

# Introduction

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```
In [2]: from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense, Dropout, Activation, Flatten
from tensorflow.keras.layers import Conv2D, MaxPooling2D
from tensorflow.keras.callbacks import TensorBoard
import pickle
import time
import numpy as np
```

# Load datasets

Here we have loaded datasets and after normalizing we have stored them as pickle file for our future work. The main datasets were collected from this link: [\(https://www.kaggle.com/alessiocorrado99/animals10\)](https://www.kaggle.com/alessiocorrado99/animals10)

```
In [ ]: for category in CATEGORIES: # do dogs ,cats, panadas ect
    path = os.path.join(DATADIR,category) # create path to all animal picture
    file
        for img in os.listdir(path): # iterate over each image per animal
            img_array = cv2.imread(os.path.join(path,img),cv2.IMREAD_GRAYSCALE)
            # convert to array
            plt.imshow(img_array, cmap='gray') # graph it
            plt.show() # display!

            break # we just want one for now so break
        break #...and one more!
```

```
In [ ]: print(img_array.shape)
IMG_SIZE = 80

new_array = cv2.resize(img_array, (IMG_SIZE, IMG_SIZE))
plt.imshow(new_array, cmap='gray')
plt.show()

training_data = []

def create_training_data():
    for category in CATEGORIES: # do dogs and cats and pandas

        path = os.path.join(DATADIR,category) # create path to dogs and cats
        and pandas
        class_num = CATEGORIES.index(category) # get the classification (0 or
        r a 1). 0=dog 1=cat

        for img in tqdm(os.listdir(path)): # iterate over each image per dogs
        and cats
            try:
                img_array = cv2.imread(os.path.join(path,img), cv2.IMREAD_GRAY
SCALE) # convert to array
                new_array = cv2.resize(img_array, (IMG_SIZE, IMG_SIZE)) # resize to normalize data size
                training_data.append([new_array, class_num]) # add this to our training_data
            except Exception as e: # in the interest in keeping the output clean...
                pass
            #except OSError as e:
            #    print("OSErrorBad img most likely", e, os.path.join(path,img))
            #except Exception as e:
            #    print("general exception", e, os.path.join(path,img))

    create_training_data()

    print(len(training_data))

#shuffle the training data
import random

random.shuffle(training_data)
for sample in training_data[:10]:
    print(sample[1])

X = []
y = []

for features,label in training_data:
    X.append(features)
    y.append(label)
```

```
print(X[0].reshape(-1, IMG_SIZE, IMG_SIZE, 1))

X = np.array(X).reshape(-1, IMG_SIZE, IMG_SIZE, 1)

#storing them in pickle

import pickle

pickle_out = open("X.pickle","wb")
pickle.dump(X, pickle_out)
pickle_out.close()

pickle_out = open("y.pickle","wb")
pickle.dump(y, pickle_out)
pickle_out.close()

pickle_in = open("X.pickle","rb")
X = pickle.load(pickle_in)

pickle_in = open("y.pickle","rb")
y = pickle.load(pickle_in)
```

## Making Models

Here we will try different dense layer value , layer size value , convocation layers value and generate different model.Every model will generate graph showing epoch accuracy and loss.Those will be shown in Tensorboard.From the graph we will try to find out which model will give best optimize result.From that model we will take out the dense layer value ,layer size value and convocation layers value.

```
In [3]: pickle_in = open("X.pickle", "rb")
X = pickle.load(pickle_in)

pickle_in = open("y.pickle", "rb")
y = pickle.load(pickle_in)

X=np.array(X/255.0)
y=np.array(y)

dense_layers = [0, 1, 2]
layer_sizes = [32, 64, 128]
conv_layers = [1, 2, 3]

for dense_layer in dense_layers:
    for layer_size in layer_sizes:
        for conv_layer in conv_layers:
            NAME = "{}-conv-{}-nodes-{}-dense-{}".format(conv_layer, layer_size, dense_layer, int(time.time()))
            print(NAME)

    model = Sequential()

    model.add(Conv2D(layer_size, (3, 3), input_shape=X.shape[1:]))
    model.add(Activation('relu'))
    model.add(MaxPooling2D(pool_size=(2, 2)))

    for l in range(conv_layer-1):
        model.add(Conv2D(layer_size, (3, 3)))
        model.add(Activation('relu'))
        model.add(MaxPooling2D(pool_size=(2, 2)))

    model.add(Flatten())

    for _ in range(dense_layer):
        model.add(Dense(layer_size))
        model.add(Activation('relu'))

    model.add(Dense(10))
    model.add(Activation('softmax'))

    tensorboard = TensorBoard(log_dir = 'C:\\\\Users\\\\mdabd\\\\logs\\\\{}'.format(NAME))

    model.compile(loss='sparse_categorical_crossentropy',
                  optimizer='adam',
                  metrics=['accuracy'],
                  )

    model.fit(X, y,
              batch_size=32,
              epochs=20,
              validation_split=0.3,
              callbacks=[tensorboard])
```

