In [1]:

```
# Import the packages we need
import keras
from keras.models import Sequential
from keras.utils import np_utils
from keras.preprocessing.image import ImageDataGenerator
from keras.layers import Dense, Activation, Flatten, Dropout, BatchNormalization
from keras.layers import Conv2D, MaxPooling2D
from keras.datasets import cifar10
from keras import regularizers, optimizers
import numpy as np

# Get the dataset
(x_train, y_train), (x_test, y_test) = cifar10.load_data()
x_train = x_train.astype('float32')
x_test = x_test.astype('float32')

# Normalization
mean = np.mean(x_train,axis=(0,1,2,3))
std = np.std(x_train,axis=(0,1,2,3))
x_train = (x_train-mean)/(std+1e-7)
x_test = (x_test-mean)/(std+1e-7)

# Preprocess our dataset
num_classes = 10
y_train = np_utils.to_categorical(y_train,num_classes)
y_test = np_utils.to_categorical(y_test,num_classes)

# Build our model
baseMapNum = 32
weight_decay = 1e-4
model = Sequential()
model.add(Conv2D(baseMapNum, (3,3), padding='same', kernel_regularizer=regularizers.l2(weight_de
cay), input_shape=x_train.shape[1:]))
model.add(Activation('relu'))
model.add(BatchNormalization())
model.add(Conv2D(baseMapNum, (3,3), padding='same', kernel_regularizer=regularizers.l2(weight_de
cay)))
model.add(Activation('relu'))
model.add(BatchNormalization())
model.add(MaxPooling2D(pool_size=(2,2)))
model.add(Dropout(0.2))

model.add(Conv2D(2*baseMapNum, (3,3), padding='same', kernel_regularizer=regularizers.l2(weight_
decay)))
model.add(Activation('relu'))
model.add(BatchNormalization())
model.add(Conv2D(2*baseMapNum, (3,3), padding='same', kernel_regularizer=regularizers.l2(weight_
decay)))
model.add(Activation('relu'))
model.add(BatchNormalization())
model.add(MaxPooling2D(pool_size=(2,2)))
model.add(Dropout(0.3))

model.add(Conv2D(4*baseMapNum, (3,3), padding='same', kernel_regularizer=regularizers.l2(weight_
decay)))
model.add(Activation('relu'))
model.add(BatchNormalization())
model.add(Conv2D(4*baseMapNum, (3,3), padding='same', kernel_regularizer=regularizers.l2(weight_
decay)))
```

```
model.add(Activation('relu'))
model.add(BatchNormalization())
model.add(MaxPooling2D(pool_size=(2,2)))
model.add(Dropout(0.4))

model.add(Flatten())
model.add(Dense(num_classes, activation='softmax'))

model.summary()

#data augmentation (increase the dataset)
datagen = ImageDataGenerator(
    featurewise_center=False,
    samplewise_center=False,
    featurewise_std_normalization=False,
    samplewise_std_normalization=False,
    zca_whitening=False,
    rotation_range=15,
    width_shift_range=0.1,
    height_shift_range=0.1,
    horizontal_flip=True,
    vertical_flip=False
    )
datagen.fit(x_train)

# Model Training
batch_size = 64
epochs=25
opt_rms = keras.optimizers.rmsprop(lr=0.001,decay=1e-6)
model.compile(loss='categorical_crossentropy',
        optimizer=opt_rms,
        metrics=['accuracy'])
model.fit_generator(datagen.flow(x_train, y_train, batch_size=batch_size),steps_per_epoch=x_trai
n.shape[0] // batch_size,epochs=3*epochs,verbose=1,validation_data=(x_test,y_test))
model.save_weights('cifar10_normal_rms_ep75.h5')

opt_rms = keras.optimizers.rmsprop(lr=0.0005,decay=1e-6)
model.compile(loss='categorical_crossentropy',
        optimizer=opt_rms,
        metrics=['accuracy'])
model.fit_generator(datagen.flow(x_train, y_train, batch_size=batch_size),steps_per_epoch=x_trai
n.shape[0] // batch_size,epochs=epochs,verbose=1,validation_data=(x_test,y_test))
model.save_weights('cifar10_normal_rms_ep100.h5')

opt_rms = keras.optimizers.rmsprop(lr=0.0003,decay=1e-6)
model.compile(loss='categorical_crossentropy',
        optimizer=opt_rms,
        metrics=['accuracy'])
model.fit_generator(datagen.flow(x_train, y_train, batch_size=batch_size),steps_per_epoch=x_trai
n.shape[0] // batch_size,epochs=epochs,verbose=1,validation_data=(x_test,y_test))
model.save_weights('cifar10_normal_rms_ep125.h5')

# Model Testing
scores = model.evaluate(x_test, y_test, batch_size=128, verbose=1)
print('\nTest result: %.3f loss: %.3f' % (scores[1]*100,scores[0]))
```

```
/Users/qiaqiasun/anaconda3/lib/python3.6/site-packages/h5py/__init__.py:36: Future
Warning: Conversion of the second argument of issubdtype from `float` to `np.float
ing` is deprecated. In future, it will be treated as `np.float64 == np.dtype(floa
t).type`.
  from ._conv import register_converters as _register_converters
Using TensorFlow backend.
```

Layer (type)	Output Shape	Param #
conv2d_1 (Conv2D)	(None, 32, 32, 32)	896
activation_1 (Activation)	(None, 32, 32, 32)	0
batch_normalization_1 (Batch	(None, 32, 32, 32)	128
conv2d_2 (Conv2D)	(None, 32, 32, 32)	9248
activation_2 (Activation)	(None, 32, 32, 32)	0
batch_normalization_2 (Batch	(None, 32, 32, 32)	128
max_pooling2d_1 (MaxPooling2	(None, 16, 16, 32)	0
dropout_1 (Dropout)	(None, 16, 16, 32)	0
conv2d_3 (Conv2D)	(None, 16, 16, 64)	18496
activation_3 (Activation)	(None, 16, 16, 64)	0
batch_normalization_3 (Batch	(None, 16, 16, 64)	256
conv2d_4 (Conv2D)	(None, 16, 16, 64)	36928
activation_4 (Activation)	(None, 16, 16, 64)	0
batch_normalization_4 (Batch	(None, 16, 16, 64)	256
max_pooling2d_2 (MaxPooling2	(None, 8, 8, 64)	0
dropout_2 (Dropout)	(None, 8, 8, 64)	0
conv2d_5 (Conv2D)	(None, 8, 8, 128)	73856
activation_5 (Activation)	(None, 8, 8, 128)	0
batch_normalization_5 (Batch	(None, 8, 8, 128)	512
conv2d_6 (Conv2D)	(None, 8, 8, 128)	147584
activation_6 (Activation)	(None, 8, 8, 128)	0
batch_normalization_6 (Batch	(None, 8, 8, 128)	512
max_pooling2d_3 (MaxPooling2	(None, 4, 4, 128)	0
dropout_3 (Dropout)	(None, 4, 4, 128)	0
flatten_1 (Flatten)	(None, 2048)	0
dense_1 (Dense)	(None, 10)	20490

```
Total params: 309,290
Trainable params: 308,394
Non-trainable params: 896
```

```
Epoch 1/75
781/781 [==============================] - 383s 490ms/step - loss: 1.9118 - acc:
```

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0.4317 - val_loss: 1.4868 - val_acc: 0.5351
Epoch 2/75
781/781 [==============================] - 369s 473ms/step - loss: 1.4657 - acc:
0.5656 - val_loss: 1.3285 - val_acc: 0.5910
Epoch 3/75
781/781 [==============================] - 1582s 2s/step - loss: 1.3093 - acc: 0.6
195 - val_loss: 1.0321 - val_acc: 0.6922
Epoch 4/75
781/781 [==============================] - 329s 422ms/step - loss: 1.2238 - acc:
0.6591 - val_loss: 1.5384 - val_acc: 0.6926
Epoch 5/75
781/781 [==============================] - 324s 414ms/step - loss: 1.1694 - acc:
0.6773 - val_loss: 0.8800 - val_acc: 0.7471
Epoch 6/75
781/781 [==============================] - 328s 420ms/step - loss: 1.0973 - acc:
0.7023 - val_loss: 1.4213 - val_acc: 0.7128
Epoch 7/75
781/781 [==============================] - 324s 415ms/step - loss: 1.0806 - acc:
0.7101 - val_loss: 0.8798 - val_acc: 0.7488
Epoch 8/75
781/781 [==============================] - 330s 422ms/step - loss: 1.0417 - acc:
0.7254 - val_loss: 0.9084 - val_acc: 0.7524
Epoch 9/75
781/781 [==============================] - 328s 420ms/step - loss: 1.0998 - acc:
0.7259 - val_loss: 0.9236 - val_acc: 0.7672
Epoch 10/75
781/781 [==============================] - 326s 417ms/step - loss: 1.1046 - acc:
0.7288 - val_loss: 0.9968 - val_acc: 0.7548
Epoch 11/75
781/781 [==============================] - 329s 421ms/step - loss: 1.0768 - acc:
0.7345 - val_loss: 0.9582 - val_acc: 0.7717
Epoch 12/75
781/781 [==============================] - 326s 417ms/step - loss: 1.0228 - acc:
0.7393 - val_loss: 0.8976 - val_acc: 0.7817
Epoch 13/75
781/781 [==============================] - 333s 426ms/step - loss: 0.9868 - acc:
0.7472 - val_loss: 3.1465 - val_acc: 0.6633
Epoch 14/75
781/781 [==============================] - 333s 426ms/step - loss: 0.9504 - acc:
0.7565 - val_loss: 1.3716 - val_acc: 0.7552
Epoch 15/75
781/781 [==============================] - 339s 435ms/step - loss: 0.9541 - acc:
0.7590 - val_loss: 1.2676 - val_acc: 0.7648
Epoch 16/75
781/781 [==============================] - 336s 430ms/step - loss: 0.9403 - acc:
0.7627 - val_loss: 1.1139 - val_acc: 0.7543
Epoch 17/75
781/781 [==============================] - 235s 301ms/step - loss: 0.9235 - acc:
0.7664 - val_loss: 0.8855 - val_acc: 0.7950
Epoch 18/75
781/781 [==============================] - 221s 283ms/step - loss: 0.9058 - acc:
0.7716 - val_loss: 1.3050 - val_acc: 0.7796
Epoch 19/75
781/781 [==============================] - 221s 283ms/step - loss: 0.9066 - acc:
0.7742 - val_loss: 0.8119 - val_acc: 0.8040
Epoch 20/75
781/781 [==============================] - 258s 331ms/step - loss: 0.8841 - acc:
0.7765 - val_loss: 1.0736 - val_acc: 0.7878
Epoch 21/75
781/781 [==============================] - 461s 590ms/step - loss: 0.9035 - acc:
0.7794 - val_loss: 0.8438 - val_acc: 0.8109
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Epoch 22/75
781/781 [==============================] - 503s 644ms/step - loss: 0.8727 - acc:
0.7832 - val_loss: 0.8441 - val_acc: 0.7974
Epoch 23/75
781/781 [==============================] - 4095s 5s/step - loss: 0.8879 - acc: 0.7
828 - val_loss: 0.9734 - val_acc: 0.7985
Epoch 24/75
781/781 [==============================] - 216s 276ms/step - loss: 0.8413 - acc:
0.7894 - val_loss: 0.9149 - val_acc: 0.8205
Epoch 25/75
781/781 [==============================] - 217s 278ms/step - loss: 0.8586 - acc:
0.7888 - val_loss: 1.3047 - val_acc: 0.7925
Epoch 26/75
781/781 [==============================] - 220s 282ms/step - loss: 0.8820 - acc:
0.7883 - val_loss: 0.7831 - val_acc: 0.8233
Epoch 27/75
781/781 [==============================] - 222s 284ms/step - loss: 0.8280 - acc:
0.7949 - val_loss: 0.8617 - val_acc: 0.8234
Epoch 28/75
781/781 [==============================] - 225s 289ms/step - loss: 0.8256 - acc:
0.7951 - val_loss: 0.9012 - val_acc: 0.8179
Epoch 29/75
781/781 [==============================] - 226s 290ms/step - loss: 0.8332 - acc:
0.7965 - val_loss: 0.7819 - val_acc: 0.8197
Epoch 30/75
781/781 [==============================] - 226s 289ms/step - loss: 0.8187 - acc:
0.7967 - val_loss: 1.0507 - val_acc: 0.7999
Epoch 31/75
781/781 [==============================] - 228s 292ms/step - loss: 0.8071 - acc:
0.8016 - val_loss: 0.9362 - val_acc: 0.8043
Epoch 32/75
781/781 [==============================] - 227s 291ms/step - loss: 0.8146 - acc:
0.7992 - val_loss: 1.1867 - val_acc: 0.7892
Epoch 33/75
781/781 [==============================] - 223s 286ms/step - loss: 0.7920 - acc:
0.8017 - val_loss: 1.1430 - val_acc: 0.8086
Epoch 34/75
781/781 [==============================] - 229s 293ms/step - loss: 0.8354 - acc:
0.7999 - val_loss: 0.8882 - val_acc: 0.8147
Epoch 35/75
781/781 [==============================] - 234s 300ms/step - loss: 0.7724 - acc:
0.8060 - val_loss: 0.7553 - val_acc: 0.8301
Epoch 36/75
781/781 [==============================] - 240s 307ms/step - loss: 0.7621 - acc:
0.8084 - val_loss: 0.8710 - val_acc: 0.8201
Epoch 37/75
781/781 [==============================] - 244s 313ms/step - loss: 0.7613 - acc:
0.8098 - val_loss: 0.7194 - val_acc: 0.8372
Epoch 38/75
781/781 [==============================] - 247s 317ms/step - loss: 0.7367 - acc:
0.8118 - val_loss: 0.8212 - val_acc: 0.8266
Epoch 39/75
781/781 [==============================] - 249s 318ms/step - loss: 0.7282 - acc:
0.8146 - val_loss: 0.7768 - val_acc: 0.8287
Epoch 40/75
781/781 [==============================] - 254s 325ms/step - loss: 0.7109 - acc:
0.8176 - val_loss: 0.7559 - val_acc: 0.8310
Epoch 41/75
781/781 [==============================] - 252s 323ms/step - loss: 0.6959 - acc:
0.8180 - val_loss: 0.6565 - val_acc: 0.8439
Epoch 42/75
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781/781 [==============================] - 251s 321ms/step - loss: 0.6816 - acc:
0.8207 - val_loss: 0.6920 - val_acc: 0.8262
Epoch 43/75
781/781 [==============================] - 250s 319ms/step - loss: 0.6684 - acc:
0.8218 - val_loss: 0.6801 - val_acc: 0.8315
Epoch 44/75
781/781 [==============================] - 248s 317ms/step - loss: 0.6601 - acc:
0.8260 - val_loss: 0.6234 - val_acc: 0.8469
Epoch 45/75
781/781 [==============================] - 245s 314ms/step - loss: 0.6512 - acc:
0.8274 - val_loss: 0.6480 - val_acc: 0.8381
Epoch 46/75
781/781 [==============================] - 244s 312ms/step - loss: 0.6485 - acc:
0.8287 - val_loss: 0.6856 - val_acc: 0.8286
Epoch 47/75
781/781 [==============================] - 242s 310ms/step - loss: 0.6483 - acc:
0.8281 - val_loss: 0.6248 - val_acc: 0.8445
Epoch 48/75
781/781 [==============================] - 241s 309ms/step - loss: 0.6382 - acc:
0.8319 - val_loss: 0.6080 - val_acc: 0.8454
Epoch 49/75
781/781 [==============================] - 242s 310ms/step - loss: 0.6337 - acc:
0.8331 - val_loss: 0.6543 - val_acc: 0.8373
Epoch 50/75
781/781 [==============================] - 242s 310ms/step - loss: 0.6362 - acc:
0.8308 - val_loss: 0.6357 - val_acc: 0.8378
Epoch 51/75
781/781 [==============================] - 243s 311ms/step - loss: 0.6327 - acc:
0.8334 - val_loss: 0.5712 - val_acc: 0.8580
Epoch 52/75
781/781 [==============================] - 243s 312ms/step - loss: 0.6320 - acc:
0.8318 - val_loss: 0.6910 - val_acc: 0.8256
Epoch 53/75
781/781 [==============================] - 234s 299ms/step - loss: 0.6211 - acc:
0.8370 - val_loss: 0.6140 - val_acc: 0.8465
Epoch 54/75
781/781 [==============================] - 228s 292ms/step - loss: 0.6222 - acc:
0.8376 - val_loss: 0.6691 - val_acc: 0.8336
Epoch 55/75
781/781 [==============================] - 224s 287ms/step - loss: 0.6213 - acc:
0.8377 - val_loss: 0.6105 - val_acc: 0.8478
Epoch 56/75
781/781 [==============================] - 221s 283ms/step - loss: 0.6210 - acc:
0.8381 - val_loss: 0.5908 - val_acc: 0.8553
Epoch 57/75
781/781 [==============================] - 220s 282ms/step - loss: 0.6184 - acc:
0.8374 - val_loss: 0.5929 - val_acc: 0.8547
Epoch 58/75
781/781 [==============================] - 220s 281ms/step - loss: 0.6160 - acc:
0.8379 - val_loss: 0.5706 - val_acc: 0.8605
Epoch 59/75
781/781 [==============================] - 220s 282ms/step - loss: 0.6193 - acc:
0.8375 - val_loss: 0.5988 - val_acc: 0.8488
Epoch 60/75
781/781 [==============================] - 220s 281ms/step - loss: 0.6108 - acc:
0.8399 - val_loss: 0.6182 - val_acc: 0.8498
Epoch 61/75
781/781 [==============================] - 219s 280ms/step - loss: 0.6099 - acc:
0.8421 - val_loss: 0.5731 - val_acc: 0.8574
Epoch 62/75
781/781 [==============================] - 220s 282ms/step - loss: 0.6074 - acc:
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0.8421 - val_loss: 0.6777 - val_acc: 0.8303
Epoch 63/75
781/781 [==============================] - 220s 282ms/step - loss: 0.6058 - acc:
0.8437 - val_loss: 0.6710 - val_acc: 0.8260
Epoch 64/75
781/781 [==============================] - 220s 282ms/step - loss: 0.6051 - acc:
0.8412 - val_loss: 0.6238 - val_acc: 0.8483
Epoch 65/75
781/781 [==============================] - 220s 282ms/step - loss: 0.6030 - acc:
0.8445 - val_loss: 0.6796 - val_acc: 0.8321
Epoch 66/75
781/781 [==============================] - 221s 283ms/step - loss: 0.5990 - acc:
0.8441 - val_loss: 0.6087 - val_acc: 0.8496
Epoch 67/75
781/781 [==============================] - 222s 284ms/step - loss: 0.5977 - acc:
0.8462 - val_loss: 0.5954 - val_acc: 0.8540
Epoch 68/75
781/781 [==============================] - 224s 286ms/step - loss: 0.5999 - acc:
0.8440 - val_loss: 0.5742 - val_acc: 0.8599
Epoch 69/75
781/781 [==============================] - 222s 284ms/step - loss: 0.5990 - acc:
0.8458 - val_loss: 0.6053 - val_acc: 0.8514
Epoch 70/75
781/781 [==============================] - 222s 284ms/step - loss: 0.5948 - acc:
0.8462 - val_loss: 0.5837 - val_acc: 0.8580
Epoch 71/75
781/781 [==============================] - 222s 284ms/step - loss: 0.5983 - acc:
0.8470 - val_loss: 0.6494 - val_acc: 0.8423
Epoch 72/75
781/781 [==============================] - 222s 285ms/step - loss: 0.5954 - acc:
0.8471 - val_loss: 0.6289 - val_acc: 0.8425
Epoch 73/75
781/781 [==============================] - 223s 285ms/step - loss: 0.5954 - acc:
0.8470 - val_loss: 0.5595 - val_acc: 0.8626
Epoch 74/75
781/781 [==============================] - 222s 285ms/step - loss: 0.5949 - acc:
0.8470 - val_loss: 0.6457 - val_acc: 0.8425
Epoch 75/75
781/781 [==============================] - 222s 285ms/step - loss: 0.5928 - acc:
0.8469 - val_loss: 0.6251 - val_acc: 0.8516
Epoch 1/25
781/781 [==============================] - 225s 288ms/step - loss: 0.5529 - acc:
0.8603 - val_loss: 0.5484 - val_acc: 0.8678
Epoch 2/25
781/781 [==============================] - 222s 284ms/step - loss: 0.5320 - acc:
0.8659 - val_loss: 0.5481 - val_acc: 0.8670
Epoch 3/25
781/781 [==============================] - 222s 284ms/step - loss: 0.5219 - acc:
0.8680 - val_loss: 0.5347 - val_acc: 0.8735
Epoch 4/25
781/781 [==============================] - 223s 285ms/step - loss: 0.5196 - acc:
0.8693 - val_loss: 0.5476 - val_acc: 0.8681
Epoch 5/25
781/781 [==============================] - 222s 284ms/step - loss: 0.5157 - acc:
0.8688 - val_loss: 0.5418 - val_acc: 0.8682
Epoch 6/25
781/781 [==============================] - 223s 285ms/step - loss: 0.5127 - acc:
0.8698 - val_loss: 0.5497 - val_acc: 0.8684
Epoch 7/25
781/781 [==============================] - 222s 284ms/step - loss: 0.5106 - acc:
0.8685 - val_loss: 0.5158 - val_acc: 0.8738
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Epoch 8/25
781/781 [==============================] - 222s 284ms/step - loss: 0.5069 - acc:
0.8702 - val_loss: 0.5036 - val_acc: 0.8743
Epoch 9/25
781/781 [==============================] - 222s 285ms/step - loss: 0.5007 - acc:
0.8706 - val_loss: 0.5295 - val_acc: 0.8719
Epoch 10/25
781/781 [==============================] - 222s 285ms/step - loss: 0.4947 - acc:
0.8721 - val_loss: 0.5379 - val_acc: 0.8669
Epoch 11/25
781/781 [==============================] - 223s 285ms/step - loss: 0.4959 - acc:
0.8738 - val_loss: 0.5541 - val_acc: 0.8661
Epoch 12/25
781/781 [==============================] - 223s 285ms/step - loss: 0.4926 - acc:
0.8725 - val_loss: 0.5421 - val_acc: 0.8660
Epoch 13/25
781/781 [==============================] - 223s 285ms/step - loss: 0.4914 - acc:
0.8732 - val_loss: 0.5463 - val_acc: 0.8654
Epoch 14/25
781/781 [==============================] - 223s 286ms/step - loss: 0.4873 - acc:
0.8742 - val_loss: 0.5400 - val_acc: 0.8696
Epoch 15/25
781/781 [==============================] - 223s 285ms/step - loss: 0.4919 - acc:
0.8719 - val_loss: 0.5049 - val_acc: 0.8795
Epoch 16/25
781/781 [==============================] - 224s 287ms/step - loss: 0.4894 - acc:
0.8718 - val_loss: 0.5119 - val_acc: 0.8739
Epoch 17/25
781/781 [==============================] - 223s 285ms/step - loss: 0.4862 - acc:
0.8737 - val_loss: 0.5043 - val_acc: 0.8734
Epoch 18/25
781/781 [==============================] - 218s 280ms/step - loss: 0.4912 - acc:
0.8710 - val_loss: 0.4604 - val_acc: 0.8884
Epoch 19/25
781/781 [==============================] - 218s 280ms/step - loss: 0.4823 - acc:
0.8740 - val_loss: 0.4987 - val_acc: 0.8767
Epoch 20/25
781/781 [==============================] - 219s 280ms/step - loss: 0.4803 - acc:
0.8751 - val_loss: 0.5208 - val_acc: 0.8677
Epoch 21/25
781/781 [==============================] - 218s 279ms/step - loss: 0.4811 - acc:
0.8736 - val_loss: 0.4852 - val_acc: 0.8806
Epoch 22/25
781/781 [==============================] - 219s 280ms/step - loss: 0.4787 - acc:
0.8768 - val_loss: 0.5522 - val_acc: 0.8619
Epoch 23/25
781/781 [==============================] - 219s 280ms/step - loss: 0.4759 - acc:
0.8755 - val_loss: 0.5677 - val_acc: 0.8566
Epoch 24/25
781/781 [==============================] - 219s 280ms/step - loss: 0.4776 - acc:
0.8763 - val_loss: 0.5058 - val_acc: 0.8726
Epoch 25/25
781/781 [==============================] - 220s 281ms/step - loss: 0.4733 - acc:
0.8756 - val_loss: 0.5124 - val_acc: 0.8757
Epoch 1/25
781/781 [==============================] - 223s 285ms/step - loss: 0.4515 - acc:
0.8833 - val_loss: 0.4800 - val_acc: 0.8812
Epoch 2/25
781/781 [==============================] - 219s 281ms/step - loss: 0.4462 - acc:
0.8858 - val_loss: 0.4751 - val_acc: 0.8837
Epoch 3/25
```

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781/781 [==============================] - 219s 281ms/step - loss: 0.4435 - acc:
0.8850 - val_loss: 0.4901 - val_acc: 0.8801
Epoch 4/25
781/781 [==============================] - 219s 281ms/step - loss: 0.4390 - acc:
0.8864 - val_loss: 0.4893 - val_acc: 0.8796
Epoch 5/25
781/781 [==============================] - 220s 281ms/step - loss: 0.4323 - acc:
0.8893 - val_loss: 0.4616 - val_acc: 0.8831
Epoch 6/25
781/781 [==============================] - 221s 283ms/step - loss: 0.4362 - acc:
0.8869 - val_loss: 0.4393 - val_acc: 0.8910
Epoch 7/25
781/781 [==============================] - 221s 283ms/step - loss: 0.4332 - acc:
0.8887 - val_loss: 0.4869 - val_acc: 0.8781
Epoch 8/25
781/781 [==============================] - 222s 285ms/step - loss: 0.4306 - acc:
0.8869 - val_loss: 0.4553 - val_acc: 0.8864
Epoch 9/25
781/781 [==============================] - 223s 286ms/step - loss: 0.4346 - acc:
0.8885 - val_loss: 0.4421 - val_acc: 0.8882
Epoch 10/25
781/781 [==============================] - 223s 286ms/step - loss: 0.4224 - acc:
0.8908 - val_loss: 0.4643 - val_acc: 0.8812
Epoch 11/25
781/781 [==============================] - 225s 288ms/step - loss: 0.4238 - acc:
0.8899 - val_loss: 0.4641 - val_acc: 0.8879
Epoch 12/25
781/781 [==============================] - 226s 290ms/step - loss: 0.4282 - acc:
0.8880 - val_loss: 0.4813 - val_acc: 0.8802
Epoch 13/25
781/781 [==============================] - 227s 291ms/step - loss: 0.4275 - acc:
0.8871 - val_loss: 0.5005 - val_acc: 0.8714
Epoch 14/25
781/781 [==============================] - 228s 292ms/step - loss: 0.4192 - acc:
0.8901 - val_loss: 0.4675 - val_acc: 0.8827
Epoch 15/25
781/781 [==============================] - 229s 293ms/step - loss: 0.4235 - acc:
0.8890 - val_loss: 0.4676 - val_acc: 0.8826
Epoch 16/25
781/781 [==============================] - 230s 295ms/step - loss: 0.4163 - acc:
0.8918 - val_loss: 0.4701 - val_acc: 0.8831
Epoch 17/25
781/781 [==============================] - 231s 295ms/step - loss: 0.4147 - acc:
0.8921 - val_loss: 0.4546 - val_acc: 0.8847
Epoch 18/25
781/781 [==============================] - 232s 297ms/step - loss: 0.4142 - acc:
0.8911 - val_loss: 0.4709 - val_acc: 0.8834
Epoch 19/25
781/781 [==============================] - 233s 298ms/step - loss: 0.4210 - acc:
0.8895 - val_loss: 0.4835 - val_acc: 0.8783
Epoch 20/25
781/781 [==============================] - 233s 299ms/step - loss: 0.4147 - acc:
0.8915 - val_loss: 0.4498 - val_acc: 0.8879
Epoch 21/25
781/781 [==============================] - 234s 300ms/step - loss: 0.4123 - acc:
0.8919 - val_loss: 0.4536 - val_acc: 0.8868
Epoch 22/25
781/781 [==============================] - 235s 301ms/step - loss: 0.4146 - acc:
0.8922 - val_loss: 0.4866 - val_acc: 0.8746
Epoch 23/25
781/781 [==============================] - 236s 302ms/step - loss: 0.4172 - acc:
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0.8899 - val_loss: 0.4775 - val_acc: 0.8784
Epoch 24/25
781/781 [==============================] - 236s 303ms/step - loss: 0.4124 - acc:
0.8910 - val_loss: 0.5359 - val_acc: 0.8651
Epoch 25/25
781/781 [==============================] - 237s 304ms/step - loss: 0.4125 - acc:
0.8916 - val_loss: 0.4710 - val_acc: 0.8799
10000/10000 [==============================] - 15s 1ms/step

Test result: 87.990 loss: 0.471
```

In [ ]: