

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']

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[...,
```

```
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())
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 <keras.engine.sequential.Sequential object at 0x00000019B1A72FA30>>
Epoch 1/5
1875/1875 [=====] - 10s 5ms/step - loss: 0.2097 - accuracy: 0.9359
Epoch 2/5
1875/1875 [=====] - 10s 5ms/step - loss: 0.0682 - accuracy: 0.9788
Epoch 3/5
1875/1875 [=====] - 10s 5ms/step - loss: 0.0486 - accuracy: 0.9844
Epoch 4/5
1875/1875 [=====] - 9s 5ms/step - loss: 0.0387 - accuracy: 0.9879
```

```
Epoch 5/5
1875/1875 [=====] - 9s 5ms/step - loss: 0.0319 - accuracy: 0.9899
```

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())
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 <keras.engine.sequential.Sequential object at 0x00000019B1A926F70>>
Epoch 1/5
1563/1563 [=====] - 25s 15ms/step - loss: 1.5557 - accuracy: 0.4331
Epoch 2/5
1563/1563 [=====] - 24s 15ms/step - loss: 1.1939 - accuracy: 0.5756
Epoch 3/5
1563/1563 [=====] - 24s 15ms/step - loss: 1.0314 - accuracy: 0.6367
Epoch 4/5
1563/1563 [=====] - 24s 16ms/step - loss: 0.9185 - accuracy: 0.6782
Epoch 5/5
1563/1563 [=====] - 25s 16ms/step - loss: 0.8367 - accuracy: 0.7063
313/313 - 1s - loss: 0.9305 - accuracy: 0.6763 - 1s/epoch - 5ms/step
0.6762999892234802
```

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[...,

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(),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 = 1)
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 <keras.engine.sequential.Sequential object at 0x00000019B1A90B340>>
Epoch 1/2
1875/1875 [=====] - 27s 14ms/step - loss: 0.1305 - accuracy: 0.9604
Epoch 2/2
1875/1875 [=====] - 26s 14ms/step - loss: 0.0413 - accuracy: 0.9872
313/313 - 1s - loss: 0.0356 - accuracy: 0.9881 - 1s/epoch - 4ms/step
```

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(),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 <keras.engine.sequential.Sequential object at 0x00000019B1AA8D190>>
Epoch 1/2
1875/1875 [=====] - 27s 14ms/step - loss: 0.1310 - accuracy: 0.9605
Epoch 2/2
1875/1875 [=====] - 26s 14ms/step - loss: 0.0426 - accuracy: 0.9869
313/313 - 1s - loss: 0.0487 - accuracy: 0.9851 - 1s/epoch - 4ms/step
WARNING:absl:Found untraced functions such as _jit_compiled_convolution_op, _jit_compiled_convolution_op, _jit_compiled_convolution_op while saving (showing 3 of 3). These functions will not be directly callable after loading.
INFO:tensorflow:Assets written to: saved_model/assets
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_7"

Layer (type)	Output Shape	Param #
<hr/>		
conv2d_19 (Conv2D)	(None, 30, 30, 32)	320
max_pooling2d_15 (MaxPooling2D)	(None, 15, 15, 32)	0
conv2d_20 (Conv2D)	(None, 13, 13, 64)	18496
max_pooling2d_16 (MaxPooling2D)	(None, 6, 6, 64)	0
conv2d_21 (Conv2D)	(None, 4, 4, 64)	36928
flatten_7 (Flatten)	(None, 1024)	0
dense_19 (Dense)	(None, 64)	65600
dense_20 (Dense)	(None, 10)	650

```
=====
Total params: 121,994
Trainable params: 121,994
Non-trainable params: 0
```

```
None
```

```
Out[ ]: [0.04871787875890732, 0.9850999712944031]
```

Question 6

```
In [ ]:
```

```
base_inputs = model_1d.layers[0].input
base_outputs = model_1d.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),
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 <keras.engine.functional.Functional object at 0x00000019B1A8C3430>>
Epoch 1/3
1875/1875 - 25s - loss: 0.0678 - accuracy: 0.9812 - 25s/epoch - 13ms/step
Epoch 2/3
1875/1875 - 24s - loss: 0.0260 - accuracy: 0.9914 - 24s/epoch - 13ms/step
Epoch 3/3
1875/1875 - 25s - loss: 0.0198 - accuracy: 0.9937 - 25s/epoch - 13ms/step
313/313 - 2s - loss: 0.0308 - accuracy: 0.9907 - 2s/epoch - 5ms/step
```

