UNC CHARLOTTE

The WILLIAM STATES LEE COLLEGE *of* ENGINEERING

Introduction to ML
Lecture 9: Generative-vs-Discriminative

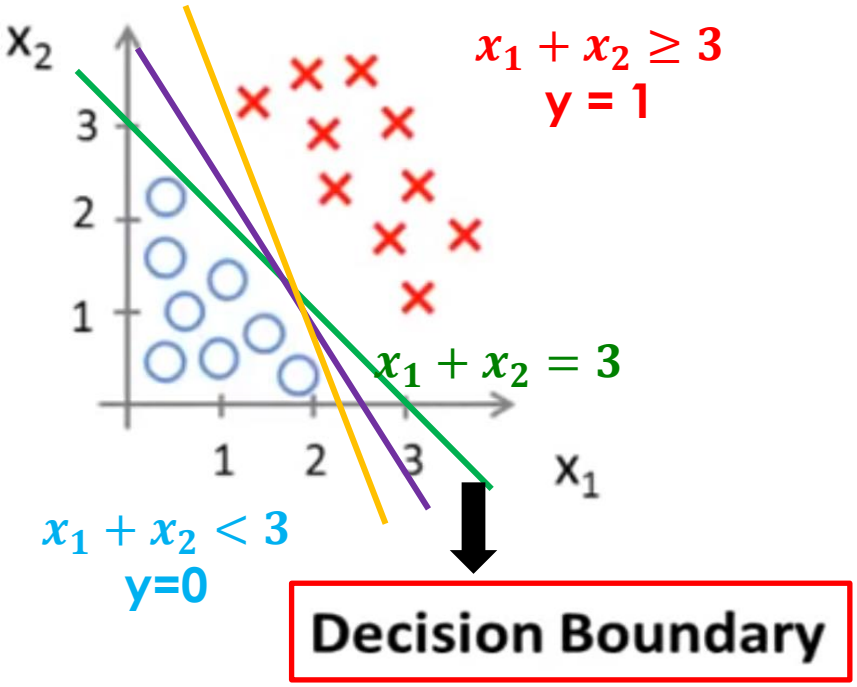
Hamed Tabkhi
Department of Electrical and Computer Engineering,
University of North Carolina Charlotte (UNCC)
htabkhiv@uncc.edu

Generative and discriminative models: An analogy

- The task is to determine the language that someone is speaking
- Generative approach:
  - is to learn each language and determine as to which language the speech belongs to
- Discriminative approach:
  - is determine the linguistic differences without learning any language– a much easier task!

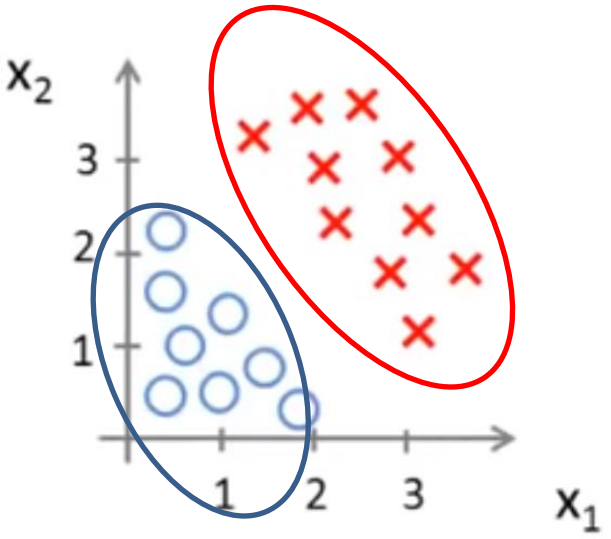
Generative and discriminative models

Discriminative model



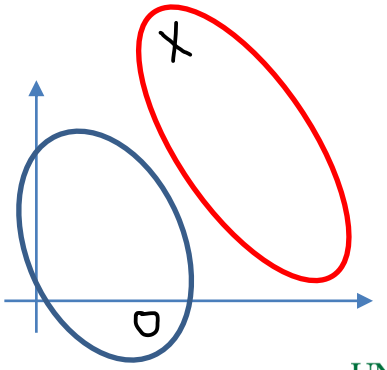
Logistic regression for classification

Generative model



Look at individual class, and build a model for that class

e.g. model distribution



UNC CHARLOTTE

Generative and discriminative models

Discriminative model

Learn $p(y|x)$

"the probability of y given x "

Class
e.g. malignant tumor or benign

Features (observation)

Generative model

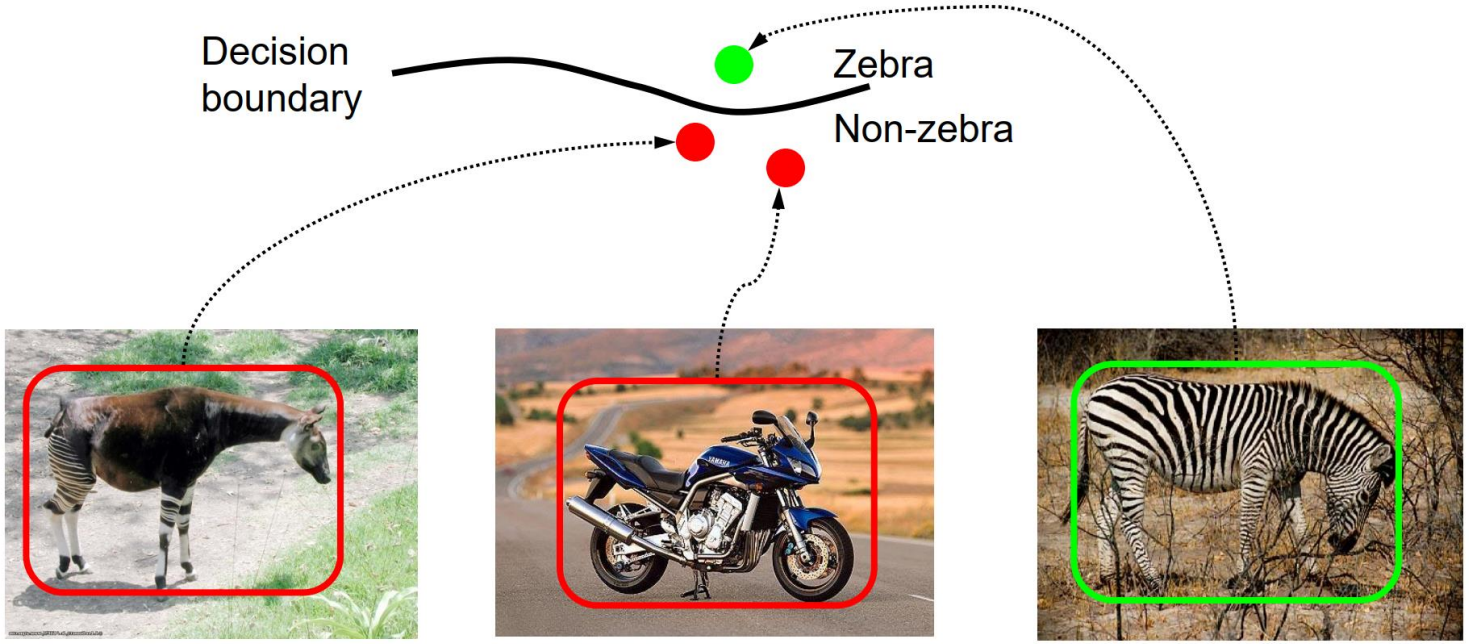
Learn $p(x|y)$

What is probability of having the feature conditioned on class y

Review

Discriminative methods

- Direct modeling of $p(zebra \mid image)$

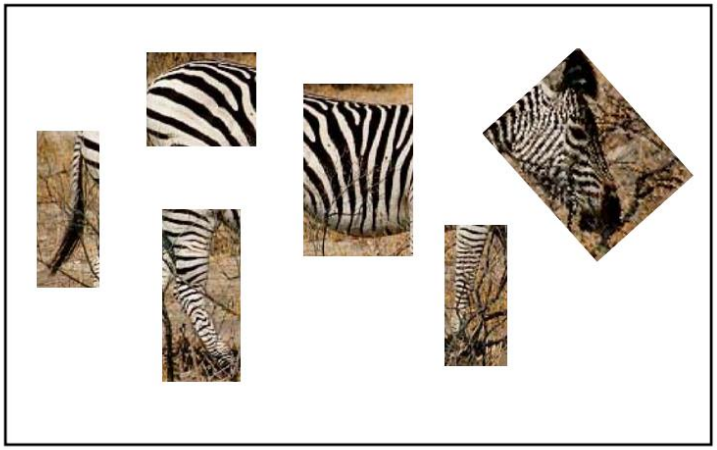


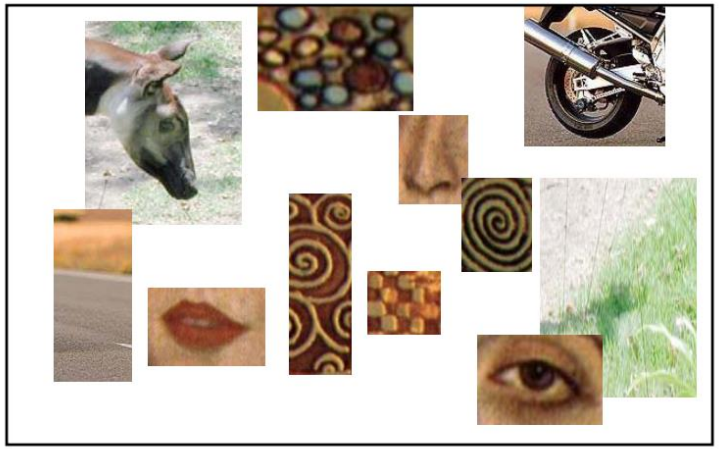
UNC CHARLOTTE

Review

Generative methods

Model $p(image \mid zebra)$ and $p(image \mid no\ zebra)$





Generative vs Discriminative Models

	Generative Models (ex. Naïve Bayes)	Discriminative Models (ex. Logistic Regression)
Classification Accuracy		
Missing Features		

Generative and discriminative models

PDF: Probability Density Function

- **Generative Methods**
  - Model class-conditional pdfs and prior probabilities
  - "Generative" since sampling can generate synthetic data points
  - Popular models
    - Gaussians, Naïve Bayes, Mixtures of multinomials
    - Mixtures of Gaussians, Mixtures of experts, Hidden Markov Models (HMM)
    - Sigmoidal belief networks, Bayesian networks, Markov random fields

- **Discriminative Methods**
  - Directly estimate posterior probabilities
  - No attempt to model underlying probability distributions
  - Focus computational resources on given task– better performance
  - Popular models
    - Logistic regression, SVMs
    - Traditional neural networks, Nearest neighbor
    - Conditional Random Fields (CRF)