JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY

ANANTAPUR

WARDROBE CATEGORIZATION USING AI

An Internship report Submitted to the

Jawaharlal Nehru Technological University, Anantapur.

In partial fulfilment for the Award of the degree of

BACHELOR OF TECHNOLOGY

IN

COMPUTER SCIENCE AND ENGINEERING

BY

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Under the Esteemed Guidance of

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SREE VENKATESWARA COLLEGE OF ENGINEERING

(Accredited with NAAC "A", UGC 2(f) Recognized & ISO 9001::2015 Certified

Approved by AICTE, New Delhi and Affiliated to JNTUA – Anantapuramu)

North Rajupalem, Kodavaluru(V&M), SPSR Nellore.

2019-2023

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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

BONAFIDE CERTIFICATE

This is to certify that the Internship report entitled **"WARDROBE CATEGORIZATION USING AI"** submitted by **CH. V. N. S. SAI DIVYESH (19JN1A0524)** is work done by him and submitted in partial fulfilment of the requirements for the award of the degree of **BACHELOR OF TECHNOLOGY in COMPUTER SCIENCE AND ENGINEERING** during the academic year **2022-2023** at **COINCENT, BANGALORE**.

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INTERNSHIP CERTIFICATE

DECLARATION

I hereby declare that the INTERNSHIP report entitled **"WARDROBE CATEGORIZATION USING AI"** done by me under the esteemed guidance of **Mrs. V. S. V. HARIKA M.Tech.,** Assistant Professor, Department of Artificial Intelligence and Data Science. This internship work has been submitted to **SREE VENKATESWARA COLLEGE OF ENGINEERING** in partial fulfilment of the requirements for the award of the degree of Bachelor of Technology in Computer Science and Engineering.

I also declare that this internship report has not been submitted at any time to another Institute or University for the award of any Degree.

Internship Associative

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ACKNOWLEDGEMENT

With immense respect, I express my sincere gratitude to **Dr. P. BABUNAIDU, Chairman, SREE VENKATESWARA COLLEGE OF ENGINEERING, NELLORE** who took keen interest and encouraged in every effort throughout this course. I own my gratitude to **Dr. P. KUMAR BABU, Principal, SREE VENKATESWARA COLLEGE OF ENGINEERING, NELLORE** for giving us the opportunity to fulfil our aspiration and become Engineers.

I would like to extend ardent thanks to **Mr. M. PRAVEEN KUMAR M.Tech., (Ph.D.), Associate Professor & Head of the Department, Computer Science and Engineering,** for endowing a practical environment in the institute.

I take this opportunity to express my sincere deep sense of gratitude to my guide **Mrs. V. S. V. HARIKA M.Tech., Assistant Professor, Department of Artificial Intelligence and Data Science,** for her significant suggestions and help in every aspect to accomplish the internship.

I would like to express my gratitude to our trainer **Mr. V. SHYAM SHARMA, Trainer, COINCENT,** for his guidance, significant suggestions and help in every aspect to accomplish the internship. His persisting encouragement, everlasting patience and keen interest in discussions have benefited me to an extent that cannot be spanned by words**.**

I am thankful to the staff members of my department for their cooperation over the completion of this internship.

Finally, I thank one and all who directly or indirectly supported me in the completion of this internship successfully.

Submitted By

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ABSTRACT

Machine learning and deep learning, as one of the most prominent fields of today are quickly improving many aspects of our life. One of the categories that provides strongest results in resolving real-world problems is **Convolutional Neural Networks (CNN)**. Fashion industries have been using Convolutional Neural Networks in e-commerce to solve several problems such as, clothing recognition, clothing searches and recommendations. However, the conventional CNN suffers from several issues including model overfit issues, challenging classification and difficult deep division of garment. It is precisely this complex depth that allows multiple classes to have the same characteristics, making the problem of separation more complex. With this paper, the state-of-art algorithms for the classification of images in the **FASHION MNIST database** are targeted. Convolutional neural network structures based on deep learning are employed for image classification of the MNIST dataset. The study aims to tackle the model overfit issue, using two different convolutional neural networks **CNN-C1** and **CNN-C2** architectures to determine which one provides better performance and results. The results show that compared with conventional deep neural network the CNN-C2 outperforms the CNN-C1 architecture and produces higher accuracy of 93.11%.

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WEEKLY OVERVIEW OF INTERNSHIP ACTIVITIES

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	13/08/2022	Saturday	Introduction to Python Programming Google Collab
	14/08/2022	Sunday	Datatypes and Operators in Python Loops in Python
	15/08/2022	Monday	Python Data Structures Python Functions
	16/08/2022	Tuesday	Assignment on Datatypes and Operators in Python Assignment on Loops in Python
	17/08/2022	Wednesday	Assignment on Python Data Structures Assignment on Python Functions

	DATE	DAY	NAME OF TOPIC/ MODULE LEARNT
2nd WEEK	18/08/2022	Thursday	Introduction to Pattern Recognition Artificial Intelligence and Types of AI
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	21/08/2022	Sunday	Examples of Supervised Learning Algorithms
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1. INTRODUCTION TO PYTHON PROGRAMMING

Python is a programming language, first released by **Guido van Rossum** in the year 1991. Python is now one of the top 5 programming languages in the world. There are different versions of Python released: Python 2.0 (2000), Python 2.7 (2010), Python 3.0 (2008), now the newest version is **Python 3.10**.

Some real-world **applications** of Python are:

a. Artificial Intelligence and Machine Learning

b. Game Development

c. Software Development

d. Scientific and Numeric Applications

e. Web Development

Some **features** of Python are:

a. Simple

b. Open-source

c. High-level

d. Object-oriented

e. Portable

f. Interpreted

g. Standard Libraries like numpy, pandas, matplotlib, os, math etc.

Python provides great functionality to deal with mathematics, statistics and scientific applications. Due to these advantages, Python is the best choice for Artificial Intelligence.

The below figure shows various Python Libraries that I have used to develop my Major Project:

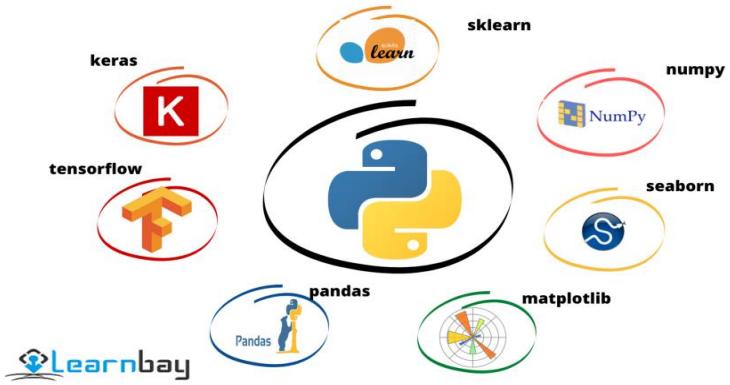


Figure 1.1: Python Libraries

2. GOOGLE COLLAB

The following steps are to be followed for writing a Python code in Google Collab:

Step 1: Visit https://colab.research.google.com/

Step 2: Sign-in with your Google Account.

Step 3: Click on File button and create New Notebook where you can start executing your Python code.

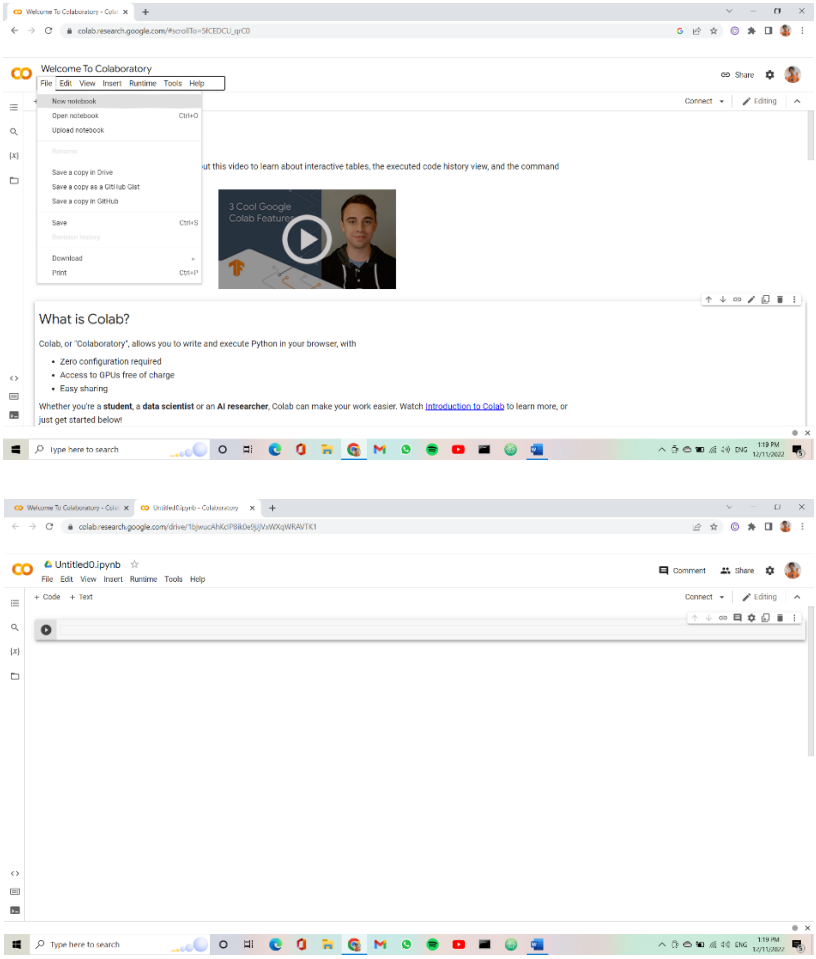


Figure 2.1: Illustration of How to use Google Collab

Step 4: You don't need to install any modules to run any code.

Step 5: You can share your Google Collab notebooks very easily with anyone.

3. DATATYPES AND OPERATORS IN PYTHON

3.1 DATATYPES: Python has the following data types built-in by default, in these categories:

Type	Representation
Text Type:	str
Numeric Types:	int, float, complex
Sequence Types:	list, tuple, range
Mapping Type:	dict
Set Types:	set, frozenset
Boolean Type:	bool
Binary Types:	bytes, bytearray
None Type:	NoneType

Table 3.1: Datatypes in Python

3.2 ARITHMETIC OPERATORS: Python has the following arithmetic operators:

Operator	Name
+	Addition
-	Subtraction
*	Multiplication
/	Division
%	Modulus
**	Exponentiation
//	Floor division

Table 3.2: Arithmetic Operators in Python

3.3 RELATIONAL OPERATORS: Python has the following relational operators:

Operator	Name
==	Equal
!=	Not equal
>	Greater than
<	Less than
>=	Greater than or equal to
<=	Less than or equal to

Table 3.3: Relational Operators in Python

3.4 LOGICAL OPERATORS: Python has the following logical operators:

Operator	Description
and	Returns True if both the statements are true
or	Returns True if one of the statements is true
not	Reverse the result, returns False if the result is true

Table 3.4: Logical Operators in Python

3.5 IDENTITY OPERATORS: Python has the following identity operators:

Operator	Description
is	Returns True if both variables are the same object
is not	Returns True if both variables are not the same object

Table 3.5: Identity Operators in Python

3.6 MEMBERSHIP OPERATORS: Python has the following membership operators:

Operator	Description
in	Returns True if a sequence with the specified value is present in the object
not in	Returns True if a sequence with the specified value is not present in the object

Table 3.6: Membership Operators in Python

3.7 BITWISE OPERATORS: Python has the following bitwise operators:

Operator	Name
&	AND
|	OR
^	XOR
~	NOT
<<	Zero fill left shift
>>	Signed right shift

Table 3.7: Bitwise Operators in Python

4. LOOPS IN PYTHON

4.1 for LOOP: An example of for loop in Python is as shown below:

```
for x in range (6):
  if x == 3:
    print (x)
  else:
    print ("Finally finished!")
```

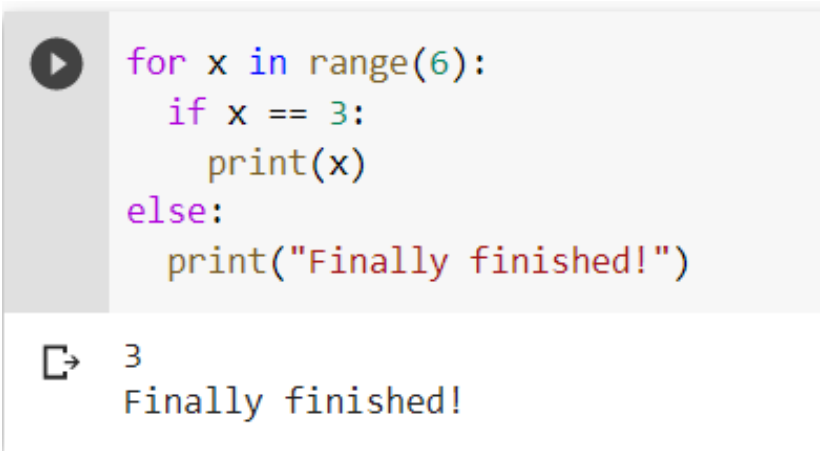


Figure 4.1: Implementation of for loop in Python

4.2 while LOOP: An example of while loop in Python is as shown below:

```
i = 1
while i < 6:
  print (i)
  i += 1
else:
  print ("i is no longer less than 6")
```

```
i = 1
while i < 6:
  print(i)
  i += 1
else:
  print("i is no longer less than 6")
```

```
1
2
3
4
5
i is no longer less than 6
```

Figure 4.2: Implementation of while loop in Python

5. PYTHON DATA STRUCTURES

5.1 STRINGS: A string is a sequence of characters. A character is simply a symbol. Strings can be created by enclosing characters inside a single quote or double-quotes. Even triple quotes can be used in Python but generally used to represent multiline strings and docstrings.

Ex:

```
my_string = “Hello”
print (my_string)
```

5.2 LISTS: Python lists are one of the most versatile data types that allow us to work with multiple elements at once. A list is created by placing elements inside square brackets [ ], separated by commas. A list can have any number of items and they may be of different types (integer, float, string, etc.).

Ex:

```
my_list = [2, 3.0, “Hello”]
print (my_list)
```

5.3 TUPLES: A tuple in Python is similar to a list. The difference between the two is that we cannot change the elements of a tuple once it is assigned whereas we can change the elements of a list. A tuple is created by placing all the elements inside parentheses ( ), separated by commas. A tuple can have any number of items and they may be of different types (integer, float, list, string, etc.).

Ex:

```
my_tuple = (2, 3.0, “Hello”)
print (my_tuple)
```

5.4 SETS: A set is an unordered collection of items. Every set element is unique (no duplicates) and must be immutable (cannot be changed). A set itself is mutable. A set is created by placing all the elements inside curly braces { }, separated by commas. To make a set without any elements, we use the built-in function set ( ) without any arguments.

Ex:

```
my_set = {1,2,3,5,7}

print (my_set)
```

5.5 DICTIONARIES: Python dictionary is an unordered collection of items. Each item of a dictionary has a key/value pair. Dictionaries are optimized to retrieve values when the key is known. Creating a dictionary is as simple as placing items inside curly braces { }, separated by commas. An item has a key and a corresponding value that is expressed as a pair (**key: value**). While the values can be of any data type and can repeat, keys must be of immutable type and must be unique.

Ex:

```
my_dict = {“name”: “Jack”, “age”: 26}

print (my_dict)
```

6. PYTHON FUNCTIONS

In Python, a function is a group of related statements that performs a specific task. Functions help break our program into smaller and modular chunks. As our program grows larger and larger, functions make it more organized and manageable. It avoids repetition and makes the code reusable. The **def keyword** is used to create a function in Python.

