VISVESVARAYA TECHNOLOGICAL UNIVERSITY

"JnanaSangama", Belgaum -590014, Karnataka.

LAB REPORT
on

Machine Learning (23CS6PCMAL)

Submitted by

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in partial fulfillment for the award of the degree of

BACHELOR OF ENGINEERING
in
COMPUTER SCIENCE AND ENGINEERING

B.M.S. COLLEGE OF ENGINEERING
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CERTIFICATE

This is to certify that the Lab work entitled "Machine Learning (23CS6PCMAL)" carried out by **Sanvi Nadiga (1BM22CS245),** who is a bonafide student of **B.M.S. College of Engineering.** It is in partial fulfillment for the award of **Bachelor of Engineering in Computer Science and Engineering** of the Visvesvaraya Technological University, Belgaum. The Lab report has been approved as it satisfies the academic requirements in respect of an Machine Learning (23CS6PCMAL) work prescribed for the said degree.

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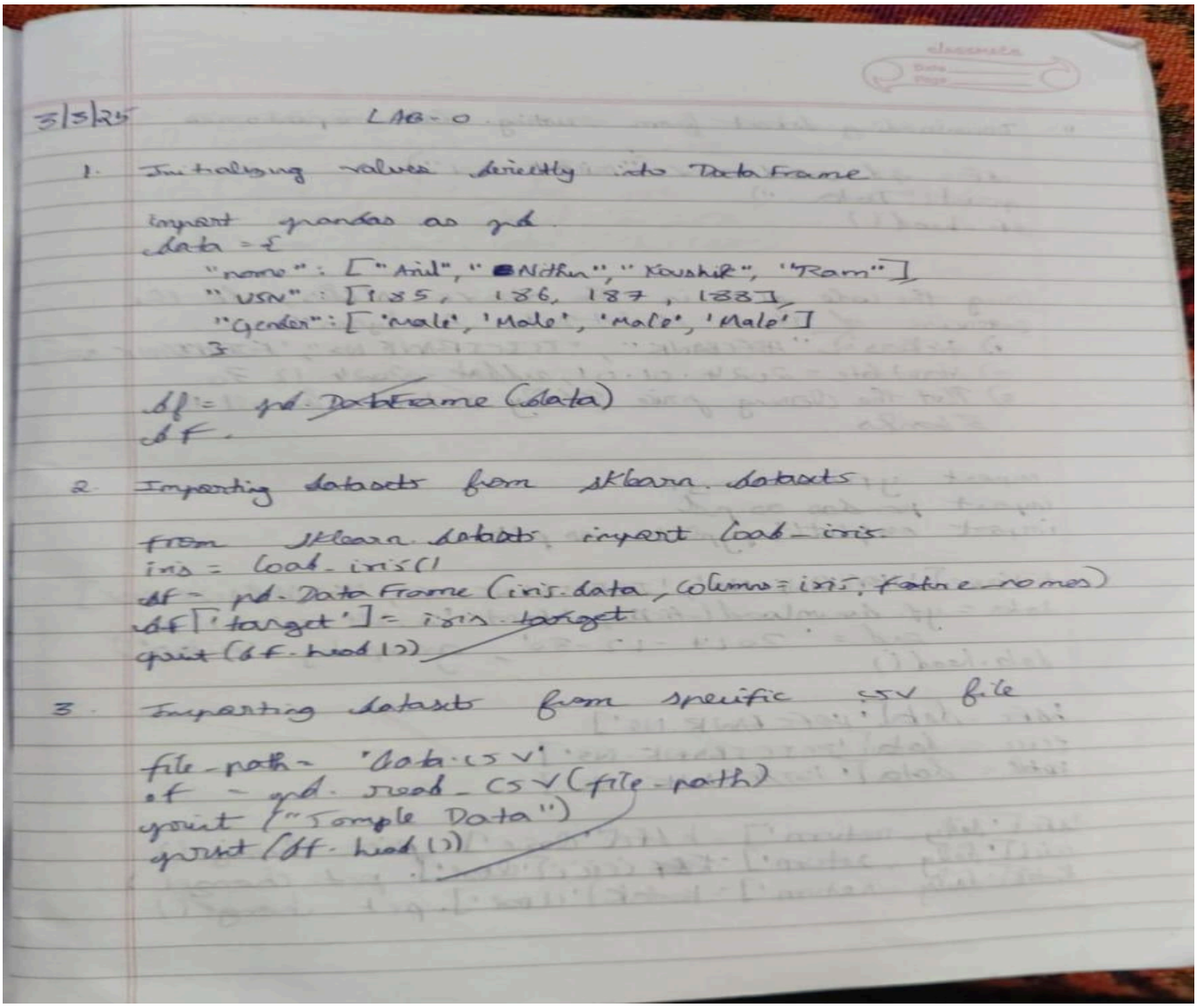
Github Link:https://github.com/sanvinadiga/ML_1BM22CS245

Program 1

Write a python program to import and export data using Pandas library functions.

Screenshot:



3/3/25 LAB-0

1. Initializing values directly into DataFrame

```
import pandas as pd
data = {
    "name": ["Anil", "Nithin", "Kaushik", "Ram"],
    "USN": [185, 186, 187, 188],
    "Gender": ['Male', 'Male', 'Male', 'Male']
    }

df = pd.DataFrame(data)
df
```

2. Importing datasets from sklearn.datasets

```
from sklearn.datasets import load_iris
iris = load_iris()
df = pd.DataFrame(iris.data, columns=iris.feature_names)
df['target'] = iris.target
print(df.head())
```

3. Importing datasets from specific .csv file

```
file_path = 'data.csv'
df = pd.read_csv(file_path)
print("Sample Data")
print(df.head())
```

4. Downloading datasets from existing data repositories.

```
df = pd.read_csv("cricket.csv")
print("Data :")
df.head()
```

Using the code given in the above slides, do the exercise of "Stock Market Data Analysis".
1) tickers = ["HDFCBANK", "ICICIBANK.NS", "KOTAKBANK.NS"]
2) Start date = 2024-01-01, end date = 2024-12-30
3) Plot the closing price & daily returns for all the 3 banks.

```
import yfinance as yf
import pandas as pd
import matplotlib.pyplot as plt

tickers = ['HDFCBANK.NS', 'ICICIBANK.NS', 'KOTAKBANK.NS']
data = yf.download(tickers, start='2024-01-01',
        end='2024-12-30', group_by='ticker')
data.head()

hdfc = data['HDFCBANK.NS']
icici = data['ICICIBANK.NS']
kotak = data['KOTAKBANK.NS']

hdfc['daily_return'] = hdfc['Close'].pct_change()
icici['daily_return'] = icici['Close'].pct_change()
kotak['daily_return'] = kotak['Close'].pct_change()
```

Code:

```
import pandas as pd
data = {
   'Name': ['Alice', 'Bob', 'Charlie', 'David'],
   'Age': [25, 30, 35, 40],
   'City': ['New York', 'Los Angeles', 'Chicago', 'Houston']
}
df = pd.DataFrame(data)
print("Sample data:")
print(df.head())

from sklearn.datasets import load_iris
iris = load_iris()
df = pd.DataFrame(iris.data, columns=iris.feature_names)
df['target'] = iris.target
print("Sample data:")
print(df.head())

from sklearn.datasets import load_iris
iris = load_iris()
df = pd.DataFrame(iris.data, columns=iris.feature_names)
df['target'] = iris.target
print("Sample data:")
print(df.head())

file_path = 'mobiles-dataset-2025.csv'
df = pd.read_csv(file_path, encoding='latin-1') # or 'cp1252' or other suitable encoding
print("Sample data:")
print(df.head())

import pandas as pd
data = {
```

```
    'USN': ['IS001','IS002','IS003','IS004','IS005'],
    'Name': ['Alice', 'Bob', 'Charlie', 'David','Eve'],
    'Marks': [25, 30, 35, 40,45]
}
df = pd.DataFrame(data)
print("Sample data:")
print(df.head())

file_path = 'sample_sales_data.csv'
df = pd.read_csv(file_path)
print("Sample data:")
print(df.head())
print("\n")

df = pd.read_csv("/content/dataset-of-diabetes .csv",encoding='latin-1')
print("Sample data:")
print(df.head())
print("\n")

df =pd.read_csv('sample_sales_data.csv')
print("Sample data:")
print(df.head())
df.to_csv('output.csv',index=False)
print("Data saved to output.csv")

sales_df =pd.read_csv('sample_sales_data.csv')
print("Sample data:")
print(sales_df.head())
sales_by_region =sales_df.groupby('Region')['Sales'].sum()
print("\nTotal sales by region:")
print(sales_by_region)
best_selling_products =sales_df.groupby('Product')['Quantity'].sum().sort_values(ascending=False)
```

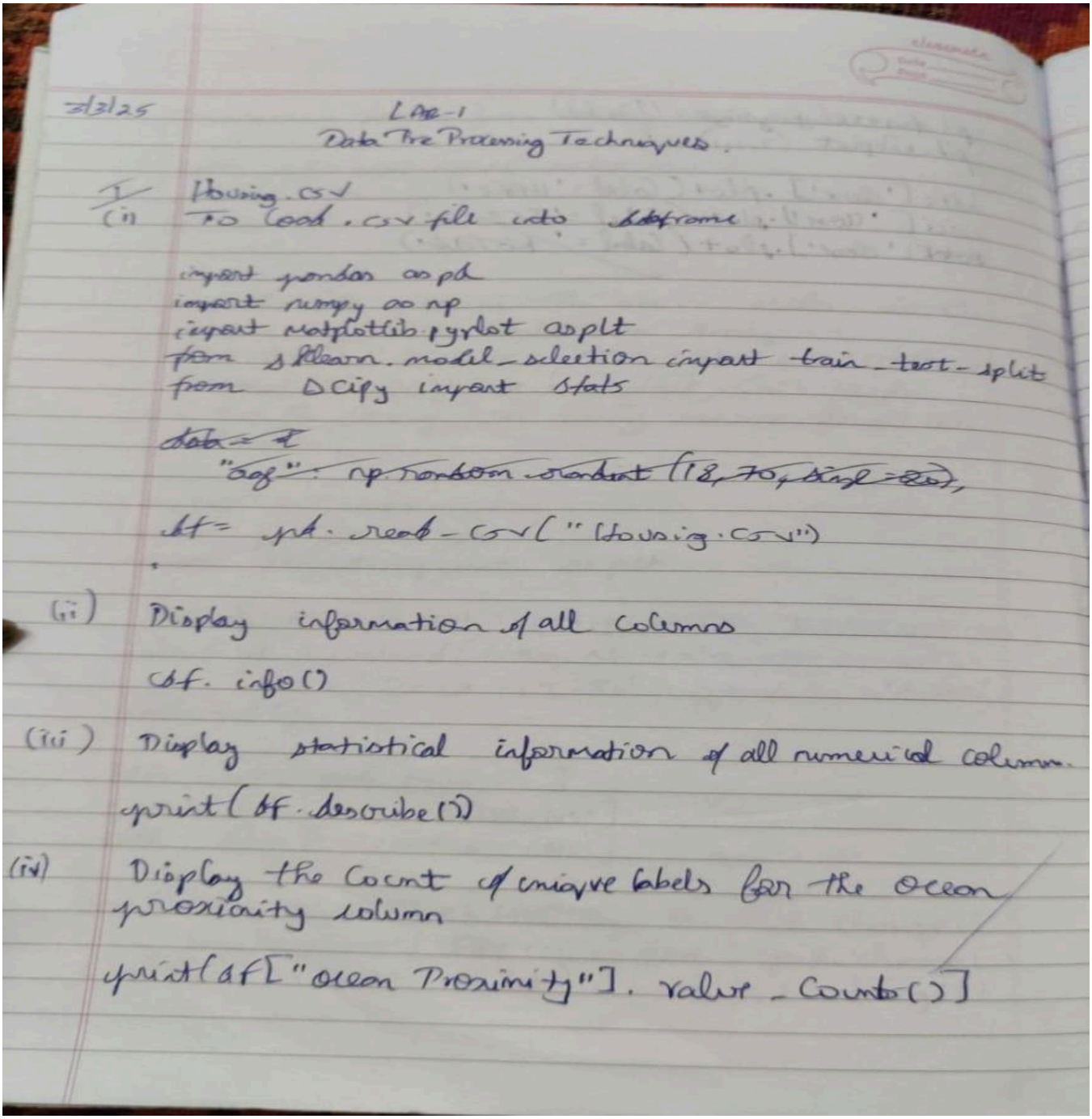
```
print("\nBest-selling products by quantity:")
print(best_selling_products)
sales_by_region.to_csv('sales_by_region.csv')
best_selling_products.to_csv('best_selling_products.csv')
print("Data saved to sales_by_region.csv and best_selling_products.csv")

import yfinance as yf
import matplotlib.pyplot as plt
tickers = ["RELIANCE.NS", "TCS.NS", "INFY.NS"]
data = yf.download(tickers, start="2022-10-01", end="2023-10-01",
                   group_by='ticker')
print("First 5 rows of the dataset:")
print(data.head())
print("\nShape of the dataset:")
print(data.shape)
print("\nColumn names:")
print(data.columns)
print("\n")
reliance_data = data['RELIANCE.NS']
print("\nSummary statistics for Reliance Industries:")
print(reliance_data.describe())
reliance_data['Daily Return'] = reliance_data['Close'].pct_change()
print("\n")
plt.figure(figsize=(12, 6))
plt.subplot(2, 1, 1)
reliance_data['Close'].plot(title="Reliance Industries - Closing Price")
plt.subplot(2, 1, 2)
reliance_data['Daily Return'].plot(title="Reliance Industries - Daily Returns", color='orange')
plt.tight_layout()
plt.show()
reliance_data.to_csv('reliance_stock_data.csv')
```

```
tickers = ["HDFCBANK.NS", "ICICI.NS", "KOTAKBANK.NS"]
data = yf.download(tickers, start="2024-01-01", end="2024-12-30",
                   group_by='ticker')
print("First 5 rows of the dataset:")
print(data.head())
print("\nShape of the dataset:")
print(data.shape)
print("\nColumn names:")
print(data.columns)
print("\n")
reliance_data = data['HDFCBANK.NS']
print("\nSummary statistics for Reliance Industries:")
print(reliance_data.describe())
reliance_data['Daily Return'] = reliance_data['Close'].pct_change()
print("\n")
plt.figure(figsize=(12, 6))
plt.subplot(2, 1, 1)
reliance_data['Close'].plot(title="HDFC Industries - Closing Price")
plt.subplot(2, 1, 2)
reliance_data['Daily Return'].plot(title="HDFCIndustries - Daily Returns", color='red')
plt.tight_layout()
plt.show()
reliance_data.to_csv('hdfc_stock_data.csv')
print("\nhdfc stock data saved to 'hdfc_stock_data.csv'.")
```

