# CIFAR10KERAS

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## 1 ECE 763 - Computer Vision - Project 03

### 1.1 Babysitting the training of a Network

#### 1.1.1 mmsardes

**Import libraries** Keras Sequential API was used to build the network. The CIFAR datasets was downloaded from keras datasets. Babysitting the training of a DNN is important as the final network performance depends a lot on how you set the hyper-parameters, how you initialize the weights, for how long you train the network etc. You don't want to over-train, or over-fit the model as it would lead to loss of generalization. General steps followed while training a DNN are 1. Pre-process the Data and select Data Augmentation schemes. 2. Choose architecture of the network 3. Double check if the loss is reasonable. 4. Hyperparameter tuning

[3]:
```
import tensorflow as tf
import matplotlib.pyplot as plt
from tensorflow.keras import Sequential
from tensorflow.keras.layers import Flatten, Dense, Conv2D, MaxPool2D, Dropout,␣
↪Reshape, BatchNormalization, Activation
from tensorflow.keras import optimizers, regularizers
from sklearn.model_selection import train_test_split
import numpy as np
from tqdm import tqdm
```

**Import and preprocess the data.** Preprocessing scheme was standard scaling by subtracting mean and dividing by the standard deviation. A basic preprocessing operation is done by subtracting the mean and dividing by the standard deviation over the dataset. This is basically zero centering the data. This makes the model less sensitive to small changes in weights and makes it easier to optimize. It also reduces the effect of outliers to some extent as the range of the data is restricted.

[4]:
```
from tensorflow.keras.datasets import cifar10
(X_train, y_train), (X_test, y_test) = cifar10.load_data()
#conv to float
(X_train, y_train), (X_test, y_test)=(X_train.astype('float32'), y_train),␣
↪(X_test.astype('float32'), y_test)
#class_names for cifar
```

```
class_name =␣
↪['airplane','automobile','bird','cat','deer','dog','frog','horse','ship','truck']
num_classes = len(class_name)
preprocess_flag=True
```

[5]:
```
def preprocess_data(X_train, X_test):
    X_train-=np.mean(X_train,axis=0)
    X_test-=np.mean(X_test,axis=0)
    X_train/=np.std(X_train,axis=0)
    X_test/=np.std(X_test,axis=0)
    return X_train, X_test
if preprocess_flag==True:
    X_train, X_test=preprocess_data(X_train, X_test)
```

[6]:
```
#shape of the image data.
iRows,iCols=X_train[0].shape[0],X_train[0].shape[1]
```

[7]:
```
X_train, X_val, y_train, y_val = train_test_split(X_train, y_train)
```

### 1.1.2 Build the CNN

Here I have chosen a basic CNN with 3 layers. 32, 64, 128 filters in the three layers. All of them being 3x3 filters with a stride of 1. All the convolutional blocks are followed by 2x2 maxpool blocks. In the end the result is flattened and connected to a FCN with one hidden layer with 128 neurons and a softmax layer with 10 units as there are 10 classes in CIFAR. All the layers have 'relu' activations. The model is created using the Sequential API in Keras. Conditions are added to tweak the network if batchnormalization and dropout is desired.

[8]:
```
#model hyperparam - Intial
LEARNING_RATE=1e-4
EPOCHS=10
L2_REG=0
BATCH_SIZE=32
DROPOUT=0.5
```

[9]:
```
#Function to create model according to given conditions.
def create_model(num_clases,L2_REG, drop=False, bnorm=False):
    model = Sequential()
    if drop==True:
        model.add(Conv2D(filters=32, kernel_size=(3,3), padding= 'same',␣
↪activation='relu',input_shape = (iRows, iCols,3)))
        model.add(MaxPool2D(pool_size=(2,2), strides = 2, padding='same'))
        model.add(Dropout(DROPOUT))
        model.add(Conv2D(filters=64, kernel_size=(3,3), padding= 'same',␣
↪activation='relu',kernel_regularizer=regularizers.l2(L2_REG),␣
↪bias_regularizer=regularizers.l2(L2_REG)))
        model.add(MaxPool2D(pool_size=(2,2), strides = 2, padding='same'))
```

```
        model.add(Conv2D(filters=128, kernel_size=(3,3), padding= 'same',␣
↪activation='relu', kernel_regularizer=regularizers.l2(L2_REG),␣
↪bias_regularizer=regularizers.l2(L2_REG)))
        model.add(MaxPool2D(pool_size=(2,2), strides = 2, padding='same'))
        model.add(Dropout(DROPOUT))

        model.add(Flatten())
        model.add(Dense(units = 128, activation='relu',␣
↪kernel_regularizer=regularizers.l2(L2_REG), bias_regularizer=regularizers.
↪l2(L2_REG)))
        model.add(Dense(units=num_classes,activation='softmax'))
    elif bnorm==True:
        model.add(Conv2D(filters=32, kernel_size=(3,3), padding=␣
↪'same',input_shape = (iRows, iCols,3)))
        model.add(BatchNormalization())
        model.add(Activation('relu'))
        model.add(MaxPool2D(pool_size=(2,2), strides = 2, padding='same'))

        model.add(Conv2D(filters=64, kernel_size=(3,3), padding= 'same',␣
↪kernel_regularizer=regularizers.l2(L2_REG), use_bias=False))
        model.add(BatchNormalization())
        model.add(Activation('relu'))
        model.add(MaxPool2D(pool_size=(2,2), strides = 2, padding='same'))

        model.add(Conv2D(filters=128, kernel_size=(3,3), padding= 'same',␣
↪kernel_regularizer=regularizers.l2(L2_REG), use_bias=False))
        model.add(BatchNormalization())
        model.add(Activation('relu'))
        model.add(MaxPool2D(pool_size=(2,2), strides = 2, padding='same'))

        model.add(Flatten())
        model.add(Dense(units = 128, kernel_regularizer=regularizers.
↪l2(L2_REG), use_bias=False))
        model.add(BatchNormalization())
        model.add(Activation('relu'))
        model.add(Dense(units=num_classes,activation='softmax'))
    else:
        model.add(Conv2D(filters=32, kernel_size=(3,3), padding= 'same',␣
↪activation='relu',input_shape = (iRows, iCols,3)))
        model.add(MaxPool2D(pool_size=(2,2), strides = 2, padding='same'))

        model.add(Conv2D(filters=64, kernel_size=(3,3), padding= 'same',␣
↪activation='relu',kernel_regularizer=regularizers.l2(L2_REG),␣
↪bias_regularizer=regularizers.l2(L2_REG)))
        model.add(MaxPool2D(pool_size=(2,2), strides = 2, padding='same'))
```

```
        model.add(Conv2D(filters=128, kernel_size=(3,3), padding= 'same',␣
↪activation='relu', kernel_regularizer=regularizers.l2(L2_REG),␣
↪bias_regularizer=regularizers.l2(L2_REG)))
        model.add(MaxPool2D(pool_size=(2,2), strides = 2, padding='same'))

        model.add(Flatten())
        model.add(Dense(units = 128, activation='relu',␣
↪kernel_regularizer=regularizers.l2(L2_REG), bias_regularizer=regularizers.
↪l2(L2_REG)))
        model.add(Dense(units=num_classes,activation='softmax'))
    return model
```

[10]:
```
model=create_model(num_classes,L2_REG)
model.summary()
```

```
WARNING:tensorflow:From C:\Users\sarde\Anaconda3\envs\tensorflow\lib\site-
packages\tensorflow_core\python\ops\resource_variable_ops.py:1630: calling
BaseResourceVariable.__init__ (from tensorflow.python.ops.resource_variable_ops)
with constraint is deprecated and will be removed in a future version.
Instructions for updating:
If using Keras pass *_constraint arguments to layers.
Model: "sequential"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d (Conv2D)              (None, 32, 32, 32)        896
_________________________________________________________________
max_pooling2d (MaxPooling2D) (None, 16, 16, 32)        0
_________________________________________________________________
conv2d_1 (Conv2D)            (None, 16, 16, 64)        18496
_________________________________________________________________
max_pooling2d_1 (MaxPooling2 (None, 8, 8, 64)          0
_________________________________________________________________
conv2d_2 (Conv2D)            (None, 8, 8, 128)         73856
_________________________________________________________________
max_pooling2d_2 (MaxPooling2 (None, 4, 4, 128)         0
_________________________________________________________________
flatten (Flatten)            (None, 2048)              0
_________________________________________________________________
dense (Dense)                (None, 128)               262272
_________________________________________________________________
dense_1 (Dense)              (None, 10)                1290
=================================================================
Total params: 356,810
Trainable params: 356,810
Non-trainable params: 0
```

---

**Compile and evaluate the Initial loss as a sanity check** The initial loss should come up to be around 2.3 for 10 classes with no regularization applied.

[11]:
```
model.compile(optimizer=optimizers.
 ↪SGD(learning_rate=LEARNING_RATE),loss='sparse_categorical_crossentropy',metrics=['sparse_ca
```

[12]:
```
model.evaluate(X_train,y_train)
```

```
37500/37500 [==============================] - 4s 110us/sample - loss: 2.3173 -
sparse_categorical_accuracy: 0.1051s - loss: 2.3194 -
sparse_categorical_accuracy: 0. - ETA: 5s - loss: 2.3183 - sparse_categorical_ -
ETA: 1s - loss: 2.3176 - sparse_categorica
```

[12]:
```
[2.317313319498698, 0.10514667]
```

**Crank up regularization** Sanity check: If we crank up the regularization we get a higher loss as expected.

[13]:
```
#model hyperparam
LEARNING_RATE=1e-4
EPOCHS=10
L2_REG=1e3

model=create_model(num_classes,L2_REG)
model.compile(optimizer=optimizers.
 ↪SGD(learning_rate=LEARNING_RATE),loss='sparse_categorical_crossentropy',metrics=['sparse_ca
model.evaluate(X_train, y_train)
```

```
37500/37500 [==============================] - 3s 68us/sample - loss:
369745.2781 - sparse_categorical_accuracy: 0.1180s - loss: 369745.2783 -
sparse_catego
```

[13]:
```
[369745.27807666664, 0.118]
```

**Try to overfit a small portion of data.** We try to overfit the small portion of the data as a sanity check with no regularization and vanilla SGD optimizer. This ensures that our model is actually learning and the loss is going down. We verify this using the training accuracy (It should reach 100% theoretically). We can also see that the model reaches a very small loss as we reach the last epoch. That's a good sanity check.

[14]:
```
#model hyperparam
LEARNING_RATE=1e-3
EPOCHS=600
L2_REG=0
```

```
X_tiny=X_train[:20]
y_tiny=y_train[:20]
```

[15]:
```
model=create_model(num_classes,L2_REG)
model.compile(optimizer=optimizers.
 ↪SGD(learning_rate=LEARNING_RATE),loss='sparse_categorical_crossentropy',metrics=['sparse_ca
history = model.fit(X_tiny,y_tiny,batch_size=2,epochs=EPOCHS, verbose=1)
```

```
Train on 20 samples
Epoch 1/600
20/20 [==============================] - 0s 14ms/sample - loss: 2.2464 -
sparse_categorical_accuracy: 0.1000
Epoch 2/600
20/20 [==============================] - 0s 181us/sample - loss: 2.2363 -
sparse_categorical_accuracy: 0.1000
Epoch 3/600
20/20 [==============================] - 0s 130us/sample - loss: 2.2263 -
sparse_categorical_accuracy: 0.1000
Epoch 4/600
20/20 [==============================] - 0s 178us/sample - loss: 2.2166 -
sparse_categorical_accuracy: 0.1000
Epoch 5/600
20/20 [==============================] - 0s 175us/sample - loss: 2.2072 -
sparse_categorical_accuracy: 0.1000
Epoch 6/600
20/20 [==============================] - 0s 181us/sample - loss: 2.1980 -
sparse_categorical_accuracy: 0.1500
Epoch 7/600
20/20 [==============================] - 0s 249us/sample - loss: 2.1890 -
sparse_categorical_accuracy: 0.1000
Epoch 8/600
20/20 [==============================] - 0s 186us/sample - loss: 2.1802 -
sparse_categorical_accuracy: 0.1000
Epoch 9/600
20/20 [==============================] - 0s 177us/sample - loss: 2.1714 -
sparse_categorical_accuracy: 0.1000
Epoch 10/600
20/20 [==============================] - 0s 150us/sample - loss: 2.1628 -
sparse_categorical_accuracy: 0.1000
Epoch 11/600
20/20 [==============================] - 0s 173us/sample - loss: 2.1542 -
sparse_categorical_accuracy: 0.1500
Epoch 12/600
20/20 [==============================] - 0s 228us/sample - loss: 2.1457 -
sparse_categorical_accuracy: 0.1500
Epoch 13/600
20/20 [==============================] - 0s 182us/sample - loss: 2.1372 -
```

```
sparse_categorical_accuracy: 0.1500
Epoch 14/600
20/20 [==============================] - 0s 193us/sample - loss: 2.1288 -
sparse_categorical_accuracy: 0.1500
Epoch 15/600
20/20 [==============================] - 0s 197us/sample - loss: 2.1205 -
sparse_categorical_accuracy: 0.1500
Epoch 16/600
20/20 [==============================] - 0s 185us/sample - loss: 2.1124 -
sparse_categorical_accuracy: 0.1500
Epoch 17/600
20/20 [==============================] - 0s 172us/sample - loss: 2.1043 -
sparse_categorical_accuracy: 0.1500
Epoch 18/600
20/20 [==============================] - 0s 228us/sample - loss: 2.0963 -
sparse_categorical_accuracy: 0.2000
Epoch 19/600
20/20 [==============================] - 0s 187us/sample - loss: 2.0885 -
sparse_categorical_accuracy: 0.2000
Epoch 20/600
20/20 [==============================] - 0s 199us/sample - loss: 2.0808 -
sparse_categorical_accuracy: 0.2000
Epoch 21/600
20/20 [==============================] - 0s 245us/sample - loss: 2.0733 -
sparse_categorical_accuracy: 0.2500
Epoch 22/600
20/20 [==============================] - 0s 199us/sample - loss: 2.0658 -
sparse_categorical_accuracy: 0.2500
Epoch 23/600
20/20 [==============================] - 0s 239us/sample - loss: 2.0585 -
sparse_categorical_accuracy: 0.2500
Epoch 24/600
20/20 [==============================] - 0s 216us/sample - loss: 2.0513 -
sparse_categorical_accuracy: 0.3000
Epoch 25/600
20/20 [==============================] - 0s 254us/sample - loss: 2.0443 -
sparse_categorical_accuracy: 0.2500
Epoch 26/600
20/20 [==============================] - 0s 201us/sample - loss: 2.0374 -
sparse_categorical_accuracy: 0.2500
Epoch 27/600
20/20 [==============================] - 0s 249us/sample - loss: 2.0307 -
sparse_categorical_accuracy: 0.2500
Epoch 28/600
20/20 [==============================] - 0s 186us/sample - loss: 2.0240 -
sparse_categorical_accuracy: 0.2500
Epoch 29/600
20/20 [==============================] - 0s 199us/sample - loss: 2.0175 -
```

```
sparse_categorical_accuracy: 0.2500
Epoch 30/600
20/20 [==============================] - 0s 284us/sample - loss: 2.0111 -
sparse_categorical_accuracy: 0.2500
Epoch 31/600
20/20 [==============================] - 0s 185us/sample - loss: 2.0048 -
sparse_categorical_accuracy: 0.2500
Epoch 32/600
20/20 [==============================] - 0s 285us/sample - loss: 1.9986 -
sparse_categorical_accuracy: 0.2500
Epoch 33/600
20/20 [==============================] - 0s 180us/sample - loss: 1.9923 -
sparse_categorical_accuracy: 0.2500
Epoch 34/600
20/20 [==============================] - 0s 182us/sample - loss: 1.9861 -
sparse_categorical_accuracy: 0.2500
Epoch 35/600
20/20 [==============================] - 0s 155us/sample - loss: 1.9799 -
sparse_categorical_accuracy: 0.2500
Epoch 36/600
20/20 [==============================] - 0s 179us/sample - loss: 1.9737 -
sparse_categorical_accuracy: 0.2500
Epoch 37/600
20/20 [==============================] - 0s 249us/sample - loss: 1.9676 -
sparse_categorical_accuracy: 0.2500
Epoch 38/600
20/20 [==============================] - 0s 200us/sample - loss: 1.9614 -
sparse_categorical_accuracy: 0.2500
Epoch 39/600
20/20 [==============================] - 0s 251us/sample - loss: 1.9554 -
sparse_categorical_accuracy: 0.2500
Epoch 40/600
20/20 [==============================] - 0s 216us/sample - loss: 1.9494 -
sparse_categorical_accuracy: 0.3000
Epoch 41/600
20/20 [==============================] - 0s 199us/sample - loss: 1.9435 -
sparse_categorical_accuracy: 0.3000
Epoch 42/600
20/20 [==============================] - 0s 252us/sample - loss: 1.9376 -
sparse_categorical_accuracy: 0.3000
Epoch 43/600
20/20 [==============================] - 0s 243us/sample - loss: 1.9317 -
sparse_categorical_accuracy: 0.3000
Epoch 44/600
20/20 [==============================] - 0s 199us/sample - loss: 1.9259 -
sparse_categorical_accuracy: 0.3000
Epoch 45/600
20/20 [==============================] - 0s 201us/sample - loss: 1.9201 -
```

```
sparse_categorical_accuracy: 0.3000
Epoch 46/600
20/20 [==============================] - 0s 202us/sample - loss: 1.9144 -
sparse_categorical_accuracy: 0.3000
Epoch 47/600
20/20 [==============================] - 0s 200us/sample - loss: 1.9086 -
sparse_categorical_accuracy: 0.3000
Epoch 48/600
20/20 [==============================] - 0s 195us/sample - loss: 1.9029 -
sparse_categorical_accuracy: 0.3000
Epoch 49/600
20/20 [==============================] - 0s 189us/sample - loss: 1.8972 -
sparse_categorical_accuracy: 0.3000
Epoch 50/600
20/20 [==============================] - 0s 173us/sample - loss: 1.8915 -
sparse_categorical_accuracy: 0.3000
Epoch 51/600
20/20 [==============================] - 0s 255us/sample - loss: 1.8860 -
sparse_categorical_accuracy: 0.3000
Epoch 52/600
20/20 [==============================] - 0s 203us/sample - loss: 1.8806 -
sparse_categorical_accuracy: 0.3500
Epoch 53/600
20/20 [==============================] - 0s 162us/sample - loss: 1.8751 -
sparse_categorical_accuracy: 0.3500
Epoch 54/600
20/20 [==============================] - 0s 217us/sample - loss: 1.8697 -
sparse_categorical_accuracy: 0.3500
Epoch 55/600
20/20 [==============================] - 0s 150us/sample - loss: 1.8644 -
sparse_categorical_accuracy: 0.3500
Epoch 56/600
20/20 [==============================] - 0s 193us/sample - loss: 1.8591 -
sparse_categorical_accuracy: 0.4500
Epoch 57/600
20/20 [==============================] - 0s 199us/sample - loss: 1.8538 -
sparse_categorical_accuracy: 0.4500
Epoch 58/600
20/20 [==============================] - 0s 239us/sample - loss: 1.8487 -
sparse_categorical_accuracy: 0.5000
Epoch 59/600
20/20 [==============================] - 0s 201us/sample - loss: 1.8435 -
sparse_categorical_accuracy: 0.5000
Epoch 60/600
20/20 [==============================] - 0s 197us/sample - loss: 1.8383 -
sparse_categorical_accuracy: 0.5000
Epoch 61/600
20/20 [==============================] - 0s 225us/sample - loss: 1.8332 -
```

```
sparse_categorical_accuracy: 0.5000
Epoch 62/600
20/20 [==============================] - 0s 199us/sample - loss: 1.8281 -
sparse_categorical_accuracy: 0.5000
Epoch 63/600
20/20 [==============================] - 0s 231us/sample - loss: 1.8230 -
sparse_categorical_accuracy: 0.5000
Epoch 64/600
20/20 [==============================] - 0s 174us/sample - loss: 1.8179 -
sparse_categorical_accuracy: 0.5000
Epoch 65/600
20/20 [==============================] - 0s 200us/sample - loss: 1.8128 -
sparse_categorical_accuracy: 0.5000
Epoch 66/600
20/20 [==============================] - 0s 240us/sample - loss: 1.8078 -
sparse_categorical_accuracy: 0.5000
Epoch 67/600
20/20 [==============================] - 0s 193us/sample - loss: 1.8027 -
sparse_categorical_accuracy: 0.5000
Epoch 68/600
20/20 [==============================] - 0s 196us/sample - loss: 1.7978 -
sparse_categorical_accuracy: 0.5000
Epoch 69/600
20/20 [==============================] - 0s 150us/sample - loss: 1.7929 -
sparse_categorical_accuracy: 0.5000
Epoch 70/600
20/20 [==============================] - 0s 190us/sample - loss: 1.7880 -
sparse_categorical_accuracy: 0.5000
Epoch 71/600
20/20 [==============================] - 0s 203us/sample - loss: 1.7830 -
sparse_categorical_accuracy: 0.5000
Epoch 72/600
20/20 [==============================] - 0s 167us/sample - loss: 1.7780 -
sparse_categorical_accuracy: 0.5000
Epoch 73/600
20/20 [==============================] - 0s 189us/sample - loss: 1.7731 -
sparse_categorical_accuracy: 0.5000
Epoch 74/600
20/20 [==============================] - 0s 223us/sample - loss: 1.7682 -
sparse_categorical_accuracy: 0.5000
Epoch 75/600
20/20 [==============================] - 0s 207us/sample - loss: 1.7634 -
sparse_categorical_accuracy: 0.5000
Epoch 76/600
20/20 [==============================] - 0s 225us/sample - loss: 1.7587 -
sparse_categorical_accuracy: 0.5000
Epoch 77/600
20/20 [==============================] - 0s 199us/sample - loss: 1.7540 -
```

```
sparse_categorical_accuracy: 0.5000
Epoch 78/600
20/20 [==============================] - 0s 206us/sample - loss: 1.7494 -
sparse_categorical_accuracy: 0.5000
Epoch 79/600
20/20 [==============================] - 0s 170us/sample - loss: 1.7447 -
sparse_categorical_accuracy: 0.5000
Epoch 80/600
20/20 [==============================] - 0s 170us/sample - loss: 1.7401 -
sparse_categorical_accuracy: 0.5000
Epoch 81/600
20/20 [==============================] - 0s 196us/sample - loss: 1.7356 -
sparse_categorical_accuracy: 0.5000
Epoch 82/600
20/20 [==============================] - 0s 250us/sample - loss: 1.7311 -
sparse_categorical_accuracy: 0.5000
Epoch 83/600
20/20 [==============================] - 0s 207us/sample - loss: 1.7267 -
sparse_categorical_accuracy: 0.5000
Epoch 84/600
20/20 [==============================] - 0s 248us/sample - loss: 1.7223 -
sparse_categorical_accuracy: 0.5000
Epoch 85/600
20/20 [==============================] - 0s 199us/sample - loss: 1.7180 -
sparse_categorical_accuracy: 0.5000
Epoch 86/600
20/20 [==============================] - 0s 185us/sample - loss: 1.7137 -
sparse_categorical_accuracy: 0.5000
Epoch 87/600
20/20 [==============================] - 0s 238us/sample - loss: 1.7093 -
sparse_categorical_accuracy: 0.5000
Epoch 88/600
20/20 [==============================] - 0s 194us/sample - loss: 1.7049 -
sparse_categorical_accuracy: 0.5000
Epoch 89/600
20/20 [==============================] - 0s 199us/sample - loss: 1.7005 -
sparse_categorical_accuracy: 0.5000
Epoch 90/600
20/20 [==============================] - 0s 199us/sample - loss: 1.6962 -
sparse_categorical_accuracy: 0.5000
Epoch 91/600
20/20 [==============================] - 0s 189us/sample - loss: 1.6918 -
sparse_categorical_accuracy: 0.5000
Epoch 92/600
20/20 [==============================] - 0s 178us/sample - loss: 1.6875 -
sparse_categorical_accuracy: 0.5000
Epoch 93/600
20/20 [==============================] - 0s 203us/sample - loss: 1.6832 -
```

```
sparse_categorical_accuracy: 0.5000
Epoch 94/600
20/20 [==============================] - 0s 190us/sample - loss: 1.6789 -
sparse_categorical_accuracy: 0.5000
Epoch 95/600
20/20 [==============================] - 0s 207us/sample - loss: 1.6747 -
sparse_categorical_accuracy: 0.5000
Epoch 96/600
20/20 [==============================] - 0s 198us/sample - loss: 1.6704 -
sparse_categorical_accuracy: 0.5000
Epoch 97/600
20/20 [==============================] - 0s 202us/sample - loss: 1.6662 -
sparse_categorical_accuracy: 0.5000
Epoch 98/600
20/20 [==============================] - 0s 186us/sample - loss: 1.6620 -
sparse_categorical_accuracy: 0.5000
Epoch 99/600
20/20 [==============================] - 0s 150us/sample - loss: 1.6579 -
sparse_categorical_accuracy: 0.5000
Epoch 100/600
20/20 [==============================] - 0s 238us/sample - loss: 1.6539 -
sparse_categorical_accuracy: 0.5000
Epoch 101/600
20/20 [==============================] - 0s 175us/sample - loss: 1.6499 -
sparse_categorical_accuracy: 0.5000
Epoch 102/600
20/20 [==============================] - 0s 210us/sample - loss: 1.6459 -
sparse_categorical_accuracy: 0.5000
Epoch 103/600
20/20 [==============================] - 0s 182us/sample - loss: 1.6420 -
sparse_categorical_accuracy: 0.5000
Epoch 104/600
20/20 [==============================] - 0s 209us/sample - loss: 1.6381 -
sparse_categorical_accuracy: 0.5000
Epoch 105/600
20/20 [==============================] - 0s 186us/sample - loss: 1.6342 -
sparse_categorical_accuracy: 0.5000
Epoch 106/600
20/20 [==============================] - 0s 187us/sample - loss: 1.6303 -
sparse_categorical_accuracy: 0.5000
Epoch 107/600
20/20 [==============================] - 0s 184us/sample - loss: 1.6264 -
sparse_categorical_accuracy: 0.5000
Epoch 108/600
20/20 [==============================] - 0s 271us/sample - loss: 1.6226 -
sparse_categorical_accuracy: 0.5000
Epoch 109/600
20/20 [==============================] - 0s 182us/sample - loss: 1.6187 -
```

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sparse_categorical_accuracy: 0.5000
Epoch 110/600
20/20 [==============================] - 0s 236us/sample - loss: 1.6149 -
sparse_categorical_accuracy: 0.5000
Epoch 111/600
20/20 [==============================] - 0s 188us/sample - loss: 1.6111 -
sparse_categorical_accuracy: 0.5000
Epoch 112/600
20/20 [==============================] - 0s 199us/sample - loss: 1.6073 -
sparse_categorical_accuracy: 0.5000
Epoch 113/600
20/20 [==============================] - 0s 220us/sample - loss: 1.6036 -
sparse_categorical_accuracy: 0.5000
Epoch 114/600
20/20 [==============================] - 0s 173us/sample - loss: 1.5999 -
sparse_categorical_accuracy: 0.5000
Epoch 115/600
20/20 [==============================] - 0s 187us/sample - loss: 1.5961 -
sparse_categorical_accuracy: 0.5000
Epoch 116/600
20/20 [==============================] - 0s 186us/sample - loss: 1.5924 -
sparse_categorical_accuracy: 0.5000
Epoch 117/600
20/20 [==============================] - 0s 187us/sample - loss: 1.5886 -
sparse_categorical_accuracy: 0.5000
Epoch 118/600
20/20 [==============================] - 0s 200us/sample - loss: 1.5849 -
sparse_categorical_accuracy: 0.5000
Epoch 119/600
20/20 [==============================] - 0s 218us/sample - loss: 1.5812 -
sparse_categorical_accuracy: 0.5000
Epoch 120/600
20/20 [==============================] - 0s 188us/sample - loss: 1.5775 -
sparse_categorical_accuracy: 0.5000
Epoch 121/600
20/20 [==============================] - 0s 221us/sample - loss: 1.5738 -
sparse_categorical_accuracy: 0.5000
Epoch 122/600
20/20 [==============================] - 0s 190us/sample - loss: 1.5702 -
sparse_categorical_accuracy: 0.5000
Epoch 123/600
20/20 [==============================] - 0s 240us/sample - loss: 1.5665 -
sparse_categorical_accuracy: 0.5000
Epoch 124/600
20/20 [==============================] - 0s 195us/sample - loss: 1.5629 -
sparse_categorical_accuracy: 0.5000
Epoch 125/600
20/20 [==============================] - 0s 178us/sample - loss: 1.5592 -
```

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sparse_categorical_accuracy: 0.5000
Epoch 126/600
20/20 [==============================] - 0s 241us/sample - loss: 1.5555 -
sparse_categorical_accuracy: 0.5000
Epoch 127/600
20/20 [==============================] - 0s 192us/sample - loss: 1.5519 -
sparse_categorical_accuracy: 0.5000
Epoch 128/600
20/20 [==============================] - 0s 224us/sample - loss: 1.5483 -
sparse_categorical_accuracy: 0.5000
Epoch 129/600
20/20 [==============================] - 0s 170us/sample - loss: 1.5447 -
sparse_categorical_accuracy: 0.5000
Epoch 130/600
20/20 [==============================] - 0s 202us/sample - loss: 1.5411 -
sparse_categorical_accuracy: 0.5000
Epoch 131/600
20/20 [==============================] - 0s 228us/sample - loss: 1.5374 -
sparse_categorical_accuracy: 0.5000
Epoch 132/600
20/20 [==============================] - 0s 238us/sample - loss: 1.5338 -
sparse_categorical_accuracy: 0.5000
Epoch 133/600
20/20 [==============================] - 0s 193us/sample - loss: 1.5302 -
sparse_categorical_accuracy: 0.5000
Epoch 134/600
20/20 [==============================] - 0s 145us/sample - loss: 1.5266 -
sparse_categorical_accuracy: 0.5000
Epoch 135/600
20/20 [==============================] - 0s 199us/sample - loss: 1.5231 -
sparse_categorical_accuracy: 0.5000
Epoch 136/600
20/20 [==============================] - 0s 152us/sample - loss: 1.5195 -
sparse_categorical_accuracy: 0.5000
Epoch 137/600
20/20 [==============================] - 0s 207us/sample - loss: 1.5159 -
sparse_categorical_accuracy: 0.5000
Epoch 138/600
20/20 [==============================] - 0s 171us/sample - loss: 1.5123 -
sparse_categorical_accuracy: 0.5000
Epoch 139/600
20/20 [==============================] - 0s 414us/sample - loss: 1.5087 -
sparse_categorical_accuracy: 0.5000
Epoch 140/600
20/20 [==============================] - 0s 230us/sample - loss: 1.5051 -
sparse_categorical_accuracy: 0.5000
Epoch 141/600
20/20 [==============================] - 0s 199us/sample - loss: 1.5015 -
```

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sparse_categorical_accuracy: 0.5000
Epoch 142/600
20/20 [==============================] - 0s 198us/sample - loss: 1.4979 -
sparse_categorical_accuracy: 0.5000
Epoch 143/600
20/20 [==============================] - 0s 179us/sample - loss: 1.4943 -
sparse_categorical_accuracy: 0.5000
Epoch 144/600
20/20 [==============================] - 0s 161us/sample - loss: 1.4906 -
sparse_categorical_accuracy: 0.5000
Epoch 145/600
20/20 [==============================] - 0s 201us/sample - loss: 1.4870 -
sparse_categorical_accuracy: 0.5000
Epoch 146/600
20/20 [==============================] - 0s 181us/sample - loss: 1.4835 -
sparse_categorical_accuracy: 0.5000
Epoch 147/600
20/20 [==============================] - 0s 243us/sample - loss: 1.4799 -
sparse_categorical_accuracy: 0.5000
Epoch 148/600
20/20 [==============================] - 0s 194us/sample - loss: 1.4763 -
sparse_categorical_accuracy: 0.5000
Epoch 149/600
20/20 [==============================] - 0s 179us/sample - loss: 1.4727 -
sparse_categorical_accuracy: 0.5000
Epoch 150/600
20/20 [==============================] - 0s 177us/sample - loss: 1.4690 -
sparse_categorical_accuracy: 0.5000
Epoch 151/600
20/20 [==============================] - 0s 123us/sample - loss: 1.4654 -
sparse_categorical_accuracy: 0.5000
Epoch 152/600
20/20 [==============================] - 0s 195us/sample - loss: 1.4618 -
sparse_categorical_accuracy: 0.5000
Epoch 153/600
20/20 [==============================] - 0s 166us/sample - loss: 1.4582 -
sparse_categorical_accuracy: 0.5000
Epoch 154/600
20/20 [==============================] - 0s 151us/sample - loss: 1.4545 -
sparse_categorical_accuracy: 0.5000
Epoch 155/600
20/20 [==============================] - 0s 140us/sample - loss: 1.4509 -
sparse_categorical_accuracy: 0.5000
Epoch 156/600
20/20 [==============================] - 0s 169us/sample - loss: 1.4473 -
sparse_categorical_accuracy: 0.5000
Epoch 157/600
20/20 [==============================] - 0s 175us/sample - loss: 1.4437 -
```

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sparse_categorical_accuracy: 0.5000
Epoch 158/600
20/20 [==============================] - 0s 136us/sample - loss: 1.4401 -
sparse_categorical_accuracy: 0.5000
Epoch 159/600
20/20 [==============================] - 0s 172us/sample - loss: 1.4365 -
sparse_categorical_accuracy: 0.5000
Epoch 160/600
20/20 [==============================] - 0s 126us/sample - loss: 1.4329 -
sparse_categorical_accuracy: 0.5000
Epoch 161/600
20/20 [==============================] - 0s 210us/sample - loss: 1.4293 -
sparse_categorical_accuracy: 0.5000
Epoch 162/600
20/20 [==============================] - 0s 204us/sample - loss: 1.4256 -
sparse_categorical_accuracy: 0.5000
Epoch 163/600
20/20 [==============================] - 0s 203us/sample - loss: 1.4220 -
sparse_categorical_accuracy: 0.5000
Epoch 164/600
20/20 [==============================] - 0s 224us/sample - loss: 1.4184 -
sparse_categorical_accuracy: 0.5000
Epoch 165/600
20/20 [==============================] - 0s 179us/sample - loss: 1.4148 -
sparse_categorical_accuracy: 0.5000
Epoch 166/600
20/20 [==============================] - 0s 203us/sample - loss: 1.4111 -
sparse_categorical_accuracy: 0.5000
Epoch 167/600
20/20 [==============================] - 0s 186us/sample - loss: 1.4075 -
sparse_categorical_accuracy: 0.5000
Epoch 168/600
20/20 [==============================] - 0s 163us/sample - loss: 1.4039 -
sparse_categorical_accuracy: 0.5000
Epoch 169/600
20/20 [==============================] - 0s 202us/sample - loss: 1.4004 -
sparse_categorical_accuracy: 0.5000
Epoch 170/600
20/20 [==============================] - 0s 221us/sample - loss: 1.3967 -
sparse_categorical_accuracy: 0.5000
Epoch 171/600
20/20 [==============================] - 0s 207us/sample - loss: 1.3931 -
sparse_categorical_accuracy: 0.5000
Epoch 172/600
20/20 [==============================] - 0s 252us/sample - loss: 1.3896 -
sparse_categorical_accuracy: 0.5000
Epoch 173/600
20/20 [==============================] - 0s 173us/sample - loss: 1.3860 -
```

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sparse_categorical_accuracy: 0.5000
Epoch 174/600
20/20 [==============================] - 0s 199us/sample - loss: 1.3824 -
sparse_categorical_accuracy: 0.5000
Epoch 175/600
20/20 [==============================] - 0s 209us/sample - loss: 1.3788 -
sparse_categorical_accuracy: 0.5000
Epoch 176/600
20/20 [==============================] - 0s 155us/sample - loss: 1.3752 -
sparse_categorical_accuracy: 0.5000
Epoch 177/600
20/20 [==============================] - 0s 168us/sample - loss: 1.3715 -
sparse_categorical_accuracy: 0.5000
Epoch 178/600
20/20 [==============================] - 0s 200us/sample - loss: 1.3679 -
sparse_categorical_accuracy: 0.5000
Epoch 179/600
20/20 [==============================] - 0s 150us/sample - loss: 1.3643 -
sparse_categorical_accuracy: 0.5000
Epoch 180/600
20/20 [==============================] - 0s 255us/sample - loss: 1.3607 -
sparse_categorical_accuracy: 0.5000
Epoch 181/600
20/20 [==============================] - 0s 199us/sample - loss: 1.3571 -
sparse_categorical_accuracy: 0.5000
Epoch 182/600
20/20 [==============================] - 0s 159us/sample - loss: 1.3535 -
sparse_categorical_accuracy: 0.5000
Epoch 183/600
20/20 [==============================] - 0s 218us/sample - loss: 1.3499 -
sparse_categorical_accuracy: 0.5000
Epoch 184/600
20/20 [==============================] - 0s 175us/sample - loss: 1.3463 -
sparse_categorical_accuracy: 0.5500
Epoch 185/600
20/20 [==============================] - 0s 217us/sample - loss: 1.3427 -
sparse_categorical_accuracy: 0.5500
Epoch 186/600
20/20 [==============================] - 0s 175us/sample - loss: 1.3392 -
sparse_categorical_accuracy: 0.6000
Epoch 187/600
20/20 [==============================] - 0s 171us/sample - loss: 1.3356 -
sparse_categorical_accuracy: 0.6000
Epoch 188/600
20/20 [==============================] - 0s 189us/sample - loss: 1.3320 -
sparse_categorical_accuracy: 0.6000
Epoch 189/600
20/20 [==============================] - 0s 212us/sample - loss: 1.3284 -
```

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sparse_categorical_accuracy: 0.6000
Epoch 190/600
20/20 [==============================] - 0s 169us/sample - loss: 1.3249 -
sparse_categorical_accuracy: 0.6000
Epoch 191/600
20/20 [==============================] - 0s 200us/sample - loss: 1.3213 -
sparse_categorical_accuracy: 0.6000
Epoch 192/600
20/20 [==============================] - 0s 173us/sample - loss: 1.3177 -
sparse_categorical_accuracy: 0.6000
Epoch 193/600
20/20 [==============================] - 0s 231us/sample - loss: 1.3141 -
sparse_categorical_accuracy: 0.6000
Epoch 194/600
20/20 [==============================] - 0s 153us/sample - loss: 1.3106 -
sparse_categorical_accuracy: 0.6000
Epoch 195/600
20/20 [==============================] - 0s 167us/sample - loss: 1.3070 -
sparse_categorical_accuracy: 0.6000
Epoch 196/600
20/20 [==============================] - 0s 168us/sample - loss: 1.3034 -
sparse_categorical_accuracy: 0.6000
Epoch 197/600
20/20 [==============================] - 0s 179us/sample - loss: 1.2998 -
sparse_categorical_accuracy: 0.6000
Epoch 198/600
20/20 [==============================] - 0s 221us/sample - loss: 1.2962 -
sparse_categorical_accuracy: 0.6000
Epoch 199/600
20/20 [==============================] - 0s 176us/sample - loss: 1.2926 -
sparse_categorical_accuracy: 0.6000
Epoch 200/600
20/20 [==============================] - 0s 181us/sample - loss: 1.2890 -
sparse_categorical_accuracy: 0.6000
Epoch 201/600
20/20 [==============================] - 0s 243us/sample - loss: 1.2854 -
sparse_categorical_accuracy: 0.6000
Epoch 202/600
20/20 [==============================] - 0s 244us/sample - loss: 1.2819 -
sparse_categorical_accuracy: 0.6000
Epoch 203/600
20/20 [==============================] - 0s 186us/sample - loss: 1.2783 -
sparse_categorical_accuracy: 0.6000
Epoch 204/600
20/20 [==============================] - 0s 211us/sample - loss: 1.2747 -
sparse_categorical_accuracy: 0.6000
Epoch 205/600
20/20 [==============================] - 0s 203us/sample - loss: 1.2711 -
```

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sparse_categorical_accuracy: 0.6000
Epoch 206/600
20/20 [==============================] - 0s 197us/sample - loss: 1.2675 -
sparse_categorical_accuracy: 0.6000
Epoch 207/600
20/20 [==============================] - 0s 175us/sample - loss: 1.2639 -
sparse_categorical_accuracy: 0.6000
Epoch 208/600
20/20 [==============================] - 0s 180us/sample - loss: 1.2603 -
sparse_categorical_accuracy: 0.6000
Epoch 209/600
20/20 [==============================] - 0s 175us/sample - loss: 1.2567 -
sparse_categorical_accuracy: 0.6000
Epoch 210/600
20/20 [==============================] - 0s 162us/sample - loss: 1.2532 -
sparse_categorical_accuracy: 0.6000
Epoch 211/600
20/20 [==============================] - 0s 211us/sample - loss: 1.2496 -
sparse_categorical_accuracy: 0.6000
Epoch 212/600
20/20 [==============================] - 0s 228us/sample - loss: 1.2460 -
sparse_categorical_accuracy: 0.6000
Epoch 213/600
20/20 [==============================] - 0s 200us/sample - loss: 1.2425 -
sparse_categorical_accuracy: 0.6000
Epoch 214/600
20/20 [==============================] - 0s 221us/sample - loss: 1.2389 -
sparse_categorical_accuracy: 0.6000
Epoch 215/600
20/20 [==============================] - 0s 186us/sample - loss: 1.2353 -
sparse_categorical_accuracy: 0.6000
Epoch 216/600
20/20 [==============================] - 0s 168us/sample - loss: 1.2317 -
sparse_categorical_accuracy: 0.6000
Epoch 217/600
20/20 [==============================] - 0s 145us/sample - loss: 1.2281 -
sparse_categorical_accuracy: 0.6000
Epoch 218/600
20/20 [==============================] - 0s 189us/sample - loss: 1.2246 -
sparse_categorical_accuracy: 0.6000
Epoch 219/600
20/20 [==============================] - 0s 199us/sample - loss: 1.2209 -
sparse_categorical_accuracy: 0.6000
Epoch 220/600
20/20 [==============================] - 0s 197us/sample - loss: 1.2173 -
sparse_categorical_accuracy: 0.6000
Epoch 221/600
20/20 [==============================] - 0s 147us/sample - loss: 1.2138 -
```

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sparse_categorical_accuracy: 0.6000
Epoch 222/600
20/20 [==============================] - 0s 181us/sample - loss: 1.2101 -
sparse_categorical_accuracy: 0.6000
Epoch 223/600
20/20 [==============================] - 0s 167us/sample - loss: 1.2066 -
sparse_categorical_accuracy: 0.6000
Epoch 224/600
20/20 [==============================] - 0s 185us/sample - loss: 1.2030 -
sparse_categorical_accuracy: 0.6000
Epoch 225/600
20/20 [==============================] - 0s 182us/sample - loss: 1.1994 -
sparse_categorical_accuracy: 0.6000
Epoch 226/600
20/20 [==============================] - 0s 151us/sample - loss: 1.1958 -
sparse_categorical_accuracy: 0.6000
Epoch 227/600
20/20 [==============================] - 0s 150us/sample - loss: 1.1923 -
sparse_categorical_accuracy: 0.6000
Epoch 228/600
20/20 [==============================] - 0s 247us/sample - loss: 1.1887 -
sparse_categorical_accuracy: 0.6000
Epoch 229/600
20/20 [==============================] - 0s 192us/sample - loss: 1.1852 -
sparse_categorical_accuracy: 0.6000
Epoch 230/600
20/20 [==============================] - 0s 221us/sample - loss: 1.1816 -
sparse_categorical_accuracy: 0.6000
Epoch 231/600
20/20 [==============================] - 0s 152us/sample - loss: 1.1781 -
sparse_categorical_accuracy: 0.6000
Epoch 232/600
20/20 [==============================] - 0s 173us/sample - loss: 1.1745 -
sparse_categorical_accuracy: 0.6000
Epoch 233/600
20/20 [==============================] - 0s 183us/sample - loss: 1.1709 -
sparse_categorical_accuracy: 0.6000
Epoch 234/600
20/20 [==============================] - 0s 220us/sample - loss: 1.1673 -
sparse_categorical_accuracy: 0.6000
Epoch 235/600
20/20 [==============================] - 0s 184us/sample - loss: 1.1637 -
sparse_categorical_accuracy: 0.6000
Epoch 236/600
20/20 [==============================] - 0s 182us/sample - loss: 1.1602 -
sparse_categorical_accuracy: 0.6000
Epoch 237/600
20/20 [==============================] - 0s 237us/sample - loss: 1.1566 -
```

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sparse_categorical_accuracy: 0.6000
Epoch 238/600
20/20 [==============================] - 0s 184us/sample - loss: 1.1530 -
sparse_categorical_accuracy: 0.6000
Epoch 239/600
20/20 [==============================] - 0s 212us/sample - loss: 1.1494 -
sparse_categorical_accuracy: 0.6000
Epoch 240/600
20/20 [==============================] - 0s 183us/sample - loss: 1.1459 -
sparse_categorical_accuracy: 0.6000
Epoch 241/600
20/20 [==============================] - 0s 198us/sample - loss: 1.1423 -
sparse_categorical_accuracy: 0.6000
Epoch 242/600
20/20 [==============================] - 0s 140us/sample - loss: 1.1388 -
sparse_categorical_accuracy: 0.6000
Epoch 243/600
20/20 [==============================] - 0s 173us/sample - loss: 1.1352 -
sparse_categorical_accuracy: 0.6000
Epoch 244/600
20/20 [==============================] - 0s 175us/sample - loss: 1.1317 -
sparse_categorical_accuracy: 0.6000
Epoch 245/600
20/20 [==============================] - 0s 273us/sample - loss: 1.1282 -
sparse_categorical_accuracy: 0.6000
Epoch 246/600
20/20 [==============================] - 0s 194us/sample - loss: 1.1246 -
sparse_categorical_accuracy: 0.6500
Epoch 247/600
20/20 [==============================] - 0s 246us/sample - loss: 1.1211 -
sparse_categorical_accuracy: 0.6500
Epoch 248/600
20/20 [==============================] - 0s 227us/sample - loss: 1.1176 -
sparse_categorical_accuracy: 0.6500
Epoch 249/600
20/20 [==============================] - 0s 184us/sample - loss: 1.1141 -
sparse_categorical_accuracy: 0.6500
Epoch 250/600
20/20 [==============================] - 0s 233us/sample - loss: 1.1106 -
sparse_categorical_accuracy: 0.6500
Epoch 251/600
20/20 [==============================] - 0s 187us/sample - loss: 1.1070 -
sparse_categorical_accuracy: 0.6500
Epoch 252/600
20/20 [==============================] - 0s 233us/sample - loss: 1.1035 -
sparse_categorical_accuracy: 0.6500
Epoch 253/600
20/20 [==============================] - 0s 190us/sample - loss: 1.1000 -
```

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sparse_categorical_accuracy: 0.6500
Epoch 254/600
20/20 [==============================] - 0s 297us/sample - loss: 1.0964 -
sparse_categorical_accuracy: 0.7000
Epoch 255/600
20/20 [==============================] - 0s 225us/sample - loss: 1.0929 -
sparse_categorical_accuracy: 0.7000
Epoch 256/600
20/20 [==============================] - 0s 191us/sample - loss: 1.0894 -
sparse_categorical_accuracy: 0.7000
Epoch 257/600
20/20 [==============================] - 0s 236us/sample - loss: 1.0859 -
sparse_categorical_accuracy: 0.7000
Epoch 258/600
20/20 [==============================] - 0s 159us/sample - loss: 1.0824 -
sparse_categorical_accuracy: 0.7000
Epoch 259/600
20/20 [==============================] - 0s 240us/sample - loss: 1.0789 -
sparse_categorical_accuracy: 0.7000
Epoch 260/600
20/20 [==============================] - 0s 218us/sample - loss: 1.0754 -
sparse_categorical_accuracy: 0.7000
Epoch 261/600
20/20 [==============================] - 0s 194us/sample - loss: 1.0719 -
sparse_categorical_accuracy: 0.7000
Epoch 262/600
20/20 [==============================] - 0s 213us/sample - loss: 1.0683 -
sparse_categorical_accuracy: 0.7000
Epoch 263/600
20/20 [==============================] - 0s 189us/sample - loss: 1.0648 -
sparse_categorical_accuracy: 0.7000
Epoch 264/600
20/20 [==============================] - 0s 246us/sample - loss: 1.0613 -
sparse_categorical_accuracy: 0.7000
Epoch 265/600
20/20 [==============================] - 0s 185us/sample - loss: 1.0578 -
sparse_categorical_accuracy: 0.7000
Epoch 266/600
20/20 [==============================] - 0s 218us/sample - loss: 1.0543 -
sparse_categorical_accuracy: 0.7000
Epoch 267/600
20/20 [==============================] - 0s 165us/sample - loss: 1.0508 -
sparse_categorical_accuracy: 0.7000
Epoch 268/600
20/20 [==============================] - 0s 149us/sample - loss: 1.0473 -
sparse_categorical_accuracy: 0.7000
Epoch 269/600
20/20 [==============================] - 0s 199us/sample - loss: 1.0438 -
```

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sparse_categorical_accuracy: 0.7000
Epoch 270/600
20/20 [==============================] - 0s 227us/sample - loss: 1.0403 -
sparse_categorical_accuracy: 0.7000
Epoch 271/600
20/20 [==============================] - 0s 163us/sample - loss: 1.0369 -
sparse_categorical_accuracy: 0.7000
Epoch 272/600
20/20 [==============================] - 0s 187us/sample - loss: 1.0334 -
sparse_categorical_accuracy: 0.7000
Epoch 273/600
20/20 [==============================] - 0s 200us/sample - loss: 1.0299 -
sparse_categorical_accuracy: 0.7000
Epoch 274/600
20/20 [==============================] - 0s 218us/sample - loss: 1.0264 -
sparse_categorical_accuracy: 0.7000
Epoch 275/600
20/20 [==============================] - 0s 208us/sample - loss: 1.0230 -
sparse_categorical_accuracy: 0.7000
Epoch 276/600
20/20 [==============================] - 0s 163us/sample - loss: 1.0195 -
sparse_categorical_accuracy: 0.7000
Epoch 277/600
20/20 [==============================] - 0s 177us/sample - loss: 1.0161 -
sparse_categorical_accuracy: 0.7000
Epoch 278/600
20/20 [==============================] - 0s 162us/sample - loss: 1.0126 -
sparse_categorical_accuracy: 0.7000
Epoch 279/600
20/20 [==============================] - 0s 254us/sample - loss: 1.0092 -
sparse_categorical_accuracy: 0.7000
Epoch 280/600
20/20 [==============================] - 0s 194us/sample - loss: 1.0058 -
sparse_categorical_accuracy: 0.7000
Epoch 281/600
20/20 [==============================] - 0s 187us/sample - loss: 1.0024 -
sparse_categorical_accuracy: 0.7000
Epoch 282/600
20/20 [==============================] - 0s 175us/sample - loss: 0.9989 -
sparse_categorical_accuracy: 0.7000
Epoch 283/600
20/20 [==============================] - 0s 194us/sample - loss: 0.9956 -
sparse_categorical_accuracy: 0.7000
Epoch 284/600
20/20 [==============================] - 0s 191us/sample - loss: 0.9921 -
sparse_categorical_accuracy: 0.7000
Epoch 285/600
20/20 [==============================] - 0s 178us/sample - loss: 0.9887 -
```

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sparse_categorical_accuracy: 0.7000
Epoch 286/600
20/20 [==============================] - 0s 148us/sample - loss: 0.9853 -
sparse_categorical_accuracy: 0.7000
Epoch 287/600
20/20 [==============================] - 0s 179us/sample - loss: 0.9819 -
sparse_categorical_accuracy: 0.7000
Epoch 288/600
20/20 [==============================] - 0s 191us/sample - loss: 0.9785 -
sparse_categorical_accuracy: 0.7000
Epoch 289/600
20/20 [==============================] - 0s 177us/sample - loss: 0.9751 -
sparse_categorical_accuracy: 0.7000
Epoch 290/600
20/20 [==============================] - 0s 220us/sample - loss: 0.9718 -
sparse_categorical_accuracy: 0.7000
Epoch 291/600
20/20 [==============================] - 0s 191us/sample - loss: 0.9684 -
sparse_categorical_accuracy: 0.7000
Epoch 292/600
20/20 [==============================] - 0s 305us/sample - loss: 0.9651 -
sparse_categorical_accuracy: 0.7000
Epoch 293/600
20/20 [==============================] - 0s 184us/sample - loss: 0.9618 -
sparse_categorical_accuracy: 0.7000
Epoch 294/600
20/20 [==============================] - 0s 189us/sample - loss: 0.9584 -
sparse_categorical_accuracy: 0.7000
Epoch 295/600
20/20 [==============================] - 0s 268us/sample - loss: 0.9551 -
sparse_categorical_accuracy: 0.7000
Epoch 296/600
20/20 [==============================] - 0s 193us/sample - loss: 0.9518 -
sparse_categorical_accuracy: 0.7000
Epoch 297/600
20/20 [==============================] - 0s 246us/sample - loss: 0.9485 -
sparse_categorical_accuracy: 0.7000
Epoch 298/600
20/20 [==============================] - 0s 192us/sample - loss: 0.9453 -
sparse_categorical_accuracy: 0.7000
Epoch 299/600
20/20 [==============================] - 0s 163us/sample - loss: 0.9420 -
sparse_categorical_accuracy: 0.7000
Epoch 300/600
20/20 [==============================] - 0s 284us/sample - loss: 0.9387 -
sparse_categorical_accuracy: 0.7000
Epoch 301/600
20/20 [==============================] - 0s 206us/sample - loss: 0.9354 -
```

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sparse_categorical_accuracy: 0.7000
Epoch 302/600
20/20 [==============================] - 0s 294us/sample - loss: 0.9321 -
sparse_categorical_accuracy: 0.7000
Epoch 303/600
20/20 [==============================] - 0s 197us/sample - loss: 0.9289 -
sparse_categorical_accuracy: 0.7000
Epoch 304/600
20/20 [==============================] - 0s 274us/sample - loss: 0.9256 -
sparse_categorical_accuracy: 0.7000
Epoch 305/600
20/20 [==============================] - 0s 192us/sample - loss: 0.9223 -
sparse_categorical_accuracy: 0.7000
Epoch 306/600
20/20 [==============================] - 0s 178us/sample - loss: 0.9190 -
sparse_categorical_accuracy: 0.7000
Epoch 307/600
20/20 [==============================] - 0s 250us/sample - loss: 0.9158 -
sparse_categorical_accuracy: 0.7000
Epoch 308/600
20/20 [==============================] - 0s 158us/sample - loss: 0.9125 -
sparse_categorical_accuracy: 0.7000
Epoch 309/600
20/20 [==============================] - 0s 251us/sample - loss: 0.9092 -
sparse_categorical_accuracy: 0.7000
Epoch 310/600
20/20 [==============================] - 0s 158us/sample - loss: 0.9060 -
sparse_categorical_accuracy: 0.7000
Epoch 311/600
20/20 [==============================] - 0s 188us/sample - loss: 0.9027 -
sparse_categorical_accuracy: 0.7000
Epoch 312/600
20/20 [==============================] - 0s 187us/sample - loss: 0.8994 -
sparse_categorical_accuracy: 0.7000
Epoch 313/600
20/20 [==============================] - 0s 216us/sample - loss: 0.8961 -
sparse_categorical_accuracy: 0.7000
Epoch 314/600
20/20 [==============================] - 0s 219us/sample - loss: 0.8929 -
sparse_categorical_accuracy: 0.7000
Epoch 315/600
20/20 [==============================] - 0s 150us/sample - loss: 0.8897 -
sparse_categorical_accuracy: 0.7000
Epoch 316/600
20/20 [==============================] - 0s 199us/sample - loss: 0.8865 -
sparse_categorical_accuracy: 0.7000
Epoch 317/600
20/20 [==============================] - 0s 175us/sample - loss: 0.8832 -
```

```
sparse_categorical_accuracy: 0.7000
Epoch 318/600
20/20 [==============================] - 0s 169us/sample - loss: 0.8800 -
sparse_categorical_accuracy: 0.7000
Epoch 319/600
20/20 [==============================] - 0s 215us/sample - loss: 0.8768 -
sparse_categorical_accuracy: 0.7000
Epoch 320/600
20/20 [==============================] - 0s 203us/sample - loss: 0.8736 -
sparse_categorical_accuracy: 0.7000
Epoch 321/600
20/20 [==============================] - 0s 221us/sample - loss: 0.8704 -
sparse_categorical_accuracy: 0.7000
Epoch 322/600
20/20 [==============================] - 0s 230us/sample - loss: 0.8672 -
sparse_categorical_accuracy: 0.7000
Epoch 323/600
20/20 [==============================] - 0s 182us/sample - loss: 0.8640 -
sparse_categorical_accuracy: 0.7000
Epoch 324/600
20/20 [==============================] - 0s 161us/sample - loss: 0.8609 -
sparse_categorical_accuracy: 0.7000
Epoch 325/600
20/20 [==============================] - 0s 248us/sample - loss: 0.8577 -
sparse_categorical_accuracy: 0.7000
Epoch 326/600
20/20 [==============================] - 0s 176us/sample - loss: 0.8546 -
sparse_categorical_accuracy: 0.7000
Epoch 327/600
20/20 [==============================] - 0s 268us/sample - loss: 0.8515 -
sparse_categorical_accuracy: 0.7000
Epoch 328/600
20/20 [==============================] - 0s 210us/sample - loss: 0.8484 -
sparse_categorical_accuracy: 0.7000
Epoch 329/600
20/20 [==============================] - 0s 250us/sample - loss: 0.8452 -
sparse_categorical_accuracy: 0.7000
Epoch 330/600
20/20 [==============================] - 0s 194us/sample - loss: 0.8422 -
sparse_categorical_accuracy: 0.7000
Epoch 331/600
20/20 [==============================] - 0s 211us/sample - loss: 0.8391 -
sparse_categorical_accuracy: 0.7000
Epoch 332/600
20/20 [==============================] - 0s 226us/sample - loss: 0.8361 -
sparse_categorical_accuracy: 0.7000
Epoch 333/600
20/20 [==============================] - 0s 198us/sample - loss: 0.8329 -
```

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sparse_categorical_accuracy: 0.7000
Epoch 334/600
20/20 [==============================] - 0s 149us/sample - loss: 0.8299 -
sparse_categorical_accuracy: 0.7000
Epoch 335/600
20/20 [==============================] - 0s 205us/sample - loss: 0.8269 -
sparse_categorical_accuracy: 0.7000
Epoch 336/600
20/20 [==============================] - 0s 225us/sample - loss: 0.8238 -
sparse_categorical_accuracy: 0.7000
Epoch 337/600
20/20 [==============================] - 0s 262us/sample - loss: 0.8207 -
sparse_categorical_accuracy: 0.7000
Epoch 338/600
20/20 [==============================] - 0s 172us/sample - loss: 0.8177 -
sparse_categorical_accuracy: 0.7000
Epoch 339/600
20/20 [==============================] - 0s 199us/sample - loss: 0.8146 -
sparse_categorical_accuracy: 0.7000
Epoch 340/600
20/20 [==============================] - 0s 190us/sample - loss: 0.8116 -
sparse_categorical_accuracy: 0.7000
Epoch 341/600
20/20 [==============================] - 0s 203us/sample - loss: 0.8086 -
sparse_categorical_accuracy: 0.7000
Epoch 342/600
20/20 [==============================] - 0s 180us/sample - loss: 0.8055 -
sparse_categorical_accuracy: 0.7000
Epoch 343/600
20/20 [==============================] - 0s 175us/sample - loss: 0.8025 -
sparse_categorical_accuracy: 0.7000
Epoch 344/600
20/20 [==============================] - 0s 167us/sample - loss: 0.7995 -
sparse_categorical_accuracy: 0.7000
Epoch 345/600
20/20 [==============================] - 0s 284us/sample - loss: 0.7964 -
sparse_categorical_accuracy: 0.7000
Epoch 346/600
20/20 [==============================] - 0s 188us/sample - loss: 0.7934 -
sparse_categorical_accuracy: 0.7000
Epoch 347/600
20/20 [==============================] - 0s 219us/sample - loss: 0.7904 -
sparse_categorical_accuracy: 0.7000
Epoch 348/600
20/20 [==============================] - 0s 187us/sample - loss: 0.7874 -
sparse_categorical_accuracy: 0.7000
Epoch 349/600
20/20 [==============================] - 0s 207us/sample - loss: 0.7844 -
```

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sparse_categorical_accuracy: 0.7000
Epoch 350/600
20/20 [==============================] - 0s 230us/sample - loss: 0.7814 -
sparse_categorical_accuracy: 0.7000
Epoch 351/600
20/20 [==============================] - 0s 178us/sample - loss: 0.7784 -
sparse_categorical_accuracy: 0.7000
Epoch 352/600
20/20 [==============================] - 0s 246us/sample - loss: 0.7754 -
sparse_categorical_accuracy: 0.7500
Epoch 353/600
20/20 [==============================] - 0s 190us/sample - loss: 0.7725 -
sparse_categorical_accuracy: 0.7500
Epoch 354/600
20/20 [==============================] - 0s 243us/sample - loss: 0.7696 -
sparse_categorical_accuracy: 0.7500
Epoch 355/600
20/20 [==============================] - 0s 199us/sample - loss: 0.7666 -
sparse_categorical_accuracy: 0.7500
Epoch 356/600
20/20 [==============================] - 0s 199us/sample - loss: 0.7636 -
sparse_categorical_accuracy: 0.7500
Epoch 357/600
20/20 [==============================] - 0s 250us/sample - loss: 0.7607 -
sparse_categorical_accuracy: 0.7500
Epoch 358/600
20/20 [==============================] - 0s 211us/sample - loss: 0.7577 -
sparse_categorical_accuracy: 0.7500
Epoch 359/600
20/20 [==============================] - 0s 236us/sample - loss: 0.7548 -
sparse_categorical_accuracy: 0.7500
Epoch 360/600
20/20 [==============================] - 0s 186us/sample - loss: 0.7519 -
sparse_categorical_accuracy: 0.7500
Epoch 361/600
20/20 [==============================] - 0s 150us/sample - loss: 0.7490 -
sparse_categorical_accuracy: 0.7500
Epoch 362/600
20/20 [==============================] - 0s 230us/sample - loss: 0.7461 -
sparse_categorical_accuracy: 0.7500
Epoch 363/600
20/20 [==============================] - 0s 189us/sample - loss: 0.7432 -
sparse_categorical_accuracy: 0.8000
Epoch 364/600
20/20 [==============================] - 0s 213us/sample - loss: 0.7403 -
sparse_categorical_accuracy: 0.8000
Epoch 365/600
20/20 [==============================] - 0s 138us/sample - loss: 0.7374 -
```

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sparse_categorical_accuracy: 0.8000
Epoch 366/600
20/20 [==============================] - 0s 192us/sample - loss: 0.7345 -
sparse_categorical_accuracy: 0.8000
Epoch 367/600
20/20 [==============================] - 0s 200us/sample - loss: 0.7317 -
sparse_categorical_accuracy: 0.8000
Epoch 368/600
20/20 [==============================] - 0s 141us/sample - loss: 0.7288 -
sparse_categorical_accuracy: 0.8000
Epoch 369/600
20/20 [==============================] - 0s 218us/sample - loss: 0.7259 -
sparse_categorical_accuracy: 0.8000
Epoch 370/600
20/20 [==============================] - 0s 218us/sample - loss: 0.7231 -
sparse_categorical_accuracy: 0.8000
Epoch 371/600
20/20 [==============================] - 0s 225us/sample - loss: 0.7203 -
sparse_categorical_accuracy: 0.8000
Epoch 372/600
20/20 [==============================] - 0s 246us/sample - loss: 0.7175 -
sparse_categorical_accuracy: 0.8000
Epoch 373/600
20/20 [==============================] - 0s 220us/sample - loss: 0.7146 -
sparse_categorical_accuracy: 0.8000
Epoch 374/600
20/20 [==============================] - 0s 206us/sample - loss: 0.7119 -
sparse_categorical_accuracy: 0.8000
Epoch 375/600
20/20 [==============================] - 0s 277us/sample - loss: 0.7090 -
sparse_categorical_accuracy: 0.8000
Epoch 376/600
20/20 [==============================] - 0s 189us/sample - loss: 0.7062 -
sparse_categorical_accuracy: 0.8000
Epoch 377/600
20/20 [==============================] - 0s 291us/sample - loss: 0.7035 -
sparse_categorical_accuracy: 0.8000
Epoch 378/600
20/20 [==============================] - 0s 196us/sample - loss: 0.7006 -
sparse_categorical_accuracy: 0.8000
Epoch 379/600
20/20 [==============================] - 0s 293us/sample - loss: 0.6979 -
sparse_categorical_accuracy: 0.8000
Epoch 380/600
20/20 [==============================] - 0s 234us/sample - loss: 0.6952 -
sparse_categorical_accuracy: 0.8000
Epoch 381/600
20/20 [==============================] - 0s 173us/sample - loss: 0.6924 -
```

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sparse_categorical_accuracy: 0.8000
Epoch 382/600
20/20 [==============================] - 0s 200us/sample - loss: 0.6896 -
sparse_categorical_accuracy: 0.8000
Epoch 383/600
20/20 [==============================] - 0s 191us/sample - loss: 0.6869 -
sparse_categorical_accuracy: 0.8000
Epoch 384/600
20/20 [==============================] - 0s 332us/sample - loss: 0.6842 -
sparse_categorical_accuracy: 0.8000
Epoch 385/600
20/20 [==============================] - 0s 200us/sample - loss: 0.6814 -
sparse_categorical_accuracy: 0.8000
Epoch 386/600
20/20 [==============================] - 0s 195us/sample - loss: 0.6787 -
sparse_categorical_accuracy: 0.8000
Epoch 387/600
20/20 [==============================] - 0s 269us/sample - loss: 0.6760 -
sparse_categorical_accuracy: 0.8000
Epoch 388/600
20/20 [==============================] - 0s 178us/sample - loss: 0.6733 -
sparse_categorical_accuracy: 0.8000
Epoch 389/600
20/20 [==============================] - 0s 266us/sample - loss: 0.6706 -
sparse_categorical_accuracy: 0.8000
Epoch 390/600
20/20 [==============================] - 0s 196us/sample - loss: 0.6679 -
sparse_categorical_accuracy: 0.8000
Epoch 391/600
20/20 [==============================] - 0s 249us/sample - loss: 0.6652 -
sparse_categorical_accuracy: 0.8000
Epoch 392/600
20/20 [==============================] - 0s 176us/sample - loss: 0.6625 -
sparse_categorical_accuracy: 0.8000
Epoch 393/600
20/20 [==============================] - 0s 204us/sample - loss: 0.6599 -
sparse_categorical_accuracy: 0.8000
Epoch 394/600
20/20 [==============================] - 0s 250us/sample - loss: 0.6572 -
sparse_categorical_accuracy: 0.8500
Epoch 395/600
20/20 [==============================] - 0s 199us/sample - loss: 0.6545 -
sparse_categorical_accuracy: 0.8500
Epoch 396/600
20/20 [==============================] - 0s 262us/sample - loss: 0.6519 -
sparse_categorical_accuracy: 0.8500
Epoch 397/600
20/20 [==============================] - 0s 203us/sample - loss: 0.6492 -
```

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sparse_categorical_accuracy: 0.8500
Epoch 398/600
20/20 [==============================] - 0s 202us/sample - loss: 0.6466 -
sparse_categorical_accuracy: 0.8500
Epoch 399/600
20/20 [==============================] - 0s 255us/sample - loss: 0.6440 -
sparse_categorical_accuracy: 0.8500
Epoch 400/600
20/20 [==============================] - 0s 170us/sample - loss: 0.6414 -
sparse_categorical_accuracy: 0.8500
Epoch 401/600
20/20 [==============================] - 0s 241us/sample - loss: 0.6387 -
sparse_categorical_accuracy: 0.8500
Epoch 402/600
20/20 [==============================] - 0s 214us/sample - loss: 0.6361 -
sparse_categorical_accuracy: 0.8500
Epoch 403/600
20/20 [==============================] - 0s 240us/sample - loss: 0.6335 -
sparse_categorical_accuracy: 0.8500
Epoch 404/600
20/20 [==============================] - 0s 213us/sample - loss: 0.6310 -
sparse_categorical_accuracy: 0.8500
Epoch 405/600
20/20 [==============================] - 0s 194us/sample - loss: 0.6284 -
sparse_categorical_accuracy: 0.8500
Epoch 406/600
20/20 [==============================] - 0s 208us/sample - loss: 0.6258 -
sparse_categorical_accuracy: 0.9000
Epoch 407/600
20/20 [==============================] - 0s 216us/sample - loss: 0.6233 -
sparse_categorical_accuracy: 0.9000
Epoch 408/600
20/20 [==============================] - 0s 205us/sample - loss: 0.6207 -
sparse_categorical_accuracy: 0.9000
Epoch 409/600
20/20 [==============================] - 0s 170us/sample - loss: 0.6181 -
sparse_categorical_accuracy: 0.9000
Epoch 410/600
20/20 [==============================] - 0s 197us/sample - loss: 0.6156 -
sparse_categorical_accuracy: 0.9000
Epoch 411/600
20/20 [==============================] - 0s 150us/sample - loss: 0.6131 -
sparse_categorical_accuracy: 0.9000
Epoch 412/600
20/20 [==============================] - 0s 219us/sample - loss: 0.6106 -
sparse_categorical_accuracy: 0.9000
Epoch 413/600
20/20 [==============================] - 0s 150us/sample - loss: 0.6081 -
```

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sparse_categorical_accuracy: 0.9000
Epoch 414/600
20/20 [==============================] - 0s 260us/sample - loss: 0.6056 -
sparse_categorical_accuracy: 0.9000
Epoch 415/600
20/20 [==============================] - 0s 169us/sample - loss: 0.6031 -
sparse_categorical_accuracy: 0.9000
Epoch 416/600
20/20 [==============================] - 0s 226us/sample - loss: 0.6007 -
sparse_categorical_accuracy: 0.9000
Epoch 417/600
20/20 [==============================] - 0s 206us/sample - loss: 0.5983 -
sparse_categorical_accuracy: 0.9000
Epoch 418/600
20/20 [==============================] - 0s 199us/sample - loss: 0.5959 -
sparse_categorical_accuracy: 0.9500
Epoch 419/600
20/20 [==============================] - 0s 194us/sample - loss: 0.5935 -
sparse_categorical_accuracy: 0.9500
Epoch 420/600
20/20 [==============================] - 0s 202us/sample - loss: 0.5910 -
sparse_categorical_accuracy: 0.9500
Epoch 421/600
20/20 [==============================] - 0s 189us/sample - loss: 0.5886 -
sparse_categorical_accuracy: 0.9500
Epoch 422/600
20/20 [==============================] - 0s 213us/sample - loss: 0.5862 -
sparse_categorical_accuracy: 0.9500
Epoch 423/600
20/20 [==============================] - 0s 186us/sample - loss: 0.5839 -
sparse_categorical_accuracy: 0.9500
Epoch 424/600
20/20 [==============================] - 0s 199us/sample - loss: 0.5814 -
sparse_categorical_accuracy: 0.9500
Epoch 425/600
20/20 [==============================] - 0s 224us/sample - loss: 0.5791 -
sparse_categorical_accuracy: 0.9500
Epoch 426/600
20/20 [==============================] - 0s 183us/sample - loss: 0.5767 -
sparse_categorical_accuracy: 0.9500
Epoch 427/600
20/20 [==============================] - 0s 218us/sample - loss: 0.5744 -
sparse_categorical_accuracy: 0.9500
Epoch 428/600
20/20 [==============================] - 0s 198us/sample - loss: 0.5720 -
sparse_categorical_accuracy: 0.9500
Epoch 429/600
20/20 [==============================] - 0s 191us/sample - loss: 0.5697 -
```

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sparse_categorical_accuracy: 0.9500
Epoch 430/600
20/20 [==============================] - 0s 164us/sample - loss: 0.5673 -
sparse_categorical_accuracy: 0.9500
Epoch 431/600
20/20 [==============================] - 0s 168us/sample - loss: 0.5650 -
sparse_categorical_accuracy: 0.9500
Epoch 432/600
20/20 [==============================] - 0s 236us/sample - loss: 0.5627 -
sparse_categorical_accuracy: 0.9500
Epoch 433/600
20/20 [==============================] - 0s 223us/sample - loss: 0.5604 -
sparse_categorical_accuracy: 0.9500
Epoch 434/600
20/20 [==============================] - 0s 274us/sample - loss: 0.5581 -
sparse_categorical_accuracy: 0.9500
Epoch 435/600
20/20 [==============================] - 0s 188us/sample - loss: 0.5558 -
sparse_categorical_accuracy: 0.9500
Epoch 436/600
20/20 [==============================] - 0s 199us/sample - loss: 0.5536 -
sparse_categorical_accuracy: 0.9500
Epoch 437/600
20/20 [==============================] - 0s 181us/sample - loss: 0.5513 -
sparse_categorical_accuracy: 0.9500
Epoch 438/600
20/20 [==============================] - 0s 184us/sample - loss: 0.5491 -
sparse_categorical_accuracy: 0.9500
Epoch 439/600
20/20 [==============================] - 0s 259us/sample - loss: 0.5468 -
sparse_categorical_accuracy: 0.9500
Epoch 440/600
20/20 [==============================] - 0s 176us/sample - loss: 0.5446 -
sparse_categorical_accuracy: 0.9500
Epoch 441/600
20/20 [==============================] - 0s 220us/sample - loss: 0.5423 -
sparse_categorical_accuracy: 0.9500
Epoch 442/600
20/20 [==============================] - 0s 191us/sample - loss: 0.5401 -
sparse_categorical_accuracy: 0.9500
Epoch 443/600
20/20 [==============================] - 0s 150us/sample - loss: 0.5379 -
sparse_categorical_accuracy: 0.9500
Epoch 444/600
20/20 [==============================] - 0s 175us/sample - loss: 0.5357 -
sparse_categorical_accuracy: 0.9500
Epoch 445/600
20/20 [==============================] - 0s 172us/sample - loss: 0.5335 -
```

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sparse_categorical_accuracy: 0.9500
Epoch 446/600
20/20 [==============================] - 0s 162us/sample - loss: 0.5313 -
sparse_categorical_accuracy: 0.9500
Epoch 447/600
20/20 [==============================] - 0s 177us/sample - loss: 0.5291 -
sparse_categorical_accuracy: 0.9500
Epoch 448/600
20/20 [==============================] - 0s 178us/sample - loss: 0.5269 -
sparse_categorical_accuracy: 0.9500
Epoch 449/600
20/20 [==============================] - 0s 181us/sample - loss: 0.5248 -
sparse_categorical_accuracy: 0.9500
Epoch 450/600
20/20 [==============================] - 0s 252us/sample - loss: 0.5227 -
sparse_categorical_accuracy: 0.9500
Epoch 451/600
20/20 [==============================] - 0s 189us/sample - loss: 0.5205 -
sparse_categorical_accuracy: 0.9500
Epoch 452/600
20/20 [==============================] - 0s 271us/sample - loss: 0.5184 -
sparse_categorical_accuracy: 0.9500
Epoch 453/600
20/20 [==============================] - 0s 185us/sample - loss: 0.5163 -
sparse_categorical_accuracy: 0.9500
Epoch 454/600
20/20 [==============================] - 0s 217us/sample - loss: 0.5142 -
sparse_categorical_accuracy: 0.9500
Epoch 455/600
20/20 [==============================] - 0s 195us/sample - loss: 0.5121 -
sparse_categorical_accuracy: 0.9500
Epoch 456/600
20/20 [==============================] - 0s 177us/sample - loss: 0.5100 -
sparse_categorical_accuracy: 0.9500
Epoch 457/600
20/20 [==============================] - 0s 206us/sample - loss: 0.5079 -
sparse_categorical_accuracy: 0.9500
Epoch 458/600
20/20 [==============================] - 0s 187us/sample - loss: 0.5059 -
sparse_categorical_accuracy: 0.9500
Epoch 459/600
20/20 [==============================] - 0s 150us/sample - loss: 0.5039 -
sparse_categorical_accuracy: 0.9500
Epoch 460/600
20/20 [==============================] - 0s 185us/sample - loss: 0.5018 -
sparse_categorical_accuracy: 0.9500
Epoch 461/600
20/20 [==============================] - 0s 176us/sample - loss: 0.4997 -
```

```
sparse_categorical_accuracy: 0.9500
Epoch 462/600
20/20 [==============================] - 0s 187us/sample - loss: 0.4978 -
sparse_categorical_accuracy: 0.9500
Epoch 463/600
20/20 [==============================] - 0s 314us/sample - loss: 0.4957 -
sparse_categorical_accuracy: 0.9500
Epoch 464/600
20/20 [==============================] - 0s 199us/sample - loss: 0.4937 -
sparse_categorical_accuracy: 0.9500
Epoch 465/600
20/20 [==============================] - 0s 209us/sample - loss: 0.4917 -
sparse_categorical_accuracy: 0.9500
Epoch 466/600
20/20 [==============================] - 0s 196us/sample - loss: 0.4898 -
sparse_categorical_accuracy: 0.9500
Epoch 467/600
20/20 [==============================] - 0s 247us/sample - loss: 0.4878 -
sparse_categorical_accuracy: 0.9500
Epoch 468/600
20/20 [==============================] - 0s 213us/sample - loss: 0.4858 -
sparse_categorical_accuracy: 0.9500
Epoch 469/600
20/20 [==============================] - 0s 161us/sample - loss: 0.4838 -
sparse_categorical_accuracy: 0.9500
Epoch 470/600
20/20 [==============================] - 0s 235us/sample - loss: 0.4819 -
sparse_categorical_accuracy: 0.9500
Epoch 471/600
20/20 [==============================] - 0s 213us/sample - loss: 0.4800 -
sparse_categorical_accuracy: 0.9500
Epoch 472/600
20/20 [==============================] - 0s 234us/sample - loss: 0.4781 -
sparse_categorical_accuracy: 0.9500
Epoch 473/600
20/20 [==============================] - 0s 196us/sample - loss: 0.4761 -
sparse_categorical_accuracy: 0.9500
Epoch 474/600
20/20 [==============================] - 0s 178us/sample - loss: 0.4741 -
sparse_categorical_accuracy: 0.9500
Epoch 475/600
20/20 [==============================] - 0s 203us/sample - loss: 0.4723 -
sparse_categorical_accuracy: 0.9500
Epoch 476/600
20/20 [==============================] - 0s 176us/sample - loss: 0.4703 -
sparse_categorical_accuracy: 0.9500
Epoch 477/600
20/20 [==============================] - 0s 146us/sample - loss: 0.4684 -
```

```
sparse_categorical_accuracy: 0.9500
Epoch 478/600
20/20 [==============================] - 0s 199us/sample - loss: 0.4665 -
sparse_categorical_accuracy: 0.9500
Epoch 479/600
20/20 [==============================] - 0s 166us/sample - loss: 0.4646 -
sparse_categorical_accuracy: 0.9500
Epoch 480/600
20/20 [==============================] - 0s 182us/sample - loss: 0.4627 -
sparse_categorical_accuracy: 0.9500
Epoch 481/600
20/20 [==============================] - 0s 208us/sample - loss: 0.4609 -
sparse_categorical_accuracy: 0.9500
Epoch 482/600
20/20 [==============================] - 0s 202us/sample - loss: 0.4590 -
sparse_categorical_accuracy: 0.9500
Epoch 483/600
20/20 [==============================] - 0s 245us/sample - loss: 0.4572 -
sparse_categorical_accuracy: 0.9500
Epoch 484/600
20/20 [==============================] - 0s 176us/sample - loss: 0.4553 -
sparse_categorical_accuracy: 0.9500
Epoch 485/600
20/20 [==============================] - 0s 228us/sample - loss: 0.4535 -
sparse_categorical_accuracy: 0.9500
Epoch 486/600
20/20 [==============================] - 0s 187us/sample - loss: 0.4517 -
sparse_categorical_accuracy: 0.9500
Epoch 487/600
20/20 [==============================] - 0s 150us/sample - loss: 0.4499 -
sparse_categorical_accuracy: 0.9500
Epoch 488/600
20/20 [==============================] - 0s 216us/sample - loss: 0.4481 -
sparse_categorical_accuracy: 0.9500
Epoch 489/600
20/20 [==============================] - 0s 187us/sample - loss: 0.4463 -
sparse_categorical_accuracy: 0.9500
Epoch 490/600
20/20 [==============================] - 0s 162us/sample - loss: 0.4446 -
sparse_categorical_accuracy: 0.9500
Epoch 491/600
20/20 [==============================] - 0s 198us/sample - loss: 0.4428 -
sparse_categorical_accuracy: 0.9500
Epoch 492/600
20/20 [==============================] - 0s 182us/sample - loss: 0.4410 -
sparse_categorical_accuracy: 0.9500
Epoch 493/600
20/20 [==============================] - 0s 199us/sample - loss: 0.4392 -
```

