Tensorflow: Introduction

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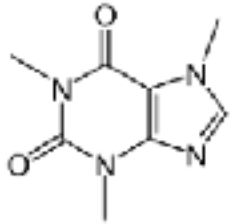
What is TF?

“TensorFlow is an open source software library for numerical computation using **data flow graphs**”

Why TF?



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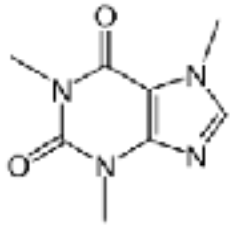
Why TF?

mxnet

theano

CNTK



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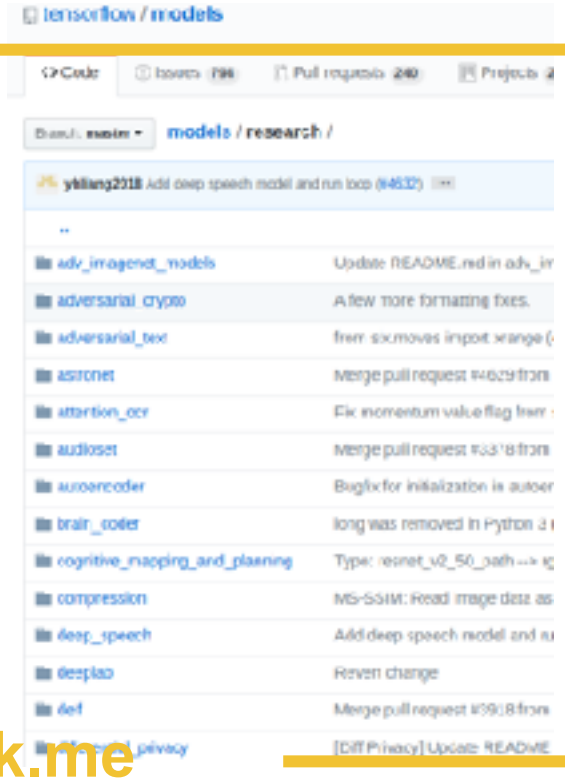
Why TF?

- Stable
- Well-documented sources
- Flexibility
- Portability
- Scalability
- Popularity

Why TF? Popularity

- Tensorboard
- Tensorflow Hub/Models
- TF Serving
- TF Lite
- Lucid
- Cleverhans
- ...



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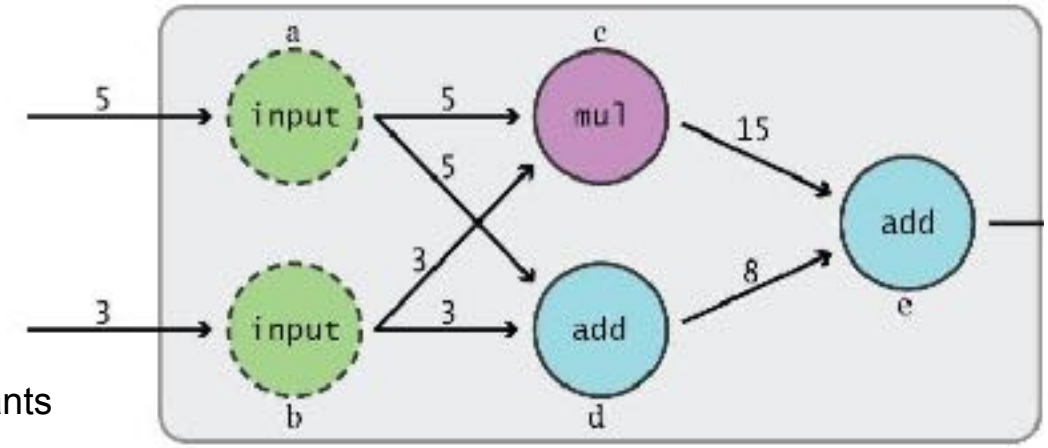
Getting Started

```
import tensorflow as tf
```

Graphs and sessions

Two phases:

- Define a computation (graph)
- Execute it (session)



Nodes: operators, variables, and constants
Edges: tensors

Tensors

In physics and mathematics:

$$\partial_\alpha F^{\alpha\beta} = \mu_0 J^\beta$$

In ML/DL just an n-dimensional array
0-d tensor: **scalar**
1-d tensor: **vector**
2-d tensor: **matrix**
...

images:
`[batch_size, height, width, channels]`
`NHWC`

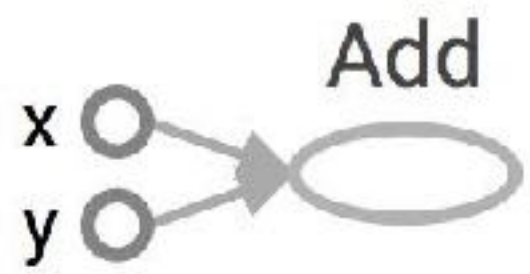
time series, text:
`[batch_size, time_steps, channels]`

