Tensorflow Workshop

Shotaro Ikeda & Akshay Mishra

http://sigai.ml

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Overview

1. Basic Tensorflow
   - Computational Graphs
2. Review: Supervised Learning
   - Review: Problem Statement
3. Supervised Learning in Tensorflow
   - Linear Regression/Classification
   - Loss Functions
4. LeNet
5. Extra Resources

Basic Tensorflow

Remarks about Tensorflow

- Quite overwhelming, especially for those new to the library.
- There is multiple ways of doing the same thing.
- Very different way of thinking vs. other libraries.

Nice Things about Tensorflow

- Very fast computation on GPUs (nearly $80x$ faster than CPU).
- Great distributed support for **large** clusters (≥ 8 GPUs).
- Many available implementations.

Tensorflow "Quirks"/Vocabulary

- Define and Run, instead of immediate feedback.
- Placeholders to transfer data into the computational graph.
- Variables for values/weights we want to learn.
- Ops to operate on individual Variables/Values
- Session to allocate the computational graph, and assign values

Computational Graphs

- Let's say we want to compute some values, given variables x, y, and z.
- $x \in \mathcal{R}^{2\times 3}$
- $y \in \mathcal{R}^{3\times 1}$
- $z \in \mathcal{R}^{2\times 1}$
- Let's try to compute $\textsc{Mean}(xy + z)$

Demo – Calculations in Tensorflow

PLACEHOLDER

Example – Conclusions

- In order to run any computation in Tensorflow, you need a Session.
    - You need to define the computational graph first
    - Then initalize your variables and session.
- Tensorflow batching is very easy to do, and fast on GPUs

Review: Supervised Learning

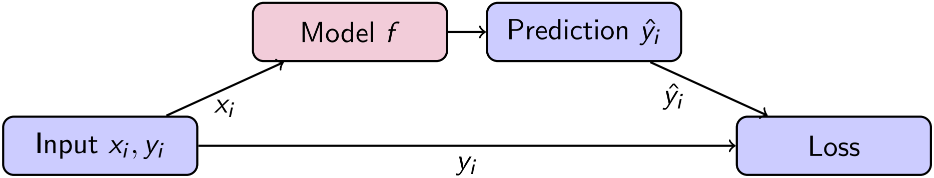
Supervised Learning - Problem Statement

- We have some dataset $d \sim \mathcal{D}$.
- d contains a bunch of points, x_i and y_i, where x_i is the ith datapoint and y_i is the ith label
- You can think of x_i as an image, and y_i being the corresponding label.
- Given enough x_i's and y_i's, is it possible to accurately predict $\hat{y}$ for some foreign, unseen inputs $\hat{x}$?

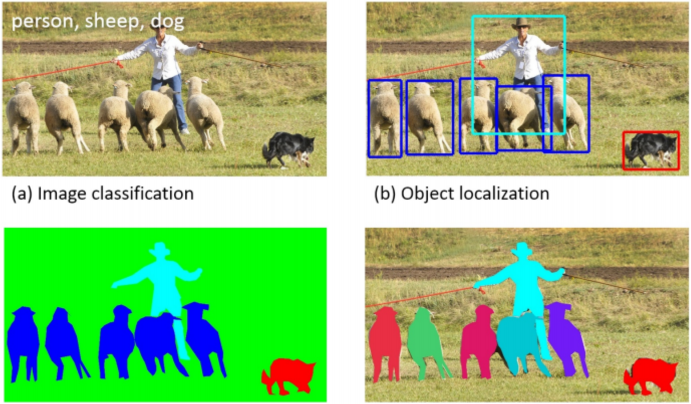
Supervised Learning - Problem Statement

- Idea: suppose there exists some function f, such that $f : a \rightarrow b$, essentially mapping our inputs x to output y.
- For the workshop today, this f is approximated by Tensorflow.

Typical Deep Network Pipeline



Examples of Supervised Learning



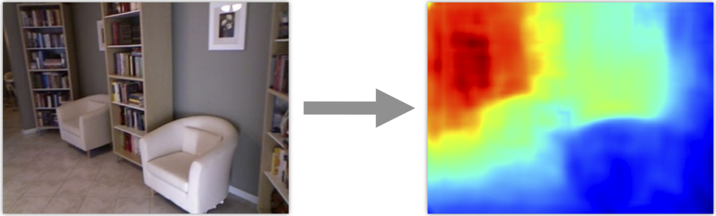
(a) Image classification

(b) Object localization

(c) Semantic segmentation

(d) This work

Examples of Supervised Learning



Single RGB Image → Depth Map

Linear Regression/Classification

Linear Models

If we have a series of points x and y, then we want to fit the function

$$y = \alpha x + \beta$$

where we learn α and β, such that it is "close" to our desired point, $\hat{y}$.
Intuition: Fitting 2D points to a line.

Tensorflow & Linear Models

You can think of a 1 layer neural network with biases, as a special case of a linear model!

MSE Loss

MSE Loss Function

We want to optimize the average distance between our predictions, so we want

$$\text{minimize } \frac{1}{n}\sum_{i=0}^{n}(f(x_i) - y_i)^2$$

Cross Entropy Loss Function

Cross Entropy Loss Function

We want to optimize the probability outputs, so we want

$$\text{minimize} \;\; -\sum_{c=0}^{C}(\hat{y_{ic}} log(y_{ic}))$$

for individual datapoints.
C is the total number of classes, and y_{ic} gives the ith datapoint and probability of the cth class.

Demo – Linear Regression and Classification

PLACEHOLDER

Linear Regression and Classification – Conclusion

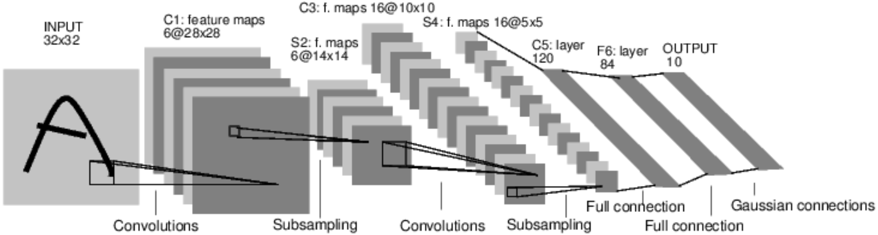
- Placeholders can be used to dynamically set the values of tensors at runtime.
- In Tensorflow, we use Variables to define what we want to learn.
- Optimizers can automatically differentiate Variables.

LeNet

Demo – Convolutions

PLACEHOLDER

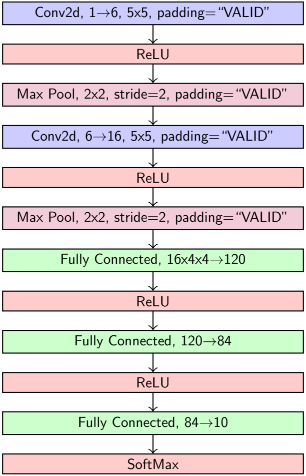
LeNet Architecture



Note!

Note – slight bug in diagram, the image size is 28x28, not 32x32.
The next slide shows the LeNet architecture that we will implement.

LeNet Architecture (in more detail)



Extra Resources

- CS231n – Recommended for beginners
- Extra Tutorial – If you want more practice using Tensorflow
- What is a Convolution?
- What is Pooling?