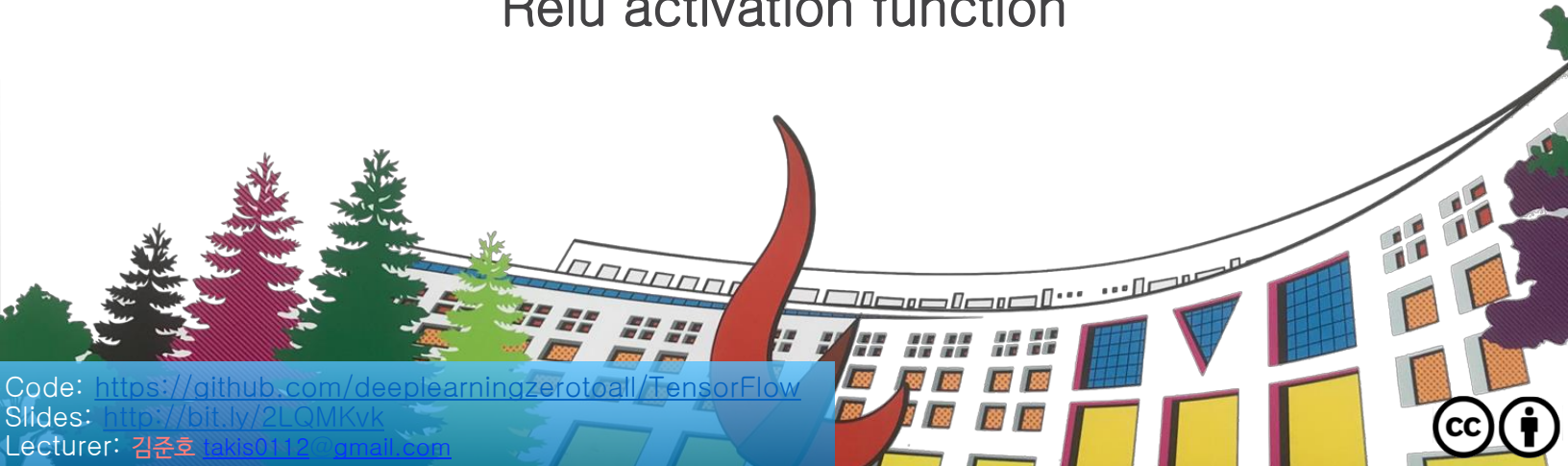
ML/DL for Everyone Season2

with TensorFlow

Lab10-1
Relu activation function



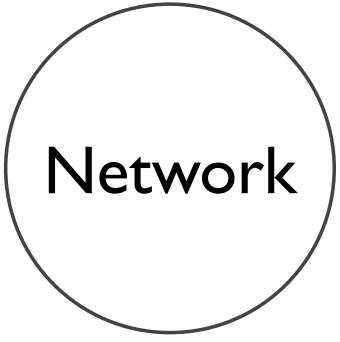
Code: https://github.com/deeplearningzerotoall/TensorFlow
Slides: http://bit.ly/2LQMKvk
Lecturer: 김준호 takis0112@gmail.com

Lab10-1: Relu activation function

- Problem of Sigmoid sigmoid의 문제점
- Why Relu ?
- Code
  - ○ load dataset
  - ○ create network
  - ○ define loss function
  - ○ experiments
    - parameters
    - model
    - eager mode
- What's Next

Problem of Sigmoid

Problem of Sigmoid



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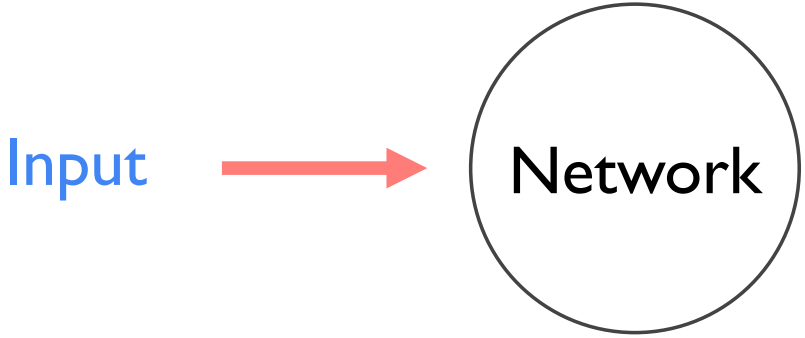
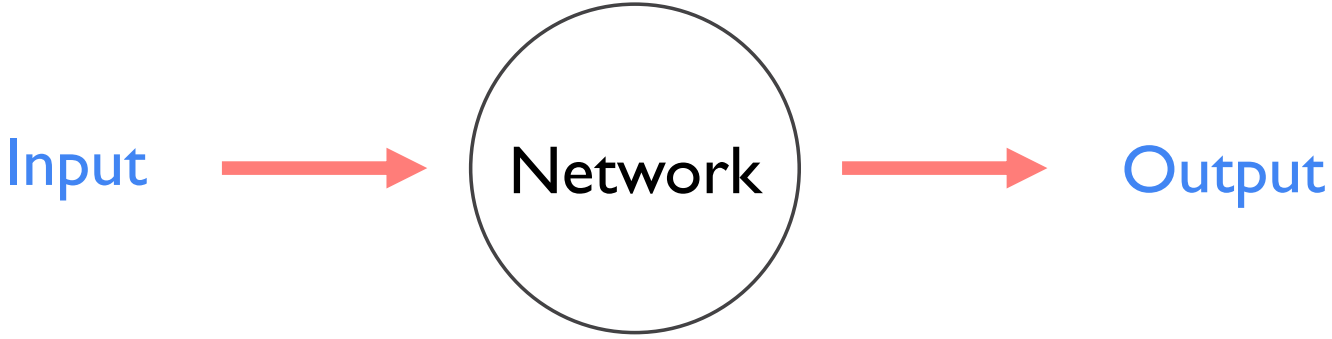


NEURAL NETWORK

Problem of Sigmoid



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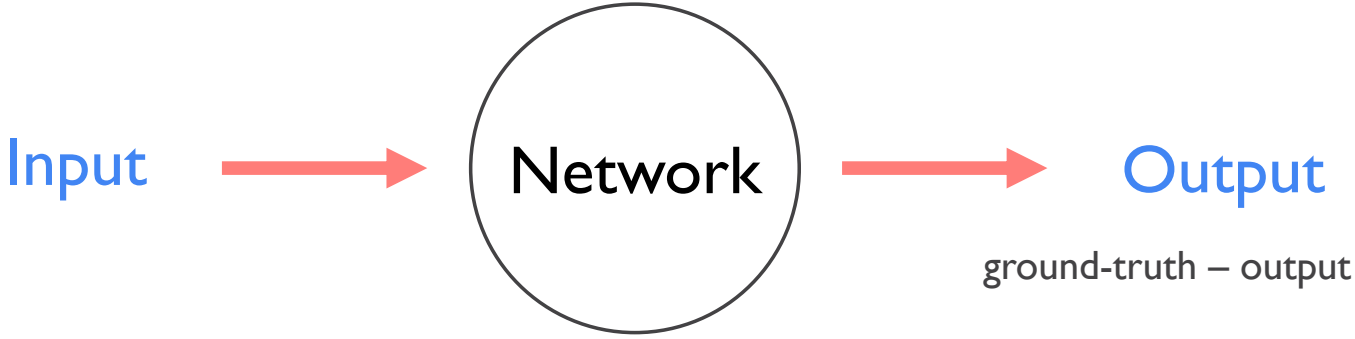

