Analysis of Heart Disease Data

Presentation on the 07.12.2022

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Why did we choose the Topic?

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- Heart diseases are one of the highest causes of mortality on earth
- The healthcare sector is information rich but knowledge poor
- Applicable in the real world
- Goal: predict if patient has a heart disease or not (Classification)

Dataset Description
Data Origin

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- Published by the University of California (UCI) in 1988
- Consists of 4 unsorted subsets:
  - Switzerland
  - Hungary
  - USA Cleveland
  - USA Long Beach
- Total of 495 positive & 404 negative = 899 measurements

Dataset Description
Features

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- Total of 76 attributes (33 Numeric 42 Categorical 1 Constant)
  - Patient data
  - (Exercise) Electrocardiogram
  - Cardiac uoroscopy
- 21245 (31%) missing values

Data Understanding
Dropped Features

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- IDs
- Dates of measurements
- Names
- Constants
- Irrelevant columns according to UCI
- Unspecified columns

Data Understanding
False Predictors

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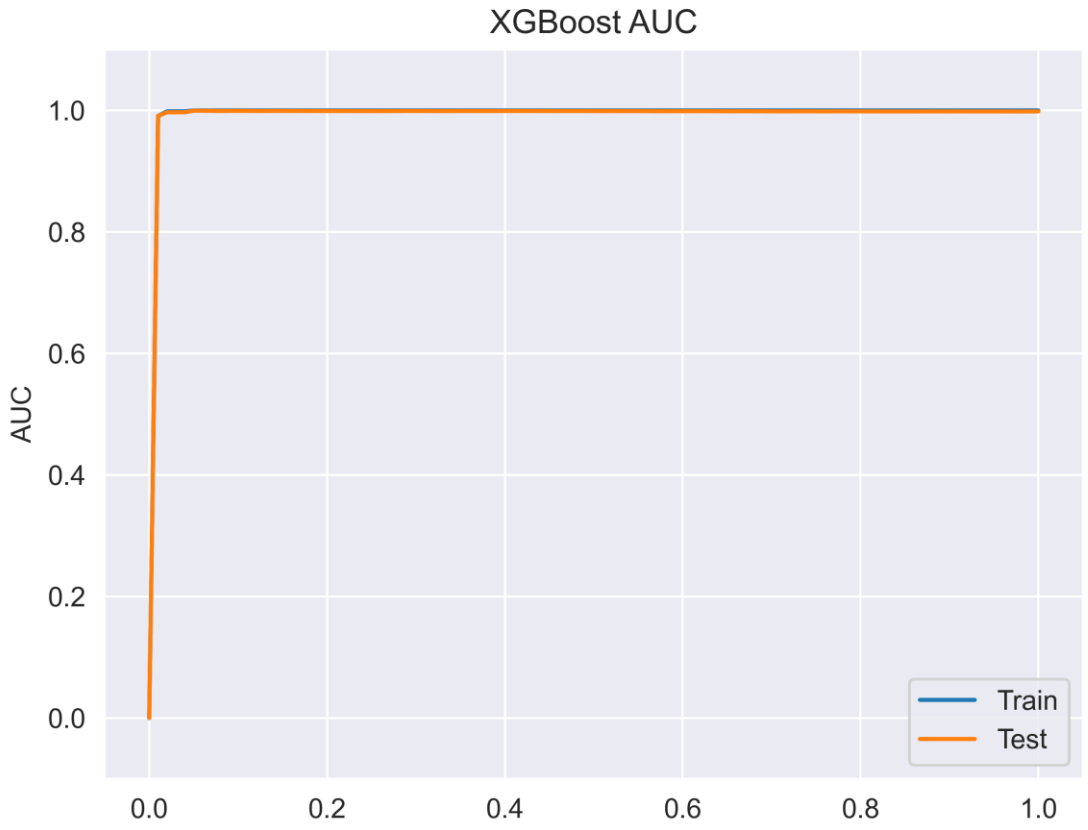

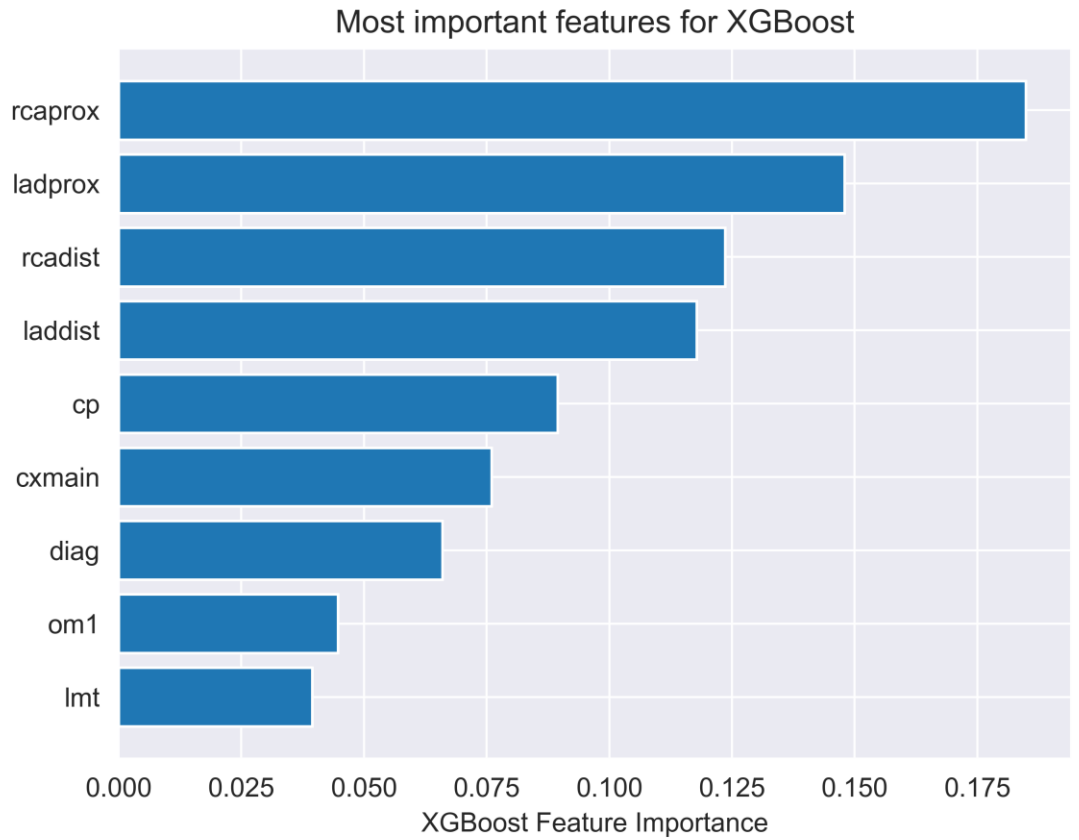

Data Understanding
Dropped Features

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- IDs
- Dates of measurements
- Names
- Constants
- Irrelevant columns according to UCI
- Unspecified columns

Data Understanding
Dropped Features

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- IDs
- Dates of measurements
- Names
- Constants
- Irrelevant columns according to UCI
- Unspecified columns
- Coronary arteries

Data Understanding
False Predictors

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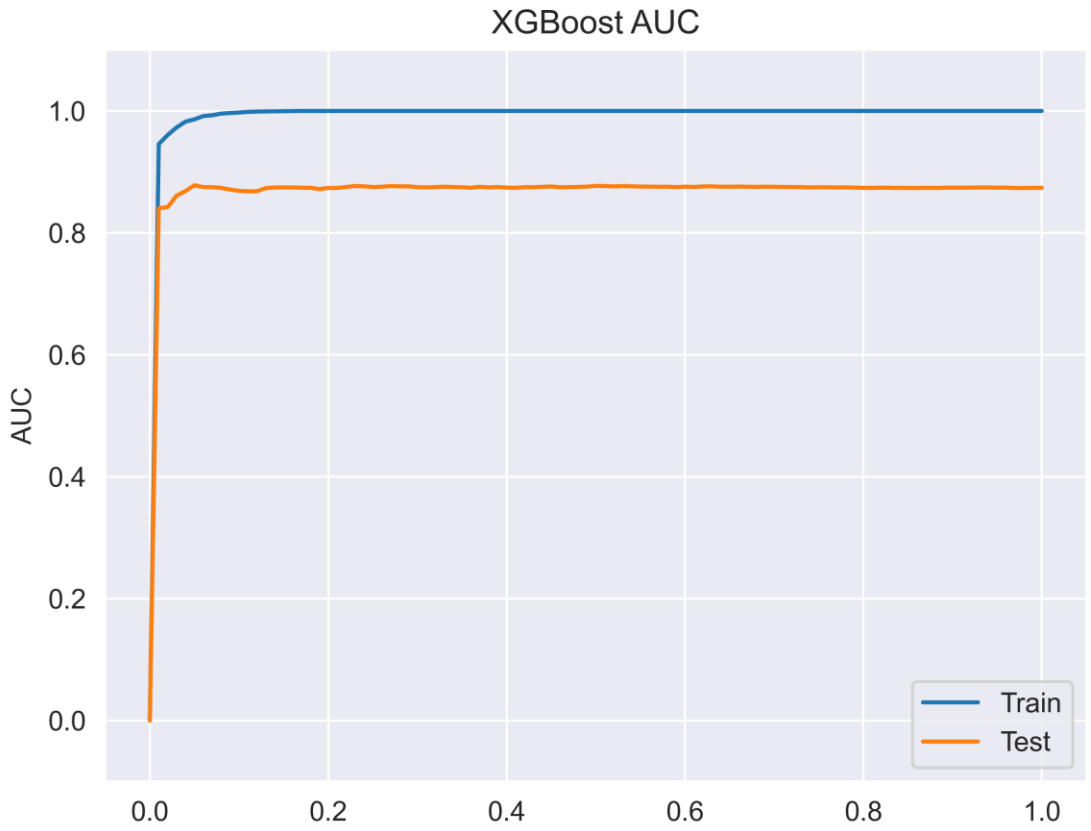

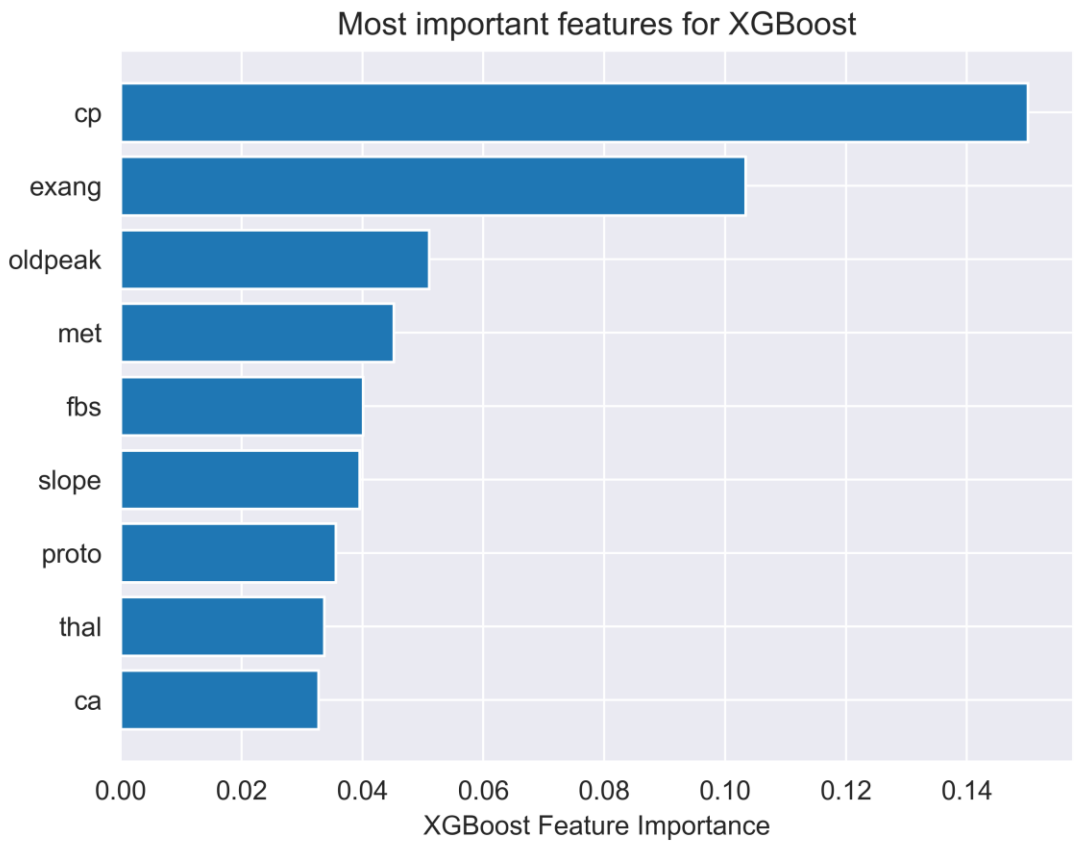

Data Understanding

Missing Features / Feature Subset Selection

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Pipeline Hyperparameters

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Name	Factor
minimum_percentage_to_be_dropped	8

Data Preparation

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- 4 Datasets -> Different encodings -> harmonised
- Validity tests
  - Cholesterin = 0
  - Blood pressure= 0

Data Preparation

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- 4 Datasets -> Different encodings -> harmonised
- Validity tests
- Outliers
  - Values outside the specified value range of UCI
  - No consideration of medical outliers

Data Preparation

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- 4 Datasets -> Different encodings -> harmonised
- Validity tests
- Outliers
- Check for inconsistencies
  - Maximum Heartrate < resting Heartrate
  - TimepointOfPeakHeartRateWhileExercising < ExerciseDuaration
  - isSmoking, NumberOfYearsSmoking, AvgNumberOfCigarettes

Data Preparation

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- 4 Datasets -> Different encodings -> harmonised
- Validity tests
- Outliers
- Check for inconsistencies
- Generate delta between rest and peak measurements
  - heart rate (resting against peak)
  - ECG (resting against exercise)

Data Preparation

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- 4 Datasets -> Different encodings -> harmonised
- Validity tests
- Outliers
- Check for inconsistencies
- Generate delta between rest and peak measurements
- OneHotEncoding applied to 5 features

Data Preparation

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- 4 Datasets -> Different encodings -> harmonised
- Validity tests
- Outliers
- Check for inconsistencies
- Generate delta between rest and peak measurements
- OneHotEncoding applied to 5 features
- Binning for age

Pipeline Hyperparameters

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Name	Factor
minimum_percentage_to_be_dropped	8
age_binning	3

Scaler and Estimator Selection

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- We had no idea. So why don‘t we take everything?
  - Let‘s go…

Pipeline Hyperparameters

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Name	Factor
minimum_percentage_to_be_dropped	8
age_binning	3
estimators	10
scaler	7

Pipeline Hyperparameters

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Name	Factor
minimum_percentage_to_be_dropped	8
age_binning	3
estimators	10
scaler	7
sampler	3

Pipeline Hyperparameters

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Name	Factor
minimum_percentage_to_be_dropped	8
age_binning	3
estimators	10
scaler	7
sampler	3
Imputer	3

Evaluation

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- Low number of samples
  - Nested stratified Cross-Validation with 10 folds
  - Saving classification report for outer loop

Pipeline Hyperparameters

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Name	Factor
minimum_percentage_to_be_dropped	8
age_binning	3
estimators	10
scaler	7
sampler	3
imputer	3
nestedCV	100

Pipeline Hyperparameters

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Name	Factor
minimum_percentage_to_be_dropped	8
age_binning	3
estimators	10
scaler	7
sampler	3
imputer	3
nestedCV	100
hyperparameters (model)	~30

Total number of fits

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Name	Factor
minimum_percentage_to_be_dropped	8
age_binning	3
estimators	10
scaler	7
sampler	3
imputer	3
nestedCV	100
hyperparameters (model)	~30
Total	**~45360000**

$$45360000 \cdot 0{,}01s = 453600s = 126h$$

Results

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- Baseline: Every patient has a heart disease
  - Accuracy: 495/899 = 0,55
- Best configuration:
  - Full grown DecisionTree with gini as criterion
  - Minimum percentage to be dropped: 0
  - 2 bins for age (<=52,>52)
  - No scaling and sampling
  - Accuracy: 0,77

Results KNN
Confusion Matrix

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Leave-One-Out Cross-Validation

	Heart disease	No heart disease
Heart disease	431	64
No heart disease	134	270

Leave-One-Group-Out Cross-Validation

	Heart disease	No heart disease
Heart disease	419	76
No heart disease	146	258

Visual result

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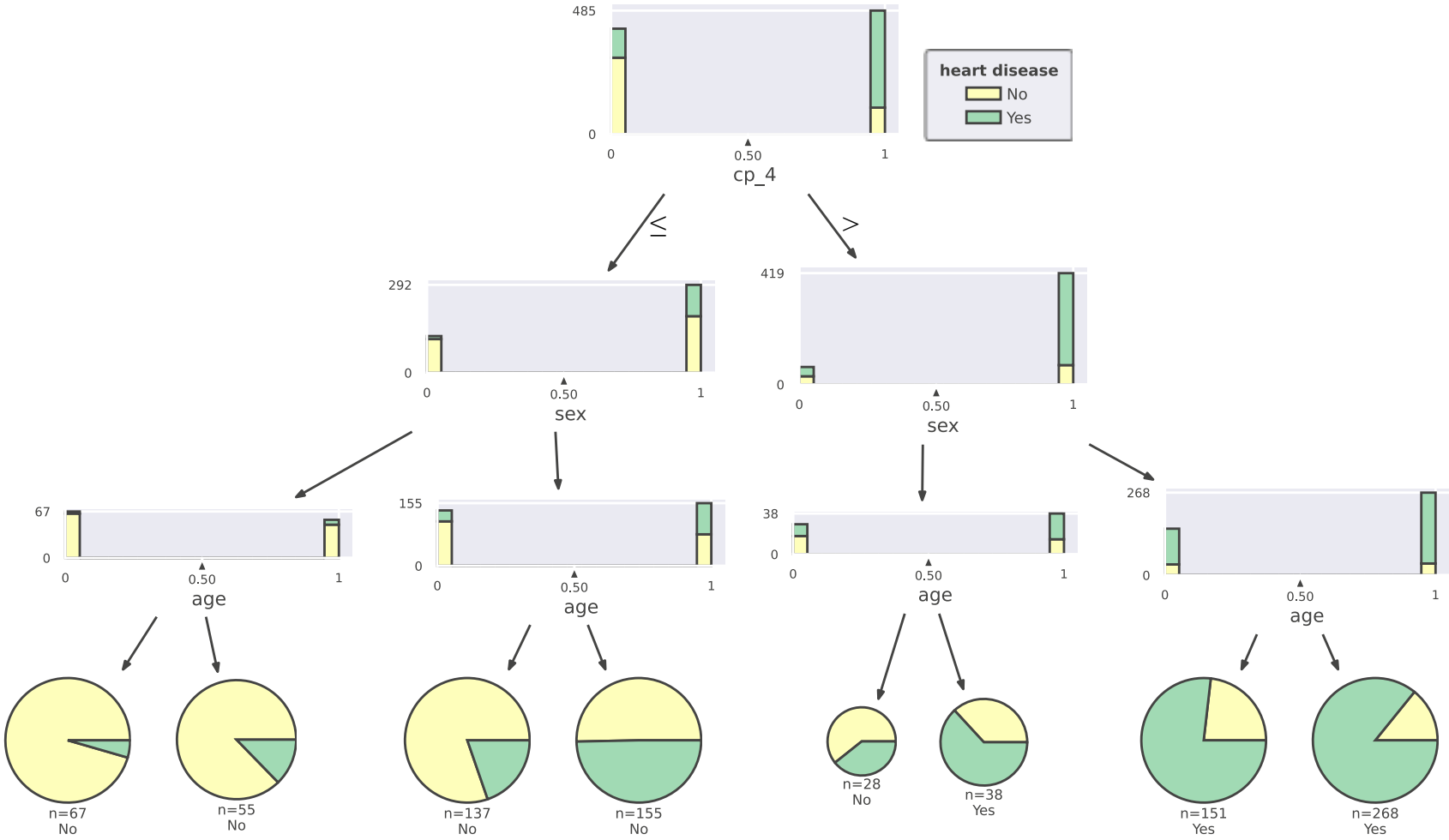

Question?

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Results

Classification Report

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Leave-One-Out Cross-Validation

	Precision	Recall	F1-score	support
No disease	0,81	0,67	0,73	404
Disease	0,76	0,87	0,81	495
Accuracy			0,78	899
Macro avg	0,79	0,77	0,77	899
Weighted avg	0,78	0,78	0,78	899

Leave-One-Group-Out Cross-Validation

	Precision	Recall	F1-score	support
No disease	0,77	0,64	0,70	404
Disease	0,74	0,85	0,79	495
Accuracy			0,75	899
Macro avg	0,76	0,74	0,74	899
Weighted avg	0,76	0,75	0,75	899

Learning 1

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```
df[df['column'] > 1] = 1
df.loc[df['column'] > 1, 'column'] = 1
```

Learning 2

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```
one_hot_encoded_features = ['cp', 'restecg', 'slope', 'ca', 'restwm']
discretizeParameters = {
    'columnTransformer__discretize': [
        'passthrough',
        KBinsDiscretizer(2, encode='ordinal', strategy='uniform'),
        KBinsDiscretizer(5, encode='ordinal', strategy='uniform')]
}
columnTransformer = ColumnTransformer(
    transformers=[
        ('discretize', KBinsDiscretizer(), ['age']),
        ('oneHotEncoder', OneHotEncoder(handle_unknown='ignore'), lambda X: [value for value in one_hot_encoded_features if value in X.columns]),
    ], remainder='passthrough')
```