J.N.T.U.H. UNIVERSITY COLLEGE OF ENGINEERING HYDERABAD
(Autonomous)

KUKATPALLY, HYDERABAD – 500 085

Certificate

Certified that this is the bonafide record of the practical work done during

the academic year ______________________ by

Name ____

Roll Number _______________________ *Class* __________________________________

in the Laboratory of ____

of the Department of ____

Signature of the Staff Member *Signature of the Head of the Department*

*Date of Examination*_________________________

Signature of the Examiner/s

Internal Examiner *External Examiner*

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Name ________________________________ *Roll Number* ________________________

Class __________________ *Year*____________ *Laboratory* __________________________

List of Experiments

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1.Write a python program to compute Central Tendency Measures: Mean, Median, Mode Measure of Dispersion: Variance, Standard Deviation *Code:*

```
import statistics as st try:
  x = list(map(int, input().split()))
  mean = st.mean(x)
median = st.median(x)
mode = st.mode(x)
  var = st.variance(x)
std = st.stdev(x)
  multimode = st.multimode(x)


  print('Mean: ', mean)
print('Median: ', median)
print('Mode: ', mode)
  print('Variance: ', var)
print('Standard deviation : ', std)
print('Multimode: ', multimode)
except st.StatisticsError:
  print('Statistical Operations require atleast one data point') except
ValueError:
  print('Only numerical values allowed')
```

Output:

```
======= RESTART: C:/Users/M.Hema Siri Ramya/OneDrive/Desktop/ML lab/ml.py ===
1 2 3 4 2 1
Mean:  2.1666666666666665
Median:  2.0
Mode:  1
Variance:  1.3666666666666667
Standard deviation :  1.1690451944500122
Multimode:  [1, 2]
```

2.Study of Python Basic Libraries such as Statistics, Math, Numpy and Scipy

Statistics:

The statistics module provides basic statistical operations for numeric data, such as mean, median, and standard deviation. Useful in simple data analysis tasks, teaching, or when NumPy/Pandas is not available.

Important functions:

- mean(): Calculates the average of numeric data.
- median(): Finds the middle value of a dataset.
- mode(): Identifies the most frequent value.
- stdev(): Computes sample standard deviation.
- variance(): Calculates how spread out the values are.

Example:

Code:

import statistics data = [10, 20, 20, 40, 50]

print("Mean:", statistics.mean(data))

print("Median:", statistics.median(data))

print("Mode:", statistics.mode(data))

print("Standard Deviation:",

statistics.stdev(data)) print("Variance:",

statistics.variance(data)) *Output*:

```
Mean: 28
Median: 20
Mode: 20
Standard Deviation: 16.431676725154983
Variance: 270
```

Math:

The math module provides access to mathematical functions like powers, roots, trigonometry, and constants like π and e. It's a built-in library. Useful in geometry, trigonometry, scientific simulations, and financial formulas.

Important functions:

- sqrt(): Returns the square root of a number.
- pow(): Raises a number to the power of another.
- factorial(): Calculates the factorial of a number.
- sin(): Computes sine of an angle (in radians).
- log(): Returns the natural logarithm of a number.

Example:

__Code:__

import math

print("Square root of 16:", math.sqrt(16)) print("2 to

the power 3:", math.pow(2, 3)) print("Factorial of 5:",

math.factorial(5)) print("Sine of 90 degrees:",

math.sin(math.radians(90))) print("Natural log of e:",

math.log(math.e)) *__Output:__*

```
Square root of 16: 4.0
2 to the power 3: 8.0
Factorial of 5: 120
Sine of 90 degrees: 1.0
Natural log of e: 1.0
```

__Numpy:__

Common in machine learning, data science, numerical methods, and simulations.

Important functions:

- array(): Creates an array for numerical computation.
- arange(): Generates evenly spaced numbers within a range. Generates numbers with a fixed step; stop value may be excluded.
- reshape(): Changes the shape of an array without changing data.
- mean(): Calculates average of array elements.
- dot(): Performs dot product of two arrays.
- linspace(): Generates evenly spaced numbers over a specified interval. Generates a fixed number of values; stop value is always included.

Example:

__Code:__

import numpy as np

a = np.array([1, 2, 3]) b =

np.array([4, 5, 6]) print("Array

A:", a) print("Array B:", b)

print("Dot product:", np.dot(a,

b)) print("Mean of A:",

np.mean(a)) print("Reshaped:",

np.reshape(np.arange(6), (2, 3)))

print("Linspace:

",np.linspace(1,5,8)) *__Output:__*

```
Array A: [1 2 3]
Array B: [4 5 6]
Dot product: 32
Mean of A: 2.0
Reshaped: [[0 1 2]
 [3 4 5]]
Linspace:  [1.         1.57142857 2.14285714 2.71428571 3.28571429 3.85714286
 4.42857143 5.        ]
```

Scipy:

Scipy.special

Use when dealing with scientific or mathematical computations involving special functions. Useful in advanced math, physics, or engineering problems.

Important functions:

- gamma(): Computes the Gamma function.
- erf(): Computes the error function.
- comb(): Calculates combinations (n choose k).
- perm(): Calculates permutations.

Example: *Code:* from scipy import

special print("Gamma(5):",

special.gamma(5))

print("Erf(1):", special.erf(1)) print("Combinations

(5C2):", special.comb(5, 2)) *Output:*

```
Gamma(5): 24.0
Erf(1): 0.8427007929497148
Combinations (5C2): 10.0
```

Scipy.linalg

Use for performing linear algebra operations. Useful in solving equations, matrix operations, and numerical analysis.

Important functions:

- inv(): Computes the inverse of a matrix.
- det(): Calculates the determinant of a matrix.
- eig(): Returns eigenvalues and eigenvectors.
- eigvals(): Returns only the eigenvalues.
- solve(): Solves systems of linear equations.

Example: *Code:*

from scipy import linalg import

numpy as np

A = np.array([[1, 2], [3, 4]]) print("Inverse:\n",

linalg.inv(A)) print("Determinant:",

linalg.det(A)) print("Eigenvalues:",

linalg.eigvals(A)) *Output:*

```
Inverse:
 [[-2.   1. ]
 [ 1.5 -0.5]]
Determinant: -2.0
Eigenvalues: [-0.37228132+0.j  5.37228132+0.j]
```

Scipy.interpolate

Use for estimating unknown values between known data points. Useful in data smoothing, graphics, and numerical modeling.

Important functions:

- interp1d(): Creates a function for linear or spline interpolation.
- griddata(): Interpolates unstructured data.
- splrep(): Computes B-spline representation of 1D curve.
- splev(): Evaluates B-spline or its derivatives.
- lagrange(): Performs Lagrange polynomial interpolation.

Example: *Code:*

from scipy.interpolate import interp1d import

numpy as np

x = np.array([0, 1, 2, 3]) y = np.array([0,

2, 4, 6]) f = interp1d(x, y)

print("Interpolated value at 1.5:",

f(1.5)) *Output:*

```
Interpolated value at 1.5: 3.0
```

Scipy.optimize

Use for finding minima, maxima, or roots of functions. Useful in operations research, machine learning, and engineering optimization.

Important functions:

- minimize(): Minimizes a scalar function.
- root(): Finds a root of a function.
- linprog(): Solves linear programming problems.
- curve_fit(): Fits a curve to data points.
- least_squares(): Solves nonlinear least-squares problems.

Example: *Code:* from scipy.optimize

import minimize f = lambda x: x**2

+ 3*x + 2 res = minimize(f, x0=0)

print("Minimum at:", res.x) *Output:*

```
Minimum at: [-1.50000001]
```

Scipy.ndimage

Use for image processing and multi-dimensional data filtering. Useful in computer vision, image analysis, and scientific imaging.

Important functions:

- gaussian_filter(): Applies Gaussian smoothing filter.
- sobel(): Computes the Sobel gradient of image.
- median_filter(): Applies median filter to reduce noise.
- rotate(): Rotates an image array.
- zoom(): Zooms in or out on an image.

Example: *Code:*

from scipy import ndimage import

numpy as np

data = np.array([[1, 2, 3], [4, 5, 6], [7, 8, 9]])

blurred = ndimage.gaussian_filter(data, sigma=1) print("Blurred:\n",

blurred)

Output:

```
Blurred:
 [[2 3 3]
 [4 5 5]
 [5 6 6]]
```

3.Study of Python Libraries for ML application such as Pandas and Matplotlib

Pandas:

Pandas is a powerful Python library for data manipulation and analysis using labeled data structures. Used in data cleaning, exploration, and preprocessing in machine learning workflows and data science tasks.

Important functions:

- read_csv(): Reads a CSV file into a DataFrame.
- head(): Displays the first few rows of a DataFrame.
- describe(): Summarizes statistics of numerical columns.
- drop(): Removes specified rows or columns.
- fillna(): Replaces missing values with a specified value.

Example:

Code:

import pandas as pd df =

pd.read_csv("data.csv")

print(df.head())

print(df.describe())

df = df.drop(columns=["UnwantedColumn"])

df = df.fillna(0)

Output:

Data.csv

Name	Age	Marks	UnwantedColumn
Alice	20	85	
Bob	22	78	extra
Charlie	21	90	extra
David	23		extra
Eva	20	88	extra

```
      Name  Age  Marks UnwantedColumn
0    Alice   20   85.0            NaN
1      Bob   22   78.0          extra
2  Charlie   21   90.0          extra
3    David   23    NaN          extra
4      Eva   20   88.0          extra
            Age      Marks
count   5.00000   4.000000
mean   21.20000  85.250000
std     1.30384   5.251984
min    20.00000  78.000000
25%    20.00000  83.250000
50%    21.00000  86.500000
75%    22.00000  88.500000
max    23.00000  90.000000
```

Matplotlib:

Matplotlib is a plotting library used to create static, animated, and interactive visualizations in Python. Used for visualizing data trends, distributions, and comparisons during analysis and ML model evaluation.

