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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B.M.S. College of Engineering,
Bull Temple Road, Bangalore 560019
(Affiliated To Visvesvaraya Technological University, Belgaum)
Department of Computer Science and Engineering

CERTIFICATE

This is to certify that the Lab work entitled "Machine Learning (23CS6PCMAL)" carried out by **Abhishek Sharanappa Angadi (1BM22CS007),** who is 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.

Dr. Seema Patil Assistant Professor Department of CSE, BMSCE	Dr. Kavitha Sooda Professor & HOD Department of CSE, BMSCE

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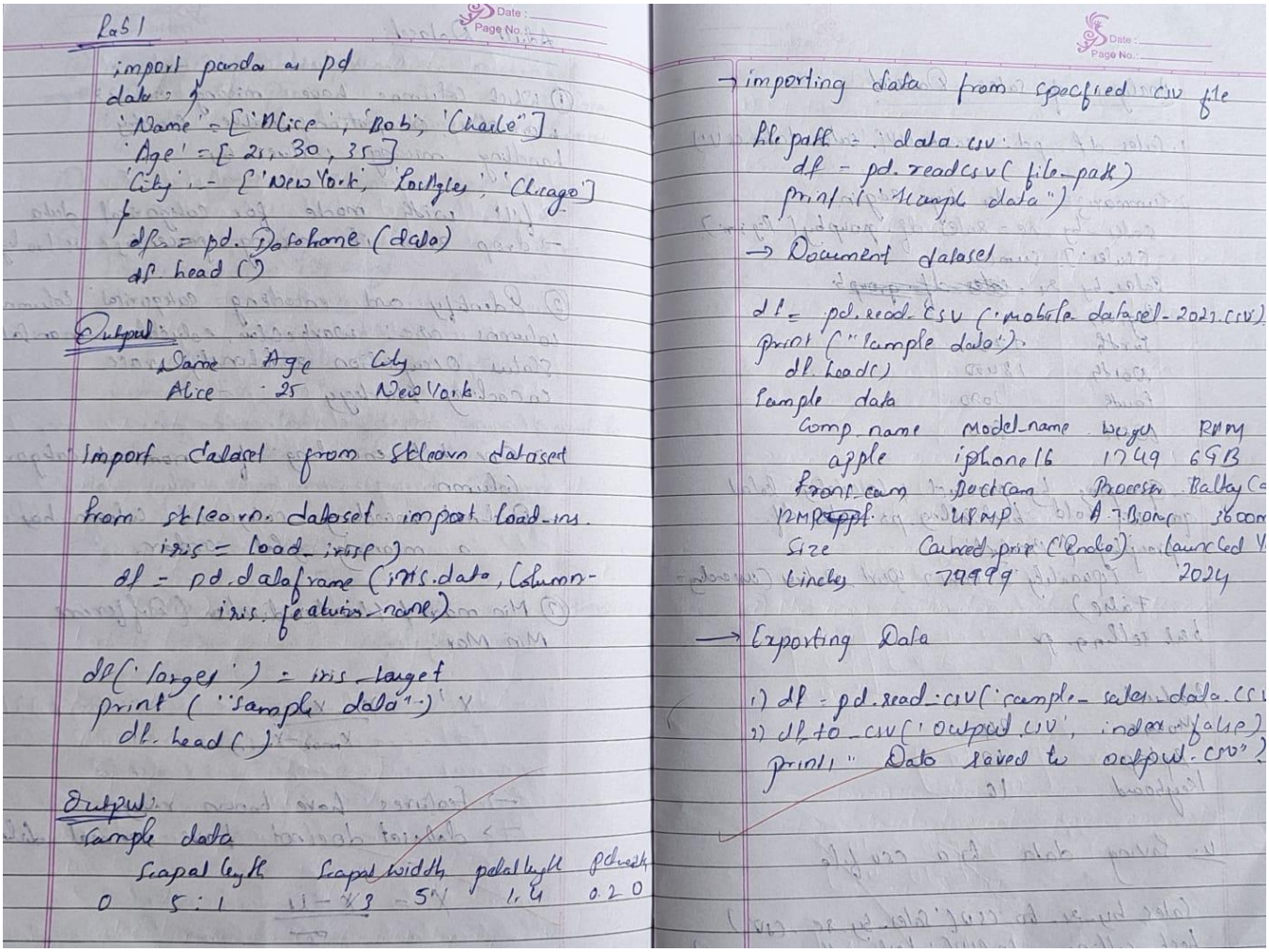
Github Link: https://github.com/Abbhi1234/6thSem-ML-Lab

Program 1

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



Analysis of Sales Dataset

1. `sales_df = pd.read_csv('sales_data.csv')`

2. Summarize sales by region
   `sales_by_re = sales_df.groupby('Region')['Sales'].sum()`
   `Sales_by_re =`

Region	
North	920
North	1840
South	1030
West	650

3. Grouping by product & calculating total quantity sold best selling_ps = sales_df.groupby('Product')['Quantity'].sum().sort_values(ascending=False)
   best selling_ps

Product	
Mouse	24
Laptop	17
Keyboard	16

4. Saving data to a csv file

   `Sales_by_re.to_csv('Sales_by_re.csv')`
   `best_selling_ps.to_csv('best_selling_ps.csv')`
   `print("In Results saved to csv file")`

Results saved to csv file.

Code:

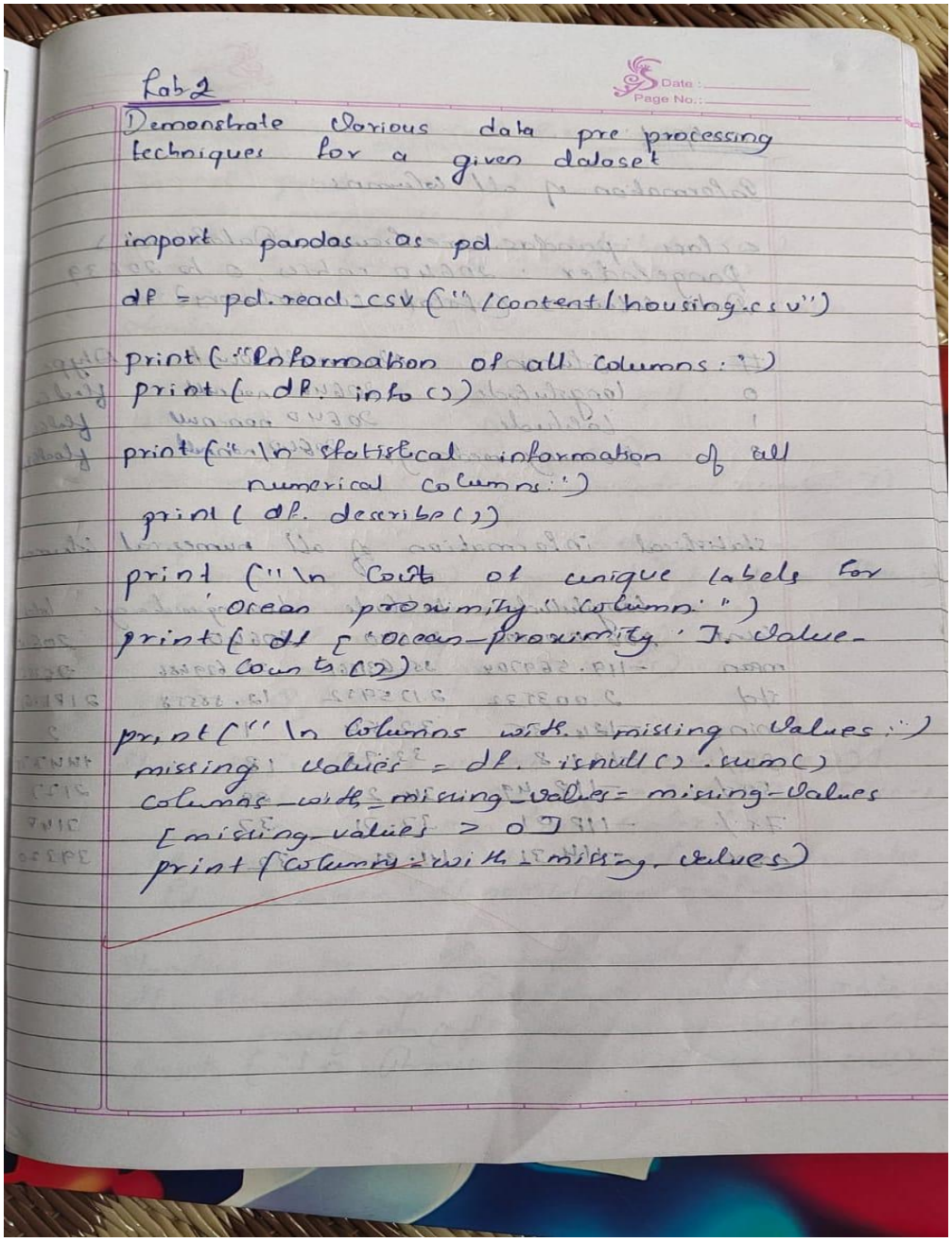
```
import yfinance as yf

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')

print("First 5 rows of the dataset:")

print(data.head())

print("\nShape of the dataset:")

print(data.shape)

print("\nColumn names:")

print(data.columns)

hdfc_data = data['HDFCBANK.NS']

print("\nSummary statistics for HDFC Bank:")

print(hdfc_data.describe())

hdfc_data['Daily Return'] = hdfc_data['Close'].pct_change()

icici_data = data['ICICIBANK.NS']

print("\nSummary statistics for ICICI Bank:")

print(icici_data.describe())

icici_data['Daily Return'] = icici_data['Close'].pct_change()

kotak_data = data['KOTAKBANK.NS']

print("\nSummary statistics for Kotak Mahindra Bank:")

print(kotak_data.describe())
```

