Training on Cloud AI Platform

This notebook illustrates distributed training on Cloud AI Platform (formerly known as Cloud ML Engine).

In [1]:
```
!sudo chown -R jupyter:jupyter /home/jupyter/training-data-analyst
```

In [2]:
```
# Ensure the right version of Tensorflow is installed.
!pip freeze | grep tensorflow==2.5
```

In [3]:
```
# change these to try this notebook out
BUCKET = 'qwiklabs-gcp-00-6779a77a27e3'
PROJECT = 'qwiklabs-gcp-00-6779a77a27e3'
REGION = 'us-central1'
```

In [4]:
```
import os
os.environ['BUCKET'] = BUCKET
os.environ['PROJECT'] = PROJECT
os.environ['REGION'] = REGION
os.environ['TFVERSION'] = '2.5'
```

In [5]:
```
%%bash
gcloud config set project $PROJECT
gcloud config set compute/region $REGION
```

```
Updated property [core/project].
Updated property [compute/region].
```

In [6]:
```
%%bash
if ! gsutil ls | grep -q gs://${BUCKET}/babyweight/preproc; then
   gsutil mb -l ${REGION} gs://${BUCKET}
   # copy canonical set of preprocessed files if you didn't do previous notebook
   gsutil -m cp -R gs://cloud-training-demos/babyweight gs://${BUCKET}
fi
```

```
Creating gs://qwiklabs-gcp-00-6779a77a27e3/...
ServiceException: 409 A Cloud Storage bucket named 'qwiklabs-gcp-00-6779a77a27e
3' already exists. Try another name. Bucket names must be globally unique across
all Google Cloud projects, including those outside of your organization.
Copying gs://cloud-training-demos/babyweight/hyperparam/1/checkpoint...
Copying gs://cloud-training-demos/babyweight/hyperparam/1/events.out.tfevents.15
29347394.cmle-training-master-ab97329ccf-0-xfhjt...
Copying gs://cloud-training-demos/babyweight/hyperparam/1/export/exporter/152934
7629/saved_model.pb...
Copying gs://cloud-training-demos/babyweight/hyperparam/1/eval/events.out.tfeven
ts.1529347627.cmle-training-master-ab97329ccf-0-xfhjt...
Copying gs://cloud-training-demos/babyweight/hyperparam/1/export/exporter/152934
7926/variables/variables.data-00000-of-00001...
Copying gs://cloud-training-demos/babyweight/hyperparam/1/export/exporter/152934
```

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7629/variables/variables.index...
Copying gs://cloud-training-demos/babyweight/hyperparam/1/export/exporter/152934
7926/saved_model.pb...
Copying gs://cloud-training-demos/babyweight/hyperparam/1/export/exporter/152934
7629/variables/variables.data-00000-of-00001...
Copying gs://cloud-training-demos/babyweight/hyperparam/1/export/exporter/152934
7926/variables/variables.index...
Copying gs://cloud-training-demos/babyweight/hyperparam/1/export/exporter/152934
8269/saved_model.pb...
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8269/variables/variables.data-00000-of-00001...
Copying gs://cloud-training-demos/babyweight/hyperparam/1/export/exporter/152934
8269/variables/variables.index...
Copying gs://cloud-training-demos/babyweight/hyperparam/1/graph.pbtxt...
Copying gs://cloud-training-demos/babyweight/hyperparam/1/model.ckpt-141975.data
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Copying gs://cloud-training-demos/babyweight/hyperparam/1/model.ckpt-141975.data
-00001-of-00003...
Copying gs://cloud-training-demos/babyweight/hyperparam/1/model.ckpt-141975.met
a...
Copying gs://cloud-training-demos/babyweight/hyperparam/1/model.ckpt-141975.data
-00002-of-00003...
Copying gs://cloud-training-demos/babyweight/hyperparam/1/model.ckpt-141975.inde
x...
Copying gs://cloud-training-demos/babyweight/hyperparam/1/model.ckpt-295591.data
-00000-of-00003...
Copying gs://cloud-training-demos/babyweight/hyperparam/1/model.ckpt-295591.data
-00001-of-00003...
Copying gs://cloud-training-demos/babyweight/hyperparam/1/model.ckpt-295591.data
-00002-of-00003...
Copying gs://cloud-training-demos/babyweight/hyperparam/1/model.ckpt-295591.inde
x...
Copying gs://cloud-training-demos/babyweight/hyperparam/1/model.ckpt-295591.met
a...
Copying gs://cloud-training-demos/babyweight/hyperparam/1/model.ckpt-317465.data
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49912/variables/variables.data-00000-of-00001...
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49912/variables/variables.index...
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50256/saved_model.pb...
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50256/variables/variables.index...
Copying gs://cloud-training-demos/babyweight/hyperparam/10/export/exporter/15293
50256/variables/variables.data-00000-of-00001...
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x...
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a...
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50524/variables/variables.index...
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a...
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529350997.cmle-training-master-3523a35558-0-92n89...
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nts.1529351171.cmle-training-master-3523a35558-0-92n89...
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51172/variables/variables.data-00000-of-00001...
Copying gs://cloud-training-demos/babyweight/hyperparam/16/export/exporter/15293
51172/saved_model.pb...
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00-of-00003...
Copying gs://cloud-training-demos/babyweight/hyperparam/16/model.ckpt-1.data-000
01-of-00003...
Copying gs://cloud-training-demos/babyweight/hyperparam/16/model.ckpt-1.data-000
02-of-00003...
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                ta-00000-of-00003...
                Copying gs://cloud-training-demos/babyweight/trained_model_tuned/graph.pbtxt...
                Copying gs://cloud-training-demos/babyweight/trained_model_tuned/model.ckpt-1.da
```