```
sparse_categorical_accuracy: 0.9500
Epoch 494/600
20/20 [==============================] - 0s 175us/sample - loss: 0.4375 -
sparse_categorical_accuracy: 0.9500
Epoch 495/600
20/20 [==============================] - 0s 161us/sample - loss: 0.4358 -
sparse_categorical_accuracy: 0.9500
Epoch 496/600
20/20 [==============================] - 0s 295us/sample - loss: 0.4341 -
sparse_categorical_accuracy: 0.9500
Epoch 497/600
20/20 [==============================] - 0s 175us/sample - loss: 0.4323 -
sparse_categorical_accuracy: 0.9500
Epoch 498/600
20/20 [==============================] - 0s 199us/sample - loss: 0.4306 -
sparse_categorical_accuracy: 0.9500
Epoch 499/600
20/20 [==============================] - 0s 199us/sample - loss: 0.4289 -
sparse_categorical_accuracy: 0.9500
Epoch 500/600
20/20 [==============================] - 0s 177us/sample - loss: 0.4273 -
sparse_categorical_accuracy: 0.9500
Epoch 501/600
20/20 [==============================] - 0s 286us/sample - loss: 0.4256 -
sparse_categorical_accuracy: 0.9500
Epoch 502/600
20/20 [==============================] - 0s 239us/sample - loss: 0.4239 -
sparse_categorical_accuracy: 0.9500
Epoch 503/600
20/20 [==============================] - 0s 204us/sample - loss: 0.4223 -
sparse_categorical_accuracy: 0.9500
Epoch 504/600
20/20 [==============================] - 0s 188us/sample - loss: 0.4206 -
sparse_categorical_accuracy: 0.9500
Epoch 505/600
20/20 [==============================] - 0s 179us/sample - loss: 0.4190 -
sparse_categorical_accuracy: 0.9500
Epoch 506/600
20/20 [==============================] - 0s 170us/sample - loss: 0.4174 -
sparse_categorical_accuracy: 0.9500
Epoch 507/600
20/20 [==============================] - 0s 189us/sample - loss: 0.4157 -
sparse_categorical_accuracy: 0.9500
Epoch 508/600
20/20 [==============================] - 0s 250us/sample - loss: 0.4141 -
sparse_categorical_accuracy: 0.9500
Epoch 509/600
20/20 [==============================] - 0s 193us/sample - loss: 0.4125 -
```

```
sparse_categorical_accuracy: 0.9500
Epoch 510/600
20/20 [==============================] - 0s 298us/sample - loss: 0.4109 -
sparse_categorical_accuracy: 0.9500
Epoch 511/600
20/20 [==============================] - 0s 175us/sample - loss: 0.4094 -
sparse_categorical_accuracy: 0.9500
Epoch 512/600
20/20 [==============================] - 0s 199us/sample - loss: 0.4078 -
sparse_categorical_accuracy: 0.9500
Epoch 513/600
20/20 [==============================] - 0s 244us/sample - loss: 0.4062 -
sparse_categorical_accuracy: 0.9500
Epoch 514/600
20/20 [==============================] - 0s 202us/sample - loss: 0.4047 -
sparse_categorical_accuracy: 0.9500
Epoch 515/600
20/20 [==============================] - 0s 254us/sample - loss: 0.4031 -
sparse_categorical_accuracy: 0.9500
Epoch 516/600
20/20 [==============================] - 0s 179us/sample - loss: 0.4016 -
sparse_categorical_accuracy: 0.9500
Epoch 517/600
20/20 [==============================] - 0s 235us/sample - loss: 0.4000 -
sparse_categorical_accuracy: 0.9500
Epoch 518/600
20/20 [==============================] - 0s 249us/sample - loss: 0.3985 -
sparse_categorical_accuracy: 0.9500
Epoch 519/600
20/20 [==============================] - 0s 177us/sample - loss: 0.3970 -
sparse_categorical_accuracy: 0.9500
Epoch 520/600
20/20 [==============================] - 0s 229us/sample - loss: 0.3955 -
sparse_categorical_accuracy: 0.9500
Epoch 521/600
20/20 [==============================] - 0s 181us/sample - loss: 0.3940 -
sparse_categorical_accuracy: 0.9500
Epoch 522/600
20/20 [==============================] - 0s 309us/sample - loss: 0.3925 -
sparse_categorical_accuracy: 0.9500
Epoch 523/600
20/20 [==============================] - 0s 175us/sample - loss: 0.3911 -
sparse_categorical_accuracy: 0.9500
Epoch 524/600
20/20 [==============================] - 0s 172us/sample - loss: 0.3896 -
sparse_categorical_accuracy: 0.9500
Epoch 525/600
20/20 [==============================] - 0s 248us/sample - loss: 0.3881 -
```

```
sparse_categorical_accuracy: 0.9500
Epoch 526/600
20/20 [==============================] - 0s 178us/sample - loss: 0.3867 -
sparse_categorical_accuracy: 0.9500
Epoch 527/600
20/20 [==============================] - 0s 292us/sample - loss: 0.3852 -
sparse_categorical_accuracy: 0.9500
Epoch 528/600
20/20 [==============================] - 0s 174us/sample - loss: 0.3838 -
sparse_categorical_accuracy: 0.9500
Epoch 529/600
20/20 [==============================] - 0s 229us/sample - loss: 0.3823 -
sparse_categorical_accuracy: 0.9500
Epoch 530/600
20/20 [==============================] - 0s 158us/sample - loss: 0.3809 -
sparse_categorical_accuracy: 0.9500
Epoch 531/600
20/20 [==============================] - 0s 190us/sample - loss: 0.3795 -
sparse_categorical_accuracy: 0.9500
Epoch 532/600
20/20 [==============================] - 0s 212us/sample - loss: 0.3781 -
sparse_categorical_accuracy: 0.9500
Epoch 533/600
20/20 [==============================] - 0s 164us/sample - loss: 0.3767 -
sparse_categorical_accuracy: 0.9500
Epoch 534/600
20/20 [==============================] - 0s 170us/sample - loss: 0.3753 -
sparse_categorical_accuracy: 0.9500
Epoch 535/600
20/20 [==============================] - 0s 186us/sample - loss: 0.3739 -
sparse_categorical_accuracy: 0.9500
Epoch 536/600
20/20 [==============================] - 0s 199us/sample - loss: 0.3726 -
sparse_categorical_accuracy: 0.9500
Epoch 537/600
20/20 [==============================] - 0s 199us/sample - loss: 0.3712 -
sparse_categorical_accuracy: 0.9500
Epoch 538/600
20/20 [==============================] - 0s 229us/sample - loss: 0.3698 -
sparse_categorical_accuracy: 0.9500
Epoch 539/600
20/20 [==============================] - 0s 182us/sample - loss: 0.3685 -
sparse_categorical_accuracy: 0.9500
Epoch 540/600
20/20 [==============================] - 0s 243us/sample - loss: 0.3672 -
sparse_categorical_accuracy: 0.9500
Epoch 541/600
20/20 [==============================] - 0s 191us/sample - loss: 0.3658 -
```

```
sparse_categorical_accuracy: 0.9500
Epoch 542/600
20/20 [==============================] - 0s 248us/sample - loss: 0.3645 -
sparse_categorical_accuracy: 0.9500
Epoch 543/600
20/20 [==============================] - 0s 199us/sample - loss: 0.3632 -
sparse_categorical_accuracy: 0.9500
Epoch 544/600
20/20 [==============================] - 0s 169us/sample - loss: 0.3618 -
sparse_categorical_accuracy: 0.9500
Epoch 545/600
20/20 [==============================] - 0s 202us/sample - loss: 0.3605 -
sparse_categorical_accuracy: 0.9500
Epoch 546/600
20/20 [==============================] - 0s 171us/sample - loss: 0.3592 -
sparse_categorical_accuracy: 0.9500
Epoch 547/600
20/20 [==============================] - 0s 199us/sample - loss: 0.3579 -
sparse_categorical_accuracy: 0.9500
Epoch 548/600
20/20 [==============================] - 0s 175us/sample - loss: 0.3566 -
sparse_categorical_accuracy: 0.9500
Epoch 549/600
20/20 [==============================] - 0s 177us/sample - loss: 0.3553 -
sparse_categorical_accuracy: 0.9500
Epoch 550/600
20/20 [==============================] - 0s 174us/sample - loss: 0.3540 -
sparse_categorical_accuracy: 0.9500
Epoch 551/600
20/20 [==============================] - 0s 243us/sample - loss: 0.3528 -
sparse_categorical_accuracy: 0.9500
Epoch 552/600
20/20 [==============================] - 0s 156us/sample - loss: 0.3515 -
sparse_categorical_accuracy: 0.9500
Epoch 553/600
20/20 [==============================] - 0s 274us/sample - loss: 0.3502 -
sparse_categorical_accuracy: 0.9500
Epoch 554/600
20/20 [==============================] - 0s 194us/sample - loss: 0.3490 -
sparse_categorical_accuracy: 0.9500
Epoch 555/600
20/20 [==============================] - 0s 305us/sample - loss: 0.3477 -
sparse_categorical_accuracy: 0.9500
Epoch 556/600
20/20 [==============================] - 0s 185us/sample - loss: 0.3465 -
sparse_categorical_accuracy: 0.9500
Epoch 557/600
20/20 [==============================] - 0s 199us/sample - loss: 0.3453 -
```

```
sparse_categorical_accuracy: 0.9500
Epoch 558/600
20/20 [==============================] - 0s 243us/sample - loss: 0.3440 -
sparse_categorical_accuracy: 0.9500
Epoch 559/600
20/20 [==============================] - 0s 177us/sample - loss: 0.3428 -
sparse_categorical_accuracy: 0.9500
Epoch 560/600
20/20 [==============================] - 0s 287us/sample - loss: 0.3416 -
sparse_categorical_accuracy: 0.9500
Epoch 561/600
20/20 [==============================] - 0s 198us/sample - loss: 0.3404 -
sparse_categorical_accuracy: 0.9500
Epoch 562/600
20/20 [==============================] - 0s 194us/sample - loss: 0.3392 -
sparse_categorical_accuracy: 0.9500
Epoch 563/600
20/20 [==============================] - 0s 224us/sample - loss: 0.3380 -
sparse_categorical_accuracy: 0.9500
Epoch 564/600
20/20 [==============================] - 0s 186us/sample - loss: 0.3368 -
sparse_categorical_accuracy: 0.9500
Epoch 565/600
20/20 [==============================] - 0s 257us/sample - loss: 0.3356 -
sparse_categorical_accuracy: 0.9500
Epoch 566/600
20/20 [==============================] - 0s 177us/sample - loss: 0.3344 -
sparse_categorical_accuracy: 0.9500
Epoch 567/600
20/20 [==============================] - 0s 199us/sample - loss: 0.3332 -
sparse_categorical_accuracy: 0.9500
Epoch 568/600
20/20 [==============================] - 0s 174us/sample - loss: 0.3320 -
sparse_categorical_accuracy: 0.9500
Epoch 569/600
20/20 [==============================] - 0s 201us/sample - loss: 0.3308 -
sparse_categorical_accuracy: 0.9500
Epoch 570/600
20/20 [==============================] - 0s 185us/sample - loss: 0.3297 -
sparse_categorical_accuracy: 0.9500
Epoch 571/600
20/20 [==============================] - 0s 179us/sample - loss: 0.3285 -
sparse_categorical_accuracy: 0.9500
Epoch 572/600
20/20 [==============================] - 0s 207us/sample - loss: 0.3274 -
sparse_categorical_accuracy: 0.9500
Epoch 573/600
20/20 [==============================] - 0s 226us/sample - loss: 0.3263 -
```

```
sparse_categorical_accuracy: 0.9500
Epoch 574/600
20/20 [==============================] - 0s 184us/sample - loss: 0.3251 -
sparse_categorical_accuracy: 0.9500
Epoch 575/600
20/20 [==============================] - 0s 175us/sample - loss: 0.3240 -
sparse_categorical_accuracy: 0.9500
Epoch 576/600
20/20 [==============================] - 0s 254us/sample - loss: 0.3228 -
sparse_categorical_accuracy: 0.9500
Epoch 577/600
20/20 [==============================] - 0s 186us/sample - loss: 0.3217 -
sparse_categorical_accuracy: 0.9500
Epoch 578/600
20/20 [==============================] - 0s 317us/sample - loss: 0.3206 -
sparse_categorical_accuracy: 0.9500
Epoch 579/600
20/20 [==============================] - 0s 178us/sample - loss: 0.3195 -
sparse_categorical_accuracy: 0.9500
Epoch 580/600
20/20 [==============================] - 0s 219us/sample - loss: 0.3184 -
sparse_categorical_accuracy: 0.9500
Epoch 581/600
20/20 [==============================] - 0s 211us/sample - loss: 0.3173 -
sparse_categorical_accuracy: 0.9500
Epoch 582/600
20/20 [==============================] - 0s 211us/sample - loss: 0.3162 -
sparse_categorical_accuracy: 0.9500
Epoch 583/600
20/20 [==============================] - 0s 235us/sample - loss: 0.3151 -
sparse_categorical_accuracy: 0.9500
Epoch 584/600
20/20 [==============================] - 0s 201us/sample - loss: 0.3140 -
sparse_categorical_accuracy: 0.9500
Epoch 585/600
20/20 [==============================] - 0s 231us/sample - loss: 0.3129 -
sparse_categorical_accuracy: 0.9500
Epoch 586/600
20/20 [==============================] - 0s 217us/sample - loss: 0.3119 -
sparse_categorical_accuracy: 0.9500
Epoch 587/600
20/20 [==============================] - 0s 228us/sample - loss: 0.3108 -
sparse_categorical_accuracy: 0.9500
Epoch 588/600
20/20 [==============================] - 0s 242us/sample - loss: 0.3098 -
sparse_categorical_accuracy: 0.9500
Epoch 589/600
20/20 [==============================] - 0s 200us/sample - loss: 0.3087 -
```

```
sparse_categorical_accuracy: 0.9500
Epoch 590/600
20/20 [==============================] - 0s 251us/sample - loss: 0.3076 -
sparse_categorical_accuracy: 0.9500
Epoch 591/600
20/20 [==============================] - 0s 216us/sample - loss: 0.3066 -
sparse_categorical_accuracy: 0.9500
Epoch 592/600
20/20 [==============================] - 0s 301us/sample - loss: 0.3056 -
sparse_categorical_accuracy: 0.9500
Epoch 593/600
20/20 [==============================] - 0s 196us/sample - loss: 0.3045 -
sparse_categorical_accuracy: 0.9500
Epoch 594/600
20/20 [==============================] - 0s 200us/sample - loss: 0.3035 -
sparse_categorical_accuracy: 0.9500
Epoch 595/600
20/20 [==============================] - 0s 233us/sample - loss: 0.3025 -
sparse_categorical_accuracy: 0.9500
Epoch 596/600
20/20 [==============================] - 0s 197us/sample - loss: 0.3015 -
sparse_categorical_accuracy: 0.9500
Epoch 597/600
20/20 [==============================] - 0s 307us/sample - loss: 0.3005 -
sparse_categorical_accuracy: 0.9500
Epoch 598/600
20/20 [==============================] - 0s 223us/sample - loss: 0.2994 -
sparse_categorical_accuracy: 0.9500
Epoch 599/600
20/20 [==============================] - 0s 187us/sample - loss: 0.2984 -
sparse_categorical_accuracy: 0.9500
Epoch 600/600
20/20 [==============================] - 0s 251us/sample - loss: 0.2974 -
sparse_categorical_accuracy: 0.9500
```

[16]:
```python
#Function for plotting loss and accuracy curves from the history variable.
def plot_curves(history):
    plt.plot(history.history['sparse_categorical_accuracy'])
    plt.plot(history.history['val_sparse_categorical_accuracy'])
    plt.title('Model accuracy')
    plt.ylabel('Accuracy')
    plt.xlabel('Epoch')
    plt.legend(['Train', 'Val'], loc='upper left')
    plt.show()

    # Plot training & validation loss values
    plt.plot(history.history['loss'])
```

```
    plt.plot(history.history['val_loss'])
    plt.title('Model loss')
    plt.ylabel('Loss')
    plt.xlabel('Epoch')
    plt.legend(['Train', 'Val'], loc='upper left')
    plt.show()
```

**Start with small regularization and find a Learning rate that makes the loss go down**
We start with a small regularization and try to find a learning rate that makes the loss go down. We can observe here that the loss is not going down. As we can see in curves below the learning rate is so small that the model is actually not learning! The validation accuracy is still around 10% owing to the random guess. Remember that the softmax function is used at the end of the network for the actual 'classification' purposes.

[22]:
```
LEARNING_RATE=1e-6
EPOCHS=10
L2_REG=1e-6

model=create_model(num_classes,L2_REG)
model.compile(optimizer=optimizers.
 ↪SGD(learning_rate=LEARNING_RATE),loss='sparse_categorical_crossentropy',metrics=['sparse_ca
model.fit(X_train, y_train, batch_size=BATCH_SIZE, epochs=EPOCHS, verbose=1, ␣
 ↪validation_data=(X_val,y_val))
```

```
Train on 37500 samples, validate on 12500 samples
Epoch 1/10
37500/37500 [==============================] - 5s 129us/sample - loss: 2.3243 -
sparse_categorical_accuracy: 0.1034 - val_loss: 2.3262 -
val_sparse_categorical_accuracy: 0.1002
Epoch 2/10
37500/37500 [==============================] - 5s 123us/sample - loss: 2.3235 -
sparse_categorical_accuracy: 0.1038 - val_loss: 2.3254 -
val_sparse_categorical_accuracy: 0.1007
Epoch 3/10
37500/37500 [==============================] - 5s 123us/sample - loss: 2.3227 -
sparse_categorical_accuracy: 0.1043 - val_loss: 2.3246 -
val_sparse_categorical_accuracy: 0.1018
Epoch 4/10
37500/37500 [==============================] - 5s 125us/sample - loss: 2.3220 -
sparse_categorical_accuracy: 0.1046 - val_loss: 2.3239 -
val_sparse_categorical_accuracy: 0.1017
Epoch 5/10
37500/37500 [==============================] - 5s 125us/sample - loss: 2.3213 -
sparse_categorical_accuracy: 0.1050 - val_loss: 2.3231 -
val_sparse_categorical_accuracy: 0.1017
Epoch 6/10
37500/37500 [==============================] - 5s 123us/sample - loss: 2.3206 -
```

```
sparse_categorical_accuracy: 0.1056 - val_loss: 2.3224 -
val_sparse_categorical_accuracy: 0.1022
Epoch 7/10
37500/37500 [==============================] - 5s 125us/sample - loss: 2.3199 -
sparse_categorical_accuracy: 0.1062 - val_loss: 2.3217 -
val_sparse_categorical_accuracy: 0.1026
Epoch 8/10
37500/37500 [==============================] - 5s 123us/sample - loss: 2.3192 -
sparse_categorical_accuracy: 0.1067 - val_loss: 2.3210 -
val_sparse_categorical_accuracy: 0.1030
Epoch 9/10
37500/37500 [==============================] - 5s 123us/sample - loss: 2.3185 -
sparse_categorical_accuracy: 0.1071 - val_loss: 2.3203 -
val_sparse_categorical_accuracy: 0.1033
Epoch 10/10
37500/37500 [==============================] - 5s 125us/sample - loss: 2.3178 -
sparse_categorical_accuracy: 0.1075 - val_loss: 2.3196 -
val_sparse_categorical_accuracy: 0.1035
```

[22]:
```
<tensorflow.python.keras.callbacks.History at 0x1f9e0b20b00>
```

**Very high Learning Rate - Loss exploding** We can now try a higher learning rate. We set the learning rate to 1e6. As we can see in the curves below the cost is so high that the loss is exploding. It is because the weights are updated by a huge number. Trying to find the optimum learning rate is very important.

[23]:
```
LEARNING_RATE=1e5
EPOCHS=10
L2_REG=1e-6

model=create_model(num_classes,L2_REG)
model.compile(optimizer=optimizers.
 ↪SGD(learning_rate=LEARNING_RATE),loss='sparse_categorical_crossentropy',metrics=['sparse_ca
model.fit(X_train, y_train, batch_size=BATCH_SIZE, epochs=EPOCHS, verbose=1, ␣
 ↪validation_data=(X_val,y_val))
```

```
Train on 37500 samples, validate on 12500 samples
Epoch 1/10
37500/37500 [==============================] - 5s 131us/sample - loss: nan -
sparse_categorical_accuracy: 0.1003 - val_loss: nan -
val_sparse_categorical_accuracy: 0.0992
Epoch 2/10
37500/37500 [==============================] - 5s 124us/sample - loss: nan -
sparse_categorical_accuracy: 0.1003 - val_loss: nan -
val_sparse_categorical_accuracy: 0.0992
Epoch 3/10
37500/37500 [==============================] - 5s 122us/sample - loss: nan -
```

```
sparse_categorical_accuracy: 0.1003 - val_loss: nan -
val_sparse_categorical_accuracy: 0.0992
Epoch 4/10
37500/37500 [==============================] - 5s 124us/sample - loss: nan -
sparse_categorical_accuracy: 0.1003 - val_loss: nan -
val_sparse_categorical_accuracy: 0.0992
Epoch 5/10
37500/37500 [==============================] - 5s 122us/sample - loss: nan -
sparse_categorical_accuracy: 0.1003 - val_loss: nan -
val_sparse_categorical_accuracy: 0.0992
Epoch 6/10
37500/37500 [==============================] - 5s 122us/sample - loss: nan -
sparse_categorical_accuracy: 0.1003 - val_loss: nan -
val_sparse_categorical_accuracy: 0.0992
Epoch 7/10
37500/37500 [==============================] - 5s 124us/sample - loss: nan -
sparse_categorical_accuracy: 0.1003 - val_loss: nan -
val_sparse_categorical_accuracy: 0.0992
Epoch 8/10
37500/37500 [==============================] - 5s 124us/sample - loss: nan -
sparse_categorical_accuracy: 0.1003 - val_loss: nan -
val_sparse_categorical_accuracy: 0.0992
Epoch 9/10
37500/37500 [==============================] - 5s 123us/sample - loss: nan -
sparse_categorical_accuracy: 0.1003 - val_loss: nan -
val_sparse_categorical_accuracy: 0.0992
Epoch 10/10
37500/37500 [==============================] - 5s 123us/sample - loss: nan -
sparse_categorical_accuracy: 0.1003 - val_loss: nan -
val_sparse_categorical_accuracy: 0.0992
```

[23]: `<tensorflow.python.keras.callbacks.History at 0x1f9e10c66a0>`

**Crank up the Learning rate to check if the loss still explodes.** We can keep trying values for which the loss will go down, but that is a trial and error method. We can adopt a cross validation strategy where we try different learning rates and regularizations in a fixed range and choose the combination that gives the best performance on the model. We can see here that the loss is still exploding for an increased LR. The learning rate is generally selected between 1e-3, 1e-4

[32]:
```
LEARNING_RATE=0.4825
EPOCHS=10
L2_REG=1e-6

model=create_model(num_classes,L2_REG)
model.compile(optimizer=optimizers.
 ↪SGD(learning_rate=LEARNING_RATE),loss='sparse_categorical_crossentropy',metrics=['sparse_ca
```

```
model.fit(X_train, y_train, batch_size=BATCH_SIZE, epochs=EPOCHS, verbose=1, ␣
↪validation_data=(X_val,y_val))
```

```
Train on 37500 samples, validate on 12500 samples
Epoch 1/10
37500/37500 [==============================] - 5s 146us/sample - loss: 2.1148 -
sparse_categorical_accuracy: 0.2051 - val_loss: 1.8623 -
val_sparse_categorical_accuracy: 0.3003
Epoch 2/10
37500/37500 [==============================] - 5s 133us/sample - loss: nan -
sparse_categorical_accuracy: 0.1827 - val_loss: nan -
val_sparse_categorical_accuracy: 0.0992
Epoch 3/10
37500/37500 [==============================] - 5s 134us/sample - loss: nan -
sparse_categorical_accuracy: 0.1003 - val_loss: nan -
val_sparse_categorical_accuracy: 0.0992
Epoch 4/10
37500/37500 [==============================] - 5s 136us/sample - loss: nan -
sparse_categorical_accuracy: 0.1003 - val_loss: nan -
val_sparse_categorical_accuracy: 0.0992
Epoch 5/10
37500/37500 [==============================] - 5s 131us/sample - loss: nan -
sparse_categorical_accuracy: 0.1003 - val_loss: nan -
val_sparse_categorical_accuracy: 0.0992
Epoch 6/10
37500/37500 [==============================] - 5s 132us/sample - loss: nan -
sparse_categorical_accuracy: 0.1003 - val_loss: nan -
val_sparse_categorical_accuracy: 0.0992
Epoch 7/10
37500/37500 [==============================] - 5s 130us/sample - loss: nan -
sparse_categorical_accuracy: 0.1003 - val_loss: nan -
val_sparse_categorical_accuracy: 0.0992
Epoch 8/10
37500/37500 [==============================] - 5s 131us/sample - loss: nan -
sparse_categorical_accuracy: 0.1003 - val_loss: nan -
val_sparse_categorical_accuracy: 0.0992
Epoch 9/10
37500/37500 [==============================] - 5s 129us/sample - loss: nan -
sparse_categorical_accuracy: 0.1003 - val_loss: nan -
val_sparse_categorical_accuracy: 0.0992
Epoch 10/10
37500/37500 [==============================] - 5s 131us/sample - loss: nan -
sparse_categorical_accuracy: 0.1003 - val_loss: nan -
val_sparse_categorical_accuracy: 0.0992
```

[32]: <tensorflow.python.keras.callbacks.History at 0x1f9e980e908>

### 1.1.3 Hyper parameter Tuning

To find the optimum learning rate and regularization to apply, we first go through a few epochs to get a rough idea of how the params work and then move on to the second stage, where we have a longer run time and a finer search.

**Coarse Search** For coarse search we take a random value of the learning rate between 1e-3 and 1e-6 and a random value for regularization. As seen in we can see the top 10 performers from the coarse search strategy, we can see that the learning ratesare restricted within the range 1e-3 and 1e-4 and the regularization between 1e-5 and 1. Thus, we narrow down the range andperform a finer search for a longer time, i.e. increase the number of epochs

[33]:
```
val_acc=[]
lrs=[]
l2_regs=[]
for i in tqdm(range(100)):
    lr = 10**np.random.uniform(-3,-6)
    l2_reg = 10**np.random.uniform(-5, 1)
    model = create_model(num_classes,l2_reg)
    model.compile(optimizer=optimizers.
↪SGD(learning_rate=lr),loss='sparse_categorical_crossentropy',metrics=['sparse_categorical_a
    history = model.fit(X_train,y_train,batch_size=BATCH_SIZE,epochs=5,␣
↪verbose=1,validation_data=(X_val,y_val))
    val_acc.append(history.history['val_sparse_categorical_accuracy'][-1])
    lrs.append(lr)
    l2_regs.append(l2_reg)
    print(history.history['val_sparse_categorical_accuracy'][-1], lr, l2_reg)
```

```
  0%|          | 0/100 [00:00<?, ?it/s]
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 5s 143us/sample - loss: 2.1678 -
sparse_categorical_accuracy: 0.2259 - val_loss: 2.0512 -
val_sparse_categorical_accuracy: 0.2704
Epoch 2/5
37500/37500 [==============================] - 5s 130us/sample - loss: 1.9566 -
sparse_categorical_accuracy: 0.3161 - val_loss: 1.8828 -
val_sparse_categorical_accuracy: 0.3415
Epoch 3/5
37500/37500 [==============================] - 5s 129us/sample - loss: 1.8110 -
sparse_categorical_accuracy: 0.3677 - val_loss: 1.7715 -
val_sparse_categorical_accuracy: 0.3769
Epoch 4/5
37500/37500 [==============================] - 5s 129us/sample - loss: 1.7045 -
sparse_categorical_accuracy: 0.4033 - val_loss: 1.6665 -
val_sparse_categorical_accuracy: 0.4150
Epoch 5/5
37500/37500 [==============================] - 5s 131us/sample - loss: 1.6172 -
```

```
sparse_categorical_accuracy: 0.4338 - val_loss: 1.5963 -
val_sparse_categorical_accuracy: 0.4356

  1%|          | 1/100 [00:25<42:09, 25.55s/it]

0.4356 0.000964651669434161 3.9585137634618574e-05
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 6s 151us/sample - loss: 196.4742
- sparse_categorical_accuracy: 0.0897 - val_loss: 196.1994 -
val_sparse_categorical_accuracy: 0.0938
Epoch 2/5
37500/37500 [==============================] - 5s 133us/sample - loss: 195.9222
- sparse_categorical_accuracy: 0.0905 - val_loss: 195.6481 -
val_sparse_categorical_accuracy: 0.0941
Epoch 3/5
37500/37500 [==============================] - 5s 131us/sample - loss: 195.3718
- sparse_categorical_accuracy: 0.0911 - val_loss: 195.0985 -
val_sparse_categorical_accuracy: 0.0945
Epoch 4/5
37500/37500 [==============================] - 5s 134us/sample - loss: 194.8229
- sparse_categorical_accuracy: 0.0911 - val_loss: 194.5504 -
val_sparse_categorical_accuracy: 0.0934
Epoch 5/5
37500/37500 [==============================] - 5s 138us/sample - loss: 194.2757
- sparse_categorical_accuracy: 0.0921 - val_loss: 194.0040 -
val_sparse_categorical_accuracy: 0.0935

  2%|          | 2/100 [00:52<42:13, 25.85s/it]

0.09352 1.1473973163643606e-06 0.5280101167034242
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 5s 146us/sample - loss: 2.4907 -
sparse_categorical_accuracy: 0.1059 - val_loss: 2.4813 -
val_sparse_categorical_accuracy: 0.1098
Epoch 2/5
37500/37500 [==============================] - 5s 130us/sample - loss: 2.4734 -
sparse_categorical_accuracy: 0.1122 - val_loss: 2.4669 -
val_sparse_categorical_accuracy: 0.1150
Epoch 3/5
37500/37500 [==============================] - 5s 132us/sample - loss: 2.4607 -
sparse_categorical_accuracy: 0.1216 - val_loss: 2.4560 -
val_sparse_categorical_accuracy: 0.1260
Epoch 4/5
37500/37500 [==============================] - 5s 131us/sample - loss: 2.4509 -
sparse_categorical_accuracy: 0.1330 - val_loss: 2.4473 -
val_sparse_categorical_accuracy: 0.1342
Epoch 5/5
37500/37500 [==============================] - 5s 130us/sample - loss: 2.4428 -
```

```
sparse_categorical_accuracy: 0.1451 - val_loss: 2.4400 -
val_sparse_categorical_accuracy: 0.1502

  3%|          | 3/100 [01:17<41:45, 25.83s/it]

0.15024 1.5044773721612762e-05 0.00042390096926228464
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 6s 148us/sample - loss: 2.3356 -
sparse_categorical_accuracy: 0.0997 - val_loss: 2.3340 -
val_sparse_categorical_accuracy: 0.0981
Epoch 2/5
37500/37500 [==============================] - 5s 132us/sample - loss: 2.3318 -
sparse_categorical_accuracy: 0.1007 - val_loss: 2.3303 -
val_sparse_categorical_accuracy: 0.0985
Epoch 3/5
37500/37500 [==============================] - 5s 131us/sample - loss: 2.3283 -
sparse_categorical_accuracy: 0.1021 - val_loss: 2.3270 -
val_sparse_categorical_accuracy: 0.0986
Epoch 4/5
37500/37500 [==============================] - 5s 132us/sample - loss: 2.3252 -
sparse_categorical_accuracy: 0.1035 - val_loss: 2.3241 -
val_sparse_categorical_accuracy: 0.0996
Epoch 5/5
37500/37500 [==============================] - 5s 132us/sample - loss: 2.3223 -
sparse_categorical_accuracy: 0.1046 - val_loss: 2.3213 -
val_sparse_categorical_accuracy: 0.1011

  4%|          | 4/100 [01:43<41:27, 25.91s/it]

0.10112 1.4032123064585471e-05 4.354653833347733e-05
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 6s 147us/sample - loss: 2.5644 -
sparse_categorical_accuracy: 0.1808 - val_loss: 2.5173 -
val_sparse_categorical_accuracy: 0.2220
Epoch 2/5
37500/37500 [==============================] - 5s 134us/sample - loss: 2.4597 -
sparse_categorical_accuracy: 0.2534 - val_loss: 2.4023 -
val_sparse_categorical_accuracy: 0.2733
Epoch 3/5
37500/37500 [==============================] - 5s 131us/sample - loss: 2.3390 -
sparse_categorical_accuracy: 0.2975 - val_loss: 2.2896 -
val_sparse_categorical_accuracy: 0.3061
Epoch 4/5
37500/37500 [==============================] - 5s 130us/sample - loss: 2.2377 -
sparse_categorical_accuracy: 0.3232 - val_loss: 2.2059 -
val_sparse_categorical_accuracy: 0.3247
Epoch 5/5
37500/37500 [==============================] - 5s 132us/sample - loss: 2.1656 -
```

```
sparse_categorical_accuracy: 0.3440 - val_loss: 2.1491 -
val_sparse_categorical_accuracy: 0.3454

  5%|          | 5/100 [02:10<41:06, 25.97s/it]

0.34536 0.0003841847995263698 0.0008248627639668004
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 6s 148us/sample - loss: 18.5547 -
sparse_categorical_accuracy: 0.1133 - val_loss: 18.3409 -
val_sparse_categorical_accuracy: 0.1356
Epoch 2/5
37500/37500 [==============================] - 5s 133us/sample - loss: 18.1352 -
sparse_categorical_accuracy: 0.1534 - val_loss: 17.9333 -
val_sparse_categorical_accuracy: 0.1754
Epoch 3/5
37500/37500 [==============================] - 5s 136us/sample - loss: 17.7333 -
sparse_categorical_accuracy: 0.1885 - val_loss: 17.5373 -
val_sparse_categorical_accuracy: 0.2074
Epoch 4/5
37500/37500 [==============================] - 5s 133us/sample - loss: 17.3425 -
sparse_categorical_accuracy: 0.2182 - val_loss: 17.1519 -
val_sparse_categorical_accuracy: 0.2301
Epoch 5/5
37500/37500 [==============================] - 5s 134us/sample - loss: 16.9608 -
sparse_categorical_accuracy: 0.2399 - val_loss: 16.7749 -
val_sparse_categorical_accuracy: 0.2454

  6%|          | 6/100 [02:36<40:55, 26.13s/it]

0.24544 0.00011603662609640516 0.04468582342314639
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 6s 150us/sample - loss: 2.3853 -
sparse_categorical_accuracy: 0.1187 - val_loss: 2.3844 -
val_sparse_categorical_accuracy: 0.1147
Epoch 2/5
37500/37500 [==============================] - 5s 134us/sample - loss: 2.3845 -
sparse_categorical_accuracy: 0.1193 - val_loss: 2.3835 -
val_sparse_categorical_accuracy: 0.1163
Epoch 3/5
37500/37500 [==============================] - 5s 133us/sample - loss: 2.3836 -
sparse_categorical_accuracy: 0.1200 - val_loss: 2.3827 -
val_sparse_categorical_accuracy: 0.1169
Epoch 4/5
37500/37500 [==============================] - 5s 134us/sample - loss: 2.3828 -
sparse_categorical_accuracy: 0.1204 - val_loss: 2.3820 -
val_sparse_categorical_accuracy: 0.1177
Epoch 5/5
37500/37500 [==============================] - 5s 133us/sample - loss: 2.3820 -
```

```
sparse_categorical_accuracy: 0.1215 - val_loss: 2.3812 -
val_sparse_categorical_accuracy: 0.1186

  7%|          | 7/100 [03:03<40:43, 26.28s/it]

0.11856 2.0088667119479095e-06 0.00019084992504096593
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 6s 151us/sample - loss: 8.5161 -
sparse_categorical_accuracy: 0.1251 - val_loss: 8.4426 -
val_sparse_categorical_accuracy: 0.1500
Epoch 2/5
37500/37500 [==============================] - 5s 135us/sample - loss: 8.3770 -
sparse_categorical_accuracy: 0.1815 - val_loss: 8.3137 -
val_sparse_categorical_accuracy: 0.2050
Epoch 3/5
37500/37500 [==============================] - 5s 139us/sample - loss: 8.2454 -
sparse_categorical_accuracy: 0.2262 - val_loss: 8.1812 -
val_sparse_categorical_accuracy: 0.2458
Epoch 4/5
37500/37500 [==============================] - 5s 136us/sample - loss: 8.1087 -
sparse_categorical_accuracy: 0.2563 - val_loss: 8.0434 -
val_sparse_categorical_accuracy: 0.2638
Epoch 5/5
37500/37500 [==============================] - 5s 138us/sample - loss: 7.9675 -
sparse_categorical_accuracy: 0.2749 - val_loss: 7.9031 -
val_sparse_categorical_accuracy: 0.2782

  8%|          | 8/100 [03:30<40:38, 26.50s/it]

0.27824 0.00019382277102167732 0.016932326511822225
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 6s 150us/sample - loss: 2.3006 -
sparse_categorical_accuracy: 0.1029 - val_loss: 2.2897 -
val_sparse_categorical_accuracy: 0.1143
Epoch 2/5
37500/37500 [==============================] - 5s 132us/sample - loss: 2.2803 -
sparse_categorical_accuracy: 0.1278 - val_loss: 2.2729 -
val_sparse_categorical_accuracy: 0.1389
Epoch 3/5
37500/37500 [==============================] - 5s 133us/sample - loss: 2.2632 -
sparse_categorical_accuracy: 0.1571 - val_loss: 2.2562 -
val_sparse_categorical_accuracy: 0.1666
Epoch 4/5
37500/37500 [==============================] - 5s 133us/sample - loss: 2.2452 -
sparse_categorical_accuracy: 0.1822 - val_loss: 2.2380 -
val_sparse_categorical_accuracy: 0.1927
Epoch 5/5
37500/37500 [==============================] - 5s 133us/sample - loss: 2.2254 -
```

```
sparse_categorical_accuracy: 0.2066 - val_loss: 2.2176 -
val_sparse_categorical_accuracy: 0.2122

  9%|         | 9/100 [03:56<40:11, 26.50s/it]

0.21216 0.00010696344535474933 1.525994848654146e-05
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 6s 155us/sample - loss: 2.3486 -
sparse_categorical_accuracy: 0.1045 - val_loss: 2.3267 -
val_sparse_categorical_accuracy: 0.1477
Epoch 2/5
37500/37500 [==============================] - 5s 138us/sample - loss: 2.3105 -
sparse_categorical_accuracy: 0.1741 - val_loss: 2.2942 -
val_sparse_categorical_accuracy: 0.1961
Epoch 3/5
37500/37500 [==============================] - 5s 136us/sample - loss: 2.2756 -
sparse_categorical_accuracy: 0.2139 - val_loss: 2.2574 -
val_sparse_categorical_accuracy: 0.2246
Epoch 4/5
37500/37500 [==============================] - 5s 138us/sample - loss: 2.2356 -
sparse_categorical_accuracy: 0.2347 - val_loss: 2.2159 -
val_sparse_categorical_accuracy: 0.2430
Epoch 5/5
37500/37500 [==============================] - 5s 138us/sample - loss: 2.1921 -
sparse_categorical_accuracy: 0.2483 - val_loss: 2.1726 -
val_sparse_categorical_accuracy: 0.2555

 10%|         | 10/100 [04:24<40:09, 26.77s/it]

0.25552 0.0001850006583602752 0.00014773909264388925
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 6s 153us/sample - loss: 4.9639 -
sparse_categorical_accuracy: 0.0985 - val_loss: 4.9587 -
val_sparse_categorical_accuracy: 0.0993
Epoch 2/5
37500/37500 [==============================] - 5s 137us/sample - loss: 4.9532 -
sparse_categorical_accuracy: 0.0997 - val_loss: 4.9489 -
val_sparse_categorical_accuracy: 0.0992
Epoch 3/5
37500/37500 [==============================] - 5s 137us/sample - loss: 4.9442 -
sparse_categorical_accuracy: 0.1008 - val_loss: 4.9404 -
val_sparse_categorical_accuracy: 0.1007
Epoch 4/5
37500/37500 [==============================] - 5s 136us/sample - loss: 4.9362 -
sparse_categorical_accuracy: 0.1010 - val_loss: 4.9329 -
val_sparse_categorical_accuracy: 0.1013
Epoch 5/5
37500/37500 [==============================] - 5s 138us/sample - loss: 4.9291 -
```

```
sparse_categorical_accuracy: 0.1022 - val_loss: 4.9262 -
val_sparse_categorical_accuracy: 0.1028

 11%|          | 11/100 [04:51<39:55, 26.91s/it]

0.1028 9.727962797494415e-06 0.007073586691929423
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 6s 156us/sample - loss: 332.1692
- sparse_categorical_accuracy: 0.1207 - val_loss: 295.3958 -
val_sparse_categorical_accuracy: 0.1305
Epoch 2/5
37500/37500 [==============================] - 5s 138us/sample - loss: 263.9506
- sparse_categorical_accuracy: 0.1396 - val_loss: 234.7856 -
val_sparse_categorical_accuracy: 0.1455
Epoch 3/5
37500/37500 [==============================] - 5s 138us/sample - loss: 209.8445
- sparse_categorical_accuracy: 0.1530 - val_loss: 186.7119 -
val_sparse_categorical_accuracy: 0.1573
Epoch 4/5
37500/37500 [==============================] - 5s 138us/sample - loss: 166.9289
- sparse_categorical_accuracy: 0.1636 - val_loss: 148.5806 -
val_sparse_categorical_accuracy: 0.1659
Epoch 5/5
37500/37500 [==============================] - 5s 137us/sample - loss: 132.8885
- sparse_categorical_accuracy: 0.1706 - val_loss: 118.3345 -
val_sparse_categorical_accuracy: 0.1735

 12%|          | 12/100 [05:18<39:44, 27.09s/it]

0.17352 4.9357645350018835e-05 1.001139705339608
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 6s 158us/sample - loss: 3.2959 -
sparse_categorical_accuracy: 0.1037 - val_loss: 3.2847 -
val_sparse_categorical_accuracy: 0.1094
Epoch 2/5
37500/37500 [==============================] - 5s 140us/sample - loss: 3.2791 -
sparse_categorical_accuracy: 0.1101 - val_loss: 3.2713 -
val_sparse_categorical_accuracy: 0.1202
Epoch 3/5
37500/37500 [==============================] - 5s 139us/sample - loss: 3.2673 -
sparse_categorical_accuracy: 0.1228 - val_loss: 3.2613 -
val_sparse_categorical_accuracy: 0.1389
Epoch 4/5
37500/37500 [==============================] - 5s 142us/sample - loss: 3.2580 -
sparse_categorical_accuracy: 0.1443 - val_loss: 3.2531 -
val_sparse_categorical_accuracy: 0.1578
Epoch 5/5
37500/37500 [==============================] - 5s 138us/sample - loss: 3.2502 -
```

```
sparse_categorical_accuracy: 0.1611 - val_loss: 3.2461 -
val_sparse_categorical_accuracy: 0.1713

 13%|         | 13/100 [05:46<39:38, 27.34s/it]

0.17128 2.468824236730592e-05 0.0026230542207942987
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 6s 158us/sample - loss: 3.6293 -
sparse_categorical_accuracy: 0.1081 - val_loss: 3.6254 -
val_sparse_categorical_accuracy: 0.1081
Epoch 2/5
37500/37500 [==============================] - 5s 139us/sample - loss: 3.6217 -
sparse_categorical_accuracy: 0.1117 - val_loss: 3.6187 -
val_sparse_categorical_accuracy: 0.1104
Epoch 3/5
37500/37500 [==============================] - 5s 138us/sample - loss: 3.6152 -
sparse_categorical_accuracy: 0.1166 - val_loss: 3.6129 -
val_sparse_categorical_accuracy: 0.1144
Epoch 4/5
37500/37500 [==============================] - 5s 140us/sample - loss: 3.6094 -
sparse_categorical_accuracy: 0.1217 - val_loss: 3.6076 -
val_sparse_categorical_accuracy: 0.1189
Epoch 5/5
37500/37500 [==============================] - 5s 137us/sample - loss: 3.6042 -
sparse_categorical_accuracy: 0.1281 - val_loss: 3.6029 -
val_sparse_categorical_accuracy: 0.1240

 14%|         | 14/100 [06:14<39:21, 27.45s/it]

0.124 1.4209551349986519e-05 0.00355893280700234
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 6s 161us/sample - loss: 3.5277 -
sparse_categorical_accuracy: 0.1709 - val_loss: 3.4881 -
val_sparse_categorical_accuracy: 0.2193
Epoch 2/5
37500/37500 [==============================] - 5s 143us/sample - loss: 3.4356 -
sparse_categorical_accuracy: 0.2415 - val_loss: 3.3900 -
val_sparse_categorical_accuracy: 0.2537
Epoch 3/5
37500/37500 [==============================] - 5s 139us/sample - loss: 3.3340 -
sparse_categorical_accuracy: 0.2653 - val_loss: 3.2957 -
val_sparse_categorical_accuracy: 0.2714
Epoch 4/5
37500/37500 [==============================] - 5s 140us/sample - loss: 3.2472 -
sparse_categorical_accuracy: 0.2886 - val_loss: 3.2188 -
val_sparse_categorical_accuracy: 0.2890
Epoch 5/5
37500/37500 [==============================] - 5s 141us/sample - loss: 3.1719 -
```

```
sparse_categorical_accuracy: 0.3131 - val_loss: 3.1472 -
val_sparse_categorical_accuracy: 0.3184

 15%|         | 15/100 [06:42<39:13, 27.69s/it]

0.3184 0.0003876357904310137 0.003416237458690826
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 6s 160us/sample - loss: 3.2182 -
sparse_categorical_accuracy: 0.0796 - val_loss: 3.2171 -
val_sparse_categorical_accuracy: 0.0794
Epoch 2/5
37500/37500 [==============================] - 5s 141us/sample - loss: 3.2162 -
sparse_categorical_accuracy: 0.0804 - val_loss: 3.2151 -
val_sparse_categorical_accuracy: 0.0815
Epoch 3/5
37500/37500 [==============================] - 5s 142us/sample - loss: 3.2142 -
sparse_categorical_accuracy: 0.0817 - val_loss: 3.2132 -
val_sparse_categorical_accuracy: 0.0822
Epoch 4/5
37500/37500 [==============================] - 5s 140us/sample - loss: 3.2124 -
sparse_categorical_accuracy: 0.0830 - val_loss: 3.2114 -
val_sparse_categorical_accuracy: 0.0828
Epoch 5/5
37500/37500 [==============================] - 5s 138us/sample - loss: 3.2106 -
sparse_categorical_accuracy: 0.0837 - val_loss: 3.2097 -
val_sparse_categorical_accuracy: 0.0838

 16%|         | 16/100 [07:10<38:57, 27.82s/it]

0.08376 1.3983415680883341e-06 0.002404787272206656
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 6s 163us/sample - loss: 25.4767 -
sparse_categorical_accuracy: 0.1014 - val_loss: 25.3717 -
val_sparse_categorical_accuracy: 0.1033
Epoch 2/5
37500/37500 [==============================] - 5s 141us/sample - loss: 25.2758 -
sparse_categorical_accuracy: 0.1094 - val_loss: 25.1771 -
val_sparse_categorical_accuracy: 0.1178
Epoch 3/5
37500/37500 [==============================] - 5s 141us/sample - loss: 25.0845 -
sparse_categorical_accuracy: 0.1258 - val_loss: 24.9888 -
val_sparse_categorical_accuracy: 0.1418
Epoch 4/5
37500/37500 [==============================] - 5s 141us/sample - loss: 24.8979 -
sparse_categorical_accuracy: 0.1414 - val_loss: 24.8039 -
val_sparse_categorical_accuracy: 0.1560
Epoch 5/5
37500/37500 [==============================] - 5s 141us/sample - loss: 24.7141 -
```

```
sparse_categorical_accuracy: 0.1497 - val_loss: 24.6214 -
val_sparse_categorical_accuracy: 0.1627

 17%|         | 17/100 [07:39<38:43, 27.99s/it]

0.16272 2.6550785995356316e-05 0.06299196594241435
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 6s 165us/sample - loss: 3.4932 -
sparse_categorical_accuracy: 0.0949 - val_loss: 3.4915 -
val_sparse_categorical_accuracy: 0.0903
Epoch 2/5
37500/37500 [==============================] - 5s 144us/sample - loss: 3.4890 -
sparse_categorical_accuracy: 0.0956 - val_loss: 3.4874 -
val_sparse_categorical_accuracy: 0.0917
Epoch 3/5
37500/37500 [==============================] - 5s 143us/sample - loss: 3.4851 -
sparse_categorical_accuracy: 0.0975 - val_loss: 3.4836 -
val_sparse_categorical_accuracy: 0.0930
Epoch 4/5
37500/37500 [==============================] - 5s 144us/sample - loss: 3.4816 -
sparse_categorical_accuracy: 0.0985 - val_loss: 3.4802 -
val_sparse_categorical_accuracy: 0.0957
Epoch 5/5
37500/37500 [==============================] - 5s 144us/sample - loss: 3.4783 -
sparse_categorical_accuracy: 0.1003 - val_loss: 3.4770 -
val_sparse_categorical_accuracy: 0.0997

 18%|         | 18/100 [08:08<38:36, 28.25s/it]

0.09968 7.604070096478901e-06 0.0031631635316854137
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 6s 161us/sample - loss: 223.6120
- sparse_categorical_accuracy: 0.1206 - val_loss: 114.0850 -
val_sparse_categorical_accuracy: 0.1363
Epoch 2/5
37500/37500 [==============================] - 5s 145us/sample - loss: 66.4376 -
sparse_categorical_accuracy: 0.1496 - val_loss: 34.6987 -
val_sparse_categorical_accuracy: 0.1632
Epoch 3/5
37500/37500 [==============================] - 5s 141us/sample - loss: 20.8899 -
sparse_categorical_accuracy: 0.1847 - val_loss: 11.6914 -
val_sparse_categorical_accuracy: 0.1156
Epoch 4/5
37500/37500 [==============================] - 5s 143us/sample - loss: 7.6894 -
sparse_categorical_accuracy: 0.1061 - val_loss: 5.0235 -
val_sparse_categorical_accuracy: 0.0990
Epoch 5/5
37500/37500 [==============================] - 5s 142us/sample - loss: 3.8637 -
```

```
sparse_categorical_accuracy: 0.1006 - val_loss: 3.0911 -
val_sparse_categorical_accuracy: 0.0978

 19%|         | 19/100 [08:36<38:18, 28.38s/it]

0.09776 0.0002521455196137213 1.0475697998690494
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 6s 162us/sample - loss: 663.7172
- sparse_categorical_accuracy: 0.0973 - val_loss: 626.5040 -
val_sparse_categorical_accuracy: 0.0986
Epoch 2/5
37500/37500 [==============================] - 5s 142us/sample - loss: 592.0988
- sparse_categorical_accuracy: 0.0977 - val_loss: 558.9176 -
val_sparse_categorical_accuracy: 0.1006
Epoch 3/5
37500/37500 [==============================] - 5s 143us/sample - loss: 528.2392
- sparse_categorical_accuracy: 0.0996 - val_loss: 498.6521 -
val_sparse_categorical_accuracy: 0.1014
Epoch 4/5
37500/37500 [==============================] - 5s 141us/sample - loss: 471.2960
- sparse_categorical_accuracy: 0.1018 - val_loss: 444.9133 -
val_sparse_categorical_accuracy: 0.1028
Epoch 5/5
37500/37500 [==============================] - 5s 145us/sample - loss: 420.5195
- sparse_categorical_accuracy: 0.1031 - val_loss: 396.9936 -
val_sparse_categorical_accuracy: 0.1063

 20%|         | 20/100 [09:05<37:57, 28.47s/it]

0.10632 1.2862936038948876e-05 1.9000978615935422
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 6s 166us/sample - loss: 2.3241 -
sparse_categorical_accuracy: 0.0951 - val_loss: 2.3135 -
val_sparse_categorical_accuracy: 0.1004
Epoch 2/5
37500/37500 [==============================] - 5s 146us/sample - loss: 2.3011 -
sparse_categorical_accuracy: 0.1151 - val_loss: 2.2949 -
val_sparse_categorical_accuracy: 0.1265
Epoch 3/5
37500/37500 [==============================] - 6s 147us/sample - loss: 2.2847 -
sparse_categorical_accuracy: 0.1446 - val_loss: 2.2802 -
val_sparse_categorical_accuracy: 0.1541
Epoch 4/5
37500/37500 [==============================] - 5s 145us/sample - loss: 2.2707 -
sparse_categorical_accuracy: 0.1682 - val_loss: 2.2669 -
val_sparse_categorical_accuracy: 0.1742
Epoch 5/5
37500/37500 [==============================] - 5s 146us/sample - loss: 2.2574 -
```

```
sparse_categorical_accuracy: 0.1877 - val_loss: 2.2537 -
val_sparse_categorical_accuracy: 0.1920

 21%|         | 21/100 [09:34<37:50, 28.74s/it]

0.192 5.603600864858877e-05 1.4375857644308472e-05
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 6s 171us/sample - loss: 2.3320 -
sparse_categorical_accuracy: 0.0982 - val_loss: 2.3316 -
val_sparse_categorical_accuracy: 0.1001
Epoch 2/5
37500/37500 [==============================] - 5s 145us/sample - loss: 2.3294 -
sparse_categorical_accuracy: 0.1005 - val_loss: 2.3292 -
val_sparse_categorical_accuracy: 0.1019
Epoch 3/5
37500/37500 [==============================] - 6s 149us/sample - loss: 2.3270 -
sparse_categorical_accuracy: 0.1034 - val_loss: 2.3269 -
val_sparse_categorical_accuracy: 0.1072
Epoch 4/5
37500/37500 [==============================] - 5s 145us/sample - loss: 2.3247 -
sparse_categorical_accuracy: 0.1077 - val_loss: 2.3247 -
val_sparse_categorical_accuracy: 0.1094
Epoch 5/5
37500/37500 [==============================] - 6s 148us/sample - loss: 2.3225 -
sparse_categorical_accuracy: 0.1113 - val_loss: 2.3226 -
val_sparse_categorical_accuracy: 0.1121

 22%|         | 22/100 [10:04<37:44, 29.03s/it]

0.11208 4.542523157199087e-06 6.252533926068026e-05
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 6s 170us/sample - loss: 184.7621
- sparse_categorical_accuracy: 0.1108 - val_loss: 143.7531 -
val_sparse_categorical_accuracy: 0.1270
Epoch 2/5
37500/37500 [==============================] - 6s 148us/sample - loss: 114.2210
- sparse_categorical_accuracy: 0.1348 - val_loss: 89.0736 -
val_sparse_categorical_accuracy: 0.1442
Epoch 3/5
37500/37500 [==============================] - 6s 150us/sample - loss: 70.9593 -
sparse_categorical_accuracy: 0.1471 - val_loss: 55.5339 -
val_sparse_categorical_accuracy: 0.1533
Epoch 4/5
37500/37500 [==============================] - 6s 160us/sample - loss: 44.4219 -
sparse_categorical_accuracy: 0.1653 - val_loss: 34.9591 -
val_sparse_categorical_accuracy: 0.1799
Epoch 5/5
37500/37500 [==============================] - 6s 147us/sample - loss: 28.1422 -
```

```
sparse_categorical_accuracy: 0.2025 - val_loss: 22.3370 -
val_sparse_categorical_accuracy: 0.2255

 23%|         | 23/100 [10:34<37:45, 29.42s/it]

0.22552 0.0001669466675681543 0.6243256036910368
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 6s 170us/sample - loss: 273.9629
- sparse_categorical_accuracy: 0.1102 - val_loss: 272.8271 -
val_sparse_categorical_accuracy: 0.1076
Epoch 2/5
37500/37500 [==============================] - 5s 144us/sample - loss: 271.6991
- sparse_categorical_accuracy: 0.1112 - val_loss: 270.5728 -
val_sparse_categorical_accuracy: 0.1090
Epoch 3/5
37500/37500 [==============================] - 5s 144us/sample - loss: 269.4545
- sparse_categorical_accuracy: 0.1127 - val_loss: 268.3378 -
val_sparse_categorical_accuracy: 0.1106
Epoch 4/5
37500/37500 [==============================] - 5s 145us/sample - loss: 267.2289
- sparse_categorical_accuracy: 0.1143 - val_loss: 266.1216 -
val_sparse_categorical_accuracy: 0.1114
Epoch 5/5
37500/37500 [==============================] - 5s 146us/sample - loss: 265.0222
- sparse_categorical_accuracy: 0.1157 - val_loss: 263.9242 -
val_sparse_categorical_accuracy: 0.1130

 24%|         | 24/100 [11:04<37:16, 29.43s/it]

0.11304 2.4105931773433393e-06 0.7390760270324491
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 6s 171us/sample - loss: 2.7614 -
sparse_categorical_accuracy: 0.0797 - val_loss: 2.7520 -
val_sparse_categorical_accuracy: 0.0766
Epoch 2/5
37500/37500 [==============================] - 6s 152us/sample - loss: 2.7442 -
sparse_categorical_accuracy: 0.0806 - val_loss: 2.7377 -
val_sparse_categorical_accuracy: 0.0816
Epoch 3/5
37500/37500 [==============================] - 6s 148us/sample - loss: 2.7319 -
sparse_categorical_accuracy: 0.0867 - val_loss: 2.7270 -
val_sparse_categorical_accuracy: 0.0910
Epoch 4/5
37500/37500 [==============================] - 6s 150us/sample - loss: 2.7223 -
sparse_categorical_accuracy: 0.0986 - val_loss: 2.7182 -
val_sparse_categorical_accuracy: 0.1070
Epoch 5/5
37500/37500 [==============================] - 6s 148us/sample - loss: 2.7142 -
```

```
sparse_categorical_accuracy: 0.1124 - val_loss: 2.7106 -
val_sparse_categorical_accuracy: 0.1215

 25%|         | 25/100 [11:34<37:06, 29.69s/it]

0.12152 2.2218493825427412e-05 0.0011422139842147219
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 7s 176us/sample - loss: 8.3041 -
sparse_categorical_accuracy: 0.0839 - val_loss: 8.2882 -
val_sparse_categorical_accuracy: 0.0866
Epoch 2/5
37500/37500 [==============================] - 6s 152us/sample - loss: 8.2712 -
sparse_categorical_accuracy: 0.0920 - val_loss: 8.2602 -
val_sparse_categorical_accuracy: 0.0979
Epoch 3/5
37500/37500 [==============================] - 6s 150us/sample - loss: 8.2462 -
sparse_categorical_accuracy: 0.1038 - val_loss: 8.2377 -
val_sparse_categorical_accuracy: 0.1097
Epoch 4/5
37500/37500 [==============================] - 6s 151us/sample - loss: 8.2254 -
sparse_categorical_accuracy: 0.1179 - val_loss: 8.2186 -
val_sparse_categorical_accuracy: 0.1229
Epoch 5/5
37500/37500 [==============================] - 6s 151us/sample - loss: 8.2073 -
sparse_categorical_accuracy: 0.1353 - val_loss: 8.2015 -
val_sparse_categorical_accuracy: 0.1381

 26%|         | 26/100 [12:05<36:57, 29.97s/it]

0.13808 2.025916977249733e-05 0.01615789182858704
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 7s 174us/sample - loss: 2.6904 -
sparse_categorical_accuracy: 0.1026 - val_loss: 2.6916 -
val_sparse_categorical_accuracy: 0.0986
Epoch 2/5
37500/37500 [==============================] - 6s 154us/sample - loss: 2.6870 -
sparse_categorical_accuracy: 0.1040 - val_loss: 2.6883 -
val_sparse_categorical_accuracy: 0.1009
Epoch 3/5
37500/37500 [==============================] - 6s 160us/sample - loss: 2.6839 -
sparse_categorical_accuracy: 0.1053 - val_loss: 2.6853 -
val_sparse_categorical_accuracy: 0.1030
Epoch 4/5
37500/37500 [==============================] - 6s 154us/sample - loss: 2.6810 -
sparse_categorical_accuracy: 0.1073 - val_loss: 2.6825 -
val_sparse_categorical_accuracy: 0.1044
Epoch 5/5
37500/37500 [==============================] - 6s 152us/sample - loss: 2.6783 -
```

```
sparse_categorical_accuracy: 0.1091 - val_loss: 2.6798 -
val_sparse_categorical_accuracy: 0.1065

 27%|         | 27/100 [12:36<36:54, 30.34s/it]

0.10648 5.585552683060652e-06 0.0009910662990293927
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 7s 192us/sample - loss: 111.8441
- sparse_categorical_accuracy: 0.0995 - val_loss: 107.5836 -
val_sparse_categorical_accuracy: 0.1085
Epoch 2/5
37500/37500 [==============================] - 6s 157us/sample - loss: 103.5532
- sparse_categorical_accuracy: 0.1244 - val_loss: 99.6235 -
val_sparse_categorical_accuracy: 0.1431
Epoch 3/5
37500/37500 [==============================] - 6s 160us/sample - loss: 95.9015 -
sparse_categorical_accuracy: 0.1513 - val_loss: 92.2714 -
val_sparse_categorical_accuracy: 0.1646
Epoch 4/5
37500/37500 [==============================] - 6s 156us/sample - loss: 88.8321 -
sparse_categorical_accuracy: 0.1675 - val_loss: 85.4775 -
val_sparse_categorical_accuracy: 0.1745
Epoch 5/5
37500/37500 [==============================] - 6s 163us/sample - loss: 82.2986 -
sparse_categorical_accuracy: 0.1754 - val_loss: 79.1980 -
val_sparse_categorical_accuracy: 0.1812

 28%|         | 28/100 [13:08<37:10, 30.98s/it]

0.1812 5.4098317879863887e-05 0.30939968375569865
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 7s 181us/sample - loss: 84.8957 -
sparse_categorical_accuracy: 0.0912 - val_loss: 84.4731 -
val_sparse_categorical_accuracy: 0.0872
Epoch 2/5
37500/37500 [==============================] - 6s 160us/sample - loss: 84.0508 -
sparse_categorical_accuracy: 0.0869 - val_loss: 83.6339 -
val_sparse_categorical_accuracy: 0.0855
Epoch 3/5
37500/37500 [==============================] - 6s 163us/sample - loss: 83.2173 -
sparse_categorical_accuracy: 0.0859 - val_loss: 82.8055 -
val_sparse_categorical_accuracy: 0.0846
Epoch 4/5
37500/37500 [==============================] - 6s 154us/sample - loss: 82.3941 -
sparse_categorical_accuracy: 0.0866 - val_loss: 81.9871 -
val_sparse_categorical_accuracy: 0.0862
Epoch 5/5
37500/37500 [==============================] - 6s 154us/sample - loss: 81.5805 -
```

```
sparse_categorical_accuracy: 0.0896 - val_loss: 81.1780 -
val_sparse_categorical_accuracy: 0.0914

 29%|         | 29/100 [13:40<36:59, 31.26s/it]

0.09136 9.622462923895183e-06 0.22487389366269248
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 7s 179us/sample - loss: 3.0968 -
sparse_categorical_accuracy: 0.1001 - val_loss: 3.0969 -
val_sparse_categorical_accuracy: 0.1010
Epoch 2/5
37500/37500 [==============================] - 6s 164us/sample - loss: 3.0953 -
sparse_categorical_accuracy: 0.1006 - val_loss: 3.0954 -
val_sparse_categorical_accuracy: 0.1015
Epoch 3/5
37500/37500 [==============================] - 6s 165us/sample - loss: 3.0938 -
sparse_categorical_accuracy: 0.1002 - val_loss: 3.0940 -
val_sparse_categorical_accuracy: 0.1012
Epoch 4/5
37500/37500 [==============================] - 6s 155us/sample - loss: 3.0924 -
sparse_categorical_accuracy: 0.1006 - val_loss: 3.0926 -
val_sparse_categorical_accuracy: 0.1016
Epoch 5/5
37500/37500 [==============================] - 6s 158us/sample - loss: 3.0910 -
sparse_categorical_accuracy: 0.1012 - val_loss: 3.0912 -
val_sparse_categorical_accuracy: 0.1017

 30%|         | 30/100 [14:13<36:50, 31.58s/it]

0.10168 3.186814800908145e-06 0.0021416990657933542
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 7s 180us/sample - loss: 4.7699 -
sparse_categorical_accuracy: 0.2038 - val_loss: 4.6369 -
val_sparse_categorical_accuracy: 0.2678
Epoch 2/5
37500/37500 [==============================] - 6s 156us/sample - loss: 4.4923 -
sparse_categorical_accuracy: 0.3050 - val_loss: 4.3785 -
val_sparse_categorical_accuracy: 0.3255
Epoch 3/5
37500/37500 [==============================] - 6s 153us/sample - loss: 4.2804 -
sparse_categorical_accuracy: 0.3516 - val_loss: 4.2089 -
val_sparse_categorical_accuracy: 0.3610
Epoch 4/5
37500/37500 [==============================] - 6s 151us/sample - loss: 4.1250 -
sparse_categorical_accuracy: 0.3834 - val_loss: 4.0646 -
val_sparse_categorical_accuracy: 0.3882
Epoch 5/5
37500/37500 [==============================] - 6s 155us/sample - loss: 3.9881 -
```

```
sparse_categorical_accuracy: 0.4120 - val_loss: 3.9360 -
val_sparse_categorical_accuracy: 0.4161

 31%|         | 31/100 [14:44<36:13, 31.50s/it]

0.41608 0.0007819861280033422 0.007013919127532981
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 7s 185us/sample - loss: 186.2096
- sparse_categorical_accuracy: 0.1041 - val_loss: 2.3037 -
val_sparse_categorical_accuracy: 0.0984
Epoch 2/5
37500/37500 [==============================] - 6s 158us/sample - loss: 2.3027 -
sparse_categorical_accuracy: 0.0982 - val_loss: 2.3026 -
val_sparse_categorical_accuracy: 0.0978
Epoch 3/5
37500/37500 [==============================] - 6s 157us/sample - loss: 2.3026 -
sparse_categorical_accuracy: 0.0995 - val_loss: 2.3026 -
val_sparse_categorical_accuracy: 0.0978
Epoch 4/5
37500/37500 [==============================] - 6s 155us/sample - loss: 2.3026 -
sparse_categorical_accuracy: 0.0990 - val_loss: 2.3026 -
val_sparse_categorical_accuracy: 0.0978
Epoch 5/5
37500/37500 [==============================] - 6s 158us/sample - loss: 2.3026 -
sparse_categorical_accuracy: 0.0998 - val_loss: 2.3026 -
val_sparse_categorical_accuracy: 0.0978

 32%|         | 32/100 [15:16<35:51, 31.65s/it]

0.09776 0.00042941208368517473 7.256472414641624
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 7s 181us/sample - loss: 3.7167 -
sparse_categorical_accuracy: 0.1762 - val_loss: 3.6680 -
val_sparse_categorical_accuracy: 0.2336
Epoch 2/5
37500/37500 [==============================] - 6s 157us/sample - loss: 3.6124 -
sparse_categorical_accuracy: 0.2597 - val_loss: 3.5608 -
val_sparse_categorical_accuracy: 0.2760
Epoch 3/5
37500/37500 [==============================] - 6s 154us/sample - loss: 3.5031 -
sparse_categorical_accuracy: 0.2891 - val_loss: 3.4597 -
val_sparse_categorical_accuracy: 0.2974
Epoch 4/5
37500/37500 [==============================] - 6s 154us/sample - loss: 3.4096 -
sparse_categorical_accuracy: 0.3116 - val_loss: 3.3781 -
val_sparse_categorical_accuracy: 0.3136
Epoch 5/5
37500/37500 [==============================] - 6s 156us/sample - loss: 3.3344 -
```

```
sparse_categorical_accuracy: 0.3342 - val_loss: 3.3115 -
val_sparse_categorical_accuracy: 0.3352

 33%|        | 33/100 [15:48<35:20, 31.65s/it]

0.3352 0.00031356329326217766 0.003955478464591665
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 7s 189us/sample - loss: 10.0441 -
sparse_categorical_accuracy: 0.0883 - val_loss: 10.0436 -
val_sparse_categorical_accuracy: 0.0856
Epoch 2/5
37500/37500 [==============================] - 6s 166us/sample - loss: 10.0401 -
sparse_categorical_accuracy: 0.0901 - val_loss: 10.0396 -
val_sparse_categorical_accuracy: 0.0873
Epoch 3/5
37500/37500 [==============================] - 6s 162us/sample - loss: 10.0362 -
sparse_categorical_accuracy: 0.0924 - val_loss: 10.0357 -
val_sparse_categorical_accuracy: 0.0907
Epoch 4/5
37500/37500 [==============================] - 6s 158us/sample - loss: 10.0324 -
sparse_categorical_accuracy: 0.0954 - val_loss: 10.0319 -
val_sparse_categorical_accuracy: 0.0940
Epoch 5/5
37500/37500 [==============================] - 6s 162us/sample - loss: 10.0287 -
sparse_categorical_accuracy: 0.0974 - val_loss: 10.0282 -
val_sparse_categorical_accuracy: 0.0960

 34%|        | 34/100 [16:21<35:14, 32.04s/it]

0.096 2.522734001584257e-06 0.020935841820015424
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 7s 186us/sample - loss: 5.3374 -
sparse_categorical_accuracy: 0.1033 - val_loss: 5.3216 -
val_sparse_categorical_accuracy: 0.1081
Epoch 2/5
37500/37500 [==============================] - 6s 163us/sample - loss: 5.3130 -
sparse_categorical_accuracy: 0.1101 - val_loss: 5.3019 -
val_sparse_categorical_accuracy: 0.1219
Epoch 3/5
37500/37500 [==============================] - 6s 158us/sample - loss: 5.2951 -
sparse_categorical_accuracy: 0.1221 - val_loss: 5.2862 -
val_sparse_categorical_accuracy: 0.1322
Epoch 4/5
37500/37500 [==============================] - 6s 159us/sample - loss: 5.2802 -
sparse_categorical_accuracy: 0.1360 - val_loss: 5.2724 -
val_sparse_categorical_accuracy: 0.1460
Epoch 5/5
37500/37500 [==============================] - 6s 161us/sample - loss: 5.2667 -
```

```
sparse_categorical_accuracy: 0.1500 - val_loss: 5.2597 -
val_sparse_categorical_accuracy: 0.1575

 35%|        | 35/100 [16:53<34:54, 32.22s/it]

0.15752 3.932727613585281e-05 0.008160266913780788
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 7s 187us/sample - loss: 33.7130 -
sparse_categorical_accuracy: 0.1805 - val_loss: 28.4008 -
val_sparse_categorical_accuracy: 0.2374
Epoch 2/5
37500/37500 [==============================] - 6s 161us/sample - loss: 24.2080 -
sparse_categorical_accuracy: 0.2514 - val_loss: 20.4837 -
val_sparse_categorical_accuracy: 0.2663
Epoch 3/5
37500/37500 [==============================] - 6s 155us/sample - loss: 17.5425 -
sparse_categorical_accuracy: 0.2811 - val_loss: 14.9436 -
val_sparse_categorical_accuracy: 0.2788
Epoch 4/5
37500/37500 [==============================] - 6s 159us/sample - loss: 12.8832 -
sparse_categorical_accuracy: 0.2992 - val_loss: 11.0656 -
val_sparse_categorical_accuracy: 0.3098
Epoch 5/5
37500/37500 [==============================] - 6s 160us/sample - loss: 9.6208 -
sparse_categorical_accuracy: 0.3207 - val_loss: 8.3542 -
val_sparse_categorical_accuracy: 0.3216

 36%|        | 36/100 [17:26<34:26, 32.28s/it]

0.3216 0.0007494829868591388 0.10151325525545962
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 7s 188us/sample - loss: 128.9068
- sparse_categorical_accuracy: 0.0986 - val_loss: 2.3026 -
val_sparse_categorical_accuracy: 0.0978
Epoch 2/5
37500/37500 [==============================] - 6s 164us/sample - loss: 2.3026 -
sparse_categorical_accuracy: 0.0991 - val_loss: 2.3026 -
val_sparse_categorical_accuracy: 0.0978
Epoch 3/5
37500/37500 [==============================] - 6s 161us/sample - loss: 2.3026 -
sparse_categorical_accuracy: 0.1005 - val_loss: 2.3026 -
val_sparse_categorical_accuracy: 0.0978
Epoch 4/5
37500/37500 [==============================] - 6s 164us/sample - loss: 2.3026 -
sparse_categorical_accuracy: 0.1000 - val_loss: 2.3026 -
val_sparse_categorical_accuracy: 0.0978
Epoch 5/5
37500/37500 [==============================] - 6s 162us/sample - loss: 2.3026 -
```

```
sparse_categorical_accuracy: 0.1007 - val_loss: 2.3026 -
val_sparse_categorical_accuracy: 0.0978

 37%|        | 37/100 [17:59<34:09, 32.53s/it]

0.09776 0.0006254588091524623 7.215923504879407
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 7s 189us/sample - loss: 2.3973 -
sparse_categorical_accuracy: 0.1376 - val_loss: 2.3918 -
val_sparse_categorical_accuracy: 0.1538
Epoch 2/5
37500/37500 [==============================] - 6s 164us/sample - loss: 2.3856 -
sparse_categorical_accuracy: 0.1631 - val_loss: 2.3815 -
val_sparse_categorical_accuracy: 0.1743
Epoch 3/5
37500/37500 [==============================] - 6s 162us/sample - loss: 2.3763 -
sparse_categorical_accuracy: 0.1786 - val_loss: 2.3730 -
val_sparse_categorical_accuracy: 0.1822
Epoch 4/5
37500/37500 [==============================] - 6s 163us/sample - loss: 2.3683 -
sparse_categorical_accuracy: 0.1841 - val_loss: 2.3654 -
val_sparse_categorical_accuracy: 0.1828
Epoch 5/5
37500/37500 [==============================] - 6s 159us/sample - loss: 2.3610 -
sparse_categorical_accuracy: 0.1874 - val_loss: 2.3583 -
val_sparse_categorical_accuracy: 0.1879

 38%|        | 38/100 [18:32<33:45, 32.67s/it]

0.18792 3.927492113566303e-05 0.00024569990027376693
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 7s 195us/sample - loss: 4.2831 -
sparse_categorical_accuracy: 0.1075 - val_loss: 4.2790 -
val_sparse_categorical_accuracy: 0.1029
Epoch 2/5
37500/37500 [==============================] - 6s 164us/sample - loss: 4.2759 -
sparse_categorical_accuracy: 0.1099 - val_loss: 4.2725 -
val_sparse_categorical_accuracy: 0.1051
Epoch 3/5
37500/37500 [==============================] - 6s 163us/sample - loss: 4.2695 -
sparse_categorical_accuracy: 0.1132 - val_loss: 4.2665 -
val_sparse_categorical_accuracy: 0.1086
Epoch 4/5
37500/37500 [==============================] - 6s 165us/sample - loss: 4.2636 -
sparse_categorical_accuracy: 0.1165 - val_loss: 4.2610 -
val_sparse_categorical_accuracy: 0.1131
Epoch 5/5
37500/37500 [==============================] - 6s 164us/sample - loss: 4.2580 -
```

```
sparse_categorical_accuracy: 0.1206 - val_loss: 4.2557 -
val_sparse_categorical_accuracy: 0.1173

 39%|        | 39/100 [19:05<33:30, 32.96s/it]

0.11728 2.2746712607133863e-05 0.005325905153592229
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 8s 200us/sample - loss: 5.0848 -
sparse_categorical_accuracy: 0.1887 - val_loss: 4.9870 -
val_sparse_categorical_accuracy: 0.2597
Epoch 2/5
37500/37500 [==============================] - 6s 168us/sample - loss: 4.8658 -
sparse_categorical_accuracy: 0.2779 - val_loss: 4.7612 -
val_sparse_categorical_accuracy: 0.2920
Epoch 3/5
37500/37500 [==============================] - 6s 163us/sample - loss: 4.6571 -
sparse_categorical_accuracy: 0.3147 - val_loss: 4.5770 -
val_sparse_categorical_accuracy: 0.3241
Epoch 4/5
37500/37500 [==============================] - 6s 167us/sample - loss: 4.4933 -
sparse_categorical_accuracy: 0.3525 - val_loss: 4.4319 -
val_sparse_categorical_accuracy: 0.3581
Epoch 5/5
37500/37500 [==============================] - 6s 164us/sample - loss: 4.3558 -
sparse_categorical_accuracy: 0.3811 - val_loss: 4.3019 -
val_sparse_categorical_accuracy: 0.3895

 40%|        | 40/100 [19:40<33:18, 33.30s/it]

0.38952 0.0006587871726348513 0.007792569492363091
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 8s 207us/sample - loss: 9.7838 -
sparse_categorical_accuracy: 0.1434 - val_loss: 9.6344 -
val_sparse_categorical_accuracy: 0.1964
Epoch 2/5
37500/37500 [==============================] - 7s 177us/sample - loss: 9.4825 -
sparse_categorical_accuracy: 0.2345 - val_loss: 9.3373 -
val_sparse_categorical_accuracy: 0.2526
Epoch 3/5
37500/37500 [==============================] - 7s 176us/sample - loss: 9.1857 -
sparse_categorical_accuracy: 0.2711 - val_loss: 9.0518 -
val_sparse_categorical_accuracy: 0.2765
Epoch 4/5
37500/37500 [==============================] - 7s 178us/sample - loss: 8.9102 -
sparse_categorical_accuracy: 0.2950 - val_loss: 8.7902 -
val_sparse_categorical_accuracy: 0.2973
Epoch 5/5
37500/37500 [==============================] - 7s 176us/sample - loss: 8.6558 -
```

```
sparse_categorical_accuracy: 0.3167 - val_loss: 8.5436 -
val_sparse_categorical_accuracy: 0.3187

 41%|        | 41/100 [20:16<33:35, 34.16s/it]

0.31872 0.00030003360568931983 0.020674203770785948
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 8s 208us/sample - loss: 2.3516 -
sparse_categorical_accuracy: 0.0991 - val_loss: 2.3515 -
val_sparse_categorical_accuracy: 0.0975
Epoch 2/5
37500/37500 [==============================] - 7s 180us/sample - loss: 2.3490 -
sparse_categorical_accuracy: 0.0991 - val_loss: 2.3489 -
val_sparse_categorical_accuracy: 0.0976
Epoch 3/5
37500/37500 [==============================] - 7s 177us/sample - loss: 2.3465 -
sparse_categorical_accuracy: 0.0989 - val_loss: 2.3465 -
val_sparse_categorical_accuracy: 0.0974
Epoch 4/5
37500/37500 [==============================] - 7s 175us/sample - loss: 2.3441 -
sparse_categorical_accuracy: 0.0988 - val_loss: 2.3441 -
val_sparse_categorical_accuracy: 0.0973
Epoch 5/5
37500/37500 [==============================] - 7s 176us/sample - loss: 2.3417 -
sparse_categorical_accuracy: 0.0987 - val_loss: 2.3419 -
val_sparse_categorical_accuracy: 0.0975

 42%|        | 42/100 [20:52<33:38, 34.81s/it]

0.09752 1.7232230565677654e-06 1.5336460699484228e-05
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 8s 214us/sample - loss: 24.1353 -
sparse_categorical_accuracy: 0.1389 - val_loss: 24.0186 -
val_sparse_categorical_accuracy: 0.1417
Epoch 2/5
37500/37500 [==============================] - 6s 173us/sample - loss: 23.9001 -
sparse_categorical_accuracy: 0.1469 - val_loss: 23.7855 -
val_sparse_categorical_accuracy: 0.1507
Epoch 3/5
37500/37500 [==============================] - 6s 168us/sample - loss: 23.6686 -
sparse_categorical_accuracy: 0.1556 - val_loss: 23.5558 -
val_sparse_categorical_accuracy: 0.1568
Epoch 4/5
37500/37500 [==============================] - 6s 172us/sample - loss: 23.4403 -
sparse_categorical_accuracy: 0.1631 - val_loss: 23.3290 -
val_sparse_categorical_accuracy: 0.1638
Epoch 5/5
37500/37500 [==============================] - 6s 170us/sample - loss: 23.2146 -
```

```
sparse_categorical_accuracy: 0.1706 - val_loss: 23.1047 -
val_sparse_categorical_accuracy: 0.1719

 43%|        | 43/100 [21:28<33:15, 35.01s/it]

0.17192 3.7275184233299485e-05 0.05938791115919884
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 8s 203us/sample - loss: 21.0529 -
sparse_categorical_accuracy: 0.1384 - val_loss: 20.5726 -
val_sparse_categorical_accuracy: 0.1714
Epoch 2/5
37500/37500 [==============================] - 6s 170us/sample - loss: 20.1117 -
sparse_categorical_accuracy: 0.1988 - val_loss: 19.6607 -
val_sparse_categorical_accuracy: 0.2262
Epoch 3/5
37500/37500 [==============================] - 6s 168us/sample - loss: 19.2194 -
sparse_categorical_accuracy: 0.2410 - val_loss: 18.7888 -
val_sparse_categorical_accuracy: 0.2562
Epoch 4/5
37500/37500 [==============================] - 6s 172us/sample - loss: 18.3643 -
sparse_categorical_accuracy: 0.2677 - val_loss: 17.9532 -
val_sparse_categorical_accuracy: 0.2664
Epoch 5/5
37500/37500 [==============================] - 6s 172us/sample - loss: 17.5452 -
sparse_categorical_accuracy: 0.2793 - val_loss: 17.1546 -
val_sparse_categorical_accuracy: 0.2786

 44%|        | 44/100 [22:03<32:41, 35.03s/it]

0.27864 0.00020091305254859844 0.05215975612601067
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 8s 203us/sample - loss: 33.2941 -
sparse_categorical_accuracy: 0.1602 - val_loss: 30.6317 -
val_sparse_categorical_accuracy: 0.2127
Epoch 2/5
37500/37500 [==============================] - 6s 171us/sample - loss: 28.2695 -
sparse_categorical_accuracy: 0.2438 - val_loss: 26.0396 -
val_sparse_categorical_accuracy: 0.2566
Epoch 3/5
37500/37500 [==============================] - 6s 173us/sample - loss: 24.0473 -
sparse_categorical_accuracy: 0.2705 - val_loss: 22.1729 -
val_sparse_categorical_accuracy: 0.2682
Epoch 4/5
37500/37500 [==============================] - 6s 170us/sample - loss: 20.4954 -
sparse_categorical_accuracy: 0.2781 - val_loss: 18.9257 -
val_sparse_categorical_accuracy: 0.2838
Epoch 5/5
37500/37500 [==============================] - 6s 171us/sample - loss: 17.5175 -
```

```
sparse_categorical_accuracy: 0.2900 - val_loss: 16.2046 -
val_sparse_categorical_accuracy: 0.2938

 45%|        | 45/100 [22:38<32:12, 35.13s/it]

0.29376 0.0004071349229244777 0.09161664554750043
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 8s 203us/sample - loss: 122.6938
- sparse_categorical_accuracy: 0.1029 - val_loss: 111.1863 -
val_sparse_categorical_accuracy: 0.1096
Epoch 2/5
37500/37500 [==============================] - 7s 174us/sample - loss: 101.1222
- sparse_categorical_accuracy: 0.1198 - val_loss: 91.6819 -
val_sparse_categorical_accuracy: 0.1316
Epoch 3/5
37500/37500 [==============================] - 7s 175us/sample - loss: 83.4225 -
sparse_categorical_accuracy: 0.1480 - val_loss: 75.6751 -
val_sparse_categorical_accuracy: 0.1623
Epoch 4/5
37500/37500 [==============================] - 7s 185us/sample - loss: 68.8956 -
sparse_categorical_accuracy: 0.1737 - val_loss: 62.5368 -
val_sparse_categorical_accuracy: 0.1807
Epoch 5/5
37500/37500 [==============================] - 6s 171us/sample - loss: 56.9719 -
sparse_categorical_accuracy: 0.1900 - val_loss: 51.7525 -
val_sparse_categorical_accuracy: 0.1935

 46%|        | 46/100 [23:14<31:50, 35.38s/it]

0.19352 0.00011676334784886833 0.3604426129962393
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 8s 214us/sample - loss: 2.5430 -
sparse_categorical_accuracy: 0.1667 - val_loss: 2.5186 -
val_sparse_categorical_accuracy: 0.1965
Epoch 2/5
37500/37500 [==============================] - 7s 177us/sample - loss: 2.4936 -
sparse_categorical_accuracy: 0.2221 - val_loss: 2.4709 -
val_sparse_categorical_accuracy: 0.2386
Epoch 3/5
37500/37500 [==============================] - 7s 174us/sample - loss: 2.4385 -
sparse_categorical_accuracy: 0.2501 - val_loss: 2.4112 -
val_sparse_categorical_accuracy: 0.2512
Epoch 4/5
37500/37500 [==============================] - 7s 174us/sample - loss: 2.3714 -
sparse_categorical_accuracy: 0.2662 - val_loss: 2.3423 -
val_sparse_categorical_accuracy: 0.2742
Epoch 5/5
37500/37500 [==============================] - 7s 176us/sample - loss: 2.3007 -
```

```
sparse_categorical_accuracy: 0.2874 - val_loss: 2.2758 -
val_sparse_categorical_accuracy: 0.2900

 47%|        | 47/100 [23:50<31:28, 35.64s/it]

0.29 0.00023060602258851014 0.0007106132500574476
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 8s 221us/sample - loss: 6.0929 -
sparse_categorical_accuracy: 0.1051 - val_loss: 6.0879 -
val_sparse_categorical_accuracy: 0.1034
Epoch 2/5
37500/37500 [==============================] - 7s 183us/sample - loss: 6.0910 -
sparse_categorical_accuracy: 0.1055 - val_loss: 6.0861 -
val_sparse_categorical_accuracy: 0.1038
Epoch 3/5
37500/37500 [==============================] - 7s 178us/sample - loss: 6.0891 -
sparse_categorical_accuracy: 0.1061 - val_loss: 6.0843 -
val_sparse_categorical_accuracy: 0.1040
Epoch 4/5
37500/37500 [==============================] - 7s 181us/sample - loss: 6.0873 -
sparse_categorical_accuracy: 0.1066 - val_loss: 6.0826 -
val_sparse_categorical_accuracy: 0.1046
Epoch 5/5
37500/37500 [==============================] - 7s 177us/sample - loss: 6.0856 -
sparse_categorical_accuracy: 0.1068 - val_loss: 6.0810 -
val_sparse_categorical_accuracy: 0.1054

 48%|        | 48/100 [24:27<31:19, 36.15s/it]

0.10536 1.2131027775849765e-06 0.010122595740440877
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 8s 211us/sample - loss: 9.5909 -
sparse_categorical_accuracy: 0.0958 - val_loss: 9.5819 -
val_sparse_categorical_accuracy: 0.0966
Epoch 2/5
37500/37500 [==============================] - 7s 178us/sample - loss: 9.5746 -
sparse_categorical_accuracy: 0.0973 - val_loss: 9.5665 -
val_sparse_categorical_accuracy: 0.0979
Epoch 3/5
37500/37500 [==============================] - 7s 178us/sample - loss: 9.5596 -
sparse_categorical_accuracy: 0.0980 - val_loss: 9.5520 -
val_sparse_categorical_accuracy: 0.0980
Epoch 4/5
37500/37500 [==============================] - 7s 177us/sample - loss: 9.5455 -
sparse_categorical_accuracy: 0.0987 - val_loss: 9.5384 -
val_sparse_categorical_accuracy: 0.0988
Epoch 5/5
37500/37500 [==============================] - 7s 178us/sample - loss: 9.5320 -
```

```
sparse_categorical_accuracy: 0.1005 - val_loss: 9.5253 -
val_sparse_categorical_accuracy: 0.0999

 49%|        | 49/100 [25:04<30:50, 36.28s/it]

0.09992 1.4631844048599698e-05 0.019732820669358053
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 8s 211us/sample - loss: 9.7750 -
sparse_categorical_accuracy: 0.1459 - val_loss: 9.6119 -
val_sparse_categorical_accuracy: 0.2014
Epoch 2/5
37500/37500 [==============================] - 7s 182us/sample - loss: 9.4487 -
sparse_categorical_accuracy: 0.2383 - val_loss: 9.2880 -
val_sparse_categorical_accuracy: 0.2566
Epoch 3/5
37500/37500 [==============================] - 7s 179us/sample - loss: 9.1250 -
sparse_categorical_accuracy: 0.2743 - val_loss: 8.9749 -
val_sparse_categorical_accuracy: 0.2812
Epoch 4/5
37500/37500 [==============================] - 7s 179us/sample - loss: 8.8221 -
sparse_categorical_accuracy: 0.2948 - val_loss: 8.6854 -
val_sparse_categorical_accuracy: 0.2966
Epoch 5/5
37500/37500 [==============================] - 7s 180us/sample - loss: 8.5405 -
sparse_categorical_accuracy: 0.3147 - val_loss: 8.4133 -
val_sparse_categorical_accuracy: 0.3214

 50%|        | 50/100 [25:41<30:23, 36.48s/it]

0.32144 0.0003445929395460478 0.02069786957287935
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 8s 212us/sample - loss: 362.6150
- sparse_categorical_accuracy: 0.1171 - val_loss: 182.2914 -
val_sparse_categorical_accuracy: 0.1386
Epoch 2/5
37500/37500 [==============================] - 7s 179us/sample - loss: 104.8159
- sparse_categorical_accuracy: 0.1561 - val_loss: 53.5132 -
val_sparse_categorical_accuracy: 0.1648
Epoch 3/5
37500/37500 [==============================] - 7s 178us/sample - loss: 31.4699 -
sparse_categorical_accuracy: 0.1773 - val_loss: 16.8731 -
val_sparse_categorical_accuracy: 0.1698
Epoch 4/5
37500/37500 [==============================] - 7s 179us/sample - loss: 10.6013 -
sparse_categorical_accuracy: 0.1270 - val_loss: 6.4482 -
val_sparse_categorical_accuracy: 0.1006
Epoch 5/5
37500/37500 [==============================] - 7s 182us/sample - loss: 4.6637 -
```

```
sparse_categorical_accuracy: 0.1027 - val_loss: 3.4821 -
val_sparse_categorical_accuracy: 0.1006

 51%|        | 51/100 [26:18<29:54, 36.62s/it]

0.10064 0.00015649101008736172 1.712912326386295
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 8s 214us/sample - loss: 173.3819
- sparse_categorical_accuracy: 0.1380 - val_loss: 155.1230 -
val_sparse_categorical_accuracy: 0.1586
Epoch 2/5
37500/37500 [==============================] - 7s 180us/sample - loss: 139.4084
- sparse_categorical_accuracy: 0.1727 - val_loss: 124.7857 -
val_sparse_categorical_accuracy: 0.1850
Epoch 3/5
37500/37500 [==============================] - 7s 184us/sample - loss: 112.1940
- sparse_categorical_accuracy: 0.1993 - val_loss: 100.4769 -
val_sparse_categorical_accuracy: 0.2069
Epoch 4/5
37500/37500 [==============================] - 7s 180us/sample - loss: 90.3859 -
sparse_categorical_accuracy: 0.2180 - val_loss: 80.9960 -
val_sparse_categorical_accuracy: 0.2197
Epoch 5/5
37500/37500 [==============================] - 7s 181us/sample - loss: 72.9084 -
sparse_categorical_accuracy: 0.2289 - val_loss: 65.3828 -
val_sparse_categorical_accuracy: 0.2271

 52%|        | 52/100 [26:55<29:26, 36.80s/it]

0.22712 9.1135805659096e-05 0.5177794938491259
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 8s 216us/sample - loss: 2.3916 -
sparse_categorical_accuracy: 0.1545 - val_loss: 2.3426 -
val_sparse_categorical_accuracy: 0.2034
Epoch 2/5
37500/37500 [==============================] - 7s 183us/sample - loss: 2.2832 -
sparse_categorical_accuracy: 0.2439 - val_loss: 2.2326 -
val_sparse_categorical_accuracy: 0.2607
Epoch 3/5
37500/37500 [==============================] - 7s 180us/sample - loss: 2.1771 -
sparse_categorical_accuracy: 0.2764 - val_loss: 2.1444 -
val_sparse_categorical_accuracy: 0.2822
Epoch 4/5
37500/37500 [==============================] - 7s 180us/sample - loss: 2.0984 -
sparse_categorical_accuracy: 0.3002 - val_loss: 2.0749 -
val_sparse_categorical_accuracy: 0.3134
Epoch 5/5
37500/37500 [==============================] - 7s 182us/sample - loss: 2.0323 -
```

```
sparse_categorical_accuracy: 0.3265 - val_loss: 2.0166 -
val_sparse_categorical_accuracy: 0.3290

 53%|       | 53/100 [27:33<28:59, 37.00s/it]

0.32904 0.0004636609521273699 0.0003353950380753399
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 8s 213us/sample - loss: 245.2756
- sparse_categorical_accuracy: 0.1183 - val_loss: 15.9616 -
val_sparse_categorical_accuracy: 0.1357
Epoch 2/5
37500/37500 [==============================] - 7s 185us/sample - loss: 5.3998 -
sparse_categorical_accuracy: 0.1003 - val_loss: 2.4767 -
val_sparse_categorical_accuracy: 0.1010
Epoch 3/5
37500/37500 [==============================] - 7s 181us/sample - loss: 2.3421 -
sparse_categorical_accuracy: 0.0988 - val_loss: 2.3048 -
val_sparse_categorical_accuracy: 0.1010
Epoch 4/5
37500/37500 [==============================] - 7s 184us/sample - loss: 2.3031 -
sparse_categorical_accuracy: 0.0986 - val_loss: 2.3026 -
val_sparse_categorical_accuracy: 0.0992
Epoch 5/5
37500/37500 [==============================] - 7s 182us/sample - loss: 2.3026 -
sparse_categorical_accuracy: 0.0998 - val_loss: 2.3026 -
val_sparse_categorical_accuracy: 0.0992

 54%|       | 54/100 [28:10<28:31, 37.22s/it]

0.0992 0.00032033563923196764 2.902263501942408
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 8s 221us/sample - loss: 607.5106
- sparse_categorical_accuracy: 0.1022 - val_loss: 603.4326 -
val_sparse_categorical_accuracy: 0.1027
Epoch 2/5
37500/37500 [==============================] - 7s 185us/sample - loss: 599.3955
- sparse_categorical_accuracy: 0.1028 - val_loss: 595.3723 -
val_sparse_categorical_accuracy: 0.1030
Epoch 3/5
37500/37500 [==============================] - 7s 185us/sample - loss: 591.3893
- sparse_categorical_accuracy: 0.1035 - val_loss: 587.4202 -
val_sparse_categorical_accuracy: 0.1029
Epoch 4/5
37500/37500 [==============================] - 7s 184us/sample - loss: 583.4907
- sparse_categorical_accuracy: 0.1037 - val_loss: 579.5748 -
val_sparse_categorical_accuracy: 0.1028
Epoch 5/5
37500/37500 [==============================] - 7s 186us/sample - loss: 575.6980
```

```
- sparse_categorical_accuracy: 0.1042 - val_loss: 571.8348 -
val_sparse_categorical_accuracy: 0.1034

 55%|       | 55/100 [28:49<28:07, 37.50s/it]

0.10344 1.740931221214868e-06 1.6535849155316449
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 8s 220us/sample - loss: 7.5674 -
sparse_categorical_accuracy: 0.0981 - val_loss: 7.5548 -
val_sparse_categorical_accuracy: 0.0983
Epoch 2/5
37500/37500 [==============================] - 7s 186us/sample - loss: 7.5477 -
sparse_categorical_accuracy: 0.0999 - val_loss: 7.5377 -
val_sparse_categorical_accuracy: 0.1003
Epoch 3/5
37500/37500 [==============================] - 7s 184us/sample - loss: 7.5318 -
sparse_categorical_accuracy: 0.1022 - val_loss: 7.5232 -
val_sparse_categorical_accuracy: 0.1047
Epoch 4/5
37500/37500 [==============================] - 7s 185us/sample - loss: 7.5179 -
sparse_categorical_accuracy: 0.1070 - val_loss: 7.5103 -
val_sparse_categorical_accuracy: 0.1140
Epoch 5/5
37500/37500 [==============================] - 7s 187us/sample - loss: 7.5052 -
sparse_categorical_accuracy: 0.1149 - val_loss: 7.4983 -
val_sparse_categorical_accuracy: 0.1234

 56%|       | 56/100 [29:27<27:41, 37.76s/it]

0.12336 1.7025261423630716e-05 0.014194731314542117
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 8s 219us/sample - loss: 107.2151
- sparse_categorical_accuracy: 0.1004 - val_loss: 103.1681 -
val_sparse_categorical_accuracy: 0.1093
Epoch 2/5
37500/37500 [==============================] - 7s 183us/sample - loss: 99.3336 -
sparse_categorical_accuracy: 0.1269 - val_loss: 95.5933 -
val_sparse_categorical_accuracy: 0.1368
Epoch 3/5
37500/37500 [==============================] - 7s 182us/sample - loss: 92.0482 -
sparse_categorical_accuracy: 0.1571 - val_loss: 88.5900 -
val_sparse_categorical_accuracy: 0.1626
Epoch 4/5
37500/37500 [==============================] - 7s 185us/sample - loss: 85.3118 -
sparse_categorical_accuracy: 0.1786 - val_loss: 82.1140 -
val_sparse_categorical_accuracy: 0.1794
Epoch 5/5
37500/37500 [==============================] - 7s 182us/sample - loss: 79.0822 -
```

```
sparse_categorical_accuracy: 0.1950 - val_loss: 76.1250 -
val_sparse_categorical_accuracy: 0.1970

 57%|       | 57/100 [30:05<27:05, 37.80s/it]

0.19696 5.610375767548278e-05 0.29638412600147895
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 8s 223us/sample - loss: 2.5445 -
sparse_categorical_accuracy: 0.0892 - val_loss: 2.5444 -
val_sparse_categorical_accuracy: 0.0874
Epoch 2/5
37500/37500 [==============================] - 7s 187us/sample - loss: 2.5423 -
sparse_categorical_accuracy: 0.0879 - val_loss: 2.5423 -
val_sparse_categorical_accuracy: 0.0881
Epoch 3/5
37500/37500 [==============================] - 7s 189us/sample - loss: 2.5403 -
sparse_categorical_accuracy: 0.0884 - val_loss: 2.5403 -
val_sparse_categorical_accuracy: 0.0882
Epoch 4/5
37500/37500 [==============================] - 7s 185us/sample - loss: 2.5383 -
sparse_categorical_accuracy: 0.0884 - val_loss: 2.5383 -
val_sparse_categorical_accuracy: 0.0876
Epoch 5/5
37500/37500 [==============================] - 7s 186us/sample - loss: 2.5365 -
sparse_categorical_accuracy: 0.0891 - val_loss: 2.5365 -
val_sparse_categorical_accuracy: 0.0886

 58%|       | 58/100 [30:43<26:37, 38.04s/it]

0.08856 5.524481121597007e-06 0.0006273208136046716
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 8s 224us/sample - loss: 59.3748 -
sparse_categorical_accuracy: 0.1099 - val_loss: 59.3511 -
val_sparse_categorical_accuracy: 0.1060
Epoch 2/5
37500/37500 [==============================] - 7s 189us/sample - loss: 59.3274 -
sparse_categorical_accuracy: 0.1105 - val_loss: 59.3036 -
val_sparse_categorical_accuracy: 0.1062
Epoch 3/5
37500/37500 [==============================] - 7s 189us/sample - loss: 59.2799 -
sparse_categorical_accuracy: 0.1111 - val_loss: 59.2562 -
val_sparse_categorical_accuracy: 0.1068
Epoch 4/5
37500/37500 [==============================] - 7s 189us/sample - loss: 59.2325 -
sparse_categorical_accuracy: 0.1115 - val_loss: 59.2089 -
val_sparse_categorical_accuracy: 0.1066
Epoch 5/5
37500/37500 [==============================] - 7s 188us/sample - loss: 59.1851 -
```

```
sparse_categorical_accuracy: 0.1123 - val_loss: 59.1616 -
val_sparse_categorical_accuracy: 0.1076

 59%|       | 59/100 [31:22<26:10, 38.31s/it]

0.1076 1.1381966834952107e-06 0.154540834196511
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 9s 227us/sample - loss: 2.3298 -
sparse_categorical_accuracy: 0.1349 - val_loss: 2.3145 -
val_sparse_categorical_accuracy: 0.1446
Epoch 2/5
37500/37500 [==============================] - 7s 188us/sample - loss: 2.2994 -
sparse_categorical_accuracy: 0.1606 - val_loss: 2.2903 -
val_sparse_categorical_accuracy: 0.1762
Epoch 3/5
37500/37500 [==============================] - 7s 191us/sample - loss: 2.2774 -
sparse_categorical_accuracy: 0.1924 - val_loss: 2.2703 -
val_sparse_categorical_accuracy: 0.2053
Epoch 4/5
37500/37500 [==============================] - 7s 189us/sample - loss: 2.2574 -
sparse_categorical_accuracy: 0.2158 - val_loss: 2.2513 -
val_sparse_categorical_accuracy: 0.2225
Epoch 5/5
37500/37500 [==============================] - 7s 190us/sample - loss: 2.2378 -
sparse_categorical_accuracy: 0.2299 - val_loss: 2.2322 -
val_sparse_categorical_accuracy: 0.2334

 60%|       | 60/100 [32:02<25:44, 38.60s/it]

0.23344 8.080858152871523e-05 4.764095388079395e-05
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 8s 225us/sample - loss: 3.7197 -
sparse_categorical_accuracy: 0.0958 - val_loss: 3.7185 -
val_sparse_categorical_accuracy: 0.0973
Epoch 2/5
37500/37500 [==============================] - 7s 189us/sample - loss: 3.7191 -
sparse_categorical_accuracy: 0.0961 - val_loss: 3.7179 -
val_sparse_categorical_accuracy: 0.0978
Epoch 3/5
37500/37500 [==============================] - 7s 186us/sample - loss: 3.7184 -
sparse_categorical_accuracy: 0.0963 - val_loss: 3.7173 -
val_sparse_categorical_accuracy: 0.0978
Epoch 4/5
37500/37500 [==============================] - 7s 187us/sample - loss: 3.7178 -
sparse_categorical_accuracy: 0.0966 - val_loss: 3.7167 -
val_sparse_categorical_accuracy: 0.0981
Epoch 5/5
37500/37500 [==============================] - 7s 187us/sample - loss: 3.7172 -
```

```
sparse_categorical_accuracy: 0.0975 - val_loss: 3.7161 -
val_sparse_categorical_accuracy: 0.0990

 61%|       | 61/100 [32:40<25:07, 38.66s/it]

0.09904 1.2216586548037365e-06 0.003799422569578589
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 9s 227us/sample - loss: 8.4490 -
sparse_categorical_accuracy: 0.1043 - val_loss: 8.4462 -
val_sparse_categorical_accuracy: 0.1018
Epoch 2/5
37500/37500 [==============================] - 7s 192us/sample - loss: 8.4449 -
sparse_categorical_accuracy: 0.1062 - val_loss: 8.4423 -
val_sparse_categorical_accuracy: 0.1038
Epoch 3/5
37500/37500 [==============================] - 7s 192us/sample - loss: 8.4409 -
sparse_categorical_accuracy: 0.1081 - val_loss: 8.4383 -
val_sparse_categorical_accuracy: 0.1056
Epoch 4/5
37500/37500 [==============================] - 7s 191us/sample - loss: 8.4370 -
sparse_categorical_accuracy: 0.1101 - val_loss: 8.4345 -
val_sparse_categorical_accuracy: 0.1066
Epoch 5/5
37500/37500 [==============================] - 7s 194us/sample - loss: 8.4331 -
sparse_categorical_accuracy: 0.1121 - val_loss: 8.4306 -
val_sparse_categorical_accuracy: 0.1086

 62%|       | 62/100 [33:20<24:41, 38.98s/it]

0.10856 5.1115929797142e-06 0.01665227525295916
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 9s 227us/sample - loss: 726.9593
- sparse_categorical_accuracy: 0.0922 - val_loss: 40.6216 -
val_sparse_categorical_accuracy: 0.1190
Epoch 2/5
37500/37500 [==============================] - 7s 193us/sample - loss: 10.8476 -
sparse_categorical_accuracy: 0.1012 - val_loss: 2.7544 -
val_sparse_categorical_accuracy: 0.0978
Epoch 3/5
37500/37500 [==============================] - 7s 189us/sample - loss: 2.4033 -
sparse_categorical_accuracy: 0.0989 - val_loss: 2.3079 -
val_sparse_categorical_accuracy: 0.0978
Epoch 4/5
37500/37500 [==============================] - 7s 193us/sample - loss: 2.3038 -
sparse_categorical_accuracy: 0.0997 - val_loss: 2.3027 -
val_sparse_categorical_accuracy: 0.0978
Epoch 5/5
37500/37500 [==============================] - 7s 191us/sample - loss: 2.3026 -
```

```
sparse_categorical_accuracy: 0.1004 - val_loss: 2.3026 -
val_sparse_categorical_accuracy: 0.0978

 63%|       | 63/100 [34:00<24:09, 39.18s/it]

0.09776 0.00010730615137772918 8.818470936148293
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 9s 229us/sample - loss: 3005.0292
- sparse_categorical_accuracy: 0.1113 - val_loss: 2888.6336 -
val_sparse_categorical_accuracy: 0.1057
Epoch 2/5
37500/37500 [==============================] - 7s 191us/sample - loss: 2778.3786
- sparse_categorical_accuracy: 0.1116 - val_loss: 2670.7691 -
val_sparse_categorical_accuracy: 0.1061
Epoch 3/5
37500/37500 [==============================] - 7s 196us/sample - loss: 2568.8371
- sparse_categorical_accuracy: 0.1118 - val_loss: 2469.3507 -
val_sparse_categorical_accuracy: 0.1060
Epoch 4/5
37500/37500 [==============================] - 7s 190us/sample - loss: 2375.1130
- sparse_categorical_accuracy: 0.1122 - val_loss: 2283.1360 -
val_sparse_categorical_accuracy: 0.1064
Epoch 5/5
37500/37500 [==============================] - 7s 192us/sample - loss: 2196.0120
- sparse_categorical_accuracy: 0.1124 - val_loss: 2110.9780 -
val_sparse_categorical_accuracy: 0.1064

 64%|       | 64/100 [34:40<23:37, 39.38s/it]

0.1064 1.978617422464193e-06 8.460611194972975
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 9s 234us/sample - loss: 118.2147
- sparse_categorical_accuracy: 0.1549 - val_loss: 45.7556 -
val_sparse_categorical_accuracy: 0.1982
Epoch 2/5
37500/37500 [==============================] - 7s 196us/sample - loss: 23.0613 -
sparse_categorical_accuracy: 0.2173 - val_loss: 10.0863 -
val_sparse_categorical_accuracy: 0.1959
Epoch 3/5
37500/37500 [==============================] - 7s 192us/sample - loss: 6.0210 -
sparse_categorical_accuracy: 0.1204 - val_loss: 3.6968 -
val_sparse_categorical_accuracy: 0.1006
Epoch 4/5
37500/37500 [==============================] - 7s 195us/sample - loss: 2.9686 -
sparse_categorical_accuracy: 0.0998 - val_loss: 2.5523 -
val_sparse_categorical_accuracy: 0.1006
Epoch 5/5
37500/37500 [==============================] - 7s 193us/sample - loss: 2.4219 -
```

```
sparse_categorical_accuracy: 0.0998 - val_loss: 2.3473 -
val_sparse_categorical_accuracy: 0.1006

 65%|       | 65/100 [35:20<23:08, 39.67s/it]

0.10064 0.0005580001767847422 0.6573479509789738
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 9s 237us/sample - loss: 6.0096 -
sparse_categorical_accuracy: 0.1013 - val_loss: 5.9989 -
val_sparse_categorical_accuracy: 0.1038
Epoch 2/5
37500/37500 [==============================] - 7s 196us/sample - loss: 5.9949 -
sparse_categorical_accuracy: 0.1023 - val_loss: 5.9862 -
val_sparse_categorical_accuracy: 0.1069
Epoch 3/5
37500/37500 [==============================] - 7s 196us/sample - loss: 5.9834 -
sparse_categorical_accuracy: 0.1039 - val_loss: 5.9761 -
val_sparse_categorical_accuracy: 0.1111
Epoch 4/5
37500/37500 [==============================] - 7s 194us/sample - loss: 5.9740 -
sparse_categorical_accuracy: 0.1075 - val_loss: 5.9677 -
val_sparse_categorical_accuracy: 0.1161
Epoch 5/5
37500/37500 [==============================] - 7s 198us/sample - loss: 5.9660 -
sparse_categorical_accuracy: 0.1121 - val_loss: 5.9606 -
val_sparse_categorical_accuracy: 0.1212

 66%|       | 66/100 [36:01<22:39, 40.00s/it]

0.1212 1.2408738382852513e-05 0.00995315736223575
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 9s 235us/sample - loss: 1527.5515
- sparse_categorical_accuracy: 0.0982 - val_loss: 1165.4502 -
val_sparse_categorical_accuracy: 0.1005
Epoch 2/5
37500/37500 [==============================] - 7s 196us/sample - loss: 909.8708
- sparse_categorical_accuracy: 0.0987 - val_loss: 694.4170 -
val_sparse_categorical_accuracy: 0.1013
Epoch 3/5
37500/37500 [==============================] - 7s 192us/sample - loss: 542.3397
- sparse_categorical_accuracy: 0.1000 - val_loss: 414.1377 -
val_sparse_categorical_accuracy: 0.1037
Epoch 4/5
37500/37500 [==============================] - 7s 195us/sample - loss: 323.6461
- sparse_categorical_accuracy: 0.1019 - val_loss: 247.3610 -
val_sparse_categorical_accuracy: 0.1068
Epoch 5/5
37500/37500 [==============================] - 7s 193us/sample - loss: 193.5149
```

```
- sparse_categorical_accuracy: 0.1069 - val_loss: 148.1223 -
val_sparse_categorical_accuracy: 0.1157

 67%|       | 67/100 [36:41<22:03, 40.11s/it]

0.11568 2.093481359752972e-05 5.288954673995898
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 9s 238us/sample - loss: 41.5497 -
sparse_categorical_accuracy: 0.1099 - val_loss: 41.1473 -
val_sparse_categorical_accuracy: 0.1182
Epoch 2/5
37500/37500 [==============================] - 7s 196us/sample - loss: 40.7548 -
sparse_categorical_accuracy: 0.1189 - val_loss: 40.3625 -
val_sparse_categorical_accuracy: 0.1258
Epoch 3/5
37500/37500 [==============================] - 7s 198us/sample - loss: 39.9785 -
sparse_categorical_accuracy: 0.1273 - val_loss: 39.5952 -
val_sparse_categorical_accuracy: 0.1324
Epoch 4/5
37500/37500 [==============================] - 7s 196us/sample - loss: 39.2191 -
sparse_categorical_accuracy: 0.1337 - val_loss: 38.8442 -
val_sparse_categorical_accuracy: 0.1410
Epoch 5/5
37500/37500 [==============================] - 7s 198us/sample - loss: 38.4756 -
sparse_categorical_accuracy: 0.1421 - val_loss: 38.1087 -
val_sparse_categorical_accuracy: 0.1492

 68%|       | 68/100 [37:22<21:32, 40.39s/it]

0.1492 4.006516242570201e-05 0.10742201767620613
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 9s 239us/sample - loss: 4.4956 -
sparse_categorical_accuracy: 0.2240 - val_loss: 4.3270 -
val_sparse_categorical_accuracy: 0.2842
Epoch 2/5
37500/37500 [==============================] - 7s 199us/sample - loss: 4.1888 -
sparse_categorical_accuracy: 0.3233 - val_loss: 4.0798 -
val_sparse_categorical_accuracy: 0.3488
Epoch 3/5
37500/37500 [==============================] - 7s 197us/sample - loss: 3.9785 -
sparse_categorical_accuracy: 0.3754 - val_loss: 3.9124 -
val_sparse_categorical_accuracy: 0.3835
Epoch 4/5
37500/37500 [==============================] - 7s 199us/sample - loss: 3.8202 -
sparse_categorical_accuracy: 0.4081 - val_loss: 3.7668 -
val_sparse_categorical_accuracy: 0.4097
Epoch 5/5
37500/37500 [==============================] - 7s 196us/sample - loss: 3.6836 -
```

```
sparse_categorical_accuracy: 0.4355 - val_loss: 3.6415 -
val_sparse_categorical_accuracy: 0.4377

 69%|       | 69/100 [38:03<21:00, 40.65s/it]

0.43768 0.0009695035623997375 0.006379965068727649
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 9s 244us/sample - loss: 2.3619 -
sparse_categorical_accuracy: 0.1122 - val_loss: 2.3485 -
val_sparse_categorical_accuracy: 0.1245
Epoch 2/5
37500/37500 [==============================] - 8s 205us/sample - loss: 2.3354 -
sparse_categorical_accuracy: 0.1370 - val_loss: 2.3272 -
val_sparse_categorical_accuracy: 0.1536
Epoch 3/5
37500/37500 [==============================] - 8s 203us/sample - loss: 2.3158 -
sparse_categorical_accuracy: 0.1678 - val_loss: 2.3086 -
val_sparse_categorical_accuracy: 0.1793
Epoch 4/5
37500/37500 [==============================] - 8s 200us/sample - loss: 2.2969 -
sparse_categorical_accuracy: 0.1865 - val_loss: 2.2898 -
val_sparse_categorical_accuracy: 0.1950
Epoch 5/5
37500/37500 [==============================] - 8s 201us/sample - loss: 2.2772 -
sparse_categorical_accuracy: 0.1990 - val_loss: 2.2700 -
val_sparse_categorical_accuracy: 0.2078

 70%|       | 70/100 [38:45<20:32, 41.07s/it]

0.20784 7.090279646453941e-05 0.0001482949607012882
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 9s 246us/sample - loss: 2.3353 -
sparse_categorical_accuracy: 0.0800 - val_loss: 2.3264 -
val_sparse_categorical_accuracy: 0.0878
Epoch 2/5
37500/37500 [==============================] - 7s 198us/sample - loss: 2.3197 -
sparse_categorical_accuracy: 0.0990 - val_loss: 2.3142 -
val_sparse_categorical_accuracy: 0.1050
Epoch 3/5
37500/37500 [==============================] - 8s 201us/sample - loss: 2.3087 -
sparse_categorical_accuracy: 0.1132 - val_loss: 2.3050 -
val_sparse_categorical_accuracy: 0.1192
Epoch 4/5
37500/37500 [==============================] - 7s 200us/sample - loss: 2.3001 -
sparse_categorical_accuracy: 0.1240 - val_loss: 2.2976 -
val_sparse_categorical_accuracy: 0.1293
Epoch 5/5
37500/37500 [==============================] - 7s 199us/sample - loss: 2.2929 -
```

```
sparse_categorical_accuracy: 0.1324 - val_loss: 2.2911 -
val_sparse_categorical_accuracy: 0.1357

 71%|       | 71/100 [39:27<19:57, 41.29s/it]

0.13568 2.7558102553493017e-05 2.0642658122091302e-05
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 9s 242us/sample - loss: 3.3444 -
sparse_categorical_accuracy: 0.1075 - val_loss: 3.3408 -
val_sparse_categorical_accuracy: 0.1042
Epoch 2/5
37500/37500 [==============================] - 8s 203us/sample - loss: 3.3387 -
sparse_categorical_accuracy: 0.1095 - val_loss: 3.3355 -
val_sparse_categorical_accuracy: 0.1064
Epoch 3/5
37500/37500 [==============================] - 8s 200us/sample - loss: 3.3337 -
sparse_categorical_accuracy: 0.1105 - val_loss: 3.3308 -
val_sparse_categorical_accuracy: 0.1082
Epoch 4/5
37500/37500 [==============================] - 8s 203us/sample - loss: 3.3292 -
sparse_categorical_accuracy: 0.1115 - val_loss: 3.3266 -
val_sparse_categorical_accuracy: 0.1104
Epoch 5/5
37500/37500 [==============================] - 8s 201us/sample - loss: 3.3252 -
sparse_categorical_accuracy: 0.1128 - val_loss: 3.3229 -
val_sparse_categorical_accuracy: 0.1116

 72%|       | 72/100 [40:09<19:22, 41.52s/it]

0.1116 4.381115340797881e-06 0.0027667712415496946
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 9s 249us/sample - loss: 2.5997 -
sparse_categorical_accuracy: 0.1039 - val_loss: 2.5906 -
val_sparse_categorical_accuracy: 0.1042
Epoch 2/5
37500/37500 [==============================] - 8s 202us/sample - loss: 2.5849 -
sparse_categorical_accuracy: 0.1050 - val_loss: 2.5792 -
val_sparse_categorical_accuracy: 0.1058
Epoch 3/5
37500/37500 [==============================] - 8s 206us/sample - loss: 2.5745 -
sparse_categorical_accuracy: 0.1084 - val_loss: 2.5704 -
val_sparse_categorical_accuracy: 0.1127
Epoch 4/5
37500/37500 [==============================] - 8s 204us/sample - loss: 2.5660 -
sparse_categorical_accuracy: 0.1149 - val_loss: 2.5626 -
val_sparse_categorical_accuracy: 0.1198
Epoch 5/5
37500/37500 [==============================] - 8s 206us/sample - loss: 2.5581 -
```

```
sparse_categorical_accuracy: 0.1251 - val_loss: 2.5552 -
val_sparse_categorical_accuracy: 0.1334

 73%|      | 73/100 [40:52<18:50, 41.87s/it]

0.13336 3.5793854402526506e-05 0.0007586720523235277
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 9s 247us/sample - loss: 2.6940 -
sparse_categorical_accuracy: 0.1711 - val_loss: 2.6351 -
val_sparse_categorical_accuracy: 0.2318
Epoch 2/5
37500/37500 [==============================] - 8s 208us/sample - loss: 2.5665 -
sparse_categorical_accuracy: 0.2640 - val_loss: 2.5098 -
val_sparse_categorical_accuracy: 0.2725
Epoch 3/5
37500/37500 [==============================] - 8s 206us/sample - loss: 2.4484 -
sparse_categorical_accuracy: 0.2952 - val_loss: 2.4088 -
val_sparse_categorical_accuracy: 0.3009
Epoch 4/5
37500/37500 [==============================] - 8s 208us/sample - loss: 2.3590 -
sparse_categorical_accuracy: 0.3247 - val_loss: 2.3303 -
val_sparse_categorical_accuracy: 0.3314
Epoch 5/5
37500/37500 [==============================] - 8s 206us/sample - loss: 2.2888 -
sparse_categorical_accuracy: 0.3521 - val_loss: 2.2681 -
val_sparse_categorical_accuracy: 0.3526

 74%|      | 74/100 [41:35<18:16, 42.18s/it]

0.35256 0.00038386290913662075 0.0011979286755808632
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 9s 248us/sample - loss: 3.6154 -
sparse_categorical_accuracy: 0.1064 - val_loss: 3.6029 -
val_sparse_categorical_accuracy: 0.1137
Epoch 2/5
37500/37500 [==============================] - 8s 208us/sample - loss: 3.5928 -
sparse_categorical_accuracy: 0.1375 - val_loss: 3.5854 -
val_sparse_categorical_accuracy: 0.1484
Epoch 3/5
37500/37500 [==============================] - 8s 207us/sample - loss: 3.5774 -
sparse_categorical_accuracy: 0.1648 - val_loss: 3.5716 -
val_sparse_categorical_accuracy: 0.1690
Epoch 4/5
37500/37500 [==============================] - 8s 208us/sample - loss: 3.5641 -
sparse_categorical_accuracy: 0.1794 - val_loss: 3.5588 -
val_sparse_categorical_accuracy: 0.1838
Epoch 5/5
37500/37500 [==============================] - 8s 206us/sample - loss: 3.5509 -
```

```
sparse_categorical_accuracy: 0.1935 - val_loss: 3.5458 -
val_sparse_categorical_accuracy: 0.1980

 75%|      | 75/100 [42:18<17:41, 42.44s/it]

0.198 5.381784655921287e-05 0.003545899325002575
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 9s 250us/sample - loss: 2872.0409
- sparse_categorical_accuracy: 0.0962 - val_loss: 2579.5118 -
val_sparse_categorical_accuracy: 0.0980
Epoch 2/5
37500/37500 [==============================] - 8s 206us/sample - loss: 2325.8827
- sparse_categorical_accuracy: 0.0959 - val_loss: 2089.0289 -
val_sparse_categorical_accuracy: 0.0980
Epoch 3/5
37500/37500 [==============================] - 8s 207us/sample - loss: 1883.6706
- sparse_categorical_accuracy: 0.0962 - val_loss: 1691.8948 -
val_sparse_categorical_accuracy: 0.0980
Epoch 4/5
37500/37500 [==============================] - 8s 205us/sample - loss: 1525.6198
- sparse_categorical_accuracy: 0.0959 - val_loss: 1370.3423 -
val_sparse_categorical_accuracy: 0.0976
Epoch 5/5
37500/37500 [==============================] - 8s 208us/sample - loss: 1235.7119
- sparse_categorical_accuracy: 0.0960 - val_loss: 1109.9861 -
val_sparse_categorical_accuracy: 0.0978

 76%|      | 76/100 [43:01<17:03, 42.63s/it]

0.09784 5.229795458797382e-06 8.610178099621942
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 9s 250us/sample - loss: 2.3611 -
sparse_categorical_accuracy: 0.0894 - val_loss: 2.3502 -
val_sparse_categorical_accuracy: 0.0908
Epoch 2/5
37500/37500 [==============================] - 8s 206us/sample - loss: 2.3450 -
sparse_categorical_accuracy: 0.0941 - val_loss: 2.3374 -
val_sparse_categorical_accuracy: 0.0984
Epoch 3/5
37500/37500 [==============================] - 8s 206us/sample - loss: 2.3334 -
sparse_categorical_accuracy: 0.1053 - val_loss: 2.3274 -
val_sparse_categorical_accuracy: 0.1126
Epoch 4/5
37500/37500 [==============================] - 8s 204us/sample - loss: 2.3236 -
sparse_categorical_accuracy: 0.1215 - val_loss: 2.3185 -
val_sparse_categorical_accuracy: 0.1266
Epoch 5/5
37500/37500 [==============================] - 8s 204us/sample - loss: 2.3146 -
```

```
sparse_categorical_accuracy: 0.1385 - val_loss: 2.3101 -
val_sparse_categorical_accuracy: 0.1450

 77%|      | 77/100 [43:44<16:23, 42.75s/it]

0.14496 4.0174107637599394e-05 8.492451209651224e-05
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 9s 252us/sample - loss: 208.2516
- sparse_categorical_accuracy: 0.1010 - val_loss: 204.4795 -
val_sparse_categorical_accuracy: 0.0964
Epoch 2/5
37500/37500 [==============================] - 8s 207us/sample - loss: 200.8069
- sparse_categorical_accuracy: 0.1014 - val_loss: 197.1738 -
val_sparse_categorical_accuracy: 0.0955
Epoch 3/5
37500/37500 [==============================] - 8s 205us/sample - loss: 193.6356
- sparse_categorical_accuracy: 0.1040 - val_loss: 190.1351 -
val_sparse_categorical_accuracy: 0.0958
Epoch 4/5
37500/37500 [==============================] - 8s 206us/sample - loss: 186.7257
- sparse_categorical_accuracy: 0.1080 - val_loss: 183.3524 -
val_sparse_categorical_accuracy: 0.1037
Epoch 5/5
37500/37500 [==============================] - 8s 204us/sample - loss: 180.0668
- sparse_categorical_accuracy: 0.1144 - val_loss: 176.8158 -
val_sparse_categorical_accuracy: 0.1125

 78%|      | 78/100 [44:27<15:43, 42.87s/it]

0.11248 1.379064767808715e-05 0.5684185252744115
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 10s 256us/sample - loss: 5.8087 -
sparse_categorical_accuracy: 0.0867 - val_loss: 5.7970 -
val_sparse_categorical_accuracy: 0.0927
Epoch 2/5
37500/37500 [==============================] - 8s 211us/sample - loss: 5.7886 -
sparse_categorical_accuracy: 0.0965 - val_loss: 5.7798 -
val_sparse_categorical_accuracy: 0.0992
Epoch 3/5
37500/37500 [==============================] - 8s 211us/sample - loss: 5.7728 -
sparse_categorical_accuracy: 0.1055 - val_loss: 5.7658 -
val_sparse_categorical_accuracy: 0.1106
Epoch 4/5
37500/37500 [==============================] - 8s 209us/sample - loss: 5.7594 -
sparse_categorical_accuracy: 0.1134 - val_loss: 5.7536 -
val_sparse_categorical_accuracy: 0.1166
Epoch 5/5
37500/37500 [==============================] - 8s 211us/sample - loss: 5.7475 -
```

```
sparse_categorical_accuracy: 0.1197 - val_loss: 5.7425 -
val_sparse_categorical_accuracy: 0.1200

 79%|      | 79/100 [45:11<15:06, 43.18s/it]

0.12 2.3604162932672514e-05 0.009401143526973894
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 10s 255us/sample - loss: 11.8483
- sparse_categorical_accuracy: 0.1782 - val_loss: 11.4299 -
val_sparse_categorical_accuracy: 0.2494
Epoch 2/5
37500/37500 [==============================] - 8s 208us/sample - loss: 11.0173 -
sparse_categorical_accuracy: 0.2797 - val_loss: 10.6237 -
val_sparse_categorical_accuracy: 0.2962
Epoch 3/5
37500/37500 [==============================] - 8s 210us/sample - loss: 10.2525 -
sparse_categorical_accuracy: 0.3154 - val_loss: 9.9152 -
val_sparse_categorical_accuracy: 0.3257
Epoch 4/5
37500/37500 [==============================] - 8s 209us/sample - loss: 9.5779 -
sparse_categorical_accuracy: 0.3430 - val_loss: 9.2759 -
val_sparse_categorical_accuracy: 0.3462
Epoch 5/5
37500/37500 [==============================] - 8s 211us/sample - loss: 8.9670 -
sparse_categorical_accuracy: 0.3648 - val_loss: 8.6926 -
val_sparse_categorical_accuracy: 0.3698

 80%|      | 80/100 [45:55<14:27, 43.37s/it]

0.36976 0.0005934300959321931 0.0270961933459066
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 10s 257us/sample - loss: 2.5468 -
sparse_categorical_accuracy: 0.0885 - val_loss: 2.5470 -
val_sparse_categorical_accuracy: 0.0889
Epoch 2/5
37500/37500 [==============================] - 8s 209us/sample - loss: 2.5456 -
sparse_categorical_accuracy: 0.0890 - val_loss: 2.5458 -
val_sparse_categorical_accuracy: 0.0894
Epoch 3/5
37500/37500 [==============================] - 8s 209us/sample - loss: 2.5443 -
sparse_categorical_accuracy: 0.0886 - val_loss: 2.5446 -
val_sparse_categorical_accuracy: 0.0891
Epoch 4/5
37500/37500 [==============================] - 8s 209us/sample - loss: 2.5432 -
sparse_categorical_accuracy: 0.0889 - val_loss: 2.5435 -
val_sparse_categorical_accuracy: 0.0895
Epoch 5/5
37500/37500 [==============================] - 8s 208us/sample - loss: 2.5420 -
```

```
sparse_categorical_accuracy: 0.0891 - val_loss: 2.5423 -
val_sparse_categorical_accuracy: 0.0903

 81%|      | 81/100 [46:39<13:47, 43.53s/it]

0.09032 1.694776074223085e-06 0.0006038825663962079
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 10s 258us/sample - loss: 2.2939 -
sparse_categorical_accuracy: 0.1563 - val_loss: 2.2493 -
val_sparse_categorical_accuracy: 0.2075
Epoch 2/5
37500/37500 [==============================] - 8s 213us/sample - loss: 2.1882 -
sparse_categorical_accuracy: 0.2467 - val_loss: 2.1278 -
val_sparse_categorical_accuracy: 0.2612
Epoch 3/5
37500/37500 [==============================] - 8s 212us/sample - loss: 2.0541 -
sparse_categorical_accuracy: 0.2929 - val_loss: 2.0012 -
val_sparse_categorical_accuracy: 0.3038
Epoch 4/5
37500/37500 [==============================] - 8s 213us/sample - loss: 1.9358 -
sparse_categorical_accuracy: 0.3317 - val_loss: 1.9004 -
val_sparse_categorical_accuracy: 0.3407
Epoch 5/5
37500/37500 [==============================] - 8s 211us/sample - loss: 1.8482 -
sparse_categorical_accuracy: 0.3608 - val_loss: 1.8321 -
val_sparse_categorical_accuracy: 0.3610

 82%|      | 82/100 [47:23<13:08, 43.82s/it]

0.36096 0.00047527204005882756 7.53769584805802e-05
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 10s 258us/sample - loss:
1083.0093 - sparse_categorical_accuracy: 0.1148 - val_loss: 551.3379 -
val_sparse_categorical_accuracy: 0.1118
Epoch 2/5
37500/37500 [==============================] - 8s 213us/sample - loss: 318.5202
- sparse_categorical_accuracy: 0.1179 - val_loss: 162.9541 -
val_sparse_categorical_accuracy: 0.1160
Epoch 3/5
37500/37500 [==============================] - 8s 213us/sample - loss: 94.8302 -
sparse_categorical_accuracy: 0.1231 - val_loss: 49.3105 -
val_sparse_categorical_accuracy: 0.1408
Epoch 4/5
37500/37500 [==============================] - 8s 211us/sample - loss: 29.3769 -
sparse_categorical_accuracy: 0.1138 - val_loss: 16.0575 -
val_sparse_categorical_accuracy: 0.0978
Epoch 5/5
37500/37500 [==============================] - 8s 214us/sample - loss: 10.2247 -
```

```
sparse_categorical_accuracy: 0.1007 - val_loss: 6.3274 -
val_sparse_categorical_accuracy: 0.0978

 83%|      | 83/100 [48:08<12:29, 44.06s/it]

0.09776 5.154762878294502e-05 5.0841119038517615
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 10s 262us/sample - loss: 21.1231
- sparse_categorical_accuracy: 0.0946 - val_loss: 21.0495 -
val_sparse_categorical_accuracy: 0.0990
Epoch 2/5
37500/37500 [==============================] - 8s 211us/sample - loss: 20.9798 -
sparse_categorical_accuracy: 0.1024 - val_loss: 20.9089 -
val_sparse_categorical_accuracy: 0.1090
Epoch 3/5
37500/37500 [==============================] - 8s 212us/sample - loss: 20.8406 -
sparse_categorical_accuracy: 0.1103 - val_loss: 20.7714 -
val_sparse_categorical_accuracy: 0.1162
Epoch 4/5
37500/37500 [==============================] - 8s 210us/sample - loss: 20.7039 -
sparse_categorical_accuracy: 0.1175 - val_loss: 20.6359 -
val_sparse_categorical_accuracy: 0.1244
Epoch 5/5
37500/37500 [==============================] - 8s 212us/sample - loss: 20.5691 -
sparse_categorical_accuracy: 0.1254 - val_loss: 20.5021 -
val_sparse_categorical_accuracy: 0.1334

 84%|      | 84/100 [48:52<11:47, 44.19s/it]

0.13336 2.920084340562622e-05 0.05118010269060469
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 10s 262us/sample - loss: 379.4109
- sparse_categorical_accuracy: 0.1324 - val_loss: 58.0805 -
val_sparse_categorical_accuracy: 0.1802
Epoch 2/5
37500/37500 [==============================] - 8s 214us/sample - loss: 19.5930 -
sparse_categorical_accuracy: 0.1156 - val_loss: 4.8600 -
val_sparse_categorical_accuracy: 0.0992
Epoch 3/5
37500/37500 [==============================] - 8s 215us/sample - loss: 3.0954 -
sparse_categorical_accuracy: 0.1003 - val_loss: 2.4198 -
val_sparse_categorical_accuracy: 0.0992
Epoch 4/5
37500/37500 [==============================] - 8s 213us/sample - loss: 2.3389 -
sparse_categorical_accuracy: 0.1003 - val_loss: 2.3080 -
val_sparse_categorical_accuracy: 0.0992
Epoch 5/5
37500/37500 [==============================] - 8s 215us/sample - loss: 2.3043 -
```

```
sparse_categorical_accuracy: 0.1003 - val_loss: 2.3028 -
val_sparse_categorical_accuracy: 0.0992

 85%|      | 85/100 [49:37<11:06, 44.43s/it]

0.0992 0.00019884404759045393 3.3044694106177337
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 10s 261us/sample - loss: 6.9427 -
sparse_categorical_accuracy: 0.1106 - val_loss: 6.9330 -
val_sparse_categorical_accuracy: 0.1136
Epoch 2/5
37500/37500 [==============================] - 8s 215us/sample - loss: 6.9249 -
sparse_categorical_accuracy: 0.1147 - val_loss: 6.9166 -
val_sparse_categorical_accuracy: 0.1190
Epoch 3/5
37500/37500 [==============================] - 8s 213us/sample - loss: 6.9093 -
sparse_categorical_accuracy: 0.1197 - val_loss: 6.9018 -
val_sparse_categorical_accuracy: 0.1257
Epoch 4/5
37500/37500 [==============================] - 8s 215us/sample - loss: 6.8950 -
sparse_categorical_accuracy: 0.1243 - val_loss: 6.8881 -
val_sparse_categorical_accuracy: 0.1301
Epoch 5/5
37500/37500 [==============================] - 8s 213us/sample - loss: 6.8815 -
sparse_categorical_accuracy: 0.1304 - val_loss: 6.8750 -
val_sparse_categorical_accuracy: 0.1351

 86%|      | 86/100 [50:22<10:24, 44.59s/it]

0.13512 2.983001501954912e-05 0.01254812067829477
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 10s 267us/sample - loss: 2.3229 -
sparse_categorical_accuracy: 0.1117 - val_loss: 2.3146 -
val_sparse_categorical_accuracy: 0.1109
Epoch 2/5
37500/37500 [==============================] - 8s 217us/sample - loss: 2.3092 -
sparse_categorical_accuracy: 0.1228 - val_loss: 2.3035 -
val_sparse_categorical_accuracy: 0.1272
Epoch 3/5
37500/37500 [==============================] - 8s 216us/sample - loss: 2.2996 -
sparse_categorical_accuracy: 0.1343 - val_loss: 2.2951 -
val_sparse_categorical_accuracy: 0.1366
Epoch 4/5
37500/37500 [==============================] - 8s 217us/sample - loss: 2.2919 -
sparse_categorical_accuracy: 0.1443 - val_loss: 2.2881 -
val_sparse_categorical_accuracy: 0.1438
Epoch 5/5
37500/37500 [==============================] - 8s 216us/sample - loss: 2.2852 -
```

```
sparse_categorical_accuracy: 0.1506 - val_loss: 2.2817 -
val_sparse_categorical_accuracy: 0.1501

 87%|      | 87/100 [51:08<09:44, 44.94s/it]

0.15008 4.370290368175263e-05 1.640522648526908e-05
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 10s 270us/sample - loss: 3.0565 -
sparse_categorical_accuracy: 0.1113 - val_loss: 3.0504 -
val_sparse_categorical_accuracy: 0.1234
Epoch 2/5
37500/37500 [==============================] - 8s 212us/sample - loss: 3.0425 -
sparse_categorical_accuracy: 0.1438 - val_loss: 3.0376 -
val_sparse_categorical_accuracy: 0.1586
Epoch 3/5
37500/37500 [==============================] - 8s 207us/sample - loss: 3.0297 -
sparse_categorical_accuracy: 0.1747 - val_loss: 3.0253 -
val_sparse_categorical_accuracy: 0.1880
Epoch 4/5
37500/37500 [==============================] - 8s 210us/sample - loss: 3.0170 -
sparse_categorical_accuracy: 0.1986 - val_loss: 3.0129 -
val_sparse_categorical_accuracy: 0.2058
Epoch 5/5
37500/37500 [==============================] - 8s 215us/sample - loss: 3.0037 -
sparse_categorical_accuracy: 0.2161 - val_loss: 2.9997 -
val_sparse_categorical_accuracy: 0.2144

 88%|      | 88/100 [51:53<08:58, 44.90s/it]

0.2144 8.350687104221956e-05 0.002063837374539443
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 12s 322us/sample - loss: 2.3129 -
sparse_categorical_accuracy: 0.1407 - val_loss: 2.2790 -
val_sparse_categorical_accuracy: 0.1948
Epoch 2/5
37500/37500 [==============================] - 8s 224us/sample - loss: 2.2380 -
sparse_categorical_accuracy: 0.2228 - val_loss: 2.1998 -
val_sparse_categorical_accuracy: 0.2399
Epoch 3/5
37500/37500 [==============================] - 8s 213us/sample - loss: 2.1498 -
sparse_categorical_accuracy: 0.2647 - val_loss: 2.1117 -
val_sparse_categorical_accuracy: 0.2709
Epoch 4/5
37500/37500 [==============================] - 8s 216us/sample - loss: 2.0631 -
sparse_categorical_accuracy: 0.2913 - val_loss: 2.0334 -
val_sparse_categorical_accuracy: 0.2933
Epoch 5/5
37500/37500 [==============================] - 8s 211us/sample - loss: 1.9892 -
```

```
sparse_categorical_accuracy: 0.3150 - val_loss: 1.9673 -
val_sparse_categorical_accuracy: 0.3145

 89%|      | 89/100 [52:41<08:23, 45.79s/it]

0.31448 0.0003180718213389353 8.768490544339196e-05
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 10s 261us/sample - loss: 284.6098
- sparse_categorical_accuracy: 0.1217 - val_loss: 3.2471 -
val_sparse_categorical_accuracy: 0.1006
Epoch 2/5
37500/37500 [==============================] - 8s 212us/sample - loss: 2.4249 -
sparse_categorical_accuracy: 0.0977 - val_loss: 2.3030 -
val_sparse_categorical_accuracy: 0.0978
Epoch 3/5
37500/37500 [==============================] - 8s 215us/sample - loss: 2.3026 -
sparse_categorical_accuracy: 0.0979 - val_loss: 2.3026 -
val_sparse_categorical_accuracy: 0.0978
Epoch 4/5
37500/37500 [==============================] - 8s 212us/sample - loss: 2.3026 -
sparse_categorical_accuracy: 0.1007 - val_loss: 2.3026 -
val_sparse_categorical_accuracy: 0.0978
Epoch 5/5
37500/37500 [==============================] - 8s 214us/sample - loss: 2.3026 -
sparse_categorical_accuracy: 0.1007 - val_loss: 2.3026 -
val_sparse_categorical_accuracy: 0.0978

 90%|      | 90/100 [53:26<07:35, 45.53s/it]

0.09776 0.0002795004280307046 5.900419878856448
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 10s 264us/sample - loss: 2.3878 -
sparse_categorical_accuracy: 0.1048 - val_loss: 2.3852 -
val_sparse_categorical_accuracy: 0.1073
Epoch 2/5
37500/37500 [==============================] - 8s 214us/sample - loss: 2.3862 -
sparse_categorical_accuracy: 0.1050 - val_loss: 2.3837 -
val_sparse_categorical_accuracy: 0.1074
Epoch 3/5
37500/37500 [==============================] - 8s 215us/sample - loss: 2.3847 -
sparse_categorical_accuracy: 0.1050 - val_loss: 2.3823 -
val_sparse_categorical_accuracy: 0.1078
Epoch 4/5
37500/37500 [==============================] - 8s 213us/sample - loss: 2.3833 -
sparse_categorical_accuracy: 0.1053 - val_loss: 2.3809 -
val_sparse_categorical_accuracy: 0.1082
Epoch 5/5
37500/37500 [==============================] - 8s 215us/sample - loss: 2.3819 -
```

```
sparse_categorical_accuracy: 0.1058 - val_loss: 2.3796 -
val_sparse_categorical_accuracy: 0.1077

 91%|      | 91/100 [54:11<06:48, 45.43s/it]

0.10768 2.2711209098199644e-06 0.00013510096169457
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 10s 270us/sample - loss: 4.8163 -
sparse_categorical_accuracy: 0.1550 - val_loss: 4.7864 -
val_sparse_categorical_accuracy: 0.2010
Epoch 2/5
37500/37500 [==============================] - 8s 215us/sample - loss: 4.7564 -
sparse_categorical_accuracy: 0.2189 - val_loss: 4.7271 -
val_sparse_categorical_accuracy: 0.2354
Epoch 3/5
37500/37500 [==============================] - 8s 218us/sample - loss: 4.6910 -
sparse_categorical_accuracy: 0.2500 - val_loss: 4.6575 -
val_sparse_categorical_accuracy: 0.2576
Epoch 4/5
37500/37500 [==============================] - 8s 214us/sample - loss: 4.6153 -
sparse_categorical_accuracy: 0.2704 - val_loss: 4.5813 -
val_sparse_categorical_accuracy: 0.2777
Epoch 5/5
37500/37500 [==============================] - 8s 217us/sample - loss: 4.5383 -
sparse_categorical_accuracy: 0.2894 - val_loss: 4.5082 -
val_sparse_categorical_accuracy: 0.2871

 92%|      | 92/100 [54:57<06:04, 45.55s/it]

0.28712 0.0002126396397266379 0.006920073289395831
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 10s 266us/sample - loss: 118.0932
- sparse_categorical_accuracy: 0.0937 - val_loss: 117.7050 -
val_sparse_categorical_accuracy: 0.0942
Epoch 2/5
37500/37500 [==============================] - 8s 217us/sample - loss: 117.3194
- sparse_categorical_accuracy: 0.0940 - val_loss: 116.9338 -
val_sparse_categorical_accuracy: 0.0947
Epoch 3/5
37500/37500 [==============================] - 8s 215us/sample - loss: 116.5508
- sparse_categorical_accuracy: 0.0946 - val_loss: 116.1679 -
val_sparse_categorical_accuracy: 0.0952
Epoch 4/5
37500/37500 [==============================] - 8s 217us/sample - loss: 115.7875
- sparse_categorical_accuracy: 0.0947 - val_loss: 115.4073 -
val_sparse_categorical_accuracy: 0.0951
Epoch 5/5
37500/37500 [==============================] - 8s 215us/sample - loss: 115.0295
```

```
- sparse_categorical_accuracy: 0.0952 - val_loss: 114.6518 -
val_sparse_categorical_accuracy: 0.0956

 93%|     | 93/100 [55:42<05:18, 45.55s/it]

0.0956 4.519190676409651e-06 0.3157081473168764
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 10s 267us/sample - loss: 457.7436
- sparse_categorical_accuracy: 0.1186 - val_loss: 455.6209 -
val_sparse_categorical_accuracy: 0.1155
Epoch 2/5
37500/37500 [==============================] - 8s 219us/sample - loss: 453.5156
- sparse_categorical_accuracy: 0.1199 - val_loss: 451.4126 -
val_sparse_categorical_accuracy: 0.1174
Epoch 3/5
37500/37500 [==============================] - 8s 218us/sample - loss: 449.3270
- sparse_categorical_accuracy: 0.1213 - val_loss: 447.2437 -
val_sparse_categorical_accuracy: 0.1185
Epoch 4/5
37500/37500 [==============================] - 8s 220us/sample - loss: 445.1774
- sparse_categorical_accuracy: 0.1222 - val_loss: 443.1135 -
val_sparse_categorical_accuracy: 0.1194
Epoch 5/5
37500/37500 [==============================] - 8s 220us/sample - loss: 441.0664
- sparse_categorical_accuracy: 0.1232 - val_loss: 439.0217 -
val_sparse_categorical_accuracy: 0.1202

 94%|     | 94/100 [56:29<04:34, 45.76s/it]

0.12024 1.604462532586685e-06 1.2392862043463517
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 10s 272us/sample - loss: 50.1715
- sparse_categorical_accuracy: 0.1147 - val_loss: 49.9080 -
val_sparse_categorical_accuracy: 0.1161
Epoch 2/5
37500/37500 [==============================] - 8s 219us/sample - loss: 49.6482 -
sparse_categorical_accuracy: 0.1243 - val_loss: 49.3905 -
val_sparse_categorical_accuracy: 0.1252
Epoch 3/5
37500/37500 [==============================] - 8s 217us/sample - loss: 49.1352 -
sparse_categorical_accuracy: 0.1317 - val_loss: 48.8820 -
val_sparse_categorical_accuracy: 0.1328
Epoch 4/5
37500/37500 [==============================] - 8s 219us/sample - loss: 48.6302 -
sparse_categorical_accuracy: 0.1379 - val_loss: 48.3808 -
val_sparse_categorical_accuracy: 0.1402
Epoch 5/5
37500/37500 [==============================] - 8s 217us/sample - loss: 48.1322 -
```

```
sparse_categorical_accuracy: 0.1451 - val_loss: 47.8862 -
val_sparse_categorical_accuracy: 0.1457

 95%|     | 95/100 [57:15<03:49, 45.91s/it]

0.14568 1.7439693823223552e-05 0.13033300220233454
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 10s 272us/sample - loss: 2.3161 -
sparse_categorical_accuracy: 0.1277 - val_loss: 2.3140 -
val_sparse_categorical_accuracy: 0.1256
Epoch 2/5
37500/37500 [==============================] - 8s 223us/sample - loss: 2.3111 -
sparse_categorical_accuracy: 0.1307 - val_loss: 2.3093 -
val_sparse_categorical_accuracy: 0.1281
Epoch 3/5
37500/37500 [==============================] - 8s 220us/sample - loss: 2.3064 -
sparse_categorical_accuracy: 0.1337 - val_loss: 2.3049 -
val_sparse_categorical_accuracy: 0.1334
Epoch 4/5
37500/37500 [==============================] - 8s 223us/sample - loss: 2.3020 -
sparse_categorical_accuracy: 0.1375 - val_loss: 2.3007 -
val_sparse_categorical_accuracy: 0.1380
Epoch 5/5
37500/37500 [==============================] - 8s 220us/sample - loss: 2.2978 -
sparse_categorical_accuracy: 0.1393 - val_loss: 2.2967 -
val_sparse_categorical_accuracy: 0.1397

 96%|     | 96/100 [58:02<03:04, 46.18s/it]

0.13968 1.1825072203385077e-05 3.20500878627329e-05
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 10s 275us/sample - loss: 2.3127 -
sparse_categorical_accuracy: 0.1700 - val_loss: 2.2480 -
val_sparse_categorical_accuracy: 0.2438
Epoch 2/5
37500/37500 [==============================] - 8s 223us/sample - loss: 2.1748 -
sparse_categorical_accuracy: 0.2720 - val_loss: 2.1149 -
val_sparse_categorical_accuracy: 0.2858
Epoch 3/5
37500/37500 [==============================] - 8s 223us/sample - loss: 2.0463 -
sparse_categorical_accuracy: 0.3109 - val_loss: 1.9999 -
val_sparse_categorical_accuracy: 0.3211
Epoch 4/5
37500/37500 [==============================] - 8s 224us/sample - loss: 1.9461 -
sparse_categorical_accuracy: 0.3387 - val_loss: 1.9182 -
val_sparse_categorical_accuracy: 0.3437
Epoch 5/5
37500/37500 [==============================] - 8s 220us/sample - loss: 1.8779 -
```

```
sparse_categorical_accuracy: 0.3594 - val_loss: 1.8647 -
val_sparse_categorical_accuracy: 0.3563

 97%|     | 97/100 [58:49<02:19, 46.48s/it]

0.35632 0.00042680709537345796 0.00014645204312502708
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 10s 275us/sample - loss: 5.0965 -
sparse_categorical_accuracy: 0.1421 - val_loss: 5.0270 -
val_sparse_categorical_accuracy: 0.1989
Epoch 2/5
37500/37500 [==============================] - 8s 220us/sample - loss: 4.9450 -
sparse_categorical_accuracy: 0.2411 - val_loss: 4.8630 -
val_sparse_categorical_accuracy: 0.2688
Epoch 3/5
37500/37500 [==============================] - 8s 223us/sample - loss: 4.7661 -
sparse_categorical_accuracy: 0.2957 - val_loss: 4.6901 -
val_sparse_categorical_accuracy: 0.3037
Epoch 4/5
37500/37500 [==============================] - 8s 220us/sample - loss: 4.6109 -
sparse_categorical_accuracy: 0.3298 - val_loss: 4.5575 -
val_sparse_categorical_accuracy: 0.3381
Epoch 5/5
37500/37500 [==============================] - 8s 222us/sample - loss: 4.4890 -
sparse_categorical_accuracy: 0.3540 - val_loss: 4.4500 -
val_sparse_categorical_accuracy: 0.3557

 98%|     | 98/100 [59:36<01:33, 46.62s/it]

0.35568 0.00046970090517299394 0.007702287836289637
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 11s 280us/sample - loss:
1074.5076 - sparse_categorical_accuracy: 0.1013 - val_loss: 1062.8932 -
val_sparse_categorical_accuracy: 0.0981
Epoch 2/5
37500/37500 [==============================] - 8s 221us/sample - loss: 1051.4601
- sparse_categorical_accuracy: 0.1014 - val_loss: 1040.0958 -
val_sparse_categorical_accuracy: 0.0982
Epoch 3/5
37500/37500 [==============================] - 8s 222us/sample - loss: 1028.9089
- sparse_categorical_accuracy: 0.1016 - val_loss: 1017.7890 -
val_sparse_categorical_accuracy: 0.0984
Epoch 4/5
37500/37500 [==============================] - 8s 220us/sample - loss: 1006.8429
- sparse_categorical_accuracy: 0.1020 - val_loss: 995.9622 -
val_sparse_categorical_accuracy: 0.0982
Epoch 5/5
37500/37500 [==============================] - 8s 224us/sample - loss: 985.2518
```

```
- sparse_categorical_accuracy: 0.1023 - val_loss: 974.6052 -
val_sparse_categorical_accuracy: 0.0986

 99%|      | 99/100 [1:00:23<00:46, 46.81s/it]

0.09856 1.576927782278241e-06 2.938548805630909
Train on 37500 samples, validate on 12500 samples
Epoch 1/5
37500/37500 [==============================] - 10s 277us/sample - loss: 2.2943 -
sparse_categorical_accuracy: 0.1235 - val_loss: 2.2750 -
val_sparse_categorical_accuracy: 0.1352
Epoch 2/5
37500/37500 [==============================] - 8s 224us/sample - loss: 2.2587 -
sparse_categorical_accuracy: 0.1588 - val_loss: 2.2427 -
val_sparse_categorical_accuracy: 0.1782
Epoch 3/5
37500/37500 [==============================] - 8s 226us/sample - loss: 2.2229 -
sparse_categorical_accuracy: 0.2040 - val_loss: 2.2032 -
val_sparse_categorical_accuracy: 0.2296
Epoch 4/5
37500/37500 [==============================] - 8s 224us/sample - loss: 2.1776 -
sparse_categorical_accuracy: 0.2541 - val_loss: 2.1527 -
val_sparse_categorical_accuracy: 0.2642
Epoch 5/5
37500/37500 [==============================] - 9s 227us/sample - loss: 2.1209 -
sparse_categorical_accuracy: 0.2790 - val_loss: 2.0924 -
val_sparse_categorical_accuracy: 0.2890

100%|      | 100/100 [1:01:11<00:00, 36.71s/it]

0.28904 0.0001900990978557527 1.3054353604719474e-05
```

[34]:
```
logs=[val_acc,lrs, l2_regs]
logs=np.array(logs)
# logs=np.sort(logs,axis=0)
```

[35]:
```
top10=np.argsort(logs[0,:])[::-1][:10]
top10
```

[35]:
```
array([68,  0, 30, 39, 79, 81, 96, 97, 73,  4], dtype=int64)
```

[36]:
```
logs[:,top10]
```

[36]:
```
array([[4.37680006e-01, 4.35600013e-01, 4.16079998e-01, 3.89519989e-01,
        3.69760007e-01, 3.60960007e-01, 3.56319994e-01, 3.55679989e-01,
        3.52560014e-01, 3.45360011e-01],
       [9.69503562e-04, 9.64651669e-04, 7.81986128e-04, 6.58787173e-04,
        5.93430096e-04, 4.75272040e-04, 4.26807095e-04, 4.69700905e-04,
```

```
 3.83862909e-04, 3.84184800e-04],
[6.37996507e-03, 3.95851376e-05, 7.01391913e-03, 7.79256949e-03,
 2.70961933e-02, 7.53769585e-05, 1.46452043e-04, 7.70228784e-03,
 1.19792868e-03, 8.24862764e-04]])
```

**Fine Search** We restrict the fine search to the smaller range and train for 15 epochs.

[37]:
```
val_acc=[]
lrs=[]
l2_regs=[]
for i in tqdm(range(30)):
    lr = 10**np.random.uniform(-3,-4)
    l2_reg = 10**np.random.uniform(-6, -2)
    model = create_model(num_classes,l2_reg)
    model.compile(optimizer=optimizers.
 ↪SGD(learning_rate=lr),loss='sparse_categorical_crossentropy',metrics=['sparse_categorical_a
    history = model.fit(X_train,y_train,batch_size=BATCH_SIZE,epochs=15,␣
 ↪verbose=1,validation_data=(X_val,y_val))
    val_acc.append(history.history['val_sparse_categorical_accuracy'][-1])
    lrs.append(lr)
    l2_regs.append(l2_reg)
    print(history.history['val_sparse_categorical_accuracy'][-1], lr, l2_reg)
```

```
  0%|          | 0/30 [00:00<?, ?it/s]
Train on 37500 samples, validate on 12500 samples
Epoch 1/15
37500/37500 [==============================] - 11s 282us/sample - loss: 2.9799 -
sparse_categorical_accuracy: 0.1231 - val_loss: 2.9437 -
val_sparse_categorical_accuracy: 0.1595
Epoch 2/15
37500/37500 [==============================] - 8s 225us/sample - loss: 2.9202 -
sparse_categorical_accuracy: 0.1755 - val_loss: 2.8953 -
val_sparse_categorical_accuracy: 0.2074
Epoch 3/15
37500/37500 [==============================] - 8s 226us/sample - loss: 2.8696 -
sparse_categorical_accuracy: 0.2220 - val_loss: 2.8453 -
val_sparse_categorical_accuracy: 0.2490
Epoch 4/15
37500/37500 [==============================] - 8s 224us/sample - loss: 2.8156 -
sparse_categorical_accuracy: 0.2556 - val_loss: 2.7909 -
val_sparse_categorical_accuracy: 0.2626
Epoch 5/15
37500/37500 [==============================] - 8s 226us/sample - loss: 2.7583 -
sparse_categorical_accuracy: 0.2783 - val_loss: 2.7351 -
val_sparse_categorical_accuracy: 0.2842
Epoch 6/15
```

```
37500/37500 [==============================] - 8s 225us/sample - loss: 2.7020 -
sparse_categorical_accuracy: 0.2987 - val_loss: 2.6813 -
val_sparse_categorical_accuracy: 0.3005
Epoch 7/15
37500/37500 [==============================] - 8s 227us/sample - loss: 2.6496 -
sparse_categorical_accuracy: 0.3187 - val_loss: 2.6322 -
val_sparse_categorical_accuracy: 0.3146
Epoch 8/15
37500/37500 [==============================] - 8s 225us/sample - loss: 2.6021 -
sparse_categorical_accuracy: 0.3339 - val_loss: 2.5872 -
val_sparse_categorical_accuracy: 0.3362
Epoch 9/15
37500/37500 [==============================] - 9s 227us/sample - loss: 2.5589 -
sparse_categorical_accuracy: 0.3489 - val_loss: 2.5467 -
val_sparse_categorical_accuracy: 0.3470
Epoch 10/15
37500/37500 [==============================] - 9s 228us/sample - loss: 2.5196 -
sparse_categorical_accuracy: 0.3603 - val_loss: 2.5094 -
val_sparse_categorical_accuracy: 0.3586
Epoch 11/15
37500/37500 [==============================] - 8s 225us/sample - loss: 2.4837 -
sparse_categorical_accuracy: 0.3709 - val_loss: 2.4742 -
val_sparse_categorical_accuracy: 0.3727
Epoch 12/15
37500/37500 [==============================] - 9s 227us/sample - loss: 2.4500 -
sparse_categorical_accuracy: 0.3802 - val_loss: 2.4429 -
val_sparse_categorical_accuracy: 0.3826
Epoch 13/15
37500/37500 [==============================] - 8s 224us/sample - loss: 2.4188 -
sparse_categorical_accuracy: 0.3889 - val_loss: 2.4145 -
val_sparse_categorical_accuracy: 0.3872
Epoch 14/15
37500/37500 [==============================] - 8s 227us/sample - loss: 2.3899 -
sparse_categorical_accuracy: 0.3981 - val_loss: 2.3841 -
val_sparse_categorical_accuracy: 0.4002
Epoch 15/15
37500/37500 [==============================] - 8s 226us/sample - loss: 2.3627 -
sparse_categorical_accuracy: 0.4072 - val_loss: 2.3600 -
val_sparse_categorical_accuracy: 0.4055

  3%|          | 1/30 [02:12<1:04:03, 132.55s/it]

0.40552 0.00020643142573058333 0.001871218618092688
Train on 37500 samples, validate on 12500 samples
Epoch 1/15
37500/37500 [==============================] - 10s 278us/sample - loss: 2.2933 -
sparse_categorical_accuracy: 0.1251 - val_loss: 2.2721 -
val_sparse_categorical_accuracy: 0.1587
Epoch 2/15
```

```
37500/37500 [==============================] - 9s 229us/sample - loss: 2.2545 -
sparse_categorical_accuracy: 0.1907 - val_loss: 2.2379 -
val_sparse_categorical_accuracy: 0.2083
Epoch 3/15
37500/37500 [==============================] - 8s 225us/sample - loss: 2.2186 -
sparse_categorical_accuracy: 0.2250 - val_loss: 2.2015 -
val_sparse_categorical_accuracy: 0.2354
Epoch 4/15
37500/37500 [==============================] - 9s 229us/sample - loss: 2.1787 -
sparse_categorical_accuracy: 0.2470 - val_loss: 2.1604 -
val_sparse_categorical_accuracy: 0.2475
Epoch 5/15
37500/37500 [==============================] - 8s 226us/sample - loss: 2.1346 -
sparse_categorical_accuracy: 0.2613 - val_loss: 2.1165 -
val_sparse_categorical_accuracy: 0.2628
Epoch 6/15
37500/37500 [==============================] - 9s 228us/sample - loss: 2.0891 -
sparse_categorical_accuracy: 0.2732 - val_loss: 2.0726 -
val_sparse_categorical_accuracy: 0.2734
Epoch 7/15
37500/37500 [==============================] - 9s 227us/sample - loss: 2.0450 -
sparse_categorical_accuracy: 0.2850 - val_loss: 2.0304 -
val_sparse_categorical_accuracy: 0.2883
Epoch 8/15
37500/37500 [==============================] - 9s 228us/sample - loss: 2.0034 -
sparse_categorical_accuracy: 0.2981 - val_loss: 1.9909 -
val_sparse_categorical_accuracy: 0.2982
Epoch 9/15
37500/37500 [==============================] - 9s 227us/sample - loss: 1.9642 -
sparse_categorical_accuracy: 0.3092 - val_loss: 1.9539 -
val_sparse_categorical_accuracy: 0.3083
Epoch 10/15
37500/37500 [==============================] - 9s 228us/sample - loss: 1.9282 -
sparse_categorical_accuracy: 0.3211 - val_loss: 1.9201 -
val_sparse_categorical_accuracy: 0.3174
Epoch 11/15
37500/37500 [==============================] - 9s 228us/sample - loss: 1.8954 -
sparse_categorical_accuracy: 0.3304 - val_loss: 1.8895 -
val_sparse_categorical_accuracy: 0.3301
Epoch 12/15
37500/37500 [==============================] - 9s 229us/sample - loss: 1.8661 -
sparse_categorical_accuracy: 0.3398 - val_loss: 1.8625 -
val_sparse_categorical_accuracy: 0.3379
Epoch 13/15
37500/37500 [==============================] - 8s 226us/sample - loss: 1.8400 -
sparse_categorical_accuracy: 0.3486 - val_loss: 1.8387 -
val_sparse_categorical_accuracy: 0.3438
Epoch 14/15
```

```
37500/37500 [==============================] - 9s 229us/sample - loss: 1.8172 -
sparse_categorical_accuracy: 0.3550 - val_loss: 1.8187 -
val_sparse_categorical_accuracy: 0.3492
Epoch 15/15
37500/37500 [==============================] - 9s 231us/sample - loss: 1.7968 -
sparse_categorical_accuracy: 0.3625 - val_loss: 1.7993 -
val_sparse_categorical_accuracy: 0.3587
  7%|         | 2/30 [04:26<1:02:00, 132.88s/it]
0.35872 0.0001379731871274599 4.472154530294427e-06
Train on 37500 samples, validate on 12500 samples
Epoch 1/15
37500/37500 [==============================] - 10s 280us/sample - loss: 4.2647 -
sparse_categorical_accuracy: 0.1196 - val_loss: 4.2503 -
val_sparse_categorical_accuracy: 0.1366
Epoch 2/15
37500/37500 [==============================] - 8s 225us/sample - loss: 4.2361 -
sparse_categorical_accuracy: 0.1405 - val_loss: 4.2231 -
val_sparse_categorical_accuracy: 0.1529
Epoch 3/15
37500/37500 [==============================] - 8s 223us/sample - loss: 4.2090 -
sparse_categorical_accuracy: 0.1601 - val_loss: 4.1961 -
val_sparse_categorical_accuracy: 0.1726
Epoch 4/15
37500/37500 [==============================] - 8s 225us/sample - loss: 4.1811 -
sparse_categorical_accuracy: 0.1818 - val_loss: 4.1677 -
val_sparse_categorical_accuracy: 0.1960
Epoch 5/15
37500/37500 [==============================] - 9s 228us/sample - loss: 4.1513 -
sparse_categorical_accuracy: 0.2078 - val_loss: 4.1370 -
val_sparse_categorical_accuracy: 0.2240
Epoch 6/15
37500/37500 [==============================] - 8s 223us/sample - loss: 4.1190 -
sparse_categorical_accuracy: 0.2334 - val_loss: 4.1040 -
val_sparse_categorical_accuracy: 0.2435
Epoch 7/15
37500/37500 [==============================] - 8s 226us/sample - loss: 4.0844 -
sparse_categorical_accuracy: 0.2505 - val_loss: 4.0692 -
val_sparse_categorical_accuracy: 0.2608
Epoch 8/15
37500/37500 [==============================] - 8s 224us/sample - loss: 4.0483 -
sparse_categorical_accuracy: 0.2661 - val_loss: 4.0337 -
val_sparse_categorical_accuracy: 0.2702
Epoch 9/15
37500/37500 [==============================] - 8s 225us/sample - loss: 4.0120 -
sparse_categorical_accuracy: 0.2767 - val_loss: 3.9984 -
val_sparse_categorical_accuracy: 0.2770
Epoch 10/15
```

