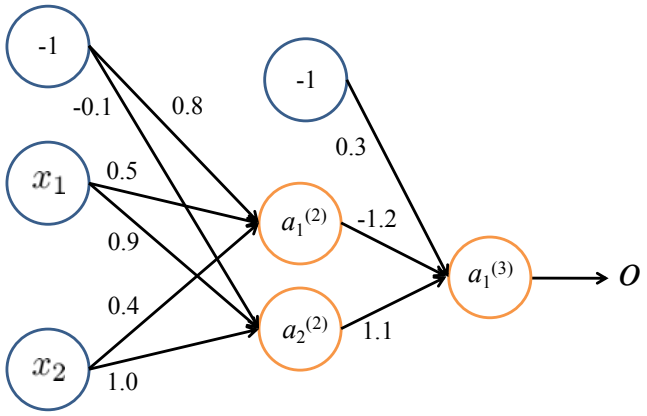
Homework2, Due Date: Mon, Mar 18

Instructor: Dr. Mohammad Pourhomayoun

Problem1: Backpropagation

In the following Neural Network, we have initialized the weights randomly. Use a training sample (X,y) = ((1,1), 0) to update the weights (perform one round of backpropagation using one training sample). Use learning rate parameter α = 0.1. Note that we have bias terms with value of -1 in this network (no need for coding for this question).



Problem2: Adjusting the hyperparameters of MNIST Digit Recognition using ANN model in Keras+TensorFlow and Grid-Search in SciKitLearn:

In this problem, we want to apply an interesting method to use the grid search capability of sklearn library to adjust the hyperparameters of Keras+Tensorflow ANN models!
To do this, we use ***KerasClassifier*** class as a wrapper for Keras models and then use it in sklearn.

Note: Please be aware that it may take a long time (hours) to finish running this code. Please start working on it early!

a- Download the Kears+Tensorflow tutorial from CSNS. Import all required modules including the following:
from keras.wrappers.scikit_learn import KerasClassifier
from sklearn.model_selection import GridSearchCV

b- Import the minst dataset, and split it into testing and training as we saw in the tutorial. Then, reshape each sample into a row vector, and scale it by dividing by 255.

c- Perform OneHotEncoding for the label ***y***. So, your label will be a vector of 10 elements for each data sample.

d- Now, define a function called ***model_creator.*** This function will define, create, and compile your neural network model according to your structure, and then return the built model as the output. For the ANN neurons/layers, use the same structure as we had in the tutorial:

```
def model_creator():
  # define:
  model = Sequential()
  # design the structure:
  model.add(…)
 # compile:
  model.compile(loss='categorical_crossentropy', optimizer='adam',
                metrics=['accuracy'])
 # return:
 return model
```

e- Fix the random state for reproducibility:
seed = 2, np.random.seed(seed)

f- Use ***KerasClassifier*** class to wrap your model as an object:
model = KerasClassifier(build_fn = model_creator, verbose=2)

g- Now, run sklearn GridSearch to find the best batch_size and epochs. Search in this range: batch_size = [30 , 50 , 100] , epochs = [10 , 15 , 20].
In your GridSearch, the estimator is the above ***model***, the scoring should be 'neg_log_loss', and you have to use 10-fold CV.

h- Based on your results, what is the best batch_size and epochs?
Now, test your model with the best batch_size and epochs on the testing set.
grid.best_estimator_.model gives you the best model found and trained in the grid-search. What is the prediction accuracy on the testing set?

WARNING: It may take a long time to finish the process (depending on your system it can be up to hours). So, don't leave it for the last minutes (late submissions will not be accepted!)