RMK ENGINEERING COLLEGE

(An Autonomous Institution)

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Thiruvallur District.

PROJECT

A Novel Method for Handwritten Digit Recognition System

DONE BY:

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1. INTRODUCTION:

1.1 PROJECT OVERVIEW:

- The handwritten digit recognition is the capability of computer applications to recognize the human handwritten digits.
- It is a hard task for the machine because handwritten digits are not perfect and can be made with many different shapes and sizes.
- The handwritten digit recognition system is a way to tackle this problem which uses the image of a digit and recognizes the digit present in the image.
- Convolutional Neural Network model created using tensor flow library over the MNIST dataset to recognize handwritten digits.
- Handwritten Digit Recognition is the capability of a computer to fete the mortal handwritten integers from different sources like images, papers, touch defenses, etc, and classify.
- them into 10 predefined classes (0-9). This has been a Content of bottomless- exploration in the field of deep literacy.
- Number recognition has numerous operations like number plate recognition, postal correspondence sorting, bank check processing, etc.
- In Handwritten number recognition, we face numerous challenges because of different styles of jotting of different peoples as it is not an Optic character recognition.

- This exploration provides a comprehensive comparison between different machine literacy and deep literacy algorithms for the purpose of handwritten number recognition.
- For this, we've used Support. Vector Machine, Multilayer Perceptron, and Convolutional.
- Neural Network. The comparison between these algorithms is carried out on the base of their delicacy, crimes, and testing-training time corroborated by plots and maps that have been constructed using matplotlib for visualization.

1.2 PURPOSE :

- Large volumes of handwritten documents can be classified as Digit.
- Accurate prediction are made and classified accordingly.
- The system not only produces a classification of the digit but also a rich description of the instantiation parameters which can yield information such as the writing style.
- The generative models can perform recognition driven segmentation.
- The method involves a relatively small number of parameters and hence training is relatively easy and fast.
- Unlike many other recognition schemes, it does not rely on some form of pre-normalization of input images, but can handle arbitrary scalings, translations and a limited degree of image rotation.

2. LITERATURE SURVEY:

2.1 EXISTING PROBLEM:

- We have planned to develop a model that recognizes the handwritten digits (from Images). A computer cannot directly confirm a what the image refers to. So, we will use here MNIST dataset where we split 80% for training the model and 20% for testing the model. Then the trained model can be used to recognize the handwritten digit by getting input in the form of image and displays the digit. The ultimate goal is to recognize human handwriting. This approach is not restricted by digits alone, we can further improve by enabling model predict the human handwritten messages.

2.2 REFERENCE:

Paper 1 - A NOVEL METHOD FOR HAND WRITTEN DIGIT RECOGNITION USING DEEP LEARNING.

Publisher: Rohini M (Assistant Professor), Dr. Surendran D (Assistant Professor)

Reference - http://troindia.in/journal/ijcesr/vol6iss6part2/32-36.pdf

Paper 2 - A NOVEL METHOD FOR HAND WRITTEN DIGIT RECOGNITION WITH NEURAL NETWORKS.

Publisher: MALOTHU NAGU (Assistant Professor), N VIJAY SHANKAR (Assistant Professor), ANNAPURNA K (Assistant Professor)

Reference - https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.228.158&rep=rep1&type=pdf

Paper 3 – A NOVEL HANDWRITTEN DIGIT CLASSIFICATION SYSTEM BASED ON CONVOLUTIONAL NEURAL NETWORK APPROACH.

Publisher: Ali Abdullah Yahya (Anqing Normal University), Jieqing Tan (Hefel University of Technology), Min Hu (Hefel University of Technology)

Reference - https://www.researchgate.net/publication/354755659_A_Novel_Handwritten_Digit_Classification_System_Based_on_Convolutional_Neural_Network_Approach

Numpy and Pandas:

- These library are used to handle data and collect data from various sources, group them together. And also Numpy allows various mathematical operations on **n-Dimensional** data. Numpy is base module for building up various data handling modules.

- **It is built on top of Numpy.** Pandas will be used to collect data and join the data that are in different file format. We can also Perform **ETL** (Exploratory data analysis). We can perform Descriptive and inferential statistic with this module.

Matplolib and Seaborn:

- These module are used for data visualization. To bring insights from data. Rather than going with numbers visualization will give clear insights and trend of the data. For example, can determine which **feature correlates** to the **target** feature. Seaborn was built on top of matplotlib. 3D plots can also be visualized.

Tensorflow and Keras:

- Tensor flow was created by the Google. In Tensor flow 2.0, Keras was combined with tensor flow which made this lot more powerful. Tensor flow is a free and open-source software library for Machine Learning and
  Artificial Intelligence. It can be used for wide range of tasks but has a particular focus on training and inference of deep neural network.

ADVANTAGES:

- Large volumes of handwritten documents can be classified as Digit.
- Accurate prediction are made and classified accordingly.
- The system not only produces a classification of the digit but also a rich description of the instantiation parameters which can yield information such as the writing style.
- The generative models can perform recognition driven segmentation.
- The method involves a relatively small number of parameters and hence training is relatively easy and fast.
- Unlike many other recognition schemes, it does not rely on some form of pre-normalization of input images, but can handle arbitrary scalings, translations and a limited degree of image rotation.

DISADVANTAGES:

- Low resolution image might affect the training.
- Bad Handwriting does not produce good output.
- The method is that it requires much more computation than more standard OCR techniques.

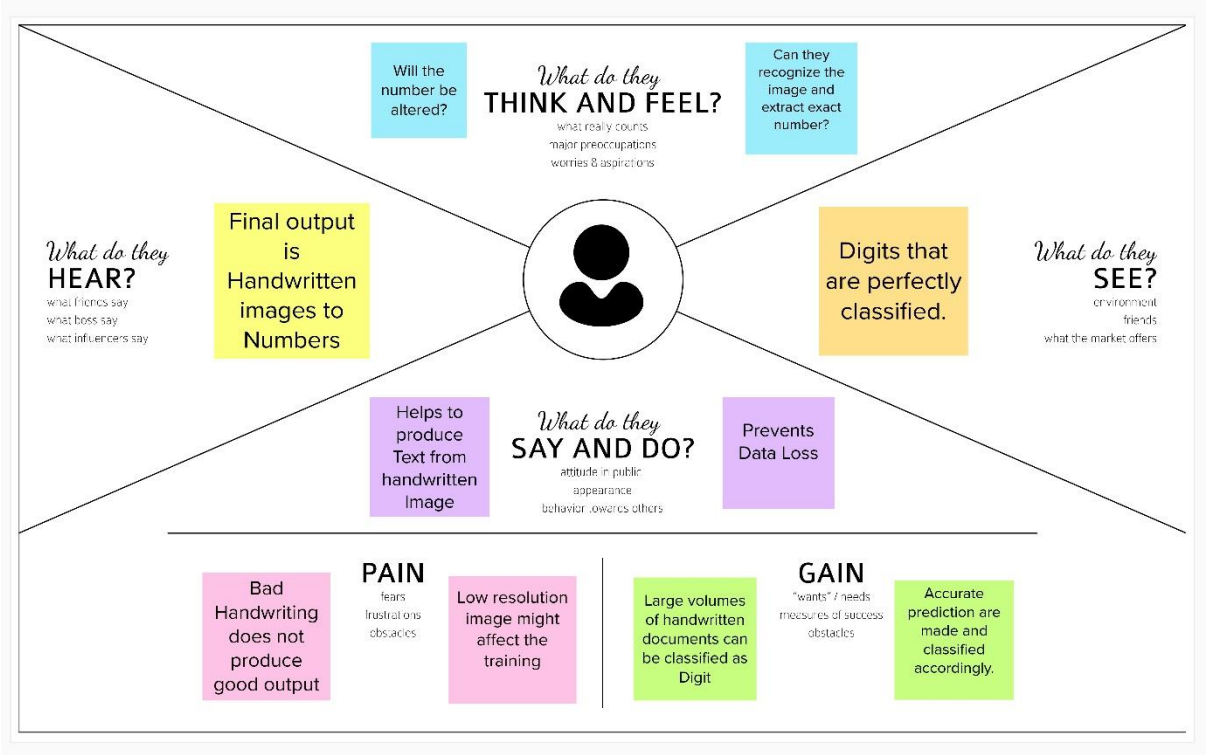
2.3 PROBLEM STATEMENT DEFINITION:

Handwriting number recognition is a challenging problem researchers had been research into this area for so long especially in the recent years. In our study there are many fields concern with numbers,

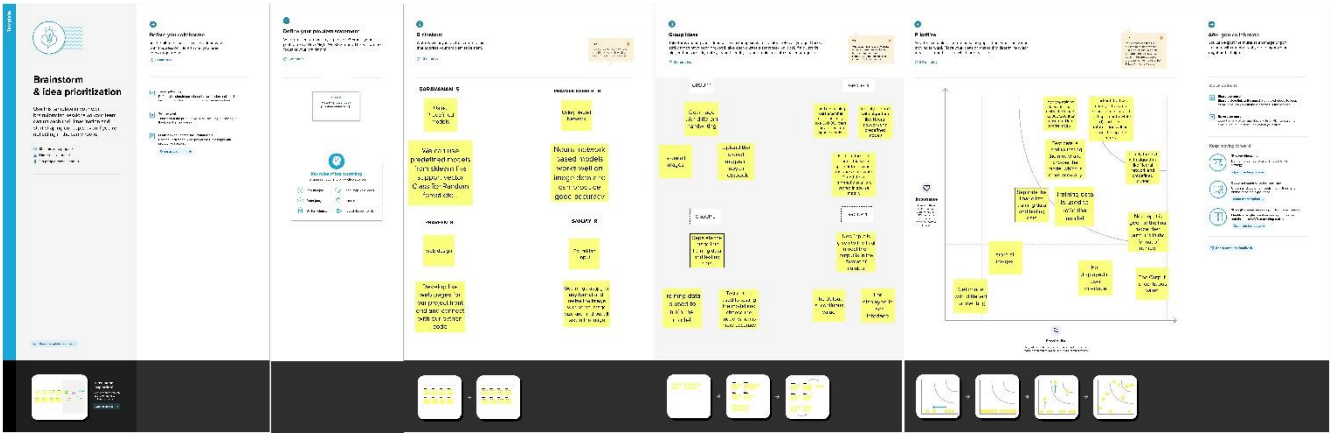
for example, checks in banks or recognizing numbers in car plates, the subject of digit recognition appears. A system for recognizing isolated digits may be as an approach for dealing with such application. In other words, to let the computer understand the Arabic numbers that is written manually by users and views them according to the computer process. Scientists and engineers with interests in image processing and pattern recognition have developed various approaches to deal with handwriting number recognition problems such as, minimum distance, decision tree and statistics.

