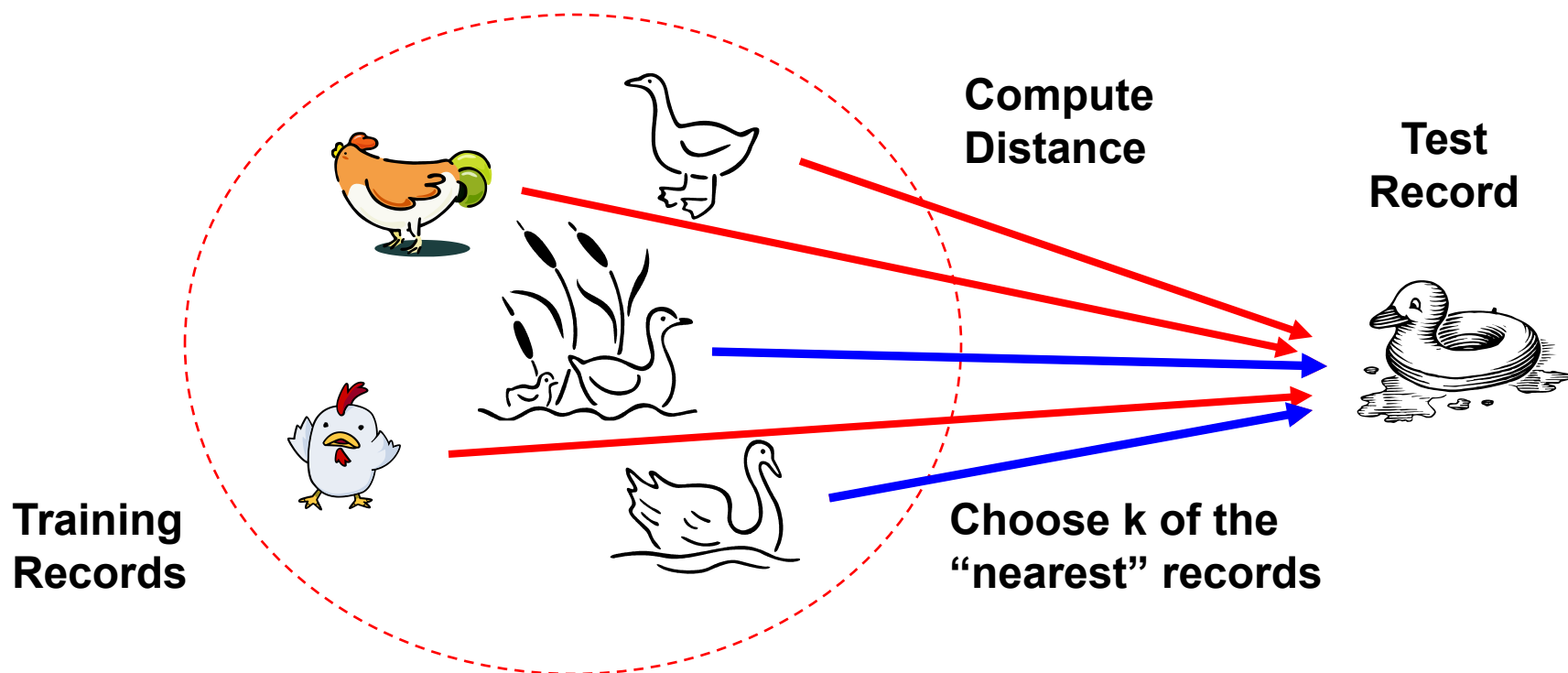


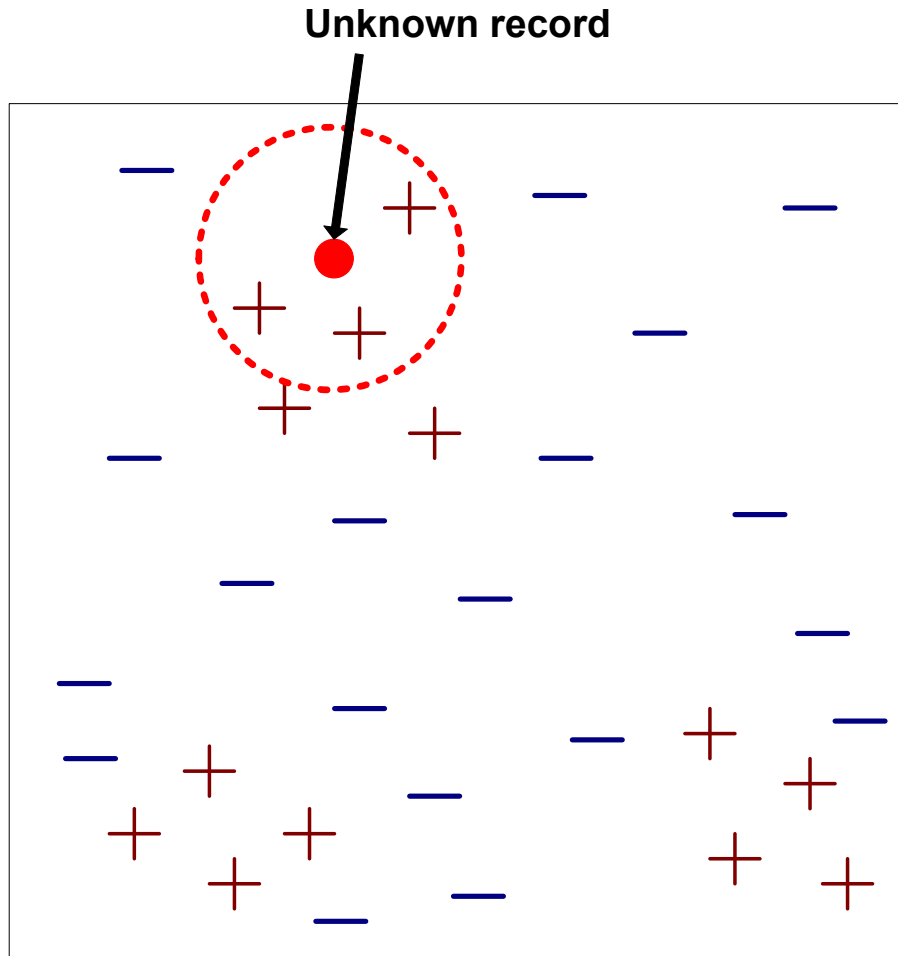
Nearest Neighbor Classification

Nearest Neighbor Classifiers

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

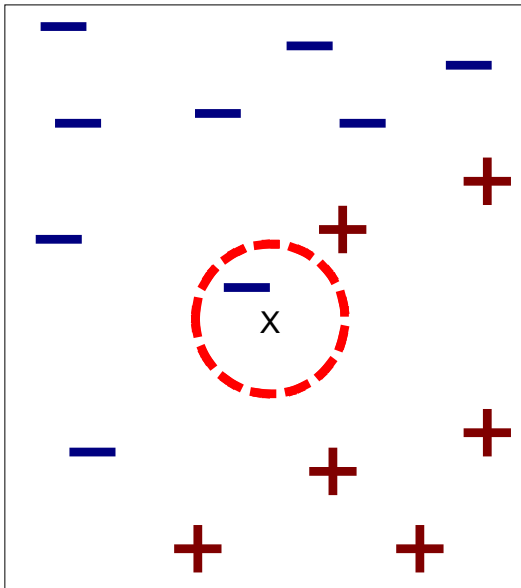


Nearest-Neighbor Classifiers

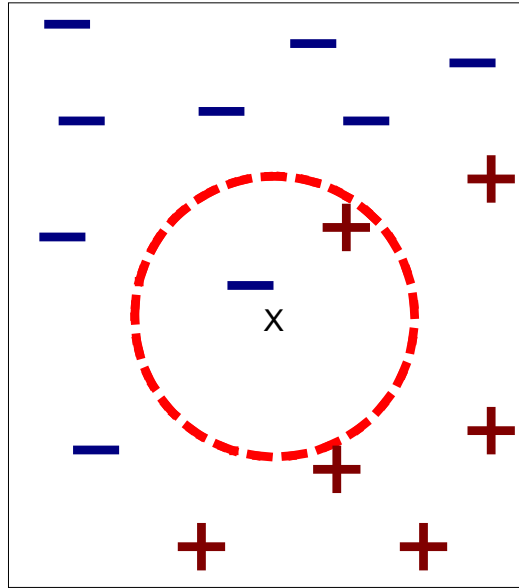


- Requires three things
 - The set of stored records
 - Distance metric to compute distance between records
 - The value of k , the number of nearest neighbors to retrieve
- To classify an unknown record:
 - Compute distance to other training records
 - Identify k nearest neighbors
 - Use class labels of nearest neighbors to determine the class label of unknown record (e.g., by taking majority vote)

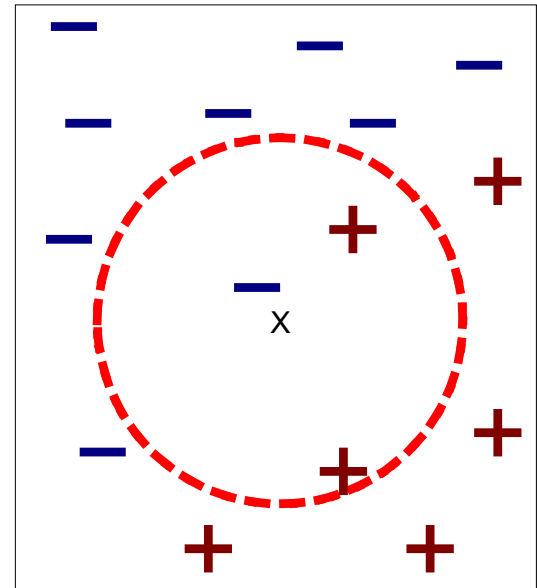
Definition of Nearest Neighbor



(a) 1-nearest neighbor



(b) 2-nearest neighbor

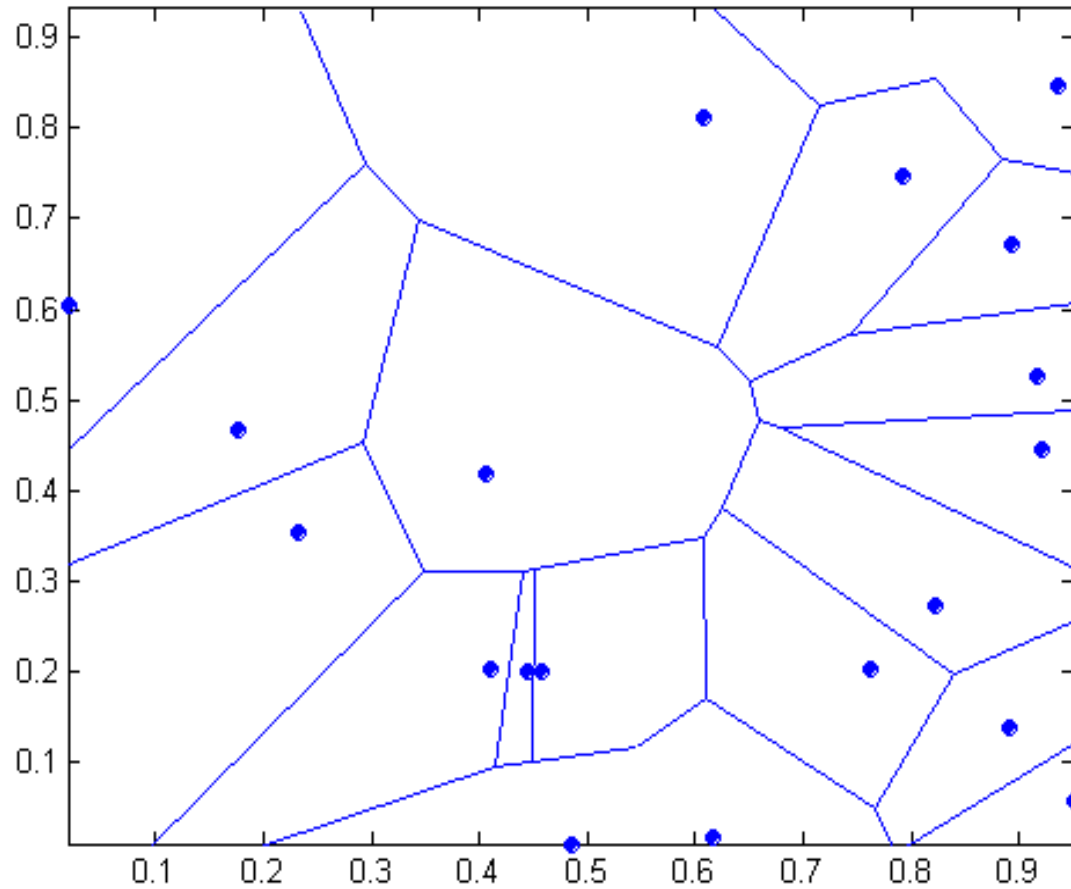


(c) 3-nearest neighbor

K-nearest neighbors of a record x are data points that have the k smallest distance to x

1 nearest-neighbor

Voronoi Diagram



Nearest Neighbor Classification

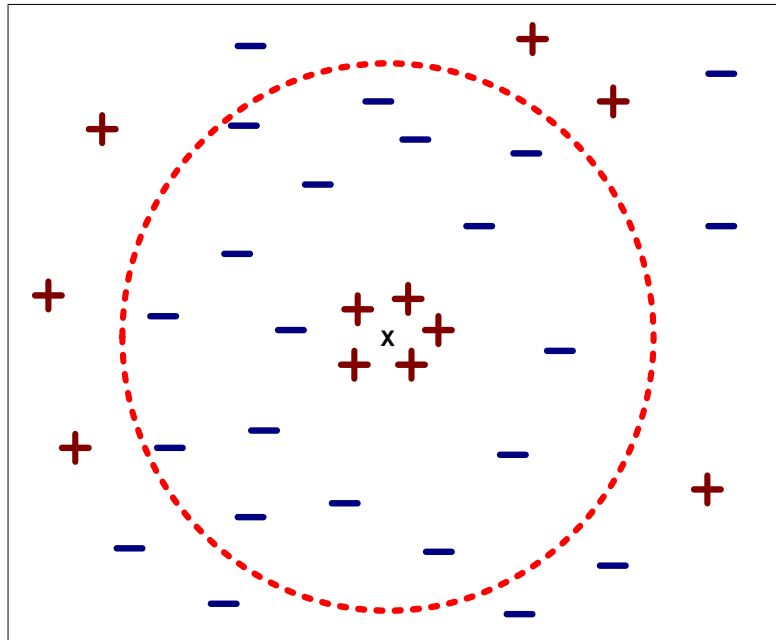
- Compute distance between two points:
 - Example: Euclidean distance

$$d(p, q) = \sqrt{\sum_i (p_i - q_i)^2}$$

- Determine the class from nearest neighbor list
 - take the majority vote of class labels among the k-nearest neighbors
 - Weigh the vote according to distance
 - ◆ weight factor, $w = 1/d^2$

Nearest Neighbor Classification...

- 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



Nearest Neighbor Classification...

- Scaling issues
 - 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

Nearest Neighbor Classification...

- Problem with Euclidean measure:
 - High dimensional data
 - ◆ curse of dimensionality
 - Can produce counter-intuitive results

1	1	1	1	1	1	1	1	1	1	1	0
---	---	---	---	---	---	---	---	---	---	---	---

VS

1	0	0	0	0	0	0	0	0	0	0	0
---	---	---	---	---	---	---	---	---	---	---	---

0	1	1	1	1	1	1	1	1	1	1	1
---	---	---	---	---	---	---	---	---	---	---	---

0	0	0	0	0	0	0	0	0	0	0	1
---	---	---	---	---	---	---	---	---	---	---	---

$d = 1.4142$

$d = 1.4142$

- ◆ Solution: Normalize the vectors to unit length

Nearest neighbor Classification...

- k-NN classifiers are lazy learners
 - It does not build models explicitly
 - Unlike eager learners such as decision tree induction and rule-based systems
 - Classifying unknown records are relatively expensive