Ex:

```
def fun (x):
    if x >= 3:
      print (x-3)
       else:
      print (x)

fun (6)
```

7. INTRODUCTION TO PATTERN RECOGNITION

Pattern recognition is the use of machine learning algorithms to identify patterns. It classifies data based on statistical information or knowledge gained from patterns and their representation. Examples are:

a. Speech Recognition System

b. Computer Vision System

c. Facial Detection System

d. Image Processing System

e. Fingerprint Identification

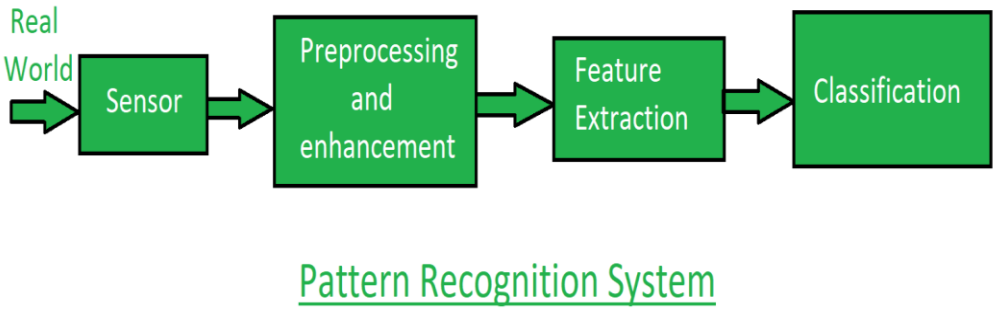


Figure 7.1: Pattern Recognition System

There are various sequences of activities that are used for designing the Pattern Recognition Systems. These activities are as follows:

a. Data Collection

b. Feature Choice

c. Model Choice

d. Training

e. Evaluation

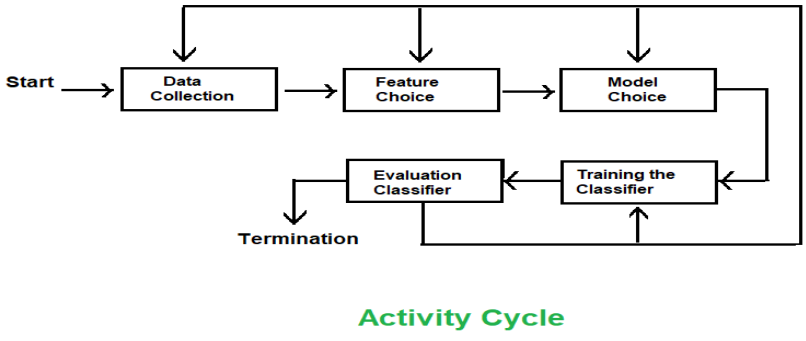


Figure 7.2: Activity Cycle of a Pattern Recognition System

8. ARTIFICIAL INTELLIGENCE

Artificial Intelligence enables us to build amazing software that can

a. improve health care,

b. enable people to overcome physical disadvantages,

c. empower smart infrastructure,

d. create incredible entertainment experiences,

e. and even save the planet!!

Simply put, AI is the creation of software that imitates human behaviours and capabilities. The **Turing Test**, proposed by **Alan Turing (1950)** was designed to provide a satisfactory definition of AI. The computer would need to possess the following capabilities:

a. Machine Learning

b. Anomaly Detection

c. Natural Language Processing

d. Computer Vision

8.1 MACHINE LEARNING: This is often the foundation for an AI system, and is the way we "teach" a computer model to make prediction and draw conclusions from data. Some of the libraries used in Python to perform ML tasks are:

Figure 8.1: Python ML Libraries

8.2 ANOMALY DETECTION: The capability to automatically detect errors or unusual activity in a system.

8.3 NATURAL LANGUAGE PROCESSING: The capability of a computer to interpret written or spoken language, and respond accordingly. Scikit-learn is the best library in Python used to perform NLP.

8.4 COMPUTER VISION: The capability of software to interpret the world visually through cameras, videos and images. OpenCV is the best library in Python used to perform computer vision:

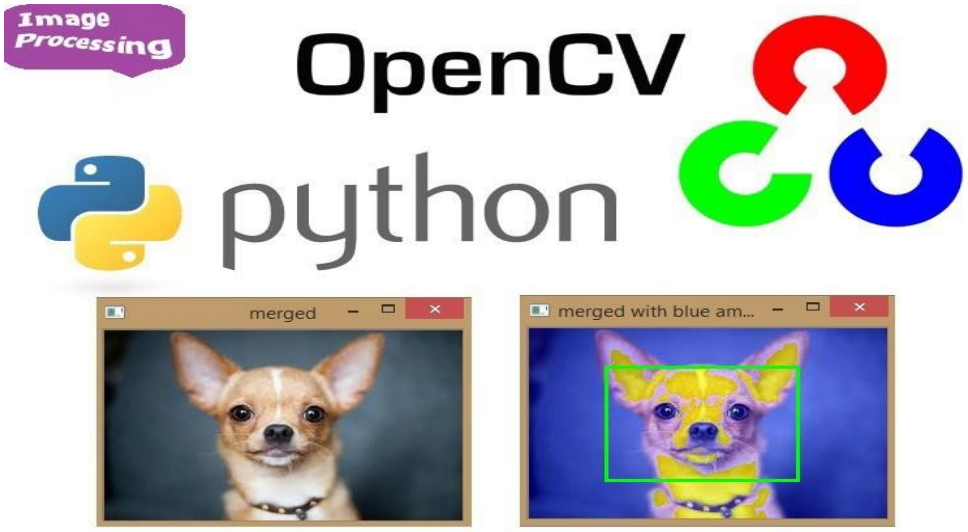


Figure 8.2: An illustration of OpenCV in Python

8.5 TYPES OF ARTIFICIAL INTELLIGENCE:

8.5.1 Narrow/Weak AI: This is a type of AI which is able to perform a dedicated task (only one task) with intelligence. It is the most commonly and currently available AI.

8.5.2 General/Strong AI: This is a type of AI which could perform any intellectual task with efficiency like a human**.** The worldwide researchers are now focused on developing machines with general AI.

8.5.3 Super AI: This is a level of intelligence of systems that machines could surpass human intelligence and can perform any task better than human. It is an outcome of general AI.

9. MACHINE LEARNING

Machine Learning is an application of AI that provides systems the ability to automatically learn and improve from experience without being explicitly programmed. Simply, ML is a technique of converting **information** into **knowledge**. Machine Learning is generally classified into 3 types:

a. Supervised Learning

b. Unsupervised Learning

c. Reinforcement Learning

9.1 SUPERVISED LEARNING: Supervised Learning is a type of machine learning where you have input variables (X) and an output variable (Y) and you use an algorithm to learn the mapping function from the input to the output.

$$\mathbf{Y = f(X)}$$

Supervised Learning is classified into 2 types:

a. Classification

b. Regression

9.1.1 Classification: Classification predictive modelling is a task of approximating a mapping function (f) from input variables (X) to discrete output variables (Y) (classes). Here, the output variable is usually a category such as **red or blue**.

Some classification algorithms are: Decision Tree Induction, Naïve Bayes Classification, Classification by Back Propagation, Support Vector Machines (SVM).

9.1.2 Regression: Regression predictive modelling is a task of approximating a mapping function (f) from input variables (X) to real or continuous output variables (Y). Here, the output variable is usually a real value such as **weight**.

