CS 2750 Machine Learning
Lecture 12

Non-parametric classification methods

Milos Hauskrecht
milos@cs.pitt.edu
5329 Sennott Square

Nonparametric vs Parametric Methods

Nonparametric models:

- More flexibility – no parametric model is needed
- But require storing the entire dataset
- and the computation is performed with all data examples.

Parametric models:

- Once fitted, only parameters need to be stored
- They are much more efficient in terms of computation
- But the model needs to be picked in advance

Non-parametric Classification methods

- Given a data set with N_k data points from class C_k and $\sum_k N_k = N$, we have

$$p(\mathbf{x}) = \frac{K}{NV}$$

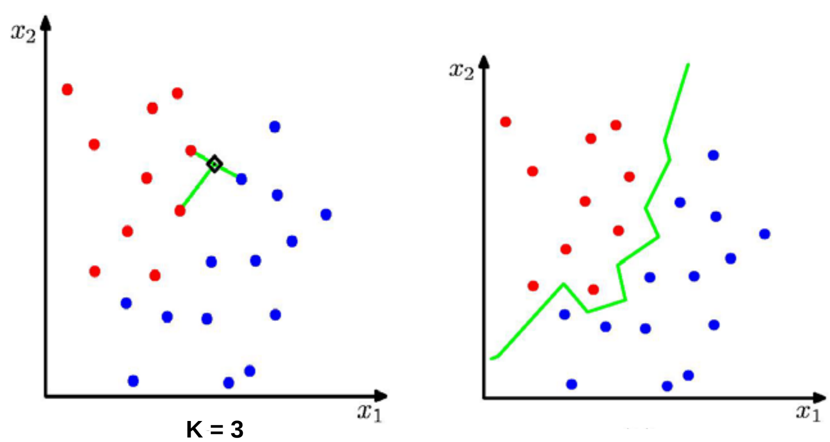
- and correspondingly

$$p(\mathbf{x}|\mathcal{C}_k) = \frac{K_k}{N_k V}.$$

- Since $p(\mathcal{C}_k) = N_k/N$, Bayes' theorem gives

$$p(\mathcal{C}_k|\mathbf{x}) = \frac{p(\mathbf{x}|\mathcal{C}_k)p(\mathcal{C}_k)}{p(\mathbf{x})} = \frac{K_k}{K}.$$

K-Nearest-Neighbours for Classification



Nonparametric kernel-based classification

- **Kernel function: k(x,x')**
  - Models similarity between x, x'
  - **Example:** Gaussian kernel we used in the kernel density estimation

$$k(x,x') = \frac{1}{(2\pi h^2)^{D/2}} \exp\left(-\frac{(x-x')^2}{2h^2} \right)$$

$$p(x) = \frac{1}{N} \sum_{i=1}^{N} k(x, x_i)$$

- **Kernel for classification**

$$p(y = C_k \mid x) = \frac{\sum_{x':y'=C_k} k(x,x')}{\sum_{x'} k(x,x')}$$