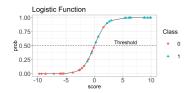
Introduction to Machine Learning

Supervised Classification In a Nutshell





Learning goals

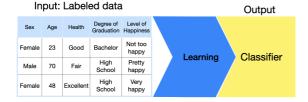
- Understand basic concept of classifiers
- Know concepts of probabilistic and scoring classifier
- Know distinction between discriminant and generative approach
- Understand ideas of logistic regression and Naive Bayes

CLASSIFICATION TASKS

- Learn function that assigns categorical class labels to observations
- Each observation belongs to exactly one class
- The task can contain two (binary) or multiple (multi-class) classes



Training



Prediction



BASIC DEFINITIONS

- For every observation a model outputs the probabilistic classifier) or score (scoring classifier) of each class
- In the multi-class case, the class label is usually assigned by choosing the class with the maximum score or probability
- In the binary case, a class label is assigned by choosing the class whose probability or score exceeds a threshold value c

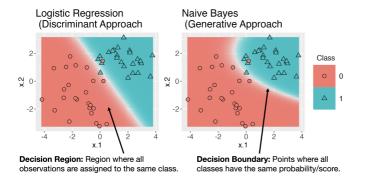




BASIC DEFINITIONS / 2

Two fundamental approaches exist to construct a classifier:

- Discriminant approach asks "What is the best prediction for the class given these data?" (uses loss functions and empirical risk minimization)
- Generative approach asks "Which class tends to have data like these?" (models the feature distributions in each class separately)





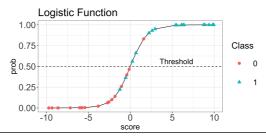
LOGISTIC REGRESSION

- Logistic regression is a discriminant approach for binary classification.
 It turns scores into probabilities with the logistic function.
- We just need to compute the probability for **one** class (usually class 1).
- ullet If the probability exceeds a threshold value ${f c} \Rightarrow$ class 1 is predicted.



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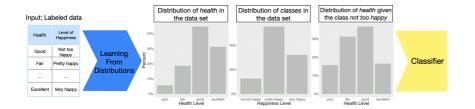
The logistic function puts all scores in order along an s-shaped line.



NAIVE BAYES

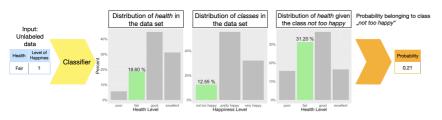
- Naive Bayes is a generative multi-class approach. It computes the class probability for each class based on the training data.
- It considers the data distribution on three different levels:
 - Marginal distributions $\mathbb{P}(X)$ of each feature (in the entire data set)
 - Marginal distribution $\mathbb{P}(Y)$ of classes (in the entire data set)
 - Conditional distributions $\mathbb{P}(X|Y)$ of each feature in each class



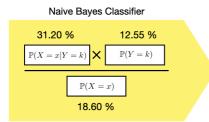


NAIVE BAYES / 2

• Example: Class probability of "not too happy" given health = "fair":







Class probability given the data

21.00 %