Machine Learning- Exercise 3

AdaBoost

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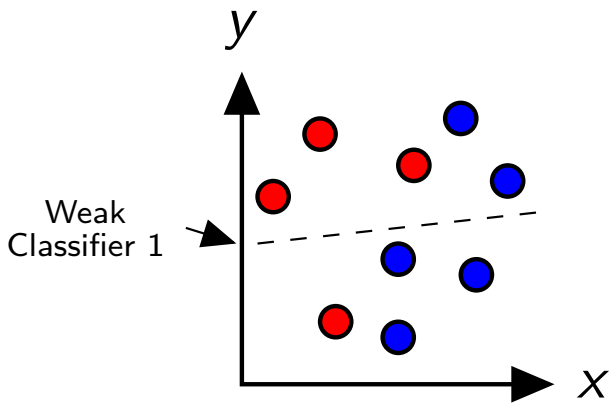
Adaboost[Freund & Schapire, 1996]-Recap

- Main idea
  - Instead of resampling, reweight misclassified training examples.
    - Increase the chance of being selected in a sampled training set.
    - Or increase the misclassification cost when training on the full set.
- Components
  - $c_k(\mathbf{x})$: "weak" or base classifier
    - Condition: $< 50\%$ training error over any distribution
  - $C(\mathbf{x})$:"strong or final classifier
- Adaboost:
  - Construct a strong classifier as a thresholded linear combination of the weighted classifiers:

$$C(\mathbf{x}) = \text{sign}\left(\sum_{k=1}^{K} \alpha_k c_k(\mathbf{x})\right)$$

Adaboost - Recap

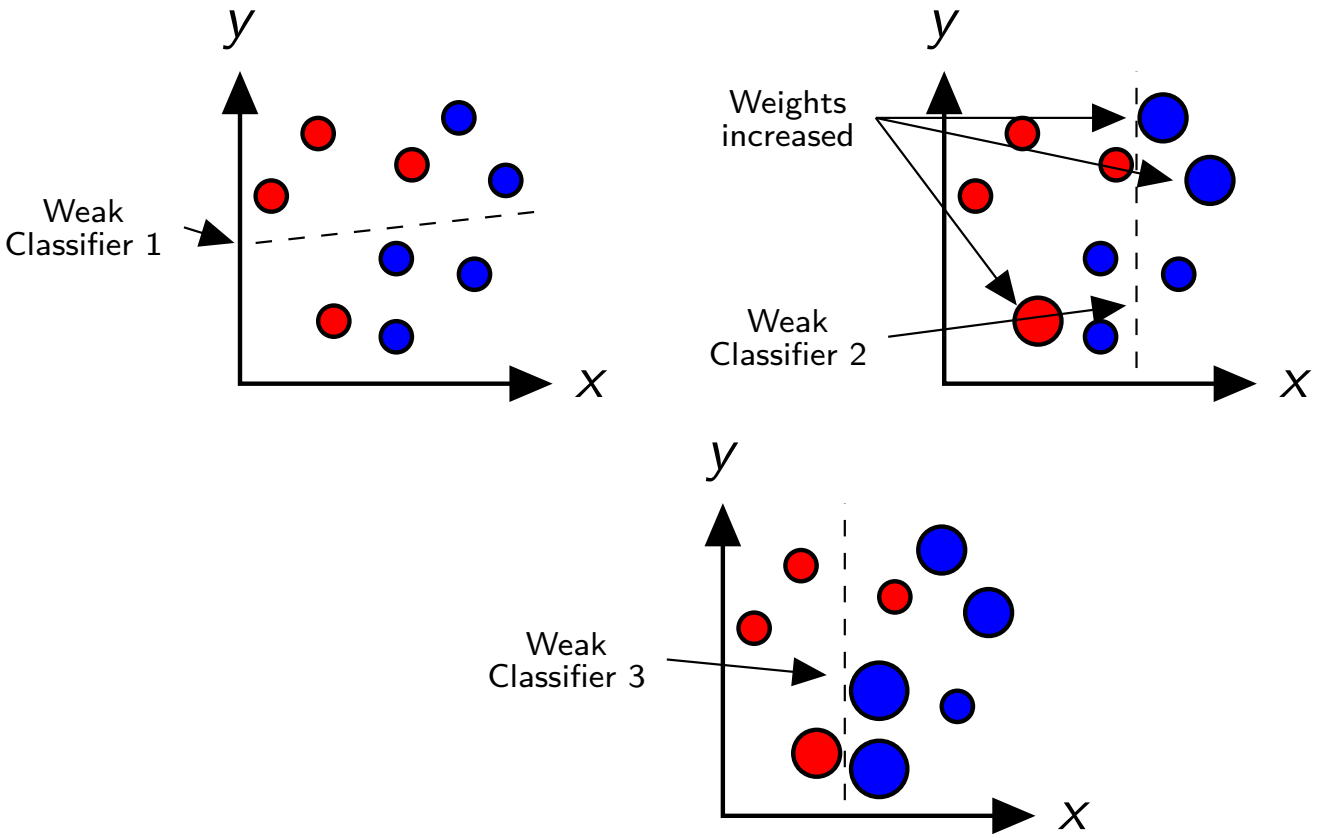


Consider a 2D feature space with positive and negative examples.

Each weak classifier splits the training examples with at least 50% accuracy.

Examples misclassified by a previous weak learner are given more emphasis at future rounds.

Adaboost - Recap



- Final classifier is combination of the weak classifiers.

Adaboost - Algorithm

- Initialization: Set $w_n^{(1)} = \frac{1}{N}$ for $n = 1, \ldots, N$.
- For $k = 1, \ldots, k$ iterations
  - Train a new weak classifier $c_k(\mathbf{X})$ using current weights $\mathbf{W}^{(k)}$ by minimizing the weighted error function
  - estimate the weighted error of this classifier on $\mathbf{X}$:

$$\epsilon_k = \frac{\sum_{n=1}^{N} w_n^{(k)} I(c_k(\mathbf{X}) \neq y_n)}{\sum_{n=1}^{N} w_n^{(k)}}$$

  - Calculate a weighting coefficient for $c_k(\mathbf{X})$:

$$\alpha_k = \ln \left\{ \frac{1 - \epsilon_k}{\epsilon_k} \right\}$$

  - Update the weighting coefficients:

$$w_n^{(k+1)} = w_n^{(k)} \exp\{\alpha_k I(c_k(\mathbf{X}) \neq y_n)\}$$