Modeling and Predicting the Occurrence of Diabetes using Machine Learning Algorithm for Classification

2024-05-06

Results

Load the Required Libraries

Load the Data

```
  gender age hypertension heart_disease smoking_history   bmi HbA1c_level
1 Female  80            0             1           never 25.19         6.6
2 Female  54            0             0         No Info 27.32         6.6
3   Male  28            0             0           never 27.32         5.7
4 Female  36            0             0         current 23.45         5.0
5   Male  76            1             1         current 20.14         4.8
  blood_glucose_level diabetes
1                 140        0
2                  80        0
3                 158        0
4                 155        0
5                 155        0
```

Summary Statistics

	vars	n	mean	sd	median	trimmed	mad	min	max	range	skew	kurtosis	se
age	1	100000	41.89	22.52	43.00	42.00	26.69	0.08	80.00	79.92	-0.05	-1.00	0.07
hypertension	2	100000	0.07	0.26	0.00	0.00	0.00	0.00	1.00	1.00	3.23	8.44	0.00
heart_disease	3	100000	0.04	0.19	0.00	0.00	0.00	0.00	1.00	1.00	4.73	20.41	0.00
bmi	4	100000	27.32	6.64	27.32	26.91	4.51	10.01	95.69	85.68	1.04	3.52	0.02
HbA1c_level	5	100000	5.53	1.07	5.80	5.57	1.19	3.50	9.00	5.50	-0.07	0.22	0.00
blood_glucose_level	6	100000	138.06	40.71	140.00	134.88	28.17	80.00	300.00	220.00	0.82	1.74	0.13
diabetes	7	100000	0.09	0.28	0.00	0.00	0.00	0.00	1.00	1.00	2.98	6.86	0.00

Model Estimation

Model One: Classification and Regression Tree (CART) Model

```
   gender age hypertension heart_disease smoking_history   bmi HbA1c_level
1  Female  80            0             1           never 25.19         6.6
```

```
2  Female  54           0            0         No Info 27.32         6.6
3    Male  28           0            0           never 27.32         5.7
4  Female  36           0            0         current 23.45         5.0
5    Male  76           1            1         current 20.14         4.8
6  Female  20           0            0           never 27.32         6.6
7  Female  44           0            0           never 19.31         6.5
8  Female  79           0            0         No Info 23.86         5.7
9    Male  42           0            0           never 33.64         4.8
10 Female  32           0            0           never 27.32         5.0
   blood_glucose_level diabetes
1                  140       No
2                   80       No
3                  158       No
4                  155       No
5                  155       No
6                   85       No
7                  200      Yes
8                   85       No
9                  145       No
10                 100       No
```

Take a sample of 300 observations for easier code execusion

```
      gender age hypertension heart_disease smoking_history   bmi HbA1c_level
41964 Female  39            0             0           never 27.64         4.8
15241   Male  77            0             1     not current 26.68         6.5
33702 Female  57            0             0           never 26.14         6.1
83023 Female  18            0             0           never 19.79         6.6
80756 Female  59            0             0           never 33.49         5.8
85374   Male  80            0             0           never 21.14         4.5
68158 Female  38            0             0           never 32.84         4.0
59944   Male  51            0             0          former 26.38         5.7
68536 Female  14            0             0         No Info 25.45         4.8
17380 Female  80            0             1            ever 23.29         3.5
      blood_glucose_level diabetes
41964                 160       No
15241                 140       No
33702                 130       No
83023                 126       No
80756                 240      Yes
85374                 140       No
68158                 155       No
59944                 140       No
68536                  80       No
17380                  85       No
```

Model Summary

```
CART

300 samples
  8 predictor
  2 classes: 'No', 'Yes'
```

```
No pre-processing
Resampling: Cross-Validated (5 fold, repeated 10 times)
Summary of sample sizes: 241, 240, 239, 240, 240, 241, ...
Resampling results across tuning parameters:

  cp         Accuracy   Kappa
  0.0000000  0.9487114  0.5134720
  0.2291667  0.9526788  0.5296865
  0.4583333  0.9353380  0.2666150

Accuracy was used to select the optimal model using the largest value.
The final value used for the model was cp = 0.2291667.
```

