Day 2 - Backpropagation Algorithm

Tags	
	Artificial Neuron, BackPropagation, Bias, Epoch, FeedForward, NeuralNetwork, ReversePass, Training, Weights

Backpropagation Algorithm

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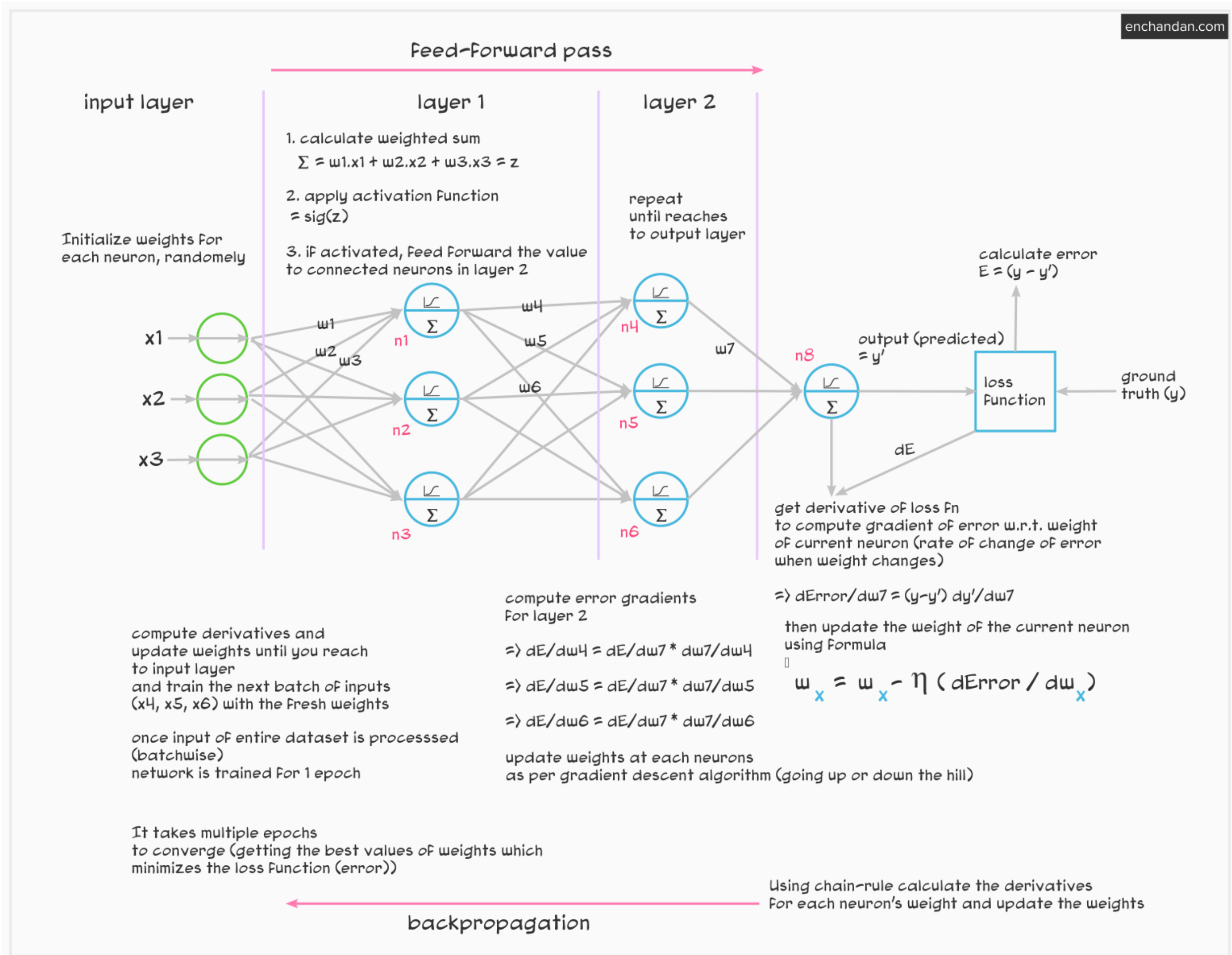
Training Process in One Picture



Context

Suppose our training dataset has 10,000 inputs

We choose the batch_size of 32

Iterations required to process entire dataset once → $10000/32 \approx 312$

Steps

- First iteration, take **32 inputs**, so **32 neurons** required at the Input layer (say $x1, x2, x3 ... x32$)

- **Initialize the weights randomly** for each input neuron and pass the values (input value and weights) to the next layer
- At each neuron in the input layer
  1. Calculate the weighted sum
     $z = \sum wx + b$
     $z = w1.x1 + w2.x2 + w3.x3 + ... + w32.x32 + bias$

     Note: I have not mentioned bias neuron in the picture above (as it's optional in the neural network)
  2. Apply activation function
     $sig(z)$
  3. If activated, feed-forward (pass it to next connected neuron) the value to the connected neurons in the next layer - layer2
- Each layer keeps the computation done on each of it's neurons (weighted sum, parameters etc). As it will be used during reverse pass.
- Repeat until you reach to the **Output layer**
- The activated weighted sum at the Output layer is the prediction (for regression problem at least, for classification problem, we might need to apply function like `Softmax()` to get the prediction)
- Compare predicted output with the ground truth and compute the error using a loss function e.g. **MSE** (Mean squared error)
- We can observe, weights are the variable elements which are affecting our prediction finally. So get derivative of the loss function w.r.t. the weights of the current neuron (Output layers) to compute the error gradients

  $$Error\ Gradient = \frac{\delta Error}{\delta w}$$

- Update weights at the current neuron as per Gradient Descent Step

  $$w_x^{new} = w_x - \eta(\frac{\delta Error}{\delta w})$$

  where η is learning rate (e.g. 0.001)

- Move to the previous layer in the network and using chain-rule calculate error gradients for that layer and update the weights of all the neurons in that layer
- Repeat the process until you reach to the **Input layer**
- You'll have fresh weights on the input neurons. Now take another batch of 32 inputs and train the network using the fresh weights
- Once the entire training dataset is processed. you have completed training an epoch.
- Usually it takes multiple epochs to converge (getting the best values of weights which minimizes the chosen loss function of the network)