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Practice Lab: Neural Networks for Handwritten Digit Recognition, Multiclass

In this exercise, you will use a neural network to recognize the hand-written digits 0-9.

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1 - Packages

First, let's run the cell below to import all the packages that you will need during this assignment.

- [numpy \(https://numpy.org/\)](https://numpy.org/) is the fundamental package for scientific computing with Python.
- [matplotlib \(http://matplotlib.org\)](http://matplotlib.org) is a popular library to plot graphs in Python.
- [tensorflow \(https://www.tensorflow.org/\)](https://www.tensorflow.org/) a popular platform for machine learning.

```
In [1]: import numpy as np
import tensorflow as tf
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense
from tensorflow.keras.activations import linear, relu, sigmoid
%matplotlib widget
import matplotlib.pyplot as plt
plt.style.use('./deeplearning.mplstyle')

import logging
logging.getLogger("tensorflow").setLevel(logging.ERROR)
tf.autograph.set_verbosity(0)

from public_tests import *

from utils import *
from lab_utils_softmax import plt_softmax
np.set_printoptions(precision=2)
```

2 - ReLU Activation

This week, a new activation was introduced, the Rectified Linear Unit (ReLU).

$$a = \max(0, z) \quad \# \text{ ReLU function}$$

```
In [2]: plt_act_trio()
```

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The example from the lecture on the right shows an application of the ReLU. In this example, the derived "awareness" feature is not binary but has a continuous range of values. The sigmoid is best for on/off or binary situations. The ReLU provides a continuous linear relationship. Additionally it has an "off" range where the output is zero. The "off" feature makes the ReLU a Non-Linear activation. Why is this needed? This enables multiple units to contribute to the resulting function without interfering. This is examined more in the supporting optional lab.

