



DAYANANDA SAGAR COLLEGE OF ENGINEERING

**(An Autonomous Institution affiliated to Visvesvaraya Technological University,
Belagavi)**

Department of Computer Science & Engineering

2023-24

FIFTH SEMESTER

ARTIFICIAL INTELLIGENCE & MACHINE LEARNING LABORATORY WITH APPLICATIONS MANUAL

Sub Code: 21CS52

DAYANANDA SAGAR COLLEGE OF ENGINEERING
DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING

Vision and Mission of the Department

Vision

To provide a vibrant learning environment in computer science and engineering with focus on industry needs and research, for the students to be successful global professionals contributing to the society.

Mission

- * To adopt a contemporary teaching learning process with emphasis on hands on and Collaborative learning.**
- * To facilitate skill development through additional training and encourage student forums for enhanced learning.**
- * To collaborate with industry partners and professional societies and make the students industry ready.**
- * To encourage innovation through multidisciplinary research and development activities.**
- * To inculcate human values and ethics to groom the students to be responsible citizens.**

DAYANANDA SAGAR COLLEGE OF ENGINEERING
DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING

Code of Conduct in the Lab

Do's

Students shall

- Come prepared for the program to be developed in the laboratory.
- Report any broken plugs or exposed electrical wires to your faculty/laboratory technician immediately.
- Turn off the machine once you have finished using it.
- Maintain silence while working in the lab.
- Keep the Computer lab premises clean and tidy.
- Place backpacks under the table or computer counters.
- Treat fellow users of the laboratory, and all equipment within the laboratory, with the appropriate level of care and respect.

Don'ts

Students shall not

- Talk on cell phones in the lab.
- Eat or drink in the laboratory.
- Touch, connect or disconnect any plug or cable without the faculty/laboratory technician's permission.
- Install or download any software or modify or delete any system files on any lab computers.
- Read or modify other users' files.
- Meddle with other users' files.
- Leave their personal belongings unattended. We are not responsible for any theft.

Course Objectives:

1. To understand the use of logic and apply it to infer unknown facts.
2. Analyze and Design Regression techniques for handling real data.
3. Analyze and implement concepts related to Data Clustering , Classification, Neural Networks and Deep Learning

Course Outcomes: At the end of the course, student will be able to:

CO1	Analyze and make use of logic to infer unknown facts using Pyke Logic Programming in Python.
CO2	Analyze and Apply Simple Linear Regression and Multiple Linear Regression using Python.
CO3	Analyze and Apply/Implement Classification/Supervised Learning Algorithms on Different Datasets.
CO4	Analyze and Apply Clustering Algorithms on Different Datasets.
CO5	Analyze and Apply Neural Networks to Real Life Problems.
CO6	Analyze and Apply Neural Networks to Real Life Problems.

Experiment No.	Contents of the Experiment	Hours	COs
1.	<p>Apply:</p> <p>a) Simple linear regression model for headBrain dataset and predict brain weight based on head size using the least square method. Findout (i) R^2 score for the predictedmodel (ii) Display the all the data points along with the fitmodel</p> <p>b) Simple linear regression model for housing_prices_SLR dataset and predict house price based on the area of thehouse using the libraryscikit_learn. Find out (i) AnalyzetheR^2scoreofpredictedtrainingandtestmodels score. (ii) Display the all the data points along with fitmodel</p>	02	CO6
2.	<p>Apply:</p> <p>a) Multiple linear regression model for student dataset and predict writing skill of student based on the math skill and reading skill of the student using the Gradient descent method. Find out R^2 score for the predicted model</p> <p>b) Multiple linear regression model for housing_prices dataset and predict housepric ebasedonthearea, floor and room size of the house using the library scikit_learn . Find out the accuracy of the model using R^2 score statistics for the predicted model</p>	02	CO6

3.	<p>Apply: Decision tree and Naïve Bayesian classifiers on breast cancer dataset. Find out</p> <ul style="list-style-type: none"> i) No of benign and malignant cases in the testing phase ii) Predict the accuracy of the both classifiers 	02	CO6
4.	<ul style="list-style-type: none"> a) Apply Partitioning k-means clustering technique on ch1ex1 dataset with different K (number of clusters) as input and record the output b) Apply Hierarchical Clustering Algorithm on seeds_less_rows dataset for extracting cluster labels of different varieties of seeds 	02	CO6
5	<p>Demonstrate</p> <ul style="list-style-type: none"> a) Usage of Sigmoid activation function in artificial neural network b) Identification of face using opencv library. 	02	CO6
6.	<p>Using Keras and Tensor flow framework</p> <ul style="list-style-type: none"> i) Load the Pima_indians_diabetes dataset ii) Design a two-layer neural network with one hidden layer and one output layer <ul style="list-style-type: none"> a. Use Relu activation function for the hidden layer b. Use sigmoid activation function for the output layer iii) Train the designed network for Pima_indians_diabetes iv) Evaluate the network v) Generate Predictions for 10samples 	02	CO6
7.	<p>Using Keras and tensor flow network</p> <ul style="list-style-type: none"> i) Load the mnist image dataset ii) Design a two-layer neural network with one hidden layer and one output layer <ul style="list-style-type: none"> a. Use CNN with Leaky Relu activation function for the hidden layer b. Use sigmoid activation function for the output layer iii) Train the designed network for mnist dataset iv) Visualize the results of <ul style="list-style-type: none"> a) Training vs validation accuracy b) Training vs Validation loss 	02	CO6
8	<p>Using Keras and tensor flow network</p> <ul style="list-style-type: none"> i) Load the imdb text dataset ii) Design a two-layer neural network with one hidden layer and one output layer <ul style="list-style-type: none"> a. Use simpleRNN in the hidden layer b. Use sigmoid activation function for the output layer iii) Train the designed network for imdb dataset iv) Visualize the results of <ul style="list-style-type: none"> a) Training vs validation accuracy b) Training vs Validation loss 	02	CO6

Text Books:

1. Stuart Russel, Peter Norvig: Artificial Intelligence A Modern Approach, 3rd Edition, Pearson Education, 2003.
2. “Data Mining Concepts and Techniques”, Jiawei Han, Micheline Kamber, Jian Pei, Elsevier (MK) 3rd Edition, 2012.
3. Deep Learning with Python: A Hands-on Introduction Nikhil Ketkar
4. <https://towardsdatascience.com/notes-on-artificial-intelligence-ai-machine-learning-ml-and-deep-learning-dl-for-56e51a2071c2>.

Reference Books:

1. Tom M. Mitchell, “Machine Learning”, McGraw-Hill Education (INDIAN EDITION), 2013. (1.1, 1.2, 1.3, 4.2, 4.4, 4.5, 4.6, 4.7).
2. An Introduction to Statistical Learning, with Applications in R (2013), by G. James, D. Witten, T. Hastie, and R. Tibshirani.
3. Nils J. Nilsson: Principles of Artificial Intelligence, Elsevier, 1980.

Program 1:

Apply:

Simple linear regression model for head Brain dataset and predict brain weight based on head size using the least square method.

Find out

i. R^2 score for the predicted model.

ii. Display all the data points along with the fitting the data points to the model.

#importing libraries

```
import numpy as np
```

```
import pandas as pd
```

```
import matplotlib.pyplot as plt
```

Reading Data

```
data = pd.read_csv('headbrain.csv')
```

```
print(data.shape)
```

```
data.head()
```

(237, 4)

	Gender	Age Range	Head Size(cm^3)	Brain Weight(grams)
0	1	1	4512	1530
1	1	1	3738	1297
2	1	1	4261	1335
3	1	1	3777	1282
4	1	1	4177	1590

Collecting X and Y

```
X = data['Head Size(cm^3)'].values
```

```
Y = data['Brain Weight(grams)'].values
```

Calculating coefficient

Mean X and Y

```
mean_x = np.mean(X)
```

```
mean_y = np.mean(Y)
```

```
print(mean_x)

print(mean_y)

# Total number of values

n = len(X)

print(n)

3633.9915611814345
1282.873417721519
237
# Using the formula to calculate b1 and b0

numer = 0

denom = 0

for i in range(n):

    numer += (X[i] - mean_x) * (Y[i] - mean_y)

    denom += (X[i] - mean_x) ** 2

b1 = numer / denom

b0 = mean_y - (b1 * mean_x)

# Printing coefficients

print("Coefficients")

print(b1, b0)

Coefficients
b1:0.26342933948939945 b0:325.57342104944223

# Plotting Values and Regression Line

max_x = np.max(X) + 100

min_x = np.min(X) - 100

# Calculating line values x and y

x = np.linspace(min_x, max_x, 1000)

y = b0 + b1 * x

# Plotting Line

plt.plot(x, y, color='#58b970', label='Regression Line')
```


Plotting Scatter Points

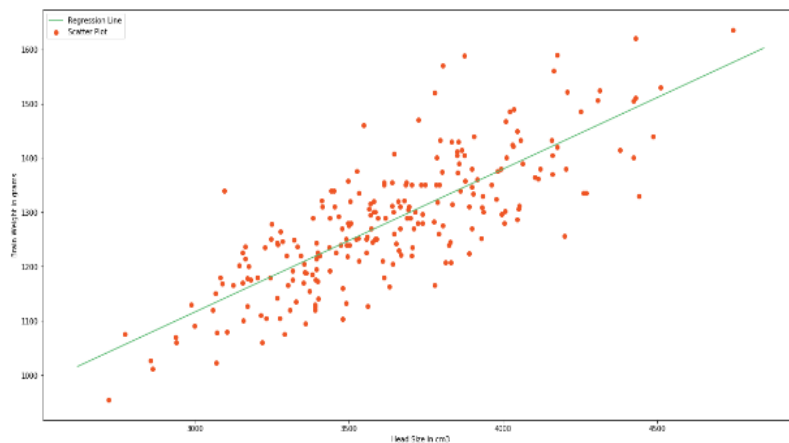
```
plt.scatter(X, Y, c='#ef5423', label='Scatter Plot')
```

```
plt.xlabel('Head Size in cm3')
```

```
plt.ylabel('Brain Weight in grams')
```

```
plt.legend()
```

```
plt.show()
```



Calculating R^2 Score

```
ss_tot = 0
```

```
ss_res = 0
```

```
for i in range(n):
```

```
    y_pred = b0 + b1 * X[i]
```

```
    ss_tot += (Y[i] - mean_y) ** 2
```

```
    ss_res += (Y[i] - y_pred) ** 2
```

```
r2 = 1 - (ss_res/ss_tot)
```

```
print("R2 Score")
```

```
print(r2)
```

R^2 Score

0.6393117199570003

Conclusion: The simple linear regression model gives average accuracy depending on the R^2 score value.

2b. Simple linear regression model for housing_prices_ SLR dataset and predict house price based on the area of the house using the library scikit_ learn.

Find out

- i. Analyze the R^2 score of predicted training and test models score.**
- ii. Display all the data points along with the fitting the data points to the model.**

Step1:importing all the libraries

```
import numpy as np
```

```
import pandas as pd
```

```
import matplotlib.pyplot as plt
```

```
%matplotlib inline
```

Step2:load dataset

```
df=pd.read_csv("housing_prices_SLR.csv",delimiter=',')
```

```
df.head()
```

	AREA	PRICE
0	1000	5618
1	1030	5201
2	1060	4779
3	1090	5425
4	1120	5657

Step3: Feature matrix and Target vector

```
x=df[['AREA']].values#feature Matrix
```

```
y=df.PRICE.values#Target Matrix
```

```
x[:5] #slicing
```

```
y[:5]
```

Step4: Split the data into 80-20

#from packagename import function

```
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=100)
```

#80 20 split,random_state to reproduce the same split everytime

```
print(x_train.shape)
```

```
print(x_test.shape)
```

```
print(x_train.shape)
```

```
print(x_test.shape)
```

```
(40, 1)
```

```
(10, 1)
```

```
(40, 1)
```

```
(10, 1)
```

```
#step5: Fit the line:Train the SLR Model
```

```
From sklearn.linear_model import Linear Regression
```

```
lr_model= Linear Regression()
```

```
lr_model.fit(x_train,y_train)
```

```
print(lr_model.intercept_) # (PRICE=(-4481.80028058845)+8.65903854)*AREA
```

```
print(lr_model.coef_)#y=c+mx
```

```
b0:-3103.34066448488
```

```
b1:[7.75979089]
```

```
lr_model=Linear Regression(fit_intercept= False)
```

```
lr_model.fit(x_train,y_train)
```

```
print(lr_model.intercept_) # (PRICE=(-4481.80028058845)+8.65903854)*AREA
```

```
print(lr_model.coef_)#y=c+mx
```

```
b0:0.0
```

```
b1:6.03609138
```

```
#step6: predict using the model
```

```
From sklearn.metrics import r2_score
```

```
y_train
```

```
lr_model.predict(x_train)
```

```
# step7: calculating R^2score using tain and test model
```

```
r2_score(y_train,lr_model.predict(x_train))
```

```
R^2_Train_Score:0.820250203127675
```

```
r2_score(y_test,lr_model.predict(x_test))
```

```
R^2_Test_Score:0.5059420550739799
```

```
lr_model.score(x_test,y_test) #2.second way of calculating R2 score
```

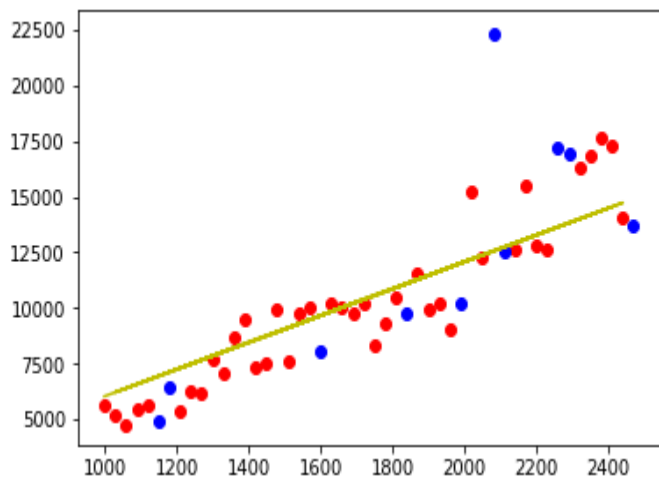
```
R^2_Test_Score:0.5059420550739799
```

```
step8:Visualizing the model
```

```
plt.scatter(x_train[:,0],y_train,c='red')
```

```
plt.scatter(x_test[:,0],y_test,c='blue')
```

```
plt.plot(x_train[:,0],lr_model.predict(x_train),c='y')
```



Conclusion: Comparing the training and testing R^2 score values, the accuracy of the simple linear regression model with respect to this dataset is average.

Program 2

Apply:

a) Multiple linear regression model for student dataset and predict writing skill of student based on the math skill and reading skill of the student using the Gradient descent method. Find out R^2 score for the predicted model.

```
#importing Libraries
```

```
import numpy as np
```

```
import pandas as pd
```

```
import matplotlib.pyplot as plt
```

```
from mpl_toolkits.mplot3d import Axes3D
```

```
data = pd.read_csv('student.csv')
```

```
print(data.shape)
```

```
data.head()
```

```
(1000, 3)
```

	Math	Reading	Writing
0	48	68	63
1	62	81	72
2	79	80	78
3	76	83	79
4	59	64	62

```
math = data['Math'].values
```

```
read = data['Reading'].values
```

```
write = data['Writing'].values
```

```
# Plotting the scores as scatter plot
```

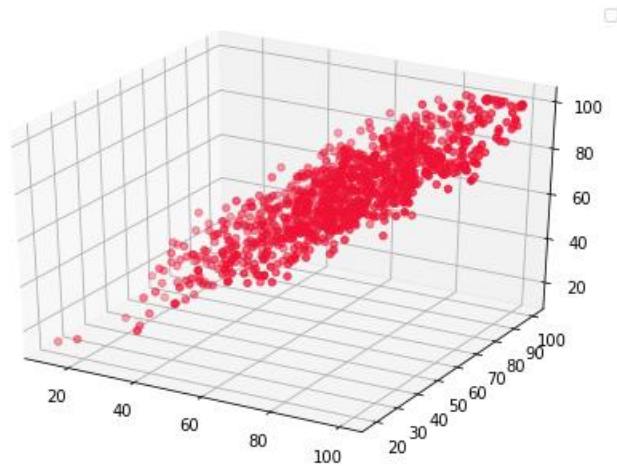
```
fig = plt.figure()
```

```
ax = Axes3D(fig)
```

```
ax.scatter(math, read, write, color='#ef1234')
```

```
plt.legend()
```

```
plt.show()
```



```
m = len(math)
x0 = np.ones(m)
X = np.array([x0, math, read]).T
```

Initial Coefficients

```
B = np.array([0, 0, 0])
Y = np.array(write)
alpha = 0.0001
defcost_function(X, Y, B):
    m = len(Y)
    J = np.sum((X.dot(B) - Y) ** 2)/(2 * m)
    return J

initail_cost = cost_function(X, Y, B)
print("Initial Cost")
print(initail_cost)

defgradient_descent(X, Y, B, alpha, iterations):
    cost_history = [0] * iterations
    m = len(Y)

    for iteration in range(iterations):
        # Hypothesis Values
        h = X.dot(B)

        # Difference b/w Hypothesis and Actual Y
        loss = h - Y

        # Gradient Calculation
```

```

    gradient = X.T.dot(loss) / m
    # Changing Values of B using Gradient
    B = B - alpha * gradient
    # New Cost Value
    cost = cost_function(X, Y, B)
    cost_history[iteration] = cost

    return B, cost_history

# 100000 Iterations
newB, cost_history = gradient_descent(X, Y, B, alpha, 100000)

# New Values of B
print("New Coefficients")
print(newB)

# Final Cost of new B
print("Final Cost")
print(cost_history[-1])

```

```

Initial Cost
2470.11
New Coefficients
[bo, b1,b2]:[-0.47889172  0.09137252  0.90144884]
Final Cost
10.475123473539167

```

```

# Model Evaluation - RMSE
defrmse(Y, Y_pred):
    rmse = np.sqrt(sum((Y - Y_pred) ** 2) / len(Y))
    return rmse

```

```

# Model Evaluation - R2 Score
def r2_score(Y, Y_pred):
    mean_y = np.mean(Y)
    ss_tot = sum((Y - mean_y) ** 2)
    ss_res = sum((Y - Y_pred) ** 2)
    r2 = 1 - (ss_res / ss_tot)

```

```
return r2

Y_pred = X.dot(newB)

print("R2 Score")
print(r2_score(Y, Y_pred))
```

R^2 Score
0.9097223273061553

Conclusion:

The accuracy of the multiple linear regression model is good depending on the R^2 score value.

b.) Multiple linear regression model for housing_prices dataset and predict house price based on the area, floor and room size of the house using the library scikit learn. Find out the accuracy of the model using R^2 score statistics for the predicted model.

#importing libraries

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

#Loading dataset

```
df=pd.read_csv("housing_prices.csv")
df.head()
```

	AREA	FLOOR	ROOM	PRICE
0	1000	7	2	5618
1	1030	7	1	5201
2	1060	1	1	4779
3	1090	6	1	5425
4	1120	0	2	5657

#setting Target and Feature Vectors

```
x=df.iloc[:,3].values
y=df.iloc[:,3].values
```

#Splitting the dataset

```
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=100)
```

Fitting the model

```
from sklearn.linear_model import LinearRegression
mlr_model= LinearRegression(fit_intercept=True)
mlr_model.fit(x_train,y_train)
print(mlr_model.intercept_) # (PRICE=(-4481.80028058845)+8.65903854)*AREA
print(mlr_model.coef_)
```

```
b0:-3106.4127920034116
```

```
[b1,b2,b3]:[ 4.68576316  71.78274093 1894.45529322]
```

```
# Finding R2 score
```

```
print(mlr_model.score(x_train,y_train))
```

```
print(mlr_model.score(x_test,y_test))
```

```
R2_Train_Score:0.9220702400776505
```

```
R2_Test_Score:0.8090037959414931
```

Conclusion:The multiple linear regression model accuracy is good with respect to this dataset by comparing R2 training and testing score values.

Program 3

Apply:

a) **Decision tree on breast cancer dataset.**

Find out

i) **No of benign and malignant cases in the testing phase.**

ii) **Predict the accuracy of the both classifier.**

```
# ## Implementation of Decision Trees
```

```
# ### Step 1 : Load required packages
```

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

```
# ### Step 2 : Load the csv/excel file into pandas dataframe and clean the data
```

```
df = pd.read_csv("../data/breast_cancer.csv")
df = df.iloc[:, :-1]
df.head()
```

```
# ### Step 3 : Create the Feature Matrix and Target Vector and check the first 5 rows
```

```
x = df.iloc[:, 2:].values
y = df.diagnosis.values
```

```
print(x[:2])
print(y[:5])
```

```
# ### Step 4 : Split the data into training set and test set
```

```
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)
```

```
# ### Step 5 : Instantiate a decision tree model and train the model
```

```
from sklearn.tree import DecisionTreeClassifier
```

```
dt_classifier = DecisionTreeClassifier()
dt_classifier.fit(x_train, y_train)
```

```
# ### Step 6 : Use the model to predict the class labels for new data
```

```

predictions = dt_classifier.predict(x_test)
prob_predictions = dt_classifier.predict_proba(x_test)

print(predictions)
print(prob_predictions)

# ### Step 7 : Calculate Accuracy score and confusion matrix for train and test data

from sklearn.metrics import accuracy_score, confusion_matrix

print("Training accuracy Score is : ", accuracy_score(y_train, dt_classifier.predict(x_train)))
print("Testing accuracy Score is : ", accuracy_score(y_test, dt_classifier.predict(x_test)))

print("Training Confusion Matrix is : \n", confusion_matrix(y_train,
dt_classifier.predict(x_train)))

print("Testing Confusion Matrix is : \n", confusion_matrix(y_test,
dt_classifier.predict(x_test)))

```

Output:

Training accuracy Score is : 1.0
Testing accuracy Score is : 0.9385964912280702

Training Confusion Matrix is:
[[286 0]
[0 169]]

Testing Confusion Matrix is:
[[71 0]
[7 36]]

Conclusion:

Comparing Training and testing accuracy scores the accuracy of Decision Tree model is good. The Correctly classified tuples for training set is (286+169) and the misclassified tuples are zero. The correctly classified for training set is (71+36) and misclassified tuples are (7+0).

3b. Apply Naïve Bayesian classifier on breast cancer dataset.

Find out

i) No of benign and malignant cases in the testing phase.

ii) Predict the accuracy of the classifier

```
# coding: utf-8

# ## Implementation of Naïve Bayes Algorithm

# ### Step 1 : Load required packages

import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import sklearn as sk

# ### Step 2 : Load the csv/excel file into pandas dataframe and clean the data

df = pd.read_csv("breast_cancer.csv")
df = df.iloc[:, :-1]
df.shape()
df.head()

# ### Step 3 : Create the Feature Matrix and Target Vector and check the first 5 rows

x = df.iloc[:, 2:].values
y = df.diagnosis.values

print(x[:2])
print(y[:5])

# ### Step 4 : Split the data into training set and test set

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=500)

x_train.shape #(455,30)

x_test.shape #(114, 30)
y_train.shape

y_test.shape

(y_train == 'M').sum()

(y_train == 'B').sum()

# Baseline model, accuracy, confusion_matrix, classification_report
```

Step 5 : Instantiate a Guassian Naive Bayes model and train the model

278/len(y_train) # Baseline model of accuracy =(more number of occurrences)/total data elements

from sklearn.metrics import accuracy_score, confusion_matrix, classification_report

baseline_pred=["B"] *len(y_train) # baseline will have beningn for everything

Baseline model of accuracy :0.610989010989011

accuracy_score(y_train,baseline_pred) # takes actual and predicted as 2 arguments

confusion_matrix(y_train,baseline_pred)# takes actual and predicted as 2 arguments

from sklearn.naive_bayes import GaussianNB

nb_model=GaussianNB()

nb_model.fit(x_train,y_train)

print(x_train)

nb_model.score(x_train,y_train)

nb_model.score(x_test,y_test)

#confusion_matrix for training data

confusion_matrix(y_train,nb_model.predict(x_train))

Training Confusion Matrix:

```
array([[269,  9],
       [ 22, 155]],
      dtype=int64)
```

#confusion_matrix for test data

confusion_matrix(y_test,nb_model.predict(x_test))

Testing Confusion Matrix:

```
array([[78,  1],
       [  2, 33]],
      dtype=int64)
```

print(classification_report(y_train,nb_model.predict(x_train)))

	precision	recall	f1-score	support
B	0.92	0.97	0.95	278
M	0.95	0.88	0.91	177
avg / total	0.93	0.93	0.93	455

```
print(classification_report(y_test,nb_model.predict(x_test)))
```

	precision	recall	f1-score	support
B	0.97	0.99	0.98	79
M	0.97	0.94	0.96	35
avg / total	0.97	0.97	0.97	114

Conclusion: The naïve bayes model is good with respect to breast cancer dataset by comparing the precision recall and F1 score values of training and testing dataset (classification report)

Program 4:

Apply:

a)Partitioning k-means clustering technique on ch1ex1 dataset with different K (number of clusters) as input and record the output.

Step 1 and 2: Import the libraries and Load the dataset.

```
import pandas as pd  
df = pd.read_csv('ch1ex1.csv')  
points = df.values
```

```
from sklearn.cluster import KMeans
```

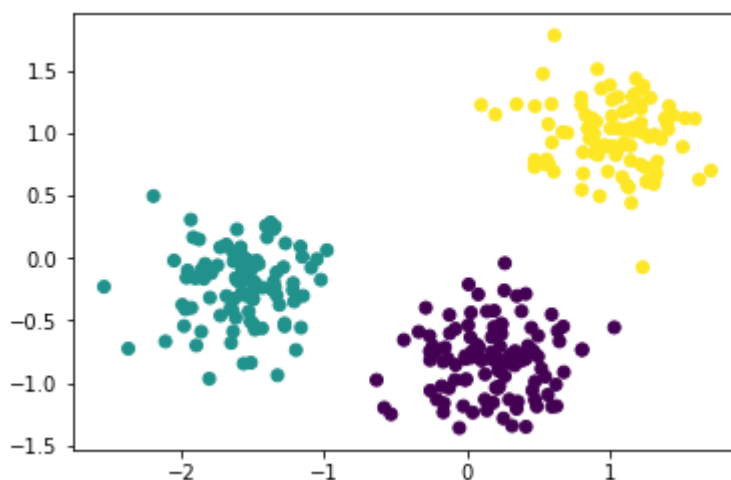
```
model = KMeans(n_clusters=3)  
model.fit(points)  
labels = model.predict(points)  
import matplotlib.pyplot as plt
```

Step 2: Assign column 0 of points to xs, and column 1 of points to ys

```
xs = points[:,0]  
ys = points[:,1]
```

Step 3: Make a scatter plot of xs and ys, specifying the c=labels keyword arguments to color the points by their cluster label. You'll see that KMeans has done a good job of identifying the clusters!

```
plt.scatter(xs, ys, c=labels)  
plt.show()
```



#This is great, but let's go one step further, and add the cluster centres (the "centroids") to the scatter plot.

Step 3: Obtain the coordinates of the centroids using the `.cluster_centers_` attribute of `model`. Assign them to `centroids`.

```
centroids = model.cluster_centers_
```

Step 4: Assign column 0 of `centroids` to `centroids_x`, and column 1 of `centroids` to `centroids_y`.

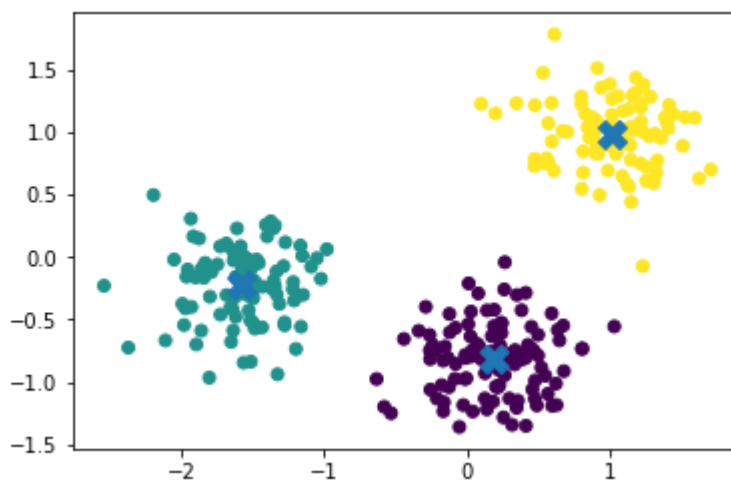
```
centroids_x = centroids[:,0]  
centroids_y = centroids[:,1]
```

Step 5: In a single cell, create two scatter plots (this will show the two on top of one another). Call `plt.show()` just once, at the end.