```
37500/37500 [==============================] - 8s 223us/sample - loss: 3.9764 -
sparse_categorical_accuracy: 0.2869 - val_loss: 3.9644 -
val_sparse_categorical_accuracy: 0.2846
Epoch 11/15
37500/37500 [==============================] - 8s 226us/sample - loss: 3.9425 -
sparse_categorical_accuracy: 0.2946 - val_loss: 3.9324 -
val_sparse_categorical_accuracy: 0.2954
Epoch 12/15
37500/37500 [==============================] - 8s 224us/sample - loss: 3.9104 -
sparse_categorical_accuracy: 0.3014 - val_loss: 3.9021 -
val_sparse_categorical_accuracy: 0.3034
Epoch 13/15
37500/37500 [==============================] - 8s 226us/sample - loss: 3.8802 -
sparse_categorical_accuracy: 0.3107 - val_loss: 3.8730 -
val_sparse_categorical_accuracy: 0.3129
Epoch 14/15
37500/37500 [==============================] - 8s 223us/sample - loss: 3.8511 -
sparse_categorical_accuracy: 0.3193 - val_loss: 3.8452 -
val_sparse_categorical_accuracy: 0.3188
Epoch 15/15
37500/37500 [==============================] - 8s 226us/sample - loss: 3.8234 -
sparse_categorical_accuracy: 0.3263 - val_loss: 3.8186 -
val_sparse_categorical_accuracy: 0.3289

 10%|          | 3/30 [06:38<59:41, 132.64s/it]

0.32888 0.00010878348094758827 0.0053521845038395
Train on 37500 samples, validate on 12500 samples
Epoch 1/15
37500/37500 [==============================] - 11s 283us/sample - loss: 2.3818 -
sparse_categorical_accuracy: 0.1175 - val_loss: 2.3617 -
val_sparse_categorical_accuracy: 0.1402
Epoch 2/15
37500/37500 [==============================] - 9s 227us/sample - loss: 2.3464 -
sparse_categorical_accuracy: 0.1608 - val_loss: 2.3362 -
val_sparse_categorical_accuracy: 0.1764
Epoch 3/15
37500/37500 [==============================] - 9s 229us/sample - loss: 2.3210 -
sparse_categorical_accuracy: 0.1892 - val_loss: 2.3113 -
val_sparse_categorical_accuracy: 0.1992
Epoch 4/15
37500/37500 [==============================] - 9s 228us/sample - loss: 2.2940 -
sparse_categorical_accuracy: 0.2128 - val_loss: 2.2835 -
val_sparse_categorical_accuracy: 0.2238
Epoch 5/15
37500/37500 [==============================] - 9s 229us/sample - loss: 2.2631 -
sparse_categorical_accuracy: 0.2339 - val_loss: 2.2516 -
val_sparse_categorical_accuracy: 0.2443
Epoch 6/15
```

```
37500/37500 [==============================] - 8s 226us/sample - loss: 2.2283 -
sparse_categorical_accuracy: 0.2526 - val_loss: 2.2165 -
val_sparse_categorical_accuracy: 0.2542
Epoch 7/15
37500/37500 [==============================] - 9s 228us/sample - loss: 2.1912 -
sparse_categorical_accuracy: 0.2657 - val_loss: 2.1800 -
val_sparse_categorical_accuracy: 0.2659
Epoch 8/15
37500/37500 [==============================] - 9s 227us/sample - loss: 2.1546 -
sparse_categorical_accuracy: 0.2728 - val_loss: 2.1455 -
val_sparse_categorical_accuracy: 0.2722
Epoch 9/15
37500/37500 [==============================] - 9s 230us/sample - loss: 2.1206 -
sparse_categorical_accuracy: 0.2793 - val_loss: 2.1136 -
val_sparse_categorical_accuracy: 0.2789
Epoch 10/15
37500/37500 [==============================] - 9s 228us/sample - loss: 2.0899 -
sparse_categorical_accuracy: 0.2869 - val_loss: 2.0849 -
val_sparse_categorical_accuracy: 0.2866
Epoch 11/15
37500/37500 [==============================] - 9s 229us/sample - loss: 2.0619 -
sparse_categorical_accuracy: 0.2949 - val_loss: 2.0578 -
val_sparse_categorical_accuracy: 0.2945
Epoch 12/15
37500/37500 [==============================] - 9s 230us/sample - loss: 2.0358 -
sparse_categorical_accuracy: 0.3021 - val_loss: 2.0327 -
val_sparse_categorical_accuracy: 0.3019
Epoch 13/15
37500/37500 [==============================] - 9s 227us/sample - loss: 2.0111 -
sparse_categorical_accuracy: 0.3112 - val_loss: 2.0085 -
val_sparse_categorical_accuracy: 0.3108
Epoch 14/15
37500/37500 [==============================] - 9s 229us/sample - loss: 1.9877 -
sparse_categorical_accuracy: 0.3214 - val_loss: 1.9856 -
val_sparse_categorical_accuracy: 0.3186
Epoch 15/15
37500/37500 [==============================] - 9s 228us/sample - loss: 1.9650 -
sparse_categorical_accuracy: 0.3311 - val_loss: 1.9635 -
val_sparse_categorical_accuracy: 0.3299

 13%|         | 4/30 [08:52<57:39, 133.05s/it]

0.32992 0.00014883211102093542 0.00019326261416182947
Train on 37500 samples, validate on 12500 samples
Epoch 1/15
37500/37500 [==============================] - 11s 281us/sample - loss: 2.3377 -
sparse_categorical_accuracy: 0.1498 - val_loss: 2.2977 -
val_sparse_categorical_accuracy: 0.2046
Epoch 2/15
```

```
37500/37500 [==============================] - 9s 240us/sample - loss: 2.2503 -
sparse_categorical_accuracy: 0.2414 - val_loss: 2.2038 -
val_sparse_categorical_accuracy: 0.2548
Epoch 3/15
37500/37500 [==============================] - 9s 233us/sample - loss: 2.1424 -
sparse_categorical_accuracy: 0.2776 - val_loss: 2.0936 -
val_sparse_categorical_accuracy: 0.2864
Epoch 4/15
37500/37500 [==============================] - 8s 226us/sample - loss: 2.0363 -
sparse_categorical_accuracy: 0.3078 - val_loss: 1.9992 -
val_sparse_categorical_accuracy: 0.3170
Epoch 5/15
37500/37500 [==============================] - 8s 224us/sample - loss: 1.9503 -
sparse_categorical_accuracy: 0.3348 - val_loss: 1.9261 -
val_sparse_categorical_accuracy: 0.3405
Epoch 6/15
37500/37500 [==============================] - 8s 226us/sample - loss: 1.8852 -
sparse_categorical_accuracy: 0.3553 - val_loss: 1.8722 -
val_sparse_categorical_accuracy: 0.3582
Epoch 7/15
37500/37500 [==============================] - 8s 224us/sample - loss: 1.8316 -
sparse_categorical_accuracy: 0.3739 - val_loss: 1.8221 -
val_sparse_categorical_accuracy: 0.3765
Epoch 8/15
37500/37500 [==============================] - 8s 226us/sample - loss: 1.7827 -
sparse_categorical_accuracy: 0.3907 - val_loss: 1.7766 -
val_sparse_categorical_accuracy: 0.3894
Epoch 9/15
37500/37500 [==============================] - 8s 224us/sample - loss: 1.7374 -
sparse_categorical_accuracy: 0.4060 - val_loss: 1.7356 -
val_sparse_categorical_accuracy: 0.4044
Epoch 10/15
37500/37500 [==============================] - 9s 227us/sample - loss: 1.6954 -
sparse_categorical_accuracy: 0.4204 - val_loss: 1.6955 -
val_sparse_categorical_accuracy: 0.4182
Epoch 11/15
37500/37500 [==============================] - 8s 224us/sample - loss: 1.6552 -
sparse_categorical_accuracy: 0.4357 - val_loss: 1.6620 -
val_sparse_categorical_accuracy: 0.4297
Epoch 12/15
37500/37500 [==============================] - 8s 226us/sample - loss: 1.6192 -
sparse_categorical_accuracy: 0.4479 - val_loss: 1.6252 -
val_sparse_categorical_accuracy: 0.4407
Epoch 13/15
37500/37500 [==============================] - 8s 224us/sample - loss: 1.5864 -
sparse_categorical_accuracy: 0.4604 - val_loss: 1.5940 -
val_sparse_categorical_accuracy: 0.4526
Epoch 14/15
```

```
37500/37500 [==============================] - 8s 226us/sample - loss: 1.5565 -
sparse_categorical_accuracy: 0.4704 - val_loss: 1.5667 -
val_sparse_categorical_accuracy: 0.4593
Epoch 15/15
37500/37500 [==============================] - 8s 227us/sample - loss: 1.5302 -
sparse_categorical_accuracy: 0.4792 - val_loss: 1.5432 -
val_sparse_categorical_accuracy: 0.4698
 17%|         | 5/30 [11:05<55:27, 133.12s/it]
0.46984 0.0003965815057752119 0.00015638464086035125
Train on 37500 samples, validate on 12500 samples
Epoch 1/15
37500/37500 [==============================] - 11s 288us/sample - loss: 2.3220 -
sparse_categorical_accuracy: 0.1911 - val_loss: 2.2479 -
val_sparse_categorical_accuracy: 0.2516
Epoch 2/15
37500/37500 [==============================] - 9s 231us/sample - loss: 2.1500 -
sparse_categorical_accuracy: 0.2856 - val_loss: 2.0774 -
val_sparse_categorical_accuracy: 0.2997
Epoch 3/15
37500/37500 [==============================] - 9s 231us/sample - loss: 2.0005 -
sparse_categorical_accuracy: 0.3271 - val_loss: 1.9558 -
val_sparse_categorical_accuracy: 0.3366
Epoch 4/15
37500/37500 [==============================] - 9s 230us/sample - loss: 1.8961 -
sparse_categorical_accuracy: 0.3585 - val_loss: 1.8691 -
val_sparse_categorical_accuracy: 0.3671
Epoch 5/15
37500/37500 [==============================] - 9s 232us/sample - loss: 1.8179 -
sparse_categorical_accuracy: 0.3846 - val_loss: 1.8007 -
val_sparse_categorical_accuracy: 0.3866
Epoch 6/15
37500/37500 [==============================] - 9s 229us/sample - loss: 1.7518 -
sparse_categorical_accuracy: 0.4070 - val_loss: 1.7420 -
val_sparse_categorical_accuracy: 0.4102
Epoch 7/15
37500/37500 [==============================] - 9s 230us/sample - loss: 1.6962 -
sparse_categorical_accuracy: 0.4274 - val_loss: 1.6986 -
val_sparse_categorical_accuracy: 0.4287
Epoch 8/15
37500/37500 [==============================] - 9s 228us/sample - loss: 1.6489 -
sparse_categorical_accuracy: 0.4401 - val_loss: 1.6493 -
val_sparse_categorical_accuracy: 0.4468
Epoch 9/15
37500/37500 [==============================] - 9s 231us/sample - loss: 1.6091 -
sparse_categorical_accuracy: 0.4569 - val_loss: 1.6179 -
val_sparse_categorical_accuracy: 0.4518
Epoch 10/15
```

```
37500/37500 [==============================] - 9s 229us/sample - loss: 1.5748 -
sparse_categorical_accuracy: 0.4697 - val_loss: 1.5927 -
val_sparse_categorical_accuracy: 0.4641
Epoch 11/15
37500/37500 [==============================] - 9s 231us/sample - loss: 1.5453 -
sparse_categorical_accuracy: 0.4811 - val_loss: 1.5576 -
val_sparse_categorical_accuracy: 0.4765
Epoch 12/15
37500/37500 [==============================] - 9s 234us/sample - loss: 1.5179 -
sparse_categorical_accuracy: 0.4922 - val_loss: 1.5413 -
val_sparse_categorical_accuracy: 0.4769
Epoch 13/15
37500/37500 [==============================] - 10s 263us/sample - loss: 1.4910 -
sparse_categorical_accuracy: 0.5020 - val_loss: 1.5110 -
val_sparse_categorical_accuracy: 0.4967
Epoch 14/15
37500/37500 [==============================] - 10s 268us/sample - loss: 1.4668 -
sparse_categorical_accuracy: 0.5111 - val_loss: 1.4929 -
val_sparse_categorical_accuracy: 0.4974
Epoch 15/15
37500/37500 [==============================] - 10s 267us/sample - loss: 1.4439 -
sparse_categorical_accuracy: 0.5200 - val_loss: 1.4598 -
val_sparse_categorical_accuracy: 0.5121

 20%|         | 6/30 [13:25<54:01, 135.08s/it]

0.51208 0.0006306066624663469 0.0002812495612976386
Train on 37500 samples, validate on 12500 samples
Epoch 1/15
37500/37500 [==============================] - 11s 289us/sample - loss: 5.7919 -
sparse_categorical_accuracy: 0.1662 - val_loss: 5.7240 -
val_sparse_categorical_accuracy: 0.2119
Epoch 2/15
37500/37500 [==============================] - 9s 231us/sample - loss: 5.6488 -
sparse_categorical_accuracy: 0.2309 - val_loss: 5.5723 -
val_sparse_categorical_accuracy: 0.2437
Epoch 3/15
37500/37500 [==============================] - 9s 231us/sample - loss: 5.4853 -
sparse_categorical_accuracy: 0.2609 - val_loss: 5.4086 -
val_sparse_categorical_accuracy: 0.2738
Epoch 4/15
37500/37500 [==============================] - 9s 232us/sample - loss: 5.3276 -
sparse_categorical_accuracy: 0.2926 - val_loss: 5.2622 -
val_sparse_categorical_accuracy: 0.3090
Epoch 5/15
37500/37500 [==============================] - 9s 230us/sample - loss: 5.1914 -
sparse_categorical_accuracy: 0.3211 - val_loss: 5.1399 -
val_sparse_categorical_accuracy: 0.3306
Epoch 6/15
```

```
37500/37500 [==============================] - 9s 232us/sample - loss: 5.0754 -
sparse_categorical_accuracy: 0.3432 - val_loss: 5.0322 -
val_sparse_categorical_accuracy: 0.3470
Epoch 7/15
37500/37500 [==============================] - 9s 230us/sample - loss: 4.9714 -
sparse_categorical_accuracy: 0.3629 - val_loss: 4.9356 -
val_sparse_categorical_accuracy: 0.3630
Epoch 8/15
37500/37500 [==============================] - 9s 232us/sample - loss: 4.8746 -
sparse_categorical_accuracy: 0.3784 - val_loss: 4.8396 -
val_sparse_categorical_accuracy: 0.3810
Epoch 9/15
37500/37500 [==============================] - 9s 230us/sample - loss: 4.7831 -
sparse_categorical_accuracy: 0.3923 - val_loss: 4.7521 -
val_sparse_categorical_accuracy: 0.3928
Epoch 10/15
37500/37500 [==============================] - 9s 232us/sample - loss: 4.6960 -
sparse_categorical_accuracy: 0.4055 - val_loss: 4.6688 -
val_sparse_categorical_accuracy: 0.4037
Epoch 11/15
37500/37500 [==============================] - 9s 236us/sample - loss: 4.6123 -
sparse_categorical_accuracy: 0.4181 - val_loss: 4.5843 -
val_sparse_categorical_accuracy: 0.4174
Epoch 12/15
37500/37500 [==============================] - 9s 231us/sample - loss: 4.5325 -
sparse_categorical_accuracy: 0.4277 - val_loss: 4.5068 -
val_sparse_categorical_accuracy: 0.4281
Epoch 13/15
37500/37500 [==============================] - 9s 233us/sample - loss: 4.4561 -
sparse_categorical_accuracy: 0.4386 - val_loss: 4.4329 -
val_sparse_categorical_accuracy: 0.4380
Epoch 14/15
37500/37500 [==============================] - 9s 230us/sample - loss: 4.3835 -
sparse_categorical_accuracy: 0.4488 - val_loss: 4.3629 -
val_sparse_categorical_accuracy: 0.4446
Epoch 15/15
37500/37500 [==============================] - 9s 232us/sample - loss: 4.3130 -
sparse_categorical_accuracy: 0.4589 - val_loss: 4.2967 -
val_sparse_categorical_accuracy: 0.4546

 23%|         | 7/30 [15:41<51:54, 135.42s/it]

0.45464 0.0003944376356556536 0.009558787384341984
Train on 37500 samples, validate on 12500 samples
Epoch 1/15
37500/37500 [==============================] - 11s 288us/sample - loss: 2.2741 -
sparse_categorical_accuracy: 0.1520 - val_loss: 2.2218 -
val_sparse_categorical_accuracy: 0.2125
Epoch 2/15
```

```
37500/37500 [==============================] - 9s 229us/sample - loss: 2.1531 -
sparse_categorical_accuracy: 0.2539 - val_loss: 2.0893 -
val_sparse_categorical_accuracy: 0.2789
Epoch 3/15
37500/37500 [==============================] - 9s 231us/sample - loss: 2.0174 -
sparse_categorical_accuracy: 0.3012 - val_loss: 1.9667 -
val_sparse_categorical_accuracy: 0.3202
Epoch 4/15
37500/37500 [==============================] - 9s 229us/sample - loss: 1.9112 -
sparse_categorical_accuracy: 0.3344 - val_loss: 1.8792 -
val_sparse_categorical_accuracy: 0.3376
Epoch 5/15
37500/37500 [==============================] - 9s 230us/sample - loss: 1.8364 -
sparse_categorical_accuracy: 0.3554 - val_loss: 1.8163 -
val_sparse_categorical_accuracy: 0.3637
Epoch 6/15
37500/37500 [==============================] - 9s 228us/sample - loss: 1.7753 -
sparse_categorical_accuracy: 0.3772 - val_loss: 1.7562 -
val_sparse_categorical_accuracy: 0.3864
Epoch 7/15
37500/37500 [==============================] - 9s 231us/sample - loss: 1.7203 -
sparse_categorical_accuracy: 0.3959 - val_loss: 1.7094 -
val_sparse_categorical_accuracy: 0.4003
Epoch 8/15
37500/37500 [==============================] - 9s 229us/sample - loss: 1.6697 -
sparse_categorical_accuracy: 0.4118 - val_loss: 1.6596 -
val_sparse_categorical_accuracy: 0.4102
Epoch 9/15
37500/37500 [==============================] - 9s 231us/sample - loss: 1.6232 -
sparse_categorical_accuracy: 0.4273 - val_loss: 1.6150 -
val_sparse_categorical_accuracy: 0.4315
Epoch 10/15
37500/37500 [==============================] - 9s 234us/sample - loss: 1.5814 -
sparse_categorical_accuracy: 0.4429 - val_loss: 1.5739 -
val_sparse_categorical_accuracy: 0.4458
Epoch 11/15
37500/37500 [==============================] - 9s 229us/sample - loss: 1.5445 -
sparse_categorical_accuracy: 0.4578 - val_loss: 1.5425 -
val_sparse_categorical_accuracy: 0.4538
Epoch 12/15
37500/37500 [==============================] - 9s 232us/sample - loss: 1.5126 -
sparse_categorical_accuracy: 0.4672 - val_loss: 1.5147 -
val_sparse_categorical_accuracy: 0.4642
Epoch 13/15
37500/37500 [==============================] - 9s 229us/sample - loss: 1.4843 -
sparse_categorical_accuracy: 0.4794 - val_loss: 1.4911 -
val_sparse_categorical_accuracy: 0.4720
Epoch 14/15
```

```
37500/37500 [==============================] - 9s 231us/sample - loss: 1.4587 -
sparse_categorical_accuracy: 0.4859 - val_loss: 1.4649 -
val_sparse_categorical_accuracy: 0.4801
Epoch 15/15
37500/37500 [==============================] - 9s 229us/sample - loss: 1.4353 -
sparse_categorical_accuracy: 0.4958 - val_loss: 1.4570 -
val_sparse_categorical_accuracy: 0.4796
 27%|         | 8/30 [17:56<49:39, 135.42s/it]
0.4796 0.0004905824819956708 3.980777817099539e-05
Train on 37500 samples, validate on 12500 samples
Epoch 1/15
37500/37500 [==============================] - 11s 291us/sample - loss: 2.2882 -
sparse_categorical_accuracy: 0.1546 - val_loss: 2.2629 -
val_sparse_categorical_accuracy: 0.1946
Epoch 2/15
37500/37500 [==============================] - 9s 227us/sample - loss: 2.2411 -
sparse_categorical_accuracy: 0.2156 - val_loss: 2.2200 -
val_sparse_categorical_accuracy: 0.2321
Epoch 3/15
37500/37500 [==============================] - 8s 225us/sample - loss: 2.1941 -
sparse_categorical_accuracy: 0.2488 - val_loss: 2.1694 -
val_sparse_categorical_accuracy: 0.2496
Epoch 4/15
37500/37500 [==============================] - 9s 227us/sample - loss: 2.1383 -
sparse_categorical_accuracy: 0.2639 - val_loss: 2.1122 -
val_sparse_categorical_accuracy: 0.2645
Epoch 5/15
37500/37500 [==============================] - 8s 226us/sample - loss: 2.0802 -
sparse_categorical_accuracy: 0.2754 - val_loss: 2.0576 -
val_sparse_categorical_accuracy: 0.2765
Epoch 6/15
37500/37500 [==============================] - 9s 228us/sample - loss: 2.0274 -
sparse_categorical_accuracy: 0.2886 - val_loss: 2.0092 -
val_sparse_categorical_accuracy: 0.2902
Epoch 7/15
37500/37500 [==============================] - 8s 226us/sample - loss: 1.9800 -
sparse_categorical_accuracy: 0.3025 - val_loss: 1.9664 -
val_sparse_categorical_accuracy: 0.3066
Epoch 8/15
37500/37500 [==============================] - 9s 228us/sample - loss: 1.9371 -
sparse_categorical_accuracy: 0.3162 - val_loss: 1.9257 -
val_sparse_categorical_accuracy: 0.3171
Epoch 9/15
37500/37500 [==============================] - 9s 227us/sample - loss: 1.8974 -
sparse_categorical_accuracy: 0.3290 - val_loss: 1.8894 -
val_sparse_categorical_accuracy: 0.3286
Epoch 10/15
```

```
37500/37500 [==============================] - 9s 228us/sample - loss: 1.8617 -
sparse_categorical_accuracy: 0.3424 - val_loss: 1.8568 -
val_sparse_categorical_accuracy: 0.3388
Epoch 11/15
37500/37500 [==============================] - 8s 226us/sample - loss: 1.8292 -
sparse_categorical_accuracy: 0.3528 - val_loss: 1.8268 -
val_sparse_categorical_accuracy: 0.3471
Epoch 12/15
37500/37500 [==============================] - 9s 228us/sample - loss: 1.7988 -
sparse_categorical_accuracy: 0.3647 - val_loss: 1.7982 -
val_sparse_categorical_accuracy: 0.3579
Epoch 13/15
37500/37500 [==============================] - 9s 229us/sample - loss: 1.7703 -
sparse_categorical_accuracy: 0.3741 - val_loss: 1.7712 -
val_sparse_categorical_accuracy: 0.3664
Epoch 14/15
37500/37500 [==============================] - 9s 227us/sample - loss: 1.7430 -
sparse_categorical_accuracy: 0.3833 - val_loss: 1.7453 -
val_sparse_categorical_accuracy: 0.3807
Epoch 15/15
37500/37500 [==============================] - 9s 230us/sample - loss: 1.7168 -
sparse_categorical_accuracy: 0.3925 - val_loss: 1.7210 -
val_sparse_categorical_accuracy: 0.3862

 30%|         | 9/30 [20:10<47:14, 134.96s/it]

0.38624 0.0001814890697033512 1.8511908522527782e-06
Train on 37500 samples, validate on 12500 samples
Epoch 1/15
37500/37500 [==============================] - 11s 293us/sample - loss: 4.8103 -
sparse_categorical_accuracy: 0.1214 - val_loss: 4.7820 -
val_sparse_categorical_accuracy: 0.1605
Epoch 2/15
37500/37500 [==============================] - 9s 230us/sample - loss: 4.7522 -
sparse_categorical_accuracy: 0.1943 - val_loss: 4.7269 -
val_sparse_categorical_accuracy: 0.2169
Epoch 3/15
37500/37500 [==============================] - 9s 233us/sample - loss: 4.6936 -
sparse_categorical_accuracy: 0.2396 - val_loss: 4.6658 -
val_sparse_categorical_accuracy: 0.2536
Epoch 4/15
37500/37500 [==============================] - 9s 230us/sample - loss: 4.6278 -
sparse_categorical_accuracy: 0.2722 - val_loss: 4.5976 -
val_sparse_categorical_accuracy: 0.2698
Epoch 5/15
37500/37500 [==============================] - 9s 232us/sample - loss: 4.5573 -
sparse_categorical_accuracy: 0.2886 - val_loss: 4.5284 -
val_sparse_categorical_accuracy: 0.2841
Epoch 6/15
```

```
37500/37500 [==============================] - 9s 231us/sample - loss: 4.4877 -
sparse_categorical_accuracy: 0.3009 - val_loss: 4.4623 -
val_sparse_categorical_accuracy: 0.3006
Epoch 7/15
37500/37500 [==============================] - 9s 234us/sample - loss: 4.4236 -
sparse_categorical_accuracy: 0.3166 - val_loss: 4.4032 -
val_sparse_categorical_accuracy: 0.3148
Epoch 8/15
37500/37500 [==============================] - 9s 229us/sample - loss: 4.3671 -
sparse_categorical_accuracy: 0.3302 - val_loss: 4.3519 -
val_sparse_categorical_accuracy: 0.3269
Epoch 9/15
37500/37500 [==============================] - 9s 231us/sample - loss: 4.3185 -
sparse_categorical_accuracy: 0.3418 - val_loss: 4.3084 -
val_sparse_categorical_accuracy: 0.3358
Epoch 10/15
37500/37500 [==============================] - 9s 230us/sample - loss: 4.2762 -
sparse_categorical_accuracy: 0.3504 - val_loss: 4.2703 -
val_sparse_categorical_accuracy: 0.3446
Epoch 11/15
37500/37500 [==============================] - 9s 232us/sample - loss: 4.2384 -
sparse_categorical_accuracy: 0.3572 - val_loss: 4.2349 -
val_sparse_categorical_accuracy: 0.3524
Epoch 12/15
37500/37500 [==============================] - 9s 230us/sample - loss: 4.2040 -
sparse_categorical_accuracy: 0.3643 - val_loss: 4.2034 -
val_sparse_categorical_accuracy: 0.3565
Epoch 13/15
37500/37500 [==============================] - 9s 234us/sample - loss: 4.1720 -
sparse_categorical_accuracy: 0.3700 - val_loss: 4.1726 -
val_sparse_categorical_accuracy: 0.3619
Epoch 14/15
37500/37500 [==============================] - 9s 235us/sample - loss: 4.1410 -
sparse_categorical_accuracy: 0.3759 - val_loss: 4.1429 -
val_sparse_categorical_accuracy: 0.3684
Epoch 15/15
37500/37500 [==============================] - 9s 230us/sample - loss: 4.1112 -
sparse_categorical_accuracy: 0.3823 - val_loss: 4.1151 -
val_sparse_categorical_accuracy: 0.3754

 33%|        | 10/30 [22:27<45:08, 135.43s/it]

0.37536 0.0001700117191881522 0.006849492538216262
Train on 37500 samples, validate on 12500 samples
Epoch 1/15
37500/37500 [==============================] - 11s 292us/sample - loss: 2.2753 -
sparse_categorical_accuracy: 0.1753 - val_loss: 2.2246 -
val_sparse_categorical_accuracy: 0.2343
Epoch 2/15
```

```
37500/37500 [==============================] - 9s 237us/sample - loss: 2.1628 -
sparse_categorical_accuracy: 0.2529 - val_loss: 2.1030 -
val_sparse_categorical_accuracy: 0.2715
Epoch 3/15
37500/37500 [==============================] - 9s 233us/sample - loss: 2.0454 -
sparse_categorical_accuracy: 0.2833 - val_loss: 2.0025 -
val_sparse_categorical_accuracy: 0.2916
Epoch 4/15
37500/37500 [==============================] - 9s 235us/sample - loss: 1.9522 -
sparse_categorical_accuracy: 0.3153 - val_loss: 1.9164 -
val_sparse_categorical_accuracy: 0.3290
Epoch 5/15
37500/37500 [==============================] - 9s 233us/sample - loss: 1.8691 -
sparse_categorical_accuracy: 0.3440 - val_loss: 1.8407 -
val_sparse_categorical_accuracy: 0.3545
Epoch 6/15
37500/37500 [==============================] - 9s 236us/sample - loss: 1.8006 -
sparse_categorical_accuracy: 0.3694 - val_loss: 1.7821 -
val_sparse_categorical_accuracy: 0.3691
Epoch 7/15
37500/37500 [==============================] - 9s 233us/sample - loss: 1.7435 -
sparse_categorical_accuracy: 0.3875 - val_loss: 1.7312 -
val_sparse_categorical_accuracy: 0.3864
Epoch 8/15
37500/37500 [==============================] - 9s 235us/sample - loss: 1.6925 -
sparse_categorical_accuracy: 0.4067 - val_loss: 1.6819 -
val_sparse_categorical_accuracy: 0.4024
Epoch 9/15
37500/37500 [==============================] - 9s 233us/sample - loss: 1.6440 -
sparse_categorical_accuracy: 0.4236 - val_loss: 1.6352 -
val_sparse_categorical_accuracy: 0.4202
Epoch 10/15
37500/37500 [==============================] - 9s 234us/sample - loss: 1.5980 -
sparse_categorical_accuracy: 0.4393 - val_loss: 1.5886 -
val_sparse_categorical_accuracy: 0.4358
Epoch 11/15
37500/37500 [==============================] - 9s 237us/sample - loss: 1.5562 -
sparse_categorical_accuracy: 0.4535 - val_loss: 1.5535 -
val_sparse_categorical_accuracy: 0.4446
Epoch 12/15
37500/37500 [==============================] - 9s 233us/sample - loss: 1.5187 -
sparse_categorical_accuracy: 0.4666 - val_loss: 1.5171 -
val_sparse_categorical_accuracy: 0.4597
Epoch 13/15
37500/37500 [==============================] - 9s 236us/sample - loss: 1.4840 -
sparse_categorical_accuracy: 0.4794 - val_loss: 1.4853 -
val_sparse_categorical_accuracy: 0.4692
Epoch 14/15
```

```
37500/37500 [==============================] - 9s 234us/sample - loss: 1.4534 -
sparse_categorical_accuracy: 0.4916 - val_loss: 1.4563 -
val_sparse_categorical_accuracy: 0.4790
Epoch 15/15
37500/37500 [==============================] - 9s 236us/sample - loss: 1.4260 -
sparse_categorical_accuracy: 0.4989 - val_loss: 1.4297 -
val_sparse_categorical_accuracy: 0.4901
 37%|        | 11/30 [24:45<43:07, 136.20s/it]
0.49008 0.0005040855530407848 2.4222719277426502e-05
Train on 37500 samples, validate on 12500 samples
Epoch 1/15
37500/37500 [==============================] - 11s 295us/sample - loss: 2.2808 -
sparse_categorical_accuracy: 0.1434 - val_loss: 2.2487 -
val_sparse_categorical_accuracy: 0.1815
Epoch 2/15
37500/37500 [==============================] - 9s 234us/sample - loss: 2.2141 -
sparse_categorical_accuracy: 0.2101 - val_loss: 2.1785 -
val_sparse_categorical_accuracy: 0.2331
Epoch 3/15
37500/37500 [==============================] - 9s 237us/sample - loss: 2.1362 -
sparse_categorical_accuracy: 0.2589 - val_loss: 2.1011 -
val_sparse_categorical_accuracy: 0.2766
Epoch 4/15
37500/37500 [==============================] - 9s 234us/sample - loss: 2.0613 -
sparse_categorical_accuracy: 0.2863 - val_loss: 2.0350 -
val_sparse_categorical_accuracy: 0.2961
Epoch 5/15
37500/37500 [==============================] - 9s 236us/sample - loss: 1.9989 -
sparse_categorical_accuracy: 0.3042 - val_loss: 1.9771 -
val_sparse_categorical_accuracy: 0.3126
Epoch 6/15
37500/37500 [==============================] - 9s 234us/sample - loss: 1.9409 -
sparse_categorical_accuracy: 0.3223 - val_loss: 1.9208 -
val_sparse_categorical_accuracy: 0.3285
Epoch 7/15
37500/37500 [==============================] - 9s 236us/sample - loss: 1.8839 -
sparse_categorical_accuracy: 0.3405 - val_loss: 1.8656 -
val_sparse_categorical_accuracy: 0.3461
Epoch 8/15
37500/37500 [==============================] - 9s 237us/sample - loss: 1.8301 -
sparse_categorical_accuracy: 0.3570 - val_loss: 1.8159 -
val_sparse_categorical_accuracy: 0.3570
Epoch 9/15
37500/37500 [==============================] - 9s 235us/sample - loss: 1.7820 -
sparse_categorical_accuracy: 0.3747 - val_loss: 1.7714 -
val_sparse_categorical_accuracy: 0.3754
Epoch 10/15
```

```
37500/37500 [==============================] - 9s 237us/sample - loss: 1.7374 -
sparse_categorical_accuracy: 0.3910 - val_loss: 1.7298 -
val_sparse_categorical_accuracy: 0.3877
Epoch 11/15
37500/37500 [==============================] - 9s 235us/sample - loss: 1.6973 -
sparse_categorical_accuracy: 0.4033 - val_loss: 1.6927 -
val_sparse_categorical_accuracy: 0.4006
Epoch 12/15
37500/37500 [==============================] - 9s 236us/sample - loss: 1.6603 -
sparse_categorical_accuracy: 0.4144 - val_loss: 1.6563 -
val_sparse_categorical_accuracy: 0.4168
Epoch 13/15
37500/37500 [==============================] - 9s 235us/sample - loss: 1.6264 -
sparse_categorical_accuracy: 0.4267 - val_loss: 1.6263 -
val_sparse_categorical_accuracy: 0.4241
Epoch 14/15
37500/37500 [==============================] - 9s 236us/sample - loss: 1.5961 -
sparse_categorical_accuracy: 0.4370 - val_loss: 1.5991 -
val_sparse_categorical_accuracy: 0.4310
Epoch 15/15
37500/37500 [==============================] - 9s 235us/sample - loss: 1.5690 -
sparse_categorical_accuracy: 0.4462 - val_loss: 1.5701 -
val_sparse_categorical_accuracy: 0.4405

 40%|        | 12/30 [27:04<41:06, 137.02s/it]

0.44048 0.00030903219973205196 1.8160318529247225e-05
Train on 37500 samples, validate on 12500 samples
Epoch 1/15
37500/37500 [==============================] - 11s 297us/sample - loss: 2.2791 -
sparse_categorical_accuracy: 0.1978 - val_loss: 2.1704 -
val_sparse_categorical_accuracy: 0.2550
Epoch 2/15
37500/37500 [==============================] - 9s 236us/sample - loss: 2.0751 -
sparse_categorical_accuracy: 0.2953 - val_loss: 2.0029 -
val_sparse_categorical_accuracy: 0.3227
Epoch 3/15
37500/37500 [==============================] - 9s 234us/sample - loss: 1.9318 -
sparse_categorical_accuracy: 0.3470 - val_loss: 1.8909 -
val_sparse_categorical_accuracy: 0.3618
Epoch 4/15
37500/37500 [==============================] - 9s 236us/sample - loss: 1.8354 -
sparse_categorical_accuracy: 0.3772 - val_loss: 1.8106 -
val_sparse_categorical_accuracy: 0.3856
Epoch 5/15
37500/37500 [==============================] - 9s 238us/sample - loss: 1.7612 -
sparse_categorical_accuracy: 0.4031 - val_loss: 1.7402 -
val_sparse_categorical_accuracy: 0.4130
Epoch 6/15
```

```
37500/37500 [==============================] - 9s 234us/sample - loss: 1.6950 -
sparse_categorical_accuracy: 0.4253 - val_loss: 1.6833 -
val_sparse_categorical_accuracy: 0.4317
Epoch 7/15
37500/37500 [==============================] - 9s 237us/sample - loss: 1.6379 -
sparse_categorical_accuracy: 0.4484 - val_loss: 1.6415 -
val_sparse_categorical_accuracy: 0.4424
Epoch 8/15
37500/37500 [==============================] - 9s 234us/sample - loss: 1.5896 -
sparse_categorical_accuracy: 0.4624 - val_loss: 1.5894 -
val_sparse_categorical_accuracy: 0.4634
Epoch 9/15
37500/37500 [==============================] - 9s 237us/sample - loss: 1.5488 -
sparse_categorical_accuracy: 0.4778 - val_loss: 1.5637 -
val_sparse_categorical_accuracy: 0.4690
Epoch 10/15
37500/37500 [==============================] - 9s 235us/sample - loss: 1.5142 -
sparse_categorical_accuracy: 0.4896 - val_loss: 1.5219 -
val_sparse_categorical_accuracy: 0.4823
Epoch 11/15
37500/37500 [==============================] - 9s 237us/sample - loss: 1.4818 -
sparse_categorical_accuracy: 0.5017 - val_loss: 1.4955 -
val_sparse_categorical_accuracy: 0.4926
Epoch 12/15
37500/37500 [==============================] - 9s 240us/sample - loss: 1.4505 -
sparse_categorical_accuracy: 0.5128 - val_loss: 1.4675 -
val_sparse_categorical_accuracy: 0.5054
Epoch 13/15
37500/37500 [==============================] - 9s 236us/sample - loss: 1.4244 -
sparse_categorical_accuracy: 0.5205 - val_loss: 1.4490 -
val_sparse_categorical_accuracy: 0.5145
Epoch 14/15
37500/37500 [==============================] - 9s 240us/sample - loss: 1.3996 -
sparse_categorical_accuracy: 0.5351 - val_loss: 1.4203 -
val_sparse_categorical_accuracy: 0.5245
Epoch 15/15
37500/37500 [==============================] - 9s 236us/sample - loss: 1.3758 -
sparse_categorical_accuracy: 0.5424 - val_loss: 1.4219 -
val_sparse_categorical_accuracy: 0.5185

 43%|        | 13/30 [29:23<39:00, 137.70s/it]

0.51848 0.0006989081769589997 0.00020571298052255593
Train on 37500 samples, validate on 12500 samples
Epoch 1/15
37500/37500 [==============================] - 11s 299us/sample - loss: 2.7078 -
sparse_categorical_accuracy: 0.2021 - val_loss: 2.5988 -
val_sparse_categorical_accuracy: 0.2640
Epoch 2/15
```

```
37500/37500 [==============================] - 9s 237us/sample - loss: 2.4872 -
sparse_categorical_accuracy: 0.3006 - val_loss: 2.4049 -
val_sparse_categorical_accuracy: 0.3225
Epoch 3/15
37500/37500 [==============================] - 9s 236us/sample - loss: 2.3317 -
sparse_categorical_accuracy: 0.3484 - val_loss: 2.2907 -
val_sparse_categorical_accuracy: 0.3586
Epoch 4/15
37500/37500 [==============================] - 9s 240us/sample - loss: 2.2253 -
sparse_categorical_accuracy: 0.3885 - val_loss: 2.1964 -
val_sparse_categorical_accuracy: 0.3914
Epoch 5/15
37500/37500 [==============================] - 9s 235us/sample - loss: 2.1343 -
sparse_categorical_accuracy: 0.4179 - val_loss: 2.1142 -
val_sparse_categorical_accuracy: 0.4196
Epoch 6/15
37500/37500 [==============================] - 9s 236us/sample - loss: 2.0577 -
sparse_categorical_accuracy: 0.4425 - val_loss: 2.0357 -
val_sparse_categorical_accuracy: 0.4509
Epoch 7/15
37500/37500 [==============================] - 9s 234us/sample - loss: 1.9944 -
sparse_categorical_accuracy: 0.4627 - val_loss: 1.9857 -
val_sparse_categorical_accuracy: 0.4671
Epoch 8/15
37500/37500 [==============================] - 9s 238us/sample - loss: 1.9427 -
sparse_categorical_accuracy: 0.4835 - val_loss: 1.9399 -
val_sparse_categorical_accuracy: 0.4817
Epoch 9/15
37500/37500 [==============================] - 9s 237us/sample - loss: 1.8969 -
sparse_categorical_accuracy: 0.4990 - val_loss: 1.9052 -
val_sparse_categorical_accuracy: 0.4935
Epoch 10/15
37500/37500 [==============================] - 9s 236us/sample - loss: 1.8570 -
sparse_categorical_accuracy: 0.5153 - val_loss: 1.8689 -
val_sparse_categorical_accuracy: 0.5060
Epoch 11/15
37500/37500 [==============================] - 9s 237us/sample - loss: 1.8213 -
sparse_categorical_accuracy: 0.5259 - val_loss: 1.8293 -
val_sparse_categorical_accuracy: 0.5201
Epoch 12/15
37500/37500 [==============================] - 9s 237us/sample - loss: 1.7877 -
sparse_categorical_accuracy: 0.5383 - val_loss: 1.8163 -
val_sparse_categorical_accuracy: 0.5276
Epoch 13/15
37500/37500 [==============================] - 9s 237us/sample - loss: 1.7577 -
sparse_categorical_accuracy: 0.5485 - val_loss: 1.7885 -
val_sparse_categorical_accuracy: 0.5330
Epoch 14/15
```

```
37500/37500 [==============================] - 9s 235us/sample - loss: 1.7306 -
sparse_categorical_accuracy: 0.5597 - val_loss: 1.7588 -
val_sparse_categorical_accuracy: 0.5442
Epoch 15/15
37500/37500 [==============================] - 9s 238us/sample - loss: 1.7034 -
sparse_categorical_accuracy: 0.5684 - val_loss: 1.7526 -
val_sparse_categorical_accuracy: 0.5480
 47%|        | 14/30 [31:42<36:51, 138.21s/it]
0.548 0.0008897323938345441 0.0013517594993773326
Train on 37500 samples, validate on 12500 samples
Epoch 1/15
37500/37500 [==============================] - 11s 299us/sample - loss: 3.6404 -
sparse_categorical_accuracy: 0.1261 - val_loss: 3.6149 -
val_sparse_categorical_accuracy: 0.1607
Epoch 2/15
37500/37500 [==============================] - 9s 234us/sample - loss: 3.5894 -
sparse_categorical_accuracy: 0.1958 - val_loss: 3.5692 -
val_sparse_categorical_accuracy: 0.2166
Epoch 3/15
37500/37500 [==============================] - 9s 232us/sample - loss: 3.5407 -
sparse_categorical_accuracy: 0.2333 - val_loss: 3.5207 -
val_sparse_categorical_accuracy: 0.2421
Epoch 4/15
37500/37500 [==============================] - 9s 231us/sample - loss: 3.4898 -
sparse_categorical_accuracy: 0.2569 - val_loss: 3.4726 -
val_sparse_categorical_accuracy: 0.2548
Epoch 5/15
37500/37500 [==============================] - 9s 231us/sample - loss: 3.4422 -
sparse_categorical_accuracy: 0.2674 - val_loss: 3.4299 -
val_sparse_categorical_accuracy: 0.2684
Epoch 6/15
37500/37500 [==============================] - 9s 233us/sample - loss: 3.4010 -
sparse_categorical_accuracy: 0.2791 - val_loss: 3.3932 -
val_sparse_categorical_accuracy: 0.2796
Epoch 7/15
37500/37500 [==============================] - 9s 232us/sample - loss: 3.3654 -
sparse_categorical_accuracy: 0.2898 - val_loss: 3.3610 -
val_sparse_categorical_accuracy: 0.2877
Epoch 8/15
37500/37500 [==============================] - 9s 233us/sample - loss: 3.3331 -
sparse_categorical_accuracy: 0.3006 - val_loss: 3.3303 -
val_sparse_categorical_accuracy: 0.2950
Epoch 9/15
37500/37500 [==============================] - 9s 231us/sample - loss: 3.3025 -
sparse_categorical_accuracy: 0.3107 - val_loss: 3.2997 -
val_sparse_categorical_accuracy: 0.3042
Epoch 10/15
```

```
37500/37500 [==============================] - 9s 235us/sample - loss: 3.2727 -
sparse_categorical_accuracy: 0.3218 - val_loss: 3.2701 -
val_sparse_categorical_accuracy: 0.3168
Epoch 11/15
37500/37500 [==============================] - 9s 231us/sample - loss: 3.2437 -
sparse_categorical_accuracy: 0.3322 - val_loss: 3.2416 -
val_sparse_categorical_accuracy: 0.3222
Epoch 12/15
37500/37500 [==============================] - 9s 233us/sample - loss: 3.2150 -
sparse_categorical_accuracy: 0.3407 - val_loss: 3.2136 -
val_sparse_categorical_accuracy: 0.3345
Epoch 13/15
37500/37500 [==============================] - 9s 231us/sample - loss: 3.1876 -
sparse_categorical_accuracy: 0.3495 - val_loss: 3.1869 -
val_sparse_categorical_accuracy: 0.3456
Epoch 14/15
37500/37500 [==============================] - 9s 233us/sample - loss: 3.1613 -
sparse_categorical_accuracy: 0.3591 - val_loss: 3.1608 -
val_sparse_categorical_accuracy: 0.3498
Epoch 15/15
37500/37500 [==============================] - 9s 231us/sample - loss: 3.1362 -
sparse_categorical_accuracy: 0.3660 - val_loss: 3.1366 -
val_sparse_categorical_accuracy: 0.3602

 50%|        | 15/30 [33:59<34:27, 137.86s/it]

0.36016 0.00014724855890079438 0.0037024521272401583
Train on 37500 samples, validate on 12500 samples
Epoch 1/15
37500/37500 [==============================] - 11s 301us/sample - loss: 2.2757 -
sparse_categorical_accuracy: 0.1555 - val_loss: 2.2336 -
val_sparse_categorical_accuracy: 0.2194
Epoch 2/15
37500/37500 [==============================] - 9s 239us/sample - loss: 2.1711 -
sparse_categorical_accuracy: 0.2583 - val_loss: 2.1129 -
val_sparse_categorical_accuracy: 0.2720
Epoch 3/15
37500/37500 [==============================] - 9s 236us/sample - loss: 2.0377 -
sparse_categorical_accuracy: 0.3029 - val_loss: 1.9824 -
val_sparse_categorical_accuracy: 0.3175
Epoch 4/15
37500/37500 [==============================] - 9s 240us/sample - loss: 1.9144 -
sparse_categorical_accuracy: 0.3403 - val_loss: 1.8759 -
val_sparse_categorical_accuracy: 0.3466
Epoch 5/15
37500/37500 [==============================] - 9s 241us/sample - loss: 1.8238 -
sparse_categorical_accuracy: 0.3674 - val_loss: 1.8011 -
val_sparse_categorical_accuracy: 0.3741
Epoch 6/15
```

```
37500/37500 [==============================] - 9s 238us/sample - loss: 1.7579 -
sparse_categorical_accuracy: 0.3885 - val_loss: 1.7398 -
val_sparse_categorical_accuracy: 0.3905
Epoch 7/15
37500/37500 [==============================] - 9s 240us/sample - loss: 1.7014 -
sparse_categorical_accuracy: 0.4085 - val_loss: 1.6908 -
val_sparse_categorical_accuracy: 0.4033
Epoch 8/15
37500/37500 [==============================] - 9s 239us/sample - loss: 1.6521 -
sparse_categorical_accuracy: 0.4245 - val_loss: 1.6428 -
val_sparse_categorical_accuracy: 0.4212
Epoch 9/15
37500/37500 [==============================] - 9s 239us/sample - loss: 1.6085 -
sparse_categorical_accuracy: 0.4386 - val_loss: 1.6034 -
val_sparse_categorical_accuracy: 0.4370
Epoch 10/15
37500/37500 [==============================] - 9s 237us/sample - loss: 1.5698 -
sparse_categorical_accuracy: 0.4515 - val_loss: 1.5687 -
val_sparse_categorical_accuracy: 0.4477
Epoch 11/15
37500/37500 [==============================] - 9s 240us/sample - loss: 1.5355 -
sparse_categorical_accuracy: 0.4647 - val_loss: 1.5403 -
val_sparse_categorical_accuracy: 0.4585
Epoch 12/15
37500/37500 [==============================] - 9s 242us/sample - loss: 1.5046 -
sparse_categorical_accuracy: 0.4735 - val_loss: 1.5132 -
val_sparse_categorical_accuracy: 0.4652
Epoch 13/15
37500/37500 [==============================] - 9s 238us/sample - loss: 1.4773 -
sparse_categorical_accuracy: 0.4841 - val_loss: 1.4791 -
val_sparse_categorical_accuracy: 0.4751
Epoch 14/15
37500/37500 [==============================] - 9s 240us/sample - loss: 1.4506 -
sparse_categorical_accuracy: 0.4943 - val_loss: 1.4579 -
val_sparse_categorical_accuracy: 0.4798
Epoch 15/15
37500/37500 [==============================] - 9s 238us/sample - loss: 1.4267 -
sparse_categorical_accuracy: 0.5024 - val_loss: 1.4292 -
val_sparse_categorical_accuracy: 0.4936
 53%|       | 16/30 [36:20<32:22, 138.74s/it]
0.4936 0.0005116049023027338 5.848694740426785e-05
Train on 37500 samples, validate on 12500 samples
Epoch 1/15
37500/37500 [==============================] - 11s 299us/sample - loss: 2.1980 -
sparse_categorical_accuracy: 0.2283 - val_loss: 2.0961 -
val_sparse_categorical_accuracy: 0.2658
Epoch 2/15
```

```
37500/37500 [==============================] - 9s 237us/sample - loss: 1.9983 -
sparse_categorical_accuracy: 0.2942 - val_loss: 1.9263 -
val_sparse_categorical_accuracy: 0.3146
Epoch 3/15
37500/37500 [==============================] - 9s 236us/sample - loss: 1.8574 -
sparse_categorical_accuracy: 0.3413 - val_loss: 1.8132 -
val_sparse_categorical_accuracy: 0.3595
Epoch 4/15
37500/37500 [==============================] - 9s 236us/sample - loss: 1.7549 -
sparse_categorical_accuracy: 0.3803 - val_loss: 1.7257 -
val_sparse_categorical_accuracy: 0.3907
Epoch 5/15
37500/37500 [==============================] - 9s 238us/sample - loss: 1.6671 -
sparse_categorical_accuracy: 0.4114 - val_loss: 1.6454 -
val_sparse_categorical_accuracy: 0.4187
Epoch 6/15
37500/37500 [==============================] - 9s 244us/sample - loss: 1.5938 -
sparse_categorical_accuracy: 0.4385 - val_loss: 1.5778 -
val_sparse_categorical_accuracy: 0.4389
Epoch 7/15
37500/37500 [==============================] - 9s 238us/sample - loss: 1.5347 -
sparse_categorical_accuracy: 0.4583 - val_loss: 1.5274 -
val_sparse_categorical_accuracy: 0.4575
Epoch 8/15
37500/37500 [==============================] - 9s 236us/sample - loss: 1.4855 -
sparse_categorical_accuracy: 0.4736 - val_loss: 1.4911 -
val_sparse_categorical_accuracy: 0.4680
Epoch 9/15
37500/37500 [==============================] - 9s 237us/sample - loss: 1.4457 -
sparse_categorical_accuracy: 0.4891 - val_loss: 1.4413 -
val_sparse_categorical_accuracy: 0.4864
Epoch 10/15
37500/37500 [==============================] - 9s 237us/sample - loss: 1.4092 -
sparse_categorical_accuracy: 0.5006 - val_loss: 1.4242 -
val_sparse_categorical_accuracy: 0.4960
Epoch 11/15
37500/37500 [==============================] - 9s 238us/sample - loss: 1.3775 -
sparse_categorical_accuracy: 0.5121 - val_loss: 1.3862 -
val_sparse_categorical_accuracy: 0.5059
Epoch 12/15
37500/37500 [==============================] - 9s 236us/sample - loss: 1.3488 -
sparse_categorical_accuracy: 0.5241 - val_loss: 1.3705 -
val_sparse_categorical_accuracy: 0.5143
Epoch 13/15
37500/37500 [==============================] - 9s 238us/sample - loss: 1.3223 -
sparse_categorical_accuracy: 0.5348 - val_loss: 1.3336 -
val_sparse_categorical_accuracy: 0.5277
Epoch 14/15
```

```
37500/37500 [==============================] - 9s 236us/sample - loss: 1.2976 -
sparse_categorical_accuracy: 0.5422 - val_loss: 1.3383 -
val_sparse_categorical_accuracy: 0.5248
Epoch 15/15
37500/37500 [==============================] - 9s 238us/sample - loss: 1.2740 -
sparse_categorical_accuracy: 0.5524 - val_loss: 1.3016 -
val_sparse_categorical_accuracy: 0.5397
 57%|       | 17/30 [38:40<30:08, 139.12s/it]
0.53968 0.000714903531955744 1.7497337589618284e-06
Train on 37500 samples, validate on 12500 samples
Epoch 1/15
37500/37500 [==============================] - 11s 303us/sample - loss: 2.6728 -
sparse_categorical_accuracy: 0.1614 - val_loss: 2.6281 -
val_sparse_categorical_accuracy: 0.2207
Epoch 2/15
37500/37500 [==============================] - 9s 237us/sample - loss: 2.5780 -
sparse_categorical_accuracy: 0.2426 - val_loss: 2.5256 -
val_sparse_categorical_accuracy: 0.2605
Epoch 3/15
37500/37500 [==============================] - 9s 241us/sample - loss: 2.4682 -
sparse_categorical_accuracy: 0.2790 - val_loss: 2.4234 -
val_sparse_categorical_accuracy: 0.2898
Epoch 4/15
37500/37500 [==============================] - 9s 240us/sample - loss: 2.3734 -
sparse_categorical_accuracy: 0.3121 - val_loss: 2.3396 -
val_sparse_categorical_accuracy: 0.3197
Epoch 5/15
37500/37500 [==============================] - 9s 237us/sample - loss: 2.2940 -
sparse_categorical_accuracy: 0.3418 - val_loss: 2.2668 -
val_sparse_categorical_accuracy: 0.3448
Epoch 6/15
37500/37500 [==============================] - 9s 241us/sample - loss: 2.2270 -
sparse_categorical_accuracy: 0.3618 - val_loss: 2.2091 -
val_sparse_categorical_accuracy: 0.3626
Epoch 7/15
37500/37500 [==============================] - 9s 238us/sample - loss: 2.1718 -
sparse_categorical_accuracy: 0.3805 - val_loss: 2.1584 -
val_sparse_categorical_accuracy: 0.3789
Epoch 8/15
37500/37500 [==============================] - 9s 242us/sample - loss: 2.1249 -
sparse_categorical_accuracy: 0.3946 - val_loss: 2.1145 -
val_sparse_categorical_accuracy: 0.3923
Epoch 9/15
37500/37500 [==============================] - 9s 238us/sample - loss: 2.0816 -
sparse_categorical_accuracy: 0.4085 - val_loss: 2.0739 -
val_sparse_categorical_accuracy: 0.4067
Epoch 10/15
```

```
37500/37500 [==============================] - 9s 241us/sample - loss: 2.0409 -
sparse_categorical_accuracy: 0.4227 - val_loss: 2.0375 -
val_sparse_categorical_accuracy: 0.4148
Epoch 11/15
37500/37500 [==============================] - 9s 241us/sample - loss: 2.0030 -
sparse_categorical_accuracy: 0.4331 - val_loss: 2.0036 -
val_sparse_categorical_accuracy: 0.4299
Epoch 12/15
37500/37500 [==============================] - 9s 237us/sample - loss: 1.9686 -
sparse_categorical_accuracy: 0.4470 - val_loss: 1.9669 -
val_sparse_categorical_accuracy: 0.4389
Epoch 13/15
37500/37500 [==============================] - 9s 240us/sample - loss: 1.9362 -
sparse_categorical_accuracy: 0.4566 - val_loss: 1.9392 -
val_sparse_categorical_accuracy: 0.4487
Epoch 14/15
37500/37500 [==============================] - 9s 238us/sample - loss: 1.9080 -
sparse_categorical_accuracy: 0.4650 - val_loss: 1.9124 -
val_sparse_categorical_accuracy: 0.4608
Epoch 15/15
37500/37500 [==============================] - 9s 240us/sample - loss: 1.8825 -
sparse_categorical_accuracy: 0.4742 - val_loss: 1.8858 -
val_sparse_categorical_accuracy: 0.4702

 60%|       | 18/30 [41:01<27:56, 139.72s/it]

0.47024 0.0003738208356996944 0.0010967017842270692
Train on 37500 samples, validate on 12500 samples
Epoch 1/15
37500/37500 [==============================] - 12s 307us/sample - loss: 2.2171 -
sparse_categorical_accuracy: 0.2024 - val_loss: 2.1109 -
val_sparse_categorical_accuracy: 0.2610
Epoch 2/15
37500/37500 [==============================] - 9s 238us/sample - loss: 2.0042 -
sparse_categorical_accuracy: 0.3003 - val_loss: 1.9316 -
val_sparse_categorical_accuracy: 0.3152
Epoch 3/15
37500/37500 [==============================] - 9s 239us/sample - loss: 1.8566 -
sparse_categorical_accuracy: 0.3480 - val_loss: 1.8064 -
val_sparse_categorical_accuracy: 0.3637
Epoch 4/15
37500/37500 [==============================] - 9s 239us/sample - loss: 1.7494 -
sparse_categorical_accuracy: 0.3838 - val_loss: 1.7143 -
val_sparse_categorical_accuracy: 0.3933
Epoch 5/15
37500/37500 [==============================] - 9s 241us/sample - loss: 1.6637 -
sparse_categorical_accuracy: 0.4146 - val_loss: 1.6387 -
val_sparse_categorical_accuracy: 0.4178
Epoch 6/15
```

```
37500/37500 [==============================] - 9s 243us/sample - loss: 1.5932 -
sparse_categorical_accuracy: 0.4377 - val_loss: 1.5767 -
val_sparse_categorical_accuracy: 0.4372
Epoch 7/15
37500/37500 [==============================] - 9s 244us/sample - loss: 1.5341 -
sparse_categorical_accuracy: 0.4574 - val_loss: 1.5318 -
val_sparse_categorical_accuracy: 0.4503
Epoch 8/15
37500/37500 [==============================] - 9s 241us/sample - loss: 1.4849 -
sparse_categorical_accuracy: 0.4762 - val_loss: 1.4824 -
val_sparse_categorical_accuracy: 0.4650
Epoch 9/15
37500/37500 [==============================] - 9s 239us/sample - loss: 1.4407 -
sparse_categorical_accuracy: 0.4898 - val_loss: 1.4412 -
val_sparse_categorical_accuracy: 0.4838
Epoch 10/15
37500/37500 [==============================] - 9s 241us/sample - loss: 1.4016 -
sparse_categorical_accuracy: 0.5048 - val_loss: 1.4098 -
val_sparse_categorical_accuracy: 0.4961
Epoch 11/15
37500/37500 [==============================] - 9s 239us/sample - loss: 1.3674 -
sparse_categorical_accuracy: 0.5162 - val_loss: 1.3724 -
val_sparse_categorical_accuracy: 0.5126
Epoch 12/15
37500/37500 [==============================] - 9s 241us/sample - loss: 1.3357 -
sparse_categorical_accuracy: 0.5282 - val_loss: 1.3576 -
val_sparse_categorical_accuracy: 0.5146
Epoch 13/15
37500/37500 [==============================] - 9s 242us/sample - loss: 1.3085 -
sparse_categorical_accuracy: 0.5392 - val_loss: 1.3189 -
val_sparse_categorical_accuracy: 0.5334
Epoch 14/15
37500/37500 [==============================] - 9s 241us/sample - loss: 1.2814 -
sparse_categorical_accuracy: 0.5504 - val_loss: 1.3318 -
val_sparse_categorical_accuracy: 0.5286
Epoch 15/15
37500/37500 [==============================] - 9s 241us/sample - loss: 1.2579 -
sparse_categorical_accuracy: 0.5598 - val_loss: 1.2923 -
val_sparse_categorical_accuracy: 0.5442
 63%|       | 19/30 [43:23<25:44, 140.38s/it]
0.54416 0.0007888092100210364 4.255791372425883e-06
Train on 37500 samples, validate on 12500 samples
Epoch 1/15
37500/37500 [==============================] - 11s 306us/sample - loss: 2.3013 -
sparse_categorical_accuracy: 0.1071 - val_loss: 2.2795 -
val_sparse_categorical_accuracy: 0.1375
Epoch 2/15
```

```
37500/37500 [==============================] - 9s 241us/sample - loss: 2.2598 -
sparse_categorical_accuracy: 0.1639 - val_loss: 2.2422 -
val_sparse_categorical_accuracy: 0.1946
Epoch 3/15
37500/37500 [==============================] - 9s 243us/sample - loss: 2.2156 -
sparse_categorical_accuracy: 0.2162 - val_loss: 2.1934 -
val_sparse_categorical_accuracy: 0.2222
Epoch 4/15
37500/37500 [==============================] - 9s 242us/sample - loss: 2.1574 -
sparse_categorical_accuracy: 0.2413 - val_loss: 2.1300 -
val_sparse_categorical_accuracy: 0.2483
Epoch 5/15
37500/37500 [==============================] - 9s 244us/sample - loss: 2.0880 -
sparse_categorical_accuracy: 0.2657 - val_loss: 2.0612 -
val_sparse_categorical_accuracy: 0.2711
Epoch 6/15
37500/37500 [==============================] - 9s 242us/sample - loss: 2.0211 -
sparse_categorical_accuracy: 0.2840 - val_loss: 2.0007 -
val_sparse_categorical_accuracy: 0.2909
Epoch 7/15
37500/37500 [==============================] - 9s 244us/sample - loss: 1.9647 -
sparse_categorical_accuracy: 0.3037 - val_loss: 1.9497 -
val_sparse_categorical_accuracy: 0.3050
Epoch 8/15
37500/37500 [==============================] - 9s 245us/sample - loss: 1.9156 -
sparse_categorical_accuracy: 0.3208 - val_loss: 1.9039 -
val_sparse_categorical_accuracy: 0.3260
Epoch 9/15
37500/37500 [==============================] - 9s 241us/sample - loss: 1.8717 -
sparse_categorical_accuracy: 0.3364 - val_loss: 1.8642 -
val_sparse_categorical_accuracy: 0.3358
Epoch 10/15
37500/37500 [==============================] - 9s 243us/sample - loss: 1.8322 -
sparse_categorical_accuracy: 0.3522 - val_loss: 1.8266 -
val_sparse_categorical_accuracy: 0.3535
Epoch 11/15
37500/37500 [==============================] - 9s 244us/sample - loss: 1.7960 -
sparse_categorical_accuracy: 0.3657 - val_loss: 1.7923 -
val_sparse_categorical_accuracy: 0.3676
Epoch 12/15
37500/37500 [==============================] - 9s 246us/sample - loss: 1.7620 -
sparse_categorical_accuracy: 0.3784 - val_loss: 1.7630 -
val_sparse_categorical_accuracy: 0.3706
Epoch 13/15
37500/37500 [==============================] - 9s 242us/sample - loss: 1.7296 -
sparse_categorical_accuracy: 0.3904 - val_loss: 1.7302 -
val_sparse_categorical_accuracy: 0.3839
Epoch 14/15
```

```
37500/37500 [==============================] - 9s 245us/sample - loss: 1.6983 -
sparse_categorical_accuracy: 0.4003 - val_loss: 1.7035 -
val_sparse_categorical_accuracy: 0.3959
Epoch 15/15
37500/37500 [==============================] - 9s 246us/sample - loss: 1.6684 -
sparse_categorical_accuracy: 0.4109 - val_loss: 1.6729 -
val_sparse_categorical_accuracy: 0.4033
 67%|       | 20/30 [45:47<23:32, 141.26s/it]
0.40328 0.00026700641560741954 2.1538311901031643e-06
Train on 37500 samples, validate on 12500 samples
Epoch 1/15
37500/37500 [==============================] - 12s 308us/sample - loss: 2.2943 -
sparse_categorical_accuracy: 0.1768 - val_loss: 2.2489 -
val_sparse_categorical_accuracy: 0.2174
Epoch 2/15
37500/37500 [==============================] - 9s 236us/sample - loss: 2.1942 -
sparse_categorical_accuracy: 0.2485 - val_loss: 2.1425 -
val_sparse_categorical_accuracy: 0.2636
Epoch 3/15
37500/37500 [==============================] - 9s 238us/sample - loss: 2.0872 -
sparse_categorical_accuracy: 0.2906 - val_loss: 2.0464 -
val_sparse_categorical_accuracy: 0.2969
Epoch 4/15
37500/37500 [==============================] - 9s 236us/sample - loss: 2.0010 -
sparse_categorical_accuracy: 0.3167 - val_loss: 1.9727 -
val_sparse_categorical_accuracy: 0.3245
Epoch 5/15
37500/37500 [==============================] - 9s 238us/sample - loss: 1.9336 -
sparse_categorical_accuracy: 0.3365 - val_loss: 1.9152 -
val_sparse_categorical_accuracy: 0.3433
Epoch 6/15
37500/37500 [==============================] - 9s 236us/sample - loss: 1.8794 -
sparse_categorical_accuracy: 0.3551 - val_loss: 1.8664 -
val_sparse_categorical_accuracy: 0.3609
Epoch 7/15
37500/37500 [==============================] - 9s 238us/sample - loss: 1.8327 -
sparse_categorical_accuracy: 0.3702 - val_loss: 1.8256 -
val_sparse_categorical_accuracy: 0.3750
Epoch 8/15
37500/37500 [==============================] - 9s 235us/sample - loss: 1.7910 -
sparse_categorical_accuracy: 0.3841 - val_loss: 1.7849 -
val_sparse_categorical_accuracy: 0.3846
Epoch 9/15
37500/37500 [==============================] - 9s 240us/sample - loss: 1.7527 -
sparse_categorical_accuracy: 0.3961 - val_loss: 1.7516 -
val_sparse_categorical_accuracy: 0.3982
Epoch 10/15
```

```
37500/37500 [==============================] - 9s 240us/sample - loss: 1.7164 -
sparse_categorical_accuracy: 0.4065 - val_loss: 1.7206 -
val_sparse_categorical_accuracy: 0.4000
Epoch 11/15
37500/37500 [==============================] - 9s 236us/sample - loss: 1.6822 -
sparse_categorical_accuracy: 0.4216 - val_loss: 1.6823 -
val_sparse_categorical_accuracy: 0.4156
Epoch 12/15
37500/37500 [==============================] - 9s 237us/sample - loss: 1.6505 -
sparse_categorical_accuracy: 0.4321 - val_loss: 1.6525 -
val_sparse_categorical_accuracy: 0.4294
Epoch 13/15
37500/37500 [==============================] - 9s 235us/sample - loss: 1.6207 -
sparse_categorical_accuracy: 0.4426 - val_loss: 1.6301 -
val_sparse_categorical_accuracy: 0.4321
Epoch 14/15
37500/37500 [==============================] - 9s 238us/sample - loss: 1.5929 -
sparse_categorical_accuracy: 0.4494 - val_loss: 1.6002 -
val_sparse_categorical_accuracy: 0.4440
Epoch 15/15
37500/37500 [==============================] - 9s 236us/sample - loss: 1.5679 -
sparse_categorical_accuracy: 0.4595 - val_loss: 1.5788 -
val_sparse_categorical_accuracy: 0.4523

 70%|       | 21/30 [48:07<21:08, 140.95s/it]

0.45232 0.00032867371406466913 0.00011348113155850548
Train on 37500 samples, validate on 12500 samples
Epoch 1/15
37500/37500 [==============================] - 11s 306us/sample - loss: 2.3118 -
sparse_categorical_accuracy: 0.1532 - val_loss: 2.2688 -
val_sparse_categorical_accuracy: 0.2121
Epoch 2/15
37500/37500 [==============================] - 9s 244us/sample - loss: 2.2131 -
sparse_categorical_accuracy: 0.2382 - val_loss: 2.1526 -
val_sparse_categorical_accuracy: 0.2589
Epoch 3/15
37500/37500 [==============================] - 9s 241us/sample - loss: 2.0843 -
sparse_categorical_accuracy: 0.2839 - val_loss: 2.0280 -
val_sparse_categorical_accuracy: 0.2950
Epoch 4/15
37500/37500 [==============================] - 9s 243us/sample - loss: 1.9702 -
sparse_categorical_accuracy: 0.3220 - val_loss: 1.9275 -
val_sparse_categorical_accuracy: 0.3279
Epoch 5/15
37500/37500 [==============================] - 9s 244us/sample - loss: 1.8828 -
sparse_categorical_accuracy: 0.3514 - val_loss: 1.8572 -
val_sparse_categorical_accuracy: 0.3591
Epoch 6/15
```

```
37500/37500 [==============================] - 9s 243us/sample - loss: 1.8206 -
sparse_categorical_accuracy: 0.3735 - val_loss: 1.8080 -
val_sparse_categorical_accuracy: 0.3752
Epoch 7/15
37500/37500 [==============================] - 9s 245us/sample - loss: 1.7710 -
sparse_categorical_accuracy: 0.3917 - val_loss: 1.7609 -
val_sparse_categorical_accuracy: 0.3898
Epoch 8/15
37500/37500 [==============================] - 9s 241us/sample - loss: 1.7261 -
sparse_categorical_accuracy: 0.4071 - val_loss: 1.7237 -
val_sparse_categorical_accuracy: 0.4036
Epoch 9/15
37500/37500 [==============================] - 9s 244us/sample - loss: 1.6847 -
sparse_categorical_accuracy: 0.4226 - val_loss: 1.6878 -
val_sparse_categorical_accuracy: 0.4198
Epoch 10/15
37500/37500 [==============================] - 9s 242us/sample - loss: 1.6453 -
sparse_categorical_accuracy: 0.4335 - val_loss: 1.6492 -
val_sparse_categorical_accuracy: 0.4277
Epoch 11/15
37500/37500 [==============================] - 9s 243us/sample - loss: 1.6092 -
sparse_categorical_accuracy: 0.4475 - val_loss: 1.6136 -
val_sparse_categorical_accuracy: 0.4406
Epoch 12/15
37500/37500 [==============================] - 9s 244us/sample - loss: 1.5756 -
sparse_categorical_accuracy: 0.4589 - val_loss: 1.5832 -
val_sparse_categorical_accuracy: 0.4544
Epoch 13/15
37500/37500 [==============================] - 9s 243us/sample - loss: 1.5447 -
sparse_categorical_accuracy: 0.4701 - val_loss: 1.5558 -
val_sparse_categorical_accuracy: 0.4642
Epoch 14/15
37500/37500 [==============================] - 9s 244us/sample - loss: 1.5167 -
sparse_categorical_accuracy: 0.4790 - val_loss: 1.5299 -
val_sparse_categorical_accuracy: 0.4728
Epoch 15/15
37500/37500 [==============================] - 9s 242us/sample - loss: 1.4903 -
sparse_categorical_accuracy: 0.4883 - val_loss: 1.5136 -
val_sparse_categorical_accuracy: 0.4778

 73%|       | 22/30 [50:30<18:53, 141.66s/it]

0.47784 0.0004531775732334906 0.00010668466084543196
Train on 37500 samples, validate on 12500 samples
Epoch 1/15
37500/37500 [==============================] - 12s 308us/sample - loss: 2.3184 -
sparse_categorical_accuracy: 0.1624 - val_loss: 2.2724 -
val_sparse_categorical_accuracy: 0.2240
Epoch 2/15
```

```
37500/37500 [==============================] - 9s 244us/sample - loss: 2.2159 -
sparse_categorical_accuracy: 0.2525 - val_loss: 2.1626 -
val_sparse_categorical_accuracy: 0.2682
Epoch 3/15
37500/37500 [==============================] - 9s 241us/sample - loss: 2.1003 -
sparse_categorical_accuracy: 0.2835 - val_loss: 2.0537 -
val_sparse_categorical_accuracy: 0.2921
Epoch 4/15
37500/37500 [==============================] - 9s 245us/sample - loss: 2.0008 -
sparse_categorical_accuracy: 0.3100 - val_loss: 1.9677 -
val_sparse_categorical_accuracy: 0.3203
Epoch 5/15
37500/37500 [==============================] - 9s 244us/sample - loss: 1.9254 -
sparse_categorical_accuracy: 0.3370 - val_loss: 1.9082 -
val_sparse_categorical_accuracy: 0.3437
Epoch 6/15
37500/37500 [==============================] - 9s 241us/sample - loss: 1.8646 -
sparse_categorical_accuracy: 0.3594 - val_loss: 1.8528 -
val_sparse_categorical_accuracy: 0.3638
Epoch 7/15
37500/37500 [==============================] - 9s 243us/sample - loss: 1.8116 -
sparse_categorical_accuracy: 0.3801 - val_loss: 1.8038 -
val_sparse_categorical_accuracy: 0.3834
Epoch 8/15
37500/37500 [==============================] - 9s 242us/sample - loss: 1.7619 -
sparse_categorical_accuracy: 0.3989 - val_loss: 1.7564 -
val_sparse_categorical_accuracy: 0.3950
Epoch 9/15
37500/37500 [==============================] - 9s 244us/sample - loss: 1.7140 -
sparse_categorical_accuracy: 0.4156 - val_loss: 1.7078 -
val_sparse_categorical_accuracy: 0.4194
Epoch 10/15
37500/37500 [==============================] - 9s 244us/sample - loss: 1.6684 -
sparse_categorical_accuracy: 0.4311 - val_loss: 1.6648 -
val_sparse_categorical_accuracy: 0.4318
Epoch 11/15
37500/37500 [==============================] - 9s 245us/sample - loss: 1.6255 -
sparse_categorical_accuracy: 0.4466 - val_loss: 1.6233 -
val_sparse_categorical_accuracy: 0.4483
Epoch 12/15
37500/37500 [==============================] - 9s 245us/sample - loss: 1.5863 -
sparse_categorical_accuracy: 0.4594 - val_loss: 1.5920 -
val_sparse_categorical_accuracy: 0.4552
Epoch 13/15
37500/37500 [==============================] - 9s 242us/sample - loss: 1.5516 -
sparse_categorical_accuracy: 0.4712 - val_loss: 1.5572 -
val_sparse_categorical_accuracy: 0.4674
Epoch 14/15
```

```
37500/37500 [==============================] - 9s 245us/sample - loss: 1.5204 -
sparse_categorical_accuracy: 0.4840 - val_loss: 1.5319 -
val_sparse_categorical_accuracy: 0.4766
Epoch 15/15
37500/37500 [==============================] - 9s 242us/sample - loss: 1.4924 -
sparse_categorical_accuracy: 0.4927 - val_loss: 1.5062 -
val_sparse_categorical_accuracy: 0.4830
 77%|      | 23/30 [52:54<16:36, 142.31s/it]
0.48304 0.000451102196937042 0.00014884543687588198
Train on 37500 samples, validate on 12500 samples
Epoch 1/15
37500/37500 [==============================] - 12s 309us/sample - loss: 4.3799 -
sparse_categorical_accuracy: 0.1598 - val_loss: 4.3187 -
val_sparse_categorical_accuracy: 0.2116
Epoch 2/15
37500/37500 [==============================] - 9s 245us/sample - loss: 4.2542 -
sparse_categorical_accuracy: 0.2479 - val_loss: 4.1930 -
val_sparse_categorical_accuracy: 0.2654
Epoch 3/15
37500/37500 [==============================] - 9s 241us/sample - loss: 4.1272 -
sparse_categorical_accuracy: 0.2839 - val_loss: 4.0723 -
val_sparse_categorical_accuracy: 0.3001
Epoch 4/15
37500/37500 [==============================] - 9s 244us/sample - loss: 4.0149 -
sparse_categorical_accuracy: 0.3132 - val_loss: 3.9707 -
val_sparse_categorical_accuracy: 0.3249
Epoch 5/15
37500/37500 [==============================] - 9s 245us/sample - loss: 3.9229 -
sparse_categorical_accuracy: 0.3398 - val_loss: 3.8911 -
val_sparse_categorical_accuracy: 0.3493
Epoch 6/15
37500/37500 [==============================] - 9s 242us/sample - loss: 3.8492 -
sparse_categorical_accuracy: 0.3592 - val_loss: 3.8247 -
val_sparse_categorical_accuracy: 0.3633
Epoch 7/15
37500/37500 [==============================] - 9s 245us/sample - loss: 3.7851 -
sparse_categorical_accuracy: 0.3732 - val_loss: 3.7652 -
val_sparse_categorical_accuracy: 0.3773
Epoch 8/15
37500/37500 [==============================] - 9s 241us/sample - loss: 3.7263 -
sparse_categorical_accuracy: 0.3860 - val_loss: 3.7130 -
val_sparse_categorical_accuracy: 0.3854
Epoch 9/15
37500/37500 [==============================] - 9s 244us/sample - loss: 3.6707 -
sparse_categorical_accuracy: 0.4002 - val_loss: 3.6547 -
val_sparse_categorical_accuracy: 0.4027
Epoch 10/15
```

```
37500/37500 [==============================] - 9s 242us/sample - loss: 3.6169 -
sparse_categorical_accuracy: 0.4120 - val_loss: 3.6042 -
val_sparse_categorical_accuracy: 0.4103
Epoch 11/15
37500/37500 [==============================] - 9s 245us/sample - loss: 3.5663 -
sparse_categorical_accuracy: 0.4236 - val_loss: 3.5524 -
val_sparse_categorical_accuracy: 0.4249
Epoch 12/15
37500/37500 [==============================] - 9s 246us/sample - loss: 3.5181 -
sparse_categorical_accuracy: 0.4350 - val_loss: 3.5119 -
val_sparse_categorical_accuracy: 0.4290
Epoch 13/15
37500/37500 [==============================] - 9s 242us/sample - loss: 3.4724 -
sparse_categorical_accuracy: 0.4449 - val_loss: 3.4643 -
val_sparse_categorical_accuracy: 0.4450
Epoch 14/15
37500/37500 [==============================] - 9s 244us/sample - loss: 3.4287 -
sparse_categorical_accuracy: 0.4540 - val_loss: 3.4254 -
val_sparse_categorical_accuracy: 0.4476
Epoch 15/15
37500/37500 [==============================] - 9s 245us/sample - loss: 3.3876 -
sparse_categorical_accuracy: 0.4631 - val_loss: 3.3826 -
val_sparse_categorical_accuracy: 0.4588

 80%|      | 24/30 [55:18<14:16, 142.77s/it]

0.4588 0.0003662925420195539 0.005764740378137585
Train on 37500 samples, validate on 12500 samples
Epoch 1/15
37500/37500 [==============================] - 12s 310us/sample - loss: 2.8502 -
sparse_categorical_accuracy: 0.1709 - val_loss: 2.8342 -
val_sparse_categorical_accuracy: 0.1814
Epoch 2/15
37500/37500 [==============================] - 9s 241us/sample - loss: 2.8167 -
sparse_categorical_accuracy: 0.1929 - val_loss: 2.8021 -
val_sparse_categorical_accuracy: 0.1998
Epoch 3/15
37500/37500 [==============================] - 9s 239us/sample - loss: 2.7805 -
sparse_categorical_accuracy: 0.2090 - val_loss: 2.7638 -
val_sparse_categorical_accuracy: 0.2149
Epoch 4/15
37500/37500 [==============================] - 9s 242us/sample - loss: 2.7388 -
sparse_categorical_accuracy: 0.2314 - val_loss: 2.7217 -
val_sparse_categorical_accuracy: 0.2380
Epoch 5/15
37500/37500 [==============================] - 9s 243us/sample - loss: 2.6945 -
sparse_categorical_accuracy: 0.2561 - val_loss: 2.6781 -
val_sparse_categorical_accuracy: 0.2603
Epoch 6/15
```

```
37500/37500 [==============================] - 9s 239us/sample - loss: 2.6493 -
sparse_categorical_accuracy: 0.2732 - val_loss: 2.6340 -
val_sparse_categorical_accuracy: 0.2718
Epoch 7/15
37500/37500 [==============================] - 9s 243us/sample - loss: 2.6046 -
sparse_categorical_accuracy: 0.2844 - val_loss: 2.5912 -
val_sparse_categorical_accuracy: 0.2870
Epoch 8/15
37500/37500 [==============================] - 9s 240us/sample - loss: 2.5619 -
sparse_categorical_accuracy: 0.2973 - val_loss: 2.5511 -
val_sparse_categorical_accuracy: 0.2938
Epoch 9/15
37500/37500 [==============================] - 9s 242us/sample - loss: 2.5216 -
sparse_categorical_accuracy: 0.3102 - val_loss: 2.5127 -
val_sparse_categorical_accuracy: 0.3099
Epoch 10/15
37500/37500 [==============================] - 9s 241us/sample - loss: 2.4843 -
sparse_categorical_accuracy: 0.3239 - val_loss: 2.4774 -
val_sparse_categorical_accuracy: 0.3198
Epoch 11/15
37500/37500 [==============================] - 9s 242us/sample - loss: 2.4497 -
sparse_categorical_accuracy: 0.3367 - val_loss: 2.4448 -
val_sparse_categorical_accuracy: 0.3290
Epoch 12/15
37500/37500 [==============================] - 9s 246us/sample - loss: 2.4175 -
sparse_categorical_accuracy: 0.3465 - val_loss: 2.4144 -
val_sparse_categorical_accuracy: 0.3432
Epoch 13/15
37500/37500 [==============================] - 9s 241us/sample - loss: 2.3880 -
sparse_categorical_accuracy: 0.3589 - val_loss: 2.3863 -
val_sparse_categorical_accuracy: 0.3518
Epoch 14/15
37500/37500 [==============================] - 9s 242us/sample - loss: 2.3605 -
sparse_categorical_accuracy: 0.3675 - val_loss: 2.3606 -
val_sparse_categorical_accuracy: 0.3616
Epoch 15/15
37500/37500 [==============================] - 9s 240us/sample - loss: 2.3348 -
sparse_categorical_accuracy: 0.3790 - val_loss: 2.3353 -
val_sparse_categorical_accuracy: 0.3729

