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Implementation

How do we select the best attribute at each node? For all attributes, we compute the information gain if the dataset is split on that attribute:

$$\text{Gain(Attribute)} = \mathcal{I}(p,n) - \left[\frac{p_0+n_0}{p+n}\mathcal{I}(p_0,n_0) + \frac{p_1+n_1}{p+n}\mathcal{I}(p_1,n_1)\right]$$

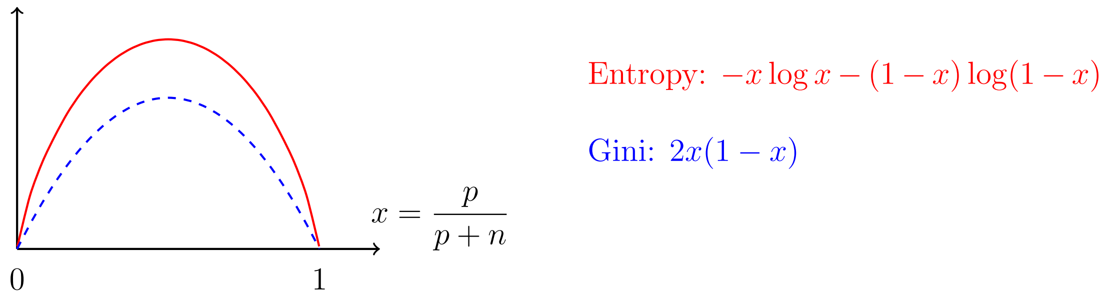
$$\begin{aligned} p_k &= \text{Number of positive examples with attribute} = k \\ n_k &= \text{Number of negative examples with attribute} = k \\ p = p_0 + p_1 &= \text{Number of positive examples before split} \\ n = n_0 + n_1 &= \text{Number of negative examples before split} \end{aligned}$$

There are two common ways to measure information.

Entropy: $$\mathcal{I}(p,n) = -\frac{p}{p+n}\log\frac{p}{p+n} - \frac{n}{p+n}\log\frac{n}{p+n} \qquad \text{if } p,n \neq 0$$
$$\mathcal{I}(p,0) = \mathcal{I}(0,n) = 0$$

Gini impurity: $$\mathcal{I}(p,n) = \frac{p}{p+n}\left(1-\frac{p}{p+n}\right) + \frac{n}{p+n}\left(1-\frac{n}{p+n}\right)$$

We used entropy since it's stated in the specification, but Gini impurity is faster to compute. Both metrics should give similar results since their graphs have a similar shape:



When comparing their graphs, their relative heights do not matter because minimizing a function is equivalent to minimizing any positive multiple of that function.

To evaluate our decision tree, we performed cross validation as follows:

1. Shuffle the dataset and split it into $K = 10$ parts
2. For each $k \in \{1, \cdots, K\}$ we train the decision tree on the dataset *excluding* part k and then test the decision tree on part k. During testing, the relevant cells in the confusion matrix are incremented.

Evaluation

Each cell of the confusion matrix is a total, not an average, over *all* folds of cross validation.

Predicted	Actual					
	Anger	Disgust	Fear	Happiness	Sadness	Surprise
Anger						
Disgust						
Fear						
Happiness						
Sadness						
Surprise						

From the confusion matrix above, we can compute these summary statistics:

	Anger	Disgust	Fear	Happiness	Sadness	Surprise
Precision						
Recall						
F_1 score						

Miscellaneous

Noisy-Clean Datasets Question

The noisy dataset has lower performance.

Ambiguity Question

In case our 6 trees predict that an image depicts more than 1 emotion, we considered the following methods of selecting 1 emotion:

1. Pick the first emotion in alphabetical order
This is effectively selecting an emotion at random.

2. Disable each active unit in turn, and take a majority vote
Example:

Pruning Question