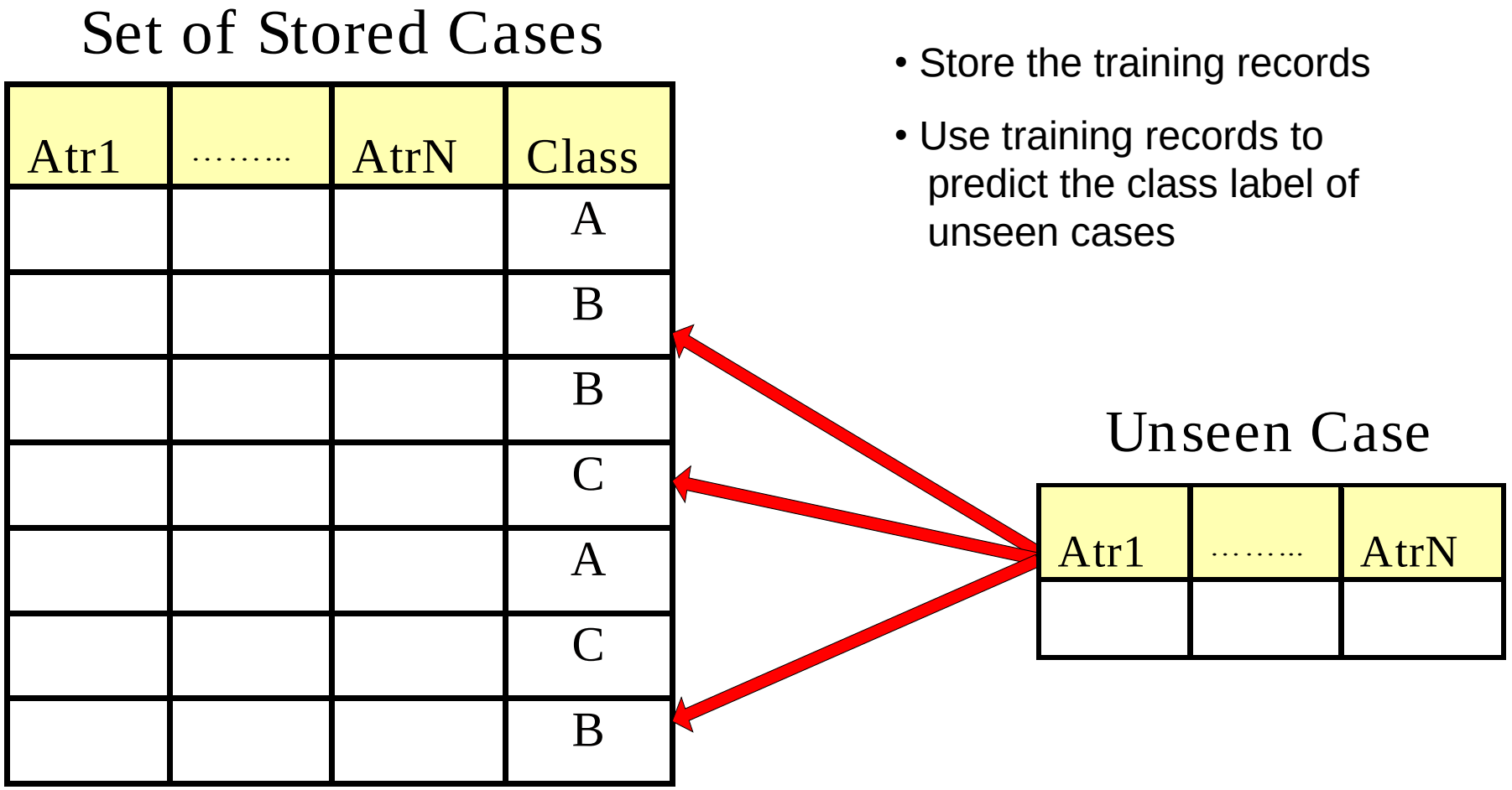
# Nearest-Neighbor Classifier

# Instance-Based Classifiers