Firstly, make the scatter plot you made above. Secondly, make a scatter plot of `centroids_x` and `centroids_y`, using `'X'` (a cross) as a marker by specifying the `marker` parameter. Set the size of the markers to be `200` using `s=200`.

```
plt.scatter(xs, ys, c=labels)  
plt.scatter(centroids_x, centroids_y, marker='X', s=200)  
plt.show()
```

Output:



The centroids are important because they are what enables KMeans to assign new, previously unseen points to the existing clusters.

Conclusion: The k-means clustering technique is applied to `ch1ex1` dataset to form clusters depending on the number of clusters as input. Then the centroid of the clustering is shown using the cross mark.

4b) Hierarchical Clustering Algorithm on seeds_less_rows dataset for extracting cluster labels of different varieties of seeds

#Extracting the cluster labels in heirarchial clustering

#we use the `fcluster()` function to extract the cluster labels for intermediate clustering, and
#compare the labels with the grain varieties using a cross-tabulation.

Step 1 and 2: importing libraries and load the dataset:

```
import pandas as pd

seeds_df = pd.read_csv('seeds-less-rows.csv')

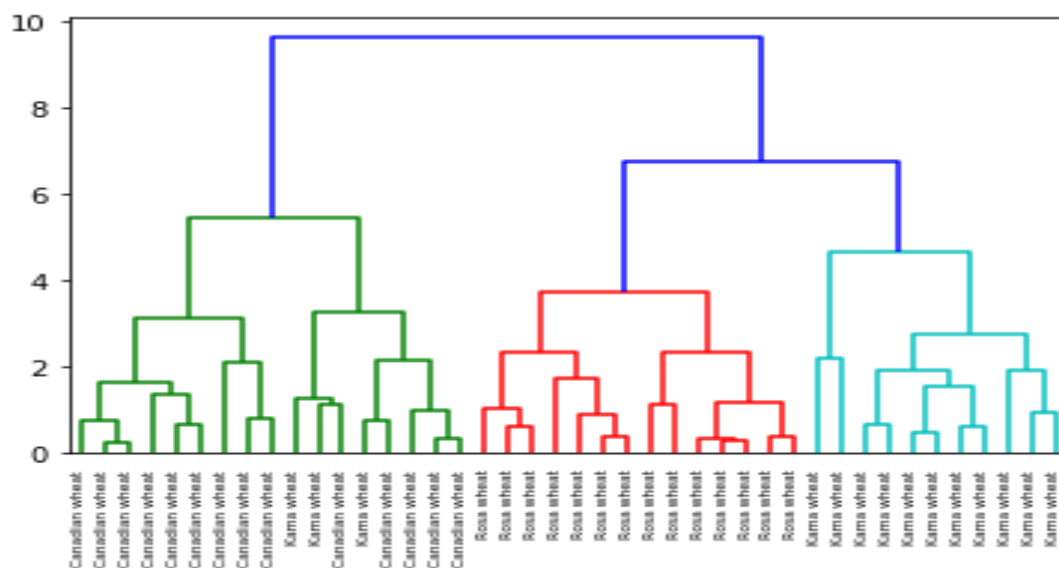
# remove the grain species from the DataFrame, save for later
varieties = list(seeds_df.pop('grain_variety'))

# extract the measurements as a NumPy array
samples = seeds_df.values
```

Step 3: Run the hierarchical clustering of the grain samples

```
from scipy.cluster.hierarchy import linkage, dendrogram
import matplotlib.pyplot as plt

mergings = linkage(samples, method='complete')
dendrogram(mergings, labels=varieties, leaf_rotation=90, leaf_font_size=6)
plt.show()
```



Step 4: Import `fcluster` from `scipy.cluster.hierarchy`

```
In[11]: from scipy.cluster.hierarchy import fcluster
```

Step 5: Obtain a flat clustering by using the `fcluster()` function on `mergings`. Specify a maximum height of 6 and the keyword argument `criterion='distance'`. Assign the result to `labels`.

```
In[12]: labels = fcluster(mergings, 6, criterion='distance')
```

Step 6: Create a `DataFrame` `df` with two columns named `'labels'` and `'varieties'`, using `labels` and `varieties`, respectively, for the column values.

```
In[13]: df = pd.DataFrame({'labels': labels, 'varieties': varieties})
```

Step 7: Create a cross-tabulation `ct` between `df['labels']` and `df['varieties']` to count the number of times each grain variety coincides with each cluster label.

```
In[14]: ct = pd.crosstab(df['labels'], df['varieties'])
```

Step 8: Display `ct` to see how your cluster labels correspond to the wheat varieties.

```
In[15]: ct
```

Output:-

Out[15]:	varieties	Canadian wheat	Kama wheat	Rosa wheat
	labels			
	1	14	3	0
	2	0	0	14
	3	0	11	0

Conclusion: Three varieties of labels extracted from 'seeds-less-rows' dataset by applying Hierarchical clustering technique as shown in the output table.

Program 5

Demonstrate:

a) Usage of Sigmoid activation function in artificial neural network

```
import numpy as np

from functools import reduce

def perceptron(weight, bias, x):
    model = np.add(np.dot(x, weight), bias)
    print('model: {}'.format(model))
    logit = 1/(1+np.exp(-model))
    print("Type: {}".format(logit))
    return np.round(logit)

def compute(logictype, weightdict, dataset):
    weights = np.array([ weightdict[logictype][w] for w in weightdict[logictype].keys()])
    output = np.array([ perceptron(weights, weightdict['bias'][logictype], val) for val in dataset])
    print(logictype)
    return logictype, output

def main():
    logic = {
        'logic_and': {
            'w0': -0.1,
            'w1': 0.2,
            'w2': 0.2
        },
        'logic_nand': {
            'w0': 0.6,
            'w1': -0.8,
            'w2': -0.8
        },
        'bias': {
            'logic_and': -0.2,
            'logic_nand': 0.3,
```

```

    }
}
dataset = np.array([
    [1,0,0],
    [1,0,1],
    [1,1,0],
    [1,1,1] ])

logic_and = compute('logic_and', logic, dataset)
logic_nand = compute('logic_nand', logic, dataset)

def template(dataset, name, data):
    # act = name[6:]

    print("Logic Function: { }".format(name[6:].upper()))

    print("X0\tX1\tX2\tY")

to Print = ["{1}\t{2}\t{3}\t{0}"].format(output, *datas) for datas, output in zip(dataset, data)]

for i in to Print:

    print(i)

    gates = [logic_and, logic_nand]

    for i in gates:

        template(dataset, *i)

if __name__ == '__main__':

    main()

```

output:

model: -0.30000000000000004

Type: 0.425557483188341

model: -0.1

Type: 0.47502081252106

model: -0.1

Type: 0.47502081252106

model: 0.10000000000000003

Type: 0.52497918747894

logic_and

model: 0.8999999999999999

Type: 0.7109495026250039

model: 0.09999999999999992

Type: 0.5249791874789399

model: 0.09999999999999992

Type: 0.5249791874789399

model: -0.7

Type: 0.3318122278318339

logic_nand

Logic Function: AND

X0	X1	X2	Y
1	0	0	0.0
1	0	1	0.0
1	1	0	0.0
1	1	1	1.0

Logic Function: NAND

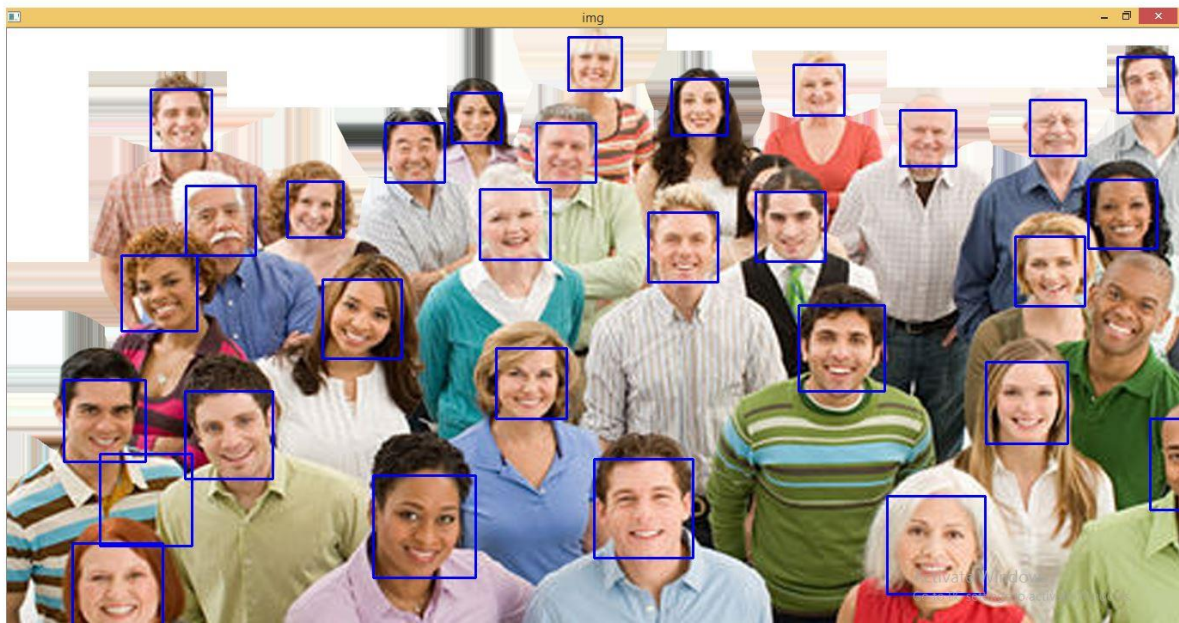
X0	X1	X2	Y
1	0	0	1.0
1	0	1	1.0
1	1	0	1.0
1	1	1	0.0

Conclusion: Sigmoid or logistic function used to display the working of AND and NAND logic functions.

