Discriminant Function and Supervised Learning

Group-3

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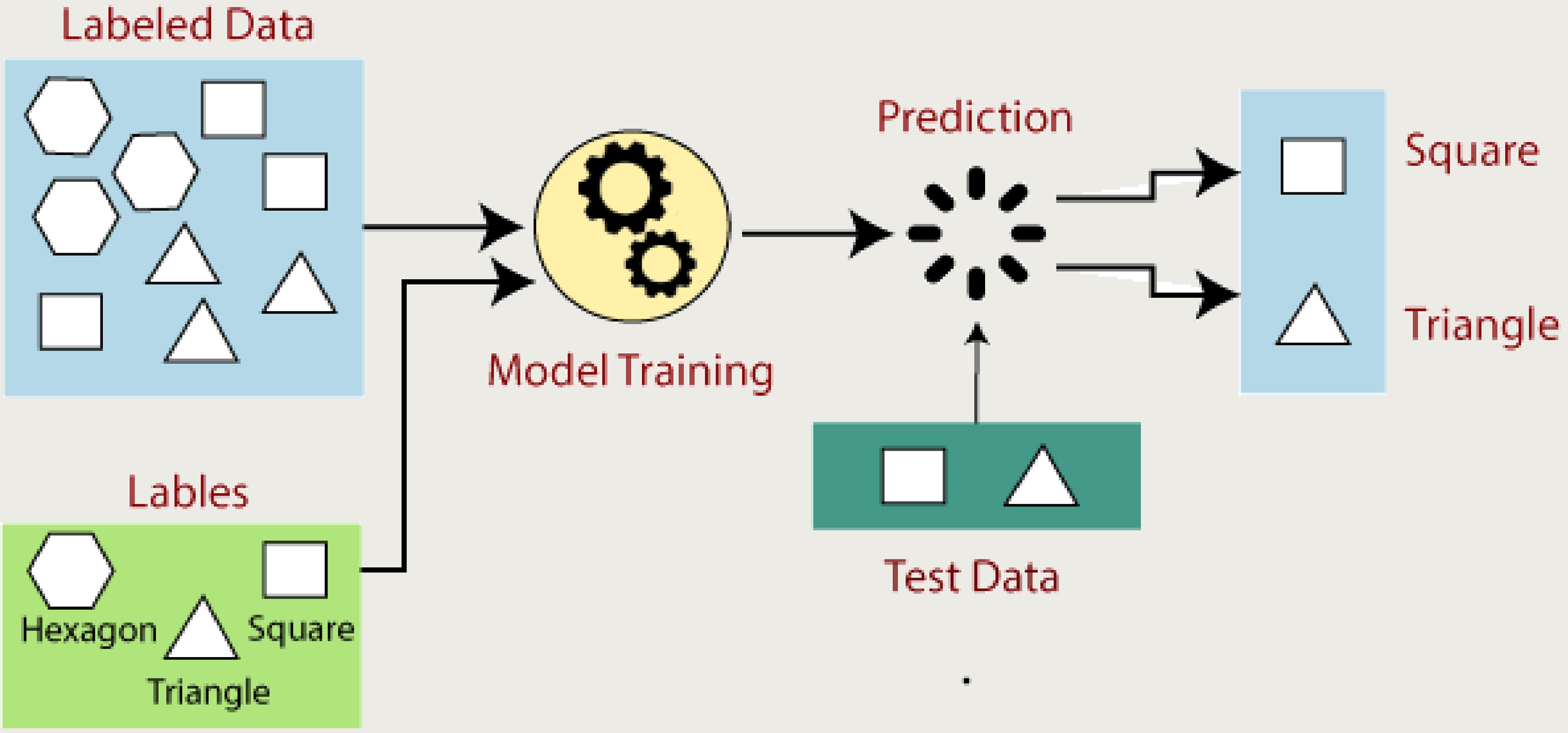
In today's data-driven world, understanding the concept of discriminant function and supervised learning is more important than ever before. Discriminant functions are mathematical models that help us classify objects or events into different categories based on their characteristics. Supervised learning, on the other hand, is a type of machine learning where the algorithm learns from labeled data to make predictions or decisions about new, unlabeled data.