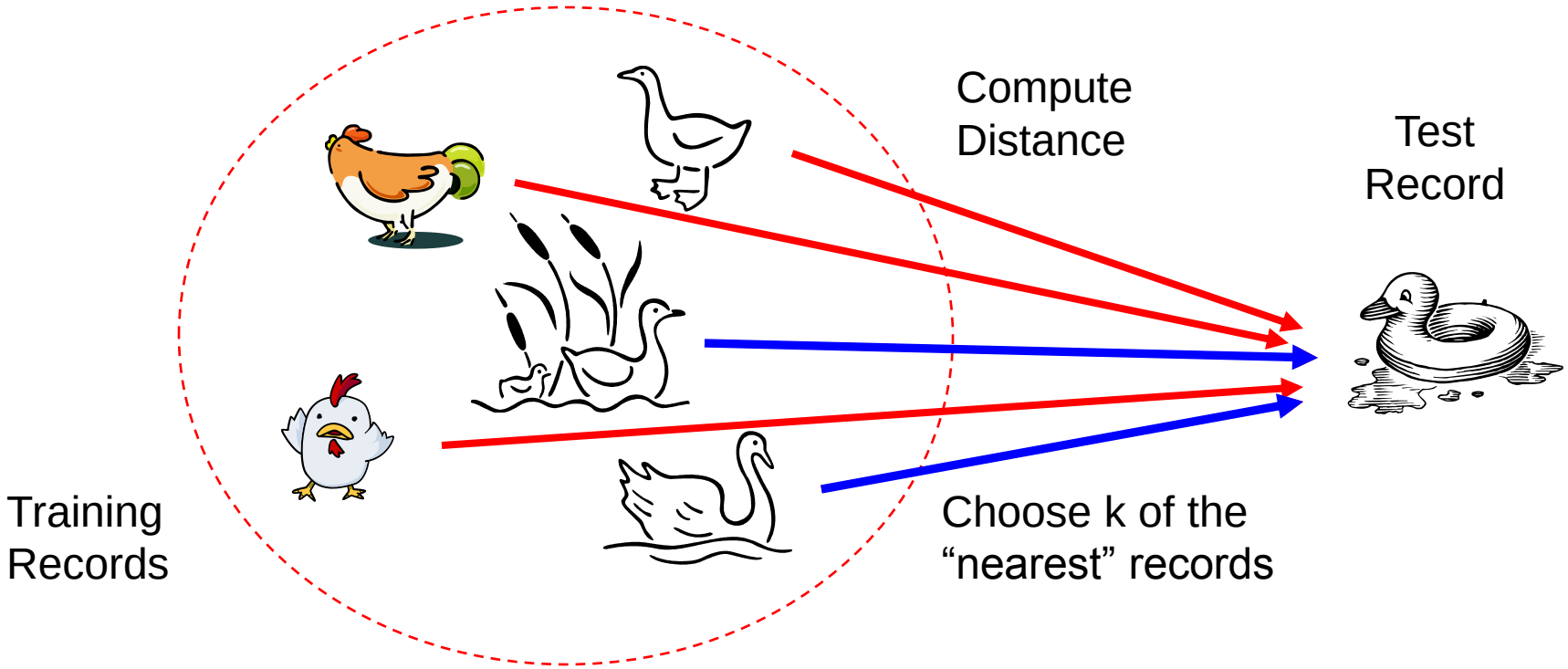

- Store the training records
- Use training records to predict the class label of unseen cases