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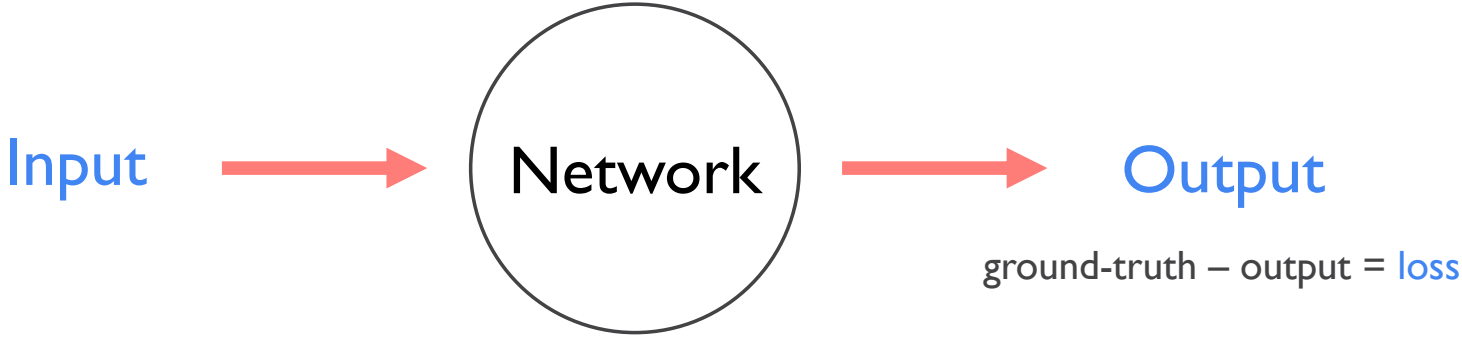

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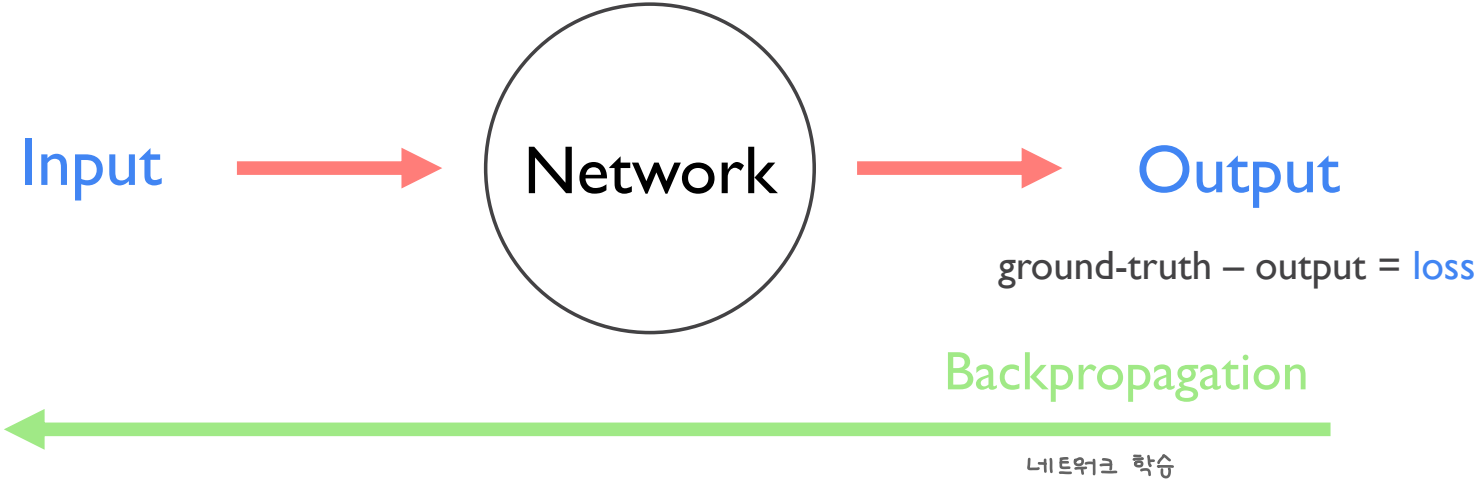

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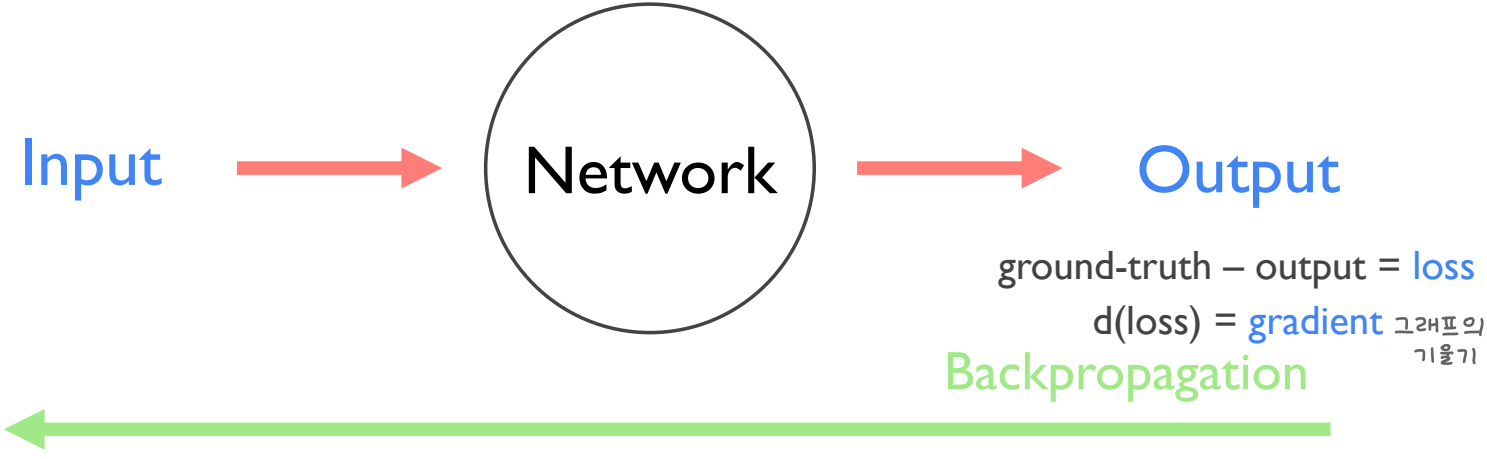

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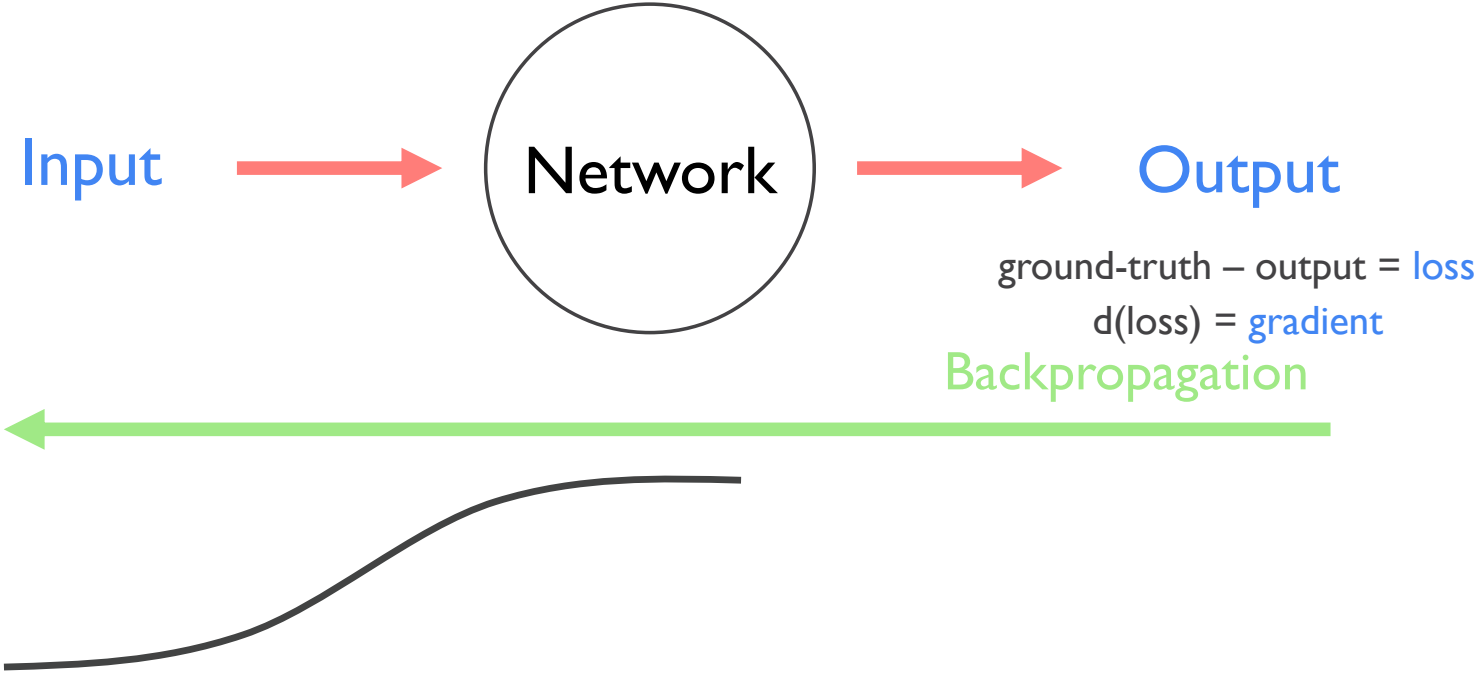

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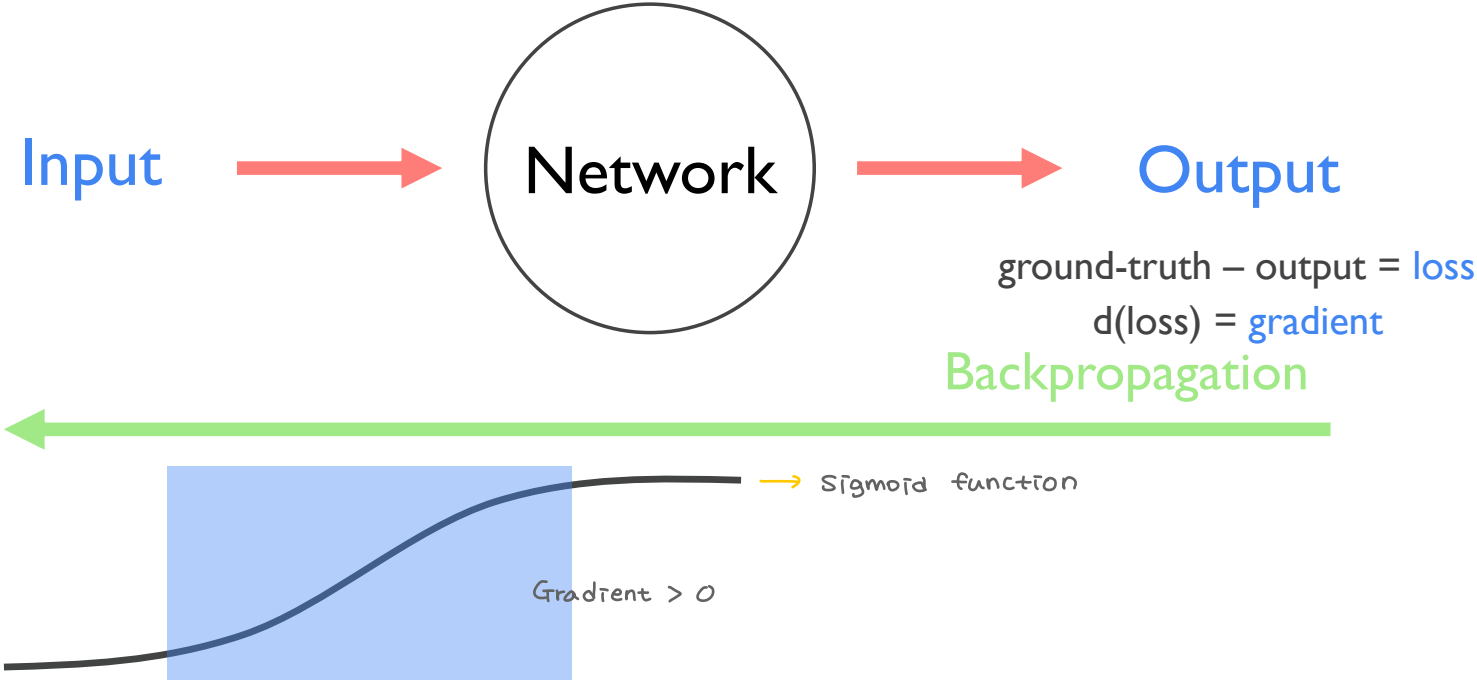

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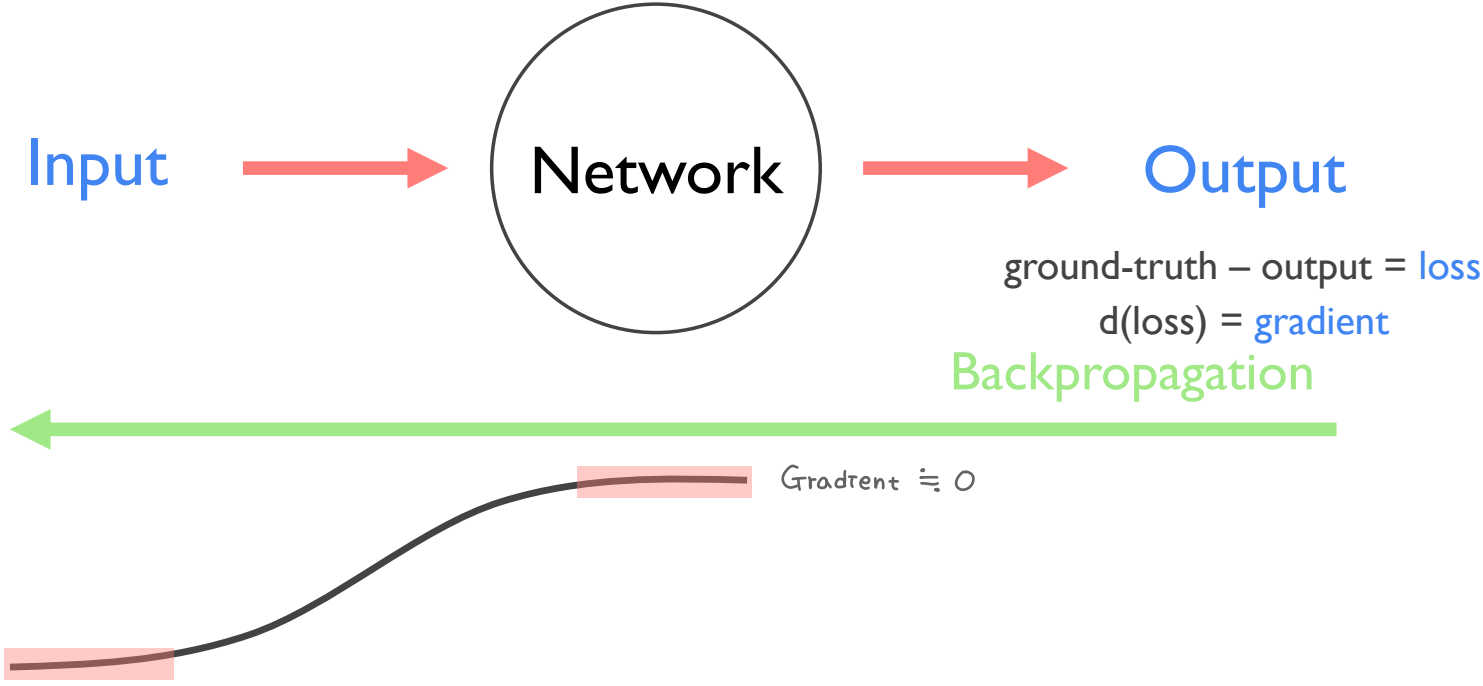

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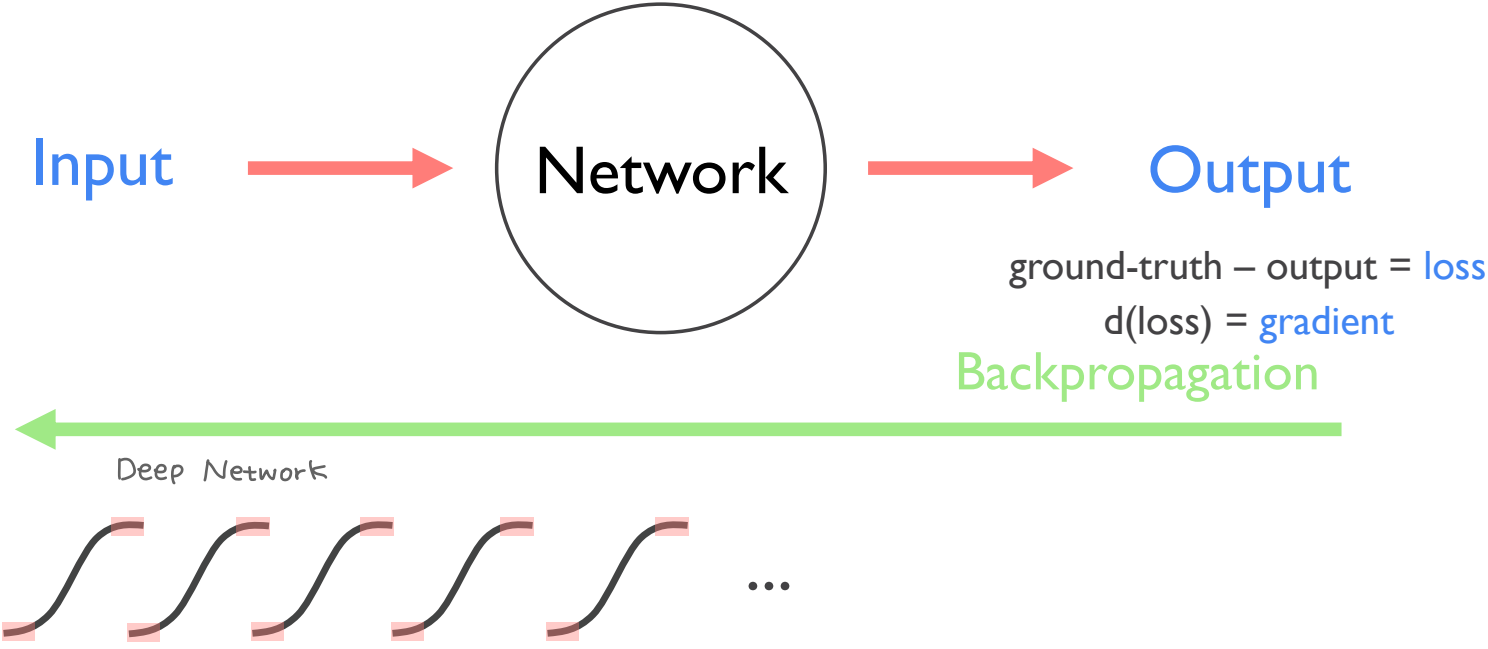

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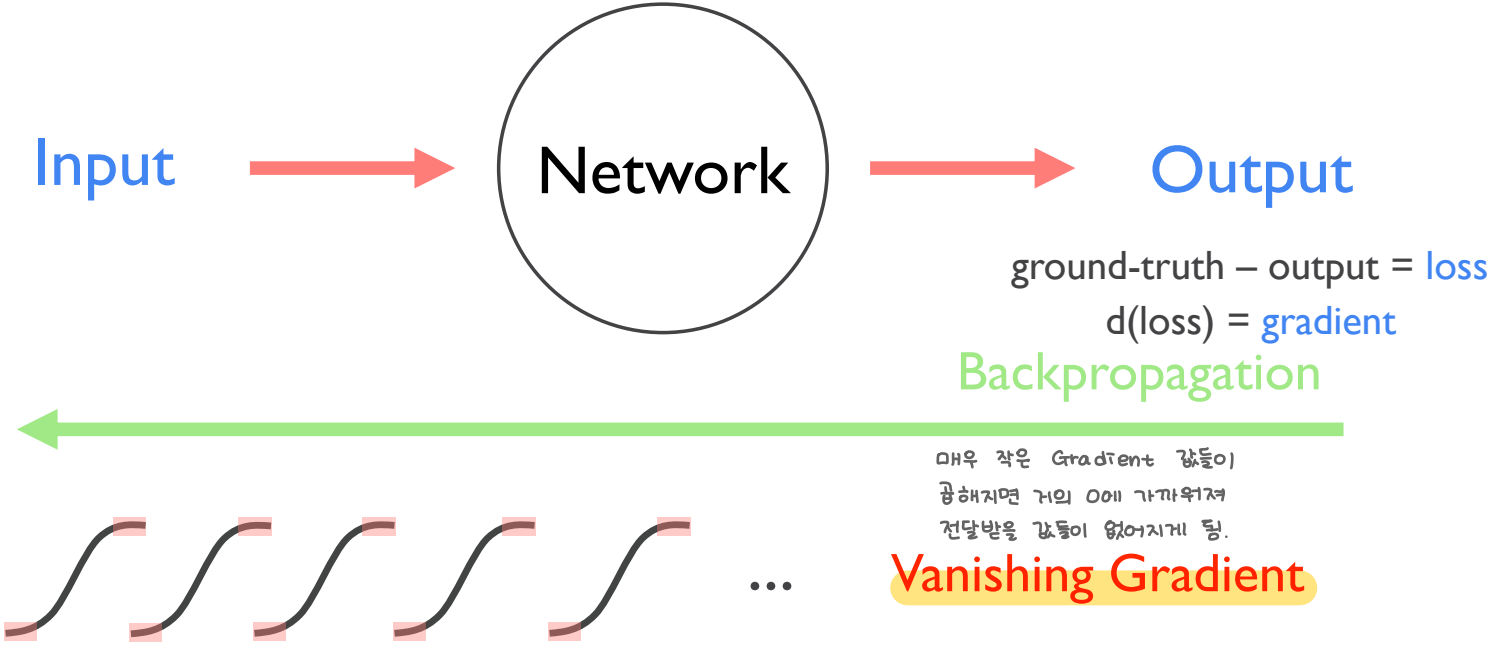

Why Relu ?

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$$f(x) = \max(0, x)$$

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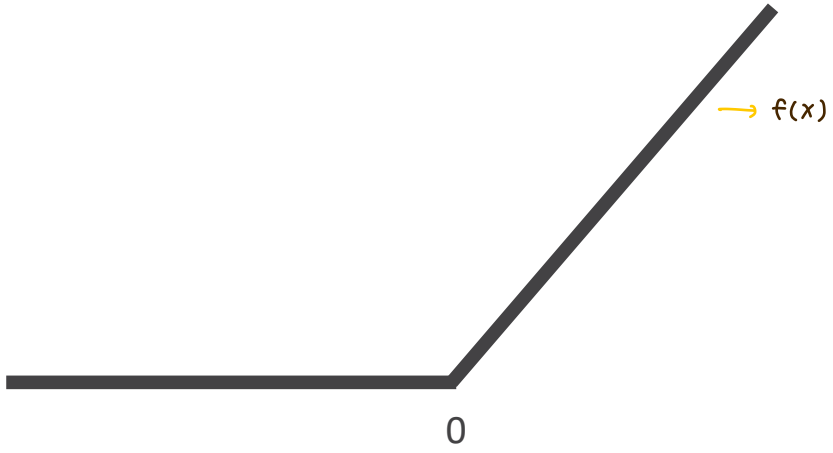

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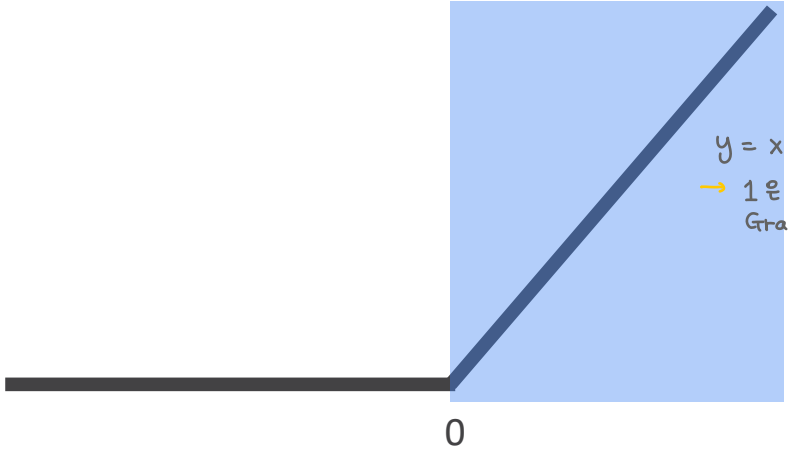


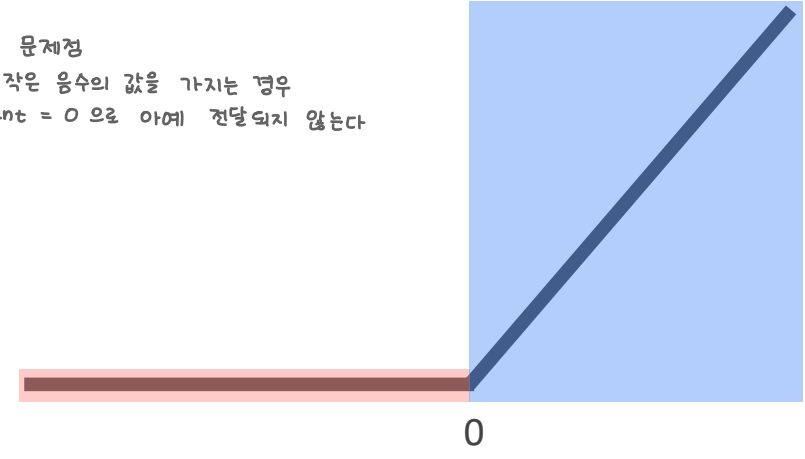
y = x , Gradient = 1

→ 1은 아무리 곱해도 1이기 때문에 Gradient 전달 잘 된다

Why Relu ?

$$f(x) = \max(0, x)$$

* Relu의 문제점
  0보다 작은 음수의 값을 가지는 경우
  Gradient = 0 으로 아예 전달되지 않는다



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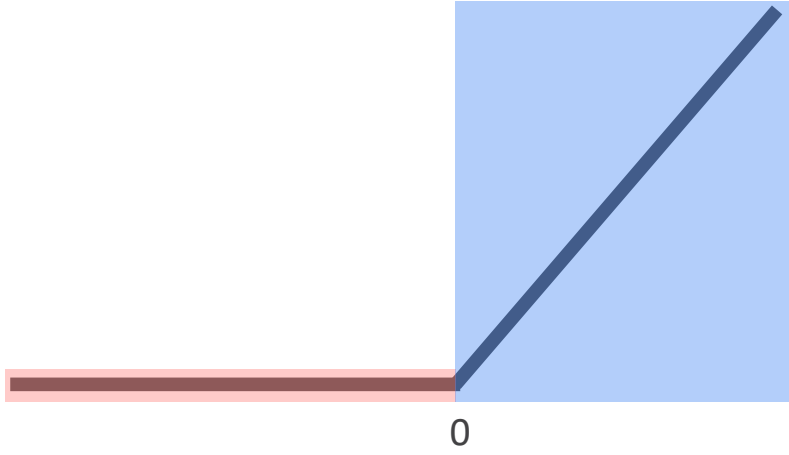

sigmoid, tanh
relu, elu, selu

Why Relu ?

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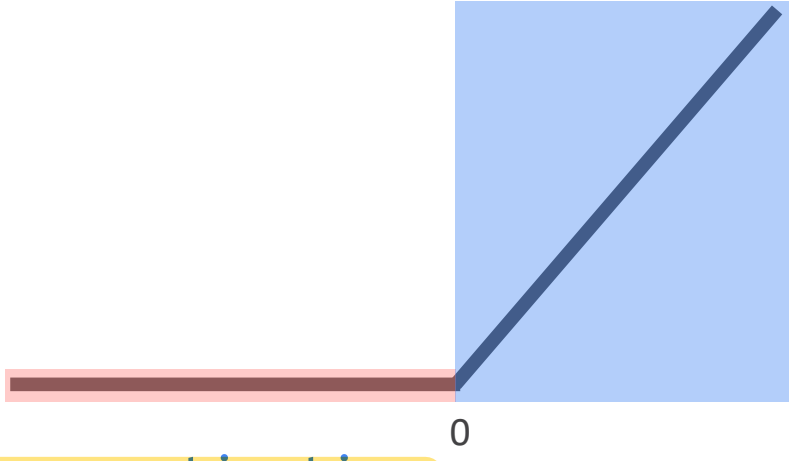

`tf.keras.activations` → sigmoid, tanh
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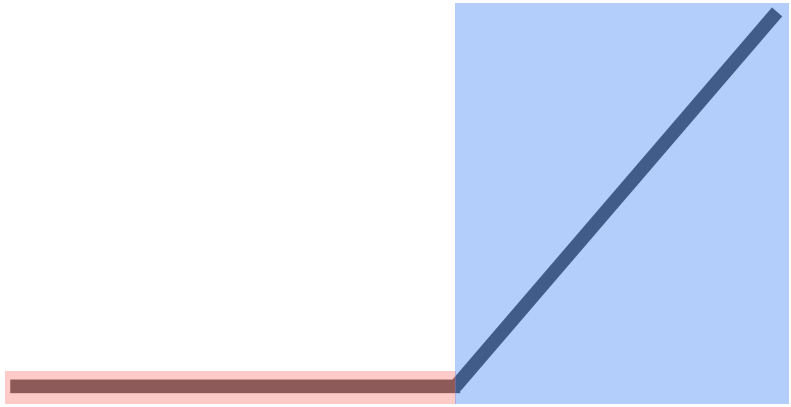
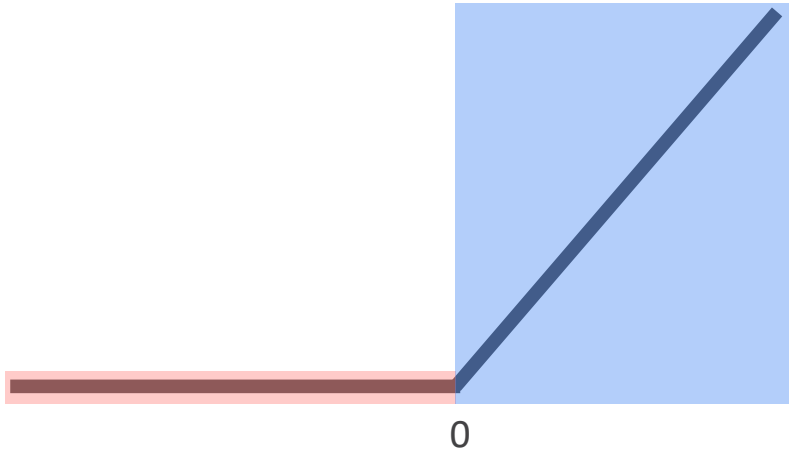


tf.keras.activations → sigmoid, tanh
relu, elu, selu

Relu의 음수에서의 문제점 해결
Relu output = 0 , leaky = $\alpha \times x$ → leaky relu

Why Relu ?

$$f(x) = \max(0, x)$$



`tf.keras.activations` → sigmoid, tanh
relu, elu, selu

`tf.keras.layers` → leaky relu

Code

Load mnist

Load mnist

```
import tensorflow as tf
import numpy as np
from tensorflow.keras.utils import to_categorical
from tensorflow.keras.datasets import mnist # fasion_mnist, cifar10, cifar100
tf.enable_eager_execution()
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→ Eager 모드로 텐서플로우 실행

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```
def load_mnist() :
    (train_data, train_labels), (test_data, test_labels) = mnist.load_data()
```

↳ 4개의 OUTPUT , 6만개의 train data , 만 개의 test data

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    train_data = np.expand_dims(train_data, axis=-1) # [N, 28, 28] -> [N, 28, 28, 1]
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```

채널을 추가할 위치,
-1 = 맨끝

→ 채널 추가
WHY?
텐서플로우가 INPUT으로
받는 Shape의 경우
[batch_size , height ,
width , Channel] 설정

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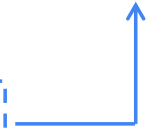

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    train_data, test_data = normalize(train_data, test_data) # [0 ~ 255] -> [0 ~ 1]
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    train_labels = to_categorical(train_labels, 10) # [N,] -> [N, 10]
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우리가 사용하는 데이터셋의 라벨의 총 개수

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One hot incoding

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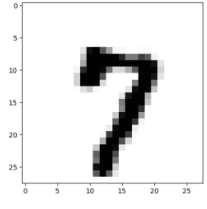

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One hot incoding

7

0	0	0	0	0	0	0	1	0	0

TRUE

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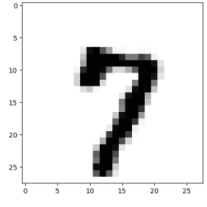

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    test_labels = to_categorical(test_labels, 10) # [N,] -> [N, 10]

    return train_data, train_labels, test_data, test_labels

def normalize(train_data, test_data):
    train_data = train_data.astype(np.float32) / 255.0
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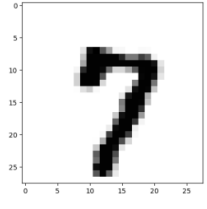
    return train_data, test_data
```

[batch_size, height, width, channel]

One hot incoding

7

0	0	0	0	0	0	0	1	0	0



Create network

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```
def flatten() :
    return tf.keras.layers.Flatten()
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def flatten() :
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def dense(channel, weight_init) :
    return tf.keras.layers.Dense(units=channel, use_bias=True, kernel_initializer=weight_init)
```

TRUE면 bias 사용

OUTPUT으로 나갈 채널 개수

Create network

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def flatten() :
    return tf.keras.layers.Flatten()

def dense(channel, weight_init) :
    return tf.keras.layers.Dense(units=channel, use_bias=True, kernel_initializer=weight_init)

def relu() :
    return tf.keras.layers.Activation(tf.keras.activations.relu)
```

Create network

```
class create_model(tf.keras.Model):
```

→ Tf. keras. Model 상속하기

Create network

```
class create_model(tf.keras.Model):
    def __init__(self, label_dim):
        super(create_model, self).__init__()
```

→ 최종적으로 몇개의 OUTPUT을 낼건지 여기선 10

Create network

```
class create_model(tf.keras.Model):
    def __init__(self, label_dim):
        super(create_model, self).__init__()

        weight_init = tf.keras.initializers.RandomNormal()
```

→ 평균이 0, 분산이 1

Create network

```
class create_model(tf.keras.Model):
    def __init__(self, label_dim):
        super(create_model, self).__init__()

        weight_init = tf.keras.initializers.RandomNormal()
        self.model = tf.keras.Sequential()
```

↳ 리스트 자료구조 타입

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        self.model = tf.keras.Sequential()

        self.model.add(flatten()) # [N, 28, 28, 1] -> [N, 784]
```

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        self.model = tf.keras.Sequential()

        self.model.add(flatten()) # [N, 28, 28, 1] -> [N, 784]

        for i in range(2):
            # [N, 784] -> [N, 256] -> [N, 256]
            self.model.add(dense(256, weight_init))
            self.model.add(relu())
```

Create network

```
class create_model(tf.keras.Model):
    def __init__(self, label_dim):
        super(create_model, self).__init__()

        weight_init = tf.keras.initializers.RandomNormal()
        self.model = tf.keras.Sequential()

        self.model.add(flatten()) # [N, 28, 28, 1] -> [N, 784]

        for i in range(2):
            # [N, 784] -> [N, 256] -> [N, 256]
            self.model.add(dense(256, weight_init))
            self.model.add(relu())

        self.model.add(dense(label_dim, weight_init)) # [N, 256] -> [N, 10]
```

Create network

```
class create_model(tf.keras.Model):
    def __init__(self, label_dim):
        super(create_model, self).__init__()

        weight_init = tf.keras.initializers.RandomNormal()
        self.model = tf.keras.Sequential()

        self.model.add(flatten()) # [N, 28, 28, 1] -> [N, 784]

        for i in range(2):
            # [N, 784] -> [N, 256] -> [N, 256]
            self.model.add(dense(256, weight_init))
            self.model.add(relu())

        self.model.add(dense(label_dim, weight_init)) # [N, 256] -> [N, 10]

    def call(self, x, training=None, mask=None):
        x = self.model(x)

        return x
```

Create network

```
def create_model(label_dim) :

    weight_init = tf.keras.initializers.RandomNormal()

    model = tf.keras.Sequential()
    model.add(flatten())

    for i in range(2) :
        model.add(dense(256, weight_init))
        model.add(relu())

    model.add(dense(label_dim, weight_init))

    return model
```

Define loss

Define loss

```python
def loss_fn(model, images, labels):
    logits = model(images, training=True)
    loss = tf.reduce_mean(tf.nn.softmax_cross_entropy_with_logits_v2(logits=logits, labels=labels))
    return loss


def accuracy_fn(model, images, labels):
    logits = model(images, training=False)
    prediction = tf.equal(tf.argmax(logits, -1), tf.argmax(labels, -1))
    accuracy = tf.reduce_mean(tf.cast(prediction, tf.float32))
    return accuracy


def grad(model, images, labels):
    with tf.GradientTape() as tape:
        loss = loss_fn(model, images, labels)
    return tape.gradient(loss, model.variables)
```

모델에 이미지를 넣어서 이미지의 숫자가 무엇인지 output으로 추출 (모델의)

Define loss

```
def loss_fn(model, images, labels):
    logits = model(images, training=True)
    loss = tf.reduce_mean(tf.nn.softmax_cross_entropy_with_logits_v2(logits=logits, labels=labels))
    return loss
```

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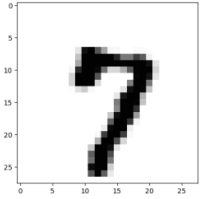
def loss_fn(model, images, labels):
    logits = model(images, training=True)
    loss = tf.reduce_mean(tf.nn.softmax_cross_entropy_with_logits_v2(logits=logits, labels=labels))
    return loss
```



0	0	0	0	0	0	0	1	0	0

label

0.1	0.1	0.0	0.2	0.0	0.0	0.0	0.6	0.0	0.0

softmax(logit)

Define loss

```python
def loss_fn(model, images, labels):
    logits = model(images, training=True)
    loss = tf.reduce_mean(tf.nn.softmax_cross_entropy_with_logits_v2(logits=logits, labels=labels))
    return loss
```

```python
def accuracy_fn(model, images, labels):
    logits = model(images, training=False)
    prediction = tf.equal(tf.argmax(logits, -1), tf.argmax(labels, -1))
    accuracy = tf.reduce_mean(tf.cast(prediction, tf.float32))
    return accuracy
```

logits 에서 가장 큰 숫자의 위치 알려준다

Define loss

```
def loss_fn(model, images, labels):
    logits = model(images, training=True)
    loss = tf.reduce_mean(tf.nn.softmax_cross_entropy_with_logits_v2(logits=logits, labels=labels))
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def accuracy_fn(model, images, labels):
    logits = model(images, training=False)
    prediction = tf.equal(tf.argmax(logits, -1), tf.argmax(labels, -1))
    accuracy = tf.reduce_mean(tf.cast(prediction, tf.float32))
    return accuracy
```

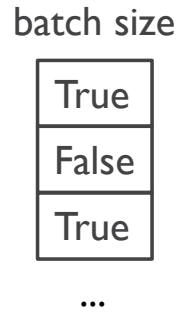
[batch size, label_dim]

Define loss

```python
def loss_fn(model, images, labels):
    logits = model(images, training=True)
    loss = tf.reduce_mean(tf.nn.softmax_cross_entropy_with_logits_v2(logits=logits, labels=labels))
    return loss

def accuracy_fn(model, images, labels):
    logits = model(images, training=False)
    prediction = tf.equal(tf.argmax(logits, -1), tf.argmax(labels, -1))
    accuracy = tf.reduce_mean(tf.cast(prediction, tf.float32))
    return accuracy
```

[batch size, label_dim]



Define loss

```python
def loss_fn(model, images, labels):
    logits = model(images, training=True)
    loss = tf.reduce_mean(tf.nn.softmax_cross_entropy_with_logits_v2(logits=logits, labels=labels))
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    accuracy = tf.reduce_mean(tf.cast(prediction, tf.float32))
    return accuracy
```
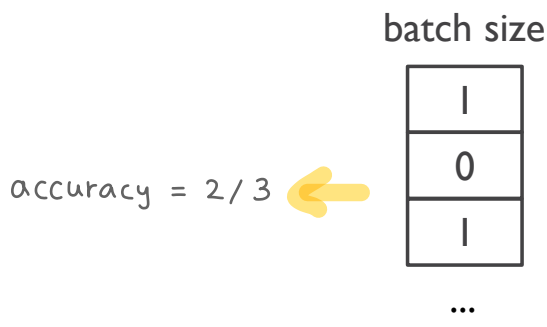

[batch size, label_dim]



Define loss

```python
def loss_fn(model, images, labels):
    logits = model(images, training=True)
    loss = tf.reduce_mean(tf.nn.softmax_cross_entropy_with_logits_v2(logits=logits, labels=labels))
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    accuracy = tf.reduce_mean(tf.cast(prediction, tf.float32))
    return accuracy
```

```python
def grad(model, images, labels):
    with tf.GradientTape() as tape:
        loss = loss_fn(model, images, labels)
    return tape.gradient(loss, model.variables)
```

Experiments (parameters)

Experiments (parameters)

```
""" dataset """
train_x, train_y, test_x, test_y = load_mnist()
```

Experiments (parameters)

```
""" dataset """
train_x, train_y, test_x, test_y = load_mnist()
```

```
""" parameters """
learning_rate = 0.001
batch_size = 128

training_epochs = 1
training_iterations = len(train_x) // batch_size

label_dim = 10
```

Experiments (parameters)

```
""" dataset """
train_x, train_y, test_x, test_y = load_mnist()
```

```
""" parameters """
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training_epochs = 1
training_iterations = len(train_x) // batch_size

label_dim = 10
```

```
""" Graph Input using Dataset API """
train_dataset = tf.data.Dataset.from_tensor_slices((train_x, train_y)).\




test_dataset = tf.data.Dataset.from_tensor_slices((test_x, test_y)).\
```

Experiments (parameters)

```
""" dataset """
train_x, train_y, test_x, test_y = load_mnist()
```

```
""" parameters """
learning_rate = 0.001
batch_size = 128

training_epochs = 1
training_iterations = len(train_x) // batch_size

label_dim = 10
```

```
""" Graph Input using Dataset API """
train_dataset = tf.data.Dataset.from_tensor_slices((train_x, train_y)).\
    shuffle(buffer_size=100000).\
```

↳ 데이터를 잘 섞어라 ↳ INPUT 의 데이터보다 숫자 크면 된다

```
test_dataset = tf.data.Dataset.from_tensor_slices((test_x, test_y)).\
    shuffle(buffer_size=100000).\
```

Experiments (parameters)

```
""" dataset """
train_x, train_y, test_x, test_y = load_mnist()
```

```
""" parameters """
learning_rate = 0.001
batch_size = 128

training_epochs = 1
training_iterations = len(train_x) // batch_size

label_dim = 10
```

```
""" Graph Input using Dataset API """
train_dataset = tf.data.Dataset.from_tensor_slices((train_x, train_y)).\
    shuffle(buffer_size=100000).\
    prefetch(buffer_size=batch_size).\
```

↳ 네트워크가 batch size 만큼 학습을 하고 있을 때
미리 메모리에 batch size 만큼 올려놔라 → 빠르게 학습

```
test_dataset = tf.data.Dataset.from_tensor_slices((test_x, test_y)).\
    shuffle(buffer_size=100000).\
    prefetch(buffer_size=len(test_x)).\
```

Experiments (parameters)

```
""" dataset """
train_x, train_y, test_x, test_y = load_mnist()
```

```
""" parameters """
learning_rate = 0.001
batch_size = 128

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```

```
""" Graph Input using Dataset API """
train_dataset = tf.data.Dataset.from_tensor_slices((train_x, train_y)).\
    shuffle(buffer_size=100000).\
    prefetch(buffer_size=batch_size).\
    batch(batch_size).\


test_dataset = tf.data.Dataset.from_tensor_slices((test_x, test_y)).\
    shuffle(buffer_size=100000).\
    prefetch(buffer_size=len(test_x)).\
    batch(len(test_x)).\
```

Experiments (parameters)

```
""" dataset """
train_x, train_y, test_x, test_y = load_mnist()
```

```
""" parameters """
learning_rate = 0.001
batch_size = 128

training_epochs = 1
training_iterations = len(train_x) // batch_size

label_dim = 10
```

```
""" Graph Input using Dataset API """
train_dataset = tf.data.Dataset.from_tensor_slices((train_x, train_y)).\
    shuffle(buffer_size=100000).\
    prefetch(buffer_size=batch_size).\
    batch(batch_size).\
    repeat()

test_dataset = tf.data.Dataset.from_tensor_slices((test_x, test_y)).\
    shuffle(buffer_size=100000).\
    prefetch(buffer_size=len(test_x)).\
    batch(len(test_x)).\
    repeat()
```

Experiments (model)

Experiments (model)

```
""" Dataset Iterator """
train_iterator = train_dataset.make_one_shot_iterator()
test_iterator = test_dataset.make_one_shot_iterator()
```

Experiments (model)

```
""" Dataset Iterator """
train_iterator = train_dataset.make_one_shot_iterator()
test_iterator = test_dataset.make_one_shot_iterator()
```

```
""" Model """
network = create_model(label_dim)
```

Experiments (model)

```
""" Dataset Iterator """
train_iterator = train_dataset.make_one_shot_iterator()
test_iterator = test_dataset.make_one_shot_iterator()
```

```
""" Model """
network = create_model(label_dim)
```

```
""" Training """
optimizer = tf.train.AdamOptimizer(learning_rate=learning_rate)
```

Experiments (Eager mode)

Experiments (Eager mode)

```
checkpoint = tf.train.Checkpoint(dnn=network)
global_step = tf.train.create_global_step()
```

→ 네트워크가 학습을 하다가 중간에 끊겼을 때
재학습을 위해 변경되었던 weight 불러냄
아 테스트 이미지의 정확도를 볼 수 있다

Experiments (Eager mode)

```
checkpoint = tf.train.Checkpoint(dnn=network)
global_step = tf.train.create_global_step()

for epoch in range(start_epoch, training_epochs):
    for idx in range(start_iteration, training_iterations):
```

Experiments (Eager mode)

```
checkpoint = tf.train.Checkpoint(dnn=network)
global_step = tf.train.create_global_step()

for epoch in range(start_epoch, training_epochs):
    for idx in range(start_iteration, training_iterations):
        train_input, train_label = train_iterator.get_next()
```

Experiments (Eager mode)

```
checkpoint = tf.train.Checkpoint(dnn=network)
global_step = tf.train.create_global_step()

for epoch in range(start_epoch, training_epochs):
    for idx in range(start_iteration, training_iterations):
        train_input, train_label = train_iterator.get_next()

        grads = grad(network, train_input, train_label)
        optimizer.apply_gradients(grads_and_vars=zip(grads, network.variables), global_step=global_step)
```

Experiments (Eager mode)

```
checkpoint = tf.train.Checkpoint(dnn=network)
global_step = tf.train.create_global_step()

for epoch in range(start_epoch, training_epochs):
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        train_input, train_label = train_iterator.get_next()

        grads = grad(network, train_input, train_label)
        optimizer.apply_gradients(grads_and_vars=zip(grads, network.variables), global_step=global_step)

        train_loss = loss_fn(network, train_input, train_label)
        train_accuracy = accuracy_fn(network, train_input, train_label)
```

Experiments (Eager mode)

```
checkpoint = tf.train.Checkpoint(dnn=network)
global_step = tf.train.create_global_step()

for epoch in range(start_epoch, training_epochs):
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        train_input, train_label = train_iterator.get_next()

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        optimizer.apply_gradients(grads_and_vars=zip(grads, network.variables), global_step=global_step)

        train_loss = loss_fn(network, train_input, train_label)
        train_accuracy = accuracy_fn(network, train_input, train_label)

        test_input, test_label = test_iterator.get_next()
        test_accuracy = accuracy_fn(network, test_input, test_label)
```

Experiments (Eager mode)

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checkpoint = tf.train.Checkpoint(dnn=network)
global_step = tf.train.create_global_step()

for epoch in range(start_epoch, training_epochs):
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        train_input, train_label = train_iterator.get_next()

        grads = grad(network, train_input, train_label)
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        train_loss = loss_fn(network, train_input, train_label)
        train_accuracy = accuracy_fn(network, train_input, train_label)

        test_input, test_label = test_iterator.get_next()
        test_accuracy = accuracy_fn(network, test_input, test_label)

        print("Epoch: [%2d] [%5d/%5d], train_loss: %.8f, train_accuracy: %.4f, test_Accuracy: %.4f" \
            % (epoch, idx, training_iterations, train_loss, train_accuracy, test_accuracy))
        counter += 1
```

Experiments (Eager mode)

```
checkpoint = tf.train.Checkpoint(dnn=network)
global_step = tf.train.create_global_step()

for epoch in range(start_epoch, training_epochs):
    for idx in range(start_iteration, training_iterations):
        train_input, train_label = train_iterator.get_next()

        grads = grad(network, train_input, train_label)
        optimizer.apply_gradients(grads_and_vars=zip(grads, network.variables), global_step=global_step)

        train_loss = loss_fn(network, train_input, train_label)
        train_accuracy = accuracy_fn(network, train_input, train_label)

        test_input, test_label = test_iterator.get_next()
        test_accuracy = accuracy_fn(network, test_input, test_label)

        print("Epoch: [%2d] [%5d/%5d], train_loss: %.8f, train_accuracy: %.4f, test_Accuracy: %.4f" \
            % (epoch, idx, training_iterations, train_loss, train_accuracy, test_accuracy))
        counter += 1

checkpoint.save(file_prefix=checkpoint_prefix + '-{}'.format(counter))
```

Experiments (Eager mode)

```
checkpoint = tf.train.Checkpoint(dnn=network)
global_step = tf.train.create_global_step()

for epoch in range(start_epoch, training_epochs):
    for idx in range(start_iteration, training_iterations):
        train_input, train_label = train_iterator.get_next()

        grads = grad(network, train_input, train_label)
        optimizer.apply_gradients(grads_and_vars=zip(grads, network.variables), global_step=global_step)

        train_loss = loss_fn(network, train_input, train_label)
        train_accuracy = accuracy_fn(network, train_input, train_label)

        test_input, test_label = test_iterator.get_next()
        test_accuracy = accuracy_fn(network, test_input, test_label)

        print("Epoch: [%2d] [%5d/%5d], train_loss: %.8f, train_accuracy: %.4f, test_Accuracy: %.4f" \
            % (epoch, idx, training_iterations, train_loss, train_accuracy, test_accuracy))
        counter += 1

checkpoint.save(file_prefix=checkpoint_prefix + '-{}'.format(counter))
```

Sigmoid : 81.31 %

Relu : 85.35 %

What's Next?

- Weight initialization
  - Xavier
  - He