Discriminative vs Generative

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Models in Machine Learning can often be divided into two main categories, *Generative* and *Discriminative*. The fundamental difference between them is:

- Discriminative models learn the (hard or soft) boundary between classes
- Generative models model the distribution of individual classes

In mathematics, discriminative models directly estimate posterior probabilities $P(y \mid x)$, while generative models model class-conditional pdfs $p(x \mid y)$ and prior probabilities $P(y)$, therefore the joint probability distributions $p(x, y)$.

Generative models often make some assumption on the underlying probability distributions and model it. Thus it is can be used to generate new samples from the learned distribution.

A simple way to distinct the two models is by considered the examples used during training. Generative model only needs examples of a particular class which it modelling. However, Discriminative model needs examples of at least two classes to find the boundary.

1 Examples

Some models can be seen as generative-discriminative pairs, e.g.,

- Classifiers: Naive Bayes and Logistic Regression
- Sequential Data: HMM and CRF

Neutral networks are discriminative model because they compute $p(output \mid input)$.

2 Discriminative and Generative Training

Training approaches can also be classified as discriminative or generative. Even though with the same model, we can choose different training approaches.

For example, the HMM-GMM model used in speech recognition, when we do MLE training with Baum–Welch algorithm, we are using a generative training method. However when we do MPE training, we are using a discriminative training method.

Online version at http://wantee.github.io/2015/03/22/discriminative-vs-generative/