03_Normalized_Model_100epo

March 24, 2020

0.1 P3. Normalized model - more epochs

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Mar 2020

- Course: *Introduction to Deep Learning & Neural Networks with Keras*
- Final Project: Build a Regression Model in Keras - Part 3 Normalized Model with more epochs

Increase he number of epochs (5 marks) Repeat Part B but use **100 epochs** this time for training.

How does the mean of the mean squared errors compare to that from Step B?

0.1.1 1.1. Download, load and clean the data

[1]:

```
import pandas as pd
import numpy as np
```

[2]:

```
# df_concrete_data = pd.read_csv('https://s3-api.us-geo.objectstorage.softlayer.
 ↪net/cf-courses-data/CognitiveClass/DL0101EN/labs/data/concrete_data.csv')

df_concrete_data = pd.read_csv("./concrete_data.csv")
df_concrete_data.head(7)
```

[2]:

```
   Cement  Blast Furnace Slag  Fly Ash  Water  Superplasticizer  \
0   540.0                 0.0      0.0  162.0               2.5
1   540.0                 0.0      0.0  162.0               2.5
2   332.5               142.5      0.0  228.0               0.0
3   332.5               142.5      0.0  228.0               0.0
4   198.6               132.4      0.0  192.0               0.0
5   266.0               114.0      0.0  228.0               0.0
6   380.0                95.0      0.0  228.0               0.0

   Coarse Aggregate  Fine Aggregate  Age  Strength
0            1040.0           676.0   28     79.99
1            1055.0           676.0   28     61.89
```

```
2              932.0            594.0  270     40.27
3              932.0            594.0  365     41.05
4              978.4            825.5  360     44.30
5              932.0            670.0   90     47.03
6              932.0            594.0  365     43.70
```

[3]:

```
# Any null value?
df_concrete_data.isnull().sum()

# ... No, good.
```

[3]:

```
Cement                0
Blast Furnace Slag    0
Fly Ash               0
Water                 0
Superplasticizer      0
Coarse Aggregate      0
Fine Aggregate        0
Age                   0
Strength              0
dtype: int64
```

0.1.2 1.2. Split data into predictors and target

[4]:

```
## Exclude columns 'Age', 'Strength' for predictors
df_predictors = df_concrete_data[df_concrete_data.columns.difference(['Age',␣
 ↪'Strength'])]

df_target = df_concrete_data['Strength']
```

0.1.3 1.3. Normalizing

[5]:

```
df_predictors_norm = (df_predictors - df_predictors.mean()) / df_predictors.
 ↪std()
df_predictors_norm.head()
```

[5]:

```
   Blast Furnace Slag    Cement  Coarse Aggregate  Fine Aggregate   Fly Ash  \
0           -0.856472  2.476712          0.862735       -1.217079 -0.846733
1           -0.856472  2.476712          1.055651       -1.217079 -0.846733
2            0.795140  0.491187         -0.526262       -2.239829 -0.846733
3            0.795140  0.491187         -0.526262       -2.239829 -0.846733
4            0.678079 -0.790075          0.070492        0.647569 -0.846733

   Superplasticizer     Water
```

```
0         -0.620147 -0.916319
1         -0.620147 -0.916319
2         -1.038638  2.174405
3         -1.038638  2.174405
4         -1.038638  0.488555
```

[6]:
```
n_cols = df_predictors_norm.shape[1]  # == df_predictors
n_cols # number of predictors
```

[6]:
```
7
```

0.1.4 1.4. Build model with keras

[7]:
```
import keras

from keras.models import Sequential
from keras.layers import Dense
```

```
Using TensorFlow backend.
```

[8]:
```
## Define regression model as a python function (which we can re-use later)

def regression_model(n_cols, nodes_per_hlayer=[10,], opt='adam',␣
 ↪loss='mean_squared_error'):
    ## 1 - Create model
    model = Sequential()
    for ix, num_nodes in enumerate(nodes_per_hlayer):
      if ix == 0: # first layer
        model.add(Dense(num_nodes, activation='relu', input_shape=(n_cols,)))
      else:
        model.add(Dense(num_nodes, activation='relu'))
    model.add(Dense(1)) # output layer

    ## 2 - Compile model
    model.compile(optimizer=opt, loss=loss, metrics=[loss])
    return model
```

[9]:
```
from sklearn.model_selection import train_test_split

## Define train/test split wrapper function

def split_data(df_pred, df_target, test_size=0.3, random_state=6776):
  X_train, X_test, y_train, y_test = train_test_split(df_pred, df_target,
                                                      test_size=test_size,
                                                      random_state=random_state)
  return (X_train, X_test, y_train, y_test) # tuple
```

0.1.5 1.5. Instanciate the model

[10]:

```
## as per spec n_cols input, 10 nodes in only 1 layer (array of length 1)
model = regression_model(n_cols, nodes_per_hlayer=[10])

model.summary()
```

```
Model: "sequential_1"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
dense_1 (Dense)              (None, 10)                80
_________________________________________________________________
dense_2 (Dense)              (None, 1)                 11
=================================================================
Total params: 91
Trainable params: 91
Non-trainable params: 0
_________________________________________________________________
```

0.1.6 1.6. Train and evaluate the model

[11]:

```
from sklearn.metrics import mean_squared_error
```

[12]:

```
## Main Train/Eval loop - 50 iterations

N = 50
mse_ary = []

for ix in range(0, N):
  ## Reset model
  model = regression_model(n_cols, nodes_per_hlayer=[10])

  ## Split the data into train and test set using opur wrapper function
  X_train, X_test, y_train, y_test = split_data(df_predictors_norm, df_target)

  ## Fit the model - No train/validation split
  _history = model.fit(X_train, y_train,
                       epochs=100,  # <--- 100 epochs
                       verbose=0)

  ## Make Predictions
  pred = model.predict(X_test)

  ## Compare to ground truth
  mse = mean_squared_error(y_test, pred)
```

```
print("Iteration: {:2d} / MSE: {:1.5f}".format(ix, mse))

## Keep it for later
mse_ary.append(mse)
```

```
WARNING: Logging before flag parsing goes to stderr.
W0322 11:46:56.934609 140436683749184 deprecation_wrapper.py:119] From /home/pas
cal/Projects/ML_DL/anaconda3/envs/tensorflow_keras_gpuenv/lib/python3.7/site-
packages/keras/backend/tensorflow_backend.py:422: The name tf.global_variables
is deprecated. Please use tf.compat.v1.global_variables instead.


Iteration:  0 / MSE: 207.05974
Iteration:  1 / MSE: 224.74386
Iteration:  2 / MSE: 206.38742
Iteration:  3 / MSE: 229.62057
Iteration:  4 / MSE: 208.31938
Iteration:  5 / MSE: 212.22085
Iteration:  6 / MSE: 217.86804
Iteration:  7 / MSE: 228.25356
Iteration:  8 / MSE: 234.14931
Iteration:  9 / MSE: 219.09961
Iteration: 10 / MSE: 222.61764
Iteration: 11 / MSE: 215.53500
Iteration: 12 / MSE: 204.55305
Iteration: 13 / MSE: 213.08729
Iteration: 14 / MSE: 225.58184
Iteration: 15 / MSE: 205.59929
Iteration: 16 / MSE: 228.68396
Iteration: 17 / MSE: 208.86463
Iteration: 18 / MSE: 199.45614
Iteration: 19 / MSE: 215.20687
Iteration: 20 / MSE: 209.20791
Iteration: 21 / MSE: 219.00924
Iteration: 22 / MSE: 216.35133
Iteration: 23 / MSE: 205.75799
Iteration: 24 / MSE: 218.03700
Iteration: 25 / MSE: 201.54907
Iteration: 26 / MSE: 220.09426
Iteration: 27 / MSE: 222.94512
Iteration: 28 / MSE: 229.21266
Iteration: 29 / MSE: 243.92618
Iteration: 30 / MSE: 207.07906
Iteration: 31 / MSE: 215.36914
Iteration: 32 / MSE: 217.24760
Iteration: 33 / MSE: 216.85839
Iteration: 34 / MSE: 259.51715
Iteration: 35 / MSE: 208.20616
```

```
Iteration: 36 / MSE: 284.95623
Iteration: 37 / MSE: 220.00691
Iteration: 38 / MSE: 216.97600
Iteration: 39 / MSE: 226.80358
Iteration: 40 / MSE: 208.03649
Iteration: 41 / MSE: 204.54661
Iteration: 42 / MSE: 214.56963
Iteration: 43 / MSE: 227.87797
Iteration: 44 / MSE: 220.99363
Iteration: 45 / MSE: 223.07783
Iteration: 46 / MSE: 212.90123
Iteration: 47 / MSE: 226.00567
Iteration: 48 / MSE: 217.44076
Iteration: 49 / MSE: 208.74910
```

[13]:

```
## Summary

print("Summary baseline model: ")
np_ary = np.array(mse_ary, dtype=np.float64)

## NOTE: using unbiased std - which means diving by N-1 (where N is the size of␣
 ↪sample here 50)
##       just in case, added biased std.
print("mean(MSE): {:2.5f} / unbiased std(MSE): {:2.5f} / biased std(MSE): {:2.
 ↪5f}"\
      .format(np.mean(np_ary), np.std(np_ary, ddof=1), np.std(np_ary, ddof=0)))
```

```
Summary baseline model:
mean(MSE): 219.00436 / unbiased std(MSE): 14.50810 / biased std(MSE): 14.36228
```

Remarks

- More iterations does improve significantly both the mean of MSE and (reduce) the spread (standard deviation) compare to both previous normalized model (with 50 epochs) and the baseline model.

Optional

[14]:

```
ix_max = np_ary.argmax()
ix_min = np_ary.argmin()

print("max: {:2.5f} at epoch: {:2d} / min: {:2.5f} at epoch: {:2d}"\
      .format(np_ary[ix_max], ix_max, np_ary[ix_min], ix_min))
```

```
max: 284.95623 at epoch: 36 / min: 199.45614 at epoch: 18
```

[15]:
```
df_ = pd.read_csv("./02_norm_model.csv")

df_['mse_03_norm100ep'] = np_ary
df_.to_csv('03_norm_100epoch_model.csv', sep=',', encoding='utf-8', index=False)
```

[16]:
```
df_.head()
```

[16]:
```
    mse_01_bl  mse_02_norm  mse_03_norm100ep
0  208.949511   355.939247        207.059742
1  210.507436   512.653717        224.743865
2  190.812754   416.278048        206.387416
3  206.248697   530.620247        229.620568
4  189.519537   369.478724        208.319380
```

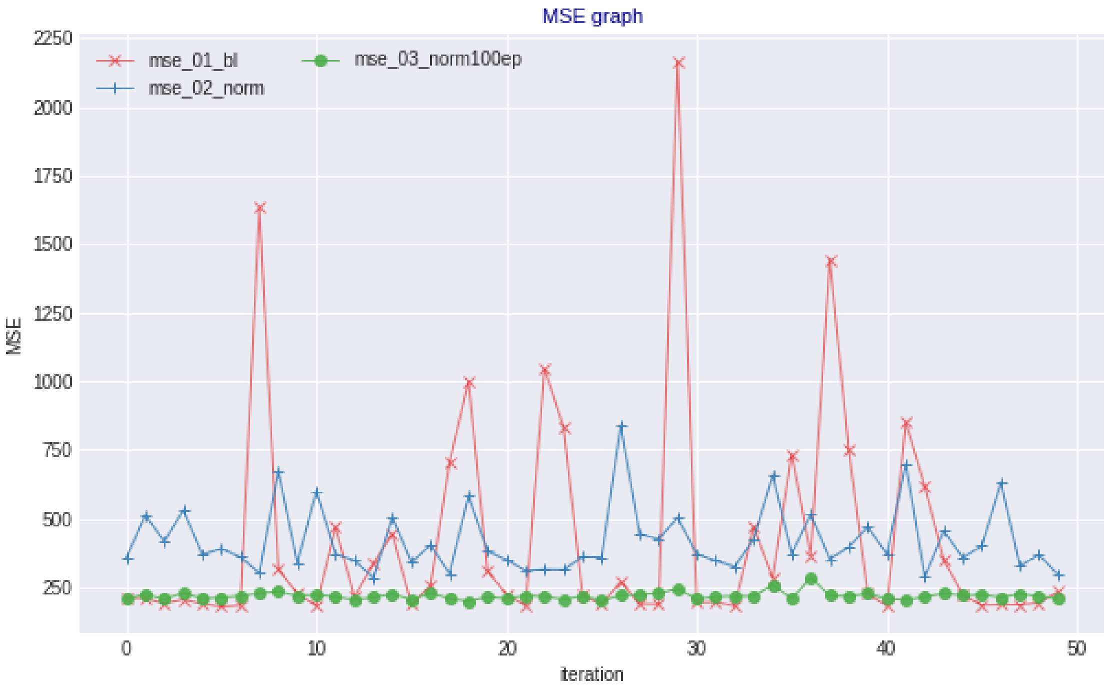
[17]:
```
df_.describe()
```

[17]:
```
         mse_01_bl  mse_02_norm  mse_03_norm100ep
count    50.000000    50.000000         50.000000
mean    424.129761   420.368508        219.004359
std     415.684991   121.693519         14.508099
min     179.674799   284.245219        199.456141
25%     189.380645   347.151831        208.777980
50%     225.632202   371.295692        217.111800
75%     462.052733   465.697787        224.327356
max    2164.597530   838.861597        284.956233
```

[18]:
```
import matplotlib.pyplot as plt
%matplotlib inline

fig = plt.figure(figsize=(10, 6))

# style
plt.style.use('seaborn-darkgrid')

# create a color palette
palette = plt.get_cmap('Set1')

# multiple line plot
ixes = list(range(0, df_.shape[0]))

alpha =0.6
mark=['x', '+', 'o']
for ix, col in enumerate(df_):
  plt.plot(ixes, df_[col], marker=mark[ix], color=palette(ix), linewidth=1,␣
 ↪alpha=alpha,
              label=df_.columns[ix])
  alpha=0.9
```

```
# Add legend
plt.legend(loc=2, ncol=2)

# Add titles
plt.title("MSE graph", loc='center', fontsize=11, fontweight=0,␣
 ↪color='darkblue')
plt.xlabel("iteration")
plt.ylabel("MSE")
```

```
[18]: Text(0, 0.5, 'MSE')
```


MSE graph
mse_01_bl
mse_02_norm
mse_03_norm100ep
MSE
iteration