Session: Information and Data Literacy

Computational Thinking and 21st Century Skills
Orientation Program
Sri Lanka Institute of Information Technology

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Previous Lecture

- Computer Networks & Internet

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Delivered by

Dr. Anuradha Karunasena

Department of Information Technology

Faculty of Computing

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Section 01: Identifying problems and their data requirements

- Introduction to Data and Information
- Identifying a Problem
- Business Problems which can solve using Data and Information
- Quality and Relevance of Data/Information Sources
- Ethical and Legal issues related to the use of Data/Information

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Section 02 : Plan how to gather the necessary Data

- Variety of techniques used to Data/Information Collection
- Data collection methods
- Qualitative and quantitative data gathering techniques

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- Descriptive statistics using spreadsheets

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Section 04: Presenting findings using appropriate tools

- Data visualization techniques
- Interpret tables, charts, and visualizations.
- Developing presentation materials to communicate findings

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Introduction to Data and Information

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Introduction to Data and Information

- What is Data ?
  - Data can be defined as a representation of facts, concepts, or instructions in a formalized manner, which should be suitable for communication, interpretation, or processing by human or electronic machine.
  - Data is represented with the help of characters such as alphabets (A-Z, a-z), digits (0-9) or special characters (+,-,/,*,<,>,= etc.)

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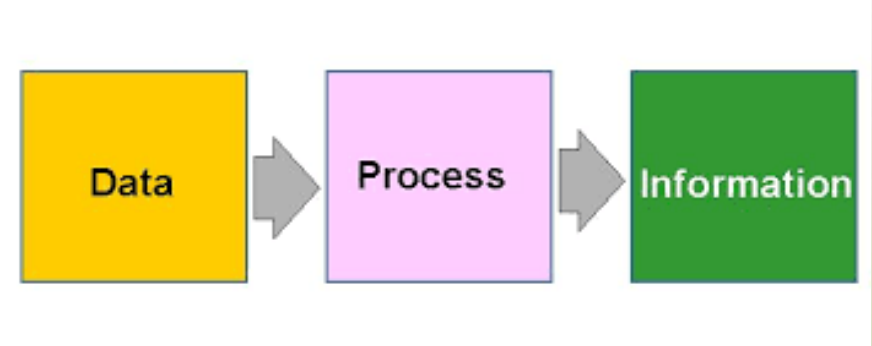
Introduction to Data and Information

- What is Information?
  - Information is organized or classified data, which has some meaningful values for the receiver.
  - Information is the processed data on which decisions and actions are based.



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Introduction to Data and Information

- For the decision to be meaningful, the processed data must qualify for the following characteristics :
  - **Timely** − Information should be available when required.
  - **Accuracy** − Information should be accurate.
  - **Completeness** − Information should be complete.

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Introduction to Data and Information

Comparison between Data and Information

Data	Information
1. Derived from Latin word ‘Datum’	1. Derived from word ‘informare’
2. Data is raw fact.	2. Processed form of data.
3. Data is based on Records & Observations	3. Information based on analysis
4. May or may not be meaningful.	4. Always meaningful.
5. Input to any system may be treated as data.	5. Output after processing system is information.
6. Understanding is difficult	6. Understanding is easy.
7. Data may not be in order.	7. Information should be in order.

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Introduction to Data and Information

Examples for Data & Information

Data	Information
Each student's test score	The average score of a class
History of temperature readings all over the world for the past 100 years	Global temperature is rising
Ticket sales on a band on tour.	Sales report by region and venue (which venue is profitable for that business)
Employee Names	Pay-slips
Product names	Invoices

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Section 01 :

Identifying Data Needs Related to a Problem

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What is a Problem?

- A problem occurs when there is a difference between what "should be" and what "is"; between the ideal and the actual situation.
- A problem:
  - expresses the difference between the hoped for and the actual situation
  - is directly or indirectly related to a desired outcome or standard of behavior

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Identifying a Problem

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Identifying a Problem

- Problem Identification consists of:
  - Clearly identifying the root cause of a problem
  - Developing a detailed problem statement that includes the effects of problem.
- Identifying a very clearly defined and specific problem is the first critical step to successfully implementing the problem-solving process.

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Business Problems which can solve using Data and Information

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Business Problems which can solve using Data and Information

- Finding what kinds of marketing campaigns are suitable for customers.
- Forecasting prices, demands, revenues & etc. in a business organization in future.
- Finding fraudulent and trustworthiness customers.
- Finding personal preferences of customers.

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Data Collection Techniques

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Variety of Techniques used to Data/ Information Collection

- Techniques of Data or Information Collection:

  1. Observations : A method under which data from the field is collected with the help of observation by the observer or by personally going to the field. It may be defined as systematic viewing, coupled with consideration of seen phenomenon

  2. Questionnaire Method : A list of questions pertaining to the survey (known as questionnaire) is prepared and sent to the various informants by post.

  3. Interview Method : This method of collecting data involves presentation or oral-verbal stimuli and reply in terms of oral-verbal responses.

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Variety of Techniques used to Data/ Information Collection

4. Case study : A form of qualitative analysis involving the very careful and complete observation of a person, a situation or an institution.

5.Focus Group: Small homogenous groups of people are brought together to informally discuss specific topics under the guidance of a moderator.

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Quality and Relevance of Data/Information Sources

Presentation Title

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Quality and Relevance of Data/Information Sources

- Five components that ensure data quality:
  - **Completeness:** Ensuring there are no gaps in the data from what was supposed to be collected and what was actually collected.
  - **Consistency:** The types of data must align with the expected versions of the data being collected.
  - **Accuracy:** Data collected is correct, relevant and accurately represents what it should.
  - **Validity:** Validity is derived from the process instead of the final result.
  - **Timeliness:** The data should be received at the expected time in order for the information to be utilized efficiently.

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Quality and Relevance of Data/Information Sources

- Two Types of Data Resources:

  1) Primary Data : Are those which are collected a fresh and for the first time and thus happen to be original in character and known as Primary data.

  Sources : Survey, Observations, Physical Testing, Mailed Questionnaires, Questionnaire

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Quality and Relevance of Data/Information Sources

2) Secondary Data : Are those which have been collected by someone else and which have already been passed through the statistical process are known as Secondary data.

Sources: Registers, Government publications, Internal records of the organization, Reports, Books, Journal articles and Websites

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Ethical and Legal Issues Related to the Use of Data/Information

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Ethical and Legal Issues Related to the Use of Data/Information

- According to the General Data Protection Regulation (GDPR- agreed upon by the European Parliament), Some of the key privacy and data protection requirements :
  - Requiring the consent of subjects for data processing
  - Anonymizing collected data to protect privacy
  - Providing data breach notifications
  - Safely handling the transfer of data across borders
  - Requiring certain companies to appoint a data protection officer to oversee GDPR compliance

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Section 02 :

Plan How to Gather the Necessary Data

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Data Collection

- Process of systematic gathering of data for a particular purpose from various sources, that has been systematically observed.
- There are several ways of collecting data.
- The choice of procedures usually depends on the objectives and design of the study and the availability of time, money and personnel.

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Qualitative and Quantitative Data Gathering Techniques

Presentation Title

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Qualitative and Quantitative Data

- **Quantitative Data :**
  - These are data that deal with quantities, values or numbers, making them measurable.
  - They are usually expressed in numerical form, such as length, size, amount, price, and even duration.
  - The statistical techniques used to generate and subsequently analyze this type of data so that quantitative data is overall seen as more reliable and objective.
  - Example : No of students per intake, Height, Weight

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Qualitative and Quantitative Data

- **Qualitative Data :**
  - These data are descriptive rather than numerical in nature.
  - They are generally not measurable, and are only gained mostly through observation.
  - Narratives often make use of adjectives and other descriptive words to refer to data on appearance, color, texture, and other qualities.
- Example : Gender: male/female

  Disease: present/absent

  Smoke: smoking/not smoking

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Section 03:

Analyzing and Interpreting Data

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Processing Data using Spreadsheets

Processing data using spreadsheets

- A spreadsheet or worksheet is a file made of rows and columns that help sort data, arrange data easily, and calculate numerical data.
- What makes a spreadsheet software program unique is its ability to calculate values using mathematical formulas and the data in cells.

Example :

Creating an overview of your bank's balance.

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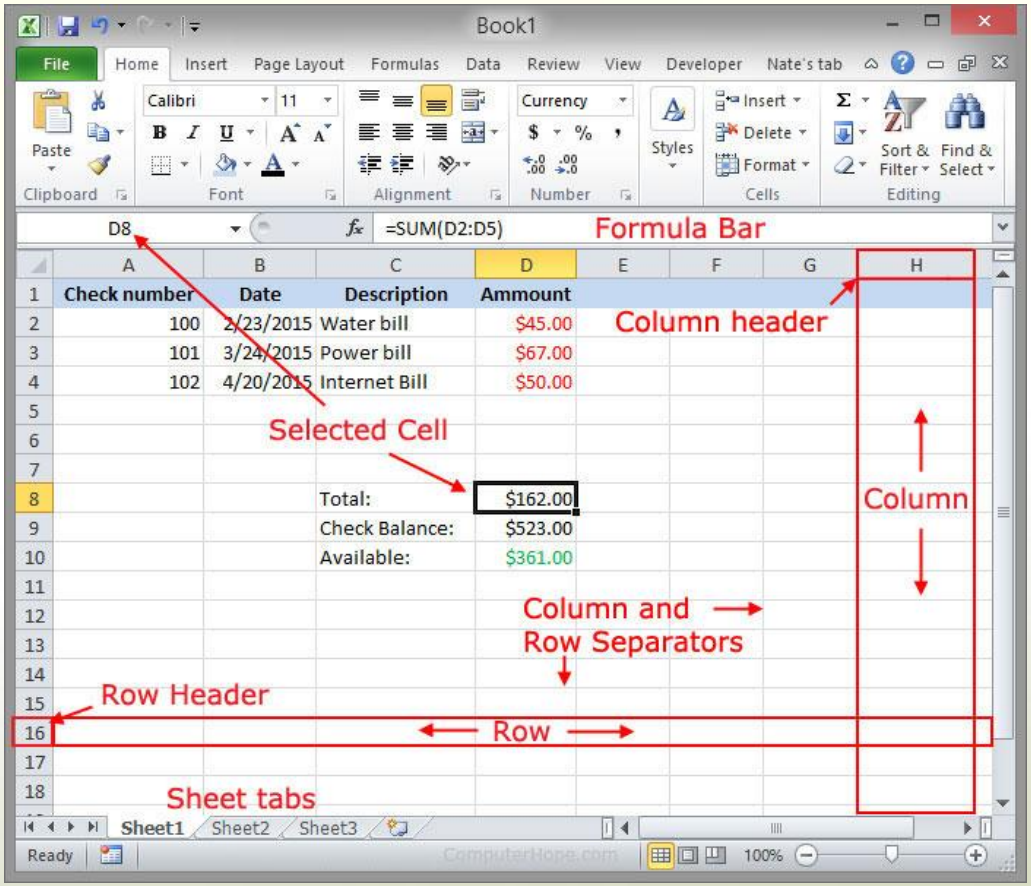
Processing Data using Spreadsheets

Spreadsheet Overview :



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Processing Data using Spreadsheets

Examples of spreadsheet programs

Today, Microsoft Excel is the most popular and widely used spreadsheet program, but there are also many alternatives such as :

- Google Sheets - (online and free)
- iWork Numbers - Apple Office Suite
- Lotus Symphony - Spreadsheets
- OpenOffice -> Calc (free)

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Processing Data using Spreadsheets

Examples and uses of a spreadsheet

- **Finance:** account information, budgets, taxes, transactions, billing, invoices, receipts, forecasts, and any payment system.
- **Forms:** Inventory handling, evaluations, performance reviews, quizzes, time sheets, patient information, and surveys.
- **School and grades** : track students, calculate grades, and identify relevant data, such as high and low scores, missing tests
- **Lists:** telephone, to-do, and grocery.

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Tools for Data Analysis

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Tools for Quantitative Data Analysis

Quantitative Data Analysis	Qualitative Data Analysis
Excel	NVIVO
Minitab	HubSpot
SPSS	MAXQDA
Stata	Quirkos
SAS	Qualtrics
MATLAB	Raven's Eye

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Data Analysis Process

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Data Analysis Process

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Data Analysis Process

- **Step 1: Define why you need data analysis**
  - At first, it is essential to define the need for data analysis
  - Consider which metrics to track along the way and Identify sources of data when it comes time to collect.

Example:

- **Need:** How to Find and Buy a Good Used Car

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Data Analysis Process

- **Metrics to Track:**
  - Brands of Used Cars
  - Prices of Used Cars
  - Features of Cars
    - Fuel Consumption
    - Engine Capacity
  - Locations of Used Cars for Sales
  - Vehicle History Reports

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Data Analysis Process

Step 2: Data collection

- After a purpose has been defined, it's time to begin the data collection.

- This step is important because whichever sources of data are chosen will determine how in-depth the analysis is.

Example: Available Sources of Data for selecting a used car

- Web Sites – Selling Websites
- News Papers/Magazines

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Data Analysis Process

Step 3: Data cleaning

- Once data is collected from all the necessary sources, data should be cleansed and sorted.
- Data cleaning is very important during the data analysis process, as not all data is good data.
- To generate accurate results, it is necessary to identify and purge duplicate data, anomalous data, and other inconsistencies.

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Data Analysis Process

Step 4: Data Analysis

- One of the last steps in the data analysis process is analyzing and manipulating the data.
- This can be done in a variety of ways :

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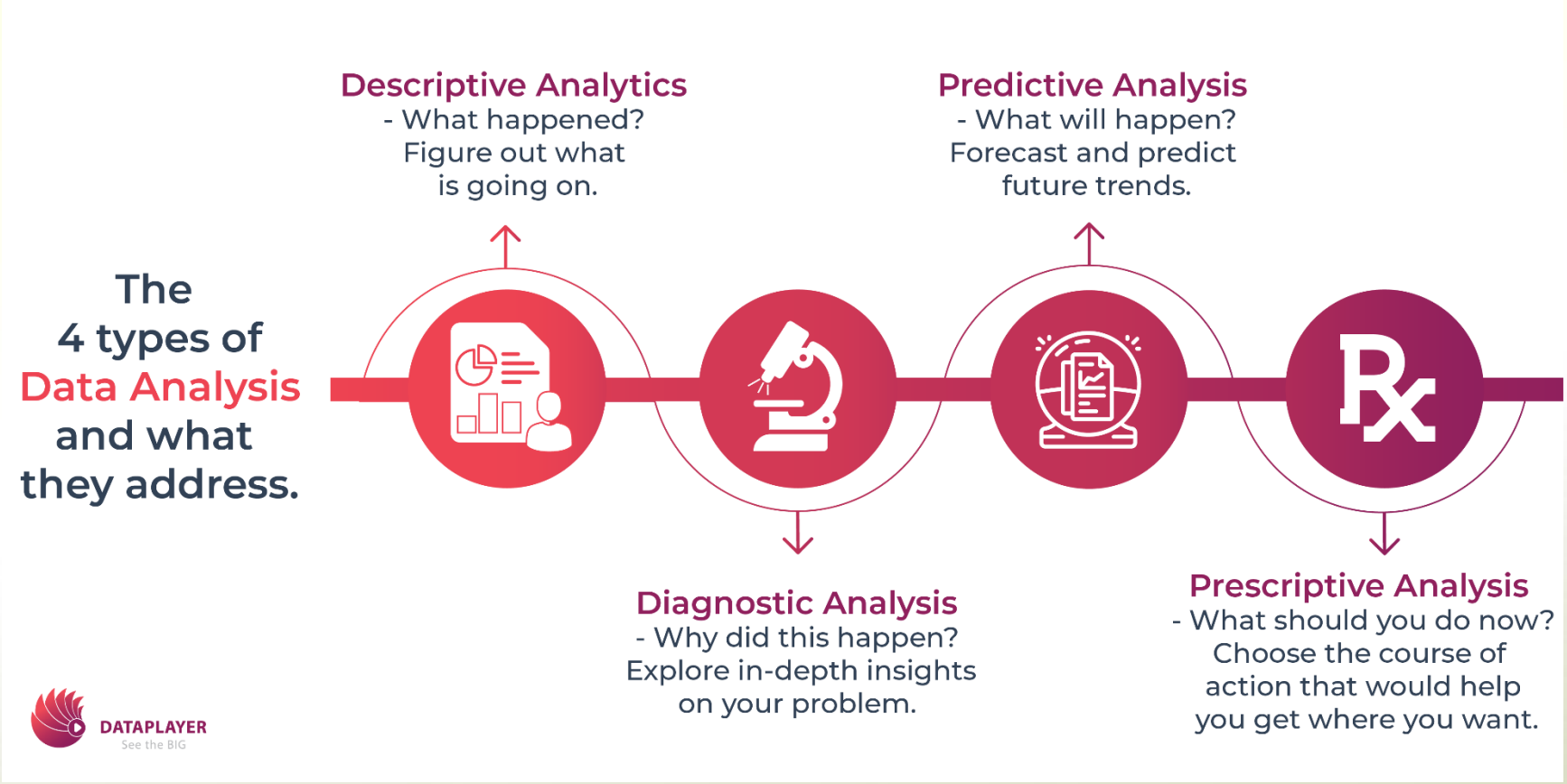
Data Analysis Process



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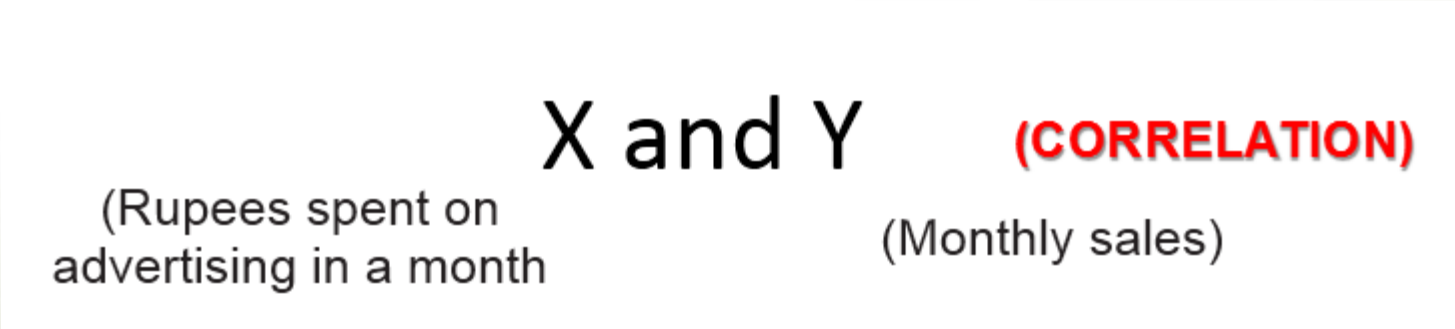
Data Analysis Process
Correlation :

- **Correlation:** Correlation is used to represent the linear relationship between two variables.
- Every business analyst should have the ability to estimate the relationship between important business variables.



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Data Analysis Process
Correlation :

Correlation Coefficient :

- The correlation Coefficient (usually denoted by r) between two variables (call them x and y) is a unit-free measure of the strength of the **linear relationship** between x and y.
- The correlation between any two variables is always between –1 and +1.

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Data Analysis Process Correlation :

- A correlation near +1 means that x and y have a strong positive linear relationship.
- That is, when x is larger than average, y tends to be larger than average, and when x is smaller than average, y also tends to be smaller than average.

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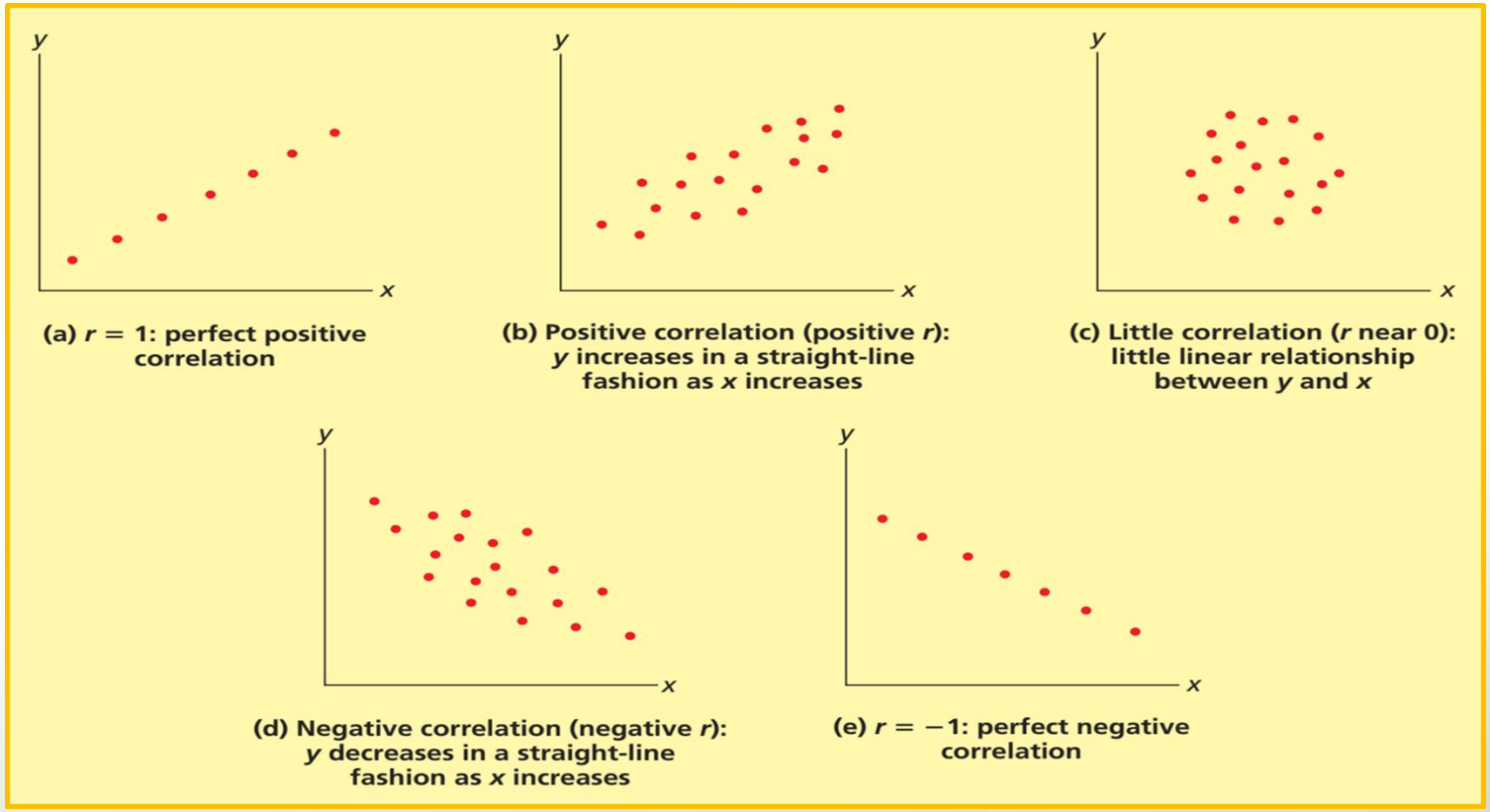
Data Analysis Process Correlation :

- Different Values of the Correlation Coefficient



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Data Analysis Process Correlation :

$$-1 \leq r \leq 1$$

Furthermore:

- Positive values denote positive linear correlation;
- Negative values denote negative linear correlation;
- A value of 0 denotes no linear correlation;
- The closer the value is to 1 or –1, the stronger the linear correlation.

- .00-.19 “very weak”
- .20-.39 “weak”
- .40-.59 “moderate”
- .60-.79 “strong”
- .80-1.0 “very strong”

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Data Analysis Process
Correlation :

X - Age of the Used Car

Y - Price of the Used Car

$$Correl(X,Y) = \frac{\sum (x-\bar{x})(y-\bar{y})}{\sqrt{\sum (x-\bar{x})^2 \sum (y-\bar{y})^2}}$$

=CORREL(array1, array2)

Age of the Used car (Years)	Price of the Used Car (LKR)
6	3,775,000
5	6,450,000
8	3,460,000
9	3,300,000
12	1,600,000
14	1,450,000
15	1,100,000
5	4,300,000
10	2,600,000
11	1,850,000
11	1,650,000
15	1,150,000
11	1,920,000
5	4,090,000
8	3,345,000
6	3,950,000
10	2,600,000
9	2,730,000
13	1,585,000
11	2,050,000

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Data Analysis Process Correlation :

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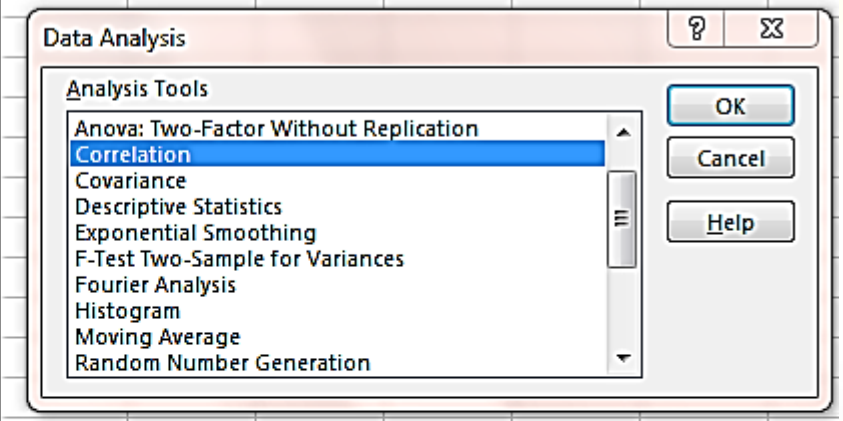

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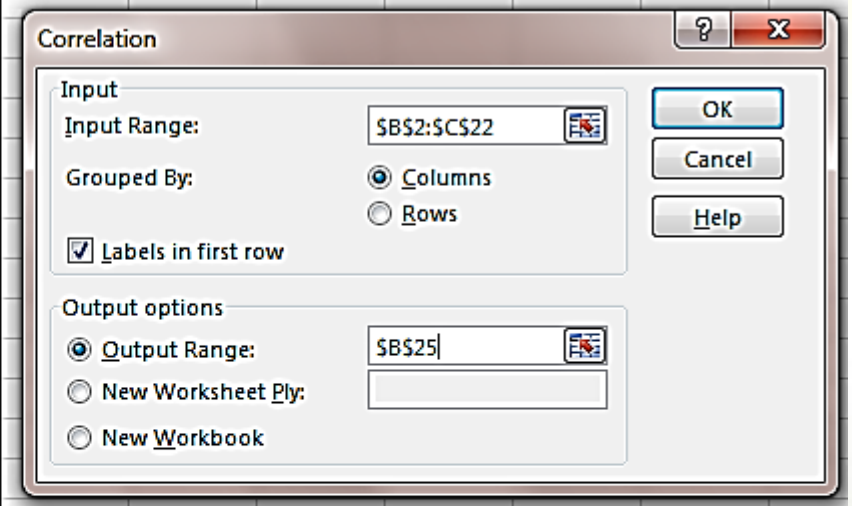

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Data Analysis Process
Correlation :

	Age of the Used car (Years)	*Price of the Used Car (LKR)*
Age of the Used Car (Years)	1	
Price of the Used Car (LKR)	-0.917253244	1

Value of correlation coefficient -0.917253244 denotes the **strong negative linear correlation** between the Price of the Used car and the Age of the Used car.

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Data Analysis Process Regression Model :

- **Regression:** Regression describes how an independent variable(s) is numerically related to the dependent variable.
- **Simple Linear Regression Model:**
- The variable that analysts try to predict is called the dependent variable.
- The variable you use for prediction is called the independent variable.

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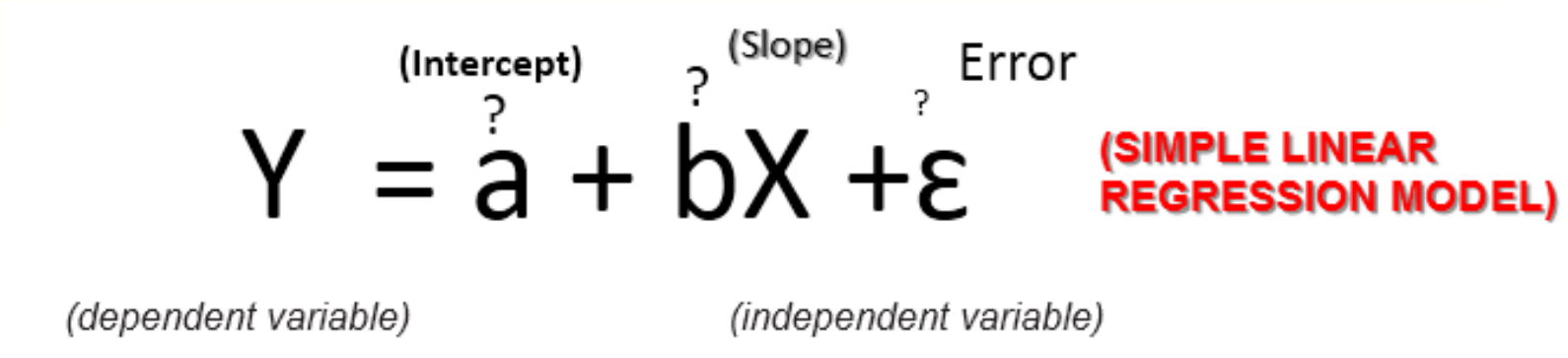
Data Analysis Process
Simple Linear Regression Model :

- **Simple Linear Regression Model:**



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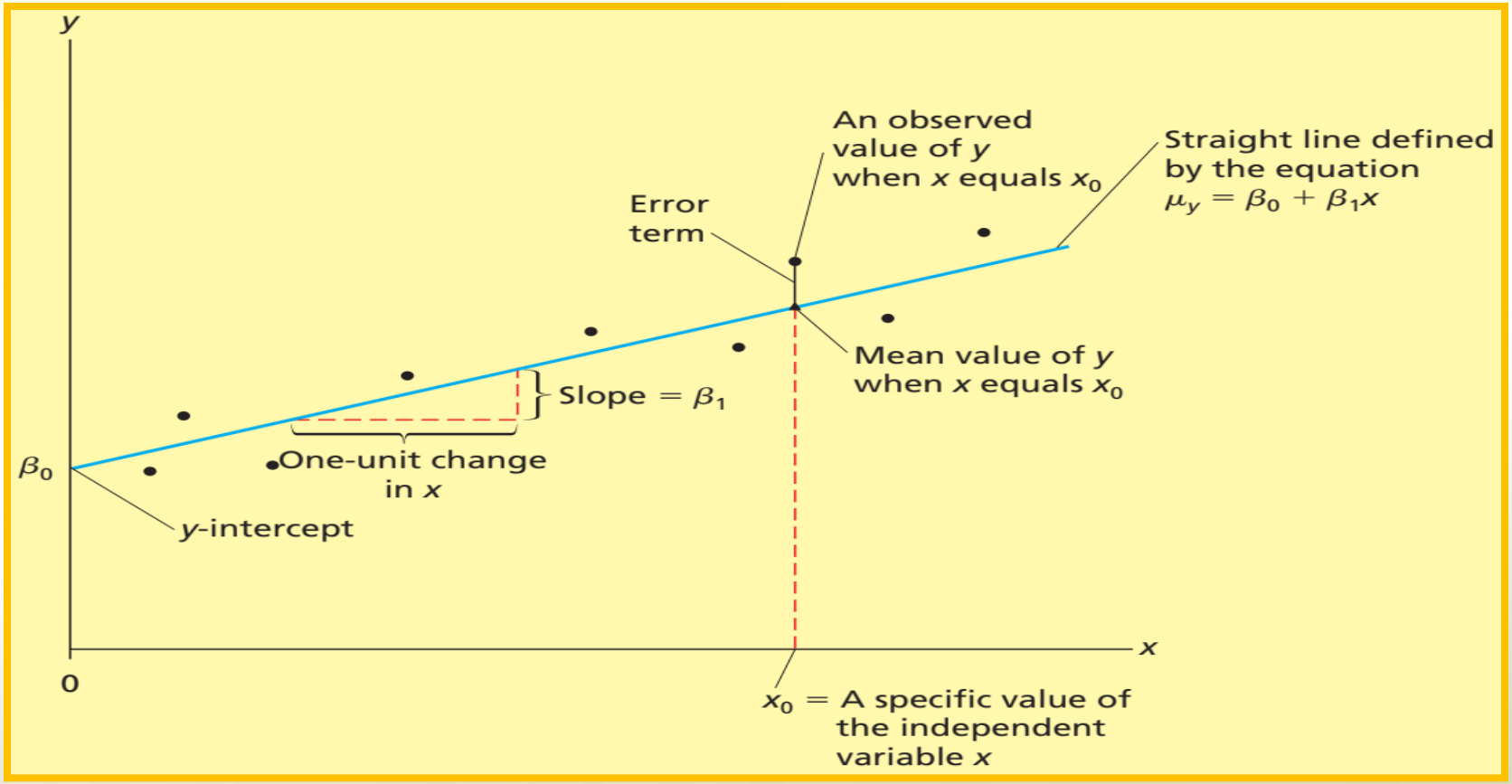
Data Analysis Process
Simple Linear Regression Model

- **Simple Linear Regression Model:**



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Data Analysis Process
Simple Linear Regression Model

- **Simple Linear Regression Model:**

The **simple linear** (or **straight line**) **regression model** is: $y = \beta_0 + \beta_1 x + \varepsilon$

Here

1 $\mu_y = \beta_0 + \beta_1 x$ is the **mean value** of the dependent variable y when the value of the independent variable is x.

2 β_0 is the **y-intercept.** β_0 is the mean value of y when x equals zero.

3 β_1 is the **slope.** β_1 is the change (amount of increase or decrease) in the mean value of y associated with a one-unit increase in x. If β_1 is positive, the mean value of y increases as x increases. If β_1 is negative, the mean value of y decreases as x increases.

4 ε is an **error term** that describes the effects on y of all factors other than the value of the independent variable x.

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Data Analysis Process – Simple Linear Regression Model:

Practical Example: Following table shows the age of the car in years and their selling price at a car sale.

Age of the Used Cars (Years)	Price of the Used Car (LKR)
6	3,775,000
5	6,450,000
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Data Analysis Process
Simple Linear Regression Model:

Enter the **Age of the Used Cars in Years** in column A with label- Age of the Used Car(Years) and the **Selling Price of Used Cars** in column B with label-Price of the Used Cars.

Steps

- Select Data : Data Analysis : Regression and click OK in the Data Analysis dialog box.
- In the Regression dialog box: Enter C3:C22 into the “Input Y Range” box. Enter B3:B22 into the “Input X Range” box.
- Place a checkmark in the Labels checkbox.

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Data Analysis Process
Simple Linear Regression Model:

- Be sure that the “Constant is Zero” checkbox is NOT checked.
- Select the “New Worksheet Ply” option and enter the name Output into the New Worksheet window.
- Click OK in the Regression dialog box to obtain the regression results in a new worksheet.

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Data Analysis Process
Simple Linear Regression Model:

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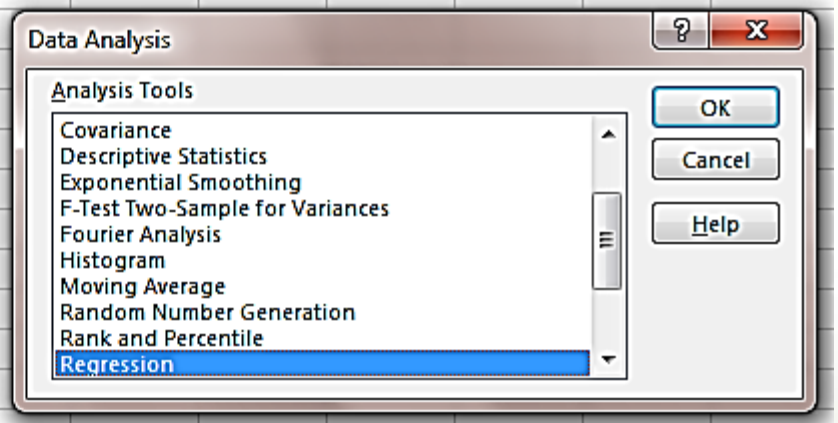

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Data Analysis Process
Simple Linear Regression Model:

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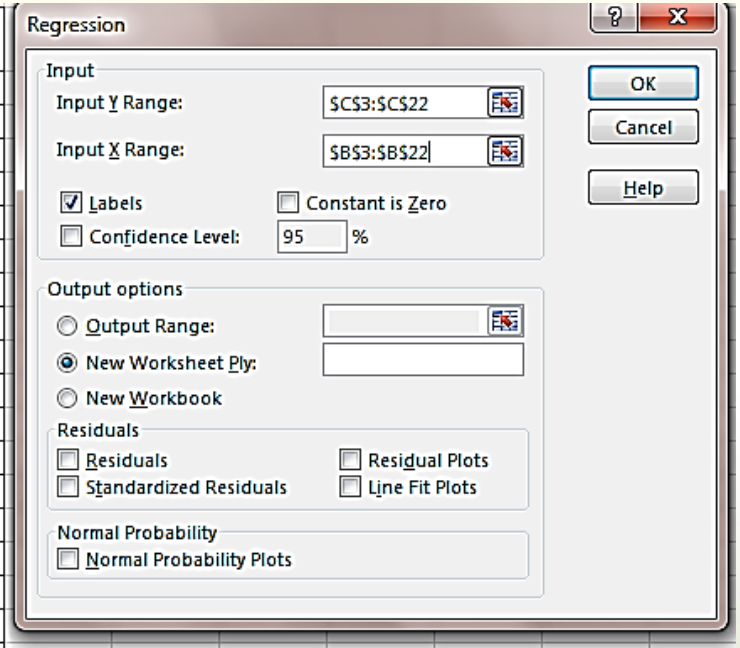

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Data Analysis Process
Simple Linear Regression Model:

$$Y = \beta_0 + \beta_1 X$$

Price Age **Regression Equation: 6558001.145 -390542.669X**

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.917157199
R Square	0.841177328
Adjusted R Square	0.831834818
Standard Error	557977.6665
Observations	19

ANOVA **(P value)**

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	2.80322E+13	2.80322E+13	90.03761475	3.32216E-08
Residual	17	5.29276E+12	3.11339E+11		
Total	18	3.3325E+13			

$(0.003 \leq 0.05)$

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	6558001.145	426894.0921	15.36212674	2.11919E-11	5657333.34	7458668.951	5657333.34	7458668.951
6	-390542.669	41158.21195	-9.488815245	3.32216E-08	-477378.9057	-303706.4322	-477378.9057	-303706.4322

$H_0: \beta_1 = 0$

$H_1: \beta_1 \neq 0$

$(0.003 \leq 0.05)$

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Data Analysis Process
Coefficient of Determination :

Coefficient of Determination (R-Square):

- How good is the “FIT” between the actual data and the regression equation?
- The Coefficient of Determination shows a numerical measure about how good is the “fit” between actual observations (x,y) and the points generated by the regression equation:

$$\hat{y} = ax + b$$

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Data Analysis Process
Coefficient of Determination :

Coefficient of Determination:

The symbol for the coefficient of determination is :

$$r^2 \rightarrow \text{range}(r^2) = [0,1]$$

Example:

Value of coefficient of determination (r-square) for the above example is 0.841353514.

It denotes that 84.1% of the variation of price of the used car can be explained by the age of the used cars.

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Data Analysis Process
Simple Linear Regression Model:

Total variation = Explained variation + Unexplained variation

$$= (\beta_0 + \beta_1 X) \qquad + (\varepsilon)$$

$$r^2 = \frac{\text{Explained variation}}{\text{Total variation}}$$

R^2 = 84% of the total variation of Price of the Used Car is explained by Age of the Used Cars

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Data Analysis Process

- **Step 5: Interpret the results**
- The final step is interpreting the results from the data analysis.
- This part is important because it’s how the actual value can be gained from the previous four steps.
- Interpreting the data analysis should validate why you conducted one in the first place.

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Data Analysis Process

Practice Example:

- High percentage (84%) of the total variation of **Price of the Used Car** is explained by **Age of the Used Cars**. It means that the prices of the used cars are highly influenced by the Age of the used car.

- There is a strong negative relationship (see coefficient β_1) of between the prices of the used cars and the Ages of the used cars. It means that when the age of a used car increased, the price of the used car is decreased.

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Section 04: Presenting the findings using appropriate Tools

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Textual Presentation

- Data can be presented using paragraphs or sentences.
- It involves enumerating important characteristics, emphasizing significant figures and identifying important features of data.
- **Examples for Textual Presentation Method:**
  - Arranges data in an ordered format, such as lowest to highest
  - Can use a stem and leaf plot for presentation
  - Can represent data in a paragraph form

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Textual Presentation

- **Practical Example:**

The following are the prices of used car found from a Car Selling Website.

LKR:

4300000	3460000	1585000	3300000
2600000	6450000	3950000	4090000
1650000	1450000	2050000	1920000
1600000	1150000	3345000	2600000
1850000	2730000	3775000	1100000

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Textual Presentation

- Arranging the above data in an ordered format : Lowest to highest order as follows :

1100000	1650000	2600000	3775000
1150000	1850000	2730000	3950000
1450000	1920000	3300000	4090000
1585000	2050000	3345000	4300000
1600000	2600000	3460000	6450000

Activity:

- Prepare a stem and leaf plot for the above data set.

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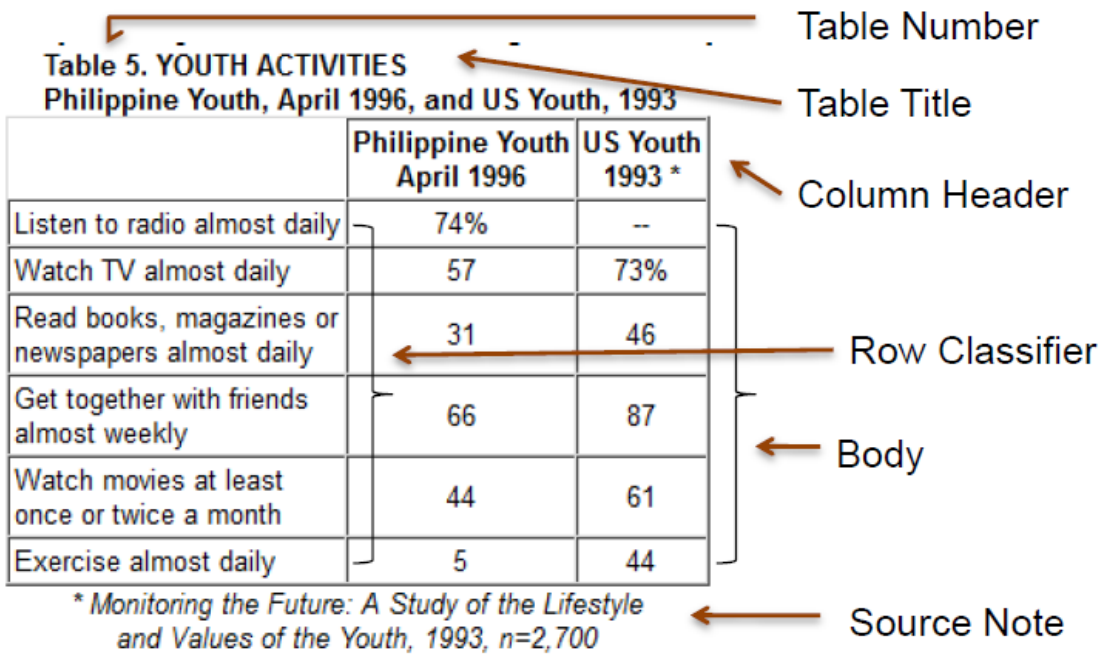
Tabular Presentation

- Data is presented in a chart or table format.

Below is a sample of a table with all of its parts indicated:



	Philippine Youth April 1996	US Youth 1993 *
Listen to radio almost daily	74%	--
Watch TV almost daily	57	73%
Read books, magazines or newspapers almost daily	31	46
Get together with friends almost weekly	66	87
Watch movies at least once or twice a month	44	61
Exercise almost daily	5	44

** Monitoring the Future: A Study of the Lifestyle and Values of the Youth, 1993, n=2,700*

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Tabular Presentation

- **Examples for Tabular Presentation Method :**
  - Frequency Distribution Table (FDT)
  - Relative FDT
  - Cumulative FDT
  - Contingency Table

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Tabular Presentation

- **Practical Example :**

Frequency Distribution Table (FDT) – Count of Available Used cars in each category – Using the pivot table in Excel

Brands	Count of Available Cars
Honda	2
Mitsubishi	2
Nissan	2
Perodua	1
Subaru	1
Suzuki	2
Toyota	10
Grand Total	**20**

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Graphical Presentation

- Data are presented in a form of graph or a diagram.
- A graph is a geometrical presentation of data.
- A graph must have a figure number and a title.
- If data came from another source, a source note should be included.
- **Examples for Graphical Presentation Method**
  - Bar Chart
  - Histogram
  - Line Chart
  - Pie Chart
  - Scatter Plot

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Graphical Presentation

- Practical Examples: Availability of Used Car of each Category

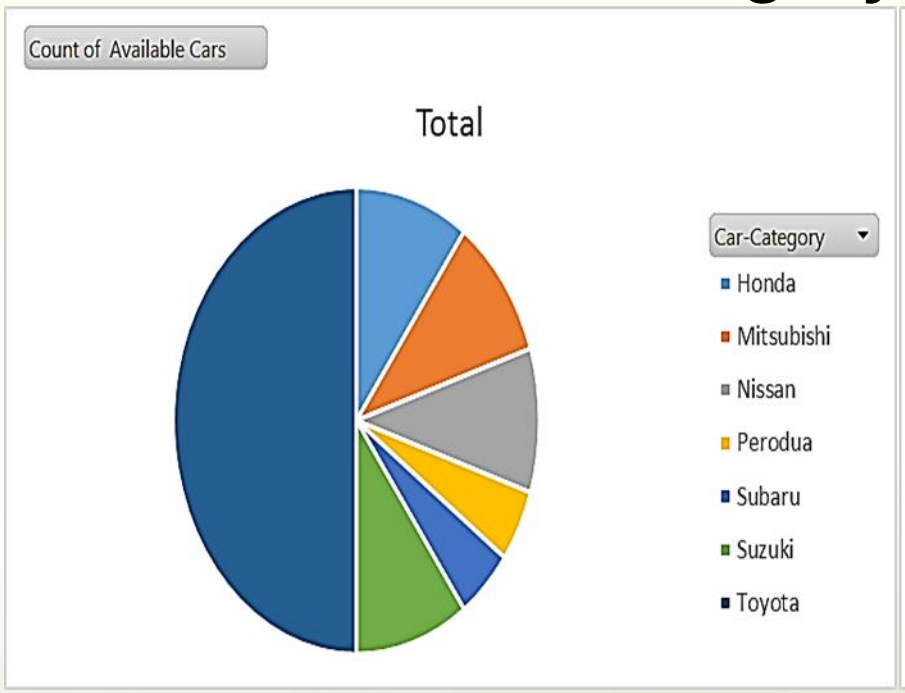

Figure 1. Pie Chart

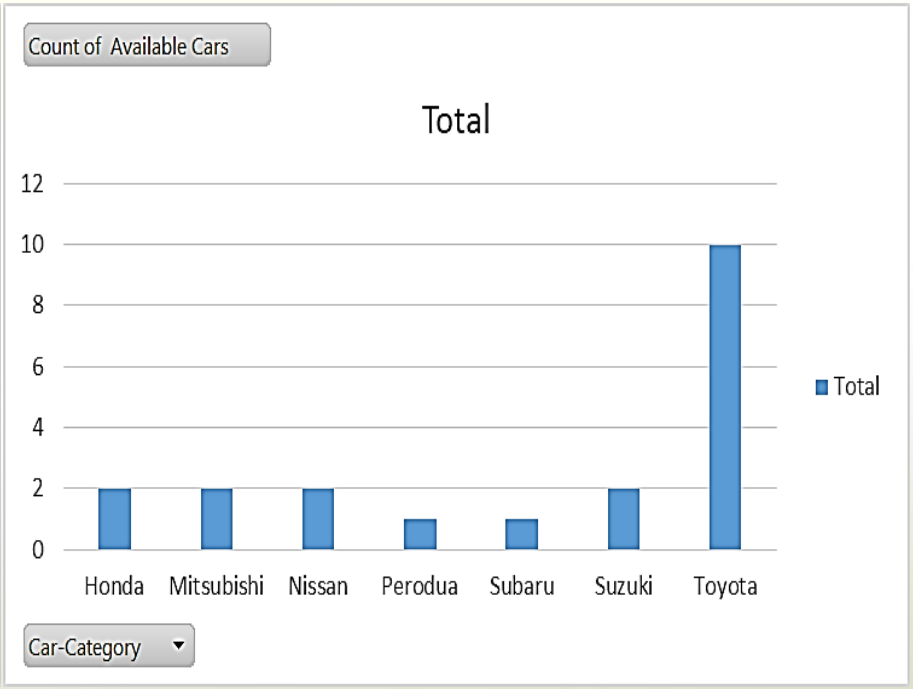

Figure 2 . Bar Chart

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Graphical Presentation
When to use Which graph :

- Bar chart: Best used when showing comparisons between categories.
- Pie chart: Best used to compare parts to the whole (get the composition).
- Line chart: Best used when trying to visualize continuous data over time.
- Scatter plot: Best used to display relationships between 2 variables.

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Q & A

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Thank You

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