Lisbon School of Economics & Management
Universidade de Lisboa

LISBOA
UNIVERSIDADE DE LISBOA

CLASSIFICATION

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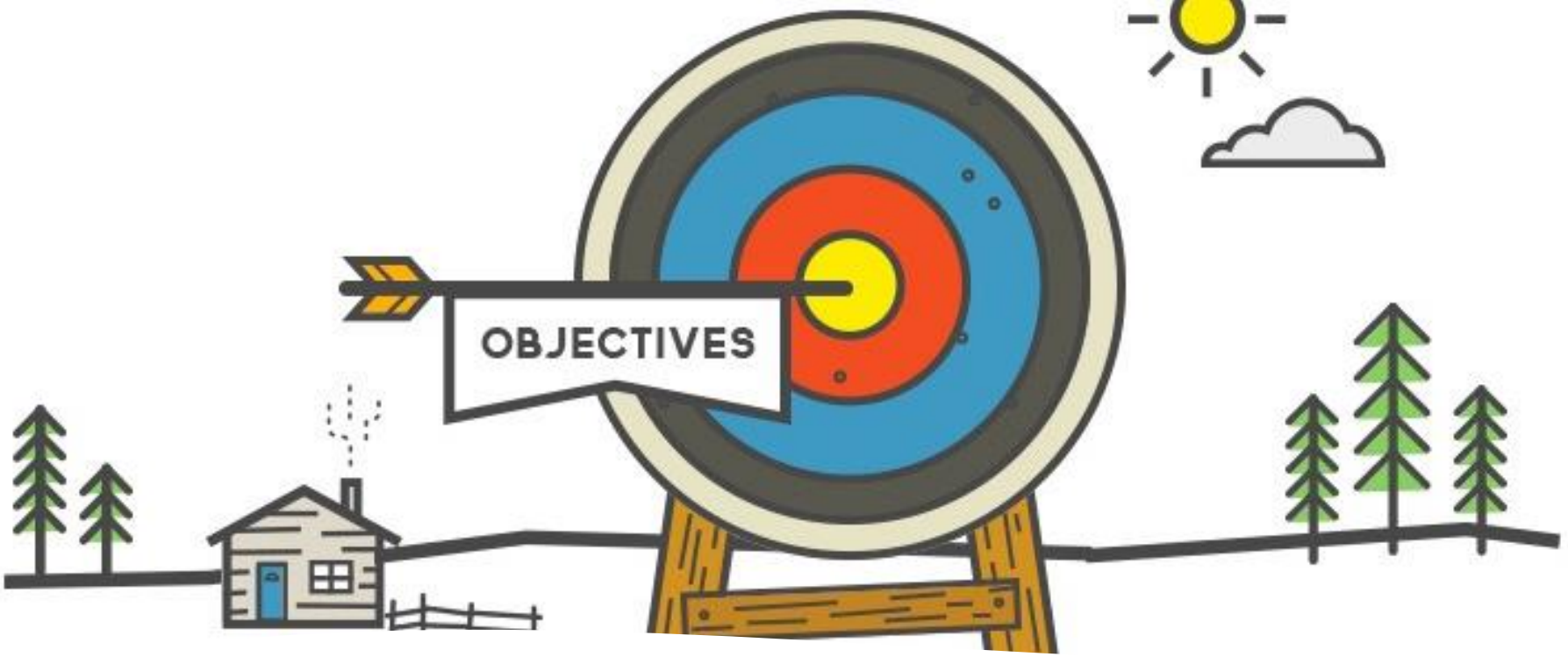


Learning Goals

- Know concept of classification
- Distinguish between main algorithms
- Apply algorithms by using python libraries

Summary

- Concept of classification
- Algorithms
  - K -Near Neighbour (KNN)
  - Support Vector Machines (SVM)
  - Naive Bayes
  - Logistic Regression
  - Decision Trees
  - Ensemble

Classification

Categorizing some unknown items into discrete set of categories or “classes”

Classification

age	address	income	ed	employ	equip	callcard	wireless	churn
33.0	7.0	136.0	5.0	5.0	0.0	1.0	1.0	Yes
33.0	12.0	33.0	2.0	0.0	0.0	0.0	0.0	Yes
30.0	9.0	30.0	1.0	2.0	0.0	0.0	0.0	No
35.0	5.0	76.0	2.0	10.0	1.0	1.0	1.0	No

age	address	income	ed	employ	equip	callcard	wireless	churn
35.0	5.0	76.0	2.0	10.0	1.0	1.0	1.0	No
35.0	14.0	80.0	2.0	15.0	0.0	1.0	0.0	?

Classification

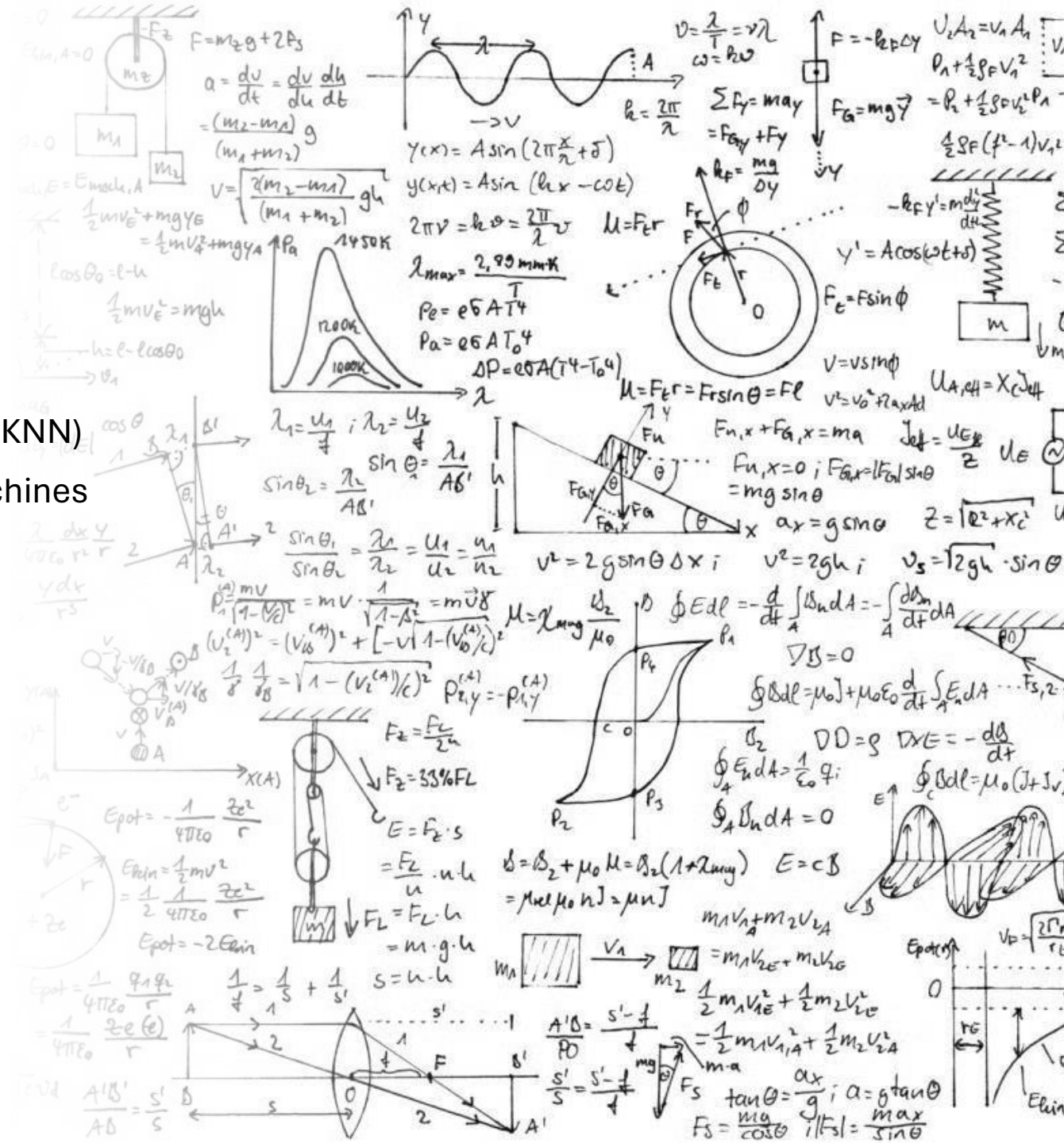
Age	Sex	BP	Cholesterol	Na	K	Drug
23	F	HIGH	HIGH	0.793	0.031	drugY
47	M	LOW	HIGH	0.739	0.056	drugC
47	M	LOW	HIGH	0.697	0.069	drugC
28	F	NORMAL	HIGH	0.564	0.072	drugX
61	F	LOW	HIGH	0.559	0.031	drugY
22	F	NORMAL	HIGH	0.677	0.079	drugX
49	F	NORMAL	HIGH	0.79	0.049	drugY
41	M	LOW	HIGH	0.767	0.069	drugC
60	M	NORMAL	HIGH	0.777	0.051	drugY
43	M	LOW	NORMAL	0.526	0.027	drugY

Categorical Variable

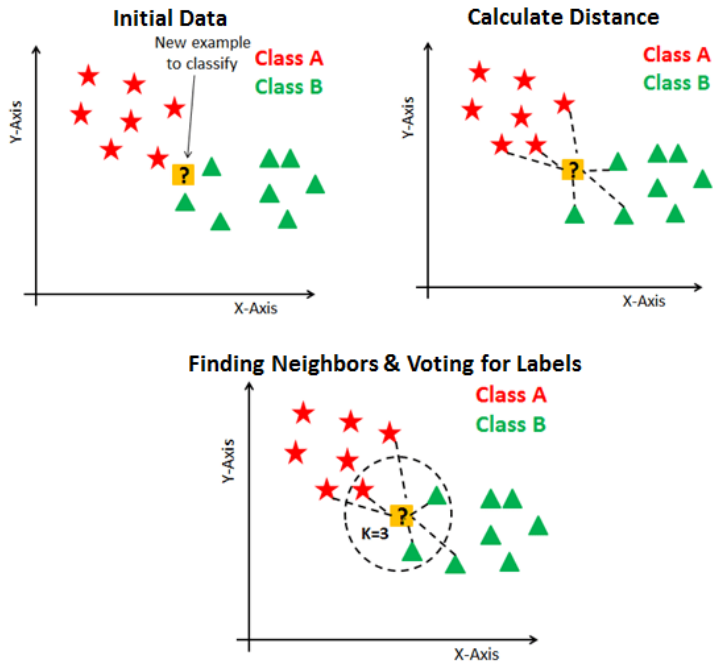
Age	Sex	BP	Cholesterol	Na	K	Drug
36	F	LOW	HIGH	0.697	0.069	

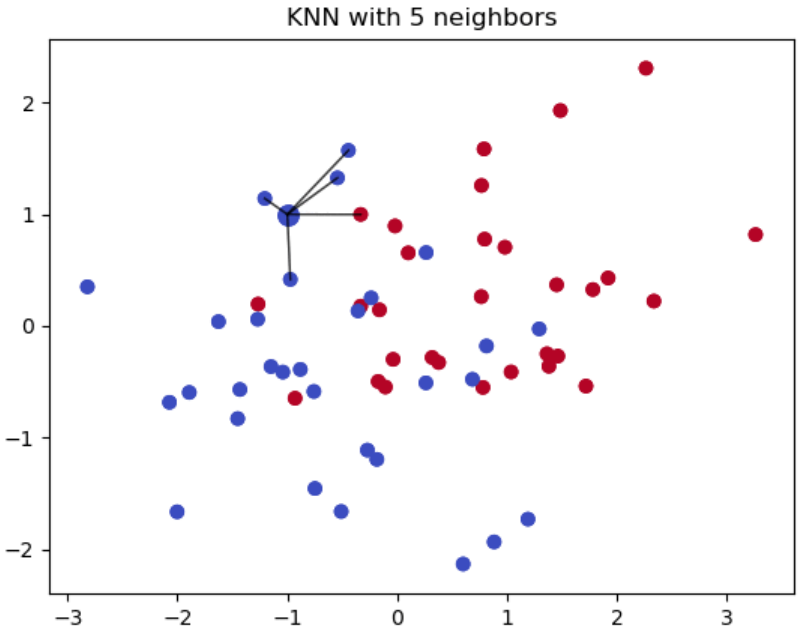
Algoritms

- K -Near Neighbour (KNN)
- Support Vector Machines (SVM)
- Naive Bayes
- Logistic Regression
- Decision Trees

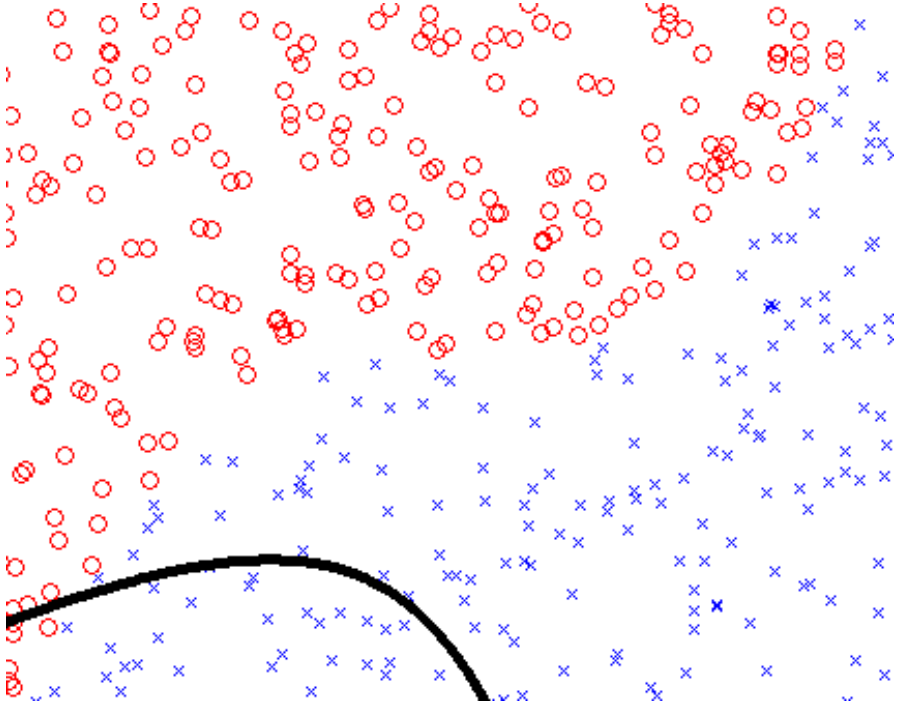


KNN

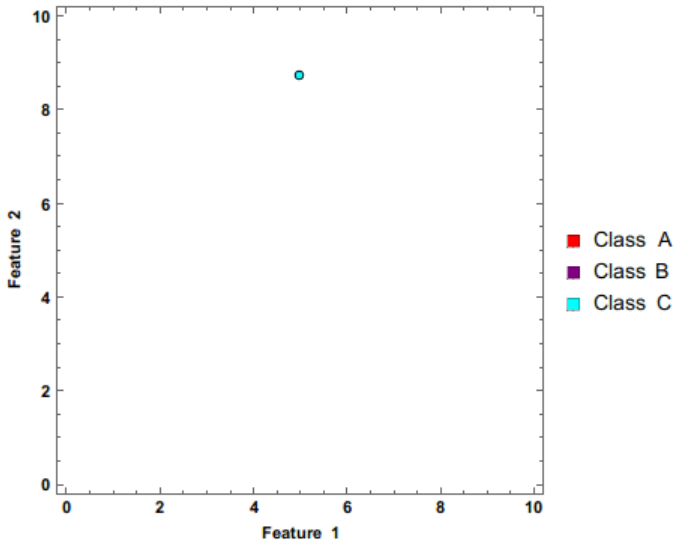

Initial Data
New example to classify
Class A
Class B
Y-Axis
X-Axis
?
Calculate Distance
Class A
Class B
Y-Axis
X-Axis
?
Finding Neighbors & Voting for Labels
Class A
Class B
Y-Axis
X-Axis
K=3
?


