Convnets in TensorFlow

CS 20SI:
TensorFlow for Deep Learning Research
Lecture 7
2/3/2017

Agenda

Playing with convolutions

Convolution support in TF

More MNIST!!!

Autoencoder

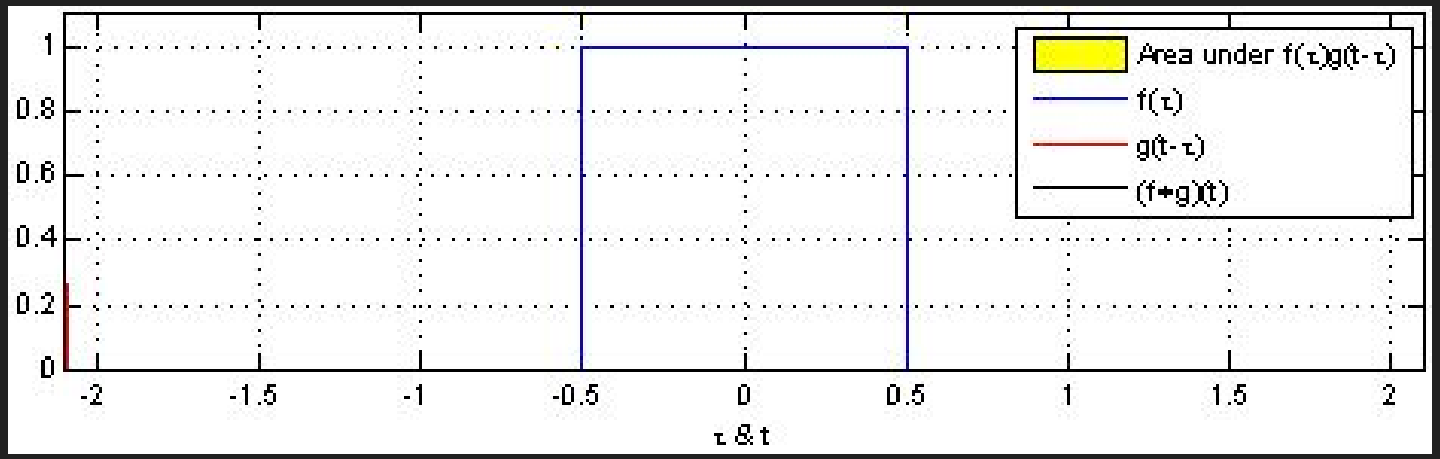
(Half) guest workshop by Nishith Khandwala

Understanding convolutions

Convolutions in maths and physics

a function derived from two given functions by integration that expresses how the shape of one is modified by the other

Convolutions in maths and physics



Convolutions in neural networks

a function derived from two given functions by element-wise multiplication that expresses how the value and shape of one is modified by the other

Convolutions in neural networks

We can use one single convolutional layer to modify a certain image

Convolutions in neural networks

We can use one single convolutional layer to modify a certain image

```
tf.nn.conv2d(input, filter, strides, padding,
use_cudnn_on_gpu=None, data_format=None, name=None)
```

Convolutions without training

input

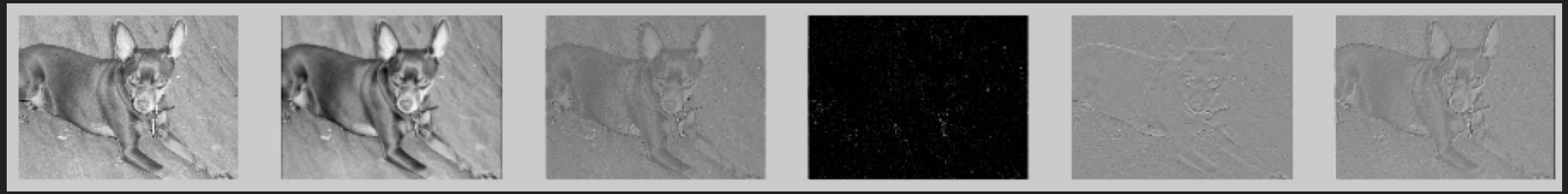
Kernel for blurring

0.0625	0.125	0.0625
0.125	0.25	0.125
0.0625	0.125	0.0625

tf.nn.conv2d

output

Some basic kernels



input blur sharpen edge top sobel emboss

See kernels.py and 07_basic_filters.py on the class GitHub!!!

Convolutions in neural networks

In training, we don’t specify kernels.
We learn kernels!

Getting dimensions right

```
tf.nn.conv2d(input, filter, strides, padding,
use_cudnn_on_gpu=None, data_format=None, name=None)
```

Input: Batch size x Height x Width x Channels

Filter: Height x Width x Input Channels x Output Channels
(e.g. [5, 5, 3, 64])
Strides: 4 element 1-D tensor, strides in each direction
(often [1, 1, 1, 1] or [1, 2, 2, 1])

Padding: ‘SAME’ or ‘VALID’

Data_format: default to NHWC

Convnet with MNIST

Getting dimensions right

Original Image
28 x 28 x 1

Conv1
Filter: 5 x 5 x 1 x 32
Stride: 1, 1, 1, 1
Out: 28 x 28 x 32
Relu
Maxpool (2 x 2 x 1)
Out: 14 x 14 x 32

Conv2
Filter: 5 x 5 x 32 x 64
Stride: 1, 1, 1, 1
Out: 14 x 14 x 64
Relu
Maxpool (2 x 2 x 1)
Out: 7 x 7 x 64

Fully connected
W: 7*7*64 x 1024
Out: 1 x 1024

Relu
Out: 1 x 1024

Softmax
W: 1024 x 10
Out: 1 x 10

Softmax
1 x 10

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Softmax
W: 1024 x 10
Out: 1 x 10

Softmax
1 x 10

(W−F+2P)/S+ 1

W: input width
F: filter width
P: padding
S: stride

More exciting math in the lecture note!

TensorFlow support

Convolution
tf.nn.conv2d

Relu
tf.nn.relu

Maxpool
tf.nn.max_pool

Fully connected
tf.nn.relu

Softmax
tf.nn.softmax_cross_enptry_with_logits

Variable scope

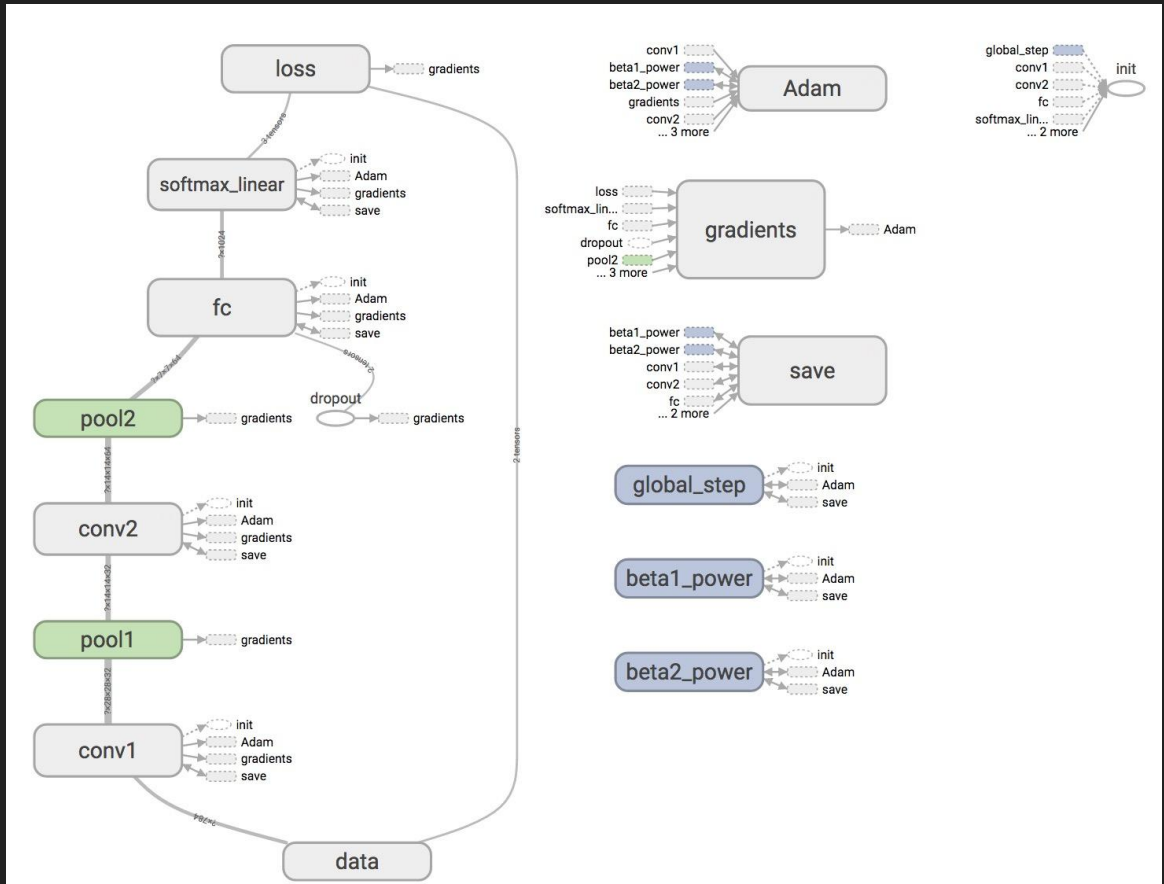
```
with tf.variable_scope('conv1') as scope:

    w = tf.get_variable('weights', [5, 5, 1, 32])
    b = tf.get_variable('biases', [32],
                        initializer=tf.random_normal_initializer())
    conv = tf.nn.conv2d(images, w, strides=[1, 1, 1, 1],
                        padding='SAME')
    conv1 = tf.nn.relu(conv + b, name=scope.name)
```

Interactive coding

Download 07_convnet_mnist_starter.py from GitHub!

