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Homework-7 Report

1. **Generative Models for Text:**
    a. Building a generative model to mimic the writing style of prominent British Mathematician, Philosopher, prolific writer, and political activist, Bertrand Russell.
    b. Downloaded the following 4 textbooks in text format:
    i. The Problems of Philosophy
    ii. The Analysis of Mind
    iii. Mysticism and Logic and Other Essays
    iv. Our Knowledge of the External World as a Field for Scientic Method in Philosophy
    c. **LSTM:**
        i. Concatenated the textbooks downloaded in 1.b.
        ii. Total Characters: 1611845
        Total Vocabulary: 100
        iii. Window size selected as W=100.
        iv. --
        v. Total Patterns: 1611745
        vi. --
        vii. Used Softmax output layer to yield a probability prediction for each of the characters between 0 and 1 and used log loss (cross entropy) as the objective function for the network.
        viii. Used whole dataset as Training dataset.
        ix. Number of Epochs chosen=15.
        x. Model checkpoint is used to keep the network weights to determine each time an improvement in loss is observed at the end of the epoch.

```
Epoch 1/15
1611745/1611745 [==============================] - 387s 240us/step - loss: 3.0493

Epoch 00001: loss improved from inf to 3.04928, saving model to weights-improvement-01-3.0493.hdf5
Epoch 2/15
1611745/1611745 [==============================] - 386s 240us/step - loss: 2.8945

Epoch 00002: loss improved from 3.04928 to 2.89454, saving model to weights-improvement-02-2.8945.hdf5
Epoch 3/15
1611745/1611745 [==============================] - 387s 240us/step - loss: 2.8276
```

Epoch 00003: loss improved from 2.89454 to 2.82755, saving model to weights-improvement-03-2.8276.hdf5
Epoch 4/15
1611745/1611745 [==============================] - 388s 241us/step - loss: 2.7838

Epoch 00004: loss improved from 2.82755 to 2.78377, saving model to weights-improvement-04-2.7838.hdf5
Epoch 5/15
1611745/1611745 [==============================] - 388s 241us/step - loss: 2.7462

Epoch 00005: loss improved from 2.78377 to 2.74624, saving model to weights-improvement-05-2.7462.hdf5
Epoch 6/15
1611745/1611745 [==============================] - 388s 241us/step - loss: 2.7128

Epoch 00006: loss improved from 2.74624 to 2.71278, saving model to weights-improvement-06-2.7128.hdf5
Epoch 7/15
1611745/1611745 [==============================] - 388s 241us/step - loss: 2.6830

Epoch 00007: loss improved from 2.71278 to 2.68295, saving model to weights-improvement-07-2.6830.hdf5
Epoch 8/15
1611745/1611745 [==============================] - 389s 241us/step - loss: 2.6541

Epoch 00008: loss improved from 2.68295 to 2.65409, saving model to weights-improvement-08-2.6541.hdf5
Epoch 9/15
1611745/1611745 [==============================] - 389s 242us/step - loss: 2.6260

Epoch 00009: loss improved from 2.65409 to 2.62601, saving model to weights-improvement-09-2.6260.hdf5
Epoch 10/15
1611745/1611745 [==============================] - 388s 241us/step - loss: 2.5979

Epoch 00010: loss improved from 2.62601 to 2.59792, saving model to weights-improvement-10-2.5979.hdf5
Epoch 11/15
1611745/1611745 [==============================] - 388s 241us/step - loss: 2.5702

Epoch 00011: loss improved from 2.59792 to 2.57024, saving model to weights-improvement-11-2.5702.hdf5
Epoch 12/15
1611745/1611745 [==============================] - 388s 241us/step - loss: 2.5438

Epoch 00012: loss improved from 2.57024 to 2.54382, saving model to weights-improvement-12-2.5438.hdf5
Epoch 13/15
1611745/1611745 [==============================] - 388s 241us/step - loss: 2.5181

Epoch 00013: loss improved from 2.54382 to 2.51808, saving model to weights-improvement-13-2.5181.hdf5
Epoch 14/15
1611745/1611745 [==============================] - 388s 241us/step - loss: 2.4926

Epoch 00014: loss improved from 2.51808 to 2.49257, saving model to weights-improvement-14-2.4926.hdf5
Epoch 15/15
1611745/1611745 [==============================] - 390s 242us/step - loss: 2.4691

