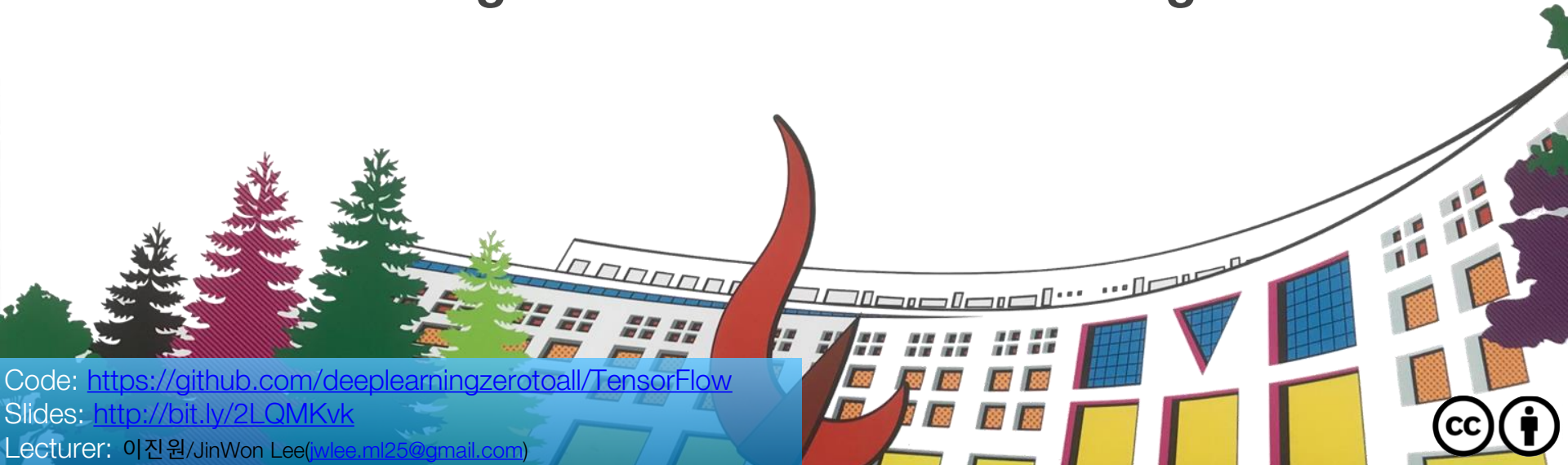
ML/DL for Everyone Season2

with TensorFlow

Lab 11-3 CNN with MNIST Dataset using tf.keras.Model Subclassing



Code: https://github.com/deeplearningzerotoall/TensorFlow
Slides: http://bit.ly/2LQMKvk
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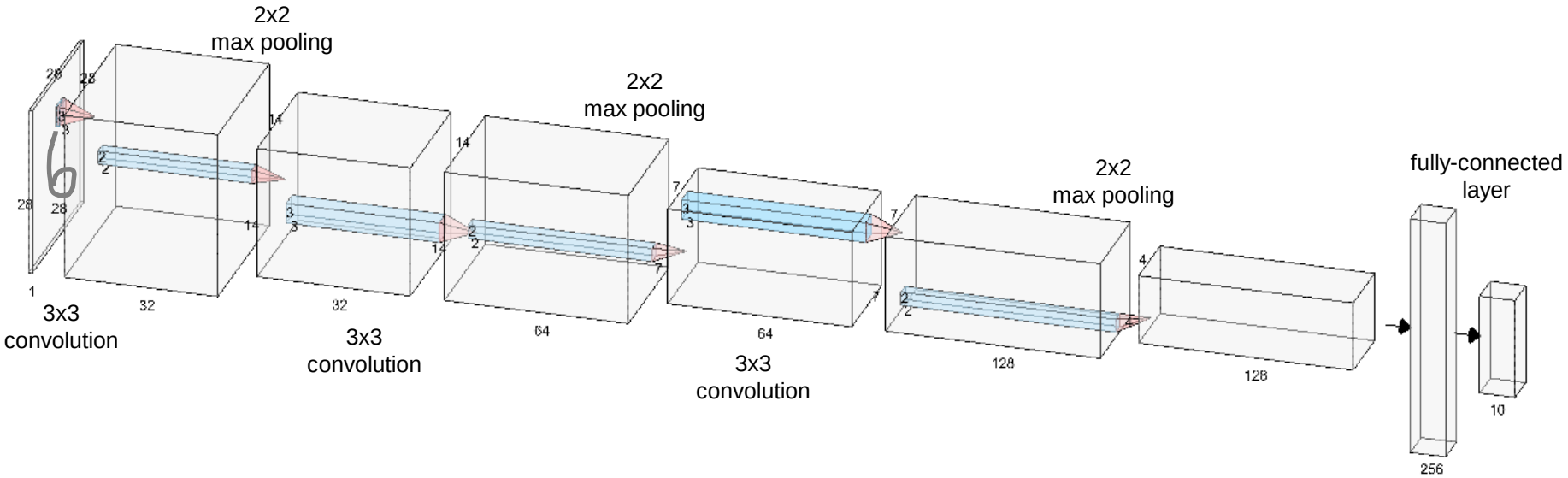
NN Implementation Flow in TensorFlow

1. Set hyper parameters – learning rate, training epochs, batch size, etc.
2. Make a data pipelining – use tf.data
3. Build a neural network model – use tf.keras.Model subclassing
4. Define a loss function – cross entropy
5. Calculate a gradient – use tf.GradientTape
6. Select an optimizer – Adam optimizer
7. Define a metric for model's performance – accuracy
8. (optional) Make a checkpoint for saving
9. Train and Validate a neural network model

CNN with MNIST Data



0. Import Libraries

```
import tensorflow as tf
from tensorflow import keras
from tensorflow.keras.utils import to_categorical
import numpy as np
import matplotlib.pyplot as plt
import os
```

1. Set Hyper Parameters

```
learning_rate = 0.001
training_epochs = 15
batch_size = 100


cur_dir = os.getcwd()
ckpt_dir_name = 'checkpoints'
model_dir_name = 'minst_cnn_subclass'

checkpoint_dir = os.path.join(cur_dir, ckpt_dir_name, model_dir_name)
os.makedirs(checkpoint_dir, exist_ok=True)

checkpoint_prefix = os.path.join(checkpoint_dir, model_dir_name)
```

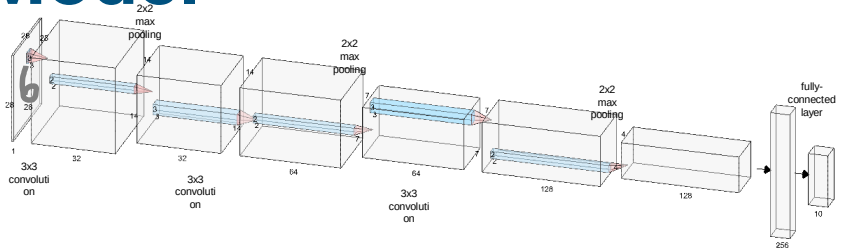
2. Make a Data Pipelining

```
mnist = keras.datasets.mnist

(train_images, train_labels), (test_images, test_labels) = mnist.load_data()

train_images = train_images.astype(np.float32) / 255.
test_images = test_images.astype(np.float32) / 255.
train_images = np.expand_dims(train_images, axis=-1)
test_images = np.expand_dims(test_images, axis=-1)

train_labels = to_categorical(train_labels, 10)
test_labels = to_categorical(test_labels, 10)

train_dataset = tf.data.Dataset.from_tensor_slices((train_images,
        train_labels)).shuffle(buffer_size=100000).batch(batch_size)
test_dataset = tf.data.Dataset.from_tensor_slices((test_images,
        test_labels)).batch(batch_size)
```

Model Subclassing

- Build a fully-customizable model by subclassing `tf.keras.Model`.
- Create layers in the `__init__` method and set them as attributes of the class intaace.
- Define the forward pass in the `call` method.

