VISVESVARAYA TECHNOLOGICAL UNIVERSITY

"JnanaSangama", Belgaum -590014, Karnataka.

LAB REPORT

On

MACHINE LEARNING

Submitted by

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in partial fulfilment for the award of the degree of
BACHELOR OF ENGINEERING

in

COMPUTER SCIENCE AND ENGINEERING

B.M.S. COLLEGE OF ENGINEERING
(Autonomous Institution under VTU)

BENGALURU-560019

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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"** carried out by **Nishant S (1BM21CS118)**, who is bonafide student of **B. M. S. College of Engineering**. It is in partial fulfilment for the award of **Bachelor of Engineering in Computer Science and Engineering** of the Visvesvaraya Technological University, Belgaum during the year 2023-24. The Lab report has been approved as it satisfies the academic requirements in respect of Machine Learning Lab - **(22CS6PCMAL)** work prescribed for the said degree.

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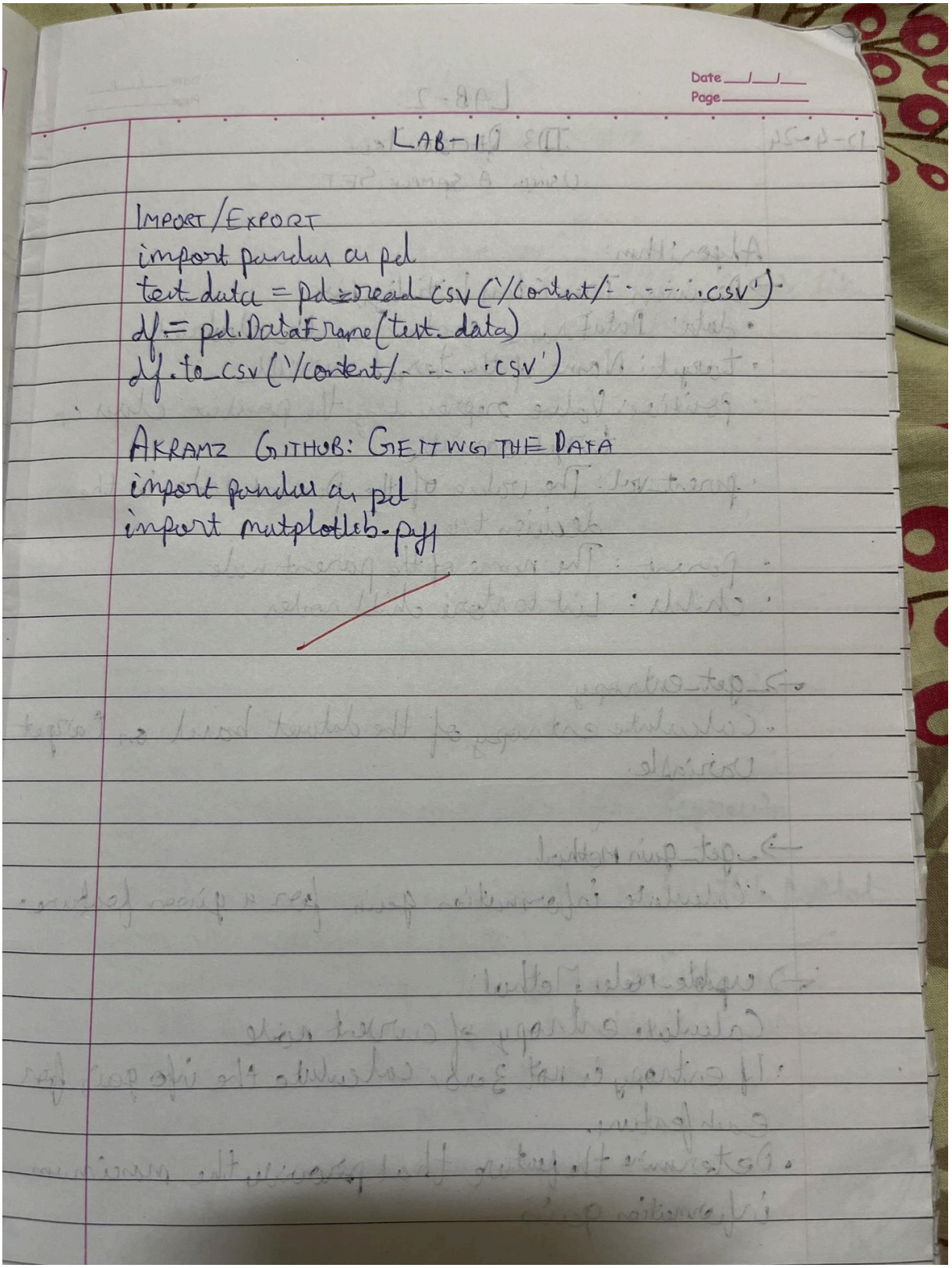
Index

Course outcomes:

CO1	Apply machine learning techniques in computing systems
CO2	Evaluate the model using metrics
CO3	Design a model using machine learning to solve a problem
CO4	Conduct experiments to solve real-world problems using appropriate machine learning techniques

5.04.2024

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

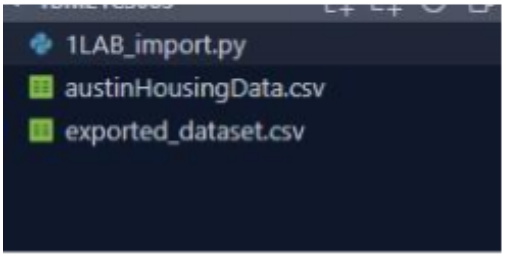



```
import pandas as pd df=pd.read_csv("austinHousingData.csv") print(df.head())
```

```
df.to_csv("exported_dataset.csv")
```

Output:

```
PS C:\Users\student\Documents\1BM21CS083> python -u "c:\Users\student\Documents\1BM21CS083\1LAB_import.py"
        zpid         city       streetAddress  zipcode  ... numOfBathrooms  numOfBedrooms  numOfStories                                          homeImage
0  111373431  pflugerville   14424 Lake Victor Dr    78660  ...           3.0              4             2  111373431_ffce26843283d3365c11d81b0e6bdc0f-p_f...
1  120980430  pflugerville      1104 Strickling Dr    78660  ...           2.0              4             1  120980430_8255c127be8dcf0a1a18b7563d987088-p_f...
2  208449383  pflugerville    1408 Fort Dessau Rd    78660  ...           2.0              3             1  208449383_a2ad649e1a7a098111dcea004a11c855-p_...
3  120981374  pflugerville      1025 Strickling Dr    78660  ...           2.0              3             1  120981374_b469367a619da85b1f5ceb69b675d88e-p_f...
4   60134862  pflugerville   15805 Donna Jane Loop    78660  ...           3.0              3             2  60134862_b1a48a3df3f111e00fbb913873e98ce2-p_f.jpg

[5 rows x 47 columns]
PS C:\Users\student\Documents\1BM21CS083>
```



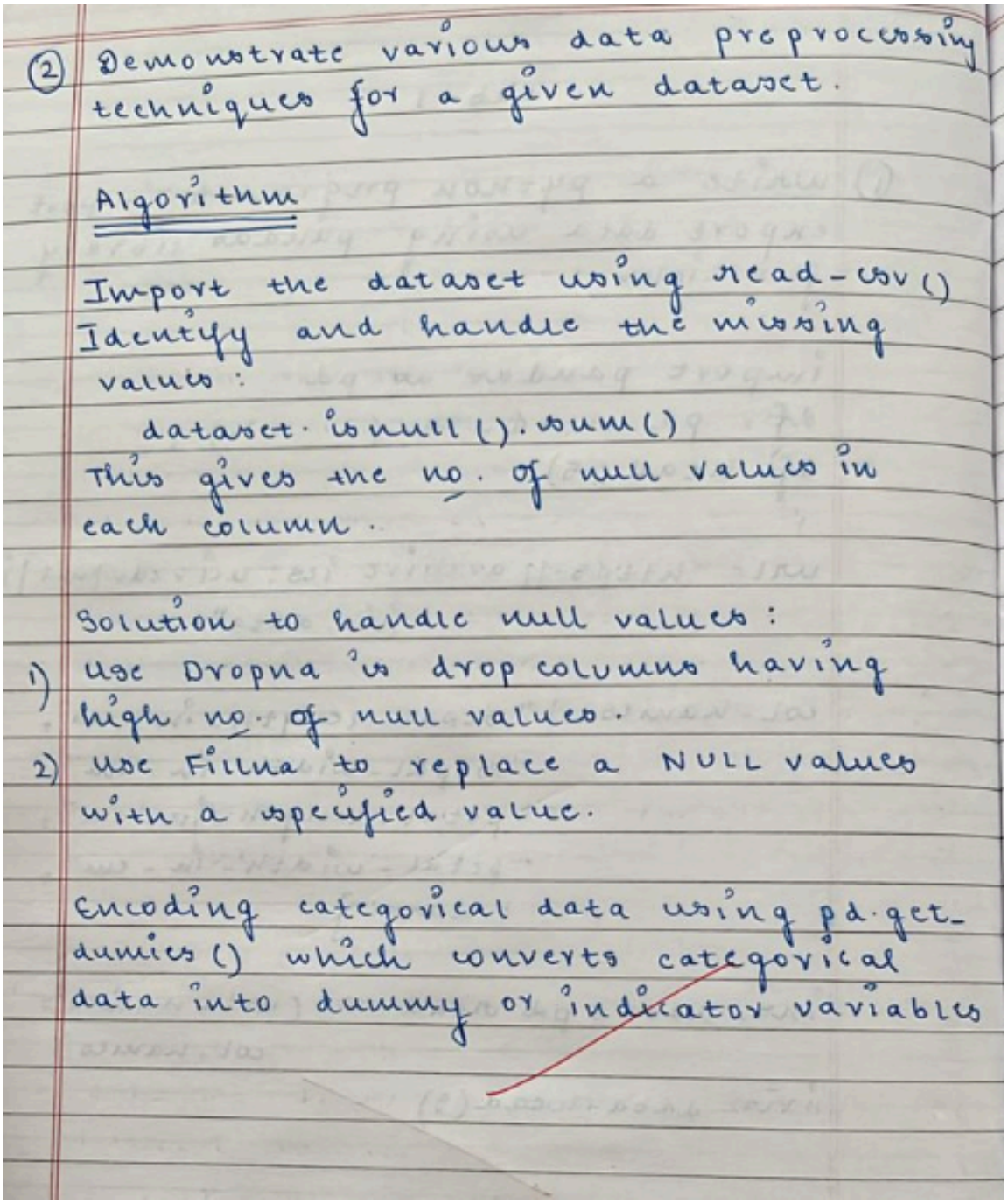

```
import pandas as pd url =
"https://archive.ics.uci.edu/ml/machine-learning-databases/iris/iris.data"

col_names = ["sepal_length_in_cm",
          "sepal_width_in_cm",
          "petal_length_in_cm",
          "petal_width_in_cm",
          "class"]
iris_data = pd.read_csv(url, names=col_names)

print(iris_data.head())

iris_data.to_csv("cleaned_iris_data.csv")
```

Output:

```
PS C:\Users\student\Documents\1BM21CS083> python -u "c:\Users\student\Documents\1BM21CS083\11ab\iris.py"
   sepal_length_in_cm  sepal_width_in_cm  petal_length_in_cm  petal_width_in_cm        class
0                 5.1                3.5                 1.4                0.2  Iris-setosa
1                 4.9                3.0                 1.4                0.2  Iris-setosa
2                 4.7                3.2                 1.3                0.2  Iris-setosa
3                 4.6                3.1                 1.5                0.2  Iris-setosa
4                 5.0                3.6                 1.4                0.2  Iris-setosa
PS C:\Users\student\Documents\1BM21CS083>
```

05.04.2024 1BM21CS124

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



(2) Demonstrate various data preprocessing techniques for a given dataset.

Algorithm

Import the dataset using read_csv()
Identify and handle the missing values:

dataset.isnull().sum()

This gives the no. of null values in each column.

Solution to handle null values:

1) Use Dropna to drop columns having high no. of null values.
2) Use Fillna to replace a NULL values with a specified value.

Encoding categorical data using pd.get_dummies() which converts categorical data into dummy or indicator variables

```
%matplotlib inline
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import sklearn
```
[1] Python

```
dataset = pd.read_csv("/content/Data.csv")
```
[2] Python

```
df = pd.DataFrame(dataset)
```
[3] Python

```
df
```
[4] Python

Outputs are collapsed ...

```
X = df.iloc[:, :-1].values  Add to CodeGPT Chat (Ctrl + Shift + E).   Add to chat (Ctrl+L) | Edit highlighted code (Ctrl+I).
y = df.iloc[:, -1].values
```
[5] Python

```
print(X)
```
[6] Python

Outputs are collapsed ...

```
print(y)
```
[7] Python

```
['No' 'Yes' 'No' 'No' 'Yes' 'Yes' 'No' 'Yes' 'No' 'Yes']
```

```
df.isnull().sum()
```
[8] Python

Outputs are collapsed ...

Dropna

```
df1 = df.copy()
```
[10] Python

```
# summarize the shape of the raw data
print("Before:",df1.shape)

# drop rows with missing values
df1.dropna(inplace=True)

# summarize the shape of the data with missing rows removed
print("After:",df1.shape)
```
[11] Python

Outputs are collapsed ...

```
# summarize the shape of the raw data
print("Before:",df1.shape)

# drop rows with missing values
df1.dropna(inplace=True)

# summarize the shape of the data with missing rows removed
print("After:",df1.shape)
```
[12] Python

Outputs are collapsed ...

Scikit-Learn

```
X
```
[13] Python

Outputs are collapsed ...

```
from sklearn.impute import SimpleImputer
imputer = SimpleImputer(missing_values=np.nan, strategy='mean')
imputer.fit(X[:, 1:3])
X[:, 1:3] = imputer.transform(X[:, 1:3])
```
[13] Python

```
print(X)
```
[14] Python

Outputs are collapsed ...