```
Out[ ]: [0.03082950785756111, 0.9907000064849854]
```

Question 7

```
In [ ]:
```

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

base_innputs=model_tl.layers[0].input
base_ouputs=model_tl.layers[-2].output
output=layers.Dense(10)(base_ouputs)

model_tl=keras.Model(inputs=base_innputs,outputs=output)
model_tl.compile(optimizer=keras.optimizers.Adam(),
    loss=keras.losses.SparseCategoricalCrossentropy(from_logits=True),
    metrics=['accuracy'])
print(model_tl.summary())
model_tl.fit(train_images,train_labels,epochs=3,verbose=2)
model_tl.evaluate(test_images, test_labels, verbose=2)
```

```
Model: "model_4"
```

Layer (type)	Output Shape	Param #
conv2d_19_input (InputLayer	[(None, 32, 32, 1)]	0
)		
conv2d_19 (Conv2D)	(None, 30, 30, 32)	320
max_pooling2d_15 (MaxPooling2D)	(None, 15, 15, 32)	0

```

g2D)

conv2d_20 (Conv2D)           (None, 13, 13, 64)      18496
max_pooling2d_16 (MaxPooling2D) (None, 6, 6, 64)      0
g2D)

conv2d_21 (Conv2D)           (None, 4, 4, 64)      36928
flatten_7 (Flatten)          (None, 1024)          0
dense_19 (Dense)             (None, 64)            65600
dense_22 (Dense)             (None, 10)            650

=====
Total params: 121,994
Trainable params: 650
Non-trainable params: 121,344

None
Epoch 1/3
1875/1875 - 8s - loss: 0.2144 - accuracy: 0.9524 - 8s/epoch - 5ms/step
Epoch 2/3
1875/1875 - 8s - loss: 0.0282 - accuracy: 0.9921 - 8s/epoch - 4ms/step
Epoch 3/3
1875/1875 - 8s - loss: 0.0230 - accuracy: 0.9934 - 8s/epoch - 4ms/step
313/313 - 1s - loss: 0.0295 - accuracy: 0.9905 - 1s/epoch - 5ms/step
Out[ ]: [0.02952304296195507, 0.9904999732971191]

```

Question 8

```

In [ ]:
model_t1=keras.applications.resnet_v2.ResNet50V2()

model_t1.trainable=False
for layer in model_t1.layers:
    assert layer.trainable==False

base_innputs=model_t1.layers[0].input
base_ouputs=model_t1.layers[-2].output
output=Dense(5)(base_ouputs)

model_t1=keras.Model(inputs=base_innputs,outputs=output)
model_t1.compile(optimizer=keras.optimizers.Adam(),
                 loss=keras.losses.SparseCategoricalCrossentropy(from_logits=True),
                 metrics=['accuracy'])
print(model_t1.summary())

```

Model: "model_6"

