

## PROJECT REPORT

# A NOVEL METHOD FOR HANDWRITTEN DIGIT RECOGNITION

*submitted by*  
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# CHAPTER 1

## INTRODUCTION

### PROJECT OVERVIEW

Handwriting recognition is one of the compelling research works going on because every individual in this world has their own style of writing. It is the capability of the computer to identify and understand handwritten digits or characters automatically. Because of the progress in the field of science and technology, everything is being digitalized to reduce human effort. Hence, there comes a need for handwritten digit recognition in many real-time applications.

MNIST data set is widely used for this recognition process and it has 70000 handwritten digits. We use Artificial neural networks to train these images and build a deep learning model. Web application is created where the user can upload an image of a handwritten digit. This image is analyzed by the model and the detected results are returned on to UI.

### PURPOSE

Digit recognition systems are capable of recognizing the digits from different sources like emails, bank cheque, papers, images, etc. and in different real-world scenarios for online handwriting recognition on computer tablets or system, recognize number plates of vehicles, processing bank cheque amounts, numeric entries in forms filled up by hand (tax forms) and so on.

# CHAPTER 2

## LITERATURE SURVEY

### EXISTING PROBLEM

The fundamental problem with handwritten digit recognition is that handwritten digits do not always have the same size, width, orientation, and margins since they vary from person to person. Additionally, there would be issues with identifying the numbers because of similarities between numerals like 1 and 7, 5 and 6, 3 and 8, 2 and 5, 2 and 7, etc. Finally, the individuality and variation of each individual's handwriting influence the structure and appearance of the digits.

### REFERENCES

#### **A Novel Method for Handwritten Digit Recognition with Neural Networks**

*Malothu Nagu, N Vijay Shankar, K. Annapurna*

Character recognition plays an important role in the modern world. It can solve more complex problems and makes humans' job easier. An example is handwritten character recognition. This is a system widely used in the world to recognize zip code or postal code for mail sorting. There are different techniques that can be used to recognize handwritten characters. Two techniques researched in this paper are Pattern Recognition and Artificial Neural Network (ANN). Both techniques are defined and different methods for each technique is also discussed.

Bayesian Decision theory, Nearest Neighbor rule, and Linear Classification or Discrimination are types of methods for Pattern Recognition. Shape recognition, Chinese Character and Handwritten Digit recognition uses Neural Network to recognize them. Neural Network is used to train and identify written digits. After training and testing, the accuracy rate reached 99%. This accuracy rate is very high.

## **A Novel Method for Hand Written Digit Recognition using Deep Learning,**

*Rohini.M ,Dr.D. Surendran*

Handwritten digit recognition has recently been of very interest among the researchers because of the evolution of various Machine Learning, Deep Learning and Computer Vision algorithms. In this report, We compare the results of some of the most widely used Machine Learning Algorithms like CNN– convolution neural networks and with Deep Learning algorithm like multilayer CNN using Keras with Theano and Tensorflow. MNIST is a dataset which is widely used for handwritten digit recognition. The dataset consist of 60,000 training images and 10,000 test images. The artificial neural networks can all most mimic the human brain and are a key ingredient in image processing field. For example Convolution Neural networks with back propagation for image processing. The applications where these handwritten digit recognition can be used are Banking sector where it can be used to maintain the security pin numbers, it can be also used for blind peoples by using sound output.

## **Handwritten Digit Recognition using Machine Learning Algorithms,**

*S M Shamim, Mohammad Badrul Alam Miah, Angona Sarker, Masud Rana & Abdullah Al Jobair*

Handwritten character recognition is one of the practically important issues in pattern recognition applications. The applications of digit recognition includes in postal mail sorting, bank check processing, form data entry, etc. The heart of the problem lies within the ability to develop an efficient algorithm that can recognize hand written digits and which is submitted by users by the way of a scanner, tablet, and other digital devices. This paper presents an approach to off-line handwritten digit recognition based on different machine learning technique. The main objective of this paper is to ensure effective and reliable approaches for recognition of handwritten digits. Several machines learning algorithm namely, Multilayer Perceptron, Support Vector Machine, Naïve Bayes, Bayes Net, Random Forest, J48 and Random Tree has been used for the recognition of digits using WEKA.

## **A Novel Handwritten Digit Classification System Based on Convolutional Neural Network Approach**

*Ali Abdullah Yahya, Jieqing Tan and Min Hu*

An enormous number of CNN classification algorithms have been proposed in the literature. Nevertheless, in these algorithms, appropriate filter size selection, data preparation, limitations in datasets, and noise have not been taken into consideration. As a consequence, most of the algorithms have failed to make a noticeable improvement in classification accuracy. To address the shortcomings of these algorithms, our paper presents the following contributions: Firstly, after taking the domain knowledge into consideration, the size of the effective receptive field (ERF) is calculated. Calculating the size of the ERF helps us to select a typical filter size which leads to enhancing the classification accuracy of our CNN. Secondly, unnecessary data leads to misleading results and this, in turn, negatively affects classification accuracy. To guarantee the dataset is free from any redundant or irrelevant variables to the target variable, data preparation is applied before implementing the data classification mission. Thirdly, to decrease the errors of training and validation, and avoid the limitation of datasets, data augmentation has been proposed. Fourthly, to simulate the real-world natural influences that can affect image quality, we propose to add an additive white Gaussian noise with  $\sigma = 0.5$  to the MNIST dataset. As a result, our CNN algorithm achieves state-of-the-art results in handwritten digit recognition, with a recognition accuracy of 99.98%, and 99.40% with 50% noise.

## **PROBLEM STATEMENT DEFINITION**

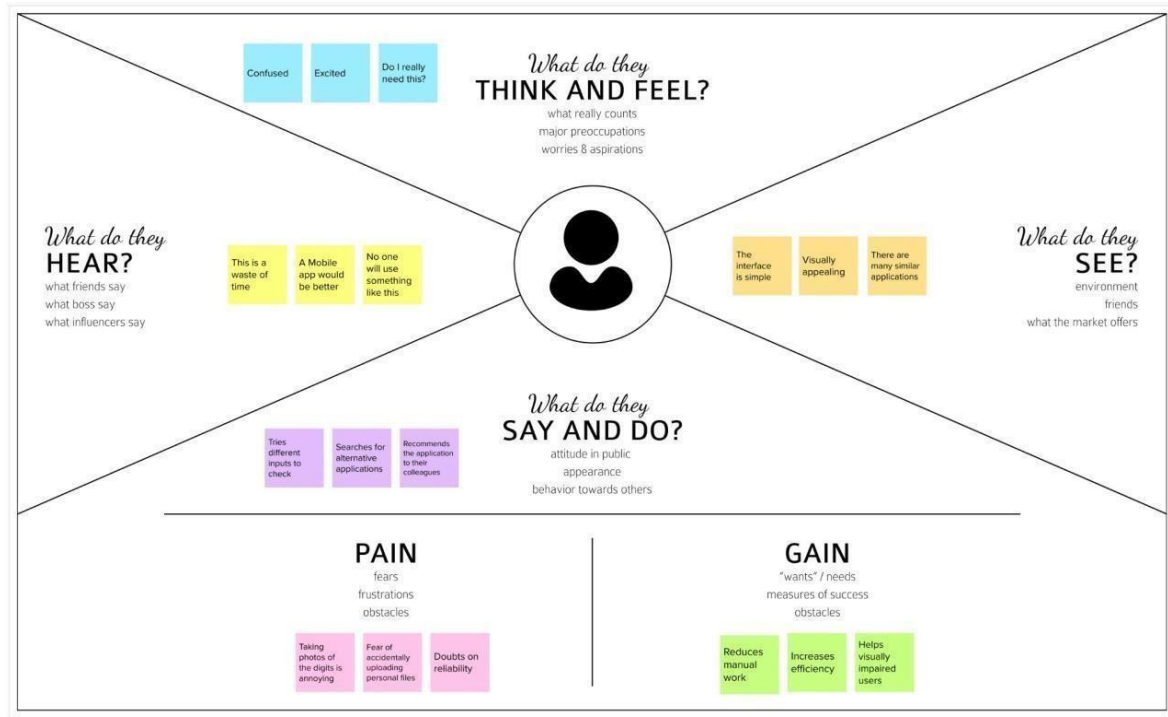
For years, the traffic department has been combating traffic law violators. These offenders endanger not only their own lives, but also the lives of other individuals. Punishing these offenders is critical to ensuring that others do not become like them. Identification of these offenders is next to impossible because it is impossible for the average individual to write down the license plate of a reckless driver. Therefore, the goal of this project is to help the traffic department identify these offenders and reduce traffic violations as a result.



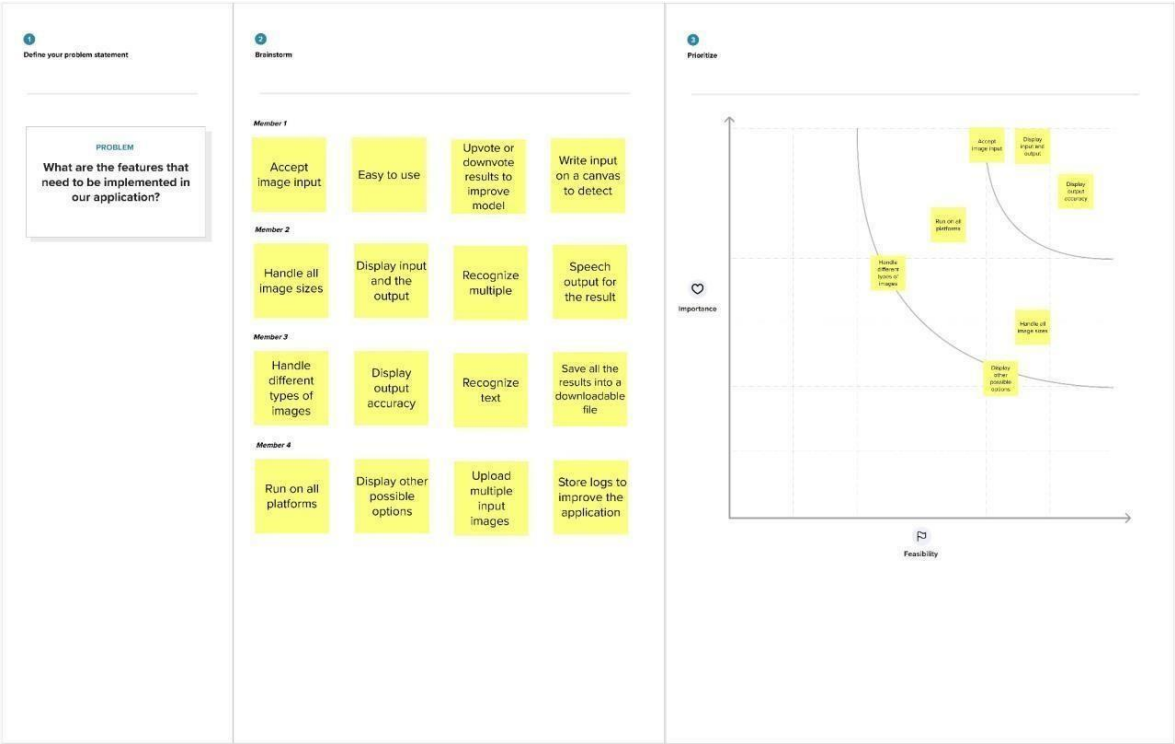
# CHAPTER 3

## IDEATION AND PROPOSED SOLUTION

### EMPATHY MAP CANVAS



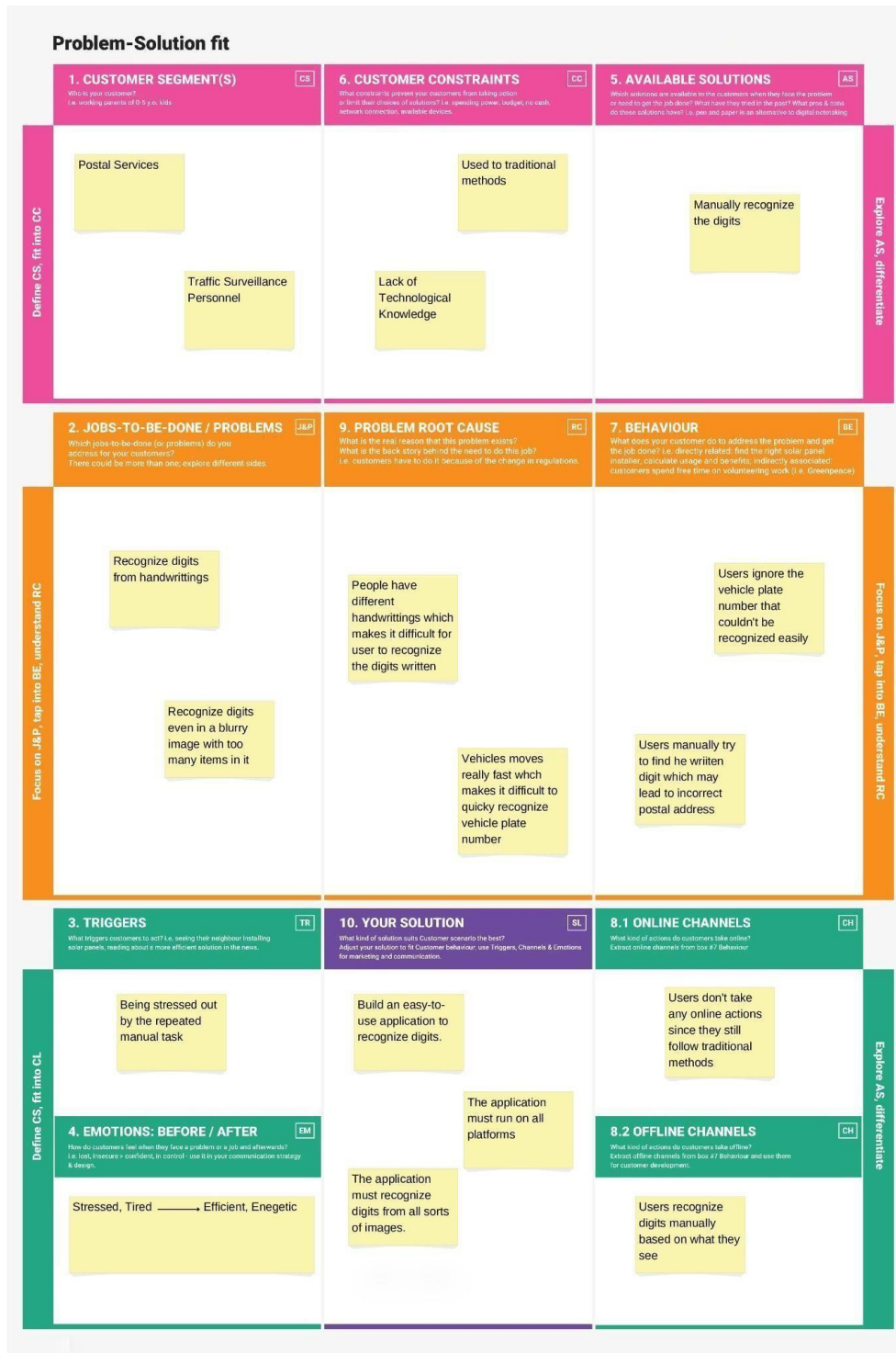
# IDEATION & BRAINSTORMING



## PROPOSED SOLUTION

S.NO	PARAMETER	DESCRIPTION
1	Problem Statement	To create an application that recognizes handwritten digits
2	Idea / Solution Description	The application takes an image as the input and accurately detects the digits in it.
3	Novelty / Uniqueness	Instead of recognizing every text, the application accurately recognizes only the digits
4	Social Impact / Customer Satisfaction	This application reduces the manual tasks that need to be performed. This improves productivity in the workplace.
5	Business Model	<p>The application can be integrated with traffic surveillance cameras to recognize vehicle number plates</p> <p>The application can be integrated with Postal systems to recognize the pin codes effectively</p>
6	Scalability of the Solution	The application can easily be scaled to accept multiple inputs and process them parallelly to further increase efficiency

# PROBLEM SOLUTION FIT



# CHAPTER 4

## REQUIREMENT ANALYSIS

### FUNCTIONAL REQUIREMENTS

FR.NO	FUNCTIONAL REQUIREMENTS	SUB REQUIREMENTS
FR-1	Model Creation	Get access the MNIST dataset
		Analyze the dataset
		Define a CNN model
		Train and Test the Model
FR-2	Application Development	Create a website to let the user recognize handwritten digits.
		Create a home page to upload images
		Create a result page to display the results
		Host the website to let the users use it from anywhere
FR-3	Input Image Upload	Let users upload images of various formats.
		Let users upload images of various size
		Prevent users from uploading unsupported image formats
		Pre-Process the image to use it on the model

		Create a database to store all the input images
FR-4	Display Results	Display the result from the model
		Display input image
		Display accuracy the result
		Display other possible predictions with their respective accuracy

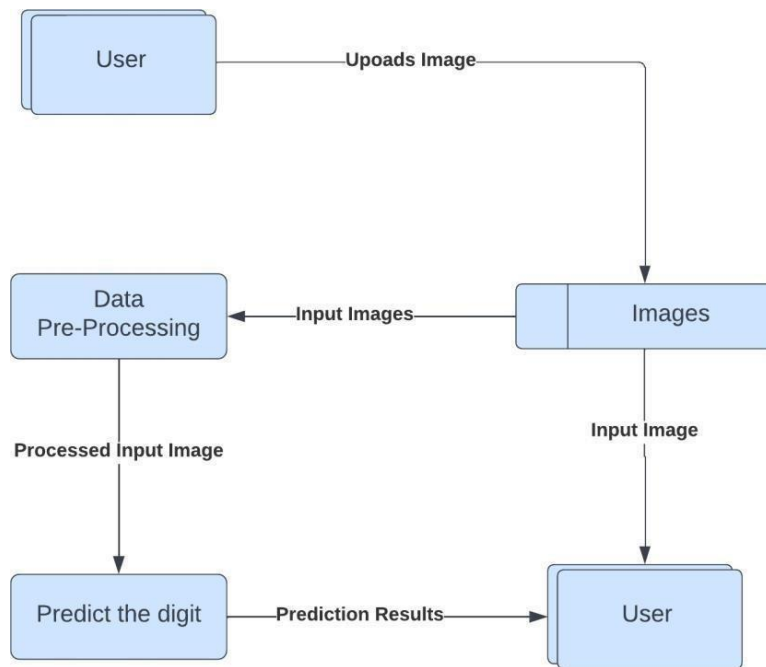
## NON FUNCTIONAL REQUIREMENTS

NFR	NON-FUNCTIONAL REQUIREMENTS	DESCRIPTION
NFR-1	Usability	The application must be usable in all devices
NFR-2	Security	The application must protect user uploaded image
NFR-3	Reliability	The application must give an accurate result as much as possible
NFR-4	Performance	The application must be fast and quick to load up
NFR-5	Availability	The application must be available to use all the time
NFR-6	Scalability	The application must scale along with the user base

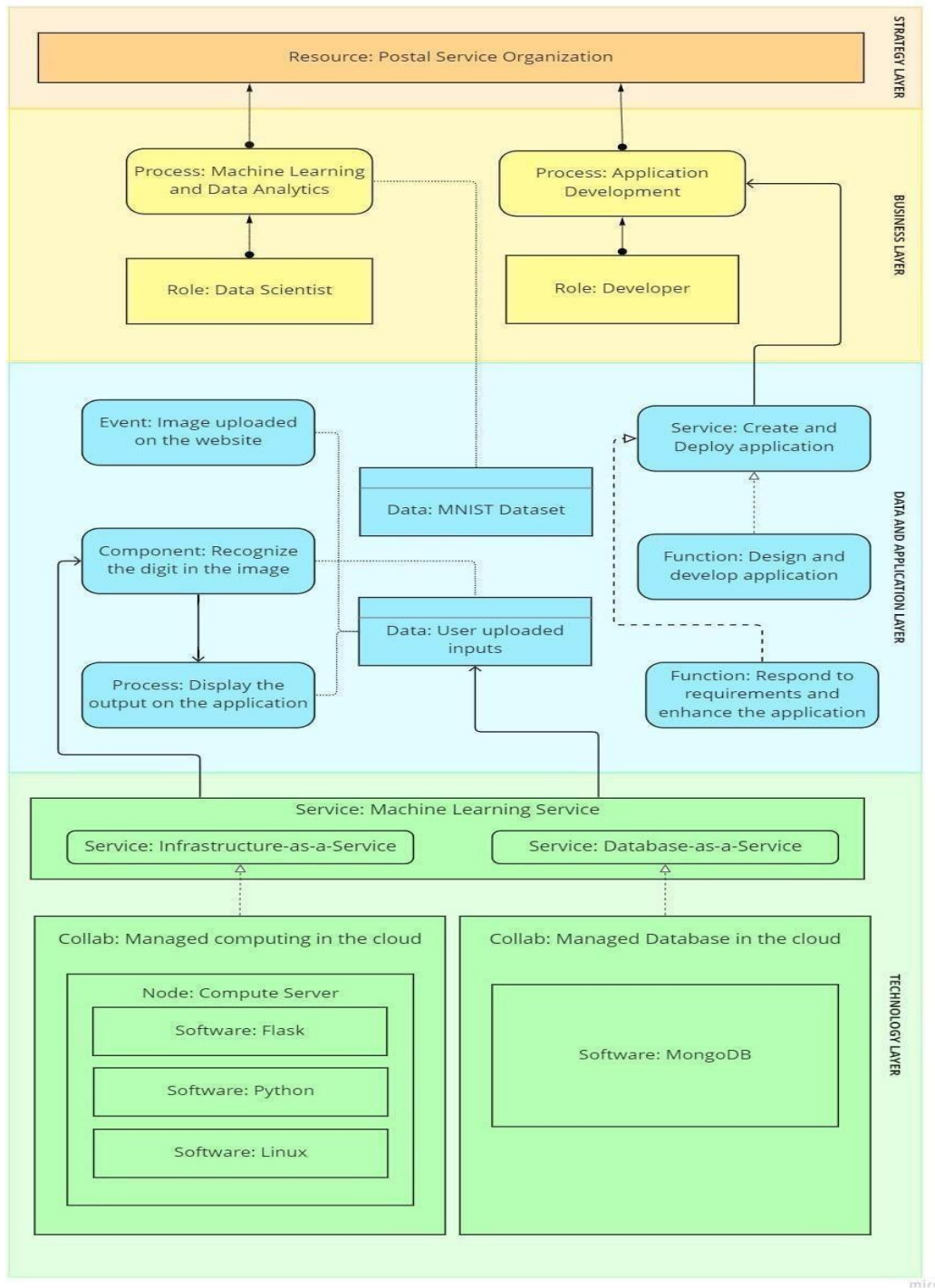
# CHAPTER 5

## PROJECT DESIGN

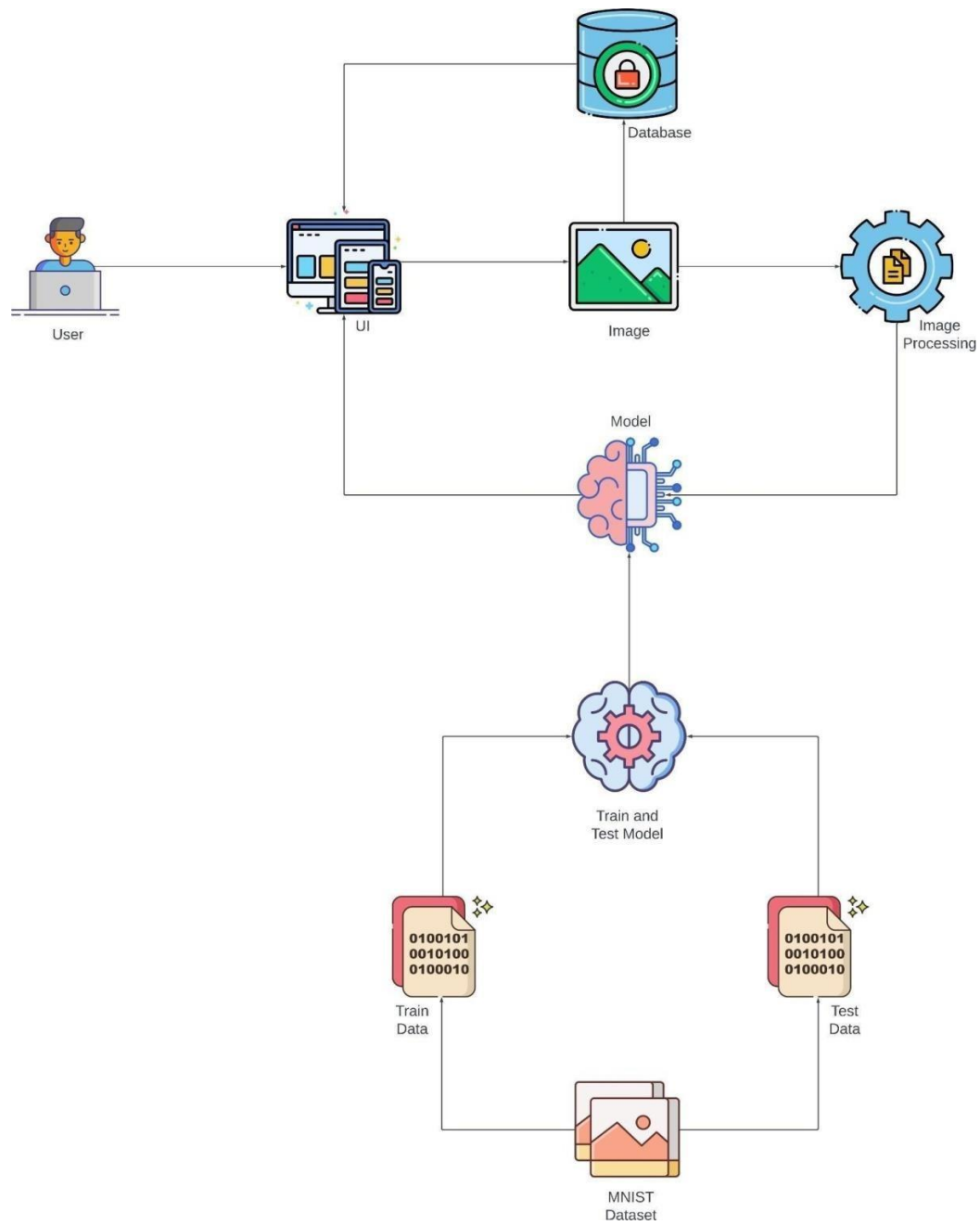
### DATA FLOW DIAGRAM



## SOLUTION & TECHNICAL ARCHITECTURE







## USER STORIES

User Type	Functional Requirements	User Story Number	User Story / Task	Acceptance Criteria	Priority	Release
Customer	Accessing the Application	USN-1	As a user, I should be able to access the application from anywhere and use on any devices	User can access the application using the browser on any device	High	Sprint-4
	Uploading Image	USN-2	As a user, I should be able to upload images to predict the digits	User can upload images	High	Sprint-3
	Viewing the Results	USN-3	As a user, I should be able to view the results	The result of the prediction is displayed	High	Sprint-3
	Viewing Other Prediction	USN-4	As a user, I should be able to see other close predictions	The accuracy of other values must be displayed	Medium	Sprint-4
	Usage Instruction	USN-5	As a user, I should have a usage instruction to know how to use the application	The usage instruction is displayed on the home page	Medium	Sprint-4

# CHAPTER 6

## PROJECT PLANNING AND SCHEDULING

### SPRINT PLANNING AND ESTIMATION

SPRINT	USER STORY / TASK	STORY POINTS	PRIORITY	TEAM MEMBERS
Sprint – I	Get the dataset	3	High	BHARATHI V
	Explore the data	2	Medium	BHARATHI V SUREKA M
	Data Pre-Processing	3	High	BHARATHI V SWATHI C
	Prepare training and testing data	3	High	BHARATHI V DEVADHARSHINI R
Sprint – II	Create the model	3	High	BHARATHI V
	Train the model	3	High	SWATHI C DEVADHARSHINI R
	Test the model	3	High	SUREKA M BHARATHI V
Sprint – III	Improve the model	2	Medium	BHARATHI V DEVADHARSHINI R
	Save the model	3	High	SWATHI C
	Build the Home Page	3	High	SWATHI C SUREKA M
	Setup a database to store input images	2	Medium	SUREKA M

Sprint – IV	Build the results page	3	High	BHARATHI V SWATHI C
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	Integrate the model with the application	3	High	BHARATHI V
	Test the application	3	High	DEVADHARSHINI R SUREKA M

## SPRINT DELIVERY SCHEDULE

SPRINT	TOTAL STORY POINTS	DURATION	SPRINT START DATE	SPRINT END DATE (PLANNED)	STORY POINTS COMPLETED (AS ON PLANNED DATE)	SPRINT RELEASE DATE (ACTUAL)
Sprint – I	11	6 Days	24 Oct 2022	29 Oct 2022	11	29 Oct 2022
Sprint – II	9	6 Days	31 Oct 2022	05 Nov 2022	9	05 Nov 2022
Sprint – III	10	6 Days	07 Oct 2022	12 Nov 2022	10	12 Nov 2022
Sprint – IV	9	6 Days	14 Nov 2022	19 Nov 2022	9	19 Nov 2022

# CHAPTER 7

## CODING & SOLUTIONING

```
# Import necessary packages
import os
import random
import string
from pathlib import Path
import numpy as np
from tensorflow.keras.models import load_model
from PIL import Image, ImageOps
```

```
def random_name_generator(n: int) -> str:
    """
    Generates a random file name.

    Args:
        n (int): Length the of the file name.

    Returns:
        str: The file name.
    """
    return ''.join(random.choices(string.ascii_uppercase + string.digits, k=n))
```

```

def recognize(image: bytes) -> tuple:
    """
    Predicts the digit in the image.

    Args:
        image (bytes): The image data.

    Returns:
        tuple: The best prediction, other predictions and file name
    """

    model=load_model(Path("./model/model.h5"))

    img = Image.open(image).convert("L")

    # Generate a random name to save the image file.
    img_name = random_name_generator(10) + '.jpg'
    if not os.path.exists(f"./static/data/"):
        os.mkdir(os.path.join('./static/', 'data'))
    img.save(Path(f"./static/data/{img_name}"))

    # Convert the Image to Grayscale, Invert it and Resize to get better prediction.
    img = ImageOps.grayscale(img)
    img = ImageOps.invert(img)
    img = img.resize((28, 28))

    # Convert the image to an array and reshape the data to make prediction.
    img2arr = np.array(img)
    img2arr = img2arr / 255.0
    img2arr = img2arr.reshape(1, 28, 28, 1)

    results = model.predict(img2arr)
    best = np.argmax(results,axis = 1)[0]

    # Get all the predictions and it's respective accuracy.
    pred = list(map(lambda x: round(x*100, 2), results[0]))

    values = [0, 1, 2, 3, 4, 5, 6, 7, 8, 9]
    others = list(zip(values, pred))

    # Get the value with the highest accuracy
    best = others.pop(best)

    return best, others, img_name

```

# CHAPTER 8

## TESTING

### TEST CASES

Test case ID	Feature Type	Component	Test Scenario	Expected Result	Actual Result	Status
HP_TC_001	UI	Home Page	Verify UI elements in the Home Page	The Home page must be displayed properly	Working as expected	PASS
HP_TC_002	UI	Home Page	Check if the UI elements are displayed properly in different screen sizes	The Home page must be displayed properly in all sizes	The UI is not displayed properly in screen size 2560 x 1801 and 768 x 630	FAIL
HP_TC_003	Functiona	Home Page	Check if user can upload their file	The input image should be uploaded to the application successfully	Working as expected	PASS
HP_TC_004	Functiona	Home Page	Check if user cannot upload unsupported files	The application should not allow user to select a non image file	User is able to upload any file	FAIL
HP_TC_005	Functiona	Home Page	Check if the page redirects to the result page once the input is given	The page should redirect to the results page	Working as expected	PASS



BE_TC_001	Functiona	Backend	Check if all the routes are working properly	All the routes should properly work	Working as expected	PASS
M_TC_001	Functiona	Model	Check if the model can handle various image sizes	The model should rescale the image and predict the results	Working as expected	PASS
M_TC_002	Functiona	Model	Check if the model predicts the digit	The model should predict the number	Working as expected	PASS
M_TC_003	Functiona	Model	Check if the model can handle complex input image	The model should predict the number in the complex image	The model fails to identify the digit since the model is not built to handle such data	FAIL
RP_TC_001	UI	Result Page	Verify UI elements in the Result Page	The Result page must be displayed properly	Working as expected	PASS
RP_TC_002	UI	Result Page	Check if the input image is displayed properly	The input image should be displayed properly	The size of the input image exceeds the display container	FAIL
RP_TC_003	UI	Result Page	Check if the result is displayed properly	The result should be displayed properly	Working as expected	PASS
RP_TC_004	UI	Result Page	Check if the other predictions are displayed properly	The other predictions should be displayed properly	Working as expected	PASS

## USER ACCEPTANCE TESTING DEFECT ANALYSIS

Resolution	Severity 1	Severity 2	Severity 3	Severity 4	Total
By Design	1	0	1	0	2
Duplicate	0	0	0	0	0
External	0	0	2	0	2
Fixed	4	1	0	1	6
Not Reproduced	0	0	0	1	1
Skipped	0	0	0	1	1
Won't Fix	1	0	1	0	2
Total	6	1	4	3	14

## TEST CASE ANALYSIS

Section	Total Cases	Not Tested	Fail	Pass
Client Application	10	0	3	7
Security	2	0	1	1
Performance	3	0	1	2
Exception Reporting	2	0	0	2

# CHAPTER 9

## RESULTS

### PERFORMANCE METRICS

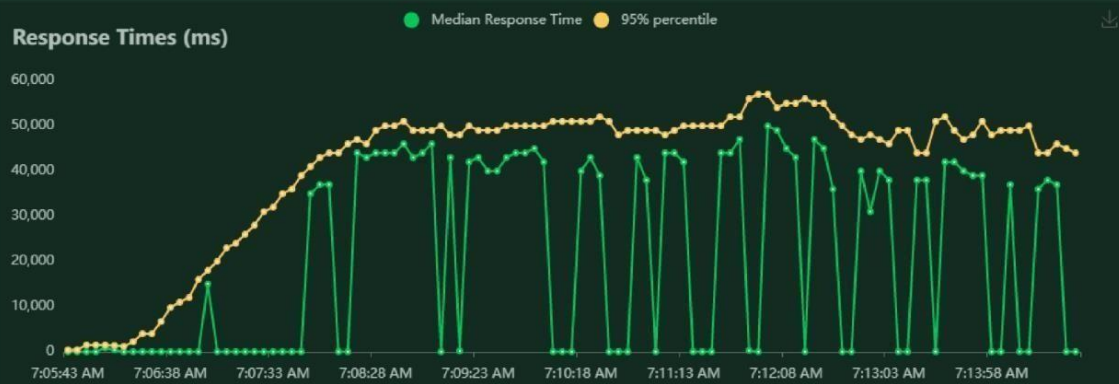
Locust Test Report									
During: 11/12/2022, 7:05:40 AM - 11/12/2022, 7:14:47 AM									
Target Host: http://127.0.0.1:5000/									
Script: locust.py									
Request Statistics									
Method	Name	# Requests	# Fails	Average (ms)	Min (ms)	Max (ms)	Average size (bytes)	RPS	Failures/s
GET	/	1043	0	13	4	290	1079	1.9	0.0
GET	/predict	1005	0	39648	385	59814	2670	1.8	0.0
Aggregated		2048	0	19462	4	59814	1859	3.7	0.0
Response Time Statistics									
Method	Name	50%ile (ms)	60%ile (ms)	70%ile (ms)	80%ile (ms)	90%ile (ms)	95%ile (ms)	99%ile (ms)	100%ile (ms)
GET	/	10	11	13	15	19	22	62	290
GET	/predict	44000	46000	47000	48000	50000	52000	55000	60000
Aggregated		36	36000	43000	45000	48000	50000	54000	60000

## Charts

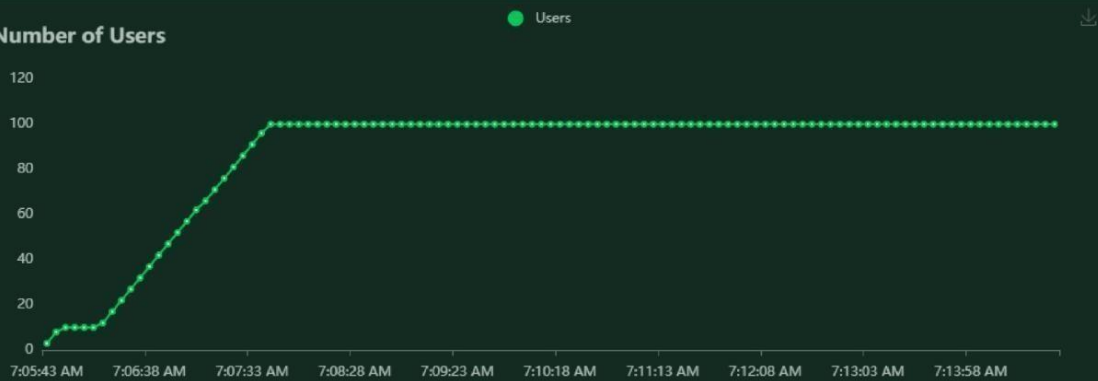
### Total Requests per Second



### Response Times (ms)



### Number of Users



# **CHAPTER 10**

## **ADVANTAGES & DISADVANTAGES**

### **ADVANTAGES**

- Reduces manual work
- More accurate than average human
- Capable of handling a lot of data
- Can be used anywhere from any device

