



# TensorFlow

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Deep Learning Architect and Engineer H2O.ai

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*AI is the new electricity!*

*Electricity transformed  
countless industries*

*AI will now do the same*

Andrew Ng

Chief Scientist of Baidu; Chairman and Co-Founder of  
Coursera; Stanford CS faculty.



## Compare Search terms ▾

deep learning

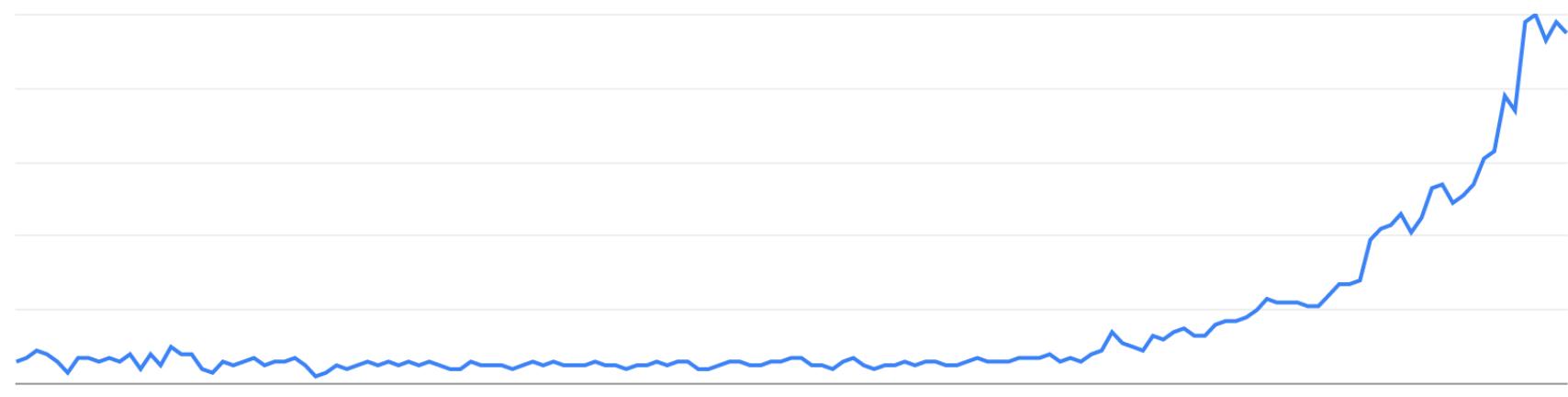
Search term

+ Add term

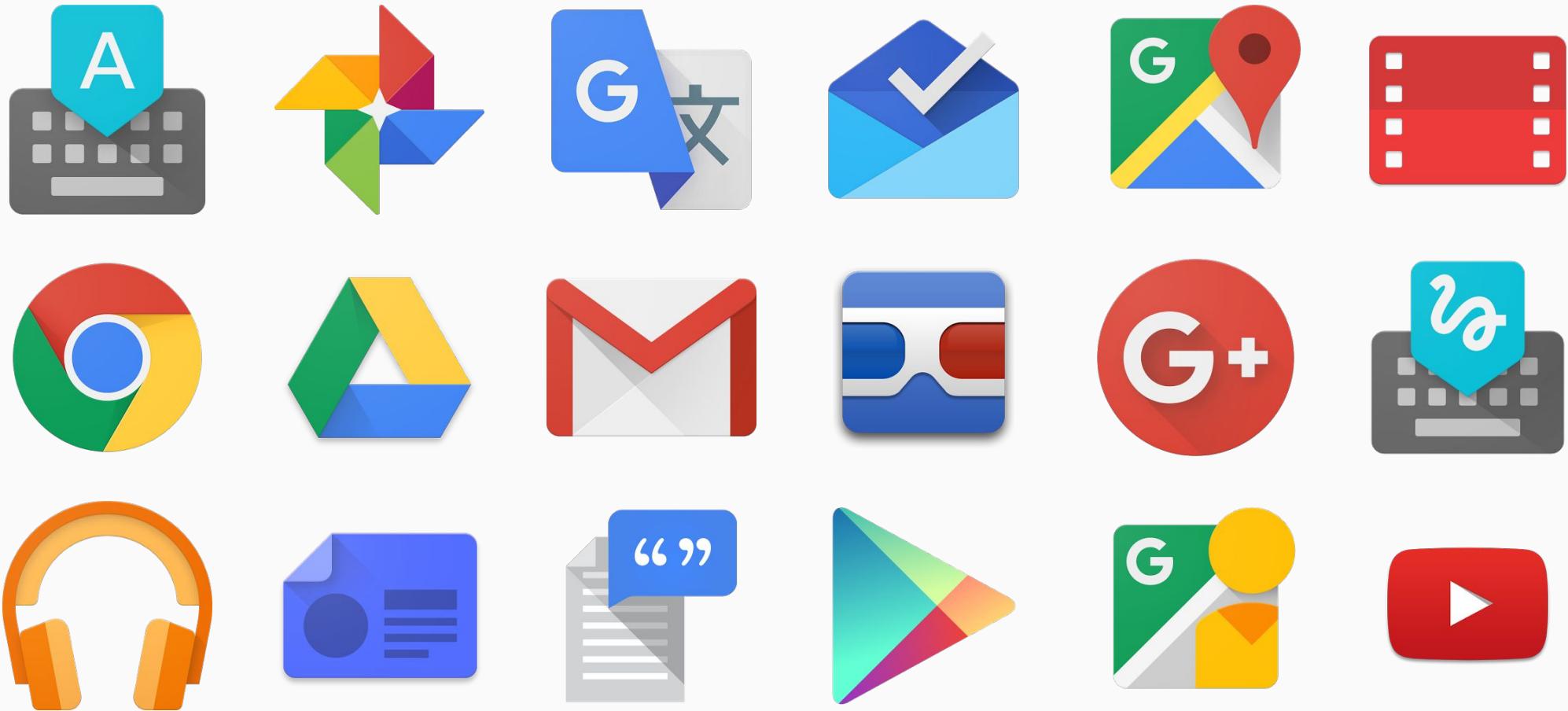
### Interest over time

News headlines

Forecast



</>





**tensorflow**  
Search term

**theano**  
Search term

**mxnet**  
Search term

+ Add term

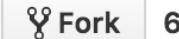
### Interest over time

News headlines Forecast



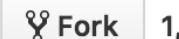
A screenshot of a GitHub repository page for "tensorflow / tensorflow". The page features a yellow wavy background banner at the top. The repository name "tensorflow / tensorflow" is at the top left, followed by a star icon, "Unwatch" (with 2,702), "Unstar" (with 28,178), a fork icon, and "Fork" (with 11,490). A red arrow points to the "Fork" button. Below this is a navigation bar with "Code" (selected), "Issues 388", "Pull requests 20", "Pulse", and "Graphs". The main content area contains the text "Computation using data flow graphs for scalable machine learning <http://tensorflow.org>". Below this are four summary boxes: "5,976 commits", "8 branches", "9 releases", and "312 contributors". A horizontal progress bar is shown below the contributor box.