Layer (type)	Output Shape	Param #	Connected to
=====			
input_3 (InputLayer)	[(None, 224, 224, 3 0)]	0	[]
conv1_pad (ZeroPadding2D)	(None, 230, 230, 3) 0	0	['input_3[0][0]']
conv1_conv (Conv2D)	(None, 112, 112, 64 9472)	9472	['conv1_pad[0][0]']
pool1_pad (ZeroPadding2D)	(None, 114, 114, 64 0)	0	['conv1_conv']

```

[0][0]']
)
pool1_pool (MaxPooling2D)      (None, 56, 56, 64)  0          ['pool1_pad
[0][0]']

conv2_block1_preact_bn (BatchN (None, 56, 56, 64)  256       ['pool1_pool
[0][0]']
ormalization)

conv2_block1_preact_relu (Acti (None, 56, 56, 64)  0          ['conv2_block1_pr
eact_bn[0][0]']
vation)

conv2_block1_1_conv (Conv2D)   (None, 56, 56, 64)  4096     ['conv2_block1_pr
eact_relu[0][0]']
]

conv2_block1_1_bn (BatchNormal (None, 56, 56, 64)  256       ['conv2_block1_1_
conv[0][0]']
ization)

conv2_block1_1_relu (Activatio (None, 56, 56, 64)  0          ['conv2_block1_1_
bn[0][0]']
n)

conv2_block1_2_pad (ZeroPaddin (None, 58, 58, 64)  0          ['conv2_block1_1_
relu[0][0]']
g2D)

conv2_block1_2_conv (Conv2D)   (None, 56, 56, 64)  36864     ['conv2_block1_2_
pad[0][0]']

conv2_block1_2_bn (BatchNormal (None, 56, 56, 64)  256       ['conv2_block1_2_
conv[0][0]']
ization)

conv2_block1_2_relu (Activatio (None, 56, 56, 64)  0          ['conv2_block1_2_
bn[0][0]']
n)

conv2_block1_0_conv (Conv2D)   (None, 56, 56, 256) 16640      ['conv2_block1_pr
eact_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]',

conv[0][0]']

conv2_block2_preact_bn (BatchN (None, 56, 56, 256) 1024      ['conv2_block1_ou
t[0][0]']
ormalization)

conv2_block2_preact_relu (Acti (None, 56, 56, 256)  0          ['conv2_block2_pr
eact_bn[0][0]']
ivation)

conv2_block2_1_conv (Conv2D)   (None, 56, 56, 64)  16384     ['conv2_block2_pr
eact_relu[0][0]']
]

conv2_block2_1_bn (BatchNormal (None, 56, 56, 64)  256       ['conv2_block2_1_

```

```
conv[0][0]']
    ization)

    conv2_block2_1_relu (Activatio (None, 56, 56, 64)  0      ['conv2_block2_1_
bn[0][0]']
n)

    conv2_block2_2_pad (ZeroPaddin (None, 58, 58, 64)  0      ['conv2_block2_1_
relu[0][0]']
g2D)

    conv2_block2_2_conv (Conv2D)   (None, 56, 56, 64)  36864  ['conv2_block2_2_
pad[0][0]']

    conv2_block2_2_bn (BatchNormal (None, 56, 56, 64)  256  ['conv2_block2_2_
conv[0][0]']
    ization)

    conv2_block2_2_relu (Activatio (None, 56, 56, 64)  0      ['conv2_block2_2_
bn[0][0]']
n)

    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_ou_
t[0][0]',

conv[0][0]']

    conv2_block3_preact_bn (BatchN (None, 56, 56, 256) 1024  ['conv2_block2_ou_
t[0][0]']
    rmalization)

    conv2_block3_preact_relu (Acti (None, 56, 56, 256)  0      ['conv2_block3_pr_
eact_bn[0][0]']
    vation)

    conv2_block3_1_conv (Conv2D)   (None, 56, 56, 64)  16384  ['conv2_block3_pr_
eact_relu[0][0]']

    conv2_block3_1_bn (BatchNormal (None, 56, 56, 64)  256  ['conv2_block3_1_
conv[0][0]']
    ization)

    conv2_block3_1_relu (Activatio (None, 56, 56, 64)  0      ['conv2_block3_1_
bn[0][0]']
n)

    conv2_block3_2_pad (ZeroPaddin (None, 58, 58, 64)  0      ['conv2_block3_1_
relu[0][0]']
g2D)

    conv2_block3_2_conv (Conv2D)   (None, 28, 28, 64)  36864  ['conv2_block3_2_
pad[0][0]']

    conv2_block3_2_bn (BatchNormal (None, 28, 28, 64)  256  ['conv2_block3_2_
conv[0][0]']
    ization)

    conv2_block3_2_relu (Activatio (None, 28, 28, 64)  0      ['conv2_block3_2_
bn[0][0]']
n)

    max_pooling2d_20 (MaxPooling2D (None, 28, 28, 256)  0      ['conv2_block2_ou
```

```

t[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_2
0[0][0]',

conv[0][0]']

conv3_block1_preact_bn (BatchN (None, 28, 28, 256) 1024      ['conv2_block3_ou
t[0][0]']
rormalization)

conv3_block1_preact_relu (Acti (None, 28, 28, 256) 0          ['conv3_block1_pr
eact_bn[0][0]']
ivation)

conv3_block1_1_conv (Conv2D)   (None, 28, 28, 128) 32768      ['conv3_block1_pr
eact_relu[0][0]']

conv3_block1_1_bn (BatchNormal (None, 28, 28, 128) 512       ['conv3_block1_1_
conv[0][0]']
ization)

conv3_block1_1_relu (Activatio (None, 28, 28, 128) 0          ['conv3_block1_1_
bn[0][0]']
n)

conv3_block1_2_pad (ZeroPaddin (None, 30, 30, 128) 0          ['conv3_block1_1_
g2D)

conv3_block1_2_conv (Conv2D)   (None, 28, 28, 128) 147456     ['conv3_block1_2_
pad[0][0]']

conv3_block1_2_bn (BatchNormal (None, 28, 28, 128) 512       ['conv3_block1_2_
conv[0][0]']
ization)

conv3_block1_2_relu (Activatio (None, 28, 28, 128) 0          ['conv3_block1_2_
bn[0][0]']
n)

conv3_block1_0_conv (Conv2D)   (None, 28, 28, 512) 131584     ['conv3_block1_pr
eact_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]',

conv[0][0]']

conv3_block2_preact_bn (BatchN (None, 28, 28, 512) 2048      ['conv3_block1_ou
t[0][0]']
rormalization)

conv3_block2_preact_relu (Acti (None, 28, 28, 512) 0          ['conv3_block2_pr
eact_bn[0][0]']
ivation)

```

conv3_block2_1_conv (Conv2D) (None, 28, 28, 128) 65536	['conv3_block2_pr eact_relu[0][0]']
conv3_block2_1_bn (BatchNormal (None, 28, 28, 128) 512	['conv3_block2_1_ conv[0][0]' ization)
conv3_block2_1_relu (Activatio (None, 28, 28, 128) 0	['conv3_block2_1_ bn[0][0]' n)
conv3_block2_2_pad (ZeroPaddin (None, 30, 30, 128) 0	['conv3_block2_1_ relu[0][0]' g2D)
conv3_block2_2_conv (Conv2D) (None, 28, 28, 128) 147456	['conv3_block2_2_ pad[0][0]']
conv3_block2_2_bn (BatchNormal (None, 28, 28, 128) 512	['conv3_block2_2_ conv[0][0]' ization)
conv3_block2_2_relu (Activatio (None, 28, 28, 128) 0	['conv3_block2_2_ bn[0][0]' n)
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 t[0][0]', conv[0][0]']
conv3_block3_preact_bn (BatchN (None, 28, 28, 512) 2048	['conv3_block2_out t[0][0]' ormalization)
conv3_block3_preact_relu (Acti (None, 28, 28, 512) 0	['conv3_block3_pr eact_bn[0][0]' vation)
conv3_block3_1_conv (Conv2D) (None, 28, 28, 128) 65536	['conv3_block3_pr eact_relu[0][0]']
conv3_block3_1_bn (BatchNormal (None, 28, 28, 128) 512	['conv3_block3_1_ conv[0][0]' ization)
conv3_block3_1_relu (Activatio (None, 28, 28, 128) 0	['conv3_block3_1_ bn[0][0]' n)
conv3_block3_2_pad (ZeroPaddin (None, 30, 30, 128) 0	['conv3_block3_1_ relu[0][0]' g2D)
conv3_block3_2_conv (Conv2D) (None, 28, 28, 128) 147456	['conv3_block3_2_ pad[0][0]']
conv3_block3_2_bn (BatchNormal (None, 28, 28, 128) 512	['conv3_block3_2_ conv[0][0]' ization)

```
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_ou'
t[0][0]',

conv[0][0]']

conv3_block4_preact_bn (BatchN (None, 28, 28, 512) 2048      ['conv3_block3_ou'
t[0][0]']
ormalization)

conv3_block4_preact_relu (Acti (None, 28, 28, 512) 0           ['conv3_block4_pr'
eact_bn[0][0]']
vation)

conv3_block4_1_conv (Conv2D)   (None, 28, 28, 128) 65536      ['conv3_block4_pr
eact_relu[0][0]']

conv3_block4_1_bn (BatchNormal (None, 28, 28, 128) 512        ['conv3_block4_1_
conv[0][0]']
ization)

conv3_block4_1_relu (Activatio (None, 28, 28, 128) 0           ['conv3_block4_1_
bn[0][0]']
n)

conv3_block4_2_pad (ZeroPaddin (None, 30, 30, 128) 0           ['conv3_block4_1_
relu[0][0]']
g2D)

conv3_block4_2_conv (Conv2D)   (None, 14, 14, 128) 147456      ['conv3_block4_2_
pad[0][0]']

conv3_block4_2_bn (BatchNormal (None, 14, 14, 128) 512        ['conv3_block4_2_
conv[0][0]']
ization)

conv3_block4_2_relu (Activatio (None, 14, 14, 128) 0           ['conv3_block4_2_
bn[0][0]']
n)

max_pooling2d_21 (MaxPooling2D (None, 14, 14, 512) 0           ['conv3_block3_ou'
t[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_2
1[0][0]',

conv[0][0]']

conv4_block1_preact_bn (BatchN (None, 14, 14, 512) 2048      ['conv3_block4_ou'
t[0][0]']
ormalization)

conv4_block1_preact_relu (Acti (None, 14, 14, 512) 0           ['conv4_block1_pr
eact_bn[0][0]']
vation)
```

```
conv4_block1_1_conv (Conv2D)    (None, 14, 14, 256) 131072      ['conv4_block1_pr  
eact_relu[0][0]'  
]  
  
conv4_block1_1_bn (BatchNormal (None, 14, 14, 256) 1024      ['conv4_block1_1_  
conv[0][0]'  
ization)  
  
conv4_block1_1_relu (Activatio (None, 14, 14, 256) 0       ['conv4_block1_1_  
bn[0][0]'  
n)  
  
conv4_block1_2_pad (ZeroPaddin (None, 16, 16, 256) 0       ['conv4_block1_1_  
relu[0][0]'  
g2D)  
  
conv4_block1_2_conv (Conv2D)    (None, 14, 14, 256) 589824     ['conv4_block1_2_  
pad[0][0]']  
  
conv4_block1_2_bn (BatchNormal (None, 14, 14, 256) 1024      ['conv4_block1_2_  
conv[0][0]'  
ization)  
  
conv4_block1_2_relu (Activatio (None, 14, 14, 256) 0       ['conv4_block1_2_  
bn[0][0]'  
n)  
  
conv4_block1_0_conv (Conv2D)    (None, 14, 14, 1024 525312     ['conv4_block1_pr  
eact_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]',  
)  
conv[0][0]')  
  
conv4_block2_preact_bn (BatchN (None, 14, 14, 1024 4096      ['conv4_block1_out  
t[0][0]'  
ormalization)  
)  
  
conv4_block2_preact_relu (Acti (None, 14, 14, 1024 0       ['conv4_block2_pr  
eact_bn[0][0]'  
vation)  
)  
  
conv4_block2_1_conv (Conv2D)    (None, 14, 14, 256) 262144     ['conv4_block2_pr  
eact_relu[0][0]']  
]  
  
conv4_block2_1_bn (BatchNormal (None, 14, 14, 256) 1024      ['conv4_block2_1_  
conv[0][0]'  
ization)  
  
conv4_block2_1_relu (Activatio (None, 14, 14, 256) 0       ['conv4_block2_1_  
bn[0][0]'  
n)  
  
conv4_block2_2_pad (ZeroPaddin (None, 16, 16, 256) 0       ['conv4_block2_1_  
relu[0][0]'  
g2D)  
  
