Data Science 450

Project: Deep learning on CIFAR-10 Dataset
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Checkpoint 2:

1. **Introduction and Goals**
   Deep learning is one of the exciting new areas in Machine learning. My goal is to use this Capstone project as a motivation to learn about Deep learning. I intend to use Tensorflow as the platform for deep learning experiments as there is a good online community support for it. For the Deep learning project, I am planning to use the CIFAR-10 dataset. I have some background in Computer Vision and Image processing, so I am hoping to leverage some of the knowledge for pre-processing image data.

2. **CIFAR Dataset**
   CIFAR Dataset [1] is subset of the Tiny Images dataset [2] . Tiny images data set contains about 80 Million images of size 32x32. Each image in the original dataset is labelled with non-abstract nouns [3] obtained from Wordnet lexical database. CIFAR-10 consists of 60,000 images of size 32x32 pixels. These images have objects/content that belong to the following classes: Airplanes, automobiles, bird, cat, deer, dog, frog, horse, ship and truck. Goal would be to train Deep Neural networks and be able correctly classify a test set.

3. **Progress Description:**
   1. **Tensorflow Installation**
      I installed Tensorflow on my machine following instructions from here: https://www.tensorflow.org/install/

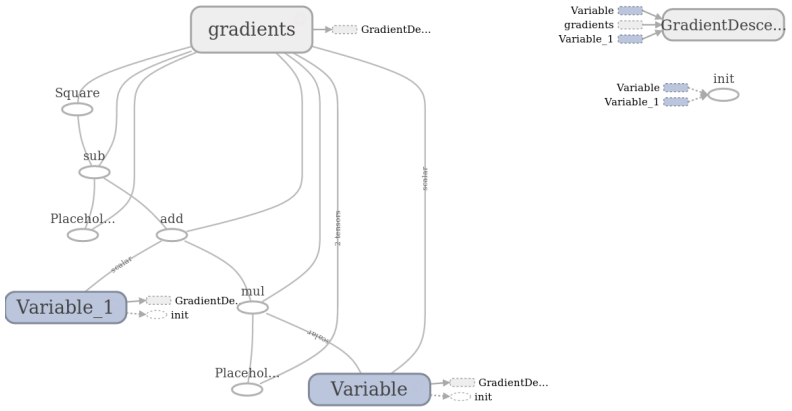
   2. **Learning about Neural Networks/Back propagation.**
      To learn about Convolutional Neural networks, I am using the notes and lectures taught in CS31N Course: http://cs231n.stanford.edu/
      The video lectures are available here:

      So far, I have completed 4 lectures and notes. In the lectures, so they taught about K-Nearest neighbors and an introduction to Neural networks. They also taught the concept of backpropagation for neural networks.

      I will continue the lectures to learn about Convolutional Neural networks after some experimentation with Tensorflow.

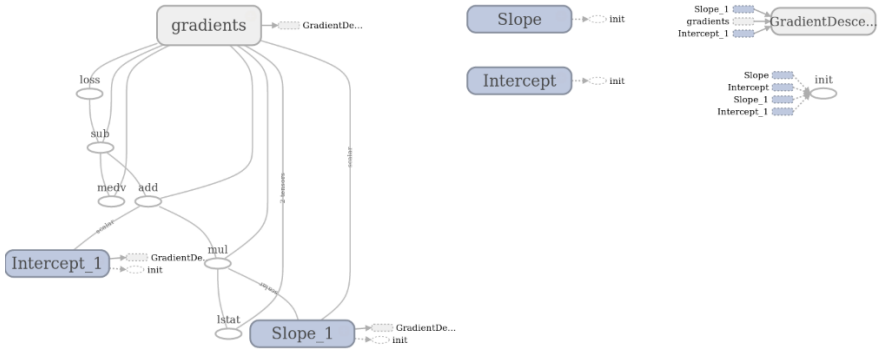
   3. **Linear Regression with Tensorflow**
      I learnt that Tensorflow supports running many machine learning algorithms. Since, I am starting to learn from scratch, I thought it will be useful to run some basic algorithm like Linear Regression with Tensorflow. Here are the results from two experiments I have run so far.

      a. **Experiment 1: Linear Regression on Synthetic Data**
         For this experiment, I generated synthetic x and y data and tried to learn the slope and intercept of the linear regression line using gradient descent. Here is the graph generated from Tensorflow:

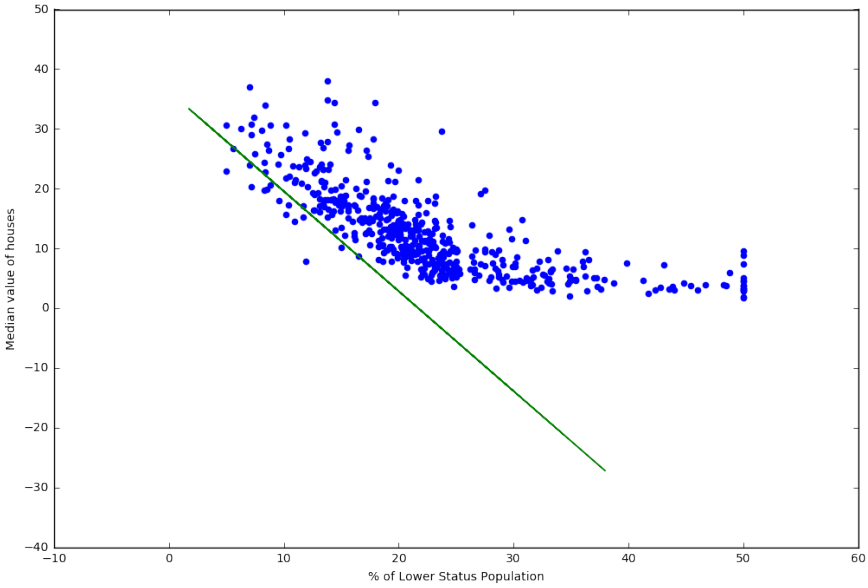


b. Experiment 2: Linear Regression on Boston Dataset

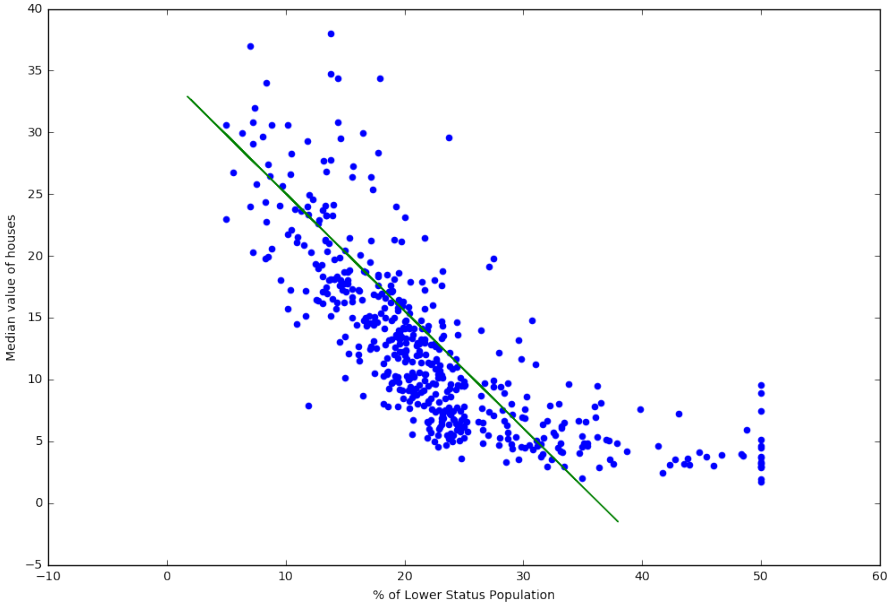
For this experiment, I experimented with the Boston dataset. In this dataset, I tried to model the median house value in a neighborhood based on the % of lower status population in the neighborhood. Here also, I used Tensorflow and gradient descent to find the optimal value of slope and intercept of the line. Here is the Tensorflow graph generated for this work:



Interestingly, I experimented with various learning rates and different number of epochs, however, the regression line fit does not seem to be very good. Here is the result generated using gradient descent:



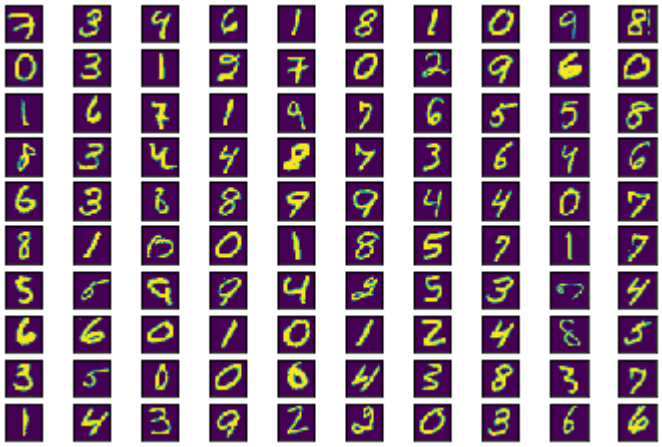
To compare, I generated another fit using Ordinary Least Square regression:



The fit from the OLS seems to be much better than the one generated with Gradient descent. Over the next 2 weeks, I will to investigate more and learn/apply Convolution Neural Networks on CIFAR data

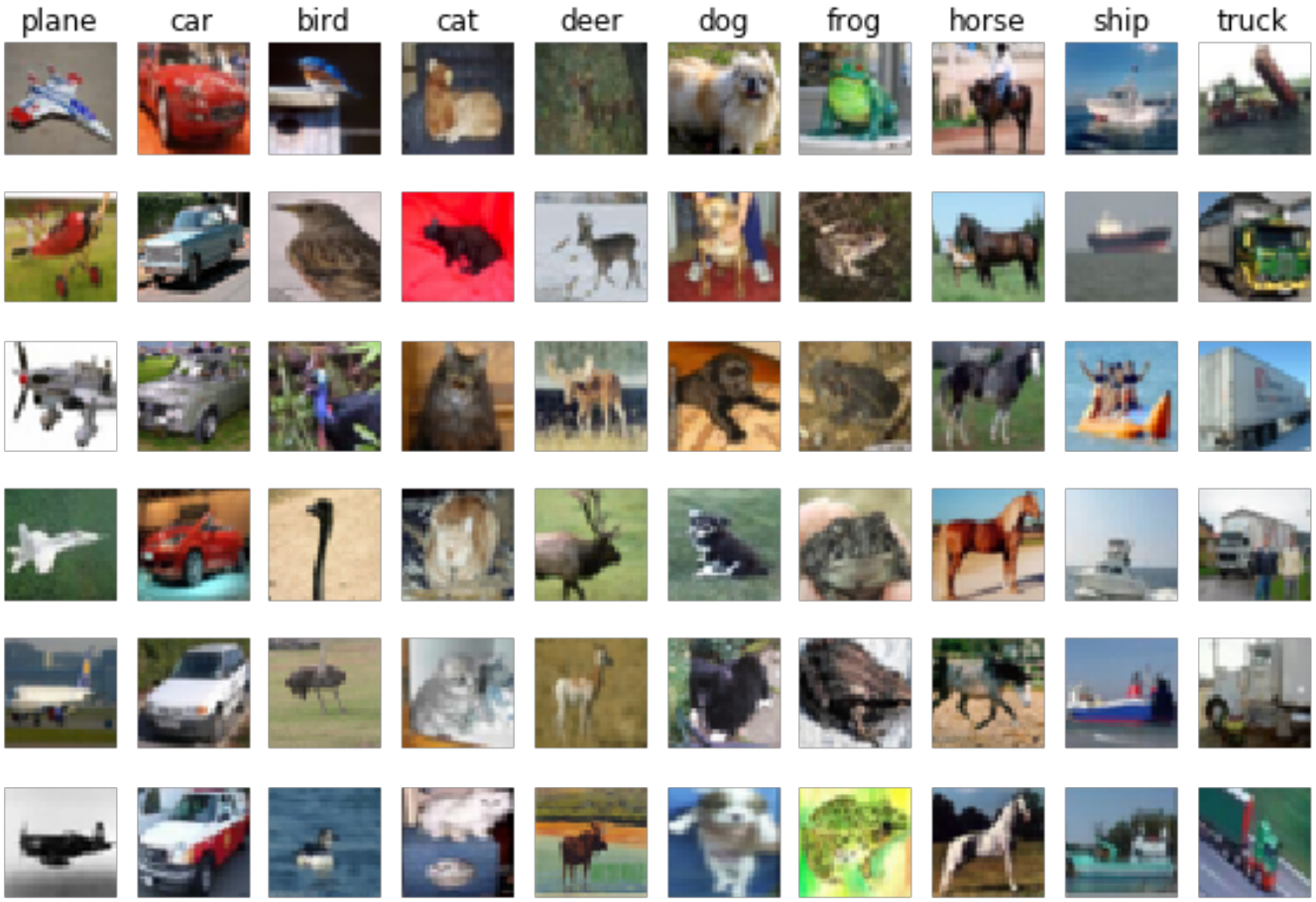
5. MINST With Tensorflow

To get a working understanding of the Deep learning, I built a neural network model for classifying MINST data.



With the MINST data and simple neural network model, I could get an accuracy of about 92% on the training and test data.

6. CIFAR With Tensor Flow

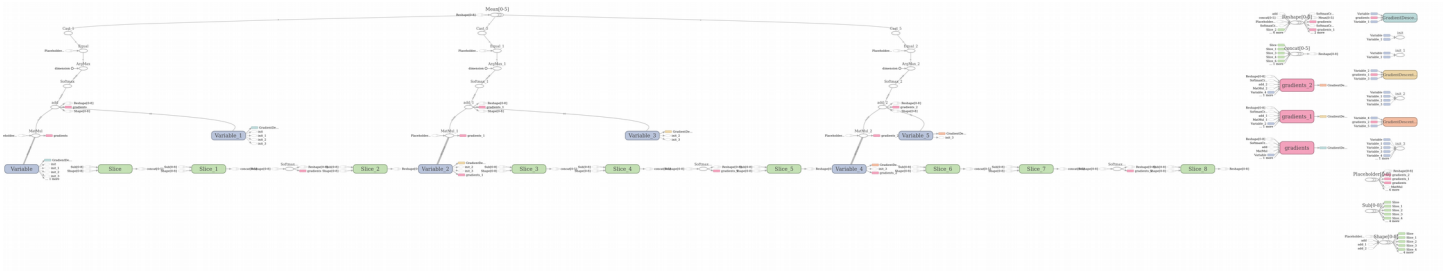


I built 3 model with Tensor flow for this:

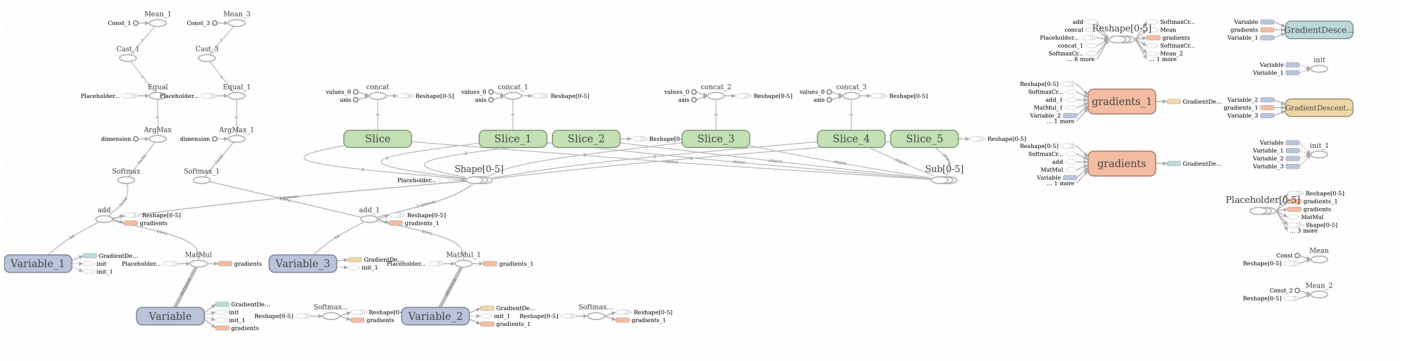
(a) Single Layer Neural Network Model
(b) Multi Layer Neural Network Model
(c) Convolution Neural Network Model

Here is the Tensor Flow graph for all the three modes

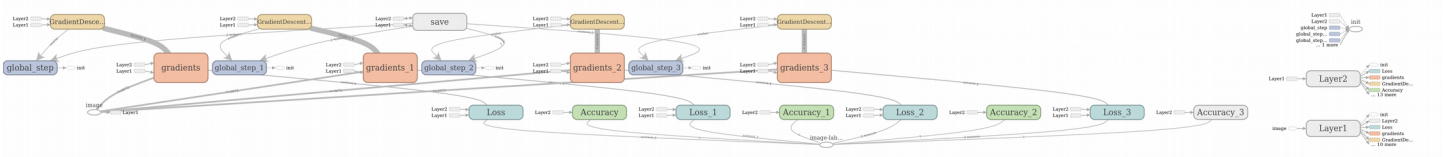
Single Layer Neural Network Model



Multi Layer Neural Network Model



Convolution Neural Network Model



5 Accuracy Results:

	Simple Neural Network	Multi Layer Neural Network	CNN Model
Training Accuracy	23%	23%	14%
Test Accuracy	24%	10%	10%

6 Learnings:

- Linear Model with Stochastic Gradient proved to be a workable solution for CIFAR data set.
- Convolution Network has many parameters that can impact the performance of the Deep network.
- My implementation of CNN is faulty as the results seem to be low even after 200-800 iterations.
- CNN is expensive and running beyond 800 iterations on a local machine is not practical

7 Reference:

1. https://www.cs.toronto.edu/~kriz/cifar.html
2. http://groups.csail.mit.edu/vision/TinyImages/
3. http://people.csail.mit.edu/torralba/publications/80millionImages.pdf
4. http://cs231n.stanford.edu/
5. Lectures: https://www.youtube.com/watch?v=NfnWJUyUJYU&list=PLkt2uSq6rBVctENoVBg1TpCC7OQi31AlC
6. https://www.tensorflow.org/install/