Deep Learning and Temporal Data Processing

Introduction to TensorFlow

Andrea Palazzi

June 21th, 2017

University of Modena and Reggio Emilia

Agenda

Purpose

Why TensorFlow

TensorFlow Basics

References

Purpose

Aim of this tutorial

This short tutorial aims at providing the very basics of TensorFlow.

The goal is to understand *what is* TensorFlow, *why do we need it* for deep learning, and *how does it work* from an high-level perspective.

Conversely, the next lectures will be more "hands-on": there we'll see actual code examples and we'll use our TF skills to tackle some easy task.

Why TensorFlow

Open source software library for numerical computation using data flow graphs.

Why not *Theano* / *Torch* / *Caffe* / *Microsoft Cognitive Toolkit* / ... ?

- Python API
- Flexible enough for research, yet built with production use in mind
- Portable on heterogeneous systems, from mobile devices to large-scale distributed machines, and on a variety of OS (Android, Windows, iOS, ...).
- TensorBoard visualization has no rival.
- Large community and supported by Google.

Disclaimer

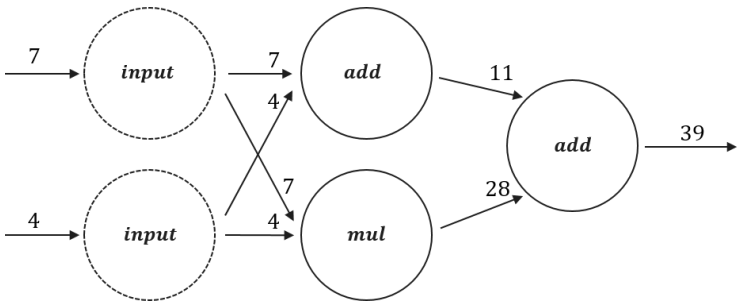
There are a variety of good resources and tutorial to learn TensorFlow.

However, please keep in mind that TensorFlow is under heavy development and is constantly changing. In case of doubt, always refer to the official site: https://www.tensorflow.org.

TensorFlow Basics

All operations are encapsulated in a computational graph.

Graph definition is totally separated from execution.



Graph Definition

Graph definition is totally separated from execution.

So what?

```
>>> import tensorflow as tf
>>>
>>> a = tf.add(7, 4)
>>> b = tf.mul(7, 4)
>>> result = tf.add(a, b)
>>> print(result)
```

Graph Definition

Graph definition is totally separated from execution.

So what?

```
>>> import tensorflow as tf
>>>
>>> a = tf.add(7, 4)
>>> b = tf.mul(7, 4)
>>> result = tf.add(a, b)
>>> print(result)
Tensor("Add_4:0", shape=(), dtype=int32)
```

What did you expect? :-)

In this framework, we can think of **tensors** as **n-dimensional matrices**.

This allows to abstract over the precise structure, *e.g.*:

0-d scalars

1-d vectors

2-d matrices

. . .

Tensors are represented as the **edges of the computational graph**.

In order to get a numerical result we have to **evaluate the symbolic graph**.

```
>>> import tensorflow as tf
>>> a = tf.add(7, 4)
>>> b = tf.mul(7, 4)
>>> result = tf.add(a, b)
>>>
>>> sess = tf.Session()
>>> print('Result: {}'.format(sess.run(result)))
Result: 39
```

A **Session** object encapsulates the environment in which Operation objects are executed, and Tensor objects are evaluated.

Placeholders

In order to fed value at execution time, TensorFlow provides a **placeholder** Operation.

Example:

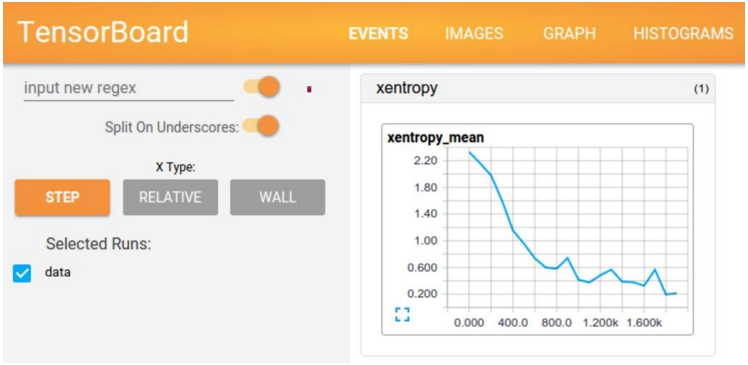
```
x = tf.placeholder(tf.float32, shape=(1024, 1024))
y = tf.matmul(x, x)

with tf.Session() as sess:
  print(sess.run(y))  # ERROR: will fail because x was not fed.

  rand_array = np.random.rand(1024, 1024)
  print(sess.run(y, feed_dict={x: rand_array}))  # Will succeed.
```

Other advanced methods for feeding the computational graph exist, but we don't cover them in these introductory lectures.

TensorBoard is a suite of visualization tools integrated with TensorFlow. You can use TensorBoard to visualize your TensorFlow graph, plot quantitative metrics about the execution of your graph, and show additional data like images that pass through it.



[1]

References

References i

[1] M. Abadi, A. Agarwal, P. Barham, E. Brevdo, Z. Chen, C. Citro, G. S. Corrado, A. Davis, J. Dean, M. Devin, S. Ghemawat, I. Goodfellow, A. Harp, G. Irving, M. Isard, Y. Jia, R. Jozefowicz, L. Kaiser, M. Kudlur, J. Levenberg, D. Mané, R. Monga, S. Moore, D. Murray, C. Olah, M. Schuster, J. Shlens, B. Steiner, I. Sutskever, K. Talwar, P. Tucker, V. Vanhoucke, V. Vasudevan, F. Viégas, O. Vinyals, P. Warden, M. Wattenberg, M. Wicke, Y. Yu, and X. Zheng. **TensorFlow: Large-scale machine learning on heterogeneous systems, 2015.** Software available from tensorflow.org.