
TensorFlow

TensorFlow

Intro to TensorFlow

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@sam_witteveen

About me

- Google Developer Expert for Machine Learning & Deep Learning
- Red Dragon AI 

- Use Deep Learning for Conversational Computing and Natural Language Understanding

Today's Talk

- What is TensorFlow
- How its being used around the world
- How you can get started

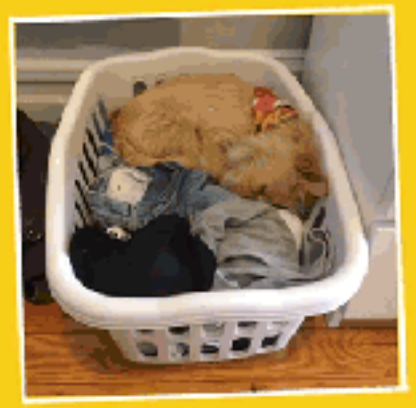
What is TensorFlow?

TensorFlow: ML for Everyone

- An open-source machine learning platform for everyone
- **Fast, flexible, and production-ready**
- Scales from research to production

IS THIS A

CAT or DOG?



CAT DOG

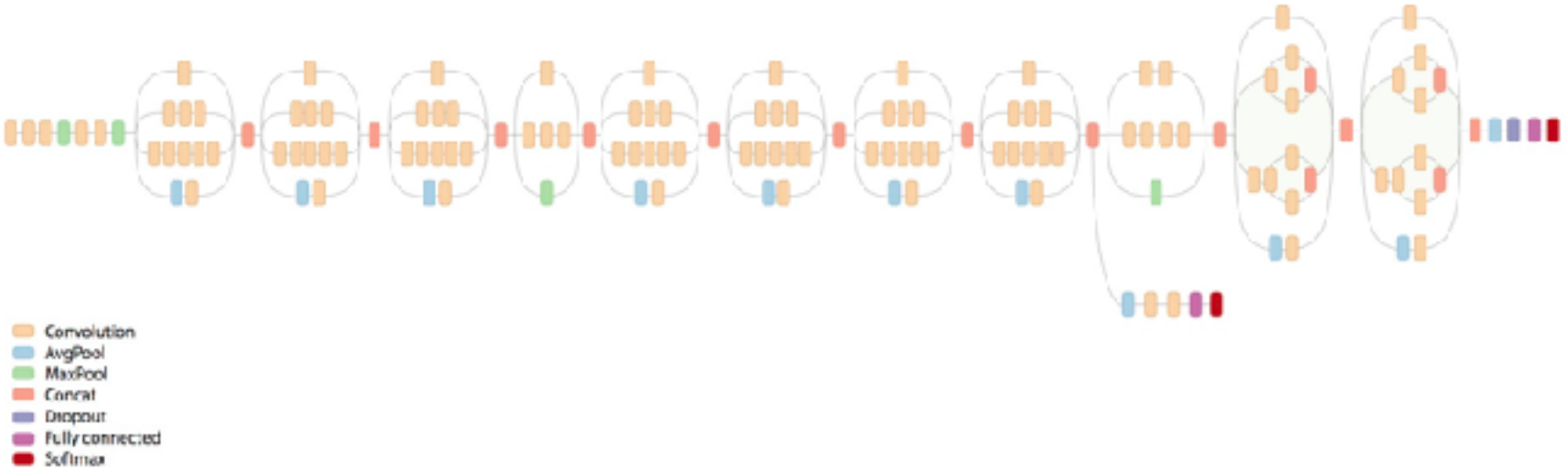
OUTPUT LAYER

ACTIVATED NEURONS

INPUT LAYER

DEEP *neural* NETWORK

Inception V3 - Deep Learning Convolutional Neural Network



Dataflow based Computational graph

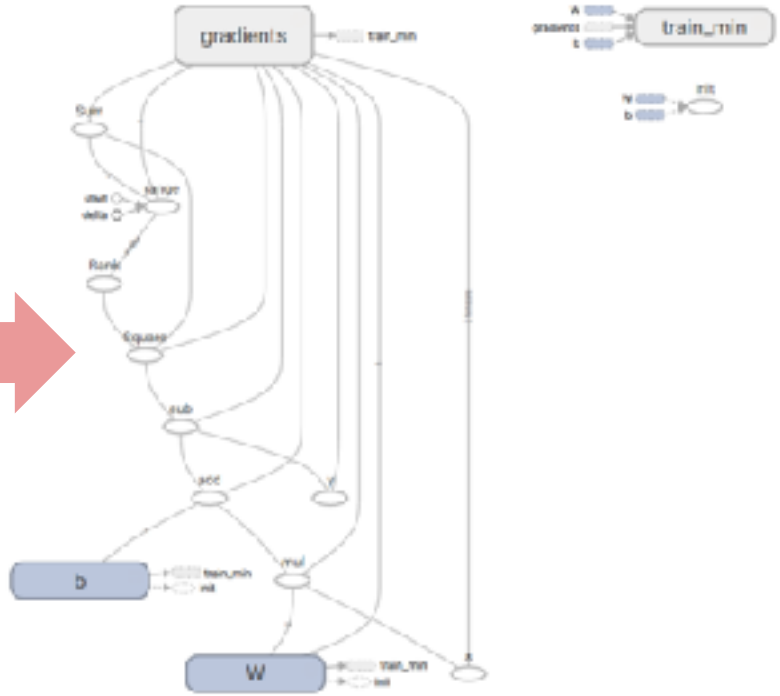
Python Program

```
import numpy as np
import tensorflow as tf

# Model parameters
W = tf.Variable([.3], tf.float32)
b = tf.Variable([-.3], tf.float32)
# Model input and output
x = tf.placeholder(tf.float32)
linear_model = W * x + b
y = tf.placeholder(tf.float32)
# loss
loss = tf.reduce_sum(tf.square(linear_model - y)) # sum of the squares
# optimizer
optimizer = tf.train.GradientDescentOptimizer(0.01)
train = optimizer.minimize(loss)
# training data
x_train = [1,2,3,4]
y_train = [0,-1,-2,-3]
# training loop
init = tf.global_variables_initializer()
sess = tf.Session()
sess.run(init) # reset values to wrong
for i in range(1000):
  sess.run(train, {x:x_train, y:y_train})

# evaluate training accuracy
curr_W, curr_b, curr_loss  = sess.run([W, b, loss], {x:x_train, y:y_train})
print("W: %s b: %s loss: %s"%(curr_W, curr_b, curr_loss))
```

TensorFlow Graph



https://www.tensorflow.org/get_started/get_started

TensorFlow Supports Many Platforms...

