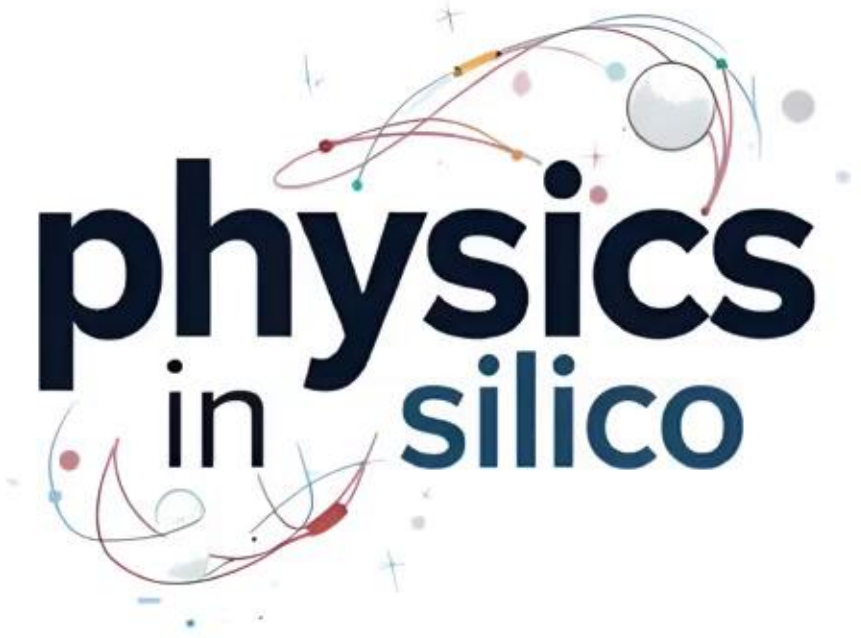


Introduction to Machine Learning

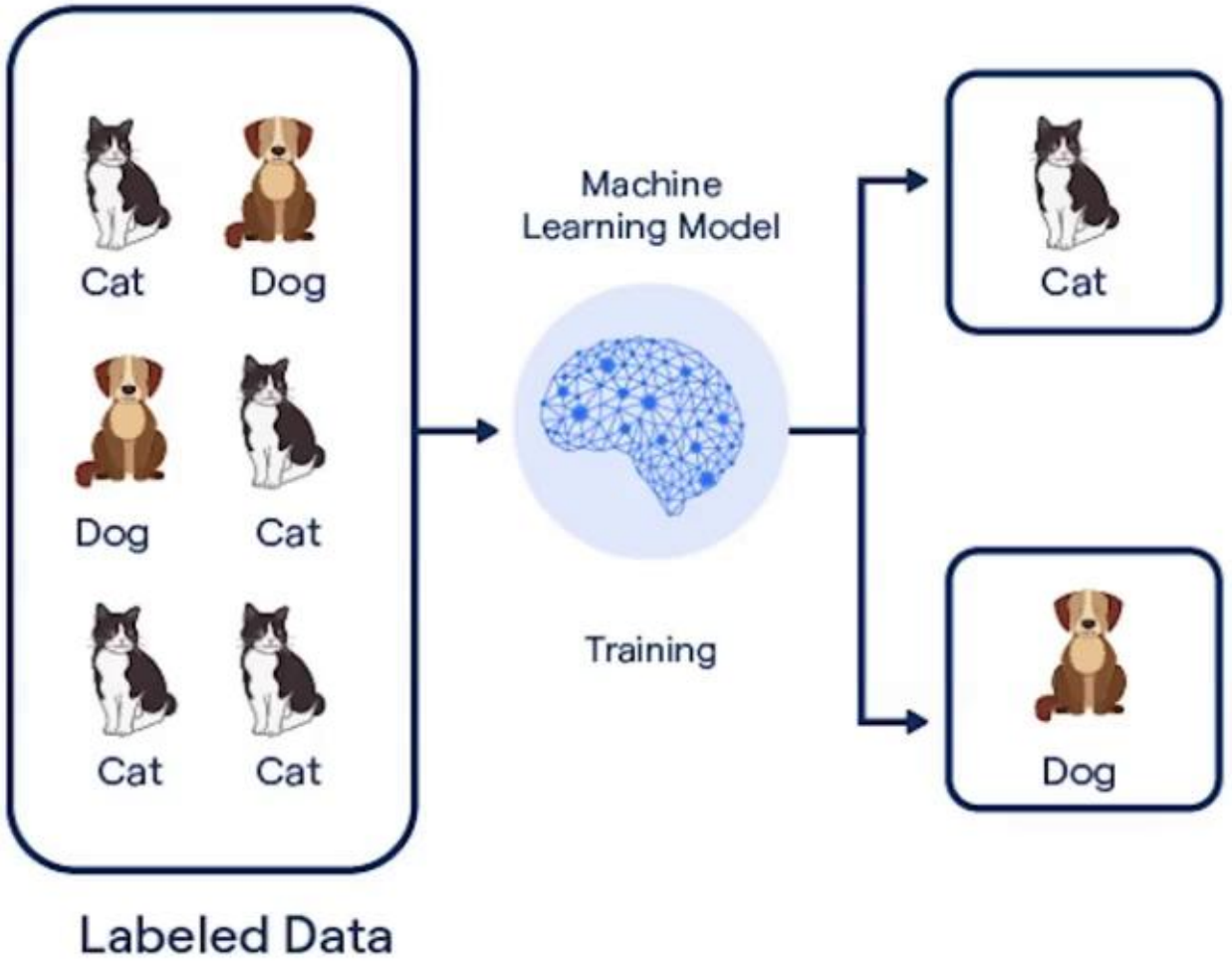
Angel Mendieta

angel.mendieta@ucr.ac.cr

What is Machine Learning?

- Learns patterns from data
