Exercise 11

Name - L.H.N.WIJEWARDENA

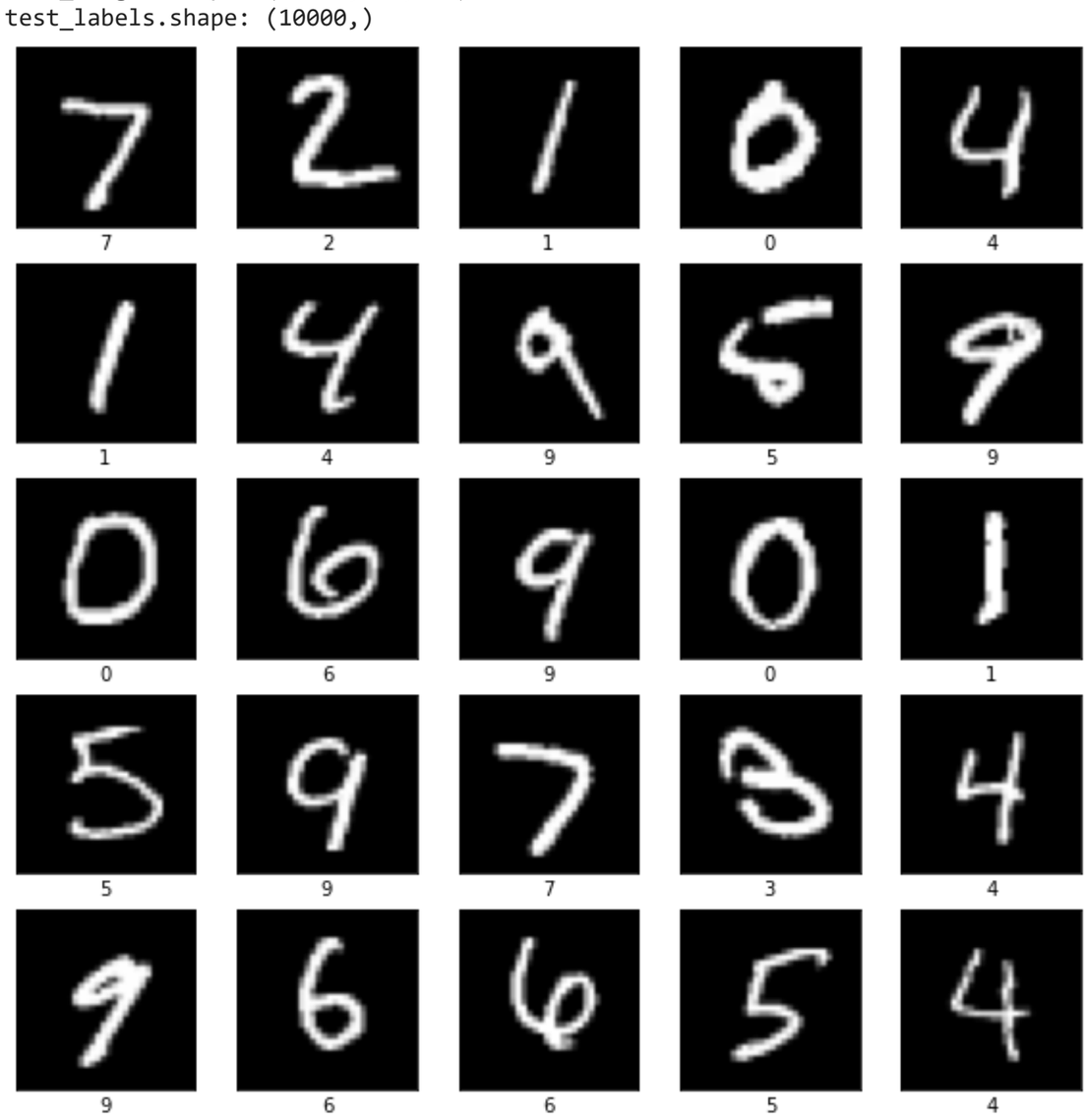
Index No - 190713x

Question 1

In [ ]:

```
import tensorflow as tf
from tensorflow import keras
from tensorflow.keras import datasets, layers, models
import numpy as np
import matplotlib.pyplot as plt

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

# Padding
paddings = tf.constant([[0, 0], [2, 2], [2, 2]])
train_images = tf.pad(train_images, paddings, constant_values=0)
test_images = tf.pad(test_images, paddings, constant_values=0)

print('train_images.shape: ', train_images.shape)
print('train_labels.shape: ', train_labels.shape)
print('test_images.shape:', test_images.shape)
print('test_labels.shape:', test_labels.shape)
class_names = ['0', '1', '2', '3', '4', '5', '6', '7', '8', '9']

plt.figure(figsize=(10,10))
for i in range(25):
    plt.subplot(5,5,i+1)
    plt.xticks([])
    plt.yticks([])
    plt.grid(False)
    plt.imshow(tf.reshape(test_images[i],[32,32]),cmap=plt.cm.gray)
    plt.xlabel(class_names[test_labels[i]])

plt.show()


train_images = tf.dtypes.cast(train_images, tf.float32)
test_images = tf.dtypes.cast(test_images, tf.float32)
train_images, test_images = train_images[..., np.newaxis]/255.0, test_images[..., np.newaxis]/255.0
```

```
train_images.shape:  (60000, 32, 32)
train_labels.shape:  (60000,)
test_images.shape: (10000, 32, 32)
test_labels.shape: (10000,)
```



In [ ]:

```
model = models.Sequential()
model.add(layers.Conv2D(6,(5,5),activation = 'relu',input_shape = (32,32,1)))
model.add(layers.AveragePooling2D((2,2)))
model.add(layers.Conv2D(16,(5,5),activation = 'relu'))
model.add(layers.AveragePooling2D((2,2)))

model.add(layers.Flatten())
model.add(layers.Dense(120,activation = 'relu'))
model.add(layers.Dense(84,activation = 'relu'))
model.add(layers.Dense(10))

model.compile(optimizer = 'adam',loss = tf.keras.losses.SparseCategoricalCrossentropy(from_logits=True),metrics = ['accuracy'])
print(model.summary)
model.fit(train_images,train_labels,epochs = 5)
test_loss, test_accuracy = model.evaluate(test_images,test_labels,verbose = 2)
```

```
<bound method Model.summary of <tensorflow.python.keras.engine.sequential.Sequential object at 0x000001551812E190>>
Epoch 1/5
1875/1875 [==============================] - 18s 9ms/step - loss: 0.2022 - accuracy: 0.9391
Epoch 2/5
1875/1875 [==============================] - 16s 8ms/step - loss: 0.0673 - accuracy: 0.9792
Epoch 3/5
1875/1875 [==============================] - 19s 10ms/step - loss: 0.0465 - accuracy: 0.9855
Epoch 4/5
1875/1875 [==============================] - 17s 9ms/step - loss: 0.0371 - accuracy: 0.9885
```

```
Epoch 5/5
1875/1875 [==============================] - 17s 9ms/step - loss: 0.0299 - accuracy: 0.9909
313/313 - 1s - loss: 0.0285 - accuracy: 0.9900
```

Question 2

In [ ]:

```
# for CIFAR10
import tensorflow as tf
from tensorflow import keras
import matplotlib.pyplot as plt
from tensorflow.keras.datasets import cifar10, mnist
import tensorflow as tf
import matplotlib.pyplot as plt
(train_images, train_labels), (test_images, test_labels) = datasets.cifar10.load_data()

# Normalize pixel values to be between 0 and 1
train_images, test_images = train_images / 255.0, test_images / 255.0
class_names = ['airplane', 'automobile', 'bird', 'cat', 'deer', 'dog', 'frog', 'horse', 'ship', 'truck']
```

In [ ]:

```
model = models.Sequential()
model.add(layers.Conv2D(32,(5,5),activation = 'relu',input_shape = (32,32,3)))
model.add(layers.MaxPool2D((2,2)))
model.add(layers.Conv2D(64,(3,3),activation = 'relu'))
model.add(layers.MaxPool2D((2,2)))
model.add(layers.Conv2D(128,(3,3),activation = 'relu'))
model.add(layers.MaxPool2D((2,2)))
model.add(layers.Flatten())
model.add(layers.Dense(64,activation = 'relu'))
model.add(layers.Dense(10))

model.compile(optimizer=keras.optimizers.Adam(learning_rate = 0.001),loss = tf.keras.losses.SparseCategoricalCrossentropy(from_logits=True),metrics = ['accuracy'])
print(model.summary)

model.fit(train_images,train_labels,epochs = 5)
test_loss, test_accuracy = model.evaluate(test_images,test_labels,verbose = 2)
print(test_accuracy)
```

```
<bound method Model.summary of <tensorflow.python.keras.engine.sequential.Sequential object at 0x0000015518149280>>
Epoch 1/5
1563/1563 [==============================] - 41s 26ms/step - loss: 1.5659 - accuracy: 0.4250
Epoch 2/5
1563/1563 [==============================] - 44s 28ms/step - loss: 1.2061 - accuracy: 0.5721
Epoch 3/5
1563/1563 [==============================] - 39s 25ms/step - loss: 1.0367 - accuracy: 0.6327
Epoch 4/5
1563/1563 [==============================] - 40s 26ms/step - loss: 0.9265 - accuracy: 0.6752
Epoch 5/5
1563/1563 [==============================] - 40s 25ms/step - loss: 0.8478 - accuracy: 0.7014
313/313 - 2s - loss: 0.9256 - accuracy: 0.6822
0.682200014591217
```

Question 3

In [ ]:

```
import tensorflow as tf
from tensorflow import keras
from tensorflow.keras import datasets, layers, models
import numpy as np
import matplotlib.pyplot as plt

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

# Padding
paddings = tf.constant([[0, 0], [2, 2], [2, 2]])
train_images = tf.pad(train_images, paddings, constant_values=0)
test_images = tf.pad(test_images, paddings, constant_values=0)

print('train_images.shape: ', train_images.shape)
print('train_labels.shape: ', train_labels.shape)
print('test_images.shape:', test_images.shape)
print('test_labels.shape:', test_labels.shape)
class_names = ['0', '1', '2', '3', '4', '5', '6', '7', '8', '9']

train_images = tf.dtypes.cast(train_images, tf.float32)
test_images = tf.dtypes.cast(test_images, tf.float32)
train_images, test_images = train_images[..., np.newaxis]/255.0, test_images[..., np.newaxis]/255.0

model_base = models.Sequential()
model_base.add(layers.Conv2D(32,(3,3),activation = 'relu',input_shape = (32,32,1)))
model_base.add(layers.MaxPool2D((2,2)))
model_base.add(layers.Conv2D(64,(3,3),activation = 'relu'))
model_base.add(layers.MaxPool2D((2,2)))
model_base.add(layers.Conv2D(64,(3,3),activation = 'relu'))

model_base.add(layers.Flatten())
model_base.add(layers.Dense(64,activation = 'relu'))
model_base.add(layers.Dense(10))

model_base.compile(optimizer =keras.optimizers.Adam(),loss = tf.keras.losses.SparseCategoricalCrossentropy(from_logits=True),metrics = ['accuracy'])
print(model_base.summary)

model_base.fit(train_images,train_labels,epochs = 2)
test_loss, test_accuracy = model_base.evaluate(test_images,test_labels,verbose = 2)
model_base.save_weights('saved_weights/')
```

```
train_images.shape:  (60000, 32, 32)
train_labels.shape:  (60000,)
test_images.shape: (10000, 32, 32)
test_labels.shape: (10000,)
<bound method Model.summary of <tensorflow.python.keras.engine.sequential.Sequential object at 0x000001551FF6E190>>
Epoch 1/2
1875/1875 [==============================] - 41s 22ms/step - loss: 0.1328 - accuracy: 0.9588
Epoch 2/2
1875/1875 [==============================] - 43s 23ms/step - loss: 0.0404 - accuracy: 0.9876
313/313 - 2s - loss: 0.0347 - accuracy: 0.9895
```

Question 4

In [ ]:

```
model_lw = models.Sequential()
model_lw.add(layers.Conv2D(32,(3,3),activation = 'relu',input_shape = (32,32,1)))
```

```
model_lw.add(layers.MaxPool2D((2,2)))
model_lw.add(layers.Conv2D(64,(3,3),activation = 'relu'))
model_lw.add(layers.MaxPool2D((2,2)))
model_lw.add(layers.Conv2D(64,(3,3),activation = 'relu'))

model_lw.add(layers.Flatten())
model_lw.add(layers.Dense(64,activation = 'relu'))
model_lw.add(layers.Dense(10))

model_lw.compile(optimizer =keras.optimizers.Adam(),loss = tf.keras.losses.SparseCategoricalCrossentropy(from_logits=True),metrics = ['accuracy'])
print(model_lw.summary)

model_lw.fit(train_images,train_labels,epochs = 2)
test_loss, test_accuracy = model_lw.evaluate(test_images,test_labels,verbose = 2)
model_lw.save('saved_model/')
```

```
<bound method Model.summary of <tensorflow.python.keras.engine.sequential.Sequential object at 0x00000155216A35E0>>
Epoch 1/2
1875/1875 [==============================] - 50s 26ms/step - loss: 0.1316 - accuracy: 0.9600
Epoch 2/2
1875/1875 [==============================] - 50s 27ms/step - loss: 0.0416 - accuracy: 0.9869
313/313 - 3s - loss: 0.0274 - accuracy: 0.9908
WARNING:tensorflow:From c:\Users\HIRUNI\anaconda3\envs\testing\lib\site-packages\tensorflow\python\training\tracking\tracking.py:111: Model.state_updates (from tensorflo
w.python.keras.engine.training) is deprecated and will be removed in a future version.
Instructions for updating:
This property should not be used in TensorFlow 2.0, as updates are applied automatically.
WARNING:tensorflow:From c:\Users\HIRUNI\anaconda3\envs\testing\lib\site-packages\tensorflow\python\training\tracking\tracking.py:111: Layer.updates (from tensorflow.pyth
on.keras.engine.base_layer) is deprecated and will be removed in a future version.
Instructions for updating:
This property should not be used in TensorFlow 2.0, as updates are applied automatically.
INFO:tensorflow:Assets written to: saved_model/assets
```

Question 5

In [ ]:

```
# loading the model
model_ld = keras.models.load_model('saved_model/')
print(model_ld.summary())
model_ld.evaluate(test_images,test_labels, verbose=2)
```

```
Model: "sequential_3"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_8 (Conv2D)            (None, 30, 30, 32)        320
_________________________________________________________________
max_pooling2d_5 (MaxPooling2 (None, 15, 15, 32)        0
_________________________________________________________________
conv2d_9 (Conv2D)            (None, 13, 13, 64)        18496
_________________________________________________________________
max_pooling2d_6 (MaxPooling2 (None, 6, 6, 64)          0
_________________________________________________________________
conv2d_10 (Conv2D)           (None, 4, 4, 64)          36928
_________________________________________________________________
flatten_3 (Flatten)          (None, 1024)              0
_________________________________________________________________
dense_7 (Dense)              (None, 64)                65600
_________________________________________________________________
dense_8 (Dense)              (None, 10)                650
=================================================================
Total params: 121,994
Trainable params: 121,994
Non-trainable params: 0
_________________________________________________________________
None
313/313 - 2s - loss: 0.0274 - accuracy: 0.0989
```

Out[ ]:

```
[0.027392050251364708, 0.09889999777078629]
```

Question 6

In [ ]:

```
base_inputs = model_ld.layers[0].input
base_outputs = model_ld.layers[-2].output
output = layers.Dense(10)(base_outputs)

new_model = keras.Model(inputs=base_inputs, outputs = output)
new_model.compile(optimizer =keras.optimizers.Adam(),loss = tf.keras.losses.SparseCategoricalCrossentropy(from_logits=True),metrics = ['accuracy'])
print(new_model.summary)

new_model.fit(train_images,train_labels,epochs = 3,verbose = 2)
new_model.evaluate(test_images, test_labels, verbose=2)
```

```
<bound method Model.summary of <tensorflow.python.keras.engine.functional.Functional object at 0x00000155227F3B80>>
Epoch 1/3
1875/1875 - 61s - loss: 0.0797 - accuracy: 0.9775
Epoch 2/3
1875/1875 - 35s - loss: 0.0266 - accuracy: 0.9917
Epoch 3/3
1875/1875 - 36s - loss: 0.0191 - accuracy: 0.9942
313/313 - 2s - loss: 0.0269 - accuracy: 0.9916
```

Out[ ]:

```
[0.026942696422338486, 0.991599977016449]
```

Question 7

In [ ]:

```
#transfer learning
model_for_tl =keras.models.load_model('saved_model/')
model_for_tl.trainable = False
for layer in model_for_tl.layers:
    assert layer.trainable == False

base_inputs = model_for_tl.layers[0].input
base_outputs = model_for_tl.layers[-2].output
output = layers.Dense(10)(base_outputs)

new_model = keras.Model(inputs=base_inputs, outputs = output)
new_model.compile(optimizer =keras.optimizers.Adam(),loss = tf.keras.losses.SparseCategoricalCrossentropy(from_logits=True),metrics = ['accuracy'])

new_model.fit(train_images,train_labels,epochs = 3,verbose = 2)
new_model.evaluate(test_images, test_labels, verbose=2)
```

```
Epoch 1/3
```

```
1875/1875 - 12s - loss: 0.2226 - accuracy: 0.9515
Epoch 2/3
1875/1875 - 12s - loss: 0.0240 - accuracy: 0.9928
Epoch 3/3
1875/1875 - 11s - loss: 0.0197 - accuracy: 0.9937
313/313 - 2s - loss: 0.0230 - accuracy: 0.9922
```

Out[ ]:
```
[0.022966761142015457, 0.9922000169754028]
```

Question 8

In [ ]:
```
model_for_tl=keras.applications.resnet_v2.ResNet50V2()

model_for_tl.trainable=False
for layer in model_for_tl.layers:
    assert layer.trainable==False

base_inputs=model_for_tl.layers[0].input
base_ouputs=model_for_tl.layers[-2].output
output=layers.Dense(5)(base_ouputs)

new_model_tl=keras.Model(inputs=base_inputs,outputs=output)
new_model_tl.compile(optimizer=keras.optimizers.Adam(),loss=keras.losses.SparseCategoricalCrossentropy(from_logits=True),metrics=['accuracy'])
print(new_model_tl.summary())
```

```
Downloading data from https://storage.googleapis.com/tensorflow/keras-applications/resnet/resnet50v2_weights_tf_dim_ordering_tf_kernels.h5
102875136/102869336 [==============================] - 16s 0us/step
Model: "functional_5"
```

Layer (type)	Output Shape	Param #	Connected to
input_1 (InputLayer)	[(None, 224, 224, 3)	0	
conv1_pad (ZeroPadding2D)	(None, 230, 230, 3)	0	input_1[0][0]
conv1_conv (Conv2D)	(None, 112, 112, 64)	9472	conv1_pad[0][0]
pool1_pad (ZeroPadding2D)	(None, 114, 114, 64)	0	conv1_conv[0][0]
pool1_pool (MaxPooling2D)	(None, 56, 56, 64)	0	pool1_pad[0][0]
conv2_block1_preact_bn (BatchNo	(None, 56, 56, 64)	256	pool1_pool[0][0]
conv2_block1_preact_relu (Activ	(None, 56, 56, 64)	0	conv2_block1_preact_bn[0][0]
conv2_block1_1_conv (Conv2D)	(None, 56, 56, 64)	4096	conv2_block1_preact_relu[0][0]
conv2_block1_1_bn (BatchNormali	(None, 56, 56, 64)	256	conv2_block1_1_conv[0][0]
conv2_block1_1_relu (Activation	(None, 56, 56, 64)	0	conv2_block1_1_bn[0][0]
conv2_block1_2_pad (ZeroPadding	(None, 58, 58, 64)	0	conv2_block1_1_relu[0][0]
conv2_block1_2_conv (Conv2D)	(None, 56, 56, 64)	36864	conv2_block1_2_pad[0][0]
conv2_block1_2_bn (BatchNormali	(None, 56, 56, 64)	256	conv2_block1_2_conv[0][0]
conv2_block1_2_relu (Activation	(None, 56, 56, 64)	0	conv2_block1_2_bn[0][0]
conv2_block1_0_conv (Conv2D)	(None, 56, 56, 256)	16640	conv2_block1_preact_relu[0][0]
conv2_block1_3_conv (Conv2D)	(None, 56, 56, 256)	16640	conv2_block1_2_relu[0][0]
conv2_block1_out (Add)	(None, 56, 56, 256)	0	conv2_block1_0_conv[0][0] conv2_block1_3_conv[0][0]
conv2_block2_preact_bn (BatchNo	(None, 56, 56, 256)	1024	conv2_block1_out[0][0]
conv2_block2_preact_relu (Activ	(None, 56, 56, 256)	0	conv2_block2_preact_bn[0][0]
conv2_block2_1_conv (Conv2D)	(None, 56, 56, 64)	16384	conv2_block2_preact_relu[0][0]
conv2_block2_1_bn (BatchNormali	(None, 56, 56, 64)	256	conv2_block2_1_conv[0][0]
conv2_block2_1_relu (Activation	(None, 56, 56, 64)	0	conv2_block2_1_bn[0][0]
conv2_block2_2_pad (ZeroPadding	(None, 58, 58, 64)	0	conv2_block2_1_relu[0][0]
conv2_block2_2_conv (Conv2D)	(None, 56, 56, 64)	36864	conv2_block2_2_pad[0][0]
conv2_block2_2_bn (BatchNormali	(None, 56, 56, 64)	256	conv2_block2_2_conv[0][0]
conv2_block2_2_relu (Activation	(None, 56, 56, 64)	0	conv2_block2_2_bn[0][0]
conv2_block2_3_conv (Conv2D)	(None, 56, 56, 256)	16640	conv2_block2_2_relu[0][0]
conv2_block2_out (Add)	(None, 56, 56, 256)	0	conv2_block1_out[0][0] conv2_block2_3_conv[0][0]
conv2_block3_preact_bn (BatchNo	(None, 56, 56, 256)	1024	conv2_block2_out[0][0]
conv2_block3_preact_relu (Activ	(None, 56, 56, 256)	0	conv2_block3_preact_bn[0][0]
conv2_block3_1_conv (Conv2D)	(None, 56, 56, 64)	16384	conv2_block3_preact_relu[0][0]
conv2_block3_1_bn (BatchNormali	(None, 56, 56, 64)	256	conv2_block3_1_conv[0][0]
conv2_block3_1_relu (Activation	(None, 56, 56, 64)	0	conv2_block3_1_bn[0][0]
conv2_block3_2_pad (ZeroPadding	(None, 58, 58, 64)	0	conv2_block3_1_relu[0][0]
conv2_block3_2_conv (Conv2D)	(None, 28, 28, 64)	36864	conv2_block3_2_pad[0][0]
conv2_block3_2_bn (BatchNormali	(None, 28, 28, 64)	256	conv2_block3_2_conv[0][0]
conv2_block3_2_relu (Activation	(None, 28, 28, 64)	0	conv2_block3_2_bn[0][0]
max_pooling2d_7 (MaxPooling2D)	(None, 28, 28, 256)	0	conv2_block2_out[0][0]
conv2_block3_3_conv (Conv2D)	(None, 28, 28, 256)	16640	conv2_block3_2_relu[0][0]
conv2_block3_out (Add)	(None, 28, 28, 256)	0	max_pooling2d_7[0][0]

				conv2_block3_3_conv[0][0]
conv3_block1_preact_bn (BatchNo	(None, 28, 28, 256)	1024		conv2_block3_out[0][0]
conv3_block1_preact_relu (Activ	(None, 28, 28, 256)	0		conv3_block1_preact_bn[0][0]
conv3_block1_1_conv (Conv2D)	(None, 28, 28, 128)	32768		conv3_block1_preact_relu[0][0]
conv3_block1_1_bn (BatchNormali	(None, 28, 28, 128)	512		conv3_block1_1_conv[0][0]
conv3_block1_1_relu (Activation	(None, 28, 28, 128)	0		conv3_block1_1_bn[0][0]
conv3_block1_2_pad (ZeroPadding	(None, 30, 30, 128)	0		conv3_block1_1_relu[0][0]
conv3_block1_2_conv (Conv2D)	(None, 28, 28, 128)	147456		conv3_block1_2_pad[0][0]
conv3_block1_2_bn (BatchNormali	(None, 28, 28, 128)	512		conv3_block1_2_conv[0][0]
conv3_block1_2_relu (Activation	(None, 28, 28, 128)	0		conv3_block1_2_bn[0][0]
conv3_block1_0_conv (Conv2D)	(None, 28, 28, 512)	131584		conv3_block1_preact_relu[0][0]
conv3_block1_3_conv (Conv2D)	(None, 28, 28, 512)	66048		conv3_block1_2_relu[0][0]
conv3_block1_out (Add)	(None, 28, 28, 512)	0		conv3_block1_0_conv[0][0] conv3_block1_3_conv[0][0]
conv3_block2_preact_bn (BatchNo	(None, 28, 28, 512)	2048		conv3_block1_out[0][0]
conv3_block2_preact_relu (Activ	(None, 28, 28, 512)	0		conv3_block2_preact_bn[0][0]
conv3_block2_1_conv (Conv2D)	(None, 28, 28, 128)	65536		conv3_block2_preact_relu[0][0]
conv3_block2_1_bn (BatchNormali	(None, 28, 28, 128)	512		conv3_block2_1_conv[0][0]
conv3_block2_1_relu (Activation	(None, 28, 28, 128)	0		conv3_block2_1_bn[0][0]
conv3_block2_2_pad (ZeroPadding	(None, 30, 30, 128)	0		conv3_block2_1_relu[0][0]
conv3_block2_2_conv (Conv2D)	(None, 28, 28, 128)	147456		conv3_block2_2_pad[0][0]
conv3_block2_2_bn (BatchNormali	(None, 28, 28, 128)	512		conv3_block2_2_conv[0][0]
conv3_block2_2_relu (Activation	(None, 28, 28, 128)	0		conv3_block2_2_bn[0][0]
conv3_block2_3_conv (Conv2D)	(None, 28, 28, 512)	66048		conv3_block2_2_relu[0][0]
conv3_block2_out (Add)	(None, 28, 28, 512)	0		conv3_block1_out[0][0] conv3_block2_3_conv[0][0]
conv3_block3_preact_bn (BatchNo	(None, 28, 28, 512)	2048		conv3_block2_out[0][0]
conv3_block3_preact_relu (Activ	(None, 28, 28, 512)	0		conv3_block3_preact_bn[0][0]
conv3_block3_1_conv (Conv2D)	(None, 28, 28, 128)	65536		conv3_block3_preact_relu[0][0]
conv3_block3_1_bn (BatchNormali	(None, 28, 28, 128)	512		conv3_block3_1_conv[0][0]
conv3_block3_1_relu (Activation	(None, 28, 28, 128)	0		conv3_block3_1_bn[0][0]
conv3_block3_2_pad (ZeroPadding	(None, 30, 30, 128)	0		conv3_block3_1_relu[0][0]
conv3_block3_2_conv (Conv2D)	(None, 28, 28, 128)	147456		conv3_block3_2_pad[0][0]
conv3_block3_2_bn (BatchNormali	(None, 28, 28, 128)	512		conv3_block3_2_conv[0][0]
conv3_block3_2_relu (Activation	(None, 28, 28, 128)	0		conv3_block3_2_bn[0][0]
conv3_block3_3_conv (Conv2D)	(None, 28, 28, 512)	66048		conv3_block3_2_relu[0][0]
conv3_block3_out (Add)	(None, 28, 28, 512)	0		conv3_block2_out[0][0] conv3_block3_3_conv[0][0]
conv3_block4_preact_bn (BatchNo	(None, 28, 28, 512)	2048		conv3_block3_out[0][0]
conv3_block4_preact_relu (Activ	(None, 28, 28, 512)	0		conv3_block4_preact_bn[0][0]
conv3_block4_1_conv (Conv2D)	(None, 28, 28, 128)	65536		conv3_block4_preact_relu[0][0]
conv3_block4_1_bn (BatchNormali	(None, 28, 28, 128)	512		conv3_block4_1_conv[0][0]
conv3_block4_1_relu (Activation	(None, 28, 28, 128)	0		conv3_block4_1_bn[0][0]
conv3_block4_2_pad (ZeroPadding	(None, 30, 30, 128)	0		conv3_block4_1_relu[0][0]
conv3_block4_2_conv (Conv2D)	(None, 14, 14, 128)	147456		conv3_block4_2_pad[0][0]
conv3_block4_2_bn (BatchNormali	(None, 14, 14, 128)	512		conv3_block4_2_conv[0][0]
conv3_block4_2_relu (Activation	(None, 14, 14, 128)	0		conv3_block4_2_bn[0][0]
max_pooling2d_8 (MaxPooling2D)	(None, 14, 14, 512)	0		conv3_block3_out[0][0]
conv3_block4_3_conv (Conv2D)	(None, 14, 14, 512)	66048		conv3_block4_2_relu[0][0]
conv3_block4_out (Add)	(None, 14, 14, 512)	0		max_pooling2d_8[0][0] conv3_block4_3_conv[0][0]
conv4_block1_preact_bn (BatchNo	(None, 14, 14, 512)	2048		conv3_block4_out[0][0]
conv4_block1_preact_relu (Activ	(None, 14, 14, 512)	0		conv4_block1_preact_bn[0][0]
conv4_block1_1_conv (Conv2D)	(None, 14, 14, 256)	131072		conv4_block1_preact_relu[0][0]
conv4_block1_1_bn (BatchNormali	(None, 14, 14, 256)	1024		conv4_block1_1_conv[0][0]
conv4_block1_1_relu (Activation	(None, 14, 14, 256)	0		conv4_block1_1_bn[0][0]
conv4_block1_2_pad (ZeroPadding	(None, 16, 16, 256)	0		conv4_block1_1_relu[0][0]
conv4_block1_2_conv (Conv2D)	(None, 14, 14, 256)	589824		conv4_block1_2_pad[0][0]
conv4_block1_2_bn (BatchNormali	(None, 14, 14, 256)	1024		conv4_block1_2_conv[0][0]

conv4_block1_2_relu (Activation	(None, 14, 14, 256)	0	conv4_block1_2_bn[0][0]
conv4_block1_0_conv (Conv2D)	(None, 14, 14, 1024)	525312	conv4_block1_preact_relu[0][0]
conv4_block1_3_conv (Conv2D)	(None, 14, 14, 1024)	263168	conv4_block1_2_relu[0][0]
conv4_block1_out (Add)	(None, 14, 14, 1024)	0	conv4_block1_0_conv[0][0] conv4_block1_3_conv[0][0]
conv4_block2_preact_bn (BatchNo	(None, 14, 14, 1024)	4096	conv4_block1_out[0][0]
conv4_block2_preact_relu (Activ	(None, 14, 14, 1024)	0	conv4_block2_preact_bn[0][0]
conv4_block2_1_conv (Conv2D)	(None, 14, 14, 256)	262144	conv4_block2_preact_relu[0][0]
conv4_block2_1_bn (BatchNormali	(None, 14, 14, 256)	1024	conv4_block2_1_conv[0][0]
conv4_block2_1_relu (Activation	(None, 14, 14, 256)	0	conv4_block2_1_bn[0][0]
conv4_block2_2_pad (ZeroPadding	(None, 16, 16, 256)	0	conv4_block2_1_relu[0][0]
conv4_block2_2_conv (Conv2D)	(None, 14, 14, 256)	589824	conv4_block2_2_pad[0][0]
conv4_block2_2_bn (BatchNormali	(None, 14, 14, 256)	1024	conv4_block2_2_conv[0][0]
conv4_block2_2_relu (Activation	(None, 14, 14, 256)	0	conv4_block2_2_bn[0][0]
conv4_block2_3_conv (Conv2D)	(None, 14, 14, 1024)	263168	conv4_block2_2_relu[0][0]
conv4_block2_out (Add)	(None, 14, 14, 1024)	0	conv4_block1_out[0][0] conv4_block2_3_conv[0][0]
conv4_block3_preact_bn (BatchNo	(None, 14, 14, 1024)	4096	conv4_block2_out[0][0]
conv4_block3_preact_relu (Activ	(None, 14, 14, 1024)	0	conv4_block3_preact_bn[0][0]
conv4_block3_1_conv (Conv2D)	(None, 14, 14, 256)	262144	conv4_block3_preact_relu[0][0]
conv4_block3_1_bn (BatchNormali	(None, 14, 14, 256)	1024	conv4_block3_1_conv[0][0]
conv4_block3_1_relu (Activation	(None, 14, 14, 256)	0	conv4_block3_1_bn[0][0]
conv4_block3_2_pad (ZeroPadding	(None, 16, 16, 256)	0	conv4_block3_1_relu[0][0]
conv4_block3_2_conv (Conv2D)	(None, 14, 14, 256)	589824	conv4_block3_2_pad[0][0]
conv4_block3_2_bn (BatchNormali	(None, 14, 14, 256)	1024	conv4_block3_2_conv[0][0]
conv4_block3_2_relu (Activation	(None, 14, 14, 256)	0	conv4_block3_2_bn[0][0]
conv4_block3_3_conv (Conv2D)	(None, 14, 14, 1024)	263168	conv4_block3_2_relu[0][0]
conv4_block3_out (Add)	(None, 14, 14, 1024)	0	conv4_block2_out[0][0] conv4_block3_3_conv[0][0]
conv4_block4_preact_bn (BatchNo	(None, 14, 14, 1024)	4096	conv4_block3_out[0][0]
conv4_block4_preact_relu (Activ	(None, 14, 14, 1024)	0	conv4_block4_preact_bn[0][0]
conv4_block4_1_conv (Conv2D)	(None, 14, 14, 256)	262144	conv4_block4_preact_relu[0][0]
conv4_block4_1_bn (BatchNormali	(None, 14, 14, 256)	1024	conv4_block4_1_conv[0][0]
conv4_block4_1_relu (Activation	(None, 14, 14, 256)	0	conv4_block4_1_bn[0][0]
conv4_block4_2_pad (ZeroPadding	(None, 16, 16, 256)	0	conv4_block4_1_relu[0][0]
conv4_block4_2_conv (Conv2D)	(None, 14, 14, 256)	589824	conv4_block4_2_pad[0][0]
conv4_block4_2_bn (BatchNormali	(None, 14, 14, 256)	1024	conv4_block4_2_conv[0][0]
conv4_block4_2_relu (Activation	(None, 14, 14, 256)	0	conv4_block4_2_bn[0][0]
conv4_block4_3_conv (Conv2D)	(None, 14, 14, 1024)	263168	conv4_block4_2_relu[0][0]
conv4_block4_out (Add)	(None, 14, 14, 1024)	0	conv4_block3_out[0][0] conv4_block4_3_conv[0][0]
conv4_block5_preact_bn (BatchNo	(None, 14, 14, 1024)	4096	conv4_block4_out[0][0]
conv4_block5_preact_relu (Activ	(None, 14, 14, 1024)	0	conv4_block5_preact_bn[0][0]
conv4_block5_1_conv (Conv2D)	(None, 14, 14, 256)	262144	conv4_block5_preact_relu[0][0]
conv4_block5_1_bn (BatchNormali	(None, 14, 14, 256)	1024	conv4_block5_1_conv[0][0]
conv4_block5_1_relu (Activation	(None, 14, 14, 256)	0	conv4_block5_1_bn[0][0]
conv4_block5_2_pad (ZeroPadding	(None, 16, 16, 256)	0	conv4_block5_1_relu[0][0]
conv4_block5_2_conv (Conv2D)	(None, 14, 14, 256)	589824	conv4_block5_2_pad[0][0]
conv4_block5_2_bn (BatchNormali	(None, 14, 14, 256)	1024	conv4_block5_2_conv[0][0]
conv4_block5_2_relu (Activation	(None, 14, 14, 256)	0	conv4_block5_2_bn[0][0]
conv4_block5_3_conv (Conv2D)	(None, 14, 14, 1024)	263168	conv4_block5_2_relu[0][0]
conv4_block5_out (Add)	(None, 14, 14, 1024)	0	conv4_block4_out[0][0] conv4_block5_3_conv[0][0]
conv4_block6_preact_bn (BatchNo	(None, 14, 14, 1024)	4096	conv4_block5_out[0][0]
conv4_block6_preact_relu (Activ	(None, 14, 14, 1024)	0	conv4_block6_preact_bn[0][0]
conv4_block6_1_conv (Conv2D)	(None, 14, 14, 256)	262144	conv4_block6_preact_relu[0][0]
conv4_block6_1_bn (BatchNormali	(None, 14, 14, 256)	1024	conv4_block6_1_conv[0][0]
conv4_block6_1_relu (Activation	(None, 14, 14, 256)	0	conv4_block6_1_bn[0][0]
conv4_block6_2_pad (ZeroPadding	(None, 16, 16, 256)	0	conv4_block6_1_relu[0][0]

```
conv4_block6_2_conv (Conv2D)    (None, 7, 7, 256)    589824      conv4_block6_2_pad[0][0]
conv4_block6_2_bn (BatchNormali (None, 7, 7, 256)    1024        conv4_block6_2_conv[0][0]
conv4_block6_2_relu (Activation (None, 7, 7, 256)    0           conv4_block6_2_bn[0][0]
max_pooling2d_9 (MaxPooling2D)  (None, 7, 7, 1024)   0           conv4_block5_out[0][0]
conv4_block6_3_conv (Conv2D)    (None, 7, 7, 1024)   263168      conv4_block6_2_relu[0][0]
conv4_block6_out (Add)          (None, 7, 7, 1024)   0           max_pooling2d_9[0][0]
                                                                 conv4_block6_3_conv[0][0]
conv5_block1_preact_bn (BatchNo (None, 7, 7, 1024)   4096        conv4_block6_out[0][0]
conv5_block1_preact_relu (Activ (None, 7, 7, 1024)   0           conv5_block1_preact_bn[0][0]
conv5_block1_1_conv (Conv2D)    (None, 7, 7, 512)    524288      conv5_block1_preact_relu[0][0]
conv5_block1_1_bn (BatchNormali (None, 7, 7, 512)    2048        conv5_block1_1_conv[0][0]
conv5_block1_1_relu (Activation (None, 7, 7, 512)    0           conv5_block1_1_bn[0][0]
conv5_block1_2_pad (ZeroPadding (None, 9, 9, 512)    0           conv5_block1_1_relu[0][0]
conv5_block1_2_conv (Conv2D)    (None, 7, 7, 512)    2359296     conv5_block1_2_pad[0][0]
conv5_block1_2_bn (BatchNormali (None, 7, 7, 512)    2048        conv5_block1_2_conv[0][0]
conv5_block1_2_relu (Activation (None, 7, 7, 512)    0           conv5_block1_2_bn[0][0]
conv5_block1_0_conv (Conv2D)    (None, 7, 7, 2048)   2099200     conv5_block1_preact_relu[0][0]
conv5_block1_3_conv (Conv2D)    (None, 7, 7, 2048)   1050624     conv5_block1_2_relu[0][0]
conv5_block1_out (Add)          (None, 7, 7, 2048)   0           conv5_block1_0_conv[0][0]
                                                                 conv5_block1_3_conv[0][0]
conv5_block2_preact_bn (BatchNo (None, 7, 7, 2048)   8192        conv5_block1_out[0][0]
conv5_block2_preact_relu (Activ (None, 7, 7, 2048)   0           conv5_block2_preact_bn[0][0]
conv5_block2_1_conv (Conv2D)    (None, 7, 7, 512)    1048576     conv5_block2_preact_relu[0][0]
conv5_block2_1_bn (BatchNormali (None, 7, 7, 512)    2048        conv5_block2_1_conv[0][0]
conv5_block2_1_relu (Activation (None, 7, 7, 512)    0           conv5_block2_1_bn[0][0]
conv5_block2_2_pad (ZeroPadding (None, 9, 9, 512)    0           conv5_block2_1_relu[0][0]
conv5_block2_2_conv (Conv2D)    (None, 7, 7, 512)    2359296     conv5_block2_2_pad[0][0]
conv5_block2_2_bn (BatchNormali (None, 7, 7, 512)    2048        conv5_block2_2_conv[0][0]
conv5_block2_2_relu (Activation (None, 7, 7, 512)    0           conv5_block2_2_bn[0][0]
conv5_block2_3_conv (Conv2D)    (None, 7, 7, 2048)   1050624     conv5_block2_2_relu[0][0]
conv5_block2_out (Add)          (None, 7, 7, 2048)   0           conv5_block1_out[0][0]
                                                                 conv5_block2_3_conv[0][0]
conv5_block3_preact_bn (BatchNo (None, 7, 7, 2048)   8192        conv5_block2_out[0][0]
conv5_block3_preact_relu (Activ (None, 7, 7, 2048)   0           conv5_block3_preact_bn[0][0]
conv5_block3_1_conv (Conv2D)    (None, 7, 7, 512)    1048576     conv5_block3_preact_relu[0][0]
conv5_block3_1_bn (BatchNormali (None, 7, 7, 512)    2048        conv5_block3_1_conv[0][0]
conv5_block3_1_relu (Activation (None, 7, 7, 512)    0           conv5_block3_1_bn[0][0]
conv5_block3_2_pad (ZeroPadding (None, 9, 9, 512)    0           conv5_block3_1_relu[0][0]
conv5_block3_2_conv (Conv2D)    (None, 7, 7, 512)    2359296     conv5_block3_2_pad[0][0]
conv5_block3_2_bn (BatchNormali (None, 7, 7, 512)    2048        conv5_block3_2_conv[0][0]
conv5_block3_2_relu (Activation (None, 7, 7, 512)    0           conv5_block3_2_bn[0][0]
conv5_block3_3_conv (Conv2D)    (None, 7, 7, 2048)   1050624     conv5_block3_2_relu[0][0]
conv5_block3_out (Add)          (None, 7, 7, 2048)   0           conv5_block2_out[0][0]
                                                                 conv5_block3_3_conv[0][0]
post_bn (BatchNormalization)    (None, 7, 7, 2048)   8192        conv5_block3_out[0][0]
post_relu (Activation)          (None, 7, 7, 2048)   0           post_bn[0][0]
avg_pool (GlobalAveragePooling2 (None, 2048)         0           post_relu[0][0]
dense_11 (Dense)                (None, 5)            10245       avg_pool[0][0]
==================================================================================================
Total params: 23,575,045
Trainable params: 10,245
Non-trainable params: 23,564,800
__________________________________________________________________________________________________
None
```

In [ ]:

```
train_images=tf.random.normal(shape=(5,224, 224, 3))
train_labels=tf.constant([0,1,2,3,4])

new_model_tl.fit(train_images,train_labels,epochs=20,verbose=2)
```

```
Epoch 1/20
1/1 - 0s - loss: 1.9467 - accuracy: 0.2000
Epoch 2/20
1/1 - 0s - loss: 1.8324 - accuracy: 0.2000
Epoch 3/20
1/1 - 0s - loss: 1.7482 - accuracy: 0.2000
Epoch 4/20
1/1 - 0s - loss: 1.6886 - accuracy: 0.0000e+00
```

```
Epoch 5/20
1/1 - 0s - loss: 1.6433 - accuracy: 0.2000
Epoch 6/20
1/1 - 0s - loss: 1.6070 - accuracy: 0.2000
Epoch 7/20
1/1 - 0s - loss: 1.5782 - accuracy: 0.2000
Epoch 8/20
1/1 - 0s - loss: 1.5553 - accuracy: 0.2000
Epoch 9/20
1/1 - 0s - loss: 1.5351 - accuracy: 0.2000
Epoch 10/20
1/1 - 0s - loss: 1.5140 - accuracy: 0.2000
Epoch 11/20
1/1 - 0s - loss: 1.4895 - accuracy: 0.2000
Epoch 12/20
1/1 - 0s - loss: 1.4614 - accuracy: 0.4000
Epoch 13/20
1/1 - 0s - loss: 1.4306 - accuracy: 0.4000
Epoch 14/20
1/1 - 0s - loss: 1.3989 - accuracy: 0.6000
Epoch 15/20
1/1 - 0s - loss: 1.3678 - accuracy: 0.8000
Epoch 16/20
1/1 - 0s - loss: 1.3381 - accuracy: 0.8000
Epoch 17/20
1/1 - 0s - loss: 1.3102 - accuracy: 0.8000
Epoch 18/20
1/1 - 0s - loss: 1.2838 - accuracy: 0.8000
Epoch 19/20
1/1 - 0s - loss: 1.2586 - accuracy: 1.0000
Epoch 20/20
1/1 - 0s - loss: 1.2343 - accuracy: 1.0000
```

Out[ ]:

```
<tensorflow.python.keras.callbacks.History at 0x15528ee4550>
```