IBM PROJECT

DOMAIN : Applied Data Science

TITLE : Smart Lender- Applicant Credibility Prediction for Loan Approval

TEAM ID : PNT2022TMID06709

DATE :20.11.2022

BATCH MEMBERS

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Faculty Advisor **HOD/CSE**

IDEATION PHASE

Submitted Date: 17.09.2022

The Problem statement of the project,Literature survey, Empathy map and Brainstroming for Idea priortization was done.

PROJECT DESIGN PHASE - I

Submitted Date: 12.10.2022

The Problem solution fit, proposed solution for the problem statement and solution architecture were made.

PROJECT DESIGN PHASE - II

Submitted Date: 16.10.2022

The Solution requirements, Architecture of Technologies used, Data Flow diagrams and Customer journey were prepared.

PROJECT PLANNING PHASE

Submitted Date: 22.10.2022

The activity list is prepared and Sprint delivery plan were made.

PROJECT DEVELOPMENT PHASE

Submitted Date: 19.11.2022

The codes and Tese cases are performed and uploaded for all four Sprints.

ASSIGNMENTS AND QUIZ

Completed all four Assignments and all four Quizzes.

COMMENTS

1. INTRODUCTION

1.1 Project Overview

The loan is approved by predicting if the loan can be given to that person on the basis of various parameters like credit score, income, age, marital status, gender, etc. The prediction model not only helps the applicant but also helps the bank by minimizing the risk and reducing the number of defaulters. Banks need to analyze for the person who applies for the loan will repay the loan or not. Bankers cannot analyze the huge amounts of data manually; it may become a big process to check whether a person will repay its loan or not. With our model the prediction will be done in less amount of time.

Lenders (investors) make loans to creditors in return for the guarantee of interest-bearing repayment. That is, the lender only makes a return (interest) if the borrower repays the loan. However, whether he or she does not repay the loan, the lender loses money. Banks make loans to customers in exchange for the guarantee of repayment. Some would default on their debts, unable to repay them for a number of reasons. The bank retains insurance to minimize the possibility of failure in the case of a default. The insured sum can cover the whole loan amount or just a portion of it. Banking processes use manual procedures to determine whether or not a borrower is suitable for a loan based on results. Manual procedures were mostly effective, but they were insufficient when there were a large number of loan applications. At that time, making a decision would take a long time. As a result, the loan prediction machine learning model can be used to assess a customer's loan status and build strategies. This model extracts and introduces the essential features of a borrower that influence the customer's loan status. Finally, it produces the planned performance (loan status). These reports make a bank manager's job simpler and quicker.

1.2 Purpose

The purpose of a loan matters because lenders use this information to not only determine your interest rates, but also whether you qualify for a loan through that lender. The purpose of a loan to determine whether you need to borrow and have the ability to make payments. Defaulting on a personal loan can have critical consequences on your credit score and can make it challenging to get other forms of credit down the road.The goal of this system is to provide a quick, immediate and easy way to select good applicants. It can offer banks special benefits. The credit forecasting system can automatically calculate the weights for each feature that participates in credit processing, and the new test data will process the same features for the assigned weights. The model can set a deadline to see if the applicant can approve the loan. Credit analysis allows to jump to specific applications and check according to priority. This system is exclusively for bank / financial company management authorities, the entire forecasting process is carried out privately and no stakeholders can change the process. The results of a particular credit ID can be sent to various departments of the bank so that they cantake appropriate action on demand. This helps all other departments handle other paperwork.

2. LITERATURE SURVEY

2.1 Existing Problem

Today, many banks/financial organizations grant loans following a lengthy verification and validation process, but there is no guarantee that the chosen applicant is the most deserving of all applicants. Using manual methods the process of loan approval takes a lot of time and people find it more frustrating. And people need to bring a lot of documents with them.

Models are compared based on performance measurements such as sensitivity and specificity. As a result of analysing, the following conclusions were drawn. However, other characteristics of customers that play a very important role in lending decisions and forecasting defaulters should also be evaluated. Some other traits, such as gender and marriage history, do not seem to be considered by the company . A credit credibility soothsaying system that helps companies make the right opinions to authorize or reject the credit claims of guests. This helps the banking assiduity to open effective distribution channels. This means that if the customer has a minimum repayment capacity, their system can avoid future risks.

Many borrowers find it difficult to choose a lender. When it comes to simple personal loans, you will find hundreds of lenders out there, each claiming to be the best. However, since one size does not fit all, one lender is not the best for all borrowers.You should compare lenders based on their loan amount, interest rate, repayment period, eligibility criteria, document requirements, customer service, and other parameters. Lastly, choose one that offers your required loan rate at a competitive interest rate with favorable terms and conditions.

No bank can lend money to a person who does not have a stable source of income to pay for regular EMIs for personal loans.Financial stability is very much important when it comes to lending money. If you change jobs regularly or do freelance work, chances are your loan application will be rejected.

2.2 References

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2.Loan Approval Prediction Machine learning - Analytics

https://www.analyticsvidhya.com/blog/2022/02/loan-approval-prediction-machine-learning/

3.Loan Prediction Using Machine Learning and Its Deployement On Web Application

https://ieeexplore.ieee.org/document/9696448

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https://ieeexplore.ieee.org › document

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7. Nikhil Madane, Siddharth Nanda-Loan Prediction using Decision tree,Journal of the Gujrat Research History, Volume 21 Issue 14s, December 2019

8. Mohamed El Mohadab, Belaid Bouikhalene, Said Safi, 'Predicting rank for scientific research papers using supervised learning' Applied Computing and Informatics 15 (2019) 182–190.

9.Anchal Goyal, Ranpreet Kaur- A survey on ensemble model of Loan Prediction, International journal of engineering trends and application(IJETA), Vol. 3 Issue 1, Jan-Feb 2016

2.3 Problem Statement Definition

Problem Statement	I am (Customer)	I'm trying to	But	Because	Which makes me feel
1	A vendor	Get a loan	The process of loan approval takes more time	Verification of documents is done manually	Exhausted
2	A business man	Expand my business	There is a lot of paper work	Checking of credentials requires a lot of documents	Stressful
3	A farmer	Increase my production	A part of my loan amount is taken by a third party	I don't have that much awareness	Disappointed
4	A teacher	Build a house	I can't get a housing loan	Because I forgot to pay the interest on time	Angry

3. IDEATION & PROPOSED SOLUTION

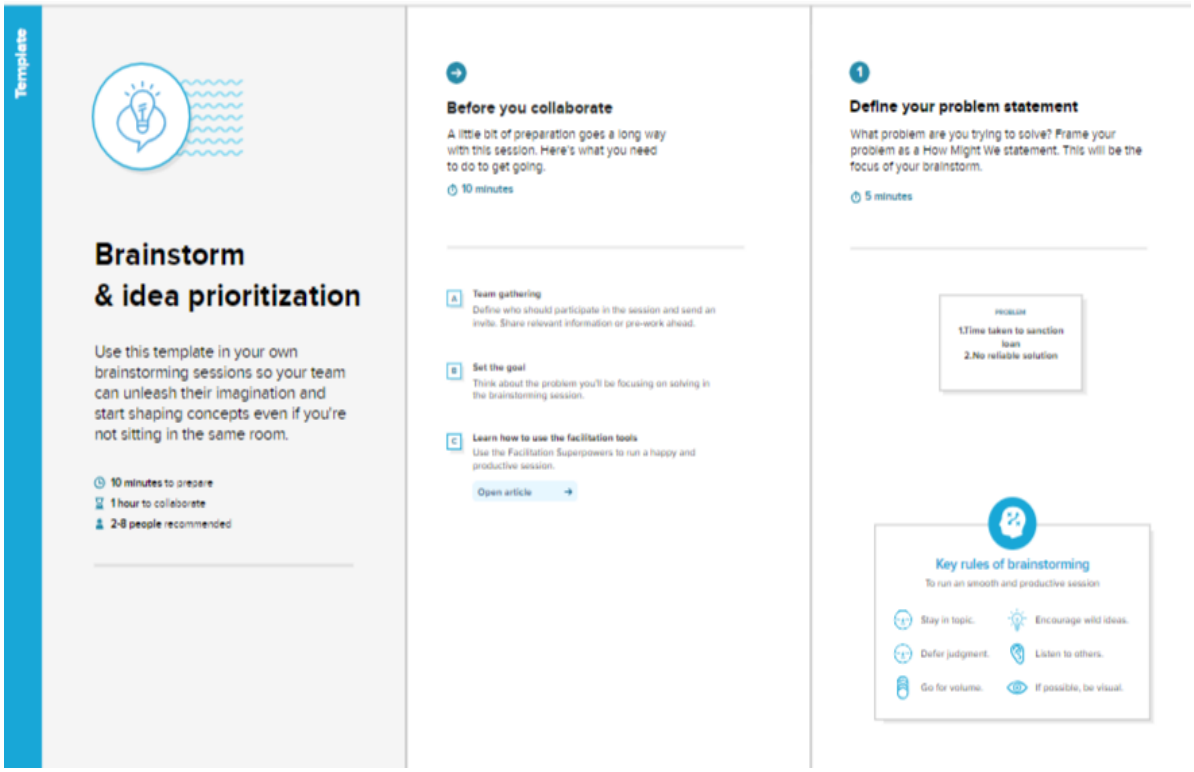
3.1 Empathy Map Canvas

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 effective 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.

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:



Step-2: Brainstorm, Idea Listing and Grouping:

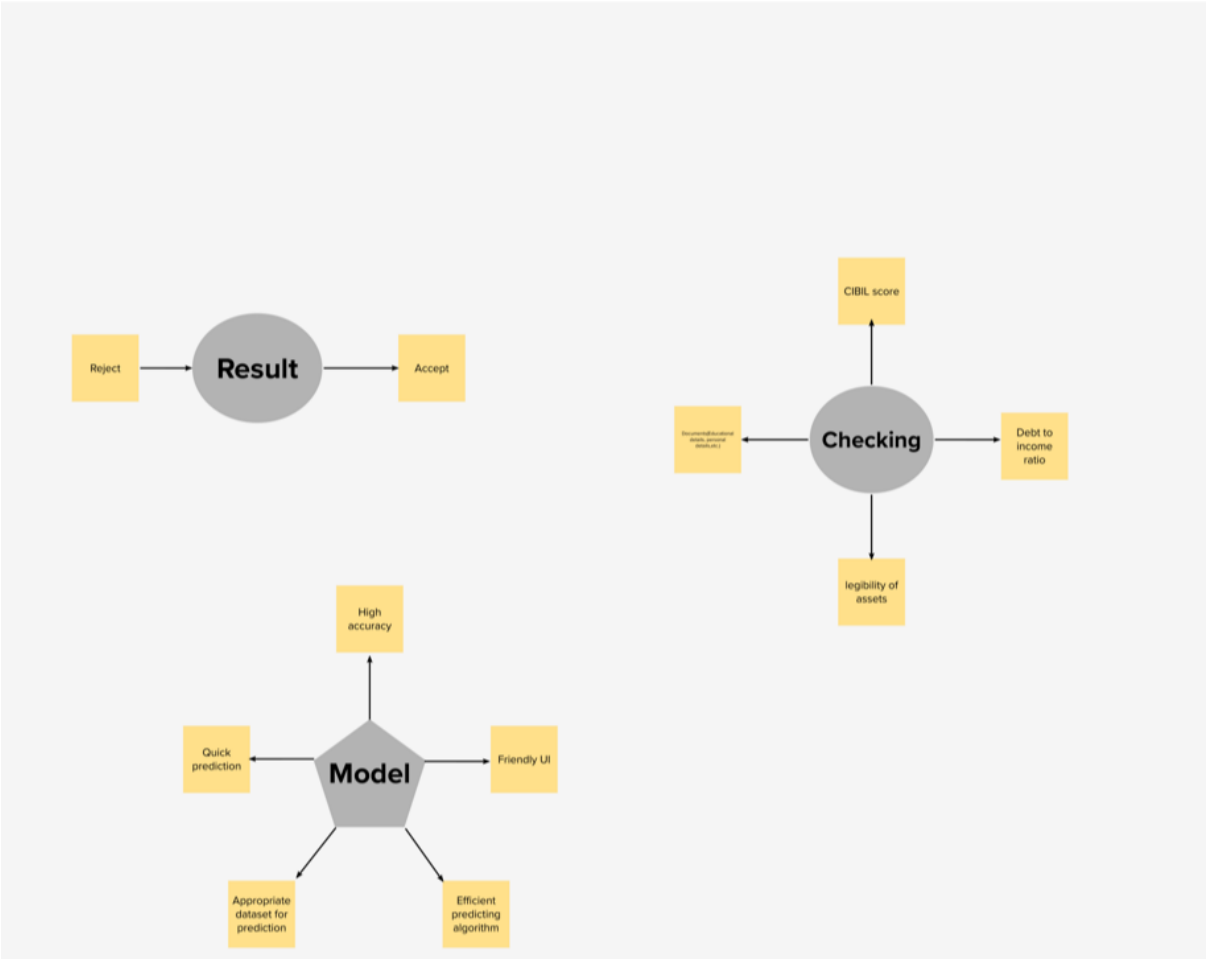
Step-3: Idea Prioritization:

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

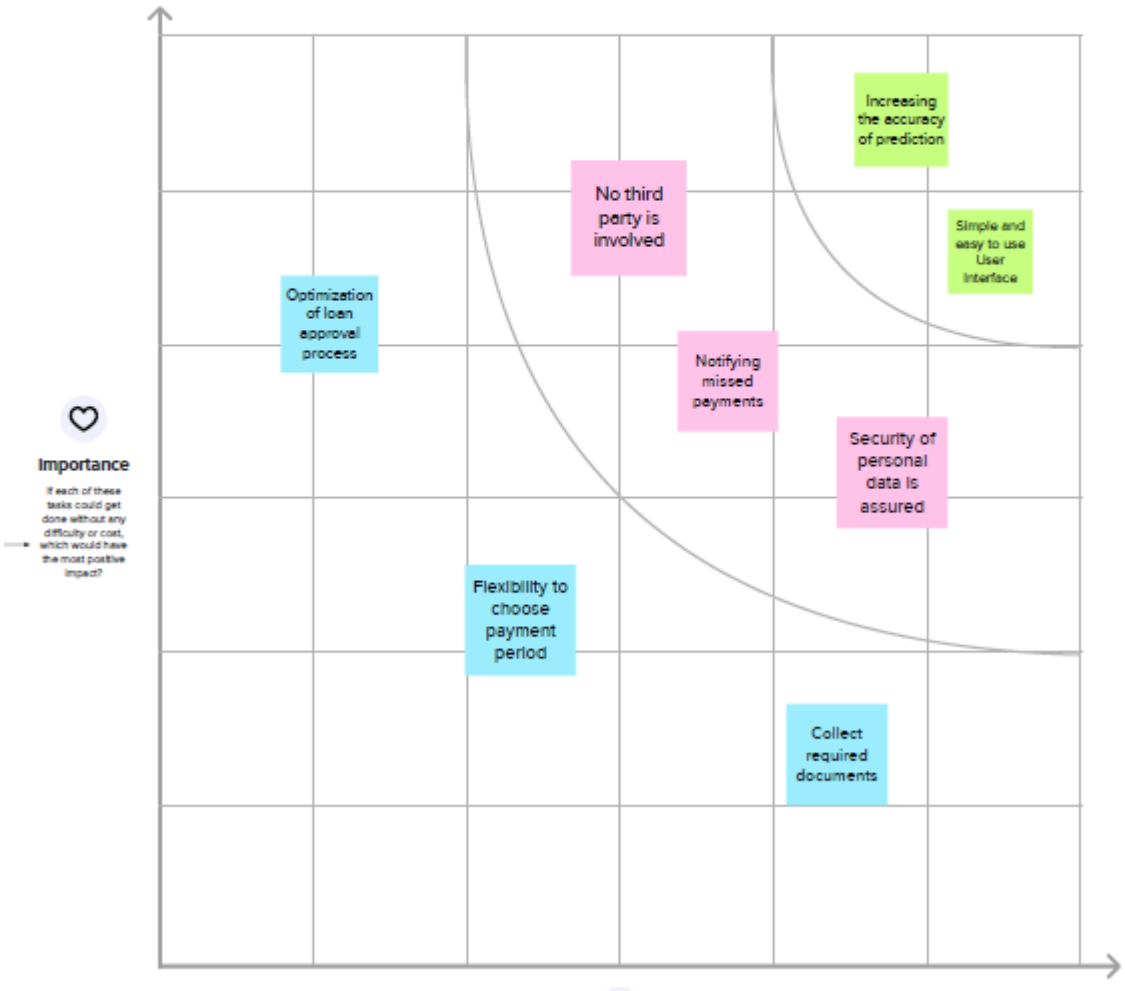


4

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



3.3 Proposed Solution:

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	• Tracking or checking the status is difficult. • Prone to human errors. • Time consumption is high. • Lot of paper works. • Poor customer service due to lack of man power.
2.	Idea / Solution description	• Tracking or checking the status becomes easy. • Reduce the potential for human error. • Time consumption of the process will be reduced. • Reduces the paper work to paperless. • Improve the effectiveness of customer service teams. • Fair eligibility prediction. We will be using classification algorithms such as Decision tree, Random Forest, KNN, and xgboost. We will train and test the data with these algorithms. From this the above ideas are implemented.
3.	Novelty / Uniqueness	As soon as the essential data are provided, the model will predict whether to approve the loan or not.
4.	Social Impact / Customer Satisfaction	One of the most important factors which affect our country's economy and financial condition is the credit system governed by the banks. As we know credit risk evaluation is very crucial, there is a variety of techniques are used for risk level calculation. In addition, credit risk is one of the main functions of the banking community.
5.	Business Model (Revenue Model)	This application can be developed with minimum cost at the same time it will provide the high performance and the result will be effective.
6.	Scalability of the Solution	Banks need not to go through the background verification process of the applicant by using this model. The model will predict the defaulter.

3.4 Problem Solution fit

Project Design Phase-I - Solution Fit Template

oject Title: Smart Lender - Applicant Credibility Prediction for Loan Approval.

Team ID: PNT2022TMID06709

Define CS, fit into CC

1. CUSTOMER SEGMENT(S) CS

- Banks or organizations which provide loans
- People who are in need of a loan

6. CUSTOMER CONSTRAINTS CC

- When the user's CIBIL score is less
- The user's required documents are missing
- The users criteria is not satisfied

5. AVAILABLE SOLUTIONS AS

- Approaching the banks in person and getting the loan
- Checking the user's loan credibility by their CIBIL score
- Checking user's loan credibility through past experiences

Explore AS, differentiate

Focus on J&P, tap into BE, understand RC

2. JOBS-TO-BE-DONE / PROBLEMS J&P

- Payment not done on correct time
- More time to sanction loan
- Missing essential documents
- Less income
- Abusing the credit

9. PROBLEM ROOT CAUSE RC

- No proper mechanism to alert the loan due
- High interest rate
- Getting loans beyond user's capability
- Not properly checking the necessary documents
- Verification is done manually

7. BEHAVIOUR BE

- Keeping track of payment dues
- Approaching third party
- Keeping all the essential documents ready
- Getting the loans only upto the user's capability

Focus on J&P, tap into BE, understand RC

Identify strong TR & EM

3. TRIGGERS TR

- Lot of time taken by banks or organization to approve the loan
- Advancement in technology
- Busy schedule of the user

10. YOUR SOLUTION SL

- Verifying the documents properly
- Providing loans only to capable users
- Accurately predicting the loan credibility of the user
- Securing the user's data
- Less time to approve loan
- Alerting the user's about payment dues
- Removing the involvement of third party

8. CHANNELS of BEHAVIOUR CH

8.1 ONLINE

Checking if they are applicable to get a loan through various means like browsing the internet.

8.2 OFFLINE

- Verifying if the bank is legit
- Checking if their data is not leaked by the bank

Identify strong TR & EM

4. EMOTIONS: BEFORE / AFTER EM

The users will feel frustrated because they need to wait for a long time to get their loan sanctioned. The banks also feel stressed because they manually need to analyze a lot of data.

4. REQUIREMENT ANALYSIS

4.1 Functional requirement

Following are the functional requirements of the proposed solution.

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	User Interaction	User register through a website
FR-2	User Input	Confirmation via Email Confirmation via OTP
FR-3	Data Collection	User enter their details and upload the required documents
FR-4	Data Verification	The data entered by the user should be in correct format as required by the trained model
FR-5	Predicting	The most accurate model is chosen for prediction
FR-6	Displaying the result	The prediction result is displayed in the user interface

4.2 Non-Functional requirement

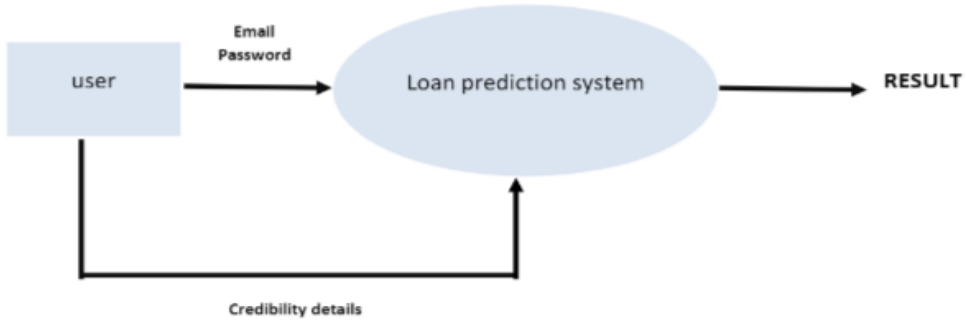
Following are the non-functional requirements of the proposed solution.

FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	Easy to use Smooth and seamless Easy to navigate
NFR-2	**Security**	Password protection Data are safe
NFR-3	**Reliability**	Up to date maintenance Durability and efficiency
NFR-4	**Performance**	No server traffic Quick prediction
NFR-5	**Availability**	platform independent Depending on requirement services are offered
NFR-6	**Scalability**	High accuracy Greater efficiency

5. PROJECT DESIGN

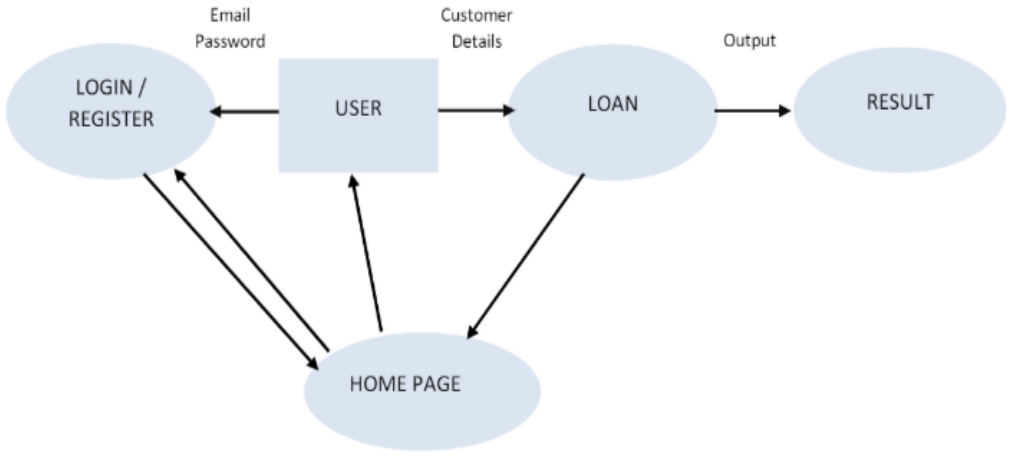
5.1 Data Flow Diagrams

0th Level Data Flow Diagram (DFD) :



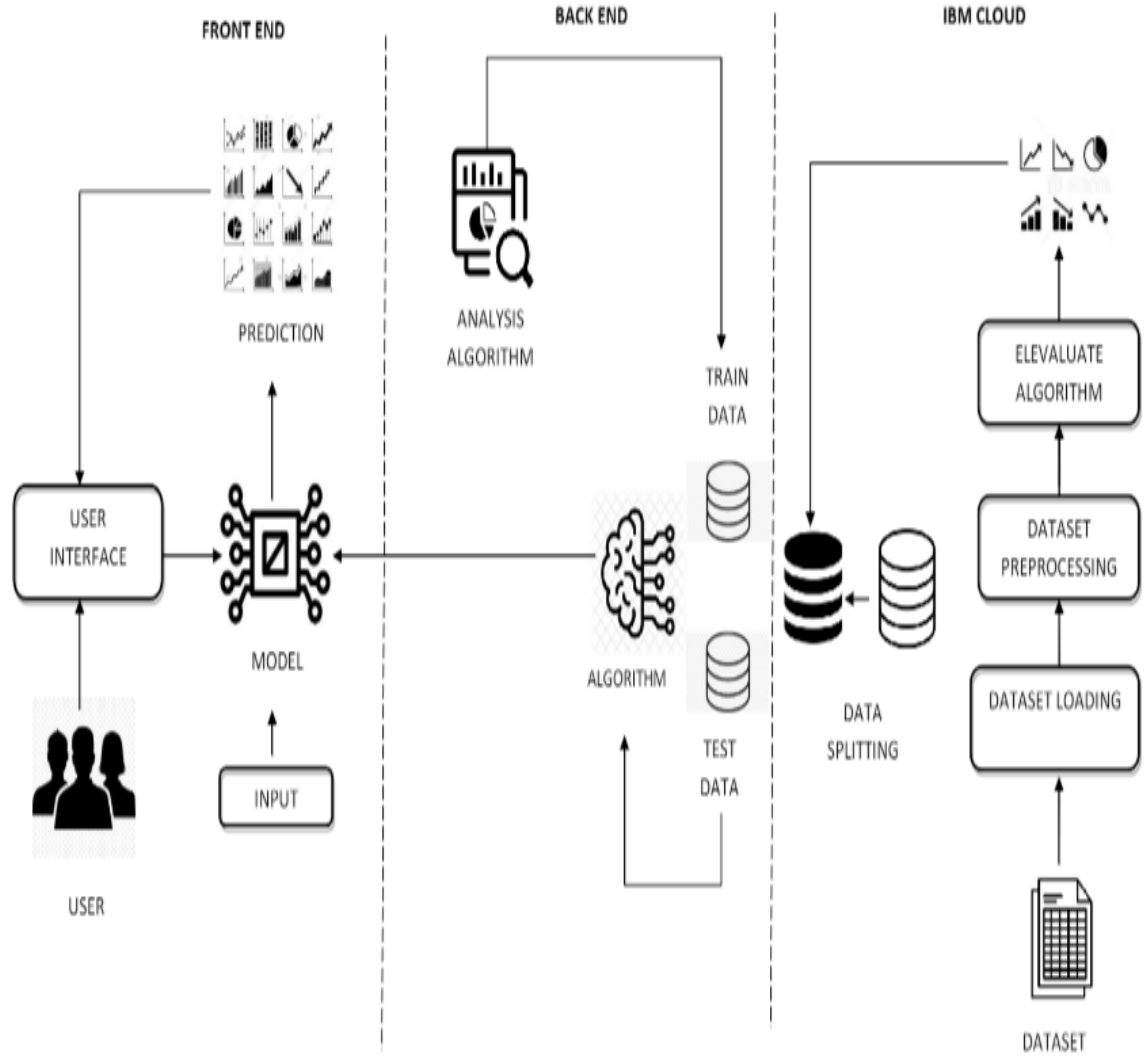
1th Level Data Flow Diagram (DFD) :

1th Level Data Flow Diagram (DFD) :



5.2 Solution & Technical Architecture

Technical Architecture:



5.3 User Stories

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Customer (Mobile user/PC user)	Registration	USN-1	As a user, I can register for the application by entering my email, password, and confirming my password.	I can access my account / dashboard	High	Sprint-1
		USN-2	As a user, I will receive confirmation email once I have registered for the application	I can receive confirmation email & click confirm	High	Sprint-1
		USN-3	As a user,I can register for the loan application through social medias	I can register and accessthe dashboard with social media accounts	Low	Sprint-2
		USN-4	As a user, I can register for the application through Google account	I can access my account and dashboard using my Google account	Medium	Sprint-1
	Login	USN-5	As a user, I can log into the application by entering email & password	I can login to my account using the registered email id and password only	High	Sprint-1
	Dashboard	USN-6	As a user, I can see if my loan is credible or not by clicking a button in my dashboard	I can view the details of the loan credibility	High	Sprint-1
Loan approval organization	Approve or disapprove loan	USN-7	As a lender I can approve or disapprove loan according to the prediction made by the system	I can make decision based on the prediction	High	Sprint-1
Administrator	Login/register	USN-8	As an administrator I should register and login to my account using a mail id and a secured password	I can access my account	High	Sprint-1
	Dashboard	USN-9	As an administrator I have access to every user's dashboard. So I can get their details for prediction	I can view and access user's dashboard	High	Sprint-1

6.PROJECT PLANNING & SCHEDULING

6.1 Sprint Planning & Estimation

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Registration	USN-1	As a user, I can register for the application by entering my email, password, and confirming my password.	5	High	Abirami P, Deepthi Sherona A
Sprint-1		USN-2	As a user, I can register for the application through Gmail	2	Medium	Pavithra K, Aro Punitha Mercy A
Sprint-1	Login	USN-3	As a user, I can log into the application by entering email & password	5	High	Deepthi Sherona A, Anuvitha G
Sprint-1	Dashboard	USN-4	As a user, I can see if my loan is credible or not by clicking a button in my dashboard	5	High	Abirami P, Anuvitha G
Sprint-1		USN-5	As an admin I must get user details from the dashboard	3	High	Pavithra K, Aro Punitha Mercy A
Sprint- 2	Data Collection	USN-6	As an admin I must collect necessary datasets for prediction	2	High	Pavithra K
Sprint-2	Data Visualization and analysis	USN-7	As an admin I must visualize and analyse the dataset	8	High	Abirami P, Aro Punitha Mercy A

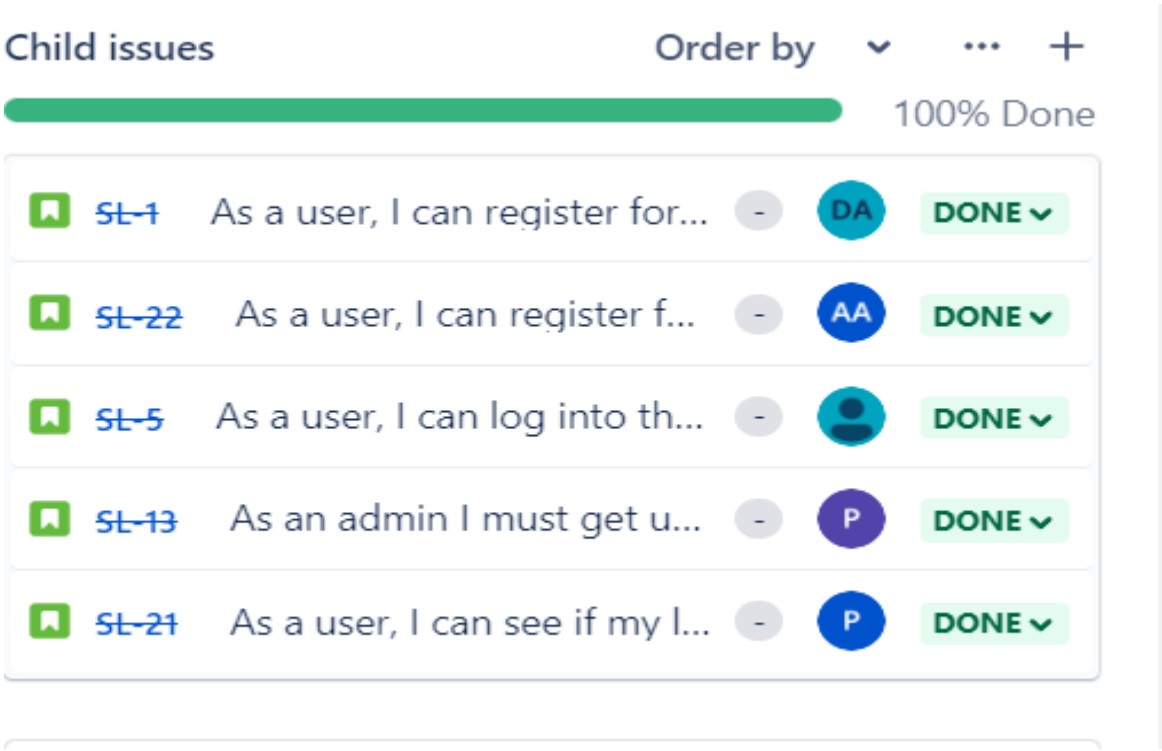
Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-2	Data Preprocessing	USN-8	As an admin I must pre process the data	8	High	Anuvitha G, Deepthi Sherona A,
Sprint-3	Model building	USN-8	As an administrator I must build a model that should get user data	8	High	Anuvitha G, Abirami P, Pavithra K
Sprint-3		USN-9	As an administrator I must use efficient algorithm to build the model	5	High	Deepthi Sherona A, Aro Punitha Mercy A
Sprint-4	Model Testing	USN-10	As an administrator I must test the model for efficient functioning	5	High	Abirami P
Sprint-4	Prediction	USN-11	As a user I must get an accurate prediction	5	High	Anuvitha G, Deepthi Sherona A
Sprint-4		USN-12	As a user I must get results if the loan is credible or not	2	High	Aro Punitha Mercy A, Pavithra K

6.2 Sprint Delivery Schedule

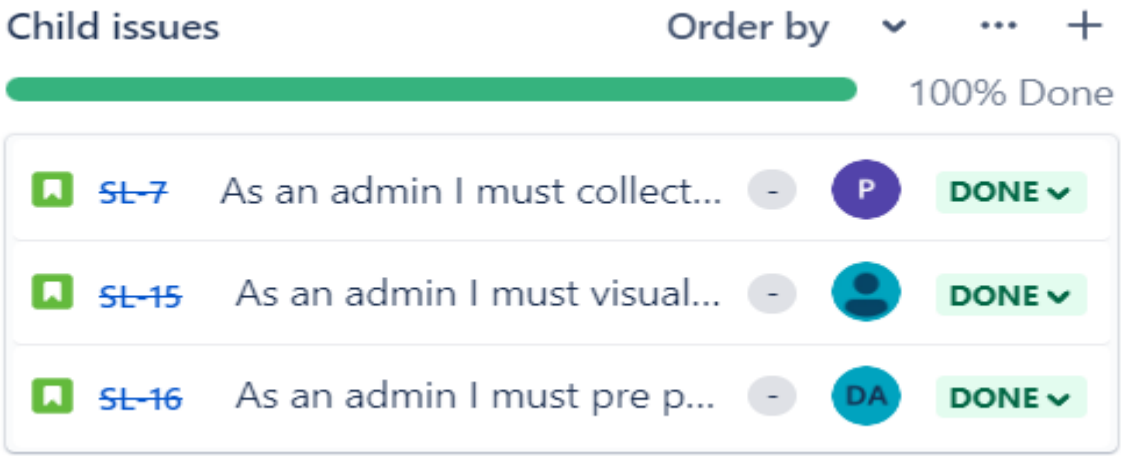
Sprint	Total Story Points	Duration	Sprint Start Date	Sprint End Date (Planned)	Story Points Completed (as on Planned End Date)	Sprint Release Date (Actual)
Sprint-1	20	6 Days	24 Oct 2022	29 Oct 2022	20	29 Oct 2022
Sprint-2	20	6 Days	31 Oct 2022	05 Nov 2022	18	31 Oct 2022
Sprint-3	20	6 Days	07 Nov 2022	12 Nov 2022	13	07 Nov 2022
Sprint-4	20	6 Days	14 Nov 2022	19 Nov 2022	12	19 Nov 2022

6.3 Reports from JIRA

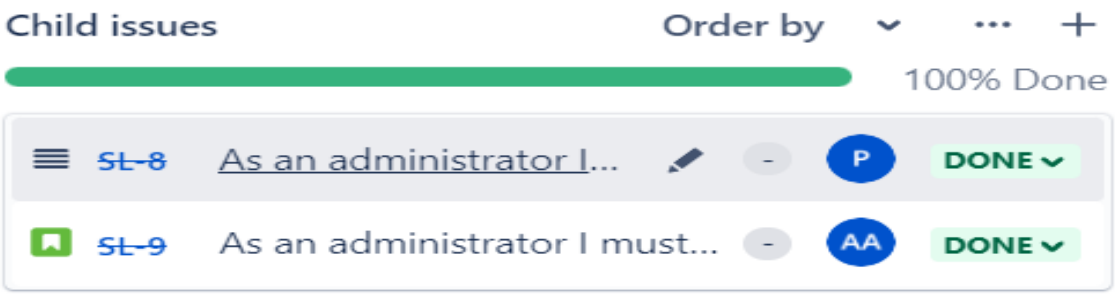
Sprint 1 :



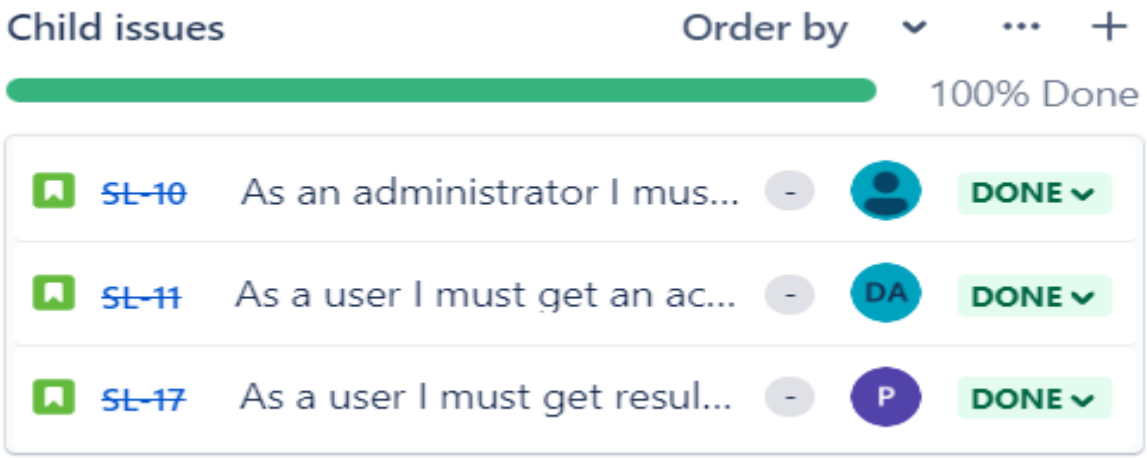
Sprint 2:



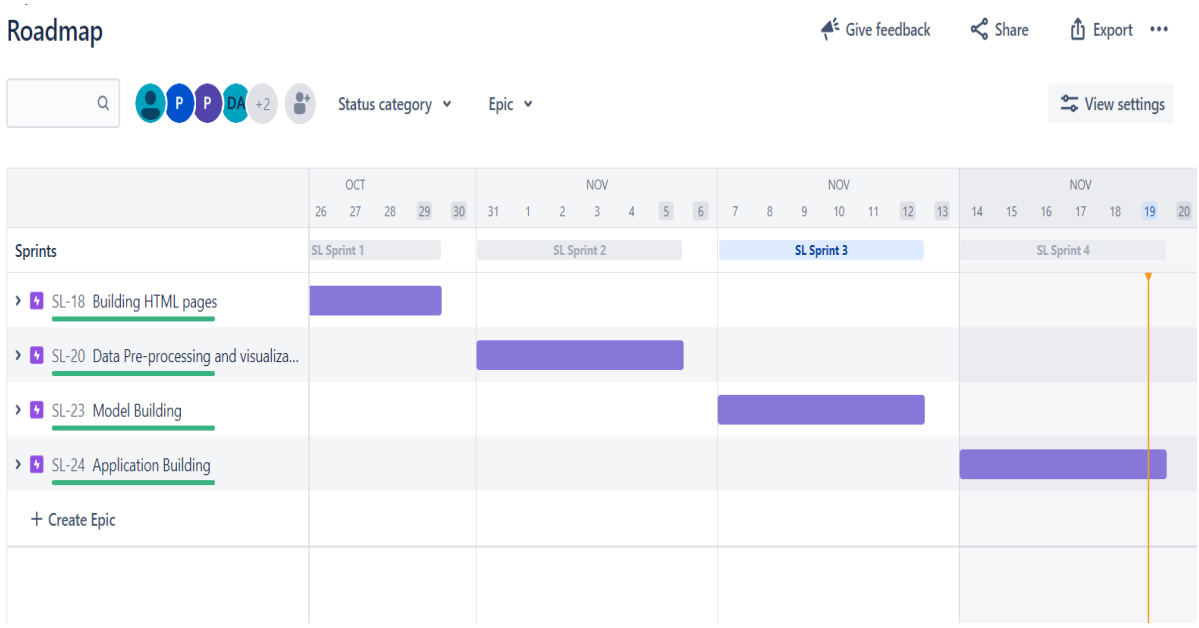
Sprint 3:



Sprint 4:



Final report:



7.CODING & SOLUTIONING

7.1 Feature 1

The customer first applies for a loan and after that, the company validates the customer eligibility for the loan.The customer wants to automate the loaneligibility process (real-time) based on their details provided while filling out online application forms. These details are Gender, Marital Status, Education, number of Dependents, Income, Loan Amount, Credit History, and others.To automate this process, we have provided a dataset to identify the customer segments that are eligible.

This model will characterize the behavior and eligibility of customers on the basis of their records. These records are taken from the customers, and a data set is created. With the help of these data sets and training machine learning model, the customer's loan credibility is checked.

The data consists of the following rows:

Loan_ID : Unique Loan ID
Gender : Male/ Female
Married : Applicant married (Y/N)
Dependents : Number of dependents
Education : Applicant Education (Graduate/ Under Graduate)
Self_Employed : Self employed (Y/N)
ApplicantIncome : Applicant income
CoapplicantIncome : Coapplicant income
LoanAmount : Loan amount in thousands of dollars
Loan_Amount_Term : Term of loan in months
Credit_History : credit history meets guidelines yes or no
Property_Area : Urban/ Semi Urban/ Rural
Loan_Status : Loan approved (Y/N) this is the target variable

7.2 Feature 2

As the process suggests the system requires information specific to the person to be fed into the system as an input and the system uses that data to analyses the same and come up with the outcomes specific to the loan eligibility of the person, based on that the loan may be approved or disapproved. The key principle that the system uses here is the inductive methods for the attributes and determine the eligibility condition for the specific applicant.

We have used multiple algorithms for training purposes like Decision Tree, Random Forest, SVC, Logistic Regression, XGB Regressor, etc.Among all the algorithms logistic regression performs best on the validation data with aaccuracy score of **82.7%**.

```
# Predict the model for testin data
predicted = logistic_model.predict(x_test)
# check the coefficeints of the trained model
print('Coefficient of model :', logistic_model.coef_)
```

Coefficient of model : [[3.316164 -0.3059193 0.09398266]]

```
# check the intercept of the model
print('Intercept of model',logistic_model.intercept_)
# Accuray Score on train dataset
# accuracy_train = accuracy_score(x_test, predicted)
score = logistic_model.score(x_train, y_train)
print('accuracy_score overall :', score)
print('accuracy_score percent :', round(score*100,2))
```

accuracy_score overall : 0.8094462540716613

accuracy_score percent : 80.94

```
# predict the target on the test dataset
predict_test = logistic_model.predict(x_test)
print('Target on test data',predict_test)
```

8.TESTING

8.1 User Acceptance Testing

4 marks

Test case ID	Feature Type	Component	Test Scenario	Steps To Execute	Test Data	Expected Result	Actual Result	Status	TC for Automation(Y/N)	Executed By
HomePage_TC_OO1	UI	Home Page	Verify user is able to see the contents and the predict button	1.Run the application 2.Verify if the contents and the button is visible or not.		The contents and button should display	Working as expected	Pass	N	Abirami P
HomePage_TC_OO2	Functional	Home Page	Verify if the user can navigate to the next page by clicking the button	1.Run the application 2.Click on Predict button 3.Verify if the user can navigate to the next page		The user should be able to navigate to the next page	Working as expected	Pass	N	Pavithra K
PredictPage_TC_OO1	UI	Predict page	Verify if the form is visible to the user	1.Run the application 2.Click on Predict button 3.See if the form us visible to the user or not		User should be able to view the form	Working as expected	Pass	N	Deepthi Sheron
PredictPage_TC_OO2	Functional	Predict page	verify if the users can enter the values in the form	1.Run the application 2.Click on Predict button 3.Enter Name, Loan ID, Gender, Marital status, Dependents, Education, Self-employed, Applicant income, Co-applicant income, Loan amount, Loan amount term, Credit history and property area.	Name: ALEX, Loan ID: 1 Gender:Male, Married:yes, Dependents:1, Education: Graduate Self-employed: yes , Applicant income: 3000 Co-applicant income: 0 Loan amount:66 Loan amount term: 360 Credit history: yes property area: urban	The user can enter the data in the form	Working as expected	Pass	N	Anuvitha G

Test case ID	Feature Type	Component	Test Scenario	Steps To Execute	Test Data	Expected Result	Actual Result	Status	TC for Automation(Y/N)	Executed By
PredictPage_TC_OO3	Functional	Predict page	Verify if all fields are required field	1.Run the application 2.Click on Predict button 3.Enter Name, Loan ID, Gender, Marital status, Dependents, Self-employed, Applicant income, Co-applicant income, Loan amount, Loan amount term, Credit history and property area. 4.Click the predict button	Name: ALEX, Loan ID: 1 Gender:Male, Married:yes, Dependents:1, Education: Nil Self-employed: yes , Applicant income: 3000 Co-applicant income: 0 Loan amount:66 Loan amount term: 360 Credit history: yes property area: urban	The user should not be able to navigate to the next page	Working as expected	Pass	N	Aro Punitha Me
PredicPage_TC_OO4	Functional	Predict page	Verify if the user is able to navigate to the result page	1.Run the application 2.Click on Predict button 3.Enter Name, Loan ID, Gender, Marital status, Dependents, Education, Self-employed, Applicant income, Co-applicant income, Loan amount, Loan amount term, Credit history and property area. 4.Click the predict button	Name: ALEX, Loan ID: 1 Gender:Male, Married:yes, Dependents:1, Education: Graduate Self-employed: yes , Applicant income: 3000 Co-applicant income: 0 Loan amount:66 Loan amount term: 360 Credit history: yes property area: urban	The user should be able to navigate to the next page.	Working as expected	Pass	N	Pavithra K

Test case ID	Feature Type	Component	Test Scenario	Steps To Execute	Test Data	Expected Result	Actual Result	Status	TC for Automation(Y/N)	Executed By
ubmitPage_TC_OO1	UI	Submit page	Verify if the user is able to navigat	1.Run the application 2.Click on Predict button 3.Enter Name, Loan ID, Gender, Marital status, Dependents, Education, Self-employed, Applicant income, Co-applicant income, Loan amount, Loan amount term, Credit history and property area. 4.Click the predict button	Name: ALEX, Loan ID: 1 Gender:Male, Married:yes, Dependents:1, Education: Graduate Self-employed: yes , Applicant income: 3000 Co-applicant income: 0 Loan amount:66 Loan amount term: 360 Credit history: yes property area: urban	The user should see the submit page	rking as exped	Pass	N	Abirami P
ubmitPage_TC_OO2	Functional	Submit page	Verify if the user can see loan is ac	1.Run the application 2.Click on Predict button 3.Enter Name, Loan ID, Gender, Marital status, Dependents, Education, Self-employed, Applicant income, Co-applicant income, Loan amount, Loan amount term, Credit history and property area. 4.Click the predict button	Name: ALEX, Loan ID: 1 Gender:Male, Married:yes, Dependents:1, Education: Graduate Self-employed: yes , Applicant income: 3000 Co-applicant income: 0 Loan amount:66 Loan amount term: 360 Credit history: yes property area: urban	The user should get loan approval m	rking as exped	Pass	N	Anuvitha G
SubmitPage_TC_OO3	Functional	Submit page	Verify if the user can see loan is re	1.Run the application 2.Click on Predict button 3.Enter Name, Loan ID, Gender, Marital status, Dependents, Education, Self-employed, Applicant income, Co-applicant income, Loan amount, Loan amount term, Credit history and property area. 4.Click the predict button	Name: ALEX, Loan ID: 1 Gender:Male, Married:yes, Dependents:1, Education: Graduate Self-employed: yes , Applicant income: 3000 Co-applicant income: 0 Loan amount:66 Loan amount term: 360 Credit history: yes property area: urban	The user's loan approval should be re	rking as exped	Pass	N	Deepthi Sheror

9.RESULTS

9.1 Performance Metrics

S. No	Parameters	values
1.	Metrics	Confusion matrix: [[73 22] [11 112]] Classification report: precision recall f1-score support 0 0.87 0.77 0.82 95 1 0.84 0.91 0.87 123 accuracy 0.85 218 macro avg 0.85 0.84 0.84 218 weighted avg 0.85 0.85 0.85 218

Random forest classifier:

```
In [71]: rf=RandomForestClassifier()
         rf.fit(x_train,y_train)
         ypred=rf.predict(x_test)

In [72]: f1_score(ypred,y_test,average='weighted')

Out[72]: 0.8503838489843778

In [73]: cv=cross_val_score(rf,x,y,cv=5)

In [74]: np.mean(cv)

Out[74]: 0.7833933093429295
```

10.ADVANTAGES & DISADVANTAGES

Advantages:

- It is productive to know all the bank details.
- The loan descriptions helps people to know about the loan schemes. And also excitement to know loan eligiblity.
- The users can get the result within a short period of time
- High accuracy algorithm is used to predict the result
- The demand of loan depends on liability of documents submitted.
- The user's document need not be verified manually which will take a lot of time.
- Performance and accuracy of the algorithms can be calculated and compared.

Disadvantages:

- Delay of login time due to network traffics.
- Users are confused whether their data is stored in website.
- Sometimes it takes more time to load the process.
- User gets disturbed by interrupted ads while looking through app.
- Customers review may be violent if they face bad experience.
- The users need a knowledge of how to use the application.
- Even though the application gives results but we cannot give assurity that the user will repay the loan correctly.
- The prediction of this model is only 82% accurate.

11.CONCLUSION

As you have researched, loans are expensive. Sometimes we need to consider the opportunity cost of decisions we make. Although we can afford the montly payment for a vehicle loan, we need to look at how much interest on the loan will cost us. Having a better understanding of loans and interest rates will help you make large purchase decisions in the future.The number of applications is increasing every day for loan approval. There are some bank policies that they have to consider while selecting an applicant for loan approval. Based on some parameters, the bank has to decide which one is best for approval. It is tough and risky to check out manually every person and then recommended for loan approval. In this work, we use a machine learning technique that will predict the person who is reliable for a loan, based on the previous record of the person whom the loan amount is accredited before. This work's primary objective is to predict whether the loan approval to a specific individual is safe or not.

12.FUTURE SCOPE

- In future, we can make the Bank Loan Approval prediction to connect with Cloud for future use to optimize the work to implement in Artifcial Intelligence environment.
- Using this model to compare various machine learning algorithm generated prediction models and the model which will give higher accuracy will be chosen as the prediction model.
- In future, we use best algorithm to predict a loan approval process to provide 100% accuracy.
- Embed many things to develop a mobile application which will useful for customers able to access our application anywhere at anytime.
- By using Natural Languague Processing technique to let user to interact with interface easily.
- Placing Virtual Assisstent Chat Bot that clarifies customers queries easily.

13.APPENDIX

Source code:

HOME.HTML

```
<!DOCTYPE html>
<html lang="en">
<head>
   <meta charset="UTF-8" />
   <meta http-equiv="X-UA-Compatible" content="IE=edge" />
   <meta name="viewport" content="width=device-width, initial-scale=1.0" />
   <title>SMART LENDER</title>
   <style>
@import
url("https://fonts.googleapis.com/css2?family=Aref+Ruqaa+Ink:wght@700&display=
swap);
@importurl("https://fonts.googleapis.com/css2?family=EB+Garamond&display=swa
p"); @import
url("https://fonts.googleapis.com/css2?family=Antic+Slab&display=swap");
      html {
         user-select: none;
      }
      body {
         margin-top: 5%;
         color: white;
      }
      html {

         /* background-image: linear-gradient(to right top, #d16ba5, #c777b9,
#ba83ca, #aa8fd8, #9a9ae1, #8aa7ec, #79b3f4, #69bff8, #52cffe, #41dfff, #46eefa,
#5ffbf1); */
         background: linear-gradient(#36d1dc, #5b86e5);
         height: 100%;
         background-position: center;
         background-repeat: no-repeat;
         background-size: cover;
         object-fit: cover;
      }

      h1 {
```

```
    font-size: 45px;
    font-family: "Aref Ruqaa Ink", serif;
}

h3 {
    font-size: 20px;
    font-family: "Antic Slab", serif;
}

h6 {
    font-size: 20px;
    font-family: "Antic Slab", serif;
}
.container,
.container:before,
.container:after {
    box-sizing: border-box;
    padding: 0;
    margin: 0;
    font: 300 1em/1.5 "Open Sans", "Helvetica Neue", Arial, sans-serif;
    text-decoration: none;
    color: #111;
}
.btn {
    background: rgba(236, 240, 241, 0.425);
}
.container {
    min-width: 500px;
    margin: 5% auto;
    text-align: center;
}
button:hover {
    cursor: pointer;
}
button {
    background: transparent;
    outline: none;
    position: relative;
    border: 3px solid #fff;
    padding: 15px 50px;
```

```
    overflow: hidden;
    border-radius: 10px;
    font-family: "Aref Ruqaa Ink", serif;
}

button:hover:before {
    opacity: 1;
    transform: translate(0, 0);
}

button:before {
    content: attr(data-hover);
    position: absolute;
    top: 1.1em;
    left: 0;
    width: 100%;
    text-transform: uppercase;
    letter-spacing: 3px;
    font-weight: 800;
    font-size: 0.8em;
    opacity: 0;
}
button div {
    text-transform: uppercase;
    letter-spacing: 3px;
    font-weight: 800;
    font-size: 0.8em;
}
@media only screen and (max-width: 600px) {
 html {
        width: 100% !important;
    }

  body {
        margin-top: 110px;
    }
    h1 {
        font-size: 40px;
    }
    h3 {
```

```
            font-size: 15px;
        }


        .container {
            min-width: 200px;
        }

        .btn {
            margin-right: 2vh;
        }

        #d {
            letter-spacing: 0px;
            font-size: 14px;
        }

        #p {
            letter-spacing: 0px;
            font-size: 14px;
        }
    }
    .aboutdiv
    {
        margin-left: 0%;
    }
</style>
</head>

<body>
  <main>
    <center>
        <div class="aboutdiv">
            <a href="about.html">
                <button style="color: #ffffff ;" class="btn"  onclick="about.html">
                    <div>About</div>
                </button>
            </a>
        </div>
        <h1>WELCOME TO SMART PREDICTOR</h1>
```

```
        <br>
        <h3>Check your loan credibility here</h3>
        <h6>
           Click the  Predict  button and enter your details to get the prediction
        </h6>

        <div class="container">
           <a href="predict.html">
              <button style="color: #ffffff ;" class="btn"  onclick="predict.html">
                 <div>Predict</div>
              </button>
           </a>
        </div>
     </center>
  </main>
</body>
</html>
```

PREDICT.HTML

```
<!DOCTYPE html>
<html lang="en">

<head>
   <meta charset="UTF-8" />
   <meta http-equiv="X-UA-Compatible" content="IE=edge" />
   <meta name="viewport" content="width=device-width, initial-scale=1.0" />
   <title>SMART LENDER</title>
   <style>
      @import
url("https://fonts.googleapis.com/css2?family=Aref+Ruqaa+Ink:wght@700&display=
swap");
      @import
url("https://fonts.googleapis.com/css2?family=Albert+Sans&display=swap");
      @import
url("https://fonts.googleapis.com/css2?family=EB+Garamond&display=swap");

      html {
         height: 100%;
```

```
    }

    body {
        margin: 0;
        margin-bottom: 50%;
        padding: 0;
        font-family: sans-serif;
        /* background: linear-gradient(#36d1dc, #5b86e5); */
        background-image: linear-gradient(to right top, #d16ba5, #c777b9, #ba83ca,
#aa8fd8, #9a9ae1, #8aa7ec, #79b3f4, #69bff8, #52cffe, #41dfff, #46eefa, #5ffbf1);
        height: 10%;
        background-position: center;
        background-repeat: no-repeat;
        background-size: cover;
        background-attachment: fixed;
        object-fit: fill;
    }

    .login-box {
        position: absolute;
        top: 100%;
        left: 50%;
        width: 600px;
        padding: 40px;
        transform: translate(-50%, -50%);
        background: rgba(0, 0, 0, 0.5);
        box-sizing: border-box;
        box-shadow: 0 15px 25px rgba(0, 0, 0, 0.6);
        border-radius: 10px;
    }

    ::placeholder {
        color: aliceblue;
    }

    .login-box h2 {
        margin: 0 0 30px;
        padding: 0;
        color: #fff;
        text-align: center;
```

```
}

.fon {
    color: #fff;
    text-align: center;
    font-family: "Albert Sans", sans-serif;
}

.login-box .user-box {
    position: relative;
}

.login-box .user-box input {
    width: 100%;
    padding: 10px 0;
    font-size: 16px;
    color: #fff;
    margin-bottom: 30px;
    border: none;
    border-bottom: 1px solid #fff;
    outline: none;
    background: transparent;
}

.login-box .user-box label {
    position: absolute;
    top: 0;
    left: 0;
    padding: 10px 0;
    font-size: 16px;
    color: #fff;
    pointer-events: none;
    transition: 0.5s;
}

.login-box .user-box input:focus~label,
.login-box .user-box input:valid~label {
    top: -20px;
    left: 0;
    color: #FCDDB0;
```

```
    font-size: 12px;
}

/*--- Button */

.container,
.container:before,
.container:after {
    box-sizing: border-box;
    padding: 0;
    margin: 0;
    font: 300 1em/1.5 "Open Sans", "Helvetica Neue", Arial, sans-serif;
    text-decoration: none;
    color: #111;
}

.btn {
    background: rgba(236, 240, 241, 0.425);
    font-family: "Aref Ruqaa Ink", serif;
}

.container {
    min-width: 500px;
    margin: 5% auto;
    text-align: center;
}

button:hover {
    cursor: pointer;
}

button {
    background: transparent;
    outline: none;
    position: relative;
    border: 3px solid #fff;
    padding: 15px 50px;
    overflow: hidden;
}
button:before {
```

```
        content: attr(data-hover);
        position: absolute;
        top: 1.1em;
        left: 0;
        width: 100%;
        text-transform: uppercase;
        letter-spacing: 3px;
        font-weight: 800;
        font-size: 0.8em;
        opacity: 0;

    }



    button div {
        text-transform: uppercase;
        letter-spacing: 3px;
        font-weight: 800;
        font-size: 0.8em;
    }
@media only screen and (max-width: 600px) {
        .login-box {
            width: 300px;
        }
        .container {
            min-width: 200px;
        }
        #d {
            letter-spacing: 0px;
            font-size: 14px;
        }

        #p {
            letter-spacing: 0px;
            font-size: 14px;
        }
        .fon {
            font-size: 15px;
        }
```

```
    }
  </style>
</head>

<body>
  <div class="login-box">
    <h2 style="text-transform: uppercase; font-family: 'Aref Ruqaa Ink', serif">
      Smart Predictor Form<br />
          </h2>
    <br />
    <form action="/submit" method="post">
      <div class="user-box">
        <input type="text" name="" required="" onfocus="this.placeholder='Enter
your name'"
          onblur="this.placeholder='' />
        <label>Name</label>
      </div>
      <div class="user-box">
        <input type="text" name="Loan_ID" required=""
onfocus="this.placeholder='Enter your Loan ID'"
          onblur="this.placeholder='' />
        <label>Loan ID</label>
      </div>
      <div class="user-box">
        <input list="gender" type="data-list" name="Gender" required=""
onchange="resetIfInvalid(this);"
          onfocus="this.placeholder='Enter your Gender'"
onblur="this.placeholder='' />
        <label>Gender</label>
        <datalist id="gender" name="gender">
          <option value="Male"></option>
          <option value="female"></option>
        </datalist>
      </div>
      <div class="user-box">
        <input list="married" type="text" name="Married" required=""
onchange="resetIfInvalid(this);"
          onfocus="this.placeholder='Enter your Marital Status'"
onblur="this.placeholder='' />
        <label>Married</label>
```

```
            <datalist id="married" name="married">
              <option value="yes"></option>
              <option value="no"></option>
            </datalist>
          </div>
          <div class="user-box">
            <input list="dep" type="text" name="Dependents" required=""
onchange="resetIfInvalid(this);"
           onfocus="this.placeholder='Enter your Dependents'"
onblur="this.placeholder="" />
            <label>Dependents</label>
            <datalist id="dep" name="dep">
              <option value="0"></option>
              <option value="1"></option>
              <option value="2"></option>
              <option value="3+"></option>
            </datalist>
          </div>
          <div class="user-box">
            <input list="edu" type="text" name="Education" required=""
onchange="resetIfInvalid(this);"
              onfocus="this.placeholder='Enter your Educational Qualification'"
onblur="this.placeholder="" />
            <label>Education</label>
            <datalist name="edu" id="edu">
              <option value="Graduate"></option>
              <option value="Non-Graduate"></option>
            </datalist>
          </div>
          <div class="user-box">
            <input list="emp" type="text" name="Self_Employes" required=""
onchange="resetIfInvalid(this);"
              onfocus="this.placeholder='Are you self employed?'"
onblur="this.placeholder="" />
            <label>Self Employed</label>
            <datalist name="emp" id="emp">
              <option value="yes"></option>
              <option value="no"></option>
            </datalist>
          </div>
```

```
        <div class="user-box">
          <input type="number" name="ApplicantIncome" required=""
            onfocus="this.placeholder='Enter your Income '"
onblur="this.placeholder="" />
          <label>Applicant Income</label>
        </div>
        <div class="user-box">
          <input type="number" name="CoaaplicantIncome" required=""
            onfocus="this.placeholder='Enter your CO Applicant Income '"
            onblur="this.placeholder="" />
          <label>CO Applicant Income</label>
        </div>
        <div class="user-box">
          <input type="number" name="LoanAmount" required=""
 onfocus="this.placeholder='Enter your Loan Amount'" onblur="this.placeholder="" />
          <label>Loan Amount</label>
        </div>
        <div class="user-box">


          <input type="number" name="Loan_Amount_Term" required=""
            onfocus="this.placeholder='Enter your loan amount term'"
onblur="this.placeholder="" />
          <label>Loan Amount Term</label>
        </div>
        <div class="user-box">
          <input list="credit" type="text" name="Credit_History" required=""
onchange="resetIfInvalid(this);"
            onfocus="this.placeholder='Enter your Credit History'"
onblur="this.placeholder="" />
          <label>Credit History</label>
          <datalist name="credit" id="credit">
            <option value="yes"></option>
            <option value="no"></option>
          </datalist>
        </div>
        <div class="user-box">
          <input list="prop" type="text" name="Property_Area" required=""
onchange="resetIfInvalid(this);"
            onfocus="this.placeholder='Enter your area of the property'"
```

```
onblur="this.placeholder="" />
            <label>Property Area</label>
            <datalist name="prop" id="prop">
               <option value="Urban"></option>
               <option value="Rural"></option>
               <option value="Semi-Rural"></option>
            </datalist>
         </div>

         <div class="container">
            <a href="submit.html">
               <button style="color: #ffffff ;" class="btn" onclick="submit.html">
                  <div>PREDICT</div>
               </button>
            </a>
         </div>
      </form>
   </div>
</body>
<script>
   function resetIfInvalid(el) {
      //just for beeing sure that nothing is done if no value selected
      if (el.value == "") return;
      var options = el.list.options;
      for (var i = 0; i < options.length; i++) {
         if (el.value == options[i].value)
            //option matches: work is done
            return;
      }
      //no match was found: reset the value
      el.value = "";
   }
</script>

</html>
```

SUBMIT.HTML

```
<!DOCTYPE html>
<html lang="en">
```

```
<head>
    <meta charset="UTF-8">
    <meta http-equiv="X-UA-Compatible" content="IE=edge">
    <meta name="viewport" content="width=device-width, initial-scale=1.0">
    <title>SMART LENDER</title>
    <style>
        @import
url('https://fonts.googleapis.com/css2?family=Aref+Ruqaa+Ink:wght@700&display=
swap');
        @import
url('https://fonts.googleapis.com/css2?family=EB+Garamond&display=swap');
        body {
            color: white;
            font-family: 'Aref Ruqaa Ink', serif;
         /*  background: linear-gradient(#36d1dc, #5b86e5);*/

          background-image: linear-gradient(to right top, #d16ba5, #c777b9, #ba83ca,
#aa8fd8, #9a9ae1, #8aa7ec, #79b3f4, #69bff8, #52cffe, #41dfff, #46eefa, #5ffbf1);
            height: 10%;
            background-position: center;
            background-repeat: no-repeat;
            background-size: cover;
            background-attachment: fixed;
            object-fit: fill;
        }
        .output {
            margin-top: 15%;
        }
    @media only screen and (max-width: 600px) {
    body {
                margin-top: 30vh;
            }
    }
        .feedback-button {
```

```
        height: 40px;
        border: solid 3px #CCCCCC;
        background:#d16ba5;
        width: 100px;
        line-height: 32px;
        -webkit-transform: rotate(-90deg);
        font-weight: 600;
        color: white;
        transform: rotate(-90deg);
        -ms-transform: rotate(-90deg);
        -moz-transform: rotate(-90deg);
        text-align: center;
        font-size: 17px;
        position: fixed;
        right: -40px;
        top: 45%;
        font-family: "Roboto", helvetica, arial, sans-serif;
        z-index: 999;
#feedback-main {
        display: none;
        float: left;
        padding-top: 0px;
    }
 #feedback-div {
        background-color: rgba(72, 72, 72, 0.4);
        padding-left: 35px;
        padding-right: 35px;
        padding-top: 35px;
        padding-bottom: 50px;
        width: 450px;
        float: left;
        left: 50%;
        position: absolute;
```

```
            margin-top: 30px;
            margin-left: -260px;
            -moz-border-radius: 7px;
            -webkit-border-radius: 7px;
        }
 .feedback-input:focus {
            background: #fff;
            box-shadow: 0;
            border: 3px solid #3498db;
            color: #3498db;
            outline: none;
            padding: 13px 13px 13px 54px;
        }
        input{
            border-radius: 5px;
        }
    </style>
    <script>
        function toggle_visibility() {
      var e = document.getElementById('feedback-main');
      if(e.style.display == 'block')
         e.style.display = 'none';
      else
         e.style.display = 'block';
   }
    </script>
</head>
<body>
    <div id="feedback-main">
        <div id="feedback-div">

         <form action="contact.php" method="post" class="form" id="feedback-form1"
name="form1" enctype="multipart/form-data" target="_blank">
```

```
          <p class="name">
            <input name="name" type="name"
class="validate[required,custom[onlyLetter],length[0,100]] feedback-input" required
placeholder="Name" id="feedback-name" />
          </p>
          <p class="email">
            <input name="email" type="email" class="validate[required,custom[email]]
feedback-input" id="feedback-email" placeholder="Email" required />
          </p>
          <p class="text">
            <textarea name="comment" type="comment"
class="validate[required,length[6,300]] feedback-input" id="feedback-comment"
required placeholder="Enter your Feedback here..."></textarea>
          </p>

          <div class="feedback-submit">
            <input type="submit" value="SEND" id="feedback-button-blue" />
            <div class="feedback-ease"></div>
          </div>
        </form>
      </div>
    </div>
    <button id="popup" class="feedback-button"
onclick="toggle_visibility()">Feedback</button>
        <script src="_include/js/feedback.js"></script>
  <main class="output">
      <center>
        <h1>SMART PREDICTOR</h1>
        <h3>{{prediction_text}}</h3>
      </center>
  </main>

</body>
</html>
```

APP.PY

```
from flask import render_template,Flask,request
import numpy as np
import pickle
import requests

# NOTE: you must manually set API_KEY below using information retrieved from your
IBM Cloud account.
API_KEY = "X51GudBOO3ZRQLfYbghe7-wxk3sx8gjehK0AUurC7om3"
token_response = requests.post('https://iam.cloud.ibm.com/identity/token',
data={"apikey":API_KEY, "grant_type": 'urn:ibm:params:oauth:grant-type:apikey'})
mltoken = token_response.json()["access_token"
header = {'Content-Type': 'application/json', 'Authorization': 'Bearer ' + mltoken}
app= Flask(__name__, template_folder='TEMPLATES')
scale = pickle.load(open('scalare.pkl','rb'))
@app.route('/')
def home():
    return render_template('home.html')
@app.route('/predict.html')
def formpg():
    return render_template('predict.html')
@app.route('/submit',methods = ['POST'])
def predict():

loan_num,gender,married,depend,education,self_emp,applicant_income,co_income,lo
an_amount,loan_term,credit_history,property_area = [x for x in request.form.values()]
    if gender == 'Male':
        gender = 1
    else:
        gender = 0

    if married == 'Yes':
        married = 1
    else:
```

```
    married = 0

if education == 'Graduate':
    education = 0
else:
    education = 1

if self_emp == 'Yes':
    self_emp = 1
else:
    self_emp = 0

if depend == '3+':
    depend = 3

applicant_income = int(applicant_income)
applicant_income = np.log(applicant_income)
loan_amount = int(loan_amount)
loan_amount = np.log(loan_amount)

if credit_history == 'Yes':
    credit_history = 1
else:
    credit_history = 0

if property_area == 'Urban':
    property_area = 2

elif property_area == 'Rural':
    property_area = 0
else:
    property_area = 1

features =
```

```
[[gender,married,depend,education,self_emp,applicant_income,co_income,loan_amo
unt,loan_term,credit_history,property_area]]
    #con_features = [np.array(features)]
    scale_features = scale.fit_transform(features)
    sf = scale_features.tolist()

    payload_scoring = {"input_data": [{"fields":
['gender','married','depend','education','self_emp','applicant_income','co_income','loan_a
mount','loan_term','credit_history','property_area'], "values": sf}]}

    response_scoring = requests.post('https://us-
south.ml.cloud.ibm.com/ml/v4/deployments/3db3d589-8548-4fa2-843f-
e06a335e6989/predictions?version=2022-11-18',
json=payload_scoring,headers={'Authorization': 'Bearer ' + mltoken})
    print("response_scoring")
    prediction = response_scoring.json()
    predict = prediction['predictions'][0]['values'][0][0]
    #prediction = model.predict(scale_features)
    if predict == 0:
        return render_template('submit.html', prediction_text ='You are eligible for loan')
    else:
        return render_template('submit.html',prediction_text = 'Sorry you are not eligible
for loan')
if __name__ == "__main__":
    app.run(debug=True)
```

Github and project demo link:

Githhub: https://github.com/IBM-EPBL/IBM-Project-23144-1659869278

Project demo:
https://drive.google.com/file/d/1LJj7vbvfOVrukG7jUEnjwrHTN1gyRlIH/view?usp=share_link