

# 监督模式识别方法总结

2009-11-17

## Model-based Methods

### Bayesian Classifier

- Minimal Error Bayesian Classifier

$$\min P(e) = \int P(e|x)p(x)dx$$

$$P(e|x) = P(\omega_i|x) \text{ if } x \text{ is assigned to } \omega_i, i \neq j$$

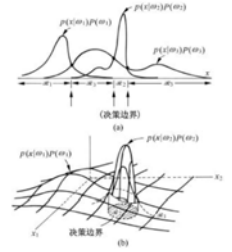
$$\therefore \text{ if } P(\omega_i|x) > P(\omega_j|x), \text{ assign } x \text{ to } \omega_i$$

Bayesian Formula:

$$P(\omega_i|x) = \frac{p(x|\omega_i)P(\omega_i)}{p(x)}$$

⇒ decision based on  $p(x|\omega_i)$  and  $P(\omega_i)$

Several equivalent forms of Bayesian decision rules.



The model

## Model-based Methods

### Bayesian Classifier

- Minimal Risk Bayesian Classifier

Considering not the error only, but the cost of the error.

$$\text{Risk: } R(\alpha_i|x) = \sum_j \lambda(\alpha_i|\omega_j)P(\omega_j|x)$$

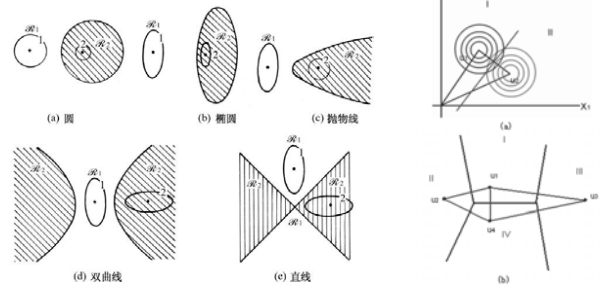
$$\text{Model: } P(\omega_i|x) = \frac{p(x|\omega_i)P(\omega_i)}{p(x)}$$

$$\text{Decision: } \alpha = \arg \min_i R(\alpha_i|x)$$

## Model-based Methods

### Bayesian Classifier

- Examples under certain distributions



## Model-based Methods

### Density estimation

- Parametric Estimation

- Maximum Likelihood Estimation

$$l(\theta) = p(\Xi|\theta) = \prod_i p(x_i|\theta)$$

--- The likelihood of getting the observation given

- Bayesian Estimation

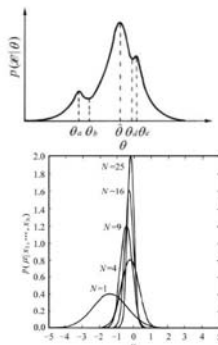
Same idea as Bayesian decision.

$$\text{Risk: } R(\hat{\theta}|x) = \int \lambda(\hat{\theta},\theta)p(\theta|x)d\theta$$

$$\hat{\theta} = \int \theta p(\theta|x)d\theta$$

$$p(\theta|\Xi) = \frac{p(\Xi|\theta)p(\theta)}{p(\Xi)}$$

⇒ ML estimation and Bayesian estimation under normal distributions.



## Model-based Methods

### Density estimation

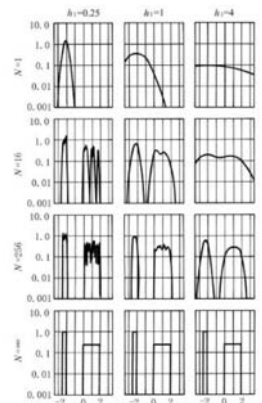
- Nonparametric Estimation

- Histogram
- Parzen Window
- $k_N$ -neighbor estimation

⇒ Advantage: no distribution assumptions

⇒ Disadvantage:

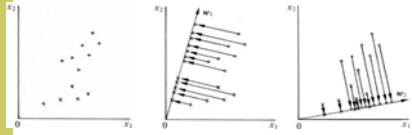
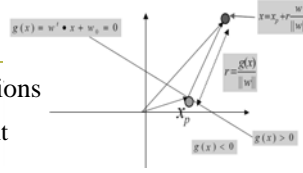
- Large sample size needed
- No closed-form solutions



## Direct Methods

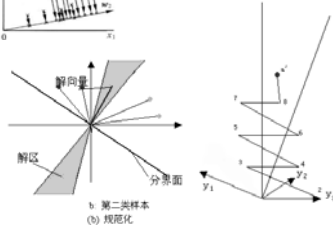
### Linear discriminant functions

- Fisher linear discriminant



- Perceptron

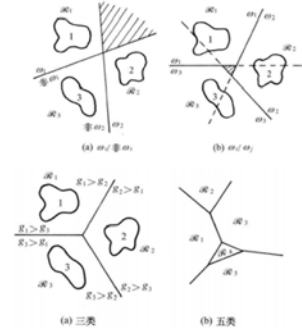
- MSE...



## Direct Methods

### Linear discriminant functions

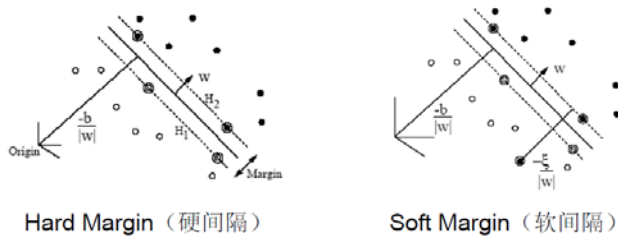
- Multiple-class problem



## Direct Methods

### Generalized linear discriminant functions

- Support vector machine (SVM)



## Direct Methods

### Nonlinear discriminant functions

- Piecewise linear discriminant functions

- Nearest neighbor methods

- 1-NN, k-NN