KNN with 5 neighbors
2
1
0
−1
−2
−3
−2
−1
0
1
2
3

SVM (support vector machine)



Naive Bayes

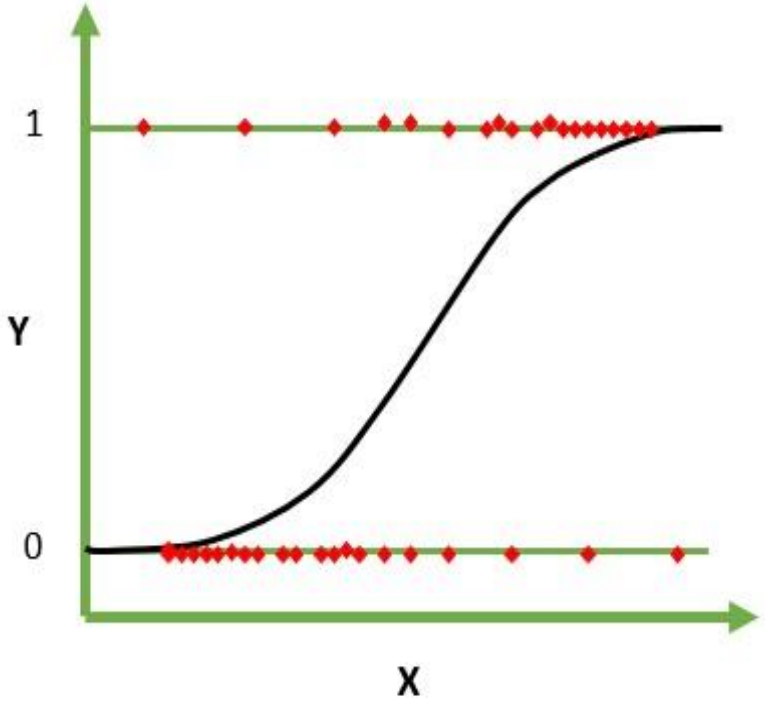


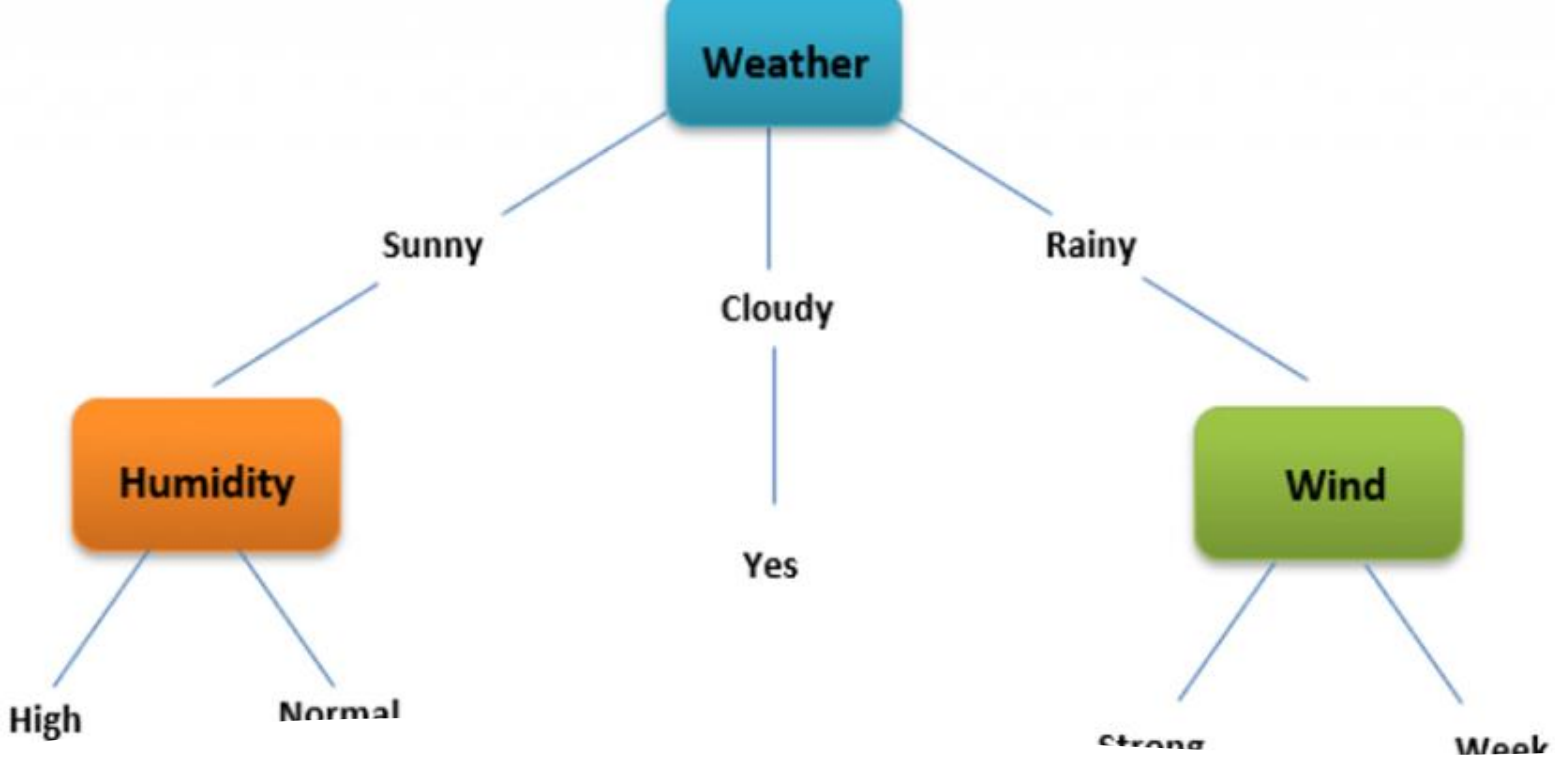
$$P(y|X) = \frac{P(X|y)P(y)}{P(X)}$$

$$X = (x_1, x_2, x_3, ..., x_n)$$

It assumes that all the features in a class are unrelated to each other.

Logistics Regression



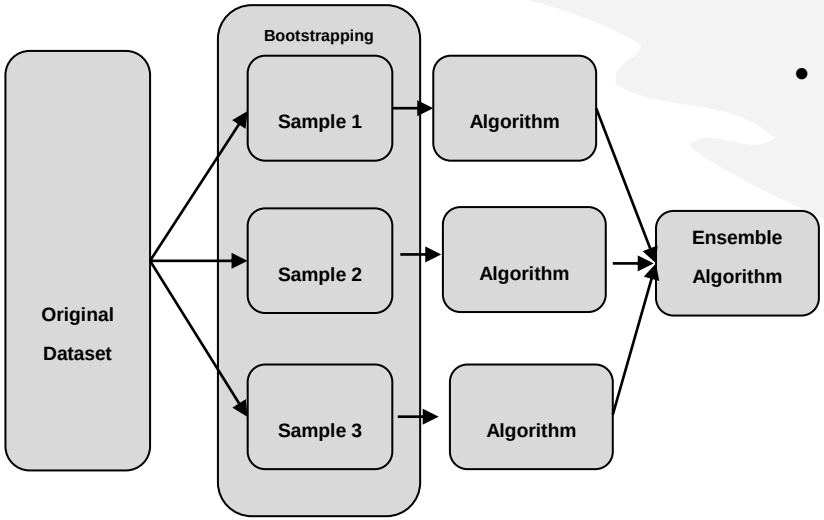


Decision Tree

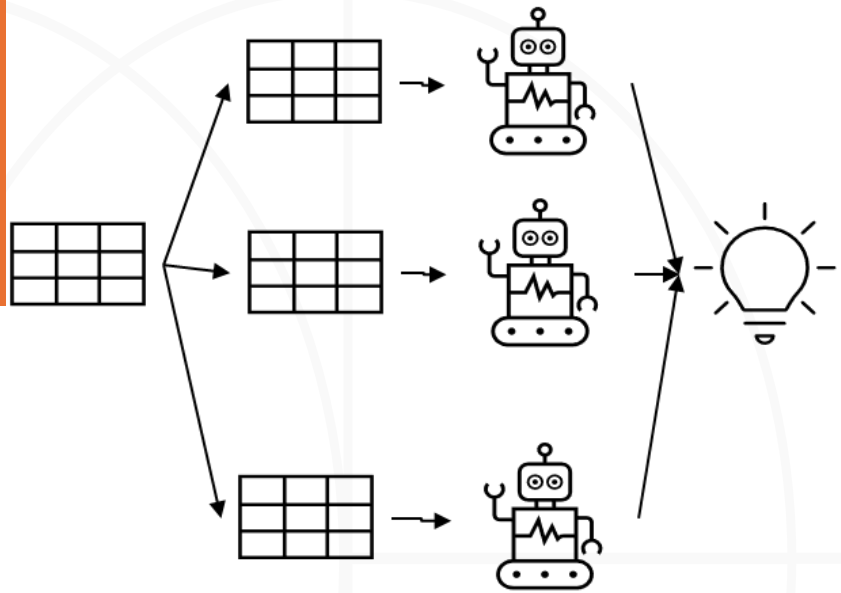
- is a non-parametric supervised learning algorithm
- Is used for classification and regression tasks.
- has a hierarchical tree structure consisting of:
  - root,
  - branches,
  - leaf.
- easy-to-understand models.

Ensemble

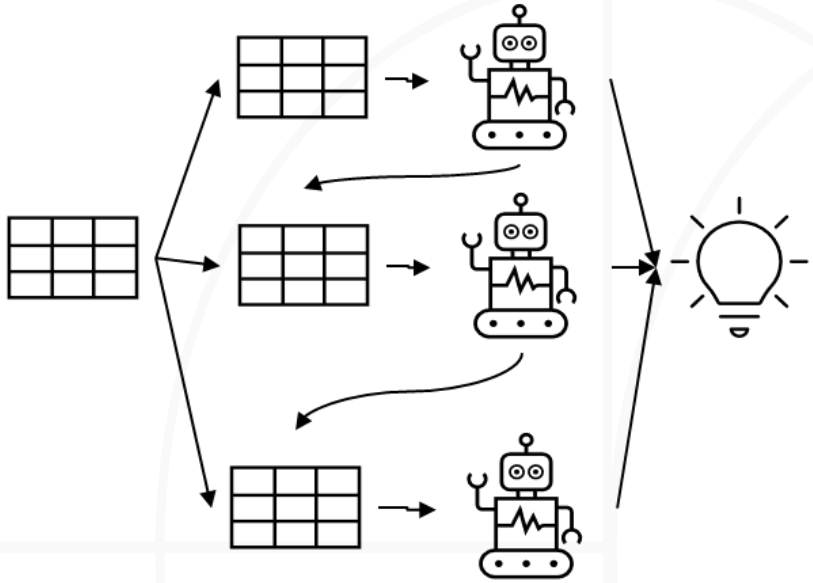
- is a Machine Learning concept
- the idea is to train multiple models using the same learning algorithm.
- used for classification, regression
- multitude of decision trees at training time
- outputting the class that is the mode of the classes (classification)



Bagging



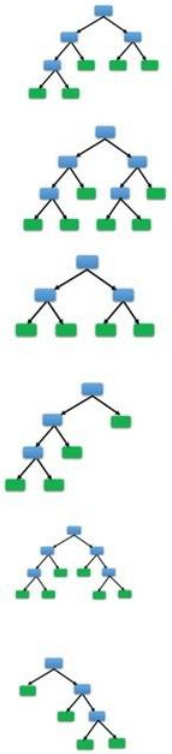
Boosting



Bagging vs. Boosting

- classification, regression and other tasks
- multitude of decision trees at training time
- outputting the class that is the mode of the classes (classification) or mean prediction (regression) of the individual trees.