MNIST Covnet graph

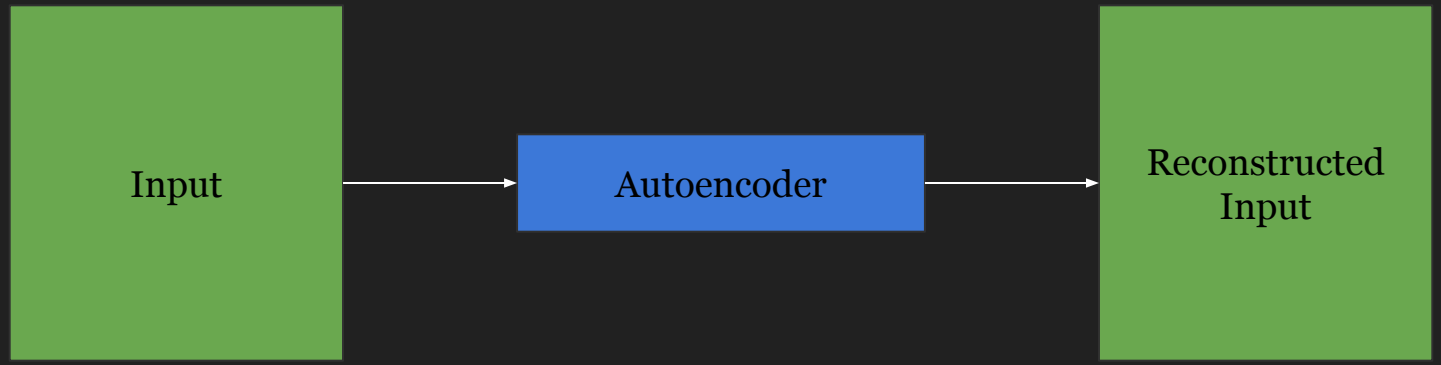


Accuracy

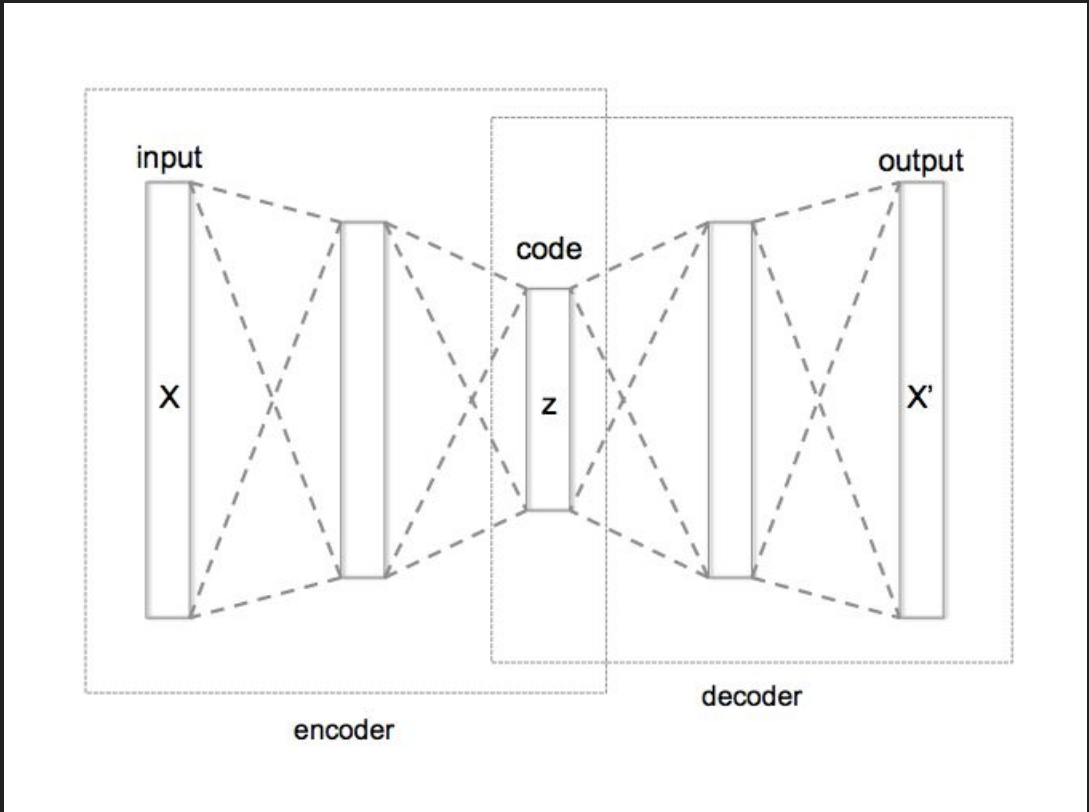
Epochs	Accuracy
1	0.9111
2	0.9401
3	0.9494
5	0.9549
10	0.9692
25	0.9736
40	0.9793
50	0.9804

Autoencoder

Autoencoder



Autoencoder



- Input and Output dimensions should match.
- Input and Output range should be same.

Autoencoder

Live coding
See autoencoder folder on GitHub

Next class

Guest lecture by Jon Shlens

Convnet

Deep Dream

Feedback: huyenn@stanford.edu

Thanks!