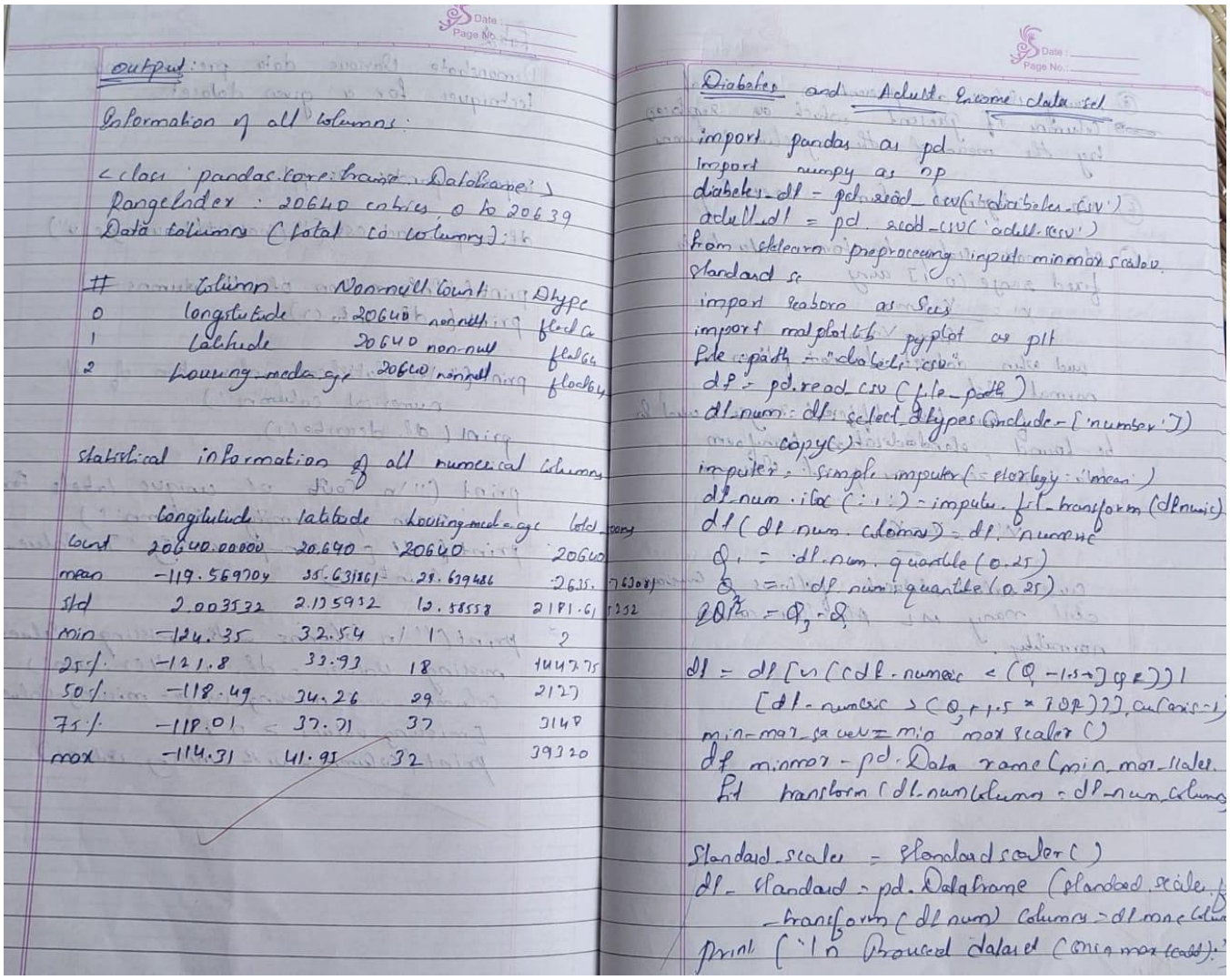
```
kotak_data['Daily Return'] = kotak_data['Close'].pct_change()

plt.figure(figsize=(14, 10))

plt.subplot(3, 2, 1)

hdfc_data['Close'].plot(title="HDFC Bank - Closing Price")

plt.subplot(3, 2, 2)

hdfc_data['Daily Return'].plot(title="HDFC Bank - Daily Returns", color='orange')

plt.subplot(3, 2, 3)

icici_data['Close'].plot(title="ICICI Bank - Closing Price")

plt.subplot(3, 2, 4)

icici_data['Daily Return'].plot(title="ICICI Bank - Daily Returns", color='orange')

plt.subplot(3, 2, 5)

kotak_data['Close'].plot(title="Kotak Mahindra Bank - Closing Price")

plt.subplot(3, 2, 6)

kotak_data['Daily Return'].plot(title="Kotak Mahindra Bank - Daily Returns", color='orange')

plt.tight_layout()

plt.show()


hdfc_data.to_csv('hdfc_bank_data.csv')

icici_data.to_csv('icici_bank_data.csv')

kotak_data.to_csv('kotak_bank_data.csv')


print("\nHDFC Bank data saved to 'hdfc_bank_data.csv'.")

print("ICICI Bank data saved to 'icici_bank_data.csv'.")

print("Kotak Bank data saved to 'kotak_bank_data.csv'.")
```

Program 2

Demonstrate various data pre-processing techniques for a given dataset

Screenshot





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
from sklearn.preprocessing import LabelEncoder
import seaborn as sns
import matplotlib.pyplot as plt

diabetes_data = pd.read_csv('/content/Dataset of Diabetes .csv')
adult_income_data = pd.read_csv('/content/adult.csv')

print("Diabetes Dataset:")
print(diabetes_data.head())
```

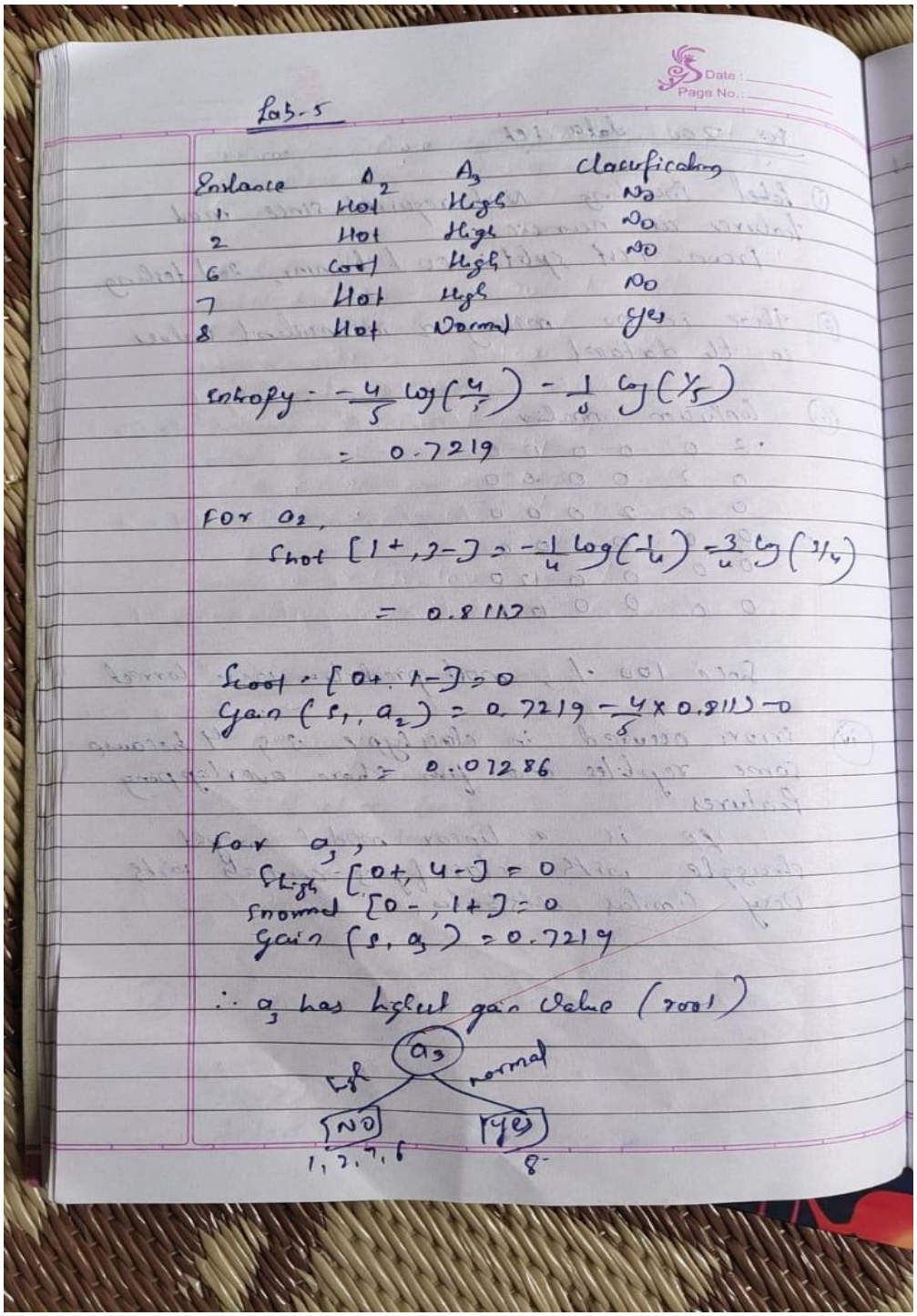
```
print("\nAdult Income Dataset:")
print(adult_income_data.head())

diabetes_numerical_cols = diabetes_data.select_dtypes(include=[np.number]).columns
diabetes_categorical_cols = diabetes_data.select_dtypes(include=[object]).columns

diabetes_imputer_num = SimpleImputer(strategy='median')
diabetes_data[diabetes_numerical_cols] =
diabetes_imputer_num.fit_transform(diabetes_data[diabetes_numerical_cols])

diabetes_imputer_cat = SimpleImputer(strategy='most_frequent')
diabetes_data[diabetes_categorical_cols] =
diabetes_imputer_cat.fit_transform(diabetes_data[diabetes_categorical_cols])

adult_income_numerical_cols = adult_income_data.select_dtypes(include=[np.number]).columns
adult_income_categorical_cols = adult_income_data.select_dtypes(include=[object]).columns

adult_income_imputer_num = SimpleImputer(strategy='median')
adult_income_data[adult_income_numerical_cols] =
adult_income_imputer_num.fit_transform(adult_income_data[adult_income_numerical_cols])

adult_income_imputer_cat = SimpleImputer(strategy='most_frequent')
adult_income_data[adult_income_categorical_cols] =
adult_income_imputer_cat.fit_transform(adult_income_data[adult_income_categorical_cols])

categorical_columns_adult = adult_income_data.select_dtypes(include=['object']).columns
label_encoder = LabelEncoder()

for col in categorical_columns_adult:
    adult_income_data[col] = label_encoder.fit_transform(adult_income_data[col])

def detect_and_remove_outliers(df):
    numerical_df = df.select_dtypes(include=[np.number])
    Q1 = numerical_df.quantile(0.25)
    Q3 = numerical_df.quantile(0.75)
    IQR = Q3 - Q1
    return df[~((numerical_df < (Q1 - 1.5 * IQR)) | (numerical_df > (Q3 + 1.5 * IQR))).any(axis=1)]

diabetes_data_cleaned = detect_and_remove_outliers(diabetes_data)
adult_income_data_cleaned = detect_and_remove_outliers(adult_income_data)

min_max_scaler = MinMaxScaler()

diabetes_numerical_cols = diabetes_data_cleaned.select_dtypes(include=[np.number]).columns
diabetes_data_normalized = diabetes_data_cleaned.copy()

