STATISTICS FOR ECONOMICS

Textbook for Class XI

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OFFICES OF THE PUBLICATION DIVISION, NCERT

NCERT Campus
Sri Aurobindo Marg
New Delhi 110 016 **Phone : 011-26562708**

108, 100 Feet Road
Hosdakere Halli Extension
Banashankari III Stage
Bengaluru 560 085 **Phone : 080-26725740**

Navjivan Trust Building
P.O.Navjivan
Ahmedabad 380 014 **Phone : 079-27541446**

CWC Campus
Opp. Dhankal Bus Stop
Panihati
Kolkata 700 114 **Phone : 033-25530454**

CWC Complex
Maligaon
Guwahati 781 021 **Phone : 0361-2674869**

Publication Team

Head, Publication Division : *M.V. Srinivasan*
Chief Editor : *Bijnan Sutar*
Chief Business Manager : *Amitabh Kumar*
Chief Production Officer (In charge) : *Deepak Jaiswal*
Editor : *M.G. Bhagat*
Assistant Production Officer : *Sayuraj A.R.*

Cover
Shweta Rao

Illustrations and Layout
Sarita Verma Mathur

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Foreword

The National Curriculum Framework (NCF), 2005, recommends that children's life at school must be linked to their life outside the school. This principle marks a departure from the legacy of bookish learning which continues to shape our system and causes a gap between the school, home and community. The syllabi and textbooks developed on the basis of NCF signify an attempt to implement this basic idea. They also attempt to discourage rote learning and the maintenance of sharp boundaries between different subject areas. We hope these measures will take us significantly further in the direction of a child-centred system of education outlined in the National Policy on Education (1986).

The success of this effort depends on the steps that school principals and teachers will take to encourage children to reflect on their own learning and to pursue imaginative activities and questions. We must recognise that, given space, time and freedom, children generate new knowledge by engaging with the information passed on to them by adults. Treating the prescribed textbook as the sole basis of examination is one of the key reasons why other resources and sites of learning are ignored. Inculcating creativity and initiative is possible if we perceive and treat children as participants in learning, not as receivers of a fixed body of knowledge.

These aims imply considerable change in school routines and mode of functioning. Flexibility in the daily time-table is as necessary as rigour in implementing the annual calendar so that the required number of teaching days are actually devoted to teaching. The methods used for teaching and evaluation will also determine how effective this textbook proves for making children's life at school a happy experience, rather than a source of stress or boredom. Syllabus designers have tried to address the problem of curricular burden by restructuring and reorienting knowledge at different stages with greater consideration for child psychology and the time available for teaching. The textbook attempts to enhance this endeavour by giving higher priority and space to opportunities for contemplation and wondering, discussion in small groups, and activities requiring hands-on experience.

The National Council of Educational Research and Training (NCERT) appreciates the hard work done by the textbook development team

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responsible for this book. We wish to thank the Chairperson of the advisory group for Social Sciences textbooks at Higher Secondary Level, Professor Hari Vasudevan and the Chief Advisor for this book, Professor Tapas Majumdar for guiding the work of this committee. Several teachers contributed to the development of this textbook; we are grateful to them and their principals for making this possible. We are indebted to the institutions and organisations which have generously permitted us to draw upon their resources, material and personnel. We are especially grateful to the members of the National Monitoring Committee, appointed by the Department of Secondary and Higher Education, Ministry of Human Resource Development under the Chairmanship of Professor Mrinal Miri and Professor G.P. Deshpande, for their valuable time and contribution. As an organisation committed to systemic reform and continuous improvement in the quality of its products, NCERT welcomes comments and suggestions which will enable us to undertake further revision and refinement.

Director
National Council of Educational
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New Delhi
20 December 2005

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Rationalisation of Content in the Textbooks

In view of the COVID-19 pandemic, it is imperative to reduce content load on students. The National Education Policy 2020, also emphasises reducing the content load and providing opportunities for experiential learning with creative mindset. In this background, the NCERT has undertaken the exercise to rationalise the textbooks across all classes. Learning Outcomes already developed by the NCERT across classes have been taken into consideration in this exercise.

Contents of the textbooks have been rationalised in view of the following:

- Overlapping with similar content included in other subject areas in the same class
- Similar content included in the lower or higher class in the same subject
- Difficulty level
- Content, which is easily accessible to students without much interventions from teachers and can be learned by children through self-learning or peer-learning
- Content, which is irrelevant in the present context

This present edition, is a reformatted version after carrying out the changes given above.

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Textbook Development Committee

Chairperson, Advisory Committee for Social Science Textbooks at Higher Secondary Level

Hari Vasudevan, *Professor,* Department of History, University of Calcutta, Kolkata

Chief Advisor

Tapas Majumdar, *Emeritus Professor,* Jawaharlal Nehru University, New Delhi

Members

Bhawna Rajput, *Sr. Lecturer,* Aditi Mahavidyalaya, Delhi University, Delhi

E. Bijoykumar Singh, *Professor,* Department of Economics, Manipur University, Imphal

M.M. Goel, *Reader,* Department of Commerce, PGDAV College (M), Delhi University, Delhi

Meera Malhotra, *Head,* Economics, Modern School, Barakhamba Road, New Delhi

Sudhir Kumar, *Reader,* A. N. Sinha Institute of Social Studies, Patna

T. P. Sinha, *Reader,* Department of Economics, S.S.N. College, Delhi University, Delhi

Member-Coordinator

Neeraja Rashmi, *Reader,* Economics, DESS, NCERT, New Delhi

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THE CONSTITUTION OF INDIA

PREAMBLE

WE, THE PEOPLE OF INDIA, having solemnly resolved to constitute India into a [1]**[SOVEREIGN SOCIALIST SECULAR DEMOCRATIC REPUBLIC]** and to secure to all its citizens :

JUSTICE, social, economic and political;

LIBERTY of thought, expression, belief, faith and worship;

EQUALITY of status and of opportunity and to promote among them all;

FRATERNITY assuring the dignity of the individual and the [2][unity and integrity of the Nation];

IN OUR CONSTITUENT ASSEMBLY this twenty-sixth day of November, 1949 do **HEREBY ADOPT, ENACT AND GIVE TO OURSELVES THIS CONSTITUTION.**

1. Subs. by the Constitution (Forty-second Amendment) Act, 1976, Sec.2, for "Sovereign Democratic Republic" (w.e.f. 3.1.1977)
2. Subs. by the Constitution (Forty-second Amendment) Act, 1976, Sec.2, for "Unity of the Nation" (w.e.f. 3.1.1977)

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CHAPTER

1

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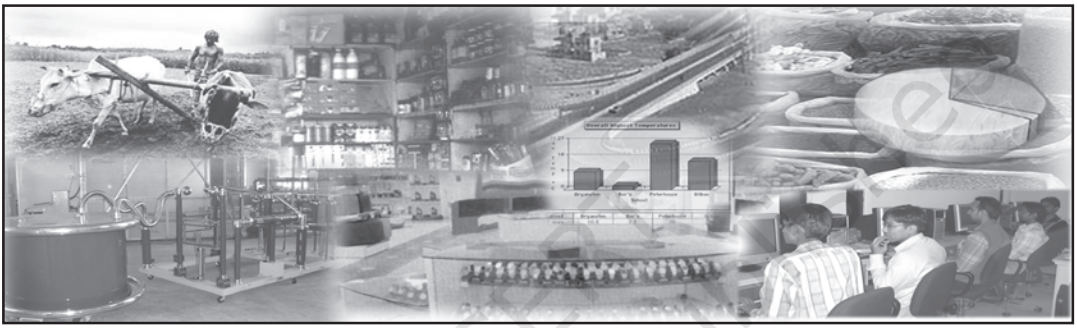
Introduction



Studying this chapter should enable you to:

- *know what the subject of economics is about;*
- *understand how economics is linked with the study of economic activities in consumption, production and distribution;*
- *understand why knowledge of statistics can help in describing consumption, production and distribution;*
- *learn about some uses of statistics in the understanding of economic activities.*

1. WHY ECONOMICS?

You have, perhaps, already had Economics as a subject for your earlier classes at school. You might have been told this subject is mainly around what *Alfred Marshall* (one of the founders of modern economics) called "*the study of man in the ordinary business of life*". Let us understand what that means.

When you buy goods (you may want to satisfy your own personal needs or those of your family or those of any other person to whom you want to make a gift) you are called a **consumer**.

When you sell goods to make a profit for yourself (you may be a shopkeeper), you are called a **seller**.

When you produce goods (you may be a farmer or a manufacturing company),or provide services (you may

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be a doctor, porter, taxi driver or transporter of goods) you are called a **producer**.

When you are in a job, working for some other person, and you get paid for it (you may be employed by somebody who pays you wages or a salary), you are called an **employee**.

When you employ somebody, giving them a wage, you are an **employer**.

In all these cases you will be called **gainfully employed** in an **economic activity**. Economic activities are ones that are undertaken for a monetary gain. This is what economists mean by **ordinary business of life**.

Activities

- List different activities of the members of your family. Would you call them economic activities? Give reasons.
- Do you consider yourself a consumer? Why?

We cannot get something for nothing

If you ever heard the story of *Aladdin* and *his Magic Lamp*, you would agree that Aladdin was a lucky guy. Whenever and whatever he wanted, he just had to rub his magic lamp and a genie appeared to fulfill his wish. When he wanted a palace to live in, the genie instantly made one for him. When he wanted expensive gifts to bring to the king when asking for his daughter's hand, he got them at the bat of an eyelid.

In real life we cannot be as lucky as Aladdin. Though, like him we have unlimited wants, we do not have a magic lamp. Take, for example, the pocket money that you get to spend. If you had more of it then you could have purchased almost all the things you wanted. But since your pocket money is limited, you have to choose only those things that you want the most. This is a basic teaching of Economics.

Activities

- Can you think for yourself of some other examples where a person with a given income has to choose which things and in what quantities he or she can buy at the prices that are being charged (called the current prices)?
- What will happen if the current prices go up?

Scarcity is the root of all economic problems. Had there been no scarcity, there would have been no economic problem. And you would not have studied Economics either. In our daily life, we face various forms of scarcity. The long queues at railway booking counters, crowded buses and trains, shortage of essential commodities, the rush to get a ticket to watch a new film, etc., are all manifestations of scarcity. We face scarcity because the things that satisfy our wants are limited in availability. Can you think of some more instances of scarcity?

The resources which the producers have are limited and also have alternative uses. Take the case of food

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that you eat every day. It satisfies your want of nourishment. Farmers employed in agriculture raise crops that produce your food. At any point of time, the resources in agriculture like land, labour, water, fertiliser, etc., are given. All these resources have alternative uses. The same resources can be used in the production of non-food crops such as rubber, cotton, jute etc. Thus, alternative uses of resources give rise to the problem of choice between different commodities that can be produced by those resources.

Activities

- Identify your wants. How many of them can you fulfill? How many of them are unfulfilled? Why you are unable to fulfill them?
- What are the different kinds of scarcity that you face in your daily life? Identify their causes.

Consumption, Production and Distribution

If you thought about it, you might have realised that Economics involves the study of man engaged in economic activities of various kinds. For this, you need to know reliable facts about all the diverse economic activities like production, consumption and distribution. Economics is often discussed in three parts: *consumption, production* and *distribution*.

We want to know how the consumer decides, given his income and many alternative goods to choose from, what to buy when he knows the prices. *This is the study of Consumption.*

We also want to know how the producer, similarly, chooses what and how to produce for the market. *This is the study of Production.*

Finally, we want to know how the national income or the total income arising from what has been produced in the country (called the Gross Domestic Product or GDP) is distributed through wages (and salaries), profits and interest (We will leave aside here income from international trade and investment). *This is the study of Distribution.*

Besides these three conventional divisions of the study of Economics about which we want to know all the facts, modern economics has to include some of the basic problems facing the country for special studies.

For example, you might want to know why or to what extent some households in our society have the capacity to earn much more than others. You may want to know how many people in the country are really poor, how many are middle-class, how many are relatively rich and so on. You

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may want to know how many are illiterate, who will not get jobs, requiring education, how many are highly educated and will have the best job opportunities and so on. In other words, you may want to know more facts in terms of numbers that would answer questions about poverty and disparity in society. If you do not like the continuance of poverty and gross disparity and want to do something about the ills of society you will need to know the facts about all these things before you can ask for appropriate actions by the government. If you know the facts it may also be possible to plan your own life better. Similarly, you hear of — some of you may even have experienced disasters like Tsunami, earthquakes, the bird flu — dangers threatening our country and so on that affect man's *'ordinary business of life'* enormously. Economists can look at these things provided they know how to collect and put together the facts about what these disasters cost systematically and correctly. You may perhaps think about it and ask yourselves whether it is right that modern economics now includes learning the basic skills involved in making useful studies for measuring poverty, how incomes are distributed, how earning opportunities are related to your education, how environmental disasters affect our lives and so on?

Obviously, if you think along these lines, you will also appreciate why we needed Statistics (which is the study of numbers relating to selected facts in a systematic form) to be added to all modern courses of modern economics.

Would you now agree with the following definition of economics that many economists use?

"Economics is the study of how people and society choose to employ scarce resources that could have alternative uses in order to produce various commodities that satisfy their wants and to distribute them for consumption among various persons and groups in society."

2. Statistics in Economics

In the previous section you were told about certain special studies that concern the basic problems facing a country. These studies required that we know more about economic facts. Such economic facts are also known as **economic data**.

The purpose of collecting data about these economic problems is to understand and explain these problems in terms of the various causes behind them. In other words, we try to analyse them. For example, when we **analyse** the hardships of poverty, we try to explain it in terms of the various factors such as unemployment, low productivity of people, backward technology, etc.

But, what purpose does the analysis of poverty serve unless we are able to find ways to mitigate it. We may, therefore, also try to find those measures that help solve an economic problem. In Economics, such measures are known as **policies**.

So, do you realise, then, that no analysis of an economic problem would

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be possible without data on various factors underlying an economic problem? And, that, in such a situation, no policies can be formulated to solve it. If yes, then you have, to a large extent, understood the basic relationship between Economics and Statistics.

3. What is Statistics?

At this stage you are probably ready to know more about Statistics. You might very well want to know what the subject 'Statistics' is all about.

Statistics deals with the collection, analysis, interpretation and presentation of numerical data. It is a branch of mathematics and also used in the disciplines such as accounting, economics, management, physics, finance, psychology and sociology.

Here we are concerned with data from the field of Economics. Most Economics data are quantitative. For example, a statement in Economics like "the production of rice in India has increased from 39.58 million tonnes in 1974–75 to 106.5 million tonnes in 2013–14, is a quantitative data.

In addition to quantitative data, Economics also uses qualitative data. The chief characteristic of such information is that they describe attributes of a single person or a group of persons that is important to record as accurately as possible even though they cannot be measured in quantitative terms. Take, for example, 'gender' that distinguishes a person as man/woman or boy/girl. It is often possible (and useful) to state the information about an attribute of a person in terms of degrees (like better/ worse; sick/ healthy/ more healthy; unskilled/ skilled/ highly skilled, etc.). Such qualitative information or statistics is often used in Economics and other social sciences and collected and stored systematically like quantitative information (on prices, incomes, taxes paid, etc.), whether for a single person or a group of persons.

You will study in the subsequent chapters that *statistics* involves *collection* of data. The next step is to present the data in *tabular, diagrammatic* and *graphic* forms. The data, then, are summarised by calculating various numerical indices, such as *mean, variance, standard deviation,* etc., that represent the broad characteristics of the collected set of information. Finally, the data are analysed and interpreted.

Activities

- Think of two examples of qualitative and quantitative data.
- Which of the following would give you qualitative data; beauty, intelligence, income earned, marks in a subject, ability to sing, learning skills?

4. What Statistics Does?

Statistics is an indispensable tool for an economist that helps him to understand an economic problem. Using its various methods, effort is made to find the causes behind it with the help of qualitative and quantitative facts of an economic problem. Once the causes of the problem are identified, it

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is easier to formulate certain policies to tackle it.

But there is more to Statistics. It enables an economist to present economic facts in a precise and definite form that helps in proper comprehension of what is stated. When economic facts are expressed in statistical terms, they become exact. Exact facts are more convincing than vague statements. For instance, saying that with precise figures, 310 people died in the recent earthquake in Kashmir, is more factual and, thus, a statistical data. Whereas, saying hundreds of people died, is not.

Statistics also helps in condensing mass data into a few numerical measures (such as mean, variance etc., about which you will learn later). These numerical measures help to summarise data. For example, it would be impossible for you to remember the incomes of all the people in a data if the number of people is very large. Yet, one can remember easily a summary figure like the average income that is obtained statistically. In this way, Statistics summarises and presents a meaningful overall information about a mass of data.

Quite often, Statistics is used in finding relationships between different economic factors. An economist may be interested in finding out what happens to the demand for a commodity when its price increases or decreases? Or, would the supply of a commodity be affected by the changes in its own price? Or, would the consumption expenditure increase when the average income increases? Or, what happens to the general price level when the government expenditure increases? Such questions can only be answered if any relationship exists between the various economic factors that have been stated above. Whether such relationships exist or not can be easily verified by applying statistical methods to their data. In some cases the economist might assume certain relationships between them and like to test whether the assumption she/he made about the relationship is valid or not. The economist can do this only by using statistical techniques.

In another instance, the economist might be interested in predicting the changes in one economic factor due to the changes in another factor. For example, she/he might be interested in knowing the impact of today's investment on the national income in future. Such an exercise cannot be undertaken without the knowledge of Statistics.

Sometimes, formulation of plans and policies requires the knowledge of future trends. For example, an economic planner has to decide in 2017 how much the economy should produce in 2020. In other words, one must know what could be the expected level of consumption in 2020 in order to decide the production plan of the economy for 2020. In this situation, one might make subjective judgement based on the guess about consumption in 2020. Alternatively, one might use statistical tools to predict consumption

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in 2020. That could be based on the data of consumption of past years or of recent years obtained by surveys. Thus, statistical methods help formulate appropriate economic policies that solve economic problems.

5. Conclusion

Today, we increasingly use Statistics to analyse serious economic problems such as rising prices, growing population, unemployment, poverty etc., to find measures that can solve such problems. Further, it also helps to evaluate the impact of such policies in solving the economic problems. For example, it can be ascertained easily using statistical techniques whether the policy of family planning is effective in checking the problem of ever-growing population.

In economic policies, Statistics plays a vital role in decision making. For example, in the present time of rising global oil prices, it might be necessary to decide how much oil India should import in 2025. The decision to import would depend on the expected domestic production of oil and the likely demand for oil in 2025. Without the use of Statistics, it cannot be determined what the expected domestic production of oil and the likely demand for it would be. Thus, the decision to import oil cannot be made unless we know the actual requirement of oil. This vital information that helps to make the decision to import oil can only be obtained statistically.

Statistical methods are no substitute for common sense!

There is an interesting story which is told to make fun of statistics. It is said that a family of four persons (husband, wife and two children) once set out to cross a river. The father knew the average depth of the river. So, he calculated the average height of his family members. Since the average height of his family members was greater than the average depth of the river, he thought they could cross safely. Consequently, some members of the family (children) drowned while crossing the river.

Does the fault lie with the statistical method of calculating averages or with the misuse of the averages?

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Recap

- Our wants are unlimited but the resources used in the production of goods that satisfy our wants are limited and scarce. Scarcity is the root of all economic problems.
- Resources have alternative uses.
- Purchase of goods by consumers to satisfy their various needs is Consumption.
- Manufacture of goods by producers for the market is Production.
- Division of the national income into wages, profits, rents and interests is Distribution.
- Statistics finds economic relationships using data and verifies them.
- Statistical tools are used in prediction of future trends.
- Statistical methods help analyse economic problems and formulate policies to solve them.

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EXERCISES

1. Mark the following statements as true or false.
   (i) Statistics can only deal with quantitative data.
   (ii) Statistics solves economic problems.
   (iii) Statistics is of no use to Economics without data.
2. Make a list of activities in a bus stand or a market place. How many of them are economic activities?
3. 'The Government and policy makers use statistical data to formulate suitable policies of economic development'. Illustrate with two examples.
4. "You have unlimited wants and limited resources to satisfy them." Explain this statement by giving two examples.
5. How will you choose the wants to be satisfied?
6. What are your reasons for studying Economics?
7. Statistical methods are no substitute for common sense. Comment with examples from your daily life.

CHAPTER

2

11098CH02

Collection of Data

Studying this chapter should enable you to:

- *understand the meaning and purpose of data collection;*
- *distinguish between primary and secondary sources;*
- *know the mode of collection of data;*
- *distinguish between Census and Sample Surveys;*
- *be familiar with the techniques of sampling;*
- *know about some important sources of secondary data.*

1. INTRODUCTION

In the previous chapter, you have read about what is economics. You also studied about the role and importance of statistics in economics. In this chapter, you will study the sources of data and the mode of data collection. The purpose of collection of data is to show evidence for reaching a sound and clear solution to a problem.

In economics, you often come across a statement like this,

"After many fluctuations the output of food grains rose to 132 million tonnes in 1978-79 from 108 million tonnes in 1970-71, but fell to 108 million tonnes in 1979-80. Production of food grains then rose continuously to 252 million tonnes in 2015-16 and touched 272 million tonnes in 2016–17."

In this statement, you can observe that the food grains production in different years does not remain the same. It varies from year to year and

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from crop to crop. As these values vary, they are called *variable*. The variables are generally represented by the letters X, Y or Z. Each value of a variable is an observation. For example, the food grain production in India varies between 108 million tonnes in 1970–71 to 272 million tonnes in 2016-17 as shown in the following table. The years are represented by variable X and the production of food grain in India (in million tonnes) is represented by variable Y.

TABLE 2.1

Production of Food Grain in India (Million Tonnes)

X	*Y*
1970–71	108
1978–79	132
1990–91	176
1997–98	194
2001–02	212
2015-16	252
2016-17	272

Here, the values of these variables X and Y are the 'data', from which we can obtain information about the production of food grains in India. To know the fluctuations in food grains production, we need the 'data' on the production of food grains in India for various years. 'Data' is a tool, which helps in understanding problems by providing information.

You must be wondering where do 'data' come from and how do we collect these? In the following sections we will discuss the types of data, method and instruments of data collection and sources of obtaining data.

2. What are the Sources of Data?

Statistical data can be obtained from two sources. The *researcher* may collect the data by conducting an enquiry. Such data are called *Primary Data,* as they are based on first hand information. Suppose, you want to know about the popularity of a filmstar among school students. For this, you will have to enquire from a large number of school students, by asking questions from them to collect the desired information. The data you get, is an example of primary data.

If the data have been collected and processed (scrutinised and tabulated) by some other agency, they are called *Secondary Data.* They can be obtained either from published sources such as government reports, documents, newspapers, books written by economists or from any other source, for example, a website. Thus, the data are *primary* to the source that collects and processes them for the first time and *secondary* for all sources that later use such data. Use of secondary data saves time and cost. For example, after collecting the data on the popularity of the filmstar among students, you publish a report. If somebody uses the data collected by you for a similar study, it becomes secondary data.

3. How do we Collect the Data?

Do you know how a manufacturer decides about a product or how a political party decides about a candidate? They conduct a survey by

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asking questions about a particular product or candidate from a large group of people. The purpose of surveys is to describe some characteristics like price, quality, usefulness (in case of the product) and popularity, honesty, loyalty (in case of the candidate). The purpose of the *survey* is to collect data. *Survey* is a method of gathering information from individuals.

Preparation of Instrument

The most common type of instrument used in surveys is questionnaire/ interview schedule. The questionnaire is either self administered by the respondent or administered by the researcher (enumerator) or trained investigator. While preparing the questionnaire/interview schedule, you should keep in mind the following points;

- *The questionnaire should not be too long*. The number of questions should be as minimum as possible.
- *The questionnaire should be easy to understand and avoid ambiguous or difficult words.*
- *The questions should be arranged in an order such that the person answering should feel comfortable.*
- *The series of questions should move from general to specific*. The questionnaire should start from general questions and proceed to more specific ones. For example:

Poor Q

(i) Is increase in electricity charges justified?

(ii) Is the electricity supply in your locality regular?

Good Q

(i) Is the electricity supply in your locality regular?

(ii) Is increase in electricity charges justified?

- *The questions should be precise and clear.* For example,

Poor Q

What percentage of your income do you spend on clothing in order to look presentable?

Good Q

What percentage of your income do you spend on clothing?

- *The questions should not be ambiguous. They should enable the respondents to answer quickly, correctly and clearly*. For example:

Poor Q

Do you spend a lot of money on books in a month?

Good Q

(Tick mark the appropriate option)

How much do you spend on books in a month?

(i) Less than Rs 200

(ii) Rs 200–300

(iii) Rs 300–400

(iv) More than Rs 400

- *The question should not use double negatives*. The questions starting with "Wouldn't you" or "Don't you" should be avoided, as they may lead to biased responses. For example:

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Poor Q
Don't you think smoking should be prohibited?
Good Q
Do you think smoking should be prohibited?

- *The question should not be a leading question, which gives a clue about how the respondent should answer*. For example:

Poor Q
How do you like the flavour of this high-quality tea?
Good Q
How do you like the flavour of this tea?

- *The question should not indicate alternatives to the answer*. For example:

Poor Q
Would you like to do a job after college or be a housewife?
Good Q
What would you like to do after college ?

The questionnaire may consist of *closed-ended* (or structured) questions or *open-ended* (or unstructured) questions. The above question about what a student wants do after college is an open-ended question.

C*losed-ended or structured* questions can either be a *two-way question* or a *multiple choice* question. When there are only two possible answers, 'yes' or 'no', it is called a two-way question.

When there is a possibility of more than two options of answers, *multiple choice* questions are more appropriate. *Example,*

Q. Why did you sell your land?
(i) To pay off the debts.
(ii) To finance children's education.
(iii) To invest in another property.
(iv) Any other (please specify).

Closed-ended questions are easy to use, score and to codify for analysis, because all respondents can choose from the given options. But they are difficult to write as the alternatives should be clearly written to represent both sides of the issue. There is also a possibility that an individual's true response is not present among the options given. For this, the choice of '*Any Other*' is provided, where the respondent can write a response, which was not anticipated by the researcher. Moreover, another limitation of multiple-choice questions is that they tend to restrict the answers by providing alternatives, without which the respondents may have answered differently.

Open-ended questions allow for more individualised responses, but they are difficult to interpret and hard to score, since there are a lot of variations in the responses. *Example,*

Q. What is your view about globalisation?

Mode of Data Collection

Have you ever come across a television show in which reporters ask questions from children, housewives or general public regarding their examination performance or a brand of soap or a

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political party? The purpose of asking questions is to do a survey for collection of data. There are three basic ways of collecting data: (i) Personal Interviews, (ii) Mailing (questionnaire) Surveys, and (iii) Telephone Interviews.

Personal Interviews

This method is used when the researcher has access to all the members. The researcher (or investigator) conducts face-to-face interviews with the respondents.

Personal interviews are preferred due to various reasons. Personal contact is made between the respondent and the interviewer. The interviewer has the opportunity of explaining the study and answering the queries of respondents. The interviewer can request the respondent to expand on answers that are particularly important. Misinterpretation and misunderstanding can be avoided. Watching the reactions of respondents can provide supplementary information.

Personal interview has some demerits too. It is expensive, as it requires trained interviewers. It takes longer time to complete the survey. Presence of the researcher may inhibit respondents from saying what they really think.

Mailing Questionnaire

When the data in a survey are collected by mail, the questionnaire is sent to each individual by *mail* with a request to complete and return it by a given date. The advantages of this method are that, it is less expensive. It allows the researcher to have access to people in remote areas too, who might be difficult to reach in person or by telephone. It does not allow influencing of the respondents by the interviewer. It also permits the respondents to take sufficient time to give thoughtful answers to the questions.

These days online surveys or surveys through short messaging service, i.e., SMS are popular. Do you know how an online survey is conducted?

The disadvantages of mail survey are that there is less opportunity to provide assistance in clarifying instructions, so there is a possibility of misunderstanding the questions. Mailing is also likely to produce low response rates due to certain factors, such as returning the questionnaire without completing it, not returning the questionnaire at all, loss of questionnaire in the mail itself, etc.

Telephone Interviews

In a telephone interview, the investigator asks questions over the

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telephone. The advantages of telephone interviews are that they are cheaper than personal interviews and can be conducted in a shorter time. They allow the researcher to assist the respondent by clarifying the questions. Telephonic interview is better in cases where the respondents are reluctant to answer certain questions in personal interviews.

The disadvantage of this method is access to people, as many people may not own telephones.

Pilot Survey

Once the questionnaire is ready, it is advisable to conduct a try-out with a small group which is known as *Pilot Survey* or *Pre-testing* of the questionnaire. The pilot survey helps in providing a preliminary idea about the survey. It helps in *pre-testing* of the questionnaire, so as to know the shortcomings and drawbacks of the questions. Pilot survey also helps in assessing the suitability of questions, clarity of instructions, performance of enumerators and the cost and time involved in the actual survey.

Activities

- You have to collect information from a person, who lives in a remote village of India. Which mode of data collection will be appropriate and why? Discuss.
- You have to interview the parents about the quality of teaching in a school. If the principal of the school is present there, what types of problems can arise?

Advantages	*Disadvantages*
Personal Interview	
• Highest Response Rate • Allows use of all types of questions • Better for using open-ended questions • Allows clarification of ambiguous questions.	• Most expensive • Possibility of influencing respondents • More time-taking.
Mailed Interview	
• Least expensive • Only method to reach remote areas • No influence on respondents • Maintains anonymity of respondents • Best for sensitive questions.	• Cannot be used by illiterates • Long response time • Does not allow explanation of unambiguous questions • Reactions cannot be watched.
Telephonic Interviews	
• Relatively low cost • Relatively less influence on respondents • Relatively high response rate.	• Limited use • Reactions cannot be watched • Possibility of influencing respondents.

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4. Census and Sample Surveys

Census or Complete Enumeration

A survey, which includes every element of the population, is known as *Census* or the *Method of Complete Enumeration*. If certain agencies are interested in studying the total population in India, they have to obtain information from all the households in rural and urban India. It is carried out every ten years. A house-to-house enquiry is carried out, covering all households in India. Demographic data on birth and death rates, literacy, employment, life expectancy, size and composition of population, etc., are collected and published by the Registrar General of India. The last *Census of India* was held in 2011.

According to the Census 2011, population of India was 121.09 crore, which was 102.87 crore in 2001. Census 1901 indicated that the population of the country was 23.83 crore. Since then, in a period of 110 years, the population of the country has increased by more than 97 crore. The average annual growth rate of population which was 2.2 per cent per year in the decade 1971-81 came down to 1.97 per cent in 1991-2001 and 1.64 per cent during 2001-2011.

Population and Sample

Population or the *Universe* in statistics means totality of the items under study. Thus, the *Population* or the *Universe* is a group to which the results of the study are intended to apply. *A population is always all the individuals/items who possess certain characteristics (or a set of characteristics),* according to the purpose of the survey. The first task in selecting a sample is to identify the *population*. Once the population is identified, the researcher selects a *method of studying it. If the researcher finds that survey of the whole population is not possible, then he/she may decide to select a Representative Sample. A sample refers to a group or section of the population from which information is to be obtained. A good sample (representative sample)* is generally smaller than the *population* and is capable of providing reasonably accurate information about the population at a much lower cost and shorter time.

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Suppose you want to study the average income of people in a certain region. According to the Census method, you would be required to find out the income of every individual in the region, add them up and divide by number of individuals to get the average income of people in the region. This method would require huge expenditure, as a large number of enumerators have to be employed. Alternatively, you select a *representative sample*, of a few individuals, from the region and find out their income. The average income of the selected group of individuals is used as an estimate of average income of the individuals of the entire region.

Example

- *Research problem*: To study the economic condition of agricultural labourers in Churachandpur district of Manipur.
- *Population*: All agricultural labourers in Churachandpur district.
- *Sample*: Ten per cent of the agricultural labourers in Churachandpur district.

Most of the surveys are sample surveys. These are preferred in statistics because of a number of reasons. A sample can provide reasonably reliable and accurate information at a lower cost and shorter time. As samples are smaller than population, more detailed information can be collected by conducting intensive enquiries. As we need a smaller team of enumerators, it is easier to train them and supervise their work more effectively.

Now the question is how do you do the sampling? There are two main types of sampling, *random* and *non-random.*

Activities

- In which years will the next Census be held in India and China?
- If you have to study the opinion of students about the new economics textbook of class XI, what will be your *population* and *sample?*
- If a researcher wants to estimate the average yield of wheat in Punjab, what will be her/his *population* and *sample*?

The following description will make their distinction clear.

Random Sampling

As the name suggests, random sampling is one where the individual units from the population (samples) are selected *at random*. The government wants to determine the impact of the rise in petrol price on the household budget of a particular locality. For this, a representative (random) sample of 30 households has to be taken and studied. The names of all 300 households of that area are written on paper and mixed, then 30 names to be interviewed are selected one by one.

In random sampling, every individual has an equal chance of being selected. In the above example, all 300 sampling units (also called *sampling frame)* of the population got an equal chance of being included in

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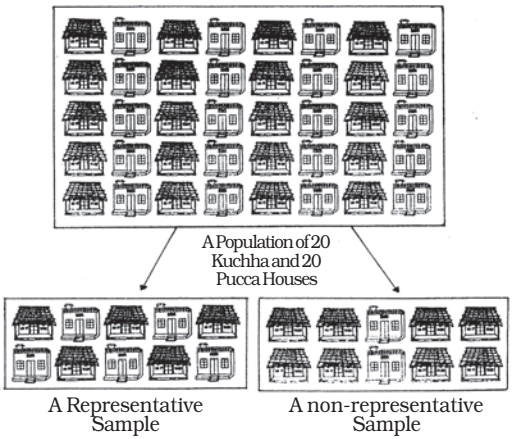

the sample of 30 units and hence the sample, such drawn, is a random sample. This is also called *lottery method*. Nowadays computer programmes are used to select random samples.

Exit Polls

You must have seen that when an election takes place, the television networks provide election coverage. They also try to predict the results. This is done through *exit polls*, wherein a random sample of voters who exit the polling booths are asked whom they voted for. From the data of the sample of voters, the prediction is made. You might have noticed that exit polls do not always predict correctly. Why?

Activity

- You have to analyse the trend of foodgrains production in India for the last fifty years. As it is difficult to collect data for all the years, you are asked to select a sample of production of ten years. Using the Random Number Tables, how will you select your sample years?

Non-Random Sampling

There may be a situation that you have to select 10 out of 100 households in a locality. You have to decide which household to select and which to reject. You may select the households conveniently situated or the households known to you or your friend. In this case, you are using your judgement (bias) in selecting 10 households. This way of selecting 10 out of 100 households is not a random selection. *In a non-random sampling method all the units of the population do not have an equal chance of being selected and convenience or judgement of the investigator plays an important role in selection of the sample.* They are mainly selected on the basis of judgment, purpose, convenience or quota and are non-random samples.

5. Sampling and Non-Sampling Errors

Sampling Errors

A population consisting of numerical values has two important characteristics which are of relevance here. First, Central Tendency which may be measured by the mean, the median or the mode. Second, Dispersion, which can be measured by caculating the "standard deviation", " mean deviation", " range", etc.

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The purpose of the sample is to get one or more estimate of the population parameters. Sampling error refers to the difference between the sample estimate and the corresponding population parameter (actual value of the characteristic of the population for example, average income, etc). *Thus, the difference between the actual value of a parameter of the population and its estimate (from the sample) is the sampling error.* It is possible to reduce the magnitude of sampling error by taking a larger sample.

Example

Consider a case of incomes of 5 farmers of Manipur. The variable x (income of farmers) has measure-ments 500, 550, 600, 650, 700. We note that the *population average* of (500 + 550 + 600 + 650 + 700) ÷ 5 = 3000 ÷ 5 = 600.

Now, suppose we select a sample of two individuals where x has measurements of 500 and 600. The *sample average* is (500 + 600) ÷ 2 = 1100 ÷ 2 = 550.

Here, the *sampling error* of the *estimate* = 600 (true value) – 550 (estimate) = 50.

Non-Sampling Errors

Non-sampling errors are more serious than sampling errors because a sampling error can be minimised by taking a larger sample. It is difficult to minimise non-sampling error, even by taking a large sample. Even a *Census* can contain non-sampling errors. Some of the non-sampling errors are:

Sampling Bias

Sampling bias occurs when the sampling plan is such that some members of the target population could not possibly be included in the sample.

Non-Response Errors

Non-response occurs if an interviewer is unable to contact a person listed in the sample or a person from the sample refuses to respond. In this case, the sample observation may not be representative.

Errors in Data Acquisition

This type of error arises from recording of incorrect responses. Suppose, the teacher asks the students to measure the length of the teacher's table in the classroom. The measurement by the students may differ. The differences may occur due to differences in measuring tape, carelessness of the students, etc. Similarly, suppose, we want to collect data on prices of oranges. We know that prices vary from shop to shop and from market to market. Prices also vary according to the quality. Therefore, we can only consider the average prices. Recording mistakes can also take place as the enumerators or the respondents may commit errors in recording or trans-scripting the data, for example, he/she may record 13 instead of 31.

6. Census of India and NSSO

There are some agencies both at the national and state level to collect,

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process and tabulate the statistical data. Some of the agencies at the national level are Census of India, National Sample Survey (NSS), Central Statistics Office (CSO), Registrar General of India (RGI), Directorate General of Commercial Intelligence and Statistics (DGCIS), Labour Bureau, etc.

The Census of India provides the most complete and continuous demographic record of population. The Census is being regularly conducted every ten years since 1881. The first Census after Independence was conducted in 1951. The Census officials collect information on various aspects of population such as the size, density, sex ratio, literacy, migration, rural-urban distribution, etc. Census data is interpreted and analysed to understand many economic and social issues in India.

The NSS was established by the Government of India to conduct nation-wide surveys on socio-economic issues. The NSS does continuous surveys in successive rounds. The data collected by NSS are released through reports and its quarterly journal *Sarvekshana*. NSS provides periodic estimates of literacy, school enrolment, utilisation of educational services, employment, unemployment, manufacturing and service sector enterprises, morbidity, maternity, child care, utilisation of the public distribution system etc. The NSS 60th round survey (January–June 2004) was on morbidity and healthcare. The NSS 68th round survey (2011-12) was on consumer expenditure. The NSS also collects details of industrial activities and retail prices for various goods. They are used by Government of India for planning puposes.

7. Conclusion

Economic facts, expressed in terms of numbers, are called data. The purpose of data collection is to understand, explain and analyse a problem and causes behind it. Primary data is obtained by conducting a survey. Survey includes various steps, which need to be planned carefully. There are various agencies which collect, process, tabulate and publish statistical data. These are used as secondary data. However, the choice of source of data and mode of data collection depends on the objective of the study.

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Recap

- Data is a tool which helps in reaching a sound conclusion on any problem.
- Primary data is based on first hand information.
- Survey can be done by personal interviews, mailing questionnaires and telephone interviews.
- Census covers every individual/unit belonging to the population.
- Sample is a smaller group selected from the population from which the relevant information would be sought.
- In a random sampling, every individual is given an equal chance of being selected for providing information.
- Sampling error is due to the difference between the value of the sample estimate and the value of the corresponding population parameter.
- Non-sampling errors can arise in data acquisition, by non-response or by bias in selection.
- Census of India and National Sample Survey are two important agencies at the national level, which collect, process and tabulate data on many important economic and social issues.

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EXERCISES

1. Frame at least four appropriate multiple-choice options for following questions:
   (i) Which of the following is the most important when you buy a new dress?
   (ii) How often do you use computers?
   (iii) Which of the newspapers do you read regularly?
   (iv) Rise in the price of petrol is justified.
   (v) What is the monthly income of your family?
2. Frame five two-way questions (with 'Yes' or 'No').
3. State whether the following statements are True or False.
   (i) There are many sources of data.
   (ii) Telephone survey is the most suitable method of collecting data, when the population is literate and spread over a large area.
   (iii) Data collected by investigator is called the secondary data.
   (iv) There is a certain bias involved in the non-random selection of samples.
   (v) Non-sampling errors can be minimised by taking large samples.
4. What do you think about the following questions? Do you find any

problem with these questions? Describe.
(i) How far do you live from the closest market?
(ii) If plastic bags are only 5 per cent of our garbage, should it be banned?
(iii) Wouldn't you be opposed to increase in price of petrol?
(iv) Do you agree with the use of chemical fertilisers?
(v) Do you use fertilisers in your fields?
(vi) What is the yield per hectare in your field?

5. You want to do a research on the popularity of Vegetable Atta Noodles among children. Design a suitable questionnaire for collecting this information.

6. In a village of 200 farms, a study was conducted to find the cropping pattern. Out of the 50 farms surveyed, 50% grew only wheat. What is the population and the sample size?

7. Give two examples each of sample, population and variable.

8. Which of the following methods give better results and why?
(a) Census (b) Sample

9. Which of the following errors is more serious and why?
(a) Sampling error (b) Non-Sampling error

10. Suppose there are 10 students in your class. You want to select three out of them. How many samples are possible?

11. Discuss how you would use the lottery method to select 3 students out of 10 in your class.

12. Does the lottery method always give you a random sample? Explain.

13. Explain the procedure for selecting a random sample of 3 students out of 10 in your class by using random number tables.

14. Do samples provide better results than surveys? Give reasons for your answer.

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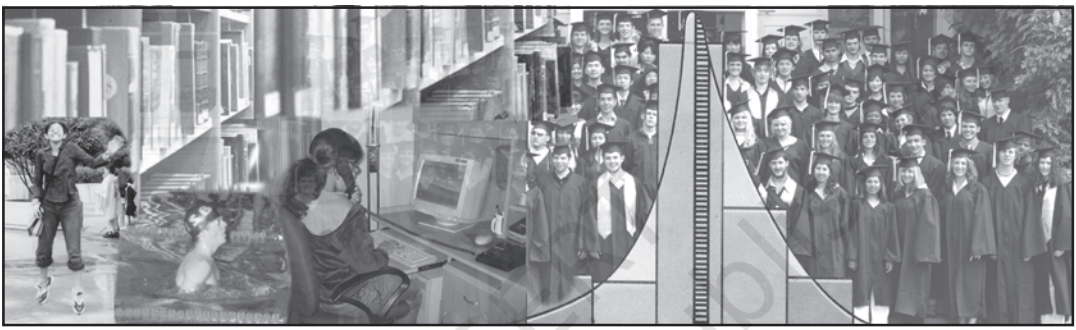
CHAPTER 3

Organisation of Data



Studying this chapter should enable you to:

- *classify the data for further statistical analysis;*
- *distinguish between quantitative and qualitative classification;*
- *prepare a frequency distribution table;*
- *know the technique of forming classes;*
- *be familiar with the method of tally marking;*
- *differentiate between univariate and bivariate frequency distributions.*

1. INTRODUCTION

In the previous chapter you have learnt about how data is collected. You also came to know the difference between census and sampling. In this chapter, you will know how the data, that you collected, are to be classified. The purpose of classifying raw data is to bring order in them so that they can be subjected to further statistical analysis easily.

Have you ever observed your local junk dealer or *kabadiwallah* to whom you sell old newspapers, broken household items, empty glass bottles, plastics, etc? He purchases these things from you and sells them to those who recycle them. But with so much junk in his shop it would be very difficult for him to manage his trade, if he had not organised them properly. To ease his situation he suitably groups or "classifies" various junk. He puts old newspapers together and

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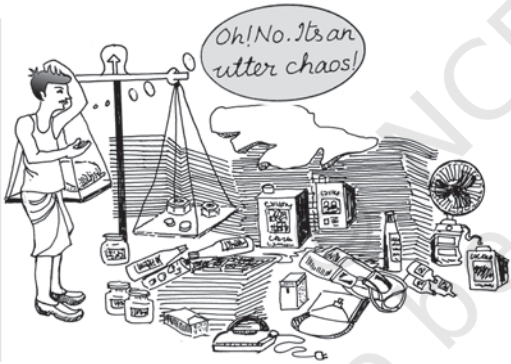
ties them with a rope. Then collects all empty glass bottles in a sack. He heaps the articles of metals in one corner of his shop and sorts them into groups like "iron", "copper", "aluminium", "brass" etc., and so on. In this way he groups his junk into different classes — "newspapers, "plastics", "glass", "metals" etc. — and brings order in them. Once his junk is arranged and classified, it becomes easier for him to find a particular item that a buyer may demand.

Likewise when you arrange your schoolbooks in a certain order, it becomes easier for you to handle them. You may classify them according to



subjects where each subject becomes a group or a class. So, when you need a particular book on history, for instance, all you need to do is to search that book in the group "History". Otherwise, you would have to search through your entire collection to find the particular book you are looking for.

While classification of objects or things saves our valuable time and effort, it is not done in an arbitrary manner. The *kabadiwallah* groups his junk according to the markets for reused goods. For example, under the group "Glass" he would put empty bottles, broken mirrors and windowpanes, etc. Similarly when you classify your history books under the group "History" you would not put a book of a different subject in that group. Otherwise the entire purpose of grouping would be lost. *Classification, therefore, is arranging or organising things into groups or classes based on some criteria.*

Activity

- Visit your local post-office to find out how letters are sorted. Do you know what the pin-code in a letter indicates? Ask your postman.

2. Raw Data

Like the *kabadiwallah's* junk, the unclassified data or *raw data* are highly disorganised. They are often very large and cumbersome to handle. To draw meaningful conclusions from them is a tedious task because they do not yield to statistical methods easily. Therefore proper organisation and presentation of such data is needed before any systematic statistical analysis is undertaken. Hence after collecting data the next step is to organise and present them in a classified form.

Suppose you want to know the performance of students in mathematics and you have collected data on marks in mathematics of 100 students of your school. If you present

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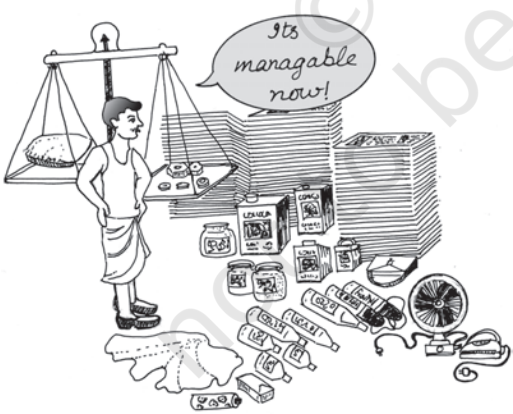
them as a table, they may appear something like Table 3.1.

TABLE 3.1
Marks in Mathematics Obtained by 100 Students in an Examination

47	45	10	60	51	56	66	100	49	40
60	59	56	55	62	48	59	55	51	41
42	69	64	66	50	59	57	65	62	50
64	30	37	75	17	56	20	14	55	90
62	51	55	14	25	34	90	49	56	54
70	47	49	82	40	82	60	85	65	66
49	44	64	69	70	48	12	28	55	65
49	40	25	41	71	80	0	56	14	22
66	53	46	70	43	61	59	12	30	35
45	44	57	76	82	39	32	14	90	25

Or you could have collected data on the monthly expenditure on food of 50 households in your neighbourhood to know their average expenditure on food. The data collected, in that case, had you presented as a table, would have resembled Table 3.2. Both Tables 3.1 and 3.2 are *raw* or *unclassified data*. In both the tables you find that



numbers are not arranged in any order. Now if you are asked for the highest marks in mathematics from Table 3.1

Table 3.2
Monthly Household Expenditure (in Rupees) on Food of 50 Households

1904	1559	3473	1735	2760
2041	1612	1753	1855	4439
5090	1085	1823	2346	1523
1211	1360	1110	2152	1183
1218	1315	1105	2628	2712
4248	1812	1264	1183	1171
1007	1180	1953	1137	2048
2025	1583	1324	2621	3676
1397	1832	1962	2177	2575
1293	1365	1146	3222	1396

then you have to first arrange the marks of 100 students either in ascending or in descending order. That is a tedious task. It becomes more tedious, if instead of 100 you have the marks of 1,000 students to handle. Similarly, in Table 3.2, you would note that it is difficult for you to ascertain the average monthly expenditure of 50 households. And this difficulty will go up manifold if the number was larger — say, 5,000 households. Like our *kabadiwallah*, who would be distressed to find a particular item when his junk becomes large and disarranged, you would face a similar situation when you try to get any information from raw data that are large. In one word, therefore, it is a tedious task to pull information from large unclassified data.

The raw data are summarised, and made comprehensible by classification. When facts of similar characteristics are placed in the same class, it enables one to locate them easily, make comparison, and draw inferences without any difficulty. You have

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studied in Chapter 2 that the Government of India conducts Census of population every ten years. About 20 crore persons were contacted in Census 2001. The raw data of census are so large and fragmented that it appears an almost impossible task to draw any meaningful conclusion from them. But when the same data is classified according to gender, education, marital status, occupation, etc., the structure and nature of population of India is, then, easily understood.

The raw data consist of observations on variables. The raw data as given in Tables 3.1 and 3.2 consist of observations on a specific or group of variables. Look at Table 3.1 for instance which contains marks in mathematics scored by 100 students. How can we make sense of these marks? The mathematics teacher looking at these marks would be thinking– How have my students done? How many have not passed? How we classify the data depends upon the purpose we have in mind. In this case, the teacher wishes to understand in some depth– how these students have done. She would probably choose to construct the frequency distribution. This is discussed in the next section.

Activity

- Collect data of total weekly expenditure of your family for a year and arrange it in a table. See how many observations you have. Arrange the data monthly and find the number of observations.

3. Classification of Data

The groups or classes of a classification is done in various ways. Instead of classifying your books according to subjects — "History", "Geography", "Mathematics", "Science", etc. — you could have classified them author-wise in an alphabetical order. Or, you could have also classified them according to the year of publication. The way you want to classify them would depend on your requirement.

Likewise the raw data is classified in various ways depending on the purpose. They can be grouped according to time. Such a classification is known as a **Chronological Classification.** In such a classification, data are classified either in ascending or in descending order with reference to time such as years, quarters, months, weeks, etc. The following example shows the population of India classified in terms of years. The variable 'population' is a **Time Series** as it depicts a series of values for different years.

Example 1

Population of India (in crores)

Year	*Population (Crores)*
1951	35.7
1961	43.8
1971	54.6
1981	68.4
1991	81.8
2001	102.7
2011	121.0

In **Spatial Classification** the data are classified with reference to geographical locations such as countries, states, cities, districts, etc.

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Example 2 shows the yeild of wheat in different countries.

Example 2

Yield of Wheat for Different Countries (2013)

Country	*Yield of wheat (kg/hectare)*
Canada	3594
China	5055
France	7254
Germany	7998
India	3154
Pakistan	2787

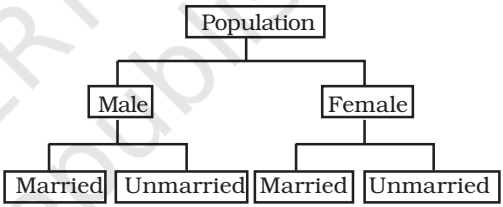
Source: Indian Agricultural Statistics at a Glance, 2015

Activities

- In Example 1, find out the years in which India's population was minimum and maximum,
- In Example 2, find the country whose yield of wheat is *slightly more* than that of India's. How much would that be in terms of percentage?
- Arrange the countries of Example 2 in the ascending order of yield. Do the same exercise for the descending order of yield.

Sometimes you come across characteristics that cannot be expressed quantitatively. Such characteristics are called *Qualities or Attributes.* For example, nationality, literacy, religion, gender, marital status, etc. They cannot be measured. Yet these *attributes* can be classified on the basis of either the presence or the absence of a qualitative characteristic. Such a classification of data on attributes is called a *Qualitative Classification.* In the following example, we find population of a country is grouped on the basis of the qualitative variable "gender". An observation could either be a male or a female. These two characteristics could be further classified on the basis of marital status as given below:

Example 3



The classification at the first stage is based on the presence and absence of an attribute, i.e., male or not male (female). At the second stage, each class — male and female, is further sub-divided on the basis of the presence or absence of another attribute, i.e., whether married or unmarried. Characteristics, like height, weight, age, income, marks of students, etc., are quantitative in nature. When the collected data of such characteristics are grouped into classes, it becomes a *Quantitative Classification.*

Activity

- The objects around can be grouped as either living or non-living. Is it a quantitative classification?

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Example 4

Frequency Distribution of Marks in Mathematics of 100 Students

Marks	*Frequency*
0–10	1
10–20	8
20–30	6
30–40	7
40–50	21
50–60	23
60–70	19
70–80	6
80–90	5
90–100	4
Total	*100*

Example 4 shows the quantitative classification of marks in mathematics of 100 students given in Table 3.1.

Activity

- Express the values of frequency of Example 4 as proportion or percentage of total frequency. Note that frequency expressed in this way is known as *relative frequency*.
- In Example 4, which class has the maximum concentration of data? Express it as percentage of total observations. Which class has the minimum concentration of data?

4. Variables: Continuous and Discrete

A simple definition of variable, which you have read in the last chapter, does not tell you how it varies. Variables differ on the basis of specific criterion. They are broadly classified into *two* types:

(i) *Continuous* and
(ii) *Discrete.*

A *continuous variable* can take *any* numerical value. It may take integral values (1, 2, 3, 4, ...), fractional values (1/2, 2/3, 3/4, ...), and values that are not exact fractions ($\sqrt{2}$ =1.414, $\sqrt{3}$ =1.732, ..., $\sqrt{7}$ =2.645). For example, the height of a student, as he/she grows say from 90 cm to 150 cm, would take all the values in between them. It can take values that are whole numbers like 90cm, 100cm, 108cm, 150cm. It can also take fractional values like 90.85 cm, 102.34 cm, 149.99cm etc. that are not whole numbers. Thus the variable "height" is capable of manifesting in every conceivable value and its values can also be broken down into infinite gradations.

Other examples of a continuous variable are weight, time, distance, etc.

Unlike a continuous variable, a *discrete variable* can take only certain values. Its value changes only by finite "jumps". It "jumps" from one value to another but does not take any intermediate value between them. For example, a variable like the "number of students in a class", for different classes, would assume values that are only whole numbers. It cannot take any fractional value like 0.5 because "half of a student" is absurd. Therefore it

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cannot take a value like 25.5 between 25 and 26. Instead its value could have been either 25 or 26. What we observe is that as its value changes from 25 to 26, the values in between them — the fractions are not taken by it. But we should not have the impression that a discrete variable cannot take any fractional value. Suppose X is a variable that takes values like 1/8, 1/16, 1/32, 1/64, ... Is it a discrete variable? Yes, because though X takes fractional values it cannot take any value between two adjacent fractional values. It changes or "jumps" from 1/8 to 1/16 and from 1/16 to 1/32. But it cannot take a value in between 1/8 and 1/16 or between 1/16 and 1/32.

Activity

- Distinguish the following variables as continuous and discrete:
  Area, volume, temperature, number appearing on a dice, crop yield, population, rainfall, number of cars on road and age.

Example 4 shows how the marks of 100 students are grouped into classes. You will be wondering as to how we got it from the raw data of Table 3.1. But, before we address this question, you must know what a frequency distribution is.

5. What is a Frequency Distribution?

A frequency distribution is a comprehensive way to classify raw data of a quantitative variable. It shows how different values of a variable (here, the marks in mathematics scored by a student) are distributed in different classes along with their corresponding class frequencies. In this case we have ten classes of marks: 0–10, 10–20, ... , 90–100. The term *Class Frequency* means the number of values in a particular class. For example, in the class 30– 40 we find 7 values of marks from raw data in Table 3.1. They are 30, 37, 34, 30, 35, 39, 32. The frequency of the class: 30–40 is thus 7. But you might be wondering why 40–which is occurring *twice* in the raw data – is not included in the class 30–40. Had it been included the class frequency of 30–40 would have been 9 instead of 7. The puzzle would be clear to you if you are patient enough to read this chapter carefully. So carry on. You will find the answer yourself.

Each class in a frequency distribution table is bounded by *Class Limits.* Class limits are the two ends of a class. The lowest value is called the *Lower Class Limit* and the highest value the *Upper Class Limit.* For example, the class limits for the class: 60–70 are 60 and 70. Its lower class limit is 60 and its upper class limit is 70. *Class Interval or Class Width* is the difference between the upper class limit and the lower class limit. For the class 60–70, the class interval is 10 (upper class limit *minus* lower class limit).

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The *Class Mid-Point* or *Class Mark* is the middle value of a class. It lies halfway between the lower class limit and the upper class limit of a class and can be ascertained in the following manner:

Class Mid-Point or Class Mark
= (Upper Class Limit + Lower Class Limit)/2

The class mark or mid-value of each class is used to represent the class. Once raw data are grouped into classes, individual observations are not used in further calculations. Instead, the class mark is used.

TABLE 3.3
The Lower Class Limits, the Upper Class Limits and the Class Mark

Class	*Frequency*	*Lower Class Limit*	*Upper Class Limit*	*Class Mark*
0–10	1	0	10	5
10–20	8	10	20	15
20–30	6	20	30	25
30–40	7	30	40	35
40–50	21	40	50	45
50–60	23	50	60	55
60–70	19	60	70	65
70–80	6	70	80	75
80–90	5	80	90	85
90–100	4	90	100	95

Frequency Curve is a graphic representation of a frequency distribution. Fig. 3.1 shows the diagrammatic presentation of the frequency distribution of the data in our example above. To obtain the frequency curve we plot the class marks on the X-axis and frequency on the Y-axis.

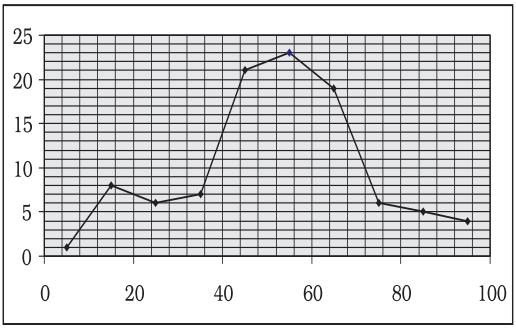

Fig3.1: *Diagrammatic Presentation of Frequency Distribution of Data.*

How to prepare a Frequency Distribution?

While preparing a frequency distribution, the following five questions need to be addressed:

1. Should we have equal or unequal sized class intervals?
2. How many classes should we have?
3. What should be the size of each class?
4. How should we determine the class limits?
5. How should we get the frequency for each class?

Should we have equal or unequal sized class intervals?

There are two situations in which unequal sized intervals are used. First, when we have data on income and other similar variables where the range is very high. For example, income per day may range from nearly Zero to many hundred crores of rupees. In such a situation, equal class intervals are not suitable because (i) if the class

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intervals are of moderate size and equal, there would be a large number of classes. (ii) If class intervals are large, we would tend to suppress information on either very small levels or very high levels of income.

Second, if a large number of values are concentrated in a small part of the range, equal class intervals would lead to lack of information on many values.

In all other cases, equal sized class intervals are used in frequency distributions.

How many classes should we have?

The number of classes is usually between six and fifteen. In case, we are using equal sized class intervals then number of classes can be the calculated by dividing the range *(the difference between the largest and the smallest values of variable)* by the size of the class intervals.

Activities

Find the range of the following:

- population of India in Example 1,
- yield of wheat in Example 2.

What should be the size of each class?

The answer to this question depends on the answer to the previous question. Given the range of the variable, we can determine the number of classes once we decide the class interval. Thus, we find that these two decisions are interlinked. We cannot decide on one without deciding on the other.

In Example 4, we have the number of classes as 10. Given the value of range as 100, the class intervals are automatically 10. Note that in the present context we have chosen class intervals that are equal in magnitude. However, we could have chosen class intervals that are not of equal magnitude. In that case, the classes would have been of unequal width.

How should we determine the class limits?

Class limits should be definite and clearly stated. Generally, open-ended classes such as "70 and over" or "less than 10" are not desirable.

The lower and upper class limits should be determined in such a manner that frequencies of each class tend to concentrate in the middle of the class intervals.

Class intervals are of two types:

(i) Inclusive class intervals: In this case, values equal to the lower and upper limits of a class are included in the frequency of that same class.

(ii) Exclusive class intervals: In this case, an item equal to either the upper or the lower class limit is excluded from the frequency of that class.

In the case of discrete variables, both exclusive and inclusive class intervals can be used.

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In the case of continuous variables, inclusive class intervals are used very often.

Examples

Suppose we have data on marks obtained by students in a test and all the marks are in full numbers (fractional marks are not allowed). Suppose the marks obtained by the students vary from 0 to 100.

This is a case of a discrete variables since fractional marks are not allowed. In this case, if we are using equal sized class intervals and decide to have 10 class intervals then the class intervals can take either of the following forms:

Inclusive form of class intervals:

0-10
11-20
21-30
-
-
91-100

Exclusive form of class intervals:

0-10
10-20
20-30
-
-
90-100

In the case of exclusive class intervals, we have to decide in advance what is to be done if we get a value equal to the value of a class limit. For example we could decide that values such as 10, 30 etc., should be put into the class intervals "0 to 10" and "20 to 30" respectively. This can be called the case of lower limit excluded.

Or else we could put the values 10, 30 etc., into the class intervals "10 to 20" and "30 to 40" respectively. This can be called the case of upper limit excluded.

Example of Continuous Variable

Suppose we have data on a variable such as height (centimeters) or weight (kilograms). This data is of the continuous type. In such cases the class intervals may be defined in the following manner:

30 Kg - 39.999... Kg

40 Kg - 49.999... Kg

50 Kg - 59.999... Kg etc.

These class intervals are understood in the following manner:

30 Kg and above and under 40 Kg

40 Kg and above and under 50 Kg

50 Kg and above and under 60 Kg, etc.

TABLE 3.4
Frequency Distribution of Incomes of 550 Employees of a Company

Income (Rs)	*Number of Employees*
800–899	50
900–999	100
1000–1099	200
1100–1199	150
1200–1299	40
1300–1399	10
Total	*550*

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Adjustment in Class Interval

A close observation of the *Inclusive Method* in Table 3.4 would show that though the variable "income" is a continuous variable, no such continuity is maintained when the classes are made. We find *"gap"* or discontinuity between the upper limit of a class and the lower limit of the next class. For example, between the upper limit of the first class: 899 and the lower limit of the second class: 900, we find a "gap" of 1. Then how do we ensure the continuity of the variable while classifying data? This is achieved by making an adjustment in the class interval. The adjustment is done in the following way:

1. Find the difference between the lower limit of the second class and the upper limit of the first class. For example, in Table 3.4 the lower limit of the second class is 900 and the upper limit of the first class is 899. The difference between them is 1, i.e. (900 – 899 = 1)
2. Divide the difference obtained in (1) by two i.e. (1/2 = 0.5)
3. Subtract the value obtained in (2) from lower limits of all classes (lower class limit – 0.5)
4. Add the value obtained in (2) to upper limits of all classes (upper class limit + 0.5).

After the adjustment that restores continuity of data in the frequency distribution, the Table 3.4 is modified into Table 3.5

After the adjustments in class limits, the equality (1) that determines the value of class-mark would be modified as the following:

Adjusted Class Mark = (Adjusted Upper Class Limit + Adjusted Lower Class Limit)/2.

TABLE 3.5
Frequency Distribution of Incomes of 550 Employees of a Company

Income (Rs)	*Number of Employees*
799.5–899.5	50
899.5–999.5	100
999.5–1099.5	200
1099.5–1199.5	150
1199.5–1299.5	40
1299.5–1399.5	10
Total	*550*

How should we get the frequency for each class?

In simple terms, *frequency of an observation means how many times that observation occurs in the raw data.* In our Table 3.1, we observe that the value 40 occurs thrice; 0 and 10 occur only once; 49 occurs five times and so on. Thus the frequency of 40 is 3, 0 is 1, 10 is 1, 49 is 5 and so on. But when the data are grouped into classes as in example 3, the Class Frequency refers to the number of values in a particular class. The counting of class frequency is done by tally marks against the particular class.

Finding class frequency by tally marking

A tally (/) is put against a class for each student whose marks are included in that class. For example, if the marks

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TABLE 3.6
Tally Marking of Marks of 100 Students in Mathematics

Class	*Observations*	*Tally Mark*	*Frequency*	*Class Mark*
0–10	0	/	1	5
10–20	10, 14, 17, 12, 14, 12, 14, 14	𝍸 ///	8	15
20–30	25, 25, 20, 22, 25, 28	𝍸 /	6	25
30–40	30, 37, 34, 39, 32, 30, 35,	𝍸 //	7	35
40–50	47, 42, 49, 49, 45, 45, 47, 44, 40, 44, 49, 46, 41, 40, 43, 48, 48, 49, 49, 40, 41	𝍸 𝍸 𝍸 𝍸 /	21	45
50–60	59, 51, 53, 56, 55, 57, 55, 51, 50, 56, 59, 56, 59, 57, 59, 55, 56, 51, 55, 56, 55, 50, 54	𝍸 𝍸 𝍸 𝍸 ///	23	55
60–70	60, 64, 62, 66, 69, 64, 64, 60, 66, 69, 62, 61, 66, 60, 65, 62, 65, 66, 65	𝍸 𝍸 𝍸 ////	19	65
70–80	70, 75, 70, 76, 70, 71	𝍸 /	6	75
80–90	82, 82, 82, 80, 85	𝍸	5	85
90–100	90, 100, 90, 90	////	4	95
	Total		*100*	

obtained by a student are 57, we put a tally (/) against class 50 –60. If the marks are 71, a tally is put against the class 70–80. If someone obtains 40 marks, a tally is put against the class 40–50. Table 3.6 shows the tally marking of marks of 100 students in mathematics from Table 3.1.

The counting of tally is made easier when four of them are put as //// and the fifth tally is placed across them as 𝍸. Tallies are then counted as groups of five. So if there are 16 tallies in a class, we put them as 𝍸 𝍸 𝍸 / for the sake of convenience. Thus frequency in a class is equal to the number of tallies against that class.

Loss of Information

The classification of data as a frequency distribution has an inherent shortcoming. While it summarises the raw data making it concise and comprehensible, it does not show the details that are found in raw data. There is a loss of information in classifying raw data though much is gained by summarising it as a classified data. Once the data are grouped into classes, an individual observation has no significance in further statistical calculations. In Example 4, the class 20–30 contains 6 observations: 25, 25, 20, 22, 25 and 28. So when these data are grouped as a class 20–30 in the frequency distribution, the latter provides only the number of records in that class (i.e. frequency = 6) but not their actual values. *All values in this class are assumed to be equal to the middle value of the class interval or class mark (i.e. 25). Further statistical calculations are based only on the*

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values of class mark and not on the values of the observations in that class. This is true for other classes as well. Thus the use of class mark instead of the actual values of the observations in statistical methods involves considerable loss of information. However, being able to make more sense of the raw data as shown more than makes this up.

Frequency distribution with unequal classes

By now you are familiar with frequency distributions of equal class intervals. You know how they are constructed out of raw data. But in some cases frequency distributions with unequal class intervals are more appropriate. If you observe the frequency distribution of Example 4, as in Table 3.6, you will notice that most of the observations are concentrated in classes 40–50, 50–60 and 60–70. Their respective frequencies are 21, 23 and 19. It means that out of 100 students, 63 (21+23+19) students are concentrated in these classes. Thus, 63 per cent are in the middle range of 40-70. The remaining 37 per cent of data are in classes 0–10, 10–20, 20–30, 30–40, 70–80, 80–90 and 90–100. These classes are sparsely populated with observations. Further you will also notice that observations in these classes deviate more from their respective class marks than in comparison to those in other classes. But if classes are to be formed in such a way that class marks coincide, as far as possible, to a value around which the observations in a

TABLE 3.7
Frequency Distribution of Unequal Classes

Class	*Observations*	*Frequency*	*Class Mark*
0–10	0	1	5
10–20	10, 14, 17, 12, 14, 12, 14, 14	8	15
20–30	25, 25, 20, 22, 25, 28	6	25
30–40	30, 37, 34, 39, 32, 30, 35,	7	35
40–45	42, 44, 40, 44, 41, 40, 43, 40, 41	9	42.5
45–50	47, 49, 49, 45, 45, 47, 49, 46, 48, 48, 49, 49	12	47.5
50–55	51, 53, 51, 50, 51, 50, 54	7	52.5
55–60	59, 56, 55, 57, 55, 56, 59, 56, 59, 57, 59, 55, 56, 55, 56, 55	16	57.5
60–65	60, 64, 62, 64, 64, 60, 62, 61, 60, 62,	10	62.5
65–70	66, 69, 66, 69, 66, 65, 65, 66, 65	9	67.5
70–80	70, 75, 70, 76, 70, 71	6	75
80–90	82, 82, 82, 80, 85	5	85
90–100	90, 100, 90, 90	4	95
	Total	*100*	

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class tend to concentrate, then unequal class interval is more appropriate.

Table 3.7 shows the same frequency distribution of Table 3.6 in terms of unequal classes. Each of the classes 40–50, 50–60 and 60–70 are split into *two* class 40–50 is divided into 40–45 and 45–50. The class 50–60 is divided into 50–55 and 55–60. And class 60–70 is divided into 60–65 and 65–70. The new classes 40–45, 45–50, 50–55, 55–60, 60–65 and 65–70 have class interval of 5. The other classes: 0–10, 10–20, 20–30, 30–40, 70–80, 80–90 and 90–100 retain their old class interval of 10. The last column of this table shows the new values of class marks for these classes. Compare them with the old values of class marks in Table 3.6. Notice that the observations in these classes deviated more from their old class mark values than their new class mark values. Thus the new class mark values are more representative of the data in these classes than the old values.

Figure 3.2 shows the frequency curve of the distribution in Table 3.7.

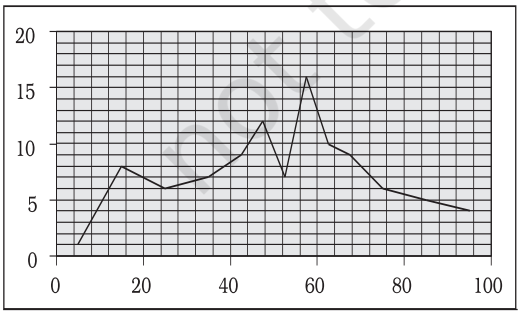

Fig. 3.2: Frequency Curve

The class marks of the table are plotted on X-axis and the frequencies are plotted on Y-axis.

Activity

- If you compare Figure 3.2 with Figure 3.1, what do you observe? Do you find any difference between them? Can you explain the difference?

Frequency array

So far we have discussed the classification of data for a continuous variable using the example of percentage marks of 100 students in mathematics. For a discrete variable, the classification of its data is known as a *Frequency Array*. Since a discrete variable takes values and not intermediate fractional values between two integral values, we have frequencies that correspond to each of its integral values.

The example in Table 3.8 illustrates a *Frequency Array*.

Table 3.8

Frequency Array of the Size of Households

Size of the Household	*Number of Households*
1	5
2	15
3	25
4	35
5	10
6	5
7	3
8	2
Total	*100*

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The variable "size of the household" is a discrete variable that only takes integral values as shown in the table.

6. Bivariate Frequency Distribution

Very often when we take a sample from a population we collect more than one type of information from each element of the sample. For example, suppose we have taken sample of 20 companies from the list of companies based in a city. Suppose that we collect information on sales and expenditure on advertisements from each company. In this case, we have bivariate sample data. Such bivariate data can be summarised using a Bivariate Frequency Distribution.

A Bivariate Frequency Distribution can be defined as the frequency distribution of two variables.

Table 3.9 shows the frequency distribution of two variables, sales and advertisement expenditure (in Rs. lakhs) of 20 companies. The values of sales are classed in different columns and the values of advertisement expenditure are classed in different rows. Each cell shows the frequency of the corresponding row and column values. For example, there are 3 firms whose sales are between Rs 135 and Rs145 lakh and their advertisement expenditures are between Rs 64 and Rs 66 thousand. The use of a bivariate distribution would be taken up in Chapter 8 on correlation.

7. Conclusion

The data collected from primary and secondary sources are raw or unclassified. Once the data are collected, the next step is to classify them for further statistical analysis. Classification brings order in the data. The chapter enables you to know how data can be classified through frequency distribution in a comprehensive manner. Once you know the techniques of classification, it will be easy for you to construct a frequency distribution, both for continuous and discrete variables.

TABLE 3.9

Bivariate Frequency Distribution of Sales (in Lakh Rs) and Advertisement Expenditure (in Thousand Rs) of 20 Firms

	115–125	*125–135*	*135–145*	*145–155*	*155–165*	*165–175*	*Total*
62–64	2	1					3
64–66	1		3				4
66–68	1	1	2	1			5
68–70		2		2			4
70–72		1	1		1	1	4
Total	*4*	*5*	*6*	*3*	*1*	*1*	*20*

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Recap

- Classification brings order to raw data.
- A Frequency Distribution shows how the different values of a variable are distributed in different classes along with their corresponding class frequencies.
- Either the upper class limit or the lower class limit is excluded in the Exclusive Method.
- Both the upper and the lower class limits are *included* in the Inclusive Method.
- In a Frequency Distribution, further statistical calculations are based only on the class mark values, instead of values of the observations.
- The classes should be formed in such a way that the class mark of each class comes as close as possible, to a value around which the observations in a class tend to concentrate.

EXERCISES

1. Which of the following alternatives is true?

(i) The class midpoint is equal to:
(a) The average of the upper class limit and the lower class limit.
(b) The product of upper class limit and the lower class limit.
(c) The ratio of the upper class limit and the lower class limit.
(d) None of the above.

(ii) The frequency distribution of two variables is known as
(a) Univariate Distribution
(b) Bivariate Distribution
(c) Multivariate Distribution
(d) None of the above

(iii) Statistical calculations in classified data are based on
(a) the actual values of observations
(b) the upper class limits
(c) the lower class limits
(d) the class midpoints

(iv) Range is the
(a) difference between the largest and the smallest observations
(b) difference between the smallest and the largest observations
(c) average of the largest and the smallest observations
(d) ratio of the largest to the smallest observation

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2. Can there be any advantage in classifying things? Explain with an example from your daily life.

3. What is a variable? Distinguish between a discrete and a continuous variable.

4. Explain the 'exclusive' and 'inclusive' methods used in classification of data.

5. Use the data in Table 3.2 that relate to monthly household expenditure (in Rs) on food of 50 households and
   (i) Obtain the range of monthly household expenditure on food.
   (ii) Divide the range into appropriate number of class intervals and obtain the frequency distribution of expenditure.
   (iii) Find the number of households whose monthly expenditure on food is
      (a) less than Rs 2000
      (b) more than Rs 3000
      (c) between Rs 1500 and Rs 2500

6. In a city 45 families were surveyed for the number of Cell phones they used. Prepare a frequency array based on their replies as recorded below.

1	3	2	2	2	2	1	2	1	2	2	3	3	3	3
3	3	2	3	2	2	6	1	6	2	1	5	1	5	3
2	4	2	7	4	2	4	3	4	2	0	3	1	4	3

7. What is 'loss of information' in classified data?

8. Do you agree that classified data is better than raw data? Why?

9. Distinguish between univariate and bivariate frequency distribution.

10. Prepare a frequency distribution by inclusive method taking class interval of 7 from the following data.

28	17	15	22	29	21	23	27	18	12	7	2	9	4
1	8	3	10	5	20	16	12	8	4	33	27	21	15
3	36	27	18	9	2	4	6	32	31	29	18	14	13
15	11	9	7	1	5	37	32	28	26	24	20	19	25
19	20	6	9										

11. "The quick brown fox jumps over the lazy dog"
    Examine the above sentence carefully and note the numbers of letters in each word. Treating the number of letters as a variable, prepare a frequency array for this data.

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Suggested Activity

- From your old mark-sheets find the marks that you obtained in mathematics in the previous class half yearly or annual examinations. Arrange them year-wise. Check whether the marks you have secured in the subject is a variable or not. Also see, if over the years, you have improved in mathematics.

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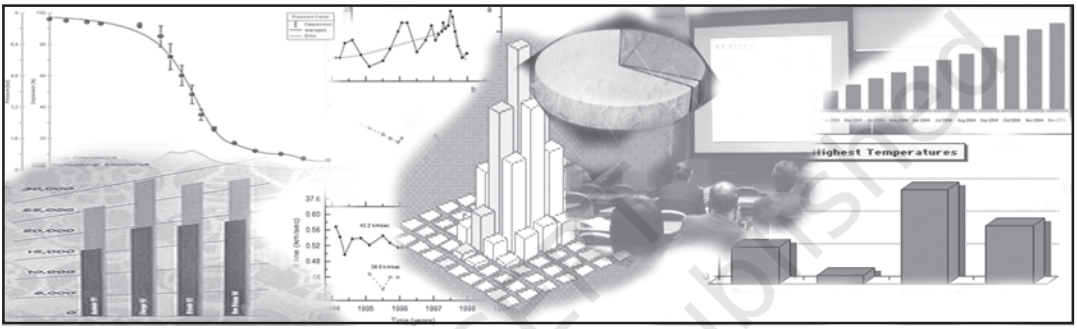
CHAPTER 4

Presentation of Data



Studying this chapter should enable you to:

- *present data using tables;*
- *represent data using appropriate diagrams.*

1. INTRODUCTION

You have already learnt in previous chapters how data are collected and organised. As data are generally voluminous, they need to be put in a compact and presentable form. This chapter deals with presentation of data precisely so that the voluminous data collected could be made usable readily and are easily comprehended. There are generally three forms of presentation of data:

- Textual or Descriptive presentation
- Tabular presentation
- Diagrammatic presentation.

2. TEXTUAL PRESENTATION OF DATA

In textual presentation, data are described within the text. When the quantity of data is not too large this form of presentation is more suitable. Look at the following cases:

Case 1

In a *bandh* call given on 08 September 2005 protesting the hike in prices of petrol and diesel, 5 petrol pumps were found open and 17 were closed whereas 2 schools were closed and remaining 9 schools were found open in a town of Bihar.

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Case 2

Census of India 2001 reported that Indian population had risen to 102 crore of which only 49 crore were females against 53 crore males. Seventy-four crore people resided in rural India and only 28 crore lived in towns or cities. While there were 62 crore non-worker population against 40 crore workers in the entire country. Urban population had an even higher share of non-workers (19 crore) against workers (9 crore) as compared to the rural population where there were 31 crore workers out of a 74 crore population...

In both the cases data have been presented only in the text. A serious drawback of this method of presentation is that one has to go through the complete text of presentation for comprehension. But, it is also true that this matter often enables one to emphasise certain points of the presentation.

3. Tabular Presentation of Data

In a tabular presentation, data are presented in rows (read horizontally) and columns (read vertically). For example see Table 4.1 tabulating information about literacy rates. It has three rows (for male, female and total) and three columns (for urban, rural and total). It is called a 3 × 3 Table giving 9 items of information in 9 boxes called the "cells" of the Table. Each cell gives information that relates an attribute of gender ("male", "female" or total) with a number (literacy percentages of rural people, urban people and total). The most important advantage of tabulation is that it organises data for further statistical treatment and decision-making. Classification used in tabulation is of four kinds:

- Qualitative
- Quantitative
- Temporal and
- Spatial

Qualitative classification

When classification is done according to attributes, such as social status, physical status, nationality, etc., it is called qualitative classification. For example, in Table 4.1 the attributes for classification are sex and location which are qualitative in nature.

TABLE 4.1

Literacy in India by sex and location (per cent)

	Location		*Total*
Sex	*Rural*	*Urban*	
Male	79	90	82
Female	59	80	65
Total	*68*	*84*	74

Source: *Census of India 2011.* (Literacy rates relate to population aged 7 years and above)

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Quantitative classification

In quantitative classification, the data are classified on the basis of characteristics which are quantitative in nature. In other words these characteristics can be measured quantitatively. For example, age, height, production, income, etc are quantitative characteristics. Classes are formed by assigning limits called class limits for the values of the characteristic under consideration. An example of quantitative classification is given in Table 4.2. Calculate the missing figures in the Table.

TABLE 4.2
Distribution of 542 respondents by their age in an election study in Bihar

Age group (yrs)	*No. of respondents*	*Per cent*
20–30	3	0.55
30–40	61	11.25
40–50	132	24.35
50–60	153	28.24
60–70	?	?
70–80	51	9.41
80–90	2	0.37
All	*?*	*100.00*

Source: *Assembly election Patna central constituency 2005, A.N. Sinha Institute of Social Studies, Patna.*

Here classifying characteristic is age in years and is quantifiable.

Activities

- Discuss how the total values are arrived at in Table 4.1
- Construct a table presenting data on preferential liking of the students of your class for Star News, Zee News, BBC World, CNN, Aaj Tak and DD News.
- Prepare a table of
  (i) heights (in cm) and
  (ii) weights (in kg) of students of your class.

Temporal classification

In this classification time becomes the classifying variable and data are categorised according to time. Time may be in hours, days, weeks, months, years, etc. For example, see Table 4.3.

TABLE 4.3
Yearly sales of a tea shop from 1995 to 2000

Years	*Sale (Rs in lakhs)*
1995	79.2
1996	81.3
1997	82.4
1998	80.5
1999	100.2
2000	91.2

Data Source: *Unpublished data.*

In this table the classifying characteristic is sales in a year and takes values in the scale of time.

Activity

- Go to your school office and collect data on the number of students studied in the school in each class for the last ten years and present the data in a table.

Spatial classification

When classification is done on the basis of place, it is called spatial classification. The place may be a village/town, block, district, state, country, etc.

Table 4.4 is an example of spatial classification.

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TABLE 4.4
Export from India to rest of the world in 2013-14 as share of total export (per cent)

Destination	*Export share*
USA	12.5
Germany	2.4
Other EU	10.9
UK	3.1
Japan	2.2
Russia	0.7
China	4.7
West Asia -Gulf Coop. Council	15.3
Other Asia	29.4
Others	18.8
All	*100.0*

(**Total Exports**: *US $ 314.40 billion*)

Activity

- Construct a table presenting data collected from students of your class according to their native states/residential locality.

4. Tabulation of Data and Parts of a Table

To construct a table it is important to learn first what are the parts of a good statistical table. When put together systematically these parts form a table. The most simple way of conceptualising a table is to present the data in rows and columns alongwith some explanatory notes. Tabulation can be done using one-way, two-way or three-way classification depending upon the number of characteristics involved. A good table should essentially have the following:

(i) Table Number

Table number is assigned to a table for identification purpose. If more than one table is presented, it is the table number that distinguishes one table from another. It is given at the top or at the beginning of the title of the table. Generally, table numbers are whole numbers in ascending order if there are many tables in a book. Subscripted numbers, like 1.2, 3.1, etc., are also used for identifying the table according to its location. For example, Table 4.5 should be read as the fifth table of the fourth chapter, and so on (See Table 4.5).

(ii) Title

The title of a table narrates about the contents of the table. It has to be clear, brief and carefully worded so that the interpretations made from the table are clear and free from ambiguity. It finds place at the head of the table succeeding the table number or just below it (See Table 4.5).

(iii) Captions or Column Headings

At the top of each column in a table a column designation is given to explain figures of the column. This is called caption or column heading (See Table 4.5).

(iv) Stubs or Row Headings

Like a caption or column heading, each row of the table has to be given a heading. The designations of the rows are also called stubs or stub items, and the complete left column is known as

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stub column. A brief description of the row headings may also be given at the left hand top in the table. (See Table 4.5).

(v) Body of the Table

Body of a table is the main part and it contains the actual data. Location of any one figure/data in the table is fixed and determined by the row and column of the table. For example, data in the second row and fourth column indicate that 25 crore females in rural India were non-workers in 2001 (See Table 4.5).

(vi) Unit of Measurement

The unit of measurement of the figures in the table (actual data) should always be stated alongwith the title. If different units are there for rows or columns of the table, these units must be stated alongwith 'stubs' or 'captions'. If figures are large, they should be rounded up and the method

Table Number

Title

Table 4.5 Population of India according to workers and non-workers by gender and location, 2001

(Crore)

Units

Column Headings/Captions

Row Headings/stubs

Location	Gender	Workers			Non-worker	Total
		Main	Marginal	Total		
Rural	Male	17	3	20	18	38
	Female	6	5	11	25	36
	Total	23	8	31	43	74
Urban	Male	7	1	8	7	15
	Female	1	0	1	12	13
	Total	8	1	9	19	28
All	Male	24	4	28	25	53
	Female	7	5	12	37	49
	Total	31	9	40	62	102

Body of the table

Source : Census of India 2001

Source

Note : Figures are rounded to nearest crore

Note

(Note : Table 4.5 presents the same data in tabular form already presented through *case 2* in textual presentation of data)

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of rounding should be indicated (See Table 4.5).

(vii) **Source**

It is a brief statement or phrase indicating the source of data presented in the table. If more than one source is there, all the sources are to be written in the source. Source is generally written at the bottom of the table. (See Table 4.5).

(viii) **Note**

Note is the last part of the table. It explains the specific feature of the data content of the table which is not self explanatory and has not been explained earlier.

Activities

- How many rows and columns are essentially required to form a table?
- Can the column/row headings of a table be quantitative?
- Can you present tables 4.2 and 4.3 after rounding off figures appropriately.
- Present the first two sentences of case 2 on p.41 as a table. Some details for this would be found elsewhere in this chapter.

5. Diagrammatic Presentation of Data

This is the third method of presenting data. This method provides the quickest understanding of the actual situation to be explained by data in comparison to tabular or textual presentations. Diagrammatic presentation of data translates quite effectively the highly abstract ideas contained in numbers into more concrete and easily comprehensible form.

Diagrams may be less accurate but are much more effective than tables in presenting the data.

There are various kinds of diagrams in common use. Amongst them the important ones are the following:

(i) Geometric diagram
(ii) Frequency diagram
(iii) Arithmetic line graph

Geometric Diagram

Bar diagram and pie diagram come in the category of geometric diagram. The bar diagrams are of three types — simple, multiple and component bar diagrams.

Bar Diagram

Simple Bar Diagram

Bar diagram comprises a group of equispaced and equiwidth rectangular bars for each class or category of data. Height or length of the bar reads the magnitude of data. The lower end of the bar touches the base line such that the height of a bar starts from the zero unit. Bars of a bar diagram can be visually compared by their relative height and accordingly data are comprehended quickly. Data for this can be of frequency or non-frequency type. In non-frequency type data a particular characteristic, say production, yield, population, etc. at various points of time or of different states are noted and corresponding bars are made of the respective heights according to the values of the characteristic to construct the diagram. The values of the characteristics (measured or counted)

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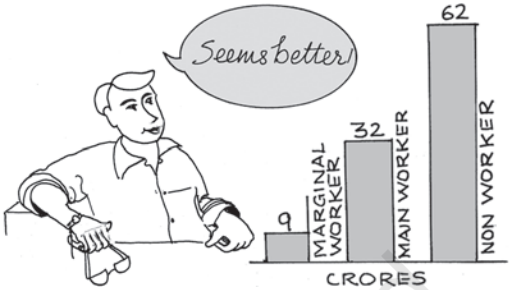
retain the identity of each value. Figure 4.1 is an example of a bar diagram.

Activity

- Collect the number of students in each class studying in the current year in your school. Draw a bar diagram for the same table.

Different types of data may require different modes of diagrammatical representation. Bar diagrams are suitable both for frequency type and non-frequency type variables and attributes. Discrete variables like family size, spots on a dice, grades in an examination, etc. and attributes such as gender, religion, caste, country, etc. can be represented by bar diagrams. Bar diagrams are more convenient for non-frequency data such as income-expenditure profile, export/imports over the years, etc.



A category that has a longer bar (literacy of Kerala) than another category (literacy of West Bengal), has more of the measured (or enumerated) characteristics than the other. Bars (also called columns) are usually used in time series data (food grain produced between 1980 and 2000, decadal variation in work participation

TABLE 4.6
Literacy Rates of Major States of India

	2001		*2011*	
Major Indian States	*Male*	*Female*	*Male*	*Female*
Andhra Pradesh (AP)	70.3	50.4	75.6	59.7
Assam (AS)	71.3	54.6	78.8	67.3
Bihar (BR)	59.7	33.1	73.4	53.3
Jharkhand (JH)	67.3	38.9	78.4	56.2
Gujarat (GJ)	79.7	57.8	87.2	70.7
Haryana (HR)	78.5	55.7	85.3	66.8
Karnataka (KA)	76.1	56.9	82.9	68.1
Kerala (KE)	94.2	87.7	96.0	92.0
Madhya Pradesh (MP)	76.1	50.3	80.5	60.0
Chhattisgarh (CH)	77.4	51.9	81.5	60.6
Maharashtra (MR)	86.0	67.0	89.8	75.5
Odisha (OD)	75.3	50.5	82.4	64.4
Punjab (PB)	75.2	63.4	81.5	71.3
Rajasthan (RJ)	75.7	43.9	80.5	52.7
Tamil Nadu (TN)	82.4	64.4	86.8	73.9
Uttar Pradesh (UP)	68.8	42.2	79.2	59.3
Uttarakhand (UK)	83.3	59.6	88.3	70.7
West Bengal (WB)	77.0	59.6	82.7	71.2
India	**75.3**	**53.7**	**82.1**	**65.5**

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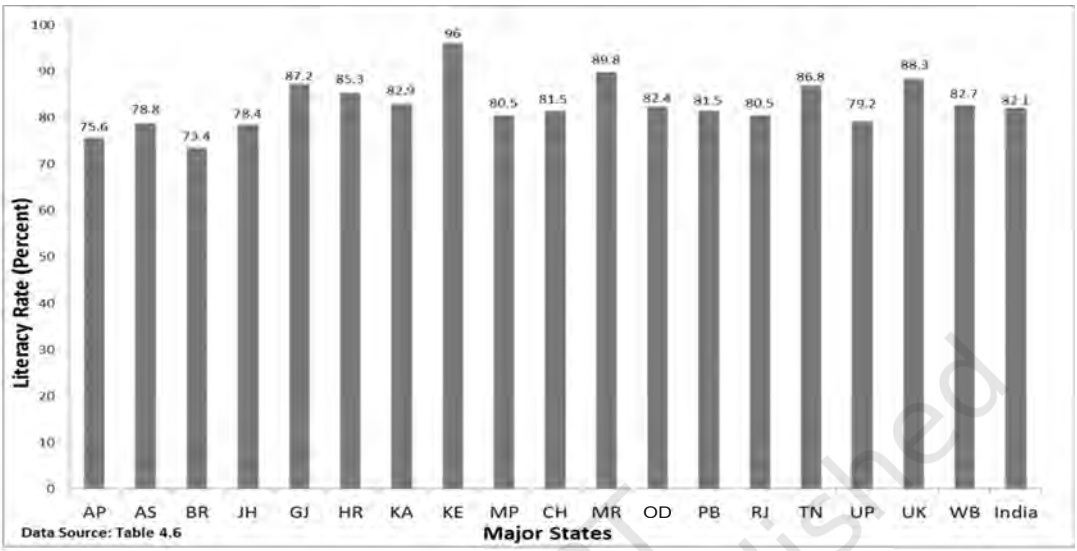

Fig. 4.1: *Bar diagram showing male literacy rates of major states of India, 2011.* (Literacy rates relate to population aged 7 years and above)

rate, registered unemployed over the years, literacy rates, etc.) (Fig 4.2).

Bar diagrams can have different forms such as multiple bar diagram and component bar diagram.

Activities

- How many states (among the major states of India) had higher female literacy rate than the national average in 2011?
- Has the gap between maximum and minimum female literacy rates over the states in two consecutive census years 2001 and 2011 declined?

Multiple Bar Diagram

Multiple bar diagrams (Fig.4.2) are used for comparing two or more sets of data, for example income and expenditure or import and export for different years, marks obtained in different subjects in different classes, etc.

Component Bar Diagram

Component bar diagrams or charts (Fig.4.3), also called sub-diagrams, are very useful in comparing the sizes of different component parts (the elements or parts which a thing is made up of) and also for throwing light on the relationship among these integral parts. For example, sales proceeds from different products, expenditure pattern in a typical Indian family (components being food, rent, medicine, education, power, etc.), budget outlay for receipts and expenditures, components of labour force, population etc. Component bar diagrams are usually shaded or coloured suitably.

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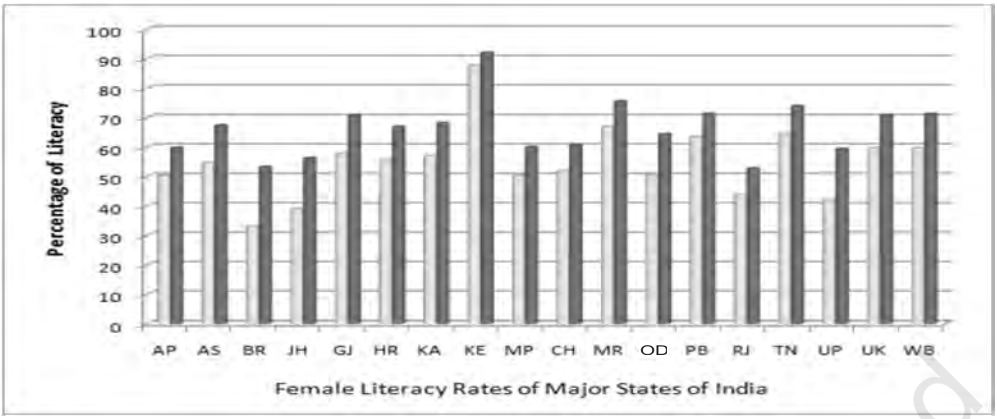

Fig. 4.2: *Multiple bar (column) diagram showing female literacy rates over two census years 2001 and 2011 by major states of India. (Data Source Table 4.6)*

Interpretation: It can be very easily derived from Figure 4.2 that female literacy rate over the years was on increase throughout the country. Similar other interpretations can be made from the figure. For example, the figure shows that the states of Bihar, Jharkhand and Uttar Pradesh experienced the sharpest rise in female literacy, etc.

TABLE 4.7
Enrolment by gender at schools (per cent) of children aged 6–14 years in a district of Bihar

Gender	*Enrolled (per cent)*	*Out of school (per cent)*
Boy	91.5	8.5
Girl	58.6	41.4
All	78.0	22.0

Data Source: *Unpublished data*

A component bar diagram shows the bar and its sub-divisions into two or more components. For example, the bar might show the total population of children in the age-group of 6–14 years. The components show the proportion of those who are enrolled and those who are not. A component bar diagram might also contain different component bars for boys, girls and the total of children in the given age group range, as shown in Figure 4.3. To construct a component bar diagram, first of all, a bar is constructed on the x-axis with its height equivalent to the total value of the bar [for per cent data the bar height is of 100 units (Figure 4.3)]. Otherwise the height is equated to total value of the bar and proportional heights of the components are worked out using unitary method. Smaller components are given priority in parting the bar.

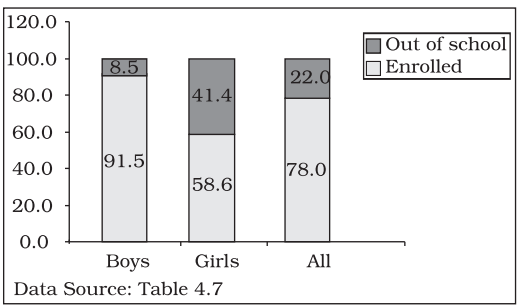

Fig. 4.3: *Enrolment at primary level in a district of Bihar (Component Bar Diagram)*

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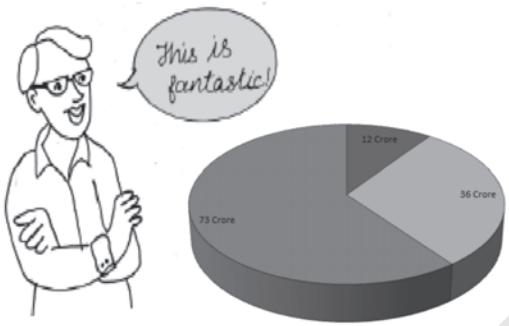
Pie Diagram

A pie diagram is also a component diagram, but unlike a bar diagram, here it is a circle whose area is proportionally divided among the components (Fig.4.4) it represents. It



is also called a pie chart. The circle is divided into as many parts as there are components by drawing straight lines from the centre to the circumference.

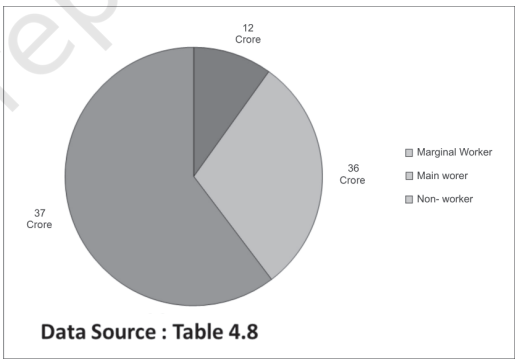
Pie charts usually are not drawn with absolute values of a category. The values of each category are first expressed as percentage of the total value of all the categories. A circle in a pie chart, irrespective of its value of radius, is thought of having 100 equal parts of 3.6° (360°/100) each. To find out the angle, the component shall subtend at the centre of the circle, each percentage figure of every component is multiplied by 3.6°. An example of this conversion of percentages of components into angular components of the circle is shown in Table 4.8.

It may be interesting to note that data represented by a component bar diagram can also be represented equally well by a pie chart, the only requirement being that absolute values of the components have to be converted into percentages before they can be used for a pie diagram.

TABLE 4.8
Distribution of Indian population (2011) by their working status (crores)

Status	*Population*	*Per cent*	*Angular Component*
Marginal Worker	12	9.9	36°
Main Worker	36	29.8	107°
Non-worker	73	60.3	217°
All	*102*	*100.0*	*360°*

Fig. 4.4: *Pie diagram for different categories of Indian population according to working status 2011.*



Activities

- Represent data presented through Figure 4.4 by a component bar diagram.
- Does the area of a pie have any bearing on the total value of the data to be represented by the pie diagram?

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Frequency Diagram

Data in the form of grouped frequency distributions are generally represented by frequency diagrams like histogram, frequency polygon, frequency curve and ogive.

Histogram

A histogram is a two dimensional diagram. It is a set of rectangles with base as the intervals between class boundaries (along X-axis) and with areas proportional to the class frequency (Fig.4.5). If the class intervals are of equal width, which they generally are, the area of the rectangles are proportional to their respective frequencies. However, in some type of data, it is convenient, at times necessary, to use varying width of class intervals. For example, when tabulating deaths by age at death, it would be very meaningful as well as useful too to have very short age intervals (0, 1, 2, ..., yrs/ 0, 7, 28, ..., days) at the beginning when death rates are very high compared to deaths at most other higher age segments of the population. For graphical representation of such data, height for area of a rectangle is the quotient of height (here frequency) and base (here width of the class interval). When intervals are equal, that is, when all rectangles have the same base, area can conveniently be represented by the frequency of any interval for purposes of comparison. When bases vary in their width, the heights of rectangles are to be adjusted to yield comparable measurements. The answer in such a situation is frequency density (class frequency divided by width of the class interval) instead of absolute frequency.

TABLE 4.9
Distribution of daily wage earners in a locality of a town

Daily earning (Rs)	No. of wage earners (f)
45–49	2
50–54	3
55–59	5
60–64	3
65–69	6
70–74	7
75–79	12
80–84	13
85–89	9
90–94	7
95–99	6
100–104	4
105–109	2
110–114	3
115–119	3

Source: *Unpublished data*

Since histograms are rectangles, a line parallel to the base line and of the same magnitude is to be drawn at a vertical distance equal to frequency (or frequency density) of the class interval. A histogram is never drawn. Since, for countinuous variables, the lower class boundary of a class interval fuses with the upper class boundary of the previous interval, equal or unequal, the rectangles are all adjacent and there is no open space between two consecutive rectangles. If the classes are not

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continuous they are first converted into continuous classes as discussed in Chapter 3. Sometimes the common portion between two adjacent rectangles (Fig.4.6) is omitted giving a better impression of continuity. The resulting figure gives the impression of a double staircase.

A histogram looks similar to a bar diagram. But there are more differences than similarities between the two than it may appear at the first impression. The spacing and the width or the area of bars are all arbitrary. It is the height and not the width or the area of the bar that really matters. A single vertical line could have served the same purpose as a bar of same width. Moreover, in histogram no space is left between two rectangles, but in a bar diagram some space must be left between consecutive bars (except in multiple bar or component bar diagram). Although the bars have the same width, the width of a bar is unimportant for the purpose of comparison. The width in a histogram is as important as its height. *We can have* a *bar diagram both for discrete and continuous variables, but histogram is drawn only for* a *continuous variable.* Histogram also gives value of ***mode*** of the frequency distribution graphically as shown in Figure 4.5 and the x-coordinate of the dotted vertical line gives the mode.

Frequency Polygon

A frequency polygon is a plane bounded by straight lines, usually four or more lines. Frequency polygon is an alternative to histogram and is also derived from histogram itself. A

Data source: Table 4.9

Fig. 4.5: *Histogram for the distribution of 85 daily wage earners in a locality of a town.*

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frequency polygon can be fitted to a histogram for studying the shape of the curve. The simplest method of drawing a frequency polygon is to join the midpoints of the topside of the consecutive rectangles of the histogram. It leaves us with the two ends away from the base line, denying the calculation of the area under the curve. The solution is to join the two end-points thus obtained to the base line at the mid-values of the two classes with zero frequency immediately at each end of the distribution. Broken lines or dots may join the two ends with the base line. Now the total area under the curve, like the area in the histogram, represents the total frequency or sample size.

Frequency polygon is the most common method of presenting grouped frequency distribution. Both class boundaries and class-marks can be used along the X-axis, the distances between two consecutive class marks being proportional/equal to the width of the class intervals. Plotting of data becomes easier if the class-marks fall on the heavy lines of the graph paper. No matter whether class boundaries or midpoints are used in the X-axis, frequencies (as ordinates) are always plotted against the mid-point of class intervals. When all the points have been plotted in the graph, they are carefully joined by a series of short straight lines. Broken lines join midpoints of two intervals, one in the beginning and the other at the end, with the two ends of the plotted curve (Fig.4.6). When comparing two or more distributions plotted on the same axes, frequency polygon is likely to be more useful since the vertical and horizontal lines of two

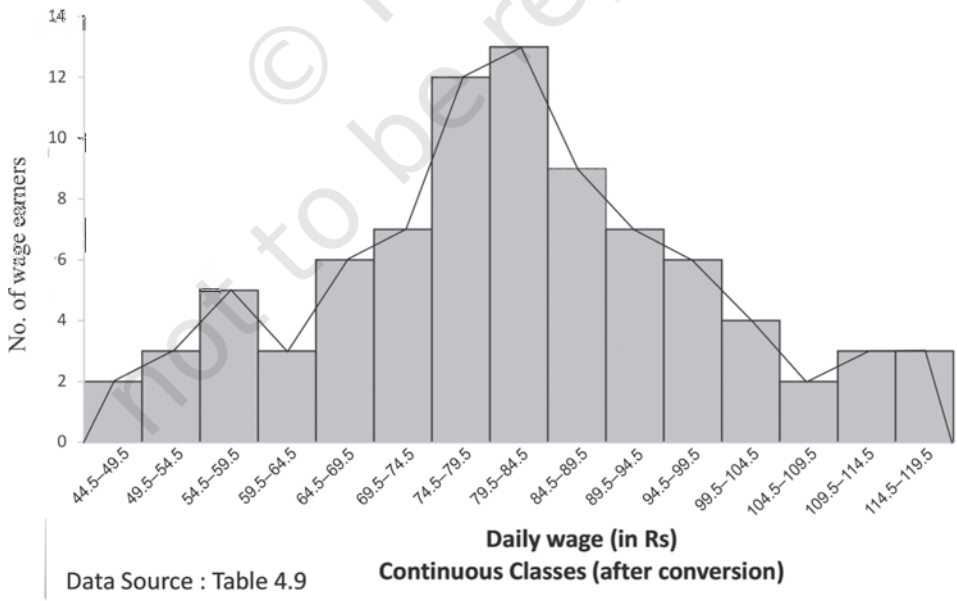

Fig. 4.6: *Frequency polygon drawn for the data given in Table 4.9*

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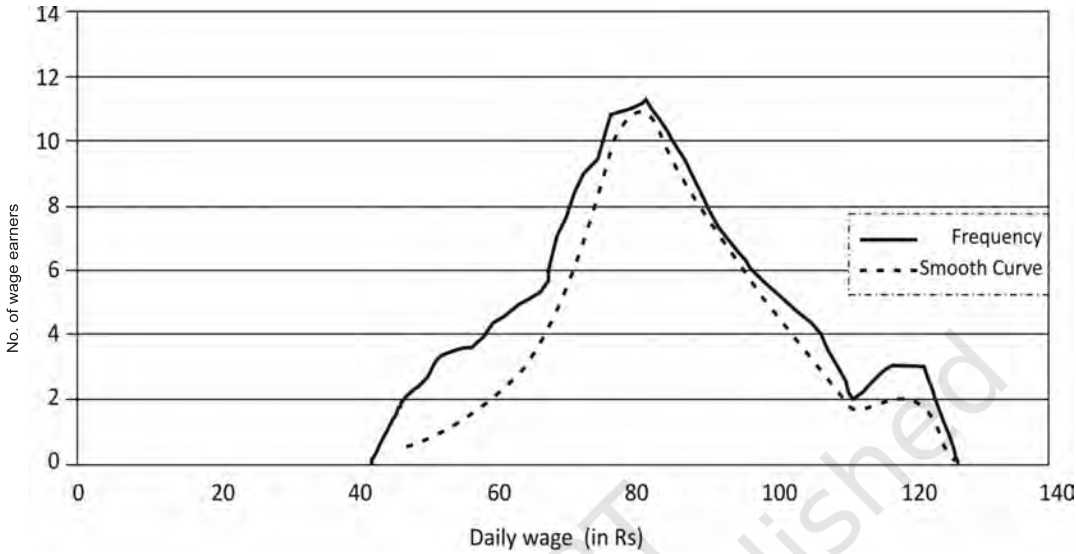

Fig. 4.7: *Frequency curve for Table 4.9*

or more distributions may coincide in a histogram.

Frequency Curve

The frequency curve is obtained by drawing a smooth freehand curve passing through the points of the frequency polygon as closely as possible. It may not necessarily pass through all the points of the frequency polygon but it passes through them as closely as possible (Fig. 4.7).

Ogive

Ogive is also called cumulative frequency curve. As there are two types of cumulative frequencies, for example "less than" type and "more than" type, accordingly there are two ogives for any grouped frequency distribution data. Here in place of simple frequencies as in the case of frequency polygon, cumulative frequencies are plotted along y-axis against class limits of the frequency distribution. For "less than" ogive the cumulative frequencies are plotted against the respective upper limits of the class intervals whereas for more than ogives the cumulative frequencies are plotted against the respective lower limits of the class interval. An interesting feature of the two ogives together is that their intersection point gives the ***median*** Fig. 4.8 (b) of the frequency distribution. As the shapes of the two ogives suggest, "less than" ogive is never decreasing and "more than" ogive is never increasing.

Arithmetic Line Graph

An arithmetic line graph is also called time series graph. In this graph, time

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TABLE 4.10
Frequency distribution of marks obtained in mathematics

Table 4.10 (a)		Table 4.10 (b)		Table 4.10 (e)	
Frequency distribution of marks obtained in mathematics		Less than cumulative frequency distribution of marks obtained in mathematics		More than cumulative frequency distribution of markes obtained in mathematics	
Marks	Number of students	Marks	'Less than' cumulative frequency	Marks	'More than' cumulative frequency
0-20	6	Less than 20	6	More than 0	64
20-40	5	Less than 40	11	More than 20	58
40-60	33	Less than 60	44	More than 40	53
60-80	14	Less than 80	58	More than 60	20
80-100	6	Less than 100	64	More than 80	6
Total	64				

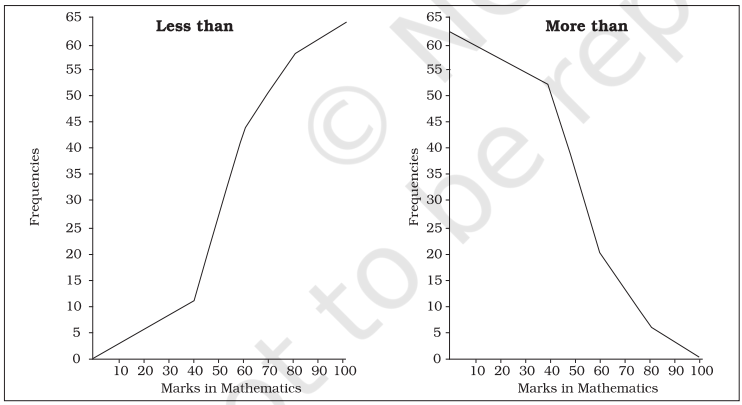

Fig. 4.8(a): *'Less than' and 'More than' ogive for data given in Table 4.10*

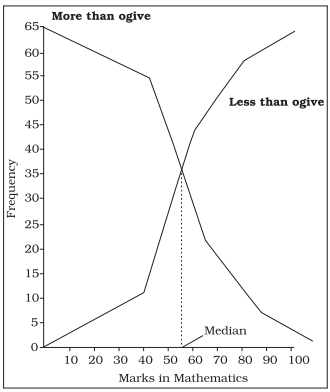

Fig. 4.8(b): *'Less than' and 'More than' ogive for data given in Table 4.10*

(hour, day/date, week, month, year, etc.) is plotted along x-axis and the value of the variable (time series data) along y-axis. A line graph by joining these plotted points, thus, obtained is called arithmetic line graph (time series graph). It helps in understanding the trend, periodicity, etc., in a long term time series data.

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Here you can see from Fig. 4.9 that for the period 1993-94 to 2013-14, the imports were more than the exports all through the period. You may notice the value of both exports and imports rising rapidy after 2001-02. Also the gap between the two (imports and exports) has widened after 2001-02.

6. Conclusion

By now you must have been able to learn how the data could be presented using various forms of presentation — textual, tabular and diagrammatic. You are now also able to make an appropriate choice of the form of data presentation as well as the type of diagram to be used for a given set of data. Thus you can make presentation of data meaningful, comprehensive and purposeful.

TABLE 4.11
Value of Exports and Imports of India (Rs in 100 crores)

Year	*Exports*	*Imports*
1993-94	698	731
1994–95	827	900
1995–96	1064	1227
1996–97	1188	1389
1997–98	1301	1542
1998-99	1398	1783
1999-2000	1591	2155
2000-01	2036	2309
2001-02	2090	2452
2002-03	2549	2964
2003-04	2934	3591
2004-05	3753	5011
2005-06	4564	6604
2006-07	5718	8815
2007-08	6559	10123
2008-09	8408	13744
2009-10	8455	13637
2010-11`	11370	16835
2011-12	14660	23455
2012-13	16343	26692
2013-14	19050	27154

Source: DGCI&S, Kolkata

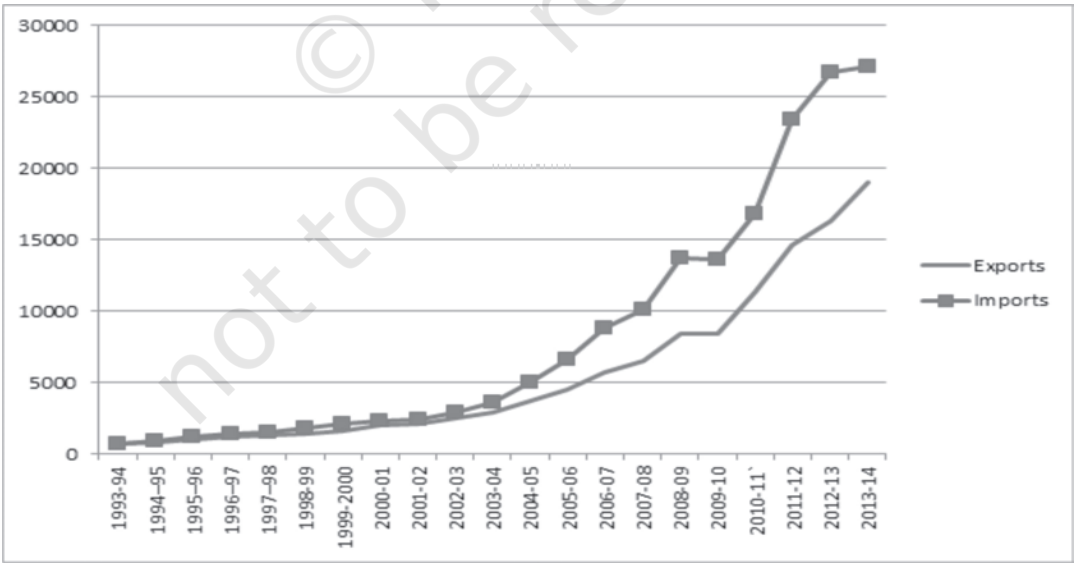

Fig. 4.9: *Arithmetic line graph for time series data given in Table 4.11*

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Recap

- Data (even voluminous data) speak meaningfully through presentation.
- For small data (quantity) textual presentation serves the purpose better.
- For large quantity of data tabular presentation helps in accommodating any volume of data for one or more variables.
- Tabulated data can be presented through diagrams which enable quicker comprehension of the facts presented otherwise.

EXERCISES

Answer the following questions, 1 to 10, choosing the correct answer

1. Bar diagram is a
   (i) one-dimensional diagram
   (ii) two-dimensional diagram
   (iii) diagram with no dimension
   (iv) none of the above

2. Data represented through a histogram can help in finding graphically the
   (i) mean
   (ii) mode
   (iii) median
   (iv) all the above

3. Ogives can be helpful in locating graphically the
   (i) mode
   (ii) mean
   (iii) median
   (iv) none of the above

4. Data represented through arithmetic line graph help in understanding
   (i) long term trend
   (ii) cyclicity in data
   (iii) seasonality in data
   (iv) all the above

5. Width of bars in a bar diagram need not be equal (True/False).

6. Width of rectangles in a histogram should essentially be equal (True/False).

7. Histogram can only be formed with continuous classification of data (True/False).

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8. Histogram and column diagram are the same method of presentation of data. (True/False)

9. Mode of a frequency distribution can be known graphically with the help of histogram. (True/False)

10. Median of a frequency distribution cannot be known from the ogives. (True/False)

11. What kind of diagrams are more effective in representing the following?
    (i) Monthly rainfall in a year
    (ii) Composition of the population of Delhi by religion
    (iii) Components of cost in a factory

12. Suppose you want to emphasise the increase in the share of urban non-workers and lower level of urbanisation in India as shown in Example 4.2. How would you do it in the tabular form?

13. How does the procedure of drawing a histogram differ when class intervals are unequal in comparison to equal class intervals in a frequency table?

14. The Indian Sugar Mills Association reported that, 'Sugar production during the first fortnight of December 2001 was about 3,87,000 tonnes, as against 3,78,000 tonnes during the same fortnight last year (2000). The off-take of sugar from factories during the first fortnight of December 2001 was 2,83,000 tonnes for internal consumption and 41,000 tonnes for exports as against 1,54,000 tonnes for internal consumption and nil for exports during the same fortnight last season.'
    (i) Present the data in tabular form.
    (ii) Suppose you were to present these data in diagrammatic form which of the diagrams would you use and why?
    (iii) Present these data diagrammatically.

15. The following table shows the estimated sectoral real growth rates (percentage change over the previous year) in GDP at factor cost.

Year	*Agriculture and allied sectors*	*Industry*	*Services*
1994–95	5.0	9.2	7.0
1995–96	–0.9	11.8	10.3
1996–97	9.6	6.0	7.1
1997–98	–1.9	5.9	9.0
1998–99	7.2	4.0	8.3
1999–2000	0.8	6.9	8.2

Represent the data as multiple time series graphs.

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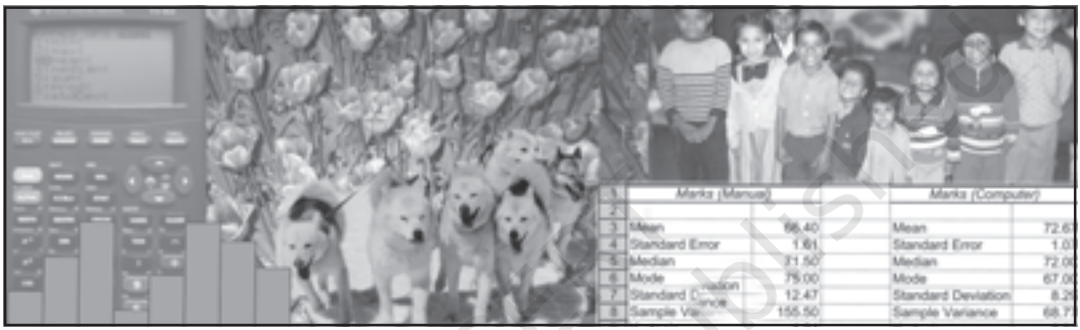
CHAPTER 5

Measures of Central Tendency



Studying this chapter should enable you to:

- *understand the need for summarising a set of data by one single number;*
- *recognise and distinguish between the different types of averages;*
- *learn to compute different types of averages;*
- *draw meaningful conclusions from a set of data;*
- *develop an understanding of which type of average would be the most useful in a particular situation.*

1. INTRODUCTION

In the previous chapter, you have read about the tabular and graphic representation of the data. In this chapter, you will study the measures of central tendency which is a numerical method to explain the data in brief. You can see examples of summarising a large set of data in day-to-day life, like average marks obtained by students of a class in a test, average rainfall in an area, average production in a factory, average income of persons living in a locality or working in a firm, etc.

Baiju is a farmer. He grows food grains in his land in a village called Balapur in Buxar district of Bihar. The village consists of 50 small farmers. Baiju has 1 acre of land. You are interested in knowing the economic condition of small farmers of Balapur. You want to compare the economic

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condition of Baiju in Balapur village. For this, you may have to evaluate the size of his land holding, by comparing with the size of land holdings of other farmers of Balapur. You may like to see if the land owned by Baiju is –

1. above average in ordinary sense (see the *Arithmetic Mean)*
2. above the size of what half the farmers own (see the *Median*)
3. above what most of the farmers own (see the *Mode*)

In order to evaluate Baiju's relative economic condition, you will have to summarise the whole set of data of land holdings of the farmers of Balapur. This can be done by the use of central tendency, which summarises the data in a single value in such a way that this single value can represent the entire data. The measuring of central tendency is a way of summarising the data in the form of a typical or representative value.

There are several statistical measures of central tendency or "averages". The three most commonly used averages are:

- Arithmetic Mean
- Median
- Mode

You should note that there are two more types of averages i.e. Geometric Mean and Harmonic Mean, which are suitable in certain situations. However, the present discussion will be limited to the three types of averages mentioned above.

2. Arithmetic Mean

Suppose the monthly income (in Rs) of six families is given as:
1600, 1500, 1400, 1525, 1625, 1630.

The mean family income is obtained by adding up the incomes and dividing by the number of families.

$$= \frac{1600+1500+1400+1525+1625+1630}{6}$$

= Rs 1,547

It implies that on an average, a family earns Rs 1,547.

Arithmetic mean is the most commonly used measure of central tendency. It is defined as the sum of the values of all observations divided by the number of observations and is usually denoted by $\overline{X}$. In general, if there are N observations as $X_1, X_2, X_3, \ldots, X_N$, then the Arithmetic Mean is given by

$$\overline{X} = \frac{X_1 + X_2 + X_3 + \ldots + X_N}{N}$$

The right hand side can be written as $\frac{\sum_{i=1}^{N} X_i}{N}$. Here, i is an index which takes successive values 1, 2, 3,...N.

For convenience, this will be written in simpler form without the index i. Thus

$\overline{X} = \frac{\sum X}{N}$, where, ΣX = sum of all observations and N = total number of observations.

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How Arithmetic Mean is Calculated

The calculation of arithmetic mean can be studied under two broad categories:

1. *Arithmetic Mean for Ungrouped Data.*
2. *Arithmetic Mean for Grouped Data.*

Arithmetic Mean for Series of Ungrouped Data

Direct Method

Arithmetic mean by *direct method* is the sum of all observations in a series divided by the total number of observations.

Example 1

Calculate Arithmetic Mean from the data showing marks of students in a class in an economics test: 40, 50, 55, 78, 58.

$$\overline{X} = \frac{\Sigma X}{N}$$

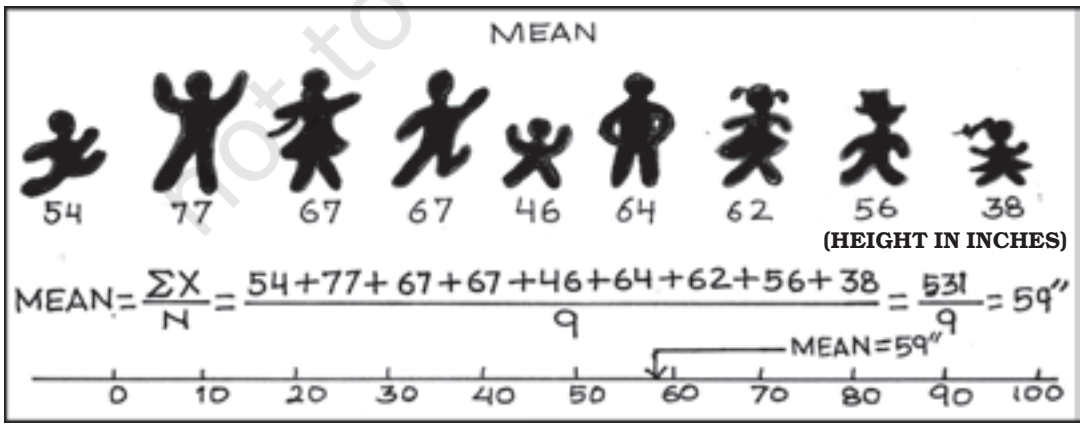
$$= \frac{40 + 50 + 55 + 78 + 58}{5} = 56.2$$

The average mark of students in the economics test is 56.2.

Assumed Mean Method

If the number of observations in the data is more and/or figures are large, it is difficult to compute arithmetic mean by direct method. The computation can be made easier by using assumed mean method.

In order to save time in calculating mean from a data set containing a large number of observations as well as large numerical figures, you can use assumed mean method. Here you assume a particular figure in the data as the arithmetic mean on the basis of logic/experience. Then you may take deviations of the said assumed mean from each of the observation. You can, then, take the summation of these deviations and divide it by the number of observations in the data. The actual arithmetic mean is estimated by taking the sum of the assumed mean and the ratio of sum of deviations to number of observations. Symbolically,



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Let, A = assumed mean
X = individual observations
N = total numbers of observations
d = deviation of assumed mean from individual observation, i.e. d = X – A

Then sum of all deviations is taken as $\Sigma d = \Sigma (X-A)$

Then find $\frac{\Sigma d}{N}$

Then add A and $\frac{\Sigma d}{N}$ to get $\overline{X}$

Therefore, $\overline{X} = A + \frac{\Sigma d}{N}$

You should remember that any value, whether existing in the data or not, can be taken as assumed mean. However, in order to simplify the calculation, centrally located value in the data can be selected as assumed mean.

Example 2

The following data shows the weekly income of 10 families.

Family
A B C D E F G H
I J
Weekly Income (in Rs)
850 700 100 750 5000 80 420 2500
400 360

Compute mean family income.

TABLE 5.1
Computation of Arithmetic Mean by Assumed Mean Method

Families	*Income (X)*	*d = X – 850*	*d′ = (X – 850)/10*
A	850	0	0
B	700	–150	–15
C	100	–750	–75
D	750	–100	–10
E	5000	+4150	+415
F	80	–770	–77
G	420	–430	–43
H	2500	+1650	+165
I	400	–450	–45
J	360	–490	–49
	11160	*+2660*	*+266*

Arithmetic Mean using *assumed mean method*

$$\overline{X} = A + \frac{\Sigma d}{N} = 850 + (2,660)/10$$
$$= \text{Rs}1,116.$$

Thus, the average weekly income of a family by both methods is Rs 1,116. You can check this by using the direct method.

Step Deviation Method

The calculations can be further simplified by dividing all the deviations taken from assumed mean by the common factor 'c'. The objective is to avoid large numerical figures, i.e., if d = X – A is very large, then find d′. This can be done as follows:

$$d' = \frac{d}{c} = \frac{X - A}{c}.$$

The formula is given below:

$$\overline{X} = A + \frac{\Sigma d'}{N} \times c$$

where d′ = (X – A)/c, c = common factor, N = number of observations, A= Assumed mean.

Thus, you can calculate the arithmetic mean in the example 2, by the step deviation method,

X = 850 + (266/10) × 10 = Rs 1,116.

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Calculation of arithmetic mean for Grouped data

Discrete Series

Direct Method

In case of *discrete series*, frequency against each observation is multiplied by the value of the observation. The values, so obtained, are summed up and divided by the total number of frequencies. Symbolically,

$$\overline{X} = \frac{\Sigma fX}{\Sigma f}$$

Where, ΣfX = sum of the product of variables and frequencies.
Σf = sum of frequencies.

Example 3

Plots in a housing colony come in only three sizes: 100 sq. metre, 200 sq. meters and 300 sq. metre and the number of plots are respectively 200 50 and 10.

TABLE 5.2
Computation of Arithmetic Mean by Direct Method

Plot size in Sq. metre X	*No. of Plots (f)*	*f X*	*d′ = X–200* 100	*fd′*
100	200	20000	–1	–200
200	50	10000	0	0
300	10	3000	+1	10
	260	*33000*	*0*	*–190*

Arithmetic mean using *direct method,*

$$\overline{X} = \frac{\sum X}{N} = \frac{33000}{260} = 126.92 \text{ Sq. metre}$$

Therefore, the mean plot size in the housing colony is 126.92 Sq. metre.

Assumed Mean Method

As in case of individual series the calculations can be simplified by using assumed mean method, as described earlier, with a simple modification. Since frequency (f) of each item is given here, we multiply each deviation (d) by the frequency to get fd. Then we get Σfd. The next step is to get the total of all frequencies i.e. Σf. Then find out $\Sigma fd / \Sigma f$. Finally, the arithmetic mean is calculated by $\overline{X} = A + \frac{\Sigma fd}{\Sigma f}$ using assumed mean method.

Step Deviation Method

In this case, the deviations are divided by the common factor 'c' which simplifies the calculation. Here we estimate $d' = \frac{d}{c} = \frac{X - A}{c}$ in order to reduce the size of numerical figures for easier calculation. Then get fd' and $\Sigma fd'$. The formula for arithmetic mean using step deviation method is given as,

$$\overline{X} = A + \frac{\Sigma fd'}{\Sigma f} \times c$$

Activity

- Find the mean plot size for the data given in example 3, by using *step deviation* and *assumed mean* methods.

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Continuous Series

Here, class intervals are given. The process of calculating arithmetic mean in case of continuous series is same as that of a discrete series. The only difference is that the mid-points of various class intervals are taken. We have already known that class intervals may be exclusive or inclusive or of unequal size. Example of exclusive class interval is, say, 0–10, 10–20 and so on. Example of inclusive class interval is, say, 0–9, 10–19 and so on. Example of unequal class interval is, say, 0–20, 20–50 and so on. In all these cases, calculation of arithmetic mean is done in a similar way.

Example 4

Calculate average marks of the following students using (a) Direct method (b) Step deviation method.

Direct Method

Marks				
0–10	10–20	20–30	30–40	40–50
50–60	60–70			
No. of Students				
5	12	15	25	8
3	2			

TABLE 5.3

Computation of Average Marks for Exclusive Class Interval by Direct Method

Mark (x)	*No. of students (f)*	*Mid value (m)*	*fm*	*d'=(m-35)/10*	*fd'*
(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
0–10	5	5	25	–3	–15
10–20	12	15	180	–2	–24
20–30	15	25	375	–1	–15
30–40	25	35	875	0	0
40–50	8	45	360	1	8
50–60	3	55	165	2	6
60–70	2	65	130	3	6
	70		*2110*		*–34*

Steps:

1. Obtain mid values for each class denoted by m.
2. Obtain Σ fm and apply the direct method formula:

$$\bar{X} = \frac{\Sigma fm}{\Sigma f} = \frac{2110}{70} = 30.14 \text{ marks}$$

Step deviation method

1. Obtain $d' = \frac{m-A}{c}$
2. Take A = 35, (any arbitrary figure), c = common factor.

$$\bar{X} = A + \frac{\Sigma fd'}{\Sigma f} \times c = 35 + \frac{(-34)}{70} \times 10$$
$$= 30.14 \text{ marks}$$

Two interesting properties of A.M.

(i) the sum of deviations of items about arithmetic mean is always equal to zero. Symbolically, $\Sigma(X - \bar{X}) = 0$.

(ii) arithmetic mean is affected by extreme values. Any large value, on either end, can push it up or down.

Weighted Arithmetic Mean

Sometimes it is important to assign weights to various items according to their importance when you calculate the arithmetic mean. For example, there are two commodities, mangoes and potatoes. You are interested in

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finding the average price of mangoes (P_1) and potatoes (P_2). The arithmetic mean will be $\frac{p_1 + p_2}{2}$. However, you might want to give more importance to the rise in price of potatoes (P_2). To do this, you may use as 'weights' the share of mangoes in the budget of the consumer (W_1) and the share of potatoes in the budget (W_2). Now the arithmetic mean weighted by the shares in the budget would be $\frac{W_1 P_1 + W_2 P_2}{W_1 + W_2}$.

In general the weighted arithmetic mean is given by,

$$\frac{w_1x_1 + w_2x_2 + \ldots + w_nx_n}{w_1 + w_2 + \ldots + w_n} = \frac{\Sigma wx}{\Sigma w}$$

When the prices rise, you may be interested in the rise in prices of commodities that are more important to you. You will read more about it in the discussion of Index Numbers in Chapter 7.

Activities

- Check property of arithmetic mean for the following example:

  X: 4 6 8 10 12
- In the above example if mean is increased by 2, then what happens to the individual observations.
- If first three items increase by 2, then what should be the values of the last two items, so that mean remains the same.
- Replace the value 12 by 96. What happens to the arithmetic mean? Comment.

3. Median

Median is that positional value of the variable which divides the distribution into two equal parts, one part comprises all values greater than or equal to the median value and the other comprises all values less than or equal to it. *The Median is the "middle" element when the data set is arranged in order of the magnitude. Since the median is determined by the position of different values, it remains unaffected if, say, the size of the largest value increases.*

Computation of median

The median can be easily computed by sorting the data from smallest to largest and finding out the middle value.

Example 5

Suppose we have the following observation in a data set: 5, 7, 6, 1, 8, 10, 12, 4, and 3.

Arranging the data, in ascending order you have:

1, 3, 4, 5, 6, 7, 8, 10, 12.

↑

The *"middle score"* is 6, so the median is 6. Half of the scores are larger than 6 and half of the scores are smaller.

If there are even numbers in the data, there will be two observations

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which fall in the middle. The median in this case is computed as the arithmetic mean of the two middle values.

Activities

- Find mean and median for all four values of the series. What do you observe?

TABLE 5.4
Mean and Median of different series

Series	*X (Variable Values)*	*Mean*	*Median*
A	1, 2, 3	?	?
B	1, 2, 30	?	?
C	1, 2, 300	?	?
D	1, 2, 3000	?	?

- Is median affected by extreme values? What are outliers?
- Is median a better method than mean?

Example 6

The following data provides marks of 20 students. You are required to calculate the median marks.

25, 72, 28, 65, 29, 60, 30, 54, 32, 53, 33, 52, 35, 51, 42, 48, 45, 47, 46, 33.

Arranging the data in an ascending order, you get

25, 28, 29, 30, 32, 33, 33, 35, 42, 45, 46, 47, 48, 51, 52, 53, 54, 60, 65, 72.

You can see that there are two observations in the middle, 45 and 46. The median can be obtained by taking the mean of the two observations:

$$\text{Median} = \frac{45+46}{2} = 45.5 \text{ marks}$$

In order to calculate median it is important to know the position of the median i.e. item/items at which the median lies. The position of the median can be calculated by the following formula:

$$\text{Position of median} = \frac{(N+1)^{th}}{2} \text{ item}$$

Where N = number of items.

You may note that the above formula gives you the position of the median in an ordered array, not the median itself. Median is computed by the formula:

$$\textit{Median} = \text{size of } \frac{(N+1)^{th}}{2} \text{ item}$$

Discrete Series

In case of discrete series the position of median i.e. $(N+1)/2^{th}$ item can be located through cumulative frequency. The corresponding value at this position is the value of median.

Example 7

The frequency distributsion of the number of persons and their respective incomes (in Rs) are given below. Calculate the median income.

Income (in Rs):	10	20	30	40
Number of persons:	2	4	10	4

In order to calculate the median income, you may prepare the frequency distribution as given below.

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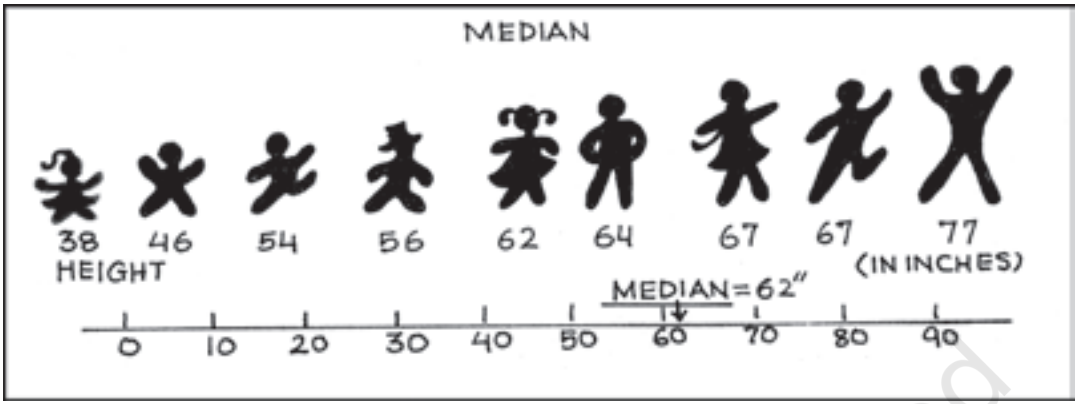

TABLE 5.5
Computation of Median for Discrete Series

Income (in Rs)	*No. of persons(f)*	*Cumulative frequency(cf)*
10	2	2
20	4	6
30	10	16
40	4	20

The median is located in the (N+1)/2 = (20+1)/2 = 10.5th observation. This can be easily located through cumulative frequency. The 10.5th observation lies in the c.f. of 16. The income corresponding to this is Rs 30, so the median income is Rs 30.

Continuous Series

In case of continuous series you have to locate the median class where N/2th item [not (N+1)/2th item] lies. The median can then be obtained as follows:

$$\text{Median} = L + \frac{(N/2 - \text{c.f.})}{f} \times h$$

Where, L = lower limit of the median class,
c.f. = cumulative frequency of the class preceding the median class,
f = frequency of the median class,
h = magnitude of the median class interval.

No adjustment is required if frequency is of unequal size or magnitude.

Example 8

Following data relates to daily wages of persons working in a factory. Compute the median daily wage.

Daily wages (in Rs):
55–60 50–55 45–50 40–45 35–40 30–35 25–30 20–25

Number of workers:
7 13 15 20 30 33 28 14

The data is arranged in descending order here.

In the above illustration median class is the value of (N/2)th item (i.e.160/2) = 80th item of the series, which lies in 35–40 class interval. Applying the formula of the median as:

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TABLE 5.6
Computation of Median for Continuous Series

Daily wages (in Rs)	*No. of Workers (f)*	*Cumulative Frequency*
20–25	14	14
25–30	28	42
30–35	33	75
35–40	30	105
40–45	20	125
45–50	15	140
50–55	13	153
55–60	7	160

$$\text{Median} = L + \frac{(N/2 - c.f.)}{f} \times h$$

$$= \frac{35 + (80 - 75)}{30} \times (40 - 35)$$

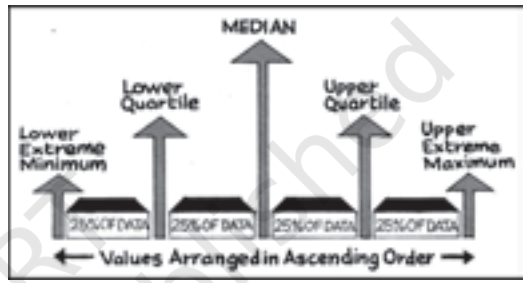
$$= \text{Rs } 35.83$$

Thus, the median daily wage is Rs 35.83. This means that 50% of the workers are getting less than or equal to Rs 35.83 and 50% of the workers are getting more than or equal to this wage.

You should remember that median, as a measure of central tendency, is not sensitive to all the values in the series. It concentrates on the values of the central items of the data.

Quartiles

Quartiles are the measures which divide the data into four equal parts, each portion contains equal number of observations. There are three quartiles. The first Quartile (denoted by Q_1) or lower quartile has 25% of the items of the distribution below it and 75% of the items are greater than it. The second Quartile (denoted by Q_2) or median has 50% of items below it and 50% of the observations above it. The third Quartile (denoted by Q_3) or upper Quartile has 75% of the items of the distribution below it and 25% of the items above it. Thus, Q_1 and Q_3 denote the two limits within which central 50% of the data lies.



Percentiles

Percentiles divide the distribution into hundred equal parts, so you can get 99 dividing positions denoted by P_1, P_2, P_3, ..., P_{99}. P_{50} is the median value. If you have secured 82 percentile in a management entrance examination, it means that your position is below 18 per cent of total candidates appeared in the examination. If a total of one lakh students appeared, where do you stand?

Calculation of Quartiles

The method for locating the Quartile is same as that of the median in case of individual and discrete series. The value of Q_1 and Q_3 of an ordered series can be obtained by the following

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formula where N is the number of observations.

$$Q_1 = \text{size of } \frac{(N+1)^{th}}{4} \text{ item}$$

$$Q_3 = \text{size of } \frac{3(N+1)^{th}}{4} \text{ item.}$$

Example 9

Calculate the value of *lower quartile* from the data of the marks obtained by ten students in an examination.
22, 26, 14, 30, 18, 11, 35, 41, 12, 32.

Arranging the data in an ascending order,
11, 12, 14, 18, 22, 26, 30, 32, 35, 41.

Q_1 = size of $\frac{(N+1)^{th}}{4}$ item = size of $\frac{(10+1)^{th}}{4}$ item = size of 2.75^{th} item
= 2nd item + .75 (3rd item – 2nd item)
= 12 + .75(14 –12) = 13.5 marks.

Activity

- Find out Q_3 yourself.

5. Mode

Sometimes, you may be interested in knowing the most typical value of a series or the value around which maximum concentration of items occurs. For example, a manufacturer would like to know the size of shoes that has maximum demand or style of the shirt that is more frequently demanded. Here, *Mode* is the most appropriate measure. The word *mode* has been derived from the French word "la Mode" which signifies the most fashionable values of a distribution, because it is repeated the highest number of times in the series. *Mode is the most frequently observed data value.* It is denoted by M_o.

Computation of Mode

Discrete Series

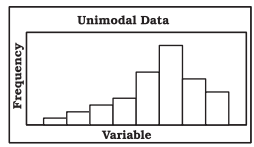
Consider the data set 1, 2, 3, 4, 4, 5. The mode for this data is 4 because 4 occurs most frequently (twice) in the data.

Example 10

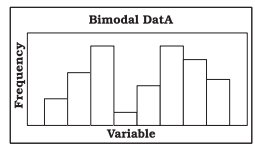
Look at the following discrete series:

Variable	10	20	30	40	50
Frequency	2	8	20	10	5

Here, as you can see the maximum frequency is 20, the value of mode is 30. In this case, as there is a unique value of mode, the data is *unimodal*. But, the mode is not necessarily unique, unlike arithmetic mean and median. You can have data with two modes (bi-modal) or more than two modes (multi-modal). It may be possible that there may be no mode if no value appears more frequent than any other value in the distribution. For example, in a series 1, 1, 2, 2, 3, 3, 4, 4, there is no mode.



Unimodal Data



Bimodal Data

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Continuous Series

In case of continuous frequency distribution, modal class is the class with largest frequency. Mode can be calculated by using the formula:

$$M_O = L + \frac{D_1}{D_1 + D_2} \times h$$

Where L = lower limit of the modal class

D_1= difference between the frequency of the modal class and the frequency of the class preceding the modal class (ignoring signs).

D_2 = difference between the frequency of the modal class and the frequency of the class succeeding the modal class (ignoring signs).

h = class interval of the distribution.

You may note that in case of continuous series, class intervals should be equal and series should be exclusive to calculate the mode. If mid points are given, class intervals are to be obtained.

Example 11

Calculate the value of modal worker family's monthly income from the following data:

Less than cumulative frequency distribution of income per month (in '000 Rs)

Income per month (in '000 Rs)	Cumulative Frequency
Less than 50	*97*
Less than 45	*95*
Less than 40	*90*
Less than 35	*80*
Less than 30	*60*
Less than 25	*30*
Less than 20	*12*
Less than 15	*4*

As you can see this is a case of cumulative frequency distribution. In order to calculate mode, you will have to convert it into an exclusive series. In this example, the series is in the descending order. This table should be converted into an ordinary frequency table (Table 5.7) to determine the modal class.

Income Group (in '000 Rs)	*Frequency*
45–50	97 – 95 = 2
40–45	95 – 90 = 5
35–40	90 – 80 = 10
30–35	80 – 60 = 20
25–30	60 – 30 = 30
20–25	30 – 12 = 18
15–20	12 – 4 = 8
10–15	4

The value of the mode lies in 25–30 class interval. By inspection also, it can be seen that this is a modal class.

Now L = 25, D_1 = (30 – 18) = 12, D_2 = (30 – 20) = 10, h = 5

Using the formula, you can obtain the value of the mode as:

M_O (in '000 Rs)

$$M_O = L + \frac{D_1}{D_1 + D_2} \times h$$

$$= 25 + \frac{12}{12 + 10} \times 5 = 27.273$$

Thus the *modal* worker family's monthly income is Rs 27.273.

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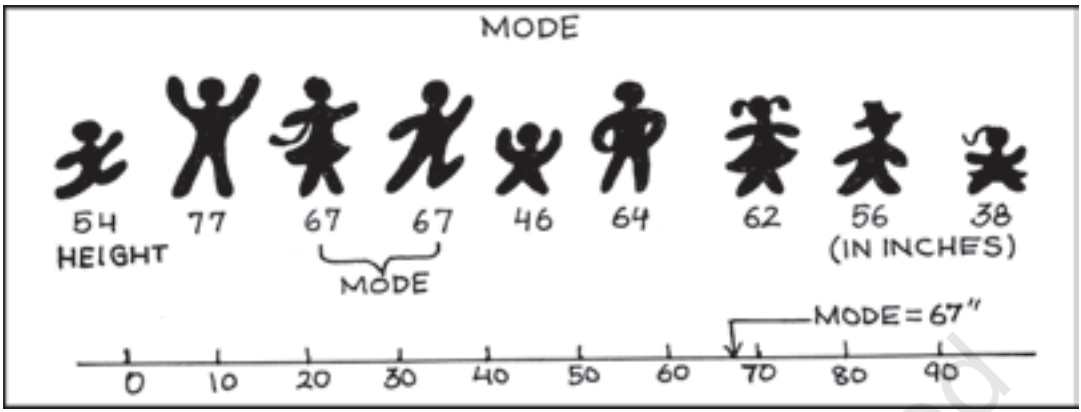

Activities

- A shoe company, making shoes for adults only, wants to know the most popular size of shoes. Which average will be most appropriate for it?
- Which average will be most appropriate for the companies producing the following goods? Why?
  (i) Diaries and notebooks
  (ii) School bags
  (iii) Jeans and T-Shirts
- Take a small survey in your class to know the students' preference for Chinese food using appropriate measure of central tendency.
- Can mode be located graphically?

6. Relative Position of Arithmetic Mean, Median and Mode

Suppose we express,

Arithmetic Mean = M_e

Median = M_i

Mode = M_o

The relative magnitude of the three are $M_e > M_i > M_o$ or $M_e < M_i < M_o$ (suffixes occurring in alphabetical order). *The median is always between the arithmetic mean and the mode.*

7. Conclusion

Measures of central tendency or averages are used to summarise the data. It specifies a single most representative value to describe the data set. Arithmetic mean is the most commonly used average. It is simple to calculate and is based on all the observations. But it is unduly affected by the presence of extreme items. Median is a better summary for such data. Mode is generally used to describe the qualitative data. Median and mode can be easily computed graphically. In case of open-ended distribution they can also be easily computed. Thus, it is important to select an appropriate average depending upon the purpose of analysis and the nature of the distribution.

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Recap

- The measure of central tendency summarises the data with a single value, which can represent the entire data.
- Arithmetic mean is defined as the sum of the values of all observations divided by the number of observations.
- The sum of deviations of items from the arithmetic mean is always equal to zero.
- Sometimes, it is important to assign weights to various items according to their importance.
- Median is the central value of the distribution in the sense that the number of values less than the median is equal to the number greater than the median.
- Quartiles divide the total set of values into four equal parts.
- Mode is the value which occurs most frequently.

EXERCISES

1. Which average would be suitable in the following cases?
   (i) Average size of readymade garments.
   (ii) Average intelligence of students in a class.
   (iii) Average production in a factory per shift.
   (iv) Average wage in an industrial concern.
   (v) When the sum of absolute deviations from average is least.
   (vi) When quantities of the variable are in ratios.
   (vii) In case of open-ended frequency distribution.

2. Indicate the most appropriate alternative from the multiple choices provided against each question.

(i) The most suitable average for qualitative measurement is
   (a) arithmetic mean
   (b) median
   (c) mode
   (d) geometric mean
   (e) none of the above

(ii) Which average is affected most by the presence of extreme items?
   (a) median
   (b) mode
   (c) arithmetic mean
   (d) none of the above

(iii) The algebraic sum of deviation of a set of n values from A.M. is
   (a) n
   (b) 0
   (c) 1

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(d) none of the above
[Ans. (i) b (ii) c (iii) b]

3. Comment whether the following statements are true or false.
(i) The sum of deviation of items from median is zero.
(ii) An average alone is not enough to compare series.
(iii) Arithmetic mean is a positional value.
(iv) Upper quartile is the lowest value of top 25% of items.
(v) Median is unduly affected by extreme observations.
[Ans. (i) False (ii) True (iii) False (iv) True (v) False]

4. If the arithmetic mean of the data given below is 28, find (a) the missing frequency, and (b) the median of the series:

Profit per retail shop (in Rs)	0-10	10-20	20-30	30-40	40-50	50-60
Number of retail shops	12	18	27	-	17	6

(Ans. The value of missing frequency is 20 and value of the median is Rs 27.41)

5. The following table gives the daily income of ten workers in a factory. Find the arithmetic mean.

Workers	A	B	C	D	E	F	G	H	I	J
Daily Income (in Rs)	120	150	180	200	250	300	220	350	370	260

(Ans. Rs 240)

6. Following information pertains to the daily income of 150 families. Calculate the arithmetic mean.

Income (in Rs)	*Number of families*
More than 75	150
,, 85	140
,, 95	115
,, 105	95
,, 115	70
,, 125	60
,, 135	40
,, 145	25

(Ans. Rs 116.3)

7. The size of land holdings of 380 families in a village is given below. Find the median size of land holdings.

Size of Land Holdings (in acres)	Less than 100	100–200	200 – 300	300–400	400 and above.
Number of families	40	89	148	64	39

(Ans. 241.22 acres)

8. The following series relates to the daily income of workers employed in a firm. Compute (a) highest income of lowest 50% workers (b) minimum income earned by the top 25% workers and (c) maximum income earned by lowest 25% workers.

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Daily Income (in Rs)	10–14	15–19	20–24	25–29	30–34	35–39
Number of workers	5	10	15	20	10	5

(Hint: compute median, lower quartile and upper quartile.)
[Ans. (a) Rs 25.11 (b) Rs 19.92 (c) Rs 29.19]

9. The following table gives production yield in kg. per hectare of wheat of 150 farms in a village. Calculate the mean, median and mode values.

Production yield (kg. per hectare)	50–53	53–56	56–59	59–62	62–65	65–68	68–71	71–74	74–77
Number of farms	3	8	14	30	36	28	16	10	5

(Ans. mean = 63.82 kg. per hectare, median = 63.67 kg. per hectare, mode = 63.29 kg. per hectare)

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CHAPTER

6

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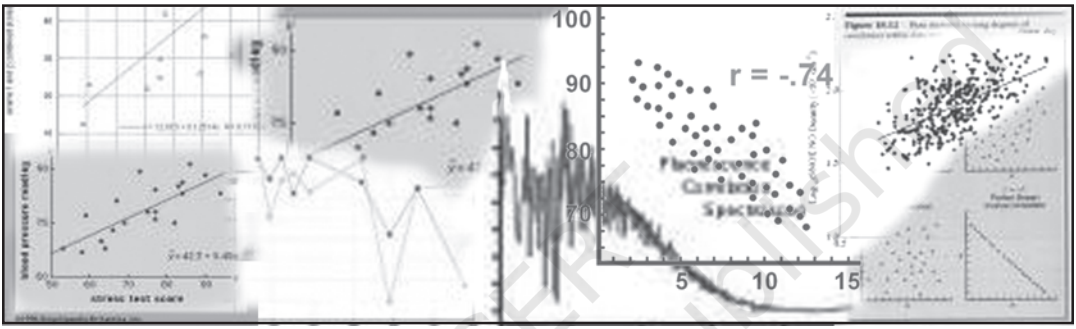
Correlation



Studying this chapter should enable you to:

- *understand the meaning of the term correlation;*
- *understand the nature of relationship between two variables;*
- *calculate the different measures of correlation;*
- *analyse the degree and direction of the relationships.*

1. INTRODUCTION

In previous chapters you have learnt how to construct summary measures out of a mass of data and changes among similar variables. Now you will learn how to examine the relationship between two variables.

As the summer heat rises, hill stations, are crowded with more and more visitors. Ice-cream sales become more brisk. Thus, the temperature is related to number of visitors and sale of ice-creams. Similarly, as the supply of tomatoes increases in your local *mandi*, its price drops. When the local harvest starts reaching the market, the price of tomatoes drops from Rs 40 per kg to Rs 4 per kg or even less. Thus supply is related to price. Correlation analysis is a means for examining such relationships systematically. It deals with questions such as:

- Is there any relationship between two variables?

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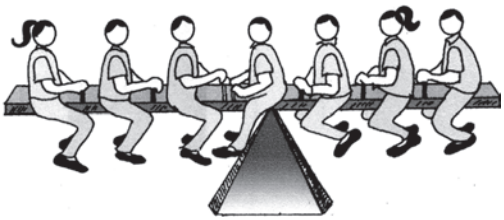
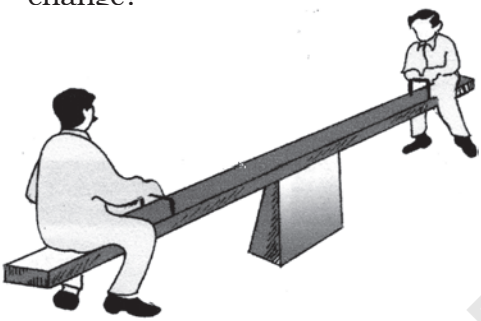
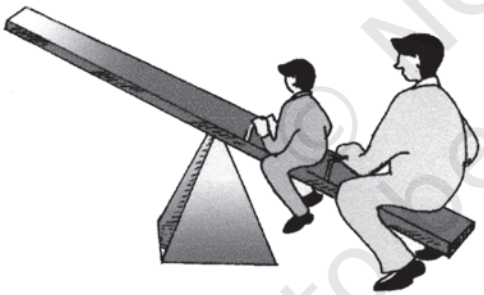


- It the value of one variable changes, does the value of the other also change?



- Do both the variables move in the same direction?



- How strong is the relationship?

2. Types of Relationship

Let us look at various types of relationship. The relation between movements in quantity demanded and the price of a commodity is an integral part of the theory of demand, which you will study in Class XII. Low agricultural productivity is related to low rainfall. Such examples of relationship may be given a cause and effect interpretation. Others may be just coincidence. The relation between the arrival of migratory birds in a sanctuary and the birth rates in the locality cannot be given any cause and effect interpretation. The relationships are simple coincidence. The relationship between size of the shoes and money in your pocket is another such example. Even if relationships exist, they are difficult to explain it.

In another instance a third variable's impact on two variables may give rise to a relation between the two variables. Brisk sale of ice-creams may be related to higher number of deaths due to drowning. The victims are not drowned due to eating of ice-creams. Rising temperature leads to brisk sale of ice-creams. Moreover, large number of people start going to swimming pools to beat the heat. This might have raised the number of deaths by drowning. Thus, temperature is behind the high correlation between the sale of ice-creams and deaths due to drowning.

What Does Correlation Measure?

Correlation studies and measures the direction and intensity of relationship among variables. Correlation measures covariation, not causation. Correlation should never be interpreted as implying cause and effect relation. The presence of correlation between two variables X and Y simply means that when the value of one variable is found to change in one direction, the value of the other

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variable is found to change either in the same direction (i.e. positive change) or in the opposite direction (i.e. negative change), but in a definite way. For simplicity we assume here that the correlation, if it exists, is linear, i.e. the relative movement of the two variables can be represented by drawing a straight line on graph paper.

Types of Correlation

Correlation is commonly classified into negative and positive correlation. The correlation is said to be positive when the variables move together in the same direction. When the income rises, consumption also rises. When income falls, consumption also falls. Sale of ice-cream and temperature move in the same direction. The correlation is negative when they move in opposite directions. When the price of apples falls its demand increases. When the prices rise its demand decreases. When you spend more time in studying, chances of your failing decline. When you spend less hours in your studies, chances of scoring low marks/grades increase. These are instances of negative correlation. The variables move in opposite direction.

3. Techniques for Measuring Correlation

Three important tools used to study correlation are scatter diagrams, Karl Pearson's coefficient of correlation and Spearman's rank correlation.

A scatter diagram visually presents the nature of association without giving any specific numerical value. A numerical measure of linear relationship between two variables is given by Karl Pearson's coefficient of correlation. A relationship is said to be linear if it can be represented by a straight line. Spearman's coefficient of correlation measures the linear association between ranks assigned to indiviual items according to their attributes. Attributes are those variables which cannot be numerically measured such as intelligence of people, physical appearance, honesty, etc.

Scatter Diagram

A scatter diagram is a useful technique for visually examining the form of relationship, without calculating any numerical value. In this technique, the values of the two variables are plotted as points on a graph paper. From a scatter diagram, one can get a fairly good idea of the nature of relationship. In a scatter diagram the degree of closeness of the scatter points and their overall direction enable us to examine the relationship. If all the points lie on a line, the correlation is perfect and is said to be in unity. If the scatter points are widely dispersed around the line, the correlation is low. The correlation is said to be linear if the scatter points lie near a line or on a line.

Scatter diagrams spanning over Fig. 6.1 to Fig. 6.5 give us an idea of

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the relationship between two variables. Fig. 6.1 shows a scatter around an upward rising line indicating the movement of the variables in the same direction. When X rises Y will also rise. This is positive correlation. In Fig. 6.2 the points are found to be scattered around a downward sloping line. This time the variables move in opposite directions. When X rises Y falls and vice versa. This is negative correlation. In Fig.6.3 there is no upward rising or downward sloping line around which the points are scattered. This is an example of no correlation. In Fig. 6.4 and Fig. 6.5, the points are no longer scattered around an upward rising or downward falling line. The points themselves are on the lines. This is referred to as perfect positive correlation and perfect negative correlation respectively.

Activity

- Collect data on height, weight and marks scored by students in your class in any two subjects in class X. Draw the scatter diagram of these variables taking two at a time. What type of relationship do you find?

A careful observation of the scatter diagram gives an idea of the nature and intensity of the relationship.

Karl Pearson's Coefficient of Correlation

This is also known as product moment correlation coefficient or simple correlation coefficient. It gives a precise numerical value of the degree of linear relationship between two variables X and Y.

It is important to note that Karl Pearson's coefficient of correlation should be used only when there is a linear relation between the variables. When there is a non-linear relation between X and Y, then calculating the Karl Pearson's coefficient of correlation can be misleading. Thus, if the true relation is of the linear type as shown by the scatter diagrams in figures 6.1, 6.2, 6.4 and 6.5, then the Karl Pearson's coefficient of correlation should be calculated and it will tell us the direction and intensity of the relation between the variables. But if the true relation is of the type shown in the scatter diagrams in Figures 6.6 or 6.7, then it means there is a non-linear relation between X and Y and we should not try to use the Karl Pearson's coefficient of correlation.

It is, therefore, advisable to first examine the scatter diagram of the relation between the variables before calculating the Karl Pearson's correlation coefficient.

Let $X_1, X_2, \ldots, X_N$ be N values of X and $Y_1, Y_2, \ldots, Y_N$ be the corresponding values of Y. In the subsequent presentations, the subscripts indicating the unit are dropped for the sake of simplicity. The arithmetic means of X and Y are defined as

$$\bar{X} = \frac{\sum X}{N}; \quad \bar{Y} = \frac{\sum Y}{N}$$

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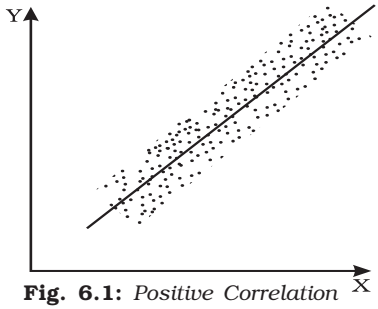

Fig. 6.1: *Positive Correlation*

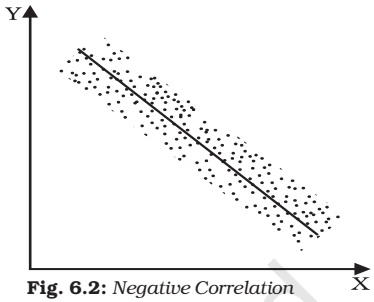

Fig. 6.2: *Negative Correlation*

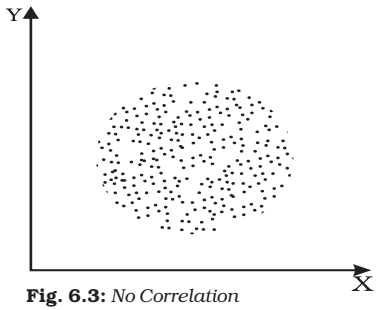

Fig. 6.3: *No Correlation*

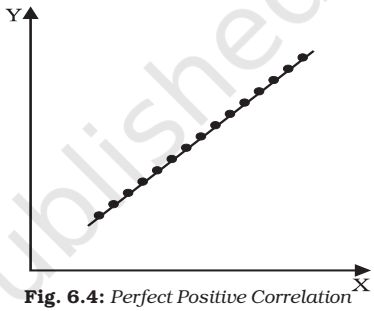

Fig. 6.4: *Perfect Positive Correlation*

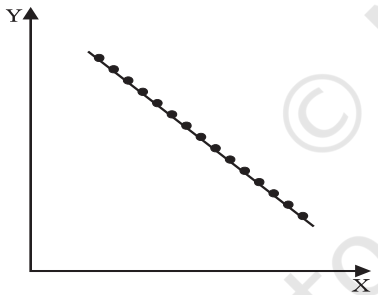

Fig. 6.5: *Perfect Negative Correlation*

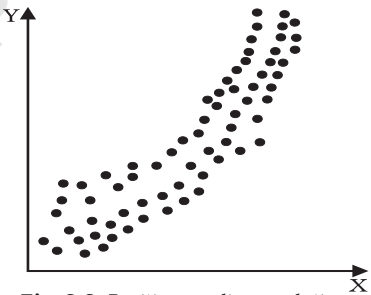

Fig. 6.6: *Positive non-linear relation*

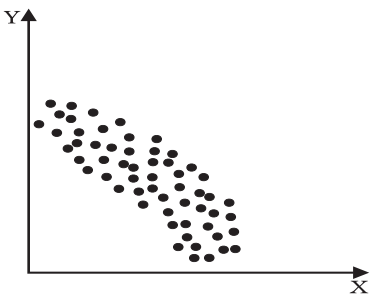

Fig. 6.7: *Negative non-linear relation*

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and their variances are as follows

$$\sigma^2 x = \frac{\sum (X - \overline{X})^2}{N} = \frac{\sum X^2}{N} - \overline{X}^2$$

and $$\sigma^2 y = \frac{\sum (Y - \overline{Y})^2}{N} = \frac{\sum Y^2}{N} - \overline{Y}^2$$

The standard deviations of X and Y, respectively, are the positive square roots of their variances. Covariance of X and Y is defined as

$$\text{Cov}(X,Y) = \frac{\sum (X - \overline{X})(Y - \overline{Y})}{N} = \frac{\sum xy}{N}$$

Where $x = X - \overline{X}$ and $y = Y - \overline{Y}$ are the deviations of the ith value of X and Y from their mean values respectively.

The sign of covariance between X and Y determines the sign of the correlation coefficient. The standard deviations are always positive. If the covariance is zero, the correlation coefficient is always zero. The product moment correlation or the Karl Pearson's measure of correlation is given by

$$r = {}^{\Sigma xy}/ N\sigma_x\sigma_y \qquad ...(1)$$

or

$$r = \frac{\sum (X - \overline{X})(Y - \overline{Y})}{\sqrt{\sum (X - \overline{X})^2}\sqrt{\sum (Y - \overline{Y})^2}} \qquad ...(2)$$

or

$$r = \frac{\frac{\sum XY - (\sum X)(\sum Y)}{N}}{\sqrt{\sum X^2 - \frac{(\sum X)^2}{N}}\sqrt{\sum Y^2 - \frac{(\sum Y)^2}{N}}} \qquad ...(3)$$

or

$$r = \frac{N\Sigma XY - (\sum X)(\sum Y)}{\sqrt{N\Sigma X^2 - (\Sigma X)^2} \bullet \sqrt{N\Sigma Y^2 - (\Sigma Y)^2}} \qquad ...(4)$$

Properties of Correlation Coefficient

Let us now discuss the properties of the correlation coefficient

- *r* has no unit. It is a pure number. It means units of measurement are not part of *r*. *r* between height in feet and weight in kilograms, for instance, could be say 0.7.
- A negative value of *r* indicates an inverse relation. A change in one variable is associated with change in the other variable in the opposite direction. When price of a commodity rises, its demand falls. When the rate of interest rises the demand for funds also falls. It is because now funds have become costlier.
- If *r* is positive the two variables move in the same direction. When the price of coffee, a substitute of tea, rises the demand for tea also rises. Improvement in irrigation facilities is associated with higher yield. When temperature rises the sale of ice-creams becomes brisk.

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- The value of the correlation coefficient lies between minus one and plus one, $-1 \leq r \leq 1$. If, in any exercise, the value of r is outside this range it indicates error in calculation.
- The magnitude of r is unaffected by the change of origin and change of scale. Given two variables X and Y let us define two new variables.

$$U = \frac{X - A}{B}; V = \frac{Y - C}{D}$$

where A and C are assumed means of X and Y respectively. B and D are common factors and of same sign. Then

$$r_{xy} = r_{uv}$$

This property is used to calculate correlation coefficient in a highly simplified manner, as in the step deviation method.
- If $r = 0$ the two variables are uncorrelated. There is no linear relation between them. However other types of relation may be there.
- If $r = 1$ or $r = -1$ the correlation is perfect and there is exact linear relation.
- A high value of r indicates strong linear relationship. Its value is said to be high when it is close to +1 or –1.
- A low value of r *(close to zero)* indicates a weak linear relation. But there may be a non-linear relation.

As you have read in Chapter 1, the statistical methods are no substitute for common sense. Here, is another example, which highlights the need for understanding the data properly before correlation is calculated and interpreted. An epidemic spreads in some villages and the government sends a team of doctors to the affected villages. The correlation between the number of deaths and the number of doctors sent to the villages is found to be positive. Normally, the healthcare facilities provided by the doctors are expected to reduce the number of deaths showing a negative correlation. This happened due to other reasons. The data relate to a specific time period. Many of the reported deaths could be terminal cases where the doctors could do little. Moreover, the benefit of the presence of doctors becomes visible only after some time. It is also possible that the reported deaths are not due to the epidemic. A tsunami suddenly hits the state and death toll rises.

Let us illustrate the calculation of r by examining the relationship between years of schooling of farmers and the annual yield per acre.

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Example 1

No. of years of schooling of farmers	*Annual yield per acre in '000 (Rs)*
0	4
2	4
4	6
6	10
8	10
10	8
12	7

Formula 1 needs the value of $\sum Xy, \sigma_x, \sigma_y$

From Table 6.1 we get,

$$\sum xy = 42,$$

$$\sigma_x = \sqrt{\frac{\sum(X-\overline{X})^2}{N}} = \sqrt{\frac{112}{7}},$$

$$\sigma_y = \sqrt{\frac{\sum(Y-\overline{Y})^2}{N}} = \sqrt{\frac{38}{7}}$$

Substituting these values in formula (1)

$$r = \frac{42}{7\sqrt{\frac{112}{7}}\sqrt{\frac{38}{7}}} = 0.644$$

The same value can be obtained from formula (2) also.

$$r = \frac{\sum(X-\overline{X})\ (Y-\overline{Y})}{\sqrt{\sum(X-\overline{X})^2}\ \sqrt{\sum(Y-\overline{Y})^2}} \quad ...(2)$$

$$r = \frac{42}{\sqrt{112}\ \sqrt{38}} = 0.644$$

Thus, years of education of farmers and annual yield per acre are positively correlated. The value of *r* is also large. It implies that more the number of years farmers invest in education, higher will be the yield per acre. It underlines the importance of farmers' education.

To use formula (3)

TABLE 6.1

Calculation of *r* between years of schooling of farmers and annual yield

Years of Education (X)	$(X-\overline{X})$	$(X-\overline{X})^2$	*Annual yield per acre in '000 Rs (Y)*	$(Y-\overline{Y})$	$(Y-\overline{Y})^2$	$(X-\overline{X})(Y-\overline{Y})$
0	–6	36	4	–3	9	18
2	–4	16	4	–3	9	12
4	–2	4	6	–1	1	2
6	0	0	10	3	9	0
8	2	4	10	3	9	6
10	4	16	8	1	1	4
12	6	36	7	0	0	0
$\sum X=42$		$\sum (X-\overline{X})^2=112$	$\sum Y=49$		$\sum (Y-\overline{Y})^2=38$	$\sum (X-\overline{X})(Y-\overline{Y})=42$

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$$r = \frac{\sum XY - \frac{(\sum X)(\sum Y)}{N}}{\sqrt{\sum X^2 - \frac{(\sum X)^2}{N}}\sqrt{\sum Y^2 - \frac{(\sum Y)^2}{N}}} \quad ...(3)$$

the value of the following expressions have to be calculated i.e.

$\sum XY, \sum X^2, \sum Y^2.$

Now apply formula (3) to get the value of *r*.

Let us know the interpretation of different values of *r*. The correlation coefficient between marks secured in English and Statistics is, say, 0.1. It means that though the marks secured in the two subjects are positively correlated, the strength of the relationship is weak. Students with high marks in English may be getting relatively low marks in statistics. Had the value of *r* been, say, 0.9, students with high marks in English will invariably get high marks in Statistics.

An example of negative correlation is the relation between arrival of vegetables in the local *mandi* and price of vegetables. If *r* is –0.9, vegetable supply in the local *mandi* will be accompanied by lower price of vegetables. Had it been –0.1, large vegetable supply will be accompanied by lower price, not as low as the price, when *r* is –0.9. The extent of price fall depends on the absolute value of *r*. Had it been zero, there would have been no fall in price, even after large supplies in the market. This is also a possibility if the increase in supply is taken care of by a good transport network transferring it to other markets.

Activity

- Look at the following table. Calculate *r* between annual growth of national income at current price and the Gross Domestic Saving as percentage of GDP.

Step deviation method to calculate correlation coefficient.

When the values of the variables are large, the burden of calculation can be considerably reduced by using a property of *r*. It is that *r* is independent of change in origin and scale. It is also known as step deviation method. It involves the transformation of the variables X and Y as follows:

TABLE 6.2

Year	*Annual growth of National Income*	*Gross Domestic Saving as percentage of GDP*
1992–93	14	24
1993–94	17	23
1994–95	18	26
1995–96	17	27
1996–97	16	25
1997–98	12	25
1998–99	16	23
1999–00	11	25
2000–01	8	24
2001–02	10	23

Source: *Economic Survey, (2004–05) Pg. 8,9*

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$$U = \frac{X - A}{B}; V = \frac{Y - C}{D}$$

where A and B are assumed means, h and k are common factors and have same signs.

Then $r_{UV} = r_{XY}$

This can be illustrated with the exercise of analysing the correlation between price index and money supply.

Example 2

Price index (X)	120	150	190	220	230
Money supply in Rs crores (Y)	1800	2000	2500	2700	3000

The simplification, using step deviation method is illustrated below. Let A = 100; h = 10; B = 1700 and k = 100

The table of transformed variables is as follows:

Calculation of *r* between price index and money supply using step deviation method

TABLE 6.3

U $\left(\frac{X-100}{10}\right)$	V $\left(\frac{Y-1700}{100}\right)$	U^2	V^2	UV
2	1	4	1	2
5	3	25	9	15
9	8	81	64	72
12	10	144	100	120
13	13	169	169	169

$\Sigma U = 41$; $\Sigma U = 35$; $\Sigma U^2 = 423$;

$\Sigma V^2 = 343$; $\Sigma UV = 378$

Substituting these values in formula (3)

$$r = \frac{\Sigma UV - \frac{(\Sigma U)(\Sigma U)}{N}}{\sqrt{\Sigma U^2 - \frac{(\Sigma U)^2}{N}}\sqrt{\Sigma V^2 - \frac{(\Sigma V)^2}{N}}} \quad (3)$$

$$= \frac{378 - \frac{41 \times 35}{5}}{\sqrt{423 - \frac{(41)^2}{5}}\sqrt{343 - \frac{(35)^2}{5}}}$$

$= 0.98$

The strong positive correlation between price index and money supply is an important premise of monetary policy. When the money supply grows the price index also rises.

Activity

- Using data related to India's population and national income, calculate the correlation between them using step deviation method.

Spearman's rank correlation

Spearman's rank correlation was developed by the British psychologist C.E. Spearman. It is used in the following situations:

1. Suppose we are trying to estimate the correlation between the heights and weights of students in a remote village where neither measuring rods nor weighing machines are

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available. In such a situation, we cannot measure height or weight, but we can certainly rank the students according to weight and height. These ranks can then be used to calculate Spearman's rank correlation coefficient.

2. Suppose we are dealing with things such as fairness, honesty or beauty. These cannot be measured in the same way as we measure income, weight or height. At most, these things can be measured relatively, for example, we may be able to rank people according to beauty (some people would argue that even this is not possible because standards and criteria of beauty may differ from person to person and culture to culture). If we wish to find the relation between variables, at least one of which is of this type, then Spearman's rank correlation coefficient is to be used.
3. Spearman's rank correlation coefficient can be used in some cases where there is a relation whose direction is clear but which is non-linear as shown when the scatter diagrams are of the type shown in Figures 6.6 and 6.7.
4. Spearman's correlation coefficient is not affected by extreme values. In this respect, it is better than Karl Pearson's correlation coefficient. Thus if the data contains some extreme values, Spearman's correlation coefficient can be very useful.

Rank correlation coefficient and simple correlation coefficient have the same interpretation. Its formula has been derived from simple correlation coefficient where individual values have been replaced by ranks. These ranks are used for the calculation of correlation. This coefficient provides a measure of linear association between ranks assigned to these units, not their values. The Spearman's rank correlation formula is

$$r_a = 1 - \frac{6\sum D^2}{n^3 - n} \qquad \ldots(4)$$

where n is the number of observations and D the deviation of ranks assigned to a variable from those assigned to the other variable.

All the properties of the simple correlation coefficient are applicable here. Like the Pearsonian Coefficient of correlation it lies between 1 and –1. However, generally it is not as accurate as the ordinary method. This is due the fact that all the information concerning the data is not utilised.

The first difference is the difference of consecutive values. The first differences of the values of items in the series, arranged in order of magnitude, are almost never constant. Usually the data cluster around the central values with smaller differences in the middle of the array.

If the first differences were constant, then r and r_k would give identical results. In general r_k is less than or equal to r.

Calculation of Rank Correlation **Coefficient**

The calculation of rank correlation will be illustrated under three situations.

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1. The ranks are given.
2. The ranks are not given. They have to be worked out from the data.
3. Ranks are repeated.

Case 1: When the ranks are given

Example 3

Five persons are assessed by three judges in a beauty contest. We have to find out which pair of judges has the nearest approach to common perception of beauty.

	Competitors				
Judge	1	2	3	4	5
A	1	2	3	4	5
B	2	4	1	5	3
C	1	3	5	2	4

There are 3 pairs of judges necessitating calculation of rank correlation thrice. Formula (4) will be used.

$$r_s = 1 - \frac{6\Sigma D^2}{n^3 - n} \quad ...(4)$$

The rank correlation between A and B is calculated as follows:

A	*B*	*D*	D^2
1	2	–1	1
2	4	–2	4
3	1	2	4
4	5	–1	1
5	3	2	4
Total			14

Substituting these values in formula (4)

$$r_s = 1 - \frac{6\Sigma D^2}{n^3 - n} \quad ...(4)$$

$$= 1 - \frac{6 \times 14}{5^3 - 5} = 1 - \frac{84}{120} = 1 - 0.7 = 0.3$$

The rank correlation between A and C is calculated as follows:

A	*C*	*D*	D^2
1	1	0	0
2	3	–1	1
3	5	–2	4
4	2	2	4
5	4	1	1
Total			10

Substituting these values in formula (4) the rank correlation is 0.5. Similarly, the rank correlation between the rankings of judges B and C is 0.9. Thus, the perceptions of judges A and C are the closest. Judges B and C have very different tastes.

Case 2: When the ranks are not given

Example 4

We are given the percentage of marks, secured by 5 students in Economics and Statistics. Then the ranking has to be worked out and the rank correlation is to be calculated.

Student	*Marks in Statistics (X)*	*Marks in Economics (Y)*
A	85	60
B	60	48
C	55	49
D	65	50
E	75	55

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Student	Ranking in Statistics (R_x)	Ranking in Economics (R_y)
A	1	1
B	4	5
C	5	4
D	3	3
E	2	2

Once the ranking is complete formula (4) is used to calculate rank correlation.

Case 3: When the ranks are repeated and ranks of not given

Example 5

The values X and Y are given as follows

X	Y
1200	75
1150	65
1000	50
990	100
800	90
780	85
760	90
750	40
730	50
700	60
620	50
600	75

In order to work out the rank correlation, the ranks of the values are worked out. Common ranks are given to the repeated items. The common rank is the mean of the ranks which those items would have assumed if they were slightly different from each other. The next item will be assigned the rank next to the rank already assumed.

Here Y has the value 50 at the 9th, 10th and 11th rank. Hence all three are given the average rank i.e. 10,

Rank of X	Rank of Y	Deviation in Ranks	D^2
1	5.5	–4.5	20.25
2	7	–5	25.00
3	10	–7	49.00
4	1	3	9.00
5	2.5	2.5	6.25
6	4	2	4.00
7	2.5	4.5	20.25
8	12	–4	16.00
9	10	–1	1.00
10	8	2	4.00
11	10	1	1.00
12	5.5	6.5	42.25
			198.00

The formula of Spearman's rank correlation coefficient when the ranks are repeated is as follows

$$r_s = 1 - \frac{6\left[\Sigma D^2 + \frac{(m_1^3 - m_1)}{12} + \frac{(m_2^3 - m_2)}{12} + \ldots\right]}{n(n^2 - 1)}$$

where m_1, m_2, ..., are the number of repetitions of ranks and $\frac{m^3{}_1 - m_1}{12}$ ..., their corresponding correction factors. The necessary correction for this data thus is

$$\frac{3^3\text{-}3}{12} + \frac{2^3\text{-}2}{12} = \frac{30}{12} = 2.5$$

Substituting the values of these expressions

$$r_s = 1\text{-}\frac{6\,(198 + 2.5)}{12^3\text{-}12} = (1\text{-}0.70) = 0.30$$

Thus, there is positive rank correlation between X and Y. Both X and Y move in the same direction. However, the

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relationship cannot be described as strong.

Activity

- Collect data on marks scored by 10 of your classmates in class IX and X examinations. Calculate the rank correlation coefficient between them. If your data do not have any repetition, repeat the exercise by taking a data set having repeated ranks. What are the circumstances in which rank correlation coefficient is preferred to simple correlation coefficient? If data are precisely measured will you still prefer rank correlation coefficient to simple correlation? When can you be indifferent to the choice? Discuss in class.

4. Conclusion

We have discussed some techniques for studying the relationship between two variables, particularly the linear relationship. The scatter diagram gives a visual presentation of the relationship and is not confined to linear relations. Karl Pearson's coefficient of correlation and Spearman's rank correlation measure linear relationship among variables. When the variables cannot be measured precisely, rank correlation can be used. These measures however do not imply causation. The knowledge of correlation gives us an idea of the direction and intensity of change in a variable when the correlated variable changes.

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Recap

- Correlation analysis studies the relation between two variables.
- Scatter diagrams give a visual presentation of the nature of relationship between two variables.
- Karl Pearson's coefficient of correlation r measures numerically only linear relationship between two variables. r lies between –1 and 1.
- When the variables cannot be measured precisely Spearman's rank correlation can be used to measure the linear relationship numerically.
- Repeated ranks need correction factors.
- Correlation does not mean causation. It only means covariation.

EXERCISES

1. The unit of correlation coefficient between height in feet and weight in kgs is
   (i) kg/feet
   (ii) percentage
   (iii) non-existent
2. The range of simple correlation coefficient is
   (i) 0 to infinity
   (ii) minus one to plus one
   (iii) minus infinity to infinity
3. If r_{xy} is positive the relation between X and Y is of the type
   (i) When Y increases X increases
   (ii) When Y decreases X increases
   (iii) When Y increases X does not change
4. If $r_{xy} = 0$ the variable X and Y are
   (i) linearly related
   (ii) not linearly related
   (iii) independent
5. Of the following three measures which can measure any type of relationship
   (i) Karl Pearson's coefficient of correlation
   (ii) Spearman's rank correlation
   (iii) Scatter diagram
6. If precisely measured data are available the simple correlation coefficient is
   (i) more accurate than rank correlation coefficient
   (ii) less accurate than rank correlation coefficient
   (iii) as accurate as the rank correlation coefficient
7. Why is r preferred to covariance as a measure of association?
8. Can *r* lie outside the –1 and 1 range depending on the type of data?
9. Does correlation imply causation?
10. When is rank correlation more precise than simple correlation coefficient?
11. Does zero correlation mean independence?
12. Can simple correlation coefficient measure any type of relationship?
13. Collect the price of five vegetables from your local market every day for a week. Calculate their correlation coefficients. Interpret the result.
14. Measure the height of your classmates. Ask them the height of their

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benchmate. Calculate the correlation coefficient of these two variables. Interpret the result.

15. List some variables where accurate measurement is difficult.

16. Interpret the values of *r* as 1, –1 and 0.

17. Why does rank correlation coefficient differ from Pearsonian correlation coefficient?

18. Calculate the correlation coefficient between the heights of fathers in inches (X) and their sons (Y)

X	65	66	57	67	68	69	70	72
Y	67	56	65	68	72	72	69	71

(Ans. r = 0.603)

19. Calculate the correlation coefficient between X and Y and comment on their relationship:

X	–3	–2	–1	1	2	3
Y	9	4	1	1	4	9

(Ans. r = 0)

20. Calculate the correlation coefficient between X and Y and comment on their relationship

X	1	3	4	5	7	8
Y	2	6	8	10	14	16

(Ans. r = 1)

Activity

- Use all the formulae discussed here to calculate r between India's national income and exports taking at least ten observations.

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CHAPTER

7

Index Numbers

Studying this chapter should enable you to:

- *understand the meaning of the term index number;*
- *become familiar with the use of some widely used index numbers;*
- *calculate an index number;*
- *appreciate its limitations.*

1. INTRODUCTION

You have learnt in the previous chapters how summary measures can be obtained from a mass of data. Now you will learn how to obtain summary measures of change in a group of related variables.

Rabi goes to the market after a long gap. He finds that the prices of most commodities have changed. Some items have become costlier, while others have become cheaper. On his return from the market, he tells his father about the change in price of the each and every item, he bought. It is bewildering to both.

The industrial sector consists of many subsectors. Each of them is changing. The output of some subsectors are rising, while it is falling in some subsectors. The changes are not uniform. Description of the individual rates of change will be difficult to understand. Can a single figure summarise these changes? Look at the following cases:

Case 1

An industrial worker was earning a salary of Rs 1,000 in 1982. Today, he

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earns Rs 12,000. Can his standard of living be said to have risen 12 times during this period? By how much should his salary be raised so that he is as well off as before?

Case 2

You must be reading about the sensex in the newspapers. The sensex crossing 8000 points is, indeed, greeted with euphoria. When, sensex dipped 600 points recently, it eroded investors' wealth by Rs 1,53,690 crores. What exactly is sensex?

Case 3

The government says inflation rate will not accelerate due to the rise in the price of petroleum products. How does one measure inflation?

These are a sample of questions you confront in your daily life. A study of the index number helps in analysing these questions.

2. What is an index number

An index number is a statistical device for measuring changes in the magnitude of a group of related variables. It represents the general trend of diverging ratios, from which it is calculated. It is a measure of the average change in a group of related variables over two different situations. The comparison may be between like categories such as persons, schools, hospitals etc. An index number also measures changes in the value of the variables such as prices of specified list of commodities, volume of production in different sectors of an industry, production of various agricultural crops, cost of living etc.

Conventionally, index numbers are expressed in terms of percentage. Of the two periods, the period with which the comparison is to be made, is known as the base period. The value in the base period is given the index number 100. If you want to know how much the price has changed in 2005 from the level in 1990, then 1990 becomes the base. The index number of any period is in proportion with it. Thus an index number of 250 indicates that the value is two and half times that of the base period.

Price index numbers measure and permit comparison of the prices of certain goods. Quantity index numbers measure the changes in the physical volume of production, construction or employment. Though price index numbers are more widely used, a production index is also an important indicator of the level of the output in the economy.

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3. Construction of an Index Number

In the following sections, the principles of constructing an index number will be illustrated through price index numbers.

Let us look at the following example:

Example 1

Calculation of simple aggregative price index

TABLE 7.1

Commodity	*Base period price (Rs)*	*Current period price (Rs)*	*Percentage change*
A	2	4	100
B	5	6	20
C	4	5	25
D	2	3	50

As you observe in this example, the percentage changes are different for every commodity. If the percentage changes were the same for all four items, a single measure would have been sufficient to describe the change. However, the percentage changes differ and reporting the percentage change for every item will be confusing. It happens when the number of commodities is large, which is common in any real market situation. *A price index represents these changes by a single numerical measure.*

There are two methods of constructing an index number. It can be computed by the *aggregative method* and by the *method of averaging relatives.*

The Aggregative Method

The formula for a *simple aggregative price index* is

$$P_{01} = \frac{\Sigma P_1}{\Sigma P_0} \times 100$$

Where P_1 and P_0 indicate the price of the commodity in the current period and base period respectively. Using the data from example 1, the *simple aggregative price index* is

$$P_{01} = \frac{4+6+5+3}{2+5+4+2} \times 100 = 138.5$$

Here, price is said to have risen by 38.5 per cent.

Do you know that such an index is of limited use? The reason is that the units of measurement of prices of various commodities are not the same. It is unweighted, because the relative importance of the items has not been properly reflected. The items are treated as having equal importance or weight. But what happens in reality? In reality the items purchased differ in order of importance. Food items occupy a large proportion of our expenditure. In that case an equal rise in the price of an item with large weight and that of an item with low weight will have different implications for the overall change in the price index.

The formula for a *weighted aggregative price index* is

$$P_{01} = \frac{\Sigma P_1 q_0}{\Sigma P_0 q_0} \times 100$$

An index number becomes a weighted index when the relative importance of items is taken care of.

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Here weights are quantity weights. To construct a weighted aggregative index, a well-specified basket of commodities is taken and its worth each year is calculated. It thus measures the changing value of a fixed aggregate of goods. Since the total value changes with a fixed basket, the change is due to price change. Various methods of calculating a weighted aggregative index use different baskets with respect to time.

Example 2

Calculation of *weighted aggregative price index*

TABLE 7.2

Commodity	*Base period* *Price* P_0	*Base period* *Quantity* q_0	*Current period* *Price* p_1	*Current period* *Quantity* q_1
A	2	10	4	5
B	5	12	6	10
C	4	20	5	15
D	2	15	3	10

$$P_{01} = \frac{\Sigma P_1 q_0}{\Sigma P_0 q_0} \times 100$$

$$= \frac{4\times10+6\times12+5\times20+3\times15}{2\times10+5\times12+4\times20+2\times15} \times 100$$

$$= \frac{257}{190} \times 100 = 135.3$$

This method uses the base period quantities as weights. A weighted aggregative price index using base period quantities as weights, is also known as *Laspeyre's price index*. It provides an explanation to the question that if the expenditure on base period basket of commodities was Rs 100, how much should be the expenditure in the current period on the same basket of commodities? As you can see here, the value of base period quantities has risen by 35.3 per cent due to price rise. Using base period quantities as weights, the price is said to have risen by 35.3 percent.

Since the current period quantities differ from the base period quantities, the index number using current period weights gives a different value of the index number.

$$P_{01} = \frac{\Sigma P_1 q_1}{\Sigma P_0 q_1} \times 100$$

$$= \frac{4\times5+6\times10+5\times15+3\times10}{2\times5+5\times10+4\times15+2\times10} \times 100$$

$$= \frac{185}{140} \times 100 = 132.1$$

It uses the current period quantities as weights. A weighted aggregative price index using current period quantities as weights is known as *Paasche's price index*. It helps in answering the question that, if the

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current period basket of commodities was consumed in the base period and if we were spending Rs 100 on it, how much should be the expenditure in current period on the same basket of commodities. Paasche's price index of 132.1 is interpreted as a price rise of 32.1 per cent. Using current period weights, the price is said to have risen by 32.1 per cent.

Method of Averaging relatives

When there is only one commodity, the price index is the ratio of the price of the commodity in the current period to that in the base period, usually expressed in percentage terms. The method of averaging relatives takes the average of these relatives when there are many commodities. The price index number using *price relatives* is defined as

$$P_{01} = \frac{1}{n} \Sigma \frac{p_1}{p_0} \times 100$$

where P_1 and P_o indicate the price of the *i*th commodity in the current period and base period respectively. The ratio $(P_1/P_0) \times 100$ is also referred to as price relative of the commodity. *n* stands for the number of commodities. In the current exmple

$$P_{01} = \frac{1}{4}\left(\frac{4}{2}+\frac{6}{5}+\frac{5}{4}+\frac{3}{2}\right)\times 100 = 149$$

Thus, the prices of the commodities have risen by 49 per cent.

The *weighted index of price relatives* is the weighted arithmetic mean of price relatives defined as

$$P01 = \frac{\Sigma_{i=1}^{n} Wi\left(\frac{P1i}{P0i} \times 100\right)}{\Sigma_{i=1}^{n} Wi}$$

where W = Weight.

In a *weighted price relative index* weights may be determined by the proportion or percentage of expenditure on them in total expenditure during the base period. It can also refer to current period depending on the formula used. These are, essentially, the value shares of different commodities in the total expenditure. In general the base period weight is preferred to the current period weight. It is because calculating the weight every year is inconvenient. It also refers to the changing values of different baskets. They are strictly not comparable. *Example 3* shows the type of information one needs for calculating *weighted price index.*

Example 3

Calculation of *weighted price relatives index*

TABLE 7.3

Commodity	*Weight in %*	*Base year price price (in Rs.)*	*Current year (in Rs)*	*Price relative*
A	40	2	4	200
B	30	5	6	120
C	20	4	5	125
D	10	2	3	150

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The weighted price index is

$$P_{01} = \frac{\sum_{i=1}^{n} W_i \left(\frac{P_{1i}}{P_{0i}} \times 100 \right)}{\sum_{i=1}^{n} W_i}$$

$$= \frac{40 \times 200 + 30 \times 120 + 20 \times 125 + 10 \times 150}{100}$$

= 156

The *weighted price index* is 156. The price index has risen by 56 per cent. The values of the *unweighted price index* and the *weighted price index* differ, as they should. The higher rise in the weighted index is due to the doubling of the most important item A in *Example 3*.

Activity

- Interchange the current period values with the base period values, in the data given in *Example 2*. Calculate the price index using Laspeyre's, and Paasche's formula. What difference do you observe from the earlier illustration?

4. Some Important Index Numbers

Consumer price index

Consumer price index (CPI), also known as *the cost of living index*, measures the average change in retail prices. Consider the statement that the *CPI for industrial workers (2001=100) is 277 in December 2014*. What does this statement mean? It means that if the industrial worker was spending Rs 100 in 2001 for a typical basket of commodities, he needs Rs 277 in December 2014 to be able to buy an identical basket of commodities. It is not necessary that he/she buys the basket. What is important is whether he has the capability to buy it.

Example 4

Construction of *consumer price index* number.

$$CPI = \frac{\Sigma WR}{\Sigma W} = \frac{9786.85}{100} = 97.86$$

This exercise shows that the cost of living has declined by 2.14 per cent. What does an index larger than 100 indicate? It means a higher cost of living necessitating an upward adjustment in wages and salaries. The rise is equal to the amount, it exceeds 100. If the index is 150, 50 per cent upward adjustment is required. The salaries of the employees have to be raised by 50 per cent.

TABLE 7.4

Item	*Weight in % W*	*Base period price (Rs)*	*Current period price (Rs)*	*$R=P_1/P_0 \times 100$ (in%)*	*WR*
Food	35	150	145	96.67	3883.45
Fuel	10	25	23	92.00	920.00
Cloth	20	75	65	86.67	1733.40
Rent	15	30	30	100.00	1500.00
Misc.	20	40	45	112.50	2250.00
					9786.85

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Consumer Price Index Number

Government agencies in India prepare a large number of consumer price index numbers. Some of them are as follows:

- Consumer Price Index Numbers for Industrial Workers with base 2001=100. Value of Index in May 2017 was 278.
- All-India Consumer Price Index Numbers for Agricultural Labourers with base 1986-87=100. Value of Index in May 2017 was 872.
- All-India Consumer Price Index Numbers for Rural Labourers with base 1986-87=100. Value of Index in May 2017 was 878.
- All-India Rural Consumer Index with base 2012 = 100. Value of Index in May 2017 was 133.3
- All-India Urban Consumer Price Index with base 2012 = 100. Value of Index in May 2017 was 129.3

  All-India Combined Consumer Price with base 2012 = 100. Value of Index in May 2017 was 131.4

In addition, these indices are available at the state level.

The detailed methods used for calculating each of these index numbers is different and it is not necessary to go into these details.

The Reserve Bank of India is using the All-India Combined Consumer Price Index as the main measure of how consumer prices are changing. Therefore, some details are necessary about this index number.

This index is now being prepared with base 2012 = 100 and many improvements have been made in accordance with international standards. The basket of items and weighing diagrams for the revised series has been prepared using the Modified Mixed Reference Period (MMRP) data of the Consumer Expenditure Survey (CES), 2011-12 of the 68th Round of National Sample Survey (NSS). The weights are as follows:

Major Groups	*Weight*
Food and beverages	45.86
Pan, tobacco and intoxicants	2.38
Clothing & footwear	6.53
Housing	10.07
Fuel & light	6.84
Misc. group	28.32
General	*100.00*

Source: *Economic Survey, 2014-15 Government of India.*

Data are provided on the rate of change per year of each of the sub-groups and main groups. So, we can find out from this data which prices are rising most of all and are, thereby, contributing to inflation.

The Consumer Food Price Index (CFPI) is the same as the Consumer Price Index for 'Food and Beverages' except that it does not include alcoholic beverages' and 'Prepared meals, snacks, sweets, etc'.

Wholesale Price Index

The Wholesale price index number indicates the change in the general price level. Unlike the CPI, it does not have any reference consumer category.

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It does not include items pertaining to services like barber charges, repairing, etc.

What does the statement "WPI with 2004-05 as base is 253 in October, 2014" mean? It means that the general price level has risen by 153 per cent during this period.

The Wholesale Price Index is now being prepared with base 2011-12 = 100. The value of the index for May 2017 was 112.8. This index uses the prices that are prevailing at the wholesale level. Only the prices of goods are included. The main types of goods and their weights are as follows:

Major Groups	*Weight*
Primary Articles	22.62
Fuel and Power	13.15
Manufactured Products	64.23
All Commodities 'Headline Inflation'	100.00
'WPI Food Index'	*24.23*

Source: *Ministry of Statistics and Programme Implementation, 2016-17*

Usually the data on Wholesale Prices is available quickly. The 'All Commodities Inflation Rate' is often referred to as 'Headline Inflation'. Sometimes the focus is on food items which comprise 24.23% of the total weight. This Food Index is made up of Food Articles from the Primary Articles group and Food Products from the Manufactured Products group. Other economists like to focus on the wholesale prices in manufactured goods (other than food articles and also excluding fuel) and for this they study 'Core Inflation' which make up around 55% of the total weight of the wholesale price index.

Index of Industrial production

Unlike the Consumer Price Index or the Wholesale Price Index, this is an index which tries to measure quantities. With effect from April 2017, the base year has been fixed at 2011-12 = 100. The reason for the fast changes in the base year is that every year a large number of items either stop being manufactured or become inconsequential, while many other new items start getting manufactured.

While the price indices were essentially weighted averages of price relatives, the index of industrial production is a weighted arithmetic mean of quantity relatives with weights being allotted to various items in proportion to value added by manufacture in the base year by using Laspeyre's formula:

$$IIP_{01} = \frac{\sum_{i=1}^{n} q_{1i} W_i}{\sum_{i=1}^{n} W_i} \times 100$$

Where IIP_{01} is the index, q_{i1} is the quantity relative for year 1 with year 0 as base for good i, W_i is the weight allotted to the good i. There are n goods in the production index.

The index of Industrial Production is available at the level of Industrial Sectors and sub-sectors. The main branches are 'Mining', 'Manufacturing' and 'Electricity'. Sometimes the focus is on what are called "core" industries

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namely coal, crude oil, natural gas, refinery products, fertilisers, steel, cement and electricity. The Eight Core Industries have a combined weight of 40.27 per cent in the IIP.

TABLE 7.5
Weightage Pattern of IIP (Industrial Production Sectors)

Sector	*Weight*
Mining	14.4
Manufacturing	77.6
Electricity	8.0
General Index	100.0

Source: *Ministry of Statistics and Programme Implementation, 2016-17*

The index of Industrial Production is also available according to the "use" of the product, that is, for example, "Primary Goods", "Consumer Durables" and so on.

TABLE 7.6
Weightage Pattern of IIP (Use-based Groups)

Group	*Weight*
Primary	34.1
Capital Goods	8.2
Intermediate Goods	17.2
Infrastructure/Construction Goods	12.3
Consumer Durables	12.8
Consumer Non-durables	15.3
General Index	100.0

Source: *Ministry of Statistics and Programme Implementation, 2016-17*

Human Development Index

Another useful index widely used to know the development of a country is Human Development Index (HDI) about which you might have studied in Class X.

Sensex

Sensex is the short form of Bombay Stock Exchange Sensitive Index with 1978–79 as base. The value of the sensex is with reference to this period.

It is the benchmark index for the Indian stock market. It consists of 30 stocks which represent 13 sectors of the economy and the companies listed are leaders in their respective industries. If

the sensex rises, it indicates that the market is doing well and investors expect better earnings from companies. It also indicates a growing confidence of

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investors in the basic health of the economy.

5. Issues in the construction of an index number

You should keep certain important issues in mind, while constructing an index number.

- You need to be clear about the purpose of the index. Calculation of a volume index will be inappropriate, when one needs a value index.
- Besides this, the items are not equally important for different groups of consumers when a consumer price index is constructed. The rise in petrol price may not directly impact the living condition of the poor agricultural labourers. Thus the items to be included in any index have to be selected carefully to be as representative as possible. Only then you will get a meaningful picture of the change.
- Every index should have a base year. This base year should be as normal as possible. Years having extreme values should not be selected as base year. The period should also not belong to too far in the past. The comparison between 1993 and 2005 is much more meaningful than a comparison between 1960 and 2005. Many items in a 1960 typical consumption basket have disappeared at present. Therefore, the base year for any index number is routinely updated.
- Another issue is the choice of the formula, which depends on the nature of question to be studied. The only difference between the Laspeyre's index and Paasche's index is the weights used in these formulae.
- Besides, there are many sources of data with different degrees of reliability. Data of poor reliability will give misleading results. Hence, due care should be taken in the collection of data. If primary data are not being used, then the most reliable source of secondary data should be chosen.

Activity

- Collect data from the local vegetable market over a week for, at least 10 items. Try to construct the daily price index for the week. What problems do you encounter in applying both methods for the construction of a price index?

6. Index number in economics

Why do we need to use the index numbers? Wholesale price index number (WPI), consumer price index number (CPI) and industrial production index (IIP) are widely used in policy making.

- Consumer index number (CPI) or cost of living index numbers are helpful in wage negotiation, formulation of income policy, price policy, rent control, taxation and general economic policy formulation.
- The wholesale price index (WPI) is used to eliminate the effect of changes in prices on aggregates, such as national income, capital formation, etc.
- The WPI is widely used to measure the rate of inflation. Inflation is a general and continuing increase in prices. If inflation becomes sufficiently large,

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money may lose its traditional function as a medium of exchange and as a unit of account. Its primary impact lies in lowering the value of money. The weekly inflation rate is given by

$\frac{X_t - X_{t-1}}{X_{t-1}} \times 100$ where X_t and X_{t-1} refer to the WPI for the tth and $(t-1)^{th}$ weeks.

- CPI are used in calculating the purchasing power of money and real wage:

(i) Purchasing power of money = 1/ Cost of living index

(ii) Real wage = (Money wage/Cost of living index) × 100

If the CPI (1982=100) is 526 in January 2005 the equivalent of a rupee in January, 2005 is given by

$$\text{Rs } \frac{100}{526} = 0.19$$

. It means that it is worth 19 paise in 1982. If the money wage of the consumer is Rs 10,000, his real wage will be

$$\text{Rs } 10{,}000 \times \frac{100}{526} = \text{Rs } 1{,}901$$

It means Rs 1,901 in 1982 has the same purchasing power as Rs 10,000 in January, 2005. If he/she was getting Rs 3,000 in 1982, he/she is worse off due to the rise in price. To maintain the 1982 standard of living the salary should be raised to Rs 15,780 which is obtained by multiplying the base period salary by the factor 526/100.

- Index of industrial production gives us a quantitative figure about the change in production in the industrial sector.
- Agricultural production index provides us a ready reckoner of the performance of agricultural sector.
- Sensex is a useful guide for investors in the stock market. If the sensex is rising, investors are optimistic of the future performance of the economy. It is an appropriate time for investment.

Where can we get these index numbers?

Some of the widely used index numbers — WPI, CPI, Index Number of Yield of Principal Crops, Index of Industrial Production, Index of Foreign Trade — are available in *Economic Survey.*

Activity

- Check from the newspapers and construct a time series of sensex with 10 observations. What happens when the base of the consumer price index is shifted from 1982 to 2000?

7. Conclusion

Estimating index number enables you to calculate a single measure of change of a large number of items. Index numbers can be calculated for price, quantity, volume, etc.

It is also clear from the formulae that the index numbers need to be interpreted carefully. The items to be included and the choice of the base period are important. Index numbers are extremely important in policy making as is evident by their various uses.

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Recap

- An index number is a statistical device for measuring relative change in a large number of items.
- There are several formulae for working out an index number and every formula needs to be interpreted carefully.
- The choice of formula largely depends on the question of interest.
- Widely used index numbers are wholesale price index, consumer price index, index of industrial production, agricultural production index and sensex.
- The index numbers are indispensable in economic policy making.

EXERCISES

1. An index number which accounts for the relative importance of the items is known as
   (i) weighted index
   (ii) simple aggregative index
   (iii) simple average of relatives
2. In most of the weighted index numbers the weight pertains to
   (i) base year
   (ii) current year
   (iii) both base and current year
3. The impact of change in the price of a commodity with little weight in the index will be
   (i) small
   (ii) large
   (iii) uncertain
4. A consumer price index measures changes in
   (i) retail prices
   (ii) wholesale prices
   (iii) producers prices
5. The item having the highest weight in consumer price index for industrial workers is
   (i) Food
   (ii) Housing
   (iii) Clothing

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6. In general, inflation is calculated by using
   (i) wholesale price index
   (ii) consumer price index
   (iii) producers' price index
7. Why do we need an index number?
8. What are the desirable properties of the base period?
9. Why is it essential to have different CPI for different categories of consumers?
10. What does a consumer price index for industrial workers measure?
11. What is the difference between a price index and a quantity index?
12. Is the change in any price reflected in a price index number?
13. Can the CPI for urban non-manual employees represent the changes in the cost of living of the President of India?
14. The monthly per capita expenditure incurred by workers for an industrial centre during 1980 and 2005 on the following items are given below. The weights of these items are 75,10, 5, 6 and 4 respectively. Prepare a weighted index number for cost of living for 2005 with 1980 as the base.

Items	*Price in 1980*	*Price in 2005*
Food	100	200
Clothing	20	25
Fuel & lighting	15	20
House rent	30	40
Misc	35	65

15. Read the following table carefully and give your comments.

INDEX OF INDUSTRIAL PRODUCTION BASE 1993–94

Industry	*Weight in %*	*1996–97*	*2003–2004*
General index	100	130.8	189.0
Mining and quarrying	10.73	118.2	146.9
Manufacturing	79.58	133.6	196.6
Electricity	10.69	122.0	172.6

16. Try to list the important items of consumption in your family.
17. If the salary of a person in the base year is Rs 4,000 per annum and the current year salary is Rs 6,000, by how much should his salary be raised to maintain the same standard of living if the CPI is 400?
18. The consumer price index for June, 2005 was 125. The food index was 120 and that of other items 135. What is the percentage of the total weight given to food?

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19. An enquiry into the budgets of the middle class families in a certain city gave the following information;

Expenses on items	*Food 35%*	*Fuel 10%*	*Clothing 20%*	*Rent 15%*	*Misc. 20%*
Price (in Rs) in 2004	1500	250	750	300	400
Price (in Rs) in 1995	1400	200	500	200	250

What is the cost of living index during the year 2004 as compared with 1995?

20. Record the daily expenditure, quantities bought and prices paid per unit of the daily purchases of your family for two weeks. How has the price change affected your family?

21. Given the following data-

Year	*CPI of industrial workers (1982 =100)*	*CPI of agricultural labourers (1986–87 = 100)*	*WPI (1993–94=100)*
1995–96	313	234	121.6
1996–97	342	256	127.2
1997–98	366	264	132.8
1998–99	414	293	140.7
1999–00	428	306	145.3
2000–01	444	306	155.7
2001–02	463	309	161.3
2002–03	482	319	166.8
2003–04	500	331	175.9

Source: *Economic Survey, 2004–2005, Government of India*

(i) Comment on the relative values of the index numbers.
(ii) Are they comparable?

22. The monthly expenditure (Rs.) of a family on some important items and the Goods and Services Tax (GST) rates applicable to these items is as follows:

Item	Monthly Expense(Rs)	GST Rate %
Cereals	1500	0
Eggs	250	0
Fish, Meat	250	0
Medicines	50	5
Biogas	50	5
Transport	100	5
Butter	50	12
Babool	10	12
Tomato Ketchup	40	12

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Biscuits	75	18
Cakes, Pastries	25	18
Branded Garments	100	18
Vacuum Cleaner, Car	1000	28

Calculate the average tax rate as far as this family is concerned.

The calculation of the average GST rate makes use of the formula for weighted average. In this case, the weights are the shares of expenditure on each category of goods. The total weight is equal to the total expenditure of the family. And the variables are the GST rates.

Category	Expenditure Weight (w)	GST Rate (x)	WX
Category 1	2000	0	0
Category 2	200	0.05	10
Category 3	100	0.12	12
Category 4	200	0.18	36
Category 5	1000	0.28	280
	3500		338

The mean GST rate as far as this family is concerned is (338)/(3500) = 0.966 i.e. 9.66%

Activity

- Consult your classteacher to make a list of widely used index numbers. Get the most recent data indicating the source. Can you tell what the unit of an index number is?
- Make a table of consumer price index for industrial workers in the last 10 years and calculate the purchasing power of money. How is it changing?

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CHAPTER

8

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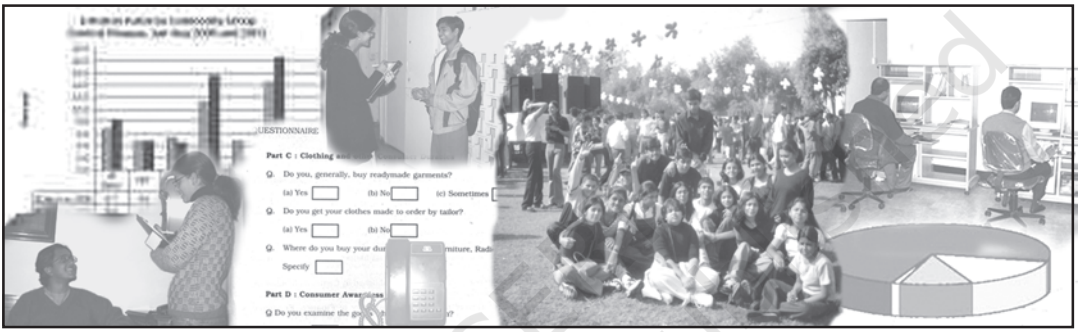
Use of Statistical Tools



Studying this chapter should enable you to:

- *be familiar with steps in designing a project;*
- *apply various statistical tools in analysing a problem.*

1. INTRODUCTION

You have studied about the various statistical tools. These tools are important for us in daily life and are used in the analysis of data pertaining to economic activities such as production, consumption, distribution, banking and insurance, trade, transport, etc. In this chapter, you will learn the method of developing a project. This will help in understanding how statistical tools and methods can be used for various types of analysis. For example, you may have to collect information about a product from the consumer or about a new product or service to be launched in the market by the producer or analyse the spread of information technology in schools and so on. Developing a project by conducting a survey and preparing a report will help in analysing relevant information and suggesting improvements in a product or system.

Steps Towards Making a Project

Identifying a problem or an area of study

At the outset, you should be clear about what you want to study. On the basis

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of your objective, you will proceed with the collection and processing of the data. For example, production or sale of a product like car, mobile phone, shoe polish, bathing soap or a detergent, may be an area of interest to you. You may like to address certain water or electricity problems relating to households of a particular area. You may like to study about consumer awareness among households, i.e., awareness about rights of consumers.

Choice of Target Group

The choice or identification of the target group is important for framing appropriate questions for your questionnaire. If your project relates to cars, then your target group will mainly be the middle income and the higher income groups. For the project studies relating to consumer products like soap, you will target all rural and urban consumers. For the availability of safe drinking water your target group can be both urban and rural population. Therefore, the choice of target groups, to identify those persons on whom you focus your attention, is very important while preparing the project report.

Collection of Data

The objective of the survey will help you to determine whether the data collection should be undertaken by using primary method, secondary method or both the methods. As you have read in Chapter 2, a first hand collection of data by using primary method can be done by using a questionnaire or an interview schedule, which may be obtained by personal interviews, mailing/postal surveys, phone, email, etc. Postal questionnaire must have a covering letter giving details about the purpose of inquiry. Your objective will be to determine the size and characteristics of your target group. For example, in a study pertaining to the primary and secondary level female literacy or consumption of a particular brand or soap, you will have to go to each and every family or household to collect the information i.e. you have to collect primary data. If sampling is used in your method of data collection, then care has to be taken about the suitability of the method of sampling.

