Chapter 5 Inductive Inference and its Types

When general observations are drawn from so many particulars as to become certain and indubitable, these are jewels of knowledge - ***Samuel Johnson***

DO YOU KNOW THAT .....

Many scientific discoveries and inventions are the results of inductive reasoning.

When you are wearing the same brand you are using analogy.

Many a times women use inductive reasoning while cooking food.

Knowingly or unknowingly we all make use of inductive reasoning in our day to day life.

Need for induction :

In the previous chapters we have dealt with the formal aspect of logic i.e. deductive logic. Deductive logic determines the relations between premise/s and conclusion without considering its content matter. Deduction is concerned with the form and not with the content of an argument. Conclusion of the deductive inference is certain but it does not gives us any new information or knowledge whereas the conclusion of inductive inference is always probable but it does gives us new information or knowledge and hence there is a need for induction.

INDUCTIVE INFERENCE

The aim of inductive inference is to establish the material truth. In inductive inference the conclusion asserts something more than what is given in the premises, for example : when we say that -

Gold expands on heating.

Silver expands on heating.

Iron expands on heating.

∴ All metals expand on heating.

In the above example on the basis of our observation of some metals expanding on heating, we make a generalization about all metals expanding on heating.

Inductive Inference is not only used for establishing general propositions but also particular propositions. Inductive inferences are of four main kinds. They are :

1. Simple enumeration
2. Analogy
3. Scientific induction
4. Hypothetico-deductive method

Out of these four, the first and the third type of inductive inference establish general propositions. The second one i.e. analogy establishes a conclusion which is about a particular proposition and the last one i.e. hypothetico-deductive method may be used to establish a general proposition or a particular proposition.

*** Activity :** state which of the following inferences are deductive inference and which are inductive inference.

1. All those who can afford medical insurance are employed.
   All actors can afford medical insurance.
   ∴ All actors are employed.

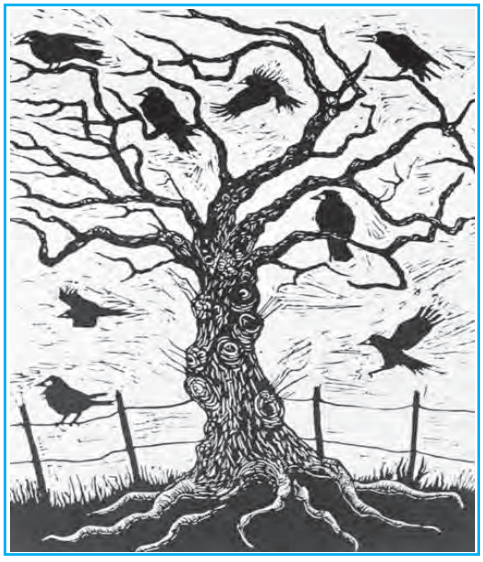
2. Sunita bought an apartment in the same building as Latika's. She paid the same price, the carpet area of her apartment is the same as Latika's apartment. Latika's apartment has five bedrooms.
   ∴ Sunita's apartment must also have five bedrooms.

3. Whoever exists is a human being.
   Pen exists.
   ∴ Pen is a human being.

4. Everytime I organized a house party, my friend comes late. Today I have organized a house party so I am sure that my friend will come late.

Simple Enumeration

Simple Enumeration is a common man's method of arriving at a generalization. Generalization is a statement of the type, 'All A is B'. It is the simplest kind of induction. The generalization of a common man differs from that of a scientist. Common man uses simple enumeration whereas scientist use scientific induction for establishing generalizations. Simple enumeration is the process of establishing a generalization on the basis of the observation of some cases or instances of a kind. Generalization in simple enumeration is supported by direct evidence. In induction by simple enumeration we generalize by going beyond what has been experienced. Induction by simple enumeration can be defined as **"what is true of several cases of a kind is true of all the cases of that kind".** It establishes a generalization on the basis of uniform and uncontradicted experience. For example :



First observed crow is black.

Second observed crow is black.

Third observed crow is black.

One lakh observed crows are black.

∴ All crows are black.

A Few more examples of simple enumeration are :

(1) Some roses have thorns.
∴ All roses have thorms.

(2) Some observed flowers have fragrance.
∴ All flowers have fragrance.

The form of simple enumeration is as follows :

All observed P's are Q.
No observed P is non Q.
∴ All P's are Q.

Generalizations established by simple enumeration have the following characteristics.

- **Uniform and Uncontradicted Experience :**

  Generalization in simple enumeration is based on uniform and uncontradicted expeience.

  For example : Ice is cold, fire is hot etc. We have never come across any contrardictory experience of ice being hot and fire being cold. In these examples the scope of generalizations are unlimited hence it is larger than the scope of evidence.

- **Absence / Lack of analysis of property:** Simple enumeration is the process of simply counting the instances (cases) to find that all these cases share a common property, However it does not involve analysis : for example - why crows are black, or why roses have thorns. Here one is not concerned in finding out why blackness goes with crows or why thorns are associated with roses.

- **Unrestricted generality :**

  The generalization established by simple enumeration is not about a class with limited number of members, for example :

  Some students in this class are smart

  ∴ All students in this class are smart.

In the given example a generalization is established but it is of restricted generality. Therefore such kind of arguments are not induction by simple enumeration. In Simple Enumeration the conclusion i.e. generalization is about unrestricted number of members. For example :

Some polar bears are white
∴ All polar bears are white

In case of simple Enumeration there is an inductive leap or jump from observed cases to unobserved or known cases to unknown cases. The scope of our generalization is unlimited and hence larger than the scope of evidence.

- **Low degree of Probability :** As the generalization of Simple Enumeration are based on uniform experience of some cases, we cannot be sure of the unobserved cases/instances possessing the same characteristics as the observed ones. Generalization such as - 'All crows are black' is accepted as true on the basis of observation, ie. direct evidence. But we cannot rule out the possibility of a contrardictory instance. Therefore it is said to be probable.
- **Value of Induction by Simple Enumeration :** The generalizations established by simple enumeration are not equally good that is to say some generalizations are good and some are bad. For example : "All crows are black" is a good one but "All swans are white" is a bad one. Mill and Bacon considers the process of Simple Enumeration as childish and unreliable. According to them the value of Simple Enumeration depends upon the number of instances observed. However they were wrong in saying because value of generalizations depends upon some more conditions. They are as follows:

1. **Wider Experience :** The generalizations of Simple Enumeration are based on wider experience. For example : All crows are black, is based on observation. When a large numbers of instances are observed, it is possible to come across contradictory instance if any.
   Example : we do not come across any non - black crows
   ∴ We conclude 'All crows are black.'
2. **Variety of experience :** Instead of observing maximum number of crows from one part of the world, if we observe some crows from different parts of the world then the generalization becomes more probable or reliable because we all are aware that sometimes the colour of the animals depends upon the climate or other conditions of that region.

   E.g. Some bears are black.

   ∴ All bears are black.

   Here this argument is bad because in polar region we find white bears due to climatic condition.
3. **Resemblances :** Value of simple enumeration is also affected by the nature of resemblances. For example - crows apart from being black, resemble each other in other physical characteristics also like pointed beak, clawed feet, etc. which are equally important characteristics of a crow.

Analogy : Analogy is a type of inductive reasoning. Analogy is a common man's inference in which the conclusion is drawn on the basis of observed resemblances (similarities). In analogy we proceed form particular to particular instance.

It may be defined as an **argument from known resemblance to further resemblance, that is to say, if two (or more) things resemble each other in certain characteristics and if one of them have further / additional characteristics, the other is also likely to have that characteristics.**

The form of analogical argument is as follows
A - is observed to have the properties P1, P2, P3, ...Pn
B - is observed to have the properties P1, P2, P3, ...Pn
A possess additional property 'q'
∴ B also has the property 'q'.

Example :

On the basis of the observed similarities between Earth and Mars, Lowell put forward an analogical argument.

Both Earth and Mars are planets.

They revolve round the Sun.

Both have water, moderate temperature and are surrounded by an atmosphere.

There is life on Earth

Therefore there is life on Mars.

The logical basis of the analogical argument is that the characteristics found together are likely to be connected with one another and therefore from the presence of one characterstic we infer the presence of another.

Value of Analogy : Some analogical arguments are good whereas some are bad. The soundness of analogical argument depends upon the following factors :

- **Relevant and important resemblances :** When the resemblance is in important and relevant characteristics, the analogial argument is good. For example : Lowell's analogy about Life on Mars is good example because they both resemble each other in important characteristics and are also relevant to the characteristic infered i.e. existence of life, as we all know water, temperature and atmosphere is necessary for existence of life.
- **Important differences :** If the differences are in important aspects, then the analogical argument is bad.
- **For example :**
  Man and monkey, both have two legs, two eyes, two hands, one nose, two ears.
  Man can read and write.
  Therefore, monkeys can also read and write.

  In this example, there are many similarities between both man and monkey but the difference is very important, i.e. man is rational whereas monkey is not as rational as man and therefore it is a bad analogical argument.
  It is important to note that the conclusion established by analogical reasoning is always probable and never certain.

The Nature of Conclusion : on the basis of the resemblances the conclusion of analogical argument should not assert more than what is justified by the evidence. The example of Earth and Mars justify the inference that there is life on Mars. But if one claims that there are human beings on Mars then the argument becomes a bad one, as too much is claimed than the evidence in the premises.

*** Activity :** Recognize whether the given analogical arguments are good or bad and give justification for the same -

Examples :

1. Daniyal and Anita reside in the same building, they go to the same college and are in same class. They are of the same height and weight. Daniyal is smart.

∴ Anita is also smart.

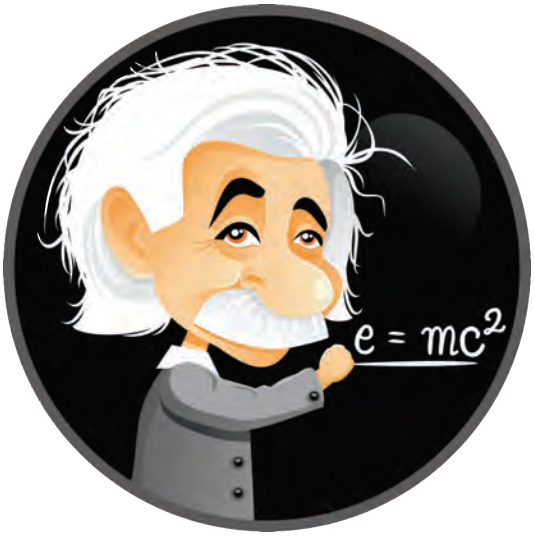
2. Last time I purchased a pair of jeans from the store, it lasted for 2 years. Today also I purchased a pair of jeans from the same store and they are manufactured by the same company. The material of these jeans is also similar to the earlier one therefore this pair of jeans will also last for 2 years.

Scientific Induction

The task of science is to understand and explain facts. Scientific induction maybe defined as, **"the process of establishing generalization on the basis of direct and indirect evidence."**

According to **Mill** and **Bacon**, "Scientific induction is the process of establishing generalization which expresses a causal relationship." This process involves the following stages -

1. Some instances are observed and it is found that they possess certain common properties.
2. A generalization is made that all the instances, of that kind have the same property.
3. The observed instance is analyzed to discover if there is a causal relationship.
4. Experimental method is used to verify and establish the suggested causal relationship.



We cannot accept Mill and Bacon's views about scientific induction. There are two reasons -

1. All scientific generalizations do not express causal relation. For eg. the generalization all bats are warm blooded is not causal, because the property of being warm blooded is not an effect of being a bat.
2. The experimental method can provide only direct evidence, but scientific induction is supported by indirect evidence too. For eg - All observed metals expand when heated. Here observation of metals is direct evidence, but scientifc generalization does not stand in isolation, it is supported by other generalizations or well established laws that is 'All gases expands on heating'. Such support by other generalization / laws forms indirect evidence for scientific generalization.

Simple Enumeration and Scientific Induction

Both induction per simple enumeration and scientific induction are process of inductive reasoning and they both establish generalization. The logical form of Simple enumeration and Scientifc induction is same ie. they both infer from some to all, observed to unobserved. But they differ in certain important characteristics. The generalizations by simple enumeration are based only on direct evidences whereas the generalizations of scientific induction are based on direct and indirect evidence. In simple enumeration no attempt is made to analyse the observed cases whereas in scientifc induction the observed instances are analysed. The generalizations by simple enumeration possess low degree of probability whereas the genralizations by scientific induction possess high degree of probability.

Hypothetico - Deductive Method (Scientific method) :

Scientific induction has limited application. It can be used for establishing only scientific generalization. It is not suitable for establishing theories nor can it be used for establishing conclusions about a particular case. So to overcome this problem we need a method which can establish all kinds of propositions. The hypothetico-deductive method fulfills these conditions. It is the scientific method.

This method uses both deductive and inductive reasoning. **Hypothetico-deductive method consists of formulating a hypothesis, deducing consequences from it and verifying those consequences by appeal to facts.** This method involves five steps. These are as follows.

1. **Observation and feeling of a problem :** The aim of science is to understand and explain facts. When the scientist comes across an unfamiliar situation and when a familiar solution cannot explain the observed facts then scientific investigation begins. For eg - In Kon Tiki expedition, sociologists observed that the ancient customs of people living on south sea islands and the people of South America are similar. The problem felt was - why there is a similarity in customs and tradition of people who live far away from each other?

2. **Formation of an initial hypothesis :** When the observed facts cannot be understood then the scientist puts forth a temporary solution to explain the observed facts. This tentative (temporary) solution is called hypothesis. After the problem was felt some sociologists suggested a hypothesis that - In ancient days people from South America must have come to south sea island and must have settled down on the island and therefore the customs are similar.

3. **Collection of additional facts :** After forming the initial hypothesis the scientist collects additional facts relevant to the Hypothesis. In kon tiki expedition, additional data regarding various routes and means of travelling the distance between South Amercia and south sea island were collected.

4. **Deductive development of the hypothesis :** This stage is not required in some cases of scientific investigation where hypothesis are directly verified i.e. either by observation or experiment and the hypothesis which cannot be verified directly the scientist make use of deductive reasoning. In this the scientists construct a deductive argument where they supposes the hypothesis to be true and using it as a premise, consequences are deduced from it. eg - As sociologist's hypothesis is not possible to verify directly, so to verify indirectly' consequences were deduced ie. if people of South America travelled to south sea island then they must have travelled only through sea route and that too in a primitive kind of boat because in ancient days only such type of primitive boats were available.

5. **Verification of hypothesis :** Indirect verification consist of finding out whether the deduced consequences take place. If the predicted consequence take place then the hypothesis is accepted and if not, then it is rejected or modificed. eg - in Kon Tiki expedition sociologists made a small primitive kind of boat and actually travelled from South America to south sea island and they could travel this long distance. So they concluded that if we could travel this long distance today it is quite possible that in ancient days also people must have travelled and this explains similarity of customs.

PUZZLES

1. Dwayne Johnson was running away with the loot from a heist (robbery) in his car along with Vin Diesel. One tyre was punctured and he dropped down to replace it. While changing the wheel he dropped the four nuts that were holding the wheel and they fell into a drain. Vin Diesel gave him an idea due to which they were able to drive till their rendezvous point (destination). What was the idea?

2. A sweet girl purchased a book from a book keeper and gave him Rs 100. The cost of the book is Rs. 30 but the shopkeeper had got no change so he gets the change from the next shop and returns the girl her Rs. 70. After sometime the next shopkeeper comes with Rs 100 note and told the bookkeeper that the note is fraud. So he takes the money back. How much loss did the shopkeeper face?

3. Famous Elevator puzzle : A man who lives on the tenth floor takes the elevator down to the first floor every morning and goes to work. In the evening when he comes back, on a rainy day or if there are people in the elevator he goes to the 10th floor directly. Otherwise he goes to the 7th floor and walks up three flights of stairs to his apartment. Can you explain why?

Summary :

Inferences are classified into Deductive and Inductive.

Non deductive inferences are classified as :

- Simple enumeration.
- Analogy.
- Scientific induction.
- Hypothetic Deductive method.

Exercises

Q. 1. Fill in the blanks with suitable words from those given in the brackets :

1. In ..... inference the conclusion asserts something more than what is given in premises. *(Deductive / Inductive)*

2. ..... is called as a common man's method of arriving at a generalization.

   (Analogy / Simple enumeration)

3. ..... is known as an argument from known resemblances to further resemblances. *(Analogy / Simple Enumeration)*

4. ..... possess highest degree of probability. *(Scientific Induction / Simple enumeration)*

5. The process of arriving at generalization in science is known as ..... . *(Simple Enumeration/ Scientific Induction)*

6. Generalizations in science are supported by ..... evidence. *(Direct / Both direct and indirect)*

7. ..... is an inference from particular to particular. *(Analogy / Simple Enumeration)*

8. ..... method uses both deductive and inductive reasoning. *(Simple Enumeration / Hypothetico-deductive method)*

9. ..... verification consists of finding out whether the deduced consequences have taken place. *(Indirect / Direct)*

10. ..... is a tentative solution. *(Hypothesis / Verification)*

Q. 2. State whether the following statements are True or False :

1. Induction is concerned with the form and not the content of an argument.
2. The generalization established in Simple Enumeration is based on uniform experience.
3. In Simple Enumeration we establish a proposition of restricted generality.
4. An Analogy is a deductive inference.
5. The generalizations established by Scientific Induction are certain.
6. Analogy involves an inductive leap.
7. The important difference between two objects does not affect the value of analogy.
8. Analogy is a deductive inference.
9. In Simple enumeration attempt is made to analyse the observed cases.
10. Hypothetico-deductive method consists of formulating a hypothesis, deducing consequences from it and verifying those consequences by appeal to facts.

Q. 3. Match the columns :

	(A)		**(B)**
1.	Scientific Induction	a.	Formal validity
2.	Simple Enumeration	b.	Temporary (tentative) solution
3.	Analogy	c.	High degree of probability
4.	Deductive Argument	d.	Based on resemblances
5.	Inductive Argument	e.	Material Validity
6.	Hypothesis	f.	Uniform experience

Q. 4. Give logical terms for the following

1. The inference in which we proceed from particular to particular instance.
2. A jump from known to unknown cases.
3. The method in which the generalization is established on the basis of uniform or uncontradictory experience.
4. The method in which the observed instances are analysed.
5. The scientific method in which both deduction and induction is involved.
6. The method in which the conclusion is based on the resemblances between two instances in certain qualities.

Q. 5. Give reason for the following :

1. There is a need for induction.
2. The method of Simple Enumeration has low degree of probability.
3. Conclusion of scientific induction has high degree of probability.

Q. 6. Explain the following :

1. Induction by Simple Enumeration.
2. Difference between Simple Enumeration and Scientific Induction.
3. The nature of analogy.
4. Value of sound analogy.

Q. 7. Answer the following questions :

1. Explain the characteristics Simple Enumeration.
2. What is Hypothetico-deductive method? and explain it's stages.
3. Explain with illustration vlaue of Simple Enumeration.
4. Explain the method of Scientific Induction.