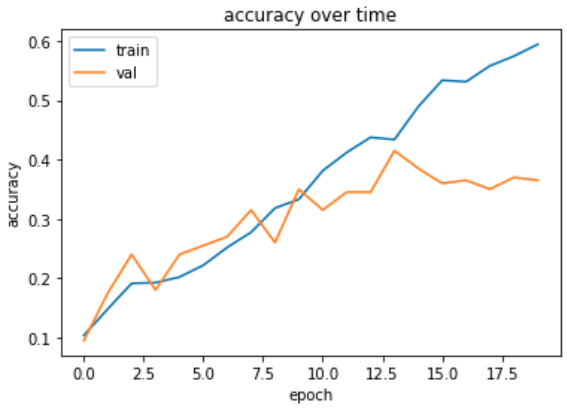
Test: 200 images for 10 classes with dropout or regularizers

```
import tensorflow as tf
cnn = tf.keras.models.Sequential()
cnn.add(tf.keras.layers.Conv2D(filters=64, kernel_size=3, activation='relu', input_shape=[128, 128, 3]))
cnn.add(tf.keras.layers.MaxPool2D(pool_size=2, strides=2))
cnn.add(tf.keras.layers.Conv2D(filters=64, kernel_size=3, activation='relu'))
cnn.add(tf.keras.layers.MaxPool2D(pool_size=2, strides=2))
cnn.add(tf.keras.layers.Conv2D(filters=128, kernel_size=3, activation='relu'))
cnn.add(tf.keras.layers.MaxPool2D(pool_size=2, strides=2))
cnn.add(tf.keras.layers.Conv2D(filters=128, kernel_size=3, activation='relu'))
cnn.add(tf.keras.layers.Dropout(0.25))
cnn.add(tf.keras.layers.MaxPool2D(pool_size=2, strides=2))
cnn.add(tf.keras.layers.Flatten())
cnn.add(tf.keras.layers.Dense(128, activation='relu', kernel_regularizer =tf.keras.regularizers.l2( l=0.01)))
cnn.add(tf.keras.layers.Dropout(0.25))
cnn.add(tf.keras.layers.Dense(len(labels), activation='softmax'))
cnn.summary()
```

```
Model: "sequential"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d (Conv2D)              (None, 126, 126, 64)      1792
_________________________________________________________________
max_pooling2d (MaxPooling2D) (None, 63, 63, 64)        0
_________________________________________________________________
conv2d_1 (Conv2D)            (None, 61, 61, 64)        36928
_________________________________________________________________
max_pooling2d_1 (MaxPooling2 (None, 30, 30, 64)        0
_________________________________________________________________
conv2d_2 (Conv2D)            (None, 28, 28, 128)       73856
_________________________________________________________________
max_pooling2d_2 (MaxPooling2 (None, 14, 14, 128)       0
_________________________________________________________________
conv2d_3 (Conv2D)            (None, 12, 12, 128)       147584
_________________________________________________________________
dropout (Dropout)            (None, 12, 12, 128)       0
_________________________________________________________________
max_pooling2d_3 (MaxPooling2 (None, 6, 6, 128)         0
_________________________________________________________________
flatten (Flatten)            (None, 4608)              0
_________________________________________________________________
dense (Dense)                (None, 128)               589952
_________________________________________________________________
dropout_1 (Dropout)          (None, 128)               0
_________________________________________________________________
dense_1 (Dense)              (None, 10)                1290
=================================================================
Total params: 851,402
Trainable params: 851,402
Non-trainable params: 0
_________________________________________________________________
```

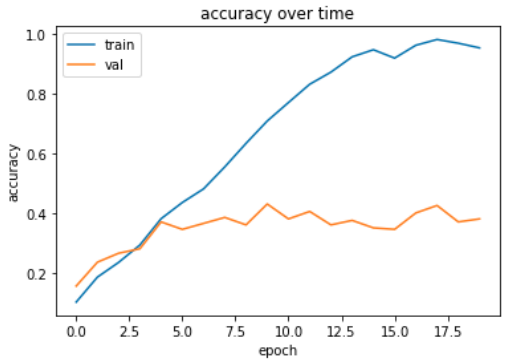


```
Epoch 10/20
50/50 [==============================] - 1s 16ms/step - loss: 1.8652 - accuracy: 0.3581 - val_loss: 1.9781 - val_accuracy: 0.3350
Epoch 11/20
50/50 [==============================] - 1s 16ms/step - loss: 1.7722 - accuracy: 0.3750 - val_loss: 2.0356 - val_accuracy: 0.3550
Epoch 12/20
50/50 [==============================] - 1s 16ms/step - loss: 1.7248 - accuracy: 0.4206 - val_loss: 2.0873 - val_accuracy: 0.2750
Epoch 13/20
50/50 [==============================] - 1s 16ms/step - loss: 1.6701 - accuracy: 0.4412 - val_loss: 2.0685 - val_accuracy: 0.3200
Epoch 14/20
50/50 [==============================] - 1s 16ms/step - loss: 1.6440 - accuracy: 0.4669 - val_loss: 2.0333 - val_accuracy: 0.3700
Epoch 15/20
50/50 [==============================] - 1s 16ms/step - loss: 1.5507 - accuracy: 0.5069 - val_loss: 2.0693 - val_accuracy: 0.3800
Epoch 16/20
50/50 [==============================] - 1s 16ms/step - loss: 1.4890 - accuracy: 0.5381 - val_loss: 2.1528 - val_accuracy: 0.3800
Epoch 17/20
50/50 [==============================] - 1s 16ms/step - loss: 1.3884 - accuracy: 0.5688 - val_loss: 2.1654 - val_accuracy: 0.3650
Epoch 18/20
50/50 [==============================] - 1s 16ms/step - loss: 1.3120 - accuracy: 0.6025 - val_loss: 2.3419 - val_accuracy: 0.3700
Epoch 19/20
50/50 [==============================] - 1s 16ms/step - loss: 1.2939 - accuracy: 0.6181 - val_loss: 2.3231 - val_accuracy: 0.3950
Epoch 20/20
50/50 [==============================] - 1s 16ms/step - loss: 1.2712 - accuracy: 0.6338 - val_loss: 2.4318 - val_accuracy: 0.3750
```

Test: 200 images for 10 classes where no dropout or regularizers

```
import tensorflow as tf
cnn = tf.keras.models.Sequential()
cnn.add(tf.keras.layers.Conv2D(filters=64, kernel_size=3, activation='relu', input_shape=[128, 128, 3]))
cnn.add(tf.keras.layers.MaxPool2D(pool_size=2, strides=2))
cnn.add(tf.keras.layers.Conv2D(filters=64, kernel_size=3, activation='relu'))
cnn.add(tf.keras.layers.MaxPool2D(pool_size=2, strides=2))
cnn.add(tf.keras.layers.Conv2D(filters=128, kernel_size=3, activation='relu'))
cnn.add(tf.keras.layers.MaxPool2D(pool_size=2, strides=2))
cnn.add(tf.keras.layers.Conv2D(filters=128, kernel_size=3, activation='relu'))
cnn.add(tf.keras.layers.MaxPool2D(pool_size=2, strides=2))
cnn.add(tf.keras.layers.Flatten())
cnn.add(tf.keras.layers.Dense(128, activation='relu'))
cnn.add(tf.keras.layers.Dense(len(labels), activation='softmax'))
cnn.summary()
```

```
Model: "sequential_1"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_4 (Conv2D)            (None, 126, 126, 64)      1792
_________________________________________________________________
max_pooling2d_4 (MaxPooling2 (None, 63, 63, 64)        0
_________________________________________________________________
conv2d_5 (Conv2D)            (None, 61, 61, 64)        36928
_________________________________________________________________
max_pooling2d_5 (MaxPooling2 (None, 30, 30, 64)        0
_________________________________________________________________
conv2d_6 (Conv2D)            (None, 28, 28, 128)       73856
_________________________________________________________________
max_pooling2d_6 (MaxPooling2 (None, 14, 14, 128)       0
_________________________________________________________________
conv2d_7 (Conv2D)            (None, 12, 12, 128)       147584
_________________________________________________________________
max_pooling2d_7 (MaxPooling2 (None, 6, 6, 128)         0
_________________________________________________________________
flatten_1 (Flatten)          (None, 4608)              0
_________________________________________________________________
dense_2 (Dense)              (None, 128)               589952
_________________________________________________________________
dense_3 (Dense)              (None, 10)                1290
=================================================================
Total params: 851,402
Trainable params: 851,402
Non-trainable params: 0
```

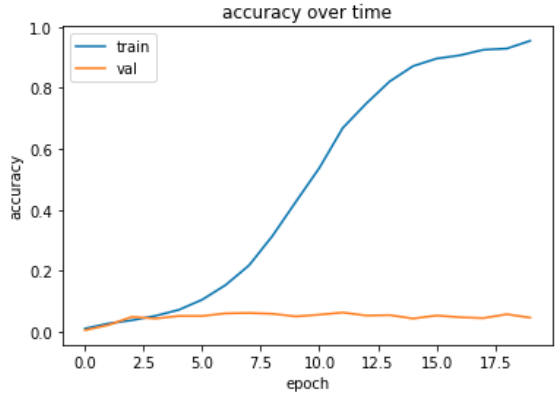



```
Epoch 10/20
50/50 [==============================] - 1s 15ms/step - loss: 0.8515 - accuracy: 0.7081 - val_loss: 2.4766 - val_accuracy: 0.4300
Epoch 11/20
50/50 [==============================] - 1s 16ms/step - loss: 0.6658 - accuracy: 0.7700 - val_loss: 2.8371 - val_accuracy: 0.3800
Epoch 12/20
50/50 [==============================] - 1s 15ms/step - loss: 0.5241 - accuracy: 0.8313 - val_loss: 3.1619 - val_accuracy: 0.4050
Epoch 13/20
50/50 [==============================] - 1s 15ms/step - loss: 0.3698 - accuracy: 0.8719 - val_loss: 4.0678 - val_accuracy: 0.3600
Epoch 14/20
50/50 [==============================] - 1s 15ms/step - loss: 0.2537 - accuracy: 0.9231 - val_loss: 4.4045 - val_accuracy: 0.3750
Epoch 15/20
50/50 [==============================] - 1s 15ms/step - loss: 0.1695 - accuracy: 0.9469 - val_loss: 4.8725 - val_accuracy: 0.3500
Epoch 16/20
50/50 [==============================] - 1s 15ms/step - loss: 0.2520 - accuracy: 0.9187 - val_loss: 4.5326 - val_accuracy: 0.3450
Epoch 17/20
50/50 [==============================] - 1s 15ms/step - loss: 0.1225 - accuracy: 0.9619 - val_loss: 5.1866 - val_accuracy: 0.4000
Epoch 18/20
50/50 [==============================] - 1s 15ms/step - loss: 0.0621 - accuracy: 0.9812 - val_loss: 5.8426 - val_accuracy: 0.4250
Epoch 19/20
50/50 [==============================] - 1s 15ms/step - loss: 0.1103 - accuracy: 0.9688 - val_loss: 5.9081 - val_accuracy: 0.3700
Epoch 20/20
50/50 [==============================] - 1s 15ms/step - loss: 0.1482 - accuracy: 0.9531 - val_loss: 5.7881 - val_accuracy: 0.3800
```

Test: 50 images for 101 classes with no dropout or regularizers

```
import tensorflow as tf
cnn = tf.keras.models.Sequential()
cnn.add(tf.keras.layers.Conv2D(filters=64, kernel_size=3, activation='relu', input_shape=[128, 128, 3]))
cnn.add(tf.keras.layers.MaxPool2D(pool_size=2, strides=2))
cnn.add(tf.keras.layers.Conv2D(filters=64, kernel_size=3, activation='relu'))
cnn.add(tf.keras.layers.MaxPool2D(pool_size=2, strides=2))
cnn.add(tf.keras.layers.Conv2D(filters=128, kernel_size=3, activation='relu'))
cnn.add(tf.keras.layers.MaxPool2D(pool_size=2, strides=2))
cnn.add(tf.keras.layers.Conv2D(filters=128, kernel_size=3, activation='relu'))
cnn.add(tf.keras.layers.MaxPool2D(pool_size=2, strides=2))
cnn.add(tf.keras.layers.Flatten())
cnn.add(tf.keras.layers.Dense(128, activation='relu'))
cnn.add(tf.keras.layers.Dense(len(labels), activation='softmax'))
cnn.summary()
```

```
Model: "sequential_3"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_12 (Conv2D)           (None, 126, 126, 64)      1792
_________________________________________________________________
max_pooling2d_12 (MaxPooling (None, 63, 63, 64)        0
_________________________________________________________________
conv2d_13 (Conv2D)           (None, 61, 61, 64)        36928
_________________________________________________________________
max_pooling2d_13 (MaxPooling (None, 30, 30, 64)        0
_________________________________________________________________
conv2d_14 (Conv2D)           (None, 28, 28, 128)       73856
_________________________________________________________________
max_pooling2d_14 (MaxPooling (None, 14, 14, 128)       0
_________________________________________________________________
conv2d_15 (Conv2D)           (None, 12, 12, 128)       147584
_________________________________________________________________
max_pooling2d_15 (MaxPooling (None, 6, 6, 128)         0
_________________________________________________________________
flatten_3 (Flatten)          (None, 4608)              0
_________________________________________________________________
dense_6 (Dense)              (None, 128)               589952
_________________________________________________________________
dense_7 (Dense)              (None, 101)               13029
=================================================================
Total params: 863,141
Trainable params: 863,141
Non-trainable params: 0
_________________________________________________________________
```




```
Epoch 10/20
177/177 [==============================] - 3s 16ms/step - loss: 2.2652 - accuracy: 0.4270 - val_loss: 5.7923 - val_accuracy: 0.0509
Epoch 11/20
177/177 [==============================] - 3s 16ms/step - loss: 1.7797 - accuracy: 0.5375 - val_loss: 7.0812 - val_accuracy: 0.0566
Epoch 12/20
177/177 [==============================] - 3s 16ms/step - loss: 1.2615 - accuracy: 0.6687 - val_loss: 8.1677 - val_accuracy: 0.0636
Epoch 13/20
177/177 [==============================] - 3s 16ms/step - loss: 0.9028 - accuracy: 0.7486 - val_loss: 9.9306 - val_accuracy: 0.0537
Epoch 14/20
177/177 [==============================] - 3s 16ms/step - loss: 0.6437 - accuracy: 0.8211 - val_loss: 11.9800 - val_accuracy: 0.0552
Epoch 15/20
177/177 [==============================] - 3s 16ms/step - loss: 0.4673 - accuracy: 0.8715 - val_loss: 13.0382 - val_accuracy: 0.0438
Epoch 16/20
177/177 [==============================] - 3s 16ms/step - loss: 0.3669 - accuracy: 0.8960 - val_loss: 14.4786 - val_accuracy: 0.0537
Epoch 17/20
177/177 [==============================] - 3s 16ms/step - loss: 0.3113 - accuracy: 0.9068 - val_loss: 15.8364 - val_accuracy: 0.0481
Epoch 18/20
177/177 [==============================] - 3s 16ms/step - loss: 0.2633 - accuracy: 0.9250 - val_loss: 16.2106 - val_accuracy: 0.0453
Epoch 19/20
177/177 [==============================] - 3s 16ms/step - loss: 0.2399 - accuracy: 0.9289 - val_loss: 16.8409 - val_accuracy: 0.0580
Epoch 20/20
177/177 [==============================] - 3s 16ms/step - loss: 0.1573 - accuracy: 0.9544 - val_loss: 18.3495 - val_accuracy: 0.0467
```

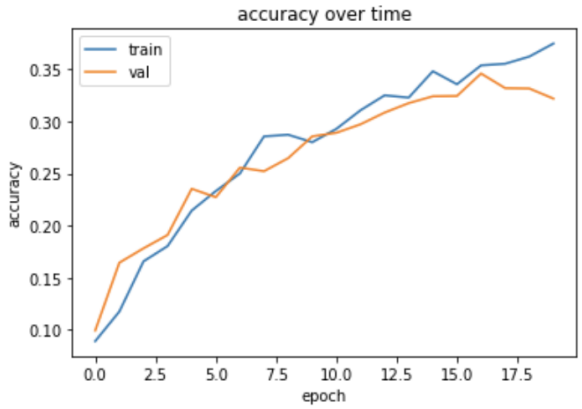
Test: 1000 images for 20 classes with no dropout or regularizers

```
import tensorflow as tf
tf.keras.backend.clear_session()
num_classes = 20

cnn = tf.keras.models.Sequential()
cnn.add(tf.keras.layers.Conv2D(filters=32, kernel_size=(5,5), activation='relu', input_shape=[img_height, img_width, 3]))
cnn.add(tf.keras.layers.Conv2D(filters=32, kernel_size=(5,5), activation='relu'))
cnn.add(tf.keras.layers.MaxPool2D(pool_size=2, strides=2))
cnn.add(tf.keras.layers.Conv2D(filters=64, kernel_size=(3,3), activation='relu'))
cnn.add(tf.keras.layers.Conv2D(filters=64, kernel_size=(3,3), activation='relu'))
cnn.add(tf.keras.layers.MaxPool2D(pool_size=2, strides=2))
cnn.add(tf.keras.layers.Flatten())
cnn.add(tf.keras.layers.Dense(128, activation='relu'))
cnn.add(tf.keras.layers.Dense(num_classes, activation='softmax'))

cnn.summary()
cnn.compile(optimizer='adam', loss="categorical_crossentropy", metrics=["accuracy"])
```

```
Model: "sequential"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d (Conv2D)              (None, 124, 124, 32)      2432
_________________________________________________________________
conv2d_1 (Conv2D)            (None, 120, 120, 32)      25632
_________________________________________________________________
max_pooling2d (MaxPooling2D) (None, 60, 60, 32)        0
_________________________________________________________________
conv2d_2 (Conv2D)            (None, 58, 58, 64)        18496
_________________________________________________________________
conv2d_3 (Conv2D)            (None, 56, 56, 64)        36928
_________________________________________________________________
max_pooling2d_1 (MaxPooling2 (None, 28, 28, 64)        0
_________________________________________________________________
flatten (Flatten)            (None, 50176)             0
_________________________________________________________________
dense (Dense)                (None, 128)               6422656
_________________________________________________________________
dense_1 (Dense)              (None, 20)                2580
=================================================================
Total params: 6,508,724
Trainable params: 6,508,724
Non-trainable params: 0
_________________________________________________________________
```

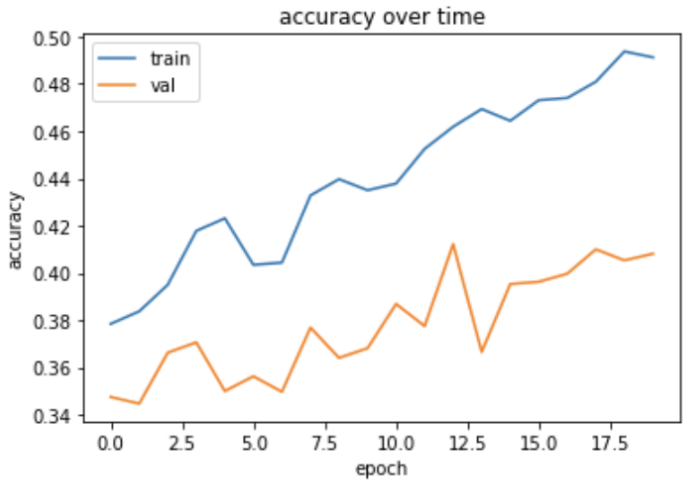
20 epochs and original images:

```
Epoch 1/20
100/100 [==============================] - 1460s 15s/step - loss: 2.9424 - accuracy: 0.0891 - val_loss: 2.8723 - val_accuracy: 0.0994
Epoch 2/20
100/100 [==============================] - 704s 7s/step - loss: 2.8167 - accuracy: 0.1175 - val_loss: 2.7115 - val_accuracy: 0.1644
Epoch 3/20
100/100 [==============================] - 496s 5s/step - loss: 2.6893 - accuracy: 0.1656 - val_loss: 2.6488 - val_accuracy: 0.1781
Epoch 4/20
100/100 [==============================] - 376s 4s/step - loss: 2.6319 - accuracy: 0.1803 - val_loss: 2.5891 - val_accuracy: 0.1909
Epoch 5/20
100/100 [==============================] - 301s 3s/step - loss: 2.5245 - accuracy: 0.2144 - val_loss: 2.4790 - val_accuracy: 0.2353
Epoch 6/20
100/100 [==============================] - 254s 3s/step - loss: 2.4476 - accuracy: 0.2331 - val_loss: 2.4601 - val_accuracy: 0.2272
Epoch 7/20
100/100 [==============================] - 208s 2s/step - loss: 2.3941 - accuracy: 0.2500 - val_loss: 2.3875 - val_accuracy: 0.2556
Epoch 8/20
100/100 [==============================] - 179s 2s/step - loss: 2.3449 - accuracy: 0.2856 - val_loss: 2.4391 - val_accuracy: 0.2522
Epoch 9/20
100/100 [==============================] - 159s 2s/step - loss: 2.3230 - accuracy: 0.2872 - val_loss: 2.3630 - val_accuracy: 0.2647
Epoch 10/20
100/100 [==============================] - 131s 1s/step - loss: 2.3318 - accuracy: 0.2800 - val_loss: 2.3215 - val_accuracy: 0.2856
Epoch 11/20
100/100 [==============================] - 114s 1s/step - loss: 2.2688 - accuracy: 0.2928 - val_loss: 2.2853 - val_accuracy: 0.2891
Epoch 12/20
100/100 [==============================] - 103s 1s/step - loss: 2.2113 - accuracy: 0.3106 - val_loss: 2.2941 - val_accuracy: 0.2972
Epoch 13/20
100/100 [==============================] - 89s 896ms/step - loss: 2.1715 - accuracy: 0.3250 - val_loss: 2.2416 - val_accuracy: 0.3084
Epoch 14/20
100/100 [==============================] - 85s 849ms/step - loss: 2.1658 - accuracy: 0.3228 - val_loss: 2.2442 - val_accuracy: 0.3175
Epoch 15/20
100/100 [==============================] - 77s 772ms/step - loss: 2.1161 - accuracy: 0.3481 - val_loss: 2.1917 - val_accuracy: 0.3241
Epoch 16/20
100/100 [==============================] - 71s 712ms/step - loss: 2.1216 - accuracy: 0.3356 - val_loss: 2.2018 - val_accuracy: 0.3244
Epoch 17/20
100/100 [==============================] - 65s 653ms/step - loss: 2.0964 - accuracy: 0.3537 - val_loss: 2.1546 - val_accuracy: 0.3459
Epoch 18/20
100/100 [==============================] - 64s 644ms/step - loss: 2.0913 - accuracy: 0.3553 - val_loss: 2.1578 - val_accuracy: 0.3319
Epoch 19/20
100/100 [==============================] - 62s 626ms/step - loss: 2.0699 - accuracy: 0.3622 - val_loss: 2.1640 - val_accuracy: 0.3316
Epoch 20/20
100/100 [==============================] - 61s 604ms/step - loss: 2.0118 - accuracy: 0.3747 - val_loss: 2.2197 - val_accuracy: 0.3219
```



