FINAL REPORT

A Novel Method For Handwritten Digit Recognition System

Team Leader:	Moniessh P
Team Member 1:	Kishore Kumar L
Team Member 2:	Shyam Gopal
Team Member 3:	Tarun K

TABLE OF CONTENT

1. **INTRODUCTION**
   1.1 Project Overview
   1.2 Purpose

2. **LITERATURE SURVEY**
   2.1 Existing problem
   2.2 References
   2.3 Problem Statement Definition

3. **IDEATION & PROPOSED SOLUTION**
   3.1 Empathy Map Canvas
   3.2 Ideation & Brainstorming
   3.3 Proposed Solution
   3.4 Problem Solution fit

4. **REQUIREMENT ANALYSIS**
   4.1 Functional requirement
   4.2 Non-Functional requirements

5. **PROJECT DESIGN**
   5.1 Data Flow Diagrams
   5.2 Solution & Technical Architecture
   5.3 User Stories

6. **PROJECT PLANNING & SCHEDULING**
   6.1 Sprint Planning & Estimation
   6.2 Sprint Delivery Schedule
   6.3 Reports from JIRA

7. **CODING & SOLUTIONING (Explain the features added in the project along with code)**
   7.1 Feature 1
   7.2 Feature 2
   7.3 Database Schema (if Applicable)

8. **TESTING**
   8.1 Test Cases
   8.2 User Acceptance Testing

9. RESULTS

9.1 Performance Metrics

10. ADVANTAGES & DISADVANTAGES

11. CONCLUSION

12. FUTURE SCOPE

13. APPENDIX

Source Code

GitHub & Project Demo Link

1. INTRODUCTION

Recognition is identifying or distinguishing a thing or an individual from the past experiences or learning. Similarly, Digit Recognition is nothing but recognizing or identifying the digits in any document. Digit recognition framework is simply the working of a machine to prepare itself or interpret the digits. Handwritten Digit Recognition is the capacity of a computer to interpret the manually written digits from various sources like messages, bank cheques, papers, pictures, and so forth and in various situations for web based handwriting recognition on PC tablets, identifying number plates of vehicles, handling bank cheques, digits entered in any forms etc.

1.1 Project Overview:

Machine Learning provides various methods through which human efforts can be reduced in recognizing the manually written digits. Deep Learning is a machine learning method that trains computers to learn through examples. With the utilization of deep learning methods, human attempts can be diminished in perceiving, learning, recognizing and in a lot more regions. The digit recognition model uses large datasets in order to recognize digits from distinctive sources. The task of handwritten digit recognition, using a classifier, has extraordinary significance and use such as – online digit recognition on PC tablets, recognize zip codes on mail, processing bank check amounts, numeric sections in structures filled up by hand and so on. There are diverse challenges faced while attempting to solve this problem. The handwritten digits are not always of the same size, thickness, or orientation and position relative to the margins. The model can actualize a pattern characterization method to perceive the handwritten digits provided in the MINIST data set of images of handwritten digits (0-9).

1.2 Purpose:

Digit Recognition is a noteworthy and important issue. As the manually written digits are not of a similar size, thickness, position and direction, in this manner, various difficulties must be considered to determine the issue of handwritten digit recognition. The uniqueness and assortment in the composition styles of various individuals additionally influence the example and presence of the digits. It is the strategy for perceiving and arranging transcribed digits. It has a wide range of applications, for example, programmed bank checks, postal locations and tax documents and so on. The aim of this project is to implement a classification algorithm to recognize the handwritten digits which makes the process of data entries and other works easier in many domains. This model enables the user to easily obtain the digital copy of handwritten digits in the form of tables that makes data entries easier and efficient.

2. LITERATURE SURVEY

Anuj Dutt in his paper demonstrated that utilizing Deep Learning systems, he had the capacity to get an extremely high measure of accuracy. By utilizing the convolutional Neural Network with Keras and Theano as backend, he was getting a accuracy of 98.72%. In addition, execution of CNN utilizing Tensorflow gives a stunningly better consequence of 99.70%. In a paper published by Saeed AL-Mansoori, Multilayer Perceptron (MLP) Neural Network was implemented to recognize and predict handwritten digits from 0 to 9.The proposed neural system was trained and tested on a dataset achieved from MNIST.

2.1 Existing problems:

Image Recognition is an imperative research area for its generally used applications. In general, the field of pattern recognition, one of the difficult undertakings is the precise computerized recognition of human handwriting. Without a doubt, this is a very difficult issue because there is an extensive diversity in handwriting from an individual to another individual. In spite of the fact that, this difference does not make any issues to people, yet, anyway it is increasingly hard to instruct computers to interpret general handwriting. Handwritten Recognition from the MNIST dataset is well known among scientists as by utilizing different classifiers for various parameters, the error rate has been decreased, for example, from linear classifier (1-layer NN) with 12% to 0.23% by a board of 35 convolution neural systems. The scope of this is to implement a Handwritten Digit Recognition framework and think about the diverse classifiers and different techniques by concentrating on how to accomplish close to human performance. For an undertaking of composing diverse digits (0-9) for various people the general issue confronted would be of digit order issue and the closeness between the digits like 1 and 7, 5 and 6, 3 and 8, 9 and 8 and so forth. Additionally, individuals compose a similar digit from various perspectives, the uniqueness and assortment in the handwriting of various people likewise impact the development and presence of the digits.

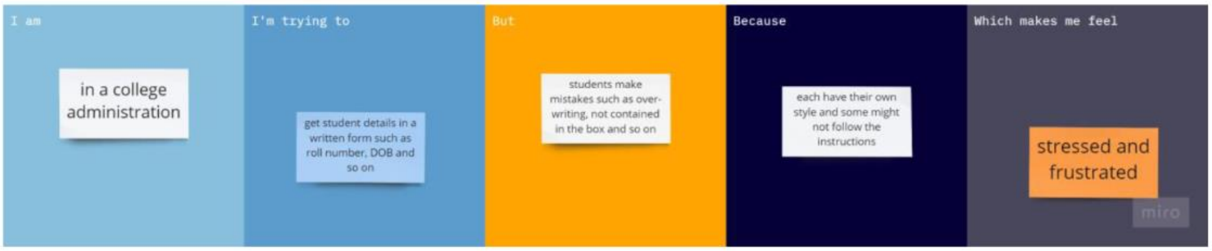
2.2 References:

- M. Wu and Z. Zhang, Handwritten Digit Classification using the MNIST Dataset, 2010.
- Dutta and A. Dutta, Handwritten digit recognition using deep learning, International Journal of Advanced Research in Computer Engineering & Technology (IJARCET), vol. 6, no. 7, July 2017.
- Al Maadeed, Somaya, and Abdelaali Hassaine, Automatic prediction of age, gender, and nationality in offline handwriting. EURASIP Journal on Image and Video Processing, no. 1 2014.
- Gaurav Jain, Jason Ko, Handwritten DigitsRecognition, Project Report, University of Toronto, 11/21/2008.
- Hamid, Norhidayu Abdul, and NilamNur Amir Sjarif,Handwritten recognition using SVM, KNN and neural network, arXiv preprint arXiv:1702.00723 (2017).
- R.G.Mihalyi, Handwritten digit classification using support vector machines, 2011.
- Z. Dan, C. Xu, The Recognition of Handwritten Digits Based on BP Neural Networks and the Implementation on Android, In: 3rd International Conference on Intelligent System Design and Engineering Applications, pp. 1498-1509, 2013.
- http://cvisioncentral.com/resourceswall/?resource=135.

2.3 Problem Statement:

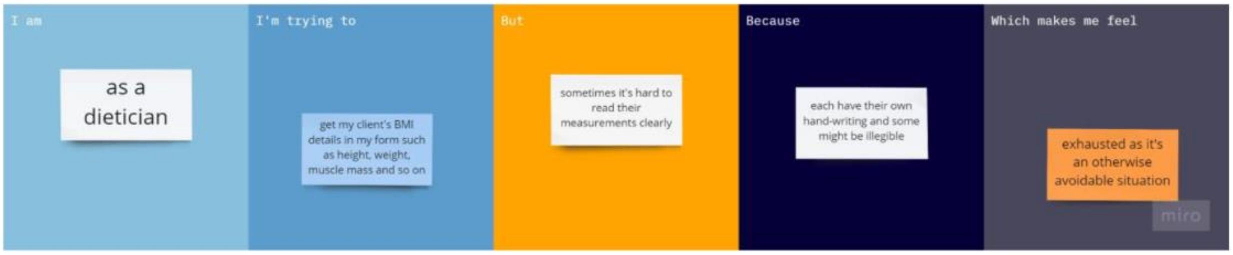
Numerical data entry is an important work in most of the domains which is more hectic to be performed manually and is also a time consuming process resulting in slowing down the rate of productivity of the workers and the organization. Therefore it is important to develop a model to sort this issue. The main objective handwritten digit recognition model is to provide a solution for this problem and ensure effective and reliable approaches for recognition of handwritten digits and make banking operations easier and error free.

Problem Statement-1:



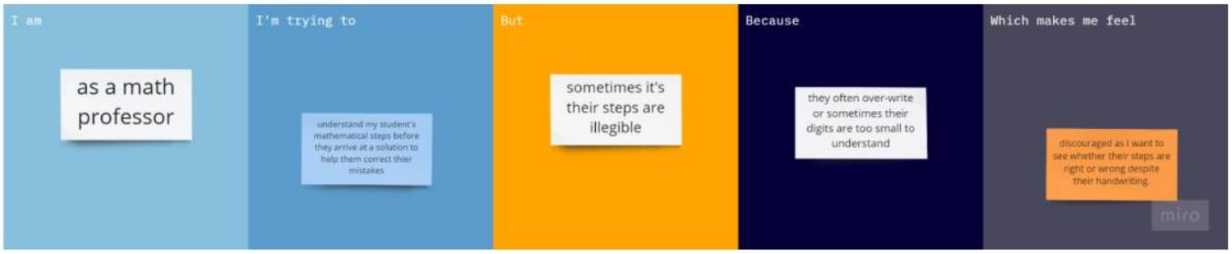
I am	I'm trying to	But	Because	Which makes me feel
in a college administration	get student details in a written form such as roll number, DOB and so on	students make mistakes such as over-writing, not contained in the box and so on	each have their own style and some might not follow the instructions	stressed and frustrated

Problem Statement-2:



I am	I'm trying to	But	Because	Which makes me feel
as a dietician	get my client's BMI details in my form such as height, weight, muscle mass and so on	sometimes it's hard to read their measurements clearly	each have their own hand-writing and some might be illegible	exhausted as it's an otherwise avoidable situation

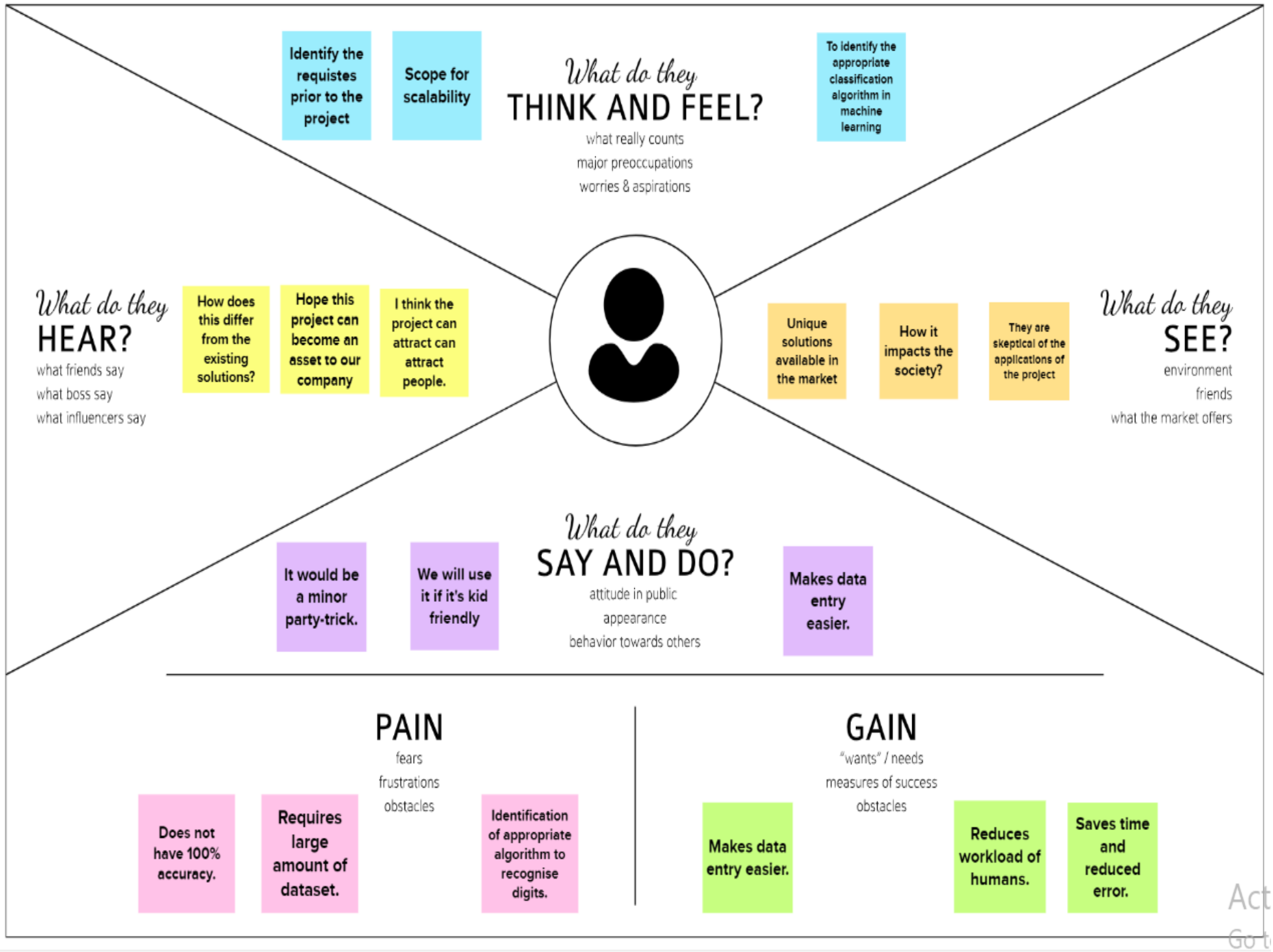
Problem Statement-3:



I am	I'm trying to	But	Because	Which makes me feel
as a math professor	understand my student's mathematical steps before they arrive at a solution to help them correct thier mistakes	sometimes it's their steps are illegible	they often over-write or sometimes their digits are too small to understand	discouraged as I want to see whether their steps are right or wrong despite their handwriting.

3. IDEATION AND PROPOSED SOLUTION

3.1 Empathy Map Canvas:



What do they THINK AND FEEL?

what really counts

major preoccupations

worries & aspirations

Identify the requistes prior to the project

Scope for scalability

To identify the appropriate classification algorithm in machine learning

What do they HEAR?

what friends say

what boss say

what influencers say

How does this differ from the existing solutions?

Hope this project can become an asset to our company

I think the project can attract can attract people.

What do they SEE?

environment

friends

what the market offers

Unique solutions available in the market

How it impacts the society?

They are skeptical of the applications of the project

What do they SAY AND DO?

attitude in public

appearance

behavior towards others

It would be a minor party-trick.

We will use it if it's kid friendly

Makes data entry easier.

PAIN

fears

frustrations

obstacles

Does not have 100% accuracy.

Requires large amount of dataset.

Identification of appropriate algorithm to recognise digits.

GAIN

"wants" / needs

measures of success

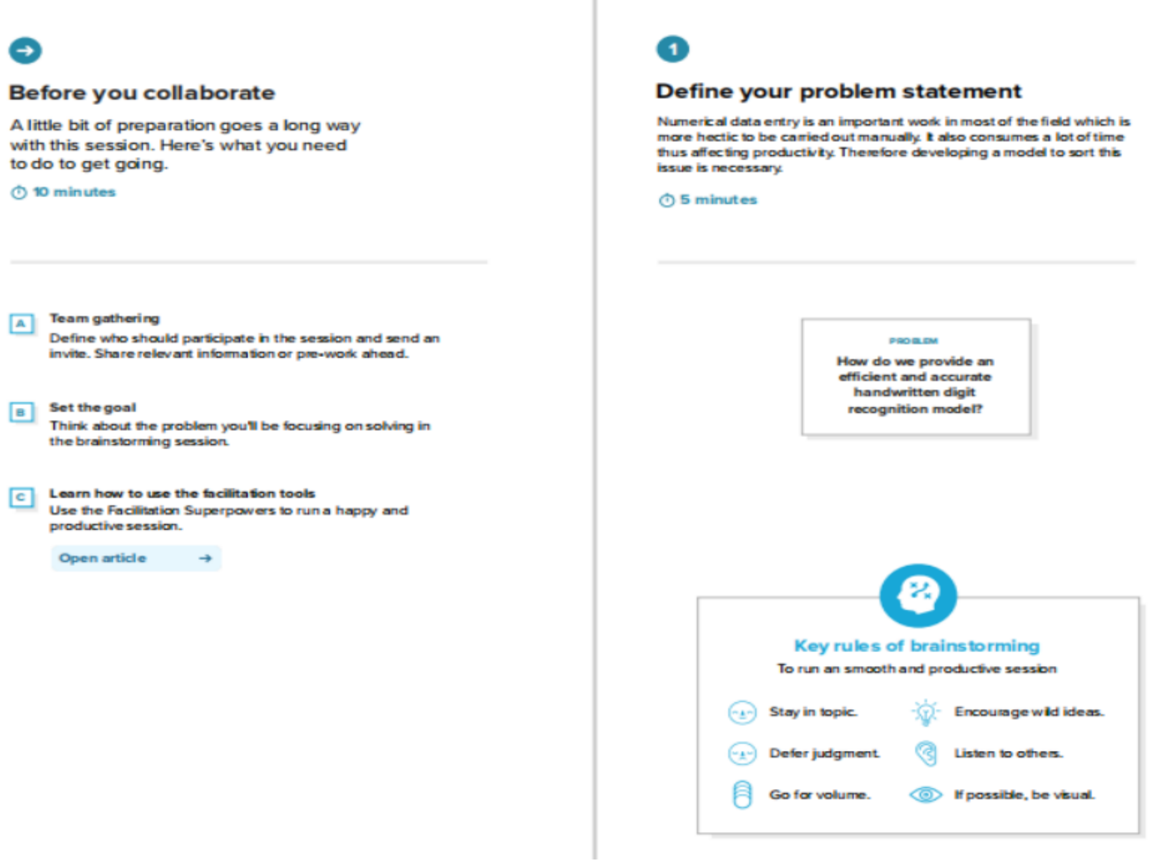
obstacles

Makes data entry easier.

Reduces workload of humans.

Saves time and reduced error.

3.2 Ideation and Brainstorm



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

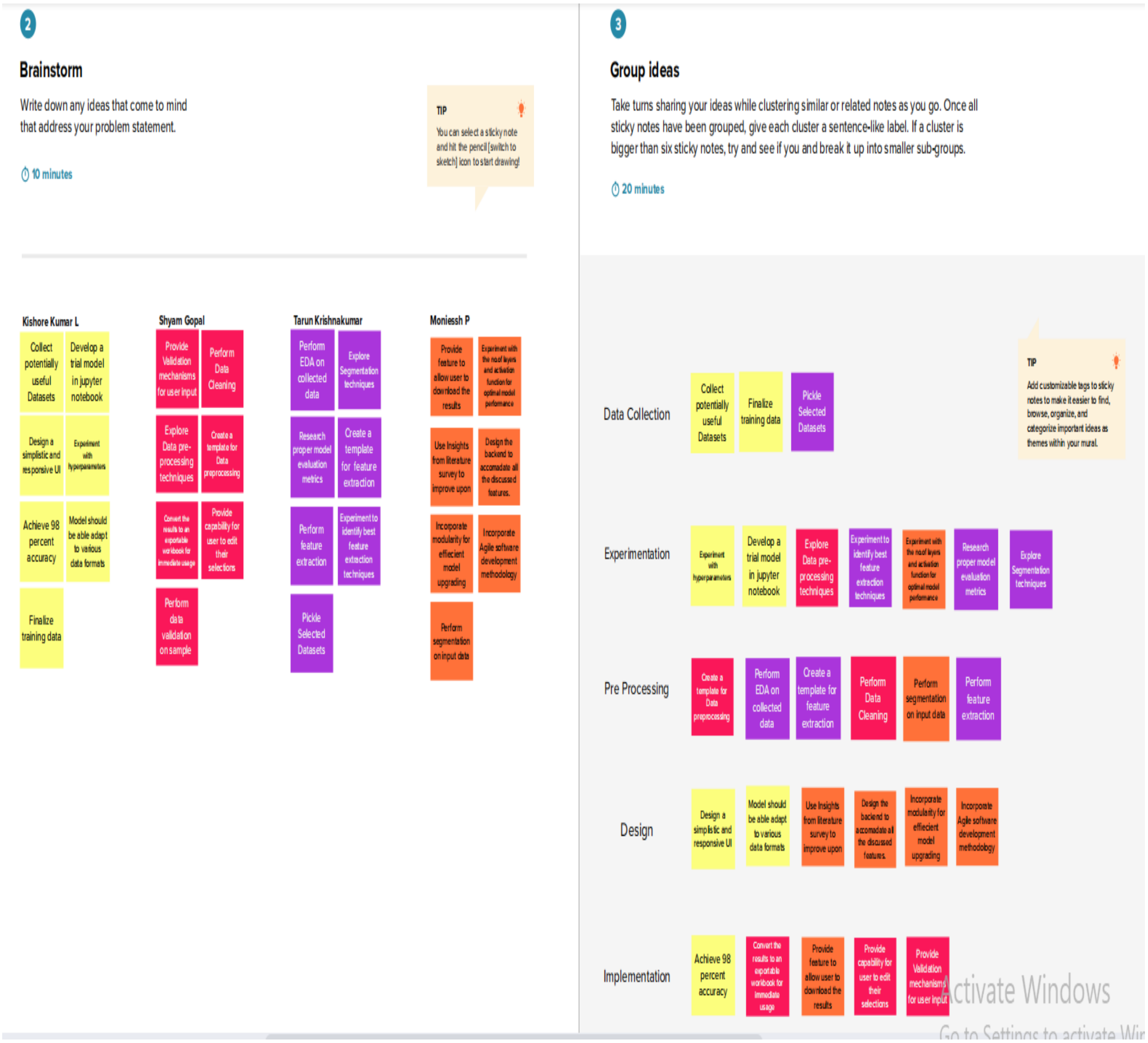
Numerical data entry is an important work in most of the field which is more hectic to be carried out manually. It also consumes a lot of time thus affecting productivity. Therefore developing a model to sort this issue is necessary.

5 minutes

PROBLEM
How do we provide an efficient and accurate handwritten digit recognition model?

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.



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!

Kishore Kumar L

- Collect potentially useful Datasets
- Develop a trial model in jupyter notebook
- Design a simplistic and responsive UI
- Experiment with hyperparameters
- Achieve 98 percent accuracy
- Model should be able adapt to various data formats
- Finalize training data

Shyam Gopal

- Provide Validation mechanisms for user input
- Perform Data Cleaning
- Explore Data pre-processing techniques
- Create a template for Data preprocessing
- Convert the results to an exportable workbook for immediate usage
- Provide capability for user to edit their selections
- Perform data validation on sample

Tarun Krishnakumar

- Perform EDA on collected data
- Explore Segmentation techniques
- Research proper model evaluation metrics
- Create a template for feature extraction
- Perform feature extraction
- Experiment to identify best feature extraction techniques
- Pickle Selected Datasets

Moniessh P

- Provide feature to allow user to download the results
- Experiment with the no.of layers and activation function for optimal model performance
- Use Insights from literature survey to improve upon
- Design the backend to accomadate all the discussed features.
- Incorporate modularity for effiecient model upgrading
- Incorporate Agile software development methodology
- Perform segmentation on input data

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 can break it up into smaller sub-groups.

20 minutes

TIP

Add customizable tags to sticky notes to make it easier to find, browse, organize, and categorize important ideas as themes within your mural.

Data Collection

- Collect potentially useful Datasets
- Finalize training data
- Pickle Selected Datasets

Experimentation

- Experiment with hyperparameters
- Develop a trial model in jupyter notebook
- Explore Data pre-processing techniques
- Experiment to identify best feature extraction techniques
- Experiment with the no.of layers and activation function for optimal model performance
- Research proper model evaluation metrics
- Explore Segmentation techniques

Pre Processing

- Create a template for Data preprocessing
- Perform EDA on collected data
- Create a template for feature extraction
- Perform Data Cleaning
- Perform segmentation on input data
- Perform feature extraction

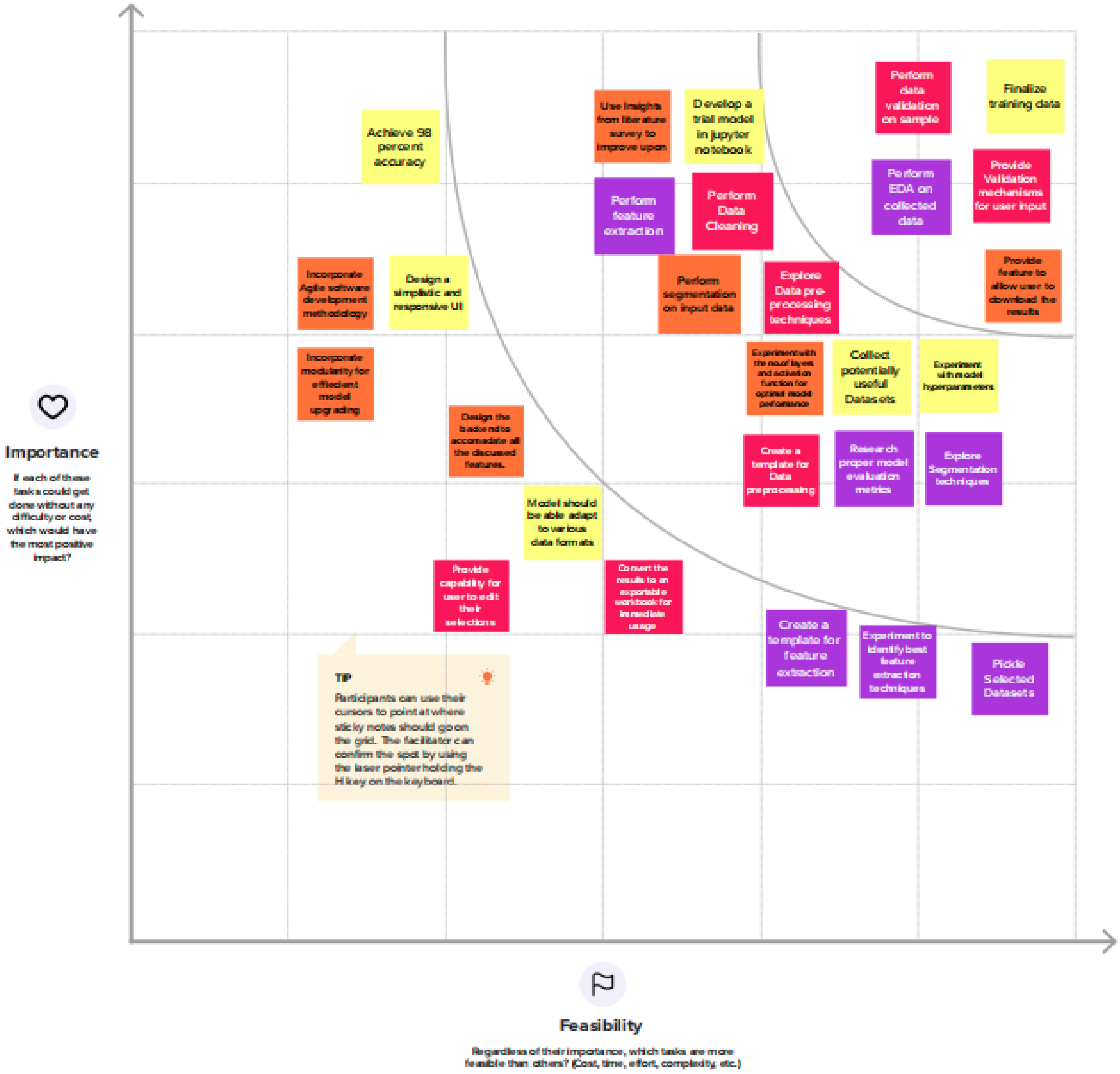
Design

- Design a simplistic and responsive UI
- Model should be able adapt to various data formats
- Use Insights from literature survey to improve upon
- Design the backend to accomadate all the discussed features.
- Incorporate modularity for effiecient model upgrading
- Incorporate Agile software development methodology

Implementation

- Achieve 98 percent accuracy
- Convert the results to an exportable workbook for immediate usage
- Provide feature to allow user to download the results
- Provide capability for user to edit their selections
- Provide Validation mechanisms for user input

Prioritization:


Achieve 98 percent accuracy
Use Insights from literature survey to improve upon
Develop a trial model in jupyter notebook
Perform data validation on sample
Finalize training data
Perform feature extraction
Perform Data Cleaning
Perform EDA on collected data
Provide Validation mechanisms for user input
Incorporate Agile software development methodology
Design a simplistic and responsive UI
Perform segmentation on input data
Explore Data pre-processing techniques
Provide feature to allow user to download the results
Incorporate modularity for effiecient model upgrading
Experiment with the no.of layers and activation function for optimal model performance
Collect potentially useful Datasets
Experiment with model hyperparameters
Design the backend to accomadate all the discussed features.
Create a template for Data preprocessing
Research proper model evaluation metrics
Explore Segmentation techniques
Model should be able adapt to various data formats
Provide capability for user to edit their selections
Convert the results to an exportable workbook for immediate usage
Create a template for feature extraction
Experiment to identify best feature extraction techniques
Pickle Selected Datasets
Importance
Feasibility

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

TIP

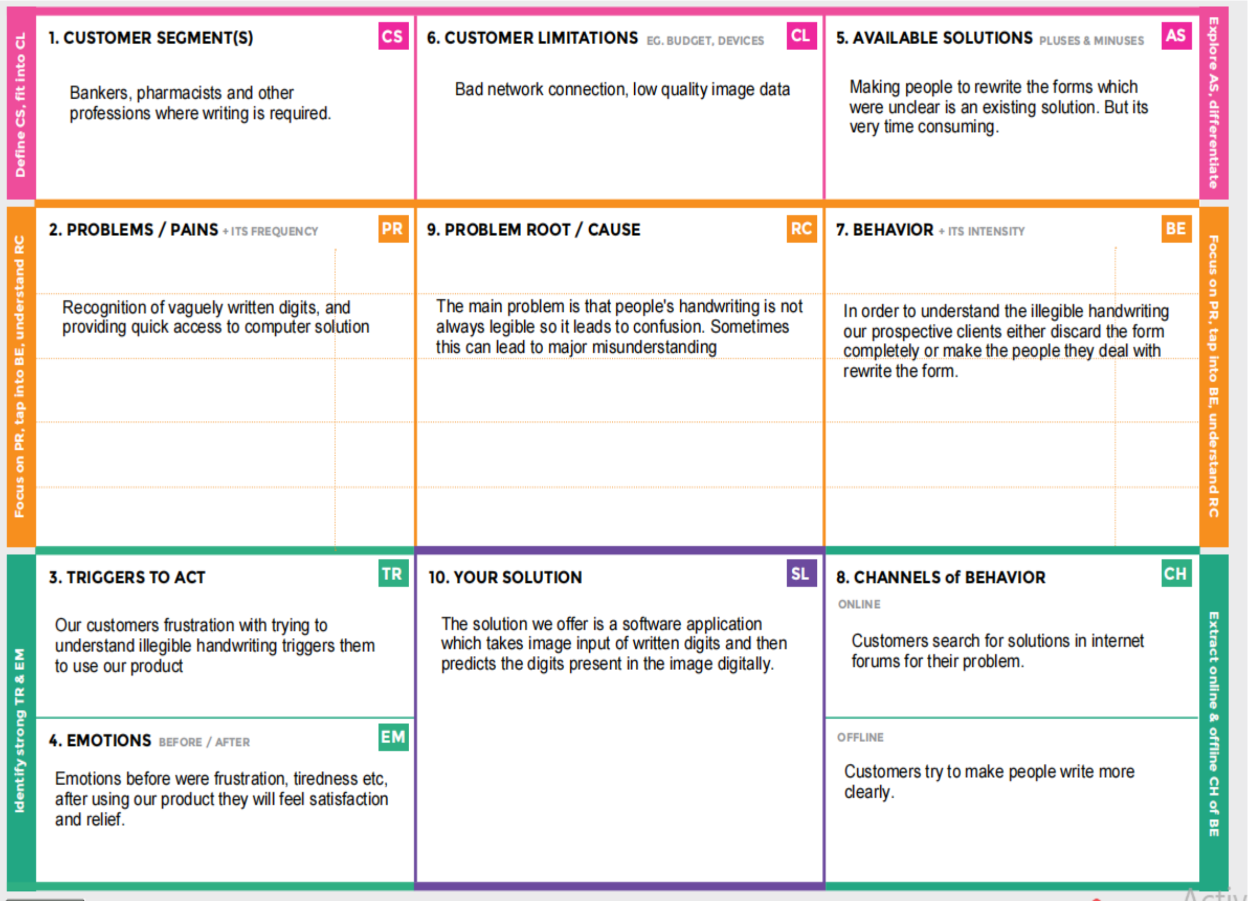
Participants can use their cursors to point at where sticky notes should go on the grid. The facilitator can confirm the spot by using the laser pointer holding the H key on the keyboard.

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

3.3 Proposed Solution:

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	Numerical data entry is an important work in most of thefieldwhichismorehecticttobecarriedoutmanually.Italsoconsumesalotoftimethusaffectingproductivity.Therefore,developingamodeltosortthisissueis necessary.
2.	Idea/Solution description	The idea is to develop a hand written digit recognition model using neural network which can recognize the digits written in piece of paper like bank cheque thus making process of entering data into the computer easier.
3.	Novelty/Uniqueness	The model that we proposed has the following uniqueness: ◆ Makes data entry easier. ◆ Reduces human workload. ◆ Saves time and reduces error. ◆ Fast and cost effective.
4.	Social Impact / Customer Satisfaction	The proposed model helps the customer in easy entry of numerical data. It helps them in reducing the error and is cost effective.
5.	Business Model(Revenue Model)	◆ For government model, it can be made free for theusershoweverforthegovernmentorganisations wecanleaseourservicesforadiscounted price. ◆ For private model, we can lease our services for the full price and depending on the private organization's guidelines they can charge or make it free for the users
6.	Scalability of the Solution	In the future instead of just recognizing the numbers, our project will be able to recognize letters and words as well as , will be able to distinguish different languages.

3.4 Problem Solution fit:



Define CS, fit into CL

1. CUSTOMER SEGMENT(S) CS

Bankers, pharmacists and other professions where writing is required.

6. CUSTOMER LIMITATIONS EG. BUDGET, DEVICES CL

Bad network connection, low quality image data

5. AVAILABLE SOLUTIONS PLUSES & MINUSES AS

Making people to rewrite the forms which were unclear is an existing solution. But its very time consuming.

Explore AS, differentiate

Focus on PR, tap into BE, understand RC

2. PROBLEMS / PAINS + ITS FREQUENCY PR

Recognition of vaguely written digits, and providing quick access to computer solution

9. PROBLEM ROOT / CAUSE RC

The main problem is that people's handwriting is not always legible so it leads to confusion. Sometimes this can lead to major misunderstanding

7. BEHAVIOR + ITS INTENSITY BE

In order to understand the illegible handwriting our prospective clients either discard the form completely or make the people they deal with rewrite the form.

Focus on PR, tap into BE, understand RC

Identify strong TR & EM

3. TRIGGERS TO ACT TR

Our customers frustration with trying to understand illegible handwriting triggers them to use our product

4. EMOTIONS BEFORE / AFTER EM

Emotions before were frustration, tiredness etc, after using our product they will feel satisfaction and relief.

10. YOUR SOLUTION SL

The solution we offer is a software application which takes image input of written digits and then predicts the digits present in the image digitally.

8. CHANNELS of BEHAVIOR CH

ONLINE

Customers search for solutions in internet forums for their problem.

OFFLINE

Customers try to make people write more clearly.

Extract online & offline CH of BE

4. REQUIREMENT ANALYSIS

4.1 Functional Requirements:

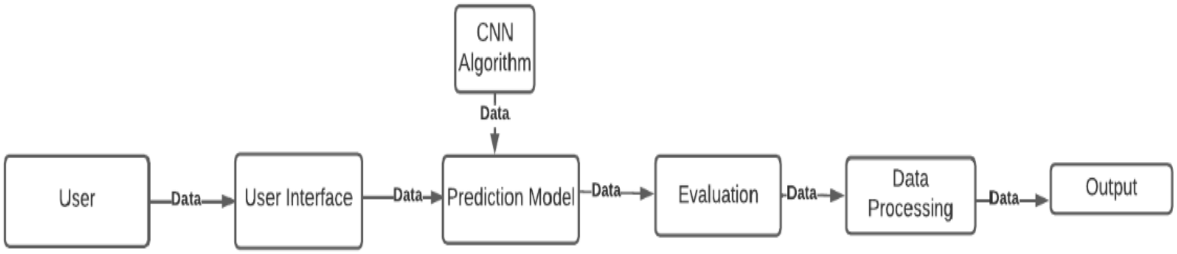
FR No.	Functional Requirement	Sub Requirement(Story/Sub-Task)
FR-1	Image Data	We require image datato recognizewhatdigitis present inthe given image.
FR-2	DL Algorithm	We use Deep Learning algorithm to process thehandwrittendigitintheimage intodigitalnumeric format.
FR-3	Website	We require a website as a User Interface for clients toaccessourservices.Thewebsiteshouldbeuser-friendly toengagetheclients
FR-4	Modified National Institution of standards and Technology Dataset	The MNIST database (Modified National Institute ofStandardsandTechnologyDatabase)isalargecollection of handwritten digits. We have a training setof 60,000 examples and a test set of 10,000 examples. Itis a subset of the larger NIST Specialty Database 3 (digitswritten by U.S. Census Bureau staff) and SpecialtyDatabase 1(digitswrittenby highschoolstudents) and containsblackandwhiteimagesofhandwrittendigits.
FR-5	Cloud	"The cloud" refers to servers that are accessed over theInternet, and the software and databases that run onthose servers. Cloud servers are located in data centersall over the world. By using cloud computing, users andcompanies do not have to manage physical serversthemselvesor runsoftwareapplications ontheirown machines.

4.2 Non-Functional Requirements:

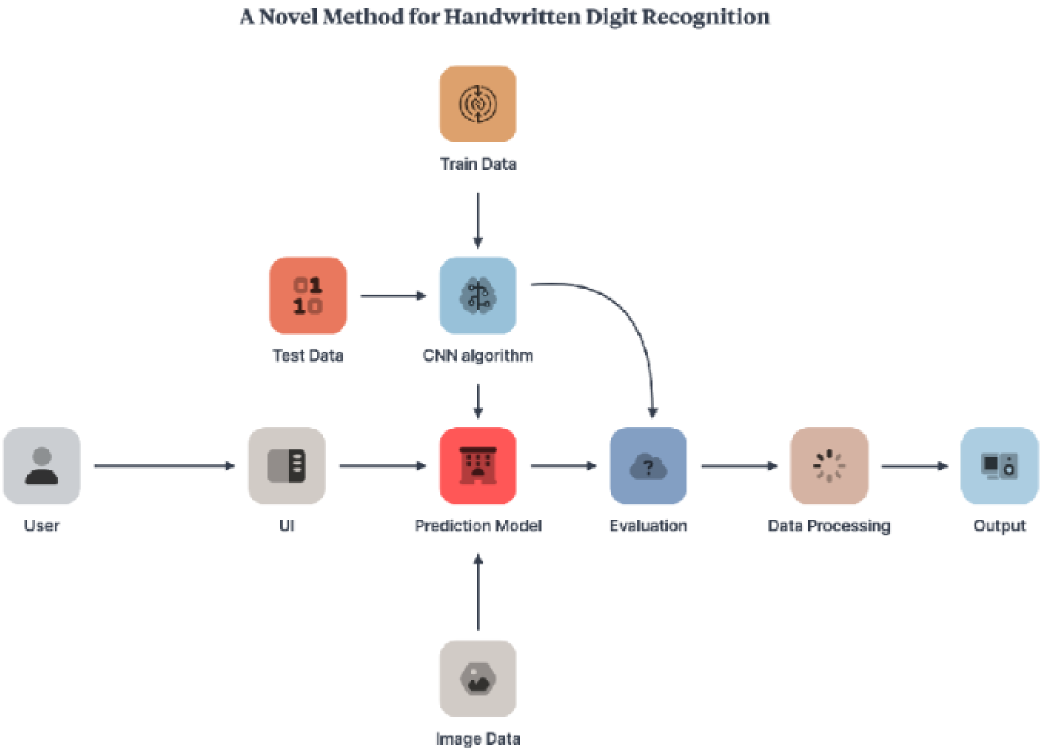
FR No.	Non-FunctionalRequirement	Description
NFR-1	**Usability**	The major reason why someone would use ourservice would be to decrease the hardship faced byemployeesthathaveto processhandwrittenforms such as bank-cheque processing, addresscomprehensionandsoon.
NFR-2	**Security**	Our service will make use of login authentication to make sure the users have some form of privacy.
NFR-3	**Reliability**	Algorithm will have an accuracy of 90%, further more the CNN algorithm will decipher the handwritten digits based on the rules defined by us which will be based upon the general handwritten digits.
NFR-4	**Performance**	Our website will be lightweight, efficient and accurate with minimum discomfort to the user.
NFR-5	**Availability**	Our website will be made public for everyone to use.
NFR-6	**Scalability**	In future, the website will be able to retain the knowledge of previous user’s data and hasten the process of digit recognition.

5. PROJECT DESIGN

5.1 Data Flow Diagram:



5.2 Solution and Technical Architecture:



5.3 User Stories:

User Type	**Functional Requirement(Epic)**	**User Story Number**	**User Story/Task**	**Acceptance criteria**	**Priority**	**Release**
Customer	Login	USN-1	As a user, I can login to my account	I can access my account	High	Sprint-1
	Image upload	USN-2	As a user I can upload my image with digits for recognition	I can upload my image	High	Sprint-1
	Output Download	USN-3	As a user I can, download the output as a text file	I can see the output file and click on download	High	Sprint-1
		USN-4	As a user I can download the output as an excel sheet	I can download the output	Medium	Sprint-2
	Image Preview	USN-5	As a user I can preview my uploaded image	I can see my image preview	Medium	Sprint-1
	Rating	USN-6	As a user I can rate the service provided by the website	I can see the rating being recorded	Low	Sprint-2
	Registration	USN-7	As a user I can register my information to create an account for the service	I can use my new credentials to access my account	Medium	Sprint-2

6. PROJECT PLANNING AND SCHEDULING

6.1 Sprint Planning & Estimation:

Sprint	Functional Requirement (Epic)	User Story Number	User Story/Task	Story Points	Priority	Team Members
Sprint-1	User Login	USN-1	The user will be presented with two options. 1. Sign-in your account if It already exists. 2. Sign-up if you are new.	1	Low	Moniessh P Kishore Kumar L ShyamGopal TarunK
Sprint-1	Dashboard	USN-2	Go to dashboard and see the available features 1. Open camera(allow permission) 2. Upload picture			Moniessh PKishoreKumar LShyam Gopal TarunK
Sprint-2	Training the model	USN-3	Comparing the input with the existing data.	2	Medium	Moniessh P KishoreKumar L Shyam Gopal TarunK
Sprint-3	Prediction	USN-4	Predict the correct output or get an outputsimilarityof90%.	2	High	Moniessh P KishoreKumarL Shyam Gopal TarunK
Sprint-4	Evaluation Metrics	USN-5	Finally the correct prediction is given as output to the user.	2	High	Moniessh P KishoreKumar L ShyamGopal TarunK
Sprint-1	Exit	USN-6	Click exit button to exit from the application	1	Low	Moniessh P KishoreKuma rL Shyam Gopal Tarun K

6.2 Print Delivery Schedule:

Sprint	Total Story Point	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	24 Oct 2022	29 Oct 2022	20	29 Oct 2022
Sprint-2	20	6 Days	31 Oct 2022	05 Nov 2022	20	05 Nov 2022
Sprint-3	20	6 Days	07 Nov 2022	12 Nov 2022	20	12 Nov 2022
Sprint-4	20	6 Days	14 Nov 2022	19 Nov 2022	20	19 Nov 2022

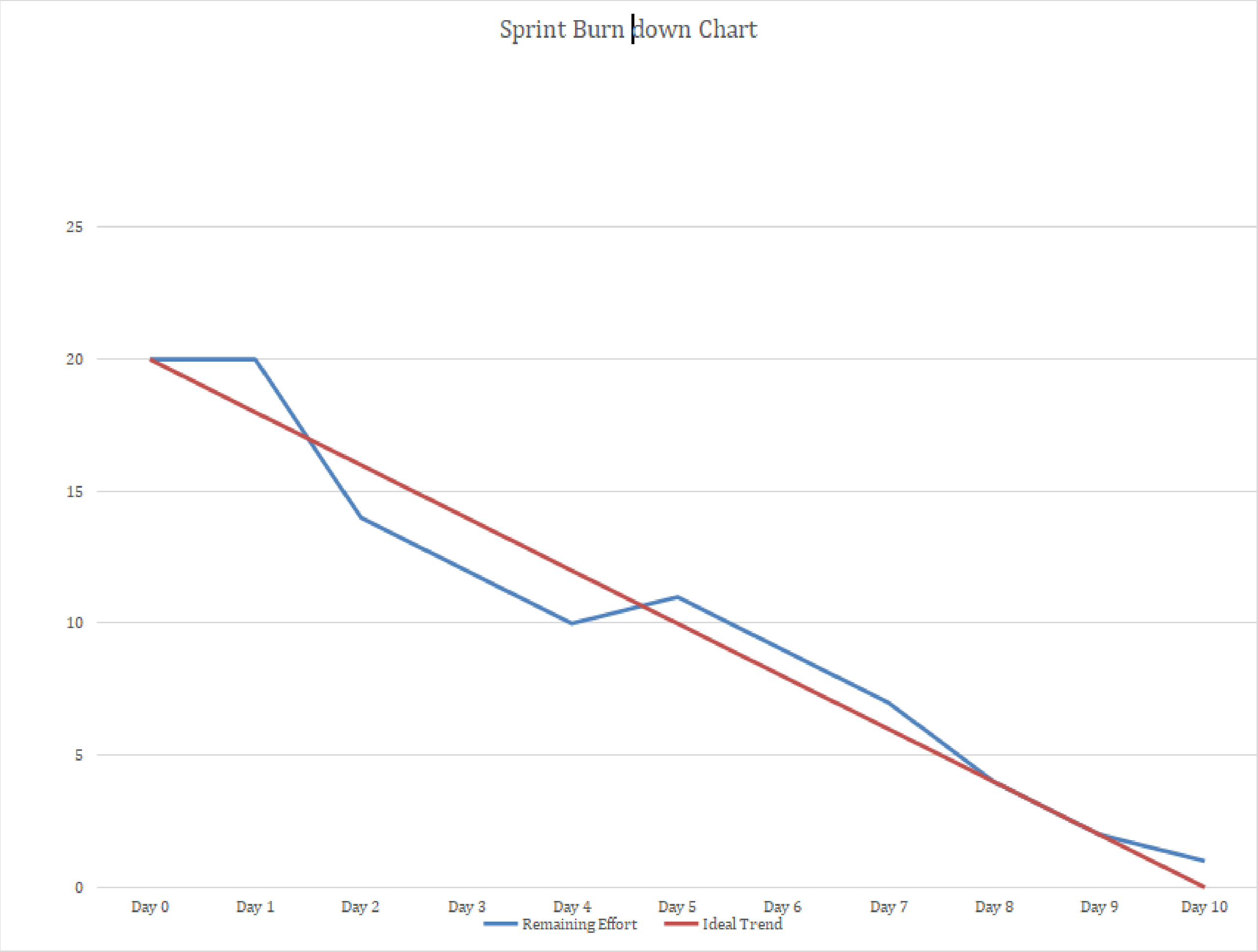
Velocity:

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

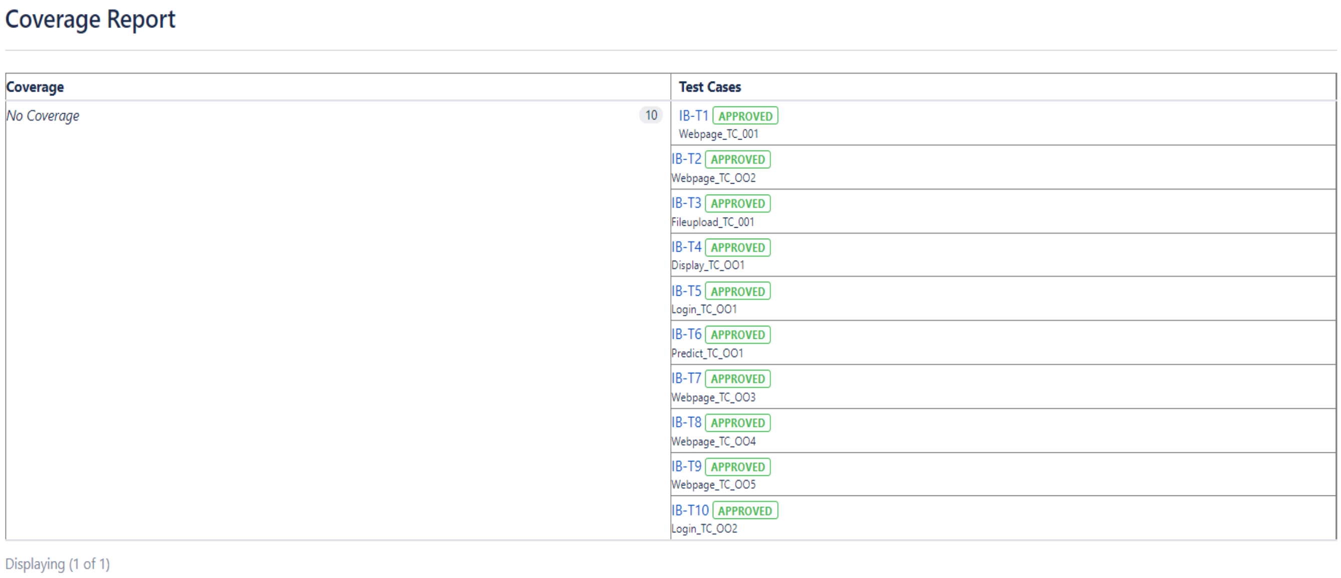
$$AV = \frac{sprint\ duration}{velocity} = \frac{20}{10} = 2$$

Burn down 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 suchas Scrum. However, burn down charts can be applied to any project containing measurable progress over time.


Sprint Burn down Chart
25
20
15
10
5
0
Day 0
Day 1
Day 2
Day 3
Day 4
Day 5
Day 6
Day 7
Day 8
Day 9
Day 10
Remaining Effort
Ideal Trend

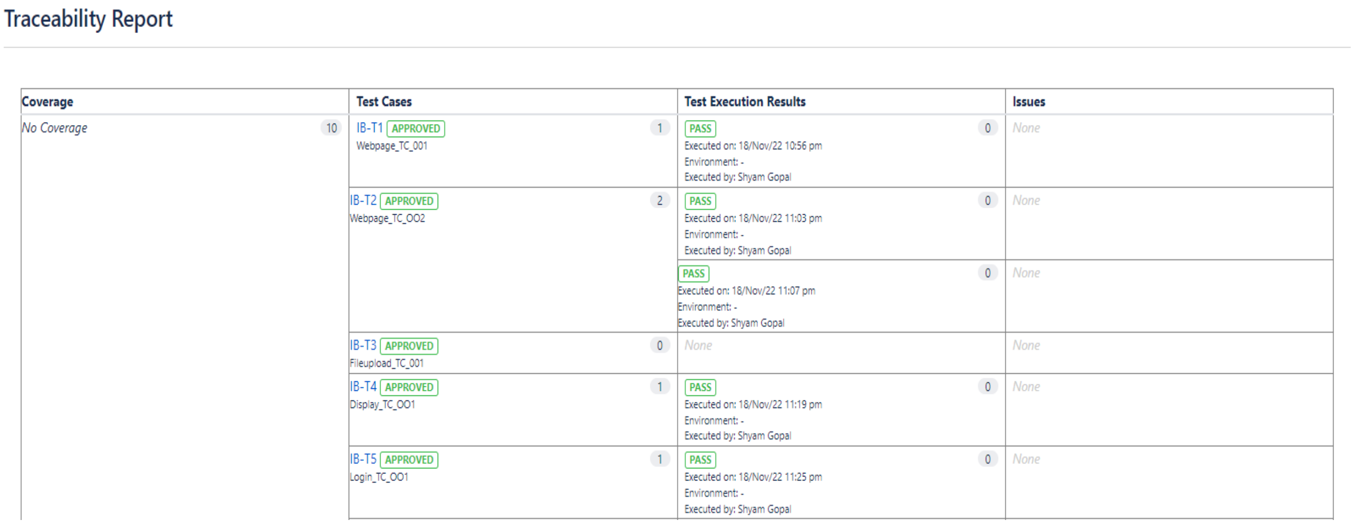
6.3 Reports from Jira:



Coverage Report

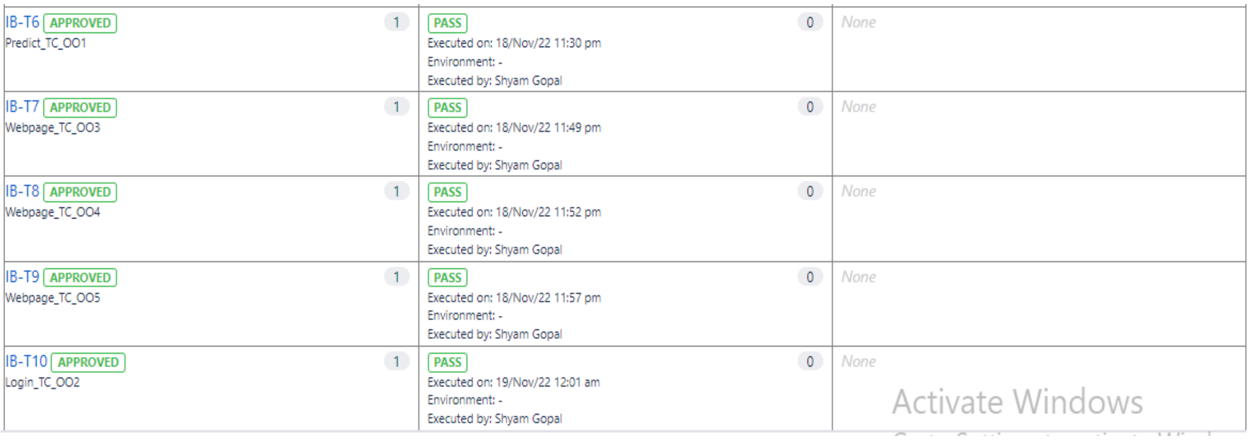
Coverage		Test Cases
No Coverage	10	IB-T1 APPROVED Webpage_TC_001
		IB-T2 APPROVED Webpage_TC_OO2
		IB-T3 APPROVED Fileupload_TC_001
		IB-T4 APPROVED Display_TC_OO1
		IB-T5 APPROVED Login_TC_OO1
		IB-T6 APPROVED Predict_TC_OO1
		IB-T7 APPROVED Webpage_TC_OO3
		IB-T8 APPROVED Webpage_TC_OO4
		IB-T9 APPROVED Webpage_TC_OO5
		IB-T10 APPROVED Login_TC_OO2

Displaying (1 of 1)

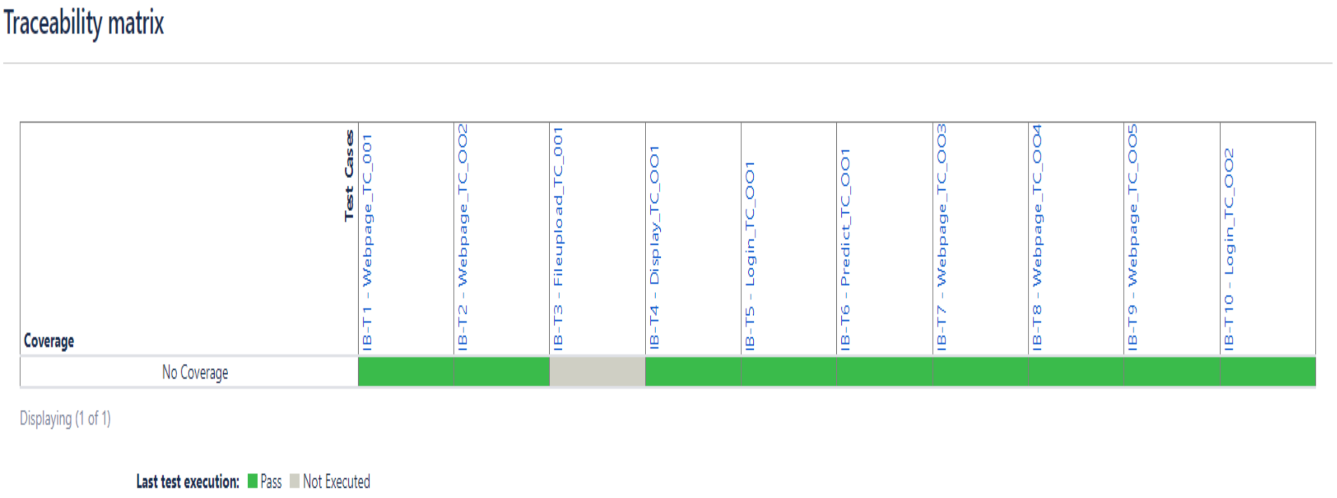


Traceability Report

Coverage		Test Cases		Test Execution Results		Issues
No Coverage	10	IB-T1 APPROVED Webpage_TC_001	1	PASS Executed on: 18/Nov/22 10:56 pm Environment: - Executed by: Shyam Gopal	0	*None*
		IB-T2 APPROVED Webpage_TC_OO2	2	PASS Executed on: 18/Nov/22 11:03 pm Environment: - Executed by: Shyam Gopal	0	*None*
				PASS Executed on: 18/Nov/22 11:07 pm Environment: - Executed by: Shyam Gopal	0	*None*
		IB-T3 APPROVED Fileupload_TC_001	0	*None*		*None*
		IB-T4 APPROVED Display_TC_OO1	1	PASS Executed on: 18/Nov/22 11:19 pm Environment: - Executed by: Shyam Gopal	0	*None*
		IB-T5 APPROVED Login_TC_OO1	1	PASS Executed on: 18/Nov/22 11:25 pm Environment: - Executed by: Shyam Gopal	0	*None*



IB-T6 APPROVED Predict_TC_001	1	PASS Executed on: 18/Nov/22 11:30 pm Environment: - Executed by: Shyam Gopal	0	None
IB-T7 APPROVED Webpage_TC_003	1	PASS Executed on: 18/Nov/22 11:49 pm Environment: - Executed by: Shyam Gopal	0	None
IB-T8 APPROVED Webpage_TC_004	1	PASS Executed on: 18/Nov/22 11:52 pm Environment: - Executed by: Shyam Gopal	0	None
IB-T9 APPROVED Webpage_TC_005	1	PASS Executed on: 18/Nov/22 11:57 pm Environment: - Executed by: Shyam Gopal	0	None
IB-T10 APPROVED Login_TC_002	1	PASS Executed on: 19/Nov/22 12:01 am Environment: - Executed by: Shyam Gopal	0	None

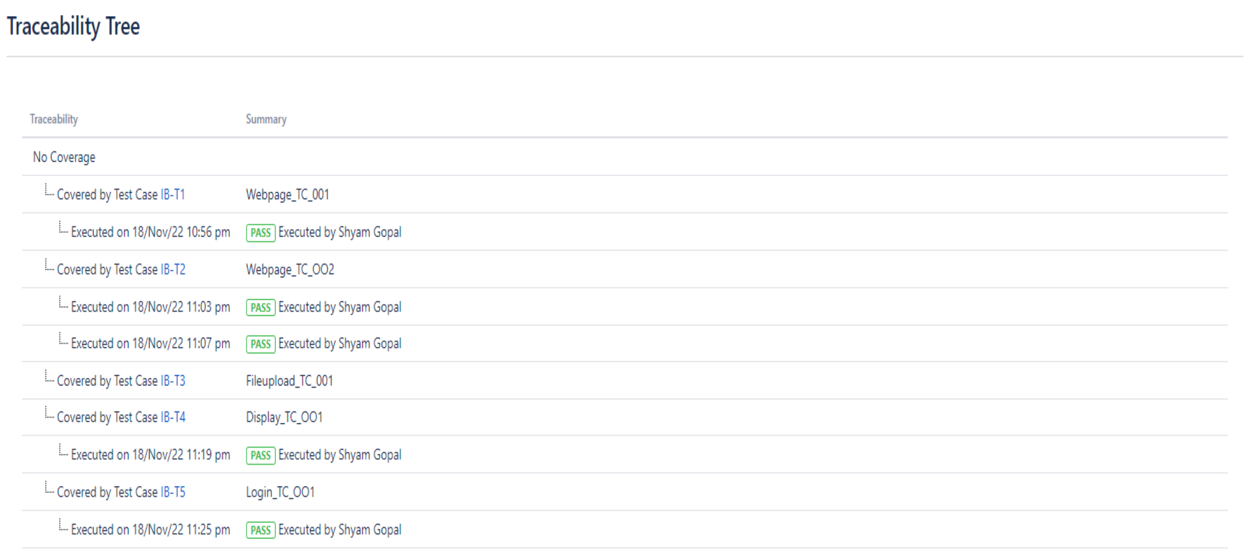


Traceability matrix

Test Cases Coverage	IB-T1 - Webpage_TC_001	IB-T2 - Webpage_TC_002	IB-T3 - Fileupload_TC_001	IB-T4 - Display_TC_001	IB-T5 - Login_TC_001	IB-T6 - Predict_TC_001	IB-T7 - Webpage_TC_003	IB-T8 - Webpage_TC_004	IB-T9 - Webpage_TC_005	IB-T10 - Login_TC_002
No Coverage	🟩	🟩	⬜	🟩	🟩	🟩	🟩	🟩	🟩	🟩

