Winnow Algorithm

Online Learning Algorithms

1. What is Winnow?

Winnow is an online learning algorithm. It learns one example at a time. It is often used when the input has simple yes/no features, such as whether an email contains certain words.

*"The **Winnow Algorithm** is an online machine learning algorithm used to make decisions based on input features. Each feature is assigned a weight that represents its importance. The algorithm calculates a score using the weights of the active features and makes a prediction, such as YES or NO. When it makes a mistake, it updates the weights of the relevant features so that it can make better predictions in the future."*

Five Applications of the Winnow Algorithm with Examples

1. Spam Email Detection: Winnow can learn which words are commonly associated with spam emails. For example, if emails containing the word "prize" are frequently spam, the algorithm increases the importance of that feature after a relevant prediction error.

2. Text Classification: It can classify text into different categories using words as features. For example, a document containing words such as "match," "player," and "score" may be classified as sports-related.

3. Web Page Filtering: It can help identify web pages that match particular topics. For example, a system filtering educational websites may assign higher weights to words such as "tutorial," "lecture," and "course."

4. Online Content Filtering: It can learn to identify unwanted or relevant content from user feedback. For example, if a user repeatedly marks messages containing certain features as unwanted, the algorithm can adjust the corresponding weights.

5. Simple Recommendation Systems: It can learn simple user preferences from feedback. For example, if a user repeatedly likes technology-related articles, the algorithm can increase the weights of features associated with technology content.

Why Is Winnow an Online Learning Algorithm?

Winnow is called an ***online learning algorithm beca***use it learns from one training example at a time, rather than requiring the entire dataset before learning begins. After each example, it makes a prediction and updates its weights if necessary. Therefore, it can continuously learn as new examples arrive.

2. The basic idea

Each feature has a weight. Start every weight at 1. For each example, add the weights of the features that are 1. If the total is at least the threshold (here, 2), predict YES; otherwise, predict NO.

If the prediction is wrong: when the correct answer is YES, multiply the weights of active features by 2. When the correct answer is NO, divide the weights of active features by 2. If the prediction is correct, do not change the weights.

3. Numerical example

Imagine deciding whether an email is spam. Feature A = “contains the word prize”; Feature B = “contains the word offer”. A value of 1 means the feature is present; 0 means absent. Use threshold = 2 and learning factor = 2.

Example	A	B	Correct answer	Score before update	Prediction	Weight update
1	1	0	YES	1	NO (1 < 2)	Wrong: A weight 1 → 2
2	1	0	YES	2	YES (2 ≥ 2)	Correct: no change
3	0	1	NO	1	NO (1 < 2)	Correct: no change

4. Step-by-step calculation

Start: Weight A = 1, Weight B = 1. Threshold = 2.

Example 1: A = 1, B = 0. Score = (1 × 1) + (0 × 1) = 1. Predict NO, but the correct answer is YES. Update active feature A: 1 × 2 = 2.

Example 2: A = 1, B = 0. New score = (1 × 2) + (0 × 1) = 2. Predict YES. Correct, so weights stay A = 2, B = 1.

Example 3: A = 0, B = 1. Score = (0 × 2) + (1 × 1) = 1. Predict NO. Correct, so weights stay A = 2, B = 1.

5. Ex:

Current weights: A = 2, B = 1. Threshold = 2. For the new example, A = 0, B = 1, and the correct answer is YES.

Question	Your answer	Solution
What is the score?	_____	1
What does the algorithm predict?	_____	NO
Is the prediction correct?	_____	No
How should active weight B change?	_____	B: 1 × 2 = 2

Remember: Winnow learns by changing weights only when it makes a mistake. This is a simplified teaching example; Winnow variants may use different thresholds and update rules.