**Decision Trees (ID3, CART)**

**Decision Tree Introduction:** A Decision Tree is a supervised machine learning algorithm used for both classification and regression tasks. It models decisions in a tree-like structure of nodes and branches:

* **Root Node:** The starting point of the tree (entire dataset).
* **Decision Nodes:** Nodes where data is split based on a feature.
* **Leaf Nodes:** Terminal nodes that provide the final prediction (class label or value).

**Working:** It splits the dataset into subsets based on the feature that results in the **best split** using metrics like **Entropy, Gini, or MSE**.

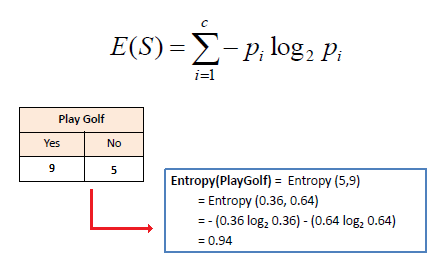
**Types of Decision Trees:**

* ID3
* CART

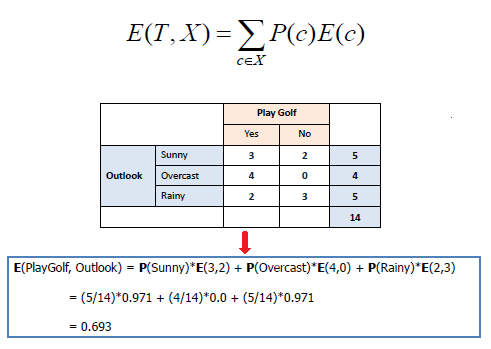
**ID3:** Works as follows:

* Calculate entropy for the dataset.
* For each feature, calculate information gain.
* Select the feature with the highest information gain to split.
* Repeat recursively on subsets until stopping criteria (all same class or no more features).

**Entropy Formula:**

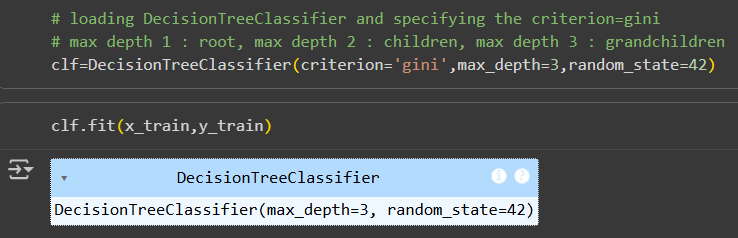


**Information Gain Formula:**



**CART:** Two types of CART:

* **Classification (CART):**
* Input: Features (numeric or categorical).
* Output: Class label (e.g., “spam” or “ham”, “disease” or “no disease”).
* Split criterion: Gini Index or Entropy.



* **Regression (CART):**
* Input: Features (numeric or categorical).
* Output: Continuous value (e.g., house price = 250,000).
* Split criterion: MSE (Mean Squared Error) or MAE (Mean Absolute Error).