```
ta-00001-of-00003...
Copying gs://cloud-training-demos/babyweight/trained_model_tuned/model.ckpt-1.da
ta-00002-of-00003...
Copying gs://cloud-training-demos/babyweight/trained_model_tuned/model.ckpt-1.in
dex...
Copying gs://cloud-training-demos/babyweight/trained_model_tuned/model.ckpt-1.me
ta...
Copying gs://cloud-training-demos/babyweight/trained_model_tuned/model.ckpt-4839
73.data-00000-of-00003...
Copying gs://cloud-training-demos/babyweight/trained_model_tuned/model.ckpt-4839
73.data-00001-of-00003...
Copying gs://cloud-training-demos/babyweight/trained_model_tuned/model.ckpt-4839
73.data-00002-of-00003...
Copying gs://cloud-training-demos/babyweight/trained_model_tuned/model.ckpt-4839
73.index...
Copying gs://cloud-training-demos/babyweight/trained_model_tuned/model.ckpt-4839
73.meta...
Copying gs://cloud-training-demos/babyweight/trained_model_tuned/model.ckpt-5714
32.data-00000-of-00003...
Copying gs://cloud-training-demos/babyweight/trained_model_tuned/model.ckpt-5714
32.data-00001-of-00003...
Copying gs://cloud-training-demos/babyweight/trained_model_tuned/model.ckpt-5714
32.data-00002-of-00003...
Copying gs://cloud-training-demos/babyweight/trained_model_tuned/model.ckpt-5714
32.index...
Copying gs://cloud-training-demos/babyweight/trained_model_tuned/model.ckpt-5714
32.meta...
- [573/573 files][  6.0 GiB/  6.0 GiB] 100% Done
Operation completed over 573 objects/6.0 GiB.
```

In [8]:
```bash
%%bash
gsutil ls gs://${BUCKET}/babyweight/preproc/*-00000*
```

```
gs://qwiklabs-gcp-00-6779a77a27e3/babyweight/preproc/eval.csv-00000-of-00012
gs://qwiklabs-gcp-00-6779a77a27e3/babyweight/preproc/train.csv-00000-of-00043
```

Now that we have the TensorFlow code working on a subset of the data, we can package the TensorFlow code up as a Python module and train it on Cloud AI Platform.

Train on Cloud AI Platform

Training on Cloud AI Platform requires:

1. Making the code a Python package
2. Using gcloud to submit the training code to Cloud AI Platform

Ensure that the AI Platform API is enabled by going to this link.

Lab Task 1

The following code edits babyweight/trainer/task.py.

In [9]:
```python
%%writefile babyweight/trainer/task.py
import argparse
import json
```

```python
import os

from . import model

import tensorflow.compat.v1 as tf
tf.disable_v2_behavior()

if __name__ == '__main__':
    parser = argparse.ArgumentParser()
    parser.add_argument(
        '--bucket',
        help = 'GCS path to data. We assume that data is in gs://BUCKET/babyweig
        required = True
    )
    parser.add_argument(
        '--output_dir',
        help = 'GCS location to write checkpoints and export models',
        required = True
    )
    parser.add_argument(
        '--batch_size',
        help = 'Number of examples to compute gradient over.',
        type = int,
        default = 512
    )
    parser.add_argument(
        '--job-dir',
        help = 'this model ignores this field, but it is required by gcloud',
        default = 'junk'
    )
    parser.add_argument(
        '--nnsize',
        help = 'Hidden layer sizes to use for DNN feature columns -- provide spa
        nargs = '+',
        type = int,
        default=[128, 32, 4]
    )
    parser.add_argument(
        '--nembeds',
        help = 'Embedding size of a cross of n key real-valued parameters',
        type = int,
        default = 3
    )

    ## TODO 1: add the new arguments here
    parser.add_argument(
        '--train_examples',
        help = 'Number of examples (in thousands) to run the training job over.
        type = int,
        default = 5000
    )
    parser.add_argument(
        '--pattern',
        help = 'Specify a pattern that has to be in input files. For example 000
        default = 'of'
    )
    parser.add_argument(
        '--eval_steps',
        help = 'Positive number of steps for which to evaluate model. Default to
        type = int,
        default = None
```

```
    )

    ## parse all arguments
    args = parser.parse_args()
    arguments = args.__dict__

    # unused args provided by service
    arguments.pop('job_dir', None)
    arguments.pop('job-dir', None)

    ## assign the arguments to the model variables
    output_dir = arguments.pop('output_dir')
    model.BUCKET       = arguments.pop('bucket')
    model.BATCH_SIZE = arguments.pop('batch_size')
    model.TRAIN_STEPS = (arguments.pop('train_examples') * 100) / model.BATCH_SI
    model.EVAL_STEPS = arguments.pop('eval_steps')
    print ("Will train for {} steps using batch_size={}".format(model.TRAIN_STEP
    model.PATTERN = arguments.pop('pattern')
    model.NEMBEDS= arguments.pop('nembeds')
    model.NNSIZE = arguments.pop('nnsize')
    print ("Will use DNN size of {}".format(model.NNSIZE))

    # Append trial_id to path if we are doing hptuning
    # This code can be removed if you are not using hyperparameter tuning
    output_dir = os.path.join(
        output_dir,
        json.loads(
            os.environ.get('TF_CONFIG', '{}')
        ).get('task', {}).get('trial', '')
    )

    # Run the training job
    model.train_and_evaluate(output_dir)
```

Overwriting babyweight/trainer/task.py

Lab Task 2

The following code edits babyweight/trainer/model.py.

In [10]:
```
%%writefile babyweight/trainer/model.py
import shutil
import numpy as np

import tensorflow.compat.v1 as tf
tf.disable_v2_behavior()

tf.logging.set_verbosity(tf.logging.INFO)

BUCKET = None   # set from task.py
PATTERN = 'of' # gets all files

# Determine CSV, label, and key columns
CSV_COLUMNS = 'weight_pounds,is_male,mother_age,plurality,gestation_weeks,key'.s
LABEL_COLUMN = 'weight_pounds'
KEY_COLUMN = 'key'

# Set default values for each CSV column
DEFAULTS = [[0.0], ['null'], [0.0], ['null'], [0.0], ['nokey']]
```

```python
# Define some hyperparameters
TRAIN_STEPS = 10000
EVAL_STEPS = None
BATCH_SIZE = 512
NEMBEDS = 3
NNSIZE = [64, 16, 4]

# Create an input function reading a file using the Dataset API
# Then provide the results to the Estimator API
def read_dataset(prefix, mode, batch_size):
    def _input_fn():
        def decode_csv(value_column):
            columns = tf.decode_csv(value_column, record_defaults=DEFAULTS)
            features = dict(zip(CSV_COLUMNS, columns))
            label = features.pop(LABEL_COLUMN)
            return features, label

        # Use prefix to create file path
        file_path = 'gs://{}/babyweight/preproc/{}*{}*'.format(BUCKET, prefix, P

        # Create list of files that match pattern
        file_list = tf.gfile.Glob(file_path)

        # Create dataset from file list
        dataset = (tf.data.TextLineDataset(file_list)  # Read text file
                    .map(decode_csv))  # Transform each elem by applying decode_

        if mode == tf.estimator.ModeKeys.TRAIN:
            num_epochs = None # indefinitely
            dataset = dataset.shuffle(buffer_size = 10 * batch_size)
        else:
            num_epochs = 1 # end-of-input after this

        dataset = dataset.repeat(num_epochs).batch(batch_size)
        return dataset.make_one_shot_iterator().get_next()
    return _input_fn

# Define feature columns
def get_wide_deep():
    # Define column types
    is_male,mother_age,plurality,gestation_weeks = \
        [\
            tf.feature_column.categorical_column_with_vocabulary_list('is_male',
                        ['True', 'False', 'Unknown']),
            tf.feature_column.numeric_column('mother_age'),
            tf.feature_column.categorical_column_with_vocabulary_list('plurality
                        ['Single(1)', 'Twins(2)', 'Triplets(3)',
                         'Quadruplets(4)', 'Quintuplets(5)','Multiple(2+)']),
            tf.feature_column.numeric_column('gestation_weeks')
        ]

    # Discretize
    age_buckets = tf.feature_column.bucketized_column(mother_age,
                        boundaries=np.arange(15,45,1).tolist())
    gestation_buckets = tf.feature_column.bucketized_column(gestation_weeks,
                        boundaries=np.arange(17,47,1).tolist())

    # Sparse columns are wide, have a linear relationship with the output
    wide = [is_male,
            plurality,
```

```python
                    age_buckets,
                    gestation_buckets]

    # Feature cross all the wide columns and embed into a lower dimension
    crossed = tf.feature_column.crossed_column(wide, hash_bucket_size=20000)
    embed = tf.feature_column.embedding_column(crossed, NEMBEDS)

    # Continuous columns are deep, have a complex relationship with the output
    deep = [mother_age,
            gestation_weeks,
            embed]
    return wide, deep

# Create serving input function to be able to serve predictions later using prov
def serving_input_fn():
    feature_placeholders = {
        'is_male': tf.placeholder(tf.string, [None]),
        'mother_age': tf.placeholder(tf.float32, [None]),
        'plurality': tf.placeholder(tf.string, [None]),
        'gestation_weeks': tf.placeholder(tf.float32, [None]),
        KEY_COLUMN: tf.placeholder_with_default(tf.constant(['nokey']), [None])
    }
    features = {
        key: tf.expand_dims(tensor, -1)
        for key, tensor in feature_placeholders.items()
    }
    return tf.estimator.export.ServingInputReceiver(features, feature_placeholde

# create metric for hyperparameter tuning
def my_rmse(labels, predictions):
    pred_values = predictions['predictions']
    return {'rmse': tf.metrics.root_mean_squared_error(labels, pred_values)}

def forward_features(estimator, key):
    def new_model_fn(features, labels, mode, config):
        spec = estimator.model_fn(features, labels, mode, config)
        predictions = spec.predictions
        predictions[key] = features[key]
        spec = spec._replace(predictions=predictions)
        return spec
    return tf.estimator.Estimator(model_fn=new_model_fn, model_dir=estimator.mod

# Create estimator to train and evaluate
def train_and_evaluate(output_dir):
    tf.summary.FileWriterCache.clear() # ensure filewriter cache is clear for Te
    wide, deep = get_wide_deep()
    EVAL_INTERVAL = 300 # seconds

    ## TODO 2a: set the save_checkpoints_secs to the EVAL_INTERVAL
    run_config = tf.estimator.RunConfig(save_checkpoints_secs = EVAL_INTERVAL,
                                        keep_checkpoint_max = 3)

    ## TODO 2b: change the dnn_hidden_units to NNSIZE
    estimator = tf.estimator.DNNLinearCombinedRegressor(
        model_dir = output_dir,
        linear_feature_columns = wide,
        dnn_feature_columns = deep,
        dnn_hidden_units = NNSIZE,
        config = run_config)

    # illustrates how to add an extra metric
```

```python
        estimator = tf.estimator.add_metrics(estimator, my_rmse)
        # for batch prediction, you need a key associated with each instance
        estimator = forward_features(estimator, KEY_COLUMN)

        ## TODO 2c: Set the third argument of read_dataset to BATCH_SIZE
        ## TODO 2d: and set max_steps to TRAIN_STEPS
        train_spec = tf.estimator.TrainSpec(
            input_fn = read_dataset('train', tf.estimator.ModeKeys.TRAIN, BATCH_SIZE
            max_steps = TRAIN_STEPS)

        exporter = tf.estimator.LatestExporter('exporter', serving_input_fn, exports

        ## TODO 2e: Lastly, set steps equal to EVAL_STEPS
        eval_spec = tf.estimator.EvalSpec(
            input_fn = read_dataset('eval', tf.estimator.ModeKeys.EVAL, 2**15),  # n
            steps = EVAL_STEPS,
            start_delay_secs = 60, # start evaluating after N seconds
            throttle_secs = EVAL_INTERVAL,  # evaluate every N seconds
            exporters = exporter)
        tf.estimator.train_and_evaluate(estimator, train_spec, eval_spec)
```

```
Overwriting babyweight/trainer/model.py
```

Lab Task 3

After moving the code to a package, make sure it works standalone. (Note the --pattern and --train_examples lines so that I am not trying to boil the ocean on my laptop). Even then, this takes about **3 minutes** in which you won't see any output ...

In [11]:

```bash
%%bash
echo "bucket=${BUCKET}"
rm -rf babyweight_trained
export PYTHONPATH=${PYTHONPATH}:${PWD}/babyweight
python -m trainer.task \
   --bucket=${BUCKET} \
   --output_dir=babyweight_trained \
   --job-dir=./tmp \
   --pattern="00000-of-" --train_examples=1 --eval_steps=1
```

```
bucket=qwiklabs-gcp-00-6779a77a27e3
Will train for 0.1953125 steps using batch_size=512
Will use DNN size of [128, 32, 4]
WARNING:tensorflow:From /opt/conda/lib/python3.7/site-packages/tensorflow/pytho
n/compat/v2_compat.py:96: disable_resource_variables (from tensorflow.python.op
s.variable_scope) is deprecated and will be removed in a future version.
Instructions for updating:
non-resource variables are not supported in the long term
INFO:tensorflow:Using config: {'_model_dir': 'babyweight_trained/', '_tf_random_
seed': None, '_save_summary_steps': 100, '_save_checkpoints_steps': None, '_save
_checkpoints_secs': 300, '_session_config': allow_soft_placement: true
graph_options {
  rewrite_options {
    meta_optimizer_iterations: ONE
  }
}
, '_keep_checkpoint_max': 3, '_keep_checkpoint_every_n_hours': 10000, '_log_step
_count_steps': 100, '_train_distribute': None, '_device_fn': None, '_protocol':
```

None, '_eval_distribute': None, '_experimental_distribute': None, '_experimental
_max_worker_delay_secs': None, '_session_creation_timeout_secs': 7200, '_checkpo
int_save_graph_def': True, '_service': None, '_cluster_spec': ClusterSpec({}),
'_task_type': 'worker', '_task_id': 0, '_global_id_in_cluster': 0, '_master':
'', '_evaluation_master': '', '_is_chief': True, '_num_ps_replicas': 0, '_num_wo
rker_replicas': 1}
INFO:tensorflow:Using config: {'_model_dir': 'babyweight_trained/', '_tf_random_
seed': None, '_save_summary_steps': 100, '_save_checkpoints_steps': None, '_save
_checkpoints_secs': 300, '_session_config': allow_soft_placement: true
graph_options {
  rewrite_options {
    meta_optimizer_iterations: ONE
  }
}
, '_keep_checkpoint_max': 3, '_keep_checkpoint_every_n_hours': 10000, '_log_step
_count_steps': 100, '_train_distribute': None, '_device_fn': None, '_protocol':
None, '_eval_distribute': None, '_experimental_distribute': None, '_experimental
_max_worker_delay_secs': None, '_session_creation_timeout_secs': 7200, '_checkpo
int_save_graph_def': True, '_service': None, '_cluster_spec': ClusterSpec({}),
'_task_type': 'worker', '_task_id': 0, '_global_id_in_cluster': 0, '_master':
'', '_evaluation_master': '', '_is_chief': True, '_num_ps_replicas': 0, '_num_wo
rker_replicas': 1}
INFO:tensorflow:Using config: {'_model_dir': 'babyweight_trained/', '_tf_random_
seed': None, '_save_summary_steps': 100, '_save_checkpoints_steps': None, '_save
_checkpoints_secs': 300, '_session_config': allow_soft_placement: true
graph_options {
  rewrite_options {
    meta_optimizer_iterations: ONE
  }
}
, '_keep_checkpoint_max': 3, '_keep_checkpoint_every_n_hours': 10000, '_log_step
_count_steps': 100, '_train_distribute': None, '_device_fn': None, '_protocol':
None, '_eval_distribute': None, '_experimental_distribute': None, '_experimental
_max_worker_delay_secs': None, '_session_creation_timeout_secs': 7200, '_checkpo
int_save_graph_def': True, '_service': None, '_cluster_spec': ClusterSpec({}),
'_task_type': 'worker', '_task_id': 0, '_global_id_in_cluster': 0, '_master':
'', '_evaluation_master': '', '_is_chief': True, '_num_ps_replicas': 0, '_num_wo
rker_replicas': 1}
INFO:tensorflow:Not using Distribute Coordinator.
INFO:tensorflow:Running training and evaluation locally (non-distributed).
INFO:tensorflow:Start train and evaluate loop. The evaluate will happen after ev
ery checkpoint. Checkpoint frequency is determined based on RunConfig arguments:
save_checkpoints_steps None or save_checkpoints_secs 300.
WARNING:tensorflow:From /opt/conda/lib/python3.7/site-packages/tensorflow/pytho
n/training/training_util.py:236: Variable.initialized_value (from tensorflow.pyt
hon.ops.variables) is deprecated and will be removed in a future version.
Instructions for updating:
Use Variable.read_value. Variables in 2.X are initialized automatically both in
eager and graph (inside tf.defun) contexts.