40 epochs and original images:

```
Epoch 1/20
100/100 [==============================] - 56s 565ms/step - loss: 2.0309 - accuracy: 0.3784 - val_loss: 2.1165 - val_accuracy: 0.3475
Epoch 2/20
100/100 [==============================] - 55s 554ms/step - loss: 1.9848 - accuracy: 0.3837 - val_loss: 2.1527 - val_accuracy: 0.3447
Epoch 3/20
100/100 [==============================] - 52s 521ms/step - loss: 1.9476 - accuracy: 0.3950 - val_loss: 2.0943 - val_accuracy: 0.3663
Epoch 4/20
100/100 [==============================] - 52s 525ms/step - loss: 1.8920 - accuracy: 0.4178 - val_loss: 2.0825 - val_accuracy: 0.3706
Epoch 5/20
100/100 [==============================] - 52s 524ms/step - loss: 1.8880 - accuracy: 0.4231 - val_loss: 2.1210 - val_accuracy: 0.3500
Epoch 6/20
100/100 [==============================] - 51s 510ms/step - loss: 1.9428 - accuracy: 0.4034 - val_loss: 2.1444 - val_accuracy: 0.3562
Epoch 7/20
100/100 [==============================] - 51s 508ms/step - loss: 1.8994 - accuracy: 0.4044 - val_loss: 2.1415 - val_accuracy: 0.3497
Epoch 8/20
100/100 [==============================] - 51s 509ms/step - loss: 1.8395 - accuracy: 0.4328 - val_loss: 2.0655 - val_accuracy: 0.3769
Epoch 9/20
100/100 [==============================] - 50s 499ms/step - loss: 1.8352 - accuracy: 0.4397 - val_loss: 2.0389 - val_accuracy: 0.3641
Epoch 10/20
100/100 [==============================] - 51s 513ms/step - loss: 1.8270 - accuracy: 0.4350 - val_loss: 2.0779 - val_accuracy: 0.3681
Epoch 11/20
100/100 [==============================] - 50s 504ms/step - loss: 1.8295 - accuracy: 0.4378 - val_loss: 2.0550 - val_accuracy: 0.3869
Epoch 12/20
100/100 [==============================] - 50s 498ms/step - loss: 1.7708 - accuracy: 0.4525 - val_loss: 2.1078 - val_accuracy: 0.3775
Epoch 13/20
100/100 [==============================] - 50s 501ms/step - loss: 1.7568 - accuracy: 0.4619 - val_loss: 2.0265 - val_accuracy: 0.4122
Epoch 14/20
100/100 [==============================] - 49s 492ms/step - loss: 1.7444 - accuracy: 0.4694 - val_loss: 2.1484 - val_accuracy: 0.3666
Epoch 15/20
100/100 [==============================] - 49s 496ms/step - loss: 1.7459 - accuracy: 0.4644 - val_loss: 2.0442 - val_accuracy: 0.3953
Epoch 16/20
100/100 [==============================] - 50s 498ms/step - loss: 1.6868 - accuracy: 0.4731 - val_loss: 2.0380 - val_accuracy: 0.3963
Epoch 17/20
100/100 [==============================] - 49s 495ms/step - loss: 1.7070 - accuracy: 0.4741 - val_loss: 1.9960 - val_accuracy: 0.3997
Epoch 18/20
100/100 [==============================] - 49s 494ms/step - loss: 1.6929 - accuracy: 0.4809 - val_loss: 1.9376 - val_accuracy: 0.4100
Epoch 19/20
100/100 [==============================] - 49s 489ms/step - loss: 1.6390 - accuracy: 0.4938 - val_loss: 2.0012 - val_accuracy: 0.4053
Epoch 20/20
100/100 [==============================] - 49s 490ms/step - loss: 1.6162 - accuracy: 0.4913 - val_loss: 1.9813 - val_accuracy: 0.4081
```



40 epochs and grayscale and nearest interpolation:

```
Epoch 1/40
100/100 [==============================] - 1624s 16s/step - loss: 2.9882 - accuracy: 0.0625 - val_loss: 2.9057 - val_accuracy: 0.0928
Epoch 2/40
100/100 [==============================] - 791s 8s/step - loss: 2.8551 - accuracy: 0.1066 - val_loss: 2.8461 - val_accuracy: 0.1081
Epoch 3/40
100/100 [==============================] - 534s 5s/step - loss: 2.8249 - accuracy: 0.1119 - val_loss: 2.8273 - val_accuracy: 0.1231
Epoch 4/40
100/100 [==============================] - 419s 4s/step - loss: 2.8120 - accuracy: 0.1300 - val_loss: 2.8336 - val_accuracy: 0.1069
Epoch 5/40
100/100 [==============================] - 344s 3s/step - loss: 2.7986 - accuracy: 0.1169 - val_loss: 2.8098 - val_accuracy: 0.1203
Epoch 6/40
100/100 [==============================] - 268s 3s/step - loss: 2.7841 - accuracy: 0.1319 - val_loss: 2.7745 - val_accuracy: 0.1391
Epoch 7/40
100/100 [==============================] - 237s 2s/step - loss: 2.7663 - accuracy: 0.1363 - val_loss: 2.7727 - val_accuracy: 0.1356
Epoch 8/40
100/100 [==============================] - 199s 2s/step - loss: 2.7373 - accuracy: 0.1628 - val_loss: 2.7740 - val_accuracy: 0.1388
Epoch 9/40
100/100 [==============================] - 155s 2s/step - loss: 2.7268 - accuracy: 0.1538 - val_loss: 2.7438 - val_accuracy: 0.1441
Epoch 10/40
100/100 [==============================] - 137s 1s/step - loss: 2.6984 - accuracy: 0.1722 - val_loss: 2.7645 - val_accuracy: 0.1412
Epoch 11/40
100/100 [==============================] - 122s 1s/step - loss: 2.7091 - accuracy: 0.1663 - val_loss: 2.7346 - val_accuracy: 0.1469
Epoch 12/40
100/100 [==============================] - 100s 998ms/step - loss: 2.6636 - accuracy: 0.1784 - val_loss: 2.7666 - val_accuracy: 0.1528
Epoch 13/40
100/100 [==============================] - 85s 850ms/step - loss: 2.6590 - accuracy: 0.1706 - val_loss: 2.7018 - val_accuracy: 0.1516
Epoch 14/40
100/100 [==============================] - 75s 756ms/step - loss: 2.6092 - accuracy: 0.1969 - val_loss: 2.6619 - val_accuracy: 0.1759
Epoch 15/40
100/100 [==============================] - 70s 705ms/step - loss: 2.6000 - accuracy: 0.1966 - val_loss: 2.6282 - val_accuracy: 0.1841
Epoch 16/40
100/100 [==============================] - 65s 650ms/step - loss: 2.5958 - accuracy: 0.2044 - val_loss: 2.6223 - val_accuracy: 0.1809
Epoch 17/40
100/100 [==============================] - 57s 570ms/step - loss: 2.5428 - accuracy: 0.2078 - val_loss: 2.5931 - val_accuracy: 0.2000
Epoch 18/40
100/100 [==============================] - 55s 550ms/step - loss: 2.5306 - accuracy: 0.2203 - val_loss: 2.6103 - val_accuracy: 0.1912
Epoch 19/40
100/100 [==============================] - 52s 522ms/step - loss: 2.5164 - accuracy: 0.2262 - val_loss: 2.5897 - val_accuracy: 0.2025
Epoch 20/40
100/100 [==============================] - 50s 498ms/step - loss: 2.4795 - accuracy: 0.2356 - val_loss: 2.5863 - val_accuracy: 0.2003
```

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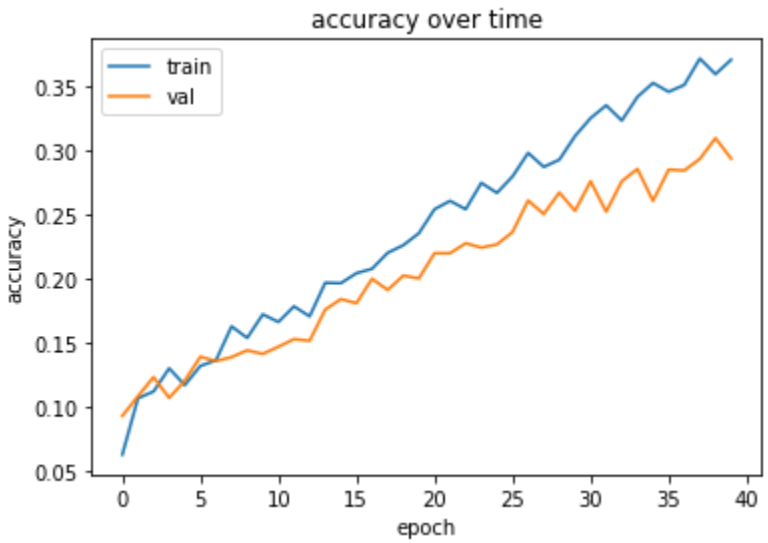
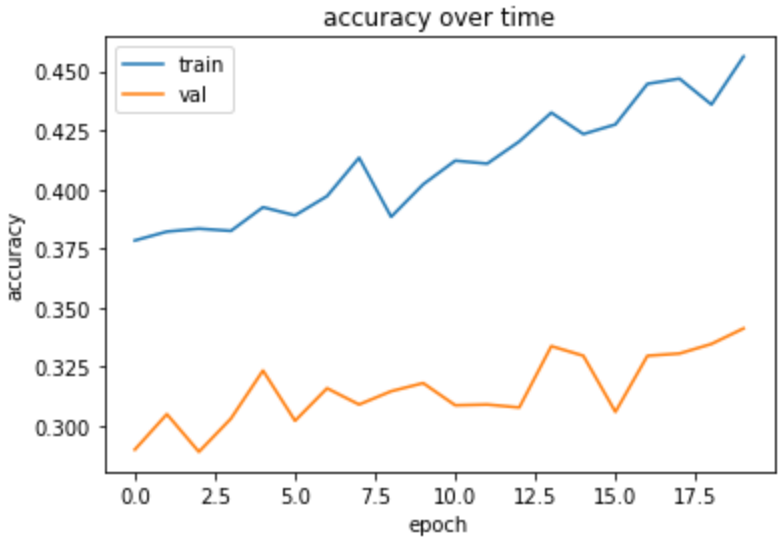
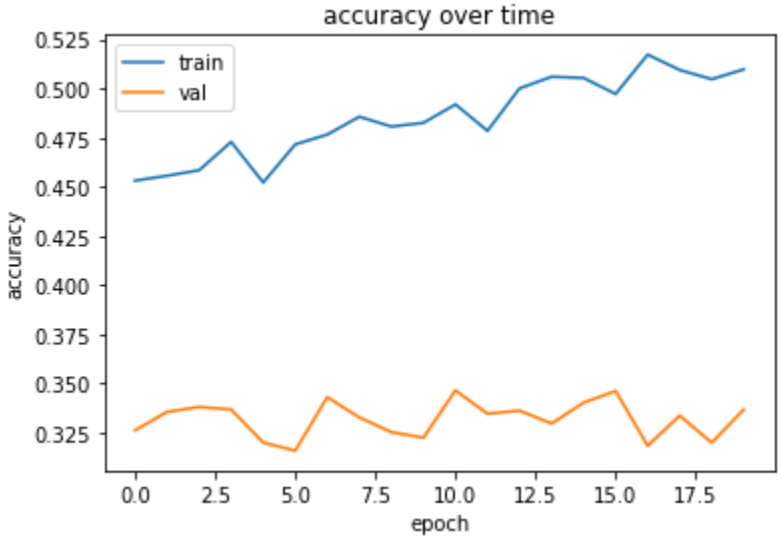
Epoch 21/40
100/100 [==============================] - 48s 481ms/step - loss: 2.4365 - accuracy: 0.2544 - val_loss: 2.5554 - val_accuracy: 0.2200
Epoch 22/40
100/100 [==============================] - 46s 459ms/step - loss: 2.4231 - accuracy: 0.2609 - val_loss: 2.5245 - val_accuracy: 0.2200
Epoch 23/40
100/100 [==============================] - 47s 469ms/step - loss: 2.4441 - accuracy: 0.2544 - val_loss: 2.5367 - val_accuracy: 0.2278
Epoch 24/40
100/100 [==============================] - 43s 435ms/step - loss: 2.3710 - accuracy: 0.2750 - val_loss: 2.5263 - val_accuracy: 0.2244
Epoch 25/40
100/100 [==============================] - 44s 441ms/step - loss: 2.3590 - accuracy: 0.2672 - val_loss: 2.5242 - val_accuracy: 0.2269
Epoch 26/40
100/100 [==============================] - 42s 421ms/step - loss: 2.3663 - accuracy: 0.2800 - val_loss: 2.4796 - val_accuracy: 0.2366
Epoch 27/40
100/100 [==============================] - 42s 422ms/step - loss: 2.2980 - accuracy: 0.2984 - val_loss: 2.4169 - val_accuracy: 0.2612
Epoch 28/40
100/100 [==============================] - 41s 416ms/step - loss: 2.3210 - accuracy: 0.2875 - val_loss: 2.4470 - val_accuracy: 0.2506
Epoch 29/40
100/100 [==============================] - 41s 414ms/step - loss: 2.2643 - accuracy: 0.2931 - val_loss: 2.4226 - val_accuracy: 0.2675
Epoch 30/40
100/100 [==============================] - 42s 423ms/step - loss: 2.2745 - accuracy: 0.3116 - val_loss: 2.3791 - val_accuracy: 0.2531
Epoch 31/40
100/100 [==============================] - 41s 416ms/step - loss: 2.2055 - accuracy: 0.3256 - val_loss: 2.3463 - val_accuracy: 0.2763
Epoch 32/40
100/100 [==============================] - 40s 405ms/step - loss: 2.1957 - accuracy: 0.3356 - val_loss: 2.5142 - val_accuracy: 0.2525
Epoch 33/40
100/100 [==============================] - 41s 413ms/step - loss: 2.2245 - accuracy: 0.3237 - val_loss: 2.3614 - val_accuracy: 0.2763
Epoch 34/40
100/100 [==============================] - 41s 407ms/step - loss: 2.1570 - accuracy: 0.3422 - val_loss: 2.3407 - val_accuracy: 0.2859
Epoch 35/40
100/100 [==============================] - 40s 406ms/step - loss: 2.1343 - accuracy: 0.3531 - val_loss: 2.4584 - val_accuracy: 0.2609
Epoch 36/40
100/100 [==============================] - 40s 402ms/step - loss: 2.1097 - accuracy: 0.3462 - val_loss: 2.3399 - val_accuracy: 0.2853
Epoch 37/40
100/100 [==============================] - 41s 407ms/step - loss: 2.0869 - accuracy: 0.3516 - val_loss: 2.3800 - val_accuracy: 0.2847
Epoch 38/40
100/100 [==============================] - 40s 401ms/step - loss: 2.0355 - accuracy: 0.3722 - val_loss: 2.3296 - val_accuracy: 0.2937
Epoch 39/40
100/100 [==============================] - 40s 402ms/step - loss: 2.0566 - accuracy: 0.3600 - val_loss: 2.2427 - val_accuracy: 0.3100
Epoch 40/40
100/100 [==============================] - 40s 401ms/step - loss: 2.0417 - accuracy: 0.3713 - val_loss: 2.3659 - val_accuracy: 0.2941

Epoch 1/20
100/100 [==============================] - 41s 412ms/step - loss: 2.0173 - accuracy: 0.3784 - val_loss: 2.3226 - val_accuracy: 0.2900
Epoch 2/20
100/100 [==============================] - 41s 412ms/step - loss: 2.0479 - accuracy: 0.3822 - val_loss: 2.2598 - val_accuracy: 0.3050
Epoch 3/20
100/100 [==============================] - 41s 415ms/step - loss: 2.0139 - accuracy: 0.3834 - val_loss: 2.3091 - val_accuracy: 0.2891
Epoch 4/20
100/100 [==============================] - 42s 418ms/step - loss: 1.9876 - accuracy: 0.3825 - val_loss: 2.2956 - val_accuracy: 0.3031
Epoch 5/20
100/100 [==============================] - 41s 413ms/step - loss: 1.9563 - accuracy: 0.3925 - val_loss: 2.2332 - val_accuracy: 0.3234
Epoch 6/20
100/100 [==============================] - 41s 412ms/step - loss: 1.9449 - accuracy: 0.3891 - val_loss: 2.2982 - val_accuracy: 0.3022
Epoch 7/20
100/100 [==============================] - 41s 413ms/step - loss: 1.9831 - accuracy: 0.3972 - val_loss: 2.2571 - val_accuracy: 0.3159
Epoch 8/20
100/100 [==============================] - 42s 423ms/step - loss: 1.9368 - accuracy: 0.4134 - val_loss: 2.2676 - val_accuracy: 0.3091
Epoch 9/20
100/100 [==============================] - 41s 415ms/step - loss: 1.9645 - accuracy: 0.3884 - val_loss: 2.2350 - val_accuracy: 0.3147
Epoch 10/20
100/100 [==============================] - 42s 423ms/step - loss: 1.9288 - accuracy: 0.4022 - val_loss: 2.2353 - val_accuracy: 0.3181
Epoch 11/20
100/100 [==============================] - 41s 415ms/step - loss: 1.8974 - accuracy: 0.4122 - val_loss: 2.2877 - val_accuracy: 0.3088
Epoch 12/20
100/100 [==============================] - 41s 411ms/step - loss: 1.8979 - accuracy: 0.4109 - val_loss: 2.2422 - val_accuracy: 0.3091
Epoch 13/20
100/100 [==============================] - 41s 412ms/step - loss: 1.8881 - accuracy: 0.4203 - val_loss: 2.3072 - val_accuracy: 0.3078
Epoch 14/20
100/100 [==============================] - 41s 414ms/step - loss: 1.8561 - accuracy: 0.4325 - val_loss: 2.2173 - val_accuracy: 0.3338
Epoch 15/20
100/100 [==============================] - 42s 419ms/step - loss: 1.8660 - accuracy: 0.4234 - val_loss: 2.2329 - val_accuracy: 0.3297
Epoch 16/20
100/100 [==============================] - 41s 409ms/step - loss: 1.8471 - accuracy: 0.4275 - val_loss: 2.3097 - val_accuracy: 0.3059
Epoch 17/20
100/100 [==============================] - 41s 413ms/step - loss: 1.7927 - accuracy: 0.4447 - val_loss: 2.2178 - val_accuracy: 0.3297
Epoch 18/20
100/100 [==============================] - 41s 414ms/step - loss: 1.8097 - accuracy: 0.4469 - val_loss: 2.2194 - val_accuracy: 0.3306
Epoch 19/20
100/100 [==============================] - 41s 409ms/step - loss: 1.8412 - accuracy: 0.4359 - val_loss: 2.1902 - val_accuracy: 0.3347
Epoch 20/20
100/100 [==============================] - 41s 407ms/step - loss: 1.7861 - accuracy: 0.4563 - val_loss: 2.2235 - val_accuracy: 0.3413
```

```
Epoch 1/20
100/100 [==============================] - 41s 414ms/step - loss: 1.7885 - accuracy: 0.4531 - val_loss: 2.2462 - val_accuracy: 0.3262
Epoch 2/20
100/100 [==============================] - 42s 425ms/step - loss: 1.8086 - accuracy: 0.4556 - val_loss: 2.2238 - val_accuracy: 0.3356
Epoch 3/20
100/100 [==============================] - 42s 424ms/step - loss: 1.7565 - accuracy: 0.4584 - val_loss: 2.1984 - val_accuracy: 0.3381
Epoch 4/20
100/100 [==============================] - 41s 416ms/step - loss: 1.7463 - accuracy: 0.4728 - val_loss: 2.2153 - val_accuracy: 0.3369
Epoch 5/20
100/100 [==============================] - 41s 414ms/step - loss: 1.7788 - accuracy: 0.4522 - val_loss: 2.2665 - val_accuracy: 0.3200
Epoch 6/20
100/100 [==============================] - 41s 411ms/step - loss: 1.7117 - accuracy: 0.4716 - val_loss: 2.2590 - val_accuracy: 0.3159
Epoch 7/20
100/100 [==============================] - 41s 409ms/step - loss: 1.6949 - accuracy: 0.4766 - val_loss: 2.2523 - val_accuracy: 0.3431
Epoch 8/20
100/100 [==============================] - 41s 409ms/step - loss: 1.6835 - accuracy: 0.4856 - val_loss: 2.2497 - val_accuracy: 0.3328
Epoch 9/20
100/100 [==============================] - 41s 407ms/step - loss: 1.6916 - accuracy: 0.4806 - val_loss: 2.2586 - val_accuracy: 0.3253
Epoch 10/20
100/100 [==============================] - 41s 407ms/step - loss: 1.7137 - accuracy: 0.4825 - val_loss: 2.2867 - val_accuracy: 0.3225
Epoch 11/20
100/100 [==============================] - 41s 409ms/step - loss: 1.6892 - accuracy: 0.4919 - val_loss: 2.2465 - val_accuracy: 0.3466
Epoch 12/20
100/100 [==============================] - 40s 405ms/step - loss: 1.6756 - accuracy: 0.4784 - val_loss: 2.2504 - val_accuracy: 0.3347
Epoch 13/20
100/100 [==============================] - 40s 406ms/step - loss: 1.6620 - accuracy: 0.5000 - val_loss: 2.2957 - val_accuracy: 0.3363
Epoch 14/20
100/100 [==============================] - 40s 406ms/step - loss: 1.6451 - accuracy: 0.5059 - val_loss: 2.3078 - val_accuracy: 0.3297
Epoch 15/20
100/100 [==============================] - 41s 408ms/step - loss: 1.6088 - accuracy: 0.5053 - val_loss: 2.3016 - val_accuracy: 0.3403
Epoch 16/20
100/100 [==============================] - 40s 405ms/step - loss: 1.6186 - accuracy: 0.4972 - val_loss: 2.2679 - val_accuracy: 0.3462
Epoch 17/20
100/100 [==============================] - 40s 406ms/step - loss: 1.5933 - accuracy: 0.5172 - val_loss: 2.3321 - val_accuracy: 0.3184
Epoch 18/20
100/100 [==============================] - 40s 407ms/step - loss: 1.6081 - accuracy: 0.5094 - val_loss: 2.2762 - val_accuracy: 0.3338
Epoch 19/20
100/100 [==============================] - 41s 407ms/step - loss: 1.5790 - accuracy: 0.5047 - val_loss: 2.3564 - val_accuracy: 0.3200
Epoch 20/20
100/100 [==============================] - 40s 406ms/step - loss: 1.6019 - accuracy: 0.5097 - val_loss: 2.2625 - val_accuracy: 0.3369
```




accuracy over time
train
val
accuracy
epoch
0.450
0.425
0.400
0.375
0.350
0.325
0.300
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5


accuracy over time
train
val
accuracy
epoch
0.525
0.500
0.475
0.450
0.425
0.400
0.375
0.350
0.325
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5

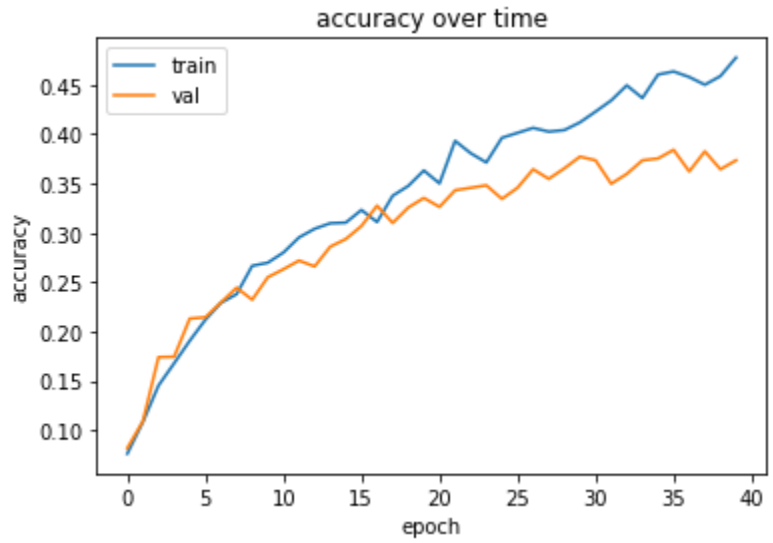
20 epochs and rotated images

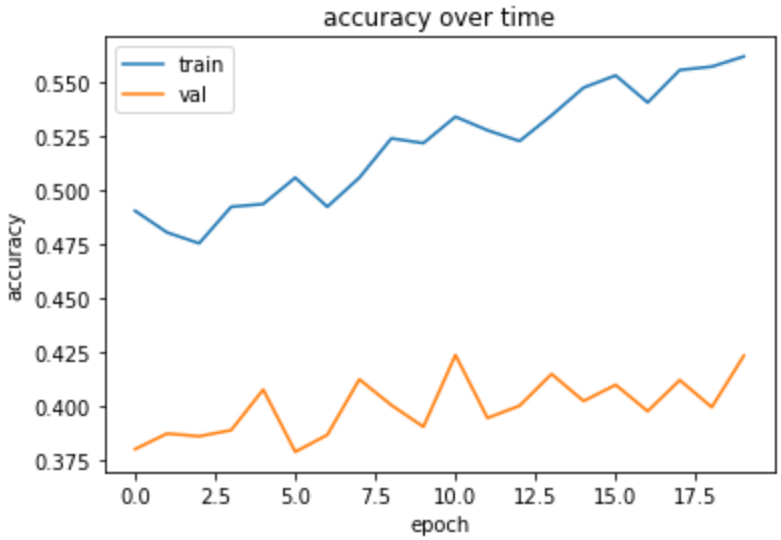
```
Epoch 1/20
250/250 [==============================] - 43s 45ms/step - loss: 2.1446 - accuracy: 0.2155 - val_loss: 2.0201 - val_accuracy: 0.2870
Epoch 2/20
250/250 [==============================] - 11s 44ms/step - loss: 1.9221 - accuracy: 0.3133 - val_loss: 1.8757 - val_accuracy: 0.3450
Epoch 3/20
250/250 [==============================] - 11s 44ms/step - loss: 1.7766 - accuracy: 0.3692 - val_loss: 1.8021 - val_accuracy: 0.3650
Epoch 4/20
250/250 [==============================] - 11s 44ms/step - loss: 1.6377 - accuracy: 0.4281 - val_loss: 1.7474 - val_accuracy: 0.3980
Epoch 5/20
250/250 [==============================] - 11s 44ms/step - loss: 1.4871 - accuracy: 0.4793 - val_loss: 1.7322 - val_accuracy: 0.4080
Epoch 6/20
250/250 [==============================] - 11s 44ms/step - loss: 1.3292 - accuracy: 0.5353 - val_loss: 1.6872 - val_accuracy: 0.4320
Epoch 7/20
250/250 [==============================] - 11s 44ms/step - loss: 1.1294 - accuracy: 0.6024 - val_loss: 1.8609 - val_accuracy: 0.3990
Epoch 8/20
250/250 [==============================] - 11s 44ms/step - loss: 0.9131 - accuracy: 0.6816 - val_loss: 1.9954 - val_accuracy: 0.4180
Epoch 9/20
250/250 [==============================] - 11s 45ms/step - loss: 0.7122 - accuracy: 0.7511 - val_loss: 2.7385 - val_accuracy: 0.3730
Epoch 10/20
250/250 [==============================] - 11s 45ms/step - loss: 0.5516 - accuracy: 0.8066 - val_loss: 2.8990 - val_accuracy: 0.3920
Epoch 11/20
250/250 [==============================] - 11s 44ms/step - loss: 0.4274 - accuracy: 0.8515 - val_loss: 3.5563 - val_accuracy: 0.3710
Epoch 12/20
250/250 [==============================] - 11s 44ms/step - loss: 0.3072 - accuracy: 0.8954 - val_loss: 4.0237 - val_accuracy: 0.3320
Epoch 13/20
250/250 [==============================] - 11s 44ms/step - loss: 0.2280 - accuracy: 0.9244 - val_loss: 4.8330 - val_accuracy: 0.3560
Epoch 14/20
250/250 [==============================] - 11s 44ms/step - loss: 0.2280 - accuracy: 0.9273 - val_loss: 5.2669 - val_accuracy: 0.3630
Epoch 15/20
250/250 [==============================] - 11s 44ms/step - loss: 0.1696 - accuracy: 0.9440 - val_loss: 4.9680 - val_accuracy: 0.3610
Epoch 16/20
250/250 [==============================] - 11s 44ms/step - loss: 0.1799 - accuracy: 0.9464 - val_loss: 5.4850 - val_accuracy: 0.3500
Epoch 17/20
250/250 [==============================] - 11s 44ms/step - loss: 0.1221 - accuracy: 0.9611 - val_loss: 5.9888 - val_accuracy: 0.3620
Epoch 18/20
250/250 [==============================] - 11s 44ms/step - loss: 0.1271 - accuracy: 0.9614 - val_loss: 6.1114 - val_accuracy: 0.3500
Epoch 19/20
250/250 [==============================] - 11s 44ms/step - loss: 0.1202 - accuracy: 0.9630 - val_loss: 5.9655 - val_accuracy: 0.3680
Epoch 20/20
250/250 [==============================] - 11s 44ms/step - loss: 0.0679 - accuracy: 0.9783 - val_loss: 6.9914 - val_accuracy: 0.3660
```

40 epochs brightened images:

```
Epoch 1/40
100/100 [==============================] - 3158s 32s/step - loss: 2.9663 - accuracy: 0.0763 - val_loss: 2.9162 - val_accuracy: 0.0819
Epoch 2/40
100/100 [==============================] - 1576s 16s/step - loss: 2.8293 - accuracy: 0.1084 - val_loss: 2.8188 - val_accuracy: 0.1091
Epoch 3/40
100/100 [==============================] - 1060s 11s/step - loss: 2.7391 - accuracy: 0.1453 - val_loss: 2.6453 - val_accuracy: 0.1741
Epoch 4/40
100/100 [==============================] - 835s 8s/step - loss: 2.6764 - accuracy: 0.1678 - val_loss: 2.6405 - val_accuracy: 0.1744
Epoch 5/40
100/100 [==============================] - 656s 7s/step - loss: 2.6072 - accuracy: 0.1906 - val_loss: 2.5581 - val_accuracy: 0.2131
Epoch 6/40
100/100 [==============================] - 535s 5s/step - loss: 2.5585 - accuracy: 0.2119 - val_loss: 2.5285 - val_accuracy: 0.2144
Epoch 7/40
100/100 [==============================] - 452s 5s/step - loss: 2.4840 - accuracy: 0.2291 - val_loss: 2.4699 - val_accuracy: 0.2294
Epoch 8/40
100/100 [==============================] - 348s 3s/step - loss: 2.4342 - accuracy: 0.2378 - val_loss: 2.4326 - val_accuracy: 0.2444
Epoch 9/40
100/100 [==============================] - 305s 3s/step - loss: 2.3665 - accuracy: 0.2666 - val_loss: 2.5256 - val_accuracy: 0.2322
Epoch 10/40
100/100 [==============================] - 246s 2s/step - loss: 2.3250 - accuracy: 0.2697 - val_loss: 2.3882 - val_accuracy: 0.2550
Epoch 11/40
100/100 [==============================] - 201s 2s/step - loss: 2.3218 - accuracy: 0.2800 - val_loss: 2.3701 - val_accuracy: 0.2631
Epoch 12/40
100/100 [==============================] - 180s 2s/step - loss: 2.2553 - accuracy: 0.2953 - val_loss: 2.3924 - val_accuracy: 0.2719
Epoch 13/40
100/100 [==============================] - 154s 2s/step - loss: 2.2607 - accuracy: 0.3041 - val_loss: 2.3502 - val_accuracy: 0.2659
Epoch 14/40
100/100 [==============================] - 138s 1s/step - loss: 2.2402 - accuracy: 0.3097 - val_loss: 2.2868 - val_accuracy: 0.2859
Epoch 15/40
100/100 [==============================] - 113s 1s/step - loss: 2.1973 - accuracy: 0.3103 - val_loss: 2.2743 - val_accuracy: 0.2937
Epoch 16/40
100/100 [==============================] - 104s 1s/step - loss: 2.1650 - accuracy: 0.3231 - val_loss: 2.2401 - val_accuracy: 0.3069
Epoch 17/40
100/100 [==============================] - 98s 988ms/step - loss: 2.1645 - accuracy: 0.3109 - val_loss: 2.2099 - val_accuracy: 0.3275
Epoch 18/40
100/100 [==============================] - 86s 854ms/step - loss: 2.1369 - accuracy: 0.3375 - val_loss: 2.2219 - val_accuracy: 0.3100
Epoch 19/40
100/100 [==============================] - 79s 793ms/step - loss: 2.1069 - accuracy: 0.3475 - val_loss: 2.2012 - val_accuracy: 0.3256
Epoch 20/40
100/100 [==============================] - 76s 765ms/step - loss: 2.0421 - accuracy: 0.3631 - val_loss: 2.1541 - val_accuracy: 0.3353
Epoch 21/40
100/100 [==============================] - 74s 743ms/step - loss: 2.1033 - accuracy: 0.3500 - val_loss: 2.1632 - val_accuracy: 0.3262
Epoch 22/40
100/100 [==============================] - 64s 648ms/step - loss: 1.9935 - accuracy: 0.3931 - val_loss: 2.1281 - val_accuracy: 0.3431
Epoch 23/40
100/100 [==============================] - 62s 628ms/step - loss: 2.0219 - accuracy: 0.3806 - val_loss: 2.1339 - val_accuracy: 0.3456
Epoch 24/40
100/100 [==============================] - 61s 616ms/step - loss: 2.0074 - accuracy: 0.3713 - val_loss: 2.1553 - val_accuracy: 0.3481
Epoch 25/40
100/100 [==============================] - 62s 619ms/step - loss: 1.9852 - accuracy: 0.3963 - val_loss: 2.1314 - val_accuracy: 0.3344
Epoch 26/40
100/100 [==============================] - 57s 576ms/step - loss: 1.9651 - accuracy: 0.4013 - val_loss: 2.1131 - val_accuracy: 0.3456
Epoch 27/40
100/100 [==============================] - 58s 581ms/step - loss: 1.9367 - accuracy: 0.4062 - val_loss: 2.0975 - val_accuracy: 0.3644
Epoch 28/40
100/100 [==============================] - 54s 548ms/step - loss: 1.9238 - accuracy: 0.4025 - val_loss: 2.1269 - val_accuracy: 0.3547
Epoch 29/40
100/100 [==============================] - 54s 547ms/step - loss: 1.9159 - accuracy: 0.4041 - val_loss: 2.0704 - val_accuracy: 0.3653
Epoch 30/40
100/100 [==============================] - 55s 554ms/step - loss: 1.8924 - accuracy: 0.4119 - val_loss: 2.0802 - val_accuracy: 0.3772
Epoch 31/40
100/100 [==============================] - 55s 552ms/step - loss: 1.8649 - accuracy: 0.4228 - val_loss: 2.1000 - val_accuracy: 0.3734
Epoch 32/40
100/100 [==============================] - 55s 553ms/step - loss: 1.8258 - accuracy: 0.4341 - val_loss: 2.1208 - val_accuracy: 0.3497
Epoch 33/40
100/100 [==============================] - 53s 529ms/step - loss: 1.7906 - accuracy: 0.4494 - val_loss: 2.1411 - val_accuracy: 0.3597
Epoch 34/40
100/100 [==============================] - 54s 538ms/step - loss: 1.8299 - accuracy: 0.4366 - val_loss: 2.0667 - val_accuracy: 0.3734
Epoch 35/40
100/100 [==============================] - 52s 526ms/step - loss: 1.7565 - accuracy: 0.4603 - val_loss: 2.1044 - val_accuracy: 0.3753
Epoch 36/40
100/100 [==============================] - 54s 539ms/step - loss: 1.7200 - accuracy: 0.4634 - val_loss: 2.0955 - val_accuracy: 0.3841
Epoch 37/40
100/100 [==============================] - 52s 526ms/step - loss: 1.7792 - accuracy: 0.4578 - val_loss: 2.0991 - val_accuracy: 0.3622
Epoch 38/40
100/100 [==============================] - 51s 517ms/step - loss: 1.7874 - accuracy: 0.4500 - val_loss: 2.0159 - val_accuracy: 0.3825
Epoch 39/40
100/100 [==============================] - 51s 513ms/step - loss: 1.7539 - accuracy: 0.4588 - val_loss: 2.0392 - val_accuracy: 0.3644
Epoch 40/40
100/100 [==============================] - 52s 520ms/step - loss: 1.7096 - accuracy: 0.4775 - val_loss: 2.0324 - val_accuracy: 0.3734
```

```
Epoch 1/20
100/100 [==============================] - 52s 526ms/step - loss: 1.6806 - accuracy: 0.4903 - val_loss: 2.0572 - val_accuracy: 0.3803
Epoch 2/20
100/100 [==============================] - 52s 519ms/step - loss: 1.6708 - accuracy: 0.4803 - val_loss: 2.0817 - val_accuracy: 0.3875
Epoch 3/20
100/100 [==============================] - 52s 523ms/step - loss: 1.7062 - accuracy: 0.4753 - val_loss: 2.0699 - val_accuracy: 0.3862
Epoch 4/20
100/100 [==============================] - 52s 519ms/step - loss: 1.6634 - accuracy: 0.4922 - val_loss: 2.0214 - val_accuracy: 0.3891
Epoch 5/20
100/100 [==============================] - 52s 520ms/step - loss: 1.6568 - accuracy: 0.4934 - val_loss: 1.9763 - val_accuracy: 0.4078
Epoch 6/20
100/100 [==============================] - 52s 523ms/step - loss: 1.6392 - accuracy: 0.5056 - val_loss: 2.1038 - val_accuracy: 0.3791
Epoch 7/20
100/100 [==============================] - 52s 524ms/step - loss: 1.6201 - accuracy: 0.4922 - val_loss: 2.0157 - val_accuracy: 0.3869
Epoch 8/20
100/100 [==============================] - 52s 520ms/step - loss: 1.5831 - accuracy: 0.5056 - val_loss: 1.9956 - val_accuracy: 0.4125
Epoch 9/20
100/100 [==============================] - 52s 524ms/step - loss: 1.5572 - accuracy: 0.5238 - val_loss: 2.0939 - val_accuracy: 0.4006
Epoch 10/20
100/100 [==============================] - 52s 523ms/step - loss: 1.5563 - accuracy: 0.5216 - val_loss: 2.0758 - val_accuracy: 0.3906
Epoch 11/20
100/100 [==============================] - 52s 526ms/step - loss: 1.5268 - accuracy: 0.5337 - val_loss: 1.9938 - val_accuracy: 0.4238
Epoch 12/20
100/100 [==============================] - 52s 525ms/step - loss: 1.5533 - accuracy: 0.5275 - val_loss: 2.0433 - val_accuracy: 0.3947
Epoch 13/20
100/100 [==============================] - 52s 525ms/step - loss: 1.5612 - accuracy: 0.5225 - val_loss: 1.9796 - val_accuracy: 0.4003
Epoch 14/20
100/100 [==============================] - 52s 524ms/step - loss: 1.5332 - accuracy: 0.5344 - val_loss: 1.9921 - val_accuracy: 0.4150
Epoch 15/20
100/100 [==============================] - 52s 524ms/step - loss: 1.4828 - accuracy: 0.5472 - val_loss: 2.0202 - val_accuracy: 0.4025
Epoch 16/20
100/100 [==============================] - 52s 527ms/step - loss: 1.4779 - accuracy: 0.5528 - val_loss: 2.0495 - val_accuracy: 0.4100
Epoch 17/20
100/100 [==============================] - 52s 525ms/step - loss: 1.4975 - accuracy: 0.5403 - val_loss: 2.0531 - val_accuracy: 0.3978
Epoch 18/20
100/100 [==============================] - 52s 524ms/step - loss: 1.4937 - accuracy: 0.5553 - val_loss: 1.9861 - val_accuracy: 0.4122
Epoch 19/20
100/100 [==============================] - 52s 526ms/step - loss: 1.4294 - accuracy: 0.5569 - val_loss: 2.0578 - val_accuracy: 0.3997
Epoch 20/20
100/100 [==============================] - 53s 529ms/step - loss: 1.4535 - accuracy: 0.5616 - val_loss: 1.9811 - val_accuracy: 0.4234
```

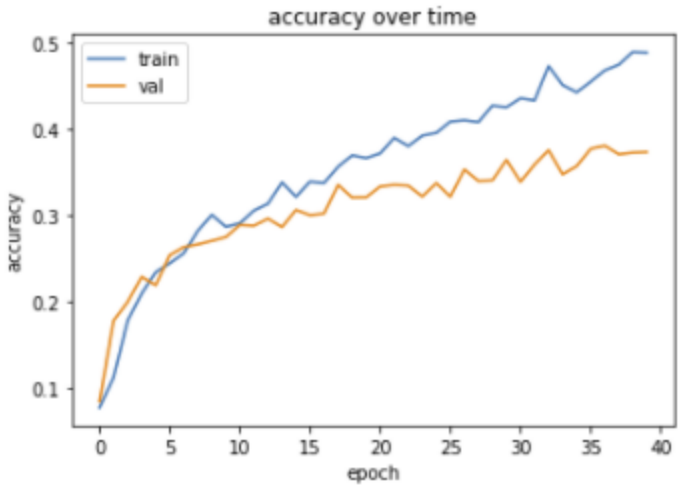



accuracy over time
train
val
accuracy
epoch
0.550
0.525
0.500
0.475
0.450
0.425
0.400
0.375
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5

40 epochs and image size 64x64

```
Epoch 15/40
100/100 [==============================] - 77s 775ms/step - loss: 2.1639 - accuracy: 0.3216 - val_loss: 2.2502 - val_accuracy: 0.3063
Epoch 16/40
100/100 [==============================] - 64s 646ms/step - loss: 2.1391 - accuracy: 0.3391 - val_loss: 2.2766 - val_accuracy: 0.3003
Epoch 17/40
100/100 [==============================] - 56s 563ms/step - loss: 2.1368 - accuracy: 0.3375 - val_loss: 2.2349 - val_accuracy: 0.3022
Epoch 18/40
100/100 [==============================] - 59s 593ms/step - loss: 2.0903 - accuracy: 0.3562 - val_loss: 2.1801 - val_accuracy: 0.3353
Epoch 19/40
100/100 [==============================] - 50s 498ms/step - loss: 2.0279 - accuracy: 0.3694 - val_loss: 2.2358 - val_accuracy: 0.3206
Epoch 20/40
100/100 [==============================] - 48s 481ms/step - loss: 2.0404 - accuracy: 0.3663 - val_loss: 2.2000 - val_accuracy: 0.3209
Epoch 21/40
100/100 [==============================] - 50s 501ms/step - loss: 2.0321 - accuracy: 0.3716 - val_loss: 2.1793 - val_accuracy: 0.3334
Epoch 22/40
100/100 [==============================] - 43s 433ms/step - loss: 1.9860 - accuracy: 0.3897 - val_loss: 2.1700 - val_accuracy: 0.3353
Epoch 23/40
100/100 [==============================] - 43s 430ms/step - loss: 1.9843 - accuracy: 0.3800 - val_loss: 2.1768 - val_accuracy: 0.3344
Epoch 24/40
100/100 [==============================] - 39s 396ms/step - loss: 1.9412 - accuracy: 0.3922 - val_loss: 2.2352 - val_accuracy: 0.3219
Epoch 25/40
100/100 [==============================] - 40s 399ms/step - loss: 1.9783 - accuracy: 0.3953 - val_loss: 2.1976 - val_accuracy: 0.3372
Epoch 26/40
100/100 [==============================] - 38s 386ms/step - loss: 1.9401 - accuracy: 0.4084 - val_loss: 2.2447 - val_accuracy: 0.3216
Epoch 27/40
100/100 [==============================] - 36s 363ms/step - loss: 1.8673 - accuracy: 0.4100 - val_loss: 2.1767 - val_accuracy: 0.3531
Epoch 28/40
100/100 [==============================] - 38s 379ms/step - loss: 1.9096 - accuracy: 0.4078 - val_loss: 2.1530 - val_accuracy: 0.3397
Epoch 29/40
100/100 [==============================] - 36s 366ms/step - loss: 1.8669 - accuracy: 0.4269 - val_loss: 2.2421 - val_accuracy: 0.3406
Epoch 30/40
100/100 [==============================] - 37s 369ms/step - loss: 1.8413 - accuracy: 0.4250 - val_loss: 2.1265 - val_accuracy: 0.3641
Epoch 31/40
100/100 [==============================] - 36s 361ms/step - loss: 1.8118 - accuracy: 0.4353 - val_loss: 2.2368 - val_accuracy: 0.3388
Epoch 32/40
100/100 [==============================] - 37s 374ms/step - loss: 1.8235 - accuracy: 0.4328 - val_loss: 2.1279 - val_accuracy: 0.3587
Epoch 33/40
100/100 [==============================] - 36s 360ms/step - loss: 1.7455 - accuracy: 0.4725 - val_loss: 2.0874 - val_accuracy: 0.3753
Epoch 34/40
100/100 [==============================] - 35s 351ms/step - loss: 1.8049 - accuracy: 0.4506 - val_loss: 2.1355 - val_accuracy: 0.3475
Epoch 35/40
100/100 [==============================] - 36s 359ms/step - loss: 1.8040 - accuracy: 0.4422 - val_loss: 2.1066 - val_accuracy: 0.3569
Epoch 36/40
100/100 [==============================] - 35s 356ms/step - loss: 1.7414 - accuracy: 0.4544 - val_loss: 2.0478 - val_accuracy: 0.3769
Epoch 37/40
100/100 [==============================] - 35s 353ms/step - loss: 1.7023 - accuracy: 0.4675 - val_loss: 2.0642 - val_accuracy: 0.3806
Epoch 38/40
100/100 [==============================] - 35s 354ms/step - loss: 1.7111 - accuracy: 0.4741 - val_loss: 2.0581 - val_accuracy: 0.3706
Epoch 39/40
100/100 [==============================] - 35s 350ms/step - loss: 1.6702 - accuracy: 0.4888 - val_loss: 2.0822 - val_accuracy: 0.3725
Epoch 40/40
100/100 [==============================] - 35s 353ms/step - loss: 1.6676 - accuracy: 0.4881 - val_loss: 2.0807 - val_accuracy: 0.3731
```

```
Epoch 1/40
100/100 [==============================] - 1963s 19s/step - loss: 2.9427 - accuracy: 0.0781 - val_loss: 2.8842 - val_accuracy: 0.0853
Epoch 2/40
100/100 [==============================] - 987s 10s/step - loss: 2.8276 - accuracy: 0.1128 - val_loss: 2.6745 - val_accuracy: 0.1784
Epoch 3/40
100/100 [==============================] - 673s 7s/step - loss: 2.6545 - accuracy: 0.1784 - val_loss: 2.5895 - val_accuracy: 0.2000
Epoch 4/40
100/100 [==============================] - 509s 5s/step - loss: 2.5557 - accuracy: 0.2097 - val_loss: 2.4911 - val_accuracy: 0.2291
Epoch 5/40
100/100 [==============================] - 410s 4s/step - loss: 2.4518 - accuracy: 0.2344 - val_loss: 2.5209 - val_accuracy: 0.2194
Epoch 6/40
100/100 [==============================] - 359s 4s/step - loss: 2.4383 - accuracy: 0.2447 - val_loss: 2.4135 - val_accuracy: 0.2541
Epoch 7/40
100/100 [==============================] - 267s 3s/step - loss: 2.3886 - accuracy: 0.2562 - val_loss: 2.4064 - val_accuracy: 0.2634
Epoch 8/40
100/100 [==============================] - 230s 2s/step - loss: 2.3411 - accuracy: 0.2822 - val_loss: 2.3662 - val_accuracy: 0.2666
Epoch 9/40
100/100 [==============================] - 196s 2s/step - loss: 2.2948 - accuracy: 0.3006 - val_loss: 2.3654 - val_accuracy: 0.2706
Epoch 10/40
100/100 [==============================] - 158s 2s/step - loss: 2.2818 - accuracy: 0.2869 - val_loss: 2.3550 - val_accuracy: 0.2750
Epoch 11/40
100/100 [==============================] - 130s 1s/step - loss: 2.2754 - accuracy: 0.2909 - val_loss: 2.2996 - val_accuracy: 0.2891
Epoch 12/40
100/100 [==============================] - 112s 1s/step - loss: 2.2474 - accuracy: 0.3056 - val_loss: 2.3243 - val_accuracy: 0.2881
Epoch 13/40
100/100 [==============================] - 99s 987ms/step - loss: 2.2282 - accuracy: 0.3134 - val_loss: 2.2745 - val_accuracy: 0.2962
Epoch 14/40
100/100 [==============================] - 90s 903ms/step - loss: 2.1681 - accuracy: 0.3381 - val_loss: 2.2723 - val_accuracy: 0.2866
Epoch 15/40
100/100 [==============================] - 77s 775ms/step - loss: 2.1639 - accuracy: 0.3216 - val_loss: 2.2502 - val_accuracy: 0.3063
Epoch 16/40
100/100 [==============================] - 64s 646ms/step - loss: 2.1391 - accuracy: 0.3391 - val_loss: 2.2766 - val_accuracy: 0.3003
Epoch 17/40
100/100 [==============================] - 56s 563ms/step - loss: 2.1368 - accuracy: 0.3375 - val_loss: 2.2349 - val_accuracy: 0.3022
Epoch 18/40
100/100 [==============================] - 59s 593ms/step - loss: 2.0903 - accuracy: 0.3562 - val_loss: 2.1801 - val_accuracy: 0.3353
Epoch 19/40
100/100 [==============================] - 50s 498ms/step - loss: 2.0279 - accuracy: 0.3694 - val_loss: 2.2358 - val_accuracy: 0.3206
Epoch 20/40
100/100 [==============================] - 48s 481ms/step - loss: 2.0404 - accuracy: 0.3663 - val_loss: 2.2000 - val_accuracy: 0.3209
Epoch 21/40
100/100 [==============================] - 50s 501ms/step - loss: 2.0321 - accuracy: 0.3716 - val_loss: 2.1793 - val_accuracy: 0.3334
Epoch 22/40
100/100 [==============================] - 43s 433ms/step - loss: 1.9860 - accuracy: 0.3897 - val_loss: 2.1700 - val_accuracy: 0.3353
Epoch 23/40
100/100 [==============================] - 43s 430ms/step - loss: 1.9843 - accuracy: 0.3800 - val_loss: 2.1768 - val_accuracy: 0.3344
Epoch 24/40
100/100 [==============================] - 39s 396ms/step - loss: 1.9412 - accuracy: 0.3922 - val_loss: 2.2352 - val_accuracy: 0.3219
Epoch 25/40
100/100 [==============================] - 40s 399ms/step - loss: 1.9783 - accuracy: 0.3953 - val_loss: 2.1976 - val_accuracy: 0.3372
Epoch 26/40
100/100 [==============================] - 38s 386ms/step - loss: 1.9401 - accuracy: 0.4084 - val_loss: 2.2447 - val_accuracy: 0.3216
Epoch 27/40
100/100 [==============================] - 36s 363ms/step - loss: 1.8673 - accuracy: 0.4100 - val_loss: 2.1767 - val_accuracy: 0.3531
Epoch 28/40
100/100 [==============================] - 38s 379ms/step - loss: 1.9096 - accuracy: 0.4078 - val_loss: 2.1530 - val_accuracy: 0.3397
Epoch 29/40
100/100 [==============================] - 36s 366ms/step - loss: 1.8669 - accuracy: 0.4269 - val_loss: 2.2421 - val_accuracy: 0.3406
Epoch 30/40
```



80 epochs and rotated images

```
Epoch 1/40
100/100 [==============================] - 1986s 20s/step - loss: 2.9519 - accuracy: 0.0806 - val_loss: 2.8322 - val_accuracy: 0.1166
Epoch 2/40
100/100 [==============================] - 1003s 10s/step - loss: 2.7939 - accuracy: 0.1256 - val_loss: 2.7864 - val_accuracy: 0.1294
Epoch 3/40
100/100 [==============================] - 707s 7s/step - loss: 2.6765 - accuracy: 0.1669 - val_loss: 2.6492 - val_accuracy: 0.1813
Epoch 4/40
100/100 [==============================] - 546s 5s/step - loss: 2.5788 - accuracy: 0.2106 - val_loss: 2.5416 - val_accuracy: 0.2059
Epoch 5/40
100/100 [==============================] - 426s 4s/step - loss: 2.4980 - accuracy: 0.2225 - val_loss: 2.5061 - val_accuracy: 0.2178
Epoch 6/40
100/100 [==============================] - 362s 4s/step - loss: 2.4438 - accuracy: 0.2500 - val_loss: 2.4420 - val_accuracy: 0.2403
Epoch 7/40
100/100 [==============================] - 285s 3s/step - loss: 2.3786 - accuracy: 0.2625 - val_loss: 2.4019 - val_accuracy: 0.2525
Epoch 8/40
100/100 [==============================] - ETA: 0s - loss: 2.3891 - accuracy: 0.2578Epoch 9/40
100/100 [==============================] - 200s 2s/step - loss: 2.3150 - accuracy: 0.2872 - val_loss: 2.4134 - val_accuracy: 0.2544
Epoch 10/40
100/100 [==============================] - 171s 2s/step - loss: 2.3367 - accuracy: 0.2709 - val_loss: 2.3581 - val_accuracy: 0.2716
Epoch 11/40
100/100 [==============================] - 147s 1s/step - loss: 2.3032 - accuracy: 0.2912 - val_loss: 2.3141 - val_accuracy: 0.2828
Epoch 12/40
100/100 [==============================] - 137s 1s/step - loss: 2.2566 - accuracy: 0.3038 - val_loss: 2.3008 - val_accuracy: 0.2803
Epoch 13/40
100/100 [==============================] - 112s 1s/step - loss: 2.2898 - accuracy: 0.2841 - val_loss: 2.2833 - val_accuracy: 0.2947
Epoch 14/40
100/100 [==============================] - 98s 983ms/step - loss: 2.2493 - accuracy: 0.3009 - val_loss: 2.2952 - val_accuracy: 0.2906
Epoch 15/40
100/100 [==============================] - 90s 908ms/step - loss: 2.2286 - accuracy: 0.3141 - val_loss: 2.2560 - val_accuracy: 0.2959
Epoch 16/40
100/100 [==============================] - 84s 848ms/step - loss: 2.2070 - accuracy: 0.3106 - val_loss: 2.2527 - val_accuracy: 0.2959
Epoch 17/40
100/100 [==============================] - 76s 769ms/step - loss: 2.2010 - accuracy: 0.3169 - val_loss: 2.2607 - val_accuracy: 0.3081
Epoch 18/40
100/100 [==============================] - ETA: 0s - loss: 2.1951 - accuracy: 0.3231Epoch 19/40
100/100 [==============================] - 69s 686ms/step - loss: 2.1414 - accuracy: 0.3363 - val_loss: 2.2295 - val_accuracy: 0.3137
Epoch 20/40
100/100 [==============================] - 66s 663ms/step - loss: 2.1660 - accuracy: 0.3278 - val_loss: 2.1824 - val_accuracy: 0.3344
100/100 [==============================] - 63s 633ms/step - loss: 2.1376 - accuracy: 0.3363 - val_loss: 2.2303 - val_accuracy: 0.2966
```

