ARTIFICIAL
INTELLIGENCE

SUDHARSHAN EDUCATIONAL TRUST

Creating Pathways to Wisdom

SUDHARSAN
ENGINEERING COLLEGE

Name : M.S.HARISH

Reg no: 814421104301

Dept :Computer Science Engineering

Title : AI Based Diabetes prediction system

INTRODUCTION:

Diabetes mellitus refers to a group of diseases that affect how the body uses blood sugar (glucose). Glucose is an important source of energy for the cells that make up the muscles and tissues. It's also the brain's main source of fuel.

The main cause of diabetes varies by type. But no matter what type of diabetes you have, it can lead to excess sugar in the blood. Too much sugar in the blood can lead to serious health problems.

Chronic diabetes conditions include type 1 diabetes and type 2 diabetes. Potentially reversible diabetes conditions include prediabetes and gestational diabetes. Prediabetes happens when blood sugar levels are higher than normal. But the blood sugar levels aren't high enough to be called diabetes. And prediabetes can lead to diabetes unless steps are taken to prevent it. Gestational diabetes happens during pregnancy. But it may go away after the baby is born.

Symptoms:

Diabetes symptoms depend on how high your blood sugar is. Some people, especially if they have prediabetes, gestational diabetes or type 2 diabetes, may not have symptoms. In type 1 diabetes, symptoms tend to come on quickly and be more severe.

Some of the symptoms of type 1 diabetes and type 2 diabetes are:

- Feeling more thirsty than usual.
- Urinating often.
- Losing weight without trying.

- Presence of ketones in the urine. Ketones are a byproduct of the breakdown of muscle and fat that happens when there's not enough available insulin.
- Feeling tired and weak.
- Feeling irritable or having other mood changes.
- Having blurry vision.
- Having slow-healing sores.
- Getting a lot of infections, such as gum, skin and vaginal infections.

Type 1 diabetes can start at any age. But it often starts during childhood or teen years. Type 2 diabetes, the more common type, can develop at any age. Type 2 diabetes is more common in people older than 40. But type 2 diabetes in children is increasing.

Problem Definition:

AI in Healthcare is an industry that always makes it necessary to make a precise decision, whether it is a treatment, test, or discharge. Diabetes is common due to modern food intake, and it is necessary to keep track of the body. AI in Diabetes helps to predict or Detect Diabetes. Any neglect in health can have a high cost for the patients and the medical practitioner. It becomes challenging for the patient to trust that this decision is taken by the machine that does not explain how it reaches a particular conclusion.

So the use of the Explainable AI is mandatory in predicting disease that will help gain the confidence of an AI system result. Explainable AI helps to get the fair and correct output without errors.

Objective:

A system is used to predict whether a patient has diabetes based on some of its health-related details such as BMI (Body Mass Index), blood pressure, Insulin, etc. This system is only for females as the dataset used to make this system exclusively belongs to the females.

Here, it is required to have an accuracy of the model to predict the correct result, as it is about someone's health. A single wrong result can have an adverse effect. Therefore, a good accuracy "Random Forest Classifier" Random Forest model is selected, which provides good accuracy to the system and generates the correct results.

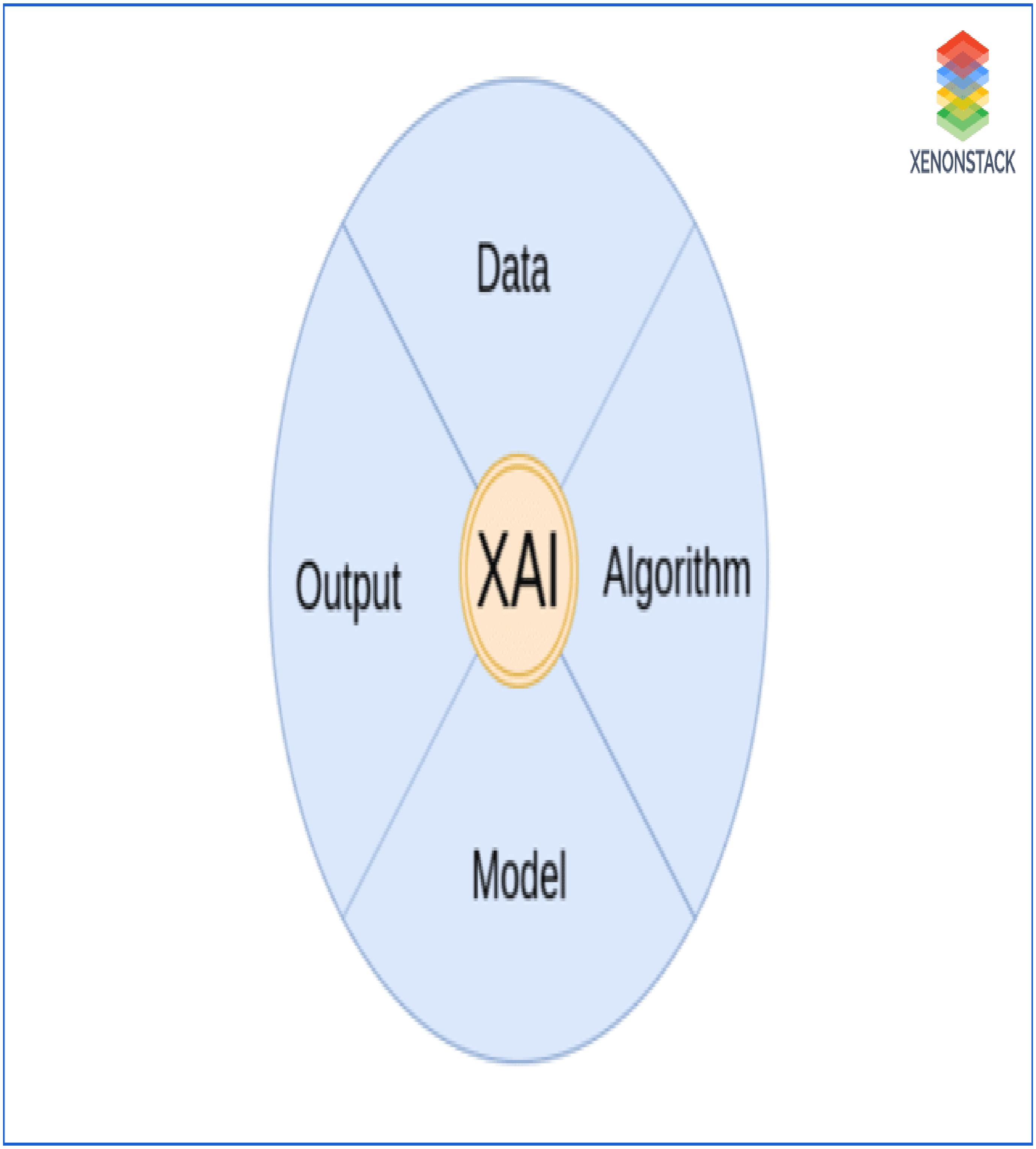
Transparency is equally essential as accuracy so that doctors, as well as the patient, can check whether the output that the system generated is accurate or not. But as we know, Random Forest classifiers belong to the opaque model family and not providing much transparency, making it difficult to understand the algorithm's complex working.

Therefore to balance, both the performance and interpretability of Akira AI, use Explainable AI here.

Design Thinking:

1. DATA SOURCE:

- **Data**: It explains the data used for the prediction, their correlation, and EDA (Exploratory Data Analysis) to understand the hidden data patterns. It tells how the data is to be used for the AI system.
- **Algorithm:** A complete transparency of the system's algorithm is given with the reason why the system chooses it and how it can be beneficial for the prediction.
- **Model**: Akira AI gives a detailed explanation of model performance and working in a user-friendly manner.
- **Output**: Akira AI gives a complete justification for the system's output with the reason. It also provides the factors that contribute to influence the result of the system.



XENONSTACK
Data
Output
XAI
Algorithm
Model

Implement Explainable AI in Diabetes Detection:

There is a step by step approach to implementing AI in Diabetes detection. From selecting data to the deploying system, Akira AI has methodologies and framework that can be implemented for providing the Explanation, such as

Selection of the right data and preprocess it for the model.

Precisely select the suitable algorithm for the system.

Use various frameworks to make the model working transparent.

Justify the model output and factors on which it depends.

To use a clear and clean deployment process.

Implement Explainable AI in Healthcare

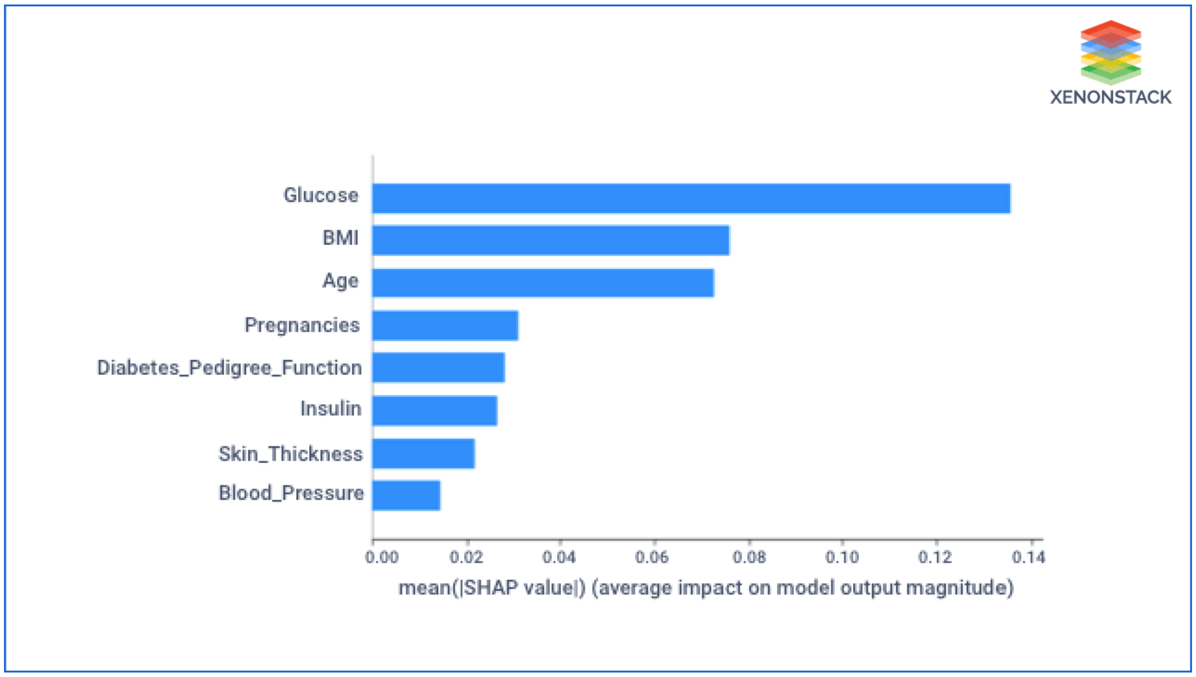
It is not required to use the Explainable AI everywhere in Healthcare. There are some cases where it is necessary to maintain privacy; it can be regarding the data and model working. Therefore we have to use Explainable AI precisely only at required places.

- We can use it when we need to give assurance to patients and doctors. Such as to prescribe medicines, to diagnose disease, etc.
- Different approaches can be used for different types of Explanations. We can implement Explainable AI in processes that need performance, trust, and confidence.

feature influences the result more

The contribution of features in making decisions can help doctors and patients to trust results.

The figure below depicts the importance of the features in predicting the output. Features are sorted by decreasing the importance from top to bottom to generate the output.

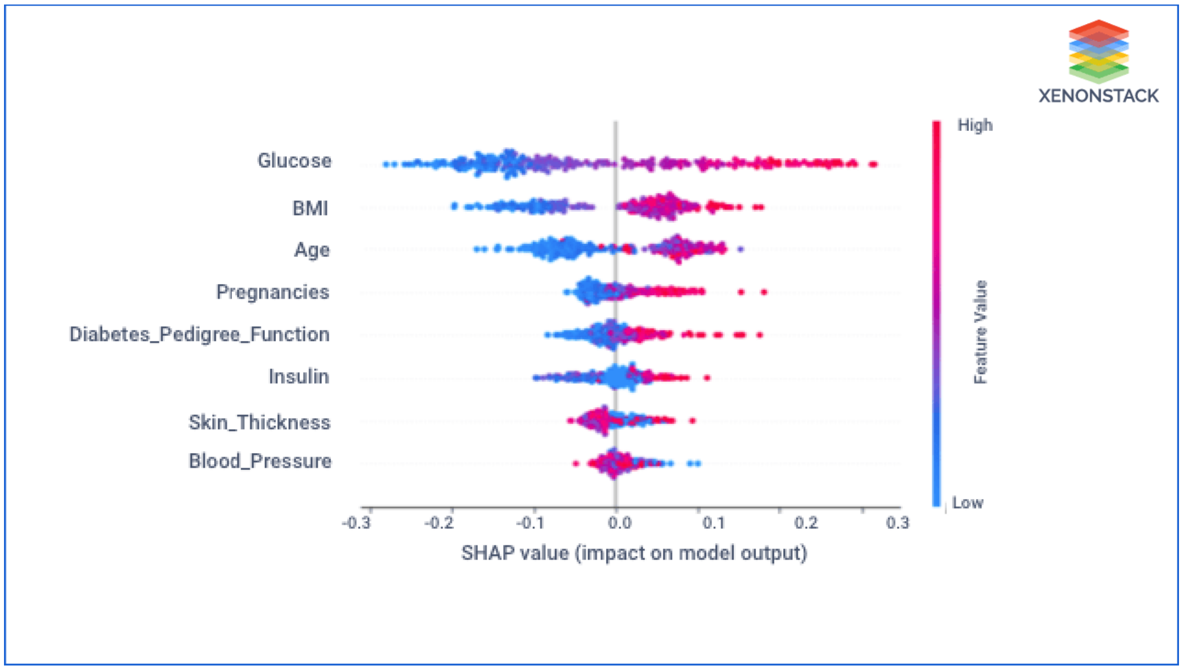


As it is showing, the Glucose value of a person influences the result more while predicting whether a person can have diabetes or not.