5b) Identification of face using opencv library

#using opencv

```
#install -c menpoopencv  
  
import numpy as np  
  
import cv2  
  
face_cascade = cv2.CascadeClassifier('haarcascade_frontalface_default.xml')  
  
img = cv2.imread('people.jpg')  
  
gray = cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)  
  
faces = face_cascade.detectMultiScale(gray, 1.1, 5)  
  
for (x,y,w,h) in faces:  
    cv2.rectangle(img,(x,y),(x+w,y+h),(255,0,0),2)  
  
    roi_gray = gray[y:y+h, x:x+w]  
    roi_color = img[y:y+h, x:x+w]  
  
    cv2.imshow('img',img)  
  
    cv2.waitKey(0)  
  
    cv2.destroyAllWindows()
```



Conclusion: Using open cv library of Neural Networks, faces are detected.

Program 6

Using Keras and Tensor flow framework

- i) Load the Pima_indians_diabetes dataset
- ii) Design a two-layer neural network with one hidden layer and one output layer
 - a. Use Relu activation function for the hidden layer
 - b. Use sigmoid activation function for the output layer
- iii) Train the designed network for Pima_indians_diabetes
- iv) Evaluate the network
- v) Generate Predictions for 10 samples

Seven key steps in using Keras to create a neural network or deep learning model, step-by-step including:

- 1) Importing necessary Libraries
- 2) How to load data.
- 3) How to define a neural network in Keras.
- 4) How to compile a Keras model using the efficient numerical backend.
- 5) How to train a model on data.
- 6) How to evaluate a model on data.
- 7) How to make predictions with the model.

```
# first neural network with keras tutorial
from numpy import loadtxt
import numpy as np
import pandas as pd
from keras import models
from keras.models import Sequential
from keras.layers import Dense
from keras import layers
from sklearn.model_selection import train_test_split
from sklearn import preprocessing
import matplotlib.pyplot as plt
dataframe=pd.read_csv('pima-indians-diabetes.csv',delimiter=',')
dataframe.head()
```

	6	148	72	35	0	33.6	0.627	50	1
0	1	85	66	29	0	26.6	0.351	31	0
1	8	183	64	0	0	23.3	0.672	32	1
2	1	89	66	23	94	28.1	0.167	21	0
3	0	137	40	35	168	43.1	2.288	33	1
4	5	116	74	0	0	25.6	0.201	30	0

```
# split into input (X) and output (y) variables
X=dataframe.iloc[:, :8]
y=dataframe.iloc[:, 8]
```

```
dataframe.shape
(767, 9)
```



```

features_train, features_test, target_train, target_test = train_test_split(X, y,
test_size=0.33, random_state=0)

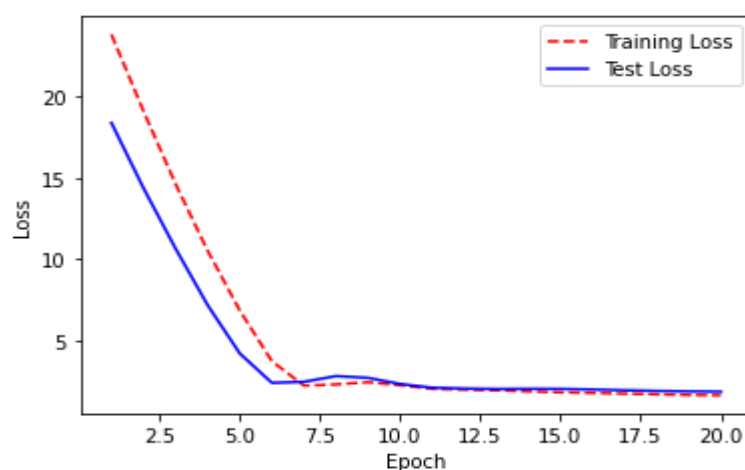
# define the keras model
network = models.Sequential()
network.add(Dense(units=8, activation="relu", input_shape=(features_train.shape[1],)))
network.add(Dense(units=8, activation="relu"))
#network.add(Dense(units=16, activation="relu"))
network.add(Dense(units=1, activation="sigmoid"))
# compile the keras model
network.compile(loss='binary_crossentropy', optimizer='adam', metrics=['accuracy'])
#network.compile(loss='mse', optimizer='RMSprop', metrics=['accuracy'])
# fit the keras model on the dataset
#network.fit(features_train, features_test, epochs=10, batch_size=100, verbose=2)
history = network.fit(features_train, target_train, epochs=20, verbose=1, batch_size=100, validation_data=(features_test, target_test))
Train on 513 samples, validate on 254 samples
Epoch 1/20
513/513 [=====] - 0s 327us/step - loss: 23.8525 - accuracy: 0.6316 - val_loss: 18.4057 - val_accuracy: 0.6929
Epoch 2/20
513/513 [=====] - 0s 29us/step - loss: 19.1240 - accuracy: 0.6316 - val_loss: 14.3790 - val_accuracy: 0.6929
Epoch 3/20
513/513 [=====] - 0s 39us/step - loss: 14.6355 - accuracy: 0.6316 - val_loss: 10.6533 - val_accuracy: 0.6929
Epoch 4/20
513/513 [=====] - 0s 47us/step - loss: 10.5196 - accuracy: 0.6316 - val_loss: 7.1659 - val_accuracy: 0.6929
Epoch 5/20
513/513 [=====] - 0s 45us/step - loss: 6.8415 - accuracy: 0.6355 - val_loss: 4.1935 - val_accuracy: 0.7008
Epoch 6/20
513/513 [=====] - 0s 43us/step - loss: 3.7177 - accuracy: 0.6550 - val_loss: 2.3824 - val_accuracy: 0.6378
Epoch 7/20
513/513 [=====] - 0s 33us/step - loss: 2.2131 - accuracy: 0.6101 - val_loss: 2.4434 - val_accuracy: 0.5630
Epoch 8/20
513/513 [=====] - 0s 37us/step - loss: 2.2830 - accuracy: 0.5497 - val_loss: 2.8009 - val_accuracy: 0.5276
Epoch 9/20
513/513 [=====] - 0s 37us/step - loss: 2.4204 - accuracy: 0.5302 - val_loss: 2.6900 - val_accuracy: 0.5394
Epoch 10/20
513/513 [=====] - 0s 39us/step - loss: 2.2307 - accuracy: 0.5439 - val_loss: 2.3109 - val_accuracy: 0.5630
Epoch 11/20

```

```

513/513 [=====] - 0s 49us/step - loss: 2.0121 - ac
curacy: 0.5828 - val_loss: 2.0812 - val_accuracy: 0.6063
Epoch 12/20
513/513 [=====] - 0s 45us/step - loss: 1.9620 - ac
curacy: 0.6199 - val_loss: 2.0272 - val_accuracy: 0.6142
Epoch 13/20
513/513 [=====] - 0s 37us/step - loss: 1.9209 - ac
curacy: 0.6355 - val_loss: 2.0020 - val_accuracy: 0.6142
Epoch 14/20
513/513 [=====] - 0s 49us/step - loss: 1.8549 - ac
curacy: 0.6179 - val_loss: 2.0124 - val_accuracy: 0.5945
Epoch 15/20
513/513 [=====] - 0s 55us/step - loss: 1.7957 - ac
curacy: 0.6082 - val_loss: 2.0066 - val_accuracy: 0.5945
Epoch 16/20
513/513 [=====] - 0s 45us/step - loss: 1.7566 - ac
curacy: 0.6082 - val_loss: 1.9706 - val_accuracy: 0.5866
Epoch 17/20
513/513 [=====] - 0s 51us/step - loss: 1.7174 - ac
curacy: 0.6160 - val_loss: 1.9221 - val_accuracy: 0.5906
Epoch 18/20
513/513 [=====] - 0s 39us/step - loss: 1.6742 - ac
curacy: 0.6179 - val_loss: 1.8809 - val_accuracy: 0.5866
Epoch 19/20
513/513 [=====] - 0s 47us/step - loss: 1.6343 - ac
curacy: 0.6238 - val_loss: 1.8540 - val_accuracy: 0.5945
Epoch 20/20
513/513 [=====] - 0s 49us/step - loss: 1.6173 - ac
curacy: 0.6296 - val_loss: 1.8372 - val_accuracy: 0.6024
training_loss=history.history["loss"]
test_loss=history.history["val_loss"]
epoch_count=range(1,len(training_loss)+1)
plt.plot(epoch_count,training_loss,"r--")
plt.plot(epoch_count,test_loss,"b-")
plt.legend(["Training Loss","Test Loss"])
plt.xlabel("Epoch")
plt.ylabel("Loss")
plt.show()

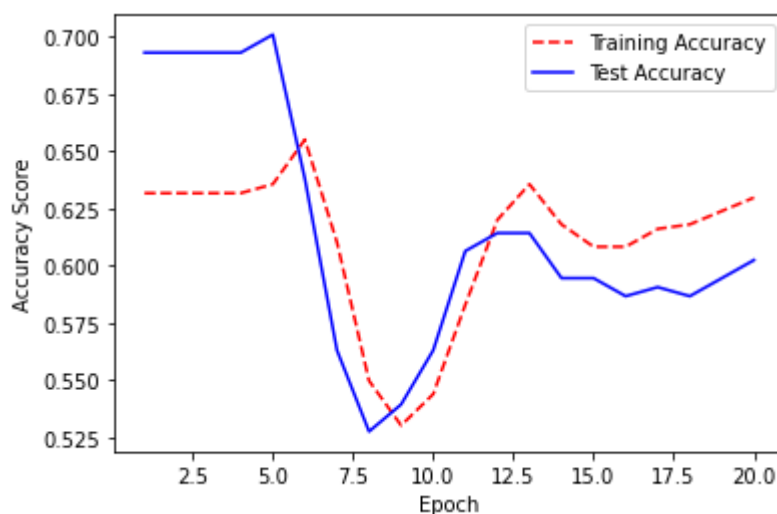
```



```

_,accuracy=network.evaluate(features_train,target_train)
print('Accuracy: %.2f'%(accuracy*100))
513/513 [=====] - 0s 215us/step
Accuracy: 63.16
# predict using the keras model
predicted_target=network.predict(features_test)
_,accuracy=network.evaluate(features_test,target_test)
print('Accuracy: %.2f'%(accuracy*100))
254/254 [=====] - 0s 35us/step
Accuracy: 60.24
#Y=target_train
for i in range(10):
print(predicted_target[i])
[0.44970706]
[0.4993118]
[0.9906837]
[0.44786653]
[0.02075692]
[0.03176354]
[0.999443]
[0.5751261]
[0.04377431]
[0.8482277]
training_accuracy=history.history["accuracy"]
test_accuracy=history.history["val_accuracy"]
plt.plot(epoch_count,training_accuracy,"r--")
plt.plot(epoch_count,test_accuracy,"b-")
plt.legend(["Training Accuracy","Test Accuracy"])
plt.xlabel("Epoch")
plt.ylabel("Accuracy Score")
plt.show()

```



Conclusion :Using Keras and Tensor flow framework loaded the Pima_indians_diabetes dataset and designed a two-layer neural network with one hidden layer and one output layer and generated predictions for 10 samples.

Program 7:

Using Keras and tensor flow network

- i) Load the mnist image dataset
- ii) Design a two-layer neural network with one hidden layer and one output layer
 - a. Use CNN with Leaky Relu activation function for the hidden layer
 - b. Use sigmoid activation function for the output layer
- iii) Train the designed network for mnist dataset
- iv) Visualize the results of
 - a) Training vs validation accuracy
 - b) Training vs Validation loss

```
import numpy as np
from keras.datasets import mnist
from keras.utils import to_categorical
import matplotlib.pyplot as plt
%matplotlib inline

Using TensorFlow backend.
import keras
from keras.models import Sequential, Input, Model
from keras.layers import Dense, Dropout, Flatten
from keras.layers import Conv2D, MaxPooling2D
from keras.layers.normalization import BatchNormalization
from keras.layers.advanced_activations import LeakyReLU

#from keras.datasets import mnist
(train_X, train_Y), (test_X, test_Y) = mnist.load_data()

print('Training data shape : ', train_X.shape, train_Y.shape)

print('Testing data shape : ', test_X.shape, test_Y.shape)

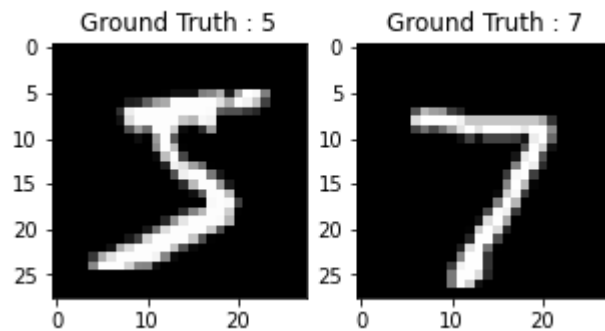
Training data shape : (60000, 28, 28) (60000,)
Testing data shape : (10000, 28, 28) (10000,)
# Find the unique numbers from the train labels
classes = np.unique(train_Y)
nClasses = len(classes)
print('Total number of outputs : ', nClasses)
print('Output classes : ', classes)

Total number of outputs : 10
Output classes : [0 1 2 3 4 5 6 7 8 9]
plt.figure(figsize=[5,5])

# Display the first image in training data
plt.subplot(121)
plt.imshow(train_X[0,:,:], cmap='gray')
plt.title("Ground Truth : {}".format(train_Y[0]))

# Display the first image in testing data
plt.subplot(122)
plt.imshow(test_X[0,:,:], cmap='gray')
plt.title("Ground Truth : {}".format(test_Y[0]))
```

```
Text(0.5, 1.0, 'Ground Truth : 7')
```



```
train_X = train_X.reshape(-1, 28,28, 1)
test_X = test_X.reshape(-1, 28,28, 1)
train_X.shape, test_X.shape
```

```
((60000, 28, 28, 1), (10000, 28, 28, 1))
```

```
train_X = train_X.astype('float32')
test_X = test_X.astype('float32')
train_X = train_X /255
test_X = test_X /255
```

```
# Change the labels from categorical to one-hot encoding
train_Y_one_hot = to_categorical(train_Y)
test_Y_one_hot = to_categorical(test_Y)
```

```
# Display the change for category label using one-hot encoding
print('Original label:', train_Y[0])
print('After conversion to one-hot:', train_Y_one_hot[0])
```

```
Original label: 5
```

```
After conversion to one-hot: [0. 0. 0. 0. 0. 1. 0. 0. 0. 0.]
```

```
From sklearn.model_selection import train_test_split
train_X,valid_X,train_label,valid_label = train_test_split(train_X, train_Y
_one_hot, test_size=0.2, random_state=13)
train_X.shape,valid_X.shape,train_label.shape,valid_label.shape
```

```
((48000, 28, 28, 1), (12000, 28, 28, 1), (48000, 10), (12000, 10))
```

```
batch_size =64
epochs =3
num_classes =10

m_model = Sequential()
m_model.add(Conv2D(32, kernel_size=(3, 3),activation='linear',input_shape=(
28,28,1),padding='same'))
m_model.add(LeakyReLU(alpha=0.1))
m_model.add(MaxPooling2D((2, 2),padding='same'))
#fashion_model.add(Conv2D(64, (3, 3), activation='linear',padding='same'))
#fashion_model.add(LeakyReLU(alpha=0.1))
```

```
#fashion_model.add(MaxPooling2D(pool_size=(2, 2),padding='same'))
#fashion_model.add(Conv2D(128, (3, 3), activation='linear',padding='same'))
#fashion_model.add(LeakyReLU(alpha=0.1))
#fashion_model.add(MaxPooling2D(pool_size=(2, 2),padding='same'))
m_model.add(Flatten())
m_model.add(Dense(128, activation='linear'))
m_model.add(LeakyReLU(alpha=0.1))
m_model.add(Dense(num_classes, activation='softmax'))

m_model.compile(loss=keras.losses.categorical_crossentropy, optimizer=keras
.optimizers.Adam(),metrics=['accuracy'])

m_model.summary()
Model: "sequential_3"
```

Layer (type)	Output Shape	Param #
conv2d_3 (Conv2D)	(None, 28, 28, 32)	320
leaky_re_lu_5 (LeakyReLU)	(None, 28, 28, 32)	0
max_pooling2d_3 (MaxPooling2	(None, 14, 14, 32)	0
flatten_3 (Flatten)	(None, 6272)	0
dense_5 (Dense)	(None, 128)	802944
leaky_re_lu_6 (LeakyReLU)	(None, 128)	0
dense_6 (Dense)	(None, 10)	1290
Total params: 804,554		
Trainable params: 804,554		
Non-trainable params: 0		

```
m_train = m_model.fit(train_X, train_label, batch_size=batch_size,epochs=ep
ochs,verbose=1,validation_data=(valid_X, valid_label))
```

Train on 48000 samples, validate on 12000 samples

Epoch 1/3

48000/48000 [=====] - 45s 928us/step - loss: 0.194
6 - accuracy: 0.9427 - val_loss: 0.0938 - val_accuracy: 0.9713

Epoch 2/3

48000/48000 [=====] - 46s 948us/step - loss: 0.063
0 - accuracy: 0.9811 - val_loss: 0.0733 - val_accuracy: 0.9762

Epoch 3/3

48000/48000 [=====] - 43s 897us/step - loss: 0.043
3 - accuracy: 0.9871 - val_loss: 0.0570 - val_accuracy: 0.9819

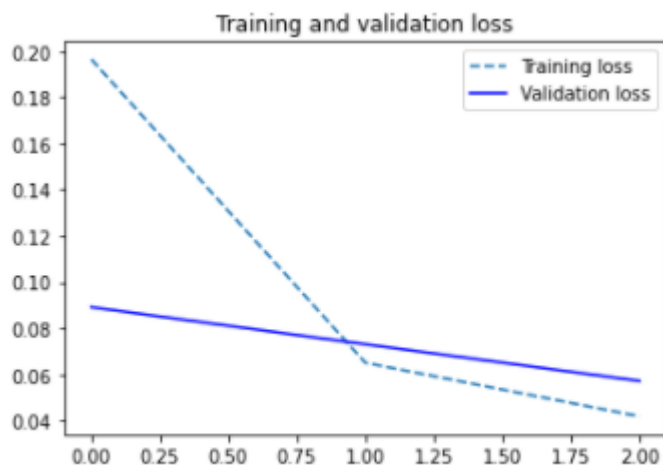
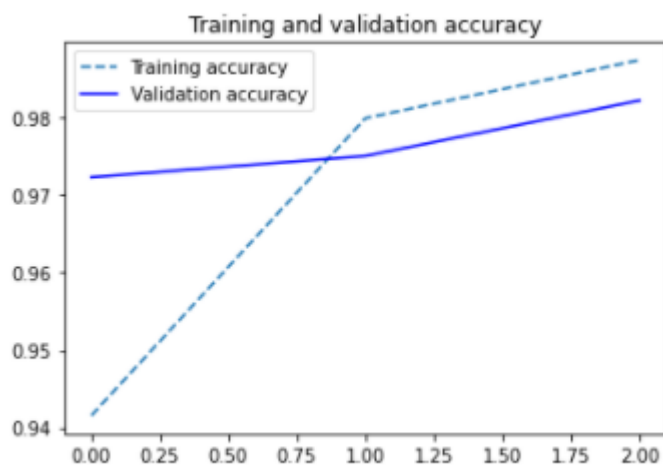
```
test_eval = m_model.evaluate(test_X, test_Y_one_hot, verbose=0)
```

```
print('Test loss:', test_eval[0])
```

```
print('Test accuracy:', test_eval[1])
```

```
Test loss: 0.052222021067142486
Test accuracy: 0.9824000000953674
```

```
accuracy = m_train.history['accuracy']
val_accuracy = m_train.history['val_accuracy']
loss = m_train.history['loss']
val_loss = m_train.history['val_loss']
epochs = range(len(accuracy))
plt.plot(epochs, accuracy, '--', label='Training accuracy')
plt.plot(epochs, val_accuracy, 'b', label='Validation accuracy')
plt.title('Training and validation accuracy')
plt.legend()
plt.figure()
plt.plot(epochs, loss, '--', label='Training loss')
plt.plot(epochs, val_loss, 'b', label='Validation loss')
plt.title('Training and validation loss')
plt.legend()
plt.show()
```



```
epochs=1
# ADDING DROPOUT
m_model = Sequential()
m_model.add(Conv2D(32, kernel_size=(3, 3),activation='linear',padding='same',input_shape=(28,28,1)))
```

```

m_model.add(LeakyReLU(alpha=0.1))
m_model.add(MaxPooling2D((2, 2),padding='same'))
m_model.add(Dropout(0.25))
#fashion_model.add(Conv2D(64, (3, 3), activation='linear',padding='same'))
#fashion_model.add(LeakyReLU(alpha=0.1))
#fashion_model.add(MaxPooling2D(pool_size=(2, 2),padding='same'))
#fashion_model.add(Dropout(0.25))
#fashion_model.add(Conv2D(128, (3, 3), activation='linear',padding='same'))
#fashion_model.add(LeakyReLU(alpha=0.1))
#fashion_model.add(MaxPooling2D(pool_size=(2, 2),padding='same'))
#fashion_model.add(Dropout(0.4))
m_model.add(Flatten())
m_model.add(Dense(128, activation='linear'))
m_model.add(LeakyReLU(alpha=0.1))
m_model.add(Dropout(0.3))
m_model.add(Dense(num_classes, activation='softmax'))

m_model.summary()

