

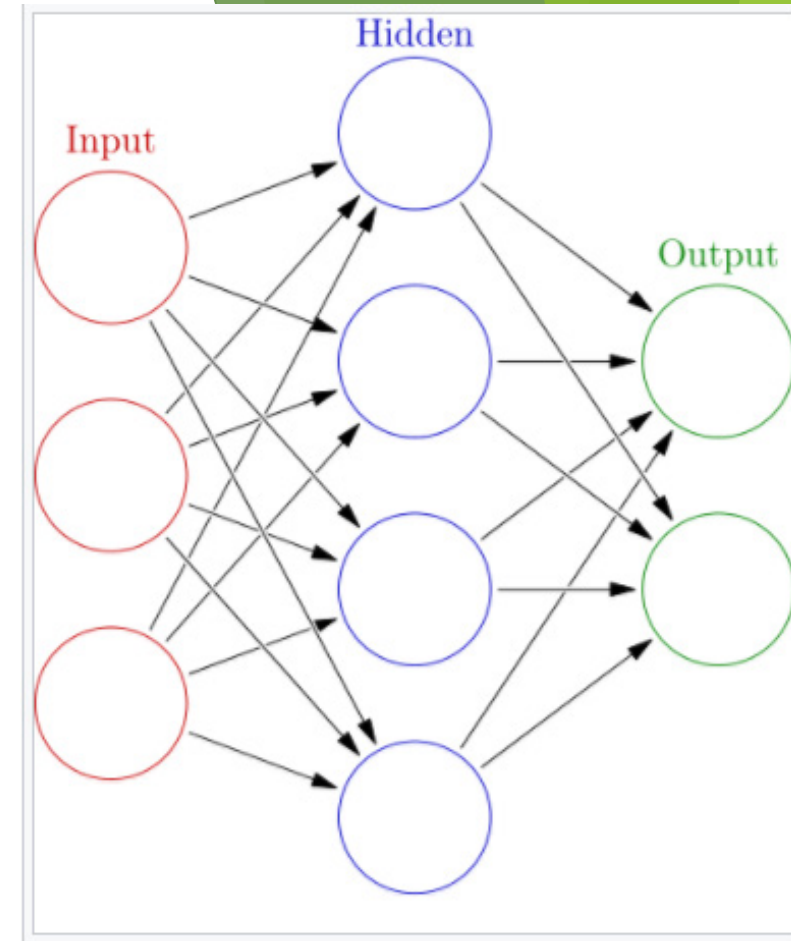
Back propagation

Outline

- ▶ Gradient descent
- ▶ Forward propagate and Back propagation
- ▶ Easy Example by tensorflow
- ▶ Homework

Gradient descent

- ▶ Neural network have many neural node
- ▶ Each neural node have its own weight and bias to compute its output
- ▶ Neural network output and Label(real answer) compute Loss function
- ▶ Know how far between output and Label(real answer) by Loss function



- ▶ Cost function is computed by output and real answer
- ▶ Output is computed by weight and bias
- ▶ Cost function is structured by weight and bias

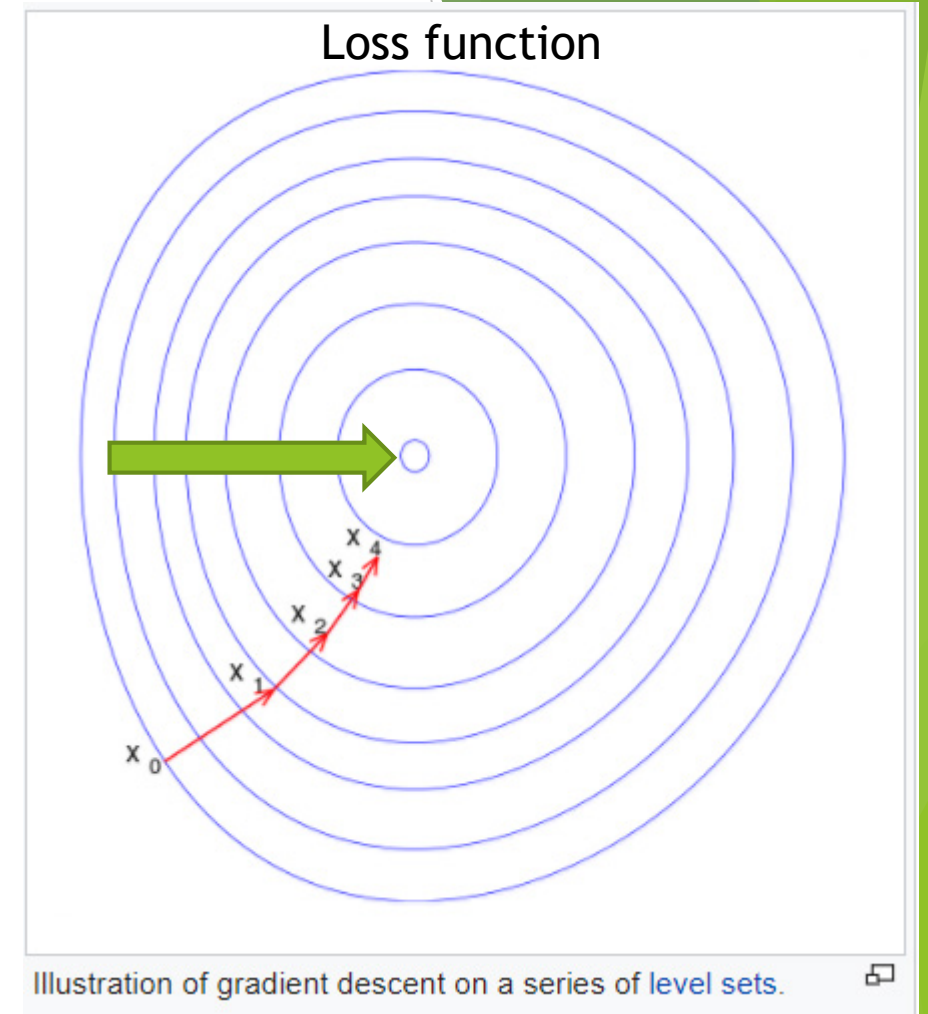
direction of the negative gradient

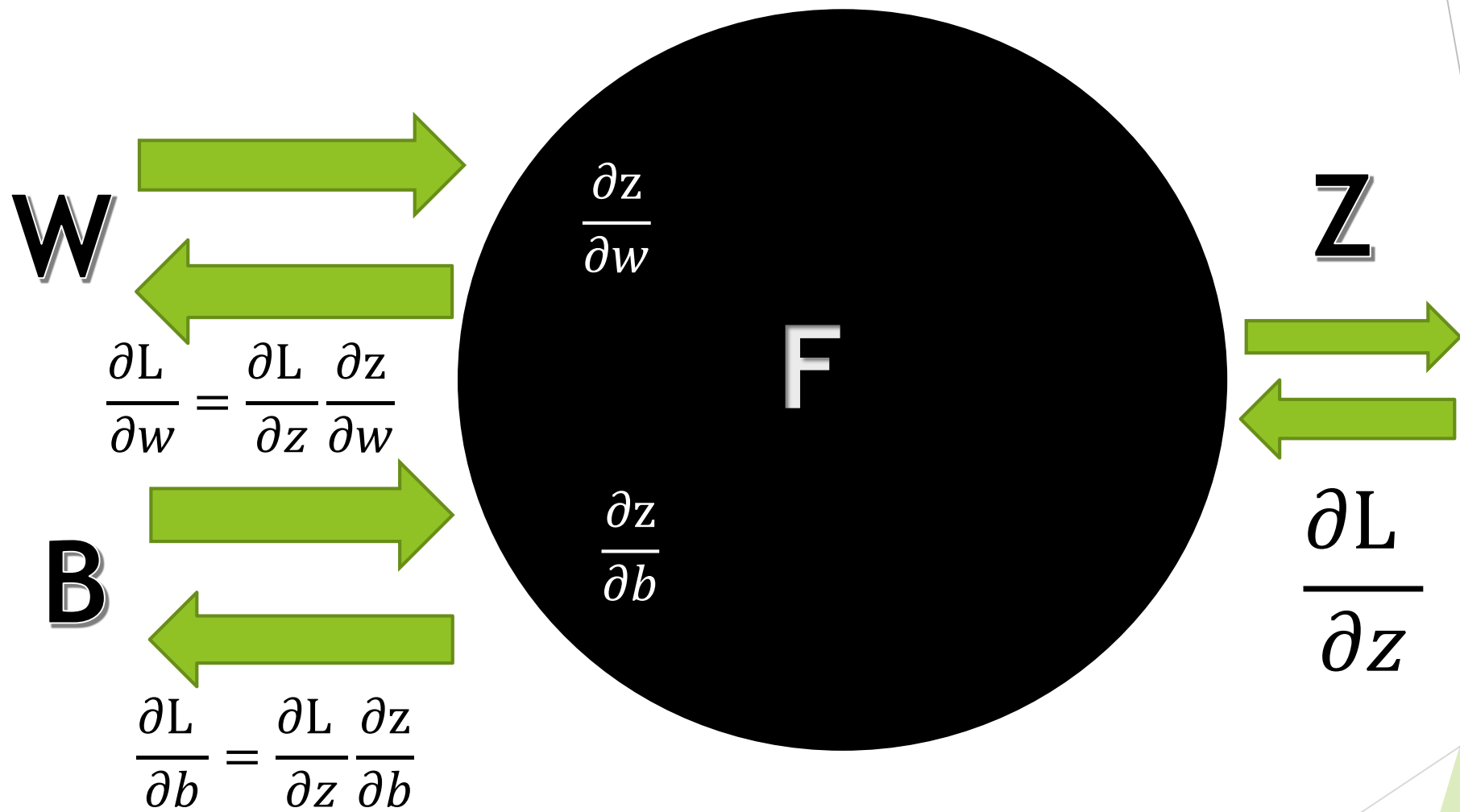
$$\mathbf{a}_{n+1} = \mathbf{a}_n - \gamma \nabla F(\mathbf{a}_n)$$

$$\mathbf{x}_{n+1} = \mathbf{x}_n - \gamma_n \nabla F(\mathbf{x}_n), \quad n \geq 0.$$

We have

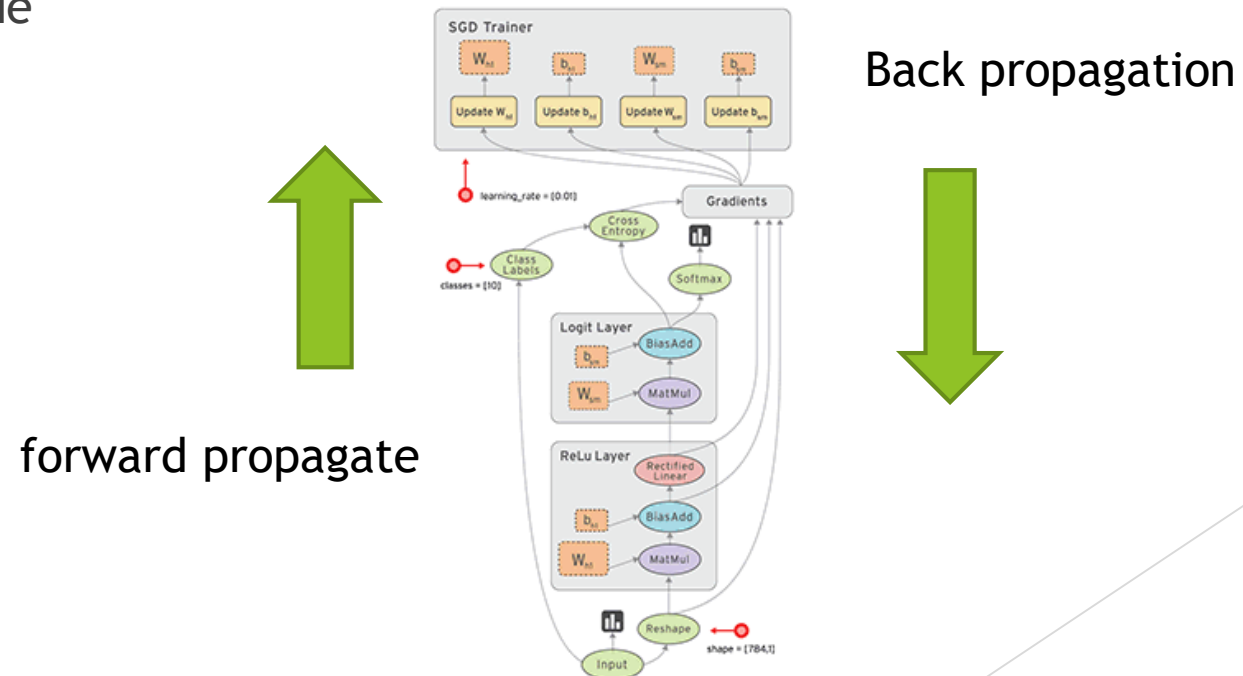
$$F(\mathbf{x}_0) \geq F(\mathbf{x}_1) \geq F(\mathbf{x}_2) \geq \cdots,$$





Forward propagate and back propagation

- ▶ Forward propagate: know neural network behaving and get the neural networks output
- ▶ Back propagation : derivative of error(Loss function) ,update weights to minima for error value



Easy example by tensorflow

- ▶ 3 x [1,3] input , 3 x [1] real answer
- ▶ hidden layer_1 have 3 input and 2 output
- ▶ hidden layer_2 have 2 input and 1 output
- ▶ Activation function : sigmoid
- ▶ loss function : Mean squared error
- ▶ Optimizer : Gradient Descent

Prepare data

```
#training data
train_1 = np.array( [[1.,2.,3.],
                    [3.,4.,5.],
                    [8.,5.,7.],
                    [7.,1.,8.]] )
train_2 = np.array( [[1.],
                    [0.],
                    [0.],
                    [1.]] )
```

Prepare input

```
input_1 = tf.placeholder(tf.float32, shape = [None, 3])  
input_2 = tf.placeholder(tf.float32, shape = [None, 1])
```

Prepare hidden layer

```
weight_1 = tf.get_variable(name='weight_1', shape = [3,2], dtype = tf.float32, initializer =  
    tf.truncated_normal_initializer(mean=0.0, stddev=0.1) )  
bias_1 = tf.get_variable(name='bias_1', shape = [2], dtype = tf.float32, initializer =  
    tf.truncated_normal_initializer(mean=0.0, stddev=0.1) )  
layer_1_output = tf.add(tf.matmul( input_1, weight_1 ), bias_1)  
  
weight_2 = tf.get_variable(name='weight_2', shape = [2,1], dtype = tf.float32, initializer =  
    tf.truncated_normal_initializer(mean=0.0, stddev=0.1) )  
bias_2 = tf.get_variable(name='bias_2', shape = [1], dtype = tf.float32, initializer =  
    tf.truncated_normal_initializer(mean=0.0, stddev=0.1) )  
layer_2_output = tf.sigmoid( tf.add(tf.matmul( layer_1_output, weight_2 ), bias_2) )
```

Prepare loss function

```
loss = tf.losses.mean_squared_error(train_2, layer_2_output)
```

Prepare optimizer

```
optimizer = tf.train.GradientDescentOptimizer(0.1)
```

Prepare How to train

```
train = optimizer.minimize(loss)
```

Prepare session to start train

```
with tf.Session() as sess:
    #initial
    init = tf.global_variables_initializer()
    sess.run( init )
    #train
    for step in range(201) :
        if step % 20 == 0:
            print ('loss : ', sess.run(loss, feed_dict = {input_1: train_1, input_2: train_2}))
            print ('predict : ', sess.run(layer_2_output, feed_dict = {input_1: train_1}))
            sess.run(train, feed_dict = {input_1: train_1, input_2: train_2})
```

```

#training data
train_1 = np.array( [[1.,2.,3.],
                    [3.,4.,5.],
                    [8.,5.,7.],
                    [7.,1.,8.]] )
train_2 = np.array( [[1.],
                    [0.],
                    [0.],
                    [1.]] )

```

```

loss : 0.251956
predict : [[ 0.46995696]
 [ 0.47192109]
 [ 0.47451538]
 [ 0.471793  ]]
loss : 0.247058
predict : [[ 0.47125581]
 [ 0.46566859]
 [ 0.46073726]
 [ 0.47128811]]
loss : 0.23654
predict : [[ 0.46862936]
 [ 0.44731638]
 [ 0.42845353]
 [ 0.47071627]]
loss : 0.0668569
predict : [[ 0.57679796]
 [ 0.27093837]
 [ 0.08406196]
 [ 0.91137868]]
loss : 0.0565343
predict : [[ 0.61291397]
 [ 0.26089114]
 [ 0.05567734]
 [ 0.92832458]]
loss : 0.0481612
predict : [[ 0.64426953]
 [ 0.24730685]
 [ 0.03547321]
 [ 0.93932498]]

```


Homework

Data.txt

1	2	3	5	7	9	5	4	8	6	9	5	1	2	3	5	4	8	6	5	4	1	2	5	8	6	9	4	2	2	4	1	↓
3	4	5	8	4	2	5	1	4	8	6	8	5	2	3	4	5	8	7	4	1	2	3	8	4	5	2	1	8	6	9	9	↓
8	5	7	9	4	2	5	8	4	2	6	9	8	7	5	1	2	5	8	7	5	2	3	8	7	5	6	2	5	8	6	2	↓
7	1	8	7	8	5	5	1	2	3	6	5	4	7	8	9	5	4	2	3	6	8	7	5	1	2	3	5	4	8	7	2	↓
4	2	5	4	5	5	7	1	8	7	8	5	7	1	8	7	8	5	7	1	8	7	8	5	7	1	8	7	8	5	2	1	↓

Answer.txt

| 1 0 0 1 0 ←

- ▶ Any number hidden layer you want
- ▶ Activation function : Anything you wanted
- ▶ loss function : Anything you wanted
- ▶ Optimizer : Anything you wanted
- ▶ Need demo

grade

- ▶ 0.005 : 1
- ▶ 0.001 : 2
- ▶ 0.0003 : 3
- ▶ 0.0006 : 4
- ▶ Use add layer function : +1

```
loss : 0.000501916
predict : [[ 0.97440165]
 [ 0.01172936]
 [ 0.01904387]
 [ 0.97416872]
 [ 0.02620688]]
```