CPU

GPU

iOS

Android

TPU

Cloud TPU

Raspberry Pi

TensorFlow support many languages

C++

Java

python

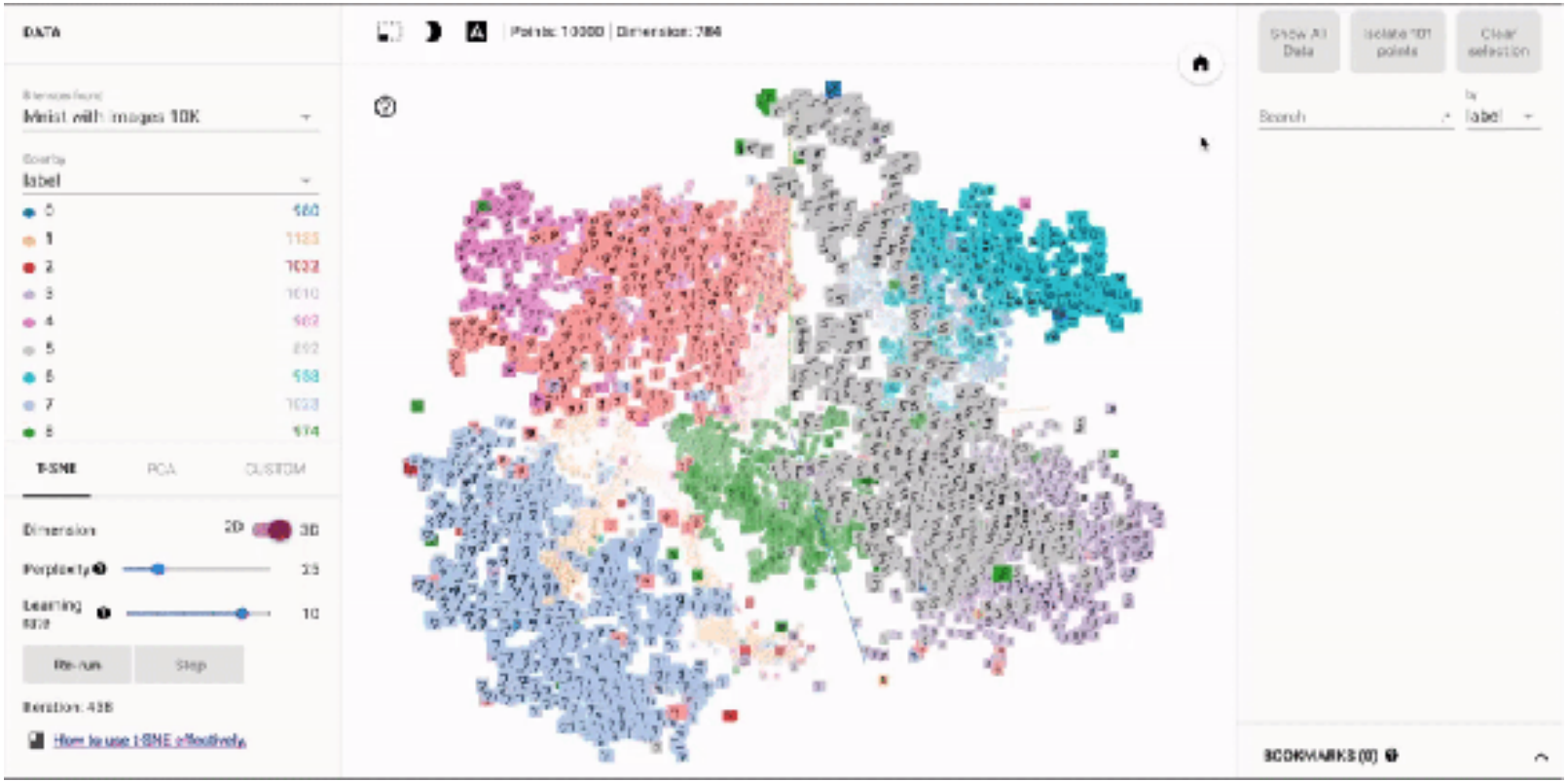
C#

julia

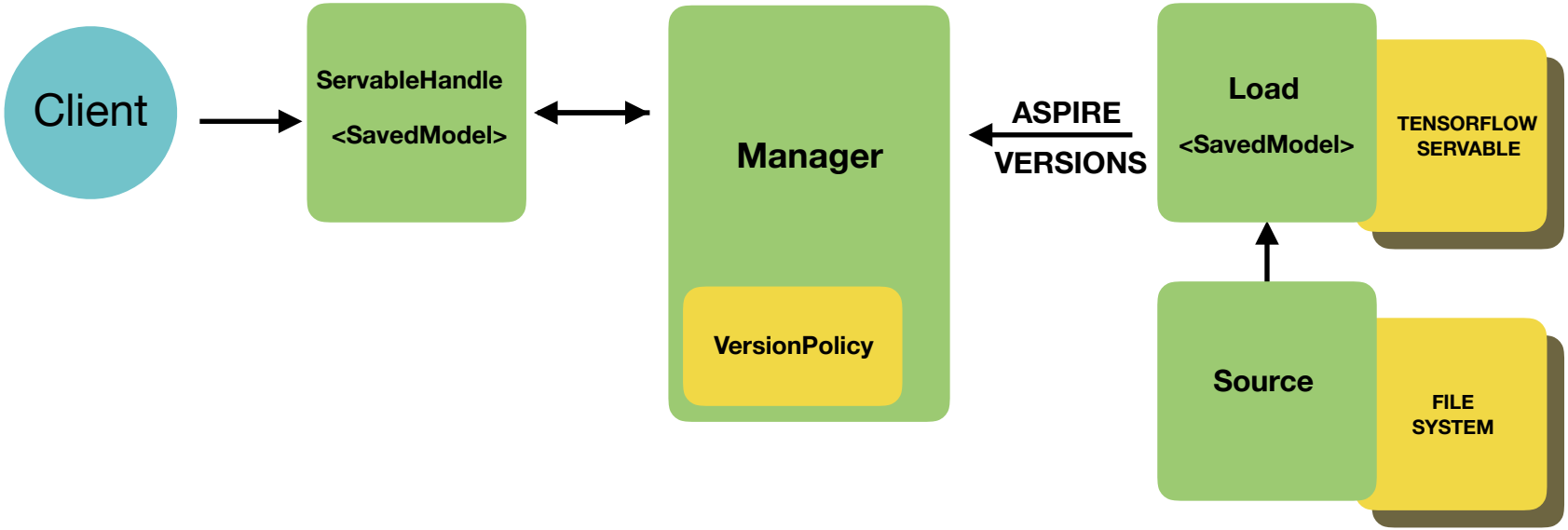
Go

Haskell

TensorFlow provides great tools like TensorBoard



TensorFlow Serving

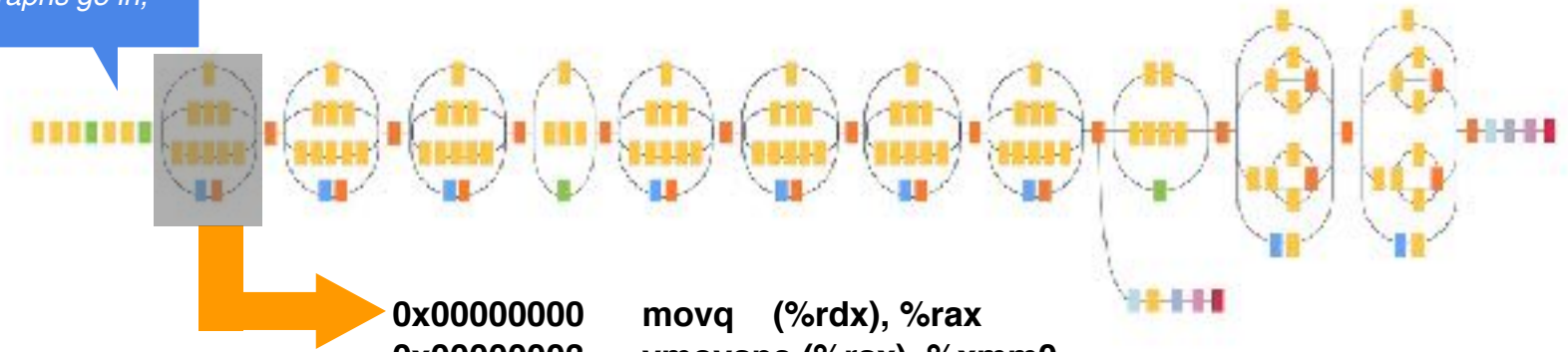


Legend:

- **Blue:** Caller-specific code
- **Green:** TensorFlow Serving core classes / APIs
- **Yellow:** Pluggable implementations

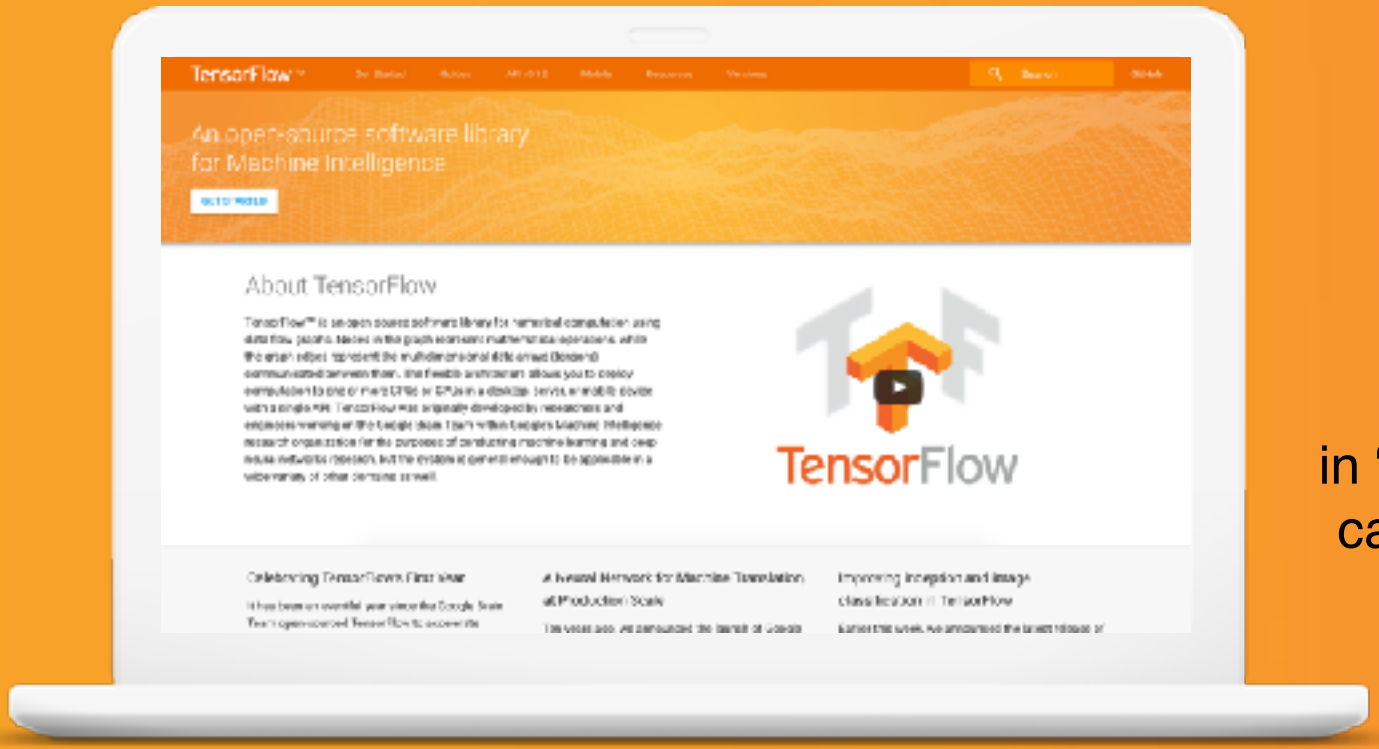
XLA: An Experimental TensorFlow Compiler

TF graphs go in,



```
0x00000000    movq    (%rdx), %rax
0x00000003    vmovaps (%rax), %xmm0
0x00000007    vmulps  %xmm0, %xmm0,
%xmm0
0x0000000b    vmovaps %xmm0, (%rdi)
                      ...
```

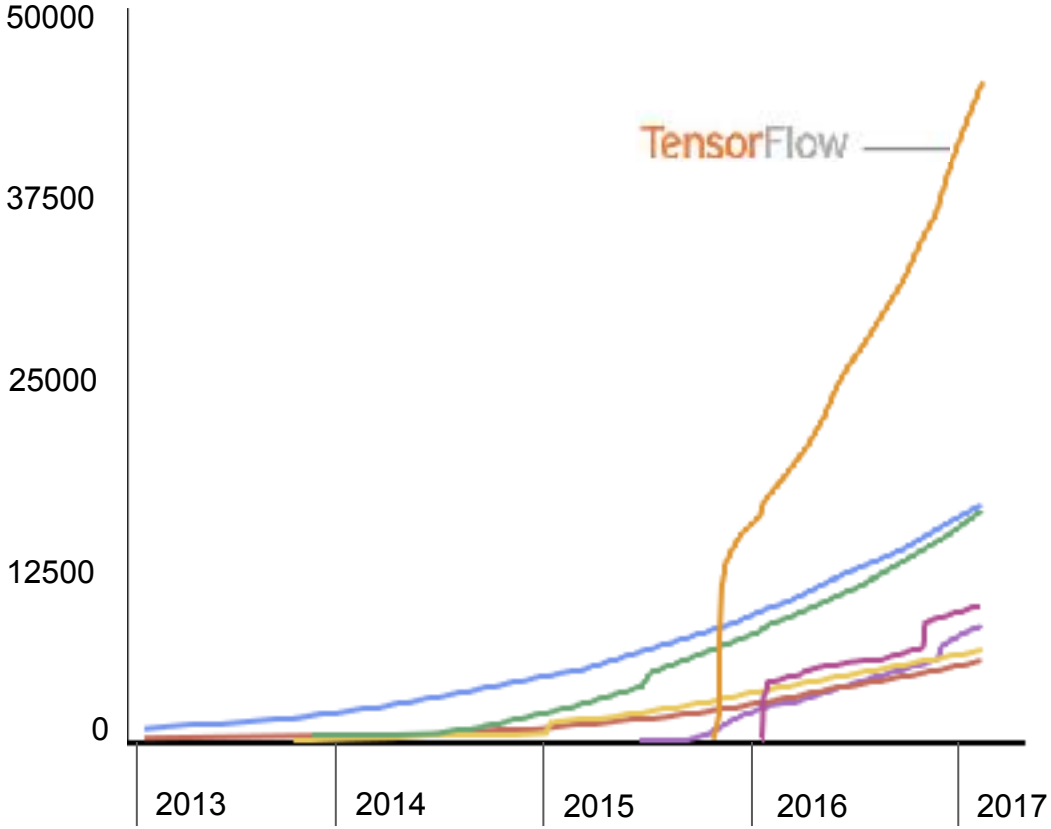
Optimized & specialized assembly comes out.



#1

repository

in “machine learning”
category on GitHub



Github Stars

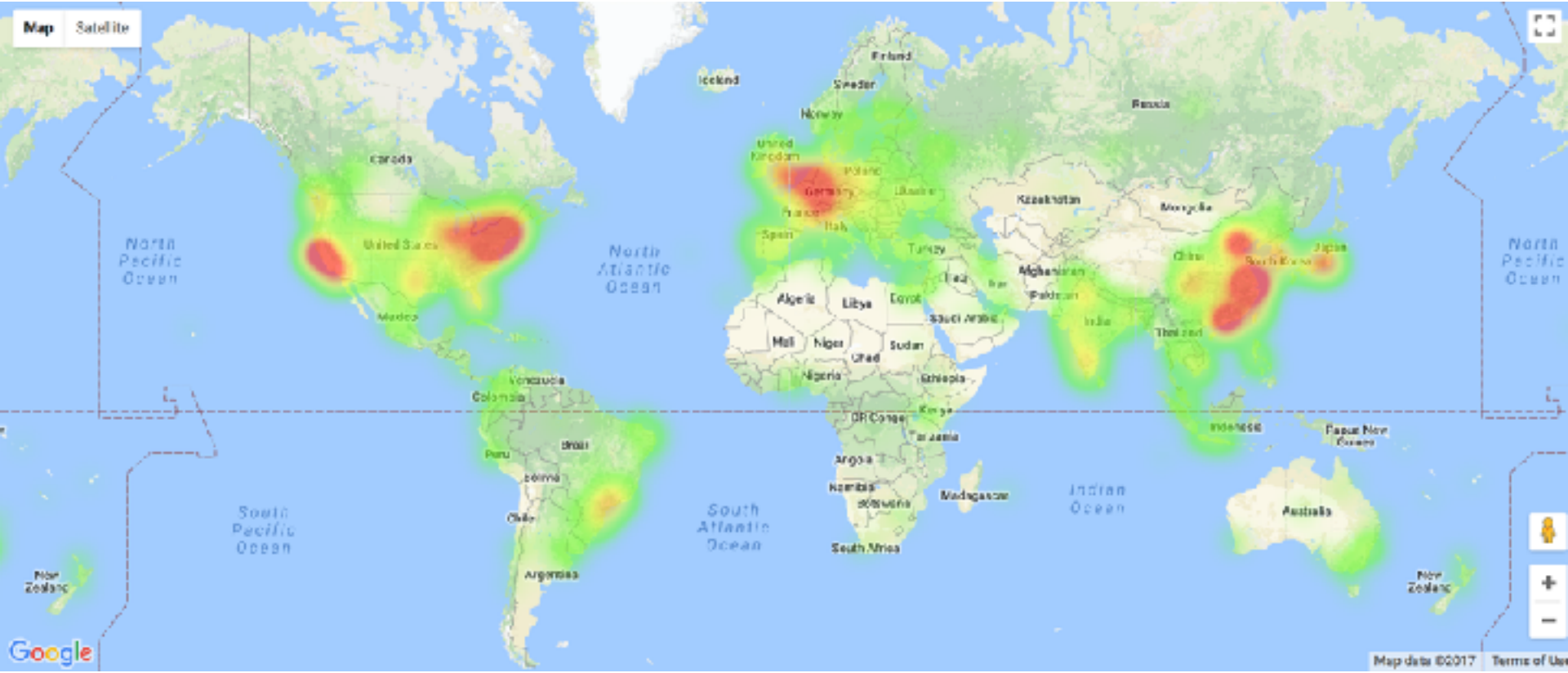
TensorFlow: A Vibrant Open-Source Community

- **Rapid development, many outside contributors**
  - 500+ non-Google contributors
  - 20,000+ commits
  - Many community created tutorials, models, translations, and projects
    - ~5,500 GitHub repositories with ‘TensorFlow’ in the title

- **Direct engagement between community and TensorFlow team**
  - 5000+ Stack Overflow questions answered
  - 5000+ GitHub issues filed and answered; 160+ new issues / week

