IBM PROJECT

A NOVEL METHOD FOR HANDWRITTEN DIGIT RECOGNITION SYSTEM

DOMAIN - ARTIFICIAL INTELLIGENCE

submitted by

PNT2022TMID29571

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Table of Contents

1. INTRODUCTION

a.Project Overview

1. Handwriting recognition is one of the compelling research works going on because every individual in this world has their own style of writing.
2. It is the capability of the computer to identify and understand handwritten digits or characters automatically.
3. Because of the progress in the field of science and technology, everything is being digitalized to reduce human effort.
4. Hence, there comes a need for handwritten digit recognition in many real-time applications.
5. MNIST data set is widely used for this recognition process and it has 70000 handwritten digits.
6. We use Artificial neural networks to train these images and build a deep learning model.
7. Web application is created where the user can upload an image of a handwritten digit.
8. This image is analysed by the model and the detected result is returned on to UI.

b.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.

2. LITERATURE SURVEY

2.1 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.

2.2 References

Paper 1: Handwritten digit recognition by combined classifiers

Author : M. Breukelen; Robert P. W. Duin; David M. J. Tax; J. E. den Hartog

Summary: Classifiers can be combined to reduce classification errors. We did experiments on a data set consisting of different sets of features of handwritten digits. Different types of classifiers were trained on these feature sets. The performances of these classifiers and combination rules were tested. The best results were acquired with the mean, median and product combination rules. The product was best for combining linear classifiers, the median for k-NN classifiers. Training a classifier on all features did not result in less errors.

Paper 2 : A trainable feature extractor for handwritten digit recognition

Author: Fabien Lauer, Ching Y. Suen, Gérard Bloch

Summary: This article focuses on the problems of feature extraction and the recognition of handwritten digits. A trainable feature extractor based on the LeNet5 convolutional neural network architecture is introduced to solve the first problem in a black box scheme without prior knowledge on the data. In order to increase the recognition rate, new training samples are generated by affine transformations and elastic distortions. Experiments are performed on the well-known MNIST database to validate the method and the results show that the system can outperform both SVMs and LeNet5 while providing performances comparable to the best performance on this database. Moreover, an analysis of the errors is conducted to discuss possible means of enhancement and their limitations.

Paper 3 : **Handwritten digit recognition by neural networks with single-layer training**
Author : S. Knerr; L. Personnaz; G. Dreyfus

Summary: It is shown that neural network classifiers with single-layer training can be applied efficiently to complex real-world classification problems such as the recognition of handwritten digits. The STEPNET procedure, which decomposes the problem into simpler sub-problems which can be solved by linear separators, is introduced. Provided appropriate data representations and learning rules are used, performance comparable to that obtained by more complex networks can be achieved. Results from two different databases are presented: an European database comprising 8700 isolated digits and a zip code database from the US Postal Service comprising 9000 segmented digits. A hardware implementation of the classifier is briefly described

2.3 Problem Statement Definition

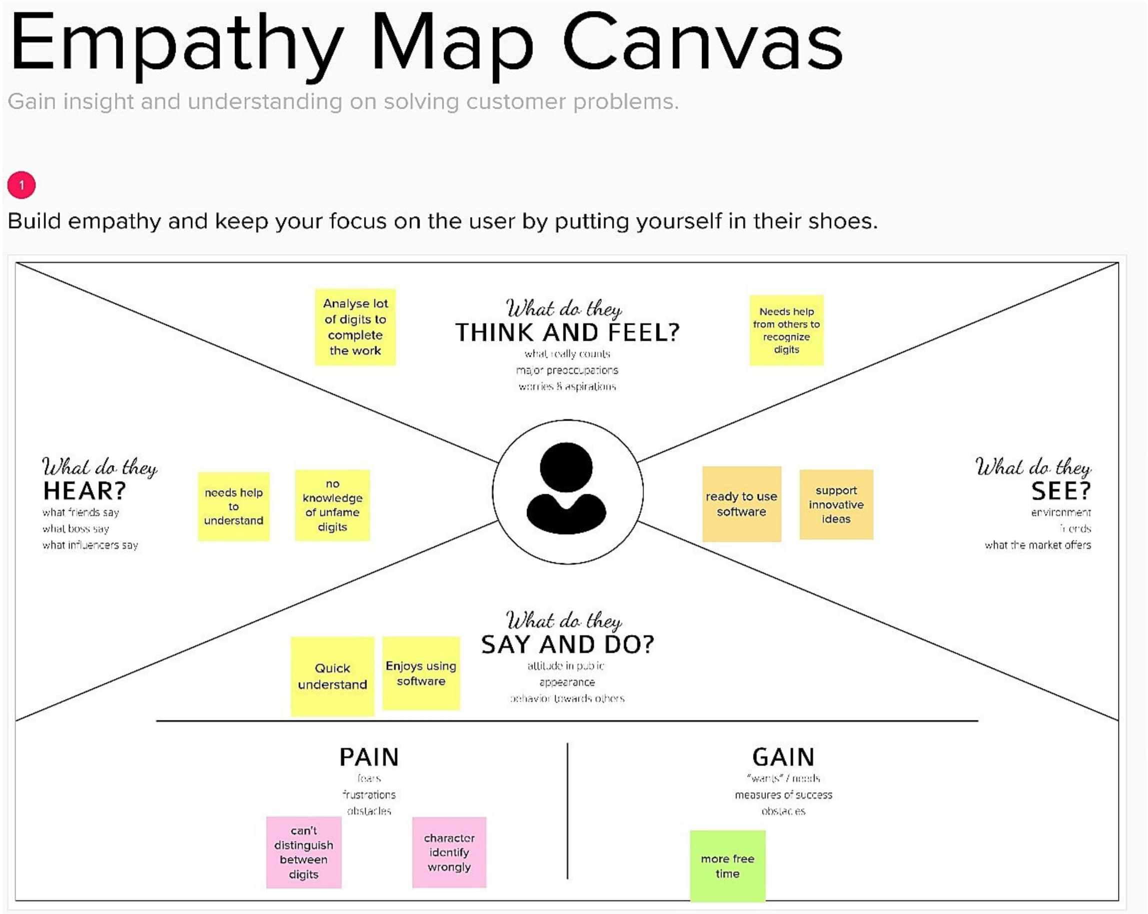
For years, the traffic department has been combating traffic law violators. These offenders endanger not only their own lives, but also the lives of other individuals. Punishing these offenders is critical to ensuring that others do not become like them. Identification of these offenders is next to impossible 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.

3. IDEATION & PROPOSED SOLUTION

3.1 Empathy Map Canvas

An empathy map is a simple, easy-to-digest visual that captures knowledge about a user’s behaviours and attitudes. It is a useful tool to helps teams better understand their users. Creating an effecting solution requires understanding the true problem and the person who is experiencing it. The exercise of creating the map helps participants consider things from the user’s perspective along with his or her goals and challenges.

Example:



Empathy Map Canvas

Gain insight and understanding on solving customer problems.

1

Build empathy and keep your focus on the user by putting yourself in their shoes.

What do they
THINK AND FEEL?
what really counts
major preoccupations
worries & aspirations

Analyse lot of digits to complete the work

Needs help from others to recognize digits

What do they
HEAR?
what friends say
what boss say
what influencers say

needs help to understand

no knowledge of unfame digits

What do they
SEE?
environment
friends
what the market offers

ready to use software

support innovative ideas

What do they
SAY AND DO?
attitude in public
appearance
behavior towards others

Quick understand

Enjoys using software

PAIN
fears
frustrations
obstacles

can't distinguish between digits

character identify wrongly

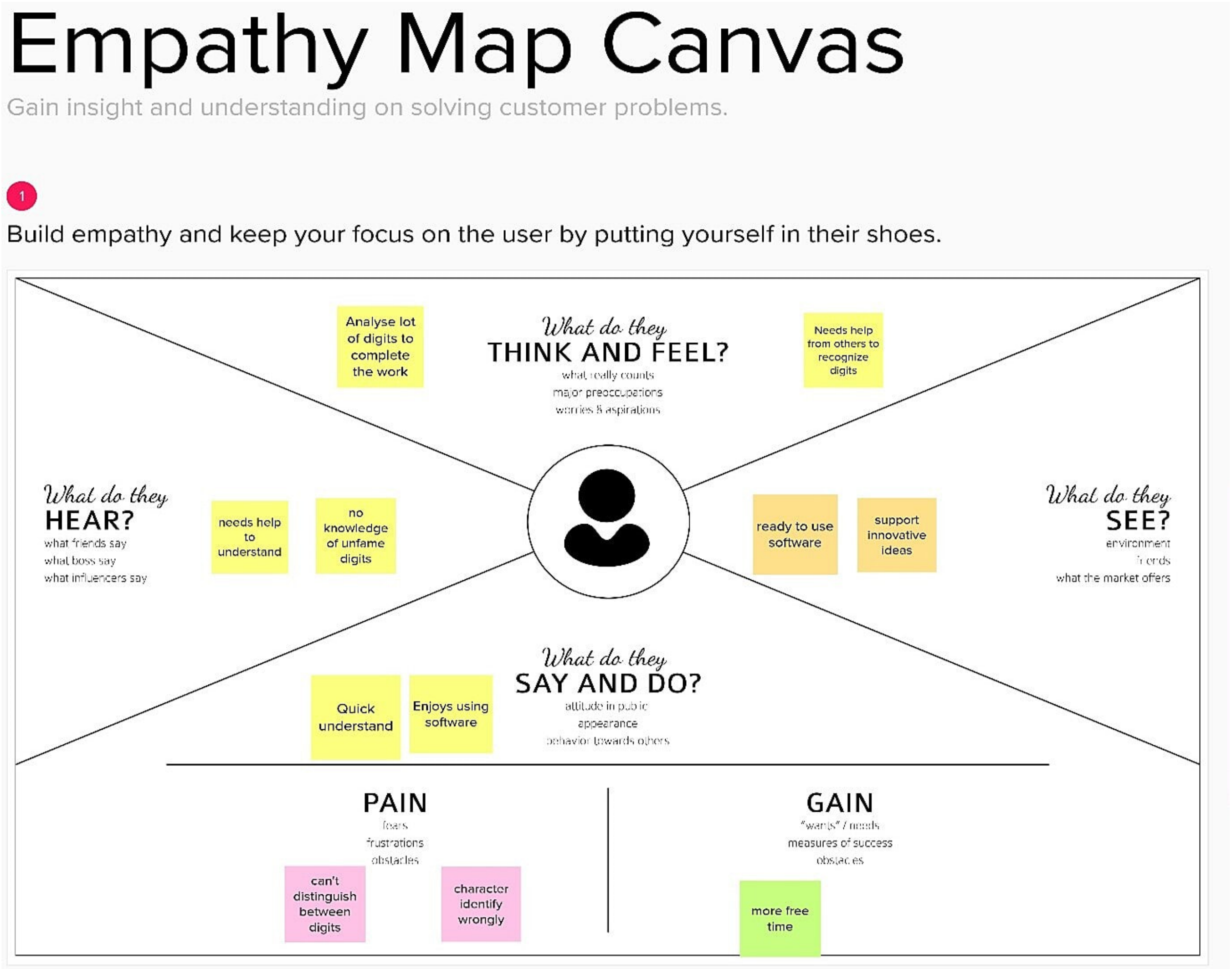
GAIN
"wants" / needs
measures of success
obstacles

more free time

3.2 Ideation & Brainstorming

Brainstorming provides a free and open environment that encourages everyone within a team to participate in the creative thinking process that leads to problem solving. Prioritizing volume over value, out-of-the-box ideas are welcome and built upon, and all participants are encouraged to collaborate, helping each other develop a rich amount of creative solutions.Use this template in your own brainstorming sessions so your team can unleash their imagination and start shaping concepts even if you're not sitting in the same room.

Step-1: Team Gathering, Collaboration and Select the Problem Statement



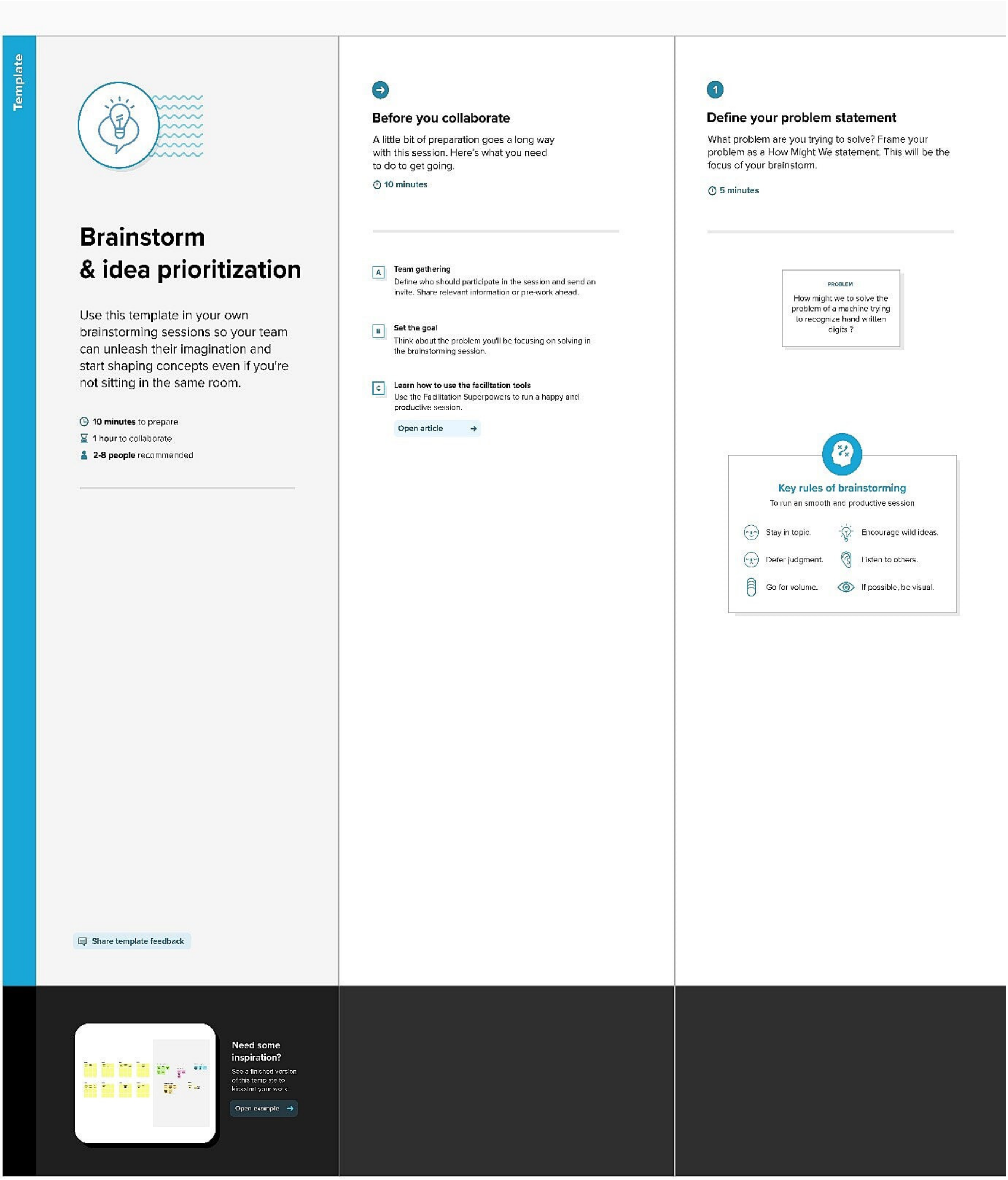
Empathy Map Canvas

Gain insight and understanding on solving customer problems.

1

Build empathy and keep your focus on the user by putting yourself in their shoes.

Step-2: Brainstorm, Idea Listing and Grouping



Template

Brainstorm & idea prioritization

Use this template in your own brainstorming sessions so your team can unleash their imagination and start shaping concepts even if you're not sitting in the same room.

10 minutes to prepare
1 hour to collaborate
2-8 people recommended

Share template feedback

Need some inspiration?

See a finished version of this template to kickstart your work.

Open example →

Before you collaborate

A little bit of preparation goes a long way with this session. Here's what you need to do to get going.

10 minutes

A **Team gathering**
Define who should participate in the session and send an invite. Share relevant information or pre-work ahead.

B **Set the goal**
Think about the problem you'll be focusing on solving in the brainstorming session.

C **Learn how to use the facilitation tools**
Use the Facilitation Superpowers to run a happy and productive session.

Open article →

1 Define your problem statement

What problem are you trying to solve? Frame your problem as a How Might We statement. This will be the focus of your brainstorm.