WARNING:tensorflow:From /home/jupyter/training-data-analyst/courses/machine_lear
ning/deepdive/06_structured/babyweight/trainer/model.py:54: DatasetV1.make_one_s
hot_iterator (from tensorflow.python.data.ops.dataset_ops) is deprecated and wil
l be removed in a future version.
Instructions for updating:
This is a deprecated API that should only be used in TF 1 graph mode and legacy
TF 2 graph mode available through `tf.compat.v1`. In all other situations -- nam
ely, eager mode and inside `tf.function` -- you can consume dataset elements usi
ng `for elem in dataset: ...` or by explicitly creating iterator via `iterator =
iter(dataset)` and fetching its elements via `values = next(iterator)`. Furtherm
ore, this API is not available in TF 2. During the transition from TF 1 to TF 2
you can use `tf.compat.v1.data.make_one_shot_iterator(dataset)` to create a TF 1

graph mode style iterator for a dataset created through TF 2 APIs. Note that thi
s should be a transient state of your code base as there are in general no guara
ntees about the interoperability of TF 1 and TF 2 code.
INFO:tensorflow:Calling model_fn.
INFO:tensorflow:Calling model_fn.
INFO:tensorflow:Calling model_fn.
/opt/conda/lib/python3.7/site-packages/tensorflow/python/keras/engine/base_layer
_v1.py:1700: UserWarning: `layer.add_variable` is deprecated and will be removed
in a future version. Please use `layer.add_weight` method instead.
  warnings.warn('`layer.add_variable` is deprecated and '
WARNING:tensorflow:From /opt/conda/lib/python3.7/site-packages/tensorflow/pytho
n/training/adagrad.py:77: calling Constant.__init__ (from tensorflow.python.ops.
init_ops) with dtype is deprecated and will be removed in a future version.
Instructions for updating:
Call initializer instance with the dtype argument instead of passing it to the c
onstructor
INFO:tensorflow:Done calling model_fn.
INFO:tensorflow:Done calling model_fn.
INFO:tensorflow:Done calling model_fn.
INFO:tensorflow:Create CheckpointSaverHook.
INFO:tensorflow:Graph was finalized.
2021-08-31 16:53:56.121627: I tensorflow/core/common_runtime/process_util.cc:14
6] Creating new thread pool with default inter op setting: 2. Tune using inter_o
p_parallelism_threads for best performance.
2021-08-31 16:53:56.177689: I tensorflow/core/platform/profile_utils/cpu_utils.c
c:114] CPU Frequency: 2200140000 Hz
INFO:tensorflow:Running local_init_op.
INFO:tensorflow:Done running local_init_op.
INFO:tensorflow:Calling checkpoint listeners before saving checkpoint 0...
INFO:tensorflow:Saving checkpoints for 0 into babyweight_trained/model.ckpt.
INFO:tensorflow:Calling checkpoint listeners after saving checkpoint 0...
2021-08-31 16:53:58.164819: I tensorflow/compiler/mlir/mlir_graph_optimization_p
ass.cc:176] None of the MLIR Optimization Passes are enabled (registered 2)
INFO:tensorflow:loss = 24069.64, step = 1
INFO:tensorflow:Calling checkpoint listeners before saving checkpoint 1...
INFO:tensorflow:Saving checkpoints for 1 into babyweight_trained/model.ckpt.
INFO:tensorflow:Calling checkpoint listeners after saving checkpoint 1...
INFO:tensorflow:Calling model_fn.
INFO:tensorflow:Calling model_fn.
INFO:tensorflow:Calling model_fn.
INFO:tensorflow:Done calling model_fn.
INFO:tensorflow:Done calling model_fn.
INFO:tensorflow:Done calling model_fn.
INFO:tensorflow:Starting evaluation at 2021-08-31T16:53:59
INFO:tensorflow:Graph was finalized.
INFO:tensorflow:Restoring parameters from babyweight_trained/model.ckpt-1
INFO:tensorflow:Running local_init_op.
INFO:tensorflow:Done running local_init_op.
INFO:tensorflow:Evaluation [1/1]
INFO:tensorflow:Inference Time : 2.31714s
INFO:tensorflow:Finished evaluation at 2021-08-31-16:54:02
INFO:tensorflow:Saving dict for global step 1: average_loss = 46.444775, global_
step = 1, label/mean = 7.2588606, loss = 1521902.4, prediction/mean = 0.5954207,
rmse = 6.81504
INFO:tensorflow:Saving 'checkpoint_path' summary for global step 1: babyweight_t
rained/model.ckpt-1
INFO:tensorflow:Calling model_fn.
INFO:tensorflow:Calling model_fn.
INFO:tensorflow:Calling model_fn.
INFO:tensorflow:Done calling model_fn.
INFO:tensorflow:Done calling model_fn.

```
INFO:tensorflow:Done calling model_fn.
WARNING:tensorflow:From /opt/conda/lib/python3.7/site-packages/tensorflow/pytho
n/saved_model/signature_def_utils_impl.py:201: build_tensor_info (from tensorflo
w.python.saved_model.utils_impl) is deprecated and will be removed in a future v
ersion.
Instructions for updating:
This function will only be available through the v1 compatibility library as tf.
compat.v1.saved_model.utils.build_tensor_info or tf.compat.v1.saved_model.build_
tensor_info.
INFO:tensorflow:Signatures INCLUDED in export for Classify: None
INFO:tensorflow:Signatures INCLUDED in export for Regress: None
INFO:tensorflow:Signatures INCLUDED in export for Predict: ['predict']
INFO:tensorflow:Signatures INCLUDED in export for Train: None
INFO:tensorflow:Signatures INCLUDED in export for Eval: None
INFO:tensorflow:Signatures EXCLUDED from export because they cannot be served
via TensorFlow Serving APIs:
INFO:tensorflow:'serving_default' : Regression input must be a single string Ten
sor; got {'is_male': <tf.Tensor 'Placeholder:0' shape=(?,) dtype=string>, 'mothe
r_age': <tf.Tensor 'Placeholder_1:0' shape=(?,) dtype=float32>, 'plurality': <t
f.Tensor 'Placeholder_2:0' shape=(?,) dtype=string>, 'gestation_weeks': <tf.Tens
or 'Placeholder_3:0' shape=(?,) dtype=float32>, 'key': <tf.Tensor 'PlaceholderWi
thDefault:0' shape=(?,) dtype=string>}
INFO:tensorflow:'regression' : Regression input must be a single string Tensor;
got {'is_male': <tf.Tensor 'Placeholder:0' shape=(?,) dtype=string>, 'mother_ag
e': <tf.Tensor 'Placeholder_1:0' shape=(?,) dtype=float32>, 'plurality': <tf.Ten
sor 'Placeholder_2:0' shape=(?,) dtype=string>, 'gestation_weeks': <tf.Tensor 'P
laceholder_3:0' shape=(?,) dtype=float32>, 'key': <tf.Tensor 'PlaceholderWithDef
ault:0' shape=(?,) dtype=string>}
WARNING:tensorflow:Export includes no default signature!
INFO:tensorflow:Restoring parameters from babyweight_trained/model.ckpt-1
INFO:tensorflow:Assets added to graph.
INFO:tensorflow:No assets to write.
INFO:tensorflow:SavedModel written to: babyweight_trained/export/exporter/temp-1
630428842/saved_model.pb
INFO:tensorflow:Loss for final step: 24069.64.
```

Lab Task 4

The JSON below represents an input into your prediction model. Write the input.json file below
with the next cell, then run the prediction locally to assess whether it produces predictions
correctly.

In [12]:
```
%%writefile inputs.json
{"key": "b1", "is_male": "True", "mother_age": 26.0, "plurality": "Single(1)", "
{"key": "g1", "is_male": "False", "mother_age": 26.0, "plurality": "Single(1)",
```

```
Writing inputs.json
```

In [13]:
```
%%bash
sudo find "/usr/lib/google-cloud-sdk/lib/googlecloudsdk/command_lib/ml_engine" -
```

In [14]:
```
%%bash
MODEL_LOCATION=$(ls -d $(pwd)/babyweight_trained/export/exporter/* | tail -1)
echo $MODEL_LOCATION1
gcloud ai-platform local predict --model-dir=$MODEL_LOCATION --json-instances=in
```

```
PREDICTIONS
[0.5062568783760071]
[0.5051468014717102]
```

If the signature defined in the model is not serving_default then you must speci
fy it via --signature-name flag, otherwise the command may fail.
WARNING: WARNING:tensorflow:From /opt/conda/lib/python3.7/site-packages/tensorfl
ow/python/compat/v2_compat.py:96: disable_resource_variables (from tensorflow.py
thon.ops.variable_scope) is deprecated and will be removed in a future version.
Instructions for updating:
non-resource variables are not supported in the long term
2021-08-31 16:55:25.387144: I tensorflow/core/common_runtime/process_util.cc:14
6] Creating new thread pool with default inter op setting: 2. Tune using inter_o
p_parallelism_threads for best performance.
WARNING:tensorflow:From /usr/lib/google-cloud-sdk/lib/third_party/ml_sdk/cloud/m
l/prediction/frameworks/tf_prediction_lib.py:236: load (from tensorflow.python.s
aved_model.loader_impl) is deprecated and will be removed in a future version.
Instructions for updating:
This function will only be available through the v1 compatibility library as tf.
compat.v1.saved_model.loader.load or tf.compat.v1.saved_model.load. There will b
e a new function for importing SavedModels in Tensorflow 2.0.
WARNING:tensorflow:From /usr/lib/google-cloud-sdk/lib/third_party/ml_sdk/cloud/m
l/prediction/frameworks/tf_prediction_lib.py:236: load (from tensorflow.python.s
aved_model.loader_impl) is deprecated and will be removed in a future version.
Instructions for updating:
This function will only be available through the v1 compatibility library as tf.
compat.v1.saved_model.loader.load or tf.compat.v1.saved_model.load. There will b
e a new function for importing SavedModels in Tensorflow 2.0.
2021-08-31 16:55:25.559908: I tensorflow/core/platform/profile_utils/cpu_utils.c
c:114] CPU Frequency: 2200140000 Hz

Lab Task 5

Once the code works in standalone mode, you can run it on Cloud AI Platform. Because this is on the entire dataset, it will take a while. The training run took about **two hours** for me. You can monitor the job from the GCP console in the Cloud AI Platform section.

In [17]:

```bash
%%bash
OUTDIR=gs://${BUCKET}/babyweight/trained_model
JOBNAME=babyweight_$(date -u +%y%m%d_%H%M%S)
echo $OUTDIR $REGION $JOBNAME
gsutil -m rm -rf $OUTDIR
gcloud ai-platform jobs submit training $JOBNAME \
  --region=$REGION \
  --module-name=trainer.task \
  --package-path=$(pwd)/babyweight/trainer \
  --job-dir=$OUTDIR \
  --staging-bucket=gs://$BUCKET \
  --scale-tier=STANDARD_1 \
  --runtime-version=2.4 \
  --python-version=3.7 \
  -- \
  --bucket=${BUCKET} \
  --output_dir=${OUTDIR} \
  --train_examples=20000
```

```
gs://qwiklabs-gcp-00-6779a77a27e3/babyweight/trained_model us-central1 babyweigh
t_210831_170241
```

```
jobId: babyweight_210831_170241
state: QUEUED
```

```
CommandException: 1 files/objects could not be removed.
Job [babyweight_210831_170241] submitted successfully.
Your job is still active. You may view the status of your job with the command

  $ gcloud ai-platform jobs describe babyweight_210831_170241

or continue streaming the logs with the command

  $ gcloud ai-platform jobs stream-logs babyweight_210831_170241
```

When I ran it, I used train_examples=20000. When training finished, I filtered in the Stackdriver log on the word "dict" and saw that the last line was:

```
Saving dict for global step 5714290: average_loss = 1.06473,
global_step = 5714290, loss = 34882.4, rmse = 1.03186
```

The final RMSE was 1.03 pounds.

Repeat training

This time with tuned parameters (note last line)

In [18]:
```bash
%%bash
OUTDIR=gs://${BUCKET}/babyweight/trained_model_tuned
JOBNAME=babyweight_$(date -u +%y%m%d_%H%M%S)
echo $OUTDIR $REGION $JOBNAME
gsutil -m rm -rf $OUTDIR
gcloud ai-platform jobs submit training $JOBNAME \
  --region=$REGION \
  --module-name=trainer.task \
  --package-path=$(pwd)/babyweight/trainer \
  --job-dir=$OUTDIR \
  --staging-bucket=gs://$BUCKET \
  --scale-tier=STANDARD_1 \
  --runtime-version=2.4 \
  --python-version=3.7 \
  -- \
  --bucket=${BUCKET} \
  --output_dir=${OUTDIR} \
  --train_examples=2000 --batch_size=35 --nembeds=16 --nnsize=281
```

```
gs://qwiklabs-gcp-00-6779a77a27e3/babyweight/trained_model_tuned us-central1 bab
yweight_210831_170323
jobId: babyweight_210831_170323
state: QUEUED
```

```
CommandException: 1 files/objects could not be removed.
Job [babyweight_210831_170323] submitted successfully.
Your job is still active. You may view the status of your job with the command

  $ gcloud ai-platform jobs describe babyweight_210831_170323

or continue streaming the logs with the command

  $ gcloud ai-platform jobs stream-logs babyweight_210831_170323
```

In [19]:

```
  File "<ipython-input-19-43b1eaa568c6>", line 1
    gcloud ai-platform jobs stream-logs babyweight_210831_170323
           ^
SyntaxError: invalid syntax
```

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