Program 2

Demonstrate various data pre-processing techniques for a given dataset.

Screenshot:



V. Display attributes with missing values

```
missing_values = df.isnull().sum()
missing_columns = missing_values[missing_values > 0]
print(missing_columns)
```

Diabetes.csv

1. Which columns in the dataset had missing values? How did you handle them?

→ Glucose, BloodPressure, SkinThickness, Insulin, BMI
→ Handled by replacing with median values.

→ In Adult, Income, WorkClass, occupation, native-country.
→ handled by filling with mode.

2. Which categorical columns did you identify in the set?

→ workclass, education, marital-status, occupation.
→ Type of Diabetes.

What is the diff b/w Min-Max scaling & standardization?

Min Max scaling is used for values with fixed range.

standardization transforms data to have zero mean & unit variance.

Code:

```
import pandas as pd
import numpy as np
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import MinMaxScaler, StandardScaler
from sklearn.impute import SimpleImputer

try:
    diabetes_df = pd.read_csv('diabetes.csv')
    adult_df = pd.read_csv('adult.csv')
except FileNotFoundError:
    print("Error: Please upload 'diabetes.csv' and 'adult.csv' to your Google Colab environment.")
    exit()

diabetes_df.head(10)
adult_df.head(10)

diabetes_df.shape
adult_df.shape

#Handling Missing Values
diabetes_numeric_cols = diabetes_df.select_dtypes(include=[np.number]).columns
diabetes_categorical_cols = diabetes_df.select_dtypes(exclude=[np.number]).columns

adult_numeric_cols = adult_df.select_dtypes(include=[np.number]).columns
adult_categorical_cols = adult_df.select_dtypes(exclude=[np.number]).columns

diabetes_numeric_imputer = SimpleImputer(strategy='mean')
adult_numeric_imputer = SimpleImputer(strategy='mean')
diabetes_df[diabetes_numeric_cols] =
```

```
diabetes_numeric_imputer.fit_transform(diabetes_df[diabetes_numeric_cols])
adult_df[adult_numeric_cols] = adult_numeric_imputer.fit_transform(adult_df[adult_numeric_cols])

diabetes_categorical_imputer = SimpleImputer(strategy='most_frequent')
adult_categorical_imputer = SimpleImputer(strategy='most_frequent')
diabetes_df[diabetes_categorical_cols] =
diabetes_categorical_imputer.fit_transform(diabetes_df[diabetes_categorical_cols])
adult_df[adult_categorical_cols] =
adult_categorical_imputer.fit_transform(adult_df[adult_categorical_cols])

print("Missing values in Diabetes dataset after imputation:")
print(diabetes_df.isnull().sum())
print("Missing values in Adult Income dataset after imputation:")
print(adult_df.isnull().sum())

adult_df.replace("?", np.nan, inplace=True)
print("Missing values in Adult Income dataset after replacing '?':")
print(adult_df.isnull().sum())

from sklearn.impute import SimpleImputer

# Identify numeric and categorical columns
adult_numeric_cols = adult_df.select_dtypes(include=[np.number]).columns
adult_categorical_cols = adult_df.select_dtypes(exclude=[np.number]).columns

# Handle missing values in numeric columns using mean imputation
adult_numeric_imputer = SimpleImputer(strategy='mean')
adult_df[adult_numeric_cols] = adult_numeric_imputer.fit_transform(adult_df[adult_numeric_cols])

# Handle missing values in categorical columns using most frequent imputation
adult_categorical_imputer = SimpleImputer(strategy='most_frequent')
adult_df[adult_categorical_cols] =
```

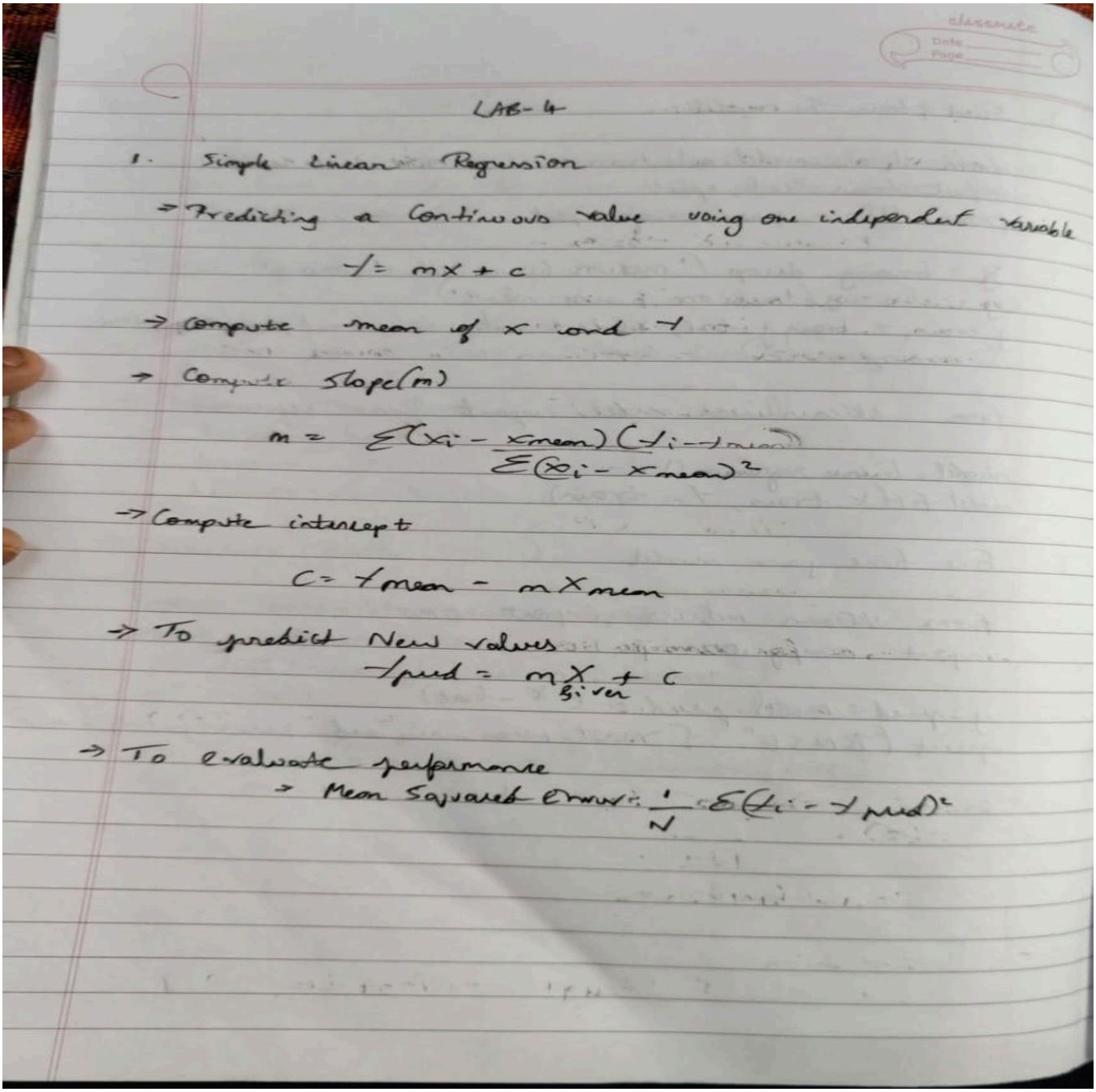
```
adult_categorical_imputer.fit_transform(adult_df[adult_categorical_cols])
print("Missing values in Adult Income dataset after imputation:")
print(adult_df.isnull().sum())

from sklearn.preprocessing import LabelEncoder
label_encoder = LabelEncoder()

# Encode categorical columns in Diabetes dataset
for col in diabetes_categorical_cols:
    diabetes_df[col] = label_encoder.fit_transform(diabetes_df[col])

# Encode categorical columns in Adult Income dataset
for col in adult_categorical_cols:
    adult_df[col] = label_encoder.fit_transform(adult_df[col])
print("Encoded columns in Diabetes dataset:")
print(diabetes_df.head())
print("Encoded columns in Adult Income dataset:")
print(adult_df.head())

#Handling outliers
def remove_outliers(df):
    Q1 = df.quantile(0.25)
    Q3 = df.quantile(0.75)
    IQR = Q3 - Q1
    df_no_outliers = df[~((df < (Q1 - 1.5 * IQR)) | (df > (Q3 + 1.5 * IQR))).any(axis=1)]
    return df_no_outliers

diabetes_df_no_outliers = remove_outliers(diabetes_df)
adult_df_no_outliers = remove_outliers(adult_df)
print("Diabetes dataset shape after removing outliers:", diabetes_df_no_outliers.shape)
print("Adult Income dataset shape after removing outliers:", adult_df_no_outliers.shape)
```

```
#Min-max scaling
from sklearn.preprocessing import MinMaxScaler
min_max_scaler = MinMaxScaler()
diabetes_scaled_minmax = pd.DataFrame(min_max_scaler.fit_transform(diabetes_df_no_outliers),
columns=diabetes_df_no_outliers.columns)
adult_scaled_minmax = pd.DataFrame(min_max_scaler.fit_transform(adult_df_no_outliers),
columns=adult_df_no_outliers.columns)
print("Diabetes dataset after Min-Max scaling:")
print(diabetes_scaled_minmax.head())
print("Adult Income dataset after Min-Max scaling:")
print(adult_scaled_minmax.head())

# Initialize Standard Scaler
from sklearn.preprocessing import StandardScaler
standard_scaler = StandardScaler()
diabetes_scaled_standard = pd.DataFrame(standard_scaler.fit_transform(diabetes_df_no_outliers),
columns=diabetes_df_no_outliers.columns)
adult_scaled_standard = pd.DataFrame(standard_scaler.fit_transform(adult_df_no_outliers),
columns=adult_df_no_outliers.columns)
print("Diabetes dataset after Standard scaling:")
print(diabetes_scaled_standard.head())
print("Adult Income dataset after Standard scaling:")
print(adult_scaled_standard.head())
```

Program 3

Implement Linear and Multi-Linear Regression algorithm using appropriate dataset.