Epoch 00015: loss improved from 2.49257 to 2.46909, saving model to weights-improvement-15-2.4691.hdf5
<keras.callbacks.History at 0x7fe3209b2e10>

The best set of weights in terms of loss is in Epoch 15 with a loss of 2.4691

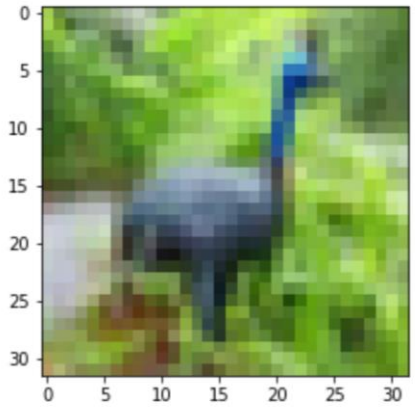
xi. Sentence used for prediction: There are those who take mental phenomena naively, just as they would physical phenomena. This school of psychologists tends not to emphasize the object.
Output: is the sere th the the sore of the sere th the the sore and the sare "and the sored of the sere th the the soene th the the sore and the sare "and the sored of the sere th the the soene th the the sore and the sare "and the sored of the sere th the the soene th the the sore and the sare "and the sored of the sere th the the soene th the the sore and the sare "and the sored of the sere th the the soene th the the sore and the sare "and the sored of the sere th the the soene th the the sore and the sare "and the sored of the sere th the the soene th the the sore and the sare "and the sored of the sere th the the soene th the the sore and the sare "and the sored of the sere th the the soene th the the sore and the sare "and the sored of the sere th the the soene th the the sore and the sare "and the sored of the sere th the the soene th the the sore and the sare "and the sored of the sere th the the soene th the the sore and the sare "and the sored of the sere th the the soe

We can see that the above predicted output isn't accurate. We can improve the performance of the model by increasing the number of Epoch's or by inputting more data (textbooks).

2. <u>(Deep) CNNs for Image Colorization:</u>

a. Dataset downloaded

b. Extracted the class birds from train and test datasets.
Shape of the data: (6000, 32, 32, 3)
One of the images:



c. Pixel's selected:
[[164 206 84]
[105 140 61]
[118 148 101]
...
[156 179 95]
[158 180 98]
[157 179 98]]

d. K-means clustering on the P vectors using k = 4:
KMeans(algorithm='auto', copy_x=True, init='k-means++', max_iter=300, n_clusters=4, n_init=10, n_jobs=None, precompute_distances='auto', random_state=None, tol=0.0001, verbose=0)
Cluster centers:
array([[156.37287845, 155.66372502, 135.67160076],
[206.58262579, 211.86674913, 211.57118882],
[49.07657012, 50.05161286, 38.58521485],
[109.02727327, 108.6914443 , 82.80830299]])

e. Original to Grayscale conversion is done using skimage.color rgb2grey function.

f. Deep Convolutional Neural Network:
Model summary:

```
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_1 (Conv2D)            (None, 32, 32, 64)        1664
_________________________________________________________________
max_pooling2d_1 (MaxPooling2 (None, 32, 32, 64)        0
_________________________________________________________________
conv2d_2 (Conv2D)            (None, 32, 32, 64)        102464
_________________________________________________________________
max_pooling2d_2 (MaxPooling2 (None, 32, 32, 64)        0
_________________________________________________________________
dense_1 (Dense)              (None, 32, 32, 32)        2080
_________________________________________________________________
dense_2 (Dense)              (None, 32, 32, 4)         132
=================================================================
Total params: 106,340
Trainable params: 106,340
Non-trainable params: 0
_________________________________________________________________
```

Output of each Epoch:

Train on 5400 samples, validate on 600 samples

Epoch 1/20

- 2s - loss: 0.8433 - acc: 0.7128 - val_loss: 0.8026 - val_acc: 0.7208

Epoch 2/20

- 2s - loss: 0.7774 - acc: 0.7242 - val_loss: 0.7565 - val_acc: 0.7165

Epoch 3/20

- 2s - loss: 0.7259 - acc: 0.7322 - val_loss: 0.7038 - val_acc: 0.7364

Epoch 4/20

- 2s - loss: 0.6895 - acc: 0.7356 - val_loss: 0.6700 - val_acc: 0.7340

Epoch 5/20

- 2s - loss: 0.6563 - acc: 0.7404 - val_loss: 0.6412 - val_acc: 0.7450

Epoch 6/20

- 2s - loss: 0.6358 - acc: 0.7408 - val_loss: 0.6166 - val_acc: 0.7448

Epoch 7/20

- 2s - loss: 0.6150 - acc: 0.7421 - val_loss: 0.6206 - val_acc: 0.7218

Epoch 8/20

- 2s - loss: 0.5951 - acc: 0.7451 - val_loss: 0.5807 - val_acc: 0.7479

Epoch 9/20

- 2s - loss: 0.5750 - acc: 0.7489 - val_loss: 0.6060 - val_acc: 0.7083

Epoch 10/20

- 2s - loss: 0.5649 - acc: 0.7468 - val_loss: 0.5714 - val_acc: 0.7258

Epoch 11/20

- 2s - loss: 0.5519 - acc: 0.7477 - val_loss: 0.5429 - val_acc: 0.7456

Epoch 12/20