Classification by Decision Tree Induction: A decision tree is a flowchart-like structure where,

- each internal node denotes a test on an attribute

- each branch represents an outcome of the test
- each leaf node holds a class label
- topmost node is the root node

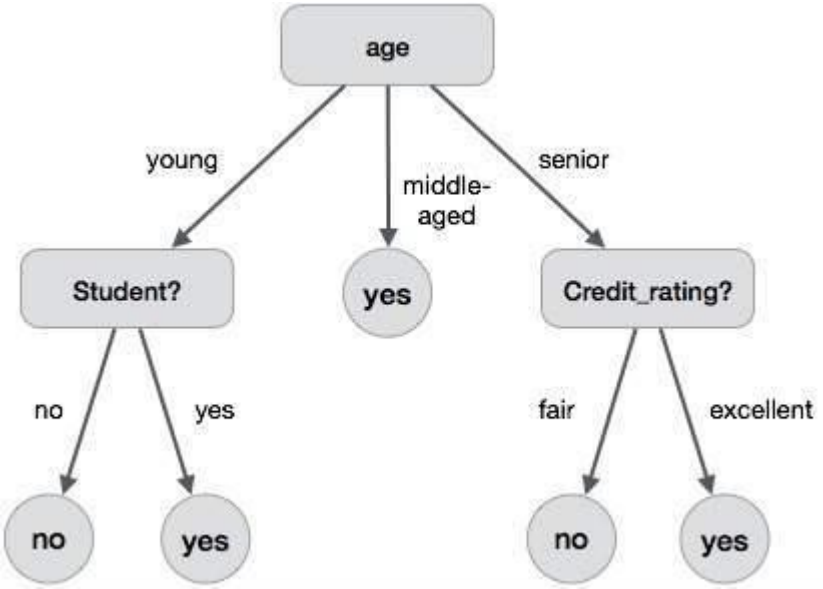


Figure 9.1: An example for Decision Tree

9.2 UNSUPERVISED LEARNING: Unsupervised Learning allows us to approach problems with little or no idea what our results should look like i.e., you only have input data (X) and no corresponding output variables.

Unsupervised Learning is classified into 2 types:

a. Clustering

b. Association

9.2.1 Clustering: A clustering problem is the one where you want to discover the inherent groupings of data, such as **grouping customers by their purchasing behaviour**.

Some clustering algorithms are: k-means Algorithm, k-medoids Algorithm.

9.2.2 Association: An association rule learning problem is the one where you want to discover the rules that describe large portions of your data, such as **people that buy bread also tend to buy milk**.

Some association rule learning algorithms are: Apriori Algorithm, FP Growth Algorithm.

k-Means Clustering Algorithm: There are 4 steps in this algorithm:

1. Partition objects into k non-empty subsets, called clusters.
2. Compute seed points as the centroids of the clusters of the current position.
3. Assign each object to the cluster with the nearest seed point.
4. Go back to step 2. Stop when no more new assignment.

Ex: O = {2,3,4,10,11,12,20,25,30} and k = 2

$M_1 = 4$ and $M_2 = 12$

$C_1 = \{2,3,4\}$ and $C_2 = \{10,11,12,20,25,30\}$ and so on until no more new assignment.

Association Rule Learning using IF-THEN rules: An example for association rule is:

IF buys (X, bread) THEN buys (X, milk);

One of the measures used for association rule learning is **Lift** measure.

Lift (A, B) = P (AUB) / P (A). P (B)

- If Lift (A, B) < 1, then A is negatively correlated to B.
- If Lift (A, B) > 1, then A is positively correlated to B.
- If Lift (A, B) = 1, then A is not correlated to B.

9.3 REINFORCEMENT LEARNING:

Reinforcement Learning is a feedback-based Machine learning technique in which an agent learns to behave in an environment by performing the actions and seeing the results of actions. For each good action, the agent gets **positive feedback** or **reward**, and for each bad action, the agent gets **negative feedback** or **penalty**.

Reinforcement Learning is classified into 2 types:

a. Active Reinforcement Learning

b. Passive Reinforcement Learning

9.3.1 Active Reinforcement Learning:

In active RL, an agent needs to decide what to do as there is no fixed policy that it can act on.

9.3.2 Passive Reinforcement Learning: In passive RL, the agent's policy is fixed i.e., it is told what to do.

10. INTRODUCTION TO COMPUTER VISION

Computer vision is a field of artificial intelligence (AI) that enables computers and systems to derive meaningful information from digital images, videos and other visual inputs and take actions or make recommendations based on that information. If AI enables computers to think, computer vision enables them to see, observe and understand. Computer vision works much the same as human vision, except humans have a head start. Human sight has the advantage of lifetimes of context to train how to tell objects apart, how far away they are, whether they are moving and whether there is something wrong in an image.

Computer vision needs lots of data. It runs analyses of data over and over until it discerns distinctions and ultimately recognize images. For example, to train a computer to recognize automobile tires, it needs to be fed vast quantities of tire images and tire-related items to learn the differences and recognize a tire, especially one with no defects.

Two essential technologies are used to accomplish this: a type of machine learning called **deep learning** and a **convolutional neural network (CNN)**.

- **Machine learning** uses algorithmic models that enable a computer to teach itself about the context of visual data. If enough data is fed through the model, the computer will "look" at the data and teach itself to tell one image from another. Algorithms enable the machine to learn by itself, rather than someone programming it to recognize an image.
- A **CNN** helps a **machine learning or deep learning** model "look" by breaking images down into pixels that are given tags or labels. It uses the labels to perform convolutions (a mathematical operation on two functions to produce a third function) and makes predictions about what it is "seeing." The neural network runs convolutions and checks the accuracy of its predictions in a series of iterations until the predictions start to come true. It is then recognizing or seeing images in a way similar to humans.

Real-world **applications** demonstrate how important computer vision is to endeavours in business, entertainment, transportation, healthcare and everyday life. Some of the **applications** are:

a. IBM used computer vision to create My Moments for the 2018 Masters golf tournament.
b. Google Translate lets users point a smartphone camera at a sign in another language and almost immediately obtain a translation of the sign in their preferred language.
c. The development of self-driving vehicles relies on computer vision to make sense of the visual input from a car's cameras and other sensors.

11. OPENCV USING PYTHON

OpenCV is a Python library that allows you to perform image processing and computer vision tasks. It provides a wide range of features, including object detection, face recognition, and tracking. In this OpenCV Tutorial in Python, we'll be learning more about the library.

OpenCV is an open-source software library for computer vision and machine learning. The OpenCV full form is Open-Source Computer Vision Library. It was created to provide a shared infrastructure for applications for computer vision and to speed up the use of machine perception in consumer products.

You can use pip to install OpenCV on windows. Use this command in the command prompt to install OpenCV:

pip install opencv-python

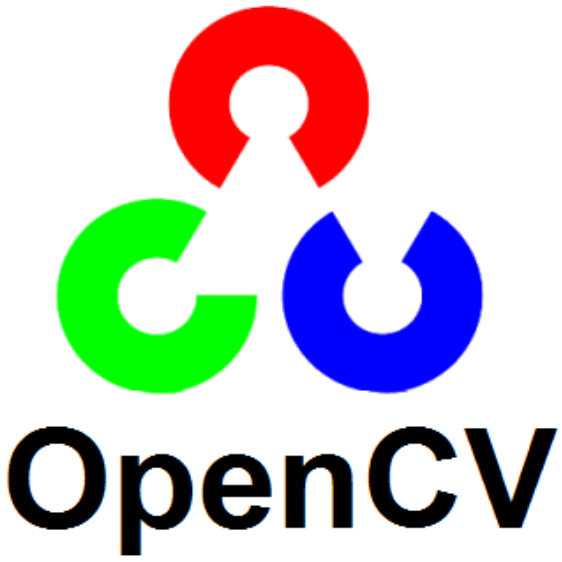


Figure 11.1: Python OpenCV Library logo

12. NUMPY LIBRARY IN PYTHON

NumPy is the fundamental package for scientific computing in Python. It is a Python library that provides a multidimensional array object, various derived objects (such as masked arrays and matrices), and an assortment of routines for fast operations on arrays, including mathematical, logical, shape manipulation, sorting, selecting, I/O, discrete Fourier transforms, basic linear algebra, basic statistical operations, random simulation and much more.

