THE UNIVERSITY OF QUEENSLAND
AUSTRALIA

Baker
HEART & DIABETES INSTITUTE

Quantum Machine Learning

Alex de Sá — Alex.deSa@baker.edu.au
Ashar Malik — Ashar.Malik@baker.edu.au

https://github.com/alexgcsa/resbaz2023

THE UNIVERSITY OF QUEENSLAND
AUSTRALIA

Baker
HEART & DIABETES INSTITUTE

~~Quantum~~ Machine Learning

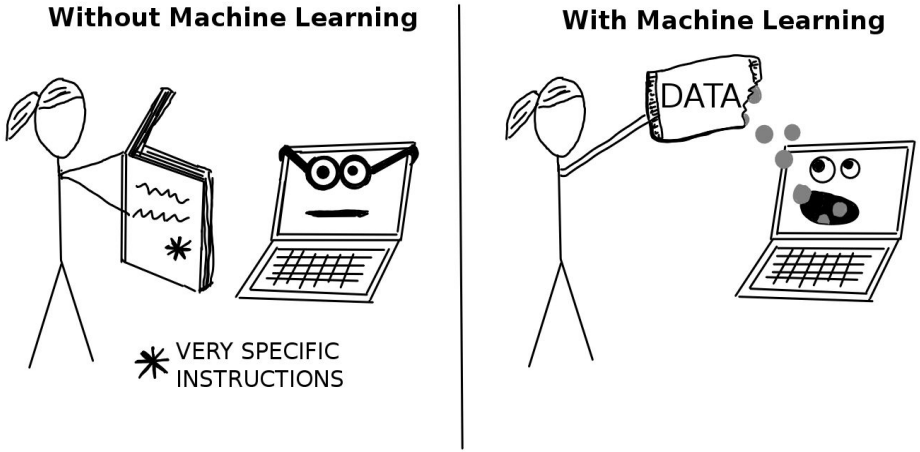
Alex de Sá — Alex.deSa@baker.edu.au
Ashar Malik — Ashar.Malik@baker.edu.au

https://github.com/alexgcsa/resbaz2023

Machine Learning

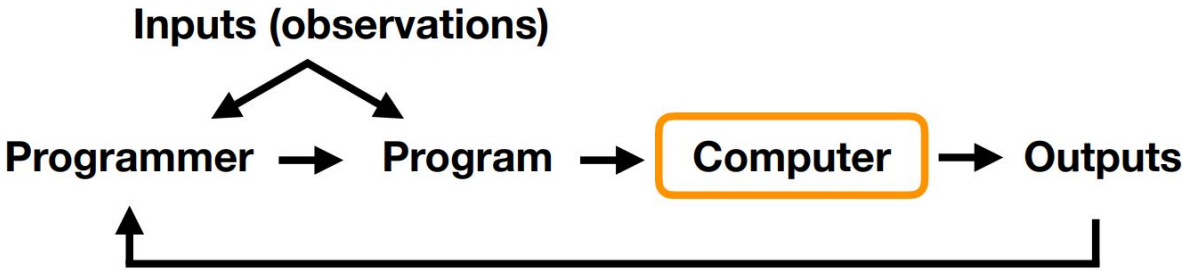
Machine learning is the field of study that gives computers the ability to learn without being explicitly programmed.

Arthur L. Samuel, AI pioneer, 1959



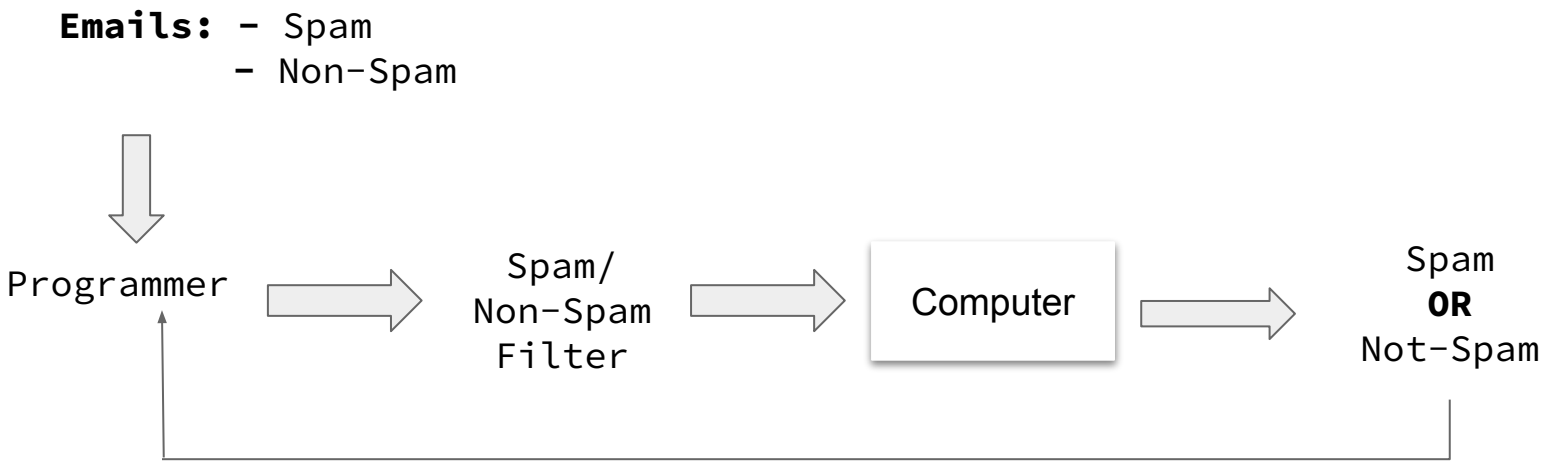
Molnar, 2021

Traditional Programming versus Machine Learning



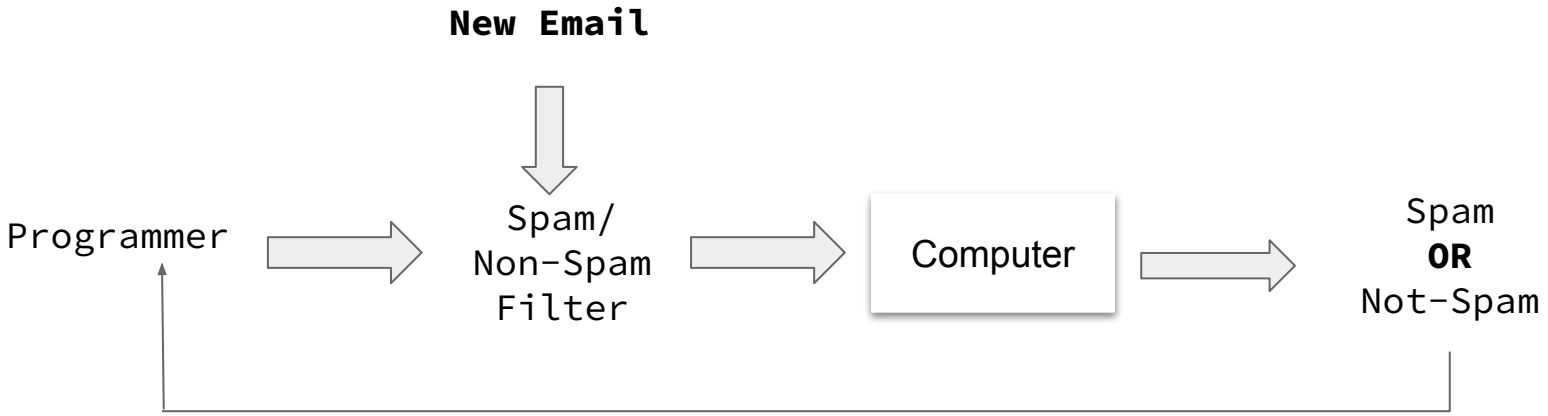
Raschka, 2021

Traditional Programming



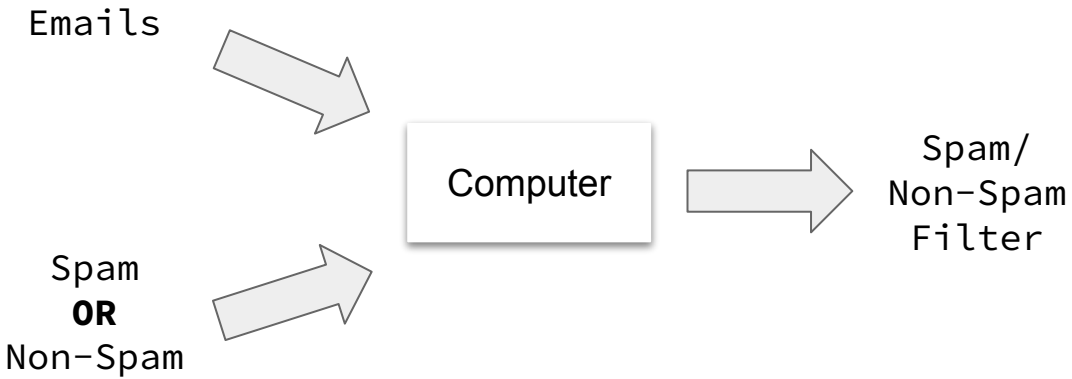
Raschka, 2021

Traditional Programming



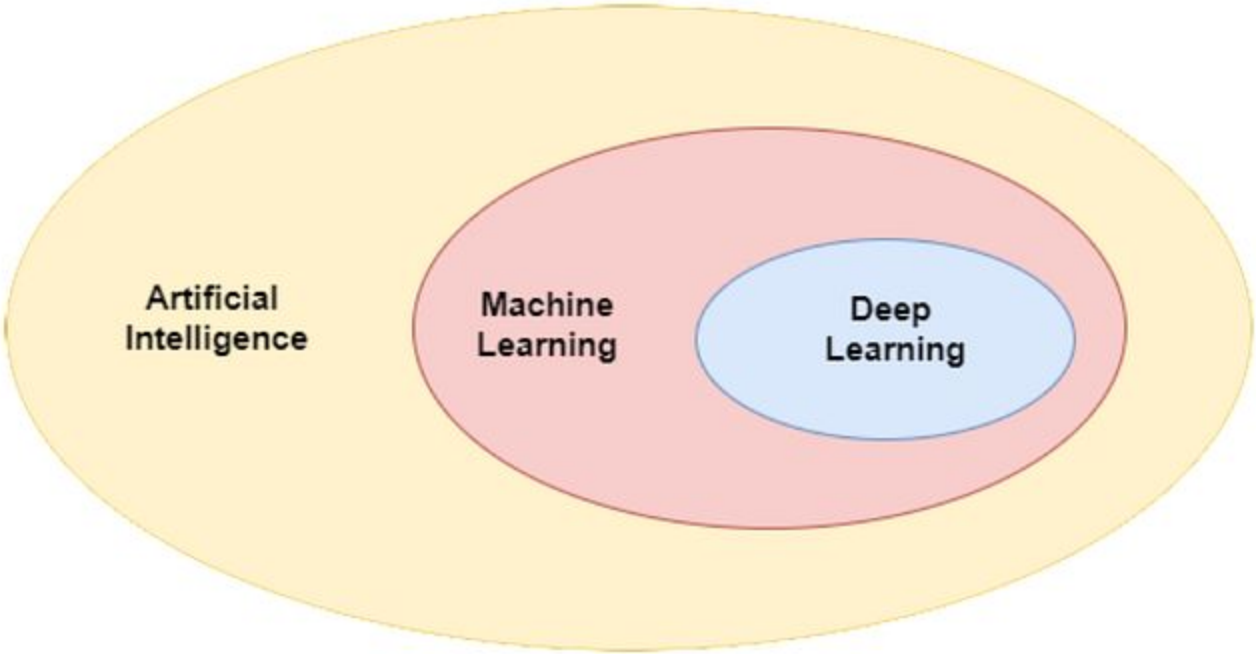
Raschka, 2021

Machine Learning



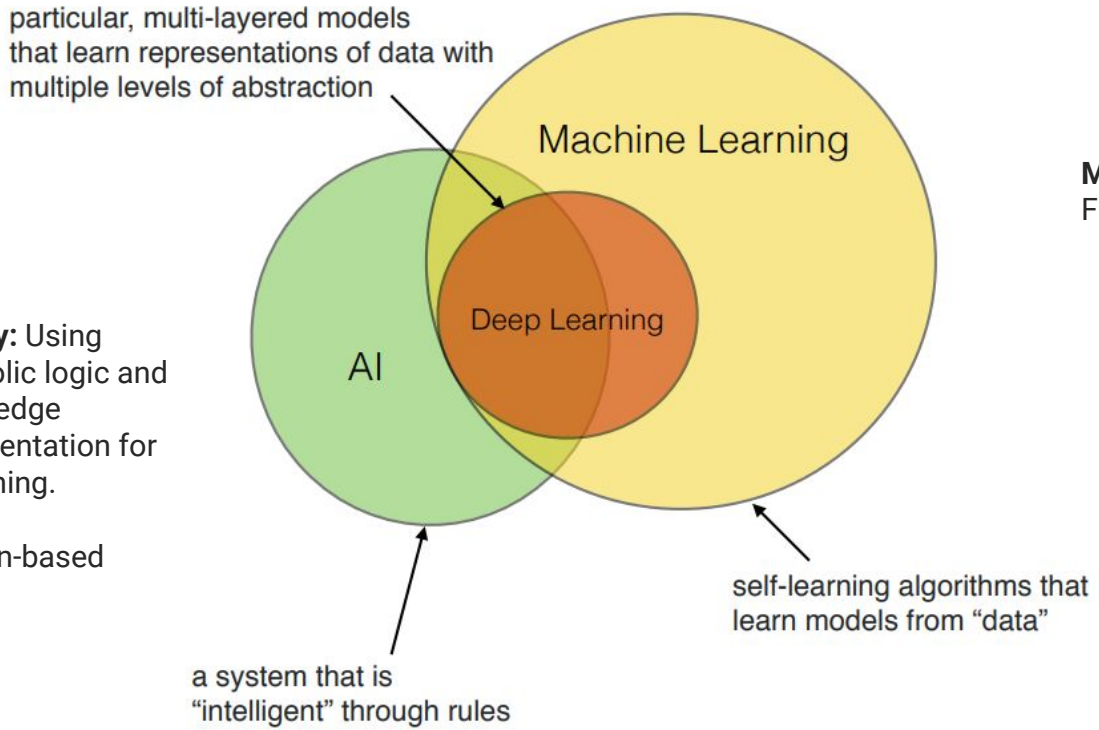
Raschka, 2021

Taxonomy of Machine Learning



Towards Data Science, 2020

Taxonomy of Machine Learning



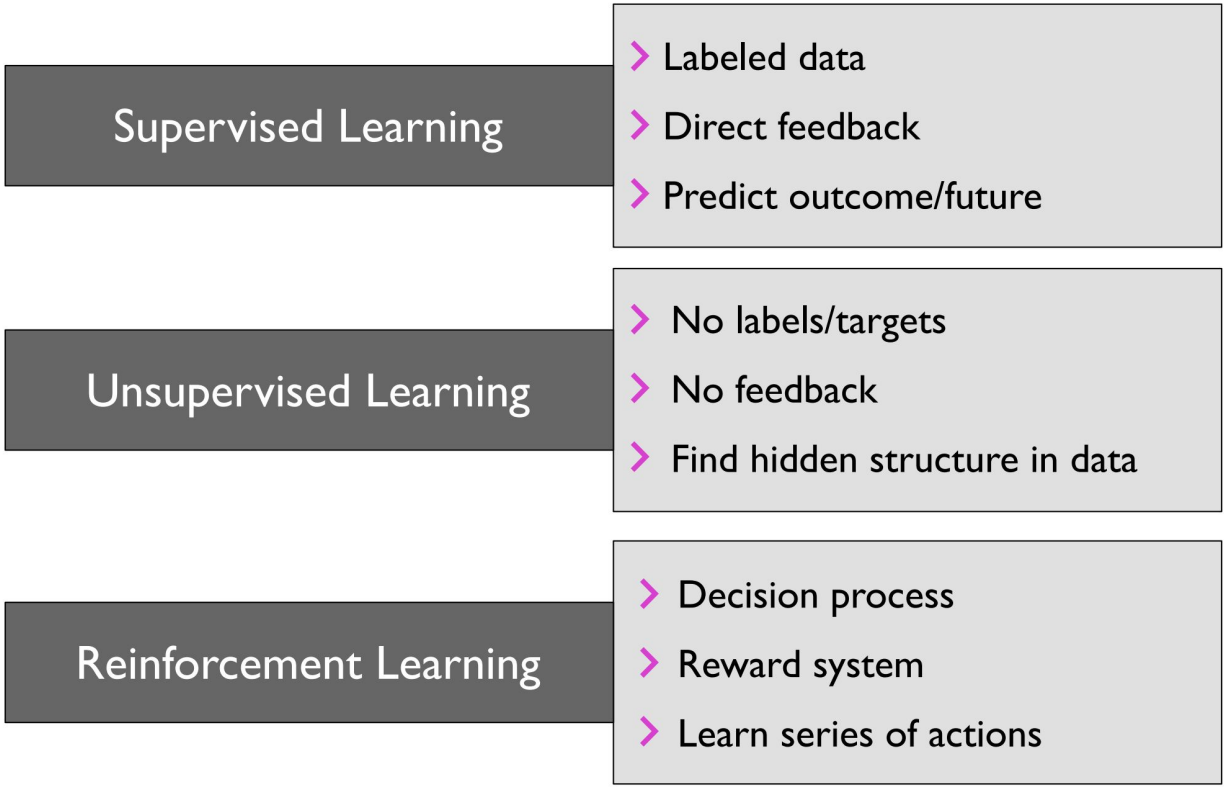
AI only: Using symbolic logic and knowledge representation for reasoning.

Human-based rules.

ML only: Predicting Flower Species

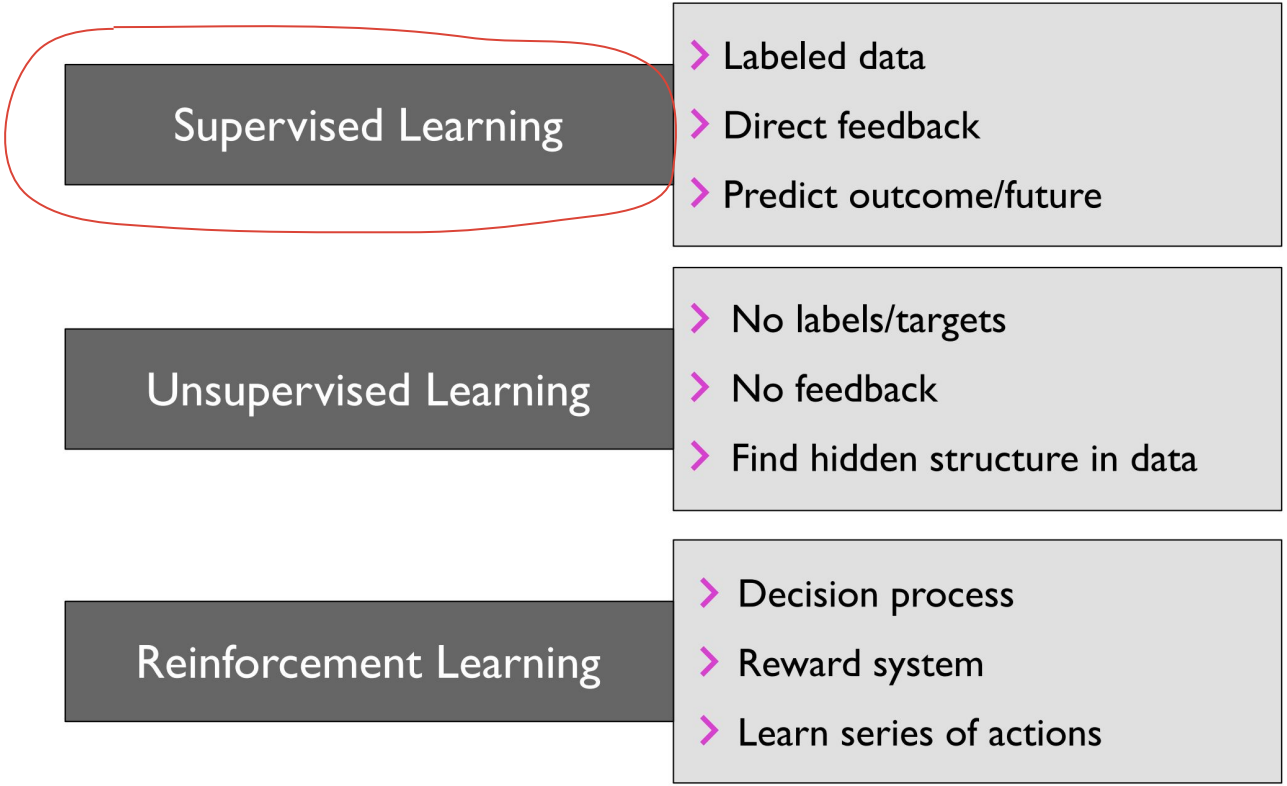
Raschka, 2021

Taxonomy of Machine Learning



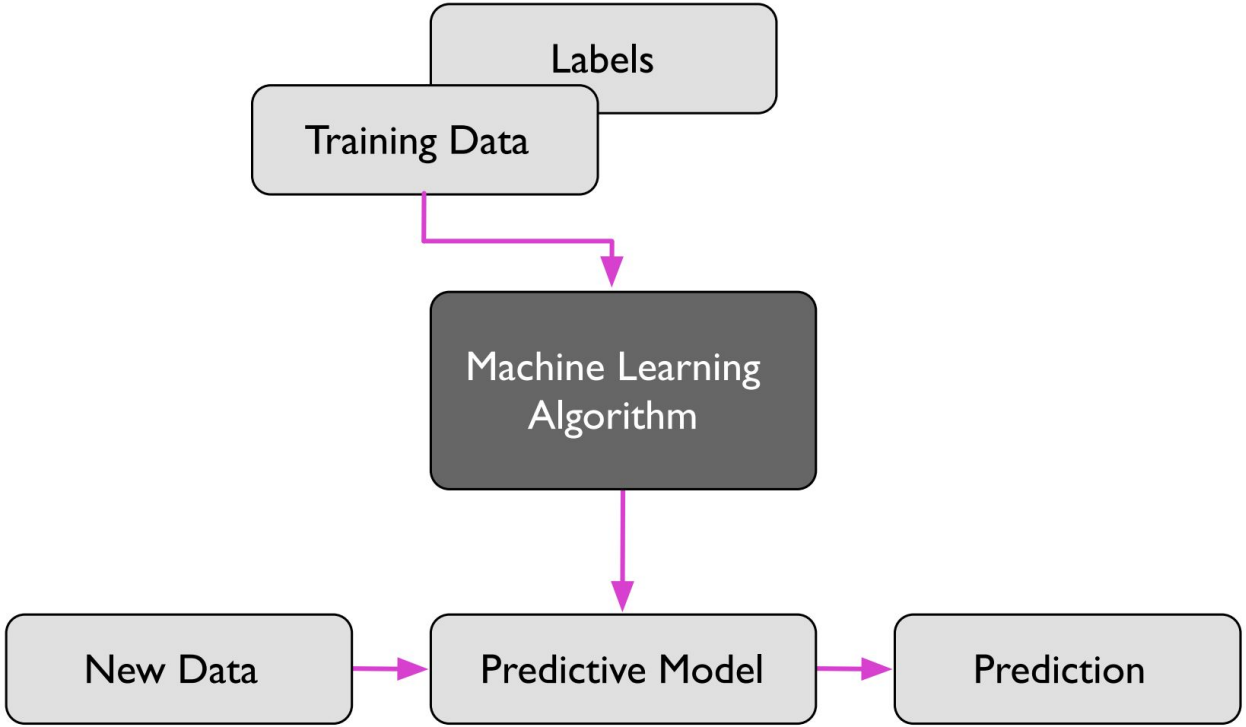
Raschka, 2021

Taxonomy of Machine Learning



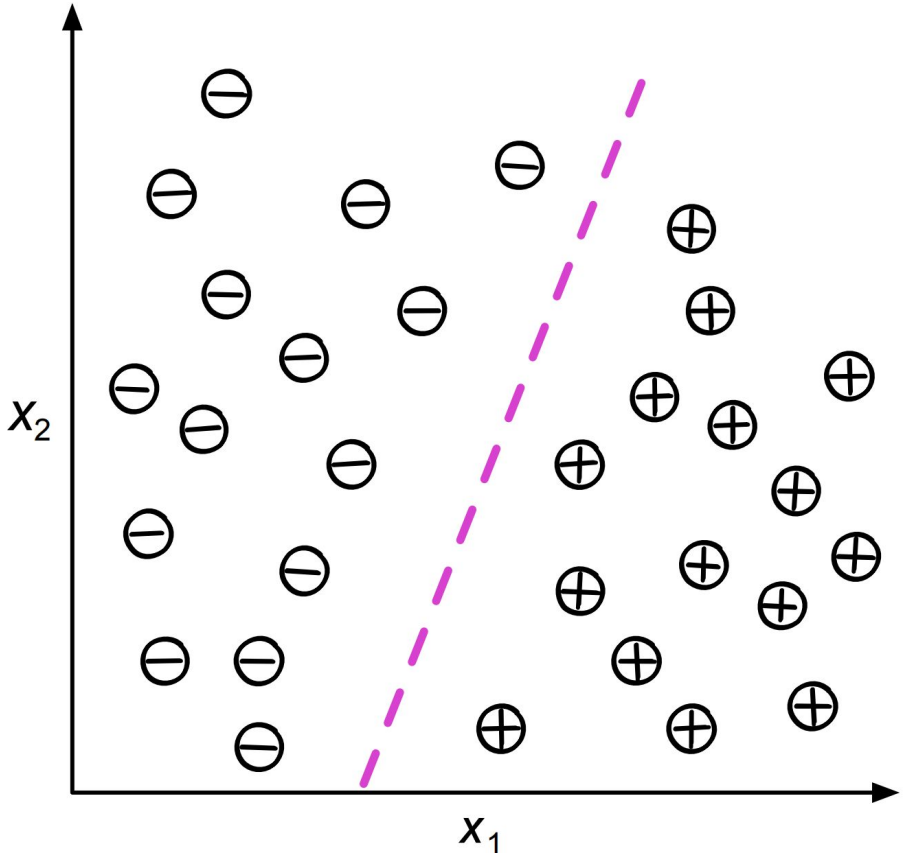
Raschka, 2021

Supervised Learning



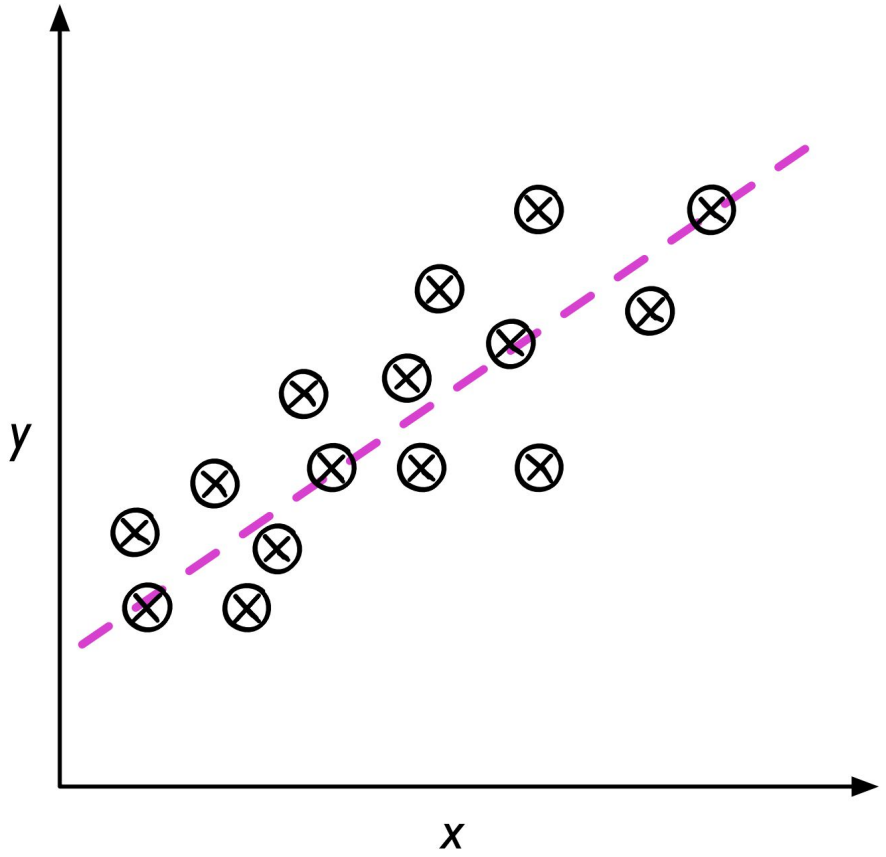
Raschka, 2021

Supervised Learning - Classification



Raschka, 2021

Supervised Learning - Regression

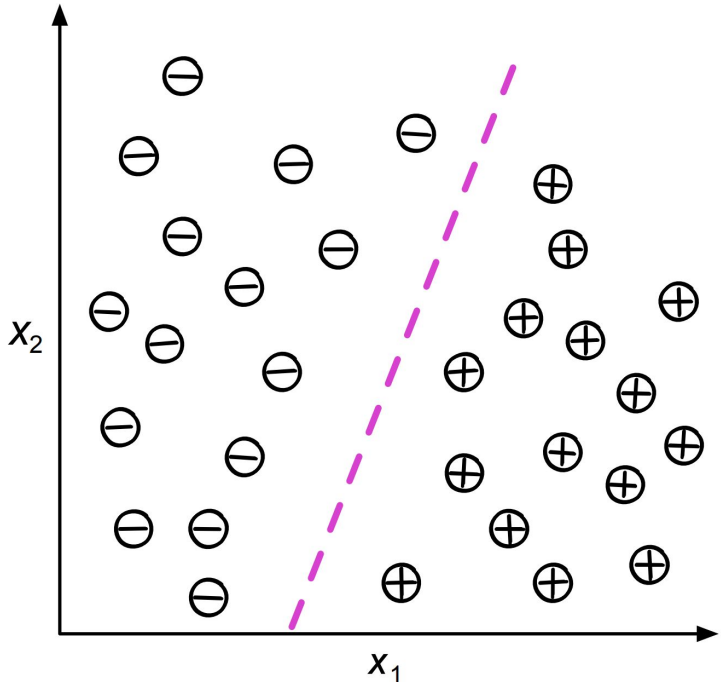


Raschka, 2021

Focusing on Classification

Decision Boundary

Definition: A decision boundary, is a surface that separates data points belonging to different class labels. (Sahu, 2021)

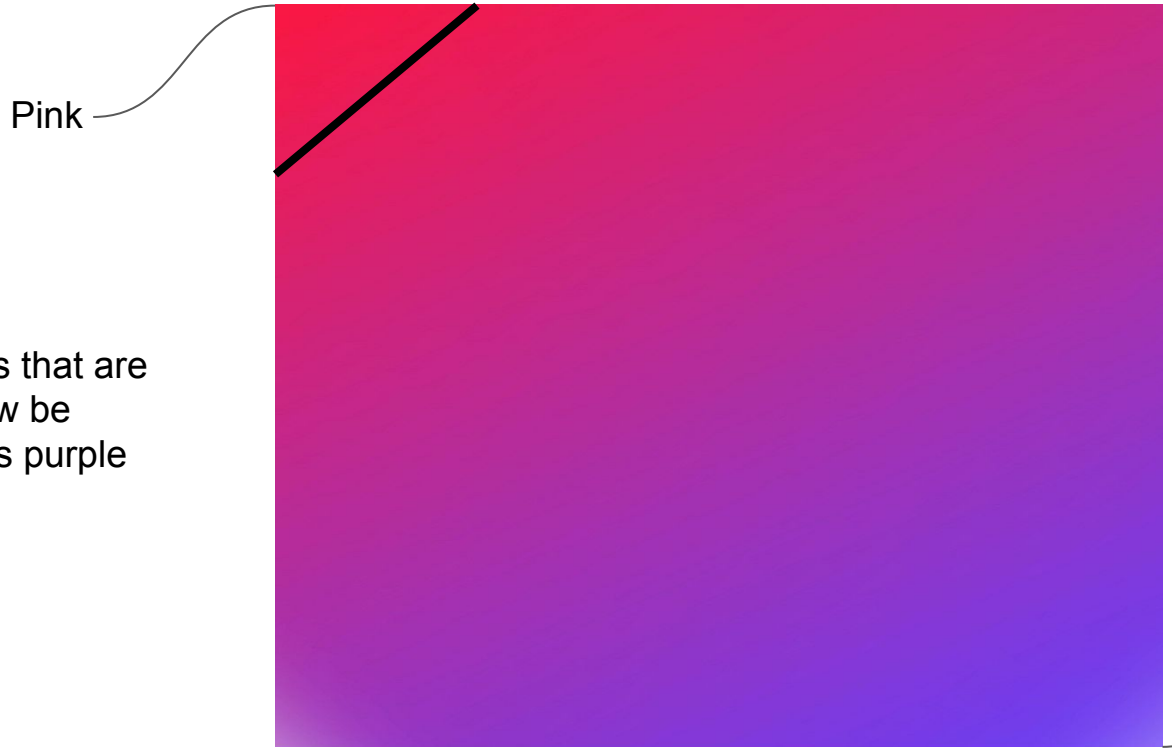


Decision Boundary

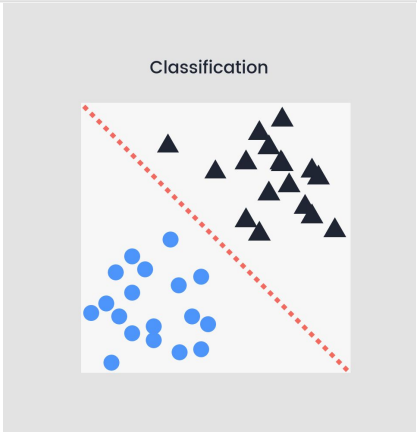
Binary
Classification

https://www.vectorstock.com/royalty-free-vector/smooth-transition-from-pink-to-purple-abstract-vector-34503450

Decision Boundary



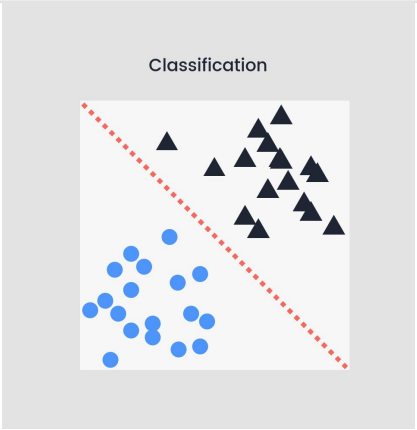
Many things that are pink will now be classified as purple



https://www.vectorstock.com/royalty-free-vector/smooth-transition-from-pink-to-purple-abstract-vector-34503450

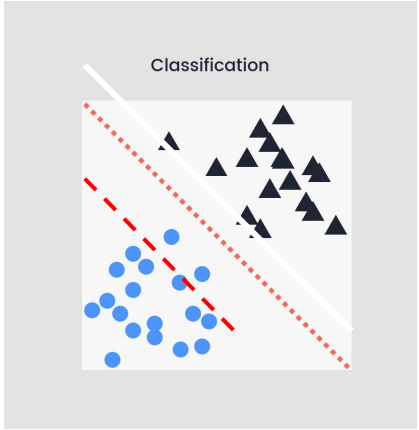
Decision Boundary

Many things that are pink will now be classified as purple



https://www.vectorstock.com/royalty-free-vector/smooth-transition-from-pink-to-purple-abstract-vector-34503450

Decision Boundary



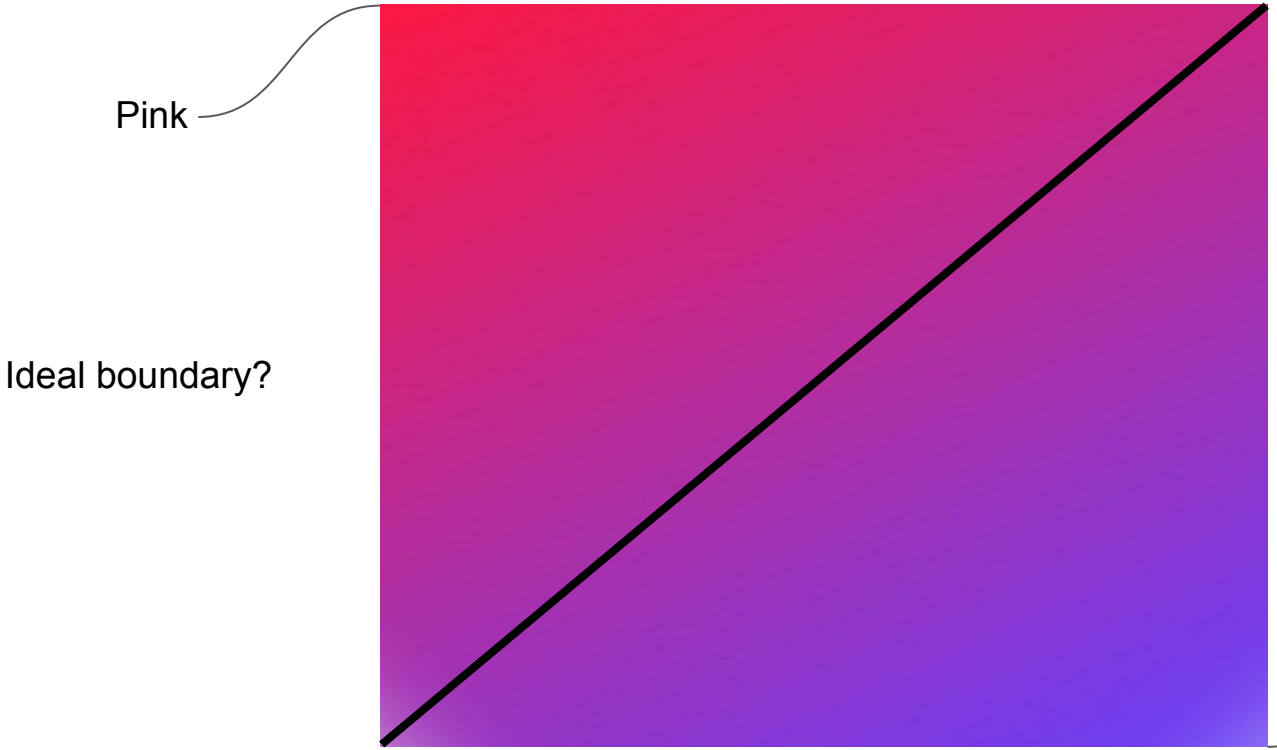
Pink

Many things that are purple will now be classified as pink

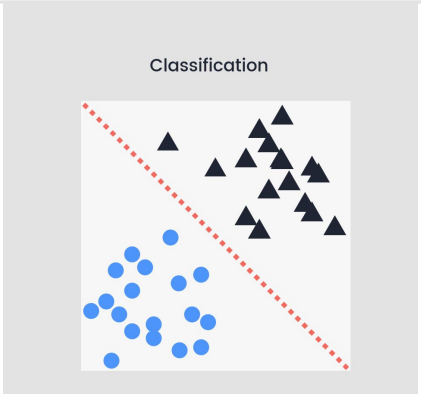
Purple

https://www.vectorstock.com/royalty-free-vector/smooth-transition-from-pink-to-purple-abstract-vector-34503450

Decision Boundary



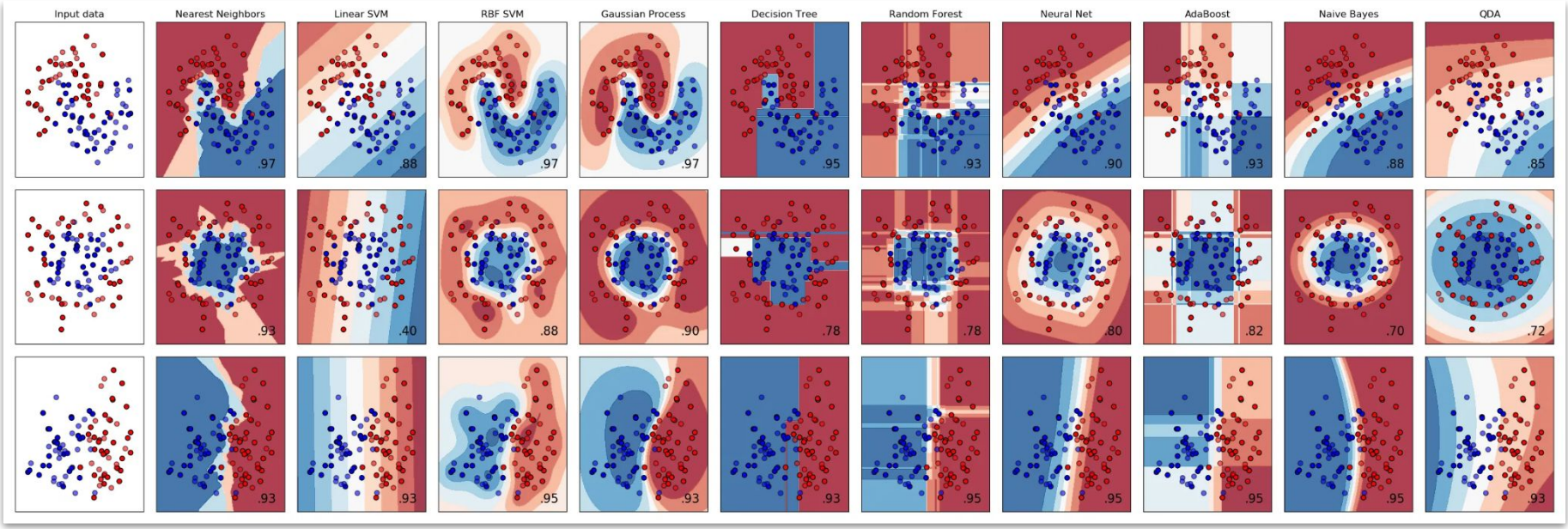
Ideal boundary?



https://www.vectorstock.com/royalty-free-vector/smooth-transition-from-pink-to-purple-abstract-vector-34503450

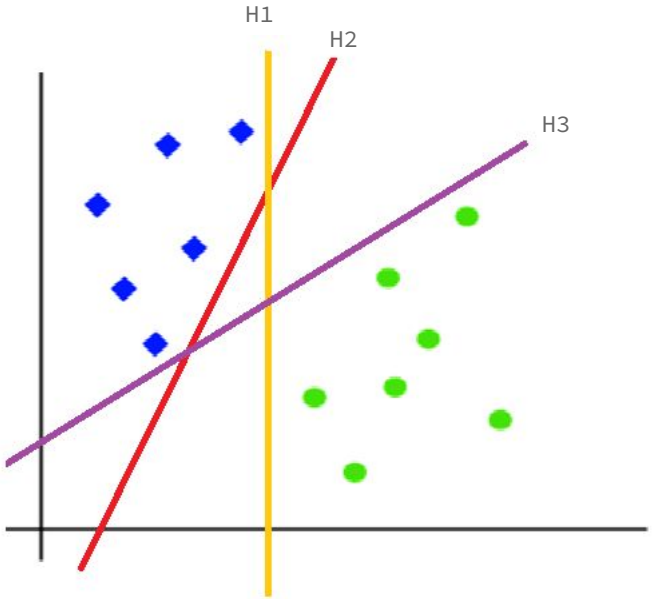
Decision Boundary

Comparison of the decision boundaries of 10 machine learning models:



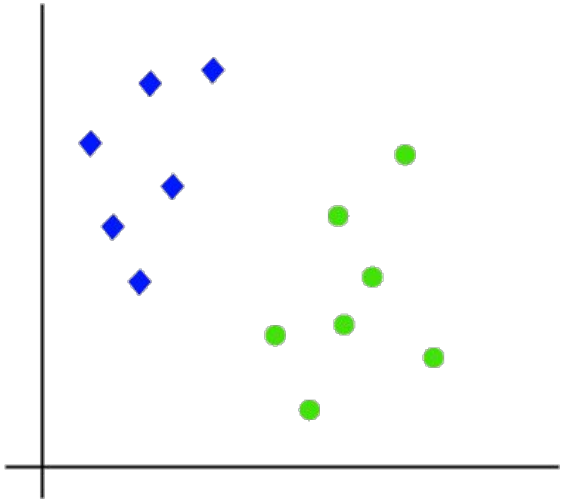
Varoquaux and Müller

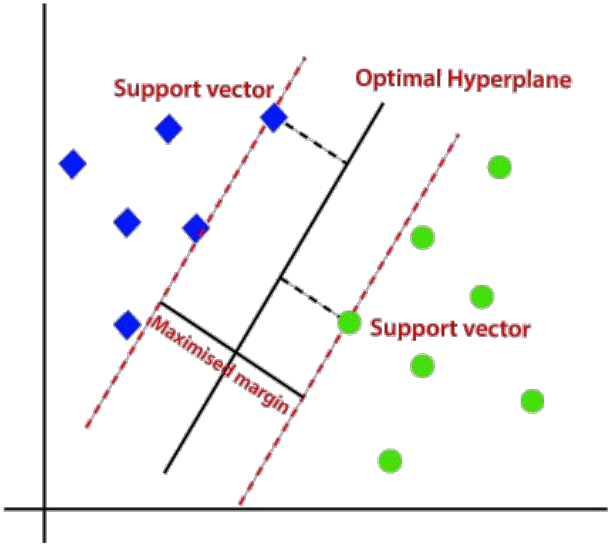
Classical Support Vector Classifier (SVC)



Saini,2023

Classical Support Vector Classifier (SVC)

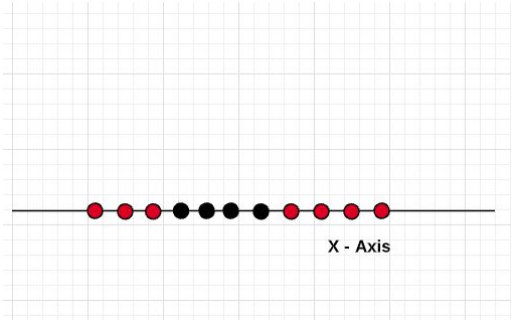




Saini,2023

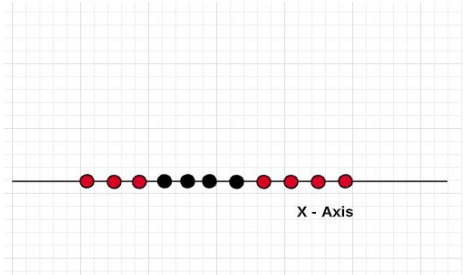
Classical Support Vector Classifier (SVC)

Support Vector Machines were developed to deal with linear data.
What happens when we take data like:



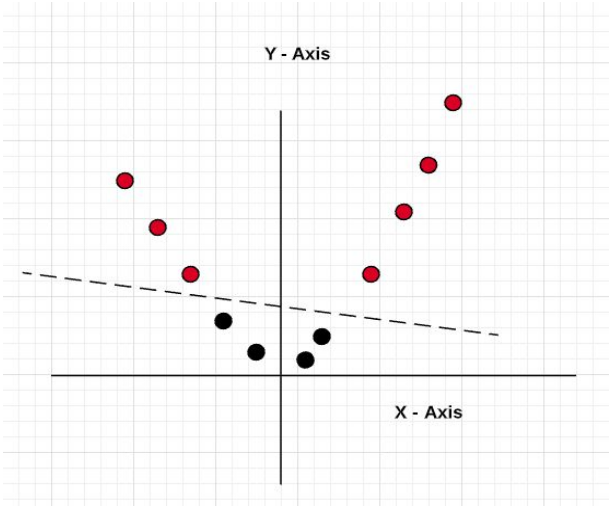
Non-linearly separable data

Classical Support Vector Classifier (SVC)



ϕ

$y = x^2$

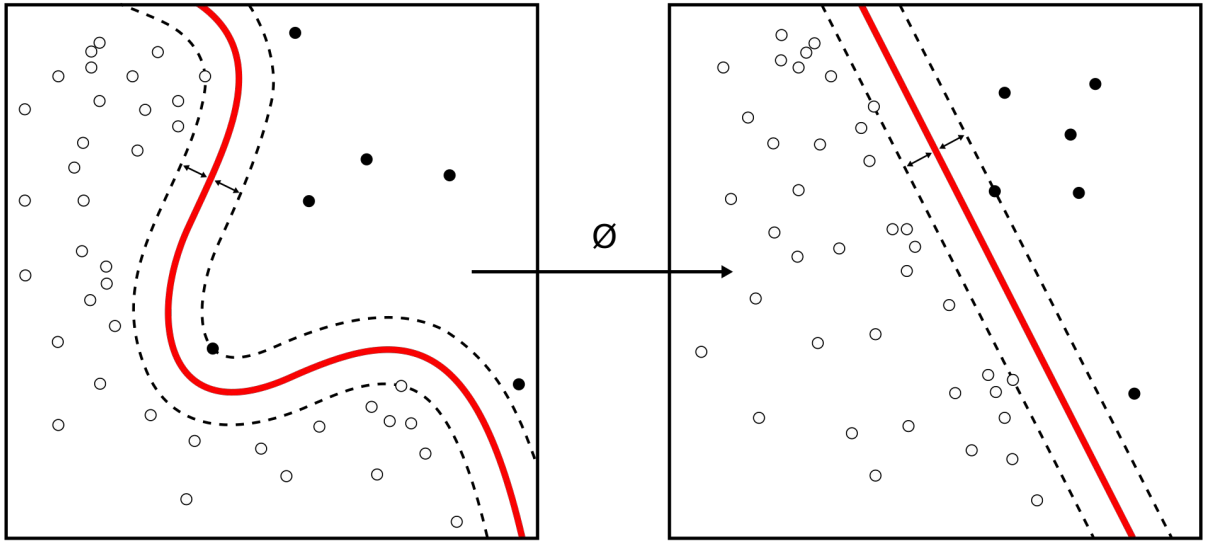


Non-linearly separable data

Support Vector Machines have a key component called **kernel machine.**

Classical Support Vector Classifier (SVC)