Important functions:

- plot(): Creates a line plot of data.
- scatter(): Makes a scatter plot of points.
- bar(): Generates bar charts.
- hist(): Plots a histogram to show data distribution.
- show(): Displays the plot window.

Example:

Code: import

matplotlib.pyplot as plt

x=['A', 'B', 'C', 'D']

y=[10, 15, 7, 12]

plt.bar(x,y,color='green')

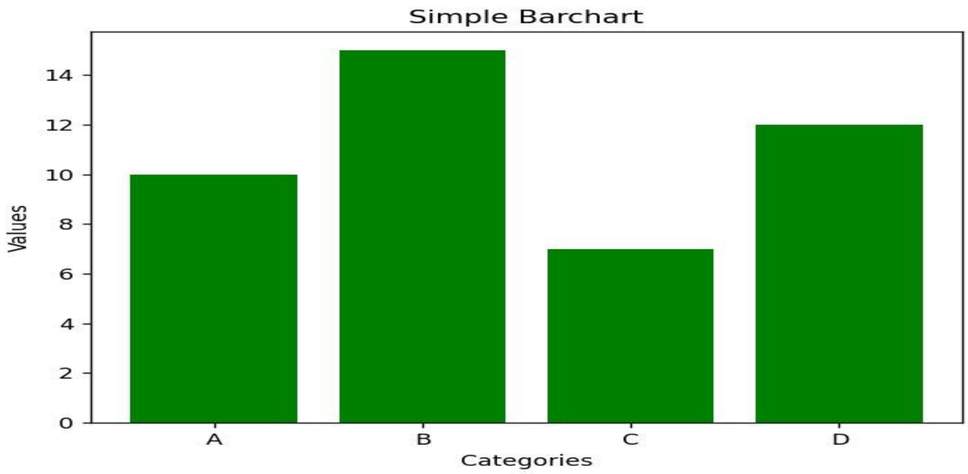
plt.xlabel('Categories')

plt.ylabel('Values')

plt.title('Simple

Barchart') plt.show()

Output:



4.Write a Python program to implement Simple Linear Regression

Code:

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

def simple_linear_regression(x, y):     Xmean,
Ymean = np.mean(x), np.mean(y)     numerator
= np.sum((x - Xmean)*(y - Ymean))
denominator = np.sum((x - Xmean)**2)     m =
numerator / denominator     b = Ymean -
m*Xmean
    return m, b

def predict(x, m, b):     return
m*x + b x = list(map(float,
input().split())) y =
list(map(float, input().split()))


x = np.array(x) y
= np.array(y)

m, b = simple_linear_regression(x, y) prediction
= predict(x, m, b)

plt.scatter(x, y, color='blue', label = 'Data points') plt.plot(x,
prediction, color = 'red', label = 'Regression Line')
```

sample_x = 3.4 predicted_y = predict(sample_x, m,

b) print(f'Predicted Y for X = {sample_x}:

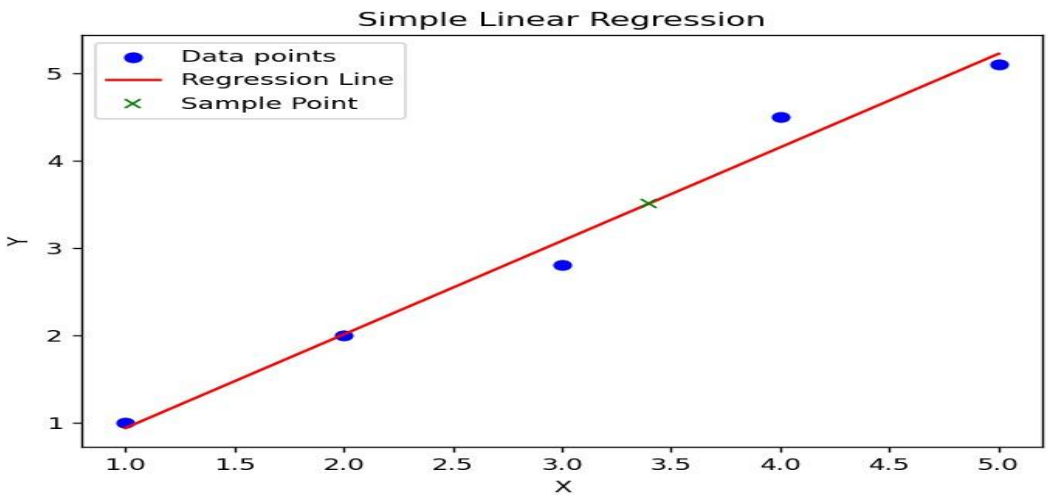
{predicted_y}')

plt.plot(sample_x, predicted_y, 'gx', label = 'Sample Point')

plt.xlabel('X') plt.ylabel('Y') plt.legend() plt.title('Simple

Linear Regression') plt.show() ***Output:***

