Neural Network

Learning Objectives:

- Use the `DNNRegressor` class in TensorFlow to predict median housing price

The data is based on 1990 census data from California. This data is at the city block level, so these features reflect the total number of rooms in that block, or the total number of people who live on that block, respectively.

Let's use a set of features to predict house value.

Set Up

In this first cell, we'll load the necessary libraries.

In [1]:

```
import math
import shutil
import numpy as np
import pandas as pd
import tensorflow as tf

tf.logging.set_verbosity(tf.logging.INFO)
pd.options.display.max_rows = 10
pd.options.display.float_format = '{:.1f}'.format
```

Next, we'll load our data set.

In [2]:

```
df = pd.read_csv("https://storage.googleapis.com/ml_universities/california_hous
ing_train.csv", sep=",")
```

Examine the data

It's a good idea to get to know your data a little bit before you work with it.

We'll print out a quick summary of a few useful statistics on each column.

This will include things like mean, standard deviation, max, min, and various quantiles.

In [3]:

```
df.head()
```

Out[3]:

	longitude	latitude	housing_median_age	total_rooms	total_bedrooms	population	househo
0	-114.3	34.2	15.0	5612.0	1283.0	1015.0	47
1	-114.5	34.4	19.0	7650.0	1901.0	1129.0	46
2	-114.6	33.7	17.0	720.0	174.0	333.0	11
3	-114.6	33.6	14.0	1501.0	337.0	515.0	22
4	-114.6	33.6	20.0	1454.0	326.0	624.0	26

In [4]:

```
df.describe()
```

Out[4]:

	longitude	latitude	housing_median_age	total_rooms	total_bedrooms	population	hou
count	17000.0	17000.0	17000.0	17000.0	17000.0	17000.0	
mean	-119.6	35.6	28.6	2643.7	539.4	1429.6	
std	2.0	2.1	12.6	2179.9	421.5	1147.9	
min	-124.3	32.5	1.0	2.0	1.0	3.0	
25%	-121.8	33.9	18.0	1462.0	297.0	790.0	
50%	-118.5	34.2	29.0	2127.0	434.0	1167.0	
75%	-118.0	37.7	37.0	3151.2	648.2	1721.0	
max	-114.3	42.0	52.0	37937.0	6445.0	35682.0	

This data is at the city block level, so these features reflect the total number of rooms in that block, or the total number of people who live on that block, respectively. Let's create a different, more appropriate feature. Because we are predicing the price of a single house, we should try to make all our features correspond to a single house as well

In [5]:

```
df['num_rooms'] = df['total_rooms'] / df['households']
df['num_bedrooms'] = df['total_bedrooms'] / df['households']
df['persons_per_house'] = df['population'] / df['households']
df.describe()
```

Out[5]:

	longitude	latitude	housing_median_age	total_rooms	total_bedrooms	population	hou
count	17000.0	17000.0	17000.0	17000.0	17000.0	17000.0	
mean	-119.6	35.6	28.6	2643.7	539.4	1429.6	
std	2.0	2.1	12.6	2179.9	421.5	1147.9	
min	-124.3	32.5	1.0	2.0	1.0	3.0	
25%	-121.8	33.9	18.0	1462.0	297.0	790.0	
50%	-118.5	34.2	29.0	2127.0	434.0	1167.0	
75%	-118.0	37.7	37.0	3151.2	648.2	1721.0	
max	-114.3	42.0	52.0	37937.0	6445.0	35682.0	

In [6]:

```
df.drop(['total_rooms', 'total_bedrooms', 'population', 'households'], axis = 1,
inplace = True)
df.describe()
```

Out[6]:

	longitude	latitude	housing_median_age	median_income	median_house_value	num_ro
count	17000.0	17000.0	17000.0	17000.0	17000.0	170
mean	-119.6	35.6	28.6	3.9	207300.9	
std	2.0	2.1	12.6	1.9	115983.8	
min	-124.3	32.5	1.0	0.5	14999.0	
25%	-121.8	33.9	18.0	2.6	119400.0	
50%	-118.5	34.2	29.0	3.5	180400.0	
75%	-118.0	37.7	37.0	4.8	265000.0	
max	-114.3	42.0	52.0	15.0	500001.0	1

Build a neural network model

In this exercise, we'll be trying to predict `median_house_value` . It will be our label (sometimes also called a target). We'll use the remaining columns as our input features.

To train our model, we'll first use the LinearRegressor (https://www.tensorflow.org/api_docs/python/tf/contrib/learn/LinearRegressor) interface. Then, we'll change to DNNRegressor

In [7]:

```
featcols = {
  colname : tf.feature_column.numeric_column(colname) \
    for colname in 'housing_median_age,median_income,num_rooms,num_bedrooms,pers
ons_per_house'.split(',')
}
# Bucketize lat, lon so it's not so high-res; California is mostly N-S, so more
 lats than lons
featcols['longitude'] = tf.feature_column.bucketized_column(tf.feature_column.nu
meric_column('longitude'),
                                                   np.linspace(-124.3, -114.3, 5
).tolist())
featcols['latitude'] = tf.feature_column.bucketized_column(tf.feature_column.num
eric_column('latitude'),
                                                  np.linspace(32.5, 42, 10).toli
st())
```

In [9]:

```
featcols.keys()
featcols['latitude']
```

Out[9]:

```
BucketizedColumn(source_column=NumericColumn(key='latitude', shape=
(1,), default_value=None, dtype=tf.float32, normalizer_fn=None), bou
ndaries=(32.5, 33.55555555555556, 34.611111111111114, 35.66666666666
6664, 36.72222222222222, 37.77777777777778, 38.833333333333336, 39.8
88888888888886, 40.94444444444444, 42.0))
```

In [10]:

```
# Split into train and eval
msk = np.random.rand(len(df)) < 0.8
traindf = df[msk]
evaldf = df[~msk]

SCALE = 100000
BATCH_SIZE= 100
OUTDIR = './housing_trained'
train_input_fn = tf.estimator.inputs.pandas_input_fn(x = traindf[list(featcols.k
eys())],
                                                    y = traindf["median_house_va
lue"] / SCALE,
                                                    num_epochs = None,
                                                    batch_size = BATCH_SIZE,
                                                    shuffle = True)
eval_input_fn = tf.estimator.inputs.pandas_input_fn(x = evaldf[list(featcols.key
s())],
                                                    y = evaldf["median_house_val
ue"] / SCALE,  # note the scaling
                                                    num_epochs = 1,
                                                    batch_size = len(evaldf),
                                                    shuffle=False)
```

In [11]:

```
# Linear Regressor
def train_and_evaluate(output_dir, num_train_steps):
  myopt = tf.train.FtrlOptimizer(learning_rate = 0.01) # note the learning rate
  estimator = tf.estimator.LinearRegressor(
                     model_dir = output_dir,
                     feature_columns = featcols.values(),
                     optimizer = myopt)

  #Add rmse evaluation metric
  def rmse(labels, predictions):
    pred_values = tf.cast(predictions['predictions'],tf.float64)
    return {'rmse': tf.metrics.root_mean_squared_error(labels*SCALE, pred_values
*SCALE)}
  estimator = tf.contrib.estimator.add_metrics(estimator,rmse)

  train_spec=tf.estimator.TrainSpec(
                     input_fn = train_input_fn,
                     max_steps = num_train_steps)
  eval_spec=tf.estimator.EvalSpec(
                     input_fn = eval_input_fn,
                     steps = None,
                     start_delay_secs = 1, # start evaluating after N seconds
                     throttle_secs = 10,  # evaluate every N seconds
                     )
  tf.estimator.train_and_evaluate(estimator, train_spec, eval_spec)

# Run training
shutil.rmtree(OUTDIR, ignore_errors = True) # start fresh each time
train_and_evaluate(OUTDIR, num_train_steps = (100 * len(traindf)) / BATCH_SIZE)
```

```
INFO:tensorflow:Using default config.
INFO:tensorflow:Using config: {'_model_dir': './housing_trained', '_
tf_random_seed': None, '_save_summary_steps': 100, '_save_checkpoint
s_steps': None, '_save_checkpoints_secs': 600, '_session_config': al
low_soft_placement: true
graph_options {
  rewrite_options {
    meta_optimizer_iterations: ONE
  }
}
, '_keep_checkpoint_max': 5, '_keep_checkpoint_every_n_hours': 1000
0, '_log_step_count_steps': 100, '_train_distribute': None, '_device
_fn': None, '_protocol': None, '_eval_distribute': None, '_experimen
tal_distribute': None, '_experimental_max_worker_delay_secs': None,
'_session_creation_timeout_secs': 7200, '_service': None, '_cluster_
spec': <tensorflow.python.training.server_lib.ClusterSpec object at
0x7ff0ed3315d0>, '_task_type': 'worker', '_task_id': 0, '_global_id_
in_cluster': 0, '_master': '', '_evaluation_master': '', '_is_chie
f': True, '_num_ps_replicas': 0, '_num_worker_replicas': 1}
WARNING:tensorflow:
The TensorFlow contrib module will not be included in TensorFlow 2.
0.
For more information, please see:
  * https://github.com/tensorflow/community/blob/master/rfcs/2018090
7-contrib-sunset.md
  * https://github.com/tensorflow/addons
  * https://github.com/tensorflow/io (for I/O related ops)
If you depend on functionality not listed there, please file an issu
e.

INFO:tensorflow:Using config: {'_model_dir': './housing_trained', '_
tf_random_seed': None, '_save_summary_steps': 100, '_save_checkpoint
s_steps': None, '_save_checkpoints_secs': 600, '_session_config': al
low_soft_placement: true
graph_options {
  rewrite_options {
    meta_optimizer_iterations: ONE
  }
}
, '_keep_checkpoint_max': 5, '_keep_checkpoint_every_n_hours': 1000
0, '_log_step_count_steps': 100, '_train_distribute': None, '_device
_fn': None, '_protocol': None, '_eval_distribute': None, '_experimen
tal_distribute': None, '_experimental_max_worker_delay_secs': None,
'_session_creation_timeout_secs': 7200, '_service': None, '_cluster_
spec': <tensorflow.python.training.server_lib.ClusterSpec object at
0x7ff0e8204a50>, '_task_type': 'worker', '_task_id': 0, '_global_id_
in_cluster': 0, '_master': '', '_evaluation_master': '', '_is_chie
f': True, '_num_ps_replicas': 0, '_num_worker_replicas': 1}
INFO:tensorflow:Not using Distribute Coordinator.
INFO:tensorflow:Running training and evaluation locally (non-distrib
uted).
INFO:tensorflow:Start train and evaluate loop. The evaluate will hap
pen after every checkpoint. Checkpoint frequency is determined based
on RunConfig arguments: save_checkpoints_steps None or save_checkpoi
nts_secs 600.
WARNING:tensorflow:From /opt/conda/lib/python3.7/site-packages/tenso
rflow_core/python/training/training_util.py:236: Variable.initialize
d_value (from tensorflow.python.ops.variables) is deprecated and wil
l be removed in a future version.
Instructions for updating:
Use Variable.read_value. Variables in 2.X are initialized automatica
```

```
lly both in eager and graph (inside tf.defun) contexts.
WARNING:tensorflow:From /opt/conda/lib/python3.7/site-packages/tenso
rflow_estimator/python/estimator/inputs/queues/feeding_queue_runner.
py:62: QueueRunner.__init__ (from tensorflow.python.training.queue_r
unner_impl) is deprecated and will be removed in a future version.
Instructions for updating:
To construct input pipelines, use the `tf.data` module.
WARNING:tensorflow:From /opt/conda/lib/python3.7/site-packages/tenso
rflow_estimator/python/estimator/inputs/queues/feeding_functions.py:
500: add_queue_runner (from tensorflow.python.training.queue_runner_
impl) is deprecated and will be removed in a future version.
Instructions for updating:
To construct input pipelines, use the `tf.data` module.
INFO:tensorflow:Calling model_fn.
INFO:tensorflow:Calling model_fn.
WARNING:tensorflow:From /opt/conda/lib/python3.7/site-packages/tenso
rflow_core/python/feature_column/feature_column_v2.py:305: Layer.add
_variable (from tensorflow.python.keras.engine.base_layer) is deprec
ated and will be removed in a future version.
Instructions for updating:
Please use `layer.add_weight` method instead.
WARNING:tensorflow:From /opt/conda/lib/python3.7/site-packages/tenso
rflow_core/python/ops/resource_variable_ops.py:1630: calling BaseRes
ourceVariable.__init__ (from tensorflow.python.ops.resource_variable
_ops) with constraint is deprecated and will be removed in a future
version.
Instructions for updating:
If using Keras pass *_constraint arguments to layers.
WARNING:tensorflow:From /opt/conda/lib/python3.7/site-packages/tenso
rflow_core/python/ops/embedding_ops.py:802: where (from tensorflow.p
ython.ops.array_ops) is deprecated and will be removed in a future v
ersion.
Instructions for updating:
Use tf.where in 2.0, which has the same broadcast rule as np.where
WARNING:tensorflow:From /opt/conda/lib/python3.7/site-packages/tenso
rflow_estimator/python/estimator/canned/linear.py:308: to_float (fro
m tensorflow.python.ops.math_ops) is deprecated and will be removed
in a future version.
Instructions for updating:
Use `tf.cast` instead.
INFO:tensorflow:Done calling model_fn.
INFO:tensorflow:Done calling model_fn.
INFO:tensorflow:Create CheckpointSaverHook.
INFO:tensorflow:Graph was finalized.
INFO:tensorflow:Running local_init_op.
INFO:tensorflow:Done running local_init_op.
WARNING:tensorflow:From /opt/conda/lib/python3.7/site-packages/tenso
rflow_core/python/training/monitored_session.py:882: start_queue_run
ners (from tensorflow.python.training.queue_runner_impl) is deprecat
ed and will be removed in a future version.
Instructions for updating:
To construct input pipelines, use the `tf.data` module.
INFO:tensorflow:Saving checkpoints for 0 into ./housing_trained/mode
l.ckpt.
INFO:tensorflow:loss = 280.96304, step = 1
INFO:tensorflow:global_step/sec: 98.9632
INFO:tensorflow:loss = 37.341797, step = 101 (1.012 sec)
INFO:tensorflow:global_step/sec: 205.908
INFO:tensorflow:loss = 138.82439, step = 201 (0.486 sec)
INFO:tensorflow:global_step/sec: 215.106
INFO:tensorflow:loss = 74.890945, step = 301 (0.468 sec)
```

```
INFO:tensorflow:global_step/sec: 216.905
INFO:tensorflow:loss = 84.91804, step = 401 (0.461 sec)
INFO:tensorflow:global_step/sec: 208.216
INFO:tensorflow:loss = 48.68508, step = 501 (0.480 sec)
INFO:tensorflow:global_step/sec: 208.345
INFO:tensorflow:loss = 40.589188, step = 601 (0.480 sec)
INFO:tensorflow:global_step/sec: 215.792
INFO:tensorflow:loss = 83.4557, step = 701 (0.460 sec)
INFO:tensorflow:global_step/sec: 170.434
INFO:tensorflow:loss = 57.208115, step = 801 (0.587 sec)
INFO:tensorflow:global_step/sec: 157.488
INFO:tensorflow:loss = 99.56625, step = 901 (0.636 sec)
INFO:tensorflow:global_step/sec: 169.021
INFO:tensorflow:loss = 52.7799, step = 1001 (0.592 sec)
INFO:tensorflow:global_step/sec: 198.004
INFO:tensorflow:loss = 46.890377, step = 1101 (0.506 sec)
INFO:tensorflow:global_step/sec: 168.619
INFO:tensorflow:loss = 35.558384, step = 1201 (0.592 sec)
INFO:tensorflow:global_step/sec: 183.729
INFO:tensorflow:loss = 185.43806, step = 1301 (0.545 sec)
INFO:tensorflow:global_step/sec: 199.033
INFO:tensorflow:loss = 40.429363, step = 1401 (0.504 sec)
INFO:tensorflow:global_step/sec: 166.257
INFO:tensorflow:loss = 101.82257, step = 1501 (0.602 sec)
INFO:tensorflow:global_step/sec: 212.017
INFO:tensorflow:loss = 44.141396, step = 1601 (0.470 sec)
INFO:tensorflow:global_step/sec: 205.468
INFO:tensorflow:loss = 92.66247, step = 1701 (0.490 sec)
INFO:tensorflow:global_step/sec: 208.824
INFO:tensorflow:loss = 87.76566, step = 1801 (0.477 sec)
INFO:tensorflow:global_step/sec: 199.669
INFO:tensorflow:loss = 83.1091, step = 1901 (0.500 sec)
INFO:tensorflow:global_step/sec: 208.115
INFO:tensorflow:loss = 49.541992, step = 2001 (0.482 sec)
INFO:tensorflow:global_step/sec: 198.714
INFO:tensorflow:loss = 38.995354, step = 2101 (0.501 sec)
INFO:tensorflow:global_step/sec: 198.34
INFO:tensorflow:loss = 45.77079, step = 2201 (0.505 sec)
INFO:tensorflow:global_step/sec: 206.419
INFO:tensorflow:loss = 50.261505, step = 2301 (0.486 sec)
INFO:tensorflow:global_step/sec: 208.534
INFO:tensorflow:loss = 66.51413, step = 2401 (0.477 sec)
INFO:tensorflow:global_step/sec: 192.811
INFO:tensorflow:loss = 50.580185, step = 2501 (0.520 sec)
INFO:tensorflow:global_step/sec: 199.693
INFO:tensorflow:loss = 56.082394, step = 2601 (0.499 sec)
INFO:tensorflow:global_step/sec: 195.698
INFO:tensorflow:loss = 38.28579, step = 2701 (0.512 sec)
INFO:tensorflow:global_step/sec: 148.644
INFO:tensorflow:loss = 121.9546, step = 2801 (0.670 sec)
INFO:tensorflow:global_step/sec: 153.679
INFO:tensorflow:loss = 48.453915, step = 2901 (0.654 sec)
INFO:tensorflow:global_step/sec: 151.307
INFO:tensorflow:loss = 113.81612, step = 3001 (0.659 sec)
INFO:tensorflow:global_step/sec: 145.714
INFO:tensorflow:loss = 36.33902, step = 3101 (0.686 sec)
INFO:tensorflow:global_step/sec: 145.214
INFO:tensorflow:loss = 41.72056, step = 3201 (0.690 sec)
INFO:tensorflow:global_step/sec: 144.844
INFO:tensorflow:loss = 112.02942, step = 3301 (0.690 sec)
INFO:tensorflow:global_step/sec: 143.948
```

```
INFO:tensorflow:loss = 81.80106, step = 3401 (0.695 sec)
INFO:tensorflow:global_step/sec: 165.876
INFO:tensorflow:loss = 74.10971, step = 3501 (0.602 sec)
INFO:tensorflow:global_step/sec: 198.052
INFO:tensorflow:loss = 44.169064, step = 3601 (0.506 sec)
INFO:tensorflow:global_step/sec: 200.919
INFO:tensorflow:loss = 30.744205, step = 3701 (0.495 sec)