 83%|      | 25/30 [57:41<11:53, 142.79s/it]

0.37288 0.00018040263751361958 0.0015392955944046117
Train on 37500 samples, validate on 12500 samples
Epoch 1/15
37500/37500 [==============================] - 12s 314us/sample - loss: 5.4232 -
sparse_categorical_accuracy: 0.1547 - val_loss: 5.3703 -
val_sparse_categorical_accuracy: 0.2026
Epoch 2/15
```

```
37500/37500 [==============================] - 9s 248us/sample - loss: 5.3194 -
sparse_categorical_accuracy: 0.2310 - val_loss: 5.2723 -
val_sparse_categorical_accuracy: 0.2453
Epoch 3/15
37500/37500 [==============================] - 9s 246us/sample - loss: 5.2142 -
sparse_categorical_accuracy: 0.2664 - val_loss: 5.1675 -
val_sparse_categorical_accuracy: 0.2718
Epoch 4/15
37500/37500 [==============================] - 9s 248us/sample - loss: 5.1104 -
sparse_categorical_accuracy: 0.2846 - val_loss: 5.0714 -
val_sparse_categorical_accuracy: 0.2850
Epoch 5/15
37500/37500 [==============================] - 9s 250us/sample - loss: 5.0182 -
sparse_categorical_accuracy: 0.3027 - val_loss: 4.9865 -
val_sparse_categorical_accuracy: 0.3025
Epoch 6/15
37500/37500 [==============================] - 9s 245us/sample - loss: 4.9340 -
sparse_categorical_accuracy: 0.3181 - val_loss: 4.9063 -
val_sparse_categorical_accuracy: 0.3216
Epoch 7/15
37500/37500 [==============================] - 9s 249us/sample - loss: 4.8544 -
sparse_categorical_accuracy: 0.3348 - val_loss: 4.8307 -
val_sparse_categorical_accuracy: 0.3370
Epoch 8/15
37500/37500 [==============================] - 9s 246us/sample - loss: 4.7803 -
sparse_categorical_accuracy: 0.3503 - val_loss: 4.7585 -
val_sparse_categorical_accuracy: 0.3529
Epoch 9/15
37500/37500 [==============================] - 9s 248us/sample - loss: 4.7117 -
sparse_categorical_accuracy: 0.3629 - val_loss: 4.6922 -
val_sparse_categorical_accuracy: 0.3637
Epoch 10/15
37500/37500 [==============================] - 9s 248us/sample - loss: 4.6467 -
sparse_categorical_accuracy: 0.3730 - val_loss: 4.6300 -
val_sparse_categorical_accuracy: 0.3746
Epoch 11/15
37500/37500 [==============================] - 9s 248us/sample - loss: 4.5851 -
sparse_categorical_accuracy: 0.3833 - val_loss: 4.5719 -
val_sparse_categorical_accuracy: 0.3859
Epoch 12/15
37500/37500 [==============================] - 9s 249us/sample - loss: 4.5262 -
sparse_categorical_accuracy: 0.3949 - val_loss: 4.5150 -
val_sparse_categorical_accuracy: 0.3934
Epoch 13/15
37500/37500 [==============================] - 9s 246us/sample - loss: 4.4698 -
sparse_categorical_accuracy: 0.4044 - val_loss: 4.4577 -
val_sparse_categorical_accuracy: 0.4035
Epoch 14/15
```

```
37500/37500 [==============================] - 9s 248us/sample - loss: 4.4158 -
sparse_categorical_accuracy: 0.4153 - val_loss: 4.4079 -
val_sparse_categorical_accuracy: 0.4092
Epoch 15/15
37500/37500 [==============================] - 9s 249us/sample - loss: 4.3643 -
sparse_categorical_accuracy: 0.4221 - val_loss: 4.3590 -
val_sparse_categorical_accuracy: 0.4179
 87%|      | 26/30 [1:00:07<09:35, 143.84s/it]
0.41792 0.00026539891051758475 0.008541428766304817
Train on 37500 samples, validate on 12500 samples
Epoch 1/15
37500/37500 [==============================] - 12s 316us/sample - loss: 2.2273 -
sparse_categorical_accuracy: 0.1960 - val_loss: 2.1365 -
val_sparse_categorical_accuracy: 0.2525
Epoch 2/15
37500/37500 [==============================] - 9s 246us/sample - loss: 2.0364 -
sparse_categorical_accuracy: 0.2837 - val_loss: 1.9578 -
val_sparse_categorical_accuracy: 0.3105
Epoch 3/15
37500/37500 [==============================] - 9s 247us/sample - loss: 1.8820 -
sparse_categorical_accuracy: 0.3354 - val_loss: 1.8271 -
val_sparse_categorical_accuracy: 0.3581
Epoch 4/15
37500/37500 [==============================] - 9s 244us/sample - loss: 1.7656 -
sparse_categorical_accuracy: 0.3791 - val_loss: 1.7276 -
val_sparse_categorical_accuracy: 0.3874
Epoch 5/15
37500/37500 [==============================] - 9s 246us/sample - loss: 1.6743 -
sparse_categorical_accuracy: 0.4117 - val_loss: 1.6461 -
val_sparse_categorical_accuracy: 0.4158
Epoch 6/15
37500/37500 [==============================] - 9s 244us/sample - loss: 1.6009 -
sparse_categorical_accuracy: 0.4371 - val_loss: 1.5824 -
val_sparse_categorical_accuracy: 0.4378
Epoch 7/15
37500/37500 [==============================] - 9s 248us/sample - loss: 1.5431 -
sparse_categorical_accuracy: 0.4582 - val_loss: 1.5298 -
val_sparse_categorical_accuracy: 0.4554
Epoch 8/15
37500/37500 [==============================] - 9s 243us/sample - loss: 1.4978 -
sparse_categorical_accuracy: 0.4736 - val_loss: 1.4888 -
val_sparse_categorical_accuracy: 0.4651
Epoch 9/15
37500/37500 [==============================] - 9s 246us/sample - loss: 1.4574 -
sparse_categorical_accuracy: 0.4867 - val_loss: 1.4598 -
val_sparse_categorical_accuracy: 0.4788
Epoch 10/15
```

```
37500/37500 [==============================] - 9s 248us/sample - loss: 1.4230 -
sparse_categorical_accuracy: 0.5010 - val_loss: 1.4161 -
val_sparse_categorical_accuracy: 0.4965
Epoch 11/15
37500/37500 [==============================] - 9s 244us/sample - loss: 1.3910 -
sparse_categorical_accuracy: 0.5117 - val_loss: 1.3894 -
val_sparse_categorical_accuracy: 0.5062
Epoch 12/15
37500/37500 [==============================] - 9s 246us/sample - loss: 1.3617 -
sparse_categorical_accuracy: 0.5247 - val_loss: 1.3698 -
val_sparse_categorical_accuracy: 0.5185
Epoch 13/15
37500/37500 [==============================] - 9s 245us/sample - loss: 1.3347 -
sparse_categorical_accuracy: 0.5311 - val_loss: 1.3433 -
val_sparse_categorical_accuracy: 0.5266
Epoch 14/15
37500/37500 [==============================] - 9s 247us/sample - loss: 1.3102 -
sparse_categorical_accuracy: 0.5420 - val_loss: 1.3192 -
val_sparse_categorical_accuracy: 0.5301
Epoch 15/15
37500/37500 [==============================] - 9s 244us/sample - loss: 1.2858 -
sparse_categorical_accuracy: 0.5493 - val_loss: 1.3052 -
val_sparse_categorical_accuracy: 0.5388

 90%|      | 27/30 [1:02:32<07:12, 144.27s/it]

0.5388 0.0006927253686067175 3.715463693133893e-06
Train on 37500 samples, validate on 12500 samples
Epoch 1/15
37500/37500 [==============================] - 12s 318us/sample - loss: 2.2565 -
sparse_categorical_accuracy: 0.1889 - val_loss: 2.1983 -
val_sparse_categorical_accuracy: 0.2556
Epoch 2/15
37500/37500 [==============================] - 9s 250us/sample - loss: 2.1175 -
sparse_categorical_accuracy: 0.2745 - val_loss: 2.0504 -
val_sparse_categorical_accuracy: 0.2850
Epoch 3/15
37500/37500 [==============================] - 9s 250us/sample - loss: 1.9814 -
sparse_categorical_accuracy: 0.3119 - val_loss: 1.9375 -
val_sparse_categorical_accuracy: 0.3162
Epoch 4/15
37500/37500 [==============================] - 9s 249us/sample - loss: 1.8790 -
sparse_categorical_accuracy: 0.3431 - val_loss: 1.8485 -
val_sparse_categorical_accuracy: 0.3500
Epoch 5/15
37500/37500 [==============================] - 9s 249us/sample - loss: 1.7993 -
sparse_categorical_accuracy: 0.3710 - val_loss: 1.7815 -
val_sparse_categorical_accuracy: 0.3743
Epoch 6/15
```

```
37500/37500 [==============================] - 9s 247us/sample - loss: 1.7329 -
sparse_categorical_accuracy: 0.3931 - val_loss: 1.7217 -
val_sparse_categorical_accuracy: 0.3979
Epoch 7/15
37500/37500 [==============================] - 9s 249us/sample - loss: 1.6732 -
sparse_categorical_accuracy: 0.4144 - val_loss: 1.6663 -
val_sparse_categorical_accuracy: 0.4166
Epoch 8/15
37500/37500 [==============================] - 9s 251us/sample - loss: 1.6194 -
sparse_categorical_accuracy: 0.4299 - val_loss: 1.6148 -
val_sparse_categorical_accuracy: 0.4334
Epoch 9/15
37500/37500 [==============================] - 9s 248us/sample - loss: 1.5712 -
sparse_categorical_accuracy: 0.4483 - val_loss: 1.5731 -
val_sparse_categorical_accuracy: 0.4486
Epoch 10/15
37500/37500 [==============================] - 9s 250us/sample - loss: 1.5307 -
sparse_categorical_accuracy: 0.4620 - val_loss: 1.5384 -
val_sparse_categorical_accuracy: 0.4558
Epoch 11/15
37500/37500 [==============================] - 9s 247us/sample - loss: 1.4939 -
sparse_categorical_accuracy: 0.4756 - val_loss: 1.5045 -
val_sparse_categorical_accuracy: 0.4662
Epoch 12/15
37500/37500 [==============================] - 9s 249us/sample - loss: 1.4629 -
sparse_categorical_accuracy: 0.4864 - val_loss: 1.4821 -
val_sparse_categorical_accuracy: 0.4711
Epoch 13/15
37500/37500 [==============================] - 9s 249us/sample - loss: 1.4341 -
sparse_categorical_accuracy: 0.4955 - val_loss: 1.4420 -
val_sparse_categorical_accuracy: 0.4907
Epoch 14/15
37500/37500 [==============================] - 9s 251us/sample - loss: 1.4076 -
sparse_categorical_accuracy: 0.5061 - val_loss: 1.4270 -
val_sparse_categorical_accuracy: 0.4951
Epoch 15/15
37500/37500 [==============================] - 9s 250us/sample - loss: 1.3836 -
sparse_categorical_accuracy: 0.5131 - val_loss: 1.3961 -
val_sparse_categorical_accuracy: 0.5075

 93%|      | 28/30 [1:04:59<04:50, 145.17s/it]

0.50752 0.0005041411373468762 2.7019842418589452e-05
Train on 37500 samples, validate on 12500 samples
Epoch 1/15
37500/37500 [==============================] - 12s 320us/sample - loss: 2.3112 -
sparse_categorical_accuracy: 0.1747 - val_loss: 2.2545 -
val_sparse_categorical_accuracy: 0.2061
Epoch 2/15
```

```
37500/37500 [==============================] - 9s 246us/sample - loss: 2.2027 -
sparse_categorical_accuracy: 0.2259 - val_loss: 2.1551 -
val_sparse_categorical_accuracy: 0.2458
Epoch 3/15
37500/37500 [==============================] - 9s 249us/sample - loss: 2.1079 -
sparse_categorical_accuracy: 0.2677 - val_loss: 2.0704 -
val_sparse_categorical_accuracy: 0.2836
Epoch 4/15
37500/37500 [==============================] - 9s 247us/sample - loss: 2.0268 -
sparse_categorical_accuracy: 0.3049 - val_loss: 1.9968 -
val_sparse_categorical_accuracy: 0.3160
Epoch 5/15
37500/37500 [==============================] - 9s 249us/sample - loss: 1.9538 -
sparse_categorical_accuracy: 0.3343 - val_loss: 1.9268 -
val_sparse_categorical_accuracy: 0.3443
Epoch 6/15
37500/37500 [==============================] - 9s 250us/sample - loss: 1.8888 -
sparse_categorical_accuracy: 0.3580 - val_loss: 1.8679 -
val_sparse_categorical_accuracy: 0.3650
Epoch 7/15
37500/37500 [==============================] - 9s 248us/sample - loss: 1.8336 -
sparse_categorical_accuracy: 0.3794 - val_loss: 1.8174 -
val_sparse_categorical_accuracy: 0.3799
Epoch 8/15
37500/37500 [==============================] - 9s 249us/sample - loss: 1.7866 -
sparse_categorical_accuracy: 0.3941 - val_loss: 1.7780 -
val_sparse_categorical_accuracy: 0.3922
Epoch 9/15
37500/37500 [==============================] - 9s 246us/sample - loss: 1.7438 -
sparse_categorical_accuracy: 0.4083 - val_loss: 1.7364 -
val_sparse_categorical_accuracy: 0.4066
Epoch 10/15
37500/37500 [==============================] - 9s 249us/sample - loss: 1.7040 -
sparse_categorical_accuracy: 0.4219 - val_loss: 1.7108 -
val_sparse_categorical_accuracy: 0.4122
Epoch 11/15
37500/37500 [==============================] - 9s 251us/sample - loss: 1.6677 -
sparse_categorical_accuracy: 0.4349 - val_loss: 1.6693 -
val_sparse_categorical_accuracy: 0.4275
Epoch 12/15
37500/37500 [==============================] - 9s 248us/sample - loss: 1.6334 -
sparse_categorical_accuracy: 0.4458 - val_loss: 1.6305 -
val_sparse_categorical_accuracy: 0.4421
Epoch 13/15
37500/37500 [==============================] - 9s 251us/sample - loss: 1.6020 -
sparse_categorical_accuracy: 0.4550 - val_loss: 1.6007 -
val_sparse_categorical_accuracy: 0.4523
Epoch 14/15
```

```
37500/37500 [==============================] - 9s 251us/sample - loss: 1.5746 -
sparse_categorical_accuracy: 0.4656 - val_loss: 1.5773 -
val_sparse_categorical_accuracy: 0.4590
Epoch 15/15
37500/37500 [==============================] - 9s 250us/sample - loss: 1.5487 -
sparse_categorical_accuracy: 0.4728 - val_loss: 1.5563 -
val_sparse_categorical_accuracy: 0.4640
 97%|      | 29/30 [1:07:27<02:25, 145.77s/it]
0.464 0.0003689436581708352 0.00013779535213403522
Train on 37500 samples, validate on 12500 samples
Epoch 1/15
37500/37500 [==============================] - 12s 321us/sample - loss: 2.6105 -
sparse_categorical_accuracy: 0.1578 - val_loss: 2.5530 -
val_sparse_categorical_accuracy: 0.2116
Epoch 2/15
37500/37500 [==============================] - 9s 248us/sample - loss: 2.4607 -
sparse_categorical_accuracy: 0.2671 - val_loss: 2.3736 -
val_sparse_categorical_accuracy: 0.2986
Epoch 3/15
37500/37500 [==============================] - 9s 251us/sample - loss: 2.2920 -
sparse_categorical_accuracy: 0.3239 - val_loss: 2.2296 -
val_sparse_categorical_accuracy: 0.3427
Epoch 4/15
37500/37500 [==============================] - 9s 251us/sample - loss: 2.1605 -
sparse_categorical_accuracy: 0.3659 - val_loss: 2.1154 -
val_sparse_categorical_accuracy: 0.3786
Epoch 5/15
37500/37500 [==============================] - 9s 249us/sample - loss: 2.0551 -
sparse_categorical_accuracy: 0.4004 - val_loss: 2.0243 -
val_sparse_categorical_accuracy: 0.4128
Epoch 6/15
37500/37500 [==============================] - 9s 251us/sample - loss: 1.9677 -
sparse_categorical_accuracy: 0.4302 - val_loss: 1.9490 -
val_sparse_categorical_accuracy: 0.4311
Epoch 7/15
37500/37500 [==============================] - 9s 249us/sample - loss: 1.9017 -
sparse_categorical_accuracy: 0.4497 - val_loss: 1.8977 -
val_sparse_categorical_accuracy: 0.4447
Epoch 8/15
37500/37500 [==============================] - 9s 251us/sample - loss: 1.8513 -
sparse_categorical_accuracy: 0.4647 - val_loss: 1.8423 -
val_sparse_categorical_accuracy: 0.4618
Epoch 9/15
37500/37500 [==============================] - 9s 253us/sample - loss: 1.8113 -
sparse_categorical_accuracy: 0.4781 - val_loss: 1.8047 -
val_sparse_categorical_accuracy: 0.4821
Epoch 10/15
```

```
37500/37500 [==============================] - 9s 250us/sample - loss: 1.7764 -
sparse_categorical_accuracy: 0.4916 - val_loss: 1.7813 -
val_sparse_categorical_accuracy: 0.4825
Epoch 11/15
37500/37500 [==============================] - 10s 266us/sample - loss: 1.7446 -
sparse_categorical_accuracy: 0.5032 - val_loss: 1.7565 -
val_sparse_categorical_accuracy: 0.4939
Epoch 12/15
37500/37500 [==============================] - 9s 250us/sample - loss: 1.7150 -
sparse_categorical_accuracy: 0.5155 - val_loss: 1.7236 -
val_sparse_categorical_accuracy: 0.5026
Epoch 13/15
37500/37500 [==============================] - 9s 252us/sample - loss: 1.6875 -
sparse_categorical_accuracy: 0.5244 - val_loss: 1.6975 -
val_sparse_categorical_accuracy: 0.5166
Epoch 14/15
37500/37500 [==============================] - 10s 253us/sample - loss: 1.6627 -
sparse_categorical_accuracy: 0.5334 - val_loss: 1.6705 -
val_sparse_categorical_accuracy: 0.5238
Epoch 15/15
37500/37500 [==============================] - 9s 250us/sample - loss: 1.6378 -
sparse_categorical_accuracy: 0.5423 - val_loss: 1.6608 -
val_sparse_categorical_accuracy: 0.5340

100%|      | 30/30 [1:09:56<00:00, 139.87s/it]

0.534 0.0007184675234522362 0.0009539288681134822
```

[38]:
```
logs=[val_acc,lrs, l2_regs]
logs=np.array(logs)
# logs=np.sort(logs,axis=0)
```

[39]:
```
top4=np.argsort(logs[0,:])[::-1][:4]
top4
```

[39]:
```
array([13, 18, 16, 26], dtype=int64)
```

[40]:
```
logs[:,top4]
```

[40]:
```
array([[5.47999978e-01, 5.44160008e-01, 5.39680004e-01, 5.38800001e-01],
       [8.89732394e-04, 7.88809210e-04, 7.14903532e-04, 6.92725369e-04],
       [1.35175950e-03, 4.25579137e-06, 1.74973376e-06, 3.71546369e-06]])
```

[41]:
```
lr, l2_reg = logs[1,top4[0]],logs[2,top4[0]]
lr, l2_reg
```

[41]:
```
(0.0008897323938345441, 0.0013517594993773326)
```

[42]:
```
lr_tuned, l2_reg_tuned = lr, l2_reg
lr_tuned, l2_reg_tuned
```

[42]:
```
(0.0008897323938345441, 0.0013517594993773326)
```

**Final Training** Now we will train the model using the top performer found using the top performer from the fine search.

[43]:
```
from tensorflow.keras.callbacks import EarlyStopping
es = EarlyStopping(monitor='val_loss', mode='min', verbose=1, patience=10)
model = create_model(num_classes,l2_reg)
model.compile(optimizer=optimizers.
 ↪SGD(learning_rate=lr),loss='sparse_categorical_crossentropy',metrics=['sparse_categorical_a
history = model.fit(X_train,y_train,batch_size=BATCH_SIZE,epochs=50,␣
 ↪verbose=1,validation_data=(X_val,y_val), callbacks=[es])
```

```
Train on 37500 samples, validate on 12500 samples
Epoch 1/50
37500/37500 [==============================] - 12s 323us/sample - loss: 2.7445 -
sparse_categorical_accuracy: 0.1938 - val_loss: 2.6626 -
val_sparse_categorical_accuracy: 0.2706
Epoch 2/50
37500/37500 [==============================] - 9s 250us/sample - loss: 2.5429 -
sparse_categorical_accuracy: 0.2978 - val_loss: 2.4410 -
val_sparse_categorical_accuracy: 0.3207
Epoch 3/50
37500/37500 [==============================] - 9s 246us/sample - loss: 2.3520 -
sparse_categorical_accuracy: 0.3453 - val_loss: 2.2963 -
val_sparse_categorical_accuracy: 0.3626
Epoch 4/50
37500/37500 [==============================] - 9s 249us/sample - loss: 2.2325 -
sparse_categorical_accuracy: 0.3865 - val_loss: 2.2009 -
val_sparse_categorical_accuracy: 0.3902
Epoch 5/50
37500/37500 [==============================] - 9s 251us/sample - loss: 2.1433 -
sparse_categorical_accuracy: 0.4166 - val_loss: 2.1179 -
val_sparse_categorical_accuracy: 0.4235
Epoch 6/50
37500/37500 [==============================] - 9s 246us/sample - loss: 2.0707 -
sparse_categorical_accuracy: 0.4400 - val_loss: 2.0733 -
val_sparse_categorical_accuracy: 0.4322
Epoch 7/50
37500/37500 [==============================] - 9s 248us/sample - loss: 2.0122 -
sparse_categorical_accuracy: 0.4608 - val_loss: 2.0031 -
val_sparse_categorical_accuracy: 0.4551
Epoch 8/50
37500/37500 [==============================] - 9s 249us/sample - loss: 1.9604 -
```

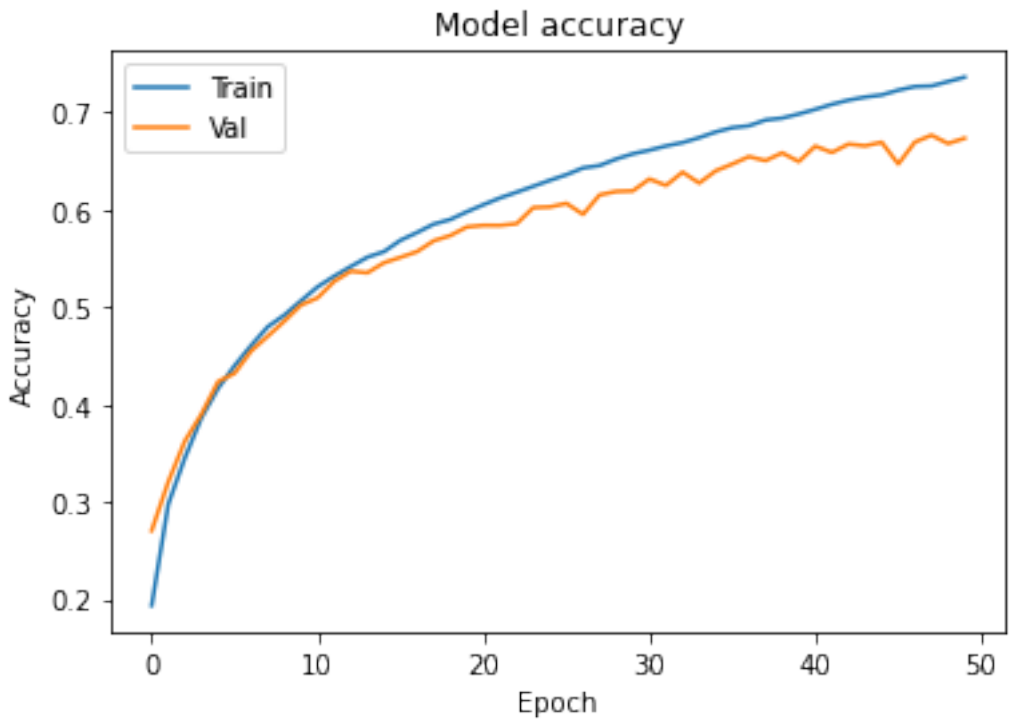
```
sparse_categorical_accuracy: 0.4799 - val_loss: 1.9612 -
val_sparse_categorical_accuracy: 0.4703
Epoch 9/50
37500/37500 [==============================] - 9s 249us/sample - loss: 1.9158 -
sparse_categorical_accuracy: 0.4919 - val_loss: 1.9165 -
val_sparse_categorical_accuracy: 0.4857
Epoch 10/50
37500/37500 [==============================] - 9s 247us/sample - loss: 1.8771 -
sparse_categorical_accuracy: 0.5066 - val_loss: 1.8725 -
val_sparse_categorical_accuracy: 0.5022
Epoch 11/50
37500/37500 [==============================] - 9s 248us/sample - loss: 1.8404 -
sparse_categorical_accuracy: 0.5209 - val_loss: 1.8566 -
val_sparse_categorical_accuracy: 0.5096
Epoch 12/50
37500/37500 [==============================] - 9s 250us/sample - loss: 1.8079 -
sparse_categorical_accuracy: 0.5318 - val_loss: 1.8134 -
val_sparse_categorical_accuracy: 0.5265
Epoch 13/50
37500/37500 [==============================] - 9s 247us/sample - loss: 1.7787 -
sparse_categorical_accuracy: 0.5417 - val_loss: 1.7884 -
val_sparse_categorical_accuracy: 0.5370
Epoch 14/50
37500/37500 [==============================] - 9s 252us/sample - loss: 1.7515 -
sparse_categorical_accuracy: 0.5513 - val_loss: 1.7931 -
val_sparse_categorical_accuracy: 0.5353
Epoch 15/50
37500/37500 [==============================] - 9s 248us/sample - loss: 1.7266 -
sparse_categorical_accuracy: 0.5570 - val_loss: 1.7461 -
val_sparse_categorical_accuracy: 0.5456
Epoch 16/50
37500/37500 [==============================] - 9s 250us/sample - loss: 1.7031 -
sparse_categorical_accuracy: 0.5687 - val_loss: 1.7390 -
val_sparse_categorical_accuracy: 0.5512
Epoch 17/50
37500/37500 [==============================] - 9s 250us/sample - loss: 1.6794 -
sparse_categorical_accuracy: 0.5767 - val_loss: 1.7098 -
val_sparse_categorical_accuracy: 0.5570
Epoch 18/50
37500/37500 [==============================] - 9s 247us/sample - loss: 1.6581 -
sparse_categorical_accuracy: 0.5853 - val_loss: 1.6813 -
val_sparse_categorical_accuracy: 0.5682
Epoch 19/50
37500/37500 [==============================] - 9s 250us/sample - loss: 1.6374 -
sparse_categorical_accuracy: 0.5900 - val_loss: 1.6679 -
val_sparse_categorical_accuracy: 0.5735
Epoch 20/50
37500/37500 [==============================] - 9s 248us/sample - loss: 1.6178 -
```

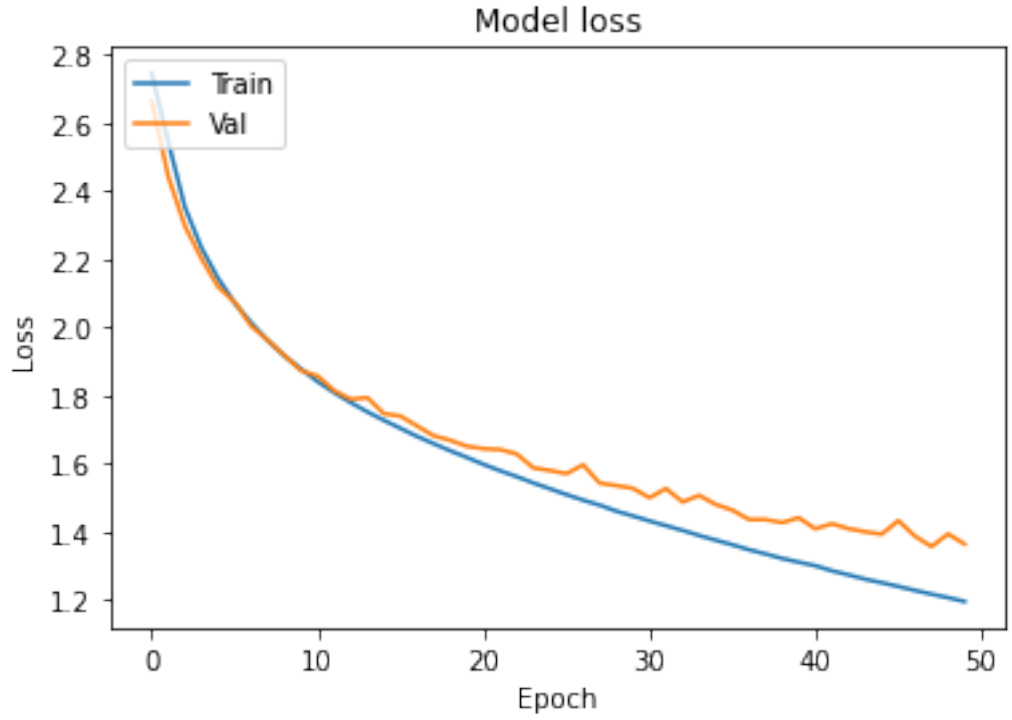
```
sparse_categorical_accuracy: 0.5980 - val_loss: 1.6505 -
val_sparse_categorical_accuracy: 0.5824
Epoch 21/50
37500/37500 [==============================] - 9s 251us/sample - loss: 1.5976 -
sparse_categorical_accuracy: 0.6053 - val_loss: 1.6435 -
val_sparse_categorical_accuracy: 0.5840
Epoch 22/50
37500/37500 [==============================] - 9s 248us/sample - loss: 1.5788 -
sparse_categorical_accuracy: 0.6122 - val_loss: 1.6408 -
val_sparse_categorical_accuracy: 0.5839
Epoch 23/50
37500/37500 [==============================] - 9s 251us/sample - loss: 1.5617 -
sparse_categorical_accuracy: 0.6181 - val_loss: 1.6280 -
val_sparse_categorical_accuracy: 0.5858
Epoch 24/50
37500/37500 [==============================] - 9s 251us/sample - loss: 1.5430 -
sparse_categorical_accuracy: 0.6241 - val_loss: 1.5873 -
val_sparse_categorical_accuracy: 0.6022
Epoch 25/50
37500/37500 [==============================] - 9s 249us/sample - loss: 1.5261 -
sparse_categorical_accuracy: 0.6302 - val_loss: 1.5794 -
val_sparse_categorical_accuracy: 0.6029
Epoch 26/50
37500/37500 [==============================] - 9s 251us/sample - loss: 1.5088 -
sparse_categorical_accuracy: 0.6360 - val_loss: 1.5703 -
val_sparse_categorical_accuracy: 0.6066
Epoch 27/50
37500/37500 [==============================] - 9s 248us/sample - loss: 1.4927 -
sparse_categorical_accuracy: 0.6430 - val_loss: 1.5963 -
val_sparse_categorical_accuracy: 0.5953
Epoch 28/50
37500/37500 [==============================] - 9s 250us/sample - loss: 1.4779 -
sparse_categorical_accuracy: 0.6454 - val_loss: 1.5426 -
val_sparse_categorical_accuracy: 0.6153
Epoch 29/50
37500/37500 [==============================] - 9s 252us/sample - loss: 1.4605 -
sparse_categorical_accuracy: 0.6521 - val_loss: 1.5354 -
val_sparse_categorical_accuracy: 0.6188
Epoch 30/50
37500/37500 [==============================] - 9s 249us/sample - loss: 1.4462 -
sparse_categorical_accuracy: 0.6574 - val_loss: 1.5273 -
val_sparse_categorical_accuracy: 0.6194
Epoch 31/50
37500/37500 [==============================] - 9s 251us/sample - loss: 1.4316 -
sparse_categorical_accuracy: 0.6611 - val_loss: 1.4997 -
val_sparse_categorical_accuracy: 0.6316
Epoch 32/50
37500/37500 [==============================] - 9s 249us/sample - loss: 1.4177 -
```

```
sparse_categorical_accuracy: 0.6655 - val_loss: 1.5265 -
val_sparse_categorical_accuracy: 0.6250
Epoch 33/50
37500/37500 [==============================] - 10s 255us/sample - loss: 1.4039 -
sparse_categorical_accuracy: 0.6690 - val_loss: 1.4873 -
val_sparse_categorical_accuracy: 0.6386
Epoch 34/50
37500/37500 [==============================] - 9s 251us/sample - loss: 1.3889 -
sparse_categorical_accuracy: 0.6740 - val_loss: 1.5067 -
val_sparse_categorical_accuracy: 0.6274
Epoch 35/50
37500/37500 [==============================] - 9s 249us/sample - loss: 1.3752 -
sparse_categorical_accuracy: 0.6799 - val_loss: 1.4798 -
val_sparse_categorical_accuracy: 0.6400
Epoch 36/50
37500/37500 [==============================] - 9s 251us/sample - loss: 1.3619 -
sparse_categorical_accuracy: 0.6843 - val_loss: 1.4634 -
val_sparse_categorical_accuracy: 0.6470
Epoch 37/50
37500/37500 [==============================] - 9s 249us/sample - loss: 1.3473 -
sparse_categorical_accuracy: 0.6862 - val_loss: 1.4358 -
val_sparse_categorical_accuracy: 0.6546
Epoch 38/50
37500/37500 [==============================] - 9s 252us/sample - loss: 1.3350 -
sparse_categorical_accuracy: 0.6922 - val_loss: 1.4356 -
val_sparse_categorical_accuracy: 0.6504
Epoch 39/50
37500/37500 [==============================] - 9s 249us/sample - loss: 1.3216 -
sparse_categorical_accuracy: 0.6941 - val_loss: 1.4267 -
val_sparse_categorical_accuracy: 0.6584
Epoch 40/50
37500/37500 [==============================] - 9s 252us/sample - loss: 1.3109 -
sparse_categorical_accuracy: 0.6983 - val_loss: 1.4410 -
val_sparse_categorical_accuracy: 0.6494
Epoch 41/50
37500/37500 [==============================] - 9s 251us/sample - loss: 1.3002 -
sparse_categorical_accuracy: 0.7031 - val_loss: 1.4086 -
val_sparse_categorical_accuracy: 0.6653
Epoch 42/50
37500/37500 [==============================] - 9s 249us/sample - loss: 1.2855 -
sparse_categorical_accuracy: 0.7082 - val_loss: 1.4234 -
val_sparse_categorical_accuracy: 0.6588
Epoch 43/50
37500/37500 [==============================] - 9s 251us/sample - loss: 1.2735 -
sparse_categorical_accuracy: 0.7125 - val_loss: 1.4089 -
val_sparse_categorical_accuracy: 0.6674
Epoch 44/50
37500/37500 [==============================] - 9s 246us/sample - loss: 1.2609 -
```

```
sparse_categorical_accuracy: 0.7157 - val_loss: 1.3998 -
val_sparse_categorical_accuracy: 0.6656
Epoch 45/50
37500/37500 [==============================] - 9s 248us/sample - loss: 1.2505 -
sparse_categorical_accuracy: 0.7178 - val_loss: 1.3927 -
val_sparse_categorical_accuracy: 0.6693
Epoch 46/50
37500/37500 [==============================] - 9s 253us/sample - loss: 1.2396 -
sparse_categorical_accuracy: 0.7228 - val_loss: 1.4326 -
val_sparse_categorical_accuracy: 0.6470
Epoch 47/50
37500/37500 [==============================] - 9s 247us/sample - loss: 1.2279 -
sparse_categorical_accuracy: 0.7265 - val_loss: 1.3873 -
val_sparse_categorical_accuracy: 0.6694
Epoch 48/50
37500/37500 [==============================] - 9s 247us/sample - loss: 1.2170 -
sparse_categorical_accuracy: 0.7271 - val_loss: 1.3566 -
val_sparse_categorical_accuracy: 0.6766
Epoch 49/50
37500/37500 [==============================] - 9s 246us/sample - loss: 1.2067 -
sparse_categorical_accuracy: 0.7316 - val_loss: 1.3934 -
val_sparse_categorical_accuracy: 0.6680
Epoch 50/50
37500/37500 [==============================] - 9s 249us/sample - loss: 1.1955 -
sparse_categorical_accuracy: 0.7361 - val_loss: 1.3639 -
val_sparse_categorical_accuracy: 0.6734
```

[44]:
```
plot_curves(history)
```

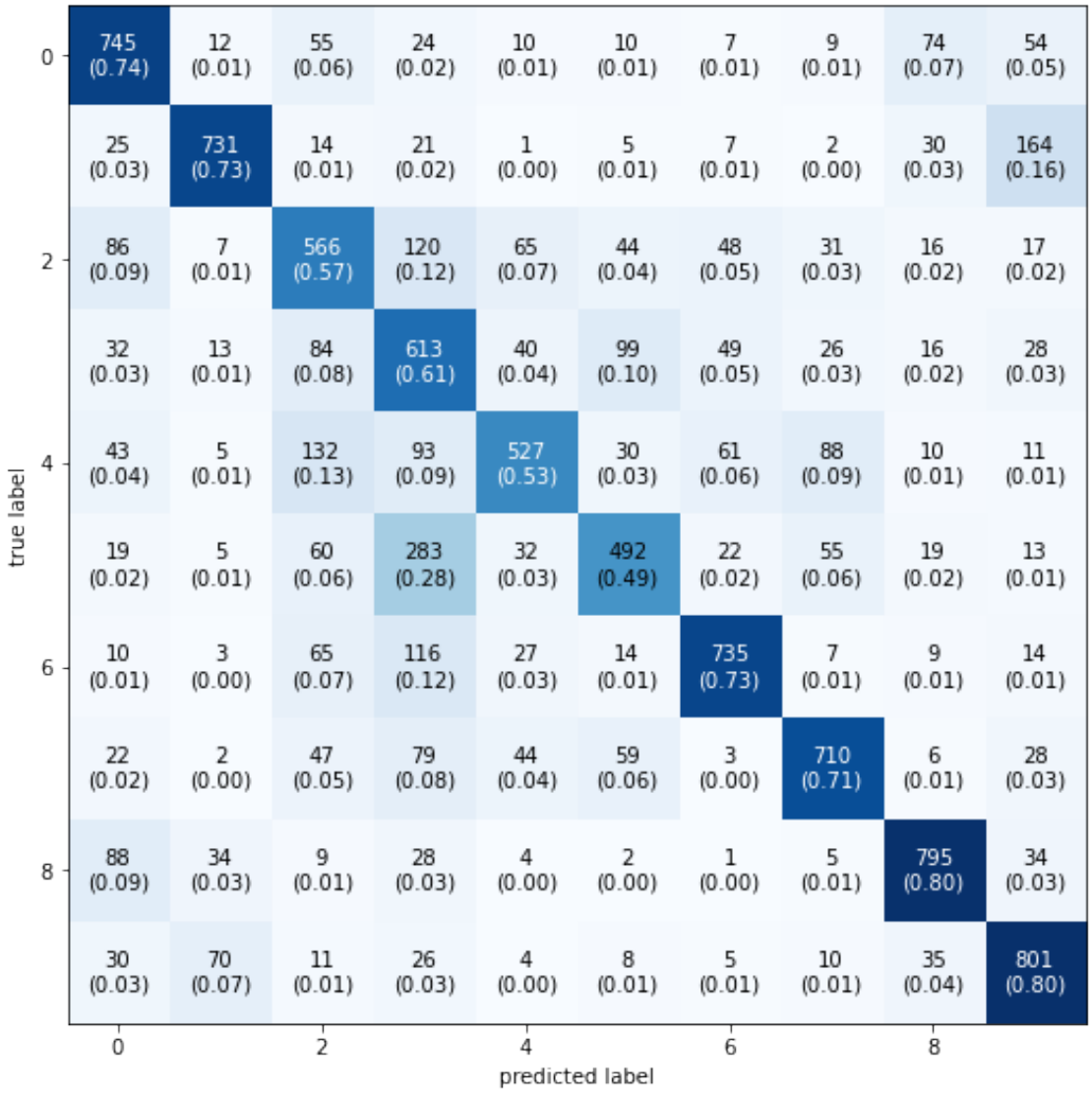

Model accuracy
Train
Val
Accuracy
0.2
0.3
0.4
0.5
0.6
0.7
0
10
20
30
40
50
Epoch


Model loss
Train
Val
Loss
1.2
1.4
1.6
1.8
2.0
2.2
2.4
2.6
2.8
0
10
20
30
40
50
Epoch

**Get predictions and find confusion matrix to get the metrics.**

[45]:
```
from mlxtend.plotting import plot_confusion_matrix
from sklearn.metrics import confusion_matrix
y_pred = model.predict_classes(X_test)
mat = confusion_matrix(y_test,y_pred)
plot_confusion_matrix(mat,figsize=(9,9), show_normed=True)
```

[45]:
```
(<Figure size 648x648 with 1 Axes>,
 <matplotlib.axes._subplots.AxesSubplot at 0x1fa21400ef0>)
```




[46]:
```
from sklearn.metrics import accuracy_score, confusion_matrix,␣
↪classification_report
```

```
print(classification_report(y_pred, y_test))
print(accuracy_score(y_pred, y_test))
```

```
              precision    recall  f1-score   support

           0       0.74      0.68      0.71      1100
           1       0.73      0.83      0.78       882
           2       0.57      0.54      0.55      1043
           3       0.61      0.44      0.51      1403
           4       0.53      0.70      0.60       754
           5       0.49      0.64      0.56       763
           6       0.73      0.78      0.76       938
           7       0.71      0.75      0.73       943
           8       0.80      0.79      0.79      1010
           9       0.80      0.69      0.74      1164

    accuracy                           0.67     10000
   macro avg       0.67      0.68      0.67     10000
weighted avg       0.68      0.67      0.67     10000

0.6715
```

### 1.1.4 Trying out Batch Norm and Dropout on the tuned hyperparameters.

[47]:
```
from tensorflow.keras.callbacks import EarlyStopping
es = EarlyStopping(monitor='val_loss', mode='min', verbose=1, patience=10)
model = create_model(num_classes,l2_reg, False, True)
model.compile(optimizer=optimizers.
 ↪SGD(learning_rate=lr),loss='sparse_categorical_crossentropy',metrics=['sparse_categorical_a
history = model.fit(X_train,y_train,batch_size=BATCH_SIZE,epochs=50,␣
 ↪verbose=1,validation_data=(X_val,y_val), callbacks=[es])
```

```
Train on 37500 samples, validate on 12500 samples
Epoch 1/50
37500/37500 [==============================] - 14s 385us/sample - loss: 2.3459 -
sparse_categorical_accuracy: 0.3403 - val_loss: 2.0777 -
val_sparse_categorical_accuracy: 0.4353
Epoch 2/50
37500/37500 [==============================] - 12s 309us/sample - loss: 2.0005 -
sparse_categorical_accuracy: 0.4693 - val_loss: 1.9120 -
val_sparse_categorical_accuracy: 0.4998
Epoch 3/50
37500/37500 [==============================] - 12s 310us/sample - loss: 1.8612 -
sparse_categorical_accuracy: 0.5205 - val_loss: 1.8090 -
val_sparse_categorical_accuracy: 0.5347
Epoch 4/50
37500/37500 [==============================] - 12s 307us/sample - loss: 1.7672 -
```

```
sparse_categorical_accuracy: 0.5578 - val_loss: 1.7310 -
val_sparse_categorical_accuracy: 0.5612
Epoch 5/50
37500/37500 [==============================] - 12s 311us/sample - loss: 1.6906 -
sparse_categorical_accuracy: 0.5859 - val_loss: 1.6759 -
val_sparse_categorical_accuracy: 0.5808
Epoch 6/50
37500/37500 [==============================] - 12s 312us/sample - loss: 1.6286 -
sparse_categorical_accuracy: 0.6083 - val_loss: 1.6270 -
val_sparse_categorical_accuracy: 0.6014
Epoch 7/50
37500/37500 [==============================] - 12s 310us/sample - loss: 1.5747 -
sparse_categorical_accuracy: 0.6249 - val_loss: 1.5840 -
val_sparse_categorical_accuracy: 0.6134
Epoch 8/50
37500/37500 [==============================] - 12s 308us/sample - loss: 1.5276 -
sparse_categorical_accuracy: 0.6422 - val_loss: 1.5478 -
val_sparse_categorical_accuracy: 0.6254
Epoch 9/50
37500/37500 [==============================] - 12s 310us/sample - loss: 1.4896 -
sparse_categorical_accuracy: 0.6548 - val_loss: 1.5221 -
val_sparse_categorical_accuracy: 0.6341
Epoch 10/50
37500/37500 [==============================] - 12s 310us/sample - loss: 1.4504 -
sparse_categorical_accuracy: 0.6680 - val_loss: 1.4892 -
val_sparse_categorical_accuracy: 0.6441
Epoch 11/50
37500/37500 [==============================] - 12s 311us/sample - loss: 1.4193 -
sparse_categorical_accuracy: 0.6775 - val_loss: 1.4600 -
val_sparse_categorical_accuracy: 0.6531
Epoch 12/50
37500/37500 [==============================] - 12s 308us/sample - loss: 1.3838 -
sparse_categorical_accuracy: 0.6916 - val_loss: 1.4547 -
val_sparse_categorical_accuracy: 0.6543
Epoch 13/50
37500/37500 [==============================] - 12s 309us/sample - loss: 1.3540 -
sparse_categorical_accuracy: 0.7008 - val_loss: 1.4214 -
val_sparse_categorical_accuracy: 0.6634
Epoch 14/50
37500/37500 [==============================] - 12s 309us/sample - loss: 1.3308 -
sparse_categorical_accuracy: 0.7077 - val_loss: 1.4047 -
val_sparse_categorical_accuracy: 0.6696
Epoch 15/50
37500/37500 [==============================] - 12s 307us/sample - loss: 1.3048 -
sparse_categorical_accuracy: 0.7135 - val_loss: 1.3925 -
val_sparse_categorical_accuracy: 0.6717
Epoch 16/50
37500/37500 [==============================] - 12s 311us/sample - loss: 1.2821 -
```

```
sparse_categorical_accuracy: 0.7236 - val_loss: 1.3929 -
val_sparse_categorical_accuracy: 0.6675
Epoch 17/50
37500/37500 [==============================] - 12s 313us/sample - loss: 1.2588 -
sparse_categorical_accuracy: 0.7284 - val_loss: 1.3700 -
val_sparse_categorical_accuracy: 0.6782
Epoch 18/50
37500/37500 [==============================] - 12s 310us/sample - loss: 1.2348 -
sparse_categorical_accuracy: 0.7392 - val_loss: 1.3551 -
val_sparse_categorical_accuracy: 0.6799
Epoch 19/50
37500/37500 [==============================] - 12s 308us/sample - loss: 1.2181 -
sparse_categorical_accuracy: 0.7441 - val_loss: 1.3459 -
val_sparse_categorical_accuracy: 0.6835
Epoch 20/50
37500/37500 [==============================] - 12s 310us/sample - loss: 1.1905 -
sparse_categorical_accuracy: 0.7540 - val_loss: 1.3550 -
val_sparse_categorical_accuracy: 0.6806
Epoch 21/50
37500/37500 [==============================] - 12s 313us/sample - loss: 1.1756 -
sparse_categorical_accuracy: 0.7589 - val_loss: 1.3177 -
val_sparse_categorical_accuracy: 0.6905
Epoch 22/50
37500/37500 [==============================] - 12s 311us/sample - loss: 1.1581 -
sparse_categorical_accuracy: 0.7630 - val_loss: 1.3220 -
val_sparse_categorical_accuracy: 0.6891
Epoch 23/50
37500/37500 [==============================] - 12s 308us/sample - loss: 1.1345 -
sparse_categorical_accuracy: 0.7707 - val_loss: 1.2975 -
val_sparse_categorical_accuracy: 0.6981
Epoch 24/50
37500/37500 [==============================] - 12s 310us/sample - loss: 1.1175 -
sparse_categorical_accuracy: 0.7769 - val_loss: 1.3230 -
val_sparse_categorical_accuracy: 0.6873
Epoch 25/50
37500/37500 [==============================] - 12s 309us/sample - loss: 1.0950 -
sparse_categorical_accuracy: 0.7847 - val_loss: 1.2882 -
val_sparse_categorical_accuracy: 0.7009
Epoch 26/50
37500/37500 [==============================] - 12s 309us/sample - loss: 1.0805 -
sparse_categorical_accuracy: 0.7883 - val_loss: 1.2833 -
val_sparse_categorical_accuracy: 0.7049
Epoch 27/50
37500/37500 [==============================] - 12s 311us/sample - loss: 1.0617 -
sparse_categorical_accuracy: 0.7926 - val_loss: 1.2749 -
val_sparse_categorical_accuracy: 0.7018
Epoch 28/50
37500/37500 [==============================] - 12s 310us/sample - loss: 1.0433 -
```

```
sparse_categorical_accuracy: 0.8007 - val_loss: 1.2785 -
val_sparse_categorical_accuracy: 0.6980
Epoch 29/50
37500/37500 [==============================] - 12s 311us/sample - loss: 1.0219 -
sparse_categorical_accuracy: 0.8081 - val_loss: 1.2681 -
val_sparse_categorical_accuracy: 0.7018
Epoch 30/50
37500/37500 [==============================] - 11s 306us/sample - loss: 1.0091 -
sparse_categorical_accuracy: 0.8142 - val_loss: 1.2546 -
val_sparse_categorical_accuracy: 0.7078
Epoch 31/50
37500/37500 [==============================] - 12s 310us/sample - loss: 0.9921 -
sparse_categorical_accuracy: 0.8181 - val_loss: 1.2735 -
val_sparse_categorical_accuracy: 0.6998
Epoch 32/50
37500/37500 [==============================] - 12s 310us/sample - loss: 0.9796 -
sparse_categorical_accuracy: 0.8207 - val_loss: 1.2623 -
val_sparse_categorical_accuracy: 0.7027
Epoch 33/50
37500/37500 [==============================] - 12s 311us/sample - loss: 0.9647 -
sparse_categorical_accuracy: 0.8269 - val_loss: 1.2505 -
val_sparse_categorical_accuracy: 0.7110
Epoch 34/50
37500/37500 [==============================] - 12s 309us/sample - loss: 0.9441 -
sparse_categorical_accuracy: 0.8334 - val_loss: 1.2640 -
val_sparse_categorical_accuracy: 0.7043
Epoch 35/50
37500/37500 [==============================] - 12s 310us/sample - loss: 0.9304 -
sparse_categorical_accuracy: 0.8380 - val_loss: 1.2444 -
val_sparse_categorical_accuracy: 0.7108
Epoch 36/50
37500/37500 [==============================] - 12s 310us/sample - loss: 0.9152 -
sparse_categorical_accuracy: 0.8437 - val_loss: 1.2355 -
val_sparse_categorical_accuracy: 0.7138
Epoch 37/50
37500/37500 [==============================] - 12s 309us/sample - loss: 0.9033 -
sparse_categorical_accuracy: 0.8474 - val_loss: 1.2476 -
val_sparse_categorical_accuracy: 0.7127
Epoch 38/50
37500/37500 [==============================] - 12s 309us/sample - loss: 0.8840 -
sparse_categorical_accuracy: 0.8531 - val_loss: 1.2370 -
val_sparse_categorical_accuracy: 0.7082
Epoch 39/50
37500/37500 [==============================] - 12s 310us/sample - loss: 0.8697 -
sparse_categorical_accuracy: 0.8578 - val_loss: 1.2346 -
val_sparse_categorical_accuracy: 0.7134
Epoch 40/50
37500/37500 [==============================] - 12s 311us/sample - loss: 0.8556 -
```

```
sparse_categorical_accuracy: 0.8610 - val_loss: 1.2283 -
val_sparse_categorical_accuracy: 0.7138
Epoch 41/50
37500/37500 [==============================] - 12s 307us/sample - loss: 0.8400 -
sparse_categorical_accuracy: 0.8664 - val_loss: 1.2381 -
val_sparse_categorical_accuracy: 0.7098
Epoch 42/50
37500/37500 [==============================] - 12s 311us/sample - loss: 0.8255 -
sparse_categorical_accuracy: 0.8742 - val_loss: 1.2246 -
val_sparse_categorical_accuracy: 0.7146
Epoch 43/50
37500/37500 [==============================] - 12s 312us/sample - loss: 0.8120 -
sparse_categorical_accuracy: 0.8777 - val_loss: 1.2477 -
val_sparse_categorical_accuracy: 0.7070
Epoch 44/50
37500/37500 [==============================] - 12s 313us/sample - loss: 0.8000 -
sparse_categorical_accuracy: 0.8809 - val_loss: 1.2248 -
val_sparse_categorical_accuracy: 0.7137
Epoch 45/50
37500/37500 [==============================] - 12s 307us/sample - loss: 0.7856 -
sparse_categorical_accuracy: 0.8847 - val_loss: 1.2293 -
val_sparse_categorical_accuracy: 0.7138
Epoch 46/50
37500/37500 [==============================] - 12s 310us/sample - loss: 0.7734 -
sparse_categorical_accuracy: 0.8891 - val_loss: 1.2294 -
val_sparse_categorical_accuracy: 0.7138
Epoch 47/50
37500/37500 [==============================] - 12s 312us/sample - loss: 0.7568 -
sparse_categorical_accuracy: 0.8957 - val_loss: 1.2318 -
val_sparse_categorical_accuracy: 0.7174
Epoch 48/50
37500/37500 [==============================] - 12s 310us/sample - loss: 0.7468 -
sparse_categorical_accuracy: 0.8979 - val_loss: 1.2466 -
val_sparse_categorical_accuracy: 0.7106
Epoch 49/50
37500/37500 [==============================] - 12s 308us/sample - loss: 0.7354 -
sparse_categorical_accuracy: 0.9007 - val_loss: 1.2297 -
val_sparse_categorical_accuracy: 0.7140
Epoch 50/50
37500/37500 [==============================] - 12s 309us/sample - loss: 0.7222 -
sparse_categorical_accuracy: 0.9063 - val_loss: 1.2426 -
val_sparse_categorical_accuracy: 0.7125
```

[48]:
```
y_pred = model.predict_classes(X_test)
mat = confusion_matrix(y_test,y_pred)
plot_confusion_matrix(mat,figsize=(9,9), show_normed=True)
print(classification_report(y_pred, y_test))
```

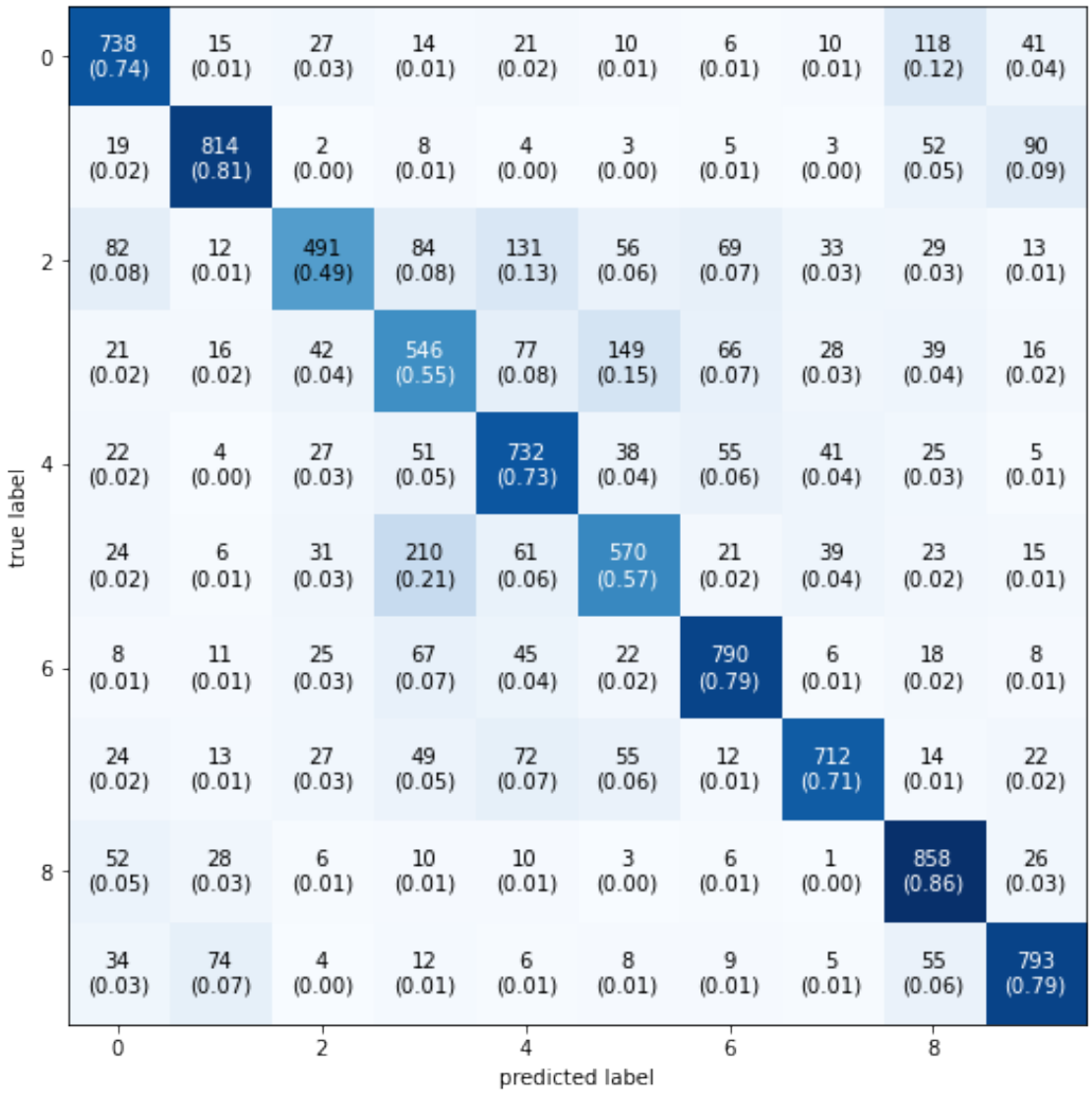
```
print(accuracy_score(y_pred, y_test))
```

```
              precision    recall  f1-score   support

           0       0.74      0.72      0.73      1024
           1       0.81      0.82      0.82       993
           2       0.49      0.72      0.58       682
           3       0.55      0.52      0.53      1051
           4       0.73      0.63      0.68      1159
           5       0.57      0.62      0.60       914
           6       0.79      0.76      0.77      1039
           7       0.71      0.81      0.76       878
           8       0.86      0.70      0.77      1231
           9       0.79      0.77      0.78      1029

    accuracy                           0.70     10000
   macro avg       0.70      0.71      0.70     10000
weighted avg       0.72      0.70      0.71     10000

0.7044
```




### 1.1.5 Check the effect of Data Preprocessing on the training.

Repeated the procedure with the preprocess flag changed to false.

[49]:
```
from tensorflow.keras.datasets import cifar10
(X_train, y_train), (X_test, y_test) = cifar10.load_data()
#conv to float
(X_train, y_train), (X_test, y_test)=(X_train.astype('float64'), y_train),␣
↪(X_test.astype('float64'), y_test)
#class_names for cifar
class_name =␣
↪['airplane','automobile','bird','cat','deer','dog','frog','horse','ship','truck']
preprocess_flag=False
```

[50]:
```
if preprocess_flag==True:
    X_train, X_test=preprocess_data(X_train, X_test)
```

[51]:
```
#model hyperparam
LEARNING_RATE=1e-4
EPOCHS=10
L2_REG=0
```

[52]:
```
model=create_model(num_classes,L2_REG)
model.summary()
```

```
Model: "sequential_150"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_450 (Conv2D)          (None, 32, 32, 32)        896
_________________________________________________________________
max_pooling2d_450 (MaxPoolin (None, 16, 16, 32)        0
_________________________________________________________________
conv2d_451 (Conv2D)          (None, 16, 16, 64)        18496
_________________________________________________________________
max_pooling2d_451 (MaxPoolin (None, 8, 8, 64)          0
_________________________________________________________________
conv2d_452 (Conv2D)          (None, 8, 8, 128)         73856
_________________________________________________________________
max_pooling2d_452 (MaxPoolin (None, 4, 4, 128)         0
_________________________________________________________________
flatten_150 (Flatten)        (None, 2048)              0
_________________________________________________________________
dense_300 (Dense)            (None, 128)               262272
_________________________________________________________________
dense_301 (Dense)            (None, 10)                1290
=================================================================
Total params: 356,810
Trainable params: 356,810
Non-trainable params: 0
_________________________________________________________________
```

[53]:
```
model.compile(optimizer=optimizers.
 ↪SGD(learning_rate=LEARNING_RATE),loss='sparse_categorical_crossentropy',metrics=['sparse_ca
model.evaluate(X_train,y_train)
```

```
50000/50000 [==============================] - 9s 178us/sample - loss: 37.8876 -
sparse_categorical_accuracy: 0.0812
```

[53]:
```
[37.887600780029295, 0.08122]
```

[54]:
```
val_acc=[]
lrs=[]
l2_regs=[]
for i in tqdm(range(100)):
    lr = 10**np.random.uniform(-3,-6)
    l2_reg = 10**np.random.uniform(-5, 1)
    model = create_model(num_classes,l2_reg)
    model.compile(optimizer=optimizers.
 ↪SGD(learning_rate=lr),loss='sparse_categorical_crossentropy',metrics=['sparse_categorical_a
    history = model.fit(X_train,y_train,batch_size=BATCH_SIZE,epochs=5,␣
 ↪verbose=1,validation_data=(X_val,y_val))
    val_acc.append(history.history['val_sparse_categorical_accuracy'][-1])
    lrs.append(lr)
    l2_regs.append(l2_reg)
    print(history.history['val_sparse_categorical_accuracy'][-1], lr, l2_reg)
```

```
  0%|          | 0/100 [00:00<?, ?it/s]

Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 16s 321us/sample - loss: 4.4687 -
sparse_categorical_accuracy: 0.1903 - val_loss: 2.3056 -
val_sparse_categorical_accuracy: 0.1392
Epoch 2/5
50000/50000 [==============================] - 13s 263us/sample - loss: 2.7116 -
sparse_categorical_accuracy: 0.2485 - val_loss: 2.3042 -
val_sparse_categorical_accuracy: 0.1442
Epoch 3/5
50000/50000 [==============================] - 13s 262us/sample - loss: 2.3584 -
sparse_categorical_accuracy: 0.2803 - val_loss: 2.3033 -
val_sparse_categorical_accuracy: 0.1482
Epoch 4/5
50000/50000 [==============================] - 13s 263us/sample - loss: 2.1868 -
sparse_categorical_accuracy: 0.3019 - val_loss: 2.3027 -
val_sparse_categorical_accuracy: 0.1555
Epoch 5/5
50000/50000 [==============================] - 13s 264us/sample - loss: 2.0771 -
sparse_categorical_accuracy: 0.3188 - val_loss: 2.3022 -
val_sparse_categorical_accuracy: 0.1585

  1%|          | 1/100 [01:13<2:01:03, 73.37s/it]

0.15848 8.660452655827102e-06 7.391720956495326e-05
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 16s 318us/sample - loss: 3.5595 -
sparse_categorical_accuracy: 0.3306 - val_loss: 3.8448 -
val_sparse_categorical_accuracy: 0.1379
Epoch 2/5
```

```
50000/50000 [==============================] - 13s 262us/sample - loss: 3.1180 -
sparse_categorical_accuracy: 0.4381 - val_loss: 3.8292 -
val_sparse_categorical_accuracy: 0.1392
Epoch 3/5
50000/50000 [==============================] - 13s 262us/sample - loss: 2.9841 -
sparse_categorical_accuracy: 0.4823 - val_loss: 3.8152 -
val_sparse_categorical_accuracy: 0.1389
Epoch 4/5
50000/50000 [==============================] - 13s 262us/sample - loss: 2.8892 -
sparse_categorical_accuracy: 0.5128 - val_loss: 3.8030 -
val_sparse_categorical_accuracy: 0.1366
Epoch 5/5
50000/50000 [==============================] - 13s 262us/sample - loss: 2.8195 -
sparse_categorical_accuracy: 0.5373 - val_loss: 3.7898 -
val_sparse_categorical_accuracy: 0.1429
  2%|          | 2/100 [02:26<1:59:37, 73.24s/it]
0.14288 0.00030997755253752687 0.0042621777050488975
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 16s 319us/sample - loss: 540.8845
- sparse_categorical_accuracy: 0.2954 - val_loss: 271.8076 -
val_sparse_categorical_accuracy: 0.1293
Epoch 2/5
50000/50000 [==============================] - 13s 258us/sample - loss: 155.7157
- sparse_categorical_accuracy: 0.3519 - val_loss: 79.4131 -
val_sparse_categorical_accuracy: 0.1686
Epoch 3/5
50000/50000 [==============================] - 13s 260us/sample - loss: 46.0875
- sparse_categorical_accuracy: 0.3290 - val_loss: 24.5027 -
val_sparse_categorical_accuracy: 0.2466
Epoch 4/5
50000/50000 [==============================] - 13s 258us/sample - loss: 14.7930
- sparse_categorical_accuracy: 0.2991 - val_loss: 8.8069 -
val_sparse_categorical_accuracy: 0.2742
Epoch 5/5
50000/50000 [==============================] - 13s 259us/sample - loss: 5.8333 -
sparse_categorical_accuracy: 0.2878 - val_loss: 4.3069 -
val_sparse_categorical_accuracy: 0.2555
  3%|          | 3/100 [03:38<1:58:04, 73.04s/it]
0.25552 7.821624978578324e-05 2.564811615707776
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 16s 319us/sample - loss: 4.7695 -
sparse_categorical_accuracy: 0.1738 - val_loss: 2.7999 -
val_sparse_categorical_accuracy: 0.1048
Epoch 2/5
```

```
50000/50000 [==============================] - 13s 264us/sample - loss: 3.1505 -
sparse_categorical_accuracy: 0.2326 - val_loss: 2.7962 -
val_sparse_categorical_accuracy: 0.1189
Epoch 3/5
50000/50000 [==============================] - 13s 263us/sample - loss: 2.8221 -
sparse_categorical_accuracy: 0.2648 - val_loss: 2.7944 -
val_sparse_categorical_accuracy: 0.1243
Epoch 4/5
50000/50000 [==============================] - 13s 261us/sample - loss: 2.6631 -
sparse_categorical_accuracy: 0.2882 - val_loss: 2.7932 -
val_sparse_categorical_accuracy: 0.1290
Epoch 5/5
50000/50000 [==============================] - 13s 262us/sample - loss: 2.5640 -
sparse_categorical_accuracy: 0.3033 - val_loss: 2.7924 -
val_sparse_categorical_accuracy: 0.1303

  4%|          | 4/100 [04:52<1:56:55, 73.08s/it]

0.13032 7.373302353750594e-06 0.001363670430351966
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 16s 322us/sample - loss: 3.4669 -
sparse_categorical_accuracy: 0.2258 - val_loss: 2.3071 -
val_sparse_categorical_accuracy: 0.1250
Epoch 2/5
50000/50000 [==============================] - 13s 262us/sample - loss: 2.1958 -
sparse_categorical_accuracy: 0.3014 - val_loss: 2.3066 -
val_sparse_categorical_accuracy: 0.1298
Epoch 3/5
50000/50000 [==============================] - 13s 264us/sample - loss: 1.9807 -
sparse_categorical_accuracy: 0.3340 - val_loss: 2.3056 -
val_sparse_categorical_accuracy: 0.1364
Epoch 4/5
50000/50000 [==============================] - 13s 264us/sample - loss: 1.8773 -
sparse_categorical_accuracy: 0.3584 - val_loss: 2.3050 -
val_sparse_categorical_accuracy: 0.1392
Epoch 5/5
50000/50000 [==============================] - 13s 264us/sample - loss: 1.8098 -
sparse_categorical_accuracy: 0.3760 - val_loss: 2.3044 -
val_sparse_categorical_accuracy: 0.1406

  5%|          | 5/100 [06:05<1:55:56, 73.23s/it]

0.14064 1.9282353681220903e-05 2.698815440459969e-05
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 16s 322us/sample - loss: 3.7696 -
sparse_categorical_accuracy: 0.1933 - val_loss: 2.3685 -
val_sparse_categorical_accuracy: 0.1237
Epoch 2/5
```

```
50000/50000 [==============================] - 13s 265us/sample - loss: 2.4800 -
sparse_categorical_accuracy: 0.2509 - val_loss: 2.3676 -
val_sparse_categorical_accuracy: 0.1222
Epoch 3/5
50000/50000 [==============================] - 13s 264us/sample - loss: 2.2431 -
sparse_categorical_accuracy: 0.2776 - val_loss: 2.3665 -
val_sparse_categorical_accuracy: 0.1232
Epoch 4/5
50000/50000 [==============================] - 13s 266us/sample - loss: 2.1226 -
sparse_categorical_accuracy: 0.2997 - val_loss: 2.3657 -
val_sparse_categorical_accuracy: 0.1246
Epoch 5/5
50000/50000 [==============================] - 13s 264us/sample - loss: 2.0458 -
sparse_categorical_accuracy: 0.3158 - val_loss: 2.3649 -
val_sparse_categorical_accuracy: 0.1238

  6%|          | 6/100 [07:19<1:55:01, 73.42s/it]

0.12376 1.131659824769087e-05 0.00019067082984828784
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 16s 327us/sample - loss: 2.6128 -
sparse_categorical_accuracy: 0.3743 - val_loss: 3.0823 -
val_sparse_categorical_accuracy: 0.1916
Epoch 2/5
50000/50000 [==============================] - 13s 266us/sample - loss: 2.2364 -
sparse_categorical_accuracy: 0.4859 - val_loss: 3.0703 -
val_sparse_categorical_accuracy: 0.2218
Epoch 3/5
50000/50000 [==============================] - 13s 265us/sample - loss: 2.0952 -
sparse_categorical_accuracy: 0.5371 - val_loss: 3.0593 -
val_sparse_categorical_accuracy: 0.2352
Epoch 4/5
50000/50000 [==============================] - 13s 268us/sample - loss: 1.9925 -
sparse_categorical_accuracy: 0.5722 - val_loss: 3.0519 -
val_sparse_categorical_accuracy: 0.2111
Epoch 5/5
50000/50000 [==============================] - 13s 266us/sample - loss: 1.9089 -
sparse_categorical_accuracy: 0.5986 - val_loss: 3.0402 -
val_sparse_categorical_accuracy: 0.2502

  7%|          | 7/100 [08:33<1:54:17, 73.74s/it]

0.25024 0.0007423504025545301 0.002192957430950753
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 16s 329us/sample - loss: 10.9091
- sparse_categorical_accuracy: 0.1662 - val_loss: 8.7332 -
val_sparse_categorical_accuracy: 0.1302
Epoch 2/5
```

```
50000/50000 [==============================] - 14s 273us/sample - loss: 9.2077 -
sparse_categorical_accuracy: 0.2281 - val_loss: 8.7246 -
val_sparse_categorical_accuracy: 0.1319
Epoch 3/5
50000/50000 [==============================] - 14s 274us/sample - loss: 8.8634 -
sparse_categorical_accuracy: 0.2565 - val_loss: 8.7177 -
val_sparse_categorical_accuracy: 0.1347
Epoch 4/5
50000/50000 [==============================] - 14s 273us/sample - loss: 8.6835 -
sparse_categorical_accuracy: 0.2770 - val_loss: 8.7112 -
val_sparse_categorical_accuracy: 0.1365
Epoch 5/5
50000/50000 [==============================] - 14s 272us/sample - loss: 8.5705 -
sparse_categorical_accuracy: 0.2942 - val_loss: 8.7050 -
val_sparse_categorical_accuracy: 0.1381
  8%|          | 8/100 [09:49<1:54:05, 74.40s/it]
0.13808 6.746816048299533e-06 0.017462224985745928
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 17s 330us/sample - loss: 142.1161
- sparse_categorical_accuracy: 0.2865 - val_loss: 125.6281 -
val_sparse_categorical_accuracy: 0.0950
Epoch 2/5
50000/50000 [==============================] - 13s 267us/sample - loss: 111.1533
- sparse_categorical_accuracy: 0.3851 - val_loss: 98.8721 -
val_sparse_categorical_accuracy: 0.1118
Epoch 3/5
50000/50000 [==============================] - 13s 268us/sample - loss: 87.3371
- sparse_categorical_accuracy: 0.4216 - val_loss: 77.9482 -
val_sparse_categorical_accuracy: 0.1281
Epoch 4/5
50000/50000 [==============================] - 13s 267us/sample - loss: 68.7293
- sparse_categorical_accuracy: 0.4398 - val_loss: 61.5792 -
val_sparse_categorical_accuracy: 0.1530
Epoch 5/5
50000/50000 [==============================] - 13s 268us/sample - loss: 54.1786
- sparse_categorical_accuracy: 0.4559 - val_loss: 48.7710 -
val_sparse_categorical_accuracy: 0.1651
  9%|          | 9/100 [11:04<1:53:04, 74.56s/it]
0.16512 9.152158785556221e-05 0.4275746481754762
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 17s 335us/sample - loss: 3.0251 -
sparse_categorical_accuracy: 0.2409 - val_loss: 2.3257 -
val_sparse_categorical_accuracy: 0.1547
Epoch 2/5
```

```
50000/50000 [==============================] - 13s 269us/sample - loss: 1.9811 -
sparse_categorical_accuracy: 0.3278 - val_loss: 2.3233 -
val_sparse_categorical_accuracy: 0.1669
Epoch 3/5
50000/50000 [==============================] - 13s 269us/sample - loss: 1.8385 -
sparse_categorical_accuracy: 0.3638 - val_loss: 2.3221 -
val_sparse_categorical_accuracy: 0.1784
Epoch 4/5
50000/50000 [==============================] - 13s 267us/sample - loss: 1.7568 -
sparse_categorical_accuracy: 0.3911 - val_loss: 2.3213 -
val_sparse_categorical_accuracy: 0.1870
Epoch 5/5
50000/50000 [==============================] - 13s 269us/sample - loss: 1.7014 -
sparse_categorical_accuracy: 0.4096 - val_loss: 2.3204 -
val_sparse_categorical_accuracy: 0.1899

 10%|          | 10/100 [12:20<1:52:13, 74.81s/it]

0.18992 3.6666307462315554e-05 0.00010584895254129705
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 16s 329us/sample - loss: 2.1937 -
sparse_categorical_accuracy: 0.3013 - val_loss: 2.3094 -
val_sparse_categorical_accuracy: 0.1415
Epoch 2/5
50000/50000 [==============================] - 14s 270us/sample - loss: 1.7073 -
sparse_categorical_accuracy: 0.3966 - val_loss: 2.3069 -
val_sparse_categorical_accuracy: 0.1548
Epoch 3/5
50000/50000 [==============================] - 14s 271us/sample - loss: 1.6003 -
sparse_categorical_accuracy: 0.4357 - val_loss: 2.3044 -
val_sparse_categorical_accuracy: 0.1726
Epoch 4/5
50000/50000 [==============================] - 14s 272us/sample - loss: 1.5303 -
sparse_categorical_accuracy: 0.4605 - val_loss: 2.3024 -
val_sparse_categorical_accuracy: 0.1798
Epoch 5/5
50000/50000 [==============================] - 14s 270us/sample - loss: 1.4761 -
sparse_categorical_accuracy: 0.4818 - val_loss: 2.3014 -
val_sparse_categorical_accuracy: 0.1859

 11%|          | 11/100 [13:35<1:51:19, 75.05s/it]

0.18592 0.0001387961910392624 3.2646822932980595e-05
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 17s 334us/sample - loss: 8.0145 -
sparse_categorical_accuracy: 0.1335 - val_loss: 2.4067 -
val_sparse_categorical_accuracy: 0.0887
Epoch 2/5
```

```
50000/50000 [==============================] - 14s 270us/sample - loss: 4.9241 -
sparse_categorical_accuracy: 0.1681 - val_loss: 2.4042 -
val_sparse_categorical_accuracy: 0.0922
Epoch 3/5
50000/50000 [==============================] - 13s 269us/sample - loss: 4.1853 -
sparse_categorical_accuracy: 0.1824 - val_loss: 2.4029 -
val_sparse_categorical_accuracy: 0.0949
Epoch 4/5
50000/50000 [==============================] - 13s 270us/sample - loss: 3.7672 -
sparse_categorical_accuracy: 0.1954 - val_loss: 2.4020 -
val_sparse_categorical_accuracy: 0.0961
Epoch 5/5
50000/50000 [==============================] - 13s 269us/sample - loss: 3.4830 -
sparse_categorical_accuracy: 0.2064 - val_loss: 2.4015 -
val_sparse_categorical_accuracy: 0.0973

 12%|         | 12/100 [14:51<1:50:21, 75.25s/it]

0.09728 1.1814154715939826e-06 0.00023552215673875294
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 17s 338us/sample - loss: 2.0872 -
sparse_categorical_accuracy: 0.3352 - val_loss: 2.2896 -
val_sparse_categorical_accuracy: 0.1826
Epoch 2/5
50000/50000 [==============================] - 14s 275us/sample - loss: 1.6058 -
sparse_categorical_accuracy: 0.4299 - val_loss: 2.2858 -
val_sparse_categorical_accuracy: 0.1995
Epoch 3/5
50000/50000 [==============================] - 14s 274us/sample - loss: 1.4958 -
sparse_categorical_accuracy: 0.4704 - val_loss: 2.2823 -
val_sparse_categorical_accuracy: 0.2111
Epoch 4/5
50000/50000 [==============================] - 14s 274us/sample - loss: 1.4193 -
sparse_categorical_accuracy: 0.4992 - val_loss: 2.2810 -
val_sparse_categorical_accuracy: 0.2220
Epoch 5/5
50000/50000 [==============================] - 14s 275us/sample - loss: 1.3622 -
sparse_categorical_accuracy: 0.5199 - val_loss: 2.2789 -
val_sparse_categorical_accuracy: 0.2313

 13%|         | 13/100 [16:08<1:49:46, 75.71s/it]

0.23128 0.00023098104944903008 1.017317191492179e-05
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 17s 338us/sample - loss: 2.1848 -
sparse_categorical_accuracy: 0.3218 - val_loss: 2.4214 -
val_sparse_categorical_accuracy: 0.1046
Epoch 2/5
```

```
50000/50000 [==============================] - 14s 272us/sample - loss: 1.7446 -
sparse_categorical_accuracy: 0.4224 - val_loss: 2.4171 -
val_sparse_categorical_accuracy: 0.1199
Epoch 3/5
50000/50000 [==============================] - 14s 274us/sample - loss: 1.6281 -
sparse_categorical_accuracy: 0.4637 - val_loss: 2.4147 -
val_sparse_categorical_accuracy: 0.1374
Epoch 4/5
50000/50000 [==============================] - 14s 274us/sample - loss: 1.5521 -
sparse_categorical_accuracy: 0.4929 - val_loss: 2.4131 -
val_sparse_categorical_accuracy: 0.1352
Epoch 5/5
50000/50000 [==============================] - 14s 273us/sample - loss: 1.4927 -
sparse_categorical_accuracy: 0.5152 - val_loss: 2.4113 -
val_sparse_categorical_accuracy: 0.1502
 14%|         | 14/100 [17:24<1:48:54, 75.98s/it]
0.15024 0.00022122603410128585 0.0003473902158777044
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 17s 338us/sample - loss: 361.8096
- sparse_categorical_accuracy: 0.2318 - val_loss: 5.1043 -
val_sparse_categorical_accuracy: 0.0984
Epoch 2/5
50000/50000 [==============================] - 14s 275us/sample - loss: 2.7170 -
sparse_categorical_accuracy: 0.1301 - val_loss: 2.3058 -
val_sparse_categorical_accuracy: 0.0984
Epoch 3/5
50000/50000 [==============================] - 14s 273us/sample - loss: 2.3031 -
sparse_categorical_accuracy: 0.0987 - val_loss: 2.3026 -
val_sparse_categorical_accuracy: 0.0984
Epoch 4/5
50000/50000 [==============================] - 14s 274us/sample - loss: 2.3026 -
sparse_categorical_accuracy: 0.0992 - val_loss: 2.3026 -
val_sparse_categorical_accuracy: 0.0984
Epoch 5/5
50000/50000 [==============================] - 14s 273us/sample - loss: 2.3026 -
sparse_categorical_accuracy: 0.0999 - val_loss: 2.3026 -
val_sparse_categorical_accuracy: 0.0984
 15%|         | 15/100 [18:41<1:48:00, 76.24s/it]
0.0984 0.00016390020948105736 6.60175322839365
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 17s 343us/sample - loss: 31.3806
- sparse_categorical_accuracy: 0.2105 - val_loss: 30.1010 -
val_sparse_categorical_accuracy: 0.1318
Epoch 2/5
```