- Makes predictions
- Improves with experience

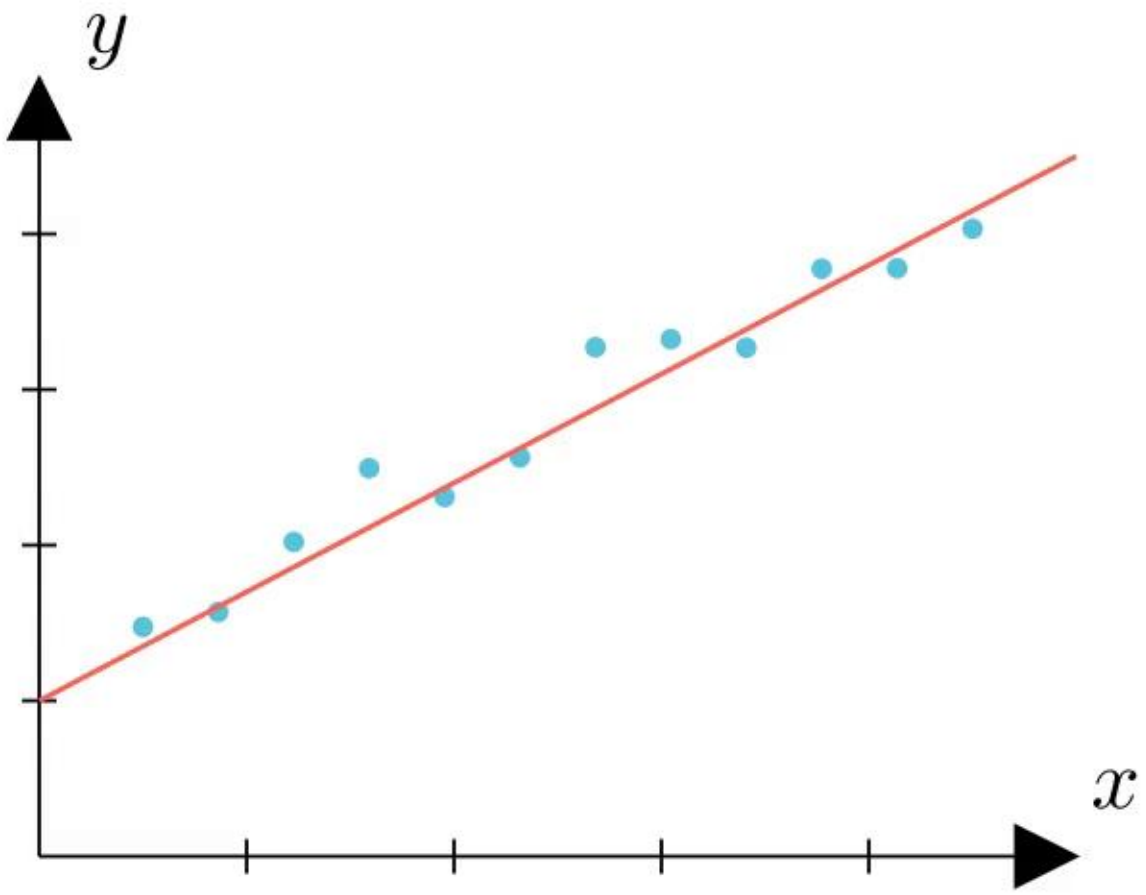
Supervised Learning



Applications:

- Email spam detection
- Image classification
- Medical diagnosis
- Speech recognition

Linear Regression



$$\text{MSE} = \frac{1}{n}\sum_{i=1}^{n}(y_i - \hat{y}_i)^2$$

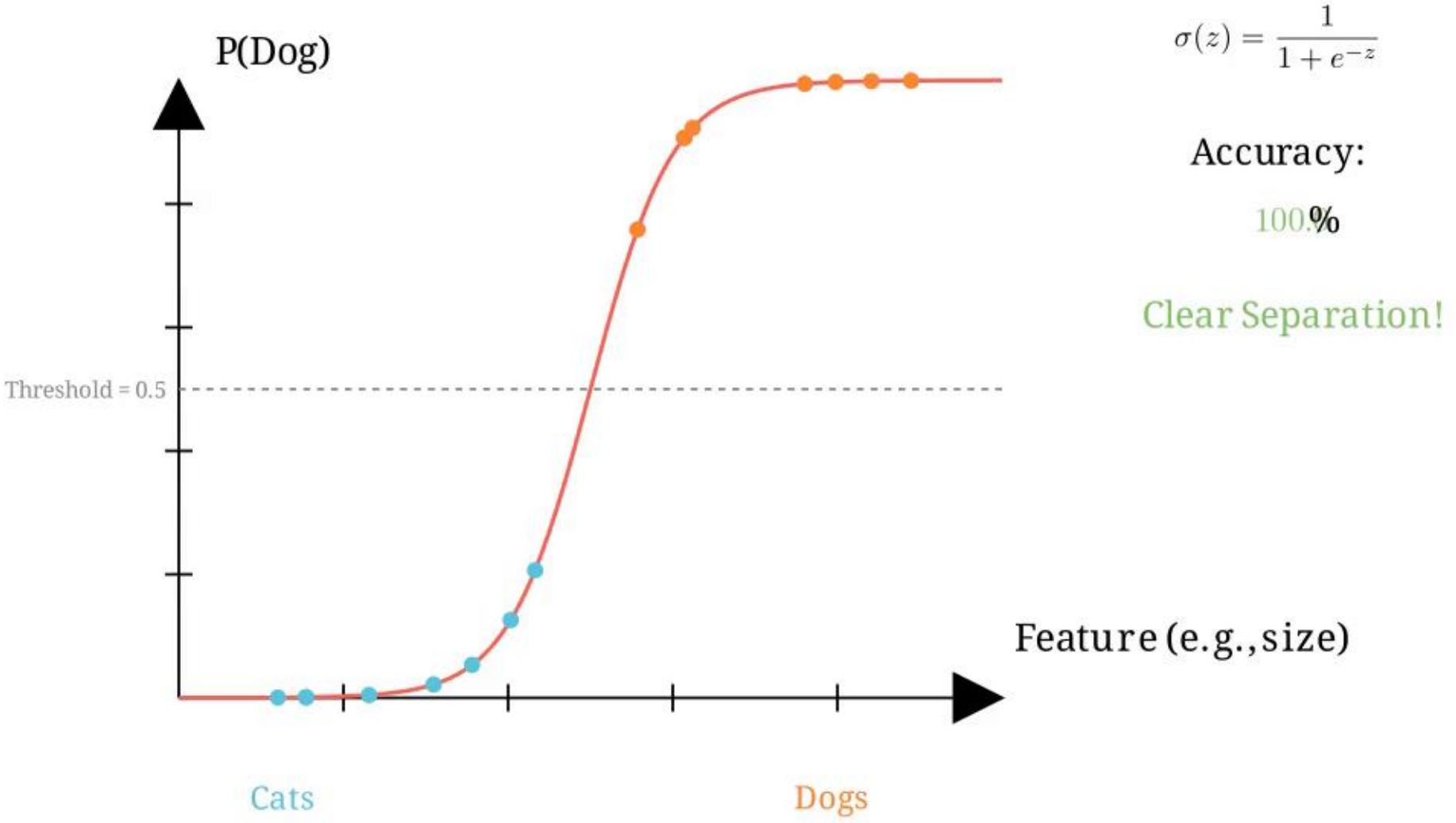
Loss (MSE):

0.15

Converged!

$$y = mx + b$$

Logistic Regression (Binary Classification)



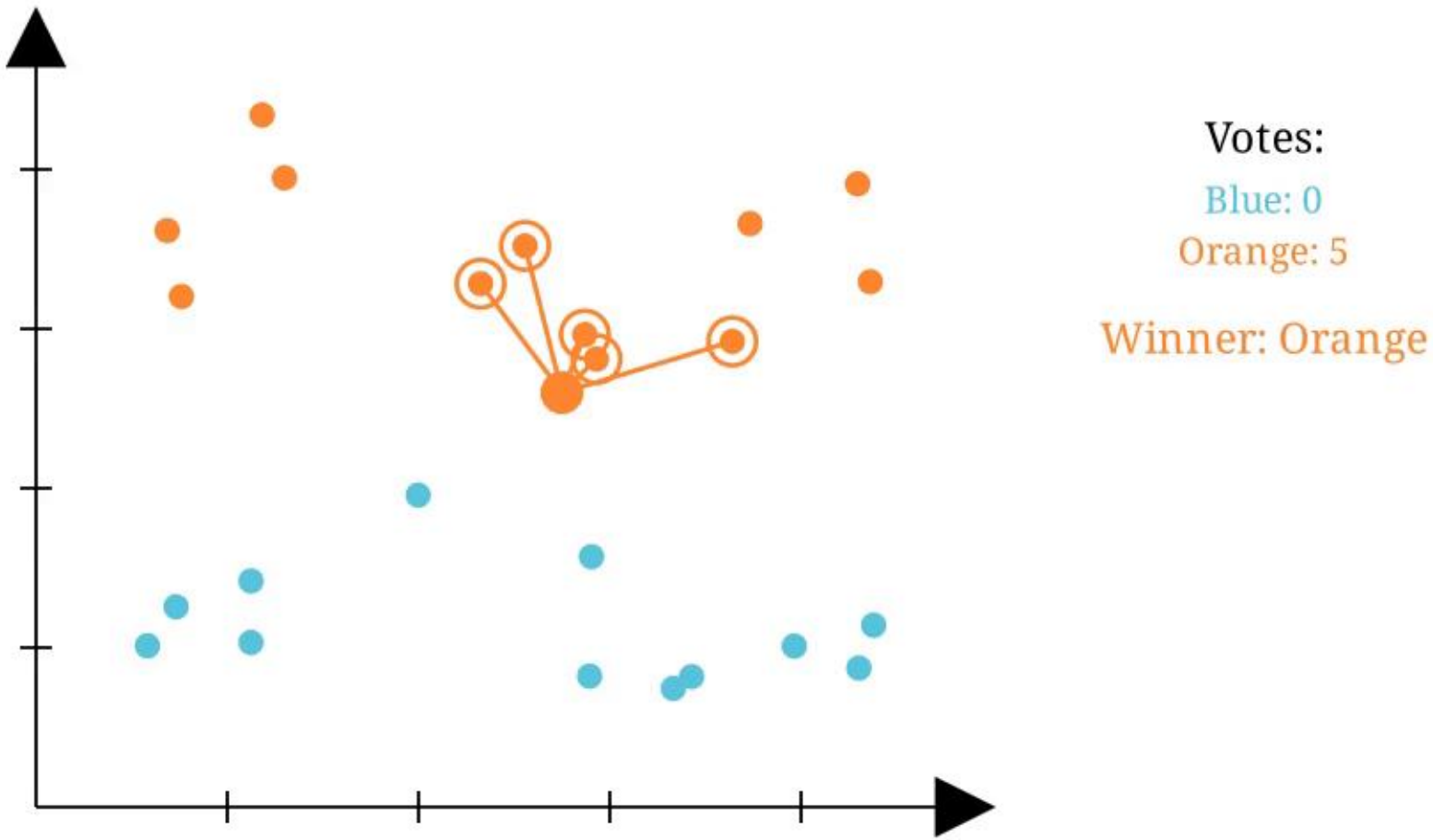
$$\sigma(z) = \frac{1}{1 + e^{-z}}$$

Accuracy:

100%

Clear Separation!

K-Nearest Neighbors (k=5)



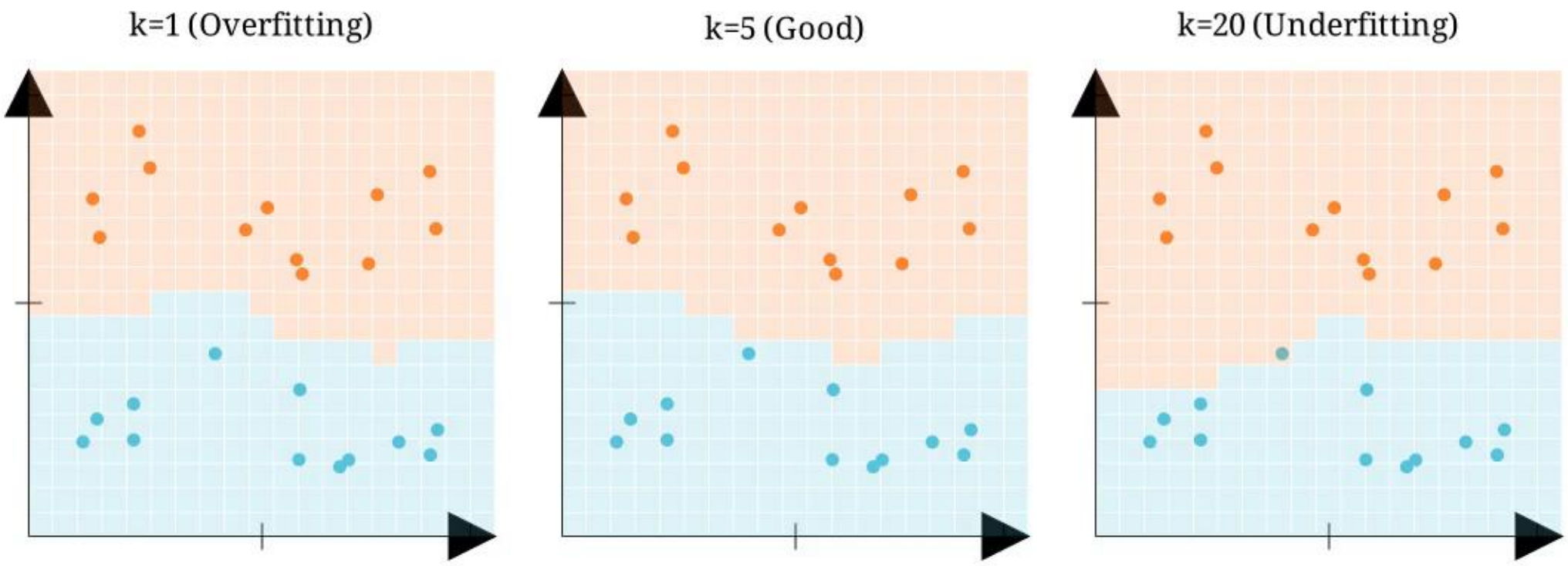
Votes:

Blue: 0

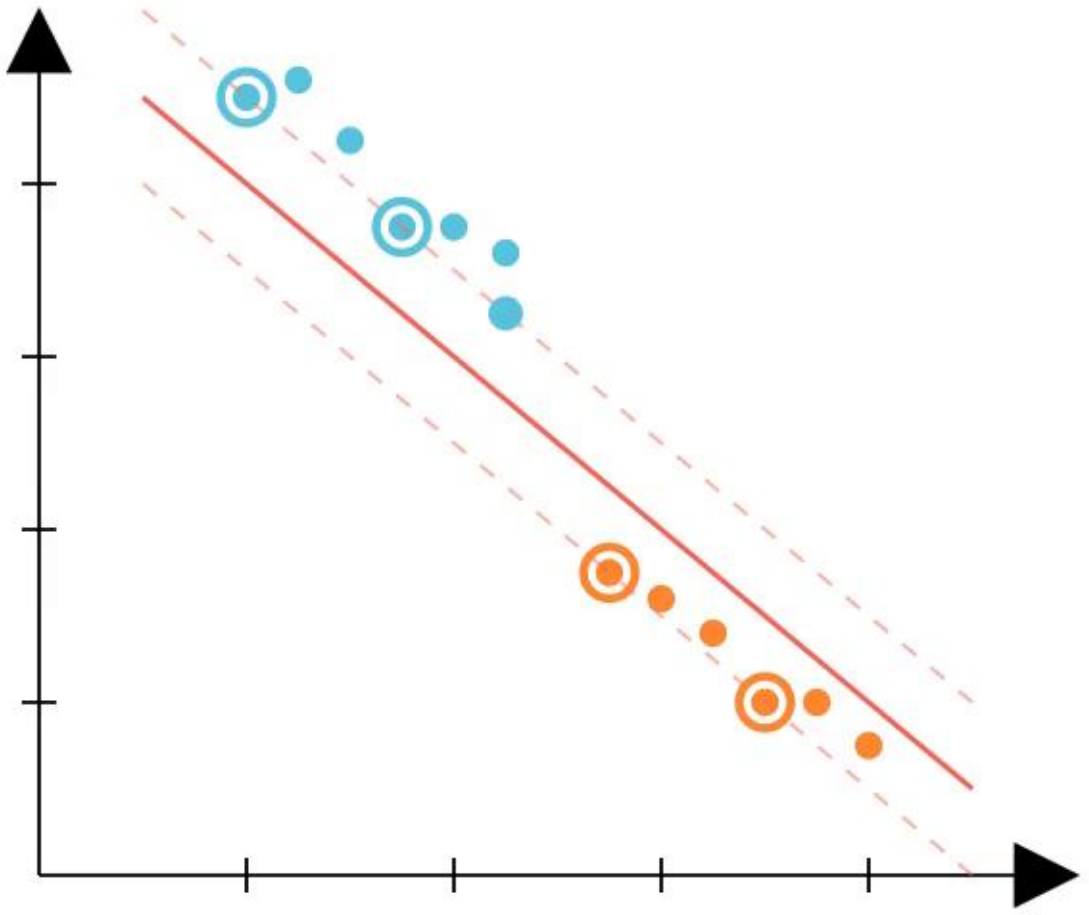
Orange: 5

Winner: Orange

KNN: Effect of k on Decision Boundary



Support Vector Machine (SVM)



Support Vectors

Lie exactly on the margin

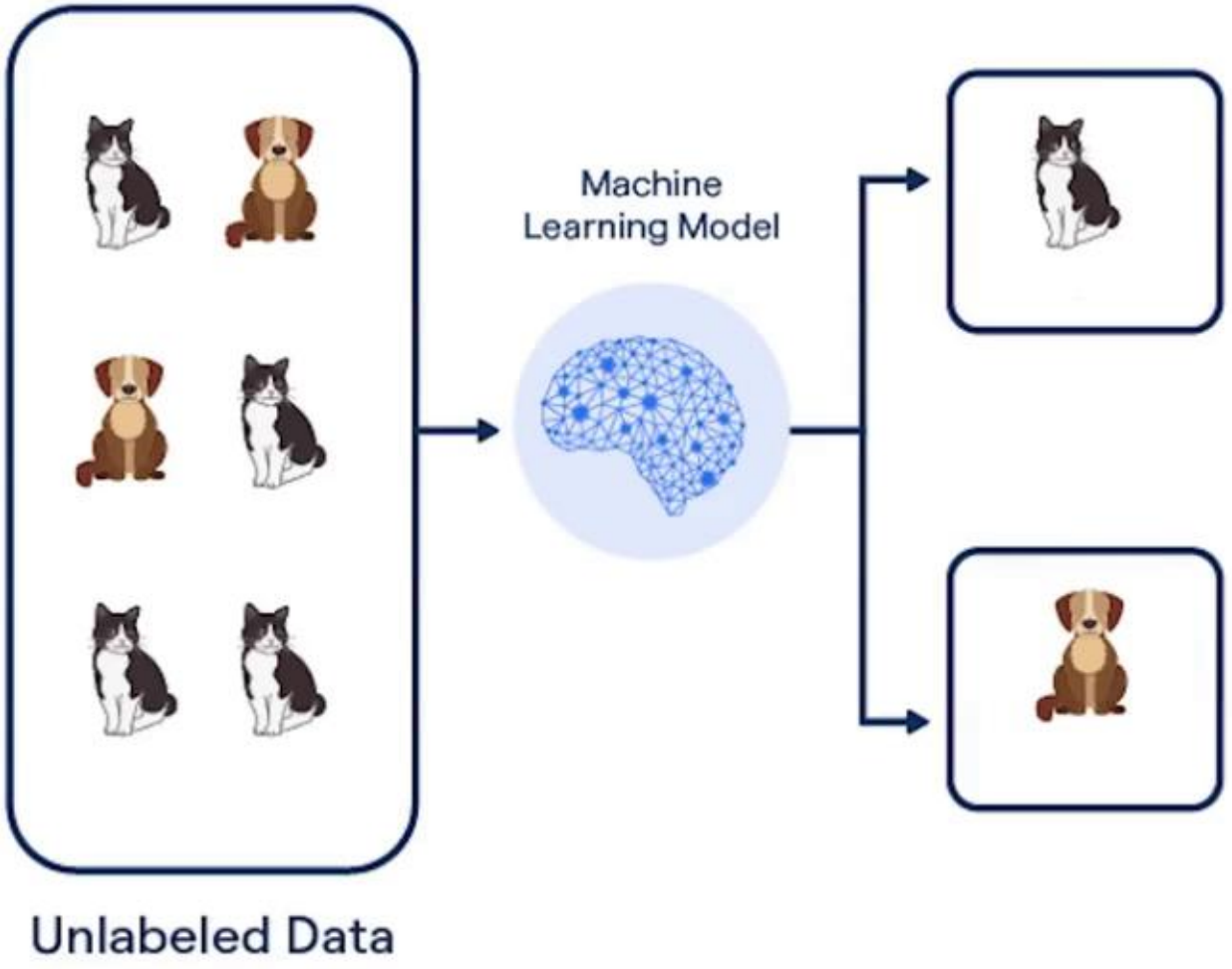
Key Property:

Only these points are needed to define the boundary

Maximum Margin

Best generalization to new data

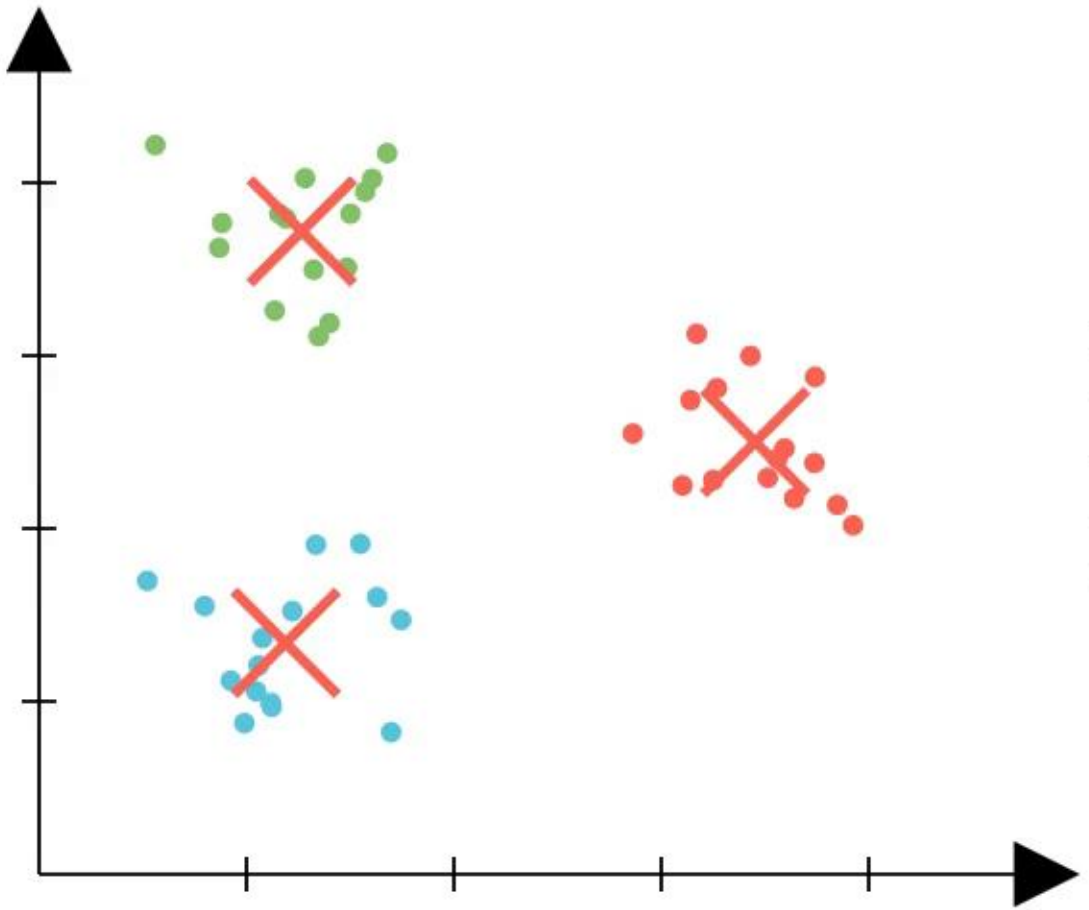
Unsupervised Learning



Applications:

- Customer segmentation
- Anomaly detection
- Data compression
- Recommendation systems

K-Means Clustering

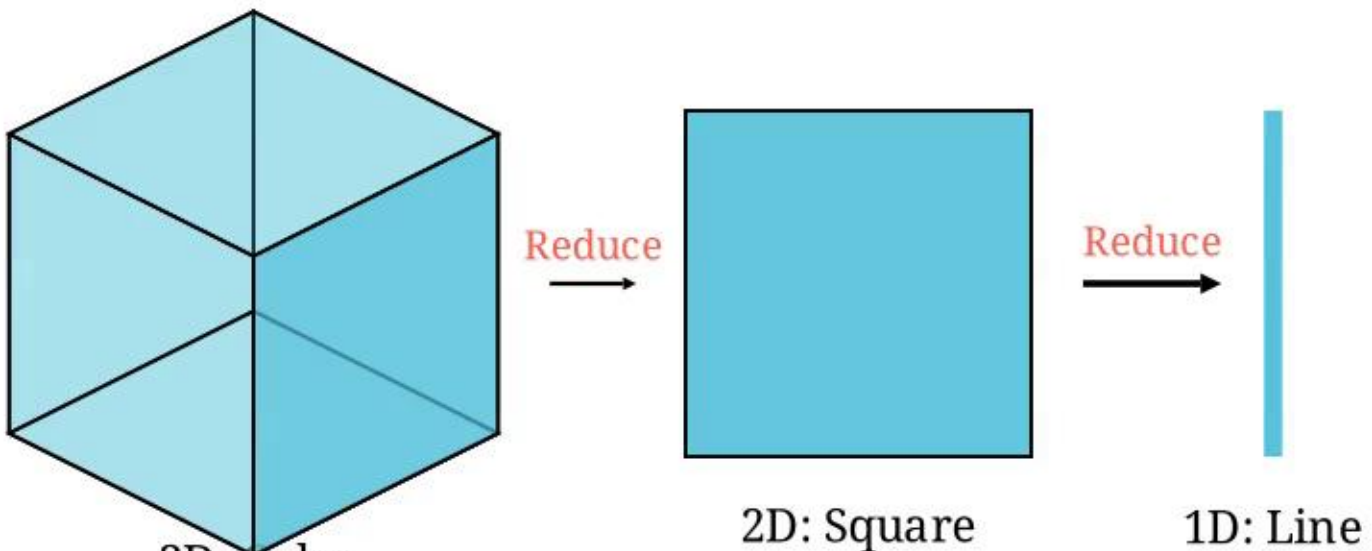


Converged!

K-Means Properties:

- Fast and simple
- Finds spherical clusters
- Requires choosing K
- May converge to local optimum

Dimensionality Reduction



Key Benefits:

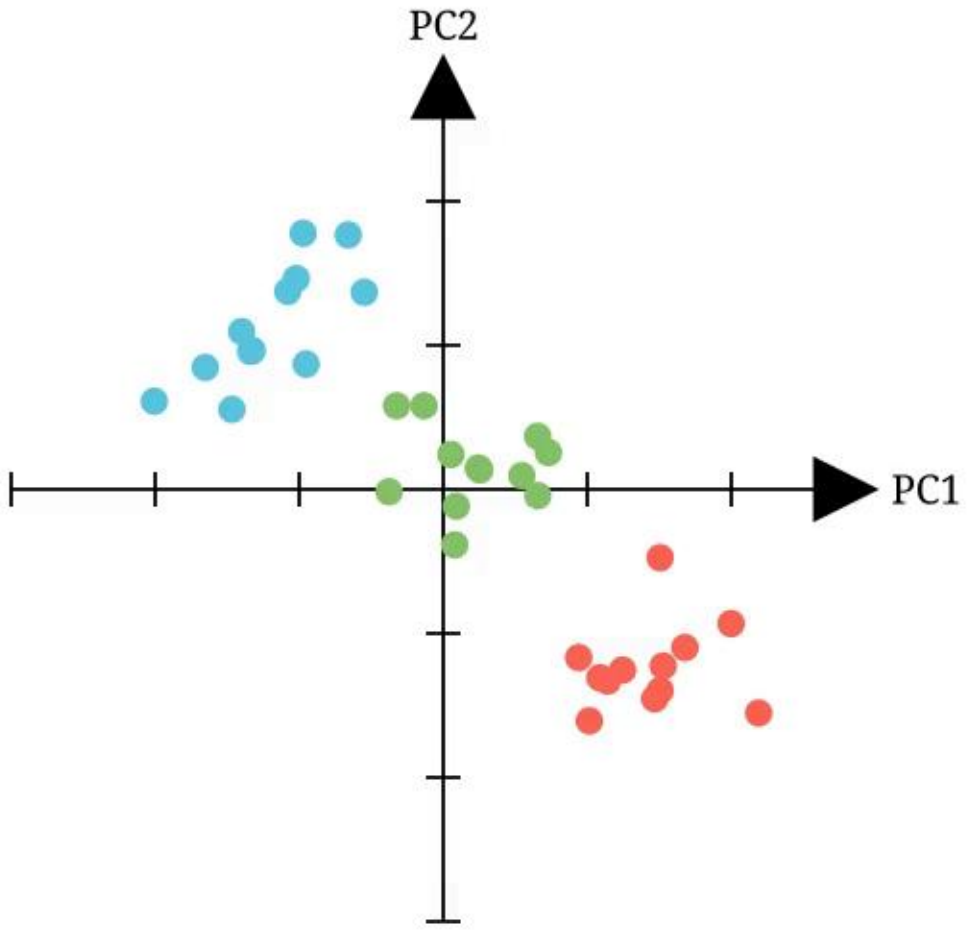
- Easier visualization
- Faster computation
- Remove noise & redundancy
- Preserve essential structure

Do we really need the HD picture to know what it is?

PCA: Principal Component Analysis

Original Features (5D):

- Length
- Height
- Weight
- Engine Size
- Fuel Efficiency (MPG)



PC1: Size & Power
(Length + Weight + Engine)

PC2: Efficiency
(Higher MPG)

Explained Variance by Component