```
1-conv-32-nodes-0-dense-1600228869
Train on 18325 samples, validate on 7854 samples
Epoch 1/20
18325/18325 [=====] - 42s 2ms/sample - loss: 1.8672
- accuracy: 0.3683 - val_loss: 1.7120 - val_accuracy: 0.4291
Epoch 2/20
18325/18325 [=====] - 41s 2ms/sample - loss: 1.4292
- accuracy: 0.5306 - val_loss: 1.5588 - val_accuracy: 0.4892
Epoch 3/20
18325/18325 [=====] - 42s 2ms/sample - loss: 1.1458
- accuracy: 0.6325 - val_loss: 1.6173 - val_accuracy: 0.4631
Epoch 4/20
18325/18325 [=====] - 46s 3ms/sample - loss: 0.9076
- accuracy: 0.7186 - val_loss: 1.5808 - val_accuracy: 0.4874
Epoch 5/20
18325/18325 [=====] - 46s 3ms/sample - loss: 0.7259
- accuracy: 0.7838 - val_loss: 1.6873 - val_accuracy: 0.4752
Epoch 6/20
18325/18325 [=====] - 43s 2ms/sample - loss: 0.5677
- accuracy: 0.8438 - val_loss: 1.6989 - val_accuracy: 0.4927
Epoch 7/20
18325/18325 [=====] - 44s 2ms/sample - loss: 0.4336
- accuracy: 0.8888 - val_loss: 1.7594 - val_accuracy: 0.5055
Epoch 8/20
18325/18325 [=====] - 44s 2ms/sample - loss: 0.3378
- accuracy: 0.9227 - val_loss: 1.8612 - val_accuracy: 0.4869
Epoch 9/20
18325/18325 [=====] - 45s 2ms/sample - loss: 0.2601
- accuracy: 0.9473 - val_loss: 1.9746 - val_accuracy: 0.4949
Epoch 10/20
18325/18325 [=====] - 44s 2ms/sample - loss: 0.1946
- accuracy: 0.9670 - val_loss: 2.0727 - val_accuracy: 0.4924
Epoch 11/20
18325/18325 [=====] - 44s 2ms/sample - loss: 0.1428
- accuracy: 0.9831 - val_loss: 2.1371 - val_accuracy: 0.5003
Epoch 12/20
18325/18325 [=====] - 43s 2ms/sample - loss: 0.1116
- accuracy: 0.9894 - val_loss: 2.2904 - val_accuracy: 0.4981
Epoch 13/20
18325/18325 [=====] - 46s 3ms/sample - loss: 0.0892
- accuracy: 0.9905 - val_loss: 2.3234 - val_accuracy: 0.4856
Epoch 14/20
18325/18325 [=====] - 43s 2ms/sample - loss: 0.0644
- accuracy: 0.9961 - val_loss: 2.4074 - val_accuracy: 0.4961
Epoch 15/20
18325/18325 [=====] - 43s 2ms/sample - loss: 0.0458
- accuracy: 0.9981 - val_loss: 2.5508 - val_accuracy: 0.4934
Epoch 16/20
18325/18325 [=====] - 44s 2ms/sample - loss: 0.0347
- accuracy: 0.9987 - val_loss: 2.6427 - val_accuracy: 0.4915
Epoch 17/20
18325/18325 [=====] - 44s 2ms/sample - loss: 0.0331
- accuracy: 0.9985 - val_loss: 2.7330 - val_accuracy: 0.4905
Epoch 18/20
18325/18325 [=====] - 45s 2ms/sample - loss: 0.0551
- accuracy: 0.9919 - val_loss: 2.9302 - val_accuracy: 0.4899
Epoch 19/20
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18325/18325 [=====] - 44s 2ms/sample - loss: 0.0343
- accuracy: 0.9968 - val_loss: 3.0121 - val_accuracy: 0.4855
Epoch 20/20
18325/18325 [=====] - 44s 2ms/sample - loss: 0.0167
- accuracy: 0.9998 - val_loss: 3.0293 - val_accuracy: 0.4913
2-conv-32-nodes-0-dense-1600229747
Train on 18325 samples, validate on 7854 samples
Epoch 1/20
18325/18325 [=====] - 81s 4ms/sample - loss: 1.8199
- accuracy: 0.3762 - val_loss: 1.6503 - val_accuracy: 0.4407
Epoch 2/20
18325/18325 [=====] - 76s 4ms/sample - loss: 1.4367
- accuracy: 0.5211 - val_loss: 1.4352 - val_accuracy: 0.5306
Epoch 3/20
18325/18325 [=====] - 76s 4ms/sample - loss: 1.2233
- accuracy: 0.5961 - val_loss: 1.3841 - val_accuracy: 0.5477
Epoch 4/20
18325/18325 [=====] - 80s 4ms/sample - loss: 1.0654
- accuracy: 0.6502 - val_loss: 1.3264 - val_accuracy: 0.5672
Epoch 5/20
18325/18325 [=====] - 74s 4ms/sample - loss: 0.9375
- accuracy: 0.6914 - val_loss: 1.3521 - val_accuracy: 0.5709
Epoch 6/20
18325/18325 [=====] - 74s 4ms/sample - loss: 0.8231
- accuracy: 0.7288 - val_loss: 1.3716 - val_accuracy: 0.5774
Epoch 7/20
18325/18325 [=====] - 74s 4ms/sample - loss: 0.7212
- accuracy: 0.7641 - val_loss: 1.4323 - val_accuracy: 0.5691
Epoch 8/20
18325/18325 [=====] - 77s 4ms/sample - loss: 0.6158
- accuracy: 0.8010 - val_loss: 1.4934 - val_accuracy: 0.5644
Epoch 9/20
18325/18325 [=====] - 76s 4ms/sample - loss: 0.5212
- accuracy: 0.8342 - val_loss: 1.6594 - val_accuracy: 0.5392
Epoch 10/20
18325/18325 [=====] - 73s 4ms/sample - loss: 0.4339
- accuracy: 0.8636 - val_loss: 1.8720 - val_accuracy: 0.5331
Epoch 11/20
18325/18325 [=====] - 73s 4ms/sample - loss: 0.3623
- accuracy: 0.8865 - val_loss: 1.8285 - val_accuracy: 0.5550
Epoch 12/20
18325/18325 [=====] - 74s 4ms/sample - loss: 0.2994
- accuracy: 0.9117 - val_loss: 2.0582 - val_accuracy: 0.5568
Epoch 13/20
18325/18325 [=====] - 80s 4ms/sample - loss: 0.2407
- accuracy: 0.9316 - val_loss: 2.1022 - val_accuracy: 0.5584
Epoch 14/20
18325/18325 [=====] - 80s 4ms/sample - loss: 0.2012
- accuracy: 0.9411 - val_loss: 2.3145 - val_accuracy: 0.5451
Epoch 15/20
18325/18325 [=====] - 81s 4ms/sample - loss: 0.1535
- accuracy: 0.9582 - val_loss: 2.4355 - val_accuracy: 0.5419
Epoch 16/20
18325/18325 [=====] - 72s 4ms/sample - loss: 0.1256
- accuracy: 0.9687 - val_loss: 2.5928 - val_accuracy: 0.5443
Epoch 17/20
18325/18325 [=====] - 75s 4ms/sample - loss: 0.1075
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- accuracy: 0.9718 - val_loss: 2.7432 - val_accuracy: 0.5486
Epoch 18/20
18325/18325 [=====] - 74s 4ms/sample - loss: 0.0986
- accuracy: 0.9756 - val_loss: 2.9095 - val_accuracy: 0.5363
Epoch 19/20
18325/18325 [=====] - 73s 4ms/sample - loss: 0.0785
- accuracy: 0.9802 - val_loss: 3.0637 - val_accuracy: 0.5368
Epoch 20/20
18325/18325 [=====] - 74s 4ms/sample - loss: 0.0706
- accuracy: 0.9824 - val_loss: 3.2841 - val_accuracy: 0.5278
3-conv-32-nodes-0-dense-1600231265
Train on 18325 samples, validate on 7854 samples
Epoch 1/20
18325/18325 [=====] - 80s 4ms/sample - loss: 1.9049
- accuracy: 0.3408 - val_loss: 1.6118 - val_accuracy: 0.4663
Epoch 2/20
18325/18325 [=====] - 81s 4ms/sample - loss: 1.4948
- accuracy: 0.4983 - val_loss: 1.4335 - val_accuracy: 0.5266
Epoch 3/20
18325/18325 [=====] - 84s 5ms/sample - loss: 1.3243
- accuracy: 0.5550 - val_loss: 1.3374 - val_accuracy: 0.5516
Epoch 4/20
18325/18325 [=====] - 84s 5ms/sample - loss: 1.2042
- accuracy: 0.5997 - val_loss: 1.3274 - val_accuracy: 0.5597
Epoch 5/20
18325/18325 [=====] - 83s 5ms/sample - loss: 1.1226
- accuracy: 0.6275 - val_loss: 1.2689 - val_accuracy: 0.5807
Epoch 6/20
18325/18325 [=====] - 81s 4ms/sample - loss: 1.0587
- accuracy: 0.6493 - val_loss: 1.2825 - val_accuracy: 0.5814
Epoch 7/20
18325/18325 [=====] - 79s 4ms/sample - loss: 1.0001
- accuracy: 0.6709 - val_loss: 1.3308 - val_accuracy: 0.5695
Epoch 8/20
18325/18325 [=====] - 80s 4ms/sample - loss: 0.9510
- accuracy: 0.6816 - val_loss: 1.2573 - val_accuracy: 0.5941
Epoch 9/20
18325/18325 [=====] - 81s 4ms/sample - loss: 0.9102
- accuracy: 0.6978 - val_loss: 1.2490 - val_accuracy: 0.5965
Epoch 10/20
18325/18325 [=====] - 80s 4ms/sample - loss: 0.8658
- accuracy: 0.7107 - val_loss: 1.2816 - val_accuracy: 0.5903
Epoch 11/20
18325/18325 [=====] - 81s 4ms/sample - loss: 0.8226
- accuracy: 0.7240 - val_loss: 1.3025 - val_accuracy: 0.5861
Epoch 12/20
18325/18325 [=====] - 81s 4ms/sample - loss: 0.7875
- accuracy: 0.7351 - val_loss: 1.3273 - val_accuracy: 0.5807
Epoch 13/20
18325/18325 [=====] - 82s 4ms/sample - loss: 0.7514
- accuracy: 0.7482 - val_loss: 1.3271 - val_accuracy: 0.5899
Epoch 14/20
18325/18325 [=====] - 78s 4ms/sample - loss: 0.7170
- accuracy: 0.7596 - val_loss: 1.3806 - val_accuracy: 0.5872
Epoch 15/20
18325/18325 [=====] - 81s 4ms/sample - loss: 0.6823
- accuracy: 0.7728 - val_loss: 1.3929 - val_accuracy: 0.5893
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Epoch 16/20
18325/18325 [=====] - 79s 4ms/sample - loss: 0.6520
- accuracy: 0.7785 - val_loss: 1.4878 - val_accuracy: 0.5666
Epoch 17/20
18325/18325 [=====] - 80s 4ms/sample - loss: 0.6138
- accuracy: 0.7905 - val_loss: 1.4961 - val_accuracy: 0.5839
Epoch 18/20
18325/18325 [=====] - 81s 4ms/sample - loss: 0.5970
- accuracy: 0.7955 - val_loss: 1.6527 - val_accuracy: 0.5509
Epoch 19/20
18325/18325 [=====] - 84s 5ms/sample - loss: 0.5634
- accuracy: 0.8093 - val_loss: 1.5241 - val_accuracy: 0.5840
Epoch 20/20
18325/18325 [=====] - 78s 4ms/sample - loss: 0.5349
- accuracy: 0.8148 - val_loss: 1.7033 - val_accuracy: 0.5544
1-conv-64-nodes-0-dense-1600232884
Train on 18325 samples, validate on 7854 samples
Epoch 1/20
18325/18325 [=====] - 77s 4ms/sample - loss: 1.8195
- accuracy: 0.3918 - val_loss: 1.6390 - val_accuracy: 0.4548
Epoch 2/20
18325/18325 [=====] - 77s 4ms/sample - loss: 1.3167
- accuracy: 0.5655 - val_loss: 1.5639 - val_accuracy: 0.4786
Epoch 3/20
18325/18325 [=====] - 79s 4ms/sample - loss: 0.9656
- accuracy: 0.6960 - val_loss: 1.5685 - val_accuracy: 0.5074
Epoch 4/20
18325/18325 [=====] - 76s 4ms/sample - loss: 0.6961
- accuracy: 0.7894 - val_loss: 1.6146 - val_accuracy: 0.5112
Epoch 5/20
18325/18325 [=====] - 80s 4ms/sample - loss: 0.4822
- accuracy: 0.8655 - val_loss: 1.7220 - val_accuracy: 0.5070
Epoch 6/20
18325/18325 [=====] - 75s 4ms/sample - loss: 0.3304
- accuracy: 0.9188 - val_loss: 1.8321 - val_accuracy: 0.5065
Epoch 7/20
18325/18325 [=====] - 76s 4ms/sample - loss: 0.2203
- accuracy: 0.9543 - val_loss: 1.9822 - val_accuracy: 0.5098
Epoch 8/20
18325/18325 [=====] - 76s 4ms/sample - loss: 0.1442
- accuracy: 0.9778 - val_loss: 2.1688 - val_accuracy: 0.5008
Epoch 9/20
18325/18325 [=====] - 76s 4ms/sample - loss: 0.0976
- accuracy: 0.9877 - val_loss: 2.3031 - val_accuracy: 0.4981
Epoch 10/20
18325/18325 [=====] - 75s 4ms/sample - loss: 0.0650
- accuracy: 0.9943 - val_loss: 2.3942 - val_accuracy: 0.5081
Epoch 11/20
18325/18325 [=====] - 78s 4ms/sample - loss: 0.0485
- accuracy: 0.9963 - val_loss: 2.4975 - val_accuracy: 0.4959
Epoch 12/20
18325/18325 [=====] - 76s 4ms/sample - loss: 0.0762
- accuracy: 0.9877 - val_loss: 2.7153 - val_accuracy: 0.4917
Epoch 13/20
18325/18325 [=====] - 77s 4ms/sample - loss: 0.0573
- accuracy: 0.9915 - val_loss: 2.8591 - val_accuracy: 0.4980
Epoch 14/20
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18325/18325 [=====] - 76s 4ms/sample - loss: 0.0467
- accuracy: 0.9930 - val_loss: 2.9649 - val_accuracy: 0.4864
Epoch 15/20
18325/18325 [=====] - 76s 4ms/sample - loss: 0.0194
- accuracy: 0.9990 - val_loss: 3.0393 - val_accuracy: 0.5056
Epoch 16/20
18325/18325 [=====] - 76s 4ms/sample - loss: 0.0174
- accuracy: 0.9986 - val_loss: 3.0748 - val_accuracy: 0.5061
Epoch 17/20
18325/18325 [=====] - 80s 4ms/sample - loss: 0.0149
- accuracy: 0.9986 - val_loss: 3.4064 - val_accuracy: 0.4859
Epoch 18/20
18325/18325 [=====] - 78s 4ms/sample - loss: 0.0608
- accuracy: 0.9852 - val_loss: 3.3529 - val_accuracy: 0.4757
Epoch 19/20
18325/18325 [=====] - 83s 5ms/sample - loss: 0.0579
- accuracy: 0.9872 - val_loss: 3.3880 - val_accuracy: 0.4898
Epoch 20/20
18325/18325 [=====] - 78s 4ms/sample - loss: 0.0148
- accuracy: 0.9987 - val_loss: 3.5335 - val_accuracy: 0.4857
2-conv-64-nodes-0-dense-1600234431
Train on 18325 samples, validate on 7854 samples
Epoch 1/20
18325/18325 [=====] - 149s 8ms/sample - loss: 1.8361
- accuracy: 0.3679 - val_loss: 1.5949 - val_accuracy: 0.4619
Epoch 2/20
18325/18325 [=====] - 148s 8ms/sample - loss: 1.4013
- accuracy: 0.5353 - val_loss: 1.4529 - val_accuracy: 0.5176
Epoch 3/20
18325/18325 [=====] - 151s 8ms/sample - loss: 1.1583
- accuracy: 0.6168 - val_loss: 1.3750 - val_accuracy: 0.5525
Epoch 4/20
18325/18325 [=====] - 154s 8ms/sample - loss: 0.9717
- accuracy: 0.6787 - val_loss: 1.3303 - val_accuracy: 0.5731
Epoch 5/20
18325/18325 [=====] - 150s 8ms/sample - loss: 0.8308
- accuracy: 0.7289 - val_loss: 1.4007 - val_accuracy: 0.5710
Epoch 6/20
18325/18325 [=====] - 150s 8ms/sample - loss: 0.6892
- accuracy: 0.7736 - val_loss: 1.4461 - val_accuracy: 0.5758
Epoch 7/20
18325/18325 [=====] - 154s 8ms/sample - loss: 0.5627
- accuracy: 0.8176 - val_loss: 1.5994 - val_accuracy: 0.5612
Epoch 8/20
18325/18325 [=====] - 151s 8ms/sample - loss: 0.4629
- accuracy: 0.8504 - val_loss: 1.6815 - val_accuracy: 0.5665
Epoch 9/20
18325/18325 [=====] - 148s 8ms/sample - loss: 0.3549
- accuracy: 0.8882 - val_loss: 1.9236 - val_accuracy: 0.5535
Epoch 10/20
18325/18325 [=====] - 147s 8ms/sample - loss: 0.2900
- accuracy: 0.9102 - val_loss: 2.0802 - val_accuracy: 0.5556
Epoch 11/20
18325/18325 [=====] - 147s 8ms/sample - loss: 0.2144
- accuracy: 0.9384 - val_loss: 2.3449 - val_accuracy: 0.5455
Epoch 12/20
18325/18325 [=====] - 145s 8ms/sample - loss: 0.1671
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- accuracy: 0.9526 - val_loss: 2.4847 - val_accuracy: 0.5503
Epoch 13/20
18325/18325 [=====] - 150s 8ms/sample - loss: 0.1247
- accuracy: 0.9659 - val_loss: 2.7148 - val_accuracy: 0.5466
Epoch 14/20
18325/18325 [=====] - 144s 8ms/sample - loss: 0.1043
- accuracy: 0.9721 - val_loss: 2.9935 - val_accuracy: 0.5413
Epoch 15/20
18325/18325 [=====] - 145s 8ms/sample - loss: 0.1043
- accuracy: 0.9709 - val_loss: 3.1285 - val_accuracy: 0.5405
Epoch 16/20
18325/18325 [=====] - 145s 8ms/sample - loss: 0.0793
- accuracy: 0.9793 - val_loss: 3.2485 - val_accuracy: 0.5388
Epoch 17/20
18325/18325 [=====] - 145s 8ms/sample - loss: 0.0643
- accuracy: 0.9834 - val_loss: 3.5272 - val_accuracy: 0.5432
Epoch 18/20
18325/18325 [=====] - 143s 8ms/sample - loss: 0.0807
- accuracy: 0.9750 - val_loss: 3.6374 - val_accuracy: 0.5302
Epoch 19/20
18325/18325 [=====] - 142s 8ms/sample - loss: 0.0708
- accuracy: 0.9783 - val_loss: 3.8258 - val_accuracy: 0.5340
Epoch 20/20
18325/18325 [=====] - 149s 8ms/sample - loss: 0.0454
- accuracy: 0.9875 - val_loss: 4.0090 - val_accuracy: 0.5365
3-conv-64-nodes-0-dense-1600237389
Train on 18325 samples, validate on 7854 samples
Epoch 1/20
18325/18325 [=====] - 170s 9ms/sample - loss: 1.8719
- accuracy: 0.3533 - val_loss: 1.6497 - val_accuracy: 0.4381
Epoch 2/20
18325/18325 [=====] - 172s 9ms/sample - loss: 1.4194
- accuracy: 0.5205 - val_loss: 1.3712 - val_accuracy: 0.5410
Epoch 3/20
18325/18325 [=====] - 171s 9ms/sample - loss: 1.2045
- accuracy: 0.5963 - val_loss: 1.2326 - val_accuracy: 0.5940
Epoch 4/20
18325/18325 [=====] - 161s 9ms/sample - loss: 1.0586
- accuracy: 0.6481 - val_loss: 1.2277 - val_accuracy: 0.5898
Epoch 5/20
18325/18325 [=====] - 161s 9ms/sample - loss: 0.9391
- accuracy: 0.6885 - val_loss: 1.2099 - val_accuracy: 0.6039
Epoch 6/20
18325/18325 [=====] - 204s 11ms/sample - loss: 0.837
- accuracy: 0.7210 - val_loss: 1.1950 - val_accuracy: 0.6056
Epoch 7/20
18325/18325 [=====] - 171s 9ms/sample - loss: 0.7451
- accuracy: 0.7527 - val_loss: 1.2041 - val_accuracy: 0.6189
Epoch 8/20
18325/18325 [=====] - 177s 10ms/sample - loss: 0.662
- accuracy: 0.7787 - val_loss: 1.3171 - val_accuracy: 0.5977
Epoch 9/20
18325/18325 [=====] - 174s 9ms/sample - loss: 0.5811
- accuracy: 0.8075 - val_loss: 1.3669 - val_accuracy: 0.6072
Epoch 10/20
18325/18325 [=====] - 178s 10ms/sample - loss: 0.509
- accuracy: 0.8297 - val_loss: 1.4295 - val_accuracy: 0.5984
```

Epoch 11/20  
18325/18325 [=====] - 202s 11ms/sample - loss: 0.443  
4 - accuracy: 0.8520 - val\_loss: 1.6564 - val\_accuracy: 0.5933  
Epoch 12/20  
18325/18325 [=====] - 189s 10ms/sample - loss: 0.376  
1 - accuracy: 0.8754 - val\_loss: 1.6213 - val\_accuracy: 0.6081  
Epoch 13/20  
18325/18325 [=====] - 194s 11ms/sample - loss: 0.324  
4 - accuracy: 0.8904 - val\_loss: 1.8698 - val\_accuracy: 0.5919  
Epoch 14/20  
18325/18325 [=====] - 200s 11ms/sample - loss: 0.280  
1 - accuracy: 0.9060 - val\_loss: 1.8449 - val\_accuracy: 0.5904  
Epoch 15/20  
18325/18325 [=====] - 189s 10ms/sample - loss: 0.238  
9 - accuracy: 0.9226 - val\_loss: 2.1191 - val\_accuracy: 0.5889  
Epoch 16/20  
18325/18325 [=====] - 176s 10ms/sample - loss: 0.197  
3 - accuracy: 0.9347 - val\_loss: 2.2539 - val\_accuracy: 0.5843  
Epoch 17/20  
18325/18325 [=====] - 184s 10ms/sample - loss: 0.170  
1 - accuracy: 0.9447 - val\_loss: 2.4550 - val\_accuracy: 0.5956  
Epoch 18/20  
18325/18325 [=====] - 170s 9ms/sample - loss: 0.1416  
- accuracy: 0.9525 - val\_loss: 2.5531 - val\_accuracy: 0.5955  
Epoch 19/20  
18325/18325 [=====] - 188s 10ms/sample - loss: 0.138  
4 - accuracy: 0.9542 - val\_loss: 2.7971 - val\_accuracy: 0.5848  
Epoch 20/20  
18325/18325 [=====] - 185s 10ms/sample - loss: 0.133  
7 - accuracy: 0.9537 - val\_loss: 2.8517 - val\_accuracy: 0.5766  
1-conv-128-nodes-0-dense-1600241006  
Train on 18325 samples, validate on 7854 samples  
Epoch 1/20  
18325/18325 [=====] - 169s 9ms/sample - loss: 1.8535  
- accuracy: 0.3896 - val\_loss: 1.5880 - val\_accuracy: 0.4725  
Epoch 2/20  
18325/18325 [=====] - 162s 9ms/sample - loss: 1.2860  
- accuracy: 0.5818 - val\_loss: 1.5817 - val\_accuracy: 0.4717  
Epoch 3/20  
18325/18325 [=====] - 164s 9ms/sample - loss: 0.9014  
- accuracy: 0.7137 - val\_loss: 1.6134 - val\_accuracy: 0.4941  
Epoch 4/20  
18325/18325 [=====] - 184s 10ms/sample - loss: 0.598  
4 - accuracy: 0.8237 - val\_loss: 1.6667 - val\_accuracy: 0.5038  
Epoch 5/20  
18325/18325 [=====] - 162s 9ms/sample - loss: 0.3784  
- accuracy: 0.8996 - val\_loss: 1.7900 - val\_accuracy: 0.5138  
Epoch 6/20  
18325/18325 [=====] - 172s 9ms/sample - loss: 0.2304  
- accuracy: 0.9492 - val\_loss: 1.9920 - val\_accuracy: 0.5045  
Epoch 7/20  
18325/18325 [=====] - 155s 8ms/sample - loss: 0.1428  
- accuracy: 0.9745 - val\_loss: 2.1782 - val\_accuracy: 0.5019  
Epoch 8/20  
18325/18325 [=====] - 148s 8ms/sample - loss: 0.0886  
- accuracy: 0.9883 - val\_loss: 2.3951 - val\_accuracy: 0.5053  
Epoch 9/20

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18325/18325 [=====] - 147s 8ms/sample - loss: 0.0563  
- accuracy: 0.9943 - val_loss: 2.5581 - val_accuracy: 0.5057  
Epoch 10/20  
18325/18325 [=====] - 145s 8ms/sample - loss: 0.0457  
- accuracy: 0.9950 - val_loss: 2.6766 - val_accuracy: 0.4902  
Epoch 11/20  
18325/18325 [=====] - 146s 8ms/sample - loss: 0.0535  
- accuracy: 0.9914 - val_loss: 2.7744 - val_accuracy: 0.4949  
Epoch 12/20  
18325/18325 [=====] - 145s 8ms/sample - loss: 0.0579  
- accuracy: 0.9888 - val_loss: 3.0350 - val_accuracy: 0.4878  
Epoch 13/20  
18325/18325 [=====] - 147s 8ms/sample - loss: 0.0370  
- accuracy: 0.9948 - val_loss: 3.0550 - val_accuracy: 0.5022  
Epoch 14/20  
18325/18325 [=====] - 148s 8ms/sample - loss: 0.0374  
- accuracy: 0.9933 - val_loss: 3.1908 - val_accuracy: 0.4879  
Epoch 15/20  
18325/18325 [=====] - 169s 9ms/sample - loss: 0.0255  
- accuracy: 0.9966 - val_loss: 3.3270 - val_accuracy: 0.5013  
Epoch 16/20  
18325/18325 [=====] - 161s 9ms/sample - loss: 0.0130  
- accuracy: 0.9988 - val_loss: 3.5674 - val_accuracy: 0.5019  
Epoch 17/20  
18325/18325 [=====] - 168s 9ms/sample - loss: 0.0106  
- accuracy: 0.9987 - val_loss: 3.9844 - val_accuracy: 0.4669  
Epoch 18/20  
18325/18325 [=====] - 175s 10ms/sample - loss: 0.064  
7 - accuracy: 0.9858 - val_loss: 3.7662 - val_accuracy: 0.4848  
Epoch 19/20  
18325/18325 [=====] - 175s 10ms/sample - loss: 0.041  
2 - accuracy: 0.9906 - val_loss: 3.7935 - val_accuracy: 0.4870  
Epoch 20/20  
18325/18325 [=====] - 169s 9ms/sample - loss: 0.0217  
- accuracy: 0.9963 - val_loss: 3.8701 - val_accuracy: 0.4985  
2-conv-128-nodes-0-dense-1600244219  
Train on 18325 samples, validate on 7854 samples  
Epoch 1/20  
18325/18325 [=====] - 391s 21ms/sample - loss: 1.811  
4 - accuracy: 0.3802 - val_loss: 1.5424 - val_accuracy: 0.4784  
Epoch 2/20  
18325/18325 [=====] - 375s 20ms/sample - loss: 1.388  
3 - accuracy: 0.5362 - val_loss: 1.4121 - val_accuracy: 0.5339  
Epoch 3/20  
18325/18325 [=====] - 402s 22ms/sample - loss: 1.119  
9 - accuracy: 0.6301 - val_loss: 1.3603 - val_accuracy: 0.5629  
Epoch 4/20  
18325/18325 [=====] - 409s 22ms/sample - loss: 0.912  
3 - accuracy: 0.6983 - val_loss: 1.3938 - val_accuracy: 0.5688  
Epoch 5/20  
18325/18325 [=====] - 358s 20ms/sample - loss: 0.737  
3 - accuracy: 0.7598 - val_loss: 1.4198 - val_accuracy: 0.5712  
Epoch 6/20  
18325/18325 [=====] - 356s 19ms/sample - loss: 0.602  
1 - accuracy: 0.8007 - val_loss: 1.5946 - val_accuracy: 0.5477  
Epoch 7/20  
18325/18325 [=====] - 351s 19ms/sample - loss: 0.448
```