# Instance Based Classifiers

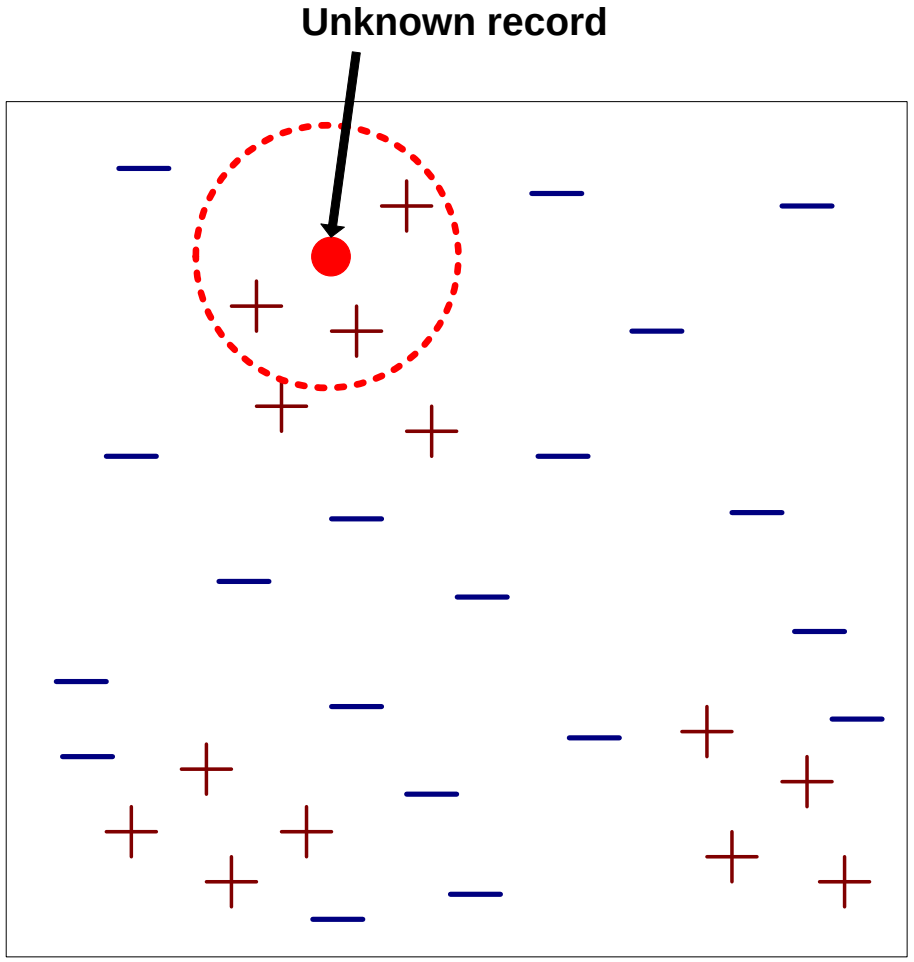
- Examples:
  - Rote-learner
    - Memorizes entire training data and performs classification only if attributes of record match one of the training examples exactly
  - Nearest neighbor
    - Uses k “closest” points (nearest neighbors) for performing classification

# Nearest Neighbor Classifiers

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



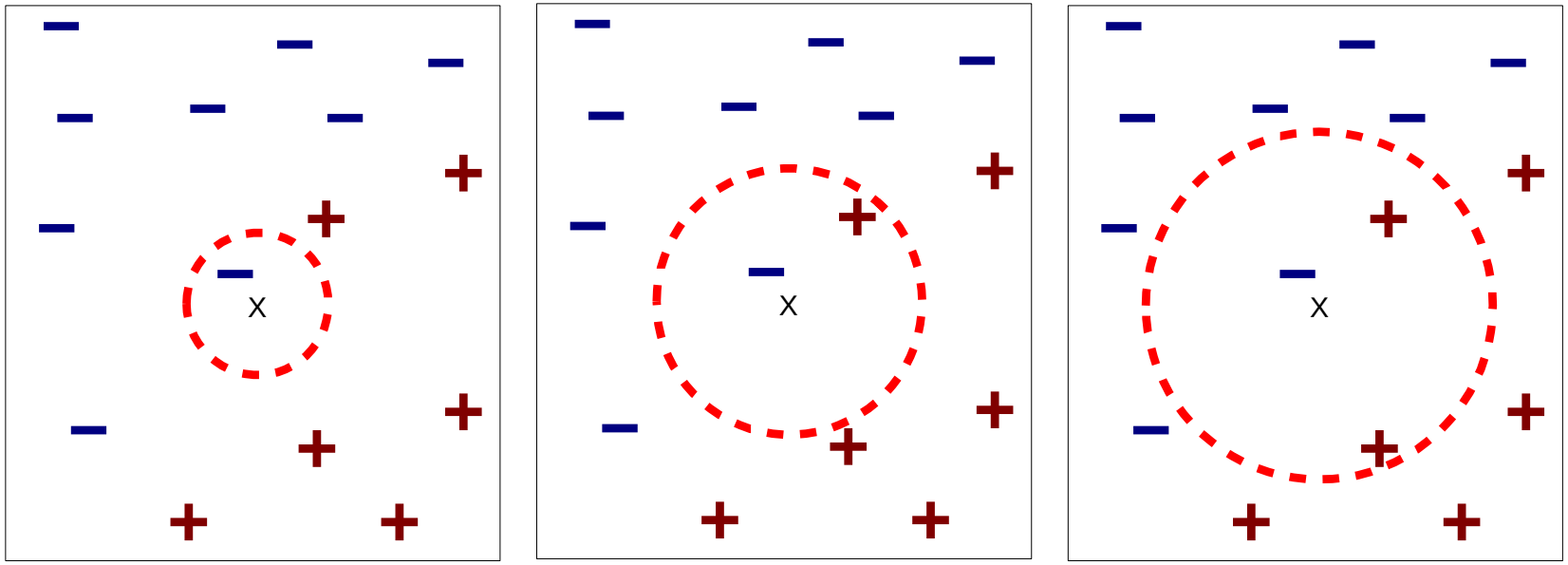
# Nearest-Neighbor Classifiers




- 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

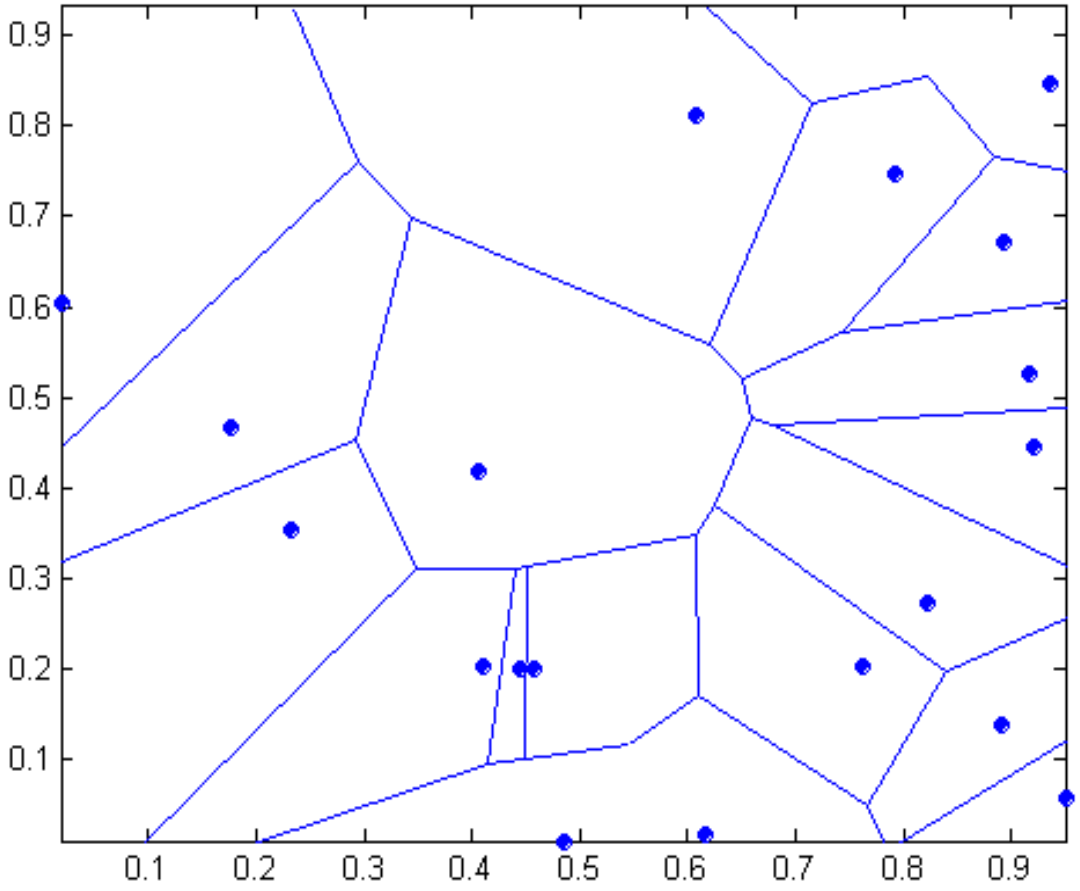



(a) 1-nearest neighbor (b) 2-nearest neighbor (c) 3-nearest neighbor

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:
  - Euclidean distance

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

  - Manhatten distance

$$d(p,q) = \sum_i |p_i - q_i|$$

  - q norm distance

$$d(p,q) = (\sum_i |p_i - q_i|^q)^{1/q}$$

- Determine the class from nearest neighbor list
  - take the majority vote of class labels among the k-nearest neighbors

$$y' = \underset{v}{\operatorname{argmax}} \sum_{(x_i, y_i) \in D_z} I(v = y_i)$$

where $D_z$ is the set of k closest training examples to z.

  - Weigh the vote according to distance

$$y' = \underset{v}{\operatorname{argmax}} \sum_{(x_i, y_i) \in D_z} w_i \times I(v = y_i)$$

