Deep Learning with Keras, Tensorflow and Statistical Programming Language, R

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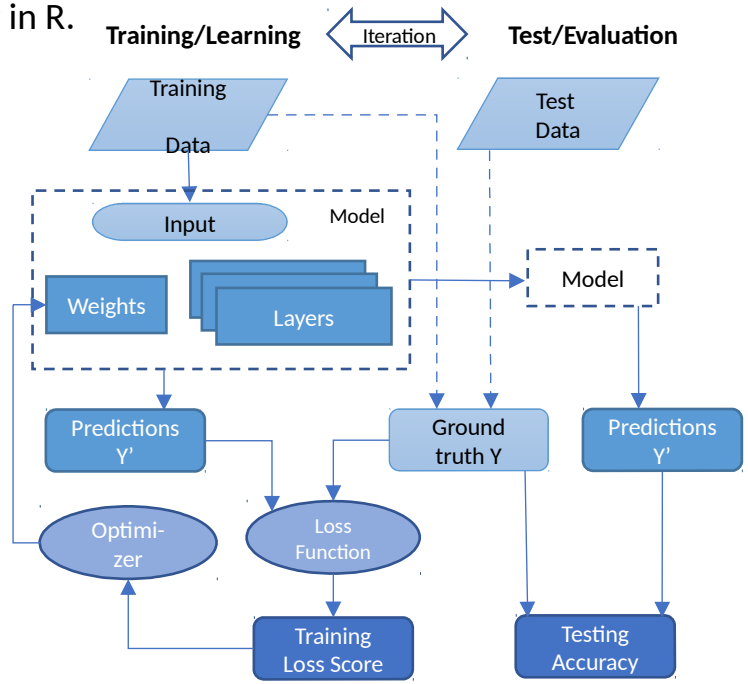
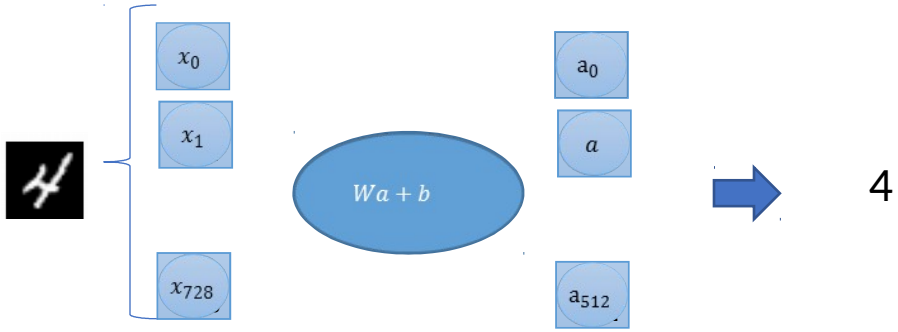
1. **Case Study**: The **MNIST database** comprises 60,000 training examples and 10,000 test examples of the handwritten digits 0–9, formatted as 28x28-pixel matrices, with each pixel carrying a grayscale value 0-255:

2. **Building a handwritten digit classifier in R**:
   Open-source numerical libraries such as Keras and Tensorflow are now available in the R programming language environment. We show a well-known **image recognition application** for the MNIST database using the Keras library in R.

3. **The Statistical Machine Learning workflow:**
   a) **Data representation and pre-processing**: Preprocess data into chosen representation and divide data into training and test datasets
   b) Define a **network architecture**, number of layers and elements in each layer, using **Keras/TF** modules
   c) Adjust network configurations, such as functions and learning rates. Train the model on training set
   d) Evaluate model on the test set and iterate back to c until satisfied



4. **The heart of the Network are the layers, comprised of linear transformation and non-linear activation function**:



5. The advantage of Keras/Tensorflow libraries is how easily one can define the network architecture and how portable the code is between platform, from powerful GPUs to mobile phones. The model above is re

```
Library(keras)
network <-
keras_model_sequential() %>%
   layer_dense(units = 512,
activation = "relu",
input_shape = c(28 * 28)) %>%
   layer_dense(units = 10,
activation = "softmax")
```

6. Explain what epochs, the training loop and learning rate (steps) are in the illustration on each side

7. Ultimately, our model is able to achieve an accuracy of ___% after ___seconds and of training