In [0]:
```
from keras.models import Sequential
from keras.layers import Dense, Activation, Flatten, Dropout, BatchNorma
lization, Add
from keras.layers import Input
from keras.models import Model
from sklearn import datasets
from keras import regularizers
from sklearn.model_selection import train_test_split
import numpy
import pandas
from keras.models import Sequential
from keras.layers import Dense
from keras.wrappers.scikit_learn import KerasClassifier
from keras.utils import np_utils
from sklearn.model_selection import cross_val_score
from sklearn.model_selection import KFold
from sklearn.preprocessing import LabelEncoder
from sklearn.pipeline import Pipeline
from keras.wrappers.scikit_learn import KerasClassifier, KerasRegressor
from sklearn.model_selection import GridSearchCV
from sklearn.metrics import accuracy_score
from keras.datasets import fashion_mnist
import matplotlib.pyplot as plt
```

TASK 1

Read iris dataset

In [0]:
```
iris = datasets.load_iris()
X = iris.data
y = iris.target
```

One hot enode response variable y

In [0]:
```
dummy_y = np_utils.to_categorical(y)
```

Train test split

In [0]:
```
X_train, X_test, y_train, y_test = train_test_split(X, dummy_y, test_siz
e=0.33, random_state=42)
```

Sequential multilayer perceptron with two hidden layers and rectified linear nonlinearities

In [0]:
```
def baseline_model(hidden, strength):
  model = Sequential()
  model.add(Dense(hidden, input_dim=4, activation='relu', kernel_regular
izer=regularizers.l2(strength)))
  model.add(Dense(hidden, activation='relu', kernel_regularizer=regulari
zers.l2(strength)))
  model.add(Dense(3, activation='softmax'))
  model.compile(loss='categorical_crossentropy', optimizer='adam', metri
cs=['accuracy'])
  return model
```

In [0]:
```
estimator = KerasClassifier(build_fn=baseline_model, epochs=20)
```

Select regularization strength and number of hidden units using GridSearchCV

In [7]:
```
param_grid = {
    'strength': [0.001, 0.01, 1, 10],
    'hidden': [8, 16, 32, 64]
}
grid = GridSearchCV(estimator, param_grid=param_grid, cv=5)
grid.fit(X_train, y_train)
```

```
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/tensorfl
ow/python/framework/op_def_library.py:263: colocate_with (from tensorfl
ow.python.framework.ops) is deprecated and will be removed in a future
version.
Instructions for updating:
Colocations handled automatically by placer.
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/tensorfl
ow/python/ops/math_ops.py:3066: to_int32 (from tensorflow.python.ops.ma
th_ops) is deprecated and will be removed in a future version.
Instructions for updating:
Use tf.cast instead.
Epoch 1/20
80/80 [==============================] - 3s 33ms/step - loss: 1.2310 -
acc: 0.2750
Epoch 2/20
80/80 [==============================] - 0s 166us/step - loss: 1.2079 -
acc: 0.2750
Epoch 3/20
80/80 [==============================] - 0s 173us/step - loss: 1.1888 -
acc: 0.2750
Epoch 4/20
80/80 [==============================] - 0s 163us/step - loss: 1.1681 -
acc: 0.2750
Epoch 5/20
80/80 [==============================] - 0s 166us/step - loss: 1.1502 -
acc: 0.2750
Epoch 6/20
80/80 [==============================] - 0s 156us/step - loss: 1.1332 -
acc: 0.2750
Epoch 7/20
80/80 [==============================] - 0s 158us/step - loss: 1.1201 -
acc: 0.2750
Epoch 8/20
80/80 [==============================] - 0s 162us/step - loss: 1.1071 -
acc: 0.2750
Epoch 9/20
80/80 [==============================] - 0s 162us/step - loss: 1.0961 -
acc: 0.2750
Epoch 10/20
80/80 [==============================] - 0s 160us/step - loss: 1.0861 -
acc: 0.2750
Epoch 11/20
80/80 [==============================] - 0s 180us/step - loss: 1.0768 -
acc: 0.2750
Epoch 12/20
80/80 [==============================] - 0s 158us/step - loss: 1.0694 -
acc: 0.3375
Epoch 13/20
80/80 [==============================] - 0s 160us/step - loss: 1.0620 -
acc: 0.4250
Epoch 14/20
80/80 [==============================] - 0s 181us/step - loss: 1.0546 -
acc: 0.4750
Epoch 15/20
80/80 [==============================] - 0s 180us/step - loss: 1.0475 -
acc: 0.5750
Epoch 16/20
```

```
80/80 [==============================] - 0s 207us/step - loss: 1.0414 -
acc: 0.6000
Epoch 17/20
80/80 [==============================] - 0s 155us/step - loss: 1.0344 -
acc: 0.6250
Epoch 18/20
80/80 [==============================] - 0s 185us/step - loss: 1.0284 -
acc: 0.6375
Epoch 19/20
80/80 [==============================] - 0s 169us/step - loss: 1.0231 -
acc: 0.6500
Epoch 20/20
80/80 [==============================] - 0s 162us/step - loss: 1.0175 -
acc: 0.6500
20/20 [==============================] - 0s 2ms/step
80/80 [==============================] - 0s 107us/step
Epoch 1/20
80/80 [==============================] - 0s 3ms/step - loss: 1.3080 - a
cc: 0.3500
Epoch 2/20
80/80 [==============================] - 0s 178us/step - loss: 1.2880 -
acc: 0.3500
Epoch 3/20
80/80 [==============================] - 0s 156us/step - loss: 1.2717 -
acc: 0.3500
Epoch 4/20
80/80 [==============================] - 0s 165us/step - loss: 1.2553 -
acc: 0.3500
Epoch 5/20
80/80 [==============================] - 0s 149us/step - loss: 1.2393 -
acc: 0.3500
Epoch 6/20
80/80 [==============================] - 0s 155us/step - loss: 1.2236 -
acc: 0.3500
Epoch 7/20
80/80 [==============================] - 0s 190us/step - loss: 1.2060 -
acc: 0.3500
Epoch 8/20
80/80 [==============================] - 0s 194us/step - loss: 1.1919 -
acc: 0.3500
Epoch 9/20
80/80 [==============================] - 0s 162us/step - loss: 1.1721 -
acc: 0.3500
Epoch 10/20
80/80 [==============================] - 0s 169us/step - loss: 1.1553 -
acc: 0.3500
Epoch 11/20
80/80 [==============================] - 0s 176us/step - loss: 1.1388 -
acc: 0.3500
Epoch 12/20
80/80 [==============================] - 0s 166us/step - loss: 1.1244 -
acc: 0.3500
Epoch 13/20
80/80 [==============================] - 0s 172us/step - loss: 1.1133 -
acc: 0.3500
Epoch 14/20
80/80 [==============================] - 0s 178us/step - loss: 1.1060 -
```

```
acc: 0.3500
Epoch 15/20
80/80 [==============================] - 0s 172us/step - loss: 1.0961 -
acc: 0.3500
Epoch 16/20
80/80 [==============================] - 0s 190us/step - loss: 1.0881 -
acc: 0.3500
Epoch 17/20
80/80 [==============================] - 0s 181us/step - loss: 1.0802 -
acc: 0.3500
Epoch 18/20
80/80 [==============================] - 0s 201us/step - loss: 1.0736 -
acc: 0.3500
Epoch 19/20
80/80 [==============================] - 0s 201us/step - loss: 1.0668 -
acc: 0.3500
Epoch 20/20
80/80 [==============================] - 0s 197us/step - loss: 1.0585 -
acc: 0.3500
20/20 [==============================] - 0s 2ms/step
80/80 [==============================] - 0s 132us/step
Epoch 1/20
80/80 [==============================] - 0s 3ms/step - loss: 3.4851 - a
cc: 0.3250
Epoch 2/20
80/80 [==============================] - 0s 178us/step - loss: 3.3532 -
acc: 0.3250
Epoch 3/20
80/80 [==============================] - 0s 215us/step - loss: 3.2102 -
acc: 0.3250
Epoch 4/20
80/80 [==============================] - 0s 168us/step - loss: 3.0794 -
acc: 0.3250
Epoch 5/20
80/80 [==============================] - 0s 164us/step - loss: 2.9481 -
acc: 0.3250
Epoch 6/20
80/80 [==============================] - 0s 166us/step - loss: 2.8275 -
acc: 0.3250
Epoch 7/20
80/80 [==============================] - 0s 181us/step - loss: 2.7091 -
acc: 0.3250
Epoch 8/20
80/80 [==============================] - 0s 171us/step - loss: 2.5806 -
acc: 0.3250
Epoch 9/20
80/80 [==============================] - 0s 169us/step - loss: 2.4636 -
acc: 0.3250
Epoch 10/20
80/80 [==============================] - 0s 175us/step - loss: 2.3519 -
acc: 0.3250
Epoch 11/20
80/80 [==============================] - 0s 169us/step - loss: 2.2413 -
acc: 0.3250
Epoch 12/20
80/80 [==============================] - 0s 168us/step - loss: 2.1270 -
acc: 0.3250
```

```
Epoch 13/20
80/80 [==============================] - 0s 163us/step - loss: 2.0244 -
acc: 0.3250
Epoch 14/20
80/80 [==============================] - 0s 171us/step - loss: 1.9179 -
acc: 0.3250
Epoch 15/20
80/80 [==============================] - 0s 181us/step - loss: 1.8183 -
acc: 0.3250
Epoch 16/20
80/80 [==============================] - 0s 210us/step - loss: 1.7266 -
acc: 0.3250
Epoch 17/20
80/80 [==============================] - 0s 187us/step - loss: 1.6355 -
acc: 0.3250
Epoch 18/20
80/80 [==============================] - 0s 190us/step - loss: 1.5433 -
acc: 0.3250
Epoch 19/20
80/80 [==============================] - 0s 206us/step - loss: 1.4589 -
acc: 0.3250
Epoch 20/20
80/80 [==============================] - 0s 147us/step - loss: 1.3771 -
acc: 0.3250
20/20 [==============================] - 0s 3ms/step
80/80 [==============================] - 0s 104us/step
Epoch 1/20
80/80 [==============================] - 0s 4ms/step - loss: 1.9336 - a
cc: 0.3375
Epoch 2/20
80/80 [==============================] - 0s 172us/step - loss: 1.8773 -
acc: 0.3375
Epoch 3/20
80/80 [==============================] - 0s 168us/step - loss: 1.8198 -
acc: 0.3375
Epoch 4/20
80/80 [==============================] - 0s 176us/step - loss: 1.7642 -
acc: 0.3375
Epoch 5/20
80/80 [==============================] - 0s 167us/step - loss: 1.7151 -
acc: 0.3375
Epoch 6/20
80/80 [==============================] - 0s 173us/step - loss: 1.6671 -
acc: 0.3500
Epoch 7/20
80/80 [==============================] - 0s 165us/step - loss: 1.6201 -
acc: 0.3625
Epoch 8/20
80/80 [==============================] - 0s 172us/step - loss: 1.5771 -
acc: 0.3875
Epoch 9/20
80/80 [==============================] - 0s 196us/step - loss: 1.5375 -
acc: 0.4000
Epoch 10/20
80/80 [==============================] - 0s 181us/step - loss: 1.4974 -
acc: 0.3500
Epoch 11/20
```

```
80/80 [==============================] - 0s 176us/step - loss: 1.4638 -
acc: 0.4000
Epoch 12/20
80/80 [==============================] - 0s 178us/step - loss: 1.4264 -
acc: 0.3750
Epoch 13/20
80/80 [==============================] - 0s 154us/step - loss: 1.3929 -
acc: 0.3625
Epoch 14/20
80/80 [==============================] - 0s 168us/step - loss: 1.3606 -
acc: 0.3750
Epoch 15/20
80/80 [==============================] - 0s 172us/step - loss: 1.3268 -
acc: 0.3500
Epoch 16/20
80/80 [==============================] - 0s 165us/step - loss: 1.2957 -
acc: 0.3625
Epoch 17/20
80/80 [==============================] - 0s 234us/step - loss: 1.2588 -
acc: 0.3750
Epoch 18/20
80/80 [==============================] - 0s 205us/step - loss: 1.2268 -
acc: 0.3750
Epoch 19/20
80/80 [==============================] - 0s 172us/step - loss: 1.1970 -
acc: 0.4000
Epoch 20/20
80/80 [==============================] - 0s 193us/step - loss: 1.1681 -
acc: 0.4125
20/20 [==============================] - 0s 4ms/step
80/80 [==============================] - 0s 128us/step
Epoch 1/20
80/80 [==============================] - 0s 4ms/step - loss: 3.6836 - a
cc: 0.3375
Epoch 2/20
80/80 [==============================] - 0s 163us/step - loss: 3.5193 -
acc: 0.3375
Epoch 3/20
80/80 [==============================] - 0s 164us/step - loss: 3.3647 -
acc: 0.3375
Epoch 4/20
80/80 [==============================] - 0s 167us/step - loss: 3.1957 -
acc: 0.3375
Epoch 5/20
80/80 [==============================] - 0s 166us/step - loss: 3.0602 -
acc: 0.3375
Epoch 6/20
80/80 [==============================] - 0s 194us/step - loss: 2.9143 -
acc: 0.3375
Epoch 7/20
80/80 [==============================] - 0s 180us/step - loss: 2.7908 -
acc: 0.3375
Epoch 8/20
80/80 [==============================] - 0s 176us/step - loss: 2.6687 -
acc: 0.3375
Epoch 9/20
80/80 [==============================] - 0s 185us/step - loss: 2.5603 -
```

```
acc: 0.3375
Epoch 10/20
80/80 [==============================] - 0s 174us/step - loss: 2.4574 -
acc: 0.3375
Epoch 11/20
80/80 [==============================] - 0s 194us/step - loss: 2.3627 -
acc: 0.3375
Epoch 12/20
80/80 [==============================] - 0s 173us/step - loss: 2.2712 -
acc: 0.3375
Epoch 13/20
80/80 [==============================] - 0s 205us/step - loss: 2.1898 -
acc: 0.3375
Epoch 14/20
80/80 [==============================] - 0s 178us/step - loss: 2.1134 -
acc: 0.3250
Epoch 15/20
80/80 [==============================] - 0s 289us/step - loss: 2.0478 -
acc: 0.2250
Epoch 16/20
80/80 [==============================] - 0s 177us/step - loss: 1.9840 -
acc: 0.0750
Epoch 17/20
80/80 [==============================] - 0s 177us/step - loss: 1.9180 -
acc: 0.0250
Epoch 18/20
80/80 [==============================] - 0s 181us/step - loss: 1.8645 -
acc: 0.0125
Epoch 19/20
80/80 [==============================] - 0s 185us/step - loss: 1.8140 -
acc: 0.0000e+00
Epoch 20/20
80/80 [==============================] - 0s 208us/step - loss: 1.7643 -
acc: 0.0000e+00
20/20 [==============================] - 0s 5ms/step
80/80 [==============================] - 0s 134us/step
Epoch 1/20
80/80 [==============================] - 0s 5ms/step - loss: 5.3295 - a
cc: 0.2750
Epoch 2/20
80/80 [==============================] - 0s 186us/step - loss: 5.1346 -
acc: 0.2750
Epoch 3/20
80/80 [==============================] - 0s 190us/step - loss: 4.9495 -
acc: 0.2750
Epoch 4/20
80/80 [==============================] - 0s 169us/step - loss: 4.7560 -
acc: 0.2750
Epoch 5/20
80/80 [==============================] - 0s 173us/step - loss: 4.5737 -
acc: 0.2750
Epoch 6/20
80/80 [==============================] - 0s 174us/step - loss: 4.3843 -
acc: 0.2750
Epoch 7/20
80/80 [==============================] - 0s 154us/step - loss: 4.1984 -
acc: 0.2750
```

```
Epoch 8/20
80/80 [==============================] - 0s 155us/step - loss: 4.0153 -
acc: 0.2750
Epoch 9/20
80/80 [==============================] - 0s 170us/step - loss: 3.8332 -
acc: 0.2750
Epoch 10/20
80/80 [==============================] - 0s 168us/step - loss: 3.6508 -
acc: 0.2750
Epoch 11/20
80/80 [==============================] - 0s 195us/step - loss: 3.4665 -
acc: 0.2750
Epoch 12/20
80/80 [==============================] - 0s 165us/step - loss: 3.2828 -
acc: 0.2750
Epoch 13/20
80/80 [==============================] - 0s 169us/step - loss: 3.0972 -
acc: 0.2750
Epoch 14/20
80/80 [==============================] - 0s 172us/step - loss: 2.9140 -
acc: 0.2750
Epoch 15/20
80/80 [==============================] - 0s 176us/step - loss: 2.7328 -
acc: 0.2750
Epoch 16/20
80/80 [==============================] - 0s 170us/step - loss: 2.5480 -
acc: 0.2750
Epoch 17/20
80/80 [==============================] - 0s 172us/step - loss: 2.3622 -
acc: 0.2750
Epoch 18/20
80/80 [==============================] - 0s 189us/step - loss: 2.1872 -
acc: 0.2750
Epoch 19/20
80/80 [==============================] - 0s 149us/step - loss: 2.0135 -
acc: 0.2750
Epoch 20/20
80/80 [==============================] - 0s 196us/step - loss: 1.8542 -
acc: 0.2750
20/20 [==============================] - 0s 6ms/step
80/80 [==============================] - 0s 127us/step
Epoch 1/20
80/80 [==============================] - 0s 5ms/step - loss: 1.8953 - a
cc: 0.1875
Epoch 2/20
80/80 [==============================] - 0s 180us/step - loss: 1.8176 -
acc: 0.2250
Epoch 3/20
80/80 [==============================] - 0s 173us/step - loss: 1.7476 -
acc: 0.2375
Epoch 4/20
80/80 [==============================] - 0s 176us/step - loss: 1.6777 -
acc: 0.2500
Epoch 5/20
80/80 [==============================] - 0s 183us/step - loss: 1.6105 -
acc: 0.2875
Epoch 6/20
```

```
80/80 [==============================] - 0s 176us/step - loss: 1.5457 -
acc: 0.2875
Epoch 7/20
80/80 [==============================] - 0s 184us/step - loss: 1.4892 -
acc: 0.3000
Epoch 8/20
80/80 [==============================] - 0s 174us/step - loss: 1.4377 -
acc: 0.3000
Epoch 9/20
80/80 [==============================] - 0s 173us/step - loss: 1.3848 -
acc: 0.3000
Epoch 10/20
80/80 [==============================] - 0s 165us/step - loss: 1.3462 -
acc: 0.3000
Epoch 11/20
80/80 [==============================] - 0s 167us/step - loss: 1.3107 -
acc: 0.2875
Epoch 12/20
80/80 [==============================] - 0s 172us/step - loss: 1.2833 -
acc: 0.2500
Epoch 13/20
80/80 [==============================] - 0s 162us/step - loss: 1.2559 -
acc: 0.1000
Epoch 14/20
80/80 [==============================] - 0s 161us/step - loss: 1.2355 -
acc: 0.0375
Epoch 15/20
80/80 [==============================] - 0s 162us/step - loss: 1.2233 -
acc: 0.1125
Epoch 16/20
80/80 [==============================] - 0s 188us/step - loss: 1.2104 -
acc: 0.3625
Epoch 17/20
80/80 [==============================] - 0s 241us/step - loss: 1.2011 -
acc: 0.5000
Epoch 18/20
80/80 [==============================] - 0s 238us/step - loss: 1.1922 -
acc: 0.5000
Epoch 19/20
80/80 [==============================] - 0s 154us/step - loss: 1.1841 -
acc: 0.5125
Epoch 20/20
80/80 [==============================] - 0s 183us/step - loss: 1.1780 -
acc: 0.5125
20/20 [==============================] - 0s 8ms/step
80/80 [==============================] - 0s 131us/step
Epoch 1/20
80/80 [==============================] - 0s 6ms/step - loss: 1.2676 - a
cc: 0.3250
Epoch 2/20
80/80 [==============================] - 0s 177us/step - loss: 1.2407 -
acc: 0.3250
Epoch 3/20
80/80 [==============================] - 0s 168us/step - loss: 1.2120 -
acc: 0.3125
Epoch 4/20
80/80 [==============================] - 0s 185us/step - loss: 1.1935 -
```

```
acc: 0.3250
Epoch 5/20
80/80 [==============================] - 0s 161us/step - loss: 1.1795 -
acc: 0.3500
Epoch 6/20
80/80 [==============================] - 0s 149us/step - loss: 1.1666 -
acc: 0.3750
Epoch 7/20
80/80 [==============================] - 0s 146us/step - loss: 1.1540 -
acc: 0.3875
Epoch 8/20
80/80 [==============================] - 0s 168us/step - loss: 1.1441 -
acc: 0.3875
Epoch 9/20
80/80 [==============================] - 0s 151us/step - loss: 1.1312 -
acc: 0.4000
Epoch 10/20
80/80 [==============================] - 0s 162us/step - loss: 1.1205 -
acc: 0.4000
Epoch 11/20
80/80 [==============================] - 0s 165us/step - loss: 1.1094 -
acc: 0.4125
Epoch 12/20
80/80 [==============================] - 0s 162us/step - loss: 1.0984 -
acc: 0.4250
Epoch 13/20
80/80 [==============================] - 0s 163us/step - loss: 1.0883 -
acc: 0.4375
Epoch 14/20
80/80 [==============================] - 0s 185us/step - loss: 1.0770 -
acc: 0.4500
Epoch 15/20
80/80 [==============================] - 0s 175us/step - loss: 1.0669 -
acc: 0.4625
Epoch 16/20
80/80 [==============================] - 0s 224us/step - loss: 1.0559 -
acc: 0.4875
Epoch 17/20
80/80 [==============================] - 0s 177us/step - loss: 1.0454 -
acc: 0.5250
Epoch 18/20
80/80 [==============================] - 0s 159us/step - loss: 1.0353 -
acc: 0.5750
Epoch 19/20
80/80 [==============================] - 0s 181us/step - loss: 1.0244 -
acc: 0.6125
Epoch 20/20
80/80 [==============================] - 0s 187us/step - loss: 1.0148 -
acc: 0.6250
20/20 [==============================] - 0s 8ms/step
80/80 [==============================] - 0s 132us/step
Epoch 1/20
80/80 [==============================] - 0s 6ms/step - loss: 2.4075 - a
cc: 0.3125
Epoch 2/20
80/80 [==============================] - 0s 183us/step - loss: 2.3287 -
acc: 0.3125
```

```
Epoch 3/20
80/80 [==============================] - 0s 233us/step - loss: 2.2502 -
acc: 0.3125
Epoch 4/20
80/80 [==============================] - 0s 146us/step - loss: 2.1824 -
acc: 0.3125
Epoch 5/20
80/80 [==============================] - 0s 178us/step - loss: 2.1150 -
acc: 0.3125
Epoch 6/20
80/80 [==============================] - 0s 168us/step - loss: 2.0534 -
acc: 0.3125
Epoch 7/20
80/80 [==============================] - 0s 171us/step - loss: 1.9926 -
acc: 0.3125
Epoch 8/20
80/80 [==============================] - 0s 155us/step - loss: 1.9377 -
acc: 0.3125
Epoch 9/20
80/80 [==============================] - 0s 156us/step - loss: 1.8856 -
acc: 0.3125
Epoch 10/20
80/80 [==============================] - 0s 168us/step - loss: 1.8322 -
acc: 0.3125
Epoch 11/20
80/80 [==============================] - 0s 164us/step - loss: 1.7893 -
acc: 0.3125
Epoch 12/20
80/80 [==============================] - 0s 233us/step - loss: 1.7463 -
acc: 0.3125
Epoch 13/20
80/80 [==============================] - 0s 171us/step - loss: 1.7044 -
acc: 0.3125
Epoch 14/20
80/80 [==============================] - 0s 156us/step - loss: 1.6686 -
acc: 0.3125
Epoch 15/20
80/80 [==============================] - 0s 200us/step - loss: 1.6297 -
acc: 0.3125
Epoch 16/20
80/80 [==============================] - 0s 189us/step - loss: 1.5985 -
acc: 0.3125
Epoch 17/20
80/80 [==============================] - 0s 168us/step - loss: 1.5686 -
acc: 0.3125
Epoch 18/20
80/80 [==============================] - 0s 185us/step - loss: 1.5381 -
acc: 0.3125
Epoch 19/20
80/80 [==============================] - 0s 191us/step - loss: 1.5124 -
acc: 0.3125
Epoch 20/20
80/80 [==============================] - 0s 195us/step - loss: 1.4852 -
acc: 0.3125
20/20 [==============================] - 0s 8ms/step
80/80 [==============================] - 0s 108us/step
Epoch 1/20
```

```
80/80 [==============================] - 1s 7ms/step - loss: 1.5187 - a
cc: 0.2875
Epoch 2/20
80/80 [==============================] - 0s 173us/step - loss: 1.4742 -
acc: 0.2750
Epoch 3/20
80/80 [==============================] - 0s 165us/step - loss: 1.4291 -
acc: 0.2500
Epoch 4/20
80/80 [==============================] - 0s 168us/step - loss: 1.3840 -
acc: 0.2625
Epoch 5/20
80/80 [==============================] - 0s 174us/step - loss: 1.3470 -
acc: 0.2875
Epoch 6/20
80/80 [==============================] - 0s 158us/step - loss: 1.3122 -
acc: 0.3000
Epoch 7/20
80/80 [==============================] - 0s 172us/step - loss: 1.2828 -
acc: 0.3000
Epoch 8/20
80/80 [==============================] - 0s 189us/step - loss: 1.2574 -
acc: 0.3000
Epoch 9/20
80/80 [==============================] - 0s 181us/step - loss: 1.2324 -
acc: 0.3000
Epoch 10/20
80/80 [==============================] - 0s 197us/step - loss: 1.2104 -
acc: 0.3000
Epoch 11/20
80/80 [==============================] - 0s 182us/step - loss: 1.1940 -
acc: 0.3000
Epoch 12/20
80/80 [==============================] - 0s 199us/step - loss: 1.1804 -
acc: 0.3125
Epoch 13/20
80/80 [==============================] - 0s 188us/step - loss: 1.1660 -
acc: 0.3250
Epoch 14/20
80/80 [==============================] - 0s 200us/step - loss: 1.1579 -
acc: 0.3000
Epoch 15/20
80/80 [==============================] - 0s 210us/step - loss: 1.1473 -
acc: 0.3250
Epoch 16/20
80/80 [==============================] - 0s 197us/step - loss: 1.1406 -
acc: 0.3875
Epoch 17/20
80/80 [==============================] - 0s 222us/step - loss: 1.1367 -
acc: 0.4000
Epoch 18/20
80/80 [==============================] - 0s 176us/step - loss: 1.1316 -
acc: 0.4375
Epoch 19/20
80/80 [==============================] - 0s 152us/step - loss: 1.1266 -
acc: 0.4125
Epoch 20/20
```

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80/80 [==============================] - 0s 175us/step - loss: 1.1224 -
acc: 0.3875
20/20 [==============================] - 0s 9ms/step
80/80 [==============================] - 0s 164us/step
Epoch 1/20
80/80 [==============================] - 1s 7ms/step - loss: 14.6841 -
 acc: 0.3750
Epoch 2/20
80/80 [==============================] - 0s 188us/step - loss: 14.4369
 - acc: 0.3750
Epoch 3/20
80/80 [==============================] - 0s 168us/step - loss: 14.2003
 - acc: 0.3750
Epoch 4/20
80/80 [==============================] - 0s 158us/step - loss: 13.9656
 - acc: 0.3750
Epoch 5/20
80/80 [==============================] - 0s 155us/step - loss: 13.7355
 - acc: 0.3750
Epoch 6/20
80/80 [==============================] - 0s 171us/step - loss: 13.5155
 - acc: 0.3750
Epoch 7/20
80/80 [==============================] - 0s 169us/step - loss: 13.2953
 - acc: 0.3750
Epoch 8/20
80/80 [==============================] - 0s 165us/step - loss: 13.0828
 - acc: 0.3750
Epoch 9/20
80/80 [==============================] - 0s 176us/step - loss: 12.8726
 - acc: 0.3750
Epoch 10/20
80/80 [==============================] - 0s 176us/step - loss: 12.6688
 - acc: 0.3750
Epoch 11/20
80/80 [==============================] - 0s 165us/step - loss: 12.4715
 - acc: 0.3750
Epoch 12/20
80/80 [==============================] - 0s 172us/step - loss: 12.2732
 - acc: 0.3750
Epoch 13/20
80/80 [==============================] - 0s 206us/step - loss: 12.0825
 - acc: 0.3750
Epoch 14/20
80/80 [==============================] - 0s 176us/step - loss: 11.8976
 - acc: 0.3750
Epoch 15/20
80/80 [==============================] - 0s 158us/step - loss: 11.7146
 - acc: 0.3750
Epoch 16/20
80/80 [==============================] - 0s 169us/step - loss: 11.5362
 - acc: 0.3750
Epoch 17/20
80/80 [==============================] - 0s 174us/step - loss: 11.3627
 - acc: 0.3750
Epoch 18/20
80/80 [==============================] - 0s 163us/step - loss: 11.1904
```

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 - acc: 0.3750
Epoch 19/20
80/80 [==============================] - 0s 171us/step - loss: 11.0240
 - acc: 0.3750
Epoch 20/20
80/80 [==============================] - 0s 176us/step - loss: 10.8615
 - acc: 0.3750
20/20 [==============================] - 0s 10ms/step
80/80 [==============================] - 0s 108us/step
Epoch 1/20
80/80 [==============================] - 1s 8ms/step - loss: 15.7789 -
 acc: 0.3500
Epoch 2/20
80/80 [==============================] - 0s 183us/step - loss: 15.5777
 - acc: 0.3500
Epoch 3/20
80/80 [==============================] - 0s 163us/step - loss: 15.3810
 - acc: 0.3500
Epoch 4/20
80/80 [==============================] - 0s 168us/step - loss: 15.1840
 - acc: 0.3500
Epoch 5/20
80/80 [==============================] - 0s 161us/step - loss: 14.9910
 - acc: 0.3500
Epoch 6/20
80/80 [==============================] - 0s 168us/step - loss: 14.8001
 - acc: 0.3500
Epoch 7/20
80/80 [==============================] - 0s 161us/step - loss: 14.6110
 - acc: 0.3500
Epoch 8/20
80/80 [==============================] - 0s 166us/step - loss: 14.4245
 - acc: 0.3625
Epoch 9/20
80/80 [==============================] - 0s 173us/step - loss: 14.2405
 - acc: 0.3625
Epoch 10/20
80/80 [==============================] - 0s 187us/step - loss: 14.0583
 - acc: 0.3625
Epoch 11/20
80/80 [==============================] - 0s 172us/step - loss: 13.8784
 - acc: 0.3625
Epoch 12/20
80/80 [==============================] - 0s 176us/step - loss: 13.7016
 - acc: 0.3750
Epoch 13/20
80/80 [==============================] - 0s 190us/step - loss: 13.5257
 - acc: 0.4000
Epoch 14/20
80/80 [==============================] - 0s 167us/step - loss: 13.3539
 - acc: 0.4000
Epoch 15/20
80/80 [==============================] - 0s 165us/step - loss: 13.1831
 - acc: 0.4000
Epoch 16/20
80/80 [==============================] - 0s 210us/step - loss: 13.0147
 - acc: 0.4125
```

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Epoch 17/20
80/80 [==============================] - 0s 212us/step - loss: 12.8489
 - acc: 0.4125
Epoch 18/20
80/80 [==============================] - 0s 219us/step - loss: 12.6852
 - acc: 0.4250
Epoch 19/20
80/80 [==============================] - 0s 244us/step - loss: 12.5235
 - acc: 0.4250
Epoch 20/20
80/80 [==============================] - 0s 242us/step - loss: 12.3641
 - acc: 0.4375
20/20 [==============================] - 0s 12ms/step
80/80 [==============================] - 0s 143us/step
Epoch 1/20
80/80 [==============================] - 1s 8ms/step - loss: 13.8477 -
 acc: 0.5750
Epoch 2/20
80/80 [==============================] - 0s 170us/step - loss: 13.6617
 - acc: 0.5625
Epoch 3/20
80/80 [==============================] - 0s 174us/step - loss: 13.4763
 - acc: 0.5875
Epoch 4/20
80/80 [==============================] - 0s 167us/step - loss: 13.2968
 - acc: 0.6250
Epoch 5/20
80/80 [==============================] - 0s 177us/step - loss: 13.1215
 - acc: 0.6375
Epoch 6/20
80/80 [==============================] - 0s 166us/step - loss: 12.9458
 - acc: 0.6250
Epoch 7/20
80/80 [==============================] - 0s 178us/step - loss: 12.7755
 - acc: 0.6125
Epoch 8/20
80/80 [==============================] - 0s 171us/step - loss: 12.6060
 - acc: 0.6125
Epoch 9/20
80/80 [==============================] - 0s 176us/step - loss: 12.4397
 - acc: 0.6000
Epoch 10/20
80/80 [==============================] - 0s 222us/step - loss: 12.2766
 - acc: 0.5875
Epoch 11/20
80/80 [==============================] - 0s 178us/step - loss: 12.1146
 - acc: 0.5750
Epoch 12/20
80/80 [==============================] - 0s 200us/step - loss: 11.9553
 - acc: 0.5875
Epoch 13/20
80/80 [==============================] - 0s 171us/step - loss: 11.7984
 - acc: 0.5750
Epoch 14/20
80/80 [==============================] - 0s 194us/step - loss: 11.6427
 - acc: 0.5875
Epoch 15/20
```

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80/80 [==============================] - 0s 163us/step - loss: 11.4895
 - acc: 0.5875
Epoch 16/20
80/80 [==============================] - 0s 174us/step - loss: 11.3383
 - acc: 0.5875
Epoch 17/20
80/80 [==============================] - 0s 166us/step - loss: 11.1889
 - acc: 0.5875
Epoch 18/20
80/80 [==============================] - 0s 167us/step - loss: 11.0417
 - acc: 0.5875
Epoch 19/20
80/80 [==============================] - 0s 182us/step - loss: 10.8963
 - acc: 0.5875
Epoch 20/20
80/80 [==============================] - 0s 212us/step - loss: 10.7531
 - acc: 0.6000
20/20 [==============================] - 0s 12ms/step
80/80 [==============================] - 0s 191us/step
Epoch 1/20
80/80 [==============================] - 1s 9ms/step - loss: 14.0006 -
 acc: 0.3500
Epoch 2/20
80/80 [==============================] - 0s 177us/step - loss: 13.8058
 - acc: 0.3500
Epoch 3/20
80/80 [==============================] - 0s 182us/step - loss: 13.6163
 - acc: 0.3500
Epoch 4/20
80/80 [==============================] - 0s 171us/step - loss: 13.4286
 - acc: 0.3500
Epoch 5/20
80/80 [==============================] - 0s 179us/step - loss: 13.2452
 - acc: 0.3500
Epoch 6/20
80/80 [==============================] - 0s 178us/step - loss: 13.0642
 - acc: 0.3500
Epoch 7/20
80/80 [==============================] - 0s 161us/step - loss: 12.8873
 - acc: 0.3500
Epoch 8/20
80/80 [==============================] - 0s 176us/step - loss: 12.7142
 - acc: 0.3500
Epoch 9/20
80/80 [==============================] - 0s 170us/step - loss: 12.5429
 - acc: 0.3500
Epoch 10/20
80/80 [==============================] - 0s 171us/step - loss: 12.3764
 - acc: 0.3500
Epoch 11/20
80/80 [==============================] - 0s 171us/step - loss: 12.2120
 - acc: 0.3500
Epoch 12/20
80/80 [==============================] - 0s 165us/step - loss: 12.0516
 - acc: 0.3500
Epoch 13/20
80/80 [==============================] - 0s 162us/step - loss: 11.8930
```

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 - acc: 0.3500
Epoch 14/20
80/80 [==============================] - 0s 164us/step - loss: 11.7379
 - acc: 0.3500
Epoch 15/20
80/80 [==============================] - 0s 168us/step - loss: 11.5847
 - acc: 0.3500
Epoch 16/20
80/80 [==============================] - 0s 196us/step - loss: 11.4351
 - acc: 0.3500
Epoch 17/20
80/80 [==============================] - 0s 185us/step - loss: 11.2873
 - acc: 0.3500
Epoch 18/20
80/80 [==============================] - 0s 168us/step - loss: 11.1423
 - acc: 0.3500
Epoch 19/20
80/80 [==============================] - 0s 166us/step - loss: 10.9989
 - acc: 0.3500
Epoch 20/20
80/80 [==============================] - 0s 178us/step - loss: 10.8575
 - acc: 0.3500
20/20 [==============================] - 0s 14ms/step
80/80 [==============================] - 0s 146us/step
Epoch 1/20
80/80 [==============================] - 1s 10ms/step - loss: 15.8296 -
acc: 0.3625
Epoch 2/20
80/80 [==============================] - 0s 174us/step - loss: 15.6284
 - acc: 0.4375
Epoch 3/20
80/80 [==============================] - 0s 168us/step - loss: 15.4316
 - acc: 0.5000
Epoch 4/20
80/80 [==============================] - 0s 169us/step - loss: 15.2346
 - acc: 0.5625
Epoch 5/20
80/80 [==============================] - 0s 171us/step - loss: 15.0422
 - acc: 0.5750
Epoch 6/20
80/80 [==============================] - 0s 171us/step - loss: 14.8516
 - acc: 0.5750
Epoch 7/20
80/80 [==============================] - 0s 174us/step - loss: 14.6641
 - acc: 0.5750
Epoch 8/20
80/80 [==============================] - 0s 173us/step - loss: 14.4791
 - acc: 0.5250
Epoch 9/20
80/80 [==============================] - 0s 165us/step - loss: 14.2973
 - acc: 0.4625
Epoch 10/20
80/80 [==============================] - 0s 169us/step - loss: 14.1180
 - acc: 0.3500
Epoch 11/20
80/80 [==============================] - 0s 186us/step - loss: 13.9417
 - acc: 0.3375
```

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Epoch 12/20
80/80 [==============================] - 0s 167us/step - loss: 13.7675
 - acc: 0.3625
Epoch 13/20
80/80 [==============================] - 0s 174us/step - loss: 13.5955
 - acc: 0.3625
Epoch 14/20
80/80 [==============================] - 0s 165us/step - loss: 13.4260
 - acc: 0.3625
Epoch 15/20
80/80 [==============================] - 0s 164us/step - loss: 13.2582
 - acc: 0.3625
Epoch 16/20
80/80 [==============================] - 0s 205us/step - loss: 13.0924
 - acc: 0.3625
Epoch 17/20
80/80 [==============================] - 0s 259us/step - loss: 12.9289
 - acc: 0.3625
Epoch 18/20
80/80 [==============================] - 0s 204us/step - loss: 12.7677
 - acc: 0.3625
Epoch 19/20
80/80 [==============================] - 0s 164us/step - loss: 12.6074
 - acc: 0.3625
Epoch 20/20
80/80 [==============================] - 0s 173us/step - loss: 12.4501
 - acc: 0.3625
20/20 [==============================] - 0s 15ms/step
80/80 [==============================] - 0s 142us/step
Epoch 1/20
80/80 [==============================] - 1s 10ms/step - loss: 158.4005
 - acc: 0.3750
Epoch 2/20
80/80 [==============================] - 0s 178us/step - loss: 156.3109
- acc: 0.3750
Epoch 3/20
80/80 [==============================] - 0s 169us/step - loss: 154.2448
- acc: 0.3750
Epoch 4/20
80/80 [==============================] - 0s 166us/step - loss: 152.1929
- acc: 0.3750
Epoch 5/20
80/80 [==============================] - 0s 175us/step - loss: 150.1665
- acc: 0.3750
Epoch 6/20
80/80 [==============================] - 0s 163us/step - loss: 148.1599
- acc: 0.3750
Epoch 7/20
80/80 [==============================] - 0s 161us/step - loss: 146.1808
- acc: 0.3750
Epoch 8/20
80/80 [==============================] - 0s 156us/step - loss: 144.2180
- acc: 0.3750
Epoch 9/20
80/80 [==============================] - 0s 145us/step - loss: 142.2822
- acc: 0.3750
Epoch 10/20
```

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80/80 [==============================] - 0s 150us/step - loss: 140.3710
- acc: 0.3750
Epoch 11/20
80/80 [==============================] - 0s 173us/step - loss: 138.4797
- acc: 0.3750
Epoch 12/20
80/80 [==============================] - 0s 182us/step - loss: 136.6147
- acc: 0.3750
Epoch 13/20
80/80 [==============================] - 0s 203us/step - loss: 134.7752
- acc: 0.3750
Epoch 14/20
80/80 [==============================] - 0s 180us/step - loss: 132.9562
- acc: 0.3750
Epoch 15/20
80/80 [==============================] - 0s 170us/step - loss: 131.1622
- acc: 0.3750
Epoch 16/20
80/80 [==============================] - 0s 161us/step - loss: 129.3931
- acc: 0.3750
Epoch 17/20
80/80 [==============================] - 0s 165us/step - loss: 127.6437
- acc: 0.3750
Epoch 18/20
80/80 [==============================] - 0s 165us/step - loss: 125.9182
- acc: 0.3750
Epoch 19/20
80/80 [==============================] - 0s 167us/step - loss: 124.2157
- acc: 0.3750
Epoch 20/20
80/80 [==============================] - 0s 169us/step - loss: 122.5338
- acc: 0.3750
20/20 [==============================] - 0s 16ms/step
80/80 [==============================] - 0s 111us/step
Epoch 1/20
80/80 [==============================] - 1s 11ms/step - loss: 121.4913
 - acc: 0.3500
Epoch 2/20
80/80 [==============================] - 0s 170us/step - loss: 119.7163
- acc: 0.3500
Epoch 3/20
80/80 [==============================] - 0s 172us/step - loss: 117.9595
- acc: 0.3500
Epoch 4/20
80/80 [==============================] - 0s 177us/step - loss: 116.2226
- acc: 0.3500
Epoch 5/20
80/80 [==============================] - 0s 168us/step - loss: 114.5066
- acc: 0.3500
Epoch 6/20
80/80 [==============================] - 0s 178us/step - loss: 112.8115
- acc: 0.3500
Epoch 7/20
80/80 [==============================] - 0s 174us/step - loss: 111.1399
- acc: 0.3500
Epoch 8/20
80/80 [==============================] - 0s 173us/step - loss: 109.4879
```

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- acc: 0.3500
Epoch 9/20
80/80 [==============================] - 0s 169us/step - loss: 107.8591
- acc: 0.3500
Epoch 10/20
80/80 [==============================] - 0s 166us/step - loss: 106.2548
- acc: 0.3500
Epoch 11/20
80/80 [==============================] - 0s 173us/step - loss: 104.6705
- acc: 0.3500
Epoch 12/20
80/80 [==============================] - 0s 174us/step - loss: 103.1083
- acc: 0.3500
Epoch 13/20
80/80 [==============================] - 0s 170us/step - loss: 101.5681
- acc: 0.3500
Epoch 14/20
80/80 [==============================] - 0s 170us/step - loss: 100.0517
- acc: 0.3500
Epoch 15/20
80/80 [==============================] - 0s 161us/step - loss: 98.5568
 - acc: 0.3500
Epoch 16/20
80/80 [==============================] - 0s 155us/step - loss: 97.0863
 - acc: 0.3500
Epoch 17/20
80/80 [==============================] - 0s 152us/step - loss: 95.6337
 - acc: 0.3500
Epoch 18/20
80/80 [==============================] - 0s 210us/step - loss: 94.2036
 - acc: 0.3500
Epoch 19/20
80/80 [==============================] - 0s 179us/step - loss: 92.7947
 - acc: 0.3500
Epoch 20/20
80/80 [==============================] - 0s 174us/step - loss: 91.4056
 - acc: 0.3500
20/20 [==============================] - 0s 17ms/step
80/80 [==============================] - 0s 146us/step
Epoch 1/20
80/80 [==============================] - 1s 12ms/step - loss: 118.0595
 - acc: 0.3000
Epoch 2/20
80/80 [==============================] - 0s 173us/step - loss: 116.3398
- acc: 0.3000
Epoch 3/20
80/80 [==============================] - 0s 189us/step - loss: 114.6405
- acc: 0.3000
Epoch 4/20
80/80 [==============================] - 0s 172us/step - loss: 112.9606
- acc: 0.3000
Epoch 5/20
80/80 [==============================] - 0s 170us/step - loss: 111.3013
- acc: 0.3000
Epoch 6/20
80/80 [==============================] - 0s 169us/step - loss: 109.6628
- acc: 0.3000
```

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Epoch 7/20
80/80 [==============================] - 0s 153us/step - loss: 108.0465
- acc: 0.3000
Epoch 8/20
80/80 [==============================] - 0s 209us/step - loss: 106.4507
- acc: 0.3000
Epoch 9/20
80/80 [==============================] - 0s 225us/step - loss: 104.8784
- acc: 0.3000
Epoch 10/20
80/80 [==============================] - 0s 157us/step - loss: 103.3268
- acc: 0.3000
Epoch 11/20
80/80 [==============================] - 0s 179us/step - loss: 101.7968
- acc: 0.3000
Epoch 12/20
80/80 [==============================] - 0s 190us/step - loss: 100.2896
- acc: 0.3000
Epoch 13/20
80/80 [==============================] - 0s 159us/step - loss: 98.8031
 - acc: 0.3000
Epoch 14/20
80/80 [==============================] - 0s 201us/step - loss: 97.3393
 - acc: 0.3000
Epoch 15/20
80/80 [==============================] - 0s 215us/step - loss: 95.8950
 - acc: 0.3000
Epoch 16/20
80/80 [==============================] - 0s 170us/step - loss: 94.4728
 - acc: 0.3000
Epoch 17/20
80/80 [==============================] - 0s 170us/step - loss: 93.0707
 - acc: 0.3000
Epoch 18/20
80/80 [==============================] - 0s 172us/step - loss: 91.6886
 - acc: 0.3000
Epoch 19/20
80/80 [==============================] - 0s 165us/step - loss: 90.3268
 - acc: 0.3000
Epoch 20/20
80/80 [==============================] - 0s 166us/step - loss: 88.9834
 - acc: 0.3000
20/20 [==============================] - 0s 18ms/step
80/80 [==============================] - 0s 143us/step
Epoch 1/20
80/80 [==============================] - 1s 12ms/step - loss: 112.3399
 - acc: 0.3375
Epoch 2/20
80/80 [==============================] - 0s 182us/step - loss: 110.6155
- acc: 0.3375
Epoch 3/20
80/80 [==============================] - 0s 134us/step - loss: 108.9119
- acc: 0.3375
Epoch 4/20
80/80 [==============================] - 0s 184us/step - loss: 107.2373
- acc: 0.3375
Epoch 5/20
```

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80/80 [==============================] - 0s 167us/step - loss: 105.5737
- acc: 0.3375
Epoch 6/20
80/80 [==============================] - 0s 165us/step - loss: 103.9457
- acc: 0.3375
Epoch 7/20
80/80 [==============================] - 0s 213us/step - loss: 102.3371
- acc: 0.3375
Epoch 8/20
80/80 [==============================] - 0s 171us/step - loss: 100.7486
- acc: 0.3375
Epoch 9/20
80/80 [==============================] - 0s 179us/step - loss: 99.1896
 - acc: 0.3375
Epoch 10/20
80/80 [==============================] - 0s 197us/step - loss: 97.6528
 - acc: 0.3375
Epoch 11/20
80/80 [==============================] - 0s 161us/step - loss: 96.1419
 - acc: 0.3375
Epoch 12/20
80/80 [==============================] - 0s 176us/step - loss: 94.6572
 - acc: 0.3375
Epoch 13/20
80/80 [==============================] - 0s 170us/step - loss: 93.1887
 - acc: 0.3375
Epoch 14/20
80/80 [==============================] - 0s 229us/step - loss: 91.7516
 - acc: 0.3375
Epoch 15/20
80/80 [==============================] - 0s 201us/step - loss: 90.3331
 - acc: 0.3375
Epoch 16/20
80/80 [==============================] - 0s 179us/step - loss: 88.9423
 - acc: 0.3375
Epoch 17/20
80/80 [==============================] - 0s 206us/step - loss: 87.5701
 - acc: 0.3375
Epoch 18/20
80/80 [==============================] - 0s 208us/step - loss: 86.2235
 - acc: 0.3375
Epoch 19/20
80/80 [==============================] - 0s 201us/step - loss: 84.8957
 - acc: 0.3375
Epoch 20/20
80/80 [==============================] - 0s 153us/step - loss: 83.5892
 - acc: 0.3375
20/20 [==============================] - 0s 19ms/step
80/80 [==============================] - 0s 147us/step
Epoch 1/20
80/80 [==============================] - 1s 13ms/step - loss: 142.0784
 - acc: 0.3625
Epoch 2/20
80/80 [==============================] - 0s 183us/step - loss: 140.1477
- acc: 0.3625
Epoch 3/20
80/80 [==============================] - 0s 169us/step - loss: 138.2381
```

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- acc: 0.3625
Epoch 4/20
80/80 [==============================] - 0s 187us/step - loss: 136.3486
- acc: 0.3625
Epoch 5/20
80/80 [==============================] - 0s 181us/step - loss: 134.4791
- acc: 0.3750
Epoch 6/20
80/80 [==============================] - 0s 169us/step - loss: 132.6311
- acc: 0.3750
Epoch 7/20
80/80 [==============================] - 0s 162us/step - loss: 130.8050
- acc: 0.3750
Epoch 8/20
80/80 [==============================] - 0s 158us/step - loss: 128.9994
- acc: 0.3750
Epoch 9/20
80/80 [==============================] - 0s 176us/step - loss: 127.2183
- acc: 0.3750
Epoch 10/20
80/80 [==============================] - 0s 178us/step - loss: 125.4567
- acc: 0.3750
Epoch 11/20
80/80 [==============================] - 0s 175us/step - loss: 123.7209
- acc: 0.3875
Epoch 12/20
80/80 [==============================] - 0s 187us/step - loss: 122.0041
- acc: 0.3875
Epoch 13/20
80/80 [==============================] - 0s 150us/step - loss: 120.3124
- acc: 0.3875
Epoch 14/20
80/80 [==============================] - 0s 159us/step - loss: 118.6404
- acc: 0.4000
Epoch 15/20
80/80 [==============================] - 0s 204us/step - loss: 116.9919
- acc: 0.4000
Epoch 16/20
80/80 [==============================] - 0s 183us/step - loss: 115.3649
- acc: 0.4125
Epoch 17/20
80/80 [==============================] - 0s 192us/step - loss: 113.7601
- acc: 0.4125
Epoch 18/20
80/80 [==============================] - 0s 167us/step - loss: 112.1769
- acc: 0.4000
Epoch 19/20
80/80 [==============================] - 0s 199us/step - loss: 110.6137
- acc: 0.4250
Epoch 20/20
80/80 [==============================] - 0s 211us/step - loss: 109.0720
- acc: 0.4250
20/20 [==============================] - 0s 20ms/step
80/80 [==============================] - 0s 166us/step
Epoch 1/20
80/80 [==============================] - 1s 13ms/step - loss: 1.7184 -
 acc: 0.2750
```

```
Epoch 2/20
80/80 [==============================] - 0s 177us/step - loss: 1.6328 -
acc: 0.2750
Epoch 3/20
80/80 [==============================] - 0s 170us/step - loss: 1.5587 -
acc: 0.2750
Epoch 4/20
80/80 [==============================] - 0s 151us/step - loss: 1.4863 -
acc: 0.2750
Epoch 5/20
80/80 [==============================] - 0s 169us/step - loss: 1.4280 -
acc: 0.2750
Epoch 6/20
80/80 [==============================] - 0s 164us/step - loss: 1.3760 -
acc: 0.2750
Epoch 7/20
80/80 [==============================] - 0s 160us/step - loss: 1.3328 -
acc: 0.2750
Epoch 8/20
80/80 [==============================] - 0s 174us/step - loss: 1.2939 -
acc: 0.2750
Epoch 9/20
80/80 [==============================] - 0s 176us/step - loss: 1.2662 -
acc: 0.2750
Epoch 10/20
80/80 [==============================] - 0s 180us/step - loss: 1.2399 -
acc: 0.2750
Epoch 11/20
80/80 [==============================] - 0s 179us/step - loss: 1.2216 -
acc: 0.2750
Epoch 12/20
80/80 [==============================] - 0s 180us/step - loss: 1.2046 -
acc: 0.2750
Epoch 13/20
80/80 [==============================] - 0s 178us/step - loss: 1.1941 -
acc: 0.2625
Epoch 14/20
80/80 [==============================] - 0s 217us/step - loss: 1.1830 -
acc: 0.0625
Epoch 15/20
80/80 [==============================] - 0s 221us/step - loss: 1.1761 -
acc: 0.0000e+00
Epoch 16/20
80/80 [==============================] - 0s 191us/step - loss: 1.1676 -
acc: 0.0000e+00
Epoch 17/20
80/80 [==============================] - 0s 175us/step - loss: 1.1600 -
acc: 0.0000e+00
Epoch 18/20
80/80 [==============================] - 0s 174us/step - loss: 1.1545 -
acc: 0.0000e+00
Epoch 19/20
80/80 [==============================] - 0s 176us/step - loss: 1.1470 -
acc: 0.0000e+00
Epoch 20/20
80/80 [==============================] - 0s 184us/step - loss: 1.1414 -
acc: 0.0125
```

```
20/20 [==============================] - 0s 21ms/step
80/80 [==============================] - 0s 143us/step
Epoch 1/20
80/80 [==============================] - 1s 14ms/step - loss: 1.7026 -
 acc: 0.3500
Epoch 2/20
80/80 [==============================] - 0s 167us/step - loss: 1.6019 -
acc: 0.3500
Epoch 3/20
80/80 [==============================] - 0s 180us/step - loss: 1.5231 -
acc: 0.3500
Epoch 4/20
80/80 [==============================] - 0s 167us/step - loss: 1.4526 -
acc: 0.3500
Epoch 5/20
80/80 [==============================] - 0s 172us/step - loss: 1.3873 -
acc: 0.3750
Epoch 6/20
80/80 [==============================] - 0s 178us/step - loss: 1.3425 -
acc: 0.4875
Epoch 7/20
80/80 [==============================] - 0s 157us/step - loss: 1.2956 -
acc: 0.5375
Epoch 8/20
80/80 [==============================] - 0s 164us/step - loss: 1.2591 -
acc: 0.4875
Epoch 9/20
80/80 [==============================] - 0s 161us/step - loss: 1.2206 -
acc: 0.4250
Epoch 10/20
80/80 [==============================] - 0s 183us/step - loss: 1.1813 -
acc: 0.4125
Epoch 11/20
80/80 [==============================] - 0s 222us/step - loss: 1.1458 -
acc: 0.4375
Epoch 12/20
80/80 [==============================] - 0s 218us/step - loss: 1.1098 -
acc: 0.4875
Epoch 13/20
80/80 [==============================] - 0s 165us/step - loss: 1.0761 -
acc: 0.5125
Epoch 14/20
80/80 [==============================] - 0s 191us/step - loss: 1.0465 -
acc: 0.5375
Epoch 15/20
80/80 [==============================] - 0s 229us/step - loss: 1.0145 -
acc: 0.5500
Epoch 16/20
80/80 [==============================] - 0s 185us/step - loss: 0.9857 -
acc: 0.5500
Epoch 17/20
80/80 [==============================] - 0s 176us/step - loss: 0.9603 -
acc: 0.5500
Epoch 18/20
80/80 [==============================] - 0s 209us/step - loss: 0.9341 -
acc: 0.5625
Epoch 19/20
```

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80/80 [==============================] - 0s 222us/step - loss: 0.9111 -
acc: 0.5625
Epoch 20/20
80/80 [==============================] - 0s 199us/step - loss: 0.8879 -
acc: 0.5750
20/20 [==============================] - 0s 22ms/step
80/80 [==============================] - 0s 148us/step
Epoch 1/20
80/80 [==============================] - 1s 15ms/step - loss: 1.1762 -
 acc: 0.3250
Epoch 2/20
80/80 [==============================] - 0s 168us/step - loss: 1.1389 -
acc: 0.3250
Epoch 3/20
80/80 [==============================] - 0s 176us/step - loss: 1.1065 -
acc: 0.3250
Epoch 4/20
80/80 [==============================] - 0s 163us/step - loss: 1.0824 -
acc: 0.3250
Epoch 5/20
80/80 [==============================] - 0s 168us/step - loss: 1.0617 -
acc: 0.3250
Epoch 6/20
80/80 [==============================] - 0s 179us/step - loss: 1.0424 -
acc: 0.3250
Epoch 7/20
80/80 [==============================] - 0s 172us/step - loss: 1.0301 -
acc: 0.3250
Epoch 8/20
80/80 [==============================] - 0s 187us/step - loss: 1.0175 -
acc: 0.3250
Epoch 9/20
80/80 [==============================] - 0s 175us/step - loss: 1.0053 -
acc: 0.3250
Epoch 10/20
80/80 [==============================] - 0s 184us/step - loss: 0.9927 -
acc: 0.4250
Epoch 11/20
80/80 [==============================] - 0s 181us/step - loss: 0.9833 -
acc: 0.5375
Epoch 12/20
80/80 [==============================] - 0s 170us/step - loss: 0.9721 -
acc: 0.5500
Epoch 13/20
80/80 [==============================] - 0s 170us/step - loss: 0.9612 -
acc: 0.5750
Epoch 14/20
80/80 [==============================] - 0s 167us/step - loss: 0.9511 -
acc: 0.6000
Epoch 15/20
80/80 [==============================] - 0s 208us/step - loss: 0.9411 -
acc: 0.6000
Epoch 16/20
80/80 [==============================] - 0s 226us/step - loss: 0.9303 -
acc: 0.6000
Epoch 17/20
80/80 [==============================] - 0s 187us/step - loss: 0.9201 -
```

```
acc: 0.6000
Epoch 18/20
80/80 [==============================] - 0s 176us/step - loss: 0.9099 -
acc: 0.6125
Epoch 19/20
80/80 [==============================] - 0s 175us/step - loss: 0.8998 -
acc: 0.6250
Epoch 20/20
80/80 [==============================] - 0s 182us/step - loss: 0.8897 -
acc: 0.6250
20/20 [==============================] - 0s 24ms/step
80/80 [==============================] - 0s 139us/step
Epoch 1/20
80/80 [==============================] - 1s 15ms/step - loss: 1.7914 -
 acc: 0.3375
Epoch 2/20
80/80 [==============================] - 0s 183us/step - loss: 1.6623 -
acc: 0.3375
Epoch 3/20
80/80 [==============================] - 0s 169us/step - loss: 1.5567 -
acc: 0.3375
Epoch 4/20
80/80 [==============================] - 0s 165us/step - loss: 1.4607 -
acc: 0.3375
Epoch 5/20
80/80 [==============================] - 0s 176us/step - loss: 1.3919 -
acc: 0.3375
Epoch 6/20
80/80 [==============================] - 0s 168us/step - loss: 1.3210 -
acc: 0.3375
Epoch 7/20
80/80 [==============================] - 0s 206us/step - loss: 1.2743 -
acc: 0.3375
Epoch 8/20
80/80 [==============================] - 0s 170us/step - loss: 1.2363 -
acc: 0.3375
Epoch 9/20
80/80 [==============================] - 0s 171us/step - loss: 1.2017 -
acc: 0.5375
Epoch 10/20
80/80 [==============================] - 0s 209us/step - loss: 1.1738 -
acc: 0.5500
Epoch 11/20
80/80 [==============================] - 0s 193us/step - loss: 1.1475 -
acc: 0.5500
Epoch 12/20
80/80 [==============================] - 0s 211us/step - loss: 1.1246 -
acc: 0.6125
Epoch 13/20
80/80 [==============================] - 0s 184us/step - loss: 1.1043 -
acc: 0.6375
Epoch 14/20
80/80 [==============================] - 0s 192us/step - loss: 1.0898 -
acc: 0.6625
Epoch 15/20
80/80 [==============================] - 0s 192us/step - loss: 1.0714 -
acc: 0.6750
```

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Epoch 16/20
80/80 [==============================] - 0s 192us/step - loss: 1.0608 -
acc: 0.6875
Epoch 17/20
80/80 [==============================] - 0s 231us/step - loss: 1.0515 -
acc: 0.6750
Epoch 18/20
80/80 [==============================] - 0s 298us/step - loss: 1.0402 -
acc: 0.6875
Epoch 19/20
80/80 [==============================] - 0s 225us/step - loss: 1.0285 -
acc: 0.6875
Epoch 20/20
80/80 [==============================] - 0s 261us/step - loss: 1.0147 -
acc: 0.6875
20/20 [==============================] - 1s 26ms/step
80/80 [==============================] - 0s 163us/step
Epoch 1/20
80/80 [==============================] - 1s 17ms/step - loss: 1.1401 -
 acc: 0.3000
Epoch 2/20
80/80 [==============================] - 0s 209us/step - loss: 1.0994 -
acc: 0.3000
Epoch 3/20
80/80 [==============================] - 0s 191us/step - loss: 1.0611 -
acc: 0.3000
Epoch 4/20
80/80 [==============================] - 0s 229us/step - loss: 1.0365 -
acc: 0.3000
Epoch 5/20
80/80 [==============================] - 0s 195us/step - loss: 1.0114 -
acc: 0.3375
Epoch 6/20
80/80 [==============================] - 0s 198us/step - loss: 0.9931 -
acc: 0.5750
Epoch 7/20
80/80 [==============================] - 0s 234us/step - loss: 0.9778 -
acc: 0.6875
Epoch 8/20
80/80 [==============================] - 0s 192us/step - loss: 0.9620 -
acc: 0.8250
Epoch 9/20
80/80 [==============================] - 0s 189us/step - loss: 0.9505 -
acc: 0.7625
Epoch 10/20
80/80 [==============================] - 0s 193us/step - loss: 0.9390 -
acc: 0.7500
Epoch 11/20
80/80 [==============================] - 0s 228us/step - loss: 0.9272 -
acc: 0.7375
Epoch 12/20
80/80 [==============================] - 0s 193us/step - loss: 0.9163 -
acc: 0.7500
Epoch 13/20
80/80 [==============================] - 0s 205us/step - loss: 0.9050 -
acc: 0.7500
Epoch 14/20
```

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80/80 [==============================] - 0s 196us/step - loss: 0.8935 -
acc: 0.7500
Epoch 15/20
80/80 [==============================] - 0s 188us/step - loss: 0.8828 -
acc: 0.7500
Epoch 16/20
80/80 [==============================] - 0s 207us/step - loss: 0.8713 -
acc: 0.7500
Epoch 17/20
80/80 [==============================] - 0s 231us/step - loss: 0.8598 -
acc: 0.7625
Epoch 18/20
80/80 [==============================] - 0s 188us/step - loss: 0.8492 -
acc: 0.8250
Epoch 19/20
80/80 [==============================] - 0s 203us/step - loss: 0.8384 -
acc: 0.8750
Epoch 20/20
80/80 [==============================] - 0s 274us/step - loss: 0.8270 -
acc: 0.8625
20/20 [==============================] - 1s 27ms/step
80/80 [==============================] - 0s 171us/step
Epoch 1/20
80/80 [==============================] - 1s 18ms/step - loss: 1.6015 -
 acc: 0.0000e+00
Epoch 2/20
80/80 [==============================] - 0s 191us/step - loss: 1.5401 -
acc: 0.0000e+00
Epoch 3/20
80/80 [==============================] - 0s 183us/step - loss: 1.4875 -
acc: 0.0000e+00
Epoch 4/20
80/80 [==============================] - 0s 184us/step - loss: 1.4348 -
acc: 0.0000e+00
Epoch 5/20
80/80 [==============================] - 0s 198us/step - loss: 1.3873 -
acc: 0.0000e+00
Epoch 6/20
80/80 [==============================] - 0s 194us/step - loss: 1.3432 -
acc: 0.0000e+00
Epoch 7/20
80/80 [==============================] - 0s 197us/step - loss: 1.3013 -
acc: 0.0250
Epoch 8/20
80/80 [==============================] - 0s 185us/step - loss: 1.2677 -
acc: 0.2375
Epoch 9/20
80/80 [==============================] - 0s 195us/step - loss: 1.2419 -
acc: 0.4375
Epoch 10/20
80/80 [==============================] - 0s 207us/step - loss: 1.2196 -
acc: 0.4750
Epoch 11/20
80/80 [==============================] - 0s 191us/step - loss: 1.1989 -
acc: 0.5125
Epoch 12/20
80/80 [==============================] - 0s 196us/step - loss: 1.1811 -
```

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acc: 0.5750
Epoch 13/20
80/80 [==============================] - 0s 209us/step - loss: 1.1648 -
acc: 0.5875
Epoch 14/20
80/80 [==============================] - 0s 211us/step - loss: 1.1506 -
acc: 0.6625
Epoch 15/20
80/80 [==============================] - 0s 220us/step - loss: 1.1370 -
acc: 0.6750
Epoch 16/20
80/80 [==============================] - 0s 188us/step - loss: 1.1239 -
acc: 0.7125
Epoch 17/20
80/80 [==============================] - 0s 198us/step - loss: 1.1108 -
acc: 0.7125
Epoch 18/20
80/80 [==============================] - 0s 196us/step - loss: 1.0976 -
acc: 0.7500
Epoch 19/20
80/80 [==============================] - 0s 204us/step - loss: 1.0849 -
acc: 0.7375
Epoch 20/20
80/80 [==============================] - 0s 180us/step - loss: 1.0723 -
acc: 0.7125
20/20 [==============================] - 1s 28ms/step
80/80 [==============================] - 0s 158us/step
Epoch 1/20
80/80 [==============================] - 1s 19ms/step - loss: 1.2072 -
 acc: 0.3500
Epoch 2/20
80/80 [==============================] - 0s 206us/step - loss: 1.1821 -
acc: 0.3500
Epoch 3/20
80/80 [==============================] - 0s 243us/step - loss: 1.1626 -
acc: 0.4125
Epoch 4/20
80/80 [==============================] - 0s 195us/step - loss: 1.1451 -
acc: 0.5750
Epoch 5/20
80/80 [==============================] - 0s 212us/step - loss: 1.1306 -
acc: 0.6250
Epoch 6/20
80/80 [==============================] - 0s 207us/step - loss: 1.1145 -
acc: 0.6375
Epoch 7/20
80/80 [==============================] - 0s 199us/step - loss: 1.0996 -
acc: 0.6500
Epoch 8/20
80/80 [==============================] - 0s 188us/step - loss: 1.0842 -
acc: 0.6500
Epoch 9/20
80/80 [==============================] - 0s 185us/step - loss: 1.0681 -
acc: 0.6500
Epoch 10/20
80/80 [==============================] - 0s 200us/step - loss: 1.0536 -
acc: 0.6500
```

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Epoch 11/20
80/80 [==============================] - 0s 190us/step - loss: 1.0401 -
acc: 0.6500
Epoch 12/20
80/80 [==============================] - 0s 206us/step - loss: 1.0243 -
acc: 0.6500
Epoch 13/20
80/80 [==============================] - 0s 259us/step - loss: 1.0102 -
acc: 0.6500
Epoch 14/20
80/80 [==============================] - 0s 271us/step - loss: 0.9972 -
acc: 0.6500
Epoch 15/20
80/80 [==============================] - 0s 206us/step - loss: 0.9833 -
acc: 0.6500
Epoch 16/20
80/80 [==============================] - 0s 190us/step - loss: 0.9697 -
acc: 0.6625
Epoch 17/20
80/80 [==============================] - 0s 194us/step - loss: 0.9570 -
acc: 0.6625
Epoch 18/20
80/80 [==============================] - 0s 179us/step - loss: 0.9451 -
acc: 0.6750
Epoch 19/20
80/80 [==============================] - 0s 208us/step - loss: 0.9328 -
acc: 0.6875
Epoch 20/20
80/80 [==============================] - 0s 202us/step - loss: 0.9204 -
acc: 0.7000
20/20 [==============================] - 1s 31ms/step
80/80 [==============================] - 0s 136us/step
Epoch 1/20
80/80 [==============================] - 2s 19ms/step - loss: 1.6456 -
 acc: 0.1250
Epoch 2/20
80/80 [==============================] - 0s 176us/step - loss: 1.5303 -
acc: 0.0375
Epoch 3/20
80/80 [==============================] - 0s 169us/step - loss: 1.4236 -
acc: 0.1125
Epoch 4/20
80/80 [==============================] - 0s 162us/step - loss: 1.3757 -
acc: 0.2750
Epoch 5/20
80/80 [==============================] - 0s 151us/step - loss: 1.3231 -
acc: 0.4375
Epoch 6/20
80/80 [==============================] - 0s 186us/step - loss: 1.2934 -
acc: 0.4875
Epoch 7/20
80/80 [==============================] - 0s 176us/step - loss: 1.2757 -
acc: 0.3625
Epoch 8/20
80/80 [==============================] - 0s 168us/step - loss: 1.2566 -
acc: 0.3375
Epoch 9/20
```

```
80/80 [==============================] - 0s 165us/step - loss: 1.2433 -
acc: 0.3375
Epoch 10/20
80/80 [==============================] - 0s 161us/step - loss: 1.2299 -
acc: 0.3500
Epoch 11/20
80/80 [==============================] - 0s 177us/step - loss: 1.2189 -
acc: 0.3625
Epoch 12/20
80/80 [==============================] - 0s 173us/step - loss: 1.2063 -
acc: 0.3750
Epoch 13/20
80/80 [==============================] - 0s 171us/step - loss: 1.1953 -
acc: 0.4000
Epoch 14/20
80/80 [==============================] - 0s 181us/step - loss: 1.1858 -
acc: 0.4500
Epoch 15/20
80/80 [==============================] - 0s 176us/step - loss: 1.1760 -
acc: 0.5250
Epoch 16/20
80/80 [==============================] - 0s 163us/step - loss: 1.1651 -
acc: 0.5375
Epoch 17/20
80/80 [==============================] - 0s 161us/step - loss: 1.1563 -
acc: 0.5125
Epoch 18/20
80/80 [==============================] - 0s 156us/step - loss: 1.1469 -
acc: 0.4875
Epoch 19/20
80/80 [==============================] - 0s 176us/step - loss: 1.1375 -
acc: 0.5125
Epoch 20/20
80/80 [==============================] - 0s 184us/step - loss: 1.1274 -
acc: 0.5125
20/20 [==============================] - 1s 29ms/step
80/80 [==============================] - 0s 157us/step
Epoch 1/20
80/80 [==============================] - 2s 19ms/step - loss: 2.6412 -
 acc: 0.3500
Epoch 2/20
80/80 [==============================] - 0s 173us/step - loss: 2.3586 -
acc: 0.3500
Epoch 3/20
80/80 [==============================] - 0s 174us/step - loss: 2.1331 -
acc: 0.3500
Epoch 4/20
80/80 [==============================] - 0s 160us/step - loss: 1.9146 -
acc: 0.3500
Epoch 5/20
80/80 [==============================] - 0s 154us/step - loss: 1.7117 -
acc: 0.3500
Epoch 6/20
80/80 [==============================] - 0s 171us/step - loss: 1.5634 -
acc: 0.3500
Epoch 7/20
80/80 [==============================] - 0s 207us/step - loss: 1.4441 -
```

```
acc: 0.3500
Epoch 8/20
80/80 [==============================] - 0s 175us/step - loss: 1.3744 -
acc: 0.3125
Epoch 9/20
80/80 [==============================] - 0s 156us/step - loss: 1.3252 -
acc: 0.0875
Epoch 10/20
80/80 [==============================] - 0s 181us/step - loss: 1.3097 -
acc: 0.1625
Epoch 11/20
80/80 [==============================] - 0s 166us/step - loss: 1.2892 -
acc: 0.2750
Epoch 12/20
80/80 [==============================] - 0s 223us/step - loss: 1.2625 -
acc: 0.3000
Epoch 13/20
80/80 [==============================] - 0s 194us/step - loss: 1.2315 -
acc: 0.2750
Epoch 14/20
80/80 [==============================] - 0s 208us/step - loss: 1.2003 -
acc: 0.2250
Epoch 15/20
80/80 [==============================] - 0s 210us/step - loss: 1.1682 -
acc: 0.0875
Epoch 16/20
80/80 [==============================] - 0s 194us/step - loss: 1.1408 -
acc: 0.0875
Epoch 17/20
80/80 [==============================] - 0s 171us/step - loss: 1.1200 -
acc: 0.1875
Epoch 18/20
80/80 [==============================] - 0s 169us/step - loss: 1.1063 -
acc: 0.3250
Epoch 19/20
80/80 [==============================] - 0s 168us/step - loss: 1.0935 -
acc: 0.3250
Epoch 20/20
80/80 [==============================] - 0s 168us/step - loss: 1.0774 -
acc: 0.3750
20/20 [==============================] - 1s 30ms/step
80/80 [==============================] - 0s 134us/step
Epoch 1/20
80/80 [==============================] - 2s 19ms/step - loss: 1.6802 -
 acc: 0.3375
Epoch 2/20
80/80 [==============================] - 0s 177us/step - loss: 1.5957 -
acc: 0.3375
Epoch 3/20
80/80 [==============================] - 0s 174us/step - loss: 1.5245 -
acc: 0.3375
Epoch 4/20
80/80 [==============================] - 0s 170us/step - loss: 1.4609 -
acc: 0.3375
Epoch 5/20
80/80 [==============================] - 0s 161us/step - loss: 1.4013 -
acc: 0.3375
```

```
Epoch 6/20
80/80 [==============================] - 0s 168us/step - loss: 1.3612 -
acc: 0.3375
Epoch 7/20
80/80 [==============================] - 0s 177us/step - loss: 1.3170 -
acc: 0.3375
Epoch 8/20
80/80 [==============================] - 0s 177us/step - loss: 1.2803 -
acc: 0.3375
Epoch 9/20
80/80 [==============================] - 0s 169us/step - loss: 1.2522 -
acc: 0.3375
Epoch 10/20
80/80 [==============================] - 0s 175us/step - loss: 1.2283 -
acc: 0.3375
Epoch 11/20
80/80 [==============================] - 0s 175us/step - loss: 1.2091 -
acc: 0.3750
Epoch 12/20
80/80 [==============================] - 0s 169us/step - loss: 1.1938 -
acc: 0.4875
Epoch 13/20
80/80 [==============================] - 0s 172us/step - loss: 1.1771 -
acc: 0.6375
Epoch 14/20
80/80 [==============================] - 0s 171us/step - loss: 1.1622 -
acc: 0.6375
Epoch 15/20
80/80 [==============================] - 0s 171us/step - loss: 1.1483 -
acc: 0.6375
Epoch 16/20
80/80 [==============================] - 0s 170us/step - loss: 1.1342 -
acc: 0.6375
Epoch 17/20
80/80 [==============================] - 0s 161us/step - loss: 1.1196 -
acc: 0.6375
Epoch 18/20
80/80 [==============================] - 0s 178us/step - loss: 1.1047 -
acc: 0.6375
Epoch 19/20
80/80 [==============================] - 0s 172us/step - loss: 1.0897 -
acc: 0.6375
Epoch 20/20
80/80 [==============================] - 0s 179us/step - loss: 1.0756 -
acc: 0.6375
20/20 [==============================] - 1s 31ms/step
80/80 [==============================] - 0s 114us/step
Epoch 1/20
80/80 [==============================] - 2s 20ms/step - loss: 24.8789 -
acc: 0.2750
Epoch 2/20
80/80 [==============================] - 0s 188us/step - loss: 24.2693
 - acc: 0.2750
Epoch 3/20
80/80 [==============================] - 0s 170us/step - loss: 23.7041
 - acc: 0.2750
Epoch 4/20
```

```
80/80 [==============================] - 0s 172us/step - loss: 23.1627
 - acc: 0.2750
Epoch 5/20
80/80 [==============================] - 0s 173us/step - loss: 22.6418
 - acc: 0.3500
Epoch 6/20
80/80 [==============================] - 0s 174us/step - loss: 22.1391
 - acc: 0.5875
Epoch 7/20
80/80 [==============================] - 0s 172us/step - loss: 21.6563
 - acc: 0.6125
Epoch 8/20
80/80 [==============================] - 0s 175us/step - loss: 21.1885
 - acc: 0.6000
Epoch 9/20
80/80 [==============================] - 0s 175us/step - loss: 20.7334
 - acc: 0.5375
Epoch 10/20
80/80 [==============================] - 0s 153us/step - loss: 20.2871
 - acc: 0.4875
Epoch 11/20
80/80 [==============================] - 0s 179us/step - loss: 19.8614
 - acc: 0.4375
Epoch 12/20
80/80 [==============================] - 0s 151us/step - loss: 19.4553
 - acc: 0.4375
Epoch 13/20
80/80 [==============================] - 0s 181us/step - loss: 19.0592
 - acc: 0.4375
Epoch 14/20
80/80 [==============================] - 0s 201us/step - loss: 18.6730
 - acc: 0.4375
Epoch 15/20
80/80 [==============================] - 0s 190us/step - loss: 18.3126
 - acc: 0.4375
Epoch 16/20
80/80 [==============================] - 0s 227us/step - loss: 17.9576
 - acc: 0.4625
Epoch 17/20
80/80 [==============================] - 0s 190us/step - loss: 17.6149
 - acc: 0.4875
Epoch 18/20
80/80 [==============================] - 0s 173us/step - loss: 17.2776
 - acc: 0.4875
Epoch 19/20
80/80 [==============================] - 0s 172us/step - loss: 16.9495
 - acc: 0.4875
Epoch 20/20
80/80 [==============================] - 0s 176us/step - loss: 16.6312
 - acc: 0.4375
20/20 [==============================] - 1s 35ms/step
80/80 [==============================] - 0s 151us/step
Epoch 1/20
80/80 [==============================] - 2s 21ms/step - loss: 26.2606 -
acc: 0.3500
Epoch 2/20
80/80 [==============================] - 0s 175us/step - loss: 25.7419
```

```
 - acc: 0.3500
Epoch 3/20
80/80 [==============================] - 0s 199us/step - loss: 25.2280
 - acc: 0.3500
Epoch 4/20
80/80 [==============================] - 0s 167us/step - loss: 24.7294
 - acc: 0.3500
Epoch 5/20
80/80 [==============================] - 0s 169us/step - loss: 24.2337
 - acc: 0.3500
Epoch 6/20
80/80 [==============================] - 0s 183us/step - loss: 23.7538
 - acc: 0.3500
Epoch 7/20
80/80 [==============================] - 0s 176us/step - loss: 23.2812
 - acc: 0.3500
Epoch 8/20
80/80 [==============================] - 0s 167us/step - loss: 22.8199
 - acc: 0.3500
Epoch 9/20
80/80 [==============================] - 0s 182us/step - loss: 22.3651
 - acc: 0.3500
Epoch 10/20
80/80 [==============================] - 0s 175us/step - loss: 21.9256
 - acc: 0.3500
Epoch 11/20
80/80 [==============================] - 0s 174us/step - loss: 21.4903
 - acc: 0.3500
Epoch 12/20
80/80 [==============================] - 0s 174us/step - loss: 21.0674
 - acc: 0.3500
Epoch 13/20
80/80 [==============================] - 0s 176us/step - loss: 20.6534
 - acc: 0.3500
Epoch 14/20
80/80 [==============================] - 0s 164us/step - loss: 20.2467
 - acc: 0.3500
Epoch 15/20
80/80 [==============================] - 0s 210us/step - loss: 19.8507
 - acc: 0.3500
Epoch 16/20
80/80 [==============================] - 0s 224us/step - loss: 19.4613
 - acc: 0.3500
Epoch 17/20
80/80 [==============================] - 0s 218us/step - loss: 19.0812
 - acc: 0.3500
Epoch 18/20
80/80 [==============================] - 0s 180us/step - loss: 18.7082
 - acc: 0.3500
Epoch 19/20
80/80 [==============================] - 0s 208us/step - loss: 18.3424
 - acc: 0.3500
Epoch 20/20
80/80 [==============================] - 0s 170us/step - loss: 17.9824
 - acc: 0.3500
20/20 [==============================] - 1s 34ms/step
80/80 [==============================] - 0s 147us/step
```

```
Epoch 1/20
80/80 [==============================] - 2s 22ms/step - loss: 25.3541 -
acc: 0.3750
Epoch 2/20
80/80 [==============================] - 0s 191us/step - loss: 24.8543
 - acc: 0.3750
Epoch 3/20
80/80 [==============================] - 0s 182us/step - loss: 24.3714
 - acc: 0.3750
Epoch 4/20
80/80 [==============================] - 0s 184us/step - loss: 23.8913
 - acc: 0.3750
Epoch 5/20
80/80 [==============================] - 0s 178us/step - loss: 23.4272
 - acc: 0.3750
Epoch 6/20
80/80 [==============================] - 0s 170us/step - loss: 22.9697
 - acc: 0.3750
Epoch 7/20
80/80 [==============================] - 0s 214us/step - loss: 22.5228
 - acc: 0.3750
Epoch 8/20
80/80 [==============================] - 0s 194us/step - loss: 22.0858
 - acc: 0.3750
Epoch 9/20
80/80 [==============================] - 0s 202us/step - loss: 21.6599
 - acc: 0.3750
Epoch 10/20
80/80 [==============================] - 0s 161us/step - loss: 21.2416
 - acc: 0.3750
Epoch 11/20
80/80 [==============================] - 0s 173us/step - loss: 20.8347
 - acc: 0.3750
Epoch 12/20
80/80 [==============================] - 0s 184us/step - loss: 20.4342
 - acc: 0.3750
Epoch 13/20
80/80 [==============================] - 0s 164us/step - loss: 20.0437
 - acc: 0.3750
Epoch 14/20
80/80 [==============================] - 0s 184us/step - loss: 19.6609
 - acc: 0.3750
Epoch 15/20
80/80 [==============================] - 0s 180us/step - loss: 19.2873
 - acc: 0.3750
Epoch 16/20
80/80 [==============================] - 0s 191us/step - loss: 18.9207
 - acc: 0.3750
Epoch 17/20
80/80 [==============================] - 0s 159us/step - loss: 18.5610
 - acc: 0.3750
Epoch 18/20
80/80 [==============================] - 0s 168us/step - loss: 18.2096
 - acc: 0.3750
Epoch 19/20
80/80 [==============================] - 0s 193us/step - loss: 17.8648
 - acc: 0.3750
```

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Epoch 20/20
80/80 [==============================] - 0s 181us/step - loss: 17.5266
 - acc: 0.3750
20/20 [==============================] - 1s 35ms/step
80/80 [==============================] - 0s 150us/step
Epoch 1/20
80/80 [==============================] - 2s 23ms/step - loss: 22.0995 -
acc: 0.3125
Epoch 2/20
80/80 [==============================] - 0s 186us/step - loss: 21.6157
 - acc: 0.3125
Epoch 3/20
80/80 [==============================] - 0s 194us/step - loss: 21.1436
 - acc: 0.3125
Epoch 4/20
80/80 [==============================] - 0s 180us/step - loss: 20.6924
 - acc: 0.3125
Epoch 5/20
80/80 [==============================] - 0s 190us/step - loss: 20.2524
 - acc: 0.3125
Epoch 6/20
80/80 [==============================] - 0s 235us/step - loss: 19.8313
 - acc: 0.3125
Epoch 7/20
80/80 [==============================] - 0s 199us/step - loss: 19.4224
 - acc: 0.3125
Epoch 8/20
80/80 [==============================] - 0s 239us/step - loss: 19.0299
 - acc: 0.3125
Epoch 9/20
80/80 [==============================] - 0s 191us/step - loss: 18.6490
 - acc: 0.3125
Epoch 10/20
80/80 [==============================] - 0s 183us/step - loss: 18.2763
 - acc: 0.3125
Epoch 11/20
80/80 [==============================] - 0s 205us/step - loss: 17.9165
 - acc: 0.3125
Epoch 12/20
80/80 [==============================] - 0s 194us/step - loss: 17.5665
 - acc: 0.3125
Epoch 13/20
80/80 [==============================] - 0s 180us/step - loss: 17.2250
 - acc: 0.3375
Epoch 14/20
80/80 [==============================] - 0s 196us/step - loss: 16.8916
 - acc: 0.3500
Epoch 15/20
80/80 [==============================] - 0s 165us/step - loss: 16.5648
 - acc: 0.3875
Epoch 16/20
80/80 [==============================] - 0s 180us/step - loss: 16.2457
 - acc: 0.4375
Epoch 17/20
80/80 [==============================] - 0s 163us/step - loss: 15.9326
 - acc: 0.4375
Epoch 18/20
```

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80/80 [==============================] - 0s 212us/step - loss: 15.6253
 - acc: 0.4625
Epoch 19/20
80/80 [==============================] - 0s 227us/step - loss: 15.3259
 - acc: 0.4750
Epoch 20/20
80/80 [==============================] - 0s 254us/step - loss: 15.0314
 - acc: 0.5000
20/20 [==============================] - 1s 36ms/step
80/80 [==============================] - 0s 165us/step
Epoch 1/20
80/80 [==============================] - 2s 23ms/step - loss: 22.9295 -
acc: 0.3000
Epoch 2/20
80/80 [==============================] - 0s 184us/step - loss: 22.4381
 - acc: 0.3000
Epoch 3/20
80/80 [==============================] - 0s 184us/step - loss: 21.9686
 - acc: 0.3000
Epoch 4/20
80/80 [==============================] - 0s 183us/step - loss: 21.5066
 - acc: 0.3000
Epoch 5/20
80/80 [==============================] - 0s 181us/step - loss: 21.0657
 - acc: 0.3000
Epoch 6/20
80/80 [==============================] - 0s 185us/step - loss: 20.6367
 - acc: 0.3000
Epoch 7/20
80/80 [==============================] - 0s 191us/step - loss: 20.2239
 - acc: 0.3000
Epoch 8/20
80/80 [==============================] - 0s 194us/step - loss: 19.8258
 - acc: 0.3000
Epoch 9/20
80/80 [==============================] - 0s 171us/step - loss: 19.4317
 - acc: 0.3000
Epoch 10/20
80/80 [==============================] - 0s 171us/step - loss: 19.0484
 - acc: 0.3000
Epoch 11/20
80/80 [==============================] - 0s 180us/step - loss: 18.6761
 - acc: 0.3000
Epoch 12/20
80/80 [==============================] - 0s 166us/step - loss: 18.3106
 - acc: 0.3000
Epoch 13/20
80/80 [==============================] - 0s 169us/step - loss: 17.9534
 - acc: 0.3000
Epoch 14/20
80/80 [==============================] - 0s 198us/step - loss: 17.6023
 - acc: 0.3000
Epoch 15/20
80/80 [==============================] - 0s 219us/step - loss: 17.2587
 - acc: 0.3000
Epoch 16/20
80/80 [==============================] - 0s 196us/step - loss: 16.9217
```

```
 - acc: 0.3000
Epoch 17/20
80/80 [==============================] - 0s 184us/step - loss: 16.5926
 - acc: 0.3000
Epoch 18/20
80/80 [==============================] - 0s 180us/step - loss: 16.2696
 - acc: 0.3000
Epoch 19/20
80/80 [==============================] - 0s 205us/step - loss: 15.9526
 - acc: 0.3000
Epoch 20/20
80/80 [==============================] - 0s 172us/step - loss: 15.6426
 - acc: 0.3000
20/20 [==============================] - 1s 38ms/step
80/80 [==============================] - 0s 163us/step
Epoch 1/20
80/80 [==============================] - 2s 24ms/step - loss: 242.8099
 - acc: 0.3500
Epoch 2/20
80/80 [==============================] - 0s 166us/step - loss: 238.1933
- acc: 0.3500
Epoch 3/20
80/80 [==============================] - 0s 234us/step - loss: 233.6457
- acc: 0.3500
Epoch 4/20
80/80 [==============================] - 0s 218us/step - loss: 229.1574
- acc: 0.3500
Epoch 5/20
80/80 [==============================] - 0s 180us/step - loss: 224.7390
- acc: 0.3500
Epoch 6/20
80/80 [==============================] - 0s 168us/step - loss: 220.3884
- acc: 0.3500
Epoch 7/20
80/80 [==============================] - 0s 164us/step - loss: 216.1087
- acc: 0.3500
Epoch 8/20
80/80 [==============================] - 0s 171us/step - loss: 211.8993
- acc: 0.3375
Epoch 9/20
80/80 [==============================] - 0s 167us/step - loss: 207.7565
- acc: 0.3375
Epoch 10/20
80/80 [==============================] - 0s 181us/step - loss: 203.6892
- acc: 0.3375
Epoch 11/20
80/80 [==============================] - 0s 162us/step - loss: 199.6918
- acc: 0.3375
Epoch 12/20
80/80 [==============================] - 0s 160us/step - loss: 195.7656
- acc: 0.3375
Epoch 13/20
80/80 [==============================] - 0s 172us/step - loss: 191.9099
- acc: 0.3375
Epoch 14/20
80/80 [==============================] - 0s 187us/step - loss: 188.1248
- acc: 0.3375
```

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Epoch 15/20
80/80 [==============================] - 0s 206us/step - loss: 184.4085
- acc: 0.3250
Epoch 16/20
80/80 [==============================] - 0s 186us/step - loss: 180.7620
- acc: 0.3375
Epoch 17/20
80/80 [==============================] - 0s 235us/step - loss: 177.1823
- acc: 0.3250
Epoch 18/20
80/80 [==============================] - 0s 200us/step - loss: 173.6692
- acc: 0.3375
Epoch 19/20
80/80 [==============================] - 0s 176us/step - loss: 170.2224
- acc: 0.3375
Epoch 20/20
80/80 [==============================] - 0s 176us/step - loss: 166.8386
- acc: 0.3375
20/20 [==============================] - 1s 39ms/step
80/80 [==============================] - 0s 145us/step
Epoch 1/20
80/80 [==============================] - 2s 25ms/step - loss: 225.1899
 - acc: 0.3000
Epoch 2/20
80/80 [==============================] - 0s 185us/step - loss: 220.8122
- acc: 0.3000
Epoch 3/20
80/80 [==============================] - 0s 175us/step - loss: 216.4965
- acc: 0.3000
Epoch 4/20
80/80 [==============================] - 0s 181us/step - loss: 212.2445
- acc: 0.3000
Epoch 5/20
80/80 [==============================] - 0s 194us/step - loss: 208.0583
- acc: 0.3000
Epoch 6/20
80/80 [==============================] - 0s 227us/step - loss: 203.9405
- acc: 0.3000
Epoch 7/20
80/80 [==============================] - 0s 184us/step - loss: 199.8908
- acc: 0.3000
Epoch 8/20
80/80 [==============================] - 0s 181us/step - loss: 195.9091
- acc: 0.3000
Epoch 9/20
80/80 [==============================] - 0s 202us/step - loss: 191.9972
- acc: 0.3000
Epoch 10/20
80/80 [==============================] - 0s 201us/step - loss: 188.1545
- acc: 0.3000
Epoch 11/20
80/80 [==============================] - 0s 213us/step - loss: 184.3813
- acc: 0.3000
Epoch 12/20
80/80 [==============================] - 0s 187us/step - loss: 180.6754
- acc: 0.3000
Epoch 13/20
```

```
80/80 [==============================] - 0s 188us/step - loss: 177.0371
- acc: 0.3000
Epoch 14/20
80/80 [==============================] - 0s 236us/step - loss: 173.4658
- acc: 0.3000
Epoch 15/20
80/80 [==============================] - 0s 228us/step - loss: 169.9612
- acc: 0.3000
Epoch 16/20
80/80 [==============================] - 0s 190us/step - loss: 166.5214
- acc: 0.3000
Epoch 17/20
80/80 [==============================] - 0s 285us/step - loss: 163.1453
- acc: 0.3250
Epoch 18/20
80/80 [==============================] - 0s 240us/step - loss: 159.8333
- acc: 0.3250
Epoch 19/20
80/80 [==============================] - 0s 221us/step - loss: 156.5837
- acc: 0.3250
Epoch 20/20
80/80 [==============================] - 0s 169us/step - loss: 153.3952
- acc: 0.3250
20/20 [==============================] - 1s 40ms/step
80/80 [==============================] - 0s 113us/step
Epoch 1/20
80/80 [==============================] - 2s 26ms/step - loss: 235.3353
 - acc: 0.3250
Epoch 2/20
80/80 [==============================] - 0s 188us/step - loss: 230.8198
- acc: 0.3250
Epoch 3/20
80/80 [==============================] - 0s 183us/step - loss: 226.3643
- acc: 0.3250
Epoch 4/20
80/80 [==============================] - 0s 182us/step - loss: 221.9868
- acc: 0.3250
Epoch 5/20
80/80 [==============================] - 0s 186us/step - loss: 217.6697
- acc: 0.3250
Epoch 6/20
80/80 [==============================] - 0s 184us/step - loss: 213.4276
- acc: 0.3250
Epoch 7/20
80/80 [==============================] - 0s 182us/step - loss: 209.2581
- acc: 0.3250
Epoch 8/20
80/80 [==============================] - 0s 174us/step - loss: 205.1599
- acc: 0.3250
Epoch 9/20
80/80 [==============================] - 0s 185us/step - loss: 201.1338
- acc: 0.3250
Epoch 10/20
80/80 [==============================] - 0s 191us/step - loss: 197.1786
- acc: 0.3250
Epoch 11/20
80/80 [==============================] - 0s 170us/step - loss: 193.2962
```

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- acc: 0.3250
Epoch 12/20
80/80 [==============================] - 0s 191us/step - loss: 189.4849
- acc: 0.3250
Epoch 13/20
80/80 [==============================] - 0s 178us/step - loss: 185.7409
- acc: 0.3250
Epoch 14/20
80/80 [==============================] - 0s 179us/step - loss: 182.0724
- acc: 0.3125
Epoch 15/20
80/80 [==============================] - 0s 184us/step - loss: 178.4677
- acc: 0.3000
Epoch 16/20
80/80 [==============================] - 0s 167us/step - loss: 174.9318
- acc: 0.2750
Epoch 17/20
80/80 [==============================] - 0s 218us/step - loss: 171.4622
- acc: 0.2500
Epoch 18/20
80/80 [==============================] - 0s 174us/step - loss: 168.0601
- acc: 0.2000
Epoch 19/20
80/80 [==============================] - 0s 186us/step - loss: 164.7194
- acc: 0.1500
Epoch 20/20
80/80 [==============================] - 0s 181us/step - loss: 161.4438
- acc: 0.1375
20/20 [==============================] - 1s 42ms/step
80/80 [==============================] - 0s 170us/step
Epoch 1/20
80/80 [==============================] - 2s 26ms/step - loss: 228.0076
 - acc: 0.2750
Epoch 2/20
80/80 [==============================] - 0s 193us/step - loss: 223.5929
- acc: 0.2750
Epoch 3/20
80/80 [==============================] - 0s 171us/step - loss: 219.2414
- acc: 0.2625
Epoch 4/20
80/80 [==============================] - 0s 176us/step - loss: 214.9543
- acc: 0.2500
Epoch 5/20
80/80 [==============================] - 0s 178us/step - loss: 210.7328
- acc: 0.2125
Epoch 6/20
80/80 [==============================] - 0s 186us/step - loss: 206.5776
- acc: 0.2000
Epoch 7/20
80/80 [==============================] - 0s 160us/step - loss: 202.4908
- acc: 0.1750
Epoch 8/20
80/80 [==============================] - 0s 171us/step - loss: 198.4730
- acc: 0.1375
Epoch 9/20
80/80 [==============================] - 0s 167us/step - loss: 194.5252
- acc: 0.1375
```

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Epoch 10/20
80/80 [==============================] - 0s 173us/step - loss: 190.6459
- acc: 0.1250
Epoch 11/20
80/80 [==============================] - 0s 195us/step - loss: 186.8369
- acc: 0.1000
Epoch 12/20
80/80 [==============================] - 0s 173us/step - loss: 183.0940
- acc: 0.1000
Epoch 13/20
80/80 [==============================] - 0s 203us/step - loss: 179.4217
- acc: 0.0875
Epoch 14/20
80/80 [==============================] - 0s 173us/step - loss: 175.8187
- acc: 0.0750
Epoch 15/20
80/80 [==============================] - 0s 187us/step - loss: 172.2807
- acc: 0.0625
Epoch 16/20
80/80 [==============================] - 0s 190us/step - loss: 168.8112
- acc: 0.0625
Epoch 17/20
80/80 [==============================] - 0s 178us/step - loss: 165.4061
- acc: 0.0625
Epoch 18/20
80/80 [==============================] - 0s 183us/step - loss: 162.0672
- acc: 0.0625
Epoch 19/20
80/80 [==============================] - 0s 275us/step - loss: 158.7902
- acc: 0.0500
Epoch 20/20
80/80 [==============================] - 0s 187us/step - loss: 155.5775
- acc: 0.0250
20/20 [==============================] - 1s 43ms/step
80/80 [==============================] - 0s 154us/step
Epoch 1/20
80/80 [==============================] - 2s 27ms/step - loss: 199.0668
 - acc: 0.3375
Epoch 2/20
80/80 [==============================] - 0s 181us/step - loss: 195.0065
- acc: 0.3375
Epoch 3/20
80/80 [==============================] - 0s 164us/step - loss: 191.0122
- acc: 0.3375
Epoch 4/20
80/80 [==============================] - 0s 160us/step - loss: 187.0836
- acc: 0.3375
Epoch 5/20
80/80 [==============================] - 0s 176us/step - loss: 183.2201
- acc: 0.3375
Epoch 6/20
80/80 [==============================] - 0s 163us/step - loss: 179.4274
- acc: 0.3375
Epoch 7/20
80/80 [==============================] - 0s 179us/step - loss: 175.7016
- acc: 0.3375
Epoch 8/20
```

```
80/80 [==============================] - 0s 195us/step - loss: 172.0451
- acc: 0.3375
Epoch 9/20
80/80 [==============================] - 0s 181us/step - loss: 168.4581
- acc: 0.3750
Epoch 10/20
80/80 [==============================] - 0s 181us/step - loss: 164.9389
- acc: 0.4750
Epoch 11/20
80/80 [==============================] - 0s 173us/step - loss: 161.4888
- acc: 0.5500
Epoch 12/20
80/80 [==============================] - 0s 189us/step - loss: 158.1039
- acc: 0.6125
Epoch 13/20
80/80 [==============================] - 0s 191us/step - loss: 154.7875
- acc: 0.6750
Epoch 14/20
80/80 [==============================] - 0s 259us/step - loss: 151.5357
- acc: 0.6875
Epoch 15/20
80/80 [==============================] - 0s 183us/step - loss: 148.3484
- acc: 0.6875
Epoch 16/20
80/80 [==============================] - 0s 186us/step - loss: 145.2258
- acc: 0.6875
Epoch 17/20
80/80 [==============================] - 0s 175us/step - loss: 142.1651
- acc: 0.6875
Epoch 18/20
80/80 [==============================] - 0s 176us/step - loss: 139.1661
- acc: 0.6750
Epoch 19/20
80/80 [==============================] - 0s 173us/step - loss: 136.2275
- acc: 0.6625
Epoch 20/20
80/80 [==============================] - 0s 204us/step - loss: 133.3482
- acc: 0.6500
20/20 [==============================] - 1s 46ms/step
80/80 [==============================] - 0s 160us/step
Epoch 1/20
80/80 [==============================] - 2s 28ms/step - loss: 1.7123 -
 acc: 0.3500
Epoch 2/20
80/80 [==============================] - 0s 195us/step - loss: 1.5074 -
acc: 0.3500
Epoch 3/20
80/80 [==============================] - 0s 172us/step - loss: 1.3600 -
acc: 0.3500
Epoch 4/20
80/80 [==============================] - 0s 186us/step - loss: 1.2569 -
acc: 0.3500
Epoch 5/20
80/80 [==============================] - 0s 173us/step - loss: 1.1701 -
acc: 0.3125
Epoch 6/20
80/80 [==============================] - 0s 166us/step - loss: 1.1145 -
```

```
acc: 0.1500
Epoch 7/20
80/80 [==============================] - 0s 164us/step - loss: 1.0663 -
acc: 0.2875
Epoch 8/20
80/80 [==============================] - 0s 166us/step - loss: 1.0362 -
acc: 0.3500
Epoch 9/20
80/80 [==============================] - 0s 179us/step - loss: 1.0068 -
acc: 0.3750
Epoch 10/20
80/80 [==============================] - 0s 221us/step - loss: 0.9862 -
acc: 0.3750
Epoch 11/20
80/80 [==============================] - 0s 175us/step - loss: 0.9613 -
acc: 0.4500
Epoch 12/20
80/80 [==============================] - 0s 175us/step - loss: 0.9393 -
acc: 0.6375
Epoch 13/20
80/80 [==============================] - 0s 183us/step - loss: 0.9175 -
acc: 0.6500
Epoch 14/20
80/80 [==============================] - 0s 189us/step - loss: 0.8972 -
acc: 0.6500
Epoch 15/20
80/80 [==============================] - 0s 186us/step - loss: 0.8779 -
acc: 0.6500
Epoch 16/20
80/80 [==============================] - 0s 197us/step - loss: 0.8600 -
acc: 0.6500
Epoch 17/20
80/80 [==============================] - 0s 192us/step - loss: 0.8433 -
acc: 0.6500
Epoch 18/20
80/80 [==============================] - 0s 203us/step - loss: 0.8270 -
acc: 0.6500
Epoch 19/20
80/80 [==============================] - 0s 189us/step - loss: 0.8102 -
acc: 0.6500
Epoch 20/20
80/80 [==============================] - 0s 171us/step - loss: 0.7939 -
acc: 0.6500
20/20 [==============================] - 1s 45ms/step
80/80 [==============================] - 0s 136us/step
Epoch 1/20
80/80 [==============================] - 2s 28ms/step - loss: 1.1252 -
 acc: 0.3500
Epoch 2/20
80/80 [==============================] - 0s 183us/step - loss: 1.0412 -
acc: 0.3875
Epoch 3/20
80/80 [==============================] - 0s 166us/step - loss: 0.9782 -
acc: 0.6125
Epoch 4/20
80/80 [==============================] - 0s 178us/step - loss: 0.9401 -
acc: 0.4000
```

```
Epoch 5/20
80/80 [==============================] - 0s 172us/step - loss: 0.9051 -
acc: 0.3750
Epoch 6/20
80/80 [==============================] - 0s 189us/step - loss: 0.8724 -
acc: 0.6250
Epoch 7/20
80/80 [==============================] - 0s 177us/step - loss: 0.8388 -
acc: 0.6625
Epoch 8/20
80/80 [==============================] - 0s 248us/step - loss: 0.8083 -
acc: 0.6750
Epoch 9/20
80/80 [==============================] - 0s 222us/step - loss: 0.7747 -
acc: 0.7000
Epoch 10/20
80/80 [==============================] - 0s 202us/step - loss: 0.7474 -
acc: 0.7625
Epoch 11/20
80/80 [==============================] - 0s 168us/step - loss: 0.7220 -
acc: 0.8375
Epoch 12/20
80/80 [==============================] - 0s 160us/step - loss: 0.7003 -
acc: 0.9000
Epoch 13/20
80/80 [==============================] - 0s 186us/step - loss: 0.6781 -
acc: 0.9250
Epoch 14/20
80/80 [==============================] - 0s 218us/step - loss: 0.6575 -
acc: 0.9250
Epoch 15/20
80/80 [==============================] - 0s 245us/step - loss: 0.6370 -
acc: 0.9000
Epoch 16/20
80/80 [==============================] - 0s 186us/step - loss: 0.6189 -
acc: 0.8875
Epoch 17/20
80/80 [==============================] - 0s 182us/step - loss: 0.6011 -
acc: 0.8875
Epoch 18/20
80/80 [==============================] - 0s 176us/step - loss: 0.5843 -
acc: 0.8875
Epoch 19/20
80/80 [==============================] - 0s 199us/step - loss: 0.5672 -
acc: 0.9000
Epoch 20/20
80/80 [==============================] - 0s 176us/step - loss: 0.5516 -
acc: 0.9375
20/20 [==============================] - 1s 47ms/step
80/80 [==============================] - 0s 142us/step
Epoch 1/20
80/80 [==============================] - 2s 29ms/step - loss: 1.2690 -
 acc: 0.3750
Epoch 2/20
80/80 [==============================] - 0s 189us/step - loss: 1.2031 -
acc: 0.3750
Epoch 3/20
```

```
80/80 [==============================] - 0s 188us/step - loss: 1.1521 -
acc: 0.3750
Epoch 4/20
80/80 [==============================] - 0s 188us/step - loss: 1.1190 -
acc: 0.4625
Epoch 5/20
80/80 [==============================] - 0s 177us/step - loss: 1.1095 -
acc: 0.4250
Epoch 6/20
80/80 [==============================] - 0s 184us/step - loss: 1.0901 -
acc: 0.3750
Epoch 7/20
80/80 [==============================] - 0s 184us/step - loss: 1.0778 -
acc: 0.3625
Epoch 8/20
80/80 [==============================] - 0s 188us/step - loss: 1.0647 -
acc: 0.4000
Epoch 9/20
80/80 [==============================] - 0s 210us/step - loss: 1.0546 -
acc: 0.5000
Epoch 10/20
80/80 [==============================] - 0s 169us/step - loss: 1.0423 -
acc: 0.5500
Epoch 11/20
80/80 [==============================] - 0s 185us/step - loss: 1.0326 -
acc: 0.5125
Epoch 12/20
80/80 [==============================] - 0s 168us/step - loss: 1.0207 -
acc: 0.5250
Epoch 13/20
80/80 [==============================] - 0s 182us/step - loss: 1.0102 -
acc: 0.5125
Epoch 14/20
80/80 [==============================] - 0s 191us/step - loss: 0.9965 -
acc: 0.5625
Epoch 15/20
80/80 [==============================] - 0s 167us/step - loss: 0.9846 -
acc: 0.5250
Epoch 16/20
80/80 [==============================] - 0s 332us/step - loss: 0.9721 -
acc: 0.5750
Epoch 17/20
80/80 [==============================] - 0s 249us/step - loss: 0.9594 -
acc: 0.7000
Epoch 18/20
80/80 [==============================] - 0s 171us/step - loss: 0.9463 -
acc: 0.7500
Epoch 19/20
80/80 [==============================] - 0s 168us/step - loss: 0.9326 -
acc: 0.7750
Epoch 20/20
80/80 [==============================] - 0s 182us/step - loss: 0.9198 -
acc: 0.8125
20/20 [==============================] - 1s 48ms/step
80/80 [==============================] - 0s 159us/step
Epoch 1/20
80/80 [==============================] - 2s 30ms/step - loss: 1.3134 -
```

```
 acc: 0.0000e+00
Epoch 2/20
80/80 [==============================] - 0s 188us/step - loss: 1.2430 -
acc: 0.0000e+00
Epoch 3/20
80/80 [==============================] - 0s 179us/step - loss: 1.1897 -
acc: 0.0125
Epoch 4/20
80/80 [==============================] - 0s 176us/step - loss: 1.1348 -
acc: 0.2000
Epoch 5/20
80/80 [==============================] - 0s 183us/step - loss: 1.0870 -
acc: 0.3375
Epoch 6/20
80/80 [==============================] - 0s 175us/step - loss: 1.0519 -
acc: 0.3500
Epoch 7/20
80/80 [==============================] - 0s 173us/step - loss: 1.0238 -
acc: 0.3500
Epoch 8/20
80/80 [==============================] - 0s 175us/step - loss: 0.9998 -
acc: 0.3625
Epoch 9/20
80/80 [==============================] - 0s 179us/step - loss: 0.9769 -
acc: 0.6750
Epoch 10/20
80/80 [==============================] - 0s 193us/step - loss: 0.9531 -
acc: 0.7000
Epoch 11/20
80/80 [==============================] - 0s 185us/step - loss: 0.9290 -
acc: 0.7375
Epoch 12/20
80/80 [==============================] - 0s 184us/step - loss: 0.9050 -
acc: 0.7625
Epoch 13/20
80/80 [==============================] - 0s 198us/step - loss: 0.8816 -
acc: 0.7625
Epoch 14/20
80/80 [==============================] - 0s 176us/step - loss: 0.8581 -
acc: 0.7625
Epoch 15/20
80/80 [==============================] - 0s 177us/step - loss: 0.8341 -
acc: 0.7750
Epoch 16/20
80/80 [==============================] - 0s 187us/step - loss: 0.8104 -
acc: 0.8125
Epoch 17/20
80/80 [==============================] - 0s 238us/step - loss: 0.7875 -
acc: 0.8125
Epoch 18/20
80/80 [==============================] - 0s 254us/step - loss: 0.7644 -
acc: 0.8125
Epoch 19/20
80/80 [==============================] - 0s 231us/step - loss: 0.7423 -
acc: 0.8125
Epoch 20/20
80/80 [==============================] - 0s 192us/step - loss: 0.7221 -
```

```
acc: 0.8250
20/20 [==============================] - 1s 49ms/step
80/80 [==============================] - 0s 173us/step
Epoch 1/20
80/80 [==============================] - 3s 31ms/step - loss: 1.1451 -
 acc: 0.4875
Epoch 2/20
80/80 [==============================] - 0s 220us/step - loss: 1.0924 -
acc: 0.7000
Epoch 3/20
80/80 [==============================] - 0s 176us/step - loss: 1.0475 -
acc: 0.6125
Epoch 4/20
80/80 [==============================] - 0s 178us/step - loss: 1.0060 -
acc: 0.4500
Epoch 5/20
80/80 [==============================] - 0s 172us/step - loss: 0.9676 -
acc: 0.4750
Epoch 6/20
80/80 [==============================] - 0s 182us/step - loss: 0.9335 -
acc: 0.5125
Epoch 7/20
80/80 [==============================] - 0s 174us/step - loss: 0.9014 -
acc: 0.4750
Epoch 8/20
80/80 [==============================] - 0s 188us/step - loss: 0.8690 -
acc: 0.5125
Epoch 9/20
80/80 [==============================] - 0s 179us/step - loss: 0.8370 -
acc: 0.6125
Epoch 10/20
80/80 [==============================] - 0s 240us/step - loss: 0.8101 -
acc: 0.7250
Epoch 11/20
80/80 [==============================] - 0s 222us/step - loss: 0.7822 -
acc: 0.7750
Epoch 12/20
80/80 [==============================] - 0s 184us/step - loss: 0.7556 -
acc: 0.8000
Epoch 13/20
80/80 [==============================] - 0s 212us/step - loss: 0.7282 -
acc: 0.8250
Epoch 14/20
80/80 [==============================] - 0s 185us/step - loss: 0.7021 -
acc: 0.8875
Epoch 15/20
80/80 [==============================] - 0s 184us/step - loss: 0.6794 -
acc: 0.8875
Epoch 16/20
80/80 [==============================] - 0s 197us/step - loss: 0.6580 -
acc: 0.8500
Epoch 17/20
80/80 [==============================] - 0s 199us/step - loss: 0.6377 -
acc: 0.8875
Epoch 18/20
80/80 [==============================] - 0s 210us/step - loss: 0.6205 -
acc: 0.9625
```

```
Epoch 19/20
80/80 [==============================] - 0s 186us/step - loss: 0.6039 -
acc: 0.9625
Epoch 20/20
80/80 [==============================] - 0s 184us/step - loss: 0.5899 -
acc: 0.9375
20/20 [==============================] - 1s 51ms/step
80/80 [==============================] - 0s 160us/step
Epoch 1/20
80/80 [==============================] - 2s 31ms/step - loss: 1.6110 -
 acc: 0.2750
Epoch 2/20
80/80 [==============================] - 0s 237us/step - loss: 1.4715 -
acc: 0.2875
Epoch 3/20
80/80 [==============================] - 0s 227us/step - loss: 1.3806 -
acc: 0.7250
Epoch 4/20
80/80 [==============================] - 0s 204us/step - loss: 1.3120 -
acc: 0.8250
Epoch 5/20
80/80 [==============================] - 0s 161us/step - loss: 1.2547 -
acc: 0.8125
Epoch 6/20
80/80 [==============================] - 0s 163us/step - loss: 1.2096 -
acc: 0.7125
Epoch 7/20
80/80 [==============================] - 0s 185us/step - loss: 1.1664 -
acc: 0.7250
Epoch 8/20
80/80 [==============================] - 0s 192us/step - loss: 1.1322 -
acc: 0.7875
Epoch 9/20
80/80 [==============================] - 0s 183us/step - loss: 1.1009 -
acc: 0.8375
Epoch 10/20
80/80 [==============================] - 0s 180us/step - loss: 1.0702 -
acc: 0.8375
Epoch 11/20
80/80 [==============================] - 0s 172us/step - loss: 1.0373 -
acc: 0.8375
Epoch 12/20
80/80 [==============================] - 0s 172us/step - loss: 1.0055 -
acc: 0.8250
Epoch 13/20
80/80 [==============================] - 0s 198us/step - loss: 0.9759 -
acc: 0.8000
Epoch 14/20
80/80 [==============================] - 0s 215us/step - loss: 0.9474 -
acc: 0.8000
Epoch 15/20
80/80 [==============================] - 0s 165us/step - loss: 0.9217 -
acc: 0.8250
Epoch 16/20
80/80 [==============================] - 0s 205us/step - loss: 0.8948 -
acc: 0.8375
Epoch 17/20
```

```
80/80 [==============================] - 0s 180us/step - loss: 0.8708 -
acc: 0.8375
Epoch 18/20
80/80 [==============================] - 0s 183us/step - loss: 0.8477 -
acc: 0.8375
Epoch 19/20
80/80 [==============================] - 0s 184us/step - loss: 0.8262 -
acc: 0.8750
Epoch 20/20
80/80 [==============================] - 0s 175us/step - loss: 0.8062 -
acc: 0.8750
20/20 [==============================] - 1s 52ms/step
80/80 [==============================] - 0s 156us/step
Epoch 1/20
80/80 [==============================] - 3s 32ms/step - loss: 1.5068 -
 acc: 0.6500
Epoch 2/20
80/80 [==============================] - 0s 184us/step - loss: 1.3801 -
acc: 0.6500
Epoch 3/20
80/80 [==============================] - 0s 180us/step - loss: 1.2701 -
acc: 0.6500
Epoch 4/20
80/80 [==============================] - 0s 176us/step - loss: 1.2113 -
acc: 0.6750
Epoch 5/20
80/80 [==============================] - 0s 185us/step - loss: 1.1624 -
acc: 0.7000
Epoch 6/20
80/80 [==============================] - 0s 168us/step - loss: 1.1411 -
acc: 0.6500
Epoch 7/20
80/80 [==============================] - 0s 189us/step - loss: 1.1259 -
acc: 0.6500
Epoch 8/20
80/80 [==============================] - 0s 189us/step - loss: 1.1054 -
acc: 0.6500
Epoch 9/20
80/80 [==============================] - 0s 193us/step - loss: 1.0822 -
acc: 0.6500
Epoch 10/20
80/80 [==============================] - 0s 183us/step - loss: 1.0561 -
acc: 0.6500
Epoch 11/20
80/80 [==============================] - 0s 187us/step - loss: 1.0366 -
acc: 0.6750
Epoch 12/20
80/80 [==============================] - 0s 176us/step - loss: 1.0153 -
acc: 0.7250
Epoch 13/20
80/80 [==============================] - 0s 176us/step - loss: 0.9978 -
acc: 0.7375
Epoch 14/20
80/80 [==============================] - 0s 211us/step - loss: 0.9795 -
acc: 0.7500
Epoch 15/20
80/80 [==============================] - 0s 178us/step - loss: 0.9621 -
```

```
acc: 0.7375
Epoch 16/20
80/80 [==============================] - 0s 176us/step - loss: 0.9429 -
acc: 0.7500
Epoch 17/20
80/80 [==============================] - 0s 178us/step - loss: 0.9254 -
acc: 0.7375
Epoch 18/20
80/80 [==============================] - 0s 169us/step - loss: 0.9081 -
acc: 0.7000
Epoch 19/20
80/80 [==============================] - 0s 181us/step - loss: 0.8916 -
acc: 0.6750
Epoch 20/20
80/80 [==============================] - 0s 186us/step - loss: 0.8769 -
acc: 0.6500
20/20 [==============================] - 1s 54ms/step
80/80 [==============================] - 0s 155us/step
Epoch 1/20
80/80 [==============================] - 3s 36ms/step - loss: 1.8622 -
 acc: 0.1875
Epoch 2/20
80/80 [==============================] - 0s 215us/step - loss: 1.7541 -
acc: 0.0125
Epoch 3/20
80/80 [==============================] - 0s 269us/step - loss: 1.6807 -
acc: 0.0000e+00
Epoch 4/20
80/80 [==============================] - 0s 282us/step - loss: 1.6133 -
acc: 0.0000e+00
Epoch 5/20
80/80 [==============================] - 0s 198us/step - loss: 1.5626 -
acc: 0.0000e+00
Epoch 6/20
80/80 [==============================] - 0s 194us/step - loss: 1.5174 -
acc: 0.0500
Epoch 7/20
80/80 [==============================] - 0s 201us/step - loss: 1.4774 -
acc: 0.3750
Epoch 8/20
80/80 [==============================] - 0s 209us/step - loss: 1.4440 -
acc: 0.3750
Epoch 9/20
80/80 [==============================] - 0s 194us/step - loss: 1.4153 -
acc: 0.3750
Epoch 10/20
80/80 [==============================] - 0s 195us/step - loss: 1.3881 -
acc: 0.3750
Epoch 11/20
80/80 [==============================] - 0s 200us/step - loss: 1.3677 -
acc: 0.3750
Epoch 12/20
80/80 [==============================] - 0s 207us/step - loss: 1.3445 -
acc: 0.3625
Epoch 13/20
80/80 [==============================] - 0s 342us/step - loss: 1.3267 -
acc: 0.4625
```

```
Epoch 14/20
80/80 [==============================] - 0s 209us/step - loss: 1.3073 -
acc: 0.4375
Epoch 15/20
80/80 [==============================] - 0s 236us/step - loss: 1.2888 -
acc: 0.4000
Epoch 16/20
80/80 [==============================] - 0s 199us/step - loss: 1.2673 -
acc: 0.4250
Epoch 17/20
80/80 [==============================] - 0s 207us/step - loss: 1.2433 -
acc: 0.4250
Epoch 18/20
80/80 [==============================] - 0s 221us/step - loss: 1.2240 -
acc: 0.5125
Epoch 19/20
80/80 [==============================] - 0s 211us/step - loss: 1.2036 -
acc: 0.6125
Epoch 20/20
80/80 [==============================] - 0s 208us/step - loss: 1.1842 -
acc: 0.7625
20/20 [==============================] - 1s 59ms/step
80/80 [==============================] - 0s 188us/step
Epoch 1/20
80/80 [==============================] - 3s 36ms/step - loss: 1.6004 -
 acc: 0.0250
Epoch 2/20
80/80 [==============================] - 0s 211us/step - loss: 1.5194 -
acc: 0.0750
Epoch 3/20
80/80 [==============================] - 0s 208us/step - loss: 1.4499 -
acc: 0.4375
Epoch 4/20
80/80 [==============================] - 0s 282us/step - loss: 1.3855 -
acc: 0.6125
Epoch 5/20
80/80 [==============================] - 0s 243us/step - loss: 1.3289 -
acc: 0.6875
Epoch 6/20
80/80 [==============================] - 0s 213us/step - loss: 1.2761 -
acc: 0.6875
Epoch 7/20
80/80 [==============================] - 0s 225us/step - loss: 1.2298 -
acc: 0.6875
Epoch 8/20
80/80 [==============================] - 0s 198us/step - loss: 1.1813 -
acc: 0.6875
Epoch 9/20
80/80 [==============================] - 0s 219us/step - loss: 1.1342 -
acc: 0.6875
Epoch 10/20
80/80 [==============================] - 0s 213us/step - loss: 1.0918 -
acc: 0.7000
Epoch 11/20
80/80 [==============================] - 0s 204us/step - loss: 1.0525 -
acc: 0.7000
Epoch 12/20
```

```
80/80 [==============================] - 0s 224us/step - loss: 1.0171 -
acc: 0.7375
Epoch 13/20
80/80 [==============================] - 0s 216us/step - loss: 0.9859 -
acc: 0.7750
Epoch 14/20
80/80 [==============================] - 0s 207us/step - loss: 0.9564 -
acc: 0.7875
Epoch 15/20
80/80 [==============================] - 0s 202us/step - loss: 0.9273 -
acc: 0.8000
Epoch 16/20
80/80 [==============================] - 0s 243us/step - loss: 0.9002 -
acc: 0.8125
Epoch 17/20
80/80 [==============================] - 0s 277us/step - loss: 0.8757 -
acc: 0.8125
Epoch 18/20
80/80 [==============================] - 0s 223us/step - loss: 0.8541 -
acc: 0.8250
Epoch 19/20
80/80 [==============================] - 0s 236us/step - loss: 0.8333 -
acc: 0.8250
Epoch 20/20
80/80 [==============================] - 0s 200us/step - loss: 0.8136 -
acc: 0.8250
20/20 [==============================] - 1s 59ms/step
80/80 [==============================] - 0s 168us/step
Epoch 1/20
80/80 [==============================] - 3s 35ms/step - loss: 1.8783 -
 acc: 0.3375
Epoch 2/20
80/80 [==============================] - 0s 186us/step - loss: 1.7633 -
acc: 0.3375
Epoch 3/20
80/80 [==============================] - 0s 174us/step - loss: 1.6696 -
acc: 0.3375
Epoch 4/20
80/80 [==============================] - 0s 198us/step - loss: 1.5847 -
acc: 0.3375
Epoch 5/20
80/80 [==============================] - 0s 185us/step - loss: 1.5162 -
acc: 0.3375
Epoch 6/20
80/80 [==============================] - 0s 195us/step - loss: 1.4609 -
acc: 0.5000
Epoch 7/20
80/80 [==============================] - 0s 181us/step - loss: 1.4126 -
acc: 0.6875
Epoch 8/20
80/80 [==============================] - 0s 191us/step - loss: 1.3675 -
acc: 0.7375
Epoch 9/20
80/80 [==============================] - 0s 189us/step - loss: 1.3269 -
acc: 0.7375
Epoch 10/20
80/80 [==============================] - 0s 201us/step - loss: 1.2892 -
```

```
acc: 0.7250
Epoch 11/20
80/80 [==============================] - 0s 196us/step - loss: 1.2542 -
acc: 0.7500
Epoch 12/20
80/80 [==============================] - 0s 209us/step - loss: 1.2241 -
acc: 0.7625
Epoch 13/20
80/80 [==============================] - 0s 192us/step - loss: 1.1988 -
acc: 0.7750
Epoch 14/20
80/80 [==============================] - 0s 228us/step - loss: 1.1728 -
acc: 0.7875
Epoch 15/20
80/80 [==============================] - 0s 204us/step - loss: 1.1465 -
acc: 0.7875
Epoch 16/20
80/80 [==============================] - 0s 178us/step - loss: 1.1216 -
acc: 0.7625
Epoch 17/20
80/80 [==============================] - 0s 231us/step - loss: 1.0971 -
acc: 0.7500
Epoch 18/20
80/80 [==============================] - 0s 189us/step - loss: 1.0732 -
acc: 0.7625
Epoch 19/20
80/80 [==============================] - 0s 192us/step - loss: 1.0499 -
acc: 0.7625
Epoch 20/20
80/80 [==============================] - 0s 189us/step - loss: 1.0283 -
acc: 0.7750
20/20 [==============================] - 1s 58ms/step
80/80 [==============================] - 0s 169us/step
Epoch 1/20
80/80 [==============================] - 3s 35ms/step - loss: 42.1808 -
acc: 0.3750
Epoch 2/20
80/80 [==============================] - 0s 191us/step - loss: 40.9200
 - acc: 0.3750
Epoch 3/20
80/80 [==============================] - 0s 194us/step - loss: 39.7348
 - acc: 0.3875
Epoch 4/20
80/80 [==============================] - 0s 187us/step - loss: 38.5863
 - acc: 0.5375
Epoch 5/20
80/80 [==============================] - 0s 192us/step - loss: 37.4995
 - acc: 0.6250
Epoch 6/20
80/80 [==============================] - 0s 177us/step - loss: 36.4582
 - acc: 0.6375
Epoch 7/20
80/80 [==============================] - 0s 192us/step - loss: 35.4485
 - acc: 0.6375
Epoch 8/20
80/80 [==============================] - 0s 185us/step - loss: 34.4673
 - acc: 0.6375
```

```
Epoch 9/20
80/80 [==============================] - 0s 196us/step - loss: 33.5080
 - acc: 0.6750
Epoch 10/20
80/80 [==============================] - 0s 183us/step - loss: 32.5704
 - acc: 0.6875
Epoch 11/20
80/80 [==============================] - 0s 169us/step - loss: 31.6558
 - acc: 0.6750
Epoch 12/20
80/80 [==============================] - 0s 186us/step - loss: 30.7633
 - acc: 0.6500
Epoch 13/20
80/80 [==============================] - 0s 190us/step - loss: 29.8948
 - acc: 0.6500
Epoch 14/20
80/80 [==============================] - 0s 166us/step - loss: 29.0514
 - acc: 0.6375
Epoch 15/20
80/80 [==============================] - 0s 193us/step - loss: 28.2273
 - acc: 0.6375
Epoch 16/20
80/80 [==============================] - 0s 177us/step - loss: 27.4278
 - acc: 0.6375
Epoch 17/20
80/80 [==============================] - 0s 196us/step - loss: 26.6500
 - acc: 0.6375
Epoch 18/20
80/80 [==============================] - 0s 195us/step - loss: 25.8919
 - acc: 0.6500
Epoch 19/20
80/80 [==============================] - 0s 189us/step - loss: 25.1552
 - acc: 0.6500
Epoch 20/20
80/80 [==============================] - 0s 189us/step - loss: 24.4378
 - acc: 0.6500
20/20 [==============================] - 1s 59ms/step
80/80 [==============================] - 0s 159us/step
Epoch 1/20
80/80 [==============================] - 3s 36ms/step - loss: 40.8994 -
acc: 0.4875
Epoch 2/20
80/80 [==============================] - 0s 187us/step - loss: 39.7574
 - acc: 0.5750
Epoch 3/20
80/80 [==============================] - 0s 181us/step - loss: 38.6608
 - acc: 0.6375
Epoch 4/20
80/80 [==============================] - 0s 181us/step - loss: 37.5837
 - acc: 0.6500
Epoch 5/20
80/80 [==============================] - 0s 178us/step - loss: 36.5431
 - acc: 0.6375
Epoch 6/20
80/80 [==============================] - 0s 184us/step - loss: 35.5293
 - acc: 0.6000
Epoch 7/20
```

```
80/80 [==============================] - 0s 177us/step - loss: 34.5428
 - acc: 0.4750
Epoch 8/20
80/80 [==============================] - 0s 254us/step - loss: 33.5818
 - acc: 0.3875
Epoch 9/20
80/80 [==============================] - 0s 251us/step - loss: 32.6441
 - acc: 0.3500
Epoch 10/20
80/80 [==============================] - 0s 196us/step - loss: 31.7314
 - acc: 0.3500
Epoch 11/20
80/80 [==============================] - 0s 174us/step - loss: 30.8411
 - acc: 0.3500
Epoch 12/20
80/80 [==============================] - 0s 180us/step - loss: 29.9752
 - acc: 0.4000
Epoch 13/20
80/80 [==============================] - 0s 207us/step - loss: 29.1313
 - acc: 0.5125
Epoch 14/20
80/80 [==============================] - 0s 207us/step - loss: 28.3107
 - acc: 0.5500
Epoch 15/20
80/80 [==============================] - 0s 236us/step - loss: 27.5133
 - acc: 0.5875
Epoch 16/20
80/80 [==============================] - 0s 211us/step - loss: 26.7360
 - acc: 0.6125
Epoch 17/20
80/80 [==============================] - 0s 179us/step - loss: 25.9801
 - acc: 0.6125
Epoch 18/20
80/80 [==============================] - 0s 190us/step - loss: 25.2456
 - acc: 0.6375
Epoch 19/20
80/80 [==============================] - 0s 211us/step - loss: 24.5303
 - acc: 0.6500
Epoch 20/20
80/80 [==============================] - 0s 185us/step - loss: 23.8351
 - acc: 0.6500
20/20 [==============================] - 1s 61ms/step
80/80 [==============================] - 0s 164us/step
Epoch 1/20
80/80 [==============================] - 3s 37ms/step - loss: 41.4709 -
acc: 0.3000
Epoch 2/20
80/80 [==============================] - 0s 183us/step - loss: 40.1859
 - acc: 0.3000
Epoch 3/20
80/80 [==============================] - 0s 197us/step - loss: 38.9530
 - acc: 0.3000
Epoch 4/20
80/80 [==============================] - 0s 169us/step - loss: 37.7829
 - acc: 0.3000
Epoch 5/20
80/80 [==============================] - 0s 168us/step - loss: 36.6836
```

```
 - acc: 0.3000
Epoch 6/20
80/80 [==============================] - 0s 171us/step - loss: 35.6293
 - acc: 0.3000
Epoch 7/20
80/80 [==============================] - 0s 179us/step - loss: 34.6189
 - acc: 0.3875
Epoch 8/20
80/80 [==============================] - 0s 197us/step - loss: 33.6489
 - acc: 0.6000
Epoch 9/20
80/80 [==============================] - 0s 178us/step - loss: 32.7177
 - acc: 0.5750
Epoch 10/20
80/80 [==============================] - 0s 182us/step - loss: 31.8083
 - acc: 0.5375
Epoch 11/20
80/80 [==============================] - 0s 182us/step - loss: 30.9290
 - acc: 0.5375
Epoch 12/20
80/80 [==============================] - 0s 179us/step - loss: 30.0760
 - acc: 0.5375
Epoch 13/20
80/80 [==============================] - 0s 175us/step - loss: 29.2455
 - acc: 0.5375
Epoch 14/20
80/80 [==============================] - 0s 213us/step - loss: 28.4345
 - acc: 0.5375
Epoch 15/20
80/80 [==============================] - 0s 235us/step - loss: 27.6467
 - acc: 0.5500
Epoch 16/20
80/80 [==============================] - 0s 194us/step - loss: 26.8800
 - acc: 0.5625
Epoch 17/20
80/80 [==============================] - 0s 181us/step - loss: 26.1339
 - acc: 0.5875
Epoch 18/20
80/80 [==============================] - 0s 217us/step - loss: 25.4074
 - acc: 0.6000
Epoch 19/20
80/80 [==============================] - 0s 223us/step - loss: 24.7007
 - acc: 0.6125
Epoch 20/20
80/80 [==============================] - 0s 225us/step - loss: 24.0134
 - acc: 0.6125
20/20 [==============================] - 1s 62ms/step
80/80 [==============================] - 0s 156us/step
Epoch 1/20
80/80 [==============================] - 3s 38ms/step - loss: 38.9406 -
acc: 0.6875
Epoch 2/20
80/80 [==============================] - 0s 191us/step - loss: 37.7985
 - acc: 0.6875
Epoch 3/20
80/80 [==============================] - 0s 188us/step - loss: 36.6908
 - acc: 0.6875
```

```
Epoch 4/20
80/80 [==============================] - 0s 185us/step - loss: 35.6248
 - acc: 0.6875
Epoch 5/20
80/80 [==============================] - 0s 192us/step - loss: 34.5889
 - acc: 0.6875
Epoch 6/20
80/80 [==============================] - 0s 182us/step - loss: 33.5846
 - acc: 0.6875
Epoch 7/20
80/80 [==============================] - 0s 176us/step - loss: 32.6067
 - acc: 0.6875
Epoch 8/20
80/80 [==============================] - 0s 225us/step - loss: 31.6669
 - acc: 0.6875
Epoch 9/20
80/80 [==============================] - 0s 182us/step - loss: 30.7649
 - acc: 0.6875
Epoch 10/20
80/80 [==============================] - 0s 184us/step - loss: 29.8915
 - acc: 0.6875
Epoch 11/20
80/80 [==============================] - 0s 186us/step - loss: 29.0473
 - acc: 0.6875
Epoch 12/20
80/80 [==============================] - 0s 195us/step - loss: 28.2279
 - acc: 0.6875
Epoch 13/20
80/80 [==============================] - 0s 200us/step - loss: 27.4330
 - acc: 0.6875
Epoch 14/20
80/80 [==============================] - 0s 204us/step - loss: 26.6571
 - acc: 0.6875
Epoch 15/20
80/80 [==============================] - 0s 195us/step - loss: 25.9046
 - acc: 0.6875
Epoch 16/20
80/80 [==============================] - 0s 200us/step - loss: 25.1728
 - acc: 0.6875
Epoch 17/20
80/80 [==============================] - 0s 207us/step - loss: 24.4611
 - acc: 0.6875
Epoch 18/20
80/80 [==============================] - 0s 223us/step - loss: 23.7694
 - acc: 0.6875
Epoch 19/20
80/80 [==============================] - 0s 197us/step - loss: 23.0967
 - acc: 0.6875
Epoch 20/20
80/80 [==============================] - 0s 215us/step - loss: 22.4449
 - acc: 0.6875
20/20 [==============================] - 1s 65ms/step
80/80 [==============================] - 0s 162us/step
Epoch 1/20
80/80 [==============================] - 3s 39ms/step - loss: 43.5391 -
acc: 0.3375
Epoch 2/20
```

```
80/80 [==============================] - 0s 184us/step - loss: 42.0967
 - acc: 0.3375
Epoch 3/20
80/80 [==============================] - 0s 176us/step - loss: 40.6868
 - acc: 0.3375
Epoch 4/20
80/80 [==============================] - 0s 171us/step - loss: 39.3771
 - acc: 0.3375
Epoch 5/20
80/80 [==============================] - 0s 174us/step - loss: 38.1432
 - acc: 0.3375
Epoch 6/20
80/80 [==============================] - 0s 173us/step - loss: 36.9838
 - acc: 0.3375
Epoch 7/20
80/80 [==============================] - 0s 166us/step - loss: 35.8889
 - acc: 0.3375
Epoch 8/20
80/80 [==============================] - 0s 171us/step - loss: 34.8541
 - acc: 0.3375
Epoch 9/20
80/80 [==============================] - 0s 171us/step - loss: 33.8570
 - acc: 0.3250
Epoch 10/20
80/80 [==============================] - 0s 178us/step - loss: 32.9088
 - acc: 0.1750
Epoch 11/20
80/80 [==============================] - 0s 184us/step - loss: 31.9965
 - acc: 0.2250
Epoch 12/20
80/80 [==============================] - 0s 187us/step - loss: 31.1149
 - acc: 0.3125
Epoch 13/20
80/80 [==============================] - 0s 187us/step - loss: 30.2534
 - acc: 0.3250
Epoch 14/20
80/80 [==============================] - 0s 206us/step - loss: 29.4222
 - acc: 0.4750
Epoch 15/20
80/80 [==============================] - 0s 248us/step - loss: 28.6096
 - acc: 0.6000
Epoch 16/20
80/80 [==============================] - 0s 197us/step - loss: 27.8200
 - acc: 0.6625
Epoch 17/20
80/80 [==============================] - 0s 189us/step - loss: 27.0529
 - acc: 0.6625
Epoch 18/20
80/80 [==============================] - 0s 224us/step - loss: 26.3062
 - acc: 0.7125
Epoch 19/20
80/80 [==============================] - 0s 199us/step - loss: 25.5803
 - acc: 0.7000
Epoch 20/20
80/80 [==============================] - 0s 224us/step - loss: 24.8737
 - acc: 0.7000
20/20 [==============================] - 1s 64ms/step
```

```
80/80 [==============================] - 0s 181us/step
Epoch 1/20
80/80 [==============================] - 3s 39ms/step - loss: 411.9868
 - acc: 0.2750
Epoch 2/20
80/80 [==============================] - 0s 198us/step - loss: 400.7934
- acc: 0.2750
Epoch 3/20
80/80 [==============================] - 0s 172us/step - loss: 389.8247
- acc: 0.2750
Epoch 4/20
80/80 [==============================] - 0s 177us/step - loss: 379.0966
- acc: 0.2750
Epoch 5/20
80/80 [==============================] - 0s 174us/step - loss: 368.6067
- acc: 0.2750
Epoch 6/20
80/80 [==============================] - 0s 181us/step - loss: 358.3636
- acc: 0.2750
Epoch 7/20
80/80 [==============================] - 0s 174us/step - loss: 348.3586
- acc: 0.2750
Epoch 8/20
80/80 [==============================] - 0s 188us/step - loss: 338.6029
- acc: 0.2750
Epoch 9/20
80/80 [==============================] - 0s 187us/step - loss: 329.0889
- acc: 0.2750
Epoch 10/20
80/80 [==============================] - 0s 164us/step - loss: 319.8206
- acc: 0.2750
Epoch 11/20
80/80 [==============================] - 0s 191us/step - loss: 310.7909
- acc: 0.2750
Epoch 12/20
80/80 [==============================] - 0s 194us/step - loss: 301.9997
- acc: 0.2750
Epoch 13/20
80/80 [==============================] - 0s 190us/step - loss: 293.4373
- acc: 0.2750
Epoch 14/20
80/80 [==============================] - 0s 200us/step - loss: 285.1086
- acc: 0.2750
Epoch 15/20
80/80 [==============================] - 0s 195us/step - loss: 277.0004
- acc: 0.3500
Epoch 16/20
80/80 [==============================] - 0s 193us/step - loss: 269.1077
- acc: 0.3875
Epoch 17/20
80/80 [==============================] - 0s 180us/step - loss: 261.4329
- acc: 0.4625
Epoch 18/20
80/80 [==============================] - 0s 192us/step - loss: 253.9610
- acc: 0.5500
Epoch 19/20
80/80 [==============================] - 0s 190us/step - loss: 246.6951
```

```
- acc: 0.6000
Epoch 20/20
80/80 [==============================] - 0s 185us/step - loss: 239.6236
- acc: 0.6500
20/20 [==============================] - 1s 66ms/step
80/80 [==============================] - 0s 155us/step
Epoch 1/20
80/80 [==============================] - 3s 40ms/step - loss: 383.6496
 - acc: 0.3000
Epoch 2/20
80/80 [==============================] - 0s 179us/step - loss: 372.9878
- acc: 0.3000
Epoch 3/20
80/80 [==============================] - 0s 173us/step - loss: 362.5536
- acc: 0.3000
Epoch 4/20
80/80 [==============================] - 0s 185us/step - loss: 352.3487
- acc: 0.3000
Epoch 5/20
80/80 [==============================] - 0s 189us/step - loss: 342.3829
- acc: 0.3000
Epoch 6/20
80/80 [==============================] - 0s 173us/step - loss: 332.6565
- acc: 0.3000
Epoch 7/20
80/80 [==============================] - 0s 173us/step - loss: 323.1631
- acc: 0.3000
Epoch 8/20
80/80 [==============================] - 0s 181us/step - loss: 313.9101
- acc: 0.3000
Epoch 9/20
80/80 [==============================] - 0s 212us/step - loss: 304.8956
- acc: 0.3000
Epoch 10/20
80/80 [==============================] - 0s 188us/step - loss: 296.1136
- acc: 0.3000
Epoch 11/20
80/80 [==============================] - 0s 196us/step - loss: 287.5627
- acc: 0.3125
Epoch 12/20
80/80 [==============================] - 0s 178us/step - loss: 279.2406
- acc: 0.3250
Epoch 13/20
80/80 [==============================] - 0s 213us/step - loss: 271.1431
- acc: 0.4125
Epoch 14/20
80/80 [==============================] - 0s 181us/step - loss: 263.2630
- acc: 0.5125
Epoch 15/20
80/80 [==============================] - 0s 226us/step - loss: 255.5977
- acc: 0.6125
Epoch 16/20
80/80 [==============================] - 0s 200us/step - loss: 248.1418
- acc: 0.6375
Epoch 17/20
80/80 [==============================] - 0s 205us/step - loss: 240.8906
- acc: 0.6500
```

```
Epoch 18/20
80/80 [==============================] - 0s 199us/step - loss: 233.8386
- acc: 0.6500
Epoch 19/20
80/80 [==============================] - 0s 236us/step - loss: 226.9812
- acc: 0.6500
Epoch 20/20
80/80 [==============================] - 0s 239us/step - loss: 220.3125
- acc: 0.6500
20/20 [==============================] - 1s 67ms/step
80/80 [==============================] - 0s 171us/step
Epoch 1/20
80/80 [==============================] - 3s 41ms/step - loss: 385.7962
 - acc: 0.3250
Epoch 2/20
80/80 [==============================] - 0s 208us/step - loss: 374.9903
- acc: 0.3250
Epoch 3/20
80/80 [==============================] - 0s 180us/step - loss: 364.4143
- acc: 0.3250
Epoch 4/20
80/80 [==============================] - 0s 202us/step - loss: 354.0681
- acc: 0.3250
Epoch 5/20
80/80 [==============================] - 0s 270us/step - loss: 343.9517
- acc: 0.3250
Epoch 6/20
80/80 [==============================] - 0s 204us/step - loss: 334.0715
- acc: 0.3250
Epoch 7/20
80/80 [==============================] - 0s 189us/step - loss: 324.4339
- acc: 0.3250
Epoch 8/20
80/80 [==============================] - 0s 173us/step - loss: 315.0325
- acc: 0.3250
Epoch 9/20
80/80 [==============================] - 0s 174us/step - loss: 305.8709
- acc: 0.3250
Epoch 10/20
80/80 [==============================] - 0s 185us/step - loss: 296.9465
- acc: 0.3250
Epoch 11/20
80/80 [==============================] - 0s 190us/step - loss: 288.2547
- acc: 0.3250
Epoch 12/20
80/80 [==============================] - 0s 201us/step - loss: 279.7963
- acc: 0.3250
Epoch 13/20
80/80 [==============================] - 0s 185us/step - loss: 271.5652
- acc: 0.3250
Epoch 14/20
80/80 [==============================] - 0s 188us/step - loss: 263.5572
- acc: 0.3250
Epoch 15/20
80/80 [==============================] - 0s 180us/step - loss: 255.7707
- acc: 0.3250
Epoch 16/20
```

```
80/80 [==============================] - 0s 195us/step - loss: 248.1970
- acc: 0.3250
Epoch 17/20
80/80 [==============================] - 0s 170us/step - loss: 240.8332
- acc: 0.3250
Epoch 18/20
80/80 [==============================] - 0s 220us/step - loss: 233.6750
- acc: 0.3250
Epoch 19/20
80/80 [==============================] - 0s 203us/step - loss: 226.7163
- acc: 0.3250
Epoch 20/20
80/80 [==============================] - 0s 216us/step - loss: 219.9521
- acc: 0.3000
20/20 [==============================] - 1s 73ms/step
80/80 [==============================] - 0s 173us/step
Epoch 1/20
80/80 [==============================] - 4s 45ms/step - loss: 387.6748
 - acc: 0.3500
Epoch 2/20
80/80 [==============================] - 0s 216us/step - loss: 376.9276
- acc: 0.3500
Epoch 3/20
80/80 [==============================] - 0s 214us/step - loss: 366.3956
- acc: 0.3500
Epoch 4/20
80/80 [==============================] - 0s 206us/step - loss: 356.0962
- acc: 0.3500
Epoch 5/20
80/80 [==============================] - 0s 208us/step - loss: 346.0275
- acc: 0.3500
Epoch 6/20
80/80 [==============================] - 0s 203us/step - loss: 336.1951
- acc: 0.3500
Epoch 7/20
80/80 [==============================] - 0s 193us/step - loss: 326.5998
- acc: 0.3500
Epoch 8/20
80/80 [==============================] - 0s 196us/step - loss: 317.2426
- acc: 0.3500
Epoch 9/20
80/80 [==============================] - 0s 183us/step - loss: 308.1235
- acc: 0.3500
Epoch 10/20
80/80 [==============================] - 0s 210us/step - loss: 299.2408
- acc: 0.3500
Epoch 11/20
80/80 [==============================] - 0s 187us/step - loss: 290.5908
- acc: 0.3625
Epoch 12/20
80/80 [==============================] - 0s 181us/step - loss: 282.1717
- acc: 0.5000
Epoch 13/20
80/80 [==============================] - 0s 184us/step - loss: 273.9802
- acc: 0.6000
Epoch 14/20
80/80 [==============================] - 0s 208us/step - loss: 266.0118
```

```
- acc: 0.6500
Epoch 15/20
80/80 [==============================] - 0s 190us/step - loss: 258.2625
- acc: 0.6625
Epoch 16/20
80/80 [==============================] - 0s 190us/step - loss: 250.7262
- acc: 0.6750
Epoch 17/20
80/80 [==============================] - 0s 219us/step - loss: 243.3988
- acc: 0.6875
Epoch 18/20
80/80 [==============================] - 0s 191us/step - loss: 236.2750
- acc: 0.6875
Epoch 19/20
80/80 [==============================] - 0s 188us/step - loss: 229.3496
- acc: 0.6875
Epoch 20/20
80/80 [==============================] - 0s 194us/step - loss: 222.6166
- acc: 0.6875
20/20 [==============================] - 1s 70ms/step
80/80 [==============================] - 0s 172us/step
Epoch 1/20
80/80 [==============================] - 3s 44ms/step - loss: 387.1379
 - acc: 0.3375
Epoch 2/20
80/80 [==============================] - 0s 208us/step - loss: 376.3809
- acc: 0.1500
Epoch 3/20
80/80 [==============================] - 0s 187us/step - loss: 365.8510
- acc: 0.0250
Epoch 4/20
80/80 [==============================] - 0s 177us/step - loss: 355.5502
- acc: 0.0500
Epoch 5/20
80/80 [==============================] - 0s 189us/step - loss: 345.4814
- acc: 0.3250
Epoch 6/20
80/80 [==============================] - 0s 187us/step - loss: 335.6481
- acc: 0.5500
Epoch 7/20
80/80 [==============================] - 0s 204us/step - loss: 326.0493
- acc: 0.5750
Epoch 8/20
80/80 [==============================] - 0s 174us/step - loss: 316.6897
- acc: 0.5625
Epoch 9/20
80/80 [==============================] - 0s 201us/step - loss: 307.5650
- acc: 0.5500
Epoch 10/20
80/80 [==============================] - 0s 184us/step - loss: 298.6755
- acc: 0.5625
Epoch 11/20
80/80 [==============================] - 0s 189us/step - loss: 290.0185
- acc: 0.5500
Epoch 12/20
80/80 [==============================] - 0s 190us/step - loss: 281.5914
- acc: 0.5750
```

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Epoch 13/20
80/80 [==============================] - 0s 209us/step - loss: 273.3898
- acc: 0.5625
Epoch 14/20
80/80 [==============================] - 0s 289us/step - loss: 265.4104
- acc: 0.5875
Epoch 15/20
80/80 [==============================] - 0s 167us/step - loss: 257.6477
- acc: 0.5625
Epoch 16/20
80/80 [==============================] - 0s 179us/step - loss: 250.0977
- acc: 0.5625
Epoch 17/20
80/80 [==============================] - 0s 207us/step - loss: 242.7546
- acc: 0.5625
Epoch 18/20
80/80 [==============================] - 0s 171us/step - loss: 235.6141
- acc: 0.5625
Epoch 19/20
80/80 [==============================] - 0s 186us/step - loss: 228.6711
- acc: 0.5625
Epoch 20/20
80/80 [==============================] - 0s 230us/step - loss: 221.9203
- acc: 0.5625
20/20 [==============================] - 1s 72ms/step
80/80 [==============================] - 0s 152us/step
Epoch 1/20
80/80 [==============================] - 4s 44ms/step - loss: 1.2070 -
 acc: 0.3250
Epoch 2/20
80/80 [==============================] - 0s 201us/step - loss: 1.0976 -
acc: 0.3750
Epoch 3/20
80/80 [==============================] - 0s 183us/step - loss: 1.0369 -
acc: 0.4375
Epoch 4/20
80/80 [==============================] - 0s 192us/step - loss: 0.9862 -
acc: 0.5625
Epoch 5/20
80/80 [==============================] - 0s 173us/step - loss: 0.9362 -
acc: 0.5625
Epoch 6/20
80/80 [==============================] - 0s 184us/step - loss: 0.8864 -
acc: 0.6750
Epoch 7/20
80/80 [==============================] - 0s 196us/step - loss: 0.8465 -
acc: 0.7500
Epoch 8/20
80/80 [==============================] - 0s 183us/step - loss: 0.8084 -
acc: 0.7000
Epoch 9/20
80/80 [==============================] - 0s 208us/step - loss: 0.7765 -
acc: 0.6875
Epoch 10/20
80/80 [==============================] - 0s 186us/step - loss: 0.7423 -
acc: 0.7250
Epoch 11/20
```

```
80/80 [==============================] - 0s 214us/step - loss: 0.7078 -
acc: 0.8500
Epoch 12/20
80/80 [==============================] - 0s 195us/step - loss: 0.6758 -
acc: 0.8500
Epoch 13/20
80/80 [==============================] - 0s 211us/step - loss: 0.6476 -
acc: 0.8625
Epoch 14/20
80/80 [==============================] - 0s 216us/step - loss: 0.6204 -
acc: 0.8375
Epoch 15/20
80/80 [==============================] - 0s 228us/step - loss: 0.5990 -
acc: 0.8000
Epoch 16/20
80/80 [==============================] - 0s 205us/step - loss: 0.5792 -
acc: 0.8000
Epoch 17/20
80/80 [==============================] - 0s 195us/step - loss: 0.5613 -
acc: 0.8250
Epoch 18/20
80/80 [==============================] - 0s 169us/step - loss: 0.5406 -
acc: 0.8500
Epoch 19/20
80/80 [==============================] - 0s 322us/step - loss: 0.5236 -
acc: 0.8625
Epoch 20/20
80/80 [==============================] - 0s 242us/step - loss: 0.5073 -
acc: 0.8875
20/20 [==============================] - 1s 75ms/step
80/80 [==============================] - 0s 180us/step
Epoch 1/20
80/80 [==============================] - 4s 49ms/step - loss: 1.3151 -
 acc: 0.3500
Epoch 2/20
80/80 [==============================] - 0s 217us/step - loss: 1.1900 -
acc: 0.3500
Epoch 3/20
80/80 [==============================] - 0s 209us/step - loss: 1.1179 -
acc: 0.3750
Epoch 4/20
80/80 [==============================] - 0s 219us/step - loss: 1.0692 -
acc: 0.5000
Epoch 5/20
80/80 [==============================] - 0s 224us/step - loss: 1.0268 -
acc: 0.5000
Epoch 6/20
80/80 [==============================] - 0s 232us/step - loss: 0.9898 -
acc: 0.8250
Epoch 7/20
80/80 [==============================] - 0s 243us/step - loss: 0.9551 -
acc: 0.8125
Epoch 8/20
80/80 [==============================] - 0s 235us/step - loss: 0.9174 -
acc: 0.7250
Epoch 9/20
80/80 [==============================] - 0s 202us/step - loss: 0.8821 -
```

```
acc: 0.7000
Epoch 10/20
80/80 [==============================] - 0s 207us/step - loss: 0.8486 -
acc: 0.7000
Epoch 11/20
80/80 [==============================] - 0s 218us/step - loss: 0.8170 -
acc: 0.7000
Epoch 12/20
80/80 [==============================] - 0s 223us/step - loss: 0.7869 -
acc: 0.6875
Epoch 13/20
80/80 [==============================] - 0s 208us/step - loss: 0.7535 -
acc: 0.7125
Epoch 14/20
80/80 [==============================] - 0s 201us/step - loss: 0.7251 -
acc: 0.8125
Epoch 15/20
80/80 [==============================] - 0s 219us/step - loss: 0.6967 -
acc: 0.8875
Epoch 16/20
80/80 [==============================] - 0s 211us/step - loss: 0.6677 -
acc: 0.9000
Epoch 17/20
80/80 [==============================] - 0s 227us/step - loss: 0.6394 -
acc: 0.8500
Epoch 18/20
80/80 [==============================] - 0s 220us/step - loss: 0.6142 -
acc: 0.8750
Epoch 19/20
80/80 [==============================] - 0s 231us/step - loss: 0.5890 -
acc: 0.8500
Epoch 20/20
80/80 [==============================] - 0s 238us/step - loss: 0.5654 -
acc: 0.8500
20/20 [==============================] - 2s 82ms/step
80/80 [==============================] - 0s 150us/step
Epoch 1/20
80/80 [==============================] - 4s 50ms/step - loss: 1.1539 -
 acc: 0.3750
Epoch 2/20
80/80 [==============================] - 0s 209us/step - loss: 1.0538 -
acc: 0.4750
Epoch 3/20
80/80 [==============================] - 0s 209us/step - loss: 0.9769 -
acc: 0.6250
Epoch 4/20
80/80 [==============================] - 0s 218us/step - loss: 0.8844 -
acc: 0.6250
Epoch 5/20
80/80 [==============================] - 0s 220us/step - loss: 0.8264 -
acc: 0.8125
Epoch 6/20
80/80 [==============================] - 0s 215us/step - loss: 0.7662 -
acc: 0.7750
Epoch 7/20
80/80 [==============================] - 0s 227us/step - loss: 0.7207 -
acc: 0.9000
```

```
Epoch 8/20
80/80 [==============================] - 0s 206us/step - loss: 0.6989 -
acc: 0.6250
Epoch 9/20
80/80 [==============================] - 0s 204us/step - loss: 0.6748 -
acc: 0.6250
Epoch 10/20
80/80 [==============================] - 0s 232us/step - loss: 0.6425 -
acc: 0.7250
Epoch 11/20
80/80 [==============================] - 0s 209us/step - loss: 0.6173 -
acc: 0.9500
Epoch 12/20
80/80 [==============================] - 0s 243us/step - loss: 0.6036 -
acc: 0.8250
Epoch 13/20
80/80 [==============================] - 0s 257us/step - loss: 0.5790 -
acc: 0.8875
Epoch 14/20
80/80 [==============================] - 0s 198us/step - loss: 0.5538 -
acc: 0.9375
Epoch 15/20
80/80 [==============================] - 0s 238us/step - loss: 0.5424 -
acc: 0.9125
Epoch 16/20
80/80 [==============================] - 0s 223us/step - loss: 0.5277 -
acc: 0.8500
Epoch 17/20
80/80 [==============================] - 0s 225us/step - loss: 0.5037 -
acc: 0.9500
Epoch 18/20
80/80 [==============================] - 0s 260us/step - loss: 0.4981 -
acc: 0.9250
Epoch 19/20
80/80 [==============================] - 0s 239us/step - loss: 0.4874 -
acc: 0.9250
Epoch 20/20
80/80 [==============================] - 0s 213us/step - loss: 0.4673 -
acc: 0.9750
20/20 [==============================] - 2s 82ms/step
80/80 [==============================] - 0s 187us/step
Epoch 1/20
80/80 [==============================] - 4s 49ms/step - loss: 1.5936 -
 acc: 0.3125
Epoch 2/20
80/80 [==============================] - 0s 215us/step - loss: 1.2703 -
acc: 0.4625
Epoch 3/20
80/80 [==============================] - 0s 266us/step - loss: 1.1246 -
acc: 0.6500
Epoch 4/20
80/80 [==============================] - 0s 225us/step - loss: 1.0851 -
acc: 0.3500
Epoch 5/20
80/80 [==============================] - 0s 218us/step - loss: 1.0731 -
acc: 0.3500
Epoch 6/20
```

```
80/80 [==============================] - 0s 216us/step - loss: 1.0579 -
acc: 0.3500
Epoch 7/20
80/80 [==============================] - 0s 210us/step - loss: 1.0165 -
acc: 0.3500
Epoch 8/20
80/80 [==============================] - 0s 210us/step - loss: 0.9720 -
acc: 0.5125
Epoch 9/20
80/80 [==============================] - 0s 201us/step - loss: 0.9273 -
acc: 0.6875
Epoch 10/20
80/80 [==============================] - 0s 232us/step - loss: 0.9042 -
acc: 0.7250
Epoch 11/20
80/80 [==============================] - 0s 230us/step - loss: 0.8797 -
acc: 0.9125
Epoch 12/20
80/80 [==============================] - 0s 257us/step - loss: 0.8536 -
acc: 0.8500
Epoch 13/20
80/80 [==============================] - 0s 288us/step - loss: 0.8230 -
acc: 0.7750
Epoch 14/20
80/80 [==============================] - 0s 237us/step - loss: 0.7944 -
acc: 0.7000
Epoch 15/20
80/80 [==============================] - 0s 243us/step - loss: 0.7673 -
acc: 0.7000
Epoch 16/20
80/80 [==============================] - 0s 239us/step - loss: 0.7419 -
acc: 0.6875
Epoch 17/20
80/80 [==============================] - 0s 240us/step - loss: 0.7195 -
acc: 0.7000
Epoch 18/20
80/80 [==============================] - 0s 242us/step - loss: 0.6979 -
acc: 0.7000
Epoch 19/20
80/80 [==============================] - 0s 220us/step - loss: 0.6743 -
acc: 0.6875
Epoch 20/20
80/80 [==============================] - 0s 233us/step - loss: 0.6509 -
acc: 0.6875
20/20 [==============================] - 2s 78ms/step
80/80 [==============================] - 0s 170us/step
Epoch 1/20
80/80 [==============================] - 4s 47ms/step - loss: 1.1950 -
 acc: 0.3000
Epoch 2/20
80/80 [==============================] - 0s 200us/step - loss: 1.1102 -
acc: 0.3500
Epoch 3/20
80/80 [==============================] - 0s 194us/step - loss: 1.0425 -
acc: 0.4000
Epoch 4/20
80/80 [==============================] - 0s 207us/step - loss: 0.9751 -
```

```
acc: 0.6875
Epoch 5/20
80/80 [==============================] - 0s 174us/step - loss: 0.9204 -
acc: 0.7250
Epoch 6/20
80/80 [==============================] - 0s 187us/step - loss: 0.8725 -
acc: 0.9625
Epoch 7/20
80/80 [==============================] - 0s 193us/step - loss: 0.8300 -
acc: 0.9625
Epoch 8/20
80/80 [==============================] - 0s 174us/step - loss: 0.7855 -
acc: 0.8875
Epoch 9/20
80/80 [==============================] - 0s 185us/step - loss: 0.7471 -
acc: 0.9000
Epoch 10/20
80/80 [==============================] - 0s 193us/step - loss: 0.7147 -
acc: 0.8375
Epoch 11/20
80/80 [==============================] - 0s 207us/step - loss: 0.6891 -
acc: 0.7375
Epoch 12/20
80/80 [==============================] - 0s 258us/step - loss: 0.6629 -
acc: 0.7750
Epoch 13/20
80/80 [==============================] - 0s 231us/step - loss: 0.6358 -
acc: 0.9500
Epoch 14/20
80/80 [==============================] - 0s 179us/step - loss: 0.6141 -
acc: 0.8375
Epoch 15/20
80/80 [==============================] - 0s 204us/step - loss: 0.5964 -
acc: 0.8000
Epoch 16/20
80/80 [==============================] - 0s 188us/step - loss: 0.5726 -
acc: 0.8500
Epoch 17/20
80/80 [==============================] - 0s 203us/step - loss: 0.5545 -
acc: 0.8500
Epoch 18/20
80/80 [==============================] - 0s 195us/step - loss: 0.5374 -
acc: 0.9125
Epoch 19/20
80/80 [==============================] - 0s 177us/step - loss: 0.5202 -
acc: 0.9375
Epoch 20/20
80/80 [==============================] - 0s 184us/step - loss: 0.5081 -
acc: 0.9375
20/20 [==============================] - 2s 78ms/step
80/80 [==============================] - 0s 176us/step
Epoch 1/20
80/80 [==============================] - 4s 47ms/step - loss: 1.8250 -
 acc: 0.3750
Epoch 2/20
80/80 [==============================] - 0s 212us/step - loss: 1.6764 -
acc: 0.3875
```

```
Epoch 3/20
80/80 [==============================] - 0s 187us/step - loss: 1.5754 -
acc: 0.7125
Epoch 4/20
80/80 [==============================] - 0s 184us/step - loss: 1.5122 -
acc: 0.6625
Epoch 5/20
80/80 [==============================] - 0s 212us/step - loss: 1.4420 -
acc: 0.7500
Epoch 6/20
80/80 [==============================] - 0s 181us/step - loss: 1.3804 -
acc: 0.8625
Epoch 7/20
80/80 [==============================] - 0s 213us/step - loss: 1.3283 -
acc: 0.6625
Epoch 8/20
80/80 [==============================] - 0s 243us/step - loss: 1.2910 -
acc: 0.6500
Epoch 9/20
80/80 [==============================] - 0s 293us/step - loss: 1.2422 -
acc: 0.6500
Epoch 10/20
80/80 [==============================] - 0s 190us/step - loss: 1.2004 -
acc: 0.7875
Epoch 11/20
80/80 [==============================] - 0s 205us/step - loss: 1.1679 -
acc: 0.8875
Epoch 12/20
80/80 [==============================] - 0s 213us/step - loss: 1.1307 -
acc: 0.9375
Epoch 13/20
80/80 [==============================] - 0s 218us/step - loss: 1.0968 -
acc: 0.8750
Epoch 14/20
80/80 [==============================] - 0s 331us/step - loss: 1.0670 -
acc: 0.8250
Epoch 15/20
80/80 [==============================] - 0s 214us/step - loss: 1.0412 -
acc: 0.8000
Epoch 16/20
80/80 [==============================] - 0s 192us/step - loss: 1.0180 -
acc: 0.8000
Epoch 17/20
80/80 [==============================] - 0s 189us/step - loss: 0.9944 -
acc: 0.8250
Epoch 18/20
80/80 [==============================] - 0s 172us/step - loss: 0.9708 -
acc: 0.8500
Epoch 19/20
80/80 [==============================] - 0s 186us/step - loss: 0.9470 -
acc: 0.8625
Epoch 20/20
80/80 [==============================] - 0s 201us/step - loss: 0.9278 -
acc: 0.8750
20/20 [==============================] - 2s 80ms/step
80/80 [==============================] - 0s 197us/step
Epoch 1/20
```

```
80/80 [==============================] - 4s 49ms/step - loss: 1.9790 -
 acc: 0.3000
Epoch 2/20
80/80 [==============================] - 0s 198us/step - loss: 1.7654 -
acc: 0.3500
Epoch 3/20
80/80 [==============================] - 0s 203us/step - loss: 1.6501 -
acc: 0.7625
Epoch 4/20
80/80 [==============================] - 0s 203us/step - loss: 1.5837 -
acc: 0.5750
Epoch 5/20
80/80 [==============================] - 0s 197us/step - loss: 1.5449 -
acc: 0.4375
Epoch 6/20
80/80 [==============================] - 0s 252us/step - loss: 1.5023 -
acc: 0.4750
Epoch 7/20
80/80 [==============================] - 0s 220us/step - loss: 1.4517 -
acc: 0.6375
Epoch 8/20
80/80 [==============================] - 0s 194us/step - loss: 1.4060 -
acc: 0.6500
Epoch 9/20
80/80 [==============================] - 0s 188us/step - loss: 1.3574 -
acc: 0.6625
Epoch 10/20
80/80 [==============================] - 0s 188us/step - loss: 1.3154 -
acc: 0.7750
Epoch 11/20
80/80 [==============================] - 0s 181us/step - loss: 1.2728 -
acc: 0.8500
Epoch 12/20
80/80 [==============================] - 0s 189us/step - loss: 1.2342 -
acc: 0.7375
Epoch 13/20
80/80 [==============================] - 0s 190us/step - loss: 1.1940 -
acc: 0.7875
Epoch 14/20
80/80 [==============================] - 0s 197us/step - loss: 1.1549 -
acc: 0.8000
Epoch 15/20
80/80 [==============================] - 0s 179us/step - loss: 1.1156 -
acc: 0.8250
Epoch 16/20
80/80 [==============================] - 0s 195us/step - loss: 1.0787 -
acc: 0.8500
Epoch 17/20
80/80 [==============================] - 0s 191us/step - loss: 1.0459 -
acc: 0.8500
Epoch 18/20
80/80 [==============================] - 0s 199us/step - loss: 1.0144 -
acc: 0.8625
Epoch 19/20
80/80 [==============================] - 0s 208us/step - loss: 0.9852 -
acc: 0.9000
Epoch 20/20
```

```
80/80 [==============================] - 0s 218us/step - loss: 0.9561 -
acc: 0.9250
20/20 [==============================] - 2s 82ms/step
80/80 [==============================] - 0s 165us/step
Epoch 1/20
80/80 [==============================] - 4s 49ms/step - loss: 2.1049 -
 acc: 0.3750
Epoch 2/20
80/80 [==============================] - 0s 204us/step - loss: 1.8649 -
acc: 0.3750
Epoch 3/20
80/80 [==============================] - 0s 195us/step - loss: 1.7469 -
acc: 0.3625
Epoch 4/20
80/80 [==============================] - 0s 175us/step - loss: 1.6797 -
acc: 0.3750
Epoch 5/20
80/80 [==============================] - 0s 208us/step - loss: 1.6364 -
acc: 0.5250
Epoch 6/20
80/80 [==============================] - 0s 183us/step - loss: 1.5849 -
acc: 0.5875
Epoch 7/20
80/80 [==============================] - 0s 187us/step - loss: 1.5240 -
acc: 0.6125
Epoch 8/20
80/80 [==============================] - 0s 201us/step - loss: 1.4716 -
acc: 0.7000
Epoch 9/20
80/80 [==============================] - 0s 181us/step - loss: 1.4257 -
acc: 0.9500
Epoch 10/20
80/80 [==============================] - 0s 188us/step - loss: 1.3838 -
acc: 0.9250
Epoch 11/20
80/80 [==============================] - 0s 192us/step - loss: 1.3384 -
acc: 0.9625
Epoch 12/20
80/80 [==============================] - 0s 193us/step - loss: 1.2935 -
acc: 0.9875
Epoch 13/20
80/80 [==============================] - 0s 179us/step - loss: 1.2516 -
acc: 0.8625
Epoch 14/20
80/80 [==============================] - 0s 241us/step - loss: 1.2181 -
acc: 0.7125
Epoch 15/20
80/80 [==============================] - 0s 232us/step - loss: 1.1795 -
acc: 0.7375
Epoch 16/20
80/80 [==============================] - 0s 187us/step - loss: 1.1380 -
acc: 0.8500
Epoch 17/20
80/80 [==============================] - 0s 204us/step - loss: 1.1012 -
acc: 0.9375
Epoch 18/20
80/80 [==============================] - 0s 220us/step - loss: 1.0670 -
```

```
acc: 0.9750
Epoch 19/20
80/80 [==============================] - 0s 183us/step - loss: 1.0335 -
acc: 0.9750
Epoch 20/20
80/80 [==============================] - 0s 203us/step - loss: 0.9990 -
acc: 0.9625
20/20 [==============================] - 2s 84ms/step
80/80 [==============================] - 0s 179us/step
Epoch 1/20
80/80 [==============================] - 4s 50ms/step - loss: 1.9932 -
 acc: 0.3125
Epoch 2/20
80/80 [==============================] - 0s 217us/step - loss: 1.7448 -
acc: 0.3125
Epoch 3/20
80/80 [==============================] - 0s 188us/step - loss: 1.5949 -
acc: 0.4875
Epoch 4/20
80/80 [==============================] - 0s 187us/step - loss: 1.5172 -
acc: 0.6875
Epoch 5/20
80/80 [==============================] - 0s 186us/step - loss: 1.4728 -
acc: 0.6875
Epoch 6/20
80/80 [==============================] - 0s 182us/step - loss: 1.4289 -
acc: 0.6875
Epoch 7/20
80/80 [==============================] - 0s 185us/step - loss: 1.3750 -
acc: 0.6875
Epoch 8/20
80/80 [==============================] - 0s 185us/step - loss: 1.3201 -
acc: 0.6875
Epoch 9/20
80/80 [==============================] - 0s 188us/step - loss: 1.2647 -
acc: 0.7000
Epoch 10/20
80/80 [==============================] - 0s 186us/step - loss: 1.2147 -
acc: 0.7000
Epoch 11/20
80/80 [==============================] - 0s 222us/step - loss: 1.1700 -
acc: 0.7625
Epoch 12/20
80/80 [==============================] - 0s 211us/step - loss: 1.1293 -
acc: 0.8250
Epoch 13/20
80/80 [==============================] - 0s 210us/step - loss: 1.0922 -
acc: 0.8250
Epoch 14/20
80/80 [==============================] - 0s 239us/step - loss: 1.0556 -
acc: 0.8250
Epoch 15/20
80/80 [==============================] - 0s 216us/step - loss: 1.0212 -
acc: 0.8375
Epoch 16/20
80/80 [==============================] - 0s 183us/step - loss: 0.9907 -
acc: 0.8875
```

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Epoch 17/20
80/80 [==============================] - 0s 217us/step - loss: 0.9602 -
acc: 0.9000
Epoch 18/20
80/80 [==============================] - 0s 203us/step - loss: 0.9334 -
acc: 0.8875
Epoch 19/20
80/80 [==============================] - 0s 184us/step - loss: 0.9077 -
acc: 0.8750
Epoch 20/20
80/80 [==============================] - 0s 196us/step - loss: 0.8825 -
acc: 0.8875
20/20 [==============================] - 2s 86ms/step
80/80 [==============================] - 0s 153us/step
Epoch 1/20
80/80 [==============================] - 4s 52ms/step - loss: 2.4856 -
 acc: 0.6000
Epoch 2/20
80/80 [==============================] - 0s 211us/step - loss: 2.0688 -
acc: 0.6375
Epoch 3/20
80/80 [==============================] - 0s 182us/step - loss: 1.7627 -
acc: 0.6375
Epoch 4/20
80/80 [==============================] - 0s 195us/step - loss: 1.5630 -
acc: 0.6375
Epoch 5/20
80/80 [==============================] - 0s 198us/step - loss: 1.4778 -
acc: 0.7375
Epoch 6/20
80/80 [==============================] - 0s 196us/step - loss: 1.4195 -
acc: 0.7125
Epoch 7/20
80/80 [==============================] - 0s 222us/step - loss: 1.3796 -
acc: 0.7000
Epoch 8/20
80/80 [==============================] - 0s 203us/step - loss: 1.3255 -
acc: 0.7125
Epoch 9/20
80/80 [==============================] - 0s 195us/step - loss: 1.2619 -
acc: 0.8375
Epoch 10/20
80/80 [==============================] - 0s 310us/step - loss: 1.2019 -
acc: 0.9250
Epoch 11/20
80/80 [==============================] - 0s 179us/step - loss: 1.1481 -
acc: 0.9250
Epoch 12/20
80/80 [==============================] - 0s 203us/step - loss: 1.1074 -
acc: 0.9125
Epoch 13/20
80/80 [==============================] - 0s 203us/step - loss: 1.0740 -
acc: 0.9000
Epoch 14/20
80/80 [==============================] - 0s 187us/step - loss: 1.0452 -
acc: 0.8875
Epoch 15/20
```

```
80/80 [==============================] - 0s 218us/step - loss: 1.0173 -
acc: 0.8500
Epoch 16/20
80/80 [==============================] - 0s 223us/step - loss: 0.9873 -
acc: 0.9000
Epoch 17/20
80/80 [==============================] - 0s 233us/step - loss: 0.9588 -
acc: 0.9250
Epoch 18/20
80/80 [==============================] - 0s 213us/step - loss: 0.9342 -
acc: 0.9375
Epoch 19/20
80/80 [==============================] - 0s 231us/step - loss: 0.9147 -
acc: 0.9125
Epoch 20/20
80/80 [==============================] - 0s 207us/step - loss: 0.8918 -
acc: 0.9500
20/20 [==============================] - 2s 86ms/step
80/80 [==============================] - 0s 177us/step
Epoch 1/20
80/80 [==============================] - 4s 52ms/step - loss: 70.2107 -
acc: 0.0875
Epoch 2/20
80/80 [==============================] - 0s 186us/step - loss: 67.3639
 - acc: 0.0000e+00
Epoch 3/20
80/80 [==============================] - 0s 185us/step - loss: 64.6299
 - acc: 0.0875
Epoch 4/20
80/80 [==============================] - 0s 204us/step - loss: 61.9956
 - acc: 0.3500
Epoch 5/20
80/80 [==============================] - 0s 191us/step - loss: 59.4568
 - acc: 0.3750
Epoch 6/20
80/80 [==============================] - 0s 202us/step - loss: 57.0078
 - acc: 0.3750
Epoch 7/20
80/80 [==============================] - 0s 205us/step - loss: 54.6429
 - acc: 0.3750
Epoch 8/20
80/80 [==============================] - 0s 192us/step - loss: 52.3634
 - acc: 0.3750
Epoch 9/20
80/80 [==============================] - 0s 197us/step - loss: 50.1678
 - acc: 0.3750
Epoch 10/20
80/80 [==============================] - 0s 189us/step - loss: 48.0554
 - acc: 0.3750
Epoch 11/20
80/80 [==============================] - 0s 192us/step - loss: 46.0242
 - acc: 0.3750
Epoch 12/20
80/80 [==============================] - 0s 204us/step - loss: 44.0736
 - acc: 0.3750
Epoch 13/20
80/80 [==============================] - 0s 228us/step - loss: 42.1993
```

```
 - acc: 0.3750
Epoch 14/20
80/80 [==============================] - 0s 217us/step - loss: 40.4001
 - acc: 0.3750
Epoch 15/20
80/80 [==============================] - 0s 230us/step - loss: 38.6730
 - acc: 0.3875
Epoch 16/20
80/80 [==============================] - 0s 200us/step - loss: 37.0159
 - acc: 0.4375
Epoch 17/20
80/80 [==============================] - 0s 202us/step - loss: 35.4260
 - acc: 0.4875
Epoch 18/20
80/80 [==============================] - 0s 209us/step - loss: 33.9006
 - acc: 0.5250
Epoch 19/20
80/80 [==============================] - 0s 213us/step - loss: 32.4392
 - acc: 0.6125
Epoch 20/20
80/80 [==============================] - 0s 208us/step - loss: 31.0378
 - acc: 0.6375
20/20 [==============================] - 2s 88ms/step
80/80 [==============================] - 0s 162us/step
Epoch 1/20
80/80 [==============================] - 4s 53ms/step - loss: 73.0291 -
acc: 0.3500
Epoch 2/20
80/80 [==============================] - 0s 199us/step - loss: 70.1400
 - acc: 0.5750
Epoch 3/20
80/80 [==============================] - 0s 271us/step - loss: 67.3565
 - acc: 0.5500
Epoch 4/20
80/80 [==============================] - 0s 201us/step - loss: 64.6693
 - acc: 0.3875
Epoch 5/20
80/80 [==============================] - 0s 198us/step - loss: 62.0620
 - acc: 0.3625
Epoch 6/20
80/80 [==============================] - 0s 190us/step - loss: 59.5419
 - acc: 0.3750
Epoch 7/20
80/80 [==============================] - 0s 182us/step - loss: 57.1086
 - acc: 0.3875
Epoch 8/20
80/80 [==============================] - 0s 180us/step - loss: 54.7593
 - acc: 0.4125
Epoch 9/20
80/80 [==============================] - 0s 206us/step - loss: 52.4948
 - acc: 0.4125
Epoch 10/20
80/80 [==============================] - 0s 197us/step - loss: 50.3161
 - acc: 0.4625
Epoch 11/20
80/80 [==============================] - 0s 215us/step - loss: 48.2173
 - acc: 0.4750
```

```
Epoch 12/20
80/80 [==============================] - 0s 199us/step - loss: 46.1979
 - acc: 0.4625
Epoch 13/20
80/80 [==============================] - 0s 197us/step - loss: 44.2574
 - acc: 0.4125
Epoch 14/20
80/80 [==============================] - 0s 205us/step - loss: 42.3941
 - acc: 0.3750
Epoch 15/20
80/80 [==============================] - 0s 184us/step - loss: 40.6016
 - acc: 0.3750
Epoch 16/20
80/80 [==============================] - 0s 242us/step - loss: 38.8799
 - acc: 0.4000
Epoch 17/20
80/80 [==============================] - 0s 184us/step - loss: 37.2280
 - acc: 0.4125
Epoch 18/20
80/80 [==============================] - 0s 236us/step - loss: 35.6415
 - acc: 0.4625
Epoch 19/20
80/80 [==============================] - 0s 203us/step - loss: 34.1193
 - acc: 0.4875
Epoch 20/20
80/80 [==============================] - 0s 204us/step - loss: 32.6592
 - acc: 0.5250
20/20 [==============================] - 2s 90ms/step
80/80 [==============================] - 0s 189us/step
Epoch 1/20
80/80 [==============================] - 4s 54ms/step - loss: 69.7794 -
acc: 0.3250
Epoch 2/20
80/80 [==============================] - 0s 205us/step - loss: 66.9786
 - acc: 0.3250
Epoch 3/20
80/80 [==============================] - 0s 178us/step - loss: 64.2710
 - acc: 0.3250
Epoch 4/20
80/80 [==============================] - 0s 191us/step - loss: 61.6476
 - acc: 0.3250
Epoch 5/20
80/80 [==============================] - 0s 192us/step - loss: 59.1143
 - acc: 0.3250
Epoch 6/20
80/80 [==============================] - 0s 198us/step - loss: 56.6706
 - acc: 0.3250
Epoch 7/20
80/80 [==============================] - 0s 185us/step - loss: 54.3145
 - acc: 0.3250
Epoch 8/20
80/80 [==============================] - 0s 198us/step - loss: 52.0432
 - acc: 0.3250
Epoch 9/20
80/80 [==============================] - 0s 196us/step - loss: 49.8570
 - acc: 0.3250
Epoch 10/20
```

```
80/80 [==============================] - 0s 199us/step - loss: 47.7529
 - acc: 0.3250
Epoch 11/20
80/80 [==============================] - 0s 225us/step - loss: 45.7316
 - acc: 0.3250
Epoch 12/20
80/80 [==============================] - 0s 202us/step - loss: 43.7850
 - acc: 0.3250
Epoch 13/20
80/80 [==============================] - 0s 238us/step - loss: 41.9163
 - acc: 0.3250
Epoch 14/20
80/80 [==============================] - 0s 187us/step - loss: 40.1212
 - acc: 0.4500
Epoch 15/20
80/80 [==============================] - 0s 210us/step - loss: 38.3999
 - acc: 0.6125
Epoch 16/20
80/80 [==============================] - 0s 193us/step - loss: 36.7495
 - acc: 0.7000
Epoch 17/20
80/80 [==============================] - 0s 186us/step - loss: 35.1659
 - acc: 0.7625
Epoch 18/20
80/80 [==============================] - 0s 210us/step - loss: 33.6486
 - acc: 0.8125
Epoch 19/20
80/80 [==============================] - 0s 186us/step - loss: 32.1920
 - acc: 0.8875
Epoch 20/20
80/80 [==============================] - 0s 244us/step - loss: 30.7959
 - acc: 0.8875
20/20 [==============================] - 2s 91ms/step
80/80 [==============================] - 0s 161us/step
Epoch 1/20
80/80 [==============================] - 4s 55ms/step - loss: 70.2370 -
acc: 0.3375
Epoch 2/20
80/80 [==============================] - 0s 204us/step - loss: 67.4064
 - acc: 0.3875
Epoch 3/20
80/80 [==============================] - 0s 184us/step - loss: 64.6786
 - acc: 0.3500
Epoch 4/20
80/80 [==============================] - 0s 190us/step - loss: 62.0387
 - acc: 0.3500
Epoch 5/20
80/80 [==============================] - 0s 188us/step - loss: 59.4912
 - acc: 0.3500
Epoch 6/20
80/80 [==============================] - 0s 193us/step - loss: 57.0326
 - acc: 0.3500
Epoch 7/20
80/80 [==============================] - 0s 190us/step - loss: 54.6663
 - acc: 0.5625
Epoch 8/20
80/80 [==============================] - 0s 188us/step - loss: 52.3813
```

```
 - acc: 0.6875
Epoch 9/20
80/80 [==============================] - 0s 183us/step - loss: 50.1837
 - acc: 0.6875
Epoch 10/20
80/80 [==============================] - 0s 178us/step - loss: 48.0689
 - acc: 0.6875
Epoch 11/20
80/80 [==============================] - 0s 203us/step - loss: 46.0358
 - acc: 0.6875
Epoch 12/20
80/80 [==============================] - 0s 187us/step - loss: 44.0807
 - acc: 0.6875
Epoch 13/20
80/80 [==============================] - 0s 241us/step - loss: 42.2026
 - acc: 0.6875
Epoch 14/20
80/80 [==============================] - 0s 207us/step - loss: 40.4008
 - acc: 0.6875
Epoch 15/20
80/80 [==============================] - 0s 202us/step - loss: 38.6708
 - acc: 0.6875
Epoch 16/20
80/80 [==============================] - 0s 202us/step - loss: 37.0102
 - acc: 0.6875
Epoch 17/20
80/80 [==============================] - 0s 222us/step - loss: 35.4179
 - acc: 0.6875
Epoch 18/20
80/80 [==============================] - 0s 231us/step - loss: 33.8912
 - acc: 0.6875
Epoch 19/20
80/80 [==============================] - 0s 253us/step - loss: 32.4260
 - acc: 0.6875
Epoch 20/20
80/80 [==============================] - 0s 202us/step - loss: 31.0215
 - acc: 0.6875
20/20 [==============================] - 2s 93ms/step
80/80 [==============================] - 0s 174us/step
Epoch 1/20
80/80 [==============================] - 4s 56ms/step - loss: 71.9242 -
acc: 0.3375
Epoch 2/20
80/80 [==============================] - 0s 212us/step - loss: 69.0206
 - acc: 0.3375
Epoch 3/20
80/80 [==============================] - 0s 214us/step - loss: 66.2551
 - acc: 0.3375
Epoch 4/20
80/80 [==============================] - 0s 221us/step - loss: 63.5945
 - acc: 0.3500
Epoch 5/20
80/80 [==============================] - 0s 221us/step - loss: 61.0200
 - acc: 0.7375
Epoch 6/20
80/80 [==============================] - 0s 227us/step - loss: 58.5368
 - acc: 0.8375
```

```
Epoch 7/20
80/80 [==============================] - 0s 225us/step - loss: 56.1415
 - acc: 0.9125
Epoch 8/20
80/80 [==============================] - 0s 242us/step - loss: 53.8301
 - acc: 0.9125
Epoch 9/20
80/80 [==============================] - 0s 230us/step - loss: 51.6016
 - acc: 0.9250
Epoch 10/20
80/80 [==============================] - 0s 226us/step - loss: 49.4551
 - acc: 0.9500
Epoch 11/20
80/80 [==============================] - 0s 212us/step - loss: 47.3887
 - acc: 0.9500
Epoch 12/20
80/80 [==============================] - 0s 242us/step - loss: 45.4017
 - acc: 0.9375
Epoch 13/20
80/80 [==============================] - 0s 219us/step - loss: 43.4922
 - acc: 0.9000
Epoch 14/20
80/80 [==============================] - 0s 233us/step - loss: 41.6580
 - acc: 0.8500
Epoch 15/20
80/80 [==============================] - 0s 243us/step - loss: 39.8964
 - acc: 0.8375
Epoch 16/20
80/80 [==============================] - 0s 234us/step - loss: 38.2052
 - acc: 0.8625
Epoch 17/20
80/80 [==============================] - 0s 283us/step - loss: 36.5813
 - acc: 0.9125
Epoch 18/20
80/80 [==============================] - 0s 265us/step - loss: 35.0242
 - acc: 0.8375
Epoch 19/20
80/80 [==============================] - 0s 243us/step - loss: 33.5290
 - acc: 0.8375
Epoch 20/20
80/80 [==============================] - 0s 242us/step - loss: 32.0936
 - acc: 0.8875
20/20 [==============================] - 2s 101ms/step
80/80 [==============================] - 0s 177us/step
Epoch 1/20
80/80 [==============================] - 5s 60ms/step - loss: 706.8058
 - acc: 0.2500
Epoch 2/20
80/80 [==============================] - 0s 210us/step - loss: 678.3901
- acc: 0.1125
Epoch 3/20
80/80 [==============================] - 0s 230us/step - loss: 650.8144
- acc: 0.3750
Epoch 4/20
80/80 [==============================] - 0s 212us/step - loss: 624.0989
- acc: 0.3750
Epoch 5/20
```

```
80/80 [==============================] - 0s 259us/step - loss: 598.2416
- acc: 0.3750
Epoch 6/20
80/80 [==============================] - 0s 237us/step - loss: 573.2491
- acc: 0.3750
Epoch 7/20
80/80 [==============================] - 0s 240us/step - loss: 549.1260
- acc: 0.3750
Epoch 8/20
80/80 [==============================] - 0s 228us/step - loss: 525.8583
- acc: 0.3750
Epoch 9/20
80/80 [==============================] - 0s 219us/step - loss: 503.4431
- acc: 0.3750
Epoch 10/20
80/80 [==============================] - 0s 224us/step - loss: 481.8613
- acc: 0.3750
Epoch 11/20
80/80 [==============================] - 0s 252us/step - loss: 461.0987
- acc: 0.3875
Epoch 12/20
80/80 [==============================] - 0s 229us/step - loss: 441.1354
- acc: 0.3750
Epoch 13/20
80/80 [==============================] - 0s 222us/step - loss: 421.9492
- acc: 0.3875
Epoch 14/20
80/80 [==============================] - 0s 218us/step - loss: 403.5188
- acc: 0.3875
Epoch 15/20
80/80 [==============================] - 0s 242us/step - loss: 385.8219
- acc: 0.4125
Epoch 16/20
80/80 [==============================] - 0s 226us/step - loss: 368.8340
- acc: 0.4375
Epoch 17/20
80/80 [==============================] - 0s 241us/step - loss: 352.5325
- acc: 0.4625
Epoch 18/20
80/80 [==============================] - 0s 280us/step - loss: 336.8941
- acc: 0.4125
Epoch 19/20
80/80 [==============================] - 0s 229us/step - loss: 321.8937
- acc: 0.4125
Epoch 20/20
80/80 [==============================] - 0s 220us/step - loss: 307.5097
- acc: 0.4250
20/20 [==============================] - 2s 98ms/step
80/80 [==============================] - 0s 191us/step
Epoch 1/20
80/80 [==============================] - 5s 57ms/step - loss: 691.3217
 - acc: 0.3500
Epoch 2/20
80/80 [==============================] - 0s 221us/step - loss: 663.4172
- acc: 0.3500
Epoch 3/20
80/80 [==============================] - 0s 209us/step - loss: 636.3431
```

```
- acc: 0.3500
Epoch 4/20
80/80 [==============================] - 0s 198us/step - loss: 610.1106
- acc: 0.3875
Epoch 5/20
80/80 [==============================] - 0s 179us/step - loss: 584.7327
- acc: 0.3125
Epoch 6/20
80/80 [==============================] - 0s 189us/step - loss: 560.2124
- acc: 0.3000
Epoch 7/20
80/80 [==============================] - 0s 195us/step - loss: 536.5440
- acc: 0.3500
Epoch 8/20
80/80 [==============================] - 0s 196us/step - loss: 513.7250
- acc: 0.3500
Epoch 9/20
80/80 [==============================] - 0s 191us/step - loss: 491.7431
- acc: 0.3625
Epoch 10/20
80/80 [==============================] - 0s 197us/step - loss: 470.5864
- acc: 0.4125
Epoch 11/20
80/80 [==============================] - 0s 185us/step - loss: 450.2389
- acc: 0.4875
Epoch 12/20
80/80 [==============================] - 0s 182us/step - loss: 430.6810
- acc: 0.5500
Epoch 13/20
80/80 [==============================] - 0s 211us/step - loss: 411.8924
- acc: 0.6000
Epoch 14/20
80/80 [==============================] - 0s 203us/step - loss: 393.8502
- acc: 0.6125
Epoch 15/20
80/80 [==============================] - 0s 191us/step - loss: 376.5325
- acc: 0.6125
Epoch 16/20
80/80 [==============================] - 0s 199us/step - loss: 359.9149
- acc: 0.6250
Epoch 17/20
80/80 [==============================] - 0s 232us/step - loss: 343.9740
- acc: 0.6250
Epoch 18/20
80/80 [==============================] - 0s 198us/step - loss: 328.6858
- acc: 0.6500
Epoch 19/20
80/80 [==============================] - 0s 193us/step - loss: 314.0264
- acc: 0.6500
Epoch 20/20
80/80 [==============================] - 0s 194us/step - loss: 299.9727
- acc: 0.6500
20/20 [==============================] - 2s 96ms/step
80/80 [==============================] - 0s 186us/step
Epoch 1/20
80/80 [==============================] - 5s 58ms/step - loss: 703.2223
 - acc: 0.3000
```

```
Epoch 2/20
80/80 [==============================] - 0s 201us/step - loss: 674.8236
- acc: 0.3000
Epoch 3/20
80/80 [==============================] - 0s 195us/step - loss: 647.2566
- acc: 0.3000
Epoch 4/20
80/80 [==============================] - 0s 200us/step - loss: 620.5562
- acc: 0.3000
Epoch 5/20
80/80 [==============================] - 0s 191us/step - loss: 594.7323
- acc: 0.3000
Epoch 6/20
80/80 [==============================] - 0s 183us/step - loss: 569.7690
- acc: 0.3000
Epoch 7/20
80/80 [==============================] - 0s 204us/step - loss: 545.6937
- acc: 0.3000
Epoch 8/20
80/80 [==============================] - 0s 173us/step - loss: 522.4793
- acc: 0.3000
Epoch 9/20
80/80 [==============================] - 0s 181us/step - loss: 500.1331
- acc: 0.3000
Epoch 10/20
80/80 [==============================] - 0s 190us/step - loss: 478.6361
- acc: 0.3000
Epoch 11/20
80/80 [==============================] - 0s 187us/step - loss: 457.9660
- acc: 0.3000
Epoch 12/20
80/80 [==============================] - 0s 202us/step - loss: 438.1143
- acc: 0.3000
Epoch 13/20
80/80 [==============================] - 0s 207us/step - loss: 419.0406
- acc: 0.3000
Epoch 14/20
80/80 [==============================] - 0s 226us/step - loss: 400.7379
- acc: 0.3000
Epoch 15/20
80/80 [==============================] - 0s 198us/step - loss: 383.1745
- acc: 0.3000
Epoch 16/20
80/80 [==============================] - 0s 268us/step - loss: 366.3226
- acc: 0.3000
Epoch 17/20
80/80 [==============================] - 0s 220us/step - loss: 350.1620
- acc: 0.3000
Epoch 18/20
80/80 [==============================] - 0s 201us/step - loss: 334.6618
- acc: 0.3000
Epoch 19/20
80/80 [==============================] - 0s 179us/step - loss: 319.8044
- acc: 0.3000
Epoch 20/20
80/80 [==============================] - 0s 186us/step - loss: 305.5595
- acc: 0.3000
```

```
20/20 [==============================] - 2s 99ms/step
80/80 [==============================] - 0s 263us/step
Epoch 1/20
80/80 [==============================] - 5s 60ms/step - loss: 709.0317
 - acc: 0.3375
Epoch 2/20
80/80 [==============================] - 0s 226us/step - loss: 680.6611
- acc: 0.3375
Epoch 3/20
80/80 [==============================] - 0s 194us/step - loss: 653.1434
- acc: 0.3375
Epoch 4/20
80/80 [==============================] - 0s 185us/step - loss: 626.4932
- acc: 0.3375
Epoch 5/20
80/80 [==============================] - 0s 184us/step - loss: 600.7070
- acc: 0.3375
Epoch 6/20
80/80 [==============================] - 0s 207us/step - loss: 575.7986
- acc: 0.3375
Epoch 7/20
80/80 [==============================] - 0s 210us/step - loss: 551.7625
- acc: 0.3375
Epoch 8/20
80/80 [==============================] - 0s 230us/step - loss: 528.5899
- acc: 0.3375
Epoch 9/20
80/80 [==============================] - 0s 197us/step - loss: 506.2686
- acc: 0.4375
Epoch 10/20
80/80 [==============================] - 0s 204us/step - loss: 484.7817
- acc: 0.5875
Epoch 11/20
80/80 [==============================] - 0s 194us/step - loss: 464.1144
- acc: 0.6750
Epoch 12/20
80/80 [==============================] - 0s 243us/step - loss: 444.2442
- acc: 0.6875
Epoch 13/20
80/80 [==============================] - 0s 230us/step - loss: 425.1503
- acc: 0.6875
Epoch 14/20
80/80 [==============================] - 0s 201us/step - loss: 406.8082
- acc: 0.6875
Epoch 15/20
80/80 [==============================] - 0s 214us/step - loss: 389.1943
- acc: 0.6875
Epoch 16/20
80/80 [==============================] - 0s 218us/step - loss: 372.2872
- acc: 0.6875
Epoch 17/20
80/80 [==============================] - 0s 211us/step - loss: 356.0594
- acc: 0.6875
Epoch 18/20
80/80 [==============================] - 0s 232us/step - loss: 340.4877
- acc: 0.6875
Epoch 19/20
```

```
80/80 [==============================] - 0s 219us/step - loss: 325.5493
- acc: 0.6875
Epoch 20/20
80/80 [==============================] - 0s 235us/step - loss: 311.2205
- acc: 0.6875
20/20 [==============================] - 2s 100ms/step
80/80 [==============================] - 0s 186us/step
Epoch 1/20
80/80 [==============================] - 5s 60ms/step - loss: 711.9192
 - acc: 0.3375
Epoch 2/20
80/80 [==============================] - 0s 202us/step - loss: 683.4269
- acc: 0.3375
Epoch 3/20
80/80 [==============================] - 0s 202us/step - loss: 655.7820
- acc: 0.3375
Epoch 4/20
80/80 [==============================] - 0s 209us/step - loss: 628.9940
- acc: 0.3375
Epoch 5/20
80/80 [==============================] - 0s 199us/step - loss: 603.0827
- acc: 0.3375
Epoch 6/20
80/80 [==============================] - 0s 206us/step - loss: 578.0469
- acc: 0.3375
Epoch 7/20
80/80 [==============================] - 0s 199us/step - loss: 553.8836
- acc: 0.3375
Epoch 8/20
80/80 [==============================] - 0s 210us/step - loss: 530.5841
- acc: 0.3375
Epoch 9/20
80/80 [==============================] - 0s 215us/step - loss: 508.1363
- acc: 0.3375
Epoch 10/20
80/80 [==============================] - 0s 235us/step - loss: 486.5273
- acc: 0.3500
Epoch 11/20
80/80 [==============================] - 0s 217us/step - loss: 465.7420
- acc: 0.4000
Epoch 12/20
80/80 [==============================] - 0s 211us/step - loss: 445.7569
- acc: 0.5125
Epoch 13/20
80/80 [==============================] - 0s 241us/step - loss: 426.5491
- acc: 0.6125
Epoch 14/20
80/80 [==============================] - 0s 254us/step - loss: 408.0984
- acc: 0.6500
Epoch 15/20
80/80 [==============================] - 0s 198us/step - loss: 390.3826
- acc: 0.6875
Epoch 16/20
80/80 [==============================] - 0s 193us/step - loss: 373.3759
- acc: 0.7000
Epoch 17/20
80/80 [==============================] - 0s 210us/step - loss: 357.0559
```

```
- acc: 0.6875
Epoch 18/20
80/80 [==============================] - 0s 229us/step - loss: 341.3973
- acc: 0.6875
Epoch 19/20
80/80 [==============================] - 0s 178us/step - loss: 326.3778
- acc: 0.7125
Epoch 20/20
80/80 [==============================] - 0s 194us/step - loss: 311.9704
- acc: 0.7125
20/20 [==============================] - 2s 101ms/step
80/80 [==============================] - 0s 186us/step
Epoch 1/20
100/100 [==============================] - 5s 49ms/step - loss: 1.7120
 - acc: 0.6400
Epoch 2/20
100/100 [==============================] - 0s 203us/step - loss: 1.5594
- acc: 0.8100
Epoch 3/20
100/100 [==============================] - 0s 218us/step - loss: 1.4724
- acc: 0.6500
Epoch 4/20
100/100 [==============================] - 0s 211us/step - loss: 1.4047
- acc: 0.6400
Epoch 5/20
100/100 [==============================] - 0s 262us/step - loss: 1.3385
- acc: 0.6500
Epoch 6/20
100/100 [==============================] - 0s 203us/step - loss: 1.2658
- acc: 0.6500
Epoch 7/20
100/100 [==============================] - 0s 187us/step - loss: 1.1948
- acc: 0.6500
Epoch 8/20
100/100 [==============================] - 0s 195us/step - loss: 1.1352
- acc: 0.6500
Epoch 9/20
100/100 [==============================] - 0s 199us/step - loss: 1.0833
- acc: 0.7500
Epoch 10/20
100/100 [==============================] - 0s 216us/step - loss: 1.0372
- acc: 0.9000
Epoch 11/20
100/100 [==============================] - 0s 233us/step - loss: 0.9996
- acc: 0.9800
Epoch 12/20
100/100 [==============================] - 0s 211us/step - loss: 0.9674
- acc: 0.9200
Epoch 13/20
100/100 [==============================] - 0s 178us/step - loss: 0.9390
- acc: 0.8700
Epoch 14/20
100/100 [==============================] - 0s 210us/step - loss: 0.9086
- acc: 0.8500
Epoch 15/20
100/100 [==============================] - 0s 182us/step - loss: 0.8756
- acc: 0.9200
```

```
Epoch 16/20
100/100 [==============================] - 0s 191us/step - loss: 0.8426
- acc: 0.9700
Epoch 17/20
100/100 [==============================] - 0s 193us/step - loss: 0.8204
- acc: 0.9000
Epoch 18/20
100/100 [==============================] - 0s 195us/step - loss: 0.7951
- acc: 0.9000
Epoch 19/20
100/100 [==============================] - 0s 196us/step - loss: 0.7701
- acc: 0.9500
Epoch 20/20
100/100 [==============================] - 0s 200us/step - loss: 0.7497
- acc: 0.9300
```

Out[7]:
```
GridSearchCV(cv=5, error_score='raise-deprecating',
       estimator=<keras.wrappers.scikit_learn.KerasClassifier object at
0x7fd80d9c7080>,
       fit_params=None, iid='warn', n_jobs=None,
       param_grid={'strength': [0.001, 0.01, 1, 10], 'hidden': [8, 16,
32, 64]},
       pre_dispatch='2*n_jobs', refit=True, return_train_score='warn',
       scoring=None, verbose=0)
```

In [8]:
```
print("Results of Grid Search")
print("Best accuracy score")
print(grid.best_score_)
print("Best parameters")
print(grid.best_params_)
```

```
Results of Grid Search
Best accuracy score
0.9
Best parameters
{'hidden': 64, 'strength': 0.01}
```

We get best parameters as - no of hidden units -64 and regularization strength- 0.01

Evaluation on independent test set

In [9]:
```
ypred = grid.predict(X_test)
y_test = [numpy.argmax(y, axis=None, out=None) for y in y_test]
print("Accuracy score on test set")
print(accuracy_score(ypred,y_test))
```

```
Accuracy score on test set
0.94
```

TASK 2

Read Fashion MNIST dataset

In [11]:
```
((trainX, trainY), (testX, testY)) = fashion_mnist.load_data()
```

```
Downloading data from http://fashion-mnist.s3-website.eu-central-1.amaz
onaws.com/train-labels-idx1-ubyte.gz
32768/29515 [================================] - 0s 4us/step
Downloading data from http://fashion-mnist.s3-website.eu-central-1.amaz
onaws.com/train-images-idx3-ubyte.gz
26427392/26421880 [==============================] - 2s 0us/step
Downloading data from http://fashion-mnist.s3-website.eu-central-1.amaz
onaws.com/t10k-labels-idx1-ubyte.gz
8192/5148 [===============================================] - 0s 0us/st
ep
Downloading data from http://fashion-mnist.s3-website.eu-central-1.amaz
onaws.com/t10k-images-idx3-ubyte.gz
4423680/4422102 [==============================] - 1s 0us/step
```

In [0]:
```
X_train = trainX.reshape(trainX.shape[0], 28, 28)
X_test = testX.reshape(testX.shape[0], 28, 28)
input_shape = (28, 28)
X_train = X_train.astype('float32')
X_test = X_test.astype('float32')

y_train = np_utils.to_categorical(trainY, 10)
y_test = np_utils.to_categorical(testY, 10)
```

Model 1. Vanilla model - multilayer perceptron. We use separate 10000 samples for model selection

In [0]:
```
def baseline_model():
  model = Sequential()
  model.add(Dense(64, input_shape=input_shape, activation='tanh'))
  model.add(Flatten())
  model.add(Dense(10, activation='softmax'))
  model.compile(loss='categorical_crossentropy', optimizer='adam', metri
cs=['accuracy'])
  return model
```

In [0]:
```
estimator = KerasClassifier(build_fn=baseline_model)
```

In [15]:
```
history = estimator.fit(X_train, y_train, epochs=100, verbose=1,
          validation_split=10/60)
```

```
Train on 50000 samples, validate on 10000 samples
Epoch 1/100
50000/50000 [==============================] - 13s 255us/step - loss:
0.5381 - acc: 0.8102 - val_loss: 0.4361 - val_acc: 0.8416
Epoch 2/100
50000/50000 [==============================] - 7s 141us/step - loss: 0.
4486 - acc: 0.8428 - val_loss: 0.4333 - val_acc: 0.8473
Epoch 3/100
50000/50000 [==============================] - 8s 164us/step - loss: 0.
4185 - acc: 0.8536 - val_loss: 0.4145 - val_acc: 0.8544
Epoch 4/100
50000/50000 [==============================] - 8s 151us/step - loss: 0.
4186 - acc: 0.8564 - val_loss: 0.4960 - val_acc: 0.8344
Epoch 5/100
50000/50000 [==============================] - 7s 141us/step - loss: 0.
3983 - acc: 0.8601 - val_loss: 0.4538 - val_acc: 0.8466
Epoch 6/100
50000/50000 [==============================] - 7s 141us/step - loss: 0.
3976 - acc: 0.8614 - val_loss: 0.5351 - val_acc: 0.8324
Epoch 7/100
50000/50000 [==============================] - 8s 158us/step - loss: 0.
4026 - acc: 0.8600 - val_loss: 0.4618 - val_acc: 0.8483
Epoch 8/100
50000/50000 [==============================] - 8s 150us/step - loss: 0.
3872 - acc: 0.8641 - val_loss: 0.4355 - val_acc: 0.8578
Epoch 9/100
50000/50000 [==============================] - 7s 142us/step - loss: 0.
3885 - acc: 0.8623 - val_loss: 0.4422 - val_acc: 0.8471
Epoch 10/100
50000/50000 [==============================] - 7s 141us/step - loss: 0.
3921 - acc: 0.8623 - val_loss: 0.4683 - val_acc: 0.8446
Epoch 11/100
50000/50000 [==============================] - 7s 141us/step - loss: 0.
3845 - acc: 0.8659 - val_loss: 0.4983 - val_acc: 0.8336
Epoch 12/100
50000/50000 [==============================] - 7s 141us/step - loss: 0.
3849 - acc: 0.8665 - val_loss: 0.5165 - val_acc: 0.8343
Epoch 13/100
50000/50000 [==============================] - 7s 141us/step - loss: 0.
3835 - acc: 0.8665 - val_loss: 0.4629 - val_acc: 0.8526
Epoch 14/100
50000/50000 [==============================] - 7s 140us/step - loss: 0.
3814 - acc: 0.8669 - val_loss: 0.4322 - val_acc: 0.8523
Epoch 15/100
50000/50000 [==============================] - 7s 140us/step - loss: 0.
3820 - acc: 0.8685 - val_loss: 0.4395 - val_acc: 0.8568
Epoch 16/100
50000/50000 [==============================] - 7s 141us/step - loss: 0.
3703 - acc: 0.8722 - val_loss: 0.4358 - val_acc: 0.8562
Epoch 17/100
50000/50000 [==============================] - 7s 141us/step - loss: 0.
3711 - acc: 0.8714 - val_loss: 0.5499 - val_acc: 0.8393
Epoch 18/100
50000/50000 [==============================] - 8s 152us/step - loss: 0.
3706 - acc: 0.8726 - val_loss: 0.4530 - val_acc: 0.8556
Epoch 19/100
50000/50000 [==============================] - 8s 155us/step - loss: 0.
```

```
3652 - acc: 0.8737 - val_loss: 0.4859 - val_acc: 0.8382
Epoch 20/100
50000/50000 [==============================] - 7s 141us/step - loss: 0.
3709 - acc: 0.8723 - val_loss: 0.4486 - val_acc: 0.8544
Epoch 21/100
50000/50000 [==============================] - 7s 141us/step - loss: 0.
3653 - acc: 0.8742 - val_loss: 0.4589 - val_acc: 0.8544
Epoch 22/100
50000/50000 [==============================] - 7s 141us/step - loss: 0.
3631 - acc: 0.8733 - val_loss: 0.4661 - val_acc: 0.8587
Epoch 23/100
50000/50000 [==============================] - 7s 142us/step - loss: 0.
3591 - acc: 0.8739 - val_loss: 0.5314 - val_acc: 0.8302
Epoch 24/100
50000/50000 [==============================] - 7s 142us/step - loss: 0.
3631 - acc: 0.8738 - val_loss: 0.4642 - val_acc: 0.8536
Epoch 25/100
50000/50000 [==============================] - 7s 141us/step - loss: 0.
3562 - acc: 0.8772 - val_loss: 0.4793 - val_acc: 0.8538
Epoch 26/100
50000/50000 [==============================] - 7s 141us/step - loss: 0.
3668 - acc: 0.8746 - val_loss: 0.4419 - val_acc: 0.8608
Epoch 27/100
50000/50000 [==============================] - 7s 141us/step - loss: 0.
3619 - acc: 0.8748 - val_loss: 0.5806 - val_acc: 0.8183
Epoch 28/100
50000/50000 [==============================] - 7s 140us/step - loss: 0.
3550 - acc: 0.8763 - val_loss: 0.4652 - val_acc: 0.8619
Epoch 29/100
50000/50000 [==============================] - 7s 148us/step - loss: 0.
3565 - acc: 0.8761 - val_loss: 0.4946 - val_acc: 0.8510
Epoch 30/100
50000/50000 [==============================] - 8s 160us/step - loss: 0.
3494 - acc: 0.8780 - val_loss: 0.5177 - val_acc: 0.8408
Epoch 31/100
50000/50000 [==============================] - 7s 141us/step - loss: 0.
3494 - acc: 0.8793 - val_loss: 0.4220 - val_acc: 0.8668
Epoch 32/100
50000/50000 [==============================] - 7s 141us/step - loss: 0.
3486 - acc: 0.8784 - val_loss: 0.4817 - val_acc: 0.8549
Epoch 33/100
50000/50000 [==============================] - 7s 142us/step - loss: 0.
3413 - acc: 0.8804 - val_loss: 0.4771 - val_acc: 0.8509
Epoch 34/100
50000/50000 [==============================] - 7s 142us/step - loss: 0.
3409 - acc: 0.8795 - val_loss: 0.4658 - val_acc: 0.8564
Epoch 35/100
50000/50000 [==============================] - 7s 141us/step - loss: 0.
3432 - acc: 0.8819 - val_loss: 0.4864 - val_acc: 0.8544
Epoch 36/100
50000/50000 [==============================] - 7s 141us/step - loss: 0.
3439 - acc: 0.8815 - val_loss: 0.4566 - val_acc: 0.8571
Epoch 37/100
50000/50000 [==============================] - 7s 141us/step - loss: 0.
3366 - acc: 0.8818 - val_loss: 0.4572 - val_acc: 0.8600
Epoch 38/100
50000/50000 [==============================] - 7s 141us/step - loss: 0.
```

```
3347 - acc: 0.8841 - val_loss: 0.4543 - val_acc: 0.8643
Epoch 39/100
50000/50000 [==============================] - 7s 141us/step - loss: 0.
3393 - acc: 0.8822 - val_loss: 0.4479 - val_acc: 0.8570
Epoch 40/100
50000/50000 [==============================] - 7s 144us/step - loss: 0.
3418 - acc: 0.8805 - val_loss: 0.4627 - val_acc: 0.8561
Epoch 41/100
50000/50000 [==============================] - 8s 164us/step - loss: 0.
3421 - acc: 0.8805 - val_loss: 0.4678 - val_acc: 0.8592
Epoch 42/100
50000/50000 [==============================] - 7s 144us/step - loss: 0.
3570 - acc: 0.8770 - val_loss: 0.5062 - val_acc: 0.8544
Epoch 43/100
50000/50000 [==============================] - 7s 142us/step - loss: 0.
3517 - acc: 0.8788 - val_loss: 0.4800 - val_acc: 0.8541
Epoch 44/100
50000/50000 [==============================] - 7s 141us/step - loss: 0.
3460 - acc: 0.8801 - val_loss: 0.5353 - val_acc: 0.8383
Epoch 45/100
50000/50000 [==============================] - 7s 141us/step - loss: 0.
3508 - acc: 0.8794 - val_loss: 0.5853 - val_acc: 0.8216
Epoch 46/100
50000/50000 [==============================] - 8s 162us/step - loss: 0.
3446 - acc: 0.8812 - val_loss: 0.4462 - val_acc: 0.8621
Epoch 47/100
50000/50000 [==============================] - 8s 153us/step - loss: 0.
3383 - acc: 0.8833 - val_loss: 0.4411 - val_acc: 0.8657
Epoch 48/100
50000/50000 [==============================] - 7s 141us/step - loss: 0.
3333 - acc: 0.8835 - val_loss: 0.5529 - val_acc: 0.8435
Epoch 49/100
50000/50000 [==============================] - 7s 142us/step - loss: 0.
3255 - acc: 0.8877 - val_loss: 0.5158 - val_acc: 0.8394
Epoch 50/100
50000/50000 [==============================] - 7s 141us/step - loss: 0.
3390 - acc: 0.8839 - val_loss: 0.5911 - val_acc: 0.8288
Epoch 51/100
50000/50000 [==============================] - 7s 145us/step - loss: 0.
3469 - acc: 0.8806 - val_loss: 0.4981 - val_acc: 0.8527
Epoch 52/100
50000/50000 [==============================] - 8s 161us/step - loss: 0.
3341 - acc: 0.8840 - val_loss: 0.4804 - val_acc: 0.8547
Epoch 53/100
50000/50000 [==============================] - 7s 143us/step - loss: 0.
3312 - acc: 0.8843 - val_loss: 0.4976 - val_acc: 0.8502
Epoch 54/100
50000/50000 [==============================] - 7s 141us/step - loss: 0.
3365 - acc: 0.8856 - val_loss: 0.4958 - val_acc: 0.8555
Epoch 55/100
50000/50000 [==============================] - 7s 140us/step - loss: 0.
3306 - acc: 0.8854 - val_loss: 0.4874 - val_acc: 0.8529
Epoch 56/100
50000/50000 [==============================] - 7s 141us/step - loss: 0.
3402 - acc: 0.8826 - val_loss: 0.5073 - val_acc: 0.8481
Epoch 57/100
50000/50000 [==============================] - 7s 142us/step - loss: 0.
```

```
3286 - acc: 0.8869 - val_loss: 0.5186 - val_acc: 0.8483
Epoch 58/100
50000/50000 [==============================] - 7s 141us/step - loss: 0.
3279 - acc: 0.8860 - val_loss: 0.5189 - val_acc: 0.8508
Epoch 59/100
50000/50000 [==============================] - 7s 141us/step - loss: 0.
3292 - acc: 0.8854 - val_loss: 0.4937 - val_acc: 0.8564
Epoch 60/100
50000/50000 [==============================] - 7s 140us/step - loss: 0.
3442 - acc: 0.8842 - val_loss: 0.5324 - val_acc: 0.8507
Epoch 61/100
50000/50000 [==============================] - 7s 142us/step - loss: 0.
3367 - acc: 0.8838 - val_loss: 0.4877 - val_acc: 0.8540
Epoch 62/100
50000/50000 [==============================] - 7s 140us/step - loss: 0.
3388 - acc: 0.8822 - val_loss: 0.4951 - val_acc: 0.8555
Epoch 63/100
50000/50000 [==============================] - 8s 161us/step - loss: 0.
3266 - acc: 0.8860 - val_loss: 0.4761 - val_acc: 0.8627
Epoch 64/100
50000/50000 [==============================] - 7s 147us/step - loss: 0.
3380 - acc: 0.8851 - val_loss: 0.5065 - val_acc: 0.8577
Epoch 65/100
50000/50000 [==============================] - 7s 141us/step - loss: 0.
3325 - acc: 0.8854 - val_loss: 0.4791 - val_acc: 0.8632
Epoch 66/100
50000/50000 [==============================] - 7s 141us/step - loss: 0.
3263 - acc: 0.8871 - val_loss: 0.5587 - val_acc: 0.8326
Epoch 67/100
50000/50000 [==============================] - 7s 141us/step - loss: 0.
3426 - acc: 0.8835 - val_loss: 0.5294 - val_acc: 0.8473
Epoch 68/100
50000/50000 [==============================] - 7s 141us/step - loss: 0.
3463 - acc: 0.8838 - val_loss: 0.5003 - val_acc: 0.8602
Epoch 69/100
50000/50000 [==============================] - 7s 141us/step - loss: 0.
3354 - acc: 0.8857 - val_loss: 0.4757 - val_acc: 0.8618
Epoch 70/100
50000/50000 [==============================] - 7s 141us/step - loss: 0.
3271 - acc: 0.8876 - val_loss: 0.4936 - val_acc: 0.8614
Epoch 71/100
50000/50000 [==============================] - 7s 141us/step - loss: 0.
3150 - acc: 0.8909 - val_loss: 0.4654 - val_acc: 0.8619
Epoch 72/100
50000/50000 [==============================] - 7s 141us/step - loss: 0.
3307 - acc: 0.8863 - val_loss: 0.4780 - val_acc: 0.8631
Epoch 73/100
50000/50000 [==============================] - 7s 140us/step - loss: 0.
3254 - acc: 0.8867 - val_loss: 0.4735 - val_acc: 0.8643
Epoch 74/100
50000/50000 [==============================] - 8s 156us/step - loss: 0.
3219 - acc: 0.8878 - val_loss: 0.4835 - val_acc: 0.8555
Epoch 75/100
50000/50000 [==============================] - 8s 151us/step - loss: 0.
3192 - acc: 0.8889 - val_loss: 0.4739 - val_acc: 0.8585
Epoch 76/100
50000/50000 [==============================] - 7s 141us/step - loss: 0.
```

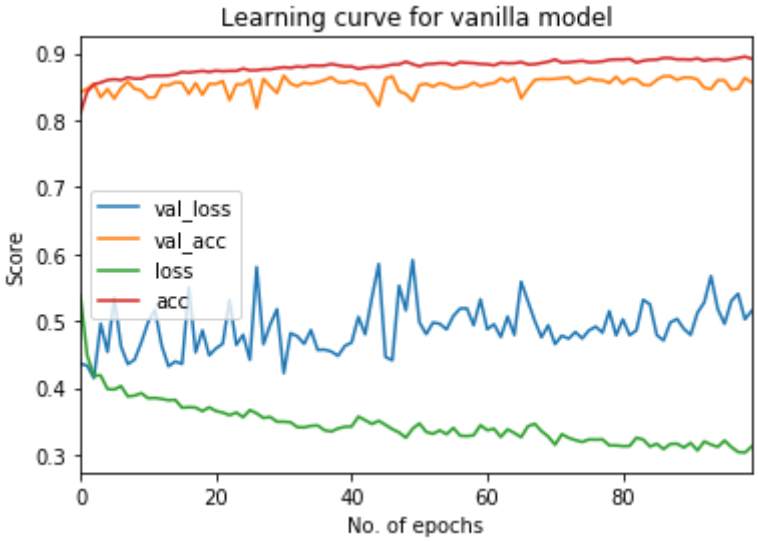
```
3229 - acc: 0.8867 - val_loss: 0.4859 - val_acc: 0.8627
Epoch 77/100
50000/50000 [==============================] - 7s 140us/step - loss: 0.
3226 - acc: 0.8870 - val_loss: 0.4915 - val_acc: 0.8603
Epoch 78/100
50000/50000 [==============================] - 7s 141us/step - loss: 0.
3230 - acc: 0.8881 - val_loss: 0.4825 - val_acc: 0.8599
Epoch 79/100
50000/50000 [==============================] - 7s 141us/step - loss: 0.
3140 - acc: 0.8903 - val_loss: 0.5147 - val_acc: 0.8557
Epoch 80/100
50000/50000 [==============================] - 7s 141us/step - loss: 0.
3139 - acc: 0.8909 - val_loss: 0.4786 - val_acc: 0.8651
Epoch 81/100
50000/50000 [==============================] - 7s 140us/step - loss: 0.
3129 - acc: 0.8909 - val_loss: 0.5023 - val_acc: 0.8549
Epoch 82/100
50000/50000 [==============================] - 7s 141us/step - loss: 0.
3131 - acc: 0.8919 - val_loss: 0.4788 - val_acc: 0.8619
Epoch 83/100
50000/50000 [==============================] - 7s 144us/step - loss: 0.
3254 - acc: 0.8862 - val_loss: 0.4860 - val_acc: 0.8613
Epoch 84/100
50000/50000 [==============================] - 8s 154us/step - loss: 0.
3227 - acc: 0.8891 - val_loss: 0.5316 - val_acc: 0.8530
Epoch 85/100
50000/50000 [==============================] - 8s 153us/step - loss: 0.
3123 - acc: 0.8904 - val_loss: 0.5249 - val_acc: 0.8523
Epoch 86/100
50000/50000 [==============================] - 8s 155us/step - loss: 0.
3164 - acc: 0.8906 - val_loss: 0.4789 - val_acc: 0.8604
Epoch 87/100
50000/50000 [==============================] - 7s 141us/step - loss: 0.
3085 - acc: 0.8932 - val_loss: 0.4708 - val_acc: 0.8659
Epoch 88/100
50000/50000 [==============================] - 7s 141us/step - loss: 0.
3161 - acc: 0.8931 - val_loss: 0.4977 - val_acc: 0.8658
Epoch 89/100
50000/50000 [==============================] - 8s 164us/step - loss: 0.
3165 - acc: 0.8910 - val_loss: 0.5031 - val_acc: 0.8604
Epoch 90/100
50000/50000 [==============================] - 8s 151us/step - loss: 0.
3107 - acc: 0.8911 - val_loss: 0.4882 - val_acc: 0.8639
Epoch 91/100
50000/50000 [==============================] - 7s 141us/step - loss: 0.
3177 - acc: 0.8905 - val_loss: 0.4791 - val_acc: 0.8639
Epoch 92/100
50000/50000 [==============================] - 7s 141us/step - loss: 0.
3064 - acc: 0.8925 - val_loss: 0.5123 - val_acc: 0.8610
Epoch 93/100
50000/50000 [==============================] - 7s 141us/step - loss: 0.
3199 - acc: 0.8891 - val_loss: 0.5276 - val_acc: 0.8486
Epoch 94/100
50000/50000 [==============================] - 7s 141us/step - loss: 0.
3151 - acc: 0.8908 - val_loss: 0.5671 - val_acc: 0.8467
Epoch 95/100
50000/50000 [==============================] - 7s 141us/step - loss: 0.
```

```
3117 - acc: 0.8915 - val_loss: 0.5179 - val_acc: 0.8599
Epoch 96/100
50000/50000 [==============================] - 8s 153us/step - loss: 0.
3212 - acc: 0.8895 - val_loss: 0.4956 - val_acc: 0.8597
Epoch 97/100
50000/50000 [==============================] - 8s 155us/step - loss: 0.
3116 - acc: 0.8913 - val_loss: 0.5300 - val_acc: 0.8458
Epoch 98/100
50000/50000 [==============================] - 7s 141us/step - loss: 0.
3041 - acc: 0.8931 - val_loss: 0.5408 - val_acc: 0.8473
Epoch 99/100
50000/50000 [==============================] - 7s 141us/step - loss: 0.
3032 - acc: 0.8952 - val_loss: 0.5025 - val_acc: 0.8632
Epoch 100/100
50000/50000 [==============================] - 7s 142us/step - loss: 0.
3124 - acc: 0.8920 - val_loss: 0.5151 - val_acc: 0.8567
```

Learning Curve for Vanilla model

In [19]:
```
pandas.DataFrame(history.history).plot()
plt.xlabel("No. of epochs")
plt.ylabel("Score")
plt.title("Learning curve for vanilla model")
```

Out[19]:
```
Text(0.5, 1.0, 'Learning curve for vanilla model')
```



The learning curve makes sense. The accuracy increases and the loss decreases with the epochs

Evaluation on test set

In [20]:
```
ypred = estimator.predict(X_test)
y_test = [numpy.argmax(y, axis=None, out=None) for y in y_test]
print("Accuracy score on test set")
print(accuracy_score(ypred,y_test))
```

```
Accuracy score on test set
0.8521
```

Model 2. Model with drop out- We use separate 10000 samples for model selection

In [0]:
```
def baseline_model2():
  model = Sequential()
  model.add(Dense(64, input_shape=input_shape, activation='tanh'))
  model.add(Dropout(0.2))
  model.add(Flatten())
  model.add(Dense(64, input_shape=input_shape, activation='tanh'))
  model.add(Dropout(0.2))
  model.add(Dense(10, activation='softmax'))
  model.compile(loss='categorical_crossentropy', optimizer='adam', metri
cs=['accuracy'])
  return model
```

In [0]:
```
estimator = KerasClassifier(build_fn=baseline_model2)
```

In [23]:
```
history = estimator.fit(X_train, y_train, epochs=100, verbose=1,
          validation_split=10/60)
```

```
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/ba
ckend/tensorflow_backend.py:3445: calling dropout (from tensorflow.pyth
on.ops.nn_ops) with keep_prob is deprecated and will be removed in a fu
ture version.
Instructions for updating:
Please use `rate` instead of `keep_prob`. Rate should be set to `rate =
1 - keep_prob`.
Train on 50000 samples, validate on 10000 samples
Epoch 1/100
50000/50000 [==============================] - 14s 277us/step - loss:
0.5709 - acc: 0.7966 - val_loss: 0.4219 - val_acc: 0.8473
Epoch 2/100
50000/50000 [==============================] - 8s 160us/step - loss: 0.
4600 - acc: 0.8343 - val_loss: 0.4041 - val_acc: 0.8519
Epoch 3/100
50000/50000 [==============================] - 9s 182us/step - loss: 0.
4404 - acc: 0.8391 - val_loss: 0.4178 - val_acc: 0.8481
Epoch 4/100
50000/50000 [==============================] - 8s 161us/step - loss: 0.
4307 - acc: 0.8447 - val_loss: 0.3837 - val_acc: 0.8622
Epoch 5/100
50000/50000 [==============================] - 8s 160us/step - loss: 0.
4220 - acc: 0.8461 - val_loss: 0.3935 - val_acc: 0.8562
Epoch 6/100
50000/50000 [==============================] - 8s 159us/step - loss: 0.
4239 - acc: 0.8455 - val_loss: 0.3955 - val_acc: 0.8571
Epoch 7/100
50000/50000 [==============================] - 8s 159us/step - loss: 0.
4160 - acc: 0.8478 - val_loss: 0.3809 - val_acc: 0.8602
Epoch 8/100
50000/50000 [==============================] - 8s 159us/step - loss: 0.
4177 - acc: 0.8494 - val_loss: 0.3915 - val_acc: 0.8589
Epoch 9/100
50000/50000 [==============================] - 9s 175us/step - loss: 0.
4109 - acc: 0.8504 - val_loss: 0.3909 - val_acc: 0.8578
Epoch 10/100
50000/50000 [==============================] - 8s 159us/step - loss: 0.
4034 - acc: 0.8543 - val_loss: 0.3914 - val_acc: 0.8534
Epoch 11/100
50000/50000 [==============================] - 8s 159us/step - loss: 0.
4017 - acc: 0.8547 - val_loss: 0.3736 - val_acc: 0.8630
Epoch 12/100
50000/50000 [==============================] - 8s 163us/step - loss: 0.
3992 - acc: 0.8537 - val_loss: 0.3831 - val_acc: 0.8581
Epoch 13/100
50000/50000 [==============================] - 9s 180us/step - loss: 0.
4041 - acc: 0.8524 - val_loss: 0.3786 - val_acc: 0.8629
Epoch 14/100
50000/50000 [==============================] - 8s 167us/step - loss: 0.
3967 - acc: 0.8553 - val_loss: 0.3820 - val_acc: 0.8600
Epoch 15/100
50000/50000 [==============================] - 9s 183us/step - loss: 0.
3864 - acc: 0.8601 - val_loss: 0.3637 - val_acc: 0.8667
Epoch 16/100
50000/50000 [==============================] - 8s 159us/step - loss: 0.
3949 - acc: 0.8561 - val_loss: 0.3814 - val_acc: 0.8571
Epoch 17/100
```

```
50000/50000 [==============================] - 8s 159us/step - loss: 0.
3912 - acc: 0.8564 - val_loss: 0.3690 - val_acc: 0.8605
Epoch 18/100
50000/50000 [==============================] - 8s 159us/step - loss: 0.
3860 - acc: 0.8593 - val_loss: 0.3656 - val_acc: 0.8653
Epoch 19/100
50000/50000 [==============================] - 8s 159us/step - loss: 0.
3998 - acc: 0.8543 - val_loss: 0.3731 - val_acc: 0.8666
Epoch 20/100
50000/50000 [==============================] - 8s 159us/step - loss: 0.
3916 - acc: 0.8568 - val_loss: 0.3738 - val_acc: 0.8618
Epoch 21/100
50000/50000 [==============================] - 8s 158us/step - loss: 0.
3875 - acc: 0.8580 - val_loss: 0.3596 - val_acc: 0.8694
Epoch 22/100
50000/50000 [==============================] - 8s 169us/step - loss: 0.
3852 - acc: 0.8595 - val_loss: 0.3777 - val_acc: 0.8612
Epoch 23/100
50000/50000 [==============================] - 9s 175us/step - loss: 0.
3883 - acc: 0.8579 - val_loss: 0.3644 - val_acc: 0.8651
Epoch 24/100
50000/50000 [==============================] - 8s 160us/step - loss: 0.
3842 - acc: 0.8595 - val_loss: 0.3662 - val_acc: 0.8687
Epoch 25/100
50000/50000 [==============================] - 8s 158us/step - loss: 0.
3843 - acc: 0.8604 - val_loss: 0.3613 - val_acc: 0.8700
Epoch 26/100
50000/50000 [==============================] - 8s 159us/step - loss: 0.
3840 - acc: 0.8588 - val_loss: 0.3526 - val_acc: 0.8715
Epoch 27/100
50000/50000 [==============================] - 8s 159us/step - loss: 0.
3803 - acc: 0.8608 - val_loss: 0.3597 - val_acc: 0.8681
Epoch 28/100
50000/50000 [==============================] - 8s 159us/step - loss: 0.
3833 - acc: 0.8598 - val_loss: 0.3691 - val_acc: 0.8623
Epoch 29/100
50000/50000 [==============================] - 8s 159us/step - loss: 0.
3780 - acc: 0.8614 - val_loss: 0.3732 - val_acc: 0.8645
Epoch 30/100
50000/50000 [==============================] - 8s 163us/step - loss: 0.
3730 - acc: 0.8641 - val_loss: 0.3518 - val_acc: 0.8681
Epoch 31/100
50000/50000 [==============================] - 8s 169us/step - loss: 0.
3701 - acc: 0.8655 - val_loss: 0.3604 - val_acc: 0.8691
Epoch 32/100
50000/50000 [==============================] - 9s 176us/step - loss: 0.
3705 - acc: 0.8636 - val_loss: 0.3586 - val_acc: 0.8712
Epoch 33/100
50000/50000 [==============================] - 9s 177us/step - loss: 0.
3695 - acc: 0.8640 - val_loss: 0.3621 - val_acc: 0.8667
Epoch 34/100
50000/50000 [==============================] - 8s 166us/step - loss: 0.
3785 - acc: 0.8609 - val_loss: 0.3601 - val_acc: 0.8670
Epoch 35/100
50000/50000 [==============================] - 9s 171us/step - loss: 0.
3753 - acc: 0.8639 - val_loss: 0.3589 - val_acc: 0.8712
Epoch 36/100
```

```
50000/50000 [==============================] - 8s 163us/step - loss: 0.
3731 - acc: 0.8631 - val_loss: 0.3567 - val_acc: 0.8652
Epoch 37/100
50000/50000 [==============================] - 8s 162us/step - loss: 0.
3693 - acc: 0.8641 - val_loss: 0.3481 - val_acc: 0.8754
Epoch 38/100
50000/50000 [==============================] - 8s 162us/step - loss: 0.
3706 - acc: 0.8644 - val_loss: 0.3599 - val_acc: 0.8701
Epoch 39/100
50000/50000 [==============================] - 8s 161us/step - loss: 0.
3686 - acc: 0.8644 - val_loss: 0.3548 - val_acc: 0.8687
Epoch 40/100
50000/50000 [==============================] - 8s 163us/step - loss: 0.
3641 - acc: 0.8638 - val_loss: 0.3509 - val_acc: 0.8721
Epoch 41/100
50000/50000 [==============================] - 8s 161us/step - loss: 0.
3655 - acc: 0.8668 - val_loss: 0.3471 - val_acc: 0.8724
Epoch 42/100
50000/50000 [==============================] - 9s 180us/step - loss: 0.
3657 - acc: 0.8637 - val_loss: 0.3550 - val_acc: 0.8675
Epoch 43/100
50000/50000 [==============================] - 8s 169us/step - loss: 0.
3628 - acc: 0.8678 - val_loss: 0.3596 - val_acc: 0.8723
Epoch 44/100
50000/50000 [==============================] - 8s 163us/step - loss: 0.
3678 - acc: 0.8657 - val_loss: 0.3538 - val_acc: 0.8702
Epoch 45/100
50000/50000 [==============================] - 8s 165us/step - loss: 0.
3670 - acc: 0.8663 - val_loss: 0.3577 - val_acc: 0.8706
Epoch 46/100
50000/50000 [==============================] - 9s 177us/step - loss: 0.
3654 - acc: 0.8663 - val_loss: 0.3542 - val_acc: 0.8708
Epoch 47/100
50000/50000 [==============================] - 8s 163us/step - loss: 0.
3685 - acc: 0.8646 - val_loss: 0.3457 - val_acc: 0.8741
Epoch 48/100
50000/50000 [==============================] - 8s 160us/step - loss: 0.
3635 - acc: 0.8675 - val_loss: 0.3515 - val_acc: 0.8725
Epoch 49/100
50000/50000 [==============================] - 8s 161us/step - loss: 0.
3670 - acc: 0.8641 - val_loss: 0.3511 - val_acc: 0.8715
Epoch 50/100
50000/50000 [==============================] - 8s 162us/step - loss: 0.
3615 - acc: 0.8676 - val_loss: 0.3441 - val_acc: 0.8759
Epoch 51/100
50000/50000 [==============================] - 8s 168us/step - loss: 0.
3583 - acc: 0.8692 - val_loss: 0.3495 - val_acc: 0.8721
Epoch 52/100
50000/50000 [==============================] - 9s 187us/step - loss: 0.
3598 - acc: 0.8685 - val_loss: 0.3511 - val_acc: 0.8684
Epoch 53/100
50000/50000 [==============================] - 9s 173us/step - loss: 0.
3605 - acc: 0.8679 - val_loss: 0.3529 - val_acc: 0.8685
Epoch 54/100
50000/50000 [==============================] - 8s 160us/step - loss: 0.
3622 - acc: 0.8662 - val_loss: 0.3454 - val_acc: 0.8712
Epoch 55/100
```

```
50000/50000 [==============================] - 8s 160us/step - loss: 0.
3622 - acc: 0.8659 - val_loss: 0.3628 - val_acc: 0.8670
Epoch 56/100
50000/50000 [==============================] - 8s 161us/step - loss: 0.
3634 - acc: 0.8668 - val_loss: 0.3562 - val_acc: 0.8707
Epoch 57/100
50000/50000 [==============================] - 8s 160us/step - loss: 0.
3617 - acc: 0.8650 - val_loss: 0.3536 - val_acc: 0.8694
Epoch 58/100
50000/50000 [==============================] - 8s 160us/step - loss: 0.
3676 - acc: 0.8646 - val_loss: 0.3601 - val_acc: 0.8667
Epoch 59/100
50000/50000 [==============================] - 8s 161us/step - loss: 0.
3678 - acc: 0.8640 - val_loss: 0.3552 - val_acc: 0.8706
Epoch 60/100
50000/50000 [==============================] - 8s 161us/step - loss: 0.
3646 - acc: 0.8666 - val_loss: 0.3561 - val_acc: 0.8698
Epoch 61/100
50000/50000 [==============================] - 9s 171us/step - loss: 0.
3596 - acc: 0.8676 - val_loss: 0.3476 - val_acc: 0.8726
Epoch 62/100
50000/50000 [==============================] - 9s 174us/step - loss: 0.
3580 - acc: 0.8661 - val_loss: 0.3519 - val_acc: 0.8708
Epoch 63/100
50000/50000 [==============================] - 8s 163us/step - loss: 0.
3674 - acc: 0.8651 - val_loss: 0.3626 - val_acc: 0.8680
Epoch 64/100
50000/50000 [==============================] - 8s 159us/step - loss: 0.
3733 - acc: 0.8640 - val_loss: 0.3535 - val_acc: 0.8720
Epoch 65/100
50000/50000 [==============================] - 8s 160us/step - loss: 0.
3711 - acc: 0.8634 - val_loss: 0.3553 - val_acc: 0.8678
Epoch 66/100
50000/50000 [==============================] - 8s 160us/step - loss: 0.
3622 - acc: 0.8686 - val_loss: 0.3492 - val_acc: 0.8735
Epoch 67/100
50000/50000 [==============================] - 8s 164us/step - loss: 0.
3644 - acc: 0.8678 - val_loss: 0.3512 - val_acc: 0.8691
Epoch 68/100
50000/50000 [==============================] - 8s 159us/step - loss: 0.
3635 - acc: 0.8677 - val_loss: 0.3492 - val_acc: 0.8725
Epoch 69/100
50000/50000 [==============================] - 8s 160us/step - loss: 0.
3573 - acc: 0.8696 - val_loss: 0.3506 - val_acc: 0.8745
Epoch 70/100
50000/50000 [==============================] - 8s 160us/step - loss: 0.
3655 - acc: 0.8663 - val_loss: 0.3601 - val_acc: 0.8691
Epoch 71/100
50000/50000 [==============================] - 9s 172us/step - loss: 0.
3577 - acc: 0.8697 - val_loss: 0.3479 - val_acc: 0.8727
Epoch 72/100
50000/50000 [==============================] - 9s 171us/step - loss: 0.
3615 - acc: 0.8678 - val_loss: 0.3517 - val_acc: 0.8741
Epoch 73/100
50000/50000 [==============================] - 8s 159us/step - loss: 0.
3569 - acc: 0.8686 - val_loss: 0.3539 - val_acc: 0.8712
Epoch 74/100
```

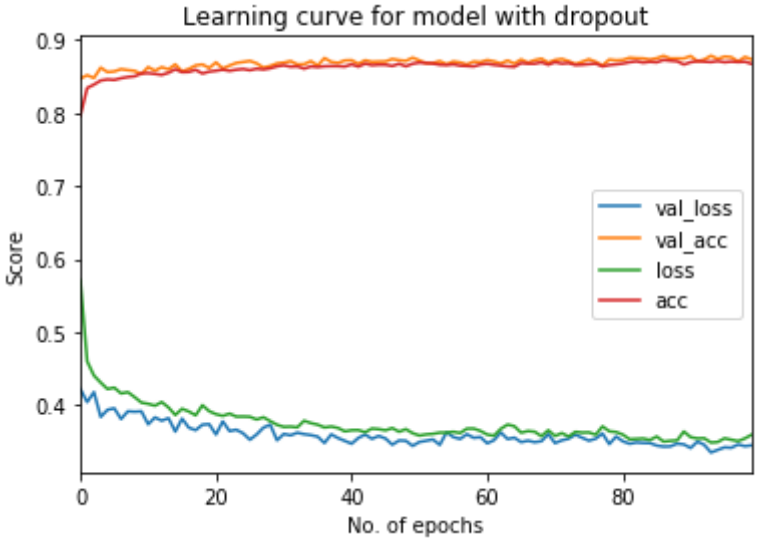
```
50000/50000 [==============================] - 8s 159us/step - loss: 0.
3633 - acc: 0.8659 - val_loss: 0.3594 - val_acc: 0.8672
Epoch 75/100
50000/50000 [==============================] - 8s 160us/step - loss: 0.
3623 - acc: 0.8663 - val_loss: 0.3553 - val_acc: 0.8703
Epoch 76/100
50000/50000 [==============================] - 8s 159us/step - loss: 0.
3626 - acc: 0.8672 - val_loss: 0.3512 - val_acc: 0.8737
Epoch 77/100
50000/50000 [==============================] - 8s 160us/step - loss: 0.
3593 - acc: 0.8678 - val_loss: 0.3540 - val_acc: 0.8702
Epoch 78/100
50000/50000 [==============================] - 8s 159us/step - loss: 0.
3708 - acc: 0.8640 - val_loss: 0.3610 - val_acc: 0.8653
Epoch 79/100
50000/50000 [==============================] - 8s 159us/step - loss: 0.
3641 - acc: 0.8659 - val_loss: 0.3466 - val_acc: 0.8733
Epoch 80/100
50000/50000 [==============================] - 8s 160us/step - loss: 0.
3631 - acc: 0.8668 - val_loss: 0.3568 - val_acc: 0.8723
Epoch 81/100
50000/50000 [==============================] - 9s 175us/step - loss: 0.
3595 - acc: 0.8679 - val_loss: 0.3504 - val_acc: 0.8728
Epoch 82/100
50000/50000 [==============================] - 9s 170us/step - loss: 0.
3531 - acc: 0.8698 - val_loss: 0.3471 - val_acc: 0.8758
Epoch 83/100
50000/50000 [==============================] - 9s 171us/step - loss: 0.
3536 - acc: 0.8710 - val_loss: 0.3488 - val_acc: 0.8751
Epoch 84/100
50000/50000 [==============================] - 8s 164us/step - loss: 0.
3541 - acc: 0.8692 - val_loss: 0.3482 - val_acc: 0.8749
Epoch 85/100
50000/50000 [==============================] - 8s 158us/step - loss: 0.
3522 - acc: 0.8704 - val_loss: 0.3480 - val_acc: 0.8734
Epoch 86/100
50000/50000 [==============================] - 8s 159us/step - loss: 0.
3569 - acc: 0.8697 - val_loss: 0.3445 - val_acc: 0.8751
Epoch 87/100
50000/50000 [==============================] - 8s 159us/step - loss: 0.
3500 - acc: 0.8728 - val_loss: 0.3431 - val_acc: 0.8784
Epoch 88/100
50000/50000 [==============================] - 8s 160us/step - loss: 0.
3510 - acc: 0.8718 - val_loss: 0.3434 - val_acc: 0.8748
Epoch 89/100
50000/50000 [==============================] - 8s 159us/step - loss: 0.
3516 - acc: 0.8711 - val_loss: 0.3472 - val_acc: 0.8749
Epoch 90/100
50000/50000 [==============================] - 9s 177us/step - loss: 0.
3638 - acc: 0.8666 - val_loss: 0.3461 - val_acc: 0.8748
Epoch 91/100
50000/50000 [==============================] - 9s 185us/step - loss: 0.
3560 - acc: 0.8698 - val_loss: 0.3412 - val_acc: 0.8782
Epoch 92/100
50000/50000 [==============================] - 8s 162us/step - loss: 0.
3542 - acc: 0.8712 - val_loss: 0.3500 - val_acc: 0.8710
Epoch 93/100
```

```
50000/50000 [==============================] - 8s 159us/step - loss: 0.
3546 - acc: 0.8705 - val_loss: 0.3456 - val_acc: 0.8733
Epoch 94/100
50000/50000 [==============================] - 8s 159us/step - loss: 0.
3486 - acc: 0.8700 - val_loss: 0.3351 - val_acc: 0.8786
Epoch 95/100
50000/50000 [==============================] - 8s 160us/step - loss: 0.
3494 - acc: 0.8713 - val_loss: 0.3386 - val_acc: 0.8742
Epoch 96/100
50000/50000 [==============================] - 8s 159us/step - loss: 0.
3545 - acc: 0.8698 - val_loss: 0.3421 - val_acc: 0.8774
Epoch 97/100
50000/50000 [==============================] - 8s 160us/step - loss: 0.
3525 - acc: 0.8706 - val_loss: 0.3415 - val_acc: 0.8766
Epoch 98/100
50000/50000 [==============================] - 8s 160us/step - loss: 0.
3506 - acc: 0.8700 - val_loss: 0.3460 - val_acc: 0.8706
Epoch 99/100
50000/50000 [==============================] - 8s 160us/step - loss: 0.
3543 - acc: 0.8705 - val_loss: 0.3437 - val_acc: 0.8770
Epoch 100/100
50000/50000 [==============================] - 8s 161us/step - loss: 0.
3594 - acc: 0.8675 - val_loss: 0.3448 - val_acc: 0.8736
```

Learning curve for model with Dropout

In [24]:
```
pandas.DataFrame(history.history).plot()
plt.xlabel("No. of epochs")
plt.ylabel("Score")
plt.title("Learning curve for model with dropout")
```

Out[24]: Text(0.5, 1.0, 'Learning curve for model with dropout')



The learning curve makes sense. The accuracy is increasing and the loss is decreasing with epochs. The learning curve is smoother as compared to vanilla model

Evaluation on test set

In [25]:
```
ypred = estimator.predict(X_test)
print("Accuracy score on test set")
print(accuracy_score(ypred,y_test))
```

```
Accuracy score on test set
0.8657
```

Performance of model with drop out is better than vanilla model

Model 3: Model using batch normalization and residual connections - We use separate 10000 samples for model selection

In [27]:
```
inputs = Input(shape=input_shape)
x1 = Dense(64, activation='tanh')(inputs)
x2 = BatchNormalization()(x1)
x3 = Flatten()(x2)
x4 = Dense(64, activation='tanh')(x3)
x5 = BatchNormalization()(x4)
x6 = Add()([x4,x5])
x7 = Dense(64, activation='tanh')(x6)
predictions = Dense(10, activation='softmax')(x7)
model = Model(inputs=inputs, outputs=predictions)
model.compile(optimizer='adam',loss='categorical_crossentropy',metrics=[
'accuracy'])
history  = model.fit(X_train, y_train, epochs=100, verbose=1,validation_
split=10/60)
```

```
Train on 50000 samples, validate on 10000 samples
Epoch 1/100
50000/50000 [==============================] - 18s 361us/step - loss:
0.4831 - acc: 0.8270 - val_loss: 0.4116 - val_acc: 0.8438
Epoch 2/100
50000/50000 [==============================] - 12s 231us/step - loss:
0.3888 - acc: 0.8586 - val_loss: 0.4042 - val_acc: 0.8507
Epoch 3/100
50000/50000 [==============================] - 12s 232us/step - loss:
0.3655 - acc: 0.8668 - val_loss: 0.3856 - val_acc: 0.8567
Epoch 4/100
50000/50000 [==============================] - 12s 232us/step - loss:
0.3553 - acc: 0.8708 - val_loss: 0.3811 - val_acc: 0.8637
Epoch 5/100
50000/50000 [==============================] - 12s 231us/step - loss:
0.3544 - acc: 0.8706 - val_loss: 0.3727 - val_acc: 0.8631
Epoch 6/100
50000/50000 [==============================] - 12s 233us/step - loss:
0.3391 - acc: 0.8742 - val_loss: 0.3644 - val_acc: 0.8648
Epoch 7/100
50000/50000 [==============================] - 13s 256us/step - loss:
0.3322 - acc: 0.8758 - val_loss: 0.3663 - val_acc: 0.8656
Epoch 8/100
50000/50000 [==============================] - 12s 232us/step - loss:
0.3311 - acc: 0.8768 - val_loss: 0.3695 - val_acc: 0.8658
Epoch 9/100
50000/50000 [==============================] - 12s 232us/step - loss:
0.3210 - acc: 0.8804 - val_loss: 0.3643 - val_acc: 0.8657
Epoch 10/100
50000/50000 [==============================] - 12s 232us/step - loss:
0.3228 - acc: 0.8805 - val_loss: 0.3726 - val_acc: 0.8650
Epoch 11/100
50000/50000 [==============================] - 12s 232us/step - loss:
0.3184 - acc: 0.8817 - val_loss: 0.3620 - val_acc: 0.8660
Epoch 12/100
50000/50000 [==============================] - 12s 234us/step - loss:
0.3081 - acc: 0.8838 - val_loss: 0.3681 - val_acc: 0.8663
Epoch 13/100
50000/50000 [==============================] - 12s 240us/step - loss:
0.3063 - acc: 0.8858 - val_loss: 0.3567 - val_acc: 0.8703
Epoch 14/100
50000/50000 [==============================] - 13s 252us/step - loss:
0.3060 - acc: 0.8848 - val_loss: 0.3557 - val_acc: 0.8685
Epoch 15/100
50000/50000 [==============================] - 12s 232us/step - loss:
0.2995 - acc: 0.8889 - val_loss: 0.3573 - val_acc: 0.8715
Epoch 16/100
50000/50000 [==============================] - 12s 231us/step - loss:
0.2989 - acc: 0.8883 - val_loss: 0.3674 - val_acc: 0.8706
Epoch 17/100
50000/50000 [==============================] - 12s 233us/step - loss:
0.2917 - acc: 0.8901 - val_loss: 0.3664 - val_acc: 0.8643
Epoch 18/100
50000/50000 [==============================] - 12s 232us/step - loss:
0.2918 - acc: 0.8894 - val_loss: 0.3527 - val_acc: 0.8702
Epoch 19/100
50000/50000 [==============================] - 13s 263us/step - loss:
```

```
0.2942 - acc: 0.8879 - val_loss: 0.3483 - val_acc: 0.8726
Epoch 20/100
50000/50000 [==============================] - 12s 250us/step - loss:
0.2882 - acc: 0.8912 - val_loss: 0.3742 - val_acc: 0.8642
Epoch 21/100
50000/50000 [==============================] - 12s 240us/step - loss:
0.2933 - acc: 0.8899 - val_loss: 0.3527 - val_acc: 0.8719
Epoch 22/100
50000/50000 [==============================] - 12s 231us/step - loss:
0.2876 - acc: 0.8919 - val_loss: 0.3468 - val_acc: 0.8777
Epoch 23/100
50000/50000 [==============================] - 12s 233us/step - loss:
0.2844 - acc: 0.8932 - val_loss: 0.3479 - val_acc: 0.8758
Epoch 24/100
50000/50000 [==============================] - 12s 232us/step - loss:
0.2851 - acc: 0.8919 - val_loss: 0.3489 - val_acc: 0.8738
Epoch 25/100
50000/50000 [==============================] - 12s 231us/step - loss:
0.2846 - acc: 0.8931 - val_loss: 0.3474 - val_acc: 0.8757
Epoch 26/100
50000/50000 [==============================] - 12s 232us/step - loss:
0.2823 - acc: 0.8927 - val_loss: 0.3592 - val_acc: 0.8698
Epoch 27/100
50000/50000 [==============================] - 13s 254us/step - loss:
0.2781 - acc: 0.8952 - val_loss: 0.3549 - val_acc: 0.8724
Epoch 28/100
50000/50000 [==============================] - 12s 234us/step - loss:
0.2803 - acc: 0.8949 - val_loss: 0.3506 - val_acc: 0.8765
Epoch 29/100
50000/50000 [==============================] - 12s 231us/step - loss:
0.2892 - acc: 0.8908 - val_loss: 0.3529 - val_acc: 0.8762
Epoch 30/100
50000/50000 [==============================] - 12s 232us/step - loss:
0.2739 - acc: 0.8972 - val_loss: 0.3515 - val_acc: 0.8728
Epoch 31/100
50000/50000 [==============================] - 12s 231us/step - loss:
0.2791 - acc: 0.8931 - val_loss: 0.3608 - val_acc: 0.8721
Epoch 32/100
50000/50000 [==============================] - 12s 232us/step - loss:
0.2670 - acc: 0.8997 - val_loss: 0.3441 - val_acc: 0.8768
Epoch 33/100
50000/50000 [==============================] - 12s 233us/step - loss:
0.2687 - acc: 0.8986 - val_loss: 0.3493 - val_acc: 0.8726
Epoch 34/100
50000/50000 [==============================] - 13s 257us/step - loss:
0.2615 - acc: 0.9018 - val_loss: 0.3525 - val_acc: 0.8747
Epoch 35/100
50000/50000 [==============================] - 12s 232us/step - loss:
0.2668 - acc: 0.8995 - val_loss: 0.3458 - val_acc: 0.8767
Epoch 36/100
50000/50000 [==============================] - 12s 232us/step - loss:
0.2720 - acc: 0.8969 - val_loss: 0.3552 - val_acc: 0.8713
Epoch 37/100
50000/50000 [==============================] - 12s 231us/step - loss:
0.2605 - acc: 0.9017 - val_loss: 0.3424 - val_acc: 0.8786
Epoch 38/100
50000/50000 [==============================] - 12s 232us/step - loss:
```

```
0.2628 - acc: 0.8992 - val_loss: 0.3381 - val_acc: 0.8795
Epoch 39/100
50000/50000 [==============================] - 12s 240us/step - loss:
0.2609 - acc: 0.9007 - val_loss: 0.3480 - val_acc: 0.8741
Epoch 40/100
50000/50000 [==============================] - 12s 241us/step - loss:
0.2592 - acc: 0.9017 - val_loss: 0.3589 - val_acc: 0.8700
Epoch 41/100
50000/50000 [==============================] - 13s 255us/step - loss:
0.2558 - acc: 0.9025 - val_loss: 0.3361 - val_acc: 0.8787
Epoch 42/100
50000/50000 [==============================] - 12s 232us/step - loss:
0.2521 - acc: 0.9049 - val_loss: 0.3421 - val_acc: 0.8816
Epoch 43/100
50000/50000 [==============================] - 12s 232us/step - loss:
0.2539 - acc: 0.9050 - val_loss: 0.3502 - val_acc: 0.8786
Epoch 44/100
50000/50000 [==============================] - 12s 230us/step - loss:
0.2501 - acc: 0.9058 - val_loss: 0.3415 - val_acc: 0.8807
Epoch 45/100
50000/50000 [==============================] - 13s 261us/step - loss:
0.2494 - acc: 0.9052 - val_loss: 0.3475 - val_acc: 0.8780
Epoch 46/100
50000/50000 [==============================] - 12s 234us/step - loss:
0.2446 - acc: 0.9060 - val_loss: 0.3359 - val_acc: 0.8773
Epoch 47/100
50000/50000 [==============================] - 12s 243us/step - loss:
0.2510 - acc: 0.9042 - val_loss: 0.3501 - val_acc: 0.8737
Epoch 48/100
50000/50000 [==============================] - 12s 246us/step - loss:
0.2472 - acc: 0.9060 - val_loss: 0.3509 - val_acc: 0.8752
Epoch 49/100
50000/50000 [==============================] - 12s 231us/step - loss:
0.2494 - acc: 0.9057 - val_loss: 0.3536 - val_acc: 0.8759
Epoch 50/100
50000/50000 [==============================] - 12s 231us/step - loss:
0.2488 - acc: 0.9050 - val_loss: 0.3398 - val_acc: 0.8749
Epoch 51/100
50000/50000 [==============================] - 12s 231us/step - loss:
0.2399 - acc: 0.9087 - val_loss: 0.3413 - val_acc: 0.8794
Epoch 52/100
50000/50000 [==============================] - 12s 232us/step - loss:
0.2358 - acc: 0.9098 - val_loss: 0.3474 - val_acc: 0.8755
Epoch 53/100
50000/50000 [==============================] - 12s 232us/step - loss:
0.2326 - acc: 0.9112 - val_loss: 0.3546 - val_acc: 0.8744
Epoch 54/100
50000/50000 [==============================] - 12s 250us/step - loss:
0.2425 - acc: 0.9066 - val_loss: 0.3367 - val_acc: 0.8793
Epoch 55/100
50000/50000 [==============================] - 12s 239us/step - loss:
0.2398 - acc: 0.9078 - val_loss: 0.3313 - val_acc: 0.8826
Epoch 56/100
50000/50000 [==============================] - 12s 232us/step - loss:
0.2312 - acc: 0.9132 - val_loss: 0.3373 - val_acc: 0.8755
Epoch 57/100
50000/50000 [==============================] - 12s 232us/step - loss:
```

```
0.2339 - acc: 0.9101 - val_loss: 0.3399 - val_acc: 0.8771
Epoch 58/100
50000/50000 [==============================] - 12s 232us/step - loss:
0.2271 - acc: 0.9136 - val_loss: 0.3399 - val_acc: 0.8823
Epoch 59/100
50000/50000 [==============================] - 12s 231us/step - loss:
0.2189 - acc: 0.9167 - val_loss: 0.3431 - val_acc: 0.8819
Epoch 60/100
50000/50000 [==============================] - 12s 231us/step - loss:
0.2232 - acc: 0.9152 - val_loss: 0.3482 - val_acc: 0.8779
Epoch 61/100
50000/50000 [==============================] - 13s 254us/step - loss:
0.2302 - acc: 0.9122 - val_loss: 0.3556 - val_acc: 0.8769
Epoch 62/100
50000/50000 [==============================] - 12s 233us/step - loss:
0.2278 - acc: 0.9131 - val_loss: 0.3422 - val_acc: 0.8780
Epoch 63/100
50000/50000 [==============================] - 12s 231us/step - loss:
0.2223 - acc: 0.9153 - val_loss: 0.3410 - val_acc: 0.8811
Epoch 64/100
50000/50000 [==============================] - 12s 231us/step - loss:
0.2179 - acc: 0.9172 - val_loss: 0.3466 - val_acc: 0.8768
Epoch 65/100
50000/50000 [==============================] - 12s 246us/step - loss:
0.2208 - acc: 0.9162 - val_loss: 0.3477 - val_acc: 0.8833
Epoch 66/100
50000/50000 [==============================] - 12s 230us/step - loss:
0.2246 - acc: 0.9140 - val_loss: 0.3485 - val_acc: 0.8824
Epoch 67/100
50000/50000 [==============================] - 12s 232us/step - loss:
0.2239 - acc: 0.9146 - val_loss: 0.3481 - val_acc: 0.8800
Epoch 68/100
50000/50000 [==============================] - 13s 257us/step - loss:
0.2190 - acc: 0.9165 - val_loss: 0.3590 - val_acc: 0.8772
Epoch 69/100
50000/50000 [==============================] - 12s 230us/step - loss:
0.2303 - acc: 0.9118 - val_loss: 0.3420 - val_acc: 0.8813
Epoch 70/100
50000/50000 [==============================] - 12s 231us/step - loss:
0.2256 - acc: 0.9146 - val_loss: 0.3584 - val_acc: 0.8789
Epoch 71/100
50000/50000 [==============================] - 13s 254us/step - loss:
0.2238 - acc: 0.9156 - val_loss: 0.3458 - val_acc: 0.8805
Epoch 72/100
50000/50000 [==============================] - 12s 241us/step - loss:
0.2154 - acc: 0.9181 - val_loss: 0.3471 - val_acc: 0.8781
Epoch 73/100
50000/50000 [==============================] - 12s 234us/step - loss:
0.2200 - acc: 0.9165 - val_loss: 0.3589 - val_acc: 0.8768
Epoch 74/100
50000/50000 [==============================] - 12s 238us/step - loss:
0.2213 - acc: 0.9150 - val_loss: 0.3592 - val_acc: 0.8749
Epoch 75/100
50000/50000 [==============================] - 13s 250us/step - loss:
0.2151 - acc: 0.9191 - val_loss: 0.3499 - val_acc: 0.8839
Epoch 76/100
50000/50000 [==============================] - 12s 232us/step - loss:
```

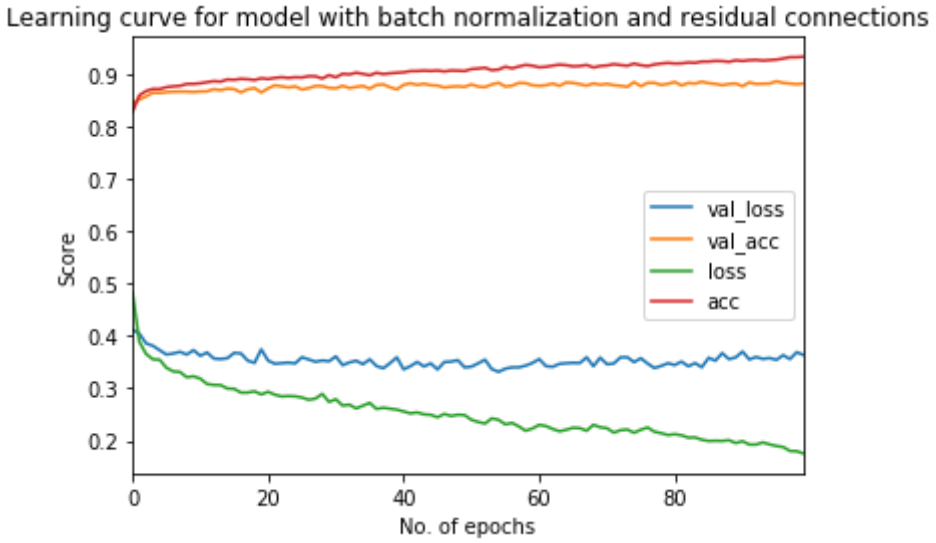
```
0.2209 - acc: 0.9161 - val_loss: 0.3572 - val_acc: 0.8761
Epoch 77/100
50000/50000 [==============================] - 12s 233us/step - loss:
0.2252 - acc: 0.9144 - val_loss: 0.3471 - val_acc: 0.8824
Epoch 78/100
50000/50000 [==============================] - 12s 231us/step - loss:
0.2171 - acc: 0.9176 - val_loss: 0.3386 - val_acc: 0.8825
Epoch 79/100
50000/50000 [==============================] - 12s 231us/step - loss:
0.2143 - acc: 0.9193 - val_loss: 0.3426 - val_acc: 0.8786
Epoch 80/100
50000/50000 [==============================] - 12s 232us/step - loss:
0.2107 - acc: 0.9205 - val_loss: 0.3477 - val_acc: 0.8806
Epoch 81/100
50000/50000 [==============================] - 12s 243us/step - loss:
0.2124 - acc: 0.9193 - val_loss: 0.3443 - val_acc: 0.8842
Epoch 82/100
50000/50000 [==============================] - 12s 246us/step - loss:
0.2103 - acc: 0.9196 - val_loss: 0.3508 - val_acc: 0.8776
Epoch 83/100
50000/50000 [==============================] - 12s 231us/step - loss:
0.2058 - acc: 0.9213 - val_loss: 0.3420 - val_acc: 0.8822
Epoch 84/100
50000/50000 [==============================] - 11s 230us/step - loss:
0.2061 - acc: 0.9207 - val_loss: 0.3479 - val_acc: 0.8811
Epoch 85/100
50000/50000 [==============================] - 11s 230us/step - loss:
0.2018 - acc: 0.9230 - val_loss: 0.3402 - val_acc: 0.8847
Epoch 86/100
50000/50000 [==============================] - 12s 230us/step - loss:
0.1994 - acc: 0.9231 - val_loss: 0.3581 - val_acc: 0.8819
Epoch 87/100
50000/50000 [==============================] - 11s 230us/step - loss:
0.1999 - acc: 0.9244 - val_loss: 0.3526 - val_acc: 0.8805
Epoch 88/100
50000/50000 [==============================] - 12s 247us/step - loss:
0.1995 - acc: 0.9240 - val_loss: 0.3670 - val_acc: 0.8781
Epoch 89/100
50000/50000 [==============================] - 12s 239us/step - loss:
0.2008 - acc: 0.9226 - val_loss: 0.3555 - val_acc: 0.8803
Epoch 90/100
50000/50000 [==============================] - 11s 230us/step - loss:
0.1955 - acc: 0.9255 - val_loss: 0.3589 - val_acc: 0.8812
Epoch 91/100
50000/50000 [==============================] - 12s 245us/step - loss:
0.1991 - acc: 0.9242 - val_loss: 0.3700 - val_acc: 0.8762
Epoch 92/100
50000/50000 [==============================] - 12s 230us/step - loss:
0.1926 - acc: 0.9257 - val_loss: 0.3549 - val_acc: 0.8833
Epoch 93/100
50000/50000 [==============================] - 12s 230us/step - loss:
0.1926 - acc: 0.9261 - val_loss: 0.3596 - val_acc: 0.8803
Epoch 94/100
50000/50000 [==============================] - 12s 231us/step - loss:
0.1966 - acc: 0.9250 - val_loss: 0.3560 - val_acc: 0.8807
Epoch 95/100
50000/50000 [==============================] - 13s 253us/step - loss:
```

```
0.1929 - acc: 0.9259 - val_loss: 0.3576 - val_acc: 0.8812
Epoch 96/100
50000/50000 [==============================] - 12s 231us/step - loss:
0.1899 - acc: 0.9268 - val_loss: 0.3542 - val_acc: 0.8854
Epoch 97/100
50000/50000 [==============================] - 12s 242us/step - loss:
0.1879 - acc: 0.9289 - val_loss: 0.3630 - val_acc: 0.8824
Epoch 98/100
50000/50000 [==============================] - 13s 250us/step - loss:
0.1803 - acc: 0.9314 - val_loss: 0.3557 - val_acc: 0.8812
Epoch 99/100
50000/50000 [==============================] - 12s 230us/step - loss:
0.1799 - acc: 0.9314 - val_loss: 0.3687 - val_acc: 0.8798
Epoch 100/100
50000/50000 [==============================] - 12s 231us/step - loss:
0.1756 - acc: 0.9323 - val_loss: 0.3635 - val_acc: 0.8812
```

Learning curve for model with Batch Normalization and Residual connections

In [29]:
```
pandas.DataFrame(history.history).plot()
plt.xlabel("No. of epochs")
plt.ylabel("Score")
plt.title("Learning curve for model with batch normalization and residua
l connections")
```

Out[29]:
```
Text(0.5, 1.0, 'Learning curve for model with batch normalization and r
esidual connections')
```



The learning curve makes sense. The accuracy is increasing and loss is decreasing with epochs

Evaluation on test set

In [34]:
```
ypred = model.predict(X_test)
ypred2 = [numpy.argmax(y, axis=None, out=None) for y in ypred]
print("Accuracy score on test set")
print(accuracy_score(ypred2,y_test))
```

```
Accuracy score on test set
0.8739
```

The performance of the model is better than both vanilla model and model with drop out

Code file for Problem 3.

In [0]:
```
###Code to obtain data via Kaggle API

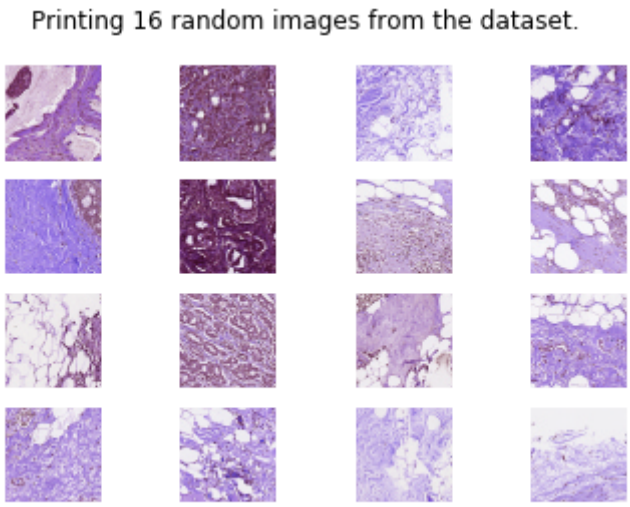
# !kaggle datasets download "paultimothymooney/breast-histopathology-images"
# !unzip breast-histopathology-images.zip
# !unzip IDC_regular_ps50_idx5.zip

import tensorflow as tf
sess = tf.Session(config=tf.ConfigProto(log_device_placement=True))
import random
from os import listdir
from glob import glob
import cv2
import matplotlib.pyplot as plt
import fnmatch
import pandas as pd
import numpy as np
from sklearn.model_selection import train_test_split
from keras.models import Sequential
from keras.layers import Dense, Dropout, Activation, Flatten, BatchNormalization, Conv2D, MaxPool2D, MaxPooling2D
from keras.utils.np_utils import to_categorical
import keras
from keras.preprocessing.image import ImageDataGenerator
from keras import optimizers
from keras.callbacks import EarlyStopping
import seaborn as sns
```

Getting data from the content directory, printing 16 random images from the dataset after resizing them to (50,50)

In [8]:
```
image_data = glob('../content/**/*.png', recursive=True)

index = 0
fig=plt.figure()
for image in random.sample(image_data,16):
    img = cv2.resize(cv2.imread(image), (50, 50))
    ax=fig.add_subplot(4, 4, index+1)
    ax.imshow(img)
    ax.axis('off')
    index += 1
fig.suptitle('Printing 16 random images from the dataset.')
plt.show()
```



Getting a list of label_0 and label_1 image files, storing images in list X and associated labels in list y. 50k images sampled randomly for this assignment.

In [14]:
```
label_0 = fnmatch.filter(image_data, '*class0.png')
label_1 = fnmatch.filter(image_data, '*class1.png')

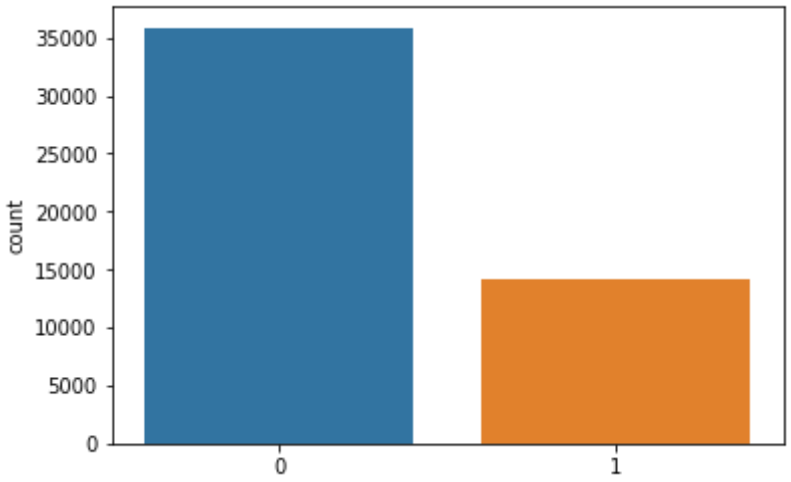
X = list()
y = list()
for image in random.sample(image_data, 50000):
    img = cv2.resize(cv2.imread(image),(40,40))
    X.append(img)
    if image in label_0:
        y.append(0)
    else:
        y.append(1)


print('The shape of each X element : ',X[0].shape)
print('Total number of images : ',len(X))
```

```
The shape of each X element :  (40, 40, 3)
Total number of images :  50000
```

In [18]:
```
sns.countplot(y)
```

Out[18]: <matplotlib.axes._subplots.AxesSubplot at 0x7fd10236a438>



Looking at the above countplot, the classes are highly imbalanced (looks like ~(70%-30%)) - this can be handled by undersampling the majority label (i.e label 0).

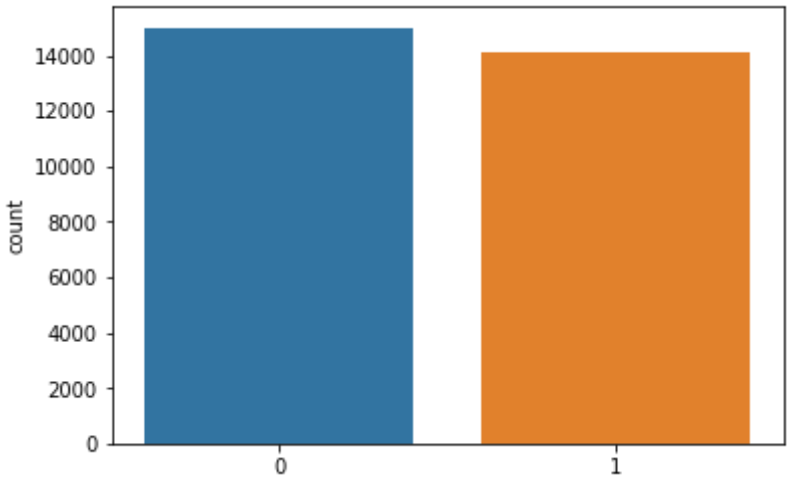
In [44]:
```
X = list()
y = list()
count_0 = 0
for image in random.sample(image_data, 50000):
    img = cv2.resize(cv2.imread(image),(40,40))
    if image in label_0:
        if count_0 <= 15000:
            X.append(img)
            y.append(0)
            count_0 += 1
    else:
        X.append(img)
        y.append(1)


print('The shape of each X element : ',X[0].shape)
print('Total number of images : ',len(X))
```

```
The shape of each X element :  (40, 40, 3)
Total number of images :  29119
```

In [45]:
```
sns.countplot(y)
```

Out[45]: <matplotlib.axes._subplots.AxesSubplot at 0x7fd0d19e27b8>



The code block above will reduce the imbalance by sampling from both classes in similar measure, resulting countplot shows the reduced imbalance. y is converted to categorical data.

In [0]:
```
num_classes = 2

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

X_trainval, X_test, y_trainval, y_test = train_test_split(X_arr, y, test
_size=0.2)
X_train, X_val, y_train, y_val = train_test_split(X_trainval, y_trainval
, test_size=0.2)

y_train = keras.utils.to_categorical(y_train, num_classes)
y_test = keras.utils.to_categorical(y_test, num_classes)
y_val = keras.utils.to_categorical(y_val, num_classes)
```

3.1

Generating the training, validation and test datasets. 80-20 split employed. Constructing a simple Model with Batch normalization.

In [76]:
```
input_shape = (40, 40, 3)
from keras.layers import Conv2D, MaxPooling2D, Flatten, BatchNormalizati
on
num_classes = 2
cnn = Sequential()
cnn.add(Conv2D(8, kernel_size=(3, 3),
                 activation='tanh',
                 input_shape=input_shape))
cnn.add(Activation("tanh"))
cnn.add(BatchNormalization())
cnn.add(MaxPooling2D(pool_size=(2, 2)))
cnn.add(Conv2D(8, (3, 3), activation='tanh'))
cnn.add(Activation("tanh"))
cnn.add(BatchNormalization())
cnn.add(MaxPooling2D(pool_size=(2, 2)))
cnn.add(Flatten())
cnn.add(Dense(64, activation='tanh'))
cnn.add(Dense(2, activation='softmax'))
es = EarlyStopping(monitor='val_loss', mode='min', verbose=1, patience=3
)
sgd = optimizers.SGD(lr=0.00005, decay=1e-6, momentum=0.9, nesterov=True
)
cnn.compile(optimizer=sgd, loss="categorical_crossentropy", metrics=['ac
curacy'])
history_cnn = cnn.fit(X_train, y_train,
                      batch_size=128, epochs=20, verbose=1, validation_d
ata = [X_val, y_val],callbacks=[es])
```

```
Train on 18636 samples, validate on 4659 samples
Epoch 1/20
18636/18636 [==============================] - 37s 2ms/step - loss: 0.6
312 - acc: 0.6836 - val_loss: 0.5628 - val_acc: 0.7405
Epoch 2/20
18636/18636 [==============================] - 36s 2ms/step - loss: 0.5
727 - acc: 0.7326 - val_loss: 0.5503 - val_acc: 0.7523
Epoch 3/20
18636/18636 [==============================] - 35s 2ms/step - loss: 0.5
596 - acc: 0.7387 - val_loss: 0.5433 - val_acc: 0.7566
Epoch 4/20
18636/18636 [==============================] - 36s 2ms/step - loss: 0.5
491 - acc: 0.7451 - val_loss: 0.5404 - val_acc: 0.7534
Epoch 5/20
18636/18636 [==============================] - 35s 2ms/step - loss: 0.5
400 - acc: 0.7519 - val_loss: 0.5270 - val_acc: 0.7624
Epoch 6/20
18636/18636 [==============================] - 35s 2ms/step - loss: 0.5
342 - acc: 0.7520 - val_loss: 0.5246 - val_acc: 0.7652
Epoch 7/20
18636/18636 [==============================] - 35s 2ms/step - loss: 0.5
257 - acc: 0.7574 - val_loss: 0.5205 - val_acc: 0.7620
Epoch 8/20
18636/18636 [==============================] - 35s 2ms/step - loss: 0.5
224 - acc: 0.7608 - val_loss: 0.5144 - val_acc: 0.7660
Epoch 9/20
18636/18636 [==============================] - 36s 2ms/step - loss: 0.5
171 - acc: 0.7608 - val_loss: 0.5089 - val_acc: 0.7710
Epoch 10/20
18636/18636 [==============================] - 36s 2ms/step - loss: 0.5
123 - acc: 0.7638 - val_loss: 0.5053 - val_acc: 0.7706
Epoch 11/20
18636/18636 [==============================] - 35s 2ms/step - loss: 0.5
082 - acc: 0.7671 - val_loss: 0.5021 - val_acc: 0.7731
Epoch 12/20
18636/18636 [==============================] - 35s 2ms/step - loss: 0.5
029 - acc: 0.7696 - val_loss: 0.4995 - val_acc: 0.7703
Epoch 13/20
18636/18636 [==============================] - 36s 2ms/step - loss: 0.5
007 - acc: 0.7707 - val_loss: 0.4951 - val_acc: 0.7768
Epoch 14/20
18636/18636 [==============================] - 36s 2ms/step - loss: 0.4
967 - acc: 0.7723 - val_loss: 0.4926 - val_acc: 0.7757
Epoch 15/20
18636/18636 [==============================] - 35s 2ms/step - loss: 0.4
937 - acc: 0.7745 - val_loss: 0.4891 - val_acc: 0.7785
Epoch 16/20
18636/18636 [==============================] - 35s 2ms/step - loss: 0.4
894 - acc: 0.7773 - val_loss: 0.4859 - val_acc: 0.7794
Epoch 17/20
18636/18636 [==============================] - 35s 2ms/step - loss: 0.4
851 - acc: 0.7795 - val_loss: 0.4838 - val_acc: 0.7806
Epoch 18/20
18636/18636 [==============================] - 35s 2ms/step - loss: 0.4
824 - acc: 0.7813 - val_loss: 0.4828 - val_acc: 0.7806
Epoch 19/20
18636/18636 [==============================] - 36s 2ms/step - loss: 0.4
```

```
804 - acc: 0.7803 - val_loss: 0.4788 - val_acc: 0.7811
Epoch 20/20
18636/18636 [==============================] - 35s 2ms/step - loss: 0.4
784 - acc: 0.7831 - val_loss: 0.4784 - val_acc: 0.7830
```

Model gives a validation accuracy of 0.783 finally. Below is the plotted curve.

Also note that 'early stopping' function has been defined for all of the following models that has patience parameter set to 3 (for the validation accuracy), i.e 3 consecutive drops in validation accuracy will cause the model to stop iterating.

In [77]:
```
import matplotlib.pyplot as plt

train_acc = history_cnn.history['acc']
val_acc = history_cnn.history['val_acc']
train_loss = history_cnn.history['loss']
val_loss = history_cnn.history['val_loss']

epochs = range(1, len(train_acc) + 1)

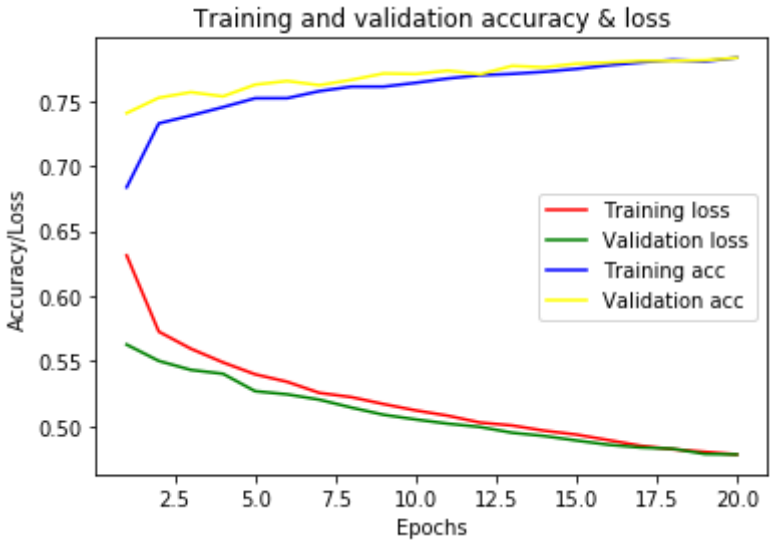
# "bo" is for "blue dot"
plt.plot(epochs, train_loss, 'red', label='Training loss')
# b is for "solid blue line"
plt.plot(epochs, val_loss, 'green', label='Validation loss')

plt.plot(epochs, train_acc, 'blue', label='Training acc')

plt.plot(epochs, val_acc, 'yellow', label='Validation acc')

plt.title('Training and validation accuracy & loss')
plt.xlabel('Epochs')
plt.ylabel('Accuracy/Loss')
plt.legend()

plt.show()
```



The plot above looks consistent - loss goes down and accuracy goes higher as we move through epochs.

3.2

In [78]:
```
datagen = ImageDataGenerator(
    vertical_flip=True,
    rotation_range=10,
    width_shift_range=0.1,
    height_shift_range=0.1,
    horizontal_flip=True)

es = EarlyStopping(monitor='val_loss', mode='min', verbose=1, patience=3
)
# the imagedatagenerator fits our model on several augmentations of the
 images.
history = cnn.fit_generator(datagen.flow(X_train,y_train, batch_size=32
),steps_per_epoch=len(X_train)/32,
                    epochs=20, verbose=1, validation_data = [X_val, y_va
l],callbacks=[es])
```

```
Epoch 1/20
583/582 [==============================] - 49s 83ms/step - loss: 0.4853
- acc: 0.7776 - val_loss: 0.5226 - val_acc: 0.7635
Epoch 2/20
583/582 [==============================] - 49s 84ms/step - loss: 0.4791
- acc: 0.7807 - val_loss: 0.5414 - val_acc: 0.7463
Epoch 3/20
583/582 [==============================] - 49s 84ms/step - loss: 0.4763
- acc: 0.7811 - val_loss: 0.4765 - val_acc: 0.7894
Epoch 4/20
583/582 [==============================] - 49s 83ms/step - loss: 0.4689
- acc: 0.7907 - val_loss: 0.4761 - val_acc: 0.7899
Epoch 5/20
583/582 [==============================] - 49s 85ms/step - loss: 0.4617
- acc: 0.7905 - val_loss: 0.5701 - val_acc: 0.7220
Epoch 6/20
583/582 [==============================] - 49s 84ms/step - loss: 0.4591
- acc: 0.7912 - val_loss: 0.4545 - val_acc: 0.8051
Epoch 7/20
583/582 [==============================] - 49s 84ms/step - loss: 0.4587
- acc: 0.7937 - val_loss: 0.4521 - val_acc: 0.8000
Epoch 8/20
583/582 [==============================] - 49s 84ms/step - loss: 0.4567
- acc: 0.7942 - val_loss: 0.4441 - val_acc: 0.8083
Epoch 9/20
583/582 [==============================] - 49s 84ms/step - loss: 0.4530
- acc: 0.7977 - val_loss: 0.4401 - val_acc: 0.8081
Epoch 10/20
583/582 [==============================] - 49s 84ms/step - loss: 0.4459
- acc: 0.7994 - val_loss: 0.4442 - val_acc: 0.8070
Epoch 11/20
583/582 [==============================] - 49s 84ms/step - loss: 0.4527
- acc: 0.7945 - val_loss: 0.4378 - val_acc: 0.8107
Epoch 12/20
583/582 [==============================] - 49s 84ms/step - loss: 0.4465
- acc: 0.7992 - val_loss: 0.4364 - val_acc: 0.8113
Epoch 13/20
583/582 [==============================] - 49s 84ms/step - loss: 0.4460
- acc: 0.7984 - val_loss: 0.5574 - val_acc: 0.7283
Epoch 14/20
583/582 [==============================] - 49s 84ms/step - loss: 0.4434
- acc: 0.8005 - val_loss: 0.4379 - val_acc: 0.8077
Epoch 15/20
583/582 [==============================] - 49s 84ms/step - loss: 0.4463
- acc: 0.7985 - val_loss: 0.4366 - val_acc: 0.8100
Epoch 00015: early stopping
```

The Image Data Generator employed above does increase the validation accuracy - it goes from 0.78 to 0.81 in this case.

Image Data Generator performs several augmentations on the image, like flips, rotations, etc.

In [79]:
```
import matplotlib.pyplot as plt

train_acc = history.history['acc']
val_acc = history.history['val_acc']
train_loss = history.history['loss']
val_loss = history.history['val_loss']

epochs = range(1, len(train_acc) + 1)

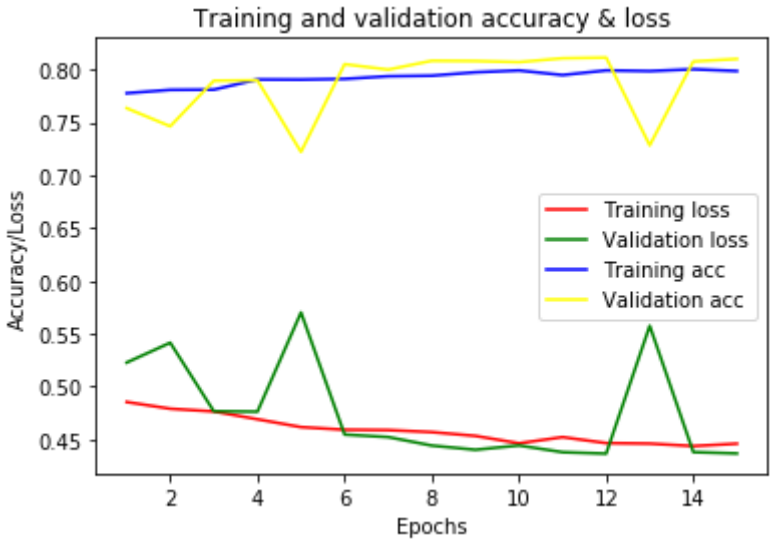
# "bo" is for "blue dot"
plt.plot(epochs, train_loss, 'red', label='Training loss')
# b is for "solid blue line"
plt.plot(epochs, val_loss, 'green', label='Validation loss')

plt.plot(epochs, train_acc, 'blue', label='Training acc')

plt.plot(epochs, val_acc, 'yellow', label='Validation acc')

plt.title('Training and validation accuracy & loss')
plt.xlabel('Epochs')
plt.ylabel('Accuracy/Loss')
plt.legend()

plt.show()
```



The plot for the losses and accuracies is again consistent with our expected results, imagedatagenerator increases the accuracy wrt the previous model.

3.3

Now we move on to building deeper models - the given network has layers conv1_1,conv1_2 ....through conv14_2.

We first start with a network without the residual connections.

In [86]:
```
input_shape = (40, 40, 3)
from keras.layers import Input,Conv2D, MaxPooling2D, Flatten, BatchNorma
lization
from keras.models import Model

num_classes = 2

model = {}

inputs = Input(shape=(40, 40, 3))
model["conv1_1"] = Conv2D(5, (3, 3), activation='tanh',
                 padding='same')(inputs)
model["conv1_2"] = Conv2D(5, (3, 3), activation='tanh',
                 padding='same')(model["conv1_1"])


for i in range(2,15,1):
    model["conv{0}_1".format(i)] =  Conv2D(5, (3, 3), activation='tanh',
                 padding='same')(model["conv{0}_2".format(i-1)])
    model["conv{0}_2".format(i)] = Conv2D(5, (3, 3), activation='tanh',
                 padding='same')(model["conv{0}_1".format(i)])


maxpool5 = MaxPooling2D(pool_size=(2, 2))(model["conv{0}_2".format(i-1
)])

flat = Flatten()(maxpool5)
dense = Dense(64, activation='relu')(flat)
predictions = Dense(num_classes, activation='softmax')(dense)
model = Model(inputs=inputs, outputs=predictions)

model.compile(optimizer=sgd,
              loss='categorical_crossentropy',
              metrics=['accuracy'])

history_deep_without_resid = model.fit_generator(datagen.flow(X_train,y_
train, batch_size=32),steps_per_epoch=len(X_train)/32,
                    epochs=10, verbose=1, validation_data = [X_val, y_va
l],callbacks=[es])
```

```
Epoch 1/10
583/582 [==============================] - 581s 997ms/step - loss: 0.68
86 - acc: 0.5926 - val_loss: 0.6830 - val_acc: 0.6514
Epoch 2/10
583/582 [==============================] - 579s 992ms/step - loss: 0.67
91 - acc: 0.6403 - val_loss: 0.6645 - val_acc: 0.6838
Epoch 3/10
583/582 [==============================] - 582s 999ms/step - loss: 0.62
33 - acc: 0.6910 - val_loss: 0.5686 - val_acc: 0.7190
Epoch 4/10
583/582 [==============================] - 579s 992ms/step - loss: 0.52
69 - acc: 0.7493 - val_loss: 0.4698 - val_acc: 0.7864
Epoch 5/10
583/582 [==============================] - 578s 992ms/step - loss: 0.48
10 - acc: 0.7808 - val_loss: 0.4761 - val_acc: 0.7804
Epoch 6/10
583/582 [==============================] - 577s 989ms/step - loss: 0.47
56 - acc: 0.7840 - val_loss: 0.4626 - val_acc: 0.7909
Epoch 7/10
583/582 [==============================] - 578s 992ms/step - loss: 0.47
23 - acc: 0.7849 - val_loss: 0.4705 - val_acc: 0.7851
Epoch 8/10
583/582 [==============================] - 579s 993ms/step - loss: 0.47
04 - acc: 0.7879 - val_loss: 0.4711 - val_acc: 0.7888
Epoch 9/10
583/582 [==============================] - 574s 985ms/step - loss: 0.46
91 - acc: 0.7901 - val_loss: 0.4594 - val_acc: 0.7944
Epoch 10/10
583/582 [==============================] - 575s 986ms/step - loss: 0.46
70 - acc: 0.7897 - val_loss: 0.4565 - val_acc: 0.7963
```

In [87]:
```
import matplotlib.pyplot as plt

train_acc = history_deep_without_resid.history['acc']
val_acc = history_deep_without_resid.history['val_acc']
train_loss = history_deep_without_resid.history['loss']
val_loss = history_deep_without_resid.history['val_loss']

epochs = range(1, len(train_acc) + 1)

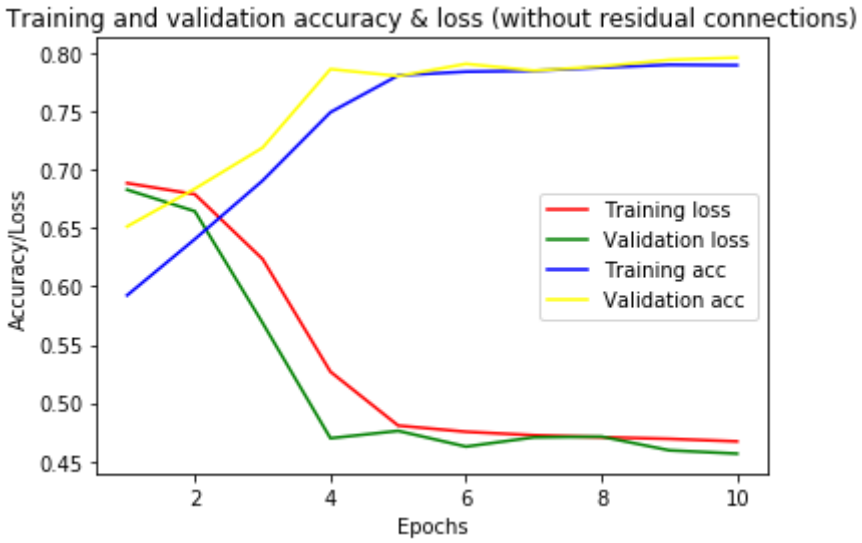
# "bo" is for "blue dot"
plt.plot(epochs, train_loss, 'red', label='Training loss')
# b is for "solid blue line"
plt.plot(epochs, val_loss, 'green', label='Validation loss')

plt.plot(epochs, train_acc, 'blue', label='Training acc')

plt.plot(epochs, val_acc, 'yellow', label='Validation acc')

plt.title('Training and validation accuracy & loss (without residual con
nections)')
plt.xlabel('Epochs')
plt.ylabel('Accuracy/Loss')
plt.legend()

plt.show()
```



Following is the plot for the accuracy and losses obtained - and are in line with expected trends wrt increasing epoch. The model stops at a validation accuracy of 0.793

Moving on to a Network with residual connections applied every alternate layer - i.e from layer 1,2 -> 3, and so on.

In [97]:
```
num_classes = 2

model = {}

inputs = Input(shape=(40, 40, 3))
model["conv1_1"] = Conv2D(5, (3, 3), activation='tanh',
                 padding='same')(inputs)
model["conv1_2"] = Conv2D(5, (3, 3), activation='tanh',
                 padding='same')(model["conv1_1"])


for i in range(2,15,1):

    if i%2 != 0:
        feed = skip
    else:
        feed = model["conv{0}_2".format(i-1)]
    model["conv{0}_1".format(i)] =  Conv2D(5, (3, 3), activation='tanh',
                 padding='same')(feed)
    model["conv{0}_2".format(i)] = Conv2D(5, (3, 3), activation='tanh',
                 padding='same')(model["conv{0}_1".format(i)])

    if i%2 == 0:
        skip = keras.layers.Add()([model["conv{0}_2".format(i-1)],model[
"conv{0}_2".format(i)]])

maxpool5 = MaxPooling2D(pool_size=(2, 2))(model["conv{0}_2".format(i-1
)])

flat = Flatten()(maxpool5)
dense = Dense(64, activation='relu')(flat)
predictions = Dense(num_classes, activation='softmax')(dense)
model = Model(inputs=inputs, outputs=predictions)

model.compile(optimizer=sgd,
              loss='categorical_crossentropy',
              metrics=['accuracy'])

history_deep_without_resid = model.fit_generator(datagen.flow(X_train,y_
train, batch_size=32),steps_per_epoch=len(X_train)/32,
                    epochs=10, verbose=1, validation_data = [X_val, y_va
l],callbacks=[es])
```

```
Epoch 1/10
583/582 [==============================] - 590s 1s/step - loss: 0.6412
- acc: 0.6417 - val_loss: 0.5857 - val_acc: 0.6954
Epoch 2/10
583/582 [==============================] - 584s 1s/step - loss: 0.5348
- acc: 0.7419 - val_loss: 0.5738 - val_acc: 0.7315
Epoch 3/10
583/582 [==============================] - 581s 997ms/step - loss: 0.48
41 - acc: 0.7772 - val_loss: 0.7073 - val_acc: 0.5754
Epoch 4/10
583/582 [==============================] - 577s 990ms/step - loss: 0.46
80 - acc: 0.7877 - val_loss: 0.5264 - val_acc: 0.7495
Epoch 5/10
583/582 [==============================] - 575s 986ms/step - loss: 0.45
98 - acc: 0.7950 - val_loss: 0.4627 - val_acc: 0.7950
Epoch 6/10
583/582 [==============================] - 571s 979ms/step - loss: 0.45
58 - acc: 0.7969 - val_loss: 0.4380 - val_acc: 0.8066
Epoch 7/10
583/582 [==============================] - 573s 982ms/step - loss: 0.44
83 - acc: 0.8016 - val_loss: 0.4346 - val_acc: 0.8096
Epoch 8/10
583/582 [==============================] - 571s 979ms/step - loss: 0.44
31 - acc: 0.8019 - val_loss: 0.4815 - val_acc: 0.7836
Epoch 9/10
583/582 [==============================] - 573s 983ms/step - loss: 0.44
56 - acc: 0.8009 - val_loss: 0.4318 - val_acc: 0.8077
Epoch 10/10
583/582 [==============================] - 572s 982ms/step - loss: 0.44
22 - acc: 0.8034 - val_loss: 0.4402 - val_acc: 0.8051
```

A slightly higher validation accuracy of 0.805 is obtained - up from 0.793. Residual connections show a marginal increase, though real effects would be visible on much larger networks.

In [98]:
```
import matplotlib.pyplot as plt

train_acc = history_deep.history['acc']
val_acc = history_deep.history['val_acc']
train_loss = history_deep.history['loss']
val_loss = history_deep.history['val_loss']

epochs = range(1, len(train_acc) + 1)

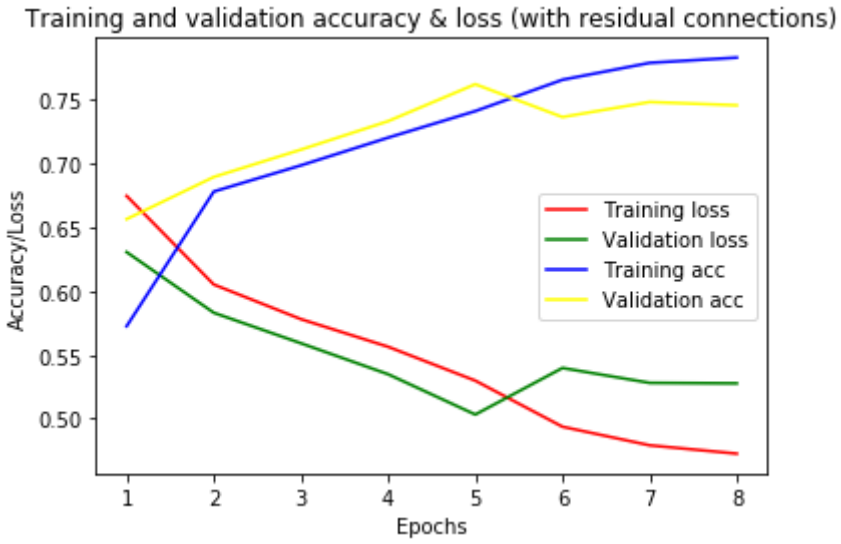
# "bo" is for "blue dot"
plt.plot(epochs, train_loss, 'red', label='Training loss')
# b is for "solid blue line"
plt.plot(epochs, val_loss, 'green', label='Validation loss')

plt.plot(epochs, train_acc, 'blue', label='Training acc')

plt.plot(epochs, val_acc, 'yellow', label='Validation acc')

plt.title('Training and validation accuracy & loss (with residual connec
tions)')
plt.xlabel('Epochs')
plt.ylabel('Accuracy/Loss')
plt.legend()

plt.show()
```



Plotting the accuracies and losses - early stopping stopped the model at the 8th epoch, and hence the increase in loss towards the end. Patience parameter was set to 3, so the model stopped appropriately.