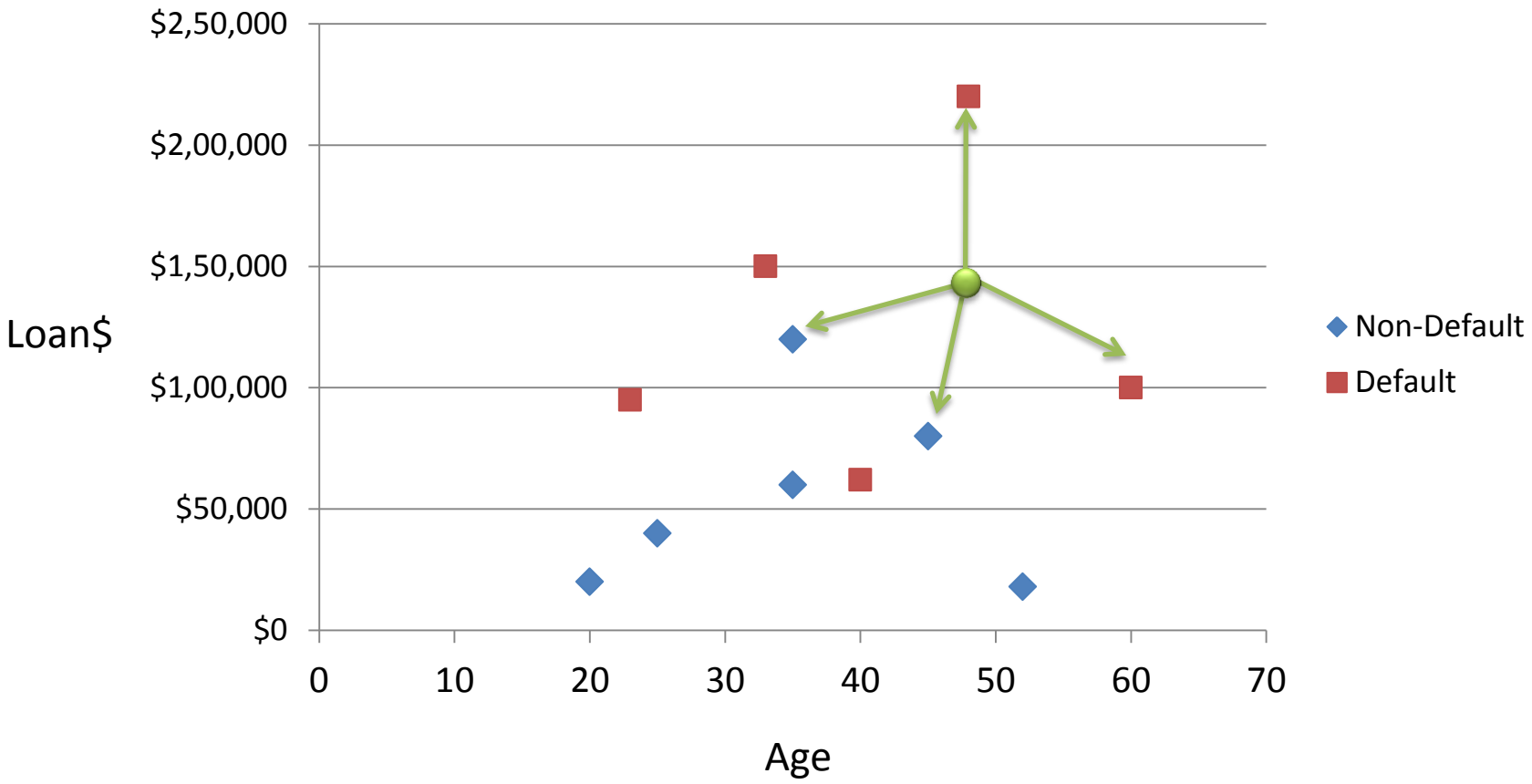
    - weight factor, $w = 1/d^2$

# The KNN classification algorithm

Let k be the number of nearest neighbors and D be the set of training examples.

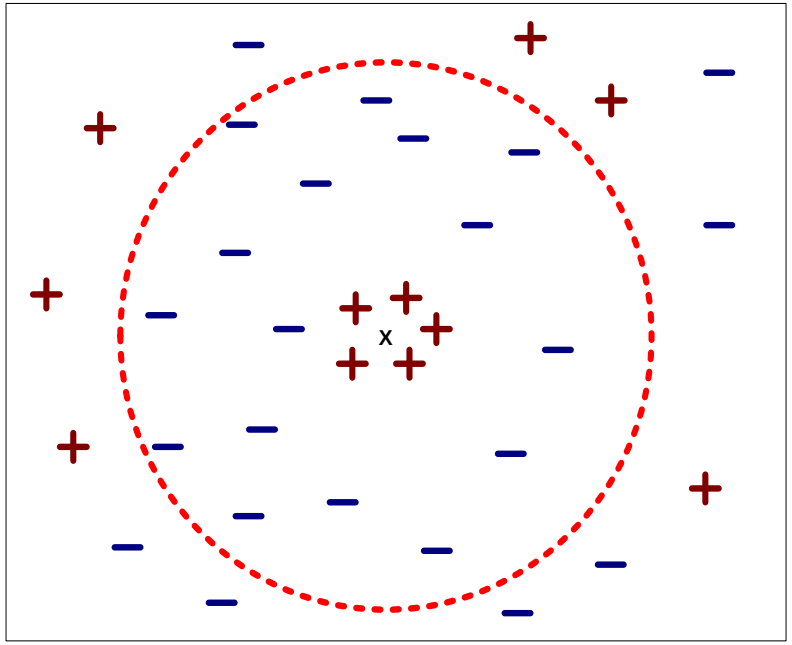
1. **for** each test example z = (**x**’,y’) **do**
2. Compute d(**x**’,**x**), the distance between z and every example, (**x**,y) ϵ D
3. Select $D_z \subseteq D$, the set of k closest training examples to z.
4. y’ = $\underset{v}{\operatorname{argmax}} \sum_{(x_i,y_i) \in D_z} I(v = y_i)$
5. **end for**

# KNN Classification



# 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…

- 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

# Thank You