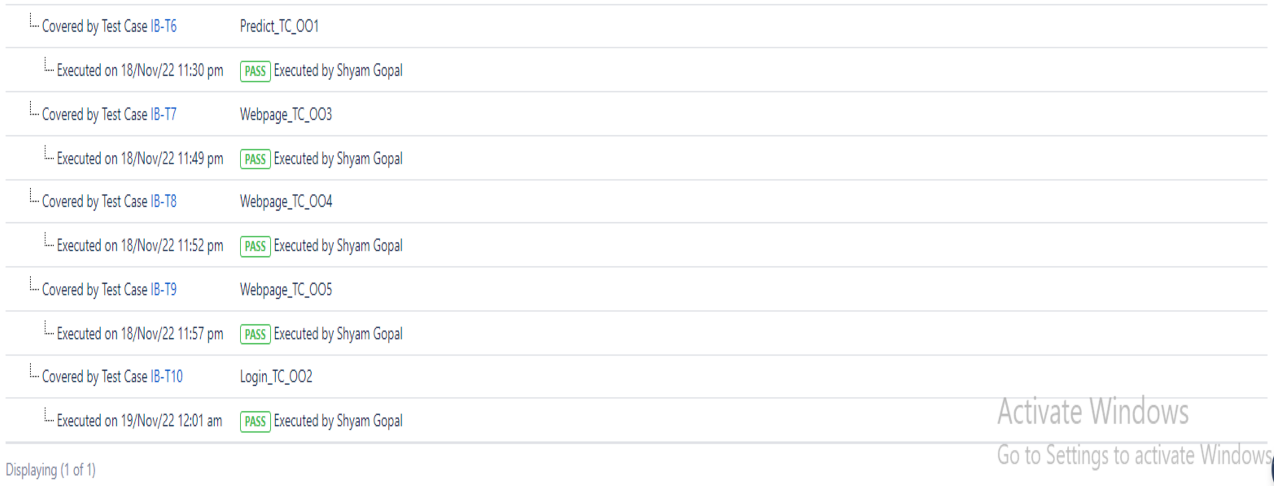
Displaying (1 of 1)

Last test execution: 🟩 Pass ⬜ Not Executed



Traceability Tree

Traceability	Summary
No Coverage	
└ Covered by Test Case IB-T1	Webpage_TC_001
└ Executed on 18/Nov/22 10:56 pm	PASS Executed by Shyam Gopal
└ Covered by Test Case IB-T2	Webpage_TC_002
└ Executed on 18/Nov/22 11:03 pm	PASS Executed by Shyam Gopal
└ Executed on 18/Nov/22 11:07 pm	PASS Executed by Shyam Gopal
└ Covered by Test Case IB-T3	Fileupload_TC_001
└ Covered by Test Case IB-T4	Display_TC_001
└ Executed on 18/Nov/22 11:19 pm	PASS Executed by Shyam Gopal
└ Covered by Test Case IB-T5	Login_TC_001
└ Executed on 18/Nov/22 11:25 pm	PASS Executed by Shyam Gopal



└ Covered by Test Case IB-T6	Predict_TC_001
└ Executed on 18/Nov/22 11:30 pm	PASS Executed by Shyam Gopal
└ Covered by Test Case IB-T7	Webpage_TC_003
└ Executed on 18/Nov/22 11:49 pm	PASS Executed by Shyam Gopal
└ Covered by Test Case IB-T8	Webpage_TC_004
└ Executed on 18/Nov/22 11:52 pm	PASS Executed by Shyam Gopal
└ Covered by Test Case IB-T9	Webpage_TC_005
└ Executed on 18/Nov/22 11:57 pm	PASS Executed by Shyam Gopal
└ Covered by Test Case IB-T10	Login_TC_002
└ Executed on 19/Nov/22 12:01 am	PASS Executed by Shyam Gopal

Displaying (1 of 1)

7. CODING AND SOLUTIONING

7.1 Libraries Installed:

pip install flask

pip install numpy

pip install keras

pip install tensorflow

pip install kerasmodel

7.2 Uploading of files into Website for Digit Recognition:

Digit recognition is one of the noteworthy and important issue. When it comes to data entry the recognition of handwritten digits becomes a hectic process and is time consuming. It takes a lot of effort to enter the data in digital form. Thus, this project provides solution to such problems where the user can upload the image file from his device which is detected by the system and the predicted output is displayed for the user.

7.3 Prediction of the digits from uploaded files:

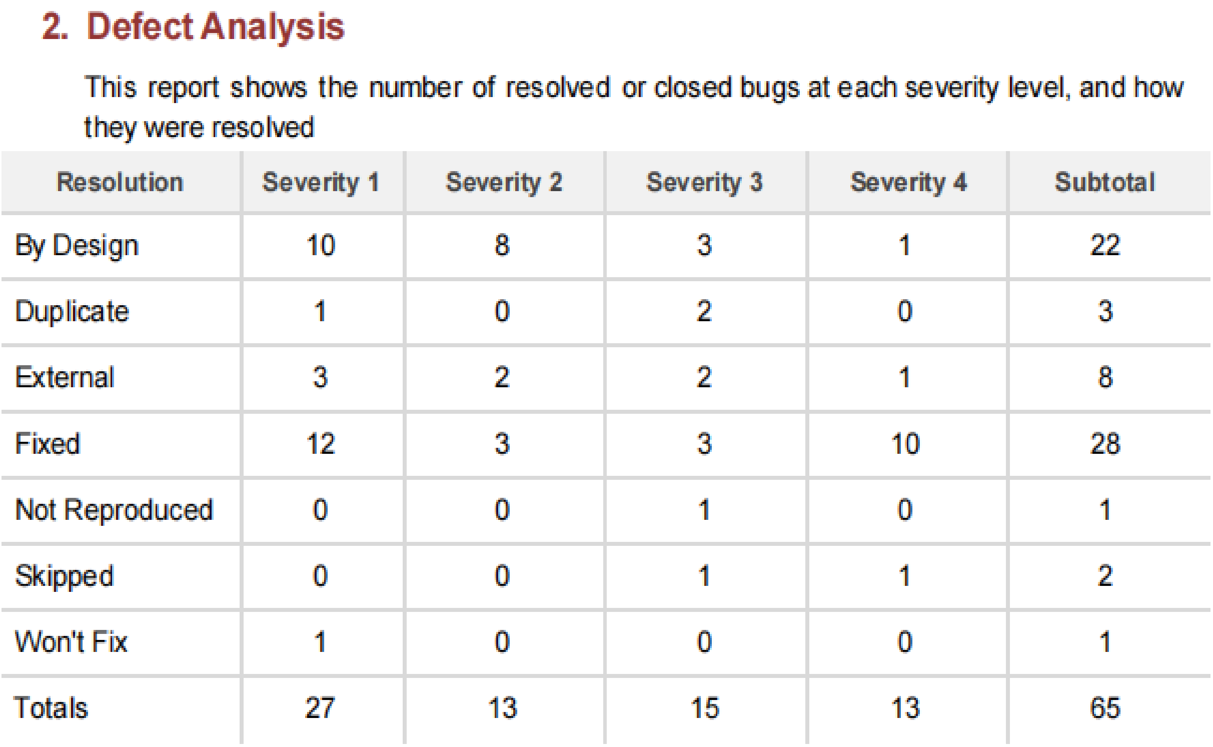
The model scans the files uploaded by the user and scans for digits in it. The model is a convolutional neural network with weights saved to HDF5 file in the data folder relative to the module's path. The handwritten digits are recognized and predicted and the output is displayed in the screen.

8. TESTING

8.1 Test Cases:

- Verify if the buttons in web page are responsive.
- Verify if the UI elements are getting displayed properly.
- Verify if the user can upload files from his system.
- Verify if the output is displayed.
- Verify if the user can login using his credentials.
- Verify if the model predicts the input accurately.
- Verify if the user is getting redirected to home page after sign in.
- Verify if the UI elements are being displayed.
- Verify if the user can navigate to other pages in navigation bar.
- Verify if the user can exit the home to sign page.

8.2 UAT Testing:



2. Defect Analysis

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

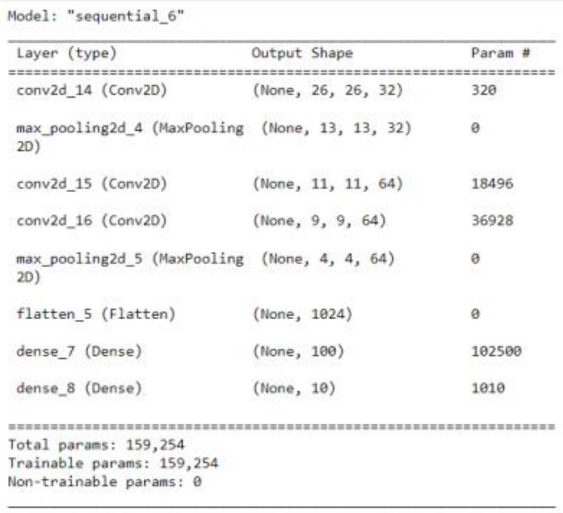
Resolution	Severity 1	Severity 2	Severity 3	Severity 4	Subtotal
By Design	10	8	3	1	22
Duplicate	1	0	2	0	3
External	3	2	2	1	8
Fixed	12	3	3	10	28
Not Reproduced	0	0	1	0	1
Skipped	0	0	1	1	2
Won't Fix	1	0	0	0	1
Totals	27	13	15	13	65

3. Test Case Analysis

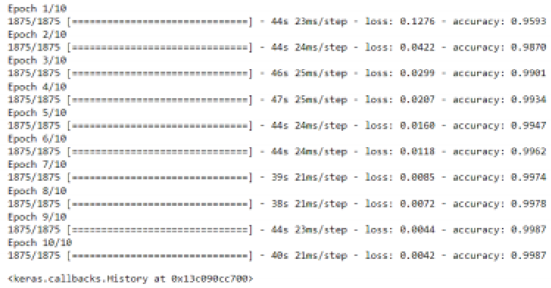
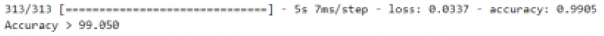
This report shows the number of test cases that have passed, failed, and untested

Section	Total Cases	Not Tested	Fail	Pass
Print Engine	6	0	0	6
Client Application	15	0	0	15
Security	2	0	0	2
Outsource Shipping	3	0	0	3
Exception Reporting	8	0	0	8
Final Report Output	6	0	0	6
Version Control	2	0	0	2

8.3 Performance Testing:

S.No.	Parameter	Values	Screenshot
1.	Model Summary	Total params: 159,254 Trainable params: 159,254 Non-trainable params: 0	

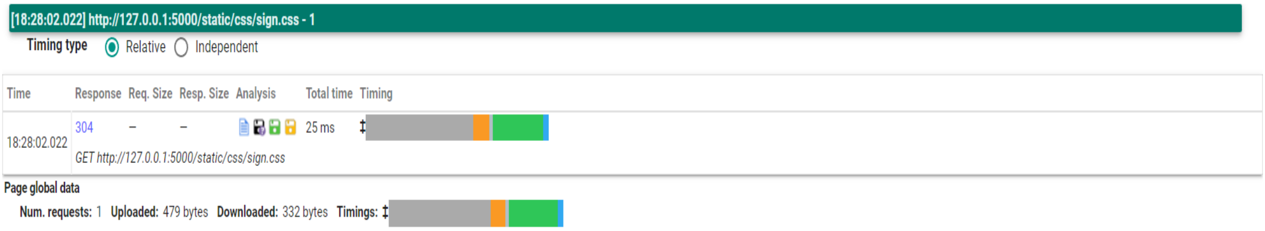
```
Model: "sequential_6"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv2d_14 (Conv2D)          (None, 26, 26, 32)        320

 max_pooling2d_4 (MaxPooling  (None, 13, 13, 32)       0
 2D)

 conv2d_15 (Conv2D)          (None, 11, 11, 64)        18496

 conv2d_16 (Conv2D)          (None, 9, 9, 64)          36928

 max_pooling2d_5 (MaxPooling  (None, 4, 4, 64)         0
 2D)

 flatten_5 (Flatten)         (None, 1024)              0

 dense_7 (Dense)             (None, 100)               102500

 dense_8 (Dense)             (None, 10)                1010

=================================================================
Total params: 159,254
Trainable params: 159,254
Non-trainable params: 0
_________________________________________________________________
```

2.	Training Accuracy	Training Accuracy: 0.9593	 Epoch 1/10 1875/1875 [==============================] - 44s 23ms/step - loss: 0.1276 - accuracy: 0.9593 Epoch 2/10 1875/1875 [==============================] - 44s 24ms/step - loss: 0.0422 - accuracy: 0.9870 Epoch 3/10 1875/1875 [==============================] - 46s 25ms/step - loss: 0.0299 - accuracy: 0.9901 Epoch 4/10 1875/1875 [==============================] - 47s 25ms/step - loss: 0.0207 - accuracy: 0.9934 Epoch 5/10 1875/1875 [==============================] - 44s 24ms/step - loss: 0.0160 - accuracy: 0.9947 Epoch 6/10 1875/1875 [==============================] - 44s 24ms/step - loss: 0.0118 - accuracy: 0.9962 Epoch 7/10 1875/1875 [==============================] - 39s 21ms/step - loss: 0.0085 - accuracy: 0.9974 Epoch 8/10 1875/1875 [==============================] - 38s 21ms/step - loss: 0.0072 - accuracy: 0.9978 Epoch 9/10 1875/1875 [==============================] - 44s 23ms/step - loss: 0.0044 - accuracy: 0.9987 Epoch 10/10 1875/1875 [==============================] - 40s 21ms/step - loss: 0.0042 - accuracy: 0.9987 <keras.callbacks.History at 0x13c090cc700>
3.	Evaluation Accuracy	Evaluation Accuracy: 99.050	 313/313 [==============================] - 5s 7ms/step - loss: 0.0337 - accuracy: 0.9905 Accuracy > 99.050

9. RESULTS

Performance Metrics:

The following images can be studied to understand the performance metrics of our system.



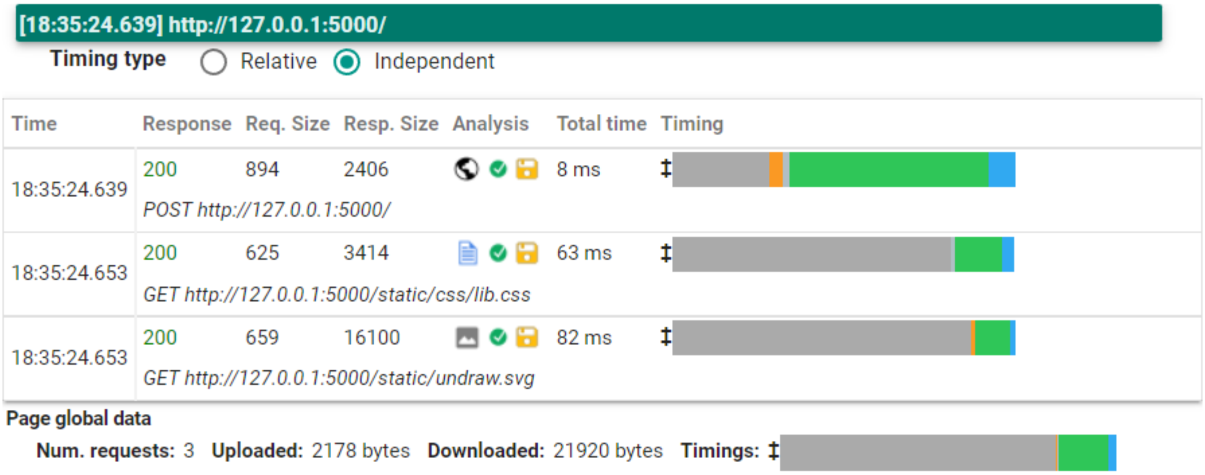
[18:28:02.022] http://127.0.0.1:5000/static/css/sign.css - 1

Timing type ● Relative ○ Independent

Time	Response	Req. Size	Resp. Size	Analysis	Total time	Timing
18:28:02.022	304 *GET http://127.0.0.1:5000/static/css/sign.css*	–	–		25 ms	‡

Page global data

Num. requests: 1 **Uploaded:** 479 bytes **Downloaded:** 332 bytes **Timings:** ‡



[18:35:24.639] http://127.0.0.1:5000/

Timing type ○ Relative ● Independent

Time	Response	Req. Size	Resp. Size	Analysis	Total time	Timing
18:35:24.639	200 *POST http://127.0.0.1:5000/*	894	2406		8 ms	‡
18:35:24.653	200 *GET http://127.0.0.1:5000/static/css/lib.css*	625	3414		63 ms	‡
18:35:24.653	200 *GET http://127.0.0.1:5000/static/undraw.svg*	659	16100		82 ms	‡

Page global data

Num. requests: 3 **Uploaded:** 2178 bytes **Downloaded:** 21920 bytes **Timings:** ‡

10. ADVANTAGES AND DISADVANTAGES

Advantages:

- Easy recognition and prediction of handwritten digits in an image or pdf.
- Makes the process of data entry easier.
- Saves time and is more efficient.
- Friendly UI.

Disadvantages:

- There may be slight mistakes in predictions.
- As there are wide range of handwriting styles and pattern it is difficult to train the model using all the digits.
- There may be slight lag in the use of website.
- User may not be able to upload multiple files at once.

11. CONCLUSION

Digit recognition plays a important part in various processes and functions in every domain in our day to day lives. It mainly helps in the process of data entry in many workplaces like banks, billing processes and so on. But it requires a lot of effort and consumes more time. A convolution neural network has been used to build a model that is trained on various hand motions. Utilizing this concept, an app is created. Thus our project provides a solution to this problem by helping the users to detect the digits in an uploaded files making the process of data entry easier and efficient.

12. FUTURE SCOPE

The following are the features that can be added in our application:

- Increase in accuracy of prediction.
- Enabling the user to upload more than one file at a time.
- Conversion of the digits in a file to tabular form making data entry easier.
- A recognition app with same features can be developed in which we may add a addition feature that pronounces the predicted digit from the image uploaded.
- We may also add a feature where the files with any format can be uploaded and the digit is predicted accordingly.

13. APPENDIX

Source Code

- **Model Building:**

```
from keras.models import Sequential
from keras.layers import Dense, Conv2D, Flatten
import matplotlib.pyplot as plt
from keras.datasets import mnist
from tensorflow.keras.utils import to_categorical
from tensorflow.keras.layers import MaxPooling2D
from tensorflow.keras.optimizers import SGD
import numpy as np
%matplotlib inline

(x_train, y_train), (x_test, y_test) = mnist.load_data()

x_train = x_train.reshape(60000,28,28,1)
x_test = x_test.reshape(10000,28,28,1)

x_train.shape

y_train = to_categorical(y_train)
```

```
y_test = to_categorical(y_test)


y_train[0]


x_train = x_train.astype('float32')

x_test = x_test.astype('float32')


x_train = x_train/255.0

x_test = x_test/255.0


model1 = Sequential()

model1.add(Conv2D(32, (3, 3), activation='relu', kernel_initializer='he_uniform', input_shape=(28, 28, 1)))

model1.add(MaxPooling2D((2, 2)))

model1.add(Conv2D(64, (3, 3), activation='relu', kernel_initializer='he_uniform'))

model1.add(Conv2D(64, (3, 3), activation='relu', kernel_initializer='he_uniform'))

model1.add(MaxPooling2D((2, 2)))

model1.add(Flatten())

model1.add(Dense(100, activation='relu', kernel_initializer='he_uniform'))

model1.add(Dense(10, activation='softmax'))

# compile model

opt = SGD(learning_rate=0.01, momentum=0.9)

model1.compile(optimizer=opt, loss='categorical_crossentropy', metrics=['accuracy'])
```

```
model1.fit(X_train, y_train, epochs=10, batch_size=32)
```

```
model1.save("final_model.h5")
```

- **Model Testing:**

```
img = Image.open('6.png')
img = img.resize((28,28))
img = np.array(img)
img = tf.image.rgb_to_grayscale(img)
img = img.numpy()
img = np.invert(img)
img = img.astype('float')
img = img/255.0
img = np.expand_dims(img,axis=0)
pred = model1.predict(img)
prediction = np.argmax(pred)
```

- **Flask App Building:**

```
import os
from flask import Flask,request,render_template,send_from_directory,url_for
from wtforms import SubmitField
from flask_cors import CORS
from keras_preprocessing import image
from keras.models import load_model
import tensorflow as tf
from PIL import Image
import numpy as np


app = Flask(__name__)
CORS(app)
```

```
model = load_model('final_model.h5')

user_list = ['ned','jon','arya','bran']
pass_list = ['head','snow','stark','wolf']

valid = ''
@app.route("/",methods=['GET','POST'])
def login():
    username = request.form.get('username')
    password = request.form.get('password')
    print(username,password)



    for i in range(len(user_list)):
        if(username == user_list[i]):
            if(password == pass_list[i]):
                return render_template("lib.html")
            else:
                valid = 'invalid credentials'
                return render_template("Signin.html",valid=valid)
    valid = 'invalid credentials'
    return render_template("Signin.html",valid=valid)

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

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

@app.route("/predict",methods=['GET','POST'])
def predict():
    basepath = ''
    filepath = ''
    if request.method=='POST':
        f = request.files['image']
        print('current path')
        basepath = os.path.dirname(__file__)
```

```
            print("current path:",basepath)
            filepath = os.path.join(basepath,'uploads',f.filename)
            print('upload folder is',filepath)
            f.save(filepath)


        img = Image.open(filepath)
        img = img.resize((28,28))
        img = np.array(img)
        img = tf.image.rgb_to_grayscale(img)
        img = img.numpy()
        img = np.invert(img)
        img = img.astype("float32")
        img = img/255.0
        img = np.expand_dims(img,axis=0)
        pred = model.predict(img)
        prediction = np.argmax(pred)
        print("PREDICTION :",prediction)

        return render_template('lib.html',prediction=str(prediction))

    file_url = None
    app.run(debug=True)
```

- **HTML Files:**

1. **Signin.html:**

```
<html>
  <head>
    <title>Login</title>
    <link rel="stylesheet" type="text/css" href="{{ url_for('static',
filename='css/sign.css')}}">
    <header>
        <nav>
            <ul>
                <li class="active"><a href="/">Sign in</a></li>
                <li><a href="Contact">Contact</a></li>
                                <li><a href="About">About</a></li>
```

```
                       <li><a
href="predict">Home</a></li>
      </ul>
    </nav>
  </header>
 </head>
 <body>
  <div class="panels-container">
   <div class="panel left-panel">
    <img src=" {{ url_for('static',
filename='undraw_welcome_cats_thqn.svg') }}">
   </div>
   <div class="panel right-panel">
  <div class="center">
   <h1><b>Sign in</b></h1>

   <form class="login_form" action="/" method="POST" >
    <div class="txt_field">
     <input type="text" name="username" placeholder="Enter
Mail Id or Username" required>
     <span></span>
    </div>
    <div class="txt_field">
     <input type="password" name="password"
placeholder="Enter Password" required>
     <span></span>
    </div>
    <button value="submit" onsubmit="Alert()" >Sign
in</button>

   </div>
   </div>



    <!--<label><input type="checkbox"> Remember
me</label>
    <div class="pass">Forgot Password?</div>
    <div class="signup_link">
     Not a member? <a href="#">Signup</a>
    </div>-->
```

```
      </form>
      {% if valid == 'invalid credentials' %}
        <script>
            alert("invalid credentials")
        </script>
    {% endif %}
    </div>

  </body>
</html>
```

2. **lib.html:**

```
<html>
  <head>
    <link
      rel="stylesheet"
      type="text/css"
      href="{{ url_for('static', filename='css/lib.css')}}"
    />

    <title>Home</title>
  </head>
  <header>
    <!-- <div class="n"> -->
    <!-- <h1 class="logo">BOOKSTORE</h1> -->
    <nav>
      <ul>
        <!--<form class="search" >
                        <input type="text" placeholder="Type to search"
>
                        <button>Search</button>
                    </form> -->
        <li><a href="/">Sign in</a></li>
        <li><a href="Contact">Contact</a></li>
        <li><a href="About">About</a></li>
        <li class="active"><a href="lib.html">Home</a></li>
        <li>HDR</li>
      </ul>
    </nav>
    <!-- </div> -->
  </header>
  <body>
    <!--<img src="bg.jpg"> -->
    <!-- <h1>Welcome,</h1> -->
    <!-- <h2>&nbsp;&nbsp;Choose your image file</h2> -->
    <div class="panels-container">
      <div class="panel left-panel">
        <div class="welcome">
          <h1>Welcome,</h1>
          <h2>

&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;&nbsp;Choose your
image file
          </h2>
        </div>
        <form
          action="/predict"
          method="post"
          id="upload-file"
          enctype="multipart/form-data"
        >
          <input
            type="file"
            accept="image/*"
            name="image"
            id="image"
            onchange="loadFile(event)"
          />
          <button
            type="submit"
            class="btn btn-primary"
            name="action"
            value="upload"
          >
            Submit
          </button>
        </form>
        <div class="display">
          <p><img id="output" width="200" /></p>
          <script>
            var loadFile = function (event) {
              var image = document.getElementById("output");
              image.src =
URL.createObjectURL(event.target.files[0]);
            };
          </script>
        </div>
        <div class="result">
          {% if prediction %}
          <h2>The predicted digit is,</h2>
          <h2>{{prediction}}</h2>
          {%endif%}
        </div>
      </div>
      <div class="panel right-panel">
        <div class="svg">
          <img src=" {{ url_for('static', filename='undraw.svg') }}" />
        </div>
      </div>
    </div>
  </body>
</html>
```

3. about.html:

```
<html>
  <head>
    <link
      rel="stylesheet"
      type="text/css"
      href="{{ url_for('static', filename='css/about.css')}}"
    />
    <nav>
      <ul>
        <li><a href="/">Sign in</a></li>
        <li><a href="Contact">Contact</a></li>
        <li class="active"><a href="About">About</a></li>
        <li><a href="lib.html">Home</a></li>
        <li>HDR</li>
      </ul>
    </nav>
  </head>
  <body>
    <h1><center>HANDWRITTEN DIGIT RECOGNITION
SYSTEM</center></h1>
    <p>
      <center>
        Handwritten digit recognition using MNIST dataset is a
major project
        made with the help of Neural Network. It basically detects
the scanned
        images of handwritten digits. We have taken this a step
further where
        our handwritten digit recognition system not only detects
scanned images
        of handwritten digits but also allows writing digits on the
screen with
        the help of an integrated GUI for recognition.
      </center>
    </p>
    <img src="{{ url_for('static',
    filename='da7d0bf6-f475-401a-b81e-c61a4ca3b2bf.jpeg')}}"
  </body>
</html>
```

4. contact.html:

```
<html>
  <head>
    <link
      rel="stylesheet"
      type="text/css"
      href="{{ url_for('static', filename='css/contact.css')}}"
    />
    <nav>
```

```
      <ul>
        <li><a href="/">Sign in</a></li>
        <li class="active"><a href="Contact">Contact</a></li>
        <li><a href="About">About</a></li>
        <li><a href="lib.html">Home</a></li>
        <li>HDR</li>
      </ul>
    </nav>
  </head>
  <body>
    <h1>HANDWRITTEN DIGIT RECOGNITION SYSTEM</h1>
    <p>
      Team ID : PNT2022TMID24883 Team Lead : Moniessh P
M1 Lead : Kishore Kumar
      L M2 Lead : Shyam Gopal M3 Lead : Tarun K
    </p>
  </body>
</html>
```

- **CSS Files:**

1. **Sign.css:**

```
* {
  margin: 0;
  padding: 0;
  box-sizing: border-box;
}
nav {
  background-color: rgba(11, 11, 11, 1);
  height: 60px;
  font-family: "Trebuchet MS", "Lucida Sans Unicode", "Lucida
Grande",
    "Lucida Sans", Arial, sans-serif;
}

header {
  width: 100%;
  height: 70px;
}
```

```
ul {
  list-style-type: none;
  overflow: hidden;
}
li {
  float: right;
  display: inline-block;
}
li a {
  color: aliceblue;
  display: block;
  font-size: 25px;
  margin: 10px;
  text-decoration: none;
  border-radius: 60px;
  padding: 3px 10px;
  font-size: large;
}
body {
  margin: 0;
  padding: 0;
  overflow: hidden;
  background-image: linear-gradient(150deg, rgb(249, 244, 249)
50%, black 50%);
  background-repeat: no-repeat;
  background-attachment: fixed;
  background-size: 100% 100%;
}
.panels-container {
  position: absolute;
  height: 100%;
  width: 100%;
  top: 60px;
  left: 0;
  display: grid;
  grid-template-columns: repeat(2, 1fr);
}
.panel left-panel {
  pointer-events: all;
  padding: 3rem 17% 2rem 12%;
}
.panel right-panel {
  pointer-events: none;
  padding: 3rem 12% 3rem 17%;
}
img {
  height: 550px;
  width: 550px;
}
.center {
  position: absolute;
  top: 50%;
  left: 80%;
  transform: translate(-50%, -50%);
  width: 420px;
  height: 420px;
  background: rgba(255, 255, 254, 0.612);
  border-radius: 30px;
  padding-top: 50px;
  box-shadow: 10px 10px 15px rgba(0, 0, 0, 0.05);
}
.center h1 {
  text-align: center;
  padding: 20px 0;
}
.center form {
  padding: 0 40px;
  box-sizing: border-box;
}
form .txt_field {
  position: relative;
  border-bottom: 2px solid #878585;
  margin: 30px 0;
}
.txt_field input {
  width: 100%;
  padding: 0 5px;
  height: 40px;
  font-size: 16px;
  border: none;
  background: none;
  outline: none;
}

.txt_field input::placeholder {
  color: rgb(21, 19, 19);
}

.txt_field input:focus ~ span::before,
.txt_field input:valid ~ span::before {
  width: 100%;
}
.pass {
  margin: 5px 0 20px 5px;
  color: #4012e5;
  cursor: pointer;
  float: right;
}
.pass:hover {
  text-decoration: underline;
}
button {
  width: 100%;
  height: 50px;
  border: 1px solid;
  /* background: rgb(249, 134, 3,70%); */
  background-color: aliceblue;
  border-radius: 25px;
  font-size: 18px;
  color: #181e22;
  font-weight: 700;
  cursor: pointer;
  outline: none;
}
button:hover {
  background: rgb(0, 0, 0);
  color: white;
  transition: 0.5s;
}
```

```
.signup_link {
  margin: 30px 0;
  text-align: center;
  font-size: 16px;
  color: #666666;
}
.signup_link a {
  color: #2691d9;
  text-decoration: none;
}
.signup_link a:hover {
  text-decoration: underline;
}
.txt_field span::before {
  content: "";
  position: absolute;
  top: 40px;
  left: 0;
  width: 0%;
  height: 2px;
  background: #000000;
  transition: 0.5s;
}
li.active a {
  background-color: rgb(245, 245, 245);
  color: black;
}
li a:hover {
  background-color: rgb(249, 247, 245);
  color: rgb(0, 0, 0);
}
```

2. **lib.css:**

```
h1 {
  color: aliceblue;
  font-family: "Franklin Gothic Medium", "Arial Narrow", Arial,
sans-serif;
  font-size: 30px;
```

```
}

/* .n {
  height: 50px;
  margin: 0;
} */
/* .logo {
  float: left;
  font-size: x-large;
  font-family: "Franklin Gothic Medium", "Arial Narrow", Arial,
sans-serif;
  height: 70px;
} */
body {
  margin: 0;
  background-color: aliceblue;
  background-image: linear-gradient(225deg, rgb(249, 244, 249)
50%, black 50%);
  background-attachment: fixed;
  max-height: 100 vh;

  /* background-image: url('lib.jpg');
         background-repeat: no-repeat;
         background-attachment: fixed;
         background-size: 100% 100%; */
}

.svg img {
  height: 500;
  width: 500;
  /* padding-bottom: 200; */
  padding-left: 100;
  padding-top: 80;
}
header {
  width: 100%;
  height: 60px;
}
.search {
  background-color: aliceblue;
  height: 50px;
  width: 200;
  border-radius: 60px;
}

input {
  /* background-color: aliceblue; */
  /* border-radius: 45px; */
  margin: 20px;
  border-style: none;
}

nav {
  background-color: rgb(0, 0, 0);
  height: 60px;
  font-family: "Trebuchet MS", "Lucida Sans Unicode", "Lucida
Grande",
    "Lucida Sans", Arial, sans-serif;
}
/* input:focus,
textarea:focus,
select:focus {
  outline: none;
} */
ul {
  list-style-type: none;
  overflow: hidden;
  height: 60px;
}
nav li {
  float: right;
  display: inline-block;
}
nav li a {
  color: aliceblue;
  display: block;
  font-size: 20px;
  margin: 10px;
  text-decoration: none;
  padding: 3px 10px;
  font-weight: 100;
}
li.active a {
  background-color: rgb(251, 251, 251);
  color: black;
  border-radius: 60px;
}
li a:hover {
  background-color: rgb(225, 225, 224);
  color: rgb(9, 9, 9);
  text-decoration: none;
  border-radius: 60px;
}
.panels-container {
  position: absolute;
  height: 100%;
  width: 100%;
  top: 60px;
  left: 0;
  display: grid;
  grid-template-columns: repeat(2, 1fr);
}
.panel left-panel {
  pointer-events: all;
  padding: 3rem 17% 2rem 12%;
}
.panel right-panel {
  pointer-events: none;
  padding: 3rem 12% 3rem 17%;
}
h1 {
  font-size: 50px;
}
h2 {
  color: aliceblue;
  font-family: "Franklin Gothic Medium", "Arial Narrow", Arial,
sans-serif;
  font-size: 40px;
}
button {
  background-color: #2f2e41;
  border-radius: 0 60px 60px 0;
  margin-inline: 5px;
  color: white;
  border: none;
  height: 50px;
  cursor: pointer;
}
.display {
  border: white;
  border-width: thick;
  position: absolute;
  height: 200;
  width: 200;
  top: 300px;
  left: 200px;
}
.result {
  padding-top: 300px;
}
form {
  position: absolute;
  height: 10;
  /* width: 0; */
  top: 50%;
  left: 20%;
  transform: translate(-50%, -250%);
  /* width: 320px; */
  background-color: aliceblue;
  padding-bottom: 50px;
  border-radius: 50px;
}

h1 {
  font-family: "Trebuchet MS", "Lucida Sans Unicode", "Lucida
Grande",
    "Lucida Sans", Arial, sans-serif;
}
p {
  color: aliceblue;
```

```
}
```

3. **about.css:**

```
nav {
  background-color: rgb(0, 0, 0);
  height: 60px;
  font-family: "Trebuchet MS", "Lucida Sans Unicode", "Lucida
Grande",
    "Lucida Sans", Arial, sans-serif;
}
h1 {
  align-content: center;
}
p {
  align-content: center;
}
body {
  margin: 0;
  background-color: aliceblue;
  /* background-image: linear-gradient(225deg, rgb(249, 244,
249) 50%, black 50%); */
  background-attachment: fixed;
  max-height: 100 vh;
}

ul {
  list-style-type: none;
  overflow: hidden;
  height: 60px;
}
nav li {
  float: right;
  display: inline-block;
}
nav li a {
  color: aliceblue;
  display: block;
  font-size: 20px;
  margin: 10px;
  text-decoration: none;
  padding: 3px 10px;
  font-weight: 100;
}
li.active a {
  background-color: rgb(251, 251, 251);
  color: black;
  border-radius: 60px;
}
li a:hover {
  background-color: rgb(225, 225, 224);
  color: rgb(9, 9, 9);
  text-decoration: none;
  border-radius: 60px;
}
```

4. **contact.css:**

```
nav {
  background-color: rgb(0, 0, 0);
  height: 60px;
  font-family: "Trebuchet MS", "Lucida Sans Unicode", "Lucida
Grande",
    "Lucida Sans", Arial, sans-serif;
}
body {
  margin: 0;
  background-color: aliceblue;
  background-attachment: fixed;
  max-height: 100 vh;
}
h1{
    align-content: center;
}
p {
  color: black;
  align-content: center;
}
```

```
ul {
  list-style-type: none;
  overflow: hidden;
  height: 60px;
}
nav li {
  float: right;
  display: inline-block;
}
nav li a {
  color: aliceblue;
  display: block;
  font-size: 20px;
  margin: 10px;
  text-decoration: none;
  padding: 3px 10px;
  font-weight: 100;
}
li.active a {
  background-color: rgb(251, 251, 251);
  color: black;
  border-radius: 60px;
}
li a:hover {
  background-color: rgb(225, 225, 224);
  color: rgb(9, 9, 9);
  text-decoration: none;
  border-radius: 60px;
}
```

GitHub Link: IBM-Project-50371-1660905452/Steps_to_Create_IBM_Cloud_Account.docx at main · IBM-EPBL/IBM-Project-50371-1660905452 (github.com)

Video Link: IBM-Project-50371-1660905452/Steps_to_Create_IBM_Cloud_Account.docx at main · IBM-EPBL/IBM-Project-50371-1660905452 (github.com)