 BVLC / caffe

 Watch ▾ 1,477    Unstar 11,333    Fork 6,825

 Code    Issues 465    Pull requests 246    Wiki    Pulse    Graphs

 dmlc / mxnet

 Watch ▾ 505    Star 4,442    Fork 1,645

 Code    Issues 429    Pull requests 25    Wiki    Pulse    Graphs

 Theano / Theano

 Watch ▾ 391    Star 4,131    Fork 1,487

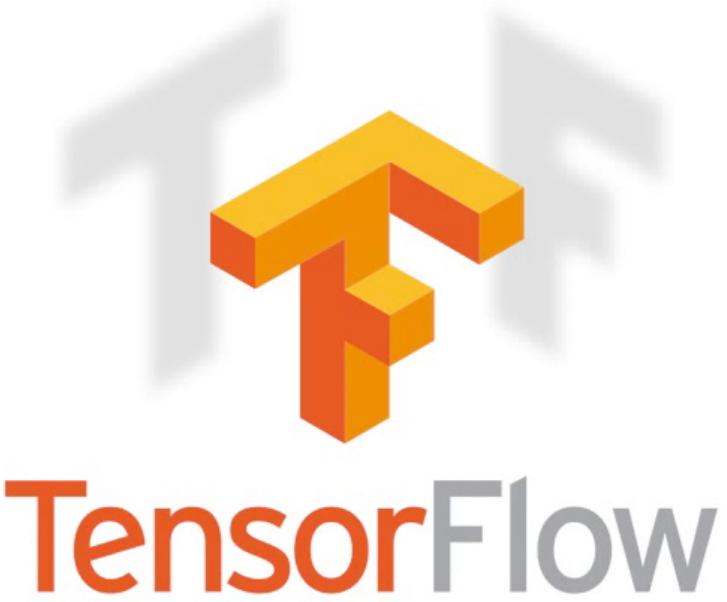
 Code    Issues 606    Pull requests 111    Wiki    Pulse    Graphs

Theano is a Python library that allows you to define, optimize, and evaluate mathematical expressions involving multi-dimensional arrays efficiently. It can use GPUs and perform efficient symbolic differentiation. <http://wwwdeeplearningnetsoftwaretheano>



TensorFlow

Why did Google open sourced it ?



*“By sharing what we believe to be one of the best machine learning toolboxes in the world, we hope to create an open standard for exchanging research ideas and putting machine learning in products.”*



TensorFlow

## Architecture

# Jeff Dean (Google)

**Spanner** - a scalable, multi-version, globally distributed, and synchronously replicated database

Some of the production system design and statistical machine translation system for Google Translate.

**BigTable**, a large-scale semi-structured storage system.

**MapReduce** a system for large-scale data processing applications.

**Google Brain** a system for large-scale artificial neural networks

**LevelDB** an open source on-disk key-value store.

**TensorFlow** an open source machine learning software library.



Python

C++

...

Framework

Core

stream\_executor



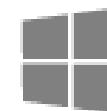
iOS



Android



Mac OS X



Windows



Linux

Platform



TensorFlow

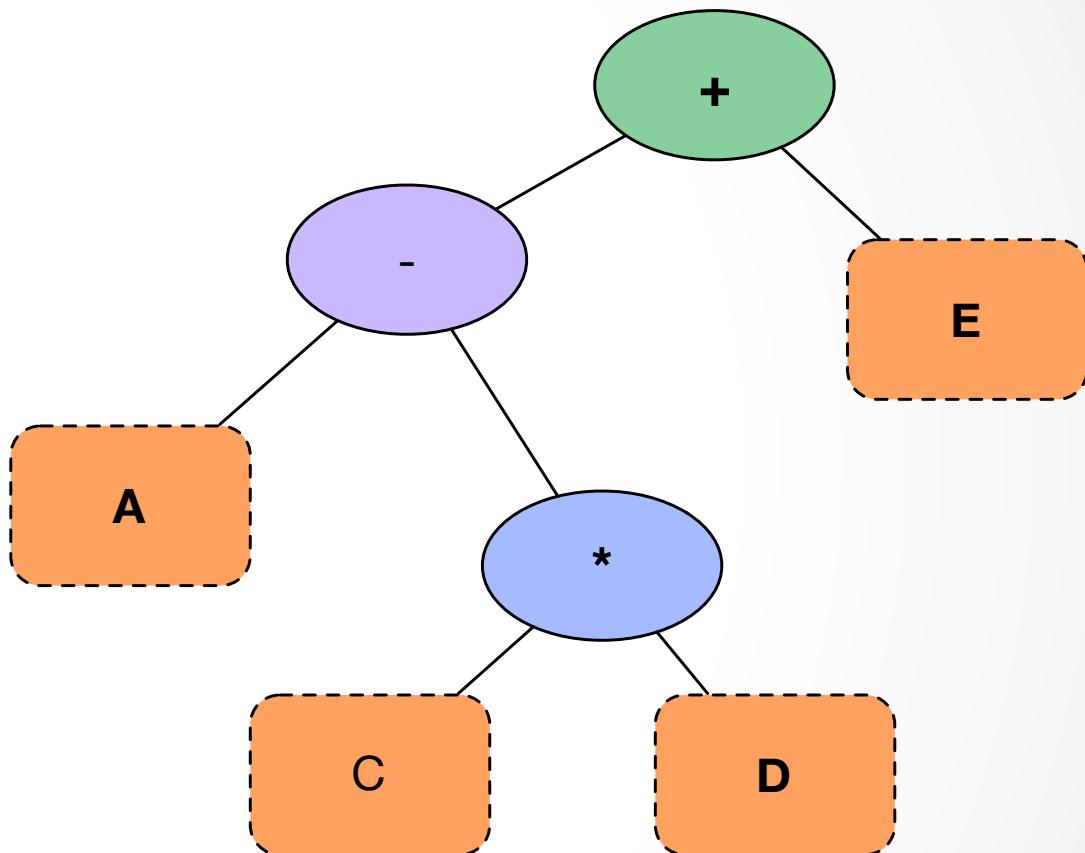
## The Data Flow Graph

```
A = 1  
C = 2  
D = 3  
E = 4
```

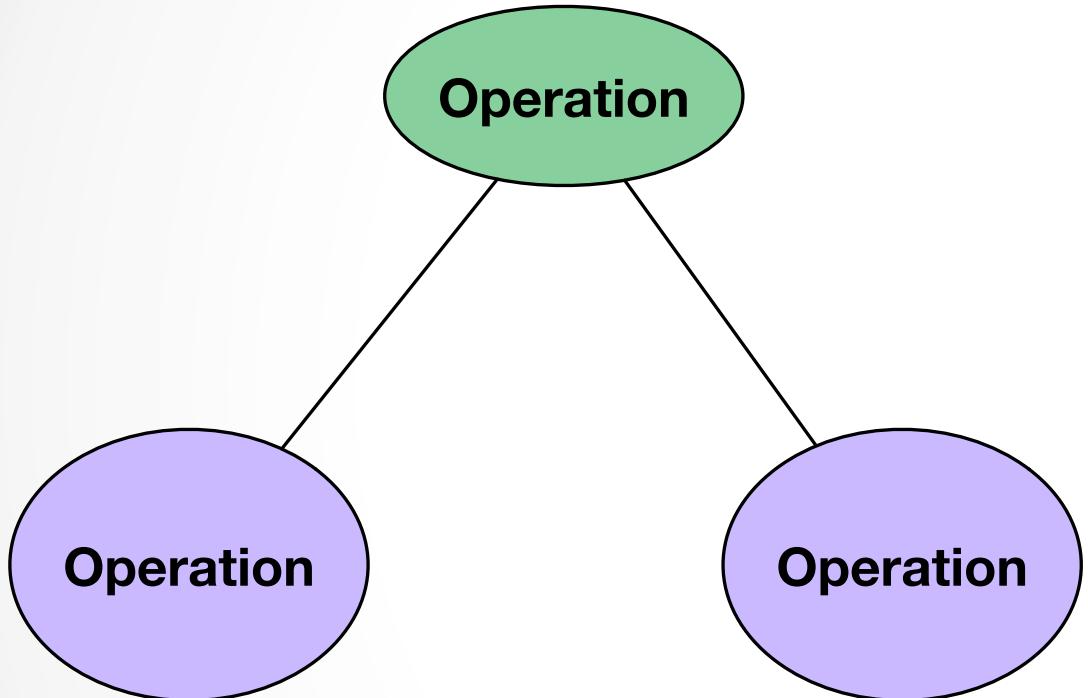
```
result = C * D
```

```
result = A - result
```