3. IDEATION AND PROPOSED SOLUTION:

3.1 EMPATHY MAP CANVAS:



3.2 IDEATION AND BRAINSTORIMG:



3.3 PROPOSED SOLUTION:

S.NO	Parameter	Description
1.	Problem Statement (Problem to be solved)	Nowadays world is transferring to digital data. Digital Data are easy to handle and bring insights. This information can be used for various purposes. So, we propose a simple project of handwritten digit recognition, where the handwritten digit is recognised by our machine learning model.
2.	Idea / Solution description	In this phase we train the neural network model on the training data(image) with certain pre-processing. Later the model is trained for several epochs until

		we get less validation error. Now the model can be used to predict new image and output what digit was written.
3.	Novelty / Uniqueness	We tried built in model like Decision tree, Random Forest etc, but the proven fact is Convolutional neural network works well on image data. So, we choose CNN.
4.	Social Impact / Customer Satisfaction	End user are satisfied since this application digitalises the data.
5.	Business Model (Revenue Model)	This Project can be further enhanced by recognising handwritten text. This will help to convert manually written old data to digital ones. Creating an application like can make good revenue since most of the data in government are handwritten.
6.	Scalability of the Solution	This application is very scalable since the model is tested in various aspect and then released for public usage.

3.4 **PROBLEM SOLUTION FIT:**

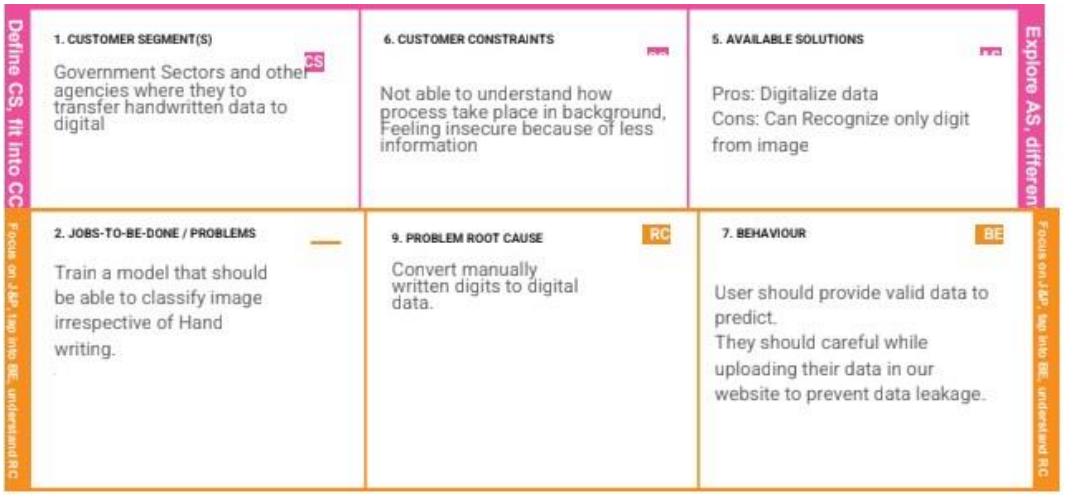
The Problem-Solution Fit simply means that you have found a problem with your customer and that the solution you have realized for it actually solves the customer's problem. It helps entrepreneurs, marketers and corporate innovators identify behavioral patterns and recognize what would work and why

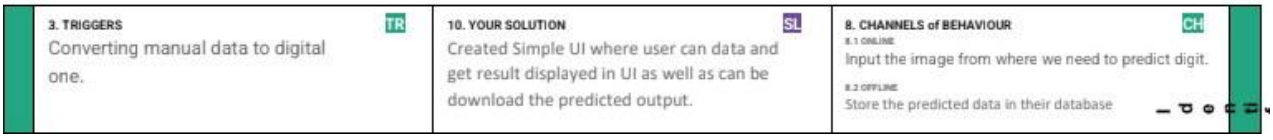
Purpose:

- Solve complex problems in a way that fits the state of your customers.
- Succeed faster and increase your solution adoption by tapping into existing mediums and channels of behavior.
- Sharpen your communication and marketing strategy with the right triggers and messaging.
- Increase touch-points with your company by finding the right problem-behavior fit and building trust by solving frequent annoyances, or urgent or costly problems.

- Understand the existing situation in order to improve it for your target group.

Template:


Define CS, fit into CC
1. CUSTOMER SEGMENT(S)
CS
Government Sectors and other agencies where they to transfer handwritten data to digital
6. CUSTOMER CONSTRAINTS
Not able to understand how process take place in background, Feeling insecure because of less information
5. AVAILABLE SOLUTIONS
Pros: Digitalize data
Cons: Can Recognize only digit from image
Explore AS, differen
Focus on J&P, tap into BE, understand RC
2. JOBS-TO-BE-DONE / PROBLEMS
Train a model that should be able to classify image irrespective of Hand writing.
9. PROBLEM ROOT CAUSE
RC
Convert manually written digits to digital data.
7. BEHAVIOUR
BE
User should provide valid data to predict.
They should careful while uploading their data in our website to prevent data leakage.
Focus on J&P, tap into BE, understand RC


3. TRIGGERS
TR
Converting manual data to digital one.
10. YOUR SOLUTION
SL
Created Simple UI where user can data and get result displayed in UI as well as can be download the predicted output.
8. CHANNELS of BEHAVIOUR
CH
8.1 ONLINE
Input the image from where we need to predict digit.
8.2 OFFLINE
Store the predicted data in their database

4. REQUIREMENT ANALYSIS:

4.1 Functional Requirements:

Following are the functional requirements of the proposed solution.

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	User Registration	Registration through Form Registration through Gmail Registration through LinkedIN
FR-2	User Confirmation	Confirmation via Email Confirmation via OTP
FR-3	Input Verification	Verify the input uploaded by user
FR-4	Read the text	Read the all text by algorithm and store in sparse matrix format
FR-5	Store the file	Storing the file in format of digit in sparse matrix
FR-6	Output	The output will be display as the digit of the file

4.2 Non-functional Requirements:

Following are the non-functional requirements of the proposed solution.

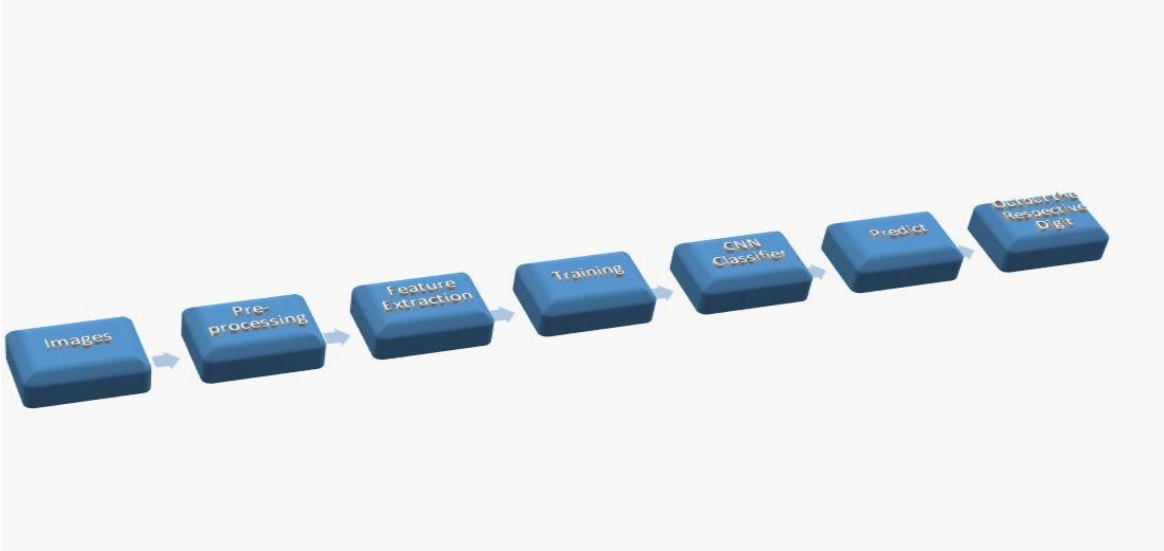
FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	The platform will be a user friendly one as the only form of input received from the user is the image only. Based on that the output will displayed in format of digit.
NFR-2	**Security**	The platform shall be made secure such a way that no data shall be leaked or accessed by unauthorised users. Our stored data should use for checking similar handwritten so the data should not leaked any where. And we have more security for that.
NFR-3	**Reliability**	The platform shall be made a more reliable one through proper analyze the input image and display the most accurate output based on analyzation and satisfying the user needs.
NFR-4	**Performance**	The handwritten recognition of digit predict with appreciable amount of efficiency by using these machine learning techniques. • Neural network • Predefined models
NFR-5	**Availability**	The platform shall be made available for all the users who wish to find the handwriting recognition for their users. Eg. Online exam malpractice, signature etc…
NFR-6		Based on the machine learning techniques, the output of the

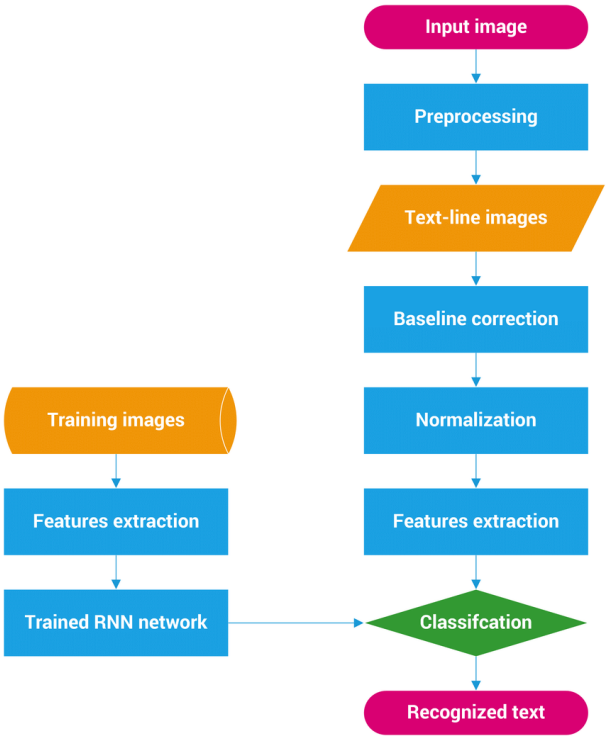
	Scalability	handwritten recognition shall be predict with nearly 80% - 90% of accurate output.

5. PROJECT DESIGN:

5.1 Daa flow diagram :

A Data Flow Diagram (DFD) is a traditional visual representation of the information flows within a system. A neat and clear DFD can depict the right amount of the system requirement graphically. It shows how data enters and leaves the system, what changes the information, and where data is stored.





5.2 SOLUTION & TECHNICAL ARCHITECTURE:

Solution architecture is a complex process – with many sub-processes – that bridgesthe gap between business problems and technology solutions. Its goals are to:

- Find the best tech solution to solve existing business problems.
- Describe the structure, characteristics, behaviour, and other aspects of thesoftware to project stakeholders.
- Define features, development phases, and solution requirements.
- Provide specifications according to which the solution is defined, managed,and delivered.

5.2 USER STORIES:

User Stories

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Customer (Mobile user)	Registration	USN-1	As a user, I can register for the application by entering my email, password, and confirming my password.	I can access my account / dashboard	High	Sprint-1
		USN-2	As a user, I will receive confirmation email once I have registered for the application	I can receive confirmation email & click confirm	High	Sprint-1
		USN-3	As a user, I can register for the application through Facebook	I can register & access the dashboard with Facebook Login	Low	Sprint-2
		USN-4	As a user, I can register for the application through Gmail	I can register & access the application through G-mail	Medium	Sprint-1
	Login	USN-5	As a user, I can log into the application by entering email & password	I can log into the application by entering email & password	High	Sprint-1
	User Confirmation	USN-6	As a user, I can Confirmation via Email Confirmation via OTP	I can access the dashboard through facebook login and get access to various tools	Medium	Sprint-1
Customer (Web user)	Registration	USN-6	As a user, I can register for the application by entering my email, password, and confirming my password.	I can access my account / dashboard	High	Sprint-1
Customer Care Executive	Access	USN-7	As a user, I can connect to the customer care executive through contact number or email.	I can connect to the customer care executive and clarify my doubts through contact number or email.	High	Sprint-1

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Administrator	Documents verification	USN-8	As a user, I can get my details and documents verified virtually from the comfort of my home.	, I can get my details and documents verified virtually from the comfort of my home.	High	Sprint-1
	Login verification	USN-9	As a user, I can get my login details verified virtually from the comfort of my home through OTP.	I can get my login details verified virtually from the comfort of my home through OTP.	High	Sprint-1

6. PROJECT PLANNING & SCHEDULING:

6.1 SPRINT PLANNING ESTIMATION:

Product Backlog, Sprint Schedule, and Estimation (4 Marks)

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Registration	USN-1	As a user, I can register for the application by entering my email, password, and confirming my password.	2	High	SARAVANAN S
Sprint-1	Login	USN-2	As a user, I can log into the application byentering email & password	1	High	PRAVEEN KEERTHI N
Sprint-2	Upload Image of digital document	USN-3	As a user, I can able to input the images of digital documents to the application	2	Medium	PRAVEEN S
Sprint-2	Prediction	USN-4	As a user, I can predict the word	1	Medium	SANJAY R

6.2 SPRINT DELIVERY SCHEDULE:

Sprint-3	Upload Image of Handwritten document	USN-5	As a user, I can able to input the imagesof the handwritten documents or images to the application	2	High	SARAVANAN S
Sprint-3	Recognize text	USN-6	As a user, I can able to choose the font of the text to be displayed	1	Medium	PRAVEEN KEERTHI N
Sprint-4	Recognize digit	USN-7	As a user I can able to get the recogniseddigit as output from the images of digital documents or images	1	Medium	SANJAY R
Sprint-4	Recognize digit	USN-8	As a user I can able to get the recogniseddigit as output from the images of handwritten documents or images	2	High	PRAVEEN S

Project Tracker, Velocity & Burndown Chart: (4 Marks)

Sprint	Total Story Points	Duration	Sprint Start Date	Sprint End Date (Planned)	Story Points Completed (as on Planned End Date)	Sprint Release Date (Actual)
Sprint-1	2	6 Days	24 Oct 2022	29 Oct 2022	2	29 Oct 2022
Sprint-2	2	6 Days	31 Oct 2022	05 Nov 2022	2	05 Nov 2022
Sprint-3	2	6 Days	07 Nov 2022	12 Nov 2022	2	12 Nov 2022
Sprint-4	2	6 Days	14 Nov 2022	19 Nov 2022	2	19 Nov 2022

Velocity:

Imagine we have a 10-day sprint duration, and the velocity of the team is 20 (points per sprint). Let's calculate the team'saverage velocity (AV)per iteration unit (story points per day)

$$AV = \frac{sprint\ duration}{velocity} = \frac{20}{10} = 2$$

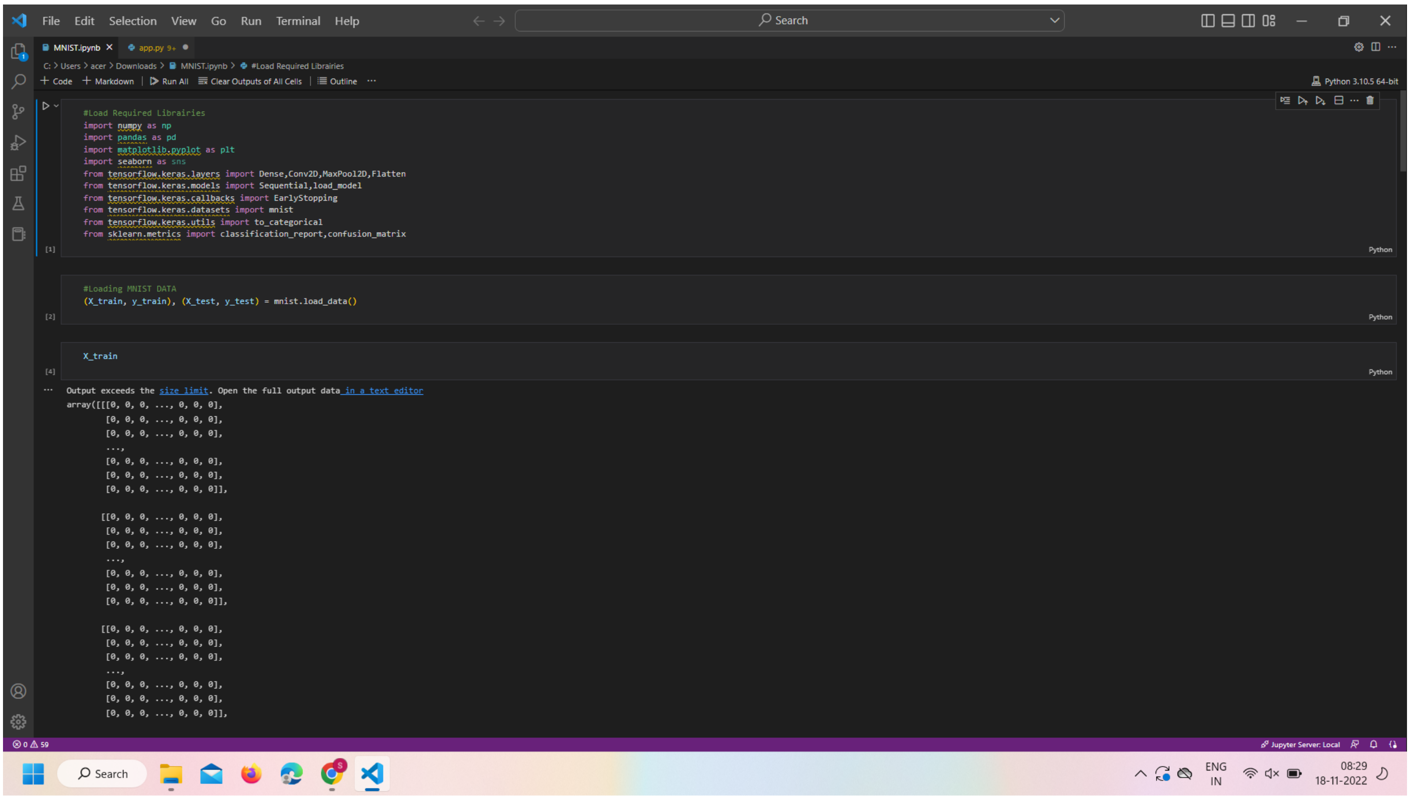
Burndown Chart:

A burn down chart is a graphical representation of work left to do versus time. It is often used in agile software development methodologies such as Scrum. However, burn down charts can be applied to any project containing measurable progress over time.

7. CODING & TECHNICAL ARCHITECTURE

7.1 FEATURE 1

MNiST.IPYB



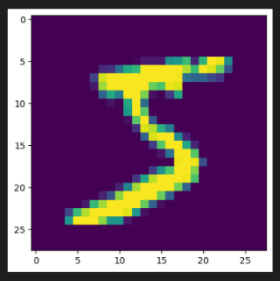
```
        [0, 0, 0, ..., 0, 0, 0],
        ...,
        [0, 0, 0, ..., 0, 0, 0],
        [0, 0, 0, ..., 0, 0, 0],
        [0, 0, 0, ..., 0, 0, 0]]], dtype=uint8)
```

```
y_train
```

```
array([5, 0, 4, ..., 5, 6, 8], dtype=uint8)
```

```
plt.imshow(X_train[0])
```

```
<matplotlib.image.AxesImage at 0x2924d8c51f0>
```




```
X_train.shape
```

```
(60000, 28, 28)
```

```
# transforming y in one hot encoding form
```

```
(60000, 28, 28)
```

```
# transforming y in one hot encoding form
y_train=to_categorical(y_train)
y_test=to_categorical(y_test)
```

```
exam=y_train[0]
```

```
X_train=X_train/255
X_test=X_test/255
```

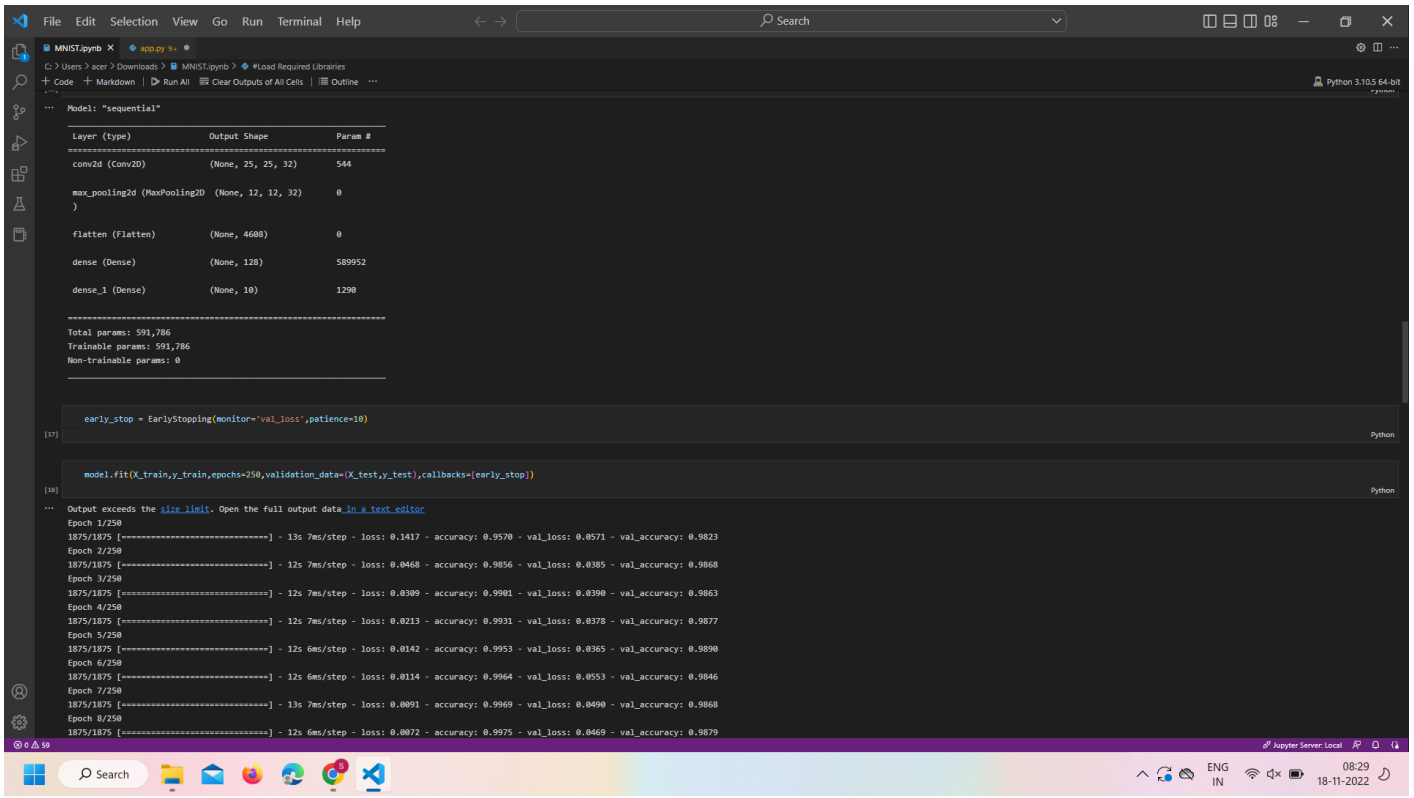
```
X_train=X_train.reshape(60000, 28, 28,1)
X_test=X_test.reshape(10000, 28, 28,1)
```

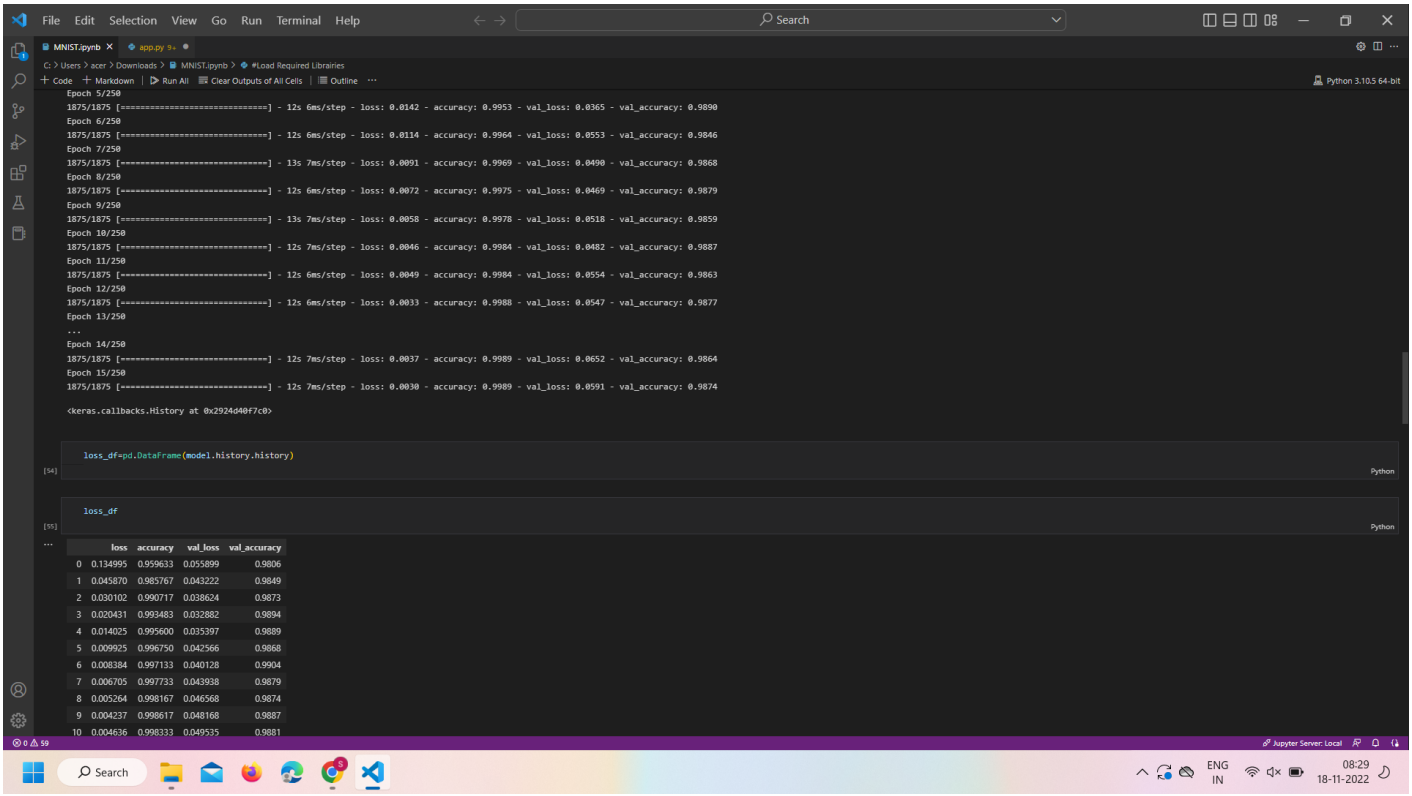
```
# MODEL BUILDING

model=Sequential()

model.add(Conv2D(filters=32,kernel_size=(4,4),strides=(1,1),input_shape=(28,28,1),activation='relu'))

model.add(MaxPool2D(pool_size=(2,2)))

model.add(Flatten())

model.add(Dense(128, activation='relu'))

model.add(Dense(10, activation='softmax'))
```

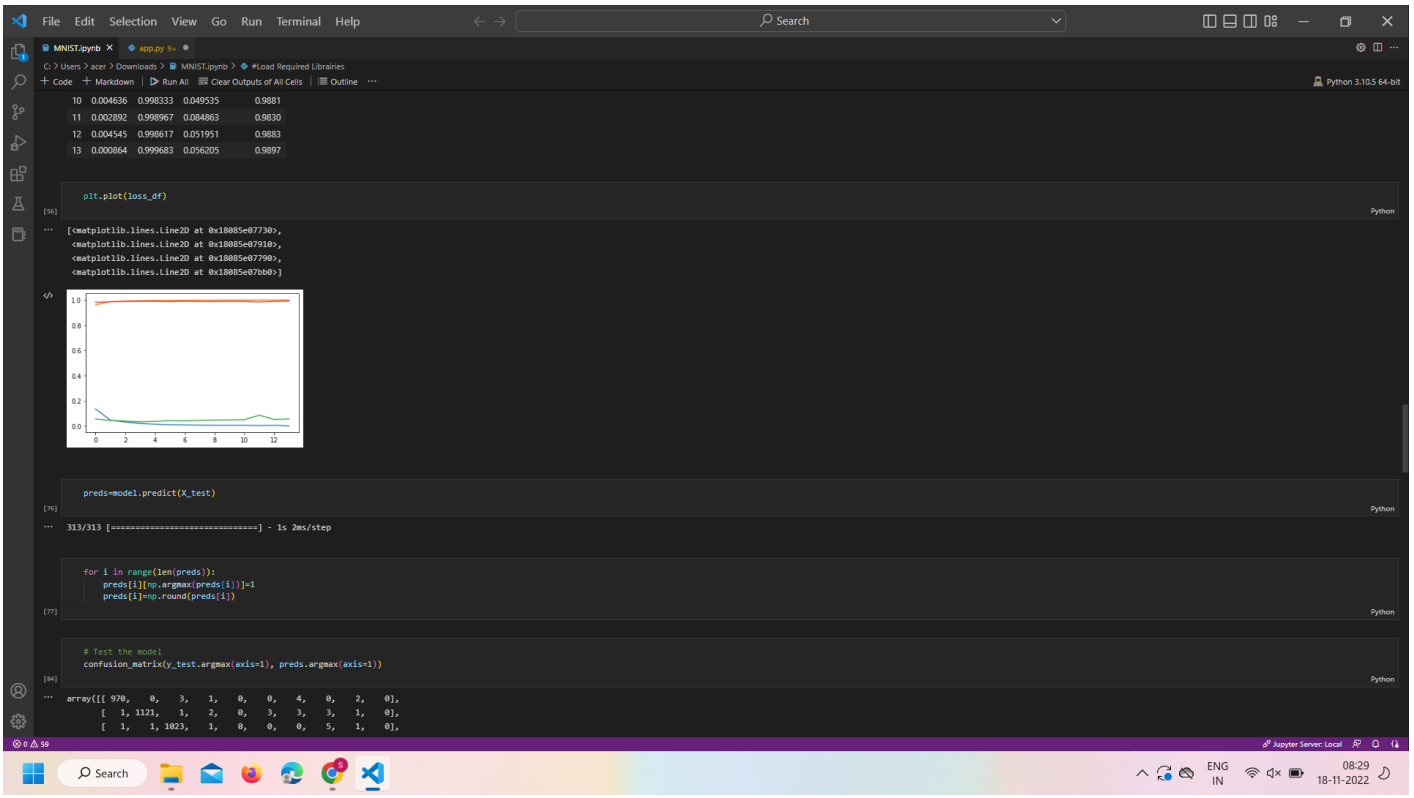
```
model.compile(loss='categorical_crossentropy',optimizer='adam',metrics=['accuracy'])
```

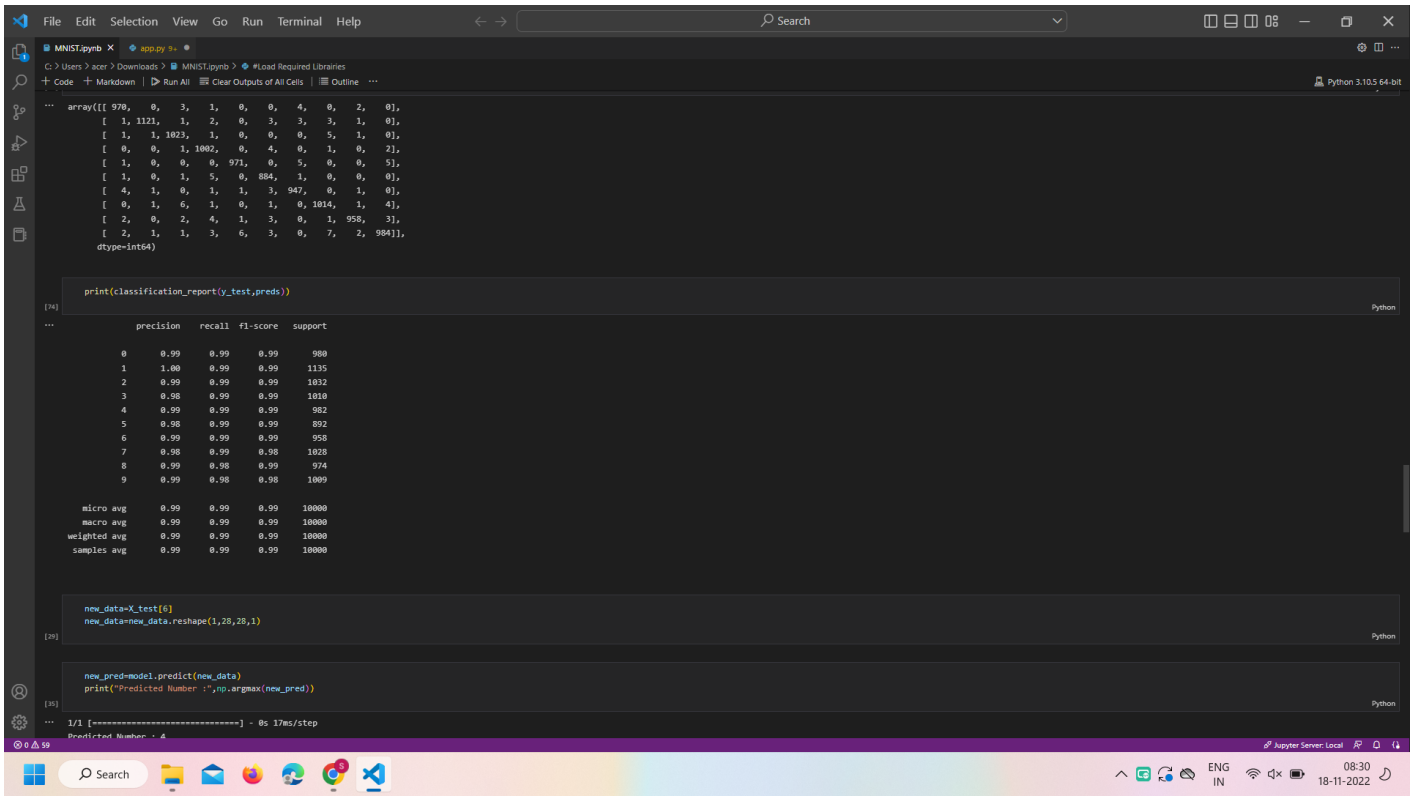
```
model.summary()
```

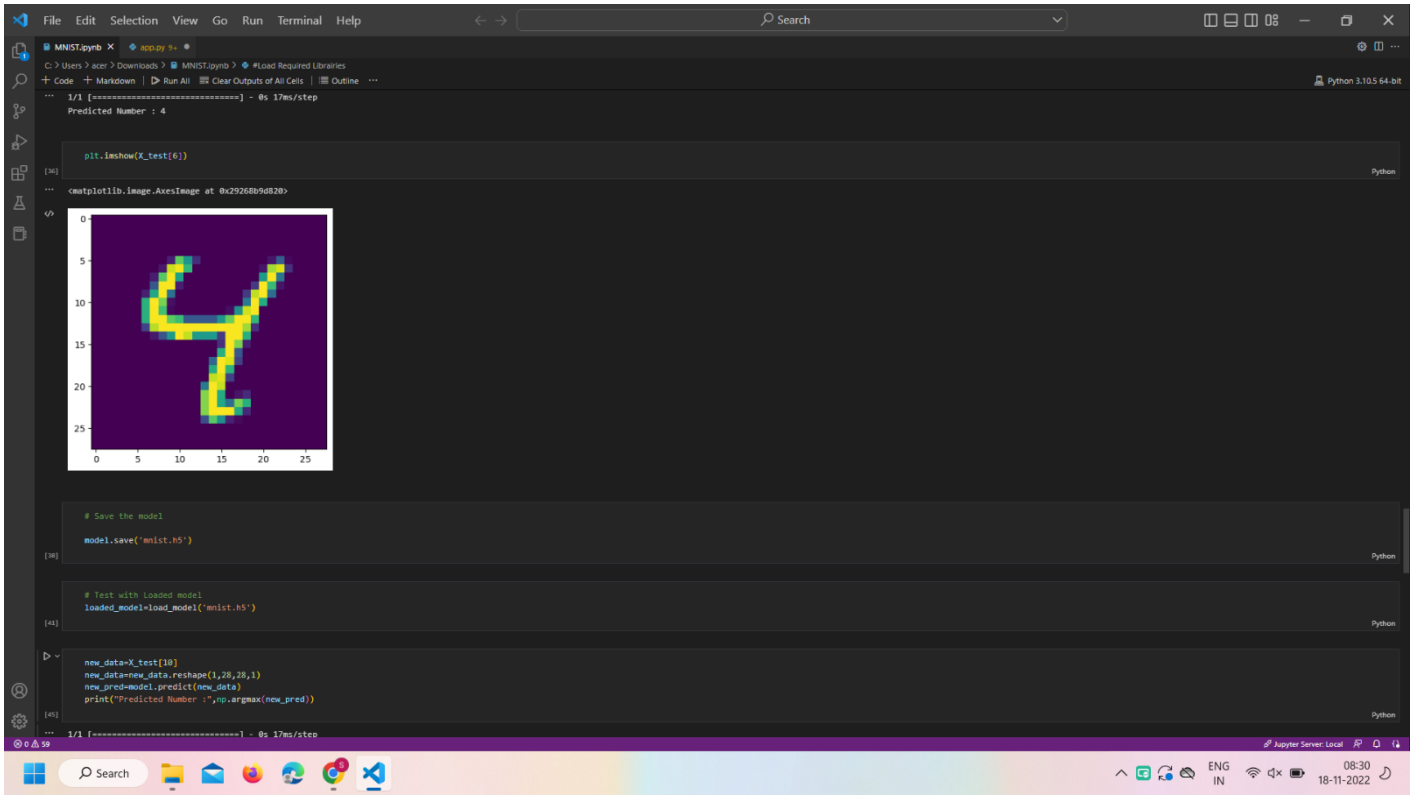
```
Model: "sequential"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
```

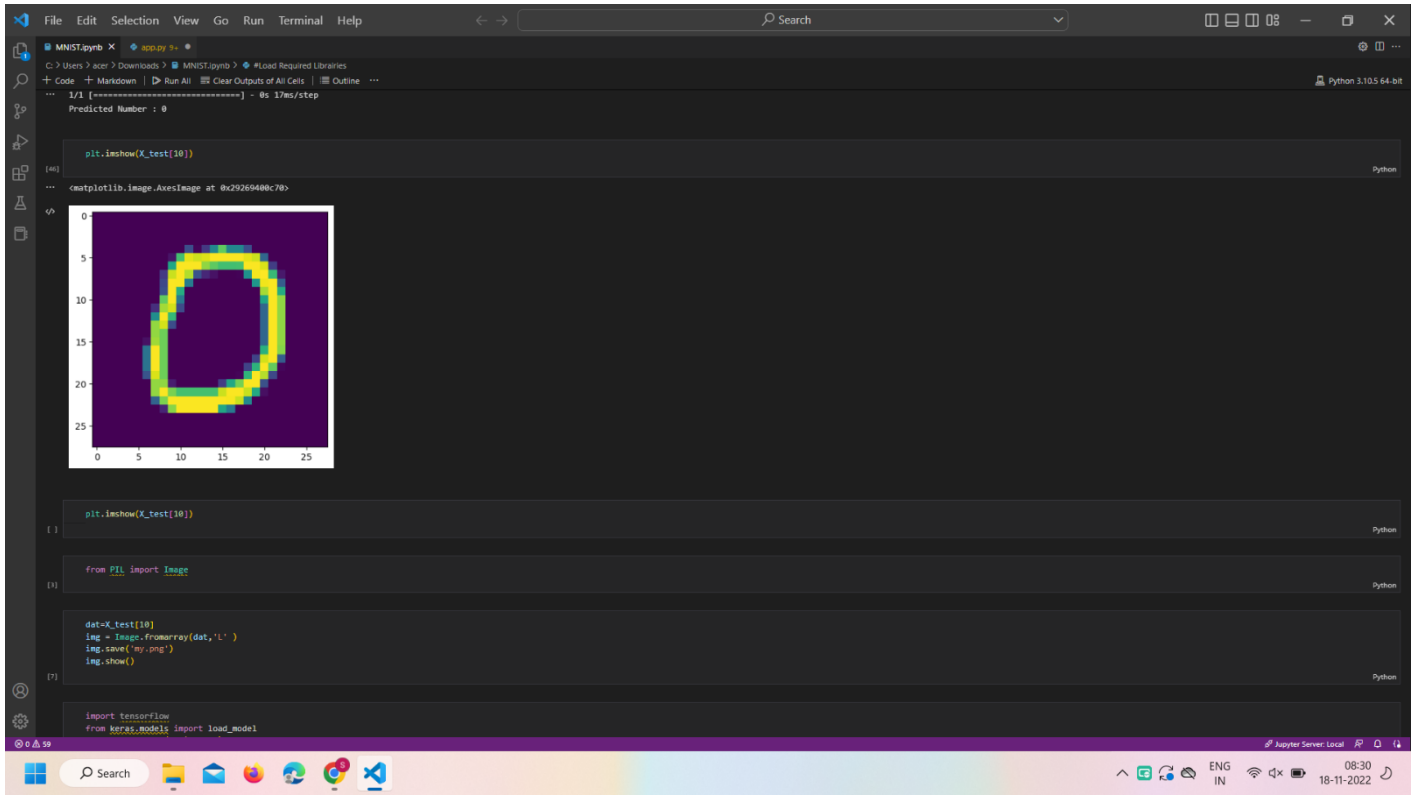

File Edit Selection View Go Run Terminal Help
Search
MNIST.ipynb
app.py 9+
C: > Users > acer > Downloads > MNIST.ipynb > #Load Required Libraries
+ Code + Markdown | Run All Clear Outputs of All Cells | Outline
Python 3.10.5 64-bit
Model: "sequential"
Layer (type) Output Shape Param #
conv2d (Conv2D) (None, 25, 25, 32) 544
max_pooling2d (MaxPooling2D (None, 12, 12, 32) 0
)
flatten (Flatten) (None, 4608) 0
dense (Dense) (None, 128) 589952
dense_1 (Dense) (None, 10) 1290
Total params: 591,786
Trainable params: 591,786
Non-trainable params: 0
early_stop = EarlyStopping(monitor='val_loss',patience=10)
[17]
Python
model.fit(X_train,y_train,epochs=250,validation_data=(X_test,y_test),callbacks=[early_stop])
[18]
Python
Output exceeds the size limit. Open the full output data in a text editor
Epoch 1/250
1875/1875 [==============================] - 13s 7ms/step - loss: 0.1417 - accuracy: 0.9570 - val_loss: 0.0571 - val_accuracy: 0.9823
Epoch 2/250
1875/1875 [==============================] - 12s 7ms/step - loss: 0.0468 - accuracy: 0.9856 - val_loss: 0.0385 - val_accuracy: 0.9868
Epoch 3/250
1875/1875 [==============================] - 12s 7ms/step - loss: 0.0309 - accuracy: 0.9901 - val_loss: 0.0390 - val_accuracy: 0.9863
Epoch 4/250
1875/1875 [==============================] - 12s 7ms/step - loss: 0.0213 - accuracy: 0.9931 - val_loss: 0.0378 - val_accuracy: 0.9877
Epoch 5/250
1875/1875 [==============================] - 12s 6ms/step - loss: 0.0142 - accuracy: 0.9953 - val_loss: 0.0365 - val_accuracy: 0.9890
Epoch 6/250
1875/1875 [==============================] - 12s 6ms/step - loss: 0.0114 - accuracy: 0.9964 - val_loss: 0.0553 - val_accuracy: 0.9846
Epoch 7/250
1875/1875 [==============================] - 13s 7ms/step - loss: 0.0091 - accuracy: 0.9969 - val_loss: 0.0490 - val_accuracy: 0.9868
Epoch 8/250
1875/1875 [==============================] - 12s 6ms/step - loss: 0.0072 - accuracy: 0.9975 - val_loss: 0.0469 - val_accuracy: 0.9879
Jupyter Server: Local
Search
ENG IN
08:29 18-11-2022

