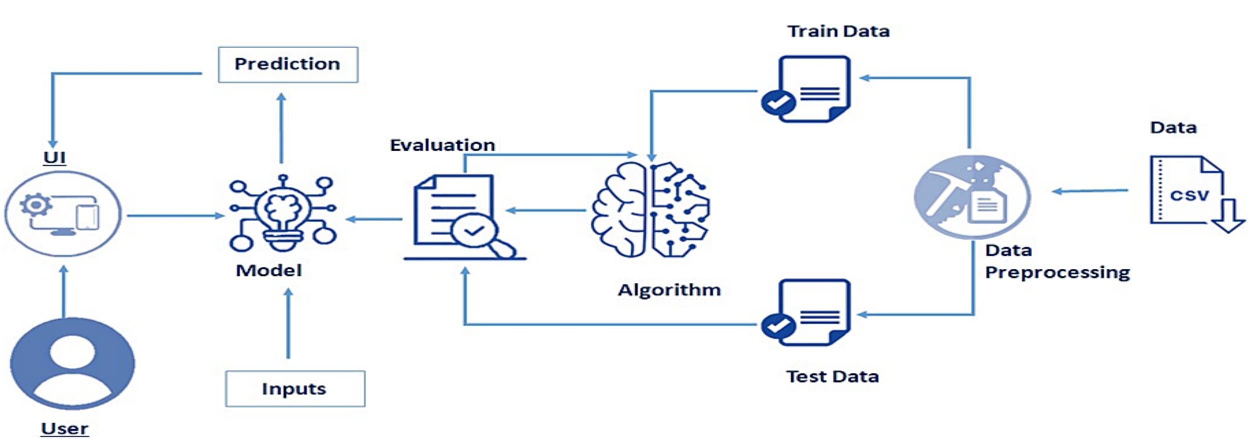
Credit Card Approval Prediction using Machine Learning

Project Description:

Nowadays, banks receive a lot of applications for issuance of credit cards. Many of them are rejected for many reasons, like high-loan balances, low-income levels, or too many inquiries on an individual's credit report. Manually analyzing these applications is error-prone and a time-consuming process. Luckily, this task can be automated with the power of machine learning and pretty much every bank does so nowadays. In this project, we will build an automatic credit card approval predictor using machine learning techniques, just like the real banks do. In this project, we will be using regression algorithms such as LogisticRegression, SGD, SVClassifier, decisiontree, RandomForest and xgboost. We will train and test the data with these algorithms. From this the best model is selected and saved in pkl format. We will be doing flask integration and flask deployment.

Technical Architecture:

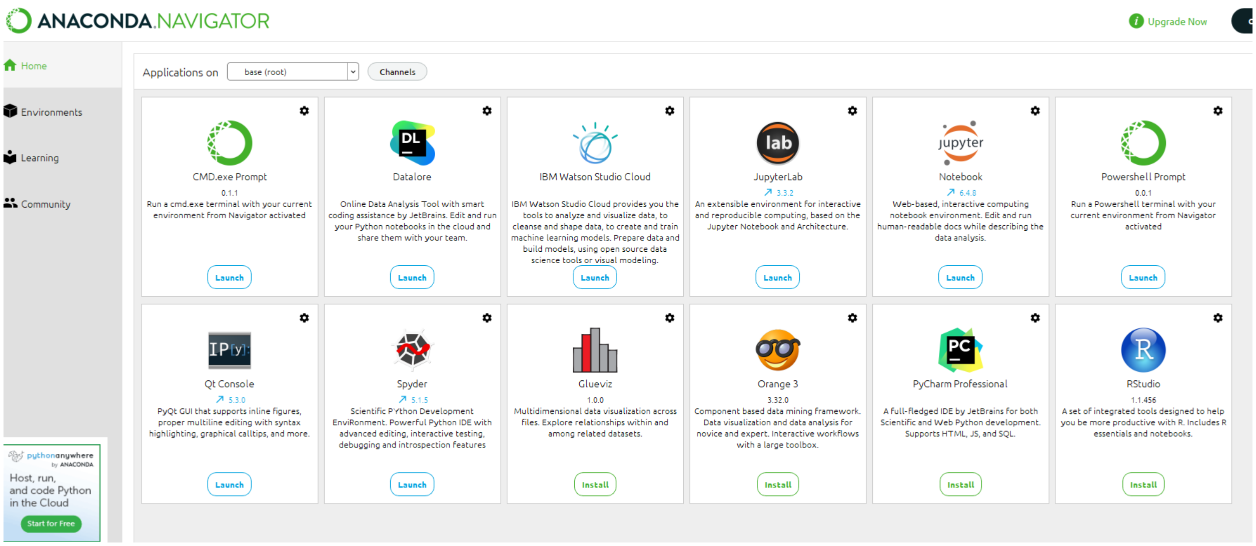


Pre requisites:

To complete this project,you must requirefollowing software’s, conceptsand packages

1. Anaconda navigator:

- Refer the link below to download anaconda navigator
- Link : https://youtu.be/1ra4zH2G4o0



2. Python packages:

- Open anaconda prompt as administrator
- Type “pip install numpy” and clickenter.
- Type “pip install pandas” and clickenter.
- Type ”pip install pickle-mixin” and click enter
- Type “pip install Flask” and click enter.

Project Objectives :

By the end of this project you will:

- Know fundamental concepts and techniques used for machine learning.
- Gain a broad understanding about data.
- Have knowledge on pre-processing the data/capping techniques on outlier and some visualization concepts.

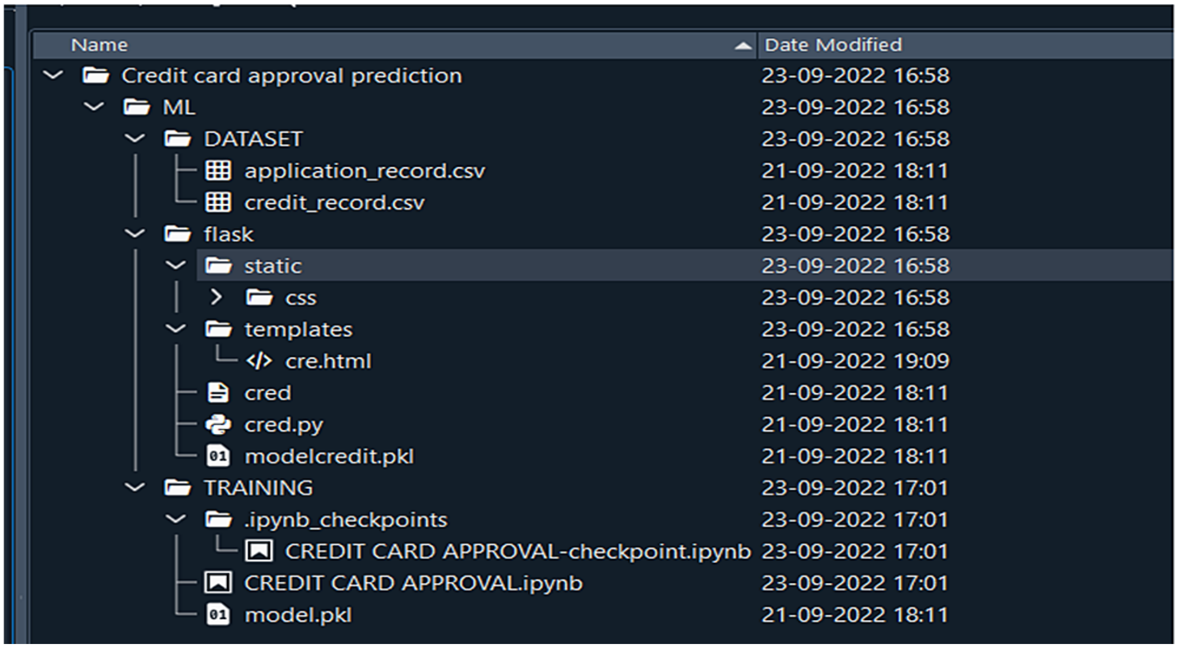
Gain some ideas on algorithm selection.

Project Flow:

- User interacts with the UI to enter the input.
- Entered input is analyzed by the model which is integrated.
-
- Once model analyses the input the prediction is showcased on the UI To accomplish this, we have to completeall the activities listed below,
- Data Collection.
  - Collect the dataset or Create the dataset
- Data Visualization
- Multivariate analysis
- Descriptive analysis
- Data Pre-processing
  - Checking for null values
  - Drop unwantedfeatures
  - Data Cleaningand merging
  - Handling categorical data
  - Splitting Data into Train and Test.
- Model Building
  - Import the model buildingLibraries
  - Initializing the model
  - Training and testing the model
  - Evaluation of Model
  - Save the Model
- Application Building
  - Create an HTML file
  - Build a Python Code

Project Structure:

Create a Project folder which contains files as shown below



- We are building a flask application which needs HTML pages storedin the templates folder and a python script cred.py for scripting. modelcredit.pkl is our saved model. Further we will use this model for flaskintegratation

Milestone 1: Data Collection:-

ML dependsheavily on data,it is the most crucialaspect that makesalgorithm trainingpossible. So this section allows you to download the required dataset.

Activity 1: Download the dataset

You can collect datasetsfrom different open sources like kaggle.com, data.gov, UCI machinelearning repository etc.

Please refer to the link given below to download the data set and to know about the dataset

https://www.kaggle.com/namphuengauawatcharo/credit-card-approval-prediction/data

Milestone 2: Visualizing and analysing the data

As the dataset is downloaded. Let us read and understand the data properly with the help ofsome visualization techniques and some analysing techniques.

Note: There is n number of techniques for understanding the data. But here we haveusedsome of it. In an additional way, you can use multiple techniques.

Activity 1: Importing the libraries

Import the necessary libraries as shown in the image.
To know about the packages refer the link given on pre requisites.

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
```

Activity 1: Read the Dataset

Our datasetformat might be in .csv,excel files, .txt,.json, etc. We can read the datasetwiththe help of pandas.

Activity 2: HandlingMissing Values

- In pandas we have a function calledread_csv() to read the dataset.As a parameter wehave to give the directory of csv file.

```
dt = pd.read_csv(r"C:\Users\jagad\Dropbox\PC\Downloads\DATASET\application_record.csv")
df = pd.read_csv(r"C:\Users\jagad\Dropbox\PC\Downloads\DATASET\credit_record.csv")
```

- head() method is used to return top n (5 by default) rows of a DataFrame or series.

```
dt.head()
```

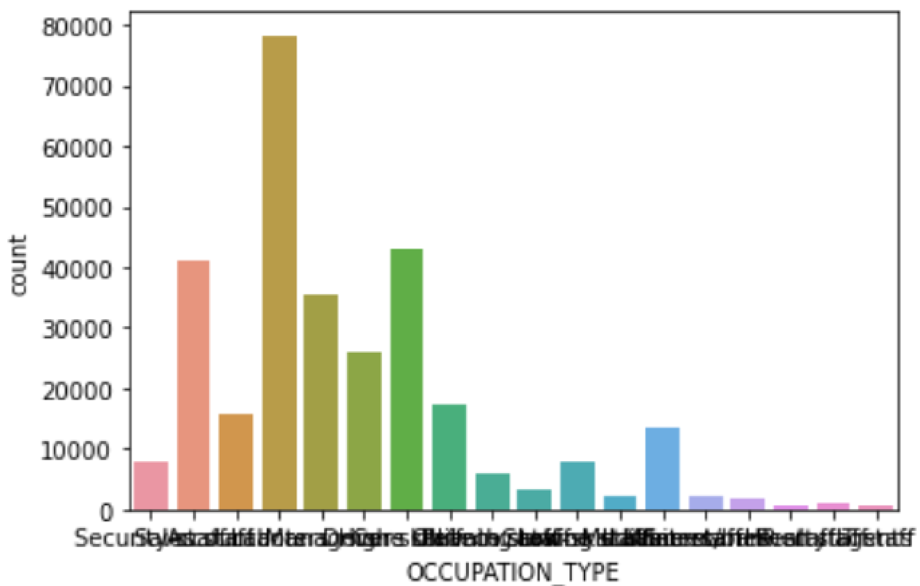
	ID	CODE_GENDER	FLAG_OWN_CAR	FLAG_OWN_REALTY	CNT_CHILDREN	AMT_INCOME_TOTAL	NAME_INCOME_TYPE
0	5008804	M	Y	Y	0	427500.0	Working
1	5008805	M	Y	Y	0	427500.0	Working
2	5008806	M	Y	Y	0	112500.0	Working
3	5008808	F	N	Y	0	270000.0	Commercial associate
4	5008809	F	N	Y	0	270000.0	Commercial associate

Activity 3: Univariate analysis

In simple words, univariate analysis is understanding the data with single feature.

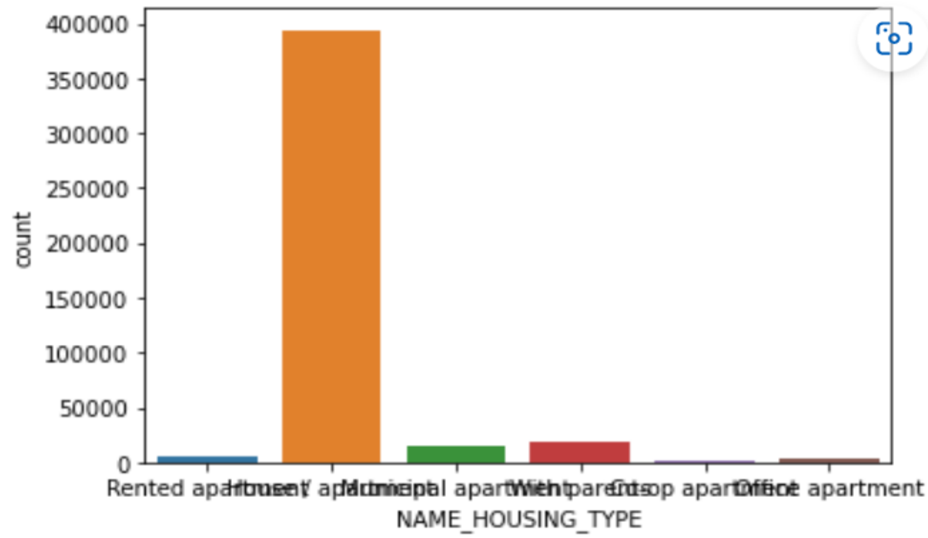
Count plot is used on occupation type feature. With the countplot(), we are going to count the uniquecategory. From the below graph, we found the numberof labors arehigh when compared to other types. For the exact count, value counts() are used.

```
<AxesSubplot:xlabel='OCCUPATION_TYPE', ylabel='count'>
```



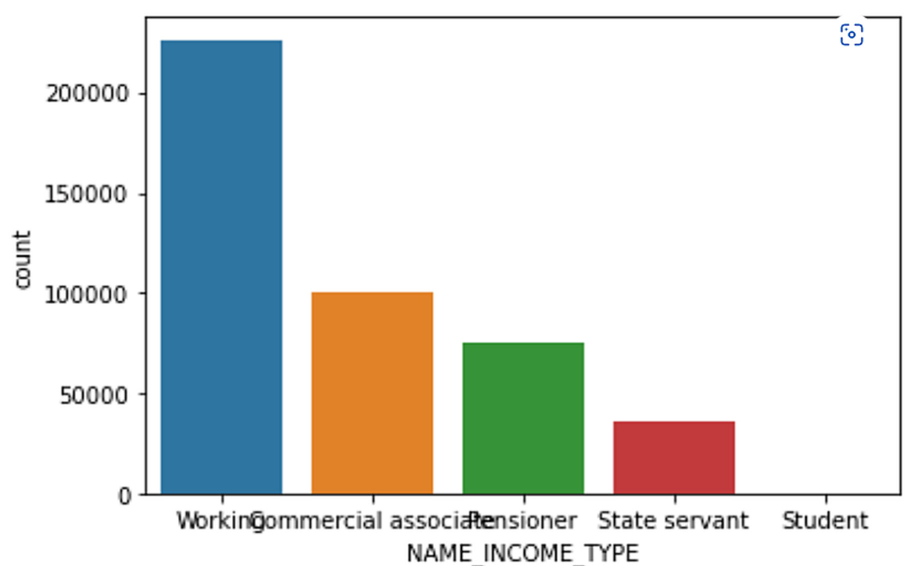
- Count plot is used on income type feature.With the countplot(), we are going to countthe unique category. From the below graph, we foundthe number of working applicant are high when compared to other types. For the exact count, value counts()are used.

```
<AxesSubplot:xlabel='NAME_HOUSING_TYPE', ylabel='count'>
```



Count plot is used on income type feature.With the countplot(), we are going to countthe unique category. From the below graph, we foundthe number of working applicant are high when compared to other types. For the exact count, value counts() are used.

```
<AxesSubplot:xlabel='NAME_INCOME_TYPE', ylabel='count'>
```

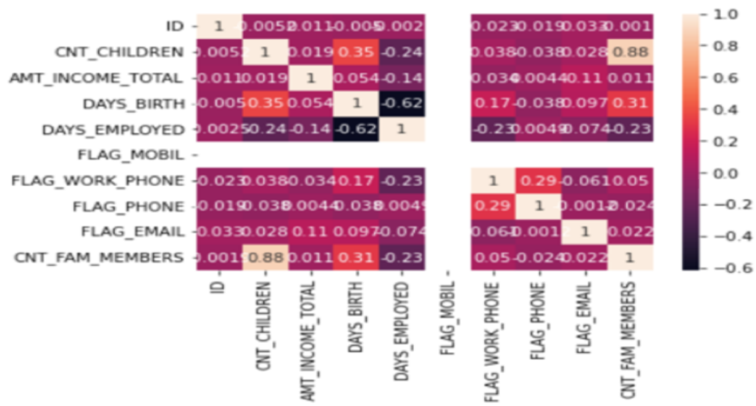


Activity 4: Multivariate analysis

In simple words, multivariate analysis is to find the relation between multiple features. Herewe have used heatmap() from seaborn package.

- To visualize the correlation of the features, heatmap() functionis used. As a parametercorr() function should be passed inside heatmap. And to display the correlation percentage annot() function is used.

```
sns.heatmap(dt.corr(),annot=True)
]: <AxesSubplot:>
```



Activity 5: Descriptive analysis

Descriptivenction called describe. With this describefunction we can understandthe unique, top and frequent values of categorical features. And we can find mean, std, min,max and percentile values of continuous features. analysis is to study the basic features of data with the statistical process.

```
dt.describe()
]:
```

	ID	CNT_CHILDREN	AMT_INCOME_TOTAL	DAYS_BIRTH	DAYS_EMPLOYED	FLAG_MOBIL	FLAG_WORK_PHONE	FLAG_PHONE
count	4.385570e+05	438557.000000	4.385570e+05	438557.000000	438557.000000	438557.0	438557.000000	438557.000000
mean	6.022176e+06	0.427390	1.875243e+05	-15997.904649	60563.675328	1.0	0.206133	0.287771
std	5.716370e+05	0.724882	1.100869e+05	4185.030007	138767.799647	0.0	0.404527	0.452724
min	5.008804e+06	0.000000	2.610000e+04	-25201.000000	-17531.000000	1.0	0.000000	0.000000
25%	5.609375e+06	0.000000	1.215000e+05	-19483.000000	-3103.000000	1.0	0.000000	0.000000
50%	6.047745e+06	0.000000	1.607805e+05	-15630.000000	-1467.000000	1.0	0.000000	0.000000
75%	6.456971e+06	1.000000	2.250000e+05	-12514.000000	-371.000000	1.0	0.000000	1.000000
max	7.999952e+06	19.000000	6.750000e+06	-7489.000000	365243.000000	1.0	1.000000	1.000000

Milestone 3: Data Pre-processing

As we have understood how the data is. Let's pre-process the collected data.

The download data set is not suitable for training the machine learning model as it might haveso much randomness so we need to clean the dataset properly in order to fetch good results.

This activity includes the following steps.

- Handling missing values
- Handling categorical data
- Handling outliers

- Scaling Techniques
- Splitting dataset into training and test set

Note: These are the general steps of pre-processing the data before using it for machine learning. Depending on the condition of your dataset, you may or may not have to go throughall these steps.

- To find the data type of columnsinfo() function is used. It gives small informationabout the features.

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1048575 entries, 0 to 1048574
Data columns (total 3 columns):
 #   Column          Non-Null Count    Dtype
---  ------          --------------    -----
 0   ID              1048575 non-null  int64
 1   MONTHS_BALANCE  1048575 non-null  int64
 2   STATUS          1048575 non-null  object
dtypes: int64(2), object(1)
memory usage: 24.0+ MB
```

- Unique() methodis used to find the unique values of features.A function is defined below to find the unique values of features.

Activity 1: Drop duplicate features

Generally, applicantids are unique in nature.But in our dataset we found some of the ids arerepeating multiple times. To handle this we have to remove the duplicate rows. Drop duplicates() function from pandas is used to remove the duplicate rows. Refer the belowdiagram.

```
#Dropping duplicate rows
dt.drop_duplicates(subset = ['CODE_GENDER','FLAG_OWN_CAR','CNT_CHILDREN','AMT_INCOME_TOTAL','NAME_INCOME_TYPE',
                             'NAME_EDUCATION_TYPE','NAME_FAMILY_STATUS','NAME_HOUSING_TYPE','DAYS_BIRTH','DAYS_EMPLOYED',
                             'FLAG_MOBIL','FLAG_WORK_PHONE','FLAG_PHONE','FLAG_EMAIL','OCCUPATION_TYPE','CNT_FAM_MEMBERS'],
                   inplace=True)
```

For checkingthe null values,df.isnull() function is used. To sum those null values we usesum() function to it. mean() function is used to find the impact of null values in features. From the below image we found, our dataset has no null values

```
dt.isnull().sum()
```

```
]:  ID                          0
    CODE_GENDER                 0
    FLAG_OWN_CAR                0
    FLAG_OWN_REALTY             0
    CNT_CHILDREN                0
    AMT_INCOME_TOTAL            0
    NAME_INCOME_TYPE            0
    NAME_EDUCATION_TYPE         0
    NAME_FAMILY_STATUS          0
    NAME_HOUSING_TYPE           0
    DAYS_BIRTH                  0
    DAYS_EMPLOYED               0
    FLAG_MOBIL                  0
    FLAG_WORK_PHONE             0
    FLAG_PHONE                  0
    FLAG_EMAIL                  0
    OCCUPATION_TYPE         27383
    CNT_FAM_MEMBERS             0
    dtype: int64
```

.

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Activity 3: Data Cleaning and merging

In this process,we are going to combinetwo inter-related columns.Our dataset have some negativevalues. Those negative values are converted into absolute values. Feature mapping is used on somecategorical columns.

- values to absolute values we use abs() function.
- Feature mapping are done in housing type, income type, education type and A function data_cleaning() is defined. A column is created by adding numberoffamily members with number of childrens.
- Six unwanted columns are dropped by drop() function. Refer the below image toknow the columns name.
- Days birth and days employed columnshave negative values.To convert the negativefamilytype columns. (This feature mapping step is an optional step).

```python
# Adding number of family members with number of children to get overall family members. data[ 'CNT_FAM_MEMBERS']
def data_clean(data):
    data['CNT_FAM_MEMBERS'] = data['CNT_FAM_MEMBERS'] + data['CNT_CHILDREN']
    dropped_cols = ['FLAG_MOBIL', 'FLAG_WORK_PHONE', 'FLAG_PHONE','FLAG_EMAIL', 'OCCUPATION_TYPE', 'CNT_CHILDREN']
    data = data.drop(dropped_cols, axis = 1)
#converting birth years and days employed to years. data[ 'DAYS_BIRTH'] = np.abs(data[ DAYS_BIRTH']/365) #Absolute
#Cleaning up categorical values to lower the count of dummy variables. housing type = { 'House / apartment' : 'Hou
    housing_type = {'House / apartment':'House / apartment','With parents': 'With parents', 'Municipal apartment':
    income_type = { 'Commercial associate': 'Working','State servant': 'Working', 'Working': 'Working', 'Pensioner
    education_type = { 'Secondary / secondary special':'secondary','Lower secondary': 'secondary', 'Higher educati
    family_status = {'Single / not married': 'Single','Separated': 'Single', 'Widow': 'Single', 'Civil marriage':
    data['NAME_HOUSING_TYPE'] = data['NAME_HOUSING_TYPE'].map(housing_type)
    data['NAME_INCOME_TYPE'] = data['NAME_INCOME_TYPE'].map(income_type)
    data['NAME_EDUCATION_TYPE']=data['NAME_EDUCATION_TYPE'].map(education_type)
    data['NAME_FAMILY_STATUS']=data['NAME_FAMILY_STATUS'].map(family_status)
    return data
```

Let's move to our second dataframe(cr).

To displaythe first five columns head() function is used. The info() method is used to find thedata types of the columns.

```
df.describe()
```

	ID	MONTHS_BALANCE
count	1.048575e+06	1.048575e+06
mean	5.068286e+06	-1.913700e+01
std	4.615058e+04	1.402350e+01
min	5.001711e+06	-6.000000e+01
25%	5.023644e+06	-2.900000e+01
50%	5.062104e+06	-1.700000e+01
75%	5.113856e+06	-7.000000e+00
max	5.150487e+06	0.000000e+00

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1048575 entries, 0 to 1048574
Data columns (total 3 columns):
 #   Column          Non-Null Count    Dtype
---  ------          --------------    -----
 0   ID              1048575 non-null  int64
 1   MONTHS_BALANCE  1048575 non-null  int64
 2   STATUS          1048575 non-null  object
dtypes: int64(2), object(1)
memory usage: 24.0+ MB
```

We are grouping the ID columnand saving it as a variable 'grouped'.

We are using as an index ID and for columnwe are using MONTHS_BALANCE and STATUS as a value.

1. Minimum MONTHS_BALANCE as a open_month
2. Maximum MONTHS_BALANCE as a end_months

And for window we are substracting end_months – open_months

```
# for credict dataset
g = df.groupby('ID')
p = df.pivot(index = 'ID',columns = 'MONTHS_BALANCE',values = 'STATUS')
p['OPEN_MONTH'] = g['MONTHS_BALANCE'].min() #0
p['END_MONTH'] = g['MONTHS_BALANCE'].max() #0
p['WINDOW'] = p['END_MONTH'] - p['OPEN_MONTH']
p['WINDOW'] = p['WINDOW'] + 1 # ADDING BECAUSE MONTH STARTS AT 0
```

```
#counting number of past dues, paid offs and no loans
p.shape
```

```
]: (45985, 64)
```

```
p['paid_off'] = p[p.iloc[:,0:61] == 'C'].count(axis=1)
p['pastdue_1-29'] = p[p.iloc[:,0:61] == '0'].count(axis=1)
p['pastdue_30-59'] = p[p.iloc[:,0:61] == '1'].count(axis=1)
p['pastdue_60-89'] = p[p.iloc[:,0:61] == '2'].count(axis=1)
p['pastdue_90-119'] = p[p.iloc[:,0:61] == '3'].count(axis=1)
p['pastdue_120-149'] = p[p.iloc[:,0:61] == '4'].count(axis=1)
p['pastdue_over_150'] = p[p.iloc[:,0:61] == '5'].count(axis=1)
p['no_loan'] = p[p.iloc[:,0:61] == 'X'].count(axis=1)
p['ID'] = p.index
```

Activity 4: FeatureEngineering

Converting the multi-classification into binary classification. For a clear understanding refer the below two images.

A ratio is based method was used ro create the target variable. for eg, given a client with a time period of 60 months, if the client given that there were more loans that were paid off on time compared to late payments. if aclient had no loans thoughtout the initaial approval of the credit card account. for simplicity sake I will not adjust the algorithm further and keep it at ratio decisioning.code is also not optimal, adjustment may be needed for the code to computer faster.

```
def feature_engineering_target(data):
    good_or_bad = []
    for index, row in data.iterrows():
        paid_off = row['paid_off']
        over_1 = row["pastdue_1-29"]
        over_30 = row['pastdue_30-59']
        over_60 = row['pastdue_60-89']
        over_90 = row['pastdue_90-119']
        over_120 = row['pastdue_120-149'] + row['pastdue_over_150']
        no_loan = row['no_loan']
        overall_pastdues = over_1+over_30+over_60+over_90+over_120
        if overall_pastdues == 0:
            if paid_off >= no_loan or paid_off <= no_loan:
                good_or_bad.append(1)
            elif paid_off == 0 and no_loan == 1:
                good_or_bad.append(1)
        elif overall_pastdues != 0 :
            if paid_off > overall_pastdues :
                good_or_bad.append(1)
            elif paid_off <= overall_pastdues :
                good_or_bad.append(0)
        elif paid_off == 0 and no_loan != 0 :
            if overall_pastdues <- no_loan or overall_pastdues >= no_loan:
                good_or_bad.append(0)
        else:
            good_or_bad.append(1)
    return good_or_bad
```

Converting our credit data into binaryformat because at last we need to predict whethera person is eligible for credit card or not?

Merging two data frameswith merge() function.

```
target = pd.DataFrame()
target['ID'] = p.index
target['paid off'] = p['paid_off'].values
target['#_of_pastdues'] = p['pastdue_1-29'].values+ p['pastdue_30-59'].values
+ p['pastdue_60-89'].values +p['pastdue_90-119'].values
+p['pastdue_120-149'].values +p['pastdue_over_150'].values
target['no_loan'] = p['no_loan'].values
target['target'] = feature_engineering_target(p)
m= dt.merge(target, how = 'inner', on = 'ID')
m.drop('ID', axis = 1, inplace = True)
```

```
m
```

5]:

	CODE_GENDER	FLAG_OWN_CAR	FLAG_OWN_REALTY	AMT_INCOME_TOTAL	NAME_INCOME_TYPE	NAME_EDUCATION_TYPE	N
0	M	Y	Y	427500.0	Working	Higher education	
1	M	Y	Y	112500.0	Working	secondary	
2	F	N	Y	270000.0	Working	secondary	
3	F	N	Y	283500.0	Pensioner	Higher education	
4	M	Y	Y	270000.0	Working	Higher education	
...	...	...	...	...	...	...	
9692	F	N	N	180000.0	Pensioner	secondary	
9693	F	N	Y	112500.0	Working	secondary	
9694	M	Y	Y	90000.0	Working	secondary	
9695	F	N	Y	157500.0	Pensioner	Higher education	
9696	M	N	Y	112500.0	Working	secondary	

9697 rows × 15 columns

Activity 5: Handling Categorical Values

As we can see our dataset has categorical data we must convert the categorical data to integer encoding or binary encoding.
To convertthe categorical featuresinto numerical featureswe use encoding technique
Thereare several techniques but in our project we are using label encoding.
Label encoder is initialized and categorical feature is passed as parameter for fit_transform() function. Label encoding uses alphabetical ordering. For the featurenames refer the below diagram

```
#handling categorical value
from sklearn.preprocessing import LabelEncoder
a = LabelEncoder()
m['CODE_GENDER'] = a.fit_transform(m['CODE_GENDER'])
m['FLAG_OWN_CAR'] = a.fit_transform(m['FLAG_OWN_CAR'])
m['FLAG_OWN_REALTY'] = a.fit_transform(m['FLAG_OWN_REALTY'])
m['NAME_INCOME_TYPE'] = a.fit_transform(m['NAME_INCOME_TYPE'])
m['NAME_EDUCATION_TYPE'] = a.fit_transform(m['NAME_EDUCATION_TYPE'])
m['NAME_FAMILY_STATUS'] = a.fit_transform(m['NAME_FAMILY_STATUS'])
m['NAME_HOUSING_TYPE'] = a.fit_transform(m['NAME_HOUSING_TYPE'])
```

.

Activity 6: Splitting data into train and test

Now let's split the Dataset into train and test sets. For splittingtraining and testingdata weare using the train_test_split() function from sklearn. As parameters, we are passing x, y, train_size, random_state. X is independent variable and y is dependent variable.

```
#spliting our data
from sklearn.model_selection import train_test_split
x = m[m.drop('target',axis=1).columns]
y = m['target']
x_train,x_test,y_train,y_test = train_test_split(x,y,train_size=0.75,random_state=0)
```

Milestone 4: Model Building:-

Now our data is cleaned and it's time to build the model.We can train our data on different algorithms. For this projectwe are applying four classification algorithms. The best model issaved basedon its performance. To evaluate the performance confusion matrix and classification report is used.

Activity 1: Logistic regression model

A function named logistic_reg is created and train and test data are passed as the parameters. Inside the function, LogisticRegression() algorithm is initialized and training data is passed tothe model with .fit() function. Test data is predicted with .predict() function and saved in newvariable. For evaluating the model, confusion matrix and classification report is done. Refer the below image.

Activity 2: SCD model

A slowly changing dimension in data management and data warehousing is a dimension which contains relatively static data which can change slowly but unpredictably, rather than according to a regular schedule.

Activity 3: SVClassifier model

In machine learning, support-vector machines are supervised learning models with associated learning algorithms that analyze data for classification and regression analysis.

Activity 4: DecisionTree model

A functionnamed d_tree is created and train and test data are passedas the parameters. Insidethe function, DecisionTreeClassifier() algorithm is initialized and training data is passed to the model with .fit() function. Test data is predicted with .predict() function and saved in newvariable. For evaluating the model, confusion matrix and classification report is done. Refer the below image.

Activity 5: RandomForest model

A function named random_forest is created and train and test data are passed as the parameters. Inside the function, RandomForestClassifier() algorithm is initialized and training data is passed to the model with .fit() function. Test data is predicted with .predict()function and saved in new variable. For evaluating the model, confusion matrix and classification report is done. Refer the below image.

Activity 6: xgboost model

A function named g_boosting is created and train and test data are passed as the parameters. Inside the function, GradientBoostingClassifier() algorithm is initialized and training data is passedto the model with .fit()function. Test data is predicted with .predict() functionand saved in new variable. For evaluating the model, confusion matrix and classification report isdone. Refer the below image.

```
. building
:ticRegression
:klearn.linear_model import LogisticRegression
:klearn.metrics import classification_report, confusion_matrix
gisticRegression(x_train, x_test, y_train, y_test):
 creating the model
del = LogisticRegression()
 feeding the training set into the model
del.fit(x_train, y_train)
 predicting the results for the test set
_pred = model.predict(x_test)
 calculating the training and testing accuracies
int('***logisticRegression***')
int("Training accuracy :", model.score(x_train, y_train))
int("Testing accuracy :", model.score(x_test, y_test))
 classification report
int(classification_report(y_test, y_pred))
 confusion matrix
int(confusion_matrix(y_test, y_pred))
```

```
from sklearn.tree import DecisionTreeClassifier
def decisionTree(x_train, x_test, y_train, y_test):
    dt=DecisionTreeClassifier()
    dt.fit(x_train,y_train)
    yPred = dt.predict(x_test)
    print('***DecisionTreeClassifier***')
    print("Training accuracy :", dt.score(x_train, y_train))
    print("Testing accuracy :", dt.score(x_test, y_test))
    print('Confusion matrix')
    print(confusion_matrix(y_test,yPred))
    print('Classification report')
    print(classification_report(y_test,yPred))
```

```
:klearn.linear_model import SGDClassifier
D(x_train, x_test, y_train, y_test):
 creating the model
del = SGDClassifier(penalty=None)
 feeding the training model into the model
del.fit(x_train, y_train)
 predicting the values for the test set
_pred = model.predict(x_test)
int('***Stochastic Gradient Descent Classifier***')
int("Training accuracy :", model.score(x_train, y_train))
int("Testing accuracy :", model.score(x_test, y_test))
 classification report
int(classification_report(y_test, y_pred))
 confusion matrix
int(confusion_matrix(y_test, y_pred))
```

```
from sklearn.ensemble import RandomForestClassifier
def randomForest(x_train, x_test, y_train, y_test):
    rf = RandomForestClassifier()
    rf.fit(x_train,y_train)
    yPred = rf.predict(x_test)
    print('***RandomForestClassifier***')
    print("Training accuracy :", rf.score(x_train, y_train))
    print("Testing accuracy :", rf.score(x_test, y_test))
    print('Confusion matrix')
    print(confusion_matrix(y_test,yPred))
    print('Classification report')
    print(classification_report(y_test,yPred))
```

```
:klearn.svm import SVC
Classifier(x_train, x_test, y_train, y_test):
 creating the model
del = SVC()
 feeding the training set into the model
del.fit(x_train, y_train)
 predicting the results for the test set
_pred = model.predict(x_test)
 calculating the training and testing accuracies
int('***Support Vector Classifier***')
int("Training accuracy :", model.score(x_train, y_train))
int("Testing accuracy :", model.score(x_test, y_test))
 classification report
int(classification_report(y_test, y_pred))
 confusion matrix
int(confusion_matrix(y_test, y_pred))
```

```
from sklearn.ensemble import GradientBoostingClassifier
def xgboost(x_train, x_test, y_train, y_test):
    xg = GradientBoostingClassifier()
    xg.fit(x_train,y_train)
    yPred = xg.predict(x_test)
    print('***GradientBoostingClassifier***')
    print("Training accuracy :", xg.score(x_train, y_train))
    print("Testing accuracy :", xg.score(x_test, y_test))
    print('Confusion matrix')
    print(confusion_matrix(y_test,yPred))
    print('Classification report')
    print(classification_report(y_test,yPred))
```

Activity 5: Save the model

Decision tree model is saved by pickle.dump() function. It saves the model as .pkl file.

```
dt=DecisionTreeClassifier()
dt.fit(x_train,y_train)
yPred = dt.predict(x_test)
```

```
import pickle
pickle.dump(dt,open("model.pkl","wb"))
```

Milestone 5: Application Building

In this section, we will be building a web application that is integrated to the model we built.A UI is provided for the uses where he has to enter the values for predictions. The enter values are given to the saved model and prediction is showcased on the UI.

This section has the following tasks

1. Building HTML Pages
2. Building serverside script

Activity1: Building Html Pages:

In our project we have created ONE HTML page, That is **cred.html**

```html
<!DOCTYPE html>
<html>
<head>
    <title> Analysis</title>
    <!-- Latest compiled and minified CSS -->
    <link rel="stylesheet" href="https://maxcdn.bootstrapcdn.com/bootstrap/3.3.7/css/bootstrap.min.css">
    <link href="C:\Users\jagad\OneDrive\Desktop\Credit card approval prediction\Credit card approval prediction\ML\flask\st
    <style type="text/css">
    .result{
    color:black;
    margin-top:30px;
    margin-bottom:20px;
    font-size:25px;
    color:red;
    }
</style>
</head>
<body>

    <div class="container">
        <div class="row">
            <div class="col-md-3"></div>
            <div class="col-md-6">
                 <div class="page-header">
                    <h1 style="color:red;">Credit Card Approval Prediction</h1>
                </div>
            </div>
        </div>
    </div>

    <div class="container">
        <div class="row">
            <div class="col-md-3"></div>
            <div class="col-md-6">
                <form action="/data_predict" method="POST">
                        <div class="col-md-6">
                            <div class="form-group">
                                <label for="gender" style="color:red;">Gender</label>
                                <select name="gender" class="form-control" id="gender">
                                    <option value="0">FEMALE</option>
                                    <option value="1">MALE</option>
                                </select>
                            </div>
                        </div>
                        <div class="col-md-6">
                            <div class="form-group">
                                <label for="car" style="color:red;">Own Car Or NOT</label>
                                <select name="car" class="form-control" id="car">
                                    <option value="0">NO</option>
                                    <option value="1">Yes</option>
                                </select>
                            </div>
                        </div>
                        <div class="col-md-6">
                            <div class="form-group">
                                <label for="estate" style="color:red;">Own Realstate</label>
                                <select name="estate" class="form-control" id="estate">
                                    <option value="0">No</option>
                                    <option value="1">Yes</option>
                                </select>
                            </div>
```

```
                        <input type="number" class="form-control" id="past" name="past" >
                    </div>
                </div>
                <div class="col-md-6">
                    <div class="form-group">

                    <label for="Loan" style="color:red;">No of Loans</label>
                        <input type="number" class="form-control" id="Loan" name="Loan" >
                    </div>
                </div>


enter>
button type="submit" class="btn btn-default" style="color:red;">Predict</button>
/center>
               </form>
           </div>
       </div>
   </div>
div class="result">
enter>
h3>You Are
 {{predictiont}}
  for credit card
/h3></center>
 </div>

   <!-- Latest compiled and minified JavaScript -->
   <script src="https://maxcdn.bootstrapcdn.com/bootstrap/3.3.7/js/bootstrap.min.js"></script
/body>
/html>
```

Activity 2: Build Python code:

Import the libraries

Pickle: Pickle is a module in Python used for serializing and de-serializing Python objects.Flask: Refer prior knowledge section mentioned above.

Here we will be using declaredconstructor to routeto the HTML page whichwe have createdearlier.

In the above example, '/' URLis bound with home.html function.Hence, when the home page of the web server is opened in browser, the html page will be rendered. Whenever youenter the valuesfrom the predicthtml page the values can be retrieved using POST Method.

Here we are routingour app to predict() function. This function retrieves all the valuesfromthe HTML page using Post request. That is stored in an array. This array is passed to the model.predict() function. This function returns the prediction. And this prediction value willrendered to the text that we have mentioned in the submit.html page earlier.