Screenshot:



2. Multiple Linear Regression

→ Predicting a continuous output using multiple independent variables.

$$y = b_0 + b_1 x_1 + b_2 x_2 \dots$$

→ Prepare dataset X & y
→ Convert data into matrix form
→ Compute regression co-efficients using normal eqn:-

$$B = ((X^T X)^{-1} X^T) y$$

To predict New values.

$$y_{pred} = X B$$

3. Logistic Regression.

It is used for classification.

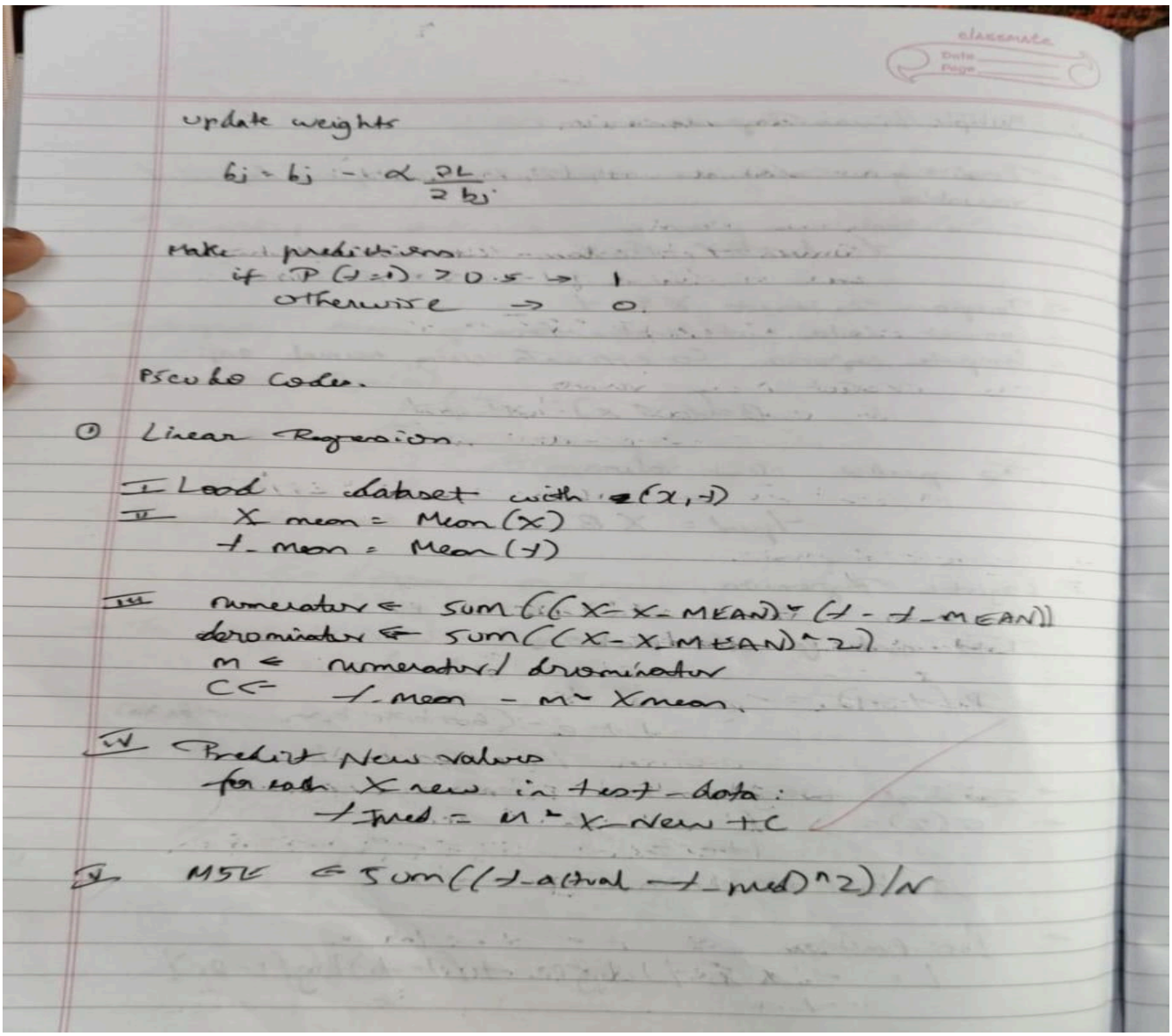
$$P(y=1) = \frac{1}{1 + e^{-(b_0 + b_1 x_1 + b_2 x_2 \dots + b_n x_n)}}$$

→ Initialise weights $b_0, b \dots b_n$
→ $\sigma(z) = \frac{1}{1+e^{-z}}$

$$z = b_0 + b_1 x_1 + b_n x_n$$

→ Loss function

$$L = \frac{-1}{N} \sum [y_i \log p_i + (1-y_i) \log (1-p_i)]$$



Code:

```
import pandas as pd
import numpy as np
from sklearn import linear_model
import matplotlib.pyplot as plt
```

```
df = pd.read_csv('housing_area_price.csv')
plt.xlabel('area')
plt.ylabel('price')
plt.scatter(df.area,df.price,color='red',marker='+')
new_df = df.drop('price',axis='columns')
new_df
price = df.price
reg = linear_model.LinearRegression()
reg.fit(new_df,price)

#(1) Predict price of a home with area = 3300 sqr ft
reg.predict([[3300]])
reg.coef_
reg.intercept_
3300*135.78767123 + 180616.43835616432

#(2) Predict price of a home with area = 5000 sqr ft
reg.predict([[5000]])

df = pd.read_csv('homeprices_Multiple_LR.csv')
df.bedrooms.median()
df.bedrooms = df.bedrooms.fillna(df.bedrooms.median())
reg = linear_model.LinearRegression()
reg.fit(df.drop('price',axis='columns'),df.price)
reg.coef_
reg.intercept_

#Find price of home with 3000 sqr ft area, 3 bedrooms, 40 year old
reg.predict([[3000, 3, 40]])
112.06244194*3000 + 23388.88007794*3 + -3231.71790863*40 + 221323.00186540384

df = pd.read_csv('canada_per_capita_income.csv')
```

```
print(df.head())
X = df[['year']]
y = df['per capita income (US$)']
reg = LinearRegression()
reg.fit(X, y)
predicted_income_2020 = reg.predict([[2020]])
print(f"Predicted per capita income for Canada in 2020: {predicted_income_2020[0]:.2f}")

plt.scatter(X, y, color='blue')
plt.plot(X, reg.predict(X), color='red')
plt.xlabel('Year')
plt.ylabel('Per Capita Income')
plt.title('Per Capita Income in Canada Over the Years')
plt.show()

df = pd.read_csv('salary.csv')
print(df.head())
print("Missing values in the dataset:")
print(df.isnull().sum())

df['YearsExperience'] = df['YearsExperience'].fillna(df['YearsExperience'].median())
print("\nMissing values after filling:")
print(df.isnull().sum())
X = df[['YearsExperience']]
y = df['Salary']
reg = LinearRegression()
reg.fit(X, y)
predicted_salary_12_years = reg.predict([[12]])
print(f"\nPredicted salary for an employee with 12 years of experience:
${predicted_salary_12_years[0]:,.2f}")

plt.scatter(X, y, color='blue')
```

```
plt.plot(X, reg.predict(X), color='red')
plt.xlabel('Years of Experience')
plt.ylabel('Salary')
plt.title('Salary vs. Years of Experience')
plt.show()

def convert_to_numeric(value):
    word_to_num = {
        'zero': 0, 'one': 1, 'two': 2, 'three': 3, 'four': 4, 'five': 5,
        'six': 6, 'seven': 7, 'eight': 8, 'nine': 9, 'ten': 10,
        'eleven': 11, 'twelve': 12, 'thirteen': 13, 'fourteen': 14,
        'fifteen': 15
    }
    return word_to_num.get(value.lower(), value) if isinstance(value, str) else value

df_hiring = pd.read_csv('hiring.csv')
print(df.head())
df_hiring['experience'] = df_hiring['experience'].apply(convert_to_numeric)

df_hiring['experience'].fillna(0, inplace=True)
df_hiring['test_score(out of 10)'].fillna(df_hiring['test_score(out of 10)'].median(), inplace=True)
df_hiring['interview_score(out of 10)'].fillna(df_hiring['interview_score(out of 10)'].median(),
inplace=True)
X_hiring = df_hiring[['experience', 'test_score(out of 10)', 'interview_score(out of 10)']]
y_hiring = df_hiring['salary($)']
reg_hiring = LinearRegression()
reg_hiring.fit(X_hiring, y_hiring)
candidates = np.array([[2, 9, 6], [12, 10, 10]])
predicted_salaries = reg_hiring.predict(candidates)

for i, candidate in enumerate(candidates):
    print(f"\nPredicted salary for candidate with {candidate[0]} yrs experience, {candidate[1]} test score,
```

```
{candidate[2]} interview score: {predicted_salaries[i]:.2f} USD")

plt.scatter(y_hiring, reg_hiring.predict(X_hiring), color='blue', label='Predicted vs Actual')
plt.xlabel("Actual Salary")
plt.ylabel("Predicted Salary")
plt.title("Actual vs Predicted Salary")
plt.legend()
plt.show()

df_companies = pd.read_csv('1000_Companies.csv')
print(df.head())
label_encoder = LabelEncoder()
df_companies['State'] = label_encoder.fit_transform(df_companies['State'])
X_companies = df_companies[['R&D Spend', 'Administration', 'Marketing Spend', 'State']]
y_companies = df_companies['Profit']
df_companies.fillna(df_companies.median(), inplace=True)
reg_companies = LinearRegression()
reg_companies.fit(X_companies, y_companies)

input_data = np.array([[91694.48, 515841.3, 11931.24, label_encoder.transform(['Florida'])[0]]])
predicted_profit = reg_companies.predict(input_data)
print(f"Predicted profit: {predicted_profit[0]:.2f} USD")

plt.scatter(y_companies, reg_companies.predict(X_companies), color='blue', label='Predicted vs
Actual')
plt.xlabel("Actual Profit")
plt.ylabel("Predicted Profit")
plt.title("Actual vs Predicted Profit")
plt.legend()
plt.show()
```

Program 4

Build Logistic Regression Model for a given dataset.

Screenshot:

Code:

```
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt

df = pd.read_csv("HR_comma_sep.csv")
print(df.info())
numericCols = df.select_dtypes(include=['float64', 'int64']).columns
plt.figure(figsize=(10, 8))
sns.heatmap(df[numericCols].corr(), annot=True, cmap='coolwarm', fmt='.2f')
plt.title("Correlation Matrix (Numeric Features)")
plt.show()

plt.figure(figsize=(8, 6))
sns.countplot(x='salary', hue='left', data=df)
plt.title("Impact of Salary on Employee Retention")
plt.xlabel("Salary Level")
plt.ylabel("Employee Count")
plt.show()

import pandas as pd
df = pd.read_csv("zoo-data.csv")
print(df.info())
print(df.head())
print(df.isnull().sum())
df.drop(columns=['animal_name'], inplace=True)
X = df.drop(columns=['class_type'])
```

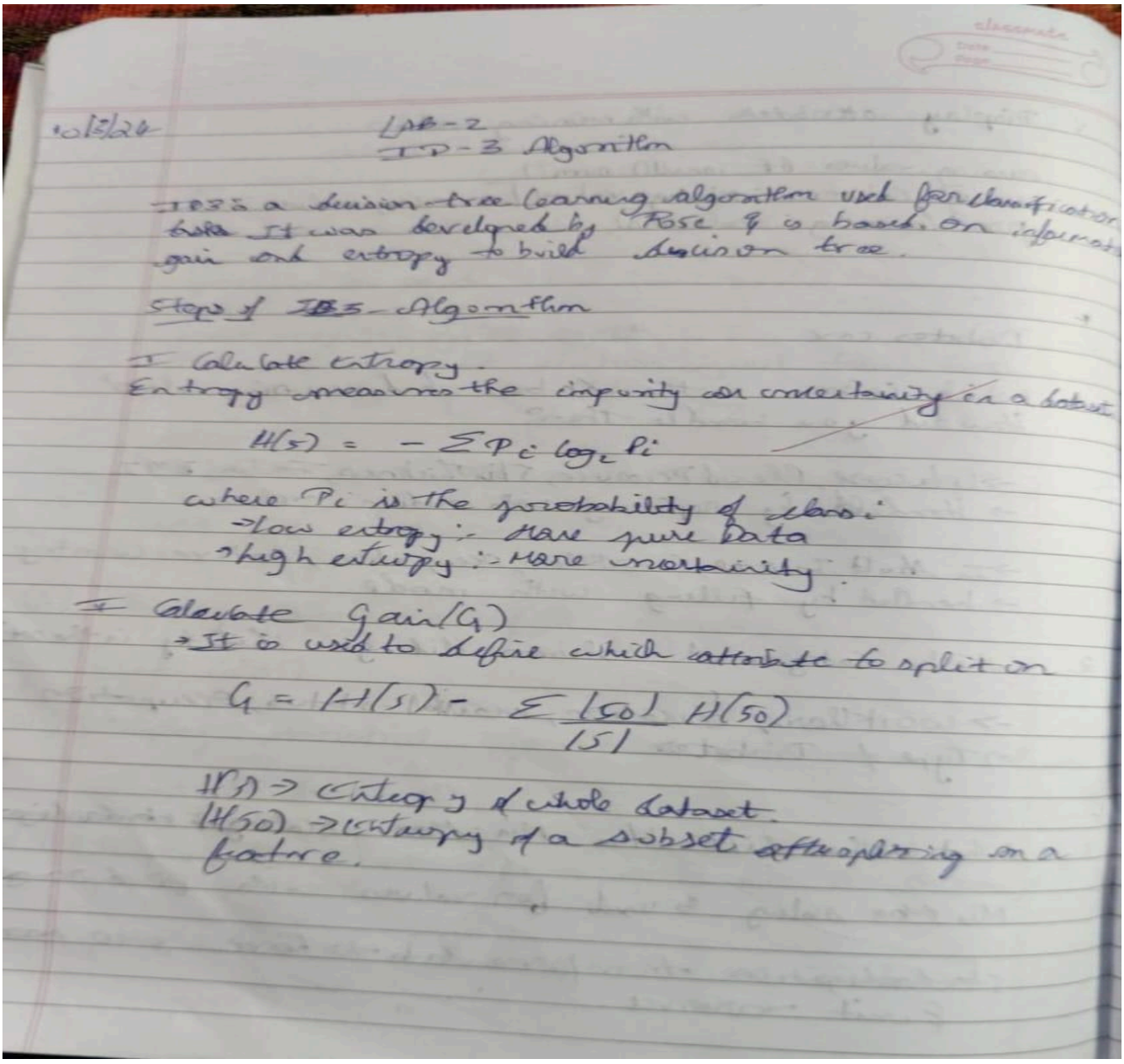
```
y = df['class_type']

from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler
from sklearn.linear_model import LogisticRegression
X_train, X_test, y_train, y_test = train_test_split(
    X, y, test_size=0.2, random_state=42, stratify=y)
scaler = StandardScaler()
X_train = scaler.fit_transform(X_train)
X_test = scaler.transform(X_test)
logreg = LogisticRegression(max_iter=200, multi_class='multinomial', solver='lbfgs')
logreg.fit(X_train, y_train)

from sklearn.metrics import accuracy_score
y_pred = logreg.predict(X_test)
accuracy = accuracy_score(y_test, y_pred)
print(f"Model Accuracy: {accuracy:.2f}")

from sklearn.metrics import confusion_matrix, ConfusionMatrixDisplay
import matplotlib.pyplot as plt
cm = confusion_matrix(y_test, y_pred)
disp = ConfusionMatrixDisplay(confusion_matrix=cm, display_labels=logreg.classes_)
disp.plot(cmap=plt.cm.Blues)
plt.title("Confusion Matrix for Zoo Animal Classification")
plt.show()

y_pred = logreg.predict(X_test)
pred_classes = [class_mapping[pred] for pred in y_pred]
print("Predicted Classes:", pred_classes)

import seaborn as sns
import matplotlib.pyplot as plt
```

```
sns.countplot(x='class_type', data=df)
plt.title("Class Distribution of Animals in Zoo Dataset")
plt.xlabel("Class Type")
plt.ylabel("Count")
plt.show()

from sklearn.metrics import confusion_matrix, ConfusionMatrixDisplay
cm = confusion_matrix(y_test, y_pred)
class_labels = [class_mapping[num] for num in logreg.classes_]
disp = ConfusionMatrixDisplay(confusion_matrix=cm, display_labels=class_labels)
disp.plot(cmap=plt.cm.Blues)
plt.title("Confusion Matrix with Class Names")
plt.show()
```

Program 5

Use an appropriate data set for building the decision tree (ID3) and apply this knowledge to classify a new sample.

Screenshot:



1. Choose the best Feature

If outlook has the highest information gain, it is chosen as root.

2. Recursively Build the tree
   - split the dataset based on selected feature
   - Repeat steps 1-3 for each subset
   - Stop when
     - All instances in a subset belong to one class
     - No features remain

Eg:

Outlook	Humidity	PlayTennis
Sunny	High	No
Sunny	Normal	No
Overcast	H	Yes
Rain	H	Yes
Rain	Normal	No
Overcast	Normal	Yes.

Yes → 4 No → 2.

$$H(S) = -\frac{4}{6}\log_2\frac{4}{6} - \frac{2}{6}\log_2\frac{2}{6}$$

$$= 0.918$$

For Outlook:

$$H(\text{Sunny}) = -\frac{1}{2}\log_2\frac{1}{2} - \frac{1}{2}\log_2\frac{1}{2}$$

$$= 1.0$$

H(overcast) = 0 (pure).

H(rain) = 1.0.

$$H(\text{outlook}) = \frac{2}{6}(1.0) + 0 + \frac{2}{6}(1.0)$$

$$= \frac{4}{6} = 0.667$$

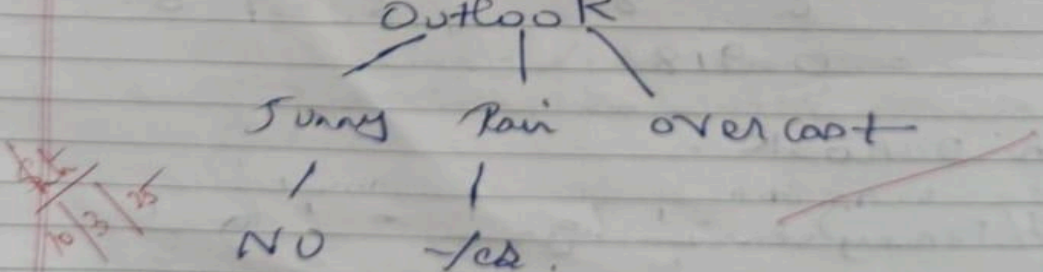
G(outlook) = 0.918 − 0.667 = 0.251

Gain for humidity.

H(high) = 0.918.
H(Normal) = 0.918.

G(humidity) = 0.918 − 0.918 = 0.

We split on ~~Data~~ outlook.



Code:

```
import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt
from sklearn.model_selection import train_test_split
from sklearn.tree import DecisionTreeClassifier
from sklearn.metrics import accuracy_score, confusion_matrix, precision_score, recall_score, f1_score
from sklearn.preprocessing import LabelEncoder

def train_and_evaluate_iris():
    iris_df = pd.read_csv("iris.csv")
    X = iris_df.drop(columns=["species"])
    y = iris_df["species"]
    y_le = LabelEncoder()
    y = y_le.fit_transform(y)
    X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)
    model = DecisionTreeClassifier(random_state=42)
    model.fit(X_train, y_train)
    y_pred = model.predict(X_test)

    # Evaluating the model
    acc = accuracy_score(y_test, y_pred)
    prec = precision_score(y_test, y_pred, average='weighted')
    rec = recall_score(y_test, y_pred, average='weighted')
    f1 = f1_score(y_test, y_pred, average='weighted')
    cm = confusion_matrix(y_test, y_pred)

    print("IRIS Dataset Classification:")
    print(f"Accuracy Score: {acc:.4f}")
    print(f"Precision Score: {prec:.4f}")
    print(f"Recall Score: {rec:.4f}")
```

```
    print(f"F1 Score: {f1:.4f}")

    plt.figure(figsize=(6, 4))
    sns.heatmap(cm, annot=True, fmt='d', cmap='Blues', xticklabels=y_le.classes_,
yticklabels=y_le.classes_)
    plt.xlabel("Predicted")
    plt.ylabel("Actual")
    plt.title("Confusion Matrix: iris.csv")
    plt.show()

train_and_evaluate_iris()

def train_and_evaluate_drug():
    drug_df = pd.read_csv("drug.csv")
    categorical_features = ["Sex", "BP", "Cholesterol"]
    label_encoders = {}
    for col in categorical_features:
        le = LabelEncoder()
        drug_df[col] = le.fit_transform(drug_df[col])
        label_encoders[col] = le
    X = drug_df.drop(columns=["Drug"])
    y = drug_df["Drug"]
    y_le = LabelEncoder()
    y = y_le.fit_transform(y)
    X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)

    model = DecisionTreeClassifier(random_state=42)
    model.fit(X_train, y_train)
    y_pred = model.predict(X_test)

    acc = accuracy_score(y_test, y_pred)
    prec = precision_score(y_test, y_pred, average='weighted')
```

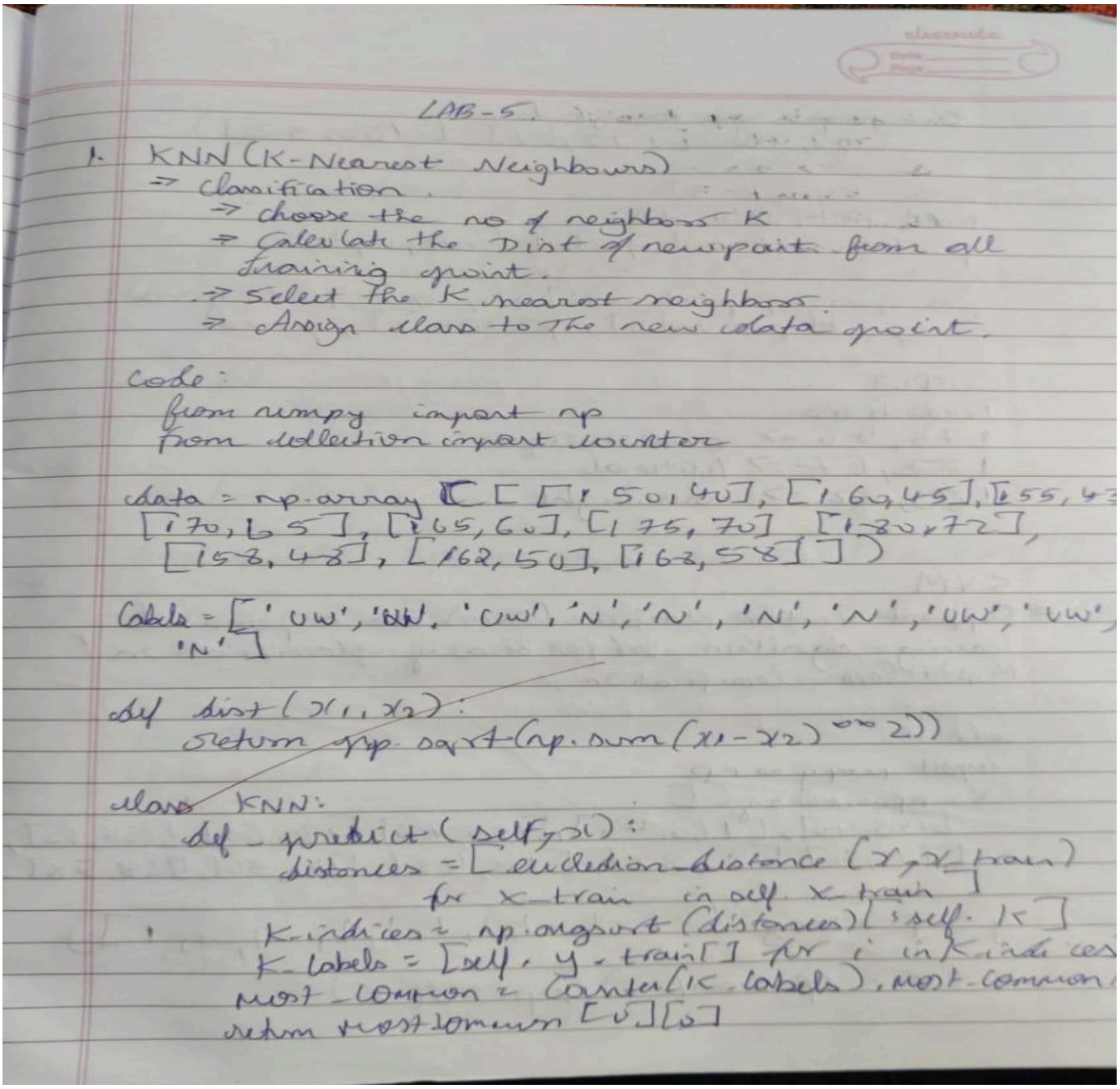
```
    rec = recall_score(y_test, y_pred, average='weighted')
    f1 = f1_score(y_test, y_pred, average='weighted')
    cm = confusion_matrix(y_test, y_pred)

    print("Drug Dataset Classification:")
    print(f"Accuracy Score: {acc:.4f}")
    print(f"Precision Score: {prec:.4f}")
    print(f"Recall Score: {rec:.4f}")
    print(f"F1 Score: {f1:.4f}")

    plt.figure(figsize=(6, 4))
    sns.heatmap(cm, annot=True, fmt='d', cmap='Blues', xticklabels=y_le.classes_,
yticklabels=y_le.classes_)
    plt.xlabel("Predicted")
    plt.ylabel("Actual")
    plt.title("Confusion Matrix: drug.csv")
    plt.show()

train_and_evaluate_drug()

import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.model_selection import train_test_split
from sklearn.tree import DecisionTreeRegressor, plot_tree
from sklearn.preprocessing import StandardScaler
from sklearn.metrics import mean_absolute_error, mean_squared_error

petrol_df = pd.read_csv("petrol_consumption.csv")
X = petrol_df.drop(columns=["Petrol_Consumption"])
y = petrol_df["Petrol_Consumption"]
```

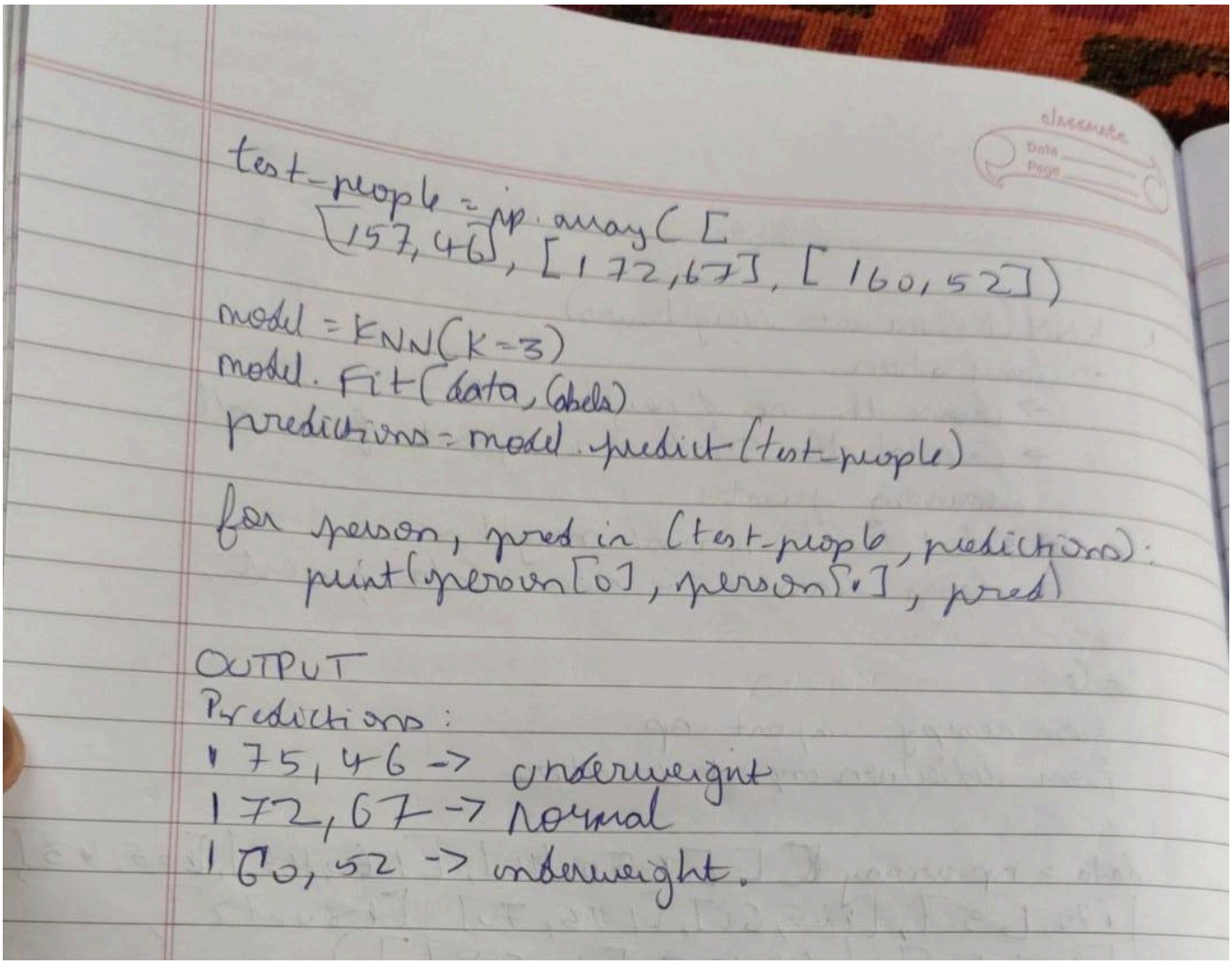
```
scaler = StandardScaler()
X_scaled = scaler.fit_transform(X)
X_train, X_test, y_train, y_test = train_test_split(X_scaled, y, test_size=0.2, random_state=42)
model = DecisionTreeRegressor(max_depth=5, random_state=42)
model.fit(X_train, y_train)
y_pred = model.predict(X_test)

print("Petrol Consumption Regression:")
print("Mean Absolute Error (MAE):", mean_absolute_error(y_test, y_pred))
print("Mean Squared Error (MSE):", mean_squared_error(y_test, y_pred))
print("Root Mean Squared Error (RMSE):", np.sqrt(mean_squared_error(y_test, y_pred)))
```

Program 6

Build KNN Classification model for a given dataset.

Screenshot:





Code:

```
import pandas as pd
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import LabelEncoder
from sklearn.preprocessing import StandardScaler
from sklearn.neighbors import KNeighborsClassifier
from sklearn.metrics import classification_report, confusion_matrix, accuracy_score
import seaborn as sns
```

```
import matplotlib.pyplot as plt

iris_df = pd.read_csv('iris.csv')
le = LabelEncoder()
iris_df['species'] = le.fit_transform(iris_df['species'])
X = iris_df.drop('species', axis=1)
y = iris_df['species']
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)

error_rates = []
accuracies = []
k_values = range(1, 10)
for k in k_values:
    knn = KNeighborsClassifier(n_neighbors=k)
    knn.fit(X_train, y_train)
    y_pred_k = knn.predict(X_test)
    error = 1 - accuracy_score(y_test, y_pred_k)
    error_rates.append(error)
    accuracies.append(accuracy_score(y_test, y_pred_k))

plt.figure(figsize=(12, 5))
plt.subplot(1, 2, 1)
plt.plot(k_values, accuracies, marker='o', color='blue')
plt.title("Accuracy vs K")
plt.xlabel("K Value")
plt.ylabel("Accuracy")

plt.subplot(1, 2, 2)
plt.plot(k_values, error_rates, marker='o', color='red')
plt.title("Error Rate vs K")
plt.xlabel("K Value")
plt.ylabel("Error Rate")
```

```
plt.tight_layout()
plt.show()
best_k = k_values[accuracies.index(max(accuracies))]
print(f"Best K: {best_k} with Accuracy: {max(accuracies):.2f}")

knn = KNeighborsClassifier(n_neighbors=best_k)
knn.fit(X_train, y_train)
y_pred = knn.predict(X_test)

# Evaluation
print("\n=== Final Evaluation on IRIS Dataset ===")
print("Accuracy Score:", accuracy_score(y_test, y_pred))
print("\nClassification Report:")
print(classification_report(y_test, y_pred, labels=[0, 1, 2], target_names=le.classes_))

# Confusion Matrix
cm = confusion_matrix(y_test, y_pred)
sns.heatmap(cm, annot=True, fmt='d', cmap='Blues',
            xticklabels=le.classes_, yticklabels=le.classes_)
plt.title("Confusion Matrix - IRIS")
plt.xlabel("Predicted")
plt.ylabel("Actual")
plt.show()

df = pd.read_csv('diabetes.csv')
X = df.drop('Outcome', axis=1)
y = df['Outcome']
scaler = StandardScaler()
X_scaled = scaler.fit_transform(X)
X_train, X_test, y_train, y_test = train_test_split(
    X_scaled, y, test_size=0.2, random_state=42, stratify=y
)
```

```
accuracy_scores = []
k_range = range(1, 21)

for k in k_range:
    knn = KNeighborsClassifier(n_neighbors=k)
    knn.fit(X_train, y_train)
    y_pred_k = knn.predict(X_test)
    acc = accuracy_score(y_test, y_pred_k)
    accuracy_scores.append(acc)

plt.figure(figsize=(8, 5))
plt.plot(k_range, accuracy_scores, marker='o', color='purple')
plt.title("Accuracy vs K (Diabetes Dataset)")
plt.xlabel("K Value")
plt.ylabel("Accuracy")
plt.xticks(k_range)
plt.grid()
plt.show()
best_k = k_range[accuracy_scores.index(max(accuracy_scores))]
print(f"Best K: {best_k} with Accuracy: {max(accuracy_scores):.2f}")

knn = KNeighborsClassifier(n_neighbors=best_k)
knn.fit(X_train, y_train)
y_pred = knn.predict(X_test)

print("=== Final Evaluation (Diabetes Dataset) ===")
print("Accuracy Score:", accuracy_score(y_test, y_pred))
print("\nClassification Report:")
print(classification_report(y_test, y_pred))

cm = confusion_matrix(y_test, y_pred)
sns.heatmap(cm, annot=True, fmt='d', cmap='Purples', xticklabels=['No Diabetes', 'Diabetes'],
```