Data contributing to making a decision in Diabetes Detection with AI:

This is the next version of the previous graph. It also shows the same things with some more information about the value of the feature.

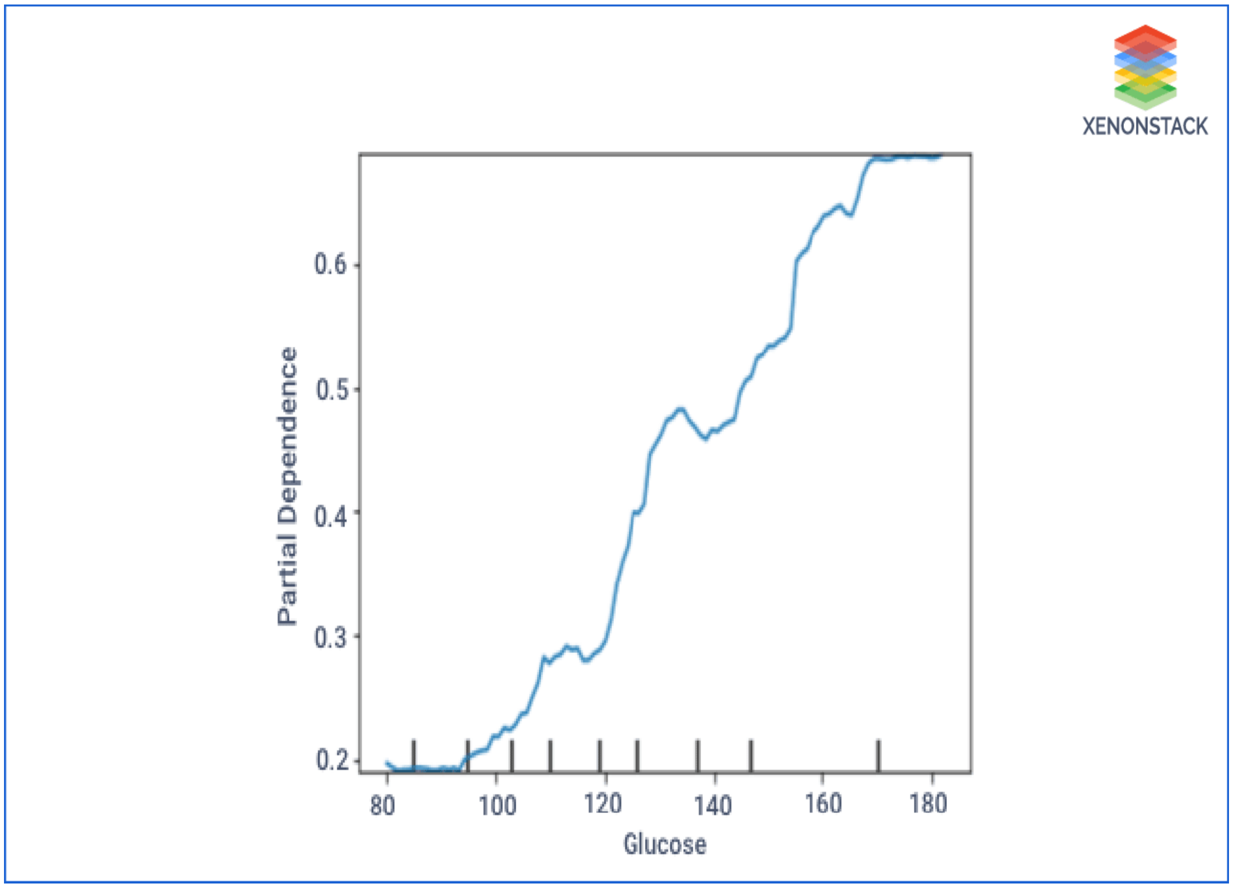
- **Feature importance**: Variables ranked in descending order of importance.
- **Impact**: The horizontal location display whether the effect of that value is associated with a higher or lower prediction.
- **Value**: Color display whether that variable is high or low for that observation. Red color devotes the high value and blue for less value. The variation in color of the dot shows the value of the feature.
- **Correlation:** A high level of "Glucose" content has a high impact on having diabetes. The "high" comes from red color, and the effect is shown on the X-axis.



change in the value of the Glucose change the system output:

After getting the answer to the first question, the customer can ask how the Glucose value change changes the system output when other parameters are not changing?

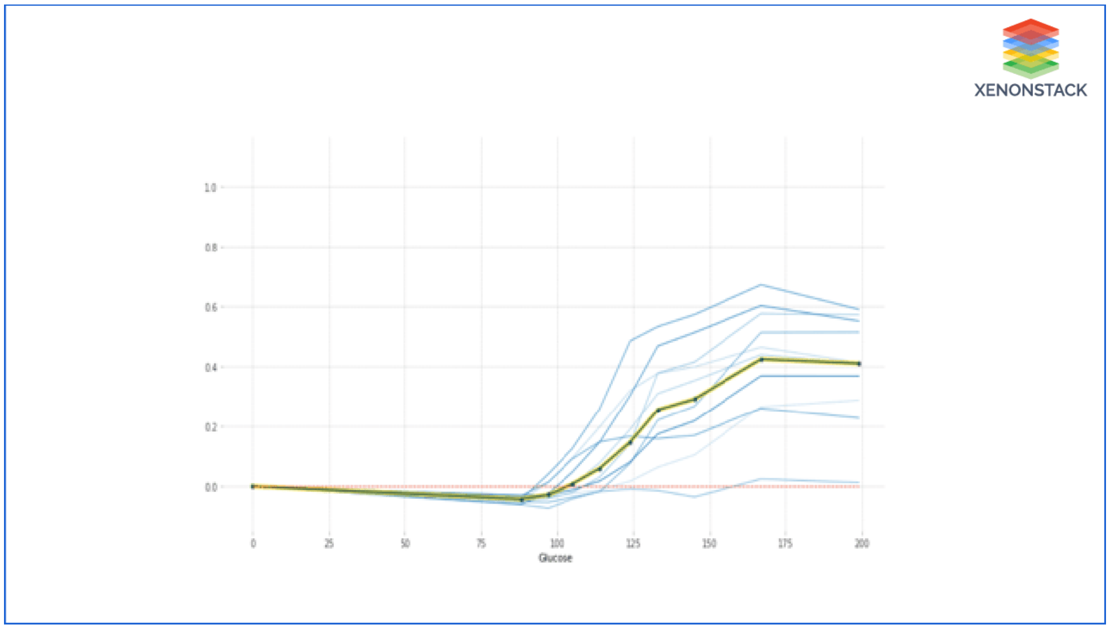
PDP shows the relation between the target response and feature. Other features are marginalized. This graph shows how a change in the value of Glucose changes the predicted output. It depicts that the increase in Glucose's value increases the probability of having diabetes to the person.



ICE (Individual Conditional Expectation) is a more detailed view of PDP. ICE is used to inspect the model's behavior for a specific instance, where everything except Glucose is held constant, fixed to its observed values. At the same time, Glucose is free to attain different values.

In PDP, other features are averaged out, but it took each case individually and the plot graph by only changing salary and remaining others constant. So this is a broad view of PDP.

In the Figure below, we just selected some of the observations. Users are free to choose any number of observations that they want to explore.

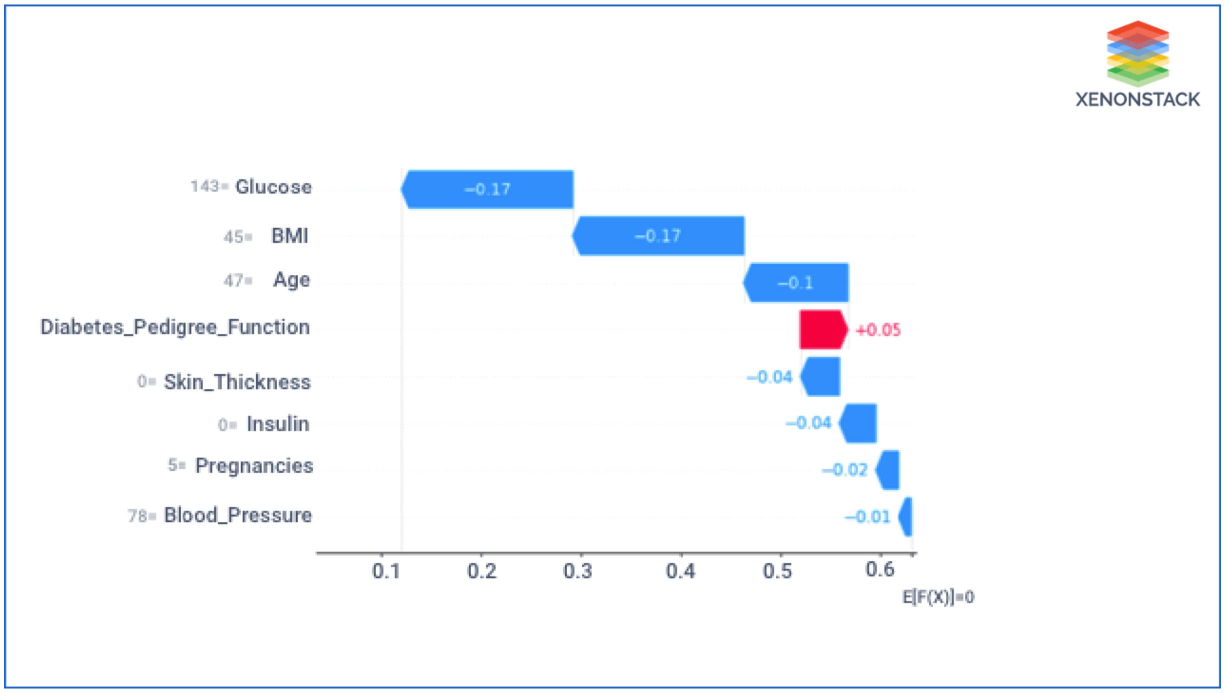


The System say I can have diabetes in the future:

Using SHAP system plots and justify its result is why it chooses individual output. The SHAP value represents the impact of feature evidence on the model's output.

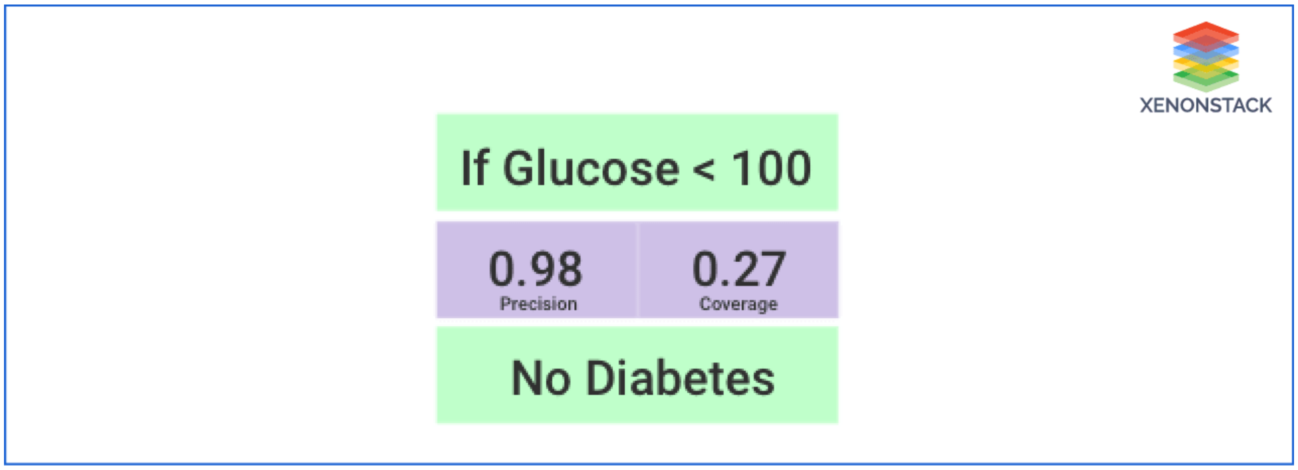
The waterfall plot depicts how each SHAP values feature moves the model output from our prior expectation under the background data distribution to the final model prediction. It gives evidence of all the features.

It displays explanations for individual predictions, so they expect a single row of an Explanation object as input. Each row shows how the positive (red) or negative (blue) contribution of each feature moves the value from the expected model output over the background dataset to the model output for this prediction.



The Value of the Glucose need to maintain in body:

The person's glucose value plays a significant part in predicting whether a person can have diabetes. Anchors can answer what Glucose's value that an individual needs to maintain to have diabetes. So this figure depicts that if that person maintains the Glucose value less than 100, it cannot have diabetes.



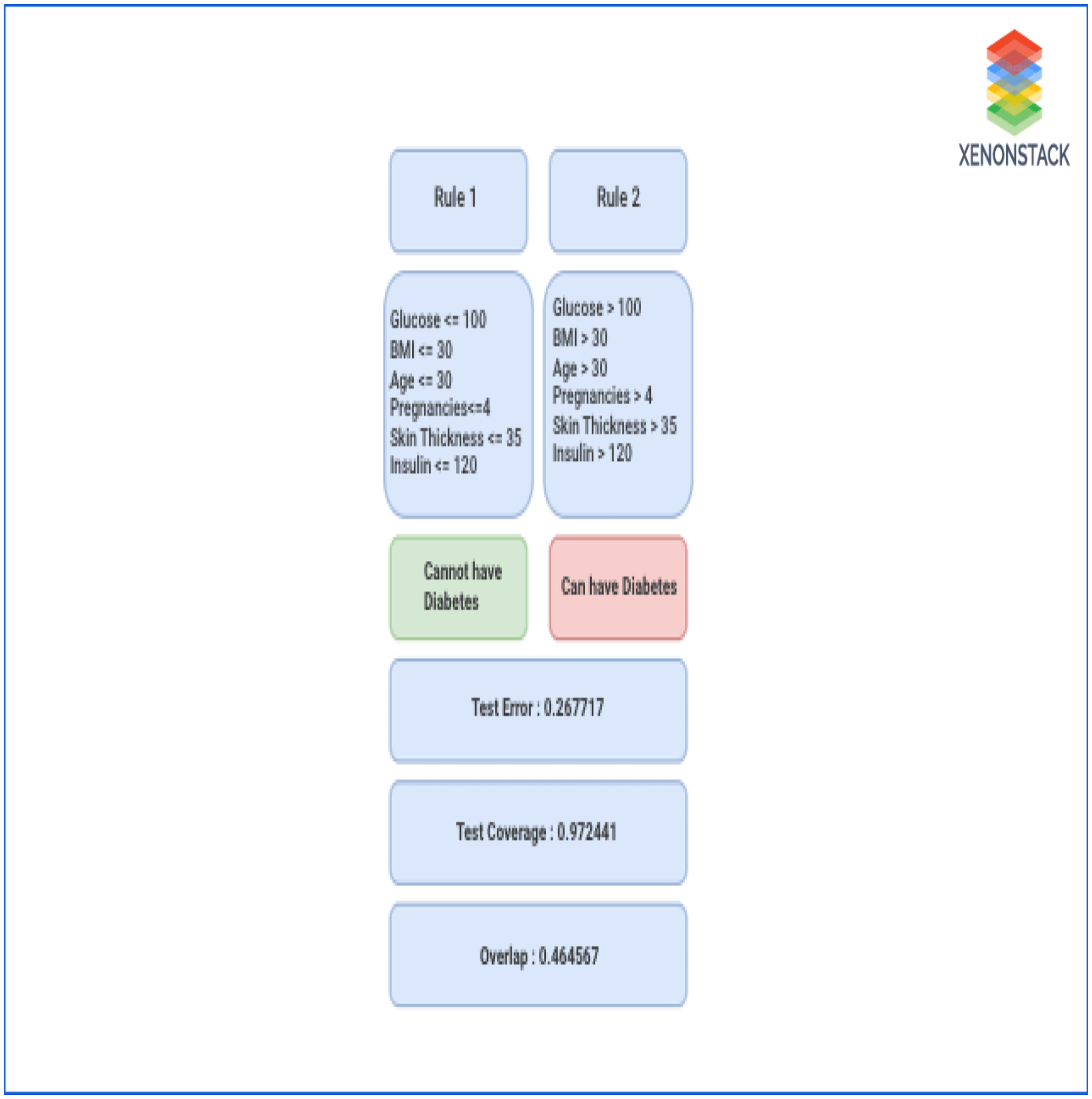
The general rule the system used to generate an output:

This is an essential question. A satisfying answer to that question can clear many doubts about the customers and bring their confidence in the system. If the system can provide the general rule that the system obeys to give the output, it can clear all the doubts regarding the algorithm's working.

We can use various methodologies to answer the question according to the algorithm we used to predict the output as we are using the Random Forest Classifiers Algorithm. Hence, we have some methods such as inTRess, defragTrees, etc., that we can use to extract the Random Forest Algorithm rule.

Here we used the defragTrees method that generates rules that the system used to predict an output, as shown in Figure below. It also provides the performance attributes from which the user can analyze and track the algorithm's performance and rule to predict an output. It follows the model's behavior on a global scale, so they can inspect it and find out whether the model has picked up any undesired functioning.

The figure describes two rules on which the system is working. It provides the value of the parameters that help to reach the system at the output. As given in Rule 1, if the value of the Glucose <= 100 and BMI <= 30 and Age <= 30 and Pregnancies <= 4 and Skin thickness <= 35 and Insulin <= 35, then the system will say that a lady doesn't have diabetes. Whereas opposite of these values as given in Rule 2 if the values of the parameters are Glucose > 100 and BMI > 30 and Age > 30 and Pregnancies > 4 and Skin thickness > 35 and Insulin> 35, then it will say that the lady can have diabetes.



It also provides the Test Error, Test coverage, and the Overlap values to understand the system's performance.

About Diabetes Prediction using Machine Learning Project:

Project Name:	**Diabetes prediction using Machine Learning**
Abstract	It's an ML-based Project which involves most of the ML steps like Collection of data, Exploring the data, Splitting of data, etc
Language/s Used:	Python
IDE	Google Colab(Recommended)
Python version (Recommended):	**Python 3.7**
Database:	https://www.kaggle.com/datasets/mathchi/diabetes-data-set
Type:	Prediction

Steps involved in Diabetes Prediction Project:

The workflow to build the end-to-end Machine Learning Project to predict Diabetes is as follows-

Collection of data
Exploring the data
Splitting the data
Training the model
Evaluating the model
Deploying the model

Data collection:

The very first step is to choose the dataset for our model. We can get a lot of different datasets from Kaggle. You just need to sign in to Kaggle and search for any dataset you need for the project. The Diabetes dataset required for our model can be downloaded here(https://www.kaggle.com/datasets/mathchi/diabetes-data-set).

This dataset is originally from the National Institute of Diabetes and Digestive and Kidney Diseases. The objective is to predict whether a patient has diabetes based on diagnostic measurements. Several constraints were placed on the selection of these instances from a larger database. In particular, all patients here are females at least 21 years old of Pima Indian heritage.

The data contains 9 columns which are as follows

- **Pregnancies**: Number of times pregnant
- **Glucose**: Plasma glucose concentration a 2 hours in an oral glucose tolerance test
- **BloodPressure**: Diastolic blood pressure (mm Hg)
- **SkinThickness**: Triceps skin fold thickness (mm)
- **Insulin**: 2-Hour serum insulin (mu U/ml)
- **BMI**: Body mass index (weight in kg/(height in m)^2)
- **DiabetesPedigreeFunction**: Diabetes pedigree function
- **Age**: Age (years)
- **Outcome**: Class variable (0 or 1)

Exploring the Data:

Now we have to set the development environment to build our project. For this project, we are going to build this Diabetes prediction using Machine Learning in Google Colab. You can also use Jupyter Notebook.

After downloading the dataset, import the necessary libraries to build the model.

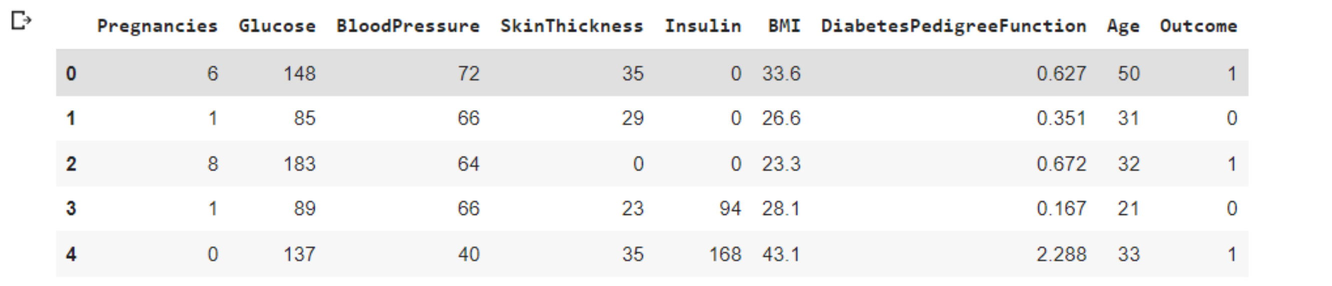
```
# Import the required libraries
import numpy as np
import pandas as pd
from sklearn.model_selection import train_test_split
from sklearn import svm
from sklearn.metrics import accuracy_score
import pickle
```

Load the data using the *read_csv* method in the pandas library. Then the *head()* method in the pandas library is used to print the rows up to the limit we specify. The default number of rows is five.

```
# Load the diabetes dataset to a pandas DataFrame
diabetes_dataset = pd.read_csv('diabetes.csv')

# Print the first 5 rows of the dataset
```

```
diabetes_dataset.head()
```

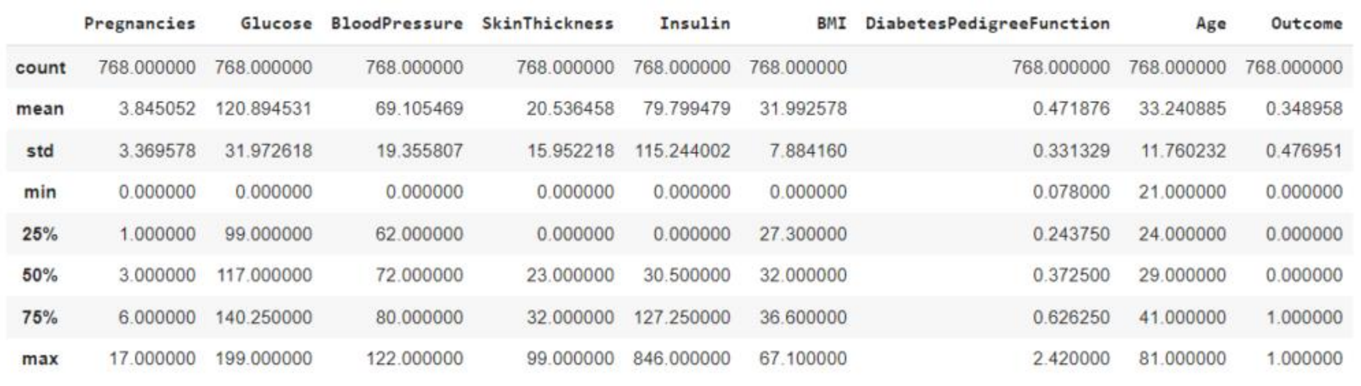
Output:



	Pregnancies	Glucose	BloodPressure	SkinThickness	Insulin	BMI	DiabetesPedigreeFunction	Age	Outcome
0	6	148	72	35	0	33.6	0.627	50	1
1	1	85	66	29	0	26.6	0.351	31	0
2	8	183	64	0	0	23.3	0.672	32	1
3	1	89	66	23	94	28.1	0.167	21	0
4	0	137	40	35	168	43.1	2.288	33	1

```
# To get the number of rows and columns in the dataset
diabetes_dataset.shape
#prints (768, 9)

# To get the statistical measures of the data
diabetes_dataset.describe()
```

Output:



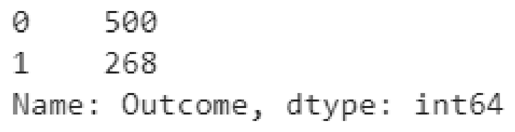
	Pregnancies	Glucose	BloodPressure	SkinThickness	Insulin	BMI	DiabetesPedigreeFunction	Age	Outcome
count	768.000000	768.000000	768.000000	768.000000	768.000000	768.000000	768.000000	768.000000	768.000000
mean	3.845052	120.894531	69.105469	20.536458	79.799479	31.992578	0.471876	33.240885	0.348958
std	3.369578	31.972618	19.355807	15.952218	115.244002	7.884160	0.331329	11.760232	0.476951
min	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.078000	21.000000	0.000000
25%	1.000000	99.000000	62.000000	0.000000	0.000000	27.300000	0.243750	24.000000	0.000000
50%	3.000000	117.000000	72.000000	23.000000	30.500000	32.000000	0.372500	29.000000	0.000000
75%	6.000000	140.250000	80.000000	32.000000	127.250000	36.600000	0.626250	41.000000	1.000000
max	17.000000	199.000000	122.000000	99.000000	846.000000	67.100000	2.420000	81.000000	1.000000

And, it is clear that the Outcome column is the output variable. So let us explore more

details about that column.

```
# To get details of the outcome 
columndiabetes_dataset['Outcome'].value_counts()
```

Output:



```
0    500
1    268
Name: Outcome, dtype: int64
```

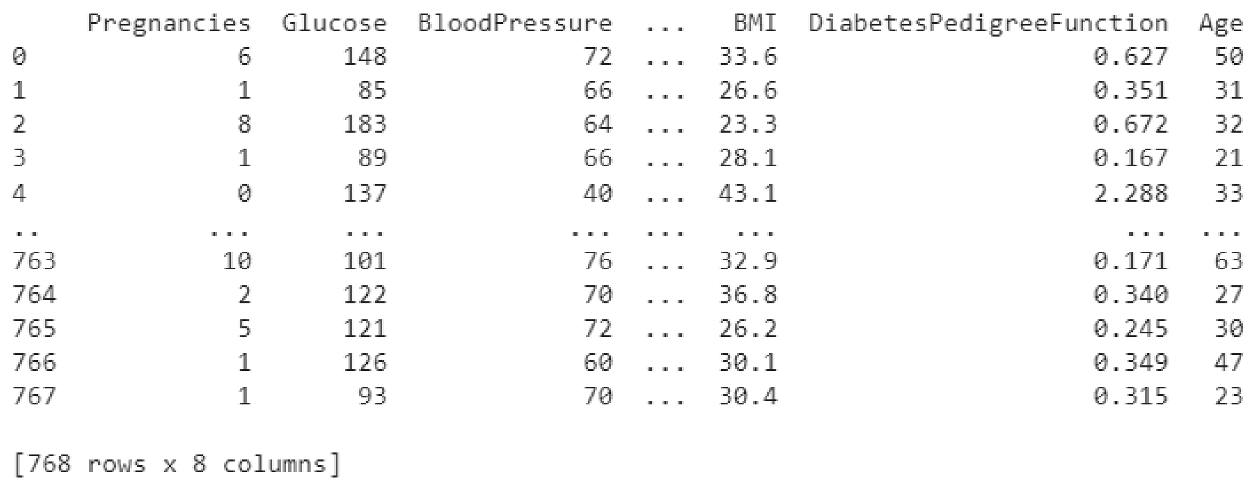
In the output, the value 1 means the person is having Diabetes, and 0 means the person is not having Diabetes. We can see the total count of people with and without Diabetes.

Splitting the data:

The next step in the building of the Machine learning model is splitting the data into training and testing sets. The training and testing data should be split in a ratio of 3:1 for better prediction results.

```
# separating the data and labels
X = diabetes_dataset.drop(columns = 'Outcome', axis=1)
Y = diabetes_dataset['Outcome']

# To print the independent variables
print(X)
```

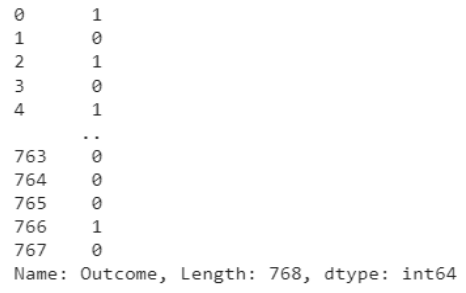
Output:



```
     Pregnancies  Glucose  BloodPressure  ...   BMI  DiabetesPedigreeFunction  Age
0              6      148             72  ...  33.6                     0.627   50
1              1       85             66  ...  26.6                     0.351   31
2              8      183             64  ...  23.3                     0.672   32
3              1       89             66  ...  28.1                     0.167   21
4              0      137             40  ...  43.1                     2.288   33
..           ...      ...            ...  ...   ...                       ...  ...
763           10      101             76  ...  32.9                     0.171   63
764            2      122             70  ...  36.8                     0.340   27
765            5      121             72  ...  26.2                     0.245   30
766            1      126             60  ...  30.1                     0.349   47
767            1       93             70  ...  30.4                     0.315   23

[768 rows x 8 columns]
```

```
# To print the outcome variable
print(Y)
```

Output**:**



```
0      1
1      0
2      1
3      0
4      1
      ..
763    0
764    0
765    0
766    1
767    0
Name: Outcome, Length: 768, dtype: int64
```

```
#Split the data into train and test
X_train, X_test, Y_train, Y_test = train_test_split(X,Y, test_size = 0.2,
stratify=Y, random_state=2)
print(X.shape, X_train.shape, X_test.shape)
```

Output:

(768, 8) (614, 8) (154, 8)

Training the model:

The next step is to build and train our model. We are going to use a Support vector classifier algorithm to build our model.

```
# Build the model
classifier = svm.SVC(kernel='linear')

# Train the support vector Machine Classifier
classifier.fit(X_train, Y_train)
```

After building the model, the model has to predict output with test data. After the prediction of the outcome with test data, we can calculate the accuracy score of the prediction results by the model.

```
# Accuracy score on the training data
X_train_prediction = classifier.predict(X_train)
training_data_accuracy = accuracy_score(X_train_prediction, Y_train)

print('Accuracy score of the training data : ', training_data_accuracy)

# Accuracy score on the test data
X_test_prediction = classifier.predict(X_test)
test_data_accuracy = accuracy_score(X_test_prediction, Y_test)

print('Accuracy score of the test data : ', test_data_accuracy)
```

Output:

```
Accuracy score of the training data: 0.7833876221498371
Accuracy score of the test data: 0.7727272727272727
```

Evaluating the model:

```
input_data = (5,166,72,19,175,25.8,0.587,51)

# Change the input_data to numpy array
input_data_as_numpy_array = np.asarray(input_data)

# Reshape the array for one instance
```

```
input_data_reshaped = input_data_as_numpy_array.reshape(1,-1)

prediction = classifier.predict(input_data_reshaped)
print(prediction)

if (prediction[0] == 0):
  print('The person is not diabetic')
else:
  print('The person is diabetic')
```

Output:

The person is diabetic

Saving the file

```
# Save the trained model
filename = 'trained_model.sav'
pickle.dump(classifier, open(filename, 'wb'))

# Load the saved model
loaded_model = pickle.load(open('trained_model.sav', 'rb'))
```

Once you run this code a new file named trained_model.sav will be saved in the project folder.

Deploying the model:

One of the most important and final steps in building a Machine Learning project is Model deployment. There are many frameworks available for deploying the Machine learning model on the web. Some of the most used Python frameworks are Django and Flask. But these frameworks require a little knowledge of languages such as HTML, CSS, and JavaScript.

So, a new framework known as Streamlit was introduced to deploy the Machine Learning model without the need to have the knowledge of Front End Languages. It is quite easy to deploy using Streamlit. So, we will use the Streamlit framework to deploy our model. Although Streamlit has many advantages over the other frameworks, lot more features are under development. If you are getting started in Machine Learning then this framework will be a perfect start to deploy your machine learning model on the web.

Python Code to Deploy ML model using Streamlit

To install Streamlit run the following command in the command prompt or terminal.

```
pip install streamlit
```

Open a new Python file and put the following code.

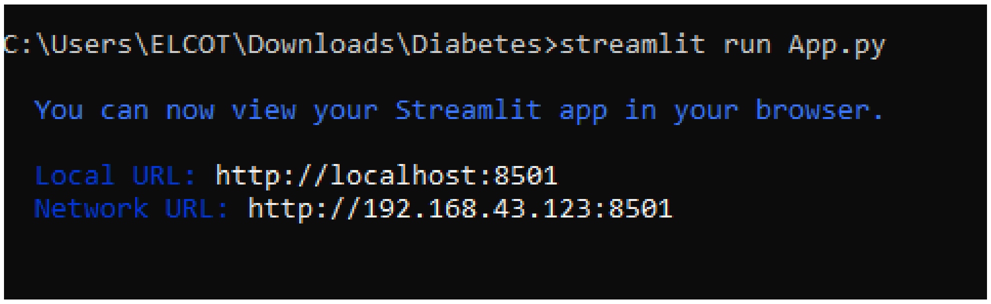
App.py

```
import numpy as np
import pickle
import streamlit as st
# Load the saved model
loaded_model = pickle.load(open('C:/Users/ELCOT/Downloads/trained_model.sav', 'rb'))
# Create a function for Prediction
def diabetes_prediction(input_data):
# Change the input_data to numpy array
input_data_as_numpy_array = np.asarray(input_data)
# Reshape the array as we are predicting for one instance
input_data_reshaped = input_data_as_numpy_array.reshape(1,-1)
prediction = loaded_model.predict(input_data_reshaped)
print(prediction)
if (prediction[0] == 0):
return 'The person is not diabetic'
else:
return 'The person is diabetic'
def main():
# Give a title
st.title('Diabetes Prediction Web App')
# To get the input data from the user
Pregnancies = st.text_input('Number of Pregnancies')
Glucose = st.text_input('Glucose Level')
BloodPressure = st.text_input('Blood Pressure value')
SkinThickness = st.text_input('Skin Thickness value')
Insulin = st.text_input('Insulin Level')
BMI = st.text_input('BMI value')
DiabetesPedigreeFunction = st.text_input('Diabetes Pedigree Function value')
Age = st.text_input('Age of the Person')
# Code for Prediction
diagnosis = ''
# Create a button for Prediction
if st.button('Diabetes Test Result'):
diagnosis = diabetes_prediction([Pregnancies, Glucose, BloodPressure, SkinThickness, Insulin, BMI,
DiabetesPedigreeFunction, Age])
```

```
st.success(diagnosis)
if __name__ == '__main__':
main()
```

Save the file after pasting the code. And then to deploy using streamlit go to command prompt and run the following command.

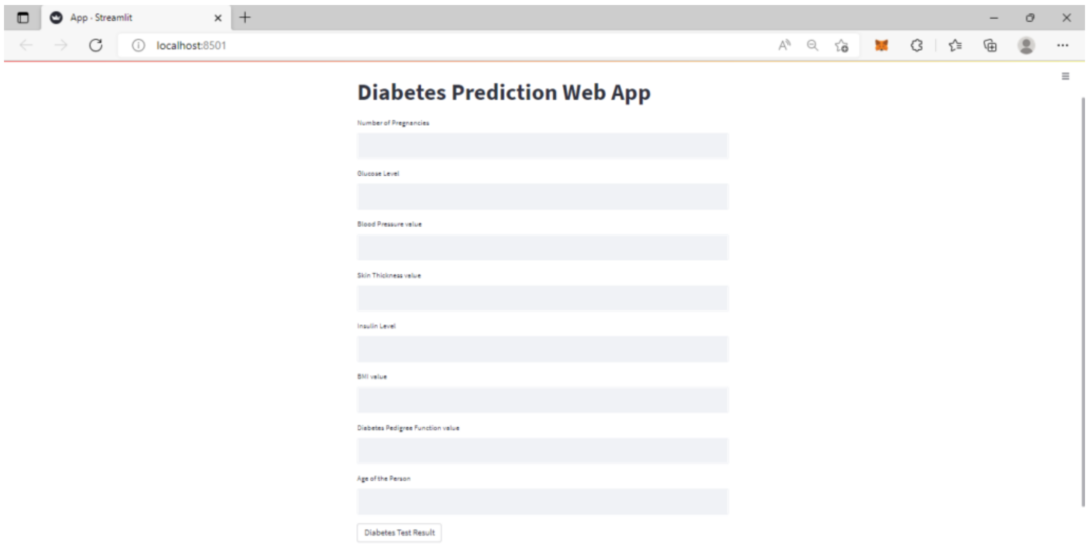
```
streamlit run App.py
(or)streamlit run filename.py
```



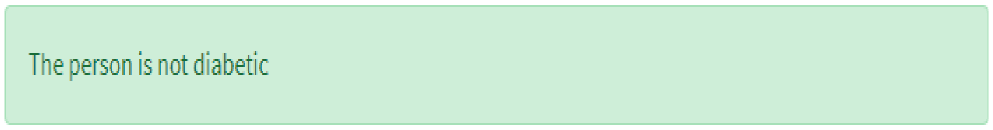
```
C:\Users\ELCOT\Downloads\Diabetes>streamlit run App.py

  You can now view your Streamlit app in your browser.

  Local URL: http://localhost:8501
  Network URL: http://192.168.43.123:8501
```

After running the command the web app will open in the localhost webserver. Otherwise, go to your browser and type *localhost:8501*. The following output will be shown.

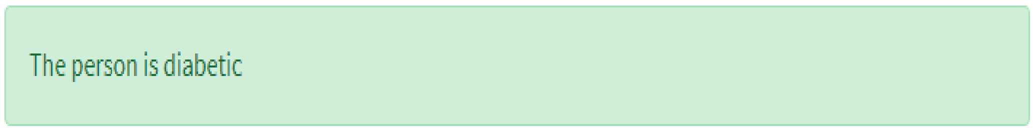
Output**:**



Sample Input data for a person does not have diabetes is {1, 85, 66, 29, 0, 26.6, 0.351, 31}. These data as input will generate the following output in the web app.


The person is not diabetic

Sample input data for a person who have diabetes is {6, 148, 72, 35, 0, 33.6, 0.627, 50}. These data as input will generate the following output in the web app.


The person is diabetic

Conclusion:

After using all these patient records, we are able to build a machine learning model (random forest – best one) to accurately predict whether or not the patients in the dataset have diabetes or not along with that we were able to draw some insights from the data via data analysis and visualization.