```

Model: "sequential_2"

Layer (type)	Output Shape	Param #
=====		
conv2d_2 (Conv2D)	(None, 28, 28, 32)	320
leaky_re_lu_3 (LeakyReLU)	(None, 28, 28, 32)	0
max_pooling2d_2 (MaxPooling2	(None, 14, 14, 32)	0
dropout_1 (Dropout)	(None, 14, 14, 32)	0
flatten_2 (Flatten)	(None, 6272)	0
dense_3 (Dense)	(None, 128)	802944
leaky_re_lu_4 (LeakyReLU)	(None, 128)	0
dropout_2 (Dropout)	(None, 128)	0
dense_4 (Dense)	(None, 10)	1290
=====		

Total params: 804,554

Trainable params: 804,554

Non-trainable params: 0

```

m_model.compile(loss=keras.losses.categorical_crossentropy, optimizer=keras
.optimizers.Adam(),metrics=['accuracy'])

```

```

m_train_dropout = m_model.fit(train_X, train_label, batch_size=batch_size,e
pochs=epochs,verbose=1,validation_data=(valid_X, valid_label))

```

Train on 48000 samples, validate on 12000 samples

Epoch 1/1

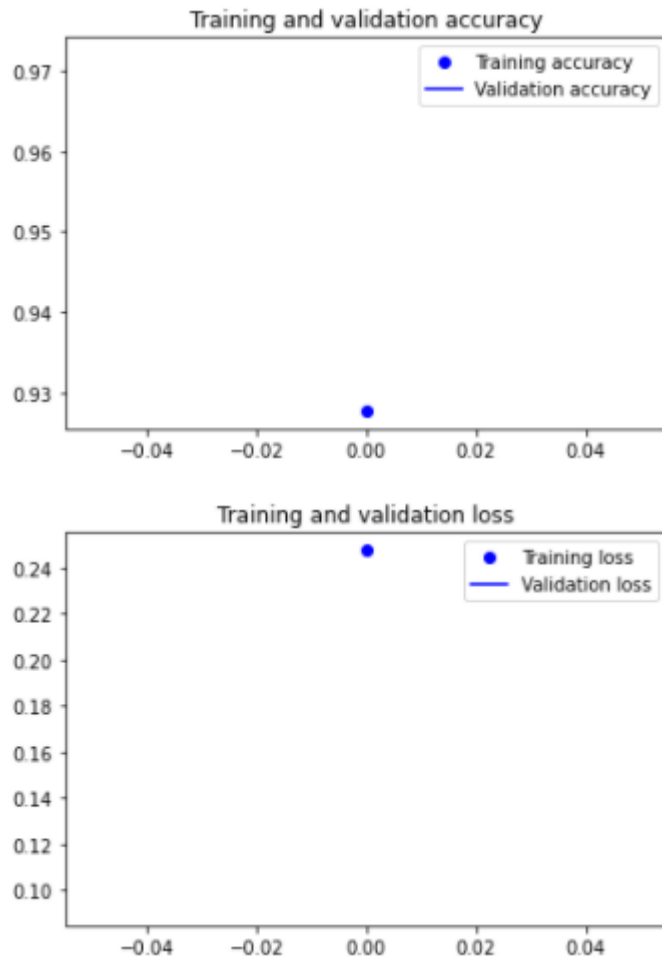

```
48000/48000 [=====] - 49s 1ms/step - loss: 0.2479
- accuracy: 0.9265 - val_loss: 0.1026 - val_accuracy: 0.9700
m_model.save("fashion_model_dropout.h5py")
test_eval = m_model.evaluate(test_X, test_Y_one_hot, verbose=1)
```

```
10000/10000 [=====] - 3s 263us/step
```

```
print('Test loss:', test_eval[0])
print('Test accuracy:', test_eval[1])
```

```
Test loss: 0.08918832793608308
Test accuracy: 0.9713000059127808
```

```
accuracy = m_train_dropout.history['accuracy']
val_accuracy = m_train_dropout.history['val_accuracy']
loss = m_train_dropout.history['loss']
val_loss = m_train_dropout.history['val_loss']
epochs = range(len(accuracy))
plt.plot(epochs, accuracy, 'bo', label='Training accuracy')
plt.plot(epochs, val_accuracy, 'b', label='Validation accuracy')
plt.title('Training and validation accuracy')
plt.legend()
plt.figure()
plt.plot(epochs, loss, 'bo', label='Training loss')
plt.plot(epochs, val_loss, 'b', label='Validation loss')
plt.title('Training and validation loss')
plt.legend()
plt.show()
```



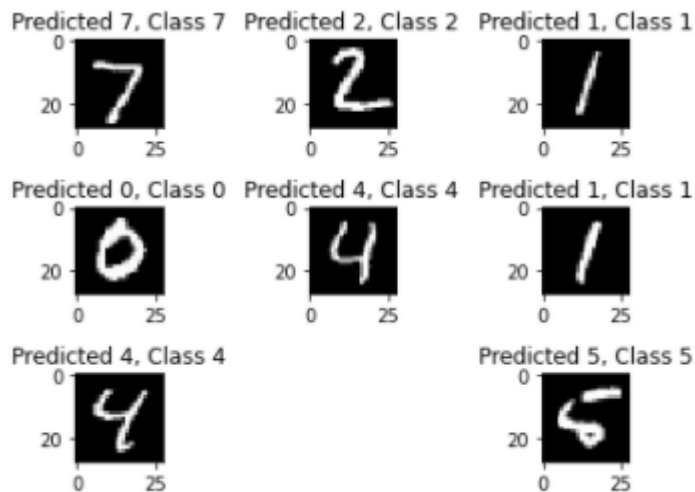
```

predicted_classes = m_model.predict(test_X)
predicted_classes = np.argmax(np.round(predicted_classes),axis=1)
predicted_classes.shape, test_Y.shape

((10000,), (10000,))

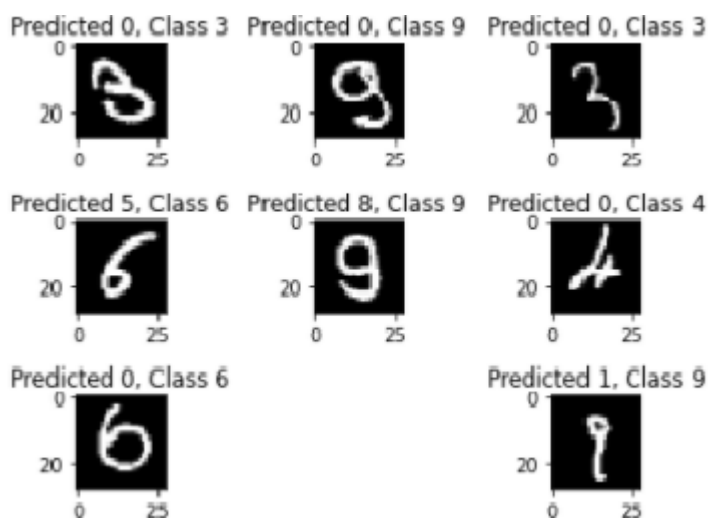
correct = np.where(predicted_classes==test_Y)[0]
print ("Found %d correct labels"%len(correct))
for i, correct in enumerate(correct[:9]):
    plt.subplot(3,3,i+1)
    plt.imshow(test_X[correct].reshape(28,28), cmap='gray', interpolation='
none')
    plt.title("Predicted {}, Class {}".format(predicted_classes[correct],
test_Y[correct]))
    plt.tight_layout()
Found 9680 correct labels

```



```
incorrect = np.where(predicted_classes!=test_Y)[0]
print ("Found %d incorrect labels"%len(incorrect))
for i, incorrect in enumerate(incorrect[:9]):
    plt.subplot(3,3,i+1)
    plt.imshow(test_X[incorrect].reshape(28,28), cmap='gray', interpolation
='none')
    plt.title("Predicted {}, Class {}".format(predicted_classes[incorrect],
test_Y[incorrect]))
    plt.tight_layout()
```

Found 320 incorrect labels



```
from sklearn.metrics import classification_report
target_names = ["Class {}".format(i) for i in range(num_classes)]
print(classification_report(test_Y, predicted_classes, target_names=target_
names))
```

	precision	recall	f1-score	support
Class 0	0.90	0.99	0.94	980
Class 1	0.98	0.99	0.99	1135
Class 2	0.99	0.94	0.96	1032
Class 3	0.97	0.99	0.98	1010
Class 4	0.98	0.98	0.98	982

Class 5	1.00	0.93	0.96	892
Class 6	0.97	0.98	0.98	958
Class 7	0.95	0.98	0.97	1028
Class 8	0.97	0.95	0.96	974
Class 9	0.99	0.94	0.96	1009
accuracy			0.97	10000
macro avg	0.97	0.97	0.97	10000
weighted avg	0.97	0.97	0.97	10000

Conclusion: Using Keras and tensor flow network loaded the mnist image dataset and designed a two-layer neural network with one hidden layer and one output layer using CNN with Leaky Relu activation function for the hidden layer.