INFO:tensorflow:global_step/sec: 192.224
INFO:tensorflow:loss = 40.090336, step = 3801 (0.521 sec)
INFO:tensorflow:global_step/sec: 157.956
INFO:tensorflow:loss = 71.27026, step = 3901 (0.633 sec)
INFO:tensorflow:global_step/sec: 192.874
INFO:tensorflow:loss = 36.61305, step = 4001 (0.518 sec)
INFO:tensorflow:global_step/sec: 189.754
INFO:tensorflow:loss = 62.671944, step = 4101 (0.528 sec)
INFO:tensorflow:global_step/sec: 196.481
INFO:tensorflow:loss = 35.295628, step = 4201 (0.510 sec)
INFO:tensorflow:global_step/sec: 202.107
INFO:tensorflow:loss = 66.82616, step = 4301 (0.494 sec)
INFO:tensorflow:global_step/sec: 186.611
INFO:tensorflow:loss = 58.215637, step = 4401 (0.537 sec)
INFO:tensorflow:global_step/sec: 194.097
INFO:tensorflow:loss = 81.31148, step = 4501 (0.514 sec)
INFO:tensorflow:global_step/sec: 176.383
INFO:tensorflow:loss = 87.33237, step = 4601 (0.564 sec)
INFO:tensorflow:global_step/sec: 167.149
INFO:tensorflow:loss = 42.050606, step = 4701 (0.599 sec)
INFO:tensorflow:global_step/sec: 182.333
INFO:tensorflow:loss = 92.98477, step = 4801 (0.551 sec)
INFO:tensorflow:global_step/sec: 186.371
INFO:tensorflow:loss = 61.73271, step = 4901 (0.540 sec)
INFO:tensorflow:global_step/sec: 191.172
INFO:tensorflow:loss = 33.46472, step = 5001 (0.519 sec)
INFO:tensorflow:global_step/sec: 190.866
INFO:tensorflow:loss = 48.513287, step = 5101 (0.524 sec)
INFO:tensorflow:global_step/sec: 175.903
INFO:tensorflow:loss = 42.4703, step = 5201 (0.571 sec)
INFO:tensorflow:global_step/sec: 192.457
INFO:tensorflow:loss = 39.125774, step = 5301 (0.514 sec)
INFO:tensorflow:global_step/sec: 196.027
INFO:tensorflow:loss = 101.73189, step = 5401 (0.510 sec)
INFO:tensorflow:global_step/sec: 189.959
INFO:tensorflow:loss = 49.56382, step = 5501 (0.532 sec)
INFO:tensorflow:global_step/sec: 177.33
INFO:tensorflow:loss = 120.18093, step = 5601 (0.564 sec)
INFO:tensorflow:global_step/sec: 178.125
INFO:tensorflow:loss = 23.887138, step = 5701 (0.560 sec)
INFO:tensorflow:global_step/sec: 161.963
INFO:tensorflow:loss = 60.37861, step = 5801 (0.616 sec)
INFO:tensorflow:global_step/sec: 134.557
INFO:tensorflow:loss = 77.99225, step = 5901 (0.742 sec)
INFO:tensorflow:global_step/sec: 141.674
INFO:tensorflow:loss = 71.670265, step = 6001 (0.706 sec)
INFO:tensorflow:global_step/sec: 141.054
INFO:tensorflow:loss = 62.109695, step = 6101 (0.709 sec)
INFO:tensorflow:global_step/sec: 137.938
INFO:tensorflow:loss = 37.47288, step = 6201 (0.726 sec)
INFO:tensorflow:global_step/sec: 147.258
INFO:tensorflow:loss = 50.953476, step = 6301 (0.678 sec)
INFO:tensorflow:global_step/sec: 144.96
INFO:tensorflow:loss = 34.984913, step = 6401 (0.691 sec)
```

```
INFO:tensorflow:global_step/sec: 135.889
INFO:tensorflow:loss = 64.07961, step = 6501 (0.735 sec)
INFO:tensorflow:global_step/sec: 140.075
INFO:tensorflow:loss = 36.273823, step = 6601 (0.715 sec)
INFO:tensorflow:global_step/sec: 145.306
INFO:tensorflow:loss = 37.723106, step = 6701 (0.687 sec)
INFO:tensorflow:global_step/sec: 146.666
INFO:tensorflow:loss = 34.681675, step = 6801 (0.683 sec)
INFO:tensorflow:global_step/sec: 144.445
INFO:tensorflow:loss = 122.63486, step = 6901 (0.692 sec)
INFO:tensorflow:global_step/sec: 144.667
INFO:tensorflow:loss = 55.770554, step = 7001 (0.691 sec)
INFO:tensorflow:global_step/sec: 148.906
INFO:tensorflow:loss = 103.35977, step = 7101 (0.674 sec)
INFO:tensorflow:global_step/sec: 154.466
INFO:tensorflow:loss = 32.182716, step = 7201 (0.648 sec)
INFO:tensorflow:global_step/sec: 144.713
INFO:tensorflow:loss = 48.218616, step = 7301 (0.688 sec)
INFO:tensorflow:global_step/sec: 147.16
INFO:tensorflow:loss = 84.51394, step = 7401 (0.677 sec)
INFO:tensorflow:global_step/sec: 142.252
INFO:tensorflow:loss = 50.21634, step = 7501 (0.709 sec)
INFO:tensorflow:global_step/sec: 170.176
INFO:tensorflow:loss = 73.654144, step = 7601 (0.585 sec)
INFO:tensorflow:global_step/sec: 199.324
INFO:tensorflow:loss = 37.09095, step = 7701 (0.499 sec)
INFO:tensorflow:global_step/sec: 189.855
INFO:tensorflow:loss = 26.351679, step = 7801 (0.526 sec)
INFO:tensorflow:global_step/sec: 183.556
INFO:tensorflow:loss = 49.2987, step = 7901 (0.548 sec)
INFO:tensorflow:global_step/sec: 187.107
INFO:tensorflow:loss = 76.27788, step = 8001 (0.537 sec)
INFO:tensorflow:global_step/sec: 178.951
INFO:tensorflow:loss = 65.55019, step = 8101 (0.555 sec)
INFO:tensorflow:global_step/sec: 189.828
INFO:tensorflow:loss = 55.7463, step = 8201 (0.528 sec)
INFO:tensorflow:global_step/sec: 176.807
INFO:tensorflow:loss = 47.76826, step = 8301 (0.565 sec)
INFO:tensorflow:global_step/sec: 143.298
INFO:tensorflow:loss = 80.15339, step = 8401 (0.699 sec)
INFO:tensorflow:global_step/sec: 142.63
INFO:tensorflow:loss = 47.304966, step = 8501 (0.699 sec)
INFO:tensorflow:global_step/sec: 153.534
INFO:tensorflow:loss = 101.237305, step = 8601 (0.653 sec)
INFO:tensorflow:global_step/sec: 194.393
INFO:tensorflow:loss = 47.63526, step = 8701 (0.514 sec)
INFO:tensorflow:global_step/sec: 186.884
INFO:tensorflow:loss = 38.648094, step = 8801 (0.535 sec)
INFO:tensorflow:global_step/sec: 198.72
INFO:tensorflow:loss = 94.90635, step = 8901 (0.504 sec)
INFO:tensorflow:global_step/sec: 193.553
INFO:tensorflow:loss = 66.477165, step = 9001 (0.516 sec)
INFO:tensorflow:global_step/sec: 205.131
INFO:tensorflow:loss = 56.034027, step = 9101 (0.486 sec)
INFO:tensorflow:global_step/sec: 172.76
INFO:tensorflow:loss = 50.190216, step = 9201 (0.580 sec)
INFO:tensorflow:global_step/sec: 195.129
INFO:tensorflow:loss = 38.163383, step = 9301 (0.512 sec)
INFO:tensorflow:global_step/sec: 186.2
INFO:tensorflow:loss = 51.45892, step = 9401 (0.536 sec)
INFO:tensorflow:global_step/sec: 194.804
```

```
INFO:tensorflow:loss = 102.869774, step = 9501 (0.514 sec)
INFO:tensorflow:global_step/sec: 197.121
INFO:tensorflow:loss = 44.12163, step = 9601 (0.507 sec)
INFO:tensorflow:global_step/sec: 185.632
INFO:tensorflow:loss = 75.14987, step = 9701 (0.539 sec)
INFO:tensorflow:global_step/sec: 188.336
INFO:tensorflow:loss = 36.476074, step = 9801 (0.532 sec)
INFO:tensorflow:global_step/sec: 175.859
INFO:tensorflow:loss = 88.33611, step = 9901 (0.568 sec)
INFO:tensorflow:global_step/sec: 158.93
INFO:tensorflow:loss = 68.801476, step = 10001 (0.628 sec)
INFO:tensorflow:global_step/sec: 143.698
INFO:tensorflow:loss = 88.13605, step = 10101 (0.700 sec)
INFO:tensorflow:global_step/sec: 142.951
INFO:tensorflow:loss = 48.23278, step = 10201 (0.697 sec)
INFO:tensorflow:global_step/sec: 146.153
INFO:tensorflow:loss = 36.445267, step = 10301 (0.680 sec)
INFO:tensorflow:global_step/sec: 144.075
INFO:tensorflow:loss = 33.726665, step = 10401 (0.694 sec)
INFO:tensorflow:global_step/sec: 144.28
INFO:tensorflow:loss = 49.21405, step = 10501 (0.693 sec)
INFO:tensorflow:global_step/sec: 151.52
INFO:tensorflow:loss = 63.831974, step = 10601 (0.660 sec)
INFO:tensorflow:global_step/sec: 152.029
INFO:tensorflow:loss = 33.151394, step = 10701 (0.658 sec)
INFO:tensorflow:global_step/sec: 192.794
INFO:tensorflow:loss = 26.712166, step = 10801 (0.522 sec)
INFO:tensorflow:global_step/sec: 199.021
INFO:tensorflow:loss = 17.541658, step = 10901 (0.502 sec)
INFO:tensorflow:global_step/sec: 178.993
INFO:tensorflow:loss = 125.16112, step = 11001 (0.559 sec)
INFO:tensorflow:global_step/sec: 189.186
INFO:tensorflow:loss = 53.405937, step = 11101 (0.530 sec)
INFO:tensorflow:global_step/sec: 181.267
INFO:tensorflow:loss = 135.97064, step = 11201 (0.550 sec)
INFO:tensorflow:global_step/sec: 182.95
INFO:tensorflow:loss = 42.337563, step = 11301 (0.547 sec)
INFO:tensorflow:global_step/sec: 192.673
INFO:tensorflow:loss = 35.931225, step = 11401 (0.519 sec)
INFO:tensorflow:global_step/sec: 172.18
INFO:tensorflow:loss = 51.41564, step = 11501 (0.581 sec)
INFO:tensorflow:global_step/sec: 176.558
INFO:tensorflow:loss = 69.72273, step = 11601 (0.567 sec)
INFO:tensorflow:global_step/sec: 184.453
INFO:tensorflow:loss = 50.293247, step = 11701 (0.542 sec)
INFO:tensorflow:global_step/sec: 193.865
INFO:tensorflow:loss = 33.343098, step = 11801 (0.516 sec)
INFO:tensorflow:global_step/sec: 186.1
INFO:tensorflow:loss = 38.532917, step = 11901 (0.538 sec)
INFO:tensorflow:global_step/sec: 181.807
INFO:tensorflow:loss = 46.453594, step = 12001 (0.551 sec)
INFO:tensorflow:global_step/sec: 192.69
INFO:tensorflow:loss = 118.29199, step = 12101 (0.517 sec)
INFO:tensorflow:global_step/sec: 189.743
INFO:tensorflow:loss = 30.031712, step = 12201 (0.526 sec)
INFO:tensorflow:global_step/sec: 188.956
INFO:tensorflow:loss = 50.898796, step = 12301 (0.528 sec)
INFO:tensorflow:global_step/sec: 153.629
INFO:tensorflow:loss = 45.3503, step = 12401 (0.656 sec)
INFO:tensorflow:global_step/sec: 184.861
INFO:tensorflow:loss = 83.138145, step = 12501 (0.537 sec)
```

```
INFO:tensorflow:global_step/sec: 196.258
INFO:tensorflow:loss = 49.183025, step = 12601 (0.510 sec)
INFO:tensorflow:global_step/sec: 181.637
INFO:tensorflow:loss = 85.87223, step = 12701 (0.550 sec)
INFO:tensorflow:global_step/sec: 197.96
INFO:tensorflow:loss = 43.6796, step = 12801 (0.508 sec)
INFO:tensorflow:global_step/sec: 181.806
INFO:tensorflow:loss = 38.95597, step = 12901 (0.547 sec)
INFO:tensorflow:global_step/sec: 184.951
INFO:tensorflow:loss = 94.84416, step = 13001 (0.542 sec)
INFO:tensorflow:global_step/sec: 190.088
INFO:tensorflow:loss = 51.963478, step = 13101 (0.525 sec)
INFO:tensorflow:global_step/sec: 184.531
INFO:tensorflow:loss = 53.21005, step = 13201 (0.538 sec)
INFO:tensorflow:global_step/sec: 172.067
INFO:tensorflow:loss = 55.20158, step = 13301 (0.585 sec)
INFO:tensorflow:global_step/sec: 154.15
INFO:tensorflow:loss = 33.731663, step = 13401 (0.651 sec)
INFO:tensorflow:global_step/sec: 182.724
INFO:tensorflow:loss = 41.420006, step = 13501 (0.544 sec)
INFO:tensorflow:global_step/sec: 190.442
INFO:tensorflow:loss = 138.55959, step = 13601 (0.525 sec)
INFO:tensorflow:Saving checkpoints for 13667 into ./housing_trained/
model.ckpt.
INFO:tensorflow:Calling model_fn.
INFO:tensorflow:Calling model_fn.
INFO:tensorflow:Done calling model_fn.
INFO:tensorflow:Done calling model_fn.
INFO:tensorflow:Starting evaluation at 2020-04-14T20:02:52Z
INFO:tensorflow:Graph was finalized.
INFO:tensorflow:Restoring parameters from ./housing_trained/model.ck
pt-13667
INFO:tensorflow:Running local_init_op.
INFO:tensorflow:Done running local_init_op.
INFO:tensorflow:Finished evaluation at 2020-04-14-20:02:53
INFO:tensorflow:Saving dict for global step 13667: average_loss = 0.
5685675, global_step = 13667, label/mean = 2.0660067, loss = 1895.03
55, prediction/mean = 2.1194465, rmse = 75403.414
INFO:tensorflow:Saving 'checkpoint_path' summary for global step 136
67: ./housing_trained/model.ckpt-13667
INFO:tensorflow:Loss for final step: 52.835007.
```

In [13]:

```
# DNN Regressor
def train_and_evaluate(output_dir, num_train_steps):
  myopt = tf.train.FtrlOptimizer(learning_rate = 0.01) # note the learning rate
  estimator = tf.estimator.DNNRegressor(model_dir = output_dir,
                              hidden_units = [100, 50, 20],
                              feature_columns = featcols.values(),
                              optimizer = myopt,
                              dropout = 0.1)
  #Add rmse evaluation metric
  def rmse(labels, predictions):
    pred_values = tf.cast(predictions['predictions'],tf.float64)
    return {'rmse': tf.metrics.root_mean_squared_error(labels*SCALE, pred_values
*SCALE)}
  estimator = tf.contrib.estimator.add_metrics(estimator,rmse)

  train_spec=tf.estimator.TrainSpec(
                     input_fn = train_input_fn,
                     max_steps = num_train_steps)
  eval_spec=tf.estimator.EvalSpec(
                     input_fn = eval_input_fn,
                     steps = None,
                     start_delay_secs = 1, # start evaluating after N seconds
                     throttle_secs = 10,  # evaluate every N seconds
                     )
  tf.estimator.train_and_evaluate(estimator, train_spec, eval_spec)

# Run training
shutil.rmtree(OUTDIR, ignore_errors = True) # start fresh each time
tf.summary.FileWriterCache.clear() # ensure filewriter cache is clear for Tensor
Board events file
train_and_evaluate(OUTDIR, num_train_steps = (100 * len(traindf)) / BATCH_SIZE)
```

```
INFO:tensorflow:Using default config.
INFO:tensorflow:Using config: {'_model_dir': './housing_trained', '_
tf_random_seed': None, '_save_summary_steps': 100, '_save_checkpoint
s_steps': None, '_save_checkpoints_secs': 600, '_session_config': al
low_soft_placement: true
graph_options {
  rewrite_options {
    meta_optimizer_iterations: ONE
  }
}
, '_keep_checkpoint_max': 5, '_keep_checkpoint_every_n_hours': 1000
0, '_log_step_count_steps': 100, '_train_distribute': None, '_device
_fn': None, '_protocol': None, '_eval_distribute': None, '_experimen
tal_distribute': None, '_experimental_max_worker_delay_secs': None,
'_session_creation_timeout_secs': 7200, '_service': None, '_cluster_
spec': <tensorflow.python.training.server_lib.ClusterSpec object at
0x7ff0d9f842d0>, '_task_type': 'worker', '_task_id': 0, '_global_id_
in_cluster': 0, '_master': '', '_evaluation_master': '', '_is_chie
f': True, '_num_ps_replicas': 0, '_num_worker_replicas': 1}
INFO:tensorflow:Using config: {'_model_dir': './housing_trained', '_
tf_random_seed': None, '_save_summary_steps': 100, '_save_checkpoint
s_steps': None, '_save_checkpoints_secs': 600, '_session_config': al
low_soft_placement: true
graph_options {
  rewrite_options {
    meta_optimizer_iterations: ONE
  }
}
, '_keep_checkpoint_max': 5, '_keep_checkpoint_every_n_hours': 1000
0, '_log_step_count_steps': 100, '_train_distribute': None, '_device
_fn': None, '_protocol': None, '_eval_distribute': None, '_experimen
tal_distribute': None, '_experimental_max_worker_delay_secs': None,
'_session_creation_timeout_secs': 7200, '_service': None, '_cluster_
spec': <tensorflow.python.training.server_lib.ClusterSpec object at
0x7ff0ed319d90>, '_task_type': 'worker', '_task_id': 0, '_global_id_
in_cluster': 0, '_master': '', '_evaluation_master': '', '_is_chie
f': True, '_num_ps_replicas': 0, '_num_worker_replicas': 1}
INFO:tensorflow:Not using Distribute Coordinator.
INFO:tensorflow:Running training and evaluation locally (non-distrib
uted).
INFO:tensorflow:Start train and evaluate loop. The evaluate will hap
pen after every checkpoint. Checkpoint frequency is determined based
on RunConfig arguments: save_checkpoints_steps None or save_checkpoi
nts_secs 600.
INFO:tensorflow:Calling model_fn.
INFO:tensorflow:Calling model_fn.
INFO:tensorflow:Done calling model_fn.
INFO:tensorflow:Done calling model_fn.
INFO:tensorflow:Create CheckpointSaverHook.
INFO:tensorflow:Graph was finalized.
INFO:tensorflow:Running local_init_op.
INFO:tensorflow:Done running local_init_op.
INFO:tensorflow:Saving checkpoints for 0 into ./housing_trained/mode
l.ckpt.
INFO:tensorflow:loss = 702.0885, step = 1
INFO:tensorflow:global_step/sec: 91.166
INFO:tensorflow:loss = 125.7796, step = 101 (1.099 sec)
INFO:tensorflow:global_step/sec: 91.5042
INFO:tensorflow:loss = 113.24868, step = 201 (1.096 sec)
INFO:tensorflow:global_step/sec: 114.804
INFO:tensorflow:loss = 62.899364, step = 301 (0.872 sec)
```

```
INFO:tensorflow:global_step/sec: 104.022
INFO:tensorflow:loss = 111.75862, step = 401 (0.960 sec)
INFO:tensorflow:global_step/sec: 132.847
INFO:tensorflow:loss = 61.81586, step = 501 (0.753 sec)
INFO:tensorflow:global_step/sec: 135.388
INFO:tensorflow:loss = 79.71949, step = 601 (0.739 sec)
INFO:tensorflow:global_step/sec: 131.386
INFO:tensorflow:loss = 61.830894, step = 701 (0.761 sec)
INFO:tensorflow:global_step/sec: 120.64
INFO:tensorflow:loss = 60.828987, step = 801 (0.830 sec)
INFO:tensorflow:global_step/sec: 117.093
INFO:tensorflow:loss = 63.11075, step = 901 (0.851 sec)
INFO:tensorflow:global_step/sec: 130.424
INFO:tensorflow:loss = 72.90083, step = 1001 (0.770 sec)
INFO:tensorflow:global_step/sec: 130.682
INFO:tensorflow:loss = 81.87669, step = 1101 (0.765 sec)
INFO:tensorflow:global_step/sec: 123.781
INFO:tensorflow:loss = 66.54986, step = 1201 (0.807 sec)
INFO:tensorflow:global_step/sec: 121.32
INFO:tensorflow:loss = 67.6452, step = 1301 (0.821 sec)
INFO:tensorflow:global_step/sec: 135.23
INFO:tensorflow:loss = 63.775875, step = 1401 (0.739 sec)
INFO:tensorflow:global_step/sec: 137.476
INFO:tensorflow:loss = 100.67943, step = 1501 (0.728 sec)
INFO:tensorflow:global_step/sec: 107.188
INFO:tensorflow:loss = 71.61807, step = 1601 (0.932 sec)
INFO:tensorflow:global_step/sec: 119.672
INFO:tensorflow:loss = 112.78421, step = 1701 (0.840 sec)
INFO:tensorflow:global_step/sec: 134.347
INFO:tensorflow:loss = 52.65922, step = 1801 (0.740 sec)
WARNING:tensorflow:It seems that global step (tf.train.get_global_st
ep) has not been increased. Current value (could be stable): 1854 vs
previous value: 1854. You could increase the global step by passing
tf.train.get_global_step() to Optimizer.apply_gradients or Optimize
r.minimize.
INFO:tensorflow:global_step/sec: 120.444
INFO:tensorflow:loss = 62.734596, step = 1901 (0.834 sec)
INFO:tensorflow:global_step/sec: 123.02
INFO:tensorflow:loss = 48.05349, step = 2001 (0.813 sec)
INFO:tensorflow:global_step/sec: 131.469
INFO:tensorflow:loss = 66.23055, step = 2101 (0.761 sec)
INFO:tensorflow:global_step/sec: 131.339
INFO:tensorflow:loss = 44.827667, step = 2201 (0.761 sec)
INFO:tensorflow:global_step/sec: 142.803
INFO:tensorflow:loss = 30.58906, step = 2301 (0.701 sec)
INFO:tensorflow:global_step/sec: 153.525
INFO:tensorflow:loss = 69.1979, step = 2401 (0.650 sec)
INFO:tensorflow:global_step/sec: 131.218
INFO:tensorflow:loss = 59.43641, step = 2501 (0.759 sec)
INFO:tensorflow:global_step/sec: 131.708
INFO:tensorflow:loss = 70.50877, step = 2601 (0.761 sec)
INFO:tensorflow:global_step/sec: 124.708
INFO:tensorflow:loss = 43.268944, step = 2701 (0.803 sec)
INFO:tensorflow:global_step/sec: 132.221
INFO:tensorflow:loss = 56.623734, step = 2801 (0.756 sec)
INFO:tensorflow:global_step/sec: 141.814
INFO:tensorflow:loss = 45.611694, step = 2901 (0.703 sec)
INFO:tensorflow:global_step/sec: 127.219
INFO:tensorflow:loss = 64.98466, step = 3001 (0.785 sec)
INFO:tensorflow:global_step/sec: 125.351
INFO:tensorflow:loss = 58.446144, step = 3101 (0.797 sec)
```

```
INFO:tensorflow:global_step/sec: 129.664
INFO:tensorflow:loss = 79.29079, step = 3201 (0.772 sec)
INFO:tensorflow:global_step/sec: 144.472
INFO:tensorflow:loss = 50.030987, step = 3301 (0.695 sec)
INFO:tensorflow:global_step/sec: 145.13
INFO:tensorflow:loss = 45.61485, step = 3401 (0.690 sec)
INFO:tensorflow:global_step/sec: 167.199
INFO:tensorflow:loss = 33.78362, step = 3501 (0.597 sec)
INFO:tensorflow:global_step/sec: 116.891
INFO:tensorflow:loss = 55.9213, step = 3601 (0.856 sec)
INFO:tensorflow:global_step/sec: 110.732
INFO:tensorflow:loss = 71.77817, step = 3701 (0.903 sec)
INFO:tensorflow:global_step/sec: 128.658
INFO:tensorflow:loss = 36.514603, step = 3801 (0.777 sec)
INFO:tensorflow:global_step/sec: 126.982
INFO:tensorflow:loss = 39.334953, step = 3901 (0.786 sec)
INFO:tensorflow:global_step/sec: 127.534
INFO:tensorflow:loss = 32.743237, step = 4001 (0.786 sec)
INFO:tensorflow:global_step/sec: 116.118
INFO:tensorflow:loss = 68.52728, step = 4101 (0.862 sec)
INFO:tensorflow:global_step/sec: 130.596
INFO:tensorflow:loss = 43.578125, step = 4201 (0.765 sec)
INFO:tensorflow:global_step/sec: 135.552
INFO:tensorflow:loss = 82.77251, step = 4301 (0.737 sec)
INFO:tensorflow:global_step/sec: 130.896
INFO:tensorflow:loss = 28.5798, step = 4401 (0.765 sec)
INFO:tensorflow:global_step/sec: 169.043
INFO:tensorflow:loss = 80.56675, step = 4501 (0.591 sec)
INFO:tensorflow:global_step/sec: 161.744
INFO:tensorflow:loss = 55.732647, step = 4601 (0.618 sec)
INFO:tensorflow:global_step/sec: 174.709
INFO:tensorflow:loss = 79.18762, step = 4701 (0.570 sec)
INFO:tensorflow:global_step/sec: 131.281
INFO:tensorflow:loss = 58.451054, step = 4801 (0.761 sec)
INFO:tensorflow:global_step/sec: 115.989
INFO:tensorflow:loss = 33.7595, step = 4901 (0.862 sec)
INFO:tensorflow:global_step/sec: 126.044
INFO:tensorflow:loss = 66.002235, step = 5001 (0.797 sec)
INFO:tensorflow:global_step/sec: 127.223
INFO:tensorflow:loss = 70.20389, step = 5101 (0.786 sec)
INFO:tensorflow:global_step/sec: 117.361
INFO:tensorflow:loss = 52.88908, step = 5201 (0.852 sec)
INFO:tensorflow:global_step/sec: 122.029
INFO:tensorflow:loss = 39.225002, step = 5301 (0.818 sec)
INFO:tensorflow:global_step/sec: 150.197
INFO:tensorflow:loss = 46.887165, step = 5401 (0.668 sec)
INFO:tensorflow:global_step/sec: 133.728
INFO:tensorflow:loss = 51.633194, step = 5501 (0.747 sec)
INFO:tensorflow:global_step/sec: 130.149
INFO:tensorflow:loss = 63.775562, step = 5601 (0.769 sec)
INFO:tensorflow:global_step/sec: 141.141
INFO:tensorflow:loss = 59.58436, step = 5701 (0.708 sec)
INFO:tensorflow:global_step/sec: 123.531
INFO:tensorflow:loss = 64.81581, step = 5801 (0.810 sec)
INFO:tensorflow:global_step/sec: 138.972
INFO:tensorflow:loss = 66.982025, step = 5901 (0.718 sec)
INFO:tensorflow:global_step/sec: 126.414
INFO:tensorflow:loss = 28.853369, step = 6001 (0.792 sec)
INFO:tensorflow:global_step/sec: 134.203
INFO:tensorflow:loss = 48.160194, step = 6101 (0.745 sec)
INFO:tensorflow:global_step/sec: 127.123
```

```
INFO:tensorflow:loss = 65.67736, step = 6201 (0.788 sec)
INFO:tensorflow:global_step/sec: 127.639
INFO:tensorflow:loss = 48.49994, step = 6301 (0.783 sec)
INFO:tensorflow:global_step/sec: 152.685
INFO:tensorflow:loss = 43.420315, step = 6401 (0.655 sec)
INFO:tensorflow:global_step/sec: 124.24
INFO:tensorflow:loss = 61.212708, step = 6501 (0.804 sec)
INFO:tensorflow:global_step/sec: 136.798
INFO:tensorflow:loss = 40.96903, step = 6601 (0.731 sec)
INFO:tensorflow:global_step/sec: 132.482
INFO:tensorflow:loss = 60.95015, step = 6701 (0.755 sec)
INFO:tensorflow:global_step/sec: 104.478
INFO:tensorflow:loss = 45.750423, step = 6801 (0.957 sec)
INFO:tensorflow:global_step/sec: 110.327
INFO:tensorflow:loss = 52.42985, step = 6901 (0.904 sec)
INFO:tensorflow:global_step/sec: 126.331
INFO:tensorflow:loss = 28.355282, step = 7001 (0.795 sec)
INFO:tensorflow:global_step/sec: 131.446
INFO:tensorflow:loss = 69.79217, step = 7101 (0.758 sec)
INFO:tensorflow:global_step/sec: 132.191
INFO:tensorflow:loss = 52.28341, step = 7201 (0.760 sec)
INFO:tensorflow:global_step/sec: 135.41
INFO:tensorflow:loss = 79.3534, step = 7301 (0.737 sec)
INFO:tensorflow:global_step/sec: 121.994
INFO:tensorflow:loss = 54.912254, step = 7401 (0.818 sec)
INFO:tensorflow:global_step/sec: 126.45
INFO:tensorflow:loss = 57.21831, step = 7501 (0.791 sec)
INFO:tensorflow:global_step/sec: 115.686
