0. Data Loading

In [1]:
```
import pandas as pd
import numpy as np
from matplotlib import pyplot as plt
from PIL import Image
from urllib import request
from io import BytesIO
import seaborn as sns
```

In [2]:
```
# from google.colab import drive
# drive.mount('/content/drive')
```

1. Data Exploring

In [3]:
```
# df = pd.read_csv('/content/drive/Shareddrives/KAR Global/CarImageURL.csv',index_col = 0)
# df = df[df['MODEL_YEAR']>=2011]
# df.dropna(subset=['MAKE','MODEL','IMAGE_URL'],inplace=True) ## Drop rows that has missing data in "Make",
# #len(df[df.duplicated()]) There are about 500k completely duplicated rows in the dataset
# df.drop_duplicates(inplace=True,ignore_index=True)
# df.fillna("NA",inplace=True) ## Fill in missing values in SERIES
# #df['IMAGE_CAPTION'].value_counts() ## We want to replace 'Front' with 'Front Photo', and replace 'Rear' w
# df['IMAGE_CAPTION']= df['IMAGE_CAPTION'].replace('Front','Front Photo')
# df['IMAGE_CAPTION'] = df['IMAGE_CAPTION'].replace('Rear','Rear Photo')
# df = df[df['IMAGE_CAPTION'].isin(['Front Photo','Rear Photo'])]
```

In [4]:
```
# top_make = list(((df['MAKE'].value_counts()/len(df)).head(30)).index)
```

In [5]:
```
# df['MAKE_1'] = df[df['MAKE'].isin(top_make)]['MAKE']
# df.loc[~df['MAKE'].isin(top_make),'MAKE_1'] = 'OTHER'
```

In [6]:
```
# df['MAKE_1'].value_counts()
```

In [7]:
```
# good_car_id = []
```

In [8]:
```
# for i in car_id:
#   if len(df[df['ASSIGNMENT_ID']==i]['IMAGE_CAPTION'].unique())==2:
#     good_car_id.append(i)
```

In [9]:
```
# good_car = np.array(good_car_id)
```

In [10]:
```
# np.save('/content/drive/Shared drives/KAR Global_1/Fine_tune_31_classes_multiple_inputs/good_car_id.npy',g
```

2. Image Downloading

In [11]:
```
pwd
```

Out[11]:
```
'/Users/chuyuchen/Desktop/UChicago/Capstone/30_class/multi_input'
```

In [12]:
```
good_car_id = list(np.load('/Users/chuyuchen/Desktop/UChicago/Capstone/30_class/multi_input/good_car_id.npy'
```

In [13]:
```
# top_make.append('OTHER')
```

In [14]:
```
# len(top_make)
```

In [15]:
```
numbering = list(i for i in range(31))
```

In [16]:
```
# top_make_dict = dict(zip(top_make,numbering))
```

In [17]:
```
# top_make_dict
```

In [18]:
```
# df = df[df['ASSIGNMENT_ID'].isin(good_car_id)]
```

In [19]:
```
# df[(df['ASSIGNMENT_ID']==15412881)&(df['IMAGE_CAPTION']=='Front Photo')].iloc[0]['IMAGE_URL']
```

In [20]:
```
# import urllib.request
# import os


# for i in top_make:
#   path = os.path.sep.join(['/content/drive/Shared drives/KAR Global_1/Fine_tune_31_classes_multiple_inputs

#   if not os.path.exists(path):
#     os.mkdir(path)
#     os.chdir(path)

#     dfs = df[(df['MAKE_1']==i) & (df['IMAGE_CAPTION']=='Front Photo')].sample(1000).reset_index(drop=True)
#     dfs_id = list(dfs['ASSIGNMENT_ID'].unique())

#     for idx,n in enumerate(dfs_id):
#         try:
#           urllib.request.urlretrieve(df[(df['ASSIGNMENT_ID']==n)&(df['IMAGE_CAPTION']=='Front Photo')].ilo
#         except:
#           continue

#     for idx,n in enumerate(dfs_id):
#         try:
#           urllib.request.urlretrieve(df[(df['ASSIGNMENT_ID']==n)&(df['IMAGE_CAPTION']=='Rear Photo')].iloc
#         except:
#           continue

#   else:
#     continue
```

In [21]:
```
# import pathlib
# data_dir = pathlib.Path('/content/drive/Shared drives/KAR Global_1/Fine_tune_31_classes_multiple_inputs')
```

In [22]:
```
# for i in top_make:
#   print('Folder '+ str(i) + ' has ' + str(len(list(data_dir.glob(str(i)+'/*')))))
```

In [23]:
```
import pathlib
import PIL.Image as Image
import cv2
```

In [ ]:
```
# data_dir = pathlib.Path('/content/drive/Shared drives/KAR Global_1/Fine_tune_31_classes_multiple_inputs')
```

In [ ]:
```
# len(list(data_dir.glob('FORD'+'/*Front*')))
```

In [ ]:
```
# for n in list(data_dir.glob('FORD'+'/*Rear*')):
#   print(n)
```

In [ ]:
```
# X_Front, y = [], []

# for i in top_make[:15]:
#     for n in list(data_dir.glob(str(i)+'/*Front*')):
#         img = cv2.imread(str(n))
```

```
#         resized_img = cv2.resize(img,(224,224))
#         X_Front.append(resized_img)
#         y.append(top_make_dict[i])
#     print('{} make is done'.format(i))
```

In [ ]:
```
# np.save('/content/drive/Shared drives/KAR Global_1/Fine_tune_31_classes_multiple_inputs/X_0_15_Front.npy',
```

In [ ]:
```
# np.save('/content/drive/Shared drives/KAR Global_1/Fine_tune_31_classes_multiple_inputs/y_0_15.npy',y)
```

In [ ]:
```
# X_Front, y = [], []

# for i in top_make[15:]:
#     for n in list(data_dir.glob(str(i)+'/*Front*')):
#         img = cv2.imread(str(n))
#         resized_img = cv2.resize(img,(224,224))
#         X_Front.append(resized_img)
#         y.append(top_make_dict[i])
#     print('{} make is done'.format(i))
```

In [ ]:
```
# np.save('/content/drive/Shared drives/KAR Global_1/Fine_tune_31_classes_multiple_inputs/X_15_31_Front.npy'
```

In [ ]:
```
# np.save('/content/drive/Shared drives/KAR Global_1/Fine_tune_31_classes_multiple_inputs/y_15_31.npy',y)
```

In [ ]:
```
# X_Rear = []

# for i in top_make[:15]:

#   for n in list(data_dir.glob(str(i)+'/*Rear*')):
#     img = cv2.imread(str(n))
#     resized_img = cv2.resize(img,(224,224))
#     X_Rear.append(resized_img)

#   print('{} make is done'.format(i))
```

In [ ]:
```
# np.save('/content/drive/Shared drives/KAR Global_1/Fine_tune_31_classes_multiple_inputs/X_0_15_Rear.npy',X
```

In [ ]:
```
# len(X_Rear)
```

In [ ]:
```
# X_Rear = []

# for i in top_make[15:]:

#   for n in list(data_dir.glob(str(i)+'/*Rear*')):
#     img = cv2.imread(str(n))
#     resized_img = cv2.resize(img,(224,224))
#     X_Rear.append(resized_img)

#   print('{} make is done'.format(i))
```

In [ ]:
```
# np.save('/content/drive/Shared drives/KAR Global_1/Fine_tune_31_classes_multiple_inputs/X_15_31_Rear.npy',
```

3. Modeling

In [24]:
```
import tensorflow as tf
import numpy as np
import cv2
from tensorflow.keras import utils
from keras.layers import Dense,Flatten,BatchNormalization,Dropout,GlobalAveragePooling2D
from keras.models import Model
from keras.preprocessing.image import ImageDataGenerator
from keras.callbacks import EarlyStopping
```

In [25]:
```
pwd
```

Out[25]:
```
'/Users/chuyuchen/Desktop/UChicago/Capstone/30_class/multi_input'
```

In [26]:
```
X_0_15_Front = np.load('/Users/chuyuchen/Desktop/UChicago/Capstone/30_class/multi_input/X_0_15_Front.npy')
X_0_15_Rear = np.load('/Users/chuyuchen/Desktop/UChicago/Capstone/30_class/multi_input/X_0_15_Rear.npy')
```

In [27]:
```
X_0_15 = np.append(X_0_15_Front,X_0_15_Rear,axis=1)
```

In [28]:
```
del X_0_15_Front
del X_0_15_Rear
```

In [29]:
```
X_15_31_Front = np.load('/Users/chuyuchen/Desktop/UChicago/Capstone/30_class/multi_input/X_15_31_Front.npy')
X_15_31_Rear = np.load('/Users/chuyuchen/Desktop/UChicago/Capstone/30_class/multi_input/X_15_31_Rear.npy')
```

In [30]:
```
X_15_31 = np.append(X_15_31_Front,X_15_31_Rear,axis=1)
```

In [31]:
```
del X_15_31_Front
del X_15_31_Rear
```

In [33]:
```
X = np.append(X_0_15,X_15_31,axis=0)
```

In [34]:
```
del X_0_15
del X_15_31
```

In [35]:
```
y_0_15 = np.load('/Users/chuyuchen/Desktop/UChicago/Capstone/30_class/multi_input/y_0_15.npy')
y_15_31 = np.load('/Users/chuyuchen/Desktop/UChicago/Capstone/30_class/multi_input/y_15_31.npy')
```

In [36]:
```
y = np.append(y_0_15,y_15_31,axis=0)
```

In [37]:
```
from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(X, y, random_state=42,stratify=y)
```

In [38]:
```
X_train, X_val, y_train, y_val = train_test_split(X_train,y_train, train_size=0.8, random_state=42,stratify=
```

In [39]:
```
num_class = 31
```

3.1 VGG 16 Model

In [40]:
```
from keras.applications.vgg16 import VGG16
```

In [41]:
```
base_model = VGG16(include_top=False,input_shape=(448,224,3))
x = Flatten(name='flatten')(base_model.output)
x = Dense(4096, activation='relu', name='d1')(x)
# x = BatchNormalization()(x)
# x = Dropout(0.5)(x)
x = Dense(4096, activation='relu', name='d2')(x)
# x = BatchNormalization()(x)
# x = Dropout(0.5)(x)
output = Dense(num_class,name='d3')(x)

model = Model(inputs=base_model.inputs, outputs=output)

model.summary()
```

```
Metal device set to: Apple M1 Pro
```

```
2022-01-27 20:58:48.254968: I tensorflow/core/common_runtime/pluggable_device/pluggable_device_factory.cc:305] Could not identify NUMA node of platform GPU ID 0, defaulting to 0. Your kernel may not have been built with NUMA support.
2022-01-27 20:58:48.255220: I tensorflow/core/common_runtime/pluggable_device/pluggable_device_factory.cc:271] Created TensorFlow device (/job:localhost/replica:0/task:0/device:GPU:0 with 0 MB memory) -> physical PluggableDevice (device: 0, name: METAL, pci bus id: <undefined>)
Model: "model"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 input_1 (InputLayer)        [(None, 448, 224, 3)]     0

 block1_conv1 (Conv2D)       (None, 448, 224, 64)      1792

 block1_conv2 (Conv2D)       (None, 448, 224, 64)      36928

 block1_pool (MaxPooling2D)  (None, 224, 112, 64)      0

 block2_conv1 (Conv2D)       (None, 224, 112, 128)     73856

 block2_conv2 (Conv2D)       (None, 224, 112, 128)     147584

 block2_pool (MaxPooling2D)  (None, 112, 56, 128)      0

 block3_conv1 (Conv2D)       (None, 112, 56, 256)      295168

 block3_conv2 (Conv2D)       (None, 112, 56, 256)      590080

 block3_conv3 (Conv2D)       (None, 112, 56, 256)      590080

 block3_pool (MaxPooling2D)  (None, 56, 28, 256)       0

 block4_conv1 (Conv2D)       (None, 56, 28, 512)       1180160

 block4_conv2 (Conv2D)       (None, 56, 28, 512)       2359808

 block4_conv3 (Conv2D)       (None, 56, 28, 512)       2359808

 block4_pool (MaxPooling2D)  (None, 28, 14, 512)       0

 block5_conv1 (Conv2D)       (None, 28, 14, 512)       2359808

 block5_conv2 (Conv2D)       (None, 28, 14, 512)       2359808

 block5_conv3 (Conv2D)       (None, 28, 14, 512)       2359808

 block5_pool (MaxPooling2D)  (None, 14, 7, 512)        0

 flatten (Flatten)           (None, 50176)             0

 d1 (Dense)                  (None, 4096)              205524992

 d2 (Dense)                  (None, 4096)              16781312

 d3 (Dense)                  (None, 31)                127007

=================================================================
Total params: 237,147,999
Trainable params: 237,147,999
Non-trainable params: 0
_________________________________________________________________
```

In [42]:

```
for layer in model.layers:
    layer.trainable = True
```

In [43]:

```
early_stopping = EarlyStopping(patience=5)
```

In [44]:

```
model.compile(
  optimizer="adam",
  loss=tf.keras.losses.SparseCategoricalCrossentropy(from_logits=True),
  metrics=['acc'])

model.fit(X_train,
          y_train,
          epochs=50,
```

```
          callbacks = early_stopping,
          validation_data=(X_val, y_val))
```

```
2022-01-27 20:59:04.487533: W tensorflow/core/platform/profile_utils/cpu_utils.cc:128] Failed to get CPU fre
quency: 0 Hz
Epoch 1/50
2022-01-27 20:59:05.031570: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:112] Pl
ugin optimizer for device_type GPU is enabled.
582/582 [==============================] - ETA: 0s - loss: 3.8671 - acc: 0.0286
2022-01-27 21:19:33.732609: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:112] Pl
ugin optimizer for device_type GPU is enabled.
582/582 [==============================] - 1317s 2s/step - loss: 3.8671 - acc: 0.0286 - val_loss: 3.4340 - v
al_acc: 0.0323
Epoch 2/50
582/582 [==============================] - 1283s 2s/step - loss: 3.4344 - acc: 0.0288 - val_loss: 3.4340 - v
al_acc: 0.0323
Epoch 3/50
582/582 [==============================] - 1276s 2s/step - loss: 3.4344 - acc: 0.0294 - val_loss: 3.4340 - v
al_acc: 0.0323
Epoch 4/50
582/582 [==============================] - 1280s 2s/step - loss: 3.4344 - acc: 0.0307 - val_loss: 3.4340 - v
al_acc: 0.0323
Epoch 5/50
582/582 [==============================] - 1279s 2s/step - loss: 3.4344 - acc: 0.0293 - val_loss: 3.4340 - v
al_acc: 0.0323
Epoch 6/50
582/582 [==============================] - 1280s 2s/step - loss: 3.4344 - acc: 0.0300 - val_loss: 3.4340 - v
al_acc: 0.0323
Epoch 7/50
582/582 [==============================] - 1285s 2s/step - loss: 3.4344 - acc: 0.0279 - val_loss: 3.4340 - v
al_acc: 0.0323
Epoch 8/50
582/582 [==============================] - 1275s 2s/step - loss: 3.4344 - acc: 0.0290 - val_loss: 3.4340 - v
al_acc: 0.0323
Epoch 9/50
582/582 [==============================] - 1285s 2s/step - loss: 3.4344 - acc: 0.0294 - val_loss: 3.4340 - v
al_acc: 0.0323
```

Out[44]:
```
<keras.callbacks.History at 0x2abbc1c70>
```

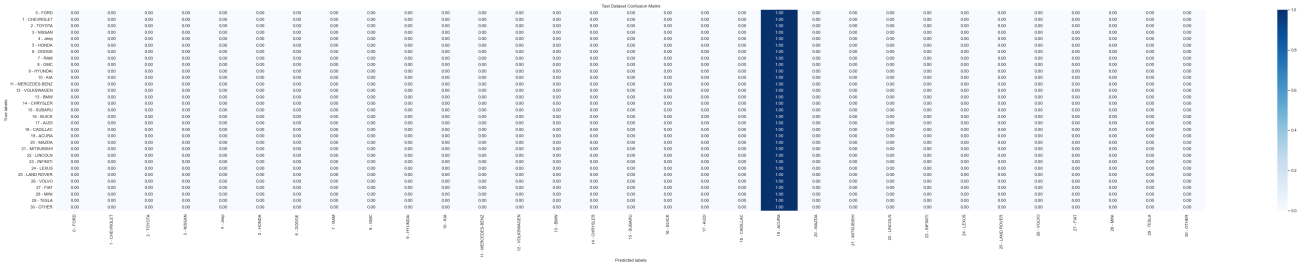
In [45]:
```
result = model.evaluate(X_test, y_test)
print("test_loss, test accuracy",result)
```

```
243/243 [==============================] - 141s 579ms/step - loss: 3.4340 - acc: 0.0323
test_loss, test accuracy [3.433993101119995, 0.032262228429317474]
```

In [46]:
```
y_pred = model.predict(X_test)
y_pred =  [np.argmax(i) for i in y_pred]
```

```
2022-01-28 00:14:13.009367: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:112] Pl
ugin optimizer for device_type GPU is enabled.
```

In [48]:
```
from sklearn.metrics import confusion_matrix
sns.set(rc = {'figure.figsize':(70,10)})

ax = plt.subplot()

labels = ['0 - FORD', '1 - CHEVROLET', '2 - TOYOTA', '3 - NISSAN', '4 - Jeep', '5 - HONDA', '6 - DODGE', '7
          '11 - MERCEDES-BENZ', '12 - VOLKSWAGEN', '13 - BMW', '14 - CHRYSLER', '15 - SUBARU', '16 - BUICK',
          '21 - MITSUBISHI', '22 - LINCOLN', '23 - INFINITI', '24 - LEXUS', '25 - LAND ROVER', '26 - VOLVO',

c = confusion_matrix(y_test,y_pred)

c_norm = c.astype('float') / c.sum(axis=1)[:, np.newaxis]

cndf = pd.DataFrame(c_norm, index=labels, columns=labels)

sns.heatmap(cndf,annot=True,fmt='.2f', cmap='Blues',ax=ax)

ax.set_xlabel('Predicted labels');ax.set_ylabel('True labels')

ax.set_title('Test Dataset Confusion Matrix');
```



3.2 MobileNet v2 Model

In [52]:
```
from keras.applications.mobilenet_v2 import MobileNetV2
```

In [ ]:
```
# https://www.pyimagesearch.com/2019/02/04/keras-multiple-inputs-and-mixed-data/

# define two sets of inputs
front = Input(shape=(224,224,3))
back = Input(shape=(224,224,3))
# the first branch operates on the first input
x = GlobalAveragePooling2D()(base_model.output)
x = Dense(8, activation="relu")(front)
x = Dense(4, activation="relu")(x)
x = Model(inputs=inputA, outputs=x)
# the second branch opreates on the second input
y = Dense(64, activation="relu")(inputB)
y = Dense(32, activation="relu")(y)
y = Dense(4, activation="relu")(y)
y = Model(inputs=inputB, outputs=y)
# combine the output of the two branches
combined = concatenate([x.output, y.output])
# apply a FC layer and then a regression prediction on the
# combined outputs
z = Dense(2, activation="relu")(combined)
z = Dense(1, activation="linear")(z)
# our model will accept the inputs of the two branches and
# then output a single value
model = Model(inputs=[x.input, y.input], outputs=z)
```

In [49]:
```
# !pip install tensorflow_hub
```

In [50]:
```
# import tensorflow_hub as hub

# feature_extractor_model = "https://tfhub.dev/google/tf2-preview/mobilenet_v2/feature_vector/4"

# pretrained_model_without_top_layer = hub.KerasLayer(
#     feature_extractor_model, input_shape=(448, 224, 3), trainable=True)
```

In [51]:
```
# model = tf.keras.Sequential([pretrained_model_without_top_layer,
#                              tf.keras.layers.Dense(num_class)])

# model.summary()
```

