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STATISTICS

WHAT IS STATISTICS?

- Origin of Word Statistics:

The word “statistics” is derived from the Latin word “Status”, which means a political state (Ahmad, 2017).

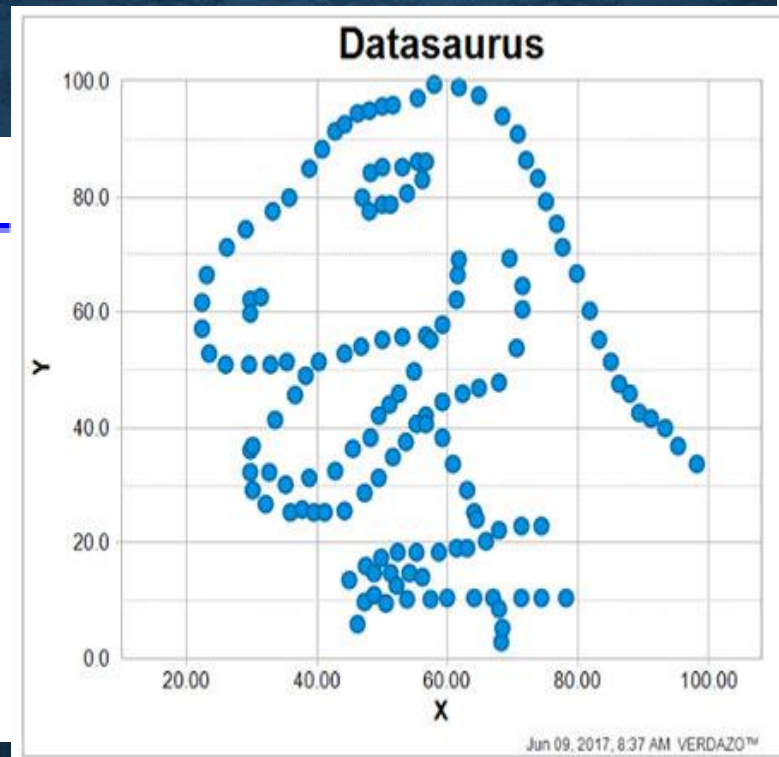
- Definition of Statistics:
- Statistics is a branch of knowledge that deals with facts and figures.
- The term statistics refers to a set of methods and rules for organizing, summarizing, and interpreting information.

WHAT IS STATISTICS?

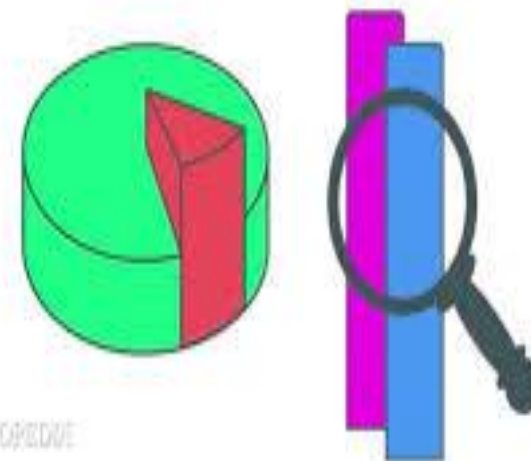
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Range
 $9 - 3 = 6$

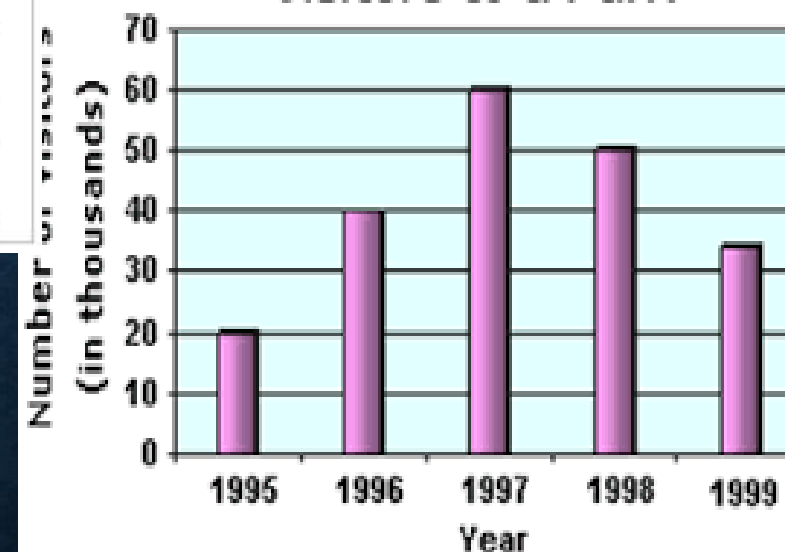


STATISTICS



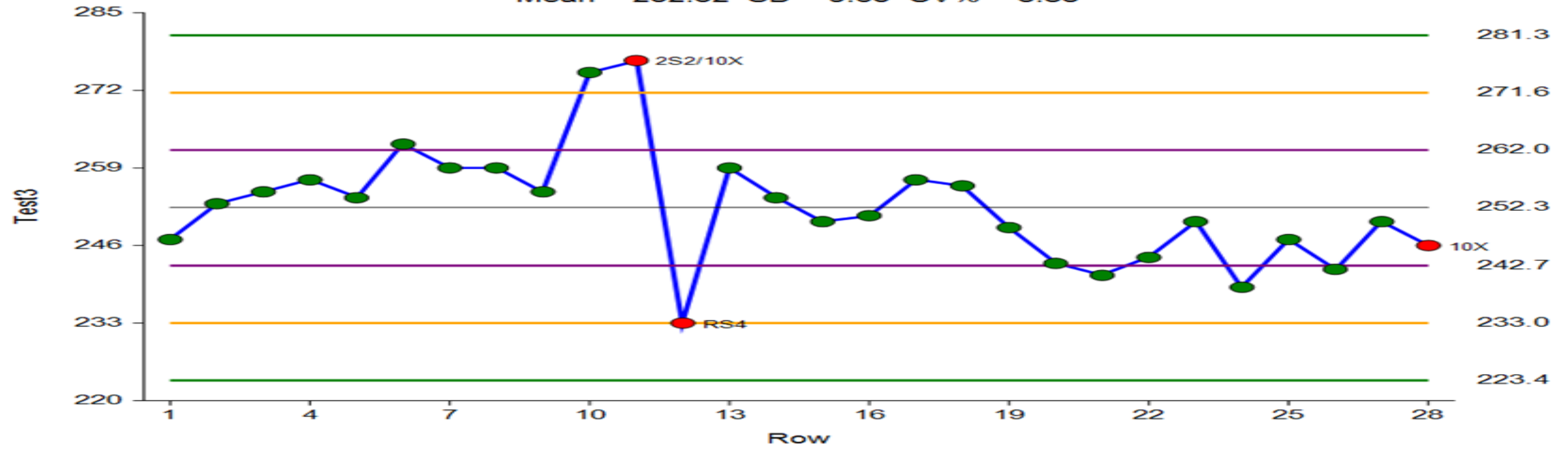
INVESTOPEDIA

Visitors to a Park



- Statistics is a methodology which a researcher uses for collecting and interpreting data and drawing conclusion from collected data (Anderson & Sclove, 1974; Agresti & Finlay, 1997).
- What data is?
- DATA ARE facts and statistics collected together for reference or analysis.
- Data Plural ----- datum Singular

Levey-Jennings Chart of Test3
Mean = 252.32 SD = 9.65 CV% = 3.83



FUNCTIONS OF STATISTICS

1- To present facts in a definite form

Daily we encounter millions of pieces of information which are often vague, indefinite and unclear. When such pieces of information undergo certain statistical techniques and are represented in the form of tables or figures, they represent things in a perspective which is easy to comprehend. For example, when we say that some students out of 1000 who appeared for B. Ed examination were declared successful. This statement is not giving as much information. But when we say that 900 students out of 1000 who appeared for B. Ed examination were declared successful; and after using certain statistical techniques we conclude that “90% of B. Ed. students were successful”; now the sentence becomes more clear and meaningful.

Standard Deviation and Variance

Deviation just means how far from the normal

Standard Deviation

The Standard Deviation is a measure of how spread out numbers are.

Its symbol is σ (the greek letter sigma)

The formula is easy: it is the **square root** of the **Variance**. So now you ask, "What is the Variance?"

Variance

The Variance is defined as:

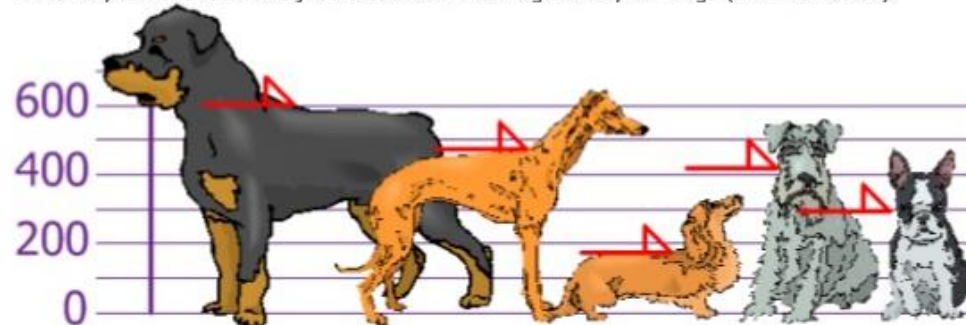
The average of the **squared** differences from the Mean.

To calculate the variance follow these steps:

- Work out the Mean (the simple average of the numbers)
- Then for each number: subtract the Mean and then square the result (the *squared difference*).
- Then work out the average of those squared differences.

Example

You and your friends have just measured the heights of your dogs (in millimeters):

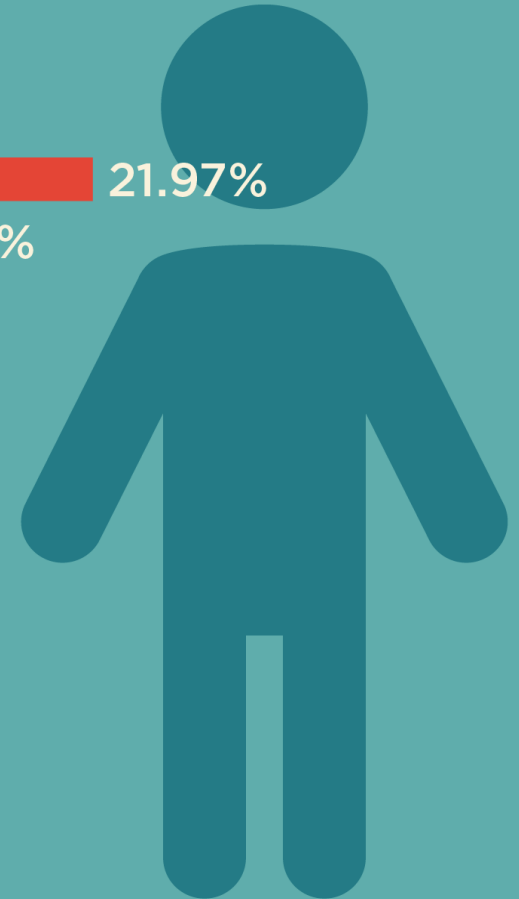
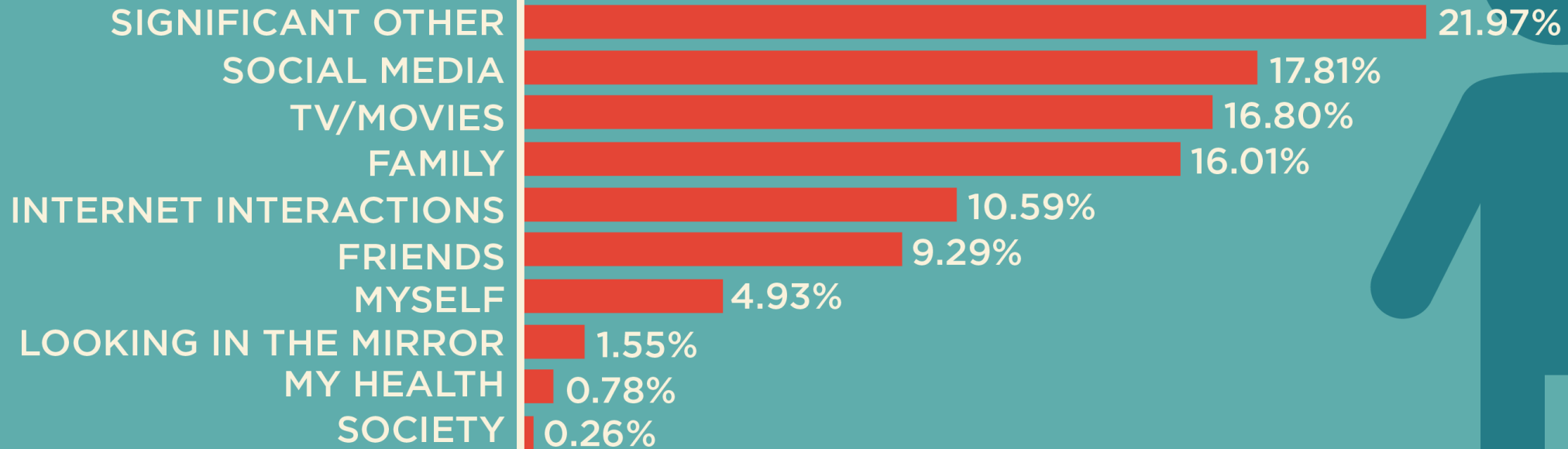


2- To simplify unmanageable and complex data

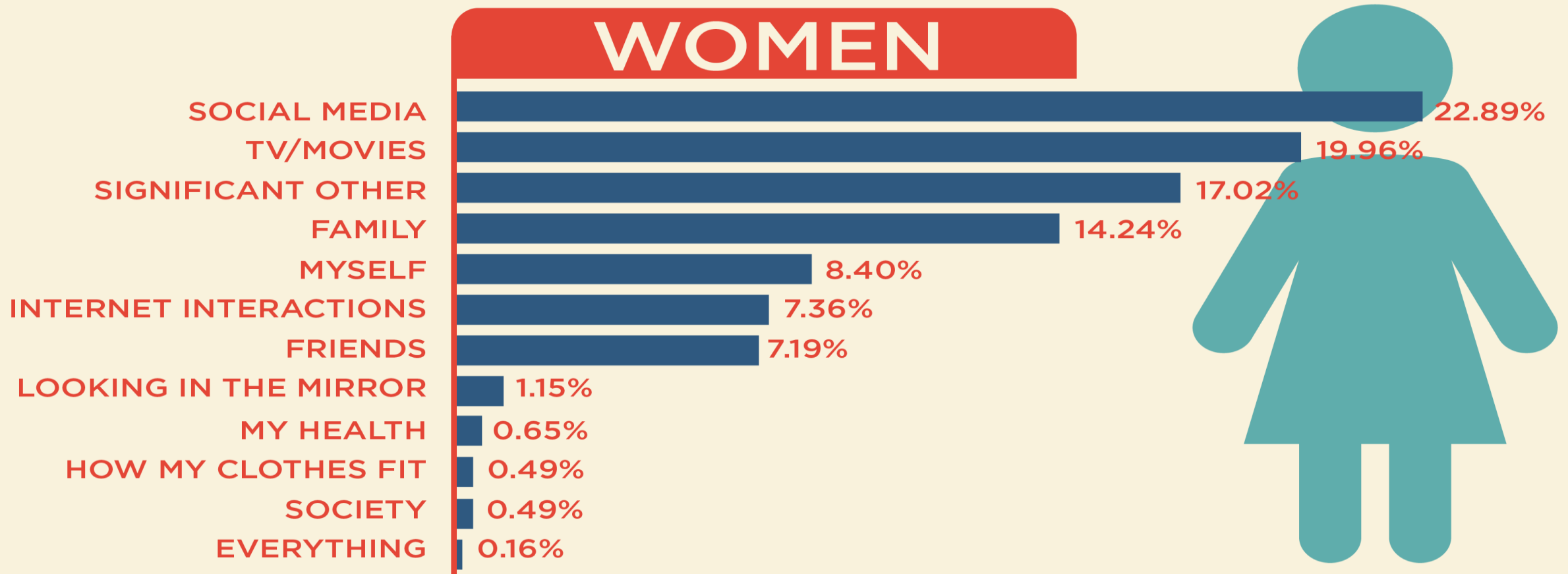
In our daily life and in research also, we often get large amount of information. To get a clear picture, statistics helps us either by simplifying such information by taking few figures to serve as a representative sample or by taking average to give a bird's eye view of the large masses. Complex data may be simplified by presenting them in the form of a tables, graphs or diagrams, or representing it through an average etc.

What Impacts How We Feel About Our Bodies?

MEN



What Impacts How We Feel About Our Bodies?

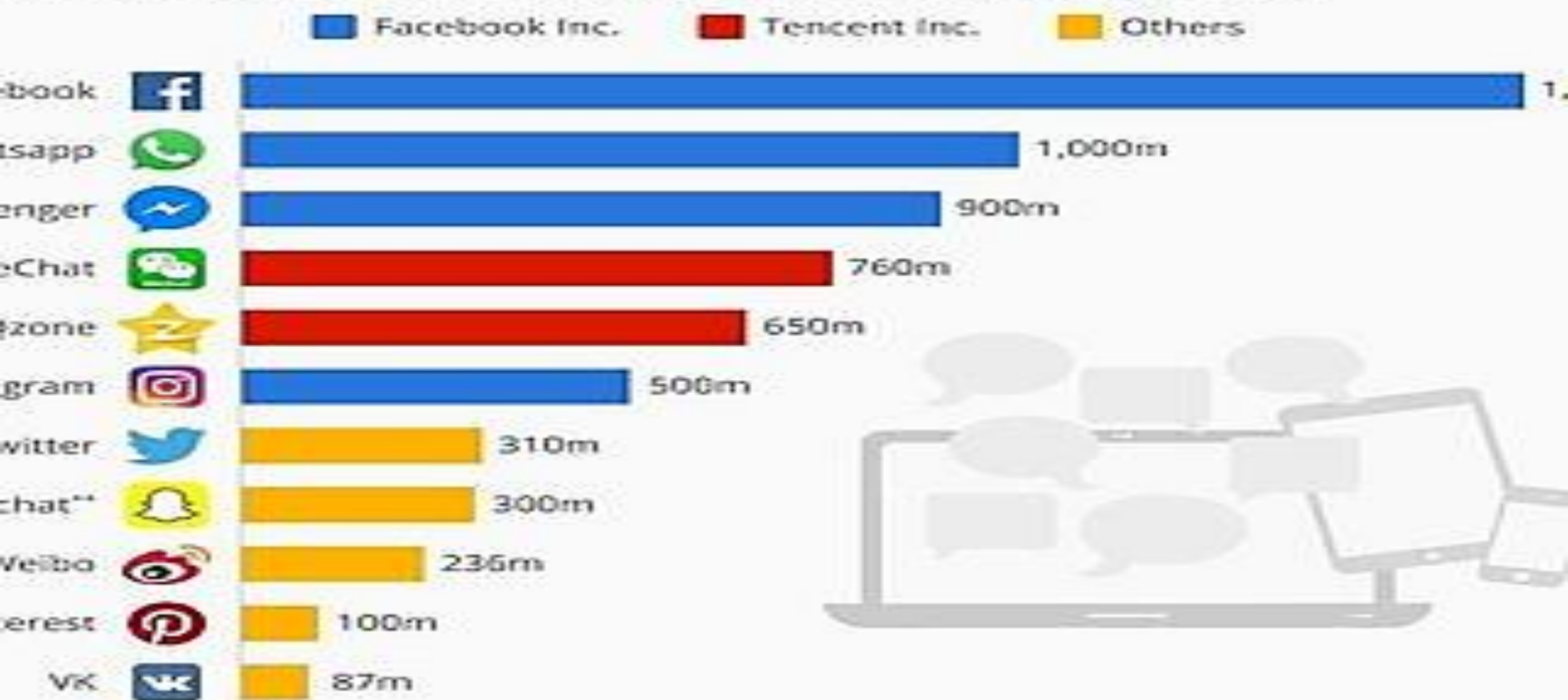


3- To use techniques for making comparisons

Often in research things become more clear and significant when they are compared with others of the same type. The comparison between two different groups is courtesy of certain statistical techniques, such as average, coefficients, rates, ratios, etc.

Facebook Inc. Dominates the Social Media Landscape

Monthly active users of selected social networks and messaging services*



* latest available data (Dec. 2015 - Jun. 2016)

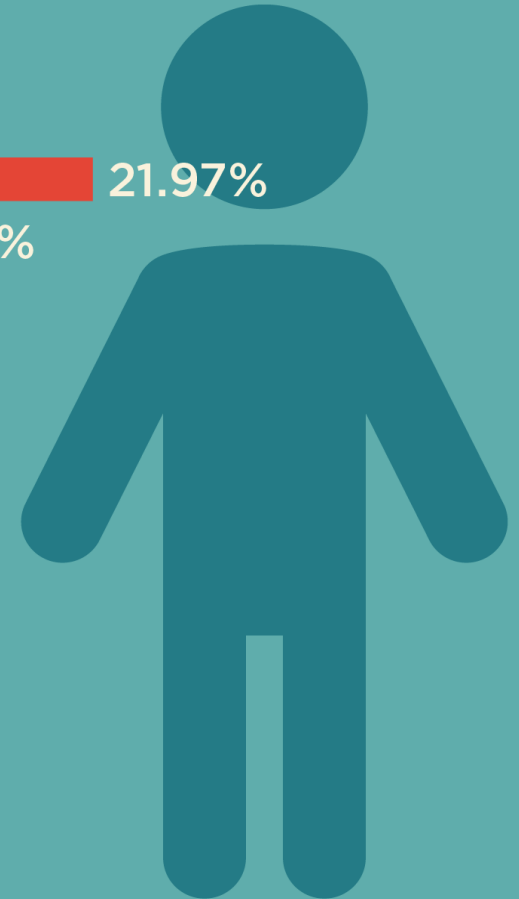
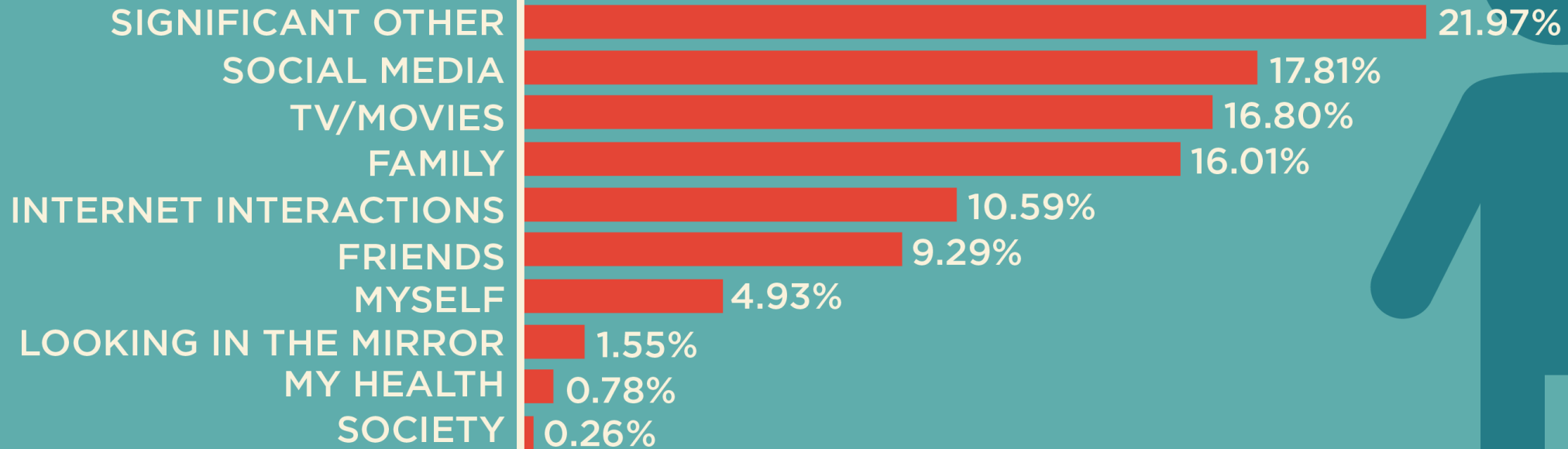
** estimate

4- To enlarge individual experience

- As an individual our knowledge is limited to what we can observe and see; and that is a very small part of the ocean of knowledge. Statistics extends our knowledge and experiences by presenting various conclusions and results, based on numerical investigations. For example, we daily listen and also have general impression that the cost of living has increased. But to know to what extent the increase has occurred, and how far the rise in prices have affected different income groups, it would be necessary to have a comparison of the rise in prices of articles consumed

What Impacts How We Feel About Our Bodies?

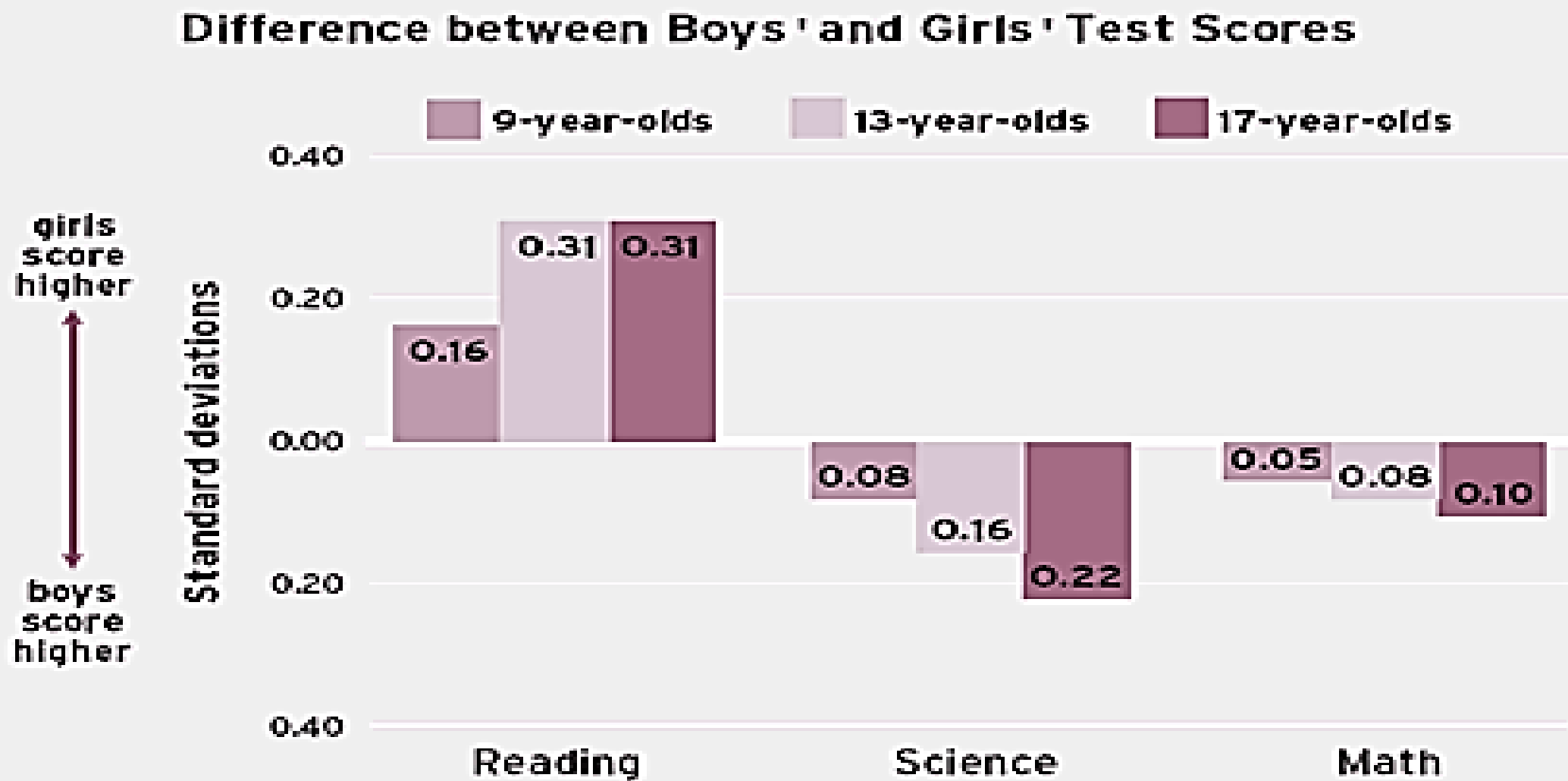
MEN



5- To provide guidance in the formulation of policies

- Statistics enable us to make correct decisions, whether they are taken by a businessman or government. In fact statistics is a great servant of business in management, government. Statistical methods are employed in industry in tackling the problem of standardization of products. Large industries maintain a separate department for statistical intelligence or statistical bureau, the work of which is to collect, compare and coordinate figures for formulating future policies of the firm regarding production and sales.

On a national assessment, boys score higher in math and science, while girls score higher in reading. The difference in reading, 0.3 standard deviations, is equivalent to approximately one grade level.



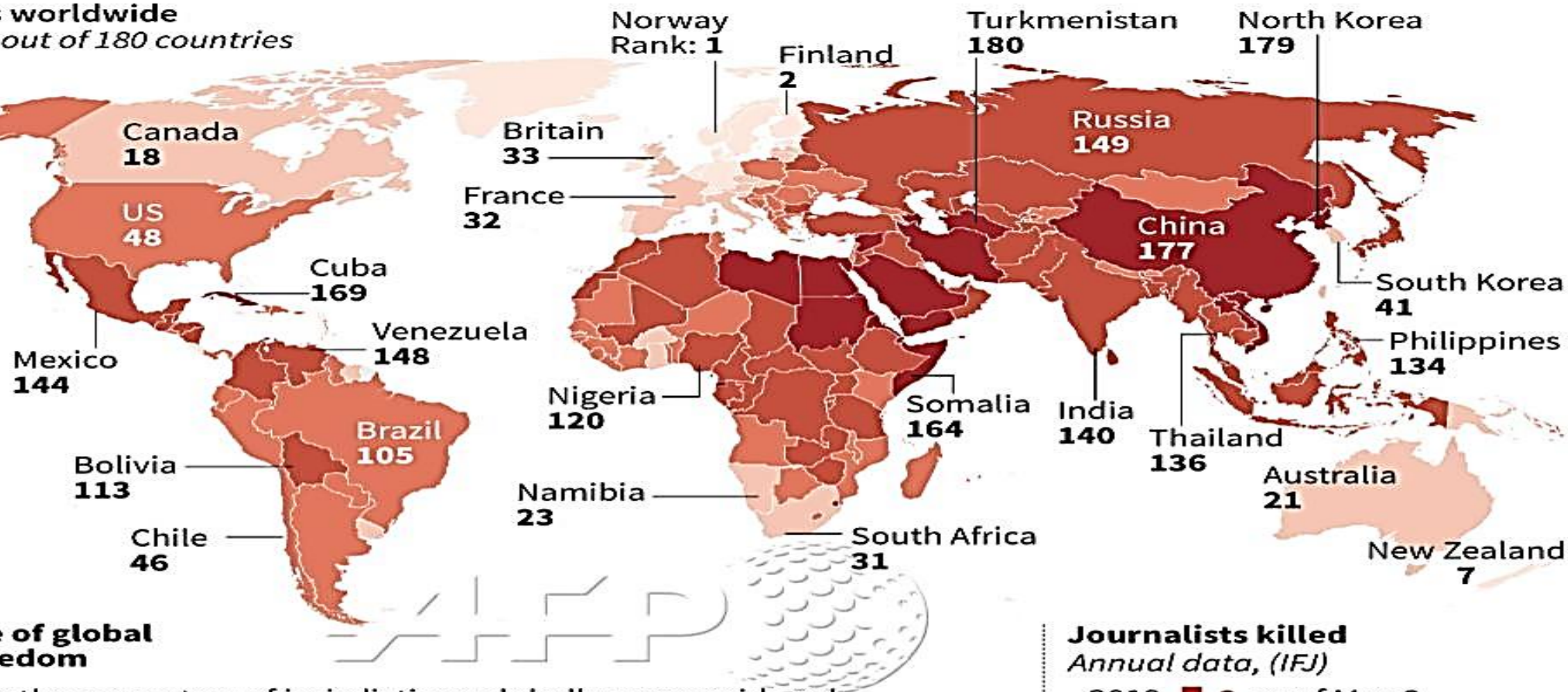
6- To enable measurement of the magnitude of a phenomenon

- Statistics enables us to measure the magnitude of a phenomenon under investigation. Estimate of the population of a country or the quantity of wheat, rice and other agricultural commodities produced in the country during any year are examples of such phenomena.

World press freedom

Rankings worldwide

Selected, out of 180 countries



The state of global press freedom

More than three quarters of jurisdictions globally are considered problematic or worse for press freedom

Percent of jurisdictions



Journalists killed

Annual data, (IFJ)



CHARACTERISTICS OF STATISTICS

- *i) Statistics consists of aggregate facts*
- The facts which can be studied in relation to time, place or frequency can be called statistics. A single isolated and unconnected fact or figure is not statistics because we cannot study it in relation to other facts and figures. Only aggregate of facts e.g. academic achievement of the students, I.Q. of a group of students, weight of students in a class, profit of a firm etc. are called statistics.

- *ii) Multiple causes affect Statistics*

- A phenomena may be affected by so many factors. We cannot study the effects of one factor on the phenomena only by ignoring others. To have a true picture we will have to study the effects of all factors on the phenomena separately as well as collectively, because effects of the factors can change with change of place, time or situation. For example, we can say that result of class X in board examination does not depend on any single factor but collectively on standard of teachers, teaching methods, teaching aids, practical's performance of students, standard of question papers, environment of the examination hall, exam supervisory staff and standard of evaluation of answers after the examination.

- ***iii) Data should be numerically expressed, enumerated or estimated***
- Data to be called statistics should be numerically expressed so that counting or measurement of data can be made possible. It means that the data or the fact must be in quantitative form as achievement scores 60, 50, 85, 78, and 91 out of 100. If it is not in quantitative form it should be quantified.

- ***iv) Statistics are enumerated or estimated according to reasonable standard of accuracy***
- For a clear picture of the phenomena under investigation, it should be researched using reasonable standard of accuracy depending upon the nature and purpose of collection of data. Data collection should be free from personal prejudices and biases. Biased and personally prejudiced data leads to inaccurate conclusion.

- *v) Statistics are collected in a Systematic Manner*
- In order to have reasonable standard of accuracy statistics/data must be collected in a very systematic manner. Any rough and haphazard method of collection will not be desirable for that may lead to improper and wrong conclusion.

- ***vi) Statistics for a Pre-determined Purpose***

- Before collection of data, investigator/researcher must have a purpose and then should collect data accordingly. Data collected without any purpose is of no use. Suppose we want to know intelligence of a section of people, we must collect data relating to I.O. level and data relating to income, attitude and interest level of that group of people will be of no use. Without having a clear idea about the purpose we will not be in a position to distinguish between necessary data and unnecessary data or relevant data and irrelevant data.

- *vii) Statistics are Capable of being placed in Relation to each other*
- Statistics is a method for the purpose of comparison etc. It must be capable of being compared; otherwise, it will lose much of its significance. Comparison can be made only if the data are homogeneous. Data on memory test can be compared with I.Q. It is with the use of comparison only that we can illustrate changes which may relate to time, place, frequency or any other character, and statistical devices are used for this purpose.

IMPORTANCE AND SCOPE OF STATISTICS

- Statistics is important in our daily life. We live in the information world and much of this information is determined mathematically with the help of statistics. It means statistics keeps us informed about day to day happening. Importance of statistics in our daily life is discussed under following headings.
- i) Every day we watch weather **forecasting**. It is possible due to some computer models based on statistical concepts. These models compare prior weather with the current weather and predict future weather.

- ii) Statistics is frequently used by the researchers. They use statistical techniques **to collect relevant data**. Otherwise there may be loss of money, time and other resources.
- iii) In business market statistics play a greater role in **Decision Making**. Statistical techniques are the key of how traders and businessmen invest and make money. Also, in industry, these tools are used in quality testing. Production managers are always interested to find out whether the product is confirming the specification or not. He uses statistical tools like inspection plan, control chart etc.

- iv) Statistics also has a big role in the **medical field**. Before any drugs prescribed, pharmacists show statistically valid rate of effectiveness. Similarly statistics is behind all other medical studies. Doctors predict diseases on the bases of statistical concepts.
- v) Print and electronic media use statistical tools to make **predictions of** winner of elections and coming government.

- vi) Statistics has widely been used in ***psychology and education to determine the reliability and validity to a test***, factor analysis etc.
- vii) Apart from above statistics has a wide application in marketing, production, finance, banking, investment, purchase, accounting and management control.

LIMITATIONS OF STATISTICS

- ***i) The use of statistics is limited to numerical studies***
- We cannot apply statistical techniques to all type of phenomena. These techniques can only be applied to the phenomena that are capable of being quantitatively measured and numerically expressed. For example, the health, intelligence, honesty, efficacy etc. cannot be quantitatively measured, and thus are unsuitable for statistical study. In order to apply statistical techniques to these constructs, first we will have to quantify them.

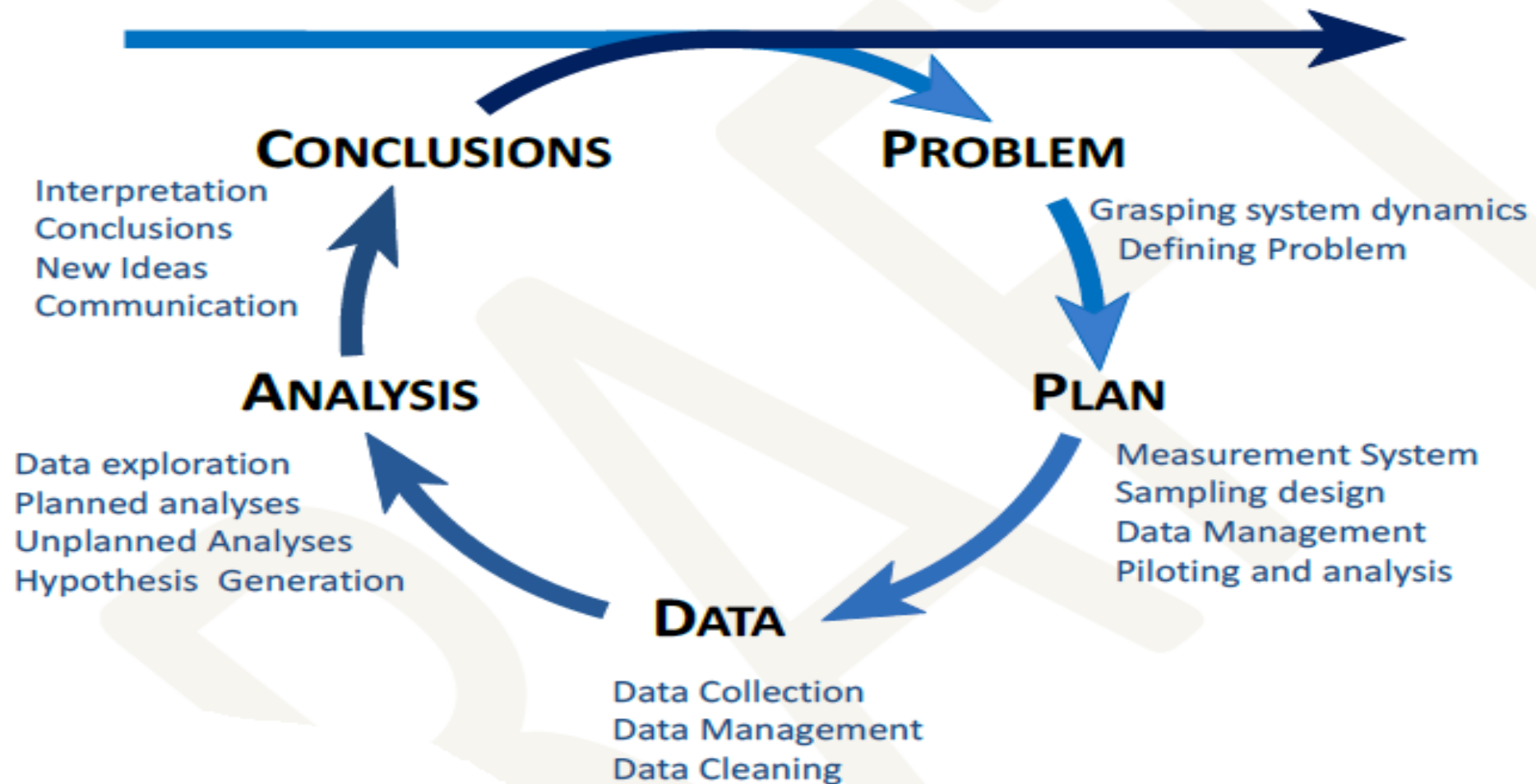
- ***ii) Statistical techniques deal with population or aggregate of individuals rather than with individuals***
- For example, when we say that the average height of a Pakistani is 1 meter and 80 centimeters, we mean to show the height not of an individual but as found by the study of all individuals living in Pakistan.

- ***iii) Statistics relies on estimation and approximations***
- Statistical techniques are not exact laws like mathematical or chemical laws. They are derived by taking a majority of cases and are not true for every individual. Thus the statistical inferences are uncertain.

- *iv) Statistical results might lead to fallacious conclusions*
- Statistical results are represented by figures, which are liable to be manipulated. Also the data placed in the hands of an expert may lead to fallacious results because figures may be stated without their context or may be applied to a fact other than the one to which they really relate. An interesting example is a survey made some years ago which reported that 33% of all the girl students at John Hopkins University dropped out in first semester of BS Applied Psychology. Whereas the University had only three girls student at that time and one of them was dropped out .

- ***“Statistics”*** as defined by the American Statistical Association (ASA) ***“is the science of learning from data, and of measuring, controlling and communicating uncertainty.”***

PPDAC



The statistical inquiry cycle

APPLICATION OF STATISTICS IN EDUCATIONAL RESEARCH

1. It helps the teacher to provide the most exact type of description.
2. It makes the teacher definite and exact in procedures and thinking.
3. It enables the teacher to summarize the results in a meaningful and convenient form.
4. It enables the teacher to draw general conclusions.
5. It helps the teacher to predict the future performance of the pupils,
6. Statistics enables the teacher to analyse some of the causal factors underlying complex and otherwise be-wildering events.

DESCRIPTIVE AND INFERENTIAL STATISTICS

Descriptive statistics

1. Descriptive statistics consist of methods for organizing and summarizing information. These are statistical procedures that are used to organize, summarize, and simplify data.
2. These techniques allow the researcher to describe large amount of information or scores in a few indices such as mean, median, standard deviation etc. These values for a sample is called statistics, for the entire population are called parameters.

Inferential Statistics

Inferential Statistics are techniques that allow a researcher to study samples and then make generalizations about the populations from which they are selected.

VARIABLES

- **A VARIABLE** is anything that varies.
- Variable is characteristic, trait or attribute that can be classified or measured.
- VARIABLE is a measurable characteristic that varies
- **Types of variables**
- **Quantitative Variables:** A broad category that includes any variable that can be counted, or has a numerical value associated with it. Example; height, weight, age etc
- **Qualitative Variables:** a broad category for any variable that can't be counted (i.e. has no numerical value) Example; Gender, country, roll numbers.

- Discrete Variables: a variable that can only take on a certain number of values. For example, “number of cars in a parking lot” is discrete because a car park can only hold so many cars. No. of Teachers, No. of rooms etc. it cannot have decimal or fractions logically.
- Continuous Variables: a variable with infinite number of values, like “time” or “weight”. These can have decimal values and fractional state.

- Independent variable: independent variables (IV) are those that are suspected of being the cause in a causal relationship. If you are asking a cause and effect question, your IV will be the variable (or variables if more than one) that you suspect causes the effect.
- Dependent variable : Dependent variables are those that are influenced by the independent variables. If you ask, "Does A cause [or predict or influence or affect, and so on] ," then B is the dependent variable (DV).
- Binary variable: a variable that can only take on two values, usually 0/1. Could also be yes/no, tall/short or some other two-variable combination. It is also called Dichotomous variable. Gender can have male and female values.
- Extraneous variable: Such factors other than the IV, which can create the same response as, like IV in DV.
- Control variable: variable that is kept constant to rule out its effects.

SCALES OF MEASUREMENT

- **Scale is the instrument used to provide the range of values or scores for each variable.**
- **There are four types of measurement scales**
 1. **Nominal Scale of Measurement**
 2. **Ordinal Scale of Measurement**
 3. **Interval Scale of Measurement**
 4. **Ratio Scale of Measurement**

- Nominal Scale of Measurement : it is also called a categorical variable because the values include two or more named categories (i.e., the word nominal comes from the Latin word for name).
- Examples: gender (e.g., female, male), employment status (e.g., full time, part time, unemployed), marital status (e.g., married, divorced, single), and type of school (e.g., public, private, charter). Likewise, nationality, socioeconomic status, race, occupation, or religious affiliation provide examples of nominal scale.
- **Ordinal SCALE OF Measurement**
- An ordinal variable **classifies persons or objects** and it **ranks** them as well. In other words, ordinal variables have, as their values, **rankings in order from highest to lowest or from most to least**.

- 3- interval SCALE OF Measurement
- **An interval variable has all the characteristics of nominal and ordinal variables, but its values also represent equal intervals. Examples:** Scores on most tests used in educational research, such as achievement, aptitude, motivation, and attitude tests, are treated as interval variables.
- 4- Ratio SCALE OF Measurement
- A ratio scale has the equal interval properties of an interval scale and it has **two additional features**:. The ratio scale has a true zero. The numbers of the ratio scale have the qualities of real numbers and can be added, subtracted, multiplied, and divided and expressed in ratio relationships.

TYPES OF DATA

- Primary data
- Primary data is originated by the researcher himself for the solution of problem in his own study. It can be collected by the researcher himself by survey, observations, physical testing, mailed questionnaire, questionnaire filled and sent by enumerators, personal interviews, telephonic interviews, focus groups discussion, case studies, etc.
- Secondary data
- The data used by the researcher already collected and recorded by any other person. Examples of secondary data are census data, publications, internal records of the organizations, reports, books, journal articles, websites etc.

EXPLORATORY DATA ANALYSIS

- Measures of Central Tendency
- Central tendency is a statistical measure to determine a single score that defines the centre of a distribution. The goal of central tendency is to find the single score that is most typical or most representative of the entire group.
- Mean
- Definition: The mean is the result of adding up all the numbers in our set and dividing by the total number of values. The mean for a distribution is the sum of the scores divided by the number of scores.
- Characteristics
- Changing a Score Changing the value of any score will change the mean.
- Introducing a New Score or Removing a Score Adding a new score to a distribution, or removing an existing score, will usually change the mean. The exception is when the new score (or the removed score) is exactly equal to the mean.

MEDIAN

- Scores in a distribution are listed in order from smallest to largest, the **median** is the midpoint of the list.

n = Number of scores

- Median is the point on the measurement scale below which 50% of the scores in the distribution are located.

1. In case if n is an odd number = order (lowest to highest) then median is the middle score in the list

2. If n is an even number = order (lowest to highest) then locate the median by finding the average of the middle two scores.

MODE

- The **mode** is the score or category that has the greatest Frequency. In this way mode is the most **frequently occurring score**

WHEN TO USE MEAN, MEDIAN AND MODE

- MEAN

1. whenever the scores are numerical values (interval or ratio scale)
2. Besides being a good representative, the mean has the added advantage of being closely related to variance and standard deviation, the most common measures of variability.

- Median

1. Extreme Scores or Skewed Distributions. The median, on the other hand, is not easily affected by extreme scores.
2. Undetermined Values
3. Ordinal Scale

- Mode

1. Nominal Scales
2. Discrete Variables

MEASURES OF DISPERSION

4.1.1 Range

The range is the simplest measure of spread and is the difference between the highest and lowest scores in a data set. In other words we can say that range is the distance between largest score and the smallest score in the distribution. We can calculate range as:

Range = Highest value of the data – Lowest value of the data

For example, if lowest and highest marks scored in a test are 22 and 95 respectively, then

$$\text{Range} = 95 - 22 = 73$$

- Mean Deviation or Average Deviation
- The mean or the average deviation is defined as the arithmetic mean of the deviations of the scores from the mean.
- For ungrouped data
- $M.D = \Sigma X - X / N$
- Standard Deviation
- Standard deviation tells how tightly all the scores are clustered around the mean in a data set. When the scores are close to the mean, standard deviation is small. And large standard deviation tells that the scores are spread apart. Standard deviation is simply square root of variance, i.e. $Standard\ deviation = \sqrt{Variance}$

- 4.1.6 Variance
- The variance of a set of scores is denoted by σ^2 and is defined as
- $\sigma^2 = \Sigma (X - \bar{X})^2 / n$

THE NORMAL CURVE

- *Normal Distribution indicate*
- normal, or bell-shaped, curve
- Fifty percent of the scores are above the mean, and 50% are below the mean.
- The mean, the median, and the mode have the same value.
- Most scores are near the mean. The farther from the mean a score is, the fewer the number of participants who attained that score.
- For every normal distribution, 34.13% of the scores fall between the mean and one standard deviation above the mean, and 34.13% of the scores fall one standard deviation below the mean (Figure)
- In other words, 68.26% of the scores are within one standard deviation of the mean ($34.13\% + 34.13\%$).
- More than 99% of the scores will fall somewhere between three standard deviations above and three standard deviations below the mean.

INFERENTIAL STATISTICS

- Inferential statistics are data analysis techniques for determining how likely it is that results obtained from a sample or samples are the same results that would have been obtained from the entire population.
- Explanation:
- In another way, inferential statistics are used to make inferences about parameters, based on the statistics from a sample. In the simplest language, whereas descriptive statistics show how often or how frequent an event or score occurred, inferential statistics help researchers to know whether they can generalize to a population of individuals based on information obtained from a limited number of research participants. As an example, imagine that a depression reduction program was implemented in an experimental research. It was found that people who attended the program scored significantly less on a depression measurement test than those who did not attend that program. (say, $\bar{X}_E = 5.35$ and $\bar{X}_C = 5.43$). Can this difference be generalized to the larger population or other samples within it? Would the program be equally successful at the district or state levels? Perhaps, although it's possible that the difference between the original two samples occurred just by chance (possibly due to characteristics of the particular individuals or area sampled). And now we get to the heart of inferential statistics, the concept of "how likely is it?". Inferential statistics allow researchers to determine the likelihood that the difference between the two means (\bar{X}_C) and mean (\bar{X}_E) is a real, significant one, rather than one attributable to sampling error. Inferential statistics use data from samples to assess likelihood (i.e., inferential statistics produce probability statements about the populations), not guarantees. The degree to which the results of a sample can be generalized to a population is always expressed in terms of probabilities; analyses do not "prove" that hypotheses are true or false.

TYPES OF INFERENCE STATISTICS

- Parametric tests
- These are considered to be the most powerful tests and should be used if their basic assumptions can be met. These assumptions are based on the nature of the population distribution and on the way the type of scale is used to quantify the data observations. However, some parametric tests (the t test and analysis of variance, in particular) are quite robust and are appropriate even when some assumptions are violated.. The assumptions for most parametric tests are the following:
 - 1. The observations are independent. The selection of one case is not dependent on the selection of any other case (there are specific parametric tests for non-independent samples).
 - 2. The samples have equal, or nearly equal, variances. This condition is particularly important to determine when samples are small.
 - 3. The variables described are expressed in interval or ratio scales. Nominal measures (frequency counts) and ordinal measures (ranking) do not qualify for parametric treatment.

- Nonparametric Tests
- The parametric tests are generally quite robust; that is, they are useful even when some of their mathematical assumptions are violated. However, sometimes it is necessary, or preferable, to use a nonparametric or distribution-free test.
- Nonparametric tests are appropriate when
- 1. The nature of the population distribution from which samples are drawn is not known to be normal.
- 2. The variables are expressed in nominal form (classified in categories and represented by frequency counts).
- 3. The variables are expressed in ordinal form (ranked in order, expressed as first, second, third, etc.).

THE LOGIC OF HYPOTHESIS TESTING

- A hypothesis is a researcher's prediction of the research findings, a statement of the researcher's expectations about the relations among the variables in the research topic.
- Non-directional hypothesis predicts only that a relation or difference exists.
- A directional hypothesis indicates the direction of the difference as well.
- A hypothesis test : A hypothesis test is a statistical method that uses sample data to evaluate a hypothesis about a population.
- Stating Hypothesis
- A general paradigm, or model, for stating hypotheses for experimental studies is P who get X do better on Y than P who do not get X (or get some other X). P refers to participants, X refers to the treatment or independent variable (IV), and Y refers to

STEPS IN HYPOTHESIS TESTING

- Step one State the hypothesis.
- The process of hypothesis testing begins by stating a hypothesis about the unknown population. Actually, two opposing hypotheses are stated. Both hypotheses are stated in terms of population parameters. The first and most important of the two hypotheses is called the null hypothesis. The null hypothesis states that the treatment has no effect. In general, the null hypothesis states that there is no change, no effect, no difference—nothing happened, hence the name null. The null hypothesis is identified by the symbol H_0 . (The H stands for hypothesis, and the zero subscript indicates that this is the zero-effect hypothesis.)
- The null hypothesis (H_0) states that in the general population there is no change, no difference, or no relationship. In the context of an experiment, H_0 predicts that the independent variable (treatment) has no effect on the dependent variable (scores) for the population. The second hypothesis is simply the opposite of the null hypothesis, and it is called the scientific, or alternative, hypothesis (H_1). This hypothesis states that the treatment has an effect on the dependent variable. The alternative hypothesis (H_1) states that there is a change, a difference, or a relationship for the general population. In the context of an experiment, H_1 predicts that the independent variable (treatment) does have an effect on the dependent variable.

- Step Two Set the criteria for a decision.
- The Alpha Level
- To find the boundaries that separate the high-probability samples from the low-probability samples, it must define exactly what is meant by “low” probability and “high” probability. This is accomplished by selecting a specific probability value, which is known as the level of significance, or the alpha level, for the hypothesis test. The alpha (α) value is a small probability that is used to identify the low-probability samples. By convention, commonly used alpha levels are $\alpha = .05$ (5%), $\alpha = .01$ (1%), and $\alpha = .001$ (0.1%). For example, with $\alpha = .05$, we separate the most unlikely 5% of the sample means (the extreme values) from the most likely 95% of the sample means (the central values).

- Step Three Collect data and compute sample statistics. Data are collected after the researcher has stated the hypotheses and established the criteria for a decision.
- This sequence of events helps ensure that a researcher makes an honest, objective evaluation of the data and does not tamper with the decision criteria after the experimental outcome is known.
- Next, the raw data from the sample are summarized with the appropriate statistics:

- Step Four: Make a decision. In the final step, the researcher uses the z-score value obtained in Step 3 to make a decision about the null hypothesis according to the criteria established in Step 2.
- If sample data are located in the critical region. By definition, a sample value in the critical region is very unlikely to occur if the null hypothesis is true. Therefore, we conclude that the sample is not consistent with H_0 and our decision is to reject the null hypothesis. Remember, the null hypothesis states that there is no treatment effect, so rejecting H_0 means we are concluding that the treatment did have an effect.

- 6.4 T-Test
- A t-test is a useful statistical technique used for comparing mean values of two data sets obtained from two groups. The comparison tells us whether these data sets are different from each other. It further tells us how significant the differences are and if these differences could have happened by chance. The statistical significance of t-test indicates whether or not the difference between the mean of two groups most likely reflects a real difference in the population from which the groups are selected.
- t-tests are used when there are two groups (male and female) or two sets of data (before and after), and the researcher wishes to compare the mean score on some continuous variable.

TYPES OF T.TEST.

i) Independent sample t-test

- Independent sample t-test is used when there are two different independent groups of people and the researcher is interested to compare their scores. In this case the researcher collects information from two different groups of people on only one occasion.
- ii) Paired sample t-test
- Paired sample t-test is also called repeated measures. It is used the researcher is interested in comparing changes in the scores of the same group tested at two different occasions.

ASSUMPTIONS OF T TEST

- The first assumption regarding t-test concerns the scale of measurement. It means that it is assumed that the dependent variable is measured at interval or ratio scale.
- The second assumption made is that of a simple random sample, that the data is collected from a representative, randomly selected portion of the total population.
- The third assumption is that the data, when plotted, results in a normal distribution i.e. in bell-shaped distribution curve.
- The fourth assumption is that the observation that make up data must independent of one another. That is, each observation or measurement must not be influenced by any other observation or measurement.
- The fifth assumption is that a reasonably large sample size is used. A large sample size means that the distribution of results should approach a normal bell-shaped curve.
- The final assumption is homogeneity of variance. Variance will be homogeneous or equal when the standard deviation of samples is approximately equal.

CORRELATION

- A correlation is a relationship between two variables. The purpose of using correlation in research is to determine the degree to which a relationship exists between two or more variables. Correlation is important in research because several hypotheses are stated in terms of correlation or lack of correlation between two variables, so correlational studies are directly related to such hypotheses.
- Regression is used when the relationship includes a dependent variable and one or more independent variables. It helps us understand which among the independent variables are related to the dependent variable, and to explore the forms of these relationships.
- Owing to the importance of correlation and regression in research, these are given in this unit in detail.

CHARACTERISTICS OF RELATIONSHIP THAT CORRELATION MEASURES

- The Direction of the Relationship
- **The form of the Relationship**
- **The Degree of the Relationship**
- Types of Correlation
- The Pearson Correlation
- **The Spearman Correlation**
- The most commonly used correlation is the Pearson Correlation. It is also known as Pearson product-moment Correlation. It measures the degree and the direction of linear relationship of between two variables. It is denoted by r , and $r = \text{degree to which X and Y vary together} / \text{degree to which X and Y vary separately} = \text{co-variability of X and Y} / \text{variability of X and Y vary separately}$

ANOVA

Analysis of Variance (ANOVA) is a hypothesis testing procedure that is used to evaluate mean differences between two or more treatments (or population). Like all other inferential procedures, ANOVA uses sample data to as a basis for drawing general conclusion about populations. Sometime, it may appear that ANOVA and t -test are two different ways of doing exactly same thing: testing for mean differences. In some cased this is true – both tests use sample data to test hypothesis about population mean. However, ANOVA has much more advantages over t -test. t -tests are used when we have compare only two groups or variables (one independent and one dependent). On the other hand ANOVA is used when we have two or more than two independent variables (treatment). Suppose we want to study the effects of three different models of teaching on the achievement of students. In this case we have three different samples to be treated using three different treatments. So ANOVA is the suitable technique to evaluate the difference.

A Chi-Square Statistic is one way to a relationship between two categorical (non-numerical) variables. The Chi-Square Statistic is a single number that tells us how much difference exists between the observed counts and the counts that one expects if there is no relationship in the population.

There are two different types of chi-square tests, both involve categorical data. These are:

- a) A chi-square goodness of fit test.
- b) A chi-square test of independence.

- When to Use the Chi-Square Goodness of Fit Test?
- The chi-square goodness of fit test is appropriate when the following conditions are met:
 - ☐ The sampling method is simple random.
 - ☐ The variable under study is categorical.
 - ☐ The expected value of the number of sample observation in each level of the variable is at least 5.