Confusion Matrix

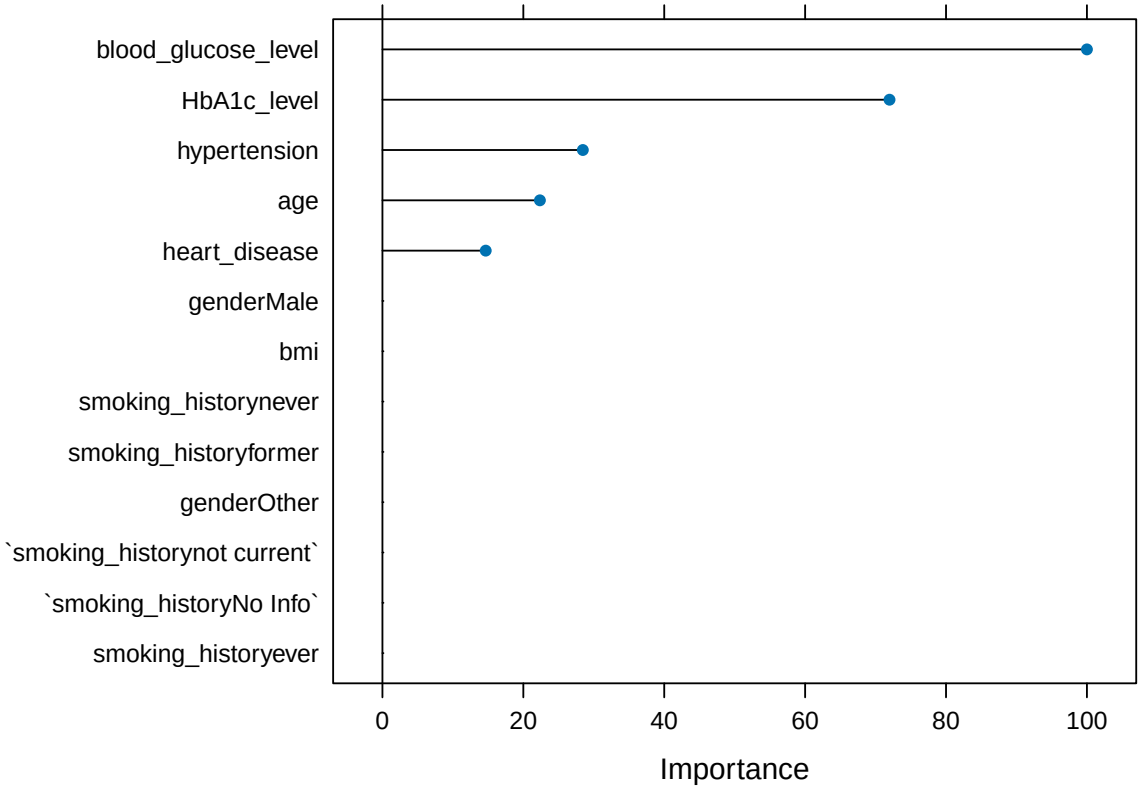
```
Confusion Matrix and Statistics

          Reference
Prediction  No Yes
       No  276  13
       Yes   0  11

               Accuracy : 0.9567
                 95% CI : (0.927, 0.9767)
    No Information Rate : 0.92
    P-Value [Acc > NIR] : 0.0084864

                  Kappa : 0.6089

 Mcnemar's Test P-Value : 0.0008741

            Sensitivity : 0.45833
            Specificity : 1.00000
         Pos Pred Value : 1.00000
         Neg Pred Value : 0.95502
             Prevalence : 0.08000
         Detection Rate : 0.03667
   Detection Prevalence : 0.03667
      Balanced Accuracy : 0.72917

       'Positive' Class : Yes
```

Variable Importance

```
rpart variable importance

                           Overall
blood_glucose_level         100.00
HbA1c_level                  71.98
hypertension                 28.45
age                          22.35
```

```
heart_disease                  14.66
genderOther                     0.00
‘smoking_historynot current‘    0.00
smoking_historynever            0.00
smoking_historyever             0.00
genderMale                      0.00
smoking_historyformer           0.00
‘smoking_historyNo Info‘        0.00
bmi                             0.00
```

Plot the Variable Importance



Model Two: Random Forest

```
Random Forest

300 samples
  8 predictor
  2 classes: 'No', 'Yes'

No pre-processing
Resampling: Cross-Validated (5 fold, repeated 10 times)
Summary of sample sizes: 241, 240, 239, 240, 240, 241, ...
```

```
Resampling results across tuning parameters:

  mtry  Accuracy   Kappa
   2    0.9470225  0.4504402
   7    0.9610406  0.6657376
  13    0.9560069  0.6506096

Accuracy was used to select the optimal model using the largest value.
The final value used for the model was mtry = 7.
```

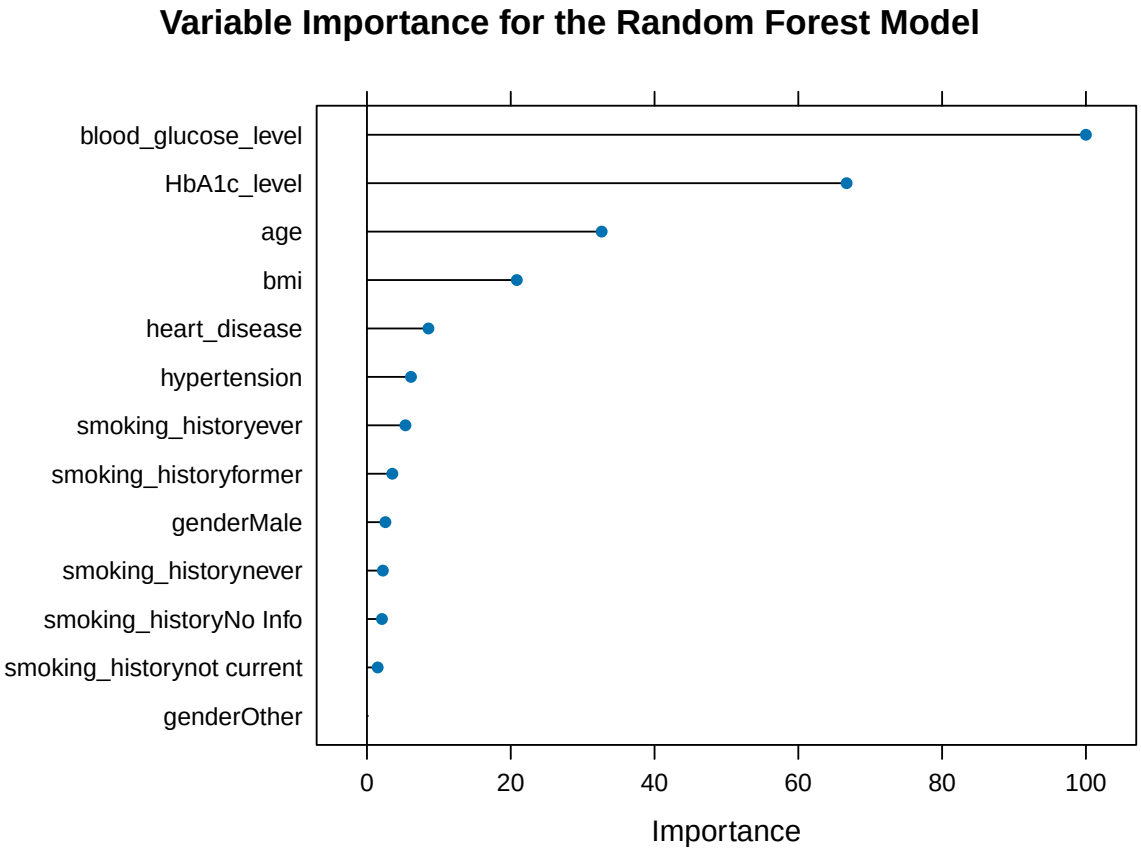
Confusion Matrix

```
Confusion Matrix and Statistics

          Reference
Prediction  No Yes
       No  276   0
       Yes   0  24

               Accuracy : 1
                 95% CI : (0.9878, 1)
    No Information Rate : 0.92
    P-Value [Acc > NIR] : 0.00000000001369

                  Kappa : 1

 Mcnemar's Test P-Value : NA

            Sensitivity : 1.00
            Specificity : 1.00
         Pos Pred Value : 1.00
         Neg Pred Value : 1.00
             Prevalence : 0.08
         Detection Rate : 0.08
   Detection Prevalence : 0.08
      Balanced Accuracy : 1.00

       'Positive' Class : Yes
```

