Intro to Artificial Intelligence

Lecture 5: Machine Learning

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Review

- Probabilistic inference
- Enumeration
- Approximate inference

Today

- What is machine learning?
- Supervised learning
- Unsupervised learning

What is machine learning?

Machine learning!

- Give the machine the ability how to solve some problems (e.g. statistical phenomenon) based on incomplete information
- Here, learning is not only a question of remembering but also of generalization to unseen cases
- Learn by example

Machine learning types

- Suppose you are building a Face recognition program
- Supervised learning (Classification):
  - You have a dataset of faces image and other images.
  - The dataset is labeled (classified) into Faces images, and other images.
  - Program task know is to classify new images based on the available dataset.
- Unsupervised learning (Clustering):
  - You don't have a dataset, and program role know is to cluster similar images for a new given dataset into different group, e.g. it can distinguish that faces are very different from landscapes, which are very different from horses.

Supervised learning

Supervised Classification

- Referred to as classification or pattern recognition.
- The goal is to find a functional mapping between the input data (patterns or examples) X, to a class label Y.
  - i.e. Y=f(X)
- A pattern is described by a set of features.
  - E.g. color of eyes, or distance between the eyes.
- Pattern recognition task can be viewed as a two dimensional matrix, whose axes are the examples and the features.

Pattern classification tasks

- Data collection and representation.
- Feature selection and/or feature reduction.
- Classification.

Classification algorithms

- Techniques for Low dimensional data sets
  - K-Nearest Neighbor Classification
  - Linear Discriminant Analysis
  - Decision Trees
  - Neural Networks

- Techniques for High dimensional data sets
  - Support Vector Machines
  - Boosting

K-Nearest Neighbor Classification

- K nearest neighbors measured by a distance function.
- These functions are valid only with continuous variables.

Euclidean $\sqrt{\sum_{i=1}^{k}(x_i - y_i)^2}$

Manhattan $\sum_{i=1}^{k}|x_i - y_i|$

Minkowski $\left(\sum_{i=1}^{k}(|x_i - y_i|)^q\right)^{1/q}$

KNN Example

- Consider the following data concerning credit default. Age and Loan are two numerical variables (predictors) and Default is the target.

Age	Loan	Default
25	$40,000	N
35	$60,000	N
45	$80,000	N
20	$20,000	N
35	$120,000	N
52	$18,000	N
23	$95,000	Y
40	$62,000	Y
60	$100,000	Y
48	$220,000	Y
33	$150,000	Y

- Know we want to classify unknown case ((Age=48 and Loan=$142,000) using Euclidean distance.) !!!!

KNN Example

- Using Euclidean distance: E.g. distance between (48, $142k) and (33, 150k)
  - Sqrt[(48-33)^2 + (142000-150000)^2] = 8000.01
- So for all the dataset

Age	Loan	Default	Distance	
25	$40,000	N	102000	
35	$60,000	N	82000	
45	$80,000	N	62000	
20	$20,000	N	122000	
35	$120,000	N	22000	2
52	$18,000	N	124000	
23	$95,000	Y	47000	
40	$62,000	Y	80000	
60	$100,000	Y	42000	3
48	$220,000	Y	78000	
33	$150,000	Y	8000	1
48	**$142,000**	**?**		

Euclidean Distance

$$D = \sqrt{(x_1 - y_1)^2 + (x_2 - y_2)^2}$$

KNN Example cont.

- Know we choose the number of neighbors K
  - If K=1 then this case is Y
  - If K=3 then we have 2 Y and 1 N which give us Y.

Age	Loan	Default	Distance	
25	$40,000	N	102000	
35	$60,000	N	82000	
45	$80,000	N	62000	
20	$20,000	N	122000	
35	$120,000	N	22000	2
52	$18,000	N	124000	
23	$95,000	Y	47000	
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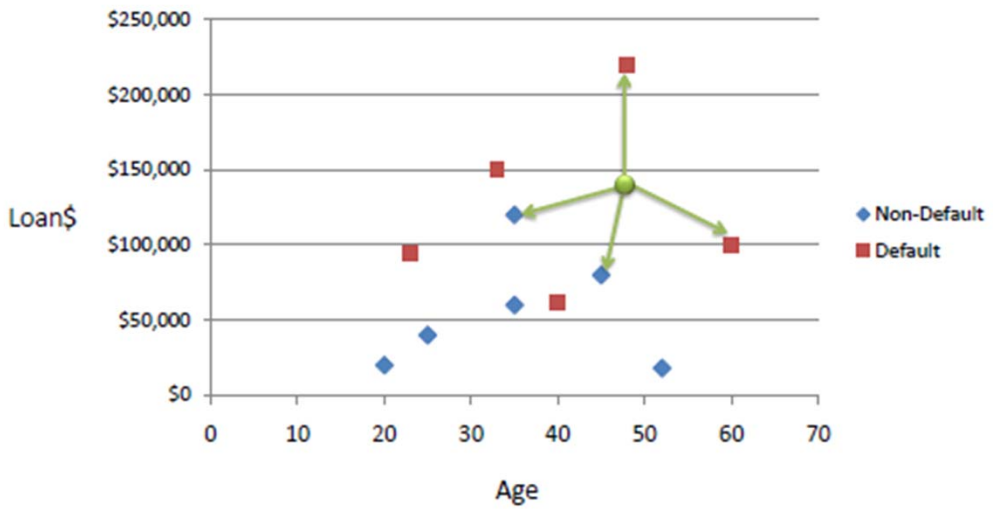
33	$150,000	Y	8000	1
48	$142,000	?		

Euclidean Distance

$$D = \sqrt{(x_1 - y_1)^2 + (x_2 - y_2)^2}$$



KNN disadvantages

- Computationally expensive
- Requires a large memory to store the training data.

Unsupervised learning

Example

- suppose you had a basket and it is filled with some fresh fruits your task is to arrange the same type fruits at one place.
- This time you don't know any thing about that fruits, you are first time seeing these fruits so how will you arrange the same type of fruits.
- What you will do first you take on fruit and you will select any physical character of that particular fruit. suppose you taken color.
- Then you will arrange them base on the color, then the groups will be some thing like this.
- RED COLOR GROUP: apples & cherry fruits.
- GREEN COLOR GROUP: bananas & grapes.
- so now you will take another physical character as size, so now the groups will be some thing like this.
- RED COLOR AND BIG SIZE: apple.
- RED COLOR AND SMALL SIZE: cherry fruits.
- GREEN COLOR AND BIG SIZE: bananas.
- GREEN COLOR AND SMALL SIZE: grapes.
- Done

Techniques and algorithms

- clustering
  - (e.g., k-means, mixture models, hierarchical clustering)

- Approaches for learning latent variable models such as
  - Expectation–maximization algorithm (EM)
  - Method of moments
  - Blind signal separation techniques