```
Epoch 22/40
100/100 [==============================] - 62s 619ms/step - loss: 2.1207 - accuracy: 0.3459 - val_loss: 2.1754 - val_accuracy: 0.3272
Epoch 23/40
100/100 [==============================] - 58s 578ms/step - loss: 2.1390 - accuracy: 0.3331 - val_loss: 2.2737 - val_accuracy: 0.3081
Epoch 24/40
100/100 [==============================] - 60s 600ms/step - loss: 2.1008 - accuracy: 0.3478 - val_loss: 2.1345 - val_accuracy: 0.3309
Epoch 25/40
100/100 [==============================] - 58s 583ms/step - loss: 2.0660 - accuracy: 0.3528 - val_loss: 2.1370 - val_accuracy: 0.3422
Epoch 26/40
100/100 [==============================] - 57s 569ms/step - loss: 2.0661 - accuracy: 0.3494 - val_loss: 2.1329 - val_accuracy: 0.3459
Epoch 27/40
100/100 [==============================] - 55s 549ms/step - loss: 2.0418 - accuracy: 0.3656 - val_loss: 2.2618 - val_accuracy: 0.3197
Epoch 28/40
100/100 [==============================] - ETA: 0s - loss: 2.0307 - accuracy: 0.3603Epoch 29/40
100/100 [==============================] - 53s 529ms/step - loss: 2.0197 - accuracy: 0.3812 - val_loss: 2.1789 - val_accuracy: 0.3219
Epoch 30/40
100/100 [==============================] - 51s 516ms/step - loss: 2.0118 - accuracy: 0.3775 - val_loss: 2.0770 - val_accuracy: 0.3606
Epoch 31/40
100/100 [==============================] - 53s 536ms/step - loss: 1.9614 - accuracy: 0.3831 - val_loss: 2.1593 - val_accuracy: 0.3497
Epoch 32/40
100/100 [==============================] - ETA: 0s - loss: 2.0486 - accuracy: 0.3606Epoch 33/40
100/100 [==============================] - 53s 534ms/step - loss: 1.9673 - accuracy: 0.3934 - val_loss: 2.0851 - val_accuracy: 0.3603
Epoch 34/40
100/100 [==============================] - 54s 547ms/step - loss: 1.9401 - accuracy: 0.3959 - val_loss: 2.0651 - val_accuracy: 0.3678
Epoch 35/40
100/100 [==============================] - 55s 555ms/step - loss: 1.9766 - accuracy: 0.3931 - val_loss: 2.0411 - val_accuracy: 0.3647
Epoch 36/40
100/100 [==============================] - 55s 552ms/step - loss: 1.8875 - accuracy: 0.4144 - val_loss: 2.0695 - val_accuracy: 0.3716
Epoch 37/40
100/100 [==============================] - 53s 528ms/step - loss: 1.9467 - accuracy: 0.3938 - val_loss: 2.0349 - val_accuracy: 0.3756
Epoch 38/40
100/100 [==============================] - 51s 517ms/step - loss: 1.9179 - accuracy: 0.4184 - val_loss: 1.9950 - val_accuracy: 0.3850
100/100 [==============================] - 51s 516ms/step - loss: 1.9454 - accuracy: 0.4100 - val_loss: 2.0084 - val_accuracy: 0.3781

Epoch 1/40
100/100 [==============================] - 52s 519ms/step - loss: 1.9176 - accuracy: 0.4050 - val_loss: 2.0234 - val_accuracy: 0.3731
Epoch 2/40
100/100 [==============================] - 51s 516ms/step - loss: 1.8640 - accuracy: 0.4225 - val_loss: 2.0756 - val_accuracy: 0.3722
Epoch 3/40
100/100 [==============================] - 52s 519ms/step - loss: 1.8496 - accuracy: 0.4250 - val_loss: 2.0712 - val_accuracy: 0.3772
Epoch 4/40
100/100 [==============================] - 51s 517ms/step - loss: 1.8560 - accuracy: 0.4184 - val_loss: 2.0372 - val_accuracy: 0.3825
Epoch 5/40
100/100 [==============================] - 52s 521ms/step - loss: 1.8541 - accuracy: 0.4244 - val_loss: 2.0064 - val_accuracy: 0.3844
Epoch 6/40
100/100 [==============================] - 51s 516ms/step - loss: 1.8194 - accuracy: 0.4425 - val_loss: 2.0276 - val_accuracy: 0.3825
Epoch 7/40
100/100 [==============================] - 52s 519ms/step - loss: 1.7917 - accuracy: 0.4475 - val_loss: 1.9618 - val_accuracy: 0.3975
Epoch 8/40
100/100 [==============================] - 51s 514ms/step - loss: 1.8238 - accuracy: 0.4253 - val_loss: 2.0910 - val_accuracy: 0.3594
Epoch 9/40
100/100 [==============================] - 51s 513ms/step - loss: 1.8330 - accuracy: 0.4319 - val_loss: 1.9800 - val_accuracy: 0.3900
Epoch 10/40
100/100 [==============================] - 51s 516ms/step - loss: 1.8054 - accuracy: 0.4416 - val_loss: 1.9422 - val_accuracy: 0.4009
Epoch 11/40
100/100 [==============================] - 51s 516ms/step - loss: 1.8045 - accuracy: 0.4412 - val_loss: 1.9110 - val_accuracy: 0.4094
Epoch 12/40
100/100 [==============================] - 51s 511ms/step - loss: 1.7464 - accuracy: 0.4569 - val_loss: 1.9411 - val_accuracy: 0.4125
Epoch 13/40
100/100 [==============================] - 51s 514ms/step - loss: 1.7934 - accuracy: 0.4369 - val_loss: 1.9574 - val_accuracy: 0.4028
Epoch 14/40
100/100 [==============================] - 51s 512ms/step - loss: 1.8049 - accuracy: 0.4462 - val_loss: 1.9820 - val_accuracy: 0.3928
Epoch 15/40
100/100 [==============================] - 51s 516ms/step - loss: 1.7611 - accuracy: 0.4547 - val_loss: 2.0138 - val_accuracy: 0.3928
Epoch 16/40
100/100 [==============================] - 51s 515ms/step - loss: 1.7697 - accuracy: 0.4509 - val_loss: 1.9207 - val_accuracy: 0.4147
Epoch 17/40
100/100 [==============================] - 51s 513ms/step - loss: 1.7278 - accuracy: 0.4688 - val_loss: 1.9174 - val_accuracy: 0.4184
Epoch 18/40
100/100 [==============================] - 51s 513ms/step - loss: 1.7447 - accuracy: 0.4638 - val_loss: 1.9032 - val_accuracy: 0.4159
Epoch 19/40
100/100 [==============================] - 51s 512ms/step - loss: 1.7486 - accuracy: 0.4634 - val_loss: 1.9457 - val_accuracy: 0.4247
Epoch 20/40
100/100 [==============================] - 52s 518ms/step - loss: 1.7467 - accuracy: 0.4588 - val_loss: 1.9212 - val_accuracy: 0.4206
```

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Epoch 21/40
100/100 [==============================] - 51s 513ms/step - loss: 1.7340 - accuracy: 0.4553 - val_loss: 1.9261 - val_accuracy: 0.4106
Epoch 22/40
100/100 [==============================] - 51s 512ms/step - loss: 1.7153 - accuracy: 0.4688 - val_loss: 1.9277 - val_accuracy: 0.4078
Epoch 23/40
100/100 [==============================] - 51s 510ms/step - loss: 1.7108 - accuracy: 0.4725 - val_loss: 1.8629 - val_accuracy: 0.4269
Epoch 24/40
100/100 [==============================] - 51s 513ms/step - loss: 1.7049 - accuracy: 0.4663 - val_loss: 1.8660 - val_accuracy: 0.4369
Epoch 26/40
100/100 [==============================] - 51s 516ms/step - loss: 1.6572 - accuracy: 0.4800 - val_loss: 1.8761 - val_accuracy: 0.4256
Epoch 27/40
100/100 [==============================] - 51s 514ms/step - loss: 1.6405 - accuracy: 0.4909 - val_loss: 1.9017 - val_accuracy: 0.4294
Epoch 28/40
100/100 [==============================] - 51s 514ms/step - loss: 1.6182 - accuracy: 0.4913 - val_loss: 1.9992 - val_accuracy: 0.4116
Epoch 29/40
100/100 [==============================] - 51s 511ms/step - loss: 1.6917 - accuracy: 0.4762 - val_loss: 1.8781 - val_accuracy: 0.4231
Epoch 30/40
100/100 [==============================] - 51s 516ms/step - loss: 1.6566 - accuracy: 0.4837 - val_loss: 1.9070 - val_accuracy: 0.4191
Epoch 31/40
100/100 [==============================] - 51s 514ms/step - loss: 1.6657 - accuracy: 0.4784 - val_loss: 1.8590 - val_accuracy: 0.4437
Epoch 32/40
100/100 [==============================] - 51s 513ms/step - loss: 1.6545 - accuracy: 0.4888 - val_loss: 1.8764 - val_accuracy: 0.4334
Epoch 34/40
100/100 [==============================] - 51s 517ms/step - loss: 1.6252 - accuracy: 0.4922 - val_loss: 1.8777 - val_accuracy: 0.4369
100/100 [==============================] - 51s 513ms/step - loss: 1.6061 - accuracy: 0.4897 - val_loss: 1.8106 - val_accuracy: 0.4475
100/100 [==============================] - 51s 513ms/step - loss: 1.6083 - accuracy: 0.5100 - val_loss: 1.8272 - val_accuracy: 0.4547
Epoch 38/40
100/100 [==============================] - 51s 513ms/step - loss: 1.6094 - accuracy: 0.4884 - val_loss: 1.7998 - val_accuracy: 0.4606
Epoch 39/40
100/100 [==============================] - 51s 516ms/step - loss: 1.6027 - accuracy: 0.5113 - val_loss: 1.8190 - val_accuracy: 0.4503
Epoch 40/40
100/100 [==============================] - 51s 513ms/step - loss: 1.5918 - accuracy: 0.5063 - val_loss: 1.8457 - val_accuracy: 0.4338
```

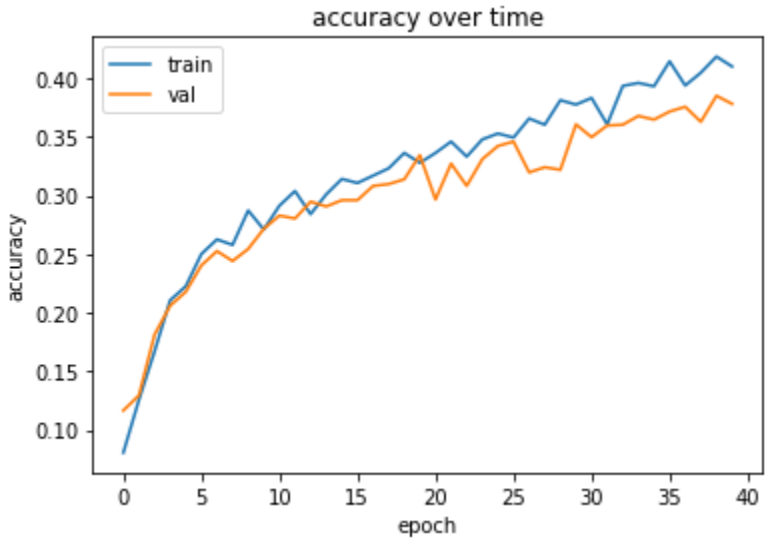

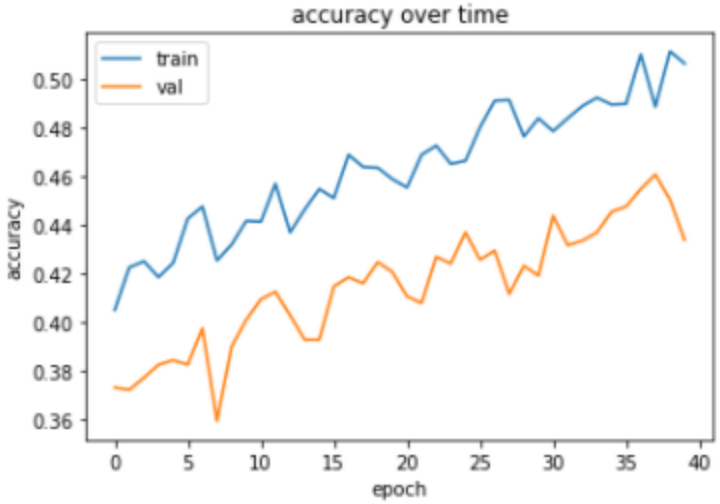
accuracy over time
train
val
accuracy
epoch
0.50
0.48
0.46
0.44
0.42
0.40
0.38
0.36
0
5
10
15
20
25
30
35
40