```python
from flask import Flask, request,render_template
app = Flask(__name__)
import joblib,pickle
import numpy as np
app = Flask(__name__)
ct= joblib.load("cred")
model = pickle.load(open("modelcredit.pkl","rb"))

@app.route('/') # rendering the html template
def predict():
    return render_template('cre.html')

@app.route('/data_predict', methods=['POST']) # route for our prediction
def data_predict():

    x_test = [[(x) for x in request.form.values()]]
    #x_test = np.array(x_test)
    #x_test=ct.transform(x_test)
    pred= model.predict(x_test)
    #print(pred)
    if pred[0]==0:
        prediction="Not Eligible"
    else:
        prediction="Eligible"

    return render_template("cre.html", predictiont=prediction)

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

Activity 3: Run the App

- Open anaconda prompt from the start menu
- Navigate to the folder where your pythonscript is.
- Nowtype “python cred.py”command
- Navigate to the localhost where you can view your web page.
- Click on the predict button from the top right corner, enter the inputs,click onthe submit button, and see the result/prediction on the

web.

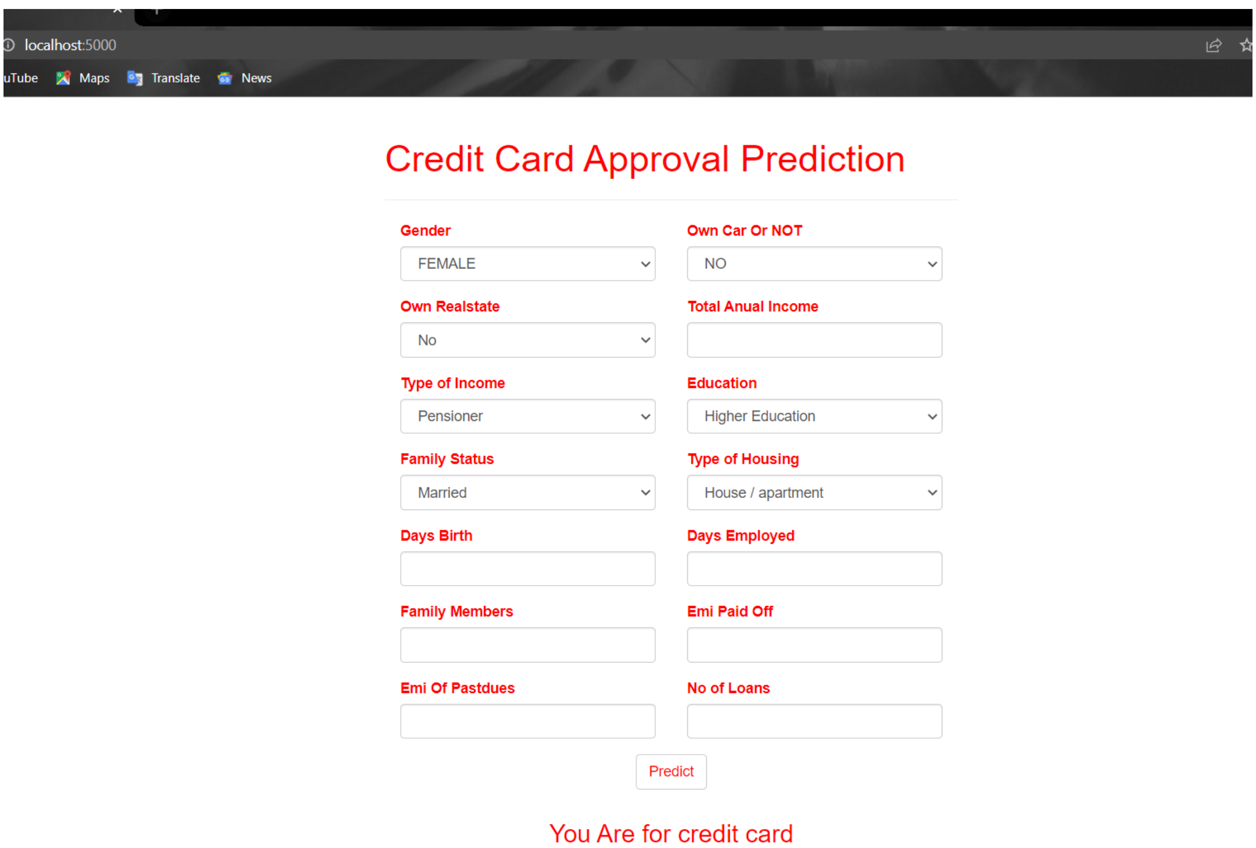
```
Python 3.9.12 (main, Apr  4 2022, 05:22:27) [MSC v.1916 64 bit (AMD64)]
Type "copyright", "credits" or "license" for more information.

IPython 8.2.0 -- An enhanced Interactive Python.

In [1]: runfile('C:/Users/jagad/Dropbox/PC/Downloads/Credit card approval prediction/Credit card
approval prediction/ML/flask/cred.py', wdir='C:/Users/jagad/Dropbox/PC/Downloads/Credit card approval
prediction/Credit card approval prediction/ML/flask')
 * Serving Flask app "cred" (lazy loading)
 * Environment: production
   WARNING: This is a development server. Do not use it in a production deployment.
   Use a production WSGI server instead.
 * Debug mode: on
 * Restarting with watchdog (windowsapi)
```

Now Enter the URL, localhost:5000 on the browser, you will redirectto cred.html page.