```
50000/50000 [==============================] - 14s 277us/sample - loss: 29.9024
- sparse_categorical_accuracy: 0.2931 - val_loss: 29.8410 -
val_sparse_categorical_accuracy: 0.1478
Epoch 3/5
50000/50000 [==============================] - 14s 277us/sample - loss: 29.4287
- sparse_categorical_accuracy: 0.3280 - val_loss: 29.5882 -
val_sparse_categorical_accuracy: 0.1558
Epoch 4/5
50000/50000 [==============================] - 14s 277us/sample - loss: 29.0721
- sparse_categorical_accuracy: 0.3546 - val_loss: 29.3395 -
val_sparse_categorical_accuracy: 0.1618
Epoch 5/5
50000/50000 [==============================] - 14s 277us/sample - loss: 28.7550
- sparse_categorical_accuracy: 0.3720 - val_loss: 29.0945 -
val_sparse_categorical_accuracy: 0.1678

 16%|         | 16/100 [19:59<1:47:24, 76.72s/it]

0.16776 1.8822414719646452e-05 0.07600958018334109
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 17s 342us/sample - loss: 6.7407 -
sparse_categorical_accuracy: 0.1431 - val_loss: 2.3088 -
val_sparse_categorical_accuracy: 0.1209
Epoch 2/5
50000/50000 [==============================] - 14s 283us/sample - loss: 4.1072 -
sparse_categorical_accuracy: 0.1865 - val_loss: 2.3065 -
val_sparse_categorical_accuracy: 0.1228
Epoch 3/5
50000/50000 [==============================] - 14s 282us/sample - loss: 3.3753 -
sparse_categorical_accuracy: 0.2079 - val_loss: 2.3052 -
val_sparse_categorical_accuracy: 0.1266
Epoch 4/5
50000/50000 [==============================] - 14s 282us/sample - loss: 3.0087 -
sparse_categorical_accuracy: 0.2258 - val_loss: 2.3044 -
val_sparse_categorical_accuracy: 0.1289
Epoch 5/5
50000/50000 [==============================] - 14s 283us/sample - loss: 2.7891 -
sparse_categorical_accuracy: 0.2393 - val_loss: 2.3036 -
val_sparse_categorical_accuracy: 0.1319

 17%|         | 17/100 [21:18<1:47:08, 77.45s/it]

0.13192 1.935458357409728e-06 2.346832291218174e-05
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 17s 347us/sample - loss: 2.0456 -
sparse_categorical_accuracy: 0.3161 - val_loss: 2.2933 -
val_sparse_categorical_accuracy: 0.1322
Epoch 2/5
```

```
50000/50000 [==============================] - 14s 280us/sample - loss: 1.6336 -
sparse_categorical_accuracy: 0.4193 - val_loss: 2.2906 -
val_sparse_categorical_accuracy: 0.1448
Epoch 3/5
50000/50000 [==============================] - 14s 280us/sample - loss: 1.5086 -
sparse_categorical_accuracy: 0.4648 - val_loss: 2.2890 -
val_sparse_categorical_accuracy: 0.1492
Epoch 4/5
50000/50000 [==============================] - 14s 279us/sample - loss: 1.4298 -
sparse_categorical_accuracy: 0.4897 - val_loss: 2.2880 -
val_sparse_categorical_accuracy: 0.1521
Epoch 5/5
50000/50000 [==============================] - 14s 279us/sample - loss: 1.3724 -
sparse_categorical_accuracy: 0.5145 - val_loss: 2.2874 -
val_sparse_categorical_accuracy: 0.1527

 18%|         | 18/100 [22:37<1:46:19, 77.80s/it]

0.15272 0.00020275646010410128 1.1092885870313044e-05
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 17s 346us/sample - loss: 61.2725
- sparse_categorical_accuracy: 0.3432 - val_loss: 7.8691 -
val_sparse_categorical_accuracy: 0.2250
Epoch 2/5
50000/50000 [==============================] - 14s 284us/sample - loss: 3.3265 -
sparse_categorical_accuracy: 0.3901 - val_loss: 2.6312 -
val_sparse_categorical_accuracy: 0.2584
Epoch 3/5
50000/50000 [==============================] - 14s 283us/sample - loss: 1.9131 -
sparse_categorical_accuracy: 0.3989 - val_loss: 2.4980 -
val_sparse_categorical_accuracy: 0.2794
Epoch 4/5
50000/50000 [==============================] - 14s 283us/sample - loss: 1.8517 -
sparse_categorical_accuracy: 0.4072 - val_loss: 2.4938 -
val_sparse_categorical_accuracy: 0.2194
Epoch 5/5
50000/50000 [==============================] - 14s 283us/sample - loss: 1.8254 -
sparse_categorical_accuracy: 0.4150 - val_loss: 2.4965 -
val_sparse_categorical_accuracy: 0.2669

 19%|         | 19/100 [23:56<1:45:39, 78.26s/it]

0.26688 0.0009760324743815582 0.6143160393120578
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 17s 344us/sample - loss:
3159.4948 - sparse_categorical_accuracy: 0.1538 - val_loss: 2914.0011 -
val_sparse_categorical_accuracy: 0.1263
Epoch 2/5
```

```
50000/50000 [==============================] - 14s 279us/sample - loss:
2697.2543 - sparse_categorical_accuracy: 0.2121 - val_loss: 2489.9991 -
val_sparse_categorical_accuracy: 0.1346
Epoch 3/5
50000/50000 [==============================] - 14s 279us/sample - loss:
2304.4234 - sparse_categorical_accuracy: 0.2409 - val_loss: 2127.8632 -
val_sparse_categorical_accuracy: 0.1390
Epoch 4/5
50000/50000 [==============================] - 14s 279us/sample - loss:
1969.1038 - sparse_categorical_accuracy: 0.2635 - val_loss: 1818.5117 -
val_sparse_categorical_accuracy: 0.1435
Epoch 5/5
50000/50000 [==============================] - 14s 282us/sample - loss:
1682.7332 - sparse_categorical_accuracy: 0.2802 - val_loss: 1554.2246 -
val_sparse_categorical_accuracy: 0.1461

 20%|         | 20/100 [25:15<1:44:27, 78.35s/it]

0.14608 2.7287134984525446e-06 9.216388581763288
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 17s 350us/sample - loss: 2.7872 -
sparse_categorical_accuracy: 0.2865 - val_loss: 2.5800 -
val_sparse_categorical_accuracy: 0.1304
Epoch 2/5
50000/50000 [==============================] - 14s 282us/sample - loss: 2.0557 -
sparse_categorical_accuracy: 0.3780 - val_loss: 2.5780 -
val_sparse_categorical_accuracy: 0.1476
Epoch 3/5
50000/50000 [==============================] - 14s 284us/sample - loss: 1.9426 -
sparse_categorical_accuracy: 0.4151 - val_loss: 2.5765 -
val_sparse_categorical_accuracy: 0.1612
Epoch 4/5
50000/50000 [==============================] - 14s 284us/sample - loss: 1.8691 -
sparse_categorical_accuracy: 0.4403 - val_loss: 2.5750 -
val_sparse_categorical_accuracy: 0.1695
Epoch 5/5
50000/50000 [==============================] - 14s 282us/sample - loss: 1.8122 -
sparse_categorical_accuracy: 0.4612 - val_loss: 2.5737 -
val_sparse_categorical_accuracy: 0.1749

 21%|         | 21/100 [26:34<1:43:35, 78.68s/it]

0.17488 9.154195055497476e-05 0.0007661567636344115
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 17s 346us/sample - loss: 4.2562 -
sparse_categorical_accuracy: 0.2240 - val_loss: 3.2598 -
val_sparse_categorical_accuracy: 0.1187
Epoch 2/5
```

```
50000/50000 [==============================] - 14s 284us/sample - loss: 3.1361 -
sparse_categorical_accuracy: 0.2882 - val_loss: 3.2574 -
val_sparse_categorical_accuracy: 0.1239
Epoch 3/5
50000/50000 [==============================] - 14s 283us/sample - loss: 2.9489 -
sparse_categorical_accuracy: 0.3223 - val_loss: 3.2560 -
val_sparse_categorical_accuracy: 0.1291
Epoch 4/5
50000/50000 [==============================] - 14s 283us/sample - loss: 2.8508 -
sparse_categorical_accuracy: 0.3461 - val_loss: 3.2549 -
val_sparse_categorical_accuracy: 0.1306
Epoch 5/5
50000/50000 [==============================] - 14s 282us/sample - loss: 2.7840 -
sparse_categorical_accuracy: 0.3651 - val_loss: 3.2540 -
val_sparse_categorical_accuracy: 0.1319

 22%|         | 22/100 [27:54<1:42:34, 78.90s/it]

0.13192 1.8104423091926943e-05 0.0026332854885286095
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 18s 352us/sample - loss: 1.9873 -
sparse_categorical_accuracy: 0.3449 - val_loss: 2.2831 -
val_sparse_categorical_accuracy: 0.1772
Epoch 2/5
50000/50000 [==============================] - 14s 288us/sample - loss: 1.5225 -
sparse_categorical_accuracy: 0.4630 - val_loss: 2.2802 -
val_sparse_categorical_accuracy: 0.1938
Epoch 3/5
50000/50000 [==============================] - 14s 287us/sample - loss: 1.3902 -
sparse_categorical_accuracy: 0.5098 - val_loss: 2.2814 -
val_sparse_categorical_accuracy: 0.2010
Epoch 4/5
50000/50000 [==============================] - 14s 287us/sample - loss: 1.3012 -
sparse_categorical_accuracy: 0.5495 - val_loss: 2.2793 -
val_sparse_categorical_accuracy: 0.1926
Epoch 5/5
50000/50000 [==============================] - 14s 289us/sample - loss: 1.2201 -
sparse_categorical_accuracy: 0.5764 - val_loss: 2.2785 -
val_sparse_categorical_accuracy: 0.1986

 23%|         | 23/100 [29:14<1:41:58, 79.46s/it]

0.19864 0.0008105007715771471 3.622876194489416e-05
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 17s 343us/sample - loss: 4.2450 -
sparse_categorical_accuracy: 0.1539 - val_loss: 2.4943 -
val_sparse_categorical_accuracy: 0.0993
Epoch 2/5
```

```
50000/50000 [==============================] - 14s 285us/sample - loss: 2.9535 -
sparse_categorical_accuracy: 0.1942 - val_loss: 2.4915 -
val_sparse_categorical_accuracy: 0.1033
Epoch 3/5
50000/50000 [==============================] - 14s 284us/sample - loss: 2.6213 -
sparse_categorical_accuracy: 0.2248 - val_loss: 2.4900 -
val_sparse_categorical_accuracy: 0.1050
Epoch 4/5
50000/50000 [==============================] - 14s 284us/sample - loss: 2.4708 -
sparse_categorical_accuracy: 0.2423 - val_loss: 2.4891 -
val_sparse_categorical_accuracy: 0.1034
Epoch 5/5
50000/50000 [==============================] - 14s 284us/sample - loss: 2.3784 -
sparse_categorical_accuracy: 0.2567 - val_loss: 2.4882 -
val_sparse_categorical_accuracy: 0.1052

 24%|         | 24/100 [30:34<1:40:39, 79.47s/it]

0.1052 5.559780932507906e-06 0.000504886949018922
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 18s 356us/sample - loss: 66.2237
- sparse_categorical_accuracy: 0.1074 - val_loss: 2.3026 -
val_sparse_categorical_accuracy: 0.1012
Epoch 2/5
50000/50000 [==============================] - 15s 291us/sample - loss: 2.3026 -
sparse_categorical_accuracy: 0.0985 - val_loss: 2.3026 -
val_sparse_categorical_accuracy: 0.1012
Epoch 3/5
50000/50000 [==============================] - 14s 289us/sample - loss: 2.3026 -
sparse_categorical_accuracy: 0.0969 - val_loss: 2.3026 -
val_sparse_categorical_accuracy: 0.1012
Epoch 4/5
50000/50000 [==============================] - 14s 290us/sample - loss: 2.3026 -
sparse_categorical_accuracy: 0.0977 - val_loss: 2.3026 -
val_sparse_categorical_accuracy: 0.0996
Epoch 5/5
50000/50000 [==============================] - 15s 290us/sample - loss: 2.3026 -
sparse_categorical_accuracy: 0.0970 - val_loss: 2.3026 -
val_sparse_categorical_accuracy: 0.0996

 25%|         | 25/100 [31:55<1:40:03, 80.04s/it]

0.0996 0.0009371490479952055 8.71299183899672
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 18s 361us/sample - loss: 13.7230
- sparse_categorical_accuracy: 0.1708 - val_loss: 10.6970 -
val_sparse_categorical_accuracy: 0.0895
Epoch 2/5
```

```
50000/50000 [==============================] - 14s 284us/sample - loss: 11.5418
- sparse_categorical_accuracy: 0.2135 - val_loss: 10.6872 -
val_sparse_categorical_accuracy: 0.0902
Epoch 3/5
50000/50000 [==============================] - 14s 284us/sample - loss: 11.0932
- sparse_categorical_accuracy: 0.2334 - val_loss: 10.6790 -
val_sparse_categorical_accuracy: 0.0909
Epoch 4/5
50000/50000 [==============================] - 14s 285us/sample - loss: 10.8733
- sparse_categorical_accuracy: 0.2483 - val_loss: 10.6714 -
val_sparse_categorical_accuracy: 0.0934
Epoch 5/5
50000/50000 [==============================] - 14s 286us/sample - loss: 10.7315
- sparse_categorical_accuracy: 0.2623 - val_loss: 10.6642 -
val_sparse_categorical_accuracy: 0.0938

 26%|         | 26/100 [33:16<1:38:58, 80.25s/it]

0.09376 4.966945386230178e-06 0.02275725488424489
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 18s 355us/sample - loss: 2.3916 -
sparse_categorical_accuracy: 0.3398 - val_loss: 2.6983 -
val_sparse_categorical_accuracy: 0.1640
Epoch 2/5
50000/50000 [==============================] - 15s 292us/sample - loss: 1.9506 -
sparse_categorical_accuracy: 0.4536 - val_loss: 2.6905 -
val_sparse_categorical_accuracy: 0.1718
Epoch 3/5
50000/50000 [==============================] - 15s 293us/sample - loss: 1.8232 -
sparse_categorical_accuracy: 0.4975 - val_loss: 2.6883 -
val_sparse_categorical_accuracy: 0.1728
Epoch 4/5
50000/50000 [==============================] - 15s 292us/sample - loss: 1.7404 -
sparse_categorical_accuracy: 0.5295 - val_loss: 2.6873 -
val_sparse_categorical_accuracy: 0.1693
Epoch 5/5
50000/50000 [==============================] - 15s 291us/sample - loss: 1.6749 -
sparse_categorical_accuracy: 0.5529 - val_loss: 2.6869 -
val_sparse_categorical_accuracy: 0.1697

 27%|         | 27/100 [34:38<1:38:16, 80.77s/it]

0.16968 0.0004720873498397735 0.0011356461034378379
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 18s 362us/sample - loss: 5.5674 -
sparse_categorical_accuracy: 0.1630 - val_loss: 2.3119 -
val_sparse_categorical_accuracy: 0.1006
Epoch 2/5
```

```
50000/50000 [==============================] - 15s 292us/sample - loss: 3.2289 -
sparse_categorical_accuracy: 0.2077 - val_loss: 2.3094 -
val_sparse_categorical_accuracy: 0.1041
Epoch 3/5
50000/50000 [==============================] - 15s 292us/sample - loss: 2.7828 -
sparse_categorical_accuracy: 0.2283 - val_loss: 2.3080 -
val_sparse_categorical_accuracy: 0.1074
Epoch 4/5
50000/50000 [==============================] - 15s 291us/sample - loss: 2.5474 -
sparse_categorical_accuracy: 0.2466 - val_loss: 2.3069 -
val_sparse_categorical_accuracy: 0.1097
Epoch 5/5
50000/50000 [==============================] - 15s 291us/sample - loss: 2.3971 -
sparse_categorical_accuracy: 0.2607 - val_loss: 2.3062 -
val_sparse_categorical_accuracy: 0.1121

 28%|         | 28/100 [36:00<1:37:23, 81.15s/it]

0.11208 3.6498107363745878e-06 1.859268030991274e-05
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 18s 363us/sample - loss: 8.9866 -
sparse_categorical_accuracy: 0.1877 - val_loss: 7.0772 -
val_sparse_categorical_accuracy: 0.1134
Epoch 2/5
50000/50000 [==============================] - 14s 283us/sample - loss: 7.4184 -
sparse_categorical_accuracy: 0.2504 - val_loss: 7.0714 -
val_sparse_categorical_accuracy: 0.1127
Epoch 3/5
50000/50000 [==============================] - 14s 284us/sample - loss: 7.0863 -
sparse_categorical_accuracy: 0.2822 - val_loss: 7.0663 -
val_sparse_categorical_accuracy: 0.1125
Epoch 4/5
50000/50000 [==============================] - 14s 285us/sample - loss: 6.9208 -
sparse_categorical_accuracy: 0.3010 - val_loss: 7.0613 -
val_sparse_categorical_accuracy: 0.1165
Epoch 5/5
50000/50000 [==============================] - 14s 286us/sample - loss: 6.8151 -
sparse_categorical_accuracy: 0.3167 - val_loss: 7.0567 -
val_sparse_categorical_accuracy: 0.1172

 29%|         | 29/100 [37:21<1:35:52, 81.02s/it]

0.1172 9.416081732502577e-06 0.012967309814815193
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 18s 366us/sample - loss: 4.8463 -
sparse_categorical_accuracy: 0.2029 - val_loss: 3.1526 -
val_sparse_categorical_accuracy: 0.1252
Epoch 2/5
```

```
50000/50000 [==============================] - 15s 293us/sample - loss: 3.3631 -
sparse_categorical_accuracy: 0.2664 - val_loss: 3.1516 -
val_sparse_categorical_accuracy: 0.1315
Epoch 3/5
50000/50000 [==============================] - 14s 288us/sample - loss: 3.0824 -
sparse_categorical_accuracy: 0.2950 - val_loss: 3.1511 -
val_sparse_categorical_accuracy: 0.1345
Epoch 4/5
50000/50000 [==============================] - 15s 290us/sample - loss: 2.9311 -
sparse_categorical_accuracy: 0.3168 - val_loss: 3.1507 -
val_sparse_categorical_accuracy: 0.1382
Epoch 5/5
50000/50000 [==============================] - 15s 292us/sample - loss: 2.8356 -
sparse_categorical_accuracy: 0.3368 - val_loss: 3.1503 -
val_sparse_categorical_accuracy: 0.1400

 30%|         | 30/100 [38:43<1:34:58, 81.41s/it]

0.14 1.1109154899548993e-05 0.0023259411615945687
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 18s 360us/sample - loss: 5.5573 -
sparse_categorical_accuracy: 0.1246 - val_loss: 2.3469 -
val_sparse_categorical_accuracy: 0.0958
Epoch 2/5
50000/50000 [==============================] - 15s 295us/sample - loss: 3.3175 -
sparse_categorical_accuracy: 0.1640 - val_loss: 2.3449 -
val_sparse_categorical_accuracy: 0.0986
Epoch 3/5
50000/50000 [==============================] - 15s 293us/sample - loss: 2.9220 -
sparse_categorical_accuracy: 0.1835 - val_loss: 2.3435 -
val_sparse_categorical_accuracy: 0.1013
Epoch 4/5
50000/50000 [==============================] - 15s 293us/sample - loss: 2.7064 -
sparse_categorical_accuracy: 0.1976 - val_loss: 2.3425 -
val_sparse_categorical_accuracy: 0.1032
Epoch 5/5
50000/50000 [==============================] - 15s 291us/sample - loss: 2.5660 -
sparse_categorical_accuracy: 0.2125 - val_loss: 2.3417 -
val_sparse_categorical_accuracy: 0.1050

 31%|         | 31/100 [40:06<1:34:06, 81.84s/it]

0.10504 3.2478376553314656e-06 0.00011255363953711129
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 18s 369us/sample - loss: 722.0889
- sparse_categorical_accuracy: 0.2321 - val_loss: 39.0534 -
val_sparse_categorical_accuracy: 0.1000
Epoch 2/5
```

```
50000/50000 [==============================] - 15s 294us/sample - loss: 10.4160
- sparse_categorical_accuracy: 0.1288 - val_loss: 2.7174 -
val_sparse_categorical_accuracy: 0.0984
Epoch 3/5
50000/50000 [==============================] - 15s 293us/sample - loss: 2.3941 -
sparse_categorical_accuracy: 0.1001 - val_loss: 2.3073 -
val_sparse_categorical_accuracy: 0.0984
Epoch 4/5
50000/50000 [==============================] - 15s 300us/sample - loss: 2.3036 -
sparse_categorical_accuracy: 0.0998 - val_loss: 2.3026 -
val_sparse_categorical_accuracy: 0.0984
Epoch 5/5
50000/50000 [==============================] - 15s 293us/sample - loss: 2.3026 -
sparse_categorical_accuracy: 0.0986 - val_loss: 2.3026 -
val_sparse_categorical_accuracy: 0.0984

 32%|        | 32/100 [41:29<1:33:16, 82.31s/it]

0.0984 8.093679238637585e-05 8.862115146376118
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 18s 367us/sample - loss: 1.8291 -
sparse_categorical_accuracy: 0.3689 - val_loss: 2.2853 -
val_sparse_categorical_accuracy: 0.1727
Epoch 2/5
50000/50000 [==============================] - 15s 295us/sample - loss: 1.4901 -
sparse_categorical_accuracy: 0.4732 - val_loss: 2.2816 -
val_sparse_categorical_accuracy: 0.1872
Epoch 3/5
50000/50000 [==============================] - 15s 294us/sample - loss: 1.3632 -
sparse_categorical_accuracy: 0.5195 - val_loss: 2.2818 -
val_sparse_categorical_accuracy: 0.1729
Epoch 4/5
50000/50000 [==============================] - 15s 293us/sample - loss: 1.2776 -
sparse_categorical_accuracy: 0.5514 - val_loss: 2.2812 -
val_sparse_categorical_accuracy: 0.1705
Epoch 5/5
50000/50000 [==============================] - 15s 293us/sample - loss: 1.2049 -
sparse_categorical_accuracy: 0.5810 - val_loss: 2.2788 -
val_sparse_categorical_accuracy: 0.1690

 33%|        | 33/100 [42:52<1:32:09, 82.53s/it]

0.16896 0.0006180041944253648 1.860954330406976e-05
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 18s 369us/sample - loss: 2.2856 -
sparse_categorical_accuracy: 0.2823 - val_loss: 2.3068 -
val_sparse_categorical_accuracy: 0.1199
Epoch 2/5
```

```
50000/50000 [==============================] - 15s 295us/sample - loss: 1.7690 -
sparse_categorical_accuracy: 0.3783 - val_loss: 2.3025 -
val_sparse_categorical_accuracy: 0.1288
Epoch 3/5
50000/50000 [==============================] - 15s 294us/sample - loss: 1.6538 -
sparse_categorical_accuracy: 0.4178 - val_loss: 2.3001 -
val_sparse_categorical_accuracy: 0.1370
Epoch 4/5
50000/50000 [==============================] - 15s 295us/sample - loss: 1.5792 -
sparse_categorical_accuracy: 0.4432 - val_loss: 2.2985 -
val_sparse_categorical_accuracy: 0.1454
Epoch 5/5
50000/50000 [==============================] - 15s 297us/sample - loss: 1.5256 -
sparse_categorical_accuracy: 0.4626 - val_loss: 2.2979 -
val_sparse_categorical_accuracy: 0.1494

 34%|        | 34/100 [44:16<1:31:03, 82.77s/it]

0.14936 9.278775280428263e-05 3.240361174412997e-05
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 18s 369us/sample - loss: 1.9729 -
sparse_categorical_accuracy: 0.3464 - val_loss: 2.3039 -
val_sparse_categorical_accuracy: 0.1502
Epoch 2/5
50000/50000 [==============================] - 15s 292us/sample - loss: 1.5086 -
sparse_categorical_accuracy: 0.4642 - val_loss: 2.2970 -
val_sparse_categorical_accuracy: 0.1672
Epoch 3/5
50000/50000 [==============================] - 15s 293us/sample - loss: 1.3672 -
sparse_categorical_accuracy: 0.5181 - val_loss: 2.2973 -
val_sparse_categorical_accuracy: 0.1633
Epoch 4/5
50000/50000 [==============================] - 15s 293us/sample - loss: 1.2660 -
sparse_categorical_accuracy: 0.5582 - val_loss: 2.2954 -
val_sparse_categorical_accuracy: 0.1678
Epoch 5/5
50000/50000 [==============================] - 15s 292us/sample - loss: 1.1872 -
sparse_categorical_accuracy: 0.5872 - val_loss: 2.2941 -
val_sparse_categorical_accuracy: 0.1703

 35%|        | 35/100 [45:39<1:29:45, 82.85s/it]

0.17032 0.000966541768600278 3.422218281672664e-05
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 18s 370us/sample - loss: 24.2141
- sparse_categorical_accuracy: 0.1507 - val_loss: 21.0367 -
val_sparse_categorical_accuracy: 0.1236
Epoch 2/5
```

```
50000/50000 [==============================] - 15s 296us/sample - loss: 21.8644
- sparse_categorical_accuracy: 0.2166 - val_loss: 21.0015 -
val_sparse_categorical_accuracy: 0.1266
Epoch 3/5
50000/50000 [==============================] - 15s 297us/sample - loss: 21.3749
- sparse_categorical_accuracy: 0.2472 - val_loss: 20.9691 -
val_sparse_categorical_accuracy: 0.1317
Epoch 4/5
50000/50000 [==============================] - 15s 297us/sample - loss: 21.1091
- sparse_categorical_accuracy: 0.2680 - val_loss: 20.9383 -
val_sparse_categorical_accuracy: 0.1336
Epoch 5/5
50000/50000 [==============================] - 15s 294us/sample - loss: 20.9358
- sparse_categorical_accuracy: 0.2850 - val_loss: 20.9082 -
val_sparse_categorical_accuracy: 0.1375
```

```
 36%|        | 36/100 [47:03<1:28:43, 83.18s/it]
```

```
0.13752 4.619224081146212e-06 0.05076776996428
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 19s 371us/sample - loss:
1042.2619 - sparse_categorical_accuracy: 0.2567 - val_loss: 548.3929 -
val_sparse_categorical_accuracy: 0.1663
Epoch 2/5
50000/50000 [==============================] - 15s 306us/sample - loss: 323.7142
- sparse_categorical_accuracy: 0.3355 - val_loss: 171.4173 -
val_sparse_categorical_accuracy: 0.2232
Epoch 3/5
50000/50000 [==============================] - 15s 305us/sample - loss: 101.7906
- sparse_categorical_accuracy: 0.3117 - val_loss: 54.7725 -
val_sparse_categorical_accuracy: 0.2628
Epoch 4/5
50000/50000 [==============================] - 15s 306us/sample - loss: 33.1341
- sparse_categorical_accuracy: 0.2754 - val_loss: 18.6513 -
val_sparse_categorical_accuracy: 0.1926
Epoch 5/5
50000/50000 [==============================] - 15s 306us/sample - loss: 11.8793
- sparse_categorical_accuracy: 0.2477 - val_loss: 7.4550 -
val_sparse_categorical_accuracy: 0.1538
```

```
 37%|        | 37/100 [48:29<1:28:11, 84.00s/it]
```

```
0.15384 3.9182233753124054e-05 4.789225082030182
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 19s 376us/sample - loss: 120.7255
- sparse_categorical_accuracy: 0.1546 - val_loss: 2.3033 -
val_sparse_categorical_accuracy: 0.1018
Epoch 2/5
```

```
50000/50000 [==============================] - 15s 301us/sample - loss: 2.3026 -
sparse_categorical_accuracy: 0.0992 - val_loss: 2.3026 -
val_sparse_categorical_accuracy: 0.1018
Epoch 3/5
50000/50000 [==============================] - 15s 302us/sample - loss: 2.3026 -
sparse_categorical_accuracy: 0.1000 - val_loss: 2.3026 -
val_sparse_categorical_accuracy: 0.1018
Epoch 4/5
50000/50000 [==============================] - 15s 300us/sample - loss: 2.3026 -
sparse_categorical_accuracy: 0.1000 - val_loss: 2.3026 -
val_sparse_categorical_accuracy: 0.1018
Epoch 5/5
50000/50000 [==============================] - 15s 299us/sample - loss: 2.3026 -
sparse_categorical_accuracy: 0.1000 - val_loss: 2.3026 -
val_sparse_categorical_accuracy: 0.1018

 38%|        | 38/100 [49:54<1:27:08, 84.33s/it]

0.10184 0.0005005824116328683 4.6895572090655335
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 19s 373us/sample - loss: 12.5445
- sparse_categorical_accuracy: 0.3018 - val_loss: 12.5221 -
val_sparse_categorical_accuracy: 0.1350
Epoch 2/5
50000/50000 [==============================] - 16s 312us/sample - loss: 11.7865
- sparse_categorical_accuracy: 0.3972 - val_loss: 12.2587 -
val_sparse_categorical_accuracy: 0.1470
Epoch 3/5
50000/50000 [==============================] - 16s 311us/sample - loss: 11.4144
- sparse_categorical_accuracy: 0.4391 - val_loss: 12.0038 -
val_sparse_categorical_accuracy: 0.1570
Epoch 4/5
50000/50000 [==============================] - 16s 313us/sample - loss: 11.0934
- sparse_categorical_accuracy: 0.4637 - val_loss: 11.7564 -
val_sparse_categorical_accuracy: 0.1628
Epoch 5/5
50000/50000 [==============================] - 16s 313us/sample - loss: 10.7965
- sparse_categorical_accuracy: 0.4846 - val_loss: 11.5169 -
val_sparse_categorical_accuracy: 0.1724

 39%|        | 39/100 [51:21<1:26:36, 85.19s/it]

0.1724 0.00014442364226493467 0.028442628253410818
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 19s 380us/sample - loss: 201.2705
- sparse_categorical_accuracy: 0.2406 - val_loss: 188.0227 -
val_sparse_categorical_accuracy: 0.1476
Epoch 2/5
```

```
50000/50000 [==============================] - 15s 307us/sample - loss: 176.1989
- sparse_categorical_accuracy: 0.3318 - val_loss: 165.5789 -
val_sparse_categorical_accuracy: 0.1646
Epoch 3/5
50000/50000 [==============================] - 15s 306us/sample - loss: 154.9993
- sparse_categorical_accuracy: 0.3759 - val_loss: 145.8770 -
val_sparse_categorical_accuracy: 0.1719
Epoch 4/5
50000/50000 [==============================] - 15s 307us/sample - loss: 136.4412
- sparse_categorical_accuracy: 0.4018 - val_loss: 128.5693 -
val_sparse_categorical_accuracy: 0.1823
Epoch 5/5
50000/50000 [==============================] - 15s 306us/sample - loss: 120.1570
- sparse_categorical_accuracy: 0.4215 - val_loss: 113.3600 -
val_sparse_categorical_accuracy: 0.1930

 40%|        | 40/100 [52:47<1:25:32, 85.55s/it]

0.19304 3.5830496950712624e-05 0.5736406679086342
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 19s 386us/sample - loss: 2.4853 -
sparse_categorical_accuracy: 0.2650 - val_loss: 2.3052 -
val_sparse_categorical_accuracy: 0.1501
Epoch 2/5
50000/50000 [==============================] - 16s 312us/sample - loss: 1.8282 -
sparse_categorical_accuracy: 0.3576 - val_loss: 2.3037 -
val_sparse_categorical_accuracy: 0.1622
Epoch 3/5
50000/50000 [==============================] - 16s 312us/sample - loss: 1.7121 -
sparse_categorical_accuracy: 0.4000 - val_loss: 2.3027 -
val_sparse_categorical_accuracy: 0.1665
Epoch 4/5
50000/50000 [==============================] - 16s 312us/sample - loss: 1.6432 -
sparse_categorical_accuracy: 0.4206 - val_loss: 2.3018 -
val_sparse_categorical_accuracy: 0.1729
Epoch 5/5
50000/50000 [==============================] - 16s 312us/sample - loss: 1.5908 -
sparse_categorical_accuracy: 0.4415 - val_loss: 2.3013 -
val_sparse_categorical_accuracy: 0.1831

 41%|        | 41/100 [54:15<1:24:46, 86.22s/it]

0.18312 7.707163423100442e-05 4.818299979831991e-05
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 20s 390us/sample - loss: 7.2589 -
sparse_categorical_accuracy: 0.1229 - val_loss: 2.3063 -
val_sparse_categorical_accuracy: 0.1279
Epoch 2/5
```

```
50000/50000 [==============================] - 16s 311us/sample - loss: 4.6956 -
sparse_categorical_accuracy: 0.1563 - val_loss: 2.3043 -
val_sparse_categorical_accuracy: 0.1302
Epoch 3/5
50000/50000 [==============================] - 16s 313us/sample - loss: 3.9854 -
sparse_categorical_accuracy: 0.1735 - val_loss: 2.3033 -
val_sparse_categorical_accuracy: 0.1348
Epoch 4/5
50000/50000 [==============================] - 16s 312us/sample - loss: 3.5907 -
sparse_categorical_accuracy: 0.1853 - val_loss: 2.3026 -
val_sparse_categorical_accuracy: 0.1349
Epoch 5/5
50000/50000 [==============================] - 16s 312us/sample - loss: 3.3373 -
sparse_categorical_accuracy: 0.1955 - val_loss: 2.3021 -
val_sparse_categorical_accuracy: 0.1363
 42%|        | 42/100 [55:43<1:23:55, 86.81s/it]
0.13632 1.117221459834184e-06 2.566521898510271e-05
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 19s 388us/sample - loss: 4.5409 -
sparse_categorical_accuracy: 0.1848 - val_loss: 2.5701 -
val_sparse_categorical_accuracy: 0.1058
Epoch 2/5
50000/50000 [==============================] - 16s 316us/sample - loss: 2.8437 -
sparse_categorical_accuracy: 0.2466 - val_loss: 2.5687 -
val_sparse_categorical_accuracy: 0.1053
Epoch 3/5
50000/50000 [==============================] - 16s 317us/sample - loss: 2.5325 -
sparse_categorical_accuracy: 0.2774 - val_loss: 2.5681 -
val_sparse_categorical_accuracy: 0.1064
Epoch 4/5
50000/50000 [==============================] - 16s 317us/sample - loss: 2.3809 -
sparse_categorical_accuracy: 0.3016 - val_loss: 2.5676 -
val_sparse_categorical_accuracy: 0.1086
Epoch 5/5
50000/50000 [==============================] - 16s 318us/sample - loss: 2.2901 -
sparse_categorical_accuracy: 0.3171 - val_loss: 2.5673 -
val_sparse_categorical_accuracy: 0.1103
 43%|        | 43/100 [57:12<1:23:08, 87.52s/it]
0.11032 1.0509701610327857e-05 0.0007278167768206475
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 19s 387us/sample - loss: 4.7910 -
sparse_categorical_accuracy: 0.1709 - val_loss: 2.3079 -
val_sparse_categorical_accuracy: 0.1059
Epoch 2/5
```

```
50000/50000 [==============================] - 15s 304us/sample - loss: 2.9746 -
sparse_categorical_accuracy: 0.2193 - val_loss: 2.3066 -
val_sparse_categorical_accuracy: 0.1127
Epoch 3/5
50000/50000 [==============================] - 15s 305us/sample - loss: 2.5695 -
sparse_categorical_accuracy: 0.2483 - val_loss: 2.3058 -
val_sparse_categorical_accuracy: 0.1138
Epoch 4/5
50000/50000 [==============================] - 15s 305us/sample - loss: 2.3534 -
sparse_categorical_accuracy: 0.2678 - val_loss: 2.3050 -
val_sparse_categorical_accuracy: 0.1171
Epoch 5/5
50000/50000 [==============================] - 15s 305us/sample - loss: 2.2228 -
sparse_categorical_accuracy: 0.2847 - val_loss: 2.3042 -
val_sparse_categorical_accuracy: 0.1205
```

```
 44%|        | 44/100 [58:39<1:21:28, 87.30s/it]
```

```
0.12048 6.074592866267217e-06 1.4202134297339958e-05
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 20s 393us/sample - loss: 363.9589
- sparse_categorical_accuracy: 0.3209 - val_loss: 164.4913 -
val_sparse_categorical_accuracy: 0.1470
Epoch 2/5
50000/50000 [==============================] - 16s 314us/sample - loss: 88.1262
- sparse_categorical_accuracy: 0.3814 - val_loss: 41.1411 -
val_sparse_categorical_accuracy: 0.1762
Epoch 3/5
50000/50000 [==============================] - 16s 312us/sample - loss: 22.6532
- sparse_categorical_accuracy: 0.3619 - val_loss: 11.7750 -
val_sparse_categorical_accuracy: 0.1554
Epoch 4/5
50000/50000 [==============================] - 16s 312us/sample - loss: 7.0486 -
sparse_categorical_accuracy: 0.3514 - val_loss: 4.7715 -
val_sparse_categorical_accuracy: 0.1746
Epoch 5/5
50000/50000 [==============================] - 16s 312us/sample - loss: 3.3092 -
sparse_categorical_accuracy: 0.3535 - val_loss: 3.0980 -
val_sparse_categorical_accuracy: 0.1686
```

```
 45%|        | 45/100 [1:00:08<1:20:19, 87.63s/it]
```

```
0.16864 0.000124271599439648 1.8480483992583205
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 20s 394us/sample - loss: 4.0341 -
sparse_categorical_accuracy: 0.1511 - val_loss: 2.3103 -
val_sparse_categorical_accuracy: 0.1137
Epoch 2/5
```

```
50000/50000 [==============================] - 16s 316us/sample - loss: 2.6422 -
sparse_categorical_accuracy: 0.2091 - val_loss: 2.3073 -
val_sparse_categorical_accuracy: 0.1196
Epoch 3/5
50000/50000 [==============================] - 16s 317us/sample - loss: 2.3995 -
sparse_categorical_accuracy: 0.2350 - val_loss: 2.3056 -
val_sparse_categorical_accuracy: 0.1238
Epoch 4/5
50000/50000 [==============================] - 16s 317us/sample - loss: 2.2626 -
sparse_categorical_accuracy: 0.2562 - val_loss: 2.3046 -
val_sparse_categorical_accuracy: 0.1262
Epoch 5/5
50000/50000 [==============================] - 16s 316us/sample - loss: 2.1704 -
sparse_categorical_accuracy: 0.2721 - val_loss: 2.3037 -
val_sparse_categorical_accuracy: 0.1275
 46%|        | 46/100 [1:01:37<1:19:22, 88.19s/it]
0.12752 6.130198036437592e-06 1.5193172131477439e-05
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 20s 392us/sample - loss: 6.9417 -
sparse_categorical_accuracy: 0.2874 - val_loss: 6.9734 -
val_sparse_categorical_accuracy: 0.1130
Epoch 2/5
50000/50000 [==============================] - 16s 311us/sample - loss: 6.3799 -
sparse_categorical_accuracy: 0.3862 - val_loss: 6.9308 -
val_sparse_categorical_accuracy: 0.1300
Epoch 3/5
50000/50000 [==============================] - 15s 308us/sample - loss: 6.2222 -
sparse_categorical_accuracy: 0.4282 - val_loss: 6.8901 -
val_sparse_categorical_accuracy: 0.1342
Epoch 4/5
50000/50000 [==============================] - 15s 307us/sample - loss: 6.1073 -
sparse_categorical_accuracy: 0.4542 - val_loss: 6.8500 -
val_sparse_categorical_accuracy: 0.1388
Epoch 5/5
50000/50000 [==============================] - 15s 309us/sample - loss: 6.0105 -
sparse_categorical_accuracy: 0.4737 - val_loss: 6.8109 -
val_sparse_categorical_accuracy: 0.1413
 47%|        | 47/100 [1:03:05<1:17:48, 88.09s/it]
0.14128 0.00010868703488978787 0.01278135988760256
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 20s 398us/sample - loss: 783.4958
- sparse_categorical_accuracy: 0.2143 - val_loss: 686.2986 -
val_sparse_categorical_accuracy: 0.1039
Epoch 2/5
```

```
50000/50000 [==============================] - 16s 316us/sample - loss: 605.3384
- sparse_categorical_accuracy: 0.2892 - val_loss: 531.4129 -
val_sparse_categorical_accuracy: 0.1144
Epoch 3/5
50000/50000 [==============================] - 16s 316us/sample - loss: 468.6097
- sparse_categorical_accuracy: 0.3329 - val_loss: 411.6815 -
val_sparse_categorical_accuracy: 0.1298
Epoch 4/5
50000/50000 [==============================] - 16s 319us/sample - loss: 362.9661
- sparse_categorical_accuracy: 0.3580 - val_loss: 319.0855 -
val_sparse_categorical_accuracy: 0.1477
Epoch 5/5
50000/50000 [==============================] - 16s 316us/sample - loss: 281.2845
- sparse_categorical_accuracy: 0.3716 - val_loss: 247.4629 -
val_sparse_categorical_accuracy: 0.1599
 48%|        | 48/100 [1:04:35<1:16:46, 88.58s/it]
0.15992 1.713241813243912e-05 2.3952041301064853
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 19s 390us/sample - loss: 88.9843
- sparse_categorical_accuracy: 0.1153 - val_loss: 2.3026 -
val_sparse_categorical_accuracy: 0.1006
Epoch 2/5
50000/50000 [==============================] - 16s 316us/sample - loss: 2.3026 -
sparse_categorical_accuracy: 0.1000 - val_loss: 2.3026 -
val_sparse_categorical_accuracy: 0.1006
Epoch 3/5
50000/50000 [==============================] - 16s 315us/sample - loss: 2.3026 -
sparse_categorical_accuracy: 0.1000 - val_loss: 2.3026 -
val_sparse_categorical_accuracy: 0.1006
Epoch 4/5
50000/50000 [==============================] - 16s 316us/sample - loss: 2.3026 -
sparse_categorical_accuracy: 0.0989 - val_loss: 2.3026 -
val_sparse_categorical_accuracy: 0.1006
Epoch 5/5
50000/50000 [==============================] - 16s 315us/sample - loss: 2.3026 -
sparse_categorical_accuracy: 0.1000 - val_loss: 2.3026 -
val_sparse_categorical_accuracy: 0.1006
 49%|        | 49/100 [1:06:04<1:15:26, 88.75s/it]
0.10064 0.0006870392241764772 6.981922149668817
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 20s 401us/sample - loss:
1634.7702 - sparse_categorical_accuracy: 0.1790 - val_loss: 1414.5388 -
val_sparse_categorical_accuracy: 0.1226
Epoch 2/5
```

```
50000/50000 [==============================] - 16s 317us/sample - loss:
1233.8110 - sparse_categorical_accuracy: 0.2466 - val_loss: 1069.0230 -
val_sparse_categorical_accuracy: 0.1306
Epoch 3/5
50000/50000 [==============================] - 16s 317us/sample - loss: 932.3381
- sparse_categorical_accuracy: 0.2851 - val_loss: 808.1589 -
val_sparse_categorical_accuracy: 0.1370
Epoch 4/5
50000/50000 [==============================] - 16s 318us/sample - loss: 704.8074
- sparse_categorical_accuracy: 0.3101 - val_loss: 611.1461 -
val_sparse_categorical_accuracy: 0.1417
Epoch 5/5
50000/50000 [==============================] - 16s 317us/sample - loss: 532.9979
- sparse_categorical_accuracy: 0.3242 - val_loss: 462.3319 -
val_sparse_categorical_accuracy: 0.1486

 50%|        | 50/100 [1:07:34<1:14:18, 89.17s/it]

0.14864 8.849240678561492e-06 5.068219322203608
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 20s 396us/sample - loss: 10.1176
- sparse_categorical_accuracy: 0.3533 - val_loss: 10.0141 -
val_sparse_categorical_accuracy: 0.1422
Epoch 2/5
50000/50000 [==============================] - 16s 318us/sample - loss: 8.7304 -
sparse_categorical_accuracy: 0.4746 - val_loss: 9.0833 -
val_sparse_categorical_accuracy: 0.1773
Epoch 3/5
50000/50000 [==============================] - 16s 319us/sample - loss: 7.7126 -
sparse_categorical_accuracy: 0.5314 - val_loss: 8.2677 -
val_sparse_categorical_accuracy: 0.2026
Epoch 4/5
50000/50000 [==============================] - 16s 318us/sample - loss: 6.8431 -
sparse_categorical_accuracy: 0.5743 - val_loss: 7.5527 -
val_sparse_categorical_accuracy: 0.2702
Epoch 5/5
50000/50000 [==============================] - 16s 320us/sample - loss: 6.0966 -
sparse_categorical_accuracy: 0.6052 - val_loss: 6.9296 -
val_sparse_categorical_accuracy: 0.2713

 51%|        | 51/100 [1:09:04<1:13:03, 89.46s/it]

0.27128 0.0008625174769695302 0.023791158565395234
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 20s 400us/sample - loss: 3.3343 -
sparse_categorical_accuracy: 0.3310 - val_loss: 3.5941 -
val_sparse_categorical_accuracy: 0.1376
Epoch 2/5
```

```
50000/50000 [==============================] - 16s 318us/sample - loss: 2.9314 -
sparse_categorical_accuracy: 0.4169 - val_loss: 3.5873 -
val_sparse_categorical_accuracy: 0.1390
Epoch 3/5
50000/50000 [==============================] - 16s 316us/sample - loss: 2.8186 -
sparse_categorical_accuracy: 0.4562 - val_loss: 3.5811 -
val_sparse_categorical_accuracy: 0.1404
Epoch 4/5
50000/50000 [==============================] - 16s 316us/sample - loss: 2.7359 -
sparse_categorical_accuracy: 0.4849 - val_loss: 3.5756 -
val_sparse_categorical_accuracy: 0.1404
Epoch 5/5
50000/50000 [==============================] - 16s 316us/sample - loss: 2.6700 -
sparse_categorical_accuracy: 0.5093 - val_loss: 3.5682 -
val_sparse_categorical_accuracy: 0.1420

 52%|       | 52/100 [1:10:34<1:11:41, 89.62s/it]

0.142 0.00019643693391209233 0.0035553967843622754
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 20s 399us/sample - loss: 26.5764
- sparse_categorical_accuracy: 0.1250 - val_loss: 21.0635 -
val_sparse_categorical_accuracy: 0.1149
Epoch 2/5
50000/50000 [==============================] - 16s 318us/sample - loss: 23.2089
- sparse_categorical_accuracy: 0.1678 - val_loss: 21.0511 -
val_sparse_categorical_accuracy: 0.1174
Epoch 3/5
50000/50000 [==============================] - 16s 316us/sample - loss: 22.5498
- sparse_categorical_accuracy: 0.1881 - val_loss: 21.0406 -
val_sparse_categorical_accuracy: 0.1194
Epoch 4/5
50000/50000 [==============================] - 16s 318us/sample - loss: 22.1779
- sparse_categorical_accuracy: 0.2008 - val_loss: 21.0309 -
val_sparse_categorical_accuracy: 0.1225
Epoch 5/5
50000/50000 [==============================] - 16s 317us/sample - loss: 21.9209
- sparse_categorical_accuracy: 0.2110 - val_loss: 21.0218 -
val_sparse_categorical_accuracy: 0.1204

 53%|       | 53/100 [1:12:04<1:10:19, 89.79s/it]

0.1204 1.2320208478575217e-06 0.0509118666838477
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 20s 397us/sample - loss: 16.1438
- sparse_categorical_accuracy: 0.1598 - val_loss: 13.6833 -
val_sparse_categorical_accuracy: 0.1227
Epoch 2/5
```

```
50000/50000 [==============================] - 16s 317us/sample - loss: 14.5120
- sparse_categorical_accuracy: 0.1930 - val_loss: 13.6737 -
val_sparse_categorical_accuracy: 0.1267
Epoch 3/5
50000/50000 [==============================] - 16s 318us/sample - loss: 14.1392
- sparse_categorical_accuracy: 0.2112 - val_loss: 13.6650 -
val_sparse_categorical_accuracy: 0.1283
Epoch 4/5
50000/50000 [==============================] - 16s 318us/sample - loss: 13.9344
- sparse_categorical_accuracy: 0.2270 - val_loss: 13.6568 -
val_sparse_categorical_accuracy: 0.1314
Epoch 5/5
50000/50000 [==============================] - 16s 316us/sample - loss: 13.7976
- sparse_categorical_accuracy: 0.2385 - val_loss: 13.6487 -
val_sparse_categorical_accuracy: 0.1330

 54%|       | 54/100 [1:13:34<1:08:54, 89.89s/it]

0.13296 3.0932495377222577e-06 0.03094673233431691
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 20s 392us/sample - loss: 591.4599
- sparse_categorical_accuracy: 0.2726 - val_loss: 329.5298 -
val_sparse_categorical_accuracy: 0.1818
Epoch 2/5
50000/50000 [==============================] - 16s 324us/sample - loss: 202.3007
- sparse_categorical_accuracy: 0.3471 - val_loss: 113.7357 -
val_sparse_categorical_accuracy: 0.2420
Epoch 3/5
50000/50000 [==============================] - 16s 323us/sample - loss: 70.2983
- sparse_categorical_accuracy: 0.3384 - val_loss: 40.3748 -
val_sparse_categorical_accuracy: 0.2809
Epoch 4/5
50000/50000 [==============================] - 16s 323us/sample - loss: 25.4270
- sparse_categorical_accuracy: 0.3111 - val_loss: 15.4094 -
val_sparse_categorical_accuracy: 0.2682
Epoch 5/5
50000/50000 [==============================] - 16s 322us/sample - loss: 10.1526
- sparse_categorical_accuracy: 0.2954 - val_loss: 6.9055 -
val_sparse_categorical_accuracy: 0.2090

 55%|       | 55/100 [1:15:06<1:07:41, 90.25s/it]

0.20896 6.610830846519546e-05 2.6104212412291687
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 20s 397us/sample - loss: 650.6492
- sparse_categorical_accuracy: 0.2678 - val_loss: 321.6387 -
val_sparse_categorical_accuracy: 0.1409
Epoch 2/5
```

```
50000/50000 [==============================] - 16s 322us/sample - loss: 182.2896
- sparse_categorical_accuracy: 0.3305 - val_loss: 91.2311 -
val_sparse_categorical_accuracy: 0.2165
Epoch 3/5
50000/50000 [==============================] - 16s 323us/sample - loss: 52.3586
- sparse_categorical_accuracy: 0.3110 - val_loss: 27.1873 -
val_sparse_categorical_accuracy: 0.2624
Epoch 4/5
50000/50000 [==============================] - 16s 323us/sample - loss: 16.2399
- sparse_categorical_accuracy: 0.2745 - val_loss: 9.3682 -
val_sparse_categorical_accuracy: 0.2207
Epoch 5/5
50000/50000 [==============================] - 16s 322us/sample - loss: 6.1797 -
sparse_categorical_accuracy: 0.2590 - val_loss: 4.4087 -
val_sparse_categorical_accuracy: 0.1961

 56%|       | 56/100 [1:16:37<1:06:25, 90.57s/it]

0.19608 6.571098756881013e-05 3.117094041866665
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 20s 408us/sample - loss: 4.3391 -
sparse_categorical_accuracy: 0.1621 - val_loss: 2.3085 -
val_sparse_categorical_accuracy: 0.1287
Epoch 2/5
50000/50000 [==============================] - 16s 329us/sample - loss: 2.9289 -
sparse_categorical_accuracy: 0.2151 - val_loss: 2.3062 -
val_sparse_categorical_accuracy: 0.1364
Epoch 3/5
50000/50000 [==============================] - 16s 325us/sample - loss: 2.6000 -
sparse_categorical_accuracy: 0.2396 - val_loss: 2.3048 -
val_sparse_categorical_accuracy: 0.1414
Epoch 4/5
50000/50000 [==============================] - 16s 325us/sample - loss: 2.4301 -
sparse_categorical_accuracy: 0.2548 - val_loss: 2.3038 -
val_sparse_categorical_accuracy: 0.1424
Epoch 5/5
50000/50000 [==============================] - 16s 326us/sample - loss: 2.3165 -
sparse_categorical_accuracy: 0.2691 - val_loss: 2.3030 -
val_sparse_categorical_accuracy: 0.1441

 57%|       | 57/100 [1:18:09<1:05:20, 91.16s/it]

0.14408 5.380110020908314e-06 2.5963345851029854e-05
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 21s 416us/sample - loss: 226.7826
- sparse_categorical_accuracy: 0.1695 - val_loss: 222.1648 -
val_sparse_categorical_accuracy: 0.1200
Epoch 2/5
```

```
50000/50000 [==============================] - 16s 326us/sample - loss: 220.1286
- sparse_categorical_accuracy: 0.2296 - val_loss: 217.1919 -
val_sparse_categorical_accuracy: 0.1238
Epoch 3/5
50000/50000 [==============================] - 16s 329us/sample - loss: 214.8792
- sparse_categorical_accuracy: 0.2561 - val_loss: 212.3470 -
val_sparse_categorical_accuracy: 0.1254
Epoch 4/5
50000/50000 [==============================] - 16s 328us/sample - loss: 209.9155
- sparse_categorical_accuracy: 0.2756 - val_loss: 207.6193 -
val_sparse_categorical_accuracy: 0.1260
Epoch 5/5
50000/50000 [==============================] - 16s 328us/sample - loss: 205.1282
- sparse_categorical_accuracy: 0.2918 - val_loss: 203.0032 -
val_sparse_categorical_accuracy: 0.1273

 58%|       | 58/100 [1:19:43<1:04:16, 91.83s/it]

0.12728 5.937876650091801e-06 0.6098124744994157
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 20s 410us/sample - loss: 27.1400
- sparse_categorical_accuracy: 0.3377 - val_loss: 26.1854 -
val_sparse_categorical_accuracy: 0.1619
Epoch 2/5
50000/50000 [==============================] - 16s 325us/sample - loss: 24.3639
- sparse_categorical_accuracy: 0.4422 - val_loss: 23.9990 -
val_sparse_categorical_accuracy: 0.1990
Epoch 3/5
50000/50000 [==============================] - 16s 325us/sample - loss: 22.1653
- sparse_categorical_accuracy: 0.4828 - val_loss: 22.0187 -
val_sparse_categorical_accuracy: 0.2399
Epoch 4/5
50000/50000 [==============================] - 16s 324us/sample - loss: 20.2023
- sparse_categorical_accuracy: 0.5125 - val_loss: 20.2224 -
val_sparse_categorical_accuracy: 0.2637
Epoch 5/5
50000/50000 [==============================] - 16s 326us/sample - loss: 18.4341
- sparse_categorical_accuracy: 0.5375 - val_loss: 18.5928 -
val_sparse_categorical_accuracy: 0.2762

 59%|       | 59/100 [1:21:15<1:02:51, 91.99s/it]

0.27624 0.0002147695504638327 0.07140517154422657
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 21s 412us/sample - loss: 3.1271 -
sparse_categorical_accuracy: 0.2265 - val_loss: 2.3183 -
val_sparse_categorical_accuracy: 0.1154
Epoch 2/5
```

```
50000/50000 [==============================] - 16s 325us/sample - loss: 2.1030 -
sparse_categorical_accuracy: 0.3106 - val_loss: 2.3167 -
val_sparse_categorical_accuracy: 0.1226
Epoch 3/5
50000/50000 [==============================] - 16s 325us/sample - loss: 1.9122 -
sparse_categorical_accuracy: 0.3528 - val_loss: 2.3156 -
val_sparse_categorical_accuracy: 0.1270
Epoch 4/5
50000/50000 [==============================] - 16s 327us/sample - loss: 1.8087 -
sparse_categorical_accuracy: 0.3829 - val_loss: 2.3148 -
val_sparse_categorical_accuracy: 0.1320
Epoch 5/5
50000/50000 [==============================] - 16s 326us/sample - loss: 1.7374 -
sparse_categorical_accuracy: 0.4035 - val_loss: 2.3139 -
val_sparse_categorical_accuracy: 0.1337

 60%|       | 60/100 [1:22:48<1:01:28, 92.20s/it]

0.13368 3.0632463017716996e-05 5.95395661501484e-05
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 21s 411us/sample - loss: 242.8830
- sparse_categorical_accuracy: 0.2870 - val_loss: 200.4616 -
val_sparse_categorical_accuracy: 0.1527
Epoch 2/5
50000/50000 [==============================] - 16s 328us/sample - loss: 167.0345
- sparse_categorical_accuracy: 0.3903 - val_loss: 138.5516 -
val_sparse_categorical_accuracy: 0.1708
Epoch 3/5
50000/50000 [==============================] - 16s 330us/sample - loss: 115.3372
- sparse_categorical_accuracy: 0.4269 - val_loss: 96.0415 -
val_sparse_categorical_accuracy: 0.1932
Epoch 4/5
50000/50000 [==============================] - 17s 332us/sample - loss: 79.8525
- sparse_categorical_accuracy: 0.4472 - val_loss: 66.8384 -
val_sparse_categorical_accuracy: 0.1927
Epoch 5/5
50000/50000 [==============================] - 17s 330us/sample - loss: 55.4808
- sparse_categorical_accuracy: 0.4550 - val_loss: 46.7733 -
val_sparse_categorical_accuracy: 0.1949

 61%|       | 61/100 [1:24:22<1:00:13, 92.65s/it]

0.19488 7.659654136940621e-05 0.7828040887107874
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 21s 414us/sample - loss: 952.7154
- sparse_categorical_accuracy: 0.2736 - val_loss: 218.5872 -
val_sparse_categorical_accuracy: 0.1749
Epoch 2/5
```

```
50000/50000 [==============================] - 16s 327us/sample - loss: 82.4458
- sparse_categorical_accuracy: 0.2729 - val_loss: 20.6276 -
val_sparse_categorical_accuracy: 0.1467
Epoch 3/5
50000/50000 [==============================] - 16s 328us/sample - loss: 9.0954 -
sparse_categorical_accuracy: 0.1846 - val_loss: 3.8634 -
val_sparse_categorical_accuracy: 0.1006
Epoch 4/5
50000/50000 [==============================] - 16s 327us/sample - loss: 2.8813 -
sparse_categorical_accuracy: 0.1535 - val_loss: 2.4354 -
val_sparse_categorical_accuracy: 0.1006
Epoch 5/5
50000/50000 [==============================] - 16s 326us/sample - loss: 2.3518 -
sparse_categorical_accuracy: 0.1078 - val_loss: 2.3138 -
val_sparse_categorical_accuracy: 0.1006
 62%|       | 62/100 [1:25:55<58:48, 92.87s/it]
0.10064 5.685076804563572e-05 6.956762439753276
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 20s 410us/sample - loss: 2.1544 -
sparse_categorical_accuracy: 0.3499 - val_loss: 2.3556 -
val_sparse_categorical_accuracy: 0.1574
Epoch 2/5
50000/50000 [==============================] - 16s 327us/sample - loss: 1.5908 -
sparse_categorical_accuracy: 0.4567 - val_loss: 2.3511 -
val_sparse_categorical_accuracy: 0.1946
Epoch 3/5
50000/50000 [==============================] - 16s 327us/sample - loss: 1.4642 -
sparse_categorical_accuracy: 0.4997 - val_loss: 2.3464 -
val_sparse_categorical_accuracy: 0.2378
Epoch 4/5
50000/50000 [==============================] - 16s 328us/sample - loss: 1.3718 -
sparse_categorical_accuracy: 0.5374 - val_loss: 2.3453 -
val_sparse_categorical_accuracy: 0.2503
Epoch 5/5
50000/50000 [==============================] - 16s 327us/sample - loss: 1.3006 -
sparse_categorical_accuracy: 0.5671 - val_loss: 2.3423 -
val_sparse_categorical_accuracy: 0.2632
 63%|       | 63/100 [1:27:28<57:22, 93.03s/it]
0.2632 0.0006185923009009729 0.00019178295056477619
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 21s 422us/sample - loss: 22.6273
- sparse_categorical_accuracy: 0.1431 - val_loss: 17.1802 -
val_sparse_categorical_accuracy: 0.1495
Epoch 2/5
```

```
50000/50000 [==============================] - 16s 330us/sample - loss: 19.4265
- sparse_categorical_accuracy: 0.1768 - val_loss: 17.1724 -
val_sparse_categorical_accuracy: 0.1583
Epoch 3/5
50000/50000 [==============================] - 17s 330us/sample - loss: 18.7945
- sparse_categorical_accuracy: 0.1913 - val_loss: 17.1656 -
val_sparse_categorical_accuracy: 0.1618
Epoch 4/5
50000/50000 [==============================] - 17s 333us/sample - loss: 18.4182
- sparse_categorical_accuracy: 0.2029 - val_loss: 17.1591 -
val_sparse_categorical_accuracy: 0.1676
Epoch 5/5
50000/50000 [==============================] - 17s 330us/sample - loss: 18.1696
- sparse_categorical_accuracy: 0.2117 - val_loss: 17.1531 -
val_sparse_categorical_accuracy: 0.1690

 64%|       | 64/100 [1:29:03<56:04, 93.46s/it]

0.16904 1.2893461543431523e-06 0.04049817673799383
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 21s 425us/sample - loss: 366.5000
- sparse_categorical_accuracy: 0.3199 - val_loss: 135.1790 -
val_sparse_categorical_accuracy: 0.1342
Epoch 2/5
50000/50000 [==============================] - 17s 337us/sample - loss: 64.5076
- sparse_categorical_accuracy: 0.3642 - val_loss: 25.3176 -
val_sparse_categorical_accuracy: 0.1838
Epoch 3/5
50000/50000 [==============================] - 17s 336us/sample - loss: 12.8941
- sparse_categorical_accuracy: 0.3449 - val_loss: 6.4805 -
val_sparse_categorical_accuracy: 0.1963
Epoch 4/5
50000/50000 [==============================] - 17s 336us/sample - loss: 4.0279 -
sparse_categorical_accuracy: 0.3411 - val_loss: 3.2466 -
val_sparse_categorical_accuracy: 0.1621
Epoch 5/5
50000/50000 [==============================] - 17s 337us/sample - loss: 2.4864 -
sparse_categorical_accuracy: 0.3422 - val_loss: 2.6934 -
val_sparse_categorical_accuracy: 0.1484

 65%|       | 65/100 [1:30:39<54:56, 94.19s/it]

0.1484 0.00013409527854376014 2.1051742194546783
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 21s 425us/sample - loss: 6.7188 -
sparse_categorical_accuracy: 0.1669 - val_loss: 2.3010 -
val_sparse_categorical_accuracy: 0.1202
Epoch 2/5
```

```
50000/50000 [==============================] - 17s 333us/sample - loss: 4.0155 -
sparse_categorical_accuracy: 0.1990 - val_loss: 2.2998 -
val_sparse_categorical_accuracy: 0.1220
Epoch 3/5
50000/50000 [==============================] - 17s 332us/sample - loss: 3.3555 -
sparse_categorical_accuracy: 0.2157 - val_loss: 2.2995 -
val_sparse_categorical_accuracy: 0.1237
Epoch 4/5
50000/50000 [==============================] - 17s 332us/sample - loss: 3.0094 -
sparse_categorical_accuracy: 0.2331 - val_loss: 2.2990 -
val_sparse_categorical_accuracy: 0.1253
Epoch 5/5
50000/50000 [==============================] - 17s 331us/sample - loss: 2.7872 -
sparse_categorical_accuracy: 0.2475 - val_loss: 2.2988 -
val_sparse_categorical_accuracy: 0.1257
 66%|       | 66/100 [1:32:14<53:34, 94.54s/it]
0.12568 3.0971650002824387e-06 2.9454647354336314e-05
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 21s 423us/sample - loss: 58.7932
- sparse_categorical_accuracy: 0.3474 - val_loss: 20.6725 -
val_sparse_categorical_accuracy: 0.2797
Epoch 2/5
50000/50000 [==============================] - 17s 332us/sample - loss: 9.8003 -
sparse_categorical_accuracy: 0.4412 - val_loss: 5.1044 -
val_sparse_categorical_accuracy: 0.3239
Epoch 3/5
50000/50000 [==============================] - 17s 333us/sample - loss: 2.8959 -
sparse_categorical_accuracy: 0.4640 - val_loss: 2.9089 -
val_sparse_categorical_accuracy: 0.3490
Epoch 4/5
50000/50000 [==============================] - 17s 332us/sample - loss: 1.8735 -
sparse_categorical_accuracy: 0.4869 - val_loss: 2.5894 -
val_sparse_categorical_accuracy: 0.2993
Epoch 5/5
50000/50000 [==============================] - 17s 333us/sample - loss: 1.6921 -
sparse_categorical_accuracy: 0.5024 - val_loss: 2.5440 -
val_sparse_categorical_accuracy: 0.3478
 67%|       | 67/100 [1:33:49<52:05, 94.71s/it]
0.34784 0.000893519401372698 0.3515911454554369
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 21s 425us/sample - loss: 181.1383
- sparse_categorical_accuracy: 0.1620 - val_loss: 176.1018 -
val_sparse_categorical_accuracy: 0.1187
Epoch 2/5
```

```
50000/50000 [==============================] - 16s 328us/sample - loss: 177.1109
- sparse_categorical_accuracy: 0.1992 - val_loss: 174.8197 -
val_sparse_categorical_accuracy: 0.1174
Epoch 3/5
50000/50000 [==============================] - 16s 328us/sample - loss: 175.1574
- sparse_categorical_accuracy: 0.2201 - val_loss: 173.5560 -
val_sparse_categorical_accuracy: 0.1194
Epoch 4/5
50000/50000 [==============================] - 16s 328us/sample - loss: 173.5461
- sparse_categorical_accuracy: 0.2343 - val_loss: 172.3065 -
val_sparse_categorical_accuracy: 0.1204
Epoch 5/5
50000/50000 [==============================] - 16s 329us/sample - loss: 172.0823
- sparse_categorical_accuracy: 0.2473 - val_loss: 171.0695 -
val_sparse_categorical_accuracy: 0.1210
 68%|       | 68/100 [1:35:24<50:27, 94.62s/it]
0.12104 2.4313377717206898e-06 0.47433807303926623
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 21s 429us/sample - loss: 4.3592 -
sparse_categorical_accuracy: 0.1793 - val_loss: 2.3403 -
val_sparse_categorical_accuracy: 0.1161
Epoch 2/5
50000/50000 [==============================] - 17s 336us/sample - loss: 2.8025 -
sparse_categorical_accuracy: 0.2439 - val_loss: 2.3382 -
val_sparse_categorical_accuracy: 0.1186
Epoch 3/5
50000/50000 [==============================] - 17s 335us/sample - loss: 2.4622 -
sparse_categorical_accuracy: 0.2719 - val_loss: 2.3369 -
val_sparse_categorical_accuracy: 0.1197
Epoch 4/5
50000/50000 [==============================] - 17s 335us/sample - loss: 2.2771 -
sparse_categorical_accuracy: 0.2933 - val_loss: 2.3359 -
val_sparse_categorical_accuracy: 0.1235
Epoch 5/5
50000/50000 [==============================] - 17s 337us/sample - loss: 2.1621 -
sparse_categorical_accuracy: 0.3100 - val_loss: 2.3351 -
val_sparse_categorical_accuracy: 0.1265
 69%|       | 69/100 [1:37:00<49:09, 95.15s/it]
0.12648 7.59390433068011e-06 0.00011242425894555951
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 22s 432us/sample - loss: 2.3319 -
sparse_categorical_accuracy: 0.3236 - val_loss: 2.5378 -
val_sparse_categorical_accuracy: 0.1450
Epoch 2/5
```

```
50000/50000 [==============================] - 17s 347us/sample - loss: 1.8917 -
sparse_categorical_accuracy: 0.4117 - val_loss: 2.5354 -
val_sparse_categorical_accuracy: 0.1508
Epoch 3/5
50000/50000 [==============================] - 17s 337us/sample - loss: 1.7827 -
sparse_categorical_accuracy: 0.4531 - val_loss: 2.5341 -
val_sparse_categorical_accuracy: 0.1555
Epoch 4/5
50000/50000 [==============================] - 17s 337us/sample - loss: 1.7105 -
sparse_categorical_accuracy: 0.4755 - val_loss: 2.5337 -
val_sparse_categorical_accuracy: 0.1590
Epoch 5/5
50000/50000 [==============================] - 17s 339us/sample - loss: 1.6537 -
sparse_categorical_accuracy: 0.5006 - val_loss: 2.5324 -
val_sparse_categorical_accuracy: 0.1596

 70%|       | 70/100 [1:38:37<47:54, 95.83s/it]

0.1596 0.00017718182037722798 0.0006718162477767732
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 22s 433us/sample - loss: 3.8503 -
sparse_categorical_accuracy: 0.1841 - val_loss: 2.3554 -
val_sparse_categorical_accuracy: 0.1137
Epoch 2/5
50000/50000 [==============================] - 17s 342us/sample - loss: 2.5509 -
sparse_categorical_accuracy: 0.2480 - val_loss: 2.3532 -
val_sparse_categorical_accuracy: 0.1154
Epoch 3/5
50000/50000 [==============================] - 17s 342us/sample - loss: 2.2775 -
sparse_categorical_accuracy: 0.2833 - val_loss: 2.3521 -
val_sparse_categorical_accuracy: 0.1165
Epoch 4/5
50000/50000 [==============================] - 17s 341us/sample - loss: 2.1407 -
sparse_categorical_accuracy: 0.3053 - val_loss: 2.3515 -
val_sparse_categorical_accuracy: 0.1161
Epoch 5/5
50000/50000 [==============================] - 17s 342us/sample - loss: 2.0517 -
sparse_categorical_accuracy: 0.3228 - val_loss: 2.3507 -
val_sparse_categorical_accuracy: 0.1152

 71%|       | 71/100 [1:40:15<46:35, 96.38s/it]

0.1152 1.0290533863897622e-05 0.00013707524695011792
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 22s 431us/sample - loss: 939.3898
- sparse_categorical_accuracy: 0.1473 - val_loss: 917.6786 -
val_sparse_categorical_accuracy: 0.1210
Epoch 2/5
```

```
50000/50000 [==============================] - 17s 338us/sample - loss: 901.9230
- sparse_categorical_accuracy: 0.1828 - val_loss: 883.4440 -
val_sparse_categorical_accuracy: 0.1266
Epoch 3/5
50000/50000 [==============================] - 17s 345us/sample - loss: 867.7621
- sparse_categorical_accuracy: 0.2041 - val_loss: 850.5262 -
val_sparse_categorical_accuracy: 0.1286
Epoch 4/5
50000/50000 [==============================] - 17s 337us/sample - loss: 835.1249
- sparse_categorical_accuracy: 0.2203 - val_loss: 818.8604 -
val_sparse_categorical_accuracy: 0.1284
Epoch 5/5
50000/50000 [==============================] - 17s 337us/sample - loss: 803.8296
- sparse_categorical_accuracy: 0.2317 - val_loss: 788.3920 -
val_sparse_categorical_accuracy: 0.1298
 72%|      | 72/100 [1:41:52<45:03, 96.55s/it]
0.12984 2.352843485482737e-06 2.579580770201384
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 22s 431us/sample - loss: 2.3812 -
sparse_categorical_accuracy: 0.2689 - val_loss: 2.3260 -
val_sparse_categorical_accuracy: 0.1177
Epoch 2/5
50000/50000 [==============================] - 17s 342us/sample - loss: 1.8228 -
sparse_categorical_accuracy: 0.3635 - val_loss: 2.3232 -
val_sparse_categorical_accuracy: 0.1280
Epoch 3/5
50000/50000 [==============================] - 17s 343us/sample - loss: 1.7037 -
sparse_categorical_accuracy: 0.4093 - val_loss: 2.3213 -
val_sparse_categorical_accuracy: 0.1387
Epoch 4/5
50000/50000 [==============================] - 17s 344us/sample - loss: 1.6290 -
sparse_categorical_accuracy: 0.4332 - val_loss: 2.3201 -
val_sparse_categorical_accuracy: 0.1482
Epoch 5/5
50000/50000 [==============================] - 17s 343us/sample - loss: 1.5737 -
sparse_categorical_accuracy: 0.4525 - val_loss: 2.3192 -
val_sparse_categorical_accuracy: 0.1569
 73%|      | 73/100 [1:43:30<43:37, 96.94s/it]
0.15688 8.79483176314785e-05 9.976661317506291e-05
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 22s 431us/sample - loss: 568.1463
- sparse_categorical_accuracy: 0.1105 - val_loss: 560.5034 -
val_sparse_categorical_accuracy: 0.1290
Epoch 2/5
```

```
50000/50000 [==============================] - 17s 343us/sample - loss: 558.3634
- sparse_categorical_accuracy: 0.1479 - val_loss: 552.7445 -
val_sparse_categorical_accuracy: 0.1282
Epoch 3/5
50000/50000 [==============================] - 17s 340us/sample - loss: 550.0601
- sparse_categorical_accuracy: 0.1661 - val_loss: 545.1089 -
val_sparse_categorical_accuracy: 0.1271
Epoch 4/5
50000/50000 [==============================] - 17s 340us/sample - loss: 542.1331
- sparse_categorical_accuracy: 0.1834 - val_loss: 537.5879 -
val_sparse_categorical_accuracy: 0.1252
Epoch 5/5
50000/50000 [==============================] - 17s 340us/sample - loss: 534.4347
- sparse_categorical_accuracy: 0.1964 - val_loss: 530.1771 -
val_sparse_categorical_accuracy: 0.1250
 74%|      | 74/100 [1:45:07<42:05, 97.15s/it]
0.12496 1.4478169751485802e-06 1.533759395239775
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 22s 435us/sample - loss: 4.8049 -
sparse_categorical_accuracy: 0.1837 - val_loss: 2.5573 -
val_sparse_categorical_accuracy: 0.1122
Epoch 2/5
50000/50000 [==============================] - 17s 345us/sample - loss: 3.2179 -
sparse_categorical_accuracy: 0.2301 - val_loss: 2.5559 -
val_sparse_categorical_accuracy: 0.1140
Epoch 3/5
50000/50000 [==============================] - 17s 345us/sample - loss: 2.8368 -
sparse_categorical_accuracy: 0.2509 - val_loss: 2.5550 -
val_sparse_categorical_accuracy: 0.1175
Epoch 4/5
50000/50000 [==============================] - 17s 346us/sample - loss: 2.6406 -
sparse_categorical_accuracy: 0.2678 - val_loss: 2.5544 -
val_sparse_categorical_accuracy: 0.1192
Epoch 5/5
50000/50000 [==============================] - 17s 345us/sample - loss: 2.5149 -
sparse_categorical_accuracy: 0.2827 - val_loss: 2.5539 -
val_sparse_categorical_accuracy: 0.1204
 75%|      | 75/100 [1:46:46<40:40, 97.61s/it]
0.1204 5.494856573143742e-06 0.000699162475137832
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 22s 439us/sample - loss: 33.3116
- sparse_categorical_accuracy: 0.2994 - val_loss: 32.4378 -
val_sparse_categorical_accuracy: 0.1322
Epoch 2/5
```

```
50000/50000 [==============================] - 17s 343us/sample - loss: 31.0087
- sparse_categorical_accuracy: 0.3994 - val_loss: 30.7817 -
val_sparse_categorical_accuracy: 0.1470
Epoch 3/5
50000/50000 [==============================] - 17s 342us/sample - loss: 29.2869
- sparse_categorical_accuracy: 0.4411 - val_loss: 29.2218 -
val_sparse_categorical_accuracy: 0.1584
Epoch 4/5
50000/50000 [==============================] - 17s 345us/sample - loss: 27.6943
- sparse_categorical_accuracy: 0.4702 - val_loss: 27.7501 -
val_sparse_categorical_accuracy: 0.1720
Epoch 5/5
50000/50000 [==============================] - 17s 341us/sample - loss: 26.2065
- sparse_categorical_accuracy: 0.4895 - val_loss: 26.3607 -
val_sparse_categorical_accuracy: 0.1822
 76%|      | 76/100 [1:48:25<39:08, 97.84s/it]
0.18224 0.00010387235755656263 0.0865962857012191
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 22s 437us/sample - loss: 5.8855 -
sparse_categorical_accuracy: 0.2678 - val_loss: 5.5938 -
val_sparse_categorical_accuracy: 0.1168
Epoch 2/5
50000/50000 [==============================] - 18s 356us/sample - loss: 5.1415 -
sparse_categorical_accuracy: 0.3504 - val_loss: 5.5796 -
val_sparse_categorical_accuracy: 0.1204
Epoch 3/5
50000/50000 [==============================] - 18s 350us/sample - loss: 5.0096 -
sparse_categorical_accuracy: 0.3871 - val_loss: 5.5669 -
val_sparse_categorical_accuracy: 0.1238
Epoch 4/5
50000/50000 [==============================] - 18s 351us/sample - loss: 4.9222 -
sparse_categorical_accuracy: 0.4144 - val_loss: 5.5545 -
val_sparse_categorical_accuracy: 0.1300
Epoch 5/5
50000/50000 [==============================] - 18s 351us/sample - loss: 4.8542 -
sparse_categorical_accuracy: 0.4332 - val_loss: 5.5424 -
val_sparse_categorical_accuracy: 0.1346
 77%|      | 77/100 [1:50:05<37:46, 98.53s/it]
0.13456 6.420087152001801e-05 0.008966958906355665
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 22s 445us/sample - loss: 1.9692 -
sparse_categorical_accuracy: 0.3469 - val_loss: 2.2967 -
val_sparse_categorical_accuracy: 0.1304
Epoch 2/5
```

```
50000/50000 [==============================] - 17s 343us/sample - loss: 1.5941 -
sparse_categorical_accuracy: 0.4377 - val_loss: 2.2953 -
val_sparse_categorical_accuracy: 0.1510
Epoch 3/5
50000/50000 [==============================] - 17s 343us/sample - loss: 1.4782 -
sparse_categorical_accuracy: 0.4771 - val_loss: 2.2931 -
val_sparse_categorical_accuracy: 0.1658
Epoch 4/5
50000/50000 [==============================] - 17s 344us/sample - loss: 1.3920 -
sparse_categorical_accuracy: 0.5067 - val_loss: 2.2916 -
val_sparse_categorical_accuracy: 0.1832
Epoch 5/5
50000/50000 [==============================] - 17s 343us/sample - loss: 1.3297 -
sparse_categorical_accuracy: 0.5313 - val_loss: 2.2894 -
val_sparse_categorical_accuracy: 0.1930
```

```
 78%|      | 78/100 [1:51:44<36:10, 98.65s/it]
```

```
0.19296 0.0003181811711467026 1.8084933299460368e-05
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 22s 438us/sample - loss: 3.1107 -
sparse_categorical_accuracy: 0.2538 - val_loss: 2.9392 -
val_sparse_categorical_accuracy: 0.1247
Epoch 2/5
50000/50000 [==============================] - 18s 352us/sample - loss: 2.5029 -
sparse_categorical_accuracy: 0.3501 - val_loss: 2.9344 -
val_sparse_categorical_accuracy: 0.1310
Epoch 3/5
50000/50000 [==============================] - 18s 353us/sample - loss: 2.3736 -
sparse_categorical_accuracy: 0.3906 - val_loss: 2.9315 -
val_sparse_categorical_accuracy: 0.1362
Epoch 4/5
50000/50000 [==============================] - 18s 353us/sample - loss: 2.2975 -
sparse_categorical_accuracy: 0.4148 - val_loss: 2.9293 -
val_sparse_categorical_accuracy: 0.1383
Epoch 5/5
50000/50000 [==============================] - 18s 354us/sample - loss: 2.2431 -
sparse_categorical_accuracy: 0.4310 - val_loss: 2.9274 -
val_sparse_categorical_accuracy: 0.1414
```

```
 79%|      | 79/100 [1:53:24<34:42, 99.19s/it]
```

```
0.14136 5.555578521256238e-05 0.0017847010364140236
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 22s 443us/sample - loss: 10.8530
- sparse_categorical_accuracy: 0.1543 - val_loss: 6.9906 -
val_sparse_categorical_accuracy: 0.1145
Epoch 2/5
```

```
50000/50000 [==============================] - 17s 342us/sample - loss: 8.3823 -
sparse_categorical_accuracy: 0.1975 - val_loss: 6.9869 -
val_sparse_categorical_accuracy: 0.1198
Epoch 3/5
50000/50000 [==============================] - 17s 343us/sample - loss: 7.7875 -
sparse_categorical_accuracy: 0.2184 - val_loss: 6.9845 -
val_sparse_categorical_accuracy: 0.1219
Epoch 4/5
50000/50000 [==============================] - 17s 343us/sample - loss: 7.4860 -
sparse_categorical_accuracy: 0.2341 - val_loss: 6.9827 -
val_sparse_categorical_accuracy: 0.1225
Epoch 5/5
50000/50000 [==============================] - 17s 343us/sample - loss: 7.2989 -
sparse_categorical_accuracy: 0.2453 - val_loss: 6.9810 -
val_sparse_categorical_accuracy: 0.1230
 80%|      | 80/100 [1:55:03<33:00, 99.05s/it]
0.12296 2.865407916166409e-06 0.012723216640415095
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 23s 450us/sample - loss: 430.6088
- sparse_categorical_accuracy: 0.1829 - val_loss: 418.1040 -
val_sparse_categorical_accuracy: 0.1220
Epoch 2/5
50000/50000 [==============================] - 18s 357us/sample - loss: 408.8412
- sparse_categorical_accuracy: 0.2370 - val_loss: 398.7748 -
val_sparse_categorical_accuracy: 0.1262
Epoch 3/5
50000/50000 [==============================] - 18s 359us/sample - loss: 389.5995
- sparse_categorical_accuracy: 0.2623 - val_loss: 380.3757 -
val_sparse_categorical_accuracy: 0.1307
Epoch 4/5
50000/50000 [==============================] - 18s 357us/sample - loss: 371.4385
- sparse_categorical_accuracy: 0.2832 - val_loss: 362.8482 -
val_sparse_categorical_accuracy: 0.1344
Epoch 5/5
50000/50000 [==============================] - 18s 357us/sample - loss: 354.1985
- sparse_categorical_accuracy: 0.2990 - val_loss: 346.1443 -
val_sparse_categorical_accuracy: 0.1362
 81%|      | 81/100 [1:56:45<31:39, 99.95s/it]
0.13624 6.411738988625678e-06 1.180861271929184
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 23s 455us/sample - loss:
1429.5954 - sparse_categorical_accuracy: 0.1870 - val_loss: 1253.4376 -
val_sparse_categorical_accuracy: 0.1155
Epoch 2/5
```

```
50000/50000 [==============================] - 17s 345us/sample - loss:
1106.4424 - sparse_categorical_accuracy: 0.2579 - val_loss: 971.3652 -
val_sparse_categorical_accuracy: 0.1249
Epoch 3/5
50000/50000 [==============================] - 17s 345us/sample - loss: 857.3338
- sparse_categorical_accuracy: 0.2984 - val_loss: 752.9866 -
val_sparse_categorical_accuracy: 0.1337
Epoch 4/5
50000/50000 [==============================] - 17s 345us/sample - loss: 664.5488
- sparse_categorical_accuracy: 0.3230 - val_loss: 583.8714 -
val_sparse_categorical_accuracy: 0.1398
Epoch 5/5
50000/50000 [==============================] - 17s 345us/sample - loss: 515.2803
- sparse_categorical_accuracy: 0.3409 - val_loss: 452.8879 -
val_sparse_categorical_accuracy: 0.1434

 82%|      | 82/100 [1:58:25<29:58, 99.93s/it]

0.14336 9.327526265620555e-06 4.377896820388835
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 23s 452us/sample - loss: 2.9706 -
sparse_categorical_accuracy: 0.3063 - val_loss: 3.1125 -
val_sparse_categorical_accuracy: 0.1442
Epoch 2/5
50000/50000 [==============================] - 18s 357us/sample - loss: 2.4972 -
sparse_categorical_accuracy: 0.4028 - val_loss: 3.1082 -
val_sparse_categorical_accuracy: 0.1530
Epoch 3/5
50000/50000 [==============================] - 18s 355us/sample - loss: 2.3841 -
sparse_categorical_accuracy: 0.4429 - val_loss: 3.1050 -
val_sparse_categorical_accuracy: 0.1598
Epoch 4/5
50000/50000 [==============================] - 18s 355us/sample - loss: 2.3049 -
sparse_categorical_accuracy: 0.4692 - val_loss: 3.1022 -
val_sparse_categorical_accuracy: 0.1624
Epoch 5/5
50000/50000 [==============================] - 18s 354us/sample - loss: 2.2423 -
sparse_categorical_accuracy: 0.4917 - val_loss: 3.0989 -
val_sparse_categorical_accuracy: 0.1654

 83%|      | 83/100 [2:00:06<28:28, 100.47s/it]

0.16536 0.00016958020960613514 0.0022237665397071373
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 23s 455us/sample - loss: 2.2246 -
sparse_categorical_accuracy: 0.2842 - val_loss: 2.3071 -
val_sparse_categorical_accuracy: 0.1586
Epoch 2/5
```

```
50000/50000 [==============================] - 18s 351us/sample - loss: 1.7727 -
sparse_categorical_accuracy: 0.3738 - val_loss: 2.3053 -
val_sparse_categorical_accuracy: 0.1666
Epoch 3/5
50000/50000 [==============================] - 18s 355us/sample - loss: 1.6562 -
sparse_categorical_accuracy: 0.4148 - val_loss: 2.3048 -
val_sparse_categorical_accuracy: 0.1682
Epoch 4/5
50000/50000 [==============================] - 18s 350us/sample - loss: 1.5842 -
sparse_categorical_accuracy: 0.4395 - val_loss: 2.3033 -
val_sparse_categorical_accuracy: 0.1720
Epoch 5/5
50000/50000 [==============================] - 18s 351us/sample - loss: 1.5334 -
sparse_categorical_accuracy: 0.4589 - val_loss: 2.3027 -
val_sparse_categorical_accuracy: 0.1732

 84%|      | 84/100 [2:01:48<26:52, 100.76s/it]

0.1732 9.41352723322352e-05 4.7484114764355654e-05
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 23s 455us/sample - loss: 2.9517 -
sparse_categorical_accuracy: 0.2484 - val_loss: 2.5065 -
val_sparse_categorical_accuracy: 0.0896
Epoch 2/5
50000/50000 [==============================] - 18s 363us/sample - loss: 2.1100 -
sparse_categorical_accuracy: 0.3458 - val_loss: 2.5052 -
val_sparse_categorical_accuracy: 0.0942
Epoch 3/5
50000/50000 [==============================] - 18s 361us/sample - loss: 1.9760 -
sparse_categorical_accuracy: 0.3868 - val_loss: 2.5043 -
val_sparse_categorical_accuracy: 0.0962
Epoch 4/5
50000/50000 [==============================] - 18s 363us/sample - loss: 1.8981 -
sparse_categorical_accuracy: 0.4093 - val_loss: 2.5032 -
val_sparse_categorical_accuracy: 0.1013
Epoch 5/5
50000/50000 [==============================] - 18s 364us/sample - loss: 1.8427 -
sparse_categorical_accuracy: 0.4273 - val_loss: 2.5021 -
val_sparse_categorical_accuracy: 0.1014

 85%|      | 85/100 [2:03:31<25:23, 101.57s/it]

0.10144 4.4261958176312025e-05 0.0005830767281309983
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 23s 452us/sample - loss: 90.4108
- sparse_categorical_accuracy: 0.2854 - val_loss: 82.9971 -
val_sparse_categorical_accuracy: 0.1331
Epoch 2/5
```

```
50000/50000 [==============================] - 18s 354us/sample - loss: 75.8233
- sparse_categorical_accuracy: 0.3903 - val_loss: 70.1814 -
val_sparse_categorical_accuracy: 0.1456
Epoch 3/5
50000/50000 [==============================] - 18s 351us/sample - loss: 63.9587
- sparse_categorical_accuracy: 0.4251 - val_loss: 59.4146 -
val_sparse_categorical_accuracy: 0.1584
Epoch 4/5
50000/50000 [==============================] - 18s 351us/sample - loss: 54.0122
- sparse_categorical_accuracy: 0.4520 - val_loss: 50.3669 -
val_sparse_categorical_accuracy: 0.1734
Epoch 5/5
50000/50000 [==============================] - 18s 355us/sample - loss: 45.6619
- sparse_categorical_accuracy: 0.4692 - val_loss: 42.7610 -
val_sparse_categorical_accuracy: 0.1862
 86%|      | 86/100 [2:05:13<23:41, 101.55s/it]
0.18616 0.00010609916576495245 0.2608564806998076
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 23s 459us/sample - loss: 55.6155
- sparse_categorical_accuracy: 0.1278 - val_loss: 52.5220 -
val_sparse_categorical_accuracy: 0.1122
Epoch 2/5
50000/50000 [==============================] - 18s 370us/sample - loss: 54.0655
- sparse_categorical_accuracy: 0.1511 - val_loss: 52.4517 -
val_sparse_categorical_accuracy: 0.1130
Epoch 3/5
50000/50000 [==============================] - 19s 370us/sample - loss: 53.5362
- sparse_categorical_accuracy: 0.1680 - val_loss: 52.3831 -
val_sparse_categorical_accuracy: 0.1136
Epoch 4/5
50000/50000 [==============================] - 19s 371us/sample - loss: 53.1841
- sparse_categorical_accuracy: 0.1813 - val_loss: 52.3153 -
val_sparse_categorical_accuracy: 0.1138
Epoch 5/5
50000/50000 [==============================] - 18s 370us/sample - loss: 52.9211
- sparse_categorical_accuracy: 0.1933 - val_loss: 52.2484 -
val_sparse_categorical_accuracy: 0.1141
 87%|      | 87/100 [2:06:58<22:14, 102.67s/it]
0.11408 1.4886107961721681e-06 0.13595739579824603
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 23s 462us/sample - loss: 26.6982
- sparse_categorical_accuracy: 0.3239 - val_loss: 25.8056 -
val_sparse_categorical_accuracy: 0.1075
Epoch 2/5
```

```
50000/50000 [==============================] - 18s 352us/sample - loss: 24.1353
- sparse_categorical_accuracy: 0.4227 - val_loss: 23.8200 -
val_sparse_categorical_accuracy: 0.1233
Epoch 3/5
50000/50000 [==============================] - 18s 354us/sample - loss: 22.1226
- sparse_categorical_accuracy: 0.4630 - val_loss: 22.0070 -
val_sparse_categorical_accuracy: 0.1309
Epoch 4/5
50000/50000 [==============================] - 18s 353us/sample - loss: 20.3089
- sparse_categorical_accuracy: 0.4944 - val_loss: 20.3487 -
val_sparse_categorical_accuracy: 0.1461
Epoch 5/5
50000/50000 [==============================] - 18s 358us/sample - loss: 18.6656
- sparse_categorical_accuracy: 0.5154 - val_loss: 18.8325 -
val_sparse_categorical_accuracy: 0.1615
 88%|      | 88/100 [2:08:41<20:31, 102.63s/it]
0.16152 0.00020248081062305642 0.06965867412135136
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 23s 454us/sample - loss: 2.8731 -
sparse_categorical_accuracy: 0.2302 - val_loss: 2.3266 -
val_sparse_categorical_accuracy: 0.1185
Epoch 2/5
50000/50000 [==============================] - 18s 368us/sample - loss: 2.0750 -
sparse_categorical_accuracy: 0.2997 - val_loss: 2.3244 -
val_sparse_categorical_accuracy: 0.1234
Epoch 3/5
50000/50000 [==============================] - 18s 366us/sample - loss: 1.9179 -
sparse_categorical_accuracy: 0.3375 - val_loss: 2.3231 -
val_sparse_categorical_accuracy: 0.1235
Epoch 4/5
50000/50000 [==============================] - 18s 367us/sample - loss: 1.8313 -
sparse_categorical_accuracy: 0.3628 - val_loss: 2.3219 -
val_sparse_categorical_accuracy: 0.1292
Epoch 5/5
50000/50000 [==============================] - 18s 367us/sample - loss: 1.7742 -
sparse_categorical_accuracy: 0.3798 - val_loss: 2.3208 -
val_sparse_categorical_accuracy: 0.1313
 89%|      | 89/100 [2:10:25<18:55, 103.19s/it]
0.13128 2.7704285935843563e-05 7.012036275360902e-05
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 23s 467us/sample - loss: 7.7564 -
sparse_categorical_accuracy: 0.1668 - val_loss: 4.3768 -
val_sparse_categorical_accuracy: 0.1333
Epoch 2/5
```

```
50000/50000 [==============================] - 18s 359us/sample - loss: 5.2421 -
sparse_categorical_accuracy: 0.2101 - val_loss: 4.3739 -
val_sparse_categorical_accuracy: 0.1356
Epoch 3/5
50000/50000 [==============================] - 18s 359us/sample - loss: 4.8022 -
sparse_categorical_accuracy: 0.2303 - val_loss: 4.3712 -
val_sparse_categorical_accuracy: 0.1388
Epoch 4/5
50000/50000 [==============================] - 18s 360us/sample - loss: 4.5758 -
sparse_categorical_accuracy: 0.2479 - val_loss: 4.3695 -
val_sparse_categorical_accuracy: 0.1410
Epoch 5/5
50000/50000 [==============================] - 18s 361us/sample - loss: 4.4327 -
sparse_categorical_accuracy: 0.2630 - val_loss: 4.3682 -
val_sparse_categorical_accuracy: 0.1434
 90%|      | 90/100 [2:12:09<17:14, 103.42s/it]
0.14344 4.39397867046771e-06 0.0056350892121210154
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 23s 457us/sample - loss: 6.2698 -
sparse_categorical_accuracy: 0.1283 - val_loss: 2.7931 -
val_sparse_categorical_accuracy: 0.1115
Epoch 2/5
50000/50000 [==============================] - 18s 362us/sample - loss: 4.2313 -
sparse_categorical_accuracy: 0.1672 - val_loss: 2.7908 -
val_sparse_categorical_accuracy: 0.1182
Epoch 3/5
50000/50000 [==============================] - 18s 363us/sample - loss: 3.7377 -
sparse_categorical_accuracy: 0.1916 - val_loss: 2.7895 -
val_sparse_categorical_accuracy: 0.1193
Epoch 4/5
50000/50000 [==============================] - 18s 361us/sample - loss: 3.4607 -
sparse_categorical_accuracy: 0.2068 - val_loss: 2.7886 -
val_sparse_categorical_accuracy: 0.1206
Epoch 5/5
50000/50000 [==============================] - 18s 360us/sample - loss: 3.2783 -
sparse_categorical_accuracy: 0.2184 - val_loss: 2.7880 -
val_sparse_categorical_accuracy: 0.1234
 91%|      | 91/100 [2:13:53<15:31, 103.55s/it]
0.12344 1.8015066857974784e-06 0.0013220280507103628
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 24s 477us/sample - loss: 5.3827 -
sparse_categorical_accuracy: 0.1891 - val_loss: 4.0009 -
val_sparse_categorical_accuracy: 0.0952
Epoch 2/5
```

```
50000/50000 [==============================] - 18s 364us/sample - loss: 4.1625 -
sparse_categorical_accuracy: 0.2549 - val_loss: 3.9973 -
val_sparse_categorical_accuracy: 0.0987
Epoch 3/5
50000/50000 [==============================] - 18s 363us/sample - loss: 3.8789 -
sparse_categorical_accuracy: 0.2867 - val_loss: 3.9946 -
val_sparse_categorical_accuracy: 0.1010
Epoch 4/5
50000/50000 [==============================] - 18s 367us/sample - loss: 3.7249 -
sparse_categorical_accuracy: 0.3108 - val_loss: 3.9924 -
val_sparse_categorical_accuracy: 0.1011
Epoch 5/5
50000/50000 [==============================] - 18s 364us/sample - loss: 3.6298 -
sparse_categorical_accuracy: 0.3306 - val_loss: 3.9907 -
val_sparse_categorical_accuracy: 0.1019
```

```
 92%|     | 92/100 [2:15:39<13:53, 104.18s/it]
```

```
0.10192 1.3075935137985462e-05 0.004557779878649727
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 24s 473us/sample - loss: 15.7122
- sparse_categorical_accuracy: 0.3218 - val_loss: 15.5434 -
val_sparse_categorical_accuracy: 0.1358
Epoch 2/5
50000/50000 [==============================] - 19s 374us/sample - loss: 14.4182
- sparse_categorical_accuracy: 0.4281 - val_loss: 14.6645 -
val_sparse_categorical_accuracy: 0.1442
Epoch 3/5
50000/50000 [==============================] - 19s 373us/sample - loss: 13.4545
- sparse_categorical_accuracy: 0.4706 - val_loss: 13.8472 -
val_sparse_categorical_accuracy: 0.1608
Epoch 4/5
50000/50000 [==============================] - 19s 374us/sample - loss: 12.5840
- sparse_categorical_accuracy: 0.5023 - val_loss: 13.0863 -
val_sparse_categorical_accuracy: 0.1809
Epoch 5/5
50000/50000 [==============================] - 19s 380us/sample - loss: 11.7832
- sparse_categorical_accuracy: 0.5259 - val_loss: 12.3763 -
val_sparse_categorical_accuracy: 0.1988
```

```
 93%|     | 93/100 [2:17:26<12:15, 105.13s/it]
```

```
0.1988 0.0002838291856925599 0.03852748221040342
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 24s 472us/sample - loss: 13.3969
- sparse_categorical_accuracy: 0.1279 - val_loss: 9.0235 -
val_sparse_categorical_accuracy: 0.0962
Epoch 2/5
```

```
50000/50000 [==============================] - 18s 367us/sample - loss: 10.9300
- sparse_categorical_accuracy: 0.1660 - val_loss: 9.0179 -
val_sparse_categorical_accuracy: 0.1082
Epoch 3/5
50000/50000 [==============================] - 18s 364us/sample - loss: 10.3339
- sparse_categorical_accuracy: 0.1849 - val_loss: 9.0142 -
val_sparse_categorical_accuracy: 0.1154
Epoch 4/5
50000/50000 [==============================] - 18s 363us/sample - loss: 10.0062
- sparse_categorical_accuracy: 0.1981 - val_loss: 9.0113 -
val_sparse_categorical_accuracy: 0.1202
Epoch 5/5
50000/50000 [==============================] - 18s 367us/sample - loss: 9.7868 -
sparse_categorical_accuracy: 0.2078 - val_loss: 9.0087 -
val_sparse_categorical_accuracy: 0.1233
 94%|      | 94/100 [2:19:11<10:31, 105.19s/it]
0.12328 1.623123335753312e-06 0.018177363237771155
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 24s 471us/sample - loss: 2.1705 -
sparse_categorical_accuracy: 0.3261 - val_loss: 2.3067 -
val_sparse_categorical_accuracy: 0.1468
Epoch 2/5
50000/50000 [==============================] - 19s 375us/sample - loss: 1.6520 -
sparse_categorical_accuracy: 0.4257 - val_loss: 2.3044 -
val_sparse_categorical_accuracy: 0.1440
Epoch 3/5
50000/50000 [==============================] - 19s 373us/sample - loss: 1.5475 -
sparse_categorical_accuracy: 0.4614 - val_loss: 2.3035 -
val_sparse_categorical_accuracy: 0.1450
Epoch 4/5
50000/50000 [==============================] - 19s 377us/sample - loss: 1.4730 -
sparse_categorical_accuracy: 0.4871 - val_loss: 2.3027 -
val_sparse_categorical_accuracy: 0.1474
Epoch 5/5
50000/50000 [==============================] - 19s 374us/sample - loss: 1.4146 -
sparse_categorical_accuracy: 0.5087 - val_loss: 2.3020 -
val_sparse_categorical_accuracy: 0.1495
 95%|      | 95/100 [2:20:59<08:49, 105.84s/it]
0.14952 0.00019092163143131873 5.286756020019272e-05
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 24s 481us/sample - loss: 45.4950
- sparse_categorical_accuracy: 0.1739 - val_loss: 43.2677 -
val_sparse_categorical_accuracy: 0.1147
Epoch 2/5
```

```
50000/50000 [==============================] - 18s 360us/sample - loss: 43.6360
- sparse_categorical_accuracy: 0.2343 - val_loss: 43.0347 -
val_sparse_categorical_accuracy: 0.1174
Epoch 3/5
50000/50000 [==============================] - 18s 360us/sample - loss: 43.0489
- sparse_categorical_accuracy: 0.2672 - val_loss: 42.8077 -
val_sparse_categorical_accuracy: 0.1193
Epoch 4/5
50000/50000 [==============================] - 18s 362us/sample - loss: 42.6420
- sparse_categorical_accuracy: 0.2886 - val_loss: 42.5844 -
val_sparse_categorical_accuracy: 0.1218
Epoch 5/5
50000/50000 [==============================] - 18s 360us/sample - loss: 42.3034
- sparse_categorical_accuracy: 0.3091 - val_loss: 42.3634 -
val_sparse_categorical_accuracy: 0.1226
 96%|      | 96/100 [2:22:44<07:02, 105.62s/it]
0.12256 7.690611416185087e-06 0.11143136406782136
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 23s 468us/sample - loss: 25.1249
- sparse_categorical_accuracy: 0.2563 - val_loss: 24.3869 -
val_sparse_categorical_accuracy: 0.1566
Epoch 2/5
50000/50000 [==============================] - 19s 370us/sample - loss: 23.7586
- sparse_categorical_accuracy: 0.3443 - val_loss: 23.9173 -
val_sparse_categorical_accuracy: 0.1718
Epoch 3/5
50000/50000 [==============================] - 19s 374us/sample - loss: 23.1564
- sparse_categorical_accuracy: 0.3902 - val_loss: 23.4623 -
val_sparse_categorical_accuracy: 0.1783
Epoch 4/5
50000/50000 [==============================] - 19s 373us/sample - loss: 22.6262
- sparse_categorical_accuracy: 0.4183 - val_loss: 23.0190 -
val_sparse_categorical_accuracy: 0.1876
Epoch 5/5
50000/50000 [==============================] - 19s 371us/sample - loss: 22.1317
- sparse_categorical_accuracy: 0.4361 - val_loss: 22.5864 -
val_sparse_categorical_accuracy: 0.1942
 97%|      | 97/100 [2:24:31<05:17, 105.95s/it]
0.19416 5.467094311922403e-05 0.06132522366569525
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 24s 488us/sample - loss: 3.5219 -
sparse_categorical_accuracy: 0.2062 - val_loss: 2.3116 -
val_sparse_categorical_accuracy: 0.1098
Epoch 2/5
```

```
50000/50000 [==============================] - 19s 375us/sample - loss: 2.3554 -
sparse_categorical_accuracy: 0.2731 - val_loss: 2.3101 -
val_sparse_categorical_accuracy: 0.1158
Epoch 3/5
50000/50000 [==============================] - 19s 375us/sample - loss: 2.1216 -
sparse_categorical_accuracy: 0.3060 - val_loss: 2.3089 -
val_sparse_categorical_accuracy: 0.1209
Epoch 4/5
50000/50000 [==============================] - 19s 377us/sample - loss: 2.0004 -
sparse_categorical_accuracy: 0.3298 - val_loss: 2.3078 -
val_sparse_categorical_accuracy: 0.1246
Epoch 5/5
50000/50000 [==============================] - 19s 373us/sample - loss: 1.9212 -
sparse_categorical_accuracy: 0.3494 - val_loss: 2.3071 -
val_sparse_categorical_accuracy: 0.1290
 98%|     | 98/100 [2:26:19<03:33, 106.69s/it]
0.12896 1.460659744598202e-05 4.240484899553023e-05
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 24s 476us/sample - loss: 42.4556
- sparse_categorical_accuracy: 0.2568 - val_loss: 41.6208 -
val_sparse_categorical_accuracy: 0.1340
Epoch 2/5
50000/50000 [==============================] - 19s 383us/sample - loss: 40.7389
- sparse_categorical_accuracy: 0.3359 - val_loss: 40.6124 -
val_sparse_categorical_accuracy: 0.1398
Epoch 3/5
50000/50000 [==============================] - 19s 383us/sample - loss: 39.6131
- sparse_categorical_accuracy: 0.3728 - val_loss: 39.6347 -
val_sparse_categorical_accuracy: 0.1471
Epoch 4/5
50000/50000 [==============================] - 19s 381us/sample - loss: 38.5768
- sparse_categorical_accuracy: 0.3975 - val_loss: 38.6850 -
val_sparse_categorical_accuracy: 0.1537
Epoch 5/5
50000/50000 [==============================] - 19s 383us/sample - loss: 37.5891
- sparse_categorical_accuracy: 0.4161 - val_loss: 37.7612 -
val_sparse_categorical_accuracy: 0.1577
 99%|     | 99/100 [2:28:08<01:47, 107.44s/it]
0.15768 3.7409079061731846e-05 0.10966399559807373
Train on 50000 samples, validate on 12500 samples
Epoch 1/5
50000/50000 [==============================] - 24s 487us/sample - loss: 5.5265 -
sparse_categorical_accuracy: 0.1429 - val_loss: 2.5308 -
val_sparse_categorical_accuracy: 0.1123
Epoch 2/5
```

```
50000/50000 [==============================] - 19s 373us/sample - loss: 3.6056 -
sparse_categorical_accuracy: 0.1921 - val_loss: 2.5275 -
val_sparse_categorical_accuracy: 0.1158
Epoch 3/5
50000/50000 [==============================] - 19s 376us/sample - loss: 3.1362 -
sparse_categorical_accuracy: 0.2191 - val_loss: 2.5258 -
val_sparse_categorical_accuracy: 0.1161
Epoch 4/5
50000/50000 [==============================] - 19s 374us/sample - loss: 2.8940 -
sparse_categorical_accuracy: 0.2376 - val_loss: 2.5247 -
val_sparse_categorical_accuracy: 0.1183
Epoch 5/5
50000/50000 [==============================] - 19s 375us/sample - loss: 2.7301 -
sparse_categorical_accuracy: 0.2533 - val_loss: 2.5241 -
val_sparse_categorical_accuracy: 0.1182

100%|      | 100/100 [2:29:56<00:00, 89.97s/it]

0.11824 3.715624466813815e-06 0.0006366319111000346
```

[55]:
```
logs=[val_acc,lrs, l2_regs]
logs=np.array(logs)
# logs=np.sort(logs,axis=0)
```

[56]:
```
top10=np.argsort(logs[0,:])[::-1][:10]
top10
```

[56]:
```
array([66, 58, 50, 18, 62,  2,  6, 12, 54, 92], dtype=int64)
```

[57]:
```
logs[:,top10]
```

[57]:
```
array([[3.47840011e-01, 2.76239991e-01, 2.71279991e-01, 2.66880006e-01,
        2.63200015e-01, 2.55519986e-01, 2.50239998e-01, 2.31279999e-01,
        2.08959997e-01, 1.98799998e-01],
       [8.93519401e-04, 2.14769550e-04, 8.62517477e-04, 9.76032474e-04,
        6.18592301e-04, 7.82162498e-05, 7.42350403e-04, 2.30981049e-04,
        6.61083085e-05, 2.83829186e-04],
       [3.51591145e-01, 7.14051715e-02, 2.37911586e-02, 6.14316039e-01,
        1.91782951e-04, 2.56481162e+00, 2.19295743e-03, 1.01731719e-05,
        2.61042124e+00, 3.85274822e-02]])
```

[58]:
```
val_acc=[]
lrs=[]
l2_regs=[]
for i in tqdm(range(30)):
    lr = 10**np.random.uniform(-3,-4)
    l2_reg = 10**np.random.uniform(-6, -2)
```

```
    model = create_model(num_classes,l2_reg)
    model.compile(optimizer=optimizers.
↪SGD(learning_rate=lr),loss='sparse_categorical_crossentropy',metrics=['sparse_categorical_a
    history = model.fit(X_train,y_train,batch_size=BATCH_SIZE,epochs=15,␣
↪verbose=1,validation_data=(X_val,y_val))
    val_acc.append(history.history['val_sparse_categorical_accuracy'][-1])
    lrs.append(lr)
    l2_regs.append(l2_reg)
    print(history.history['val_sparse_categorical_accuracy'][-1], lr, l2_reg)
```

```
  0%|          | 0/30 [00:00<?, ?it/s]
Train on 50000 samples, validate on 12500 samples
Epoch 1/15
50000/50000 [==============================] - 24s 485us/sample - loss: 2.4555 -
sparse_categorical_accuracy: 0.3506 - val_loss: 2.7841 -
val_sparse_categorical_accuracy: 0.1463
Epoch 2/15
50000/50000 [==============================] - 19s 380us/sample - loss: 2.0269 -
sparse_categorical_accuracy: 0.4506 - val_loss: 2.7795 -
val_sparse_categorical_accuracy: 0.1560
Epoch 3/15
50000/50000 [==============================] - 19s 379us/sample - loss: 1.9097 -
sparse_categorical_accuracy: 0.4935 - val_loss: 2.7762 -
val_sparse_categorical_accuracy: 0.1586
Epoch 4/15
50000/50000 [==============================] - 19s 379us/sample - loss: 1.8278 -
sparse_categorical_accuracy: 0.5234 - val_loss: 2.7727 -
val_sparse_categorical_accuracy: 0.1657
Epoch 5/15
50000/50000 [==============================] - 19s 379us/sample - loss: 1.7656 -
sparse_categorical_accuracy: 0.5478 - val_loss: 2.7698 -
val_sparse_categorical_accuracy: 0.1614
Epoch 6/15
50000/50000 [==============================] - 19s 380us/sample - loss: 1.7108 -
sparse_categorical_accuracy: 0.5676 - val_loss: 2.7682 -
val_sparse_categorical_accuracy: 0.1576
Epoch 7/15
50000/50000 [==============================] - 19s 382us/sample - loss: 1.6636 -
sparse_categorical_accuracy: 0.5834 - val_loss: 2.7661 -
val_sparse_categorical_accuracy: 0.1658
Epoch 8/15
50000/50000 [==============================] - 19s 382us/sample - loss: 1.6245 -
sparse_categorical_accuracy: 0.6008 - val_loss: 2.7633 -
val_sparse_categorical_accuracy: 0.1602
Epoch 9/15
50000/50000 [==============================] - 19s 379us/sample - loss: 1.5875 -
sparse_categorical_accuracy: 0.6120 - val_loss: 2.7626 -
```

```
val_sparse_categorical_accuracy: 0.1590
Epoch 10/15
50000/50000 [==============================] - 19s 381us/sample - loss: 1.5536 -
sparse_categorical_accuracy: 0.6239 - val_loss: 2.7614 -
val_sparse_categorical_accuracy: 0.1602
Epoch 11/15
50000/50000 [==============================] - 19s 378us/sample - loss: 1.5215 -
sparse_categorical_accuracy: 0.6342 - val_loss: 2.7587 -
val_sparse_categorical_accuracy: 0.1696
Epoch 12/15
50000/50000 [==============================] - 19s 379us/sample - loss: 1.4941 -
sparse_categorical_accuracy: 0.6444 - val_loss: 2.7578 -
val_sparse_categorical_accuracy: 0.1744
Epoch 13/15
50000/50000 [==============================] - 19s 382us/sample - loss: 1.4696 -
sparse_categorical_accuracy: 0.6520 - val_loss: 2.7560 -
val_sparse_categorical_accuracy: 0.1693
Epoch 14/15
50000/50000 [==============================] - 19s 379us/sample - loss: 1.4448 -
sparse_categorical_accuracy: 0.6613 - val_loss: 2.7533 -
val_sparse_categorical_accuracy: 0.1734
Epoch 15/15
50000/50000 [==============================] - 19s 380us/sample - loss: 1.4207 -
sparse_categorical_accuracy: 0.6706 - val_loss: 2.7522 -
val_sparse_categorical_accuracy: 0.1712

  3%|          | 1/30 [04:59<2:24:46, 299.54s/it]

0.1712 0.000340582134981923 0.0013333893009474457
Train on 50000 samples, validate on 12500 samples
Epoch 1/15
50000/50000 [==============================] - 25s 492us/sample - loss: 2.0412 -
sparse_categorical_accuracy: 0.3269 - val_loss: 2.2911 -
val_sparse_categorical_accuracy: 0.1557
Epoch 2/15
50000/50000 [==============================] - 19s 370us/sample - loss: 1.5692 -
sparse_categorical_accuracy: 0.4415 - val_loss: 2.2879 -
val_sparse_categorical_accuracy: 0.1566
Epoch 3/15
50000/50000 [==============================] - 19s 371us/sample - loss: 1.4374 -
sparse_categorical_accuracy: 0.4857 - val_loss: 2.2843 -
val_sparse_categorical_accuracy: 0.1783
Epoch 4/15
50000/50000 [==============================] - 19s 372us/sample - loss: 1.3564 -
sparse_categorical_accuracy: 0.5162 - val_loss: 2.2824 -
val_sparse_categorical_accuracy: 0.1788
Epoch 5/15
50000/50000 [==============================] - 19s 373us/sample - loss: 1.2935 -
sparse_categorical_accuracy: 0.5415 - val_loss: 2.2810 -
```

```
val_sparse_categorical_accuracy: 0.1791
Epoch 6/15
50000/50000 [==============================] - 19s 371us/sample - loss: 1.2464 -
sparse_categorical_accuracy: 0.5577 - val_loss: 2.2798 -
val_sparse_categorical_accuracy: 0.1888
Epoch 7/15
50000/50000 [==============================] - 19s 374us/sample - loss: 1.2025 -
sparse_categorical_accuracy: 0.5763 - val_loss: 2.2792 -
val_sparse_categorical_accuracy: 0.1879
Epoch 8/15
50000/50000 [==============================] - 19s 370us/sample - loss: 1.1667 -
sparse_categorical_accuracy: 0.5877 - val_loss: 2.2791 -
val_sparse_categorical_accuracy: 0.1845
Epoch 9/15
50000/50000 [==============================] - 19s 372us/sample - loss: 1.1346 -
sparse_categorical_accuracy: 0.6005 - val_loss: 2.2773 -
val_sparse_categorical_accuracy: 0.2029
Epoch 10/15
50000/50000 [==============================] - 19s 377us/sample - loss: 1.1023 -
sparse_categorical_accuracy: 0.6138 - val_loss: 2.2765 -
val_sparse_categorical_accuracy: 0.2009
Epoch 11/15
50000/50000 [==============================] - 19s 370us/sample - loss: 1.0745 -
sparse_categorical_accuracy: 0.6231 - val_loss: 2.2763 -
val_sparse_categorical_accuracy: 0.2013
Epoch 12/15
50000/50000 [==============================] - 19s 370us/sample - loss: 1.0489 -
sparse_categorical_accuracy: 0.6328 - val_loss: 2.2753 -
val_sparse_categorical_accuracy: 0.2098
Epoch 13/15
50000/50000 [==============================] - 19s 376us/sample - loss: 1.0228 -
sparse_categorical_accuracy: 0.6431 - val_loss: 2.2747 -
val_sparse_categorical_accuracy: 0.2178
Epoch 14/15
50000/50000 [==============================] - 19s 372us/sample - loss: 1.0018 -
sparse_categorical_accuracy: 0.6507 - val_loss: 2.2748 -
val_sparse_categorical_accuracy: 0.2031
Epoch 15/15
50000/50000 [==============================] - 19s 373us/sample - loss: 0.9803 -
sparse_categorical_accuracy: 0.6593 - val_loss: 2.2732 -
val_sparse_categorical_accuracy: 0.2246

  7%|          | 2/30 [09:54<2:19:05, 298.04s/it]

0.22464 0.00032230219838556276 3.7440545698221587e-06
Train on 50000 samples, validate on 12500 samples
Epoch 1/15
50000/50000 [==============================] - 24s 482us/sample - loss: 2.1021 -
sparse_categorical_accuracy: 0.3206 - val_loss: 2.2958 -
```

```
val_sparse_categorical_accuracy: 0.1443
Epoch 2/15
50000/50000 [==============================] - 19s 374us/sample - loss: 1.6131 -
sparse_categorical_accuracy: 0.4242 - val_loss: 2.2939 -
val_sparse_categorical_accuracy: 0.1652
Epoch 3/15
50000/50000 [==============================] - 19s 373us/sample - loss: 1.5032 -
sparse_categorical_accuracy: 0.4632 - val_loss: 2.2930 -
val_sparse_categorical_accuracy: 0.1671
Epoch 4/15
50000/50000 [==============================] - 19s 383us/sample - loss: 1.4286 -
sparse_categorical_accuracy: 0.4926 - val_loss: 2.2909 -
val_sparse_categorical_accuracy: 0.1758
Epoch 5/15
50000/50000 [==============================] - 19s 374us/sample - loss: 1.3724 -
sparse_categorical_accuracy: 0.5116 - val_loss: 2.2889 -
val_sparse_categorical_accuracy: 0.1880
Epoch 6/15
50000/50000 [==============================] - 19s 374us/sample - loss: 1.3262 -
sparse_categorical_accuracy: 0.5288 - val_loss: 2.2876 -
val_sparse_categorical_accuracy: 0.1887
Epoch 7/15
50000/50000 [==============================] - 19s 375us/sample - loss: 1.2842 -
sparse_categorical_accuracy: 0.5463 - val_loss: 2.2866 -
val_sparse_categorical_accuracy: 0.1874
Epoch 8/15
50000/50000 [==============================] - 19s 375us/sample - loss: 1.2524 -
sparse_categorical_accuracy: 0.5575 - val_loss: 2.2861 -
val_sparse_categorical_accuracy: 0.1936
Epoch 9/15
50000/50000 [==============================] - 19s 373us/sample - loss: 1.2211 -
sparse_categorical_accuracy: 0.5694 - val_loss: 2.2850 -
val_sparse_categorical_accuracy: 0.1936
Epoch 10/15
50000/50000 [==============================] - 19s 376us/sample - loss: 1.1936 -
sparse_categorical_accuracy: 0.5810 - val_loss: 2.2853 -
val_sparse_categorical_accuracy: 0.1900
Epoch 11/15
50000/50000 [==============================] - 20s 394us/sample - loss: 1.1668 -
sparse_categorical_accuracy: 0.5914 - val_loss: 2.2836 -
val_sparse_categorical_accuracy: 0.1945
Epoch 12/15
50000/50000 [==============================] - 19s 376us/sample - loss: 1.1452 -
sparse_categorical_accuracy: 0.5982 - val_loss: 2.2836 -
val_sparse_categorical_accuracy: 0.1910
Epoch 13/15
50000/50000 [==============================] - 19s 377us/sample - loss: 1.1248 -
sparse_categorical_accuracy: 0.6070 - val_loss: 2.2843 -
```

```
val_sparse_categorical_accuracy: 0.1876
Epoch 14/15
50000/50000 [==============================] - 19s 374us/sample - loss: 1.1050 -
sparse_categorical_accuracy: 0.6130 - val_loss: 2.2838 -
val_sparse_categorical_accuracy: 0.1910
Epoch 15/15
50000/50000 [==============================] - 19s 373us/sample - loss: 1.0857 -
sparse_categorical_accuracy: 0.6211 - val_loss: 2.2819 -
val_sparse_categorical_accuracy: 0.2011

 10%|          | 3/30 [14:51<2:14:03, 297.90s/it]

0.20112 0.00019138515885339346 1.4465308715216947e-06
Train on 50000 samples, validate on 12500 samples
Epoch 1/15
50000/50000 [==============================] - 24s 490us/sample - loss: 2.0550 -
sparse_categorical_accuracy: 0.3269 - val_loss: 2.3031 -
val_sparse_categorical_accuracy: 0.1404
Epoch 2/15
50000/50000 [==============================] - 19s 373us/sample - loss: 1.6468 -
sparse_categorical_accuracy: 0.4190 - val_loss: 2.3007 -
val_sparse_categorical_accuracy: 0.1571
Epoch 3/15
50000/50000 [==============================] - 19s 374us/sample - loss: 1.5482 -
sparse_categorical_accuracy: 0.4552 - val_loss: 2.2990 -
val_sparse_categorical_accuracy: 0.1651
Epoch 4/15
50000/50000 [==============================] - 19s 375us/sample - loss: 1.4822 -
sparse_categorical_accuracy: 0.4796 - val_loss: 2.2983 -
val_sparse_categorical_accuracy: 0.1723
Epoch 5/15
50000/50000 [==============================] - 19s 375us/sample - loss: 1.4294 -
sparse_categorical_accuracy: 0.4994 - val_loss: 2.2982 -
val_sparse_categorical_accuracy: 0.1719
Epoch 6/15
50000/50000 [==============================] - 19s 374us/sample - loss: 1.3859 -
sparse_categorical_accuracy: 0.5154 - val_loss: 2.2980 -
val_sparse_categorical_accuracy: 0.1740
Epoch 7/15
50000/50000 [==============================] - 19s 375us/sample - loss: 1.3482 -
sparse_categorical_accuracy: 0.5291 - val_loss: 2.2974 -
val_sparse_categorical_accuracy: 0.1747
Epoch 8/15
50000/50000 [==============================] - 19s 375us/sample - loss: 1.3120 -
sparse_categorical_accuracy: 0.5420 - val_loss: 2.2968 -
val_sparse_categorical_accuracy: 0.1764
Epoch 9/15
50000/50000 [==============================] - 19s 375us/sample - loss: 1.2823 -
sparse_categorical_accuracy: 0.5543 - val_loss: 2.2958 -
```

```
val_sparse_categorical_accuracy: 0.1784
Epoch 10/15
50000/50000 [==============================] - 19s 375us/sample - loss: 1.2530 -
sparse_categorical_accuracy: 0.5633 - val_loss: 2.2963 -
val_sparse_categorical_accuracy: 0.1775
Epoch 11/15
50000/50000 [==============================] - 19s 374us/sample - loss: 1.2266 -
sparse_categorical_accuracy: 0.5718 - val_loss: 2.2950 -
val_sparse_categorical_accuracy: 0.1783
Epoch 12/15
50000/50000 [==============================] - 19s 376us/sample - loss: 1.2027 -
sparse_categorical_accuracy: 0.5811 - val_loss: 2.2955 -
val_sparse_categorical_accuracy: 0.1779
Epoch 13/15
50000/50000 [==============================] - 19s 377us/sample - loss: 1.1786 -
sparse_categorical_accuracy: 0.5900 - val_loss: 2.2946 -
val_sparse_categorical_accuracy: 0.1782
Epoch 14/15
50000/50000 [==============================] - 19s 376us/sample - loss: 1.1583 -
sparse_categorical_accuracy: 0.5989 - val_loss: 2.2947 -
val_sparse_categorical_accuracy: 0.1750
Epoch 15/15
50000/50000 [==============================] - 19s 376us/sample - loss: 1.1375 -
sparse_categorical_accuracy: 0.6057 - val_loss: 2.2952 -
val_sparse_categorical_accuracy: 0.1810

 13%|         | 4/30 [19:48<2:08:55, 297.51s/it]

0.18096 0.0002098279648027104 2.3926026621752303e-05
Train on 50000 samples, validate on 12500 samples
Epoch 1/15
50000/50000 [==============================] - 25s 493us/sample - loss: 3.0375 -
sparse_categorical_accuracy: 0.2918 - val_loss: 3.1693 -
val_sparse_categorical_accuracy: 0.1088
Epoch 2/15
50000/50000 [==============================] - 19s 380us/sample - loss: 2.5909 -
sparse_categorical_accuracy: 0.3980 - val_loss: 3.1636 -
val_sparse_categorical_accuracy: 0.1234
Epoch 3/15
50000/50000 [==============================] - 19s 378us/sample - loss: 2.4726 -
sparse_categorical_accuracy: 0.4375 - val_loss: 3.1592 -
val_sparse_categorical_accuracy: 0.1349
Epoch 4/15
50000/50000 [==============================] - 19s 381us/sample - loss: 2.3937 -
sparse_categorical_accuracy: 0.4623 - val_loss: 3.1559 -
val_sparse_categorical_accuracy: 0.1458
Epoch 5/15
50000/50000 [==============================] - 19s 378us/sample - loss: 2.3339 -
sparse_categorical_accuracy: 0.4834 - val_loss: 3.1520 -
```

```
val_sparse_categorical_accuracy: 0.1469
Epoch 6/15
50000/50000 [==============================] - 19s 381us/sample - loss: 2.2833 -
sparse_categorical_accuracy: 0.5016 - val_loss: 3.1487 -
val_sparse_categorical_accuracy: 0.1536
Epoch 7/15
50000/50000 [==============================] - 19s 379us/sample - loss: 2.2386 -
sparse_categorical_accuracy: 0.5152 - val_loss: 3.1460 -
val_sparse_categorical_accuracy: 0.1566
Epoch 8/15
50000/50000 [==============================] - 19s 380us/sample - loss: 2.2005 -
sparse_categorical_accuracy: 0.5305 - val_loss: 3.1426 -
val_sparse_categorical_accuracy: 0.1513
Epoch 9/15
50000/50000 [==============================] - 19s 379us/sample - loss: 2.1673 -
sparse_categorical_accuracy: 0.5415 - val_loss: 3.1399 -
val_sparse_categorical_accuracy: 0.1516
Epoch 10/15
50000/50000 [==============================] - 19s 379us/sample - loss: 2.1334 -
sparse_categorical_accuracy: 0.5535 - val_loss: 3.1371 -
val_sparse_categorical_accuracy: 0.1577
Epoch 11/15
50000/50000 [==============================] - 19s 383us/sample - loss: 2.1071 -
sparse_categorical_accuracy: 0.5622 - val_loss: 3.1347 -
val_sparse_categorical_accuracy: 0.1618
Epoch 12/15
50000/50000 [==============================] - 19s 379us/sample - loss: 2.0799 -
sparse_categorical_accuracy: 0.5709 - val_loss: 3.1320 -
val_sparse_categorical_accuracy: 0.1694
Epoch 13/15
50000/50000 [==============================] - 19s 380us/sample - loss: 2.0552 -
sparse_categorical_accuracy: 0.5811 - val_loss: 3.1292 -
val_sparse_categorical_accuracy: 0.1649
Epoch 14/15
50000/50000 [==============================] - 19s 379us/sample - loss: 2.0306 -
sparse_categorical_accuracy: 0.5890 - val_loss: 3.1270 -
val_sparse_categorical_accuracy: 0.1722
Epoch 15/15
50000/50000 [==============================] - 19s 379us/sample - loss: 2.0129 -
sparse_categorical_accuracy: 0.5936 - val_loss: 3.1249 -
val_sparse_categorical_accuracy: 0.1725

 17%|         | 5/30 [24:47<2:04:14, 298.18s/it]

0.17248 0.00014707994739180828 0.002384959790953719
Train on 50000 samples, validate on 12500 samples
Epoch 1/15
50000/50000 [==============================] - 25s 496us/sample - loss: 2.2485 -
sparse_categorical_accuracy: 0.3015 - val_loss: 2.3058 -
```

```
val_sparse_categorical_accuracy: 0.1465
Epoch 2/15
50000/50000 [==============================] - 19s 380us/sample - loss: 1.7450 -
sparse_categorical_accuracy: 0.3890 - val_loss: 2.3035 -
val_sparse_categorical_accuracy: 0.1547
Epoch 3/15
50000/50000 [==============================] - 19s 379us/sample - loss: 1.6415 -
sparse_categorical_accuracy: 0.4253 - val_loss: 2.3014 -
val_sparse_categorical_accuracy: 0.1610
Epoch 4/15
50000/50000 [==============================] - 19s 378us/sample - loss: 1.5708 -
sparse_categorical_accuracy: 0.4489 - val_loss: 2.3008 -
val_sparse_categorical_accuracy: 0.1618
Epoch 5/15
50000/50000 [==============================] - 19s 378us/sample - loss: 1.5177 -
sparse_categorical_accuracy: 0.4692 - val_loss: 2.3005 -
val_sparse_categorical_accuracy: 0.1606
Epoch 6/15
50000/50000 [==============================] - 19s 379us/sample - loss: 1.4721 -
sparse_categorical_accuracy: 0.4841 - val_loss: 2.3007 -
val_sparse_categorical_accuracy: 0.1622
Epoch 7/15
50000/50000 [==============================] - 19s 383us/sample - loss: 1.4334 -
sparse_categorical_accuracy: 0.4989 - val_loss: 2.3004 -
val_sparse_categorical_accuracy: 0.1654
Epoch 8/15
50000/50000 [==============================] - 19s 379us/sample - loss: 1.3973 -
sparse_categorical_accuracy: 0.5107 - val_loss: 2.2996 -
val_sparse_categorical_accuracy: 0.1649
Epoch 9/15
50000/50000 [==============================] - 19s 378us/sample - loss: 1.3665 -
sparse_categorical_accuracy: 0.5237 - val_loss: 2.2990 -
val_sparse_categorical_accuracy: 0.1658
Epoch 10/15
50000/50000 [==============================] - 19s 380us/sample - loss: 1.3366 -
sparse_categorical_accuracy: 0.5331 - val_loss: 2.2981 -
val_sparse_categorical_accuracy: 0.1680
Epoch 11/15
50000/50000 [==============================] - 19s 379us/sample - loss: 1.3105 -
sparse_categorical_accuracy: 0.5434 - val_loss: 2.2979 -
val_sparse_categorical_accuracy: 0.1662
Epoch 12/15
50000/50000 [==============================] - 19s 382us/sample - loss: 1.2890 -
sparse_categorical_accuracy: 0.5507 - val_loss: 2.2972 -
val_sparse_categorical_accuracy: 0.1661
Epoch 13/15
50000/50000 [==============================] - 19s 380us/sample - loss: 1.2654 -
sparse_categorical_accuracy: 0.5615 - val_loss: 2.2973 -
```

```
val_sparse_categorical_accuracy: 0.1691
Epoch 14/15
50000/50000 [==============================] - 19s 379us/sample - loss: 1.2445 -
sparse_categorical_accuracy: 0.5673 - val_loss: 2.2975 -
val_sparse_categorical_accuracy: 0.1677
Epoch 15/15
50000/50000 [==============================] - 19s 379us/sample - loss: 1.2242 -
sparse_categorical_accuracy: 0.5757 - val_loss: 2.2974 -
val_sparse_categorical_accuracy: 0.1690

 20%|         | 6/30 [29:48<1:59:29, 298.73s/it]

0.16896 0.0001342778517839686 4.0798957889452306e-05
Train on 50000 samples, validate on 12500 samples
Epoch 1/15
50000/50000 [==============================] - 25s 491us/sample - loss: 1.9313 -
sparse_categorical_accuracy: 0.3592 - val_loss: 2.3059 -
val_sparse_categorical_accuracy: 0.1219
Epoch 2/15
50000/50000 [==============================] - 19s 386us/sample - loss: 1.4977 -
sparse_categorical_accuracy: 0.4625 - val_loss: 2.3056 -
val_sparse_categorical_accuracy: 0.1214
Epoch 3/15
50000/50000 [==============================] - 19s 388us/sample - loss: 1.3696 -
sparse_categorical_accuracy: 0.5141 - val_loss: 2.3025 -
val_sparse_categorical_accuracy: 0.1239
Epoch 4/15
50000/50000 [==============================] - 19s 387us/sample - loss: 1.2707 -
sparse_categorical_accuracy: 0.5473 - val_loss: 2.3017 -
val_sparse_categorical_accuracy: 0.1268
Epoch 5/15
50000/50000 [==============================] - 19s 387us/sample - loss: 1.1925 -
sparse_categorical_accuracy: 0.5784 - val_loss: 2.3004 -
val_sparse_categorical_accuracy: 0.1265
Epoch 6/15
50000/50000 [==============================] - 19s 388us/sample - loss: 1.1263 -
sparse_categorical_accuracy: 0.6019 - val_loss: 2.2991 -
val_sparse_categorical_accuracy: 0.1274
Epoch 7/15
50000/50000 [==============================] - 19s 387us/sample - loss: 1.0725 -
sparse_categorical_accuracy: 0.6242 - val_loss: 2.2983 -
val_sparse_categorical_accuracy: 0.1301
Epoch 8/15
50000/50000 [==============================] - 20s 392us/sample - loss: 1.0216 -
sparse_categorical_accuracy: 0.6411 - val_loss: 2.2971 -
val_sparse_categorical_accuracy: 0.1333
Epoch 9/15
50000/50000 [==============================] - 19s 386us/sample - loss: 0.9779 -
sparse_categorical_accuracy: 0.6596 - val_loss: 2.2933 -
```

```
val_sparse_categorical_accuracy: 0.1386
Epoch 10/15
50000/50000 [==============================] - 19s 388us/sample - loss: 0.9406 -
sparse_categorical_accuracy: 0.6707 - val_loss: 2.2945 -
val_sparse_categorical_accuracy: 0.1415
Epoch 11/15
50000/50000 [==============================] - 19s 387us/sample - loss: 0.9061 -
sparse_categorical_accuracy: 0.6830 - val_loss: 2.2930 -
val_sparse_categorical_accuracy: 0.1437
Epoch 12/15
50000/50000 [==============================] - 20s 391us/sample - loss: 0.8715 -
sparse_categorical_accuracy: 0.6964 - val_loss: 2.2940 -
val_sparse_categorical_accuracy: 0.1434
Epoch 13/15
50000/50000 [==============================] - 19s 390us/sample - loss: 0.8415 -
sparse_categorical_accuracy: 0.7065 - val_loss: 2.2936 -
val_sparse_categorical_accuracy: 0.1452
Epoch 14/15
50000/50000 [==============================] - 19s 388us/sample - loss: 0.8134 -
sparse_categorical_accuracy: 0.7175 - val_loss: 2.2934 -
val_sparse_categorical_accuracy: 0.1449
Epoch 15/15
50000/50000 [==============================] - 19s 385us/sample - loss: 0.7825 -
sparse_categorical_accuracy: 0.7268 - val_loss: 2.2910 -
val_sparse_categorical_accuracy: 0.1515

 23%|         | 7/30 [34:53<1:55:18, 300.82s/it]

0.15152 0.0008699784680401431 1.081620518324613e-05
Train on 50000 samples, validate on 12500 samples
Epoch 1/15
50000/50000 [==============================] - 25s 504us/sample - loss: 1.8453 -
sparse_categorical_accuracy: 0.3661 - val_loss: 2.2849 -
val_sparse_categorical_accuracy: 0.1563
Epoch 2/15
50000/50000 [==============================] - 19s 382us/sample - loss: 1.5083 -
sparse_categorical_accuracy: 0.4607 - val_loss: 2.2821 -
val_sparse_categorical_accuracy: 0.1637
Epoch 3/15
50000/50000 [==============================] - 19s 380us/sample - loss: 1.4000 -
sparse_categorical_accuracy: 0.5020 - val_loss: 2.2814 -
val_sparse_categorical_accuracy: 0.1750
Epoch 4/15
50000/50000 [==============================] - 19s 380us/sample - loss: 1.3176 -
sparse_categorical_accuracy: 0.5321 - val_loss: 2.2816 -
val_sparse_categorical_accuracy: 0.1744
Epoch 5/15
50000/50000 [==============================] - 19s 380us/sample - loss: 1.2484 -
sparse_categorical_accuracy: 0.5575 - val_loss: 2.2806 -
```

```
val_sparse_categorical_accuracy: 0.1831
Epoch 6/15
50000/50000 [==============================] - 19s 380us/sample - loss: 1.1910 -
sparse_categorical_accuracy: 0.5786 - val_loss: 2.2791 -
val_sparse_categorical_accuracy: 0.1774
Epoch 7/15
50000/50000 [==============================] - 19s 384us/sample - loss: 1.1370 -
sparse_categorical_accuracy: 0.6013 - val_loss: 2.2773 -
val_sparse_categorical_accuracy: 0.1738
Epoch 8/15
50000/50000 [==============================] - 19s 381us/sample - loss: 1.0908 -
sparse_categorical_accuracy: 0.6193 - val_loss: 2.2760 -
val_sparse_categorical_accuracy: 0.1838
Epoch 9/15
50000/50000 [==============================] - 19s 381us/sample - loss: 1.0491 -
sparse_categorical_accuracy: 0.6345 - val_loss: 2.2756 -
val_sparse_categorical_accuracy: 0.1795
Epoch 10/15
50000/50000 [==============================] - 19s 380us/sample - loss: 1.0101 -
sparse_categorical_accuracy: 0.6466 - val_loss: 2.2751 -
val_sparse_categorical_accuracy: 0.1816
Epoch 11/15
50000/50000 [==============================] - 19s 381us/sample - loss: 0.9779 -
sparse_categorical_accuracy: 0.6574 - val_loss: 2.2729 -
val_sparse_categorical_accuracy: 0.1763
Epoch 12/15
50000/50000 [==============================] - 19s 382us/sample - loss: 0.9473 -
sparse_categorical_accuracy: 0.6701 - val_loss: 2.2725 -
val_sparse_categorical_accuracy: 0.1879
Epoch 13/15
50000/50000 [==============================] - 19s 383us/sample - loss: 0.9152 -
sparse_categorical_accuracy: 0.6810 - val_loss: 2.2727 -
val_sparse_categorical_accuracy: 0.1847
Epoch 14/15
50000/50000 [==============================] - 19s 380us/sample - loss: 0.8887 -
sparse_categorical_accuracy: 0.6911 - val_loss: 2.2705 -
val_sparse_categorical_accuracy: 0.1790
Epoch 15/15
50000/50000 [==============================] - 19s 380us/sample - loss: 0.8640 -
sparse_categorical_accuracy: 0.6988 - val_loss: 2.2696 -
val_sparse_categorical_accuracy: 0.1874

 27%|         | 8/30 [39:55<1:50:27, 301.23s/it]

0.18736 0.0005748387840345341 2.310176355887451e-06
Train on 50000 samples, validate on 12500 samples
Epoch 1/15
50000/50000 [==============================] - 25s 501us/sample - loss: 1.8645 -
sparse_categorical_accuracy: 0.3619 - val_loss: 2.2914 -
```

```
val_sparse_categorical_accuracy: 0.1488
Epoch 2/15
50000/50000 [==============================] - 19s 389us/sample - loss: 1.4841 -
sparse_categorical_accuracy: 0.4692 - val_loss: 2.2869 -
val_sparse_categorical_accuracy: 0.1470
Epoch 3/15
50000/50000 [==============================] - 20s 390us/sample - loss: 1.3469 -
sparse_categorical_accuracy: 0.5256 - val_loss: 2.2851 -
val_sparse_categorical_accuracy: 0.1502
Epoch 4/15
50000/50000 [==============================] - 19s 390us/sample - loss: 1.2454 -
sparse_categorical_accuracy: 0.5603 - val_loss: 2.2834 -
val_sparse_categorical_accuracy: 0.1524
Epoch 5/15
50000/50000 [==============================] - 19s 389us/sample - loss: 1.1629 -
sparse_categorical_accuracy: 0.5938 - val_loss: 2.2822 -
val_sparse_categorical_accuracy: 0.1540
Epoch 6/15
50000/50000 [==============================] - 19s 389us/sample - loss: 1.0950 -
sparse_categorical_accuracy: 0.6154 - val_loss: 2.2803 -
val_sparse_categorical_accuracy: 0.1538
Epoch 7/15
50000/50000 [==============================] - 20s 391us/sample - loss: 1.0342 -
sparse_categorical_accuracy: 0.6372 - val_loss: 2.2777 -
val_sparse_categorical_accuracy: 0.1636
Epoch 8/15
50000/50000 [==============================] - 19s 389us/sample - loss: 0.9854 -
sparse_categorical_accuracy: 0.6557 - val_loss: 2.2752 -
val_sparse_categorical_accuracy: 0.1596
Epoch 9/15
50000/50000 [==============================] - 19s 390us/sample - loss: 0.9358 -
sparse_categorical_accuracy: 0.6734 - val_loss: 2.2733 -
val_sparse_categorical_accuracy: 0.1685
Epoch 10/15
50000/50000 [==============================] - 19s 390us/sample - loss: 0.8931 -
sparse_categorical_accuracy: 0.6898 - val_loss: 2.2714 -
val_sparse_categorical_accuracy: 0.1743
Epoch 11/15
50000/50000 [==============================] - 19s 389us/sample - loss: 0.8541 -
sparse_categorical_accuracy: 0.7035 - val_loss: 2.2701 -
val_sparse_categorical_accuracy: 0.1713
Epoch 12/15
50000/50000 [==============================] - 20s 391us/sample - loss: 0.8181 -
sparse_categorical_accuracy: 0.7161 - val_loss: 2.2708 -
val_sparse_categorical_accuracy: 0.1714
Epoch 13/15
50000/50000 [==============================] - 20s 391us/sample - loss: 0.7803 -
sparse_categorical_accuracy: 0.7279 - val_loss: 2.2689 -
```

```
val_sparse_categorical_accuracy: 0.1772
Epoch 14/15
50000/50000 [==============================] - 19s 390us/sample - loss: 0.7491 -
sparse_categorical_accuracy: 0.7389 - val_loss: 2.2657 -
val_sparse_categorical_accuracy: 0.1763
Epoch 15/15
50000/50000 [==============================] - 19s 389us/sample - loss: 0.7151 -
sparse_categorical_accuracy: 0.7526 - val_loss: 2.2633 -
val_sparse_categorical_accuracy: 0.1851

 30%|         | 9/30 [45:03<1:46:04, 303.08s/it]

0.18512 0.0009664194360701518 1.086527858133712e-06
Train on 50000 samples, validate on 12500 samples
Epoch 1/15
50000/50000 [==============================] - 25s 503us/sample - loss: 2.1020 -
sparse_categorical_accuracy: 0.3220 - val_loss: 2.3480 -
val_sparse_categorical_accuracy: 0.1098
Epoch 2/15
50000/50000 [==============================] - 19s 385us/sample - loss: 1.6443 -
sparse_categorical_accuracy: 0.4286 - val_loss: 2.3449 -
val_sparse_categorical_accuracy: 0.1234
Epoch 3/15
50000/50000 [==============================] - 19s 383us/sample - loss: 1.5192 -
sparse_categorical_accuracy: 0.4775 - val_loss: 2.3429 -
val_sparse_categorical_accuracy: 0.1314
Epoch 4/15
50000/50000 [==============================] - 19s 382us/sample - loss: 1.4401 -
sparse_categorical_accuracy: 0.5060 - val_loss: 2.3406 -
val_sparse_categorical_accuracy: 0.1422
Epoch 5/15
50000/50000 [==============================] - 19s 384us/sample - loss: 1.3792 -
sparse_categorical_accuracy: 0.5293 - val_loss: 2.3394 -
val_sparse_categorical_accuracy: 0.1434
Epoch 6/15
50000/50000 [==============================] - 19s 386us/sample - loss: 1.3312 -
sparse_categorical_accuracy: 0.5464 - val_loss: 2.3387 -
val_sparse_categorical_accuracy: 0.1511
Epoch 7/15
50000/50000 [==============================] - 19s 385us/sample - loss: 1.2895 -
sparse_categorical_accuracy: 0.5652 - val_loss: 2.3372 -
val_sparse_categorical_accuracy: 0.1542
Epoch 8/15
50000/50000 [==============================] - 19s 386us/sample - loss: 1.2537 -
sparse_categorical_accuracy: 0.5771 - val_loss: 2.3374 -
val_sparse_categorical_accuracy: 0.1588
Epoch 9/15
50000/50000 [==============================] - 19s 384us/sample - loss: 1.2211 -
sparse_categorical_accuracy: 0.5889 - val_loss: 2.3366 -
```

```
val_sparse_categorical_accuracy: 0.1614
Epoch 10/15
50000/50000 [==============================] - 19s 384us/sample - loss: 1.1923 -
sparse_categorical_accuracy: 0.6005 - val_loss: 2.3358 -
val_sparse_categorical_accuracy: 0.1676
Epoch 11/15
50000/50000 [==============================] - 19s 385us/sample - loss: 1.1662 -
sparse_categorical_accuracy: 0.6093 - val_loss: 2.3356 -
val_sparse_categorical_accuracy: 0.1728
Epoch 12/15
50000/50000 [==============================] - 19s 388us/sample - loss: 1.1398 -
sparse_categorical_accuracy: 0.6171 - val_loss: 2.3342 -
val_sparse_categorical_accuracy: 0.1744
Epoch 13/15
50000/50000 [==============================] - 19s 386us/sample - loss: 1.1175 -
sparse_categorical_accuracy: 0.6266 - val_loss: 2.3347 -
val_sparse_categorical_accuracy: 0.1801
Epoch 14/15
50000/50000 [==============================] - 19s 384us/sample - loss: 1.0962 -
sparse_categorical_accuracy: 0.6367 - val_loss: 2.3339 -
val_sparse_categorical_accuracy: 0.1806
Epoch 15/15
50000/50000 [==============================] - 19s 384us/sample - loss: 1.0759 -
sparse_categorical_accuracy: 0.6422 - val_loss: 2.3336 -
val_sparse_categorical_accuracy: 0.1849

 33%|        | 10/30 [50:07<1:41:09, 303.47s/it]

0.18488 0.0002621993548817394 0.0001426171946174907 4
Train on 50000 samples, validate on 12500 samples
Epoch 1/15
50000/50000 [==============================] - 25s 498us/sample - loss: 2.5972 -
sparse_categorical_accuracy: 0.3424 - val_loss: 2.9934 -
val_sparse_categorical_accuracy: 0.1434
Epoch 2/15
50000/50000 [==============================] - 20s 393us/sample - loss: 2.1889 -
sparse_categorical_accuracy: 0.4682 - val_loss: 2.9823 -
val_sparse_categorical_accuracy: 0.1392
Epoch 3/15
50000/50000 [==============================] - 20s 393us/sample - loss: 2.0328 -
sparse_categorical_accuracy: 0.5247 - val_loss: 2.9720 -
val_sparse_categorical_accuracy: 0.1461
Epoch 4/15
50000/50000 [==============================] - 20s 394us/sample - loss: 1.9294 -
sparse_categorical_accuracy: 0.5632 - val_loss: 2.9614 -
val_sparse_categorical_accuracy: 0.1393
Epoch 5/15
50000/50000 [==============================] - 20s 393us/sample - loss: 1.8414 -
sparse_categorical_accuracy: 0.5891 - val_loss: 2.9515 -
```

```
val_sparse_categorical_accuracy: 0.1458
Epoch 6/15
50000/50000 [==============================] - 20s 394us/sample - loss: 1.7720 -
sparse_categorical_accuracy: 0.6126 - val_loss: 2.9414 -
val_sparse_categorical_accuracy: 0.1432
Epoch 7/15
50000/50000 [==============================] - 20s 392us/sample - loss: 1.7098 -
sparse_categorical_accuracy: 0.6343 - val_loss: 2.9341 -
val_sparse_categorical_accuracy: 0.1447
Epoch 8/15
50000/50000 [==============================] - 20s 391us/sample - loss: 1.6515 -
sparse_categorical_accuracy: 0.6511 - val_loss: 2.9219 -
val_sparse_categorical_accuracy: 0.1443
Epoch 9/15
50000/50000 [==============================] - 20s 392us/sample - loss: 1.5986 -
sparse_categorical_accuracy: 0.6675 - val_loss: 2.9141 -
val_sparse_categorical_accuracy: 0.1433
Epoch 10/15
50000/50000 [==============================] - 20s 394us/sample - loss: 1.5510 -
sparse_categorical_accuracy: 0.6849 - val_loss: 2.9059 -
val_sparse_categorical_accuracy: 0.1562
Epoch 11/15
50000/50000 [==============================] - 20s 393us/sample - loss: 1.5059 -
sparse_categorical_accuracy: 0.6943 - val_loss: 2.8947 -
val_sparse_categorical_accuracy: 0.1650
Epoch 12/15
50000/50000 [==============================] - 20s 397us/sample - loss: 1.4636 -
sparse_categorical_accuracy: 0.7074 - val_loss: 2.8867 -
val_sparse_categorical_accuracy: 0.1668
Epoch 13/15
50000/50000 [==============================] - 20s 394us/sample - loss: 1.4185 -
sparse_categorical_accuracy: 0.7213 - val_loss: 2.8809 -
val_sparse_categorical_accuracy: 0.1722
Epoch 14/15
50000/50000 [==============================] - 20s 395us/sample - loss: 1.3817 -
sparse_categorical_accuracy: 0.7325 - val_loss: 2.8703 -
val_sparse_categorical_accuracy: 0.1768
Epoch 15/15
50000/50000 [==============================] - 20s 396us/sample - loss: 1.3453 -
sparse_categorical_accuracy: 0.7437 - val_loss: 2.8617 -
val_sparse_categorical_accuracy: 0.1785

 37%|        | 11/30 [55:17<1:36:44, 305.50s/it]

0.17848 0.000995676056817449 0.0019379997528952964
Train on 50000 samples, validate on 12500 samples
Epoch 1/15
50000/50000 [==============================] - 25s 509us/sample - loss: 2.1065 -
sparse_categorical_accuracy: 0.3120 - val_loss: 2.2928 -
```

```
val_sparse_categorical_accuracy: 0.1506
Epoch 2/15
50000/50000 [==============================] - 19s 382us/sample - loss: 1.6475 -
sparse_categorical_accuracy: 0.4133 - val_loss: 2.2886 -
val_sparse_categorical_accuracy: 0.1713
Epoch 3/15
50000/50000 [==============================] - 19s 380us/sample - loss: 1.5193 -
sparse_categorical_accuracy: 0.4581 - val_loss: 2.2867 -
val_sparse_categorical_accuracy: 0.1773
Epoch 4/15
50000/50000 [==============================] - 19s 381us/sample - loss: 1.4347 -
sparse_categorical_accuracy: 0.4886 - val_loss: 2.2854 -
val_sparse_categorical_accuracy: 0.1818
Epoch 5/15
50000/50000 [==============================] - 19s 382us/sample - loss: 1.3738 -
sparse_categorical_accuracy: 0.5120 - val_loss: 2.2842 -
val_sparse_categorical_accuracy: 0.1848
Epoch 6/15
50000/50000 [==============================] - 19s 382us/sample - loss: 1.3251 -
sparse_categorical_accuracy: 0.5286 - val_loss: 2.2831 -
val_sparse_categorical_accuracy: 0.1872
Epoch 7/15
50000/50000 [==============================] - 19s 382us/sample - loss: 1.2849 -
sparse_categorical_accuracy: 0.5465 - val_loss: 2.2819 -
val_sparse_categorical_accuracy: 0.1882
Epoch 8/15
50000/50000 [==============================] - 19s 381us/sample - loss: 1.2486 -
sparse_categorical_accuracy: 0.5605 - val_loss: 2.2810 -
val_sparse_categorical_accuracy: 0.1923
Epoch 9/15
50000/50000 [==============================] - 19s 382us/sample - loss: 1.2177 -
sparse_categorical_accuracy: 0.5722 - val_loss: 2.2801 -
val_sparse_categorical_accuracy: 0.1999
Epoch 10/15
50000/50000 [==============================] - 19s 385us/sample - loss: 1.1894 -
sparse_categorical_accuracy: 0.5844 - val_loss: 2.2798 -
val_sparse_categorical_accuracy: 0.1956
Epoch 11/15
50000/50000 [==============================] - 19s 383us/sample - loss: 1.1625 -
sparse_categorical_accuracy: 0.5938 - val_loss: 2.2787 -
val_sparse_categorical_accuracy: 0.2030
Epoch 12/15
50000/50000 [==============================] - 19s 385us/sample - loss: 1.1386 -
sparse_categorical_accuracy: 0.6017 - val_loss: 2.2782 -
val_sparse_categorical_accuracy: 0.2028
Epoch 13/15
50000/50000 [==============================] - 19s 382us/sample - loss: 1.1152 -
sparse_categorical_accuracy: 0.6134 - val_loss: 2.2773 -
```

```
val_sparse_categorical_accuracy: 0.2042
Epoch 14/15
50000/50000 [==============================] - 19s 381us/sample - loss: 1.0953 -
sparse_categorical_accuracy: 0.6203 - val_loss: 2.2780 -
val_sparse_categorical_accuracy: 0.2021
Epoch 15/15
50000/50000 [==============================] - 19s 387us/sample - loss: 1.0742 -
sparse_categorical_accuracy: 0.6263 - val_loss: 2.2767 -
val_sparse_categorical_accuracy: 0.2059

 40%|        | 12/30 [1:00:20<1:31:25, 304.76s/it]

0.20592 0.00019405688159192139 1.0386964163982537e-05
Train on 50000 samples, validate on 12500 samples
Epoch 1/15
50000/50000 [==============================] - 26s 510us/sample - loss: 3.9666 -
sparse_categorical_accuracy: 0.3223 - val_loss: 4.2345 -
val_sparse_categorical_accuracy: 0.1382
Epoch 2/15
50000/50000 [==============================] - 20s 396us/sample - loss: 3.5245 -
sparse_categorical_accuracy: 0.4304 - val_loss: 4.2133 -
val_sparse_categorical_accuracy: 0.1519
Epoch 3/15
50000/50000 [==============================] - 20s 394us/sample - loss: 3.3822 -
sparse_categorical_accuracy: 0.4752 - val_loss: 4.1931 -
val_sparse_categorical_accuracy: 0.1575
Epoch 4/15
50000/50000 [==============================] - 20s 396us/sample - loss: 3.2816 -
sparse_categorical_accuracy: 0.5053 - val_loss: 4.1733 -
val_sparse_categorical_accuracy: 0.1598
Epoch 5/15
50000/50000 [==============================] - 20s 394us/sample - loss: 3.1982 -
sparse_categorical_accuracy: 0.5310 - val_loss: 4.1540 -
val_sparse_categorical_accuracy: 0.1574
Epoch 6/15
50000/50000 [==============================] - 20s 393us/sample - loss: 3.1330 -
sparse_categorical_accuracy: 0.5493 - val_loss: 4.1352 -
val_sparse_categorical_accuracy: 0.1755
Epoch 7/15
50000/50000 [==============================] - 20s 396us/sample - loss: 3.0692 -
sparse_categorical_accuracy: 0.5656 - val_loss: 4.1162 -
val_sparse_categorical_accuracy: 0.1862
Epoch 8/15
50000/50000 [==============================] - 20s 397us/sample - loss: 3.0163 -
sparse_categorical_accuracy: 0.5807 - val_loss: 4.0989 -
val_sparse_categorical_accuracy: 0.1877
Epoch 9/15
50000/50000 [==============================] - 20s 394us/sample - loss: 2.9618 -
sparse_categorical_accuracy: 0.5952 - val_loss: 4.0805 -
```

```
val_sparse_categorical_accuracy: 0.1946
Epoch 10/15
50000/50000 [==============================] - 20s 395us/sample - loss: 2.9129 -
sparse_categorical_accuracy: 0.6050 - val_loss: 4.0631 -
val_sparse_categorical_accuracy: 0.1882
Epoch 11/15
50000/50000 [==============================] - 20s 396us/sample - loss: 2.8659 -
sparse_categorical_accuracy: 0.6169 - val_loss: 4.0445 -
val_sparse_categorical_accuracy: 0.2024
Epoch 12/15
50000/50000 [==============================] - 20s 394us/sample - loss: 2.8221 -
sparse_categorical_accuracy: 0.6275 - val_loss: 4.0284 -
val_sparse_categorical_accuracy: 0.2058
Epoch 13/15
50000/50000 [==============================] - 20s 396us/sample - loss: 2.7805 -
sparse_categorical_accuracy: 0.6379 - val_loss: 4.0106 -
val_sparse_categorical_accuracy: 0.2157
Epoch 14/15
50000/50000 [==============================] - 20s 394us/sample - loss: 2.7376 -
sparse_categorical_accuracy: 0.6474 - val_loss: 3.9939 -
val_sparse_categorical_accuracy: 0.2169
Epoch 15/15
50000/50000 [==============================] - 20s 395us/sample - loss: 2.6999 -
sparse_categorical_accuracy: 0.6543 - val_loss: 3.9775 -
val_sparse_categorical_accuracy: 0.2192

 43%|        | 13/30 [1:05:32<1:26:56, 306.87s/it]

0.2192 0.0002882848246780948 0.005531911366413246
Train on 50000 samples, validate on 12500 samples
Epoch 1/15
50000/50000 [==============================] - 26s 512us/sample - loss: 2.0052 -
sparse_categorical_accuracy: 0.3613 - val_loss: 2.3914 -
val_sparse_categorical_accuracy: 0.1814
Epoch 2/15
50000/50000 [==============================] - 20s 393us/sample - loss: 1.5995 -
sparse_categorical_accuracy: 0.4678 - val_loss: 2.3831 -
val_sparse_categorical_accuracy: 0.2227
Epoch 3/15
50000/50000 [==============================] - 19s 388us/sample - loss: 1.4717 -
sparse_categorical_accuracy: 0.5140 - val_loss: 2.3784 -
val_sparse_categorical_accuracy: 0.2404
Epoch 4/15
50000/50000 [==============================] - 19s 389us/sample - loss: 1.3829 -
sparse_categorical_accuracy: 0.5475 - val_loss: 2.3763 -
val_sparse_categorical_accuracy: 0.2481
Epoch 5/15
50000/50000 [==============================] - 20s 392us/sample - loss: 1.3164 -
sparse_categorical_accuracy: 0.5734 - val_loss: 2.3739 -
```

```
val_sparse_categorical_accuracy: 0.2183
Epoch 6/15
50000/50000 [==============================] - 20s 390us/sample - loss: 1.2585 -
sparse_categorical_accuracy: 0.5954 - val_loss: 2.3714 -
val_sparse_categorical_accuracy: 0.2518
Epoch 7/15
50000/50000 [==============================] - 20s 392us/sample - loss: 1.2096 -
sparse_categorical_accuracy: 0.6143 - val_loss: 2.3702 -
val_sparse_categorical_accuracy: 0.2350
Epoch 8/15
50000/50000 [==============================] - 19s 388us/sample - loss: 1.1699 -
sparse_categorical_accuracy: 0.6288 - val_loss: 2.3683 -
val_sparse_categorical_accuracy: 0.2283
Epoch 9/15
50000/50000 [==============================] - 19s 390us/sample - loss: 1.1284 -
sparse_categorical_accuracy: 0.6431 - val_loss: 2.3653 -
val_sparse_categorical_accuracy: 0.2474
Epoch 10/15
50000/50000 [==============================] - 20s 391us/sample - loss: 1.0959 -
sparse_categorical_accuracy: 0.6561 - val_loss: 2.3638 -
val_sparse_categorical_accuracy: 0.2453
Epoch 11/15
50000/50000 [==============================] - 20s 395us/sample - loss: 1.0653 -
sparse_categorical_accuracy: 0.6658 - val_loss: 2.3636 -
val_sparse_categorical_accuracy: 0.2426
Epoch 12/15
50000/50000 [==============================] - 20s 391us/sample - loss: 1.0333 -
sparse_categorical_accuracy: 0.6771 - val_loss: 2.3617 -
val_sparse_categorical_accuracy: 0.2398
Epoch 13/15
50000/50000 [==============================] - 21s 423us/sample - loss: 1.0067 -
sparse_categorical_accuracy: 0.6858 - val_loss: 2.3613 -
val_sparse_categorical_accuracy: 0.2254
Epoch 14/15
50000/50000 [==============================] - 21s 428us/sample - loss: 0.9819 -
sparse_categorical_accuracy: 0.6958 - val_loss: 2.3600 -
val_sparse_categorical_accuracy: 0.2252
Epoch 15/15
50000/50000 [==============================] - 21s 420us/sample - loss: 0.9591 -
sparse_categorical_accuracy: 0.7053 - val_loss: 2.3581 -
val_sparse_categorical_accuracy: 0.2458

 47%|        | 14/30 [1:10:46<1:22:24, 309.04s/it]

0.24584 0.0005767811309161894 0.00029196157710713116
Train on 50000 samples, validate on 12500 samples
Epoch 1/15
50000/50000 [==============================] - 27s 537us/sample - loss: 4.6470 -
sparse_categorical_accuracy: 0.3112 - val_loss: 4.8147 -
```

```
val_sparse_categorical_accuracy: 0.1286
Epoch 2/15
50000/50000 [==============================] - 21s 425us/sample - loss: 4.1831 -
sparse_categorical_accuracy: 0.4069 - val_loss: 4.7897 -
val_sparse_categorical_accuracy: 0.1390
Epoch 3/15
50000/50000 [==============================] - 21s 412us/sample - loss: 4.0502 -
sparse_categorical_accuracy: 0.4462 - val_loss: 4.7680 -
val_sparse_categorical_accuracy: 0.1540
Epoch 4/15
50000/50000 [==============================] - 20s 409us/sample - loss: 3.9541 -
sparse_categorical_accuracy: 0.4733 - val_loss: 4.7471 -
val_sparse_categorical_accuracy: 0.1657
Epoch 5/15
50000/50000 [==============================] - 21s 410us/sample - loss: 3.8723 -
sparse_categorical_accuracy: 0.4968 - val_loss: 4.7269 -
val_sparse_categorical_accuracy: 0.1752
Epoch 6/15
50000/50000 [==============================] - 21s 413us/sample - loss: 3.8030 -
sparse_categorical_accuracy: 0.5147 - val_loss: 4.7064 -
val_sparse_categorical_accuracy: 0.1819
Epoch 7/15
50000/50000 [==============================] - 20s 410us/sample - loss: 3.7386 -
sparse_categorical_accuracy: 0.5327 - val_loss: 4.6873 -
val_sparse_categorical_accuracy: 0.1848
Epoch 8/15
50000/50000 [==============================] - 20s 410us/sample - loss: 3.6809 -
sparse_categorical_accuracy: 0.5443 - val_loss: 4.6672 -
val_sparse_categorical_accuracy: 0.1922
Epoch 9/15
50000/50000 [==============================] - 21s 412us/sample - loss: 3.6303 -
sparse_categorical_accuracy: 0.5566 - val_loss: 4.6499 -
val_sparse_categorical_accuracy: 0.1914
Epoch 10/15
50000/50000 [==============================] - 21s 418us/sample - loss: 3.5799 -
sparse_categorical_accuracy: 0.5679 - val_loss: 4.6302 -
val_sparse_categorical_accuracy: 0.1903
Epoch 11/15
50000/50000 [==============================] - 20s 410us/sample - loss: 3.5331 -
sparse_categorical_accuracy: 0.5792 - val_loss: 4.6118 -
val_sparse_categorical_accuracy: 0.1862
Epoch 12/15
50000/50000 [==============================] - 20s 409us/sample - loss: 3.4888 -
sparse_categorical_accuracy: 0.5907 - val_loss: 4.5931 -
val_sparse_categorical_accuracy: 0.1908
Epoch 13/15
50000/50000 [==============================] - 21s 413us/sample - loss: 3.4464 -
sparse_categorical_accuracy: 0.5950 - val_loss: 4.5752 -
```