Obtain variable importance

```
rf variable importance

                          Overall
blood_glucose_level       100.000
HbA1c_level                66.716
age                        32.644
bmi                        20.844
heart_disease               8.551
hypertension                6.125
smoking_historyever         5.350
smoking_historyformer       3.531
```

```
genderMale                    2.564
smoking_historynever          2.215
smoking_historyNo Info        2.087
smoking_historynot current    1.489
genderOther                   0.000
```



Model Three: k-Nearest Neighbors

View the Final Model

```
k-Nearest Neighbors

300 samples
  8 predictor
  2 classes: 'No', 'Yes'

Pre-processing: centered (13), scaled (13)
Resampling: Cross-Validated (5 fold, repeated 10 times)
Summary of sample sizes: 241, 240, 239, 240, 240, 241, ...
Resampling results across tuning parameters:

  k   Accuracy   Kappa
   5  0.9340103  0.2845934
   7  0.9363440  0.3020008
```

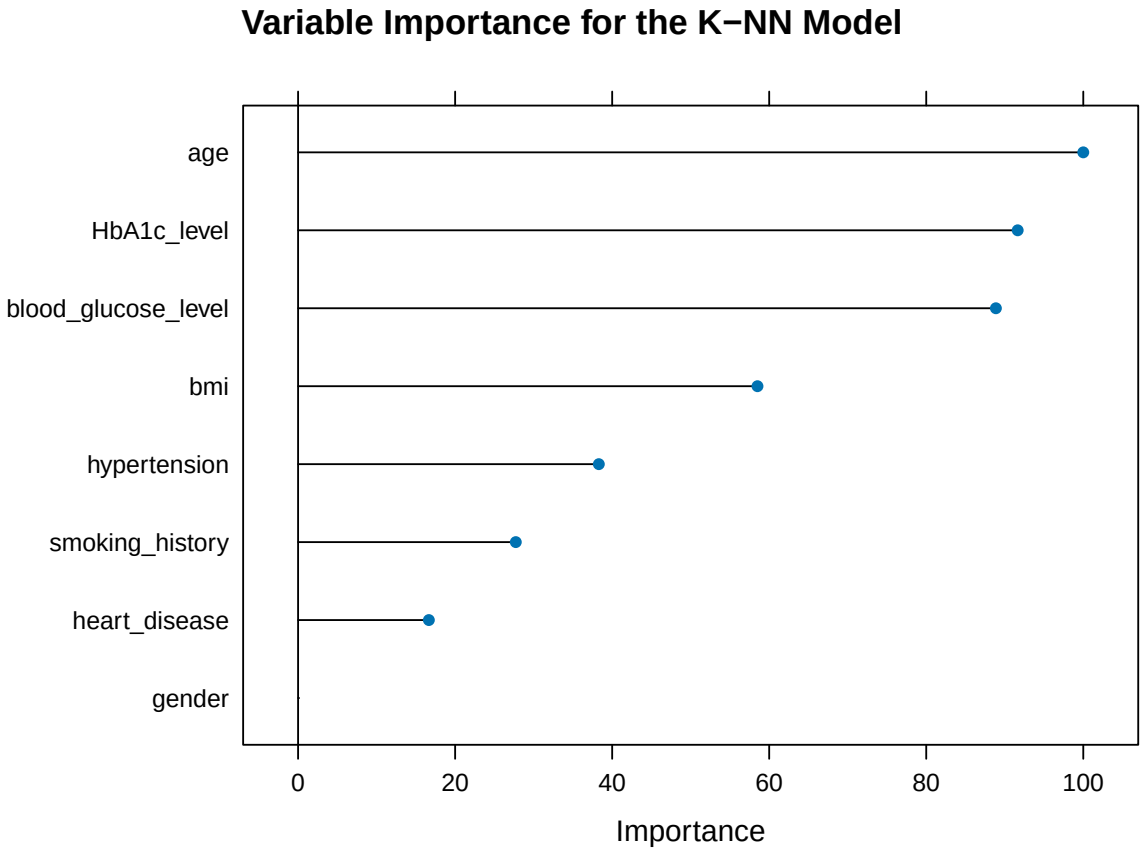
```
   9  0.9326937  0.2466591
  11  0.9290210  0.1662212
  13  0.9273542  0.1381262

Accuracy was used to select the optimal model using the largest value.
The final value used for the model was k = 7.
```