Data Flow Graph

```
import tensorflow as tf
a = tf.add(3, 5)
```

```
>> Tensor("Add:0", shape=(),
dtype=int32)
(Not 8)
```

Nodes: operators, variables, and constants
Edges: tensors



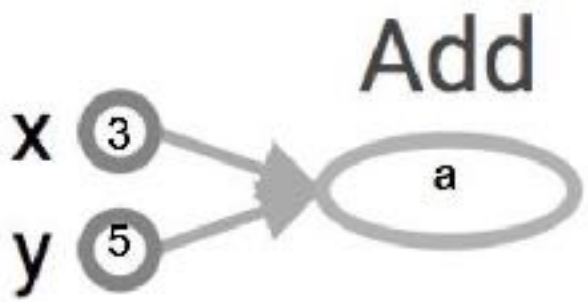
How to run computation

Create a session
Evaluate the graph, feed and fetch

```
import tensorflow as tf
a = tf.add(3, 5)

with tf.Session() as sess:

    print(sess.run(a))
```



tf.Session() and session.run(...)

```
import tensorflow as tf

# default graph created, look at tf.get_default_graph()

x, y = tf.placeholder(tf.float32), tf.placeholder(tf.float32)  # just input
nodes
a = tf.add(x, y)  # some nodes appeared in graph

with tf.Session() as sess:  # memory allocated

    sess.run(a, feed_dict={x: 1.0, y: -1.0}) # execution run

    sess.run(a)  # error, value is not persistent between sess.run
```

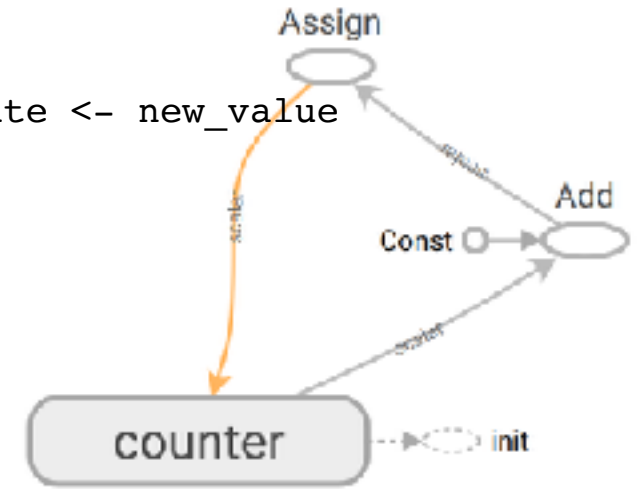
More graphs

Simple counter with persistent value between executions

```
state = tf.Variable(0, name="counter")
new_value = tf.add(state, tf.constant(1))
update_op = tf.assign(state, new_value)   # state <- new_value

with tf.Session() as sess:
    sess.run(tf.initialize_all_variables())
    sess.run(state) # 0

    for i in range(10):
        sess.run(update_op)
        sess.run(state) # 1,2,3,4, ...
```



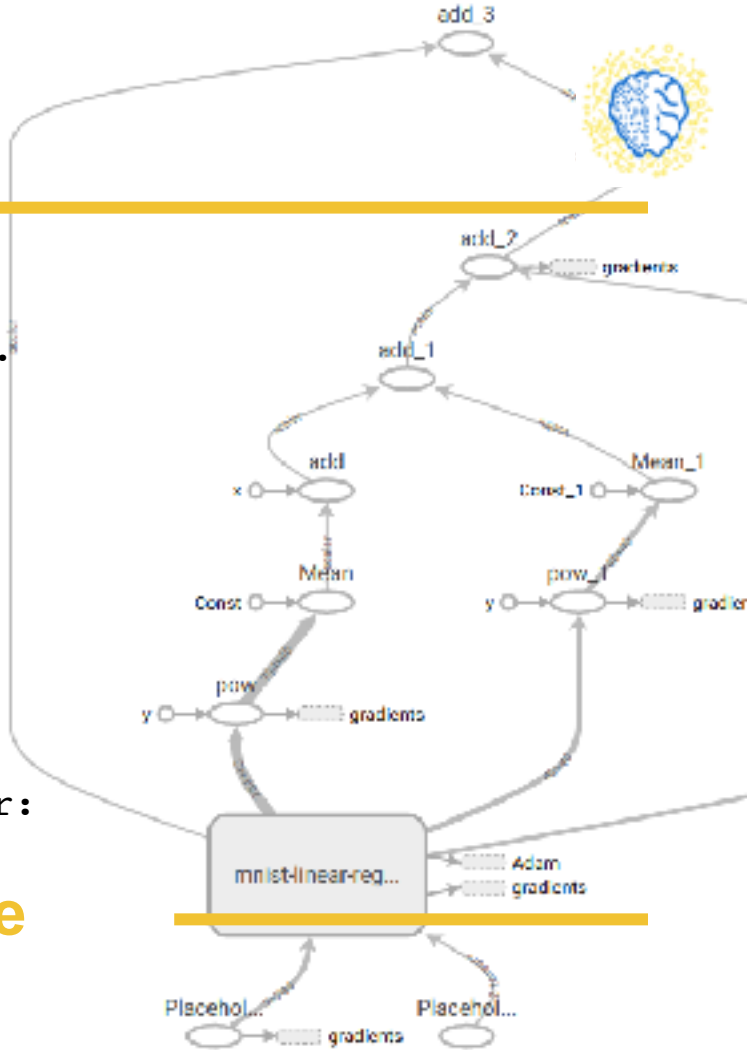
Neural Networks

```
x, y  = tf.placeholder(tf.float32, ...],
tf.placeholder(tf.int32, …)
W, b = tf.get_variable(“very_weight”, ....), ...

y_pred = tf.matmul(x, W) + b
loss = tf.reduce_mean((y - y_pred) ** 2)

opt = tf.train.AdamOptimizer()
train_op = opt.minimize(loss)

with tf.Session() as sess:
    sess.run(tf.initialize_all_variables())
    for (x_batch, y_batch) in very_data_iterator:
        loss, _ = sess.run([loss, train_op],
       feed_dict={x: x_batch, y: y_batch})
```



Why graphs

Pros:

1. Only route from feed to fetch will executes
2. Auto-differentiation
3. Suitable for distributed computation (CPU/GPU/TPU/…)

Cons:

1. Tricky to adapt some algorithms to graph execution
2. Difficult to debug

How to work with TF

- Build iterator for your data
- Make the model with placeholder and optimizer
- Run epochs with training and validation subgraphs
- Monitor the process
- Measure perfomance

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Simplified TF

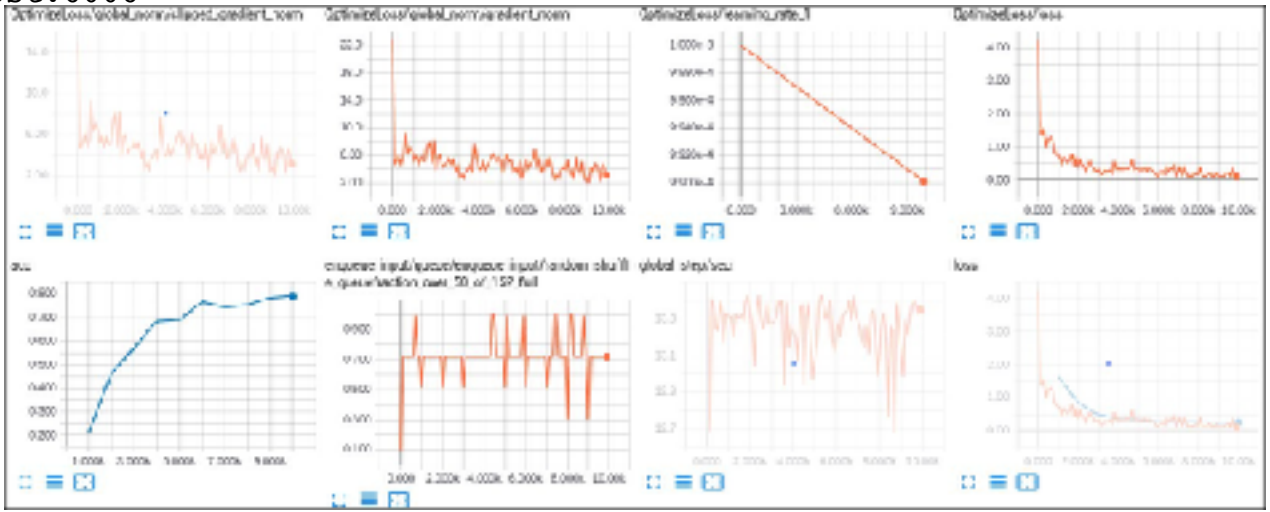
1. High-level API: Keras, TFLearn, Pretty Tensor
2. Some common tools: TFSlim
3. Standardize boiler-plate code: **tf.Estimators**
4. Input pipeline: **tf.data.Dataset**

Tensorboard

```
tf.summary.scalar('cross_entropy', cross_entropy)

merged = tf.summary.merge_all()

writer = tf.summary.FileWriter('./train', sess.graph)

...

   summary, _, step = sess.run([merged, train_step, global_step],
 feed_dict=...)

   writer.add_summary(summary, step)
```

Tensorboard

```
# >> tensorboard --logdir=./train/

# goto: http://localhost:6006
```



Hub: images/texts/

```
import tensorflow_hub as hub

with tf.Graph().as_default():
  embed = hub.Module("https://tfhub.dev/som
  it = embed(["Hello world!",
              "Benoît B. Mandelbrot",
              "deephack.me"])
  with tf.Session() as sess:
    sess.run(tf.global_variables_initialize
    sess.run(tf.tables_initializer())

    sess.run(it) # vectorization of texts
```

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Conclusion

1. TF is a two-phase framework (define computations, then execute)
2. Nice tools for visualization and monitoring (tensorboard)

What's next?

- tf.data.Dataset API
- MonitoredSession
- Estimators API
- Distributed execution (horovod)