5 minutes

PROBLEM

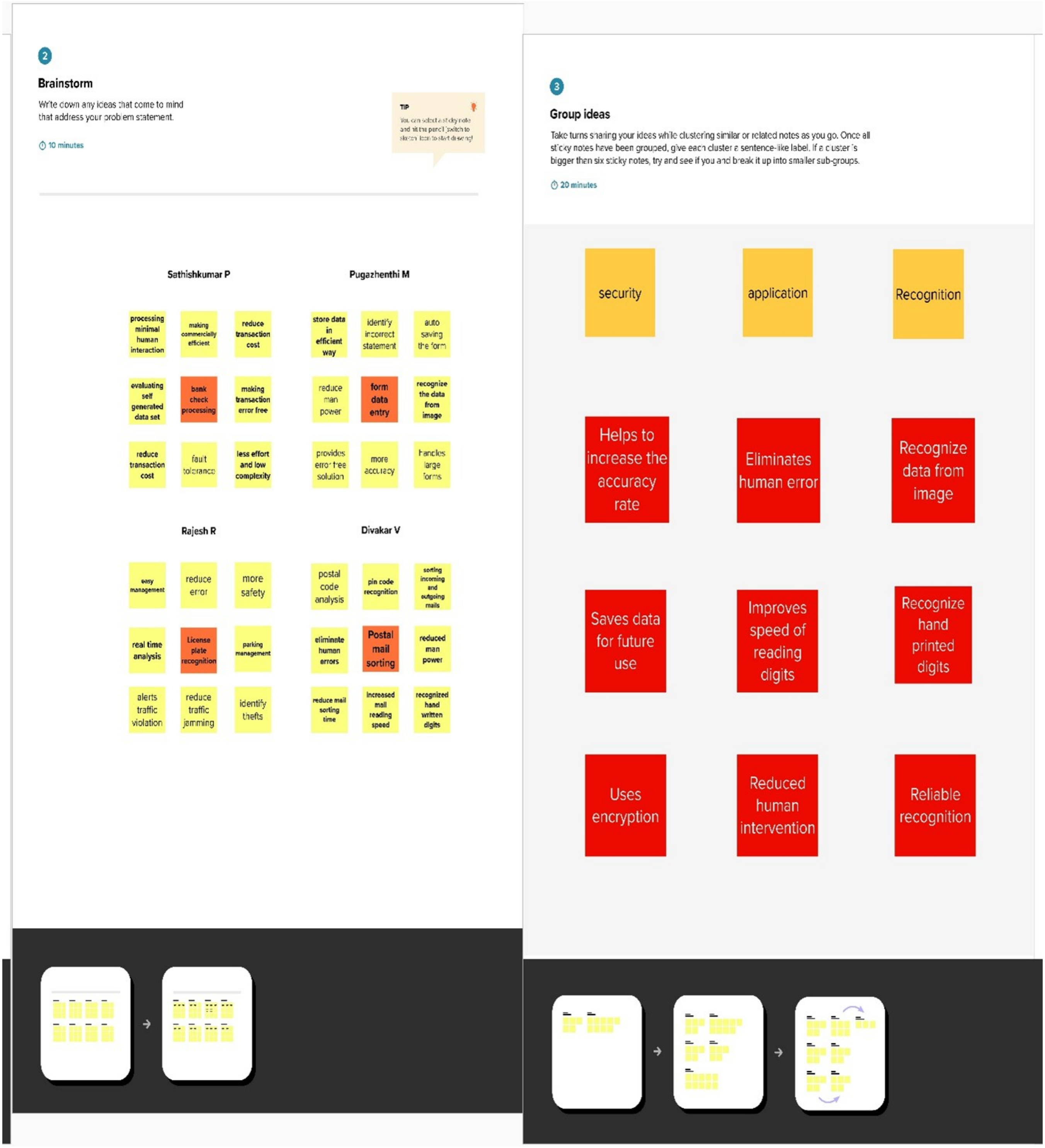
How might we to solve the problem of a machine trying to recognize hand written digits ?

Key rules of brainstorming

To run an smooth and productive session

Stay in topic.
Encourage wild ideas.
Defer judgment.
Listen to others.
Go for volume.
If possible, be visual.

Step-3: Idea Prioritization



2

Brainstorm

Write down any ideas that come to mind that address your problem statement.

10 minutes

TIP

You can select a sticky note and hit the pencil [switch to sketch] icon to start drawing!

Sathishkumar P

- processing minimal human interaction
- making commercially efficient
- reduce transaction cost
- evaluating self generated data set
- bank check processing
- making transaction error free
- reduce transaction cost
- fault tolerance
- less effort and low complexity

Pugazhenthi M

- store data in efficient way
- identify incorrect statement
- auto saving the form
- reduce man power
- form data entry
- recognize the data from image
- provides error free solution
- more accuracy
- handles large forms

Rajesh R

- easy management
- reduce error
- more safety
- real time analysis
- License plate recognition
- parking management
- alerts traffic violation
- reduce traffic jamming
- identify thefts

Divakar V

- postal code analysis
- pin code recognition
- sorting incoming and outgoing mails
- eliminate human errors
- Postal mail sorting
- reduced man power
- reduce mail sorting time
- Increased mail reading speed
- recognized hand written digits

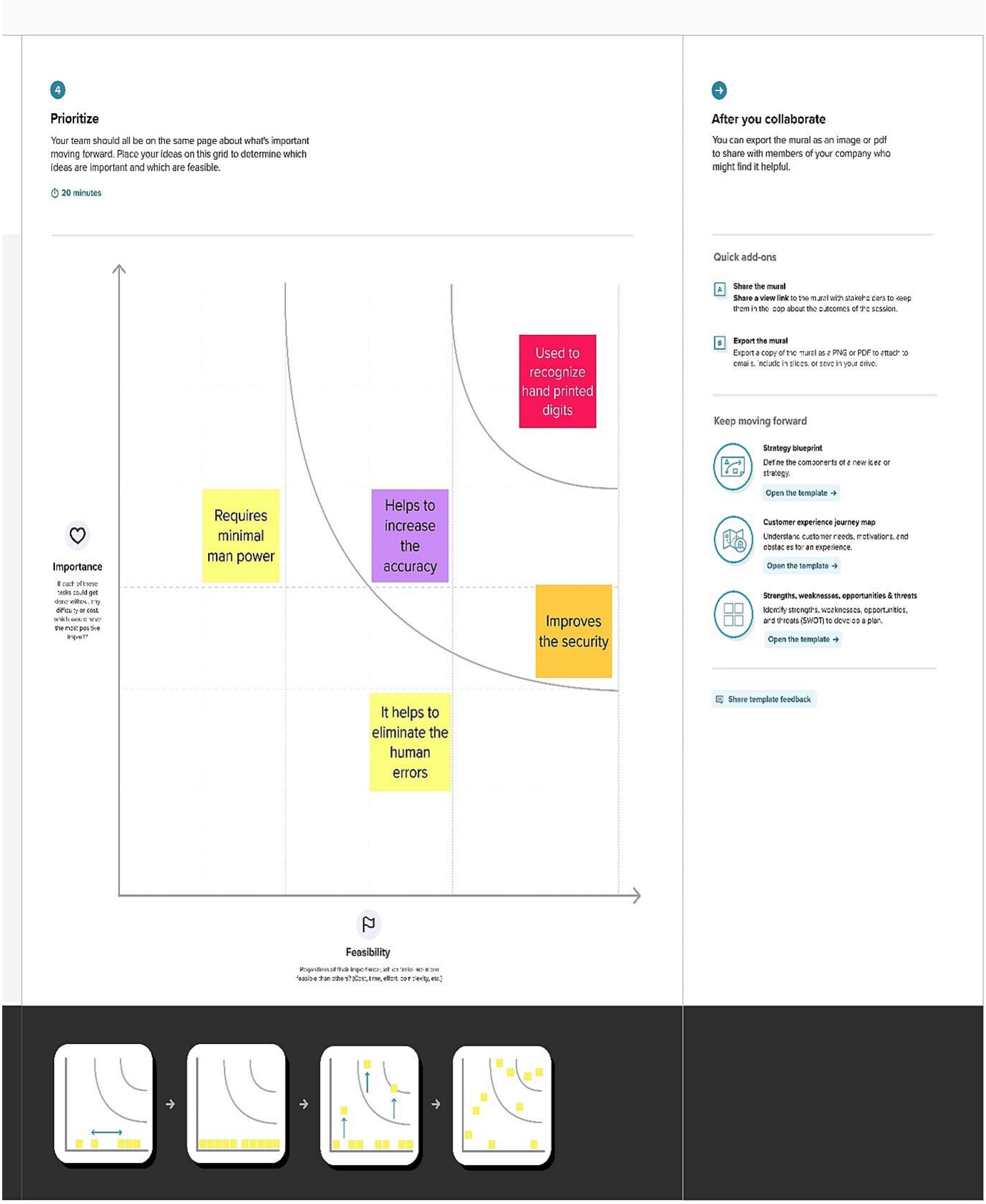
3

Group ideas

Take turns sharing your ideas while clustering similar or related notes as you go. Once all sticky notes have been grouped, give each cluster a sentence-like label. If a cluster is bigger than six sticky notes, try and see if you and break it up into smaller sub-groups.

20 minutes

security	application	Recognition
Helps to increase the accuracy rate	Eliminates human error	Recognize data from image
Saves data for future use	Improves speed of reading digits	Recognize hand printed digits
Uses encryption	Reduced human intervention	Reliable recognition



4
Used to recognize hand printed digits
Requires minimal man power
Helps to increase the accuracy
Improves the security
It helps to eliminate the human errors
Importance
Feasibility
A
B
Open the template →
Open the template →
Open the template →
Share template feedback

Prioritize

Your team should all be on the same page about what's important moving forward. Place your ideas on this grid to determine which ideas are important and which are feasible.

20 minutes

Importance

If each of these tasks could get done without any difficulty or cost, which would have the most positive impact?

Feasibility

Regardless of their importance, which tasks are more feasible than others? (Cost, time, effort, complexity, etc.)

After you collaborate

You can export the mural as an image or pdf to share with members of your company who might find it helpful.

Quick add-ons

Share the mural
Share a view link to the mural with stakeholders to keep them in the loop about the outcomes of the session.

Export the mural
Export a copy of the mural as a PNG or PDF to attach to emails, include in slides, or save in your drive.

Keep moving forward

Strategy blueprint
Define the components of a new idea or strategy.

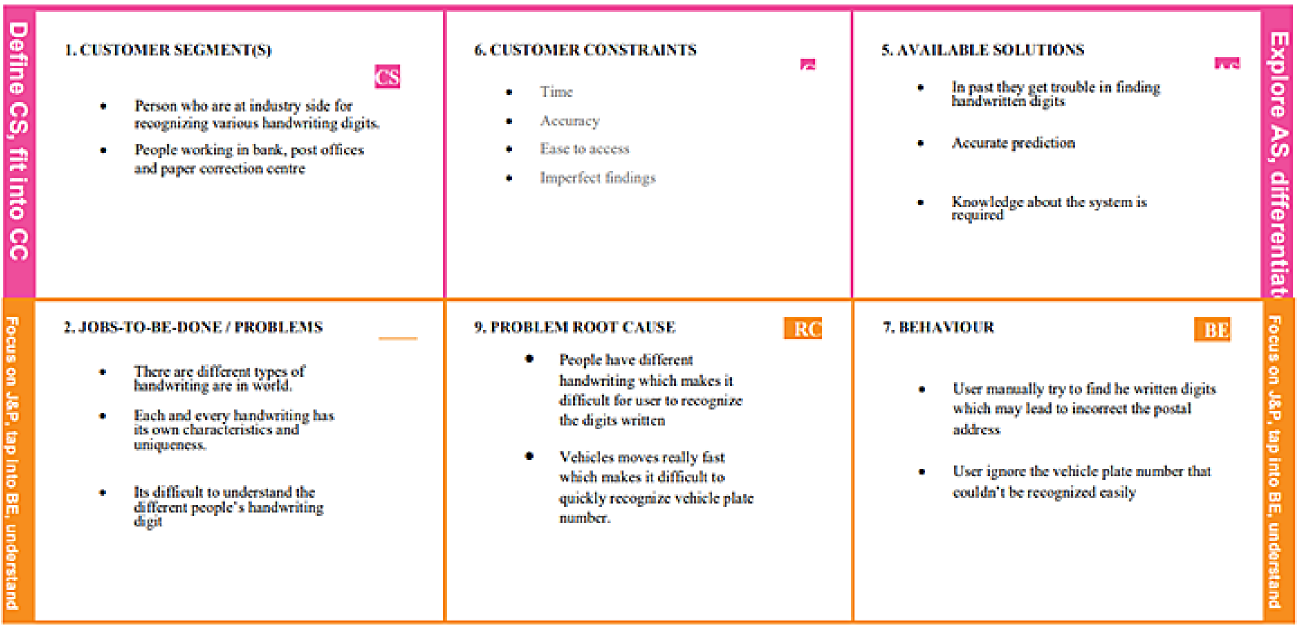
Customer experience journey map
Understand customer needs, motivations, and obstacles for an experience.

Strengths, weaknesses, opportunities & threats
Identify strengths, weaknesses, opportunities, and threats (SWOT) to develop a plan.

3.3 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/ CustomerSatisfaction	This application reduces the manual tasks that need to be performed. This improves productivity in the workplace.
5.	Business Model(RevenueModel)	This application can be integrated with traffic surveillance cameras to recognizes vehicle number plates. This application can be integrated with postal systems to recognizes thepin codes effectively.
6.	Scalability of the Solution	This application can easily be scaled toaccept multiple inputsand process parallelogram to further increase efficiency

3.4 Problem Solution fit.



Define CS, fit into CC

1. CUSTOMER SEGMENT(S)

CS

- Person who are at industry side for recognizing various handwriting digits.
- People working in bank, post offices and paper correction centre

6. CUSTOMER CONSTRAINTS

- Time
- Accuracy
- Ease to access
- Imperfect findings

5. AVAILABLE SOLUTIONS

- In past they get trouble in finding handwritten digits
- Accurate prediction
- Knowledge about the system is required

Explore AS, differentiat

Focus on J&P, tap into BE, understand

2. JOBS-TO-BE-DONE / PROBLEMS

- There are different types of handwriting are in world.
- Each and every handwriting has its own characteristics and uniqueness.
- Its difficult to understand the different people's handwriting digit

9. PROBLEM ROOT CAUSE

RC

- People have different handwriting which makes it difficult for user to recognize the digits written
- Vehicles moves really fast which makes it difficult to quickly recognize vehicle plate number.

7. BEHAVIOUR

BE

- User manually try to find he written digits which may lead to incorrect the postal address
- User ignore the vehicle plate number that couldn't be recognized easily

Focus on J&P, tap into BE, understand

4. REQUIREMENT ANALYSIS

4.1 Functional requirement :

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	In essence, the product transforms handwritten digits into digital data.	In order to compare the data and produce an output in digital form, the user is first asked to draw a number on the canvas. The model that is then created is then used.
FR-2	Identifying and displaying thehandwritten digit.	identifying and displaying the handwritten digit.
FR-3	Using a command that downloads the dataset from the program's website, you can import the dataset file directly into the software. In the same directory as the program, save the dataset file.	Installing packages and applications.
FR-4	Construct a neural network with the same number of nodes in the input layer as the arrays' pixel count.	Nil

FR-5	Making the Neural NetworkActive	Packages – tensor flow

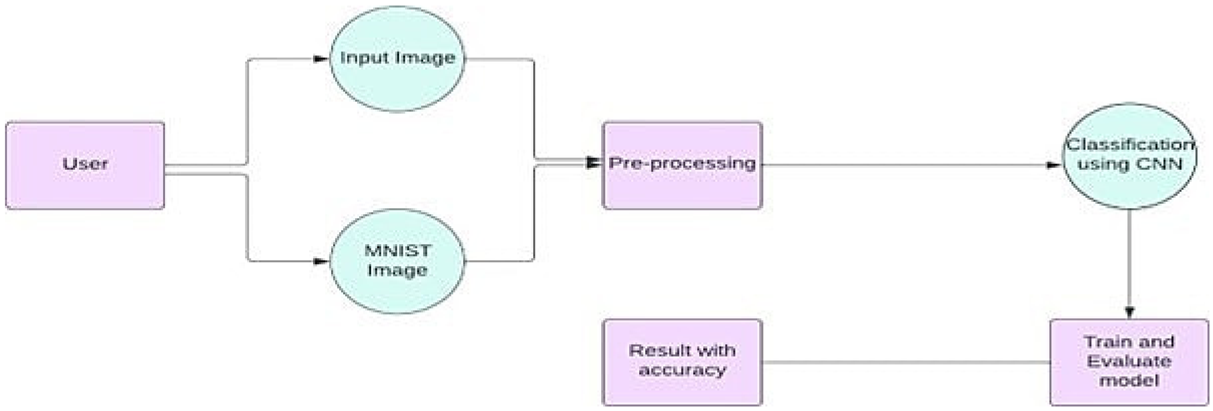
4.2Non-Functional requirements :

FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	System design should be easily understood and user friendly to users. Furthermore, users of all skill levels of users should be able to navigate itwithout problems.
NFR-2	**Security**	The system should automatically be able to authenticate all users with their unique usernameand password
NFR-3	**Performance**	Should reduce the delay in information when hundreds of requests are given.
NFR-4	**Availability**	Information is restricted to each users limitedaccess
NFR-5	**Scalability**	the system should be able to handle 10000users accessing the site at the same time

5.PROJECT DESIGN

5.1 Data Flow Diagrams

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.