You can use pip to install NumPy on windows. Use this command in the command prompt to install NumPy:

pip install numpy

Figure 12.1: Python NumPy Library logo

13. PANDAS AND MATPLOTLIB LIBRARIES IN PYTHON

Pandas is a Python library for data analysis. It was started by Wes McKinney in 2008 out of a need for a powerful and flexible quantitative analysis tool, Pandas has grown into one of the most popular Python libraries. It has an extremely active community of contributors.

Pandas is built on top of two core Python libraries: **matplotlib** for data visualization and **NumPy** for mathematical operations. Pandas acts as a wrapper over these libraries, allowing you to access many of matplotlib's and NumPy's methods with less code.

You can use pip to install Pandas on windows. Use this command in the command prompt to install Pandas:

pip install pandas

Figure 13.1: Python Pandas Library logo

Matplotlib is a comprehensive library for creating static, animated, and interactive visualizations in Python. Matplotlib makes easy things easy and hard things possible. Matplotlib can:

a. Create publication quality plots.
b. Make interactive figures that can zoom, pan, update.
c. Customize visual style and layout.
d. Export to many file formats.

You can use pip to install Matplotlib on windows. Use this command in the command prompt to install Matplotlib:

pip install matplotlib

Figure 13.2: Python Matplotlib Library logo

14. PROJECT WORK

14.1 CODING:

Name of the Project: WARDROBE CATEGORIZATION USING AI

Aim of the Project: The objective of this project is to develop a machine which identifies the category of clothing and classifies them accordingly.

Source Code of the Project:

```
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
import tensorflow as tf
import keras
(x_train, y_train), (x_test, y_test) = tf.keras.datasets.fashion_mnist.load_data ()

# PRINT THE SHAPE OF DATA

x_train.shape, y_train.shape, "**********", x_test.shape, y_test.shape

y_train[0]

class_labels = ["T-shirt/top", "Trouser", "Pullover", "Dress", "Coat", "Sandal", "Shirt", "Sneaker", "Bag", "Ankle boot"]

class_labels

# SHOW IMAGE

plt.imshow (x_train[0], cmap = 'Greys')

plt.figure (figsize = (16,16))

j = 1

for i in np.random.randint (0,1000,25):

    plt.subplot (5,5,j)

    j += 1
```

```
    plt.imshow (x_train[i], cmap = 'Greys')
    plt.axis ('off')
    plt.title ('{} / {}'.format (class_labels[y_train[i]], y_train[i]))
x_train.ndim
x_train = np.expand_dims (x_train, -1)
x_train.ndim
x_test = np.expand_dims (x_test, -1)
# FEATURE SCALING
x_train = x_train/255
x_test = x_test/255
# SPLIT DATASET
from sklearn.model_selection import train_test_split
x_train, x_validation, y_train, y_validation = train_test_split (x_train, y_train, test_size = 0.2, random_state = 2020)
x_train.shape, x_validation.shape, y_train.shape, y_validation.shape
# BUILDING CNN MODEL
model = keras.models.Sequential ([
   keras.layers.Conv2D (filters = 32, kernel_size = 3,  strides = (1,1), padding = 'valid', activation = 'relu', input_shape = [28,28,1]),
   keras.layers.MaxPooling2D (pool_size = (2,2)),
   keras.layers.Flatten (),
   keras.layers.Dense (units = 128, activation = 'relu'),
   keras.layers.Dense (units = 10, activation = 'softmax')
])
```

```
# SUMMARY OF THE MODEL

model.summary()

# COMPILE THE MODEL

model.compile (optimizer = 'adam', loss = 'sparse_categorical_crossentropy', metrics = ['accuracy'])

# TRAIN THE MODEL

model.fit (x_train, y_train, epochs = 10, batch_size = 512, verbose = 1, validation_data = (x_validation, y_validation))

# TEST THE MODEL

y_pred = model.predict (x_test)

y_pred.round (2)

y_test

model.evaluate (x_test, y_test)

plt.figure (figsize = (16,30))

j = 1

for i in np.random.randint (0,1000,60):

    plt.subplot (10,6,j)

    j += 1

    plt.imshow (x_test[i].reshape(28,28), cmap = 'Greys')

    plt.title ('Actual = {} / {} \nPredicted - {} / {}'.format (class_labels [y_test[i]], y_test[i], class_labels [np.argmax (y_pred[i])], np.argmax (y_pred[i])))

    plt.axis ('off')

# EVALUATE THE MODEL

# CONFUSION MATRIX
```

```
from sklearn.metrics import confusion_matrix

plt.figure (figsize = (16,9))

y_pred_labels = [np.argmax (label) for label in y_pred]

cm = confusion_matrix (y_test, y_pred_labels)

# SHOW THE CONFUSION MATRIX

sns.heatmap (cm, annot = True, fmt = 'd', xticklabels = class_labels, yticklabels = class_labels)

# SHOW THE CLASSIFICATION REPORT

from sklearn.metrics import classification_report

cr = classification_report (y_test, y_pred_labels, target_names = class_labels)

print (cr)

# SAVE THE MODEL

model.save ('fashion_mnist_cnn_model.h5')
```

14.2 OUTPUT SCREENSHOTS:

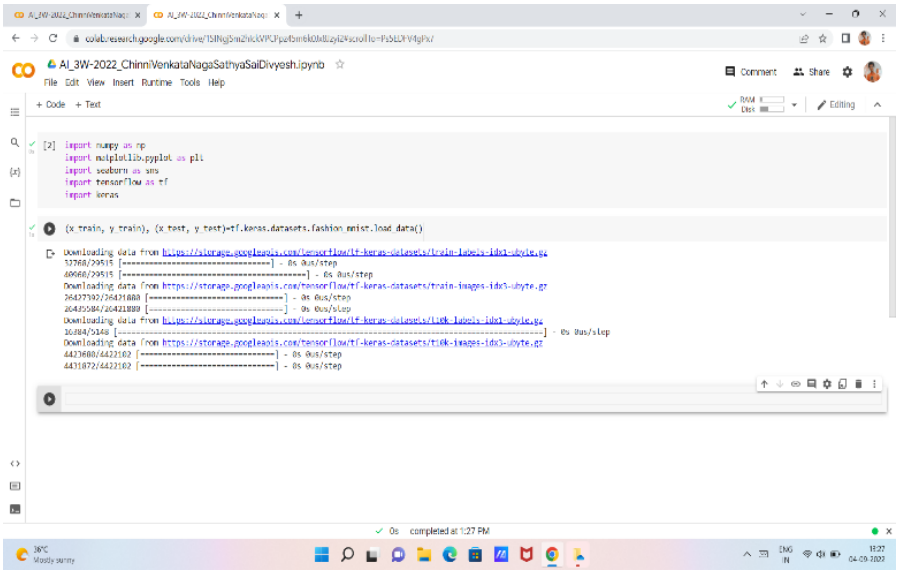


Figure 14.1: Import the required Libraries

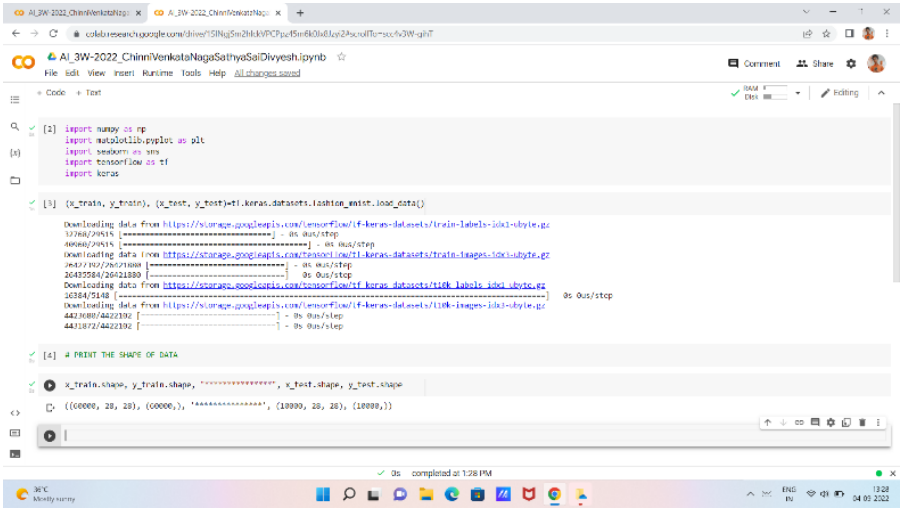


Figure 14.2: Print the shape of data

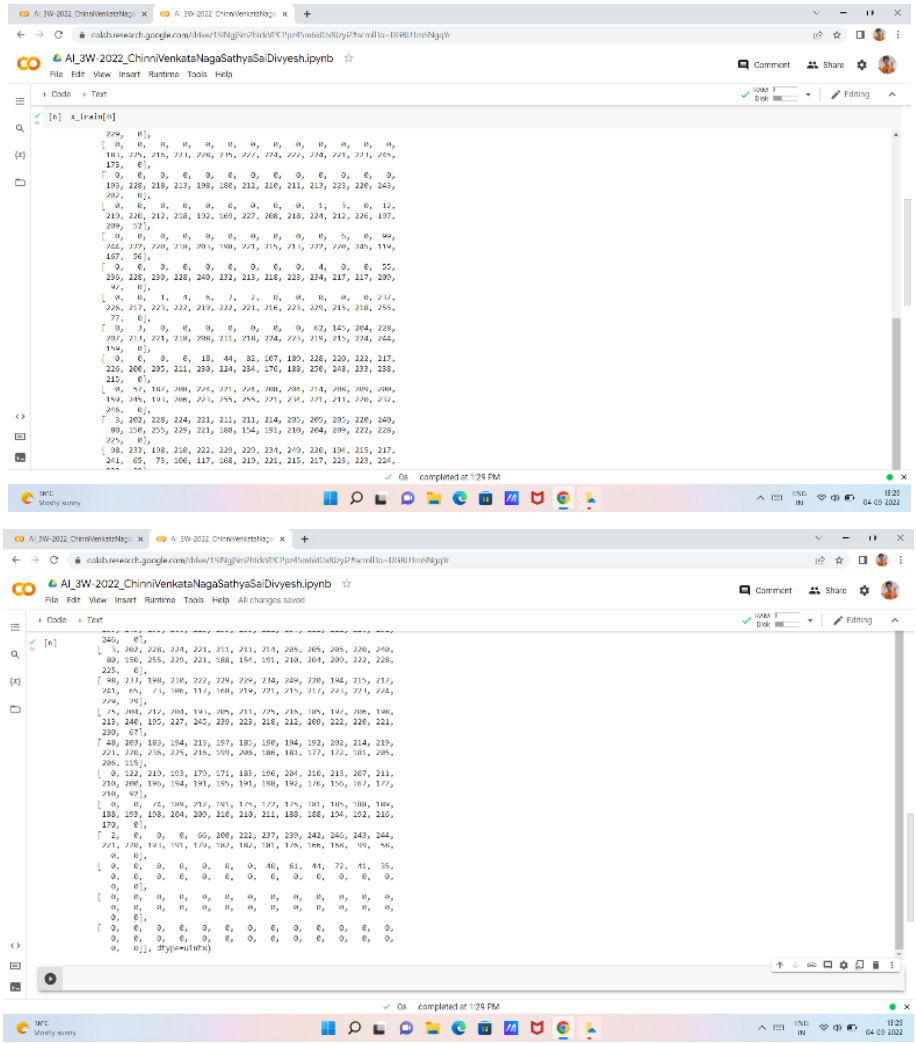


Figure 14.3: x_train [0] dataset

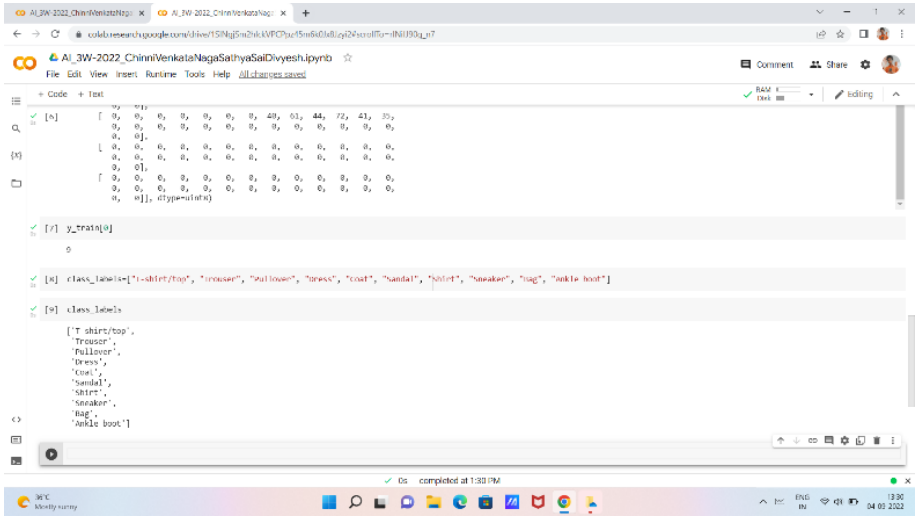


Figure 14.4: y_train [0] dataset and Class Labels

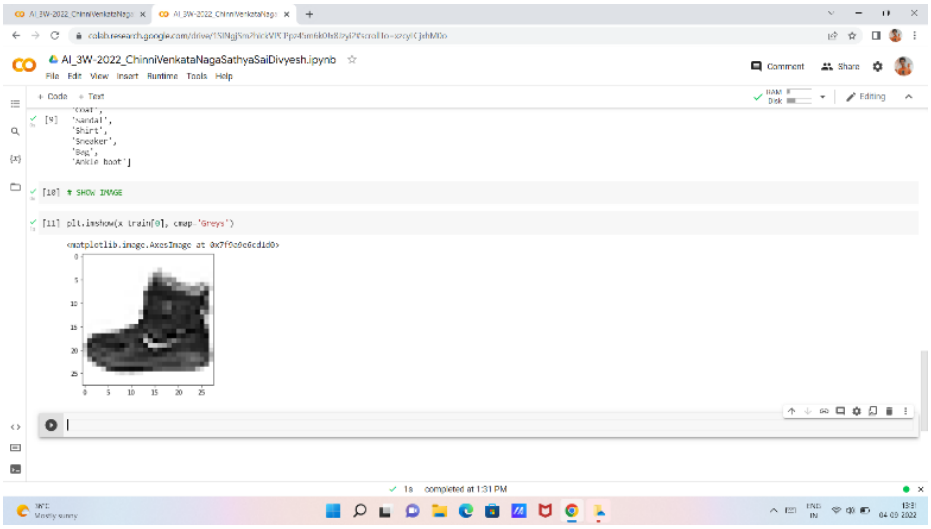


Figure 14.5: Show the sample image

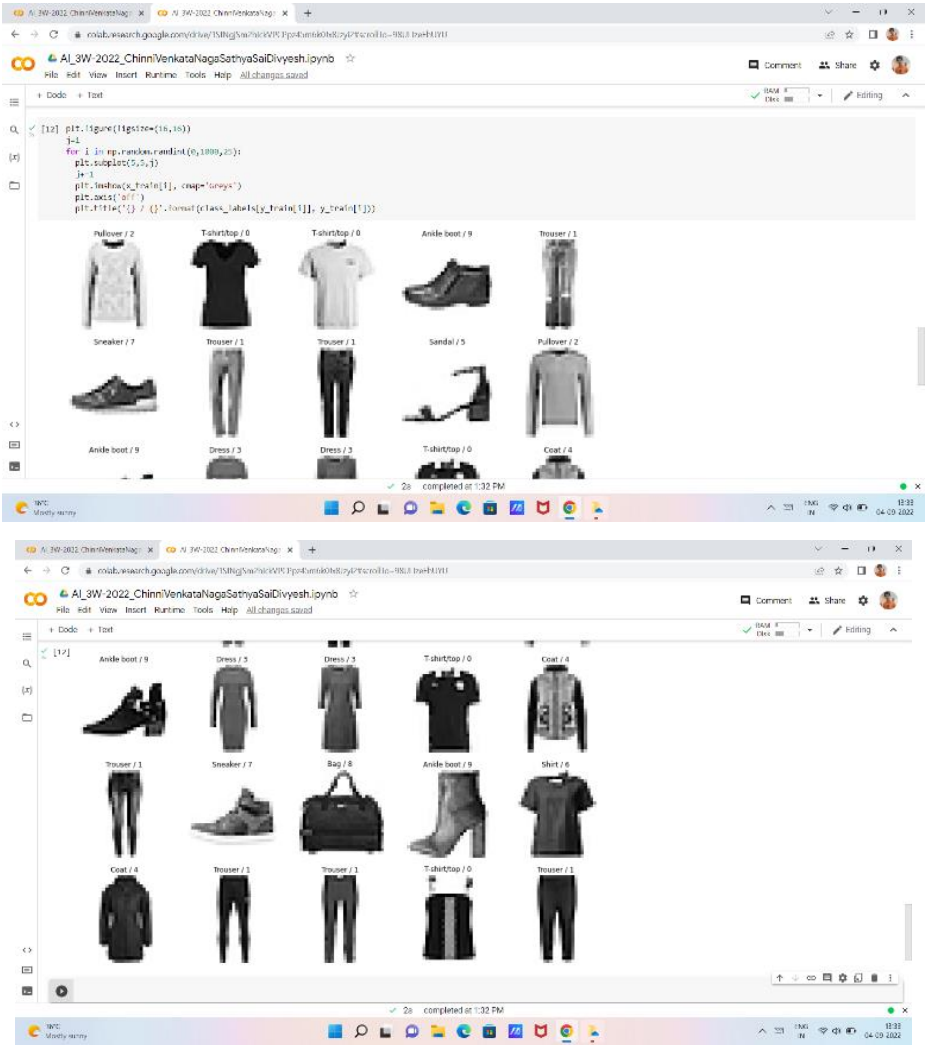


Figure 14.6: Display 25 random images

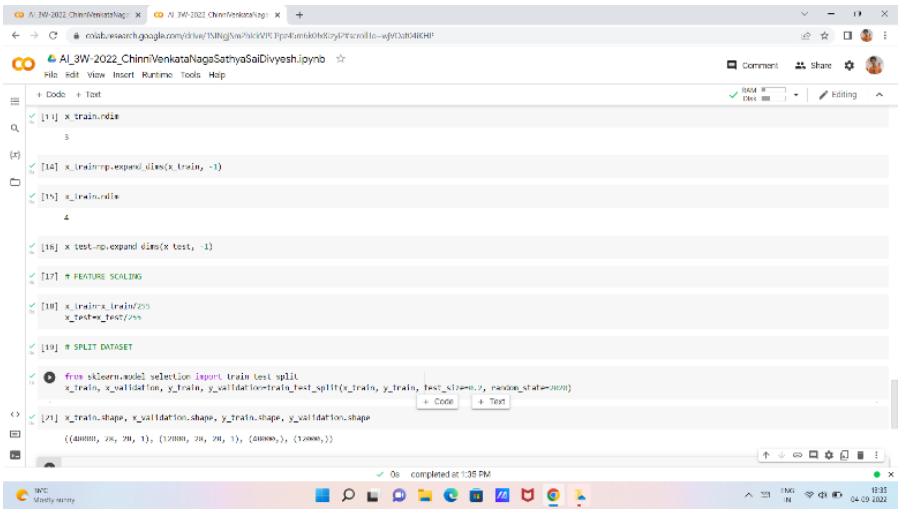


