Implementing ALEXNET WITH CIFAR100 dataset

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Subject - Machine Learning

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ASSIGNMENT 3 Part 2(From Scratch)

```
from __future__ import print_function
import tensorflow.compat.v1 as tf
from keras.models import Model
import keras
import pandas as pd
from tensorflow.keras.callbacks import TensorBoard
from tensorflow import keras
from keras.datasets import cifar100
from keras.models import Sequential
from keras.layers import Dense, Dropout, Activation, Flatten, Input
from keras.layers import Conv2D, MaxPooling2D, ZeroPadding2D
from keras.optimizers import SGD
from keras.regularizers import l2
from keras.callbacks import Callback, LearningRateScheduler, TensorBoard, ModelCheckpoint
from keras.preprocessing.image import ImageDataGenerator
from keras.utils import print_summary, to_categorical
from keras import backend as K
import numpy as np
import matplotlib
import json
from matplotlib import pyplot as plt
from keras.models import Sequential
from keras.optimizers import Adam
from keras.callbacks import ModelCheckpoint
from keras.models import load_model
from keras.layers import Lambda, Conv2D, MaxPooling2D, Dropout, Dense, Flatten, Activation
```

```
import sys
import os
import cv2
from PIL import Image
import numpy as np
from skimage.transform import resize
from skimage import data, io, filters
from skimage.transform import rescale
import time
from keras.layers.normalization import BatchNormalization
from sklearn.model_selection import StratifiedShuffleSplit
```

The default version of TensorFlow in Colab will soon switch to TensorFlow 2.x.
We recommend you upgrade now or ensure your notebook will continue to use TensorFlow 1.x via the `%tensorflow_version 1.x` magic: more info.

```
Using TensorFlow backend
```

```
NAME = "Alexnet_cifar100"
NUM_CLASSES = 100
num_classes = 100
```

```
(x_train, y_train), (x_test, y_test) = cifar100.load_data()
```

```
x_train = np.array([cv2.resize(img, (224, 224), interpolation=cv2.INTER_CUBIC) for img in x_train])#-----------------------changing
x_test = np.array([cv2.resize(img, (224, 224), interpolation=cv2.INTER_CUBIC) for img in x_test])#--------- orignal data iamges are
                                                                                                   #- there are 50000 testing images so
```

```
print(x_train.shape)
print(x_test.shape)#----printing shape of values
print(y_train.shape)
```

```
(50000, 224, 224, 3)
(10000, 224, 224, 3)
(50000, 1)
```

```
y_train = to_categorical(y_train, NUM_CLASSES)
y_test = to_categorical(y_test, NUM_CLASSES)
```

Double-click (or enter) to edit

```
x_train = x_train.astype(np.float32)#---------------------normalizaing the data
x_test = x_test.astype(np.float32)
x_train = x_train / 255
x_test = x_test / 255
```

```
#x_train = x_train[1:200]
#label_train = label_train[1:200]
#x_test = x_test[1:300]
#label_test = label_test[1:300]
print(x_train.shape)
print(y_train.shape)
print(x_test.shape)
print(y_test.shape)#-----------------------verifying the shapes again

#x = []
#for i in range(len(x_train)):

  # img = cv2.resize(x_train[i], (224, 224))
```

```
     # x.append(img)
```

```
(50000, 224, 224, 3)
(50000, 100)
(10000, 224, 224, 3)
(10000, 100)
```

```
print(type(x_test))
```

```
<class 'numpy.ndarray'>
```

```
def Alexnet(n_class=100, init_lr = 0.01):#---------------Starting the main architecture of ALEXNET

    # Convolution layer 1
    inputs = Input((224,224,3))
    conv1 = Conv2D(filters=96, input_shape=(224,224,3), kernel_size=(11,11),activation = 'relu',strides=(4,4), padding='same')(input
    conv1 = Dropout(0.2)(conv1)

    pool1 = MaxPooling2D(pool_size=(2,2), strides=(2,2), padding='same')(conv1)

    # Convolution layer 2
    conv2 = Conv2D(filters=256,kernel_size=(5,5),activation ='relu',strides=(1,1), padding='same')(pool1)
    conv2 = Dropout(0.2)(conv2)
    pool2 = MaxPooling2D(pool_size=(2,2), strides=(2,2), padding='same')(conv2)

    # Convolution layer 3
    conv3 = Conv2D(filters=384,kernel_size=(3,3),activation = 'relu',strides=(4,4), padding='same')(pool2)
    conv3 = Dropout(0.2)(conv3)
    pool3 = MaxPooling2D(pool_size=(2,2), strides=(2,2), padding='same')(conv3)

    # Convolution layer 4
    conv4 = Conv2D(filters=384,kernel_size=(3,3),activation = 'relu',strides=(4,4), padding='same')(pool3)
    conv4 = Dropout(0.2)(conv4)

    # Convolution layer 5
    conv5 = Conv2D(filters=256,kernel_size=(3,3),activation = 'relu',strides=(4,4), padding='same')(conv4)
    conv5 = Dropout(0.2)(conv5)
    pool5 = MaxPooling2D(pool_size=(2,2), strides=(2,2), padding='same')(conv5)

    conv6 = Flatten() (pool5)
    # FCC Layer 1
    conv6 = Dense(4096) (conv6)
    conv6 = Activation('relu') (conv6)
    conv6 = Dropout(0.5)(conv6)
    # FCC layer 2
    conv7 = Dense(4096) (conv6)
    conv7 = Activation('relu') (conv7)
    conv7 = Dropout(0.5)(conv7)


    # FCC layer 3 #---------------------------There are total 8 layers (Alexnet)
    conv8 = Dense(n_class)(conv7)
    conv8 = Activation('softmax')(conv8)

    model = Model(input=inputs, output=conv8)


    model.compile(loss="categorical_crossentropy", optimizer= Adam(lr=init_lr) , metrics=['accuracy'] )


    return model




model = Alexnet()#---------------Getting model
model.summary()
#model.load_weights('Alexnet_weights.h5', by_name=True)
```

```
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:66: The name tf.get_default_g

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:541: The name tf.placeholder 

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:4432: The name tf.random_uni

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:148: The name tf.placeholder_

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:3733: calling dropout (from t
Instructions for updating:
Please use `rate` instead of `keep_prob`. Rate should be set to `rate = 1 - keep_prob`.
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:4267: The name tf.nn.max_pool

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/optimizers.py:793: The name tf.train.Optimizer is deprecate

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:3576: The name tf.log is depr

Model: "model_1"
_________________________________________________________________
Layer (type)                 Output Shape              Param #   
=================================================================
input_1 (InputLayer)         (None, 224, 224, 3)       0         
_________________________________________________________________
conv2d_1 (Conv2D)            (None, 56, 56, 96)        34944     
_________________________________________________________________
dropout_1 (Dropout)          (None, 56, 56, 96)        0         
_________________________________________________________________
max_pooling2d_1 (MaxPooling2 (None, 28, 28, 96)        0         
_________________________________________________________________
conv2d_2 (Conv2D)            (None, 28, 28, 256)       614656    
_________________________________________________________________
dropout_2 (Dropout)          (None, 28, 28, 256)       0         
_________________________________________________________________
max_pooling2d_2 (MaxPooling2 (None, 14, 14, 256)       0         
_________________________________________________________________
conv2d_3 (Conv2D)            (None, 4, 4, 384)         885120    
_________________________________________________________________
dropout_3 (Dropout)          (None, 4, 4, 384)         0         
_________________________________________________________________
max_pooling2d_3 (MaxPooling2 (None, 2, 2, 384)         0         
_________________________________________________________________
conv2d_4 (Conv2D)            (None, 1, 1, 384)         1327488   
```

```
conv2d_4 (Conv2D)            (None, 1, 1, 384)         1327488
_________________________________________________________________
dropout_4 (Dropout)          (None, 1, 1, 384)         0
_________________________________________________________________
conv2d_5 (Conv2D)            (None, 1, 1, 256)         884992
_________________________________________________________________
dropout_5 (Dropout)          (None, 1, 1, 256)         0
_________________________________________________________________
max_pooling2d_4 (MaxPooling2 (None, 1, 1, 256)         0
_________________________________________________________________
flatten_1 (Flatten)          (None, 256)               0
_________________________________________________________________
dense_1 (Dense)              (None, 4096)              1052672
_________________________________________________________________
activation_1 (Activation)    (None, 4096)              0
_________________________________________________________________
dropout_6 (Dropout)          (None, 4096)              0
_________________________________________________________________
dense_2 (Dense)              (None, 4096)              16781312
_________________________________________________________________
activation_2 (Activation)    (None, 4096)              0
_________________________________________________________________
dropout_7 (Dropout)          (None, 4096)              0
_________________________________________________________________
dense_3 (Dense)              (None, 100)               409700
_________________________________________________________________
activation_3 (Activation)    (None, 100)               0
=================================================================
Total params: 21,990,884
Trainable params: 21,990,884
Non-trainable params: 0
_________________________________________________________________
/usr/local/lib/python3.6/dist-packages/ipykernel_launcher.py:45: UserWarning: Update your `Model` call to the Keras 2 API: `Mode
```

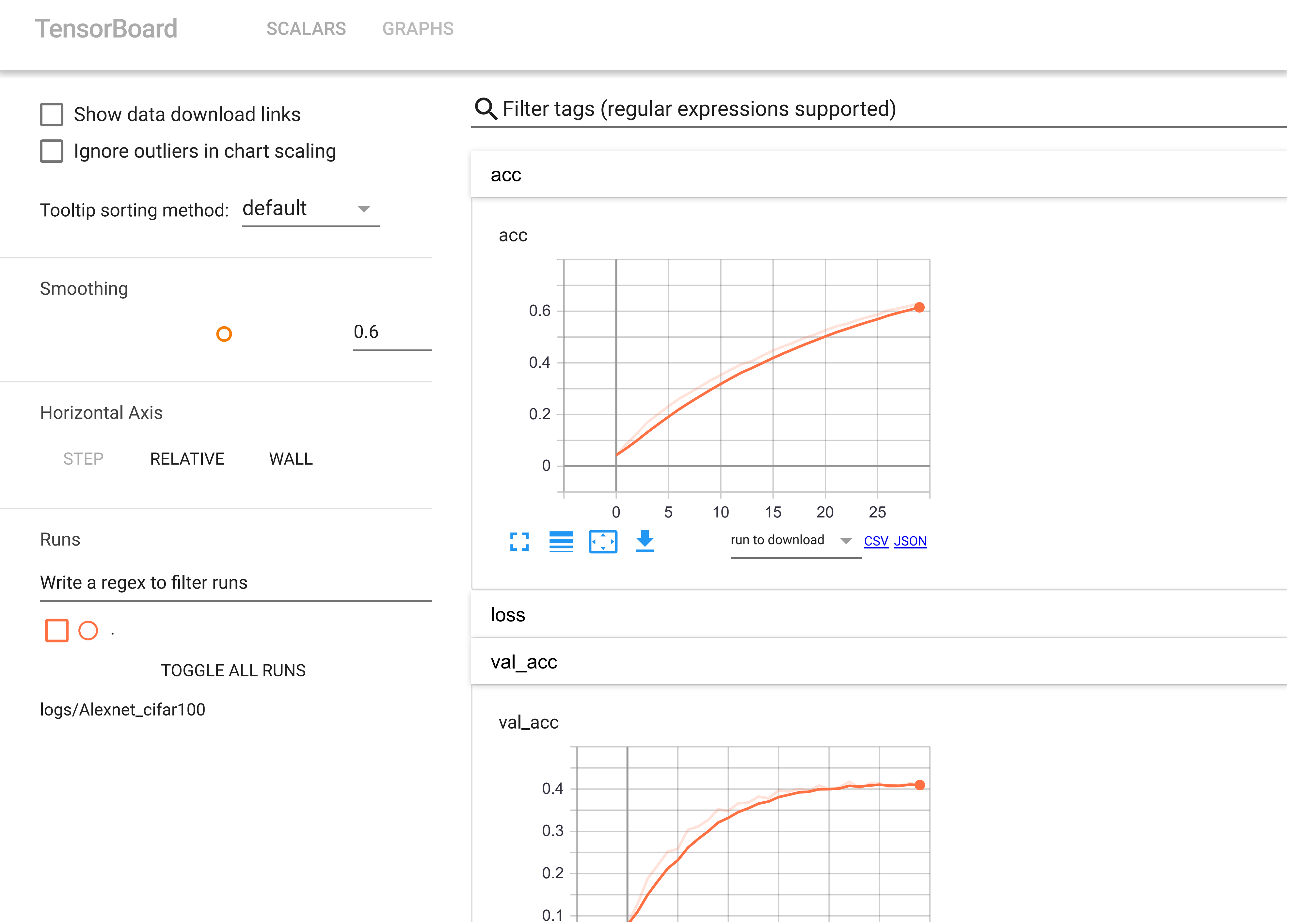
```
tensorboard = TensorBoard(log_dir="logs/{}".format(NAME))#------------Tensorboard will be used as log files
checkpoint = ModelCheckpoint('best_model_simple.h5',  #--- only the best model will be forwared in next epoch
                             monitor='val_loss',
                             verbose=0,
                             save_best_only= True,
                             mode='auto')


model.compile(loss='categorical_crossentropy', #--------------------Model will compile from here
              optimizer=Adam(lr=1.0e-4),
              metrics = ['accuracy'])
average_accuracy = 0
d =0





  #model.load_weights('Alexnet_weights.h5', by_name=True)
model_details = model.fit(x_train, y_train,#---------------------Putting our cifar100 data in alexnet
                    batch_size = 128, # number of samples
                    epochs = 30, # number of epochs
                    validation_data= (x_test, y_test),
                    callbacks=[checkpoint, tensorboard],
                    verbose=1)
```

```
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/tensorflow_core/python/ops/math_grad.py:1424: where (from tensorf
Instructions for updating:
Use tf.where in 2.0, which has the same broadcast rule as np.where
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:1033: The name tf.assign_add

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:1020: The name tf.assign is

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:3005: The name tf.Session is

Train on 50000 samples, validate on 10000 samples
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:190: The name tf.get_default_

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:197: The name tf.ConfigProto

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:207: The name tf.global_varia

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:216: The name tf.is_variable_

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:223: The name tf.variables_i

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/callbacks.py:1122: The name tf.summary.merge_all is depreca

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/callbacks.py:1125: The name tf.summary.FileWriter is deprec

Epoch 1/30
50000/50000 [==============================] - 48s 970us/step - loss: 4.2845 - acc: 0.0427 - val_loss: 4.0759 - val_acc: 0.0784
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/callbacks.py:1265: The name tf.Summary is deprecated. Pleas

Epoch 2/30
50000/50000 [==============================] - 44s 884us/step - loss: 3.9028 - acc: 0.0867 - val_loss: 3.8633 - val_acc: 0.1285
Epoch 3/30
50000/50000 [==============================] - 44s 885us/step - loss: 3.6568 - acc: 0.1284 - val_loss: 3.5697 - val_acc: 0.1881
Epoch 4/30
50000/50000 [==============================] - 44s 885us/step - loss: 3.4163 - acc: 0.1702 - val_loss: 3.3823 - val_acc: 0.2198
Epoch 5/30
50000/50000 [==============================] - 44s 884us/step - loss: 3.2440 - acc: 0.2015 - val_loss: 3.2286 - val_acc: 0.2521
Epoch 6/30
50000/50000 [==============================] - 44s 886us/step - loss: 3.0780 - acc: 0.2322 - val_loss: 3.1157 - val_acc: 0.2586
Epoch 7/30
50000/50000 [==============================] - 44s 885us/step - loss: 2.9344 - acc: 0.2609 - val_loss: 2.9746 - val_acc: 0.3038
Epoch 8/30
50000/50000 [==============================] - 44s 885us/step - loss: 2.8020 - acc: 0.2837 - val_loss: 2.8909 - val_acc: 0.3113
```

```
Epoch 9/30
50000/50000 [==============================] - 44s 885us/step - loss: 2.6810 - acc: 0.3074 - val_loss: 2.7893 - val_acc: 0.3267
Epoch 10/30
50000/50000 [==============================] - 44s 885us/step - loss: 2.5610 - acc: 0.3316 - val_loss: 2.7328 - val_acc: 0.3520
Epoch 11/30
50000/50000 [==============================] - 44s 887us/step - loss: 2.4505 - acc: 0.3529 - val_loss: 2.6893 - val_acc: 0.3484
Epoch 12/30
50000/50000 [==============================] - 44s 885us/step - loss: 2.3526 - acc: 0.3751 - val_loss: 2.5797 - val_acc: 0.3662
Epoch 13/30
50000/50000 [==============================] - 44s 886us/step - loss: 2.2614 - acc: 0.3951 - val_loss: 2.5565 - val_acc: 0.3680
Epoch 14/30
50000/50000 [==============================] - 44s 886us/step - loss: 2.1906 - acc: 0.4072 - val_loss: 2.4639 - val_acc: 0.3821
Epoch 15/30
50000/50000 [==============================] - 44s 885us/step - loss: 2.0974 - acc: 0.4281 - val_loss: 2.4699 - val_acc: 0.3779
Epoch 16/30
50000/50000 [==============================] - 44s 885us/step - loss: 2.0108 - acc: 0.4479 - val_loss: 2.4024 - val_acc: 0.3968
Epoch 17/30
50000/50000 [==============================] - 44s 884us/step - loss: 1.9450 - acc: 0.4640 - val_loss: 2.4219 - val_acc: 0.3945
Epoch 18/30
50000/50000 [==============================] - 44s 884us/step - loss: 1.8696 - acc: 0.4793 - val_loss: 2.3699 - val_acc: 0.4007
Epoch 19/30
50000/50000 [==============================] - 44s 883us/step - loss: 1.8038 - acc: 0.4965 - val_loss: 2.3703 - val_acc: 0.3961
Epoch 20/30
50000/50000 [==============================] - 44s 885us/step - loss: 1.7435 - acc: 0.5093 - val_loss: 2.3183 - val_acc: 0.4082
Epoch 21/30
50000/50000 [==============================] - 44s 884us/step - loss: 1.6807 - acc: 0.5262 - val_loss: 2.3561 - val_acc: 0.4003
Epoch 22/30
50000/50000 [==============================] - 44s 884us/step - loss: 1.6108 - acc: 0.5408 - val_loss: 2.3269 - val_acc: 0.4032
Epoch 23/30
50000/50000 [==============================] - 44s 886us/step - loss: 1.5719 - acc: 0.5504 - val_loss: 2.2665 - val_acc: 0.4175
Epoch 24/30
50000/50000 [==============================] - 44s 885us/step - loss: 1.5142 - acc: 0.5652 - val_loss: 2.3497 - val_acc: 0.4025
Epoch 25/30
50000/50000 [==============================] - 44s 885us/step - loss: 1.4683 - acc: 0.5767 - val_loss: 2.3230 - val_acc: 0.4126
Epoch 26/30
50000/50000 [==============================] - 44s 884us/step - loss: 1.4194 - acc: 0.5868 - val_loss: 2.3055 - val_acc: 0.4130
Epoch 27/30
50000/50000 [==============================] - 44s 887us/step - loss: 1.3606 - acc: 0.6036 - val_loss: 2.3294 - val_acc: 0.4048
Epoch 28/30
50000/50000 [==============================] - 44s 885us/step - loss: 1.3272 - acc: 0.6109 - val_loss: 2.3380 - val_acc: 0.4074
Epoch 29/30
50000/50000 [==============================] - 44s 886us/step - loss: 1.2860 - acc: 0.6199 - val_loss: 2.3099 - val_acc: 0.4142
```

```
    Epoch 30/30
    50000/50000 [==============================] - 44s 886us/step - loss: 1.2413 - acc: 0.6309 - val_loss: 2.3309 - val_acc: 0.4081
```

```
%load_ext tensorboard
%tensorboard --logdir logs/Alexnet_cifar100
```



TensorBoard SCALARS GRAPHS

□ Show data download links

□ Ignore outliers in chart scaling

Tooltip sorting method: default

Smoothing

0.6

Horizontal Axis

STEP RELATIVE WALL

Runs

Write a regex to filter runs

□ ○ .

TOGGLE ALL RUNS

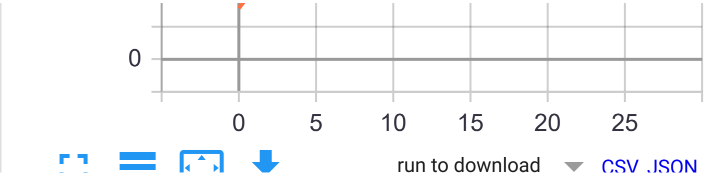
logs/Alexnet_cifar100

Filter tags (regular expressions supported)

acc

loss

val_acc



```
hist_df = pd.DataFrame(model_details.history)
hist_csv_file = 'history.csv'
with open(hist_csv_file, mode='w') as f:
    hist_df.to_csv(f)
```

```
!jupyter nbconvert --to HTML from_scratch_Alexnet_Cifar100.ipynb
```

```
[NbConvertApp] Converting notebook from_scratch_Alexnet_Cifar100.ipynb to HTML
[NbConvertApp] Writing 332832 bytes to from_scratch_Alexnet_Cifar100.html
```

New Section