

C1_W3_Lab_2_custom-dense-layer

February 24, 2021

1 Ungraded Lab: Building a Custom Dense Layer

In this lab, we'll walk through how to create a custom layer that inherits the [Layer](#) class. Unlike simple Lambda layers you did previously, the custom layer here will contain weights that can be updated during training.

1.1 Imports

```
[1]: try:
      # %tensorflow_version only exists in Colab.
      %tensorflow_version 2.x
    except Exception:
      pass

    import tensorflow as tf
    import numpy as np
```

1.2 Custom Layer with weights

To make custom layer that is trainable, we need to define a class that inherits the [Layer](#) base class from Keras. The Python syntax is shown below in the class declaration. This class requires three functions: `__init__()`, `build()` and `call()`. These ensure that our custom layer has a *state* and *computation* that can be accessed during training or inference.

```
[2]: # inherit from this base class
    from tensorflow.keras.layers import Layer

    class SimpleDense(Layer):

        def __init__(self, units=32):
            '''Initializes the instance attributes'''
            super(SimpleDense, self).__init__()
            self.units = units

        def build(self, input_shape):
```

```

'''Create the state of the layer (weights)'''
# initialize the weights
w_init = tf.random_normal_initializer()
self.w = tf.Variable(name="kernel",
                    initial_value=w_init(shape=(input_shape[-1], self.units),
                                         dtype='float32'),
                    trainable=True)

# initialize the biases
b_init = tf.zeros_initializer()
self.b = tf.Variable(name="bias",
                    initial_value=b_init(shape=(self.units,), dtype='float32'),
                    trainable=True)

def call(self, inputs):
    '''Defines the computation from inputs to outputs'''
    return tf.matmul(inputs, self.w) + self.b

```

Now we can use our custom layer like below:

```

[3]: # declare an instance of the class
my_dense = SimpleDense(units=1)

# define an input and feed into the layer
x = tf.ones((1, 1))
y = my_dense(x)

# parameters of the base Layer class like `variables` can be used
print(my_dense.variables)

```

```

[<tf.Variable 'simple_dense/kernel:0' shape=(1, 1) dtype=float32,
 numpy=array([[0.05704862]], dtype=float32)>, <tf.Variable 'simple_dense/bias:0'
 shape=(1,) dtype=float32, numpy=array([0.], dtype=float32)>]

```

Let's then try using it in simple network:

```

[4]: # define the dataset
xs = np.array([-1.0, 0.0, 1.0, 2.0, 3.0, 4.0], dtype=float)
ys = np.array([-3.0, -1.0, 1.0, 3.0, 5.0, 7.0], dtype=float)

# use the Sequential API to build a model with our custom layer
my_layer = SimpleDense(units=1)
model = tf.keras.Sequential([my_layer])

# configure and train the model
model.compile(optimizer='sgd', loss='mean_squared_error')
model.fit(xs, ys, epochs=500, verbose=0)

```

```
# perform inference
print(model.predict([10.0]))

# see the updated state of the variables
print(my_layer.variables)
```

```
[[18.981268]]
[<tf.Variable 'sequential/simple_dense_1/kernel:0' shape=(1, 1) dtype=float32,
 numpy=array([[1.997285]], dtype=float32)>, <tf.Variable
 'sequential/simple_dense_1/bias:0' shape=(1,) dtype=float32,
 numpy=array([-0.99158233], dtype=float32)>]
```

```
[ ]:
```