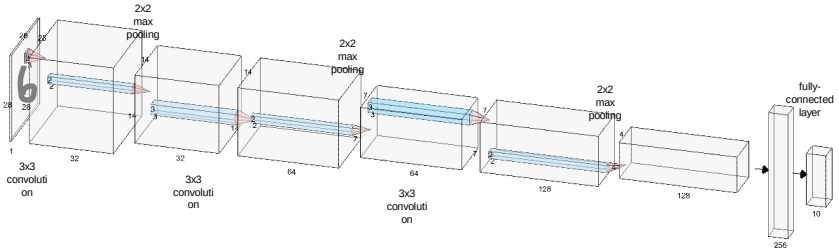
3. Build a Neural Network Model – Model Subclassing




```
class MNISTModel(tf.keras.Model):
    def __init__(self):
        super(MNISTModel, self).__init__()
        self.conv1 = keras.layers.Conv2D(filters=32, kernel_size=3, padding='SAME',
         activation=tf.nn.relu)
        self.pool1 = keras.layers.MaxPool2D(padding='SAME')
        self.conv2 = keras.layers.Conv2D(filters=64, kernel_size=3, padding='SAME',
         activation=tf.nn.relu)
        self.pool2 = keras.layers.MaxPool2D(padding='SAME')
        self.conv3 = keras.layers.Conv2D(filters=128, kernel_size=3, padding='SAME',
         activation=tf.nn.relu)
        self.pool3 = keras.layers.MaxPool2D(padding='SAME')
        self.pool3_flat = keras.layers.Flatten()
        self.dense4 = keras.layers.Dense(units=256, activation=tf.nn.relu)
        self.drop4 = keras.layers.Dropout(rate=0.4)
        self.dense5 = keras.layers.Dense(units=10)
```

3. Build a Neural Network Model – Model Subclassing

```
def call(self, inputs, training=False):
    net = self.conv1(inputs)
    net = self.pool1(net)
    net = self.conv2(net)
    net = self.pool2(net)
    net = self.conv3(net)
    net = self.pool3(net)
    net = self.pool3_flat(net)
    net = self.dense4(net)
    net = self.drop4(net)
    net = self.dense5(net)
    return net
```




```
model = MNISTModel()
```

4. Define a Loss Function
5. Calculate a Gradient

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

6. Select an Optimizer
7. Define a Metric for Model's Performance
8. Make a Checkpoint for Saving

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

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

checkpoint = tf.train.Checkpoint(cnn=model)
```

9. Train and Validate a Neural Network Model

```
for epoch in range(training_epochs):
    avg_loss = 0.
    avg_train_acc = 0.
    avg_test_acc = 0.
    train_step = 0
    test_step = 0

    for images, labels in train_dataset:
        grads = grad(model, images, labels)
        optimizer.apply_gradients(zip(grads, model.variables))
        loss = loss_fn(model, images, labels)
        acc = evaluate(model, images, labels)
        avg_loss = avg_loss + loss
        avg_train_acc = avg_train_acc + acc
        train_step += 1
    avg_loss = avg_loss / train_step
    avg_train_acc = avg_train_acc / train_step
```

9. Train and Validate a Neural Network Model

```
for images, labels in test_dataset:
        acc = evaluate(model, images, labels)
        avg_test_acc = avg_test_acc + acc
        test_step += 1
    avg_test_acc = avg_test_acc / test_step

    print('Epoch:', '{}'.format(epoch + 1), 'loss =', '{:.8f}'.format(avg_loss),
          'train accuracy = ', '{:.4f}'.format(avg_train_acc),
          'test accuracy = ', '{:.4f}'.format(avg_test_acc))

    checkpoint.save(file_prefix=checkpoint_prefix)
```

Accuracy : 99.35%

What's Next?

- CNN with MNIST Dataset using Model Ensemble