TEAM ID: PNT2022TMID00521

SMART LENDER-APPLICANT PREDICTION FOR LOAN APPROVAL

Team Leader

RAGHUL.R

Team Members

RAGHUL.D
PRABHAKARAN.S
RAAHULL.R

CHAPTER -1
INTRODUCTION

1. INTRODUCTION

Banks make the majority of their income through loans. Loan approval is a critical step for financial institutions. It is extremely difficult to estimate the probability of loan repayment by customers due to a growing incidence of loan defaults, and banking authorities are finding it increasingly difficult to appropriately access loan requests and address the dangers of individuals defaulting on loans. Many scholars have focused on loan approval system prediction in recent years. Machine learning is a powerful tool for predicting outcomes from massive amounts of data. A large amount of a bank's assets are directly derived from interest earned on loans made. Lending loans has significant risks, including the borrower's inability to repay the loan within the time frame specified. It is known as "credit risk." The worthiness of an applicant for loan acceptance or rejection was determined by a numerical score known as a "credit score." As a result, the use of various Machine Learning approaches that properly identify people to lend to and assist banks in identifying loan defaulters for much-reduced credit risk.To anticipate client loan acceptance, four algorithms are used: the Random Forest method, the Decision Tree algorithm, the KNN algorithm, and the XGBoost algorithm. All four methods will be run on the same dataset to select the approach with the highest accuracy for deploying the model. We will now create a bank loan prediction system listing machine learning techniques, so that the system will automatically identify the most qualified people to authorize the loan.

1.1 Project Overview

Loan Prediction is extremely beneficial to both bank employees and applicants. The goal is to give a quick, straightforward approach to choose qualified applicants. They have a presence in all urban, suburban, and rural regions. After that firm or bank checks the consumer's loan eligibility,the customer applies for a loan or not.Based on the criteria loan approval or rejection will be provided to the applicants.

1.3 Purpose

One of the most significant financial instruments is the loan. Every bank is attempting to come up with successful marketing techniques to get clients to apply for loans. Some consumers, meanwhile, behave badly once their applications are accepted. The solution is for banks to develop techniques for anticipating client behaviour. The banking industry frequently uses machine learning algorithms, which perform well for this purpose. Here, I'll be utilising machine learning models to anticipate lending behaviour. Finding the most appropriate model and relevant attribute identification.

CHAPTER-2
LITERATURE SURVEY

2.1 Existing System

Anomaly detection is based on individual behavior profiling and works by identifying any variation from the norm. It has three drawbacks when used to identify online banking fraud. First, for an individual, previous behavior data are frequently insufficient for profiling his/her behavior pattern. Second, due to the heterogeneous nature of transaction data, there is no standard handling of multiple attribute values, which might be a barrier to the model's development and future use. Third, the transaction data are extremely skewed, making efficient use of the label information difficult. Anomaly detection is frequently plagued by weak generalization and a high false alarm rate.

2.2 References

1. Arun Kumar, Ishan Garg and Sanmeer Kaur, Loan Approval Prediction based on Machine Learning Approach.

2. Mohamed El Mohadab, Belaid Bouikhalene and Said Safi, "Predicting rank for scientific research papers using supervised learning", Applied Computing and Informatics, vol. 15, pp. 182-190, 2019.

3. K. Hanumantha Rao, G. Srinivas, A. Damodhar and M. Vikas Krishna, "Implementation of Anomaly Detection Technique Using Machine Learning Algorithms", International Journal of Computer Science and Telecommunications, vol. 2, no. 3, June 2011.

4. J.R. Quinlan, Induction of decision trees, Machine learning Springer, vol. 1, no. 1, pp. 81-106, 1086.

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6. J.M. Chambers, "Computational methods for data analysis" in Applied Statistics, Wiley, vol. 1, no. 2, pp. 1-10.

7. Kumar Arun, Garg Ishan, Kaur Sanmeet, May-Jun. 2016. Loan Approval Prediction based on Machine Learning Approach, IOSR Journal of Computer Engineering (IOSR-JCE)
8. Wei Li, Shuai Ding, Yi Chen, and Shanlin Yang, Heterogeneous Ensemble for Default Prediction of Peer-to-Peer Lending in China, Key Laboratory of Process Optimization and Intelligent Decision-Making, Ministry of Education, Hefei University of Technology, Hefei 2009, China

2.3 Problem Statement Definition

R3P Housing Finance company deals in all kinds of home loans. They have a presence across all urban, semi-urban and rural areas. The customer first applies for a home loan and after that, the company validates the customer eligibility for the loan. Company wants to automate the loan eligibility process (real time) based on customer detail provided while filling online application form. These details are Gender, Marital Status, Education, Number of Dependents, Income, Loan Amount, Credit History and others. To automate this process, they have given a problem to identify the customers segments, those are eligible for loan amount so that they can specifically target these customers. Here they have provided a partial data set

LITERATURE SURVEY

TITLE 1: Improving Information Quality in Loan Approval Processes for Fair Lending and Fair Pricing

AUTHOR: M. Cary Collins

DESCRIPTION: Bank data management on loan approval processes has great room for improvements of information quality and data problems prevention especially with regards to fair lending and fair pricing practices. They first reviewed briefly typical data collection protocols deployed at many financial institutions for loan approval and loan pricing. Federal regulations mandate portions of these data protocols. While discussing the data capture and analysis for fair lending, they illustrated some initial key steps currently needed for improving information quality to all parties involved.

TITLE 2: Loan Credibility Prediction System Based on Decision Tree Algorithm

AUTHOR: Sivasree M S, Rekha Sunny T

DESCRIPTION: Data mining techniques are becoming very popular nowadays because of the wide availability of huge quantity of data and the need for transforming such data into knowledge. Data mining techniques are implemented in various domains such as retail industry, biological data analysis, intrusion detection, telecommunication industry and other scientific applications. Techniques of data mining are also be used in the banking industry which help them compete in the market well equipped. In this paper, they introduced a prediction model for the bankers that will help them predict the credible customers who have applied for a loan. Decision Tree Algorithm is being applied to predict the attributes relevant for credibility. A prototype of the model has been described in this paper which can be used by the organizations for making the right decisions to approve or reject the loan request from the customers.

TITLE 3: Loan Approval Prediction based on Machine Learning Approach

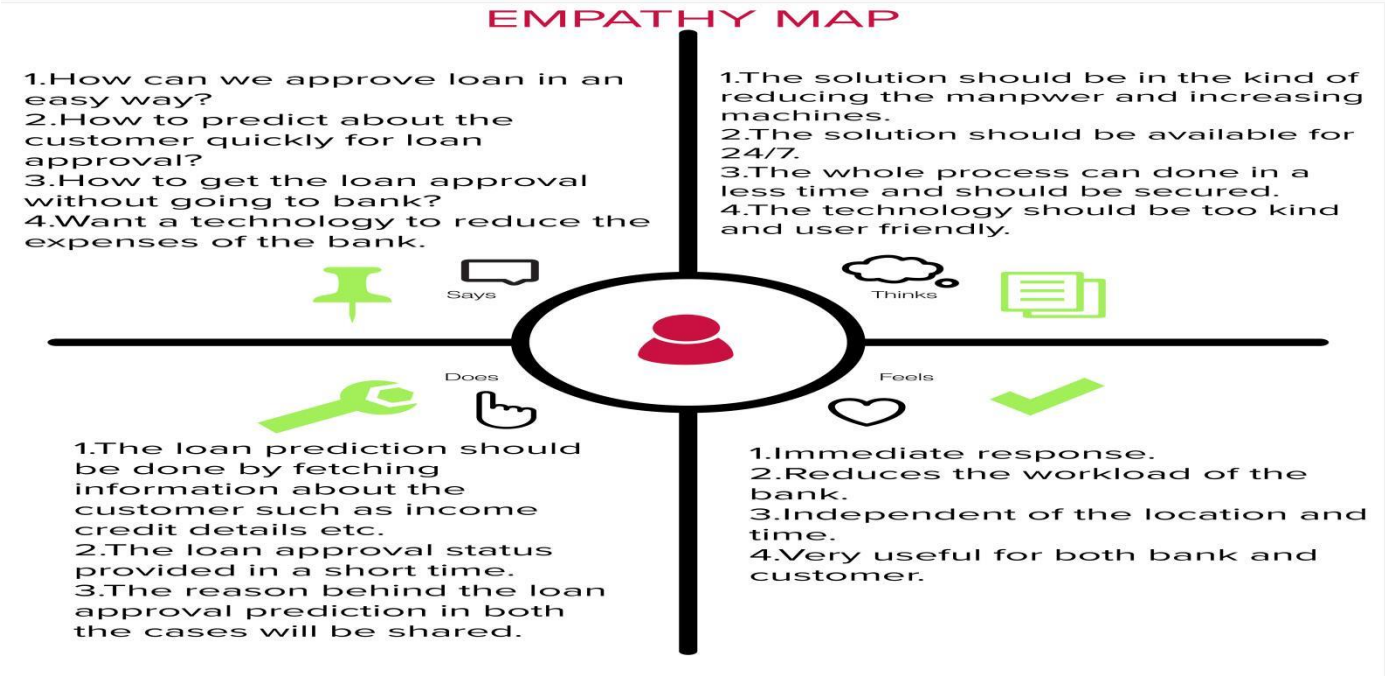
AUTHOR: Kumar Arun, Garg Ishan, Kaur Sanmeet

DESCRIPTION: With the enhancement in the banking sector, lots of people apply for bank loans but the bank has its limited assets which it grants to only limited people , so finding out to whom the loan can be granted is a typical process for the banks. So, in this paper , they tried to reduce this risk by selecting the safe person so as to save lots of bank efforts and asselt. The main goal of this paper is to predict if loan assignment to a specific person will be safe or not. This paper has into four sections (i) Collection of data (ii) Comparing the machine learning models on collected data (iii) Training the system on most promising.

CHAPTER-3
IDEATION AND PROPOSED SOLUTION

3.1 Empathy Map Canvas

The Empathy Map Canvas helps teams develop deep, shared understanding and empathy for other people. People use it to help them improve customer experience, to navigate organizational politics, to design better work environments, and a host of other things.



3.2 Ideation And Brainstroming

Brainstroming is the term which breaks any idea that come to our mind which addresses our problem statement.It deals to discuss the ides to the team members and gather the ideas from them.Each team members reveals their ideas about bank loan prediction such as check the loan amount of the applicant, Occupation of the applicant,Gender of the applicant,Marital status of the applicant,Identity proof of the applicant.It involves to collect group ideas,Ideas prioritization.

Template

Brainstorm & idea prioritization

In this Template share ideas and further ideas can be written here to modify accordingly , leader will modify these chart based on mentor feedback

- 2 months to prepare
- 1 month to collaborate
- 4 Members

Before you collaborate

We have to make sure wether the IBM management provide us good data , we have to make proper planning , analyzing the problem and learn additional skills like storytelling , stakeholder analysis , etc.

A Team gathering
RAGHUL R(team leader) will gather group and instruct , ask idea and lead the group further.

B Set the goal
- Higher Accuracy
- Clean Visuals
- Clean Code
- More Insights

C Learn how to use the facilitation tools
1. Youtube and IBM sessions to learn concepts.
2. Use documentation to code new concepts.
3. Use discord , stackoverflow to clear doubts

1

Applicant Credibility Prediction for Loan Approval

This data science project will help finance and banking people who give 100's of loan to their applicant and this group project will help stakeholder will come to the number if applicant who are eligible and not eligible by using data visualization , machine learning algorithms an stakeholder will make data driven decisions from this project

PROBLEM

We are gonna solve this problem by using machine learning algorithms such as Xgboost, Random and other conventional libraries. We use spark to handle big data, numpy and pandas for reshaping ,cleaning data,etc.

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

ideas that come to mind that address your problem statement

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

RAGHUL R

RAAHUL R

RAGHUL D

PRABHAKARAN S

3

Group ideas

Share ideas and we can make further planning based on mentor feedback

RAGHUL R
like Numpy , pandas , pbkdy

RAAHULL R
like Matplotlib

RAGHUL D
like seaborn for clean visualization , use existing techniques if possible.

PRABHAKARAN S
Refactor code if possible , use clean visuals and use required libraries to reduce complexity.

RAGHUL R
like Apache spark to store big data

RAAHULL R
like Numpy , pandas , Matplotlib

RAGHUL R
like Xgboost for regression

RAAHULL R
like charts like barchart , piechart , ribbon chart based on data provided

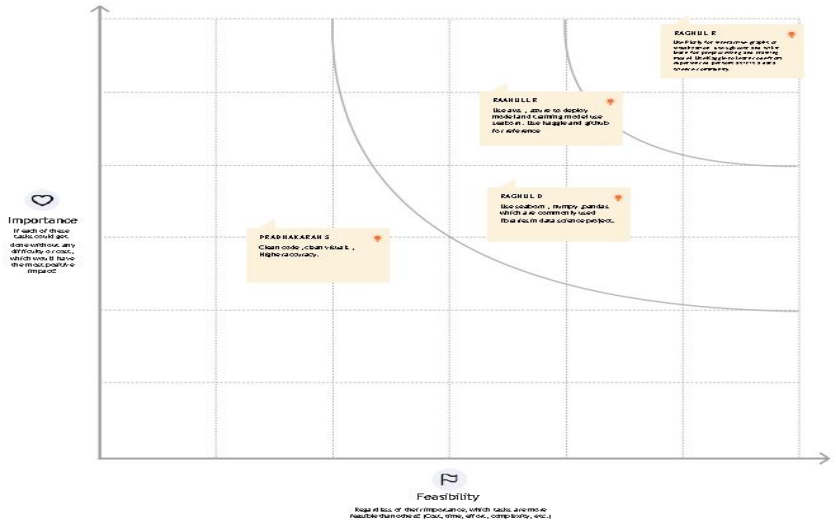
RAGHUL R
like aws or azure for model training and deploying model

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



After you collaborate

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

Quick add-ons

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

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

Keep moving forward

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

Customer experience journey map
Understand customer needs, motivations, and obstacles for an experience.
Open the template →

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

Share template feedback

3.3 Proposed Solution

In the suggested system, we aggregate datasets from several sources to generate a generalized dataset and employ four machine learning algorithms on the same dataset, including Random forest, kNN, Decision tree, and XGBoost. The dataset we gathered for predicting supplied data is divided into 7:3 training and test sets. The data model generated using machine learning algorithms is applied to the training set, and the test set prediction is done using the method with the highest performance based on the maximum test result from the four algorithms.

3.4 Problem Solution Fit

The problem-Solution Fit basically implies that you identified a problem with your consumer and that the solution you devised genuinely solves the problem.Problem solution fit deals to have customer segments,Jobs to be done/Problems,Triggers, Customer Constraints,Problem root cause,General Solutions,Behavior and Available solutions,

Problem-Solution fit canvas 2.0

AMALTAMA

- Credits misusage
- Funds issues

CS

6. CUSTOMER CONSTRAINTS

C

What constraints prevent your customers from taking action or limit their choices of solutions? i.e. spending power, budget, no cash, network connection, available devices.

5. AVAILABLE

A

Which solutions are available to the customers when they face the problem or need to get the job done? What have they tried in the past? What pros & cons do these solutions have? i.e. pen and paper is an alternative to digital notetaking

Define CS, fit into

- Bankers
- Business Domain
- Finance Industry

- Credit check
- Banker users
- Customer norms
- Reliability on trust

- Credit score
- Civil score
- Frequent bank user
- Own large business with funds
- Assets and properties

Explore AS,

2. JOBS-TO-BE-DONE / PROBLEMS

J&P

Which jobs-to-be-done (or problems) do you address for your customers?

9. PROBLEM ROOT CAUSE

R

What is the real reason that this problem exists?
What is the back story behind the need to do this job?
i.e. customers have to do it because of the change in regulations.

7. BEHAVIOUR

B

What does your customer do to address the problem and getthe job done? i.e. directly related: find the right solar panel installer, calculate usage and benefits; indirectly associated: customers spend free time on volunteering work (i.e. Greenpeace)

Focus on J&P, tap into BE, understand

- Credits misusage
- Funds issues
- Check bounce
- EMI not returned
- Bad credentials
- Misbehaving with finance service
- Bad debts
- No loan returns

- Credits misusage
- Funds issues
- Check bounce
- EMI not returned
- Bad credentials
- Misbehaving with finance
- Bad debts
- No loan returns

- Positive approach ahead of banks
- Proper funds repay
- Confusion on transactions

Focus on J&P, tap into BE, understand

3. TRIGGERS

TR

What triggers customers to act? i.e. seeing their neighbour installingsolar panels, reading about a more efficient solution in the news.

10. YOUR SOLUTION

SL

What kind of solution suits Customer scenario the best?
Adjust your solution to fit Customer behaviour, use Triggers, Channels & Emotions for marketing and communication.

8.1 ONLINE CHANNELS

CH

What kind of actions do customers take online?Extract online channels from box #7 Behaviour

Define CS, fit into CL

- Advertising
- Continuous customer engagement

- Proper Document verification
- Customer Background verification
- Bank user details
- Secure Data storage

- Proper Document verification
- Customer Background verification

Explore AS, differentiate

4. EMOTIONS: BEFORE / AFTER

EM

How do customers feel when they face a problem or a job and afterwards?
i.e. lost, insecure > confident, in control - use it in your communication strategy & design.

8.2 OFFLINE CHANNELS

CH

What kind of actions do customers take offline?
Extract offline channels from box #7 Behaviour and use them for customer development

- Easy to approach banks
- Time consuming
- Quick process

If you are working on an existing business, write down your current solution first, fill in the canvas, and check how much it fits reality.
If you are working on a new business proposition, then keep it blank until you fill in the canvas and come up with a solution that fits within customer limitations, solves a problem and matches customer behaviour.

CHAPTER-4

REQUIREMENT ANALYSIS

4.1 Functional Requirement

A functional requirement document specifies the functionality of a system or one of its subsystems. It also relies on the type of programme, expected users, and the system on which the software is run.Functional user requirements may be high-level declarations of what the system should perform, but functional system requirements should also specify the system services in depth.

Functional Requirements are:

- ◊ User Click the Predict Button
- ◊ User Fill the Application
- ◊ Message generated

User Fill the Application

User will follow the steps to apply the bank loan

Message generated

If the loan approvedor rejected the message will begenerated

4.2 Non-Funcctional Rerquirements

A non-functional requirement (NFR) is one that defines criteria for judging the functioning of a system rather than particular behaviors. They differ from functional requirements, which describe precise behavior or functions. The system design includes a thorough plan for accomplishing functional requirements. Because non-functional needs are frequently architecturally significant, the plan for accomplishing them is outlined in the system architecture.

Non-functional Requirements are:

- ◊ Usability
- ◊ Security
- ◊ Reliability
- ◊ Performance
- ◊ Availability
- ◊ Scalability

Usability

The application of the user interfaceshould besimple and easy to use

Security

The data given by the user must be more secure would prevent from the unauthorized access to save the user detail to prevent from the attack

Reliability

The users can access the website without any Problem

Performance

The user should not be wait for more time duringthe registration or login or performing any other activity in the application shouldbe efficient

Availability

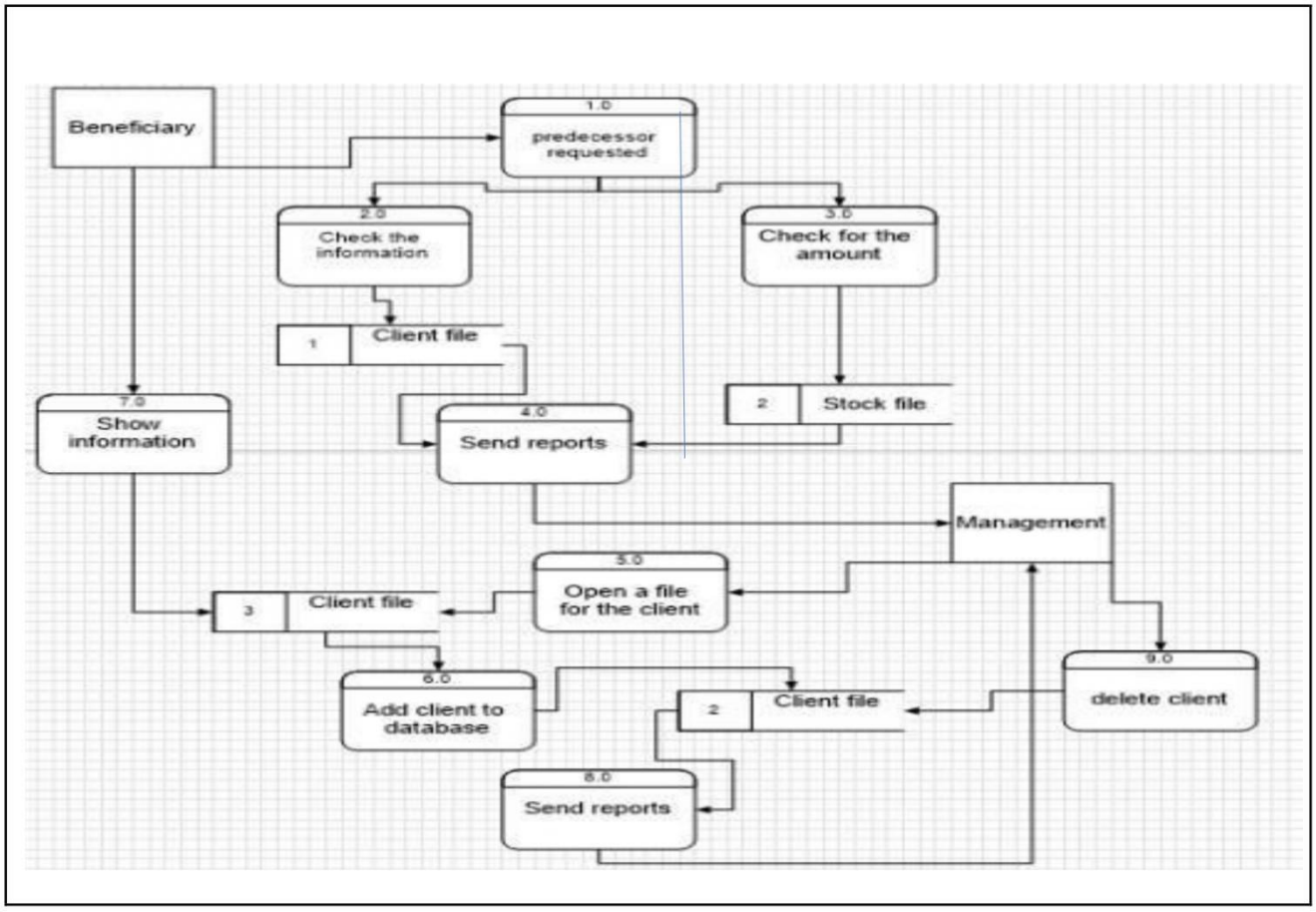
The user interfaceof the application interactive must be available in all the time when the user enter

CHAPTER-5

PROJECT DESIGN

5.1 Data Flow Diagram

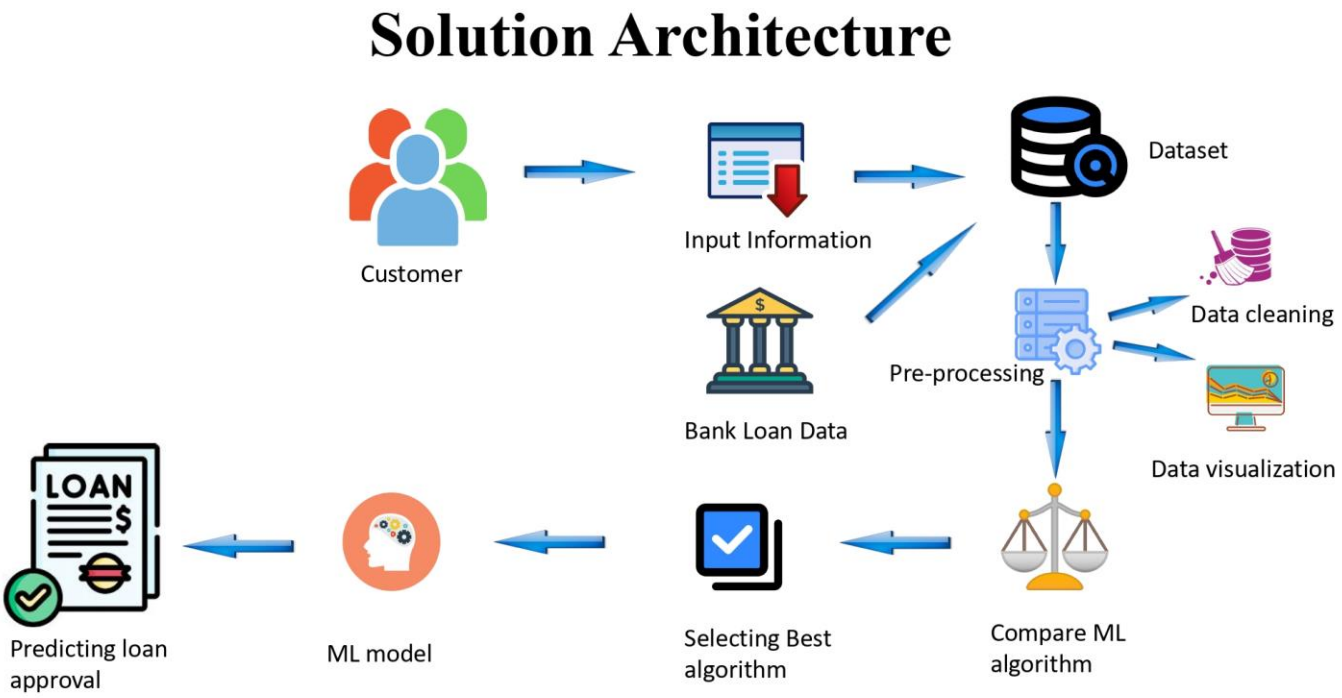
A Data Flow Diagram (DFD) is a traditional visual representation of the information flows within a system. A neat and clear DFD can depict the right amount of the systemrequirement graphically. It shows how data entersand leaves the system, what changes the information, and where data is stored.Geneerally it shows clear view of thethe system requirements.The bank loan prediction deals to Manage the loan records,Monitor payments,Manage Applicant Information,Check and update the loan.



5.2 Solution And Technical Architecture

Solution Architecture

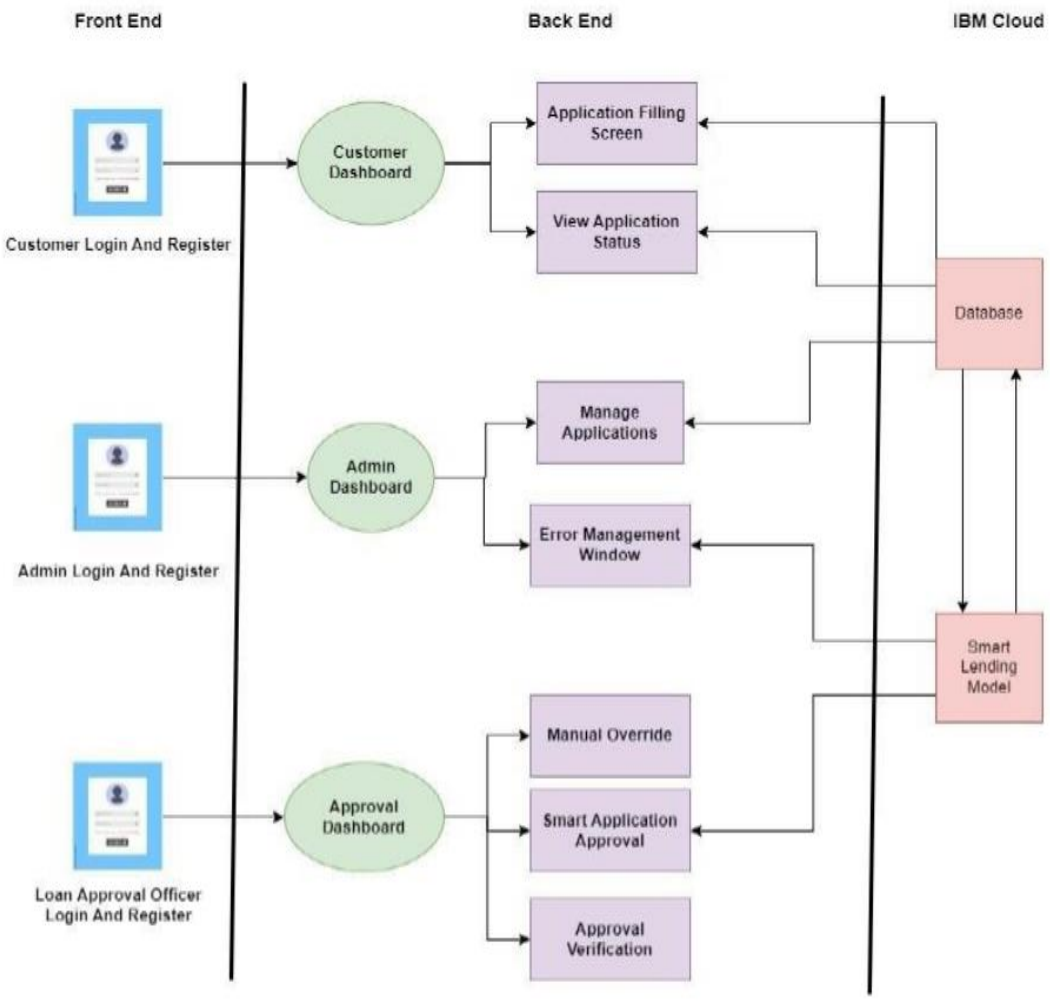
The process of designing solutions based on predetermined procedures, rules, and best practises with the goal of ensuring that the generated solution fits inside the corporate architecture in terms of information architecture, system portfolios, integration needs, and other factors. It may therefore be defined as a set of roles, procedures, and documentation aimed at addressing specific business goals, requirements, or challenges through the design and development of applications and information systems.



Technical Architecture:

In Front End ,it involves to create the User Interface by using HTML,CSS.In Back End, it contains Customer Dashboard,Admin Dashboard,Approval Dashboard,Customer Dashboard connect to the Application Form and Application Status.Admin Dashboard connects to the manage application.Approval Dashboard connects to the Application Approval and Application Verification.In IBM Cloud which which contains Database and Loan Predicting Windows.Database connects to the Customer Dashboard,Admin Dashboard and Loan Predicting Window connects to the Approval Dashboard.

Technical Architecture:



5.3 User Stories

It handles tasks such as logging into the IBM account in Sprint 1. Download the dataset and visualise it. It performs activities such as pre-processing the dataset in sprint 2. Model the algorithm Decision Tree modelbuilding, Knn modelbuilding, Random Forest modelbuilding, Xgboost modelbuilding, and then assess the models. In Sprint 3, it completes tasks such as integrating the model with Flask and Finally it deploy our project on IBM Cloud.

- To design a dashboard similar to the User Interface, As a user, you may fill out the application and access it through the user interface.
- You can also fill out the application and check for available sources.
- It conducts tasks such as registering all team members to IBM Cloud in sprint 4.
- On the IBM Cloud, train the model.
- Install the website on IBM Cloud.
- The user applies for the loan (the loan can be checked by the user).

CHAPTER-6

PROJECT PLANNING & SCHEDULING

6.1 Sprint Planning and Estimation

Sprint Planning

A sprint is essentially a predetermined length of time in which a development team needs to perform a specified amount of work. Sprints are often scheduled to last two weeks, although they can last as little as one week or as long as a month.The limited time span of a sprint forces developers to focus on sending out tiny, incremental improvements rather than massive, sweeping ones. As a result, significantly less debugging is necessary, and clients may have a more smooth experience with the programme.Generally it is used to create product backlog and contains sprint 1,2,3,4.Each performs some specific tasks to do so.

Sprint-1

In Sprint 1 which involve to create the functional requirement of User Registration and Login and Dataset. It performs the task such as To login the IBM account,Download the dataset and visualize the dataset.

Sprint-2

In sprint 2 ,which involves to create the functional requirent of use model. It performs the tasks such as Pre-process the dataset,Model the algorithm Decision Tree model building,Knn model Random Forest model and Xgboost model and then evaluate the models.

Sprint-3

In Sprint 3,which involve to create the functional requirement of Dashboard (User Interface).It perform the task such as To integrate the model with flask,To create a dashboard as like User

Interface,As a user able to fill the application and accessthe application on the user interface,To fill the application and check for theavailability sources.

Sprint- 4

In Sprint 4 ,which involve to create the functional requirement of Deployed the websitein IBM Cloud. It performs the task such as Register all the team membersto IBM Cloud,Train the model on IBM Cloud,Deploy the website on IBM Cloud,User apply for the loan (user can check the loan eligibility or not).

Sprint Estimation

Sprint Estimation is part of the Sprint Turnover process, which happens at the end of the last sprint but before the next sprint starts. It make sure to check our JIRA for issues that were thrown out of the previous sprint or issues that emerged during the sprint time. To ensure that this process runs well or not.

Velocity:

Calculate the team's average velocity (AV) periteration unit (story points per day) .

AV= Sprint Duration/Velocity=20/10=2

Sprint-1 = 20/9=2.2

Sprint-2 = 20/6=3.33

Sprint-3 =20/6 = 3..33

Sprint-3 = 19/6 = 3.16

Total Velocity= 79/2 7= 2.92

6.2 Sprint Delivery Schedule

In Sprint 1 ,which involve to create the functional requirement of User Registration and Login and Dataset . It performs the task such as To login the IBM account,Download the dataset and

visualize the datase.Total duration required to complete sprint 1 was 9 days.

In sprint 2 ,which involves to create the functional requirent of use mode.It performs the tasks such as Pre-process the dataset,Model the algorithm Decision Tree modelbuilding,building of Knn model,Random Forest model,Decision Tree model,Xgboost model.and then evaluate the models.Total duration required to complete sprint 2 was 6 days.

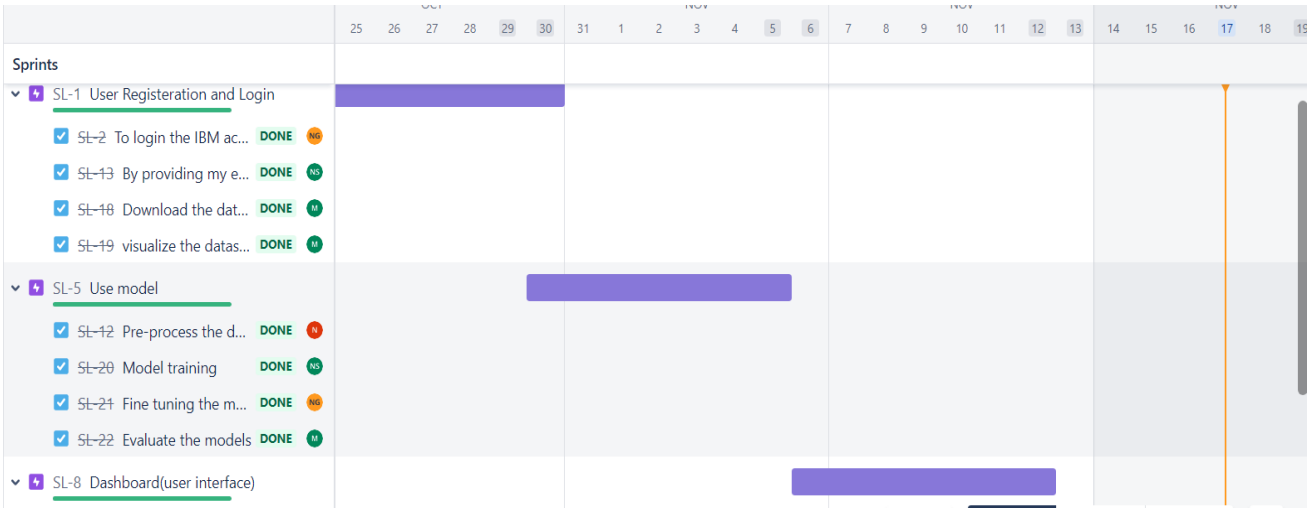
In Sprint 3 ,which involve to create the functional requirement of Dashboard (User Interface).It performs the task such as To integrate the model with flask,To create a dashboard as like User Interface,As a user able to fill the application and access the application on the user interface,To fill the application and check for the availability sourcesToatal duration required to complete sprint 3 was 6 days.

In Sprint 4 ,which involve to create the functional requirement of Register,Deployed the website in IBM Cloud.It performs the task such as Register all the team members to IBM Cloud,Train the model on IBM Cloud,Deploy the website on IBM Cloud,User apply for the loan (user can check theloan eligibility or not).Total duration required to complete sprint 4 was 6 days

6.3 Reports from JIRA

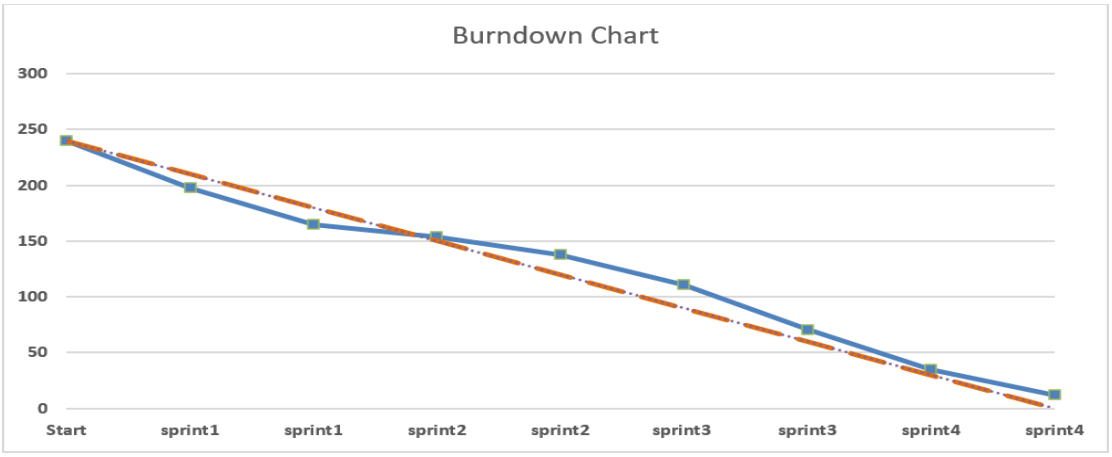
Jira

Jira Software is part of a solution family that assists teams of all sizes with job management. Jira was initially intended to be a bug and problem tracker. Jira, on the other hand, has evolved into a robust task management platform for various sorts of applications, ranging from requirements and test case management to agile development.



Burndown chart

A burn down chart is a graphical representation of work left to do versus time. It is often used in agile software development methodologies such as Scrum.



CHAPTER-7

CODING & SOLUTIONING

FEATURE:

Feature Engineering

```
data.info()

data.isnull().sum()

data['Gender'].fillna(data['Gender'].mode()[0], inplace=True)

data['Married'].fillna(data['Married'].mode()[0], inplace=True)

data['Dependents'].fillna(data['Dependents'].mode()[0], inplace=True)

data['Self_Employed'].fillna(data['Self_Employed'].mode()[0], inplace=True)

data['LoanAmount'].fillna(data['LoanAmount'].mode()[0], inplace=True)

data['Loan_Amount_Term'].fillna(data['Loan_Amount_Term'].mode()[0], inplace=True)

data['Credit_History'].fillna(data['Credit_History'].mode()[0], inplace=True)

data.info()
```

Missing values in the column "Loan monthly payment" indicate that consumers did not make loan payments. In this case, instead of the mean or median, the missing values should be imputed with zero. The original data has a category target variable. It is divided into four categories, numbered A through D. To make the prediction, I must encode the category variable as 1 or 0, representing binary classes.By using the alforithm in machine learning is able to predict the loan approval.

Random Forest Algorithm

```
def randomForest(x_train,x_test,y_train,y_test):
    rf = RandomForestClassifier()
    rf.fit(x_train,y_train)
    pred_test = rf.predict(x_test)
   print('Confusion Matrix')
   print(confusion_matrix(y_test,pred_test))
   print('Classification Report')
   print(classification_report(y_test,pred_test))
   print('Score')
    print(rf.score(x_test,y_test))
```

Comparison of Randim Forest Algorithm Vs KNN Vs Decision Tree:

CHAPTER-8

TESTING

User Acceptance Testing

Purpose Of Document: The purpose of this document is to briefly explain the test coverage and open issues of the [Smart Lender - Applicant Credibility Prediction for Loan Approval] project at the time of the release to User AcceptanceTesting(UAT).

Defect AnalysiS: This report shows the number of resolved or closed bugs ateach severity level, and how they were resolved.

UAT Report Submission and usage of tools

	Total StoryPoints	**Duration**	**Sprint Start Date**	**Sprint End Date(Planned)**	**Story Point Completed(as an planned enddate)**	**Sprint Release Date(Actual)**
Sprint-1	10	9 Days	21 Oct2022	30 Oct 2022	20	29 Oct 2022
Sprint-2	20	6 Days	31 Oct2022	05 Nov 2022	20	05 Nov 2022
Sprint-3	11	6 Days	06 Nov2022	12 Nov 2022	20	12 Nov 2022
Sprint-4	19	6 Days	12 Nov 2022	19 Nov 2022	19	19 Nov 2022

CHAPTER-9
RESULTS

9.1 Performance Metrics

FIS Financial View, for example, compiles useful indicators and KPIs and then helps organize and explain them so you can react to trends, uncover performance possibilities, and monitor financial health. In bank laon prediction ,the upside of the framework is that we present the prerequisites as a calculation, and while confirming the subtleties, we decide the necessities that have beenendorsed and that meet the rerequisites of the unlawful client.

Decision Tree

Decision trees may be used to forecast numerical values (regression) as well as categorise data. The decision tree which hold ,

Performance metrices of decision tree:

Confusion Matrix

[[49 14]

[20 58]]

Classification Report

	precision	recall	f1-score	support
0	0.71	0.78	0.74	63
1	0.81	0.74	0.77	78
accuracy			0.76	141
macro avg	0.76	0.76	0.76	141
weighted avg	0.76	0.76	0.76	141

Score:0.7588652482269503

Random Forest

In a random forest, the machine learning algorithm predicts a value or category by combining the results from a number of decision trees.The random forest algorithm is a bagging technique extension that use both bagging and feature randomization to produce an uncorrelated forest of decision trees.

Preformance matrices of Random forest algorithm:

Confusion Matrix

[[44 18]

[6 72]]

Classification Report

	precision	recall	f1-score	support
0	0.88	0.71	0.79	62
1	0.80	0.92	0.86	78
accuracy			0.83	140
macro avg	0.84	0.82	0.82	140
weighted avg	0.84	0.83	0.83	140

Score

0.8285714285714286

K-Nearest Neighbors algorithm

The k-nearest neighbors algorithm, also known as KNN or k-NN, is a non-parametric, supervised learning classifier, which uses proximity to make classifications or predictions about the grouping of an individual data point.

Performance matrices of KNN algorithm:

Confusion Matrix

[[40 27]

[26 50]]

Classification Report

	precision	recall	f1-score	support
0	0.61	0.60	0.60	67
1	0.65	0.66	0.65	76
accuracy			0.63	143
macro avg	0.63	0.63	0.63	143
weighted avg	0.63	0.63	0.63	143

Score

0.6293706293706294

XGboost

XGBoost, or Extreme Gradient Boost, is a machine learning technique used to create gradient boosting decision trees. When it comes to unstructured data, such as photos and unstructured text data, ANN models (Artificial neural network) appear to be at the top of the list when it comes to prediction.

Performance matrices of Xgboost algorithm:

Confusion Matrix

[[53 16]

[25 44]]

Classification Report

	precision	recall	f1-score	support
0	0.68	0.77	0.72	69
1	0.73	0.64	0.68	69
accuracy			0.70	138
macro avg	0.71	0.70	0.70	138
weighted avg	0.71	0.70	0.70	138

score

0.7028985507246377

Evaluating Performance Of The Models:

When compared alla the other algorithms Random Forest Algorithm has the high est accuracy of 0.8285714285714286. By using this algorithm ,we obtain the prediction for the loan approval or rejection.

F1-Score:

0.7833417327163604

Mean:

0.8228181529673121

CHAPTER-10
ADVANTAGES & DISADVANTAGES

Advantages

Various sources to generate a generalised dataset and apply four machine learning algorithms to the dataset, including Random forest, Logistic regression, and Decision tree.

- The advantage of the framework is that we show the requirements as a calculation, and while checking the subtleties, we determine the demands that have been approved and fulfil the requirements of the illicit customer.
- The framework is rated higher than high even out information. The shown structure is similar to a good memory.
- The risk of spreading to the necessary framework is minimal.
- Slight changes in information have little effect on the hyper plant.
- Performance and accuracy of the algorithms can be calculated and compared.
- Class imbalance can be dealt with machine learning approaches

Disadvantages

- They provided a mathematical model and did not employ machine learning methods.
- The problem of class imbalance was not addressed, and appropriate measures were not adopted.
- Existing frameworks typically fail. Computations are undeniably difficult because many of the outcomes are linked.

CHAPTER-11

CONCLUSION

The analysis begins with data cleansing and missing value processing, followed by exploratory analysis, model creation, and model evaluation. When we receive a better accuracy score and other performance indicators on the public test set, we will have the best accuracy. This paper can assist in predicting whether or not an applicant will be approved for a bank loan. When a consumer suffers a calamity, for example, the calculation cannot predict the outcome. This assessment paper can be used to determine whether a customer is capable.

APPENDIX

Source Code

Home.html

```
<!DOCTYPE html>
<html lang="en">
  <head>
    <meta charset="UTF-8" />
    <title>Loan Prediction</title>
      <link rel="stylesheet" type="text/css"
href="https://stackpath.bootstrapcdn.com/bootstrap/4.3.1/css/bootstrap.min.css"
integrity="sha384-
ggOyR0iXCbMQv3Xipma34MD+dH/1fQ784/j6cY/iJTQUOhcWr7x9JvoRxT2MZw1T"
crossorigin="anonymous">
    <link rel="stylesheet" type="text/css"
href="https://codepen.io/skjha5993/pen/bXqWpR.css">
  </head>
  <body>
    <header class="speaker-form-header">
      <center><h1>SMART LOAN PREDICTION</h1></center>

    </header>
    {% block content %}
       <div class="container">
    <form action="{{ url_for('predict') }}" method="post" class="speaker-form">
      <div class="form-row">
        <label for="full-name">Name</label>
        <input id="full-name" name="full-name" class="form-control" type="text" required/>
      </div>
      <div >

      </div>
      <br><br>
      <div class="form-row">

        <button class="btn btn-primary float-right">Submit</button>
      </div>
    </form>
       </div>
    {% endblock %}
```

```
  </body>
</html>
```

predict.html

```
<!DOCTYPE html>
<html lang="en">
  <head>
    <style>
      .header {
  width: 500px;
  height: 50px;
  margin: 50px;


  justify-content: center;
  align-items: center;
}
    </style>
    <meta charset="UTF-8" />
    <title>Loan Prediction</title>

          <link rel="stylesheet" type="text/css"
href="https://stackpath.bootstrapcdn.com/bootstrap/4.3.1/css/bootstrap.min.css"
integrity="sha384-
ggOyR0iXCbMQv3Xipma34MD+dH/1fQ784/j6cY/iJTQUOhcWr7x9JvoRxT2MZw1T"
crossorigin="anonymous">
    <link rel="stylesheet" type="text/css"
href="https://codepen.io/skjha5993/pen/bXqWpR.css">
  </head>
  <body>
    <div class="header">
      <h1>SMART LOAN PREDICTION</h1>
      <p>Welcome {{project_name}}!!!</p>

    </div>
    <div class="container">
    <form action="{{ url_for('evaluate') }}" method="post" class="speaker-form">

      <div class="form-row">
        <label for="Gender">Gender</label>
        <select class="form-control"  id="Gender" name="Gender" required>
          <option value="1">Male</option>
```

```
    <option value="0">Female</option>
  </select>
</div><br>
<div class="form-row">
  <label for="Married">Married</label>
  <select class="form-control"  id="Married" name="Married" required>
    <option value="1">Yes</option>
    <option value="0">No</option>
  </select>
</div><br>
<div class="form-row">
  <label for="Dependents">Dependents</label>
  <input
        class="form-control"
    id="Dependents"
    name="Dependents"
    type="number"
    min="0"
    max="3"
    placeholder="No of Dependents on you....."
    required
  />
</div><br>
<div class="form-row">
  <label for="Education">Education</label>
  <select class="form-control"  id="Education" name="Education" required>
    <option value="0">Graduate</option>
    <option value="1">Not Graduate</option>
  </select>
</div><br>
<div class="form-row">
  <label for="Self Employed">Self Employed</label>
  <select class="form-control"  id="Self Employed" name="Self Employed" required>
    <option value="1">Yes</option>
    <option value="0">No</option>
  </select>
</div><br>
<div class="form-row">
  <label for="Applicant Income">Applicant Income</label>
  <input
        class="form-control"
    id="Applicant Income"
```

```
    name="Applicant Income"
    type="number"
    min="0"
    placeholder="Your Income....."
    required
   />
</div><br>
<div class="form-row">
  <label for="Co Applicant Income">Co Applicant Income</label>
  <input
        class="form-control"
    id="Co Applicant Income"
    name="Co Applicant Income"
    type="number"
    min="0"
    placeholder="Your Co Applicant Income....."
    required
   />
</div><br>
<div class="form-row">
  <label for="Loan Amount">Loan Amount</label>
  <input
        class="form-control"
    id="Loan Amount"
    name="Loan Amount"
    type="number"
    min="0"
    placeholder="Enter the Loan Amount....."
    required
   />
</div><br>
<div class="form-row">
  <label for="Loan Amount Term">Loan Amount Term</label>
  <input
        class="form-control"
    id="Loan Amount Term"
    name="Loan Amount Term"
    type="number"
    min="0"
    placeholder="Enter the Loan Amount Term in days....."
    required
   />
```

```
    </div><br>
    <div class="form-row">
      <label for="Credit History">Credit History</label>
      <select class="form-control"  id="Credit History" name="Credit History" required>
        <option value="1">Yes</option>
        <option value="0">No</option>
      </select>
    </div><br>
    <div class="form-row">
      <label for="Property Area">Property Area</label>
      <select class="form-control"  id="Property Area" name="Property Area" required>
        <option value="0">Urban</option>
        <option value="1">Semiurban</option>
        <option value="2">Rural</option>
      </select>
    </div><br>
    <!-- <div class="form-row">
      <label for="abstract">Abstract</label>
      <textarea id="abstract" name="abstract"></textarea>
      <div class="instructions">Describe your talk in 500 words or less</div>
    </div>
    <div class="form-row">
      <label class="checkbox-label" for="available">
        <input
          id="available"
          name="available"
          type="checkbox"
          value="is-available"
        />
        <span>I’m actually available the date of the talk</span>
      </label>
    </div> -->
    <div class="form-row">
      <button class="btn btn-primary float-right">Submit</button>
    </div><br><br>
   </form>
    </div>
  </body>
</html>
```

main.py

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

# NOTE: you must manually set API_KEY below using information retrieved from your
IBM Cloud account.
API_KEY = "gty1PYR_T522sN6_r51HL2g88kxNxhyQXGVp5uPGmGFC"
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__)
model = pickle.load(open(r'rdf.pkl','rb'))
@app.route("/", methods=['GET', 'POST'])
def home():
    return render_template("home.html")

@app.route("/predict",methods=['POST','GET'])
def predict():
    if request.method == 'POST':
        project_name=request.form['full-name']
        print(project_name)
    return render_template("predict.html",project_name=project_name)

@app.route("/success",methods=['POST','GET'])
def evaluate():
    input_feature = [int(x) for x in request.form.values()]
    print(input_feature)
    # input_feature=[np.array(input_feature)]
    print(input_feature)
    names = ['Gender', 'Married', 'Dependents', 'Education', 'Self Employed', 'Applicant
Income', 'Coapplicant Income', 'Loan Amount', 'Loan_Amount_Term', 'Credit_History',
'Property_Area']

    # NOTE: manually define and pass the array(s) of values to be scored in the next line
    payload_scoring = {"input_data": [{"fields": [names],
                                       "values": [input_feature]}]}
```

```
    response_scoring = requests.post(
        'https://us-south.ml.cloud.ibm.com/ml/v4/deployments/a05131f3-dcb8-46cd-bf08-
1c2ecf28cc86/predictions?version=2022-11-13',
        json=payload_scoring,
        headers={'Authorization': 'Bearer ' + mltoken})
    predictions = response_scoring.json()
    prediction = predictions['predictions'][0]['values'][0][0]
    print("Scoring response")
    print(response_scoring.json())
    print(prediction)

    # data = pandas.DataFrame(input_feature, columns=names)
    # print(data)
    # prediction=model.predict(data)
    # print(prediction)
    # prediction = int(prediction)
    # print(type(prediction))
    loan=1
    if (prediction == 0):
        loan=0
        return render_template("success.html",result = "Loan will Not be
Approved",loan=loan)
    else:
        return render_template("success.html",result = "Loan will be Approved",loan=loan)
    return render_template("success.html")


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

Loan_Prediction.ipynb

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<th>Property_Area</th>\n <th>Loan_Status</th>\n </tr>\n </thead>\n <tbody>\n <tr>\n <th>0</th>\n <td>1</td>\n <td>1</td>\n <td>0</td>\n <td>0</td>\n <td>0</td>\n <td>8.699515</td>\n <td>2250.0</td>\n <td>5.579730</td>\n <td>360.0</td>\n <td>1</td>\n <td>1</td>\n <td>0</td>\n </tr>\n <tr>\n <th>1</th>\n <td>1</td>\n <td>1</td>\n <td>0</td>\n <td>0</td>\n <td>0</td>\n <td>7.992269</td>\n <td>2900.0</td>\n <td>4.875197</td>\n <td>360.0</td>\n <td>1</td>\n <td>1</td>\n <td>1</td>\n </tr>\n <tr>\n <th>2</th>\n <td>1</td>\n <td>1</td>\n <td>2</td>\n <td>0</td>\n <td>0</td>\n <td>8.740337</td>\n <td>1695.0</td>\n <td>5.347108</td>\n <td>360.0</td>\n <td>1</td>\n <td>1</td>\n <td>1</td>\n </tr>\n <tr>\n <th>3</th>\n <td>1</td>\n <td>1</td>\n <td>0</td>\n <td>0</td>\n <td>0</td>\n <td>7.641564</td>\n <td>3150.0</td>\n <td>4.852030</td>\n <td>360.0</td>\n <td>1</td>\n <td>1</td>\n <td>1</td>\n </tr>\n <tr>\n <th>4</th>\n <td>1</td>\n <td>0</td>\n <td>0</td>\n <td>0</td>\n <td>0</td>\n <td>8.334712</td>\n <td>0.0</td>\n <td>4.584967</td>\n <td>360.0</td>\n <td>0</td>\n <td>1</td>\n <td>0</td>\n </tr>\n </tbody>\n</table>\n "}, "metadata": {}}]}, {"metadata": {}, "cell_type": "code", "source": "import pandas as pd\nimport numpy as np\nfrom sklearn.preprocessing import MaxAbsScaler\nfrom sklearn.tree import DecisionTreeClassifier\nfrom sklearn.ensemble import RandomForestClassifier\nfrom sklearn.neighbors import KNeighborsClassifier\nfrom sklearn.ensemble import GradientBoostingClassifier\nfrom sklearn.metrics import confusion_matrix\nfrom sklearn.metrics import classification_report\nfrom sklearn.model_selection import cross_val_score\nfrom sklearn.metrics import f1_score\nimport pickle", "execution_count": 31, "outputs": []}, {"metadata": {}, "cell_type": "code", "source": "scaler = MaxAbsScaler()", "execution_count": 32, "outputs": []}, {"metadata": {}, "cell_type": "code", "source": "train_y = train.iloc[:,-1]\ntrain_x = train.drop('Loan_Status',axis=1)\n\ntest_y = test.iloc[:,-1]\ntest_x = test.drop('Loan_Status',axis=1)\nx = pd.concat([train_x,test_x],axis=0)\ny = pd.concat([train_y,test_y],axis=0)", "execution_count": 33, "outputs": []}, {"metadata": {}, "cell_type": "code", "source": "train_x = scaler.fit_transform(train_x)\ntest_x = scaler.transform(test_x)\n\ndt = DecisionTreeClassifier()\ndt.fit(train_x,train_y)\ny_pred = dt.predict(test_x)\nprint(\"**** Decision Tree Classifier ****\")\nprint('Confusion Matrix')\nprint(confusion_matrix(test_y,y_pred))\nprint('Classification Report')\nprint(classification_report(test_y,y_pred))", "execution_count": 34, "outputs": [{"output_type": "stream", "text": "**** Decision Tree Classifier ****\nConfusion Matrix\n[[23 20]\n [16 64]]\nClassification Report\n precision recall f1-score support\n\n 0 0.59 0.53 0.56 43\n 1 0.76 0.80 0.78 80\n\n accuracy 0.71 123\n macro avg 0.68 0.67 0.67 123\nweighted avg 0.70 0.71 0.70 123\n\n", "name": "stdout"}]}, {"metadata": {"scrolled": true}, "cell_type": "code", "source": "", "execution_count": null, "outputs": []}, {"metadata": {}, "cell_type": "code", "source": "pip install ibm_watson_machine_learning\n", "execution_count": 35, "outputs": [{"output_type": "stream", "text": "Requirement already satisfied: ibm_watson_machine_learning in /opt/conda/envs/Python-3.9/lib/python3.9/site-packages (1.0.257)\nRequirement already

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GITHUB LINK: IBM-EPBL/IBM-Project-8764-1658929155: Smart Lender - Applicant Credibility Prediction for Loan Approval (github.com)