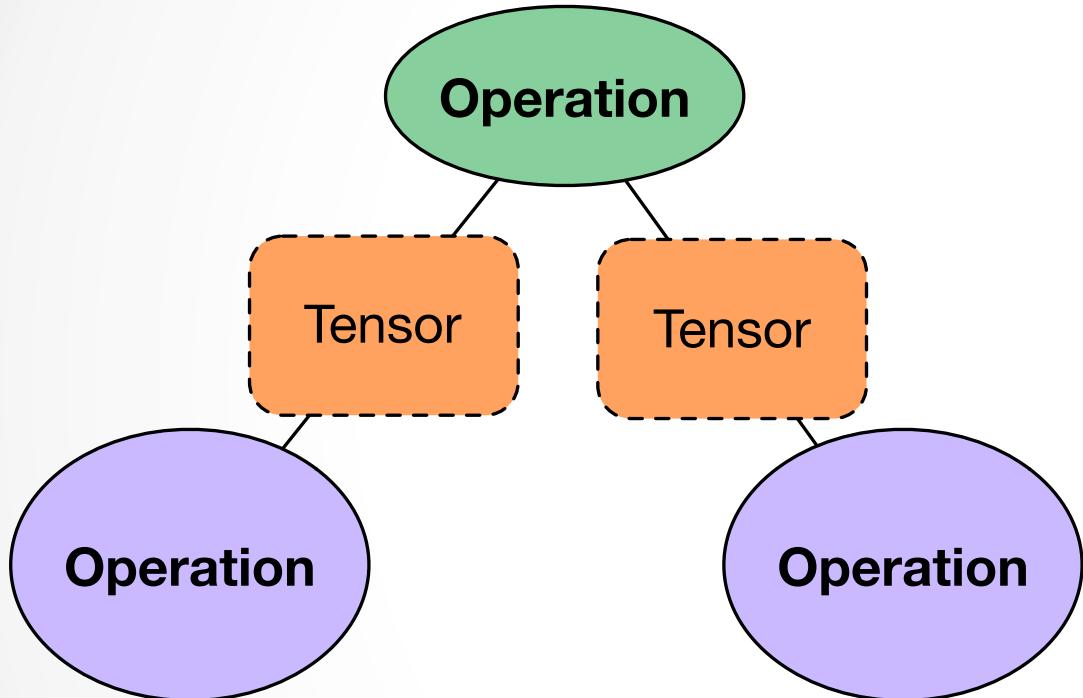
```
result = result + E
```

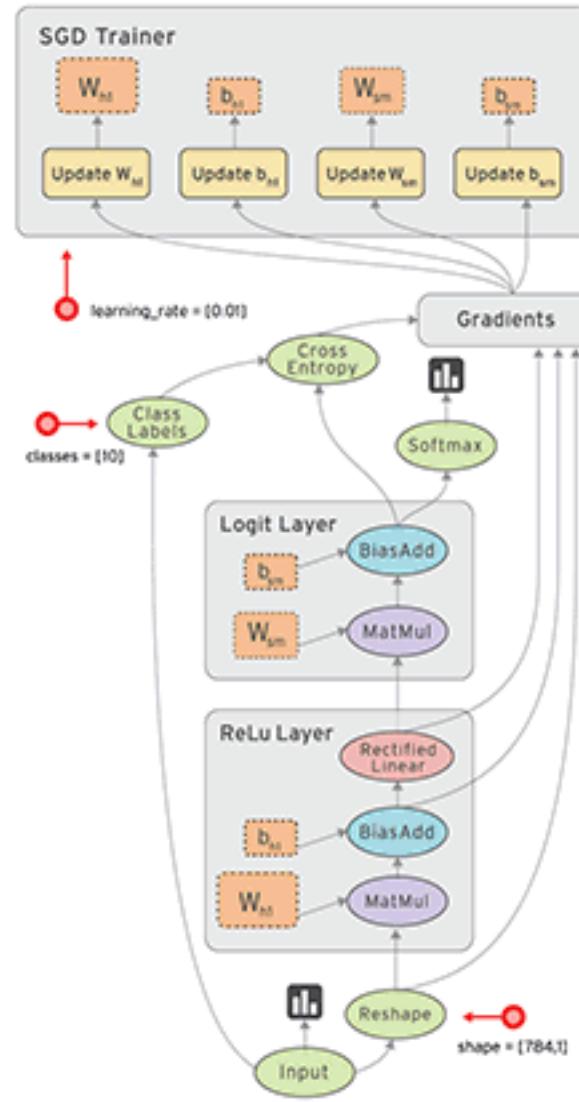


# Operations are the nodes



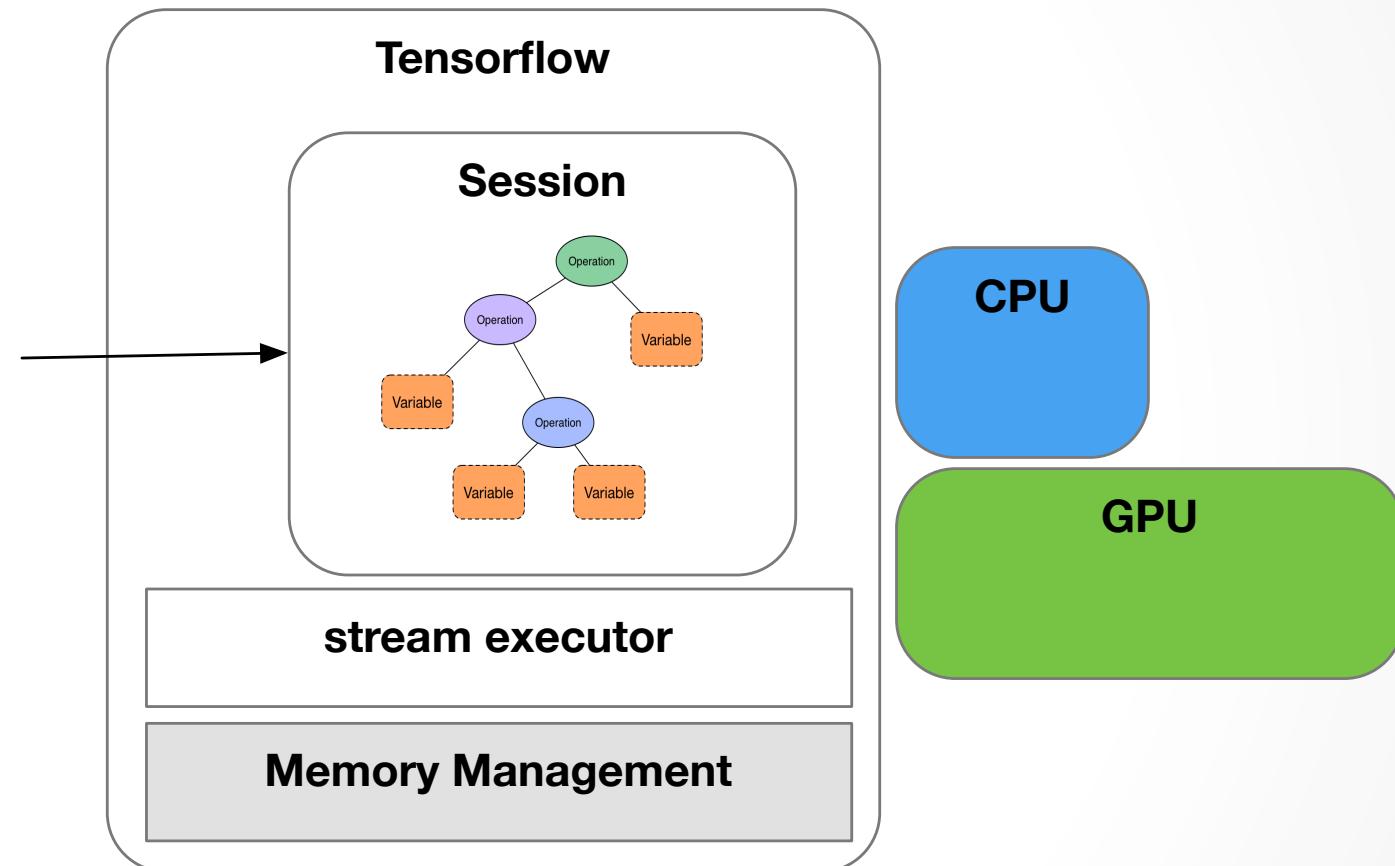
# Tensors are the edges





Python API

```
tf.get_variable()  
session = tf.Session()  
  
tf.placeholder(..  
tf.truncated_variable(..  
tf.Variable(..  
tf.relu(..
```





TensorFlow

## Tensorflow Library

## **Tensorflow Operation Libraries:**

1. Tensor manipulation (join, split, ...)
2. Deep learning ops (ReLU, Sigmoid, BatchNorm..)
3. Optimizer (RMSProp AdaGrad, AdaDelta, ..)
- 4. Automatic Differentiation**
5. Image Manipulation (Crop, resize, rotate ..)
6. Mp3 Audio extraction

And many more ...



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Tensorboard



TensorFlow

H<sub>2</sub>O.ai

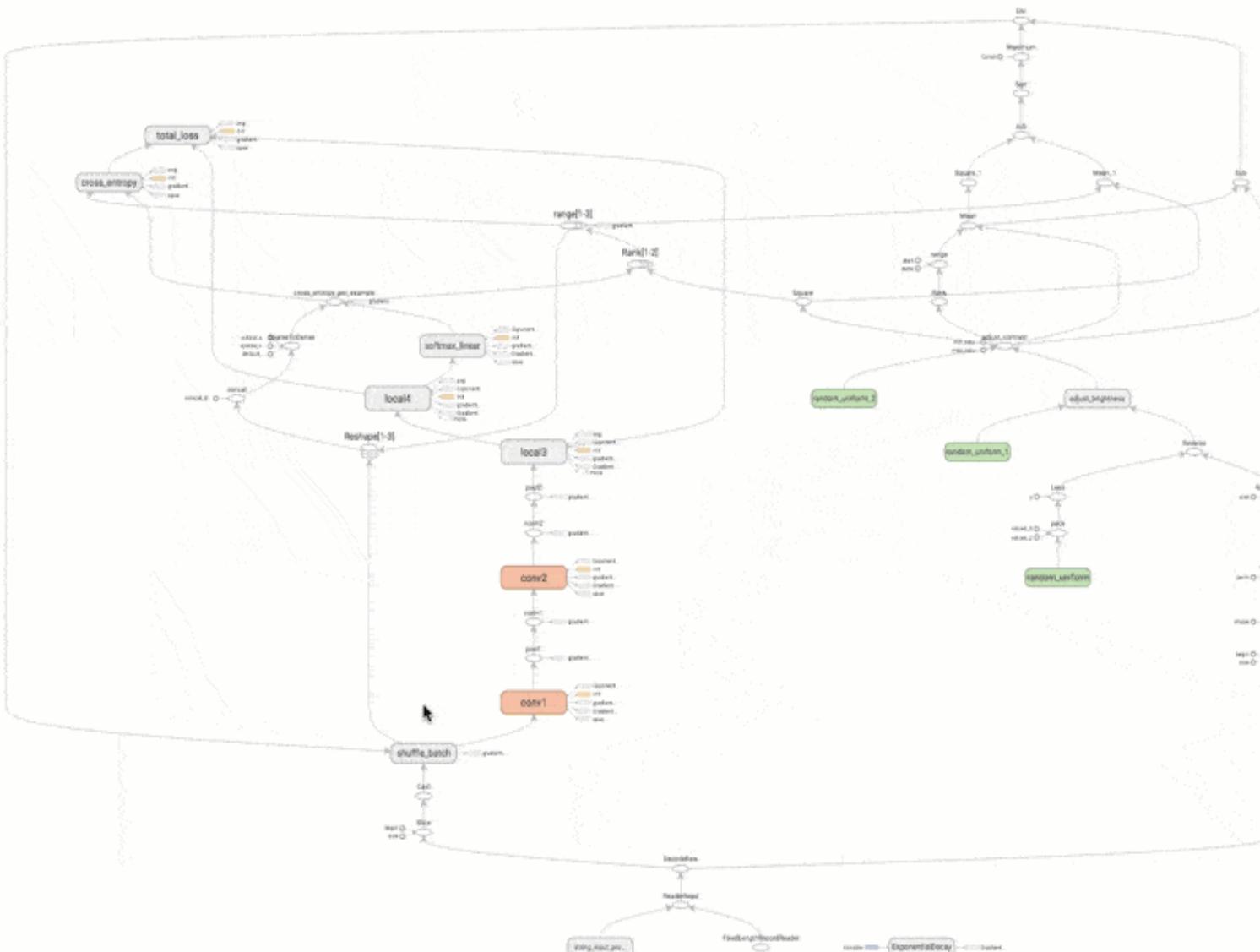
## Tensorboard Interactive Demo



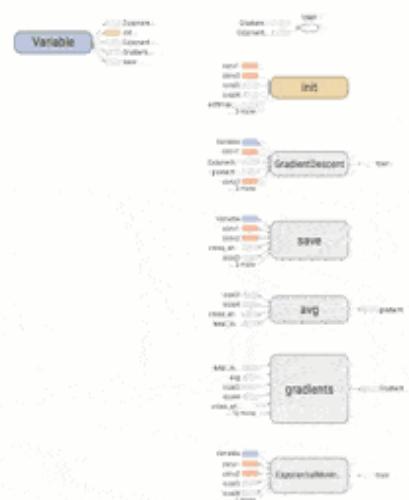
Fit to screen  
Run cifar-train

Upload Choose File  
Color Structure  
color: same substructure  
gray: unique substructure