### **DISADVANTAGES**

- Cannot handle complex data
- All the data must be in digital format
- Requires a high performance server for faster predictions
- Prone to occasional errors

# CHAPTER 11

## CONCLUSION

This project demonstrated a web application that uses machine learning to recognise handwritten numbers. Flask, HTML, CSS, JavaScript, and a few other technologies were used to create this project. The model predicts the handwritten digit using a CNN network. During testing, the model achieved a 99.61% recognition rate. The proposed project is scalable and can easily handle a huge number of users. Since it is a web application, it is compatible with any device that can run a browser. This project is extremely useful in real-world scenarios such as recognizing number plates of vehicles, processing bank cheque amounts, numeric entries in forms filled up by hand (tax forms) and so on. There is so much room for improvement, which can be implemented in subsequent versions.

# CHAPTER 12

## FUTURE SCOPE

This project is far from complete and there is a lot of room for improvement. Some of the improvements that can be made to this project are as follows:

- Add support to detect from digits multiple images and save the results
- Add support to detect multiple digits
- Improve model to detect digits from complex images
- Add support to different languages to help users from all over the world

This project has endless potential and can always be enhanced to become better. Implementing this concept in the real world will benefit several industries and reduce the workload on many workers, enhancing overall work efficiency.

# APPENDIX

## SOURCE CODE

### MODEL CREATION

```
# Load the necessary packages
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
from keras.utils import np_utils
from tensorflow.keras.datasets import mnist
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Conv2D, Dense, Flatten
from tensorflow.keras.optimizers import Adam
from tensorflow.keras.models import load_model
from PIL import Image, ImageOps

# Load the data
(X_train, y_train), (X_test, y_test) = mnist.load_data()

# Data pre-processing
X_train = X_train.reshape(60000, 28, 28, 1).astype('float32')
X_test = X_test.reshape(10000, 28, 28, 1).astype('float32')

number_of_classes = 10
Y_train = np_utils.to_categorical(y_train, number_of_classes)
Y_test = np_utils.to_categorical(y_test, number_of_classes)
```

```
# Create the model
model = Sequential()
model.add(Conv2D(64, (3, 3), input_shape=(28, 28, 1), activation="relu"))
model.add(Conv2D(32, (3, 3), activation="relu"))
model.add(Flatten())
model.add(Dense(number_of_classes, activation="softmax"))

model.compile(loss='categorical_crossentropy', optimizer="Adam", metrics=["accuracy"])

# Train the model
model.fit(X_train, Y_train, batch_size=32, epochs=5, validation_data=(X_test, Y_test))

# Evaluate the model
metrics = model.evaluate(X_test, Y_test, verbose=0)
print("Metrics (Test Loss & Test Accuracy): ")
print(metrics)

# Save the model
model.save("model.h5")
```



```
# Test the saved model
model=load_model("model.h5")

img = Image.open("sample.png").convert("L")
img = img.resize((28, 28))
img2arr = np.array(img)
img2arr = img2arr.reshape(1, 28, 28, 1)
results = model.predict(img2arr)
results = np.argmax(results,axis = 1)
results = pd.Series(results,name="Label")
print(results)
```

## FLASK APP

```
from flask import Flask,render_template,request
from recognizer import recognize

app=Flask(__name__)

@app.route('/')
def main():
    return render_template("home.html")

@app.route('/predict',methods=['POST'])
def predict():
    if request.method=='POST':
        image = request.files.get('photo', '')
        best, others, img_name = recognize(image)
        return render_template("predict.html", best=best, others=others, img_name=img_name)

if __name__=="__main__":
    app.run()
```

## RECOGNIZER

```
# Import necessary packages
import os
import random
import string
from pathlib import Path
import numpy as np
from tensorflow.keras.models import load_model
from PIL import Image, ImageOps
```

```
def random_name_generator(n: int) -> str:
    """
    Generates a random file name.

    Args:
        n (int): Length the of the file name.

    Returns:
        str: The file name.
    """
    return ''.join(random.choices(string.ascii_uppercase + string.digits, k=n))
```

```
def recognize(image: bytes) -> tuple:
    """
    Predicts the digit in the image.

    Args:
        image (bytes): The image data.

    Returns:
        tuple: The best prediction, other predictions and file name
    """

    model=load_model(Path("./model/model.h5"))

    img = Image.open(image).convert("L")

    # Generate a random name to save the image file.
    img_name = random_name_generator(10) + '.jpg'
    if not os.path.exists(f"./static/data/"):
        os.mkdir(os.path.join('./static/', 'data'))
    img.save(Path(f"./static/data/{img_name}"))

    # Convert the Image to Grayscale, Invert it and Resize to get better prediction.
    img = ImageOps.grayscale(img)
    img = ImageOps.invert(img)
    img = img.resize((28, 28))

    # Convert the image to an array and reshape the data to make prediction.
    img2arr = np.array(img)
    img2arr = img2arr / 255.0
    img2arr = img2arr.reshape(1, 28, 28, 1)

    results = model.predict(img2arr)
    best = np.argmax(results,axis = 1)[0]

    # Get all the predictions and it's respective accuracy.
    pred = List(map(lambda x: round(x*100, 2), results[0]))

    values = [0, 1, 2, 3, 4, 5, 6, 7, 8, 9]
    others = List(zip(values, pred))

    # Get the value with the highest accuracy
    best = others.pop(best)

    return best, others, img_name
```

## HOME PAGE (HTML)

```
<html>
  <head>
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />
    <title>Handwritten Digit Recognition</title>
    <link rel="icon" type="image/svg" sizes="32x32" href="{{url_for('static',filename='images/icon.svg')}}" />
    <link rel="stylesheet" href="{{url_for('static',filename='css/main.css')}}" />
    <script src="https://unpkg.com/feather-icons"></script>
    <script defer src="{{url_for('static',filename='js/script.js')}}"></script>
  </head>
  <body>
    <div class="container">
      <div class="heading">
        <h1 class="heading__main">Handwritten Digit Recognizer</h1>
        <h2 class="heading__sub">Easily analyze and detect handwritten digits</h2>
      </div>
      <div class="upload-container">
        <div class="form-wrapper">
          <form class="upload" action="/predict" method="post" enctype="multipart/form-data">
            <label id="Label" for="upload-image"><i data-feather="file-plus"></i>Select File</label>
            <input type="file" name="photo" id="upload-image" hidden />
            <button type="submit" id="up_btn"></button>
          </form>
          
        </div>
      </div>
    </div>
  </body>
</html>
```

## HOME PAGE (CSS)

```
@import url("https://fonts.googleapis.com/css2?family=Overpass:wght@200;300;400;500;600;700;900&display=swap");

* {
  padding: 0;
  margin: 0;
}

body {
  color: black;
  font-family: "Overpass", sans-serif;
}
```

```

.container {
  width: 100%;
  height: 100%;
  display: flex;
  flex-direction: column;
  justify-content: center;
  align-items: center;
  background-color: white;
}

.heading {
  margin-top: -2rem;
  padding-bottom: 2rem;
  width: fit-content;
  text-align: center;
}

.heading .heading__main {
  font-size: 3rem;
  font-weight: 550;
}

.heading .heading__sub {
  font-size: 1rem;
  color: rgb(90, 88, 88);
}

.upload-container {
  box-shadow: 0 0 20px rgb(172, 170, 170);
  width: 40rem;
  height: 25rem;
  padding: 1.5rem;
}

.form-wrapper {
  background-color: rgba(190, 190, 190, 0.5);
  width: 100%;
  height: 100%;
  display: flex;
  border: 1px dashed black;
  justify-content: center;
  align-items: center;
}

.form-wrapper #Loading {
  display: none;
  position: absolute;
}

```

```

.form-wrapper .upload {
  display: flex;
  justify-content: center;
  align-items: center;
  width: 8rem;
  height: -webkit-fit-content;
  height: -moz-fit-content;
  height: fit-content;
  border-radius: 6px;
  color: white;
  background-color: rgb(114, 96, 182);
  box-shadow: 0 5px 10px rgb(146, 135, 247);
}

.form-wrapper .upload #up_btn {
  display: none;
}

.form-wrapper .upload label {
  font-size: 1rem;
  font-weight: 600;
  color: white;
  height: 100%;
  width: 100%;
  padding: 10px;
  display: block;
}

.form-wrapper .upload svg {
  height: 15px;
  width: auto;
  padding-right: 8px;
  margin-bottom: -2px;
}

@media screen and (max-width: 700px) {
  .upload-container {
    height: 20rem;
    width: 18rem;
    margin-top: 3.5rem;
    margin-bottom: -8rem;
  }

  .heading .heading__main {
    margin-top: -6rem;
    font-size: 2rem;
    padding-bottom: 1rem;
  }
}

```

## HOME PAGE (JS)

```
feather.replace(); // Load feather icons

form = document.querySelector('.upload')
loading = document.querySelector("#Loading")
select = document.querySelector("#upload-image");

select.addEventListener("change", (e) => {
    e.preventDefault();

    form.submit()
    form.style.visibility = "hidden";
    loading.style.display = 'flex';
});
```

## PREDICT PAGE (HTML)

```
<html>
  <head>
    <title>Prediction | Handwritten Digit Recognition</title>
    <link rel="stylesheet" href="{{url_for('static',filename='css/predict.css')}}" />
    <link rel="icon" type="image/svg" sizes="32x32" href="{{url_for('static',filename='images/icon.svg')}}" />
    <meta name="viewport" content="width=device-width, initial-scale=1.0" />
  </head>
  <body>
    <div class="container">
      <h1>Prediction</h1>
      <div class="result-wrapper">
        <div class="input-image-container">
          
        </div>
        <div class="result-container">
          <div class="value">{{best.0}}</div>
          <div class="accuracy">{{best.1}}%</div>
        </div>
      </div>
      <h1>Other Predictions</h1>
      <div class="other_predictions">
        {% for x in others %}
          <div class="value">
            <h2>{{x.0}}</h2>
            <div class="accuracy">{{x.1}}%</div>
          </div>
        {% endfor %}
      </div>
    </div>
  </body>
</html>
```

```

@import url("https://fonts.googleapis.com/css2?family=Overpass:wght@200;300;400;500;600;700;900&display=swap");

body {
  color: black;
  font-family: "Overpass", sans-serif;
}

h1 {
  padding-top: 2rem;
}

.container {
  display: flex;
  justify-content: center;
  align-items: center;
  flex-direction: column;
}

.result-wrapper {
  width: -webkit-fit-content;
  width: -moz-fit-content;
  width: fit-content;
  height: -webkit-fit-content;
  height: -moz-fit-content;
  height: fit-content;
  box-shadow: 0 0 10px rgb(126, 125, 125);
  padding: 1.5rem;
  display: flex;
  justify-content: center;
  align-items: center;
  -moz-column-gap: 1rem;
  column-gap: 1rem;
}

.result-wrapper .input-image-container,
.result-wrapper .result-container {
  width: 15rem;
  height: 15rem;
  border: 1px dashed black;
  justify-content: center;
  display: flex;
  align-items: center;
  flex-direction: column;
  background-color: rgb(209, 206, 206);
}

```

```

.result-wrapper .input-image-container img {
  width: 60%;
  height: 60%;
  background-color: aqua;
  background-size: contain;
}

.result-wrapper .result-container .value {
  font-size: 6rem;
}

.result-wrapper .result-container .accuracy {
  margin-top: -1rem;
}

.other_predictions {
  display: flex;
  justify-content: center;
  align-items: center;
  flex-wrap: wrap;
  column-gap: 1rem;
  row-gap: 1rem;
  font-weight: 700;
}

.other_predictions .value {
  display: flex;
  justify-content: center;
  align-items: center;
  flex-direction: column;
  width: 5rem;
  height: 5rem;
  box-shadow: 0 0 7px rgb(158, 157, 157);
}

.other_predictions .value div {
  margin-top: -1.2rem;
}

@media screen and (max-width: 700px) {
  h1 {
    font-size: 2.3rem;
  }

  .result-wrapper .input-image-container,
  .result-wrapper .result-container {
    width: 7rem;
    height: 7rem;
  }

  .result-wrapper .result-container .value {
    font-size: 4rem;
  }
}

```





<https://github.com/IBM-EPBL/IBM-Project-32160-1660208425>