CS 74 Project Proposal: Neural Network Image Classification with Manual and Automatic Feature Selection

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1   The Problem

Image classification cannot be solved using hard-coded systems, but can be solved using machine learning methods. Its applications include reverse image searching, optical character recognition, and facial detection.

This project will focus on implementing neural networks to categorize an image, with one network handling hand-picked features and another handling automatically selected features. We will then compare the performance of these two networks.

2   Methods

We will use artificial neural networks to tackle the high-dimensionality problem of image classification. The data set is composed of a large number of samples with many features; thus, the relationships between the features are difficult to describe using conventional methods but well-suited to machine learning in neural networks.

Neural networks are organized into layers, where layers are composed of nodes linked by weighted connections. We will implement a back-propagational neural network. The learning will be a supervised process that occurs with each cycle via a forward activation flow of output and a backwards error propagation. During the backwards error propagation, the weighted connections will be revised [1].

Automatic feature selection will be implemented via k-means clustering [2].

3   Data

We intend to use the CIFAR-10 dataset, which consists of 60,000 32x32-pixel images sorted into 10 different categories based on subject. Each pixel contains an (R,G,B) value. We have a set of 50,000 images for training purposes and 10,000 for testing.
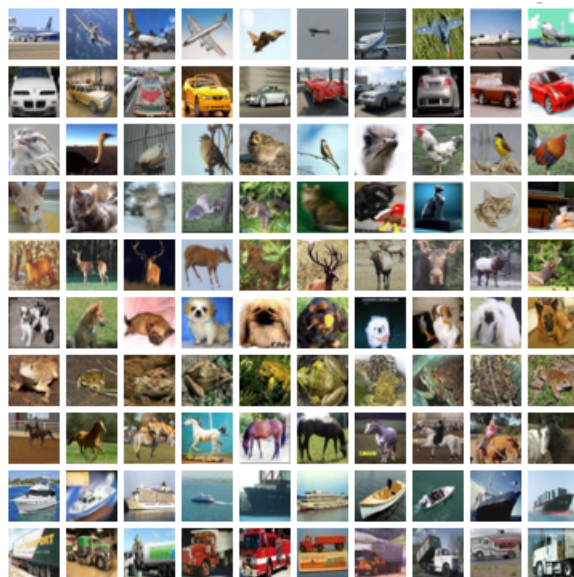
4   Timeline

1. **Oct 2 - Oct 9**: Familiarize ourselves with neural networks. Understand the different types of neural networks, how they're used for classification, their structure, and the relevant algorithms used to fit them (back-propagation). Familiarize ourselves with the data format as well as research typical techniques for manual and automated feature extraction from images.

2. **Oct 9 - 23**: Begin coding a neural network classifier that takes manually generated inputs. Tinker around with different variations. Implement several layers with different numbers of neurons per layer.

3. **Oct 23 - Oct 28**: Milestone: Have neural network classifier that takes manually generated inputs. Have started coding neural network to perform automatic feature selection.

4. **Oct 28 - Nov 18** Finish a neural network that performs automatic feature selection and compare its performance with the performance of the manual-feature classifier. Wrap up project documentation to prepare for final presentation and report.

5   Sources

1. Josef Burger. "A Basic Introduction To Neural Networks." Accessed September 30, 2014. *http://pages.cs.wisc.edu/ bolo/shipyard/neural/local.html*.

2. Adam Coates, Honglak Lee, and Andrew Y. Ng. "An Analysis of Single-Layer Networks in Unsupervised Feature Learning." *AISTATS* 14, 2011.

3. Daniel Shiffman. "Chapter 10. Neural Networks" in *The Nature of Code.* 2012.

4. Jong-Ho Kim, Jae-Won Lee, Byoung-Doo Kang, O-Hwa Kwon, Chi-Young Seong, Sang-Kyoon Kim, and Se-Myung Park. "Hierarchical Classification of Object Images Using Neural Networks." *Lecture Notes in Computer Science Volume 3972*, 2006, 322-330.