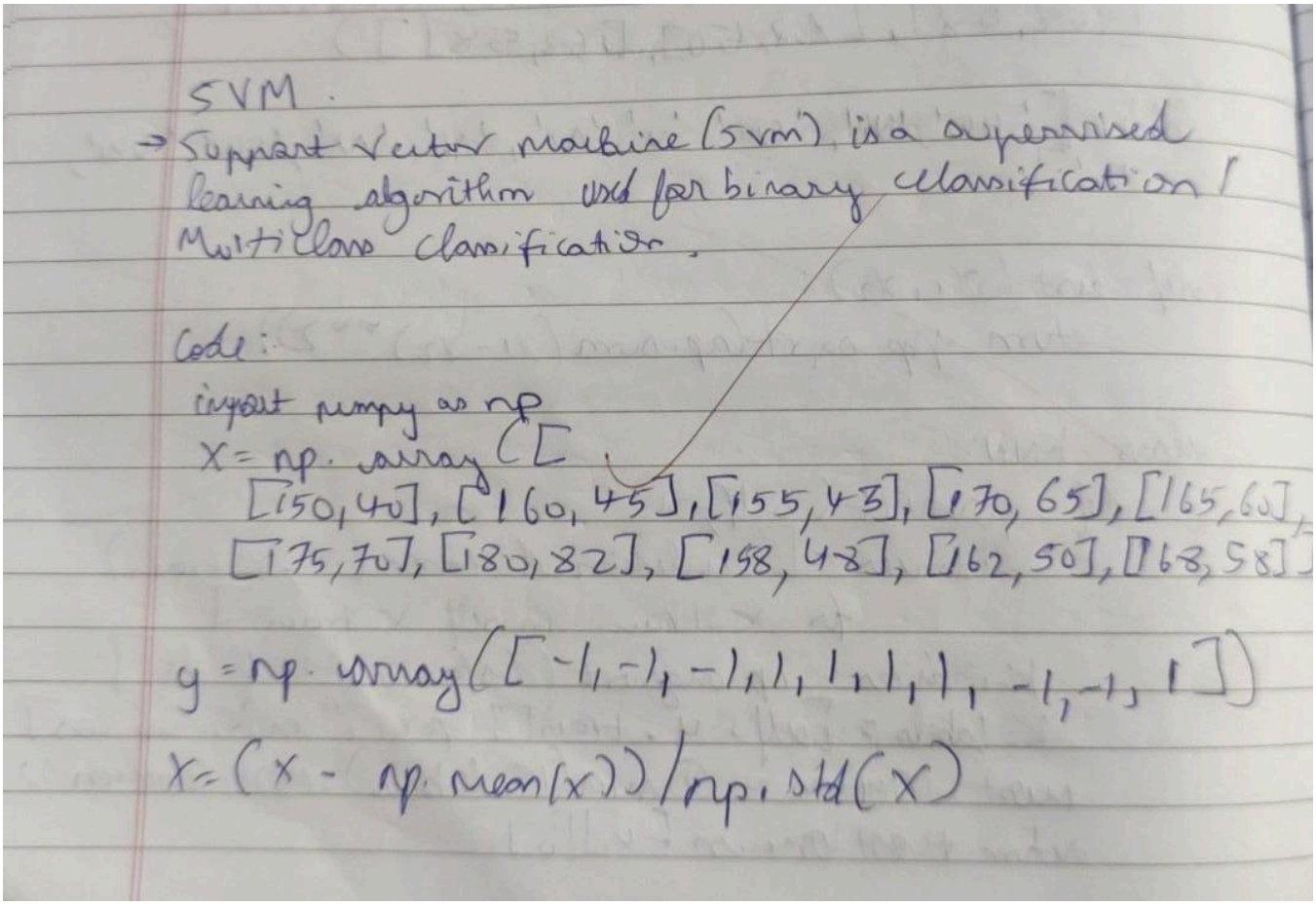
```
yticklabels=['No Diabetes', 'Diabetes'])
plt.title("Confusion Matrix - Diabetes")
plt.xlabel("Predicted")
plt.ylabel("Actual")
plt.show()

heart_df = pd.read_csv('heart.csv')
X = heart_df.drop('target', axis=1)
y = heart_df['target']
scaler = StandardScaler()
X_scaled = scaler.fit_transform(X)
X_train, X_test, y_train, y_test = train_test_split(
    X_scaled, y, test_size=0.2, random_state=42, stratify=y
)
accuracy_scores = []
k_range = range(1, 21)

for k in k_range:
    knn = KNeighborsClassifier(n_neighbors=k)
    knn.fit(X_train, y_train)
    y_pred_k = knn.predict(X_test)
    acc = accuracy_score(y_test, y_pred_k)
    accuracy_scores.append(acc)

plt.figure(figsize=(8, 5))
plt.plot(k_range, accuracy_scores, marker='o', color='red')
plt.title("Accuracy vs K (Heart Dataset)")
plt.xlabel("K Value")
plt.ylabel("Accuracy")
plt.xticks(k_range)
plt.grid()
plt.show()
```

```
best_k = k_range[accuracy_scores.index(max(accuracy_scores))]
print(f"Best K: {best_k} with Accuracy: {max(accuracy_scores):.2f}")

knn = KNeighborsClassifier(n_neighbors=best_k)
knn.fit(X_train, y_train)
y_pred = knn.predict(X_test)

print("=== Final Evaluation (Heart Dataset) ===")
print("\nAccuracy Score:", accuracy_score(y_test, y_pred))
print("\nClassification Report:")
print(classification_report(y_test, y_pred, target_names=['No Disease', 'Disease']))
cm = confusion_matrix(y_test, y_pred)
sns.heatmap(cm, annot=True, fmt='d', cmap='Reds', xticklabels=['No Disease', 'Disease'],
yticklabels=['No Disease', 'Disease'])
plt.title("Confusion Matrix - Heart Disease")
plt.xlabel("Predicted")
plt.ylabel("Actual")
plt.show()
```

Program 7

Build Support vector machine model for a given dataset.

Screenshot:



```
class SVM:
    for _ in range (self.n_iters):
        for idx, x_i in enumerate(x):
        condition = y[idx] * (np.dot(x_i, self.w) + self.b)

        if condition:
            self.w = self.lr * (2 * self.lambda_param * self.w)
        else:
            self.w -> self.lr * (2 * self.lambda_param * self.w)

    def predict(self, x):
        approx = np.dot(x, self.w) + self.b
        return np.sign(approx)

model = SVM()

test_people = np.array([[157, 40], [172, 67], [6, 57]])

test_people = (test_people - np.mean(x))/np.std(x)

predictions = model.predict(test_people)
```

OUT
underweight
normal
underweight

1/4

Code:

```
import pandas as pd
import numpy as np
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import LabelEncoder, StandardScaler
from sklearn.svm import SVC
from sklearn.metrics import accuracy_score, confusion_matrix, roc_auc_score, roc_curve
from sklearn.preprocessing import label_binarize
import matplotlib.pyplot as plt
import seaborn as sns

iris = pd.read_csv("iris.csv")
label_encoder = LabelEncoder()
iris['species'] = label_encoder.fit_transform(iris['species'])
class_names_iris = label_encoder.classes_
X_iris = iris.drop('species', axis=1)
y_iris = iris['species']
X_train_iris, X_test_iris, y_train_iris, y_test_iris = train_test_split(X_iris, y_iris, test_size=0.2,
random_state=42)

scaler = StandardScaler()
X_train_iris = scaler.fit_transform(X_train_iris)
X_test_iris = scaler.transform(X_test_iris)
svm_linear = SVC(kernel='linear')
svm_linear.fit(X_train_iris, y_train_iris)
y_pred_linear = svm_linear.predict(X_test_iris)
acc_linear = accuracy_score(y_test_iris, y_pred_linear)
cm_linear = confusion_matrix(y_test_iris, y_pred_linear)

plt.figure(figsize=(6,4))
sns.heatmap(cm_linear, annot=True, fmt='d', cmap='Blues', xticklabels=class_names_iris,
yticklabels=class_names_iris)
```

```
plt.title(f'IRIS SVM Linear Kernel\nAccuracy: {acc_linear:.2f}')
plt.xlabel("Predicted Label")
plt.ylabel("True Label")
plt.tight_layout()
plt.show()

svm_rbf = SVC(kernel='rbf')
svm_rbf.fit(X_train_iris, y_train_iris)
y_pred_rbf = svm_rbf.predict(X_test_iris)
acc_rbf = accuracy_score(y_test_iris, y_pred_rbf)
cm_rbf = confusion_matrix(y_test_iris, y_pred_rbf)

plt.figure(figsize=(6,4))
sns.heatmap(cm_rbf, annot=True, fmt='d', cmap='Greens', xticklabels=class_names_iris,
yticklabels=class_names_iris)
plt.title(f'IRIS SVM RBF Kernel\nAccuracy: {acc_rbf:.2f}')
plt.xlabel("Predicted Label")
plt.ylabel("True Label")
plt.tight_layout()
plt.show()

letters = pd.read_csv("letter-recognition.csv")
X_letters = letters.drop('letter', axis=1)
y_letters = letters['letter']
label_encoder_letters = LabelEncoder()
y_letters_encoded = label_encoder_letters.fit_transform(y_letters)
class_names_letters = label_encoder_letters.classes_

X_train_letters, X_test_letters, y_train_letters, y_test_letters = train_test_split(
    X_letters, y_letters_encoded, test_size=0.2, random_state=42)

scaler_letters = StandardScaler()
```

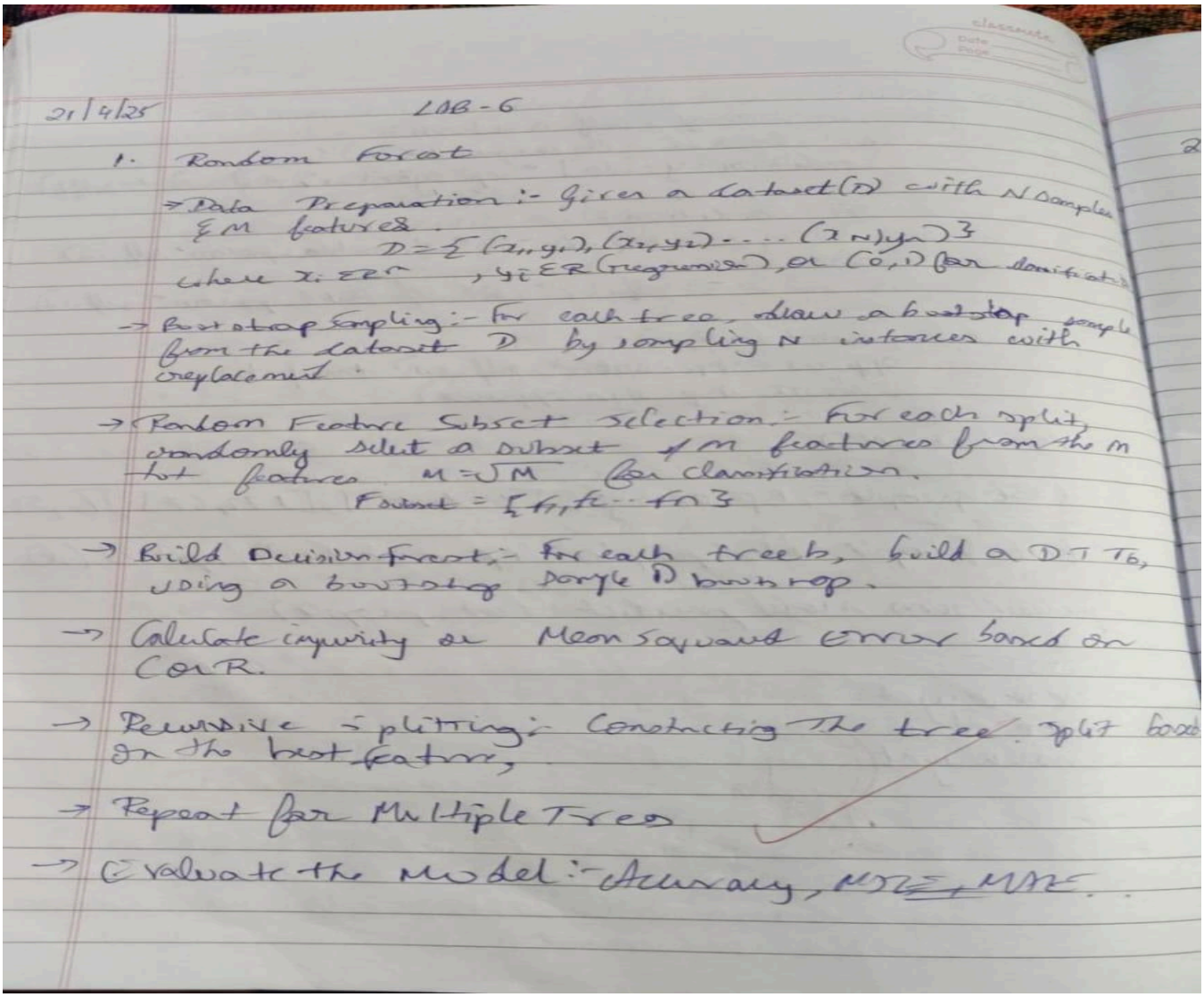
```
X_train_letters = scaler_letters.fit_transform(X_train_letters)
X_test_letters = scaler_letters.transform(X_test_letters)
svm_letters = SVC(kernel='rbf', probability=True)
svm_letters.fit(X_train_letters, y_train_letters)

y_pred_letters = svm_letters.predict(X_test_letters)
acc_letters = accuracy_score(y_test_letters, y_pred_letters)
cm_letters = confusion_matrix(y_test_letters, y_pred_letters)

plt.figure(figsize=(14, 12))
sns.heatmap(cm_letters, annot=True, fmt='d', cmap='Purples',
            xticklabels=class_names_letters,
            yticklabels=class_names_letters,
            annot_kws={"size": 8},
            cbar=True)
plt.title(f'Letter Recognition - SVM RBF Kernel\nAccuracy: {acc_letters*100:.2f}%', fontsize=16)
plt.xlabel("Predicted Label", fontsize=14)
plt.ylabel("True Label", fontsize=14)
plt.xticks(rotation=45)
plt.yticks(rotation=0)
plt.tight_layout()
plt.show()

y_test_binarized = label_binarize(y_test_letters, classes=np.arange(len(class_names_letters)))
y_score = svm_letters.predict_proba(X_test_letters)
auc_score = roc_auc_score(y_test_binarized, y_score, average='macro')

fpr = dict()
tpr = dict()
for i in range(len(class_names_letters)):
    fpr[i], tpr[i], _ = roc_curve(y_test_binarized[:, i], y_score[:, i])
```

```
plt.figure(figsize=(8, 6))
for i in range(0, len(class_names_letters), 4): # Plot every 4th class
    plt.plot(fpr[i], tpr[i], lw=1.5, label=f'Class {class_names_letters[i]}')

plt.plot([0, 1], [0, 1], color='navy', lw=2, linestyle='--')
plt.xlabel("False Positive Rate")
plt.ylabel("True Positive Rate")
plt.title(f"Multi-Class ROC Curve (Macro AUC = {auc_score:.6f})")
plt.legend(loc="lower right", fontsize='small')
plt.grid()
plt.tight_layout()
plt.show()

print(f"Exact AUC Score = {auc_score}")
```

Program 8

Implement Random forest ensemble method on a given dataset.

Screenshot:



Code:

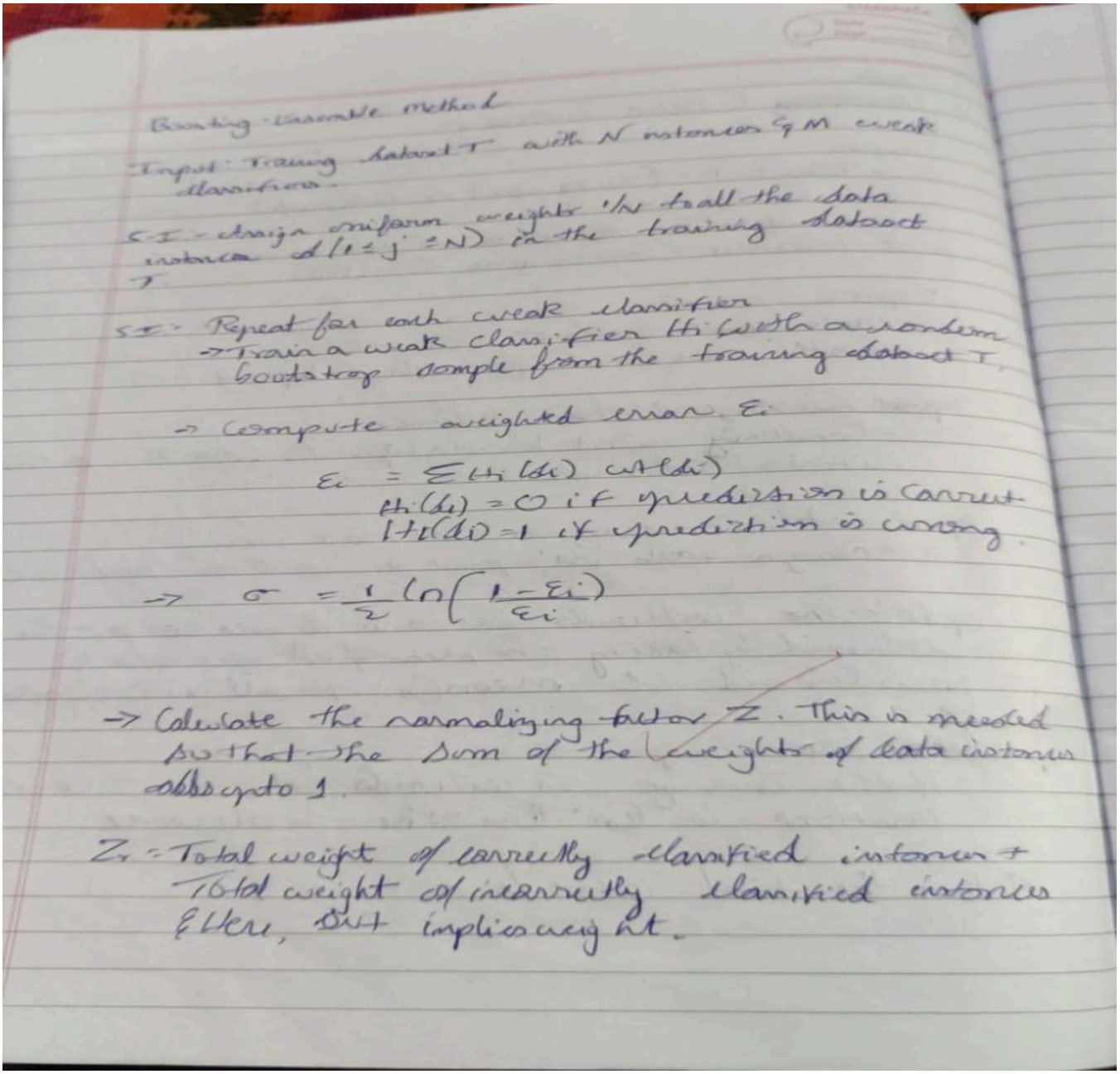
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.ensemble import RandomForestClassifier
from sklearn.model_selection import train_test_split
from sklearn.metrics import accuracy_score
from sklearn.preprocessing import LabelEncoder
from sklearn.metrics import confusion_matrix

iris_df = pd.read_csv("iris.csv")
X = iris_df.drop('species', axis=1)
y = iris_df['species']
le = LabelEncoder()
y_encoded = le.fit_transform(y)

X_train, X_test, y_train, y_test = train_test_split(X, y_encoded, test_size=0.3, random_state=42)
rf_model = RandomForestClassifier(n_estimators=10, random_state=42)
rf_model.fit(X_train, y_train)
y_pred = rf_model.predict(X_test)
print("Random Forest Accuracy with 10 trees:", accuracy_score(y_test, y_pred))

scores = []
n_range = range(1, 101)
best_model = None
best_preds = None

for n in n_range:
    model = RandomForestClassifier(n_estimators=n, random_state=42)
    model.fit(X_train, y_train)
    preds = model.predict(X_test)
```

```
    acc = accuracy_score(y_test, preds)
    scores.append(acc)
    if acc == max(scores):
        best_model = model
        best_preds = preds

best_score = max(scores)
best_n = n_range[scores.index(best_score)]
print(f"Best Random Forest Accuracy: {best_score:.4f} with {best_n} trees")

plt.figure(figsize=(10, 5))
plt.plot(n_range, scores, marker='o', linestyle='-', color='blue')
plt.title('Random Forest Accuracy vs Number of Trees (Iris Dataset)')
plt.xlabel('Number of Trees')
plt.ylabel('Accuracy')
plt.grid(True)
plt.show()

cm = confusion_matrix(y_test, best_preds)
plt.figure(figsize=(6, 5))
sns.heatmap(cm, annot=True, fmt='d', cmap='Blues', xticklabels=le.classes_, yticklabels=le.classes_)
plt.title(f"Confusion Matrix for Best Random Forest Model ({best_n} Trees)")
plt.xlabel("Predicted")
plt.ylabel("Actual")
plt.show()
```

Program 9

Implement Boosting ensemble method on a given dataset.

Screenshot:



Code:

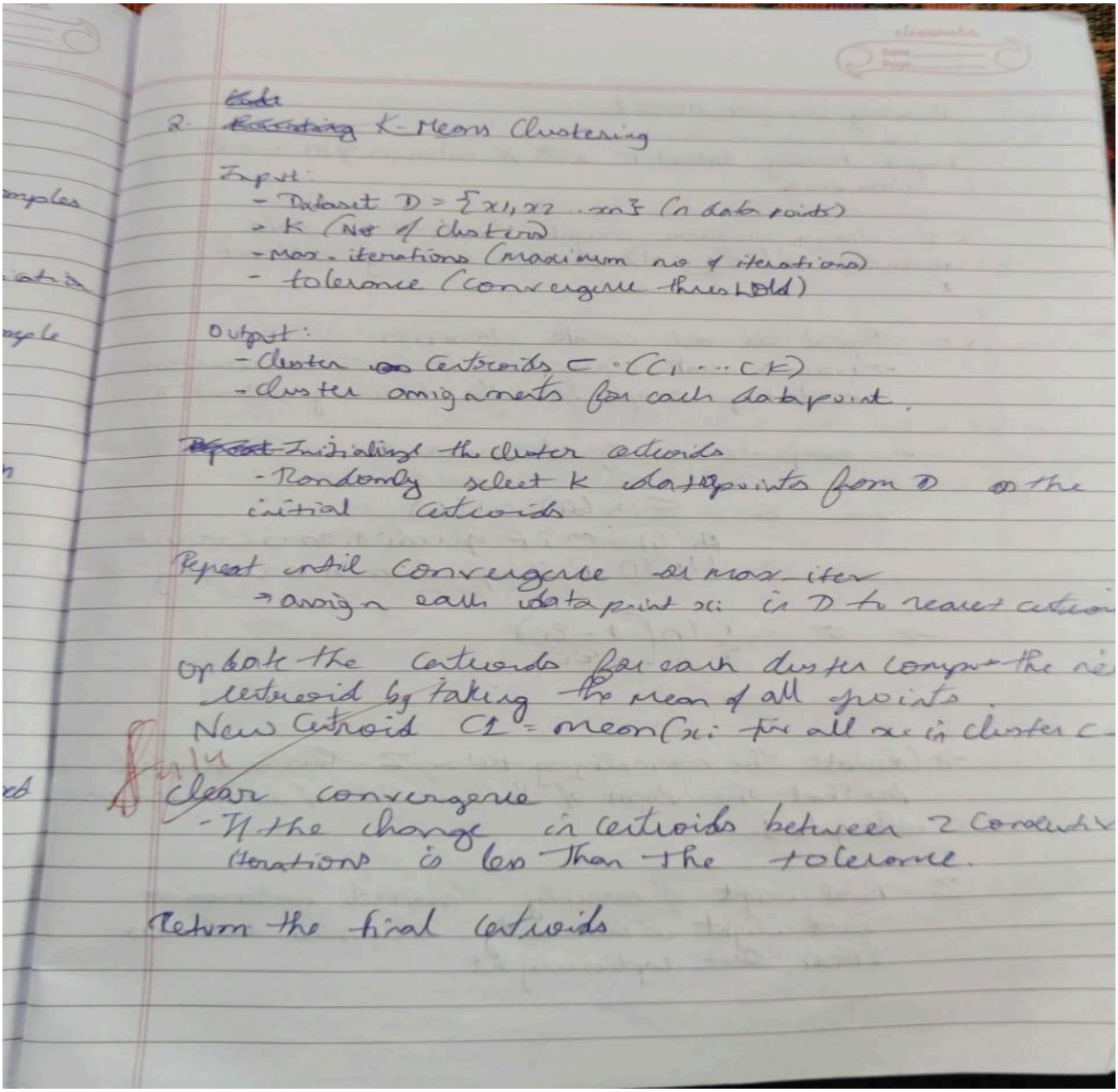
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.ensemble import AdaBoostClassifier
from sklearn.model_selection import train_test_split
from sklearn.metrics import accuracy_score
from sklearn.preprocessing import LabelEncoder
from sklearn.metrics import confusion_matrix

income_df = pd.read_csv("income.csv")
X_income = income_df.drop('income_level', axis=1)
y_income = income_df['income_level']
X_train_i, X_test_i, y_train_i, y_test_i = train_test_split(X_income, y_income, test_size=0.3,
random_state=42)

ada_model = AdaBoostClassifier(n_estimators=10, random_state=42)
ada_model.fit(X_train_i, y_train_i)
y_pred_i = ada_model.predict(X_test_i)
print("AdaBoost Accuracy with 10 estimators:", accuracy_score(y_test_i, y_pred_i))

scores_ada = []
n_range_ada = range(1, 51)
best_model_ada = None
best_preds_ada = None

for n in n_range_ada:
    model = AdaBoostClassifier(n_estimators=n, random_state=42)
    model.fit(X_train_i, y_train_i)
    preds = model.predict(X_test_i)
    acc = accuracy_score(y_test_i, preds)
```

```
    scores_ada.append(acc)
    if acc == max(scores_ada):
        best_model_ada = model
        best_preds_ada = preds

best_score_ada = max(scores_ada)
best_n_ada = n_range_ada[scores_ada.index(best_score_ada)]
print(f"Best AdaBoost Accuracy: {best_score_ada:.4f} with {best_n_ada} estimators")

plt.figure(figsize=(10, 5))
plt.plot(n_range_ada, scores_ada, marker='o', linestyle='-', color='orange')
plt.title('AdaBoost Accuracy vs Number of Estimators (Income Dataset)')
plt.xlabel('Number of Estimators')
plt.ylabel('Accuracy')
plt.grid(True)
plt.show()

cm_ada = confusion_matrix(y_test_i, best_preds_ada)
plt.figure(figsize=(6, 5))
sns.heatmap(cm_ada, annot=True, fmt='d', cmap='Oranges', xticklabels=[0, 1], yticklabels=[0, 1])
plt.title(f"Confusion Matrix for Best AdaBoost Model ({best_n_ada} Estimators)")
plt.xlabel("Predicted")
plt.ylabel("Actual")
plt.show()
```

Program 10

Build k-Means algorithm to cluster a set of data stored in a .CSV file.

Screenshot:



Code:

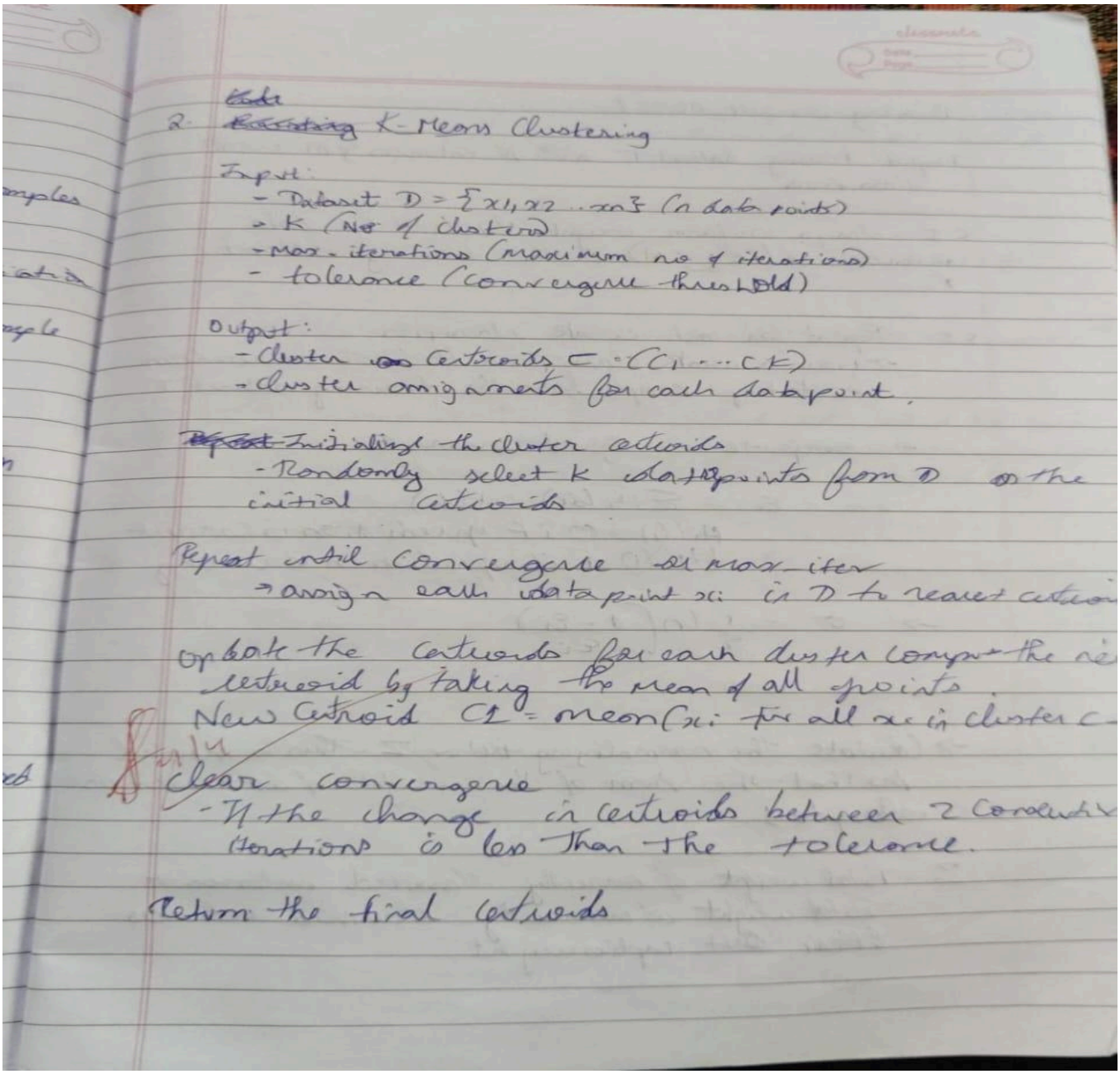
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
from sklearn.model_selection import train_test_split
from scipy import stats
import seaborn as sns
from sklearn.model_selection import train_test_split
from sklearn.metrics import accuracy_score
from sklearn.metrics import classification_report, confusion_matrix, accuracy_score
from sklearn.cluster import KMeans
from sklearn.preprocessing import StandardScaler

df1=pd.read_csv("iris.csv")
df1.head()
df = df1.drop(['sepal_length','sepal_width','species'],axis=1)
scaler = StandardScaler()
scaled_df = scaler.fit_transform(df)
wcss = []
for i in range(1, 11):
kmeans = KMeans(n_clusters=i, init='k-means++', max_iter=300, n_init=10, random_state=0)
kmeans.fit(scaled_df)
wcss.append(kmeans.inertia_)
plt.plot(range(1, 11), wcss)
plt.title('Elbow Method')
plt.xlabel('Number of clusters')
plt.ylabel('WCSS')
plt.show()

kmeans = KMeans(n_clusters=3, init='k-means++', max_iter=300, n_init=10, random_state=0)
pred_y = kmeans.fit_predict(scaled_df)
df['cluster'] = pred_y
```

```
plt.scatter(df['petal_length'], df['petal_width'], c=df['cluster'])
plt.title('Clusters of Iris Flowers')
plt.xlabel('Petal Length')
plt.ylabel('Petal Width')
plt.show()
```

Program 11

Implement Dimensionality reduction using Principal Component Analysis (PCA) method.

Screenshot:



Code:

```
from google.colab import files
heart=files.upload()
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
from sklearn.model_selection import train_test_split
from scipy import stats
import seaborn as sns
from sklearn.preprocessing import LabelEncoder, OneHotEncoder
from sklearn.model_selection import train_test_split
from sklearn.metrics import accuracy_score
from sklearn.metrics import classification_report, confusion_matrix, accuracy_score
from sklearn.preprocessing import StandardScaler
from sklearn.svm import SVC
from sklearn.linear_model import LogisticRegression
from sklearn.ensemble import RandomForestClassifier
from sklearn.decomposition import PCA

df1=pd.read_csv("heart.csv")
df1.head()
text_cols = df1.select_dtypes(include=['object']).columns
label_encoder = LabelEncoder()
for col in text_cols:
df1[col] = label_encoder.fit_transform(df1[col])
print(df1.head())
X = df1.drop('HeartDisease', axis=1)
y = df1['HeartDisease']
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)
scaler = StandardScaler()
X_train = scaler.fit_transform(X_train)
X_test = scaler.transform(X_test)
```

```
# Support Vector Machine
svm_model = SVC(kernel='linear', random_state=42)
svm_model.fit(X_train, y_train)
svm_predictions = svm_model.predict(X_test)
svm_accuracy = accuracy_score(y_test, svm_predictions)
print(f"SVM Accuracy: {svm_accuracy}")

# Logistic Regression
lr_model = LogisticRegression(random_state=42)
lr_model.fit(X_train, y_train)
lr_predictions = lr_model.predict(X_test)
lr_accuracy = accuracy_score(y_test, lr_predictions)
print(f"Logistic Regression Accuracy: {lr_accuracy}")

# Random Forest
rf_model = RandomForestClassifier(random_state=42)
rf_model.fit(X_train, y_train)
rf_predictions = rf_model.predict(X_test)
rf_accuracy = accuracy_score(y_test, rf_predictions)
print(f"Random Forest Accuracy: {rf_accuracy}")

models = {
"SVM": svm_accuracy,
"Logistic Regression": lr_accuracy,
"Random Forest": rf_accuracy}
best_model = max(models, key=models.get)
print(f"\nBest Model: {best_model} with accuracy {models[best_model]}")

pca = PCA(n_components=0.95)
X_train_pca = pca.fit_transform(X_train)
X_test_pca = pca.transform(X_test)
```

```
svm_model_pca = SVC(kernel='linear', random_state=42)
svm_model_pca.fit(X_train_pca, y_train)
svm_predictions_pca = svm_model_pca.predict(X_test_pca)
svm_accuracy_pca = accuracy_score(y_test, svm_predictions_pca)
print(f"SVM Accuracy (with PCA): {svm_accuracy_pca}")

lr_model_pca = LogisticRegression(random_state=42)
lr_model_pca.fit(X_train_pca, y_train)
lr_predictions_pca = lr_model_pca.predict(X_test_pca)
lr_accuracy_pca = accuracy_score(y_test, lr_predictions_pca)
print(f"Logistic Regression Accuracy (with PCA): {lr_accuracy_pca}")

rf_model_pca = RandomForestClassifier(random_state=42)
rf_model_pca.fit(X_train_pca, y_train)
rf_predictions_pca = rf_model_pca.predict(X_test_pca)
rf_accuracy_pca = accuracy_score(y_test, rf_predictions_pca)
print(f"Random Forest Accuracy (with PCA): {rf_accuracy_pca}")

models_pca = {
"SVM": svm_accuracy_pca,
"Logistic Regression": lr_accuracy_pca,
"Random Forest": rf_accuracy_pca}
best_model_pca = max(models_pca, key=models_pca.get)
print(f"\nBest Model (with PCA): {best_model_pca} with accuracy {models_pca[best_model_pca]}")
```