Classification Accuracy

```
Confusion Matrix and Statistics

          Reference
Prediction  No Yes
       No  275  18
       Yes   1   6

               Accuracy : 0.9367
                 95% CI : (0.9029, 0.9614)
    No Information Rate : 0.92
    P-Value [Acc > NIR] : 0.1694788

                  Kappa : 0.3641

 Mcnemar's Test P-Value : 0.0002419

            Sensitivity : 0.25000
            Specificity : 0.99638
         Pos Pred Value : 0.85714
         Neg Pred Value : 0.93857
             Prevalence : 0.08000
         Detection Rate : 0.02000
   Detection Prevalence : 0.02333
      Balanced Accuracy : 0.62319

       'Positive' Class : Yes
```

Variable Importance

```
ROC curve variable importance

                    Importance
age                     100.00
HbA1c_level              91.65
blood_glucose_level      88.87
bmi                      58.51
hypertension             38.30
smoking_history          27.73
heart_disease            16.65
gender                    0.00
```



Model Four: Naive Bayes

View the Model

```
Naive Bayes

300 samples
  8 predictor
  2 classes: 'No', 'Yes'

Pre-processing: centered (13), scaled (13)
Resampling: Cross-Validated (5 fold, repeated 10 times)
Summary of sample sizes: 241, 240, 239, 240, 240, 241, ...
Resampling results across tuning parameters:

  usekernel  Accuracy   Kappa
  FALSE      0.6518562  0.2228126
   TRUE      0.9436779  0.4067932

Tuning parameter 'laplace' was held constant at a value of 0
Tuning
 parameter 'adjust' was held constant at a value of 1
Accuracy was used to select the optimal model using the largest value.
The final values used for the model were laplace = 0, usekernel = TRUE
```

