Introduction to Machine Learning

Your Trainer

Who am I?

- Study of Aeronautics, and Economics
- Data Scientist at SiemensGamesa

- Author at Medium: https://medium.com/@bert.gollnick
- Udemy Instructor:

PyTorch Ultimate: From Basics to Cutting-Edge

Become an expert applying the most popular Deep Learning framework PyTorch

Bert Gollnick

4.8 ★★★★★ (19)

9 total hours · 95 lectures · All Levels

R Ultimate: Learn R for Data Science and Machine Learning

R Basics, Data Science, Statistical Machine Learning models, Deep Learning, Shiny and much more (All R code included)

Bert Gollnick

4.8 ★★★★★ (37)

22.5 total hours · 199 lectures · All Levels

Agenda

What we will learn today

General Intro

- Types of Machine Learning
- Models

Classification

- Confusion Matrix
- ROC Curve

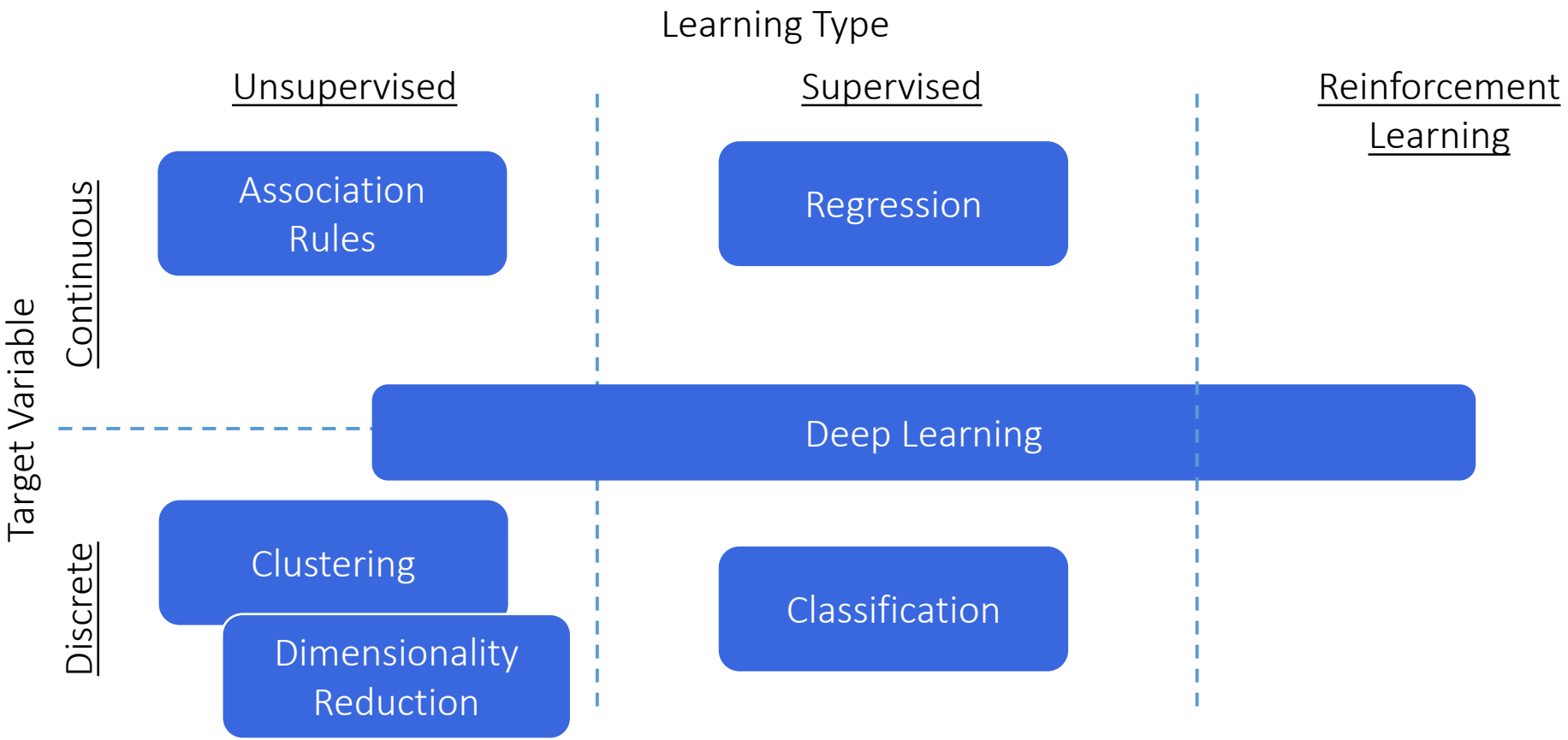
Specific Algorithms

- Analysis Steps
- Logistic Regression

Types of Machine Learning

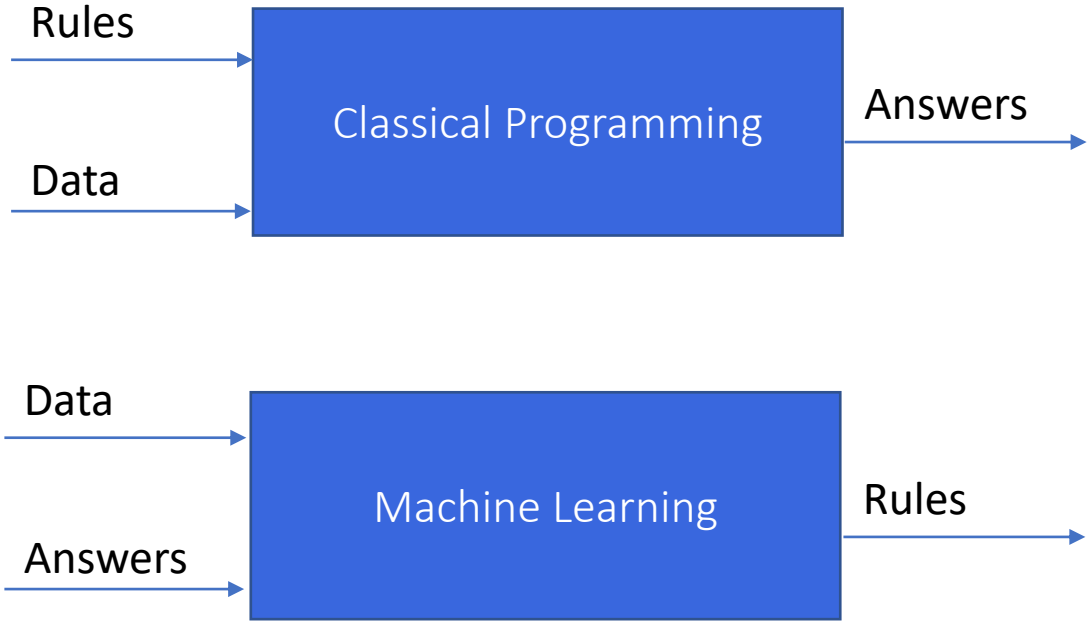
Types of Machine Learning

Machine Learning Types



Types of Machine Learning

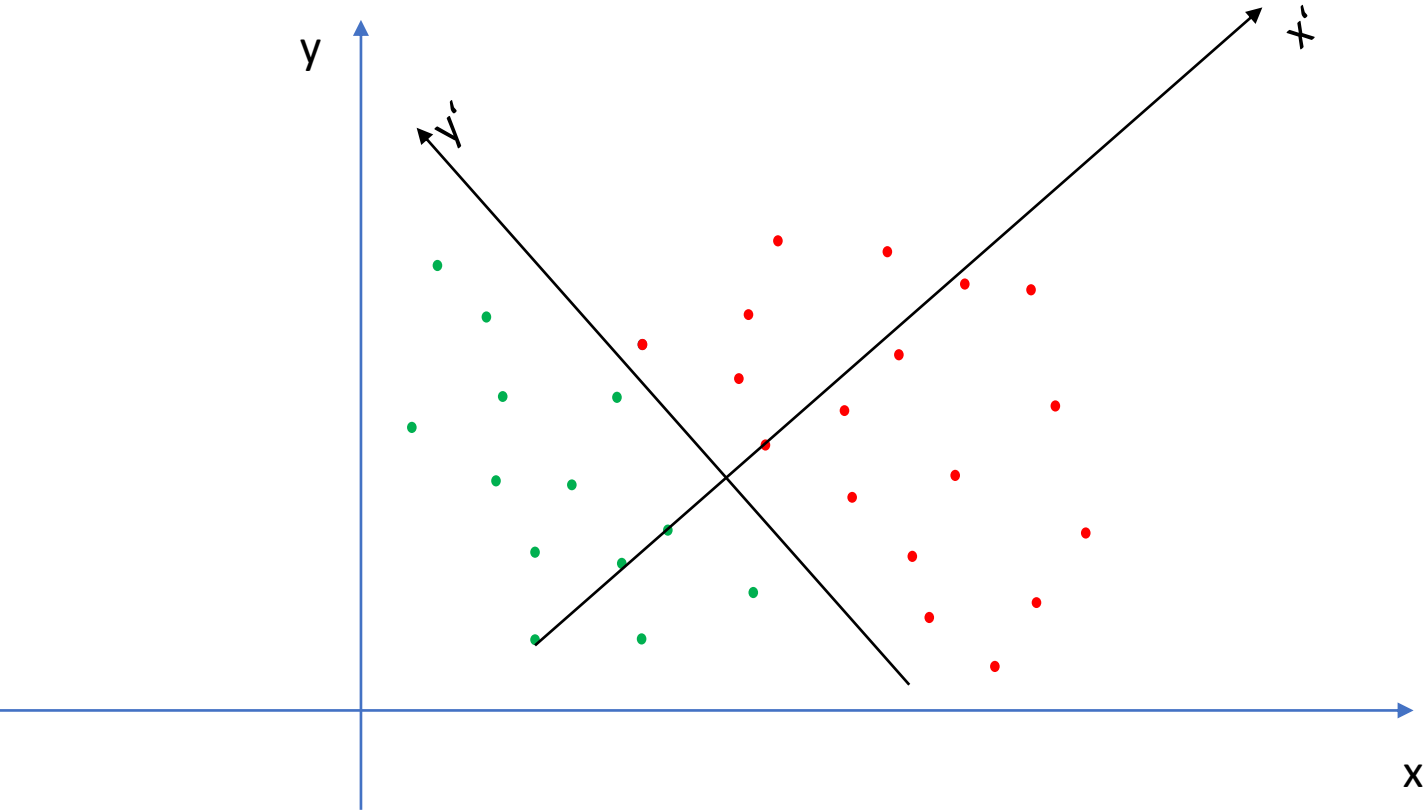
Classical Programming and Machine Learning



Inspired by: Francois Chollet and J.J. Allaire „Deep Learning with R and Keras“

Types of Machine Learning

Data Transformation



Classification

Red, if x‘>0

Green, if x‘<=0

Types of Machine Learning

Example: School Class

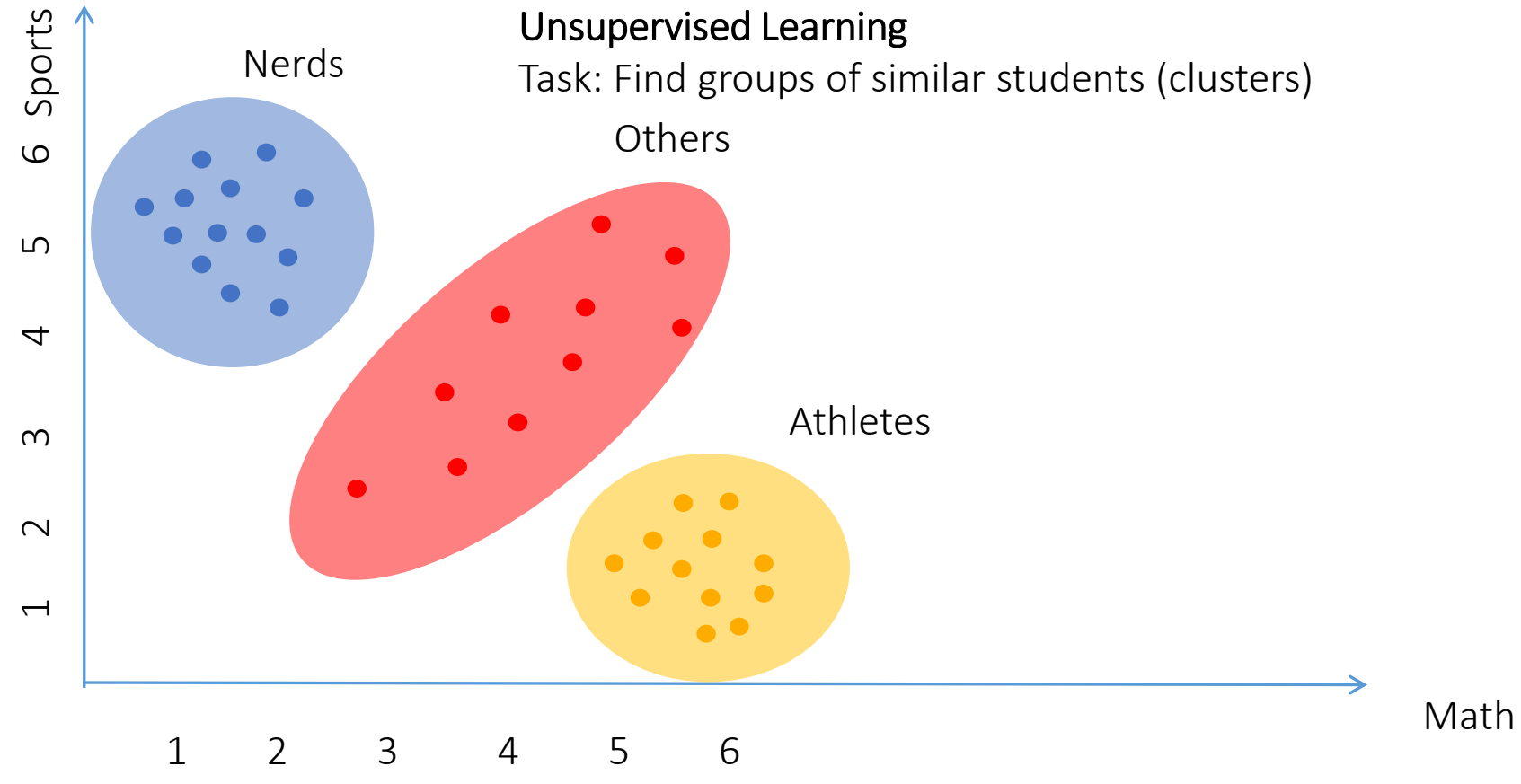
Supervised Learning

Task: Use Label / Target Variable for Learning/Prediction

Name	Age	Learning Method	Class	Grade
Anton	14	A	Sport	2
Bert	15	B	Sport	2
Clare	13	A	Sport	3
Dave	16	B	Math	1
Emilia	15	A	Math	2
…				

Types of Machine Learning

Example: School Class



Types of Machine Learning

Example: School Class

Reinforcement Learning

-Assign Learning Method to each student **one by one**.

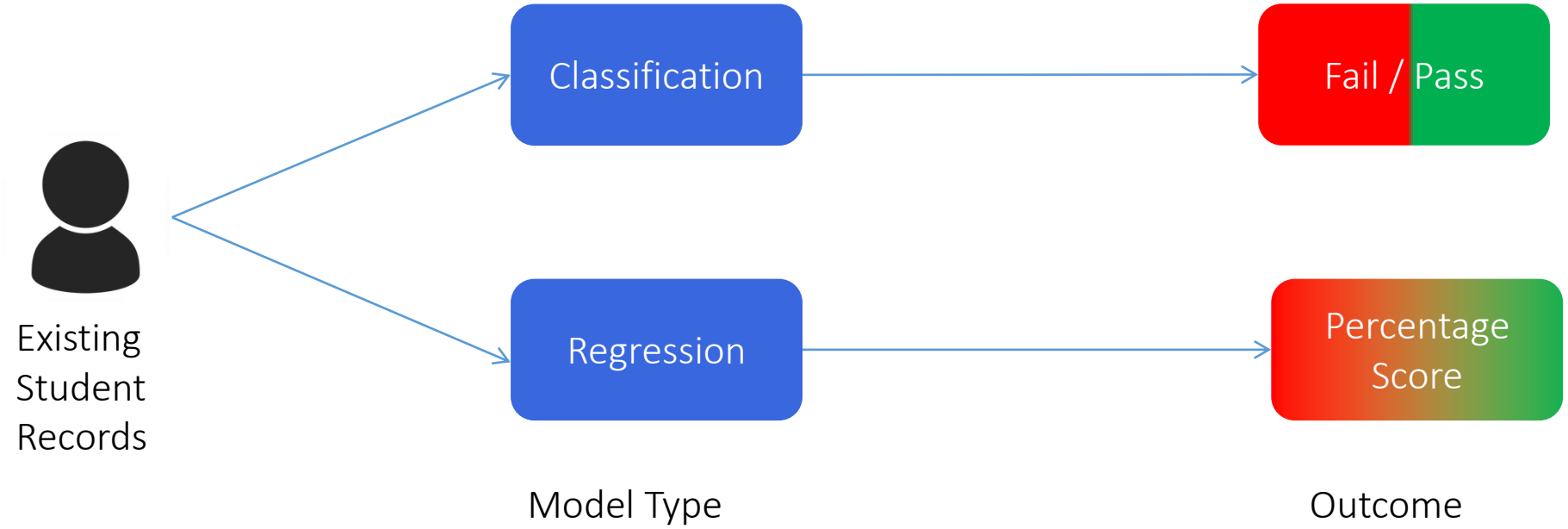
-Task: Find which learning method should be chosen in future

-RL Methods find faster solution than A/B tests.

Name	Age	Learning Method	Class	Grade
Anton	14	A	Sport	2
Bert	15	B	Sport	2
Clare	13	A	Sport	3
Dave	16	B	Math	1
Emilia	15	A	Math	2
…				

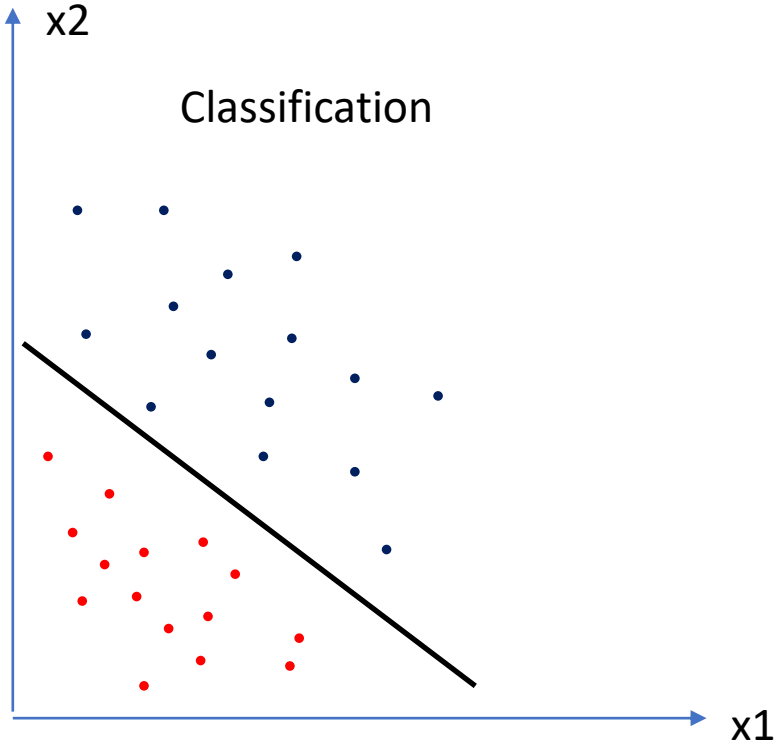
Types of Machine Learning

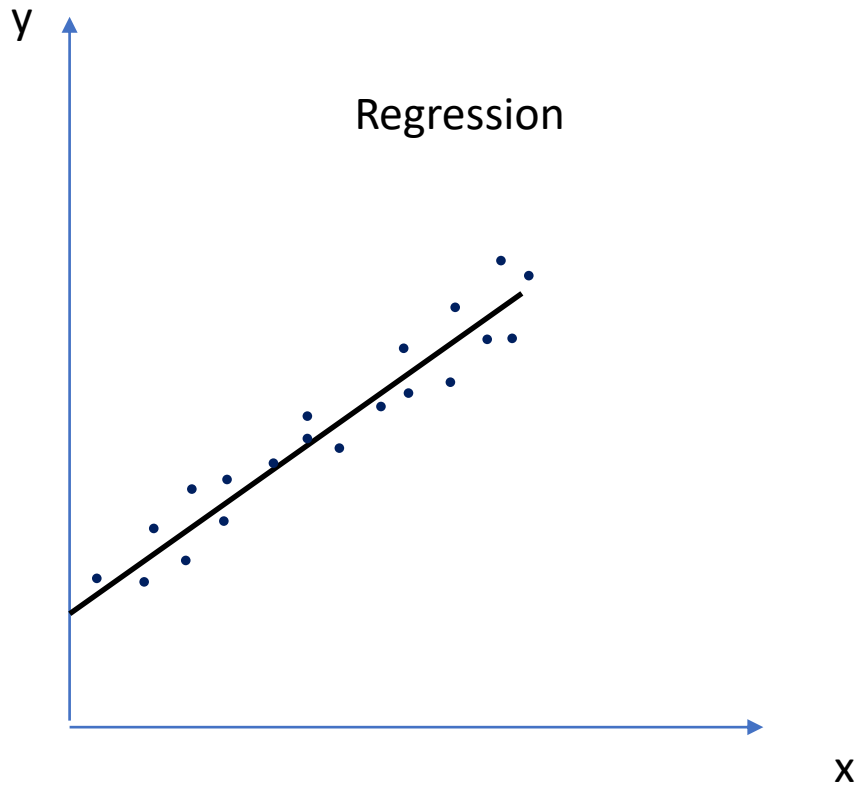
Example: Student Test Prediction



Types of Machine Learning

Example: Classification and Regression Plot

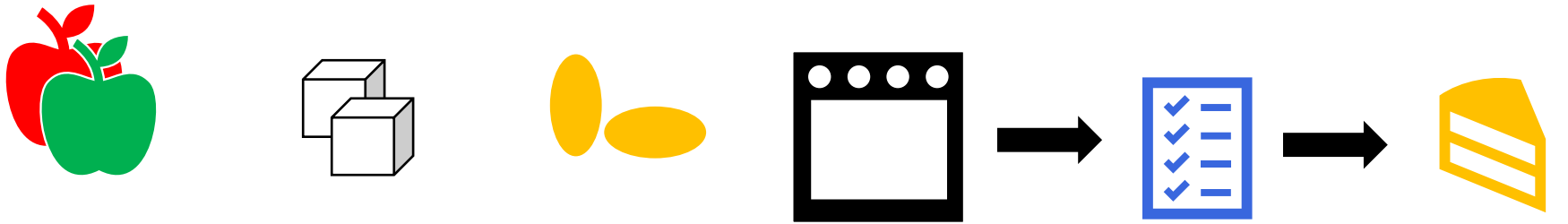




Models

Models

High-Level Analogy



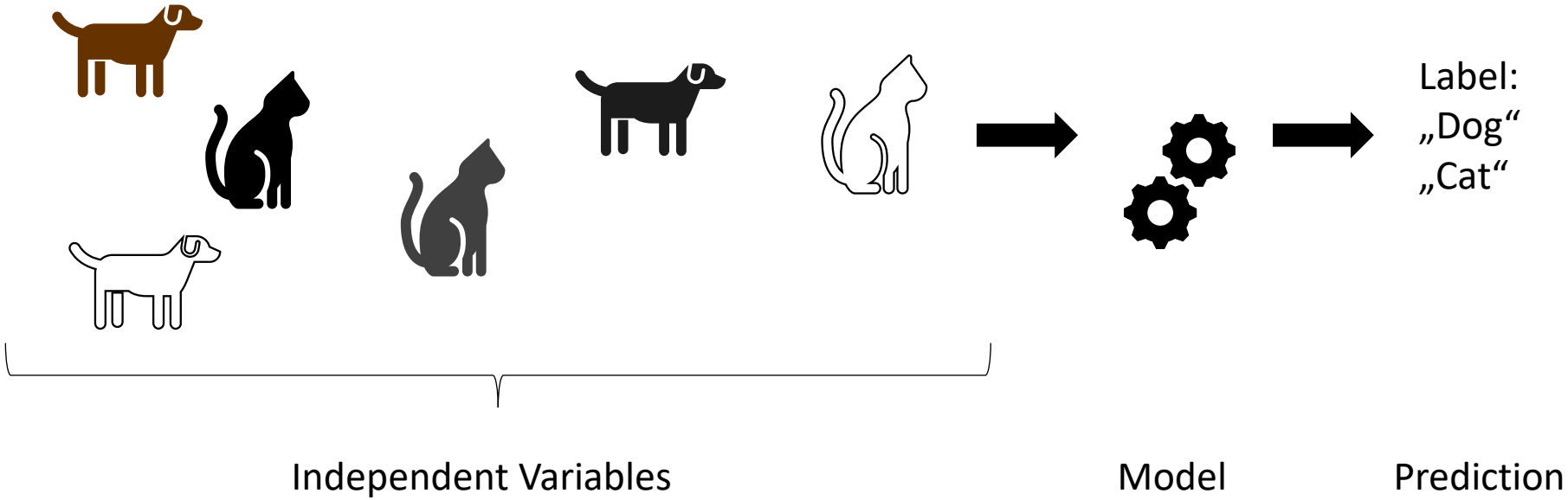
Ingredients + technical equipment (Requirements)

Recipe

Result

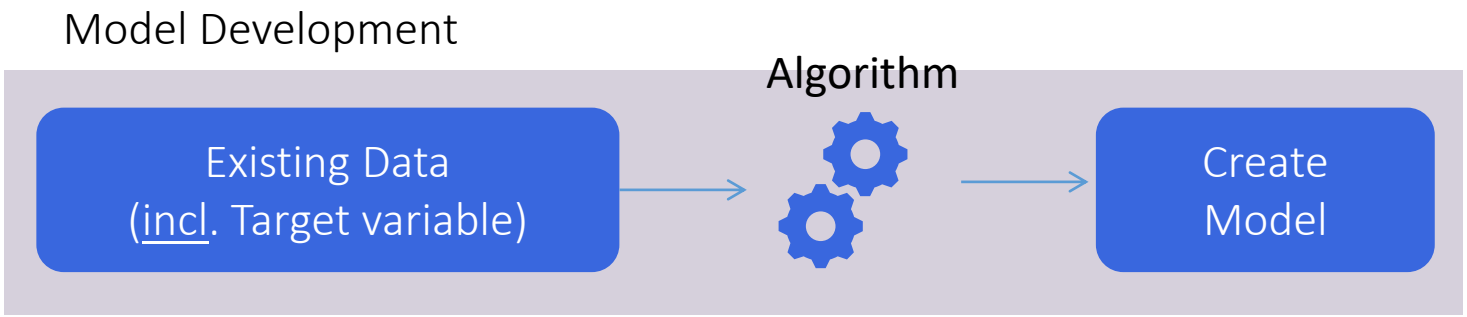
Models

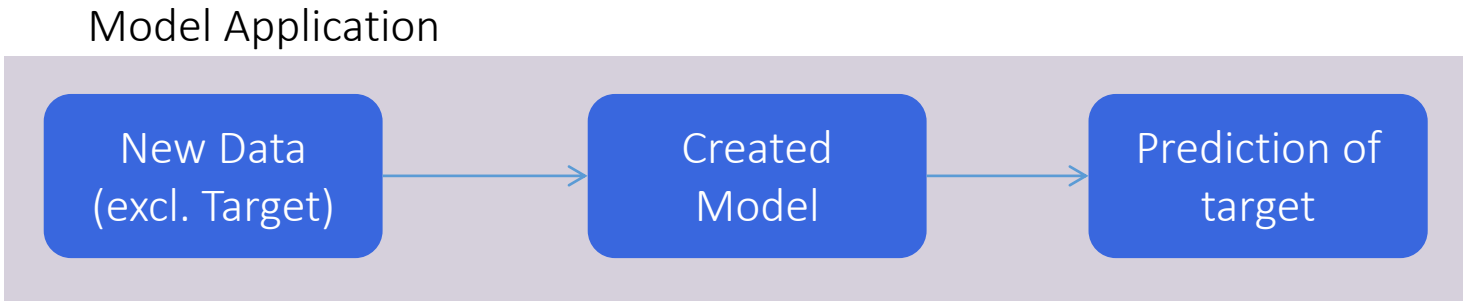
High-Level Analogy



Models

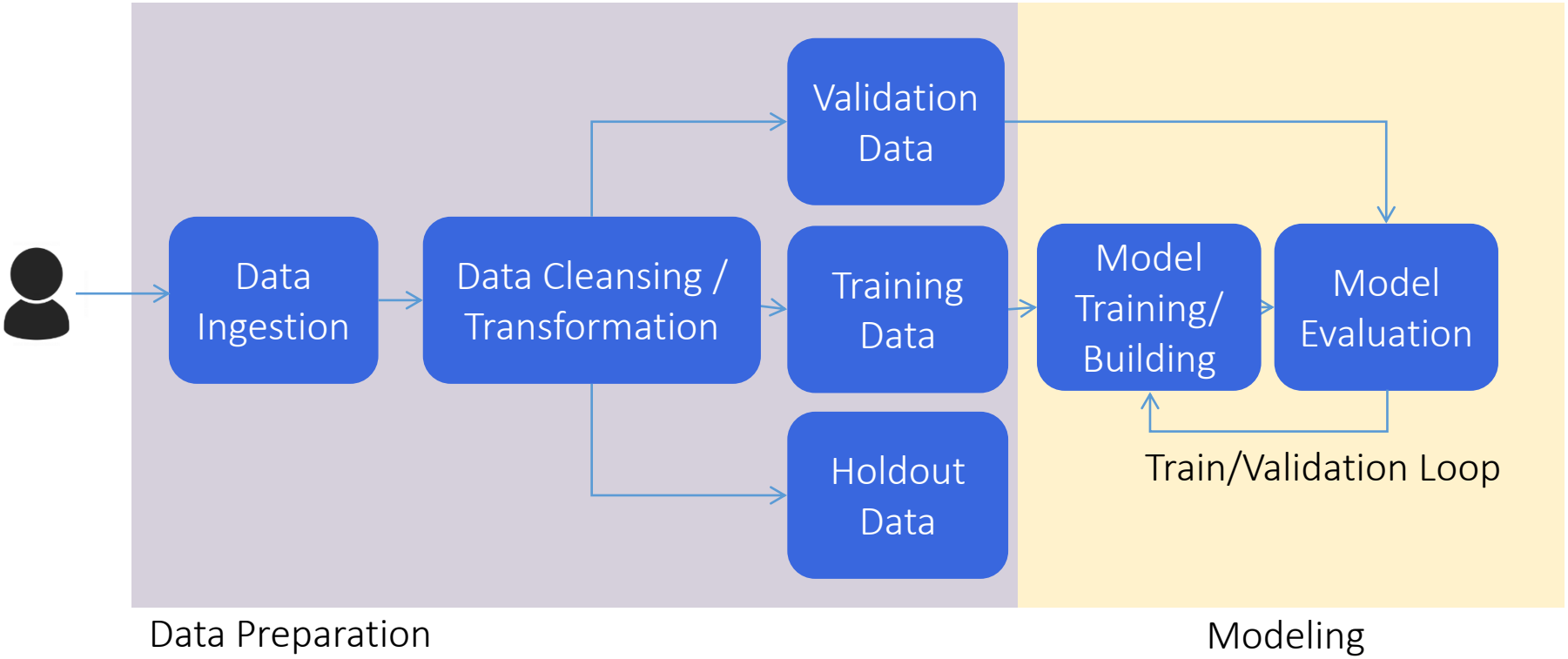
Model Development and -application





Models

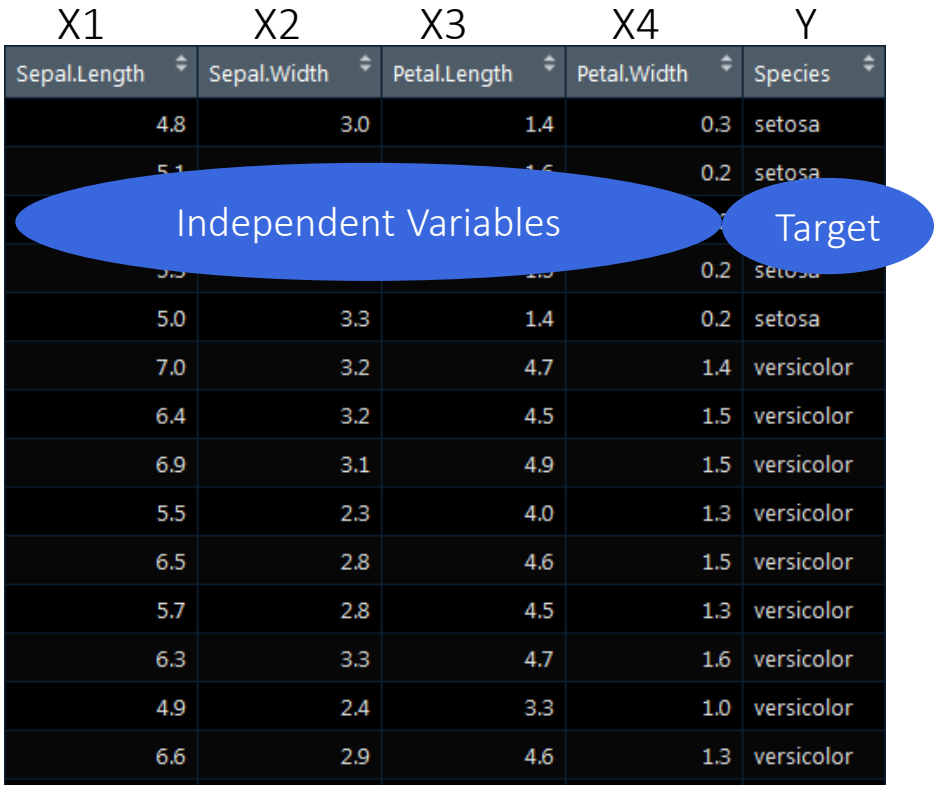
Detailed Model Development



Models

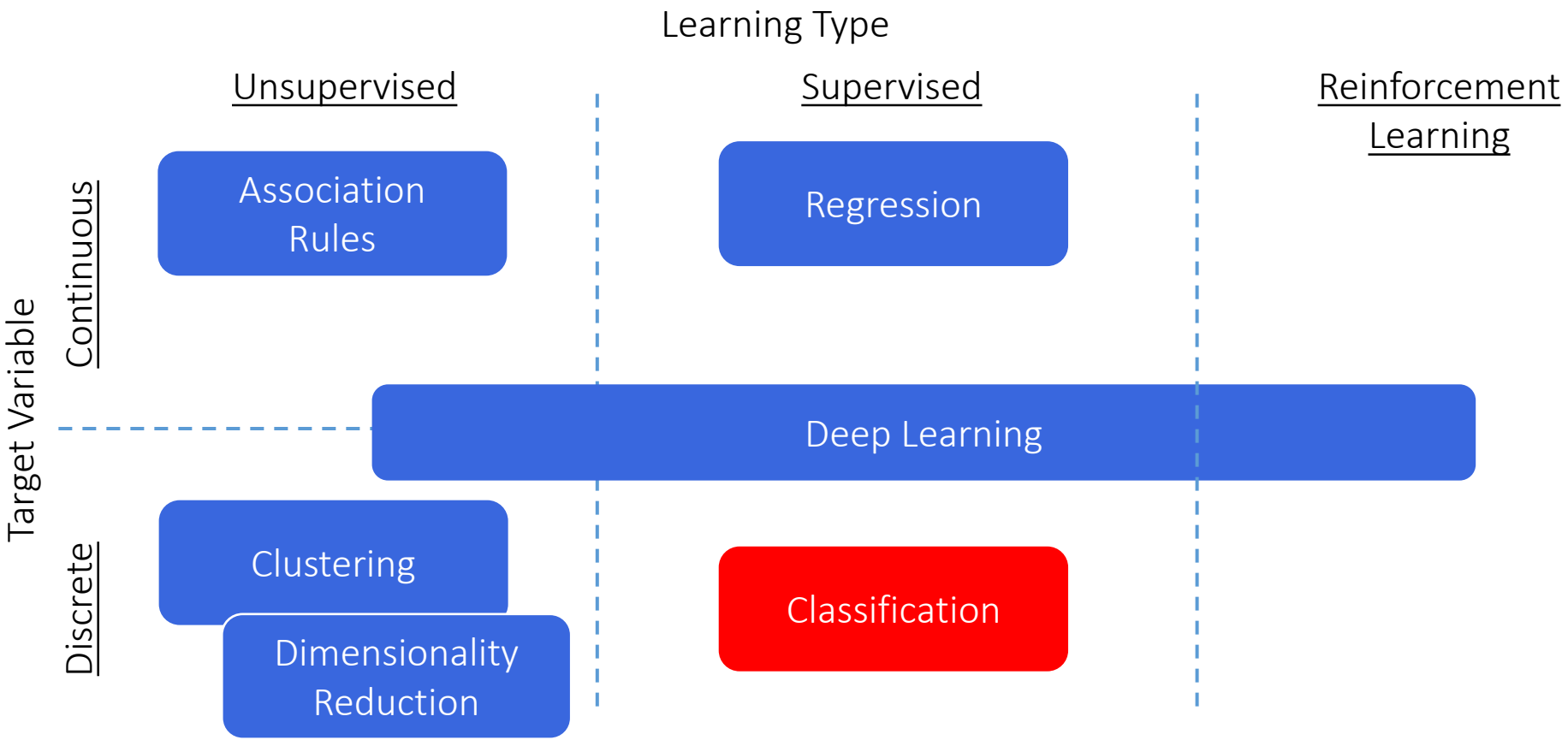
Example

- Task: Target variable (dependent variable) should be predicted.
- Predictors (independent variables) are used to create a model based on an existing relationship between independent and dependent variable.
- Model „learns“ relationship
- Learned model can then be applied to new data.



Our Focus in Today's Class

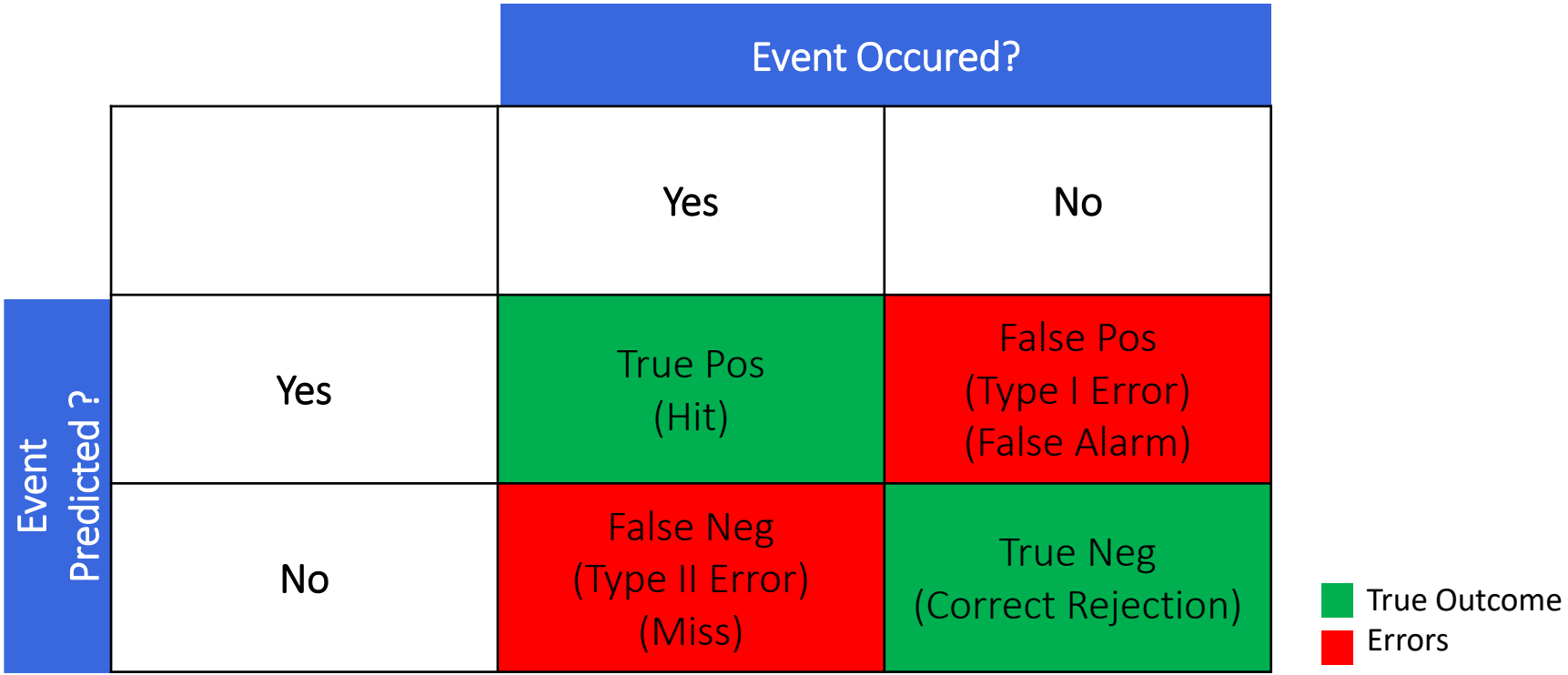
Classification



Classification

Confusion Matrix

Example



Confusion Matrix

Example: Tsunami

		Event Occured?	
		Yes	No
Event Predicted ?	Yes	Tsunami was observed, when it actually happened	A tsunami was predicted, but there was none
	No	There was a tsunami, but it was not predicted.	No tsunami occurred and nothing was Predicted

True Outcome
Less-critical Error
Critical Error

Confusion Matrix

Performance Measures: Accuracy

Numerator

Effect Observed?		Effect Exists? Yes	Effect Exists? No
	Yes	True Pos	False Pos
	No	False Neg	True Neg

Denominator

Effect Observed?		Effect Exists? Yes	Effect Exists? No
	Yes	True Pos	False Pos
	No	False Neg	True Neg

$$\text{Accuracy} = \frac{TP+TN}{TP+TN+FP+FN}$$

Usually compared to baseline result or to compare models

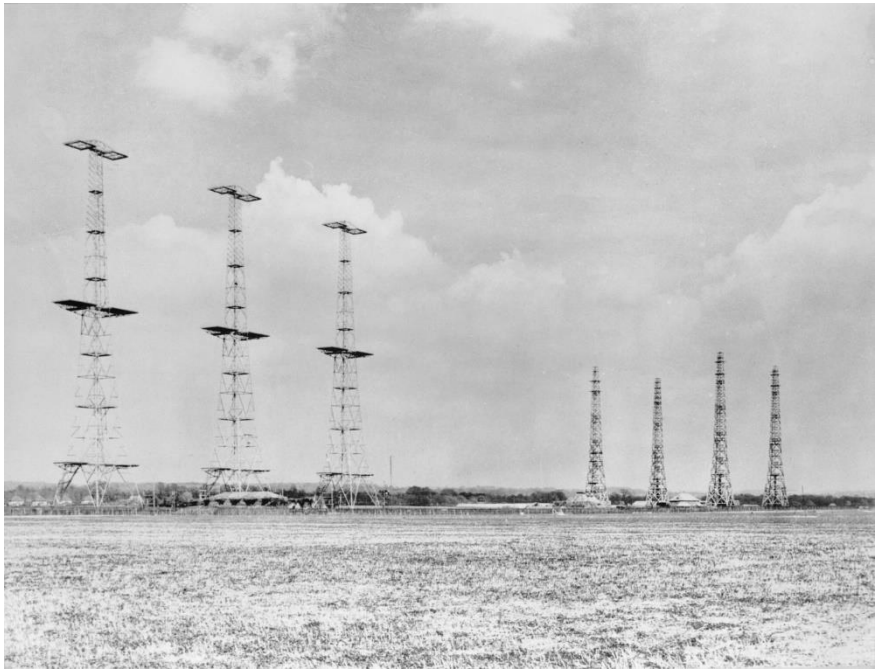
ROC Curve

ROC Curve - 101

Introduction

Receiver Operating Characteristics (**ROC**) Curve

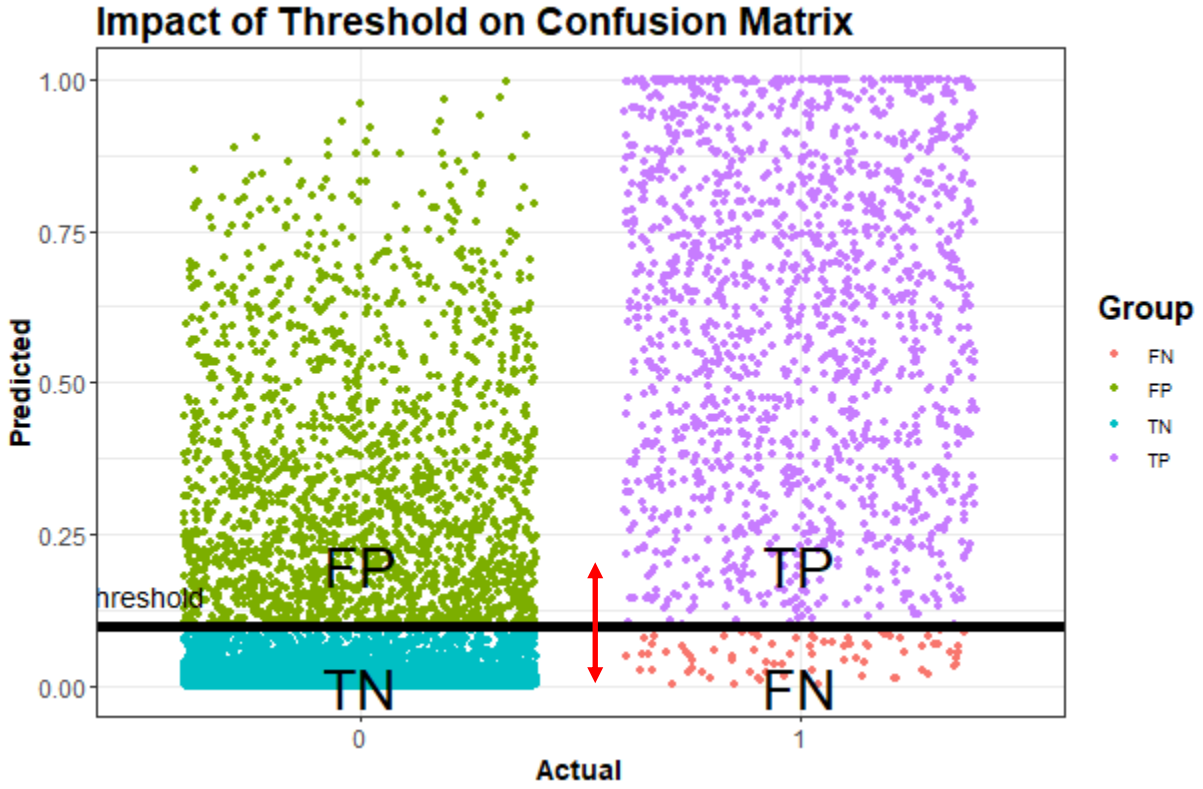
- First developed and used during WWII for detecting enemy objects in battlefields
- Later used in psychology, medicine, forecasting of natural hazards, …
- … and finally **model performance assessment**



Source: https://commons.wikimedia.org/wiki/File:Chain_Home_radar_installation_at_Poling,_Sussex,_1945._CH15173.jpg

ROC Curve - 101

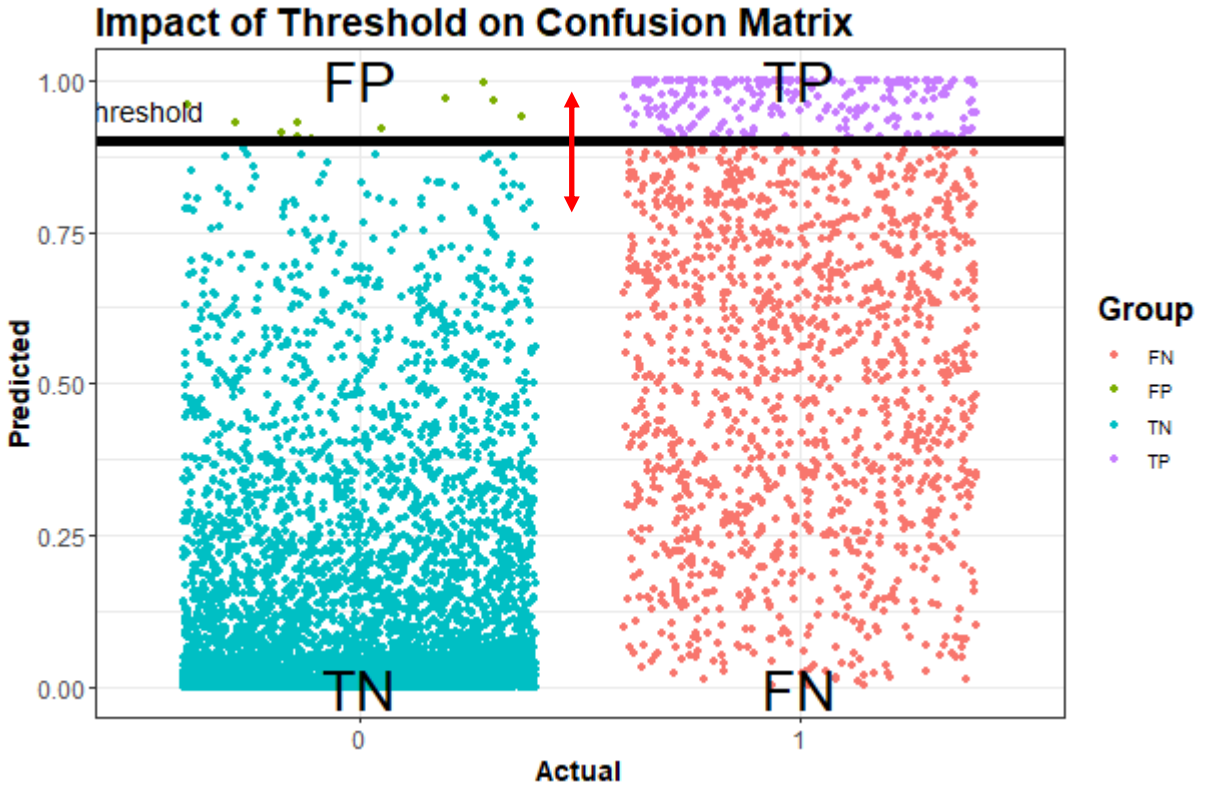
From Confusion Matrix to ROC Curve



Actuals	PredNeg	PredPos
ActNeg	3117	1842
ActPos	84	1469

ROC Curve - 101

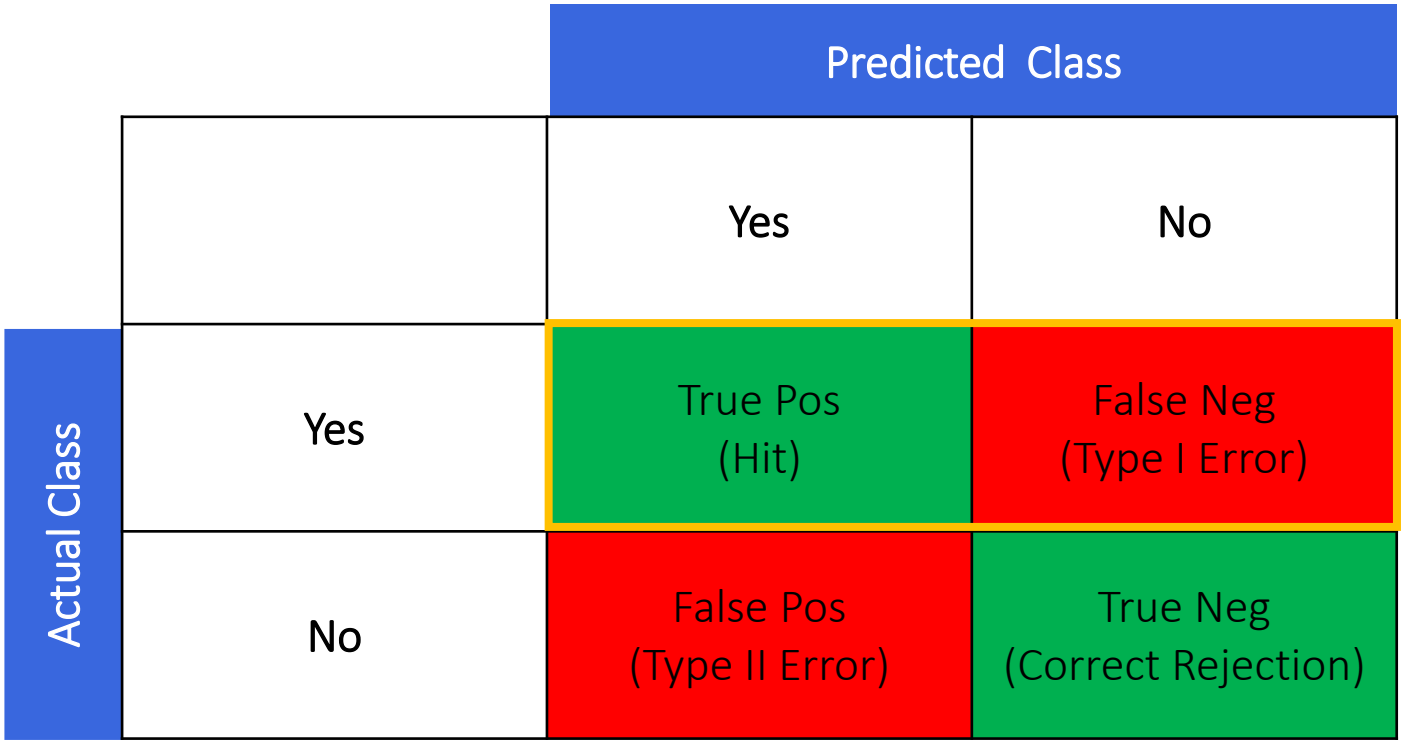
From Confusion Matrix to ROC Curve



Actuals	PredNeg	PredPos
ActNeg	4948	11
ActPos	1305	248

ROC Curve - 101

From Confusion Matrix to ROC Curve



$$TPR = \frac{TP}{TP + FN}$$

→ Y Axis on ROC Curve

ROC Curve - 101

From Confusion Matrix to ROC Curve

		Predicted Class: Yes	Predicted Class: No
Actual Class	Yes	True Pos (Hit)	False Neg (Type I Error)
Actual Class	No	False Pos (Type II Error)	True Neg (Correct Rejection)

$$FPR = \frac{FP}{FP + TN}$$

→ X Axis on ROC Curve

ROC Curve - 101

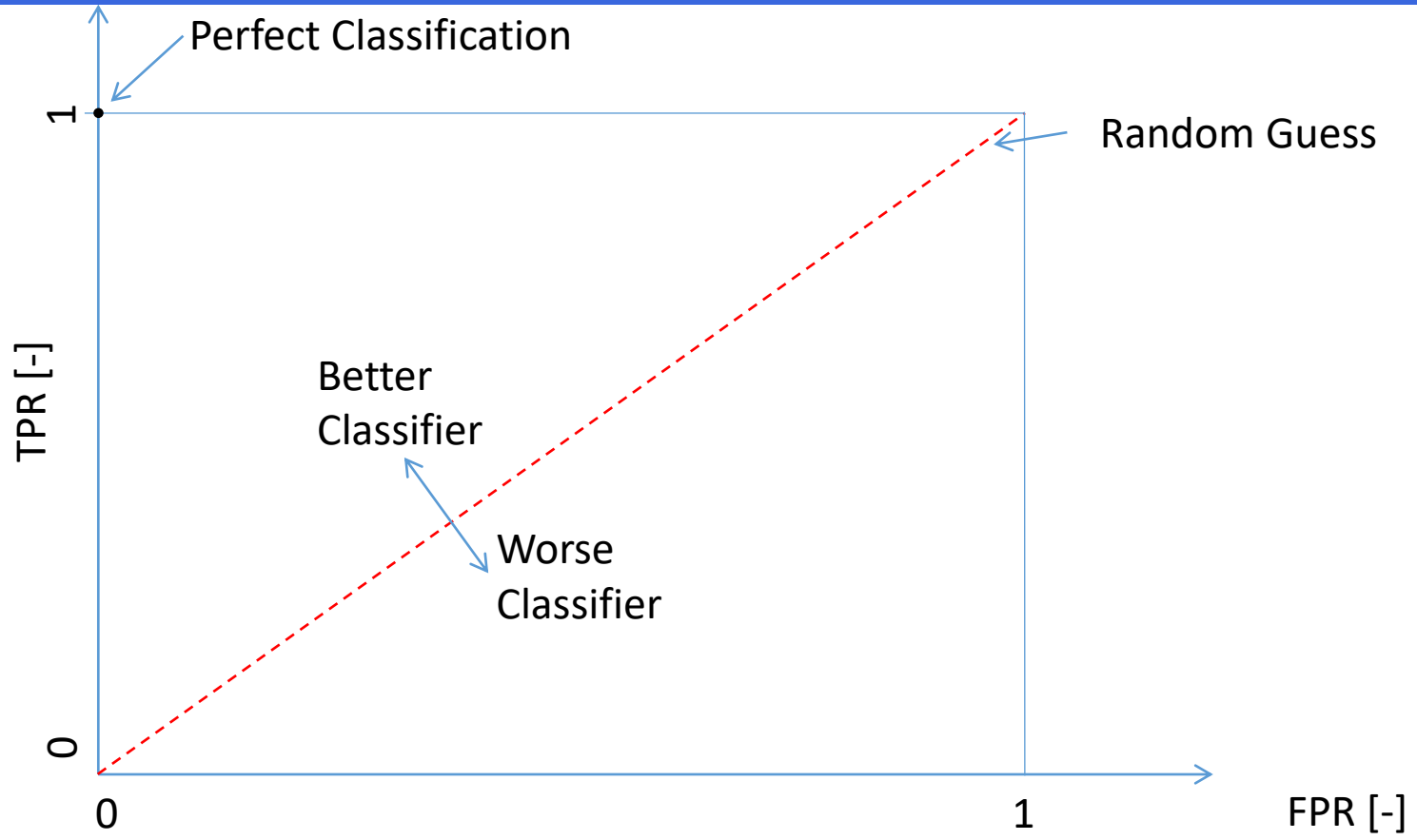
From Confusion Matrix to ROC Curve

Example

Threshold	TN	FP	FN	TP	FPR	TPR
0.01	1318	3641	3	1550	0.73	1
0.02	1776	3183	10	1543	0.64	0.99
…						
0.98	4958	1	1431	122	0	0.08
0.99	4958	1	1448	105	0	0.07

ROC Curve - 101

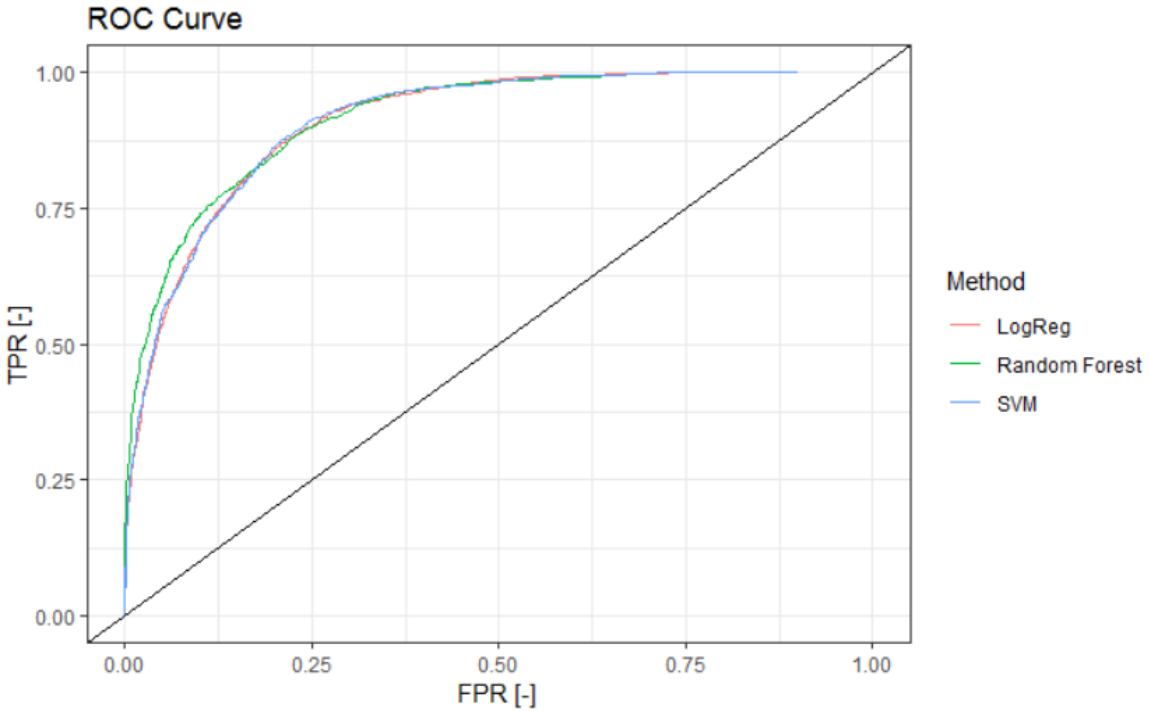
ROC Curve



ROC Curve - 101

Purpose

- Different methods can be compared

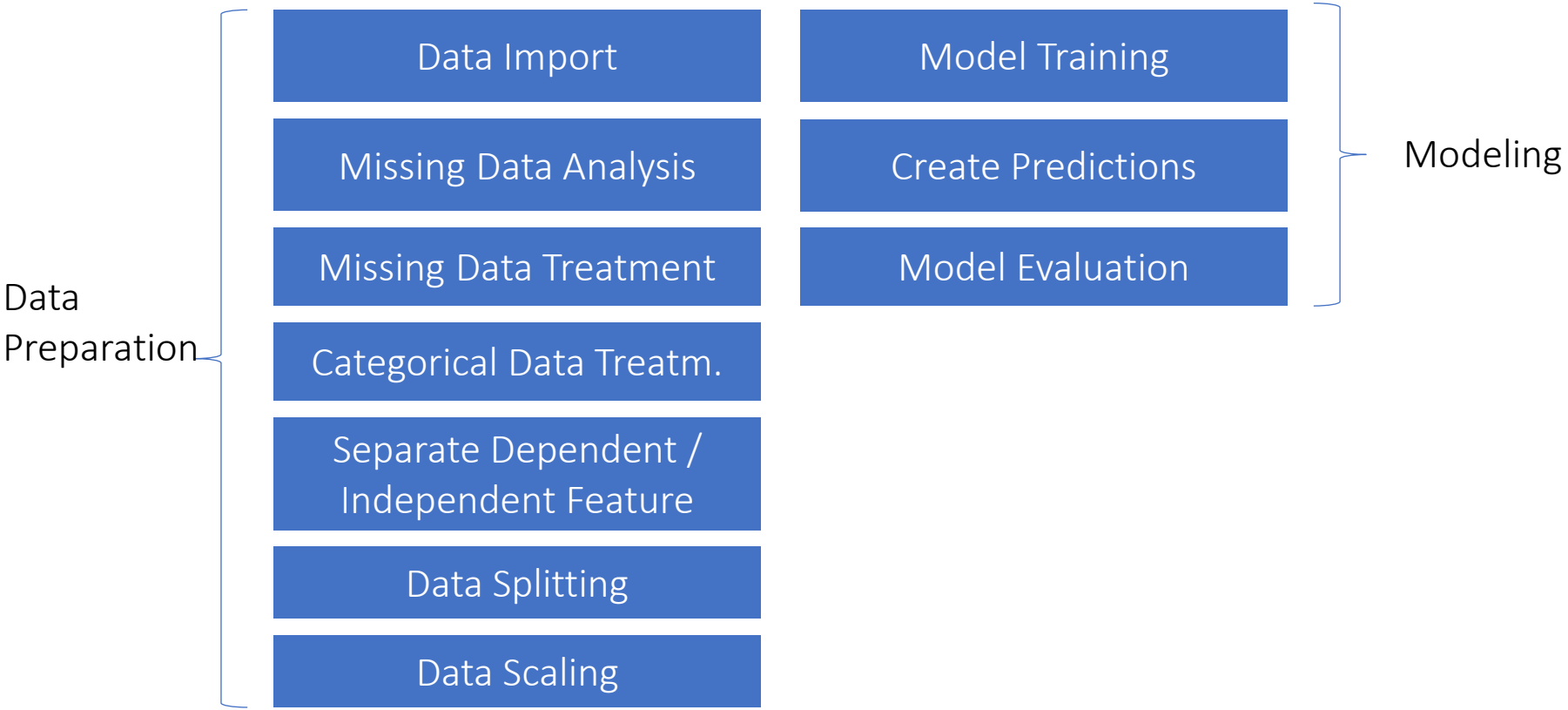


Source: own graph

Analysis Steps

Analysis Steps

Sample Steps



Logistic Regression

Logistic Regression

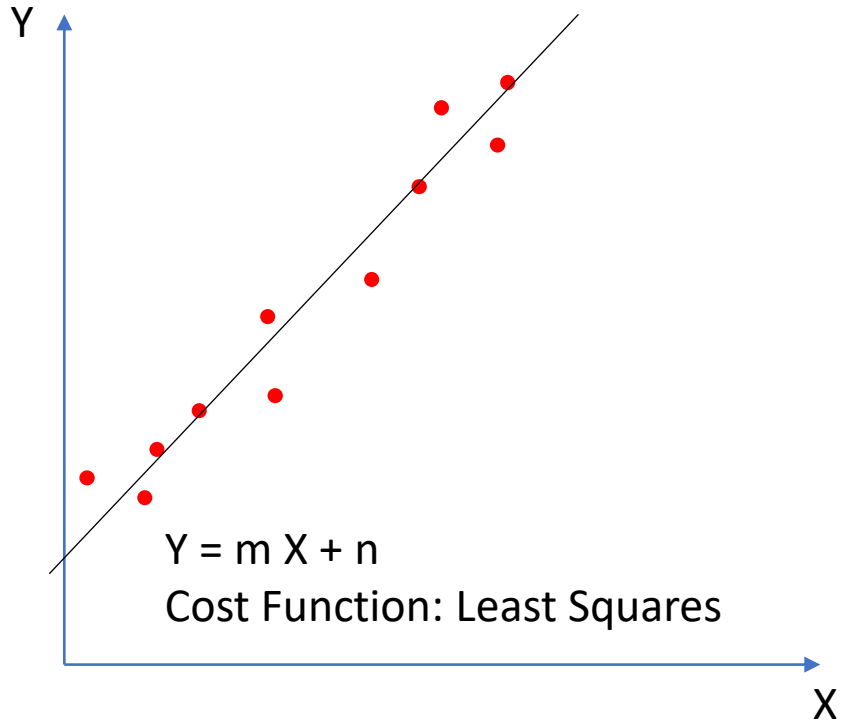
Introduction

- Suitable for classification tasks (don‘t get confused by „regression“)
- Only works for binary classifier
- Independent variables can be continous or discrete
- Related to classical regression

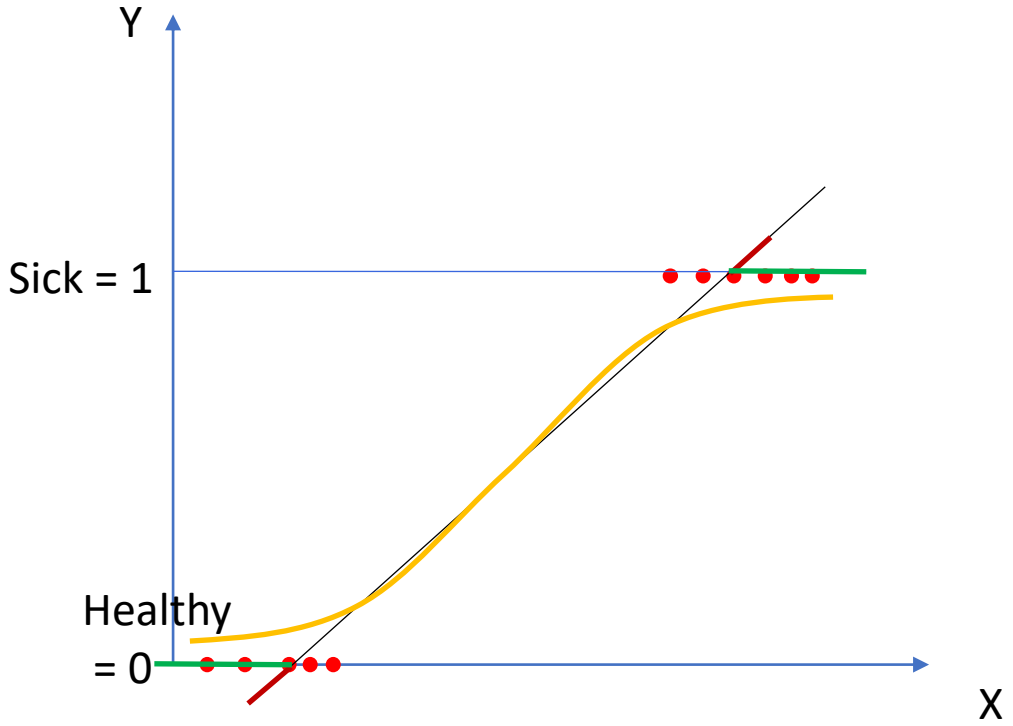
Logistic Regression

From Linear Regression to Logistic Regression

Linear Regression



Logistic Regression



Logistic Regression

From Linear Regression to Logistic Regression

Logistic Regression

$$Y = mX + n$$

Transform Target Variable with Sigmoid Function

$$p = \frac{1}{1 + e^{-Y}}$$

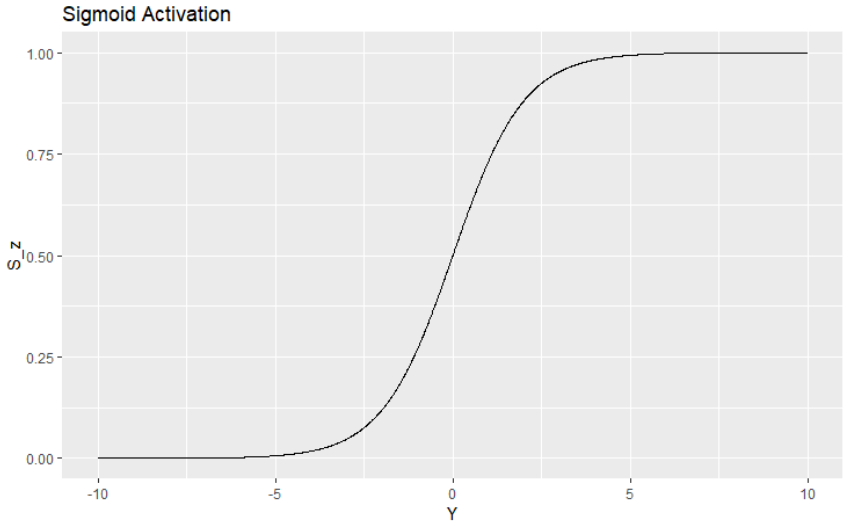
Rewrite Formula:

$$Y = ln\left(\frac{p}{1-p}\right)$$

Logit-Transformation of Target Variable:

$$Y = ln\left(\frac{p}{1-p}\right)$$

$$ln\left(\frac{p}{1-p}\right) = mX + n$$



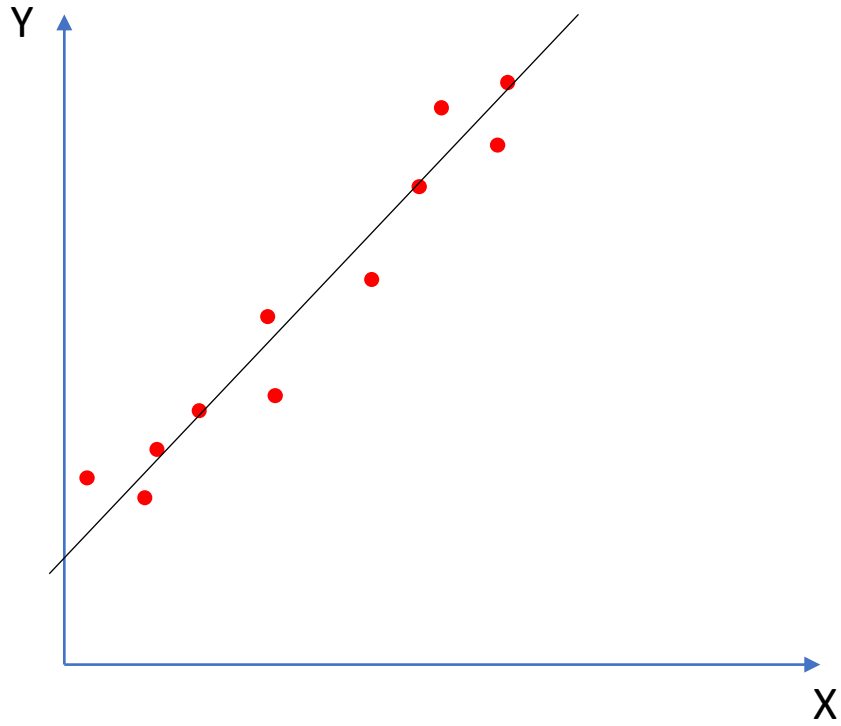
Sigmoid function maps results to 0 to 1 range.

$$S(x) = \frac{1}{1 + e^{-x}}$$

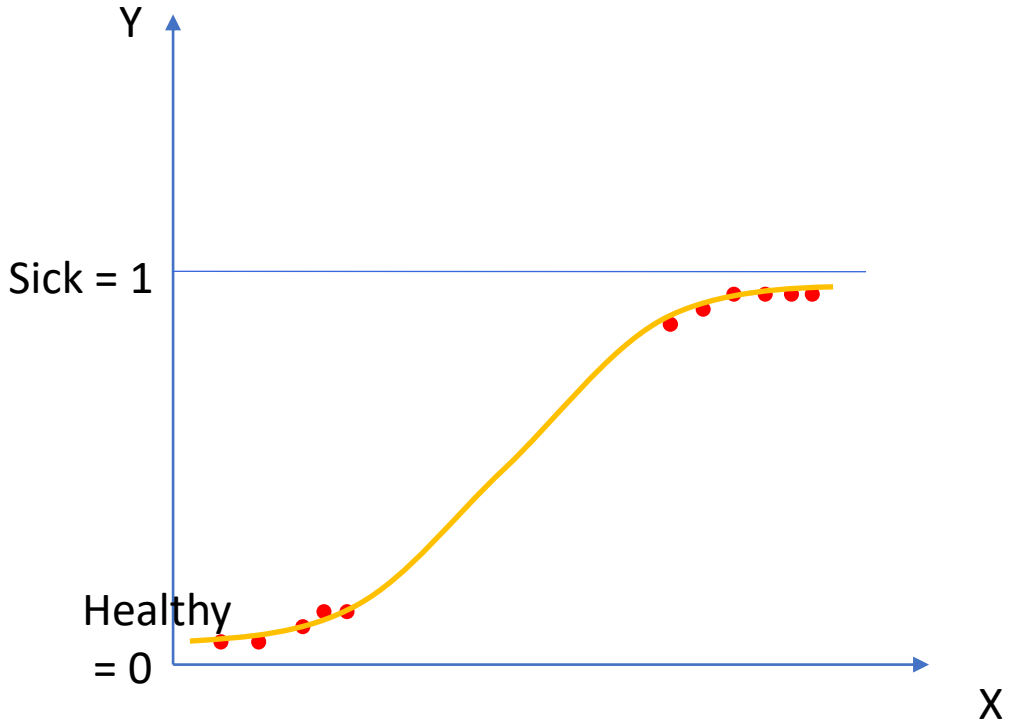
Logistic Regression

From Linear Regression to Logistic Regression

Linear Regression

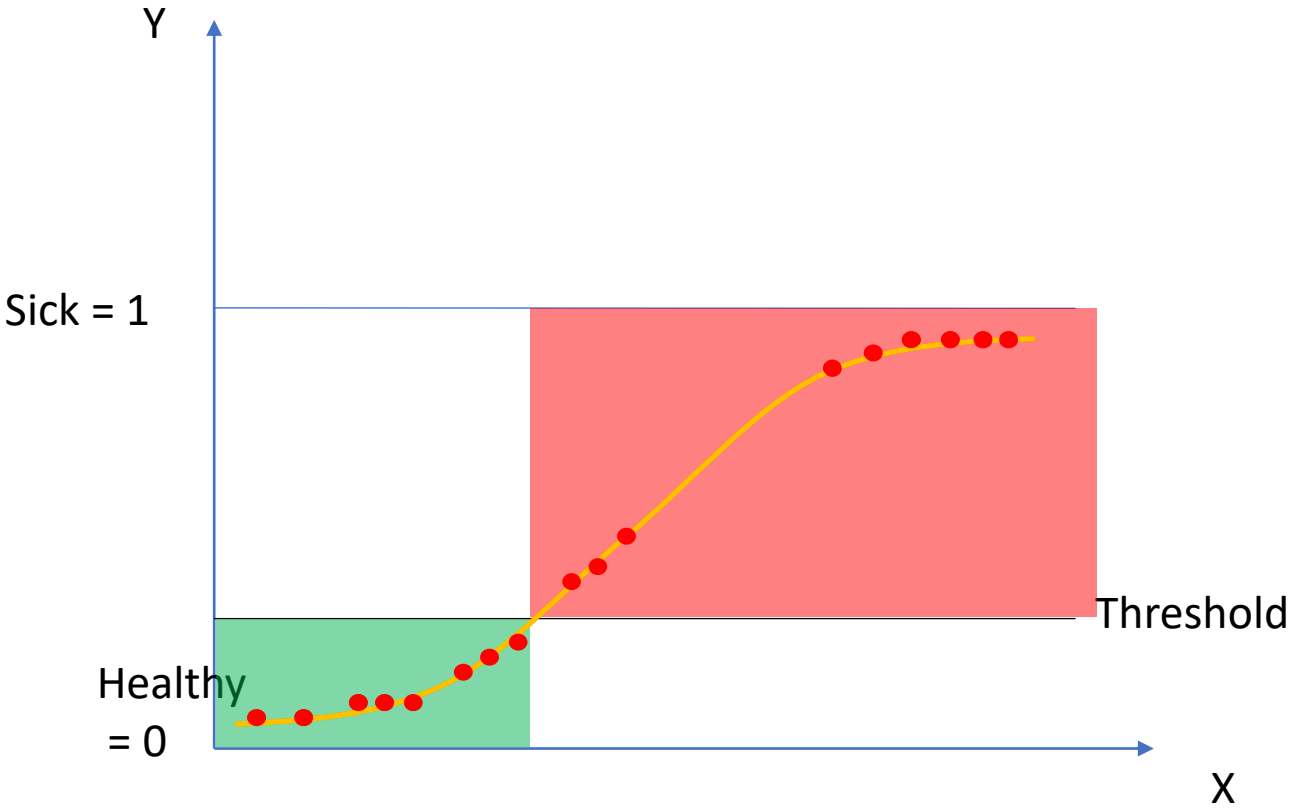


Logistic Regression



Logistic Regression

From Probabilities to Classes



Logistic Regression

From Probabilities to Classes