CZ4042 NEURAL NETWORKS
PROJECT 1 REPORT

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Part A: Classification

Introduction

The Landsat satellites are part of a continuous effort between NASA and the US Geological Survey to acquire land remote sensing data. The Multispectral Scanner (MSS) sensor aboard the satellites acquires imagery of the earth in four different spectral bands — two of these are in the visible region (corresponding approximately to green and red regions of the visible spectrum) and two are in the (near) infra-red.

The database consists of the multi-spectral values of pixels in 3×3 neighbourhoods in a satellite image, and the classification associated with the central pixel in each neighbourhood. The aim is to predict this classification, given the multi-spectral values.

The whole data set contains 6435 lines. In each line, the multi-spectral values of a neighborhood are specified: the four values for the top-left pixel are given first, followed by the top-middle pixel and then the top-right pixel, and so on with the pixels read out in sequence left-to-right and top-to-bottom. These multi-spectral values are integer-coded from 0 (black) to 255 (white). The class value of the centre pixel is coded as another integer:

Integer	Class
1	red soil
2	cotton crop
3	grey soil
4	damp grey soil
5	soil with vegetation stubble
6	mixture class (all types present)
7	very damp grey soil

No line of class 6 is present in the data set. The training set contains 4435 lines, while the testing set contains 2000 lines.

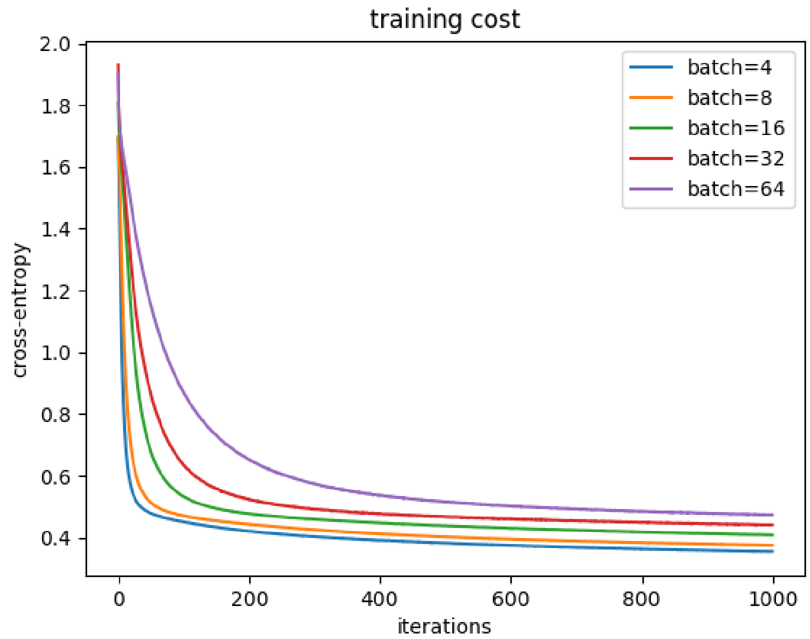
Multilayer feed-forward neural networks are suitable to solve classification problems like this, because it can approximate an arbitrary nonlinear function to a high degree of accuracy, given enough training data.

Experiments

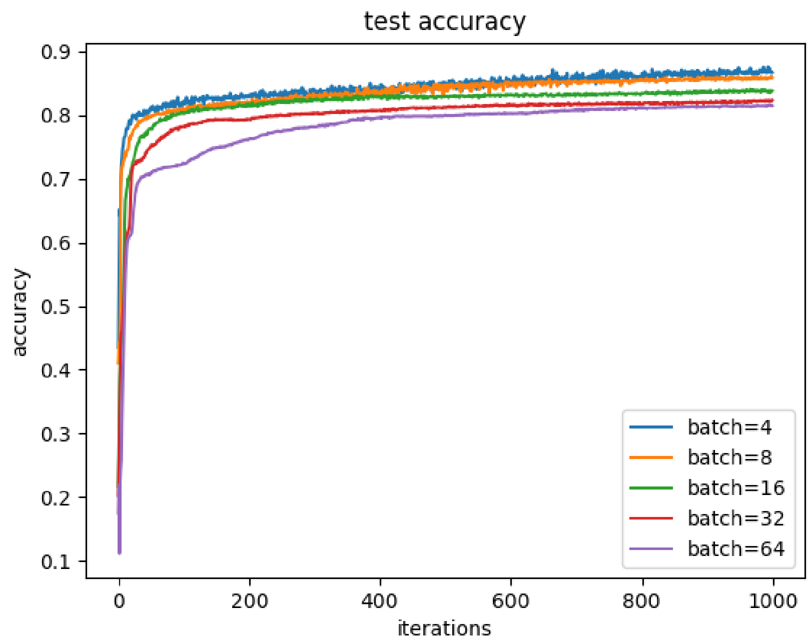
We implemented the neural network as a function `train_test ()` taking three optional parameters: `batch_size`, `hl_neuron` (the hidden layer neuron count) and `decay`. Each experiment is performed by utilizing the search function `search()`, which takes two additional input, the search parameter (either `batch_size`, `hl_neuron` or `decay`) and the search space associated with it. The function would loop through the possible values of the parameter, and train and test the neural network accordingly; graphs are stored and displayed after each experiment.

Experiment 1: Determining the optimal batch size (Question 2)

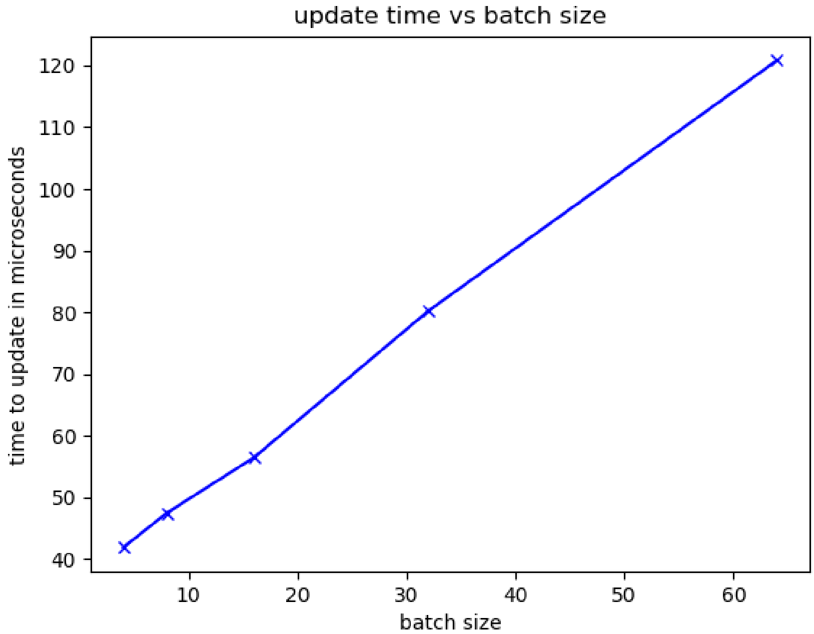
The parameter `batch_size` is varied in the search space $[4, 8, 16, 32, 64]$. Plotting the training errors against the number of epochs for different batch sizes:



Plotting the test accuracy against the number of epochs for different batch sizes:



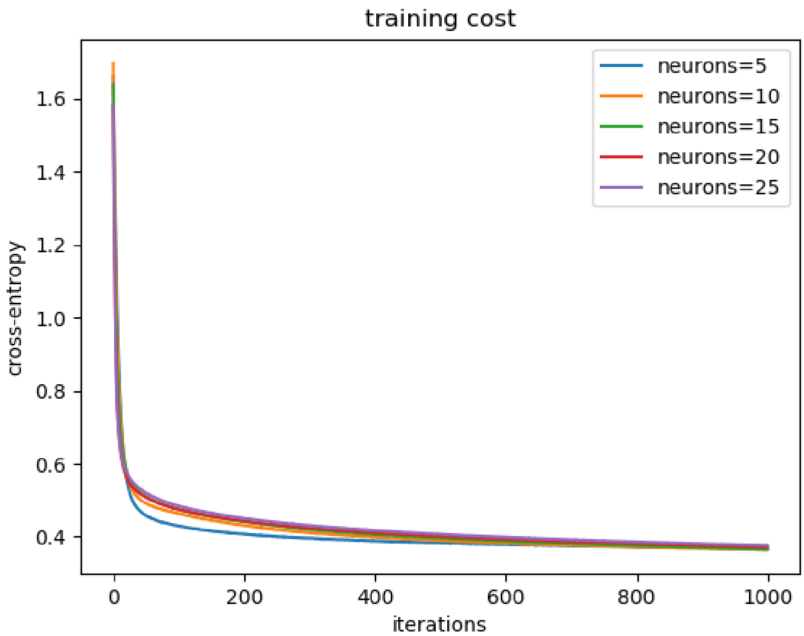
Plotting the time taken to update parameters for different batch sizes:



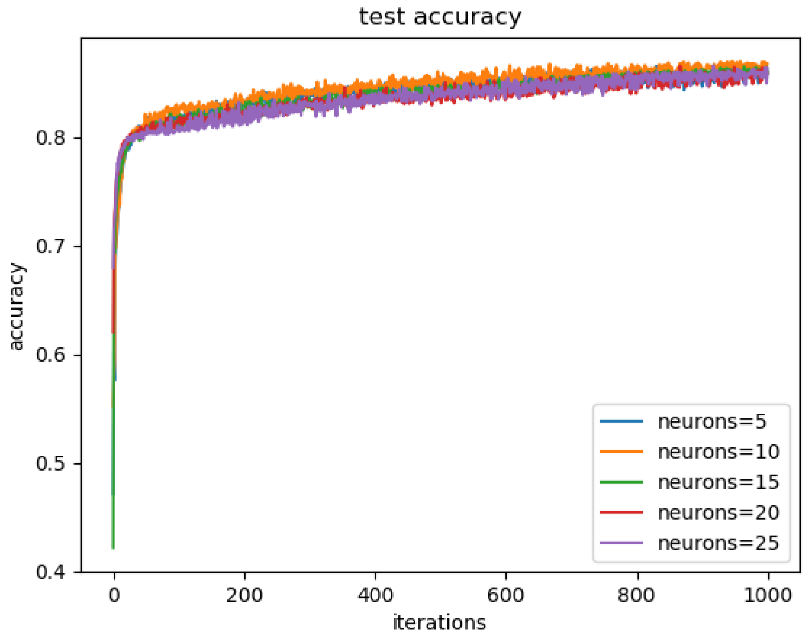
We decided to choose batch size of 4, for the highest test accuracy.

Experiment 2: Determining the optimal number of hidden neurons (Question 3)

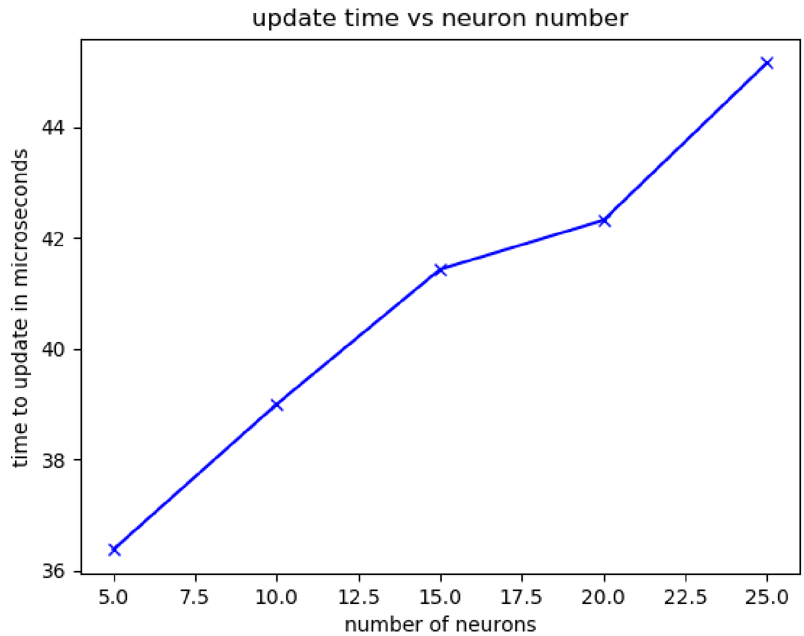
The parameter `hl_neuron` is varied in the search space $[5, 10, 15, 20, 25]$. Plotting the training errors against the number of epochs for different hidden neuron counts:



Plotting the test accuracy against the number of epochs for different hidden neuron counts:



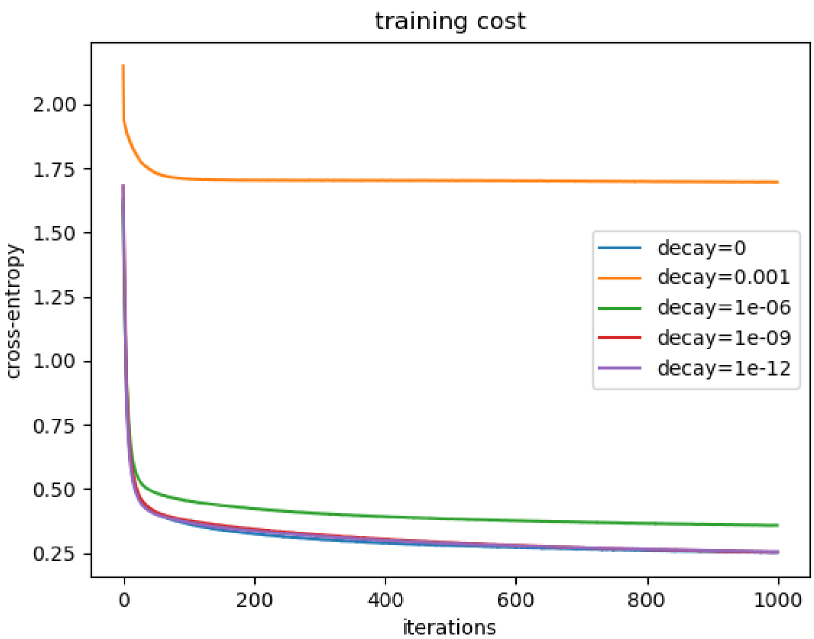
Plotting the time taken to update parameters for different hidden neuron counts:



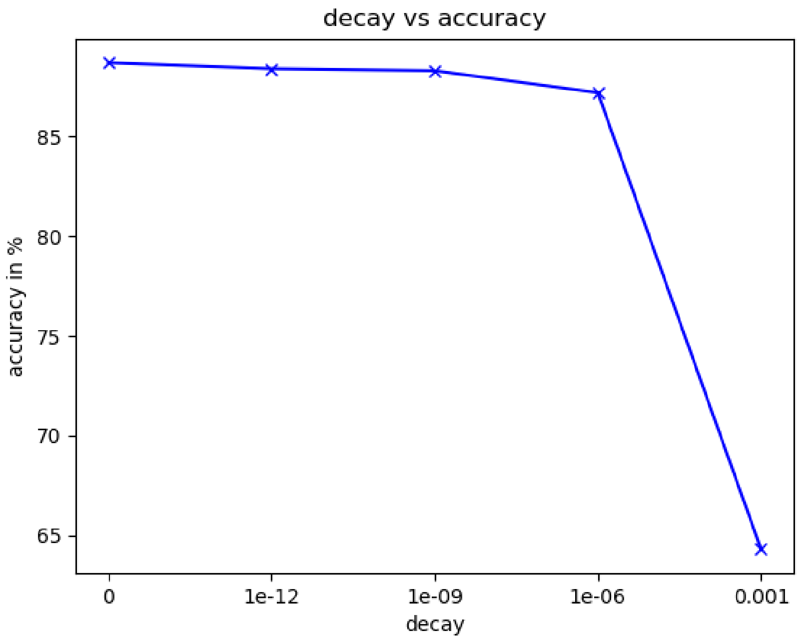
We decided to choose 10 hidden neurons, for the highest test accuracy.

Experiment 3: Determining the optimal decay parameter (Question 4)

The parameter `decay` is varied in the search space $[0, 10^{-12}, 10^{-9}, 10^{-6}, 10^{-3}]$. Plotting the training errors against the number of epochs for different decay parameters:



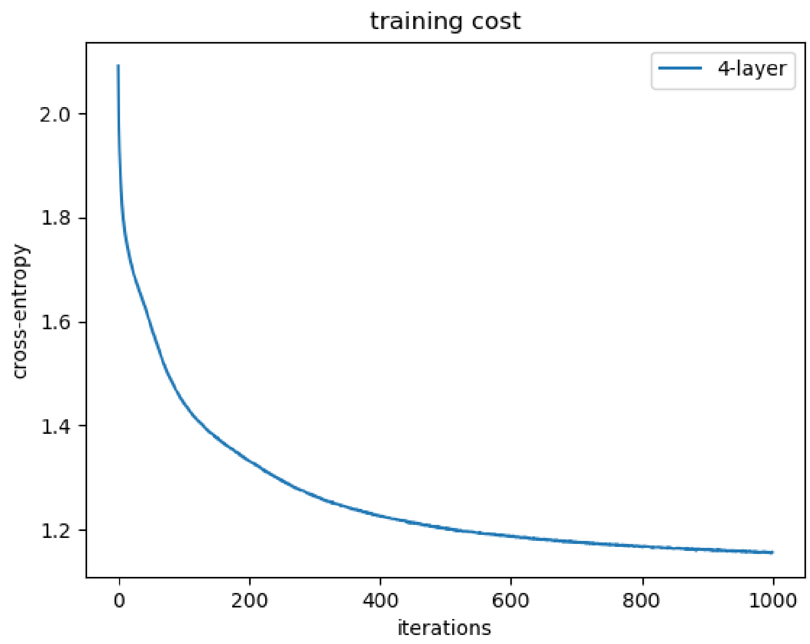
Plotting the test accuracy against the decay parameters:



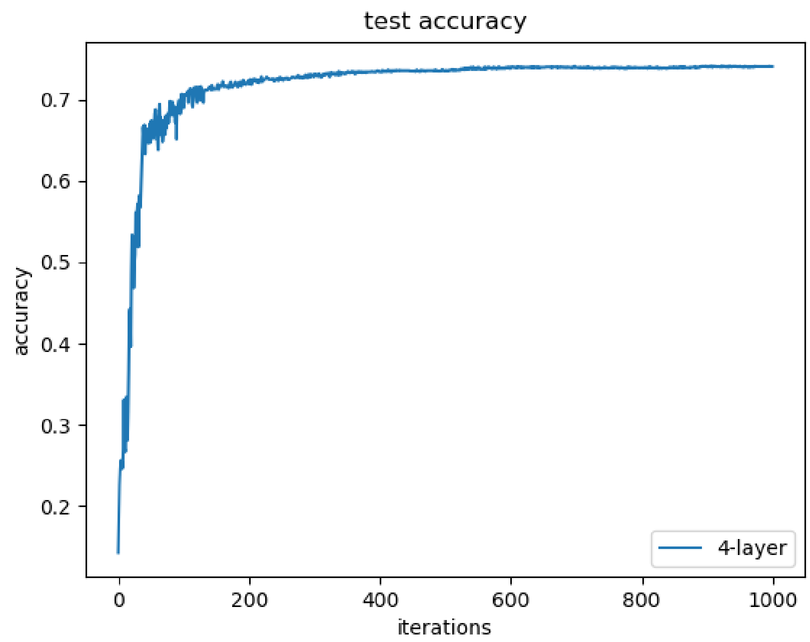
We decided to choose decay parameter 10^{-9}, for the highest accuracy.

Experiment 4: The 4-layer neural network (Question 4)

Plotting the training errors against the number of epochs for the 4-layer network:



Plotting the test accuracy against the number of epochs for the 4-layer network:



The 3-layer network achieves a higher accuracy compared to the 4-layer network. This shows that more layers do not neccesarily lead to higher performance in a feedforward neural network.