# RNERALLA_WEEK1_TENSOR

March 21, 2021

[1]:
```
'''Trains a simple deep NN on the MNIST dataset.

Gets to 98.40% test accuracy after 20 epochs
(there is *a lot* of margin for parameter tuning).
2 seconds per epoch on a K520 GPU.
'''

from tensorflow import keras
from tensorflow.keras.datasets import mnist
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense, Dropout
from tensorflow.keras.optimizers import RMSprop

batch_size = 128
num_classes = 10
epochs = 20

# the data, split between train and test sets
(x_train, y_train), (x_test, y_test) = mnist.load_data()

x_train = x_train.reshape(60000, 784)
x_test = x_test.reshape(10000, 784)
x_train = x_train.astype('float32')
x_test = x_test.astype('float32')
x_train /= 255
x_test /= 255
print(x_train.shape[0], 'train samples')
print(x_test.shape[0], 'test samples')

# convert class vectors to binary class matrices
y_train = keras.utils.to_categorical(y_train, num_classes)
y_test = keras.utils.to_categorical(y_test, num_classes)

model = Sequential()
model.add(Dense(512, activation='relu', input_shape=(784,)))
model.add(Dropout(0.2))
model.add(Dense(512, activation='relu'))
```

```
model.add(Dropout(0.2))
model.add(Dense(num_classes, activation='softmax'))

model.summary()

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

history = model.fit(x_train, y_train,
                    batch_size=batch_size,
                    epochs=epochs,
                    verbose=1,
                    validation_data=(x_test, y_test))
score = model.evaluate(x_test, y_test, verbose=0)
print('Test loss:', score[0])
print('Test accuracy:', score[1])
```

```
Downloading data from https://storage.googleapis.com/tensorflow/tf-keras-
datasets/mnist.npz
11493376/11490434 [==============================] - 1s 0us/step
60000 train samples
10000 test samples
Model: "sequential"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
dense (Dense)                (None, 512)               401920
_________________________________________________________________
dropout (Dropout)            (None, 512)               0
_________________________________________________________________
dense_1 (Dense)              (None, 512)               262656
_________________________________________________________________
dropout_1 (Dropout)          (None, 512)               0
_________________________________________________________________
dense_2 (Dense)              (None, 10)                5130
=================================================================
Total params: 669,706
Trainable params: 669,706
Non-trainable params: 0
_________________________________________________________________
Epoch 1/20
469/469 [==============================] - 6s 11ms/step - loss: 0.4338 -
accuracy: 0.8631 - val_loss: 0.1146 - val_accuracy: 0.9642
Epoch 2/20
469/469 [==============================] - 4s 9ms/step - loss: 0.1076 -
accuracy: 0.9672 - val_loss: 0.0901 - val_accuracy: 0.9708
```

```
Epoch 3/20
469/469 [==============================] - 4s 10ms/step - loss: 0.0742 -
accuracy: 0.9772 - val_loss: 0.0717 - val_accuracy: 0.9792
Epoch 4/20
469/469 [==============================] - 4s 9ms/step - loss: 0.0562 -
accuracy: 0.9823 - val_loss: 0.0753 - val_accuracy: 0.9792
Epoch 5/20
469/469 [==============================] - 4s 9ms/step - loss: 0.0466 -
accuracy: 0.9860 - val_loss: 0.0774 - val_accuracy: 0.9805
Epoch 6/20
469/469 [==============================] - 4s 9ms/step - loss: 0.0424 -
accuracy: 0.9870 - val_loss: 0.0727 - val_accuracy: 0.9822
Epoch 7/20
469/469 [==============================] - 4s 9ms/step - loss: 0.0360 -
accuracy: 0.9883 - val_loss: 0.0690 - val_accuracy: 0.9833
Epoch 8/20
469/469 [==============================] - 4s 9ms/step - loss: 0.0307 -
accuracy: 0.9905 - val_loss: 0.0897 - val_accuracy: 0.9827
Epoch 9/20
469/469 [==============================] - 4s 9ms/step - loss: 0.0281 -
accuracy: 0.9913 - val_loss: 0.0884 - val_accuracy: 0.9818
Epoch 10/20
469/469 [==============================] - 4s 9ms/step - loss: 0.0277 -
accuracy: 0.9924 - val_loss: 0.0907 - val_accuracy: 0.9805
Epoch 11/20
469/469 [==============================] - 4s 9ms/step - loss: 0.0247 -
accuracy: 0.9929 - val_loss: 0.0995 - val_accuracy: 0.9825
Epoch 12/20
469/469 [==============================] - 4s 9ms/step - loss: 0.0242 -
accuracy: 0.9930 - val_loss: 0.0982 - val_accuracy: 0.9842
Epoch 13/20
469/469 [==============================] - 4s 9ms/step - loss: 0.0236 -
accuracy: 0.9932 - val_loss: 0.1093 - val_accuracy: 0.9837
Epoch 14/20
469/469 [==============================] - 4s 9ms/step - loss: 0.0200 -
accuracy: 0.9944 - val_loss: 0.1084 - val_accuracy: 0.9842
Epoch 15/20
469/469 [==============================] - 4s 9ms/step - loss: 0.0215 -
accuracy: 0.9938 - val_loss: 0.0985 - val_accuracy: 0.9851
Epoch 16/20
469/469 [==============================] - 4s 9ms/step - loss: 0.0225 -
accuracy: 0.9941 - val_loss: 0.1287 - val_accuracy: 0.9829
Epoch 17/20
469/469 [==============================] - 4s 9ms/step - loss: 0.0208 -
accuracy: 0.9942 - val_loss: 0.1125 - val_accuracy: 0.9848
Epoch 18/20
469/469 [==============================] - 4s 9ms/step - loss: 0.0197 -
accuracy: 0.9950 - val_loss: 0.1334 - val_accuracy: 0.9837
```

```
Epoch 19/20
469/469 [==============================] - 4s 9ms/step - loss: 0.0183 -
accuracy: 0.9946 - val_loss: 0.1353 - val_accuracy: 0.9820
Epoch 20/20
469/469 [==============================] - 4s 9ms/step - loss: 0.0168 -
accuracy: 0.9953 - val_loss: 0.1323 - val_accuracy: 0.9828
Test loss: 0.13227351009845734
Test accuracy: 0.9828000068664551
```

[ ]: