

IBM Coursera Advance Data Science Capstone Project

Project: Heart Disease Prediction

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Dataset

Kaggle dataset : Heart disease UCI

<https://www.kaggle.com/ronitf/heart-disease-uci>

303 records with 13 attribute and target field refers to the presence of heart disease in the patient



Use case

The Heart disease UCI dataset contains 14 variables and 303 records along with a target field of having or not having heart disease.

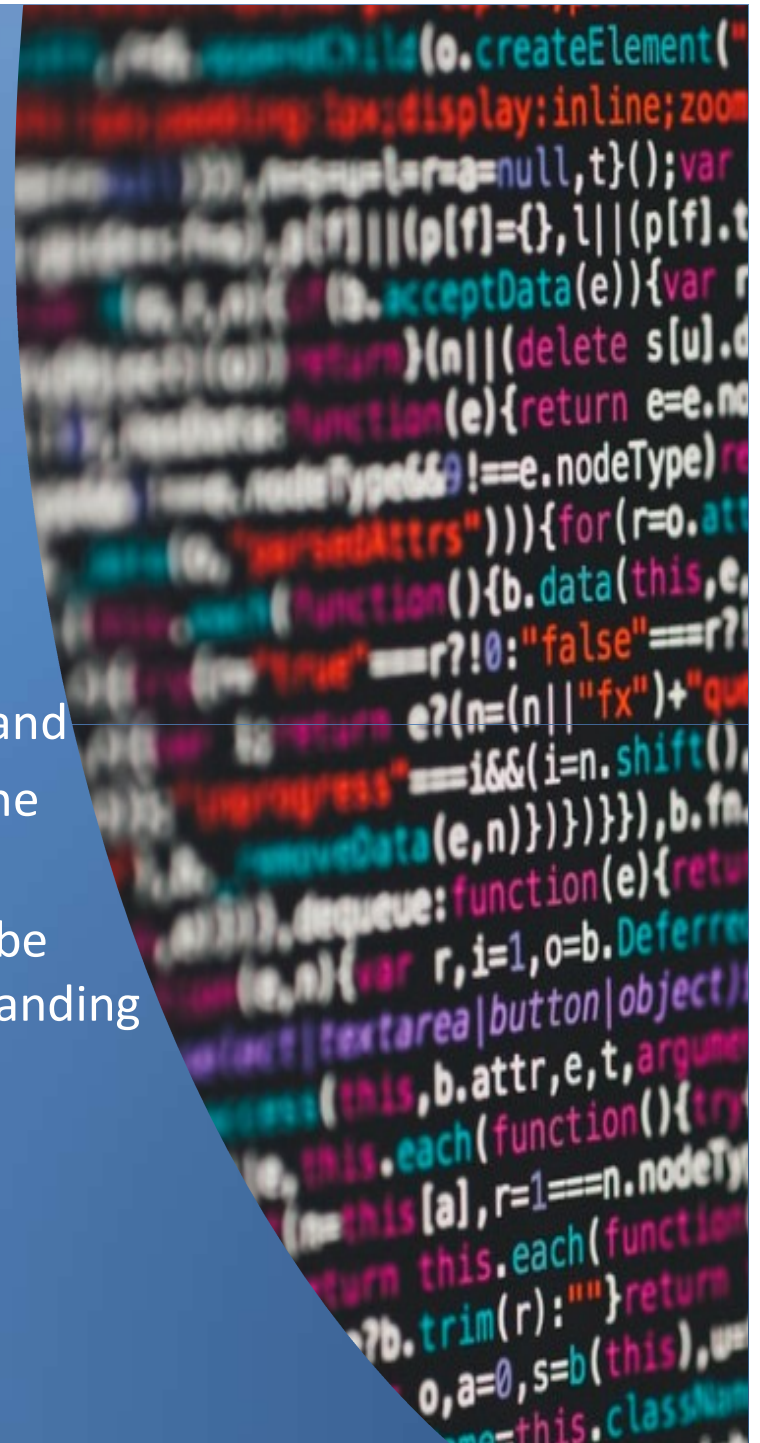
The scope of this project is to find any correlation between the data in order to understand and calculate the event of an heart disease in the patient. The data will be used in different ML supervised and unsupervised models.



Solution

Different Machine learning models will be trained and tested to predict the event of an heart disease in the patient

A Jupyter Notebook in the IBM Watson Studio will be implemented to get the best model and data understanding



ML Algorithms

Binary classification model to predict the event of an heart disease.

Models :

Supervised:

- Linear model

 - Logistic Regression

- Ensaibled Models

 - Decision Tree

 - Random Forest

 - Gradient Boosted Trees

- Deep learning

 - Feed Forward Neural network

Unsupervised:

- K-means model



Technology

Spark Mlib for ML algorithms

Keras for neural network



Data Analysis

Dataset information.

age: The person's age in years

sex: The person's sex (1 = male, 0 = female)

cp: The chest pain experienced (Value 1: typical angina, Value 2: atypical angina, Value 3: non-anginal pain, Value 4: no chest pain)

trestbps: The person's resting blood pressure (mm Hg on admission to the hospital)

chol: The person's cholesterol measurement in mg/dl

fbs: The person's fasting blood sugar (> 120 mg/dl, 1 = true; 0 = false)

restecg: Resting electrocardiographic measurement (0 = normal, 1 = having ST-T wave abnormality, 2 = showing a probable left bundle branch block, 3 = showing a right bundle branch block)

thalach: The person's maximum heart rate achieved

exang: Exercise induced angina (1 = yes; 0 = no)

oldpeak: ST depression induced by exercise relative to rest ('ST' relates to positions on the ECG plot. See more here: <https://www.kaggle.com/competitions/heart-disease-uci>)

slope: the slope of the peak exercise ST segment (Value 1: upsloping, Value 2: flat, Value 3: downsloping)

ca: The number of major vessels (0-3)

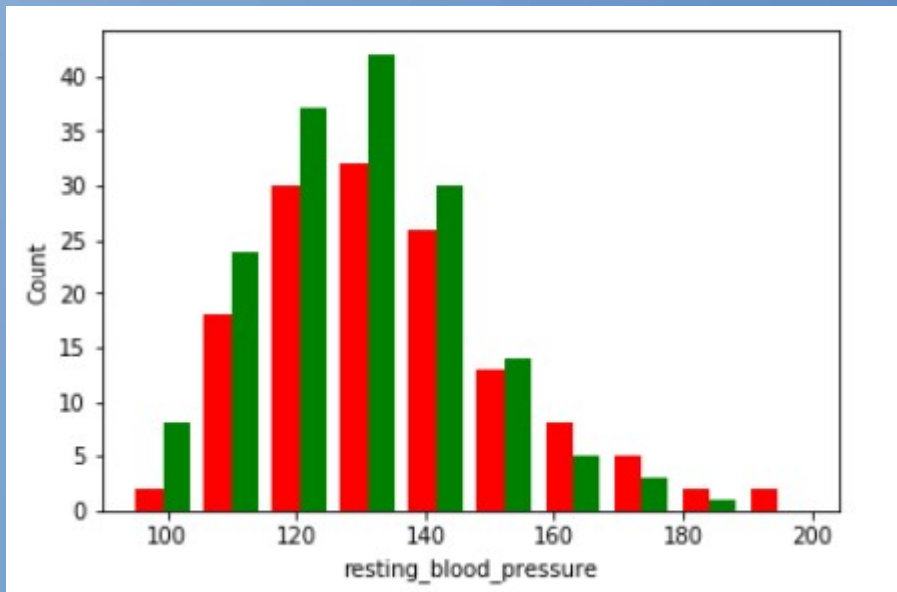
thal: Thallium Stress Test (3 = normal; 6 = fixed defect; 7 = reversable defect)

target: Heart disease (0 = no, 1 = yes)

	age	sex	cp	trestbps	chol	fbs	restecg	thalach	exang	oldpeak	slope	ca	thal	target
0	63	1	3	145	233	1	0	150	0	2.3	0	0	1	1
1	37	1	2	130	250	0	1	187	0	3.5	0	0	2	1
2	41	0	1	130	204	0	0	172	0	1.4	2	0	2	1
3	56	1	1	120	236	0	1	178	0	0.8	2	0	2	1
4	57	0	0	120	354	0	1	163	1	0.6	2	0	2	1

