Google Cloud

Machine Learning at Scale

TensorFlow in the Cloud

Yufeng Guo
Developer Advocate
@YufengG
yufengg.com

Machine Learning
is
using many ***examples***
to ***answer questions***

Training

many

examples

Prediction

answer

questions

Training

many

examples

Prediction

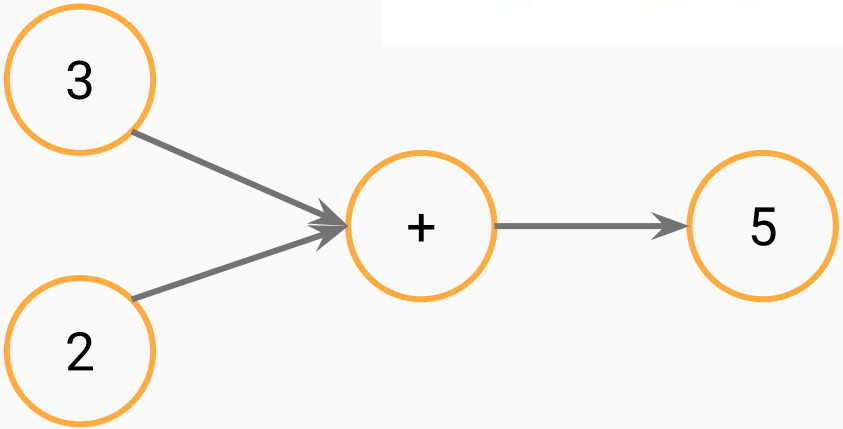
answer questions

- Fast, flexible, and scalable open-source machine learning library
- For research and production
- Distributed training and serving predictions
- Apache 2.0 license

https://research.googleblog.com/2016/11/celebrating-tensorflows-first-year.html

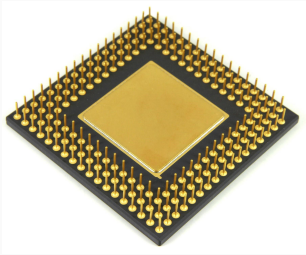
A multidimensional array.

TensorFlow



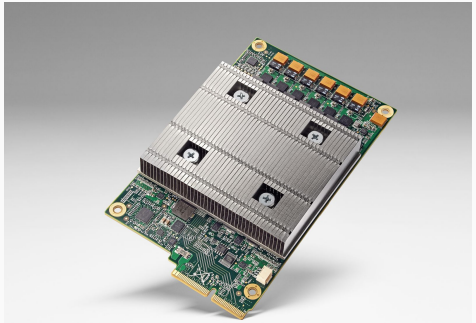
A graph of operations.

TensorFlow Supports Many Platforms...



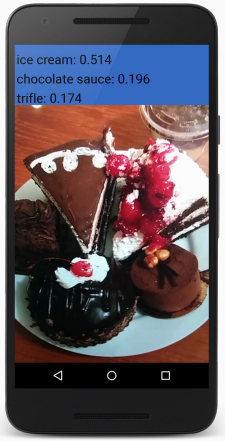
CPU

GPU

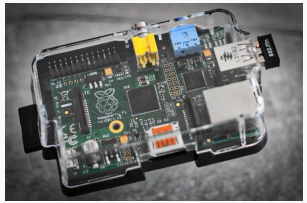


TPU

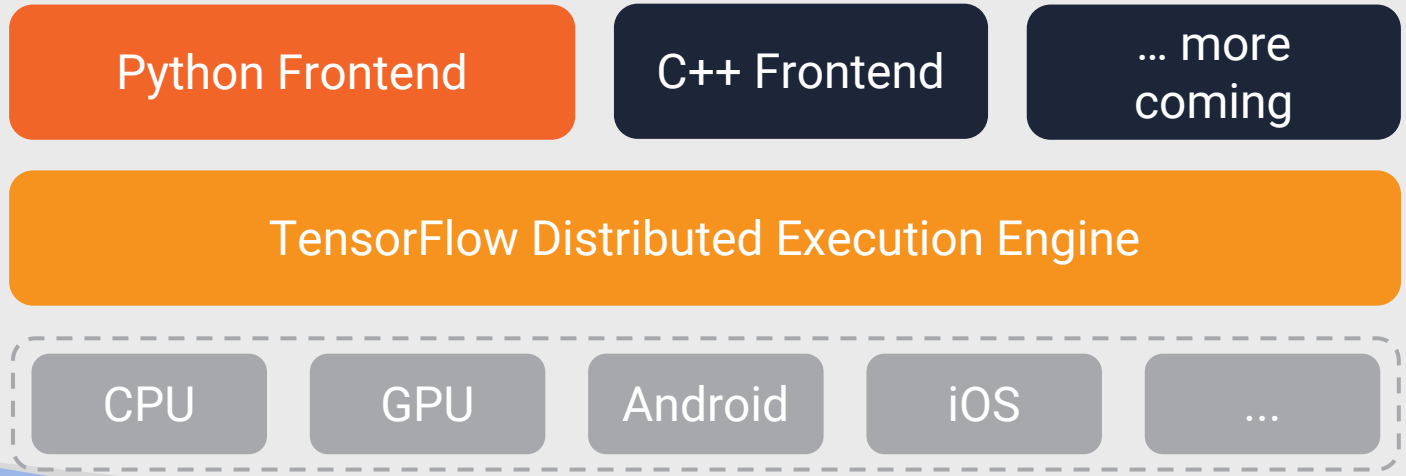
Android

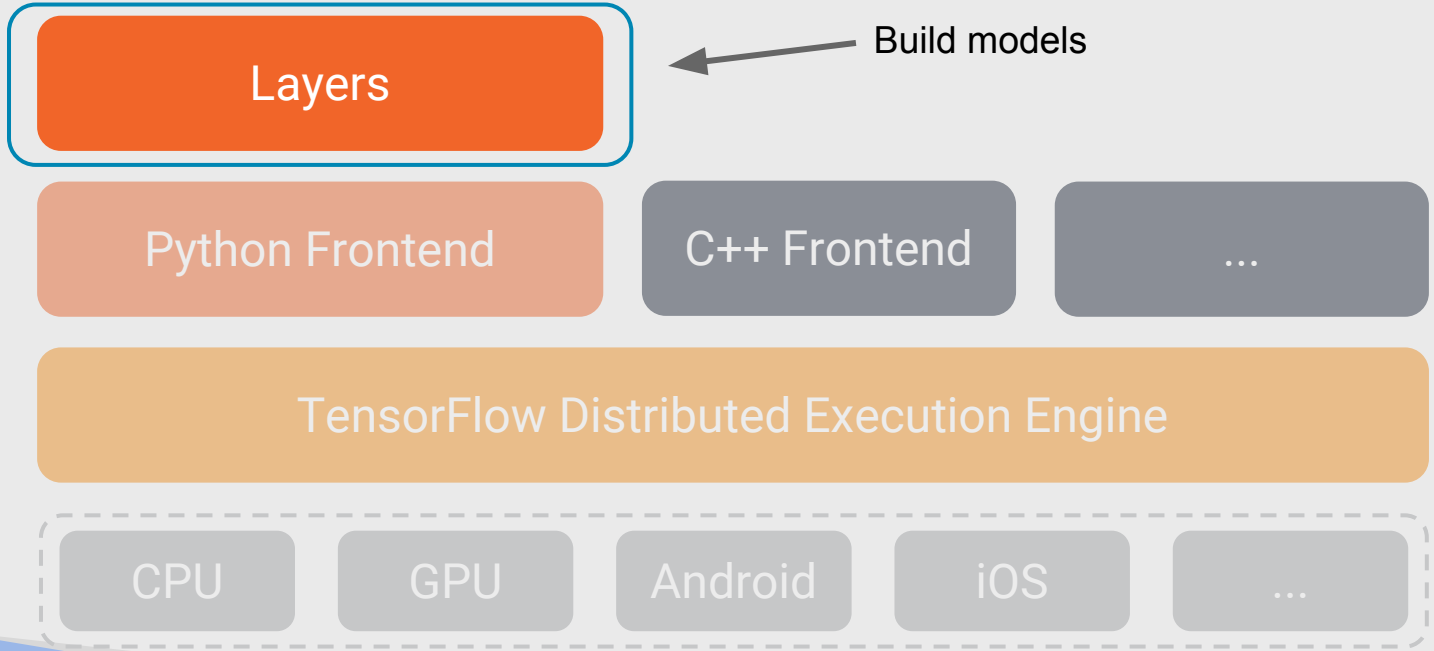


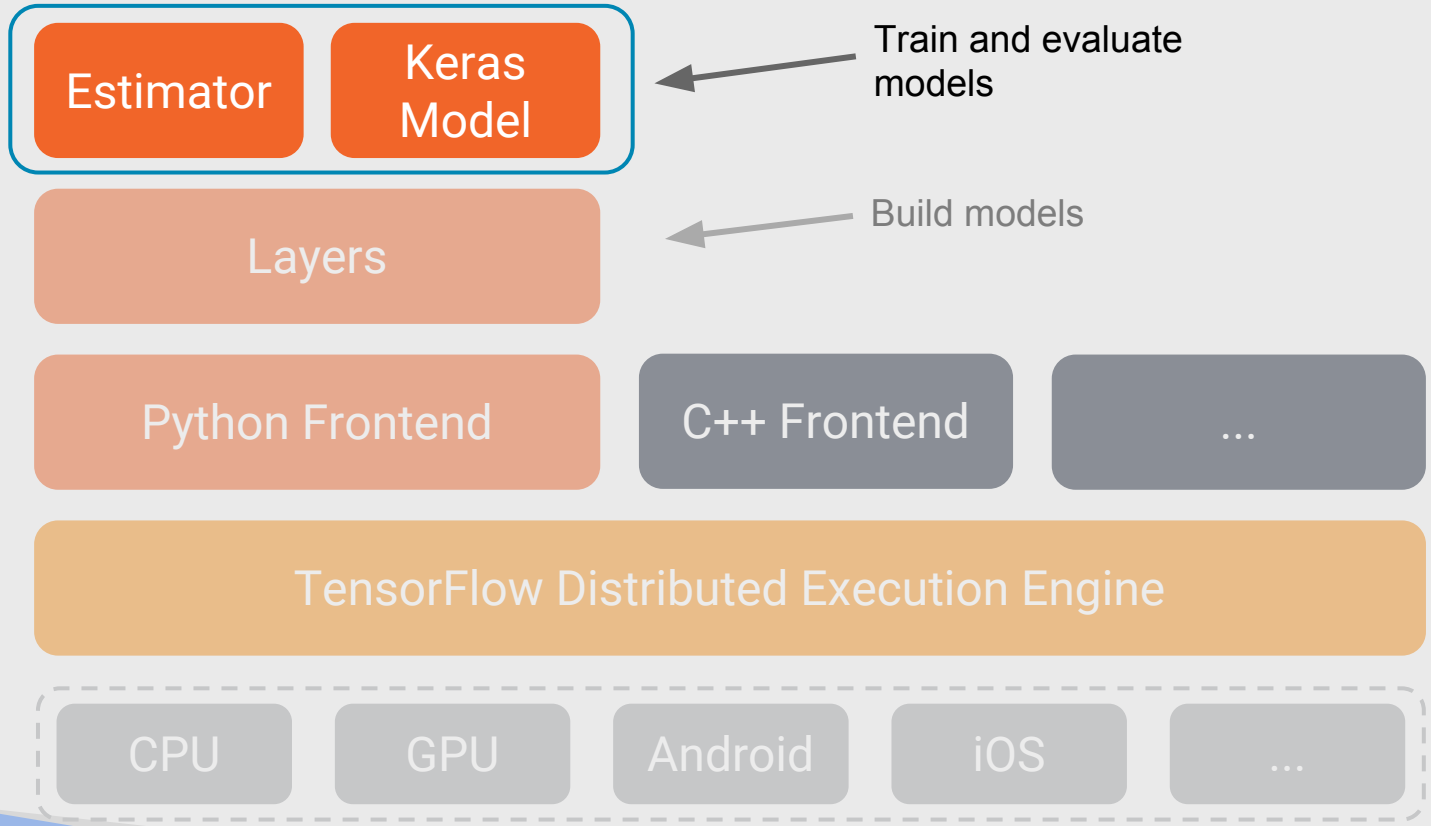
iOS

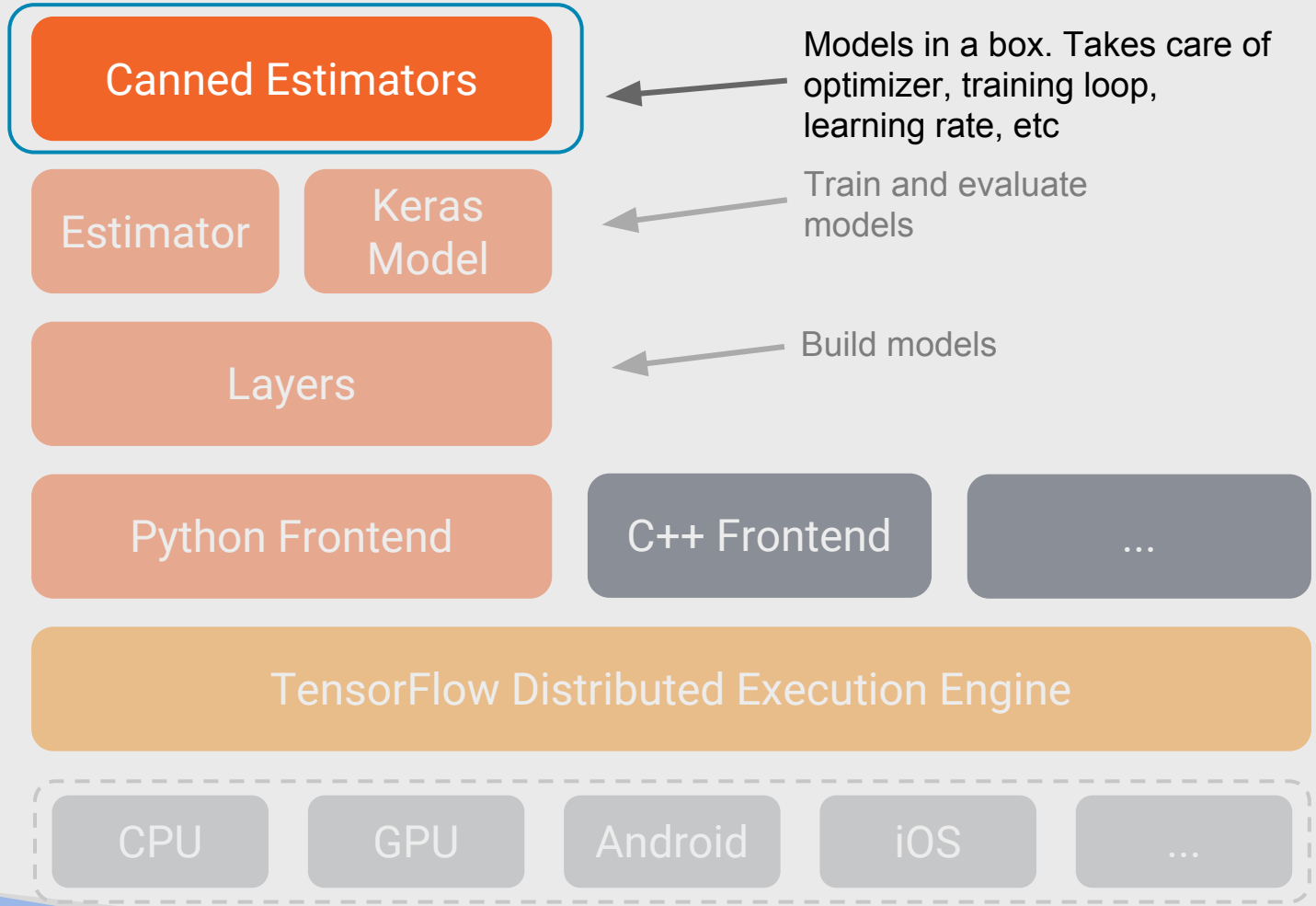


Raspberry Pi


Python Frontend
C++ Frontend
… more coming
TensorFlow Distributed Execution Engine
CPU
GPU
Android
iOS
…


Layers
Build models
Python Frontend
C++ Frontend
...
TensorFlow Distributed Execution Engine
CPU
GPU
Android
iOS
...


Estimator
Keras Model
Train and evaluate models
Layers
Build models
Python Frontend
C++ Frontend
...
TensorFlow Distributed Execution Engine
CPU
GPU
Android
iOS
...