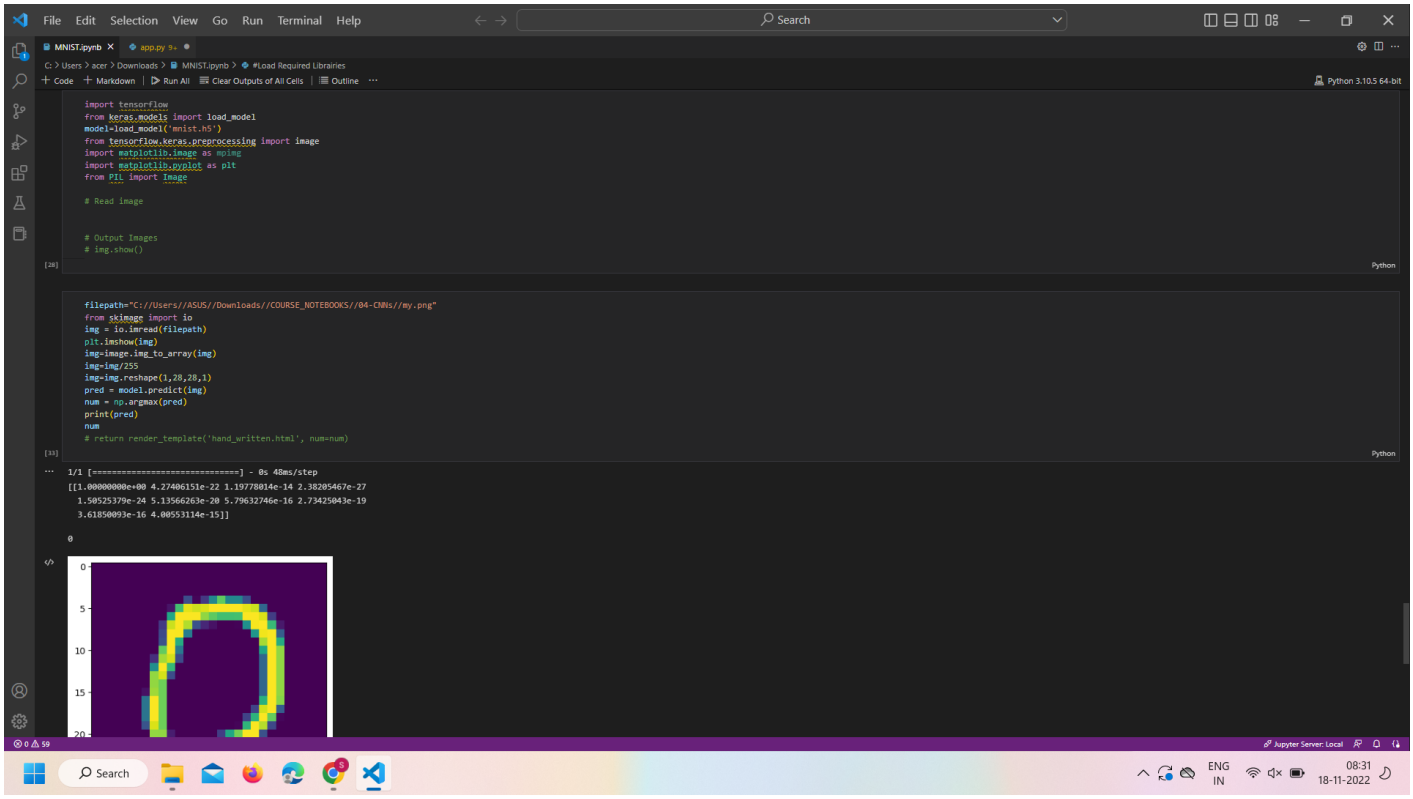

File Edit Selection View Go Run Terminal Help
Search
MNIST.ipynb
app.py 9+
C: > Users > acer > Downloads > MNIST.ipynb > #Load Required Libraries
+ Code + Markdown | Run All Clear Outputs of All Cells | Outline
Python 3.10.5 64-bit
Epoch 5/250
1875/1875 [==============================] - 12s 6ms/step - loss: 0.0142 - accuracy: 0.9953 - val_loss: 0.0365 - val_accuracy: 0.9890
Epoch 6/250
1875/1875 [==============================] - 12s 6ms/step - loss: 0.0114 - accuracy: 0.9964 - val_loss: 0.0553 - val_accuracy: 0.9846
Epoch 7/250
1875/1875 [==============================] - 13s 7ms/step - loss: 0.0091 - accuracy: 0.9969 - val_loss: 0.0490 - val_accuracy: 0.9868
Epoch 8/250
1875/1875 [==============================] - 12s 6ms/step - loss: 0.0072 - accuracy: 0.9975 - val_loss: 0.0469 - val_accuracy: 0.9879
Epoch 9/250
1875/1875 [==============================] - 13s 7ms/step - loss: 0.0058 - accuracy: 0.9978 - val_loss: 0.0518 - val_accuracy: 0.9859
Epoch 10/250
1875/1875 [==============================] - 12s 7ms/step - loss: 0.0046 - accuracy: 0.9984 - val_loss: 0.0482 - val_accuracy: 0.9887
Epoch 11/250
1875/1875 [==============================] - 12s 6ms/step - loss: 0.0049 - accuracy: 0.9984 - val_loss: 0.0554 - val_accuracy: 0.9863
Epoch 12/250
1875/1875 [==============================] - 12s 6ms/step - loss: 0.0033 - accuracy: 0.9988 - val_loss: 0.0547 - val_accuracy: 0.9877
Epoch 13/250
...
Epoch 14/250
1875/1875 [==============================] - 12s 7ms/step - loss: 0.0037 - accuracy: 0.9989 - val_loss: 0.0652 - val_accuracy: 0.9864
Epoch 15/250
1875/1875 [==============================] - 12s 7ms/step - loss: 0.0030 - accuracy: 0.9989 - val_loss: 0.0591 - val_accuracy: 0.9874
<keras.callbacks.History at 0x2924d40f7c0>
loss_df=pd.DataFrame(model.history.history)
[54]
Python
loss_df
[55]
Python
loss accuracy val_loss val_accuracy
0 0.134995 0.959633 0.055899 0.9806
1 0.045870 0.985767 0.043222 0.9849
2 0.030102 0.990717 0.038624 0.9873
3 0.020431 0.993483 0.032882 0.9894
4 0.014025 0.995600 0.035397 0.9889
5 0.009925 0.996750 0.042566 0.9868
6 0.008384 0.997133 0.040128 0.9904
7 0.006705 0.997733 0.043938 0.9879
8 0.005264 0.998167 0.046568 0.9874
9 0.004237 0.998617 0.048168 0.9887
10 0.004636 0.998333 0.049535 0.9881
Jupyter Server: Local
Search
ENG IN
08:29 18-11-2022


File Edit Selection View Go Run Terminal Help
Search
MNIST.ipynb
app.py 9+
C: > Users > acer > Downloads > MNIST.ipynb > #Load Required Libraries
+ Code + Markdown | Run All Clear Outputs of All Cells | Outline
Python 3.10.5 64-bit
10 0.004636 0.998333 0.049535 0.9881
11 0.002892 0.998967 0.084863 0.9830
12 0.004545 0.998617 0.051951 0.9883
13 0.000864 0.999683 0.056205 0.9897
plt.plot(loss_df)
[56]
Python
[<matplotlib.lines.Line2D at 0x18085e07730>,
<matplotlib.lines.Line2D at 0x18085e07910>,
<matplotlib.lines.Line2D at 0x18085e07790>,
<matplotlib.lines.Line2D at 0x18085e07bb0>]
1.0
0.8
0.6
0.4
0.2
0.0
0
2
4
6
8
10
12
preds=model.predict(X_test)
[76]
Python
313/313 [==============================] - 1s 2ms/step
for i in range(len(preds)):
preds[i][np.argmax(preds[i])]=1
preds[i]=np.round(preds[i])
[77]
Python
# Test the model
confusion_matrix(y_test.argmax(axis=1), preds.argmax(axis=1))
[84]
Python
array([[970, 0, 3, 1, 0, 0, 4, 0, 2, 0],
[1, 1121, 1, 2, 0, 3, 3, 3, 1, 0],
[1, 1, 1023, 1, 0, 0, 0, 5, 1, 0],
Jupyter Server: Local
Search
ENG
IN
08:29
18-11-2022


File Edit Selection View Go Run Terminal Help
Search
MNIST.ipynb
app.py 9+
C: > Users > acer > Downloads > MNIST.ipynb > #Load Required Libraries
+ Code + Markdown | Run All Clear Outputs of All Cells | Outline
Python 3.10.5 64-bit
array([[970, 0, 3, 1, 0, 0, 4, 0, 2, 0],
[1, 1121, 1, 2, 0, 3, 3, 3, 1, 0],
[1, 1, 1023, 1, 0, 0, 0, 5, 1, 0],
[0, 0, 1, 1002, 0, 4, 0, 1, 0, 2],
[1, 0, 0, 0, 971, 0, 5, 0, 0, 5],
[1, 0, 1, 5, 0, 884, 1, 0, 0, 0],
[4, 1, 0, 1, 1, 3, 947, 0, 1, 0],
[0, 1, 6, 1, 0, 1, 0, 1014, 1, 4],
[2, 0, 2, 4, 1, 3, 0, 1, 958, 3],
[2, 1, 1, 3, 6, 3, 0, 7, 2, 984]],
dtype=int64)
print(classification_report(y_test,preds))
[74]
Python
precision recall f1-score support
0 0.99 0.99 0.99 980
1 1.00 0.99 0.99 1135
2 0.99 0.99 0.99 1032
3 0.98 0.99 0.99 1010
4 0.99 0.99 0.99 982
5 0.98 0.99 0.99 892
6 0.99 0.99 0.99 958
7 0.98 0.99 0.98 1028
8 0.99 0.98 0.99 974
9 0.99 0.98 0.98 1009
micro avg 0.99 0.99 0.99 10000
macro avg 0.99 0.99 0.99 10000
weighted avg 0.99 0.99 0.99 10000
samples avg 0.99 0.99 0.99 10000
new_data=X_test[6]
new_data=new_data.reshape(1,28,28,1)
[29]
Python
new_pred=model.predict(new_data)
print("Predicted Number :",np.argmax(new_pred))
[35]
Python
1/1 [==============================] - 0s 17ms/step
Jupyter Server: Local
Search
ENG
IN
08:30
18-11-2022


File Edit Selection View Go Run Terminal Help
Search
MNIST.ipynb
app.py 9+
C: > Users > acer > Downloads > MNIST.ipynb > #Load Required Libraries
+ Code + Markdown | Run All Clear Outputs of All Cells | Outline
Python 3.10.5 64-bit
1/1 [==============================] - 0s 17ms/step
Predicted Number : 4
plt.imshow(X_test[6])
[36]
Python
<matplotlib.image.AxesImage at 0x29268b9d820>
0
5
10
15
20
25
# Save the model
model.save('mnist.h5')
[38]
Python
# Test with Loaded model
loaded_model=load_model('mnist.h5')
[41]
Python
new_data=X_test[10]
new_data=new_data.reshape(1,28,28,1)
new_pred=model.predict(new_data)
print("Predicted Number :",np.argmax(new_pred))
[45]
Python
1/1 [==============================] - 0s 17ms/step
Jupyter Server: Local
Search
ENG
IN
08:30
18-11-2022


