

Practical Business Statistics



Maria Catherine Borres

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LIST OF ABBREVIATIONS

confidence interval
exploratory data analysis
first in, first out
gross domestic process
gross national product
Japanese Union of Scientists and Engineers
keep it short and simple
last in, first out
null hypothesis significance tests

PREFACE

Businesses in the modern and fast-paced world are developing enormously. They have huge competition among themselves and are driven by the motivation to excel and be ahead of everyone. The businesses have been involving statistics to make sure that they act in the right manner and make informed decisions on the matters that concern them.

Statistics is a widely-discussed field in the business world today. The business people want to know the in and out of all the things and to verify them using the statistical information they get. The statistics make them aware of the trends in a particular field, especially the consumer-related fields, and help them revise or reform their policies according to the results.

The book tries to inform the readers about the various roles of statistics and the methods that are used in the field of business statistics to get the required information. It also focuses on different statistical methods that are used widely in the business world.

The book starts off by introducing the field and subject of statistics to the readers and explain its characteristics. It also enlists various types of statistics that are adopted in several situations and conditions. The book describes the role of statistics and focuses on the research and development in the field.

The book talks about the subject of Data Mining and Big Data. It talks about the role of data mining in the practical scenarios of business statistics. It also dwells on the application of Big Data in those scenarios. The book throws light on the current trend in the way data mining is used and discusses the issues that come up in Big Data and data mining.

Moving further, the book throws light about data structure by introducing and defining the meaning of data structure and associating them with algorithms. The book describes the characteristics of data structures and enlists various types of data structures. It explains the meaning of variability and its role in the business processes. It also throws light on the process of data collection in data structures.

The book then talks about histogram and discusses the history of it. It lists the various parts of histogram and the typical shapes in it. It discusses the applications of histogram in the businesses, so that the readers know about their importance. The book throws light on the variability in statistics and highlights its significance and the properties of measuring it. It lists down the reasons for popularity of standard deviation and talks about the range in standard deviation. The book throws light on the coefficient of variation and brings the various kinds of variabilities to readers' focus.

The book moves forward to discuss about the probability in statistics and describes the meaning of it. It talks about conditional probability and explains the Bayes' Theorem to the readers. The book throws light on the discrete random variables and the use of simulation in probabilistic problems.

Then, the book introduces the uncertainty in numbers to the readers. It talks about taking decisions with the uncertain numbers and explains the basics related to it. The book talks about random variables and highlights the importance of uncertain numbers in the discount calculations in the company valuation.

The book throws light of the importance of report writing in statistics and explains the meaning of a statistical report to the readers. It talks about the methods in communicating data and suggests some important points in report writing to the readers.

CHAPTER 1

STATISTICS AND ITS ROLE IN BUSINESSES

KEYWORDS

- Business Statistics
- SPSS
- Six Sigma
- Data Collection
- Research and
 Development
- Numerical Data
- Inferences
- Market Value
- Business Models
- Finances

LEARNING OBJECTIVES:

After reading this chapter, you would be able to:

- understand the meaning and characteristics of statistics;
- explain the different types of statistics;
- discuss the role of statistics in business;
- the role of research and development and the role of statistics in research and development field.

1.1. INTRODUCTION

Statistics is a branch of mathematics which has a very vast significance and can be applied in different types of fields. In a general sense, statistics can be described as the process of collection, analysis, interpretation and drawing conclusion from the given information.

From a more scientific approach, statistics can be described as a collection of methodologies, which are developed by researchers and mathematicians, for the purpose of interpretation and conclusion drawn from the available data. Statistics touches fields ranging from collection and analysis to interpretation and conclusion to the process done to bring all these domains in the picture. We can explain 'statistics' as a collection of numerical data which is presented in a quantitative form. This type of data ranges from objects, subjects, to areas, and processes. This kind of data has unlimited scope and is not bounded by the reference or relevance. From a larger perspective, this kind of data is related to the gross national product (GNP), agriculture share in the national market, manufacturing process, production, and gross domestic process (GDP). Statistics is based on the framework designed for the collection and analysis of data. People have a preconceived notion that statistics is just related to the collection and tabulation of data in a desired ordered form. This notion is just the tip of the iceberg. Statistics is a branch of science which deals with extraction of information from a given numerical data.



Figure 1.1: In any organization, the key to success is good decision making. That could be achieved if good statistical techniques are used to reach onto a decision.

Source: https://upload.wikimedia.org/wikipedia/commons/3/36/Strategic_ Decision_Making.jpg These methods are especially useful in finding out the answers to questions like: What type and amount of data are needed to be collected?; What's the process for the organization and summarization of the data?; What can we conclude from the available data?; What can we decipher from the concluded result and how can we figure out the uncertainties?

For the sake of brevity, we can say that statistics provide us the tools for:



Manufacturing process are the steps through which raw materials are transformed into a final product.

Figure 1.2: The field of statistics provides three different tools: Designing, Description and Inferences.

- Designing: to plan and carry out research work.
- Description: preparing a summary of the available data and exploring more in the process.
- Inference: for predicting and generalizing the events based on the given data.

Statistics can also be considered as a science that deals with events and phenomena that are conventionally uncertain. In practice, statistics is utilized in the field of medicine for terming the success rate of a treatment, **advertisement** field where a consumer's behavior is predicted, views of the millennial towards sex and marriage, etc. In this modern era, we can witness the utilization of statistics in nearly every field.

It has been observed that independent organizations of different size use statistics at a high rate. This can be easily seen in the annual reports published by the organizations in which the data related to revenue, sales and production are specifically mentioned.

This kind of data is known as field data where an employed person collects it on a regular basis and drafts it, generally speaking, at the end of a quarter, based on his conducted surveys. This kind of data is needed to be regularly updated, otherwise its scope becomes limited and it gets confined within the boundaries of the current time-frame.

1.2. CHARACTERISTICS OF STATISTICS

Some of the important characteristics of statistics are:

- Statistics deals with the aggregation of the available facts. Which implies that a single available figure cannot be termed as statistics. For example, the percentage growth of population of a country is not statistics but the same figure for multiple years will be considered as statistics.
 - Different factors have different effects on statistics. For example, production of a product depends on various factors such as its demand, market

Advertisement usually takes in the form of calligraphic signboards and inked papers. value, spending power of consumer etc.

- Statistics must not deter form accuracy. Discrepancies in the figures and available data always lead to wrong conclusions. Therefore, it is always advised to draw conclusions based on accurate data.
- The process collection of data should be systematized. A set of data collected in a random way will always be unreliable and will lead to misleading conclusions.
- Lastly, collected data should be placed categorically which properly shows the relationship between different categories. Data collected in a haphazard manner without establishing any relationship between different sets of data will always lead to illogical conclusions.

1.3. TYPES OF STATISTICS

There are two major types of statistics: descriptive statistics and inferential statistics.

1.3.1 Descriptive Statistics

Descriptive statistics consists of dealing with collection, summary, and simplification of the data which on its own a quite time-consuming task. The main objective behind these tasks is to draw meaningful conclusions based on the available data. This kind of statistics helps us in analyzing the data in a systematic way. This process of descriptive statistics starts with collecting the relevant data for the problem presented to us. In the field of physics and biology, for example, collection of data is an integral part of the whole experiment.

A properly planned categorization of the raw data helps us to extract out the hidden meaning present in the given data to the maximum by utilization of the various summarizing techniques. These are the measure of central tendency, dispersion, **skewness**, and kurtosis, as these measurements plays an integral role in constituting descriptive statistics.

1.3.2 Inferential Statistics

Skewness is

asymmetry in a statistical distribution, in which the curve appears distorted or skewed either to the left or to the right. Inferential statistics, which is also named as inductive statistics, works beyond the levels of the collection, summarize and presentation of the raw data in order to describe a situation. It involves a practice of drawing a broader picture from a given set of data by generalizing the collective meaning extracted from the given data by analyzing a part of the observation about the given data. The collective observation on which a conclusion can be drawn, or which can be generalized, is known as a population or a universe.

Sample is the name given to the part of this collective picture which serves the purpose of observation on the collected data and analyzing this data for the purpose of getting the general picture about the universe. If we want to collect the require information about a population,

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it can be done by analyzing all the basic units which comprise the population. This process of covering total population is known as census.

However, developing a clear picture of a total population with the help of census doesn't always produce the desired result because of several reasons. It involves large investment in the form of time and money which prohibits the conduction of census. Moreover, the process of observing each individual basic unit with relevant to the nature of the experiment might lead cause to various adverse effects to the whole experiment.

In this type of scenario, the only viable solution exist is to observe only a small part of the population and collect the desired information from the small sample itself. This is also cost and time effective. This is the main working process of the inference statistics. Therefore, this whole process can be summarized as extracting of the desired information from a sample and utilizing it to draw broader level conclusion for the entire population.

1.4. ROLE OF STATISTICS IN BUSI-NESS

The role of statistics in the field of business management is of utmost importance. It can be utilized for the purpose of rating different business models, organizations, market capital, finance institutions, etc.



Figure 1.3: Statistics help the business to have plans according to the preferences of their customers, and mostly all the activities of any businessman is dependent upon statistical information.

Source: https://c.pxhere.com/images/36/c4/9cd41bd 3709cfb9551c9169dc632–1567615.jpg!d

The scope of statistics in the field of **business management** extend beyond the farthest horizons. By deploying appropriate statistical tools, owners have the opportunity to increase the production of his company by manifolds. The appropriate statistical skills can also help the managers to find the optimized production value along with that, the tasks like management of the workforce becomes relatively easy and effective, and wastage of the useful resources can also be minimized.

Business Management is

an ideal choice for anyone wanting to fast-track their career or learn more about the realities of starting or managing a business. Large amount of data has already been collected by the companies while doing its daily businesses. This notion has become an integral part of the statistical argument because of the over reliance of the businesses on the internet.

On the internet, this task of collecting the raw data has become relatively easy because of the availability of the large amount of data related to a single customer, like number of times of opening emails, number of searches for a particular company item, etc. The statistics comes into play in determining the trend based on these collected data and concluding the results like company's production, and strategy, among others.

In fact, the statistical tools, learned at the most basic level at schools by students like mean, mode, and median can prove to be of utter importance in a log run in the world of business. For example, finding the median salary given by an organization, or average production rate over several years help us to draw important conclusions.

1.4.1. Management of Performance

Statistics can be utilized by a manager in a business for the purpose checking out the performance of employees. A manager need to collect the data related to the performance of an employee, such as number of working hours of that particular employee for a particular month or number of units produced in a particular timeframe. The next task is the analysis of the collected data for the purpose of figuring out the ways of enhancing of the performance of the employee by drawing conclusions based on the collected data.

Many companies are also involved in collecting abstract data related to an employee such as job satisfaction, or happiness while working, which can be utilized to maintain a level of motivation and ensure a long tenure of the employee in the company.

As an example, if the manager finds out that the working hours of a particular employee

tends to decrease on Mondays by two hours, this should be communicated by the manager to the employee and appropriate solution will be discussed.

The statistics plays an integral role in the process of management; utilizing the statistical tools, a manager can analyze the level of performance and production capabilities of his workforce for example, in the case of hours worked or tasks completed on a daily basis. After this, the managers can use the acquired data to develop some techniques in order to improve the working efficiency of his workers and increase the **productivity** of his company.

Most of the companies are involved in compiling the aggregate data related to the performance of the employees. For example, if a manager finds out that the efficiency of an employee decreases every week right before the start of the weekend, then he need to discuss appropriate strategies with his employer in order to come back to the previous routine so that it would not decrease the production of the company.

At the same time, it is also important to maintain the happiness and satisfaction level of the employee as this will ensure their long tenure in the company. Still, managers should avoid too much data about an employee as every employee needs a personal space.

1.4.2. Alternative Scenarios

The job of a manager goes way beyond ensuring the increase in the productivity of the employees. He has to take part in different

is computed by dividing average output per period by the total costs incurred or resources (capital, energy, material, personnel) consumed in that period

Productivity

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activities with the other managers from different departments for the process of decision making. Along with keeping in check the performance of their own workforce, these managers are also involved in decision making process along with the other managers. They utilize the statistics for the comparison between different alternative scenarios and selecting the best available option.

These decisions can be based on the choice of the particular hardware, processing unit, the type of rental service preferred by the customer and the likes. For instance, they can consider using the same software which was best utilized by a competitor company or before deciding, they can use statistics to figure out its advantages, like the number of customer orders which can be processed by that software on an average daily basis. Then their team gathers all these performance data from the software company and other sources and take decisions in the purchasing department.

1.4.3. Data Collection

The collected data which is going to be analyzed for utilizing the statistical tools should involve only effective techniques not adhering to which will lead to the inconsequential and falsified results. This in turn will prove to be nonbeneficial. We can take the advantage of these data by comparing the actual sales with the projected sales which will benefit us in long term for deciding the future investments and requirement of the capital to fulfill a big order.



Figure 1.4: Data Collection is important because that is how a statistician utilizes the data in an effective way to further use the statistical tools for successful decision making.

Source: https://www.maxpixel.net/static/photo/1x/ Data-Collection-Data-Facebook-Policy-Worldwide-3253678.jpg

Managers also have to keep in mind to use a logical approach for the collection of data. For example, a manager can utilize the statistical tools for determining the rise or fall in the level of sales of previous products in order to predict the sales of the future products. Using the conclusions drawn from these studies, he can pin-point the least-performing product and can allocate the resources for its development or discarding the product altogether.

In some scenarios, the customers' identity involved in the data collection are being kept anonymously. This is done to minimize the risk of security failure where customers' data can be easily breached and can be easily utilized for illegal purposes.

The data of customer can also be abused by a company employee for his own gain which should be avoided. Privacy laws also prohibit the companies to use the personal data of the customers for their own monetary and power gains.

The design of the experiment related to **data collection** tells us the nature of the data which has to be collected or generated. Thus, the problem of kind of data which is needed to be collected is resolved when the final decision regarding the design of the experiment is taken. Physics involves these kinds of processes for the utilization of statistics.

In the fields of social sciences, which generally involves collection of relevant data with the help of questionnaire and surveys conducted within a relevant group of people, the problem is a bit complicated. This is because the process of creating a relevant questionnaire and survey is in itself a sophisticated task. Plus, the number and type of people selects for the designed questionnaires and surveys and the criteria involved in their selection come with their own repercussions and results.

Furthermore, the data which has been collected have to be assessed first in order to assemble and present it in such a way that it looks appropriate and appear readable. In order to assist a better understanding of the conclusion, various diagrams and charts can also be used. However, in order to use graphs, diagrams, or tables, the initially collected data has to be categorized properly with relevance to the designed experiment and also has to be analyzed to check the establishment of the desired relationship between different categories. **Data collection** is the process of gathering and measuring information on targeted variables in an established system, which then enables one to answer relevant questions and evaluate outcomes.

1.5. RESEARCH AND DEVELOP-MENT

Statistics is also being applied in the field of market research and development of the product. This is one of a critical purpose served by statistics where a sample of population, for instance, is asked to react on a given product and the data of their responses are collected. This data proves to be of critical importance in the launch and development of a new product.

Another example of this is when a random number of people, called the *sample*, are asked to test a newly developed product. These types of survey are conducted by the managers to check for the demand of a particular product among target customers in the market.

When the survey results are positive, it automatically justifies the amount of money spent on the development of the product. Most of the time, a break-even analysis is also conducted which determines the required amount of consumers using the product to cover the development cost.

1.5.1. The Big Picture

Statistics proves to be a crucial tool in setting up the big picture for a company by doing research on a sample. This helps in the reduction of market research cost and it also provide a clear picture of the entire market. This also shows us the cost and time effective nature of the statistics.

1.5.1.1. Support of Judgment

Statistics helps in creating an assertive outlook in the decision-making process. A conclusion drawn based on collected empirical data is more accurate and helps a manager to sell the product easily.

1.5.1.2. Relationship

We can establish a relationship between different variable by the process of analyzing the data. For example, we can relate the sale of a product and change in season, or how a discount effects the sale of various products. A deeper level of statistical study can even establish a relationship between consumer's behavior and his preferences.

1.5.1.3. Ensures Quality

Statistical tools which are widely used in the field of statistics are **Six Sigma** and Lean Manufacturing. These tools serve businesses to a larger extent. These tools help make it possible for the production of desired goods and products with minimal wastage. Moreover, productivity and efficiency is also improved by the utilization of these tools. Therefore, these tools help us in saving financial resources and give us the assurance of quality of the produced product.

In today's era, almost all the ventures and businesses utilize statistics for their smooth working. They use tools like Microsoft Excel for organizing their data. In the future, a greater number of business venture will depend on the branch of statistics. With the advent of modern technology, it seems inevitable that the statistics will be more deeply involved with the business ventures in the near future. Six Sigma is a disciplined, statistical-based, data-driven approach and continuous improvement methodology for eliminating defects in a product, process or service.

REVIEW QUESTIONS:

- 1. Define statistics.
- 2. Discuss the characteristics of statistics.
- 3. What are the roles of statistics in businesses?
- 4. In what way research and development gets impacted by statistics when it comes to business?
- 5. Are the statistical tools used in businesses cost-effective?
- 6. What do you understand by the term inferential statistics?
- 7. What is the role of statistical tool in businesses. How is data collection in statistics helps in the decision making of an organization?
- 8. What do you understand by the term census?
- 9. Explain data collection in context to statistics.
- 10. How are inferences and designing related to statistics?

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CHAPTER

2

DATA MINING AND BIG DATA

KEYWORDS

- Data Mining
- Big Data
- Business Statistics
- Cost-Effective Method
- Business Intelligence
- Exploratory data
 analysis
- Data Structures
- Forecasting
- Statistical Query

LEARNING OBJECTIVES:

After reading this chapter, you would be able:

- to understand the concept of Data Mining and its relevance to the Practical Business Statistics;
- to gain knowledge of the usage and relevance of the Big Data in Practical Business Statistics;
- to understand some of the models and systems of Data Mining that are being used in the field of Practical Business Statistics;
- to understand the difference in the method of usage of Data Mining and Big Data that are being used in Business Statistics;
 - to gain knowledge about the application of the Big Data and Data Mining and the issues that is being experienced by the statisticians in the modern times.

2.1. INTRODUCTION

Data mining is defined as a procedure that examines a large amount of data to find new and unseen data that helps in improving the effectiveness of the business. There are several numbers of industries who have been accepting the technique of data mining to their missioncritical business processes in order to attain the competitive benefits and also help in the growth of the business. This topic will exemplify some of the applications of the data in the field of sales and marketing, banking and finance, healthcare and insurance, and transportation and medicine.





Data mining allows the businesses to recognize the unseen patterns which are inside the past purchasing transaction data, therefore providing assistance in planning and introducing the innovative marketing movements in a rapid and cost-effective method.

Statistics is very important to confirm that the meaningful, accurate information is abstracted from Big Data. The subsequent concerns are serious and are only aggravated by **Big Data**:

- Quality of the data and missing data;
- Observational nature of data, so that causal queries like the contrast of interferences may be subject to confounding;
- Assessment of the doubt of forecasts, predictions, and model;

- The scientific discipline of statistics provides their fined methods and models to bear on these concerns;
- Statisticians provide assistance in translating the scientific query into a statistical query, which comprises of cautiously defining the data structure;
- The fundamental system that produced the data (the model); and what the user is trying to assess (the parameter or parameters that are to be assessed) or forecast.

2.2. ROLE OF DATA MINING IN PRACTICAL BUSINESS STATIS-TICS

Everyone thinks of data mining as the procedure of recognizing accurate, new, potentially valuable, and eventually clear comprehensible patterns or models in data to take the vital decision of the business.

- The term "valid" means that the patterns hold in general,
- The term "novel" that the individual is not aware about the pattern beforehand, and
- The term "understandable" means that the individual can understand and comprehend the patterns.

Henceforth, the process of data mining is just like statistics—it is not just demonstrating and calculation, nor a product that can be bought, but an entire problem-solving cycle or procedure that must be understood by the help of team effort. **Big data** is a term that describes the large volume of data – both structured and unstructured – that inundates a business on a day-to-day basis. The description of the right business issue is the complicated part of effective **data mining**. This is because it is completely a communication issue. The technical individual who is examining the data is required to recognize what the business actually wants.

Even the most progressive algorithms cannot figure out that what is most significant for the business. The individual should never forget that the "garbage in" produces "garbage out."

database Data preprocessing or the cleaning of the data systems. or the preparation of the data is also considered as an important part of the process of the data mining. The quality choices and quality mining outcomes are derived from the quality data. The data are always dirty and are not prepared for the process of data mining in the actual world.



Figure 2.2: Preparation of data is extremely required in the process of data mining.

Source: https://www.maxpixel.net/static/photo/1x/ American-Business-Analytics-Agenda-Black-And-White-3511208.jpg

The data is required to be integrated from the diverse sources; (1) data is consisting of the missing values, is incomplete data; (2) data is

Data mining is the process of discovering patterns in large data sets involving methods at the intersection of machine learning, statistics, and database systems. noisy, is it comprise of the outliers or mistakes, and inconsistent values (for instance, consists of inconsistencies in codes or names); and (3) data are not at the correct level of combination.

The most important part of data mining is concerned with the examination of data and the application of the software techniques for the discovery of the patterns and consistencies in the groups of data. It is the computer which is in charge for discovering the patterns by recognizing the basic instructions and characteristics in the data. The decision of a specific integration of techniques to use in a particular situation relies on both the nature of the data mining work to be achieved as well as the nature of the accessible data.

The concept is that it is likely to strike gold in unanticipated places as the software of the data mining abstracts patterns that are not previously visible, or so understandable that no one has seen them before. The procedure of the analysis begins with a set of data, make use of a methodology to develop an optimum depiction of the structure of the data during which time knowledge is attained.

Once the knowledge has been attained this can be extended to larger groups of data functioning on the supposition that the larger group of data set has structure which is analogous to the sample data. This is similar to a mining operation where large amounts of lowgrade materials are moved through in order to discover something that is valuable.

This sounds familiar, doesn't it? Initially, statistics is described as the science of learning from data. And secondly, recall that the key **Depiction** is reference conveyed

through pictures.

order from data to knowledge is from the data to information and from the information to knowledge.

2.2.1. Some Examples of Data Mining in Practical Business Statistics

This order is briefly exemplified. Data are what the user can capture and store (for instance, client data, store data, demographical data, topographical data), and it is converted in to information when it became appropriate to the decision problem. The available information tells about the items of data. For example, X exists in Z; S is Y years old; X and S moved; W has money in Z), and it is converted in to knowledge when it is applied in the effective completion of the decision procedure.

Henceforth, knowledge relates items of information (for instance, a quantity Q of product A is used in the area Z; the clienteles of class L make use of N% of C at the period D). The latter is certainly a piece of the so called "business intelligence" chain, which involves from data to information, from information to knowledge, from knowledge to decision, and from decision to action (for instance, encourage product A in the area of Z; mail advertisements to the relatives or families of profile P; cross-sell service B to the customers E).

It has been observed that the most important issue, the main concern is to identify how to change from data to knowledge, or as J. Naisbitt stated: "We are drowning in information but are starving for knowledge." The important solution to such issue is data mining and/or statistics. With the process of **data mining**, the businesses can examine the past activities of the clients in order to make the strategic choices for the upcoming times. Keep in mind, though, that the methods and the apparatuses of the data mining are similarly applicable in the areas that is ranging from law enforcement to radio astronomy, medication and industrial process control.

2.3. BIG DATA AND PRACTICAL BUSINESS STATISTICS

What does statistics bring to Big Data and where are the opportunities?

• Big Data will often not be assisted in an improved way by the approaches like the "off the shelf" or black box computational apparatuses that operate in low-dimensional and less complex settings, and thus, it needs personalized statistical approaches.

Statisticians or the analysts are considered as experts at measuring and modifying for bias; calculating the level of uncertainty; formulating studies and modeling approaches; evaluating the quality of data; listing the restrictions of studies; handling the concerns like the missing data and other sources of nonsampling mistakes; developing models for the examination of the compound data structures; making the approaches for causal inference and relative efficiency; removing the terminated and unproductive variables; integrating the information from the several sources; and Data mining is

the process of discovering patterns in large data sets involving methods at the intersection of machine learning, statistics, and database systems. methods Walmart

determining the efficient data visualization



Figure 2.3: Major supply chains like Walmart are putting the Big Data to use to attain better results for Practical Business Statistics

Source: https://live.staticflickr.com/7367/12331640 945 62ca186bf0 b.jpg

Walmart is considered as the major retailer in the world and the world's largest business that generate the largest revenue, with over two million workers and twenty thousand stores in 28 nations. With operations on this scale, it is no surprise that they have long seen the value in data analytics.

In the year 2004, when Hurricane Sandy hit the US, they observed that the unpredicted visions were exposed as soon as the data was studied as a whole, rather than as secluded distinct sets.

They have tried to do the prediction of the demand for emergency supplies in the face of the imminent Hurricane Sandy, CIO Linda Dillman turned up some of the astonishing statistics.

Aside from flashlights and emergency apparatus, anticipated bad climatic conditions had given rise to an increase in sales of strawberry Pop Tarts in veracious numbers of other locations. The additional supplies of these were shipped to the provisions in Hurricane Sandy's path in the year 2012 and traded enormously well.

The appropriate examination of the realtime data is understood as a main key in driving business performance – as the Senior Statistical Analyst of the Walmart, Naveen Peddamail runs Walmart's Data Cafe and given the statement that: "If you cannot get visions until you have analyzed the auctions for a period of seven days or a month, then you have lost the sales in that period of time. The objective is always to get the information to the business cohorts as quick as it can be done, so that these business partners can take some action and cut down the turnaround time. It is considered as proactive and reactive analytics."

In addition, Peddamail also gives an example of a grocery team which is struggling in order to identify why the sales of a specific produce were suddenly decreasing. Once their data was handled by the analysts of the cafe, it was recognized very rapidly that the decrease in the sales was directly attributed to a fault in the pricing.

The mistake was instantly corrected by the analysts of the café and the sales were improved in some of the days. The auctions across the diverse stores in the diverse geographical regions can also be handled in real-time.

2.4. CURRENT TRENDS IN THE US-AGE OF DATA MINING AND BIG DATA IN PRACTICAL BUSINESS STATISTICS

The present use of the phrase tends to have invented in the field of computer science. A description that has been repeated frequently is "a procedure that deals with the finding of unseen knowledge, unanticipated patterns, and new instructions from the large databases, mainly the detection of the optimal groups and interesting inconsistencies." Not astonishingly, this sounds questionably like the part of the **statistical analysis**.



Figure 2.4: There are various changes and alterations in the field of Practical Business Statistics which help in creating new business trends.

Source: https://images.pexels.com/photos/590045/ pexels-photo-590045.jpeg?auto=compress&cs=tiny srgb&dpr=2&h=650&w=940

Many of the techniques of the data mining are analogous to the elementary statistical methods of exploratory data analysis (EDA) and data visualization that have been utilized for

Statistical analysis

is a component of data analytics. In the context of business intelligence (BI), statistical analysis involves collecting and scrutinizing every data sample in a set of items from which samples can be drawn. many of the years. More significantly, the similar statistical issues that have plagued the analysts or the statisticians and non-statisticians the same in their analysis attempts have not, in any way, been solved by the application of the of Data Mining and Big Data software. Consequently, Data Mining and Big Data software, rather than being a solution, may add little to the toolboxes of investigators already acquainted and with access to the elementary statistical apparatuses.

2.5. ISSUES IN THE USAGE OF BIG DATA AND DATA MINING IN PRAC-TICAL BUSINESS STATISTICS

First and foremost, the huge sets of the data are still groups of data, and it is significant to recognize how the data were actually gathered. Any inferences from the process of analysis will just be as good as the innovative data.

The investigators who are burdened because of the "bad" data are faced with a severe drawback, and in extreme situation, not even the refined statistical techniques can focus on the purposes to any degree of **gratification**.

The one reason of bad data is the deprived stipulation of the purposes. For example, the poorly expressed or unclear purposes can give rise to the gathering of the data that provide the replies to the incorrect query.

Gratification is

the pleasurable emotional reaction of happiness in response to a fulfillment of a desire or goal.



Figure 2.5: One of a major use of practical business statistics is in the analysis of global share of social networking.

Source: https://c.pxhere.com/photos/35/5c/analytics_business_chart_charts_data_data_analysis_ desk_device-1554545.jpg!d

The approaches of the collection of the bad data can also give rise to the prejudices in the data or result in data not demonstrative of the populace that was to be experimented. The other issues comprise of the data that has been combined over significant variables and sets of the data with the great amounts of missing data.

The enormously large sets of the data are generally quite compound in nature, frequently comprising scores of variables, many of which can only be defined by non-linear relations. There are several variables that can also interact with each other.

All these concerns combine to make many statistical processes, like the Analysis of

Variance or Regression Analysis, hard to apply. Also, the care should be provided so that data which is containing many variables is not "over analyzed." No matter how big the data set is in the beginning, if it is divided into sufficient Regression analysections, important changes will be observed among the clusters simply by chance.

EDA and data visualization methods, though the relationship mainly descriptive, continue to be the main starting points to recognize the associations in the data. Such kinds of methods comprise of the box plots and histograms of the distinct variables and scatter plots of sets of variables.

These graphical depictions can give rise to the decrease in the number of variables that must be addressed by turning the spotlight on the strong trends or patterns that are available in the data. More graphical demonstrations, though, required to be established that can define the higher dimensional patterns in the data in an improved way.

On the other hand, multivariate methods like the cluster analysis may permit the investigators to recognize the collections or groups of the connected variables. By decreasing the dimension of the data to a few groups, it may be likely to make use of the standard statistical tools for all the following analysis.

The restraints that are available on the software packages may avert the standard analysis of data sets with the huge numbers of examinations. The amount of data that is required to be examined can be decreased by the process of sampling the database.

So, the software packages can be utilized on the data that is sampled. Simple random samples,

sis is a powerful statistical method that allows you to examine between two or more variables of interest.

where every single observation has the similar chance of selection, are simple, normally used plans. Though, these accept that the database that must be sampled is homogenous or similar in nature.

If there are groups of data in the database, a simple random sample will not be considered as an efficient device and the following inferences may be prejudiced. In these kinds of scenarios, the other sampling plans should be observed.

Even though the large sets of the data introduce extra difficulties to their analysis, the investigators should not neglect the elementary statistical ideas that have served so well at the time of examining the smaller sets of the data.

The approaches of the collection of the data should reflect the complete purposes and the original analysis should be composed of EDA and data visualization methods. Once a comprehensive identification of the data has been achieved, more complex approaches, like the cluster analysis or database sampling, can be undertaken.

REVIEW QUESTIONS:

- 1. Define 'Data Mining' with respect to Practical Business Statistics.
- 2. What is the relevance of Data Mining with Business Statistics in the modern world?
- 3. With the help of examples, explain the various aspects of the implementation of the data mining in Practical Business Statistics.
- 4. How is the usage of Data Mining helps in segregating the data that is relevant to any industry?
- 5. Discuss the different processes of Data Mining that are used in Practical Business Statistics.
- 6. Define the following terms in relation to Practical Business Statistics:
- a. Valid
- b. Novel
- c. Understandable
- 7. Why is data processing an integral part of Data Mining?
- 8. Describe the various functions that are completed by the usage of Big Data in Practical Business Statistics.
- 9. What are the current trends that are being followed in Big Data and Data Mining?
- 10. What are challenges that are being faced in the usage of Big Data and Data Mining in the field of Practical Business Statistics?

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CHAPTER 3

DATA STRUCTURE

KEYWORDS

- Data Collection
- Variability
- Generic Specification
- Interquartile Range
- Hash Tables
- Homogeneous Data
 Structure
- Non-Homogenous Structure
- Standard Deviation
- Storage Structures
- Recursion
- Algorithms

LEARNING OBJECTIVES:

After reading this chapter, you would be able to understand:

- data structure and algorithms;
- characteristics of data structure;
- types of data structure;
- variability;
- variability in business processes;
- data collection;
- automatic collection of a generic specification.

3.1. INTRODUCTION

The process of Data structure mentions to the approaches or methodologies of managing various units of data within the larger data sets. Attaining and preserving a particular data structures will assist in advancement of the data access as well as value. Data structures also assists programmers to execute several types of tasks which are related to the programming. It is an efficient or productive approach to understand the data structures.

For instance, a very basic example of the data structure is an array. In array, more than one data bits are coordinated into a group sharing a common label. This assists programs call these data bits or perform other work on the data set as a complete.

Another example of the data structure is a stack. In stacks, it places the data units in comparative chain of command, permitting the code functions to operate on the data with a coordinated approach, like pushing a new data unit into a stack, or removing the data unit from the top of a stack.



Figure 3.1: Basic concept of the data structure and algorithms.

Source: https://upload.wikimedia.org/wikipedia/commons/8/80/Data_ Structure_Diagram.jpg

Simply put, the concept of the data structure joins together with that of virtual objects as well as the virtual reality. As the data is more decoratively arranged with the help of the developers and others, the data becomes more useful and efficient, permitting the development of the virtual reality. This is a core concept of several numbers of technological advances from years ago.

3.2. DEFINITION OF A DATA STRUCTURE AND ALGORITHMS

Data structures and algorithms are very important components in several numbers of the computing applications. When the programmers design and develop applications, then the programmers are required to model the application data. What this data be made up of rely on the purpose and with regards to the use of the application.

Nevertheless, it is typically a necessity for any type of the application to insert, edit as well as query a data store. Data structures provide several types of the ways to store data items. On the other hand, the algorithms offer several types of approaches or techniques in order to managing this data.



a data organization, management, and storage format that enables efficient access and modification.

Data structure is

Figure 3.2: Algorithms and Data Structures by Sergey Skrobotov at Holberton School.

Source: https://farm8.staticflickr.com/7704/265668 31050_1cbc07c55b_b.jpg

3.2.1. Application Data

Computing applications use several types of various data. Some of the applications model data within database systems, in which case the database system manages or organizes the details of the selection of the data structures, along with the algorithms to organize or handle them.

In several cases, applications model their own data. When the programmers choose what type of data structure to apply for a specific set of data in an application, they require to take into account the particular data items to be stored, the dealings among the data items and how the data will be accessed from within the application logic.

3.2.2. Storage Structures

Programming languages provides a huge variety of the data structure options. When the programmers choose data structures for their applications, they contemplate the nature of the data as well as what the application is going to do with it. Arrays are among the most common data structures.

An array can store a segment of the data values in a linear structure, with each of the element accessed with the help of the its index position within the data. Some of the data structures avoid the programs from storing identical values. Also, some of the data structures preserve a system of ordering for the items stored.

3.2.3. Searching

When a program tries to search the data structure for a specific item, it uses an **algorithm**. An algorithm is a process, which is defined in code, for carrying out the particular type of job. Searching the data structure is one of the most general programming actions and consisting of several types of algorithm.

When the programmers are executing the algorithms in order to search the data structures in their applications, the programmer attempts to make these types of the algorithms as effective or productive as possible to make the most of the performance.

Algorithm is a set of instructions, typically to solve a class of problems or perform a computation.

3.2.4. Sorting

Depending on the type of the data structures and processes taking participation in an application, it may become very important to categorize the data stored within it. Several types of the data structures enforce particular types of limits on the applications.

For instance, if a program is running with the help of a data structure, for example a list, but this type of the data structure only permits new items to be added at one end. As an outcome the stored data will comprise data that is not in a proper manner.

Sorting algorithms give permission to the programmers to either rearrange data structures, ordering them according to the value, or to copy the items in order, into a second data structure.

3.2.5. Recursion

Algorithms to manage the data structures every so often is consisting of the recursion. With the help of the recursion, an algorithm calls itself. This means that it duplicates its own the processes as part of a looping structure, with each and every of the step simplifying the issue at hand.

Recursive algorithms give the permission to the programmers to execute the effective or productive **sorting** and the several types of the approaches or techniques in searching within their applications. Nevertheless, writing recursive algorithms can be very challenging for the beginners, as it does necessitate a very crucial amount of practice.

Sorting is any process of arranging items systematically, and has two common, yet distinct meanings: ordering: arranging items in a sequence ordered by some criterion; categorizing: grouping items with similar properties.

3.3. CHARACTERISTICS OF DATA STRUCTURES

Data structures are every so often categorized with the help of their characteristics. Possible characteristics are discussed below:



Figure 3.3: Characteristics of the data structure.

3.3.1. Linear or Nonlinear

This characteristic explains whether the data items are organized in chronological sequence with the help of an array, (linear) or in an unordered sequence, sometimes, with the help of a graph (nonlinear).

3.3.2. Homogeneous or Non-Homogeneous

This characteristic explains whether all the data items in a given repository are of the same kind (homogenous) or of different types in nature (non-homogenous).

3.3.3. Static or Dynamic

This distinguishing explains how the data structures are accumulated. Static data structures have fixed sizes, structures as well as memory locations at the time of assembling. Dynamic data structures have sizes, structures as well as memory locations that can shrink or expand according to the application.

3.4. TYPES OF DATA STRUCTURES

Data structure kinds are distinguished with the help of what types of actions are essential or what types of algorithms are going to be used. These types are listed in the following subsections.

3.4.1. Arrays

An **array** stores a collection of items at adjoining memory locations. Items that are of the same kind get stored with each other or together so that the position of the each and every component can be evaluated or retrieved with no trouble. Arrays can be fixed or flexible in length. Array is a container object that holds a fixed number of values of a single type.

3.4.2. Stacks

A stack stores a collection of items in the linear order that operations are applied. This order could be last in, first out (LIFO) or first in, first out (FIFO).



Figure 3.4: A representation of LIFO (Last in, first out).

Source: https://upload.wikimedia.org/wikipedia/it/ thumb/b/b5/FIFO-LIFO.svg/1270px-FIFO-LIFO. svg.png

3.4.3. Queues

A queue stores a collection of items which are identical to a stack; nevertheless, the operation order can only be first in, first out.

3.4.4. Linked lists

A linked list stores a collection of items in a linear order. Each of the component or element or node, in a linked list consists of a data item as well as a reference, or link, to the next item in the list.

3.4.5. Trees

A tree stores a collection of items in an abstract, hierarchical way. Each node is connected to other nodes and can have manifold the subvalues and is also known as children.

3.4.6. Graphs

A graph stores a collection of items in a nonlinear fashion. Graphs are made up of a finite set of nodes, also known as vertices, and lines that join them, also known as edges. These are very useful in order to represent real-life systems like computer networks.

3.4.7. Tries

A tries, or keyword tree, is a data structure that stores strings as the data items that can be managed in a visual graph.

3.4.8. Hash Tables

A hash table, or a hash map, stores a collection of items in an associative array that plots keys to values. A hash table works with the help of a hash function to alter an index into an array of buckets that is consisting of the required data item.

These are well thought-out as a complicated data structures as they can store huge amounts of the interconnected data. Examples of primitive, or basic, data structures are integers, floats, and Booleans and they could be characters as well. Array is a container object that holds a fixed number of values of a single type.

3.5. WHAT IS VARIABILITY?

Variability (which is also known as spread or dispersion) mentions to how spread out a set of data is. Variability provides an approach to explain how much the data sets fluctuates as well as permits the individual to apply statistics to associate the data to other sets of data as well. The four main approaches to explain the variability in a data set are:

- Range
- Interquartile range
- Variance
 - Standard deviation

Interquartile range is a measure of variability, based on dividing a data set into quartiles.



Figure 3.5: Four different approaches to explain the concept of variability.

3.5.1. Range

The range is the quantity among the smallest and largest item which is present in the set. Any individual can discover the variety with the help of the taking away the smallest number from the largest. For instance, let's assume any individual earned an amount of \$250 in a period of one week, \$30 in the following week and \$800 on the third week. The range for his or her pay (that is how much it fluctuates) is \$30 to \$800.

3.5.2. Interquartile Range

The interquartile range is almost the same as the range, only as a replacement of stating the scale or bucket for the entire data set, the individual is giving the amount for the "middle fifty." It is every so often more helpful as compare to the scale or bucket because it tells his or her where the most of the values lie.

The formula is IQR = Q3 - Q1, whereas the Q3 is the third quartile and Q1 is the first quartile. The individual is basically taking one of the smallest values (at the 25th percentile) and taking away it from one of the largest values (at the 75th percentile).

The adjacent boxplot determines the interquartile range, represented with the help of the box. The whiskers (which are the lines coming out from either side of the box) shows the first quarter of the data and the last quarter.



Figure 3.6: Interquartile range.

3.5.3. Variance

The variance of a data set provides an approximate idea of how spread out the data is. A small number for the variance means that the data set is tightly bunched together, and a large number means that the values are more spread away from each other. The variance is not often beneficial apart from to evaluate the **standard deviation**.

Standard Deviation

is a measure of how spread out numbers are.

3.5.4. Standard Deviation

The standard deviation depicts that how tightly the data is bunched around the mean (also known as the average). A small Standard deviation shows that the data is closely bunched and the individual also have a taller bell curve; a large Standard Deviation tells that the data is more spread away from each other.



Figure 3.7: Standard deviation.

3.6. VARIABILITY IN BUSINESS PROCESSES: AUTOMATICALLY OBTAINING A GENERIC SPECIFI-CATION

The existence of several numbers of process alternatives is unavoidable in several numbers of modern organizations. Nevertheless, **variability** in business process aids has proven to be a very difficult job as it necessitates a flexible business process specification that assists the essential process variants, and at the same time being submissive with the help of the policies and regulations.

Declarative tactics or methods could help variability, with the help of offering instructions or guidelines to slow down the behavior of the process and in this way, permitting several types of variants. However, manual specification of these instructions or guidelines are very difficult and are prone to having errors. As such, these types of tools are essential to make sure that the replication and overlap of these instructions or guidelines is dodged as much as possible, while retaining maintainability.

It is helpful in presenting the several types of process variants in a single compound prime event structure, as well as offers a way or a technique to subsequently derive variability instructions or guidelines from this compound prime event structure.

The approach is calculated with the help of conducting an investigative assessment on several numbers of sets of real-life business process variants, which covers the case from the Dutch eGovernment, to establish the efficiency

Variability is the extent to which data points in a statistical distribution or data set diverge from the average value as well as the extent to which these data points differ from each other. as well as the applicability of the technique or methodology.

3.7. WHAT IS DATA COLLECTION?

The Data Collection is a process in which the researcher collects the information or data from all of the appropriate sources to discover answers to the research issues, test the **hypothesis** as well as assess the results.

Through the course of collecting the data or information, the researcher must need to recognize the kind of data which has to be collected, source of data, as well as the technique to be used in collecting the data. In the same way, the answers to the questions that who, when and where the data is to be collected should be well studied by the researcher.

The choice of the data collection approaches relies on the research issues under the study, the research design and the information to be collected about the variable. Extensively, the methods or approaches for the data collection can be specified into two categories which are mentioned below:

3.7.1. Primary Data Collection Methods

The primary data are the first-hand data, which is gathered by the researcher for the first time and is original in nature. The researcher gathered the fresh data when the research issue is distinct, and no related research work has been done with the help of any other person or researcher.

The outcomes of the research are more precise when the data is gathered straightly with

Hypothesis is a proposed explanation for a phenomenon.

the help of the researcher but, it is expensive as well as it consumes a lot of time.

3.7.2. Secondary Data Collection Methods

When the data is gathered with the help of someone else for his research work and has already passed across the statistical examination is called the secondary data. In the same way, the secondary data is the second-hand data which is readily available from the other sources.

One of the benefits of application of the secondary data is that it is very cost effective in nature and at the same time it is easily available, however, the genuineness of the findings may be questioned.

In the same way, the researcher can get the data from either of the sources according or relying on the nature of study of the researcher and the pursued research objective.

REVIEW QUESTIONS:

- 1. Discuss what have you understood with the term data structure and algorithms.
- 2. Explain the significance of the application data and storage structures with respect to the data structure.
- 3. What are the various characteristics of the data structure?
- 4. Describe the terms searching, sorting, and recursion in the context of data structure and algorithms.
- 5. What are the various types of the data structure?
- 6. What is the meaning of the term variability?
- 7. Explain the basic concept of the variability in the business processes.
- 8. What do you understand by the term data collection? How is data collection being important for the businesses?
- 9. Define primary data collection methods.
- 10. Explain the secondary data collection methods with respect to the fundamentals of data collection.
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CHAPTER

4

DISTRIBUTION OF DATA: HISTOGRAM

KEYWORDS

- Histogram
- Pareto Analysis
- Scatter Diagram
- Electric Control Chart
- Data Visualization
- Japanese Union of Scientists and Engineers (JUSE)
- Motor Assembly
- Normal Distribution
- Uniform Distribution
- Business Data Analysis
 Graph
- Double-Peaked
 Distribution

LEARNING OBJECTIVES:

In this chapter, you will learn about:

- history of histogram;
- different parts of histogram;
- different shapes of distribution in histogram;
- application of histogram in business.

4.1. INTRODUCTION

One of the popular graphing tools is histogram. The histogram can be used to summarize either discrete or continuous data which are measured on an interval scale. Most often, it is used to show the major features of the distribution of a data in a convenient form. Division of the range of possible values given in a data set is done into classes or groups in the histogram.

For every group, a rectangle is made with an equal base length to range the values in that particular group and also, an area proportional to the number of observations that fall into that group. It means that the rectangles which are drawn will be of non-uniform height.

While performing financial analysis as well as valuation, it includes dealing with the large sets of **numerical data**. This kind of data includes financial statements, peer company data, financial ratios, stock returns, macro-economic indicators and commodity prices.

This sort of data helps in analyzing the company or industry to understand its history and current status and also, make forecasts of the future. Some of the large sets of data can proved to be overwhelming and confusing at time. In such situations, the user must use statistical tools which can help in collecting, analyzing, interpreting and presenting the data.

Visualization of data can be done by using histograms. There are some questions which can be answered with the help of histograms, such as:

- How does the company is performing in comparison to its peers and that can be represented by financial ratios?
- What is the performance of company in comparison to the past and so it can be represented by the financial ratios?
- What is the behavior of stock returns, commodity prices and macro-economic indicators historically?

Simply put, a histogram can prove to be very useful if someone wants to calculate an average or a median of any data set. Along with presenting those statistics, the histogram can also present the whole distribution of the data which in turn can improve the analysis and can also provide conclusions which could not be shown after calculating average and median.

4.2. HISTOGRAM

Histograms are the type of graphs which provide a visual interpretation of the numerical data and that is done by indicating the number of the data points that is present within a range of values. Such ranges of the values are known as classes or bins. By using the bars, the frequency of the data falls in each of the class which is depicted. The frequency of the data values in the bin is greater when the bar is high.

Some other features of the **histogram** include that the x-axis is measured in ranges to define various parts of the data.

Histograms can be described as an excellent way of describing numerical x-value data. For example, while graphing the height and weight graph, the height of several merchants is taken on the x-axis and the weight of the merchants are taken on the y-axis and thus it would use a histogram because the values present on the x-axis are arithmetic values.

In case, there are colors present on the x-axis which can change their acceptance on the y-axis and it will not use a histogram. The reason behind this is that the colors do not have arithmetic values, but they are categorical. Usually, while relating uncompromised data, bar graphs are used and for linking arithmetical data, it is more appropriate to use histograms.

In the cases of big set of measurements, histograms can be used to arrange and display the data and thus, provides more user friendly

Numerical

data is data that is measurable, such as time, height, weight, amount, and so on.

Histogram is a

graphical display of data using bars of different heights.

as well as understandable format. Histogram makes it easy to understand most of the values that fall in a measurement scale.



Figure 4.1: Histogram is known as the graphical representation of data by using bars of variable heights.

Source: https://files.transtutors.com/book/qimage/ image06152015043.png

4.2.1. History of the Histogram

The implementation of the histogram was first done by Kaoru Ishikawa. He is one of the Japan's most renowned experts on the topic of quality improvement. In 1950, he then became a member of the Japanese Union of Scientists and Engineers (JUSE). Ishikawa wanted to make quality control comprehensible to all workers. He standardized the *Seven Basic Tools of Quality Control* after being inspired by a particular lecture given by Edward Deming.



Figure 4.2: Kaoru Ishikawa.

Source: https://commons.wikimedia.org/wiki/ File:Kaoru_Ishikawa.jpg

Ishikawa believed that most of the problems caused in a company can be solved by using these seven tools and that it can easily be taught to any member of the organization. This easy combination of the graphical nature makes the statistical analysis much easier for everyone.

• Cause-and-Effect Diagram (also called Ishikawa or Fishbone Diagrams): This diagram identifies a number of possible causes responsible for any effect or any further problem and helps in characterizing ideas into useful categories.



Figure 4.3: Cause-and-effect diagram for factors contributing to defect.

Source: https://commons.wikimedia.org/wiki/ File:Cause_and_effect_diagram_for_defect_XXX. svg

- Check Sheet: Check sheet is a structured and prepared form which is used for collecting and analyzing data. It is generic tool that can used for various purposes such as:
- For the assessment of the shape of **probability distribution** of particular process
- For defect cause and defect location, etc.

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Munipred set			111			11		
Wrong part issues		1		11				
Siles on parts		12		1.10				
Words in Labora			6 - 1	1111	11	111		
manual dimension						11		1 4
Ashesive later			1					
Maxing multicler								1
Barray Baller			11111			3		1
TOTAL			(-		1

Figure 4.4: Check sheet for motor assembly.

Source: https://commons.wikimedia.org/wiki/ File:Check_sheet_for_motor_assembly.svg

Probability distribution is a mathematical function that provides the probabilities of occurrence of different possible outcomes in an experiment. • **Control Chart:** Control chart is a graph which is used to study about the changes in the process over time. It compares the current data to historical control limits which leads to the results related to whether the variation in the process is consistent or is unpredictable that is it is affected by some special causes of variation.



Figure 4.5: Western electric control chart.

Source: https://commons.wikimedia.org/wiki/ File:Rule_1_-Western_electric_control_chart.svg

- **Histogram:** Histogram is the most common method which is used for representing the frequency distributions or to show how often each and every different value in any set containing data occurs.
- **Pareto chart:** Pareto chart is a **bar graph** which is used for showing the factors which are very significant.

Bar graph is a chart or graph that presents categorical data with rectangular bars with heights or lengths proportional to the values that they represent.



Figure 4.6: Pareto analysis on the causes of engine overheating.

Source: https://commons.wikimedia.org/wiki/ File:Pareto_analysis.svg

> • Scatter diagram: Scatter diagram is a graph which contains pairs of numerical data and one variable on each axis and shows the relationship between them.



Figure 4.7: Scatter diagram.

Source: https://www.spcforexcel.com/files/images/ scatter-diagram-images/speed-time-scatter-diagram. jpg • Stratification: Stratification is a technique which distinguishes data which is gathered by using a variety of sources so the patterns can be seen. It is also known as flow charts or run charts.

4.2.2. Parts of Histogram

- **The title:** The information which is contained in the histogram is best described by using the title.
- **X-axis:** The x-axis are the intervals which represents the scale of values in which the measurements fall under.
- **Y-axis:** The y-axis are the intervals which shows the number of occurrences of the values within the intervals set by the x-axis.
- The bars: The bars' height represents the number of times that the value occurred within the interval and the width shows the interval that is covered. In some histograms with equal bins, the width will be equal across all the bars.

4.2.3. Typical Histogram Shapes

Normal Distribution

Normal distribution contains a normal pattern having curve in bell – shaped. In a **normal distribution**, the points are more likely to occur on one side of the average as on the other. There are cases where other distributions look similar to the normal distribution. There are statistical calculations which are carried out in order to prove a normal distribution.

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



Figure 4.8: Normal distribution.

Source: https://commons.wikimedia.org/wiki/ File:Normal_distribution_pdf.svg

The term 'normal' refers to as the typical distribution for a particular process. For example, there are many processes which have natural limit on one side, and they can produce skewed distributions. For such process, the normal means typical even though the distribution is not considered normal.

Skewed Distribution

The skewed distribution is considered to be asymmetrical. The reason being a natural limit which prevent outcomes on one side. The peak of the distribution is off center towards the limit while the tail is stretched away from it. For example, a distribution of analysis of any product can be skewed because that product cannot be more than 100 % pure. Another example of natural limits can be holes that cannot have a diameter which is less than the diameter of the drill bit or the callhandling times which cannot be zero. Depending on the direction of the tail, these distributions are said to be right or left-skewed.



Figure 4.9: Skewed distribution.

Source: https://commons.wikimedia.org/wiki/ File:Negative_and_positive_skew_diagrams_(English).svg

Double-Peaked or Bimodal Distribution

The curve that represents the bimodal distribution looks like a two-humped camel. It shows the outcomes of two models with different distributions and are combined in one set of data. Example for bimodal distribution includes a distribution of production data from a two-shift operation, in case each shift produces a different distribution of results. Such problems are often seen in **stratification**.

Stratification is a system or formation of layers, classes, or categories.



Figure 4.10: Double-peaked or bimodal distribution.

Source: https://commons.wikimedia.org/wiki/ File:Bimodal.png

Edge Peak Distribution

The curve shown by the edge peak distribution looks like the normal distribution. There is only one difference and that is, it has a large peak at one tail. This is usually caused by the faulty construction of the histogram, with data combined into a group labeled 'greater than.'

Comb Distribution

The bars in the comb distribution is alternatively tall and short. This distribution is considered as a result of the rounded off-data or an incorrectly constructed histogram. Let's take an example in temperature. The data related to temperature if rounded off to the nearest 0.2 degrees will show a comb like shape if the width of the bar for the histogram were 0.1 degree.

Uniform Distribution

A uniform distribution provides a little information about the system. For example, in

73

a state lottery, each class has about the same number of elements. This can further describe a distribution which contains several modes also referred to as peaks.



Figure 4.11: Uniform distribution.

Source: https://commons.wikimedia.org/wiki/ File:Beta(1,1)_Uniform_distribution_-_J._Rodal. png

If the histogram has this kind of shape, then check if various sources of the variation have been combined. After that, start analyzing them separately.

If as the cause if this pattern is not because of the multiple source of variation, then different groupings should be tried in order to check if the result can be a more useful pattern. This can be a simple method, that is, changing the starting and ending points of the cells or changing the number of the cells. A **uniform distribution** often shows a small number of the classes.

Random Distribution

A random distribution contains no specific pattern. Similar to uniform distribution, it can

Uniform distri-bution is a distribution that has constant probability. further be described as a distribution who does not have several modes or peaks. If the histogram contains this shape, it should be checked to see if various sources of the variation have been combined or not. And if yes, then they should be analyzed separately.

As the cause of this pattern, if the multiple sources of variation do not seem to be the reason, then different groupings can be tried to see if a more useful pattern as a result. A random distribution often seems to have a large number of classes.

4.3. APPLICATION OF HISTO-GRAM IN BUSINESS

The histogram was originated from the outside of Lean and **Six Sigma**. Despite that fact, it contains many applications in that area, especially in the organizations that rely largely on the statistical analysis. It is said to be a flexible tool which can be used for various purposes. If it is used correctly, it can show a lot of things about the operations that are running in the organizations.

The histogram is a popular tool having many applications in various fields and it can be commonly seen in various environments. For a leader, it is very important to know the possibilities which is offered by the histogram and it should be used in whatever way possible. In order to improve the performance of the company, the leader must use the histogram in a proper way, and it is required for them to understand it correct implications.

Six Sigma is a disciplined,

statistical-based, data-driven approach and continuous improvement methodology for eliminating defects in a product, process or service.



Figure 4.12: Histograms are used for business improvement purposes.

Source: https://pixabay.com/illustrations/graph-chart-sales-increase-841606/

One of the best uses of the histograms is for the purpose of quality improvement. As a tool, it should be understood where the histogram needs to be used and the type of problem it can solve.

Identifying the Most Common Process Outcome

While analyzing the histogram, it can be immediately revealed what could be the most common outcome of a process having a number of varying outcomes. By collecting a number of data related to the final state of the process and further organizing it in a histogram, any special trend can quickly become apparent.

When there are a large number of possible outcomes, things can become complicated. This happens especially, when some of the data regrouped up and appears with one another commonly.

Identifying Data Symmetry

Sometimes there are two trends which tends to go in two directions altogether. To identify those occurrences and know about the processes, histogram makes it much easy for the user. There are situations when the process and occurrences can produce symmetrical results then at that time histograms should be used.

To optimize some types of processes, the histogram is proved to be very useful. In addition, the histogram is also helpful in identifying the possible issues in the cases where symmetry is not expected in the results.

Spotting Deviations

Whenever there are deviations in the results from the expected values, then the histogram can help in such cases. When collection of all the data points is done and then they are arranged in an appropriate manner for a quick review then the histogram can work, and it can help in spotting when the results are not moving in a right direction.

When there are small number of data points, the histogram can prove to be the most easy and useful tool for spotting the errors and identifying the deviation causing point. By keeping a list of histograms that is been obtained from the data and after further referring to them can help in making things easy for the purpose of analysis as it can identify the deviation causing factor and also the recent changes in the operations.

Verifying Equal Distribution

There are some cases where the symmetry is the thing the person is looking for. Especially in

Spotting is defined as light vaginal bleeding that happens outside of your regular periods.

those cases where a process is very much prone to random deviations. If maximized coverage of the outputs is required, then the histogram can be used as it will be the simplest tool to be used in such cases.

If any data point is going below its standard norms, then this can be visible by using histograms. Appropriate measures can be taken to correct the situation. One can have full control over the variation of the outputs, when the histograms are used in combination with the historical analysis.

Spotting Areas that Require Little Effort

For determining the place where efforts are being put or identifying a specific task which required a little more effort, could be done with the help of histogram. There is some process which do not require much attention, so the histogram while using the current **resource allocation**, can easily find out the task or the process.

Histograms keep a check on the resources if they are going in the right place. By doing so, the resources from the area which do not matter too much can be identified and further removed. It can be rerouted so as the part of the process that currently needs it. Ultimately, there will be a point of equilibrium which is achieved where the things will run optimally.

To Summarize Large Data Sets Graphically

Using histograms, the understanding become easy for the users and this can be done by summarizing it on a tally sheet and thus, organizing it into a histogram. Resource allocation is the process of assigning and managing assets in a manner that supports an organization>s strategic goals.

To Compare Process Results with Specification Limits

When the process specification limits are used in the histograms, then it can help in knowing easily if the current procedure is able to produce good results or not.

To Use a Tool to Assist in Decision Making

The use of histograms of all sizes, shapes or spread of data can help in assisting for inspecting the issues and making decisions. It should be made sure that the data should be of current time and it should be known from where the data have been collected.

Performing measurements cannot be further used for making decisions if they are made from the process which are different from the ones which are collected under the conditions which are known or not of current time.

General Synopsis

The most general purpose of using histogram is presenting a summary which easily understandable about certain data. Such data can be of any type. The data in the written form is transferred on a chart that has vertical blocks. The number of blocks present in the chart depends upon the number of categories of data that has been collected.

For example, if frequency is being measured for a week then the horizontal line will contain seven sections and the vertical line will indicate the number of times the event occurred.

Statistical Purpose

The histogram can be used to determine the statistical information, and this can be done by using data which are presented in the histogram. This includes, the mean value, the maximum value and the minimum value. The mean value referred to as the average of all the blocks. The maximum value refers the highest block and the minimum value refers to the lowest block.

The number of blocks means the number of items that is being measured for example, months in a year. The peak of each block contains a number on the vertical line, and it can determine the **frequency**.



Frequency is the number of occurrences of a repeating event per unit of time.

Figure 4.13: Different kinds of business data analysis graph.

Source: https://thumbs.dreamstime.com/z/businessdata-graph-analytics-vector-elements-bar-piecharts-diagrams-graphs-flat-icon-infographicsdesign-75002075.jpg

Business Intelligence

Histogram can also be effectively used in the field of business intelligence. When the business intelligence is collected from the search performance, then the averages are global.

The metrics, which should immediately come into the mind, are like cost-per-click, costper-acquisition and the average position.

Cost Per Acquisition

is a marketing metric that measures the aggregate cost to acquire one paying customer on a level

Histogram for Quality Improvement

For the purpose of quality improvement, histogram is proved to be very useful in any organization whether it is small-scale campaign or channel organization or a larger scale organization. The histograms can help you in visualizing data in a clear manner that can transfer complex ideas across the board. This can be used to make sure that everyone in the organization understands the implications of some specific actions and not just higher-ranking individuals having a lot of experience in the data analysis.

> Histograms are used in most of the common corporate presentation and in some other similar contexts and so it can be a good reason to adopt it in the organizations.

> A histogram helps in showing if the data is centered in a well-manner or not around a certain axis point. And in some cases, where this is important for the operations, it can show a lot about the way by which the company should run.

Combining Histograms with Other Analysis Tools

Histograms can be used in combination with some other tools for data analysis and further can be used for quality improvements as well. For application in some new environment, histograms are best to use because of the simplicity it has. It is not much hard to combine the data that is collected from certain sources with the representation mode of a histogram that will allow the user to obtain an interesting overview of some specific types of data.

A good type of histogram can also help by showing a lot information about some types of data which are normally difficult to visualize by using other methods. But using the histograms in an over extended manner can create much problems in the long run.

REVIEW QUESTIONS:

- 1. Define Histogram.
- 2. Name the person who first implemented histogram.
- 3. Name the Seven Basic Tools of Quality Control.
- 4. What are the parts of histogram?
- 5. Name the different types of distribution.
- 6. What is the shape of curve in normal distribution? Give a general graph showing normal distribution.
- 7. Draw a generalized graph for the type of skewed distribution.
- 8. What is the shape of the curve which represents bimodal distribution?
- 9. Why does a leader of any organization should use histogram?
- 10. Briefly provide two points regarding the application of histogram in business.

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CHAPTER **5**

VARIABILITY AND DATA IN BUSINESS

KEYWORDS

- Good Measures of Dispersion
- Standard Deviation
- Business Consideration
- Superficial
- Range Quick
- Coefficient of Variation'
- Skew
- Samples
- Induced Variability
- Sample Variability
- Natural Variability

LEARNING OBJECTIVES:

After reading this chapter, you would be able to:

- understand the concept of variation;
- know the concept of standard deviation;
- understand the definition of range;
- understand the types of variability in samples;
- learn about the reasons of standard deviation popularity;
- gain knowledge about the effects of adding or rescaling the data.

5.1. INTRODUCTION

The data points in a statistical distribution or data set deviate from the average value is the limit of variability and the degree to which these data points vary from each other. It is most generally implemented to inconsistency of investment returns in the financial context.

The variability of investment returns is as important to professional investors as learning the value of the returns itself. The deviation of data from its mean value is also defined as Variability. This concept is implemented in the fields of statistics and finance.

The variability is also defined as the difference being shown by data points inside a data set, as associated to each other or as related to the mean in the statistical studies. The use of the range, variance or standard deviation of a data set is used to expressed the variation. For instance, the field of finance uses these concepts as they are specifically applied to price data and the returns that changes in price imply.

The difference between the largest and smallest value allocated to the variable being assessed is called as range. The range is displayed by a single number in the statistical analysis. This range is most generally mentioning to the highest and lowest price value for a given day or period in terms of the **financial data**. The spread present between price points within that period is representative of standard deviation, and the square of the standard deviation founded on the list of data points in that same period is called as variance.

5.1.1. Variability in Investing

The returns obtained on an investment are regulated by variability and gives a point of comparison for additional assessment. The use of Sharpe ratio, measures the extra return or risk premium per unit of risk for an asset. In short, the Sharpe ratio gives a metric to relate the amount of compensation an investor receives with association to the total risk being assumed by holding said investment.

The amount of return experienced beyond investments that are thought to be free of risk is the basis of extra return. The asset with the greatest Sharpe ratio gives more return for the same amount of risk if other factors are in balance.

The yield or result of a system or process will go unavoidable change in it as all systems vary over time. The two main types of variations are (1) Common, which is embedded in a system, and (2) Special, which happens by changes in the circumstances or environment.

The range of variability at time of following measurements being recorded is displayed by the variable. The two major categories of data are quantitative data and qualitative data in statistics. This classification is based on the kind of characteristics that are measured.

These actions do not display the degree of dispersion or variability in a distribution. The knowledge of the pattern of the data can be easily learned with the support from the concept of dispersion or variability. Moreover, the greater extent of uniformity that is low degree of dispersion is in demand quality. If there exist in business the high degree of variability in the raw material, then it cannot find mass production cost-effective.

The appropriate equity share for investment is being sought by an investor. The investor should evade those shares that are highly fluctuating – sometimes having very high prices whereas monitoring the movement of share prices and at other times are going very low. There is greater risk in the investment in shares in the circumstances of such huge disturbance. The shares in which risk is not too much is preferred by the investor.

Financial data is information about a company that tells you about its financial health and performance. The different calculations of central value provide us one single figure that show the entire data. The set of observations cannot be properly described by the average alone, till all the observations are the same. The variability or dispersion of the observations is important to be defined. The central value might be the same in two or more distributions but, there can be wide differences in the formation of distribution. The methods of dispersion assist us in learning this important characteristic of a distribution. These are some important definitions of dispersion as given by various experts from time to time.

The A.L. Bowley has stated that the measure of the variation of the items is dispersion. According to Spiegel, the degree to which numerical data incline to spread about an average value is called the variation of dispersion of the data. The Brooks & Dick has stated that the diffusion or spread is the extent of the scatter or variation of the variable around a central value is defined as **dispersion**.

Dispersion is the phenomenon in which the phase velocity of a wave depends on its frequency. According to Simpson & Kajka, the measurement of the spread of the mass of figures in a series about an average is called measure of variation or diffusion. The diffusion that is also known as scatter, spread or variation calculates the degree to which the items vary from some central value as learned from these definitions.

The averages of the second order are another name given to dispersion as it provides the differences of various types from an average. In the context of dispersion, the average makes more sense. For example, if the average wage of the workers of factory A is Rs. 3885 and that of factory B is Rs. 3900, one cannot arrive at

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conclusion that the workers of factory B are in good condition as in factory B there may be much greater dispersion in the distribution of wages.

5.2. SIGNIFICANCE AND PROPER-TIES OF MEASURING VARIATION

The four-primary purpose are fulfilled by measures of variation:

- The extent of which the average is demonstrative of the mass is shown by the Measures of variation point. The average is a normal when dispersion is low value in the way that it closely signifies the individual value and it is dependable in the sense that it is a good approximation of the average in the corresponding universe. The dispersion is large in other situation, then the average is not so distinctive, and except the sample is very large, the average might be quite untrustworthy.
- The control of nature and reason of variation in a way to control the variation itself is the other purpose of measuring dispersion. For instance, the pulse beat and blood pressure are the main guides to analysis in context of health. The effective operation needs control of quality variation the reasons of which are pursued through inspection is primary to the control of causes of variation in the context of industrial production. The amount of variability is the measurement of

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disparity of the distribution of income or wealth in the context of social sciences.

The permit to do the comparison of two or more series with relation to their variability is given by measures of dispersion. The way of defining uniformity of consistency is also done by the study of variation. A high degree of variation would mean little uniformity or consistency, whereas a low degree of variation would mean great uniformity or consistency.

5.2.1. The Good Measure of Dispersion Should Have These Features

- It should be easy to understand.
- It should be easy to compute.
- It must be strictly defined.
- Every item of the distribution should be included in it.
- It should be agreeable to future algebraic treatment.
- The sampling stability must be in it.
- The risky items should not unnecessary affect it.

5.3. MEASURING SPREAD USING STANDARD DEVIATION

The statistical concept utilized to measure the quantity of variability or dispersion around an average is defined as standard deviation. The instability is measured by it is known
in context of technical words. The alteration between the actual and the average value is called as dispersion. The greater this dispersion or **variability** is, the higher is the standard deviation.

For example, if an investor invests in reputable company shares, he can generate an average year on year return of 25%. But its value goes up and down. In present times, the managers understand risk. They are not likely to invest in shares that go up and down as it entails a very heavy risk.

The range provides the simple measure of diffusion by giving the minimum and maximum values of data. There is another method called standard deviation or an equal measure called variance to calculate dispersion. The standard deviation basically characterized as:

- The dispersion is measured by it that is the variation of individual data points from the mean.
- The differences are squared that is positives and negatives all become positive.
- The average of these squared differences is taken away.

5.3.1. Reasons of Standard Deviation Popularity

There are separate advantages of standard deviation over any other measure of dispersion.

• It calculates the deviation from the mean, that is a very important figure that displays the central tendency.

Variability is the extent to which data points in a statistical distribution or data set diverge from the average value as well as the extent to which these data points differ from each other.

- The negative numbers become positive by squaring it.
- It shows the contraction effect, that is the square of small numbers is smaller and large numbers larger, which is the expanding effect.
- The square is a good function.

5.4. THE STANDARD DEVIATION AND ITS INTERPRETATION

5.4.1. Business Consideration

The promise of full return is an illusion and it is not the reality in the share markets. The full story is not explained to the investors. The diffusion is not told to the investors they only know the central value of it. It is only explained that one can gain 25% return, but it does not explain that the return can be 10% to 60%, so that the average can be 25%, and investor may have to sell it 10%. In this situation, the **diversification** of risk is the answer.

Diversification is

a risk management strategy that mixes a wide variety of investments within a portfolio.

The estimation of the data values generally is given by standard deviation. It is the primary method for summarizing the amount of unpredictability in a situation and it is provided by the standard deviation. It calculates the extent of unpredictability of individuals about their average.

For example, if all numbers are the same, like the simple data set 5.5, 5.5, 5.5, 5.5 the average will be X = 5.5 and the standard deviation will be S = 0, showing the fact that this trivial data set shows no unpredictability of any type.

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Generally, the data sets show some variability. Each data value will be some distance away from the average, and the standard deviation will review the limit of this variability.

Think about this other simple data set, but with some difference: 43.0, 17.7, 8.7, and -47.4. These numbers show the rates of return for example, 43.0% for four stocks Maytag, Boston Scientific, Catalytic, and Mitcham Industries picked at random by throwing darts at a newspaper page of stock listings. The average value again is X = 5.5, showing that these stocks had a 5.5% average rate of return though a portfolio with equivalent amounts of money invested in each stock would have had this 5.5% average performance.

The data values are significantly different from one another though the average is the same as usual. The first data value, 43.0, is at a distance X1 -X = 43:0 - 5:5 = 37:5 from average, displaying that Maytag's rate of return was 37.5 percentage points above average. The last data value, -47.4, is at a distance X4 - X = -47:4-5:5 = -52:9 from average, showing that Mitcham Industries frequency of return was 52.9 percentage points less than average that is less because it is negative.

The deviations are summarized by standard deviation. Though it is not possible to average them as some are negative and some are positive, and the result is always the zero. Instead, the standard method will first square each number that is, multiply it by itself to delete the minus sign, sum, divide by n - 1, and at last take the square root as it undoes the squaring that has been done previously.

5.4.2. Difference between the Standard Deviation and the Variance

The variance is the square of the standard deviation computed. The variability measure in statistics is shown by variance at many instances, particularly by them that regularly use the formulas, but the standard deviation is generally a good selection.

There is no extra information that is comprised in variance and it is tougher to interpret than the standard deviation in practice. For example, the **expenditure** in dollars contained in a data set, the variance will be in units of squared dollars, a method that is difficult to associate; though, the standard deviation will be a number measured in good old familiar dollars.

Expenditure is funds used by a business, organization, or corporation to attain new assets, improve existing ones, or reduce a liability.

5.4.3. Interpreting the Standard Deviation

The standard deviation is an easy and has direct interpretation. It summarizes the normal distance from average for the separate data values. The measure of the variability of these individuals is its result. The standard deviation signifies the distinctive deviation size, it is expected that some individuals are closer to the average than this standard, whereas others will be beyond away.

Some data values can be less than one standard deviation from the average, whereas others will be more than one standard deviation away from the average.

5.5. THE RANGE: QUICK AND SU-PERFICIAL

The range is defined as the largest data minus the smallest data value and it signifies the size or degree of the data.

For example, the range of a small data set signifying the number of orders taken lately for each of five product lines.

The range of data set (85, 246, 92, 508, 153)

- = Largest Smallest
- = 508 92
- = 416

The range is quickly computed by scanning a list of numbers to select the smallest and largest and then subtracting it. Back in the old days, before the advent of electronic calculators and computers, the simplicity of computation led many people to use the range as a measure of changeability. The range is not in practice as often now, and there is an easier calculation for standard deviation.

The range is an important measure of variation when the extremes of the data—the largest and smallest values, are significant.

It can fulfill the two purposes:

- The complete level of the data can be defined by it.
- To search for errors in the data.

Suppose that during the recording of the data, there happened a huge error, it will incline to turn up as a large or small value, the range will immediately seem too large, judging by common sense. It makes the range useful for editing the data, that is, for error checking.

5.6. THE COEFFICIENT OF VARIA-TION A RELATIVE VARIABILITY MEASURE

The standard deviation divided by the average, is a comparative measure of difference as a percentage or proportion of the average is defined as the coefficient of variation. There are no negative numbers probable in the data set normally.

For example, if the approximate spend by a customer per trip to the supermarket is 35.26 dollars and the standard deviation is 14.08 dollars, then the coefficient of variation is 14.08/35.26 = 0.399, or 39.9%. It shows that generally the amount spent per shopping trip differs by about 39.9% from the average value. The general difference is 14.08 dollars in the standard deviation, but it amounts to 39.9% that is the coefficient of variation comparative to the average.

The coefficient of variation has no measurement units. It is defined as the pure number, a part or percentage, whose measurement units have canceled each other in the procedure of dividing standard deviation by average. It creates the **coefficient of variation** useful in that situations where one does not care about the real or absolute size of the differences, and only the relative size is important.

Coefficient of variation is a statistical measure of the dispersion of data points in a data series around the mean.

5.6.1. Effects of Adding To/Or Rescaling the Data

There is no requirement to recalculate the summaries like the representative value, that

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is the mean, median, mode, and percentiles, or variability measures, that is the standard deviation, range, coefficient of variation if the circumstances are changed in an orderly way.

There are some rules that show how quickly one can find the summaries for a new situation. If a fixed number is added to each data value, then this same number is added to the average, median, mode, and percentiles to attain the conforming summaries for the new data set. For example, adding a new admission fee of 5 dollars to accounts previously worth 38, 93, 25, and 89 says that the accounts are now worth \$43, \$98, \$30, and \$94.

The average value per account has jumped dollars precisely 5 dollars, from 61.25 dollar to 66.25 dollars. In place of recalculation of the average for the new account values, one can simply add 5 dollars to the old average. This rule applies to other measures; for example, the median rises by \$5, from \$63.50 to \$68.50. Though the standard deviation and range are unaltered, from the time data values are moved but maintain the same distance from each other. The coefficient of variation does change, and may be easily calculated from the standard deviation and the new average.

5.6.2. Skew

The values of a variable that are very different from most of the values and it is measured by the concept of skew. For example, income is skewed because most people make between 0 dollar and 200,000, but millions are the income of only selected individuals. The variable is positively skewed if the extreme values are higher than the majority of values. The extreme values are less than most values then the variable is negatively skewed.

5.7. TYPES OF VARIABILITY IN SAMPLES

The sample is generally used in an attempt to study a population, also for ease or because it is not possible to access the total population. The differences that might happen in these consequences is used to defined the Variability. The variability of general form contains the following:

- Observational or measurement variability
- Natural variability
- Induced variability
- Sample variability

5.7.1. Measurement Variability

There are differences in the instruments or in the people using those instruments that were utilized to quantify the measure of variability. For example, if an individual is collecting data on how long it takes for a ball to drop from a height by having students calculating the time of the drop with a stopwatch, one can feel measurement variability if the two stopwatches utilized were made by different companies.

Suppose, one stopwatch calculates the nearest second, while the other one calculates the nearest tenth of a second. The measurement variability can happen because two different people are collecting the data. The result will differ as the reaction times in pressing the button on the stopwatch might be different. The differences in result might be impacted by measure of variability.

5.7.2. Natural Variability

The alterations that naturally happens because members of a population differ from each other happens from natural variability.

For example, if we have two similar corn plants and expose both plants to the same amount of water and sunlight, it might still grow at different speed simply because they are two different corn plants. The natural variability can explain the result.

5.7.3. Induced Variability

The induced variability is the complement to natural variability. It happens because individuals have artificially penetrated an element of variation that was not present in natural manner.

For example, to study memory, the different people can be allocated to different groups, and then inducing a variable in one group by preventing the amount of sleep they get. The variation in result might be affected by induced variability.

5.7.4. Sample Variability

The situation when multiple random samples are taken from the same population is called sample variability.

For instance, if the four surveys of 50 people that were randomly selected from a given population are conducted, the differences in result might be affected by **sample variability**.

Sampling variability refers to the fact that the statistical information from

information from a sample (called a statistic) will vary as the random sampling is repeated.

REVIEW QUESTIONS

- 1. What is variability in context of business statistics?
- 2. Explain the significance and properties of measuring variation.
- 3. Explain the feature of effective measure of dispersion.
- 4. Explain the concept of measuring spread using standard deviation.
- 5. Define the range and describe its characteristics.
- 6. Explain the coefficient of variation.
- 7. What are the effects of adding to /or rescaling the data?
- 8. What are different types of variability in samples?
- 9. Discuss how to interpret the Standard Deviation.
- 10. What are the reasons behind the popularity of Standard Deviation?

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CHAPTER

6

PROBABILITY: THE OCCURRENCES IN BUSINESSES

KEYWORDS

- Probability
- Probabilistic model
- Conditional probability
- Discrete variables
- Distinct values
- Associative identity
- Bayes' Theorem
- Randomness
- Simulations
- Multiplication

LEARNING OBJECTIVES:

In this chapter, you will learn about:

- sample spaces and events in a probability function;
- conditional probability and multiplication rule associated with it;
- importance of Bayes' Theorem;
- discrete random variables and their calculations;
- simulations based on probabilistic models and their importance.

6.1. INTRODUCTION TO PROBABILITY

A question always arises in many debates based on philosophy, that questions the occurrence of various events in the universe based on randomness. In the current world, many professionals make use of the probabilistic and statistical tools in professions such as scientific research, manufacturing, engineering and modelling of business development.

The use of probability and statistics to reach on conclusions regarding some events has been there since the previous century and are currently under the processes of refining and further development. It is important to know about the basic of probability and statistics, so that the people know the way in which randomness works.

One area in which probability and statistics plays an important role is in iris recognition in the **biometric system**. Biometry is a field of science that aims at identifying an individual, depending on their biological features which may include their fingerprints, or voice.

The researches that have taken place lately, indicate that the recognition system based on iris scanning can have the uppermost hand among all the human identification systems developed until now. This technology of recognizing the iris is based on the qualities of iris that are evidently visible.

The system installed for this purpose, converts the qualities into an 'iris code' that comprises of 2048 bits, by using a video camera. The conversion is carried out in a manner so that the code does not change with variations in the size of the iris or that of the pupil.

Despite this, it is not important for the iris code of a person to be identical at various points of time or place. Hence, it becomes necessary to spare some number of bits to cater to the mismatching in the identification process of a person and surprisingly, the mismatch allowed in the iris recognition system is up to 34%.

So, there may be questions regarding the authenticity of such a system. But the answer lies in the fact that no two people have same kind of iris. In fact, there are numerous iris codes that take the value of either 1 or 0, in the whole code, amounting to about half of the total data present.

However, just one bit in the whole code does not decide on the whole sequence, that comprises of the other 2047 bits and it is important for the whole sequence of the bits to be different, so that two persons can be distinguished. If it is put in simple words, the single bits cannot do much technological system on their own to establish differences, unless they are correlated to each other. This is where probability comes into use.

6.1.1. Sample Spaces

The sets in which those elements, that decide the results of the experiments that are to be conducted and are to be focused on, are known as sample spaces. Consider the most fundamental Probability is a event, which is the toss of a coin.

It is known that the coin must land on at events will occur. least one of the faces, and not on the edge. It leaves only two possibilities: heads and tails. Hence, the sample space that must be taken for this experiment is

 $\Omega = \{H, T\}.$

Considering one more situation in which a person may be asked randomly about the month in which their birthday may fall. The sample space in such a situation will be given by:

 $\Omega = \{$ January, February, March, April, May, June, July, August, September, October, November, December}.

There may be a situation in which one may be asked to tell a point of load in the scaled model of a bridge, at which the structure of the bridge will collapse. Even though, in real example, a person can calculate the load only up to five decimal places, in proper calculation, the

Biometric system is a that uses information about a person (or other biological organism) to identify that person.

measure quantifying the likelihood that

load can be expressed in terms of any positive number and the sample space for this can be given by:

 $\Omega = (0, \infty).$

In such a case, even though the load may not go beyond a certain upper limit in real life, restricting the outcome to a certain value is never an advisable step to take and neither a beneficial one.

6.1.2. Events

The subsets in sample space are referred to as events. The occurrence of an event A takes place only in case when the result of the activity, can be found among the elements in the set A. For instance, in the activity where the month of the birthday was asked, a reference can be made to the months that are longer than others.

This means that the months being referred to over here are the ones that have 31 days in them. This may be called event L which can be given by:

 $L = {January, March, May, July, August, October, December}.$

The events may be joined together as per the operations of the set that regularly take place. For instance, the months that contain the letter 'r' in their spelling, are represented by an event, say R. Then,

 $R = {$ January, February, March, April, September, October, November, December $}.$

In this case, the months that are long as well as contain the letter 'r' in their full name, are given by: $L \cap R = {$ January, March, October, December $}.$

The set that is given by $L \cap R$, is known as the intersection of the events L and R and takes place only in the case when both L and R occur together.

In the same manner, there is another operation in which the union of two sets A and B occurs, which is represented by $A \cup B$. This can take place in the case where at least one of the events is occurring.

There is one more operation that can be done in these events, which is known by 'taking compliment.' The compliment of an event refers to the condition which occurs only if the event does not take place. For instance, the compliment of an event A is given by:

Ac = { $\omega \in \Omega$: $\omega / \in A$ }.

In the case of taking compliment of Ω , the value that is reached is denoted by \emptyset and that represents an **empty set**, indicating the occurrence of an impossible event.

6.2. PROBABILITY

It is the basic need of the people to know the extent to which it is likely that an event may occur. To find the likeability, a probability must be assigned to every event. The allocation of probabilities for the events that may take place is always a challenging task.

To assign a probability to an event, the probability function is used. This probability function demonstrates two fundamental properties. **Empty set** is the unique set having no elements; its size or cardinality (count of elements in a set) is zero. The first property states that the result of an activity always lies among the elements of the sample space. The second property involves the additive property that a probability function may demonstrate. This property is implied when the probability function must show the additivity in sets more than two in number.

For instance, in case of three events that are not connected to each other, A, B and C, if A is in union with B, then C will remain unconnected to $A \cup B$. This can be given as:

 $P(A \cup B \cup C) = P(A \cup B) + P(C) = P(A) + P(B) + P(C).$

6.2.1. Conditional Probability

Consider the example of the birth month again. Let it be assumed that the person is born in the 'long month' and it may also be assumed that the month he is born in is the one 'with the letter r.' This assumption leaves out five of the total elements from the sample space as the month cannot be February, April, June, September, and November.



Figure 6.1: A probability tree diagram explaining the various scenarios in probability.

Source: https://upload.wikimedia.org/wikipedia/ commons/thumb/9/9c/Probability_tree_diagram. svg/1024px-Probability_tree_diagram.svg.png Now only seven out of the original twelve elements remain. Only four of these elements fall under the set $R \cap L$, which is given by:

 $R \cap L = {$ January, March, October, December $}.$

Only these four elements satisfy the conditions, which makes it important to reevaluate the probability as 4/7. This probability, in the mathematical terminology, is known as probability of R given L, and can be expressed as

P(R|L) = 4/7.

But this cannot be taken in the same manner as P (R \cap L), which is calculated as 1/3. It may also be stated that P (R |L) is same as the P (R \cap L) proportion of P(L).

6.2.2. The Multiplication Rule

If the left and right parts of the expression for **conditional probability** are multiplied by P(C), it will reach a useful conclusion.

For the events A and C, the multiplication can be given by:

 $P(A \cap C) = P(A \mid C) \cdot P(C).$

So, when the probability of $A \cap C$ is to be evaluated, it can be done by breaking it into two parts. In the first one P(C) can be calculated and in the second part P (A | C) can be calculated. This method is generally much easier to adopt in comparison to calculating P (A \cap C) directly.

Conditional probability is

a measure of the probability of an event occurring given that another event has (by assumption, presumption, assertion or evidence) occurred.

6.3. BAYES' THEOREM

The Bayes' theorem is applied to calculate the probability of an activity by referring to the information given regarding the conditions which have a connection to the activity. This means that if the conditional probability P(A/B) is known, then the Bayes' rule can be applied to calculate the reverse probability P(B/A).

This can be done in the following manner:

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

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

$$P(A \cap B) = P\left(\frac{A}{B}\right) * P(B) = P\left(\frac{B}{A}\right) * P(A)$$

$$P\left(\frac{B}{A}\right) = P\left(\frac{A}{B}\right) * \frac{P(B)}{P(A)}$$

The statements that is reached in the above deduction, is the way in which Bayes' rule is normally represented.

This formula can be further generalized. The generalization states that if the events that occur multiple times is given by A and it forms an exhaustive set with another event B, it can be given by:

$$P(A_i/B) = \frac{P(B|Ai)*P(Ai)}{\sum (i=1 \text{ to } n) P(B|Ai)*P(Ai)}$$

6.3.1. Example of Bayes Theorem and Probability Trees

Consider an example that talks about the patients that are suffering from breast cancer. Suppose that the patients are tested three times each, prior to a confirmation of cancer in them by the oncologist. Assume that the normal belief in public is that there are approximately 1.48 people out of 1000 that are currently suffering from breast cancer in the United States, at a time this test is conducted.

Suppose that the patients are tested multiple times and through different means. A person had to undergo three tests for breast cancer and the cancer could be said to be found in them only if all three of them tested positively.

The sensitivity of the test which is approximately 93% is known as the true positive rate, while the specificity of the test, which is approximately 99% is referred to as the true negative rate.

If the patient is tested positive in the first test, the probability of the patient having cancer is given by P (has cancer | first test +).

P(cancer) = 0.00148.

Sensitivity can be denoted as P (+ | cancer) = 0.93 and specificity can be denoted as P (- | no cancer).

As there is no other information available on this activity, it can be believed that the patient can be sampled individually in a random manner. This result in the development of the belief that there are 0.148% of patients that have the probability of suffering from cancer. Conclusively, taking a compliment of this, it can be stated that the probability of a patient not suffering from cancer is 100 - 0.148%. All these results can be illustrated by drawing a tree to show the probabilities.



Figure 6.2: The probability tree for the problem on cancer patients.

Moving on, the probability of a patient suffering from cancer must be calculated. It is given that the patient testes positive on the first attempt. This probability is given by P (cancer|+).

$$P(cancer|+) = \frac{P(cancer and +)}{P(+)}$$

P (cancer and +) = P (cancer) * P (+) = 0.00148 * 0.93

P (no cancer and +) = P (no cancer) * P (+) = 0.99852 * 0.01

If the actual probability of the person testing positive is to be calculated then both the cases must be considered, that is, the patient may be suffering from cancer and hence, test positive, or the patient may not be suffering from cancer, but still test positive.

$$P(CANCER|+) = \frac{P(cancer and+)}{P(cancer and+) + P(no cancer and+)} = 0.12$$

This implies that the probability of the person testing positive for cancer in the first test, is about 12%. This probability is called **posterior probability**.

6.3.1.1. Independence

The independence between two events implies that the information of one of the events does not affect the probability of the occurrence of the other event. Putting it in simple terms, the events that do not influence each other's occurrence are known to be independent of each other.

For example, the independence is useful in the experiments conducted on a regular scale. This independence can be damaged in a manner that the equipment of the experiment is not cleaned or is not recalibrated after one experiment is done.

This independence can also be absent from an experiment in case that the observers, who are supposed to be independent of each other, are not separated from each other or taken away from a common point that can impact their observations.

This is evident in the way when the people can hear about a 'fact' in different ways from different people. Getting to know about a fact from different sources, is considered to have **credibility** in it, until it is known that the sources have gotten the fact from a common source themselves.

This indicated that the final sources were not independent. If all these statements and conclusions are expressed in terms of statement, it would be:

Posterior probabil-

ity is the probability an event will happen after all evidence or background information has been taken into account.

Credibil-

ity comprises the objective and subjective components of the believability of a source or message. A is independent of B if P(A|B) = P(A).

This implies that the any kind of information on the occurrence of B will not alter the probability in which A would occur. If this is talked about in terms of the events as subsets, if an outcome is known to come in B, then it will not impact the probability which would be assigned for A.

In the case where A and B are independent, as explained above, the multiplication rule can be expressed as:

 $P(A \cap B) = P(A|B) \cdot P(B) = P(A) \cdot P(B).$

This can be given as the definition for independence.

6.4. DISCRETE RANDOM VARIA-BLES

6.4.1. Definition of Discrete Random Variable

The discretion of a variable randomly taken, say X, can be stated only in case where the variable can represent a finite number of distinct values or the number of distinct values is a countable **infinite number**. A discrete random variable can assume a value from a sample space that can or cannot be counted.

6.4.2. Probability for a Discrete Random Variable

The probability assigned to the activity of X assuming the value x, which is given by P

Infinite number is a number so big, that it is impossible to physically write it. (X=x), can be given as all the probabilities added together, that fall among the sample elements of Ω , which have been allocated the value x. In this way, this is generally referred to as the probability function for X.

6.4.3. Probability Distribution for a Discrete Random Variable

For a discrete random variable X, the probability distribution can be stated by any method of representation such as a formula, a graph or a table. The distribution must represent that P(x) = P(X=x), which must be true for all the values of x.



Figure 6.3: An illustration of the probability distribution of discrete variables.

Source: https://upload.wikimedia.org/wikipedia/ commons/8/82/Discrete_probability_distribution_ illustration.png The allocation of the non-zero probabilities for a discrete random variable in a probability distribution can be done for a number of distinct values of x, that are countable in nature. If a value of x is not allocated a positive probability, it must be understood that,

P(X=x) = 0.

The function given by f(x) p(x) = P(X=x), can be true for all the value of x that fall in the range of X, is known as the probability distribution of X. This function is generally known as the **probability mass function** that stands true for a discrete random variable X.

6.4.4. Probability Density Function

Probability Density Function that is commonly known as PDF, is calculated for a continuous random variable, indicates the probability of an outcome that may be taking place within a range. A single outcome or result may have zero probability of taking place, which was not the way in case of discrete random variables.

With probability density function, there is a probability that an event may occur from the values in the given continuous set of values. The magnitude of the number then defines the probability of having a continuous random variable, near a specific point.

In simple words, a distribution that can provide a continuous random variable, can be called the probability density function. This is similar to a normal distribution that corresponds to the PDF of a normally distributed continuous random variable.

Probability mass function is a function that gives the probability that a discrete random variable is exactly equal to some value.

6.5. SIMULATION

At time, the complications in the probabilistic models grow to such extents that the tools, generally used in mathematics, prove insufficient for the calculations to be conducted and the answers to be found. For these situations, **stochastic simulation** can be used as an alternative approach.

In this kind of simulation, the values may be produced that satisfy the random variables and be used in the model, which can reflect the result of the whole system.

6.5.1. The Meaning of Simulation

Various professional fields such as that of technology, business, science, and government, make use of some models, so as to get a better understanding of the actual reality and the part that is focused on, is called 'interest.'

At times, the models are in the form of physical representation of the actual object. For instance, a scaled model of a chemical plant or one of airplane that is to be tested in a wind tunnel. There are also models that are not in physical forms and are abstract.

Stochastic simula-

tion is a simulation that traces the evolution of variables that can change stochastically (randomly) with certain probabilities.



Figure 6.4: A plane in a wind tunnel ready for simulation at NACA, California.

Source: https://media.defense.gov/2011/ Jul/01/2000241499/-1/-1/0/441014-O-0000U-985. JPG

These may be among the macroeconomic models that comprise of some equations that reveal the results of interest rates, inflation, unemployment or some partial differential equations that describe the patterns in weather found across the globe.

In simulation, the models are used to develop some exclusive situations that represent some real-time situations, which are used to observe the response in the system and then the results are analyzed to know about the real-time effect of such situations.

This method of simulations helps to conduct the experiments that are very expensive to be conducted in real world, or they may be dangerous to conduct, or may simply be impossible to be done at a huge scale. Some sample questions that the simulations can easily answer are:

• What would happen to the average temperature of the earth if the

greenhouse gas emissions are reduced significantly by 30%?

- What will happen to a plane if two of the four engines stop midway in the air?
- How will the wealth distribution reflect in the public, if the tax rates are slashed by 50%?

In simulations, generally the situations that are experimented or tested are the ones in which the conditions are very random and uncertain, which requires them to be modeled exclusively. These models are probabilistic in nature, as they comprise of a lot of random variables.

6.5.2. Stochastic Simulation

In the stochastic simulation, the values are calculated for all the random variables that are there in the model, as per the distributions that have been laid out and recording all the situations and analyzing them to observe what happens.

The generated values are known as the realizations of the random variables. The reason as to why the stochastic simulation must be learnt is that the only alternative to the complicated and unsolvable problems is simulation, and that it is through simulation that the random variables can be allocated some value.

6.5.3. Modelling the System

Amodel meant for stochastic simulation is already in order. This implies that some information about the system is already known. Like the number of people arriving at a place in a day or the water consumption of people on average. However, the time of arrival corresponding to an individual cannot be predicted.

Here, some random variables are used to describe them. For instance, one can assign T1 to the time that has elapsed between the starting time and the arrival of the first person, T2 to the time elapsed between the arrival of the first and the arrival of the second customer and so on. One may assign S_i to the total time used by a person 'i' to utilize the pump to get water. This time, in a proper terminology can be referred to as the service time.

6.5.4. Computation with Random Variables

There are quite a lot of ways in which new variable can be made from the old ones. However, this is not the sole objective of computation, as the new variables are automatically created while solving a problem. The variances and the expectations corresponding to the new variables may be evaluated by using the formula that involves change-of -variable.

The calculations corresponding to the discrete random variables can be carried out in the same way as has been stated earlier in the chapter.

REVIEW QUESTIONS

- 1. How can you define probability?
- 2. Explain 'sample spaces' with respect to probability.
- 3. What is meant by 'events' in probability?
- 4. What is the expression for the associative rule in probability?
- 5. Give the expression for conditional probability.
- 6. Define the role of multiplication in probability.
- 7. What are the discrete random variables?
- 8. How does one use discrete random variables?
- 9. What is meant by simulation?
- 10. What are the various ways in which simulation can solve some impossible tasks?

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CHAPTER

7

UNCERTAIN NUMBERS IN THE BUSINESS: RAN-DOM VARIABLES

KEYWORDS

- Quantification
- Regression
- Variability
- Random Variables
- Company Valuation
- Uncertain Numbers
- Prediction
- Central limit
 proposition
- Normal distribution
- Probability

LEARNING OBJECTIVES:

After reading this chapter, you would be able to:

- explain uncertain numbers in the business;
- identify the usages of random variables in business;
- explain uncertain numbers in relation to data science;
- identify the types of random variables;
- explain the discrete random variables;
- define continuous variables;
- explain the discount rate in company valuation with random variables;
- explain how random variables could help in business models;
- differentiate business models with random variables.
- Usage of random variables in predicting future course of the business.

7.1. INTRODUCTION

Regression quantification is a statistical apparatus being used for the detection of links between variables. Usually, the detector ascertain the causal effect of one variable over the another—the effect of a price hike over demand, for instance, or the effect of changes in the money stream upon the inflation rate.

Regression quantification is used to figure out the strength and the course of the relationship between two linearly in relation to variables, X and Y. X is the "independent" variable and Y is the "dependent" variable.

The two basic kinds of regression quantification are:

- **Simple regression analysis**: It is used to figure out the relationship between a dependent variable and a single independent variable. For instance, the link between crop yields and rainfall.
- **Multiple regression analysis**: It is used to figure out the relationship between a dependent variable and two or more independent variables; for instance, the link between the income of employees and their experience as well as their education.



Figure 7.1: Business are effectively using regression analysis in their projects.

Source: https://cdn.pixabay.com/photo/2018/05/01/11/39/busi-ness-3365360_960_720.jpg

More than one regression analysis introduces numerous extended complexities but many give more realistic results than simple regression analysis.

Regression analysis is solely based on numerous strong expectations about the variables that are being assessed. Several key examinations are being used to make sure that the end results are valid, including hypothesis tests. These tests are being used to make sure that the regression output is not simply due to random chance but indicate an actual relationship between two or more variables.

An estimated regression equivalence may be used for a great variety of business applications, which includes:

- Computing the effect on a corporation's benefit of an increase in profits.
- Figuring out how sensitive a corporation's sales are to variations in marketing expenditures.
- Observing how a **stock** value is being affected by variation in interest values.

Regression analysis may also be used for prediction purposes. For instance, a regression comparison may be used to predict the future request for a company's products.

Due to the dangerous complexity of regression analysis, it is often applied through the usage of specialized calculators or spreadsheet applications.

A random variable is a variable whose value is not known or a function that projects values

Stock is a general term used to describe the ownership certificates of any company.

to each of an experiment's outcomes. Random variables are often denoted by letters and can be classified as: (1) discrete, which are variables that have exact values, and (2) continuous, which are variables that can have any values within a continuous range or set.

Random variables are usually used in econometric or regression analysis to figure out statistical relations among one another.

A random variable has a cost that is uncertain and figured out by chance events. A discrete random variable will take on values that are independent and distinct. Listed below are examples of discrete random variable:

- the number of airplanes owned by an airline business.
- the number of people awaiting in line at a grocery store checkout.
- the number of cars readily available for rent by a rental agency.
- the number of patents developed by a research and development section.

Suppose, someone select one card from a standard deck of cards. The value of the card a person will select is uncertain and could be figured out by chance. In the same way, the value of the card before being chosen is a random variable.

The predictive values this random variable can attain are the values of each card present in the deck: two, three, four, and so on. Because these values are distinct, indivisible values, the random variable is discrete.

After a person have selected a card, its value is no longer non-certain and therefore, is not
random. For instance, if the person draws a five card, five is the value that the discrete **random variable** has attained. However, five is not a random variable on its own.\

Business related decisions are often solely based on imprecise, uncertain, or vague data. Likewise, the penalties of an action are sometimes equally unpredictable, thus tapping the decision maker into a twofold jeopardy. Pretentious that the effects of an activity can be demonstrated by a random variable, then the decision problem spirals down to associating different effects (random variables) by associating their distribution functions.

Though the full space of probability distributions cannot be well-organized, a properly limited subset of distributions can be totally ordered in an almost meaningful way. Researchers call these as "loss-distributions," since they deliver a substitute for the idea of loss-functions in decision theory. This chapter introduces the theory behind the needed restrictions and the constructible total ordering on random loss variables, which makes the decisions under uncertainty of significances.

Using data developed from simulations, researchers demonstrate the practical applicability of different approaches explained in different sections explained in this chapter.

7.2. DECISIONS WITH UNCERTAIN NUMBERS

In many practical circumstances, decision making is a matter of critical situations and important options being based on vague, fuzzy,

Random variable is a numerical description of the outcome of a statistical experiment.

and most importantly are empirical data. While reasoning under non-certainty in the sense of making choice with known consequences under uncertain preconditions is a well-researched sector taking choices with uncertain penalties has attained substantially less focus.

This section projects a decision system to take the best option from a set of choices, whose values or benefit for the decision maker are readily present only in terms of a random variable. More formally, researchers describe a method to look for the best among two possible random variables, R1, and R2 by creating a novel stochastic order on a suitably limited subset of probability distributions.

Our collation will be total, so that the partiality between two activities with random values R1, and R2, is always well explained and a choice can be made. There exist several programs where such a system of decision making on abstract spaces of random variables is required.

To project method, let us use a couple of example data sets coming from the risk management context. In risk management, decisions typically have uncertain values that cannot be quantified by a conventional von Neumann-Morgenstern **utility function**. For instance, a security incident in a large company can either be made public, or kept secret.

Utility function

is an important concept that measures preferences over a set of goods and services.



Figure 7.2: Values of risk management cannot be quantified by conventional von Neumann-Morgenstern utility function.

Source: https://cdn.pixabay.com/photo/2018/02/20/10/28/business-3167295_960_720. jpg

The doubt in this case is either lead on from the public community's answer; if the event is to be made public or the residual danger of information leakage (such as, by whistleblowing). The question that arises here is: Which is the better option, given that the outcomes can be explained by random variables?

For such an environment, suitable approaches to figure out the consequence distributions using simulations are readily present, but those approaches do not provision the decision-making process directly.

Characteristically, risk management is worried with extreme events, since small distortions may be covered by the natural pliability of the analyzed framework (for instance, by an organization's infrastructure or the enterprise itself). For this aim, decisions normally be contingent on the distribution's tails. Certainly, heavy- and fat-tailed deliveries are common options to model rare but plain incidents in over-all risk management.

We usually build our structure with this obligation of **risk management** in mind, but started from the recognized need that the moments of a distribution play for decision making, researchers illustrate a simple use of the first moment in this regard that is common in information technology risk management, to inspire the requirement to comprise more data in a decision.

Risk

management

is the process of identifying, assessing and controlling threats to an organization's capital and earnings. Interestingly, the ordering that researchers define here is solely dependent on the full moment sequence, but figures out similar circumstances as other stochastic orders, only with an explicit attention on the probability mass situated in the distribution's tails. In addition, researchers pick some example data sets from risk management programs, and projects how a decision can be made based on empirical information.

The main contribution of this work is twofold: First, while any stochastic order could be used for decision making on actions with random variables explaining their outcome, not all of them are equally suitable in a risk management context. The ordering researchers present in this chapter are specifically designed to fit into this sector.

Second, the method of constructing the ordering is new and maybe of independent scientific attention having applications beyond numerous contexts. In the theoretical sections, this work is a condensed version (provided as supporting information S1 file), while it extends this preliminary research by practical examples and concrete algorithms to efficiently choose best actions despite random consequences and with a sound practical meaning.

7.3. BASICS OF UNCERTAIN NUM-BERS FOR DATA SCIENCE IN BUSINESS

For anyone being introduced to data science, uncertain numbers are a must know concept. Concepts of uncertain numbers theory are the backbone of many important concepts in data science in relation to business, from **inferential statistics** to Bayesian networks. It would not be wrong to state that the journey of mastering statistics begins with probability.

In this section, the basics of this theory are being introduced. Then this section introduces binomial distribution, central limit proposition, normal distribution and Z-score. This section will explain each concept with an illustrative example.

Researchers have explained each concept in a simplistic manner to make sure scholars do not feel overload of mathematical concepts.

Simply put, probability is an intuitive area. We use it almost on a daily basis without necessarily realizing that we are speaking and applying probability for the execution of our daily work.

Inferential

statistics use a random sample of data taken from a population to describe and make inferences about the population.



Figure 7.3: Normal Distribution. It is the most frequently used kind of distribution in application of statistics.

Source: https://upload.wikimedia.org/wikipedia/ commons/9/9e/Normal_Distribution_NIST.gif

Daily life is full of uncertainties. We do not know the outcomes of a particular situation until it occurs. Will it rain today? Will I pass the next math test? Will my favorite team win the toss? Will I get a promotion in next 6 months? All these questions are examples of uncertain situations we live in. Let us map them to few common methods, which will help in going forward.

Experiment – These are noncertain situations, which could have more than one consequence. Whether it rains on a daily basis is an example of experiment.

Outcome – It is the result of a single trial. So, if it rains today, the outcome of today's trial from the experiment is "It rained."

Event – It refers to one or more outcome from a scenario. "It rained" is one of the possible events for this experiment.

Probability – It is a measure of how likely an event will occur. So, if there is a 60% chance that it will rain tomorrow, the probability of the outcome "it rained" for tomorrow is 0.6.

7.4. RANDOM VARIABLES

Random variables calculate the probability of occurrence of an event. To understand this, we need to put a system to express the outcome in numbers. We can do this by framing the outcome of an experiment to numbers.

Let us define X to be the outcome of a coin toss.

X = outcome of a coin toss

Possible Outcomes:

1 if heads

0 if tails

Let us take another case.

Suppose, someone win the game if the person gets a sum of 8 while rolling two fair dice. We define the random variable Y to be the sum of the upward face of two fair dice.

Y can attain values = (2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12)

There are few things to observe about random variables:

Each value of the random variable may or may not be compared likely. There is only 1 possible combination of dice, with sum $2\{(1,1)\}$, while a sum of 5 can be attained by $\{(1,4), (2,3), (3,2), (4,1)\}$. So, 5 is more likely to be obtain as compared to 2. On the other hand, the like hood of a head or a tail in a coin toss is equal and obviously, the probability is 50–50. Occasionally, the random variables can only take secure values, or values only in a certain interval. For example, in a dice, the top face will only project values between 1 and 6. It cannot take a 2.25 or a 1.5. Likewise, when a coin is tossed, it can only show heads and tails and nothing else. On the other hand, if it defines random variable to be the amount of sugar in an orange, it can take any value like 1.4g, 1.45g, 1.456g, 1.4568g and so on. All these values are possible and all infinite values in between them are also possible. So, in this scenario, the random variable is constant with a possibility of all real numbers.

Do not think random variable as an old-style variable, even though both are called variables, like y = x+2, where the value of y is dependent on x. Random variable is explained in terms of the outcome of a process. Researchers usually quantify the process with the help of the random variable.

7.4.1. Types of Random Variables

Random variables are categorised into discrete and continuous variables. The important difference between the two categories is the kind of possible values that each variable can attain. In addition, the type of random variable states the particular technique of finding a probability distribution function.

7.4.1.1. Discrete

A discrete random variable is a random variable whose values take only a finite number of values. The best instance of a **discrete variable** is a dice. Throwing a dice is a basically random event. At the same time, the dice can take only a finite number of outputs $\{1, 2, 3, 4, 5, \text{ and } 6\}$.



Discrete variable is one that cannot take on all values within the limits of the variable.

Figure 7.4: Dice is a good example of discrete random variable.

Source: https://live.staticflickr. com/6191/6097248541_c543884415_b.jpg

Each consequence of a discrete random variable comprises of a certain probability. For instance, the probability of each dice outcome is 1/6 because the outcomes are of equal probabilities. It has to be emphasized that the total probability outcome of a discrete variable is normally equal to 1.

7.4.1.2. Continuous

Contrasting discrete variables, continuous random variables can take on a non-countable infinite number of possible values. One of the examples of a continuous variable is the returns of stocks. The returns can take an infinite number of possible values, mostly in percentages.

Due to the above stated reason, the probability of a certain outcome for the continuous random variable is zero. However, there is always a nonnegative likelihood that a certain outcome will lie within the interval between two values.

7.4.2. Random Variables in Finance and Business

In business, random variables are widely used in business modelling, **scenario analysis**, and risk management. In business models and simulations, the chances of the variables represent the chances of random singularities that affect the price of a security or figure out the risk level of an investment.

Scenario analysis is

a process of analyzing possible future events by considering alternative possible outcomes. For example, a variable may be applied to represent the price of an asset at some point in the future or signal the obtainability of an opposing event.

7.5. DISCOUNT RATE IN COMPA-NY VALUATION WITH RANDOM VARIABLES

Notwithstanding the extensive acceptance and use of the Discounted Cash Flow approach to business valuation, there is a growing recognition of its important limitations. Discounted Cash Flow analyses are solely based on a static projection ignoring flexibility and variability, and this tends to disvalue investments with nonlinear payments. The major criticism is pointed on the use of a single discount rate to discount free cash flows, irrespective of differences in risk or financing.

This method may help figure out the value of the company on an average, but it fails to project the variety of uncertainties behind each factor within the model. As been discussed throughout the chapter, a company cannot be valued without a rich understanding of the risk profile of its functioning cash flows. Basic methods in this matter are stress examination or whatif measuring, whose focus is to estimate how the value of the company responds to different potential economic situations.



Figure 7.5: To predict the future of a business one needs to assess random variables.

Source: https://encrypted-tbn0.gstatic.com/imag es?q=tbn:ANd9GcSF0T11FrdtMg9mk-UI3WVvVCXkuK39rOCV_UVuQnmW8EMLFmJ4IA

An important question regards the lowest level of free cash flows the organization can be expected to create under the worst possible economic situation and whether the company will still be able to enclose its debt duties. In reaction to this data, managers may figure out to lower some risk contacts or reduce leverage to lower the company's risk outline. This perception is related to the chances of the company's default, which is a quite important aspect of its value. This includes a risk analysis of future cash flow, nevertheless, this needs consideration of a theoretical shift from traditional Discounted Cash Flow conventions.

Analysis being done in a risk analysis spreadsheet system is usually projected as a spreading of company value because the cash flows are also being explained as distributions rather than their expected values. conceptually, this is still incorrect. Since a value of the company projects what the organization is worth at the moment of valuation, it can have no uncertainty as there can be only one such number.

The issue is that the risk has been twice counted by first **discounting** at the risk being carried by discounted rate and then projecting the company value as a distribution. The conceptually correct approach for measuring the value of the company under these conditions is free rate. Such distribution is, however, quite impossible to interpret and incomparable with results of other models.

Discounting is

the process of determining the present value of a payment or a stream of payments that is to be received in the future. Since there is no method to cover this problem, it is suggested by practitioners to smear risk adjusted discount rate to create a distribution of company value. The mean value of the organization will be closer than the one calculated by the Discounted Cash Flow method, because it includes asymmetrical distributions, correlations and other phenomena already explained in this chapter.

REVIEW QUESTIONS:

- 1. What do you understand about the Uncertain Numbers in The Business?
- 2. How can random variables be used in business?
- 3. Define uncertain numbers in relation to data science.
- 4. Explain the different types of random variables.
- 5. What do you understand about the term continuous variables?
- 6. Define discrete random variables.
- 7. Explain the discount rate in company valuation with random variables.
- 8. Characterize the different business models with random variables.
- 9. How can random variables be used in predicting future course of the business?
- 10. How can business models get help from the variable numbers?

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CHAPTER

8

CONFIDENCE INTERVAL: THE ESTIMATIONS

KEYWORDS

- Confidence Interval
- Confidence Limit
- Sample Size
- Regression
- Interpretation
- Statistical Differences
- Bootstrap Confidence Interval
- Population Parameter
- Null Hypothesis

LEARNING OBJECTIVES:

After reading this chapter, you would be able to undertand:

- the meaning of confidence interval and its confidence limits;
- the role of confidence intervals in interpreting results;
 - sample size;

• Bootstrap confidence intervals for measures of the relationship between two variables.

8.1. INTRODUCTION

Calculations made from sample observations that give some inclination of the true population parameters to at least a certain degree of accuracy give a range of values which is the **Confidence Interval (CI)** of a statistic.

The CI is derived from the specific sample may not incorporate the true value of the parameter even though it projects existence of the unknown population parameter to some degree. As a result, the user selects about 95% confidence level on which the CIs are built up. In other words, when the same population is evaluated again and again with random samples, the true value is expected to be the same in about 95% of the calculated intervals.

The sample characteristics do not determine the confidence level which is actually selected by the user. The CI can be calculated at any level of confidence which can vary from 90% to 99% but the most commonly used value is 95%. Bounds or limits are define as the extreme ends of CI.

The CIs can be either two-sided or even one-sided. The population parameter is bracketed by the lower (below) and upper (above) bound in a two-sided CI whereas in a one-sided CI, either an upper or lower bound is applied to the population parameter which provides either a lower or an upper magnitude limit.

Reduction of risk is the main purpose of market research. We are able to make better decisions by evaluating and understanding the various alternatives which have been made available as a result of the information provided by a well-conducted research. By reporting results without taking into consideration the confidence interval we inadvertently increase risk rather than reducing it.

A very few understand and appreciate the true importance of confidence interval even though the concept is covered in detail during the first course on statistics. Risks are an inherent part of confidence intervals. By considering possible variations in the population of a given sample, CI projects an approximate range which contains the actual answer. As one cannot be more specific than the range projected, CIs act as the bright cautionary yellow sign. The implications of ignoring the CIs need to be pondered upon. If one gives a specific number from a range, assuming that the individuals reading it shall make an allowance for a **sampling error**, they would believe that the precise figure has been obtained from a sample, leaving scope for sampling error. It needs to be reiterated that this event is not always true.

Incidentally, it has been suggested by the science of decision analysis that it may not be the case. In decision analysis, making a realistic assessment of the data that is largely uncertain and continues to be a major challenge for the decision makers. Estimating confidence level through a narrow range is the most common tendency. Risk gets heightened when confidence interval is underestimated.

Nowadays, it has become extremely important to have accurate confidence intervals. In order to provide information on segments, samples which have already been made small due to the reduced market research budgets are further divided.

A set of differences that are true but largely unknown and are statistically compatible with the differences that have been observed comprise the confidence interval. A two-sided confidence interval of 95% is the standard practice for the statistical compatibility. A typical confidence interval is reported as, "There was a 10% (95% CI, 2% to 18%) difference in mortality." This implies that the statistical compatibility of the data was true to the extent of as small as 2% and as large as 18% even though the observed mortality difference was 10% (for instance, 70% in comparison to 60%).

Confidence interval (CI) is

a type of interval estimate, computed from the statistics of the observed data, that might contain the true value of an unknown population parameter.

Sampling

error is a deviation in sampled value versus the true population value due to the fact the sample is not representative of the population or biased in some way. It is understood that the true value of the population parameter shall be C% where varied random samples of the population have been taken and the confidence interval for population parameter is at C%. A population parameter's interval estimate is provided by a confidence interval. The sampling distribution of the statistic on which the confidence interval is based, the specific level of confidence and the availability of a random sample from the population are the prerequisites for calculating a confidence interval.

Properties:

- The precision of the estimates reduces with an increase in the width of the interval as our confidence level sees a rise. To be specific, a confidence interval of 80% shall not be as wide as a confidence interval that is 90%.
- For the same value of the standard deviation when the level of confidence is kept constant, the width of the confidence interval is reduced by an increase in the sample size, N, making the estimate more precise.
- The interval always contains the sample statistic. Incidentally, the core of the confidence interval is the sample statistic.
- The true population parameter shall be in C% of the samples where a different confidence interval is calculated for each different samples that has been created. The true population

parameter shall not be contained in 100 - C% of those intervals.

Statisticians are likely to debate upon the point projected by the above question. An unknown but fixed number portrays the population parameter in the most elementary classes on statistics. Probabilities cannot be assigned to these numbers as it is not a random variable. To do otherwise would be unintelligible. To elucidate: if 12.4 is the true value of the population mean, the probability of $\mu = 12.4$ are 1, which implies that the probability of u holding any other value is nil. To put it simply, the population parameter (and the probability of it being in the interval being 1.0) is either contained or not contained (where the probability of it being in the interval is nil) in the confidence interval

A varied number of intervals are created from different samples in confidence intervals. In a CI of 95%, only 5% of the intervals from the sample population shall not carry the true population parameter whereas, 95% of the intervals shall contain them. In other words, we can be confident up to 95% that if we calculate one interval from the one sample that we pick, the population parameter shall be present in the sample.

A wider interval is considered to be more accurate by many people. They basically mean that the possibility of the population parameter being present is higher when the confidence level is higher (and hence, wider) in an interval. This method of using the ideas of probability for interpreting confidence levels cannot be considered a correct one.

8.1.1. Interpretation of Confidence Interval

It is easy to interpret CI statistically. The results would be significant statistically where the CI is fully on one or the other side of the no difference marker, 1 in ratios and 0 in continuous data. But the results cease to be significant statistically where the marker is crossed by the interval.

Data with normal distributions projects this kind of a result but other measures like the median, which are more appropriate need to be used where the data is more skewed. This article does not cover the discussions pertaining to skewed data. An additional value of the CI is the importance or interpretation of **clinical significance**. Even results that are statistically significant, it may not mean much clinically as can be seen by the CI values.

Clinical

significance is the practical importance of a treatment effect—whether it has a real genuine, palpable, noticeable effect on daily life. We may take the example of a study where mastoidectomy was conducted on a large number of subjects and half of them were treated with canal wall up whereas the other half underwent a treatment with canal wall down mastoidectomy resulting in a mean difference of 3dB in hearing. A 3dB mean difference has a CI range varying from 1 to 5dB and P is 0.05. Hence, it could safely be said that the canal wall up procedure was favorable as revealed by the statistics of the mean difference.

Clinically speaking such a small difference may not seem relevant. At the same time where it is found that the mean difference is 15dB where the number of subjects is lesser, the results would become statistically important and relevant as the value of P is 0.05 and the range of CI varies from -1 to 31dB. In order to ensure that the difference holds good and is relevant clinically as well as statistically, it would be prudent to ensure that a larger number of subjects are tested.

If a large number of samples are taken from the universal parent population, the range of values which would have the mean shall be within the boundaries of a 95% CI about the mean. In simpler words, if repeated trials, observation or experiments are carried out with respect to different samples provided all other parameters remain constant as in the initial sample, 95% of the means in the latter measures would also be within the same range.

The confidence levels in the original mean are thus reflected in such a case. This gives us a clear picture of the values as to whether the data holds clinical importance and not just the statistical significance as the CI falls totally on either side of the difference marker (that is, 1 if proportions and 0 if continuous variables).

On the other hand, information pertaining to the values with respect to the variables that were measured is not obtained through the value of P which only reveals the statistical significance of the results. Hence, in order to clearly describe the outcomes of trials, experiments or observations CI is always considered a better option.

8.2. THE CONFIDENCE LIMITS

The actual characteristics of the population can be measured through statistics and the 95% confidence concept tells as to how far these statistic measures are useful. In ninety-five out of a hundred cases, the limits below and above our point estimates can be set within which the population's "true" value can be found. In other words, out of a hundred samples, ninety-five the true population value shall be within the confidence interval where a hundred samples from the population are taken.

Around the statistics, these limits are referred to as the 95% confidence levels. The upper 95% confidence limit refers to the value above the summary statistics and lower 95% confidence limit is used for the lower limit. The 95% confidence interval is made up of these two limits. We can say with the 95% assurances that the lower and upper limits that have been determined in a confidence interval that has been created are the boundaries within which the true value for the population lies.

As per the size of the sample, the width of the confidence interval (the distance between the upper and lower limits) varies. The confidence interval around the rate gets narrower when rate is calculated for a larger number of events or denominator. For instance, there are a thousand births in a county, for an estimate of the low birth weight percent, the confidence interval around such a number shall be wide.

For a constant proportion, the confidence interval tends to become wider where there is a decrease in the number of live births. The size of the denominator used to calculate the proportion causes a variation in the width of the confidence interval.

8.2.1. Statistical Differences

The statistical significance of a mathematical difference can be easily decided through a confidence interval. For instance, one may want to know whether the infant mortality rate is remarkably different for a county when compared to the rate for the state of California where the relevant confidence interval and statistic for that county is available.

It can be checked if the figure of the State is included in the country's rate of the confidence interval. Only if it is not the case, it can be concluded that the two rates are different. The confidence interval can be used in different ways through the data templates.

The State's benchmark figure can be used to compare the county's confidence interval. At the same time, the Healthy People 2000 or 2010 objective can also be used for the purpose of comparison for the county. To check whether the rate has varied over a period of time for the county, the confidence interval of the county in the recent years can also be looked into.

8.3. THE ROLE OF CONFIDENCE INTERVALS IN INTERPRETING RESULTS

A difference of either 0% or 25% is not ruled out statistically by a result of 14% (CI – 1% to 29%). Whenever a result reveals something like this, the author usually says in an ensuing discussion that, "The study may have had too little power to have detected a small difference," where the differences ruled out by the study are left rather vague and it is made to appear that the differences have been left out not due to the results but rather due to design.

On the basis of what is actually seen and observed, confidence interval clearly states as to which differences are ruled out statistically and which ones are not. Hence, such **vagueness** is uncalled for. Sometimes, researchers explain results that are not significant by stating that "Statistical significance was not achieved because of small sample size." In such cases, despite the zero effect not having been excluded, the researchers imply that they believe in the truth of the effect that has been observed.

Vagueness

refers to an important problem in semantics, metaphysics and philosophical logic. Even though this statement is not really incorrect, data alone can never justify it. When the non-achievement of effective results is taken to be dependent on a small sample size, say, n=2 could be used as the basic premise in all experiments. External evidence (reasons ingrained in biology and other studies) and evidence from this kind of an experiment should then be the basis behind an author's belief that a non-significant difference that has been observed is actually real.

8.3.1. Sample Size Calculation Using Predicted Confidence Intervals

Even though confidence interval is an estimate, it is an interval of numbers rather than being only one number. A sample data that has been given is used to calculate the range of values which forms the interval of numbers. A population parameter that is unknown is usually included in the confidence interval. Power and precision (which is the 95% confidence interval's width) are related to each other mathematically as they are both linked to sample size. The precision of an experiment's results can be predicted approximately for any given "clinically important difference" and power.

A ritualistic dance can be said to connote a consultation of a typical sample size. It can be understood as a case where the investigator wants the statistician to justify the number of participants (sample size) where the former is already clear about the number, he/she wishes to include in that specific case. This is done by calculating the "detectable" difference for the sample size rather than it being the other way around.

Any figure lower than 80% raises doubts, hence, the statistician uses at least much power in the calculations. The "clinically important difference" is not guided by any set of guidelines, thus, anything can be used for the calculations. In the majority of the cases, a larger than likely "detectable difference" is calculated by the investigators.

In order to get the approval for a proposed large differences are often accepted by researchers, as the reviewing bodies do not comment on this "detectable difference" nor does it have to be quoted at the times of analysis of the results of the study. A direct result of this is that, it keeps in business people who do meta-analysis and the large number of reports that are clinically important find their way into journals but these have non-significant results statistically as the clinical experiments are far too small. Researchers can clearly understand the relevance and significance of effects of taking such sample size by making the predicted confidence intervals their main area of focus.

A difference that is clinically important may not be ruled out where wide "confidence intervals" are revealed due to choosing a "detectable difference" that is too large.

8.3.2. Confidence Intervals Depend on Sample Size

Increasing the sample size is a simple solution to being able to meet the target for the mean but at the same time getting a higher confidence level.

The confidence interval becomes smaller whenever the data in the sample increases. The mean tends to be in sync with the true population value as the data increases and the chances of the sample being reflective of the entire population are higher.

For instance, where eighty participants were targeted, the 95% confidence interval was 39.8, 54.4 with a mean of 47.1 for all the participants. The target having been 60 seconds and the value achieved being far lower, the test would have been okay for a go-ahead if a larger number of people had been targeted.

Interestingly, more sampling needs to be done in order to get a confidence level that is narrow. However, in most cases, one does not want to carry out much sampling when the confidence interval needs to be calculated.

8.4. BOOTSTRAP CONFIDENCE INTERVALS FOR MEASURES OF THE RELATIONSHIP BETWEEN TWO VARIABLES

The relationship between two variables garners far more interest from the researchers rather than a single variable. Only if there is something to compare, the mean responses to questionnaire scales become useful. When a paradigm is used to test a hypothesis, a p-value is derived after setting up a null hypothesis which is neither related nor has a difference and then deduces the consistency of the data with respect to that hypothesis.

Similarly, for a measure of this relationship or difference, a confidence interval is set up in the paradigm related to confidence interval. Just the way mean of a single variable is used, the same method is used through the power of the bootstrap approach. The general possibilities for two variables shall be listed after the two examples that follow:

Firstly, in data collected from the society of accountant's various methods can be used to analyze the relationship between age and the socializing levels of the accountants. The simplest method to calculate this is to compare the mean response to relevant questions as given by the old (fifty-five years and older) and the younger (up to the age of 35) members.

A difference in the attitude between the two age brackets was revealed through a difference of 1.0 which was found between the means, as the mean from the older members was 1.0 and that from the younger ones was 2.0. There would still be questions about the applicability of such a result to the members in general as only a small sample was considered in this example.

A **null hypothesis** with no difference is set up in the conventional method whereby a value is derived for p. A p-value (based on ANOVA) of 4% is given by the Compare means procedure in SPSS. For each resample here, statistics uses the difference of the two means to bootstrap a confidence interval.

Probability theory-based methods can be used to derive confidence intervals. For instance, amongst others confidence intervals for regression coefficients, means and correlations can be produced through SPSS. At the same time, as shown in the introduction, the three advantages are inherent in the bootstrap approach.

A bare minimum of technical expertise is required to understand the rationale behind this – the explanation of the percentile interval has no statistical tables, standard deviations, variances or standard errors. Normality of data and other assumptions have no checks, the central limit theorem has no appeals and nor do the other theorems of mathematical statistics.

Confidence intervals can be directly constructed from the results of simulation through a simple process using computers. Wherever it is difficult to find conventional solutions like analyzing the difference between two correlations, the bootstrap approach can be generally applied to the problems.

Null hypothesis is

a type of hypothesis used in statistics that proposes that no statistical significance exists in a set of given observations.

REVIEW QUESTIONS:

- 1. What do you understand about the term confidence interval?
- 2. What is Bootstrap confidence interval?
- 3. Describe the role of confidence interval in interpreting the results in any business.
- 4. Describe the meaning of statistical differences.
- 5. What is the confidence limit?
- 6. What is the predicted confidence interval and how is it used to calculate the sample size?
- 7. What happens to confidence interval when the sample size increases?
- 8. What are the detectable differences?
- 9. Describe the properties of confidence interval.
- 10. What is the standard practice for the statistical compatibility?

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CHAPTER

9

HYPOTHESIS TEST-ING AND REGRESSION ANALYSIS

KEYWORDS

- Interference
- Forecast
- Hypothesis testing
- Regression analysis
- Scatterplot
- Multicollinearity
- Linear regression
 models
- Residuals
- Plausibly
- Nonlinearity

LEARNING OBJECTIVES:

In this chapter, you will learn about:

- constructing a hypothesis test;
- the usage of hypothesis test;

•

- objectives of regression models;
- roles that variables play in regression models;

• qualitative and quantitative approach.

9.1. INTRODUCTIONT

It is important to construct a hypothesis test for a linear regression model as they are so much crucial in statistics. Linear regression lines are a common way to create prediction models for two variable data. Since the models are not perfect, the person can use the hypothesis test to determine if there is a relationship between the two variables or if there is none. If there is a connected correlation in the situation, then is it a strong positive relationship between the two variables. If there is no correlation, then it shows a negative relationship between the two variables.

But in most cases in regression problems, people do not actually have the entirety of the population data and the idea with estimators is that, people can apply some sort of tool, perhaps using least squares and that provides some insight as to what is going on in the population. The idea about making statements or making conclusions regarding what is going on in the population (given that it only has a sample), is known as **interference** in statistics.

9.2. USES OF HYPOTHESIS TESTS

Hypothesis tests are our way of making statements or conclusion about what is going on in the population given that they only have a sample. For instance, the people are interested in finding out whether an individual's level of income was affected by their parental level of income. They have a whole different individuals, their income along with their parental income. At the time of performing the regression and with the sample of data, it turns out the individuals' level of income is equal to 30,000 US dollars, plus 0.1 times whatever their parental income was. For argument's sake, let say that they have included all other important variables in this regression, just so that they do not run into the issue of endogeneity or bias regresses.

So, at the time of putting a value of 0.1, it may appear to suggest that parental income is associated with a high level of their children's level income. They can sometimes think about various causal stories for such condition, but there could be an issue with the estimate.

This value of 0.1 is just a number and it is difficult to conclude whether that is brought about because of picking all individuals that are coming from a particular area or particular income class. Whether it is a result of the fact that the actual true parameter value in the population is in fact 0.1, at this point estimate, people cannot differentiate between these two cases. That is when people need to think about what is the sampling distribution of least squares because without it, the people will not be able to do anything else.

Fitting the regression line is only the first and very small step in econometric analysis. In **applied economics**, people are generally interested in testing the hypothesis about some hypothesis value of the population parameter.

9.3. NULL HYPOTHESIS

Statistical inference is the act of generalizing from sample (the data) to a larger phenomenon (the population) with calculated degree of certainty. The prior chapter introduced the most important form of inference: estimation. It introduces the second form of inference: null hypothesis significance tests (NHST), or "hypothesis testing" for short.

The main statistical end product of NHST is the P-value, which is the most commonly encountered inferential statistics and most frequently misunderstood, misinterpreted, and misconstrued statistics in the biomedical and public health literature.

Most teachers of statistics do not fully understand P-values. Not even specialist **Interference** is a phenomenon in which two waves superpose to form a resultant wave of greater, lower, or the same amplitude.

Applied economics

is the application of economic theory and econometrics in specific settings. scientists can easily explain them. Since the process of NHST revolves around the P-value, let us start with its definition, which is easiest to remember with this notation:

P-value \equiv Pr (data or data more extreme | H0 true)

where:

 $Pr \equiv probability$

 $|\equiv$ "given" or "conditional upon"

 $H0 \equiv$ the null hypothesis

Thus, the P-value answers the question, "If the null hypothesis were true, what is the probability of observing the current data or data that is more extreme."

Note that the P-value is NOT the probability that the hypothesis (or any other hypothesis) is right or wrong. In fact, it assumes the null hypothesis is right! In light of these facts, there are actually two classical schools of thought on how best to use the P-value: The Fisher and Neymann-Pearson schools.

There is also a Bayesian way to interpret the P-value, but that presents a whole other set of dilemmas. As a starting point, we will consider the P-value as a calculated index which, as it gets smaller and smaller, it provides stronger-andstronger evidence against the null hypothesis.

9.4. OBJECTIVES OF SIMPLE LIN-EAR REGRESSION

Linear regression can be used in both types of forecasting methods. In the case of causal methods, the causal model may consist of a **linear regression** with several explanatory variables. This method is useful when there is no time component. For example, a company might want to forecast when a material will melt under different conditions of temperature and pressure.

Simple Regression model or regression models have two main objectives.

The first one is going to establish if there is a relationship between two variables. It is important to talk about positive relationship between two variables if they tend to move together in the sense that when one increases. The other one increases as well and conversely in a negative relationship, it is important to find that if one variables value increase, the other variables values tend to decrease.

More specifically, it is important to discuss about statistically significant relationships between the two variables. Let's discuss about some examples on average that we can expect that people or families that earn higher income will generally spend more of a given product. In this case, there is a positive relationship between income and spending.

It could also analyze and test if there is a relationship between wage and gender. We could ask if men are more likely to earn higher wages than women. This case talk about gender discrimination, which is negative and we do not want it, but it can actually use the regression models to test if that relationship exists.

Another example is to find odd is relationship between a student's, height and the student's exam scores. People should expect

Linear regression

is a linear approach to modeling the relationship between a scalar response (or dependent variable) and one or more explanatory variables (or independent variables). no relationship to exist and they can use for regression models to test.

The second objective is to forecast new observation and how people can use what they know about an existing relationship to forecast unobserved values.

For example, if people know that their sales tend to grow over time and they actually even know how strong this relationship is, then they can use this information to predict or to forecast what will their sales be over the next quarter.

Also, if they had data in stores, they would know valuable information like, how profitable different stores are, its relationship between how much competition a store is facing in a given location or what the population of a location is and how those variables impact the stores profitability. They could use what they know about previous stores to evaluate the profitability of a new inexistence store.

No one know how profitable the new store is going to be but, if people know how much competition they are going to face, then they should know how much people who live nearby the store can use this information to forecast that stores profitability.

9.5. DIFFERENT ROLES IN LINE-AR REGRESSION

In general, it is important to talk about two different roles that variables play in regression models. The first one is the dependent variable. Its values depend on something else and it can be denoted as Y.

The other role is the independent variable. This is the variable that explains the other one, and that its values are independent, hence its name. It is donated as X.

The linear equation is going to have beta0 term which is the intercept or the constant and the beta1 which is the coefficient of X or the slope of X. This is a linear equation because it will appear as a straight line if we plot them in B dimensional plot.

Y = a + bxY = mx + b

9.5.1. Business Decisions and Simple Linear Regression

Suppose a student-run cafe wants to reduce their food waste while maximizing their profits. They are trying to figure out that how many wraps they should make today. They have collected data concerning sales and maximum daily temperature over the last 48 days. They know the maximum temperature today will be about 65 degrees Fahrenheit, and they want to know if they can use that information to identify how many wraps they will sell.

If they make too many wraps, then it will be wasted. If they do not make enough wraps, they are losing potential profit. They want to use a simple linear regression model to predict how many wraps they will sell given today's temperature. In other words, their predictor variable or X variable is temperature in Fahrenheit. Their response variable or Y variable is the number of wraps sold. These are both quantitative variables, so simple linear regression is an appropriate procedure.

It is necessary to predict the number of wraps that will be sold using the maximum daily temperature. It is also important to remember to check the assumptions. First, there is a need to check if there is a linear relationship between maximum daily temperature and wraps sold using the first scatterplot. People can see that there is a **linear relationship** between the two variables although, the relationship appears to be relatively weak.

It is important to examine the scatterplot of residuals versus fits. There are two things that needs to be observed. The first is the independence of errors, so there should not be a correlation between the residuals and the fitted values. People also want to look for equal error variances. So, the variances of the residuals should be the same across all fitted values.

The last that needs to be checked is the normality of errors. It can be done by looking at the normal probability plot or by looking at a histogram of the residuals. In both cases, the individual can see that the residuals are approximately normally distributed.

9.6. FORECASTING AND REGRES-SION

The regression technique of forecasting is castoff, as the name implies, it means **forecasting**

Linear relation-

ship is a statistical term used to describe a straightline relationship between a variable and a constant. and finding the causal relationship between variables. An important related, almost identical concept involves the advantages of linear regression, which is a procedure for modelling the value of one variable on the values of one or more other variables.

9.6.1. Types of Forecasts

There are three types of forecasts:

- qualitative;
- time series; and
- casual models.

The time series and casual are quantitative forecasts and so, they rely on a lot more numbers than the qualitative forecast.

For example, the less people in the war and more giants, it can be easily forecasted that less people cannot beat and go well and rather, lost a lot of lives. Maybe, a better choice would be for them to pay the opposing force and look towards a settlement and they can amicably part ways.

More modern example, everyone often care about is the outcome of sports games. Suppose got red and it faces off against blue on a friendly game of football. If they got the fantasy team as the people really want to know the outcome of the game because they want to beat their friends. So, the sports analysts help to make predictions of the outcome of the game.

On the other hand, businesses deal and typically want to anticipate revenue and cost, and this allows to develop and rise a strategy where we change it when we need to. **Forecasting** is the process of making predictions of the future based on past and present data and most commonly by analysis of trends.

There are certain steps for developing a forecast:

Firstly, it is important to determine how they want to use the forecast and what are the people trying to obtain, like if they are predicting the outcome of a sporting event like football or if they are trying to predict ice cream sales and what flavors they should stock.

Secondly, it is important to identify the items the individual need to forecast. Suppose, there is A, B and C that are all relevant to the business, but to develop the forecast maybe they only need B and C.

Thirdly, it is important to determine the time horizon. Will the forecast be for a short term, like one to thirty days? Or maybe medium, which can be from one month to one year? Or it may be a long time forecast of more than a year.

Once it has done then it is necessary to select the forecasting models, the organizations need a board of superior analysts and a reliable computer to develop an analytic quantitative model.

The person can use the model to predict past events and compare the models forecasts and to see that the forecast is close to the actual and not far away. It became easy to forecast and implement the result and can act on it.

9.6.2. Qualitative and Quantitative

Qualitative and quantitative is when individual incorporate judgment or subjective factors into the forecasting model. Suppose in the sports analyst board, they are able to incorporate moods, the value of the game and a whole bunch of non-quantitative aspects and making that forecast.

A time series is required to predict the future, so the data is arranged by month over month and it is in a sequential time and can use that to extrapolate what the future is going to look like, so moving average, exponential smoothing and linear regression analysis are the part of the time series.

Casual models can be identified when individuals estimate relationships between variables and factors that influence the forecasted value, so this is regression analysis.

For **time-series analysis**, it is possible to develop a linear regression model that simply fits a line to the variable's historical performance and extrapolates that into the future. This is unable to account for seasonality or other cycles, as well as nonlinearity, but if the variable in question is plausibly linear, using linear regression to forecast it might yield a useful prediction.

Because much economic data has cycles, multiple trends and non-linearity, simple linear regression is often inappropriate for time-series work. On the other hand, linear regression and related statistical approaches are useful for causal models due to their ability to consider several different factors and evaluate the impact of each one. **Time series analysis** is a statistical technique that deals with time series data, or trend analysis.

REVIEW QUESTIONS:

- 1. When can a person use the Hypothesis Test?
- 2. What are the uses of Hypothesis Test?
- 3. What are the major objectives in regression models or in simple regression?
- 4. Explain the different types of forecasts.
- 5. What types of errors can be identified in the simple linear regression?
- 6. Give two examples related to the Simple Linear Regression.
- 7. How can a business earn profit with the use of forecasting?
- 8. Explain the factors used in forecasting and regression.
- 9. Explain the theory of Null Hypothesis.

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CHAPTER **10**

REPORT WRITING: COMMUNICATING THE RESULTS

KEYWORDS

- Communicating
 Report
- Conclusion
- The Written Word
- Narrative
- Language
- Report Writing
- Comprehensive Details
- Evaluation
- Postgraphe
- Analysis
- Statistical Report

LEARNING OBJECTIVES:

After studying this chapter, you should be able to:

• explain the meaning of statistical report;

• discuss the role of statistical report in decision making and planning process;

• examine the methods to communicate data with business organizations and other interested stakeholders;

• explain the suggestion in writing the report;

• understand the importance of using simple language in writing report.

10.1. INTRODUCTION

Writing the statistical report is the final step after the series of step such as establishing relationship between variables, forecasting of the result, and evaluating the last parameter has been made. It is the last and crucial step in the investigation as the decisions and strategies formation depend on this report.

After the final report has been prepared, it is time to share the statistical analysis of the results with the world. There are different ways in which result can be communicated. For instance, after doing a series of steps and calculations, the final suggestion can be of two to three words such as recommending clients to "buy low, sell high" or give an oral presentation to your peers. However, in a written report, there is a need to give detailed descriptions about findings and various facts.

It is usually seen that communicating technical results is a difficult task for statistical investigator for a number of reasons. First, in most data analyses, there is no one way or method to communicate the results to readers. One cannot establish right answers in statistical analysis.

To establish a "right" answer, there is a need to evaluate the pros and cons of an issue and weigh their relative merits. In statistical reports, the aim of investigator is trying to establish the relationship between the variables and communicate the feature of data in a more general pattern, a much more complex and difficult task.

Second, most of the reports aimed at serving a single client, or audience. However, it is read by large number of people having different perception, knowledge, belief and most importantly their statistical knowledge varies extensively. It is vital to consider the huge diversity in readership when concluding or giving remarks about any research report. This become even more difficult when the statistical investigator does not know whom the secondary audience may be.

Third, the statistical reports are developed by investigator by taking into consideration huge variable at large, using technical knowledge of statistical concepts, and giving importance to underlying substantive issues. Drawing on these different skill sets can be challenging. Even for a generally effective writer, any confusion in the analysis is inevitably reflected in the report.

Communication of statistical results can be a brief oral recommendation to a client or an extensive 100-page research writings. However, a typical business reports consists of a 10- to 20page report, which summarized the key variable and facts and concluded the final findings.

One of the primary characteristics of the business **statistical report** is to provide the reader with an understanding of the key facts of the data. Comprehensive details are included in the report so that readers can evaluate or analyze other valuable and key information which they are looking for.

10.2. WHAT IS A STATISTICAL RE-PORT?

Statistical report can be defined as collection of all the data, quantitative as well as qualitative, together to assimilate the results. Conclusion drawn is based on various findings and the relationship between different variables. Without a suitable and appropriate statistical research report, it is not easy to come out with precise and accurate results that are required by the organizations.

Graphics and text are two key elements that are used in presenting the report which can be easily understand by the readers. A picture gives the opportunity to readers to interpret the information independently while the text helps in describing the data. This explains one of the key terms of a system called Postgraphe because it combines the data with a text generator called

Statistical Report

gives an objective description of numerical data that are presented in a statistical table. pretext, which helps in sharing the information with the help of text and graphics to help the readers to understand the result.

The system often represents the data in a tabular form in a similar manner as it is presented in a spreadsheet, which put the value in the columns of the table. In this chapter, the primary focus will be on the graphics generation along with the detailed description of results, so that the business companies can take the relevant decisions from the information being provided to them by the statistical investigator.

10.2.1. Writers Intention and the Characteristics of Graphics



Figure 10.1: Different methods to calculate results.

Source: https://storage.needpix.com/rsynced_im-ages/spreadsheet-98491_1280.png

One of the statistical investigators recognizes the importance of algorithm in presenting the result report to businesses. This algorithm helps in representing the graphical methods for each type of variables. It is generally used by the investigator by integrating the theoretical aspect of data and variables. All these works help in highlighting the importance of graphics at the global level as well as at the level of individual components. The former level relates upon the efficiency of a type of graphic for a kind of data.

For example, it is often seen that spatial position is always more helpful than color for continuous variables. The role of the latter level is to examine the job of the graphics in the transmission of the message. For example, horizontal bar charts play a very important role in comparing values of different variables, but curves and vertical bar charts is very helpful for temporal data.

10.2.2. Implementation of Postgraphe

10.2.2.1. Input to the System

In addition to the table of numbers that helps to an easy interpretation of data, there is a need to add three annotations to examine the information which is relevant and need to be part of the report. These annotations mainly carry different set of variables highlighting the intension of writers.

These different set of variable play huge role in selecting the appropriate kind of graphics. They are usually worked in hierarchies and id of high importance in establishing the relation between different set of variables. **Information** is stimuli that has meaning in some context for its receiver.

Planning is the process of thinking about the activities required to achieve a desired goal.

The major concern of the statistical investigator is how to present the data and certain facts in a report and how to express it, so that it can be understand by the readers. The **information** is organized in such a manner that it become easy for the readers to make interpretation from the data presented in the report. Every section in the statistical report is expressed with the help of graphs to evaluate different data sets and variables.

Postgraphe tries to find out the smallest set of graphics that able to highlight the intension of the writers, which can be the presentation of different data sets and number along with the correlation of variables and the distribution of a variable over another one.

10.2.2.2. Planning

Planning is one of the most important tasks in which various decisions need to be taken such as which methods of statistics should be used to get the desired results. As there are different methods available to calculate the value of variables, using the best methods for the different set of data is the critical and most important step in the process of **planning**.

In planning the decisions related to identification of data, recording of data and then calculating the result with high accuracy is very much important because all the decision done by the business organizations are dependent on these findings. Therefore, the value must be calculated by taking into consideration all factors and variables.

10.2.2.3. Grouping

In statistics, the primary purpose of grouping is to interpret the relevant information from the data available, so that the result from the data carries the interest of all variables. It helps in establishing the relationship between different set of variables in a way to achieve the high accuracy in reports.

10.2.2.4. Composition

The role of composition is to check the feasibility of group and to establish the best figure to express it.

10.2.2.5. Realization

For the low-level generation of graphic primitives, it plays a huge role at this stage that a figure cannot be produced because of physical reasons. It is either too big to fit or it can be said that not enough grey levels are available.

This low-level work is quite involved because it always needs to consider 3D constraints as well as the limitations of the media. For this, we had to develop a Postscript generation system in Prolog in order to determine the exact position of each element such as (line, character, and axis) of a generated graphic.

10.2.2.6. Post-optimization

The primary objective of post optimization is to eliminate identical graphics which can be possible to happen because the heuristics speed up the system, but in doing so, there are more risk of not getting the best solutions.

10.2.3. Conclusion

In the end of writing a report, a conclusion about the result is presented. The conclusion simply carries the reason for a result and highlighted the certain findings of the information. Conclusion is the **amalgamation** of the qualitative as well as quantitative data and result of the different sets of data. Conclusion play huge role for further actions and decision making that is basis for business planning.

Most of the business leaders just consider conclusion in taking key decision for their company. It is primarily because conclusion is the brief result of the huge data sets and information presented in the report and it is enough to take certain key decisions.

10.3. METHODS FOR COMMUNI-CATING DATA



Figure 10.2: Communicating report with stakeholders via internet.

Source: https://live.staticflickr.com/8367/84646614 09_32aa7a26a6_b.jpg

Amalgamation is

the combination of two or more companies, known as a consolidation. To present the information in an efficient and effective manner to the readers, it is important to integrate number, words, and graph so that readers will be able to understand the information and can take relevant decisions from the information provided. Thus, the creators of data presentations must draw on background skills from several areas including:

- an understanding of the underlying substantive area;
- a basic understanding of key statistical concepts;
- relevant skills and knowledge to present data in attractive manner;
- basic information about the audience to which report is being presented.

This balanced background play a very important role in presenting the data. If the purpose is to create the interest among audience to read the report or to attract attention, then more emphasis should be given to the designing aspects of the report.

In addition, it is generally seen that some statistical investigators with good quantitative skills put maximum efforts to simplify the presentation in order to reach to the wider audience. By not giving more importance to appropriate design attributes, they reveal only part of the numerical information and hide the true story of their data. To quote Albert Einstein, "You should make your models as simple as possible, but not simpler."



10.4. SUGGESTIONS IN REPORT WRITING

Figure 10.3: Different ways to present report.

Source: https://cdn.pixabay.com/photo/2016/12/24/01/24/accounting-1928237_960_720. png

10.4.1. The Written Word

The primary objective of the statistical investigator is to develop "effective" news release or other document, such as a report or an analytical article.

One of the most important question is how can a statistical report be effective? The following suggestions should be considered by the statistical investigator in order to make the result report effective:

- Describe brief story about the data.
- Maintain reports by taking audience into consideration. Ask yourself, "Why should my audience want to read about this?"

- Present in such a way that it attracts reader's attention, maybe by using catchy headline or image.
- Make the report in an easy and concise manner so that it is easily understood, as well as interesting and often entertaining.
- Encourages business leaders, including the media, to make use of statistics report in such a way that add impact to the readers of what they are communicating.

10.4.2. Target Audience: Your First Decision

One of the major decisions that statistical investigator should take is to pinpoint an audience: Who are you writing for? Quite simply, the audience is in the driver's seat. The primary aim is to serve what the audience want. Statistical investigator should always take into considerations the need of the audience and always listen to them in order to find and select the right narratives, language, appearances, and visual and graphic devices that will capture their attention.

It is usually seen that within past few years, the choice of audience has become more complex and it is gradually becoming even more complicated with the increase in the use of internet. Nowadays, most statistical organization mandate to share the result of the investigation with the general audience, who are non-specialized, fairly well-educated laypeople. Most of the businesses now printing press releases whenever their annual report is prepared, in order to communicate with their stakeholders. This practice is usually followed by those companies comprising of large number of stakeholders. Other companies who have few stakeholders send report to them personally.

Nowadays, most of the statistical organizations have their own website and published the result of the investigation on their website, or disseminate report via emails or other internet-based platforms. It means that they can connect to their audience living in any part of the world. It helps in connecting the various stakeholders together: the public, bankers, data users, financial analysts, students, university professors, and so on.

With the rapid development in the technology, there is significant change in the way how information is communicated with others. Successful commercial media play a huge role in this and thus, continuously monitor – often in real time – to attract their audience at large. Statistical investigator must keep this thing in mind, that their report should not be modified or altered by media, which may have bad impact on the authenticity of the report.

10.4.3. Understand the Context in Which You Are Communicating

Statistical communication should be done by keeping in mind the interest of audience. It should not occur in isolation. Therefore, it is essential to know about the content in which you are communicating. The need and wants of audience to consume the content is rapidly changing. There is also a significant difference between the generations who are the reader of the statistical report, what are their basic knowledge, technical skills and ability to comprehend its quantitative aspect.

When the statistical investigators are planning about communicating the result of the study, they should keep in mind the latest trends in online media, which represent both opportunities and risks to the investigator:

- The World Wide Web has started gaining importance as a medium for entertainment. Any result that is not interested and attracted will not achieve its objective.
- When the result of the statistical report is being shared with business leaders, it should be presented in such a way that business leaders can easily find the key information they are looking for.
- Statistical investigator should be careful while sending the report to the companies as it may contain sensitive information and there is a high chance that the information may hacked when it is being shared via internet.

10.4.4. Narrative: Telling the Story

First and foremost, find a story. In order to present meaningful result to a general audience, it is essential to accurately conclude the information from the available numbers. The word "story" always unconsidered in the statistical/scientific world, because it always carries weigh in fiction world and if used in the statistical report, may seemed as misinterpretation of the data. This view might be justified if story does not accurately relate with the numerical aspect of the statistics.

However, the alternative, such as completely ignore the stories may result in compromising with the quality of the results. Whenever the results are all about numbers and quantitative facts, then the people often distrust statistics and feel that the results are misleading. It is primarily because they do not able to understand the data. In addition, whenever the investigator concludes information from the data, people who read the report fail to establish the relation between variable and unable to come out with the relevant conclusion.

Without a story line, it become very difficult for readers to understand just a simple description of numbers. A statistical story must be able to amalgamate the numbers and knowledge of the data. Otherwise, it may be interesting, but in fact all wrong.

10.4.5. Language: Keep It Clear, Concise, and Simple

It is well known that the result report with the simple language is always preferred by the readers. The popular saying, "keep it short and simple" (KISS) is always true is and is of high importance in the context of statistical research report. It is not only valid for qualitative information but also for quantitative data such as tables, visuals and graphics.

Always present the information in a clear and concise manner, free from technical jargon. The information that is written in a standard manner may not be always helpful as it is devoid from simplicity. It is also not even accepted by the audience at large. Using plain language is not patronizing, trivializing or over-simplifying. Neither it means that it contains grammatical errors. Plain language always conveys valuable meaning to its audience. It should always be prepared by taking into consideration audience preferences. It is usually believed that Plain language is faster to read and helps in faster decision making and planning process. It is of great help to business leaders who do not possess technical knowledge and need to look for the key information from the results.

10.4.6. Evaluating the Impact: Media Analysis

Statistical investigators must ask question from themselves, "Is their audience are intelligent enough to interpret the results from the data?" "Will they able to predict the accurate result in order to make the sound economic, and practical policies?"

All these cannot be accurately analyzed unless the data is released and read by the audience at large. It is the only best way available with the statistical organizations to examine how the information is consumed by both the business as well as media and what kind of interpretation will be done from the report. Some methods include:

• Taking various initiative such as development of "Voice of the

Customer Program" or started taking customer feedback.

- Increasing the interest among stakeholders through user-groups and focus-groups.
- Conduct user surveys or consult influential clients on a one-to-one basis.
- Engaging in research activities program to gain an insight into the sensitive issue or an audience that is difficult to access.
- Use relevant skills and technology to evaluate the Internet traffic to know about the platforms where the data should be shared and disseminate among interested users.
 - Analyze and search keyword patterns and make use of advanced tools and technique in order to gain an insight into the information that audience is looking for.

10.5. CONCLUSION

In the end, it is concluded that writing of report is one of the most critical tasks as the writer need to consider various factors in mind before writing a report. In statistical report, there are various methods to arrive at a result, and the role of the statistical investigator is to identify and choose the best methods to calculate the accurate results.

Furthermore, there are various ways to present the data such as graphical way, tabular way and writing the information. It is up to the author of the report that either he wants to use a single method or combination of all. Also, the writer of the report should keep in mind that the report should be free from technical jargon, so that it can be easily understand by the readers.

REVIEW QUESTIONS:

- 1. What do you mean by statistical report? Explain in detail.
- 2. What is the primary objective of writing a statistical report?
- 3. What factors should the writer keep in mind before writing a report?
- 4. What is the use of postgraphe in report writing?
- 5. Why is planning important in writing a report?
- 6. Why is grouping of data sets vital to arrive at an accurate result?
- 7. What are the different methods to communicate data to businesses?
- 8. Explain the different suggestions that are essential in writing a report.
- 9. Why it is important to know about target audience before writing a report?
- 10. Why it is essential to write a report in simple language?

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Practical Business Statistics

Businesses in the modern and fast-paced world are developing enormously. They have huge competition among themselves and are driven by the motivation to excel and be ahead of everyone. The businesses have been involving statistics to make sure that they act in the right manner and make informed decisions on the matters that concern them.

Statistics is a widely-discussed field in the business world today. The business people want to know the in and out of all the things and to verify them using the statistical information they get. The statistics make them aware of the trends in a particular field, especially the consumer-related fields, and help them revise or reform their policies according to the results.

The book tries to inform the readers about the various roles of statistics and the methods that are used in the field of business statistics to get the required information. It also focuses on different statistical methods that are used widely in the business world.

The book starts off by introducing the field and subject of statistics to the readers and explain its characteristics. It also enlists various types of statistics that are adopted in several situations and conditions. The book describes the role of statistics and focuses on the research and development in the field.

The book talks about the subject of Data Mining and Big Data. It talks about the role of data mining in the practical scenarios of business statistics. It also dwells on the application of Big Data in those scenarios. The book throws light on the current trend in the way data mining is used and discusses the issues that come up in Big Data and data mining.

Moving further, the book throws light about data structure by introducing and defining the meaning of data structure and associating them with algorithms. The book describes the characteristics of data structures and enlists various types of data structures. It explains the meaning of variability and its role in the business processes. It also throws light on the process of data collection in data structures.

The book then talks about histogram and discusses the history of it. It lists the various parts of histogram and the typical shapes in it. It discusses the applications of histogram in the businesses, so that the readers know about their importance.

The book throws light on the variability in statistics and highlights its significance and the properties of measuring it. It lists down the reasons for popularity of standard deviation and talks about the range in standard deviation. The book throws light on the coefficient of variation and brings the various kinds of variabilities to readers' focus.

The book moves forward to discuss about the probability in statistics and describes the meaning of it. It talks about conditional probability and explains the Bayes' Theorem to the readers. The book throws light on the discrete random variables and the use of simulation in probabilistic problems.

Then, the book introduces the uncertainty in numbers to the readers. It talks about taking decisions with the uncertain numbers and explains the basics related to it. The book talks about random variables and highlights the importance of uncertain numbers in the discount calculations in the company valuation.

The book throws light of the importance of report writing in statistics and explains the meaning of a statistical report to the readers. It talks about the methods in communicating data and suggests some important points in report writing to the readers.



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