Figure 14.7: Feature Scaling and Split the Dataset

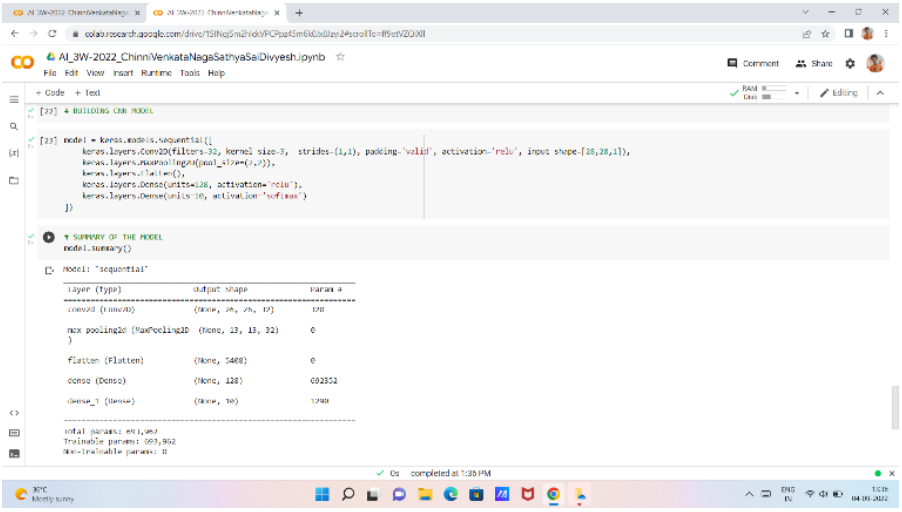


Figure 14.8: Build the CNN Model

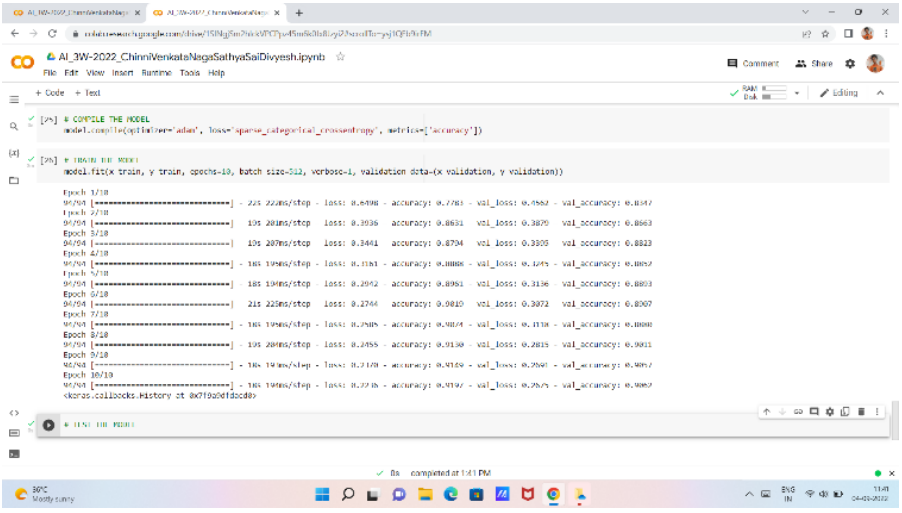


Figure 14.9: Compile and Train the Model

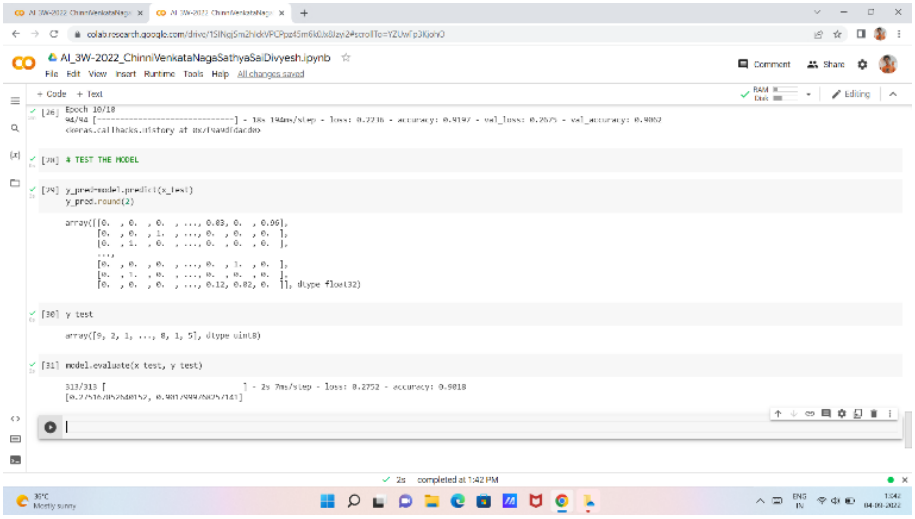
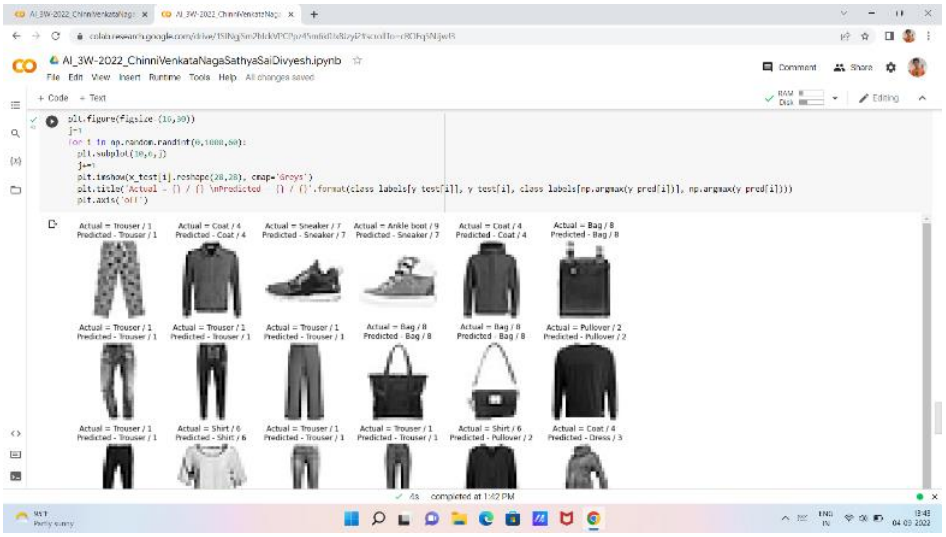


Figure 14.10: Test the Model



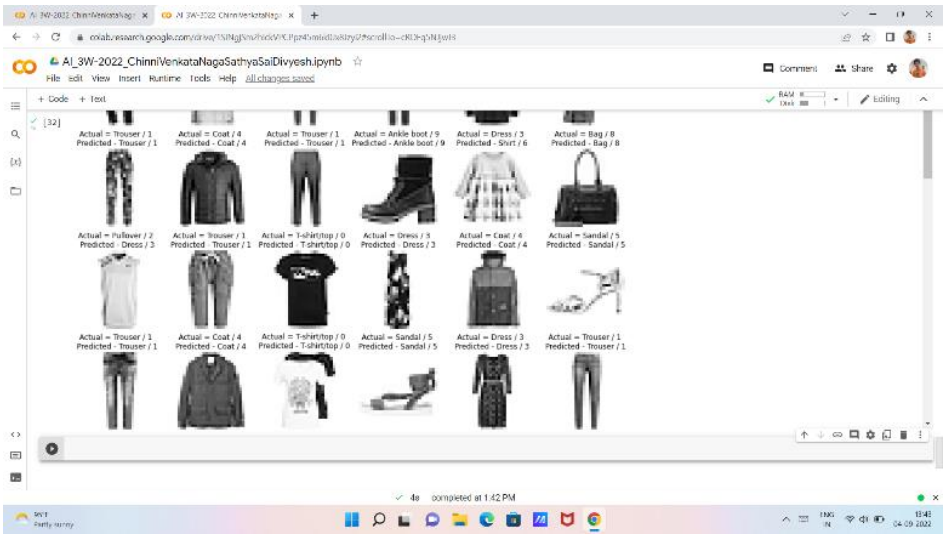


Figure 14.11: Display 60 random images

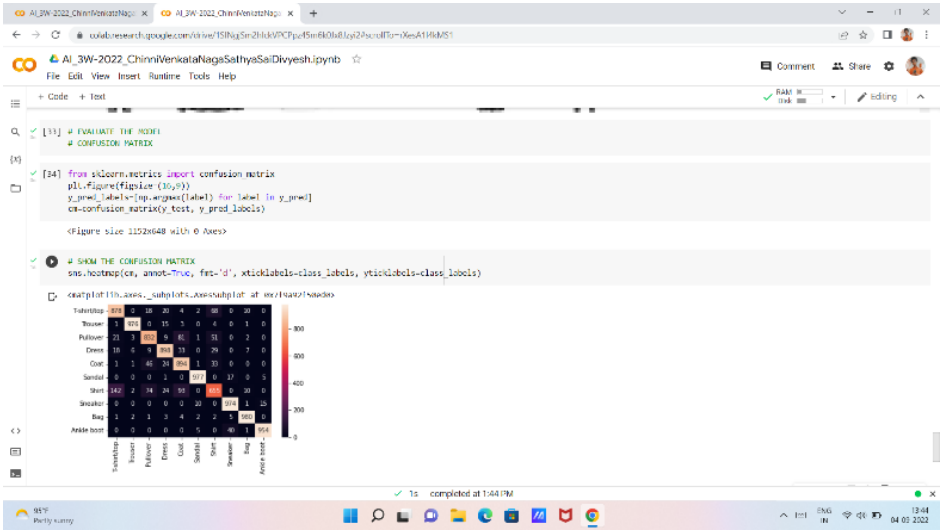


Figure 14.12: Evaluate the Model using Confusion Matrix

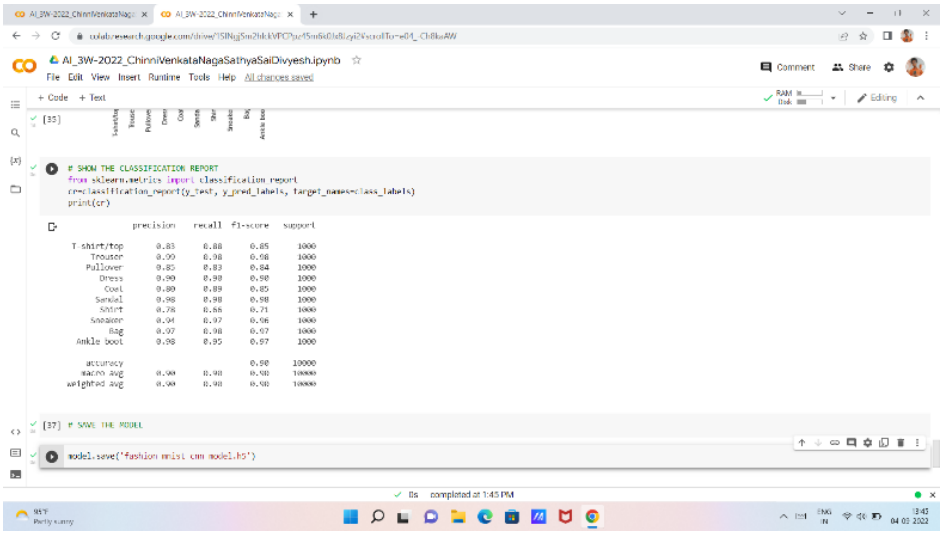


Figure 14.13: Show the Classification Report and Save the Model

15. CONCLUSION

Artificial Intelligence and Machine Learning are trending topics in today's time. While developers are passionately trying to learn it, it is crucial to be familiar with the solutions. Python plays a head of table when it comes to AI.

Python provides the benefit of a reasonable code. AI and ML require solving complex algorithms. However, the simplicity of Python will ensure that developers can easily write the codes.

16. REFERENCES

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