ISTANBUL DATA SCIENCE BOOTCAMP

Discriminative and Generative Model Comparison

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Discriminative and Generative Model

What are Discriminative Models?

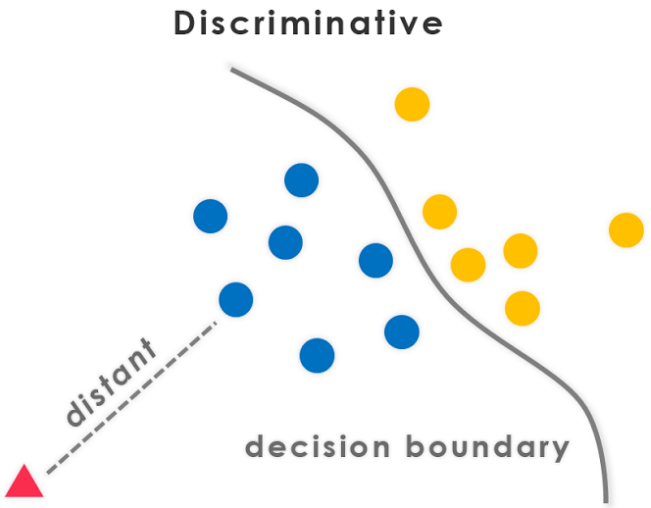
The discriminative model refers to a class of models used in Statistical Classification, mainly used for supervised machine learning. These types of models are also known as conditional models since they learn the boundaries between classes or labels in a dataset.

Discriminative models (just as in the literal meaning) separate classes instead of modeling the conditional probability and don't make any assumptions about the data points. But these models are not capable of generating new data points. Therefore, the ultimate objective of discriminative models is to separate one class from another.

If we have some outliers present in the dataset, then discriminative models work better compared to generative models i.e, discriminative models are more robust to outliers. However, there is one major drawback of these models is the misclassification problem, i.e., wrongly classifying a data point.

Some Examples of Discriminative Models

- Logistic regression
- Scalar Vector Machine (SVMs)
- Traditional neural networks
- Nearest neighbor
- Conditional Random Fields (CRFs)
- Decision Trees and Random Forest



What are Generative Models?

Generative models are considered as a class of statistical models that can generate new data instances. These models are used in unsupervised machine learning as a means to perform tasks such as

- Probability and Likelihood estimation,
- Modeling data points,
- To describe the phenomenon in data,
- To distinguish between classes based on these probabilities.

Since these types of models often rely on the Bayes theorem to find the joint probability, so generative models can tackle a more complex task than analogous discriminative models.

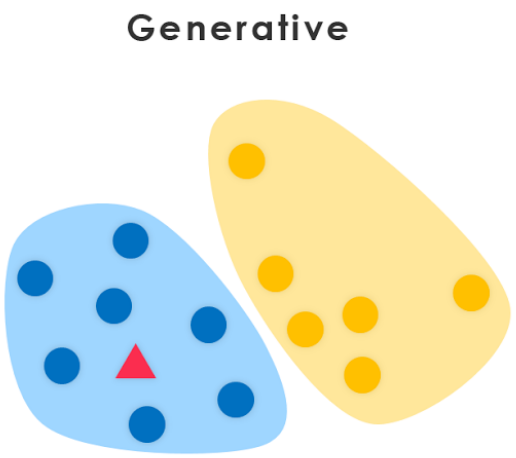
So, Generative models focus on the distribution of individual classes in a dataset and the learning algorithms tend to model the underlying patterns or distribution of the data points. These models use the concept of joint probability and create the instances where a given feature (x) or input and the desired output or label (y) exist at the same time.

These models use probability estimates and likelihood to model data points and differentiate between different class labels present in a dataset. Unlike discriminative models, these models are also capable of generating new data points.

However, they also have a major drawback – If there is a presence of outliers in the dataset, then it affects these types of models to a significant extent.

Some Examples of Generative Models

- Naïve Bayes
- Bayesian networks
- Markov random fields
- Hidden Markov Models (HMMs)
- Latent Dirichlet Allocation (LDA)
- Generative Adversarial Networks (GANs)
- Autoregressive Model



Difference between Discriminative and Generative Models

Core Idea

Discriminative models draw boundaries in the data space, while generative models try to model how data is placed throughout the space. A generative model focuses on explaining how the data was generated, while a discriminative model focuses on predicting the labels of the data.

Mathematical Intuition

In mathematical terms, a discriminative machine learning trains a model which is done by learning parameters that maximize the conditional probability P(Y|X), while on the other hand, a generative model learns parameters by maximizing the joint probability of P(X, Y).

Applications

Discriminative models recognize existing data i.e, discriminative modeling identifies tags and sorts data and can be used to classify data while Generative modeling produces something.

Since these models use different approaches to machine learning, so both are suited for specific tasks i.e, Generative models are useful for unsupervised learning tasks while discriminative models are useful for supervised learning tasks.

Outliers

Generative models have more impact on outliers than discriminative models.

Computational Cost

Discriminative models are computationally cheap as compared to generative models.

Comparison between Discriminative and Generative Models

Based on Performance

Generative models need fewer data to train compared with discriminative models since generative models are more biased as they make stronger assumptions i.e, assumption of conditional independence.

Based on Missing Data

In general, if we have missing data in our dataset, then Generative models can work with these missing data, while on the contrary discriminative models can't. This is because, in generative models, still we can estimate the posterior by marginalizing over the unseen variables. However, for discriminative models, we usually require all the features X to be observed.

Based on Accuracy Score

If the assumption of conditional independence violates, then at that time generative models are less accurate than discriminative models.

Based on Applications

Discriminative models are called “discriminative” since they are useful for discriminating Y’s label i.e, target outcome, so they can only solve classification problems while Generative models have more applications besides classification such as,

- Samplings,
- Bayes learning,
- MAP inference, etc.

References

1- CHIRAG GOYAL - analyticsvidhya