File Edit Selection View Go Run Terminal Help
Search
MNIST.ipynb
app.py 9+
C: > Users > acer > Downloads > MNIST.ipynb > #Load Required Libraries
+ Code + Markdown | Run All Clear Outputs of All Cells | Outline
Python 3.10.5 64-bit
1/1 [==============================] - 0s 17ms/step
Predicted Number : 0
plt.imshow(X_test[10])
[46]
Python
<matplotlib.image.AxesImage at 0x29269400c70>
0
5
10
15
20
25
plt.imshow(X_test[10])
[ ]
Python
from PIL import Image
[3]
Python
dat=X_test[10]
img = Image.fromarray(dat,'L')
img.save('my.png')
img.show()
[7]
Python
import tensorflow
from keras.models import load_model
Jupyter Server: Local
Search
ENG
IN
08:30
18-11-2022



7.2 FEATURE 2:

Handwritten.html

hand_written - Notepad

File Edit View

```
<html>

<head>
  <title>Digit Recognition WebApp</title>

  <meta name="viewport" content="width=device-width">
  <!-- GoogleFont -->
  <link href="https://fonts.googleapis.com/css2?family=Prompt:wght@600&display=swap" rel="stylesheet">
  <link href="https://fonts.googleapis.com/css2?family=Varela+Round&display=swap" rel="stylesheet">
  <link href="https://fonts.googleapis.com/css2?family=Source+Code+Pro:wght@500&display=swap" rel="stylesheet">
  <link href="https://fonts.googleapis.com/css?family=Calistoga|Josefin+Sans:400,700|Pacifico&display=swap" rel="stylesheet">
  <!-- bootstrap -->
  <link rel="stylesheet" href="https://stackpath.bootstrapcdn.com/bootstrap/4.3.1/css/bootstrap.min.css" integrity="sha384-ggOyR0iXCbMQv3Xipma34MD+dH/1fQ784/j6cY/iJTQUOhcWr7x9JvoRxT2MZw1T" crossorigin="anonymous">
  <link rel="stylesheet" type= "text/css" href={{ url_for('static', filename='hand_written.css') }}>
  <!-- fontawesome -->
  <script src="https://kit.fontawesome.com/b3aed9cb07.js" crossorigin="anonymous"></script>

  <script src="https://code.jquery.com/jquery-3.3.1.slim.min.js" integrity="sha384-q8i/X+965DzO0rT7abK41JStQIAqVgRVzpbzo5smXKp4YfRvH+8abtTE1Pi6jizo" crossorigin="anonymous"></script>
  <script src="https://cdnjs.cloudflare.com/ajax/libs/popper.js/1.14.7/umd/popper.min.js" integrity="sha384-UO2eT0CpHqdSJQ6hJty5KVphtPhzWj9WO1clHTMGa3JDZwrnQq4sF86dIHNDz0W1" crossorigin="anonymous"></script>
  <script src="https://stackpath.bootstrapcdn.com/bootstrap/4.3.1/js/bootstrap.min.js" integrity="sha384-JjSmVgyd0p3pXB1rRibZUAYoIIy6OrQ6VrjIEaFf/nJGzIxFDsf4x0xIM+B07jRM" crossorigin="anonymous"></script>
  <script src="https://cdn.jsdelivr.net/npm/@tensorflow/tfjs@latest"></script>

</head>

<body >
  <section>
    <div class="aa">
      <br>
  <h1 class="welcome">IBM PROJECT

    <br>
  <div id="team_id">TEAM ID : PNT2022TMID15811</div>

  </div>
  <div class="bb"></div>
  </h1>
  </section>
    <section id="title">
      <br>
    <h4 class="heading">Handwritten Digit Recognition Website</h4>
    <br><br>
      <p>
        The website is designed to predict the handwritten digit.
      </p>

  </section>

  <section id="content">
```

hand_written - Notepad

File Edit View

```
<script src="https://stackpath.bootstrapcdn.com/bootstrap/4.3.1/js/bootstrap.min.js" integrity="sha384-JjSmVgyd0p3pXB1rRibZUAYoIIy6OrQ6VrjIEaFf/nJGzIxFDsf4x0xIM+B07jRM" crossorigin="anonymous"></script>
<script src="https://cdn.jsdelivr.net/npm/@tensorflow/tfjs@latest"></script>

</head>

<body >
  <section>
    <div class="aa">
      <br>
  <h1 class="welcome">IBM PROJECT

    <br>
  <div id="team_id">TEAM ID : PNT2022TMID15811</div>

  </div>
  <div class="bb"></div>
  </h1>
  </section>
    <section id="title">
      <br>
    <h4 class="heading">Handwritten Digit Recognition Website</h4>
    <br><br>
      <p>
        The website is designed to predict the handwritten digit.
      </p>

  </section>

  <section id="content">

        <div >
          <form method="post" action="/predict" enctype="multipart/form-data">

              <input class="box" type="file" name="file" accept="image/png, image/jpeg">
              <br><br>
              <input class="submit" type="Submit" value="Submit">

          </form>
    </div>
  <div class="predict">
    <h1 >Predicted Number : {{num}}</h1>

  </div>

  </section>

</body>

</html>
```

Ln 1, Col 1 80% Windows (CRLF) UTF-8

Hand_written.css

hand_written - Notepad

File Edit View

```
body{
  width:100%;
  height: 100vh;
  background-image: linear-gradient(rgba(0,0,0,0.75),rgba(0,0,0,0.75)),url(Bg2.png);

}


#confidence{
  font-family: 'Josefin Sans', sans-serif;
  margin-top: 7.5%;
}

#content{
  margin: 0 auto;
  padding:-3% 15%;
  padding-bottom: 0;

}

.welcome{
   text-align: center;
   position: relative;
   color: #87c2b8;

   padding-top: 1%;
   padding-bottom: 1%;
   font-weight: bold;
   font-family: 'Prompt', sans-serif;
}

#team_id{
   text-align: right;
   font-size: 20px;
   padding-right: 3%;
   color:#e9f4f1;
}
.aa{
  border-bottom: 4px solid #009688;
  border-radius: 0px;
background: linear-gradient(145deg, #20483b, #1b3c32);
box-shadow:  21px 21px 42px #0e1e19,
             -21px -21px 42px #2f6855;
z-index: -1;
          }
.bb{
  height: 4px;
  background-color: aliceblue;
```

Ln 1, Col 1

hand_written - Notepad

File Edit View

```
z-index: -1;
          }
.bb{
  height: 4px;
  background-color: aliceblue;
  border-radius: 0px;
background: linear-gradient(145deg, #20483b, #1b3c32);
box-shadow:  21px 21px 42px #0e1e19,
             -21px -21px 42px #2f6855;
    z-index:-1;
}
#title{
  padding: 1.5% 15%;
  margin: 0 auto;
  text-align: center;
}
.predict h1{
  font-family: 'Varela Round', sans-serif;
  font-weight: 700;
  font-size: 2rem;
  color:aliceblue;
  position:absolute;
           top:600px;
           left:600px;

}


.heading{
  font-family: 'Varela Round', sans-serif;
  color:aliceblue;
  font-weight: 700;
  font-size: 2rem;
  display: inline;
}
 .box{
  position:absolute;
           top:400px;
           color:aliceblue;
           left:650px;
}
.submit{
  position:absolute;
  top:500px;
  left:680px;
           border:2px solid #009688;
           background:transparent;
           border-radius:50px;
           height:40px;
           color:white;
```

hand_written - Notepad

File Edit View

```
  left:680px;
            border:2px solid #009688;
            background:transparent;
            border-radius:50px;
            height:40px;
            color:white;
            width:130px;

            box-shadow: 2px 0px 0px #009688;
            overflow: hidden;

}


.submit:hover{

     background-color: #009688 ;
     color: aliceblue;
}
#choose_file{
            width:300px;
            color:aliceblue;
            background:aliceblue;
            border:2px solid #009688;
            outline:none;
            box-shadow: 2px 5px 2px #009688;
            border-radius:50px;
        }
        ::-webkit-file-upload-button{
          border:2px solid #009688;
            color: aliceblue;
            background-color:transparent;
            border-radius:50px;
            height:40px;

            width:100px;
            box-shadow: 2px 0px 0px #009688;
        }
        ::-webkit-file-upload-button:hover{
            background-color: #009688 ;
            color: aliceblue;
     }
.leftside{
  text-align: center;
  margin: 0 auto;
  margin-top: 2%;
  /* padding-left: 10%; */
}

#frame{
```

Ln 1, Col 1

hand_written - Notepad

File Edit View

```
     color: aliceblue;
}
#choose_file{
            width:300px;
            color:aliceblue;
            background:aliceblue;
            border:2px solid #009688;
            outline:none;
            box-shadow: 2px 5px 2px #009688;
            border-radius:50px;
        }
        ::-webkit-file-upload-button{
          border:2px solid #009688;
            color: aliceblue;
            background-color:transparent;
            border-radius:50px;
            height:40px;

            width:100px;
            box-shadow: 2px 0px 0px #009688;
        }
        ::-webkit-file-upload-button:hover{
            background-color: #009688 ;
            color: aliceblue;
     }
.leftside{
  text-align: center;
  margin: 0 auto;
  margin-top: 2%;
  /* padding-left: 10%; */
}

#frame{
  margin-right: 10%;
}



p{
  font-family: 'Source Code Pro', monospace,sans-serif;
  color:aliceblue;
  margin-top: 1%;
}

@media (min-width: 720px) {
  .leftside{
    padding-left: 10%;
  }
}
```

Ln 1, Col 1

APP.py

File Edit Selection View Go Run Terminal Help

Search

app.py 9+

C: > Users > acer > Videos > handwritten > app.py > ...

```
from flask import Flask,request, url_for, redirect, render_template
import tensorflow
from werkzeug.utils import secure_filename
import os
from keras.models import load_model
from keras.preprocessing import image
import numpy as np
from skimage import io
from PIL import Image
import numpy as np

app = Flask(__name__)

model=load_model('mnist.h5')


@app.route('/')
def hello_world():
    return render_template("hand_written.html")


@app.route('/predict',methods=['POST','GET'])
def predict():
    if request.method == "POST":

        img= Image.open(request.files['file'].stream).convert("1")

        print(img)
        img=img.resize((28,28))
        im2arr = np.array(img)
        im2arr=im2arr.reshape(1,28,28,1)
        pred = model.predict(im2arr)
        num = np.argmax(pred)
        print(num)
        return render_template('hand_written.html', num=num)


if __name__ == '__main__':
    app.run(debug=True)
```

8. TESTING

8.1 TEST CASES:

This report shows the number of test cases that have passed, failed, and untested.

Section Total	Total Cases	Not Tested	Fail	Pass
Home page	10	0	4	6
Predict page	20	0	15	5
Upload	7	0	2	5
result	6	0	4	2

8.2 USER ACCEPTANCE TESTING

The purpose of this document is to briefly explain the test coverage and open issues of the [ProductName] project at the time of the release to User Acceptance Testing (UAT).

Defect Analysis

This report shows the number of resolved or closed bugs at each severity level, and how they were resolved.

Resolution	Severity 1	Severity 2	Severity 3	Severity 4	Subtotal
By Design	10	4	2	3	20
Duplicate	1	0	3	0	4
External	2	3	0	1	6
Fixed	11	2	4	20	37
Not Reproduced	0	0	1	0	1
Skipped	0	0	1	1	2
Won't Fix	0	5	2	1	8
Totals	24	14	13	26	77

9. RESULTS

9.1 performance metrics

$$\text{Accuracy} = \frac{\text{Number of correct predictions}}{\text{Total number of predictions}}$$

$$\text{Accuracy} = \frac{TP + TN}{TP + TN + FP + FN}$$

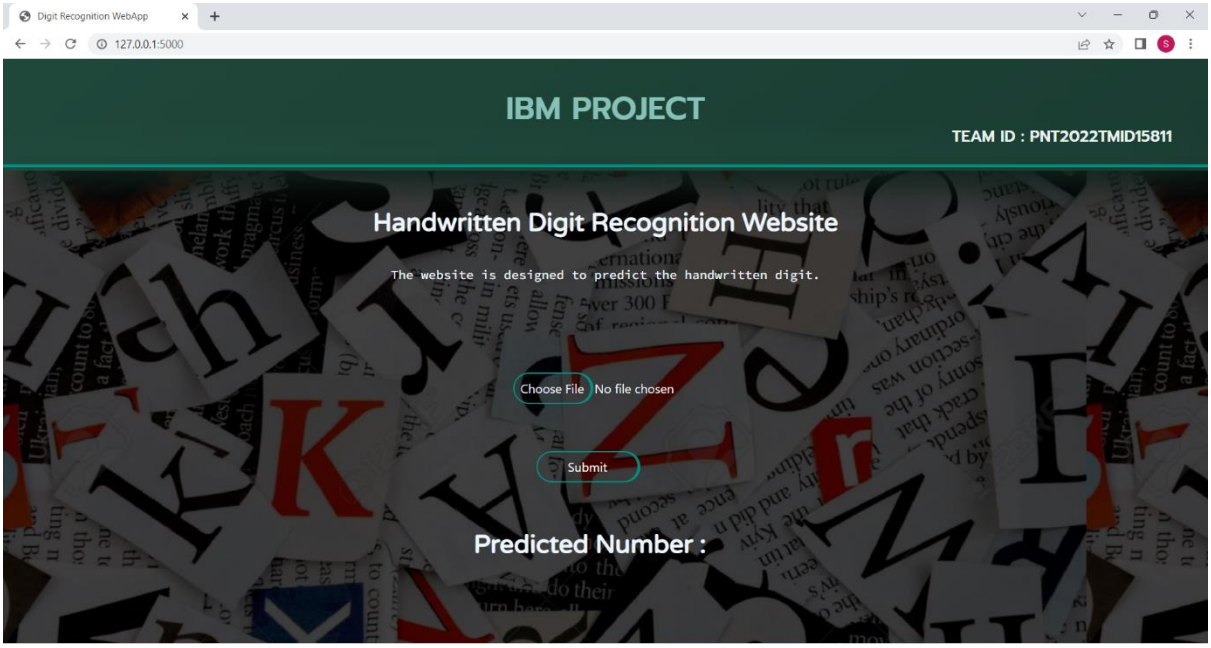
$$\text{Precision} = \frac{True\ Positive}{True\ Positive + False\ Positive}$$

$$\text{Recall} = \frac{True\ Positive}{True\ Positive + False\ Negative}$$

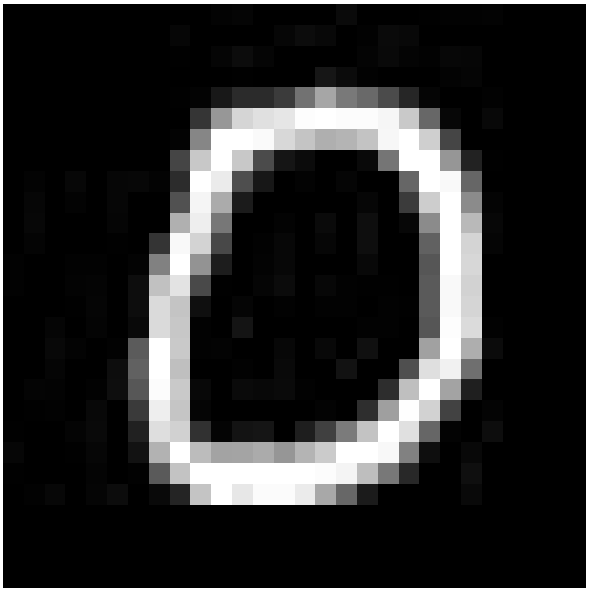
$$\text{F1} = 2 \times \frac{Precision * Recall}{Precision + Recall}$$

OUTPUT:

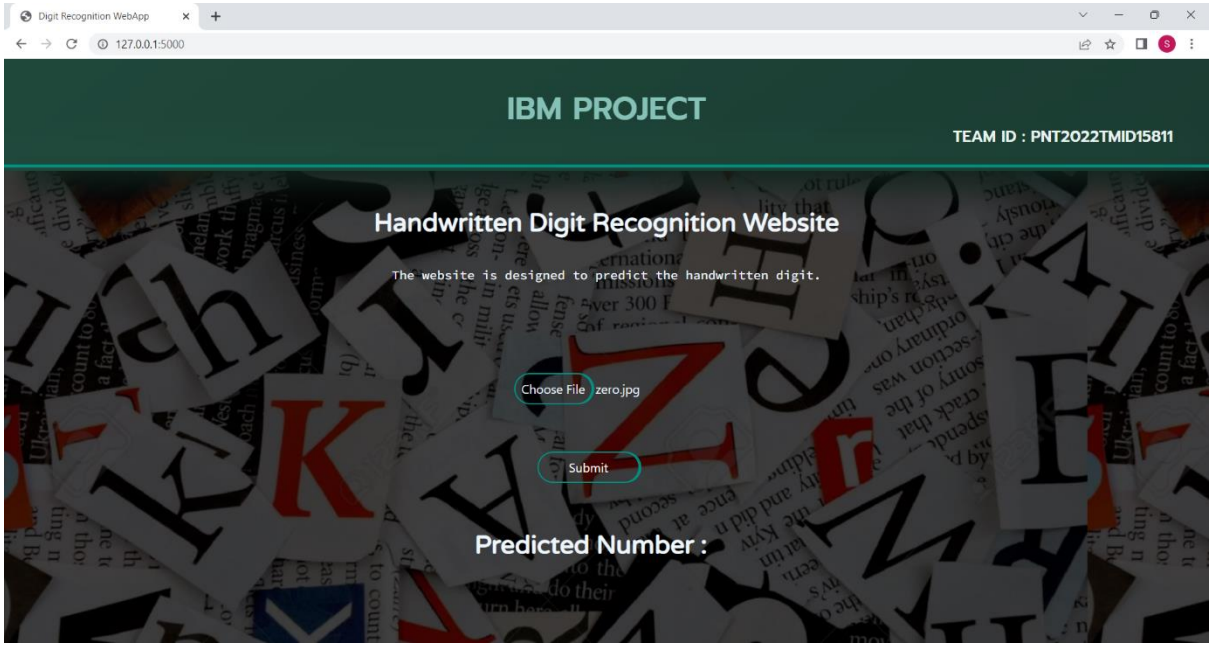
BEFORE CHOOSING THE FILE:



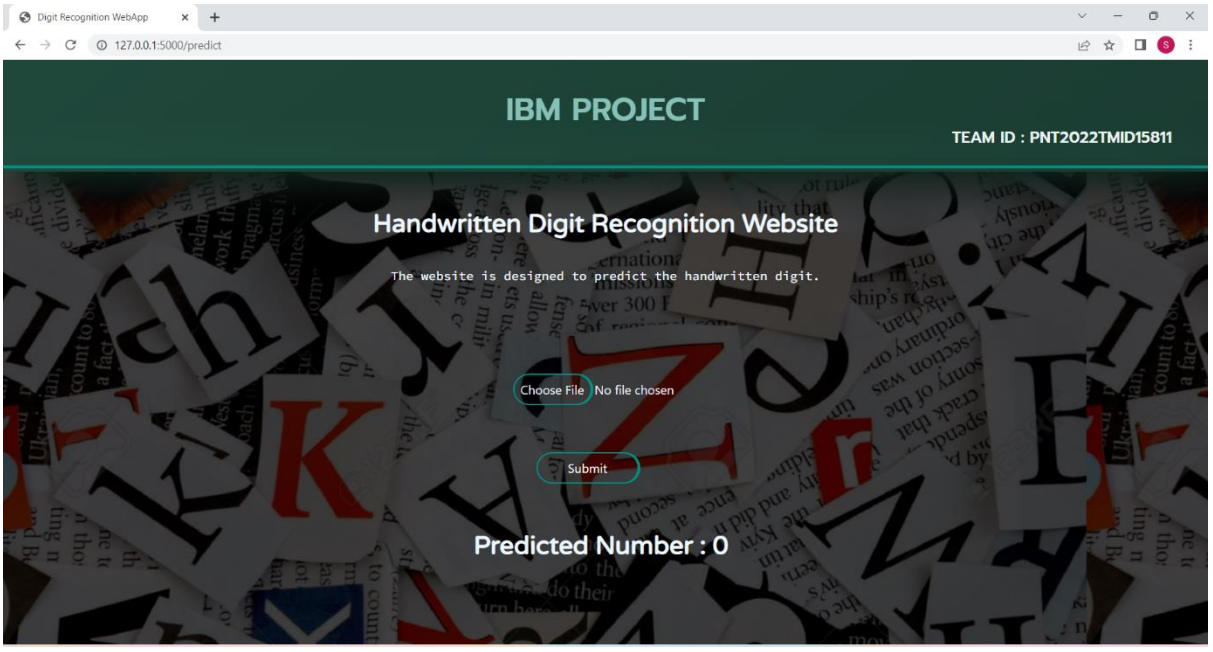
INPUT IMAGE:



BEFORE GETTING OUTPUT:



OUTPUT:



10. ADVANTAGES AND DISADVANTAGES

ADVANTAGES:

- Large volumes of handwritten documents can be classified as Digit.
- Accurate prediction are made and classified accordingly.
- The system not only produces a classification of the digit but also a rich description of the instantiation parameters which can yield information such as the writing style.
- The generative models can perform recognition driven segmentation.
- The method involves a relatively small number of parameters and hence training is relatively easy and fast.
- Unlike many other recognition schemes, it does not rely on some form of pre-normalization of input images, but can handle arbitrary scalings, translations and a limited degree of image rotation.

DISADVANTAGES:

- Low resolution image might affect the training.
- Bad Handwriting does not produce good output.
- The method is that it requires much more computation than more standard OCR techniques.

11. C0NCLUSION:

Hence we created a website for that can detect the digit return in image.

12. FUTURE SCOPE :

We can enhance this project by adding functionalities like recognizing text in order to prevent manual handwritten data.

13. APPENDIX:

SOURCE CODE - https://github.com/IBM-EPBL/IBM-Project-25395-1659962037/blob/main/FINAL%20DELIVERABLES/MNIST.ipynb

GITHUB & Project demo link -

https://github.com/IBM-EPBL/IBM-Project-25395-1659962037