1 Supervised learning

Method where you train the program by feeding the learning algorithm with a mapping of inputs to correct outputs.

1.1 Regression

Regression is curve fitting: learn a continuous input $\rightarrow$ output mapping from a set of examples.

1.2 Classification

Outputs are discrete variables (category labels). Learn a decision boundary that separates one class from the other. Generally, a confidence is also desired, i.e., how sure are we that the input belongs to the chosen category.

1.3 Training set

The training set is a set of m $(X,\, y)$ pairs, where:

$$\begin{aligned} X \in \mathbb{R}^d & \quad \text{models the input.} \\ y \in \{0, 1\} & \quad \text{models the output.} \end{aligned}$$

1.4 Error function

The error function for a model $f : X \mapsto y$ parameterized by W applied to a dataset $\{(X,\, y)\}$ of size m is:

$$\min_W \sum_{i=1}^{m} \left(f_W(X_i) - y_i\right)^2$$

1.5 Perceptron

Perceptron is the trivial neural network. The model for a parameter $W = (\text{threshold}, w_1, \ldots, w_d)$ and inputs of the form $(1, x_1, \ldots, x_d)$ is given by

$$f_W(X) = \text{sign}(W^\top X)$$

If x_i is evidence for approval, then w_i should be high.
If x_i is evidence for denial, then w_i should be low.

1.5.1 Learning algorithm

The learning algorithm of the Perceptron is quite simple. For a training set $S = \{\, (X_1,\, y_1),\ \ (X_1,\, y_1),\ \ \ldots\}$

- Show each sample in sequence repetitively.
- If the output is correct, do nothing.
- If the produced output is negative, and the correct output is positive, increase/decrease the weights whose inputs are positive/negative.
- If the produced output is positive, and the correct output is negative, decrease/increase the weights whose inputs are positive/negative.

2 Reinforcement learning

Method where you train the program by rewarding the learning algorithm positively or negatively according to the produced results. This method is similar to how we teach animals.

3 Unsupervised learning

Given only inputs as training, find a pattern: discover clusters, manifolds, embedding.