Tensorflow Workshop

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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

demos/basics.ipynb

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

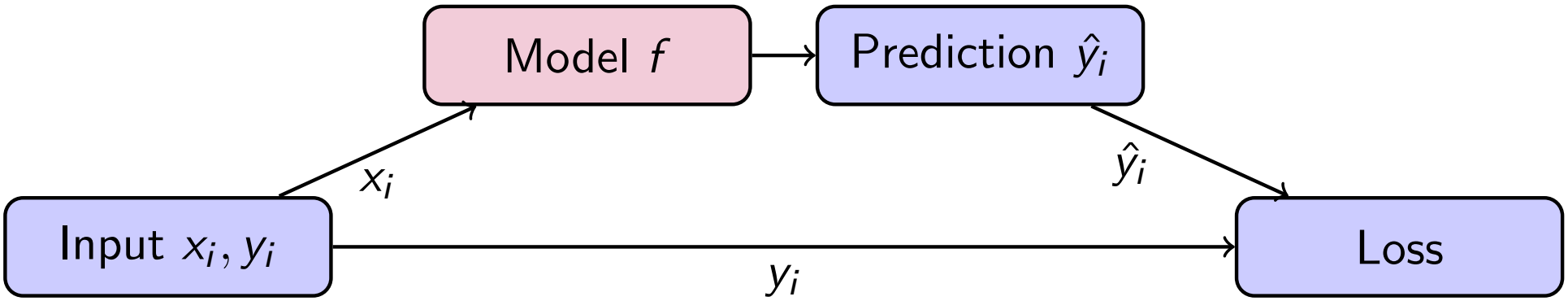
Supervised Learning - Problem Statement

- 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

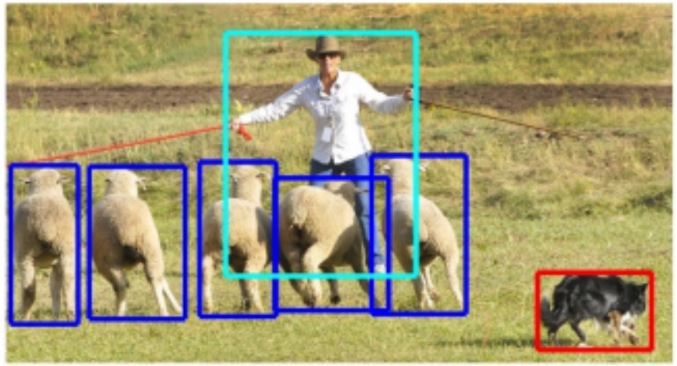
- Idea: suppose there exists some function f, such that $f : a \rightarrow b$, essentially mapping our inputs x to output y.
- For the workshop today, this f is approximated by Tensorflow.

Typical Deep Network Pipeline



Examples of Supervised Learning

(a) Image classification

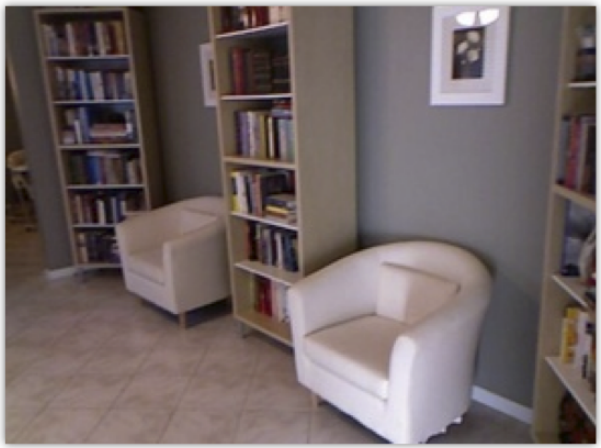


(b) Object localization

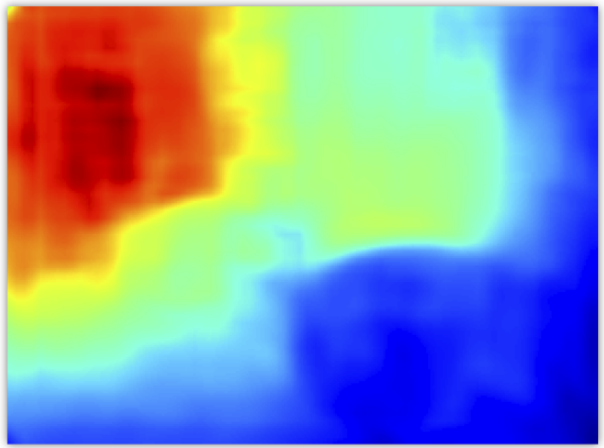
(c) Semantic segmentation

(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

demos/linear.ipynb

Linear Regression and Classification – Conclusion

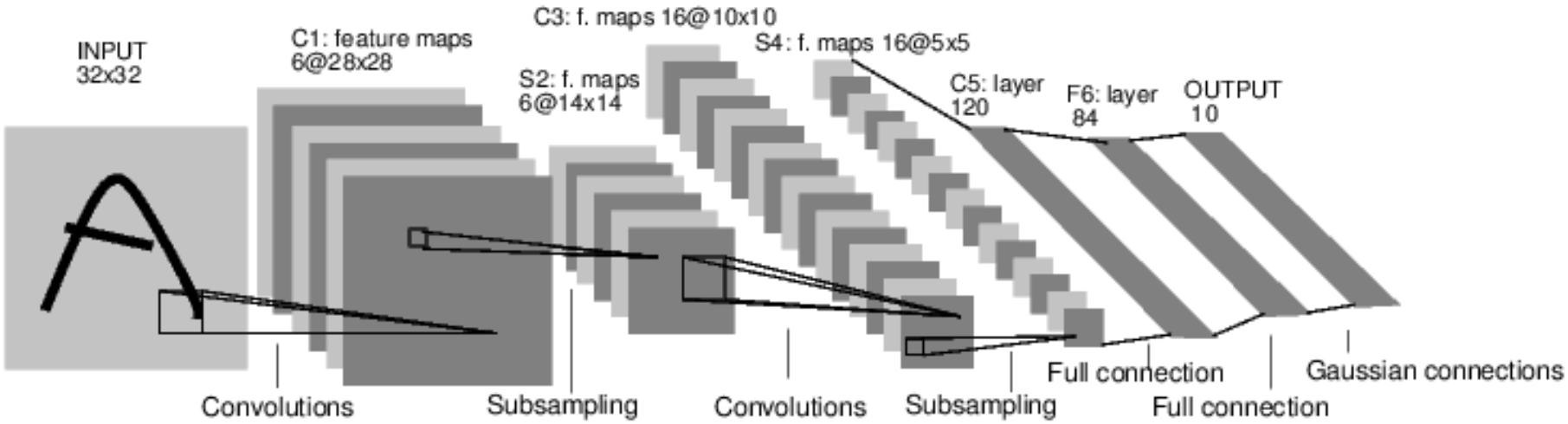
- Placeholders can be used to dynamically set the values of tensors at runtime.
- In Tensorflow, we use Variables to define what we want to learn.
- Optimizers can automatically differentiate Variables.

LeNet

Demo – Convolutions

demos/convs.ipynb

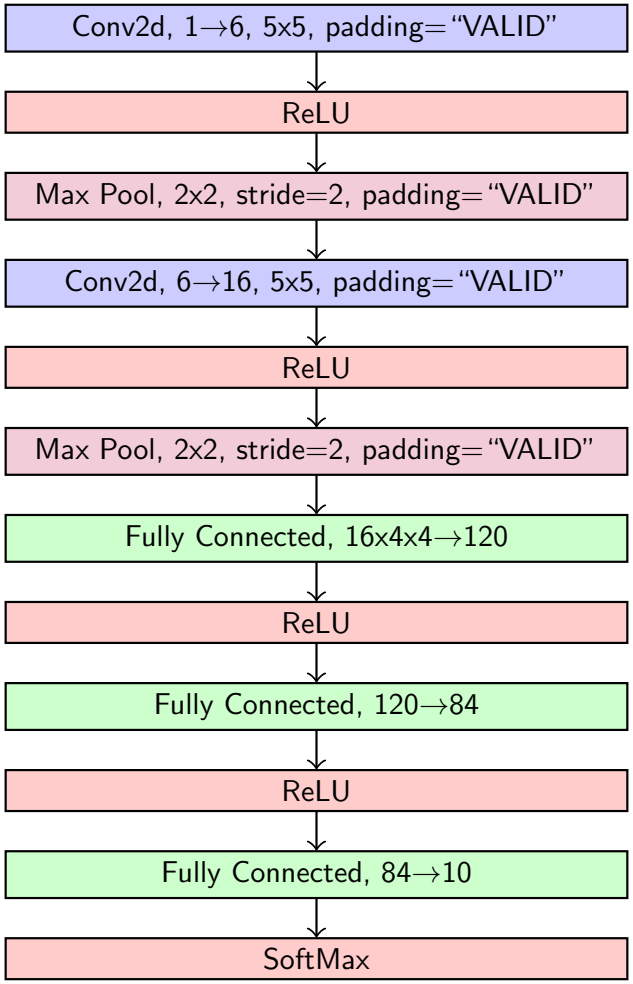
LeNet Architecture



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)



Activity – LeNet

demos/mnist.ipynb

Extra Resources

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