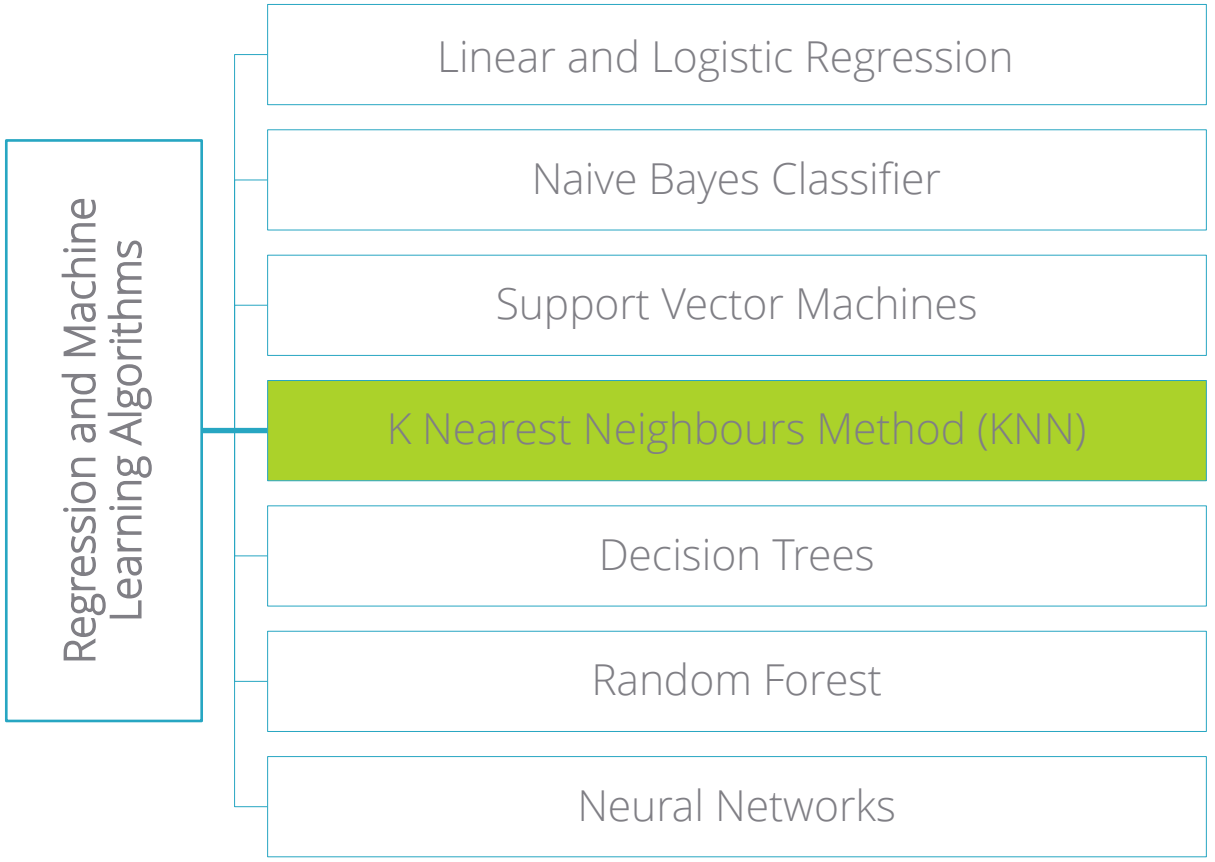
K Nearest Neighbours Classifier
ML ALGORITHM

MACHINE LEARNING METHODS

There is lot of overlapping between statistical modeling and machine learning. The Regression Models are used extensively in ML applications.



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Contents

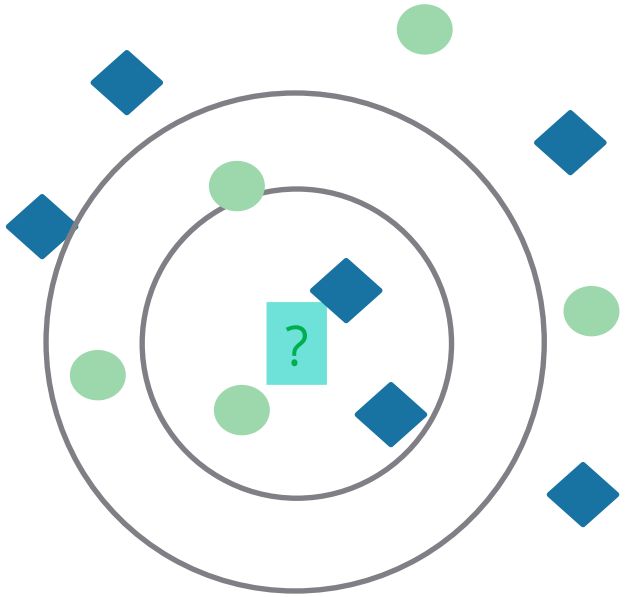
KNN for Classification

- Training dataset has 11 observations belonging to two categories.
- 12th observation is introduced, class of which is not known.
- **Nearest neighbour algorithm classifies new observation to the class of the training observation closest to it.**

When K=1, nearest one case is considered

As we go on increasing K, classification may vary

K	Classification
1	Blue
3	Blue
5	Green



Three most important components of this method are **Distance** between cases, **Value of K** and **Voting** criteria.

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Simple Example To Understand KNN Method

Age	Current Debt	Default
25	40,000	N
35	60,000	N
45	80,000	N
20	20,000	N
35	120,000	N
52	18,000	N
23	95,000	Y
40	62,000	Y
60	100,000	Y
48	220,000	Y
33	150,000	Y
48	142,000	?

New observation will be **classified** as "N" or "Y" based on KNN method

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Distance Based on Standardised Variables

$$X_s = \frac{X - Min}{Max - Min}$$

Alternatively, can also be used

Age	Current Debt	Default	Distance
0.125	0.11	N	0.7652
0.375	0.21	N	0.5200
0.625	0.31	N	0.3160
0	0.01	N	0.9245
0.375	0.50	N	0.3428
0.8	0.00	N	0.6220
0.075	0.38	Y	0.6669
0.5	0.22	Y	0.4437
1	0.41	Y	0.3650
0.7	1.00	Y	0.3861
0.325	0.65	Y	0.3771
0.7	0.61	?	

New observation will be classified as "N" based on nearest neighbor(K=1)

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Selection of K

The second component of KNN model is selecting the appropriate value for K

- If K = 1, the case is classified using the nearest neighbour
- However, K is usually greater than 1. Consider the following when choosing K :
  - Mostly odd numbered K is preferred to avoid tie.
  - For a very large K the classifier may result in misclassification, as group of nearest neighbours may include data points which are actually located far away from it.

Thumb Rule :

K = sqrt (n)

n is the number of observations in training data

Voting Criteria

Most common criteria for classification decision is **Majority Voting.**

Frequency of each class in K instances is measured. Class having the highest frequency is attributed to the new case.

Eg. Suppose for K = 7, 4 cases belong to class A and 3 to class B. New case is given class A

Drawback:

Classification is inappropriate when the class distribution is skewed. That is, examples of a more frequent class tend to dominate the prediction of the new example, because they tend to be common among the k nearest neighbors due to their large number.

?

Is there a way to correct this?
One option to remove this drawback is to create training data with equal class frequency. However, this is possible only if data is very large.

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Case Study – Predicting Loan Defaulters

Background

- The bank possesses demographic and transactional data of its loan customers. If the bank has a robust model to predict defaulters it can undertake better resource allocation.

Objective

- To predict whether the customer applying for the loan will be a defaulter

Available Information

- Sample size is 389
- Age group, Years at current address, Years at current employer, Debt to Income Ratio, Credit Card Debts, Other Debts are the independent variables
- Defaulter (=1 if defaulter, 0 otherwise) is the dependent variable

Data Snapshot

BANK LOAN KNN

Variables

SN	AGE	EMPLOY	ADDRESS	DEBTINC	CREDDEBT	OTHDEBT	DEFAULTER

Column	Description	Type	Measurement	Possible Values
SN	Serial Number		-	-
AGE	Age Groups	Categorical	1(<28 years),2(28-40 years),3(>40 years)	3
EMPLOY	Number of years customer working at current employer	Continuous	-	Positive value
ADDRESS	Number of years customer staying at current address	Continuous	-	Positive value
DEBTINC	Debt to Income Ratio	Continuous	-	Positive value
CREDDEBT	Credit Card Debt	Continuous	-	Positive value
OTHDEBT	Other Debt	Continuous	-	Positive value
DEFAULTER	Whether customer defaulted on loan	Binary	1(Defaulter), 0(Non-Defaulter)	2

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KNN Classification in Python

```
# Importing the Libraries
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt

from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler
from sklearn.neighbors import KNeighborsClassifier

from sklearn.metrics import confusion_matrix, f1_score,
precision_score, recall_score, accuracy_score,
roc_curve, roc_auc_score
```

KNN Classification in Python

```
# Importing the Data
bankloan = pd.read_csv("BANK LOAN KNN.csv")

# Preparing data by removing unwanted variables
bankloan1 = bankloan.drop(['SN','AGE'], axis = 1)



bankloan1.head()
```

- **drop()** is used to remove unwanted variables. AGE is removed because it is a categorical variable.
- **axis = 1** drops columns.

```
# Output
```

	EMPLOY	ADDRESS	DEBTINC	CREDDEBT	OTHDEBT	DEFAULTER
0	17	12	9.3	11.36	5.01	1
1	2	0	17.3	1.79	3.06	1
2	12	11	3.6	0.13	1.24	0
3	3	4	24.4	1.36	3.28	1
4	24	14	10.0	3.93	2.47	0

KNN Classification in Python

```
# Creating Train and Test Datasets
X = bankloan1.loc[:,bankloan1.columns != 'DEFAULTER']
y = bankloan1.loc[:, 'DEFAULTER']



X_train, X_test, y_train, y_test = train_test_split(X, y,
                                                    test_size=0.30,
                                                    random_state = 999)
```

- **train_test_split()** from sklearn.model_selection is used to split dataset into random train and test sets.
- **test_size** represents the proportion of dataset to be included in the test set
- **random_state** sets the seed for the random number generator

KNN Classification in Python

```
# Preparing Variables
scaler = StandardScaler()
scaler.fit(X_train)

X_train = scaler.transform(X_train)
X_test = scaler.transform(X_test)
X_train
```

- **StandardScaler()** from sklearn.preprocessing is a generic function used for centering or scaling columns of a numeric matrix. The default method for scaling is (X-Mean)/SD.

```
# Output
```

```
array([[-0.89496854, -0.29977261,  1.11865332, -0.28678534,  0.00538471],
       [-0.23076269, -1.21765047,  1.07813931,  1.32686881, -0.1734379 ],
       [ 0.26739169,  0.00618668,  0.26785916, -0.20818328,  0.80582882],
       ...,
       [-0.06471123,  1.07704418, -0.69097236, -0.3191509 , -0.42889879],
       [-0.56286562,  0.15916632,  0.28136383, -0.18044137, -0.50553705],
       [-1.22707147, -0.14679297,  0.24084982,  0.2356872 , -0.40051425]])
```

- All the continuous predictors are now scaled to mean=0 and sd=1.
- Note: Test data is transformed using the train data parameters

KNN Classification in Python

```
# Building the KNN Classifier (Continuous Predictors)
KNNclassifier = KNeighborsClassifier(n_neighbors =
                                     int(np.sqrt(len(X)).round()))
# using thumb rule k ~= sqrt(n)
KNNclassifier.fit(X_train, y_train)
```

- **KNeighborsClassifier()** from sklearn.neighbors performs k-nearest neighbour classification
- **n_neighbors=** specifies the value of k.

KNN Classification in Python

```
# Predictions on Test Data
y_pred = KNNclassifier.predict(X_test)
```

predict() predicts the class labels of the provided data. The default threshold is 0.5.

```
# Confusion Matrix
confusion_matrix(y_test, y_pred, labels=[0, 1])
array([[49, 7],
       [24, 37]])

accuracy_score(y_test, y_pred)
0.7350427350427351

precision_score(y_test, y_pred)
0.8409090909090909

recall_score(y_test, y_pred)
0.6065573770491803
```

- **accuracy_score() =** number of correct predictions out of total predictions
- **precision_score()** = true positives / (true positives + false positives)
- **recall_score()** also known as 'Sensitivity' = true positives / (true positives + false negatives)

Note : Output will be slightly different as ob

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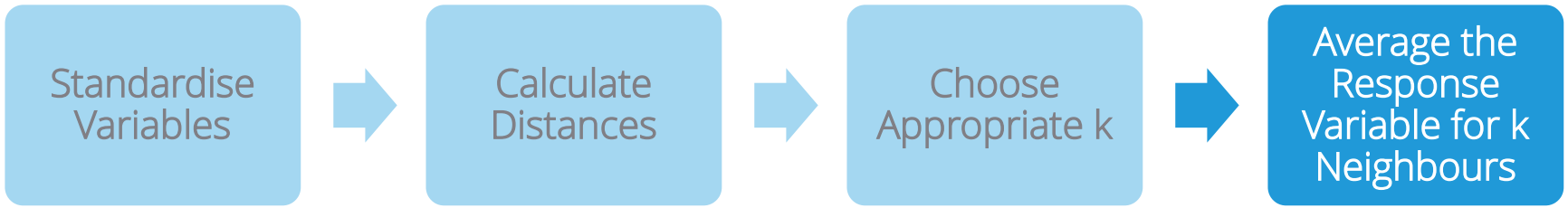
KNN for Regression

KNN algorithm can also be extended to regression problems, i.e. **when the dependent variable is continuous**

Process flow for classification and regression is the same, except for the last step



Average value of the response variable for k neighbours is calculated and assigned to the new case.

`KNeighborsRegressor()` from sklearn.neighbors can be used to run k-nearest neighbour regression in Python.

Get an Edge!

- KNN can be used for categorical variables as well.
- Before executing knn on train-test data, categorical variables have to be converted to numeric variables by creating dummy variables.

Quick Recap

In this session, we learnt about **KNN Classifier** :

KNN for Classification	• Three most important components of this method are **Distance** between cases, **Value of K** and **Voting** criteria.
KNN for Classification in Python	• `KNeighborsClassifier()` from `sklearn.neighbors.`
KNN for Regression	• KNN algorithm can also be extended to regression problems **when the dependent variable is continuous.**
KNN for Regression in Python	• `KNeighborsRegressor()` from `sklearn.neighbors.`

THANK YOU!!

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