CS578 – Interactive and Transparent Machine Learning

Topic: ML

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Machine Learning

- "Programs that improve performance by experience at a given task"
  - Tom Mitchell, Machine Learning
- Performance: a metric of success, an objective function
  - E.g., accuracy, precision, recall, …
- Experience: data
- Task: classification, regression, clustering, reinforcement learning
- Example applications
  - Face detection, speech recognition, hand-written/optical character recognition, medical diagnosis, credit scoring, product recommendations, document classification, …

ML Subcategories

1. Supervised learning
2. Unsupervised learning
3. Reinforcement learning

Supervised Learning

- Data: <X, Y> pairs
  - X: input variable, a.k.a., features, objects, instances, …
  - Y: a target variable, a.k.a., class, label, response, …
- Objective: learn a function f(X) -> Y
  - Y: discrete -> classification
  - Y: real-valued -> regression
- Examples
  - Prediction
  - Recognition
  - Detection

Unsupervised Learning

- Data: <X>
  - X: input variable, a.k.a., features, objects, instances, …
  - No target variable
- Objective: cluster the data, find groupings in the data
- Examples:
  - Topic detection
  - Clustering (e.g., k-means)

Reinforcement Learning

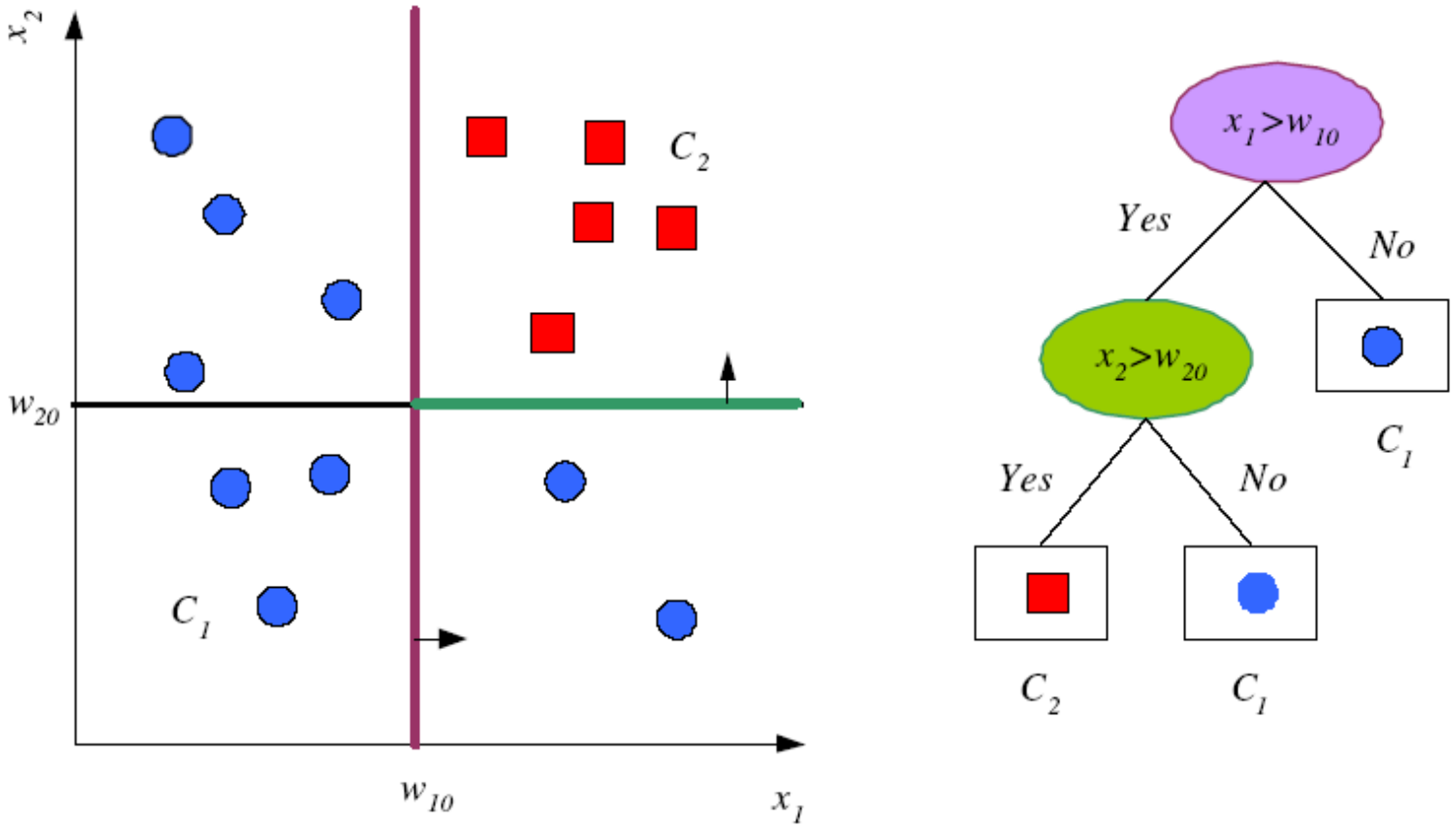
- Input: Sequences of actions and rewards
- Objective: find out a sequence of actions that maximizes expected reward
- Examples
  - Game playing
  - Robotics

Classification/Regression

- Decision Trees
- Naïve Bayes
- Logistic Regression
- Support Vector Machines
- Neural networks / deep learning
- Linear Regression
- Lasso
- Ridge
- …

Examples of Supervised Learning Approaches

Decision Trees



Credit: Ethem Alpaydin. Introduction to Machine Learning. 3rd Edition.
http://www.cmpe.boun.edu.tr/~ethem/i2ml3e

Logistic Regression

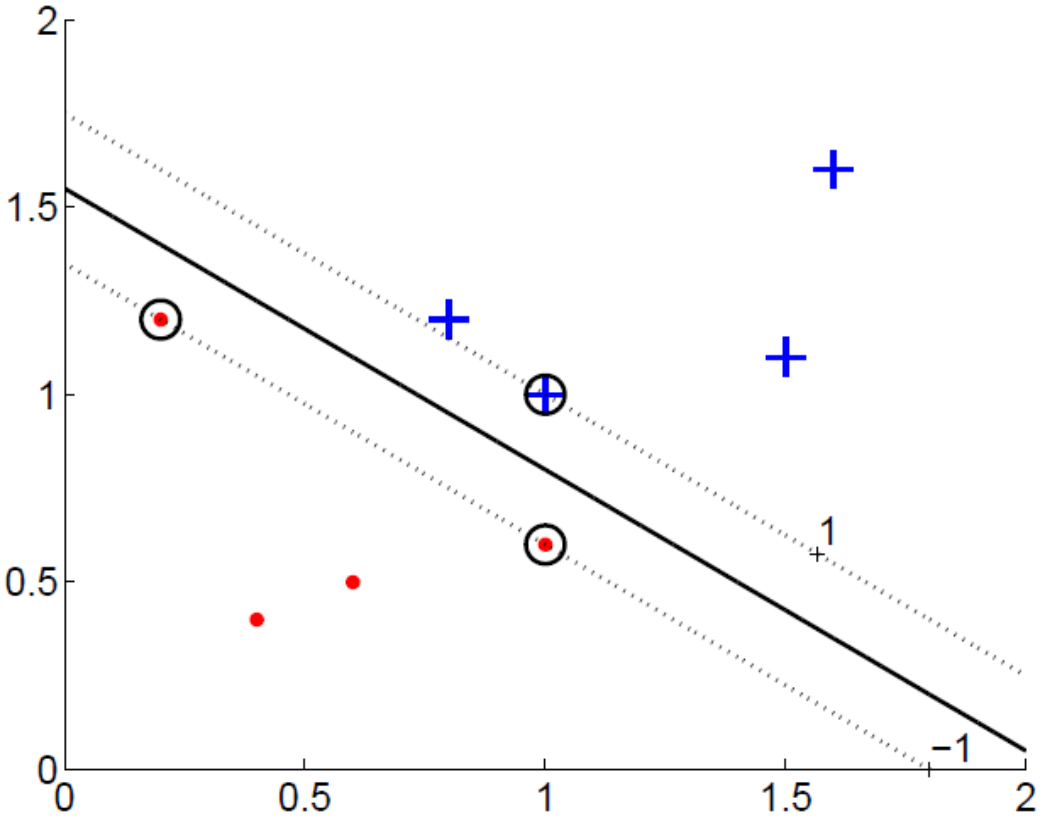
- Assumes $P\left(Y \middle| \vec{X}\right)$ follows the logistic function

$$P(Y = false \mid X_1, X_2, \cdots, X_n) = \frac{1}{1 + e^{w_0 + \sum_{i=1}^{n} w_i X_i}}$$

$$P(Y = true \mid X_1, X_2, \cdots, X_n) = \frac{e^{w_0 + \sum_{i=1}^{n} w_i X_i}}{1 + e^{w_0 + \sum_{i=1}^{n} w_i X_i}}$$

- Learning: estimate the weights $w_0, w_1, \ldots, w_n$

Support Vector Machines



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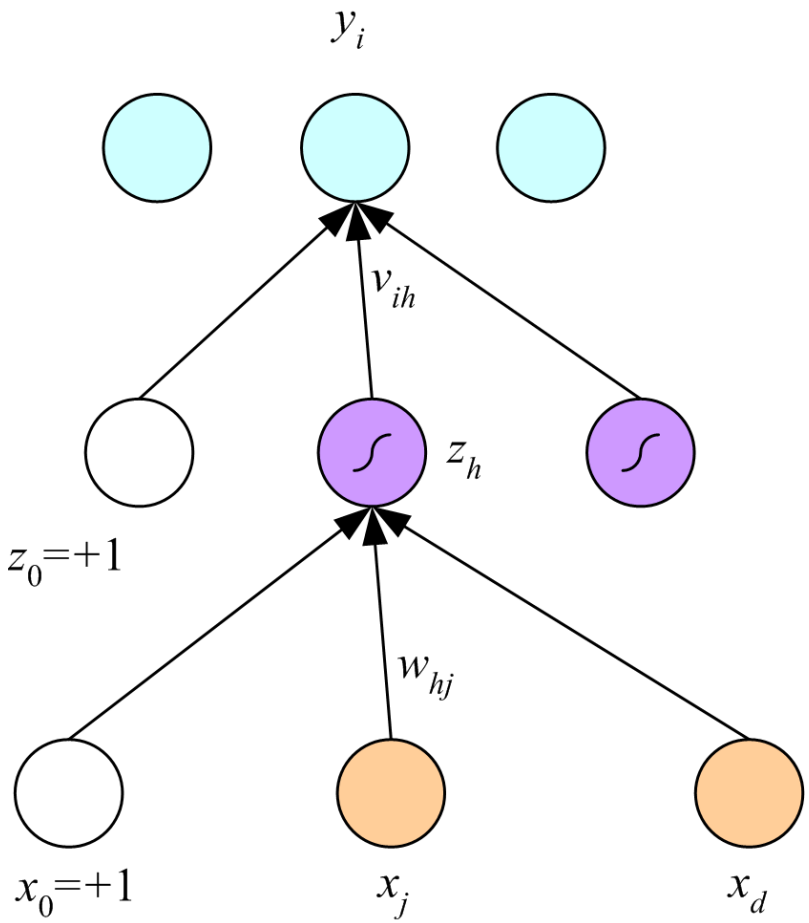
Neural Networks



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CS578 vs CS584

- In CS584, you'll learn
  - The foundation of the algorithms
- In CS578, you'll learn
  - The foundation
  - The transparency
  - The interaction

Let's see an Example

- Logistic regression
  - Foundation: gradient optimization to estimate the weights
  - Transparency
    - Model: what did the model learn? What do the values of the weights tell us about features and their importance?
    - Prediction: when an object is classified by this model, which feature values contributed to each class and how much?
  - Interaction
    - If we want to label more objects, which one should we label next?
    - Can we provide any rationales into the learning process?

Why Transparency?

- At least three audiences
  - Development
  - Middle users
  - End users
- Think about medical diagnosis
  - Development: you, the ML expert
  - Middle user: the doctor
  - End user: the patient
  - Why is transparency important for these audiences?

Rest of the Semester

- I'll cover
  - The foundations
    - I'll use OneNote for this part
  - Transparency of the model and its predictions
  - Interaction with the model
    - I'll use Jupyter Notebooks for these two parts
- You'll have
  - Assignments
    - Get practical experience
  - Quizzes and final exam
    - Test your course knowledge
  - Project
    - Write (proposal, code, and reports) and present