```
======= RESTART: C:/Users/M.Hema Siri Ramya/OneDrive/Desktop/ML lab/ml.py
1 2 3 4 5
1 2 2.8 4.5 5.1
```



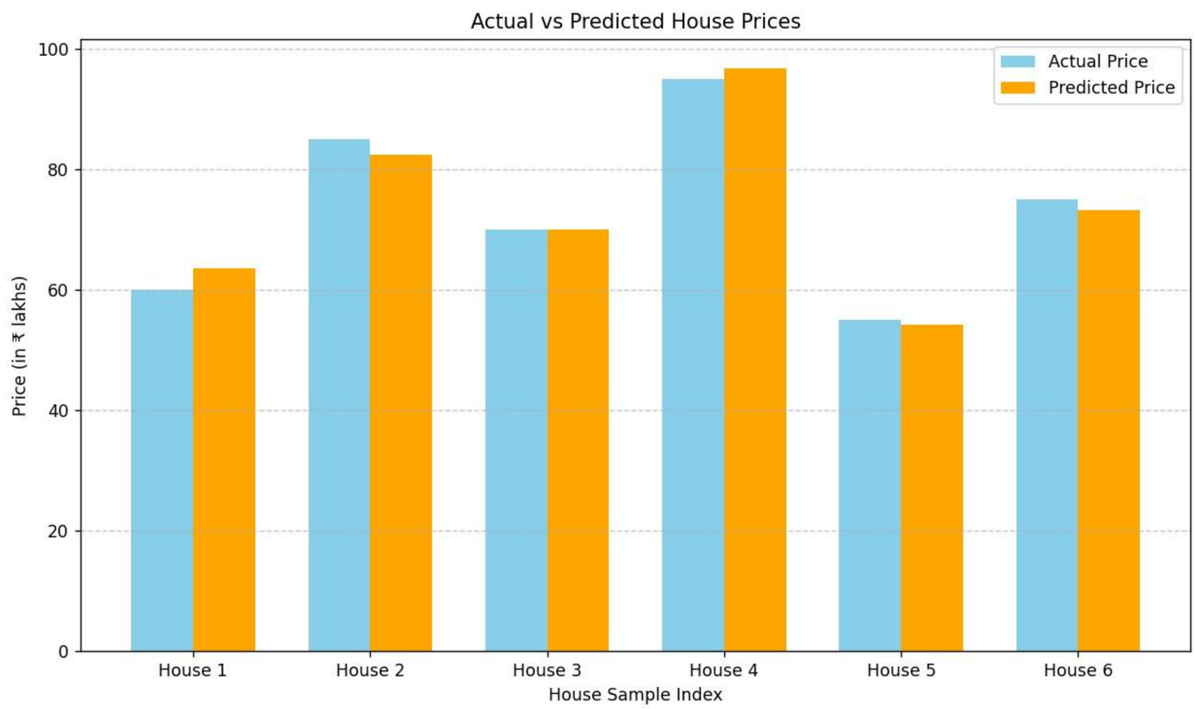
5.Implementation of Multiple Linear Regression for House Price Prediction using sklearn *Code:*

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

from sklearn.linear_model import LinearRegression

from sklearn.metrics import mean_squared_error


# Features: [Area (sqft), Bedrooms, Age of house (years)]

X = np.array([

   [1500, 3, 10],

   [2000, 4, 5],

   [1700, 3, 8],

   [2500, 4, 2],
   [1400, 2, 15],

   [1800, 3, 7]

])

# Target: House prices (in ₹ lakhs) y

= np.array([60, 85, 70, 95, 55, 75])

model = LinearRegression()

model.fit(X, y)


y_pred = model.predict(X)


mse = mean_squared_error(y, y_pred) print(f"Mean

Squared Error (MSE): {mse:.2f}")


new_house = np.array([[2300, 4, 3]]) predicted_price

= model.predict(new_house)

print(f"Predicted price for [2300 sqft, 4 bedrooms, 3 yrs old]: ₹{predicted_price[0]:.2f} lakhs")


plt.figure(figsize=(10, 6))
```

```
bar_width = 0.35 index =
np.arange(len(y))

plt.bar(index, y, bar_width, label='Actual Price', color='skyblue') plt.bar(index +
bar_width, y_pred, bar_width, label='Predicted Price', color='orange')

plt.xlabel('House Sample Index')
plt.ylabel('Price (in ₹ lakhs)') plt.title('Actual vs Predicted House
Prices') plt.xticks(index + bar_width / 2, [f'House {i+1}' for i in
range(len(y))]) plt.legend()
plt.grid(axis='y', linestyle='--', alpha=0.7)
plt.tight_layout() plt.show()
```

Output:

```
Mean Squared Error (MSE): 4.41
Predicted price for [2300 sqft, 4 bedrooms, 3 yrs old]: ₹91.18 lakhs
```



6.Implementation of Decision tree using sklearn and its parameter tuning

Code:

```
from sklearn.datasets import load_iris from

sklearn.model_selection import train_test_split, GridSearchCV from

sklearn.tree import DecisionTreeClassifier, plot_tree from

sklearn.metrics import accuracy_score import matplotlib.pyplot as

plt import numpy as np


iris = load_iris()

X = iris.data y =

iris.target

X_train, X_test, y_train, y_test = train_test_split(X,y,test_size=0.2,random_state=42)


dt = DecisionTreeClassifier(criterion = 'gini', random_state = 42)

params={

   'max_depth': [2,3,5],

   'criterion': ['gini', 'entropy']

   }

grid = GridSearchCV(dt, params, cv = 5) grid.fit(X_train,

y_train)

best_dt = grid.best_estimator_ y_pred =

best_dt.predict(X_test) print('Accuracy: ',

accuracy_score(y_test, y_pred)) print('Best

Parameters: ', grid.best_params_)


# Sample to test sample = np.array([[5.1, 3.5, 3.65,

0.2]]) predicted_class = best_dt.predict(sample)[0]

predicted_name = iris.target_names[predicted_class]
```

print(f"Sample: {sample}") print(f"Predicted Class:

{predicted_class} ({predicted_name})")

Find the node index the sample reaches

node_indicator = best_dt.decision_path(sample) leaf_id

= best_dt.apply(sample)[0] print(f"Sample reached leaf

node: {leaf_id}") print(f"Sample path:

{node_indicator}")

node_index = node_indicator.indices

print('Path:', end='') for

i in node_index:

  print(str(i)+'->', end='')

print('reached')

Plot and highlight the decision path plt.figure(figsize=(16,

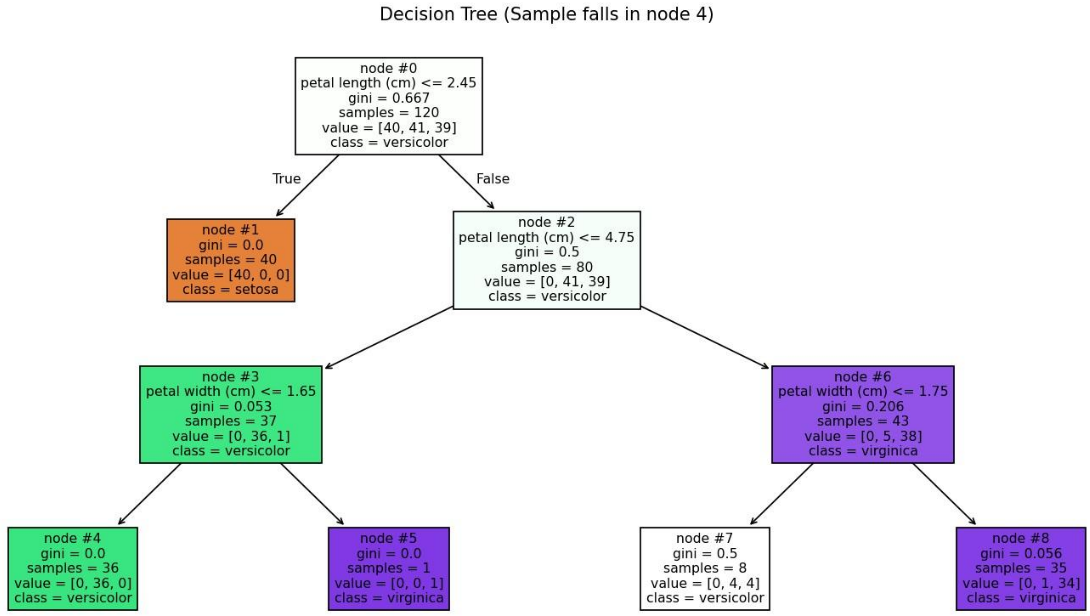
5))

plot_tree(best_dt, filled=True, feature_names=iris.feature_names,
class_names=iris.target_names, node_ids = True)

plt.title(f"Decision Tree (Sample falls in node {leaf_id})") plt.show()

Output:

```
Accuracy:  1.0
Best Parameters:  {'criterion': 'gini', 'max_depth': 3}
Sample: [[5.1  3.5  3.65 0.2 ]]
Predicted Class: 1 (versicolor)
Sample reached leaf node: 4
Sample path: <Compressed Sparse Row sparse matrix of dtype 'int64'
	with 4 stored elements and shape (1, 9)>
  Coords	Values
  (0, 0)	1
  (0, 2)	1
  (0, 3)	1
  (0, 4)	1
Path:0->2->3->4->reached
```