In [53]:
```
base_model = MobileNetV2(include_top=False, input_shape=(448,224,3))
x = GlobalAveragePooling2D()(base_model.output)
output = Dense(num_class)(x)

model = Model(inputs=base_model.inputs, outputs=output)

model.summary()
```

```
WARNING:tensorflow:`input_shape` is undefined or non-square, or `rows` is not in [96, 128, 160, 192, 224]. W
eights for input shape (224, 224) will be loaded as the default.
Model: "model_1"
__________________________________________________________________________________________________
 Layer (type)                   Output Shape         Param #     Connected to
==================================================================================================
 input_2 (InputLayer)           [(None, 448, 224, 3  0           []
                                )]

 Conv1 (Conv2D)                 (None, 224, 112, 32  864         ['input_2[0][0]']
                                )

 bn_Conv1 (BatchNormalization)  (None, 224, 112, 32  128         ['Conv1[0][0]']
                                )

 Conv1_relu (ReLU)              (None, 224, 112, 32  0           ['bn_Conv1[0][0]']
                                )

 expanded_conv_depthwise (Depth  (None, 224, 112, 32  288        ['Conv1_relu[0][0]']
 wiseConv2D)                    )

 expanded_conv_depthwise_BN (Ba  (None, 224, 112, 32  128        ['expanded_conv_depthwise[0][0]']
 tchNormalization)              )

 expanded_conv_depthwise_relu (  (None, 224, 112, 32  0          ['expanded_conv_depthwise_BN[0][0
 ReLU)                          )                                ]']

 expanded_conv_project (Conv2D)  (None, 224, 112, 16  512        ['expanded_conv_depthwise_relu[0]
                                )                                [0]']

 expanded_conv_project_BN (Batc  (None, 224, 112, 16  64         ['expanded_conv_project[0][0]']
 hNormalization)                )

 block_1_expand (Conv2D)        (None, 224, 112, 96  1536        ['expanded_conv_project_BN[0][0]'
                                )                                ]

 block_1_expand_BN (BatchNormal  (None, 224, 112, 96  384        ['block_1_expand[0][0]']
 ization)                       )

 block_1_expand_relu (ReLU)     (None, 224, 112, 96  0           ['block_1_expand_BN[0][0]']
                                )

 block_1_pad (ZeroPadding2D)    (None, 225, 113, 96  0           ['block_1_expand_relu[0][0]']
                                )

 block_1_depthwise (DepthwiseCo  (None, 112, 56, 96)  864        ['block_1_pad[0][0]']
 nv2D)

 block_1_depthwise_BN (BatchNor  (None, 112, 56, 96)  384        ['block_1_depthwise[0][0]']
 malization)

 block_1_depthwise_relu (ReLU)  (None, 112, 56, 96)  0           ['block_1_depthwise_BN[0][0]']

 block_1_project (Conv2D)       (None, 112, 56, 24)  2304        ['block_1_depthwise_relu[0][0]']

 block_1_project_BN (BatchNorma  (None, 112, 56, 24)  96         ['block_1_project[0][0]']
 lization)

 block_2_expand (Conv2D)        (None, 112, 56, 144  3456        ['block_1_project_BN[0][0]']
                                )

 block_2_expand_BN (BatchNormal  (None, 112, 56, 144  576        ['block_2_expand[0][0]']
 ization)                       )

 block_2_expand_relu (ReLU)     (None, 112, 56, 144  0           ['block_2_expand_BN[0][0]']
                                )

 block_2_depthwise (DepthwiseCo  (None, 112, 56, 144  1296       ['block_2_expand_relu[0][0]']
 nv2D)                          )

 block_2_depthwise_BN (BatchNor  (None, 112, 56, 144  576        ['block_2_depthwise[0][0]']
 malization)                    )

 block_2_depthwise_relu (ReLU)  (None, 112, 56, 144  0           ['block_2_depthwise_BN[0][0]']
                                )

 block_2_project (Conv2D)       (None, 112, 56, 24)  3456        ['block_2_depthwise_relu[0][0]']

 block_2_project_BN (BatchNorma  (None, 112, 56, 24)  96         ['block_2_project[0][0]']
```

```
lization)

block_2_add (Add)              (None, 112, 56, 24)  0           ['block_1_project_BN[0][0]',
                                                                 'block_2_project_BN[0][0]']

block_3_expand (Conv2D)        (None, 112, 56, 144  3456        ['block_2_add[0][0]']
                               )

block_3_expand_BN (BatchNormal  (None, 112, 56, 144  576        ['block_3_expand[0][0]']
ization)                       )

block_3_expand_relu (ReLU)     (None, 112, 56, 144  0           ['block_3_expand_BN[0][0]']
                               )

block_3_pad (ZeroPadding2D)    (None, 113, 57, 144  0           ['block_3_expand_relu[0][0]']
                               )

block_3_depthwise (DepthwiseCo  (None, 56, 28, 144)  1296       ['block_3_pad[0][0]']
nv2D)

block_3_depthwise_BN (BatchNor  (None, 56, 28, 144)  576        ['block_3_depthwise[0][0]']
malization)

block_3_depthwise_relu (ReLU)  (None, 56, 28, 144)  0           ['block_3_depthwise_BN[0][0]']

block_3_project (Conv2D)       (None, 56, 28, 32)   4608        ['block_3_depthwise_relu[0][0]']

block_3_project_BN (BatchNorma  (None, 56, 28, 32)  128         ['block_3_project[0][0]']
lization)

block_4_expand (Conv2D)        (None, 56, 28, 192)  6144        ['block_3_project_BN[0][0]']

block_4_expand_BN (BatchNormal  (None, 56, 28, 192)  768        ['block_4_expand[0][0]']
ization)

block_4_expand_relu (ReLU)     (None, 56, 28, 192)  0           ['block_4_expand_BN[0][0]']

block_4_depthwise (DepthwiseCo  (None, 56, 28, 192)  1728       ['block_4_expand_relu[0][0]']
nv2D)

block_4_depthwise_BN (BatchNor  (None, 56, 28, 192)  768        ['block_4_depthwise[0][0]']
malization)

block_4_depthwise_relu (ReLU)  (None, 56, 28, 192)  0           ['block_4_depthwise_BN[0][0]']

block_4_project (Conv2D)       (None, 56, 28, 32)   6144        ['block_4_depthwise_relu[0][0]']

block_4_project_BN (BatchNorma  (None, 56, 28, 32)  128         ['block_4_project[0][0]']
lization)

block_4_add (Add)              (None, 56, 28, 32)   0           ['block_3_project_BN[0][0]',
                                                                 'block_4_project_BN[0][0]']

block_5_expand (Conv2D)        (None, 56, 28, 192)  6144        ['block_4_add[0][0]']

block_5_expand_BN (BatchNormal  (None, 56, 28, 192)  768        ['block_5_expand[0][0]']
ization)

block_5_expand_relu (ReLU)     (None, 56, 28, 192)  0           ['block_5_expand_BN[0][0]']

block_5_depthwise (DepthwiseCo  (None, 56, 28, 192)  1728       ['block_5_expand_relu[0][0]']
nv2D)

block_5_depthwise_BN (BatchNor  (None, 56, 28, 192)  768        ['block_5_depthwise[0][0]']
malization)

block_5_depthwise_relu (ReLU)  (None, 56, 28, 192)  0           ['block_5_depthwise_BN[0][0]']

block_5_project (Conv2D)       (None, 56, 28, 32)   6144        ['block_5_depthwise_relu[0][0]']

block_5_project_BN (BatchNorma  (None, 56, 28, 32)  128         ['block_5_project[0][0]']
lization)

block_5_add (Add)              (None, 56, 28, 32)   0           ['block_4_add[0][0]',
                                                                 'block_5_project_BN[0][0]']

block_6_expand (Conv2D)        (None, 56, 28, 192)  6144        ['block_5_add[0][0]']

block_6_expand_BN (BatchNormal  (None, 56, 28, 192)  768        ['block_6_expand[0][0]']
```

```
ization)

block_6_expand_relu (ReLU)     (None, 56, 28, 192)  0           ['block_6_expand_BN[0][0]']

block_6_pad (ZeroPadding2D)    (None, 57, 29, 192)  0           ['block_6_expand_relu[0][0]']

block_6_depthwise (DepthwiseCo  (None, 28, 14, 192)  1728       ['block_6_pad[0][0]']
nv2D)

block_6_depthwise_BN (BatchNor  (None, 28, 14, 192)  768        ['block_6_depthwise[0][0]']
malization)

block_6_depthwise_relu (ReLU)  (None, 28, 14, 192)  0           ['block_6_depthwise_BN[0][0]']

block_6_project (Conv2D)       (None, 28, 14, 64)   12288       ['block_6_depthwise_relu[0][0]']

block_6_project_BN (BatchNorma  (None, 28, 14, 64)  256         ['block_6_project[0][0]']
lization)

block_7_expand (Conv2D)        (None, 28, 14, 384)  24576       ['block_6_project_BN[0][0]']

block_7_expand_BN (BatchNormal  (None, 28, 14, 384)  1536       ['block_7_expand[0][0]']
ization)

block_7_expand_relu (ReLU)     (None, 28, 14, 384)  0           ['block_7_expand_BN[0][0]']

block_7_depthwise (DepthwiseCo  (None, 28, 14, 384)  3456       ['block_7_expand_relu[0][0]']
nv2D)

block_7_depthwise_BN (BatchNor  (None, 28, 14, 384)  1536       ['block_7_depthwise[0][0]']
malization)

block_7_depthwise_relu (ReLU)  (None, 28, 14, 384)  0           ['block_7_depthwise_BN[0][0]']

block_7_project (Conv2D)       (None, 28, 14, 64)   24576       ['block_7_depthwise_relu[0][0]']

block_7_project_BN (BatchNorma  (None, 28, 14, 64)  256         ['block_7_project[0][0]']
lization)

block_7_add (Add)              (None, 28, 14, 64)   0           ['block_6_project_BN[0][0]',
                                                                 'block_7_project_BN[0][0]']

block_8_expand (Conv2D)        (None, 28, 14, 384)  24576       ['block_7_add[0][0]']

block_8_expand_BN (BatchNormal  (None, 28, 14, 384)  1536       ['block_8_expand[0][0]']
ization)

block_8_expand_relu (ReLU)     (None, 28, 14, 384)  0           ['block_8_expand_BN[0][0]']

block_8_depthwise (DepthwiseCo  (None, 28, 14, 384)  3456       ['block_8_expand_relu[0][0]']
nv2D)

block_8_depthwise_BN (BatchNor  (None, 28, 14, 384)  1536       ['block_8_depthwise[0][0]']
malization)

block_8_depthwise_relu (ReLU)  (None, 28, 14, 384)  0           ['block_8_depthwise_BN[0][0]']

block_8_project (Conv2D)       (None, 28, 14, 64)   24576       ['block_8_depthwise_relu[0][0]']

block_8_project_BN (BatchNorma  (None, 28, 14, 64)  256         ['block_8_project[0][0]']
lization)

block_8_add (Add)              (None, 28, 14, 64)   0           ['block_7_add[0][0]',
                                                                 'block_8_project_BN[0][0]']

block_9_expand (Conv2D)        (None, 28, 14, 384)  24576       ['block_8_add[0][0]']

block_9_expand_BN (BatchNormal  (None, 28, 14, 384)  1536       ['block_9_expand[0][0]']
ization)

block_9_expand_relu (ReLU)     (None, 28, 14, 384)  0           ['block_9_expand_BN[0][0]']

block_9_depthwise (DepthwiseCo  (None, 28, 14, 384)  3456       ['block_9_expand_relu[0][0]']
nv2D)

block_9_depthwise_BN (BatchNor  (None, 28, 14, 384)  1536       ['block_9_depthwise[0][0]']
malization)

block_9_depthwise_relu (ReLU)  (None, 28, 14, 384)  0           ['block_9_depthwise_BN[0][0]']
```

```
block_9_project (Conv2D)       (None, 28, 14, 64)   24576       ['block_9_depthwise_relu[0][0]']

block_9_project_BN (BatchNorma  (None, 28, 14, 64)  256         ['block_9_project[0][0]']
lization)

block_9_add (Add)              (None, 28, 14, 64)   0           ['block_8_add[0][0]',
                                                                 'block_9_project_BN[0][0]']

block_10_expand (Conv2D)       (None, 28, 14, 384)  24576       ['block_9_add[0][0]']

block_10_expand_BN (BatchNorma  (None, 28, 14, 384)  1536       ['block_10_expand[0][0]']
lization)

block_10_expand_relu (ReLU)    (None, 28, 14, 384)  0           ['block_10_expand_BN[0][0]']

block_10_depthwise (DepthwiseC  (None, 28, 14, 384)  3456       ['block_10_expand_relu[0][0]']
onv2D)

block_10_depthwise_BN (BatchNo  (None, 28, 14, 384)  1536       ['block_10_depthwise[0][0]']
rmalization)

block_10_depthwise_relu (ReLU)  (None, 28, 14, 384)  0          ['block_10_depthwise_BN[0][0]']

block_10_project (Conv2D)      (None, 28, 14, 96)   36864       ['block_10_depthwise_relu[0][0]']

block_10_project_BN (BatchNorm  (None, 28, 14, 96)  384         ['block_10_project[0][0]']
alization)

block_11_expand (Conv2D)       (None, 28, 14, 576)  55296       ['block_10_project_BN[0][0]']

block_11_expand_BN (BatchNorma  (None, 28, 14, 576)  2304       ['block_11_expand[0][0]']
lization)

block_11_expand_relu (ReLU)    (None, 28, 14, 576)  0           ['block_11_expand_BN[0][0]']

block_11_depthwise (DepthwiseC  (None, 28, 14, 576)  5184       ['block_11_expand_relu[0][0]']
onv2D)

block_11_depthwise_BN (BatchNo  (None, 28, 14, 576)  2304       ['block_11_depthwise[0][0]']
rmalization)

block_11_depthwise_relu (ReLU)  (None, 28, 14, 576)  0          ['block_11_depthwise_BN[0][0]']

block_11_project (Conv2D)      (None, 28, 14, 96)   55296       ['block_11_depthwise_relu[0][0]']

block_11_project_BN (BatchNorm  (None, 28, 14, 96)  384         ['block_11_project[0][0]']
alization)

block_11_add (Add)             (None, 28, 14, 96)   0           ['block_10_project_BN[0][0]',
                                                                 'block_11_project_BN[0][0]']

block_12_expand (Conv2D)       (None, 28, 14, 576)  55296       ['block_11_add[0][0]']

block_12_expand_BN (BatchNorma  (None, 28, 14, 576)  2304       ['block_12_expand[0][0]']
lization)

block_12_expand_relu (ReLU)    (None, 28, 14, 576)  0           ['block_12_expand_BN[0][0]']

block_12_depthwise (DepthwiseC  (None, 28, 14, 576)  5184       ['block_12_expand_relu[0][0]']
onv2D)

block_12_depthwise_BN (BatchNo  (None, 28, 14, 576)  2304       ['block_12_depthwise[0][0]']
rmalization)

block_12_depthwise_relu (ReLU)  (None, 28, 14, 576)  0          ['block_12_depthwise_BN[0][0]']

block_12_project (Conv2D)      (None, 28, 14, 96)   55296       ['block_12_depthwise_relu[0][0]']

block_12_project_BN (BatchNorm  (None, 28, 14, 96)  384         ['block_12_project[0][0]']
alization)

block_12_add (Add)             (None, 28, 14, 96)   0           ['block_11_add[0][0]',
                                                                 'block_12_project_BN[0][0]']

block_13_expand (Conv2D)       (None, 28, 14, 576)  55296       ['block_12_add[0][0]']

block_13_expand_BN (BatchNorma  (None, 28, 14, 576)  2304       ['block_13_expand[0][0]']
lization)
```

```
block_13_expand_relu (ReLU)    (None, 28, 14, 576)  0           ['block_13_expand_BN[0][0]']

block_13_pad (ZeroPadding2D)   (None, 29, 15, 576)  0           ['block_13_expand_relu[0][0]']

block_13_depthwise (DepthwiseC  (None, 14, 7, 576)  5184        ['block_13_pad[0][0]']
onv2D)

block_13_depthwise_BN (BatchNo  (None, 14, 7, 576)  2304        ['block_13_depthwise[0][0]']
rmalization)

block_13_depthwise_relu (ReLU)  (None, 14, 7, 576)  0           ['block_13_depthwise_BN[0][0]']

block_13_project (Conv2D)      (None, 14, 7, 160)   92160       ['block_13_depthwise_relu[0][0]']

block_13_project_BN (BatchNorm  (None, 14, 7, 160)  640         ['block_13_project[0][0]']
alization)

block_14_expand (Conv2D)       (None, 14, 7, 960)   153600      ['block_13_project_BN[0][0]']

block_14_expand_BN (BatchNorma  (None, 14, 7, 960)  3840        ['block_14_expand[0][0]']
lization)

block_14_expand_relu (ReLU)    (None, 14, 7, 960)   0           ['block_14_expand_BN[0][0]']

block_14_depthwise (DepthwiseC  (None, 14, 7, 960)  8640        ['block_14_expand_relu[0][0]']
onv2D)

block_14_depthwise_BN (BatchNo  (None, 14, 7, 960)  3840        ['block_14_depthwise[0][0]']
rmalization)

block_14_depthwise_relu (ReLU)  (None, 14, 7, 960)  0           ['block_14_depthwise_BN[0][0]']

block_14_project (Conv2D)      (None, 14, 7, 160)   153600      ['block_14_depthwise_relu[0][0]']

block_14_project_BN (BatchNorm  (None, 14, 7, 160)  640         ['block_14_project[0][0]']
alization)

block_14_add (Add)             (None, 14, 7, 160)   0           ['block_13_project_BN[0][0]',
                                                                 'block_14_project_BN[0][0]']

block_15_expand (Conv2D)       (None, 14, 7, 960)   153600      ['block_14_add[0][0]']

block_15_expand_BN (BatchNorma  (None, 14, 7, 960)  3840        ['block_15_expand[0][0]']
lization)

block_15_expand_relu (ReLU)    (None, 14, 7, 960)   0           ['block_15_expand_BN[0][0]']

block_15_depthwise (DepthwiseC  (None, 14, 7, 960)  8640        ['block_15_expand_relu[0][0]']
onv2D)

block_15_depthwise_BN (BatchNo  (None, 14, 7, 960)  3840        ['block_15_depthwise[0][0]']
rmalization)

block_15_depthwise_relu (ReLU)  (None, 14, 7, 960)  0           ['block_15_depthwise_BN[0][0]']

block_15_project (Conv2D)      (None, 14, 7, 160)   153600      ['block_15_depthwise_relu[0][0]']

block_15_project_BN (BatchNorm  (None, 14, 7, 160)  640         ['block_15_project[0][0]']
alization)

block_15_add (Add)             (None, 14, 7, 160)   0           ['block_14_add[0][0]',
                                                                 'block_15_project_BN[0][0]']

block_16_expand (Conv2D)       (None, 14, 7, 960)   153600      ['block_15_add[0][0]']

block_16_expand_BN (BatchNorma  (None, 14, 7, 960)  3840        ['block_16_expand[0][0]']
lization)

block_16_expand_relu (ReLU)    (None, 14, 7, 960)   0           ['block_16_expand_BN[0][0]']

block_16_depthwise (DepthwiseC  (None, 14, 7, 960)  8640        ['block_16_expand_relu[0][0]']
onv2D)

block_16_depthwise_BN (BatchNo  (None, 14, 7, 960)  3840        ['block_16_depthwise[0][0]']
rmalization)

block_16_depthwise_relu (ReLU)  (None, 14, 7, 960)  0           ['block_16_depthwise_BN[0][0]']
```

```
block_16_project (Conv2D)      (None, 14, 7, 320)   307200      ['block_16_depthwise_relu[0][0]']

block_16_project_BN (BatchNorm  (None, 14, 7, 320)  1280        ['block_16_project[0][0]']
alization)

Conv_1 (Conv2D)                (None, 14, 7, 1280)  409600      ['block_16_project_BN[0][0]']

Conv_1_bn (BatchNormalization)  (None, 14, 7, 1280)  5120       ['Conv_1[0][0]']

out_relu (ReLU)                (None, 14, 7, 1280)  0           ['Conv_1_bn[0][0]']

global_average_pooling2d (Glob  (None, 1280)        0           ['out_relu[0][0]']
alAveragePooling2D)

dense (Dense)                  (None, 31)           39711       ['global_average_pooling2d[0][0]'
                                                                ]

==================================================================================================
Total params: 2,297,695
Trainable params: 2,263,583
Non-trainable params: 34,112
__________________________________________________________________________________________________
```

In [54]:

```
for layer in model.layers:
    layer.trainable = True
```

In [55]:

```
early_stopping = EarlyStopping(patience=5)
```

In [57]:

```
model.compile(
  optimizer="adam",
  loss=tf.keras.losses.SparseCategoricalCrossentropy(from_logits=True),
  metrics=['acc'])

model.fit(X_train,
          y_train,
          epochs=50,
          callbacks = early_stopping,
          validation_data=(X_val, y_val))
```

```
Epoch 1/50
2022-01-28 00:53:20.317796: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:112] Pl
ugin optimizer for device_type GPU is enabled.
582/582 [==============================] - ETA: 0s - loss: 3.3824 - acc: 0.0531
2022-01-28 00:57:25.104806: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:112] Pl
ugin optimizer for device_type GPU is enabled.
```

```
582/582 [==============================] - 271s 452ms/step - loss: 3.3824 - acc: 0.0531 - val_loss: 18.2410
- val_acc: 0.0333
Epoch 2/50
582/582 [==============================] - 293s 501ms/step - loss: 3.1702 - acc: 0.0980 - val_loss: 21.1178
- val_acc: 0.0566
Epoch 3/50
582/582 [==============================] - 292s 502ms/step - loss: 2.9831 - acc: 0.1527 - val_loss: 11.0236
- val_acc: 0.1004
Epoch 4/50
582/582 [==============================] - 291s 500ms/step - loss: 2.8723 - acc: 0.1872 - val_loss: 3.9775 -
val_acc: 0.3135
Epoch 5/50
582/582 [==============================] - 292s 501ms/step - loss: 2.8177 - acc: 0.2049 - val_loss: 2.0788 -
val_acc: 0.5432
Epoch 6/50
582/582 [==============================] - 291s 500ms/step - loss: 2.7829 - acc: 0.2123 - val_loss: 1.3866 -
val_acc: 0.6568
Epoch 7/50
582/582 [==============================] - 291s 501ms/step - loss: 2.7495 - acc: 0.2227 - val_loss: 4.7090 -
val_acc: 0.3897
Epoch 8/50
582/582 [==============================] - 290s 499ms/step - loss: 2.7447 - acc: 0.2248 - val_loss: 1.7988 -
val_acc: 0.6112
Epoch 9/50
582/582 [==============================] - 290s 498ms/step - loss: 2.7203 - acc: 0.2313 - val_loss: 0.8162 -
val_acc: 0.8071
Epoch 10/50
582/582 [==============================] - 294s 505ms/step - loss: 2.7070 - acc: 0.2364 - val_loss: 0.5819 -
val_acc: 0.8357
Epoch 11/50
582/582 [==============================] - 292s 502ms/step - loss: 2.7153 - acc: 0.2341 - val_loss: 0.7630 -
val_acc: 0.7994
Epoch 12/50
582/582 [==============================] - 293s 503ms/step - loss: 2.7039 - acc: 0.2369 - val_loss: 0.9518 -
val_acc: 0.7615
Epoch 13/50
582/582 [==============================] - 299s 513ms/step - loss: 2.6938 - acc: 0.2412 - val_loss: 0.6372 -
val_acc: 0.8308
Epoch 14/50
582/582 [==============================] - 302s 519ms/step - loss: 2.6930 - acc: 0.2411 - val_loss: 1.7553 -
val_acc: 0.6417
Epoch 15/50
582/582 [==============================] - 309s 531ms/step - loss: 2.6958 - acc: 0.2386 - val_loss: 0.7001 -
val_acc: 0.8200
```

Out[57]:
```
<keras.callbacks.History at 0x2f6dbf460>
```

In [58]:
```
model.evaluate(X_test,y_test)
```

```
243/243 [==============================] - 49s 200ms/step - loss: 0.7130 - acc: 0.8161
```

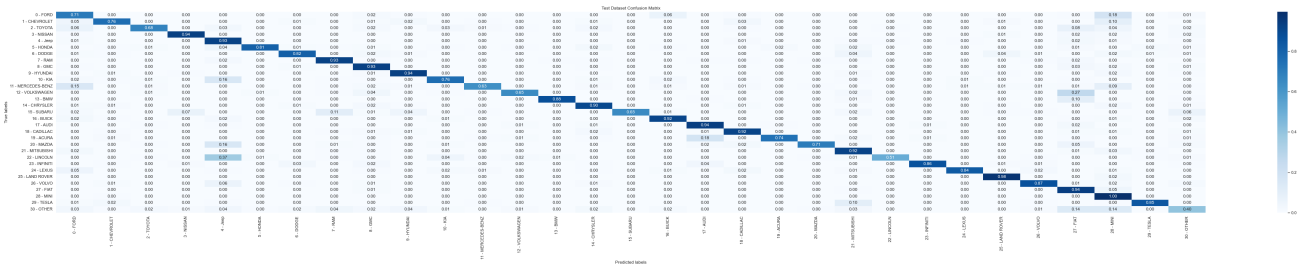
Out[58]:
```
[0.7130213975906372, 0.8161053657531738]
```

In [59]:
```
y_pred = model.predict(X_test)
y_pred =  [np.argmax(i) for i in y_pred]
```

```
2022-01-28 02:07:28.819944: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:112] Pl
ugin optimizer for device_type GPU is enabled.
```

In [60]:
```
from sklearn.metrics import confusion_matrix
sns.set(rc = {'figure.figsize':(70,10)})
ax = plt.subplot()

labels = ['0 - FORD', '1 - CHEVROLET', '2 - TOYOTA', '3 - NISSAN', '4 - Jeep', '5 - HONDA', '6 - DODGE', '7
          '11 - MERCEDES-BENZ', '12 - VOLKSWAGEN', '13 - BMW', '14 - CHRYSLER', '15 - SUBARU', '16 - BUICK',
          '21 - MITSUBISHI', '22 - LINCOLN', '23 - INFINITI', '24 - LEXUS', '25 - LAND ROVER', '26 - VOLVO',

c = confusion_matrix(y_test,y_pred)

c_norm = c.astype('float') / c.sum(axis=1)[:, np.newaxis]

cndf = pd.DataFrame(c_norm, index=labels, columns=labels)

sns.heatmap(cndf,annot=True,fmt='.2f', cmap='Blues',ax=ax)

ax.set_xlabel('Predicted labels');ax.set_ylabel('True labels')
```

```
ax.set_title('Test Dataset Confusion Matrix');
```



3.3 EfficientNet B0 Model

In [ ]:
```
# feature_extractor_model = "https://tfhub.dev/tensorflow/efficientnet/lite0/feature-vector/2"

# pretrained_model_without_top_layer = hub.KerasLayer(
#     feature_extractor_model, input_shape=(224, 224, 3), trainable=True)
```

In [ ]:
```
# model = tf.keras.Sequential([pretrained_model_without_top_layer,
#                              tf.keras.layers.Dense(num_class)])

# model.summary()
```

In [61]:
```
from keras.applications.efficientnet import EfficientNetB0
```

In [62]:
```
base_model = EfficientNetB0(include_top=False, input_shape=(448,224,3))
x = GlobalAveragePooling2D()(base_model.output)
x = Dropout(0.5)(x)
output = Dense(num_class)(x)

model = Model(inputs=base_model.inputs, outputs=output)

model.summary()
```

```
Downloading data from https://storage.googleapis.com/keras-applications/efficientnetb0_notop.h5
16711680/16705208 [==============================] - 1s 0us/step
16719872/16705208 [==============================] - 1s 0us/step
Model: "model_2"
```

Layer (type)	Output Shape	Param #	Connected to
input_3 (InputLayer)	[(None, 448, 224, 3)]	0	[]
rescaling (Rescaling)	(None, 448, 224, 3)	0	['input_3[0][0]']
normalization (Normalization)	(None, 448, 224, 3)	7	['rescaling[0][0]']
stem_conv_pad (ZeroPadding2D)	(None, 449, 225, 3)	0	['normalization[0][0]']
stem_conv (Conv2D)	(None, 224, 112, 32)	864	['stem_conv_pad[0][0]']
stem_bn (BatchNormalization)	(None, 224, 112, 32)	128	['stem_conv[0][0]']
stem_activation (Activation)	(None, 224, 112, 32)	0	['stem_bn[0][0]']
block1a_dwconv (DepthwiseConv2D)	(None, 224, 112, 32)	288	['stem_activation[0][0]']
block1a_bn (BatchNormalization)	(None, 224, 112, 32)	128	['block1a_dwconv[0][0]']
block1a_activation (Activation)	(None, 224, 112, 32)	0	['block1a_bn[0][0]']
block1a_se_squeeze (GlobalAveragePooling2D)	(None, 32)	0	['block1a_activation[0][0]']
block1a_se_reshape (Reshape)	(None, 1, 1, 32)	0	['block1a_se_squeeze[0][0]']
block1a_se_reduce (Conv2D)	(None, 1, 1, 8)	264	['block1a_se_reshape[0][0]']
block1a_se_expand (Conv2D)	(None, 1, 1, 32)	288	['block1a_se_reduce[0][0]']
block1a_se_excite (Multiply)	(None, 224, 112, 32)	0	['block1a_activation[0][0]', 'block1a_se_expand[0][0]']
block1a_project_conv (Conv2D)	(None, 224, 112, 16)	512	['block1a_se_excite[0][0]']
block1a_project_bn (BatchNormalization)	(None, 224, 112, 16)	64	['block1a_project_conv[0][0]']
block2a_expand_conv (Conv2D)	(None, 224, 112, 96)	1536	['block1a_project_bn[0][0]']
block2a_expand_bn (BatchNormalization)	(None, 224, 112, 96)	384	['block2a_expand_conv[0][0]']
block2a_expand_activation (Activation)	(None, 224, 112, 96)	0	['block2a_expand_bn[0][0]']
block2a_dwconv_pad (ZeroPadding2D)	(None, 225, 113, 96)	0	['block2a_expand_activation[0][0]']
block2a_dwconv (DepthwiseConv2D)	(None, 112, 56, 96)	864	['block2a_dwconv_pad[0][0]']
block2a_bn (BatchNormalization)	(None, 112, 56, 96)	384	['block2a_dwconv[0][0]']
block2a_activation (Activation)	(None, 112, 56, 96)	0	['block2a_bn[0][0]']
block2a_se_squeeze (GlobalAveragePooling2D)	(None, 96)	0	['block2a_activation[0][0]']
block2a_se_reshape (Reshape)	(None, 1, 1, 96)	0	['block2a_se_squeeze[0][0]']
block2a_se_reduce (Conv2D)	(None, 1, 1, 4)	388	['block2a_se_reshape[0][0]']

```
block2a_se_expand (Conv2D)     (None, 1, 1, 96)     480         ['block2a_se_reduce[0][0]']

block2a_se_excite (Multiply)   (None, 112, 56, 96)  0           ['block2a_activation[0][0]',
                                                                 'block2a_se_expand[0][0]']

block2a_project_conv (Conv2D)  (None, 112, 56, 24)  2304        ['block2a_se_excite[0][0]']

block2a_project_bn (BatchNorma  (None, 112, 56, 24)  96         ['block2a_project_conv[0][0]']
lization)

block2b_expand_conv (Conv2D)   (None, 112, 56, 144  3456        ['block2a_project_bn[0][0]']
                               )

block2b_expand_bn (BatchNormal  (None, 112, 56, 144  576        ['block2b_expand_conv[0][0]']
ization)                       )

block2b_expand_activation (Act  (None, 112, 56, 144  0          ['block2b_expand_bn[0][0]']
ivation)                       )

block2b_dwconv (DepthwiseConv2  (None, 112, 56, 144  1296       ['block2b_expand_activation[0][0]
D)                             )                                 ']

block2b_bn (BatchNormalization  (None, 112, 56, 144  576        ['block2b_dwconv[0][0]']
)                              )

block2b_activation (Activation  (None, 112, 56, 144  0          ['block2b_bn[0][0]']
)                              )

block2b_se_squeeze (GlobalAver  (None, 144)         0           ['block2b_activation[0][0]']
agePooling2D)

block2b_se_reshape (Reshape)   (None, 1, 1, 144)    0           ['block2b_se_squeeze[0][0]']

block2b_se_reduce (Conv2D)     (None, 1, 1, 6)      870         ['block2b_se_reshape[0][0]']

block2b_se_expand (Conv2D)     (None, 1, 1, 144)    1008        ['block2b_se_reduce[0][0]']

block2b_se_excite (Multiply)   (None, 112, 56, 144  0           ['block2b_activation[0][0]',
                               )                                 'block2b_se_expand[0][0]']

block2b_project_conv (Conv2D)  (None, 112, 56, 24)  3456        ['block2b_se_excite[0][0]']

block2b_project_bn (BatchNorma  (None, 112, 56, 24)  96         ['block2b_project_conv[0][0]']
lization)

block2b_drop (Dropout)         (None, 112, 56, 24)  0           ['block2b_project_bn[0][0]']

block2b_add (Add)              (None, 112, 56, 24)  0           ['block2b_drop[0][0]',
                                                                 'block2a_project_bn[0][0]']

block3a_expand_conv (Conv2D)   (None, 112, 56, 144  3456        ['block2b_add[0][0]']
                               )

block3a_expand_bn (BatchNormal  (None, 112, 56, 144  576        ['block3a_expand_conv[0][0]']
ization)                       )

block3a_expand_activation (Act  (None, 112, 56, 144  0          ['block3a_expand_bn[0][0]']
ivation)                       )

block3a_dwconv_pad (ZeroPaddin  (None, 115, 59, 144  0          ['block3a_expand_activation[0][0]
g2D)                           )                                 ']

block3a_dwconv (DepthwiseConv2  (None, 56, 28, 144)  3600       ['block3a_dwconv_pad[0][0]']
D)

block3a_bn (BatchNormalization  (None, 56, 28, 144)  576        ['block3a_dwconv[0][0]']
)

block3a_activation (Activation  (None, 56, 28, 144)  0          ['block3a_bn[0][0]']
)

block3a_se_squeeze (GlobalAver  (None, 144)         0           ['block3a_activation[0][0]']
agePooling2D)

block3a_se_reshape (Reshape)   (None, 1, 1, 144)    0           ['block3a_se_squeeze[0][0]']

block3a_se_reduce (Conv2D)     (None, 1, 1, 6)      870         ['block3a_se_reshape[0][0]']
```

```
block3a_se_expand (Conv2D)     (None, 1, 1, 144)    1008        ['block3a_se_reduce[0][0]']

block3a_se_excite (Multiply)   (None, 56, 28, 144)  0           ['block3a_activation[0][0]',
                                                                 'block3a_se_expand[0][0]']

block3a_project_conv (Conv2D)  (None, 56, 28, 40)   5760        ['block3a_se_excite[0][0]']

block3a_project_bn (BatchNorma  (None, 56, 28, 40)  160         ['block3a_project_conv[0][0]']
lization)

block3b_expand_conv (Conv2D)   (None, 56, 28, 240)  9600        ['block3a_project_bn[0][0]']

block3b_expand_bn (BatchNormal  (None, 56, 28, 240)  960        ['block3b_expand_conv[0][0]']
ization)

block3b_expand_activation (Act  (None, 56, 28, 240)  0          ['block3b_expand_bn[0][0]']
ivation)

block3b_dwconv (DepthwiseConv2  (None, 56, 28, 240)  6000       ['block3b_expand_activation[0][0]
D)                                                              ']

block3b_bn (BatchNormalization  (None, 56, 28, 240)  960        ['block3b_dwconv[0][0]']
)

block3b_activation (Activation  (None, 56, 28, 240)  0          ['block3b_bn[0][0]']
)

block3b_se_squeeze (GlobalAver  (None, 240)         0           ['block3b_activation[0][0]']
agePooling2D)

block3b_se_reshape (Reshape)   (None, 1, 1, 240)    0           ['block3b_se_squeeze[0][0]']

block3b_se_reduce (Conv2D)     (None, 1, 1, 10)     2410        ['block3b_se_reshape[0][0]']

block3b_se_expand (Conv2D)     (None, 1, 1, 240)    2640        ['block3b_se_reduce[0][0]']

block3b_se_excite (Multiply)   (None, 56, 28, 240)  0           ['block3b_activation[0][0]',
                                                                 'block3b_se_expand[0][0]']

block3b_project_conv (Conv2D)  (None, 56, 28, 40)   9600        ['block3b_se_excite[0][0]']

block3b_project_bn (BatchNorma  (None, 56, 28, 40)  160         ['block3b_project_conv[0][0]']
lization)

block3b_drop (Dropout)         (None, 56, 28, 40)   0           ['block3b_project_bn[0][0]']

block3b_add (Add)              (None, 56, 28, 40)   0           ['block3b_drop[0][0]',
                                                                 'block3a_project_bn[0][0]']

block4a_expand_conv (Conv2D)   (None, 56, 28, 240)  9600        ['block3b_add[0][0]']

block4a_expand_bn (BatchNormal  (None, 56, 28, 240)  960        ['block4a_expand_conv[0][0]']
ization)

block4a_expand_activation (Act  (None, 56, 28, 240)  0          ['block4a_expand_bn[0][0]']
ivation)

block4a_dwconv_pad (ZeroPaddin  (None, 57, 29, 240)  0          ['block4a_expand_activation[0][0]
g2D)                                                            ']

block4a_dwconv (DepthwiseConv2  (None, 28, 14, 240)  2160       ['block4a_dwconv_pad[0][0]']
D)

block4a_bn (BatchNormalization  (None, 28, 14, 240)  960        ['block4a_dwconv[0][0]']
)

block4a_activation (Activation  (None, 28, 14, 240)  0          ['block4a_bn[0][0]']
)

block4a_se_squeeze (GlobalAver  (None, 240)         0           ['block4a_activation[0][0]']
agePooling2D)

block4a_se_reshape (Reshape)   (None, 1, 1, 240)    0           ['block4a_se_squeeze[0][0]']

block4a_se_reduce (Conv2D)     (None, 1, 1, 10)     2410        ['block4a_se_reshape[0][0]']

block4a_se_expand (Conv2D)     (None, 1, 1, 240)    2640        ['block4a_se_reduce[0][0]']

block4a_se_excite (Multiply)   (None, 28, 14, 240)  0           ['block4a_activation[0][0]',
```

```
                                                                 'block4a_se_expand[0][0]']

block4a_project_conv (Conv2D)  (None, 28, 14, 80)   19200       ['block4a_se_excite[0][0]']

block4a_project_bn (BatchNorma  (None, 28, 14, 80)  320         ['block4a_project_conv[0][0]']
lization)

block4b_expand_conv (Conv2D)   (None, 28, 14, 480)  38400       ['block4a_project_bn[0][0]']

block4b_expand_bn (BatchNormal  (None, 28, 14, 480)  1920       ['block4b_expand_conv[0][0]']
ization)

block4b_expand_activation (Act  (None, 28, 14, 480)  0          ['block4b_expand_bn[0][0]']
ivation)

block4b_dwconv (DepthwiseConv2  (None, 28, 14, 480)  4320       ['block4b_expand_activation[0][0]
D)                                                              ']

block4b_bn (BatchNormalization  (None, 28, 14, 480)  1920       ['block4b_dwconv[0][0]']
)

block4b_activation (Activation  (None, 28, 14, 480)  0          ['block4b_bn[0][0]']
)

block4b_se_squeeze (GlobalAver  (None, 480)         0           ['block4b_activation[0][0]']
agePooling2D)

block4b_se_reshape (Reshape)   (None, 1, 1, 480)    0           ['block4b_se_squeeze[0][0]']

block4b_se_reduce (Conv2D)     (None, 1, 1, 20)     9620        ['block4b_se_reshape[0][0]']

block4b_se_expand (Conv2D)     (None, 1, 1, 480)    10080       ['block4b_se_reduce[0][0]']

block4b_se_excite (Multiply)   (None, 28, 14, 480)  0           ['block4b_activation[0][0]',
                                                                 'block4b_se_expand[0][0]']

block4b_project_conv (Conv2D)  (None, 28, 14, 80)   38400       ['block4b_se_excite[0][0]']

block4b_project_bn (BatchNorma  (None, 28, 14, 80)  320         ['block4b_project_conv[0][0]']
lization)

block4b_drop (Dropout)         (None, 28, 14, 80)   0           ['block4b_project_bn[0][0]']

block4b_add (Add)              (None, 28, 14, 80)   0           ['block4b_drop[0][0]',
                                                                 'block4a_project_bn[0][0]']

block4c_expand_conv (Conv2D)   (None, 28, 14, 480)  38400       ['block4b_add[0][0]']

block4c_expand_bn (BatchNormal  (None, 28, 14, 480)  1920       ['block4c_expand_conv[0][0]']
ization)

block4c_expand_activation (Act  (None, 28, 14, 480)  0          ['block4c_expand_bn[0][0]']
ivation)

block4c_dwconv (DepthwiseConv2  (None, 28, 14, 480)  4320       ['block4c_expand_activation[0][0]
D)                                                              ']

block4c_bn (BatchNormalization  (None, 28, 14, 480)  1920       ['block4c_dwconv[0][0]']
)

block4c_activation (Activation  (None, 28, 14, 480)  0          ['block4c_bn[0][0]']
)

block4c_se_squeeze (GlobalAver  (None, 480)         0           ['block4c_activation[0][0]']
agePooling2D)

block4c_se_reshape (Reshape)   (None, 1, 1, 480)    0           ['block4c_se_squeeze[0][0]']

block4c_se_reduce (Conv2D)     (None, 1, 1, 20)     9620        ['block4c_se_reshape[0][0]']

block4c_se_expand (Conv2D)     (None, 1, 1, 480)    10080       ['block4c_se_reduce[0][0]']

block4c_se_excite (Multiply)   (None, 28, 14, 480)  0           ['block4c_activation[0][0]',
                                                                 'block4c_se_expand[0][0]']

block4c_project_conv (Conv2D)  (None, 28, 14, 80)   38400       ['block4c_se_excite[0][0]']

block4c_project_bn (BatchNorma  (None, 28, 14, 80)  320         ['block4c_project_conv[0][0]']
lization)
```

```
block4c_drop (Dropout)         (None, 28, 14, 80)   0           ['block4c_project_bn[0][0]']

block4c_add (Add)              (None, 28, 14, 80)   0           ['block4c_drop[0][0]',
                                                                 'block4b_add[0][0]']

block5a_expand_conv (Conv2D)   (None, 28, 14, 480)  38400       ['block4c_add[0][0]']

block5a_expand_bn (BatchNormal  (None, 28, 14, 480)  1920       ['block5a_expand_conv[0][0]']
ization)

block5a_expand_activation (Act  (None, 28, 14, 480)  0          ['block5a_expand_bn[0][0]']
ivation)

block5a_dwconv (DepthwiseConv2  (None, 28, 14, 480)  12000      ['block5a_expand_activation[0][0]
D)                                                               ']

block5a_bn (BatchNormalization  (None, 28, 14, 480)  1920       ['block5a_dwconv[0][0]']
)

block5a_activation (Activation  (None, 28, 14, 480)  0          ['block5a_bn[0][0]']
)

block5a_se_squeeze (GlobalAver  (None, 480)         0           ['block5a_activation[0][0]']
agePooling2D)

block5a_se_reshape (Reshape)   (None, 1, 1, 480)    0           ['block5a_se_squeeze[0][0]']

block5a_se_reduce (Conv2D)     (None, 1, 1, 20)     9620        ['block5a_se_reshape[0][0]']

block5a_se_expand (Conv2D)     (None, 1, 1, 480)    10080       ['block5a_se_reduce[0][0]']

block5a_se_excite (Multiply)   (None, 28, 14, 480)  0           ['block5a_activation[0][0]',
                                                                 'block5a_se_expand[0][0]']

block5a_project_conv (Conv2D)  (None, 28, 14, 112)  53760       ['block5a_se_excite[0][0]']

block5a_project_bn (BatchNorma  (None, 28, 14, 112)  448        ['block5a_project_conv[0][0]']
lization)

block5b_expand_conv (Conv2D)   (None, 28, 14, 672)  75264       ['block5a_project_bn[0][0]']

block5b_expand_bn (BatchNormal  (None, 28, 14, 672)  2688       ['block5b_expand_conv[0][0]']
ization)

block5b_expand_activation (Act  (None, 28, 14, 672)  0          ['block5b_expand_bn[0][0]']
ivation)

block5b_dwconv (DepthwiseConv2  (None, 28, 14, 672)  16800      ['block5b_expand_activation[0][0]
D)                                                               ']

block5b_bn (BatchNormalization  (None, 28, 14, 672)  2688       ['block5b_dwconv[0][0]']
)

block5b_activation (Activation  (None, 28, 14, 672)  0          ['block5b_bn[0][0]']
)

block5b_se_squeeze (GlobalAver  (None, 672)         0           ['block5b_activation[0][0]']
agePooling2D)

block5b_se_reshape (Reshape)   (None, 1, 1, 672)    0           ['block5b_se_squeeze[0][0]']

block5b_se_reduce (Conv2D)     (None, 1, 1, 28)     18844       ['block5b_se_reshape[0][0]']

block5b_se_expand (Conv2D)     (None, 1, 1, 672)    19488       ['block5b_se_reduce[0][0]']

block5b_se_excite (Multiply)   (None, 28, 14, 672)  0           ['block5b_activation[0][0]',
                                                                 'block5b_se_expand[0][0]']

block5b_project_conv (Conv2D)  (None, 28, 14, 112)  75264       ['block5b_se_excite[0][0]']

block5b_project_bn (BatchNorma  (None, 28, 14, 112)  448        ['block5b_project_conv[0][0]']
lization)

block5b_drop (Dropout)         (None, 28, 14, 112)  0           ['block5b_project_bn[0][0]']

block5b_add (Add)              (None, 28, 14, 112)  0           ['block5b_drop[0][0]',
                                                                 'block5a_project_bn[0][0]']
```

```
block5c_expand_conv (Conv2D)   (None, 28, 14, 672)  75264       ['block5b_add[0][0]']

block5c_expand_bn (BatchNormal  (None, 28, 14, 672)  2688       ['block5c_expand_conv[0][0]']
ization)

block5c_expand_activation (Act  (None, 28, 14, 672)  0          ['block5c_expand_bn[0][0]']
ivation)

block5c_dwconv (DepthwiseConv2  (None, 28, 14, 672)  16800      ['block5c_expand_activation[0][0]
D)                                                              ']

block5c_bn (BatchNormalization  (None, 28, 14, 672)  2688       ['block5c_dwconv[0][0]']
)

block5c_activation (Activation  (None, 28, 14, 672)  0          ['block5c_bn[0][0]']
)

block5c_se_squeeze (GlobalAver  (None, 672)         0          ['block5c_activation[0][0]']
agePooling2D)

block5c_se_reshape (Reshape)   (None, 1, 1, 672)    0          ['block5c_se_squeeze[0][0]']

block5c_se_reduce (Conv2D)     (None, 1, 1, 28)     18844      ['block5c_se_reshape[0][0]']

block5c_se_expand (Conv2D)     (None, 1, 1, 672)    19488      ['block5c_se_reduce[0][0]']

block5c_se_excite (Multiply)   (None, 28, 14, 672)  0          ['block5c_activation[0][0]',
                                                                 'block5c_se_expand[0][0]']

block5c_project_conv (Conv2D)  (None, 28, 14, 112)  75264      ['block5c_se_excite[0][0]']

block5c_project_bn (BatchNorma  (None, 28, 14, 112)  448       ['block5c_project_conv[0][0]']
lization)

block5c_drop (Dropout)         (None, 28, 14, 112)  0          ['block5c_project_bn[0][0]']

block5c_add (Add)              (None, 28, 14, 112)  0          ['block5c_drop[0][0]',
                                                                 'block5b_add[0][0]']

block6a_expand_conv (Conv2D)   (None, 28, 14, 672)  75264      ['block5c_add[0][0]']

block6a_expand_bn (BatchNormal  (None, 28, 14, 672)  2688       ['block6a_expand_conv[0][0]']
ization)

block6a_expand_activation (Act  (None, 28, 14, 672)  0          ['block6a_expand_bn[0][0]']
ivation)

block6a_dwconv_pad (ZeroPaddin  (None, 31, 17, 672)  0          ['block6a_expand_activation[0][0]
g2D)                                                            ']

block6a_dwconv (DepthwiseConv2  (None, 14, 7, 672)  16800      ['block6a_dwconv_pad[0][0]']
D)

block6a_bn (BatchNormalization  (None, 14, 7, 672)  2688       ['block6a_dwconv[0][0]']
)

block6a_activation (Activation  (None, 14, 7, 672)  0          ['block6a_bn[0][0]']
)

block6a_se_squeeze (GlobalAver  (None, 672)         0          ['block6a_activation[0][0]']
agePooling2D)

block6a_se_reshape (Reshape)   (None, 1, 1, 672)    0          ['block6a_se_squeeze[0][0]']

block6a_se_reduce (Conv2D)     (None, 1, 1, 28)     18844      ['block6a_se_reshape[0][0]']

block6a_se_expand (Conv2D)     (None, 1, 1, 672)    19488      ['block6a_se_reduce[0][0]']

block6a_se_excite (Multiply)   (None, 14, 7, 672)   0          ['block6a_activation[0][0]',
                                                                 'block6a_se_expand[0][0]']

block6a_project_conv (Conv2D)  (None, 14, 7, 192)   129024     ['block6a_se_excite[0][0]']

block6a_project_bn (BatchNorma  (None, 14, 7, 192)  768        ['block6a_project_conv[0][0]']
lization)

block6b_expand_conv (Conv2D)   (None, 14, 7, 1152)  221184     ['block6a_project_bn[0][0]']

block6b_expand_bn (BatchNormal  (None, 14, 7, 1152)  4608      ['block6b_expand_conv[0][0]']
```

```
ization)

block6b_expand_activation (Act  (None, 14, 7, 1152)  0          ['block6b_expand_bn[0][0]']
ivation)

block6b_dwconv (DepthwiseConv2  (None, 14, 7, 1152)  28800      ['block6b_expand_activation[0][0]
D)                                                              ']

block6b_bn (BatchNormalization  (None, 14, 7, 1152)  4608       ['block6b_dwconv[0][0]']
)

block6b_activation (Activation  (None, 14, 7, 1152)  0          ['block6b_bn[0][0]']
)

block6b_se_squeeze (GlobalAver  (None, 1152)         0          ['block6b_activation[0][0]']
agePooling2D)

block6b_se_reshape (Reshape)    (None, 1, 1, 1152)   0          ['block6b_se_squeeze[0][0]']

block6b_se_reduce (Conv2D)      (None, 1, 1, 48)     55344      ['block6b_se_reshape[0][0]']

block6b_se_expand (Conv2D)      (None, 1, 1, 1152)   56448      ['block6b_se_reduce[0][0]']

block6b_se_excite (Multiply)    (None, 14, 7, 1152)  0          ['block6b_activation[0][0]',
                                                                 'block6b_se_expand[0][0]']

block6b_project_conv (Conv2D)   (None, 14, 7, 192)   221184     ['block6b_se_excite[0][0]']

block6b_project_bn (BatchNorma  (None, 14, 7, 192)   768        ['block6b_project_conv[0][0]']
lization)

block6b_drop (Dropout)          (None, 14, 7, 192)   0          ['block6b_project_bn[0][0]']

block6b_add (Add)               (None, 14, 7, 192)   0          ['block6b_drop[0][0]',
                                                                 'block6a_project_bn[0][0]']

block6c_expand_conv (Conv2D)    (None, 14, 7, 1152)  221184     ['block6b_add[0][0]']

block6c_expand_bn (BatchNormal  (None, 14, 7, 1152)  4608       ['block6c_expand_conv[0][0]']
ization)

block6c_expand_activation (Act  (None, 14, 7, 1152)  0          ['block6c_expand_bn[0][0]']
ivation)

block6c_dwconv (DepthwiseConv2  (None, 14, 7, 1152)  28800      ['block6c_expand_activation[0][0]
D)                                                              ']

block6c_bn (BatchNormalization  (None, 14, 7, 1152)  4608       ['block6c_dwconv[0][0]']
)

block6c_activation (Activation  (None, 14, 7, 1152)  0          ['block6c_bn[0][0]']
)

block6c_se_squeeze (GlobalAver  (None, 1152)         0          ['block6c_activation[0][0]']
agePooling2D)

block6c_se_reshape (Reshape)    (None, 1, 1, 1152)   0          ['block6c_se_squeeze[0][0]']

block6c_se_reduce (Conv2D)      (None, 1, 1, 48)     55344      ['block6c_se_reshape[0][0]']

block6c_se_expand (Conv2D)      (None, 1, 1, 1152)   56448      ['block6c_se_reduce[0][0]']

block6c_se_excite (Multiply)    (None, 14, 7, 1152)  0          ['block6c_activation[0][0]',
                                                                 'block6c_se_expand[0][0]']

block6c_project_conv (Conv2D)   (None, 14, 7, 192)   221184     ['block6c_se_excite[0][0]']

block6c_project_bn (BatchNorma  (None, 14, 7, 192)   768        ['block6c_project_conv[0][0]']
lization)

block6c_drop (Dropout)          (None, 14, 7, 192)   0          ['block6c_project_bn[0][0]']

block6c_add (Add)               (None, 14, 7, 192)   0          ['block6c_drop[0][0]',
                                                                 'block6b_add[0][0]']

block6d_expand_conv (Conv2D)    (None, 14, 7, 1152)  221184     ['block6c_add[0][0]']

block6d_expand_bn (BatchNormal  (None, 14, 7, 1152)  4608       ['block6d_expand_conv[0][0]']
ization)
```

```
block6d_expand_activation (Act  (None, 14, 7, 1152)  0          ['block6d_expand_bn[0][0]']
ivation)

block6d_dwconv (DepthwiseConv2  (None, 14, 7, 1152)  28800      ['block6d_expand_activation[0][0]
D)                                                               ']

block6d_bn (BatchNormalization  (None, 14, 7, 1152)  4608       ['block6d_dwconv[0][0]']
)

block6d_activation (Activation  (None, 14, 7, 1152)  0          ['block6d_bn[0][0]']
)

block6d_se_squeeze (GlobalAver  (None, 1152)         0          ['block6d_activation[0][0]']
agePooling2D)

block6d_se_reshape (Reshape)    (None, 1, 1, 1152)   0          ['block6d_se_squeeze[0][0]']

block6d_se_reduce (Conv2D)      (None, 1, 1, 48)     55344      ['block6d_se_reshape[0][0]']

block6d_se_expand (Conv2D)      (None, 1, 1, 1152)   56448      ['block6d_se_reduce[0][0]']

block6d_se_excite (Multiply)    (None, 14, 7, 1152)  0          ['block6d_activation[0][0]',
                                                                 'block6d_se_expand[0][0]']

block6d_project_conv (Conv2D)   (None, 14, 7, 192)   221184     ['block6d_se_excite[0][0]']

block6d_project_bn (BatchNorma  (None, 14, 7, 192)   768        ['block6d_project_conv[0][0]']
lization)

block6d_drop (Dropout)          (None, 14, 7, 192)   0          ['block6d_project_bn[0][0]']

block6d_add (Add)               (None, 14, 7, 192)   0          ['block6d_drop[0][0]',
                                                                 'block6c_add[0][0]']

block7a_expand_conv (Conv2D)    (None, 14, 7, 1152)  221184     ['block6d_add[0][0]']

block7a_expand_bn (BatchNormal  (None, 14, 7, 1152)  4608       ['block7a_expand_conv[0][0]']
ization)

block7a_expand_activation (Act  (None, 14, 7, 1152)  0          ['block7a_expand_bn[0][0]']
ivation)

block7a_dwconv (DepthwiseConv2  (None, 14, 7, 1152)  10368      ['block7a_expand_activation[0][0]
D)                                                               ']

block7a_bn (BatchNormalization  (None, 14, 7, 1152)  4608       ['block7a_dwconv[0][0]']
)

block7a_activation (Activation  (None, 14, 7, 1152)  0          ['block7a_bn[0][0]']
)

block7a_se_squeeze (GlobalAver  (None, 1152)         0          ['block7a_activation[0][0]']
agePooling2D)

block7a_se_reshape (Reshape)    (None, 1, 1, 1152)   0          ['block7a_se_squeeze[0][0]']

block7a_se_reduce (Conv2D)      (None, 1, 1, 48)     55344      ['block7a_se_reshape[0][0]']

block7a_se_expand (Conv2D)      (None, 1, 1, 1152)   56448      ['block7a_se_reduce[0][0]']

block7a_se_excite (Multiply)    (None, 14, 7, 1152)  0          ['block7a_activation[0][0]',
                                                                 'block7a_se_expand[0][0]']

block7a_project_conv (Conv2D)   (None, 14, 7, 320)   368640     ['block7a_se_excite[0][0]']

block7a_project_bn (BatchNorma  (None, 14, 7, 320)   1280       ['block7a_project_conv[0][0]']
lization)

top_conv (Conv2D)               (None, 14, 7, 1280)  409600     ['block7a_project_bn[0][0]']

top_bn (BatchNormalization)     (None, 14, 7, 1280)  5120       ['top_conv[0][0]']

top_activation (Activation)     (None, 14, 7, 1280)  0          ['top_bn[0][0]']

global_average_pooling2d_1 (Gl  (None, 1280)         0          ['top_activation[0][0]']
obalAveragePooling2D)

dropout (Dropout)               (None, 1280)         0          ['global_average_pooling2d_1[0][0
```

```
                                                                 ']
 dense_1 (Dense)                (None, 31)           39711       ['dropout[0][0]']
==================================================================================================
Total params: 4,089,282
Trainable params: 4,047,259
Non-trainable params: 42,023
__________________________________________________________________________________________________
```

In [63]:
```
for layer in model.layers:
    layer.trainable = True
```

In [64]:
```
early_stopping = EarlyStopping(patience=5)
```

In [65]:
```
model.compile(
  optimizer="adam",
  loss=tf.keras.losses.SparseCategoricalCrossentropy(from_logits=True),
  metrics=['acc'])

model.fit(X_train,
          y_train,
          epochs=50,
          callbacks = early_stopping,
          validation_data=(X_val, y_val))
```

```
Epoch 1/50
2022-01-28 02:08:29.140486: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:112] Plugin optimizer for device_type GPU is enabled.
582/582 [==============================] - ETA: 0s - loss: 3.2686 - acc: 0.0889
2022-01-28 02:16:57.869374: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:112] Plugin optimizer for device_type GPU is enabled.
582/582 [==============================] - 549s 925ms/step - loss: 3.2686 - acc: 0.0889 - val_loss: 1.6682 - val_acc: 0.5194
Epoch 2/50
582/582 [==============================] - 542s 928ms/step - loss: 2.8611 - acc: 0.1977 - val_loss: 0.6517 - val_acc: 0.8204
Epoch 3/50
582/582 [==============================] - 539s 927ms/step - loss: 2.7472 - acc: 0.2275 - val_loss: 0.6919 - val_acc: 0.8140
Epoch 4/50
582/582 [==============================] - 540s 928ms/step - loss: 2.7191 - acc: 0.2357 - val_loss: 0.3115 - val_acc: 0.9133
Epoch 5/50
582/582 [==============================] - 540s 928ms/step - loss: 2.7017 - acc: 0.2398 - val_loss: 0.2796 - val_acc: 0.9239
Epoch 6/50
582/582 [==============================] - 540s 928ms/step - loss: 2.6848 - acc: 0.2443 - val_loss: 0.2836 - val_acc: 0.9249
Epoch 7/50
582/582 [==============================] - 540s 927ms/step - loss: 2.6792 - acc: 0.2460 - val_loss: 0.4248 - val_acc: 0.8985
Epoch 8/50
582/582 [==============================] - 540s 928ms/step - loss: 2.6681 - acc: 0.2529 - val_loss: 0.4080 - val_acc: 0.8935
Epoch 9/50
582/582 [==============================] - 540s 928ms/step - loss: 2.6779 - acc: 0.2480 - val_loss: 0.2179 - val_acc: 0.9424
Epoch 10/50
582/582 [==============================] - 540s 927ms/step - loss: 2.6689 - acc: 0.2510 - val_loss: 0.2767 - val_acc: 0.9314
Epoch 11/50
582/582 [==============================] - 540s 927ms/step - loss: 2.6693 - acc: 0.2483 - val_loss: 0.3454 - val_acc: 0.9125
Epoch 12/50
582/582 [==============================] - 540s 928ms/step - loss: 2.6629 - acc: 0.2516 - val_loss: 0.6578 - val_acc: 0.8518
Epoch 13/50
582/582 [==============================] - 540s 927ms/step - loss: 2.6671 - acc: 0.2491 - val_loss: 0.2356 - val_acc: 0.9383
Epoch 14/50
582/582 [==============================] - 540s 928ms/step - loss: 2.6523 - acc: 0.2555 - val_loss: 0.2648 - val_acc: 0.9316
```

Out[65]:
```
<keras.callbacks.History at 0x2c4dd5be0>
```

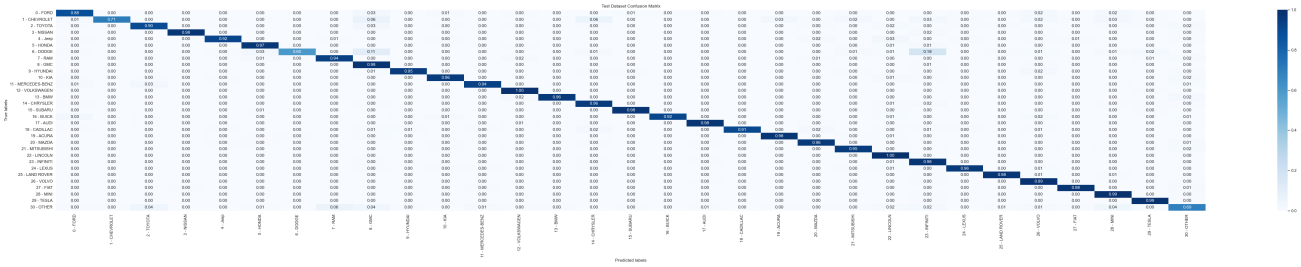
In [66]:
```
model.evaluate(X_test,y_test)
```

Out[66]:
```
243/243 [==============================] - 78s 316ms/step - loss: 0.2700 - acc: 0.9312
[0.27000555396080017, 0.9312169551849365]
```

In [67]:
```
y_pred = model.predict(X_test)
y_pred =  [np.argmax(i) for i in y_pred]
```

```
2022-01-28 04:15:59.128063: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:112] Pl
ugin optimizer for device_type GPU is enabled.
```

In [68]:
```
from sklearn.metrics import confusion_matrix
sns.set(rc = {'figure.figsize':(70,10)})
ax = plt.subplot()

labels = ['0 - FORD', '1 - CHEVROLET', '2 - TOYOTA', '3 - NISSAN', '4 - Jeep', '5 - HONDA', '6 - DODGE', '7
          '11 - MERCEDES-BENZ', '12 - VOLKSWAGEN', '13 - BMW', '14 - CHRYSLER', '15 - SUBARU', '16 - BUICK',
          '21 - MITSUBISHI', '22 - LINCOLN', '23 - INFINITI', '24 - LEXUS', '25 - LAND ROVER', '26 - VOLVO',

c = confusion_matrix(y_test,y_pred)

c_norm = c.astype('float') / c.sum(axis=1)[:, np.newaxis]

cndf = pd.DataFrame(c_norm, index=labels, columns=labels)

sns.heatmap(cndf,annot=True,fmt='.2f', cmap='Blues',ax=ax)

ax.set_xlabel('Predicted labels');ax.set_ylabel('True labels')

ax.set_title('Test Dataset Confusion Matrix');
```



3.4 ResNet 152 Model

In [ ]:
```
# feature_extractor_model = "https://tfhub.dev/google/imagenet/resnet_v2_152/feature_vector/5"

# pretrained_model_without_top_layer = hub.KerasLayer(
#     feature_extractor_model, input_shape=(224, 224, 3), trainable=True)
```

In [ ]:
```
# model = tf.keras.Sequential([pretrained_model_without_top_layer,
#                              tf.keras.layers.Dense(num_class)])

# model.summary()
```

In [69]:
```
from keras.applications.resnet import ResNet152
```

In [70]:
```
base_model = ResNet152(include_top=False,input_shape=(448,224,3))
x = GlobalAveragePooling2D()(base_model.output)
output = Dense(num_class)(x)

model = Model(inputs=base_model.inputs,outputs=output)

model.summary()
```

```
Downloading data from https://storage.googleapis.com/tensorflow/keras-applications/resnet/resnet152_weights_
tf_dim_ordering_tf_kernels_notop.h5
234700800/234698864 [==============================] - 7s 0us/step
234708992/234698864 [==============================] - 7s 0us/step
Model: "model_3"
```

Layer (type)	Output Shape	Param #	Connected to
input_4 (InputLayer)	[(None, 448, 224, 3)]	0	[]
conv1_pad (ZeroPadding2D)	(None, 454, 230, 3)	0	['input_4[0][0]']
conv1_conv (Conv2D)	(None, 224, 112, 64)	9472	['conv1_pad[0][0]']
conv1_bn (BatchNormalization)	(None, 224, 112, 64)	256	['conv1_conv[0][0]']
conv1_relu (Activation)	(None, 224, 112, 64)	0	['conv1_bn[0][0]']
pool1_pad (ZeroPadding2D)	(None, 226, 114, 64)	0	['conv1_relu[0][0]']
pool1_pool (MaxPooling2D)	(None, 112, 56, 64)	0	['pool1_pad[0][0]']
conv2_block1_1_conv (Conv2D)	(None, 112, 56, 64)	4160	['pool1_pool[0][0]']
conv2_block1_1_bn (BatchNormalization)	(None, 112, 56, 64)	256	['conv2_block1_1_conv[0][0]']
conv2_block1_1_relu (Activation)	(None, 112, 56, 64)	0	['conv2_block1_1_bn[0][0]']
conv2_block1_2_conv (Conv2D)	(None, 112, 56, 64)	36928	['conv2_block1_1_relu[0][0]']
conv2_block1_2_bn (BatchNormalization)	(None, 112, 56, 64)	256	['conv2_block1_2_conv[0][0]']
conv2_block1_2_relu (Activation)	(None, 112, 56, 64)	0	['conv2_block1_2_bn[0][0]']
conv2_block1_0_conv (Conv2D)	(None, 112, 56, 256)	16640	['pool1_pool[0][0]']
conv2_block1_3_conv (Conv2D)	(None, 112, 56, 256)	16640	['conv2_block1_2_relu[0][0]']
conv2_block1_0_bn (BatchNormalization)	(None, 112, 56, 256)	1024	['conv2_block1_0_conv[0][0]']
conv2_block1_3_bn (BatchNormalization)	(None, 112, 56, 256)	1024	['conv2_block1_3_conv[0][0]']
conv2_block1_add (Add)	(None, 112, 56, 256)	0	['conv2_block1_0_bn[0][0]', 'conv2_block1_3_bn[0][0]']
conv2_block1_out (Activation)	(None, 112, 56, 256)	0	['conv2_block1_add[0][0]']
conv2_block2_1_conv (Conv2D)	(None, 112, 56, 64)	16448	['conv2_block1_out[0][0]']
conv2_block2_1_bn (BatchNormalization)	(None, 112, 56, 64)	256	['conv2_block2_1_conv[0][0]']
conv2_block2_1_relu (Activation)	(None, 112, 56, 64)	0	['conv2_block2_1_bn[0][0]']
conv2_block2_2_conv (Conv2D)	(None, 112, 56, 64)	36928	['conv2_block2_1_relu[0][0]']
conv2_block2_2_bn (BatchNormalization)	(None, 112, 56, 64)	256	['conv2_block2_2_conv[0][0]']
conv2_block2_2_relu (Activation)	(None, 112, 56, 64)	0	['conv2_block2_2_bn[0][0]']
conv2_block2_3_conv (Conv2D)	(None, 112, 56, 256)	16640	['conv2_block2_2_relu[0][0]']

```
conv2_block2_3_bn (BatchNormal  (None, 112, 56, 256  1024       ['conv2_block2_3_conv[0][0]']
ization)                        )

conv2_block2_add (Add)          (None, 112, 56, 256  0           ['conv2_block1_out[0][0]',
                                )                                 'conv2_block2_3_bn[0][0]']

conv2_block2_out (Activation)   (None, 112, 56, 256  0           ['conv2_block2_add[0][0]']
                                )

conv2_block3_1_conv (Conv2D)    (None, 112, 56, 64)  16448       ['conv2_block2_out[0][0]']

conv2_block3_1_bn (BatchNormal  (None, 112, 56, 64)  256        ['conv2_block3_1_conv[0][0]']
ization)

conv2_block3_1_relu (Activatio  (None, 112, 56, 64)  0          ['conv2_block3_1_bn[0][0]']
n)

conv2_block3_2_conv (Conv2D)    (None, 112, 56, 64)  36928       ['conv2_block3_1_relu[0][0]']

conv2_block3_2_bn (BatchNormal  (None, 112, 56, 64)  256        ['conv2_block3_2_conv[0][0]']
ization)

conv2_block3_2_relu (Activatio  (None, 112, 56, 64)  0          ['conv2_block3_2_bn[0][0]']
n)

conv2_block3_3_conv (Conv2D)    (None, 112, 56, 256  16640       ['conv2_block3_2_relu[0][0]']
                                )

conv2_block3_3_bn (BatchNormal  (None, 112, 56, 256  1024       ['conv2_block3_3_conv[0][0]']
ization)                        )

conv2_block3_add (Add)          (None, 112, 56, 256  0           ['conv2_block2_out[0][0]',
                                )                                 'conv2_block3_3_bn[0][0]']

conv2_block3_out (Activation)   (None, 112, 56, 256  0           ['conv2_block3_add[0][0]']
                                )

conv3_block1_1_conv (Conv2D)    (None, 56, 28, 128)  32896       ['conv2_block3_out[0][0]']

conv3_block1_1_bn (BatchNormal  (None, 56, 28, 128)  512        ['conv3_block1_1_conv[0][0]']
ization)

conv3_block1_1_relu (Activatio  (None, 56, 28, 128)  0          ['conv3_block1_1_bn[0][0]']
n)

conv3_block1_2_conv (Conv2D)    (None, 56, 28, 128)  147584      ['conv3_block1_1_relu[0][0]']

conv3_block1_2_bn (BatchNormal  (None, 56, 28, 128)  512        ['conv3_block1_2_conv[0][0]']
ization)

conv3_block1_2_relu (Activatio  (None, 56, 28, 128)  0          ['conv3_block1_2_bn[0][0]']
n)

conv3_block1_0_conv (Conv2D)    (None, 56, 28, 512)  131584      ['conv2_block3_out[0][0]']

conv3_block1_3_conv (Conv2D)    (None, 56, 28, 512)  66048       ['conv3_block1_2_relu[0][0]']

conv3_block1_0_bn (BatchNormal  (None, 56, 28, 512)  2048       ['conv3_block1_0_conv[0][0]']
ization)

conv3_block1_3_bn (BatchNormal  (None, 56, 28, 512)  2048       ['conv3_block1_3_conv[0][0]']
ization)

conv3_block1_add (Add)          (None, 56, 28, 512)  0           ['conv3_block1_0_bn[0][0]',
                                                                  'conv3_block1_3_bn[0][0]']

conv3_block1_out (Activation)   (None, 56, 28, 512)  0           ['conv3_block1_add[0][0]']

conv3_block2_1_conv (Conv2D)    (None, 56, 28, 128)  65664       ['conv3_block1_out[0][0]']

conv3_block2_1_bn (BatchNormal  (None, 56, 28, 128)  512        ['conv3_block2_1_conv[0][0]']
ization)

conv3_block2_1_relu (Activatio  (None, 56, 28, 128)  0          ['conv3_block2_1_bn[0][0]']
n)

conv3_block2_2_conv (Conv2D)    (None, 56, 28, 128)  147584      ['conv3_block2_1_relu[0][0]']
```

```
conv3_block2_2_bn (BatchNormal  (None, 56, 28, 128)  512        ['conv3_block2_2_conv[0][0]']
ization)

conv3_block2_2_relu (Activatio  (None, 56, 28, 128)  0          ['conv3_block2_2_bn[0][0]']
n)

conv3_block2_3_conv (Conv2D)   (None, 56, 28, 512)  66048      ['conv3_block2_2_relu[0][0]']

conv3_block2_3_bn (BatchNormal  (None, 56, 28, 512)  2048       ['conv3_block2_3_conv[0][0]']
ization)

conv3_block2_add (Add)         (None, 56, 28, 512)  0          ['conv3_block1_out[0][0]',
                                                                 'conv3_block2_3_bn[0][0]']

conv3_block2_out (Activation)  (None, 56, 28, 512)  0          ['conv3_block2_add[0][0]']

conv3_block3_1_conv (Conv2D)   (None, 56, 28, 128)  65664      ['conv3_block2_out[0][0]']

conv3_block3_1_bn (BatchNormal  (None, 56, 28, 128)  512        ['conv3_block3_1_conv[0][0]']
ization)

conv3_block3_1_relu (Activatio  (None, 56, 28, 128)  0          ['conv3_block3_1_bn[0][0]']
n)

conv3_block3_2_conv (Conv2D)   (None, 56, 28, 128)  147584     ['conv3_block3_1_relu[0][0]']

conv3_block3_2_bn (BatchNormal  (None, 56, 28, 128)  512        ['conv3_block3_2_conv[0][0]']
ization)

conv3_block3_2_relu (Activatio  (None, 56, 28, 128)  0          ['conv3_block3_2_bn[0][0]']
n)

conv3_block3_3_conv (Conv2D)   (None, 56, 28, 512)  66048      ['conv3_block3_2_relu[0][0]']

conv3_block3_3_bn (BatchNormal  (None, 56, 28, 512)  2048       ['conv3_block3_3_conv[0][0]']
ization)

conv3_block3_add (Add)         (None, 56, 28, 512)  0          ['conv3_block2_out[0][0]',
                                                                 'conv3_block3_3_bn[0][0]']

conv3_block3_out (Activation)  (None, 56, 28, 512)  0          ['conv3_block3_add[0][0]']

conv3_block4_1_conv (Conv2D)   (None, 56, 28, 128)  65664      ['conv3_block3_out[0][0]']

conv3_block4_1_bn (BatchNormal  (None, 56, 28, 128)  512        ['conv3_block4_1_conv[0][0]']
ization)

conv3_block4_1_relu (Activatio  (None, 56, 28, 128)  0          ['conv3_block4_1_bn[0][0]']
n)

conv3_block4_2_conv (Conv2D)   (None, 56, 28, 128)  147584     ['conv3_block4_1_relu[0][0]']

conv3_block4_2_bn (BatchNormal  (None, 56, 28, 128)  512        ['conv3_block4_2_conv[0][0]']
ization)

conv3_block4_2_relu (Activatio  (None, 56, 28, 128)  0          ['conv3_block4_2_bn[0][0]']
n)

conv3_block4_3_conv (Conv2D)   (None, 56, 28, 512)  66048      ['conv3_block4_2_relu[0][0]']

conv3_block4_3_bn (BatchNormal  (None, 56, 28, 512)  2048       ['conv3_block4_3_conv[0][0]']
ization)

conv3_block4_add (Add)         (None, 56, 28, 512)  0          ['conv3_block3_out[0][0]',
                                                                 'conv3_block4_3_bn[0][0]']

conv3_block4_out (Activation)  (None, 56, 28, 512)  0          ['conv3_block4_add[0][0]']

conv3_block5_1_conv (Conv2D)   (None, 56, 28, 128)  65664      ['conv3_block4_out[0][0]']

conv3_block5_1_bn (BatchNormal  (None, 56, 28, 128)  512        ['conv3_block5_1_conv[0][0]']
ization)

conv3_block5_1_relu (Activatio  (None, 56, 28, 128)  0          ['conv3_block5_1_bn[0][0]']
n)

conv3_block5_2_conv (Conv2D)   (None, 56, 28, 128)  147584     ['conv3_block5_1_relu[0][0]']

conv3_block5_2_bn (BatchNormal  (None, 56, 28, 128)  512        ['conv3_block5_2_conv[0][0]']
```

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ization)

conv3_block5_2_relu (Activatio  (None, 56, 28, 128)  0          ['conv3_block5_2_bn[0][0]']
n)

conv3_block5_3_conv (Conv2D)   (None, 56, 28, 512)  66048       ['conv3_block5_2_relu[0][0]']

conv3_block5_3_bn (BatchNormal  (None, 56, 28, 512)  2048       ['conv3_block5_3_conv[0][0]']
ization)

conv3_block5_add (Add)         (None, 56, 28, 512)  0          ['conv3_block4_out[0][0]',
                                                                 'conv3_block5_3_bn[0][0]']

conv3_block5_out (Activation)  (None, 56, 28, 512)  0          ['conv3_block5_add[0][0]']

conv3_block6_1_conv (Conv2D)   (None, 56, 28, 128)  65664       ['conv3_block5_out[0][0]']

conv3_block6_1_bn (BatchNormal  (None, 56, 28, 128)  512       ['conv3_block6_1_conv[0][0]']
ization)

conv3_block6_1_relu (Activatio  (None, 56, 28, 128)  0          ['conv3_block6_1_bn[0][0]']
n)

conv3_block6_2_conv (Conv2D)   (None, 56, 28, 128)  147584      ['conv3_block6_1_relu[0][0]']

conv3_block6_2_bn (BatchNormal  (None, 56, 28, 128)  512       ['conv3_block6_2_conv[0][0]']
ization)

conv3_block6_2_relu (Activatio  (None, 56, 28, 128)  0          ['conv3_block6_2_bn[0][0]']
n)

conv3_block6_3_conv (Conv2D)   (None, 56, 28, 512)  66048       ['conv3_block6_2_relu[0][0]']

conv3_block6_3_bn (BatchNormal  (None, 56, 28, 512)  2048       ['conv3_block6_3_conv[0][0]']
ization)

conv3_block6_add (Add)         (None, 56, 28, 512)  0          ['conv3_block5_out[0][0]',
                                                                 'conv3_block6_3_bn[0][0]']

conv3_block6_out (Activation)  (None, 56, 28, 512)  0          ['conv3_block6_add[0][0]']

conv3_block7_1_conv (Conv2D)   (None, 56, 28, 128)  65664       ['conv3_block6_out[0][0]']

conv3_block7_1_bn (BatchNormal  (None, 56, 28, 128)  512       ['conv3_block7_1_conv[0][0]']
ization)

conv3_block7_1_relu (Activatio  (None, 56, 28, 128)  0          ['conv3_block7_1_bn[0][0]']
n)

conv3_block7_2_conv (Conv2D)   (None, 56, 28, 128)  147584      ['conv3_block7_1_relu[0][0]']

conv3_block7_2_bn (BatchNormal  (None, 56, 28, 128)  512       ['conv3_block7_2_conv[0][0]']
ization)

conv3_block7_2_relu (Activatio  (None, 56, 28, 128)  0          ['conv3_block7_2_bn[0][0]']
n)

conv3_block7_3_conv (Conv2D)   (None, 56, 28, 512)  66048       ['conv3_block7_2_relu[0][0]']

conv3_block7_3_bn (BatchNormal  (None, 56, 28, 512)  2048       ['conv3_block7_3_conv[0][0]']
ization)

conv3_block7_add (Add)         (None, 56, 28, 512)  0          ['conv3_block6_out[0][0]',
                                                                 'conv3_block7_3_bn[0][0]']

conv3_block7_out (Activation)  (None, 56, 28, 512)  0          ['conv3_block7_add[0][0]']

conv3_block8_1_conv (Conv2D)   (None, 56, 28, 128)  65664       ['conv3_block7_out[0][0]']

conv3_block8_1_bn (BatchNormal  (None, 56, 28, 128)  512       ['conv3_block8_1_conv[0][0]']
ization)

conv3_block8_1_relu (Activatio  (None, 56, 28, 128)  0          ['conv3_block8_1_bn[0][0]']
n)

conv3_block8_2_conv (Conv2D)   (None, 56, 28, 128)  147584      ['conv3_block8_1_relu[0][0]']

conv3_block8_2_bn (BatchNormal  (None, 56, 28, 128)  512       ['conv3_block8_2_conv[0][0]']
ization)
```

```
conv3_block8_2_relu (Activatio  (None, 56, 28, 128)  0          ['conv3_block8_2_bn[0][0]']
n)

conv3_block8_3_conv (Conv2D)   (None, 56, 28, 512)  66048      ['conv3_block8_2_relu[0][0]']

conv3_block8_3_bn (BatchNormal  (None, 56, 28, 512)  2048       ['conv3_block8_3_conv[0][0]']
ization)

conv3_block8_add (Add)         (None, 56, 28, 512)  0          ['conv3_block7_out[0][0]',
                                                                 'conv3_block8_3_bn[0][0]']

conv3_block8_out (Activation)  (None, 56, 28, 512)  0          ['conv3_block8_add[0][0]']

conv4_block1_1_conv (Conv2D)   (None, 28, 14, 256)  131328     ['conv3_block8_out[0][0]']

conv4_block1_1_bn (BatchNormal  (None, 28, 14, 256)  1024       ['conv4_block1_1_conv[0][0]']
ization)

conv4_block1_1_relu (Activatio  (None, 28, 14, 256)  0          ['conv4_block1_1_bn[0][0]']
n)

conv4_block1_2_conv (Conv2D)   (None, 28, 14, 256)  590080     ['conv4_block1_1_relu[0][0]']

conv4_block1_2_bn (BatchNormal  (None, 28, 14, 256)  1024       ['conv4_block1_2_conv[0][0]']
ization)

conv4_block1_2_relu (Activatio  (None, 28, 14, 256)  0          ['conv4_block1_2_bn[0][0]']
n)

conv4_block1_0_conv (Conv2D)   (None, 28, 14, 1024  525312     ['conv3_block8_out[0][0]']
                               )

conv4_block1_3_conv (Conv2D)   (None, 28, 14, 1024  263168     ['conv4_block1_2_relu[0][0]']
                               )

conv4_block1_0_bn (BatchNormal  (None, 28, 14, 1024  4096       ['conv4_block1_0_conv[0][0]']
ization)                       )

conv4_block1_3_bn (BatchNormal  (None, 28, 14, 1024  4096       ['conv4_block1_3_conv[0][0]']
ization)                       )

conv4_block1_add (Add)         (None, 28, 14, 1024  0          ['conv4_block1_0_bn[0][0]',
                               )                                 'conv4_block1_3_bn[0][0]']

conv4_block1_out (Activation)  (None, 28, 14, 1024  0          ['conv4_block1_add[0][0]']
                               )

conv4_block2_1_conv (Conv2D)   (None, 28, 14, 256)  262400     ['conv4_block1_out[0][0]']

conv4_block2_1_bn (BatchNormal  (None, 28, 14, 256)  1024       ['conv4_block2_1_conv[0][0]']
ization)

conv4_block2_1_relu (Activatio  (None, 28, 14, 256)  0          ['conv4_block2_1_bn[0][0]']
n)

conv4_block2_2_conv (Conv2D)   (None, 28, 14, 256)  590080     ['conv4_block2_1_relu[0][0]']

conv4_block2_2_bn (BatchNormal  (None, 28, 14, 256)  1024       ['conv4_block2_2_conv[0][0]']
ization)

conv4_block2_2_relu (Activatio  (None, 28, 14, 256)  0          ['conv4_block2_2_bn[0][0]']
n)

conv4_block2_3_conv (Conv2D)   (None, 28, 14, 1024  263168     ['conv4_block2_2_relu[0][0]']
                               )

conv4_block2_3_bn (BatchNormal  (None, 28, 14, 1024  4096       ['conv4_block2_3_conv[0][0]']
ization)                       )

conv4_block2_add (Add)         (None, 28, 14, 1024  0          ['conv4_block1_out[0][0]',
                               )                                 'conv4_block2_3_bn[0][0]']

conv4_block2_out (Activation)  (None, 28, 14, 1024  0          ['conv4_block2_add[0][0]']
                               )

conv4_block3_1_conv (Conv2D)   (None, 28, 14, 256)  262400     ['conv4_block2_out[0][0]']

conv4_block3_1_bn (BatchNormal  (None, 28, 14, 256)  1024       ['conv4_block3_1_conv[0][0]']
```

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ization)

conv4_block3_1_relu (Activatio  (None, 28, 14, 256)  0          ['conv4_block3_1_bn[0][0]']
n)

conv4_block3_2_conv (Conv2D)   (None, 28, 14, 256)  590080      ['conv4_block3_1_relu[0][0]']

conv4_block3_2_bn (BatchNormal  (None, 28, 14, 256)  1024       ['conv4_block3_2_conv[0][0]']
ization)

conv4_block3_2_relu (Activatio  (None, 28, 14, 256)  0          ['conv4_block3_2_bn[0][0]']
n)

conv4_block3_3_conv (Conv2D)   (None, 28, 14, 1024  263168      ['conv4_block3_2_relu[0][0]']
                               )

conv4_block3_3_bn (BatchNormal  (None, 28, 14, 1024  4096       ['conv4_block3_3_conv[0][0]']
ization)                       )

conv4_block3_add (Add)         (None, 28, 14, 1024  0          ['conv4_block2_out[0][0]',
                               )                                 'conv4_block3_3_bn[0][0]']

conv4_block3_out (Activation)  (None, 28, 14, 1024  0          ['conv4_block3_add[0][0]']
                               )

conv4_block4_1_conv (Conv2D)   (None, 28, 14, 256)  262400      ['conv4_block3_out[0][0]']

conv4_block4_1_bn (BatchNormal  (None, 28, 14, 256)  1024       ['conv4_block4_1_conv[0][0]']
ization)

conv4_block4_1_relu (Activatio  (None, 28, 14, 256)  0          ['conv4_block4_1_bn[0][0]']
n)

conv4_block4_2_conv (Conv2D)   (None, 28, 14, 256)  590080      ['conv4_block4_1_relu[0][0]']

conv4_block4_2_bn (BatchNormal  (None, 28, 14, 256)  1024       ['conv4_block4_2_conv[0][0]']
ization)

conv4_block4_2_relu (Activatio  (None, 28, 14, 256)  0          ['conv4_block4_2_bn[0][0]']
n)

conv4_block4_3_conv (Conv2D)   (None, 28, 14, 1024  263168      ['conv4_block4_2_relu[0][0]']
                               )

conv4_block4_3_bn (BatchNormal  (None, 28, 14, 1024  4096       ['conv4_block4_3_conv[0][0]']
ization)                       )

conv4_block4_add (Add)         (None, 28, 14, 1024  0          ['conv4_block3_out[0][0]',
                               )                                 'conv4_block4_3_bn[0][0]']

conv4_block4_out (Activation)  (None, 28, 14, 1024  0          ['conv4_block4_add[0][0]']
                               )

conv4_block5_1_conv (Conv2D)   (None, 28, 14, 256)  262400      ['conv4_block4_out[0][0]']

conv4_block5_1_bn (BatchNormal  (None, 28, 14, 256)  1024       ['conv4_block5_1_conv[0][0]']
ization)

conv4_block5_1_relu (Activatio  (None, 28, 14, 256)  0          ['conv4_block5_1_bn[0][0]']
n)

conv4_block5_2_conv (Conv2D)   (None, 28, 14, 256)  590080      ['conv4_block5_1_relu[0][0]']

conv4_block5_2_bn (BatchNormal  (None, 28, 14, 256)  1024       ['conv4_block5_2_conv[0][0]']
ization)

conv4_block5_2_relu (Activatio  (None, 28, 14, 256)  0          ['conv4_block5_2_bn[0][0]']
n)

conv4_block5_3_conv (Conv2D)   (None, 28, 14, 1024  263168      ['conv4_block5_2_relu[0][0]']
                               )

conv4_block5_3_bn (BatchNormal  (None, 28, 14, 1024  4096       ['conv4_block5_3_conv[0][0]']
ization)                       )

conv4_block5_add (Add)         (None, 28, 14, 1024  0          ['conv4_block4_out[0][0]',
                               )                                 'conv4_block5_3_bn[0][0]']

conv4_block5_out (Activation)  (None, 28, 14, 1024  0          ['conv4_block5_add[0][0]']
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                                )

conv4_block6_1_conv (Conv2D)   (None, 28, 14, 256)  262400      ['conv4_block5_out[0][0]']

conv4_block6_1_bn (BatchNormal  (None, 28, 14, 256)  1024       ['conv4_block6_1_conv[0][0]']
ization)

conv4_block6_1_relu (Activatio  (None, 28, 14, 256)  0          ['conv4_block6_1_bn[0][0]']
n)

conv4_block6_2_conv (Conv2D)   (None, 28, 14, 256)  590080      ['conv4_block6_1_relu[0][0]']

conv4_block6_2_bn (BatchNormal  (None, 28, 14, 256)  1024       ['conv4_block6_2_conv[0][0]']
ization)

conv4_block6_2_relu (Activatio  (None, 28, 14, 256)  0          ['conv4_block6_2_bn[0][0]']
n)

conv4_block6_3_conv (Conv2D)   (None, 28, 14, 1024  263168      ['conv4_block6_2_relu[0][0]']
                                )

conv4_block6_3_bn (BatchNormal  (None, 28, 14, 1024  4096       ['conv4_block6_3_conv[0][0]']
ization)                        )

conv4_block6_add (Add)         (None, 28, 14, 1024  0           ['conv4_block5_out[0][0]',
                                )                                'conv4_block6_3_bn[0][0]']

conv4_block6_out (Activation)  (None, 28, 14, 1024  0           ['conv4_block6_add[0][0]']
                                )

conv4_block7_1_conv (Conv2D)   (None, 28, 14, 256)  262400      ['conv4_block6_out[0][0]']

conv4_block7_1_bn (BatchNormal  (None, 28, 14, 256)  1024       ['conv4_block7_1_conv[0][0]']
ization)

conv4_block7_1_relu (Activatio  (None, 28, 14, 256)  0          ['conv4_block7_1_bn[0][0]']
n)

conv4_block7_2_conv (Conv2D)   (None, 28, 14, 256)  590080      ['conv4_block7_1_relu[0][0]']

conv4_block7_2_bn (BatchNormal  (None, 28, 14, 256)  1024       ['conv4_block7_2_conv[0][0]']
ization)

conv4_block7_2_relu (Activatio  (None, 28, 14, 256)  0          ['conv4_block7_2_bn[0][0]']
n)

conv4_block7_3_conv (Conv2D)   (None, 28, 14, 1024  263168      ['conv4_block7_2_relu[0][0]']
                                )

conv4_block7_3_bn (BatchNormal  (None, 28, 14, 1024  4096       ['conv4_block7_3_conv[0][0]']
ization)                        )

conv4_block7_add (Add)         (None, 28, 14, 1024  0           ['conv4_block6_out[0][0]',
                                )                                'conv4_block7_3_bn[0][0]']

conv4_block7_out (Activation)  (None, 28, 14, 1024  0           ['conv4_block7_add[0][0]']
                                )

conv4_block8_1_conv (Conv2D)   (None, 28, 14, 256)  262400      ['conv4_block7_out[0][0]']

conv4_block8_1_bn (BatchNormal  (None, 28, 14, 256)  1024       ['conv4_block8_1_conv[0][0]']
ization)

conv4_block8_1_relu (Activatio  (None, 28, 14, 256)  0          ['conv4_block8_1_bn[0][0]']
n)

conv4_block8_2_conv (Conv2D)   (None, 28, 14, 256)  590080      ['conv4_block8_1_relu[0][0]']

conv4_block8_2_bn (BatchNormal  (None, 28, 14, 256)  1024       ['conv4_block8_2_conv[0][0]']
ization)

conv4_block8_2_relu (Activatio  (None, 28, 14, 256)  0          ['conv4_block8_2_bn[0][0]']
n)

conv4_block8_3_conv (Conv2D)   (None, 28, 14, 1024  263168      ['conv4_block8_2_relu[0][0]']
                                )

conv4_block8_3_bn (BatchNormal  (None, 28, 14, 1024  4096       ['conv4_block8_3_conv[0][0]']
ization)                        )
```

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conv4_block8_add (Add)         (None, 28, 14, 1024  0           ['conv4_block7_out[0][0]',
                               )                                 'conv4_block8_3_bn[0][0]']

conv4_block8_out (Activation)  (None, 28, 14, 1024  0           ['conv4_block8_add[0][0]']
                               )

conv4_block9_1_conv (Conv2D)   (None, 28, 14, 256)  262400      ['conv4_block8_out[0][0]']

conv4_block9_1_bn (BatchNormal  (None, 28, 14, 256)  1024       ['conv4_block9_1_conv[0][0]']
ization)

conv4_block9_1_relu (Activatio  (None, 28, 14, 256)  0          ['conv4_block9_1_bn[0][0]']
n)

conv4_block9_2_conv (Conv2D)   (None, 28, 14, 256)  590080      ['conv4_block9_1_relu[0][0]']

conv4_block9_2_bn (BatchNormal  (None, 28, 14, 256)  1024       ['conv4_block9_2_conv[0][0]']
ization)

conv4_block9_2_relu (Activatio  (None, 28, 14, 256)  0          ['conv4_block9_2_bn[0][0]']
n)

conv4_block9_3_conv (Conv2D)   (None, 28, 14, 1024  263168      ['conv4_block9_2_relu[0][0]']
                               )

conv4_block9_3_bn (BatchNormal  (None, 28, 14, 1024  4096       ['conv4_block9_3_conv[0][0]']
ization)                       )

conv4_block9_add (Add)         (None, 28, 14, 1024  0           ['conv4_block8_out[0][0]',
                               )                                 'conv4_block9_3_bn[0][0]']

conv4_block9_out (Activation)  (None, 28, 14, 1024  0           ['conv4_block9_add[0][0]']
                               )

conv4_block10_1_conv (Conv2D)  (None, 28, 14, 256)  262400      ['conv4_block9_out[0][0]']

conv4_block10_1_bn (BatchNorma  (None, 28, 14, 256)  1024       ['conv4_block10_1_conv[0][0]']
lization)

conv4_block10_1_relu (Activati  (None, 28, 14, 256)  0          ['conv4_block10_1_bn[0][0]']
on)

conv4_block10_2_conv (Conv2D)  (None, 28, 14, 256)  590080      ['conv4_block10_1_relu[0][0]']

conv4_block10_2_bn (BatchNorma  (None, 28, 14, 256)  1024       ['conv4_block10_2_conv[0][0]']
lization)

conv4_block10_2_relu (Activati  (None, 28, 14, 256)  0          ['conv4_block10_2_bn[0][0]']
on)

conv4_block10_3_conv (Conv2D)  (None, 28, 14, 1024  263168      ['conv4_block10_2_relu[0][0]']
                               )

conv4_block10_3_bn (BatchNorma  (None, 28, 14, 1024  4096       ['conv4_block10_3_conv[0][0]']
lization)                      )

conv4_block10_add (Add)        (None, 28, 14, 1024  0           ['conv4_block9_out[0][0]',
                               )                                 'conv4_block10_3_bn[0][0]']

conv4_block10_out (Activation)  (None, 28, 14, 1024  0          ['conv4_block10_add[0][0]']
                               )

conv4_block11_1_conv (Conv2D)  (None, 28, 14, 256)  262400      ['conv4_block10_out[0][0]']

conv4_block11_1_bn (BatchNorma  (None, 28, 14, 256)  1024       ['conv4_block11_1_conv[0][0]']
lization)

conv4_block11_1_relu (Activati  (None, 28, 14, 256)  0          ['conv4_block11_1_bn[0][0]']
on)

conv4_block11_2_conv (Conv2D)  (None, 28, 14, 256)  590080      ['conv4_block11_1_relu[0][0]']

conv4_block11_2_bn (BatchNorma  (None, 28, 14, 256)  1024       ['conv4_block11_2_conv[0][0]']
lization)

conv4_block11_2_relu (Activati  (None, 28, 14, 256)  0          ['conv4_block11_2_bn[0][0]']
on)
```

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conv4_block11_3_conv (Conv2D)  (None, 28, 14, 1024  263168      ['conv4_block11_2_relu[0][0]']
                               )

conv4_block11_3_bn (BatchNorma  (None, 28, 14, 1024  4096       ['conv4_block11_3_conv[0][0]']
lization)                      )

conv4_block11_add (Add)        (None, 28, 14, 1024  0           ['conv4_block10_out[0][0]',
                               )                                 'conv4_block11_3_bn[0][0]']

conv4_block11_out (Activation)  (None, 28, 14, 1024  0          ['conv4_block11_add[0][0]']
                               )

conv4_block12_1_conv (Conv2D)  (None, 28, 14, 256)  262400      ['conv4_block11_out[0][0]']

conv4_block12_1_bn (BatchNorma  (None, 28, 14, 256)  1024       ['conv4_block12_1_conv[0][0]']
lization)

conv4_block12_1_relu (Activati  (None, 28, 14, 256)  0          ['conv4_block12_1_bn[0][0]']
on)

conv4_block12_2_conv (Conv2D)  (None, 28, 14, 256)  590080      ['conv4_block12_1_relu[0][0]']

conv4_block12_2_bn (BatchNorma  (None, 28, 14, 256)  1024       ['conv4_block12_2_conv[0][0]']
lization)

conv4_block12_2_relu (Activati  (None, 28, 14, 256)  0          ['conv4_block12_2_bn[0][0]']
on)

conv4_block12_3_conv (Conv2D)  (None, 28, 14, 1024  263168      ['conv4_block12_2_relu[0][0]']
                               )

conv4_block12_3_bn (BatchNorma  (None, 28, 14, 1024  4096       ['conv4_block12_3_conv[0][0]']
lization)                      )

conv4_block12_add (Add)        (None, 28, 14, 1024  0           ['conv4_block11_out[0][0]',
                               )                                 'conv4_block12_3_bn[0][0]']

conv4_block12_out (Activation)  (None, 28, 14, 1024  0          ['conv4_block12_add[0][0]']
                               )

conv4_block13_1_conv (Conv2D)  (None, 28, 14, 256)  262400      ['conv4_block12_out[0][0]']

conv4_block13_1_bn (BatchNorma  (None, 28, 14, 256)  1024       ['conv4_block13_1_conv[0][0]']
lization)

conv4_block13_1_relu (Activati  (None, 28, 14, 256)  0          ['conv4_block13_1_bn[0][0]']
on)

conv4_block13_2_conv (Conv2D)  (None, 28, 14, 256)  590080      ['conv4_block13_1_relu[0][0]']

conv4_block13_2_bn (BatchNorma  (None, 28, 14, 256)  1024       ['conv4_block13_2_conv[0][0]']
lization)

conv4_block13_2_relu (Activati  (None, 28, 14, 256)  0          ['conv4_block13_2_bn[0][0]']
on)

conv4_block13_3_conv (Conv2D)  (None, 28, 14, 1024  263168      ['conv4_block13_2_relu[0][0]']
                               )

conv4_block13_3_bn (BatchNorma  (None, 28, 14, 1024  4096       ['conv4_block13_3_conv[0][0]']
lization)                      )

conv4_block13_add (Add)        (None, 28, 14, 1024  0           ['conv4_block12_out[0][0]',
                               )                                 'conv4_block13_3_bn[0][0]']

conv4_block13_out (Activation)  (None, 28, 14, 1024  0          ['conv4_block13_add[0][0]']
                               )

conv4_block14_1_conv (Conv2D)  (None, 28, 14, 256)  262400      ['conv4_block13_out[0][0]']

conv4_block14_1_bn (BatchNorma  (None, 28, 14, 256)  1024       ['conv4_block14_1_conv[0][0]']
lization)

conv4_block14_1_relu (Activati  (None, 28, 14, 256)  0          ['conv4_block14_1_bn[0][0]']
on)

conv4_block14_2_conv (Conv2D)  (None, 28, 14, 256)  590080      ['conv4_block14_1_relu[0][0]']

conv4_block14_2_bn (BatchNorma  (None, 28, 14, 256)  1024       ['conv4_block14_2_conv[0][0]']
```

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lization)

conv4_block14_2_relu (Activati  (None, 28, 14, 256)  0          ['conv4_block14_2_bn[0][0]']
on)

conv4_block14_3_conv (Conv2D)  (None, 28, 14, 1024  263168      ['conv4_block14_2_relu[0][0]']
                               )

conv4_block14_3_bn (BatchNorma  (None, 28, 14, 1024  4096       ['conv4_block14_3_conv[0][0]']
lization)                      )

conv4_block14_add (Add)        (None, 28, 14, 1024  0           ['conv4_block13_out[0][0]',
                               )                                 'conv4_block14_3_bn[0][0]']

conv4_block14_out (Activation)  (None, 28, 14, 1024  0          ['conv4_block14_add[0][0]']
                               )

conv4_block15_1_conv (Conv2D)  (None, 28, 14, 256)  262400      ['conv4_block14_out[0][0]']

conv4_block15_1_bn (BatchNorma  (None, 28, 14, 256)  1024       ['conv4_block15_1_conv[0][0]']
lization)

conv4_block15_1_relu (Activati  (None, 28, 14, 256)  0          ['conv4_block15_1_bn[0][0]']
on)

conv4_block15_2_conv (Conv2D)  (None, 28, 14, 256)  590080      ['conv4_block15_1_relu[0][0]']

conv4_block15_2_bn (BatchNorma  (None, 28, 14, 256)  1024       ['conv4_block15_2_conv[0][0]']
lization)

conv4_block15_2_relu (Activati  (None, 28, 14, 256)  0          ['conv4_block15_2_bn[0][0]']
on)

conv4_block15_3_conv (Conv2D)  (None, 28, 14, 1024  263168      ['conv4_block15_2_relu[0][0]']
                               )

conv4_block15_3_bn (BatchNorma  (None, 28, 14, 1024  4096       ['conv4_block15_3_conv[0][0]']
lization)                      )

conv4_block15_add (Add)        (None, 28, 14, 1024  0           ['conv4_block14_out[0][0]',
                               )                                 'conv4_block15_3_bn[0][0]']

conv4_block15_out (Activation)  (None, 28, 14, 1024  0          ['conv4_block15_add[0][0]']
                               )

conv4_block16_1_conv (Conv2D)  (None, 28, 14, 256)  262400      ['conv4_block15_out[0][0]']

conv4_block16_1_bn (BatchNorma  (None, 28, 14, 256)  1024       ['conv4_block16_1_conv[0][0]']
lization)

conv4_block16_1_relu (Activati  (None, 28, 14, 256)  0          ['conv4_block16_1_bn[0][0]']
on)

conv4_block16_2_conv (Conv2D)  (None, 28, 14, 256)  590080      ['conv4_block16_1_relu[0][0]']

conv4_block16_2_bn (BatchNorma  (None, 28, 14, 256)  1024       ['conv4_block16_2_conv[0][0]']
lization)

conv4_block16_2_relu (Activati  (None, 28, 14, 256)  0          ['conv4_block16_2_bn[0][0]']
on)

conv4_block16_3_conv (Conv2D)  (None, 28, 14, 1024  263168      ['conv4_block16_2_relu[0][0]']
                               )

conv4_block16_3_bn (BatchNorma  (None, 28, 14, 1024  4096       ['conv4_block16_3_conv[0][0]']
lization)                      )

conv4_block16_add (Add)        (None, 28, 14, 1024  0           ['conv4_block15_out[0][0]',
                               )                                 'conv4_block16_3_bn[0][0]']

conv4_block16_out (Activation)  (None, 28, 14, 1024  0          ['conv4_block16_add[0][0]']
                               )

conv4_block17_1_conv (Conv2D)  (None, 28, 14, 256)  262400      ['conv4_block16_out[0][0]']

conv4_block17_1_bn (BatchNorma  (None, 28, 14, 256)  1024       ['conv4_block17_1_conv[0][0]']
lization)

conv4_block17_1_relu (Activati  (None, 28, 14, 256)  0          ['conv4_block17_1_bn[0][0]']
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on)

conv4_block17_2_conv (Conv2D)  (None, 28, 14, 256)  590080      ['conv4_block17_1_relu[0][0]']

conv4_block17_2_bn (BatchNorma  (None, 28, 14, 256)  1024       ['conv4_block17_2_conv[0][0]']
lization)

conv4_block17_2_relu (Activati  (None, 28, 14, 256)  0          ['conv4_block17_2_bn[0][0]']
on)

conv4_block17_3_conv (Conv2D)  (None, 28, 14, 1024  263168      ['conv4_block17_2_relu[0][0]']
                               )

conv4_block17_3_bn (BatchNorma  (None, 28, 14, 1024  4096       ['conv4_block17_3_conv[0][0]']
lization)                      )

conv4_block17_add (Add)        (None, 28, 14, 1024  0           ['conv4_block16_out[0][0]',
                               )                                 'conv4_block17_3_bn[0][0]']

conv4_block17_out (Activation)  (None, 28, 14, 1024  0          ['conv4_block17_add[0][0]']
                               )

conv4_block18_1_conv (Conv2D)  (None, 28, 14, 256)  262400      ['conv4_block17_out[0][0]']

conv4_block18_1_bn (BatchNorma  (None, 28, 14, 256)  1024       ['conv4_block18_1_conv[0][0]']
lization)

conv4_block18_1_relu (Activati  (None, 28, 14, 256)  0          ['conv4_block18_1_bn[0][0]']
on)

conv4_block18_2_conv (Conv2D)  (None, 28, 14, 256)  590080      ['conv4_block18_1_relu[0][0]']

conv4_block18_2_bn (BatchNorma  (None, 28, 14, 256)  1024       ['conv4_block18_2_conv[0][0]']
lization)

conv4_block18_2_relu (Activati  (None, 28, 14, 256)  0          ['conv4_block18_2_bn[0][0]']
on)

conv4_block18_3_conv (Conv2D)  (None, 28, 14, 1024  263168      ['conv4_block18_2_relu[0][0]']
                               )

conv4_block18_3_bn (BatchNorma  (None, 28, 14, 1024  4096       ['conv4_block18_3_conv[0][0]']
lization)                      )

conv4_block18_add (Add)        (None, 28, 14, 1024  0           ['conv4_block17_out[0][0]',
                               )                                 'conv4_block18_3_bn[0][0]']

conv4_block18_out (Activation)  (None, 28, 14, 1024  0          ['conv4_block18_add[0][0]']
                               )

conv4_block19_1_conv (Conv2D)  (None, 28, 14, 256)  262400      ['conv4_block18_out[0][0]']

conv4_block19_1_bn (BatchNorma  (None, 28, 14, 256)  1024       ['conv4_block19_1_conv[0][0]']
lization)

conv4_block19_1_relu (Activati  (None, 28, 14, 256)  0          ['conv4_block19_1_bn[0][0]']
on)

conv4_block19_2_conv (Conv2D)  (None, 28, 14, 256)  590080      ['conv4_block19_1_relu[0][0]']

conv4_block19_2_bn (BatchNorma  (None, 28, 14, 256)  1024       ['conv4_block19_2_conv[0][0]']
lization)

conv4_block19_2_relu (Activati  (None, 28, 14, 256)  0          ['conv4_block19_2_bn[0][0]']
on)

conv4_block19_3_conv (Conv2D)  (None, 28, 14, 1024  263168      ['conv4_block19_2_relu[0][0]']
                               )

conv4_block19_3_bn (BatchNorma  (None, 28, 14, 1024  4096       ['conv4_block19_3_conv[0][0]']
lization)                      )

conv4_block19_add (Add)        (None, 28, 14, 1024  0           ['conv4_block18_out[0][0]',
                               )                                 'conv4_block19_3_bn[0][0]']

conv4_block19_out (Activation)  (None, 28, 14, 1024  0          ['conv4_block19_add[0][0]']
                               )

conv4_block20_1_conv (Conv2D)  (None, 28, 14, 256)  262400      ['conv4_block19_out[0][0]']
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conv4_block20_1_bn (BatchNorma  (None, 28, 14, 256)  1024       ['conv4_block20_1_conv[0][0]']
lization)

conv4_block20_1_relu (Activati  (None, 28, 14, 256)  0          ['conv4_block20_1_bn[0][0]']
on)

conv4_block20_2_conv (Conv2D)  (None, 28, 14, 256)  590080     ['conv4_block20_1_relu[0][0]']

conv4_block20_2_bn (BatchNorma  (None, 28, 14, 256)  1024       ['conv4_block20_2_conv[0][0]']
lization)

conv4_block20_2_relu (Activati  (None, 28, 14, 256)  0          ['conv4_block20_2_bn[0][0]']
on)

conv4_block20_3_conv (Conv2D)  (None, 28, 14, 1024  263168     ['conv4_block20_2_relu[0][0]']
                               )

conv4_block20_3_bn (BatchNorma  (None, 28, 14, 1024  4096       ['conv4_block20_3_conv[0][0]']
lization)                      )

conv4_block20_add (Add)        (None, 28, 14, 1024  0          ['conv4_block19_out[0][0]',
                               )                                 'conv4_block20_3_bn[0][0]']

conv4_block20_out (Activation)  (None, 28, 14, 1024  0         ['conv4_block20_add[0][0]']
                               )

conv4_block21_1_conv (Conv2D)  (None, 28, 14, 256)  262400     ['conv4_block20_out[0][0]']

conv4_block21_1_bn (BatchNorma  (None, 28, 14, 256)  1024       ['conv4_block21_1_conv[0][0]']
lization)

conv4_block21_1_relu (Activati  (None, 28, 14, 256)  0          ['conv4_block21_1_bn[0][0]']
on)

conv4_block21_2_conv (Conv2D)  (None, 28, 14, 256)  590080     ['conv4_block21_1_relu[0][0]']

conv4_block21_2_bn (BatchNorma  (None, 28, 14, 256)  1024       ['conv4_block21_2_conv[0][0]']
lization)

conv4_block21_2_relu (Activati  (None, 28, 14, 256)  0          ['conv4_block21_2_bn[0][0]']
on)

conv4_block21_3_conv (Conv2D)  (None, 28, 14, 1024  263168     ['conv4_block21_2_relu[0][0]']
                               )

conv4_block21_3_bn (BatchNorma  (None, 28, 14, 1024  4096       ['conv4_block21_3_conv[0][0]']
lization)                      )

conv4_block21_add (Add)        (None, 28, 14, 1024  0          ['conv4_block20_out[0][0]',
                               )                                 'conv4_block21_3_bn[0][0]']

conv4_block21_out (Activation)  (None, 28, 14, 1024  0         ['conv4_block21_add[0][0]']
                               )

conv4_block22_1_conv (Conv2D)  (None, 28, 14, 256)  262400     ['conv4_block21_out[0][0]']

conv4_block22_1_bn (BatchNorma  (None, 28, 14, 256)  1024       ['conv4_block22_1_conv[0][0]']
lization)

conv4_block22_1_relu (Activati  (None, 28, 14, 256)  0          ['conv4_block22_1_bn[0][0]']
on)

conv4_block22_2_conv (Conv2D)  (None, 28, 14, 256)  590080     ['conv4_block22_1_relu[0][0]']

conv4_block22_2_bn (BatchNorma  (None, 28, 14, 256)  1024       ['conv4_block22_2_conv[0][0]']
lization)

conv4_block22_2_relu (Activati  (None, 28, 14, 256)  0          ['conv4_block22_2_bn[0][0]']
on)

conv4_block22_3_conv (Conv2D)  (None, 28, 14, 1024  263168     ['conv4_block22_2_relu[0][0]']
                               )

conv4_block22_3_bn (BatchNorma  (None, 28, 14, 1024  4096       ['conv4_block22_3_conv[0][0]']
lization)                      )

conv4_block22_add (Add)        (None, 28, 14, 1024  0          ['conv4_block21_out[0][0]',
                               )                                 'conv4_block22_3_bn[0][0]']
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conv4_block22_out (Activation)  (None, 28, 14, 1024  0          ['conv4_block22_add[0][0]']
                                )

conv4_block23_1_conv (Conv2D)  (None, 28, 14, 256)  262400      ['conv4_block22_out[0][0]']

conv4_block23_1_bn (BatchNorma  (None, 28, 14, 256)  1024       ['conv4_block23_1_conv[0][0]']
lization)

conv4_block23_1_relu (Activati  (None, 28, 14, 256)  0          ['conv4_block23_1_bn[0][0]']
on)

conv4_block23_2_conv (Conv2D)  (None, 28, 14, 256)  590080      ['conv4_block23_1_relu[0][0]']

conv4_block23_2_bn (BatchNorma  (None, 28, 14, 256)  1024       ['conv4_block23_2_conv[0][0]']
lization)

conv4_block23_2_relu (Activati  (None, 28, 14, 256)  0          ['conv4_block23_2_bn[0][0]']
on)

conv4_block23_3_conv (Conv2D)  (None, 28, 14, 1024  263168      ['conv4_block23_2_relu[0][0]']
                                )

conv4_block23_3_bn (BatchNorma  (None, 28, 14, 1024  4096       ['conv4_block23_3_conv[0][0]']
lization)                       )

conv4_block23_add (Add)        (None, 28, 14, 1024  0          ['conv4_block22_out[0][0]',
                                )                                'conv4_block23_3_bn[0][0]']

conv4_block23_out (Activation)  (None, 28, 14, 1024  0          ['conv4_block23_add[0][0]']
                                )

conv4_block24_1_conv (Conv2D)  (None, 28, 14, 256)  262400      ['conv4_block23_out[0][0]']

conv4_block24_1_bn (BatchNorma  (None, 28, 14, 256)  1024       ['conv4_block24_1_conv[0][0]']
lization)

conv4_block24_1_relu (Activati  (None, 28, 14, 256)  0          ['conv4_block24_1_bn[0][0]']
on)

conv4_block24_2_conv (Conv2D)  (None, 28, 14, 256)  590080      ['conv4_block24_1_relu[0][0]']

conv4_block24_2_bn (BatchNorma  (None, 28, 14, 256)  1024       ['conv4_block24_2_conv[0][0]']
lization)

conv4_block24_2_relu (Activati  (None, 28, 14, 256)  0          ['conv4_block24_2_bn[0][0]']
on)

conv4_block24_3_conv (Conv2D)  (None, 28, 14, 1024  263168      ['conv4_block24_2_relu[0][0]']
                                )

conv4_block24_3_bn (BatchNorma  (None, 28, 14, 1024  4096       ['conv4_block24_3_conv[0][0]']
lization)                       )

conv4_block24_add (Add)        (None, 28, 14, 1024  0          ['conv4_block23_out[0][0]',
                                )                                'conv4_block24_3_bn[0][0]']

conv4_block24_out (Activation)  (None, 28, 14, 1024  0          ['conv4_block24_add[0][0]']
                                )

conv4_block25_1_conv (Conv2D)  (None, 28, 14, 256)  262400      ['conv4_block24_out[0][0]']

conv4_block25_1_bn (BatchNorma  (None, 28, 14, 256)  1024       ['conv4_block25_1_conv[0][0]']
lization)

conv4_block25_1_relu (Activati  (None, 28, 14, 256)  0          ['conv4_block25_1_bn[0][0]']
on)

conv4_block25_2_conv (Conv2D)  (None, 28, 14, 256)  590080      ['conv4_block25_1_relu[0][0]']

conv4_block25_2_bn (BatchNorma  (None, 28, 14, 256)  1024       ['conv4_block25_2_conv[0][0]']
lization)

conv4_block25_2_relu (Activati  (None, 28, 14, 256)  0          ['conv4_block25_2_bn[0][0]']
on)

conv4_block25_3_conv (Conv2D)  (None, 28, 14, 1024  263168      ['conv4_block25_2_relu[0][0]']
                                )
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conv4_block25_3_bn (BatchNorma  (None, 28, 14, 1024  4096       ['conv4_block25_3_conv[0][0]']
lization)                       )

conv4_block25_add (Add)         (None, 28, 14, 1024  0          ['conv4_block24_out[0][0]',
                                )                                'conv4_block25_3_bn[0][0]']

conv4_block25_out (Activation)  (None, 28, 14, 1024  0          ['conv4_block25_add[0][0]']
                                )

conv4_block26_1_conv (Conv2D)   (None, 28, 14, 256)  262400     ['conv4_block25_out[0][0]']

conv4_block26_1_bn (BatchNorma  (None, 28, 14, 256)  1024       ['conv4_block26_1_conv[0][0]']
lization)

conv4_block26_1_relu (Activati  (None, 28, 14, 256)  0          ['conv4_block26_1_bn[0][0]']
on)

conv4_block26_2_conv (Conv2D)   (None, 28, 14, 256)  590080     ['conv4_block26_1_relu[0][0]']

conv4_block26_2_bn (BatchNorma  (None, 28, 14, 256)  1024       ['conv4_block26_2_conv[0][0]']
lization)

conv4_block26_2_relu (Activati  (None, 28, 14, 256)  0          ['conv4_block26_2_bn[0][0]']
on)

conv4_block26_3_conv (Conv2D)   (None, 28, 14, 1024  263168     ['conv4_block26_2_relu[0][0]']
                                )

conv4_block26_3_bn (BatchNorma  (None, 28, 14, 1024  4096       ['conv4_block26_3_conv[0][0]']
lization)                       )

conv4_block26_add (Add)         (None, 28, 14, 1024  0          ['conv4_block25_out[0][0]',
                                )                                'conv4_block26_3_bn[0][0]']

conv4_block26_out (Activation)  (None, 28, 14, 1024  0          ['conv4_block26_add[0][0]']
                                )

conv4_block27_1_conv (Conv2D)   (None, 28, 14, 256)  262400     ['conv4_block26_out[0][0]']

conv4_block27_1_bn (BatchNorma  (None, 28, 14, 256)  1024       ['conv4_block27_1_conv[0][0]']
lization)

conv4_block27_1_relu (Activati  (None, 28, 14, 256)  0          ['conv4_block27_1_bn[0][0]']
on)

conv4_block27_2_conv (Conv2D)   (None, 28, 14, 256)  590080     ['conv4_block27_1_relu[0][0]']

conv4_block27_2_bn (BatchNorma  (None, 28, 14, 256)  1024       ['conv4_block27_2_conv[0][0]']
lization)

conv4_block27_2_relu (Activati  (None, 28, 14, 256)  0          ['conv4_block27_2_bn[0][0]']
on)

conv4_block27_3_conv (Conv2D)   (None, 28, 14, 1024  263168     ['conv4_block27_2_relu[0][0]']
                                )

conv4_block27_3_bn (BatchNorma  (None, 28, 14, 1024  4096       ['conv4_block27_3_conv[0][0]']
lization)                       )

conv4_block27_add (Add)         (None, 28, 14, 1024  0          ['conv4_block26_out[0][0]',
                                )                                'conv4_block27_3_bn[0][0]']

conv4_block27_out (Activation)  (None, 28, 14, 1024  0          ['conv4_block27_add[0][0]']
                                )

conv4_block28_1_conv (Conv2D)   (None, 28, 14, 256)  262400     ['conv4_block27_out[0][0]']

conv4_block28_1_bn (BatchNorma  (None, 28, 14, 256)  1024       ['conv4_block28_1_conv[0][0]']
lization)

conv4_block28_1_relu (Activati  (None, 28, 14, 256)  0          ['conv4_block28_1_bn[0][0]']
on)

conv4_block28_2_conv (Conv2D)   (None, 28, 14, 256)  590080     ['conv4_block28_1_relu[0][0]']

conv4_block28_2_bn (BatchNorma  (None, 28, 14, 256)  1024       ['conv4_block28_2_conv[0][0]']
lization)

conv4_block28_2_relu (Activati  (None, 28, 14, 256)  0          ['conv4_block28_2_bn[0][0]']
```

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on)

conv4_block28_3_conv (Conv2D)  (None, 28, 14, 1024  263168      ['conv4_block28_2_relu[0][0]']
                               )

conv4_block28_3_bn (BatchNorma  (None, 28, 14, 1024  4096       ['conv4_block28_3_conv[0][0]']
lization)                      )

conv4_block28_add (Add)        (None, 28, 14, 1024  0           ['conv4_block27_out[0][0]',
                               )                                 'conv4_block28_3_bn[0][0]']

conv4_block28_out (Activation)  (None, 28, 14, 1024  0          ['conv4_block28_add[0][0]']
                               )

conv4_block29_1_conv (Conv2D)  (None, 28, 14, 256)  262400      ['conv4_block28_out[0][0]']

conv4_block29_1_bn (BatchNorma  (None, 28, 14, 256)  1024       ['conv4_block29_1_conv[0][0]']
lization)

conv4_block29_1_relu (Activati  (None, 28, 14, 256)  0          ['conv4_block29_1_bn[0][0]']
on)

conv4_block29_2_conv (Conv2D)  (None, 28, 14, 256)  590080      ['conv4_block29_1_relu[0][0]']

conv4_block29_2_bn (BatchNorma  (None, 28, 14, 256)  1024       ['conv4_block29_2_conv[0][0]']
lization)

conv4_block29_2_relu (Activati  (None, 28, 14, 256)  0          ['conv4_block29_2_bn[0][0]']
on)

conv4_block29_3_conv (Conv2D)  (None, 28, 14, 1024  263168      ['conv4_block29_2_relu[0][0]']
                               )

conv4_block29_3_bn (BatchNorma  (None, 28, 14, 1024  4096       ['conv4_block29_3_conv[0][0]']
lization)                      )

conv4_block29_add (Add)        (None, 28, 14, 1024  0           ['conv4_block28_out[0][0]',
                               )                                 'conv4_block29_3_bn[0][0]']

conv4_block29_out (Activation)  (None, 28, 14, 1024  0          ['conv4_block29_add[0][0]']
                               )

conv4_block30_1_conv (Conv2D)  (None, 28, 14, 256)  262400      ['conv4_block29_out[0][0]']

conv4_block30_1_bn (BatchNorma  (None, 28, 14, 256)  1024       ['conv4_block30_1_conv[0][0]']
lization)

conv4_block30_1_relu (Activati  (None, 28, 14, 256)  0          ['conv4_block30_1_bn[0][0]']
on)

conv4_block30_2_conv (Conv2D)  (None, 28, 14, 256)  590080      ['conv4_block30_1_relu[0][0]']

conv4_block30_2_bn (BatchNorma  (None, 28, 14, 256)  1024       ['conv4_block30_2_conv[0][0]']
lization)

conv4_block30_2_relu (Activati  (None, 28, 14, 256)  0          ['conv4_block30_2_bn[0][0]']
on)

conv4_block30_3_conv (Conv2D)  (None, 28, 14, 1024  263168      ['conv4_block30_2_relu[0][0]']
                               )

conv4_block30_3_bn (BatchNorma  (None, 28, 14, 1024  4096       ['conv4_block30_3_conv[0][0]']
lization)                      )

conv4_block30_add (Add)        (None, 28, 14, 1024  0           ['conv4_block29_out[0][0]',
                               )                                 'conv4_block30_3_bn[0][0]']

conv4_block30_out (Activation)  (None, 28, 14, 1024  0          ['conv4_block30_add[0][0]']
                               )

conv4_block31_1_conv (Conv2D)  (None, 28, 14, 256)  262400      ['conv4_block30_out[0][0]']

conv4_block31_1_bn (BatchNorma  (None, 28, 14, 256)  1024       ['conv4_block31_1_conv[0][0]']
lization)

conv4_block31_1_relu (Activati  (None, 28, 14, 256)  0          ['conv4_block31_1_bn[0][0]']
on)

conv4_block31_2_conv (Conv2D)  (None, 28, 14, 256)  590080      ['conv4_block31_1_relu[0][0]']
```

```
conv4_block31_2_bn (BatchNorma  (None, 28, 14, 256)  1024       ['conv4_block31_2_conv[0][0]']
lization)

conv4_block31_2_relu (Activati  (None, 28, 14, 256)  0          ['conv4_block31_2_bn[0][0]']
on)

conv4_block31_3_conv (Conv2D)  (None, 28, 14, 1024  263168      ['conv4_block31_2_relu[0][0]']
                               )

conv4_block31_3_bn (BatchNorma  (None, 28, 14, 1024  4096       ['conv4_block31_3_conv[0][0]']
lization)                      )

conv4_block31_add (Add)        (None, 28, 14, 1024  0          ['conv4_block30_out[0][0]',
                               )                                 'conv4_block31_3_bn[0][0]']

conv4_block31_out (Activation)  (None, 28, 14, 1024  0         ['conv4_block31_add[0][0]']
                               )

conv4_block32_1_conv (Conv2D)  (None, 28, 14, 256)  262400      ['conv4_block31_out[0][0]']

conv4_block32_1_bn (BatchNorma  (None, 28, 14, 256)  1024       ['conv4_block32_1_conv[0][0]']
lization)

conv4_block32_1_relu (Activati  (None, 28, 14, 256)  0          ['conv4_block32_1_bn[0][0]']
on)

conv4_block32_2_conv (Conv2D)  (None, 28, 14, 256)  590080      ['conv4_block32_1_relu[0][0]']

conv4_block32_2_bn (BatchNorma  (None, 28, 14, 256)  1024       ['conv4_block32_2_conv[0][0]']
lization)

conv4_block32_2_relu (Activati  (None, 28, 14, 256)  0          ['conv4_block32_2_bn[0][0]']
on)

conv4_block32_3_conv (Conv2D)  (None, 28, 14, 1024  263168      ['conv4_block32_2_relu[0][0]']
                               )

conv4_block32_3_bn (BatchNorma  (None, 28, 14, 1024  4096       ['conv4_block32_3_conv[0][0]']
lization)                      )

conv4_block32_add (Add)        (None, 28, 14, 1024  0          ['conv4_block31_out[0][0]',
                               )                                 'conv4_block32_3_bn[0][0]']

conv4_block32_out (Activation)  (None, 28, 14, 1024  0         ['conv4_block32_add[0][0]']
                               )

conv4_block33_1_conv (Conv2D)  (None, 28, 14, 256)  262400      ['conv4_block32_out[0][0]']

conv4_block33_1_bn (BatchNorma  (None, 28, 14, 256)  1024       ['conv4_block33_1_conv[0][0]']
lization)

conv4_block33_1_relu (Activati  (None, 28, 14, 256)  0          ['conv4_block33_1_bn[0][0]']
on)

conv4_block33_2_conv (Conv2D)  (None, 28, 14, 256)  590080      ['conv4_block33_1_relu[0][0]']

conv4_block33_2_bn (BatchNorma  (None, 28, 14, 256)  1024       ['conv4_block33_2_conv[0][0]']
lization)

conv4_block33_2_relu (Activati  (None, 28, 14, 256)  0          ['conv4_block33_2_bn[0][0]']
on)

conv4_block33_3_conv (Conv2D)  (None, 28, 14, 1024  263168      ['conv4_block33_2_relu[0][0]']
                               )

conv4_block33_3_bn (BatchNorma  (None, 28, 14, 1024  4096       ['conv4_block33_3_conv[0][0]']
lization)                      )

conv4_block33_add (Add)        (None, 28, 14, 1024  0          ['conv4_block32_out[0][0]',
                               )                                 'conv4_block33_3_bn[0][0]']

conv4_block33_out (Activation)  (None, 28, 14, 1024  0         ['conv4_block33_add[0][0]']
                               )

conv4_block34_1_conv (Conv2D)  (None, 28, 14, 256)  262400      ['conv4_block33_out[0][0]']

conv4_block34_1_bn (BatchNorma  (None, 28, 14, 256)  1024       ['conv4_block34_1_conv[0][0]']
lization)
```

```
conv4_block34_1_relu (Activati  (None, 28, 14, 256)  0          ['conv4_block34_1_bn[0][0]']
on)

conv4_block34_2_conv (Conv2D)  (None, 28, 14, 256)  590080      ['conv4_block34_1_relu[0][0]']

conv4_block34_2_bn (BatchNorma  (None, 28, 14, 256)  1024       ['conv4_block34_2_conv[0][0]']
lization)

conv4_block34_2_relu (Activati  (None, 28, 14, 256)  0          ['conv4_block34_2_bn[0][0]']
on)

conv4_block34_3_conv (Conv2D)  (None, 28, 14, 1024  263168      ['conv4_block34_2_relu[0][0]']
                               )

conv4_block34_3_bn (BatchNorma  (None, 28, 14, 1024  4096       ['conv4_block34_3_conv[0][0]']
lization)                      )

conv4_block34_add (Add)        (None, 28, 14, 1024  0           ['conv4_block33_out[0][0]',
                               )                                 'conv4_block34_3_bn[0][0]']

conv4_block34_out (Activation)  (None, 28, 14, 1024  0          ['conv4_block34_add[0][0]']
                               )

conv4_block35_1_conv (Conv2D)  (None, 28, 14, 256)  262400      ['conv4_block34_out[0][0]']

conv4_block35_1_bn (BatchNorma  (None, 28, 14, 256)  1024       ['conv4_block35_1_conv[0][0]']
lization)

conv4_block35_1_relu (Activati  (None, 28, 14, 256)  0          ['conv4_block35_1_bn[0][0]']
on)

conv4_block35_2_conv (Conv2D)  (None, 28, 14, 256)  590080      ['conv4_block35_1_relu[0][0]']

conv4_block35_2_bn (BatchNorma  (None, 28, 14, 256)  1024       ['conv4_block35_2_conv[0][0]']
lization)

conv4_block35_2_relu (Activati  (None, 28, 14, 256)  0          ['conv4_block35_2_bn[0][0]']
on)

conv4_block35_3_conv (Conv2D)  (None, 28, 14, 1024  263168      ['conv4_block35_2_relu[0][0]']
                               )

conv4_block35_3_bn (BatchNorma  (None, 28, 14, 1024  4096       ['conv4_block35_3_conv[0][0]']
lization)                      )

conv4_block35_add (Add)        (None, 28, 14, 1024  0           ['conv4_block34_out[0][0]',
                               )                                 'conv4_block35_3_bn[0][0]']

conv4_block35_out (Activation)  (None, 28, 14, 1024  0          ['conv4_block35_add[0][0]']
                               )

conv4_block36_1_conv (Conv2D)  (None, 28, 14, 256)  262400      ['conv4_block35_out[0][0]']

conv4_block36_1_bn (BatchNorma  (None, 28, 14, 256)  1024       ['conv4_block36_1_conv[0][0]']
lization)

conv4_block36_1_relu (Activati  (None, 28, 14, 256)  0          ['conv4_block36_1_bn[0][0]']
on)

conv4_block36_2_conv (Conv2D)  (None, 28, 14, 256)  590080      ['conv4_block36_1_relu[0][0]']

conv4_block36_2_bn (BatchNorma  (None, 28, 14, 256)  1024       ['conv4_block36_2_conv[0][0]']
lization)

conv4_block36_2_relu (Activati  (None, 28, 14, 256)  0          ['conv4_block36_2_bn[0][0]']
on)

conv4_block36_3_conv (Conv2D)  (None, 28, 14, 1024  263168      ['conv4_block36_2_relu[0][0]']
                               )

conv4_block36_3_bn (BatchNorma  (None, 28, 14, 1024  4096       ['conv4_block36_3_conv[0][0]']
lization)                      )

conv4_block36_add (Add)        (None, 28, 14, 1024  0           ['conv4_block35_out[0][0]',
                               )                                 'conv4_block36_3_bn[0][0]']

conv4_block36_out (Activation)  (None, 28, 14, 1024  0          ['conv4_block36_add[0][0]']
                               )
```

```
conv5_block1_1_conv (Conv2D)   (None, 14, 7, 512)   524800      ['conv4_block36_out[0][0]']

conv5_block1_1_bn (BatchNormal  (None, 14, 7, 512)  2048        ['conv5_block1_1_conv[0][0]']
ization)

conv5_block1_1_relu (Activatio  (None, 14, 7, 512)  0           ['conv5_block1_1_bn[0][0]']
n)

conv5_block1_2_conv (Conv2D)   (None, 14, 7, 512)   2359808     ['conv5_block1_1_relu[0][0]']

conv5_block1_2_bn (BatchNormal  (None, 14, 7, 512)  2048        ['conv5_block1_2_conv[0][0]']
ization)

conv5_block1_2_relu (Activatio  (None, 14, 7, 512)  0           ['conv5_block1_2_bn[0][0]']
n)

conv5_block1_0_conv (Conv2D)   (None, 14, 7, 2048)  2099200     ['conv4_block36_out[0][0]']

conv5_block1_3_conv (Conv2D)   (None, 14, 7, 2048)  1050624     ['conv5_block1_2_relu[0][0]']

conv5_block1_0_bn (BatchNormal  (None, 14, 7, 2048)  8192       ['conv5_block1_0_conv[0][0]']
ization)

conv5_block1_3_bn (BatchNormal  (None, 14, 7, 2048)  8192       ['conv5_block1_3_conv[0][0]']
ization)

conv5_block1_add (Add)         (None, 14, 7, 2048)  0           ['conv5_block1_0_bn[0][0]',
                                                                 'conv5_block1_3_bn[0][0]']

conv5_block1_out (Activation)  (None, 14, 7, 2048)  0           ['conv5_block1_add[0][0]']

conv5_block2_1_conv (Conv2D)   (None, 14, 7, 512)   1049088     ['conv5_block1_out[0][0]']

conv5_block2_1_bn (BatchNormal  (None, 14, 7, 512)  2048        ['conv5_block2_1_conv[0][0]']
ization)

conv5_block2_1_relu (Activatio  (None, 14, 7, 512)  0           ['conv5_block2_1_bn[0][0]']
n)

conv5_block2_2_conv (Conv2D)   (None, 14, 7, 512)   2359808     ['conv5_block2_1_relu[0][0]']

conv5_block2_2_bn (BatchNormal  (None, 14, 7, 512)  2048        ['conv5_block2_2_conv[0][0]']
ization)

conv5_block2_2_relu (Activatio  (None, 14, 7, 512)  0           ['conv5_block2_2_bn[0][0]']
n)

conv5_block2_3_conv (Conv2D)   (None, 14, 7, 2048)  1050624     ['conv5_block2_2_relu[0][0]']

conv5_block2_3_bn (BatchNormal  (None, 14, 7, 2048)  8192       ['conv5_block2_3_conv[0][0]']
ization)

conv5_block2_add (Add)         (None, 14, 7, 2048)  0           ['conv5_block1_out[0][0]',
                                                                 'conv5_block2_3_bn[0][0]']

conv5_block2_out (Activation)  (None, 14, 7, 2048)  0           ['conv5_block2_add[0][0]']

conv5_block3_1_conv (Conv2D)   (None, 14, 7, 512)   1049088     ['conv5_block2_out[0][0]']

conv5_block3_1_bn (BatchNormal  (None, 14, 7, 512)  2048        ['conv5_block3_1_conv[0][0]']
ization)

conv5_block3_1_relu (Activatio  (None, 14, 7, 512)  0           ['conv5_block3_1_bn[0][0]']
n)

conv5_block3_2_conv (Conv2D)   (None, 14, 7, 512)   2359808     ['conv5_block3_1_relu[0][0]']

conv5_block3_2_bn (BatchNormal  (None, 14, 7, 512)  2048        ['conv5_block3_2_conv[0][0]']
ization)

conv5_block3_2_relu (Activatio  (None, 14, 7, 512)  0           ['conv5_block3_2_bn[0][0]']
n)

conv5_block3_3_conv (Conv2D)   (None, 14, 7, 2048)  1050624     ['conv5_block3_2_relu[0][0]']

conv5_block3_3_bn (BatchNormal  (None, 14, 7, 2048)  8192       ['conv5_block3_3_conv[0][0]']
ization)
```

```
conv5_block3_add (Add)         (None, 14, 7, 2048)  0           ['conv5_block2_out[0][0]',
                                                                 'conv5_block3_3_bn[0][0]']

conv5_block3_out (Activation)  (None, 14, 7, 2048)  0           ['conv5_block3_add[0][0]']

global_average_pooling2d_2 (Gl  (None, 2048)        0           ['conv5_block3_out[0][0]']
obalAveragePooling2D)

dense_2 (Dense)                (None, 31)           63519       ['global_average_pooling2d_2[0][0
                                                                 ]']

==================================================================================================
Total params: 58,434,463
Trainable params: 58,283,039
Non-trainable params: 151,424
__________________________________________________________________________________________________
```

In [71]:
```
for layer in model.layers:
    layer.trainable = True
```

In [72]:
```
early_stopping = EarlyStopping(patience=5)
```

In [73]:
```
model.compile(
  optimizer="adam",
  loss=tf.keras.losses.SparseCategoricalCrossentropy(from_logits=True),
  metrics=['acc'])

model.fit(X_train,
          y_train,
          epochs=50,
          callbacks = early_stopping,
          validation_data=(X_val, y_val))
```

```
Epoch 1/50
2022-01-28 04:17:37.646697: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:112] Plugin optimizer for device_type GPU is enabled.
582/582 [==============================] - ETA: 0s - loss: 3.4761 - acc: 0.0327
2022-01-28 04:38:43.780055: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:112] Plugin optimizer for device_type GPU is enabled.
```

```
582/582 [==============================] - 1365s 2s/step - loss: 3.4761 - acc: 0.0327 - val_loss: 3.4550 - v
al_acc: 0.0340
Epoch 2/50
582/582 [==============================] - 1401s 2s/step - loss: 3.4477 - acc: 0.0354 - val_loss: 18.9397 -
val_acc: 0.0484
Epoch 3/50
582/582 [==============================] - 1397s 2s/step - loss: 3.4394 - acc: 0.0340 - val_loss: 3.4415 - v
al_acc: 0.0381
Epoch 4/50
582/582 [==============================] - 1397s 2s/step - loss: 3.4372 - acc: 0.0356 - val_loss: 3.4304 - v
al_acc: 0.0318
Epoch 5/50
582/582 [==============================] - 1397s 2s/step - loss: 3.4236 - acc: 0.0350 - val_loss: 8.7089 - v
al_acc: 0.0348
Epoch 6/50
582/582 [==============================] - 1396s 2s/step - loss: 3.4120 - acc: 0.0390 - val_loss: 3.3732 - v
al_acc: 0.0791
Epoch 7/50
582/582 [==============================] - 1398s 2s/step - loss: 3.4005 - acc: 0.0405 - val_loss: 5.5854 - v
al_acc: 0.0576
Epoch 8/50
582/582 [==============================] - 1396s 2s/step - loss: 3.3744 - acc: 0.0465 - val_loss: 4.1791 - v
al_acc: 0.0690
Epoch 9/50
582/582 [==============================] - 1397s 2s/step - loss: 3.3315 - acc: 0.0562 - val_loss: 4.2415 - v
al_acc: 0.1019
Epoch 10/50
582/582 [==============================] - 1397s 2s/step - loss: 3.3082 - acc: 0.0624 - val_loss: 2.9309 - v
al_acc: 0.1596
Epoch 11/50
582/582 [==============================] - 1397s 2s/step - loss: 3.2709 - acc: 0.0707 - val_loss: 2.7586 - v
al_acc: 0.2153
Epoch 12/50
582/582 [==============================] - 1400s 2s/step - loss: 3.2285 - acc: 0.0826 - val_loss: 3.2782 - v
al_acc: 0.1135
Epoch 13/50
582/582 [==============================] - 1398s 2s/step - loss: 3.1771 - acc: 0.0969 - val_loss: 2.6326 - v
al_acc: 0.2703
Epoch 14/50
582/582 [==============================] - 1399s 2s/step - loss: 3.1111 - acc: 0.1188 - val_loss: 2.5102 - v
al_acc: 0.3058
Epoch 15/50
582/582 [==============================] - 1403s 2s/step - loss: 3.0525 - acc: 0.1342 - val_loss: 3.7779 - v
al_acc: 0.2163
Epoch 16/50
582/582 [==============================] - 1413s 2s/step - loss: 2.9772 - acc: 0.1579 - val_loss: 3.5165 - v
al_acc: 0.2508
Epoch 17/50
582/582 [==============================] - 1408s 2s/step - loss: 2.9097 - acc: 0.1764 - val_loss: 2.0281 - v
al_acc: 0.4465
Epoch 18/50
582/582 [==============================] - 1405s 2s/step - loss: 2.8736 - acc: 0.1877 - val_loss: 1.2149 - v
al_acc: 0.6473
Epoch 19/50
582/582 [==============================] - 1403s 2s/step - loss: 2.8209 - acc: 0.2046 - val_loss: 2.1193 - v
al_acc: 0.4389
Epoch 20/50
582/582 [==============================] - 1406s 2s/step - loss: 2.7827 - acc: 0.2139 - val_loss: 1.0649 - v
al_acc: 0.6987
Epoch 21/50
582/582 [==============================] - 1400s 2s/step - loss: 2.7508 - acc: 0.2250 - val_loss: 2.3648 - v
al_acc: 0.4819
Epoch 22/50
582/582 [==============================] - 1400s 2s/step - loss: 2.7390 - acc: 0.2266 - val_loss: 1.0935 - v
al_acc: 0.6966
Epoch 23/50
582/582 [==============================] - 1402s 2s/step - loss: 2.7184 - acc: 0.2304 - val_loss: 3.9244 - v
al_acc: 0.3376
Epoch 24/50
582/582 [==============================] - 1404s 2s/step - loss: 2.7016 - acc: 0.2382 - val_loss: 1.0540 - v
al_acc: 0.7346
Epoch 25/50
582/582 [==============================] - 1398s 2s/step - loss: 2.6771 - acc: 0.2459 - val_loss: 1.2921 - v
al_acc: 0.6987
Epoch 26/50
582/582 [==============================] - 1398s 2s/step - loss: 2.6830 - acc: 0.2433 - val_loss: 1.1366 - v
al_acc: 0.6989
Epoch 27/50
582/582 [==============================] - 1399s 2s/step - loss: 2.6718 - acc: 0.2465 - val_loss: 1.1282 - v
```

```
al_acc: 0.7097
Epoch 28/50
582/582 [==============================] - 1398s 2s/step - loss: 2.6717 - acc: 0.2449 - val_loss: 0.9867 - v
al_acc: 0.7619
Epoch 29/50
582/582 [==============================] - 1397s 2s/step - loss: 2.6656 - acc: 0.2487 - val_loss: 1.4528 - v
al_acc: 0.6701
Epoch 30/50
582/582 [==============================] - 1401s 2s/step - loss: 2.6631 - acc: 0.2484 - val_loss: 1.9282 - v
al_acc: 0.5877
Epoch 31/50
582/582 [==============================] - 1407s 2s/step - loss: 2.6620 - acc: 0.2491 - val_loss: 2.2004 - v
al_acc: 0.5129
Epoch 32/50
582/582 [==============================] - 1404s 2s/step - loss: 2.6598 - acc: 0.2508 - val_loss: 0.9054 - v
al_acc: 0.7869
Epoch 33/50
582/582 [==============================] - 1404s 2s/step - loss: 2.6589 - acc: 0.2511 - val_loss: 0.8900 - v
al_acc: 0.7847
Epoch 34/50
582/582 [==============================] - 1399s 2s/step - loss: 2.6666 - acc: 0.2487 - val_loss: 1.6044 - v
al_acc: 0.6688
Epoch 35/50
582/582 [==============================] - 1397s 2s/step - loss: 2.6604 - acc: 0.2512 - val_loss: 0.9665 - v
al_acc: 0.7626
Epoch 36/50
582/582 [==============================] - 1396s 2s/step - loss: 2.6510 - acc: 0.2535 - val_loss: 0.9958 - v
al_acc: 0.7847
Epoch 37/50
582/582 [==============================] - 1396s 2s/step - loss: 2.6553 - acc: 0.2533 - val_loss: 1.1359 - v
al_acc: 0.7460
Epoch 38/50
582/582 [==============================] - 1396s 2s/step - loss: 2.6487 - acc: 0.2533 - val_loss: 1.5068 - v
al_acc: 0.6759
```

Out[73]:
```
<keras.callbacks.History at 0x2a9cbf2b0>
```

In [74]:
```
model.evaluate(X_test,y_test)
```

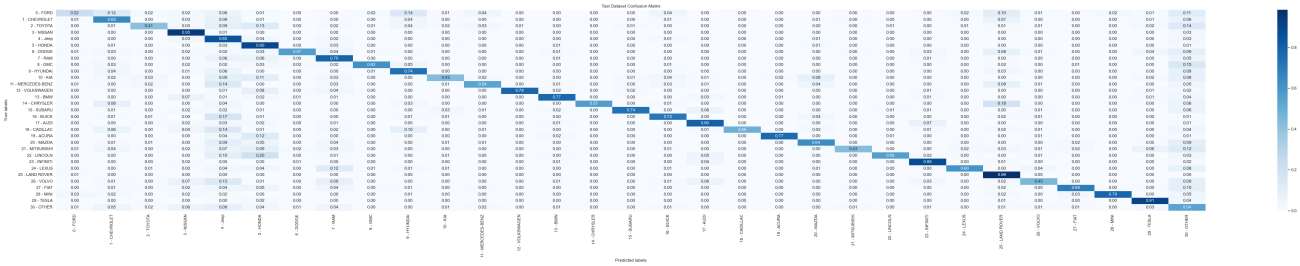
```
243/243 [==============================] - 181s 747ms/step - loss: 1.5867 - acc: 0.6698
```

Out[74]:
```
[1.586732268333435, 0.6697638630867004]
```

In [75]:
```
y_pred = model.predict(X_test)
y_pred =  [np.argmax(i) for i in y_pred]
```

```
2022-01-28 19:06:51.413539: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:112] Pl
ugin optimizer for device_type GPU is enabled.
```

In [76]:
```
from sklearn.metrics import confusion_matrix
sns.set(rc = {'figure.figsize':(70,10)})
ax = plt.subplot()

labels = ['0 - FORD', '1 - CHEVROLET', '2 - TOYOTA', '3 - NISSAN', '4 - Jeep', '5 - HONDA', '6 - DODGE', '7
          '11 - MERCEDES-BENZ', '12 - VOLKSWAGEN', '13 - BMW', '14 - CHRYSLER', '15 - SUBARU', '16 - BUICK',
          '21 - MITSUBISHI', '22 - LINCOLN', '23 - INFINITI', '24 - LEXUS', '25 - LAND ROVER', '26 - VOLVO',

c = confusion_matrix(y_test,y_pred)

c_norm = c.astype('float') / c.sum(axis=1)[:, np.newaxis]

cndf = pd.DataFrame(c_norm, index=labels, columns=labels)

sns.heatmap(cndf,annot=True,fmt='.2f', cmap='Blues',ax=ax)

ax.set_xlabel('Predicted labels');ax.set_ylabel('True labels')

ax.set_title('Test Dataset Confusion Matrix');
```



3.5 DenseNet 121 Model

In [77]:
```
from keras.applications.densenet import DenseNet121
```

In [78]:
```
base_model = DenseNet121(include_top=False,input_shape=(448,224,3))
x = GlobalAveragePooling2D()(base_model.output)
output = Dense(num_class)(x)
model = Model(inputs=base_model.inputs,outputs=output)

model.summary()
```

```
Downloading data from https://storage.googleapis.com/tensorflow/keras-applications/densenet/densenet121_weig
hts_tf_dim_ordering_tf_kernels_notop.h5
29089792/29084464 [==============================] - 1s 0us/step
29097984/29084464 [==============================] - 1s 0us/step
Model: "model_4"
__________________________________________________________________________________________________
 Layer (type)                   Output Shape         Param #     Connected to
==================================================================================================
 input_5 (InputLayer)           [(None, 448, 224, 3  0           []
                                )]

 zero_padding2d (ZeroPadding2D)  (None, 454, 230, 3)  0          ['input_5[0][0]']

 conv1/conv (Conv2D)            (None, 224, 112, 64  9408        ['zero_padding2d[0][0]']
                                )

 conv1/bn (BatchNormalization)  (None, 224, 112, 64  256         ['conv1/conv[0][0]']
                                )

 conv1/relu (Activation)        (None, 224, 112, 64  0           ['conv1/bn[0][0]']
                                )

 zero_padding2d_1 (ZeroPadding2  (None, 226, 114, 64  0          ['conv1/relu[0][0]']
 D)                             )

 pool1 (MaxPooling2D)           (None, 112, 56, 64)  0           ['zero_padding2d_1[0][0]']

 conv2_block1_0_bn (BatchNormal  (None, 112, 56, 64)  256        ['pool1[0][0]']
 ization)

 conv2_block1_0_relu (Activatio  (None, 112, 56, 64)  0          ['conv2_block1_0_bn[0][0]']
 n)

 conv2_block1_1_conv (Conv2D)   (None, 112, 56, 128  8192        ['conv2_block1_0_relu[0][0]']
                                )

 conv2_block1_1_bn (BatchNormal  (None, 112, 56, 128  512        ['conv2_block1_1_conv[0][0]']
 ization)                       )

 conv2_block1_1_relu (Activatio  (None, 112, 56, 128  0          ['conv2_block1_1_bn[0][0]']
 n)                             )

 conv2_block1_2_conv (Conv2D)   (None, 112, 56, 32)  36864       ['conv2_block1_1_relu[0][0]']

 conv2_block1_concat (Concatena  (None, 112, 56, 96)  0          ['pool1[0][0]',
 te)                                                              'conv2_block1_2_conv[0][0]']

 conv2_block2_0_bn (BatchNormal  (None, 112, 56, 96)  384        ['conv2_block1_concat[0][0]']
 ization)

 conv2_block2_0_relu (Activatio  (None, 112, 56, 96)  0          ['conv2_block2_0_bn[0][0]']
 n)

 conv2_block2_1_conv (Conv2D)   (None, 112, 56, 128  12288       ['conv2_block2_0_relu[0][0]']
                                )

 conv2_block2_1_bn (BatchNormal  (None, 112, 56, 128  512        ['conv2_block2_1_conv[0][0]']
 ization)                       )

 conv2_block2_1_relu (Activatio  (None, 112, 56, 128  0          ['conv2_block2_1_bn[0][0]']
 n)                             )

 conv2_block2_2_conv (Conv2D)   (None, 112, 56, 32)  36864       ['conv2_block2_1_relu[0][0]']

 conv2_block2_concat (Concatena  (None, 112, 56, 128  0          ['conv2_block1_concat[0][0]',
 te)                            )                                 'conv2_block2_2_conv[0][0]']

 conv2_block3_0_bn (BatchNormal  (None, 112, 56, 128  512        ['conv2_block2_concat[0][0]']
 ization)                       )

 conv2_block3_0_relu (Activatio  (None, 112, 56, 128  0          ['conv2_block3_0_bn[0][0]']
 n)                             )

 conv2_block3_1_conv (Conv2D)   (None, 112, 56, 128  16384       ['conv2_block3_0_relu[0][0]']
                                )

 conv2_block3_1_bn (BatchNormal  (None, 112, 56, 128  512        ['conv2_block3_1_conv[0][0]']
 ization)                       )
```

```
conv2_block3_1_relu (Activation)  (None, 112, 56, 128)  0      ['conv2_block3_1_bn[0][0]']

conv2_block3_2_conv (Conv2D)      (None, 112, 56, 32)   36864  ['conv2_block3_1_relu[0][0]']

conv2_block3_concat (Concatenate  (None, 112, 56, 160)  0      ['conv2_block2_concat[0][0]',
)                                                               'conv2_block3_2_conv[0][0]']

conv2_block4_0_bn (BatchNormaliz  (None, 112, 56, 160)  640    ['conv2_block3_concat[0][0]']
ation)

conv2_block4_0_relu (Activation)  (None, 112, 56, 160)  0      ['conv2_block4_0_bn[0][0]']

conv2_block4_1_conv (Conv2D)      (None, 112, 56, 128)  20480  ['conv2_block4_0_relu[0][0]']

conv2_block4_1_bn (BatchNormaliz  (None, 112, 56, 128)  512    ['conv2_block4_1_conv[0][0]']
ation)

conv2_block4_1_relu (Activation)  (None, 112, 56, 128)  0      ['conv2_block4_1_bn[0][0]']

conv2_block4_2_conv (Conv2D)      (None, 112, 56, 32)   36864  ['conv2_block4_1_relu[0][0]']

conv2_block4_concat (Concatenate  (None, 112, 56, 192)  0      ['conv2_block3_concat[0][0]',
)                                                               'conv2_block4_2_conv[0][0]']

conv2_block5_0_bn (BatchNormaliz  (None, 112, 56, 192)  768    ['conv2_block4_concat[0][0]']
ation)

conv2_block5_0_relu (Activation)  (None, 112, 56, 192)  0      ['conv2_block5_0_bn[0][0]']

conv2_block5_1_conv (Conv2D)      (None, 112, 56, 128)  24576  ['conv2_block5_0_relu[0][0]']

conv2_block5_1_bn (BatchNormaliz  (None, 112, 56, 128)  512    ['conv2_block5_1_conv[0][0]']
ation)

conv2_block5_1_relu (Activation)  (None, 112, 56, 128)  0      ['conv2_block5_1_bn[0][0]']

conv2_block5_2_conv (Conv2D)      (None, 112, 56, 32)   36864  ['conv2_block5_1_relu[0][0]']

conv2_block5_concat (Concatenate  (None, 112, 56, 224)  0      ['conv2_block4_concat[0][0]',
)                                                               'conv2_block5_2_conv[0][0]']

conv2_block6_0_bn (BatchNormaliz  (None, 112, 56, 224)  896    ['conv2_block5_concat[0][0]']
ation)

conv2_block6_0_relu (Activation)  (None, 112, 56, 224)  0      ['conv2_block6_0_bn[0][0]']

conv2_block6_1_conv (Conv2D)      (None, 112, 56, 128)  28672  ['conv2_block6_0_relu[0][0]']

conv2_block6_1_bn (BatchNormaliz  (None, 112, 56, 128)  512    ['conv2_block6_1_conv[0][0]']
ation)

conv2_block6_1_relu (Activation)  (None, 112, 56, 128)  0      ['conv2_block6_1_bn[0][0]']

conv2_block6_2_conv (Conv2D)      (None, 112, 56, 32)   36864  ['conv2_block6_1_relu[0][0]']

conv2_block6_concat (Concatenate  (None, 112, 56, 256)  0      ['conv2_block5_concat[0][0]',
)                                                               'conv2_block6_2_conv[0][0]']

pool2_bn (BatchNormalization)     (None, 112, 56, 256)  1024   ['conv2_block6_concat[0][0]']

pool2_relu (Activation)           (None, 112, 56, 256)  0      ['pool2_bn[0][0]']

pool2_conv (Conv2D)               (None, 112, 56, 128)  32768  ['pool2_relu[0][0]']

pool2_pool (AveragePooling2D)     (None, 56, 28, 128)   0      ['pool2_conv[0][0]']
```

```
conv3_block1_0_bn (BatchNormal  (None, 56, 28, 128)  512        ['pool2_pool[0][0]']
ization)

conv3_block1_0_relu (Activatio  (None, 56, 28, 128)  0          ['conv3_block1_0_bn[0][0]']
n)

conv3_block1_1_conv (Conv2D)   (None, 56, 28, 128)  16384      ['conv3_block1_0_relu[0][0]']

conv3_block1_1_bn (BatchNormal  (None, 56, 28, 128)  512        ['conv3_block1_1_conv[0][0]']
ization)

conv3_block1_1_relu (Activatio  (None, 56, 28, 128)  0          ['conv3_block1_1_bn[0][0]']
n)

conv3_block1_2_conv (Conv2D)   (None, 56, 28, 32)   36864      ['conv3_block1_1_relu[0][0]']

conv3_block1_concat (Concatena  (None, 56, 28, 160)  0          ['pool2_pool[0][0]',
te)                                                              'conv3_block1_2_conv[0][0]']

conv3_block2_0_bn (BatchNormal  (None, 56, 28, 160)  640        ['conv3_block1_concat[0][0]']
ization)

conv3_block2_0_relu (Activatio  (None, 56, 28, 160)  0          ['conv3_block2_0_bn[0][0]']
n)

conv3_block2_1_conv (Conv2D)   (None, 56, 28, 128)  20480      ['conv3_block2_0_relu[0][0]']

conv3_block2_1_bn (BatchNormal  (None, 56, 28, 128)  512        ['conv3_block2_1_conv[0][0]']
ization)

conv3_block2_1_relu (Activatio  (None, 56, 28, 128)  0          ['conv3_block2_1_bn[0][0]']
n)

conv3_block2_2_conv (Conv2D)   (None, 56, 28, 32)   36864      ['conv3_block2_1_relu[0][0]']

conv3_block2_concat (Concatena  (None, 56, 28, 192)  0          ['conv3_block1_concat[0][0]',
te)                                                              'conv3_block2_2_conv[0][0]']

conv3_block3_0_bn (BatchNormal  (None, 56, 28, 192)  768        ['conv3_block2_concat[0][0]']
ization)

conv3_block3_0_relu (Activatio  (None, 56, 28, 192)  0          ['conv3_block3_0_bn[0][0]']
n)

conv3_block3_1_conv (Conv2D)   (None, 56, 28, 128)  24576      ['conv3_block3_0_relu[0][0]']

conv3_block3_1_bn (BatchNormal  (None, 56, 28, 128)  512        ['conv3_block3_1_conv[0][0]']
ization)

conv3_block3_1_relu (Activatio  (None, 56, 28, 128)  0          ['conv3_block3_1_bn[0][0]']
n)

conv3_block3_2_conv (Conv2D)   (None, 56, 28, 32)   36864      ['conv3_block3_1_relu[0][0]']

conv3_block3_concat (Concatena  (None, 56, 28, 224)  0          ['conv3_block2_concat[0][0]',
te)                                                              'conv3_block3_2_conv[0][0]']

conv3_block4_0_bn (BatchNormal  (None, 56, 28, 224)  896        ['conv3_block3_concat[0][0]']
ization)

conv3_block4_0_relu (Activatio  (None, 56, 28, 224)  0          ['conv3_block4_0_bn[0][0]']
n)

conv3_block4_1_conv (Conv2D)   (None, 56, 28, 128)  28672      ['conv3_block4_0_relu[0][0]']

conv3_block4_1_bn (BatchNormal  (None, 56, 28, 128)  512        ['conv3_block4_1_conv[0][0]']
ization)

conv3_block4_1_relu (Activatio  (None, 56, 28, 128)  0          ['conv3_block4_1_bn[0][0]']
n)

conv3_block4_2_conv (Conv2D)   (None, 56, 28, 32)   36864      ['conv3_block4_1_relu[0][0]']

conv3_block4_concat (Concatena  (None, 56, 28, 256)  0          ['conv3_block3_concat[0][0]',
te)                                                              'conv3_block4_2_conv[0][0]']

conv3_block5_0_bn (BatchNormal  (None, 56, 28, 256)  1024       ['conv3_block4_concat[0][0]']
ization)
```

```
conv3_block5_0_relu (Activatio  (None, 56, 28, 256)  0          ['conv3_block5_0_bn[0][0]']
n)

conv3_block5_1_conv (Conv2D)   (None, 56, 28, 128)  32768      ['conv3_block5_0_relu[0][0]']

conv3_block5_1_bn (BatchNormal  (None, 56, 28, 128)  512        ['conv3_block5_1_conv[0][0]']
ization)

conv3_block5_1_relu (Activatio  (None, 56, 28, 128)  0          ['conv3_block5_1_bn[0][0]']
n)

conv3_block5_2_conv (Conv2D)   (None, 56, 28, 32)   36864      ['conv3_block5_1_relu[0][0]']

conv3_block5_concat (Concatena  (None, 56, 28, 288)  0          ['conv3_block4_concat[0][0]',
te)                                                              'conv3_block5_2_conv[0][0]']

conv3_block6_0_bn (BatchNormal  (None, 56, 28, 288)  1152       ['conv3_block5_concat[0][0]']
ization)

conv3_block6_0_relu (Activatio  (None, 56, 28, 288)  0          ['conv3_block6_0_bn[0][0]']
n)

conv3_block6_1_conv (Conv2D)   (None, 56, 28, 128)  36864      ['conv3_block6_0_relu[0][0]']

conv3_block6_1_bn (BatchNormal  (None, 56, 28, 128)  512        ['conv3_block6_1_conv[0][0]']
ization)

conv3_block6_1_relu (Activatio  (None, 56, 28, 128)  0          ['conv3_block6_1_bn[0][0]']
n)

conv3_block6_2_conv (Conv2D)   (None, 56, 28, 32)   36864      ['conv3_block6_1_relu[0][0]']

conv3_block6_concat (Concatena  (None, 56, 28, 320)  0          ['conv3_block5_concat[0][0]',
te)                                                              'conv3_block6_2_conv[0][0]']

conv3_block7_0_bn (BatchNormal  (None, 56, 28, 320)  1280       ['conv3_block6_concat[0][0]']
ization)

conv3_block7_0_relu (Activatio  (None, 56, 28, 320)  0          ['conv3_block7_0_bn[0][0]']
n)

conv3_block7_1_conv (Conv2D)   (None, 56, 28, 128)  40960      ['conv3_block7_0_relu[0][0]']

conv3_block7_1_bn (BatchNormal  (None, 56, 28, 128)  512        ['conv3_block7_1_conv[0][0]']
ization)

conv3_block7_1_relu (Activatio  (None, 56, 28, 128)  0          ['conv3_block7_1_bn[0][0]']
n)

conv3_block7_2_conv (Conv2D)   (None, 56, 28, 32)   36864      ['conv3_block7_1_relu[0][0]']

conv3_block7_concat (Concatena  (None, 56, 28, 352)  0          ['conv3_block6_concat[0][0]',
te)                                                              'conv3_block7_2_conv[0][0]']

conv3_block8_0_bn (BatchNormal  (None, 56, 28, 352)  1408       ['conv3_block7_concat[0][0]']
ization)

conv3_block8_0_relu (Activatio  (None, 56, 28, 352)  0          ['conv3_block8_0_bn[0][0]']
n)

conv3_block8_1_conv (Conv2D)   (None, 56, 28, 128)  45056      ['conv3_block8_0_relu[0][0]']

conv3_block8_1_bn (BatchNormal  (None, 56, 28, 128)  512        ['conv3_block8_1_conv[0][0]']
ization)

conv3_block8_1_relu (Activatio  (None, 56, 28, 128)  0          ['conv3_block8_1_bn[0][0]']
n)

conv3_block8_2_conv (Conv2D)   (None, 56, 28, 32)   36864      ['conv3_block8_1_relu[0][0]']

conv3_block8_concat (Concatena  (None, 56, 28, 384)  0          ['conv3_block7_concat[0][0]',
te)                                                              'conv3_block8_2_conv[0][0]']

conv3_block9_0_bn (BatchNormal  (None, 56, 28, 384)  1536       ['conv3_block8_concat[0][0]']
ization)

conv3_block9_0_relu (Activatio  (None, 56, 28, 384)  0          ['conv3_block9_0_bn[0][0]']
n)
```

```
conv3_block9_1_conv (Conv2D)   (None, 56, 28, 128)  49152       ['conv3_block9_0_relu[0][0]']

conv3_block9_1_bn (BatchNormal  (None, 56, 28, 128)  512        ['conv3_block9_1_conv[0][0]']
ization)

conv3_block9_1_relu (Activatio  (None, 56, 28, 128)  0          ['conv3_block9_1_bn[0][0]']
n)

conv3_block9_2_conv (Conv2D)   (None, 56, 28, 32)   36864       ['conv3_block9_1_relu[0][0]']

conv3_block9_concat (Concatena  (None, 56, 28, 416)  0          ['conv3_block8_concat[0][0]',
te)                                                              'conv3_block9_2_conv[0][0]']

conv3_block10_0_bn (BatchNorma  (None, 56, 28, 416)  1664       ['conv3_block9_concat[0][0]']
lization)

conv3_block10_0_relu (Activati  (None, 56, 28, 416)  0          ['conv3_block10_0_bn[0][0]']
on)

conv3_block10_1_conv (Conv2D)  (None, 56, 28, 128)  53248       ['conv3_block10_0_relu[0][0]']

conv3_block10_1_bn (BatchNorma  (None, 56, 28, 128)  512        ['conv3_block10_1_conv[0][0]']
lization)

conv3_block10_1_relu (Activati  (None, 56, 28, 128)  0          ['conv3_block10_1_bn[0][0]']
on)

conv3_block10_2_conv (Conv2D)  (None, 56, 28, 32)   36864       ['conv3_block10_1_relu[0][0]']

conv3_block10_concat (Concaten  (None, 56, 28, 448)  0          ['conv3_block9_concat[0][0]',
ate)                                                             'conv3_block10_2_conv[0][0]']

conv3_block11_0_bn (BatchNorma  (None, 56, 28, 448)  1792       ['conv3_block10_concat[0][0]']
lization)

conv3_block11_0_relu (Activati  (None, 56, 28, 448)  0          ['conv3_block11_0_bn[0][0]']
on)

conv3_block11_1_conv (Conv2D)  (None, 56, 28, 128)  57344       ['conv3_block11_0_relu[0][0]']

conv3_block11_1_bn (BatchNorma  (None, 56, 28, 128)  512        ['conv3_block11_1_conv[0][0]']
lization)

conv3_block11_1_relu (Activati  (None, 56, 28, 128)  0          ['conv3_block11_1_bn[0][0]']
on)

conv3_block11_2_conv (Conv2D)  (None, 56, 28, 32)   36864       ['conv3_block11_1_relu[0][0]']

conv3_block11_concat (Concaten  (None, 56, 28, 480)  0          ['conv3_block10_concat[0][0]',
ate)                                                             'conv3_block11_2_conv[0][0]']

conv3_block12_0_bn (BatchNorma  (None, 56, 28, 480)  1920       ['conv3_block11_concat[0][0]']
lization)

conv3_block12_0_relu (Activati  (None, 56, 28, 480)  0          ['conv3_block12_0_bn[0][0]']
on)

conv3_block12_1_conv (Conv2D)  (None, 56, 28, 128)  61440       ['conv3_block12_0_relu[0][0]']

conv3_block12_1_bn (BatchNorma  (None, 56, 28, 128)  512        ['conv3_block12_1_conv[0][0]']
lization)

conv3_block12_1_relu (Activati  (None, 56, 28, 128)  0          ['conv3_block12_1_bn[0][0]']
on)

conv3_block12_2_conv (Conv2D)  (None, 56, 28, 32)   36864       ['conv3_block12_1_relu[0][0]']

conv3_block12_concat (Concaten  (None, 56, 28, 512)  0          ['conv3_block11_concat[0][0]',
ate)                                                             'conv3_block12_2_conv[0][0]']

pool3_bn (BatchNormalization)  (None, 56, 28, 512)  2048        ['conv3_block12_concat[0][0]']

pool3_relu (Activation)        (None, 56, 28, 512)  0           ['pool3_bn[0][0]']

pool3_conv (Conv2D)            (None, 56, 28, 256)  131072      ['pool3_relu[0][0]']

pool3_pool (AveragePooling2D)  (None, 28, 14, 256)  0           ['pool3_conv[0][0]']

conv4_block1_0_bn (BatchNormal  (None, 28, 14, 256)  1024       ['pool3_pool[0][0]']
```

```
ization)

conv4_block1_0_relu (Activatio  (None, 28, 14, 256)  0          ['conv4_block1_0_bn[0][0]']
n)

conv4_block1_1_conv (Conv2D)   (None, 28, 14, 128)  32768      ['conv4_block1_0_relu[0][0]']

conv4_block1_1_bn (BatchNormal  (None, 28, 14, 128)  512        ['conv4_block1_1_conv[0][0]']
ization)

conv4_block1_1_relu (Activatio  (None, 28, 14, 128)  0          ['conv4_block1_1_bn[0][0]']
n)

conv4_block1_2_conv (Conv2D)   (None, 28, 14, 32)   36864      ['conv4_block1_1_relu[0][0]']

conv4_block1_concat (Concatena  (None, 28, 14, 288)  0          ['pool3_pool[0][0]',
te)                                                              'conv4_block1_2_conv[0][0]']

conv4_block2_0_bn (BatchNormal  (None, 28, 14, 288)  1152       ['conv4_block1_concat[0][0]']
ization)

conv4_block2_0_relu (Activatio  (None, 28, 14, 288)  0          ['conv4_block2_0_bn[0][0]']
n)

conv4_block2_1_conv (Conv2D)   (None, 28, 14, 128)  36864      ['conv4_block2_0_relu[0][0]']

conv4_block2_1_bn (BatchNormal  (None, 28, 14, 128)  512        ['conv4_block2_1_conv[0][0]']
ization)

conv4_block2_1_relu (Activatio  (None, 28, 14, 128)  0          ['conv4_block2_1_bn[0][0]']
n)

conv4_block2_2_conv (Conv2D)   (None, 28, 14, 32)   36864      ['conv4_block2_1_relu[0][0]']

conv4_block2_concat (Concatena  (None, 28, 14, 320)  0          ['conv4_block1_concat[0][0]',
te)                                                              'conv4_block2_2_conv[0][0]']

conv4_block3_0_bn (BatchNormal  (None, 28, 14, 320)  1280       ['conv4_block2_concat[0][0]']
ization)

conv4_block3_0_relu (Activatio  (None, 28, 14, 320)  0          ['conv4_block3_0_bn[0][0]']
n)

conv4_block3_1_conv (Conv2D)   (None, 28, 14, 128)  40960      ['conv4_block3_0_relu[0][0]']

conv4_block3_1_bn (BatchNormal  (None, 28, 14, 128)  512        ['conv4_block3_1_conv[0][0]']
ization)

conv4_block3_1_relu (Activatio  (None, 28, 14, 128)  0          ['conv4_block3_1_bn[0][0]']
n)

conv4_block3_2_conv (Conv2D)   (None, 28, 14, 32)   36864      ['conv4_block3_1_relu[0][0]']

conv4_block3_concat (Concatena  (None, 28, 14, 352)  0          ['conv4_block2_concat[0][0]',
te)                                                              'conv4_block3_2_conv[0][0]']

conv4_block4_0_bn (BatchNormal  (None, 28, 14, 352)  1408       ['conv4_block3_concat[0][0]']
ization)

conv4_block4_0_relu (Activatio  (None, 28, 14, 352)  0          ['conv4_block4_0_bn[0][0]']
n)

conv4_block4_1_conv (Conv2D)   (None, 28, 14, 128)  45056      ['conv4_block4_0_relu[0][0]']

conv4_block4_1_bn (BatchNormal  (None, 28, 14, 128)  512        ['conv4_block4_1_conv[0][0]']
ization)

conv4_block4_1_relu (Activatio  (None, 28, 14, 128)  0          ['conv4_block4_1_bn[0][0]']
n)

conv4_block4_2_conv (Conv2D)   (None, 28, 14, 32)   36864      ['conv4_block4_1_relu[0][0]']

conv4_block4_concat (Concatena  (None, 28, 14, 384)  0          ['conv4_block3_concat[0][0]',
te)                                                              'conv4_block4_2_conv[0][0]']

conv4_block5_0_bn (BatchNormal  (None, 28, 14, 384)  1536       ['conv4_block4_concat[0][0]']
ization)

conv4_block5_0_relu (Activatio  (None, 28, 14, 384)  0          ['conv4_block5_0_bn[0][0]']
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n)

conv4_block5_1_conv (Conv2D)   (None, 28, 14, 128)  49152       ['conv4_block5_0_relu[0][0]']

conv4_block5_1_bn (BatchNormal  (None, 28, 14, 128)  512        ['conv4_block5_1_conv[0][0]']
ization)

conv4_block5_1_relu (Activatio  (None, 28, 14, 128)  0          ['conv4_block5_1_bn[0][0]']
n)

conv4_block5_2_conv (Conv2D)   (None, 28, 14, 32)   36864       ['conv4_block5_1_relu[0][0]']

conv4_block5_concat (Concatena  (None, 28, 14, 416)  0          ['conv4_block4_concat[0][0]',
te)                                                              'conv4_block5_2_conv[0][0]']

conv4_block6_0_bn (BatchNormal  (None, 28, 14, 416)  1664       ['conv4_block5_concat[0][0]']
ization)

conv4_block6_0_relu (Activatio  (None, 28, 14, 416)  0          ['conv4_block6_0_bn[0][0]']
n)

conv4_block6_1_conv (Conv2D)   (None, 28, 14, 128)  53248       ['conv4_block6_0_relu[0][0]']

conv4_block6_1_bn (BatchNormal  (None, 28, 14, 128)  512        ['conv4_block6_1_conv[0][0]']
ization)

conv4_block6_1_relu (Activatio  (None, 28, 14, 128)  0          ['conv4_block6_1_bn[0][0]']
n)

conv4_block6_2_conv (Conv2D)   (None, 28, 14, 32)   36864       ['conv4_block6_1_relu[0][0]']

conv4_block6_concat (Concatena  (None, 28, 14, 448)  0          ['conv4_block5_concat[0][0]',
te)                                                              'conv4_block6_2_conv[0][0]']

conv4_block7_0_bn (BatchNormal  (None, 28, 14, 448)  1792       ['conv4_block6_concat[0][0]']
ization)

conv4_block7_0_relu (Activatio  (None, 28, 14, 448)  0          ['conv4_block7_0_bn[0][0]']
n)

conv4_block7_1_conv (Conv2D)   (None, 28, 14, 128)  57344       ['conv4_block7_0_relu[0][0]']

conv4_block7_1_bn (BatchNormal  (None, 28, 14, 128)  512        ['conv4_block7_1_conv[0][0]']
ization)

conv4_block7_1_relu (Activatio  (None, 28, 14, 128)  0          ['conv4_block7_1_bn[0][0]']
n)

conv4_block7_2_conv (Conv2D)   (None, 28, 14, 32)   36864       ['conv4_block7_1_relu[0][0]']

conv4_block7_concat (Concatena  (None, 28, 14, 480)  0          ['conv4_block6_concat[0][0]',
te)                                                              'conv4_block7_2_conv[0][0]']

conv4_block8_0_bn (BatchNormal  (None, 28, 14, 480)  1920       ['conv4_block7_concat[0][0]']
ization)

conv4_block8_0_relu (Activatio  (None, 28, 14, 480)  0          ['conv4_block8_0_bn[0][0]']
n)

conv4_block8_1_conv (Conv2D)   (None, 28, 14, 128)  61440       ['conv4_block8_0_relu[0][0]']

conv4_block8_1_bn (BatchNormal  (None, 28, 14, 128)  512        ['conv4_block8_1_conv[0][0]']
ization)

conv4_block8_1_relu (Activatio  (None, 28, 14, 128)  0          ['conv4_block8_1_bn[0][0]']
n)

conv4_block8_2_conv (Conv2D)   (None, 28, 14, 32)   36864       ['conv4_block8_1_relu[0][0]']

conv4_block8_concat (Concatena  (None, 28, 14, 512)  0          ['conv4_block7_concat[0][0]',
te)                                                              'conv4_block8_2_conv[0][0]']

conv4_block9_0_bn (BatchNormal  (None, 28, 14, 512)  2048       ['conv4_block8_concat[0][0]']
ization)

conv4_block9_0_relu (Activatio  (None, 28, 14, 512)  0          ['conv4_block9_0_bn[0][0]']
n)

conv4_block9_1_conv (Conv2D)   (None, 28, 14, 128)  65536       ['conv4_block9_0_relu[0][0]']
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conv4_block9_1_bn (BatchNormal  (None, 28, 14, 128)  512        ['conv4_block9_1_conv[0][0]']
ization)

conv4_block9_1_relu (Activatio  (None, 28, 14, 128)  0          ['conv4_block9_1_bn[0][0]']
n)

conv4_block9_2_conv (Conv2D)   (None, 28, 14, 32)   36864       ['conv4_block9_1_relu[0][0]']

conv4_block9_concat (Concatena  (None, 28, 14, 544)  0          ['conv4_block8_concat[0][0]',
te)                                                              'conv4_block9_2_conv[0][0]']

conv4_block10_0_bn (BatchNorma  (None, 28, 14, 544)  2176       ['conv4_block9_concat[0][0]']
lization)

conv4_block10_0_relu (Activati  (None, 28, 14, 544)  0          ['conv4_block10_0_bn[0][0]']
on)

conv4_block10_1_conv (Conv2D)  (None, 28, 14, 128)  69632       ['conv4_block10_0_relu[0][0]']

conv4_block10_1_bn (BatchNorma  (None, 28, 14, 128)  512        ['conv4_block10_1_conv[0][0]']
lization)

conv4_block10_1_relu (Activati  (None, 28, 14, 128)  0          ['conv4_block10_1_bn[0][0]']
on)

conv4_block10_2_conv (Conv2D)  (None, 28, 14, 32)   36864       ['conv4_block10_1_relu[0][0]']

conv4_block10_concat (Concaten  (None, 28, 14, 576)  0          ['conv4_block9_concat[0][0]',
ate)                                                             'conv4_block10_2_conv[0][0]']

conv4_block11_0_bn (BatchNorma  (None, 28, 14, 576)  2304       ['conv4_block10_concat[0][0]']
lization)

conv4_block11_0_relu (Activati  (None, 28, 14, 576)  0          ['conv4_block11_0_bn[0][0]']
on)

conv4_block11_1_conv (Conv2D)  (None, 28, 14, 128)  73728       ['conv4_block11_0_relu[0][0]']

conv4_block11_1_bn (BatchNorma  (None, 28, 14, 128)  512        ['conv4_block11_1_conv[0][0]']
lization)

conv4_block11_1_relu (Activati  (None, 28, 14, 128)  0          ['conv4_block11_1_bn[0][0]']
on)

conv4_block11_2_conv (Conv2D)  (None, 28, 14, 32)   36864       ['conv4_block11_1_relu[0][0]']

conv4_block11_concat (Concaten  (None, 28, 14, 608)  0          ['conv4_block10_concat[0][0]',
ate)                                                             'conv4_block11_2_conv[0][0]']

conv4_block12_0_bn (BatchNorma  (None, 28, 14, 608)  2432       ['conv4_block11_concat[0][0]']
lization)

conv4_block12_0_relu (Activati  (None, 28, 14, 608)  0          ['conv4_block12_0_bn[0][0]']
on)

conv4_block12_1_conv (Conv2D)  (None, 28, 14, 128)  77824       ['conv4_block12_0_relu[0][0]']

conv4_block12_1_bn (BatchNorma  (None, 28, 14, 128)  512        ['conv4_block12_1_conv[0][0]']
lization)

conv4_block12_1_relu (Activati  (None, 28, 14, 128)  0          ['conv4_block12_1_bn[0][0]']
on)

conv4_block12_2_conv (Conv2D)  (None, 28, 14, 32)   36864       ['conv4_block12_1_relu[0][0]']

conv4_block12_concat (Concaten  (None, 28, 14, 640)  0          ['conv4_block11_concat[0][0]',
ate)                                                             'conv4_block12_2_conv[0][0]']

conv4_block13_0_bn (BatchNorma  (None, 28, 14, 640)  2560       ['conv4_block12_concat[0][0]']
lization)

conv4_block13_0_relu (Activati  (None, 28, 14, 640)  0          ['conv4_block13_0_bn[0][0]']
on)

conv4_block13_1_conv (Conv2D)  (None, 28, 14, 128)  81920       ['conv4_block13_0_relu[0][0]']

conv4_block13_1_bn (BatchNorma  (None, 28, 14, 128)  512        ['conv4_block13_1_conv[0][0]']
lization)
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conv4_block13_1_relu (Activati  (None, 28, 14, 128)  0          ['conv4_block13_1_bn[0][0]']
on)

conv4_block13_2_conv (Conv2D)  (None, 28, 14, 32)   36864       ['conv4_block13_1_relu[0][0]']

conv4_block13_concat (Concaten  (None, 28, 14, 672)  0          ['conv4_block12_concat[0][0]',
ate)                                                             'conv4_block13_2_conv[0][0]']

conv4_block14_0_bn (BatchNorma  (None, 28, 14, 672)  2688       ['conv4_block13_concat[0][0]']
lization)

conv4_block14_0_relu (Activati  (None, 28, 14, 672)  0          ['conv4_block14_0_bn[0][0]']
on)

conv4_block14_1_conv (Conv2D)  (None, 28, 14, 128)  86016       ['conv4_block14_0_relu[0][0]']

conv4_block14_1_bn (BatchNorma  (None, 28, 14, 128)  512        ['conv4_block14_1_conv[0][0]']
lization)

conv4_block14_1_relu (Activati  (None, 28, 14, 128)  0          ['conv4_block14_1_bn[0][0]']
on)

conv4_block14_2_conv (Conv2D)  (None, 28, 14, 32)   36864       ['conv4_block14_1_relu[0][0]']

conv4_block14_concat (Concaten  (None, 28, 14, 704)  0          ['conv4_block13_concat[0][0]',
ate)                                                             'conv4_block14_2_conv[0][0]']

conv4_block15_0_bn (BatchNorma  (None, 28, 14, 704)  2816       ['conv4_block14_concat[0][0]']
lization)

conv4_block15_0_relu (Activati  (None, 28, 14, 704)  0          ['conv4_block15_0_bn[0][0]']
on)

conv4_block15_1_conv (Conv2D)  (None, 28, 14, 128)  90112       ['conv4_block15_0_relu[0][0]']

conv4_block15_1_bn (BatchNorma  (None, 28, 14, 128)  512        ['conv4_block15_1_conv[0][0]']
lization)

conv4_block15_1_relu (Activati  (None, 28, 14, 128)  0          ['conv4_block15_1_bn[0][0]']
on)

conv4_block15_2_conv (Conv2D)  (None, 28, 14, 32)   36864       ['conv4_block15_1_relu[0][0]']

conv4_block15_concat (Concaten  (None, 28, 14, 736)  0          ['conv4_block14_concat[0][0]',
ate)                                                             'conv4_block15_2_conv[0][0]']

conv4_block16_0_bn (BatchNorma  (None, 28, 14, 736)  2944       ['conv4_block15_concat[0][0]']
lization)

conv4_block16_0_relu (Activati  (None, 28, 14, 736)  0          ['conv4_block16_0_bn[0][0]']
on)

conv4_block16_1_conv (Conv2D)  (None, 28, 14, 128)  94208       ['conv4_block16_0_relu[0][0]']

conv4_block16_1_bn (BatchNorma  (None, 28, 14, 128)  512        ['conv4_block16_1_conv[0][0]']
lization)

conv4_block16_1_relu (Activati  (None, 28, 14, 128)  0          ['conv4_block16_1_bn[0][0]']
on)

conv4_block16_2_conv (Conv2D)  (None, 28, 14, 32)   36864       ['conv4_block16_1_relu[0][0]']

conv4_block16_concat (Concaten  (None, 28, 14, 768)  0          ['conv4_block15_concat[0][0]',
ate)                                                             'conv4_block16_2_conv[0][0]']

conv4_block17_0_bn (BatchNorma  (None, 28, 14, 768)  3072       ['conv4_block16_concat[0][0]']
lization)

conv4_block17_0_relu (Activati  (None, 28, 14, 768)  0          ['conv4_block17_0_bn[0][0]']
on)

conv4_block17_1_conv (Conv2D)  (None, 28, 14, 128)  98304       ['conv4_block17_0_relu[0][0]']

conv4_block17_1_bn (BatchNorma  (None, 28, 14, 128)  512        ['conv4_block17_1_conv[0][0]']
lization)

conv4_block17_1_relu (Activati  (None, 28, 14, 128)  0          ['conv4_block17_1_bn[0][0]']
on)
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conv4_block17_2_conv (Conv2D)  (None, 28, 14, 32)   36864       ['conv4_block17_1_relu[0][0]']

conv4_block17_concat (Concaten  (None, 28, 14, 800)  0          ['conv4_block16_concat[0][0]',
ate)                                                             'conv4_block17_2_conv[0][0]']

conv4_block18_0_bn (BatchNorma  (None, 28, 14, 800)  3200       ['conv4_block17_concat[0][0]']
lization)

conv4_block18_0_relu (Activati  (None, 28, 14, 800)  0          ['conv4_block18_0_bn[0][0]']
on)

conv4_block18_1_conv (Conv2D)  (None, 28, 14, 128)  102400      ['conv4_block18_0_relu[0][0]']

conv4_block18_1_bn (BatchNorma  (None, 28, 14, 128)  512        ['conv4_block18_1_conv[0][0]']
lization)

conv4_block18_1_relu (Activati  (None, 28, 14, 128)  0          ['conv4_block18_1_bn[0][0]']
on)

conv4_block18_2_conv (Conv2D)  (None, 28, 14, 32)   36864       ['conv4_block18_1_relu[0][0]']

conv4_block18_concat (Concaten  (None, 28, 14, 832)  0          ['conv4_block17_concat[0][0]',
ate)                                                             'conv4_block18_2_conv[0][0]']

conv4_block19_0_bn (BatchNorma  (None, 28, 14, 832)  3328       ['conv4_block18_concat[0][0]']
lization)

conv4_block19_0_relu (Activati  (None, 28, 14, 832)  0          ['conv4_block19_0_bn[0][0]']
on)

conv4_block19_1_conv (Conv2D)  (None, 28, 14, 128)  106496      ['conv4_block19_0_relu[0][0]']

conv4_block19_1_bn (BatchNorma  (None, 28, 14, 128)  512        ['conv4_block19_1_conv[0][0]']
lization)

conv4_block19_1_relu (Activati  (None, 28, 14, 128)  0          ['conv4_block19_1_bn[0][0]']
on)

conv4_block19_2_conv (Conv2D)  (None, 28, 14, 32)   36864       ['conv4_block19_1_relu[0][0]']

conv4_block19_concat (Concaten  (None, 28, 14, 864)  0          ['conv4_block18_concat[0][0]',
ate)                                                             'conv4_block19_2_conv[0][0]']

conv4_block20_0_bn (BatchNorma  (None, 28, 14, 864)  3456       ['conv4_block19_concat[0][0]']
lization)

conv4_block20_0_relu (Activati  (None, 28, 14, 864)  0          ['conv4_block20_0_bn[0][0]']
on)

conv4_block20_1_conv (Conv2D)  (None, 28, 14, 128)  110592      ['conv4_block20_0_relu[0][0]']

conv4_block20_1_bn (BatchNorma  (None, 28, 14, 128)  512        ['conv4_block20_1_conv[0][0]']
lization)

conv4_block20_1_relu (Activati  (None, 28, 14, 128)  0          ['conv4_block20_1_bn[0][0]']
on)

conv4_block20_2_conv (Conv2D)  (None, 28, 14, 32)   36864       ['conv4_block20_1_relu[0][0]']

conv4_block20_concat (Concaten  (None, 28, 14, 896)  0          ['conv4_block19_concat[0][0]',
ate)                                                             'conv4_block20_2_conv[0][0]']

conv4_block21_0_bn (BatchNorma  (None, 28, 14, 896)  3584       ['conv4_block20_concat[0][0]']
lization)

conv4_block21_0_relu (Activati  (None, 28, 14, 896)  0          ['conv4_block21_0_bn[0][0]']
on)

conv4_block21_1_conv (Conv2D)  (None, 28, 14, 128)  114688      ['conv4_block21_0_relu[0][0]']

conv4_block21_1_bn (BatchNorma  (None, 28, 14, 128)  512        ['conv4_block21_1_conv[0][0]']
lization)

conv4_block21_1_relu (Activati  (None, 28, 14, 128)  0          ['conv4_block21_1_bn[0][0]']
on)

conv4_block21_2_conv (Conv2D)  (None, 28, 14, 32)   36864       ['conv4_block21_1_relu[0][0]']
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conv4_block21_concat (Concaten  (None, 28, 14, 928)  0          ['conv4_block20_concat[0][0]',
ate)                                                             'conv4_block21_2_conv[0][0]']

conv4_block22_0_bn (BatchNorma  (None, 28, 14, 928)  3712       ['conv4_block21_concat[0][0]']
lization)

conv4_block22_0_relu (Activati  (None, 28, 14, 928)  0          ['conv4_block22_0_bn[0][0]']
on)

conv4_block22_1_conv (Conv2D)  (None, 28, 14, 128)  118784     ['conv4_block22_0_relu[0][0]']

conv4_block22_1_bn (BatchNorma  (None, 28, 14, 128)  512        ['conv4_block22_1_conv[0][0]']
lization)

conv4_block22_1_relu (Activati  (None, 28, 14, 128)  0          ['conv4_block22_1_bn[0][0]']
on)

conv4_block22_2_conv (Conv2D)  (None, 28, 14, 32)   36864      ['conv4_block22_1_relu[0][0]']

conv4_block22_concat (Concaten  (None, 28, 14, 960)  0          ['conv4_block21_concat[0][0]',
ate)                                                             'conv4_block22_2_conv[0][0]']

conv4_block23_0_bn (BatchNorma  (None, 28, 14, 960)  3840       ['conv4_block22_concat[0][0]']
lization)

conv4_block23_0_relu (Activati  (None, 28, 14, 960)  0          ['conv4_block23_0_bn[0][0]']
on)

conv4_block23_1_conv (Conv2D)  (None, 28, 14, 128)  122880     ['conv4_block23_0_relu[0][0]']

conv4_block23_1_bn (BatchNorma  (None, 28, 14, 128)  512        ['conv4_block23_1_conv[0][0]']
lization)

conv4_block23_1_relu (Activati  (None, 28, 14, 128)  0          ['conv4_block23_1_bn[0][0]']
on)

conv4_block23_2_conv (Conv2D)  (None, 28, 14, 32)   36864      ['conv4_block23_1_relu[0][0]']

conv4_block23_concat (Concaten  (None, 28, 14, 992)  0          ['conv4_block22_concat[0][0]',
ate)                                                             'conv4_block23_2_conv[0][0]']

conv4_block24_0_bn (BatchNorma  (None, 28, 14, 992)  3968       ['conv4_block23_concat[0][0]']
lization)

conv4_block24_0_relu (Activati  (None, 28, 14, 992)  0          ['conv4_block24_0_bn[0][0]']
on)

conv4_block24_1_conv (Conv2D)  (None, 28, 14, 128)  126976     ['conv4_block24_0_relu[0][0]']

conv4_block24_1_bn (BatchNorma  (None, 28, 14, 128)  512        ['conv4_block24_1_conv[0][0]']
lization)

conv4_block24_1_relu (Activati  (None, 28, 14, 128)  0          ['conv4_block24_1_bn[0][0]']
on)

conv4_block24_2_conv (Conv2D)  (None, 28, 14, 32)   36864      ['conv4_block24_1_relu[0][0]']

conv4_block24_concat (Concaten  (None, 28, 14, 1024  0          ['conv4_block23_concat[0][0]',
ate)                           )                                 'conv4_block24_2_conv[0][0]']

pool4_bn (BatchNormalization)  (None, 28, 14, 1024  4096       ['conv4_block24_concat[0][0]']
                               )

pool4_relu (Activation)         (None, 28, 14, 1024  0          ['pool4_bn[0][0]']
                               )

pool4_conv (Conv2D)            (None, 28, 14, 512)  524288     ['pool4_relu[0][0]']

pool4_pool (AveragePooling2D)  (None, 14, 7, 512)   0          ['pool4_conv[0][0]']

conv5_block1_0_bn (BatchNormal  (None, 14, 7, 512)  2048       ['pool4_pool[0][0]']
ization)

conv5_block1_0_relu (Activatio  (None, 14, 7, 512)  0          ['conv5_block1_0_bn[0][0]']
n)

conv5_block1_1_conv (Conv2D)   (None, 14, 7, 128)   65536      ['conv5_block1_0_relu[0][0]']

conv5_block1_1_bn (BatchNormal  (None, 14, 7, 128)  512        ['conv5_block1_1_conv[0][0]']
```

```
ization)

conv5_block1_1_relu (Activatio  (None, 14, 7, 128)  0           ['conv5_block1_1_bn[0][0]']
n)

conv5_block1_2_conv (Conv2D)   (None, 14, 7, 32)    36864       ['conv5_block1_1_relu[0][0]']

conv5_block1_concat (Concatena  (None, 14, 7, 544)  0           ['pool4_pool[0][0]',
te)                                                              'conv5_block1_2_conv[0][0]']

conv5_block2_0_bn (BatchNormal  (None, 14, 7, 544)  2176        ['conv5_block1_concat[0][0]']
ization)

conv5_block2_0_relu (Activatio  (None, 14, 7, 544)  0           ['conv5_block2_0_bn[0][0]']
n)

conv5_block2_1_conv (Conv2D)   (None, 14, 7, 128)   69632       ['conv5_block2_0_relu[0][0]']

conv5_block2_1_bn (BatchNormal  (None, 14, 7, 128)  512         ['conv5_block2_1_conv[0][0]']
ization)

conv5_block2_1_relu (Activatio  (None, 14, 7, 128)  0           ['conv5_block2_1_bn[0][0]']
n)

conv5_block2_2_conv (Conv2D)   (None, 14, 7, 32)    36864       ['conv5_block2_1_relu[0][0]']

conv5_block2_concat (Concatena  (None, 14, 7, 576)  0           ['conv5_block1_concat[0][0]',
te)                                                              'conv5_block2_2_conv[0][0]']

conv5_block3_0_bn (BatchNormal  (None, 14, 7, 576)  2304        ['conv5_block2_concat[0][0]']
ization)

conv5_block3_0_relu (Activatio  (None, 14, 7, 576)  0           ['conv5_block3_0_bn[0][0]']
n)

conv5_block3_1_conv (Conv2D)   (None, 14, 7, 128)   73728       ['conv5_block3_0_relu[0][0]']

conv5_block3_1_bn (BatchNormal  (None, 14, 7, 128)  512         ['conv5_block3_1_conv[0][0]']
ization)

conv5_block3_1_relu (Activatio  (None, 14, 7, 128)  0           ['conv5_block3_1_bn[0][0]']
n)

conv5_block3_2_conv (Conv2D)   (None, 14, 7, 32)    36864       ['conv5_block3_1_relu[0][0]']

conv5_block3_concat (Concatena  (None, 14, 7, 608)  0           ['conv5_block2_concat[0][0]',
te)                                                              'conv5_block3_2_conv[0][0]']

conv5_block4_0_bn (BatchNormal  (None, 14, 7, 608)  2432        ['conv5_block3_concat[0][0]']
ization)

conv5_block4_0_relu (Activatio  (None, 14, 7, 608)  0           ['conv5_block4_0_bn[0][0]']
n)

conv5_block4_1_conv (Conv2D)   (None, 14, 7, 128)   77824       ['conv5_block4_0_relu[0][0]']

conv5_block4_1_bn (BatchNormal  (None, 14, 7, 128)  512         ['conv5_block4_1_conv[0][0]']
ization)

conv5_block4_1_relu (Activatio  (None, 14, 7, 128)  0           ['conv5_block4_1_bn[0][0]']
n)

conv5_block4_2_conv (Conv2D)   (None, 14, 7, 32)    36864       ['conv5_block4_1_relu[0][0]']

conv5_block4_concat (Concatena  (None, 14, 7, 640)  0           ['conv5_block3_concat[0][0]',
te)                                                              'conv5_block4_2_conv[0][0]']

conv5_block5_0_bn (BatchNormal  (None, 14, 7, 640)  2560        ['conv5_block4_concat[0][0]']
ization)

conv5_block5_0_relu (Activatio  (None, 14, 7, 640)  0           ['conv5_block5_0_bn[0][0]']
n)

conv5_block5_1_conv (Conv2D)   (None, 14, 7, 128)   81920       ['conv5_block5_0_relu[0][0]']

conv5_block5_1_bn (BatchNormal  (None, 14, 7, 128)  512         ['conv5_block5_1_conv[0][0]']
ization)

conv5_block5_1_relu (Activatio  (None, 14, 7, 128)  0           ['conv5_block5_1_bn[0][0]']
```

```
n)

conv5_block5_2_conv (Conv2D)   (None, 14, 7, 32)    36864       ['conv5_block5_1_relu[0][0]']

conv5_block5_concat (Concatena  (None, 14, 7, 672)  0           ['conv5_block4_concat[0][0]',
te)                                                              'conv5_block5_2_conv[0][0]']

conv5_block6_0_bn (BatchNormal  (None, 14, 7, 672)  2688        ['conv5_block5_concat[0][0]']
ization)

conv5_block6_0_relu (Activatio  (None, 14, 7, 672)  0           ['conv5_block6_0_bn[0][0]']
n)

conv5_block6_1_conv (Conv2D)   (None, 14, 7, 128)   86016       ['conv5_block6_0_relu[0][0]']

conv5_block6_1_bn (BatchNormal  (None, 14, 7, 128)  512         ['conv5_block6_1_conv[0][0]']
ization)

conv5_block6_1_relu (Activatio  (None, 14, 7, 128)  0           ['conv5_block6_1_bn[0][0]']
n)

conv5_block6_2_conv (Conv2D)   (None, 14, 7, 32)    36864       ['conv5_block6_1_relu[0][0]']

conv5_block6_concat (Concatena  (None, 14, 7, 704)  0           ['conv5_block5_concat[0][0]',
te)                                                              'conv5_block6_2_conv[0][0]']

conv5_block7_0_bn (BatchNormal  (None, 14, 7, 704)  2816        ['conv5_block6_concat[0][0]']
ization)

conv5_block7_0_relu (Activatio  (None, 14, 7, 704)  0           ['conv5_block7_0_bn[0][0]']
n)

conv5_block7_1_conv (Conv2D)   (None, 14, 7, 128)   90112       ['conv5_block7_0_relu[0][0]']

conv5_block7_1_bn (BatchNormal  (None, 14, 7, 128)  512         ['conv5_block7_1_conv[0][0]']
ization)

conv5_block7_1_relu (Activatio  (None, 14, 7, 128)  0           ['conv5_block7_1_bn[0][0]']
n)

conv5_block7_2_conv (Conv2D)   (None, 14, 7, 32)    36864       ['conv5_block7_1_relu[0][0]']

conv5_block7_concat (Concatena  (None, 14, 7, 736)  0           ['conv5_block6_concat[0][0]',
te)                                                              'conv5_block7_2_conv[0][0]']

conv5_block8_0_bn (BatchNormal  (None, 14, 7, 736)  2944        ['conv5_block7_concat[0][0]']
ization)

conv5_block8_0_relu (Activatio  (None, 14, 7, 736)  0           ['conv5_block8_0_bn[0][0]']
n)

conv5_block8_1_conv (Conv2D)   (None, 14, 7, 128)   94208       ['conv5_block8_0_relu[0][0]']

conv5_block8_1_bn (BatchNormal  (None, 14, 7, 128)  512         ['conv5_block8_1_conv[0][0]']
ization)

conv5_block8_1_relu (Activatio  (None, 14, 7, 128)  0           ['conv5_block8_1_bn[0][0]']
n)

conv5_block8_2_conv (Conv2D)   (None, 14, 7, 32)    36864       ['conv5_block8_1_relu[0][0]']

conv5_block8_concat (Concatena  (None, 14, 7, 768)  0           ['conv5_block7_concat[0][0]',
te)                                                              'conv5_block8_2_conv[0][0]']

conv5_block9_0_bn (BatchNormal  (None, 14, 7, 768)  3072        ['conv5_block8_concat[0][0]']
ization)

conv5_block9_0_relu (Activatio  (None, 14, 7, 768)  0           ['conv5_block9_0_bn[0][0]']
n)

conv5_block9_1_conv (Conv2D)   (None, 14, 7, 128)   98304       ['conv5_block9_0_relu[0][0]']

conv5_block9_1_bn (BatchNormal  (None, 14, 7, 128)  512         ['conv5_block9_1_conv[0][0]']
ization)

conv5_block9_1_relu (Activatio  (None, 14, 7, 128)  0           ['conv5_block9_1_bn[0][0]']
n)

conv5_block9_2_conv (Conv2D)   (None, 14, 7, 32)    36864       ['conv5_block9_1_relu[0][0]']
```

```
conv5_block9_concat (Concatena  (None, 14, 7, 800)  0           ['conv5_block8_concat[0][0]',
te)                                                              'conv5_block9_2_conv[0][0]']

conv5_block10_0_bn (BatchNorma  (None, 14, 7, 800)  3200        ['conv5_block9_concat[0][0]']
lization)

conv5_block10_0_relu (Activati  (None, 14, 7, 800)  0           ['conv5_block10_0_bn[0][0]']
on)

conv5_block10_1_conv (Conv2D)  (None, 14, 7, 128)   102400      ['conv5_block10_0_relu[0][0]']

conv5_block10_1_bn (BatchNorma  (None, 14, 7, 128)  512         ['conv5_block10_1_conv[0][0]']
lization)

conv5_block10_1_relu (Activati  (None, 14, 7, 128)  0           ['conv5_block10_1_bn[0][0]']
on)

conv5_block10_2_conv (Conv2D)  (None, 14, 7, 32)    36864       ['conv5_block10_1_relu[0][0]']

conv5_block10_concat (Concaten  (None, 14, 7, 832)  0           ['conv5_block9_concat[0][0]',
ate)                                                             'conv5_block10_2_conv[0][0]']

conv5_block11_0_bn (BatchNorma  (None, 14, 7, 832)  3328        ['conv5_block10_concat[0][0]']
lization)

conv5_block11_0_relu (Activati  (None, 14, 7, 832)  0           ['conv5_block11_0_bn[0][0]']
on)

conv5_block11_1_conv (Conv2D)  (None, 14, 7, 128)   106496      ['conv5_block11_0_relu[0][0]']

conv5_block11_1_bn (BatchNorma  (None, 14, 7, 128)  512         ['conv5_block11_1_conv[0][0]']
lization)

conv5_block11_1_relu (Activati  (None, 14, 7, 128)  0           ['conv5_block11_1_bn[0][0]']
on)

conv5_block11_2_conv (Conv2D)  (None, 14, 7, 32)    36864       ['conv5_block11_1_relu[0][0]']

conv5_block11_concat (Concaten  (None, 14, 7, 864)  0           ['conv5_block10_concat[0][0]',
ate)                                                             'conv5_block11_2_conv[0][0]']

conv5_block12_0_bn (BatchNorma  (None, 14, 7, 864)  3456        ['conv5_block11_concat[0][0]']
lization)

conv5_block12_0_relu (Activati  (None, 14, 7, 864)  0           ['conv5_block12_0_bn[0][0]']
on)

conv5_block12_1_conv (Conv2D)  (None, 14, 7, 128)   110592      ['conv5_block12_0_relu[0][0]']

conv5_block12_1_bn (BatchNorma  (None, 14, 7, 128)  512         ['conv5_block12_1_conv[0][0]']
lization)

conv5_block12_1_relu (Activati  (None, 14, 7, 128)  0           ['conv5_block12_1_bn[0][0]']
on)

conv5_block12_2_conv (Conv2D)  (None, 14, 7, 32)    36864       ['conv5_block12_1_relu[0][0]']

conv5_block12_concat (Concaten  (None, 14, 7, 896)  0           ['conv5_block11_concat[0][0]',
ate)                                                             'conv5_block12_2_conv[0][0]']

conv5_block13_0_bn (BatchNorma  (None, 14, 7, 896)  3584        ['conv5_block12_concat[0][0]']
lization)

conv5_block13_0_relu (Activati  (None, 14, 7, 896)  0           ['conv5_block13_0_bn[0][0]']
on)

conv5_block13_1_conv (Conv2D)  (None, 14, 7, 128)   114688      ['conv5_block13_0_relu[0][0]']

conv5_block13_1_bn (BatchNorma  (None, 14, 7, 128)  512         ['conv5_block13_1_conv[0][0]']
lization)

conv5_block13_1_relu (Activati  (None, 14, 7, 128)  0           ['conv5_block13_1_bn[0][0]']
on)

conv5_block13_2_conv (Conv2D)  (None, 14, 7, 32)    36864       ['conv5_block13_1_relu[0][0]']

conv5_block13_concat (Concaten  (None, 14, 7, 928)  0           ['conv5_block12_concat[0][0]',
ate)                                                             'conv5_block13_2_conv[0][0]']
```

```
conv5_block14_0_bn (BatchNorma  (None, 14, 7, 928)  3712        ['conv5_block13_concat[0][0]']
lization)

conv5_block14_0_relu (Activati  (None, 14, 7, 928)  0           ['conv5_block14_0_bn[0][0]']
on)

conv5_block14_1_conv (Conv2D)  (None, 14, 7, 128)   118784      ['conv5_block14_0_relu[0][0]']

conv5_block14_1_bn (BatchNorma  (None, 14, 7, 128)  512         ['conv5_block14_1_conv[0][0]']
lization)

conv5_block14_1_relu (Activati  (None, 14, 7, 128)  0           ['conv5_block14_1_bn[0][0]']
on)

conv5_block14_2_conv (Conv2D)  (None, 14, 7, 32)    36864       ['conv5_block14_1_relu[0][0]']

conv5_block14_concat (Concaten  (None, 14, 7, 960)  0           ['conv5_block13_concat[0][0]',
ate)                                                             'conv5_block14_2_conv[0][0]']

conv5_block15_0_bn (BatchNorma  (None, 14, 7, 960)  3840        ['conv5_block14_concat[0][0]']
lization)

conv5_block15_0_relu (Activati  (None, 14, 7, 960)  0           ['conv5_block15_0_bn[0][0]']
on)

conv5_block15_1_conv (Conv2D)  (None, 14, 7, 128)   122880      ['conv5_block15_0_relu[0][0]']

conv5_block15_1_bn (BatchNorma  (None, 14, 7, 128)  512         ['conv5_block15_1_conv[0][0]']
lization)

conv5_block15_1_relu (Activati  (None, 14, 7, 128)  0           ['conv5_block15_1_bn[0][0]']
on)

conv5_block15_2_conv (Conv2D)  (None, 14, 7, 32)    36864       ['conv5_block15_1_relu[0][0]']

conv5_block15_concat (Concaten  (None, 14, 7, 992)  0           ['conv5_block14_concat[0][0]',
ate)                                                             'conv5_block15_2_conv[0][0]']

conv5_block16_0_bn (BatchNorma  (None, 14, 7, 992)  3968        ['conv5_block15_concat[0][0]']
lization)

conv5_block16_0_relu (Activati  (None, 14, 7, 992)  0           ['conv5_block16_0_bn[0][0]']
on)

conv5_block16_1_conv (Conv2D)  (None, 14, 7, 128)   126976      ['conv5_block16_0_relu[0][0]']

conv5_block16_1_bn (BatchNorma  (None, 14, 7, 128)  512         ['conv5_block16_1_conv[0][0]']
lization)

conv5_block16_1_relu (Activati  (None, 14, 7, 128)  0           ['conv5_block16_1_bn[0][0]']
on)

conv5_block16_2_conv (Conv2D)  (None, 14, 7, 32)    36864       ['conv5_block16_1_relu[0][0]']

conv5_block16_concat (Concaten  (None, 14, 7, 1024)  0          ['conv5_block15_concat[0][0]',
ate)                                                             'conv5_block16_2_conv[0][0]']

bn (BatchNormalization)        (None, 14, 7, 1024)  4096        ['conv5_block16_concat[0][0]']

relu (Activation)              (None, 14, 7, 1024)  0           ['bn[0][0]']

global_average_pooling2d_3 (Gl  (None, 1024)        0           ['relu[0][0]']
obalAveragePooling2D)

dense_3 (Dense)                (None, 31)           31775       ['global_average_pooling2d_3[0][0
                                                                 ]']

==================================================================================================
Total params: 7,069,279
Trainable params: 6,985,631
Non-trainable params: 83,648
__________________________________________________________________________________________________
```

In [79]:

```
for layer in model.layers:
    layer.trainable = True
```

In [80]:
```
early_stopping = EarlyStopping(patience=5)
```

In [81]:
```
model.compile(
  optimizer="adam",
  loss=tf.keras.losses.SparseCategoricalCrossentropy(from_logits=True),
  metrics=['acc'])

model.fit(X_train,
          y_train,
          epochs=50,
          callbacks = early_stopping,
          validation_data=(X_val, y_val))
```

```
Epoch 1/50
2022-01-28 19:10:14.992804: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:112] Plugin optimizer for device_type GPU is enabled.
582/582 [==============================] - ETA: 0s - loss: 3.5088 - acc: 0.0321
2022-01-28 19:23:05.475357: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:112] Plugin optimizer for device_type GPU is enabled.
```

```
582/582 [==============================] - 846s 1s/step - loss: 3.5088 - acc: 0.0321 - val_loss: 3.4823 -
val_acc: 0.0409
Epoch 2/50
582/582 [==============================] - 855s 1s/step - loss: 3.5106 - acc: 0.0320 - val_loss: 23.9521 -
val_acc: 0.0353
Epoch 3/50
582/582 [==============================] - 850s 1s/step - loss: 3.4760 - acc: 0.0366 - val_loss: 3.4192 -
val_acc: 0.0355
Epoch 4/50
582/582 [==============================] - 856s 1s/step - loss: 3.4539 - acc: 0.0388 - val_loss: 3.8812 -
val_acc: 0.0669
Epoch 5/50
582/582 [==============================] - 857s 1s/step - loss: 3.4377 - acc: 0.0424 - val_loss: 3.5541 -
val_acc: 0.0359
Epoch 6/50
582/582 [==============================] - 851s 1s/step - loss: 3.4184 - acc: 0.0457 - val_loss: 4.8263 -
val_acc: 0.0613
Epoch 7/50
582/582 [==============================] - 860s 1s/step - loss: 3.4023 - acc: 0.0484 - val_loss: 3.3535 -
val_acc: 0.1022
Epoch 8/50
582/582 [==============================] - 868s 1s/step - loss: 3.3908 - acc: 0.0493 - val_loss: 7.1726 -
val_acc: 0.0637
Epoch 9/50
582/582 [==============================] - 858s 1s/step - loss: 3.3692 - acc: 0.0565 - val_loss: 3.5140 -
val_acc: 0.1000
Epoch 10/50
582/582 [==============================] - 864s 1s/step - loss: 3.3423 - acc: 0.0599 - val_loss: 3.8332 -
val_acc: 0.0817
Epoch 11/50
582/582 [==============================] - 855s 1s/step - loss: 3.3146 - acc: 0.0691 - val_loss: 3.9182 -
val_acc: 0.1335
Epoch 12/50
582/582 [==============================] - 874s 2s/step - loss: 3.2650 - acc: 0.0816 - val_loss: 2.7548 -
val_acc: 0.2469
Epoch 13/50
582/582 [==============================] - 892s 2s/step - loss: 3.2271 - acc: 0.0882 - val_loss: 3.1110 -
val_acc: 0.1671
Epoch 14/50
582/582 [==============================] - 898s 2s/step - loss: 3.1795 - acc: 0.1025 - val_loss: 2.4532 -
val_acc: 0.3062
Epoch 15/50
582/582 [==============================] - 890s 2s/step - loss: 3.1289 - acc: 0.1144 - val_loss: 3.1654 -
val_acc: 0.2520
Epoch 16/50
582/582 [==============================] - 856s 1s/step - loss: 3.0855 - acc: 0.1280 - val_loss: 2.1631 -
val_acc: 0.3735
Epoch 17/50
582/582 [==============================] - 855s 1s/step - loss: 3.0433 - acc: 0.1376 - val_loss: 1.8934 -
val_acc: 0.4432
Epoch 18/50
582/582 [==============================] - 852s 1s/step - loss: 3.0034 - acc: 0.1504 - val_loss: 1.7311 -
val_acc: 0.5103
Epoch 19/50
582/582 [==============================] - 854s 1s/step - loss: 2.9611 - acc: 0.1632 - val_loss: 1.6894 -
val_acc: 0.5271
Epoch 20/50
582/582 [==============================] - 874s 1s/step - loss: 2.9295 - acc: 0.1741 - val_loss: 1.5704 -
val_acc: 0.5529
Epoch 21/50
582/582 [==============================] - 899s 2s/step - loss: 2.9040 - acc: 0.1800 - val_loss: 2.2442 -
val_acc: 0.4282
Epoch 22/50
582/582 [==============================] - 887s 2s/step - loss: 2.8747 - acc: 0.1838 - val_loss: 1.5325 -
val_acc: 0.5705
Epoch 23/50
582/582 [==============================] - 880s 2s/step - loss: 2.8346 - acc: 0.1982 - val_loss: 1.3489 -
val_acc: 0.6378
Epoch 24/50
582/582 [==============================] - 875s 2s/step - loss: 2.8048 - acc: 0.2079 - val_loss: 0.9772 -
val_acc: 0.7273
Epoch 25/50
582/582 [==============================] - 852s 1s/step - loss: 2.7903 - acc: 0.2132 - val_loss: 1.2752 -
val_acc: 0.6578
Epoch 26/50
582/582 [==============================] - 851s 1s/step - loss: 2.7800 - acc: 0.2138 - val_loss: 1.5982 -
val_acc: 0.5746
Epoch 27/50
582/582 [==============================] - 851s 1s/step - loss: 2.7599 - acc: 0.2185 - val_loss: 1.1199 -
```

```
val_acc: 0.6789
Epoch 28/50
582/582 [==============================] - 850s 1s/step - loss: 2.7460 - acc: 0.2238 - val_loss: 1.1678 -
val_acc: 0.6770
Epoch 29/50
582/582 [==============================] - 850s 1s/step - loss: 2.7400 - acc: 0.2260 - val_loss: 0.9061 -
val_acc: 0.7544
Epoch 30/50
582/582 [==============================] - 849s 1s/step - loss: 2.7369 - acc: 0.2278 - val_loss: 0.7586 -
val_acc: 0.7839
Epoch 31/50
582/582 [==============================] - 849s 1s/step - loss: 2.7173 - acc: 0.2322 - val_loss: 1.3206 -
val_acc: 0.6854
Epoch 32/50
582/582 [==============================] - 849s 1s/step - loss: 2.7074 - acc: 0.2336 - val_loss: 1.3931 -
val_acc: 0.6658
Epoch 33/50
582/582 [==============================] - 850s 1s/step - loss: 2.7135 - acc: 0.2306 - val_loss: 2.1147 -
val_acc: 0.5372
Epoch 34/50
582/582 [==============================] - 849s 1s/step - loss: 2.6981 - acc: 0.2369 - val_loss: 1.0885 -
val_acc: 0.7262
Epoch 35/50
582/582 [==============================] - 849s 1s/step - loss: 2.6925 - acc: 0.2406 - val_loss: 0.9634 -
val_acc: 0.7535
```

Out[81]:
```
<keras.callbacks.History at 0x315d38b20>
```

In [82]:
```
model.evaluate(X_test,y_test)
```

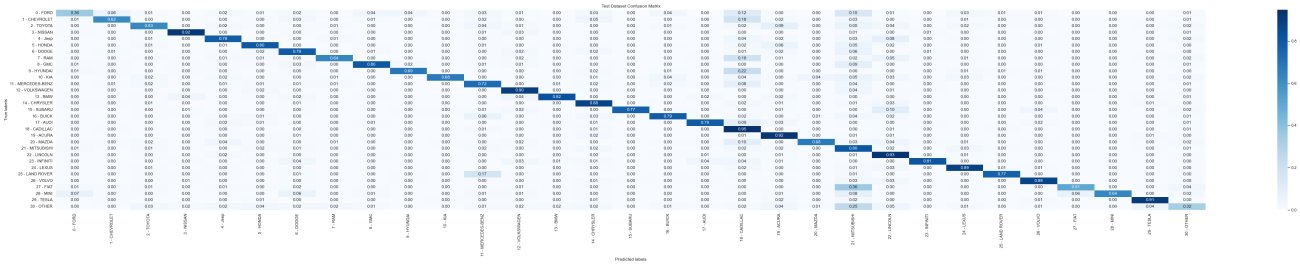
```
243/243 [==============================] - 140s 574ms/step - loss: 0.9670 - acc: 0.7543
```

Out[82]:
```
[0.9669987559318542, 0.7542909383773804]
```

In [83]:
```
y_pred = model.predict(X_test)
y_pred =  [np.argmax(i) for i in y_pred]
```

```
2022-01-29 03:35:15.902266: I tensorflow/core/grappler/optimizers/custom_graph_optimizer_registry.cc:112] Pl
ugin optimizer for device_type GPU is enabled.
```

In [84]:
```
from sklearn.metrics import confusion_matrix
sns.set(rc = {'figure.figsize':(70,10)})
ax = plt.subplot()

labels = ['0 - FORD', '1 - CHEVROLET', '2 - TOYOTA', '3 - NISSAN', '4 - Jeep', '5 - HONDA', '6 - DODGE', '7
          '11 - MERCEDES-BENZ', '12 - VOLKSWAGEN', '13 - BMW', '14 - CHRYSLER', '15 - SUBARU', '16 - BUICK',
          '21 - MITSUBISHI', '22 - LINCOLN', '23 - INFINITI', '24 - LEXUS', '25 - LAND ROVER', '26 - VOLVO',

c = confusion_matrix(y_test,y_pred)

c_norm = c.astype('float') / c.sum(axis=1)[:, np.newaxis]

cndf = pd.DataFrame(c_norm, index=labels, columns=labels)

sns.heatmap(cndf,annot=True,fmt='.2f', cmap='Blues',ax=ax)

ax.set_xlabel('Predicted labels');ax.set_ylabel('True labels')

ax.set_title('Test Dataset Confusion Matrix');
```



In [ ]:
```
```