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2 - accuracy: 0.8578 - val_loss: 1.9449 - val_accuracy: 0.5362
Epoch 8/20
18325/18325 [=====] - 342s 19ms/sample - loss: 0.346
1 - accuracy: 0.8880 - val_loss: 1.9773 - val_accuracy: 0.5411
Epoch 9/20
18325/18325 [=====] - 343s 19ms/sample - loss: 0.262
3 - accuracy: 0.9189 - val_loss: 2.1867 - val_accuracy: 0.5467
Epoch 10/20
18325/18325 [=====] - 346s 19ms/sample - loss: 0.195
2 - accuracy: 0.9418 - val_loss: 2.3192 - val_accuracy: 0.5514
Epoch 11/20
18325/18325 [=====] - 339s 18ms/sample - loss: 0.140
1 - accuracy: 0.9599 - val_loss: 2.6702 - val_accuracy: 0.5471
Epoch 12/20
18325/18325 [=====] - 342s 19ms/sample - loss: 0.111
8 - accuracy: 0.9670 - val_loss: 2.8797 - val_accuracy: 0.5340
Epoch 13/20
18325/18325 [=====] - 339s 19ms/sample - loss: 0.098
0 - accuracy: 0.9705 - val_loss: 3.1416 - val_accuracy: 0.5364
Epoch 14/20
18325/18325 [=====] - 339s 18ms/sample - loss: 0.082
7 - accuracy: 0.9762 - val_loss: 3.4487 - val_accuracy: 0.5387
Epoch 15/20
18325/18325 [=====] - 339s 19ms/sample - loss: 0.077
9 - accuracy: 0.9768 - val_loss: 3.4596 - val_accuracy: 0.5395
Epoch 16/20
18325/18325 [=====] - 340s 19ms/sample - loss: 0.078
8 - accuracy: 0.9762 - val_loss: 3.6565 - val_accuracy: 0.5318
Epoch 17/20
18325/18325 [=====] - 337s 18ms/sample - loss: 0.085
2 - accuracy: 0.9728 - val_loss: 3.8474 - val_accuracy: 0.5362
Epoch 18/20
18325/18325 [=====] - 339s 18ms/sample - loss: 0.058
5 - accuracy: 0.9820 - val_loss: 4.0429 - val_accuracy: 0.5288
Epoch 19/20
18325/18325 [=====] - 336s 18ms/sample - loss: 0.039
5 - accuracy: 0.9901 - val_loss: 4.0030 - val_accuracy: 0.5227
Epoch 20/20
18325/18325 [=====] - 337s 18ms/sample - loss: 0.045
6 - accuracy: 0.9883 - val_loss: 4.2175 - val_accuracy: 0.5272
3-conv-128-nodes-0-dense-1600251281
Train on 18325 samples, validate on 7854 samples
Epoch 1/20
18325/18325 [=====] - 375s 20ms/sample - loss: 1.867
1 - accuracy: 0.3526 - val_loss: 1.6065 - val_accuracy: 0.4656
Epoch 2/20
18325/18325 [=====] - 375s 20ms/sample - loss: 1.423
5 - accuracy: 0.5241 - val_loss: 1.3259 - val_accuracy: 0.5592
Epoch 3/20
18325/18325 [=====] - 376s 21ms/sample - loss: 1.205
0 - accuracy: 0.5992 - val_loss: 1.2697 - val_accuracy: 0.5768
Epoch 4/20
18325/18325 [=====] - 374s 20ms/sample - loss: 1.043
4 - accuracy: 0.6521 - val_loss: 1.1943 - val_accuracy: 0.6071
Epoch 5/20
18325/18325 [=====] - 397s 22ms/sample - loss: 0.897
2 - accuracy: 0.7010 - val_loss: 1.1818 - val_accuracy: 0.6213
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Epoch 6/20
18325/18325 [=====] - 392s 21ms/sample - loss: 0.772
0 - accuracy: 0.7390 - val_loss: 1.2405 - val_accuracy: 0.6155
Epoch 7/20
18325/18325 [=====] - 387s 21ms/sample - loss: 0.647
7 - accuracy: 0.7843 - val_loss: 1.2421 - val_accuracy: 0.6291
Epoch 8/20
18325/18325 [=====] - 383s 21ms/sample - loss: 0.522
5 - accuracy: 0.8265 - val_loss: 1.3541 - val_accuracy: 0.6234
Epoch 9/20
18325/18325 [=====] - 377s 21ms/sample - loss: 0.417
8 - accuracy: 0.8588 - val_loss: 1.4174 - val_accuracy: 0.6213
Epoch 10/20
18325/18325 [=====] - 371s 20ms/sample - loss: 0.332
0 - accuracy: 0.8868 - val_loss: 1.6423 - val_accuracy: 0.6081
Epoch 11/20
18325/18325 [=====] - 371s 20ms/sample - loss: 0.251
2 - accuracy: 0.9171 - val_loss: 1.8916 - val_accuracy: 0.6113
Epoch 12/20
18325/18325 [=====] - 371s 20ms/sample - loss: 0.203
9 - accuracy: 0.9320 - val_loss: 2.0440 - val_accuracy: 0.5889
Epoch 13/20
18325/18325 [=====] - 371s 20ms/sample - loss: 0.152
6 - accuracy: 0.9509 - val_loss: 2.2711 - val_accuracy: 0.6016
Epoch 14/20
18325/18325 [=====] - 371s 20ms/sample - loss: 0.131
6 - accuracy: 0.9549 - val_loss: 2.3268 - val_accuracy: 0.5987
Epoch 15/20
18325/18325 [=====] - 370s 20ms/sample - loss: 0.118
3 - accuracy: 0.9605 - val_loss: 2.5826 - val_accuracy: 0.6039
Epoch 16/20
18325/18325 [=====] - 372s 20ms/sample - loss: 0.110
1 - accuracy: 0.9619 - val_loss: 2.7728 - val_accuracy: 0.5912
Epoch 17/20
18325/18325 [=====] - 370s 20ms/sample - loss: 0.103
5 - accuracy: 0.9646 - val_loss: 2.8123 - val_accuracy: 0.6087
Epoch 18/20
18325/18325 [=====] - 370s 20ms/sample - loss: 0.069
1 - accuracy: 0.9774 - val_loss: 2.9853 - val_accuracy: 0.5913
Epoch 19/20
18325/18325 [=====] - 370s 20ms/sample - loss: 0.088
8 - accuracy: 0.9704 - val_loss: 3.0512 - val_accuracy: 0.5766
Epoch 20/20
18325/18325 [=====] - 370s 20ms/sample - loss: 0.090
5 - accuracy: 0.9677 - val_loss: 3.1227 - val_accuracy: 0.5921
1-conv-32-nodes-1-dense-1600258796
Train on 18325 samples, validate on 7854 samples
Epoch 1/20
18325/18325 [=====] - 44s 2ms/sample - loss: 2.0795
- accuracy: 0.2572 - val_loss: 1.8785 - val_accuracy: 0.3361
Epoch 2/20
18325/18325 [=====] - 43s 2ms/sample - loss: 1.7459
- accuracy: 0.3978 - val_loss: 1.6880 - val_accuracy: 0.4267
Epoch 3/20
18325/18325 [=====] - 43s 2ms/sample - loss: 1.4944
- accuracy: 0.4891 - val_loss: 1.7039 - val_accuracy: 0.4286
Epoch 4/20
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18325/18325 [=====] - 43s 2ms/sample - loss: 1.2915
- accuracy: 0.5596 - val_loss: 1.6878 - val_accuracy: 0.4380
Epoch 5/20
18325/18325 [=====] - 43s 2ms/sample - loss: 1.0731
- accuracy: 0.6448 - val_loss: 1.5893 - val_accuracy: 0.4882
Epoch 6/20
18325/18325 [=====] - 44s 2ms/sample - loss: 0.8675
- accuracy: 0.7142 - val_loss: 1.6732 - val_accuracy: 0.4829
Epoch 7/20
18325/18325 [=====] - 44s 2ms/sample - loss: 0.6857
- accuracy: 0.7819 - val_loss: 1.7493 - val_accuracy: 0.4994
Epoch 8/20
18325/18325 [=====] - 43s 2ms/sample - loss: 0.5218
- accuracy: 0.8439 - val_loss: 1.8899 - val_accuracy: 0.4915
Epoch 9/20
18325/18325 [=====] - 43s 2ms/sample - loss: 0.3931
- accuracy: 0.8872 - val_loss: 2.0081 - val_accuracy: 0.4873
Epoch 10/20
18325/18325 [=====] - 43s 2ms/sample - loss: 0.2781
- accuracy: 0.9289 - val_loss: 2.0804 - val_accuracy: 0.4874
Epoch 11/20
18325/18325 [=====] - 43s 2ms/sample - loss: 0.1947
- accuracy: 0.9549 - val_loss: 2.3016 - val_accuracy: 0.4868
Epoch 12/20
18325/18325 [=====] - 44s 2ms/sample - loss: 0.1413
- accuracy: 0.9704 - val_loss: 2.5067 - val_accuracy: 0.4842
Epoch 13/20
18325/18325 [=====] - 44s 2ms/sample - loss: 0.1021
- accuracy: 0.9811 - val_loss: 2.6837 - val_accuracy: 0.4850
Epoch 14/20
18325/18325 [=====] - 44s 2ms/sample - loss: 0.0690
- accuracy: 0.9898 - val_loss: 3.0010 - val_accuracy: 0.4882
Epoch 15/20
18325/18325 [=====] - 44s 2ms/sample - loss: 0.0507
- accuracy: 0.9932 - val_loss: 3.0657 - val_accuracy: 0.4717
Epoch 16/20
18325/18325 [=====] - 46s 2ms/sample - loss: 0.0811
- accuracy: 0.9812 - val_loss: 3.3270 - val_accuracy: 0.4599
Epoch 17/20
18325/18325 [=====] - 46s 2ms/sample - loss: 0.0570
- accuracy: 0.9887 - val_loss: 3.2985 - val_accuracy: 0.4688
Epoch 18/20
18325/18325 [=====] - 46s 3ms/sample - loss: 0.0243
- accuracy: 0.9971 - val_loss: 3.6119 - val_accuracy: 0.4768
Epoch 19/20
18325/18325 [=====] - 46s 2ms/sample - loss: 0.0109
- accuracy: 0.9995 - val_loss: 3.6992 - val_accuracy: 0.4785
Epoch 20/20
18325/18325 [=====] - 45s 2ms/sample - loss: 0.0071
- accuracy: 0.9997 - val_loss: 3.9285 - val_accuracy: 0.4651
2-conv-32-nodes-1-dense-1600259680
Train on 18325 samples, validate on 7854 samples
Epoch 1/20
18325/18325 [=====] - 75s 4ms/sample - loss: 2.0094
- accuracy: 0.2978 - val_loss: 1.7727 - val_accuracy: 0.3910
Epoch 2/20
18325/18325 [=====] - 74s 4ms/sample - loss: 1.6124
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- accuracy: 0.4542 - val_loss: 1.5372 - val_accuracy: 0.4820
Epoch 3/20
18325/18325 [=====] - 74s 4ms/sample - loss: 1.3956
- accuracy: 0.5274 - val_loss: 1.4366 - val_accuracy: 0.5190
Epoch 4/20
18325/18325 [=====] - 71s 4ms/sample - loss: 1.2562
- accuracy: 0.5746 - val_loss: 1.3946 - val_accuracy: 0.5313
Epoch 5/20
18325/18325 [=====] - 73s 4ms/sample - loss: 1.1398
- accuracy: 0.6168 - val_loss: 1.4568 - val_accuracy: 0.5135
Epoch 6/20
18325/18325 [=====] - 72s 4ms/sample - loss: 1.0519
- accuracy: 0.6412 - val_loss: 1.3955 - val_accuracy: 0.5387
Epoch 7/20
18325/18325 [=====] - 72s 4ms/sample - loss: 0.9457
- accuracy: 0.6823 - val_loss: 1.3992 - val_accuracy: 0.5425
Epoch 8/20
18325/18325 [=====] - 73s 4ms/sample - loss: 0.8536
- accuracy: 0.7120 - val_loss: 1.4119 - val_accuracy: 0.5541
Epoch 9/20
18325/18325 [=====] - 72s 4ms/sample - loss: 0.7638
- accuracy: 0.7413 - val_loss: 1.4732 - val_accuracy: 0.5452
Epoch 10/20
18325/18325 [=====] - 71s 4ms/sample - loss: 0.6779
- accuracy: 0.7705 - val_loss: 1.6503 - val_accuracy: 0.5298
Epoch 11/20
18325/18325 [=====] - 71s 4ms/sample - loss: 0.6009
- accuracy: 0.7971 - val_loss: 1.6860 - val_accuracy: 0.5302
Epoch 12/20
18325/18325 [=====] - 71s 4ms/sample - loss: 0.5216
- accuracy: 0.8241 - val_loss: 1.7413 - val_accuracy: 0.5321
Epoch 13/20
18325/18325 [=====] - 70s 4ms/sample - loss: 0.4467
- accuracy: 0.8509 - val_loss: 1.8942 - val_accuracy: 0.5376
Epoch 14/20
18325/18325 [=====] - 72s 4ms/sample - loss: 0.3808
- accuracy: 0.8733 - val_loss: 2.0453 - val_accuracy: 0.5368
Epoch 15/20
18325/18325 [=====] - 72s 4ms/sample - loss: 0.3182
- accuracy: 0.8978 - val_loss: 2.2857 - val_accuracy: 0.5237
Epoch 16/20
18325/18325 [=====] - 72s 4ms/sample - loss: 0.2713
- accuracy: 0.9118 - val_loss: 2.4804 - val_accuracy: 0.5045
Epoch 17/20
18325/18325 [=====] - 79s 4ms/sample - loss: 0.2269
- accuracy: 0.9271 - val_loss: 2.6295 - val_accuracy: 0.5122
Epoch 18/20
18325/18325 [=====] - 76s 4ms/sample - loss: 0.1895
- accuracy: 0.9412 - val_loss: 2.8106 - val_accuracy: 0.5166
Epoch 19/20
18325/18325 [=====] - 77s 4ms/sample - loss: 0.1645
- accuracy: 0.9485 - val_loss: 3.0278 - val_accuracy: 0.5144
Epoch 20/20
18325/18325 [=====] - 77s 4ms/sample - loss: 0.1496
- accuracy: 0.9533 - val_loss: 3.2336 - val_accuracy: 0.5145
3-conv-32-nodes-1-dense-1600261148
Train on 18325 samples, validate on 7854 samples
```

Epoch 1/20  
18325/18325 [=====] - 81s 4ms/sample - loss: 1.9427  
- accuracy: 0.3229 - val\_loss: 1.6588 - val\_accuracy: 0.4217  
Epoch 2/20  
18325/18325 [=====] - 81s 4ms/sample - loss: 1.5746  
- accuracy: 0.4570 - val\_loss: 1.5824 - val\_accuracy: 0.4613  
Epoch 3/20  
18325/18325 [=====] - 82s 4ms/sample - loss: 1.3878  
- accuracy: 0.5258 - val\_loss: 1.3747 - val\_accuracy: 0.5360  
Epoch 4/20  
18325/18325 [=====] - 81s 4ms/sample - loss: 1.2710  
- accuracy: 0.5666 - val\_loss: 1.3279 - val\_accuracy: 0.5507  
Epoch 5/20  
18325/18325 [=====] - 82s 4ms/sample - loss: 1.1929  
- accuracy: 0.5960 - val\_loss: 1.3767 - val\_accuracy: 0.5365  
Epoch 6/20  
18325/18325 [=====] - 80s 4ms/sample - loss: 1.1208  
- accuracy: 0.6222 - val\_loss: 1.2665 - val\_accuracy: 0.5722  
Epoch 7/20  
18325/18325 [=====] - 79s 4ms/sample - loss: 1.0493  
- accuracy: 0.6451 - val\_loss: 1.2732 - val\_accuracy: 0.5766  
Epoch 8/20  
18325/18325 [=====] - 78s 4ms/sample - loss: 1.0033  
- accuracy: 0.6602 - val\_loss: 1.2707 - val\_accuracy: 0.5809  
Epoch 9/20  
18325/18325 [=====] - 78s 4ms/sample - loss: 0.9447  
- accuracy: 0.6841 - val\_loss: 1.2970 - val\_accuracy: 0.5733  
Epoch 10/20  
18325/18325 [=====] - 80s 4ms/sample - loss: 0.8924  
- accuracy: 0.7008 - val\_loss: 1.2723 - val\_accuracy: 0.5780  
Epoch 11/20  
18325/18325 [=====] - 81s 4ms/sample - loss: 0.8470  
- accuracy: 0.7145 - val\_loss: 1.2726 - val\_accuracy: 0.5877  
Epoch 12/20  
18325/18325 [=====] - 80s 4ms/sample - loss: 0.8073  
- accuracy: 0.7288 - val\_loss: 1.3030 - val\_accuracy: 0.5871  
Epoch 13/20  
18325/18325 [=====] - 80s 4ms/sample - loss: 0.7613  
- accuracy: 0.7442 - val\_loss: 1.3621 - val\_accuracy: 0.5688  
Epoch 14/20  
18325/18325 [=====] - 80s 4ms/sample - loss: 0.7161  
- accuracy: 0.7608 - val\_loss: 1.3849 - val\_accuracy: 0.5862  
Epoch 15/20  
18325/18325 [=====] - 83s 5ms/sample - loss: 0.6813  
- accuracy: 0.7701 - val\_loss: 1.4396 - val\_accuracy: 0.5698  
Epoch 16/20  
18325/18325 [=====] - 80s 4ms/sample - loss: 0.6369  
- accuracy: 0.7874 - val\_loss: 1.4827 - val\_accuracy: 0.5744  
Epoch 17/20  
18325/18325 [=====] - 83s 5ms/sample - loss: 0.5984  
- accuracy: 0.7996 - val\_loss: 1.5143 - val\_accuracy: 0.5708  
Epoch 18/20  
18325/18325 [=====] - 78s 4ms/sample - loss: 0.5560  
- accuracy: 0.8144 - val\_loss: 1.5825 - val\_accuracy: 0.5657  
Epoch 19/20  
18325/18325 [=====] - 77s 4ms/sample - loss: 0.5251  
- accuracy: 0.8204 - val\_loss: 1.6392 - val\_accuracy: 0.5783

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Epoch 20/20
18325/18325 [=====] - 77s 4ms/sample - loss: 0.4895
- accuracy: 0.8323 - val_loss: 1.7059 - val_accuracy: 0.5681
1-conv-64-nodes-1-dense-1600262749
Train on 18325 samples, validate on 7854 samples
Epoch 1/20
18325/18325 [=====] - 93s 5ms/sample - loss: 1.9909
- accuracy: 0.3162 - val_loss: 1.7697 - val_accuracy: 0.4040
Epoch 2/20
18325/18325 [=====] - 92s 5ms/sample - loss: 1.5334
- accuracy: 0.4821 - val_loss: 1.5934 - val_accuracy: 0.4694
Epoch 3/20
18325/18325 [=====] - 92s 5ms/sample - loss: 1.1893
- accuracy: 0.6094 - val_loss: 1.5597 - val_accuracy: 0.4969
Epoch 4/20
18325/18325 [=====] - 92s 5ms/sample - loss: 0.8658
- accuracy: 0.7241 - val_loss: 1.5928 - val_accuracy: 0.5024
Epoch 5/20
18325/18325 [=====] - 92s 5ms/sample - loss: 0.6023
- accuracy: 0.8162 - val_loss: 1.7699 - val_accuracy: 0.4957
Epoch 6/20
18325/18325 [=====] - 92s 5ms/sample - loss: 0.3744
- accuracy: 0.8970 - val_loss: 1.8540 - val_accuracy: 0.5138
Epoch 7/20
18325/18325 [=====] - 93s 5ms/sample - loss: 0.2237
- accuracy: 0.9444 - val_loss: 2.1570 - val_accuracy: 0.4851
Epoch 8/20
18325/18325 [=====] - 91s 5ms/sample - loss: 0.1220
- accuracy: 0.9766 - val_loss: 2.3086 - val_accuracy: 0.5079
Epoch 9/20
18325/18325 [=====] - 92s 5ms/sample - loss: 0.0660
- accuracy: 0.9912 - val_loss: 2.5950 - val_accuracy: 0.4973
Epoch 10/20
18325/18325 [=====] - 92s 5ms/sample - loss: 0.0540
- accuracy: 0.9913 - val_loss: 2.7252 - val_accuracy: 0.5046
Epoch 11/20
18325/18325 [=====] - 92s 5ms/sample - loss: 0.0587
- accuracy: 0.9869 - val_loss: 2.9308 - val_accuracy: 0.4822
Epoch 12/20
18325/18325 [=====] - 93s 5ms/sample - loss: 0.0682
- accuracy: 0.9845 - val_loss: 3.0946 - val_accuracy: 0.4883
Epoch 13/20
18325/18325 [=====] - 92s 5ms/sample - loss: 0.0452
- accuracy: 0.9901 - val_loss: 3.4745 - val_accuracy: 0.4792
Epoch 14/20
18325/18325 [=====] - 92s 5ms/sample - loss: 0.0348
- accuracy: 0.9928 - val_loss: 3.7008 - val_accuracy: 0.4794
Epoch 15/20
18325/18325 [=====] - 92s 5ms/sample - loss: 0.0418
- accuracy: 0.9905 - val_loss: 3.7591 - val_accuracy: 0.4796
Epoch 16/20
18325/18325 [=====] - 93s 5ms/sample - loss: 0.0346
- accuracy: 0.9915 - val_loss: 3.6460 - val_accuracy: 0.4851
Epoch 17/20
18325/18325 [=====] - 92s 5ms/sample - loss: 0.0275
- accuracy: 0.9940 - val_loss: 3.9715 - val_accuracy: 0.4871
Epoch 18/20
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18325/18325 [=====] - 91s 5ms/sample - loss: 0.0291
- accuracy: 0.9932 - val_loss: 4.0023 - val_accuracy: 0.4772
Epoch 19/20
18325/18325 [=====] - 91s 5ms/sample - loss: 0.0268
- accuracy: 0.9937 - val_loss: 3.9384 - val_accuracy: 0.4864
Epoch 20/20
18325/18325 [=====] - 92s 5ms/sample - loss: 0.0491
- accuracy: 0.9871 - val_loss: 4.3225 - val_accuracy: 0.4744
2-conv-64-nodes-1-dense-1600264591
Train on 18325 samples, validate on 7854 samples
Epoch 1/20
18325/18325 [=====] - 142s 8ms/sample - loss: 1.9064
- accuracy: 0.3439 - val_loss: 1.6346 - val_accuracy: 0.4389
Epoch 2/20
18325/18325 [=====] - 142s 8ms/sample - loss: 1.4543
- accuracy: 0.5112 - val_loss: 1.4821 - val_accuracy: 0.4959
Epoch 3/20
18325/18325 [=====] - 142s 8ms/sample - loss: 1.2008
- accuracy: 0.5951 - val_loss: 1.3561 - val_accuracy: 0.5486
Epoch 4/20
18325/18325 [=====] - 143s 8ms/sample - loss: 1.0205
- accuracy: 0.6617 - val_loss: 1.3363 - val_accuracy: 0.5630
Epoch 5/20
18325/18325 [=====] - 142s 8ms/sample - loss: 0.8580
- accuracy: 0.7145 - val_loss: 1.4343 - val_accuracy: 0.5490
Epoch 6/20
18325/18325 [=====] - 140s 8ms/sample - loss: 0.6977
- accuracy: 0.7693 - val_loss: 1.4794 - val_accuracy: 0.5448
Epoch 7/20
18325/18325 [=====] - 141s 8ms/sample - loss: 0.5535
- accuracy: 0.8159 - val_loss: 1.6357 - val_accuracy: 0.5638
Epoch 8/20
18325/18325 [=====] - 141s 8ms/sample - loss: 0.4113
- accuracy: 0.8681 - val_loss: 1.8867 - val_accuracy: 0.5505
Epoch 9/20
18325/18325 [=====] - 152s 8ms/sample - loss: 0.2977
- accuracy: 0.9053 - val_loss: 2.0901 - val_accuracy: 0.5411
Epoch 10/20
18325/18325 [=====] - 151s 8ms/sample - loss: 0.2103
- accuracy: 0.9348 - val_loss: 2.4295 - val_accuracy: 0.5460
Epoch 11/20
18325/18325 [=====] - 149s 8ms/sample - loss: 0.1457
- accuracy: 0.9559 - val_loss: 2.6908 - val_accuracy: 0.5322
Epoch 12/20
18325/18325 [=====] - 141s 8ms/sample - loss: 0.1029
- accuracy: 0.9715 - val_loss: 2.8577 - val_accuracy: 0.5430
Epoch 13/20
18325/18325 [=====] - 141s 8ms/sample - loss: 0.0866
- accuracy: 0.9753 - val_loss: 3.1017 - val_accuracy: 0.5308
Epoch 14/20
18325/18325 [=====] - 141s 8ms/sample - loss: 0.0858
- accuracy: 0.9732 - val_loss: 3.1921 - val_accuracy: 0.5462
Epoch 15/20
18325/18325 [=====] - 142s 8ms/sample - loss: 0.0903
- accuracy: 0.9715 - val_loss: 3.3868 - val_accuracy: 0.5388
Epoch 16/20
18325/18325 [=====] - 141s 8ms/sample - loss: 0.0755
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- accuracy: 0.9769 - val_loss: 3.4875 - val_accuracy: 0.5377
Epoch 17/20
18325/18325 [=====] - 142s 8ms/sample - loss: 0.0438
- accuracy: 0.9875 - val_loss: 3.8536 - val_accuracy: 0.5382
Epoch 18/20
18325/18325 [=====] - 140s 8ms/sample - loss: 0.0378
- accuracy: 0.9896 - val_loss: 4.1049 - val_accuracy: 0.5343
Epoch 19/20
18325/18325 [=====] - 140s 8ms/sample - loss: 0.0820
- accuracy: 0.9748 - val_loss: 4.4016 - val_accuracy: 0.5248
Epoch 20/20
18325/18325 [=====] - 140s 8ms/sample - loss: 0.0665
- accuracy: 0.9786 - val_loss: 4.0802 - val_accuracy: 0.5253
3-conv-64-nodes-1-dense-1600267446
Train on 18325 samples, validate on 7854 samples
Epoch 1/20
18325/18325 [=====] - 154s 8ms/sample - loss: 1.9843
- accuracy: 0.3050 - val_loss: 1.7703 - val_accuracy: 0.3838
Epoch 2/20
18325/18325 [=====] - 153s 8ms/sample - loss: 1.5187
- accuracy: 0.4862 - val_loss: 1.4662 - val_accuracy: 0.5075
Epoch 3/20
18325/18325 [=====] - 159s 9ms/sample - loss: 1.2813
- accuracy: 0.5653 - val_loss: 1.3397 - val_accuracy: 0.5476
Epoch 4/20
18325/18325 [=====] - 157s 9ms/sample - loss: 1.1257
- accuracy: 0.6208 - val_loss: 1.3413 - val_accuracy: 0.5569
Epoch 5/20
18325/18325 [=====] - 157s 9ms/sample - loss: 1.0039
- accuracy: 0.6596 - val_loss: 1.2355 - val_accuracy: 0.5908
Epoch 6/20
18325/18325 [=====] - 155s 8ms/sample - loss: 0.8809
- accuracy: 0.7035 - val_loss: 1.2183 - val_accuracy: 0.6020
Epoch 7/20
18325/18325 [=====] - 157s 9ms/sample - loss: 0.7776
- accuracy: 0.7384 - val_loss: 1.2834 - val_accuracy: 0.5926
Epoch 8/20
18325/18325 [=====] - 153s 8ms/sample - loss: 0.6797
- accuracy: 0.7699 - val_loss: 1.3328 - val_accuracy: 0.5867
Epoch 9/20
18325/18325 [=====] - 154s 8ms/sample - loss: 0.5781
- accuracy: 0.8069 - val_loss: 1.3904 - val_accuracy: 0.5937
Epoch 10/20
18325/18325 [=====] - 154s 8ms/sample - loss: 0.4932
- accuracy: 0.8339 - val_loss: 1.5085 - val_accuracy: 0.5937
Epoch 11/20
18325/18325 [=====] - 154s 8ms/sample - loss: 0.4167
- accuracy: 0.8611 - val_loss: 1.6393 - val_accuracy: 0.5949
Epoch 12/20
18325/18325 [=====] - 155s 8ms/sample - loss: 0.3328
- accuracy: 0.8911 - val_loss: 1.8402 - val_accuracy: 0.5919
Epoch 13/20
18325/18325 [=====] - 156s 9ms/sample - loss: 0.2697
- accuracy: 0.9101 - val_loss: 2.0058 - val_accuracy: 0.5847
Epoch 14/20
18325/18325 [=====] - 156s 9ms/sample - loss: 0.2199
- accuracy: 0.9246 - val_loss: 2.1676 - val_accuracy: 0.5837
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Epoch 15/20
18325/18325 [=====] - 156s 9ms/sample - loss: 0.1933
- accuracy: 0.9345 - val_loss: 2.3189 - val_accuracy: 0.5789
Epoch 16/20
18325/18325 [=====] - 154s 8ms/sample - loss: 0.1526
- accuracy: 0.9472 - val_loss: 2.5025 - val_accuracy: 0.5679
Epoch 17/20
18325/18325 [=====] - 154s 8ms/sample - loss: 0.1318
- accuracy: 0.9568 - val_loss: 2.6519 - val_accuracy: 0.5716
Epoch 18/20
18325/18325 [=====] - 154s 8ms/sample - loss: 0.1397
- accuracy: 0.9517 - val_loss: 3.0496 - val_accuracy: 0.5700
Epoch 19/20
18325/18325 [=====] - 154s 8ms/sample - loss: 0.1045
- accuracy: 0.9644 - val_loss: 3.1218 - val_accuracy: 0.5623
Epoch 20/20
18325/18325 [=====] - 154s 8ms/sample - loss: 0.1092
- accuracy: 0.9634 - val_loss: 3.4416 - val_accuracy: 0.5623
1-conv-128-nodes-1-dense-1600270549
Train on 18325 samples, validate on 7854 samples
Epoch 1/20
18325/18325 [=====] - 234s 13ms/sample - loss: 2.025
1 - accuracy: 0.3157 - val_loss: 1.7353 - val_accuracy: 0.4191
Epoch 2/20
18325/18325 [=====] - 231s 13ms/sample - loss: 1.462
8 - accuracy: 0.5186 - val_loss: 1.6075 - val_accuracy: 0.4693
Epoch 3/20
18325/18325 [=====] - 228s 12ms/sample - loss: 1.113
9 - accuracy: 0.6355 - val_loss: 1.5225 - val_accuracy: 0.5046
Epoch 4/20
18325/18325 [=====] - 226s 12ms/sample - loss: 0.787
2 - accuracy: 0.7505 - val_loss: 1.6540 - val_accuracy: 0.5126
Epoch 5/20
18325/18325 [=====] - 232s 13ms/sample - loss: 0.505
5 - accuracy: 0.8464 - val_loss: 1.7603 - val_accuracy: 0.5117
Epoch 6/20
18325/18325 [=====] - 236s 13ms/sample - loss: 0.284
1 - accuracy: 0.9198 - val_loss: 2.1162 - val_accuracy: 0.4994
Epoch 7/20
18325/18325 [=====] - 238s 13ms/sample - loss: 0.164
1 - accuracy: 0.9611 - val_loss: 2.2857 - val_accuracy: 0.5020
Epoch 8/20
18325/18325 [=====] - 228s 12ms/sample - loss: 0.089
4 - accuracy: 0.9830 - val_loss: 2.5865 - val_accuracy: 0.5022
Epoch 9/20
18325/18325 [=====] - 228s 12ms/sample - loss: 0.057
5 - accuracy: 0.9900 - val_loss: 2.8353 - val_accuracy: 0.4948
Epoch 10/20
18325/18325 [=====] - 233s 13ms/sample - loss: 0.064
7 - accuracy: 0.9858 - val_loss: 3.2998 - val_accuracy: 0.4554
Epoch 11/20
18325/18325 [=====] - 231s 13ms/sample - loss: 0.065
6 - accuracy: 0.9847 - val_loss: 3.1603 - val_accuracy: 0.4846
Epoch 12/20
18325/18325 [=====] - 268s 15ms/sample - loss: 0.053
8 - accuracy: 0.9871 - val_loss: 3.3327 - val_accuracy: 0.4953
Epoch 13/20
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18325/18325 [=====] - 280s 15ms/sample - loss: 0.035
2 - accuracy: 0.9923 - val_loss: 3.4258 - val_accuracy: 0.4817
Epoch 14/20
18325/18325 [=====] - 276s 15ms/sample - loss: 0.041
5 - accuracy: 0.9898 - val_loss: 3.5739 - val_accuracy: 0.4743
Epoch 15/20
18325/18325 [=====] - 286s 16ms/sample - loss: 0.041
1 - accuracy: 0.9901 - val_loss: 3.8527 - val_accuracy: 0.4724
Epoch 16/20
18325/18325 [=====] - 249s 14ms/sample - loss: 0.052
0 - accuracy: 0.9865 - val_loss: 3.8087 - val_accuracy: 0.4757
Epoch 17/20
18325/18325 [=====] - 270s 15ms/sample - loss: 0.031
6 - accuracy: 0.9924 - val_loss: 4.1290 - val_accuracy: 0.4661
Epoch 18/20
18325/18325 [=====] - 273s 15ms/sample - loss: 0.034
3 - accuracy: 0.9910 - val_loss: 4.3161 - val_accuracy: 0.4785
Epoch 19/20
18325/18325 [=====] - 251s 14ms/sample - loss: 0.021
0 - accuracy: 0.9951 - val_loss: 4.5010 - val_accuracy: 0.4604
Epoch 20/20
18325/18325 [=====] - 270s 15ms/sample - loss: 0.026
1 - accuracy: 0.9940 - val_loss: 4.3487 - val_accuracy: 0.4818
2-conv-128-nodes-1-dense-1600275518
Train on 18325 samples, validate on 7854 samples
Epoch 1/20
18325/18325 [=====] - 373s 20ms/sample - loss: 1.909
1 - accuracy: 0.3382 - val_loss: 1.6485 - val_accuracy: 0.4524
Epoch 2/20
18325/18325 [=====] - 370s 20ms/sample - loss: 1.527
4 - accuracy: 0.4829 - val_loss: 1.4979 - val_accuracy: 0.4861
Epoch 3/20
18325/18325 [=====] - 392s 21ms/sample - loss: 1.306
9 - accuracy: 0.5572 - val_loss: 1.3532 - val_accuracy: 0.5382
Epoch 4/20
18325/18325 [=====] - 393s 21ms/sample - loss: 1.114
8 - accuracy: 0.6238 - val_loss: 1.3822 - val_accuracy: 0.5423
Epoch 5/20
18325/18325 [=====] - 375s 20ms/sample - loss: 0.961
8 - accuracy: 0.6755 - val_loss: 1.3995 - val_accuracy: 0.5406
Epoch 6/20
18325/18325 [=====] - 387s 21ms/sample - loss: 0.810
2 - accuracy: 0.7306 - val_loss: 1.4416 - val_accuracy: 0.5535
Epoch 7/20
18325/18325 [=====] - 375s 20ms/sample - loss: 0.661
7 - accuracy: 0.7799 - val_loss: 1.5342 - val_accuracy: 0.5568
Epoch 8/20
18325/18325 [=====] - 359s 20ms/sample - loss: 0.518
4 - accuracy: 0.8282 - val_loss: 1.7009 - val_accuracy: 0.5414
Epoch 9/20
18325/18325 [=====] - 358s 20ms/sample - loss: 0.406
1 - accuracy: 0.8655 - val_loss: 2.0513 - val_accuracy: 0.5237
Epoch 10/20
18325/18325 [=====] - 355s 19ms/sample - loss: 0.295
8 - accuracy: 0.9046 - val_loss: 2.2719 - val_accuracy: 0.5368
Epoch 11/20
18325/18325 [=====] - 352s 19ms/sample - loss: 0.217
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7 - accuracy: 0.9315 - val_loss: 2.6393 - val_accuracy: 0.5234
Epoch 12/20
18325/18325 [=====] - 354s 19ms/sample - loss: 0.155
8 - accuracy: 0.9516 - val_loss: 2.8117 - val_accuracy: 0.5205
Epoch 13/20
18325/18325 [=====] - 353s 19ms/sample - loss: 0.128
9 - accuracy: 0.9585 - val_loss: 3.1500 - val_accuracy: 0.5241
Epoch 14/20
18325/18325 [=====] - 355s 19ms/sample - loss: 0.111
9 - accuracy: 0.9654 - val_loss: 3.3169 - val_accuracy: 0.5242
Epoch 15/20
18325/18325 [=====] - 354s 19ms/sample - loss: 0.076
9 - accuracy: 0.9771 - val_loss: 3.6874 - val_accuracy: 0.5233
Epoch 16/20
18325/18325 [=====] - 353s 19ms/sample - loss: 0.088
0 - accuracy: 0.9699 - val_loss: 3.9320 - val_accuracy: 0.5225
Epoch 17/20
18325/18325 [=====] - 353s 19ms/sample - loss: 0.086
0 - accuracy: 0.9722 - val_loss: 3.8893 - val_accuracy: 0.5075
Epoch 18/20
18325/18325 [=====] - 354s 19ms/sample - loss: 0.088
0 - accuracy: 0.9700 - val_loss: 4.1613 - val_accuracy: 0.5013
Epoch 19/20
18325/18325 [=====] - 356s 19ms/sample - loss: 0.063
4 - accuracy: 0.9810 - val_loss: 4.3682 - val_accuracy: 0.5171
Epoch 20/20
18325/18325 [=====] - 361s 20ms/sample - loss: 0.053
3 - accuracy: 0.9823 - val_loss: 4.6744 - val_accuracy: 0.5131
3-conv-128-nodes-1-dense-1600282804
Train on 18325 samples, validate on 7854 samples
Epoch 1/20
18325/18325 [=====] - 382s 21ms/sample - loss: 1.841
6 - accuracy: 0.3657 - val_loss: 1.5207 - val_accuracy: 0.4875
Epoch 2/20
18325/18325 [=====] - 379s 21ms/sample - loss: 1.353
8 - accuracy: 0.5447 - val_loss: 1.3188 - val_accuracy: 0.5519
Epoch 3/20
18325/18325 [=====] - 376s 21ms/sample - loss: 1.122
1 - accuracy: 0.6230 - val_loss: 1.2363 - val_accuracy: 0.5834
Epoch 4/20
18325/18325 [=====] - 376s 20ms/sample - loss: 0.942
9 - accuracy: 0.6846 - val_loss: 1.2067 - val_accuracy: 0.5978
Epoch 5/20
18325/18325 [=====] - 374s 20ms/sample - loss: 0.768
9 - accuracy: 0.7429 - val_loss: 1.2230 - val_accuracy: 0.6031
Epoch 6/20
18325/18325 [=====] - 377s 21ms/sample - loss: 0.590
2 - accuracy: 0.8014 - val_loss: 1.3353 - val_accuracy: 0.6092
Epoch 7/20
18325/18325 [=====] - 376s 21ms/sample - loss: 0.440
6 - accuracy: 0.8511 - val_loss: 1.5952 - val_accuracy: 0.6011
Epoch 8/20
18325/18325 [=====] - 377s 21ms/sample - loss: 0.295
5 - accuracy: 0.8989 - val_loss: 1.7514 - val_accuracy: 0.5973
Epoch 9/20
18325/18325 [=====] - 384s 21ms/sample - loss: 0.196
6 - accuracy: 0.9365 - val_loss: 2.0498 - val_accuracy: 0.5788
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Epoch 10/20
18325/18325 [=====] - 390s 21ms/sample - loss: 0.168
4 - accuracy: 0.9442 - val_loss: 2.1825 - val_accuracy: 0.5901
Epoch 11/20
18325/18325 [=====] - 372s 20ms/sample - loss: 0.121
2 - accuracy: 0.9602 - val_loss: 2.4137 - val_accuracy: 0.5979
Epoch 12/20
18325/18325 [=====] - 371s 20ms/sample - loss: 0.111
6 - accuracy: 0.9629 - val_loss: 2.6353 - val_accuracy: 0.6077
Epoch 13/20
18325/18325 [=====] - 371s 20ms/sample - loss: 0.090
3 - accuracy: 0.9701 - val_loss: 2.9654 - val_accuracy: 0.5891
Epoch 14/20
18325/18325 [=====] - 371s 20ms/sample - loss: 0.098
3 - accuracy: 0.9652 - val_loss: 2.8440 - val_accuracy: 0.5774
Epoch 15/20
18325/18325 [=====] - 369s 20ms/sample - loss: 0.087
1 - accuracy: 0.9705 - val_loss: 3.1202 - val_accuracy: 0.5803
Epoch 16/20
18325/18325 [=====] - 370s 20ms/sample - loss: 0.061
2 - accuracy: 0.9803 - val_loss: 3.1198 - val_accuracy: 0.5877
Epoch 17/20
18325/18325 [=====] - 370s 20ms/sample - loss: 0.080
8 - accuracy: 0.9738 - val_loss: 3.2341 - val_accuracy: 0.5915
Epoch 18/20
18325/18325 [=====] - 370s 20ms/sample - loss: 0.077
7 - accuracy: 0.9761 - val_loss: 3.3571 - val_accuracy: 0.5834
Epoch 19/20
18325/18325 [=====] - 370s 20ms/sample - loss: 0.049
4 - accuracy: 0.9838 - val_loss: 3.4705 - val_accuracy: 0.5868
Epoch 20/20
18325/18325 [=====] - 369s 20ms/sample - loss: 0.077
9 - accuracy: 0.9741 - val_loss: 3.5292 - val_accuracy: 0.5780
1-conv-32-nodes-2-dense-1600290300
Train on 18325 samples, validate on 7854 samples
Epoch 1/20
18325/18325 [=====] - 44s 2ms/sample - loss: 2.0899
- accuracy: 0.2511 - val_loss: 1.9103 - val_accuracy: 0.3285
Epoch 2/20
18325/18325 [=====] - 43s 2ms/sample - loss: 1.8370
- accuracy: 0.3547 - val_loss: 1.8037 - val_accuracy: 0.3666
Epoch 3/20
18325/18325 [=====] - 43s 2ms/sample - loss: 1.6569
- accuracy: 0.4226 - val_loss: 1.7257 - val_accuracy: 0.4030
Epoch 4/20
18325/18325 [=====] - 43s 2ms/sample - loss: 1.4625
- accuracy: 0.4910 - val_loss: 1.6463 - val_accuracy: 0.4386
Epoch 5/20
18325/18325 [=====] - 43s 2ms/sample - loss: 1.2982
- accuracy: 0.5518 - val_loss: 1.7276 - val_accuracy: 0.4318
Epoch 6/20
18325/18325 [=====] - 43s 2ms/sample - loss: 1.1209
- accuracy: 0.6164 - val_loss: 1.6967 - val_accuracy: 0.4573
Epoch 7/20
18325/18325 [=====] - 43s 2ms/sample - loss: 0.9615
- accuracy: 0.6745 - val_loss: 1.8049 - val_accuracy: 0.4467
Epoch 8/20
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18325/18325 [=====] - 43s 2ms/sample - loss: 0.8205  
- accuracy: 0.7208 - val\_loss: 1.9779 - val\_accuracy: 0.4371  
Epoch 9/20  
18325/18325 [=====] - 43s 2ms/sample - loss: 0.6886  
- accuracy: 0.7693 - val\_loss: 2.1337 - val\_accuracy: 0.4298  
Epoch 10/20  
18325/18325 [=====] - 43s 2ms/sample - loss: 0.5564  
- accuracy: 0.8157 - val\_loss: 2.3195 - val\_accuracy: 0.4362  
Epoch 11/20  
18325/18325 [=====] - 42s 2ms/sample - loss: 0.4589  
- accuracy: 0.8495 - val\_loss: 2.5044 - val\_accuracy: 0.4399  
Epoch 12/20  
18325/18325 [=====] - 42s 2ms/sample - loss: 0.3818  
- accuracy: 0.8758 - val\_loss: 2.8340 - val\_accuracy: 0.4450  
Epoch 13/20  
18325/18325 [=====] - 42s 2ms/sample - loss: 0.3092  
- accuracy: 0.9028 - val\_loss: 3.0515 - val\_accuracy: 0.4237  
Epoch 14/20  
18325/18325 [=====] - 42s 2ms/sample - loss: 0.2694  
- accuracy: 0.9154 - val\_loss: 3.3245 - val\_accuracy: 0.4197  
Epoch 15/20  
18325/18325 [=====] - 42s 2ms/sample - loss: 0.2387  
- accuracy: 0.9237 - val\_loss: 3.5825 - val\_accuracy: 0.4320  
Epoch 16/20  
18325/18325 [=====] - 42s 2ms/sample - loss: 0.2124  
- accuracy: 0.9323 - val\_loss: 3.8483 - val\_accuracy: 0.4197  
Epoch 17/20  
18325/18325 [=====] - 42s 2ms/sample - loss: 0.1720  
- accuracy: 0.9486 - val\_loss: 4.1980 - val\_accuracy: 0.4339  
Epoch 18/20  
18325/18325 [=====] - 44s 2ms/sample - loss: 0.1581  
- accuracy: 0.9532 - val\_loss: 4.3013 - val\_accuracy: 0.4194  
Epoch 19/20  
18325/18325 [=====] - 45s 2ms/sample - loss: 0.1380  
- accuracy: 0.9584 - val\_loss: 4.6243 - val\_accuracy: 0.4236  
Epoch 20/20  
18325/18325 [=====] - 43s 2ms/sample - loss: 0.1495  
- accuracy: 0.9550 - val\_loss: 4.5749 - val\_accuracy: 0.3970  
**2-conv-32-nodes-2-dense-1600291156**  
Train on 18325 samples, validate on 7854 samples  
Epoch 1/20  
18325/18325 [=====] - 70s 4ms/sample - loss: 2.0160  
- accuracy: 0.2858 - val\_loss: 1.8435 - val\_accuracy: 0.3514  
Epoch 2/20  
18325/18325 [=====] - 70s 4ms/sample - loss: 1.6878  
- accuracy: 0.4159 - val\_loss: 1.6417 - val\_accuracy: 0.4398  
Epoch 3/20  
18325/18325 [=====] - 69s 4ms/sample - loss: 1.4971  
- accuracy: 0.4816 - val\_loss: 1.5366 - val\_accuracy: 0.4635  
Epoch 4/20  
18325/18325 [=====] - 69s 4ms/sample - loss: 1.3579  
- accuracy: 0.5282 - val\_loss: 1.4359 - val\_accuracy: 0.5070  
Epoch 5/20  
18325/18325 [=====] - 70s 4ms/sample - loss: 1.2360  
- accuracy: 0.5702 - val\_loss: 1.4134 - val\_accuracy: 0.5256  
Epoch 6/20  
18325/18325 [=====] - 70s 4ms/sample - loss: 1.1287

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- accuracy: 0.6043 - val_loss: 1.3821 - val_accuracy: 0.5382
Epoch 7/20
18325/18325 [=====] - 70s 4ms/sample - loss: 1.0181
- accuracy: 0.6468 - val_loss: 1.4017 - val_accuracy: 0.5458
Epoch 8/20
18325/18325 [=====] - 70s 4ms/sample - loss: 0.9247
- accuracy: 0.6856 - val_loss: 1.4584 - val_accuracy: 0.5299
Epoch 9/20
18325/18325 [=====] - 69s 4ms/sample - loss: 0.8421
- accuracy: 0.7149 - val_loss: 1.5314 - val_accuracy: 0.5421
Epoch 10/20
18325/18325 [=====] - 75s 4ms/sample - loss: 0.7573
- accuracy: 0.7410 - val_loss: 1.5956 - val_accuracy: 0.5303
Epoch 11/20
18325/18325 [=====] - 72s 4ms/sample - loss: 0.6661
- accuracy: 0.7749 - val_loss: 1.6357 - val_accuracy: 0.5409
Epoch 12/20
18325/18325 [=====] - 71s 4ms/sample - loss: 0.5867
- accuracy: 0.8028 - val_loss: 1.7733 - val_accuracy: 0.5425
Epoch 13/20
18325/18325 [=====] - 71s 4ms/sample - loss: 0.5254
- accuracy: 0.8240 - val_loss: 1.9127 - val_accuracy: 0.5334
Epoch 14/20
18325/18325 [=====] - 71s 4ms/sample - loss: 0.4530
- accuracy: 0.8481 - val_loss: 2.0330 - val_accuracy: 0.5302
Epoch 15/20
18325/18325 [=====] - 70s 4ms/sample - loss: 0.3951
- accuracy: 0.8688 - val_loss: 2.2818 - val_accuracy: 0.5246
Epoch 16/20
18325/18325 [=====] - 71s 4ms/sample - loss: 0.3333
- accuracy: 0.8879 - val_loss: 2.4024 - val_accuracy: 0.5279
Epoch 17/20
18325/18325 [=====] - 71s 4ms/sample - loss: 0.2881
- accuracy: 0.9052 - val_loss: 2.5711 - val_accuracy: 0.5177
Epoch 18/20
18325/18325 [=====] - 71s 4ms/sample - loss: 0.2498
- accuracy: 0.9172 - val_loss: 2.9807 - val_accuracy: 0.4933
Epoch 19/20
18325/18325 [=====] - 71s 4ms/sample - loss: 0.2218
- accuracy: 0.9263 - val_loss: 2.9951 - val_accuracy: 0.5055
Epoch 20/20
18325/18325 [=====] - 71s 4ms/sample - loss: 0.1980
- accuracy: 0.9352 - val_loss: 3.2334 - val_accuracy: 0.5194
3-conv-32-nodes-2-dense-1600292568
Train on 18325 samples, validate on 7854 samples
Epoch 1/20
18325/18325 [=====] - 76s 4ms/sample - loss: 2.0099
- accuracy: 0.2879 - val_loss: 1.7382 - val_accuracy: 0.4046
Epoch 2/20
18325/18325 [=====] - 76s 4ms/sample - loss: 1.6814
- accuracy: 0.4196 - val_loss: 1.6036 - val_accuracy: 0.4419
Epoch 3/20
18325/18325 [=====] - 76s 4ms/sample - loss: 1.5132
- accuracy: 0.4793 - val_loss: 1.5197 - val_accuracy: 0.4700
Epoch 4/20
18325/18325 [=====] - 76s 4ms/sample - loss: 1.4000
- accuracy: 0.5150 - val_loss: 1.3888 - val_accuracy: 0.5253
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Epoch 5/20  
18325/18325 [=====] - 76s 4ms/sample - loss: 1.3124  
- accuracy: 0.5432 - val\_loss: 1.3605 - val\_accuracy: 0.5294  
Epoch 6/20  
18325/18325 [=====] - 76s 4ms/sample - loss: 1.2302  
- accuracy: 0.5772 - val\_loss: 1.3093 - val\_accuracy: 0.5479  
Epoch 7/20  
18325/18325 [=====] - 76s 4ms/sample - loss: 1.1753  
- accuracy: 0.5977 - val\_loss: 1.3204 - val\_accuracy: 0.5535  
Epoch 8/20  
18325/18325 [=====] - 76s 4ms/sample - loss: 1.1233  
- accuracy: 0.6150 - val\_loss: 1.2916 - val\_accuracy: 0.5633  
Epoch 9/20  
18325/18325 [=====] - 76s 4ms/sample - loss: 1.0722  
- accuracy: 0.6335 - val\_loss: 1.3668 - val\_accuracy: 0.5509  
Epoch 10/20  
18325/18325 [=====] - 76s 4ms/sample - loss: 1.0384  
- accuracy: 0.6436 - val\_loss: 1.3593 - val\_accuracy: 0.5586  
Epoch 11/20  
18325/18325 [=====] - 76s 4ms/sample - loss: 0.9928  
- accuracy: 0.6639 - val\_loss: 1.2763 - val\_accuracy: 0.5747  
Epoch 12/20  
18325/18325 [=====] - 77s 4ms/sample - loss: 0.9618  
- accuracy: 0.6742 - val\_loss: 1.3405 - val\_accuracy: 0.5708  
Epoch 13/20  
18325/18325 [=====] - 75s 4ms/sample - loss: 0.9237  
- accuracy: 0.6885 - val\_loss: 1.2494 - val\_accuracy: 0.5898  
Epoch 14/20  
18325/18325 [=====] - 75s 4ms/sample - loss: 0.8865  
- accuracy: 0.6969 - val\_loss: 1.2786 - val\_accuracy: 0.5882  
Epoch 15/20  
18325/18325 [=====] - 77s 4ms/sample - loss: 0.8564  
- accuracy: 0.7087 - val\_loss: 1.3046 - val\_accuracy: 0.5816  
Epoch 16/20  
18325/18325 [=====] - 76s 4ms/sample - loss: 0.8196  
- accuracy: 0.7259 - val\_loss: 1.3916 - val\_accuracy: 0.5685  
Epoch 17/20  
18325/18325 [=====] - 75s 4ms/sample - loss: 0.7896  
- accuracy: 0.7351 - val\_loss: 1.4030 - val\_accuracy: 0.5519  
Epoch 18/20  
18325/18325 [=====] - 76s 4ms/sample - loss: 0.7635  
- accuracy: 0.7434 - val\_loss: 1.3249 - val\_accuracy: 0.5895  
Epoch 19/20  
18325/18325 [=====] - 76s 4ms/sample - loss: 0.7240  
- accuracy: 0.7578 - val\_loss: 1.3630 - val\_accuracy: 0.5779  
Epoch 20/20  
18325/18325 [=====] - 76s 4ms/sample - loss: 0.6895  
- accuracy: 0.7670 - val\_loss: 1.4347 - val\_accuracy: 0.5849  
**1-conv-64-nodes-2-dense-1600294089**  
Train on 18325 samples, validate on 7854 samples  
Epoch 1/20  
18325/18325 [=====] - 93s 5ms/sample - loss: 1.8951  
- accuracy: 0.3468 - val\_loss: 1.6699 - val\_accuracy: 0.4220  
Epoch 2/20  
18325/18325 [=====] - 92s 5ms/sample - loss: 1.4845  
- accuracy: 0.4948 - val\_loss: 1.6007 - val\_accuracy: 0.4655  
Epoch 3/20

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18325/18325 [=====] - 92s 5ms/sample - loss: 1.1576
- accuracy: 0.6063 - val_loss: 1.5342 - val_accuracy: 0.4929
Epoch 4/20
18325/18325 [=====] - 90s 5ms/sample - loss: 0.8382
- accuracy: 0.7235 - val_loss: 1.6426 - val_accuracy: 0.4982
Epoch 5/20
18325/18325 [=====] - 89s 5ms/sample - loss: 0.5445
- accuracy: 0.8263 - val_loss: 1.8823 - val_accuracy: 0.4980
Epoch 6/20
18325/18325 [=====] - 90s 5ms/sample - loss: 0.3284
- accuracy: 0.8994 - val_loss: 2.1907 - val_accuracy: 0.4843
Epoch 7/20
18325/18325 [=====] - 89s 5ms/sample - loss: 0.1844
- accuracy: 0.9485 - val_loss: 2.5940 - val_accuracy: 0.4790
Epoch 8/20
18325/18325 [=====] - 89s 5ms/sample - loss: 0.1218
- accuracy: 0.9667 - val_loss: 3.0185 - val_accuracy: 0.4845
Epoch 9/20
18325/18325 [=====] - 89s 5ms/sample - loss: 0.1128
- accuracy: 0.9669 - val_loss: 3.3217 - val_accuracy: 0.4899
Epoch 10/20
18325/18325 [=====] - 90s 5ms/sample - loss: 0.0855
- accuracy: 0.9765 - val_loss: 3.5100 - val_accuracy: 0.4786
Epoch 11/20
18325/18325 [=====] - 89s 5ms/sample - loss: 0.0743
- accuracy: 0.9795 - val_loss: 4.2135 - val_accuracy: 0.4672
Epoch 12/20
18325/18325 [=====] - 89s 5ms/sample - loss: 0.0749
- accuracy: 0.9771 - val_loss: 3.7656 - val_accuracy: 0.4754
Epoch 13/20
18325/18325 [=====] - 89s 5ms/sample - loss: 0.0521
- accuracy: 0.9854 - val_loss: 4.0152 - val_accuracy: 0.4688
Epoch 14/20
18325/18325 [=====] - 89s 5ms/sample - loss: 0.0788
- accuracy: 0.9763 - val_loss: 4.2732 - val_accuracy: 0.4684
Epoch 15/20
18325/18325 [=====] - 89s 5ms/sample - loss: 0.0525
- accuracy: 0.9850 - val_loss: 4.3376 - val_accuracy: 0.4507
Epoch 16/20
18325/18325 [=====] - 89s 5ms/sample - loss: 0.0476
- accuracy: 0.9866 - val_loss: 4.8382 - val_accuracy: 0.4655
Epoch 17/20
18325/18325 [=====] - 89s 5ms/sample - loss: 0.0595
- accuracy: 0.9828 - val_loss: 4.5992 - val_accuracy: 0.4531
Epoch 18/20
18325/18325 [=====] - 89s 5ms/sample - loss: 0.0519
- accuracy: 0.9844 - val_loss: 4.9583 - val_accuracy: 0.4447
Epoch 19/20
18325/18325 [=====] - 89s 5ms/sample - loss: 0.0486
- accuracy: 0.9865 - val_loss: 5.0862 - val_accuracy: 0.4655
Epoch 20/20
18325/18325 [=====] - 89s 5ms/sample - loss: 0.0484
- accuracy: 0.9874 - val_loss: 5.1756 - val_accuracy: 0.4747
2-conv-64-nodes-2-dense-1600295884
Train on 18325 samples, validate on 7854 samples
Epoch 1/20
18325/18325 [=====] - 140s 8ms/sample - loss: 1.9309
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- accuracy: 0.3250 - val_loss: 1.8156 - val_accuracy: 0.3671
Epoch 2/20
18325/18325 [=====] - 140s 8ms/sample - loss: 1.5080
- accuracy: 0.4815 - val_loss: 1.4613 - val_accuracy: 0.5013
Epoch 3/20
18325/18325 [=====] - 139s 8ms/sample - loss: 1.2442
- accuracy: 0.5780 - val_loss: 1.3440 - val_accuracy: 0.5430
Epoch 4/20
18325/18325 [=====] - 140s 8ms/sample - loss: 1.0563
- accuracy: 0.6411 - val_loss: 1.3910 - val_accuracy: 0.5374
Epoch 5/20
18325/18325 [=====] - 140s 8ms/sample - loss: 0.8828
- accuracy: 0.7030 - val_loss: 1.3683 - val_accuracy: 0.5521
Epoch 6/20
18325/18325 [=====] - 140s 8ms/sample - loss: 0.6977
- accuracy: 0.7634 - val_loss: 1.4490 - val_accuracy: 0.5593
Epoch 7/20
18325/18325 [=====] - 140s 8ms/sample - loss: 0.5414
- accuracy: 0.8199 - val_loss: 1.6055 - val_accuracy: 0.5537
Epoch 8/20
18325/18325 [=====] - 140s 8ms/sample - loss: 0.3899
- accuracy: 0.8726 - val_loss: 1.7478 - val_accuracy: 0.5546
Epoch 9/20
18325/18325 [=====] - 140s 8ms/sample - loss: 0.2684
- accuracy: 0.9150 - val_loss: 2.1035 - val_accuracy: 0.5540
Epoch 10/20
18325/18325 [=====] - 140s 8ms/sample - loss: 0.1993
- accuracy: 0.9363 - val_loss: 2.3931 - val_accuracy: 0.5360
Epoch 11/20
18325/18325 [=====] - 140s 8ms/sample - loss: 0.1454
- accuracy: 0.9543 - val_loss: 2.6678 - val_accuracy: 0.5452
Epoch 12/20
18325/18325 [=====] - 140s 8ms/sample - loss: 0.1132
- accuracy: 0.9628 - val_loss: 3.0811 - val_accuracy: 0.5326
Epoch 13/20
18325/18325 [=====] - 140s 8ms/sample - loss: 0.1057
- accuracy: 0.9651 - val_loss: 3.4077 - val_accuracy: 0.5385
Epoch 14/20
18325/18325 [=====] - 140s 8ms/sample - loss: 0.1009
- accuracy: 0.9671 - val_loss: 3.4694 - val_accuracy: 0.5339
Epoch 15/20
18325/18325 [=====] - 140s 8ms/sample - loss: 0.0900
- accuracy: 0.9708 - val_loss: 3.6016 - val_accuracy: 0.5349
Epoch 16/20
18325/18325 [=====] - 140s 8ms/sample - loss: 0.0913
- accuracy: 0.9709 - val_loss: 3.7531 - val_accuracy: 0.5392
Epoch 17/20
18325/18325 [=====] - 139s 8ms/sample - loss: 0.0724
- accuracy: 0.9756 - val_loss: 3.8506 - val_accuracy: 0.5163
Epoch 18/20
18325/18325 [=====] - 139s 8ms/sample - loss: 0.0530
- accuracy: 0.9826 - val_loss: 4.2130 - val_accuracy: 0.5236
Epoch 19/20
18325/18325 [=====] - 139s 8ms/sample - loss: 0.0785
- accuracy: 0.9741 - val_loss: 4.1602 - val_accuracy: 0.5318
Epoch 20/20
18325/18325 [=====] - 139s 8ms/sample - loss: 0.0681
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- accuracy: 0.9778 - val_loss: 4.2752 - val_accuracy: 0.5219
3-conv-64-nodes-2-dense-1600298680
Train on 18325 samples, validate on 7854 samples
Epoch 1/20
18325/18325 [=====] - 151s 8ms/sample - loss: 1.9363
- accuracy: 0.3178 - val_loss: 1.5956 - val_accuracy: 0.4542
Epoch 2/20