- 2s - loss: 0.5386 - acc: 0.7488 - val_loss: 0.5317 - val_acc: 0.7519

Epoch 13/20

- 2s - loss: 0.5274 - acc: 0.7488 - val_loss: 0.5197 - val_acc: 0.7518

Epoch 14/20

- 2s - loss: 0.5163 - acc: 0.7491 - val_loss: 0.5115 - val_acc: 0.7513

Epoch 15/20

- 2s - loss: 0.5072 - acc: 0.7485 - val_loss: 0.4973 - val_acc: 0.7493

Epoch 16/20

- 2s - loss: 0.4940 - acc: 0.7499 - val_loss: 0.4893 - val_acc: 0.7551

Epoch 17/20

- 2s - loss: 0.4870 - acc: 0.7485 - val_loss: 0.4854 - val_acc: 0.7573

Epoch 18/20

- 2s - loss: 0.4814 - acc: 0.8098 - val_loss: 0.4805 - val_acc: 0.8496

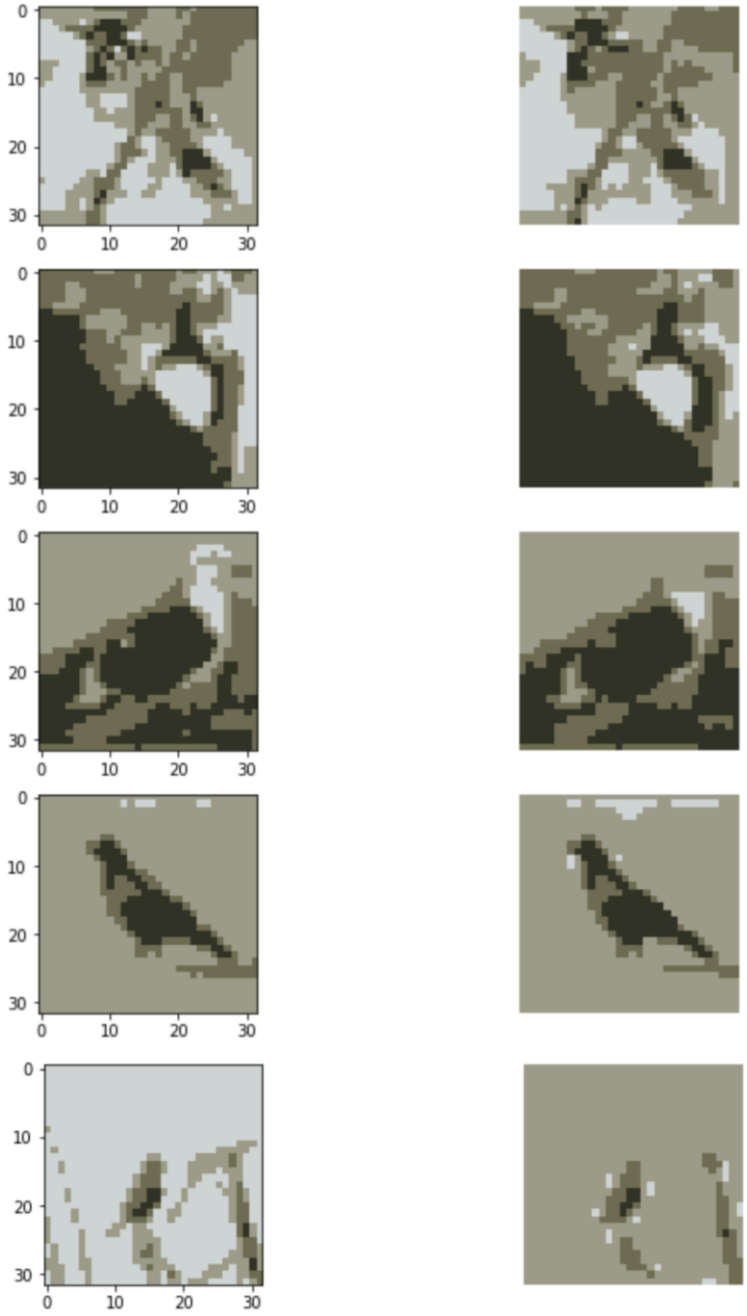
Epoch 19/20

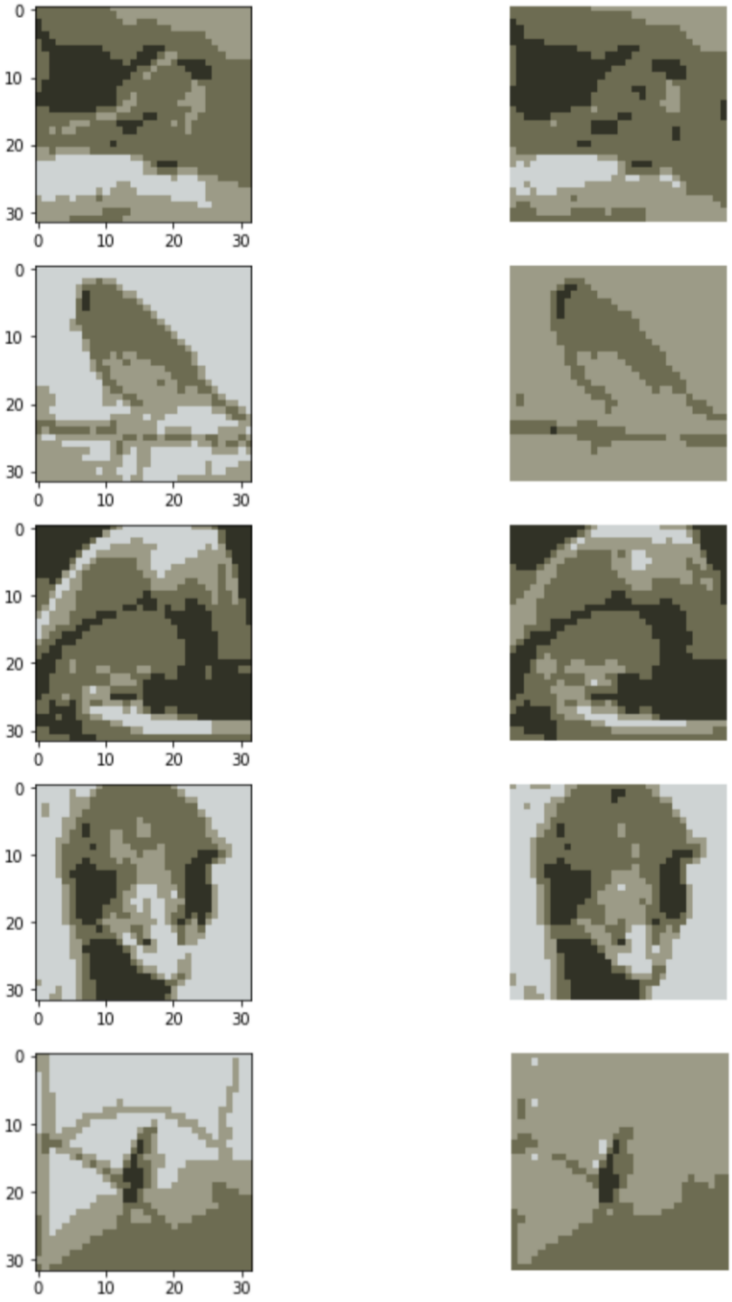
- 2s - loss: 0.4669 - acc: 0.8575 - val_loss: 0.4659 - val_acc: 0.8668

Epoch 20/20

- 2s - loss: 0.4611 - acc: 0.8587 - val_loss: 0.4594 - val_acc: 0.8469

Comparing the artificially colored versions of the first 10 images in the test set with the original images:




0
10
20
30
0
10
20
30

Plotting training and test errors: