DATA ANALYTICS WITH EXCEL

(BCS358A)

LAB MANUAL

For

III SEMESTER

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING

MIJAR MOODUBIDIRE

VISION OF THE INSTITUTE

"Transformative education by pursuing excellence in Engineering and Management through enhancing skills to meet the evolving needs of the community"

MISSION OF THE INSTITUTE

1. To bestow quality technical education to imbibe knowledge, creativity and ethos to students community.
2. To inculcate the best engineering practices through transformative education.
3. To develop a knowledgeable individual for a dynamic industrial scenario.
4. To inculcate research, entrepreneurial skills and human values in order to cater the needs of the society

VISION OF THE DEPARTMENT

"Engendering competent, excellent professionals by transforming the knowledge and computing skills to individuals through modern innovative tools and techniques"

MISSION OF THE DEPARTMENT

1. To produce skilled, creative software developers through rigorous training.
2. To conduct specific technical courses to keep abreast to the latest technological developments and transformations in the domain.
3. To implement the ideas of research and innovations in interdisciplinary domains.
4. To establish Industry-Institute Interaction programs to enhance the skills of employability and entrepreneurship.

General Lab Guidelines:

- Conduct yourself in a responsible manner at all times in the laboratory. Intentional misconduct will lead to the exclusion from the lab.
- Do not wander around, or distract other students, or interfere with the laboratory experiments of other students.
- Read the handout and procedures before starting the experiments. Follow all written and verbal instructions carefully. If you do not understand the procedures, ask the instructor or teaching assistant.
- Attendance in all the labs is mandatory, absence permitted only with prior permission from Class teacher.
- The workplace has to be tidy before, during and after the experiment.
- Do not eat food, drink beverages or chew gum in the laboratory.

DO'S:-

- Uniform and ID card are must.
- Strictly follow the procedures for conduction of experiments.
- Records have to be submitted every week for evaluation.
- Chairs and stools should be kept under the workbenches when not in use.
- After the lab session, switch off the systems and every supply, .
- Keep your belongings in designated area.
- Sign the log book when you enter/leave the laboratory.

DONT'S:-

- Don't touch open wires unless you are sure that there is no voltage. Always disconnect the plug by pulling on the connector body not by the cable. Switch off the supply while you make changes in connections of wires.
- Students are not allowed to work in laboratory alone or without presence of the teaching staff/ instructor.
- No additional material should be carried by the students during regular labs.
- Avoid stepping on electrical wires or any other computer cables.
- Without permission no downloads or installations

(Effective from the academic year 2023 -2024)

SEMESTER – III

Course Code	BCS358A	CIE Marks	50
Number of Contact Hours/Week	0:0:2:0	SEE Marks	50
Total Number of Lab Contact Hours	40	Exam Hours	03
Credits – 1			

SYLLABUS

Course objectives:

- To Apply analysis techniques to datasets in Excel
- Learn how to use Pivot Tables and Pivot Charts to streamline your workflow in Excel
- Understand and Identify the principles of data analysis
- Become adept at using Excel functions and techniques for analysis
- Build presentation ready dashboards in Excel

1. Getting Started with Excel: Creation of spread sheets, Insertion of rows and columns, Drag & Fill, use of Aggregate functions.
2. Working with Data : Importing data, Data Entry & Manipulation, Sorting & Filtering.
3. Working with Data: Data Validation, Pivot Tables & Pivot Charts.
4. Data Analysis Process: Conditional Formatting, What-If Analysis, Data Tables, Charts & Graphs.
5. Cleaning Data with Text Functions: use of UPPER and LOWER, TRIM function, Concatenate.
6. Cleaning Data Containing Date and Time Values: use of DATEVALUE function, DATEADD and DATEDIF, TIMEVALUE functions.
7. Conditional Formatting: formatting, parsing, and highlighting data in spreadsheets during data analysis.
8. Working with Multiple Sheets: work with multiple sheets within a workbook is crucial for organizing and managing data, perform complex calculations and create comprehensive reports.
9. Create worksheet with following fields: Empno, Ename, Basic Pay(BP), Travelling Allowance(TA), Dearness Allowance(DA), House Rent Allowance(HRA), Income Tax(IT), Provident Fund(PF), Net Pay(NP). Use appropriate formulas to calculate the above scenario. Analyse the data using appropriate chart and report the data.
10. Create worksheet on Inventory Management: Sheet should contain Product code, Product name, Product type, MRP, Cost after % of discount, Date of purchase. Use appropriate formulas to calculate the above scenario. Analyse the data using appropriate chart and report the data.
11. Create worksheet on Sales analysis of Merchandise Store: data consisting of Order ID, Customer ID, Gender, age, date of order, month, online platform, Category of product, size, quantity, amount, shipping city and other details. Use of formula to segregate different categories and perform a comparative study using pivot tables and different sort of charts.
12. Generation of report & presentation using Autofilter &macro.

1. GETTING STARTED WITH EXCEL

1.CREATION OF SPREADSHEET:

- Open Microsoft Excel, locate Excel on your computer and open a new blank workbook.
- Create a new spreadsheet : click on tab at the bottom and add new sheet.
- Enter data into cells: click on cell,type your data and press enter,data is stored in your spreadsheet.

2.INSERTION OF ROWS AND COLUMNS:

- Select a row or column, click on row number or column letter to highlight it.
- Right click and choose “Insert”. This action adds a new row above or a new column to left of your selection.

3. DRAG AND FILL:

- Enter a value in a cell: type a number or text into the cell.
- Drag the small square at cell’s bottom right corner. When you position your cursor over this square,it becomes a small square “handle”.Click and drag it to adjacent cellsto autofill a series of pattern.

4.USE AGGREGATE FUNCTION:

- Used to perform basic functions/calculations on set of data.
- Click on the cell and enter a formula using this general form.
- Formula:

=AGGREGATE(Function Number, Options ,Rows/Columns)

To use large and small functions:

=LARGE(Range,k)

=SMALL(Range,k)

s.no	usn	name	mark 1	mark 2		total
1	4al22cs128	abhishek	100	90		190
2	4al22cs129	hafeeza	95	88		183
3	4al22cs130	krishna	90	95		185
4	4al22cs131	manara	85	85		170
5	4al22cs132	munawar	85	94		179
6	4al22cs133	sameeksha	75	80		155
7	4al22cs134	shabana	70	90		160
8	4al22cs135	shlagana	65	96		161
9	4al22cs136	sriraksha	60	75		135
10	4al22cs137	sudeeksha	55	99		154
		COUNT	10	10		
		AVERAGE	78	95		
		MAX	100	99		
		MIN	55	75		
		SUM	780	892		
		1ST LARGE	100	99		
		1ST SMALL	55	75		

2. WORKING WITH DATA: IMPORTING DATA, DATA ENTRY & MANIPULATION, SORTING & FILTERING.

Topics

1. Importing Data
2. Data Entry
3. Data Manipulation
4. Sorting and Filtering

1. IMPORTING DATA

- Go to "Data" Tab at top of Excel Window.
- Use the "Get Data" or "From Text" options to import data from external sources like text files.

2. DATA ENTRY

- Click on cell, type your data and Press "Enter".
- Navigate to other cells using arrow keys or clicking.

3. DATA MANIPULATION

a) Basic Manipulation:
- Right click to cut, copy, paste data.
- Use Ctrl + C and Ctrl + V to copy and paste respectively.

b) To copy data into another sheet

➢ Method 1
- Right click on the Sheet 1.
- Choose move and copy.
- Tick up "Copy".

➢ Method 2
- Make new sheet.
- In first row click the cell and write "=".
- Then go back to the sheet which is required to copy.
- Drag the entire data and press enter.
- Go back to your newssheet and drag the cell where you wrote "=".
- Now the content is copied.

4. SORTING AND FILTERING

- Sorting
- Click and drag the specific row.
- Right click and choose sort.
- Choose custom sort.

Sort according to ascending or descending order.

	A	B	C
1	Si no.	Unsorted	Sorted
2	1	6	-8
3	2	4	-4
4	3	9	-2
5	4	7	1
6	5	-8	2
7	6	-2	3
8	7	9	4
9	8	1	6
10	9	-4	7
11	10	2	9

- Filtering
- Click on sort and filter.
- Choose filter.
- Then choose which data to be hide from the top of the table.

	A	B	C
1	SI. NO	MARK 1	MARK 2
2	1	89	94
3	2	88	62
4	3	74	84
5	4	91	86
6	5	74	
7	6	76	93
8	7	85	74
9	8	81	80
10	9	96	77
11	10	90	71

3. WORKING WITH DATA: DATA VALIDATION, PIVOT TABLES & PIVOT

CHARTS.

- PivotTables: They are the tables that allow analyzing and collecting useful data from large and deleted data set.

To insert Pivot Chart:

- Note: use clean and Tabular data i.e. organized in the form of fields and data. All columns need to have named fields:
- Select range of cells.
- Select Insert and choose Pivot table. Tick Pivot table.
- ThiscreatesaPivottablebasedontableinexisitingworkbookornewworkbook.
- There is a pivot table based on Table in existing fields options bar where we can add to remove fields from pivot table and perform functions like sum ,count , average etc using & values "value fields settings".

Pivot charts:

It is visual representation of Pivot table

To insert a pivot chart:

- Select arrange of cells of table
- Select Insert and choose Pivot chart
- Select where your want chart to appear
- Select fields to display in fields option bar.

Note:

Any changes you make in table, changes pivot table You can change type of chart in change type option

Data Validation:

It is used to construct the type of data or number /values given to data that is entered in cell by user

To Insert/application steps:

Select cells that you want this validation Select data and choose data validation On Settings tab

Under allow options, you can choose:

whole number->restricts other type & can only use whole number decimal->Accepts only decimal number list -> To picks data from drop down list

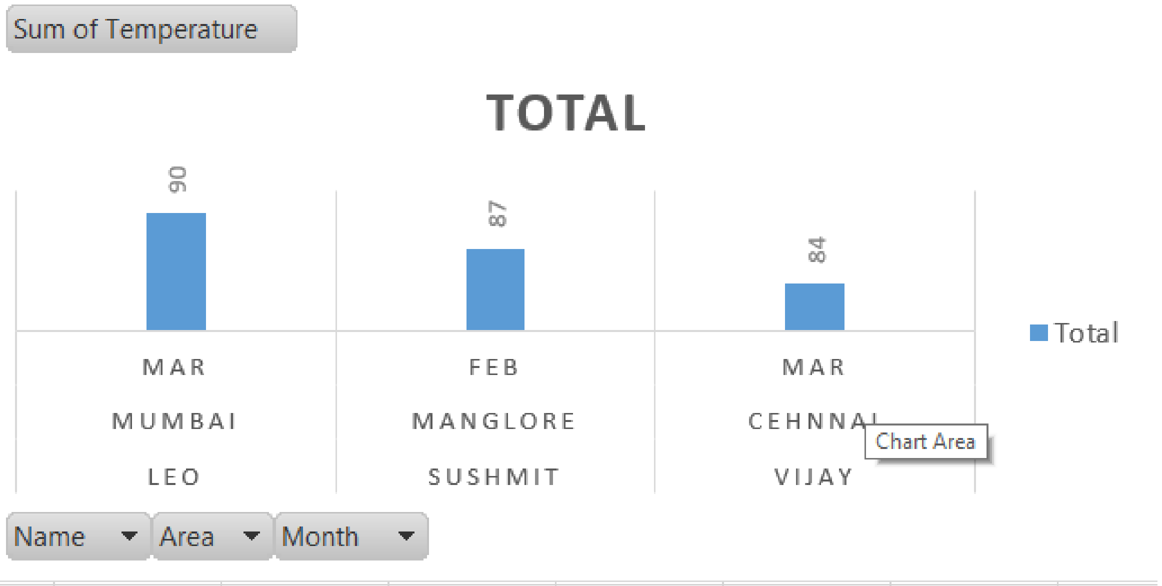
Date->Accepts only date Time->Accepts only Time

Then Select the condition i.e. range
Then go to input message and put a message which will be popped when input is correct Select error message which are of 3 types:

Stop -> stops from entering Warning -> warns before entering
Information->pops up message when entered

Name	Area	Temperature	Month
vijay	Chennai	25	Mar
Sushmit	Manglore	26	Feb
Leo	Mumbai	27	Mar
vijay	Chennai	28	Mar
Sushmit	Manglore	29	Feb
Leo	Mumbai	30	Mar
vijay	Chennai	31	Mar
Sushmit	Manglore	32	Feb
Leo	Mumbai	33	Mar

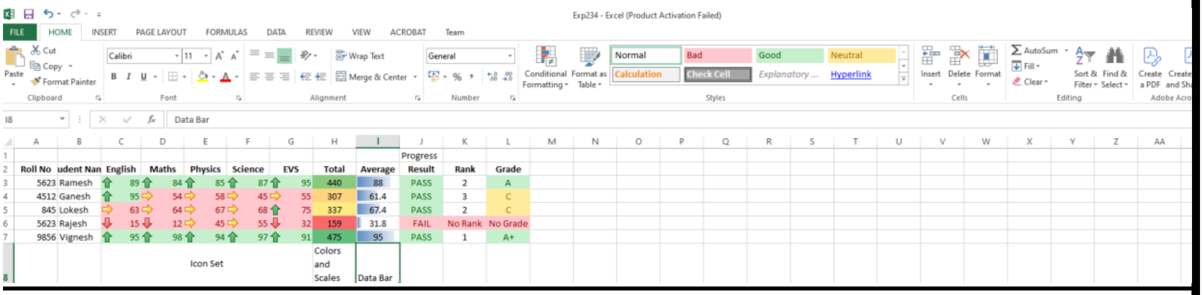
Row Labels	Sum of Temperature
Leo	**90**
Mumbai	**90**
Mar	90
Sushmit	**87**
Manglore	**87**
Feb	87
vijay	**84**
Cehnnai	**84**
Mar	84
Grand Total	**261**



4. Data Analysis Process: Conditional Formatting, What-if Analysis, Data Tables, Charts & Graphs.

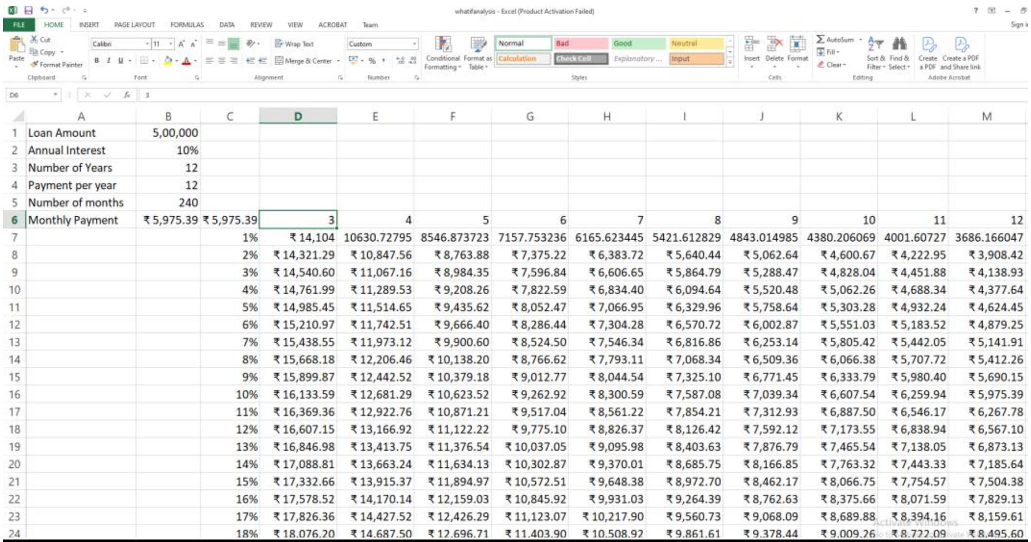
Following steps has to follow for making **conditional formatting**

1. Select all fields in the excel table
2. Select conditional format menu then click whatever conditional to select for the corresponding process
3. In the conditional formatting we can choose icon bar, data bar, color scaling also



	A	B	C	D	E	F	G	H	I	J	K	L
1										Progress		
2	Roll No	udent Nan	English	Maths	Physics	Science	EVS	Total	Average	Result	Rank	Grade
3	5623	Ramesh	89	84	85	87	95	440	88	PASS	2	A
4	4512	Ganesh	95	54	58	45	55	307	61.4	PASS	3	C
5	845	Lokesh	63	64	67	68	75	337	67.4	PASS	2	C
6	5623	Rajesh	15	12	45	55	32	159	31.8	FAIL	No Rank	No Grade
7	9856	Vignesh	95	98	94	97	91	475	95	PASS	1	A+
8				Icon Set				Colors and Scales	Data Bar			

What-if Analysis



	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Loan Amount	5,00,000											
2	Annual Interest	10%											
3	Number of Years	12											
4	Payment per year	12											
5	Number of months	240											
6	Monthly Payment	₹5,975.39	₹5,975.39	3	4	5	6	7	8	9	10	11	12
7			1%	₹14,104	10630.72795	8546.873723	7157.753236	6165.623445	5421.612829	4843.014985	4380.206069	4001.60727	3686.166047
8			2%	₹14,321.29	₹10,847.56	₹8,763.88	₹7,375.22	₹6,383.72	₹5,640.44	₹5,062.64	₹4,600.67	₹4,222.95	₹3,908.42
9			3%	₹14,540.60	₹11,067.16	₹8,984.35	₹7,596.84	₹6,606.65	₹5,864.79	₹5,288.47	₹4,828.04	₹4,451.88	₹4,138.93
10			4%	₹14,761.99	₹11,289.53	₹9,208.26	₹7,822.59	₹6,834.40	₹6,094.64	₹5,520.48	₹5,062.26	₹4,688.34	₹4,377.64
11			5%	₹14,985.45	₹11,514.65	₹9,435.62	₹8,052.47	₹7,066.95	₹6,329.96	₹5,758.64	₹5,303.28	₹4,932.24	₹4,624.45
12			6%	₹15,210.97	₹11,742.51	₹9,666.40	₹8,286.44	₹7,304.28	₹6,570.72	₹6,002.87	₹5,551.03	₹5,183.52	₹4,879.25
13			7%	₹15,438.55	₹11,973.12	₹9,900.60	₹8,524.50	₹7,546.34	₹6,816.86	₹6,253.14	₹5,805.42	₹5,442.05	₹5,141.91
14			8%	₹15,668.18	₹12,206.46	₹10,138.20	₹8,766.62	₹7,793.11	₹7,068.34	₹6,509.36	₹6,066.38	₹5,707.72	₹5,412.26
15			9%	₹15,899.87	₹12,442.52	₹10,379.18	₹9,012.77	₹8,044.54	₹7,325.10	₹6,771.45	₹6,333.79	₹5,980.40	₹5,690.15
16			10%	₹16,133.59	₹12,681.29	₹10,623.52	₹9,262.92	₹8,300.59	₹7,587.08	₹7,039.34	₹6,607.54	₹6,259.94	₹5,975.39
17			11%	₹16,369.36	₹12,922.76	₹10,871.21	₹9,517.04	₹8,561.22	₹7,854.21	₹7,312.93	₹6,887.50	₹6,546.17	₹6,267.78
18			12%	₹16,607.15	₹13,166.92	₹11,122.22	₹9,775.10	₹8,826.37	₹8,126.42	₹7,592.12	₹7,173.55	₹6,838.94	₹6,567.10
19			13%	₹16,846.98	₹13,413.75	₹11,376.54	₹10,037.05	₹9,095.98	₹8,403.63	₹7,876.79	₹7,465.54	₹7,138.05	₹6,873.13
20			14%	₹17,088.81	₹13,663.24	₹11,634.13	₹10,302.87	₹9,370.01	₹8,685.75	₹8,166.85	₹7,763.32	₹7,443.33	₹7,185.64
21			15%	₹17,332.66	₹13,915.37	₹11,894.97	₹10,572.51	₹9,648.38	₹8,972.70	₹8,462.17	₹8,066.75	₹7,754.57	₹7,504.38
22			16%	₹17,578.52	₹14,170.14	₹12,159.03	₹10,845.92	₹9,931.03	₹9,264.39	₹8,762.63	₹8,375.66	₹8,071.59	₹7,829.13
23			17%	₹17,826.36	₹14,427.52	₹12,426.29	₹11,123.07	₹10,217.90	₹9,560.73	₹9,068.09	₹8,689.88	₹8,394.16	₹8,159.61
24			18%	₹18,076.20	₹14,687.50	₹12,696.71	₹11,403.90	₹10,508.92	₹9,861.61	₹9,378.44	₹9,009.26	₹8,722.09	₹8,495.60

Data Menu having What-if Analysis condition available. This is helps for one or two cells changing many filed of data will change automatically.

5. Cleaning Data with Text Functions: use of UPPER and LOWER, TRIM function, Concatenate.

The text functions for cleaning data are:

1. UPPER AND LOWER FUNCTIONS:
   - Converts lowercase letters into uppercase letters and vice versa

   Syntax: =upper(select row/column)
   =lower(select row/column)

2. TRIM FUNCTION:
   - Removes all spaces from text string
   - It does not remove single space between words

   Syntax: =text(trim)

3. CONCATENATE FUNCTION:
   - It joins several text strings into one single text string

Syntax: =concatenate(text1,text2………text n)
OR
=concatenate(cell1,cell2………..cell n)

- If you select a full column, then after getting result data, drag it and get all results of remaining

4. NESTED FUNCTIONS:
   - Two or more functions can be used to get the single line

   Syntax: function1(function2(value))

	A	B	C	D	E	F	G
1	NAME	PLACE	UPPER	LOWER	TRIM	CONCATENATE	
2	AdarsH	Mumbai	ADARSH	adarsh	AdarsH	AdarsHMumbai	
3	SanNidhI	Bangalore	SANNIDHI	sannidhi	SanNidhI	SanNidhIBangalore	
4	krIsHmA	Mysore	KRISHMA	krishma	krIsHmA	krIsHmAMysore	
5							
6							
7							

6. **Cleaning Data Containing Date and Time Values: use of DATEVALUE function, DATEADD and DATEDIF, TIMEVALUE functions.**

Using Date time functions we can clean date and time value

I. Date value function :

- It converts a date that is stored as text to a number that excel recognizes
  Ex: “1\1\2008”→39448
  Syntax:=date value (Date_text)

  NOTE:
  29.12.2023(wrong)
  29122023(wrong)
  29-12-2023(wrong)
  But 29-DEC-2023 OR 29/DEC/2023 (correct)
- First change value to text value than use data value function

II. Dated if function:

- Calculate number of days,months or years between two dates i.e,difference between them.
- **Syntax**: =dated if (start_date,end_date,”unit”)

  Here→”y”→number of years in time period
  “m”→number of month in time period
  “D”→number of days in time period

III. Time values funtions

→ It is used to convert text time in to decimal value
Syntax: =time value (text)
→ To change the time values numbers to time
  - Click that specific cell
  - Right click and choose format cell
  - In that choose time format and click done.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	DOB	DATEVALUE			Date if						Time Value			
2	29-12-2023	45289	21-DEC-2023	45281	28-11-2004	29-12-2023	6970	229	19		10:30 AM	10:30:00		
3	30-12-2023	45290	22-DEC-2023	45282							10:30 PM	22:30:00		
4	31-12-2023	45291	23-DEC-2023	45283	01-01-1990	28-11-2004	5445	178	14					
5	01-01-2024	45292	24-DEC-2023	45284										

7. Conditional Formatting: formatting, parsing, and highlighting data in spreadsheets during data analysis.

Formatting, parsing and highlighting data in spreadsheets during data analysis.

1.Creation Of Spreadsheet:

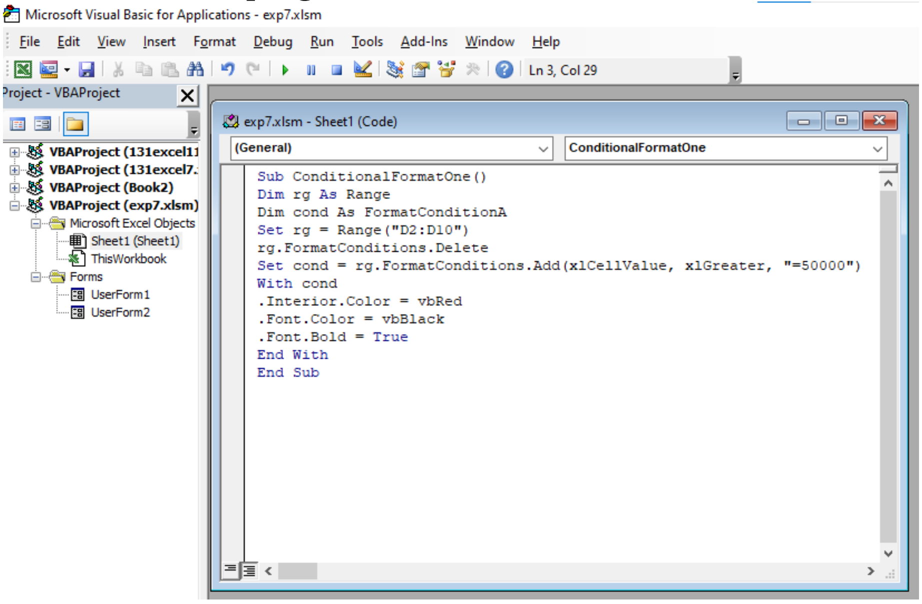
- Open Microsoft Excel: Locate Excel on your computer and open a new,blank workbook.
- Create a new spreadsheet: Click on table at the bottom and add sheet.
- Enter the data into cells: Click on cell,enter Employee ID,Employee name,company,salary in your spreadsheet.

Data Table:

	A	B	C	D
1	EMPLOYEE ID	EMPLOYEE NAME	COMPANY	SALARY
2	CS131	SHARANYA	GOOGLE	100000
3	CS132	SHIVANI	AMAZON	90000
4	CS133	KHUSHI	SAMSUNG	50000
5	CS134	PRATHI	TCS	45000
6	CS135	ANU	IBM	60000
7	CS136	REKHA	HP	35000
8	CS137	SUMA	MICROSOFT	85000
9	CS138	DIYA	FLIPKART	60000
10	CS139	DIVYA	AMAZON	95000

- Give name and save the above table as ExcelMacro-Enabled Workbook
- Then go to Developer and click on visual basic and double click on sheet1(sheet1).

2. Write the below program.



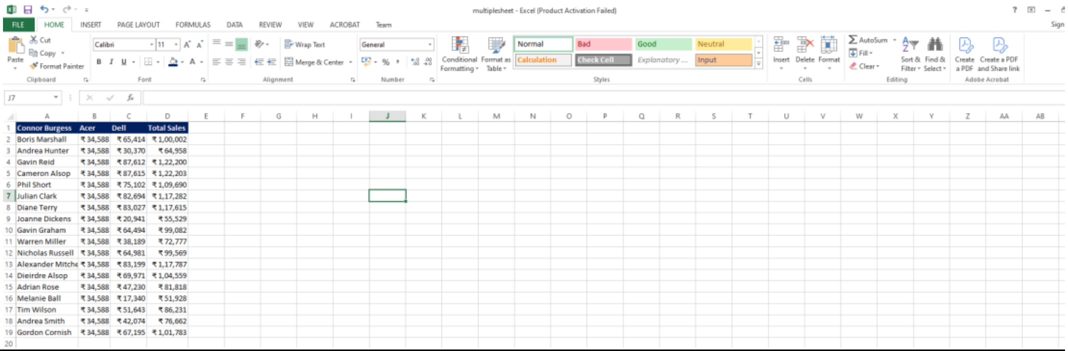

```
Sub ConditionalFormatOne()
Dim rg As Range
Dim cond As FormatCondition
Set rg = Range("D2:D10")
rg.FormatConditions.Delete
Set cond = rg.FormatConditions.Add(xlCellValue, xlGreater, "=50000")
With cond
.Interior.Color = vbRed
.Font.Color = vbBlack
.Font.Bold = True
End With
End Sub
```

3.OUTPUT:

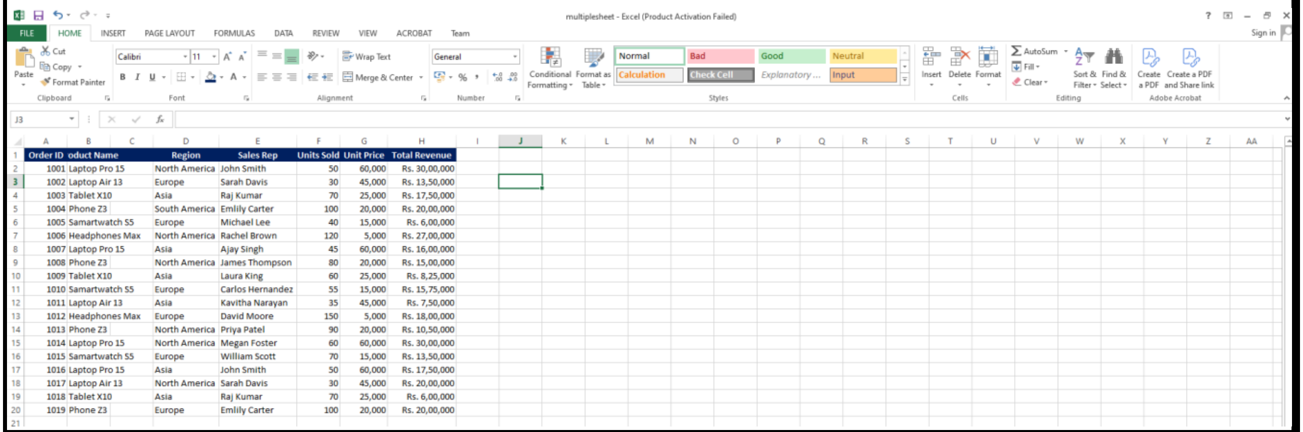
	A	B	C	D
1	EMPLOYEE ID	EMPLOYEE NAME	COMPANY	SALARY
2	CS131	SHARANYA	GOOGLE	100000
3	CS132	SHIVANI	AMAZON	90000
4	CS133	KHUSHI	SAMSUNG	50000
5	CS134	PRATHI	TCS	45000
6	CS135	ANU	IBM	60000
7	CS136	REKHA	HP	35000
8	CS137	SUMA	MICROSOFT	85000
9	CS138	DIYA	FLIPKART	60000
10	CS139	DIVYA	AMAZON	95000

- Here the salaries which are greater than 50000 are highlighted.

8. Working with Multiple Sheets: work with multiple sheets within a workbook is crucial for organizing and managing data perform complex calculations and create comprehensive reports.



Connor Burgess	Acer	Dell	Total Sales
Boris Marshall	₹ 34,588	₹ 65,414	₹ 1,00,002
Andrea Hunter	₹ 34,588	₹ 30,370	₹ 64,958
Gavin Reid	₹ 34,588	₹ 87,612	₹ 1,22,200
Cameron Alsop	₹ 34,588	₹ 87,615	₹ 1,22,203
Phil Short	₹ 34,588	₹ 75,102	₹ 1,09,690
Julian Clark	₹ 34,588	₹ 82,694	₹ 1,17,282
Diane Terry	₹ 34,588	₹ 83,027	₹ 1,17,615
Joanne Dickens	₹ 34,588	₹ 20,941	₹ 55,529
Gavin Graham	₹ 34,588	₹ 64,494	₹ 99,082
Warren Miller	₹ 34,588	₹ 38,189	₹ 72,777
Nicholas Russell	₹ 34,588	₹ 64,981	₹ 99,569
Alexander Mitche	₹ 34,588	₹ 83,199	₹ 1,17,787
Dieirdre Alsop	₹ 34,588	₹ 69,971	₹ 1,04,559
Adrian Rose	₹ 34,588	₹ 47,230	₹ 81,818
Melanie Ball	₹ 34,588	₹ 17,340	₹ 51,928
Tim Wilson	₹ 34,588	₹ 51,643	₹ 86,231
Andrea Smith	₹ 34,588	₹ 42,074	₹ 76,662
Gordon Cornish	₹ 34,588	₹ 67,195	₹ 1,01,783



Order ID	oduct Name	Region	Sales Rep	Units Sold	Unit Price	Total Revenue
1001	Laptop Pro 15	North America	John Smith	50	60,000	Rs. 30,00,000
1002	Laptop Air 13	Europe	Sarah Davis	30	45,000	Rs. 13,50,000
1003	Tablet X10	Asia	Raj Kumar	70	25,000	Rs. 17,50,000
1004	Phone Z3	South America	Emlily Carter	100	20,000	Rs. 20,00,000
1005	Samartwatch S5	Europe	Michael Lee	40	15,000	Rs. 6,00,000
1006	Headphones Max	North America	Rachel Brown	120	5,000	Rs. 27,00,000
1007	Laptop Pro 15	Asia	Ajay Singh	45	60,000	Rs. 16,00,000
1008	Phone Z3	North America	James Thompson	80	20,000	Rs. 15,00,000
1009	Tablet X10	Asia	Laura King	60	25,000	Rs. 8,25,000
1010	Samartwatch S5	Europe	Carlos Hernandez	55	15,000	Rs. 15,75,000
1011	Laptop Air 13	Asia	Kavitha Narayan	35	45,000	Rs. 7,50,000
1012	Headphones Max	Europe	David Moore	150	5,000	Rs. 18,00,000
1013	Phone Z3	North America	Priya Patel	90	20,000	Rs. 10,50,000
1014	Laptop Pro 15	North America	Megan Foster	60	60,000	Rs. 30,00,000
1015	Samartwatch S5	Europe	William Scott	70	15,000	Rs. 13,50,000
1016	Laptop Pro 15	Asia	John Smith	50	60,000	Rs. 17,50,000
1017	Laptop Air 13	North America	Sarah Davis	30	45,000	Rs. 20,00,000
1018	Tablet X10	Asia	Raj Kumar	70	25,000	Rs. 6,00,000
1019	Phone Z3	Europe	Emlily Carter	100	20,000	Rs. 20,00,000

This multiple sheets concepts one sheet any value has been changed remaining all sheets will reflect the data

9. Create worksheet with following fields: Empno, Ename, Basic Pay(BP), Travelling Allowance(TA), Dearness Allowance(DA), House Rent Allowance(HRA), Income Tax(IT), Provident Fund(PF), Net Pay(NP). Use appropriate formulas to calculate the above scenario. Analyse the data using appropriate chart and report the data.

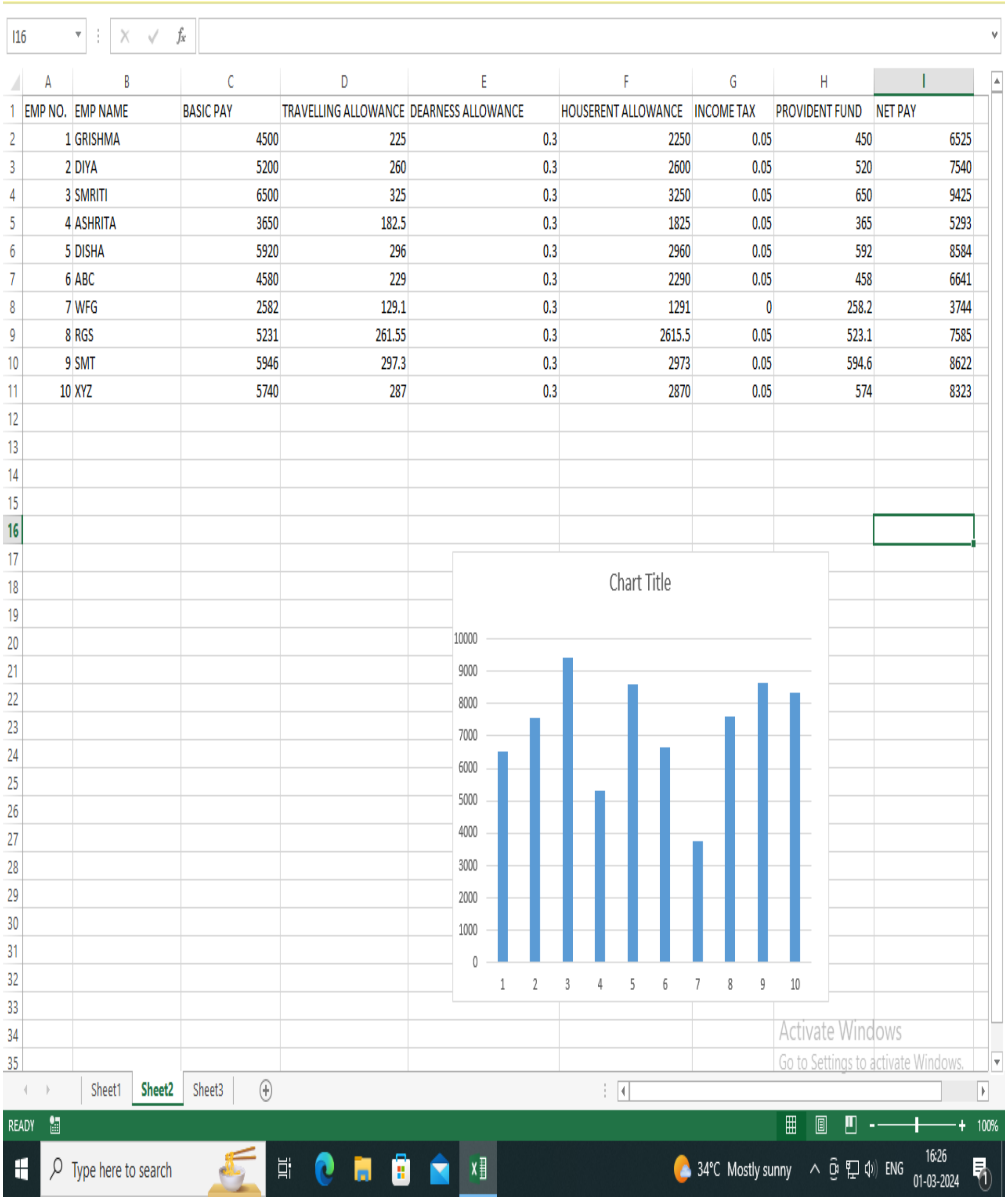
Step 1: Input the employee name, number and basic pay into a excel sheet.
Step 2: Calculate TA, DA, HRA, IT, PF and NP.

- To calculate Travelling allowance.
  We can assume 5% Basic pay(5% BP)
  5% * Bp=0.05 * cell(BP)
- To calculate Dearness Allowance.

  Use the if function in excel.
  Goto formulas and then click logical test and provide the values for true and false outcomes in respective fields.
  Logical test: cell of BP * 25000(C2>25000)
  Value if true: cell of BP * 0.3 (C2*0.3)
  Value if false: cell of BP * 0.2 (C2*0.2)
- To calculate Income tax:
  Apply the if function in excel sheet similar to DA
  Logical_test (C2+D2+E2+F2)>50000
  Value if true C2+D2+E2+F2 *0.5
  Value if false 0
- To calculate Provident fund
  Cell BP*0.1(C2*0.1)
- To calculate Net pay
  C2+D2+E2+F2 -G2–H2

Cell of IT+ Cell of TA + Cell of DA + Cell of HRA +Cell of IT –Cell of PF

Analyze the data using appropriate char



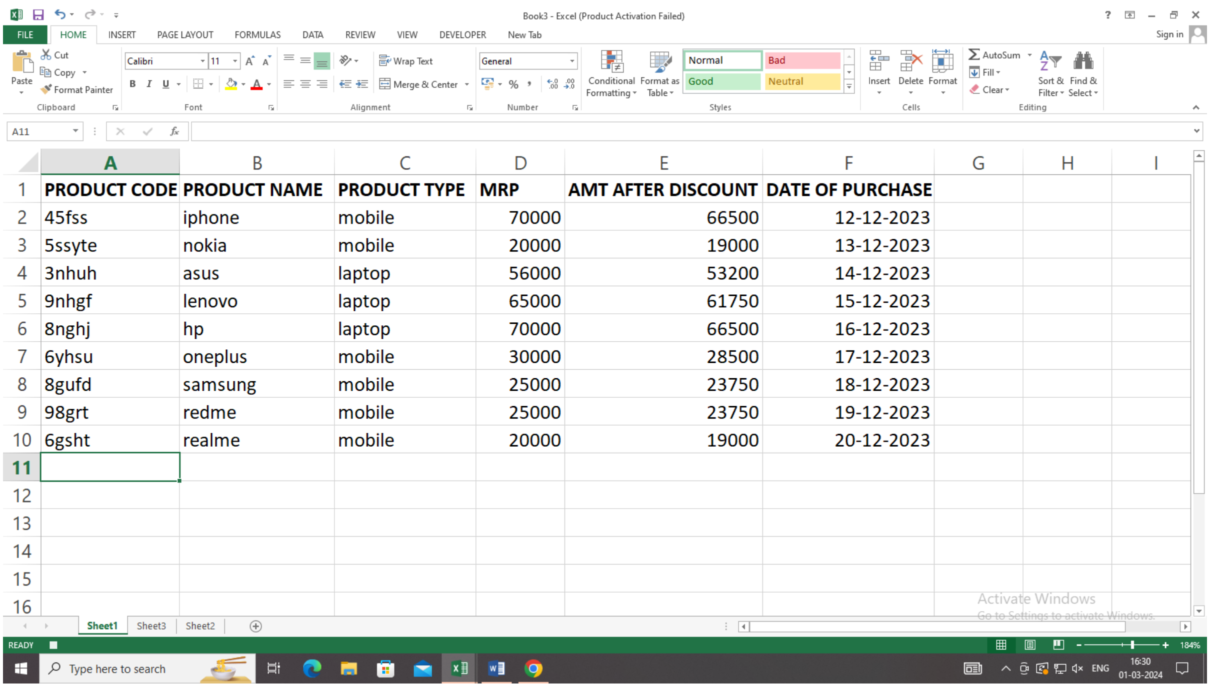
EMP NO.	EMP NAME	BASIC PAY	TRAVELLING ALLOWANCE	DEARNESS ALLOWANCE	HOUSERENT ALLOWANCE	INCOME TAX	PROVIDENT FUND	NET PAY
1	GRISHMA	4500	225	0.3	2250	0.05	450	6525
2	DIYA	5200	260	0.3	2600	0.05	520	7540
3	SMRITI	6500	325	0.3	3250	0.05	650	9425
4	ASHRITA	3650	182.5	0.3	1825	0.05	365	5293
5	DISHA	5920	296	0.3	2960	0.05	592	8584
6	ABC	4580	229	0.3	2290	0.05	458	6641
7	WFG	2582	129.1	0.3	1291	0	258.2	3744
8	RGS	5231	261.55	0.3	2615.5	0.05	523.1	7585
9	SMT	5946	297.3	0.3	2973	0.05	594.6	8622
10	XYZ	5740	287	0.3	2870	0.05	574	8323

10. Create worksheet on Inventory Management: Sheet should contain Product code, Product name, Product type, MRP, Cost after % of discount, Date of purchase. Use appropriate formulas to calculate the above scenario. Analyze the data using appropriate chart and report the data.

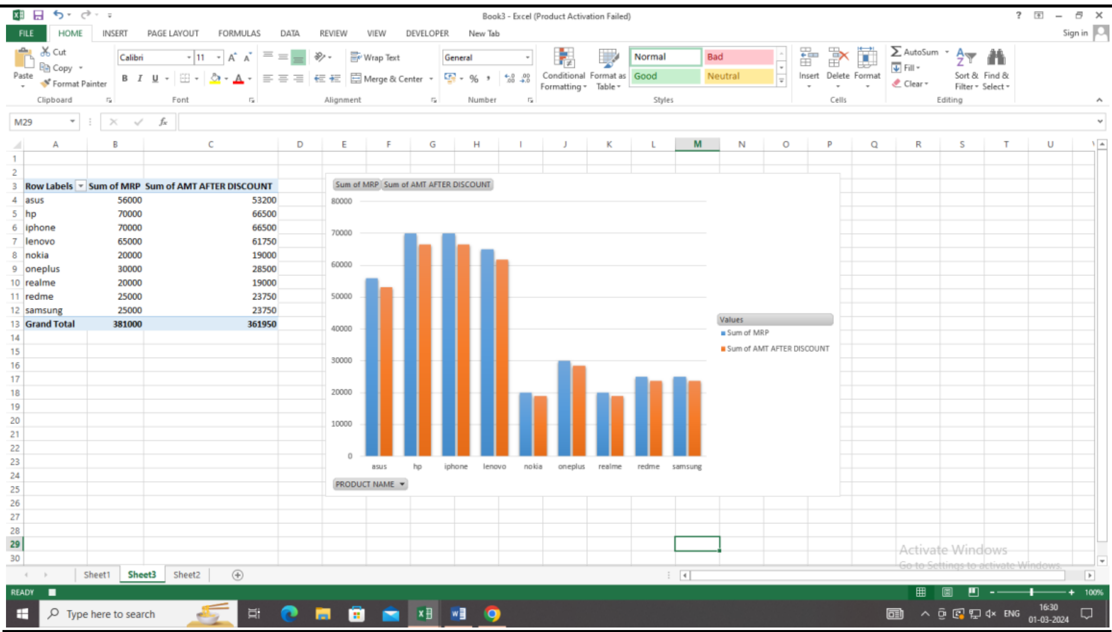
Create a worksheet on Inventory management sheet should contain product contain Product code, Product name, Product type, MRP, Cost after 5% of discount, Date of purchase.

Use appropriate formulas to calculate the above scenario. Analyze the data using appropriate chart and report the data.

Input the Product code, Product type, MRP and date.
Then calculate amount after discount.
To calculate, cell of MRP - (MRP*0.05)
P2 = (D2*0.05)



PRODUCT CODE	PRODUCT NAME	PRODUCT TYPE	MRP	AMT AFTER DISCOUNT	DATE OF PURCHASE
45fss	iphone	mobile	70000	66500	12-12-2023
5ssyte	nokia	mobile	20000	19000	13-12-2023
3nhuh	asus	laptop	56000	53200	14-12-2023
9nhgf	lenovo	laptop	65000	61750	15-12-2023
8nghj	hp	laptop	70000	66500	16-12-2023
6yhsu	oneplus	mobile	30000	28500	17-12-2023
8gufd	samsung	mobile	25000	23750	18-12-2023
98grt	redme	mobile	25000	23750	19-12-2023
6gsht	realme	mobile	20000	19000	20-12-2023


Row Labels | Sum of MRP | Sum of AMT AFTER DISCOUNT
asus 56000 53200
hp 70000 66500
iphone 70000 66500
lenovo 65000 61750
nokia 20000 19000
oneplus 30000 28500
realme 20000 19000
redme 25000 23750
samsung 25000 23750
Grand Total 381000 361950
Sum of MRP
Sum of AMT AFTER DISCOUNT
Values
PRODUCT NAME
Sheet1
Sheet3
Sheet2
READY

ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING LABORATORY

(18CSL76)

LAB MANUAL

For

VII SEMESTER

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING
MIJAR MOODUBIDIRE

VISION OF THE INSTITUTE

"Transformative education by pursuing excellence in Engineering and Management through enhancing skills to meet the evolving needs of the community"

MISSION OF THE INSTITUTE

5. To bestow quality technical education to imbibe knowledge, creativity and ethos to students community.
6. To inculcate the best engineering practices through transformative education.
7. To develop a knowledgeable individual for a dynamic industrial scenario.
8. To inculcate research, entrepreneurial skills and human values in order to cater the needs of the society

VISION OF THE DEPARTMENT

"Engendering competent, excellent professionals by transforming the knowledge and computing skills to individuals through modern innovative tools and techniques"

MISSION OF THE DEPARTMENT

5. To produce skilled, creative software developers through rigorous training.
6. To conduct specific technical courses to keep abreast to the latest technological developments and transformations in the domain.
7. To implement the ideas of research and innovations in interdisciplinary domains.

To establish Industry-Institute Interaction programs to enhance the skillsof employability and entrepreneurship.

General Lab Guidelines:

- Conduct yourself in a responsible manner at all times in the laboratory. Intentional misconduct will lead to the exclusion from the lab.
- Do not wander around, or distract other students, or interfere with the laboratory experiments of other students.
- Read the handout and procedures before starting the experiments. Follow all written and verbal instructions carefully. If you do not understand the procedures, ask the instructor or teaching assistant.
- Attendance in all the labs is mandatory, absence permitted only with prior permission from Class teacher.
- The workplace has to be tidy before, during and after the experiment.
- Do not eat food, drink beverages or chew gum in the laboratory.

DO'S:-

- Uniform and ID card are must.
- Strictly follow the procedures for conduction of experiments.
- Records have to be submitted every week for evaluation.
- Chairs and stools should be kept under the workbenches when not in use.
- After the lab session, switch off the systems and every supply, .
- Keep your belongings in designated area.
- Sign the log book when you enter/leave the laboratory.

DONT'S:-

- Don't touch open wires unless you are sure that there is no voltage. Always disconnect the plug by pulling on the connector body not by the cable. Switch off the supply while you make changes in connections of wires.
- Students are not allowed to work in laboratory alone or without presence of the teaching staff/ instructor.
- No additional material should be carried by the students during regular labs.
- Avoid stepping on electrical wires or any other computer cables.

Without permission no downloads or installations

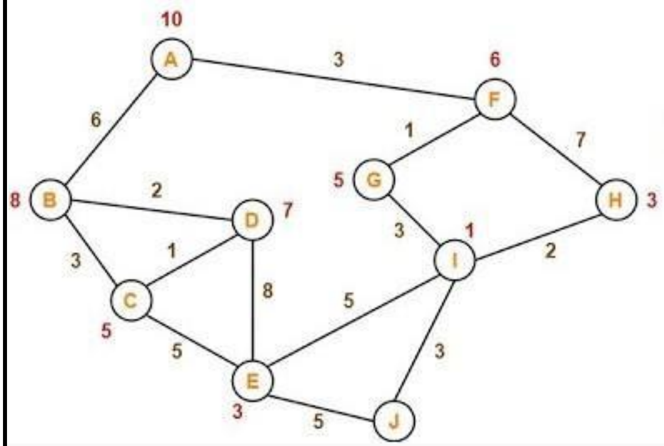
1. Implementation of A Star Search Algorithm

Program :

```
def aStarAlgo(start_node, stop_node):
    open_set = set(start_node)
    closed_set = set()
    g = {}              #store distance from starting node
    parents = {}        # parents contains an adjacency map of all nodes
    #distance of starting node from itself is zero
    g[start_node] = 0
    #start_node is root node i.e it has no parent nodes
    #so start_node is set to its own parent node
    parents[start_node] = start_node
    while len(open_set) > 0:
        n = None
        #node with lowest f() is found
        for v in open_set:
            if n == None or g[v] + heuristic(v) < g[n] + heuristic(n):
                n = v
        if n == stop_node or Graph_nodes[n] == None:
            pass
        else:
            for (m, weight) in get_neighbors(n):
                #nodes 'm' not in first and last set are added to first
                #n is set its parent
                if m not in open_set and m not in closed_set:
                    open_set.add(m)
                    parents[m]  =  n
                    g[m] = g[n] + weight
                #for each node m,compare its distance from start i.e g(m) to the
                #from start through n node
                else:
                    if g[m] > g[n] + weight:
                        #update g(m)
                        g[m] = g[n] + weight
                        #change parent of m to n
                        parents[m] = n
                        #if m in closed set,remove and add to open
```

```
                    if m in closed_set:
                        closed_set.remove(m)
                        open_set.add(m)
        if n == None:
            print('Path does not exist!')
            return None

        # if the current node is the stop_node
        # then we begin reconstruct in the path from it to the start_node
        if n == stop_node:
            path = []
            while parents[n] != n:
                path.append(n)
                n = parents[n]
            path.append(start_node)
            path.reverse()
            print('Path found: {}'.format(path))
            return path
        # remove n from the open_list, and add it to closed_list
        # because all of his neighbors were inspected
        open_set.remove(n)
        closed_set.add(n)
    print('Path does not exist!')
    return None

#define function to return neighbor and its distance
#from the passed node
def get_neighbors(v):
    if v in  Graph_nodes:
        return Graph_nodes[v]
    else:
        return None
```

EXAMPLE 1

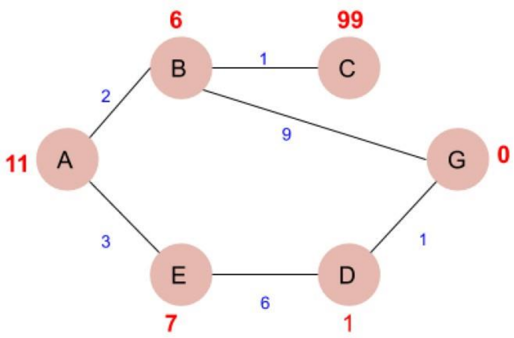



```
#for simplicity we ll consider heuristic  distances  given
#and this function returns heuristic distance for all nodes
def heuristic(n):
    H_dist = {
        'A':  11,
        'B': 6,
        'C': 5,
        'D': 7,
        'E': 3,
        'F': 6,
        'G': 5,
        'H': 3,
        'I': 1,
        'J': 0
    }
    return H_dist[n]
#Describe your graph here
Graph_nodes = {
    'A': [('B', 6), ('F', 3)],
    'B': [('A', 6), ('C', 3), ('D', 2)],
    'C': [('B', 3), ('D', 1), ('E', 5)],
    'D': [('B', 2), ('C', 1), ('E', 8)],
    'E': [('C', 5), ('D', 8), ('I', 5), ('J', 5)],
    'F': [('A', 3), ('G', 1), ('H', 7)],
    'G': [('F', 1), ('I', 3)],
    'H': [('F', 7), ('I', 2)],
    'I': [('E', 5), ('G', 3), ('H', 2), ('J', 3)],
}
aStarAlgo('A', 'J')
```

OUTPUT

Path found: ['A', 'F', 'G', 'I', 'J']

EXAMPLE 2




```
#for simplicity we ll consider heuristic  distances  given
#and this function returns heuristic distance for all nodes
def heuristic(n):
    H_dist = {
        'A': 11,
        'B': 6,
        'C': 99,
        'D': 1,
        'E': 7,
        'G': 0,
    }
    return H_dist[n]

#Describe your graph here
Graph_nodes = {
    'A': [('B', 2), ('E', 3)],
    'B': [('A', 2), ('C', 1), ('G', 9)],
    'C': [('B', 1)],
    'D': [('E', 6), ('G', 1)],
    'E': [('A', 3), ('D', 6)],
    'G': [('B', 9), ('D', 1)]
}
aStarAlgo('A', 'G')
```

Output:

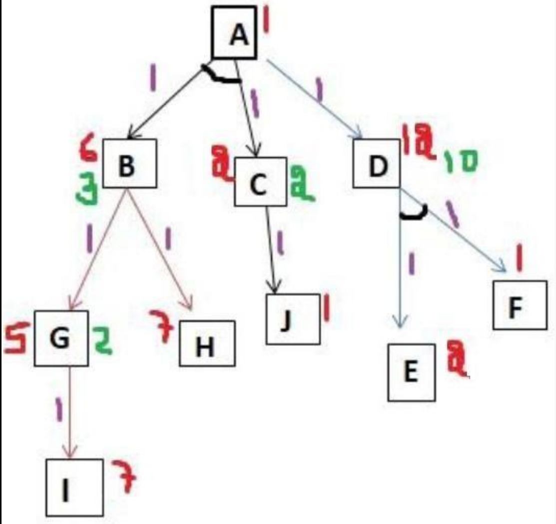
Path found: ['A', 'E', 'D', 'G']

2. Implementation of AO Star Search Algorithm

```
# Cost to find the AND and OR path
def calc_cost(H, condition, weight = 1):
	cost = {}
	if 'AND' in condition:
		AND_nodes = condition['AND']
		Path_A = ' AND '.join(AND_nodes)
		PathA = sum(H[node]+weight for node in AND_nodes)
		cost[Path_A] = PathA

	if 'OR' in condition:
		OR_nodes = condition['OR']
		Path_B =' OR '.join(OR_nodes)
		PathB = min(H[node]+weight for node in OR_nodes)
		cost[Path_B] = PathB
	return cost
# Update the cost
def update_cost(H, Conditions, weight=1):
	Main_nodes = list(Conditions.keys())
	Main_nodes.reverse()
	least_cost= {}
	for key in Main_nodes:
		condition = Conditions[key]
		print(key,':', Conditions[key],'>>>', calc_cost(H, condition, weight))
		c = calc_cost(H, condition, weight)
		H[key] = min(c.values())
		least_cost[key] = calc_cost(H, condition, weight)
	return least_cost
# Print the shortest path
def shortest_path(Start,Updated_cost, H):
	Path = Start
	if Start in Updated_cost.keys():
		Min_cost = min(Updated_cost[Start].values())
		key = list(Updated_cost[Start].keys())
		values = list(Updated_cost[Start].values())
		Index = values.index(Min_cost)

		# FIND MINIMIMUM PATH KEY
		Next = key[Index].split()
		# ADD TO PATH FOR OR PATH
		if len(Next) == 1:

			Start =Next[0]
			Path += '<--' +shortest_path(Start, Updated_cost, H)
		# ADD TO PATH FOR AND PATH
		else:
			Path +='<--('+key[Index]+') '

			Start = Next[0]
			Path += '[' +shortest_path(Start, Updated_cost, H) + ' + '

			Start = Next[-1]
			Path += shortest_path(Start, Updated_cost, H) + ']'

	return Path
```

```
H = {'A': -1, 'B': 5, 'C': 2, 'D': 4, 'E': 7, 'F': 9, 'G': 3, 'H': 0, 'I':0, 'J':0}

Conditions  = {
'A': {'OR': ['B'], 'AND': ['C', 'D']},
'B': {'OR': ['E', 'F']},
'C': {'OR': ['G'], 'AND': ['H', 'I']},
'D': {'OR': ['J']}
}
# weight
weight = 1
# Updated cost
print('Updated Cost :')
Updated_cost = update_cost(H, Conditions, weight=1)
print('*'*75)
print('Shortest Path :\n',shortest_path('A', Updated_cost,H))
```

#Graph – 1 as Input to AO Star Search Algorithm



#OUTPUT

```
Updated Cost :
D : {'OR': ['J']} >>> {'J': 1}
C : {'OR': ['G'], 'AND': ['H', 'I']} >>> {'H AND I': 2, 'G': 4}
B : {'OR': ['E', 'F']} >>> {'E OR F': 8}
A : {'OR': ['B'], 'AND': ['C', 'D']} >>> {'C AND D': 5, 'B': 9}
***************************************************************************
Shortest Path :
 A<--(C AND D) [C<--(H AND I) [H + I] + D<--J]
```

3. Implement Candidate Elimination Algorithm to get Consistent Version Space

Problem Statement: For a given set of training data examples stored in a .CSV file, implement and demonstrate the Candidate-Elimination algorithm to output a description of the set of all hypotheses consistent with the training examples.

Candidate-Elimination Algorithm:

1. Load data set
2. *G* <-maximally general hypotheses in H
3. S <- maximally specific hypotheses in H
4. For each training example d=<x,c(x)> Case 1 : If d is a positive example

Remove from G any hypothesis that is inconsistent with dFor each hypothesis s in S that is not consistent with d

- *Remove s from S.*
- *Add to S all minimal generalizations h of s such that*
  - *h consistent with d*
  - *Some member of G is more general than h*
- *Remove from S any hypothesis that is more general than another hypothesis in S*

Case 2: If d is a negative example

Remove from S any hypothesis that is inconsistent with dFor each hypothesis g in G that is not consistent with d

**Remove g from G.*

**Add to G all minimal specializations h of g such that*

o *h consistent with d*

o *Some member of S is more specific than h*

- *Remove from G any hypothesis that is less general than another hypothesis in G*

```
import numpy as np
import pandas as pd

data = pd.read_csv(path+'/enjoysport.csv')
concepts = np.array(data.iloc[:,0:-1])
print("\nInstances are:\n",concepts)
target = np.array(data.iloc[:,-1])
```

```
print("\nTarget Values are: ",target)

def learn(concepts, target):
    specific_h = concepts[0].copy()
    print("\nInitialization of specific_h and genearal_h")
    print("\nSpecific Boundary: ", specific_h)
    general_h = [["?" for i in range(len(specific_h))] for i in range(len(specific_h))]
    print("\nGeneric Boundary: ",general_h)

    for i, h in enumerate(concepts):
        print("\nInstance", i+1 , "is ", h)
        if target[i] == "yes":
            print("Instance is Positive ")
            for x in range(len(specific_h)):
                if h[x]!= specific_h[x]:
                    specific_h[x] ='?'
                    general_h[x][x] ='?'

        if target[i] == "no":
            print("Instance is Negative ")
            for x in range(len(specific_h)):
                if h[x]!= specific_h[x]:
                    general_h[x][x] = specific_h[x]
                else:
                    general_h[x][x] = '?'

        print("Specific Bundary after ", i+1, "Instance is ", specific_h)
        print("Generic Boundary after ", i+1, "Instance is ", general_h)
        print("\n")

    indices = [i for i, val in enumerate(general_h) if val == ['?', '?', '?', '?', '?', '?']]
    for i in indices:
        general_h.remove(['?', '?', '?', '?', '?', '?'])
    return specific_h, general_h

s_final, g_final = learn(concepts, target)

print("Final Specific_h: ", s_final, sep="\n")
print("Final General_h: ", g_final, sep="\n")
```

Dataset:

EnjoySport Dataset is saved as .csv (comma separated values) file in the current working directory otherwise use the complete path of the dataset set in the program:

sky	airtemp	humidity	wind	water	forecast	enjoysport
sunny	warm	normal	strong	warm	same	yes
sunny	warm	high	strong	warm	same	yes
rainy	cold	high	strong	warm	change	no
sunny	warm	high	strong	cool	change	yes

OUTPUT

Final Specific_h: [‘sunny’ ‘warm’ ‘?’ ‘strong’ ‘?’ ‘?’]

Final General_h: [[‘sunny’, ‘?’, ‘?’, ‘?’, ‘?’, ‘?’], [‘?’, ‘warm’, ‘?’, ‘?’, ‘?’, ‘?’]]

4. Decision Tree ID3 Algorithm

Problem Statement: Write a program to demonstrate the working of the decision tree-based ID3 algorithm. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample.

```
ID3(Examples, Target_attribute, Attributes)

Examples are the training examples.
Target_attribute is the attribute whose value is to be predicted by the tree.
Attributes is a list of other attributes that may be tested by the learned decision tree.
Returns a decision tree that correctly classifies the given Examples.

Create a Root node for the tree
If all Examples are positive, Return the single-node tree Root, with label = +
If all Examples are negative, Return the single-node tree Root, with label = -
If Attributes is empty, Return the single-node tree Root,
with label = most common value of Target_attribute in Examples

Otherwise Begin
  A ← the attribute from Attributes that best* classifies Examples
  The decision attribute for Root ← A
  For each possible value, vi, of A,
    Add a new tree branch below Root, corresponding to the test A = vi
    Let Examples vi, be the subset of Examples that have value vi for A
    If Examples vi , is empty
      Then below this new branch add a leaf node with
      label = most common value of Target_attribute in Examples
    Else
      below this new branch add the subtree
      ID3(Examples vi, Targe_tattribute, Attributes – {A}))
End
Return Root
```

Import libraries and read data using read_csv() function. Remove the target from the data and store attributes in the features variable.

Program

```
import pandas as pd
import math
import numpy as np

data = pd.read_csv("Dataset/4-dataset.csv")
features = [feat for feat in data]
features.remove("answer")
```

Create a class named Node with four members children, value, isLeaf and pred.

```
class Node:
    def __init__(self):
        self.children = []
        self.value = ""
        self.isLeaf = False
        self.pred = ""
```

Define a function called entropy to find the entropy oof the dataset.

```
def entropy(examples):
    pos = 0.0
    neg = 0.0
    for _, row in examples.iterrows():
        if row["answer"] == "yes":
```

```
            pos += 1
        else:
            neg += 1
    if pos == 0.0 or neg == 0.0:
        return 0.0
    else:
        p = pos / (pos + neg)
        n = neg / (pos + neg)
        return -(p * math.log(p, 2) + n * math.log(n, 2))
```

Define a function named info_gain to find the gain of the attribute

```
def info_gain(examples, attr):
    uniq = np.unique(examples[attr])
    #print ("\n",uniq)
    gain = entropy(examples)
    #print ("\n",gain)
    for u in uniq:
        subdata = examples[examples[attr] == u]
        #print ("\n",subdata)
        sub_e = entropy(subdata)
        gain -= (float(len(subdata)) / float(len(examples))) * sub_e
        #print ("\n",gain)
    return gain
```

Define a function named ID3 to get the decision tree for the given dataset

```
def ID3(examples, attrs):
    root = Node()

    max_gain = 0
    max_feat = ""
    for feature in attrs:
        #print ("\n",examples)
        gain = info_gain(examples, feature)
        if gain > max_gain:
            max_gain = gain
            max_feat = feature
    root.value = max_feat
    #print ("\nMax feature attr",max_feat)
    uniq = np.unique(examples[max_feat])
    #print ("\n",uniq)
    for u in uniq:
        #print ("\n",u)
        subdata = examples[examples[max_feat] == u]
        #print ("\n",subdata)
        if entropy(subdata) == 0.0:
            newNode = Node()
            newNode.isLeaf = True
            newNode.value = u
            newNode.pred = np.unique(subdata["answer"])
            root.children.append(newNode)
        else:
            dummyNode = Node()
            dummyNode.value = u
            new_attrs = attrs.copy()
            new_attrs.remove(max_feat)
            child = ID3(subdata, new_attrs)
            dummyNode.children.append(child)
            root.children.append(dummyNode)

    return root
```

Define a function named printTree to draw the decision tree

```
def printTree(root: Node, depth=0):
```

```
    for i in range(depth):
        print("\t", end="")
    print(root.value, end="")
    if root.isLeaf:
        print(" -> ", root.pred)
    print()
    for child in root.children:
        printTree(child, depth + 1)
```

Define a function named classify to classify the new example

```
def classify(root: Node, new):
    for child in root.children:
        if child.value == new[root.value]:
            if child.isLeaf:
                print ("Predicted Label for new example", new," is:", child.pred)
                exit
            else:
                classify (child.children[0], new)
```

Finally, call the ID3, printTree and classify functions

```
root = ID3(data, features)
print("Decision Tree is:")
printTree(root)
print (" -------------------- ")

new = {"outlook":"sunny", "temperature":"hot", "humidity":"normal", "wind":"strong"}
classify (root, new)
```

Output:

```
Outlook
  rain
        Wind
                strong
                        no
                weak
                        yes
  overcast
        yes

  sunny
        Humidity
                normal
                        yes
                high
                        no
```

```
Decision Tree is:
```

```
outlook
	overcast ->  ['yes']

	rain
		wind
			strong ->  ['no']

			weak ->  ['yes']

	sunny
		humidity
			high ->  ['no']

			normal ->  ['yes']

```

```
Predicted Label for new example {'outlook': 'sunny',
'temperature': 'hot', 'humidity': 'normal', 'wind': 'strong'}  is:
['yes']
```

5. Back propagation Algorithm

Problem Statement: Build an Artificial Neural Network by implementing the Backpropagation algorithm and test the same using appropriate data sets.

```
import numpy as np

X = np.array(([2, 9], [1, 5], [3, 6]), dtype=float)
y = np.array(([92], [86], [89]), dtype=float)
X = X/np.amax(X,axis=0) #maximum of X array longitudinally
y = y/100

#Sigmoid Function
def sigmoid (x):
    return 1/(1 + np.exp(-x))

#Derivative of Sigmoid Function
def derivatives_sigmoid(x):
    return x * (1 - x)

#Variable initialization
epoch=5 #Setting training iterations
lr=0.1 #Setting learning rate

inputlayer_neurons = 2 #number of features in data set
hiddenlayer_neurons = 3 #number of hidden layers neurons
output_neurons = 1 #number of neurons at output layer
#weight and bias initialization

wh=np.random.uniform(size=(inputlayer_neurons,hiddenlayer_neurons))
bh=np.random.uniform(size=(1,hiddenlayer_neurons))
wout=np.random.uniform(size=(hiddenlayer_neurons,output_neurons))
bout=np.random.uniform(size=(1,output_neurons))

#draws a random range of numbers uniformly of dim x*y
for i in range(epoch):
    #Forward Propogation
    hinp1=np.dot(X,wh)
    hinp=hinp1 + bh
    hlayer_act = sigmoid(hinp)
    outinp1=np.dot(hlayer_act,wout)
    outinp= outinp1+bout
    output = sigmoid(outinp)

    #Backpropagation
    EO = y-output
    outgrad = derivatives_sigmoid(output)
    d_output = EO * outgrad
    EH = d_output.dot(wout.T)
    hiddengrad = derivatives_sigmoid(hlayer_act)#how much hidden layer wts contributed to error
    d_hiddenlayer = EH * hiddengrad

    wout += hlayer_act.T.dot(d_output) *lr # dotproduct of nextlayererror and currentlayerop
    wh += X.T.dot(d_hiddenlayer) *lr

    print ("-----------Epoch-", i+1, "Starts -----------")
    print("Input: \n" + str(X))
    print("Actual Output: \n" + str(y))
    print("Predicted Output: \n" ,output)
    print ("-----------Epoch-", i+1, "Ends ----------\n")
```

```
print("Input: \n" + str(X))
print("Actual Output: \n" + str(y))
print("Predicted Output: \n" ,output)
```

Training Examples:

Example	Sleep	Study	Expected % in Exams
1	2	9	92
2	1	5	86
3	3	6	89

Normalize the input

Example	Sleep	Study	Expected % in Exams
1	2/3 = 0.66666667	9/9 = 1	0.92
2	1/3 = 0.33333333	5/9 = 0.55555556	0.86
3	3/3 = 1	6/9 = 0.66666667	0.89

Output

```
————Epoch- 1 Starts————-
Input:
[[0.66666667 1. ]
[0.33333333 0.55555556]
[1. 0.66666667]]
Actual Output:
[[0.92]
[0.86]
[0.89]]
Predicted Output:
[[0.81951208]
[0.8007242 ]
[0.82485744]]
————Epoch- 1 Ends————-

————Epoch- 2 Starts————-
Input:
[[0.66666667 1. ]
[0.33333333 0.55555556]
[1. 0.66666667]]
Actual Output:
[[0.92]
[0.86]
[0.89]]
```

```
Predicted Output:
[[0.82033938]
[0.80153634]
[0.82568134]]
————–Epoch- 2 Ends———-

————–Epoch- 3 Starts———-
Input:
[[0.66666667 1. ]
[0.33333333 0.55555556]
[1. 0.66666667]]
Actual Output:
[[0.92]
[0.86]
[0.89]]
Predicted Output:
[[0.82115226]
[0.80233463]
[0.82649072]]
————–Epoch- 3 Ends———-

————–Epoch- 4 Starts———-
Input:
[[0.66666667 1. ]
[0.33333333 0.55555556]
[1. 0.66666667]]
Actual Output:
[[0.92]
[0.86]
[0.89]]
Predicted Output:
[[0.82195108]
[0.80311943]
[0.82728598]]
————–Epoch- 4 Ends———-
```

6. Naïve Bayesian Classifier

Problem Statement: Write a program to implement the naïve Bayesian classifier for a sample training data set stored as a .CSV file. Compute the accuracy of the classifier, considering few test data sets.

Bayes' Theorem is stated as:

$$P(h|D) = \frac{P(D|h)P(h)}{P(D)}$$

Where,

P(h|D) is the probability of hypothesis h given the data D. This is called the **posterior probability**.

P(D|h) is the probability of data d given that the hypothesis h was true.

P(h) is the probability of hypothesis h being true. This is called the **prior probability of h.**

P(D) is the probability of the data. This is called the **prior probability of D**

After calculating the posterior probability for a number of different hypotheses h, and is interested in finding the most probable hypothesis h ∈ H given the observed data D. Any such maximally probable hypothesis is called a ***maximum a posteriori (MAP) hypothesis***.

Bayes theorem to calculate the posterior probability of each candidate hypothesis is ***hMAP*** is a MAP hypothesis provided.

$$h_{MAP} = \arg\max_{h \in H} P(h|D)$$

$$= \arg\max_{h \in H} \frac{P(D|h)P(h)}{P(D)}$$

$$= \arg\max_{h \in H} P(D|h)P(h)$$

(Ignoring P(D) since it is a constant)

Gaussian Naive Bayes

A Gaussian Naive Bayes algorithm is a special type of Naïve Bayes algorithm. It's specifically used when the features have continuous values. It's also assumed that all the features are following a Gaussian distribution i.e., normal distribution

Representation for Gaussian Naive Bayes

We calculate the probabilities for input values for each class using a frequency. With real- valued inputs, we can calculate the mean and standard deviation of input values (x) for each class to summarize the distribution.

This means that in addition to the probabilities for each class, we must also store the mean and standard deviations for each input variable for each class.

Gaussian Naive Bayes Model from Data

The probability density function for the normal distribution is defined by two parameters (mean and standard deviation) and calculating the mean and standard deviation values of each input variable (x) for each class value.

$$\mu = \frac{1}{n}\sum_{i=1}^{n} x_i$$ Mean

$$\sigma = \left[\frac{1}{n-1}\sum_{i=1}^{n}(x_i - \mu)^2\right]^{0.5}$$ Standard deviation

$$f(x) = \frac{1}{\sqrt{2\pi}\sigma} e^{-\frac{(x-\mu)^2}{2\sigma^2}}$$ Normal distribution

Examples:
The data set used in this program is the ***Pima Indians Diabetes problem***.
This data set is comprised of 768 observations of medical details for Pima Indians patents. The records describe instantaneous measurements taken from the patient such as their age, the number of times pregnant and blood workup. All patients are women aged 21 or older. All attributes are numeric, and their units vary from attribute to attribute.

The attributes are Pregnancies, Glucose, BloodPressure, SkinThickness, Insulin, BMI, DiabeticPedigreeFunction, Age, Outcome

Each record has a class value that indicates whether the patient suffered an onset of diabetes within 5 years of when the measurements were taken (1) or not (0)

Sample Examples:

Examples	Pregnancies	Glucose	BP	Skin Thickness	Insulin	BMI	Diabetic Pedigree Function	Age	Outcome
1	6	148	72	35		33.6	0.627	50	1
2	1	85	66	29		26.6	0.351	31	
3	8	183	64			23.3	0.672	32	1
4	1	89	66	23	94	28.1	0.167	21	
5		137	40	35	168	43.1	2.288	33	1
6	5	116	74			25.6	0.201	30	
7	3	78	50	32	88	31	0.248	26	1
8	10	115				35.3	0.134	29	

9	2	197	70	45	543	30.5	0.158	53	1
10	8	125	96				0.232	54	1

Python Program to Implement and Demonstrate Naïve Bayesian Classifier Machine Learning

```
import csv
import random
import math

def loadcsv(filename):
        lines = csv.reader(open(filename, "r"));
        dataset = list(lines)
        for i in range(len(dataset)):
    #converting strings into numbers for processing
                dataset[i] = [float(x) for x in dataset[i]]
        return dataset
def splitdataset(dataset, splitratio):
  #67% training size
        trainsize = int(len(dataset) * splitratio);
        trainset = []
        copy = list(dataset);
        while len(trainset) < trainsize:
#generate indices for the dataset list randomly to pick ele for training data
                index = random.randrange(len(copy));
                trainset.append(copy.pop(index))
        return [trainset, copy]
def separatebyclass(dataset):
        separated = {} #dictionary of classes 1 and 0
#creates a dictionary of classes 1 and 0 where the values are
#the instances belonging to each class
        for i in range(len(dataset)):
                vector = dataset[i]
                if (vector[-1] not in separated):
                        separated[vector[-1]] = []
                separated[vector[-1]].append(vector)
        return separated
def mean(numbers):
        return sum(numbers)/float(len(numbers))
def stdev(numbers):
        avg = mean(numbers)
```

```
            variance = sum([pow(x-avg,2) for x in numbers])/float(len(numbers)-1)
            return math.sqrt(variance)
 def summarize(dataset): #creates a dictionary of classes
            summaries = [(mean(attribute), stdev(attribute)) for attribute in zip(*dataset)];
            del summaries[-1] #excluding labels +ve or -ve
            return summaries
 def summarizebyclass(dataset):
            separated = separatebyclass(dataset);
   #print(separated)
            summaries = {}
            for classvalue, instances in separated.items():
#for key,value in dic.items()
#summaries is a dic of tuples(mean,std) for each class value
                        summaries[classvalue] = summarize(instances) #summarize is used to cal to
mean and std
            return summaries
 def calculateprobability(x, mean, stdev):
            exponent = math.exp(-(math.pow(x-mean,2)/(2*math.pow(stdev,2))))
            return (1 / (math.sqrt(2*math.pi) * stdev)) * exponent

def calculateclassprobabilities(summaries, inputvector):
            probabilities = {} # probabilities contains the all prob of all class of test data
            for classvalue, classsummaries in summaries.items():#class and attribute information as
mean and sd
                        probabilities[classvalue] = 1
                        for i in range(len(classsummaries)):
                                    mean, stdev = classsummaries[i] #take mean and sd of every attribute
for class 0 and 1 seperaely
                                    x = inputvector[i] #testvector's first attribute
                                    probabilities[classvalue] *= calculateprobability(x, mean, stdev);#use
normal dist
            return probabilities

def predict(summaries, inputvector): #training and test data is passed
            probabilities = calculateclassprobabilities(summaries, inputvector)
            bestLabel, bestProb = None, -1
            for classvalue, probability in probabilities.items():#assigns that class which has he
highest prob
                        if bestLabel is None or probability > bestProb:
                                    bestProb = probability
                                    bestLabel = classvalue
```

```
        return bestLabel

def getpredictions(summaries, testset):
        predictions = []
        for i in range(len(testset)):
                result = predict(summaries, testset[i])
                predictions.append(result)
        return predictions

def getaccuracy(testset, predictions):
        correct = 0
        for i in range(len(testset)):
                if testset[i][-1] == predictions[i]:
                        correct += 1
        return (correct/float(len(testset))) * 100.0

def main():
        filename = 'naivedata.csv'
        splitratio = 0.67
        dataset = loadcsv(filename);

        trainingset, testset = splitdataset(dataset, splitratio)
        print('Split {0} rows into train={1} and test={2} rows'.format(len(dataset), len(trainingset),
len(testset)))
        # prepare model
        summaries = summarizebyclass(trainingset);
        #print(summaries)
    # test model
        predictions = getpredictions(summaries, testset) #find the predictions of test data with
the training data
        accuracy = getaccuracy(testset, predictions)
        print('Accuracy of the classifier is : {0}%'.format(accuracy))
 main()
```

Output

Split 768 rows into train=514 and test=254

Rows Accuracy of the classifier is : 71.65354330708661%

7. Implement the K-Means and Estimation & Maximization Algorithm

Problem Statement: Apply EM algorithm to cluster a set of data stored in a .CSV file. Use the same data set for clustering using the k-Means algorithm. Compare the results of these two algorithms and comment on the quality of clustering. You can add Java/Python ML library classes/API in the program.

Python Program to Implement and Demonstrate K-Means and EM Algorithm Machine Learning

```
from sklearn.cluster import KMeans
from sklearn.mixture import GaussianMixture
import sklearn.metrics as metrics
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt

names = ['Sepal_Length','Sepal_Width','Petal_Length','Petal_Width', 'Class']

dataset = pd.read_csv("8-dataset.csv", names=names)

X = dataset.iloc[:, :-1]

label = {'Iris-setosa': 0,'Iris-versicolor': 1, 'Iris-virginica': 2}

y = [label[c] for c in dataset.iloc[:, -1]]

plt.figure(figsize=(14,7))
colormap=np.array(['red','lime','black'])

# REAL PLOT
plt.subplot(1,3,1)
plt.title('Real')
plt.scatter(X.Petal_Length,X.Petal_Width,c=colormap[y])

# K-PLOT
model=KMeans(n_clusters=3, random_state=0).fit(X)
plt.subplot(1,3,2)
plt.title('KMeans')
plt.scatter(X.Petal_Length,X.Petal_Width,c=colormap[model.labels_])

print('The accuracy score of K-Mean: ',metrics.accuracy_score(y, model.labels_))
print('The Confusion matrixof K-Mean:\n',metrics.confusion_matrix(y, model.labels_))

# GMM PLOT
gmm=GaussianMixture(n_components=3, random_state=0).fit(X)
y_cluster_gmm=gmm.predict(X)
plt.subplot(1,3,3)
plt.title('GMM Classification')
plt.scatter(X.Petal_Length,X.Petal_Width,c=colormap[y_cluster_gmm])

print('The accuracy score of EM: ',metrics.accuracy_score(y, y_cluster_gmm))
print('The Confusion matrix of EM:\n ',metrics.confusion_matrix(y, y_cluster_gmm))
```

Output

The accuracy score of K-Mean: 0.24

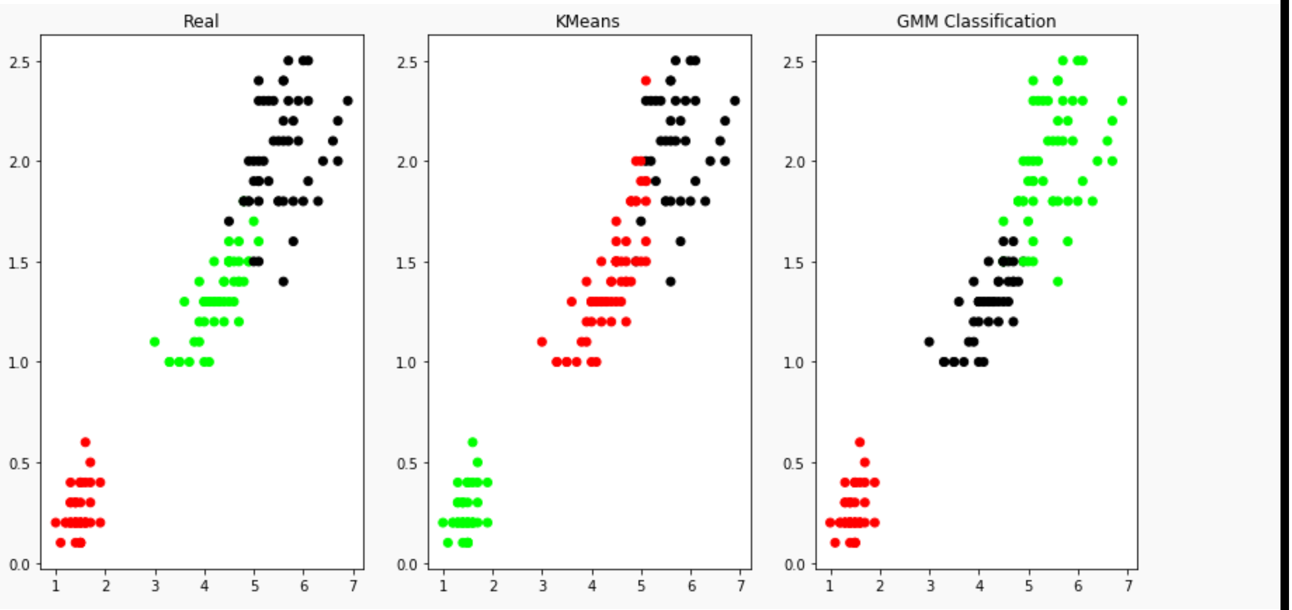
The Confusion matrixof K-Mean:

[[0 50 0]
[48 0 2]
[14 0 36]]

The accuracy score of EM: 0.36666666666666664

The Confusion matrix of EM:

[[50 0 0]
[0 5 45]
[0 50 0]]



The data set

5.1	3.5	1.4	0.2	Iris-setosa
4.9	3	1.4	0.2	Iris-setosa
4.7	3.2	1.3	0.2	Iris-setosa
4.6	3.1	1.5	0.2	Iris-setosa
5	3.6	1.4	0.2	Iris-setosa
5.4	3.9	1.7	0.4	Iris-setosa
4.6	3.4	1.4	0.3	Iris-setosa
5	3.4	1.5	0.2	Iris-setosa
4.4	2.9	1.4	0.2	Iris-setosa
4.9	3.1	1.5	0.1	Iris-setosa
5.4	3.7	1.5	0.2	Iris-setosa
4.8	3.4	1.6	0.2	Iris-setosa
4.8	3	1.4	0.1	Iris-setosa
4.3	3	1.1	0.1	Iris-setosa
5.8	4	1.2	0.2	Iris-setosa
5.7	4.4	1.5	0.4	Iris-setosa
5.4	3.9	1.3	0.4	Iris-setosa
5.1	3.5	1.4	0.3	Iris-setosa
5.7	3.8	1.7	0.3	Iris-setosa
5.1	3.8	1.5	0.3	Iris-setosa
5.4	3.4	1.7	0.2	Iris-setosa
5.1	3.7	1.5	0.4	Iris-setosa
4.6	3.6	1	0.2	Iris-setosa
5.1	3.3	1.7	0.5	Iris-setosa
4.8	3.4	1.9	0.2	Iris-setosa
5	3	1.6	0.2	Iris-setosa
5	3.4	1.6	0.4	Iris-setosa
5.2	3.5	1.5	0.2	Iris-setosa
5.2	3.4	1.4	0.2	Iris-setosa
3.2	1.6	0.2	Iris-setosa	
3.1	1.6	0.2	Iris-setosa	
5.4	3.4	1.5	0.4	Iris-setosa
5.2	4.1	1.5	0.1	Iris-setosa
5.5	4.2	1.4	0.2	Iris-setosa
4.9	3.1	1.5	0.1	Iris-setosa
5	3.2	1.2	0.2	Iris-setosa
5.5	3.5	1.3	0.2	Iris-setosa
4.9	3.1	1.5	0.1	Iris-setosa
4.4	3	1.3	0.2	Iris-setosa
5.1	3.4	1.5	0.2	Iris-setosa
5	3.5	1.3	0.3	Iris-setosa
4.5	2.3	1.3	0.3	Iris-setosa
4.4	3.2	1.3	0.2	Iris-setosa
5	3.5	1.6	0.6	Iris-setosa
5.1	3.8	1.9	0.4	Iris-setosa
4.8	3	1.4	0.3	Iris-setosa
5.1	3.8	1.6	0.2	Iris-setosa
4.6	3.2	1.4	0.2	Iris-setosa
5.3	3.7	1.5	0.2	Iris-setosa
5	3.3	1.4	0.2	Iris-setosa
7	3.2	4.7	1.4	Iris-versicolor
6.4	3.2	4.5	1.5	Iris-versicolor
6.9	3.1	4.9	1.5	Iris-versicolor
5.5	2.3	4	1.3	Iris-versicolor
6.5	2.8	4.6	1.5	Iris-versicolor
5.7	2.8	4.5	1.3	Iris-versicolor
6.3	3.3	4.7	1.6	Iris-versicolor

4.9	2.4	3.3	1	Iris-versicolor
6.6	2.9	4.6	1.3	Iris-versicolor
5.2	2.7	3.9	1.4	Iris-versicolor
5	2	3.5	1	Iris-versicolor
5.9	3	4.2	1.5	Iris-versicolor
6	2.2	4	1	Iris-versicolor
2.9 4.7	1.4	Iris-versicolor		
5.6	2.9	3.6	1.3	Iris-versicolor
6.7	3.1	4.4	1.4	Iris-versicolor
5.6	3	4.5	1.5	Iris-versicolor
5.8	2.7	4.1	1	Iris-versicolor
6.2	2.2	4.5	1.5	Iris-versicolor
5.6	2.5	3.9	1.1	Iris-versicolor
5.9	3.2	4.8	1.8	Iris-versicolor
6.1	2.8	4	1.3	Iris-versicolor
6.3	2.5	4.9	1.5	Iris-versicolor
6.1	2.8	4.7	1.2	Iris-versicolor
6.4	2.9	4.3	1.3	Iris-versicolor
6.6	3	4.4	1.4	Iris-versicolor
6.8	2.8	4.8	1.4	Iris-versicolor
6.7	3	5	1.7	Iris-versicolor
6	2.9	4.5	1.5	Iris-versicolor
5.7	2.6	3.5	1	Iris-versicolor
5.5	2.4	3.8	1.1	Iris-versicolor
5.5	2.4	3.7	1	Iris-versicolor
5.8	2.7	3.9	1.2	Iris-versicolor
6	2.7	5.1	1.6	Iris-versicolor
5.4	3	4.5	1.5	Iris-versicolor
6	3.4	4.5	1.6	Iris-versicolor
6.7	3.1	4.7	1.5	Iris-versicolor
6.3	2.3	4.4	1.3	Iris-versicolor
5.6	3	4.1	1.3	Iris-versicolor
5.5	2.5	4	1.3	Iris-versicolor
5.5	2.6	4.4	1.2	Iris-versicolor
6.1	3	4.6	1.4	Iris-versicolor
5.8	2.6	4	1.2	Iris-versicolor
5	2.3	3.3	1	Iris-versicolor
2.7 4.2	1.3	Iris-versicolor		
3 4.2	1.2	Iris-versicolor		
5.7	2.9	4.2	1.3	Iris-versicolor
6.2	2.9	4.3	1.3	Iris-versicolor
5.1	2.5	3	1.1	Iris-versicolor
5.7	2.8	4.1	1.3	Iris-versicolor
6.3	3.3	6	2.5	Iris-virginica
5.8	2.7	5.1	1.9	Iris-virginica
7.1	3	5.9	2.1	Iris-virginica
6.3	2.9	5.6	1.8	Iris-virginica
6.5	3	5.8	2.2	Iris-virginica
7.6	3	6.6	2.1	Iris-virginica
4.9	2.5	4.5	1.7	Iris-virginica
7.3	2.9	6.3	1.8	Iris-virginica
6.7	2.5	5.8	1.8	Iris-virginica
7.2	3.6	6.1	2.5	Iris-virginica
6.5	3.2	5.1	2	Iris-virginica
6.4	2.7	5.3	1.9	Iris-virginica
6.8	3	5.5	2.1	Iris-virginica
2.5 5	2	Iris-virginica		
2.8 5.1	2.4	Iris-virginica		
3.2 5.3	2.3	Iris-virginica		
3 5.5	1.8	Iris-virginica		

7.7	3.8	6.7	2.2	Iris-virginica
7.7	2.6	6.9	2.3	Iris-virginica
6	2.2	5	1.5	Iris-virginica
6.9	3.2	5.7	2.3	Iris-virginica
5.6	2.8	4.9	2	Iris-virginica
7.7	2.8	6.7	2	Iris-virginica
6.3	2.7	4.9	1.8	Iris-virginica
6.7	3.3	5.7	2.1	Iris-virginica
7.2	3.2	6	1.8	Iris-virginica
6.2	2.8	4.8	1.8	Iris-virginica
6.1	3	4.9	1.8	Iris-virginica
6.4	2.8	5.6	2.1	Iris-virginica
7.2	3	5.8	1.6	Iris-virginica
7.4	2.8	6.1	1.9	Iris-virginica
7.9	3.8	6.4	2	Iris-virginica
6.4	2.8	5.6	2.2	Iris-virginica
6.3	2.8	5.1	1.5	Iris-virginica
6.1	2.6	5.6	1.4	Iris-virginica
7.7	3	6.1	2.3	Iris-virginica
3.4 5.6	2.4	Iris-virginica		
3.1 5.5	1.8	Iris-virginica		
6	3	4.8	1.8	Iris-virginica
6.9	3.1	5.4	2.1	Iris-virginica
6.7	3.1	5.6	2.4	Iris-virginica
6.9	3.1	5.1	2.3	Iris-virginica
5.8	2.7	5.1	1.9	Iris-virginica
6.8	3.2	5.9	2.3	Iris-virginica
6.7	3.3	5.7	2.5	Iris-virginica
6.7	3	5.2	2.3	Iris-virginica
6.3	2.5	5	1.9	Iris-virginica
6.5	3	5.2	2	Iris-virginica
6.2	3.4	5.4	2.3	Iris-virginica
5.9	3	5.1	1.8	Iris-virginica

8. k-Nearest Neighbour Algorithm

Problem Statement: Write a program to implement the k-Nearest Neighbour algorithm to classify the iris data set. Print both correct and wrong predictions. Java/Python ML library classes can be used for this problem

Python Program to Implement the k-Nearest Neighbour Algorithm

K-Nearest Neighbor Algorithm

Training algorithm:

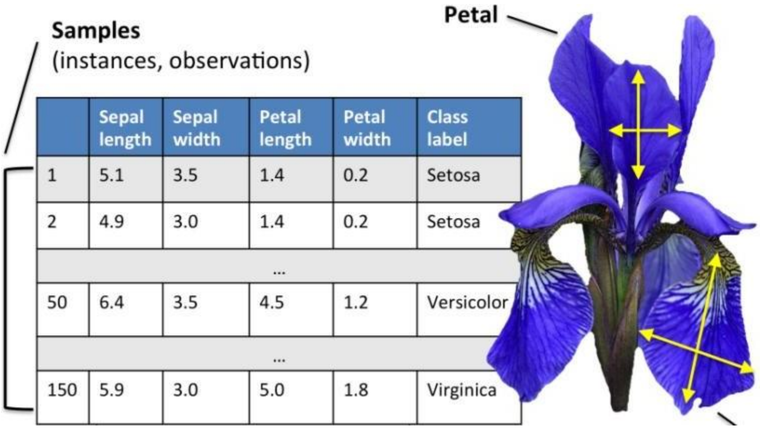
- For each training example (x, f (x)), add the example to the list training examples Classification algorithm:
  - Given a query instance x_q to be classified,
    - Let $x_1 \ldots x_k$ denote the k instances from training examples that are nearest to x_q
    - Return

$$\hat{f}(x_q) \leftarrow \frac{\sum_{i=1}^{k} f(x_i)}{k}$$

- Where, $f(x_i)$ function to calculate the mean value of the k nearest training examples.

Data Set:

Iris Plants Dataset: Dataset contains 150 instances (50 in each of three classes) Number of Attributes: 4 numeric, predictive attributes and the Class.



Sample Data

	sepal-length	sepal-width	petal-length	petal-width	Class
0	5.1	3.5	1.4	0.2	Iris-setosa
1	4.9	3.0	1.4	0.2	Iris-setosa
2	4.7	3.2	1.3	0.2	Iris-setosa
3	4.6	3.1	1.5	0.2	Iris-setosa
4	5.0	3.6	1.4	0.2	Iris-setosa

Use the same data set as previous one

Program

```
import numpy as np
import pandas as pd
from  sklearn.neighbors  import  KNeighborsClassifier
from  sklearn.model_selection  import  train_test_split
from sklearn import metrics

names = ['sepal-length', 'sepal-width',  'petal-length',  'petal-width',  'Class']

# Read dataset to pandas dataframe
dataset = pd.read_csv("9-dataset.csv", names=names)
X  =  dataset.iloc[:, :-1]
y = dataset.iloc[:, -1]
print(X.head())
Xtrain, Xtest, ytrain, ytest = train_test_split(X, y, test_size=0.10)

classifier = KNeighborsClassifier(n_neighbors=5).fit(Xtrain, ytrain)

ypred = classifier.predict(Xtest)

i = 0
print  ("\n................................................................................................................")
print ('%-25s %-25s %-25s' % ('Original Label', 'Predicted Label', 'Correct/Wrong'))
print ("................................................................................................................")
for label in ytest:
    print ('%-25s %-25s' % (label, ypred[i]), end="")
    if (label == ypred[i]):
        print ('  %-25s'  % ('Correct'))
    else:
        print (' %-25s' % ('Wrong'))
    i = i + 1
print  ("................................................................................................................")
print("\nConfusion    Matrix:\n",metrics.confusion_matrix(ytest,     ypred))
print  ("................................................................................................................")
print("\nClassification    Report:\n",metrics.classification_report(ytest,     ypred))
print  ("................................................................................................................")
print('Accuracy of the classifer is %0.2f' % metrics.accuracy_score(ytest,ypred))
print  ("................................................................................................................")
```

Output

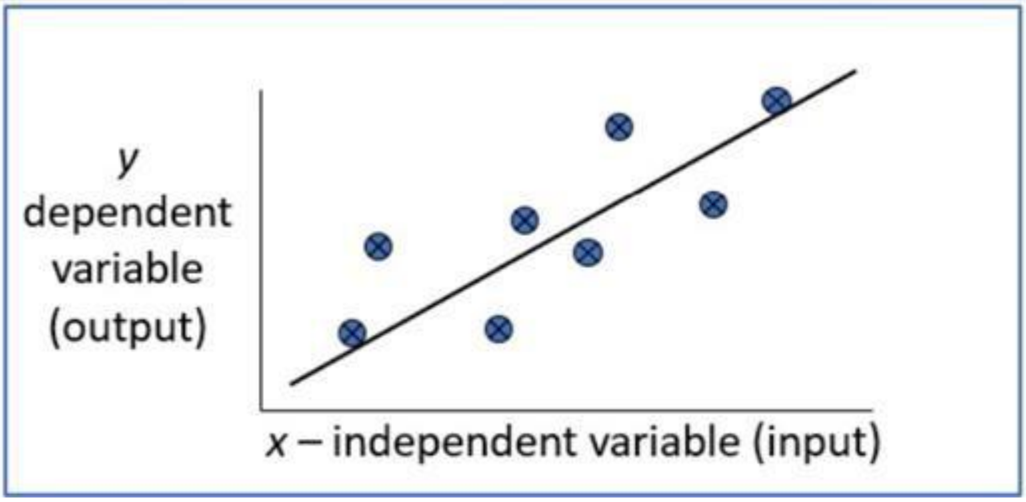
```
  sepal-length  sepal-width  petal-length  petal-width
0          5.1          3.5           1.4          0.2
1          4.9          3.0           1.4          0.2
2          4.7          3.2           1.3          0.2
3          4.6          3.1           1.5          0.2
4          5.0          3.6           1.4          0.2

-------------------------------------------------------------------------------
Original Label          Predicted Label          Correct/Wrong
-------------------------------------------------------------------------------
Iris-versicolor         Iris-versicolor          Correct
Iris-virginica          Iris-versicolor          Wrong
Iris-virginica          Iris-virginica           Correct
Iris-versicolor         Iris-versicolor          Correct
Iris-setosa             Iris-setosa              Correct
Iris-versicolor         Iris-versicolor          Correct
Iris-setosa             Iris-setosa              Correct
Iris-setosa             Iris-setosa              Correct
Iris-virginica          Iris-virginica           Correct
Iris-virginica          Iris-versicolor          Wrong
Iris-virginica          Iris-virginica           Correct
Iris-setosa             Iris-setosa              Correct
Iris-virginica          Iris-virginica           Correct
Iris-virginica          Iris-virginica           Correct
Iris-versicolor         Iris-versicolor          Correct
-------------------------------------------------------------------------------

Confusion Matrix:
 [[4 0 0]
 [0 4 0]
 [0 2 5]]
-------------------------------------------------------------------------------

Classification Report:
                 precision    recall  f1-score   support

    Iris-setosa       1.00      1.00      1.00         4
Iris-versicolor       0.67      1.00      0.80         4
 Iris-virginica       1.00      0.71      0.83         7

    avg / total       0.91      0.87      0.87        15

-------------------------------------------------------------------------------
Accuracy of the classifier is 0.87
-------------------------------------------------------------------------------
```

9. Locally Weighted Regression Algorithm

Problem Statement: Implement the non-parametric Locally Weighted Regression algorithm in order to fit data points. Select the appropriate data set for your experiment and draw graphs.

Regression:

- Regression is a technique from statistics that are used to predict values of the desired target quantity when the target quantity is continuous.
  - In regression, we seek to identify (or estimate) a continuous variable y associated with a given input vector x.
    - y is called the dependent variable.
    - x is called the independent variable.



Loess/Lowess Regression:
Loess regression is a nonparametric technique that uses local weighted regression to fit a smooth curve through points in a scatter plot.

Lowess Algorithm:
Locally weighted regression is a very powerful nonparametric model used in statistical learning.

Given a dataset X, y, we attempt to find a model parameter β(x) that minimizes residual sum of weighted squared errors.
The weights are given by a kernel function (k or w) which can be chosen arbitrarily

Algorithm

1. Read the Given data Sample to X and the curve (linear or nonlinear) to Y
2. Set the value for Smoothening parameter or Free parameter say τ
3. Set the bias /Point of interest set x0 which is a subset of X
4. Determine the weight matrix using :

$$w(x, x_o) = e^{-\frac{(x-x_o)^2}{2\tau^2}}$$

5. Determine the value of model term parameter β using:

$$\hat{\beta}(x_o) = (X^T W X)^{-1} X^T W y$$

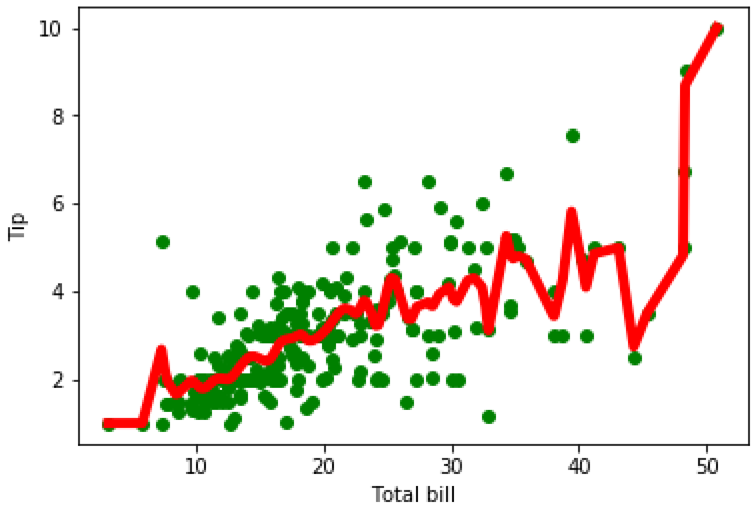
6. Prediction = x0*β

Program

```
import matplotlib.pyplot as plt
import pandas as pd
import numpy as np

def kernel(point, xmat, k):
    m,n = np.shape(xmat)
    weights = np.mat(np1.eye((m)))
    for j in range(m):
        diff = point - X[j]
        weights[j,j] = np.exp(diff*diff.T/(-2.0*k**2))
    return weights

def localWeight(point, xmat, ymat, k):
    wei = kernel(point,xmat,k)
    W = (X.T*(wei*X)).I*(X.T*(wei*ymat.T))
    return W

def localWeightRegression(xmat, ymat, k):
    m,n = np.shape(xmat)
    ypred = np.zeros(m)
    for i in range(m):
        ypred[i] = xmat[i]*localWeight(xmat[i],xmat,ymat,k)
    return ypred

# load data points
data = pd.read_csv('10-dataset.csv')
bill = np.array(data.total_bill)
tip = np.array(data.tip)

#preparing and add 1 in bill
mbill = np.mat(bill)
mtip = np.mat(tip)

m= np.shape(mbill)[1]
one = np.mat(np1.ones(m))
X = np.hstack((one.T,mbill.T))

#set k here
ypred = localWeightRegression(X,mtip,0.5)
```

```
SortIndex = X[:,1].argsort(0)
xsort = X[SortIndex][:,0]

fig = plt.figure()
ax = fig.add_subplot(1,1,1)
ax.scatter(bill,tip, color='green')
ax.plot(xsort[:,1],ypred[SortIndex], color = 'red', linewidth=5)
plt.xlabel('Total bill')
plt.ylabel('Tip')
plt.show();
```