- **Use in ML classes is growing: Toronto, Berkeley, Stanford, ...**

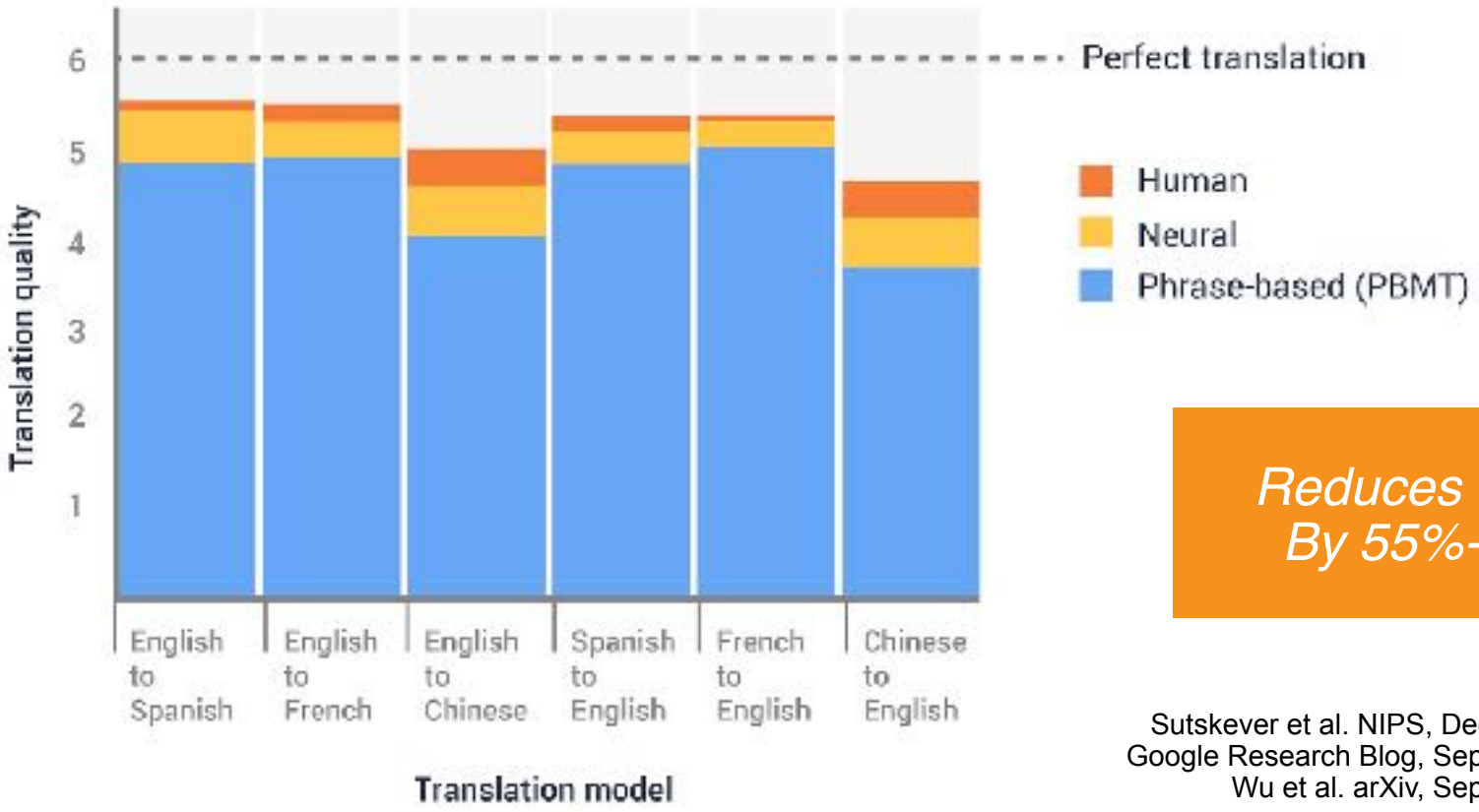
Use of TensorFlow Worldwide



Use in South East Asia

What is TensorFlow being used for?

Neural Machine Translation



Reduces Errors By 55%-85%

Sutskever et al. NIPS, Dec 2014
Google Research Blog, Sept 2016
Wu et al. arXiv, Sept 2016

Show and Tell

https://research.googleblog.com/2016/09/show-and-tell-image-captioning-open.html

Mobile Deployment

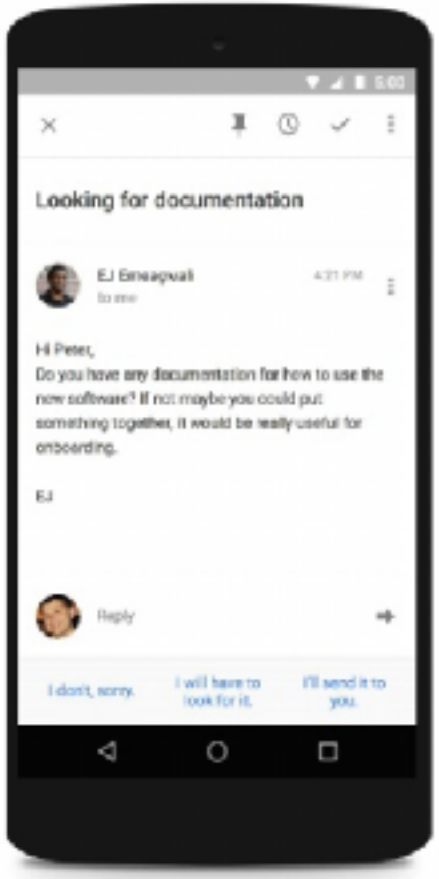
Inbox by Gmail

Smart Reply

April 1, 2009: April Fool's Day joke

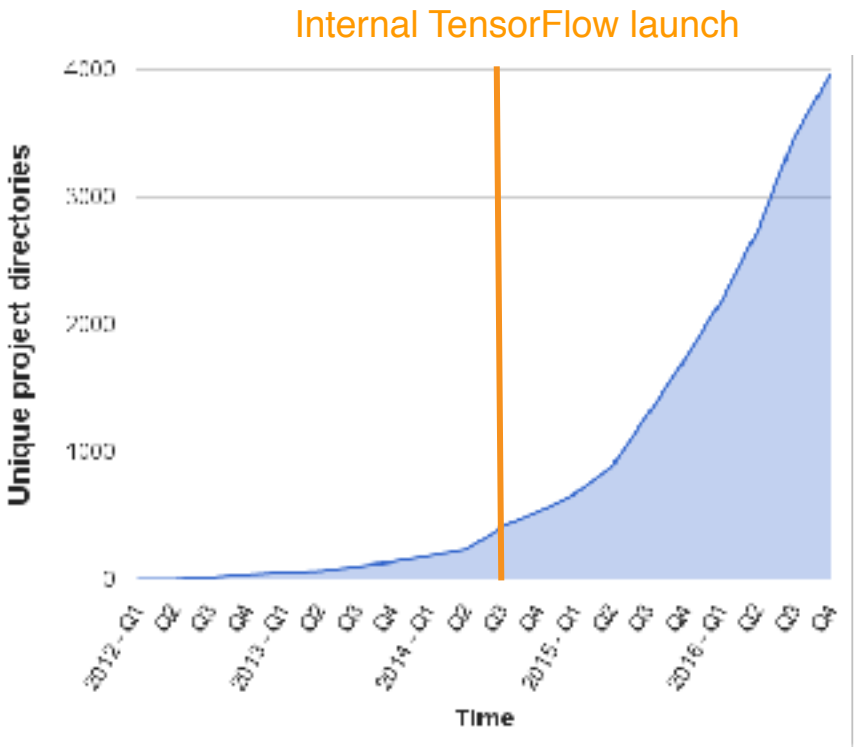
Nov 5, 2015: Launched Real Product

Feb 1, 2016: >10% of mobile Inbox replies



Research at Google

of Google directories containing model description files

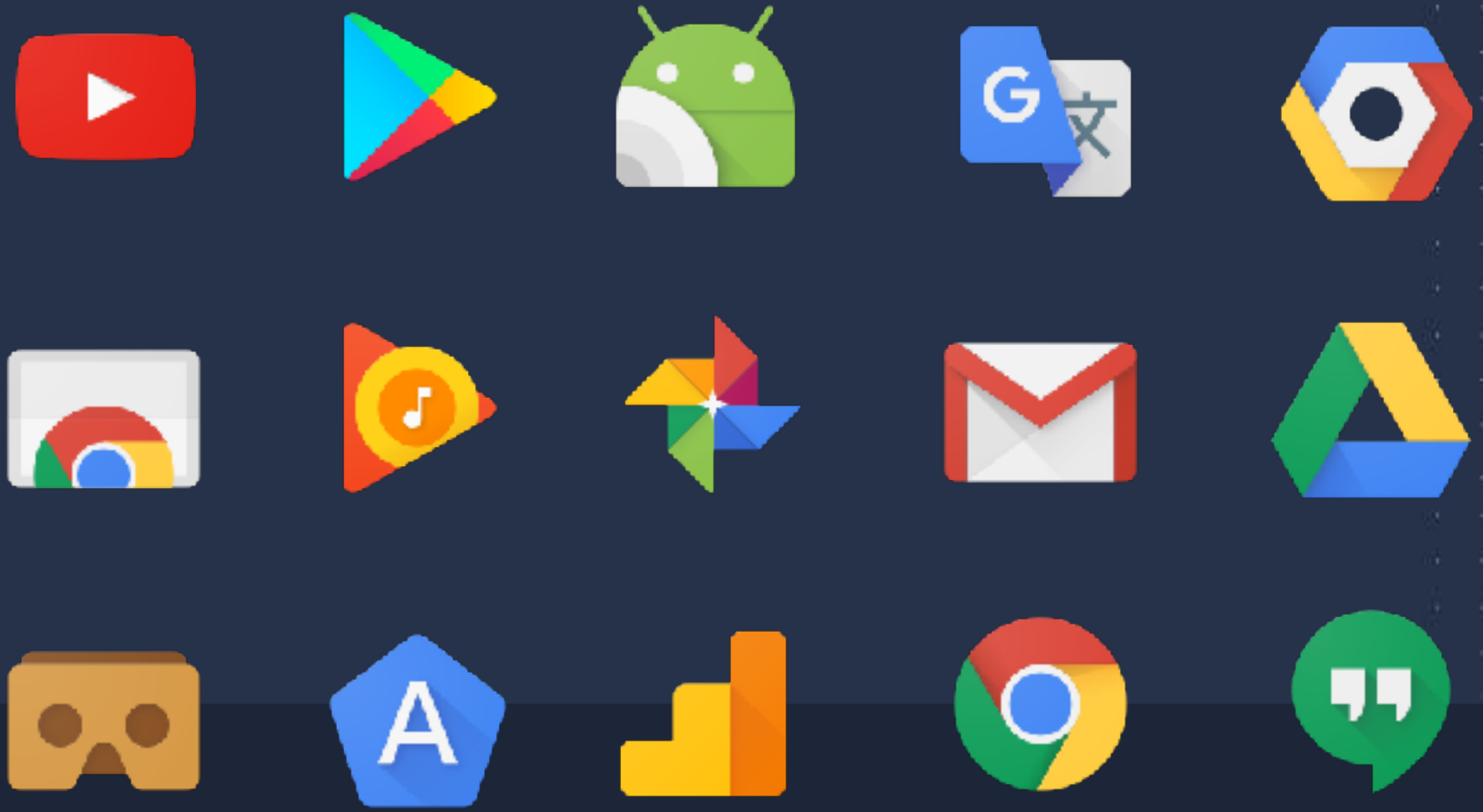


Production use in many areas:

Search
Gmail
Translate
Maps
Android
Photos
Speech
YouTube
Play
… many others ...

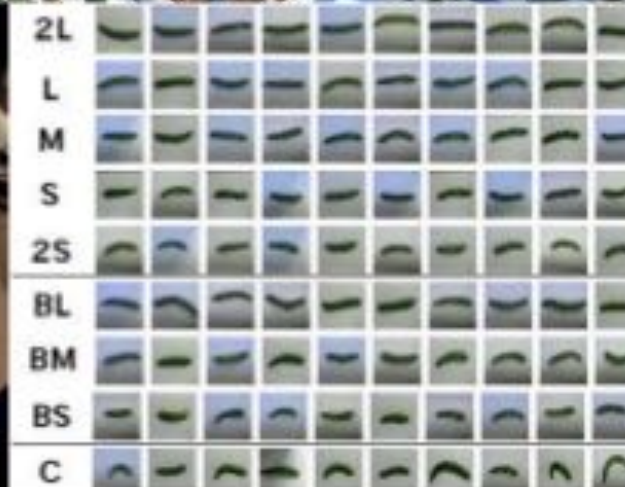
Research use for:

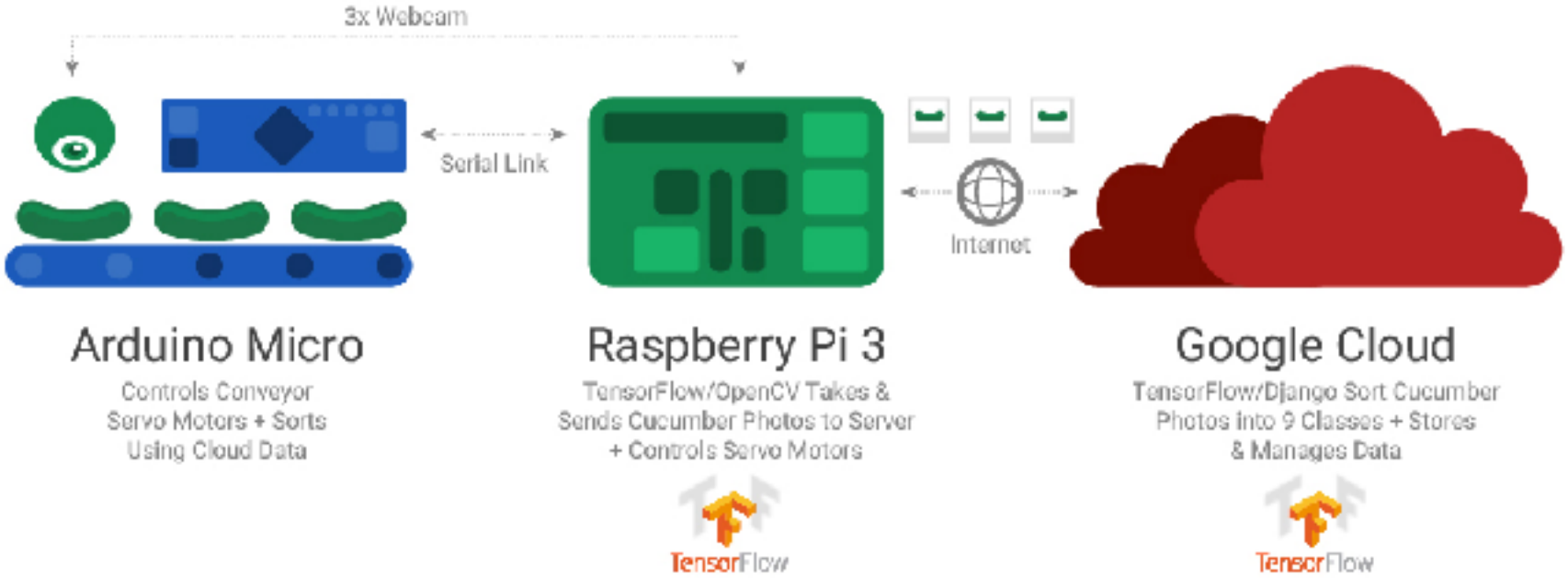
100s of projects and papers



TensorFlow is for **everyone**

TensorFlow powered Cucumber Sorter



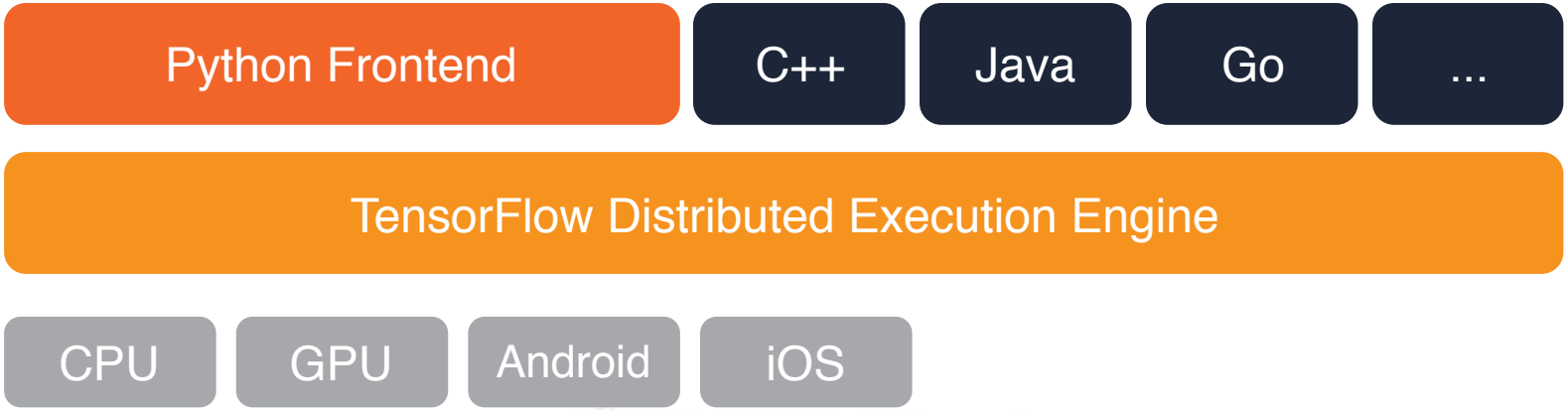


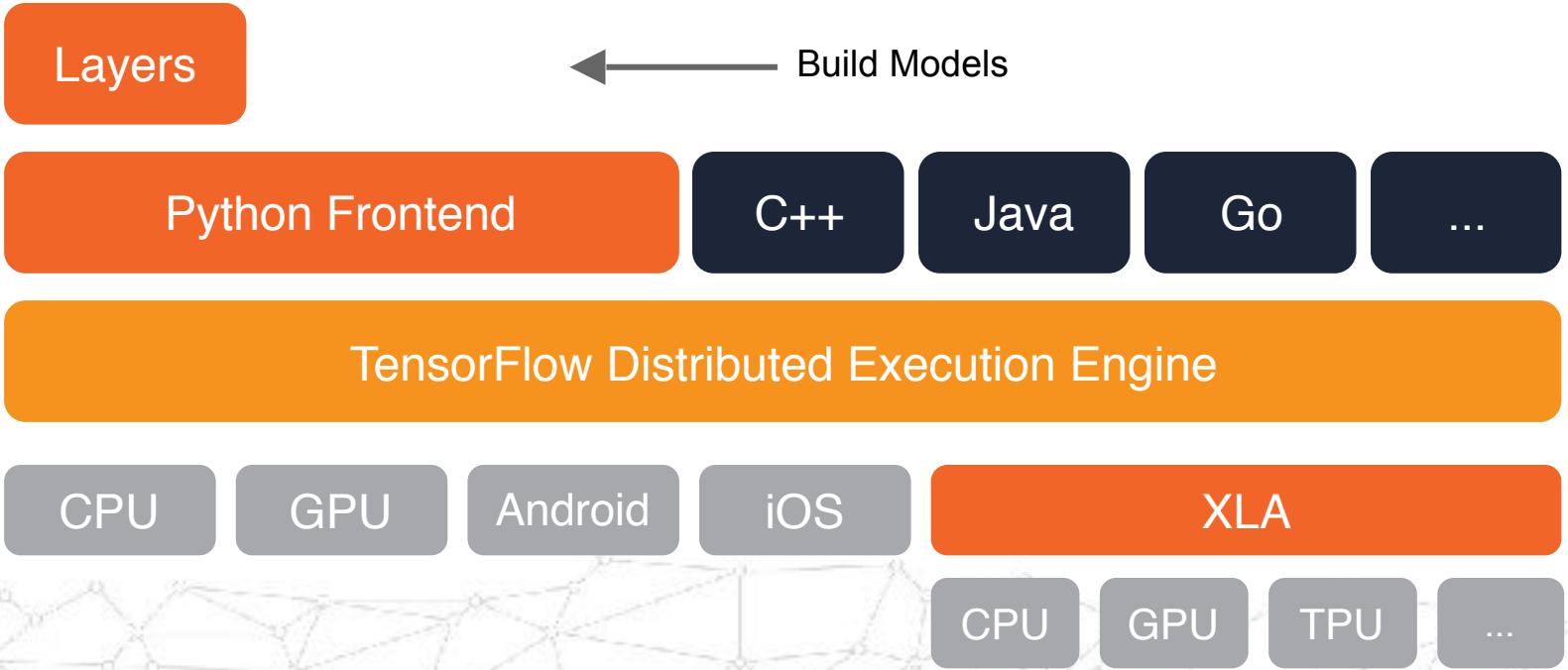
https://cloud.google.com/blog/big-data/2016/08/how-a-japanese-cucumber-farmer-is-using-deep-learning-and-tensorflow

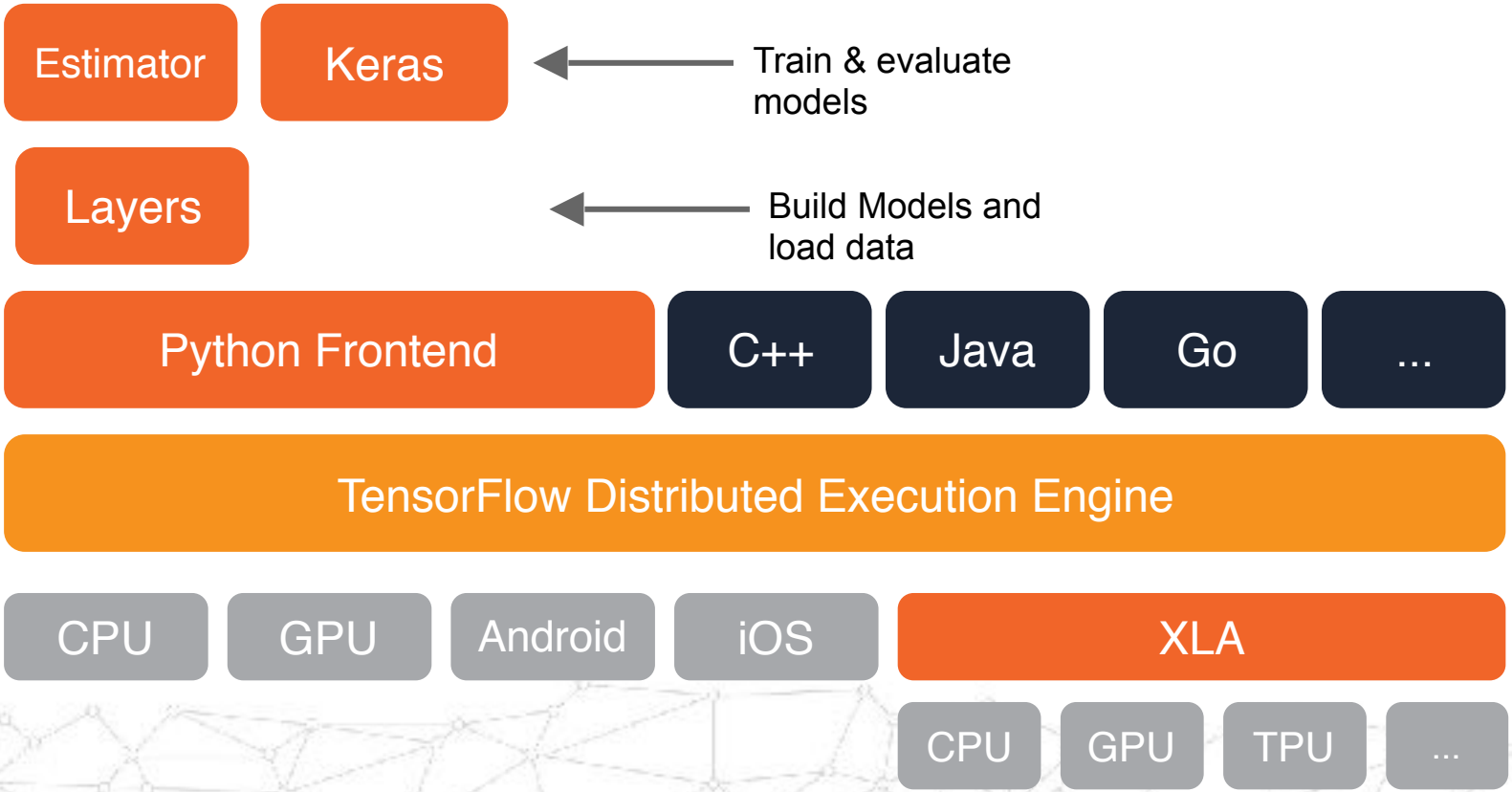
Getting Started

Key parts of the TensorFlow API

TensorFlow pre v1.0


Python Frontend
C++
Java
Go
...
TensorFlow Distributed Execution Engine
CPU
GPU
Android
iOS


Layers
Build Models
Python Frontend
C++
Java
Go
...
TensorFlow Distributed Execution Engine
CPU
GPU
Android
iOS
XLA
CPU
GPU
TPU
...


Estimator
Keras
Train & evaluate models
Layers
Build Models and load data
Python Frontend
C++
Java
Go
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TensorFlow Distributed Execution Engine
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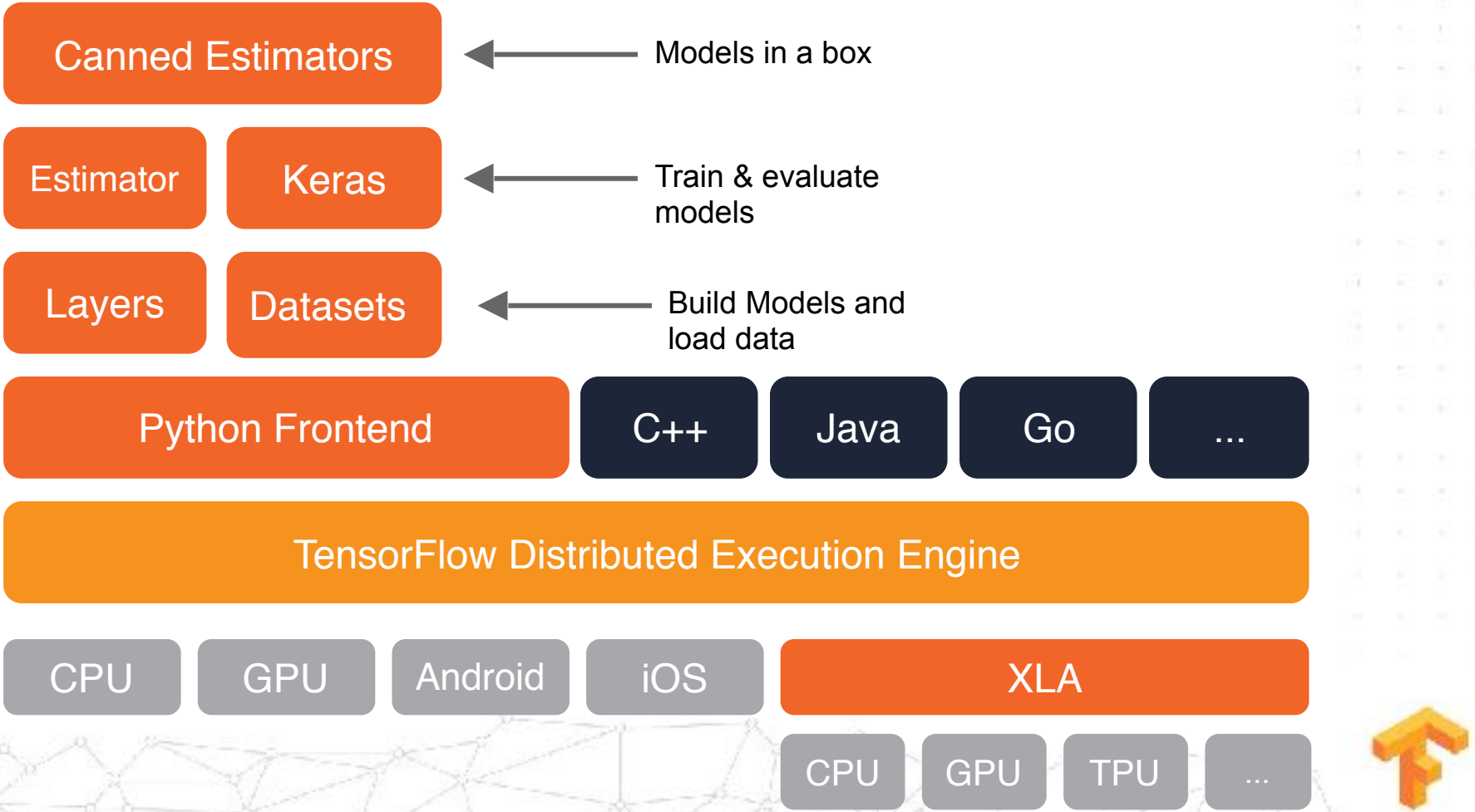
TensorFlow 1.4

open source machine learning


Canned Estimators
Models in a box
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Datasets
Build Models and load data
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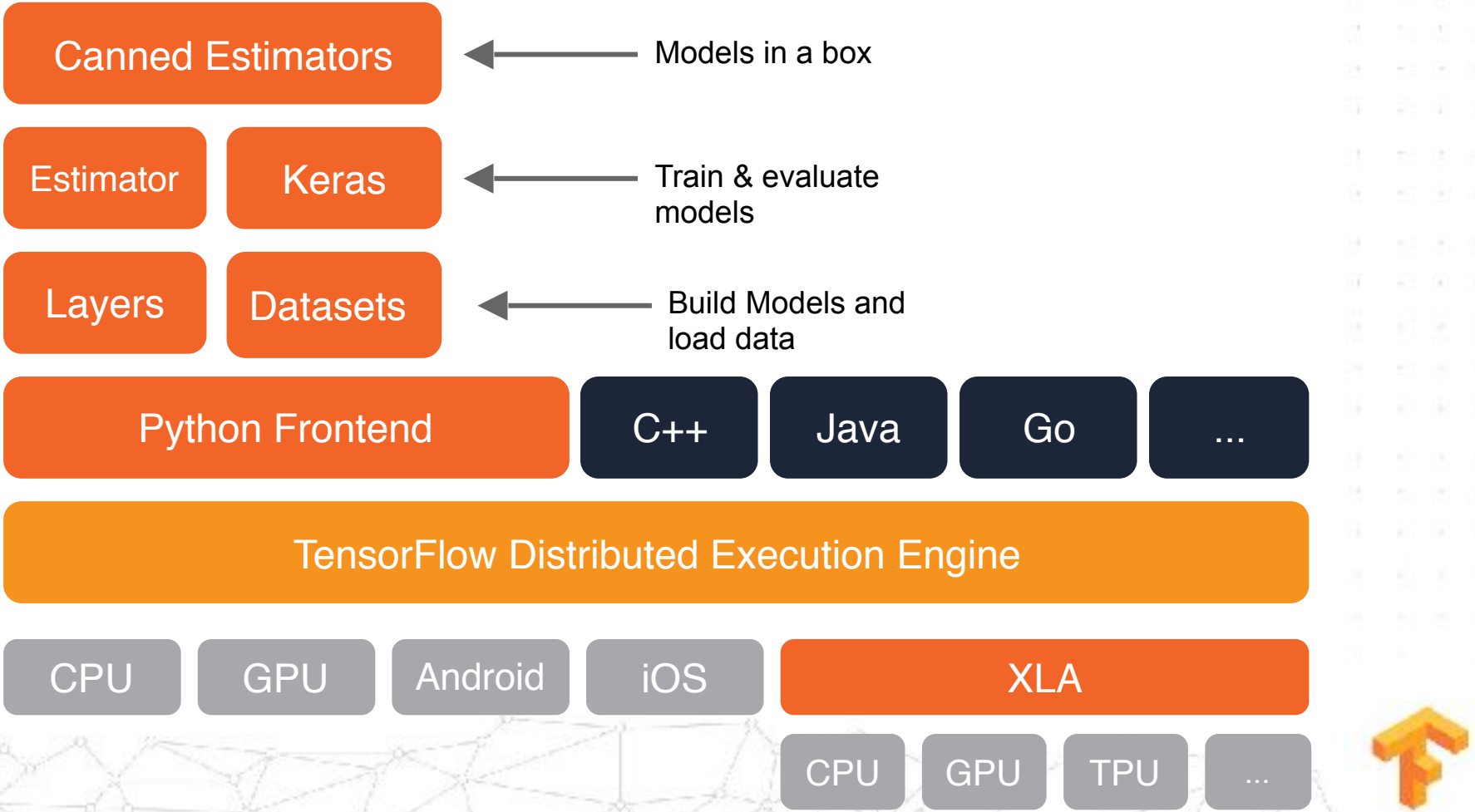
TensorFlow v1.4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...

Flexible: High level APIs

Low-Level Python API

```
import numpy as np
import tensorflow as tf

W = tf.Variable([.3], tf.float32)
b = tf.Variable([-.3], tf.float32)
x = tf.placeholder(tf.float32)
linear_model = W * x + b
y = tf.placeholder(tf.float32)
loss = tf.reduce_sum(tf.square(linear_model - y))
optimizer = tf.train.GradientDescentOptimizer(0.01)
train = optimizer.minimize(loss)
x_train = [1,2,3,4]
y_train = [0,-1,-2,-3]
init = tf.global_variables_initializer()
sess = tf.Session()
sess.run(init) # reset values to wrong
for i in range(1000):
  sess.run(train, {x:x_train, y:y_train})
curr_W, curr_b, curr_loss  = sess.run([W, b, loss], {x:x_train, y:y_train})
```

High-Level Python API

```
import tensorflow as tf
import numpy as np

features = [tf.contrib.layers.real_valued_column("x", dimension=1)]
estimator = tf.contrib.learn.LinearRegressor(feature_columns=features)
x = np.array([1., 2., 3., 4.])
y = np.array([0., -1., -2., -3.])
input_fn = tf.contrib.learn.io.numpy_input_fn({"x":x}, y, batch_size=4,
                                              num_epochs=1000)
estimator.fit(input_fn=input_fn, steps=1000)
estimator.evaluate(input_fn=input_fn)
```

https://www.tensorflow.org/get_started/get_started

Flexible: High level APIs

Low-Level Python API

```
import numpy as np
import tensorflow as tf

W
b =
x =
lin
y =
los
op
tra
x_train = [1,2,3,4]
y_train = [0,-1,-2,-3]
init = tf.global_variables_initializer()
sess = tf.Session()
sess.run(init) # reset values to wrong
for i in range(1000):
  sess.run(train, {x:x_train, y:y_train})
curr_W, curr_b, curr_loss  = sess.run([W, b, loss], {x:x_train, y:y_train})
```

15 lines

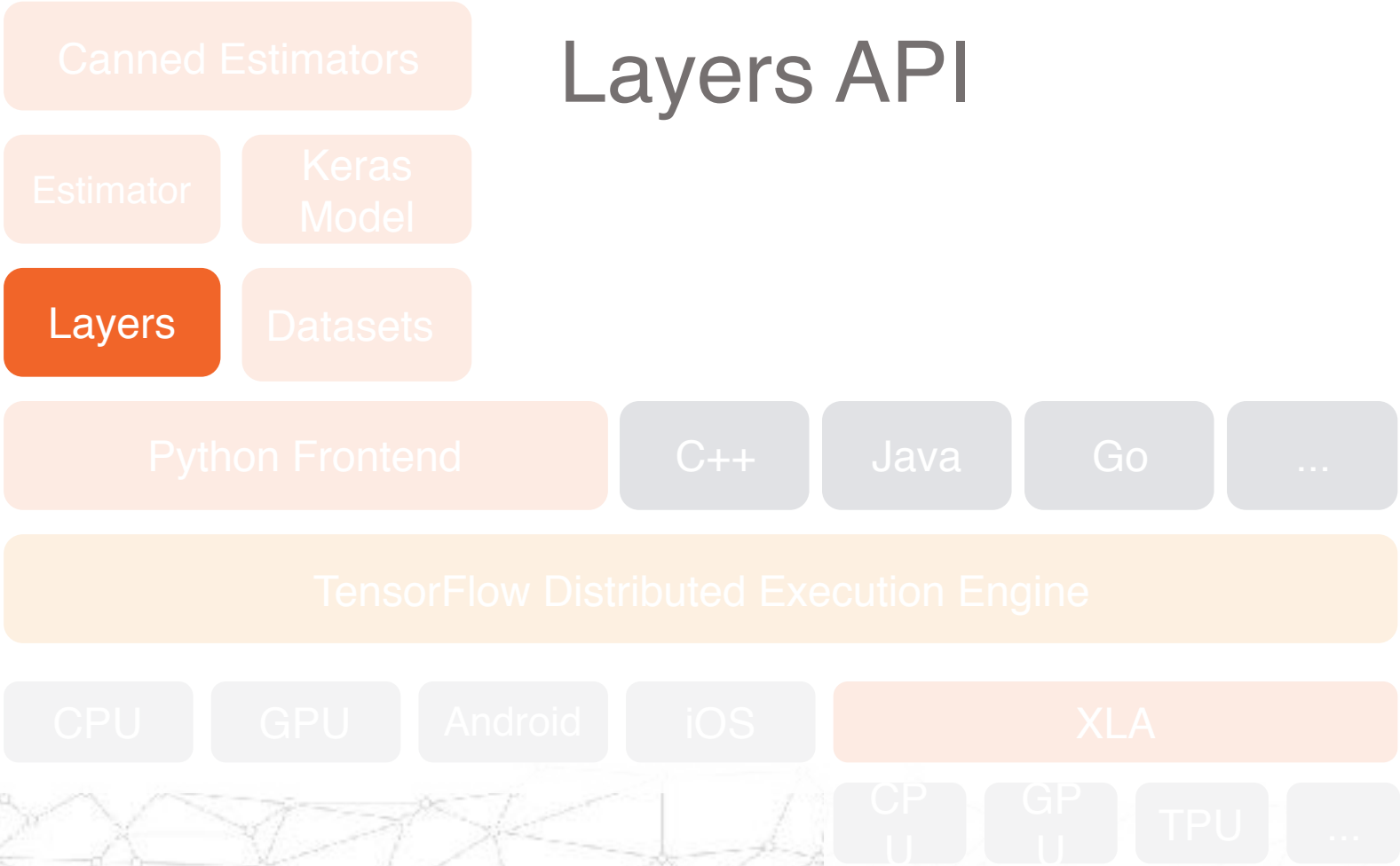
High-Level Python API

```
import tensorflow as tf
import numpy as n

features = [tf.contri
estimator = tf.contr
x = np.array([1., 2.
y = np.array([0., -1
input_fn = tf.contrib

estimator.fit(input_
estimator.evaluate(input_fn=input_fn)
```

7 lines

https://www.tensorflow.org/get_started/get_started

Layers API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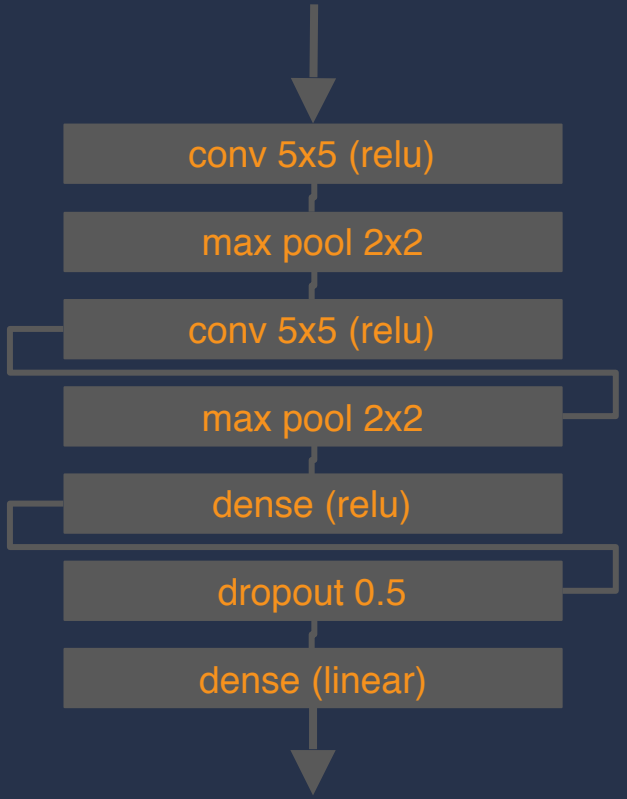
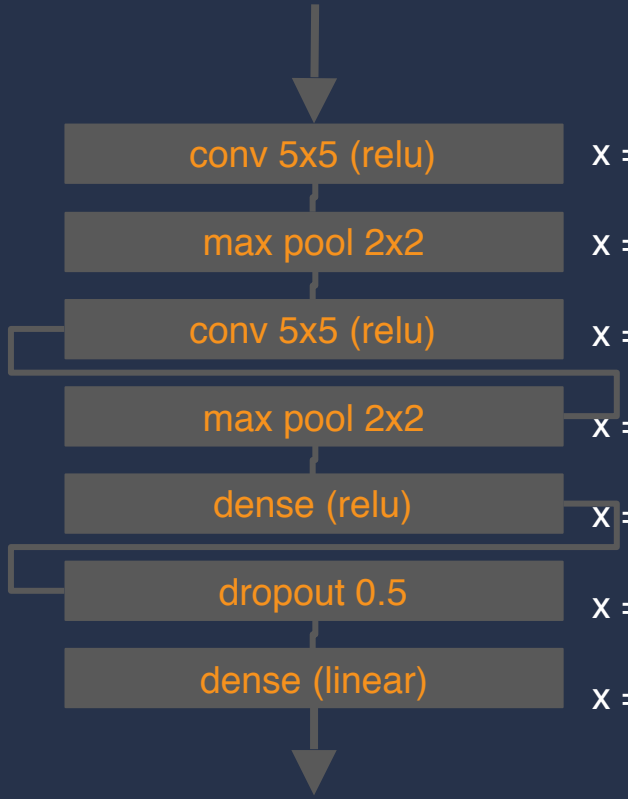

conv 5x5 (relu)
max pool 2x2
conv 5x5 (relu)
max pool 2x2
dense (relu)
dropout 0.5
dense (linear)


```
x = tf.layers.conv2d(x, kernel_size=[5,5], ...)
```

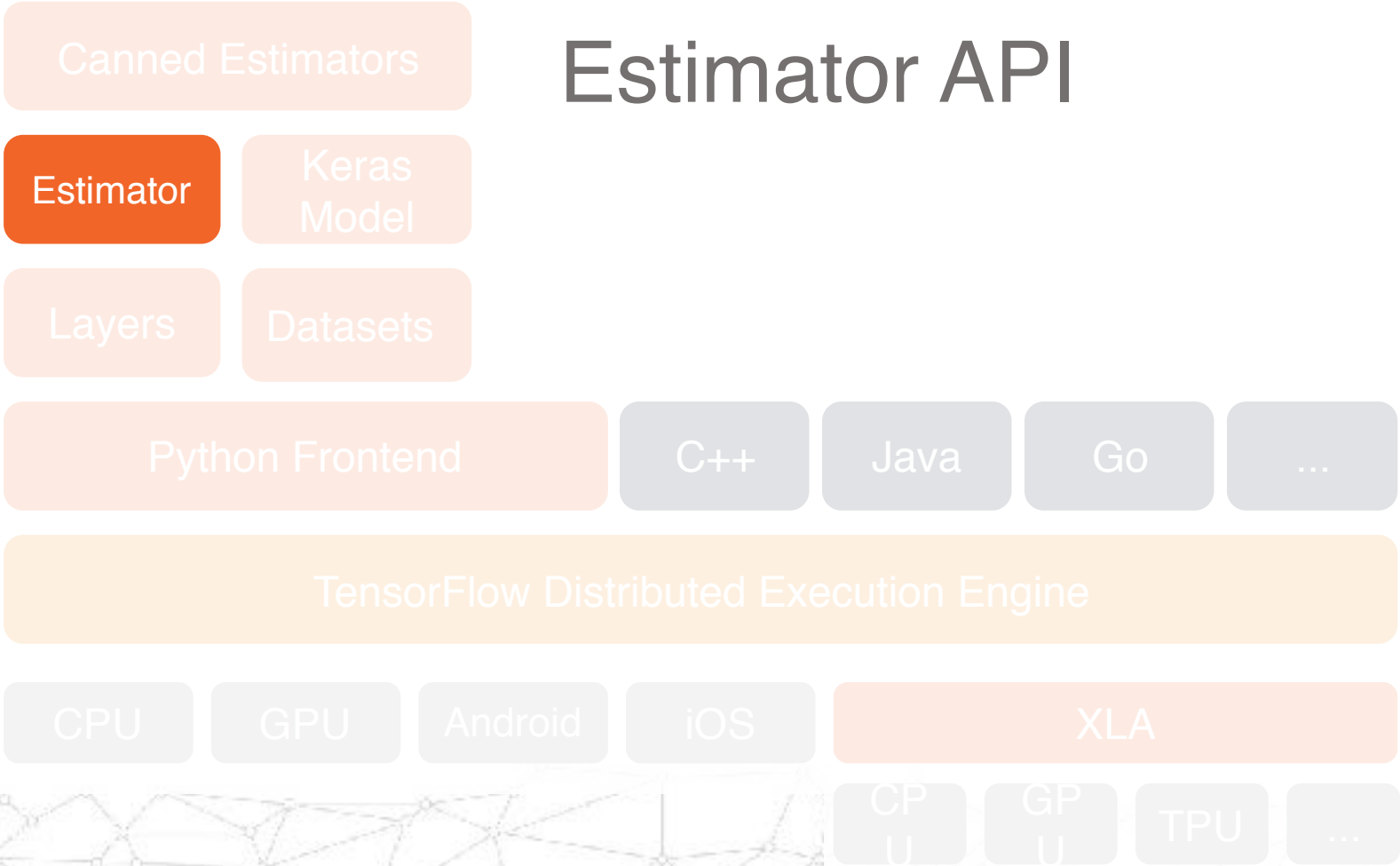

```
x = tf.layers.conv2d(x, kernel_size=[5,5], ...)
```

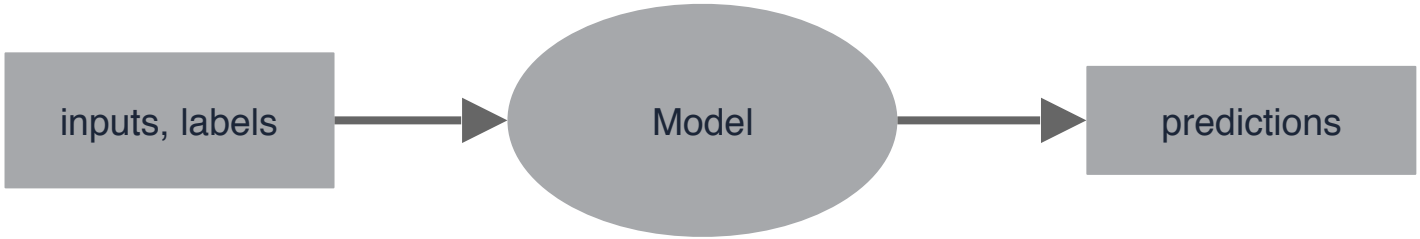
```
x = tf.layers.max_pooling2d(x, kernel_size=[2,2], ...)
```

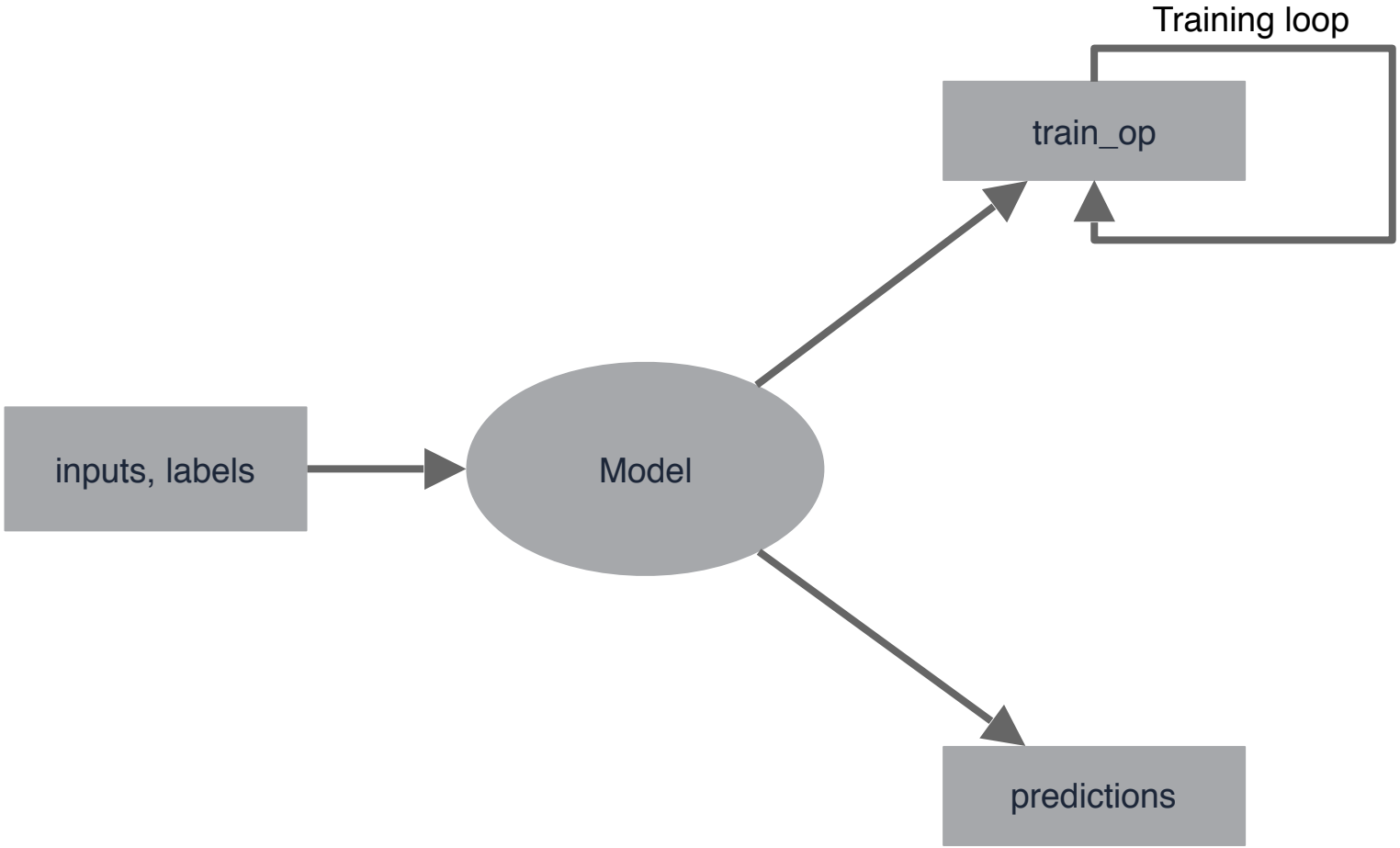


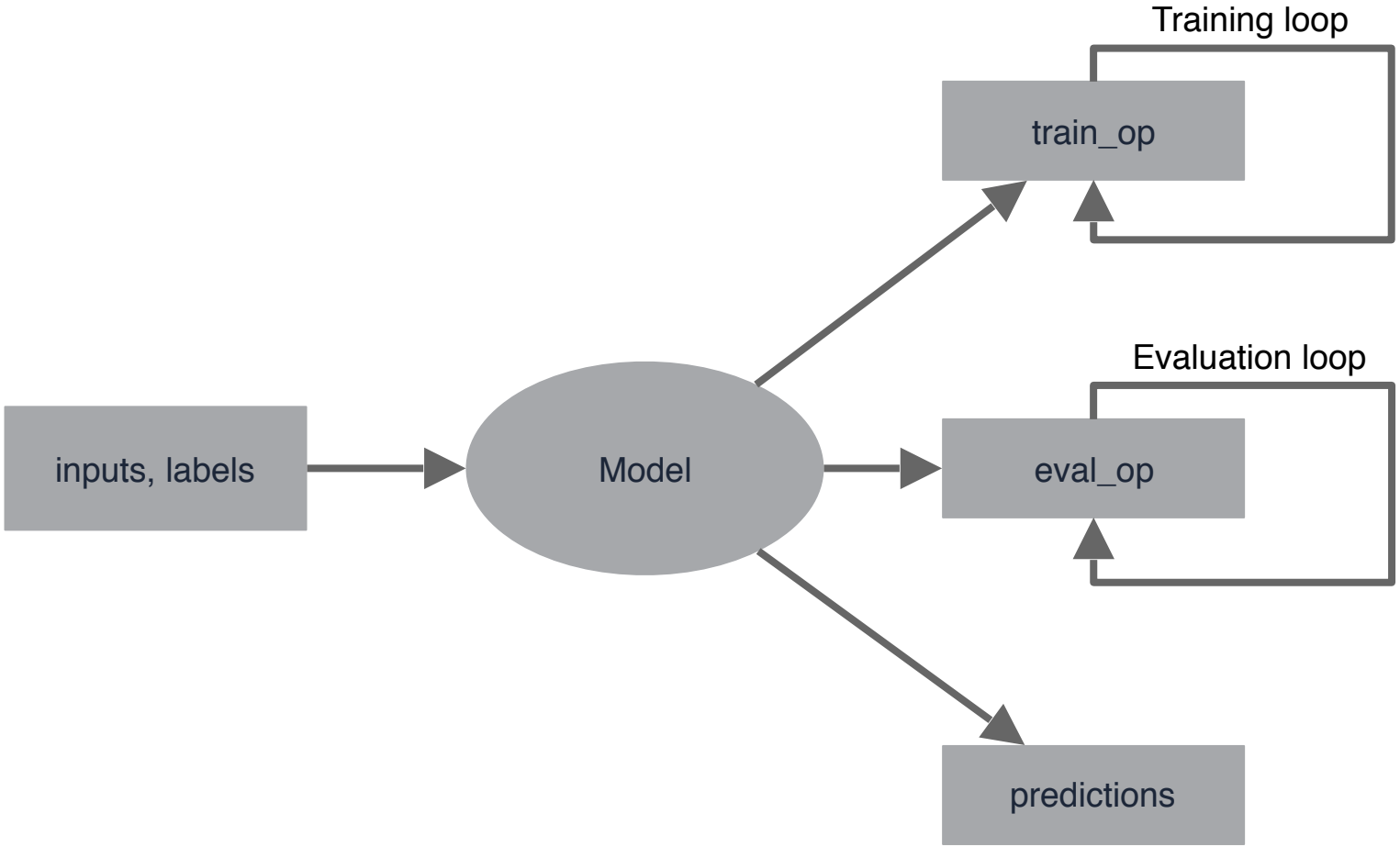

```
x = tf.layers.conv2d(x, kernel_size=[5,5], ...)
x = tf.layers.max_pooling2d(x, kernel_size=[2,2], ...)
x = tf.layers.conv2d(x, kernel_size=[5,5], ...)
x = tf.layers.max_pooling2d(x, kernel_size=[2,2], ...)
x = tf.layers.dense(x, activation_fn=tf.nn.relu)
x = tf.layers.dropout(x, 0.5)
x = tf.layers.dense(x)
```

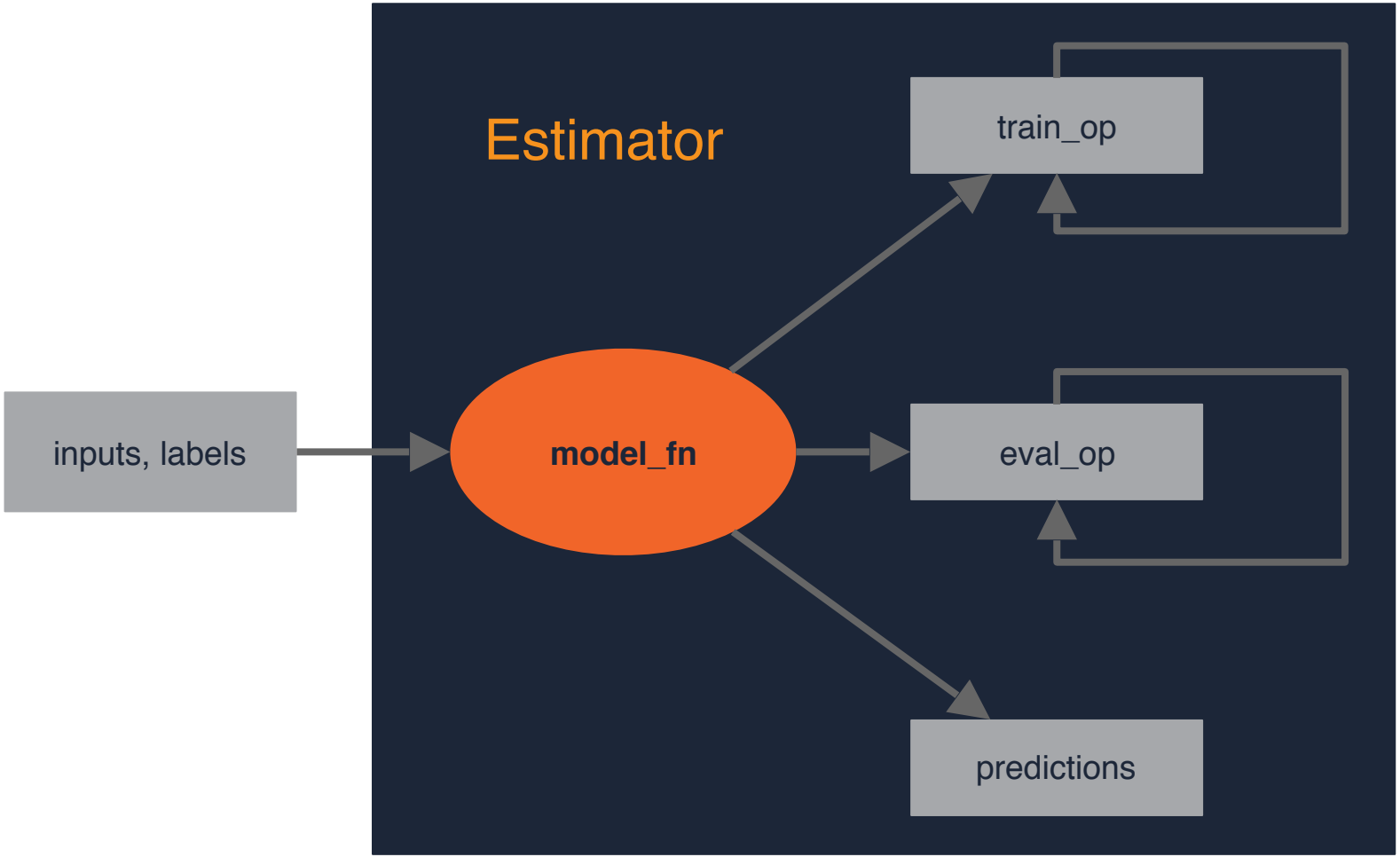
Estimator API

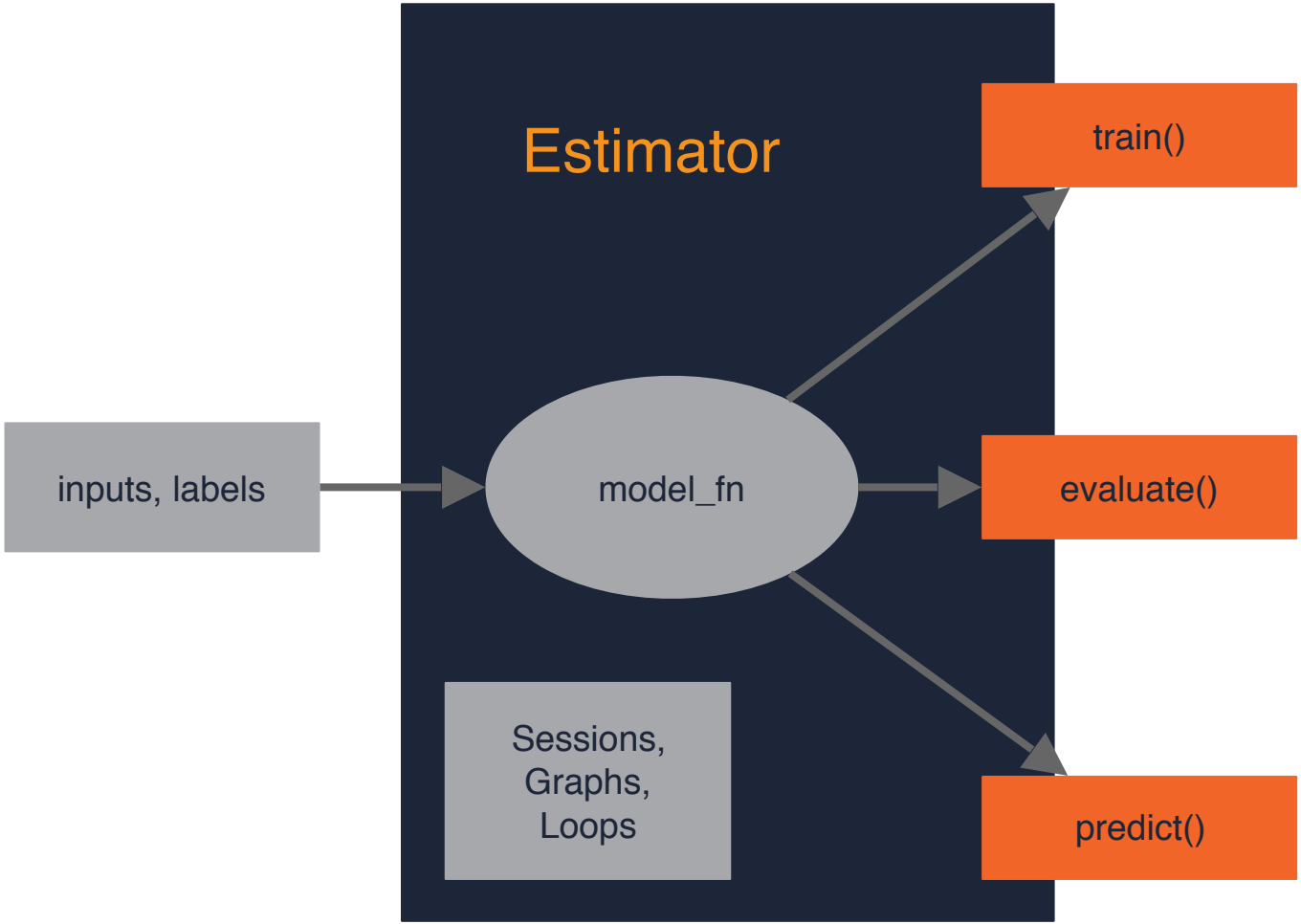


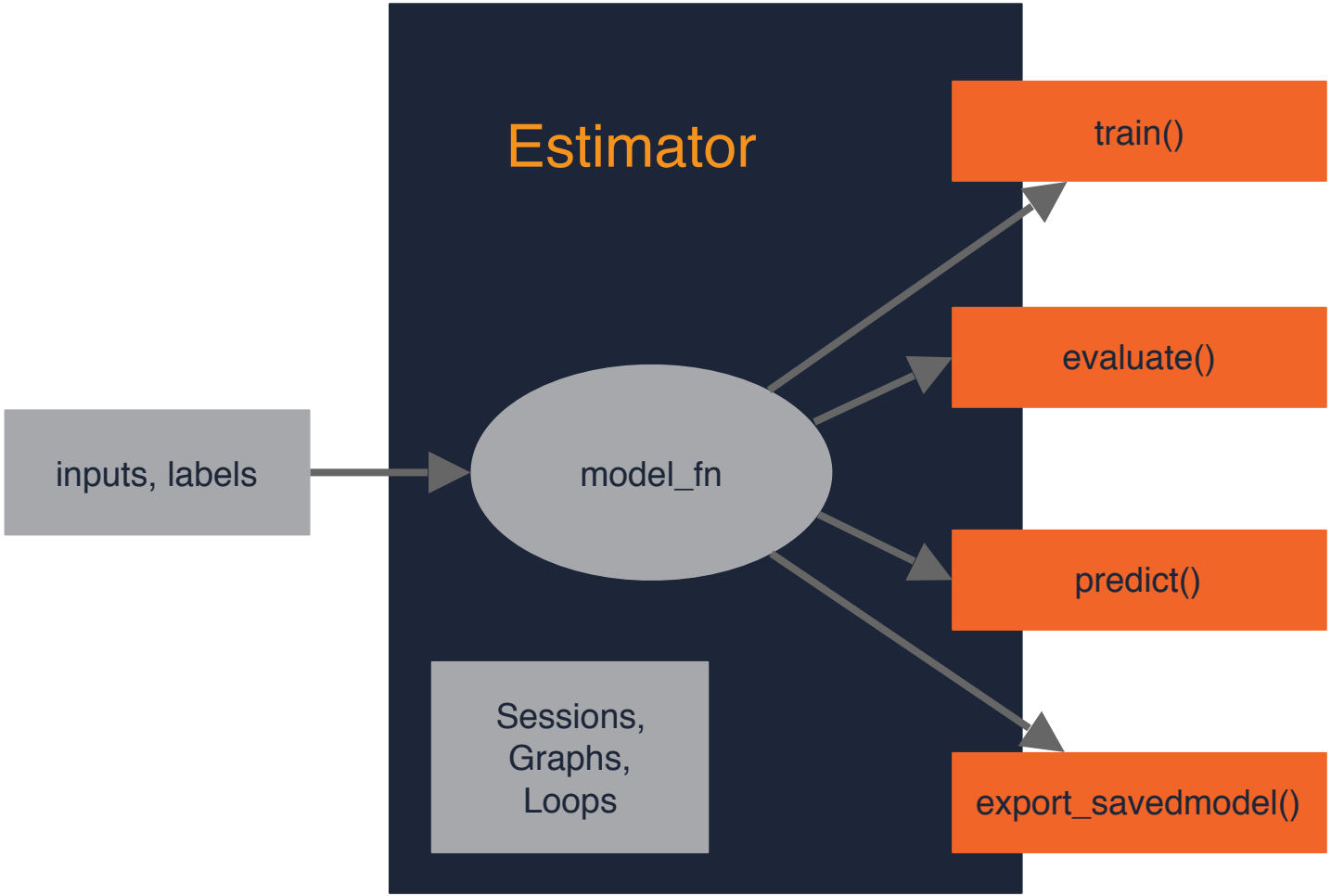

inputs, labels
Model
predictions


Training loop
train_op
inputs, labels
Model
predictions


Training loop
train_op
Evaluation loop
inputs, labels
Model
eval_op
predictions


Estimator
train_op
inputs, labels
model_fn
eval_op
predictions

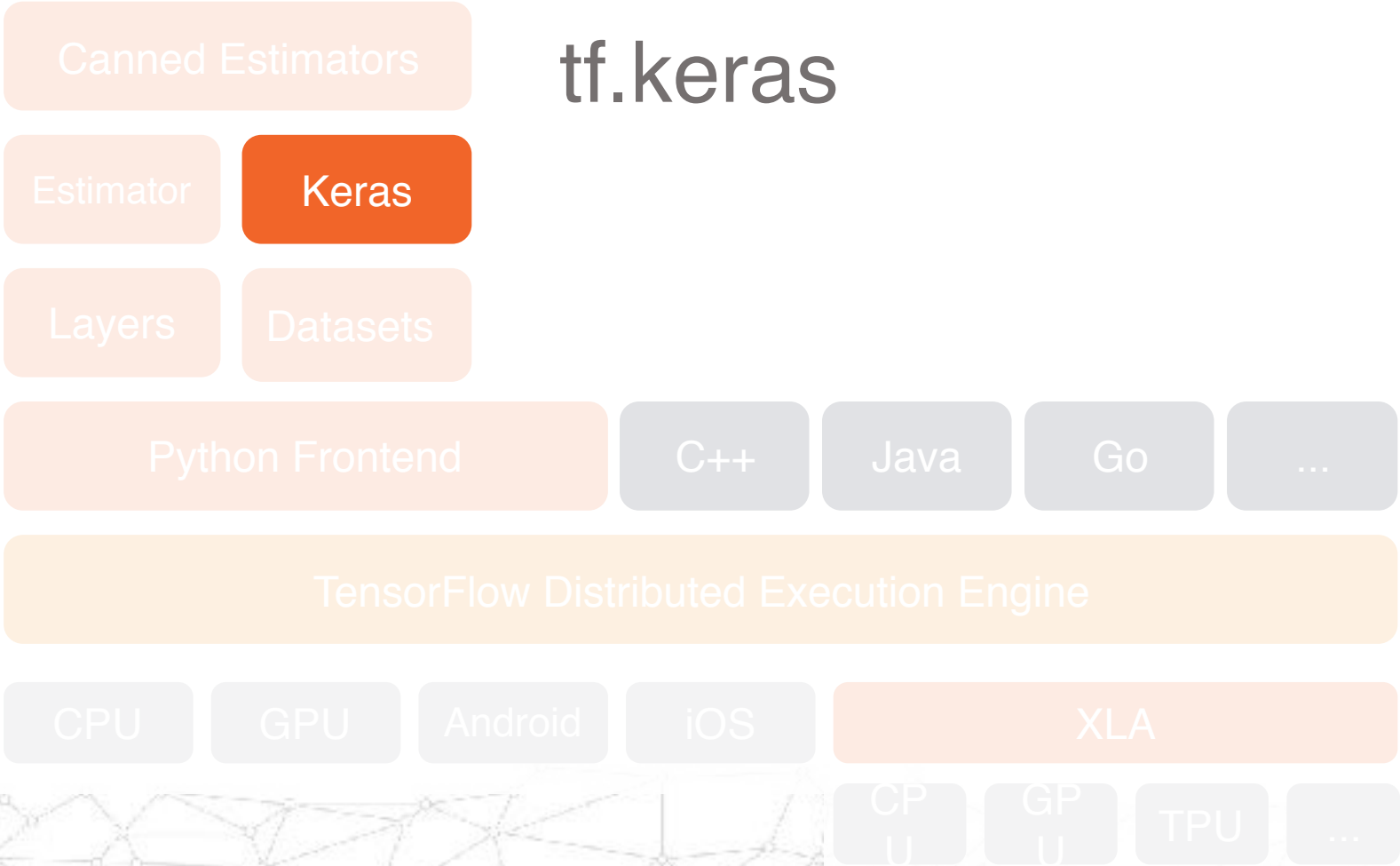

Estimator
train()
inputs, labels
model_fn
evaluate()
Sessions,
Graphs,
Loops
predict()


Estimator
train()
evaluate()
predict()
export_savedmodel()
inputs, labels
model_fn
Sessions,
Graphs,
Loops

Custom Estimators

- Input_fn
- model_fn
- train
- evaluate
- export_savedmodel

tf.keras


Canned Estimators
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Python Frontend
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TensorFlow Distributed Execution Engine
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Android
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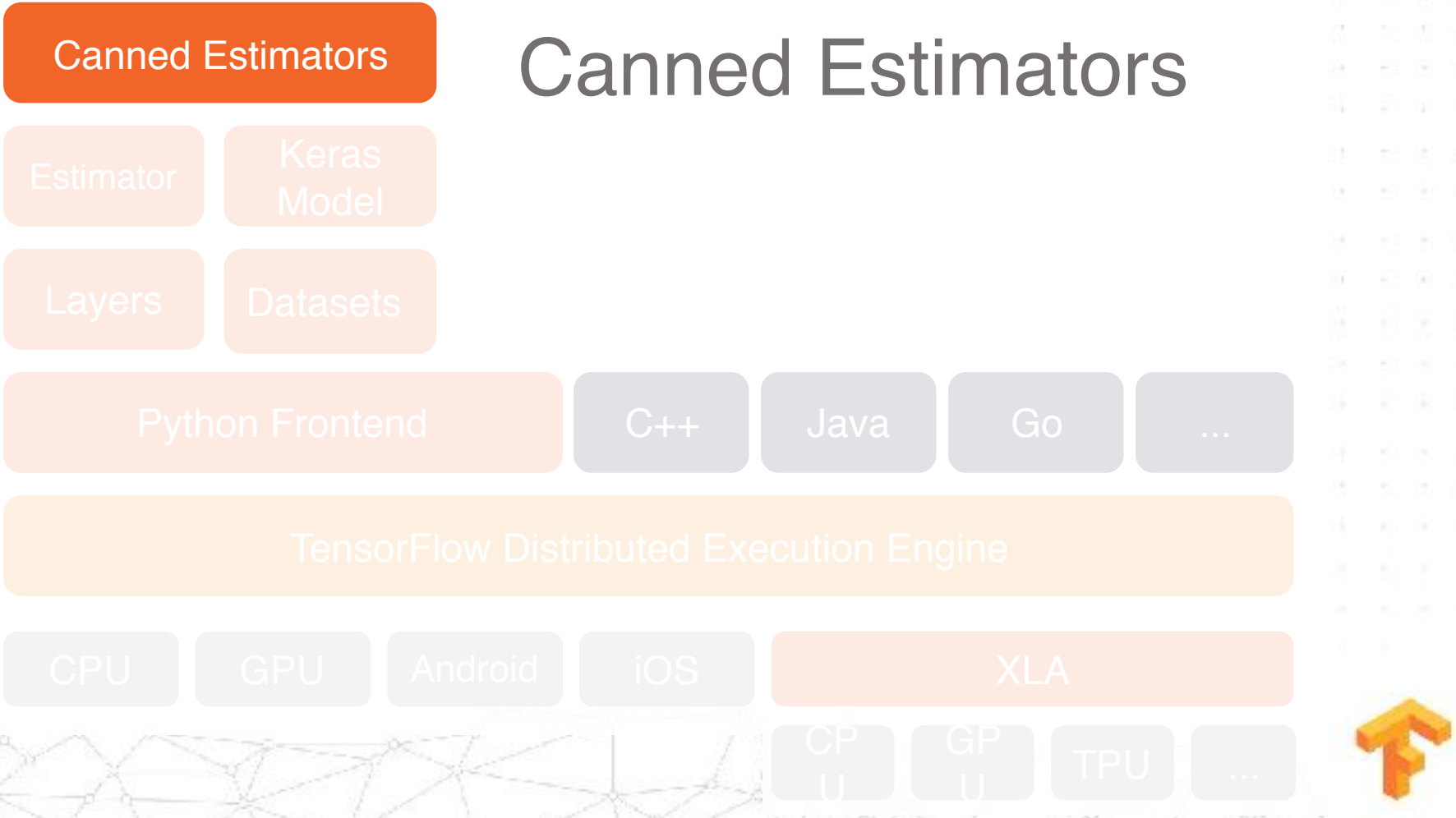
XLA
CPU
GPU
TPU
...

```
video = tf.keras.layers.Input(shape=(None, 150, 150, 3))
cnn = tf.keras.applications.InceptionV3(weights='imagenet',
                                        include_top=False,
                                        pool='avg')

cnn.trainable = False
```


Canned Estimators
Canned Estimators
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TensorFlow Distributed Execution Engine
CPU
GPU
Android
iOS
XLA
CPU
GPU
TPU
...

```
area = real_valued_column(“square_foot”),
rooms = real_valued_column(“num_rooms”),
zip_code = sparse_column_with_integerized_feature(“zip_code”, 100000)


regressor = DNNRegressor(
    feature_columns=[area, rooms, embedding_column(zip_code, 8)],
    hidden_units=[1024, 512, 256])

regressor.train(train_input_fn)

regressor.evaluate(eval_input_fn)
```

TensorFlow v1.4

Code time!!

http://playground.tensorflow.org