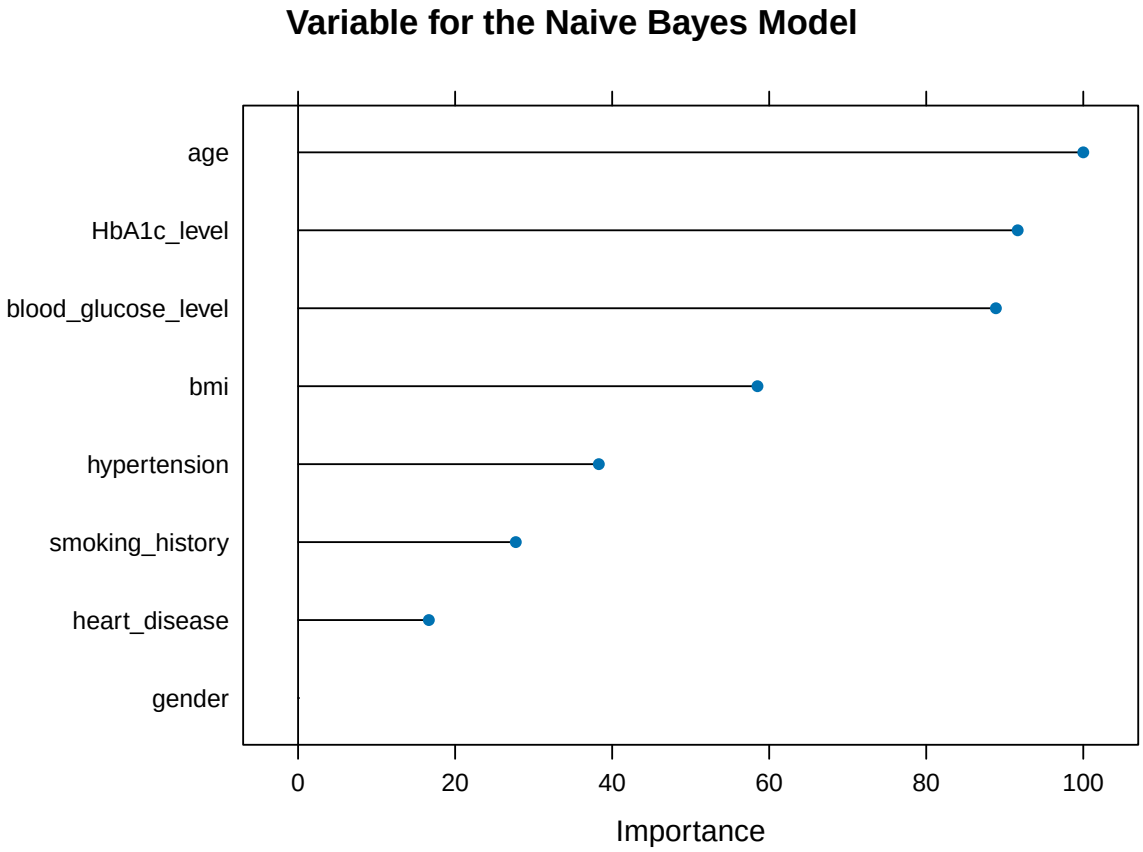
```
 and adjust = 1.
```

Prediction and Classification Accuracy

```
Confusion Matrix and Statistics

          Reference
Prediction  No Yes
       No  276  16
       Yes   0   8

               Accuracy : 0.9467
                 95% CI : (0.9148, 0.9692)
    No Information Rate : 0.92
    P-Value [Acc > NIR] : 0.0492508

                  Kappa : 0.4792

 Mcnemar's Test P-Value : 0.0001768

            Sensitivity : 0.33333
            Specificity : 1.00000
         Pos Pred Value : 1.00000
         Neg Pred Value : 0.94521
             Prevalence : 0.08000
         Detection Rate : 0.02667
   Detection Prevalence : 0.02667
      Balanced Accuracy : 0.66667

       'Positive' Class : Yes
```

Variable Importance

```
ROC curve variable importance

                     Importance
age                      100.00
HbA1c_level               91.65
blood_glucose_level       88.87
bmi                       58.51
hypertension              38.30
smoking_history           27.73
heart_disease             16.65
gender                     0.00
```



Model Five: Support Vector Machine (SVM)

View the Model

```
Support Vector Machines with Linear Kernel

300 samples
  8 predictor
  2 classes: 'No', 'Yes'

Pre-processing: centered (13), scaled (13)
Resampling: Cross-Validated (5 fold, repeated 10 times)
Summary of sample sizes: 241, 240, 239, 240, 240, 241, ...
Resampling results:

  Accuracy   Kappa
  0.9433946  0.5337302

Tuning parameter 'C' was held constant at a value of 1
```