Random Forest



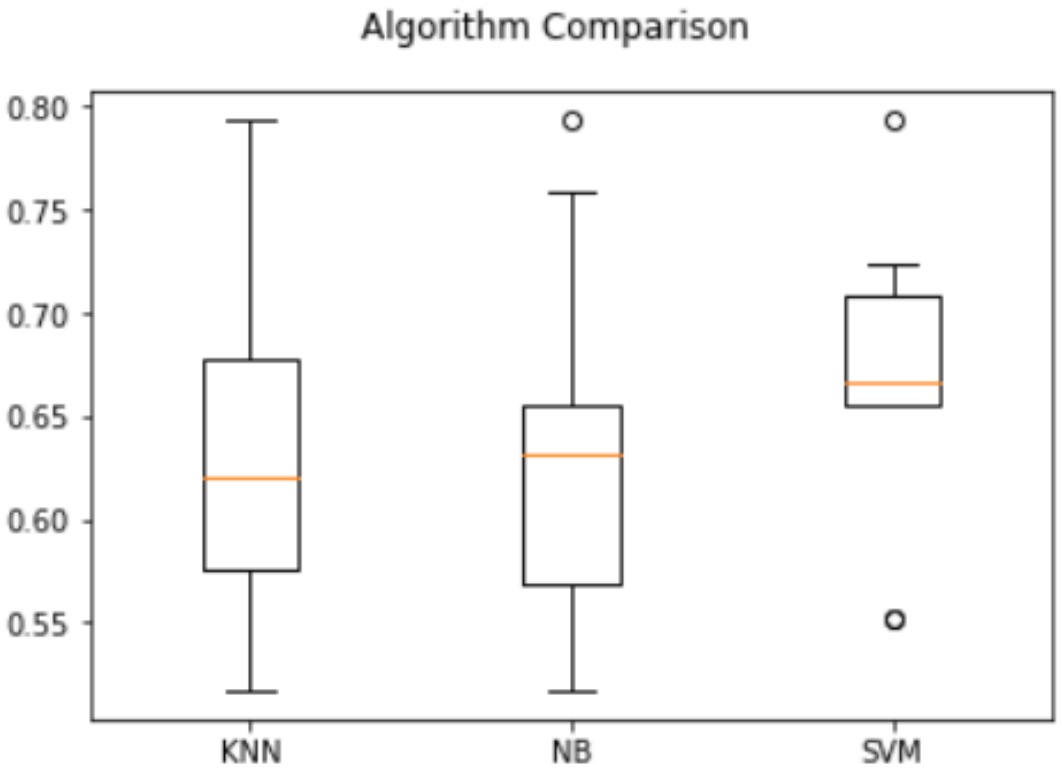
Random Forest in Action!!!

```
from sklearn.preprocessing import StandardScaler
standardizer=StandardScaler()
X=standardizer.fit_transform(Xfeatures)
```

```
from sklearn import model_selection
from sklearn.neighbors import KNeighborsClassifier
from sklearn.naive_bayes import GaussianNB
from sklearn.svm import SVC

models = []
models.append(('KNN', KNeighborsClassifier()))
models.append(('NB', GaussianNB()))
models.append(('SVM', SVC()))

results = []
names = []
scoring = 'accuracy'

seed = 7

for name, model in models:
    #, random_state=seed
    kfold = model_selection.KFold(n_splits=10)
    cv_results = model_selection.cross_val_score(model, X, Y, cv=kfold, scoring=scoring)
    results.append(cv_results)
    names.append(name)
    msg = "%s: %f (%f)" % (name, cv_results.mean(), cv_results.std())
    print(msg)
```

```
KNN: 0.635222 (0.084238)
NB: 0.635099 (0.084984)
SVM: 0.666872 (0.070033)
```

```
import matplotlib.pyplot as plt

fig = plt.figure()
fig.suptitle('Algorithm Comparison')
ax = fig.add_subplot(111)
plt.boxplot(results)
ax.set_xticklabels(names)
plt.show()
```



Conclusions

- Classification
- K -Near Neighbour (KNN)
- Support Vector Machines (SVM)
- Naive Bayes
- Logistic Regression
- Decision Trees
- Ensemble

References

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