A More Realistic Problem

Due Dec 6 by 3:30pm   **Points** 40   **Submitting** on paper

Available after Nov 15 at 3:30pm

Handwriting Recognition With the MNIST Database

At this point, you should pretty much have all of the tools necessary to make a respectable (perhaps not absolutely at the cutting edge of state-of-the-art, but not too far away) show of tackling a real-world problem. This means a problem where the data, in terms of both size and cruftiness, is reasonably substantial. So, let's take a crack at **the MNIST database**   **(https://en.wikipedia.org/wiki/MNIST_database)** , a database of handwritten digits that was originally collected by the National Institute of Standards and Technology and is commonly used to evaluate image processing and machine learning algorithms. Rather than spend a lot of time describing this dataset, please go to its **canonical home page**   **(http://yann.lecun.com/exdb/mnist/)** . There, you can find a complete description, download links, and the results of others' work on this dataset, with links to their papers providing "full" descriptions of what they did. One of the advantages of using such a standard dataset is that there is also code already written to do such things as read the data into Matlab, such as from **this wiki page**   **(http://ufldl.stanford.edu/wiki/index.php/Using_the_MNIST_Dataset)** at Stanford.

Requirements

This assignment is structured as a mini-project, and you have some latitude in deciding exactly what you will do to satisfy the assignment requirements. What you *must* do is:

- Write all non-trivial code to implement your ANN and its learning algorithms.
- Use a multi-layer ANN, with at least one layer using a non-linear transfer function.
- Explore at least one aspect of this ANN architecture or learning algorithm, assessing the relationship between this aspect and the learning process and the resultant network's performance on the test set.
- Relate what you have done to what you've learned in this class.
- Write a professional report documenting what you have done and your results.

You should consider this an opportunity to really dig in to some part of the design and training of ANNs. For example, you might decide to explore regularization, investigating how varying the regularization parameters, alpha and beta, affects the number of "useful" parameters (parameters near zero) and network performance. (This is just one, off-the-cuff, example; there are many possibilities here.) Since this is a very well-used data set, you can easily tell how well your ANN does compared to many in the literature.

Report

As indicated above, you should document your work in a professional report (think back to CSS 301). At a minimum, your report should include:

- Title and author
- Abstract: a brief, one paragraph summary of what you were investigating and what you found out (write this last)
- Introduction: a complete description of what you are investigating and how that relates to the course/textbook content or ANN literature
- Methods: Describe exactly what you did, in enough detail and with enough clarity that someone else could duplicate it (put your code listing in an appendix). Make sure this includes descriptions of any data analysis.
- Results: Describe what you saw. This should include appropriate and clear graphs; see the ANN literature and what you've seen in this class for guidance regarding the kinds of graphs that are generally found to be useful.
- Conclusion: State what you learned. This is different than "results" — "results" just presents data. Here you interpret it, indicate what it means, connect it to other concepts or others' results, etc.