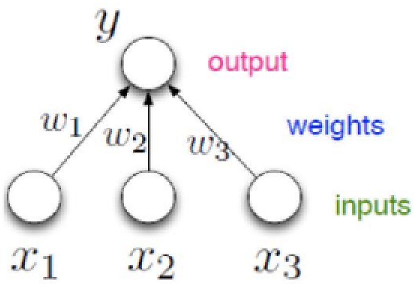
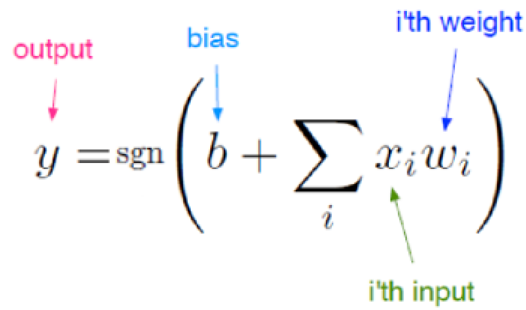
Week 3 Note

Perceptron

- Perceptron aka McCulloch-Pitts Neuron





- Perceptron Algorithm
  1: Initialize $w = 0$
  2: while All training examples are not correctly classified do
  3: for $(x, y) \in S$ do
  4: if $y \cdot w^T x \leq 0$ then
  5: $w \leftarrow w + yx$

  > We assume no bias for simplicity:
  >
  > - Loop over each (feature, label) pair in the dataset
  > - If the pair (x, y) is misclassified
  > - Update the weight vector w

- Gradient Descent for One-Layer NN
  - 1: Initialize $w^{(1)} = 0, b^{(1)} = 0$
  - 2: for $t = 1, 2, \ldots, T$ do
    3: Use (3), (2) to compute gradients

$$\nabla w = -\frac{1}{n} \sum_{i=1}^{n} \frac{\partial C_i(w^{(t)})}{\partial w^{(t)}}$$
$$\nabla b = -\frac{1}{n} \sum_{i=1}^{n} \frac{\partial C_i(w^{(t)})}{\partial b^{(t)}}$$

  - 4: Update the model

$$w^{(t+1)} = w^{(t)} - \eta_t \nabla w$$
$$b^{(t+1)} = b^{(t)} - \eta_t \nabla b$$

> T is the number of iterations

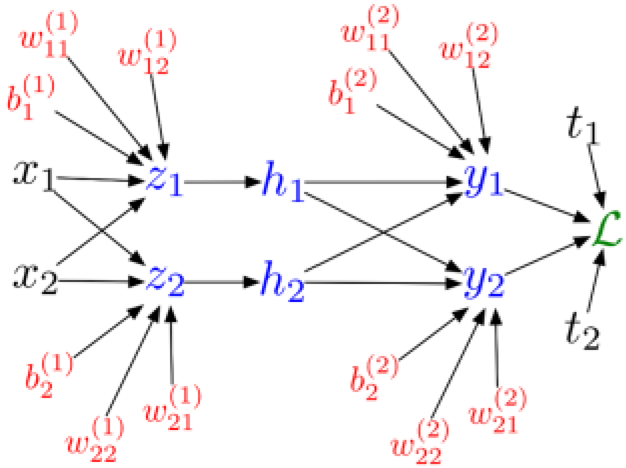
- Soft perceptron
- Chain rule

$$\frac{\partial}{\partial t} f = \frac{\partial f}{\partial g} \frac{\partial g}{\partial t}$$

- Gradient descent

$$\frac{\partial}{\partial w_i} C = (\sigma(\sum_{j}^{m} w_j x_j + b) - y)\, \sigma'(\sum_{j}^{m} w_j x_j + b)\, x$$

- Backpropagation Algorithm
    - `Forward pass`: Move forward through graph to compute all intermediate results
    - `Backward pass`: Move backward through graph compute all gradients
- Computation Graphs
    - Directed and acyclic
    - Nodes: variables
    - Edges: computation
    - Enable calc. of gradients
- Backpropagation
    - Efficient computation of gradients
    - Forward pass to compute values
    - Backward pass to compute gradients
        - Use successor result



Roger Grosse: CSC 311 Spring 2020: Introduction to Machine Learning