Program 8:

Using Keras and tensor flow network

- i) Load the imdb text dataset
- ii) Design a two-layer neural network with one hidden layer and one output layer
 - a. Use simple RNN in the hidden layer
 - b. Use sigmoid activation function for the output layer
- iii) Train the designed network for imdb dataset
- iv) Visualize the results of
 - a) Training vs validation accuracy
 - b) Training vs Validation loss

```
from keras.models import Sequential
from keras.layers import Embedding, SimpleRNN
from keras.datasets import imdb
from keras.preprocessing import sequence
from keras.layers import Dense
max_features =10000
maxlen =500
batch_size =32

print('Loading data...')
(input_train, y_train), (input_test, y_test) = imdb.load_data( num_words=ma
x_features)
#(input_train, y_train), (input_test, y_test) = imdb.load_data()
print(len(input_train), 'train sequences')
print(len(input_test), 'test sequences')
print('Pad sequences (samples x time)')
input_train = sequence.pad_sequences(input_train, maxlen=maxlen)
input_test = sequence.pad_sequences(input_test, maxlen=maxlen)
print('input_train shape:', input_train.shape)
print('input_test shape:', input_test.shape)
```

```
25000 train sequences
25000 test sequences
Pad sequences (samples x time)
input_train shape: (25000, 500)
input_test shape: (25000, 500)
```

```
model = Sequential()
model.add(Embedding(max_features, 32)) #max_feature=10,000 so, 320,000
model.add(SimpleRNN(32)) # (32+32+1) *32=2080
model.add(Dense(1, activation='sigmoid')) # (32+1) *1=33
model.summary()
```

```
Model: "sequential_2"
```

Layer (type)	Output Shape	Param #
embedding_2 (Embedding)	(None, None, 32)	320000
simple_rnn_2 (SimpleRNN)	(None, 32)	2080

dense_2 (Dense)	(None, 1)	33
-----------------	-----------	----

Total params: 322,113
 Trainable params: 322,113
 Non-trainable params: 0

```
model.compile(optimizer='rmsprop', loss='binary_crossentropy', metrics=['acc'])
```

```
history = model.fit(input_train, y_train, epochs=10, batch_size=128, validation_split=0.2)
```

Train on 20000 samples, validate on 5000 samples

Epoch 1/10

20000/20000 [=====] - 33s 2ms/step - loss: 0.5955
- acc: 0.6679 - val_loss: 0.5106 - val_acc: 0.7566

Epoch 2/10

20000/20000 [=====] - 36s 2ms/step - loss: 0.3544
- acc: 0.8530 - val_loss: 0.4272 - val_acc: 0.8158

Epoch 3/10

20000/20000 [=====] - 37s 2ms/step - loss: 0.2823
- acc: 0.8870 - val_loss: 0.3698 - val_acc: 0.8652

Epoch 4/10

20000/20000 [=====] - 41s 2ms/step - loss: 0.2192
- acc: 0.9174 - val_loss: 0.4816 - val_acc: 0.7870

Epoch 5/10

20000/20000 [=====] - 36s 2ms/step - loss: 0.1675
- acc: 0.9376 - val_loss: 0.4021 - val_acc: 0.8440

Epoch 6/10

20000/20000 [=====] - 32s 2ms/step - loss: 0.1261
- acc: 0.9570 - val_loss: 0.4502 - val_acc: 0.8312

Epoch 7/10

20000/20000 [=====] - 32s 2ms/step - loss: 0.0758
- acc: 0.9740 - val_loss: 0.4815 - val_acc: 0.8328

Epoch 8/10

20000/20000 [=====] - 35s 2ms/step - loss: 0.0552
- acc: 0.9829 - val_loss: 0.5122 - val_acc: 0.8474

Epoch 9/10

20000/20000 [=====] - 33s 2ms/step - loss: 0.0313
- acc: 0.9908 - val_loss: 0.5852 - val_acc: 0.8282

Epoch 10/10

20000/20000 [=====] - 32s 2ms/step - loss: 0.0239
- acc: 0.9933 - val_loss: 0.6137 - val_acc: 0.8376

```
predicted_classes = model.predict(input_test)
```

```
import numpy as np
```

```
predicted_classes = np.argmax(np.round(predicted_classes), axis=1)
```

```
predicted_classes.shape, y_test.shape
```

```
((25000,), (25000,))
```

```
correct = np.where(predicted_classes==y_test)[0]
```

```
print ("Found %d correct labels"%len(correct))
```

Found 12500 correct labels

```
incorrect = np.where(predicted_classes!=y_test)[0]
print ("Found %d incorrect labels"%len(incorrect))
```

Found 12500 incorrect labels

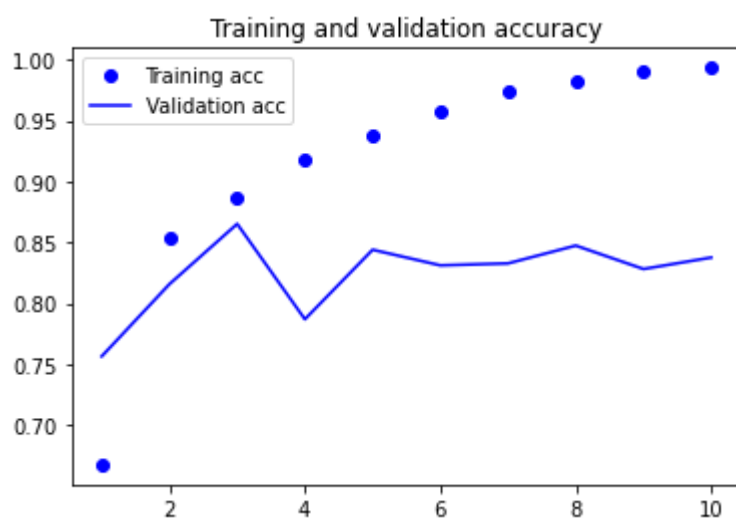
```
from sklearn.metrics import classification_report
num_classes=2
target_names = ["Class {}".format(i) for i in range(num_classes)]
print(classification_report(y_test, predicted_classes, target_names=target_
names))
```

	precision	recall	f1-score	support
Class 0	0.50	1.00	0.67	12500
Class 1	0.00	0.00	0.00	12500
accuracy			0.50	25000
macro avg	0.25	0.50	0.33	25000
weighted avg	0.25	0.50	0.33	25000

```
_warn_prf(average, modifier, msg_start, len(result))
```

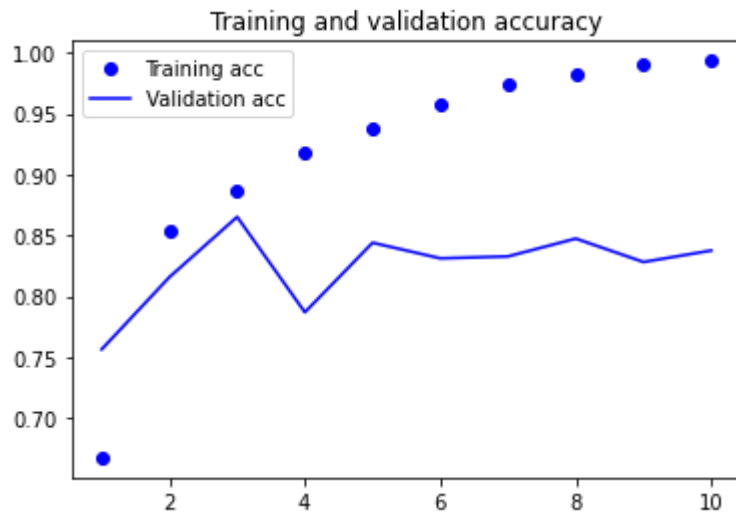
```
import matplotlib.pyplot as plt
acc = history.history['acc']
val_acc = history.history['val_acc']
epochs =range(1, len(acc) +1)
plt.plot(epochs, acc, 'bo', label='Training acc')
plt.plot(epochs, val_acc, 'b', label='Validation acc')
plt.title('Training and validation accuracy')
plt.legend()
```

<matplotlib.legend.Legend at 0x22133e2fd08>



```
plt.figure()
loss = history.history['loss']
val_loss = history.history['val_loss']
epochs =range(1, len(acc) +1)
plt.plot(epochs, loss, 'bo', label='Training loss')
```

```
plt.plot(epochs, val_loss, 'b', label='Validation loss')
plt.title('Training and validation loss')
plt.legend()
plt.show().
```



Conclusion: Using Keras and tensor flow network loaded the imdb text dataset and designed a two-layer neural network with one hidden layer and one output layer using simple RNN in the hidden layer.