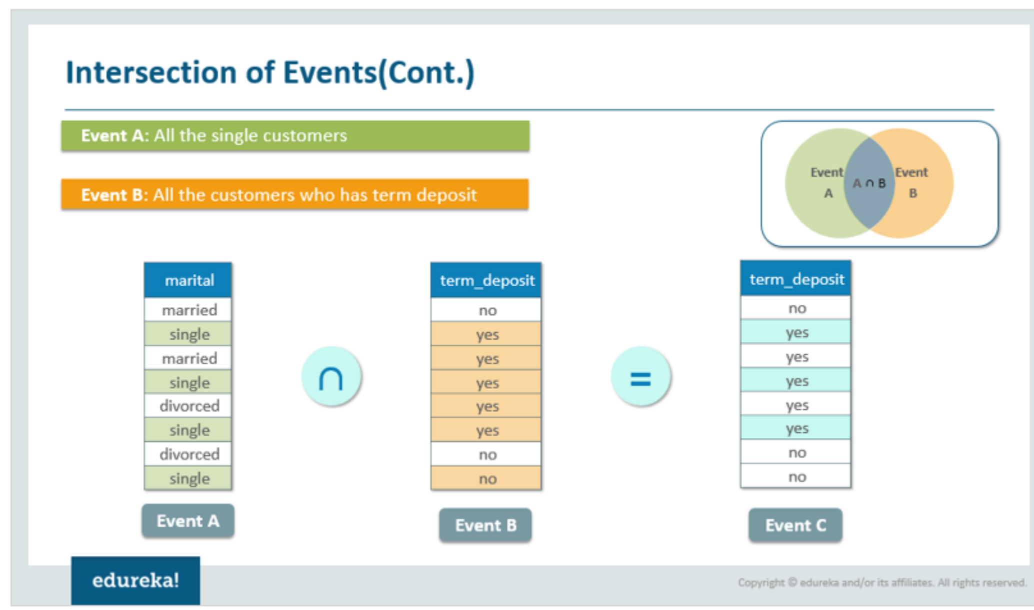
Part – I: Recap

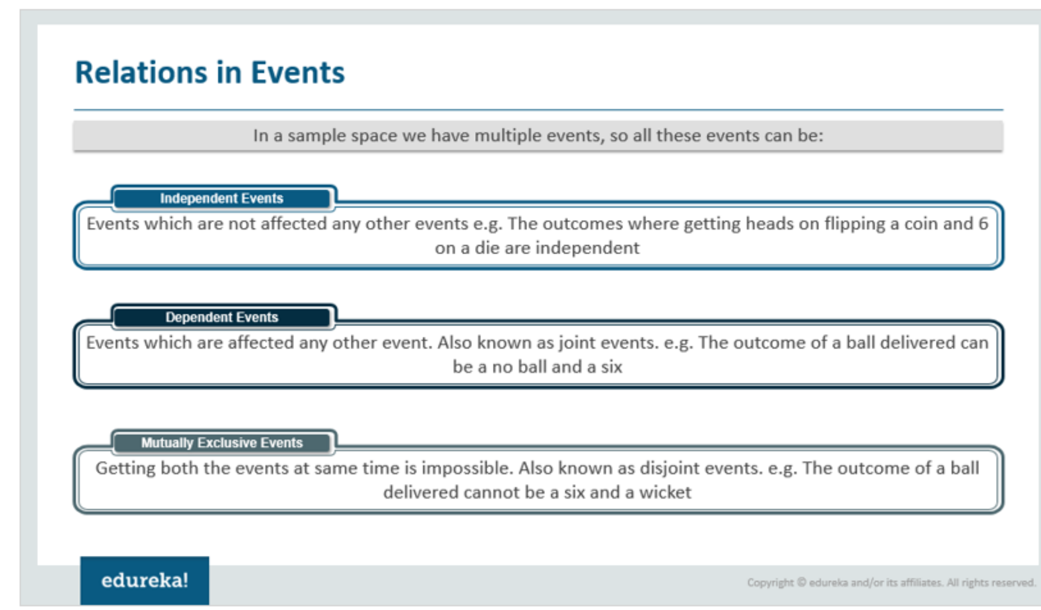












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Part – II
Section – I

Video: Conditional Probability

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Conditional Probability

Conditional probability of an event A is the probability that the event will occur given the knowledge that an event B has already occurred

Conditional Probability of event A based on event B

Dependent Events

If A and B are dependent events then the expression for conditional probability is given by:

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

Independent Events

If A and B are independent events then the expression for conditional probability is given by :

$$P(A|B) = P(A)$$

- **Example:**
  - If a customer has university degree, what will be probability that he is a male
  - Given that the customer has taken term deposit, find the probability that he/she is married
  - If a customer has a blue collar job, find the probability that he has housing

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Section – I
Quiz

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ALICE's QUESTION

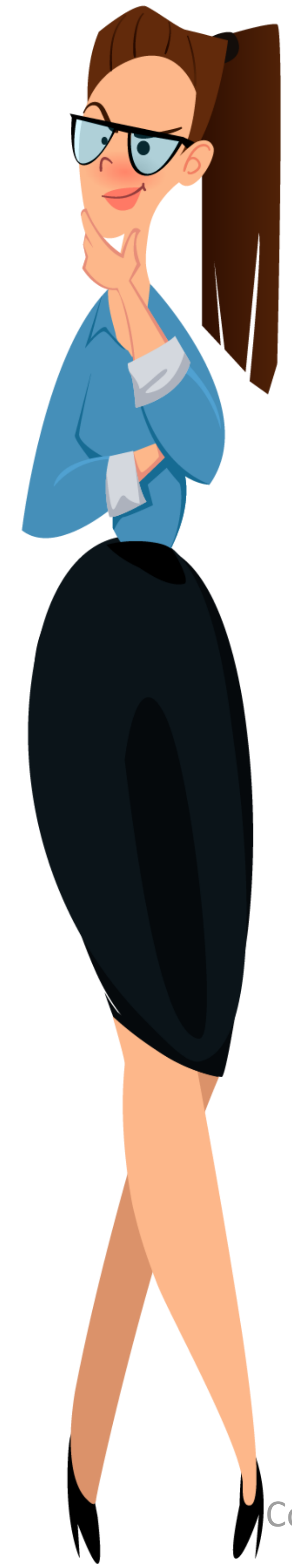
1. If there are 3 oranges and 3 apples in a box. If two fruits are taken out, then what will be the probability that first one is orange and other one is apple?

A> $\frac{2}{5}$

B> $\frac{3}{5}$

C> $\frac{3}{10}$

D> None of the above



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A> $\frac{2}{5}$

B> $\frac{3}{5}$

C> $\frac{3}{10}$

D> None of the above

Explanation: P(A) : $\frac{3}{6} = \frac{1}{2}$ P(B) : $\frac{3}{5}$

P(A)*P(B) : $\frac{1}{2} * \frac{3}{5} = \frac{3}{10} = 0.3$

ALICE's QUESTION

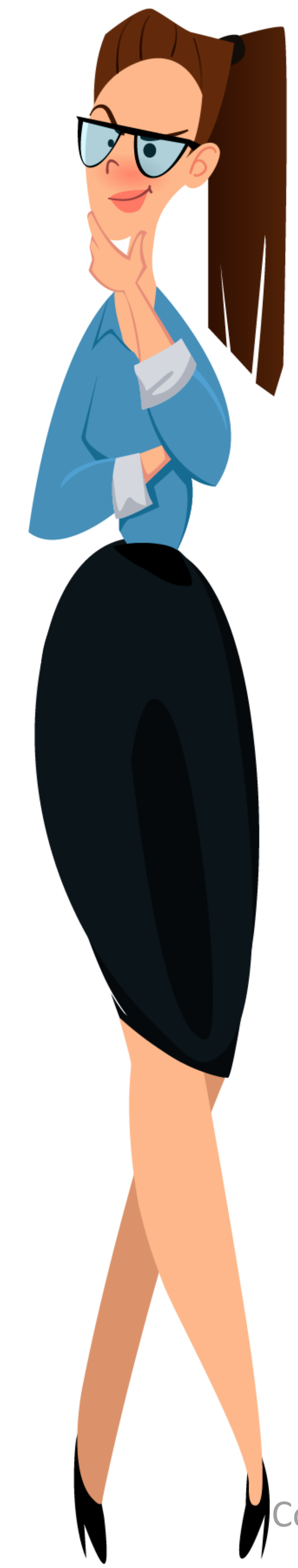
2. Let A={2,3,4,…,20}. A number randomly chosen is a prime number. What will be the probability that it is more than 10?

A> $\frac{5}{10}$

B> $\frac{1}{10}$

C> $\frac{1}{5}$

D> None of the above



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ALICE's QUESTION

2. Let A={2,3,4,…,20}. A number randomly chosen is a prime number. What will be the probability that it is more than 10?

A> $\frac{5}{10}$

B> $\frac{1}{10}$

C> $\frac{1}{5}$

D> None of the above

Explanation: Let A(Prime number): {2,3,5,7,11,13,17,19};

Let B(n>10): 10; P(B):10/19; P(A∩B): 4/19; P(A):8/19

P(B|A): $\frac{4/19}{8/19} = \frac{4}{8} = \frac{1}{2} = \frac{5}{10}$

ALICE’s QUESTION

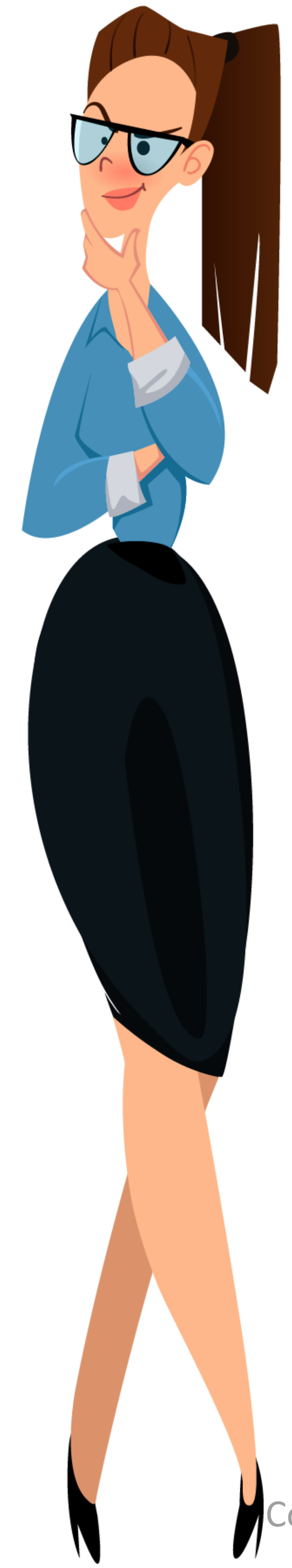
3. In an aptitude test the probability that a learner knows the correct answer is $\frac{2}{3}$. The probability of the guessed answer being correct when he does not know the answer is $\frac{1}{4}$. Given that the learner has answered the question correctly, the conditional probability that the learner knows the correct answer is:

A> $\frac{2}{3}$

B> $\frac{8}{13}$

C> $\frac{8}{9}$

D> None of the above



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ALICE's QUESTION

3. Given that the learner has answered the question correctly, the conditional probability that the learner knows the correct answer is:

A> $\frac{2}{3}$

B> $\frac{8}{13}$

C> $\frac{8}{9}$

D> None of the above

Explanation: Let's define the events as:

A = Learner knows the correct answer

C = Learner answered correctly.

Probability learner knows the answer when he answered correct one:

$$P(A|C)=\frac{P(C|A)*P(A)}{P(C|A)*P(A)+P(C|Not\ A)*P(Not\ A)}=\frac{1*\frac{2}{3}}{1*\frac{2}{3}+\frac{1}{4}*\frac{1}{3}}=\frac{8}{9}$$

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Section – I
Practice Questions

Example 2: Marital Status

Probability Experiment

Given that the customer has taken term deposit, find the probability that he/she is married

Event A: Customer has taken term deposit

Event B: Customer is married

Event C: Customer is married and has term deposit

marital	term_deposit		
	no	yes	All
divorced	4136	476	4612
married	22396	2532	24928
single	9948	1620	11568
unknown	68	12	80
All	36548	4640	41188

Event occurrence:

A: 4640 **B:** 24928 **C(A ∩ B) :** 2532 **S:** 41188

$$P(A \cap B) = \frac{2532}{41188} = 0.0614$$

$$P(A) = \frac{4640}{41188} = 0.113$$

$$P(B|A) = \frac{P(A \text{ and } B)}{P(A)} = \frac{0.0614}{0.113} = 0.544$$

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Example 3: Housing

Probability Experiment

If a customer has a blue collar job, find the probability that he has housing

Event A: Customer has a blue collar job

Event B: Customer has housing

Event C: Customer has blue collar job and housing and has term deposit

housing	job												
	admin.	blue-collar	entrepreneur	housemaid	management	retired	self-employed	services	student	technician	unemployed	unknown	All
no	4636	4304	641	491	1363	784	641	1818	381	2980	430	153	18622
yes	5786	4950	815	569	1561	936	780	2151	494	3763	584	177	22566
All	10422	9254	1456	1060	2924	1720	1421	3969	875	6743	1014	330	41188

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Example 3: Housing(Cont.)

Event A: Customer has a blue collar job

Event B: Customer has housing

Event C: Customer has blue collar job and housing and has term deposit

Event occurrence:

A: 9254 **B:** 22566 **C(A ∩ B) :** 4950 **S:** 41188

$$P(A \cap B) = \frac{4950}{41188} = 0.120$$

$$P(A) = \frac{9254}{41188} = 0.225$$

$$P(B|A) = \frac{P(A \text{ and } B)}{P(A)} = \frac{0.120}{0.225} = 0.535$$

Probability that a customer has housing, if he has a blue collar job is **0.535**

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In-Class Practice Session - I

Mobimania is a smartphone retailers spread across the India. To perceive customer choice, they collected past months sales data along with the rating given by the customers. Find the answers to the following questions after reading *Mobiles.csv* separated by pipe(|):

Q1. Find the probability that a randomly picked customer rated his newly bought phone 4 out of 5.

Q2. Find the probability that a phone has IPS display.

Q3. Find the probability that a randomly bought phone has brand name Xiaomi.

Q4. Find the probability that a phone has 23MP front and rear camera.

Q5. Find the probability that a phone has 256GB ROM and 8GB RAM.

Get the dataset from here: *https://www.dropbox.com/s/00d81prb1q7hxw2/Mobiles.csv*

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In-Class Practice Session - I

Q6. If a randomly purchased phone has 64GB ROM, what will be the probability it has 4GB RAM?

Q7. Given the phone has MicroSD Slot, find out the probability that it has at least 3 star rating.

Q8. If the phone has 3 star ratings, find the probability that it has at least 8 GB RAM.

Q9. Given the phone has an IPS display, find the probability that it has a 8MP rear camera.

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Section – II

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Video: Random Variables & Probability Distribution Functions

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Introduction to Random Variables

A Random Variable is a variable whose possible values are numerical outcomes of a random function, which is usually denoted by **X**

- **Example** – Consider the event of tossing a coin twice
- The sample space becomes = {HH, HT, TH, TT}
- Let X be a random variable representing the phenomenon of obtaining a Head
- The possible values of X are 2,1,0

Probability Distribution Function

- Describes how the probabilities are distributed over the possible values of a random variable
- It can then be plotted on a graph with the help of Probability Distribution Functions

From the above figure, we can determine that customer with a salary less than 5K is likely to be a female

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Types of Probability Distribution Functions

For Continuous Variables

01 Uniform Distribution

02 Exponential Distribution

03 Normal Distribution

For Discrete Variables

01 Bernoulli Distribution

02 Binomial Distribution

03 Geometric Distribution

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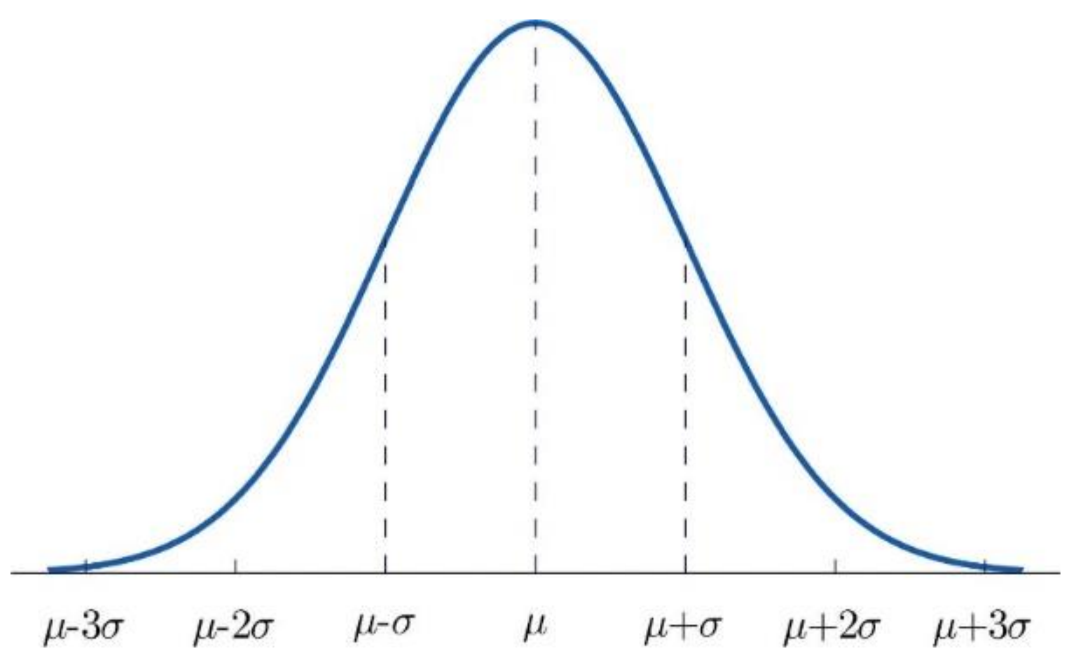
Normal Distribution

- The Normal Distribution is a probability distribution that associates a normal random variable X with a cumulative probability
- Also known as Gaussian Distribution



$$Y = [\ 1/\sigma * \mathrm{sqrt}(2\pi)\ ] * e^{-(x - \mu)2/2\sigma 2}$$

Where,
- *X* is a normal random variable
- μ is the mean and
- σ is the standard deviation

Note: Normal Random variable is variable with mean at 0 and variance equal to 1

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Binomial Distribution

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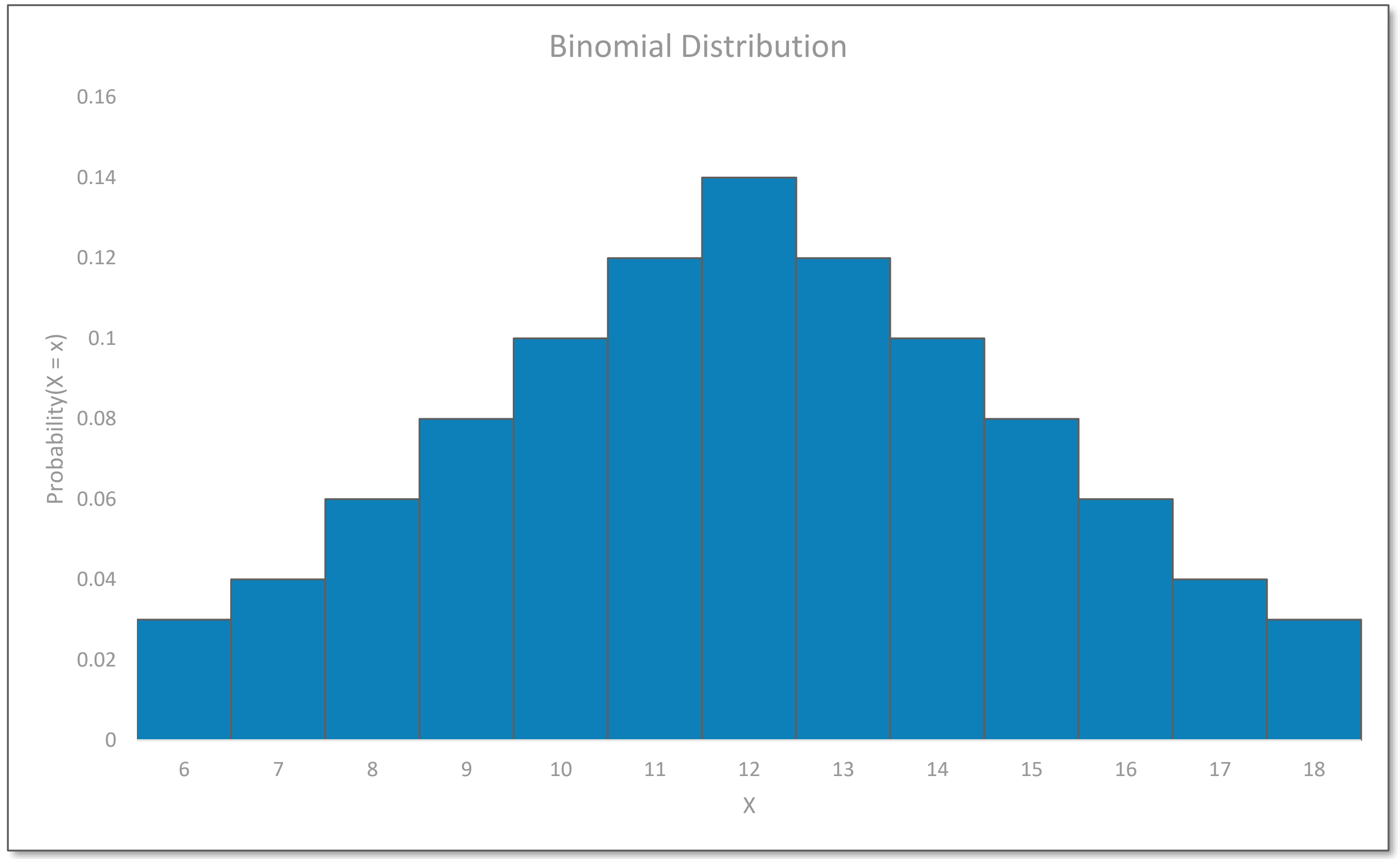
Binomial Distribution

- This distribution applies when N independent Bernoulli trials are carried out each with the same probability p of success
- The probability distribution becomes a Binomial
- Distribution with the equation as follows:



Let there be N trials each with success probability p &

total number of trials with successes be k

$$f(X: N, p) = \binom{N}{k} p^k p^{(N-k)}$$

- Example – Probability if guessing a correct answer for a multiple choice question with 4 options is 0.25
- Then the probability of passing an exam with 20 such questions becomes Binomial

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Section – III
Quiz

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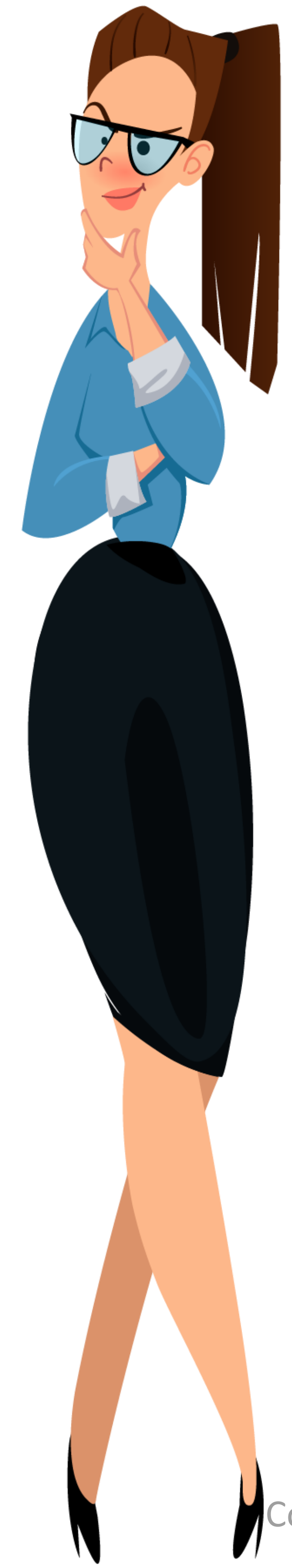
ALICE’s QUESTION

1. Which statements are true about Normal Distribution?

A> Mean = Median = Mode
B> It is a discrete probability distribution
C> Skewness is 0
D> It is asymmetric



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1. Which statements are true about Normal Distribution?

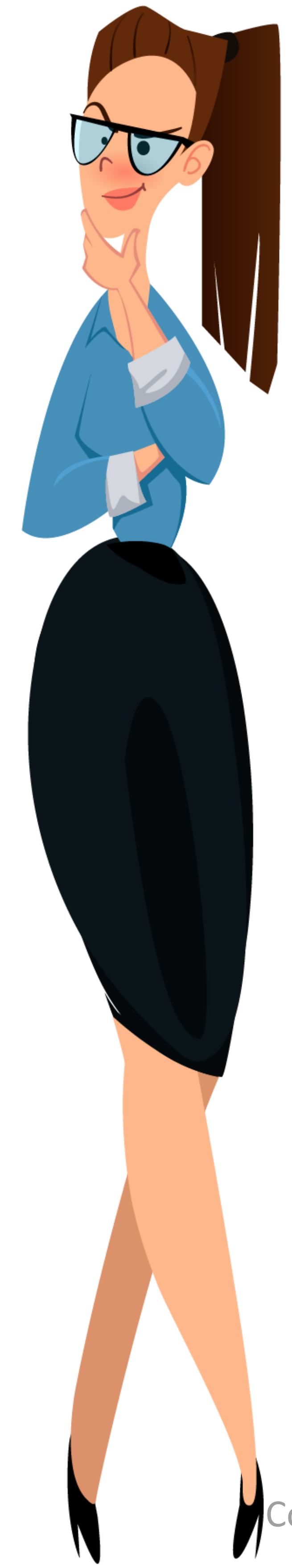
A> Mean = Median = Mode
B> It is a discrete probability distribution
C> Skewness is 0
D> It is asymmetric

Explanation: Normal distribution is a continuous probability distribution and normal distribution is symmetric.

ALICE's QUESTION

2. A normal distribution is having a mean 5 and standard deviation 2, given a point 7.3 find how many standard deviations away it is from mean using z-scores.

```
A> 2.3
B> 1.15
C> 2
D> 1.5
```



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ALICE's QUESTION

2. A normal distribution is having a mean 5 and standard deviation 2, given a point 7.3 find how many standard deviations away it is from mean using z-scores.

A> 2.3
B> 1.15
C> 2
D> 1.5

Explanation: Calculate z-score for that point, (7.3 – 5)/2 = 1.15. It means 7.3 is 1.15 standard deviations away from mean.

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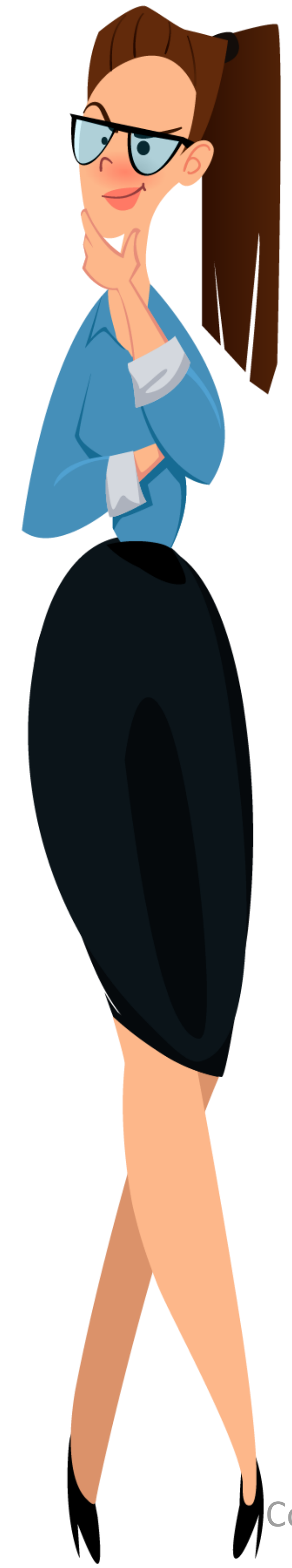
ALICE’s QUESTION

3. A company ships 5000 car air conditioners. They can work for 10000 hours on an average before needing recharge, with a standard deviation of 500 hours. Assuming the working time of the ACs are normally distributed. If a AC is randomly selected to be tracked for recharge, find the expected number of ACs that needs recharge after 11000 hours:

A> 225 ACs
B> 522 ACs
C> 228 ACs
D> 227 ACs



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A> 225 ACs
B> 522 ACs
C> 228 ACs
D> 227 ACs

$$Y = [\ 1/\sigma * \mathrm{sqrt}(2\pi)\ ] * e^{-(x - \mu)2/2\sigma 2}$$

Explanation: Calculate z-score for that point, $z = \frac{(11000-1000)}{500} = 2$, then using z-table we get, P = 1-0.9772 = 0.228, which gives 228 ACs

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In-Class Practice Session - II

Q1. Men heights have a mean of 63.6 inches and a standard deviation of 2.5 inches.
Find the z-score corresponding to a man with a height of 78 inches.

Q2. The local electricity authority conducted a study on electrical bills. It was found that average bill amount was 527 with a standard deviation of 112. What is the probability that a citizen's bill will be more than 500?

Q3. The average IQ of a human being is 100 and standard deviation of 16. A certain individual has an IQ of 160.

1. What is the difference between Individual's IQ and the mean?
2. How many standard deviations is that?
3. Convert Individual's IQ score to a z score.
4. If we consider, usual IQ scores to be those that z-scores between -2 and 2, then is the Individual's IQ usual or unusual?

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