Advanced Topics in Machine Learning

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1 Lecture - 1

The objective is to minimize the regret function in the net timestpes T

$$R_T = \sum_T l(y_t, a_t) - \min_{a \in A} \sum_T l(y_t, a) \tag{1}$$

The loss in 1 is like loss in hindisght. The sum term that is $\sum_T l(y_t, a_t)$ is a good cumulative loss but it is hard to compare two algorithms, The adversary can simply always beat you everywhere. However he cannot do this with the Regret loss function, because his choice of actions even though that maximizes the first may actually start to maximize the second term also.

Algorithm 1 OF Framework

for $t = 1 \to T$ **do**
  Algorithm A chooses $a_t \in A$
  $y_t \leftarrow f(a_t)$
  $l_t \leftarrow l(y_t, a_t) \quad l \in \mathcal{L}$ ▷ I must do well on every single l
end for

The interpretation is that the environment is not being modelled, it is completely adversarial in its nature and the objective is to minimize the regret

It is unclear why the actions dont change in the RHT of the regret function.
Applications may include weather filetring, spam filtering and stoick prediction. In spam filtering the objective function

In stock prediction, the reward can be considered to be some r_t (decided by the adversary) and the weight vector is that of the distribution of money in the stocks The loss will be negative of the sum of inner products.

$$l = -\sum_t \langle p_t, r_t \rangle \tag{2}$$

Algorithm 2 Learning with Expert advice

Require: N experts

for $t = 1 \rightarrow T$ **do**
  Create expert predictions D
  Algorithm A chooses $p_t \in D$
  Adversary chooses y_t and l_t
  $l_t \leftarrow l(y_t, a_t) \quad l \in \mathcal{L}$ $\triangleright$ I must do well on every single l
end for

Say that the problem is Binary outputm i.e the p_t and y_t are both binary output (space $\mathcal{Y} = 0, 1$) There is exactly

Algorithm 3 Majority voting

Require: N experts

for $t = 1 \rightarrow T$ **do**
  Create expert predictions D
  Algorithm A chooses The Majority $p_t \in D$
  Adversary chooses y_t and l_t
  if $l_t(p_t, y_t) = 1$ **then**
    Throw out the majority
  else
    Keep the majority, no loss incurred
  end if
end for