```
val_sparse_categorical_accuracy: 0.1901
Epoch 14/15
50000/50000 [==============================] - 21s 412us/sample - loss: 3.4067 -
sparse_categorical_accuracy: 0.6055 - val_loss: 4.5575 -
val_sparse_categorical_accuracy: 0.1813
Epoch 15/15
50000/50000 [==============================] - 21s 416us/sample - loss: 3.3698 -
sparse_categorical_accuracy: 0.6101 - val_loss: 4.5390 -
val_sparse_categorical_accuracy: 0.1854

 50%|        | 15/30 [1:16:12<1:18:32, 314.16s/it]

0.18536 0.0001874729424715447 0.006914370077366992
Train on 50000 samples, validate on 12500 samples
Epoch 1/15
50000/50000 [==============================] - 26s 524us/sample - loss: 2.3765 -
sparse_categorical_accuracy: 0.2867 - val_loss: 2.3076 -
val_sparse_categorical_accuracy: 0.1317
Epoch 2/15
50000/50000 [==============================] - 20s 405us/sample - loss: 1.7602 -
sparse_categorical_accuracy: 0.3842 - val_loss: 2.3032 -
val_sparse_categorical_accuracy: 0.1445
Epoch 3/15
50000/50000 [==============================] - 20s 404us/sample - loss: 1.6356 -
sparse_categorical_accuracy: 0.4267 - val_loss: 2.3012 -
val_sparse_categorical_accuracy: 0.1530
Epoch 4/15
50000/50000 [==============================] - 20s 404us/sample - loss: 1.5572 -
sparse_categorical_accuracy: 0.4535 - val_loss: 2.2994 -
val_sparse_categorical_accuracy: 0.1572
Epoch 5/15
50000/50000 [==============================] - 20s 406us/sample - loss: 1.4982 -
sparse_categorical_accuracy: 0.4722 - val_loss: 2.2985 -
val_sparse_categorical_accuracy: 0.1633
Epoch 6/15
50000/50000 [==============================] - 20s 405us/sample - loss: 1.4500 -
sparse_categorical_accuracy: 0.4901 - val_loss: 2.2975 -
val_sparse_categorical_accuracy: 0.1609
Epoch 7/15
50000/50000 [==============================] - 20s 405us/sample - loss: 1.4092 -
sparse_categorical_accuracy: 0.5024 - val_loss: 2.2968 -
val_sparse_categorical_accuracy: 0.1669
Epoch 8/15
50000/50000 [==============================] - 20s 406us/sample - loss: 1.3740 -
sparse_categorical_accuracy: 0.5171 - val_loss: 2.2961 -
val_sparse_categorical_accuracy: 0.1674
Epoch 9/15
50000/50000 [==============================] - 20s 407us/sample - loss: 1.3431 -
sparse_categorical_accuracy: 0.5304 - val_loss: 2.2957 -
```

```
val_sparse_categorical_accuracy: 0.1721
Epoch 10/15
50000/50000 [==============================] - 20s 406us/sample - loss: 1.3159 -
sparse_categorical_accuracy: 0.5397 - val_loss: 2.2949 -
val_sparse_categorical_accuracy: 0.1733
Epoch 11/15
50000/50000 [==============================] - 20s 403us/sample - loss: 1.2922 -
sparse_categorical_accuracy: 0.5512 - val_loss: 2.2944 -
val_sparse_categorical_accuracy: 0.1766
Epoch 12/15
50000/50000 [==============================] - 20s 404us/sample - loss: 1.2700 -
sparse_categorical_accuracy: 0.5584 - val_loss: 2.2938 -
val_sparse_categorical_accuracy: 0.1767
Epoch 13/15
50000/50000 [==============================] - 20s 406us/sample - loss: 1.2505 -
sparse_categorical_accuracy: 0.5657 - val_loss: 2.2931 -
val_sparse_categorical_accuracy: 0.1814
Epoch 14/15
50000/50000 [==============================] - 20s 408us/sample - loss: 1.2311 -
sparse_categorical_accuracy: 0.5716 - val_loss: 2.2927 -
val_sparse_categorical_accuracy: 0.1767
Epoch 15/15
50000/50000 [==============================] - 20s 404us/sample - loss: 1.2124 -
sparse_categorical_accuracy: 0.5798 - val_loss: 2.2920 -
val_sparse_categorical_accuracy: 0.1846

 53%|       | 16/30 [1:21:33<1:13:46, 316.15s/it]

0.18464 0.00010508918513318796 5.379237275192309e-05
Train on 50000 samples, validate on 12500 samples
Epoch 1/15
50000/50000 [==============================] - 26s 517us/sample - loss: 1.8794 -
sparse_categorical_accuracy: 0.3611 - val_loss: 2.2916 -
val_sparse_categorical_accuracy: 0.1570
Epoch 2/15
50000/50000 [==============================] - 20s 402us/sample - loss: 1.5117 -
sparse_categorical_accuracy: 0.4604 - val_loss: 2.2908 -
val_sparse_categorical_accuracy: 0.1636
Epoch 3/15
50000/50000 [==============================] - 20s 400us/sample - loss: 1.3922 -
sparse_categorical_accuracy: 0.5079 - val_loss: 2.2884 -
val_sparse_categorical_accuracy: 0.1834
Epoch 4/15
50000/50000 [==============================] - 20s 400us/sample - loss: 1.3056 -
sparse_categorical_accuracy: 0.5421 - val_loss: 2.2866 -
val_sparse_categorical_accuracy: 0.1882
Epoch 5/15
50000/50000 [==============================] - 20s 401us/sample - loss: 1.2334 -
sparse_categorical_accuracy: 0.5682 - val_loss: 2.2858 -
```

```
val_sparse_categorical_accuracy: 0.1967
Epoch 6/15
50000/50000 [==============================] - 20s 402us/sample - loss: 1.1731 -
sparse_categorical_accuracy: 0.5912 - val_loss: 2.2850 -
val_sparse_categorical_accuracy: 0.2039
Epoch 7/15
50000/50000 [==============================] - 20s 401us/sample - loss: 1.1213 -
sparse_categorical_accuracy: 0.6115 - val_loss: 2.2826 -
val_sparse_categorical_accuracy: 0.2110
Epoch 8/15
50000/50000 [==============================] - 20s 401us/sample - loss: 1.0757 -
sparse_categorical_accuracy: 0.6259 - val_loss: 2.2832 -
val_sparse_categorical_accuracy: 0.2067
Epoch 9/15
50000/50000 [==============================] - 20s 400us/sample - loss: 1.0371 -
sparse_categorical_accuracy: 0.6418 - val_loss: 2.2805 -
val_sparse_categorical_accuracy: 0.2097
Epoch 10/15
50000/50000 [==============================] - 20s 402us/sample - loss: 1.0031 -
sparse_categorical_accuracy: 0.6533 - val_loss: 2.2803 -
val_sparse_categorical_accuracy: 0.2142
Epoch 11/15
50000/50000 [==============================] - 20s 401us/sample - loss: 0.9700 -
sparse_categorical_accuracy: 0.6686 - val_loss: 2.2803 -
val_sparse_categorical_accuracy: 0.2043
Epoch 12/15
50000/50000 [==============================] - 20s 400us/sample - loss: 0.9438 -
sparse_categorical_accuracy: 0.6746 - val_loss: 2.2794 -
val_sparse_categorical_accuracy: 0.1932
Epoch 13/15
50000/50000 [==============================] - 20s 400us/sample - loss: 0.9185 -
sparse_categorical_accuracy: 0.6834 - val_loss: 2.2779 -
val_sparse_categorical_accuracy: 0.2193
Epoch 14/15
50000/50000 [==============================] - 20s 401us/sample - loss: 0.8911 -
sparse_categorical_accuracy: 0.6939 - val_loss: 2.2773 -
val_sparse_categorical_accuracy: 0.2091
Epoch 15/15
50000/50000 [==============================] - 20s 400us/sample - loss: 0.8667 -
sparse_categorical_accuracy: 0.7022 - val_loss: 2.2759 -
val_sparse_categorical_accuracy: 0.2107

 57%|       | 17/30 [1:26:50<1:08:31, 316.30s/it]

0.21072 0.0005445948630986223 2.713756412211016e-05
Train on 50000 samples, validate on 12500 samples
Epoch 1/15
50000/50000 [==============================] - 26s 525us/sample - loss: 2.1574 -
sparse_categorical_accuracy: 0.3205 - val_loss: 2.3034 -
```

```
val_sparse_categorical_accuracy: 0.1231
Epoch 2/15
50000/50000 [==============================] - 20s 400us/sample - loss: 1.6403 -
sparse_categorical_accuracy: 0.4171 - val_loss: 2.3005 -
val_sparse_categorical_accuracy: 0.1334
Epoch 3/15
50000/50000 [==============================] - 20s 401us/sample - loss: 1.5299 -
sparse_categorical_accuracy: 0.4568 - val_loss: 2.2991 -
val_sparse_categorical_accuracy: 0.1374
Epoch 4/15
50000/50000 [==============================] - 20s 399us/sample - loss: 1.4552 -
sparse_categorical_accuracy: 0.4846 - val_loss: 2.2980 -
val_sparse_categorical_accuracy: 0.1480
Epoch 5/15
50000/50000 [==============================] - 20s 400us/sample - loss: 1.3955 -
sparse_categorical_accuracy: 0.5083 - val_loss: 2.2981 -
val_sparse_categorical_accuracy: 0.1471
Epoch 6/15
50000/50000 [==============================] - 20s 402us/sample - loss: 1.3484 -
sparse_categorical_accuracy: 0.5248 - val_loss: 2.2971 -
val_sparse_categorical_accuracy: 0.1467
Epoch 7/15
50000/50000 [==============================] - 20s 401us/sample - loss: 1.3057 -
sparse_categorical_accuracy: 0.5413 - val_loss: 2.2952 -
val_sparse_categorical_accuracy: 0.1523
Epoch 8/15
50000/50000 [==============================] - 20s 398us/sample - loss: 1.2643 -
sparse_categorical_accuracy: 0.5585 - val_loss: 2.2949 -
val_sparse_categorical_accuracy: 0.1491
Epoch 9/15
50000/50000 [==============================] - 20s 399us/sample - loss: 1.2264 -
sparse_categorical_accuracy: 0.5725 - val_loss: 2.2943 -
val_sparse_categorical_accuracy: 0.1495
Epoch 10/15
50000/50000 [==============================] - 20s 400us/sample - loss: 1.1978 -
sparse_categorical_accuracy: 0.5838 - val_loss: 2.2938 -
val_sparse_categorical_accuracy: 0.1493
Epoch 11/15
50000/50000 [==============================] - 20s 401us/sample - loss: 1.1682 -
sparse_categorical_accuracy: 0.5938 - val_loss: 2.2934 -
val_sparse_categorical_accuracy: 0.1490
Epoch 12/15
50000/50000 [==============================] - 20s 401us/sample - loss: 1.1405 -
sparse_categorical_accuracy: 0.6040 - val_loss: 2.2918 -
val_sparse_categorical_accuracy: 0.1541
Epoch 13/15
50000/50000 [==============================] - 20s 398us/sample - loss: 1.1146 -
sparse_categorical_accuracy: 0.6130 - val_loss: 2.2910 -
```

```
val_sparse_categorical_accuracy: 0.1523
Epoch 14/15
50000/50000 [==============================] - 20s 401us/sample - loss: 1.0904 -
sparse_categorical_accuracy: 0.6239 - val_loss: 2.2901 -
val_sparse_categorical_accuracy: 0.1566
Epoch 15/15
50000/50000 [==============================] - 20s 399us/sample - loss: 1.0710 -
sparse_categorical_accuracy: 0.6290 - val_loss: 2.2893 -
val_sparse_categorical_accuracy: 0.1618

 60%|       | 18/30 [1:32:06<1:03:16, 316.36s/it]

0.16176 0.00023316437483187895 2.5929929510489484e-05
Train on 50000 samples, validate on 12500 samples
Epoch 1/15
50000/50000 [==============================] - 26s 529us/sample - loss: 2.3090 -
sparse_categorical_accuracy: 0.2957 - val_loss: 2.3338 -
val_sparse_categorical_accuracy: 0.1206
Epoch 2/15
50000/50000 [==============================] - 20s 408us/sample - loss: 1.7553 -
sparse_categorical_accuracy: 0.3901 - val_loss: 2.3315 -
val_sparse_categorical_accuracy: 0.1315
Epoch 3/15
50000/50000 [==============================] - 21s 411us/sample - loss: 1.6394 -
sparse_categorical_accuracy: 0.4299 - val_loss: 2.3301 -
val_sparse_categorical_accuracy: 0.1413
Epoch 4/15
50000/50000 [==============================] - 20s 408us/sample - loss: 1.5612 -
sparse_categorical_accuracy: 0.4567 - val_loss: 2.3286 -
val_sparse_categorical_accuracy: 0.1460
Epoch 5/15
50000/50000 [==============================] - 20s 410us/sample - loss: 1.5017 -
sparse_categorical_accuracy: 0.4764 - val_loss: 2.3275 -
val_sparse_categorical_accuracy: 0.1537
Epoch 6/15
50000/50000 [==============================] - 21s 412us/sample - loss: 1.4524 -
sparse_categorical_accuracy: 0.4955 - val_loss: 2.3261 -
val_sparse_categorical_accuracy: 0.1577
Epoch 7/15
50000/50000 [==============================] - 20s 409us/sample - loss: 1.4104 -
sparse_categorical_accuracy: 0.5105 - val_loss: 2.3247 -
val_sparse_categorical_accuracy: 0.1622
Epoch 8/15
50000/50000 [==============================] - 20s 408us/sample - loss: 1.3756 -
sparse_categorical_accuracy: 0.5255 - val_loss: 2.3246 -
val_sparse_categorical_accuracy: 0.1638
Epoch 9/15
50000/50000 [==============================] - 20s 410us/sample - loss: 1.3447 -
sparse_categorical_accuracy: 0.5362 - val_loss: 2.3243 -
```

```
val_sparse_categorical_accuracy: 0.1664
Epoch 10/15
50000/50000 [==============================] - 21s 412us/sample - loss: 1.3142 -
sparse_categorical_accuracy: 0.5481 - val_loss: 2.3233 -
val_sparse_categorical_accuracy: 0.1694
Epoch 11/15
50000/50000 [==============================] - 20s 410us/sample - loss: 1.2870 -
sparse_categorical_accuracy: 0.5602 - val_loss: 2.3225 -
val_sparse_categorical_accuracy: 0.1702
Epoch 12/15
50000/50000 [==============================] - 20s 408us/sample - loss: 1.2634 -
sparse_categorical_accuracy: 0.5682 - val_loss: 2.3220 -
val_sparse_categorical_accuracy: 0.1717
Epoch 13/15
50000/50000 [==============================] - 20s 410us/sample - loss: 1.2417 -
sparse_categorical_accuracy: 0.5764 - val_loss: 2.3215 -
val_sparse_categorical_accuracy: 0.1750
Epoch 14/15
50000/50000 [==============================] - 20s 410us/sample - loss: 1.2184 -
sparse_categorical_accuracy: 0.5865 - val_loss: 2.3211 -
val_sparse_categorical_accuracy: 0.1737
Epoch 15/15
50000/50000 [==============================] - 20s 404us/sample - loss: 1.1987 -
sparse_categorical_accuracy: 0.5938 - val_loss: 2.3207 -
val_sparse_categorical_accuracy: 0.1770

 63%|       | 19/30 [1:37:29<58:21, 318.35s/it]

0.17696 0.00014069897368155227 9.889550606157632e-05
Train on 50000 samples, validate on 12500 samples
Epoch 1/15
50000/50000 [==============================] - 27s 532us/sample - loss: 3.7781 -
sparse_categorical_accuracy: 0.3203 - val_loss: 3.9890 -
val_sparse_categorical_accuracy: 0.1413
Epoch 2/15
50000/50000 [==============================] - 20s 406us/sample - loss: 3.3338 -
sparse_categorical_accuracy: 0.4150 - val_loss: 3.9766 -
val_sparse_categorical_accuracy: 0.1669
Epoch 3/15
50000/50000 [==============================] - 20s 404us/sample - loss: 3.2146 -
sparse_categorical_accuracy: 0.4566 - val_loss: 3.9666 -
val_sparse_categorical_accuracy: 0.1798
Epoch 4/15
50000/50000 [==============================] - 20s 405us/sample - loss: 3.1351 -
sparse_categorical_accuracy: 0.4854 - val_loss: 3.9573 -
val_sparse_categorical_accuracy: 0.1815
Epoch 5/15
50000/50000 [==============================] - 20s 405us/sample - loss: 3.0695 -
sparse_categorical_accuracy: 0.5052 - val_loss: 3.9492 -
```

```
val_sparse_categorical_accuracy: 0.1807
Epoch 6/15
50000/50000 [==============================] - 20s 406us/sample - loss: 3.0182 -
sparse_categorical_accuracy: 0.5221 - val_loss: 3.9411 -
val_sparse_categorical_accuracy: 0.1769
Epoch 7/15
50000/50000 [==============================] - 20s 404us/sample - loss: 2.9733 -
sparse_categorical_accuracy: 0.5351 - val_loss: 3.9328 -
val_sparse_categorical_accuracy: 0.1804
Epoch 8/15
50000/50000 [==============================] - 20s 404us/sample - loss: 2.9282 -
sparse_categorical_accuracy: 0.5469 - val_loss: 3.9250 -
val_sparse_categorical_accuracy: 0.1762
Epoch 9/15
50000/50000 [==============================] - 20s 404us/sample - loss: 2.8930 -
sparse_categorical_accuracy: 0.5589 - val_loss: 3.9165 -
val_sparse_categorical_accuracy: 0.1802
Epoch 10/15
50000/50000 [==============================] - 20s 405us/sample - loss: 2.8579 -
sparse_categorical_accuracy: 0.5690 - val_loss: 3.9089 -
val_sparse_categorical_accuracy: 0.1782
Epoch 11/15
50000/50000 [==============================] - 20s 405us/sample - loss: 2.8251 -
sparse_categorical_accuracy: 0.5783 - val_loss: 3.9009 -
val_sparse_categorical_accuracy: 0.1856
Epoch 12/15
50000/50000 [==============================] - 20s 403us/sample - loss: 2.7963 -
sparse_categorical_accuracy: 0.5850 - val_loss: 3.8933 -
val_sparse_categorical_accuracy: 0.1821
Epoch 13/15
50000/50000 [==============================] - 22s 444us/sample - loss: 2.7644 -
sparse_categorical_accuracy: 0.5947 - val_loss: 3.8856 -
val_sparse_categorical_accuracy: 0.1868
Epoch 14/15
50000/50000 [==============================] - 22s 445us/sample - loss: 2.7373 -
sparse_categorical_accuracy: 0.6022 - val_loss: 3.8779 -
val_sparse_categorical_accuracy: 0.1859
Epoch 15/15
50000/50000 [==============================] - 23s 454us/sample - loss: 2.7122 -
sparse_categorical_accuracy: 0.6085 - val_loss: 3.8704 -
val_sparse_categorical_accuracy: 0.1855

 67%|       | 20/30 [1:42:56<53:28, 320.86s/it]

0.18552 0.00015944026639358493 0.004654580560415391
Train on 50000 samples, validate on 12500 samples
Epoch 1/15
50000/50000 [==============================] - 30s 599us/sample - loss: 4.6227 -
sparse_categorical_accuracy: 0.2848 - val_loss: 4.6650 -
```

```
val_sparse_categorical_accuracy: 0.1334
Epoch 2/15
50000/50000 [==============================] - 21s 411us/sample - loss: 4.0817 -
sparse_categorical_accuracy: 0.3913 - val_loss: 4.6500 -
val_sparse_categorical_accuracy: 0.1468
Epoch 3/15
50000/50000 [==============================] - 20s 408us/sample - loss: 3.9440 -
sparse_categorical_accuracy: 0.4373 - val_loss: 4.6360 -
val_sparse_categorical_accuracy: 0.1550
Epoch 4/15
50000/50000 [==============================] - 22s 433us/sample - loss: 3.8499 -
sparse_categorical_accuracy: 0.4648 - val_loss: 4.6227 -
val_sparse_categorical_accuracy: 0.1570
Epoch 5/15
50000/50000 [==============================] - 21s 427us/sample - loss: 3.7775 -
sparse_categorical_accuracy: 0.4878 - val_loss: 4.6096 -
val_sparse_categorical_accuracy: 0.1607
Epoch 6/15
50000/50000 [==============================] - 24s 482us/sample - loss: 3.7161 -
sparse_categorical_accuracy: 0.5039 - val_loss: 4.5964 -
val_sparse_categorical_accuracy: 0.1601
Epoch 7/15
50000/50000 [==============================] - 22s 438us/sample - loss: 3.6664 -
sparse_categorical_accuracy: 0.5187 - val_loss: 4.5837 -
val_sparse_categorical_accuracy: 0.1673
Epoch 8/15
50000/50000 [==============================] - 22s 439us/sample - loss: 3.6195 -
sparse_categorical_accuracy: 0.5325 - val_loss: 4.5716 -
val_sparse_categorical_accuracy: 0.1662
Epoch 9/15
50000/50000 [==============================] - 22s 439us/sample - loss: 3.5785 -
sparse_categorical_accuracy: 0.5410 - val_loss: 4.5590 -
val_sparse_categorical_accuracy: 0.1660
Epoch 10/15
50000/50000 [==============================] - 22s 437us/sample - loss: 3.5397 -
sparse_categorical_accuracy: 0.5517 - val_loss: 4.5464 -
val_sparse_categorical_accuracy: 0.1691
Epoch 11/15
50000/50000 [==============================] - 23s 460us/sample - loss: 3.5039 -
sparse_categorical_accuracy: 0.5629 - val_loss: 4.5343 -
val_sparse_categorical_accuracy: 0.1670
Epoch 12/15
50000/50000 [==============================] - 22s 437us/sample - loss: 3.4676 -
sparse_categorical_accuracy: 0.5697 - val_loss: 4.5221 -
val_sparse_categorical_accuracy: 0.1728
Epoch 13/15
50000/50000 [==============================] - 23s 462us/sample - loss: 3.4371 -
sparse_categorical_accuracy: 0.5769 - val_loss: 4.5099 -
```

```
val_sparse_categorical_accuracy: 0.1733
Epoch 14/15
50000/50000 [==============================] - 23s 458us/sample - loss: 3.4058 -
sparse_categorical_accuracy: 0.5844 - val_loss: 4.4979 -
val_sparse_categorical_accuracy: 0.1754
Epoch 15/15
50000/50000 [==============================] - 22s 448us/sample - loss: 3.3740 -
sparse_categorical_accuracy: 0.5933 - val_loss: 4.4865 -
val_sparse_categorical_accuracy: 0.1739

 70%|       | 21/30 [1:48:46<49:27, 329.69s/it]

0.17392 0.0001277531304246562 0.006497085769265344
Train on 50000 samples, validate on 12500 samples
Epoch 1/15
50000/50000 [==============================] - 28s 559us/sample - loss: 2.1284 -
sparse_categorical_accuracy: 0.3148 - val_loss: 2.2883 -
val_sparse_categorical_accuracy: 0.1529
Epoch 2/15
50000/50000 [==============================] - 22s 441us/sample - loss: 1.6513 -
sparse_categorical_accuracy: 0.4122 - val_loss: 2.2846 -
val_sparse_categorical_accuracy: 0.1714
Epoch 3/15
50000/50000 [==============================] - 24s 488us/sample - loss: 1.5385 -
sparse_categorical_accuracy: 0.4491 - val_loss: 2.2817 -
val_sparse_categorical_accuracy: 0.1906
Epoch 4/15
50000/50000 [==============================] - 24s 485us/sample - loss: 1.4651 -
sparse_categorical_accuracy: 0.4770 - val_loss: 2.2800 -
val_sparse_categorical_accuracy: 0.1990
Epoch 5/15
50000/50000 [==============================] - 24s 477us/sample - loss: 1.4089 -
sparse_categorical_accuracy: 0.4981 - val_loss: 2.2793 -
val_sparse_categorical_accuracy: 0.2035
Epoch 6/15
50000/50000 [==============================] - 21s 424us/sample - loss: 1.3638 -
sparse_categorical_accuracy: 0.5150 - val_loss: 2.2781 -
val_sparse_categorical_accuracy: 0.1994
Epoch 7/15
50000/50000 [==============================] - 21s 424us/sample - loss: 1.3248 -
sparse_categorical_accuracy: 0.5312 - val_loss: 2.2775 -
val_sparse_categorical_accuracy: 0.2002
Epoch 8/15
50000/50000 [==============================] - 22s 435us/sample - loss: 1.2917 -
sparse_categorical_accuracy: 0.5434 - val_loss: 2.2759 -
val_sparse_categorical_accuracy: 0.2078
Epoch 9/15
50000/50000 [==============================] - 22s 448us/sample - loss: 1.2589 -
sparse_categorical_accuracy: 0.5592 - val_loss: 2.2758 -
```

```
val_sparse_categorical_accuracy: 0.2050
Epoch 10/15
50000/50000 [==============================] - 22s 442us/sample - loss: 1.2334 -
sparse_categorical_accuracy: 0.5677 - val_loss: 2.2748 -
val_sparse_categorical_accuracy: 0.2070
Epoch 11/15
50000/50000 [==============================] - 22s 433us/sample - loss: 1.2080 -
sparse_categorical_accuracy: 0.5763 - val_loss: 2.2740 -
val_sparse_categorical_accuracy: 0.2110
Epoch 12/15
50000/50000 [==============================] - 24s 473us/sample - loss: 1.1847 -
sparse_categorical_accuracy: 0.5844 - val_loss: 2.2731 -
val_sparse_categorical_accuracy: 0.2137
Epoch 13/15
50000/50000 [==============================] - 22s 437us/sample - loss: 1.1627 -
sparse_categorical_accuracy: 0.5930 - val_loss: 2.2714 -
val_sparse_categorical_accuracy: 0.2209
Epoch 14/15
50000/50000 [==============================] - 23s 451us/sample - loss: 1.1431 -
sparse_categorical_accuracy: 0.6004 - val_loss: 2.2712 -
val_sparse_categorical_accuracy: 0.2216
Epoch 15/15
50000/50000 [==============================] - 21s 411us/sample - loss: 1.1254 -
sparse_categorical_accuracy: 0.6068 - val_loss: 2.2709 -
val_sparse_categorical_accuracy: 0.2227

 73%|       | 22/30 [1:54:39<44:52, 336.61s/it]

0.22272 0.00015895897232191453 4.071233584960201e-06
Train on 50000 samples, validate on 12500 samples
Epoch 1/15
50000/50000 [==============================] - 27s 541us/sample - loss: 2.3937 -
sparse_categorical_accuracy: 0.3048 - val_loss: 2.3499 -
val_sparse_categorical_accuracy: 0.1203
Epoch 2/15
50000/50000 [==============================] - 21s 414us/sample - loss: 1.7452 -
sparse_categorical_accuracy: 0.3983 - val_loss: 2.3485 -
val_sparse_categorical_accuracy: 0.1285
Epoch 3/15
50000/50000 [==============================] - 21s 414us/sample - loss: 1.6398 -
sparse_categorical_accuracy: 0.4333 - val_loss: 2.3478 -
val_sparse_categorical_accuracy: 0.1255
Epoch 4/15
50000/50000 [==============================] - 21s 417us/sample - loss: 1.5674 -
sparse_categorical_accuracy: 0.4596 - val_loss: 2.3470 -
val_sparse_categorical_accuracy: 0.1310
Epoch 5/15
50000/50000 [==============================] - 21s 415us/sample - loss: 1.5127 -
sparse_categorical_accuracy: 0.4783 - val_loss: 2.3464 -
```

```
val_sparse_categorical_accuracy: 0.1309
Epoch 6/15
50000/50000 [==============================] - 21s 414us/sample - loss: 1.4658 -
sparse_categorical_accuracy: 0.4974 - val_loss: 2.3456 -
val_sparse_categorical_accuracy: 0.1382
Epoch 7/15
50000/50000 [==============================] - 21s 414us/sample - loss: 1.4310 -
sparse_categorical_accuracy: 0.5092 - val_loss: 2.3453 -
val_sparse_categorical_accuracy: 0.1350
Epoch 8/15
50000/50000 [==============================] - 21s 416us/sample - loss: 1.3978 -
sparse_categorical_accuracy: 0.5215 - val_loss: 2.3445 -
val_sparse_categorical_accuracy: 0.1427
Epoch 9/15
50000/50000 [==============================] - 21s 413us/sample - loss: 1.3681 -
sparse_categorical_accuracy: 0.5335 - val_loss: 2.3443 -
val_sparse_categorical_accuracy: 0.1429
Epoch 10/15
50000/50000 [==============================] - 21s 416us/sample - loss: 1.3432 -
sparse_categorical_accuracy: 0.5416 - val_loss: 2.3441 -
val_sparse_categorical_accuracy: 0.1409
Epoch 11/15
50000/50000 [==============================] - 21s 416us/sample - loss: 1.3199 -
sparse_categorical_accuracy: 0.5497 - val_loss: 2.3434 -
val_sparse_categorical_accuracy: 0.1420
Epoch 12/15
50000/50000 [==============================] - 21s 424us/sample - loss: 1.2962 -
sparse_categorical_accuracy: 0.5589 - val_loss: 2.3431 -
val_sparse_categorical_accuracy: 0.1441
Epoch 13/15
50000/50000 [==============================] - 21s 415us/sample - loss: 1.2734 -
sparse_categorical_accuracy: 0.5686 - val_loss: 2.3418 -
val_sparse_categorical_accuracy: 0.1506
Epoch 14/15
50000/50000 [==============================] - 21s 416us/sample - loss: 1.2559 -
sparse_categorical_accuracy: 0.5743 - val_loss: 2.3413 -
val_sparse_categorical_accuracy: 0.1513
Epoch 15/15
50000/50000 [==============================] - 21s 414us/sample - loss: 1.2378 -
sparse_categorical_accuracy: 0.5828 - val_loss: 2.3412 -
val_sparse_categorical_accuracy: 0.1510

 77%|      | 23/30 [2:00:08<38:59, 334.20s/it]

0.15104 0.000139663091083837 0.00012346864685546156
Train on 50000 samples, validate on 12500 samples
Epoch 1/15
50000/50000 [==============================] - 26s 522us/sample - loss: 1.9111 -
sparse_categorical_accuracy: 0.3615 - val_loss: 2.2989 -
```

```
val_sparse_categorical_accuracy: 0.1464
Epoch 2/15
50000/50000 [==============================] - 20s 391us/sample - loss: 1.4900 -
sparse_categorical_accuracy: 0.4687 - val_loss: 2.2954 -
val_sparse_categorical_accuracy: 0.1610
Epoch 3/15
50000/50000 [==============================] - 20s 401us/sample - loss: 1.3583 -
sparse_categorical_accuracy: 0.5157 - val_loss: 2.2910 -
val_sparse_categorical_accuracy: 0.1714
Epoch 4/15
50000/50000 [==============================] - 20s 390us/sample - loss: 1.2653 -
sparse_categorical_accuracy: 0.5511 - val_loss: 2.2905 -
val_sparse_categorical_accuracy: 0.1726
Epoch 5/15
50000/50000 [==============================] - 20s 390us/sample - loss: 1.1916 -
sparse_categorical_accuracy: 0.5800 - val_loss: 2.2886 -
val_sparse_categorical_accuracy: 0.1845
Epoch 6/15
50000/50000 [==============================] - 19s 390us/sample - loss: 1.1309 -
sparse_categorical_accuracy: 0.6047 - val_loss: 2.2860 -
val_sparse_categorical_accuracy: 0.1989
Epoch 7/15
50000/50000 [==============================] - 20s 391us/sample - loss: 1.0769 -
sparse_categorical_accuracy: 0.6251 - val_loss: 2.2859 -
val_sparse_categorical_accuracy: 0.1966
Epoch 8/15
50000/50000 [==============================] - 20s 392us/sample - loss: 1.0292 -
sparse_categorical_accuracy: 0.6420 - val_loss: 2.2837 -
val_sparse_categorical_accuracy: 0.2051
Epoch 9/15
50000/50000 [==============================] - 20s 392us/sample - loss: 0.9878 -
sparse_categorical_accuracy: 0.6556 - val_loss: 2.2820 -
val_sparse_categorical_accuracy: 0.2031
Epoch 10/15
50000/50000 [==============================] - 21s 423us/sample - loss: 0.9481 -
sparse_categorical_accuracy: 0.6724 - val_loss: 2.2819 -
val_sparse_categorical_accuracy: 0.1981
Epoch 11/15
50000/50000 [==============================] - 20s 406us/sample - loss: 0.9138 -
sparse_categorical_accuracy: 0.6817 - val_loss: 2.2797 -
val_sparse_categorical_accuracy: 0.2057
Epoch 12/15
50000/50000 [==============================] - 20s 403us/sample - loss: 0.8830 -
sparse_categorical_accuracy: 0.6957 - val_loss: 2.2782 -
val_sparse_categorical_accuracy: 0.2046
Epoch 13/15
50000/50000 [==============================] - 20s 402us/sample - loss: 0.8488 -
sparse_categorical_accuracy: 0.7060 - val_loss: 2.2788 -
```

```
val_sparse_categorical_accuracy: 0.2014
Epoch 14/15
50000/50000 [==============================] - 20s 402us/sample - loss: 0.8184 -
sparse_categorical_accuracy: 0.7182 - val_loss: 2.2747 -
val_sparse_categorical_accuracy: 0.2149
Epoch 15/15
50000/50000 [==============================] - 22s 431us/sample - loss: 0.7933 -
sparse_categorical_accuracy: 0.7251 - val_loss: 2.2748 -
val_sparse_categorical_accuracy: 0.1909

 80%|      | 24/30 [2:05:25<32:54, 329.03s/it]

0.19088 0.0008676374458507624 1.9100380114073537e-06
Train on 50000 samples, validate on 12500 samples
Epoch 1/15
50000/50000 [==============================] - 29s 579us/sample - loss: 2.4503 -
sparse_categorical_accuracy: 0.2754 - val_loss: 2.2954 -
val_sparse_categorical_accuracy: 0.1577
Epoch 2/15
50000/50000 [==============================] - 25s 502us/sample - loss: 1.7633 -
sparse_categorical_accuracy: 0.3745 - val_loss: 2.2906 -
val_sparse_categorical_accuracy: 0.1782
Epoch 3/15
50000/50000 [==============================] - 23s 453us/sample - loss: 1.6398 -
sparse_categorical_accuracy: 0.4184 - val_loss: 2.2881 -
val_sparse_categorical_accuracy: 0.1886
Epoch 4/15
50000/50000 [==============================] - 22s 440us/sample - loss: 1.5561 -
sparse_categorical_accuracy: 0.4479 - val_loss: 2.2861 -
val_sparse_categorical_accuracy: 0.1946
Epoch 5/15
50000/50000 [==============================] - 23s 468us/sample - loss: 1.4962 -
sparse_categorical_accuracy: 0.4701 - val_loss: 2.2840 -
val_sparse_categorical_accuracy: 0.2074
Epoch 6/15
50000/50000 [==============================] - 25s 496us/sample - loss: 1.4450 -
sparse_categorical_accuracy: 0.4885 - val_loss: 2.2823 -
val_sparse_categorical_accuracy: 0.2101
Epoch 7/15
50000/50000 [==============================] - 25s 491us/sample - loss: 1.4056 -
sparse_categorical_accuracy: 0.5039 - val_loss: 2.2804 -
val_sparse_categorical_accuracy: 0.2192
Epoch 8/15
50000/50000 [==============================] - 25s 491us/sample - loss: 1.3701 -
sparse_categorical_accuracy: 0.5181 - val_loss: 2.2787 -
val_sparse_categorical_accuracy: 0.2247
Epoch 9/15
50000/50000 [==============================] - 24s 483us/sample - loss: 1.3367 -
sparse_categorical_accuracy: 0.5304 - val_loss: 2.2780 -
```

```
val_sparse_categorical_accuracy: 0.2278
Epoch 10/15
50000/50000 [==============================] - 24s 477us/sample - loss: 1.3078 -
sparse_categorical_accuracy: 0.5410 - val_loss: 2.2766 -
val_sparse_categorical_accuracy: 0.2349
Epoch 11/15
50000/50000 [==============================] - 25s 495us/sample - loss: 1.2828 -
sparse_categorical_accuracy: 0.5512 - val_loss: 2.2757 -
val_sparse_categorical_accuracy: 0.2352
Epoch 12/15
50000/50000 [==============================] - 24s 476us/sample - loss: 1.2569 -
sparse_categorical_accuracy: 0.5601 - val_loss: 2.2750 -
val_sparse_categorical_accuracy: 0.2346
Epoch 13/15
50000/50000 [==============================] - 23s 456us/sample - loss: 1.2352 -
sparse_categorical_accuracy: 0.5669 - val_loss: 2.2738 -
val_sparse_categorical_accuracy: 0.2399
Epoch 14/15
50000/50000 [==============================] - 21s 421us/sample - loss: 1.2129 -
sparse_categorical_accuracy: 0.5747 - val_loss: 2.2735 -
val_sparse_categorical_accuracy: 0.2421
Epoch 15/15
50000/50000 [==============================] - 22s 441us/sample - loss: 1.1960 -
sparse_categorical_accuracy: 0.5822 - val_loss: 2.2727 -
val_sparse_categorical_accuracy: 0.2418

 83%|      | 25/30 [2:11:35<28:27, 341.45s/it]

0.24184 0.00010956173580256938 6.282400591333463e-06
Train on 50000 samples, validate on 12500 samples
Epoch 1/15
50000/50000 [==============================] - 31s 615us/sample - loss: 2.0450 -
sparse_categorical_accuracy: 0.3623 - val_loss: 2.4478 -
val_sparse_categorical_accuracy: 0.1466
Epoch 2/15
50000/50000 [==============================] - 24s 473us/sample - loss: 1.6201 -
sparse_categorical_accuracy: 0.4756 - val_loss: 2.4455 -
val_sparse_categorical_accuracy: 0.1565
Epoch 3/15
50000/50000 [==============================] - 23s 459us/sample - loss: 1.4810 -
sparse_categorical_accuracy: 0.5285 - val_loss: 2.4395 -
val_sparse_categorical_accuracy: 0.1801
Epoch 4/15
50000/50000 [==============================] - 23s 459us/sample - loss: 1.3843 -
sparse_categorical_accuracy: 0.5647 - val_loss: 2.4375 -
val_sparse_categorical_accuracy: 0.1706
Epoch 5/15
50000/50000 [==============================] - 23s 460us/sample - loss: 1.3099 -
sparse_categorical_accuracy: 0.5911 - val_loss: 2.4348 -
```

```
val_sparse_categorical_accuracy: 0.1875
Epoch 6/15
50000/50000 [==============================] - 23s 458us/sample - loss: 1.2435 -
sparse_categorical_accuracy: 0.6189 - val_loss: 2.4328 -
val_sparse_categorical_accuracy: 0.2003
Epoch 7/15
50000/50000 [==============================] - 23s 455us/sample - loss: 1.1872 -
sparse_categorical_accuracy: 0.6369 - val_loss: 2.4302 -
val_sparse_categorical_accuracy: 0.1914
Epoch 8/15
50000/50000 [==============================] - 25s 491us/sample - loss: 1.1385 -
sparse_categorical_accuracy: 0.6542 - val_loss: 2.4286 -
val_sparse_categorical_accuracy: 0.1977
Epoch 9/15
50000/50000 [==============================] - 24s 472us/sample - loss: 1.0947 -
sparse_categorical_accuracy: 0.6704 - val_loss: 2.4293 -
val_sparse_categorical_accuracy: 0.2006
Epoch 10/15
50000/50000 [==============================] - 23s 462us/sample - loss: 1.0532 -
sparse_categorical_accuracy: 0.6854 - val_loss: 2.4292 -
val_sparse_categorical_accuracy: 0.1930
Epoch 11/15
50000/50000 [==============================] - 22s 434us/sample - loss: 1.0196 -
sparse_categorical_accuracy: 0.6984 - val_loss: 2.4244 -
val_sparse_categorical_accuracy: 0.2094
Epoch 12/15
50000/50000 [==============================] - 22s 442us/sample - loss: 0.9835 -
sparse_categorical_accuracy: 0.7091 - val_loss: 2.4255 -
val_sparse_categorical_accuracy: 0.2110
Epoch 13/15
50000/50000 [==============================] - 22s 443us/sample - loss: 0.9511 -
sparse_categorical_accuracy: 0.7199 - val_loss: 2.4233 -
val_sparse_categorical_accuracy: 0.2044
Epoch 14/15
50000/50000 [==============================] - 22s 441us/sample - loss: 0.9191 -
sparse_categorical_accuracy: 0.7330 - val_loss: 2.4225 -
val_sparse_categorical_accuracy: 0.2008
Epoch 15/15
50000/50000 [==============================] - 24s 477us/sample - loss: 0.8903 -
sparse_categorical_accuracy: 0.7423 - val_loss: 2.4192 -
val_sparse_categorical_accuracy: 0.2157

 87%|      | 26/30 [2:17:40<23:13, 348.46s/it]

0.21568 0.0009489958198466797 0.00042974200906577666
Train on 50000 samples, validate on 12500 samples
Epoch 1/15
50000/50000 [==============================] - 31s 627us/sample - loss: 2.0792 -
sparse_categorical_accuracy: 0.3292 - val_loss: 2.3759 -
```

```
val_sparse_categorical_accuracy: 0.0974
Epoch 2/15
50000/50000 [==============================] - 24s 470us/sample - loss: 1.6942 -
sparse_categorical_accuracy: 0.4247 - val_loss: 2.3729 -
val_sparse_categorical_accuracy: 0.1065
Epoch 3/15
50000/50000 [==============================] - 22s 450us/sample - loss: 1.5807 -
sparse_categorical_accuracy: 0.4657 - val_loss: 2.3719 -
val_sparse_categorical_accuracy: 0.1051
Epoch 4/15
50000/50000 [==============================] - 22s 443us/sample - loss: 1.5062 -
sparse_categorical_accuracy: 0.4905 - val_loss: 2.3702 -
val_sparse_categorical_accuracy: 0.1054
Epoch 5/15
50000/50000 [==============================] - 23s 453us/sample - loss: 1.4461 -
sparse_categorical_accuracy: 0.5116 - val_loss: 2.3687 -
val_sparse_categorical_accuracy: 0.1073
Epoch 6/15
50000/50000 [==============================] - 23s 458us/sample - loss: 1.4000 -
sparse_categorical_accuracy: 0.5288 - val_loss: 2.3675 -
val_sparse_categorical_accuracy: 0.1077
Epoch 7/15
50000/50000 [==============================] - 23s 464us/sample - loss: 1.3574 -
sparse_categorical_accuracy: 0.5470 - val_loss: 2.3667 -
val_sparse_categorical_accuracy: 0.1114
Epoch 8/15
50000/50000 [==============================] - 23s 464us/sample - loss: 1.3212 -
sparse_categorical_accuracy: 0.5580 - val_loss: 2.3651 -
val_sparse_categorical_accuracy: 0.1174
Epoch 9/15
50000/50000 [==============================] - 23s 462us/sample - loss: 1.2888 -
sparse_categorical_accuracy: 0.5703 - val_loss: 2.3638 -
val_sparse_categorical_accuracy: 0.1184
Epoch 10/15
50000/50000 [==============================] - 23s 454us/sample - loss: 1.2582 -
sparse_categorical_accuracy: 0.5831 - val_loss: 2.3623 -
val_sparse_categorical_accuracy: 0.1254
Epoch 11/15
50000/50000 [==============================] - 22s 439us/sample - loss: 1.2330 -
sparse_categorical_accuracy: 0.5923 - val_loss: 2.3615 -
val_sparse_categorical_accuracy: 0.1276
Epoch 12/15
50000/50000 [==============================] - 22s 434us/sample - loss: 1.2072 -
sparse_categorical_accuracy: 0.6021 - val_loss: 2.3601 -
val_sparse_categorical_accuracy: 0.1294
Epoch 13/15
50000/50000 [==============================] - 23s 460us/sample - loss: 1.1852 -
sparse_categorical_accuracy: 0.6094 - val_loss: 2.3598 -
```

```
val_sparse_categorical_accuracy: 0.1309
Epoch 14/15
50000/50000 [==============================] - 25s 495us/sample - loss: 1.1632 -
sparse_categorical_accuracy: 0.6182 - val_loss: 2.3585 -
val_sparse_categorical_accuracy: 0.1364
Epoch 15/15
50000/50000 [==============================] - 25s 491us/sample - loss: 1.1438 -
sparse_categorical_accuracy: 0.6236 - val_loss: 2.3574 -
val_sparse_categorical_accuracy: 0.1399
 90%|      | 27/30 [2:23:45<17:40, 353.54s/it]
0.13992 0.0002351547355080936 0.0002017990678365622
Train on 50000 samples, validate on 12500 samples
Epoch 1/15
50000/50000 [==============================] - 30s 610us/sample - loss: 2.0147 -
sparse_categorical_accuracy: 0.3346 - val_loss: 2.2944 -
val_sparse_categorical_accuracy: 0.1199
Epoch 2/15
50000/50000 [==============================] - 23s 457us/sample - loss: 1.5957 -
sparse_categorical_accuracy: 0.4271 - val_loss: 2.2923 -
val_sparse_categorical_accuracy: 0.1409
Epoch 3/15
50000/50000 [==============================] - 23s 454us/sample - loss: 1.4816 -
sparse_categorical_accuracy: 0.4699 - val_loss: 2.2915 -
val_sparse_categorical_accuracy: 0.1575
Epoch 4/15
50000/50000 [==============================] - 22s 431us/sample - loss: 1.4045 -
sparse_categorical_accuracy: 0.4990 - val_loss: 2.2897 -
val_sparse_categorical_accuracy: 0.1652
Epoch 5/15
50000/50000 [==============================] - 23s 469us/sample - loss: 1.3484 -
sparse_categorical_accuracy: 0.5206 - val_loss: 2.2884 -
val_sparse_categorical_accuracy: 0.1768
Epoch 6/15
50000/50000 [==============================] - 24s 470us/sample - loss: 1.3017 -
sparse_categorical_accuracy: 0.5363 - val_loss: 2.2875 -
val_sparse_categorical_accuracy: 0.1860
Epoch 7/15
50000/50000 [==============================] - 23s 453us/sample - loss: 1.2592 -
sparse_categorical_accuracy: 0.5525 - val_loss: 2.2865 -
val_sparse_categorical_accuracy: 0.1868
Epoch 8/15
50000/50000 [==============================] - 22s 449us/sample - loss: 1.2236 -
sparse_categorical_accuracy: 0.5669 - val_loss: 2.2854 -
val_sparse_categorical_accuracy: 0.2006
Epoch 9/15
50000/50000 [==============================] - 23s 453us/sample - loss: 1.1909 -
sparse_categorical_accuracy: 0.5811 - val_loss: 2.2843 -
```

```
val_sparse_categorical_accuracy: 0.1984
Epoch 10/15
50000/50000 [==============================] - 23s 462us/sample - loss: 1.1579 -
sparse_categorical_accuracy: 0.5911 - val_loss: 2.2833 -
val_sparse_categorical_accuracy: 0.2073
Epoch 11/15
50000/50000 [==============================] - 24s 486us/sample - loss: 1.1323 -
sparse_categorical_accuracy: 0.5977 - val_loss: 2.2828 -
val_sparse_categorical_accuracy: 0.2080
Epoch 12/15
50000/50000 [==============================] - 23s 464us/sample - loss: 1.1042 -
sparse_categorical_accuracy: 0.6111 - val_loss: 2.2819 -
val_sparse_categorical_accuracy: 0.2178
Epoch 13/15
50000/50000 [==============================] - 24s 473us/sample - loss: 1.0836 -
sparse_categorical_accuracy: 0.6176 - val_loss: 2.2813 -
val_sparse_categorical_accuracy: 0.2184
Epoch 14/15
50000/50000 [==============================] - 24s 481us/sample - loss: 1.0584 -
sparse_categorical_accuracy: 0.6272 - val_loss: 2.2807 -
val_sparse_categorical_accuracy: 0.2236
Epoch 15/15
50000/50000 [==============================] - 24s 483us/sample - loss: 1.0367 -
sparse_categorical_accuracy: 0.6355 - val_loss: 2.2798 -
val_sparse_categorical_accuracy: 0.2254

 93%|     | 28/30 [2:29:52<11:54, 357.45s/it]

0.22544 0.00028745777121261045 1.881027370322522e-06
Train on 50000 samples, validate on 12500 samples
Epoch 1/15
50000/50000 [==============================] - 32s 636us/sample - loss: 2.2144 -
sparse_categorical_accuracy: 0.3173 - val_loss: 2.4488 -
val_sparse_categorical_accuracy: 0.1496
Epoch 2/15
50000/50000 [==============================] - 25s 497us/sample - loss: 1.7764 -
sparse_categorical_accuracy: 0.4197 - val_loss: 2.4447 -
val_sparse_categorical_accuracy: 0.1593
Epoch 3/15
50000/50000 [==============================] - 25s 493us/sample - loss: 1.6605 -
sparse_categorical_accuracy: 0.4636 - val_loss: 2.4428 -
val_sparse_categorical_accuracy: 0.1632
Epoch 4/15
50000/50000 [==============================] - 26s 516us/sample - loss: 1.5795 -
sparse_categorical_accuracy: 0.4913 - val_loss: 2.4415 -
val_sparse_categorical_accuracy: 0.1657
Epoch 5/15
50000/50000 [==============================] - 25s 504us/sample - loss: 1.5191 -
sparse_categorical_accuracy: 0.5152 - val_loss: 2.4406 -
```

```
val_sparse_categorical_accuracy: 0.1688
Epoch 6/15
50000/50000 [==============================] - 25s 498us/sample - loss: 1.4731 -
sparse_categorical_accuracy: 0.5330 - val_loss: 2.4395 -
val_sparse_categorical_accuracy: 0.1723
Epoch 7/15
50000/50000 [==============================] - 25s 496us/sample - loss: 1.4278 -
sparse_categorical_accuracy: 0.5490 - val_loss: 2.4378 -
val_sparse_categorical_accuracy: 0.1753
Epoch 8/15
50000/50000 [==============================] - 25s 504us/sample - loss: 1.3966 -
sparse_categorical_accuracy: 0.5607 - val_loss: 2.4372 -
val_sparse_categorical_accuracy: 0.1743
Epoch 9/15
50000/50000 [==============================] - 24s 472us/sample - loss: 1.3624 -
sparse_categorical_accuracy: 0.5740 - val_loss: 2.4368 -
val_sparse_categorical_accuracy: 0.1725
Epoch 10/15
50000/50000 [==============================] - 24s 482us/sample - loss: 1.3361 -
sparse_categorical_accuracy: 0.5830 - val_loss: 2.4362 -
val_sparse_categorical_accuracy: 0.1820
Epoch 11/15
50000/50000 [==============================] - 27s 540us/sample - loss: 1.3059 -
sparse_categorical_accuracy: 0.5939 - val_loss: 2.4355 -
val_sparse_categorical_accuracy: 0.1783
Epoch 12/15
50000/50000 [==============================] - 26s 520us/sample - loss: 1.2824 -
sparse_categorical_accuracy: 0.6012 - val_loss: 2.4353 -
val_sparse_categorical_accuracy: 0.1793
Epoch 13/15
50000/50000 [==============================] - 26s 519us/sample - loss: 1.2565 -
sparse_categorical_accuracy: 0.6130 - val_loss: 2.4342 -
val_sparse_categorical_accuracy: 0.1876
Epoch 14/15
50000/50000 [==============================] - 26s 515us/sample - loss: 1.2356 -
sparse_categorical_accuracy: 0.6199 - val_loss: 2.4341 -
val_sparse_categorical_accuracy: 0.1797
Epoch 15/15
50000/50000 [==============================] - 26s 520us/sample - loss: 1.2148 -
sparse_categorical_accuracy: 0.6276 - val_loss: 2.4329 -
val_sparse_categorical_accuracy: 0.1809

 97%|      | 29/30 [2:36:30<06:09, 369.73s/it]

0.18088 0.00024572486841065573 0.000416207174772339
Train on 50000 samples, validate on 12500 samples
Epoch 1/15
50000/50000 [==============================] - 34s 680us/sample - loss: 2.2348 -
sparse_categorical_accuracy: 0.2921 - val_loss: 2.3152 -
```

```
val_sparse_categorical_accuracy: 0.1345
Epoch 2/15
50000/50000 [==============================] - 25s 504us/sample - loss: 1.7484 -
sparse_categorical_accuracy: 0.3858 - val_loss: 2.3125 -
val_sparse_categorical_accuracy: 0.1382
Epoch 3/15
50000/50000 [==============================] - 24s 484us/sample - loss: 1.6338 -
sparse_categorical_accuracy: 0.4255 - val_loss: 2.3104 -
val_sparse_categorical_accuracy: 0.1447
Epoch 4/15
50000/50000 [==============================] - 24s 488us/sample - loss: 1.5581 -
sparse_categorical_accuracy: 0.4539 - val_loss: 2.3082 -
val_sparse_categorical_accuracy: 0.1559
Epoch 5/15
50000/50000 [==============================] - 25s 501us/sample - loss: 1.4998 -
sparse_categorical_accuracy: 0.4743 - val_loss: 2.3063 -
val_sparse_categorical_accuracy: 0.1678
Epoch 6/15
50000/50000 [==============================] - 25s 497us/sample - loss: 1.4570 -
sparse_categorical_accuracy: 0.4899 - val_loss: 2.3053 -
val_sparse_categorical_accuracy: 0.1646
Epoch 7/15
50000/50000 [==============================] - 24s 478us/sample - loss: 1.4183 -
sparse_categorical_accuracy: 0.5044 - val_loss: 2.3042 -
val_sparse_categorical_accuracy: 0.1743
Epoch 8/15
50000/50000 [==============================] - 24s 490us/sample - loss: 1.3879 -
sparse_categorical_accuracy: 0.5161 - val_loss: 2.3032 -
val_sparse_categorical_accuracy: 0.1894
Epoch 9/15
50000/50000 [==============================] - 26s 528us/sample - loss: 1.3590 -
sparse_categorical_accuracy: 0.5255 - val_loss: 2.3018 -
val_sparse_categorical_accuracy: 0.1922
Epoch 10/15
50000/50000 [==============================] - 25s 496us/sample - loss: 1.3343 -
sparse_categorical_accuracy: 0.5354 - val_loss: 2.3016 -
val_sparse_categorical_accuracy: 0.1939
Epoch 11/15
50000/50000 [==============================] - 25s 491us/sample - loss: 1.3115 -
sparse_categorical_accuracy: 0.5450 - val_loss: 2.3009 -
val_sparse_categorical_accuracy: 0.2062
Epoch 12/15
50000/50000 [==============================] - 25s 491us/sample - loss: 1.2904 -
sparse_categorical_accuracy: 0.5520 - val_loss: 2.2999 -
val_sparse_categorical_accuracy: 0.2237
Epoch 13/15
50000/50000 [==============================] - 25s 495us/sample - loss: 1.2706 -
sparse_categorical_accuracy: 0.5584 - val_loss: 2.2989 -
```

```
val_sparse_categorical_accuracy: 0.2188
Epoch 14/15
50000/50000 [==============================] - 26s 516us/sample - loss: 1.2528 -
sparse_categorical_accuracy: 0.5657 - val_loss: 2.2981 -
val_sparse_categorical_accuracy: 0.2241
Epoch 15/15
50000/50000 [==============================] - 24s 487us/sample - loss: 1.2361 -
sparse_categorical_accuracy: 0.5732 - val_loss: 2.2975 -
val_sparse_categorical_accuracy: 0.2244

100%|      | 30/30 [2:43:05<00:00, 326.17s/it]

0.2244 0.00010864962255959528 6.226177539282907e-05
```

[59]:
```
logs=[val_acc,lrs, l2_regs]
logs=np.array(logs)
# logs=np.sort(logs,axis=0)
```

[60]:
```
top4=np.argsort(logs[0,:])[::-1][:4]
top4
```

[60]:
```
array([13, 24, 27,  1], dtype=int64)
```

[61]:
```
logs[:,top4]
```

[61]:
```
array([[2.45839998e-01, 2.41840005e-01, 2.25439996e-01, 2.24639997e-01],
       [5.76781131e-04, 1.09561736e-04, 2.87457771e-04, 3.22302198e-04],
       [2.91961577e-04, 6.28240059e-06, 1.88102737e-06, 3.74405457e-06]])
```

[62]:
```
lr, l2_reg = logs[1,top4[0]],logs[2,top4[0]]
```

[63]:
```
from tensorflow.keras.callbacks import EarlyStopping
es = EarlyStopping(monitor='val_loss', mode='min', verbose=1, patience=10)
model = create_model(num_classes,l2_reg)
model.compile(optimizer=optimizers.
 ↪SGD(learning_rate=lr),loss='sparse_categorical_crossentropy',metrics=['sparse_categorical_a
history = model.fit(X_train,y_train,batch_size=64,epochs=50,␣
 ↪verbose=1,validation_data=(X_val,y_val), callbacks=[es])
```

```
Train on 50000 samples, validate on 12500 samples
Epoch 1/50
50000/50000 [==============================] - 20s 409us/sample - loss: 2.0945 -
sparse_categorical_accuracy: 0.3228 - val_loss: 2.3993 -
val_sparse_categorical_accuracy: 0.1599
Epoch 2/50
50000/50000 [==============================] - 13s 269us/sample - loss: 1.7258 -
sparse_categorical_accuracy: 0.4220 - val_loss: 2.3958 -
```

```
val_sparse_categorical_accuracy: 0.1717
Epoch 3/50
50000/50000 [==============================] - 14s 271us/sample - loss: 1.6158 -
sparse_categorical_accuracy: 0.4625 - val_loss: 2.3943 -
val_sparse_categorical_accuracy: 0.1639
Epoch 4/50
50000/50000 [==============================] - 13s 268us/sample - loss: 1.5423 -
sparse_categorical_accuracy: 0.4889 - val_loss: 2.3933 -
val_sparse_categorical_accuracy: 0.1808
Epoch 5/50
50000/50000 [==============================] - 14s 283us/sample - loss: 1.4831 -
sparse_categorical_accuracy: 0.5113 - val_loss: 2.3921 -
val_sparse_categorical_accuracy: 0.1820
Epoch 6/50
50000/50000 [==============================] - 14s 271us/sample - loss: 1.4428 -
sparse_categorical_accuracy: 0.5264 - val_loss: 2.3906 -
val_sparse_categorical_accuracy: 0.1710
Epoch 7/50
50000/50000 [==============================] - 13s 269us/sample - loss: 1.3972 -
sparse_categorical_accuracy: 0.5438 - val_loss: 2.3892 -
val_sparse_categorical_accuracy: 0.1749
Epoch 8/50
50000/50000 [==============================] - 14s 270us/sample - loss: 1.3638 -
sparse_categorical_accuracy: 0.5561 - val_loss: 2.3888 -
val_sparse_categorical_accuracy: 0.1835
Epoch 9/50
50000/50000 [==============================] - 14s 271us/sample - loss: 1.3276 -
sparse_categorical_accuracy: 0.5696 - val_loss: 2.3875 -
val_sparse_categorical_accuracy: 0.1695
Epoch 10/50
50000/50000 [==============================] - 13s 269us/sample - loss: 1.2979 -
sparse_categorical_accuracy: 0.5809 - val_loss: 2.3854 -
val_sparse_categorical_accuracy: 0.1870
Epoch 11/50
50000/50000 [==============================] - 13s 269us/sample - loss: 1.2695 -
sparse_categorical_accuracy: 0.5909 - val_loss: 2.3850 -
val_sparse_categorical_accuracy: 0.1778
Epoch 12/50
50000/50000 [==============================] - 13s 268us/sample - loss: 1.2378 -
sparse_categorical_accuracy: 0.6039 - val_loss: 2.3833 -
val_sparse_categorical_accuracy: 0.1840
Epoch 13/50
50000/50000 [==============================] - 14s 276us/sample - loss: 1.2142 -
sparse_categorical_accuracy: 0.6114 - val_loss: 2.3828 -
val_sparse_categorical_accuracy: 0.1850
Epoch 14/50
50000/50000 [==============================] - 14s 286us/sample - loss: 1.1863 -
sparse_categorical_accuracy: 0.6234 - val_loss: 2.3823 -
```

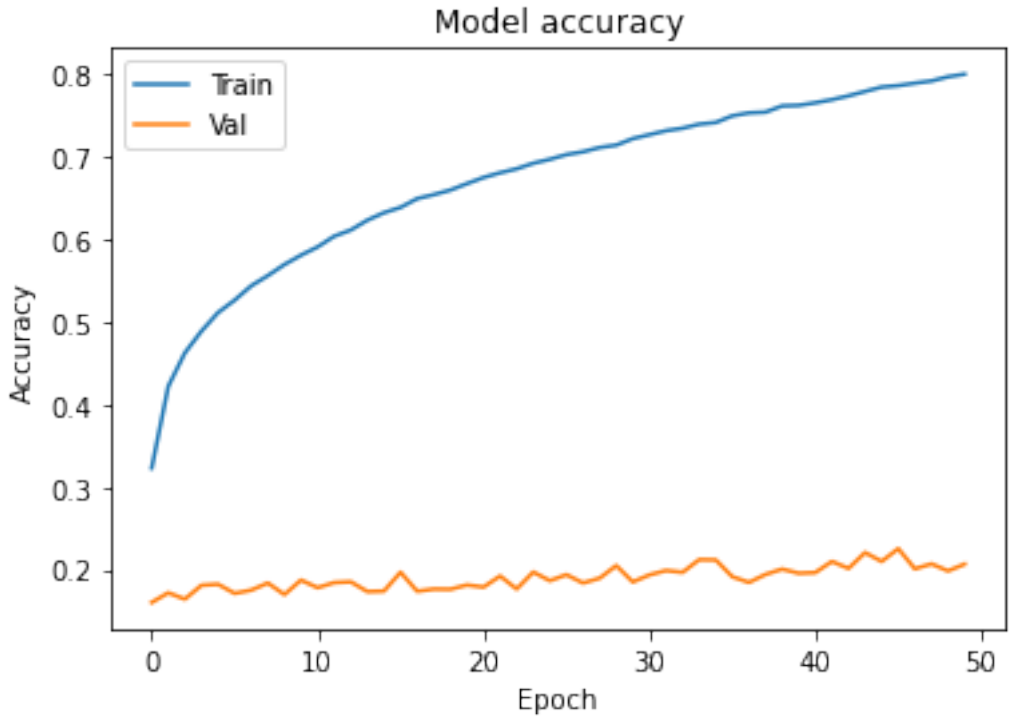
```
val_sparse_categorical_accuracy: 0.1731
Epoch 15/50
50000/50000 [==============================] - 14s 277us/sample - loss: 1.1600 -
sparse_categorical_accuracy: 0.6324 - val_loss: 2.3815 -
val_sparse_categorical_accuracy: 0.1737
Epoch 16/50
50000/50000 [==============================] - 14s 276us/sample - loss: 1.1427 -
sparse_categorical_accuracy: 0.6389 - val_loss: 2.3803 -
val_sparse_categorical_accuracy: 0.1966
Epoch 17/50
50000/50000 [==============================] - 14s 278us/sample - loss: 1.1185 -
sparse_categorical_accuracy: 0.6495 - val_loss: 2.3809 -
val_sparse_categorical_accuracy: 0.1735
Epoch 18/50
50000/50000 [==============================] - 14s 280us/sample - loss: 1.1013 -
sparse_categorical_accuracy: 0.6543 - val_loss: 2.3796 -
val_sparse_categorical_accuracy: 0.1762
Epoch 19/50
50000/50000 [==============================] - 14s 283us/sample - loss: 1.0801 -
sparse_categorical_accuracy: 0.6598 - val_loss: 2.3794 -
val_sparse_categorical_accuracy: 0.1759
Epoch 20/50
50000/50000 [==============================] - 14s 288us/sample - loss: 1.0606 -
sparse_categorical_accuracy: 0.6676 - val_loss: 2.3779 -
val_sparse_categorical_accuracy: 0.1811
Epoch 21/50
50000/50000 [==============================] - 14s 288us/sample - loss: 1.0414 -
sparse_categorical_accuracy: 0.6751 - val_loss: 2.3774 -
val_sparse_categorical_accuracy: 0.1786
Epoch 22/50
50000/50000 [==============================] - 14s 290us/sample - loss: 1.0288 -
sparse_categorical_accuracy: 0.6809 - val_loss: 2.3775 -
val_sparse_categorical_accuracy: 0.1920
Epoch 23/50
50000/50000 [==============================] - 14s 278us/sample - loss: 1.0113 -
sparse_categorical_accuracy: 0.6856 - val_loss: 2.3773 -
val_sparse_categorical_accuracy: 0.1762
Epoch 24/50
50000/50000 [==============================] - 14s 277us/sample - loss: 0.9937 -
sparse_categorical_accuracy: 0.6924 - val_loss: 2.3744 -
val_sparse_categorical_accuracy: 0.1968
Epoch 25/50
50000/50000 [==============================] - 14s 276us/sample - loss: 0.9801 -
sparse_categorical_accuracy: 0.6972 - val_loss: 2.3754 -
val_sparse_categorical_accuracy: 0.1863
Epoch 26/50
50000/50000 [==============================] - 14s 277us/sample - loss: 0.9660 -
sparse_categorical_accuracy: 0.7029 - val_loss: 2.3740 -
```

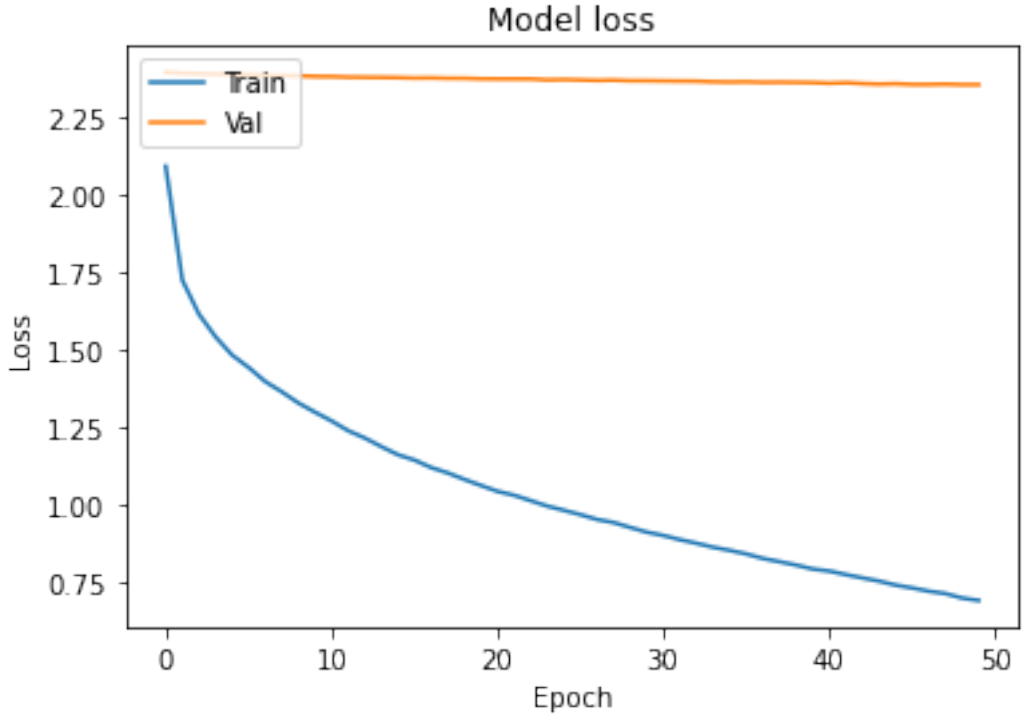
```
val_sparse_categorical_accuracy: 0.1936
Epoch 27/50
50000/50000 [==============================] - 14s 281us/sample - loss: 0.9504 -
sparse_categorical_accuracy: 0.7063 - val_loss: 2.3725 -
val_sparse_categorical_accuracy: 0.1835
Epoch 28/50
50000/50000 [==============================] - 12s 242us/sample - loss: 0.9405 -
sparse_categorical_accuracy: 0.7114 - val_loss: 2.3733 -
val_sparse_categorical_accuracy: 0.1894
Epoch 29/50
50000/50000 [==============================] - 12s 236us/sample - loss: 0.9245 -
sparse_categorical_accuracy: 0.7143 - val_loss: 2.3716 -
val_sparse_categorical_accuracy: 0.2046
Epoch 30/50
50000/50000 [==============================] - 12s 237us/sample - loss: 0.9093 -
sparse_categorical_accuracy: 0.7223 - val_loss: 2.3715 -
val_sparse_categorical_accuracy: 0.1848
Epoch 31/50
50000/50000 [==============================] - 12s 235us/sample - loss: 0.8985 -
sparse_categorical_accuracy: 0.7270 - val_loss: 2.3709 -
val_sparse_categorical_accuracy: 0.1934
Epoch 32/50
50000/50000 [==============================] - 12s 237us/sample - loss: 0.8848 -
sparse_categorical_accuracy: 0.7318 - val_loss: 2.3704 -
val_sparse_categorical_accuracy: 0.1986
Epoch 33/50
50000/50000 [==============================] - 12s 238us/sample - loss: 0.8732 -
sparse_categorical_accuracy: 0.7348 - val_loss: 2.3700 -
val_sparse_categorical_accuracy: 0.1965
Epoch 34/50
50000/50000 [==============================] - 12s 236us/sample - loss: 0.8603 -
sparse_categorical_accuracy: 0.7397 - val_loss: 2.3681 -
val_sparse_categorical_accuracy: 0.2118
Epoch 35/50
50000/50000 [==============================] - 12s 236us/sample - loss: 0.8503 -
sparse_categorical_accuracy: 0.7418 - val_loss: 2.3673 -
val_sparse_categorical_accuracy: 0.2115
Epoch 36/50
50000/50000 [==============================] - 12s 237us/sample - loss: 0.8386 -
sparse_categorical_accuracy: 0.7499 - val_loss: 2.3680 -
val_sparse_categorical_accuracy: 0.1911
Epoch 37/50
50000/50000 [==============================] - 12s 236us/sample - loss: 0.8241 -
sparse_categorical_accuracy: 0.7534 - val_loss: 2.3664 -
val_sparse_categorical_accuracy: 0.1842
Epoch 38/50
50000/50000 [==============================] - 12s 236us/sample - loss: 0.8135 -
sparse_categorical_accuracy: 0.7544 - val_loss: 2.3668 -
```

```
val_sparse_categorical_accuracy: 0.1939
Epoch 39/50
50000/50000 [==============================] - 12s 235us/sample - loss: 0.8026 -
sparse_categorical_accuracy: 0.7619 - val_loss: 2.3662 -
val_sparse_categorical_accuracy: 0.2004
Epoch 40/50
50000/50000 [==============================] - 12s 236us/sample - loss: 0.7899 -
sparse_categorical_accuracy: 0.7626 - val_loss: 2.3656 -
val_sparse_categorical_accuracy: 0.1954
Epoch 41/50
50000/50000 [==============================] - 12s 236us/sample - loss: 0.7832 -
sparse_categorical_accuracy: 0.7657 - val_loss: 2.3634 -
val_sparse_categorical_accuracy: 0.1962
Epoch 42/50
50000/50000 [==============================] - 12s 237us/sample - loss: 0.7717 -
sparse_categorical_accuracy: 0.7695 - val_loss: 2.3652 -
val_sparse_categorical_accuracy: 0.2097
Epoch 43/50
50000/50000 [==============================] - 12s 235us/sample - loss: 0.7610 -
sparse_categorical_accuracy: 0.7741 - val_loss: 2.3623 -
val_sparse_categorical_accuracy: 0.2012
Epoch 44/50
50000/50000 [==============================] - 12s 236us/sample - loss: 0.7506 -
sparse_categorical_accuracy: 0.7795 - val_loss: 2.3605 -
val_sparse_categorical_accuracy: 0.2204
Epoch 45/50
50000/50000 [==============================] - 12s 237us/sample - loss: 0.7377 -
sparse_categorical_accuracy: 0.7848 - val_loss: 2.3618 -
val_sparse_categorical_accuracy: 0.2097
Epoch 46/50
50000/50000 [==============================] - 12s 236us/sample - loss: 0.7285 -
sparse_categorical_accuracy: 0.7865 - val_loss: 2.3593 -
val_sparse_categorical_accuracy: 0.2252
Epoch 47/50
50000/50000 [==============================] - 12s 241us/sample - loss: 0.7179 -
sparse_categorical_accuracy: 0.7895 - val_loss: 2.3594 -
val_sparse_categorical_accuracy: 0.2007
Epoch 48/50
50000/50000 [==============================] - 12s 242us/sample - loss: 0.7103 -
sparse_categorical_accuracy: 0.7921 - val_loss: 2.3603 -
val_sparse_categorical_accuracy: 0.2067
Epoch 49/50
50000/50000 [==============================] - 12s 243us/sample - loss: 0.6958 -
sparse_categorical_accuracy: 0.7972 - val_loss: 2.3587 -
val_sparse_categorical_accuracy: 0.1982
Epoch 50/50
50000/50000 [==============================] - 12s 245us/sample - loss: 0.6880 -
sparse_categorical_accuracy: 0.8004 - val_loss: 2.3587 -
```

```
val_sparse_categorical_accuracy: 0.2064
```

[64]:
```
plot_curves(history)
```



[65]:
```
model.fit(X_train, y_train, batch_size=BATCH_SIZE, epochs=1, verbose=1)
```

```
Train on 50000 samples
50000/50000 [==============================] - 17s 346us/sample - loss: 0.7390 -
sparse_categorical_accuracy: 0.7785
```

[65]:
```
<tensorflow.python.keras.callbacks.History at 0x1fa1f6e2828>
```

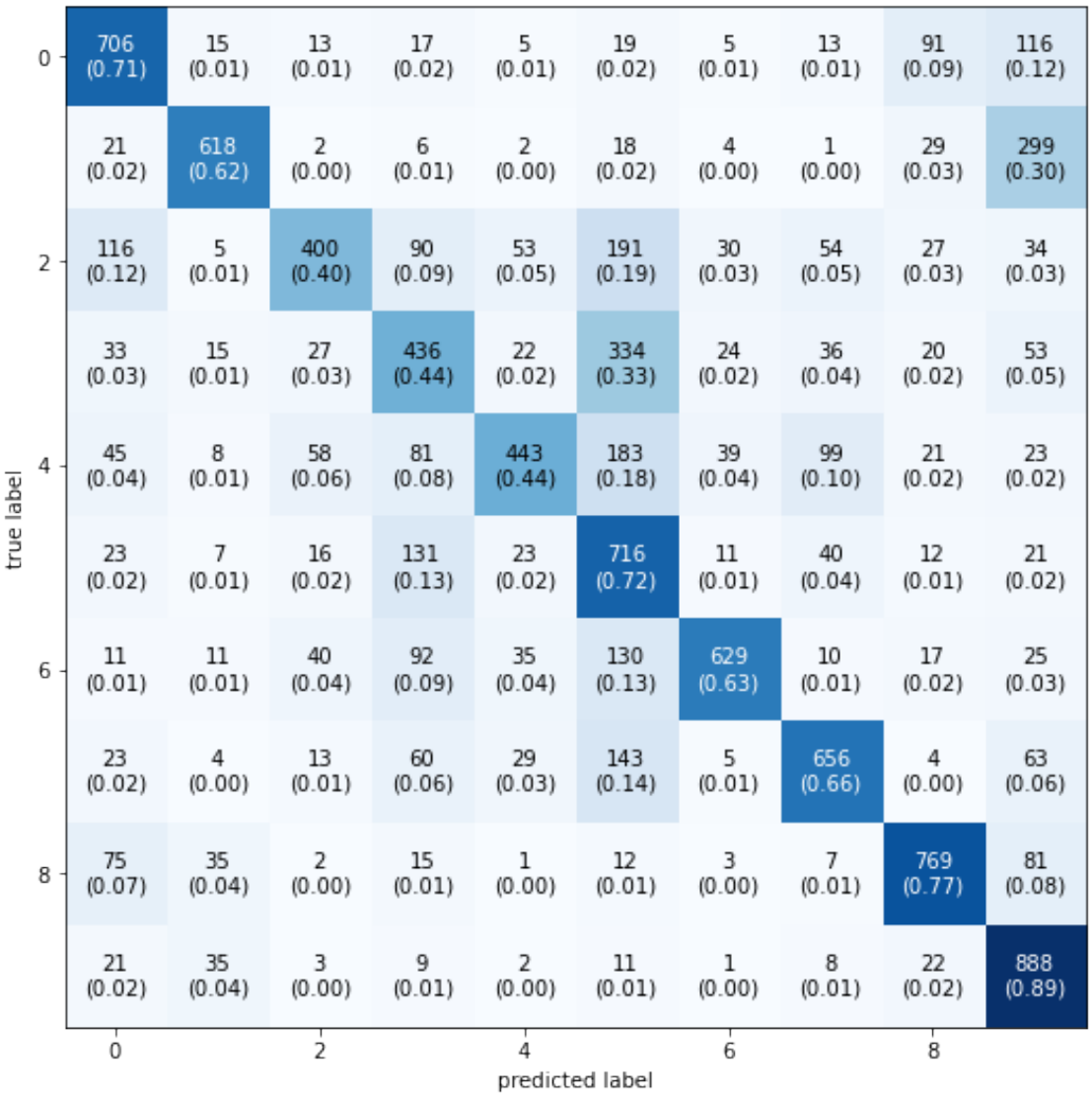
[66]:
```
y_pred = model.predict_classes(X_test)
mat = confusion_matrix(y_test,y_pred)
plot_confusion_matrix(mat,figsize=(9,9), show_normed=True)
print(classification_report(y_pred, y_test))
print(accuracy_score(y_pred, y_test))
```

```
              precision    recall  f1-score   support

           0       0.71      0.66      0.68      1074
           1       0.62      0.82      0.71       753
           2       0.40      0.70      0.51       574
           3       0.44      0.47      0.45       937
           4       0.44      0.72      0.55       615
           5       0.72      0.41      0.52      1757
           6       0.63      0.84      0.72       751
           7       0.66      0.71      0.68       924
           8       0.77      0.76      0.76      1012
           9       0.89      0.55      0.68      1603

    accuracy                           0.63     10000
   macro avg       0.63      0.66      0.63     10000
weighted avg       0.67      0.63      0.63     10000

0.6261
```


706 (0.71) 15 (0.01) 13 (0.01) 17 (0.02) 5 (0.01) 19 (0.02) 5 (0.01) 13 (0.01) 91 (0.09) 116 (0.12)
21 (0.02) 618 (0.62) 2 (0.00) 6 (0.01) 2 (0.00) 18 (0.02) 4 (0.00) 1 (0.00) 29 (0.03) 299 (0.30)
116 (0.12) 5 (0.01) 400 (0.40) 90 (0.09) 53 (0.05) 191 (0.19) 30 (0.03) 54 (0.05) 27 (0.03) 34 (0.03)
33 (0.03) 15 (0.01) 27 (0.03) 436 (0.44) 22 (0.02) 334 (0.33) 24 (0.02) 36 (0.04) 20 (0.02) 53 (0.05)
45 (0.04) 8 (0.01) 58 (0.06) 81 (0.08) 443 (0.44) 183 (0.18) 39 (0.04) 99 (0.10) 21 (0.02) 23 (0.02)
23 (0.02) 7 (0.01) 16 (0.02) 131 (0.13) 23 (0.02) 716 (0.72) 11 (0.01) 40 (0.04) 12 (0.01) 21 (0.02)
11 (0.01) 11 (0.01) 40 (0.04) 92 (0.09) 35 (0.04) 130 (0.13) 629 (0.63) 10 (0.01) 17 (0.02) 25 (0.03)
23 (0.02) 4 (0.00) 13 (0.01) 60 (0.06) 29 (0.03) 143 (0.14) 5 (0.01) 656 (0.66) 4 (0.00) 63 (0.06)
75 (0.07) 35 (0.04) 2 (0.00) 15 (0.01) 1 (0.00) 12 (0.01) 3 (0.00) 7 (0.01) 769 (0.77) 81 (0.08)
21 (0.02) 35 (0.04) 3 (0.00) 9 (0.01) 2 (0.00) 11 (0.01) 1 (0.00) 8 (0.01) 22 (0.02) 888 (0.89)
0
2
4
6
8
true label
0
2
4
6
8
predicted label