Canned Estimators
Models in a box. Takes care of optimizer, training loop, learning rate, etc
Estimator
Keras Model
Train and evaluate models
Layers
Build models
Python Frontend
C++ Frontend
...
TensorFlow Distributed Execution Engine
CPU
GPU
Android
iOS
...

```
area = real_valued_column("square_foot"),
rooms = real_valued_column("num_rooms"),
zip_code = sparse_column_with_integerized_feature("zip_code",
10000)

classifier = DNNClassifier(
    feature_columns=[area, rooms, embedding_column(zip_code, 8)],
    hidden_units=[1024, 512, 256, 128])

classifier.fit(train_input_fn)

results = classifier.evaluate(eval_input_fn)

print(results)
```

```
classifier = DNNLinearCombinedRegressor(
    linear_feature_columns=[area, rooms, embedding_column(zip_code, 8)],
    linear_optimizer=tf.train.FtrlOptimizer(learning_rate=0.01,
                                            l2_regularization_strength=0.1),
    dnn_feature_columns=[real_valued_column(area),
                         real_valued_column(rooms)]
    dnn_optimizer=tf.train.AdagradOptimizer(learning_rate=0.01,
                                            initial_accumulator_value=0.1),
    dnn_activation_fn=tf.nn.relu,
    dnn_dropout = 0.5,
    gradient_clip_norm=0.1,
    hidden_units=[1024, 512, 256, 128])

classifier.fit(train_input_fn)
classifier.evaluate(eval_input_fn)
```

<Storytime>

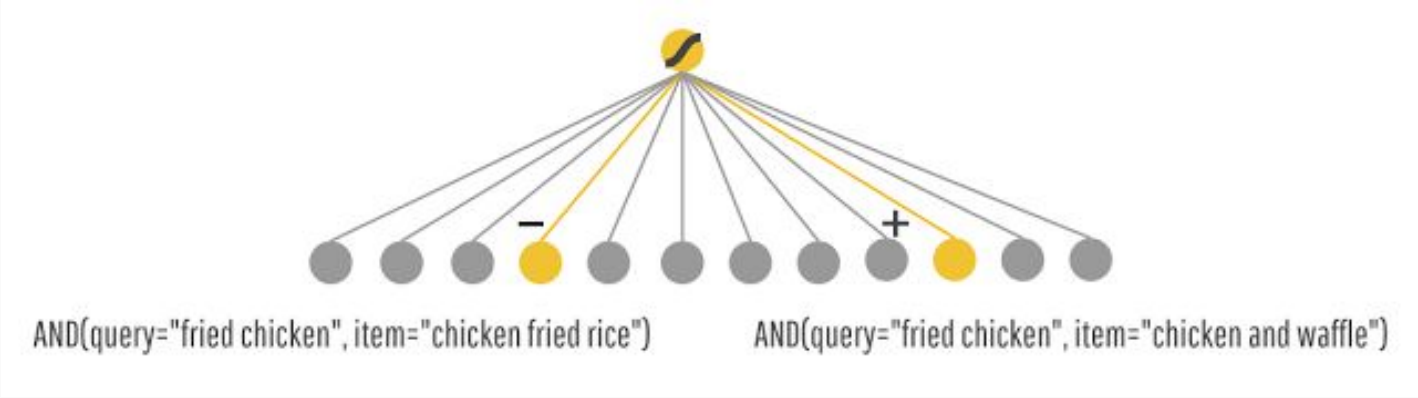
Motivation - a "magical" food app

Just **Launch** and Iterate

- Naive character matching
- Say "Fried chicken"
- Get "Chicken Fried Rice"
- Oops. Now what?
- Machine learning to the rescue!

v2.0: **memorize** all the things!

- Train a linear TF model



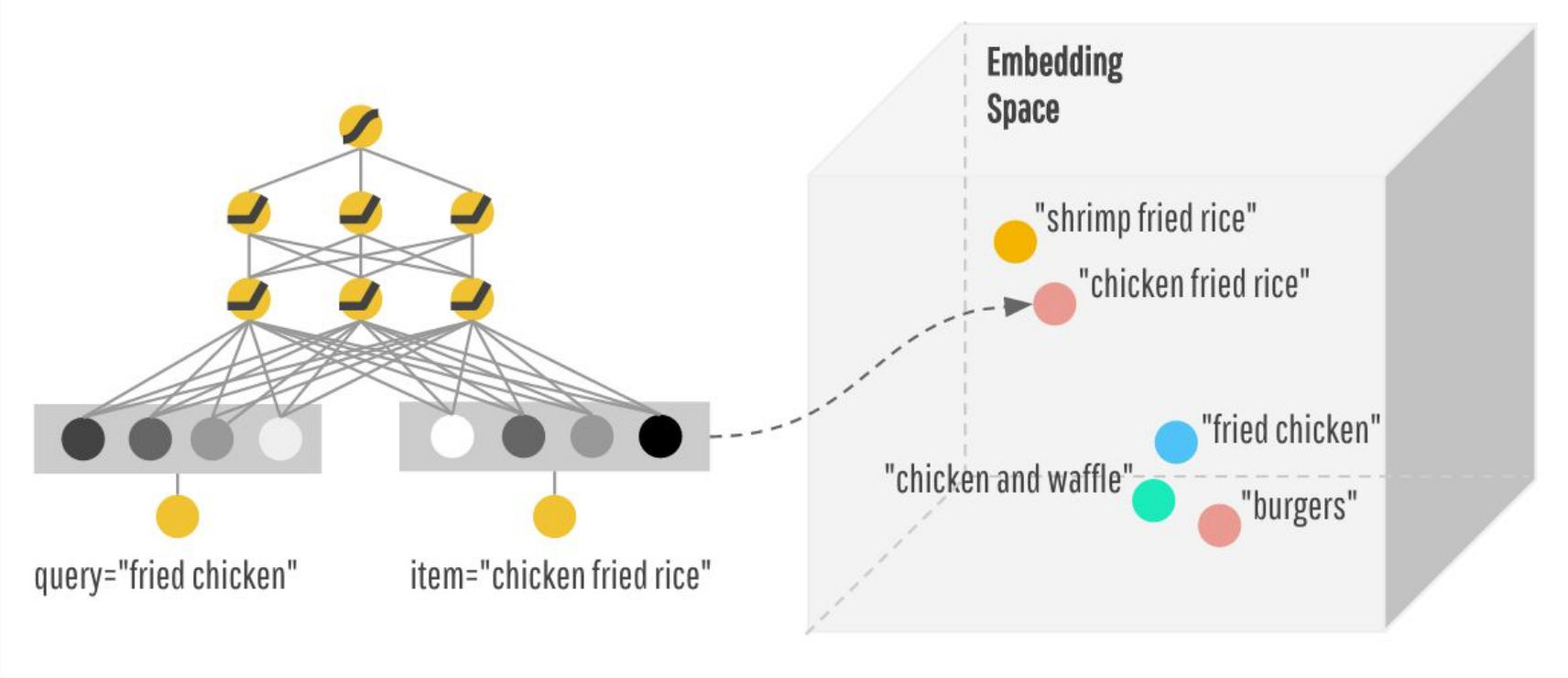
- Your app is gaining traction!

Problem: Your users are bored!

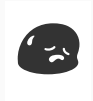
- Too many  & waffles
- Show me similar, but different food

- Your users are **picky** 

v3.0: More generalized recommendations for all



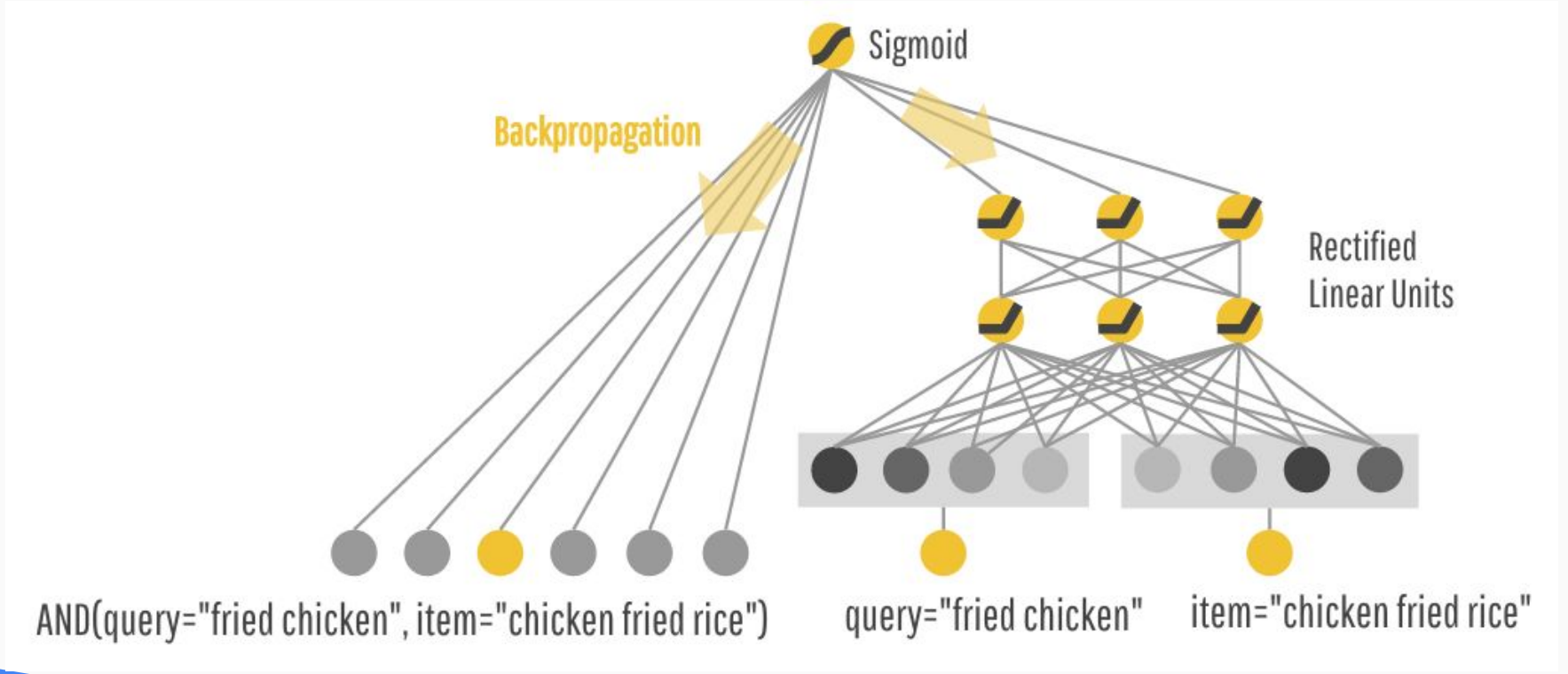
No good deed goes unpunished

- Some recommendations are "too general"
  - Irrelevant dishes are being sent
- Your users are **still picky** 

No good deed goes unpunished

- 2 types of requests: specific and general
- "iced decaf latte with nonfat milk" != "hot latte with whole milk"
- “seafood” or “italian food” or “fast food”
- **How to balance this?**

v4.0: Why not both?

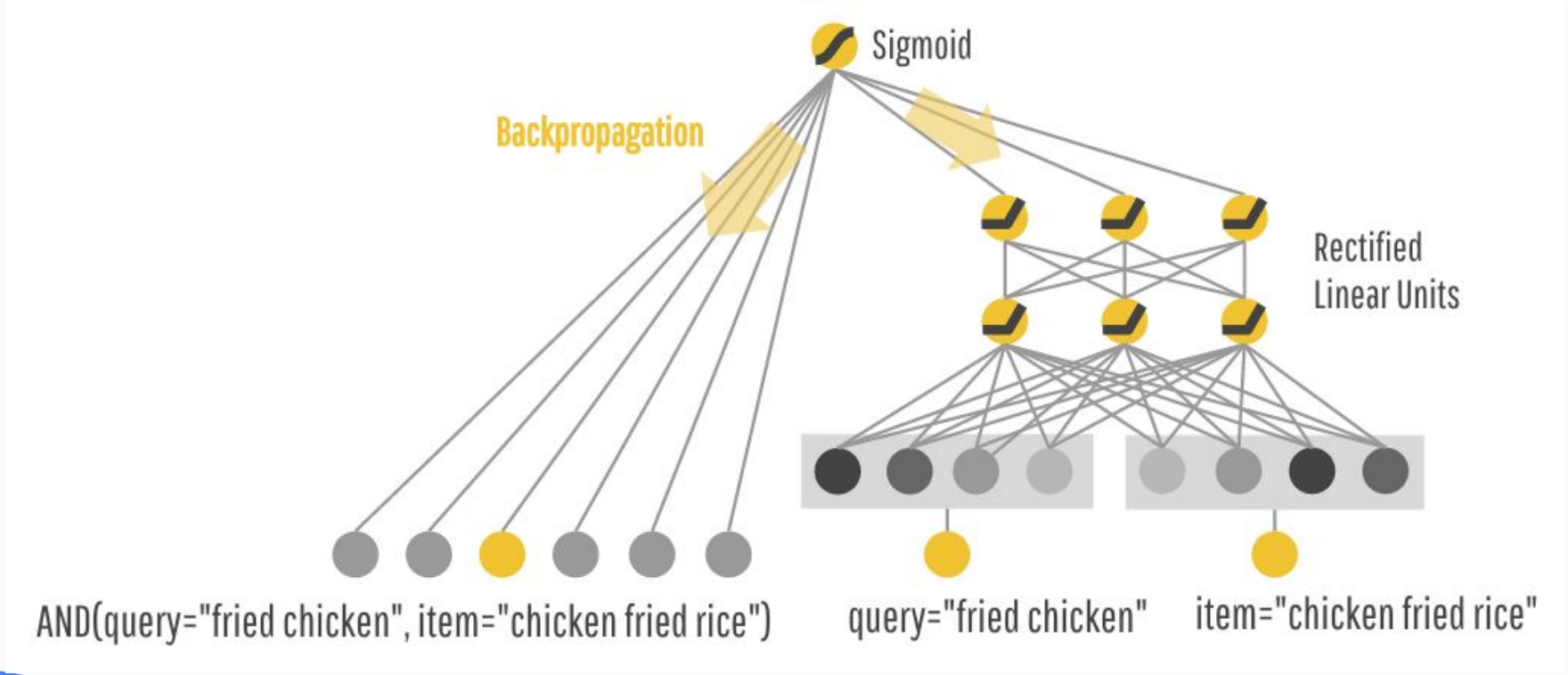


Wide & Deep

memorization
relevance

generalization
diversity

Wide and Deep



</Storytime>

Meet our dataset: US Census Data

- **Task**: predict whether the household has an annual income of over $50K
- Over **32k** training examples
- Extracted from the 1994 US Census by Barry Becker.

Meet our dataset: US Census Data

Column Name	Type	Description
age	Continuous	The age of the individual
workclass	Categorical	The type of employer the individual has (government, military, private, etc.).
fnlwgt	Continuous	The number of people the census takers believe that observation represents (sample weight). Not used.
education	Categorical	The highest level of education achieved for that individual.
education_num	Continuous	The highest level of education in numerical form.
marital_status	Categorical	Marital status of the individual.

Meet our dataset: US Census Data

Column Name	Type	Description
occupation	Categorical	The occupation of the individual.
relationship	Categorical	Wife, Own-child, Husband, Not-in-family, Other-relative, Unmarried.
race	Categorical	White, Asian-Pac-Islander, Amer-Indian-Eskimo, Other, Black.
gender	Categorical	Female, Male.
capital_gain	Continuous	Capital gains recorded.
capital_loss	Continuous	Capital Losses recorded.

Meet our dataset: US Census Data

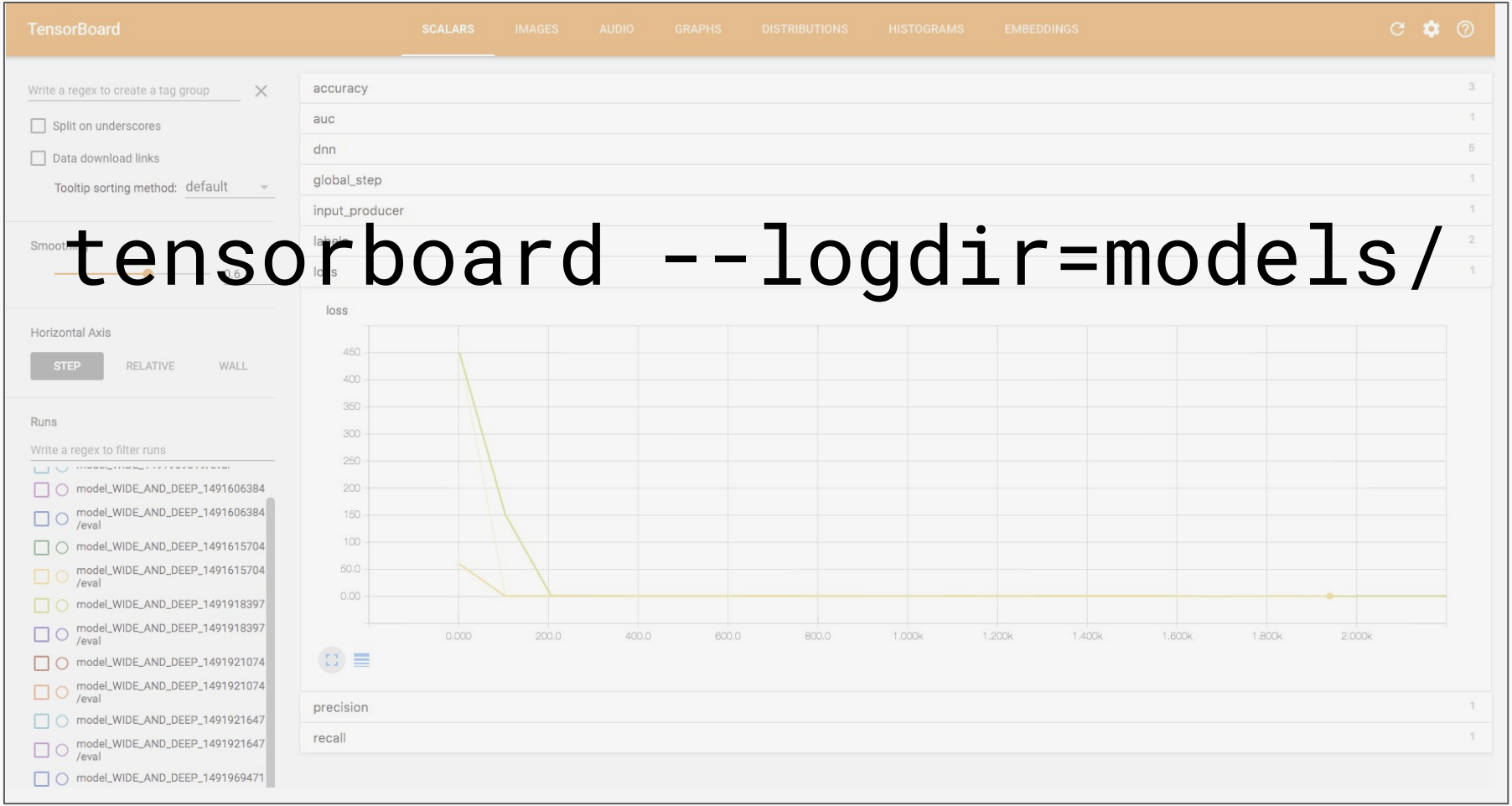
Column Name	Type	Description
hours_per_week	Continuous	Hours worked per week.
native_country	Categorical	Country of origin of the individual.
income_bracket	**Categorical**	**">50K" or "<=50K", meaning whether the person makes more than $50,000 annually.**

Wide & Deep

memorization	generalization
relevance	diversity
Sparse	Dense/Real
Categorical	Continuous

To the code!

bit.ly/widendeep-census



tensorboard --logdir=models/

@YufengG

Training

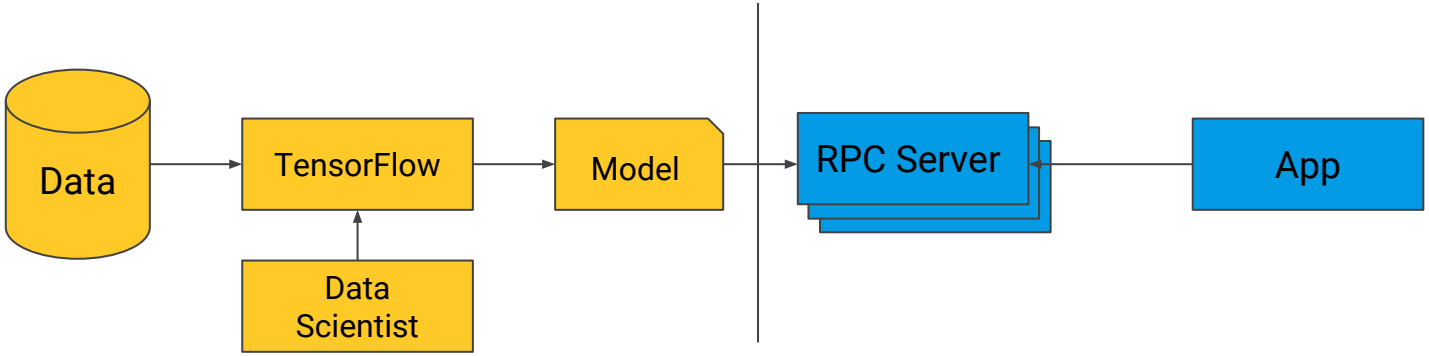
many

examples

Prediction

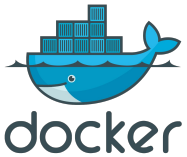
answer questions

What is Serving?

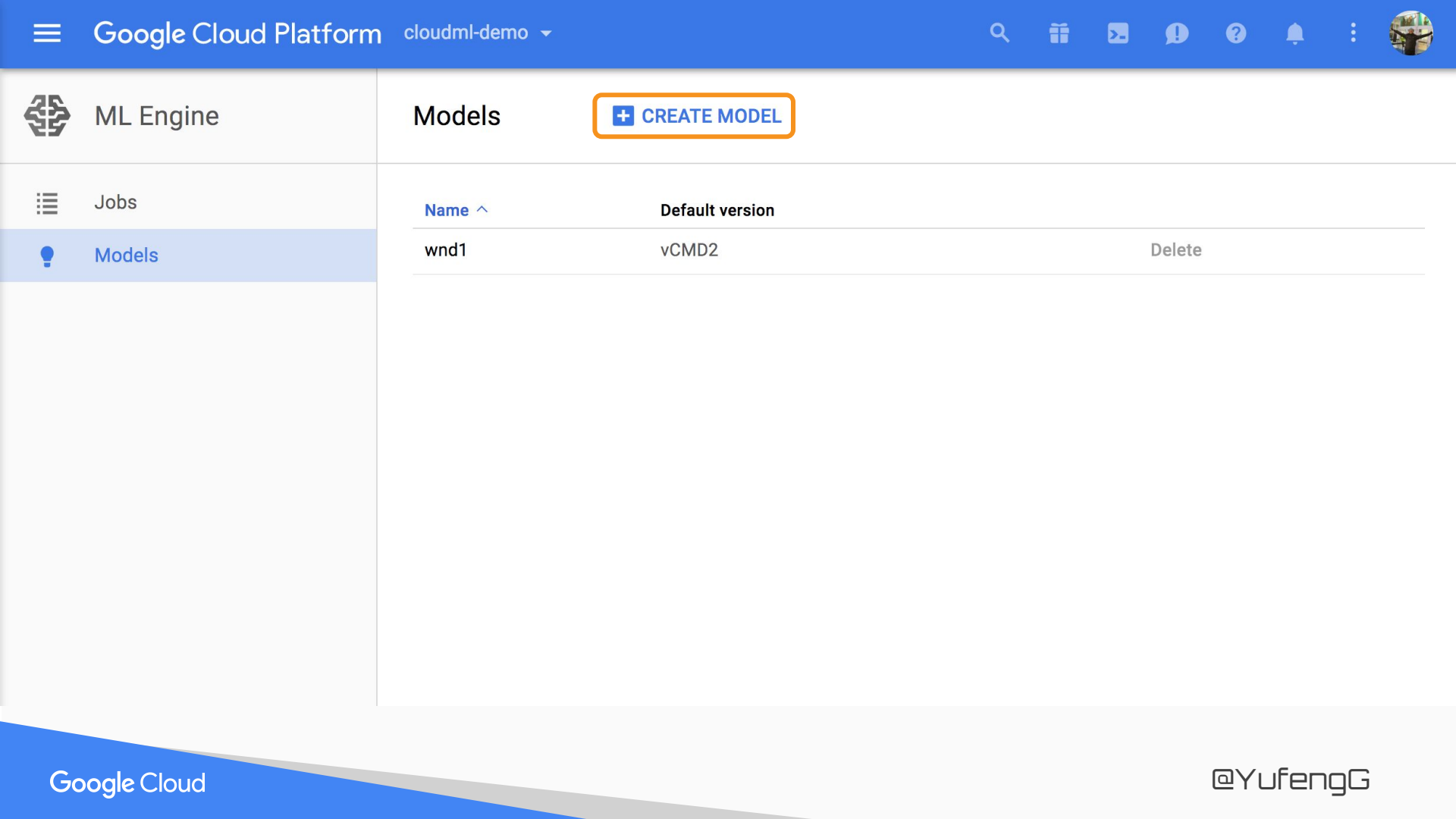


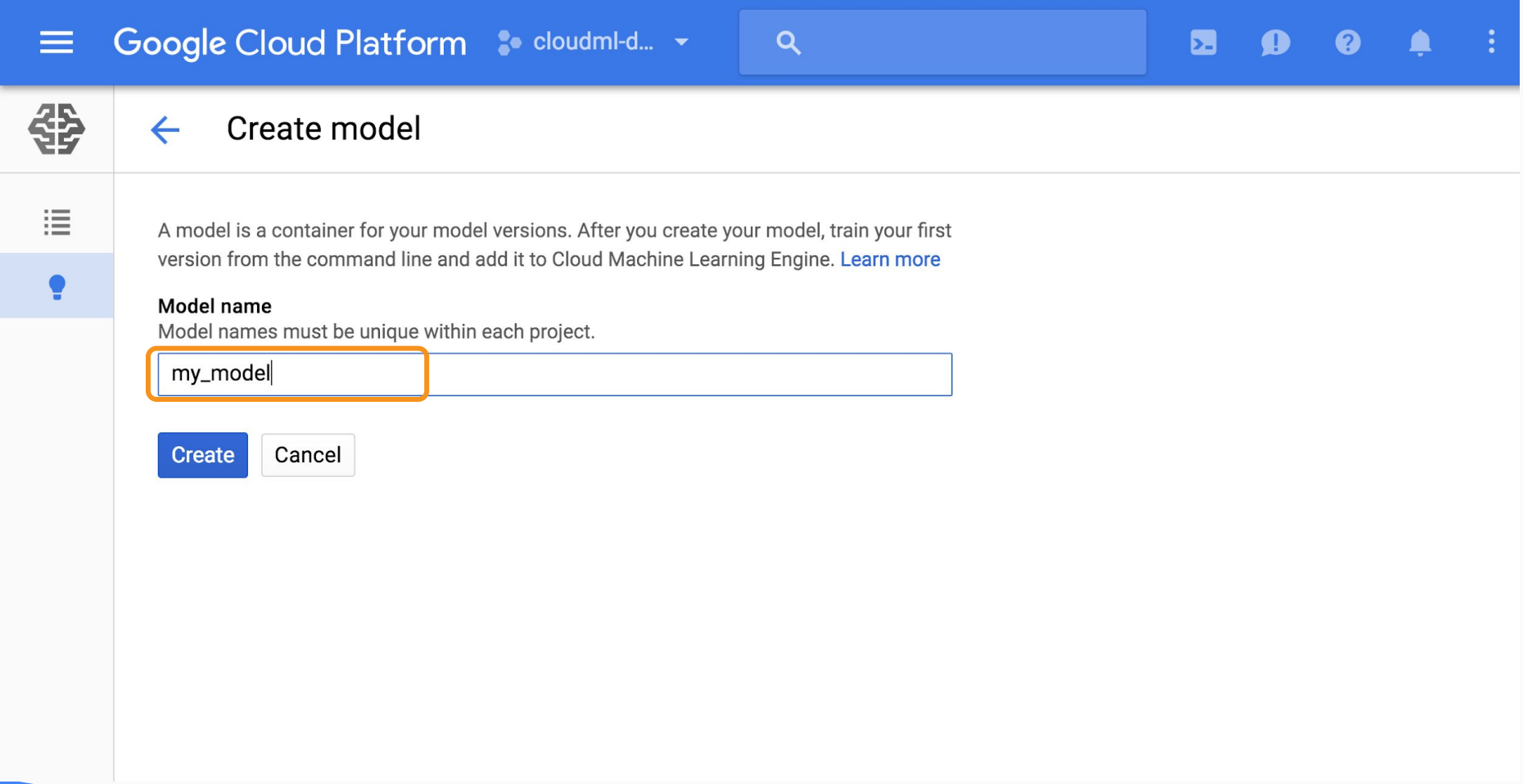
What is TensorFlow Serving?

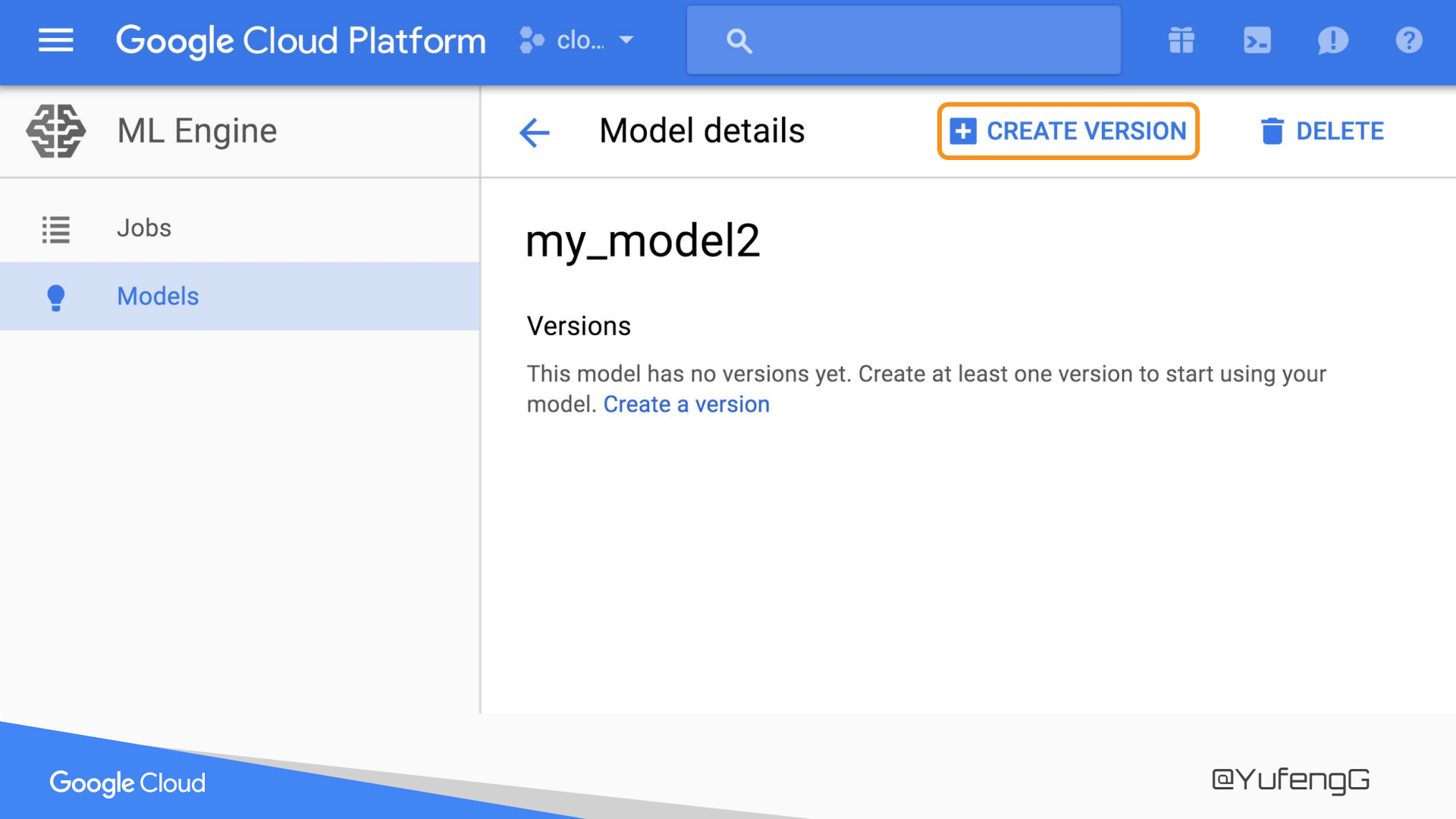
- C++ Libraries
  - TensorFlow model save / export formats
  - Generic core platform
- Binaries
  - Best practices out of the box
  - Docker containers, K8s tutorial
- Hosted Service across
  - Google Cloud ML Engine
  - Internal service

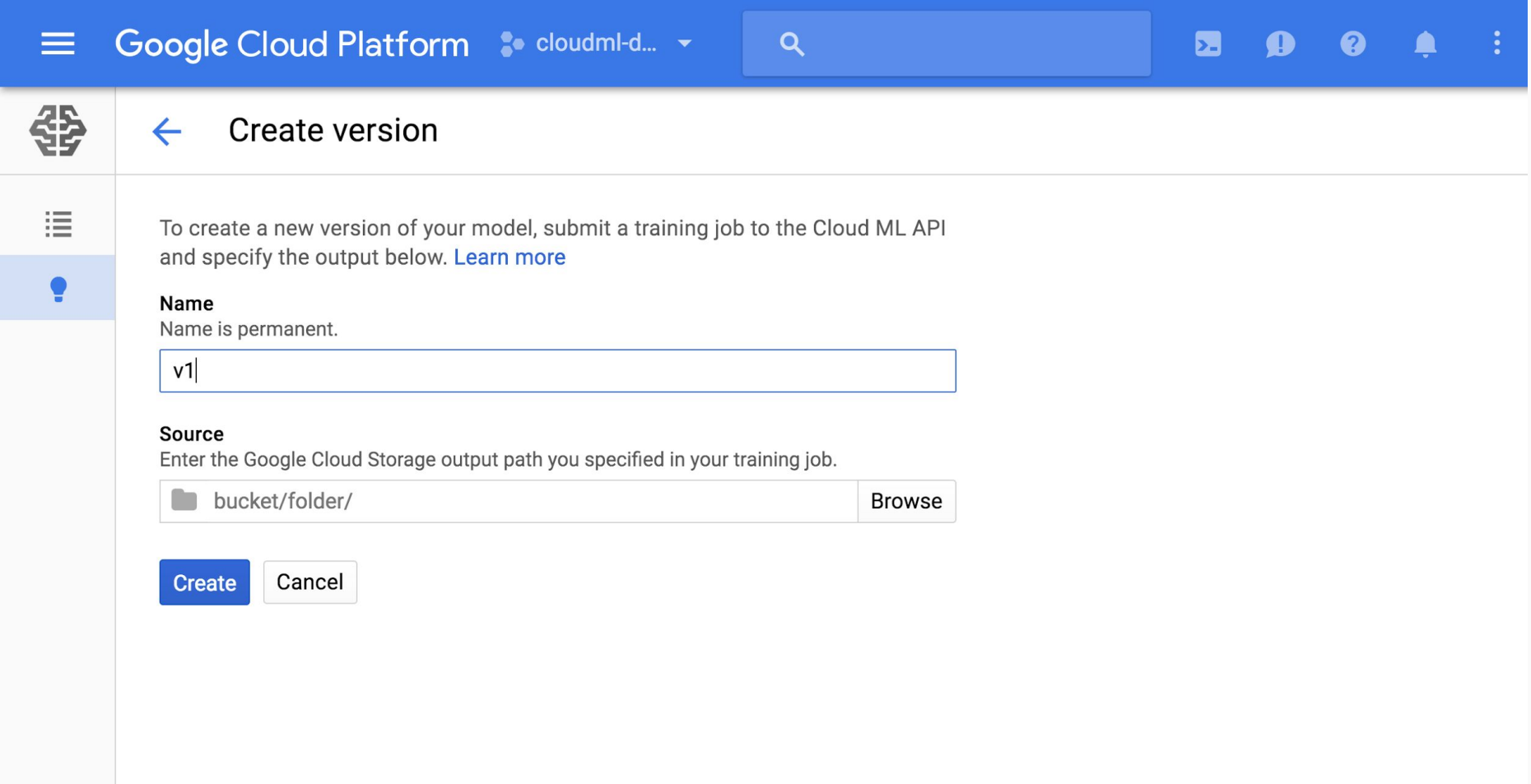


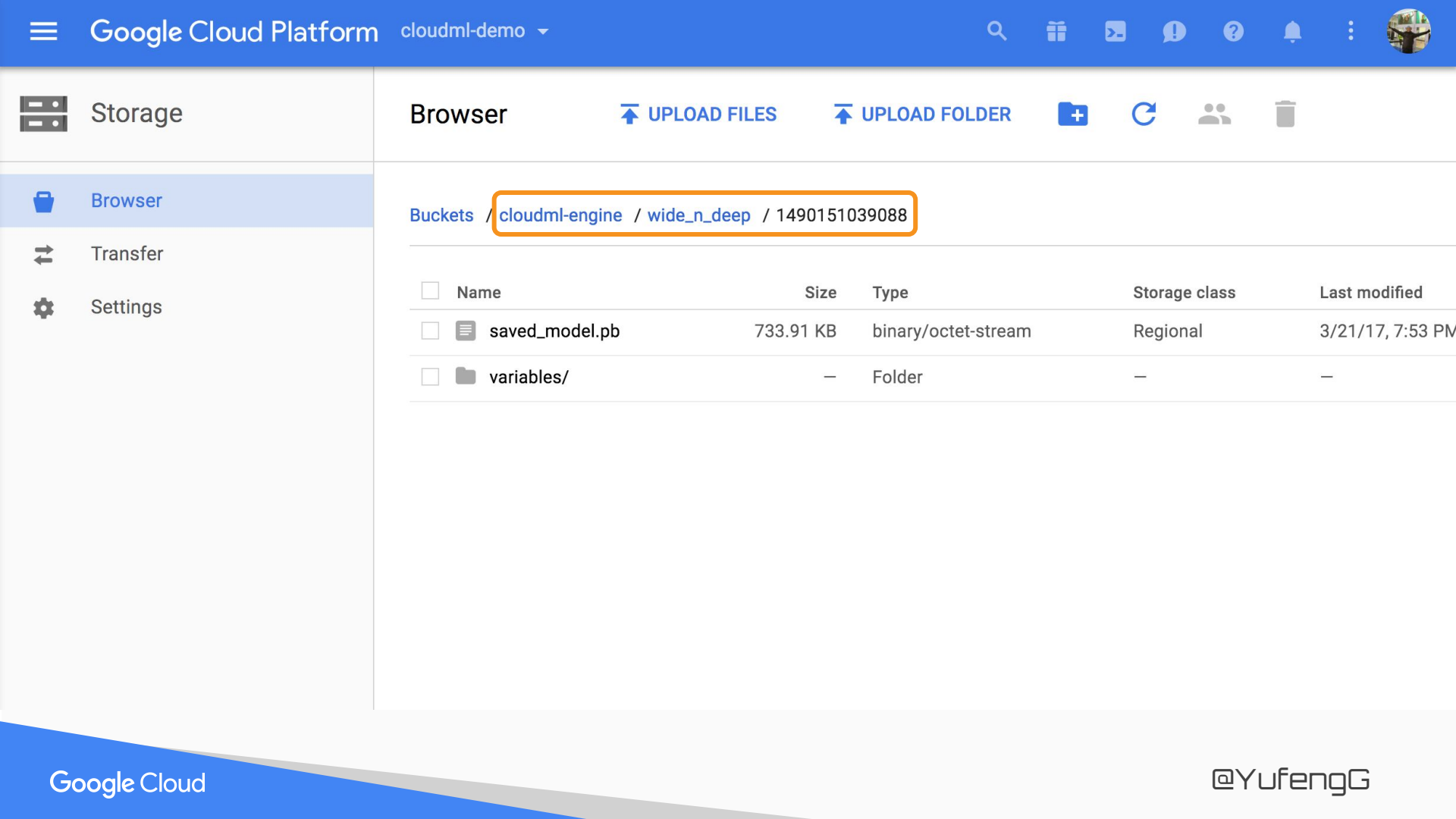
Model Creation

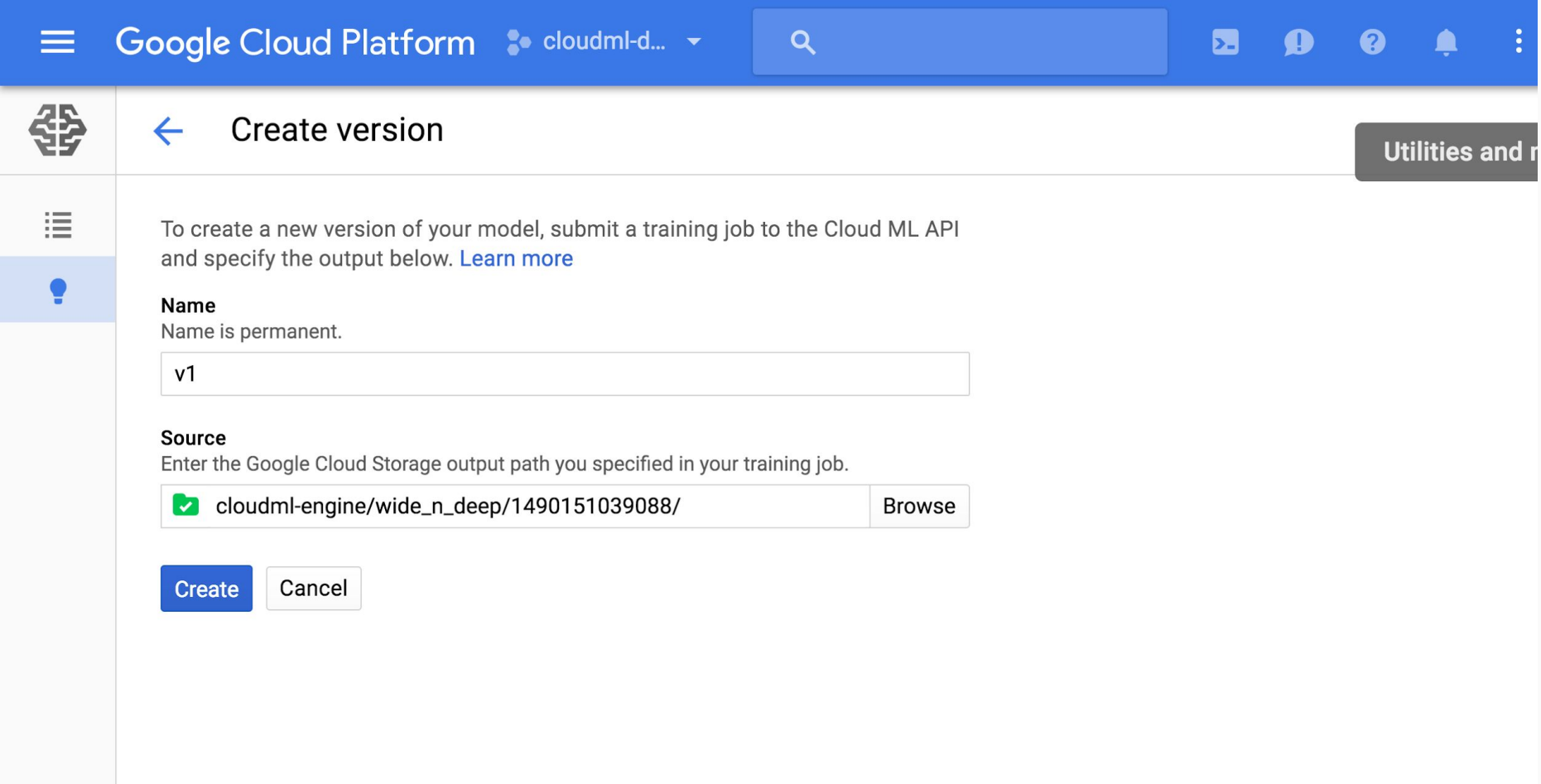

Google Cloud Platform
cloudml-demo
ML Engine
Jobs
Models
Models
CREATE MODEL
Name
Default version
wnd1
vCMD2
Delete

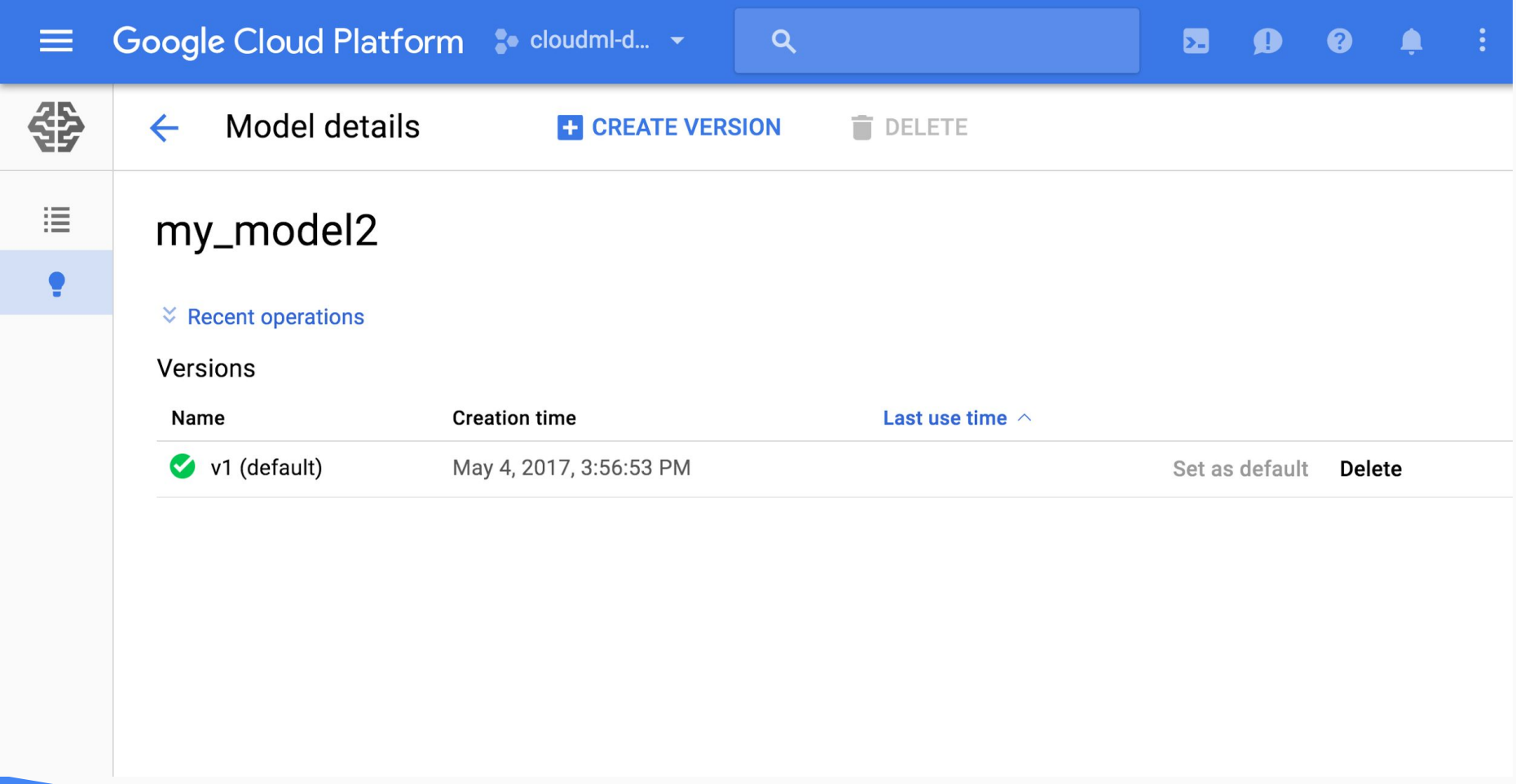

Google Cloud Platform
cloudml-d...
Create model
A model is a container for your model versions. After you create your model, train your first version from the command line and add it to Cloud Machine Learning Engine. Learn more
Model name
Model names must be unique within each project.
my_model
Create
Cancel


Google Cloud Platform
clo...
ML Engine
Jobs
Models
Model details
CREATE VERSION
DELETE
my_model2
Versions
This model has no versions yet. Create at least one version to start using your model. Create a version
Google Cloud
@YufengG


Google Cloud Platform
cloudml-d...
Create version
To create a new version of your model, submit a training job to the Cloud ML API and specify the output below. Learn more
Name
Name is permanent.
v1
Source
Enter the Google Cloud Storage output path you specified in your training job.
bucket/folder/
Browse
Create
Cancel


Google Cloud Platform
cloudml-demo
Storage
Browser
Transfer
Settings
Browser
UPLOAD FILES
UPLOAD FOLDER
Buckets / cloudml-engine / wide_n_deep / 1490151039088
Name
Size
Type
Storage class
Last modified
saved_model.pb
733.91 KB
binary/octet-stream
Regional
3/21/17, 7:53 PM
variables/
–
Folder
–
–


Google Cloud Platform
cloudml-d...
Create version
Utilities and r
To create a new version of your model, submit a training job to the Cloud ML API and specify the output below. Learn more
Name
Name is permanent.
v1
Source
Enter the Google Cloud Storage output path you specified in your training job.
cloudml-engine/wide_n_deep/1490151039088/
Browse
Create
Cancel


Google Cloud Platform
cloudml-d...
Model details
CREATE VERSION
DELETE
my_model2
Recent operations
Versions
Name
Creation time
Last use time
v1 (default)
May 4, 2017, 3:56:53 PM
Set as default
Delete

```
export MODEL_NAME='my_model'
gcloud ml-engine models --regions us-central1 create $MODEL_NAME
```

```
export MODEL_NAME='cloudwnd'
export VERSION_NAME='learn_runner_standard'
export DEPLOYMENT_SOURCE='gs://cloudml-engine/widendeep_yufeng
g_20170410_164903/model_WIDE_AND_DEEP_1491857627/export/Servo/
1491857907860'

$ gcloud ml-engine versions create $VERSION_NAME --model
$MODEL_NAME --origin $DEPLOYMENT_SOURCE
Creating version (this might take a few minutes)......
```

Instance Prediction

```
{
  "age": 25,
  "workclass": " Private",
  "education": " 11th",
  "education_num": 7,
  "marital_status": "
Never-married",
  "occupation": "
Machine-op-inspct",
  "relationship": "
Own-child",
  "race": " Black",
  "gender": " Male",
  "capital_gain": 0,
  "capital_loss": 0,
  "hours_per_week": 40,
  "native_country": "
United-States"
}
```

```
{
  "age": 42,
  "workclass": "
Self-emp-inc",
  "education": " HS-grad",
  "education_num": 9,
  "marital_status": "
Married-civ-spouse",
  "occupation": "
Exec-managerial",
  "relationship": " Husband",
  "race": " White",
  "gender": " Male",
  "capital_gain": 5178,
  "capital_loss": 0,
  "hours_per_week": 50,
  "native_country": "
United-States"
}
```

```
$ gcloud ml-engine predict --model wnd1 --version vCMD2 --json-instances census.json
CLASSES  LOGISTIC                 LOGITS                   PROBABILITIES
0        [0.0051437602378427 98]  [-5.2648138999938965]    [0.9948562383651733, 0.0051437602378427 98]
1        [0.8839852213859558]     [2.0307230949401855]     [0.1160147413611412, 0.8839852213859558]
```

```
PROBABILITIES
[0.9948562383651733, 0.0051437602378427 98]
[0.1160147413611412, 0.8839852213859558]
```

```
{
  "probabilities": [
    0.11601490527391434,
    0.8839850425720215
  ],
  "logits": [
    2.030721426010132
  ],
  "classes": 1,
  "logistic": [
    0.8839850425720215
  ]
}
```

```
{
  "probabilities": [
    0.9948562383651733,
    0.005143760237842798
  ],
  "logits": [
    -5.2648138999938965
  ],
  "classes": 0,
  "logistic": [
    0.005143760237842798
  ]
}
```

Training

many *examples*

Prediction

answer questions

Training

many *examples*

Prediction

answer questions

Training

many *examples*

Prediction

answer questions

Thank you!

@YufengG
yufengg.com

Resources:

Cloud Machine Learning Engine
cloud.google.com/ml-engine

TensorFlow
tensorflow.org

To the code!
bit.ly/widendeep-census
bit.ly/widendeep-code

The End