Using Dummies

```
df2
```
[15] Python

Outputs are collapsed ...

```
pd.get_dummies(df2)  Add to CodeGPT Chat (Ctrl + Shift + E).   Add to chat (Ctrl+L) | Edit highlighted code (Ctrl+I).
```
[16] Python

Outputs are collapsed ...

```
df2
```

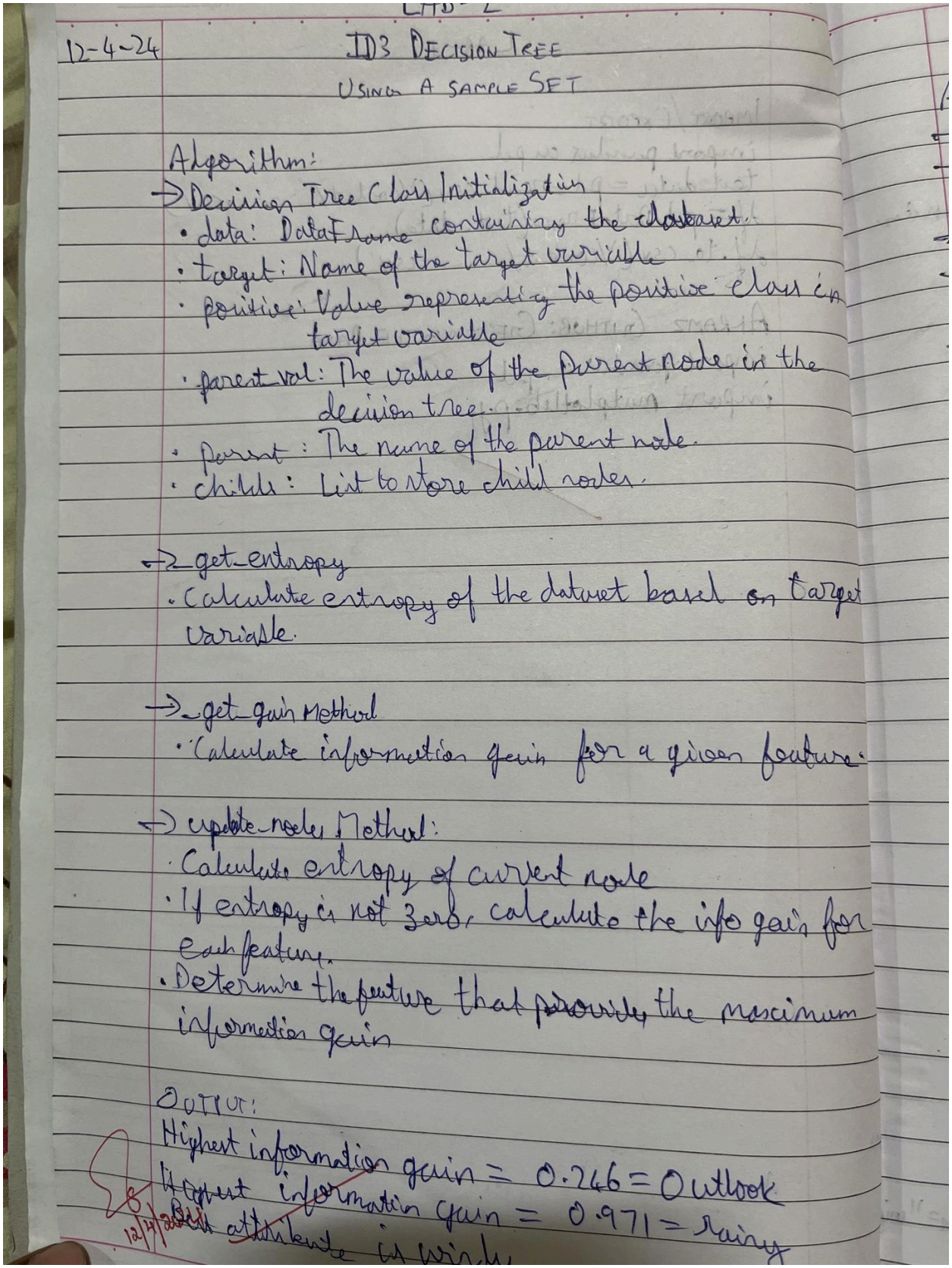
	Country	Age	Salary	Purchased
0	France	44.0	72000.0	No
1	Spain	27.0	48000.0	Yes
2	Germany	30.0	54000.0	No
3	Spain	38.0	61000.0	No
4	Germany	40.0	NaN	Yes
5	France	35.0	58000.0	Yes
6	Spain	NaN	52000.0	No
7	France	48.0	79000.0	Yes
8	Germany	50.0	83000.0	No
9	France	37.0	67000.0	Yes

```
pd.get_dummies(df2)
```

	Age	Salary	Country_France	Country_Germany	Country_Spain	Purchased_No	Purchased_Yes
0	44.0	72000.0	True	False	False	True	False
1	27.0	48000.0	False	False	True	False	True
2	30.0	54000.0	False	True	False	True	False
3	38.0	61000.0	False	False	True	True	False
4	40.0	NaN	False	True	False	False	True
5	35.0	58000.0	True	False	False	False	True
6	NaN	52000.0	False	False	True	True	False
7	48.0	79000.0	True	False	False	False	True
8	50.0	83000.0	False	True	False	True	False
9	37.0	67000.0	True	False	False	False	True

12/04/2024

Decision Tree Algorithm:



LAB-2

12-4-24

ID3 DECISION TREE

USING A SAMPLE SET

Algorithm:

→ Decision Tree Class Initialization
- data: DataFrame containing the dataset.
- target: Name of the target variable
- positive: Value representing the positive class in target variable
- parent_val: The value of the parent node in the decision tree.
- parent: The name of the parent node.
- childs: List to store child nodes.

→ get_entropy
- Calculate entropy of the dataset based on target variable.

→ get_gain Method
- Calculate information gain for a given feature.

→ update_node Method:
- Calculate entropy of current node
- If entropy is not zero, calculate the info gain for each feature.
- Determine the feature that provides the maximum information gain

OUTPUT:

Highest information gain = 0.246 = Outlook

Highest information gain = 0.971 = Rainy

Best attribute is Windy

12/4/2024

Code and output:

```
print(f'Entropy of the entire dataset: {find_entropy(data.play)}')
```
Python

```
Entropy of the entire dataset: 0.94
```

```
entropy_and_infogain(data, 'temp')
```
Python

Outputs are collapsed ...

```
entropy_and_infogain(data, 'humidity')
```
Python

Outputs are collapsed ...

```
entropy_and_infogain(data, 'windy')
```
Python

Outputs are collapsed ...

#Rainy -outlook

```
rainy = data[data['outlook'] == 'rainy']
rainy.style.applymap(highlight)\
    .set_properties(subset=data.columns, **{'width': '100px'})\
    .set_table_styles([{'selector': 'th', 'props': [('background-color', 'lightgray'), ('border', '1px solid gray'),
                                                    ('font-weight', 'bold')]},
     {'selector': 'tr:hover', 'props': [('background-color', 'white'), ('border', '1.5px solid black')]}])
```
Python

Outputs are collapsed ...

```
print(f'Entropy of the Rainy dataset: {find_entropy(rainy.play)}')
```
Python

```
Entropy of the Rainy dataset: 0.971
```

```
entropy_and_infogain(rainy, 'temp')
```
Python

Outputs are collapsed ...

```
entropy_and_infogain(rainy, 'humidity')
```
Python

```
entropy_and_infogain(rainy, 'temp')
```
Python

Outputs are collapsed ...

```
entropy_and_infogain(rainy, 'humidity')
```
Python

Outputs are collapsed ...

```
entropy_and_infogain(rainy, 'windy')
```
Python

Outputs are collapsed ...

wind has highest information gain

Output:

```
def highlight(cell_value):
    '''
    Highlight yes / no values in the dataframe
    '''
    color_1 = 'background-color: pink;'
    color_2 = 'background-color: lightgreen;'

    if cell_value == 'no':
        return color_1
    elif cell_value == 'yes':
        return color_2

data.style.applymap(highlight)\
    .set_properties(subset=data.columns, **{'width': '100px'})\
    .set_table_styles([{'selector': 'th', 'props': [('background-color', 'lightgray'), ('border', '1px solid gray'),
                                                    ('font-weight', 'bold')]},
     {'selector': 'tr:hover', 'props': [('background-color', 'white'), ('border', '1.5px solid black')]}])
```
Python

	outlook	temp	humidity	windy	play
0	sunny	hot	high	False	no
1	sunny	hot	high	True	no
2	overcast	hot	high	False	yes
3	rainy	mild	high	False	yes
4	rainy	cool	normal	False	yes
5	rainy	cool	normal	True	no
6	overcast	cool	normal	True	yes
7	sunny	mild	high	False	no
8	sunny	cool	normal	False	yes
9	rainy	mild	normal	False	yes
10	sunny	mild	normal	True	yes
11	overcast	mild	high	True	yes
12	overcast	hot	normal	False	yes
13	rainy	mild	high	True	no

```
print(f'Entropy of the entire dataset: {find_entropy(data.play)}')
```

```
Entropy of the entire dataset: 0.94
```

```
entropy_and_infogain(data, 'temp')
```

	temp	play
0	hot	no
1	hot	no
2	hot	yes
3	hot	yes

```
Entropy of temp - hot = 1.0
```

	temp	play
4	mild	yes
7	mild	no
8	mild	yes
10	mild	yes
11	mild	yes
12	mild	no

```
Entropy of temp - mild = 0.918
```

	temp	play
5	cool	yes
6	cool	no
9	cool	yes
13	cool	yes

```
Entropy of temp - cool = 0.811
Information Gain for temp = 0.029
```

```
entropy_and_infogain(data, 'humidity')
```

	humidity	play
0	high	no
1	high	no
2	high	yes
3	high	yes
7	high	no
8	high	yes
12	high	no

```
Entropy of humidity - high = 0.985
```

	humidity	play
4	normal	yes
5	normal	no
6	normal	yes
9	normal	yes
10	normal	yes
11	normal	yes
13	normal	yes

```
Entropy of humidity - normal = 0.592
Information Gain for humidity = 0.151
```

```
entropy_and_infogain(data, 'windy')
```

	windy	play
0	False	no
2	False	yes
3	False	yes
4	False	yes
7	False	no
8	False	yes
10	False	yes
13	False	yes

```
Entropy of windy - False = 0.811
```

	windy	play
1	True	no
5	True	no
6	True	yes
11	True	yes
12	True	yes
9	True	no

```
Entropy of windy - True = 1.0
Information Gain for windy = 0.048
```

#Rainy -outlook

```python
rainy = data[data['outlook'] == 'rainy']
rainy.style.applymap(highlight)\
    .set_properties(subset=data.columns, **{'width': '100px'})\
    .set_table_styles([{'selector': 'th', 'props': [('background-color', 'lightgray'), ('border', '1px solid gray'),
                                                    ('font-weight', 'bold')]},
     {'selector': 'tr:hover', 'props': [('background-color', 'white'), ('border', '1.5px solid black')]}])
```

[9] Python

	outlook	temp	humidity	windy	play
3	rainy	mild	high	False	yes
4	rainy	cool	normal	False	yes
5	rainy	cool	normal	True	no
9	rainy	mild	normal	False	yes
13	rainy	mild	high	True	no

```python
print(f'Entropy of the Rainy dataset: {find_entropy(rainy.play)}')
```

[10] Python

```
Entropy of the Rainy dataset: 0.971
```

```python
entropy_and_infogain(rainy, 'temp')
```

[11] Python

	temp	play
3	mild	yes
4	mild	yes
13	mild	no

```
Entropy of temp - mild = 0.918
```

	temp	play
5	cool	yes
9	cool	yes

```
Entropy of temp - cool = 1.0
Information Gain for temp = 0.02
```

```python
entropy_and_infogain(rainy, 'humidity')
```

[12] Python

	humidity	play
3	high	yes
13	high	no

```
Entropy of humidity - high = 1.0
```

	humidity	play
4	normal	yes
5	normal	no
9	normal	yes

```
Entropy of humidity - normal = 0.918
Information Gain for humidity = 0.02
```

```python
entropy_and_infogain(rainy, 'windy')
```

[13] Python

	windy	play
3	False	yes
4	False	yes
9	False	yes

```
Entropy of windy - False = 0.0
```

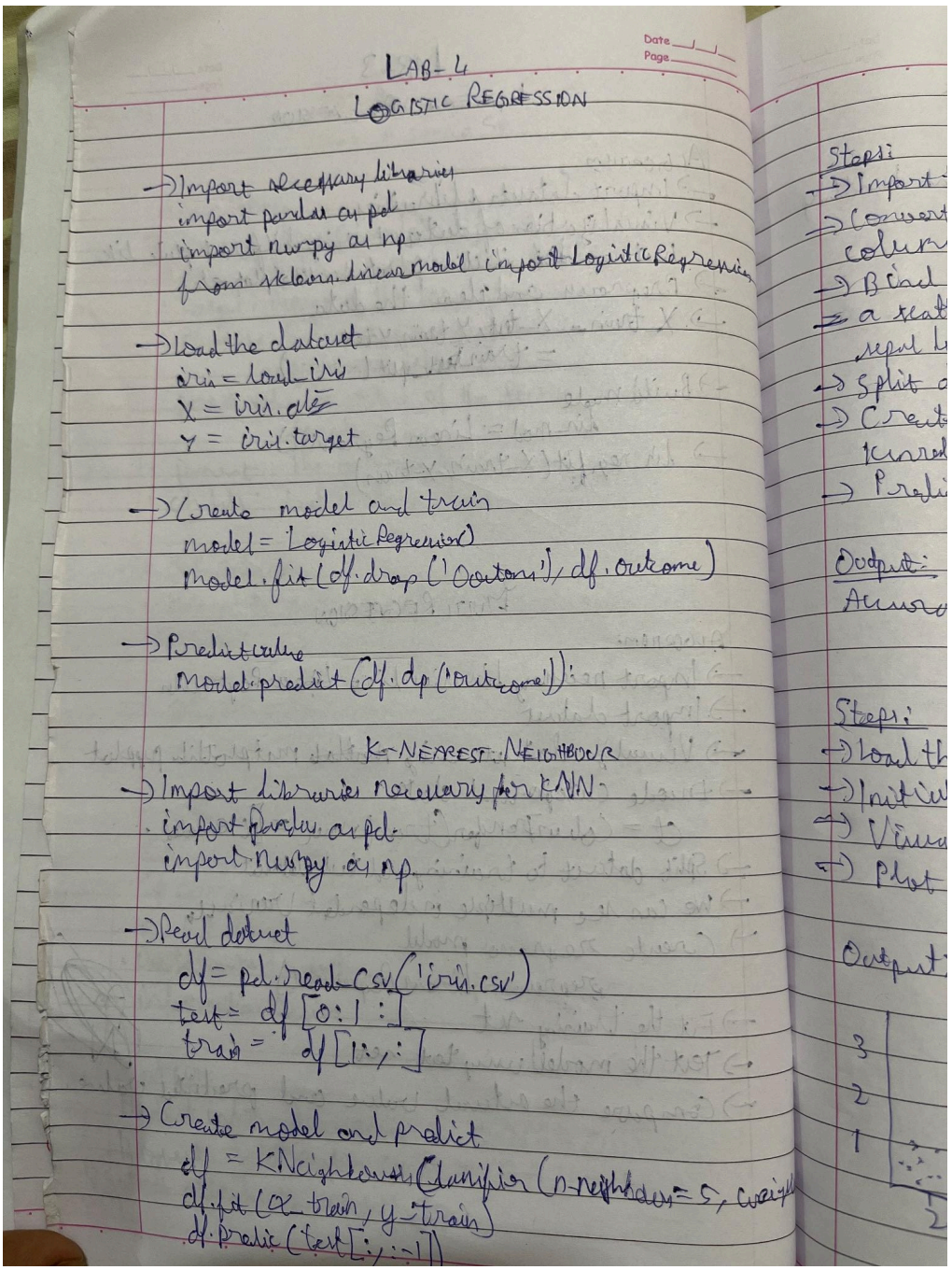
	windy	play
5	True	no
13	True	no

```
Entropy of windy - True = 0.0
Information Gain for windy = 0.971
```

wind has highest information gain

03/05/2024

Build KNN Classification model for a given dataset.:



LAB-4

LOGISTIC REGRESSION

→ Import necessary libraries
import pandas as pd
import numpy as np
from sklearn.linear_model import LogisticRegression

→ Load the dataset
iris = load_iris
X = iris.data
y = iris.target

→ Create model and train
model = LogisticRegression()
model.fit(df.drop('Outcome'), df.Outcome)

→ Predict value
model.predict(df.dp('Outcome'))

K-NEAREST NEIGHBOUR

→ Import libraries necessary for KNN
import pandas as pd
import numpy as np

→ Read dataset
df = pd.read_csv('iris.csv')
test = df[0:1:]
train = df[1:,:]

→ Create model and predict
df = KNeighborsClassifier(n_neighbors=5, weigh
df.fit(X_train, y_train)
df.predic(test[:,:-1])

Steps:
→ Import
→ Convert
colum
→ Read
→ a feat
repl
→ Split
→ Creat
Classi
→ Predi

Output:
Accura

Steps:
→ Load th
→ Initia
→ Visua
→ Plot

Output

Code and output:

```
for var in df.columns:
    print(df[var].value_counts())
```

Python

Outputs are collapsed …

```
df['Bare_Nuclei'] = pd.to_numeric(df['Bare_Nuclei'], errors='coerce')
```

Python

```
df.dtypes
```

Python

Outputs are collapsed …

```
df.isnull().sum()
```

Python

Outputs are collapsed …

```
# check `na` values in the dataframe

df.isna().sum()
```

Python

Outputs are collapsed …

```
# check frequency distribution of `Bare_Nuclei` column

df['Bare_Nuclei'].value_counts()
```

Python

Outputs are collapsed …

```
# check unique values in `Bare_Nuclei` column

df['Bare_Nuclei'].unique()
```

Python

```
array([ 1., 10.,  2.,  4.,  3.,  9.,  7., nan,  5.,  8.,  6.])
```

```
# check for nan values in `Bare_Nuclei` column …
```

```
16
```

```
# view frequency distribution of values in `Class` variable

df['Class'].value_counts()
```

Python

Outputs are collapsed …

```
import numpy as np
```

Python

```
# view summary statistics in numerical variables

print(round(df.describe(),2))
```

Python

Outputs are collapsed …

```
X = df.drop(['Class'], axis=1)

y = df['Class']
```

Python

```
from sklearn.model_selection import train_test_split

X_train, X_test, y_train, y_test = train_test_split(X, y, test_size = 0.2, random_state = 0)
```

Python

```
X_train.shape, X_test.shape
```

Python

Outputs are collapsed …

```
for col in X_train.columns:
    if X_train[col].isnull().mean()>0:
        print(col, round(X_train[col].isnull().mean(),4))
```

Python

```
Bare_Nuclei 0.0233
```

```
…
```

```
cols = X_train.columns
```

Python

```
from sklearn.preprocessing import StandardScaler ...
```

```
X_train = pd.DataFrame(X_train, columns=[cols])
```
[36] Python

```
X_test = pd.DataFrame(X_test, columns=[cols])
```
[34] Python

```
X_train.head() ...
```

	Clump_thickness	Uniformity_Cell_Size	Uniformity_Cell_Shape	Marginal_Adhesion	Single_Epithelial_Cell_Size	Bare_Nuclei	Bland_Chromatin	Normal_Nucleoli	Mitoses
0	2.028383	0.299506	0.289573	1.119077	-0.546543	1.858957	-0.577774	0.041241	-0.324258
1	1.669451	2.257680	2.304569	-0.622471	3.106879	1.297589	-0.159953	0.041241	-0.324258
2	-1.202005	-0.679581	-0.717925	0.074148	-1.003220	-0.104329	-0.995595	-0.608165	-0.324258
3	-0.125209	-0.026856	-0.046260	-0.622471	-0.546543	-0.665096	-0.159953	0.041241	-0.324258
4	0.233723	-0.353219	-0.382092	-0.274161	-0.546543	-0.665096	-0.577774	-0.283462	-0.324258

```
# import KNeighbors ClaSSifier from sklearn
from sklearn.neighbors import KNeighborsClassifier


# instantiate the model
knn = KNeighborsClassifier(n_neighbors=3)


# fit the model to the training set
knn.fit(X_train, y_train)
```
[33] Python

Outputs are collapsed ...

```
y_pred = knn.predict(X_test)

y_pred
```
[23] Python

Outputs are collapsed ...

```
knn.predict_proba(X_test)[:,0]
```
[36] Python

Outputs are collapsed ...

```
from sklearn.metrics import accuracy_score

print('Model accuracy score: {0:0.4f}'. format(accuracy_score(y_test, y_pred)))
```
[35] Python

Outputs are collapsed ...

```
y_pred_train = knn.predict(X_train) ...
```

```
print('Training-set accuracy score: {0:0.4f}'. format(accuracy_score(y_train, y_pred_train)))
```
[37] Python

Outputs are collapsed ...

Python

Output:

```
df.shape
```
[3] Python

```
(699, 11)
```

```
col_names = ['Id', 'Clump_thickness', 'Uniformity_Cell_Size', 'Uniformity_Cell_Shape', 'Marginal_Adhesion',
             'Single_Epithelial_Cell_Size', 'Bare_Nuclei', 'Bland_Chromatin', 'Normal_Nucleoli', 'Mitoses', 'Class']

df.columns = col_names

df.columns
```
[4] Python

```
Index(['Id', 'Clump_thickness', 'Uniformity_Cell_Size',
       'Uniformity_Cell_Shape', 'Marginal_Adhesion',
       'Single_Epithelial_Cell_Size', 'Bare_Nuclei', 'Bland_Chromatin',
       'Normal_Nucleoli', 'Mitoses', 'Class'],
      dtype='object')
```

```
df.head()
```
[5] Python

	Id	Clump_thickness	Uniformity_Cell_Size	Uniformity_Cell_Shape	Marginal_Adhesion	Single_Epithelial_Cell_Size	Bare_Nuclei	Bland_Chromatin	Normal_Nucleoli	Mitoses	Class
0	1000025	5	1	1	1	2	1	3	1	1	2
1	1002945	5	4	4	5	7	10	3	2	1	2
2	1015425	3	1	1	1	2	2	3	1	1	2
3	1016277	6	8	8	1	3	4	3	7	1	2
4	1017023	4	1	1	3	2	1	3	1	1	2

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 699 entries, 0 to 698
Data columns (total 10 columns):
 #   Column                       Non-Null Count  Dtype 
---  ------                       --------------  ----- 
 0   Clump_thickness              699 non-null    int64 
 1   Uniformity_Cell_Size         699 non-null    int64 
 2   Uniformity_Cell_Shape        699 non-null    int64 
 3   Marginal_Adhesion            699 non-null    int64 
 4   Single_Epithelial_Cell_Size  699 non-null    int64 
 5   Bare_Nuclei                  699 non-null    object
 6   Bland_Chromatin              699 non-null    int64 
 7   Normal_Nucleoli              699 non-null    int64 
 8   Mitoses                      699 non-null    int64 
 9   Class                        699 non-null    int64 
dtypes: int64(9), object(1)
memory usage: 54.7+ KB
```

```
for var in df.columns:

    print(df[var].value_counts())
```

[8] Python

```
Clump_thickness
1     145
5     130
3     108
4      80
10     69
2      50
8      46
6      34
7      23
9      14
Name: count, dtype: int64
Uniformity_Cell_Size
1     384
10     67
3      52
2      45
4      40
5      30
8      29
6      27
7      19
9       6
Name: count, dtype: int64
Uniformity_Cell_Shape
...
Class
2    458
4    241
Name: count, dtype: int64
```

```
df['Bare_Nuclei'] = pd.to_numeric(df['Bare_Nuclei'], errors='coerce')
```

[9] Python

```
df.dtypes
```

[10] Python

```
Clump_thickness                int64
Uniformity_Cell_Size           int64
Uniformity_Cell_Shape          int64
Marginal_Adhesion              int64
Single_Epithelial_Cell_Size    int64
Bare_Nuclei                  float64
Bland_Chromatin                int64
Normal_Nucleoli                int64
Mitoses                        int64
Class                          int64
dtype: object
```

```
df.isnull().sum()
```

[11] Python

```
Clump_thickness               0
Uniformity_Cell_Size          0
Uniformity_Cell_Shape         0
Marginal_Adhesion             0
Single_Epithelial_Cell_Size   0
Bare_Nuclei                  16
Bland_Chromatin               0
Normal_Nucleoli               0
Mitoses                       0
Class                         0
dtype: int64
```

```
# check `na` values in the dataframe

df.isna().sum()
```

[12] Python

```
Clump_thickness               0
Uniformity_Cell_Size          0
Uniformity_Cell_Shape         0
Marginal_Adhesion             0
Single_Epithelial_Cell_Size   0
Bare_Nuclei                  16
Bland_Chromatin               0
Normal_Nucleoli               0
Mitoses                       0
Class                         0
dtype: int64
```

```
# check frequency distribution of `Bare_Nuclei` column

df['Bare_Nuclei'].value_counts()
```

```
Bare_Nuclei
1.0     402
10.0    132
2.0      30
5.0      30
3.0      28
8.0      21
4.0      19
9.0       9
7.0       8
6.0       4
Name: count, dtype: int64
```

```
# check unique values in `Bare_Nuclei` column

df['Bare_Nuclei'].unique()
```

```
array([ 1., 10.,  2.,  4.,  3.,  9.,  7., nan,  5.,  8.,  6.])
```

```
# check for nan values in `Bare_Nuclei` column
```

```
16
```

```
# view frequency distribution of values in `Class` variable

df['Class'].value_counts()
```

```
Class
2    458
4    241
Name: count, dtype: int64
```

```
import numpy as np
```

```
# view summary statistics in numerical variables

print(round(df.describe(),2))
```

```
       Clump_thickness  Uniformity_Cell_Size  Uniformity_Cell_Shape  \
count           699.00                699.00                 699.00
mean              4.42                  3.13                   3.21
std               2.82                  3.05                   2.97
min               1.00                  1.00                   1.00
25%               2.00                  1.00                   1.00
50%               4.00                  1.00                   1.00
75%               6.00                  5.00                   5.00
max              10.00                 10.00                  10.00

       Marginal_Adhesion  Single_Epithelial_Cell_Size  Bare_Nuclei  \
count             699.00                       699.00       683.00
mean                2.81                         3.22         3.54
std                 2.86                         2.21         3.64
min                 1.00                         1.00         1.00
25%                 1.00                         2.00         1.00
50%                 1.00                         2.00         1.00
75%                 4.00                         4.00         6.00
max                10.00                        10.00        10.00

       Bland_Chromatin  Normal_Nucleoli  Mitoses   Class
count           699.00           699.00   699.00  699.00
mean              3.44             2.87     1.59    2.69
std               2.44             3.05     1.72    0.95
min               1.00             1.00     1.00    2.00
25%               2.00             1.00     1.00    2.00
50%               3.00             1.00     1.00    2.00
75%               5.00             4.00     1.00    4.00
max              10.00            10.00    10.00    4.00
```

```
X_test = pd.DataFrame(X_test, columns=[cols])
```

```
X_train.head()
```

	Clump_thickness	Uniformity_Cell_Size	Uniformity_Cell_Shape	Marginal_Adhesion	Single_Epithelial_Cell_Size	Bare_Nuclei	Bland_Chromatin	Normal_Nucleoli	Mitoses
0	2.028383	0.299506	0.289573	1.119077	-0.546543	1.858357	-0.577774	0.041241	-0.324258
1	1.669451	2.257680	2.304569	-0.622471	3.106879	1.297589	-0.159953	0.041241	-0.324258
2	-1.202005	-0.679581	-0.717925	0.074148	-1.003220	-0.104329	-0.995595	-0.608165	-0.324258
3	-0.125209	-0.026056	-0.046260	-0.622471	-0.546543	-0.665096	-0.159953	0.041241	-0.324258
4	0.233723	-0.353219	-0.382092	-0.274161	-0.546543	-0.665096	-0.577774	-0.283462	-0.324258

```
# import KNeighbors ClaSSifier from sklearn
from sklearn.neighbors import KNeighborsClassifier


# instantiate the model
knn = KNeighborsClassifier(n_neighbors=3)


# fit the model to the training set
knn.fit(X_train, y_train)
```

```
KNeighborsClassifier(n_neighbors=3)
```

```
y_pred = knn.predict(X_test)

y_pred
```

```
array([2, 2, 4, 2, 4, 2, 4, 2, 4, 2, 2, 2, 4, 4, 4, 2, 2, 4, 4, 2, 4, 4,
       2, 2, 2, 4, 2, 2, 4, 4, 2, 2, 2, 2, 2, 2, 4, 2, 2, 2, 2, 2, 2,
       4, 4, 2, 4, 2, 4, 4, 2, 2, 4, 2, 2, 2, 2, 2, 2, 4, 2, 2, 4, 4, 4,
       4, 2, 2, 4, 2, 2, 4, 4, 2, 2, 2, 2, 4, 2, 2, 4, 2, 2, 4, 2, 2,
       4, 4, 2, 2, 2, 4, 2, 2, 4, 2, 4, 4, 2, 2, 4, 2, 2, 2, 2, 2, 2,
       4, 4, 4, 2, 2, 2, 2, 2, 4, 4, 4, 4, 2, 4, 2, 2, 4, 4, 4, 4, 4, 2,
       2, 4, 4, 2, 2, 4, 2, 2])
```

```
y_pred = knn.predict(X_test)

y_pred
```

[33] Python

```
array([2, 2, 4, 2, 4, 2, 4, 2, 4, 2, 2, 2, 4, 4, 4, 2, 2, 4, 4, 2, 4, 4,
       2, 2, 2, 4, 2, 2, 4, 4, 4, 2, 2, 2, 2, 2, 2, 2, 4, 2, 2, 2, 2, 2,
       4, 4, 2, 4, 2, 4, 4, 4, 2, 2, 4, 2, 2, 2, 2, 2, 2, 4, 2, 2, 4, 4, 4,
       4, 2, 2, 4, 2, 2, 4, 4, 4, 2, 2, 2, 2, 4, 2, 2, 4, 2, 2, 2, 4, 2,
       4, 2, 2, 2, 2, 4, 2, 2, 2, 4, 2, 4, 4, 4, 2, 2, 4, 2, 2, 2, 2, 2,
       4, 4, 4, 2, 2, 2, 2, 2, 4, 4, 4, 4, 2, 4, 2, 2, 4, 4, 4, 4, 4, 2,
       2, 4, 4, 2, 2, 4, 2, 2])
```

```
knn.predict_proba(X_test)[:,0]
```

[36] Python

```
array([1.        , 1.        , 0.33333333, 1.        , 0.        ,
       1.        , 0.        , 1.        , 0.        , 0.66666667,
       1.        , 1.        , 0.        , 0.33333333, 0.        ,
       1.        , 1.        , 0.        , 0.        , 1.        ,
       0.        , 0.        , 1.        , 1.        , 1.        ,
       0.        , 1.        , 1.        , 0.        , 0.        ,
       1.        , 1.        , 1.        , 1.        , 1.        ,
       0.66666667, 1.        , 0.        , 1.        , 1.        ,
       1.        , 1.        , 1.        , 1.        , 0.        ,
       0.        , 1.        , 0.        , 1.        , 0.        ,
       0.        , 1.        , 1.        , 0.        , 1.        ,
       1.        , 1.        , 1.        , 0.66666667, 1.        ,
       0.        , 1.        , 1.        , 0.        , 0.        ,
       0.33333333, 0.        , 1.        , 1.        , 0.        ,
       1.        , 1.        , 0.        , 0.        , 1.        ,
       1.        , 1.        , 1.        , 0.        , 1.        ,
       1.        , 1.        , 0.        , 1.        , 1.        ,
       1.        , 0.        , 1.        , 0.        , 0.        ,
       1.        , 1.        , 0.66666667, 0.        , 1.        ,
       1.        , 1.        , 0.        , 1.        , 0.        ,
       0.        , 1.        , 1.        , 1.        , 0.        ,
       1.        , 1.        , 1.        , 1.        , 1.        ,
       0.        , 0.33333333, 0.        , 1.        , 1.        ,
       1.        , 1.        , 1.        , 0.        , 0.        ,
       0.        , 0.33333333, 1.        , 0.        , 1.        ,
       1.        , 0.33333333, 0.33333333, 0.        , 0.        ,
       0.        , 1.        , 1.        , 0.33333333, 0.        ,
       1.        , 1.        , 0.        , 1.        , 1.        ])
```

```
from sklearn.metrics import accuracy_score

print('Model accuracy score: {0:0.4f}'. format(accuracy_score(y_test, y_pred)))
```

[39] Python

```
Model accuracy score: 0.9714
```

```
y_pred_train = knn.predict(X_train)
```

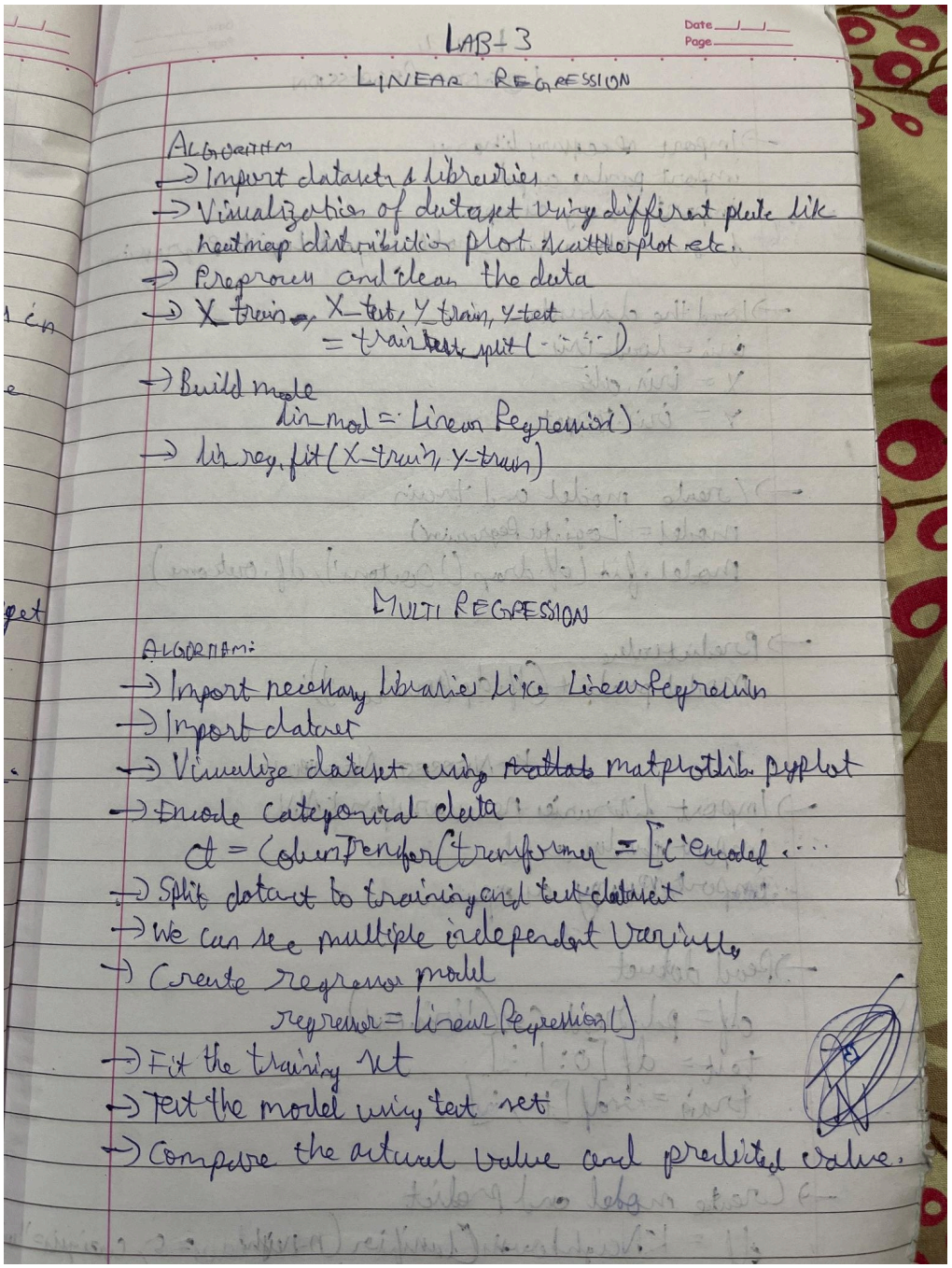
```
print('Training-set accuracy score: {0:0.4f}'. format(accuracy_score(y_train, y_pred_train)))
```

[7] Python

```
Training-set accuracy score: 0.9821
```

03/05/2024

Linear Regression



LAB-3

LINEAR REGRESSION

ALGORITHM

→ Import datasets & libraries
→ Visualization of dataset using different plots like heatmap distribution plot, scatterplot etc.
→ Preprocess and clean the data
→ X_train, X_test, Y_train, Y_test = train_test_split(...)
→ Build model
lin_mod = LinearRegression()
→ lin_reg.fit(X_train, Y_train)

MULTI REGRESSION

ALGORITHM:

→ Import necessary libraries like LinearRegression
→ Import dataset
→ Visualize dataset using matplotlib.pyplot
→ Encode categorical data:
ct = ColumnTransformer(transformers = [('encoder', ...
→ Split dataset to training and test dataset
→ We can see multiple independent variable
→ Create regressor model
regressor = LinearRegression()
→ Fit the training set
→ Test the model using test set
→ Compare the actual value and predicted value.

Code and output:

```
y_pred = model.predict(X_test)
```

```
y_pred
```

```
array([ 90555.15,  59516.62, 106544.7 ,  64219.43,  68922.24, 123474.81,
        84911.78,  63278.87,  65159.99,  61397.74,  37883.7 ,  50111.  ])
```

```
from sklearn.metrics import mean_absolute_error, mean_absolute_percentage_error, mean_squared_error
```

```
import numpy as np
```

```
mean_absolute_error(y_test,y_pred)
```

```
4005.9263101681768
```

Multiple Regression

```
house = pd.read_csv('https://github.com/YBIFoundation/Dataset/raw/main/Boston.csv')
```

```
house.head()
```

	CRIM	ZN	INDUS	CHAS	NX	RM	AGE	DIS	RAD	TAX	PTRATIO	B	LSTAT	MEDV
0	0.00632	18.0	2.31	0	0.538	6.575	65.2	4.0900	1	296.0	15.3	396.90	4.98	24.0
1	0.02731	0.0	7.07	0	0.469	6.421	78.9	4.9671	2	242.0	17.8	396.90	9.14	21.6
2	0.02729	0.0	7.07	0	0.469	7.185	61.1	4.9671	2	242.0	17.8	392.83	4.03	34.7
3	0.03237	0.0	2.18	0	0.458	6.998	45.8	6.0622	3	222.0	18.7	394.63	2.94	33.4
4	0.06905	0.0	2.18	0	0.458	7.147	54.2	6.0622	3	222.0	18.7	396.90	5.33	36.2

```
house.describe()
```

	CRIM	ZN	INDUS	CHAS	NX	RM	AGE	DIS	RAD	TAX	PTRATIO	B	LSTAT	MEDV
count	506.000000	506.000000	506.000000	506.000000	506.000000	506.000000	506.000000	506.000000	506.000000	506.000000	506.000000	506.000000	506.000000	506.000000
mean	3.613524	11.363636	11.136779	0.069170	0.554695	6.284634	68.574901	3.795043	9.549407	408.237154	18.455534	356.674032	12.653063	22.532806
std	8.601545	23.322453	6.860353	0.253994	0.115878	0.702617	28.148861	2.105710	8.707259	168.537116	2.164946	91.294864	7.141062	9.197104
min	0.006320	0.000000	0.460000	0.000000	0.385000	3.561000	2.900000	1.129600	1.000000	187.000000	12.600000	0.320000	1.730000	5.000000
25%	0.082045	0.000000	5.190000	0.000000	0.449000	5.885500	45.025000	2.100175	4.000000	279.000000	17.400000	375.377500	6.950000	17.025000
50%	0.256510	0.000000	9.690000	0.000000	0.538000	6.208500	77.500000	3.207450	5.000000	330.000000	19.050000	391.440000	11.360000	21.200000
75%	3.677083	12.500000	18.100000	0.000000	0.624000	6.623500	94.075000	5.188425	24.000000	666.000000	20.200000	396.225000	16.955000	25.000000
max	88.976200	100.000000	27.740000	1.000000	0.871000	8.780000	100.000000	12.126500	24.000000	711.000000	22.000000	396.900000	37.970000	50.000000

```
house.columns
```

```
Index(['CRIM', 'ZN', 'INDUS', 'CHAS', 'NX', 'RM', 'AGE', 'DIS', 'RAD', 'TAX',
       'PTRATIO', 'B', 'LSTAT', 'MEDV'],
      dtype='object')
```

```
y = house['MEDV']
```

```
X = house.drop(['MEDV'],axis=1)
```

```
from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(X,y, train_size=0.7, random_state=2529)
```

```
X_train.shape, X_test.shape, y_train.shape, y_test.shape
```

```
((354, 13), (152, 13), (354,), (152,))
```

```
from sklearn.linear_model import LinearRegression
model = LinearRegression()
```

```python
# Step 6 : train or fit model
model.fit(X_train,y_train)
```

```
LinearRegression()
```

```python
model.intercept_
```

```
34.21916368862993
```

```python
model.coef_
```

```
array([-1.29e-01,  3.65e-02,  1.54e-02,  2.35e+00, -2.04e+01,  4.41e+00,
        4.61e-03, -1.59e+00,  2.51e-01, -9.60e-03, -9.64e-01,  1.01e-02,
       -5.43e-01])
```

```python
# Step 7 : predict model
y_pred = model.predict(X_test)
```

```python
y_pred
```

```
array([31.72, 22.02, 21.17, 39.78, 20.1 , 22.86, 18.36, 14.79, 22.56,
       21.35, 18.38, 27.97, 29.86,  6.45, 10.68, 26.25, 21.89, 25.23,
        3.62, 36.22, 24.08, 22.94, 14.27, 20.79, 24.23, 16.74, 18.75,
       20.97, 28.51, 20.86,  9.23, 17.07, 22.07, 22.23, 39.26, 26.17,
       42.5 , 19.35, 34.52, 14.07, 13.81, 23.28, 11.79,  9.01, 21.65,
       25.55, 18.17, 16.82, 14.66, 14.86, 33.79, 33.27, 15.49, 24.08,
       27.64, 19.58, 45.02, 20.97, 20.07, 27.67, 34.59, 12.71, 23.66,
       31.66, 28.97, 32.46, 13.93, 35.49, 19.36, 19.6 ,  1.44, 24.1 ,
       33.67, 20.62, 26.89, 21.29, 31.95, 29.74, 13.93, 13.82, 19.76,
       21.54, 20.87, 23.63, 28.8 , 23.64,  6.95, 22.2 , -6.82, 16.97,
       16.77, 25.44, 14.95,  3.72, 15.03, 16.91, 21.46, 31.66, 30.72,
       23.73, 22.19, 13.76, 18.47, 18.15, 36.6 , 27.49, 11.  , 17.26,
       22.49, 16.53, 29.49, 22.89, 24.68, 20.36, 19.69, 22.55, 27.32,
       24.86, 20.2 , 29.14,  7.43,  5.85, 25.35, 38.73, 23.94, 25.28,
       20.11, 19.75, 25.07, 35.16, 27.32, 27.26, 31.4 , 16.55, 14.3 ,
       23.77,  7.65, 23.35, 21.37, 26.12, 25.32, 13.12, 17.67, 36.2 ,
       20.5 , 27.95, 22.46, 18.15, 31.24, 20.85, 27.36, 30.53])
```