## Main Graph



## Auxiliary nodes



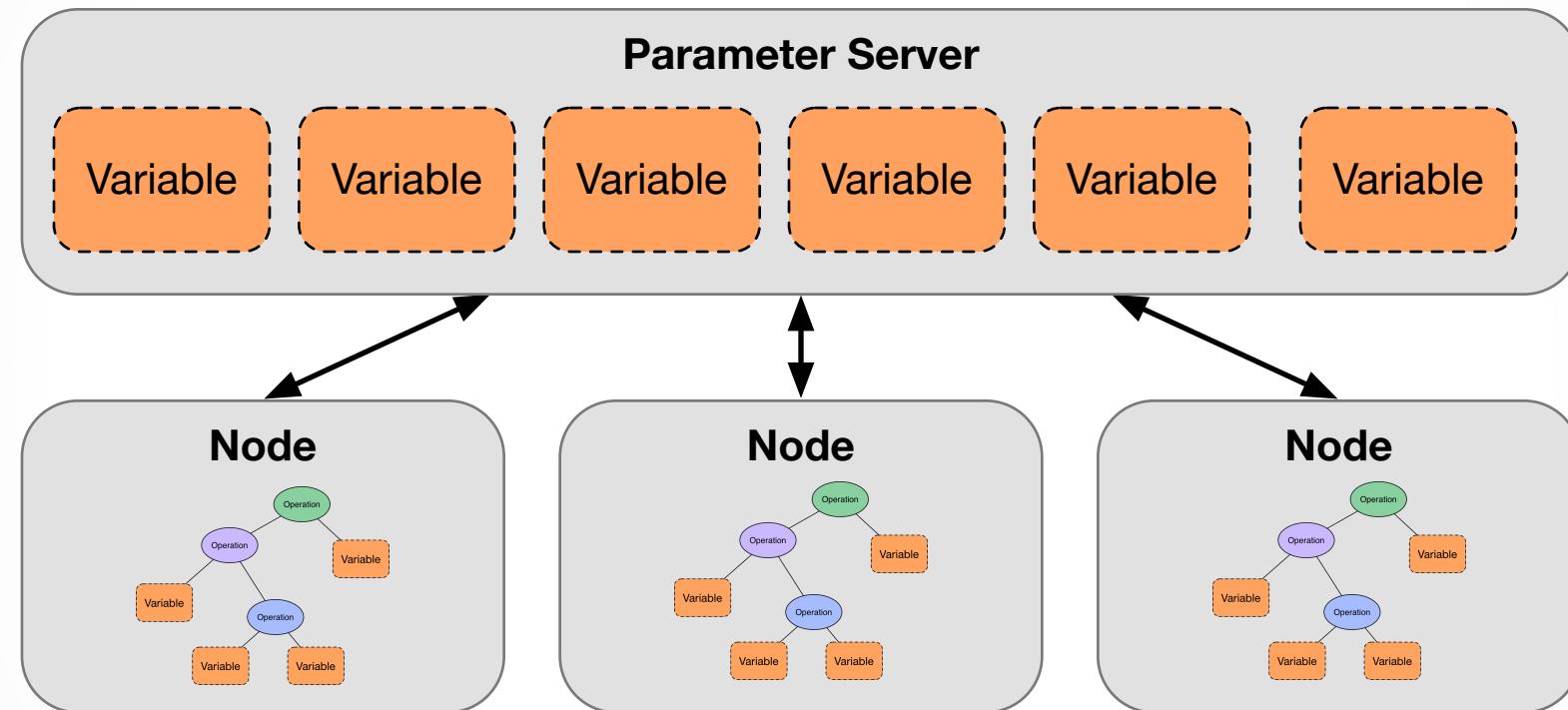
Graph (\* = expandable)  
Namespace\*  
OpNode  
Unconnected series\*  
Connected series\*  
Constant  
Summary  
Dataflow edge  
Control dependency edge  
Reference edge



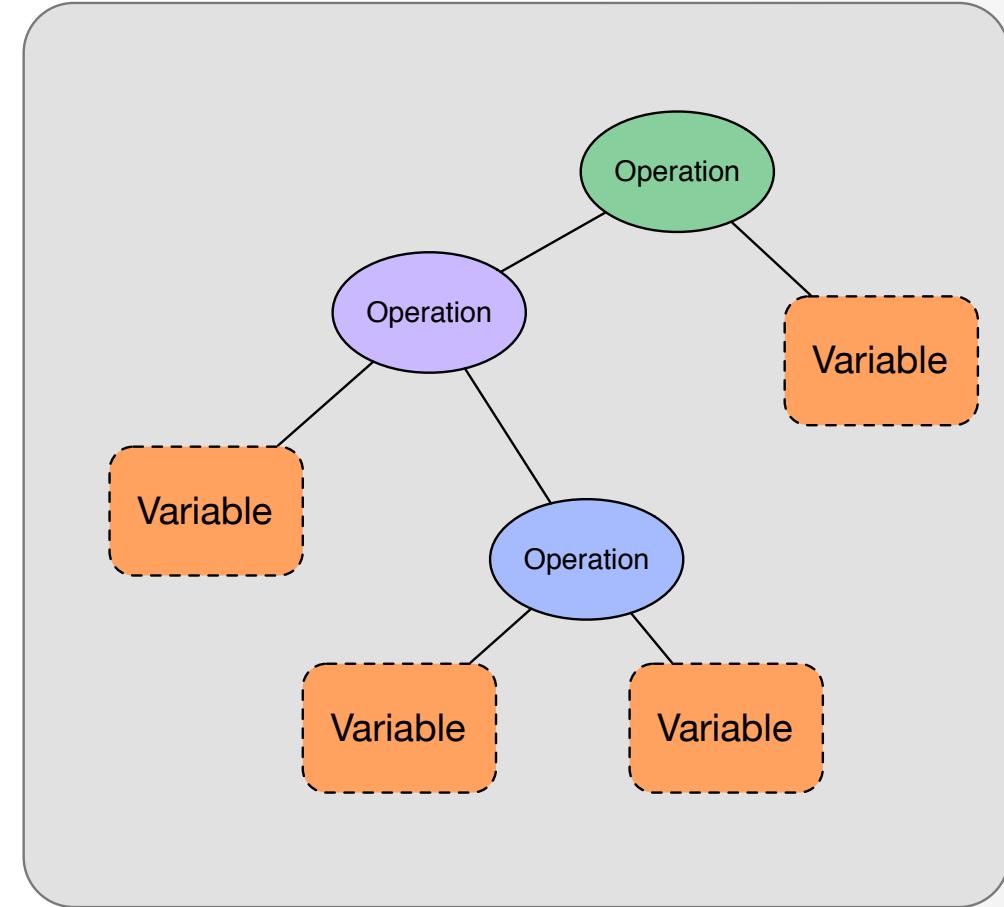
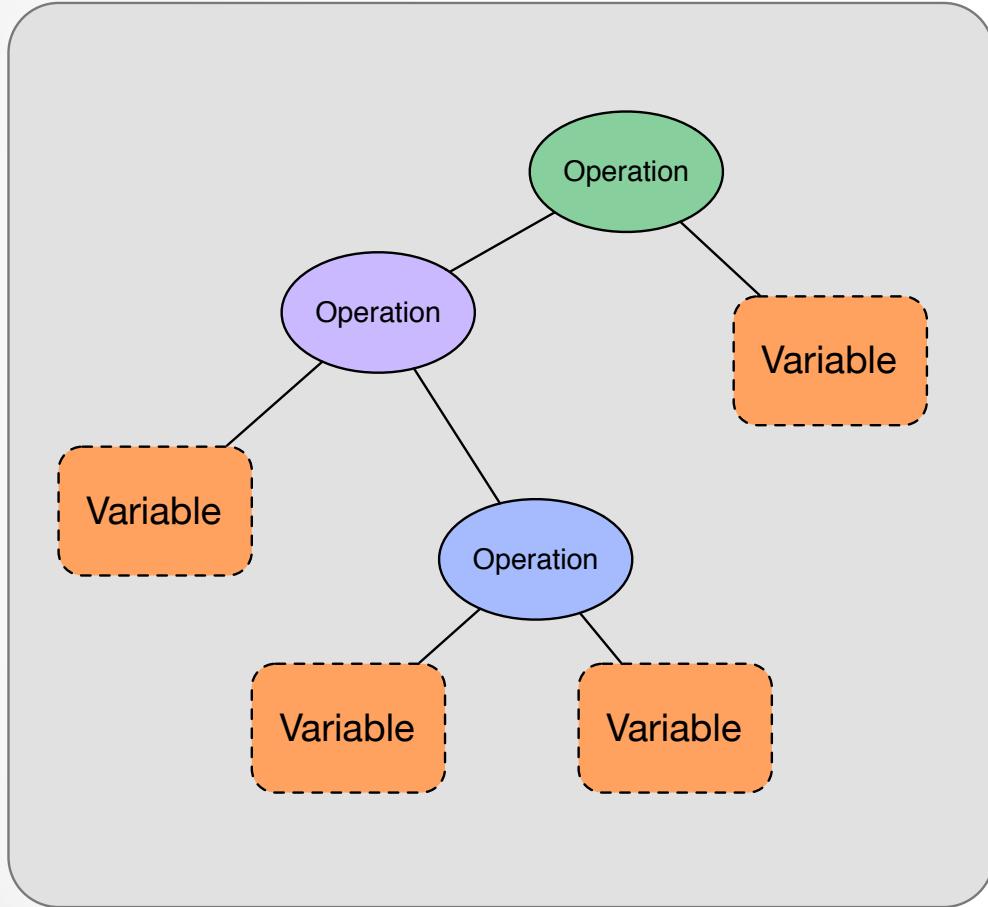
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## Distributed Graph Execution

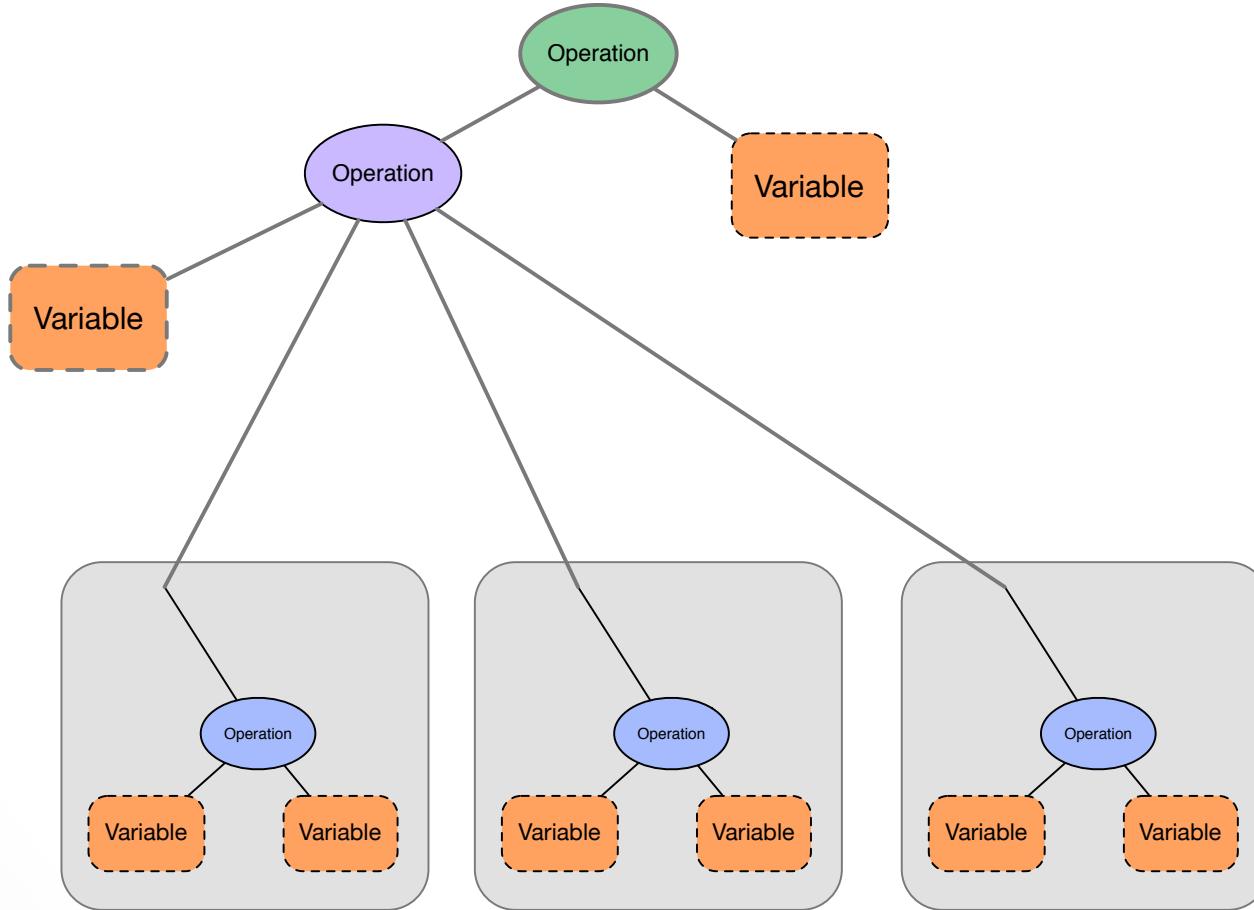
# Asynchronous Gradient Descent Training

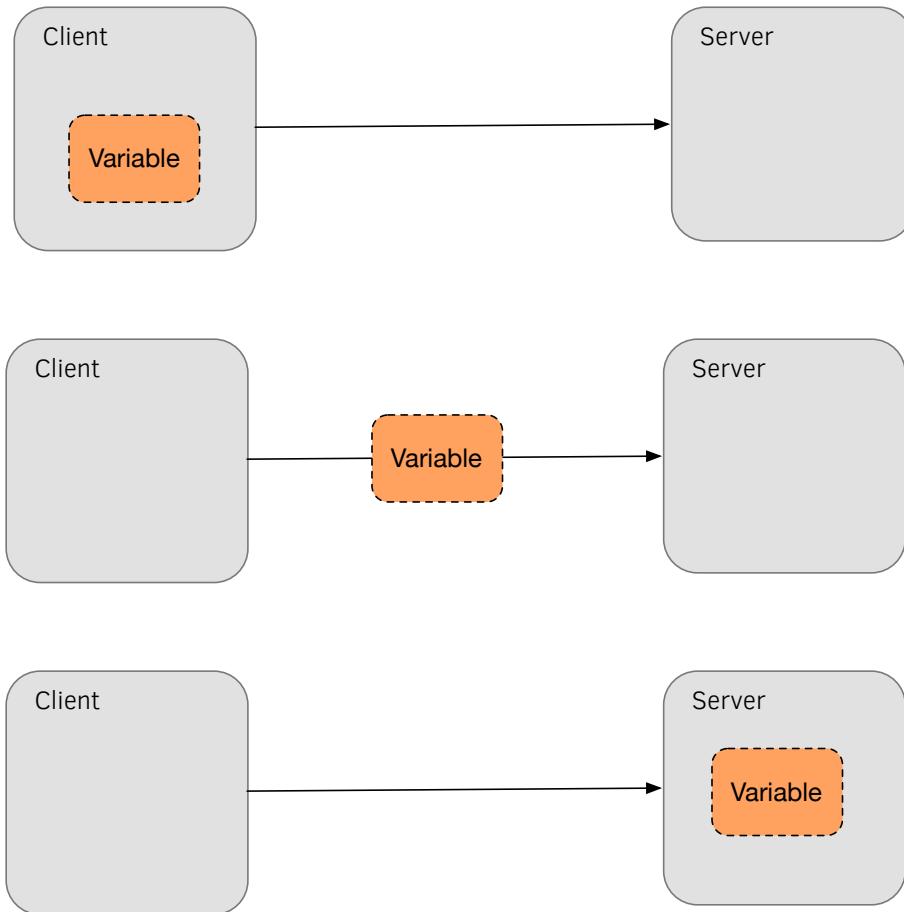


# Replicate the Whole Graph



# Replicate only Part of the Graph





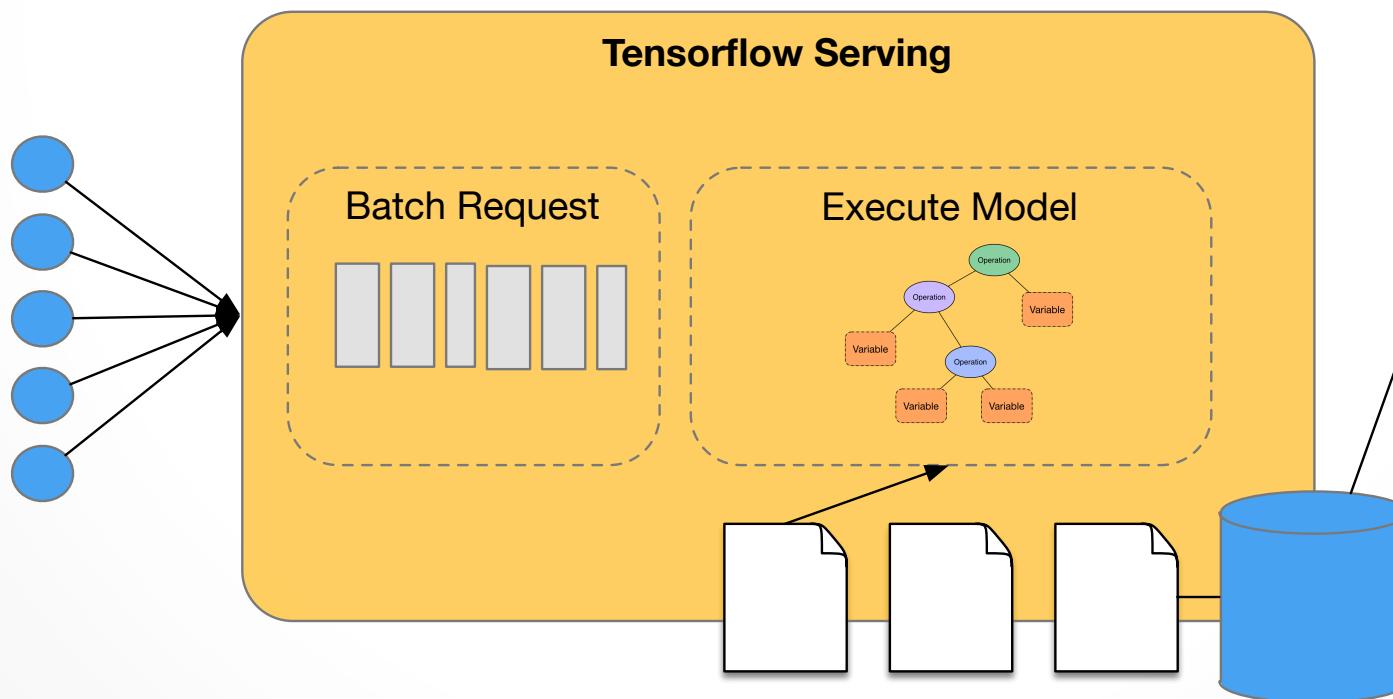
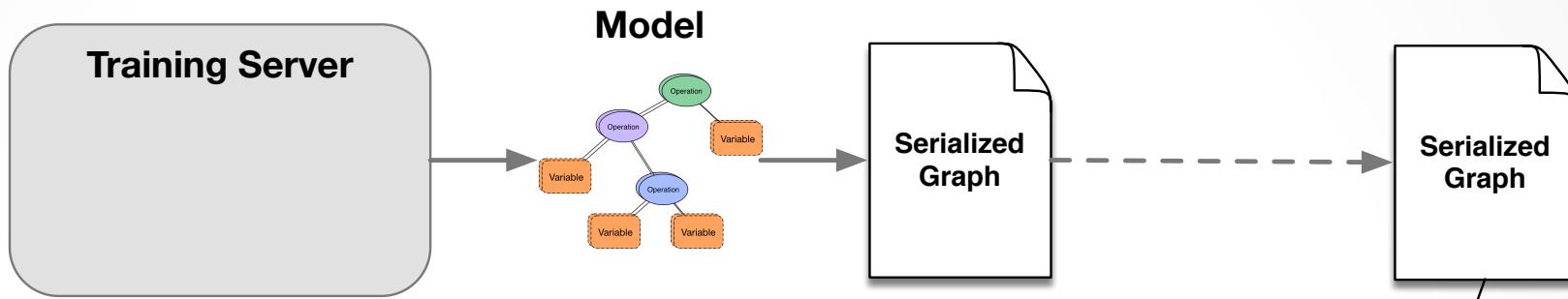
<http://www.grpc.io/>



