Lecture 12
TensorFlow

GEOL 4397: Data analytics and machine learning for geoscientists

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EARTH AND ATMOSPHERIC SCIENCES

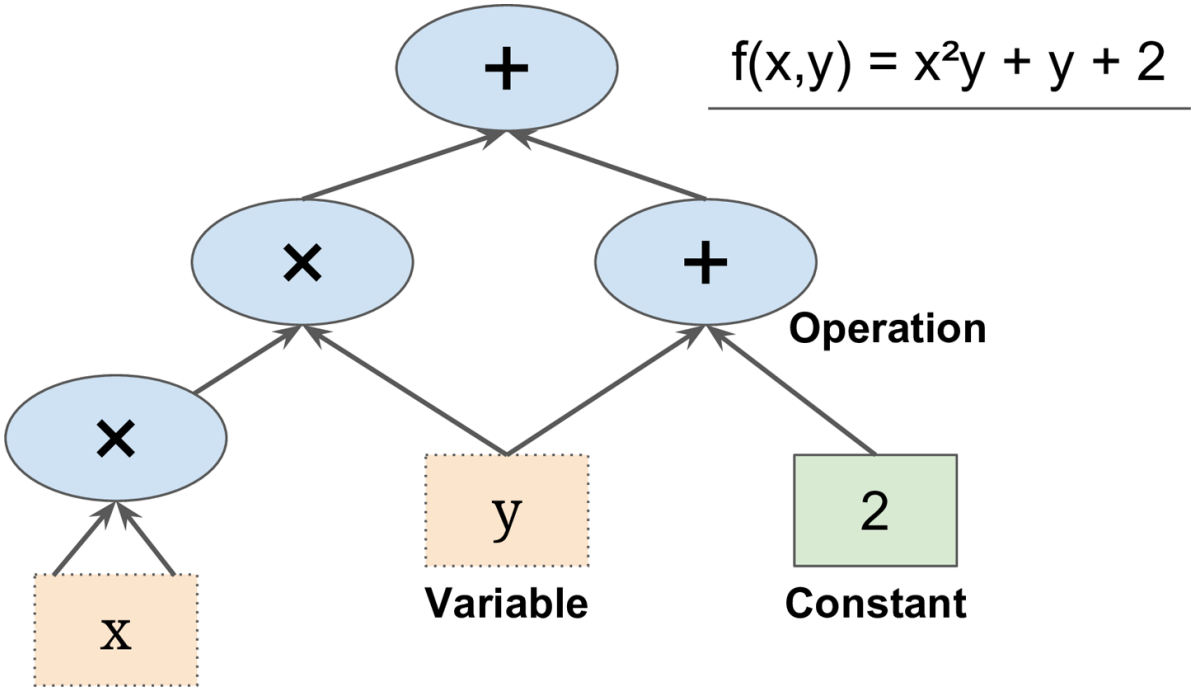
Outline

- Computation graph
- TensorFlow

Computation Graph

Computation graph

- A graph refers to a set of nodes connected via edges.
- Each node represents an operation.
- Each edge allows data to flow from one node to another in a directed manner.



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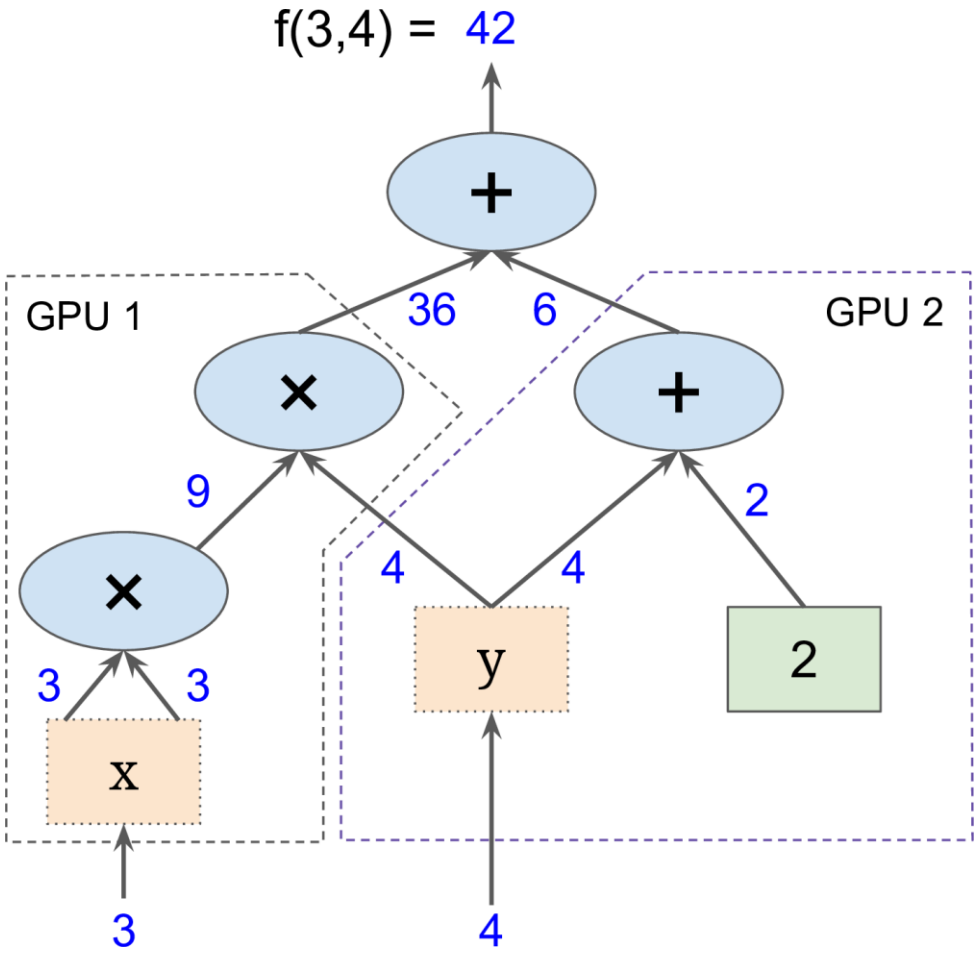
Computation graph



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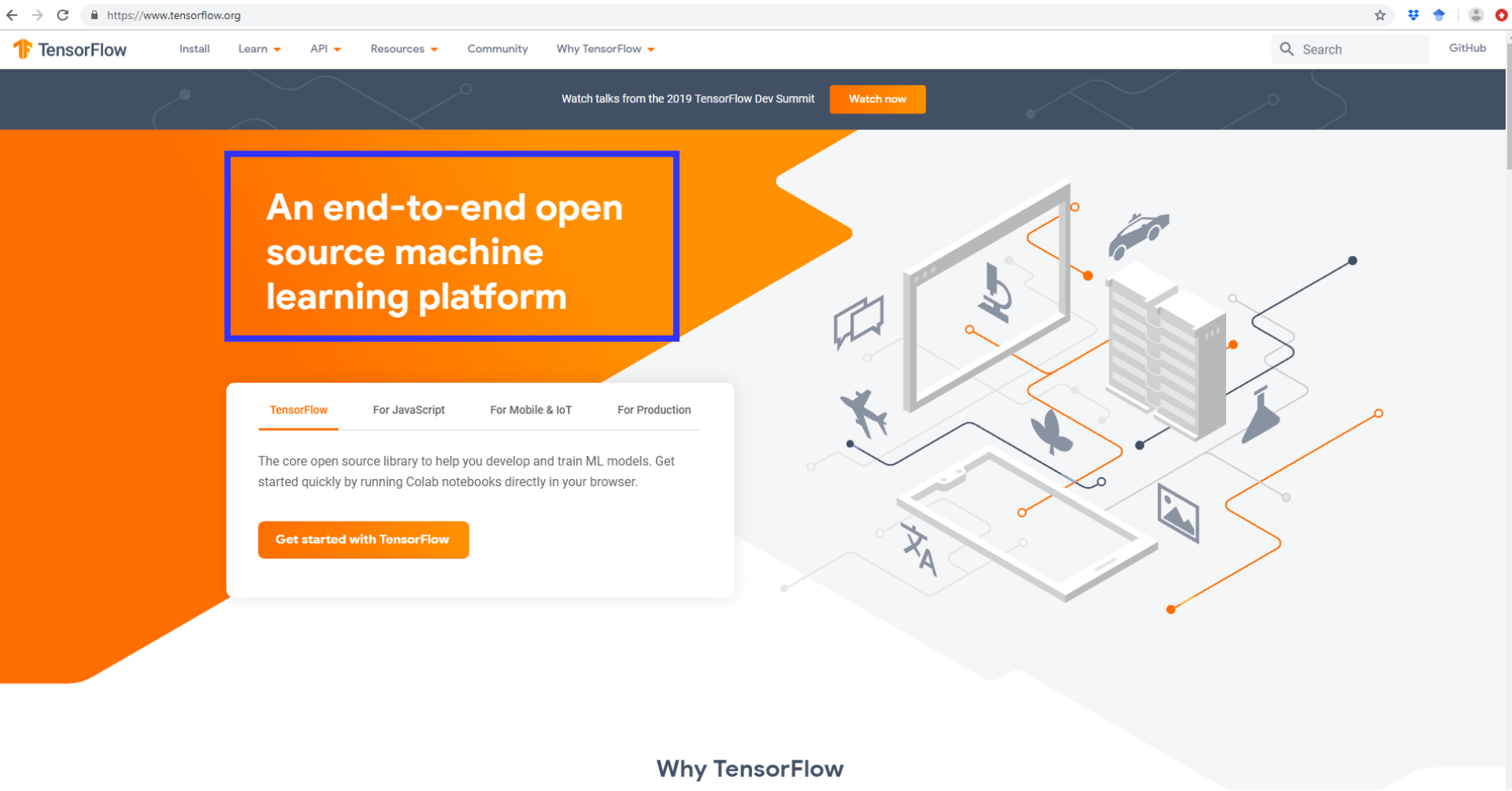
TensorFlow


https://www.tensorflow.org
TensorFlow
Install
Learn
API
Resources
Community
Why TensorFlow
Search
GitHub
Watch talks from the 2019 TensorFlow Dev Summit
Watch now
An end-to-end open source machine learning platform
TensorFlow
For JavaScript
For Mobile & IoT
For Production
The core open source library to help you develop and train ML models. Get started quickly by running Colab notebooks directly in your browser.
Get started with TensorFlow
Why TensorFlow

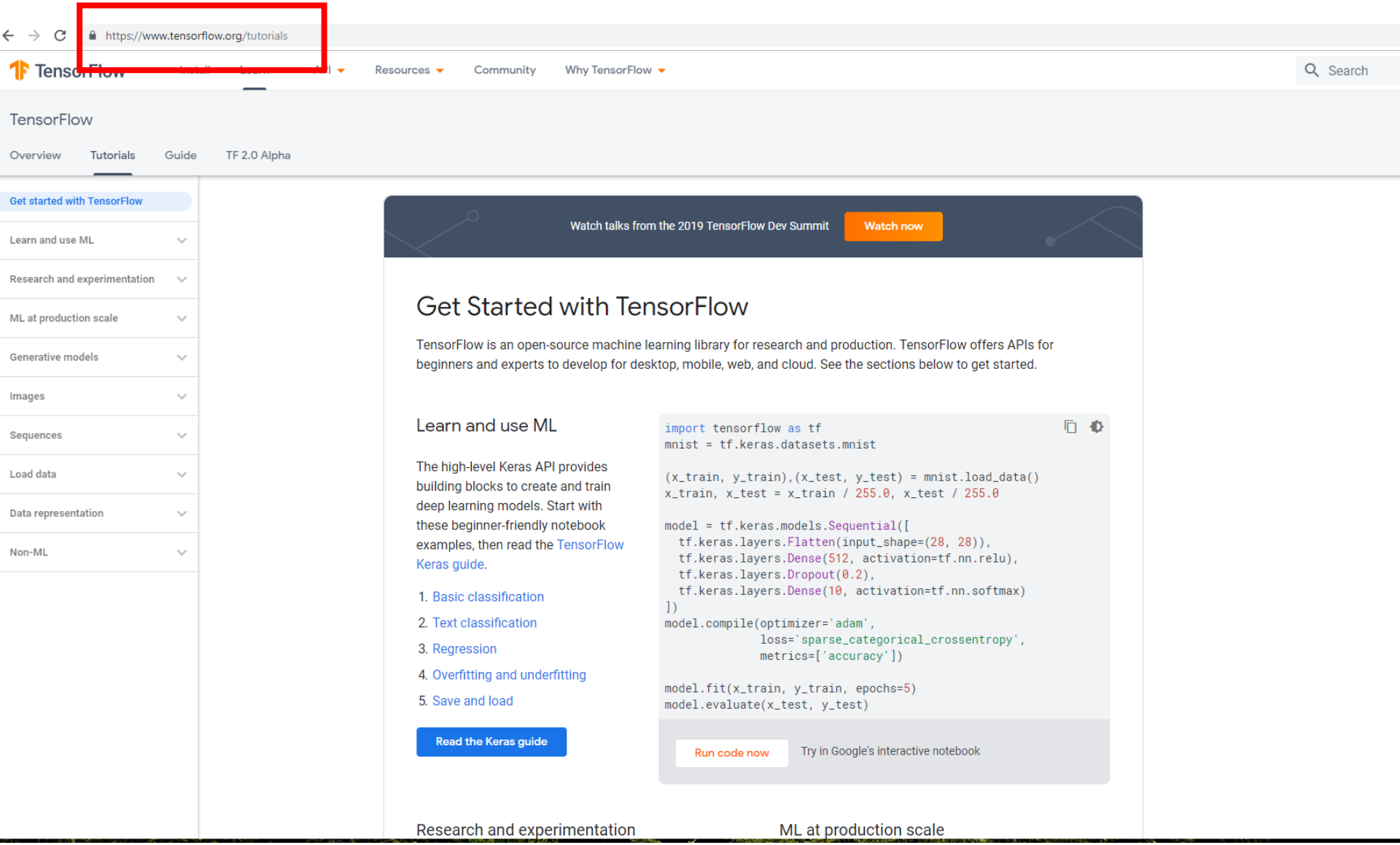

https://www.tensorflow.org/tutorials
Resources
Community
Why TensorFlow
Search
TensorFlow
Overview
Tutorials
Guide
TF 2.0 Alpha
Get started with TensorFlow
Learn and use ML
Research and experimentation
ML at production scale
Generative models
Images
Sequences
Load data
Data representation
Non-ML
Watch talks from the 2019 TensorFlow Dev Summit
Watch now
Get Started with TensorFlow
TensorFlow is an open-source machine learning library for research and production. TensorFlow offers APIs for beginners and experts to develop for desktop, mobile, web, and cloud. See the sections below to get started.
Learn and use ML
The high-level Keras API provides building blocks to create and train deep learning models. Start with these beginner-friendly notebook examples, then read the TensorFlow Keras guide.
1. Basic classification
2. Text classification
3. Regression
4. Overfitting and underfitting
5. Save and load
Read the Keras guide
import tensorflow as tf
mnist = tf.keras.datasets.mnist
(x_train, y_train),(x_test, y_test) = mnist.load_data()
x_train, x_test = x_train / 255.0, x_test / 255.0
model = tf.keras.models.Sequential([
tf.keras.layers.Flatten(input_shape=(28, 28)),
tf.keras.layers.Dense(512, activation=tf.nn.relu),
tf.keras.layers.Dropout(0.2),
tf.keras.layers.Dense(10, activation=tf.nn.softmax)
])
model.compile(optimizer='adam',
loss='sparse_categorical_crossentropy',
metrics=['accuracy'])
model.fit(x_train, y_train, epochs=5)
model.evaluate(x_test, y_test)
Run code now
Try in Google's interactive notebook
Research and experimentation
ML at production scale

Table 9-1. Open source Deep Learning libraries (not an exhaustive list)

Library	API	Platforms	Started by	Year
Caffe	Python, C++, Matlab	Linux, macOS, Windows	Y. Jia, UC Berkeley (BVLC)	2013
Deeplearning4j	Java, Scala, Clojure	Linux, macOS, Windows, Android	A. Gibson, J.Patterson	2014
H2O	Python, R	Linux, macOS, Windows	H2O.ai	2014
MXNet	Python, C++, others	Linux, macOS, Windows, iOS, Android	DMLC	2015
TensorFlow	Python, C++	Linux, macOS, Windows, iOS, Android	Google	2015
Theano	Python	Linux, macOS, iOS	University of Montreal	2010
Torch	C++, Lua	Linux, macOS, iOS, Android	R. Collobert, K. Kavukcuoglu, C. Farabet	2002

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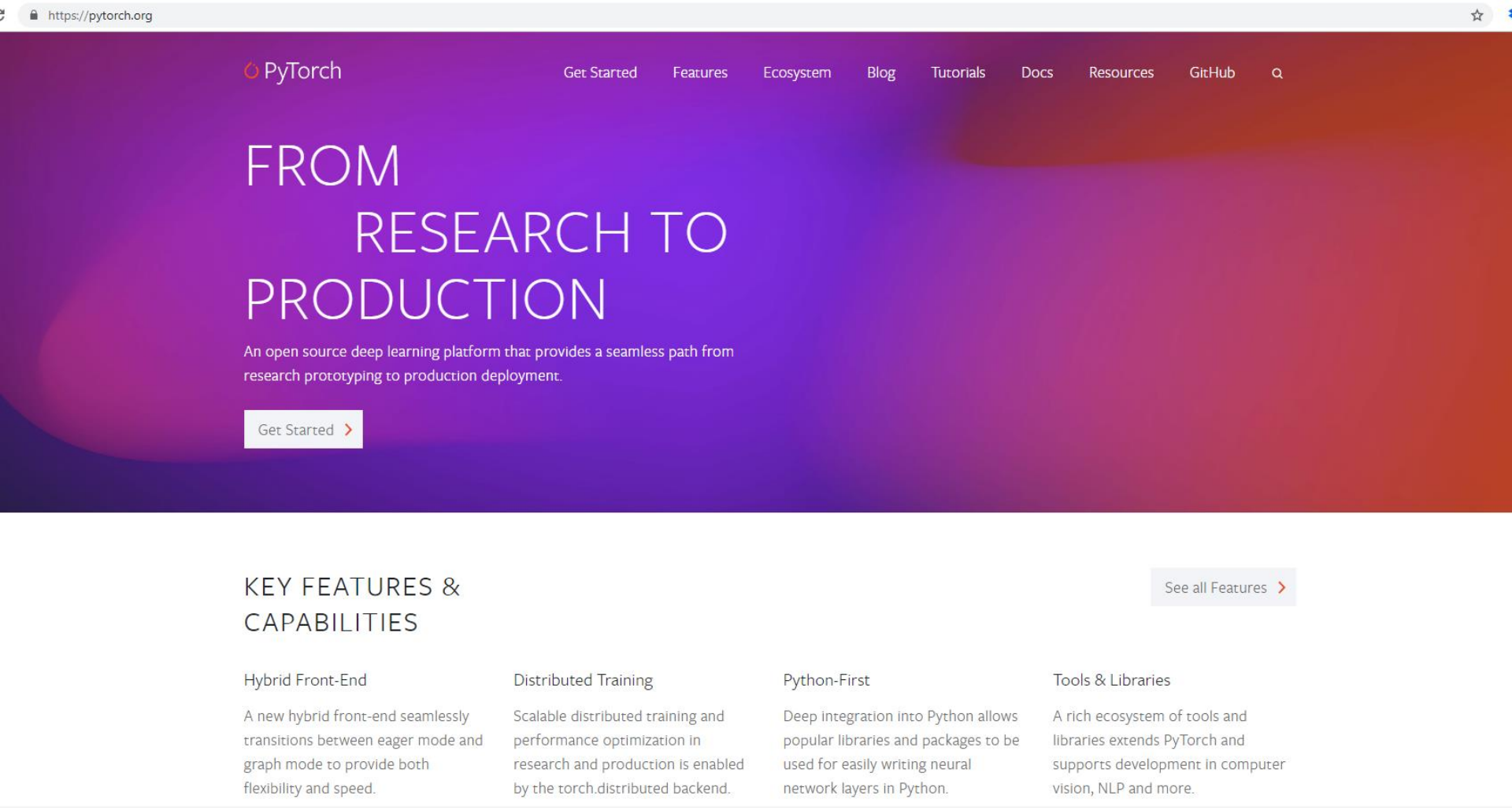
https://pytorch.org
PyTorch
Get Started
Features
Ecosystem
Blog
Tutorials
Docs
Resources
GitHub
FROM
RESEARCH TO
PRODUCTION
An open source deep learning platform that provides a seamless path from research prototyping to production deployment.
Get Started
KEY FEATURES &
CAPABILITIES
See all Features
Hybrid Front-End
A new hybrid front-end seamlessly transitions between eager mode and graph mode to provide both flexibility and speed.
Distributed Training
Scalable distributed training and performance optimization in research and production is enabled by the torch.distributed backend.
Python-First
Deep integration into Python allows popular libraries and packages to be used for easily writing neural network layers in Python.
Tools & Libraries
A rich ecosystem of tools and libraries extends PyTorch and supports development in computer vision, NLP and more.

TensorFlow

- What is tensor?
- A tensor is a generalization of vectors and matrices to higher dimensions.
- TensorFlow regards all data that flow in a graph as tensor. (Therefore, the name TensorFlow)
- The rank of a tensor is its number of dimensions.

Rank	Math entity
0	Scalar (magnitude only)
1	Vector (magnitude and direction)
2	Matrix (table of numbers)
3	3-Tensor (cube of numbers)
n	n-Tensor (you get the idea)

https://www.tensorflow.org/programmers_guide/tensors

TensorFlow

- Computation graph defines how tensors flow in a graph in order to perform some computational tasks.

- TensorFlow is a powerful open source software library for numerical computation, particularly well suited for large scale machine learning. (Back-end is optimized C++ code)

- Originally developed by Google Brain team
- Open-sourced in Nov. 2015.
- Powers many of Google's large-scale services such as Google Cloud Speech, Google Photos, and Google Search

Distributed computing

- TensorFlow supports distributed computing
- Splitting computations across hundreds of servers
- Can train a network of millions of parameters on a training set composed of billions of instances with millions of features each

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To use TensorFlow

- Create a graph
- Execute the graph

Use Jupyter Notebook to illustrate TensorFlow

In-class quiz

```
x = tf.placeholder(tf.float32, shape=(5,10))
w = tf.placeholder(tf.float32, shape=(10,1))
b = tf.constant([[-1],[-1],[-1],[-1],[-1]], tf.float32, shape=(5,1))
xw = tf.matmul(x,w)
xwb = xw + b
s = tf.reduce_max(xwb)
```

Draw the corresponding computation graph