Output



Data Set:

total_bill	tip	sex	smoker	day	time	size
16.99	1.01	Female	No	Sun	Dinner	2
10.34	1.66	Male	No	Sun	Dinner	3
21.01	3.5	Male	No	Sun	Dinner	3
23.68	3.31	Male	No	Sun	Dinner	2
24.59	3.61	Female	No	Sun	Dinner	4
25.29	4.71	Male	No	Sun	Dinner	4
8.77	2	Male	No	Sun	Dinner	2
26.88	3.12	Male	No	Sun	Dinner	4
15.04	1.96	Male	No	Sun	Dinner	2
14.78	3.23	Male	No	Sun	Dinner	2
10.27	1.71	Male	No	Sun	Dinner	2
35.26	5	Female	No	Sun	Dinner	4
15.42	1.57	Male	No	Sun	Dinner	2
18.43	3	Male	No	Sun	Dinner	4
14.83	3.02	Female	No	Sun	Dinner	2
21.58	3.92	Male	No	Sun	Dinner	2
10.33	1.67	Female	No	Sun	Dinner	3
16.29	3.71	Male	No	Sun	Dinner	3
16.97	3.5	Female	No	Sun	Dinner	3

20.65	3.35	Male	No	Sat	Dinner	3
17.92	4.08	Male	No	Sat	Dinner	2
20.29	2.75	Female	No	Sat	Dinner	2
15.77	2.23	Female	No	Sat	Dinner	2
39.42	7.58	Male	No	Sat	Dinner	4
19.82	3.18	Male	No	Sat	Dinner	2
17.81	2.34	Male	No	Sat	Dinner	4
13.37	2	Male	No	Sat	Dinner	2
12.69	2	Male	No	Sat	Dinner	2
21.7	4.3	Male	No	Sat	Dinner	2
19.65	3	Female	No	Sat	Dinner	2
9.55	1.45	Male	No	Sat	Dinner	2
18.35	2.5	Male	No	Sat	Dinner	4
15.06	3	Female	No	Sat	Dinner	2
20.69	2.45	Female	No	Sat	Dinner	4
17.78	3.27	Male	No	Sat	Dinner	2
24.06	3.6	Male	No	Sat	Dinner	3
16.31	2	Male	No	Sat	Dinner	3
16.93	3.07	Female	No	Sat	Dinner	3
18.69	2.31	Male	No	Sat	Dinner	3
31.27	5	Male	No	Sat	Dinner	3
16.04	2.24	Male	No	Sat	Dinner	3
17.46	2.54	Male	No	Sun	Dinner	2
13.94	3.06	Male	No	Sun	Dinner	2
9.68	1.32	Male	No	Sun	Dinner	2
30.4	5.6	Male	No	Sun	Dinner	4
18.29	3	Male	No	Sun	Dinner	2
22.23	5	Male	No	Sun	Dinner	2
32.4	6	Male	No	Sun	Dinner	4
28.55	2.05	Male	No	Sun	Dinner	3
18.04	3	Male	No	Sun	Dinner	2
12.54	2.5	Male	No	Sun	Dinner	2
10.29	2.6	Female	No	Sun	Dinner	2
34.81	5.2	Female	No	Sun	Dinner	4
9.94	1.56	Male	No	Sun	Dinner	2
25.56	4.34	Male	No	Sun	Dinner	4
19.49	3.51	Male	No	Sun	Dinner	2
38.01	3	Male	Yes	Sat	Dinner	4
26.41	1.5	Female	No	Sat	Dinner	2
11.24	1.76	Male	Yes	Sat	Dinner	2
48.27	6.73	Male	No	Sat	Dinner	4
20.29	3.21	Male	Yes	Sat	Dinner	2
13.81	2	Male	Yes	Sat	Dinner	2
11.02	1.98	Male	Yes	Sat	Dinner	2
18.29	3.76	Male	Yes	Sat	Dinner	4
17.59	2.64	Male	No	Sat	Dinner	3
20.08	3.15	Male	No	Sat	Dinner	3
16.45	2.47	Female	No	Sat	Dinner	2

3.07	1	Female	Yes	Sat	Dinner	1
20.23	2.01	Male	No	Sat	Dinner	2
15.01	2.09	Male	Yes	Sat	Dinner	2
12.02	1.97	Male	No	Sat	Dinner	2
17.07	3	Female	No	Sat	Dinner	3
26.86	3.14	Female	Yes	Sat	Dinner	2
25.28	5	Female	Yes	Sat	Dinner	2
14.73	2.2	Female	No	Sat	Dinner	2
10.51	1.25	Male	No	Sat	Dinner	2
17.92	3.08	Male	Yes	Sat	Dinner	2
27.2	4	Male	No	Thur	Lunch	4
22.76	3	Male	No	Thur	Lunch	2
17.29	2.71	Male	No	Thur	Lunch	2
19.44	3	Male	Yes	Thur	Lunch	2
16.66	3.4	Male	No	Thur	Lunch	2
10.07	1.83	Female	No	Thur	Lunch	1
32.68	5	Male	Yes	Thur	Lunch	2
15.98	2.03	Male	No	Thur	Lunch	2
34.83	5.17	Female	No	Thur	Lunch	4
13.03	2	Male	No	Thur	Lunch	2
18.28	4	Male	No	Thur	Lunch	2
24.71	5.85	Male	No	Thur	Lunch	2
21.16	3	Male	No	Thur	Lunch	2
28.97	3	Male	Yes	Fri	Dinner	2
22.49	3.5	Male	No	Fri	Dinner	2
5.75	1	Female	Yes	Fri	Dinner	2
16.32	4.3	Female	Yes	Fri	Dinner	2
22.75	3.25	Female	No	Fri	Dinner	2
40.17	4.73	Male	Yes	Fri	Dinner	4
27.28	4	Male	Yes	Fri	Dinner	2
12.03	1.5	Male	Yes	Fri	Dinner	2
21.01	3	Male	Yes	Fri	Dinner	2
12.46	1.5	Male	No	Fri	Dinner	2
11.35	2.5	Female	Yes	Fri	Dinner	2
15.38	3	Female	Yes	Fri	Dinner	2
44.3	2.5	Female	Yes	Sat	Dinner	3
22.42	3.48	Female	Yes	Sat	Dinner	2
20.92	4.08	Female	No	Sat	Dinner	2
15.36	1.64	Male	Yes	Sat	Dinner	2
20.49	4.06	Male	Yes	Sat	Dinner	2
25.21	4.29	Male	Yes	Sat	Dinner	2
18.24	3.76	Male	No	Sat	Dinner	2
14.31	4	Female	Yes	Sat	Dinner	2
14	3	Male	No	Sat	Dinner	2
7.25	1	Female	No	Sat	Dinner	1
38.07	4	Male	No	Sun	Dinner	3
23.95	2.55	Male	No	Sun	Dinner	2
25.71	4	Female	No	Sun	Dinner	3

17.31	3.5	Female	No	Sun	Dinner	2
29.93	5.07	Male	No	Sun	Dinner	4
10.65	1.5	Female	No	Thur	Lunch	2
12.43	1.8	Female	No	Thur	Lunch	2
24.08	2.92	Female	No	Thur	Lunch	4
11.69	2.31	Male	No	Thur	Lunch	2
13.42	1.68	Female	No	Thur	Lunch	2
14.26	2.5	Male	No	Thur	Lunch	2
15.95	2	Male	No	Thur	Lunch	2
12.48	2.52	Female	No	Thur	Lunch	2
29.8	4.2	Female	No	Thur	Lunch	6
8.52	1.48	Male	No	Thur	Lunch	2
14.52	2	Female	No	Thur	Lunch	2
11.38	2	Female	No	Thur	Lunch	2
22.82	2.18	Male	No	Thur	Lunch	3
19.08	1.5	Male	No	Thur	Lunch	2
20.27	2.83	Female	No	Thur	Lunch	2
11.17	1.5	Female	No	Thur	Lunch	2
12.26	2	Female	No	Thur	Lunch	2
18.26	3.25	Female	No	Thur	Lunch	2
8.51	1.25	Female	No	Thur	Lunch	2
10.33	2	Female	No	Thur	Lunch	2
14.15	2	Female	No	Thur	Lunch	2
16	2	Male	Yes	Thur	Lunch	2
13.16	2.75	Female	No	Thur	Lunch	2
17.47	3.5	Female	No	Thur	Lunch	2
34.3	6.7	Male	No	Thur	Lunch	6
41.19	5	Male	No	Thur	Lunch	5
27.05	5	Female	No	Thur	Lunch	6
16.43	2.3	Female	No	Thur	Lunch	2
8.35	1.5	Female	No	Thur	Lunch	2
18.64	1.36	Female	No	Thur	Lunch	3
11.87	1.63	Female	No	Thur	Lunch	2
9.78	1.73	Male	No	Thur	Lunch	2
7.51	2	Male	No	Thur	Lunch	2
14.07	2.5	Male	No	Sun	Dinner	2
13.13	2	Male	No	Sun	Dinner	2
17.26	2.74	Male	No	Sun	Dinner	3
24.55	2	Male	No	Sun	Dinner	4
19.77	2	Male	No	Sun	Dinner	4
29.85	5.14	Female	No	Sun	Dinner	5
48.17	5	Male	No	Sun	Dinner	6
25	3.75	Female	No	Sun	Dinner	4
13.39	2.61	Female	No	Sun	Dinner	2
16.49	2	Male	No	Sun	Dinner	4
21.5	3.5	Male	No	Sun	Dinner	4
12.66	2.5	Male	No	Sun	Dinner	2
16.21	2	Female	No	Sun	Dinner	3

13.81	2	Male	No	Sun	Dinner	2
17.51	3	Female	Yes	Sun	Dinner	2
24.52	3.48	Male	No	Sun	Dinner	3
20.76	2.24	Male	No	Sun	Dinner	2
31.71	4.5	Male	No	Sun	Dinner	4
10.59	1.61	Female	Yes	Sat	Dinner	2
10.63	2	Female	Yes	Sat	Dinner	2
50.81	10	Male	Yes	Sat	Dinner	3
15.81	3.16	Male	Yes	Sat	Dinner	2
7.25	5.15	Male	Yes	Sun	Dinner	2
31.85	3.18	Male	Yes	Sun	Dinner	2
16.82	4	Male	Yes	Sun	Dinner	2
32.9	3.11	Male	Yes	Sun	Dinner	2
17.89	2	Male	Yes	Sun	Dinner	2
14.48	2	Male	Yes	Sun	Dinner	2
9.6	4	Female	Yes	Sun	Dinner	2
34.63	3.55	Male	Yes	Sun	Dinner	2
34.65	3.68	Male	Yes	Sun	Dinner	4
23.33	5.65	Male	Yes	Sun	Dinner	2
45.35	3.5	Male	Yes	Sun	Dinner	3
23.17	6.5	Male	Yes	Sun	Dinner	4
40.55	3	Male	Yes	Sun	Dinner	2
20.69	5	Male	No	Sun	Dinner	5
20.9	3.5	Female	Yes	Sun	Dinner	3
30.46	2	Male	Yes	Sun	Dinner	5
18.15	3.5	Female	Yes	Sun	Dinner	3
23.1	4	Male	Yes	Sun	Dinner	3
15.69	1.5	Male	Yes	Sun	Dinner	2
19.81	4.19	Female	Yes	Thur	Lunch	2
28.44	2.56	Male	Yes	Thur	Lunch	2
15.48	2.02	Male	Yes	Thur	Lunch	2
16.58	4	Male	Yes	Thur	Lunch	2
7.56	1.44	Male	No	Thur	Lunch	2
10.34	2	Male	Yes	Thur	Lunch	2
43.11	5	Female	Yes	Thur	Lunch	4
13	2	Female	Yes	Thur	Lunch	2
13.51	2	Male	Yes	Thur	Lunch	2
18.71	4	Male	Yes	Thur	Lunch	3
12.74	2.01	Female	Yes	Thur	Lunch	2
13	2	Female	Yes	Thur	Lunch	2
16.4	2.5	Female	Yes	Thur	Lunch	2
20.53	4	Male	Yes	Thur	Lunch	4
16.47	3.23	Female	Yes	Thur	Lunch	3
26.59	3.41	Male	Yes	Sat	Dinner	3
38.73	3	Male	Yes	Sat	Dinner	4
24.27	2.03	Male	Yes	Sat	Dinner	2
12.76	2.23	Female	Yes	Sat	Dinner	2
30.06	2	Male	Yes	Sat	Dinner	3

25.89	5.16	Male	Yes	Sat	Dinner	4
48.33	9	Male	No	Sat	Dinner	4
13.27	2.5	Female	Yes	Sat	Dinner	2
28.17	6.5	Female	Yes	Sat	Dinner	3
12.9	1.1	Female	Yes	Sat	Dinner	2
28.15	3	Male	Yes	Sat	Dinner	5
11.59	1.5	Male	Yes	Sat	Dinner	2
7.74	1.44	Male	Yes	Sat	Dinner	2
30.14	3.09	Female	Yes	Sat	Dinner	4
12.16	2.2	Male	Yes	Fri	Lunch	2
13.42	3.48	Female	Yes	Fri	Lunch	2
8.58	1.92	Male	Yes	Fri	Lunch	1
15.98	3	Female	No	Fri	Lunch	3
13.42	1.58	Male	Yes	Fri	Lunch	2
16.27	2.5	Female	Yes	Fri	Lunch	2
10.09	2	Female	Yes	Fri	Lunch	2
20.45	3	Male	No	Sat	Dinner	4
13.28	2.72	Male	No	Sat	Dinner	2
22.12	2.88	Female	Yes	Sat	Dinner	2
24.01	2	Male	Yes	Sat	Dinner	4
15.69	3	Male	Yes	Sat	Dinner	3
11.61	3.39	Male	No	Sat	Dinner	2
10.77	1.47	Male	No	Sat	Dinner	2
15.53	3	Male	Yes	Sat	Dinner	2
10.07	1.25	Male	No	Sat	Dinner	2
12.6	1	Male	Yes	Sat	Dinner	2
32.83	1.17	Male	Yes	Sat	Dinner	2
35.83	4.67	Female	No	Sat	Dinner	3
29.03	5.92	Male	No	Sat	Dinner	3
27.18	2	Female	Yes	Sat	Dinner	2
22.67	2	Male	Yes	Sat	Dinner	2
17.82	1.75	Male	No	Sat	Dinner	2
18.78	3	Female	No	Thur	Dinner	2

**** Students have to work on different data sets to improve their knowledge**