Homework2, Due Date: Sun, Mar 15

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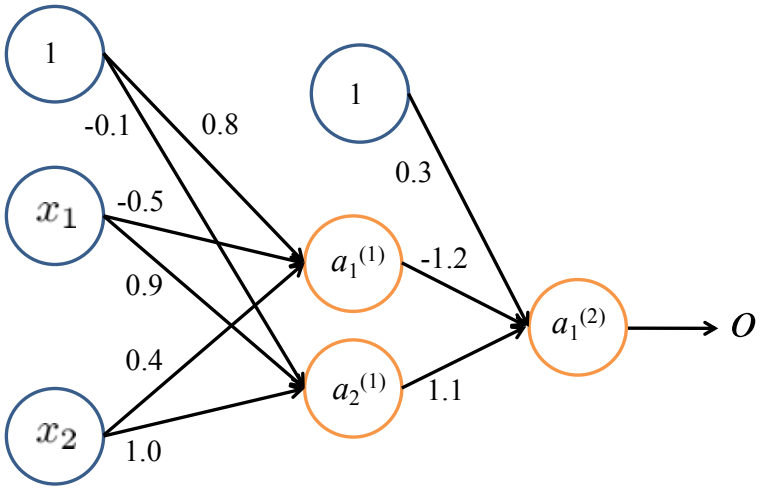
Problem1: Backpropagation

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 (Lec11-Lab4). 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 (check out the tutorial).

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 (use the same structure as we had in the tutorial):
    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 (you learned it in Lec10-Lab3) 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!)