```python
# Step 8 : model accuracy
from sklearn.metrics import mean_absolute_error, mean_absolute_percentage_error, mean_squared_error
```

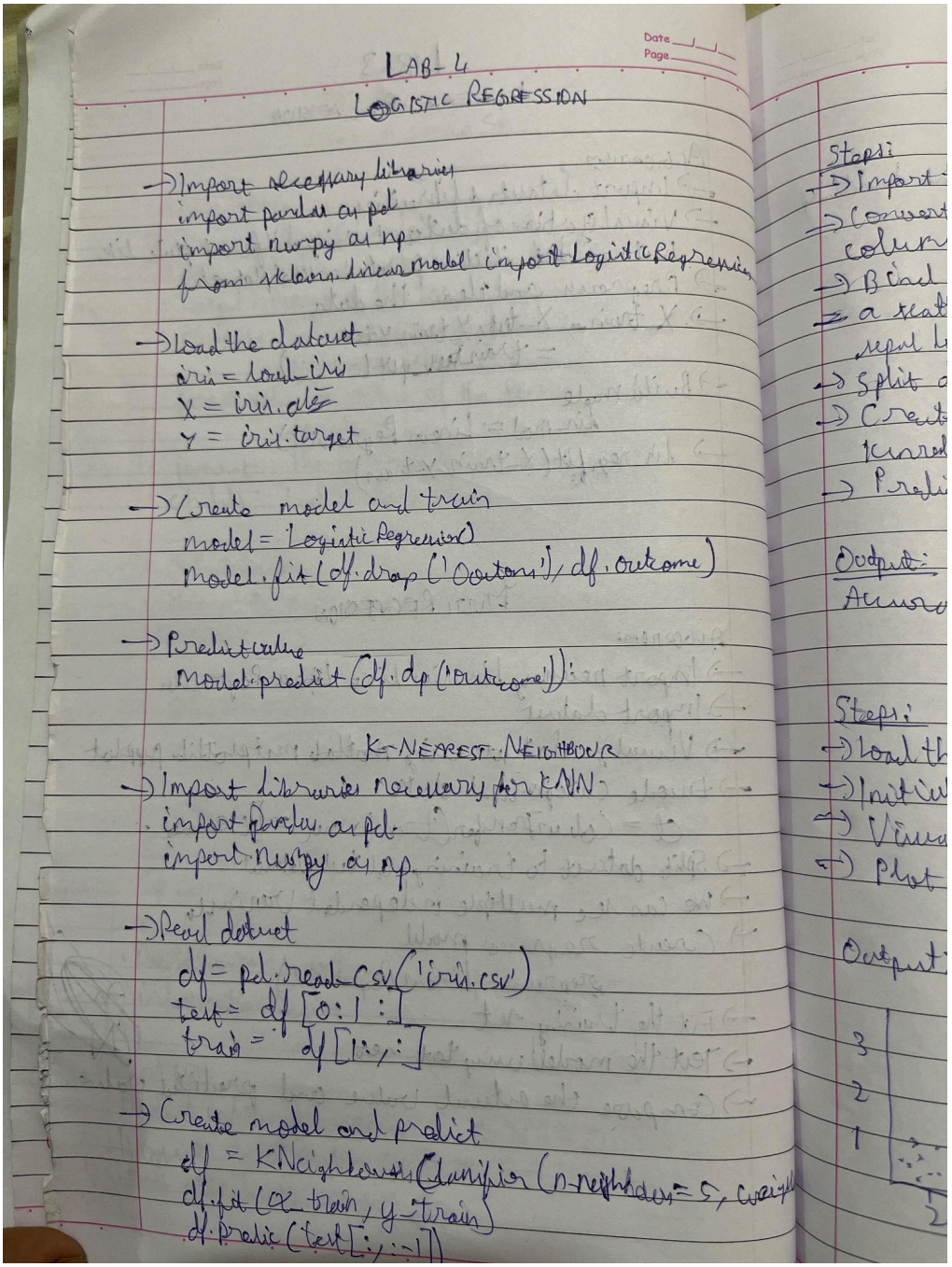
```python
mean_absolute_error(y_test,y_pred)
```

```
3.155030927602485
```

```python

```

03/05/2024

Logistic Regression



LAB-4

LOGISTIC REGRESSION

→ Import necessary libraries
import pandas as pd
import numpy as np
from sklearn.linear_model import LogisticRegression

→ Load the dataset
iris = load_iris
X = iris.data
y = iris.target

→ Create model and train
model = LogisticRegression()
model.fit(df.drop('Outcome'), df.Outcome)

→ Predict value
model.predict(df.dp('Outcome'))

K-NEAREST NEIGHBOUR

→ Import libraries necessary for KNN
import pandas as pd
import numpy as np

→ Read dataset
df = pd.read_csv('iris.csv')
test = df[0:1:]
train = df[1:,:]

→ Create model and predict
df = KNeighborsClassifier(n_neighbors=5, weigh
df.fit(X_train, y_train)
df.predic(test[:,:-1])

Steps:
→ Import
→ Convert
colum
→ Bind
→ a feat
input
→ Split
→ Creat
Kneigh
→ Predi

Output:
Accur

Steps:
→ Load th
→ Initiat
→ Visua
→ Plot

Output:

3
2
1

```python
def initialize_weights_and_bias(dimension):
    w = np.full((dimension,1),0.01)
    b = 0.0
    return w, b
```

[9] Python

```python
def sigmoid(z):
    y_head = 1/(1+np.exp(-z))
    return y_head
```

[10] Python

```python
def forward_backward_propagation(w,b,x_train,y_train):
    # forward propagation
    z = np.dot(w.T,x_train) + b
    y_head = sigmoid(z)
    loss = -y_train*np.log(y_head)-(1-y_train)*np.log(1-y_head)
    cost = (np.sum(loss))/x_train.shape[1]      # x_train.shape[1]  is for scaling
    # backward propagation
    derivative_weight = (np.dot(x_train,((y_head-y_train).T)))/x_train.shape[1] # x_train.shape[1]  is for scaling
    derivative_bias = np.sum(y_head-y_train)/x_train.shape[1]                 # x_train.shape[1]  is for scaling
    gradients = {"derivative_weight": derivative_weight,"derivative_bias": derivative_bias}
    return cost,gradients
```

Python

```python
def update(w, b, x_train, y_train, learning_rate,number_of_iterarion):
    cost_list = []
    cost_list2 = []
    index = []
    # updating(learning) parameters is number_of_iterarion times
    for i in range(number_of_iterarion):
        # make forward and backward propagation and find cost and gradients
        cost,gradients = forward_backward_propagation(w,b,x_train,y_train)
        cost_list.append(cost)
        w = w - learning_rate * gradients["derivative_weight"]
        b = b - learning_rate * gradients["derivative_bias"]
        if i % 10 == 0:
            cost_list2.append(cost)
            index.append(i)
            print ("Cost after iteration %i: %f" %(i, cost))
    # we update(learn) parameters weights and bias
    parameters = {"weight": w,"bias": b}
    plt.plot(index,cost_list2)
    plt.xticks(index,rotation='vertical')
    plt.xlabel("Number of Iterarion")
    plt.ylabel("Cost")
    plt.show()
    return parameters, gradients, cost_list
```

Python

```python
def predict(w,b,x_test):
    # x_test is a input for forward propagation
    z = sigmoid(np.dot(w.T,x_test)+b)
    Y_prediction = np.zeros((1,x_test.shape[1]))
    # if z is bigger than 0.5, our prediction is sign one (y_head=1),
    # if z is smaller than 0.5, our prediction is sign zero (y_head=0),
    for i in range(z.shape[1]):
        if z[0,i]<= 0.5:
            Y_prediction[0,i] = 0
        else:
            Y_prediction[0,i] = 1

    return Y_prediction
```

[11] Python

```
!pip install mymodule
```

[18] Python

```
Collecting mymodule
  Downloading myModule-1.0.0.tar.gz (787 bytes)
  Preparing metadata (setup.py) ... done
Building wheels for collected packages: mymodule
  Building wheel for mymodule (setup.py) ... done
  Created wheel for mymodule: filename=myModule-1.0.0-py3-none-any.whl size=1413 sha256=2cdcfae4d015fdc631a533b7e726b48c29061c95d1a6a50b070d71cb04054f3f
  Stored in directory: /root/.cache/pip/wheels/f4/64/ed/4ac2e7514f3e85b8aea309dff4c236817b10c4d0809e5511d8
Successfully built mymodule
Installing collected packages: mymodule
Successfully installed mymodule-1.0.0
```

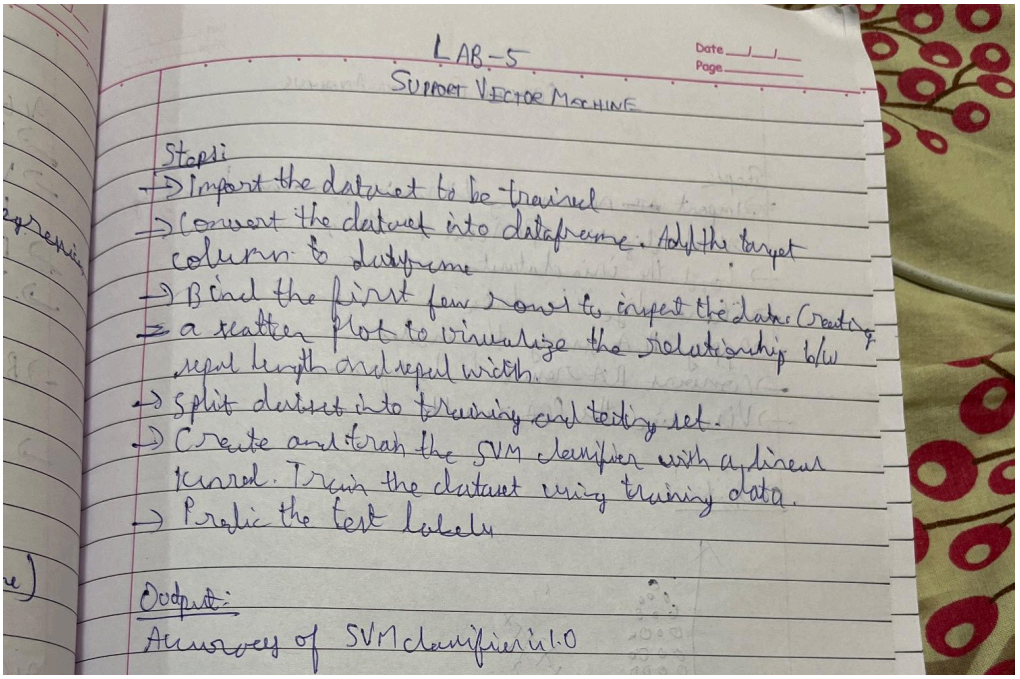
```python
def sigmoid(z):
    return 1 / (1 + np.exp(-z))

def initialize_weights_and_bias(dim):
    w = np.zeros((dim, 1))
    b = 0
    return w, b

def compute_cost(w, b, x, y):
    m = x.shape[1]
    A = sigmoid(np.dot(w.T, x) + b)
    cost = -1 / m * np.sum(y * np.log(A) + (1 - y) * np.log(1 - A))
    return cost

def propagate(w, b, x, y):
    m = x.shape[1]
    A = sigmoid(np.dot(w.T, x) + b)
    dw = 1 / m * np.dot(x, (A - y).T)
    db = 1 / m * np.sum(A - y)
    return dw, db

def logistic_regression(x_train, y_train, x_test, y_test, learning_rate, num_iterations):
    # Initialize
    dimension = x_train.shape[0]  # Number of features
    w, b = initialize_weights_and_bias(dimension)
    costs = []

    # Gradient Descent
    for i in range(num_iterations):
        # Forward and Backward Propagation
        dw, db = propagate(w, b, x_train, y_train)

        # Update parameters
        w -= learning_rate * dw
        b -= learning_rate * db

        # Record the costs
        if i % 100 == 0:
            cost = compute_cost(w, b, x_train, y_train)
            costs.append(cost)
            print(f"Cost after iteration {i}: {cost}")

    # Evaluate model
    y_prediction_train = predict(w, b, x_train)
    y_prediction_test = predict(w, b, x_test)

    train_accuracy = 100 - np.mean(np.abs(y_prediction_train - y_train)) * 100
    test_accuracy = 100 - np.mean(np.abs(y_prediction_test - y_test)) * 100

    print("Train accuracy: {} %".format(train_accuracy))
    print("Test accuracy: {} %".format(test_accuracy))

    return w, b

# Assuming you have defined the predict function
# def predict(w, b, x):
#     ...

# Assuming you have defined x_train, y_train, x_test, y_test, learning_rate, and num_iterations
logistic_regression(x_train, y_train, x_test, y_test, learning_rate=1, num_iterations=100)
```

```
Cost after iteration 0: 0.6782740160052536
Train accuracy: 80.74534161490683 %
Test accuracy: 81.3953488372093 %

(array([[ 1.77806654e-02],
        [ 1.10160388e-02],
        [ 1.27806976e-01],
        [ 1.95749649e+00],
        [ 1.85931875e-05],
        [ 2.68863405e-04],
        [ 4.89020048e-04],
        [ 2.63106803e-04],
        [ 3.49357933e-05],
        [-2.02145931e-05],
        [ 1.25690784e-03],
        [-3.98285024e-04],
        [ 8.96937014e-03],
        [ 2.02420962e-01],
        [-3.60718647e-06],
        [ 4.19150446e-05],
        [ 6.03411729e-05],
        [ 2.00740406e-05],
        [-6.24803672e-06],
        [ 6.24944780e-07],
        [ 2.79506973e-02],
        [ 1.99326360e-02],
        [ 1.98774923e-01],
        [ 3.39189908e+00],
        [ 5.79135019e-05],
 ...
        [ 1.25862280e-03],
        [ 4.60695564e-04],
        [ 1.89671301e-04],
        [ 3.52490835e-05]]),
 -1.5161875221606185)
```

24/05/2024

Build Support vector machine model for a given dataset

Algorithm:



Code and Output:

```
df.drop('id', axis=1, inplace=True) #drop redundant columns
```

```
df.describe().T
```

	count	mean	std	min	25%	50%	75%	max
radius_mean	569.0	14.127292	3.524049	6.981000	11.700000	13.370000	15.780000	28.11000
texture_mean	569.0	19.289649	4.301036	9.710000	16.170000	18.840000	21.800000	39.28000
perimeter_mean	569.0	91.969033	24.298981	43.790000	75.170000	86.240000	104.100000	188.50000
area_mean	569.0	654.889104	351.914129	143.500000	420.300000	551.100000	782.700000	2501.00000
smoothness_mean	569.0	0.096360	0.014064	0.052630	0.086370	0.095870	0.105300	0.16340
compactness_mean	569.0	0.104341	0.052813	0.019380	0.064920	0.092630	0.130400	0.34540
concavity_mean	569.0	0.088799	0.079720	0.000000	0.029560	0.061540	0.130700	0.42680
concave points_mean	569.0	0.048919	0.038803	0.000000	0.020310	0.033500	0.074000	0.20120
symmetry_mean	569.0	0.181162	0.027414	0.106000	0.161900	0.179200	0.195700	0.30400
fractal_dimension_mean	569.0	0.062798	0.007060	0.049960	0.057700	0.061540	0.066120	0.09744
radius_se	569.0	0.405172	0.277313	0.111500	0.232400	0.324200	0.478900	2.87300
texture_se	569.0	1.216853	0.551648	0.360200	0.833900	1.108000	1.474000	4.88500
perimeter_se	569.0	2.866059	2.021855	0.757000	1.606000	2.287000	3.357000	21.98000
area_se	569.0	40.337079	45.491006	6.802000	17.850000	24.530000	45.190000	542.20000
smoothness_se	569.0	0.007041	0.003003	0.001713	0.005169	0.006380	0.008146	0.03113
compactness_se	569.0	0.025478	0.017908	0.002252	0.013080	0.020450	0.032450	0.13540
concavity_se	569.0	0.031894	0.030186	0.000000	0.015090	0.025890	0.042050	0.39600
concave points_se	569.0	0.011796	0.006170	0.000000	0.007638	0.010930	0.014710	0.05279
symmetry_se	569.0	0.020542	0.008266	0.007882	0.015160	0.018730	0.023480	0.07895
fractal_dimension_se	569.0	0.003795	0.002646	0.000895	0.002248	0.003187	0.004558	0.02984
radius_worst	569.0	16.269190	4.833242	7.930000	13.010000	14.970000	18.790000	36.04000
texture_worst	569.0	25.677223	6.146258	12.020000	21.080000	25.410000	29.720000	49.54000
perimeter_worst	569.0	107.261213	33.602542	50.410000	84.110000	97.660000	125.400000	251.20000
area_worst	569.0	880.583128	569.356993	185.200000	515.300000	686.500000	1084.000000	4254.00000
smoothness_worst	569.0	0.132369	0.022832	0.071170	0.116600	0.131300	0.146000	0.22260
compactness_worst	569.0	0.254265	0.157336	0.027290	0.147200	0.211900	0.339100	1.05800
concavity_worst	569.0	0.272188	0.208624	0.000000	0.114500	0.226700	0.382800	1.25200
concave points_worst	569.0	0.114606	0.065732	0.000000	0.064930	0.099930	0.161400	0.29100
symmetry_worst	569.0	0.290076	0.061867	0.156500	0.250400	0.282200	0.317900	0.66380
fractal_dimension_worst	569.0	0.083946	0.018061	0.055040	0.071460	0.080040	0.092080	0.20750

```
df['diagnosis'] = (df['diagnosis'] == 'M').astype(int) #encode the label into 1/0
```

```
corr = df.corr()
```

```python
# Get the absolute value of the correlation
cor_target = abs(corr["diagnosis"])

# Select highly correlated features (threshold = 0.2)
relevant_features = cor_target[cor_target>0.2]

# Collect the names of the features
names = [index for index, value in relevant_features.items()]

# Drop the target variable from the results
names.remove('diagnosis')

# Display the results
print(names)
```

```
['radius_mean', 'texture_mean', 'perimeter_mean', 'area_mean', 'smoothness_mean', 'compactness_mean', 'concavity_mean', 'concave points_mean', 'symmetry_mean', 'radius_se', 'perimeter_se', 'area_se', 'compactness_se', 'concavity_se', 'concave points_se', 'radius_worst', 'texture_worst', 'perimeter_worst', 'area_worst', 'smoothness_worst',
```

```python
X = df[names].values
y = df['diagnosis']
```

```python
def scale(X):
    """
    Standardizes the data in the array X.

    Parameters:
        X (numpy.ndarray): Features array of shape (n_samples, n_features).

    Returns:
        numpy.ndarray: The standardized features array.
    """
    # Calculate the mean and standard deviation of each feature
    mean = np.mean(X, axis=0)
    std = np.std(X, axis=0)

    # Standardize the data
    X = (X - mean) / std
    return X
```

```python
X = scale(X)
```

```python
X = scale(X)
```

```python
def train_test_split(X, y, random_state=41, test_size=0.2):
    """
    Splits the data into training and testing sets.

    Parameters:
        X (numpy.ndarray): Features array of shape (n_samples, n_features).
        y (numpy.ndarray): Target array of shape (n_samples,).
        random_state (int): Seed for the random number generator. Default is 42.
        test_size (float): Proportion of samples to include in the test set. Default is 0.2.

    Returns:
        Tuple[numpy.ndarray]: A tuple containing X_train, X_test, y_train, y_test.
    """
    # Get number of samples
    n_samples = X.shape[0]

    # Set the seed for the random number generator
    np.random.seed(random_state)

    # Shuffle the indices
    shuffled_indices = np.random.permutation(np.arange(n_samples))

    # Determine the size of the test set
    test_size = int(n_samples * test_size)

    # Split the indices into test and train
    test_indices = shuffled_indices[:test_size]
    train_indices = shuffled_indices[test_size:]

    # Split the features and target arrays into test and train
    X_train, X_test = X[train_indices], X[test_indices]
    y_train, y_test = y[train_indices], y[test_indices]

    return X_train, X_test, y_train, y_test
```

```python
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size = 0.2, random_state=42) #split the  data into traing and validatin
```

```python
class SVM:
    """
    A Support Vector Machine (SVM) implementation using gradient descent.

    Parameters:
    -----------
    iterations : int, default=1000
        The number of iterations for gradient descent.
    lr : float, default=0.01
        The learning rate for gradient descent.
    lambdaa : float, default=0.01
        The regularization parameter.

    Attributes:
    -----------
    lambdaa : float
        The regularization parameter.
    iterations : int
        The number of iterations for gradient descent.
    lr : float
        The learning rate for gradient descent.
    w : numpy array
        The weights.
    b : float
        The bias.

    Methods:
    --------
    initialize_parameters(X)
        Initializes the weights and bias.
    gradient_descent(X, y)
        Updates the weights and bias using gradient descent.
    update_parameters(dw, db)
        Updates the weights and bias.
    fit(X, y)
        Fits the SVM to the data.
    predict(X)
        Predicts the labels for the given data.

    """

    def __init__(self, iterations=1000, lr=0.01, lambdaa=0.01):
        """
        Initializes the SVM model.

        Parameters:
        -----------
        iterations : int, default=1000
            The number of iterations for gradient descent.
        lr : float, default=0.01
            The learning rate for gradient descent.
        lambdaa : float, default=0.01
            The regularization parameter.
        """
        self.lambdaa = lambdaa
        self.iterations = iterations
        self.lr = lr
        self.w = None
        self.b = None
    def initialize_parameters(self, X):
        """
        Initializes the weights and bias.

        Parameters:
        -----------
        X : numpy array
            The input data.
        """
```

```
        m, n = X.shape
        self.w = np.zeros(n)
        self.b = 0

    def gradient_descent(self, X, y):
        """
        Updates the weights and bias using gradient descent.

        Parameters:
        -----------
        X : numpy array
            The input data.
        y : numpy array
            The target values.
        """
        y_ = np.where(y <= 0, -1, 1)
        for i, x in enumerate(X):
            if y_[i] * (np.dot(x, self.w) - self.b) >= 1:
                dw = 2 * self.lambdaa * self.w
                db = 0
            else:
                dw = 2 * self.lambdaa * self.w - np.dot(x, y_[i])
                db = y_[i]
            self.update_parameters(dw, db)

    def update_parameters(self, dw, db):
        """
        Updates the weights and bias.

        Parameters:
        -----------
        dw : numpy array
            The change in weights.
        db : float
            The change in bias.
        """
        self.w = self.w - self.lr * dw
        self.b = self.b - self.lr * db
    def fit(self, X, y):
        """
        Fits the SVM to the data.

        Parameters:
        -----------
        X : numpy array
            The input data.
        y : numpy array
            The target values.
        """
        self.initialize_parameters(X)
        for i in range(self.iterations):
            self.gradient_descent(X, y)


    def predict(self, X):
        """
        Predicts the class labels for the test data.

        Parameters
        ----------
        X : array-like, shape (n_samples, n_features)
            The input data.

        Returns
        -------
        y_pred : array-like, shape (n_samples,)
            The predicted class labels.

        """
```

```
        # get the outputs
        output = np.dot(X, self.w) - self.b
        # get the signs of the labels depending on if it's greater/less than zero
        label_signs = np.sign(output)
        #set predictions to 0 if they are less than or equal to -1 else set them to 1
        predictions = np.where(label_signs <= -1, 0, 1)
        return predictions
```

Python

```
def accuracy(y_true, y_pred):
    """
    Computes the accuracy of a classification model.

    Parameters:
    ----------
        y_true (numpy array): A numpy array of true labels for each data point.
        y_pred (numpy array): A numpy array of predicted labels for each data point.

    Returns:
    ----------
        float: The accuracy of the model
    """
    total_samples = len(y_true)
    correct_predictions = np.sum(y_true == y_pred)
    return (correct_predictions / total_samples)
```

Python

```
model = SVM()
model.fit(X_train,y_train)
predictions = model.predict(X_test)

accuracy(y_test, predictions)
```

Python

```
0.9823008849557522
```

```
model.predict([-0.47069478, -0.16948594, -0.44139056, -0.49198076,  0.2311423,
       -0.02765051, -0.38984741, 0.27623152,  0.41394187, -0.03274266,
       -0.18269561, 0.22385292, 0.35591235, 0.16192549, -0.23133322,
       0.25003051, -0.16896536, -0.33303537, 0.35620025,  0.0435902 ,
       -0.10478068, -0.02441212, -0.26056318,  0.18520441,  0.10485784]])
```

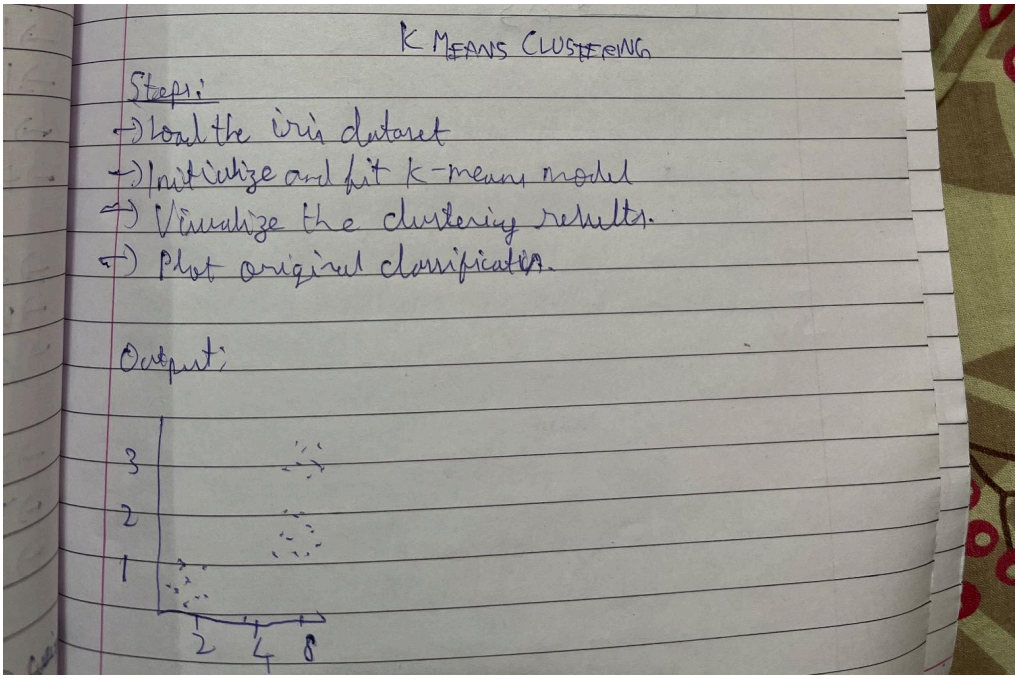
Python

```
array(0)
```

24/05/2024

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

Algorithm:




```
        Returns:
        numpy.ndarray: array containing the index of the centroid for each point
        """
        X = np.expand_dims(X, axis=1) # expand dimensions to match shape of centroids
        distance = np.linalg.norm(X - self.centroids, axis=-1) # calculate Euclidean distance between each point and each centroid
        points = np.argmin(distance, axis=1) # assign each point to the closest centroid
        assert len(points) == X.shape[0], "Number of assigned points should equal the number of data points."
        return points

    def compute_mean(self, X, points):
        """
        Compute the mean of the points assigned to each centroid.

        Parameters:
        X (numpy.ndarray): dataset to cluster
        points (numpy.ndarray): array containing the index of the centroid for each point

        Returns:
        numpy.ndarray: array containing the new centroids for each cluster
        """
        centroids = np.zeros((self.K, X.shape[1])) # initialize array to store centroids
        for i in range(self.K):
            centroid_mean = X[points == i].mean(axis=0) # calculate mean of the points assigned to the current centroid
            centroids[i] = centroid_mean # assign the new centroid to the mean of its points
        return centroids

    def fit(self, X, iterations=10):
        """
        Cluster the dataset using the K-Means algorithm.

        Parameters:
        X (numpy.ndarray): dataset to cluster
        iterations (int): number of iterations to perform (default=10)

        Returns:
        numpy.ndarray: array containing the final centroids for each cluster
        numpy.ndarray: array containing the index of the centroid for each point
        """
        self.initialize_centroids(X) # initialize the centroids
        for i in range(iterations):
            points = self.assign_points_centroids(X) # assign each point to the nearest centroid
            self.centroids = self.compute_mean(X, points) # compute the new centroids based on the mean of their points

            # Assertions for debugging and validation
            assert len(self.centroids) == self.K, "Number of centroids should equal K."
            assert X.shape[1] == self.centroids.shape[1], "Dimensionality of centroids should match input data."
            assert max(points) < self.K, "Cluster index should be less than K."
            assert min(points) >= 0, "Cluster index should be non-negative."

        return self.centroids, points
```

python

```
X = X.values
```

python

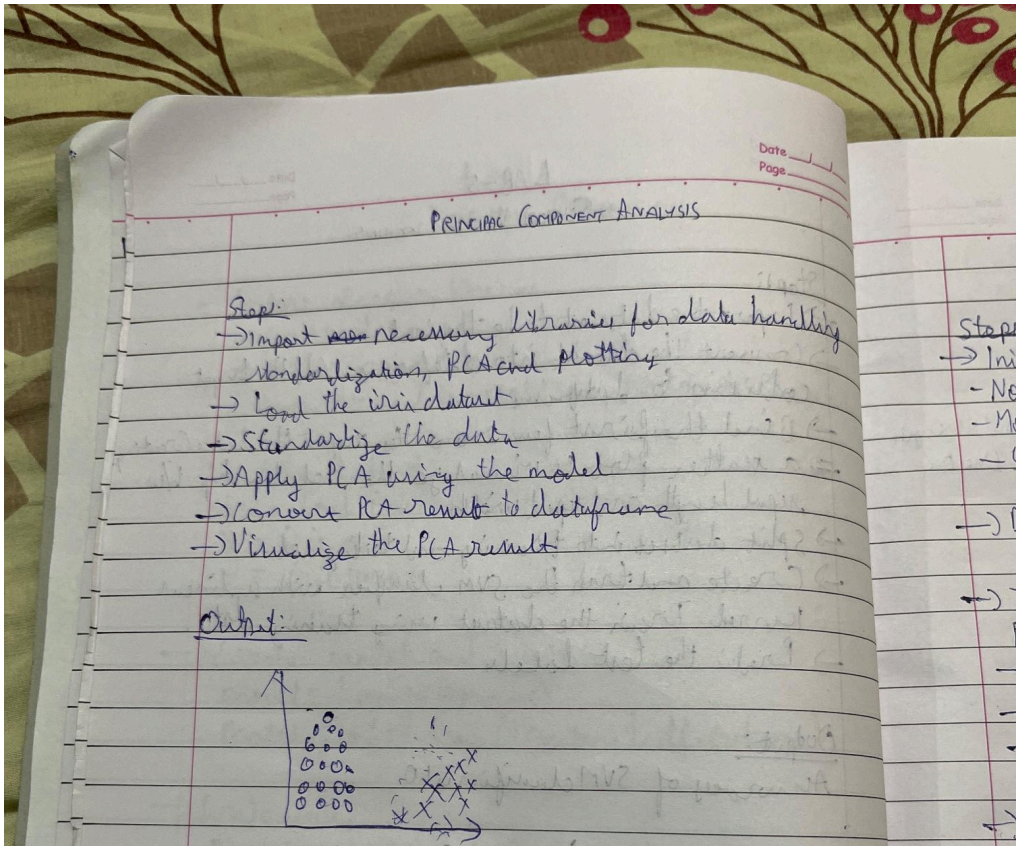
```
kmeans = Kmeans(3)

centroids, points = kmeans.fit(X, 1000)
```

python

```python
fig = go.Figure()
fig.add_trace(go.Scatter(
    x=X[points == 0, 0], y=X[points == 0, 1],
    mode='markers',marker_color='#58ACE2',name='Iris-setosa'
))

fig.add_trace(go.Scatter(
    x=X[points == 1, 0], y=X[points == 1, 1],
    mode='markers',marker_color='#c5e0f6',name='Iris-versicolour'
))

fig.add_trace(go.Scatter(
    x=X[points == 2, 0], y=X[points == 2, 1],
    mode='markers',marker_color='#7D3AC1',name='Iris-virginica'
))

fig.add_trace(go.Scatter(
    x=centroids[:, 0], y=centroids[:,1],
    mode='markers',marker_color='#CA3ACD',marker_symbol=4,marker_size=13,name='Centroids'
))
fig.update_layout(template='plotly_dark',width=1000, height=500,)
```

24/05/2024

Implement Dimensionality reduction using Principle Component Analysis (PCA) Algorithm:




```python
# Get the absolute value of the correlation
cor_target = abs(corr["diagnosis"])

# Select highly correlated features (threshold = 0.2)
relevant_features = cor_target[cor_target>0.2]

# Collect the names of the features
names = [index for index, value in relevant_features.items()]

# Drop the target variable from the results
names.remove('diagnosis')

# Display the results
print(names)
```

```
['radius_mean', 'texture_mean', 'perimeter_mean', 'area_mean', 'smoothness_mean', 'compactness_mean', 'concavity_mean', 'concave points_mean', 'symmetry_mean', 'radius_se', 'perimeter_se', 'area_se', 'compactness_se', 'concavity_se', 'concave points_se', 'radius_worst', 'texture_worst', 'perimeter_worst', 'area_worst', 'smoothness_worst',
```

```python
X = df[names].values
```

```python
class PCA:
    """
    Principal Component Analysis (PCA) class for dimensionality reduction.
    """

    def __init__(self, n_components):
        """
        Constructor method that initializes the PCA object with the number of components to retain.

        Args:
        - n_components (int): Number of principal components to retain.
        """
        self.n_components = n_components
    def fit(self, X):
        """
        Fits the PCA model to the input data and computes the principal components.

        Args:
        - X (numpy.ndarray): Input data matrix with shape (n_samples, n_features).
        """
        # Compute the mean of the input data along each feature dimension.
        mean = np.mean(X, axis=0)

        # Subtract the mean from the input data to center it around zero.
        X = X - mean
```

```python
        # Compute the covariance matrix of the centered input data.
        cov = np.cov(X.T)

        # Compute the eigenvectors and eigenvalues of the covariance matrix.
        eigenvalues, eigenvectors = np.linalg.eigh(cov)
        # Reverse the order of the eigenvalues and eigenvectors.
        eigenvalues = eigenvalues[::-1]
        eigenvectors = eigenvectors[:,::-1]

        # Keep only the first n_components eigenvectors as the principal components.
        self.components = eigenvectors[:,:self.n_components]

        # Compute the explained variance ratio for each principal component.
        # Compute the total variance of the input data
        total_variance = np.sum(np.var(X, axis=0))

        # Compute the variance explained by each principal component
        self.explained_variances = eigenvalues[:self.n_components]

        # Compute the explained variance ratio for each principal component
        self.explained_variance_ratio_ = self.explained_variances / total_variance
    def transform(self, X):
        """
        Transforms the input data by projecting it onto the principal components.

        Args:
        - X (numpy.ndarray): Input data matrix with shape (n_samples, n_features).

        Returns:
        - transformed_data (numpy.ndarray): Transformed data matrix with shape (n_samples, n_components).
        """
        # Center the input data around zero using the mean computed during the fit step.
        X = X - np.mean(X, axis=0)

        # Project the centered input data onto the principal components.
        transformed_data = np.dot(X, self.components)

        return transformed_data

    def fit_transform(self, X):
        """
        Fits the PCA model to the input data and computes the principal components then
        transforms the input data by projecting it onto the principal components.

        Args:
        - X (numpy.ndarray): Input data matrix with shape (n_samples, n_features).
        """
        self.fit(X)
        transformed_data = self.transform(X)
        return transformed_data
```

Python

```python
pca = PCA(2)
```

Python

```python
pca.fit(X)
```

Python

```python
pca.explained_variance_ratio_
```

Python

```
array([0.98377428, 0.01620498])
```

```python
X_transformed = pca.transform(X)
```

Python

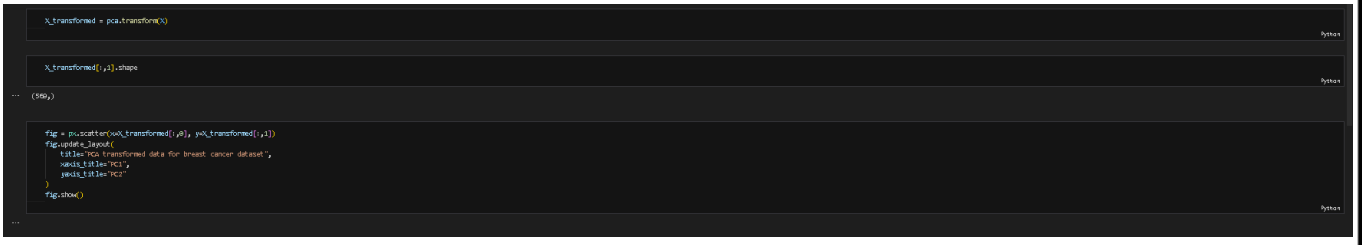
```python
X_transformed[:,1].shape
```

Python

```
(569,)
```

```python
fig = px.scatter(x=X_transformed[:,0], y=X_transformed[:,1])
fig.update_layout(
    title="PCA transformed data for breast cancer dataset",
    xaxis_title="PC1",
    yaxis_title="PC2"
)
fig.show()
```

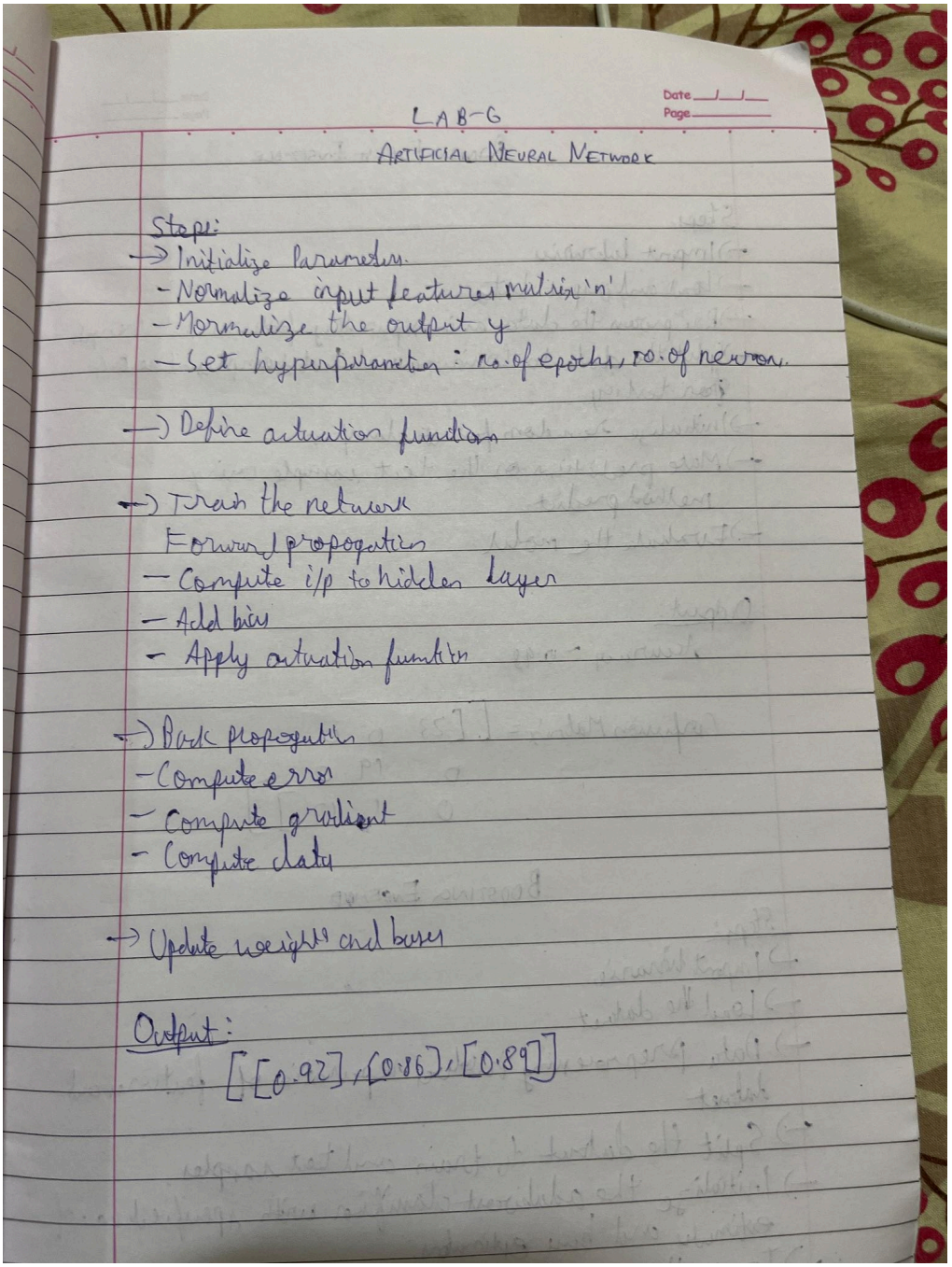
Python



31.05.2024

Build Artificial Neural Network model with back propagation on a given dataset

Algorithm:



LAB-6

ARTIFICIAL NEURAL NETWORK

Steps:

→ Initialize parameters.
- Normalize input features matrix 'x'
- Normalize the output y
- Set hyperparameters: no. of epochs, no. of neuron.

→ Define activation function

→ Train the network
Forward propogation
- Compute i/p to hidden layer
- Add bias
- Apply activation function

→ Back propogation
- Compute error
- Compute gradient
- Compute delta

→ Update weights and bases

Output:

[[0.92],[0.86],[0.89]]

```
import numpy as np
from sklearn.model_selection import train_test_split

db = np.loadtxt("/content/duke-breast-cancer.txt")
print("Database raw shape (%s,%s)" % np.shape(db))
```

```
Database raw shape (86,7130)
```

```
np.random.shuffle(db)
y = db[:, 0]
x = np.delete(db, [0], axis=1)
x_train, x_test, y_train, y_test = train_test_split(x, y, test_size=0.1)
print(np.shape(x_train),np.shape(x_test))
```

```
(77, 7129) (9, 7129)
```

```
hidden_layer = np.zeros(72)
weights = np.random.random((len(x[0]), 72))
output_layer = np.zeros(2)
hidden_weights = np.random.random((72, 2))
```

```
def sum_function(weights, index_locked_col, x):
    result = 0
    for i in range(0, len(x)):
        result += x[i] * weights[i][index_locked_col]
    return result
```

```
def activate_layer(layer, weights, x):
    for i in range(0, len(layer)):
        layer[i] = 1.7159 * np.tanh(2.0 * sum_function(weights, i, x) / 3.0)
```

```
def soft_max(layer):
    soft_max_output_layer = np.zeros(len(layer))
    for i in range(0, len(layer)):
        denominator = 0
        for j in range(0, len(layer)):
            denominator += np.exp(layer[j] - np.max(layer))
        soft_max_output_layer[i] = np.exp(layer[i] - np.max(layer)) / denominator
    return soft_max_output_layer
```

```
def recalculate_weights(learning_rate, weights, gradient, activation):
    for i in range(0, len(weights)):
        for j in range(0, len(weights[i])):
            weights[i][j] = (learning_rate * gradient[j] * activation[i]) + weights[i][j]
```

```
def back_propagation(hidden_layer, output_layer, one_hot_encoding, learning_rate, x):
    output_derivative = np.zeros(2)
    output_gradient = np.zeros(2)
    for i in range(0, len(output_layer)):
        output_derivative[i] = (1.0 - output_layer[i]) * output_layer[i]
    for i in range(0, len(output_layer)):
        output_gradient[i] = output_derivative[i] * (one_hot_encoding[i] - output_layer[i])
    hidden_derivative = np.zeros(72)
    hidden_gradient = np.zeros(72)
    for i in range(0, len(hidden_layer)):
        hidden_derivative[i] = (1.0 - hidden_layer[i]) * (1.0 + hidden_layer[i])
    for i in range(0, len(hidden_layer)):
        sum_ = 0
        for j in range(0, len(output_gradient)):
            sum_ += output_gradient[j] * hidden_weights[i][j]
        hidden_gradient[i] = sum_ * hidden_derivative[i]
    recalculate_weights(learning_rate, hidden_weights, output_gradient, hidden_layer)
    recalculate_weights(learning_rate, weights, hidden_gradient, x)
```

```
[13] one_hot_encoding = np.zeros((2,2))
     for i in range(0, len(one_hot_encoding)):
         one_hot_encoding[i][i] = 1
     training_correct_answers = 0
     for i in range(0, len(x_train)):
         activate_layer(hidden_layer, weights, x_train[i])
         activate_layer(output_layer, hidden_weights, hidden_layer)
         output_layer = soft_max(output_layer)
         training_correct_answers += 1 if y_train[i] == np.argmax(output_layer) else 0
         back_propagation(hidden_layer, output_layer, one_hot_encoding[int(y_train[i])], -1, x_train[i])
     print("MLP Correct answers while learning: %s / %s (Accuracy = %s) on %s database." % (training_correct_answers, len(x_train),
                                                                                            training_correct_answers/len(x_train),"Duke breast cancer"))
```

```
MLP Correct answers while learning: 44 / 77 (Accuracy = 0.5714285714285714) on Duke breast cancer database.
```

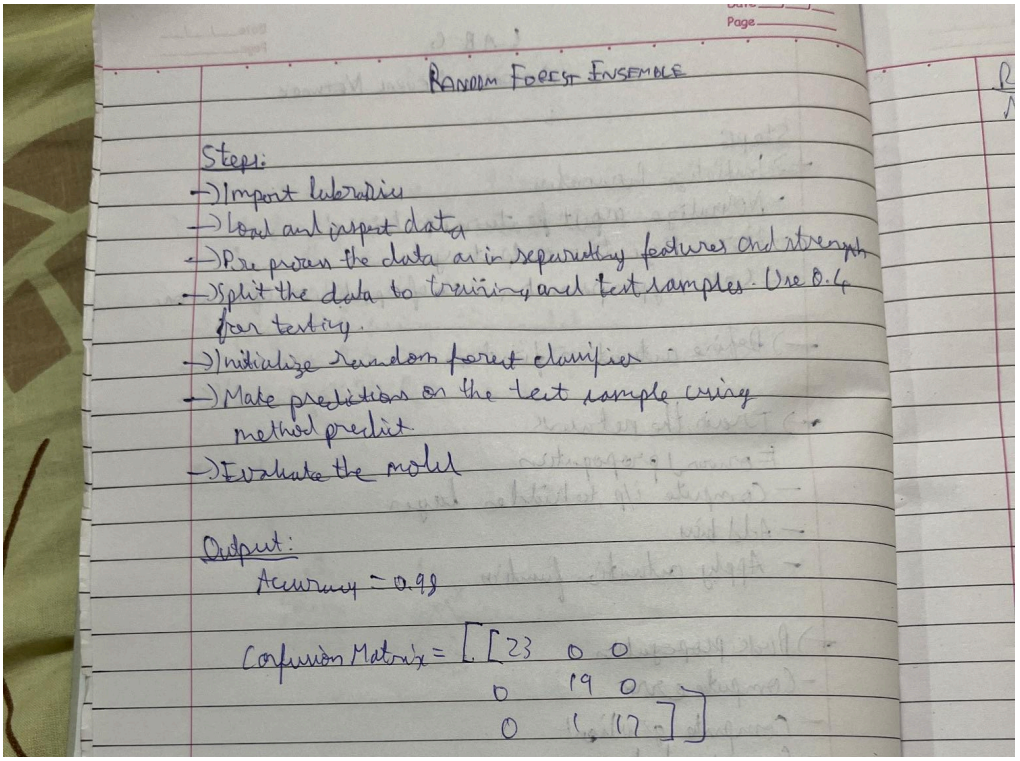
```
[11] testing_correct_answers = 0
     for i in range(0, len(x_test)):
         activate_layer(hidden_layer, weights, x_test[i])
         activate_layer(output_layer, hidden_weights, hidden_layer)
         output_layer = soft_max(output_layer)
         testing_correct_answers += 1 if y_test[i] == np.argmax(output_layer) else 0
     print("MLP Correct answers while testing: %s / %s (Accuracy = %s) on %s database" % (testing_correct_answers, len(x_test),
                                                                                          testing_correct_answers/len(x_test), "Duke breast cancer"))
```

```
MLP Correct answers while testing: 8 / 9 (Accuracy = 0.8888888888888888) on Duke breast cancer database
```

31.05.2024

Implement Random forest ensemble method on a given dataset.

Algorithm:




```
iris['Species'] = iris['Species'].astype("category")
codes = iris['Species'].cat.codes
```

```
def train_test_split(X, y, random_state=42, test_size=0.2):
    """
    Splits the data into training and testing sets.

