CS 66: Machine Learning

Prof. Sara Mathieson

Spring 2019

Outline for March 8

- AdaBoost
  - Handout 8
- Midterm 1

- **Lab 4 due TONIGHT**
- Office hours TODAY 1-3pm

Outline for March 8

- AdaBoost
  - Handout 8
- Midterm 1

Today

- AdaBoost
- Midterm 1

* Office Hours
  1-3 pm
  TODAY
* Lab 4 due
  TONIGHT

Boosting Idea

Train (start w/ equal weights)

for T iters:

* learn classifier
* update weights

Test

for each test example:

* use all classifiers to predict
* vote based on training score

AdaBoost

set $w_i^{(1)} = \frac{1}{n}$ $\forall$ train examples

for T iterations (index: t)

* fit $h^{(t)}(x)$ to weighted training data

d-tree with low depth.

(depth = 1 => stump)

* compute weighted error

train

$$\varepsilon_t = \sum_{i=1}^{n} w_i^{(t)} \cdot \mathbb{1}\left(y_i \neq h^{(t)}(\vec{x}_i)\right)$$

train

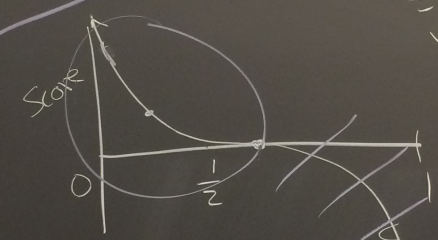
$h^{(t)}(\vec{x}_i))$

* compute score

$$\alpha_t = \frac{1}{2} \ln\left(\frac{1-\varepsilon_t}{\varepsilon_t}\right) = 1?$$

natural log

$\Rightarrow \varepsilon_t = \frac{1}{2}$ random guessing



$\varepsilon_t = \frac{1}{4}$

$$\alpha_t = \frac{1}{2} \ln\left(\frac{3/4}{1/4}\right)$$

$\varepsilon_t = \frac{3}{4}$ flip!

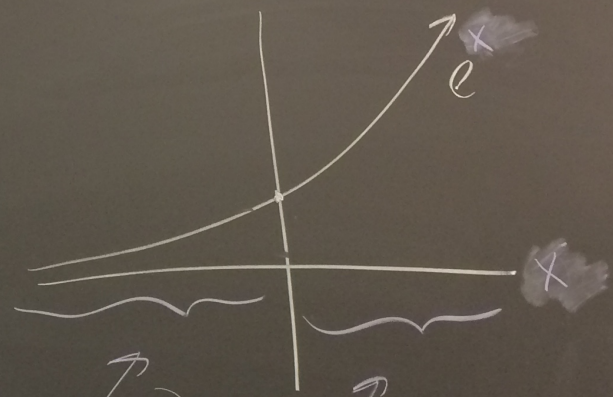
$\varepsilon_t = \frac{1}{4}$

* upd

in

* update weights $\quad y \in \{-1, 1\}$

$$w_i^{(t+1)} = c_t \, w_i^{(t)} \exp\left(-y_i \alpha_t h^{(t)}(\vec{x}_i)\right)$$



intuition

correctly classified : $w_i^{(t+1)} = c_t \, w_i^{(t)} \cdot \underbrace{\exp(-\alpha_t)}_{\text{less than } 1}$

incorrectly classified : $w_i^{(t+1)} = c_t \, w_i^{(t)} \underbrace{\exp(\alpha_t)}_{\text{greater than } 1}$

$y_i = h^{(t)}(\vec{x}_i)$

$1 \quad 1$

$-1 \quad -1$

$y_i \neq h^{(t)}(\vec{x}_i)$

$1 \quad -1$

$-1 \quad 1$

$\vec{x}_i)$

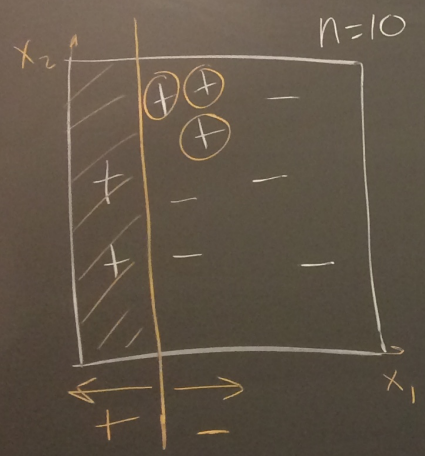
$)$

testing

$$h(\vec{x}) = \text{sign}\left(\sum_{t=1}^{T} \alpha_t \underbrace{h^{(t)}(\vec{x})}_{\{-1,\,1\}}\right)$$

Outline for March 8

- AdaBoost
  - Handout 8
- Midterm 1



$n=10$

$$w_i^{(1)} = \frac{1}{10}$$

$$\varepsilon_t = \frac{3}{10}$$

$$\alpha_t = \frac{1}{2}\ln\left(\frac{1-\frac{3}{10}}{\frac{3}{10}}\right) = \ln\sqrt{\frac{7}{3}} \approx 0.42$$

$w_i^{(2)}$ if correct? $\quad c_1 \frac{1}{10} \cancel{\exp}\left(-\ln\sqrt{\frac{7}{3}}\right)$

$w_i^{(2)}$ if incorrect? $\quad c_1 \frac{1}{10} \cancel{\exp}\left(+\ln\sqrt{\frac{7}{3}}\right)$

$$c_1\left(\quad\right)^{\frac{7}{10}} + c_1\left(\quad\right)^{\frac{3}{10}} = 1$$

$$c_1 = \frac{5}{21}\cdot\sqrt{21}$$

$$\boxed{\frac{1}{14}}$$

$$\boxed{\frac{1}{6}}$$

Outline for March 8

- AdaBoost
  - Handout 8
- Midterm 1

Midterm 1 Curve

- A: 88-100
- B: 76-87
- C: 64-75
- D: 52-63
- Below 52: not passing (please meet with me)

Midterm 1 Solutions
(not posted in slides)