Supervised Learning

Supervised learning is a type of machine learning where the algorithm is trained on labeled data. In other words, the algorithm is given input/output pairs and learns to map inputs to outputs based on the training data.

Supervised learning is a process of providing input data as well as correct output data to the machine learning model. The aim of a supervised learning algorithm is to find a mapping function to map the input variable(x) with the output variable(y).

In the real-world, supervised learning can be used for Risk Assessment, Image classification, Fraud Detection, spam filtering, etc.


Labeled Data
Lables
Hexagon
Square
Triangle
Model Training
Prediction
Test Data
Square
Triangle

Applications of Supervised Learning

- **Natural Language Processing (NLP):** Supervised learning is widely used in NLP tasks, such as sentiment analysis, machine translation, and named entity recognition.

- **Regression Analysis**: In regression problems, supervised learning is used to predict continuous numerical values. For example, it can be used for predicting housing prices based on features like location, size, and amenities.

- **Recommended Systems:** Supervised learning can be used to build recommendation engines that suggest products, movies, or content to users based on their past preferences and behaviors.

- **Financial Forecasting:** Supervised learning models can be employed to predict stock prices, market trends, or other financial indicators based on historical data.

- **Autonomous Vehicles:** In the context of self-driving cars, supervised learning is used to train models that can recognize and respond to various objects, such as pedestrians, vehicles, and traffic signs.

Discriminant function

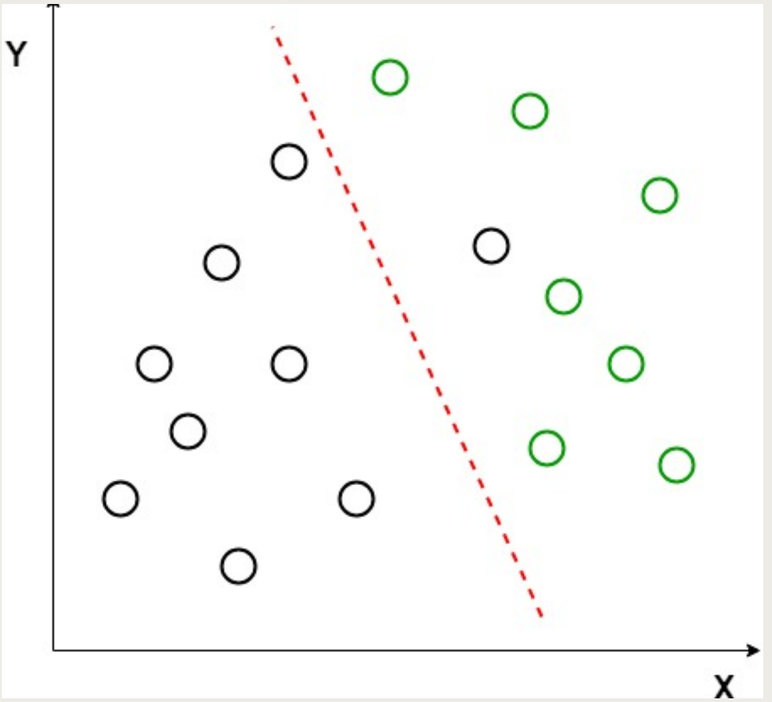
A discriminant function is a mathematical function used in supervised learning to classify data into categories based on specific features. It is trained on labeled data to predict new unlabeled data points, aiming to find the decision boundary that separates different classes in the feature space.

Types of Discriminant Function

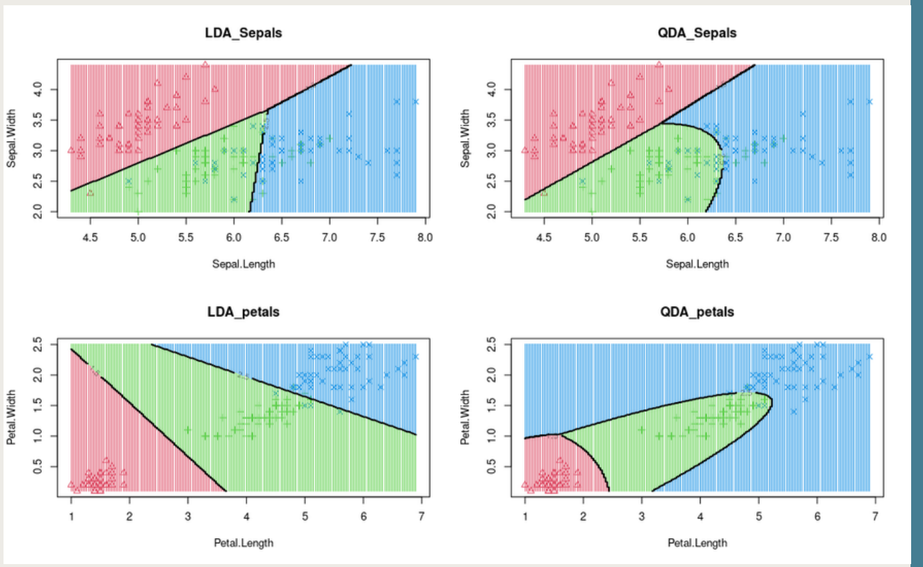
Discriminant functions are used in supervised learning to classify input data into one of two or more categories.

There are several types of discriminant functions, including linear and quadratic discriminant functions.

- **Linear discriminant functions** are often used when there are only two categories and the input data is relatively simple.



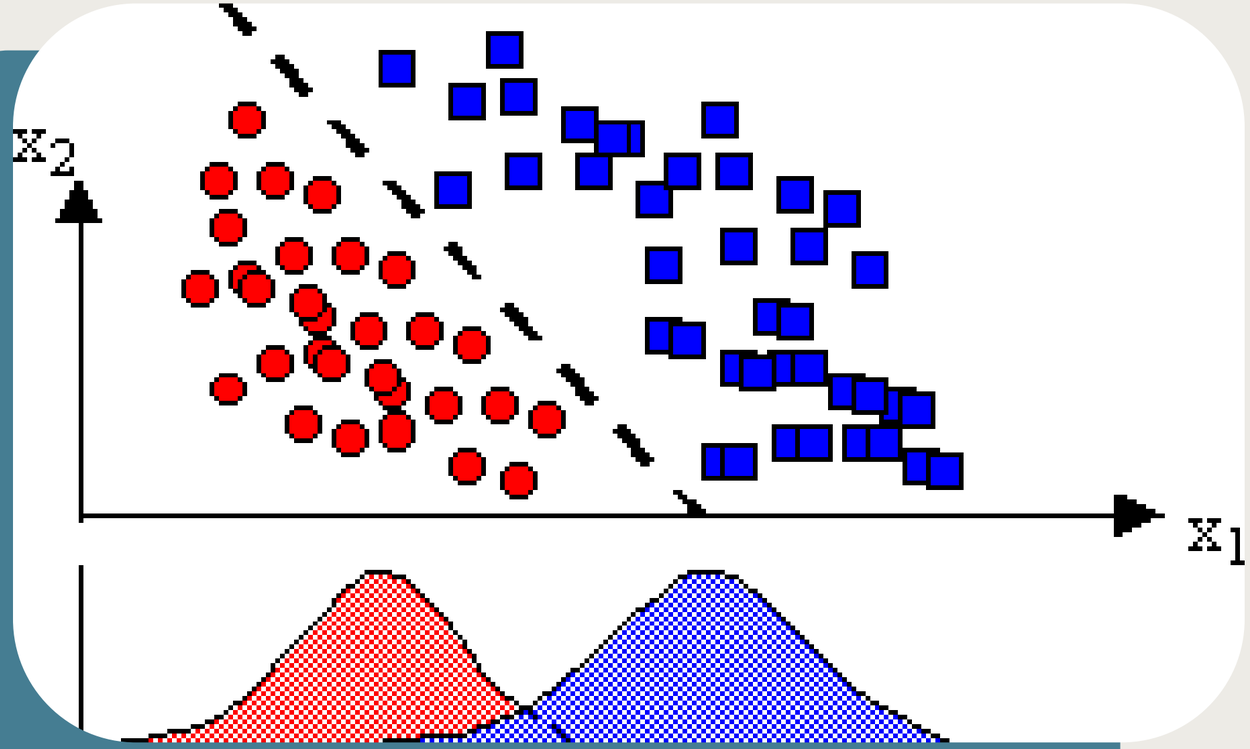
- **Quadratic discriminant functions**, on the other hand, are better suited for more complex data sets with multiple categories.



Mathematical Formulation

Assumptions:

- C = {C1, C2, ..., Ck} - A Set of Classes
- x = (x1, x2, ..., xn) - Feature Vector representing the Input Data



The discriminant function, denoted as $g_i(x)$, is associated with class C_i and is defined as follows:

$$g_i(x) = f_i(x) - \ln(P(C_i)),$$

where:

- $f_i(x)$ is the discriminant score function for class C_i, which is a function of the feature vector x. The specific form of $f_i(x)$ depends on the chosen classification algorithm, such as linear discriminant analysis, support vector machines, or neural networks.
- $P(C_i)$ is the prior probability of class C_i, which represents the probability that an arbitrary input belongs to class C_i before observing any feature information. The prior probabilities can be estimated from the training dataset or set manually if prior knowledge is available.

Once the discriminant scores $g_i(x)$ are computed for each class, the input x is assigned to the class with the highest discriminant score, i.e.,

$$\text{predicted\_class} = \text{argmax}_i(g_i(x))$$

Applications of Discriminant Functions

- **Image and Object Recognition:** In computer vision, discriminant functions are used for tasks like object recognition, face recognition, and image classification.
- **Classification:** Discriminant functions are widely used for classification tasks where the goal is to assign an input data point to one of several predefined classes.
- **Fraud Detection:** In finance and security applications, discriminant functions can be employed to detect fraudulent activities by analyzing patterns in transaction data.

- **Speech Recognition:** In speech processing, discriminant functions can be applied to identify spoken words or phrases

- **Medical Diagnosis:** Discriminant functions are used in medical applications for diagnosing diseases based on patient data, such as symptoms, lab results, or medical images.

- **Fraud Detection:** In finance and security applications, discriminant functions can be employed to detect fraudulent activities by analyzing patterns in transaction data.

Challenges in using Discriminant Functions in Computer Vision

Representative Data:

Ensuring training data is representative of real-world scenarios is crucial for accurate classification.

Non-Linearity:

Some real-world problems require non-linear classifiers to handle complex patterns.

Overfitting:

Preventing overfitting is essential to ensure the model generalizes well to new, unseen data.

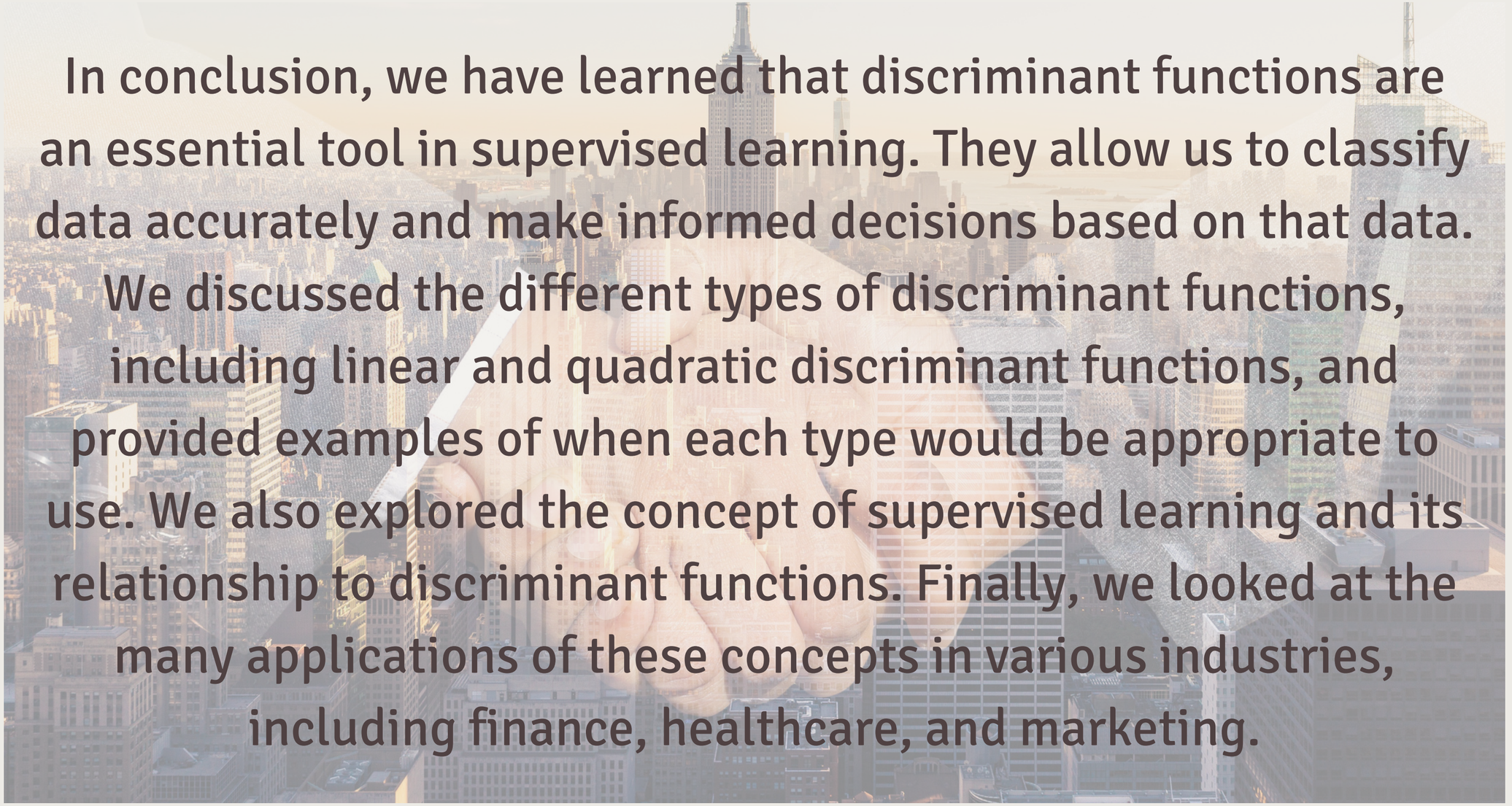
Imbalanced Data:

Dealing with imbalanced class distributions is necessary to avoid biased predictions.

Feature Selection:

Choosing relevant and informative features significantly impacts the discriminant function's performance

Conclusion



In conclusion, we have learned that discriminant functions are an essential tool in supervised learning. They allow us to classify data accurately and make informed decisions based on that data. We discussed the different types of discriminant functions, including linear and quadratic discriminant functions, and provided examples of when each type would be appropriate to use. We also explored the concept of supervised learning and its relationship to discriminant functions. Finally, we looked at the many applications of these concepts in various industries, including finance, healthcare, and marketing.


Thank you :)