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## Tensor Serving

<http://github.com/tensorflow/serving>





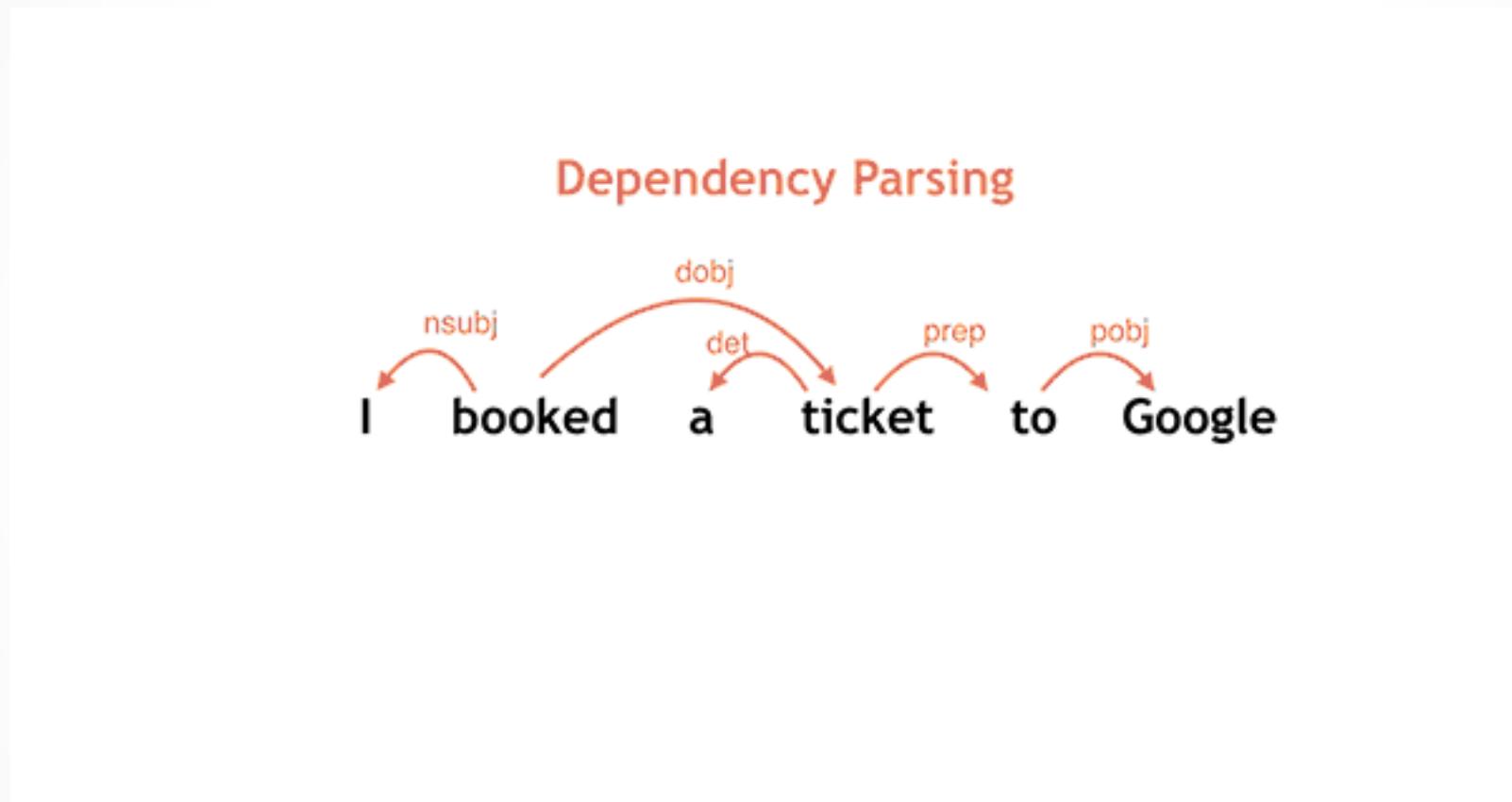
TensorFlow

Open Source Models

# github.com/tensorflow/models

 autoencoder	merged changes from #25	4 months ago
 inception	Misspelling in parameter (factfor --> factor)	27 days ago
 namigner	add the namigner model (#147)	2 months ago
 neural_gpu	Add to neural_gpu documentation.	a month ago
 swivel	remove unneeded assignment	28 days ago
 syntaxnet	Compatibility with tensorflow master (#204)	21 days ago
 transformer	Use tf.softmax_cross_entropy_with_logits to calculate loss (#181)	27 days ago

# Syntaxnet



<https://research.googleblog.com/2016/05/announcing-syntaxnet-worlds-most.html>

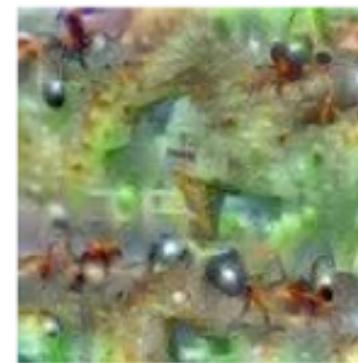
# Inception



Hartebeest



Measuring Cup



Ant



Starfish



Anemone Fish



Banana



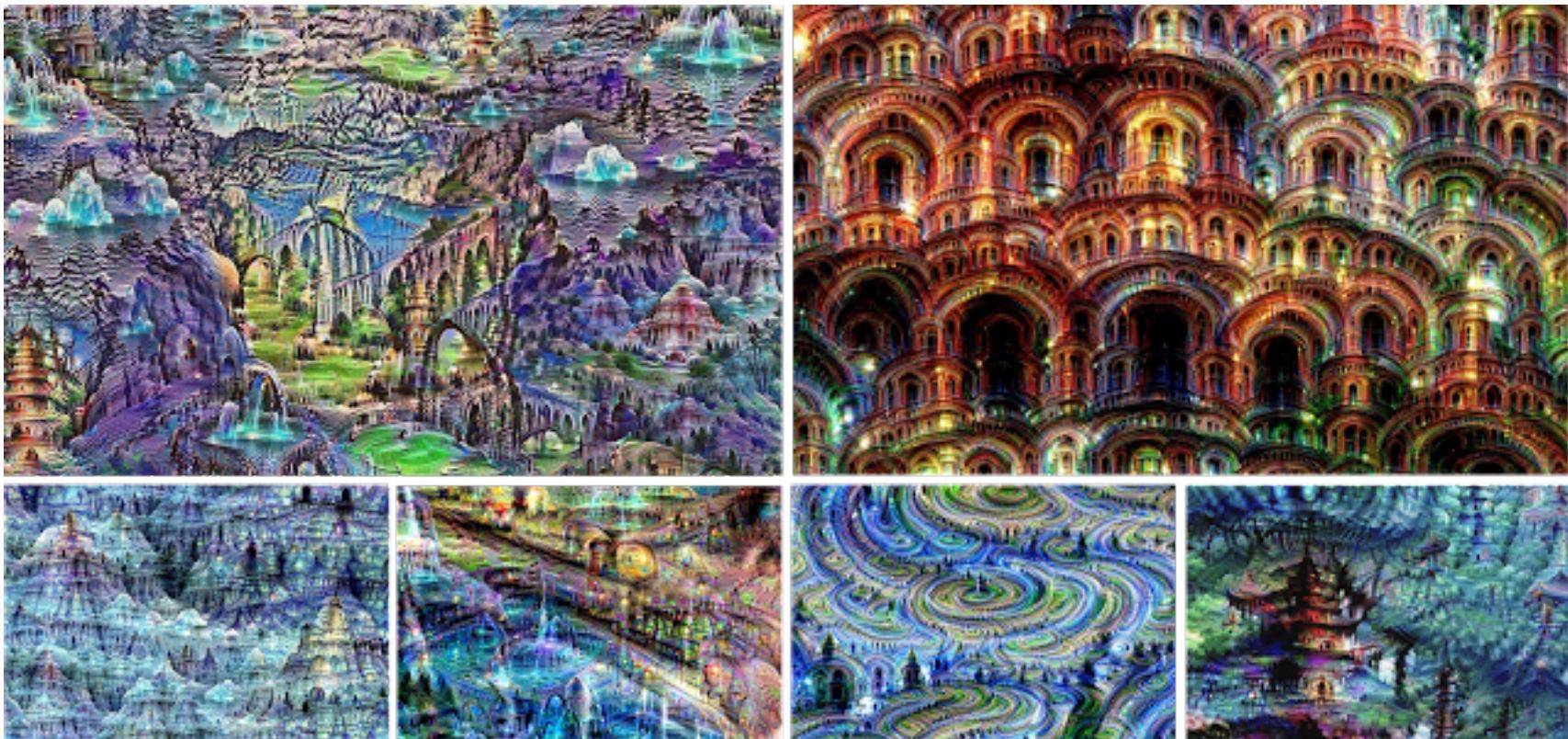
Parachute



Screw

<https://research.googleblog.com/2015/06/inceptionism-going-deeper-into-neural.html>

# Inception



<https://research.googleblog.com/2015/06/inceptionism-going-deeper-into-neural.html>

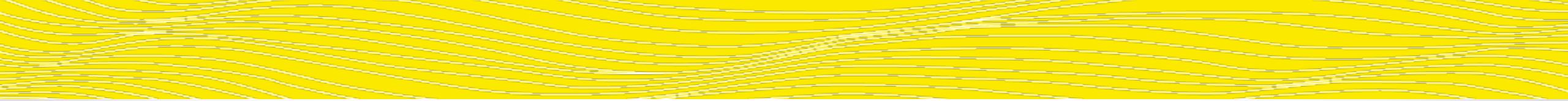


TensorFlow

## H2O & Tensorflow



**H20 & Tensorflow**  
AI everywhere  
architecture  
tools  
serving  
models  
**H20**



# Thank you

(Come talk to me)

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H<sub>2</sub>O.ai