    Parameters:
        X (numpy.ndarray): Features array of shape (n_samples, n_features).
        y (numpy.ndarray): Target array of shape (n_samples,).
        random_state (int): Seed for the random number generator. Default is 42.
        test_size (float): Proportion of samples to include in the test set. Default is 0.2.

    Returns:
        Tuple[numpy.ndarray]: A tuple containing X_train, X_test, y_train, y_test.
    """
    # Get number of samples
    n_samples = X.shape[0]

    # Set the seed for the random number generator
    np.random.seed(random_state)

    # Shuffle the indices
    shuffled_indices = np.random.permutation(np.arange(n_samples))

    # Determine the size of the test set
    test_size = int(n_samples * test_size)

    # Split the indices into test and train
    test_indices = shuffled_indices[:test_size]
    train_indices = shuffled_indices[test_size:]

    # Split the features and target arrays into test and train
    X_train, X_test = X[train_indices], X[test_indices]
    y_train, y_test = y[train_indices], y[test_indices]

    return X_train, X_test, y_train, y_test
```

```
X = iris.iloc[:, :-1].values
y = iris.iloc[:, -1].values.reshape(-1,1)
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=.2, random_state=41)
```

```
from sklearn.tree import DecisionTreeClassifier
m = DecisionTreeClassifier()
```

```python
class RandomForest:
    """
    A random forest classifier.

    Parameters
    ----------
    n_trees : int, default=7
        The number of trees in the random forest.
    max_depth : int, default=7
        The maximum depth of each decision tree in the random forest.
    min_samples : int, default=2
        The minimum number of samples required to split an internal node
        of each decision tree in the random forest.

    Attributes
    ----------
    n_trees : int
        The number of trees in the random forest.
    max_depth : int
        The maximum depth of each decision tree in the random forest.
    min_samples : int
        The minimum number of samples required to split an internal node
        of each decision tree in the random forest.
    trees : list of DecisionTreeClassifier
        The decision trees in the random forest.
    """

    def __init__(self, n_trees=7, max_depth=7, min_samples=2):
        """
        Initialize the random forest classifier.

        Parameters
        ----------
        n_trees : int, default=7
            The number of trees in the random forest.
        max_depth : int, default=7
            The maximum depth of each decision tree in the random forest.
        min_samples : int, default=2
            The minimum number of samples required to split an internal node
            of each decision tree in the random forest.
        """
        self.n_trees = n_trees
        self.max_depth = max_depth
        self.min_samples = min_samples
        self.trees = []

    def fit(self, X, y):
        """
        Build a random forest classifier from the training set (X, y).

        Parameters
        ----------
        X : array-like of shape (n_samples, n_features)
            The training input samples.
        y : array-like of shape (n_samples,)
            The target values.

        Returns
        -------
```

```python
        Returns
        -------
        self : object
            Returns self.
        """
        # Create an empty list to store the trees.
        self.trees = []
        # Concatenate X and y into a single dataset.
        dataset = np.concatenate((X, y.reshape(-1, 1)), axis=1)
        # Loop over the number of trees.
        for _ in range(self.n_trees):
            # Create a decision tree instance.
            tree = DecisionTreeClassifier(max_depth=self.max_depth, min_samples_split=self.min_samples)
            # Sample from the dataset with replacement (bootstrapping).
            dataset_sample = self.bootstrap_samples(dataset)
            # Get the X and y samples from the dataset sample.
            X_sample, y_sample = dataset_sample[:, :-1], dataset_sample[:, -1]
            # Fit the tree to the X and y samples.
            tree.fit(X_sample, y_sample)
            # Store the tree in the list of trees.
            self.trees.append(tree)
        return self

    def bootstrap_samples(self, dataset):
        """
        Bootstrap the dataset by sampling from it with replacement.

        Parameters
        ----------
        dataset : array-like of shape (n_samples, n_features + 1)
            The dataset to bootstrap.

        Returns
        -------
        dataset_sample : array-like of shape (n_samples, n_features + 1)
            The bootstrapped dataset sample.
        """
        # Get the number of samples in the dataset.
        n_samples = dataset.shape[0]
        # Generate random indices to index into the dataset with replacement.
        np.random.seed(1)
        indices = np.random.choice(n_samples, n_samples, replace=True)
        # Return the bootstrapped dataset sample using the generated indices.
        dataset_sample = dataset[indices]
        return dataset_sample

    def most_common_label(self, y):
        """
        Return the most common label in an array of labels.

        Parameters
        ----------
        y : array-like of shape (n_samples,)
            The array of labels.

        Returns
        -------
        most_occuring_value : int or float
            The most common label in the array.
        """
        y = list(y)
        # get the highest present class in the array
        most_occuring_value = max(y, key=y.count)
        return most_occuring_value

    def predict(self, X):
        """
        Predict class for X.
```

```
        Parameters
        ----------
        X : array-like of shape (n_samples, n_features)
            The input samples.

        Returns
        -------
        majority_predictions : array-like of shape (n_samples,)
            The predicted classes.
        """
        #get prediction from each tree in the tree list on the test data
        predictions = np.array([tree.predict(X) for tree in self.trees])
        # get prediction for the same sample from all trees for each sample in the test data
        preds = np.swapaxes(predictions, 0, 1)
        #get the most voted value by the trees and store it in the final predictions array
        majority_predictions = np.array([self.most_common_label(pred) for pred in preds])
        return majority_predictions
```

Python

```
def accuracy(y_true, y_pred):
    """
    Computes the accuracy of a classification model.

    Parameters:
    y_true (numpy array): A numpy array of true labels for each data point.
    y_pred (numpy array): A numpy array of predicted labels for each data point.

    Returns:
    float: The accuracy of the model, expressed as a percentage.
    """
    y_true = y_true.flatten()
    total_samples = len(y_true)
    correct_predictions = np.sum(y_true == y_pred)
    return (correct_predictions / total_samples)
```

Python

```
from sklearn.preprocessing import LabelEncoder

label_encoder = LabelEncoder()
y_train_encoded = label_encoder.fit_transform(y_train)
y_test_encoded = label_encoder.transform(y_test)
```

Python

```
/usr/local/lib/python3.10/dist-packages/sklearn/preprocessing/_label.py:116: DataConversionWarning:

A column-vector y was passed when a 1d array was expected. Please change the shape of y to (n_samples, ), for example using ravel().

/usr/local/lib/python3.10/dist-packages/sklearn/preprocessing/_label.py:134: DataConversionWarning:

A column-vector y was passed when a 1d array was expected. Please change the shape of y to (n_samples, ), for example using ravel().
```

```
from sklearn.preprocessing import LabelEncoder

label_encoder = LabelEncoder()
y_train_encoded = label_encoder.fit_transform(y_train.ravel())
y_test_encoded = label_encoder.transform(y_test.ravel())
model = RandomForest(10, 10, 2)
model.fit(X_train, y_train_encoded)

predictions = model.predict(X_test)
accuracy(y_test_encoded, predictions)
```

Python

```
0.9333333333333333
```

```
from sklearn.tree import DecisionTreeClassifier

# Create and train the decision tree model
dt = DecisionTreeClassifier()
dt.fit(X_train, y_train_encoded)

# Make predictions on the test data
predictions = dt.predict(X_test)

# Calculate accuracy
accuracy(y_test_encoded, predictions)
```

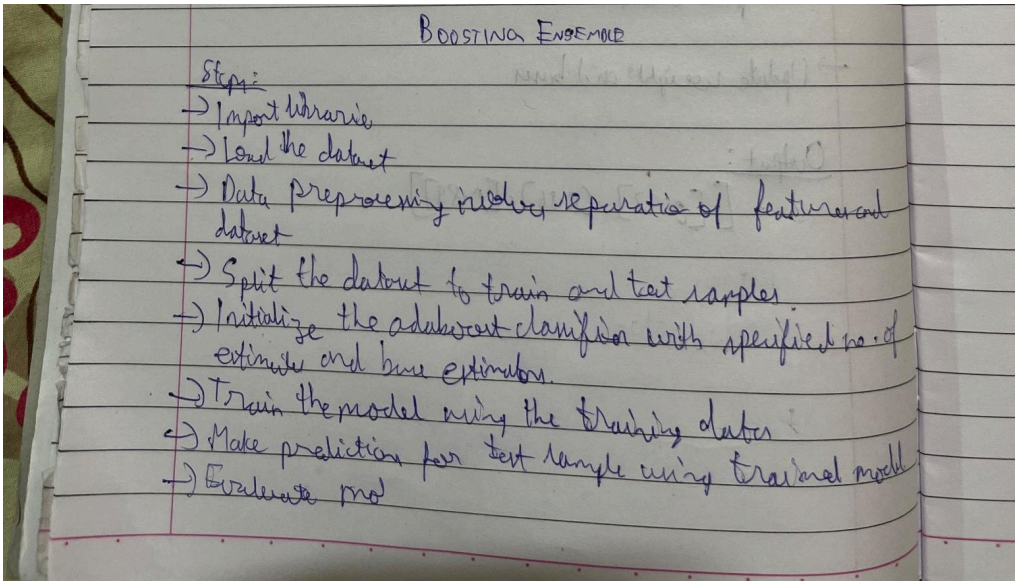
Python

```
0.9
```

31.05.2024

Implement Boosting ensemble method on a given dataset.

Algorithm:



```python
# Define AdaBoost class
class AdaBoost:

    def __init__(self):
        self.alphas = []
        self.G_M = []
        self.M = None
        self.training_errors = []
        self.prediction_errors = []

    def fit(self, X, y, M = 100):
        '''
        Fit model. Arguments:
        X: independent variables - array-like matrix
        y: target variable - array-like vector
        M: number of boosting rounds. Default is 100 - integer
        '''

        # Clear before calling
        self.alphas = []
        self.training_errors = []
        self.M = M

        # Iterate over M weak classifiers
        for m in range(0, M):

            # Set weights for current boosting iteration
            if m == 0:
                w_i = np.ones(len(y)) * 1 / len(y)  # At m = 0, weights are all the same and equal to 1 / N
            else:
                # (d) Update w_i
                w_i = update_weights(w_i, alpha_m, y, y_pred)

            # (a) Fit weak classifier and predict labels
            G_m = DecisionTreeClassifier(max_depth = 1)     # Stump: Two terminal-node classification tree
            G_m.fit(X, y, sample_weight = w_i)
            y_pred = G_m.predict(X)

            self.G_M.append(G_m) # Save to list of weak classifiers

            # (b) Compute error
            error_m = compute_error(y, y_pred, w_i)
```

[15]

```python
                w_i = update_weights(w_i, alpha_m, y, y_pred)

            # (a) Fit weak classifier and predict labels
            G_m = DecisionTreeClassifier(max_depth = 1)     # Stump: Two terminal-node classification tree
            G_m.fit(X, y, sample_weight = w_i)
            y_pred = G_m.predict(X)

            self.G_M.append(G_m) # Save to list of weak classifiers

            # (b) Compute error
            error_m = compute_error(y, y_pred, w_i)
            self.training_errors.append(error_m)

            # (c) Compute alpha
            alpha_m = compute_alpha(error_m)
            self.alphas.append(alpha_m)

        assert len(self.G_M) == len(self.alphas)

    def predict(self, X):
        '''
        Predict using fitted model. Arguments:
        X: independent variables - array-like
        '''

        # Initialise dataframe with weak predictions for each observation
        weak_preds = pd.DataFrame(index = range(len(X)), columns = range(self.M))

        # Predict class label for each weak classifier, weighted by alpha_m
        for m in range(self.M):
            y_pred_m = self.G_M[m].predict(X) * self.alphas[m]
            weak_preds.iloc[:,m] = y_pred_m

        # Calculate final predictions
        y_pred = (1 * np.sign(weak_preds.T.sum())).astype(int)

        return y_pred
```

```
[17] import pandas as pd
     import numpy as np
     from sklearn.model_selection import train_test_split
     from sklearn.tree import DecisionTreeClassifier

     # Dataset
     df = pd.read_csv('/content/spambase.data', header = None)

     # Column names
     names = pd.read_csv('/content/spambase.names', sep = ':', skiprows=range(0, 33), header = None)
     col_names = list(names[0])
     col_names.append('Spam')

     # Rename df columns
     df.columns = col_names

     # Convert classes in target variable to {-1, 1}
     df['Spam'] = df['Spam'] * 2 - 1

     # Train - test split
     X_train, X_test, y_train, y_test = train_test_split(df.drop(columns = 'Spam').values,
                                                         df['Spam'].values,
                                                         train_size = 3065,
                                                         random_state = 2)
```

```
# Fit model
ab = AdaBoost()
ab.fit(X_train, y_train, M = 400)

# Predict on test set
y_pred = ab.predict(X_test)

from sklearn.metrics import accuracy_score

# Calculate accuracy
accuracy = accuracy_score(y_test, y_pred)
print("Accuracy:", accuracy)
```

```
Accuracy: 0.9440104166666666
```