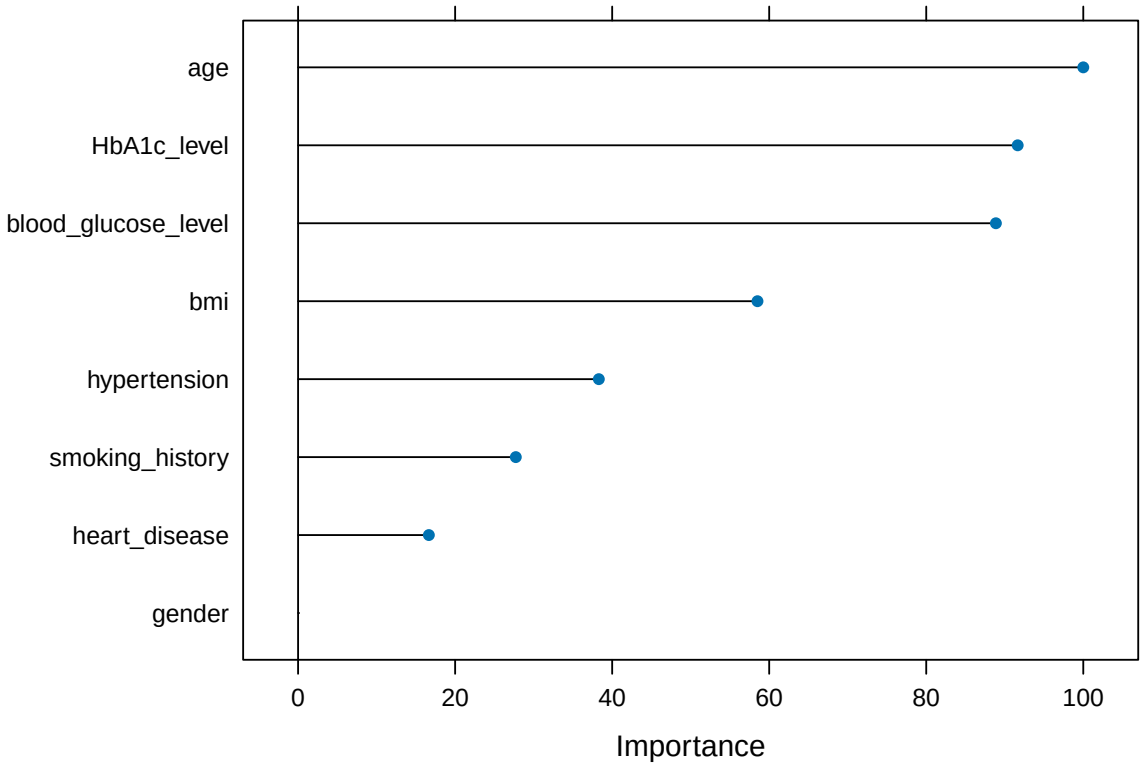
Prediction and Classification Accuracy

```
Confusion Matrix and Statistics
```

```
          Reference
Prediction  No Yes
       No  273  10
       Yes   3  14

               Accuracy : 0.9567
                 95% CI : (0.927, 0.9767)
    No Information Rate : 0.92
    P-Value [Acc > NIR] : 0.008486

                  Kappa : 0.6604

 Mcnemar's Test P-Value : 0.096092

            Sensitivity : 0.58333
            Specificity : 0.98913
         Pos Pred Value : 0.82353
         Neg Pred Value : 0.96466
             Prevalence : 0.08000
         Detection Rate : 0.04667
   Detection Prevalence : 0.05667
      Balanced Accuracy : 0.78623

       'Positive' Class : Yes
```

Variable Importance

```
ROC curve variable importance

                    Importance
age                     100.00
HbA1c_level              91.65
blood_glucose_level      88.87
bmi                      58.51
hypertension             38.30
smoking_history          27.73
heart_disease            16.65
gender                    0.00
```


Variable Importance for Support Vector Machine
age
HbA1c_level
blood_glucose_level
bmi
hypertension
smoking_history
heart_disease
gender
0
20
40
60
80
100
Importance

Reference

Mustafa, M. (2023). Diabetes prediction dataset. Kaggle.com. https://www.kaggle.com/datasets/iammustafatz/diabetes-prediction-dataset