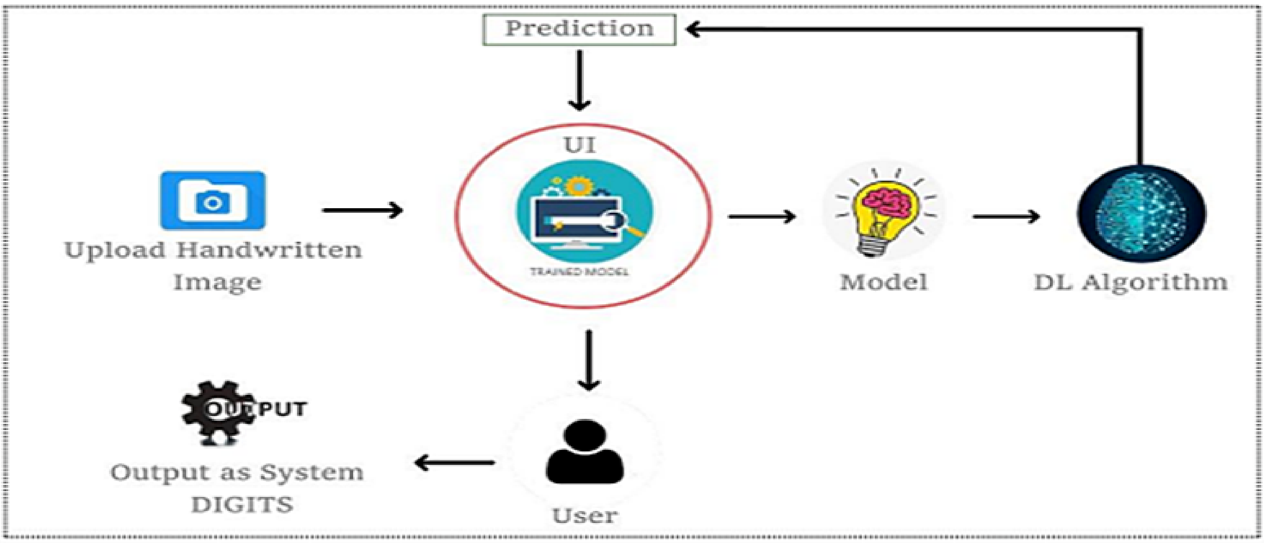


5.2 Solution & Technical Architecture

Solution architecture is a complex process – with many sub-processes – that bridges the gap between business problems and technology solutions.

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

Architecture diagram :



5.3 User Stories:

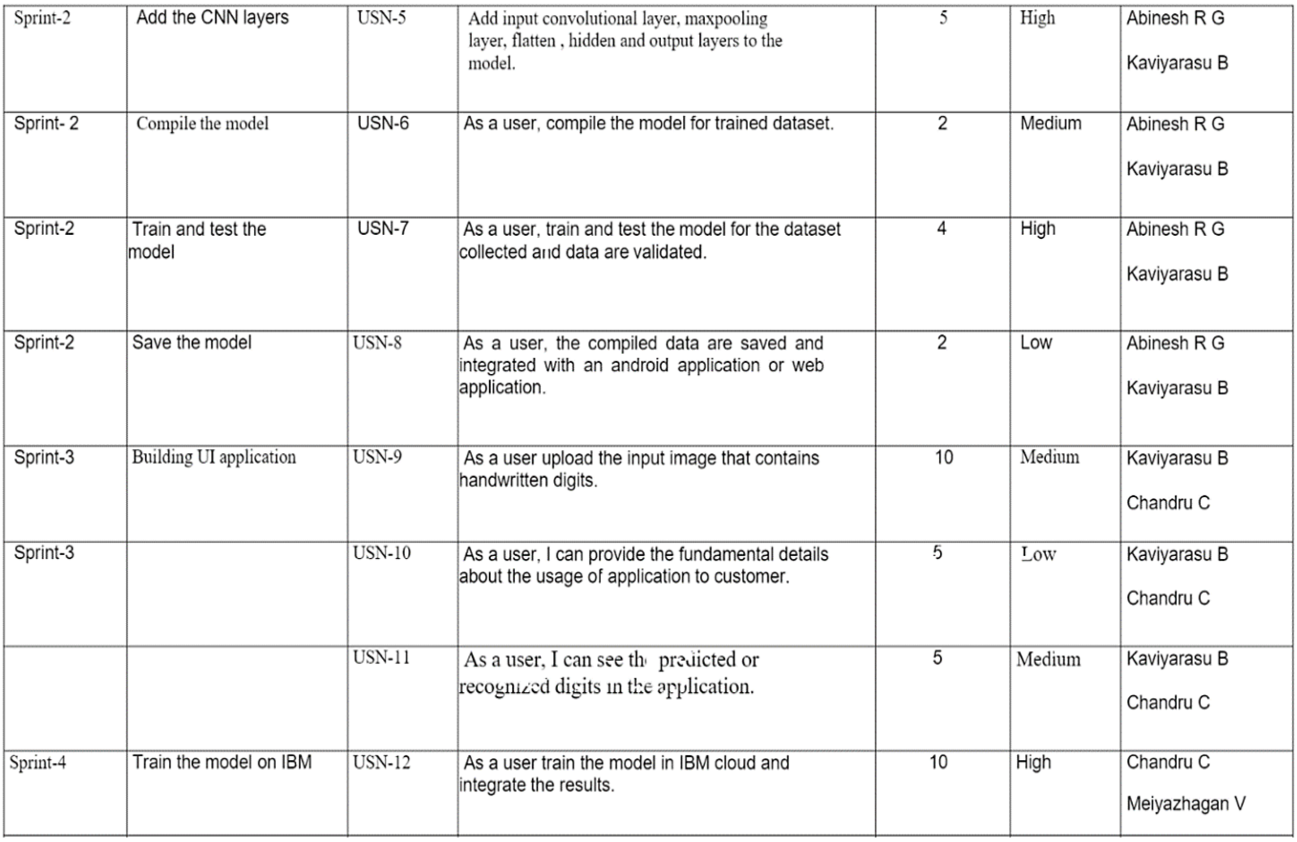
User Type	Functional Requirement(Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release

Customer (Mobile user)	Registration	USN-1	I can sign up for the application as a user by providing my email address, a password, and a password confirmation.	I can access my dashboard or account.	High	Sprint-1
		USN-2	When I register for the application as a user,I will get a confirmation email.	I can get a confirmation email and confirm it.	High	Sprint-1
		USN-3	I can sign up for the application as a user through Facebook.	I can log in to Facebook to register and access the dashboard.	Low	Sprint-2
		USN-4	I can register for the application through as a user throughGmail		Medium	Sprint-1
	Login	USN-5	I can log into the application by entering email& password as a user		High	Sprint-1
	Dashboard	USN-6	Visit the dashboard for accessing the features of the application	Additionally, I'm able to comprehend directions, and the homepage is user-friendly.	Low	Sprint-1
	Upload Image	USN-7	As a user, I can able to input the images of digital documents to the application	As a user, I can able to input the images of digital documents to the application	High	Sprint-3
	Predict	USN-8	I can obtain the recognised digit from the images of digital documents or photos as an end user.	From digital documents or photos, I may access the identified digits.	High	Sprint-3
		USN-9	I will train and evaluate the input as a user to ensure the output is as accurate as possible.	I'm able to train and test the application till the results are as accurate as possible.	Medium	Sprint-4

Customer (Webuser)	Login	USN-10	As a user,I can use the application by entering my email and password.	I can access my account	Medium	Sprint-4
Customer Care Executive	Dashboard	USN-11	Upload the image	Recognizing and get the output	High	Sprint-1
Administrator	Security	USN-12	updated the features	checking the security	Medium	Sprint-1

6. PROJECT PLANNING & SCHEDULING

6.1 Sprint Planning & Estimation:



Sprint-2	Add the CNN layers	USN-5	Add input convolutional layer, maxpooling layer, flatten , hidden and output layers to the model.	5	High	Abinesh R G Kaviyarasu B
Sprint- 2	Compile the model	USN-6	As a user, compile the model for trained dataset.	2	Medium	Abinesh R G Kaviyarasu B
Sprint-2	Train and test the model	USN-7	As a user, train and test the model for the dataset collected and data are validated.	4	High	Abinesh R G Kaviyarasu B
Sprint-2	Save the model	USN-8	As a user, the compiled data are saved and integrated with an android application or web application.	2	Low	Abinesh R G Kaviyarasu B
Sprint-3	Building UI application	USN-9	As a user upload the input image that contains handwritten digits.	10	Medium	Kaviyarasu B Chandru C
Sprint-3		USN-10	As a user, I can provide the fundamental details about the usage of application to customer.	5	Low	Kaviyarasu B Chandru C
		USN-11	As a user, I can see the predicted or recognized digits in the application.	5	Medium	Kaviyarasu B Chandru C
Sprint-4	Train the model on IBM	USN-12	As a user train the model in IBM cloud and integrate the results.	10	High	Chandru C Meiyazhagan V

6.2 Sprint Delivery Schedule:

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	20	6 Days	31 Oct 2022	05 Nov 2022	20	06Nov2022
Sprint-2	20	6 Days	06 Nov 2022	08 Nov 2022	20	09 Nov 2022
Sprint-3	20	6 Days	09 Nov 2022	12 Nov 2022	20	12 Nov 2022
Sprint-4	20	6 Days	14 Nov 2022	17 Nov 2022	20	17 Nov 2022

