Basics

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1 Activation Functions

Sigmoid function

$$\sigma(x) = \frac{1}{1+e^{-x}}. \tag{1}$$

Softmax function

$$\text{Softmax}(x_i) = \frac{e^{x_i}}{\sum_{k=1}^{n} x_k}. \tag{2}$$

ReLU function

$$\text{ReLU}(x) = \begin{cases} 0 & \text{if } x < 0 \\ x & \text{otherwise} \end{cases}. \tag{3}$$

2 Evaluation Metrics

2.1 Binary Classification

In the binary classification, there are two sample classes: positive and negative. We define the following concepts:

- True Positive (TP): The number of samples that are correctly identified as positive.
- True Negative (TN): The number of samples that are correctly identified as negative.
- False Positive (FP): The number of samples that are indeed negative but identified as positive.
- False Negative (FN): The number of samples that are indeed positive but identified as negative.

Accuracy Accuracy measures how many *samples* are correctly predicted in *all predictions*.

$$\text{Accuracy} = \frac{\text{TP} + \text{TN}}{\text{TP} + \text{TN} + \text{FP} + \text{FN}}. \tag{4}$$

Precision Precision measures how many *positive samples* are correctly predicted in *all positive predictions*.

$$\text{Precision} = \frac{\text{TP}}{\text{TP} + \text{FP}}. \tag{5}$$

Recall Recall measures how many *positive samples* are correctly predicted in *all positive samples*.

$$\text{Recall} = \frac{\text{TP}}{\text{TP} + \text{FN}}. \tag{6}$$

F_1-Score F_1-score is a combination of Precision and Recall.

$$F_1 = \frac{1}{\text{Precision}^{-1} + \text{Recall}^{-1}} = 2 \cdot \frac{\text{Precision} \cdot \text{Recall}}{\text{Precision} + \text{Recall}} = \frac{\text{TP}}{\text{TP} + \frac{1}{2}(\text{FP} + \text{FN})}. \tag{7}$$

AUC Area under the receiver operating characteristic (ROC) curve.

Remark

- When the classes of samples are imbalanced, accuracy may not be a good metric to evaluation the prediction performance. Considering other four metrics.
- When the cost of identifying positive samples as negative is high, i.e., we want to decrease FP, considering improving Precision. When the cost of identifying negative samples as positive is high, i.e., we want to decrease FN, considering improving Recall.