

Online Classification with Specificity Constraints

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Binary Classification

- **Binary classification** problem, each input is classified into +1 or -1.

$$\text{True positive rate} = \frac{\text{Positives correctly classified}}{\text{Total positives}}$$

$$\text{False positive rate} = \frac{\text{Negatives incorrectly classified}}{\text{Total negatives}}$$

Five discrete classifiers A-E:

D is **perfect**

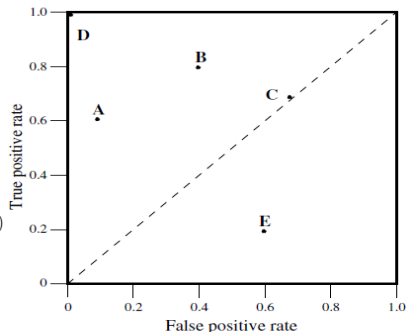
A is more **conservative** than B

(It makes positive classifications only with strong evidence resulting in both low tp-rate and fp-rate.)

C is **random** (no info about the class)

E is **worse than random**

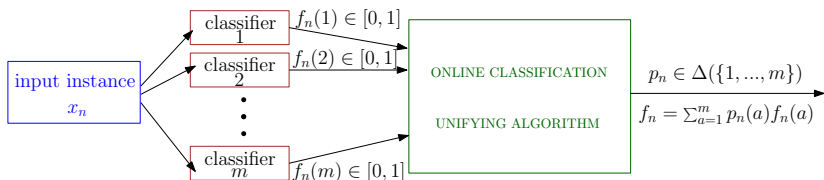
(incorrect info about the class)



- **Typical goal: Maximize true positive rate under false positive rate constraints.**

Online Classification Using Unifying Algorithm

- **Online** classification problem, no training set is given in advance.
- We are given m classifiers, which at each stage $n = 1, 2, \dots$ map the input instance to the probability of the instance to belong to the positive class.
- An **online classification unifying algorithm** combines the outputs of the m classifiers in order to attain a given goal.



Our Goal

Design a **no-regret** unifying algorithm that asymptotically:

(i) Has average true positive rate not worse than the true positive rate of the best convex combination of the m given classifiers (in hindsight),

(ii) Its false positive rate is less than γ , for some $0 < \gamma < 1$,

for any possible sequence of classifiers' outputs and input labels.

This is a special case of the **regret minimization problem with constraints**.

In This Paper We...

- Formulate the online classification problem as a special case of the **regret minimization problem with constraints**.
- Review known results on this problem. In particular, it is known that the above **strict goal is not attainable**, and thus some **relaxation** is needed.
- Propose a relaxed goal, and devise a **computationally efficient** online unifying algorithm that attains this goal.

To the best of our knowledge, this is the **first polynomial algorithm for the regret minimization problem with constraints**.