diabetes_data_normalized[diabetes_numerical_cols] =
```

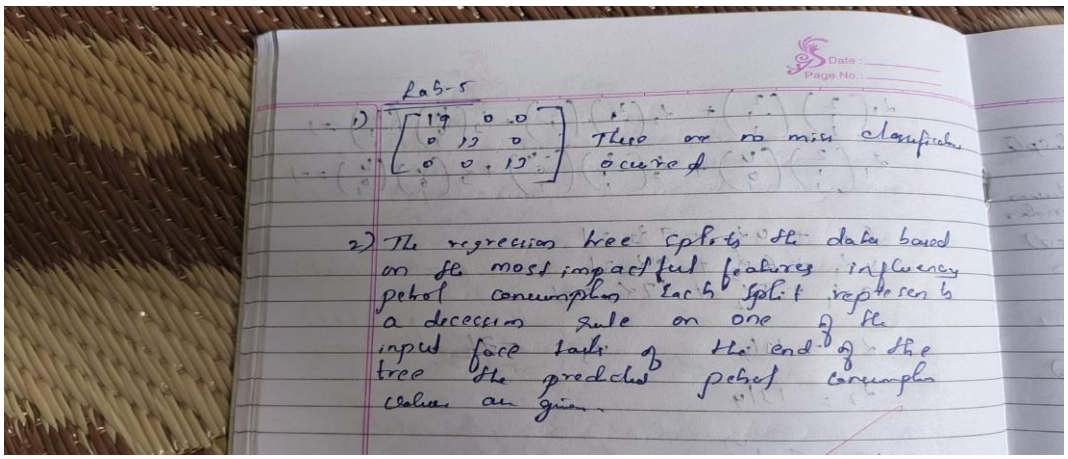
```
min_max_scaler.fit_transform(diabetes_data_cleaned[diabetes_numerical_cols])

adult_income_numerical_cols =
adult_income_data_cleaned.select_dtypes(include=[np.number]).columns
adult_income_data_normalized = adult_income_data_cleaned.copy()

adult_income_data_normalized[adult_income_numerical_cols] =
min_max_scaler.fit_transform(adult_income_data_cleaned[adult_income_numerical_cols])

standard_scaler = StandardScaler()

diabetes_data_standardized = diabetes_data_cleaned.copy()
diabetes_data_standardized[diabetes_numerical_cols] =
standard_scaler.fit_transform(diabetes_data_cleaned[diabetes_numerical_cols])

adult_income_data_standardized = adult_income_data_cleaned.copy()
adult_income_data_standardized[adult_income_numerical_cols] =
standard_scaler.fit_transform(adult_income_data_cleaned[adult_income_numerical_cols])
```

Program 3

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

Screenshot:





Code:

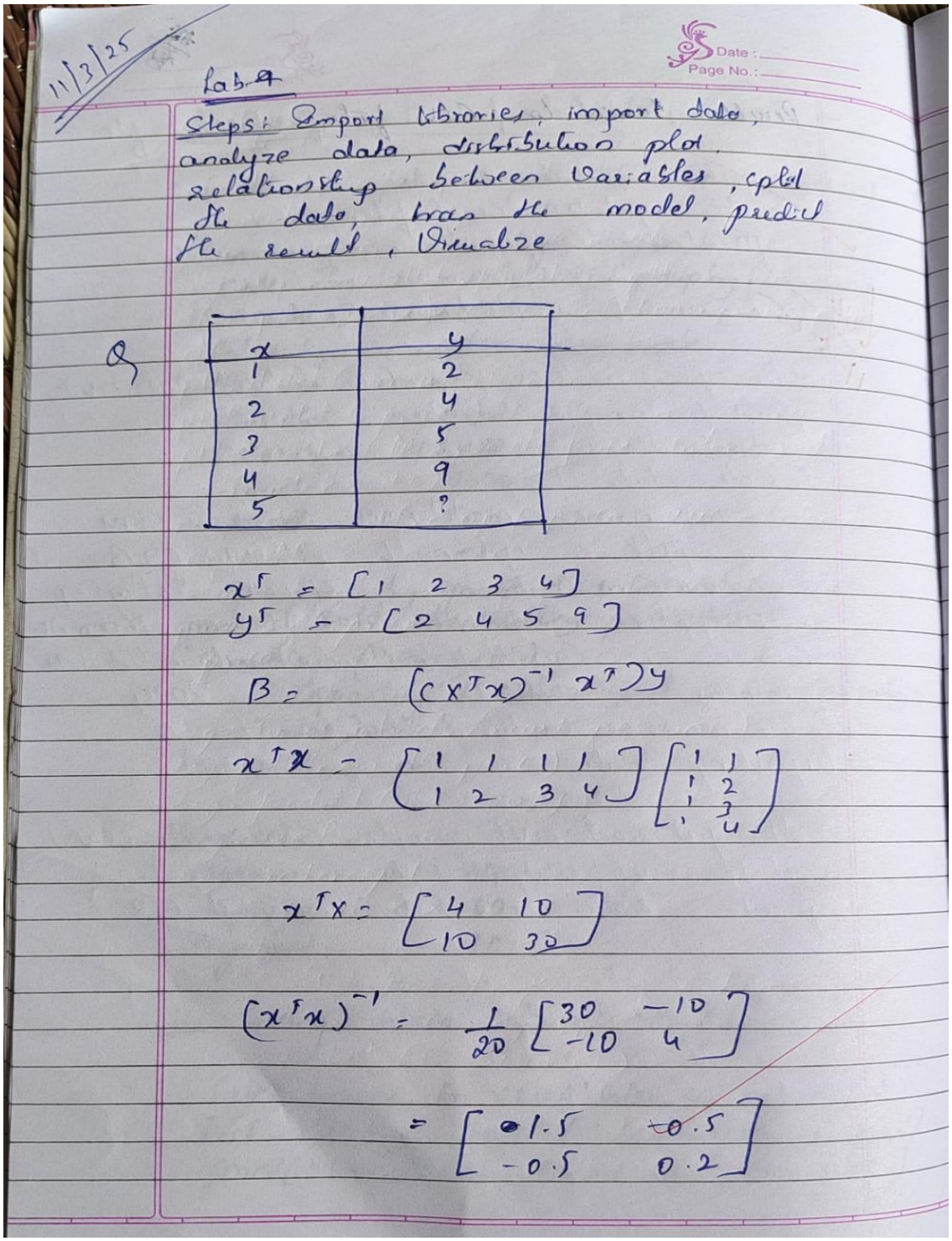
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
from sklearn.model_selection import train_test_split
from sklearn.tree import DecisionTreeClassifier, DecisionTreeRegressor, plot_tree
from sklearn.metrics import accuracy_score, confusion_matrix, classification_report,
mean_absolute_error, mean_squared_error
from sklearn.preprocessing import LabelEncoder

iris = pd.read_csv("/content/iris (4).csv")
drug = pd.read_csv("/content/drug.csv")
petrol = pd.read_csv("/content/petrol_consumption.csv")

X_iris = iris.iloc[:, :-1]
y_iris = iris.iloc[:, -1]
X_train, X_test, y_train, y_test = train_test_split(X_iris, y_iris, test_size=0.2, random_state=42)

dtc = DecisionTreeClassifier()
dtc.fit(X_train, y_train)
y_pred = dtc.predict(X_test)

print("Decision Tree Classification for IRIS Dataset:")
print("Accuracy:", accuracy_score(y_test, y_pred))
print("Confusion Matrix:\n", confusion_matrix(y_test, y_pred))
print("Classification Report:\n", classification_report(y_test, y_pred))

X_drug = drug.iloc[:, :-1]
y_drug = drug.iloc[:, -1]

le = LabelEncoder()
```

```
for col in X_drug.select_dtypes(include=['object']).columns:
    X_drug[col] = le.fit_transform(X_drug[col])

X_train, X_test, y_train, y_test = train_test_split(X_drug, y_drug, test_size=0.2, random_state=42)

dtc = DecisionTreeClassifier()
dtc.fit(X_train, y_train)
y_pred = dtc.predict(X_test)

print("\nDecision Tree Classification for Drug Dataset:")
print("Accuracy:", accuracy_score(y_test, y_pred))
print("Confusion Matrix:\n", confusion_matrix(y_test, y_pred))
print("Classification Report:\n", classification_report(y_test, y_pred))

X_petrol = petrol.iloc[:, :-1]
y_petrol = petrol.iloc[:, -1]
X_train, X_test, y_train, y_test = train_test_split(X_petrol, y_petrol, test_size=0.2, random_state=42)

dtr = DecisionTreeRegressor()
dtr.fit(X_train, y_train)
y_pred = dtr.predict(X_test)

print("\nDecision Tree Regression for Petrol Consumption:")
print("Mean Absolute Error:", mean_absolute_error(y_test, y_pred))
print("Mean Squared Error:", mean_squared_error(y_test, y_pred))
print("Root Mean Squared Error:", np.sqrt(mean_squared_error(y_test, y_pred)))
```

Program 4

Implement Linear and Multi-Linear Regression algorithm using appropriate dataset

Screenshot



$$(X^T X)^{-1} X^T = \begin{bmatrix} 1.5 & -0.5 \\ -0.5 & 0.2 \end{bmatrix} \begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & 2 & 3 & 4 \end{bmatrix}$$

$$= \begin{bmatrix} 1 & 0.5 & 0 & -0.5 \\ -0.3 & -0.1 & 0.1 & 0.3 \end{bmatrix}$$

$$\left((X^T X)^{-1} X^T\right) y = \begin{bmatrix} 1 & 0.5 & 0 & -0.5 \\ -0.3 & -0.1 & 0.1 & 0.3 \end{bmatrix} \begin{bmatrix} 2 \\ 4 \\ 5 \\ 9 \end{bmatrix}$$

$$\Rightarrow \begin{bmatrix} -0.5 \\ 2.2 \end{bmatrix} \longrightarrow \begin{bmatrix} \text{Intercept} \\ \text{slope} \end{bmatrix}$$

$$y = \beta_0 + \beta_1 X + e \qquad [x \cdot 5]_{cf}$$

$$y = (-0.5) + (2.2)(5) + e$$

$$y = -0.5 + 11 + e$$

$$y = 10.5 + e \;//$$

Code:

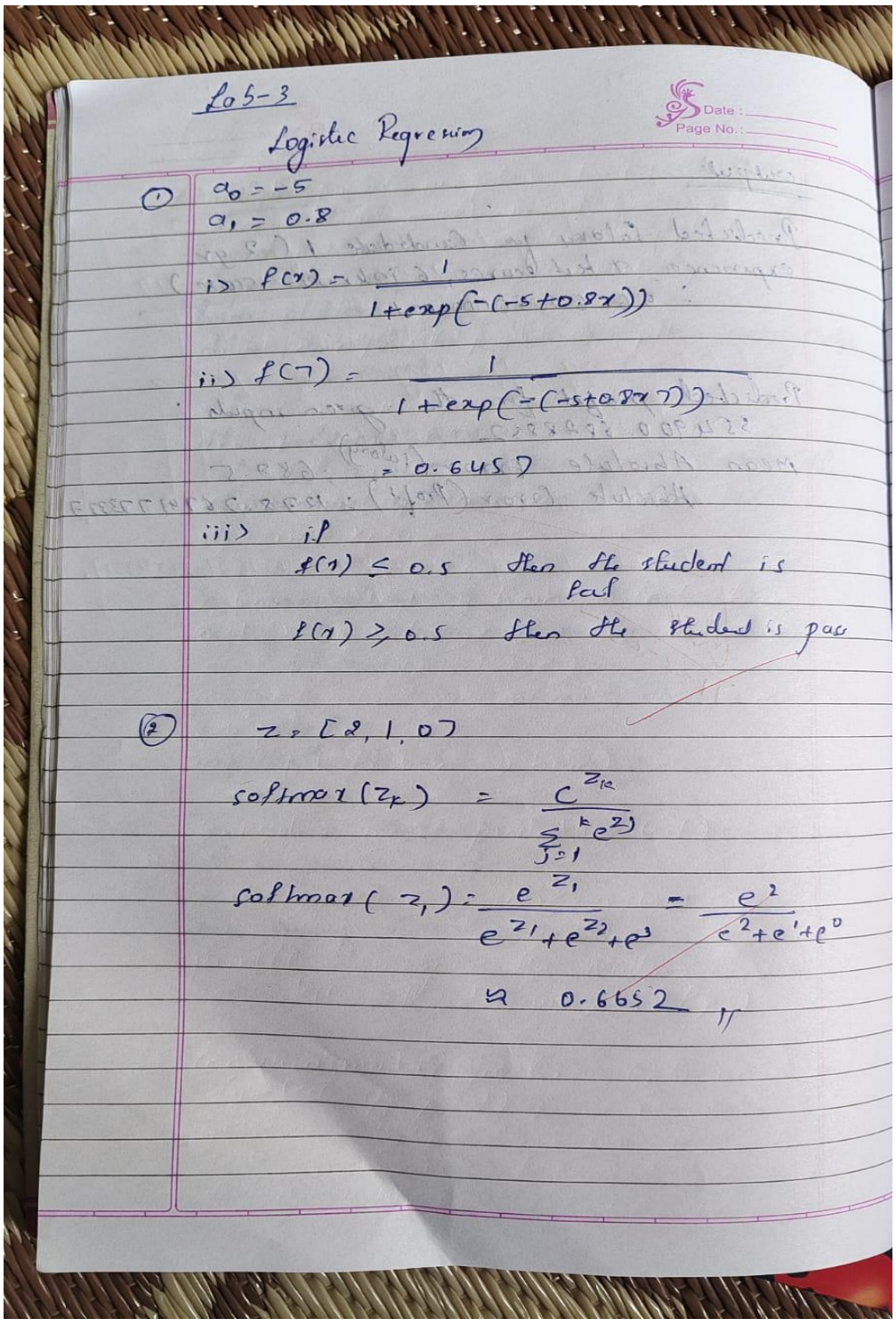
```
import pandas as pd
import numpy as np
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LinearRegression
from sklearn.preprocessing import LabelEncoder
from sklearn.metrics import mean_absolute_error
import matplotlib.pyplot as plt

hiring_data = pd.read_csv('hiring.csv')
print(hiring_data.head())
hiring_data = hiring_data.dropna()

experience_mapping = {
    '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,
}

hiring_data['experience'] = hiring_data['experience'].replace(experience_mapping)
hiring_data['experience'] = pd.to_numeric(hiring_data['experience'], errors='coerce')

if hiring_data['experience'].isnull().any():
    print("Warning: There are still non-numeric values in the 'experience' column.")
    hiring_data = hiring_data.dropna(subset=['experience'])

X_hiring = hiring_data[['experience', 'test_score(out of 10)', 'interview_score(out of 10)']]
y_hiring = hiring_data['salary($)']

X_train_hiring, X_test_hiring, y_train_hiring, y_test_hiring = train_test_split(X_hiring, y_hiring,
test_size=0.2, random_state=42)

regressor_hiring = LinearRegression()
regressor_hiring.fit(X_train_hiring, y_train_hiring)

candidate_1 = np.array([[2, 9, 6]])
candidate_2 = np.array([[12, 10, 10]])

salary_1 = regressor_hiring.predict(candidate_1)
salary_2 = regressor_hiring.predict(candidate_2)

print(f"Predicted salary for candidate 1 (2 yr experience, 9 test score, 6 interview score):
{salary_1[0]}")
print(f"Predicted salary for candidate 2 (12 yr experience, 10 test score, 10 interview score):
{salary_2[0]}")
```

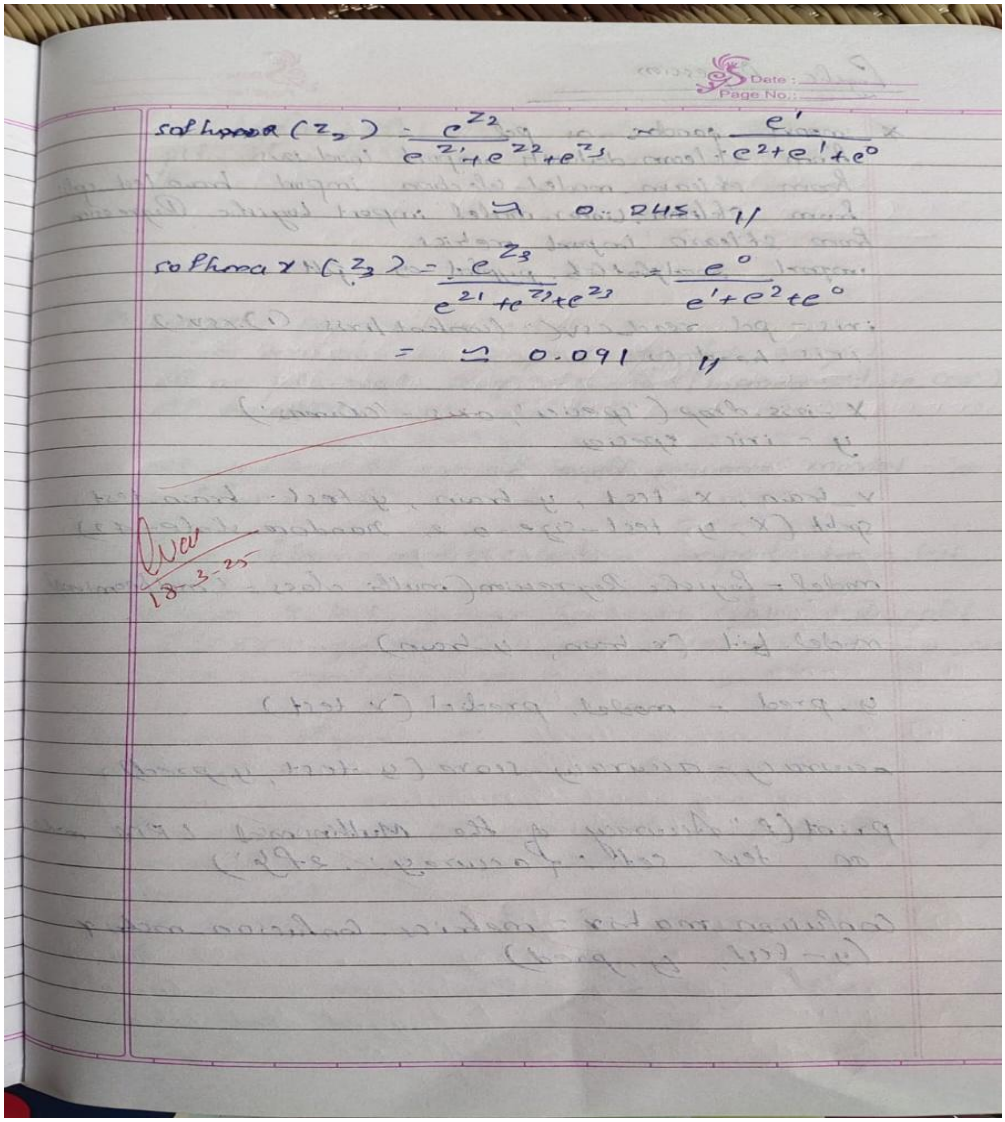
```
companies_data = pd.read_csv('/content/1000_Companies.csv')
print(companies_data.head())
companies_data = companies_data.dropna()

label_encoder = LabelEncoder()
companies_data['State'] = label_encoder.fit_transform(companies_data['State'])

X_companies = companies_data[['R&D Spend', 'Administration', 'Marketing Spend', 'State']]
y_companies = companies_data['Profit']

X_train_companies, X_test_companies, y_train_companies, y_test_companies =
train_test_split(X_companies, y_companies, test_size=0.2, random_state=42)

regressor_companies = LinearRegression()
regressor_companies.fit(X_train_companies, y_train_companies)

input_data = np.array([[91694.48, 515841.3, 11931.24, label_encoder.transform(['Florida'])[0]]])
predicted_profit = regressor_companies.predict(input_data)

print(f"Predicted profit for the given inputs (Florida State): {predicted_profit[0]}")

y_pred_hiring = regressor_hiring.predict(X_test_hiring)
mae_hiring = mean_absolute_error(y_test_hiring, y_pred_hiring)
print(f"Mean Absolute Error for Salary Prediction: {mae_hiring}")

y_pred_companies = regressor_companies.predict(X_test_companies)
mae_companies = mean_absolute_error(y_test_companies, y_pred_companies)
print(f"Mean Absolute Error for Profit Prediction: {mae_companies}")
```

Program 5

Build Logistic Regression Model for a given dataset

Screenshot





Code:

```
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.preprocessing import StandardScaler
from sklearn.linear_model import LogisticRegression
from sklearn.metrics import accuracy_score, confusion_matrix

file_path = 'HR_comma_sep.csv'
```

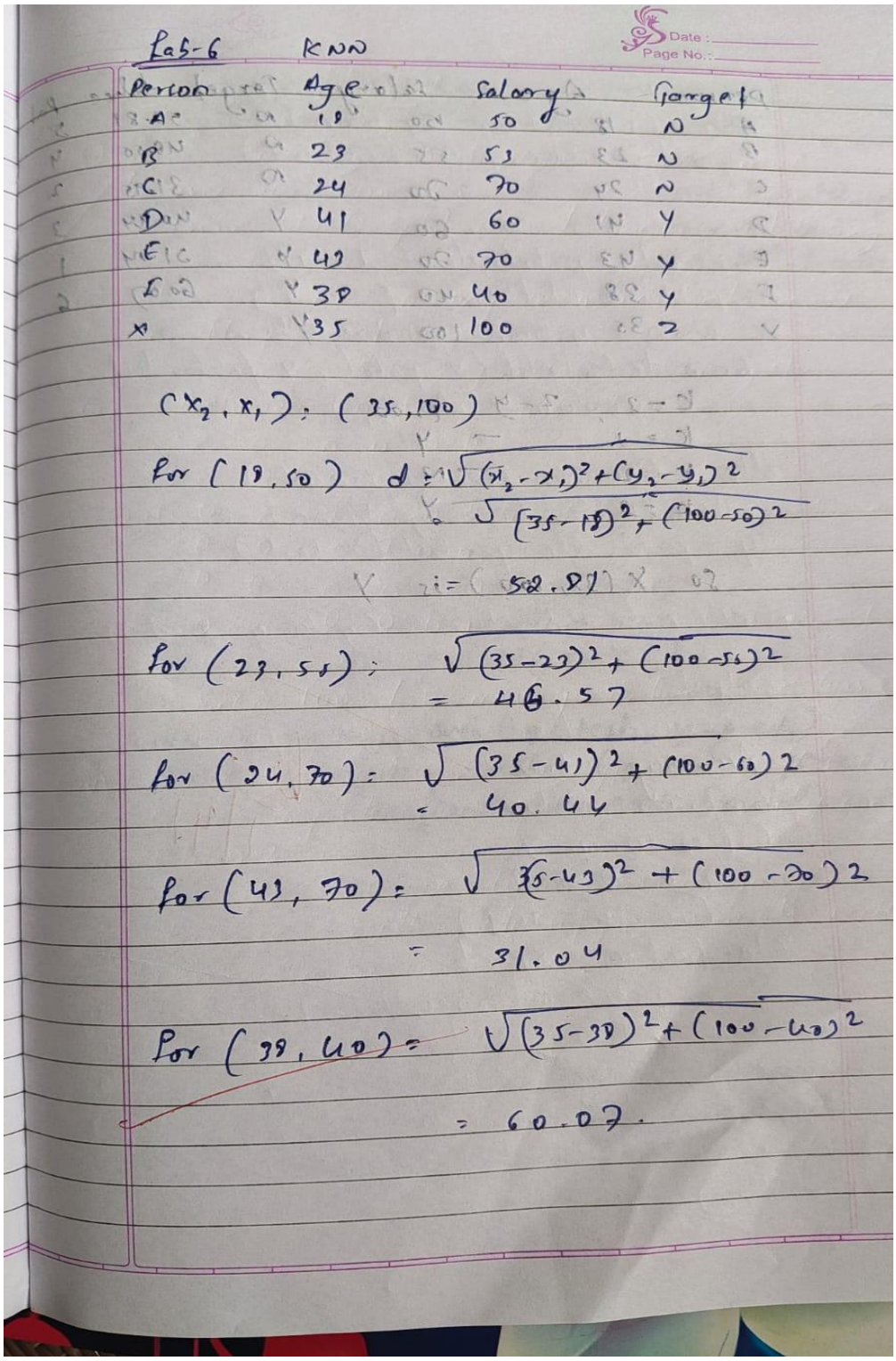
```
data = pd.read_csv(file_path)

print(data.info())

print(data.head())

print(data.describe())

plt.figure(figsize=(8, 5))
sns.countplot(x='salary', hue='left', data=data)
plt.title('Impact of Salary on Employee Retention')
plt.xlabel('Salary')
plt.ylabel('Count')
plt.legend(title='Employee Retention', labels=['Stayed', 'Left'])
plt.show()

plt.figure(figsize=(10, 6))
sns.countplot(x='Department', hue='left', data=data)
plt.title('Impact of Department on Employee Retention')
plt.xlabel('Department')
plt.ylabel('Count')
plt.legend(title='Employee Retention', labels=['Stayed', 'Left'])
plt.xticks(rotation=45)
plt.show()

data_encoded = pd.get_dummies(data, columns=['salary', 'Department'], drop_first=True)

print(data_encoded.info())

X = data_encoded.drop('left', axis=1)
y = data_encoded['left']

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

scaler = StandardScaler()
X_train_scaled = scaler.fit_transform(X_train)
X_test_scaled = scaler.transform(X_test)

logreg = LogisticRegression(max_iter=1000)

logreg.fit(X_train_scaled, y_train)

y_pred = logreg.predict(X_test_scaled)

accuracy = accuracy_score(y_test, y_pred)
print(f"Accuracy of the Logistic Regression Model: {accuracy * 100:.2f}%")

cm = confusion_matrix(y_test, y_pred)
```

```
plt.figure(figsize=(6, 5))
sns.heatmap(cm, annot=True, fmt='d', cmap='Blues', cbar=False, xticklabels=['Stayed', 'Left'],
yticklabels=['Stayed', 'Left'])
plt.title('Confusion Matrix')
plt.xlabel('Predicted')
plt.ylabel('Actual')
plt.show()
```

Program 6

Build KNN Classification model for a given dataset.

Screenshot



Person	Age	Salary	Target	dist	Rel
A	18	50	N	52.81	5
B	23	55	N	48.55	4
C	24	70	N	31.95	2
D	41	60	Y	40.44	3
E	43	70	Y	31.04	1
F	38	40	Y	60.07	6
X	35	100	Y		

K = 3, 2 - Y

K = 1 — Y

K = 2 — N

K = 3 — Y

So X (35, 100) is Y

Code:

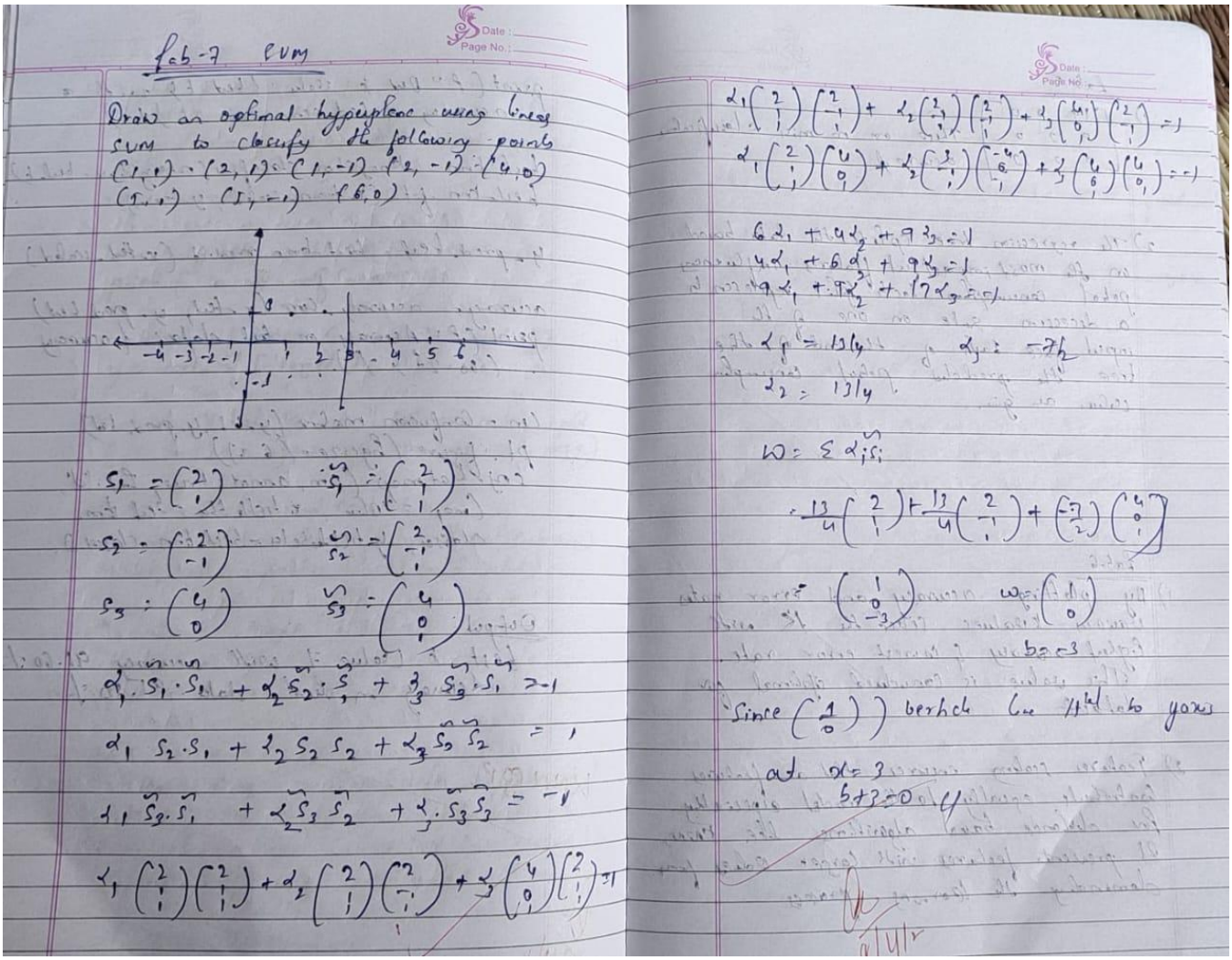
```
import pandas as pd
import numpy as np
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler
from sklearn.neighbors import KNeighborsClassifier
from sklearn.metrics import accuracy_score, confusion_matrix, classification_report
import matplotlib.pyplot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

iris_df = pd.read_csv('/content/iris (3).csv')

print(iris_df.head())

X_iris = iris_df.drop(columns=['species'])
y_iris = iris_df['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)

knn_iris = KNeighborsClassifier(n_neighbors=3)

knn_iris.fit(X_train_iris, y_train_iris)

y_pred_iris = knn_iris.predict(X_test_iris)

accuracy_iris = accuracy_score(y_test_iris, y_pred_iris)
print(f"Accuracy on Iris test data: {accuracy_iris * 100:.2f}%")

cm_iris = confusion_matrix(y_test_iris, y_pred_iris)
sns.heatmap(cm_iris, annot=True, fmt="d", cmap="Blues", xticklabels=knn_iris.classes_,
yticklabels=knn_iris.classes_)
plt.title("Confusion Matrix for Iris Dataset")
plt.xlabel('Predicted')
plt.ylabel('True')
plt.show()

print("Classification Report for Iris Dataset:")
print(classification_report(y_test_iris, y_pred_iris))

diabetes_df = pd.read_csv('diabetes.csv')
print(diabetes_df.head())
```

```
X_diabetes = diabetes_df.drop(columns=['Outcome'])
y_diabetes = diabetes_df['Outcome']

X_train_diabetes, X_test_diabetes, y_train_diabetes, y_test_diabetes = train_test_split(X_diabetes,
y_diabetes, test_size=0.2, random_state=42)

scaler = StandardScaler()
X_train_diabetes = scaler.fit_transform(X_train_diabetes)
X_test_diabetes = scaler.transform(X_test_diabetes)

knn_diabetes = KNeighborsClassifier(n_neighbors=5)

knn_diabetes.fit(X_train_diabetes, y_train_diabetes)

y_pred_diabetes = knn_diabetes.predict(X_test_diabetes)

accuracy_diabetes = accuracy_score(y_test_diabetes, y_pred_diabetes)
print(f"Accuracy on Diabetes test data: {accuracy_diabetes * 100:.2f}%")

cm_diabetes = confusion_matrix(y_test_diabetes, y_pred_diabetes)
sns.heatmap(cm_diabetes, annot=True, fmt="d", cmap="Blues", xticklabels=knn_diabetes.classes_,
yticklabels=knn_diabetes.classes_)
plt.title("Confusion Matrix for Diabetes Dataset")
plt.xlabel('Predicted')
plt.ylabel('True')
plt.show()

print("Classification Report for Diabetes Dataset:")
print(classification_report(y_test_diabetes, y_pred_diabetes))
```

Program 7

Build Support vector machine model for a given dataset

Screenshot



Code:

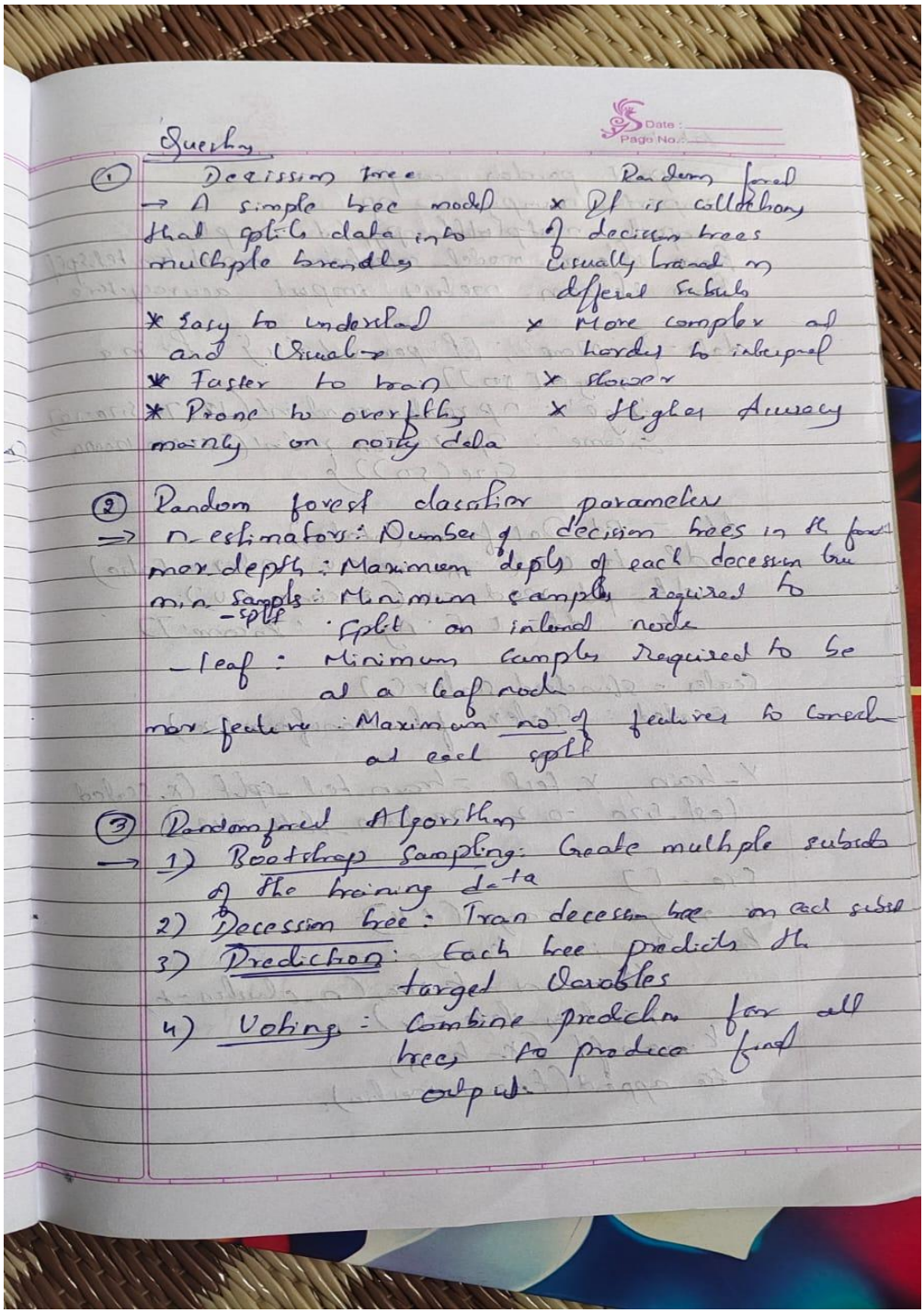
```
import pandas as pd
from sklearn.model_selection import train_test_split
from sklearn.svm import SVC
from sklearn.metrics import accuracy_score, confusion_matrix, roc_auc_score, roc_curve
from sklearn.preprocessing import LabelEncoder, label_binarize
import matplotlib.pyplot as plt
import numpy as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

```
import seaborn as sns

df = pd.read_csv("/content/letter-recognition.csv")

top_classes = df['letter'].value_counts().head(5).index.tolist()
df = df[df['letter'].isin(top_classes)]

X = df.iloc[:, 1:]
y = df.iloc[:, 0]

label_encoder = LabelEncoder()
y_encoded = label_encoder.fit_transform(y)

y_bin = label_binarize(y_encoded, classes=np.unique(y_encoded))
n_classes = y_bin.shape[1]

X_train, X_test, y_train, y_test_bin = train_test_split(X, y_bin, test_size=0.2, random_state=42)

svm_model = SVC(kernel='linear', probability=True)
svm_model.fit(X_train, y_train.argmax(axis=1))
y_score = svm_model.predict_proba(X_test)

y_pred = svm_model.predict(X_test)
y_true = y_test_bin.argmax(axis=1)

print("Accuracy:", accuracy_score(y_true, y_pred))
print("Confusion Matrix:\n", confusion_matrix(y_true, y_pred))

plt.figure()
for i in range(n_classes):
    fpr, tpr, _ = roc_curve(y_test_bin[:, i], y_score[:, i])
    auc = roc_auc_score(y_test_bin[:, i], y_score[:, i])
    plt.plot(fpr, tpr, label=f"{label_encoder.inverse_transform([i])[0]} AUC={auc:.2f}")
plt.plot([0, 1], [0, 1], 'k--')
plt.title("ROC Curve (Top 5 Classes)")
plt.xlabel("False Positive Rate")
plt.ylabel("True Positive Rate")
plt.legend(loc="lower right")
plt.tight_layout()
plt.show()

macro_auc = roc_auc_score(y_test_bin, y_score, average="macro")
print("Macro AUC Score:", macro_auc)
```

Program 8

Implement Random forest ensemble method on a given dataset.

Screenshot



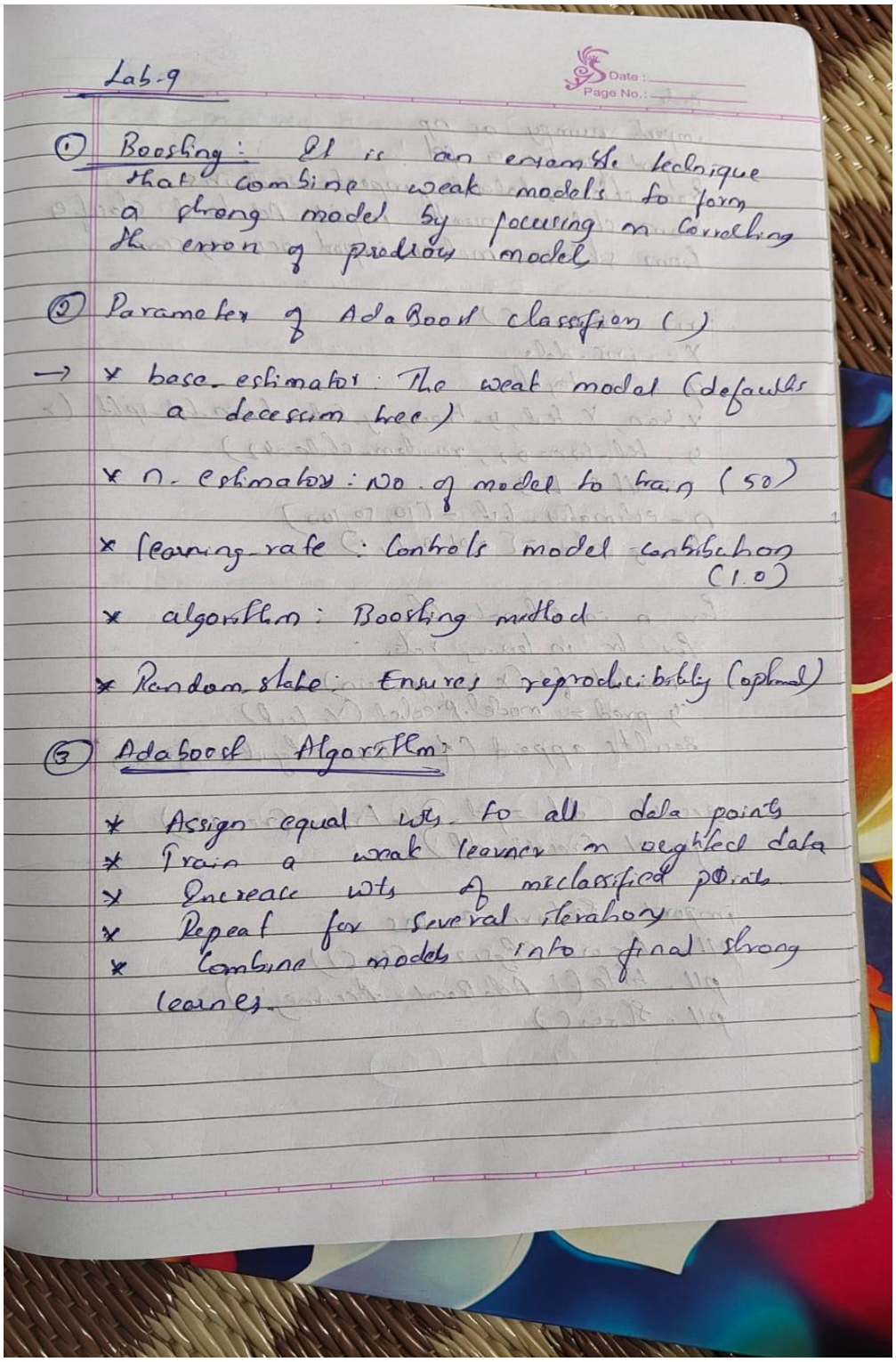
Code:

```
import pandas as pd
from sklearn.model_selection import train_test_split
from sklearn.ensemble import RandomForestClassifier
from sklearn.metrics import accuracy_score, confusion_matrix
from sklearn import preprocessing

df = pd.read_csv('/content/train.csv')

X = df.iloc[:, :-1]
y = df.iloc[:, -1]

for column in X.columns:
    if X[column].dtype == 'object':
      le = preprocessing.LabelEncoder()
      X[column] = le.fit_transform(X[column])

if y.dtype == 'object':
  le = preprocessing.LabelEncoder()
  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)

rf_classifier = RandomForestClassifier(random_state=42)
rf_classifier.fit(X_train, y_train)

y_pred = rf_classifier.predict(X_test)

accuracy = accuracy_score(y_test, y_pred)
conf_matrix = confusion_matrix(y_test, y_pred)

print(f"Accuracy: {accuracy}")
print(f"Confusion Matrix:\n{conf_matrix}")
```

Program 9

Implement Boosting ensemble method on a given dataset.

Screenshot



Code:

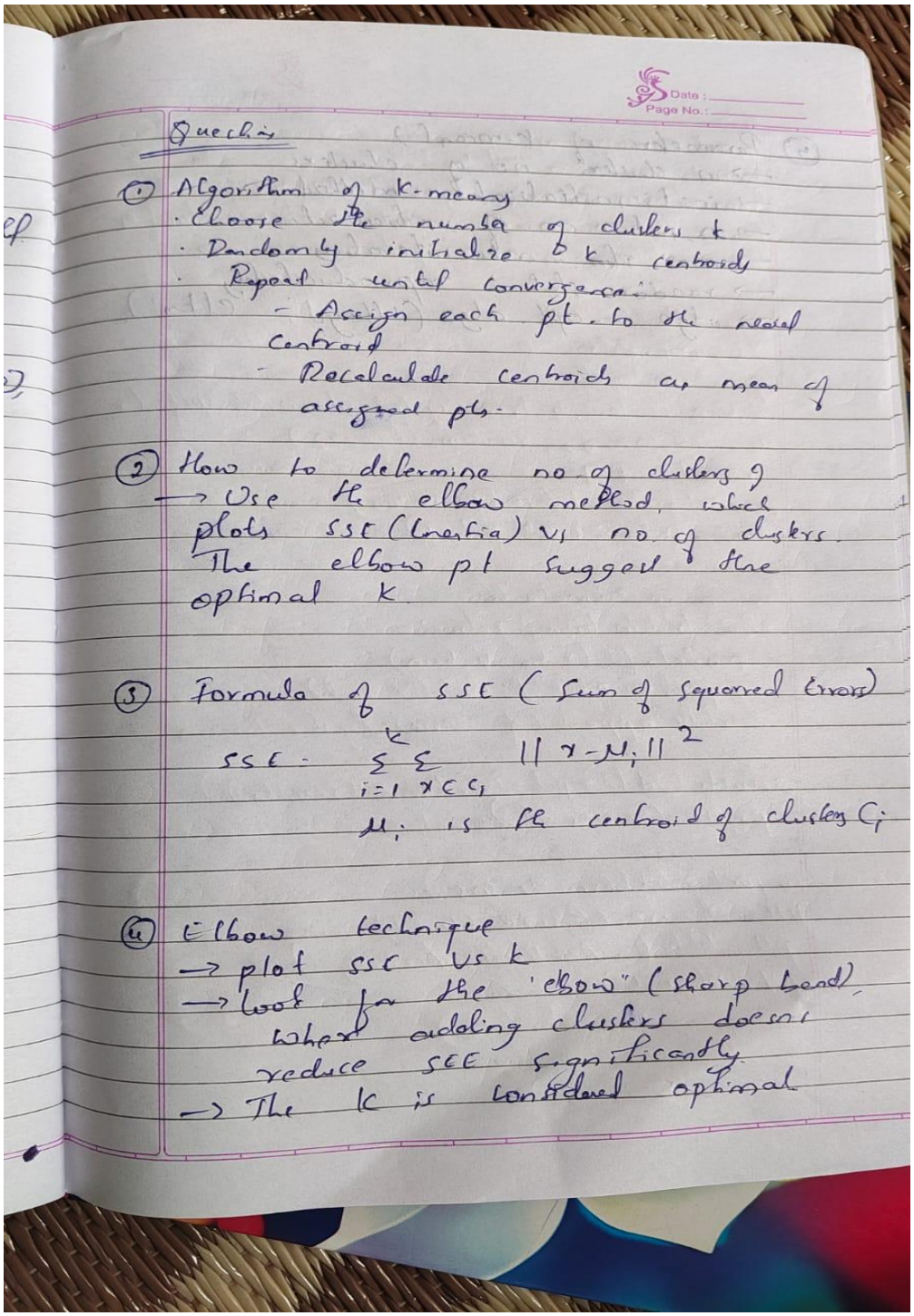
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
from sklearn.datasets import load_iris
from sklearn.ensemble import AdaBoostClassifier
from sklearn.tree import DecisionTreeClassifier
from sklearn.linear_model import LogisticRegression
from sklearn.model_selection import train_test_split
from sklearn.metrics import accuracy_score

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)

results = []

n_estimators_list = [10, 50, 100]
learning_rates = [0.01, 0.1, 1]

for n in n_estimators_list:
    for lr in learning_rates:
        tree_base = DecisionTreeClassifier(max_depth=1)
        model = AdaBoostClassifier(estimator=tree_base, n_estimators=n, learning_rate=lr,
random_state=42)
        model.fit(X_train, y_train)
        y_pred = model.predict(X_test)
        acc = accuracy_score(y_test, y_pred)
        results.append({
            'Base': 'DecisionTree',
            'n_estimators': n,
            'learning_rate': lr,
            'Accuracy': acc
        })

for n in n_estimators_list:
    for lr in learning_rates:
        log_reg_base = LogisticRegression(max_iter=1000)
        model = AdaBoostClassifier(estimator=log_reg_base, n_estimators=n, learning_rate=lr,
random_state=42)
        model.fit(X_train, y_train)
        y_pred = model.predict(X_test)
        acc = accuracy_score(y_test, y_pred)
```

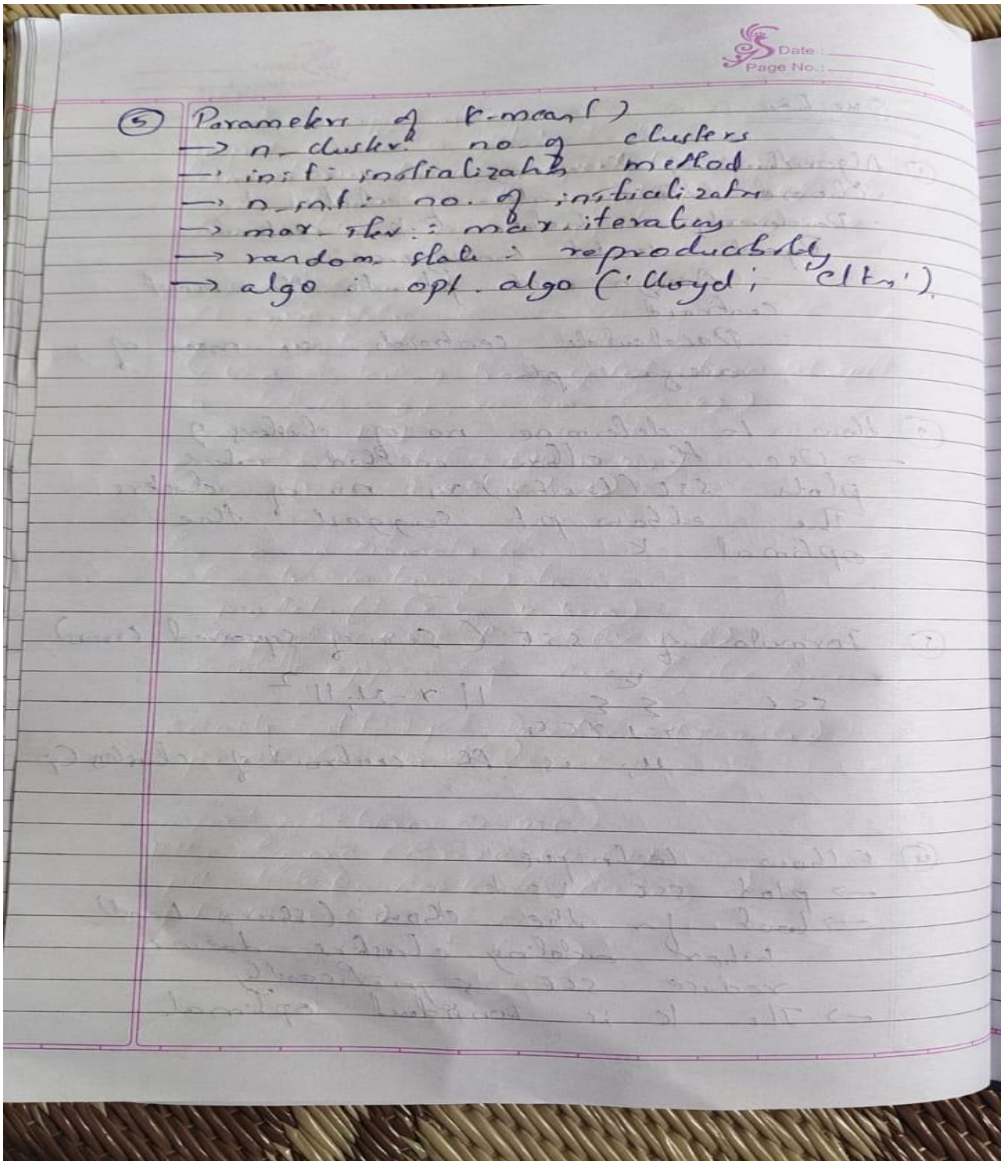
```
        results.append({
            'Base': 'LogisticRegression',
            'n_estimators': n,
            'learning_rate': lr,
            'Accuracy': acc
        })

results_df = pd.DataFrame(results)
print(results_df)

import seaborn as sns
plt.figure(figsize=(12, 6))
sns.barplot(x='n_estimators', y='Accuracy', hue='Base', data=results_df, ci=None)
plt.title('AdaBoost Accuracy with Different Estimators and n_estimators')
plt.show()
```

Program 10

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

Screenshot





Code:

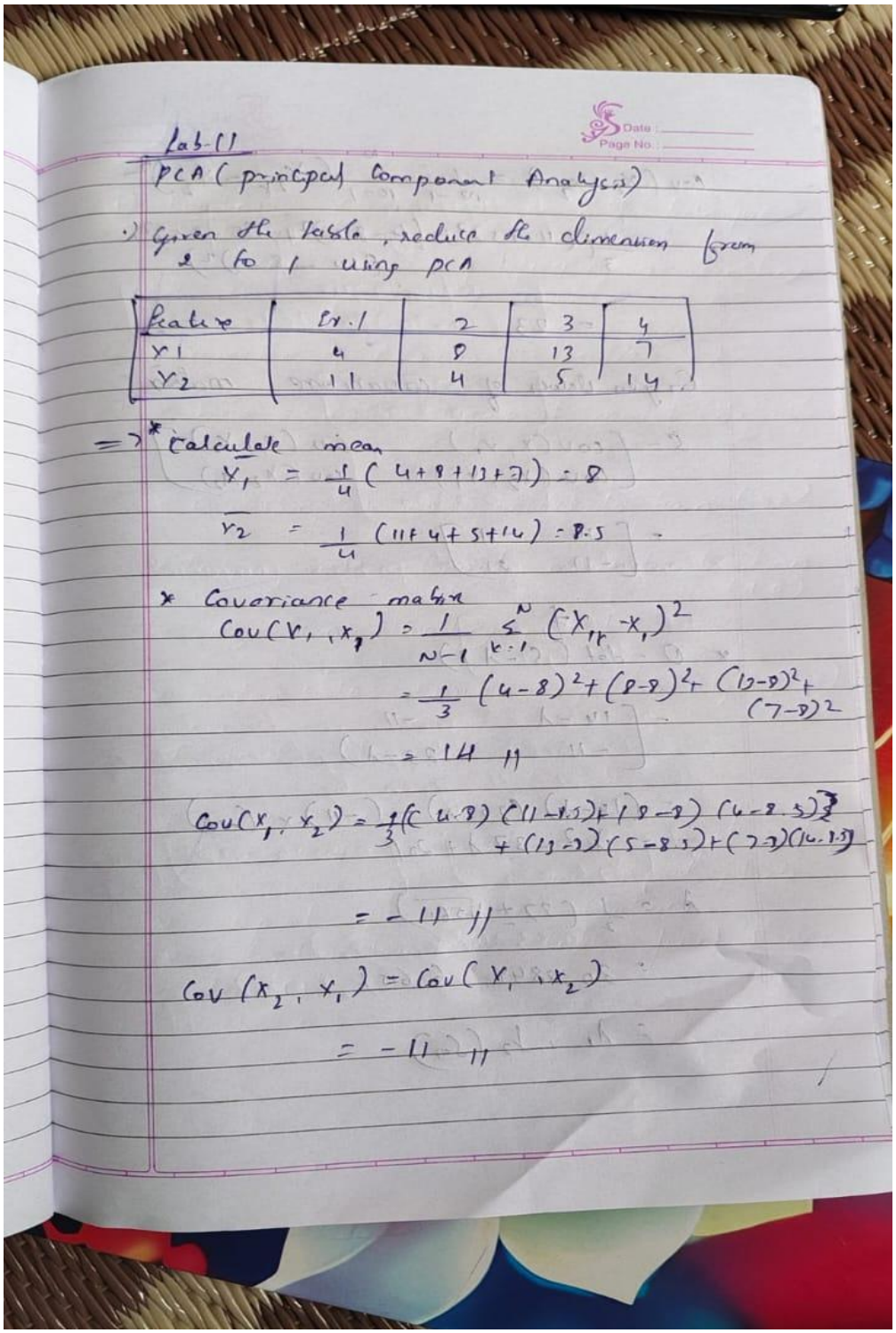
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
from sklearn.cluster import KMeans
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler
from sklearn.metrics import accuracy_score
```

```
data = {
    'Name': [f'Person_{i+1}' for i in range(50)],
    'Age': np.random.randint(18, 70, size=50),
    'Income': np.random.randint(20000, 120000, size=50)
}

df = pd.DataFrame(data)

df.to_csv('income.csv', index=False)

df = pd.read_csv('income.csv')

X = df[['Age', 'Income']]

scaler = StandardScaler()
X_scaled = scaler.fit_transform(X)

X_train, X_test = train_test_split(X_scaled, test_size=0.2, random_state=42)

sse = []
k_range = range(1, 11)
for k in k_range:
    kmeans = KMeans(n_clusters=k, random_state=42)
    kmeans.fit(X_train)
    sse.append(kmeans.inertia_)

plt.plot(k_range, sse, marker='o')
plt.title('SSE vs Number of Clusters')
plt.xlabel('Number of Clusters')
plt.ylabel('Sum of Squared Errors (SSE)')
plt.show()

optimal_k = 3
kmeans = KMeans(n_clusters=optimal_k, random_state=42)
kmeans.fit(X_train)
y_pred = kmeans.predict(X_test)

print(f'Predicted Clusters for Test Data: {y_pred}')
```

Program 11

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

Screenshot



Lab-11

PCA (principal Component Analysis)

1) Given the table, reduce the dimension from 2 to 1 using PCA

Feature	Ex.1	2	3	4
X_1	4	8	13	7
X_2	11	4	5	14

=> * Calculate mean

$\bar{X_1} = \frac{1}{4}(4+8+13+7) = 8$

$\bar{X_2} = \frac{1}{4}(11+4+5+14) = 8.5$

* Covariance matrix

$Cov(X_1, X_1) = \frac{1}{N-1}\sum_{k=1}^{N}(X_{1k} - \bar{X_1})^2$

$= \frac{1}{3}(4-8)^2 + (8-8)^2 + (13-8)^2 + (7-8)^2$

$= 14$ //

$Cov(X_1, X_2) = \frac{1}{3}[(4-8)(11-8.5) + (8-8)(4-8.5) + (13-8)(5-8.5) + (7-8)(14-8.5)]$

$= -11$ //

$Cov(X_2, X_1) = Cov(X_1, X_2)$

$= -11$ //

$$\text{Cov}(X_1, X_2) = \frac{1}{n-1} \sum_{k=1}^{n} (X_{2k} - \bar{X}_2)^2$$

$$= \frac{1}{3}\left[(11-8.5)^2 + (4-8.5)^2 + (5-8.5)^2 + (14-8.5)^2\right]$$

$$= 23$$

Eigen Values of covariance matrix

$$S = \begin{bmatrix} \text{cov}(X_1, X_1) & \text{cov}(X_1, X_2) \\ \text{cov}(X_2, X_1) & \text{cov}(X_2, X_2) \end{bmatrix}$$

$$= \begin{bmatrix} 14 & -11 \\ -11 & 23 \end{bmatrix}$$

* $Q = \det(S - \lambda I)$

$$= \begin{bmatrix} 14-\lambda & -11 \\ -11 & 23-\lambda \end{bmatrix}$$

$$= (14-\lambda)(23-\lambda) - (-11) \times (-11)$$

$$= \lambda^2 - 37\lambda + 201$$

$$\lambda = \frac{1}{2}(37 \pm \sqrt{565})$$

$$= \{30.3849,\ 6.615\}$$

$$= \lambda_1, \lambda_2 \ (\lambda_1 > \lambda_2)$$

* Computation of eigenvectors

$$V = \begin{bmatrix} u_1 \\ u_2 \end{bmatrix}$$

$$\begin{bmatrix} 0 \\ 0 \end{bmatrix} = (S - \lambda_1 I) X$$

$$= \begin{bmatrix} 14-\lambda_1 & -11 \\ -11 & 23-\lambda_1 \end{bmatrix} \begin{bmatrix} u_1 \\ u_2 \end{bmatrix}$$

$$= \begin{bmatrix} (14-\lambda_1)u_1 - 11u_2 \\ -11u_1 + (23-\lambda_1)u_2 \end{bmatrix}$$

$$(14-\lambda_1)u_1 - 11u_2 = 0$$

$$-11u_1 + (23-\lambda_1)u_2 = 0$$

Using theory of system of linear eqn

$$\frac{u_1}{11} = \frac{u_2}{14-\lambda_1} = t_1$$

$$u_1 = 11t_1, \quad u_2 = (14-\lambda_1)t_1$$

(t is real number)

$$t = 1$$

$$U_1 = \begin{bmatrix} 11 \\ 14-\lambda_1 \end{bmatrix}$$

To find a unit eigen vector, we compute length of x_1

$$\|U_1\| = \sqrt{11^2 + (14-\lambda_1)^2}$$

$$= \sqrt{11^2 + (14-30.3849)^2}$$

$$= 19.7348$$

a unit eigenvector corresponding to λ_1 is

$$e_1 = \begin{bmatrix} v_1/\|v_1\| \\ (v_2-\lambda_1)/\|v_1\| \end{bmatrix}$$

$$= \begin{bmatrix} v_1/19.7348 \\ (v_2-30.3846)/(19.7348) \end{bmatrix}$$

$$\therefore = \begin{bmatrix} 0.5574 \\ -0.8303 \end{bmatrix}$$

Similarly

$$e_2 = \begin{bmatrix} 0.8303 \\ 0.5574 \end{bmatrix}$$

* Computation of 1st principal component

let, $\begin{bmatrix} x_{1k} \\ x_{2k} \end{bmatrix}$

be the k^{th} sample in the above table (data), 1st principal component of this or is given by

$$e_1^T \begin{bmatrix} x_{1k} - \bar{x}_1 \\ x_{2k} - \bar{x}_2 \end{bmatrix} = \begin{bmatrix} 0.5574 & -0.8303 \end{bmatrix} \begin{bmatrix} x_{1k} - \bar{x}_1 \\ x_{2k} - \bar{x}_2 \end{bmatrix}$$

$$= 0.5574(x_{1k} - \bar{x}_1) - 0.8303(x_{2k} - \bar{x}_2)$$

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Code:

```
import pandas as pd
import numpy as np
from sklearn.preprocessing import StandardScaler, LabelEncoder
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LogisticRegression
from sklearn.ensemble import RandomForestClassifier
from sklearn.svm import SVC
from sklearn.metrics import accuracy_score
from sklearn.decomposition import PCA
from scipy import stats

df = pd.read_csv('heart (2).csv')

z_scores = np.abs(stats.zscore(df.select_dtypes(include=[np.number])))
df_no_outliers = df[(z_scores < 3).all(axis=1)]

df_cleaned = df_no_outliers.copy()
for col in df_cleaned.select_dtypes(include='object').columns:
    df_cleaned[col] = LabelEncoder().fit_transform(df_cleaned[col])

X = df_cleaned.drop('HeartDisease', axis=1)
y = df_cleaned['HeartDisease']

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)

models = {
    "Logistic Regression": LogisticRegression(max_iter=1000),
    "Random Forest": RandomForestClassifier(),
    "SVM": SVC()
}

print("Accuracy without PCA:")
for name, model in models.items():
    model.fit(X_train, y_train)
    y_pred = model.predict(X_test)
    acc = accuracy_score(y_test, y_pred)
    print(f"{name}: {acc:.4f}")

pca = PCA(n_components=5)
X_pca = pca.fit_transform(X_scaled)
X_train_pca, X_test_pca, y_train, y_test = train_test_split(X_pca, y, test_size=0.2, random_state=42,
```

```
stratify=y)

print("\nAccuracy with PCA:")
for name, model in models.items():
    model.fit(X_train_pca, y_train)
    y_pred = model.predict(X_test_pca)
    acc = accuracy_score(y_test, y_pred)
    print(f"{name}: {acc:.4f}")
```