Secondary data can also be used provided it suits your requirement. Secondary data are usually used when there is paucity of time, money and manpower resources and the information is easily available.

Organisation and Presentation of Data

After collecting the data, you need to process the information so received, by organising and presenting them with the help of tabulation and suitable diagrams, e.g. bar diagrams, pie diagrams, etc. about which you have studied in chapter 3 and 4.

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Analysis and Interpretation

Measures of Central Tendency (e.g. mean), Measures of Dispersion (e.g. Standard deviation), and Correlation will enable you to calculate the average, variability and relationship, if it exists among the variables. You have acquired the knowledge related to above-mentioned measures in chapters 5 and 6.

Conclusion

The last step will be to draw meaningful conclusions after analysing and interpreting the results. If possible you must try to predict the **future prospects** and suggestions relating to growth and government policies, etc. on the basis of the information collected.

Bibliography

In this section, you need to mention the details of all the secondary sources, i.e., magazines, newspapers, research reports used for developing the project.

2. Suggested List of Projects

These are a few suggested projects. You are free to choose any topic that deals with an economic issue.

1. Consider yourself as an advisor to Transport Minister who aims to bring about a better and coordinated system of transportation. Prepare a project report.
2. You may be working in a village cottage industry. It could be a unit manufacturing *dhoop, agarbatti,* candles, jute products, etc. You want to start a new unit of your own. Prepare a project proposal for getting a bank loan.
3. Suppose you are a marketing manager in a company and recently you have put up advertisements about your consumer product. Prepare a report on the effect of advertisements on the sale of your product.
4. You are a District Education Officer, who wants to assess the literacy levels and the reasons for dropping out of school children. Prepare a report.
5. Suppose you are a Vigilance Officer of an area and you receive complaints about overcharging of goods by traders i.e., charging a higher price than the Maximum Retail Price (MRP). Visit a few shops and prepare a report on the complaint.
6. Consider yourself to be the head of Gram Panchayat of a particular village who wants to improve amenities like safe drinking water to your people. Address your issues in a report form.
7. As a representative of a local government, you want to assess the participation of women in various employment schemes in your area. Prepare a project report.
8. You are the Chief Health Officer of a rural block. Identify the issues to be addressed through a project study. This may include health and sanitation problems in the area.
9. As the Chief Inspector of Food and Civil Supplies department, you have received a complaint about

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food adulteration in the area of your duty. Conduct a survey to find the magnitude of the problem.

10. Prepare a report on Polio immunisation programme in a particular area.
11. You are a Bank Officer and want to survey the saving habits of the people by taking into consideration income and expenditure of the people. Prepare a report.
12. Suppose you are part of a group of students who wants to study farming practices and the problems facing farmers in a village. Prepare a project report.

3. Sample Project

This is a sample project for your guidance. Depending on the subject of your study the method used will obviously be different from the one used here.

Project

X is a young entrepreneur who wants to set up a factory to produce toothpaste. You are asked to advise X about how he should proceed.

One of the first things you could do would be to study people's tastes with regard to toothpastes, their monthly expenses on toothpaste and other relevant facts. For this, you may decide to collect primary data.

The data is to be collected with the help of a questionnaire. Whatever questionnaire you use must be capable of generating the information which you need for your study. Suppose you decide that the most important information that you need for your study is:

- The average monthly expenditure on toothpaste
- The brands of toothpaste that are currently in demand
- The attitude of the customers towards these brands
- Customers' preferences in regard to ingredients in the toothpaste
- The major media influences on consumers' demand for toothpaste
- The relation between income and all the above factors.

If you can get hold of a questionnaire that has already been tried out and tested (perhaps for some similar study), you could use it after suitably modifying it to suit your requirements. Otherwise, you may need to prepare the questionnaire yourself, making sure that all the required information has been asked for.

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EXAMPLE OF QUESTIONNAIRE TO BE USED FOR THIS PROJECT REPORT

1. Name
2. Sex
3. Ages of family members (in years)
.....
.....
.....
.....
.....
.....
4. Total Number of family members:-
5. Monthly family income
6. Location of residence Urban ☐
Rural ☐
7. Major occupation of the main bread-winner:
   (i) Service ☐
   (ii) Professional ☐
   (iii) Manufacturer ☐
   (iv) Trader ☐
   (v) Any other (please specify) ☐
8. Does your family use toothpaste to clean your teeth?
   Yes ☐ No ☐
9. If Yes, then according to you what should be the essential qualities of a good toothpaste (you can tick more than one option):
   (i) Plain ☐
   (ii) Gel ☐
   (iii) Antiseptic ☐
   (iv) Flavoured ☐
   (v) Carries Protection ☐
   (vi) Fluoride ☐
   (vii) Other ———
10. If Yes, which brand of toothpaste do you use? ———
11. How many 100 gram packs of this toothpaste do you use per month?
12. Are you satisfied with this toothpaste? Yes ☐ No ☐
13. Are you prepared to try out a new toothpaste? Yes ☐ No ☐
14. If Yes, what are the features you would like in the new toothpaste? (you can tick more than one option):
   (i) Plain ☐
   (ii) Gel ☐
   (iii) Antiseptic ☐
   (iv) Flavoured ☐
   (v) Carries Protection ☐
   (vi) Fluoride ☐
   (vii) Other ———
15. What are the main sources of your information about toothpaste?
   (i) Cinema ☐
   (ii) Exhibitions ☐
   (iii) Internet ☐
   (iv) Magazines ☐
   (v) Newspapers ☐
   (vi) Radio ☐
   (vii) Sales Representatives ☐
   (viii) Television ☐
   (ix) Other ———

DATA ANALYSIS AND INTERPRETATION

After collecting the required information you now have to organise and analyse. The final report may be as follows:

EXAMPLE OF SIMPLIFIED PROJECT REPORT

1. **Total Sample Size:** 100 households

2. **Location:** Urban 67%
Rural 33%

Observation: Majority of users belonged to urban area.

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(i) *Age distribution*

Age in years	*No. of Persons*
Below 10	74
10–20	56
20–30	91
30–40	146
40–50	93
Above 50	40
Total	*500*

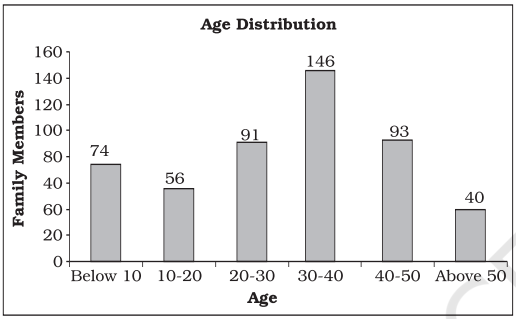

Fig. 8.1: *Bar diagram*

Observation: Majority of the persons surveyed belonged to age group 20–50 years.

(ii) *Family Size*

Family size	*No. of families*
1–2	20
3–4	40
5–6	30
Above 6	10
Total	*100*

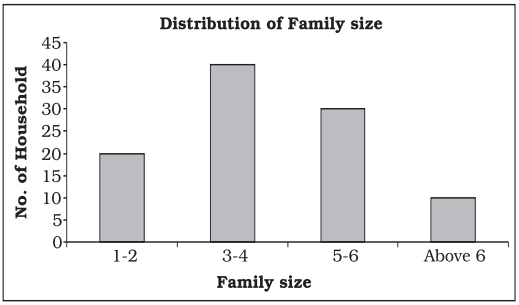

Fig. 8.2: *Bar diagram*

Observation: Majority of the families surveyed have 3–6 members.

(iii) *Monthly Family Income status*

Income	*No. of Households*
0 - 10,000	20
10,000–20,000	40
20,000–30,000	30
30,000 - 40,000	10

Frequncy Distribution of Monthly Family Income and Calculation of Mean and Standard Deviation

Income Class (1)	*Midpoint x* (2)	*Freq. f* (3)	*d'=(X-20000)/5000* (4)	*fd'* (5)	*f'd'²* (6)
0-10000	5000	20	-3	-60	180
10000-20000	15000	40	-1	-40	40
20000-30000	25000	30	1	30	30
30000-40000	35000	10	3	30	90
		100		-40	340

Histogram for this data is shown below.

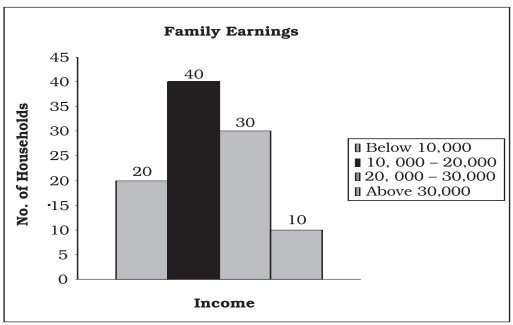

Fig. 8.3: *Histogram*

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Observation: Majority of the families surveyed have monthly income between 10,000 to 30,000.

$$\overline{X} = A + \frac{\sum d'}{\sum f} \quad c = 2000 + \frac{(-40)}{100} \times 5000$$

$$= 20000 - 2000 = 18000$$

$$\sigma = \sqrt{\frac{\sum fd'^2}{\sum f} - \left(\frac{\sum fd'}{\sum f}\right)^2} \times c$$

$$\sigma = \sqrt{\frac{340}{100} - \left(\frac{-40}{100}\right)^2} \times c$$

$$= \sqrt{3.40 - 0.16} \times 5000$$

$$= \sqrt{3.24} \times 5000$$

$$= 1.8 \times 5000$$

$$= 9000$$

The mean income was Rs.18000 and standard deviation was Rs.9000

(iv) ***Monthly Family budget on toothpaste***

The mean expenditure on toothpaste per household was Rs. 104 per month and standard deviation was Rs.35.60.

$$\overline{X} = A + \frac{\sum fd'}{\sum f} \times c$$

$$= 100 + \frac{10}{100} \times 40$$

$$= 104$$

$$\sigma = \sqrt{\frac{\sum fd'^2}{\sum f} - \left(\frac{\sum fd'}{\sum f}\right)^2} \times 40$$

$$\sigma = \sqrt{\frac{80}{100} - \left(\frac{10}{100}\right)^2} \times 40$$

$$= \sqrt{0.8 - 0.01} \times 40$$

$$= \sqrt{0.79} \times 40$$

$$= 0.89 \times 40$$

$$= 35.60$$

Frequncy Distribution of Monthly Family Expenditure on Toothpaste and Calculation of Mean and Standard Deviation

Income Class (1)	*Midpoint x* (2)	*Freq. f* (3)	*d'=(X-100)/40* (4)	*fd'* (5)	*fd'²* (6)
0-40	20	5	-2	-10	20
40-80	60	20	-1	-20	20
80-120	100	40	0	0	0
120-160	140	30	1	30	30
160-200	180	5	2	10	20
		100		10	90

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(v) *Major Occupational Status*

Family Occupation	*No. of Families*
Service	30
Professional	5
Manufacture	10
Trader	40
Any other (please specify)	15

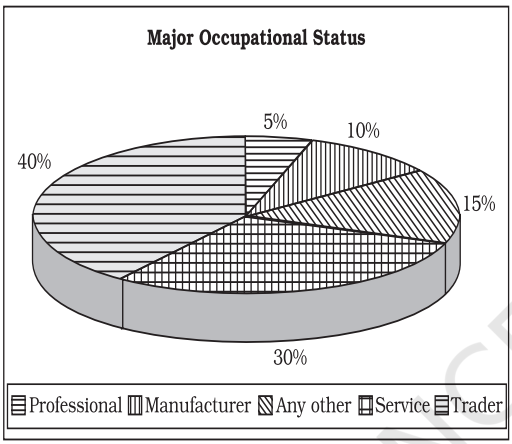

Fig. 8.4: *Pie diagram*

Observation: Majority of the families surveyed were either service class or traders.

(vi) *Preferred use of toothpaste*

Brand	*No. of Hh.*	*Brand*	*No. of Hh.*
Aquafresh	5	Anchor	4
Cibaca	9	Babool	3
Close-up	12	Promise	3
Colgate	18	Meswak	5
Pepsodent	20	OralB	7
Pearl	4	Sensodyne	7
Any other	3		

Observation: Pepsodent, Colgate and Close-up were the most preferred brands.

(vii) *Basis of selection*

Features	*Family members*
Advertisement	15
Persuaded by the Dentist	5
Price	35
Quality	45
Taste	20
Ingredients	10
Standardised marking	50
Tried new product	10
Company's brand name	35

Observation: Majority of the people selected the toothpaste on the basis of standardised markings, quality, price and company's brand name.

(viii) *Taste and Preferences*

Brand	*Satisfied*	*Unsatisfied*
Aquafresh	2	3
Cibaca	5	4
Close up	10	2
Colgate	16	2
Meswak	3	2
Pepsodent	18	2
Anchor	2	2
Babool	2	1
Promise	2	1
OralB	4	3
Sensodyne	5	2
Pearl	2	2

Observation: Amongst the most used toothpastes the percentage of dissatisfaction was relatively less.

(ix) *Ingredients Preference*

Plain	40
Gel	70
Antiseptic	80
Flavoured	50
Carries protective	30
Fluoride	10

Observation: Majority of the people preferred gel and antiseptic-based toothpastes over the others.

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(x) *Media Influence*

Advertisement	*Families Influenced*
Television	47
Newspaper	30
Magazine	20
Cinema	25
Sales representative	15
Exhibits - stall	10
Radio	18

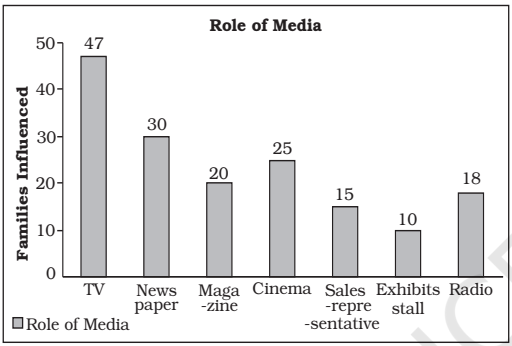

Fig. 8.5: *Bar diagram*

Observation: Majority of people came to know about the product either through television or through newspaper.

(xi) *Concluding Note of the Project Report*

Majority of the users belonged to urban area. Most of the people who were surveyed belonged to age group 25 to 50 years and had an average 3–6 members in a family. The monthly income of these families ranged between Rs 10,000 and Rs 30,000 and their main occupations were service and trading. Expenditure on toothpaste accounted for about Rs.104 per month per household. Pepsodent, Colgate and Close-up were the most preferred brands in the households surveyed. People preferred those brands of toothpaste which has either gel or antiseptic based. A lot of people get influenced by advertisements and the most popular medium to get across through people is television.

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Recap

- The objective of the study should be clearly identified.
- The population and sample has to be chosen carefully.
- The objective of survey will indicate the type of data to be used.
- A questionnaire/interview schedule is prepared.
- Collected data can be analysed by using various statistical tools.
- Results are interpreted to draw meaningful conclusions.

APPENDIX A

GLOSSARY OF STATISTICAL TERMS

Analysis Understanding and explaining an economic problem in terms of the various causes behind it.

Assumed Mean An approximate value in order to simplify calculation.

Attribute A characteristic that is qualitative in nature. It cannot be measured.

Bimodal Distribution A distribution which has two mode values.

Bivariate Distribution Frequency distribution of two variables.

Census Method A method of data collection, which requires that observations are taken on *all* the individuals in a population.

Chronological Classification Classification based on time.

Class Frequency Number of observations in a class.

Class Interval Difference between the upper and the lower class limits.

Class Mark Class midpoint

Class Midpoint Middle value of a class. It is the representative value of different observations in a class. It is equal to (upper class limit + lower class limit)/2.

Classification Arranging or organising similar things into groups or classes.

Consumer One who buys goods for one's own personal needs or for the needs of one's family or as a gift to someone.

Constant A constant is also a quantity used to describe an attribute, but it will *not* change during calculation or investigation.

Continuous Variable A quantitative variable that can take any numerical value.

Cyclicity Periodicity in data variation with time period of more than one year.

Decile A partition value that divides the data into ten equal parts.

Discrete Variable A quantitative variable that takes only certain values. It changes from one value to another by finite "jumps". The intermediate values between two adjacent values are not taken by the variable.

Economics Study of how people and society choose to employ scarce resources that could have alternative uses in order to produce various commodities that satisfy their wants and to distribute them for consumption among various persons and groups in society.

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Employee One who gets paid for a job or for working for another person.

Employer One who pays another person to do or do some work.

Enumerator A person who collects the data.

Exclusive Method A method of classifying observations in which an observation equal to either the upper class limit or the lower class limit of a class is not put in that class but is put in the class above or below.

Frequency The number of times an observation occurs in raw data. In a frequency distribution it means the number of observations in a class.

Frequency Array A classification of a discrete variable that shows different values of the variable along with their corresponding frequencies.

Frequency Curve The graph of a frequency distribution in which class frequencies on Y-axis are plotted against the values of class marks on X-axis.

Frequency Distribution A classification of a quantitative variable that shows how different values of the variable are distributed in different classes along with their corresponding class frequencies.

Inclusive Method A method of classifying observations in which an observations equal to the upper class limit of a class as well as the lower class limit is put in that class.

Informant Individual/unit *from* whom the desired information is obtained.

Multi Modal Distribution The distribution that has more than two modes.

Non-Sampling Error It arises in data collection due to (i) sampling bias, (ii) non-response, (iii) error in data acquisition.

Observation A unit of raw data.

Percentiles A value which divides the data into hundred equal parts so there are 99 percentiles in the data.

Policy The measure to solve an economic problem.

Population Population means *all* the individuals/units for whom the information has to be sought.

Qualitative Classification Classification based on quality. For example classification of people according to gender, marital status etc.

Qualitative Data Information or data expressed in terms of qualities.

Quantitative Data A (often large) set of numbers systematically arranged for conveying specific information on a subject for better understanding or decision-making.

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Questionnaire A list of questions prepared by an investigator on the subject of enquiry. The respondent is required to answer the questions.

Random Sampling It is a method of sampling in which the representative set of informants is selected in a way that every individual is given equal chance of being selected as an informant.

Range Difference between the maximum and the minimum values of a variable.

Relative Frequency Frequency of a class as proportion or percentage of total frequency

Sample Survey Method A method, where observations are obtained on a representative set of individuals (the sample), selected from the population.

Sampling Error It is the numerical difference between the estimate from the sample and the corresponding true value of the parameter from the population.

Scarcity It means the lack of availability.

Seasonality Periodicity in data variation with time period less than one year.

Seller One who sells goods for profit.

Service Provider One who provides a service to others for a payment.

Spatial Classification Classification based on geographical location.

Statistics The method of collecting, organising, presenting and analysing data to draw meaningful conclusion. Further, it also means data.

Structured Questionnaire Structured Questionnaire consists of "closed-ended" questions, for which alternative possible answers to choose from are provided.

Tally Marking The counting of observations in a class using tally (/) marks. Tallies are grouped in fives.

Time Series Data arranged in chronological order or two variable data where one of the variables is time.

Univariate Distribution The frequency distribution of one variable.

Variable A variable is a quantity used to measure an "attribute" (such as height, weight, number etc.) of some thing or some persons, which can take different values in different situations.

Weighted Average The average is calculated by providing the different data points with different weights.

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TABLE OF TWO-DIGIT RANDOM NUMBERS

03 47 43 73 86	36 96 47 36 61	46 98 63 71 62	33 26 16 80 45	60 11 14 10 95
97 74 24 67 62	42 81 14 57 20	42 53 32 37 32	27 07 36 07 51	24 51 79 89 73
16 76 62 27 66	56 50 26 71 07	32 90 79 78 53	13 55 38 58 59	88 97 54 14 10
12 56 85 99 26	96 96 68 27 31	05 03 72 93 15	57 12 10 14 21	88 26 49 81 76
55 59 56 35 64	38 54 82 46 22	31 62 43 09 90	06 18 44 32 53	23 83 01 30 30
16 22 77 94 39	49 54 43 54 82	17 37 93 23 78	87 35 20 96 43	84 26 34 91 64
84 42 17 53 31	57 24 55 06 88	77 04 74 47 67	21 76 33 50 25	83 92 12 06 76
63 01 63 78 59	16 95 55 67 19	98 10 50 71 75	12 86 73 58 07	44 39 52 38 79
33 21 12 34 29	78 64 56 07 82	52 42 07 44 38	15 51 00 13 42	99 66 02 79 54
57 60 86 32 44	09 47 27 96 54	49 17 46 09 62	90 52 84 77 27	08 02 73 43 28
18 18 07 92 46	44 17 16 58 09	79 83 86 19 62	06 76 50 03 10	55 23 64 05 05
26 62 38 97 75	84 16 07 44 99	83 11 46 32 24	20 14 85 88 45	10 93 72 88 71
23 42 40 64 74	82 97 77 77 81	07 45 32 14 08	32 98 94 07 72	93 85 79 10 75
52 36 28 19 95	50 92 26 11 97	00 56 76 31 38	80 22 02 53 53	86 60 42 04 53
37 85 94 35 12	83 39 50 08 30	42 34 07 96 88	54 42 06 87 98	35 85 29 48 39
70 29 17 12 13	40 33 20 38 26	13 89 51 03 74	17 76 37 13 04	07 74 21 19 30
56 62 18 37 35	96 83 50 87 75	97 12 25 93 47	70 33 24 03 54	97 77 46 44 80
99 49 57 22 77	88 42 95 45 72	16 64 36 16 00	04 43 18 66 79	94 77 24 21 90
16 08 15 04 72	33 27 14 34 09	45 59 34 68 49	12 72 07 34 45	99 27 72 95 14
31 16 93 32 43	50 27 89 87 19	20 15 37 00 49	52 85 66 60 44	38 68 88 11 80
68 34 30 13 70	55 74 30 77 40	44 22 78 84 26	04 33 46 09 52	68 07 97 06 57
74 57 25 65 76	59 29 97 68 60	71 91 38 67 54	13 58 18 24 76	15 54 55 95 52
27 42 37 86 53	48 55 90 65 72	96 57 69 36 10	96 46 92 42 45	97 60 49 04 91
00 39 68 29 61	66 37 32 20 30	77 84 57 03 29	10 45 65 04 26	11 04 96 67 24
29 94 98 94 24	68 49 69 10 82	53 75 91 93 30	34 25 20 57 27	40 48 73 51 92
16 90 82 66 59	83 62 64 11 12	67 19 00 71 74	60 47 21 29 68	02 02 37 03 31
11 27 94 75 06	06 09 19 74 66	02 94 37 34 02	76 70 90 30 86	38 45 94 30 38
35 24 10 16 20	33 32 51 26 38	79 78 45 04 91	16 92 53 56 16	02 75 50 95 98
38 23 16 86 38	42 38 97 01 50	87 75 66 81 41	40 01 74 91 62	48 51 84 08 32
31 96 25 91 47	96 44 33 49 13	34 86 82 53 91	00 52 43 48 85	27 55 26 89 62
66 67 40 67 14	64 05 71 95 86	11 05 65 09 68	76 83 20 37 90	57 16 00 11 66
14 90 84 45 11	75 73 88 05 90	52 27 41 14 86	22 98 12 22 08	07 52 74 95 80
68 05 51 18 00	33 96 02 75 19	07 60 62 93 55	59 33 82 43 90	49 37 38 44 59
20 46 78 73 90	97 51 40 14 02	04 02 33 31 08	39 54 16 49 36	47 95 93 13 30
64 19 58 97 79	15 06 15 93 20	01 90 10 75 06	40 78 78 89 62	02 67 74 17 33
05 26 93 70 60	22 35 85 15 13	92 03 51 59 77	59 56 78 06 83	52 91 05 70 74
07 97 10 88 23	09 98 42 99 64	61 71 62 99 15	06 51 29 16 93	58 05 77 09 51
68 71 86 85 85	54 87 66 47 54	73 32 08 11 12	44 95 92 63 16	29 56 24 29 48
26 99 61 65 53	58 37 78 80 70	42 10 50 67 42	32 17 55 85 74	94 44 67 16 94
14 65 52 68 75	87 59 36 22 41	26 78 63 06 55	13 08 27 01 50	15 29 39 39 43

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APPENDIX B (Cont.)

17 53 77 58 71	71 41 61 50 72	12 41 94 96 26	44 95 27 36 99	02 96 74 30 83
90 26 59 21 19	23 52 23 33 12	96 93 02 18 39	07 02 18 36 07	25 99 32 70 23
41 23 52 55 99	31 04 49 69 96	10 47 48 45 88	13 41 43 89 20	97 17 14 49 17
60 20 50 81 69	31 99 73 68 68	35 81 33 03 76	24 30 12 48 60	18 99 10 72 34
91 25 38 05 90	94 58 28 41 36	45 37 59 03 09	90 35 57 29 12	82 62 54 65 60
34 50 57 74 37	98 80 33 00 91	09 77 93 19 82	74 94 80 04 04	45 07 31 66 49
85 22 04 39 43	73 81 53 94 79	33 62 46 86 28	08 31 54 46 31	53 94 13 38 47
09 79 13 77 48	73 82 97 22 21	05 03 27 24 83	72 89 44 05 60	35 80 39 94 88
88 75 80 18 14	22 95 75 42 49	39 32 82 22 49	02 48 07 70 37	16 04 61 67 87
90 96 23 70 00	39 00 03 06 90	55 85 78 38 36	94 37 30 69 32	90 89 00 76 33
53 74 23 99 67	61 32 28 69 84	94 62 67 86 24	98 33 41 19 95	47 53 53 38 09
63 38 06 86 54	99 00 65 26 94	02 82 90 23 07	79 62 67 80 60	75 91 12 81 19
35 30 58 21 46	06 72 17 10 94	25 21 31 75 96	49 28 24 00 49	55 65 79 78 07
63 43 36 82 69	65 51 18 37 88	61 38 44 12 45	32 92 85 88 65	54 34 81 85 35
98 25 37 55 26	01 91 82 81 46	74 71 12 94 97	24 02 71 37 07	03 92 18 66 75
02 63 21 17 69	71 50 80 89 56	38 15 70 11 48	43 40 45 86 98	00 83 26 91 03
64 55 22 21 82	48 22 28 06 00	61 54 13 43 91	82 78 12 23 29	06 66 24 12 27
85 07 26 13 89	01 10 07 82 04	59 63 69 36 03	69 11 15 83 80	13 29 54 19 28
58 54 16 24 15	51 54 44 82 00	62 61 65 04 69	38 18 65 18 97	85 72 13 49 21
34 85 27 84 87	61 48 64 56 26	90 18 48 13 26	37 70 15 42 57	65 65 80 39 07
03 92 18 27 46	57 99 16 96 56	30 33 72 85 22	84 64 38 56 98	99 01 30 98 64
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08 45 93 15 22	60 21 75 46 91	98 77 27 85 42	28 88 61 08 84	69 62 03 42 73
07 08 55 18 40	45 44 75 13 90	24 94 96 61 02	57 55 66 83 15	73 42 37 11 61
01 85 89 95 66	51 10 19 34 88	15 84 97 19 75	12 76 39 43 78	64 63 91 08 25
72 84 71 14 35	19 11 58 49 26	50 11 17 17 76	86 31 57 20 18	95 60 78 46 75
88 78 28 16 84	13 52 53 94 53	75 45 69 30 96	73 89 65 70 31	99 17 43 48 76
45 17 75 65 57	28 40 19 72 12	25 12 74 75 67	60 40 60 81 19	24 62 01 61 16
96 76 28 12 54	22 01 11 94 25	71 96 16 16 88	68 64 36 74 45	19 59 50 88 92
43 31 67 72 30	24 02 94 08 63	38 32 36 66 02	69 36 38 25 39	48 03 45 15 22
50 44 66 44 21	66 06 58 05 62	68 15 54 35 02	42 35 48 96 32	14 52 41 52 48
22 66 22 15 86	26 63 75 41 99	58 42 36 72 24	58 37 52 18 51	03 37 18 39 11
96 24 40 14 51	23 22 30 88 57	95 67 47 29 83	94 69 40 06 07	18 16 36 78 86
31 73 91 61 19	60 20 72 93 48	98 57 07 23 69	65 95 39 69 58	56 80 30 19 44
78 60 73 99 84	43 89 94 36 45	56 69 47 07 41	90 22 91 07 12	78 35 34 08 72
84 37 90 61 56	70 10 23 98 05	85 11 34 76 60	76 48 45 34 60	01 64 18 39 96
36 67 10 08 23	98 93 35 08 86	99 29 76 29 81	33 34 91 58 93	63 14 52 32 52
07 28 59 07 48	89 64 58 89 75	83 85 62 27 89	30 14 78 56 27	86 63 59 80 02
10 15 83 87 60	79 24 31 66 56	21 48 24 06 93	91 98 94 05 49	01 47 59 38 00
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51 86 32 68 92	33 98 74 66 99	40 14 71 94 58	45 94 19 38 81	14 44 99 81 07
35 91 70 29 13	80 03 54 07 27	96 94 78 32 66	50 95 52 74 33	13 80 55 62 54
37 71 67 95 13	20 02 44 95 94	64 85 04 05 72	01 32 90 76 14	53 89 74 60 41
93 66 13 83 27	92 79 64 64 72	28 54 96 53 84	48 14 52 98 94	56 07 93 89 30

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WHAT THEY SAY

☞ Statistics are no substitute for judgement.

Henry Clay

☞ I abhor averages, I like the individual case. A man may have six meals one day and none the next, making an average of three meals per day, but that is not a good way to live.

Louis D. Brandies

☞ The weather man is never wrong. Suppose he says that there's an 80% chance of rain. If it rains, the 80% chance came up, if it doesn't, the 20% chance come up.

Saul Barron

☞ The death of one man is a tragedy. The death of millions is a statistic.

Joseph Stalin

☞ When she told me I was average, she was just being mean.

Mike Beckman

☞ Why is a physician held in much higher esteem than a statistician? A physician makes an analysis of a complex illness whereas a statistician makes you ill with a complex analysis!

Gary C. Ramseyer

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NOTES

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