Data Analysis

Data visualization



Data Analysis

Statistical information

	age	sex	chest_pain_type	resting_blood_pressure	cholesterol	fasting_blood_sugar	rest_ecg	max_heart_rate_achieved
count	302.00000	302.00000	302.00000	302.00000	302.00000	302.00000	302.00000	302.00000
mean	54.42053	0.682119	0.963576	131.602649	246.500000	0.149007	0.526490	149.569536
std	9.04797	0.466426	1.032044	17.563394	51.753489	0.356686	0.526027	22.903527
min	29.00000	0.000000	0.000000	94.000000	126.000000	0.000000	0.000000	71.000000
25%	48.00000	0.000000	0.000000	120.000000	211.000000	0.000000	0.000000	133.250000
50%	55.50000	1.000000	1.000000	130.000000	240.500000	0.000000	1.000000	152.500000
75%	61.00000	1.000000	2.000000	140.000000	274.750000	0.000000	1.000000	166.000000
max	77.00000	1.000000	3.000000	200.000000	564.000000	1.000000	2.000000	202.000000

Correlation matrix

	age	sex	chest_pain_type	resting_blood_pressure	cholesterol	fasting_blood_sugar	rest_ecg	max_heart_rate_ach
age	1	-0.09	-0.06	0.28	0.21	0.12	-0.11	-0.4
sex	-0.09	1	-0.05	-0.06	-0.2	0.05	-0.06	-0.05
chest_pain_type	-0.06	-0.05	1	0.05	-0.07	0.1	0.04	0.29
resting_blood_pressure	0.28	-0.06	0.05	1	0.13	0.18	-0.12	-0.05
cholesterol	0.21	-0.2	-0.07	0.13	1	0.01	-0.15	-0.01
fasting_blood_sugar	0.12	0.05	0.1	0.18	0.01	1	-0.08	-0.01
rest_ecg	-0.11	-0.06	0.04	-0.12	-0.15	-0.08	1	0.04
max_heart_rate_achieved	-0.4	-0.05	0.29	-0.05	-0.01	-0.01	0.04	1
exercise_induced_angina	0.09	0.14	-0.39	0.07	0.06	0.02	-0.07	-0.38
st_depression	0.21	0.1	-0.15	0.19	0.05	0	-0.06	-0.34
st_slope	-0.16	-0.03	0.12	-0.12	0	-0.06	0.09	0.38
num_major_vessels	0.3	0.11	-0.2	0.1	0.09	0.14	-0.08	-0.23
thallium	0.07	0.21	-0.16	0.06	0.1	-0.03	-0.01	-0.09
target	-0.22	-0.28	0.43	-0.15	-0.08	-0.03	0.13	0.42

Feautures

- Clean data set (no null or missing values)
- Data indexing, vectorization, normalization
- New feature like age field aggregated per decade
- Split data set for training and test



Model evaluation

- Target class is well balanced

```
Total records number = 302  
Heart Disease class = 54 %  
No heart Disease class = 45 %
```

- Evaluation metric : accuracy and f1 score used to evaluate performance
- review evaluation metrics of train/test based on model parameters



Model performance

- LogisticRegression
 - Train Accuracy = 0.8380
 - Train f1 = 0.8366
 - Test Accuracy = 0.8545
 - Test f1 = 0.8545
 - DecisionTreeClassifier
 - Train Accuracy = 0.9554
 - Train f1 = 0.9554
 - Test Accuracy = 0.7636
 - Test f1 = 0.7665
- | |
|----------------------|
| Train Error = 0.1619 |
| Train Error = 0.1633 |
| Test Error = 0.1454 |
| Test Error = 0.1454 |
| Train Error = 0.0445 |
| Train Error = 0.0445 |
| Test Error = 0.2363 |
| Test Error = 0.2334 |



Model performance

- RandomForestClassifier
 - Train Accuracy = 0.9716
Train f1 = 0.9716
 - Test Accuracy = 0.8363
Test Error = 0.1636
 - Test f1 = 0.8371
Test Error = 0.1628
- GBTClassifier
 - Train Accuracy = 0.9958
Train Error = 0.0041
 - Train f1 = 0.9958
Train Error = 0.0041
 - Test Accuracy = 0.8196
Test Error = 0.1803
 - Test f1 = 0.8176
Test Error = 0.1823



Model performance

- K-means
- Accuracy 0.7847
- FF Neural Network
- Test Accuracy: 0.8999
- Test loss: 0.4385



Deployment

Use Jupyter Notebook with IBM Watson Studio: supervised and unsupervised algorithms implemented and evaluated



Conclusion

Best performance with:

RandomForestClassifier and GBT Classifier

Performance changes also with train and test samples, a bigger and balanced dataset could help to get better performances.