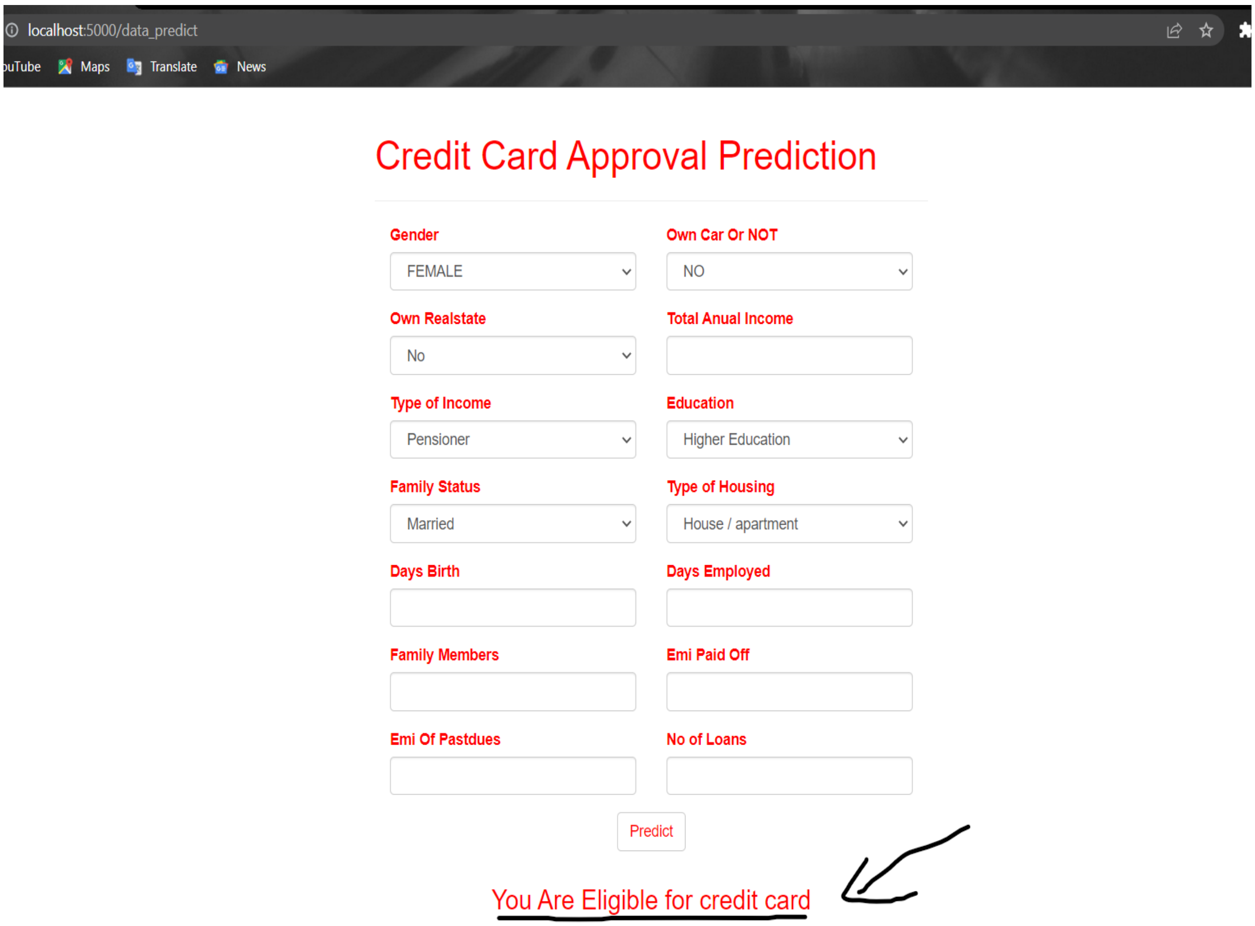
Let’s look our credpage



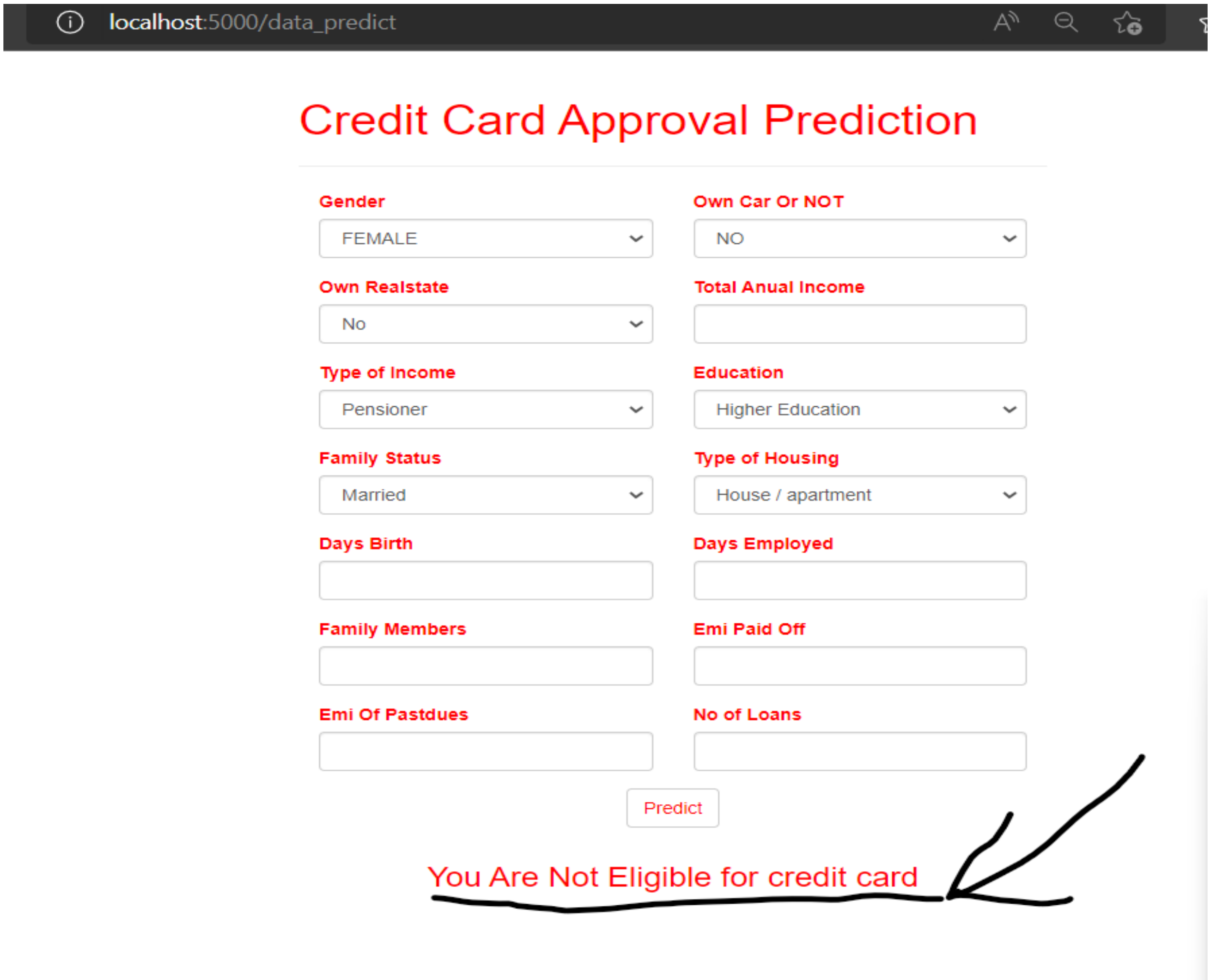
To predict your credit card eligibility, clickon predict button.The output will be

displayed on page.

now see the Eligibile result in the credit card approval prediction.



And now see the not Eligible result in the credit card approval prediction.



So this is the output after entering some values.

Thank You