7.Implementation of KNN using sklearn

Code:

```
import numpy as np from sklearn.datasets import load_iris from

sklearn.model_selection import train_test_split, GridSearchCV from

sklearn.metrics import accuracy_score from sklearn.neighbors

import KNeighborsClassifier import matplotlib.pyplot as plt


data = load_iris()

X = data.data y =

data.target

X_train, X_test, y_train, y_test = train_test_split(X,y,test_size=0.2,random_state=42)


knn = KNeighborsClassifier(n_neighbors=3)

knn.fit(X_train, y_train) y_pred =

knn.predict(X_test) accuracy =

accuracy_score(y_test, y_pred)

print('Accuracy before tuning: ', accuracy)
```

```
param_grid = {
   'n_neighbors' : [3,5,7,9],
   'weights' : ['uniform', 'distance'],
   'metric' : ['euclidean', 'manhattan']
   }
grid = GridSearchCV(    estimator =
KNeighborsClassifier(),
param_grid = param_grid,
   cv = 5
   )
grid.fit(X_train, y_train) print('Best Parameters: ',
grid.best_params_) print('Best Cross-Validation
Score: ', grid.best_score_)

best_knn_model = grid.best_estimator_ y_pred_tuned =
best_knn_model.predict(X_test) tuned_accuracy =
accuracy_score(y_test, y_pred_tuned) print('Accuracy
after parameter tuning: ', tuned_accuracy)

#Sample testing sample = np.array([[5.1, 3.5, 1.4, 0.2]])
predicted_class = best_knn_model.predict(sample)
print('Predicted Class: ', data.target_names[predicted_class[0]])

from matplotlib.colors import ListedColormap

feature_x = 0  # sepal length
feature_y = 2  # petal length
X_vis = X_train[:, [feature_x, feature_y]] y_vis =
y_train cmap_bold = ListedColormap(['red',
'green', 'blue'])
```

Retrain KNN with selected features knn_vis =

KNeighborsClassifier(**grid.best_params_)

knn_vis.fit(X_vis, y_vis) sample_2d = sample[:, [feature_x,

feature_y]] neighbors = knn_vis.kneighbors(sample_2d,

return_distance=False)

plt.figure(figsize=(8, 6)) plt.scatter(X_vis[:, 0], X_vis[:, 1], c=y_vis,

cmap=cmap_bold, edgecolor='k', s=50)

plt.scatter(sample_2d[0, 0], sample_2d[0, 1], c='yellow', edgecolor='k', s=100, label='Sample Point')

plt.scatter(X_vis[neighbors[0], 0], X_vis[neighbors[0], 1], facecolors='none', edgecolors='black', s=100, linewidths=2, label='Nearest Neighbors')

plt.xlabel(data.feature_names[feature_x])

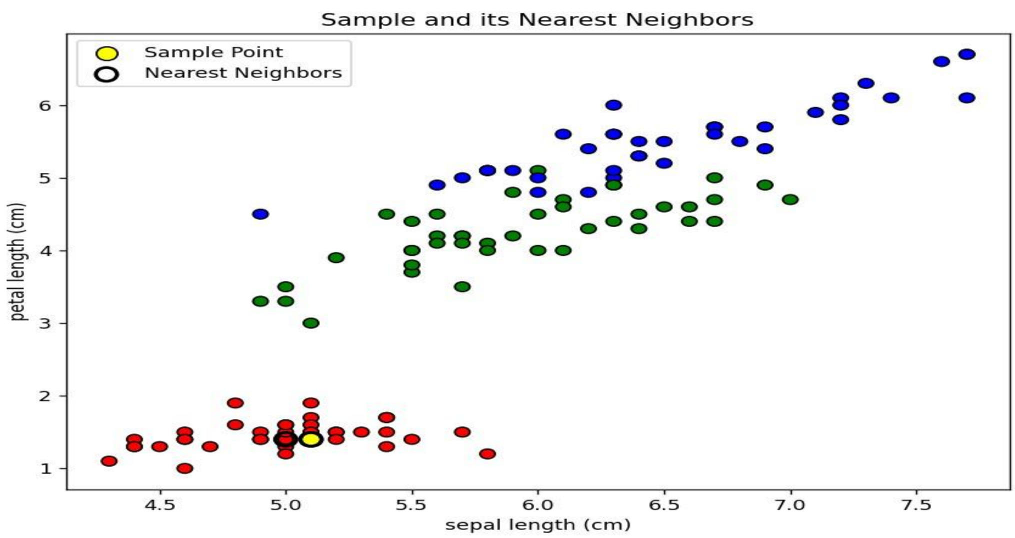
plt.ylabel(data.feature_names[feature_y])

plt.title('Sample and its Nearest Neighbors')

plt.legend() plt.show()

Output:

```
Accuracy before tuning:  1.0

Best Parameters:  {'metric': 'euclidean', 'n_neighbors': 3, 'weights': 'uniform'
}
Best Cross-Validation Score:  0.9583333333333334
Accuracy after parameter tuning:  1.0
Predicted Class:  setosa
```



8.Implementation of Logistic Regression using sklearn

Code: import numpy as np import matplotlib.pyplot as plt from

sklearn.datasets import load_iris from sklearn.linear_model

import LogisticRegression from sklearn.model_selection import

train_test_split from sklearn.metrics import accuracy_score,

classification_report

iris = load_iris()

X = iris.data y =

iris.target

# Binary classification: Setosa = 1, Others = 0
y_binary = (y == 0).astype(int)

X_train, X_test, y_train, y_test = train_test_split(X, y_binary, test_size=0.2, random_state=42)

model = LogisticRegression() model.fit(X_train,

y_train)

print("Model Evaluation:") y_pred = model.predict(X_test)

print("Accuracy:", accuracy_score(y_test, y_pred))

print("Classification Report:\n", classification_report(y_test, y_pred))

Sample testing sample = [[5.1, 3.5, 1.4,

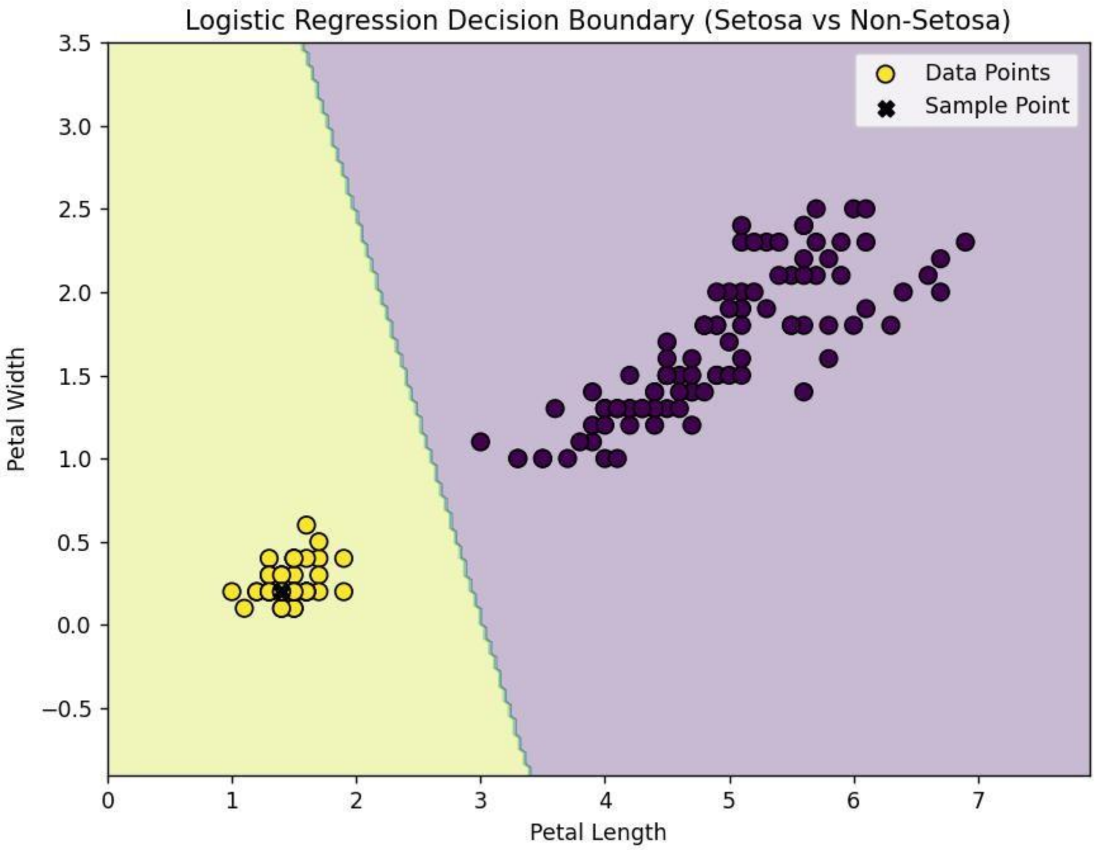
0.2]] predicted_class =

model.predict(sample) probability =

model.predict_proba(sample)

```
print("Sample Evaluation:") print("Predicted class (0 = Non-Setosa, 1 =
Setosa):", predicted_class[0]) print("Probability [Non-Setosa, Setosa]:",
probability[0])

#  Visualization using petal length and width (Use only petal length and width)
X_plot = X[:, 2:4] y_plot = y_binary sample_plot = [sample[0][2], sample[0][3]]
# Petal length and width of sample

# Train model for plotting model_plot
= LogisticRegression()
model_plot.fit(X_plot, y_plot)

# Mesh grid for decision boundary x_min, x_max =
X_plot[:, 0].min() - 1, X_plot[:, 0].max() + 1 y_min, y_max =
X_plot[:, 1].min() - 1, X_plot[:, 1].max() + 1 xx, yy =
np.meshgrid(np.linspace(x_min, x_max, 200),
                 np.linspace(y_min, y_max, 200))
Z = model_plot.predict(np.c_[xx.ravel(), yy.ravel()])
Z = Z.reshape(xx.shape)

plt.figure(figsize=(8, 6)) plt.contourf(xx, yy, Z,
alpha=0.3, cmap='viridis')
plt.scatter(X_plot[:, 0], X_plot[:, 1], c=y_plot, edgecolor='k', cmap='viridis', s=60, label='Data
Points')
plt.scatter(sample_plot[0], sample_plot[1], color='black', s=50, marker='X', label='Sample
Point') plt.xlabel("Petal Length") plt.ylabel("Petal Width") plt.title("Logistic Regression
Decision Boundary (Setosa vs Non-Setosa)") plt.legend() plt.show()
```
__Output:__

```
Model Evaluation:
Accuracy: 1.0
Classification Report:
              precision    recall  f1-score   support

           0       1.00      1.00      1.00        20
           1       1.00      1.00      1.00        10

    accuracy                           1.00        30
   macro avg       1.00      1.00      1.00        30
weighted avg       1.00      1.00      1.00        30

Sample Evaluation:
Predicted class (0 = Non-Setosa, 1 = Setosa): 1
Probability [Non-Setosa, Setosa]: [0.02010505 0.97989495]
```



9.Implementation of K-Means Clustering

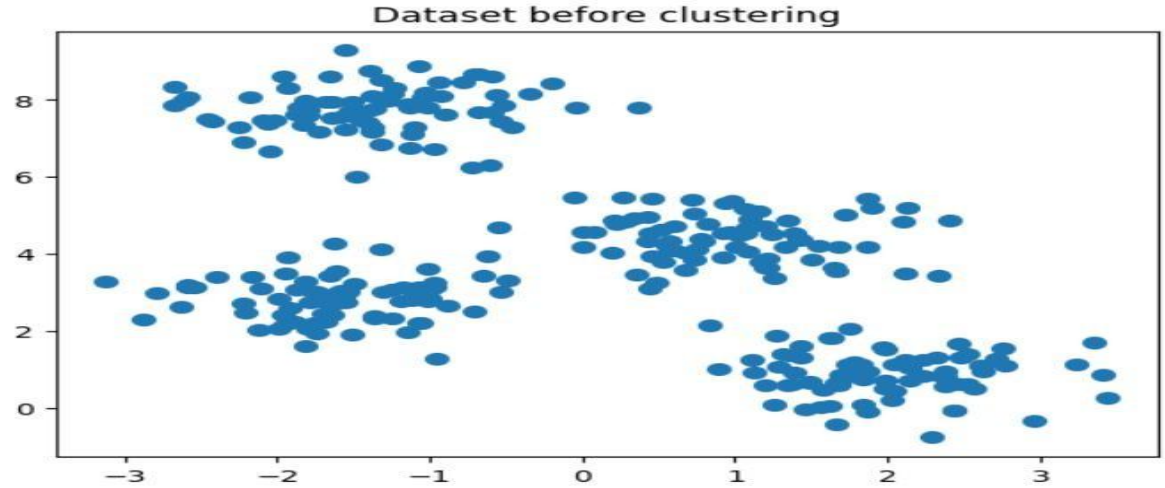
Code:

```
import numpy as np import
matplotlib.pyplot as plt from
sklearn.datasets import make_blobs from
sklearn.cluster import KMeans

x, y = make_blobs(n_samples=300, centers=4, cluster_std=0.60, random_state=0)

plt.scatter(x[:,0], x[:,1], s=50) plt.title('Dataset
before clustering') plt.show()

kmeans = KMeans(n_clusters=4)
kmeans.fit(x) centers =
kmeans.cluster_centers_ labels =
kmeans.labels_

plt.scatter(x[:,0], x[:,1], c = labels, s = 50, cmap='viridis') plt.scatter(centers[:,0],
centers[:,1], c='red', s=200, alpha=0.75, marker='X')
# Adding the cluster numbers as labels near the cluster centers for
i, center in enumerate(centers):
   plt.text(center[0], center[1], f'Cluster {i}', color='black', fontsize=17, ha='left', va='top')
plt.title('K-Means Clustering with sample testing')

#Sample Testing
sample = np.array([[0.5, 1.5], [3.0, 6.0], [-1.5, 2.5]]) plt.scatter(sample[0,
0], sample[0, 1], c = 'brown', s=200, marker = 'P') predicted_labels =
kmeans.predict(sample)
for i, new_sample in enumerate(sample):
```

print(f'Sample {new_sample} : {predicted_labels[i]}')

print('Centers: ', centers) plt.show()

Output:




```
Sample [0.5 1.5] : 0
Sample [3. 6.] : 3
Sample [-1.5  2.5] : 2
Centers:  [[ 1.98258281  0.86771314]
 [-1.37324398  7.75368871]
 [-1.58438467  2.83081263]
 [ 0.94973532  4.41906906]]
```