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# How to Prepare Probability for SSC CGL Tier II - Study Notes in PDF

The SSC will be conducting the SSC CGL Tier II Exam soon! The SSC CGL Prelims Exam was conducted from 5th August to 24th August 2017. This year the exam pattern for Prelims Exam also underwent some major changes. There are a total of 4733 vacancies to be filled this year. If you are confident that you will make it through to the SSC CGL Tier II, then you can read the article given below. This article will help on **How to Prepare Probability for SSC CGL Tier II**. In the following article, you will know in detail about Probability theory, Conditional Probability, Bayes' Theorem etc. You can also take our [SSC CGL Online Mock Tests](#) to boost up your preparation strategy.

## Probability for SSC - Probability Theory

The term **probability** is a quantitative measure of **uncertainty**. It quantifies the concept of chance or likelihood. The theory of probability provides the random phenomena to measure the chance of possible outcomes for which the outcome is uncertain i.e. whether a particular event will occur or not. For an event that will occur, its probability is 100%. For an event that will not occur, its probability is 0.

**For e.g.** if the probability of any particular event is  $1/4$ , then it indicates that there is 25% chance that an event will occur and 75% chance that an event will not occur.

Any operation whose outcome is well defined is called **Experiment** and whose outcome is not well defined is called **Random Experiment** but in the random experiment all the possible outcomes are known in advance but the exact outcome cannot be predicted in advance. The list of possible outcomes of a random experiment must be **exhaustive** and **mutually exclusive**.





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- **For e.g.** in the role of a die, there are 6 outcomes, and the probability of each outcome is  $1/6$
- **For e.g.** in the toss of two coins, there are 4 outcomes, and the probability of each outcome is  $1/4$

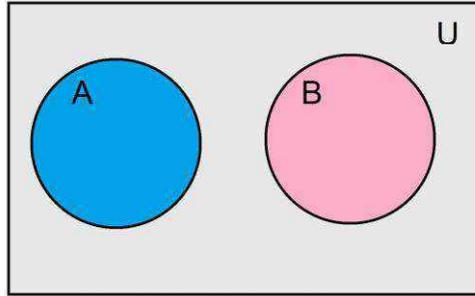
### Few important terms associated with probability are:-

- **Sample Space (S):** In a random event, the set of all the possible number of outcomes is known as sample space
- **Event (E):** In a random event, the set of a favorable number of outcomes is known as an event. Event **E** is a subset of sample space **S**
  - **Simple event:** It is the event which has only one outcome. **For e.g.** the event of getting head while tossing a coin
  - **Compound event:** It is the event which has more than one outcome. **For e.g.** the event of getting odd or even while rolling a die
  - **Mutually exclusive event:** The random experiment that results in the occurrence of only one of the  $n$  outcomes. It means that occurrence of one event excludes the occurrence of the other. g. if a coin is tossed, the result is a head or a tail, but not both. That is, the outcomes are defined so as to be mutually exclusive.

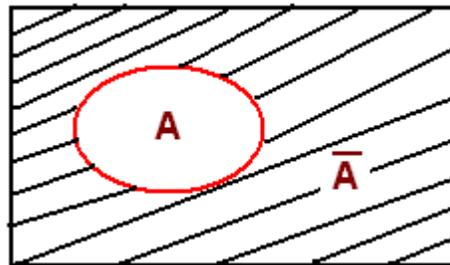
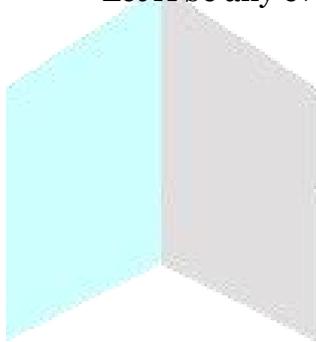
Let A and B are two mutually exclusive events, then

- $P(A \cap B) = 0$
- $P(A \cup B) = P(A) + P(B)$



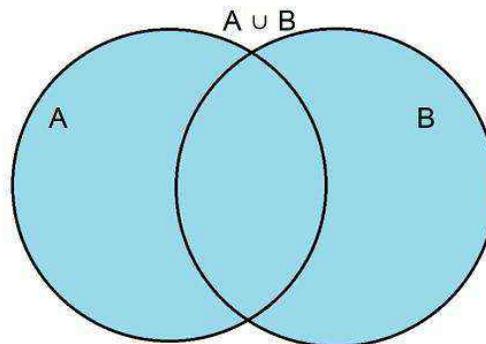


- If A and B are two **mutually exclusive** and **exhaustive events** then,
  - $P(A) + P(B) = 1$
- **Equally likely event:** Each outcome of the random experiment has an equal chance of occurring
- Let A be any event and be its **complimentary event**, then  $P(A) + P(\bar{A}) = 1$



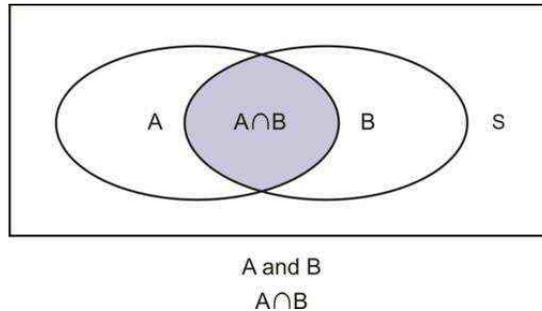
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- **Union of event ( $A \cup B$ ):** It occurs if the event A occurs or the event B occurs i.e. it consists of all the outcomes that are either in A or in B or in both events.





- **Intersection of event (A B):** It occurs if the event A occurs and the event B occurs i.e. it consists of all the outcomes that are both in A and B



### Conditional Probability: -

When we have extra information, then how the probability of an event does change is being defined by the conditional probability.

- For e.g. if we toss a coin 3 times, then the probability of 3 heads =  $1/8$  as the sample space is { HHH, HHT, HTH, HTT, THH, THT, TTH, TTT }

This is called conditional probability, as it takes into account additional conditions. It is denoted as  $P(A|B)$  and is read as 'the conditional probability of A given B'. It can also be written as,

$$P(A|B) = \frac{P(A \cap B)}{P(B)}, \text{ provided, } P(B) \neq 0$$

Where,  $P(A \cap B)$  = probability of both A and B occurring

- For e.g. given a deck of 52 cards, you drew a black card, what's the probability that it's a four. So out of the 52 cards, 26 black cards are there. Given a black card, there are two fours. Therefore,  $P(\text{four} | \text{black}) = 2/26 = 1/13$



**Independent Event:** Two events are said to be independent if the occurrence of either one of the two events does not affect the occurrence of the other event. Two events are said to be independent if

- $P(A|B) = P(A)$
- $P(B|A) = P(B)$
- $p(A \cap B) = P(A) \cdot P(B)$

### Compound Probability:

It is equal to the probability of the first event multiplied by the probability of the second event. It is the joint occurrence of two or more simple events.

- When X and Y are two independent events. Then,
  - $P(X \text{ and } Y) = P(X) * P(Y)$
- When the events are dependent then,
  - $P(X \text{ and } Y) = P(X) * P(Y \text{ following } X)$

These are the cases when both parts of the compound events are true. But, when one or more part of the compound event holds true, then the compound probability is given by

$$P(X \text{ or } Y) = P(X) + P(Y)$$

### Bayes' Theorem

It describes the probability of an event, based on the prior knowledge of conditions related to the event. It is a direct application of conditional probabilities i.e. how to find  $P(B|A)$  from  $P(A|B)$

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



Where,

- A and B are events and  $P(A) \neq 0$
- $P(A)$  and  $P(B)$  are the probabilities of observing A and B without regard to each other
- $P(B|A)$  a conditional probability of observing event A given that B is true
- $P(A|B)$  a probability of observing event B given that A is true.

It also exists in different form i.e.

$$P(B|A) = \frac{P(B) \cdot P(A|B)}{P(A|B) \cdot P(B) + P(A|\bar{B}) \cdot P(\bar{B})}$$

Where,

- $\bar{B}$  is an event complementary to B.

### Probability for SSC - Random Variable and Probability Distributions

A Random Variable takes defined set of values with different probabilities. It takes real values in accordance with the change in the outcome of the random experiment. **For e.g.** if you roll a die, the outcome is random. Random variable can be **Discrete** or **Continuous**.

- **Discrete** Random Variable has a finite or countable infinite number of values.  
For e.g. Dead / Alive
- **Continuous** Random Variable has non countable infinite possible values. For e.g. Blood Pressure

### Probability Distributions Functions:



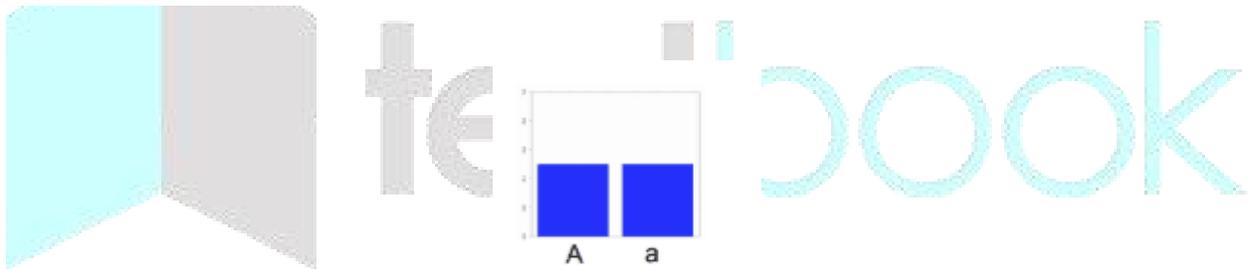
It describes how probabilities are distributed over the values of the random variable. It also maps the possible values of  $x$  against their respective probabilities of occurrence,  $p(x)$ . It range from 0 to 1

- $p(x) \geq 0$ , for all values of  $x$
- $\sum p(x) = 1$

- **Discrete Probability Distributions:**

Let  $X$  be the discrete Random Variable. Then, the probability mass function (pmf),  $f(x)$ , of  $X$  is :

$$f(x) = \begin{cases} P(X = x), & x \in \Omega \\ 0, & x \notin \Omega \end{cases}$$

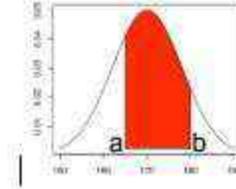


- **Continuous Probability Distributions:**

Let  $X$  be the continuous Random Variable. Then, the probability density function (pdf),  $f(x)$ , of  $X$  for any two numbers  $a$  and  $b$  with  $a \leq b$  is :



- $F(x) \geq 0$
- $\int_{-\infty}^{+\infty} F(x)dx = 1$
- $P(a \leq x \leq b) = \int_a^b F(x)dx$



All the probability distributions are characterized by **an expected value** (mean) and a **variance** (standard deviation squared)

**Expected Value:** It is just the average or mean ( $\mu$ ) of random variable X. It is sometimes called weighted average. It is extremely useful concept for good decision making

- **Discrete Expected Value:** Let X be a discrete random variable that takes on values in the set D and has a pmf  $f(x)$ . Then, the expected or mean value of X is:

$$\mu_x = E[X] = \sum_{X \in D} x \cdot f(x)$$

- **Continuous Expected Value:** The expected or mean value of a continuous random variable X with pdf  $f(x)$  is:

$$\mu_x = E[X] = \int_{-\infty}^{+\infty} x \cdot f(x)dx$$

**Variance:**



- **Discrete:** Let  $X$  be a discrete random variable with pmf  $f(x)$  and expected value  $\mu$ . Then, the variance of  $X$  is:

$$\sigma^2_x = V[X] = \sum_{x \in D} (x - \mu)^2 = E[(X - \mu)^2]$$

- **Continuous:** The variance of a continuous random variable  $X$  with pdf  $f(x)$  and mean is  $\mu$ :

$$\sigma^2_x = V[X] = \int_{-\infty}^{\infty} (X - \mu)^2 \cdot f(x) dx = E[(X - \mu)^2]$$

### Probability Higher moments of a Random Variable:

The **Moments** of a random variable are expected values of powers or related functions of the random variable. Expected value is called the first moment of a random variable. Variance is called the second central moment or second moment about the mean of a random variable

1. The  $r^{\text{th}}$  moment of  $X$  (about the origin) is  $\mu_r = E(X^r)$ , provided that the moment exists
2. The  $r^{\text{th}}$  moment of  $X$  (about the mean) is  $\mu_r' = E[(X - \mu)^r]$ , provided that the moment exists

- The mean is a measure of the “center” or “location” of a distribution.

Let,

- $n$  = number of identical trials



- $P(S), P(F)$  = two outcomes i.e. success or failure
  - $P(S) = p; P(F) = q = 1 - p$
- Trials are independent
- $x$  is the number of success in 'n' trials

1. **pmf** of Binomial Distribution =

$$P(X = x) = \binom{n}{x} p^x q^{n-x}$$

2. **cdf** of Binomial Distribution =

$$P(X \leq x) = \sum_{y=0}^x \binom{n}{y} p^y q^{n-y}$$

3. **Mean** of Binomial Distribution ( $\mu$ ) :  $np$
4. **Variance** of Binomial Distribution ( $\sigma^2$ ) :  $npq$

Where,

- $\binom{n}{x}$  is the number of ways of getting the desired results
  - $p^x$  is the probability of getting the required number of successes
  - $q^{n-x}$  is the probability of getting the required number of failures
- 
- **For e.g.** if in a class 40% of the students are male, what is the probability that 6 of the first 10 students walking in will be male?



$$\begin{aligned}
 P(x) &= \binom{n}{x} p^x q^{n-x} \\
 &= \binom{10}{6} (0.4)^6 (0.6)^{10-6} \\
 &= 210 \times 0.004096 \times 0.1296 \\
 &= 0.1115
 \end{aligned}$$

### Poisson distribution

It occurs when there are events which don't occur as outcome of a definite number of trails of an experiment but which occur at random point of time and space. It evaluates the probability of a number of occurrences out of many opportunities.



Where,

$$P(x) = \frac{\lambda^x e^{-\lambda}}{x!}$$

- $\lambda$  = mean number of occurrences in the given unit

**Mean** of Poisson distribution ( $\mu$ ) :  $\lambda$

**Variance** of Poisson distribution ( $\sigma^2$ ) :  $\lambda$

$$\begin{aligned}
 E(x) &= \sum_{x=0}^{\infty} x \frac{\lambda^x e^{-\lambda}}{x!} = \lambda \sum_{x=1}^{\infty} \frac{\lambda^{x-1} e^{-\lambda}}{(x-1)!} = \lambda, \\
 E(x^2 - x) &= \lambda^2 \sum_{x=2}^{\infty} \frac{\lambda^{x-2} e^{-\lambda}}{(x-2)!} = \lambda^2, \text{Var}(x) = \lambda.
 \end{aligned}$$

- **For e.g.** number of deaths from diseases such as heart attack or cancer or due to snake bite
- **For e.g.** number of suicide reported on a particular day

This distribution is used in situations where 'events' happen at certain points in time. It approximates the binomial distribution.



## Normal Distribution

It is a relative frequency distribution of errors. It is symmetrical about its mean. A continuous random variable  $X$  is said to have a normal distribution with parameters  $\mu$  and  $\sigma > 0$ , if the pdf of  $X$  is

Where,

- $-\infty < x < \infty$
- $e \cong 2.71828$
- $\pi = 3.14159$

**Mean** of Normal distribution  $E(X) = \mu$

**Variance** of Normal distribution  $V(X) = \sigma^2$

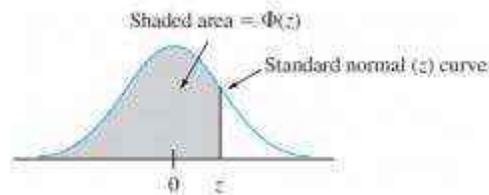
The Normal distribution with parameter values  $\mu = 0$  and  $\sigma = 1$  is called the standard normal distribution and is denoted by  $Z$

$$f(z; 0, 1) = \frac{1}{\sqrt{2\pi}} e^{-\frac{z^2}{2}}$$

Where,

- $-\infty < z < \infty$

The graph of  $f(z; 0, 1)$  is called the standard normal curve



## Exponential distributions



X is said to have an exponential distribution with the rate parameter  $(\theta > 0)$  if the pdf of X is

$$f(x; \theta) = \begin{cases} \theta = e^{-\theta x} & x \geq 0 \\ 0 & \text{otherwise} \end{cases}$$

On integrating,  $\mu = \frac{1}{\theta}, \sigma^2 = \frac{1}{\theta^2}$

**CDF:**

$$f(x; \theta) = \begin{cases} 0 & x < 0 \\ 1 - e^{-\theta x} & x \geq 0 \end{cases}$$

### Joint distribution of two random variables

If X and Y are two random variables, the probability distribution that defines their simultaneous behavior is called a joint probability distribution

Let X and Y be two discrete random variables, and let S denote the two-dimensional support of X and Y. Then, the function  $f(x, y) = P(X = x, Y = y)$  is a joint probability mass function (abbreviated p.m.f.) if it satisfies the following three conditions:

$$f_{XY}(x, y) \geq 0 \quad \text{and} \quad \sum_x \sum_y f_{XY}(x, y) = 1.$$

In the case of only two random variables, this is called a **bivariate distribution** and for any number of random variables, this is called a **multivariate distribution**.

Two discrete random variables X and Y are independent if the joint probability mass function satisfies

$$P(X = x \text{ and } Y = y) = P(X = x) \cdot P(Y = y) \text{ for all } x \text{ and } y.$$



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