

Tensorflow的相关概念

该课程主要为大家讲授如下的内容：

- Tensorflow的基本概念和设计
- tensorflow的工作原理概览
- tensorflow的优点

1. tensorflow的基本概念

Tensorflow是一个集成了许多设计模式和功能的AI系统。从编程的观点来看，tensorflow是一个库（library），提供了在机器学习尤其是深度学习工程中可复用的数据结构和功能。

什么是tensorflow

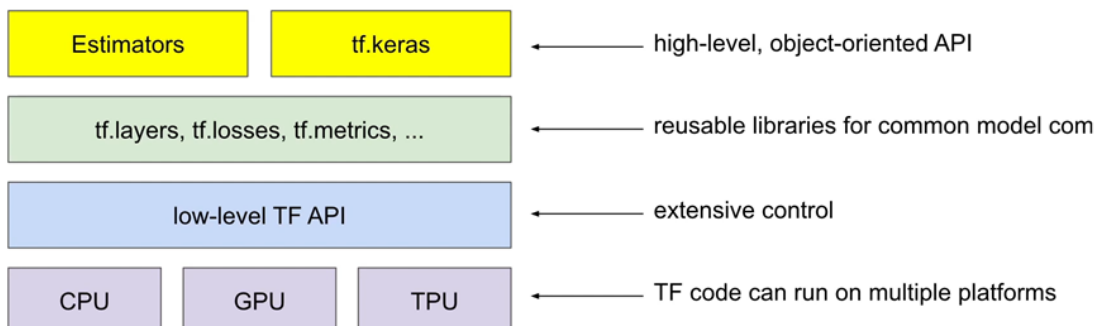
- TensorFlow is an end-to-end open source platform for **machine learning**. (Tensorflow Overview Page)
- TensorFlow is a **free and open-source software library** for **machine learning** and artificial intelligence. (Wikipedia)
- TensorFlow is a **machine learning system** that operates at large scale and in heterogeneous environments. (Google Brain, *TensorFlow: A system for large-scale machine learning*)

2. tensorflow的设计概述

Tensorflow有一套垂直分级的设计，能够提供不同层次的API和相应的

功能供开发者使用。

tensorflow的设计



图片来源: <https://developers.google.com/machine-learning/crash-course/first-steps-with-tensorflow/toolkit>

3. tensorflow的工作原理概览

1. dataflow graph

dataflow graph (在pytorch中被称为computational graph或计算图) 是一种优化计算的设计。它能够规划计算流程, 存储计算状态, 并因此而能够引入并行计算功能来加速AI算法。

简单了解tensorflow的工作原理



TensorFlow uses **dataflow graphs** to represent computation, shared state, and the operations that **mutate that state**. It maps the nodes of a dataflow graph across many machines in a cluster, and within a machine across multiple computational devices, including multicore CPUs, general-purpose GPUs, and custom-designed ASICs known as Tensor Processing Units (TPUs).



TensorFlow uses a **unified dataflow graph** to represent both **the computation in an algorithm and the state on which the algorithm operates**.
(Google Brain, *TensorFlow: A system for large-scale machine learning*)



总结: tensorflow使用dataflow graph进行计算。

2. tensor

从纯理论上讲, Tensor是可以用于表示一切数据的高维数组, 可以存储深度学习模型中的参数。Tensorflow中的tensor类型数据集成了并行计算的设计, 可以在内存和现存之间互相转移、高效利用计算资源。

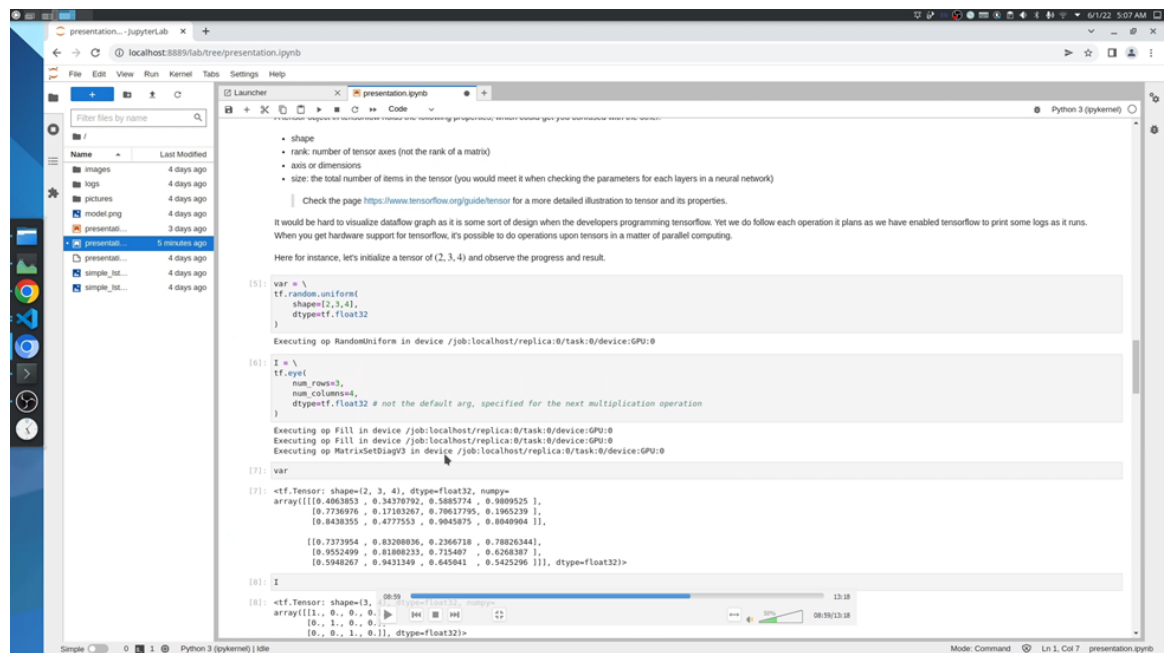
简单了解 tensorflow 的工作原理

· In the general case, an array of numbers arranged on a regular grid with a variable number of axes is known as a tensor. We denote a tensor named "A" with this typeface: A. We identify the element of A at coordinates (i,j,k) by writing $A_{i,j,k}$. (Ian Goodfellow, Yoshua Bengio, Aaron Courville, Deep Learning)

· Tensors are multi-dimensional arrays with a uniform type.
(Tensors, TensorFlow basics, TensorFlow Guide Page)

· 总结：（简单来说，）tensor是高维的数组。

通过打开tensorflow中的调试选项，可以观察到该类型的数据在运算时的一些状态。



```
• shape
• rank: number of tensor axes (not the rank of a matrix)
• axis or dimensions
• size: the total number of items in the tensor (you would meet it when checking the parameters for each layers in a neural network)

Check the page https://www.tensorflow.org/guide/tensor for a more detailed illustration to tensor and its properties.

It would be hard to visualize dataflow graph as it is some sort of design when the developers programming tensorflow. Yet we do follow each operation it plans as we have enabled tensorflow to print some logs as it runs.
When you get hardware support for tensorflow, it's possible to do operations upon tensors in a matter of parallel computing.

Here for instance, let's initialize a tensor of (2, 3, 4) and observe the progress and result.

[5]: var = \
      tf.random_uniform(
        shape=[2,3,4],
        dtype=tf.float32
      )
      Executing op RandomUniform in device /job:localhost/replica:0/task:0/device:GPU:0

[6]: I = \
      tf.eye(
        num_rows=3,
        num_columns=4,
        dtype=tf.float32 # not the default arg, specified for the next multiplication operation
      )
      Executing op Fill in device /job:localhost/replica:0/task:0/device:GPU:0
      Executing op Fill in device /job:localhost/replica:0/task:0/device:GPU:0
      Executing op MatrixSetDiagV3 in device /job:localhost/replica:0/task:0/device:GPU:0

[7]: var
      <tf.Tensor shape=(2, 3, 4), dtype=float32, numpy=
      array([[[[0.4963853, 0.3437792, 0.5885774, 0.9809525],
              [0.7380376, 0.17183267, 0.78617795, 0.1965229],
              [0.8438355, 0.477553, 0.9045875, 0.8048984]],
              [[0.7373954, 0.83208036, 0.2366718, 0.78826344],
              [0.9552499, 0.81808233, 0.715407, 0.6268387],
              [0.5948267, 0.9431349, 0.645041, 0.5425296]]], dtype=float32)>

[8]: I
      <tf.Tensor shape=(3, 4), dtype=float32, numpy=
      array([[1., 0., 0., 0.],
            [0., 1., 0., 0.],
            [0., 0., 1., 0.]], dtype=float32)>
```

4. tensorflow的优点

Tensorflow的设计使得它具有一系列优点，包括

1. 帮助开发者快速构建模型
2. 计算效率高
3. 可迁移性好
4. 功能丰富