Classification and Prediction

——K-Nearest Neighbour——

徐华

清华大学 计算机系 智能技术与系统国家重点实验室

xuhua@tsinghua.edu.cn

1

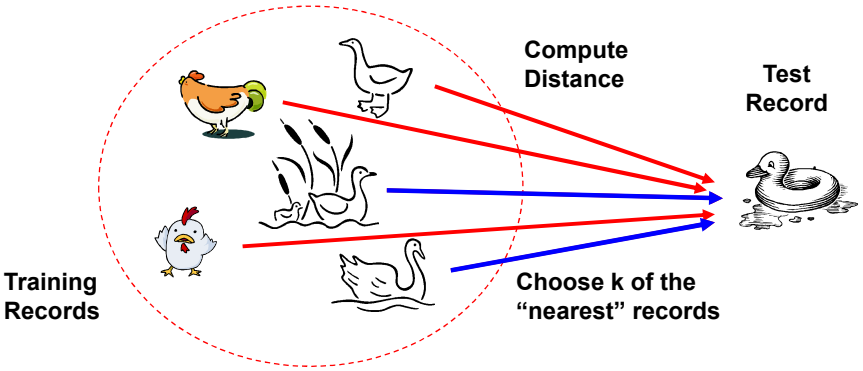
Classification and Prediction

- Basic Concepts
- Issues Regarding Classification and Prediction
- Decision Tree
- Bayesian Classification
- Neural Networks
- Support Vector Machines (SVM)
- K-Nearest Neighbor
- Associative classification
- Classification Accuracy

2

Nearest Neighbor Classifiers

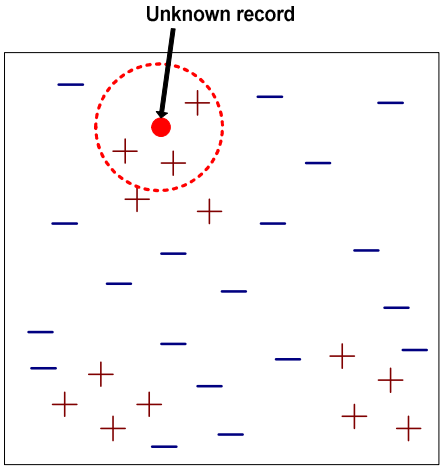
- **Basic idea:**
  - If it walks like a duck, quacks like a duck, then it' s probably a duck



3

Nearest Neighbor Classifiers

- **Requires the following:**
  - A set of labeled records
  - Proximity metric to compute distance/similarity between a pair of records
    - e.g., Euclidean distance
  - The value of *k*, the number of nearest neighbors to retrieve
  - A method for using class labels of K nearest neighbors to determine the class label of unknown record (e.g., by taking majority vote)



4

How to Determine the class label of a Test Sample?

- **Take the majority vote of class labels among the k-nearest neighbors**
- **Weight the vote according to distance**
  - weight factor, $w = 1/d^2$

5

Choice of proximity measure matters

- **For documents, cosine is better than correlation or Euclidean**

1 1 1 1 1 1 1 1 1 1 1 0		0 0 0 0 0 0 0 0 0 0 0 1
	vs	
0 1 1 1 1 1 1 1 1 1 1 1		1 0 0 0 0 0 0 0 0 0 0 0

Euclidean distance = 1.4142 for both pairs, but the cosine similarity measure has different values for these pairs.

- **Cosine Distance**

$$dist(A,B) = 1 - cos(A,B) = \frac{||A||_2||B||_2 - A \cdot B}{||A||_2||B||_2}$$ ，距离恒大于等于0

6

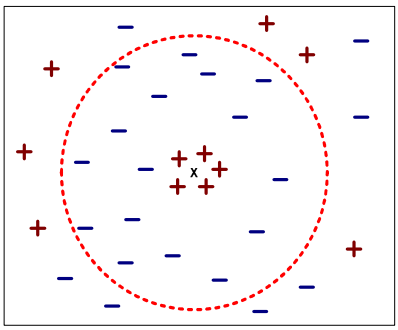
Nearest Neighbor Classifiers

- **Data preprocessing is often required**
  - Attributes may have to be scaled to prevent distance measures from being dominated by one of the attributes
    - Example:
      - height of a person may vary from 1.5m to 1.8m
      - weight of a person may vary from 90lb to 300lb
      - income of a person may vary from $10K to $1M
  - Time series are often standardized to have 0 means a standard deviation of 1

7

Nearest Neighbor Classifiers

- **Choosing the value of k:**
  - If k is too small, sensitive to noise points
  - If k is too large, neighborhood may include points from other classes

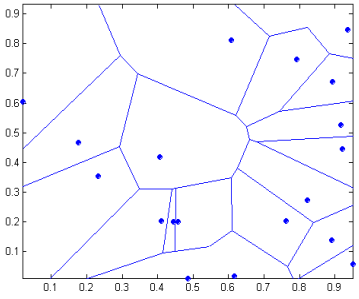


8

Nearest Neighbor Classifiers

- **Nearest neighbor classifiers are local classifiers**
- **They can produce decision boundaries of arbitrary shapes.**

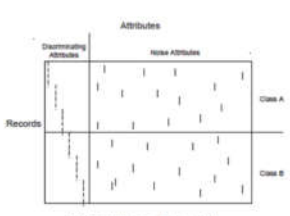
1-nn decision boundary is a Voronoi Diagram



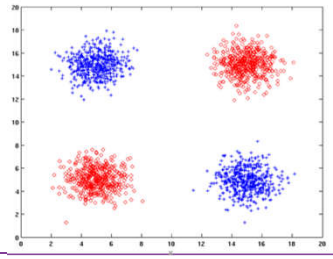
9

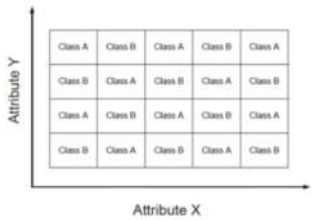
Nearest Neighbor Classifiers

- **How to handle missing values in training and test sets?**
  - Proximity computations normally require the presence of all attributes
  - Some approaches use the subset of attributes present in two instances
    - This may not produce good results since it effectively uses different proximity measures for each pair of instances
    - Thus, proximities are not comparable
  - Irrelevant attributes add noise to the proximity measure
  - Redundant attributes bias the proximity measure towards certain attributes



(a) Synthetic data set 1.





10

Improving KNN Efficiency

- **Avoid having to compute distance to all objects in the training set**
  - Multi-dimensional access methods (k-d trees)
  - Fast approximate similarity search
  - Locality Sensitive Hashing (LSH)
- **Condensing**
  - Determine a smaller set of objects that give the same performance
- **Editing**
  - Remove objects to improve efficiency

Thanks !