

CS 300 - Artificial Intelligence– Fall 2024

Assignment 4

100 points

Due: Friday, 12/13/24 at 11:59PM

This assignment has two parts. In the first part you explore multilayer neural networks at a high level. In the second part, you implement a multilayer neural network for an image classification task.

In addition to the packages you used for Assignment 3, you will need to install tensorflow with keras (tensorflow) for Part B. Do note that to install tensorflow, you need the 64-bit version of Python installed; installation will fail otherwise. Once you have it installed, you can run this in your regular Jupyter notebooks.

If you want to pursue an online approach, you can use Google's notebook site, Colabs (<https://colab.research.google.com>). In many ways, this editor is easier than Jupyter, and runs all jupyter notebooks directly. It will save the notebooks in your google account. You should be able to upload and download notebooks as required. Colabs does place a limit of 12 hours continuous processing, and it will deactivate with inactivity.

Part A (20 points)

The TensorFlow playground (<https://playground.tensorflow.org/>) is a nice simulator built by the TensorFlow team. In this part, you will train several binary classifiers in just a few clicks, and tweak the model's architecture and hyperparameters to get some understanding on how neural networks work.

- Try training the neural network by clicking the run button (top left). How quickly does it find a solution for each of the four sample classification tasks?
- Try replacing the tanh activation function with the ReLU function and train the network again. What can you say about the output (shape and time taken to get a good classification)?
- Modify the network architecture to have just one hidden layer with three neurons. Train it multiple times (to reset the network weights, click the reset button). What can you comment about this training vs. your answer in (a.)?
- Remove one neuron to keep just two. Retrain the network. What can you comment about this training vs. your answer in (a.) and (c.)?
- Set the number of neurons to eight and train the network several times. What can you comment about this training vs. your answer in (a.), (c.) and (d.)?

Provide your answers to (a) through (e) in a PDF file

Part B (80 points)

Download and run the notebook FNist.ipynb on Canvas, either by running it on your computer, or on Colabs. Look through this example carefully.

Then create a similar notebook, and train a deep Multilayer Neural Network on the MNIST dataset (you can load this using `keras.datasets.mnist.load_data()`). The MNIST dataset is a set of images of handwritten digits 0-9, with the associated target classes also numbered as 0-9. Play around with the different layers and hyperparameters in your network, train your model on the training set and then test it on the test set (The data is already split into training and test sets). Provide sufficient text explanations in your notebook so it is clear what you are doing in each code cell.

A change you must make is you should modify the neural network architecture (layers, connections, etc.) so that you are not using the identical architecture that is used in the MNIST example.

What is the highest accuracy you can achieve? **Clearly state this in your notebook.**

Submission

Submit, zipped up in a folder **Assignment4** and uploaded to the Canvas drop box **Assignment 4** by the deadline, the following:

1. Your answers to Part A in a PDF file
2. Your answers to Part B as a notebook along with any associated files (you do not need to include the data set file. **Please include all the output generated by your notebook too! Do not clear the outputs!**)