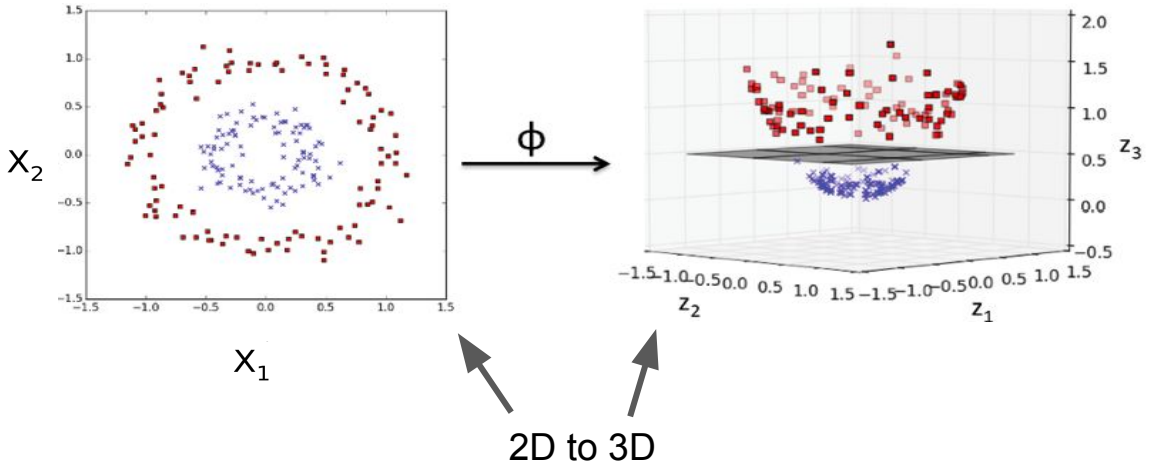
A **Kernel Function** manipulates the training data to transform a non-linear lower dimension space into a higher dimension space, which we can get a linear decision boundary



SVM - Wikipedia

Classical Support Vector Classifier (SVC)

A **Kernel Function** manipulates the training data to transform a non-linear lower dimension space into a higher dimension space, which we can get a linear decision boundary



SVM - Wikipedia

Github Repository

https://github.com/alexgcsa/resbaz2023

ML Resources

- Tom Mitchell's Book and Youtube Course:
  - https://www.cs.cmu.edu/~tom/mlbook.html
  - https://www.youtube.com/watch?v=m4NlfvrRCdg&list=PLl-BBnDxtUt1hLXmIwu27P22bTi6VwMkN
- Sebastian Raschka's Course:
  - https://sebastianraschka.com/blog/2021/ml-course.html
- Andrew Ng's Course:
  - https://www.coursera.org/specializations/machine-learning-introduction

THE UNIVERSITY OF QUEENSLAND
AUSTRALIA

Baker
HEART & DIABETES INSTITUTE

~~Quantum~~ Machine Learning

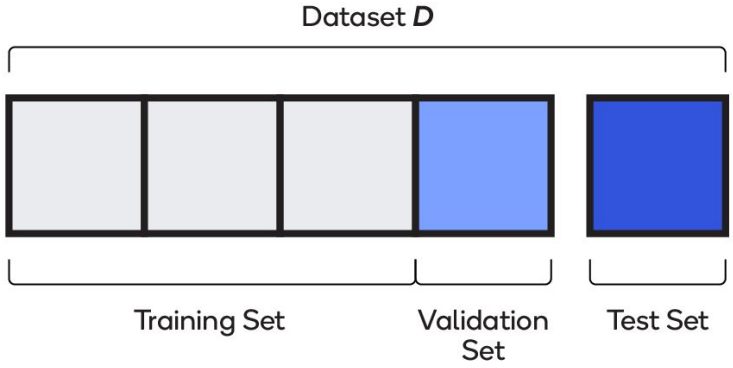
Alex de Sá — Alex.deSa@baker.edu.au
Ashar Malik — Ashar.Malik@baker.edu.au

https://github.com/alexgcsa/resbaz2023

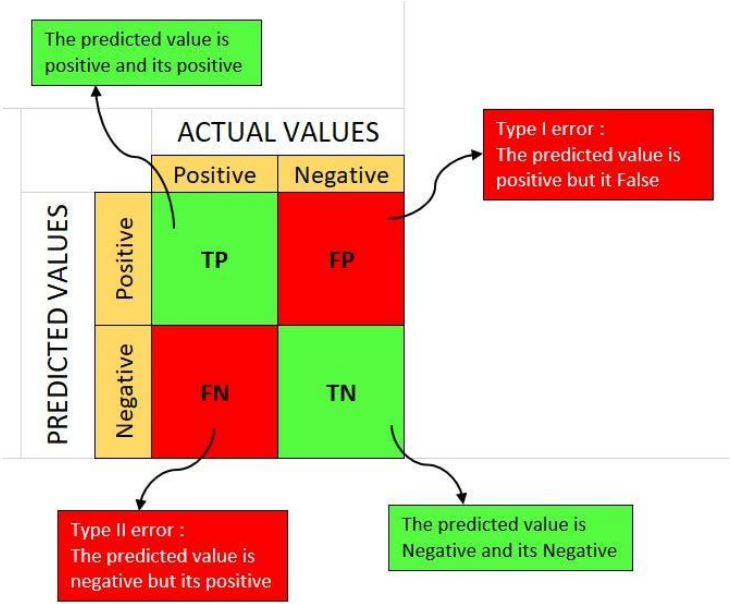
K-Fold Cross-Validation

Train/Test

Test the model on new data, assessing its generalisation



Classification Metrics

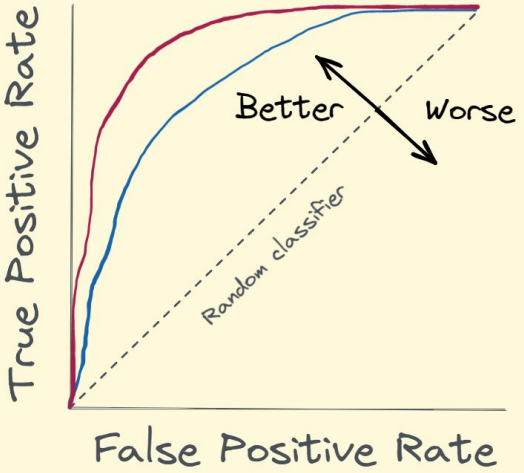


$$\text{Accuracy} = \frac{TP + TN}{\text{Total Samples}}$$

$$\text{Precision} = \frac{TP}{TP + FP}$$

$$\text{Recall} = \frac{TP}{TP + FN}$$

$$\text{F1 Score} = \frac{2 \times \text{Precision} \times \text{Recall}}{\text{Precision} + \text{Recall}}$$



[Towards Data Science, 2023]

[Medium, 2020]