conv4_block2_2_conv (Conv2D)    (None, 14, 14, 256) 589824     ['conv4_block2_2_
```

```
pad[0][0]']

    conv4_block2_2_bn (BatchNormal  (None, 14, 14, 256)  1024      ['conv4_block2_2_
conv[0][0]']
    ization)

    conv4_block2_2_relu (Activatio  (None, 14, 14, 256)  0      ['conv4_block2_2_
bn[0][0]']
    n)

    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_
t[0][0]',

)
conv[0][0]']

    conv4_block3_preact_bn (BatchN  (None, 14, 14, 1024  4096  ['conv4_block2_out_
t[0][0]']
    ormalization)
    )

    conv4_block3_preact_relu (Acti  (None, 14, 14, 1024  0      ['conv4_block3_pr_
eact_bn[0][0]']
    vation)
    )

    conv4_block3_1_conv (Conv2D)   (None, 14, 14, 256)  262144  ['conv4_block3_pr_
eact_relu[0][0]']
    )

    conv4_block3_1_bn (BatchNormal (None, 14, 14, 256)  1024      ['conv4_block3_1_
conv[0][0]']
    ization)

    conv4_block3_1_relu (Activatio (None, 14, 14, 256)  0      ['conv4_block3_1_
bn[0][0]']
    n)

    conv4_block3_2_pad (ZeroPaddin (None, 16, 16, 256)  0      ['conv4_block3_1_
relu[0][0]']
    g2D)

    conv4_block3_2_conv (Conv2D)   (None, 14, 14, 256)  589824  ['conv4_block3_2_
pad[0][0]']

    conv4_block3_2_bn (BatchNormal (None, 14, 14, 256)  1024      ['conv4_block3_2_
conv[0][0]']
    ization)

    conv4_block3_2_relu (Activatio (None, 14, 14, 256)  0      ['conv4_block3_2_
bn[0][0]']
    n)

    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_
t[0][0]',

)
conv[0][0]']

    conv4_block4_preact_bn (BatchN  (None, 14, 14, 1024  4096  ['conv4_block3_out_
t[0][0]']
    ormalization)
    )
```

```
conv4_block4_preact_relu (Activation) (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 (BatchNormal) (None, 14, 14, 256) 1024 ['conv4_block4_1_ization)
conv4_block4_1_relu (Activation) (None, 14, 14, 256) 0 ['conv4_block4_1_bn[0][0]']
n)
conv4_block4_2_pad (ZeroPadding2D) (None, 16, 16, 256) 0 ['conv4_block4_1_relu[0][0]']
g2D)
conv4_block4_2_conv (Conv2D) (None, 14, 14, 256) 589824 ['conv4_block4_2_pad[0][0]']
)
conv4_block4_2_bn (BatchNormal) (None, 14, 14, 256) 1024 ['conv4_block4_2_ization)
conv4_block4_2_relu (Activation) (None, 14, 14, 256) 0 ['conv4_block4_2_bn[0][0]']
n)
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]', )
conv[0][0]')
conv4_block5_preact_bn (BatchNormalization) (None, 14, 14, 1024) 4096 ['conv4_block4_out[0][0]']
)
conv4_block5_preact_relu (Activation) (None, 14, 14, 1024) 0 ['conv4_block5_preact_bn[0][0]']
vation)
)
conv4_block5_1_conv (Conv2D) (None, 14, 14, 256) 262144 ['conv4_block5_preact_relu[0][0]']
]
conv4_block5_1_bn (BatchNormal) (None, 14, 14, 256) 1024 ['conv4_block5_1_ization)
conv4_block5_1_relu (Activation) (None, 14, 14, 256) 0 ['conv4_block5_1_bn[0][0]']
n)
conv4_block5_2_pad (ZeroPadding2D) (None, 16, 16, 256) 0 ['conv4_block5_1_relu[0][0]']
g2D)
conv4_block5_2_conv (Conv2D) (None, 14, 14, 256) 589824 ['conv4_block5_2_]
```

```
pad[0][0]']

    conv4_block5_2_bn (BatchNormal  (None, 14, 14, 256)  1024      ['conv4_block5_2_
conv[0][0]']
    ization)

    conv4_block5_2_relu (Activatio  (None, 14, 14, 256)  0      ['conv4_block5_2_
bn[0][0]']
    n)

    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_ou_
t[0][0]', )
    )

    conv4_block6_preact_bn (BatchN (None, 14, 14, 1024  4096  ['conv4_block5_ou_
t[0][0]']
    ormalization)
    )

    conv4_block6_preact_relu (Acti (None, 14, 14, 1024  0      ['conv4_block6_pr_
eact_bn[0][0]']
    vation)
    )

    conv4_block6_1_conv (Conv2D)   (None, 14, 14, 256)  262144  ['conv4_block6_pr_
eact_relu[0][0]']
    )

    conv4_block6_1_bn (BatchNormal (None, 14, 14, 256)  1024      ['conv4_block6_1_
conv[0][0]']
    ization)

    conv4_block6_1_relu (Activatio (None, 14, 14, 256)  0      ['conv4_block6_1_
bn[0][0]']
    n)

    conv4_block6_2_pad (ZeroPaddin (None, 16, 16, 256)  0      ['conv4_block6_1_
relu[0][0]']
    g2D)

    conv4_block6_2_conv (Conv2D)   (None, 7, 7, 256)   589824  ['conv4_block6_2_
pad[0][0]']

    conv4_block6_2_bn (BatchNormal (None, 7, 7, 256)   1024  ['conv4_block6_2_
conv[0][0]']
    ization)

    conv4_block6_2_relu (Activatio (None, 7, 7, 256)   0      ['conv4_block6_2_
bn[0][0]']
    n)

    max_pooling2d_22 (MaxPooling2D (None, 7, 7, 1024)  0      ['conv4_block5_ou_
t[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_2_
2[0][0]', )
    )

    conv4_block6_out (Add)       (None, 7, 7, 1024)  0      ['max_pooling2d_2_
conv[0][0]']
```

conv5_block1_preact_bn (BatchN (None, 7, 7, 1024) 4096	t[0][0]'	ormalization)		['conv4_block6_out']
conv5_block1_preact_relu (Acti (None, 7, 7, 1024) 0	eact_bn[0][0]'	vation)		['conv5_block1_pr']
conv5_block1_1_conv (Conv2D) (None, 7, 7, 512) 524288	eact_relu[0][0]'			['conv5_block1_pr']
conv5_block1_1_bn (BatchNormal (None, 7, 7, 512) 2048	conv[0][0]'	ization)		['conv5_block1_1_']
conv5_block1_1_relu (Activatio (None, 7, 7, 512) 0	bn[0][0]'	n)		['conv5_block1_1_']
conv5_block1_2_pad (ZeroPaddin (None, 9, 9, 512) 0	relu[0][0]'	g2D)		['conv5_block1_1_']
conv5_block1_2_conv (Conv2D) (None, 7, 7, 512) 2359296	pad[0][0]'			['conv5_block1_2_']
conv5_block1_2_bn (BatchNormal (None, 7, 7, 512) 2048	conv[0][0]'	ization)		['conv5_block1_2_']
conv5_block1_2_relu (Activatio (None, 7, 7, 512) 0	bn[0][0]'	n)		['conv5_block1_2_']
conv5_block1_0_conv (Conv2D) (None, 7, 7, 2048) 2099200	eact_relu[0][0]'			['conv5_block1_pr']
conv5_block1_3_conv (Conv2D) (None, 7, 7, 2048) 1050624	relu[0][0]'			['conv5_block1_2_']
conv5_block1_out (Add) (None, 7, 7, 2048) 0	conv[0][0]',			['conv5_block1_0_']
conv5_block1_out (Add) (None, 7, 7, 2048) 0	conv[0][0]'			'conv5_block1_3_']
conv5_block2_preact_bn (BatchN (None, 7, 7, 2048) 8192	t[0][0]'	ormalization)		['conv5_block1_out']
conv5_block2_preact_relu (Acti (None, 7, 7, 2048) 0	eact_bn[0][0]'	vation)		['conv5_block2_pr']
conv5_block2_1_conv (Conv2D) (None, 7, 7, 512) 1048576	eact_relu[0][0]'			['conv5_block2_pr']
conv5_block2_1_bn (BatchNormal (None, 7, 7, 512) 2048	conv[0][0]'	ization)		['conv5_block2_1_']
conv5_block2_1_relu (Activatio (None, 7, 7, 512) 0	bn[0][0]'	n)		['conv5_block2_1_']

conv5_block2_2_pad (ZeroPaddin relu[0][0]')	(None, 9, 9, 512)	0	['conv5_block2_1_
g2D)			
conv5_block2_2_conv (Conv2D)	(None, 7, 7, 512)	2359296	['conv5_block2_2_
pad[0][0]'			
conv5_block2_2_bn (BatchNormal conv[0][0]')	(None, 7, 7, 512)	2048	['conv5_block2_2_
ization)			
conv5_block2_2_relu (Activatio bn[0][0]')	(None, 7, 7, 512)	0	['conv5_block2_2_
n)			
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
t[0][0]',			'conv5_block2_3_
conv[0][0]'			
conv5_block3_preact_bn (BatchN t[0][0]')	(None, 7, 7, 2048)	8192	['conv5_block2_out
ormalization)			
conv5_block3_preact_relu (Acti eact_bn[0][0]')	(None, 7, 7, 2048)	0	['conv5_block3_pr
vation)			
conv5_block3_1_conv (Conv2D)	(None, 7, 7, 512)	1048576	['conv5_block3_pr
eact_relu[0][0]']
conv5_block3_1_bn (BatchNormal conv[0][0]')	(None, 7, 7, 512)	2048	['conv5_block3_1_
ization)			
conv5_block3_1_relu (Activatio bn[0][0]')	(None, 7, 7, 512)	0	['conv5_block3_1_
n)			
conv5_block3_2_pad (ZeroPaddin relu[0][0]')	(None, 9, 9, 512)	0	['conv5_block3_1_
g2D)			
conv5_block3_2_conv (Conv2D)	(None, 7, 7, 512)	2359296	['conv5_block3_2_
pad[0][0]'			
conv5_block3_2_bn (BatchNormal conv[0][0]')	(None, 7, 7, 512)	2048	['conv5_block3_2_
ization)			
conv5_block3_2_relu (Activatio bn[0][0]')	(None, 7, 7, 512)	0	['conv5_block3_2_
n)			
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
t[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 (GlobalAveragePooling (None, 2048)       0         ['post_relu[0][0]']

2D)
```

In []:

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

model_t1.fit(train_images,train_labels,epochs=20,verbose=2)
```

```
Epoch 1/20
1/1 - 2s - loss: 1.8653 - accuracy: 0.2000 - 2s/epoch - 2s/step
Epoch 2/20
1/1 - 0s - loss: 1.7368 - accuracy: 0.2000 - 202ms/epoch - 202ms/step
Epoch 3/20
1/1 - 0s - loss: 1.6405 - accuracy: 0.2000 - 200ms/epoch - 200ms/step
Epoch 4/20
1/1 - 0s - loss: 1.5762 - accuracy: 0.4000 - 215ms/epoch - 215ms/step
Epoch 5/20
1/1 - 0s - loss: 1.5326 - accuracy: 0.2000 - 233ms/epoch - 233ms/step
Epoch 6/20
1/1 - 0s - loss: 1.4988 - accuracy: 0.2000 - 219ms/epoch - 219ms/step
Epoch 7/20
1/1 - 0s - loss: 1.4707 - accuracy: 0.4000 - 208ms/epoch - 208ms/step
Epoch 8/20
1/1 - 0s - loss: 1.4466 - accuracy: 0.4000 - 206ms/epoch - 206ms/step
Epoch 9/20
1/1 - 0s - loss: 1.4241 - accuracy: 0.6000 - 208ms/epoch - 208ms/step
Epoch 10/20
1/1 - 0s - loss: 1.4004 - accuracy: 0.4000 - 211ms/epoch - 211ms/step
Epoch 11/20
1/1 - 0s - loss: 1.3736 - accuracy: 0.4000 - 210ms/epoch - 210ms/step
Epoch 12/20
1/1 - 0s - loss: 1.3434 - accuracy: 0.4000 - 210ms/epoch - 210ms/step
Epoch 13/20
1/1 - 0s - loss: 1.3109 - accuracy: 0.4000 - 210ms/epoch - 210ms/step
Epoch 14/20
1/1 - 0s - loss: 1.2774 - accuracy: 0.6000 - 207ms/epoch - 207ms/step
Epoch 15/20
1/1 - 0s - loss: 1.2446 - accuracy: 0.6000 - 209ms/epoch - 209ms/step
Epoch 16/20
1/1 - 0s - loss: 1.2134 - accuracy: 1.0000 - 201ms/epoch - 201ms/step
Epoch 17/20
1/1 - 0s - loss: 1.1843 - accuracy: 1.0000 - 232ms/epoch - 232ms/step
Epoch 18/20
1/1 - 0s - loss: 1.1571 - accuracy: 1.0000 - 206ms/epoch - 206ms/step
Epoch 19/20
1/1 - 0s - loss: 1.1316 - accuracy: 1.0000 - 196ms/epoch - 196ms/step
Epoch 20/20
1/1 - 0s - loss: 1.1071 - accuracy: 1.0000 - 199ms/epoch - 199ms/step
```

Out[]: <keras.callbacks.History at 0x19b19b57310>