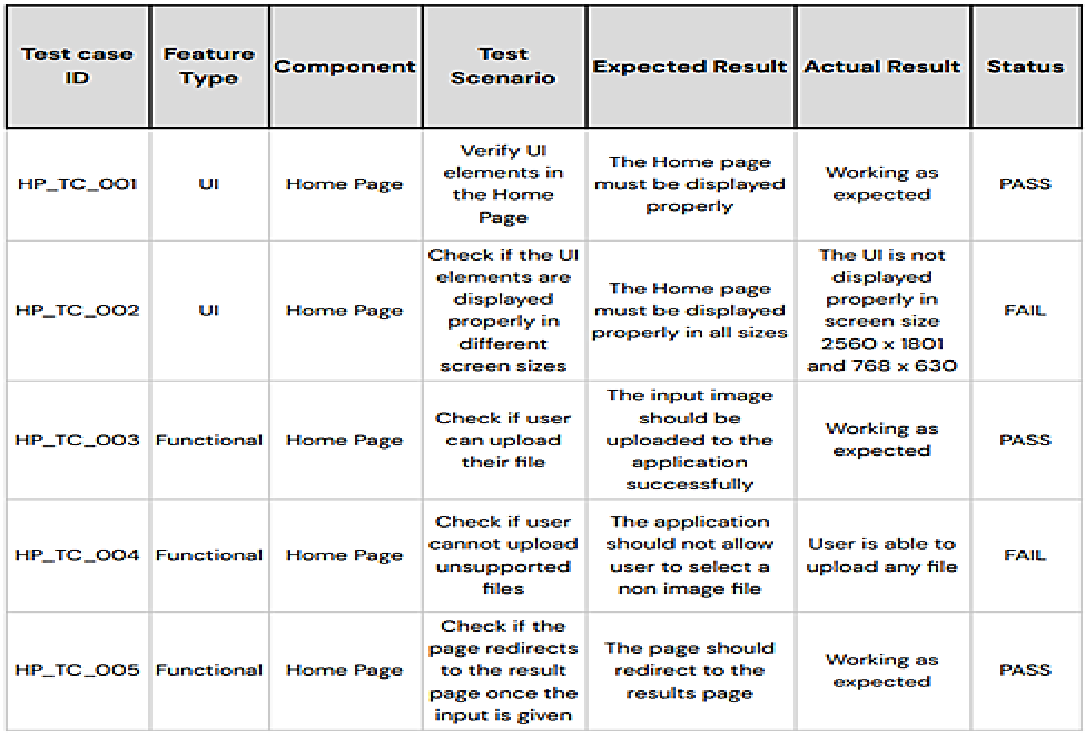
7. CODING & SOLUTIONING

7.1 Feature 1:

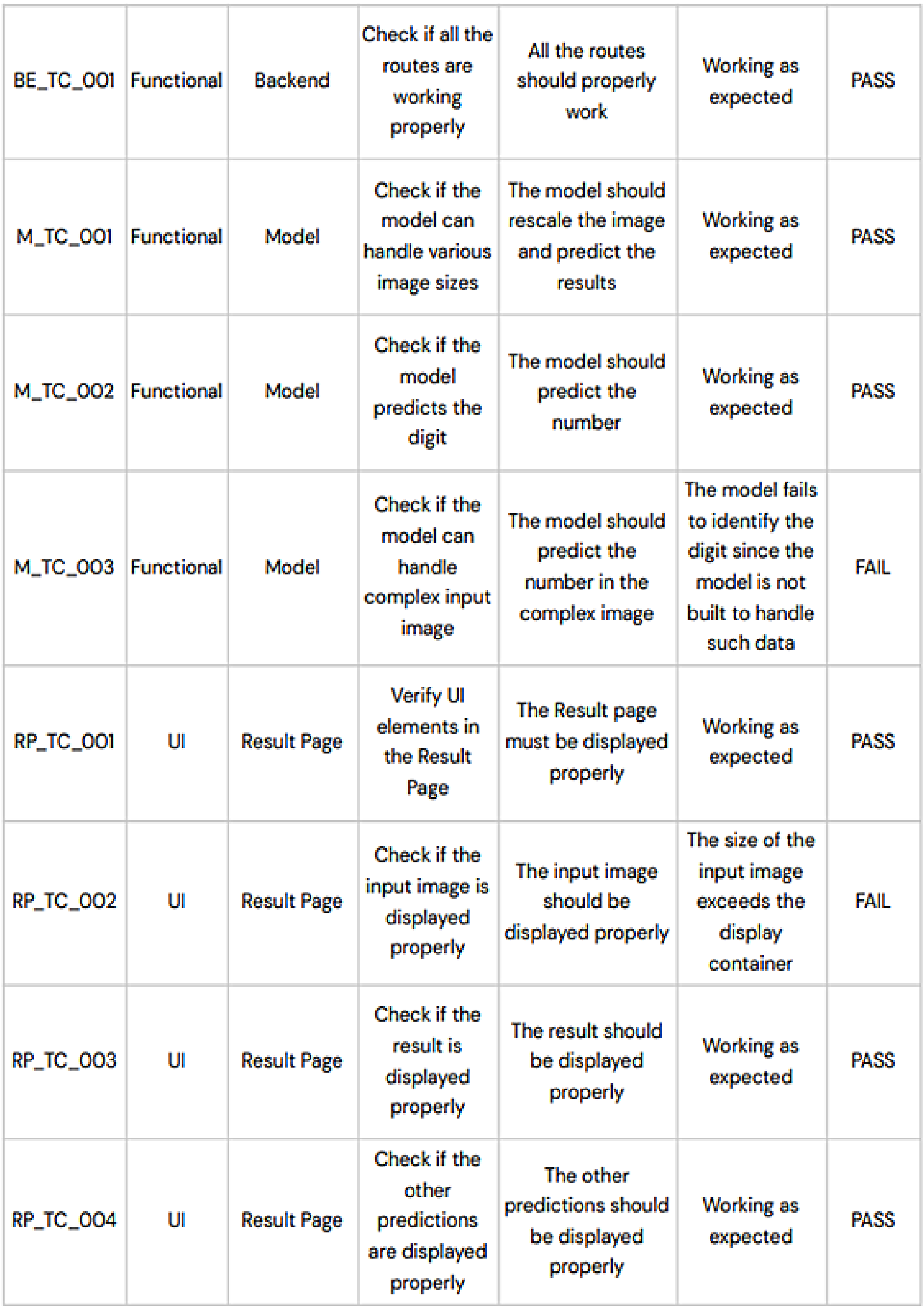
```
from unittest import result
from flask import Flask,render_template,request,redirect,url_for
#
import numpy as np
from PIL import Image
from tensorflow.keras.models import load_model
#
# from tensorflow.k

app = Flask(__name__)

@app.route('/',methods=["GET"])
def index():
    return render_template('index.html')
@app.route('/predict',methods=["POST","GET"])
def predict():
    if request.method == "POST":
        print(request.files['image'])
        img = Image.open(request.files['image'].stream).convert("L")
        img = img.resize((28,28))
        imgToArr = np.array(img)
        imgToArr = imgToArr.reshape(1,28,28,1)
        pred = model.predict([imgToArr])
        print(pred)
        y_pred = np.argmax(pred,axis=1)
        print("The image is "+str(y_pred))
        #return redirect('/output',message = y_pred)
        return redirect( url_for('.output',number = str(y_pred[0])))
    if request.method=="GET":
        return render_template('web.html')

@app.route('/output',methods=["GET"])
def output():
    val = request.args.get('number')
    if  val :
        print(val)
        return render_template('result.html',result = val)
    return redirect('/')
if __name__=="__main__":
    model = load_model('models/mnistCNN.h5')
# Show the model architecture
    app.run(debug=True)
```

8. TESTING

test case

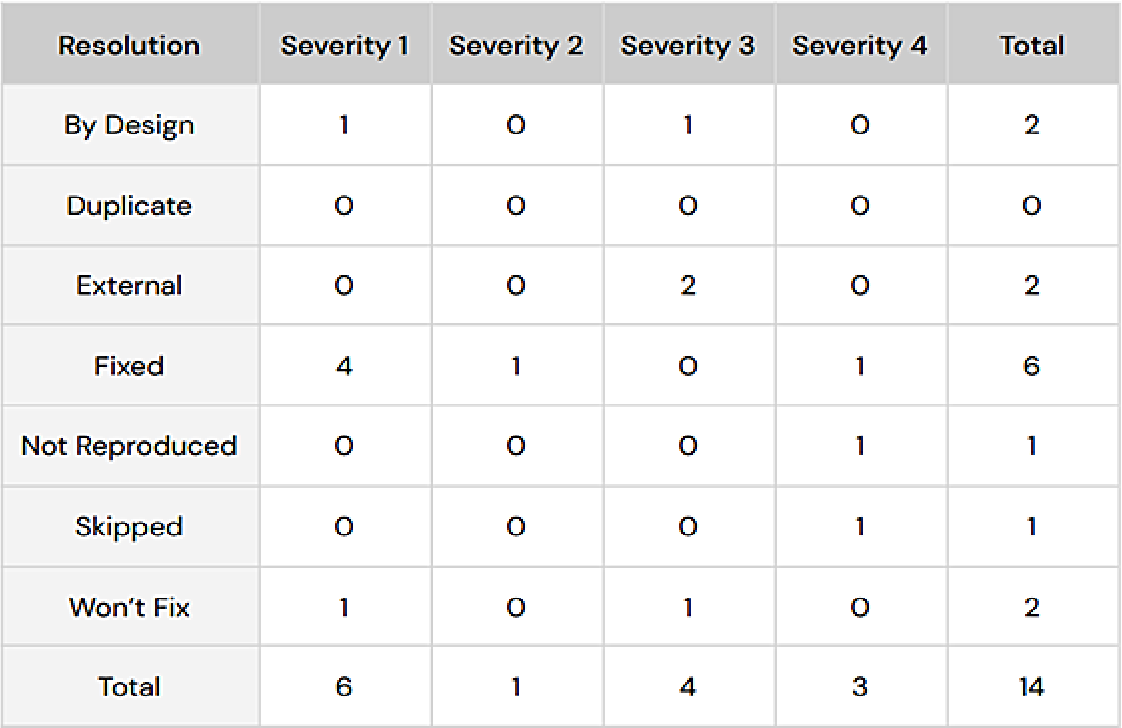


Test case ID	Feature Type	Component	Test Scenario	Expected Result	Actual Result	Status
HP_TC_001	UI	Home Page	Verify UI elements in the Home Page	The Home page must be displayed properly	Working as expected	PASS
HP_TC_002	UI	Home Page	Check if the UI elements are displayed properly in different screen 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	Functional	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	Functional	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	Functional	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



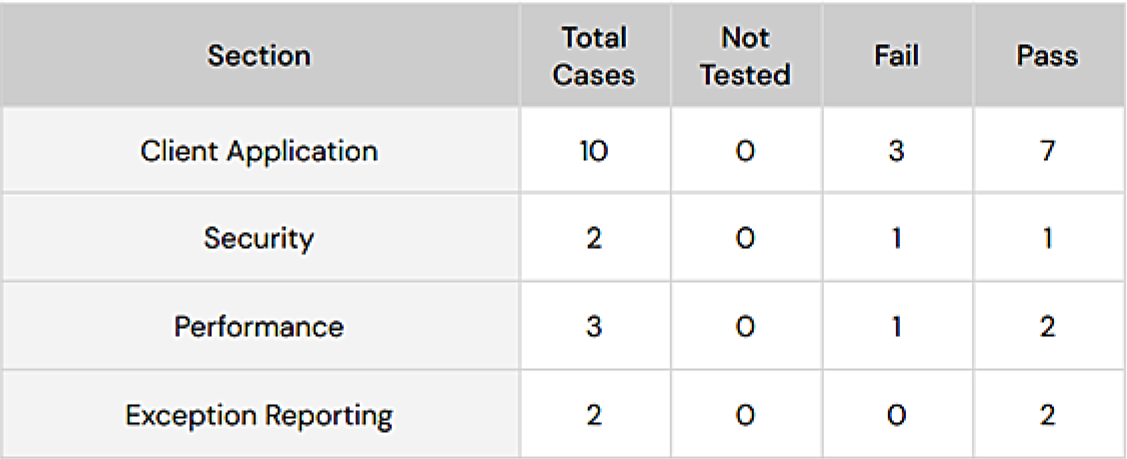
BE_TC_001	Functional	Backend	Check if all the routes are working properly	All the routes should properly work	Working as expected	PASS
M_TC_001	Functional	Model	Check if the model can handle various image sizes	The model should rescale the image and predict the results	Working as expected	PASS
M_TC_002	Functional	Model	Check if the model predicts the digit	The model should predict the number	Working as expected	PASS
M_TC_003	Functional	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 Test(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

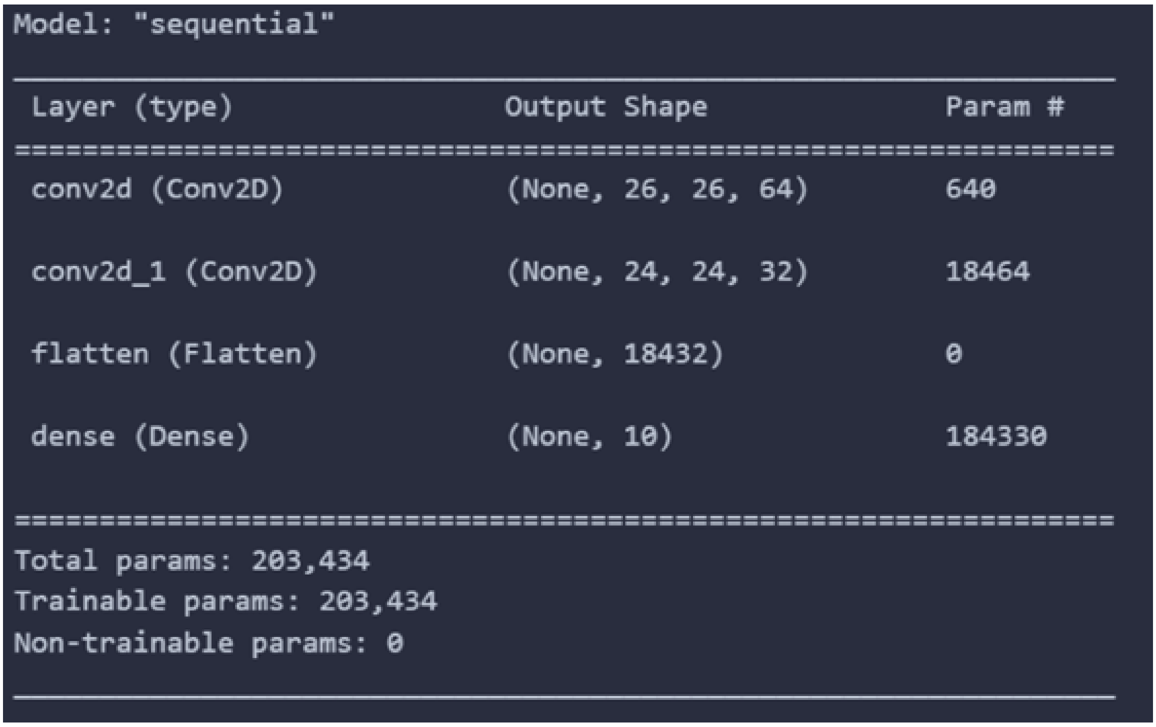
Test case design



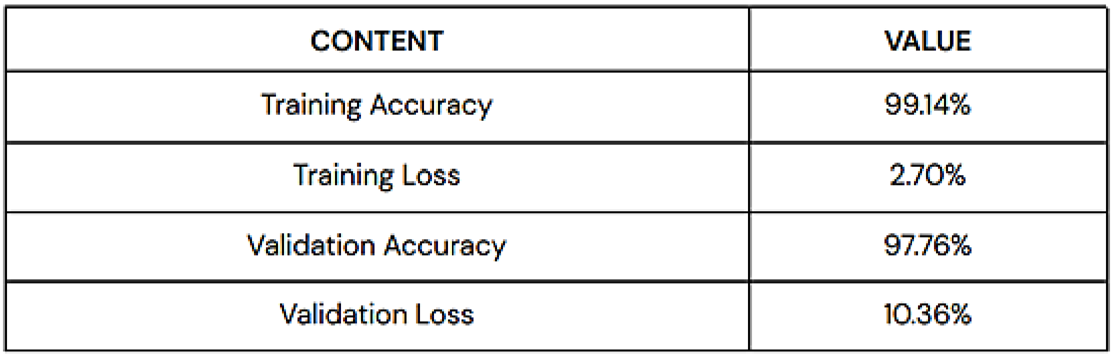
Section	Total Cases	Not Tested	Fail	Pass
Client Application	10	0	3	7
Security	2	0	1	1
Performance	3	0	1	2
Exception Reporting	2	0	0	2

9.RESULTS

Performance Metrics



```
Model: "sequential"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv2d (Conv2D)             (None, 26, 26, 64)        640

 conv2d_1 (Conv2D)           (None, 24, 24, 32)        18464

 flatten (Flatten)           (None, 18432)             0

 dense (Dense)               (None, 10)                184330

=================================================================
Total params: 203,434
Trainable params: 203,434
Non-trainable params: 0
_________________________________________________________________
```



CONTENT	VALUE
Training Accuracy	99.14%
Training Loss	2.70%
Validation Accuracy	97.76%
Validation Loss	10.36%

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

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 99.01% 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.

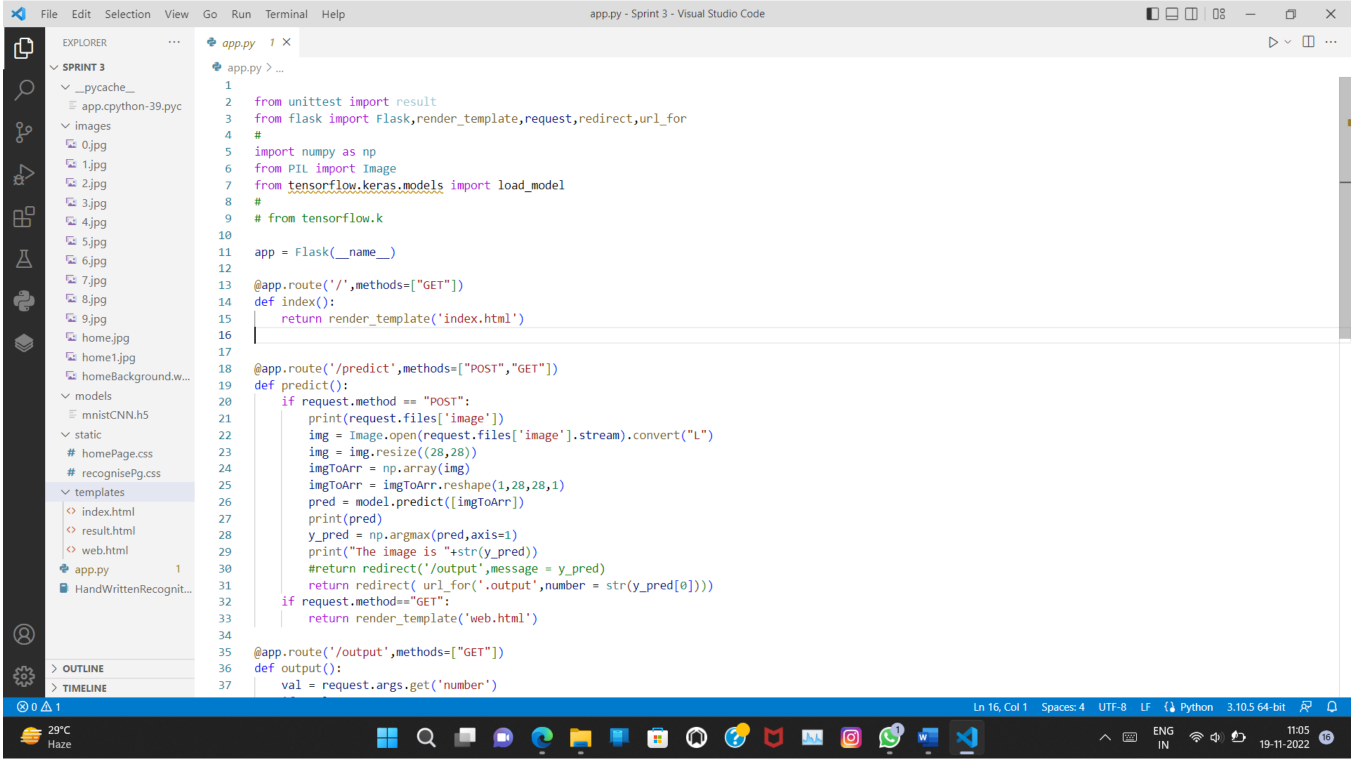
12. FUTURE SCOPE

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:

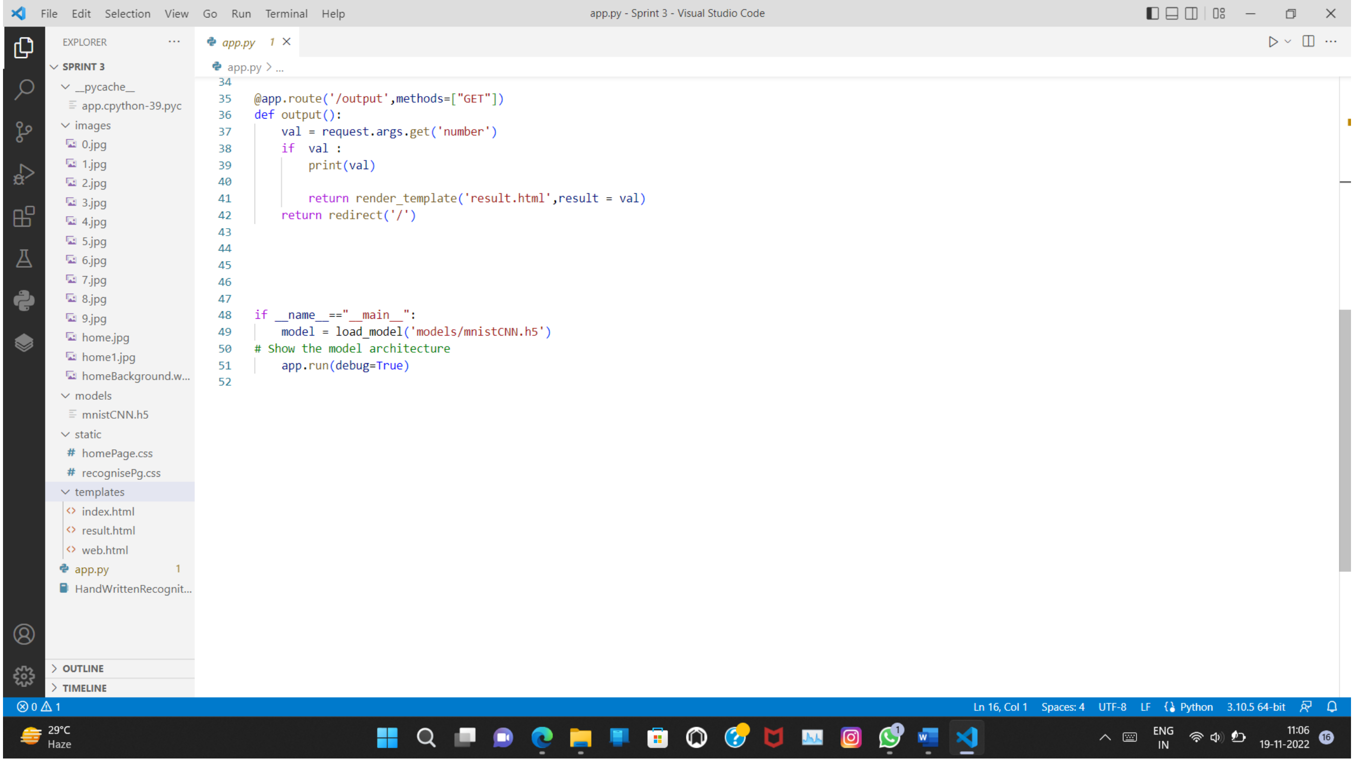
- Add support to detect from digits multiple images and save the results
- Add support to detect multiple digits
- Improve model to detect digits from complex images
- Add support to different languages to help users from all over the world

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.

13. APPENDIX Source Code GitHub



```python

from unittest import result
from flask import Flask,render_template,request,redirect,url_for
#
import numpy as np
from PIL import Image
from tensorflow.keras.models import load_model
#
# from tensorflow.k

app = Flask(__name__)

@app.route('/',methods=["GET"])
def index():
    return render_template('index.html')


@app.route('/predict',methods=["POST","GET"])
def predict():
    if request.method == "POST":
        print(request.files['image'])
        img = Image.open(request.files['image'].stream).convert("L")
        img = img.resize((28,28))
        imgToArr = np.array(img)
        imgToArr = imgToArr.reshape(1,28,28,1)
        pred = model.predict([imgToArr])
        print(pred)
        y_pred = np.argmax(pred,axis=1)
        print("The image is "+str(y_pred))
        #return redirect('/output',message = y_pred)
        return redirect( url_for('.output',number = str(y_pred[0])))
    if request.method=="GET":
        return render_template('web.html')

@app.route('/output',methods=["GET"])
def output():
    val = request.args.get('number')
```



app.py - Sprint 3 - Visual Studio Code
File Edit Selection View Go Run Terminal Help
EXPLORER
SPRINT 3
Ln 16, Col 1 Spaces: 4 UTF-8 LF Python 3.10.5 64-bit
29°C Haze
11:06 19-11-2022

```python

@app.route('/output',methods=["GET"])
def output():
    val = request.args.get('number')
    if  val :
        print(val)

        return render_template('result.html',result = val)
    return redirect('/')





if __name__=="__main__":
    model = load_model('models/mnistCNN.h5')
# Show the model architecture
    app.run(debug=True)

```

Project Demo

https://youtu.be/HDclB0Ko0d4