18325/18325 [=====] - 151s 8ms/sample - loss: 1.4863
- accuracy: 0.4885 - val_loss: 1.3662 - val_accuracy: 0.5348
Epoch 3/20
18325/18325 [=====] - 151s 8ms/sample - loss: 1.2833
- accuracy: 0.5583 - val_loss: 1.3293 - val_accuracy: 0.5453
Epoch 4/20
18325/18325 [=====] - 151s 8ms/sample - loss: 1.1514
- accuracy: 0.6102 - val_loss: 1.2941 - val_accuracy: 0.5688
Epoch 5/20
18325/18325 [=====] - 151s 8ms/sample - loss: 1.0282
- accuracy: 0.6528 - val_loss: 1.3058 - val_accuracy: 0.5828
Epoch 6/20
18325/18325 [=====] - 151s 8ms/sample - loss: 0.9211
- accuracy: 0.6886 - val_loss: 1.2731 - val_accuracy: 0.5861
Epoch 7/20
18325/18325 [=====] - 152s 8ms/sample - loss: 0.8169
- accuracy: 0.7224 - val_loss: 1.2328 - val_accuracy: 0.5914
Epoch 8/20
18325/18325 [=====] - 152s 8ms/sample - loss: 0.7279
- accuracy: 0.7547 - val_loss: 1.3067 - val_accuracy: 0.5973
Epoch 9/20
18325/18325 [=====] - 152s 8ms/sample - loss: 0.6272
- accuracy: 0.7876 - val_loss: 1.3123 - val_accuracy: 0.6092
Epoch 10/20
18325/18325 [=====] - 151s 8ms/sample - loss: 0.5358
- accuracy: 0.8207 - val_loss: 1.4443 - val_accuracy: 0.6048
Epoch 11/20
18325/18325 [=====] - 151s 8ms/sample - loss: 0.4690
- accuracy: 0.8421 - val_loss: 1.4186 - val_accuracy: 0.6112
Epoch 12/20
18325/18325 [=====] - 151s 8ms/sample - loss: 0.3846
- accuracy: 0.8698 - val_loss: 1.6343 - val_accuracy: 0.5940
Epoch 13/20
18325/18325 [=====] - 151s 8ms/sample - loss: 0.3320
- accuracy: 0.8887 - val_loss: 1.8182 - val_accuracy: 0.5901
Epoch 14/20
18325/18325 [=====] - 152s 8ms/sample - loss: 0.2710
- accuracy: 0.9074 - val_loss: 1.9932 - val_accuracy: 0.5951
Epoch 15/20
18325/18325 [=====] - 152s 8ms/sample - loss: 0.2300
- accuracy: 0.9204 - val_loss: 2.1775 - val_accuracy: 0.5802
Epoch 16/20
18325/18325 [=====] - 151s 8ms/sample - loss: 0.1995
- accuracy: 0.9306 - val_loss: 2.2491 - val_accuracy: 0.5838
Epoch 17/20
18325/18325 [=====] - 151s 8ms/sample - loss: 0.2105
- accuracy: 0.9272 - val_loss: 2.3380 - val_accuracy: 0.5945
Epoch 18/20
18325/18325 [=====] - 150s 8ms/sample - loss: 0.1535
- accuracy: 0.9482 - val_loss: 2.7151 - val_accuracy: 0.5770
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Epoch 19/20  
18325/18325 [=====] - 151s 8ms/sample - loss: 0.1500  
- accuracy: 0.9479 - val\_loss: 2.7303 - val\_accuracy: 0.5801  
Epoch 20/20  
18325/18325 [=====] - 151s 8ms/sample - loss: 0.1372  
- accuracy: 0.9550 - val\_loss: 2.8444 - val\_accuracy: 0.5786  
1-conv-128-nodes-2-dense-1600301703  
Train on 18325 samples, validate on 7854 samples  
Epoch 1/20  
18325/18325 [=====] - 224s 12ms/sample - loss: 1.841  
- accuracy: 0.3680 - val\_loss: 1.5675 - val\_accuracy: 0.4735  
Epoch 2/20  
18325/18325 [=====] - 223s 12ms/sample - loss: 1.281  
- accuracy: 0.5705 - val\_loss: 1.4667 - val\_accuracy: 0.5162  
Epoch 3/20  
18325/18325 [=====] - 223s 12ms/sample - loss: 0.804  
- accuracy: 0.7352 - val\_loss: 1.5752 - val\_accuracy: 0.5118  
Epoch 4/20  
18325/18325 [=====] - 223s 12ms/sample - loss: 0.402  
- accuracy: 0.8707 - val\_loss: 1.9542 - val\_accuracy: 0.4995  
Epoch 5/20  
18325/18325 [=====] - 225s 12ms/sample - loss: 0.171  
- accuracy: 0.9514 - val\_loss: 2.6155 - val\_accuracy: 0.4963  
Epoch 6/20  
18325/18325 [=====] - 222s 12ms/sample - loss: 0.092  
- accuracy: 0.9733 - val\_loss: 2.7021 - val\_accuracy: 0.4730  
Epoch 7/20  
18325/18325 [=====] - 222s 12ms/sample - loss: 0.097  
- accuracy: 0.9736 - val\_loss: 3.1384 - val\_accuracy: 0.4927  
Epoch 8/20  
18325/18325 [=====] - 222s 12ms/sample - loss: 0.087  
- accuracy: 0.9741 - val\_loss: 3.5269 - val\_accuracy: 0.4787  
Epoch 9/20  
18325/18325 [=====] - 222s 12ms/sample - loss: 0.065  
- accuracy: 0.9827 - val\_loss: 4.0436 - val\_accuracy: 0.4831  
Epoch 10/20  
18325/18325 [=====] - 222s 12ms/sample - loss: 0.059  
- accuracy: 0.9838 - val\_loss: 3.7924 - val\_accuracy: 0.4828  
Epoch 11/20  
18325/18325 [=====] - 221s 12ms/sample - loss: 0.058  
- accuracy: 0.9837 - val\_loss: 3.8965 - val\_accuracy: 0.4882  
Epoch 12/20  
18325/18325 [=====] - 222s 12ms/sample - loss: 0.035  
- accuracy: 0.9896 - val\_loss: 3.9978 - val\_accuracy: 0.4739  
Epoch 13/20  
18325/18325 [=====] - 222s 12ms/sample - loss: 0.043  
- accuracy: 0.9878 - val\_loss: 3.9406 - val\_accuracy: 0.4694  
Epoch 14/20  
18325/18325 [=====] - 221s 12ms/sample - loss: 0.051  
- accuracy: 0.9846 - val\_loss: 4.5418 - val\_accuracy: 0.4789  
Epoch 15/20  
18325/18325 [=====] - 221s 12ms/sample - loss: 0.043  
- accuracy: 0.9864 - val\_loss: 4.6517 - val\_accuracy: 0.4618  
Epoch 16/20  
18325/18325 [=====] - 221s 12ms/sample - loss: 0.047  
- accuracy: 0.9865 - val\_loss: 4.6157 - val\_accuracy: 0.4770  
Epoch 17/20

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18325/18325 [=====] - 222s 12ms/sample - loss: 0.047
2 - accuracy: 0.9865 - val_loss: 4.8444 - val_accuracy: 0.4535
Epoch 18/20
18325/18325 [=====] - 222s 12ms/sample - loss: 0.039
5 - accuracy: 0.9886 - val_loss: 5.5633 - val_accuracy: 0.4649
Epoch 19/20
18325/18325 [=====] - 221s 12ms/sample - loss: 0.031
2 - accuracy: 0.9916 - val_loss: 4.6228 - val_accuracy: 0.4542
Epoch 20/20
18325/18325 [=====] - 221s 12ms/sample - loss: 0.035
6 - accuracy: 0.9902 - val_loss: 5.2516 - val_accuracy: 0.4649
2-conv-128-nodes-2-dense-1600306146
Train on 18325 samples, validate on 7854 samples
Epoch 1/20
18325/18325 [=====] - 345s 19ms/sample - loss: 1.879
9 - accuracy: 0.3430 - val_loss: 1.6044 - val_accuracy: 0.4519
Epoch 2/20
18325/18325 [=====] - 346s 19ms/sample - loss: 1.472
3 - accuracy: 0.4964 - val_loss: 1.4280 - val_accuracy: 0.5163
Epoch 3/20
18325/18325 [=====] - 345s 19ms/sample - loss: 1.205
9 - accuracy: 0.5923 - val_loss: 1.3440 - val_accuracy: 0.5472
Epoch 4/20
18325/18325 [=====] - 346s 19ms/sample - loss: 0.997
9 - accuracy: 0.6595 - val_loss: 1.3158 - val_accuracy: 0.5586
Epoch 5/20
18325/18325 [=====] - 346s 19ms/sample - loss: 0.800
7 - accuracy: 0.7286 - val_loss: 1.4774 - val_accuracy: 0.5306
Epoch 6/20
18325/18325 [=====] - 346s 19ms/sample - loss: 0.619
8 - accuracy: 0.7944 - val_loss: 1.6290 - val_accuracy: 0.5456
Epoch 7/20
18325/18325 [=====] - 348s 19ms/sample - loss: 0.461
9 - accuracy: 0.8442 - val_loss: 1.8051 - val_accuracy: 0.5418
Epoch 8/20
18325/18325 [=====] - 345s 19ms/sample - loss: 0.325
6 - accuracy: 0.8934 - val_loss: 2.1123 - val_accuracy: 0.5435
Epoch 9/20
18325/18325 [=====] - 345s 19ms/sample - loss: 0.226
9 - accuracy: 0.9250 - val_loss: 2.4357 - val_accuracy: 0.5497
Epoch 10/20
18325/18325 [=====] - 345s 19ms/sample - loss: 0.169
6 - accuracy: 0.9437 - val_loss: 2.8321 - val_accuracy: 0.5358
Epoch 11/20
18325/18325 [=====] - 345s 19ms/sample - loss: 0.148
9 - accuracy: 0.9519 - val_loss: 2.9969 - val_accuracy: 0.5204
Epoch 12/20
18325/18325 [=====] - 347s 19ms/sample - loss: 0.113
9 - accuracy: 0.9610 - val_loss: 3.2649 - val_accuracy: 0.5260
Epoch 13/20
18325/18325 [=====] - 347s 19ms/sample - loss: 0.114
3 - accuracy: 0.9613 - val_loss: 3.6611 - val_accuracy: 0.5258
Epoch 14/20
18325/18325 [=====] - 346s 19ms/sample - loss: 0.075
8 - accuracy: 0.9749 - val_loss: 3.9852 - val_accuracy: 0.5414
Epoch 15/20
18325/18325 [=====] - 346s 19ms/sample - loss: 0.101
```

```
8 - accuracy: 0.9684 - val_loss: 3.7839 - val_accuracy: 0.5158
Epoch 16/20
18325/18325 [=====] - 347s 19ms/sample - loss: 0.099
2 - accuracy: 0.9667 - val_loss: 3.7850 - val_accuracy: 0.5357
Epoch 17/20
18325/18325 [=====] - 346s 19ms/sample - loss: 0.057
0 - accuracy: 0.9825 - val_loss: 3.9274 - val_accuracy: 0.5228
Epoch 18/20
18325/18325 [=====] - 346s 19ms/sample - loss: 0.073
6 - accuracy: 0.9769 - val_loss: 4.1115 - val_accuracy: 0.5004
Epoch 19/20
18325/18325 [=====] - 345s 19ms/sample - loss: 0.093
1 - accuracy: 0.9700 - val_loss: 4.1832 - val_accuracy: 0.5157
Epoch 20/20
18325/18325 [=====] - 348s 19ms/sample - loss: 0.060
6 - accuracy: 0.9807 - val_loss: 4.4115 - val_accuracy: 0.5283
3-conv-128-nodes-2-dense-1600313068
Train on 18325 samples, validate on 7854 samples
Epoch 1/20
18325/18325 [=====] - 369s 20ms/sample - loss: 1.898
2 - accuracy: 0.3351 - val_loss: 1.6580 - val_accuracy: 0.4273
Epoch 2/20
18325/18325 [=====] - 369s 20ms/sample - loss: 1.451
1 - accuracy: 0.5033 - val_loss: 1.3455 - val_accuracy: 0.5383
Epoch 3/20
18325/18325 [=====] - 370s 20ms/sample - loss: 1.185
5 - accuracy: 0.5933 - val_loss: 1.2415 - val_accuracy: 0.5786
Epoch 4/20
18325/18325 [=====] - 369s 20ms/sample - loss: 0.985
1 - accuracy: 0.6606 - val_loss: 1.1810 - val_accuracy: 0.6024
Epoch 5/20
18325/18325 [=====] - 369s 20ms/sample - loss: 0.784
2 - accuracy: 0.7306 - val_loss: 1.2192 - val_accuracy: 0.6080
Epoch 6/20
18325/18325 [=====] - 374s 20ms/sample - loss: 0.607
8 - accuracy: 0.7925 - val_loss: 1.2684 - val_accuracy: 0.6271
Epoch 7/20
18325/18325 [=====] - 370s 20ms/sample - loss: 0.435
3 - accuracy: 0.8558 - val_loss: 1.4236 - val_accuracy: 0.6091
Epoch 8/20
18325/18325 [=====] - 376s 20ms/sample - loss: 0.306
8 - accuracy: 0.8956 - val_loss: 1.7791 - val_accuracy: 0.6047
Epoch 9/20
18325/18325 [=====] - 375s 20ms/sample - loss: 0.232
1 - accuracy: 0.9202 - val_loss: 1.8985 - val_accuracy: 0.6081
Epoch 10/20
18325/18325 [=====] - 377s 21ms/sample - loss: 0.161
2 - accuracy: 0.9473 - val_loss: 2.2238 - val_accuracy: 0.5998
Epoch 11/20
18325/18325 [=====] - 373s 20ms/sample - loss: 0.137
5 - accuracy: 0.9536 - val_loss: 2.2274 - val_accuracy: 0.5839
Epoch 12/20
18325/18325 [=====] - 371s 20ms/sample - loss: 0.128
6 - accuracy: 0.9580 - val_loss: 2.3438 - val_accuracy: 0.5887
Epoch 13/20
18325/18325 [=====] - 373s 20ms/sample - loss: 0.107
3 - accuracy: 0.9644 - val_loss: 2.9024 - val_accuracy: 0.6040
```

```

Epoch 14/20
18325/18325 [=====] - 370s 20ms/sample - loss: 0.089
3 - accuracy: 0.9699 - val_loss: 2.7699 - val_accuracy: 0.5974
Epoch 15/20
18325/18325 [=====] - 374s 20ms/sample - loss: 0.113
7 - accuracy: 0.9620 - val_loss: 2.6947 - val_accuracy: 0.5908
Epoch 16/20
18325/18325 [=====] - 373s 20ms/sample - loss: 0.085
1 - accuracy: 0.9722 - val_loss: 2.9330 - val_accuracy: 0.5952
Epoch 17/20
18325/18325 [=====] - 369s 20ms/sample - loss: 0.083
9 - accuracy: 0.9724 - val_loss: 3.0319 - val_accuracy: 0.5940
Epoch 18/20
18325/18325 [=====] - 371s 20ms/sample - loss: 0.076
4 - accuracy: 0.9741 - val_loss: 3.2557 - val_accuracy: 0.5921
Epoch 19/20
18325/18325 [=====] - 371s 20ms/sample - loss: 0.079
4 - accuracy: 0.9748 - val_loss: 3.1622 - val_accuracy: 0.5945
Epoch 20/20
18325/18325 [=====] - 375s 20ms/sample - loss: 0.070
7 - accuracy: 0.9777 - val_loss: 3.1856 - val_accuracy: 0.6039

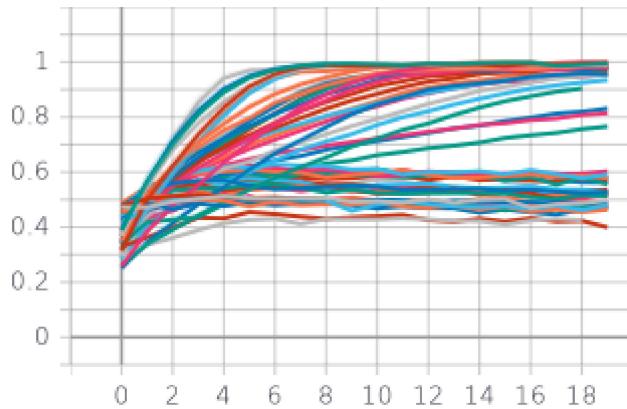
```

## Graph from Models

From the above models we have generated graphs for each of the model and they are shown below. First graph is for epoch accuracy and second one is for epoch loss from those models.

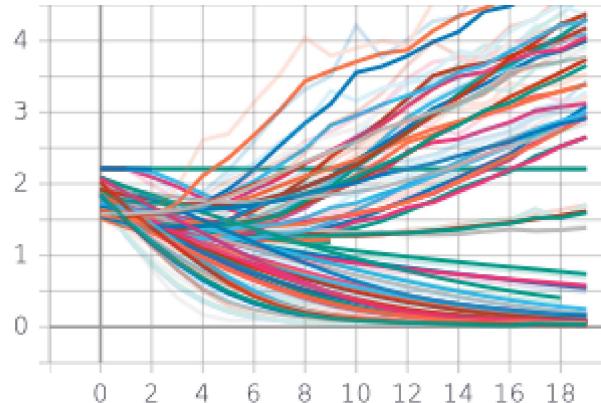
```
In [10]: from IPython.display import Image
Image("./Downloads/epoch_accuracy.png")
```

Out[10]:



```
In [12]: from IPython.display import Image  
Image("./Downloads/epoch_loss(1).png")
```

Out[12]:



## Selected Model

After analyzing we have seen that 128 nodes , 1 convo layer , 0 dense at 9 epoch gives better solution. So we have taken the value and made a model with that value and saved it separately.

```
In [ ]: pickle_in = open("X.pickle", "rb")
X = pickle.load(pickle_in)

pickle_in = open("y.pickle", "rb")
y = pickle.load(pickle_in)

X=np.array(X/255.0)
y=np.array(y)

dense_layers = [0]
layer_sizes = [128]
conv_layers = [1]

for dense_layer in dense_layers:
    for layer_size in layer_sizes:
        for conv_layer in conv_layers:
            NAME = "{}-conv-{}-nodes-{}-dense-{}".format(conv_layer, layer_size, dense_layer, int(time.time()))
            print(NAME)

model = Sequential()

model.add(Conv2D(layer_size, (3, 3), input_shape=X.shape[1:]))
model.add(Activation('relu'))
model.add(MaxPooling2D(pool_size=(2, 2)))

for l in range(conv_layer-1):
    model.add(Conv2D(layer_size, (3, 3)))
    model.add(Activation('relu'))
    model.add(MaxPooling2D(pool_size=(2, 2)))

model.add(Flatten())

for _ in range(dense_layer):
    model.add(Dense(layer_size))
    model.add(Activation('relu'))

model.add(Dense(10))
model.add(Activation('softmax'))

tensorboard = TensorBoard(log_dir = 'C:\\\\Users\\\\mdabd\\\\logs\\\\{}'.format(NAME))

model.compile(loss='sparse_categorical_crossentropy',
              optimizer='adam',
              metrics=['accuracy'],
              )

model.fit(X, y,
           batch_size=32,
           epochs=9,
           validation_split=0.3,
           callbacks=[tensorboard])
model.save('128x1_selected_model-CNN.model')
```

# Result

Lastly as our validation loss is not small so we were facing a lot wrong prediction in the time of testing.Though our loss is low and accuracy is high but because of high validation loss that prediction was 20-40% correct while we were testing the model with picture that was not included in our system.With this model we have done some testing using a cow and dog picture.We did not include the wrong prediction result here.

```
In [8]: import numpy as np
import cv2
import tensorflow as tf
import matplotlib.pyplot as plt
# if using a Jupyter notebook, include:
%matplotlib inline

CATEGORIES = ["butterfly", "cat", "chicken", "cow", "dog", "elephant", "horse", "sheep", "spider", "squirrel"]

def prepare(filepath):
    IMG_SIZE = 80 # 50 in txt-based
    img_array = cv2.imread(filepath, cv2.IMREAD_GRAYSCALE) # read in the image, convert to grayscale
    new_array = cv2.resize(img_array, (IMG_SIZE, IMG_SIZE)) # resize image to match model's expected sizing
    return new_array.reshape(-1, IMG_SIZE, IMG_SIZE, 1) # return the image with shaping that TF wants.

model = tf.keras.models.load_model("128x1_selected_model-CNN.model")

### for cow classification

img = cv2.imread('./data/Sample/cow.jpeg')
gray = cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)

plt.imshow(gray)
plt.title('Input Picture')
plt.show()

prediction = model.predict([prepare('C:/Users/mdabd/data/Sample/cow.jpeg')])
print(prediction) # will be a list in a list.

x_pos = np.arange(len(CATEGORIES))
CTEs = [prediction[0][0], prediction[0][1], prediction[0][2], prediction[0][3], prediction[0][4], prediction[0][5], prediction[0][6], prediction[0][7], prediction[0][8], prediction[0][9]]
fig, ax = plt.subplots()

ax.bar(x_pos, CTEs, align='center', alpha=0.5)
ax.set_ylabel('Predicted value')
ax.set_xticks(x_pos)
ax.set_xticklabels(CATEGORIES)
ax.set_title('Graph of classification')
ax.yaxis.grid(True)

# Save the figure and show
plt.tight_layout()
plt.savefig('bar_plot.png')
plt.show()

## for dog classification
```

```
img = cv2.imread('./data/Sample/dog1.jpg')
gray = cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)

plt.imshow(gray)
plt.title('Input Picture')
plt.show()

prediction = model.predict([prepare('C:/Users/mdabd/data/Sample/dog1.jpg')])
#img = cv2.imread('/data/Sample/dog1.jpg')

print(prediction) # will be a List in a List.

x_pos = np.arange(len(CATEGORIES))
CTEs = [prediction[0][0], prediction[0][1], prediction[0][2], prediction[0][3], prediction[0][4], prediction[0][5], prediction[0][6], prediction[0][7], prediction[0][8], prediction[0][9]]
fig, ax = plt.subplots()

ax.bar(x_pos, CTEs, align='center', alpha=0.5)
ax.set_ylabel('Predicted value')
ax.set_xticks(x_pos)
ax.set_xticklabels(CATEGORIES)
ax.set_title('Graph of classification')
ax.yaxis.grid(True)

# Save the figure and show
plt.tight_layout()
plt.savefig('bar_plot.png')
plt.show()

##for cat

img = cv2.imread('./data/Sample/cat1.jpg')
gray = cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)

plt.imshow(gray)
plt.title('Input Picture')
plt.show()

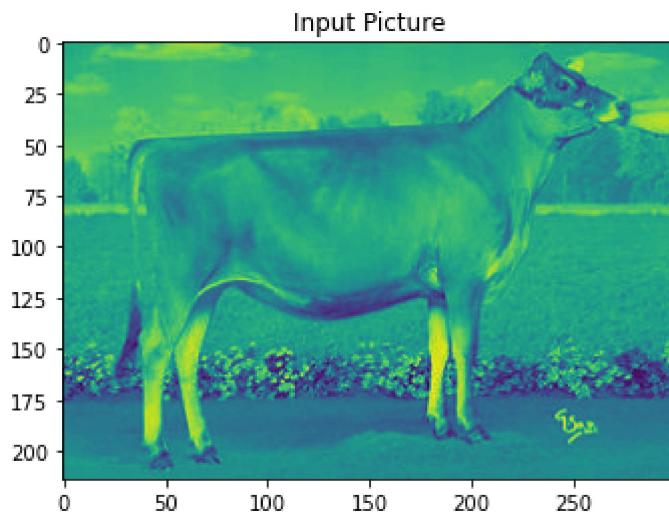
prediction = model.predict([prepare('C:/Users/mdabd/data/Sample/cat1.jpg')])
#img = cv2.imread('/data/Sample/dog1.jpg')

print(prediction) # will be a List in a List.

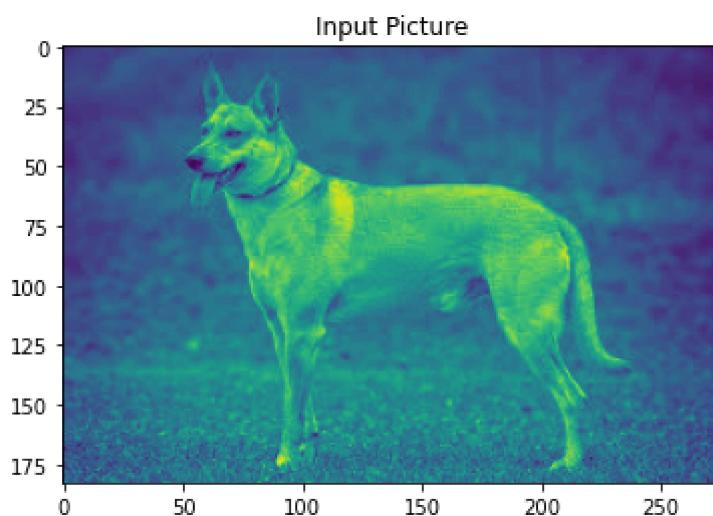
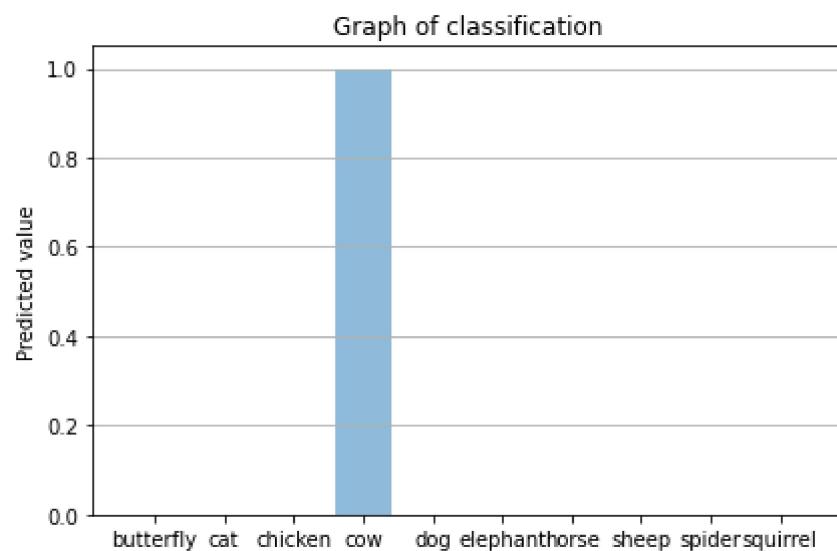
x_pos = np.arange(len(CATEGORIES))
CTEs = [prediction[0][0], prediction[0][1], prediction[0][2], prediction[0][3], prediction[0][4], prediction[0][5], prediction[0][6], prediction[0][7], prediction[0][8], prediction[0][9]]
fig, ax = plt.subplots()
```

```
ax.bar(x_pos, CTEs, align='center', alpha=0.5)
ax.set_ylabel('Predicted value')
ax.set_xticks(x_pos)
ax.set_xticklabels(CATEGORIES)
ax.set_title('Graph of classification')
ax.yaxis.grid(True)

# Save the figure and show
plt.tight_layout()
plt.savefig('bar_plot.png')
plt.show()
```

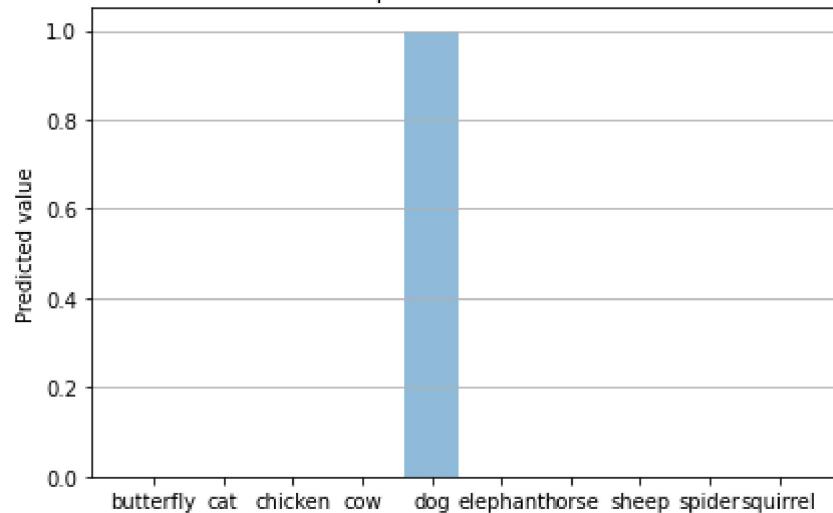


```
[[0. 0. 0. 1. 0. 0. 0. 0. 0. 0.]]
```

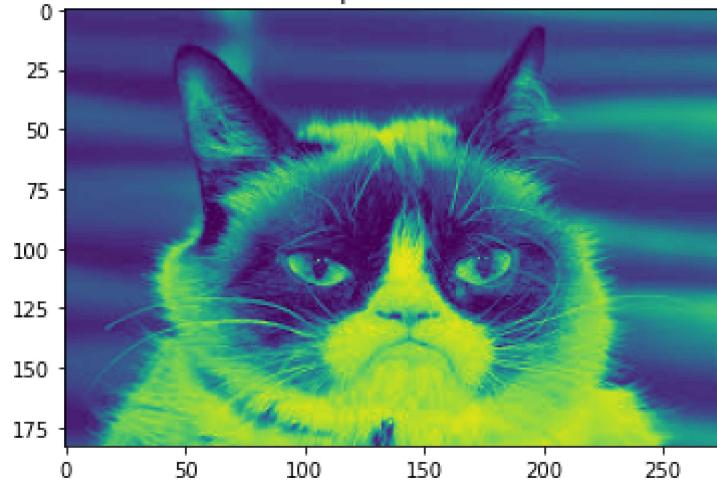


```
[[0. 0. 0. 0. 1. 0. 0. 0. 0. 0.]]
```

Graph of classification

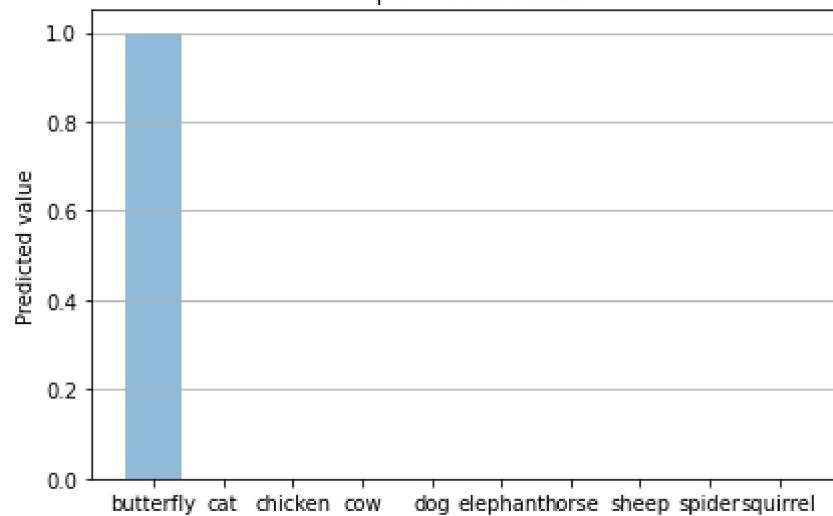


Input Picture



```
[[1. 0. 0. 0. 0. 0. 0. 0. 0. 0.]]
```

Graph of classification



## Resul Analysis

Here we have tested the best model that we have got and give input 3 pictures of cow , dog, cat. We have observed that it gives right prediction for cow and dog but in terms of cat it gives wrong prediction.

## Discussion and Future Direction

Here we have faced a lot of problems like hardware issue , network issue etc.As we did not use gpu version of tensorflow it was taking a lots of time in training.Thats why we could not try moren different models to get more optimize model.So lastly we have decided some future work which will be done in the future.

1. More data will be collected for training.
2. Try to use gpu version.
3. We will make object detection of animal using our own custom model.
4. Try to make more robust model which will be able to detect and classify object from more complex pictures.
5. We will try to make real time object detection.