# Herzerkrankung

July 30, 2025

[42]:
```
# Import Libraries

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

[43]:
```
#1.Load Data
df=pd.read_csv(r"C:\Users\goex1\Desktop\Data Science - Heart Disease\framingham.
 ↪csv")

#2. Overview of dataset
df.head(10)
```

[43]:

| | male | age | education | currentSmoker | cigsPerDay | BPMeds | prevalentStroke | prevalentHyp | diabetes | totChol | sysBP | diaBP | BMI | heartRate | glucose |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1 | 39 | 4.0 | 0 | 0.0 | 0.0 | 0 | 0 | 0 | 195.0 | 106.0 | 70.0 | 26.97 | 80.0 | 77.0 |
| 1 | 0 | 46 | 2.0 | 0 | 0.0 | 0.0 | 0 | 0 | 0 | 250.0 | 121.0 | 81.0 | 28.73 | 95.0 | 76.0 |
| 2 | 1 | 48 | 1.0 | 1 | 20.0 | 0.0 | 0 | 0 | 0 | 245.0 | 127.5 | 80.0 | 25.34 | 75.0 | 70.0 |
| 3 | 0 | 61 | 3.0 | 1 | 30.0 | 0.0 | 0 | 1 | 0 | 225.0 | 150.0 | 95.0 | 28.58 | 65.0 | 103.0 |
| 4 | 0 | 46 | 3.0 | 1 | 23.0 | 0.0 | 0 | 0 | 0 | 285.0 | 130.0 | 84.0 | 23.10 | 85.0 | 85.0 |
| 5 | 0 | 43 | 2.0 | 0 | 0.0 | 0.0 | 0 | 1 | 0 | 228.0 | 180.0 | 110.0 | 30.30 | 77.0 | 99.0 |
| 6 | 0 | 63 | 1.0 | 0 | 0.0 | 0.0 | 0 | 0 | 0 | 205.0 | 138.0 | 71.0 | 33.11 | 60.0 | 85.0 |
| 7 | 0 | 45 | 2.0 | 1 | 20.0 | 0.0 | 0 | 0 | 0 | 313.0 | 100.0 | 71.0 | 21.68 | 79.0 | 78.0 |
| 8 | 1 | 52 | 1.0 | 0 | 0.0 | 0.0 | 0 | 1 | 0 | 260.0 | 141.5 | 89.0 | 26.36 | 76.0 | 79.0 |
| 9 | 1 | 43 | 1.0 | 1 | 30.0 | 0.0 | 0 | 1 | 0 | 225.0 | 162.0 | 107.0 | 23.61 | 93.0 | 88.0 |

```
   TenYearCHD
0           0
1           0
2           0
3           1
4           0
5           0
6           1
7           0
8           0
9           0
```

[44]:
```
numerische_spalten = df.select_dtypes(include='float64').columns

#2. Overview about dataset
df.describe()
```

[44]:

| | male | age | education | currentSmoker | cigsPerDay |
|---|---|---|---|---|---|
| count | 4238.000000 | 4238.000000 | 4133.000000 | 4238.000000 | 4209.000000 |
| mean | 0.429212 | 49.584946 | 1.978950 | 0.494101 | 9.003089 |
| std | 0.495022 | 8.572160 | 1.019791 | 0.500024 | 11.920094 |
| min | 0.000000 | 32.000000 | 1.000000 | 0.000000 | 0.000000 |
| 25% | 0.000000 | 42.000000 | 1.000000 | 0.000000 | 0.000000 |
| 50% | 0.000000 | 49.000000 | 2.000000 | 0.000000 | 0.000000 |
| 75% | 1.000000 | 56.000000 | 3.000000 | 1.000000 | 20.000000 |
| max | 1.000000 | 70.000000 | 4.000000 | 1.000000 | 70.000000 |

| | BPMeds | prevalentStroke | prevalentHyp | diabetes | totChol |
|---|---|---|---|---|---|
| count | 4185.000000 | 4238.000000 | 4238.000000 | 4238.000000 | 4188.000000 |
| mean | 0.029630 | 0.005899 | 0.310524 | 0.025720 | 236.721585 |
| std | 0.169584 | 0.076587 | 0.462763 | 0.158316 | 44.590334 |
| min | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 107.000000 |
| 25% | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 206.000000 |
| 50% | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 234.000000 |
| 75% | 0.000000 | 0.000000 | 1.000000 | 0.000000 | 263.000000 |
| max | 1.000000 | 1.000000 | 1.000000 | 1.000000 | 696.000000 |

| | sysBP | diaBP | BMI | heartRate | glucose |
|---|---|---|---|---|---|
| count | 4238.000000 | 4238.000000 | 4219.000000 | 4237.000000 | 3850.000000 |
| mean | 132.352407 | 82.893464 | 25.802008 | 75.878924 | 81.966753 |
| std | 22.038097 | 11.910850 | 4.080111 | 12.026596 | 23.959998 |
| min | 83.500000 | 48.000000 | 15.540000 | 44.000000 | 40.000000 |
| 25% | 117.000000 | 75.000000 | 23.070000 | 68.000000 | 71.000000 |
| 50% | 128.000000 | 82.000000 | 25.400000 | 75.000000 | 78.000000 |
| 75% | 144.000000 | 89.875000 | 28.040000 | 83.000000 | 87.000000 |
| max | 295.000000 | 142.500000 | 56.800000 | 143.000000 | 394.000000 |

```
        TenYearCHD
count  4238.000000
mean      0.151958
std       0.359023
min       0.000000
25%       0.000000
50%       0.000000
75%       0.000000
max       1.000000
```

[45]:
```
#Data types korrigieren:

df['male'] = df['male'].astype('Int64')
df['age'] = df['age'].astype('float64')
df['currentSmoker'] = df['currentSmoker'].astype('int64')
```

[ ]:
```
#barplots of all variables#

for feature in df:
    sns.histplot(data=df,x=feature, color="navy")
    plt.title(f" Barplot - {feature}")
    plt.show()
```

[ ]:
```
#Boxplot of all numeric data#

numerische_spalten = df.select_dtypes(include='float64').columns


for feature in numerische_spalten:
    sns.boxplot(data=df, y=feature, color="orange")
    plt.title(f'Boxplot - {feature}')
    plt.show()
```

[46]:
```
#Missing Data?

df.isnull().sum()
```

[46]:
```
male                0
age                 0
education         105
currentSmoker       0
cigsPerDay         29
BPMeds             53
prevalentStroke     0
prevalentHyp        0
diabetes            0
```

```
totChol          50
sysBP             0
diaBP             0
BMI              19
heartRate         1
glucose         388
TenYearCHD        0
dtype: int64
```

[47]:
```
# Data Imputation

df['education'] = df['education'].fillna(0).astype('int64')
df['cigsPerDay'] = df['cigsPerDay'].fillna(0).astype('float64')
df['BPMeds'] = df['BPMeds'].fillna(0).astype('int64')
df['totChol'] = df['totChol'].fillna(df['totChol'].mean()).astype('float64')
df['BMI'] = df['BMI'].fillna(df['BMI'].mean()).astype('float64')
df['heartRate'] = df['heartRate'].fillna(df['heartRate'].mean()).
 ↪astype('float64')
df['glucose'] = df['glucose'].fillna(df['glucose'].mean()).astype('float64')
```

[48]:
```
#Feature Selection

X = df[['male', 'age', 'education', 'currentSmoker', 'cigsPerDay', 'BPMeds',␣
 ↪'prevalentStroke', 'prevalentHyp',
       'diabetes', 'totChol', 'sysBP', 'diaBP', 'BMI', 'heartRate', 'glucose']]

y = df['TenYearCHD']
```

[49]:
```
#Train-Test-Split

from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(X,y, test_size=0.33,␣
 ↪random_state=42)
```

[50]:
```
#Model training

from sklearn.linear_model import LogisticRegression

logistic=LogisticRegression(class_weight="balanced")

logistic.fit(X_train,y_train)
```

```
c:\Users\goex1\AppData\Local\Programs\Python\Python313\Lib\site-
packages\sklearn\linear_model\_logistic.py:465: ConvergenceWarning: lbfgs failed
to converge (status=1):
STOP: TOTAL NO. OF ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
```

```
    https://scikit-learn.org/stable/modules/preprocessing.html
Please also refer to the documentation for alternative solver options:
    https://scikit-learn.org/stable/modules/linear_model.html#logistic-
regression
  n_iter_i = _check_optimize_result(
```

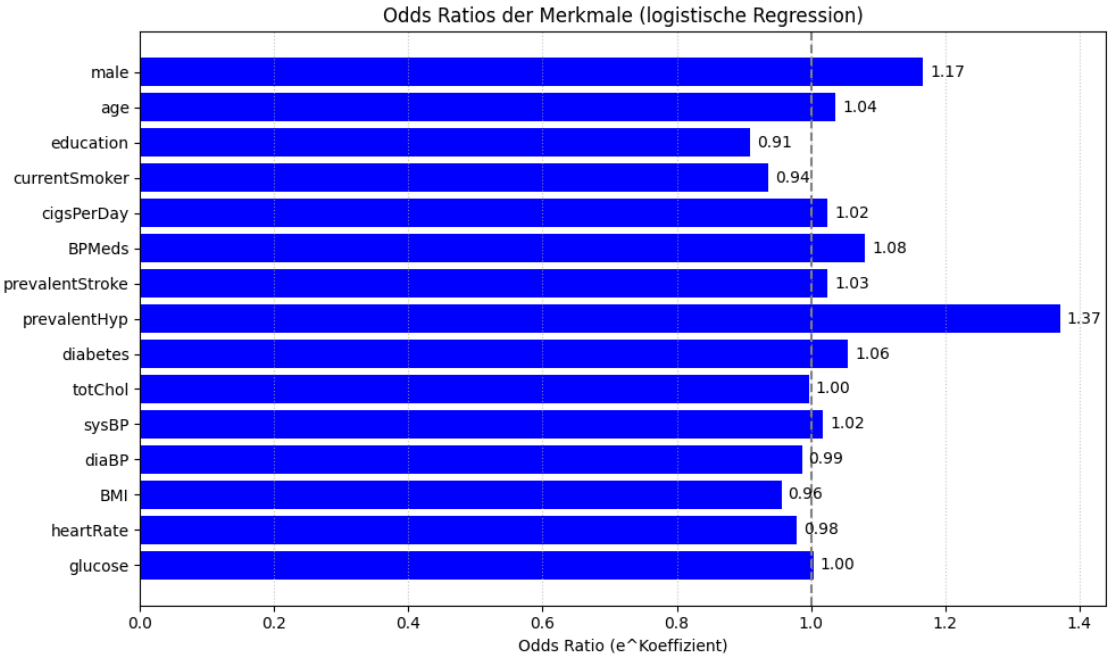
[50]:
```
LogisticRegression(class_weight='balanced')
```

[51]:
```
#Model Test

y_pred=logistic.predict(X_test)

print(X_train.columns)

print("Coefficients of features:",logistic.coef_)
```

```
Index(['male', 'age', 'education', 'currentSmoker', 'cigsPerDay', 'BPMeds',
       'prevalentStroke', 'prevalentHyp', 'diabetes', 'totChol', 'sysBP',
       'diaBP', 'BMI', 'heartRate', 'glucose'],
      dtype='object')
Coefficients of features: [[ 0.15454414  0.03633438 -0.09451545 -0.06496995
0.02453128  0.07807864
   0.02470405  0.31570853  0.05384273 -0.00307005  0.01784372 -0.01346751
  -0.04493906 -0.02106447  0.00345368]]
```

[56]:
```
#Graphical representation of the results

# Features und Koeffizienten

features = X_train.columns
coefficients = logistic.coef_[0]
odds_ratios = np.exp(coefficients)

df = pd.DataFrame({
    'Feature': features,
    'Odds Ratio': odds_ratios
})

# Odds Ratios berechnen
odds_ratios = np.exp(coefficients)


# Balkendiagramm erstellen
plt.figure(figsize=(10, 6))
bars = plt.barh(df['Feature'], df['Odds Ratio'], color='blue')
plt.axvline(1.0, color='gray', linestyle='--')
plt.xlabel('Odds Ratio (e^Koeffizient)')
plt.title('Odds Ratios der Merkmale (logistische Regression)')
```

```
plt.gca().invert_yaxis()
plt.grid(axis='x', linestyle=':', alpha=0.7)

# 5. Werte an Balken schreiben
for bar in bars:
    width = bar.get_width()
    plt.text(width + 0.01, bar.get_y() + bar.get_height()/2,
             f'{width:.2f}', va='center')

plt.tight_layout()
plt.show()
```




[54]:
```
#Model Quality

from sklearn.metrics import accuracy_score, confusion_matrix,␣
 ↪classification_report

acc=accuracy_score(y_test,y_pred)
print(acc)

confusion=confusion_matrix(y_test,y_pred)
print(confusion)

classification=classification_report(y_test,y_pred)
print(classification)
```

```
0.6375982844889206
[[763 431]
 [ 76 129]]
              precision    recall  f1-score   support

           0       0.91      0.64      0.75      1194
           1       0.23      0.63      0.34       205

    accuracy                           0.64      1399
   macro avg       0.57      0.63      0.54      1399
weighted avg       0.81      0.64      0.69      1399
```

[55]:
```python
probas = logistic.predict_proba(X_test)[:, 1]

# Neuen, niedrigeren Threshold setzen
threshold = 0.385

# Vorhersagen basierend auf neuem Threshold erzeugen
y_pred_new = (probas >= threshold).astype(int)

from sklearn.metrics import classification_report

print(classification_report(y_test, y_pred_new))
```

```
              precision    recall  f1-score   support

           0       0.92      0.34      0.50      1194
           1       0.18      0.83      0.29       205

    accuracy                           0.41      1399
   macro avg       0.55      0.58      0.39      1399
weighted avg       0.81      0.41      0.47      1399
```