INFO:tensorflow:loss = 55.15736, step = 7601 (0.864 sec)
INFO:tensorflow:global_step/sec: 122.237
INFO:tensorflow:loss = 66.79991, step = 7701 (0.818 sec)
INFO:tensorflow:global_step/sec: 134.238
INFO:tensorflow:loss = 35.448727, step = 7801 (0.744 sec)
INFO:tensorflow:global_step/sec: 130.574
INFO:tensorflow:loss = 27.105396, step = 7901 (0.768 sec)
INFO:tensorflow:global_step/sec: 140.108
INFO:tensorflow:loss = 56.469055, step = 8001 (0.712 sec)
INFO:tensorflow:global_step/sec: 118.514
INFO:tensorflow:loss = 47.856808, step = 8101 (0.846 sec)
INFO:tensorflow:global_step/sec: 119.944
INFO:tensorflow:loss = 70.25543, step = 8201 (0.832 sec)
INFO:tensorflow:global_step/sec: 155.583
INFO:tensorflow:loss = 34.344624, step = 8301 (0.646 sec)
INFO:tensorflow:global_step/sec: 129.369
INFO:tensorflow:loss = 58.09215, step = 8401 (0.773 sec)
INFO:tensorflow:global_step/sec: 124.709
INFO:tensorflow:loss = 33.595848, step = 8501 (0.802 sec)
INFO:tensorflow:global_step/sec: 182.118
INFO:tensorflow:loss = 83.90042, step = 8601 (0.548 sec)
INFO:tensorflow:global_step/sec: 148.977
INFO:tensorflow:loss = 58.44483, step = 8701 (0.671 sec)
INFO:tensorflow:global_step/sec: 126.172
INFO:tensorflow:loss = 52.17053, step = 8801 (0.793 sec)
INFO:tensorflow:global_step/sec: 136.088
INFO:tensorflow:loss = 39.766182, step = 8901 (0.735 sec)
INFO:tensorflow:global_step/sec: 142.913
INFO:tensorflow:loss = 41.61505, step = 9001 (0.700 sec)
INFO:tensorflow:global_step/sec: 127.424
INFO:tensorflow:loss = 56.099854, step = 9101 (0.784 sec)
INFO:tensorflow:global_step/sec: 132.856
INFO:tensorflow:loss = 39.263412, step = 9201 (0.750 sec)
```

```
INFO:tensorflow:global_step/sec: 124.126
INFO:tensorflow:loss = 48.11157, step = 9301 (0.810 sec)
INFO:tensorflow:global_step/sec: 120.676
INFO:tensorflow:loss = 45.50254, step = 9401 (0.824 sec)
INFO:tensorflow:global_step/sec: 136.332
INFO:tensorflow:loss = 32.744392, step = 9501 (0.733 sec)
INFO:tensorflow:global_step/sec: 127.736
INFO:tensorflow:loss = 25.082954, step = 9601 (0.785 sec)
INFO:tensorflow:global_step/sec: 133.641
INFO:tensorflow:loss = 111.24377, step = 9701 (0.746 sec)
INFO:tensorflow:global_step/sec: 117.979
INFO:tensorflow:loss = 34.964523, step = 9801 (0.851 sec)
INFO:tensorflow:global_step/sec: 127.189
INFO:tensorflow:loss = 95.71257, step = 9901 (0.786 sec)
INFO:tensorflow:global_step/sec: 123.994
INFO:tensorflow:loss = 22.21669, step = 10001 (0.805 sec)
INFO:tensorflow:global_step/sec: 148.797
INFO:tensorflow:loss = 47.250668, step = 10101 (0.674 sec)
INFO:tensorflow:global_step/sec: 131.711
INFO:tensorflow:loss = 57.693676, step = 10201 (0.759 sec)
INFO:tensorflow:global_step/sec: 123.817
INFO:tensorflow:loss = 56.825714, step = 10301 (0.808 sec)
INFO:tensorflow:global_step/sec: 117.048
INFO:tensorflow:loss = 55.020412, step = 10401 (0.855 sec)
INFO:tensorflow:global_step/sec: 130.516
INFO:tensorflow:loss = 37.31606, step = 10501 (0.766 sec)
INFO:tensorflow:global_step/sec: 123.586
INFO:tensorflow:loss = 51.270798, step = 10601 (0.809 sec)
INFO:tensorflow:global_step/sec: 113.747
INFO:tensorflow:loss = 37.515316, step = 10701 (0.878 sec)
INFO:tensorflow:global_step/sec: 132.731
INFO:tensorflow:loss = 49.52246, step = 10801 (0.750 sec)
INFO:tensorflow:global_step/sec: 119.065
INFO:tensorflow:loss = 45.505577, step = 10901 (0.840 sec)
INFO:tensorflow:global_step/sec: 119.69
INFO:tensorflow:loss = 51.64119, step = 11001 (0.839 sec)
INFO:tensorflow:global_step/sec: 126.454
INFO:tensorflow:loss = 31.725523, step = 11101 (0.791 sec)
INFO:tensorflow:global_step/sec: 126.887
INFO:tensorflow:loss = 65.507126, step = 11201 (0.787 sec)
INFO:tensorflow:global_step/sec: 125.856
INFO:tensorflow:loss = 53.716873, step = 11301 (0.795 sec)
INFO:tensorflow:global_step/sec: 118.728
INFO:tensorflow:loss = 90.40224, step = 11401 (0.843 sec)
INFO:tensorflow:global_step/sec: 122.866
INFO:tensorflow:loss = 32.217796, step = 11501 (0.813 sec)
INFO:tensorflow:global_step/sec: 124.237
INFO:tensorflow:loss = 40.150986, step = 11601 (0.805 sec)
INFO:tensorflow:global_step/sec: 115.967
INFO:tensorflow:loss = 57.60331, step = 11701 (0.863 sec)
INFO:tensorflow:global_step/sec: 120.212
INFO:tensorflow:loss = 54.525154, step = 11801 (0.831 sec)
INFO:tensorflow:global_step/sec: 124.147
INFO:tensorflow:loss = 44.91095, step = 11901 (0.806 sec)
INFO:tensorflow:global_step/sec: 120.494
INFO:tensorflow:loss = 49.41998, step = 12001 (0.830 sec)
INFO:tensorflow:global_step/sec: 122.435
INFO:tensorflow:loss = 61.790955, step = 12101 (0.816 sec)
INFO:tensorflow:global_step/sec: 126.59
INFO:tensorflow:loss = 38.754284, step = 12201 (0.791 sec)
INFO:tensorflow:global_step/sec: 128.294
```

```
INFO:tensorflow:loss = 56.13942, step = 12301 (0.779 sec)
INFO:tensorflow:global_step/sec: 141.224
INFO:tensorflow:loss = 30.603182, step = 12401 (0.708 sec)
INFO:tensorflow:global_step/sec: 128.086
INFO:tensorflow:loss = 38.05499, step = 12501 (0.780 sec)
INFO:tensorflow:global_step/sec: 131.378
INFO:tensorflow:loss = 21.00216, step = 12601 (0.759 sec)
INFO:tensorflow:global_step/sec: 140.839
INFO:tensorflow:loss = 57.00307, step = 12701 (0.710 sec)
INFO:tensorflow:global_step/sec: 128.789
INFO:tensorflow:loss = 45.223587, step = 12801 (0.780 sec)
INFO:tensorflow:global_step/sec: 121.215
INFO:tensorflow:loss = 67.82974, step = 12901 (0.821 sec)
INFO:tensorflow:global_step/sec: 115.228
INFO:tensorflow:loss = 29.327522, step = 13001 (0.871 sec)
INFO:tensorflow:global_step/sec: 131.905
INFO:tensorflow:loss = 28.699604, step = 13101 (0.758 sec)
INFO:tensorflow:global_step/sec: 147.311
INFO:tensorflow:loss = 50.11611, step = 13201 (0.676 sec)
INFO:tensorflow:global_step/sec: 122.832
INFO:tensorflow:loss = 69.573395, step = 13301 (0.814 sec)
INFO:tensorflow:global_step/sec: 118.956
INFO:tensorflow:loss = 41.39156, step = 13401 (0.844 sec)
INFO:tensorflow:global_step/sec: 119.026
INFO:tensorflow:loss = 47.34402, step = 13501 (0.838 sec)
INFO:tensorflow:global_step/sec: 129.132
INFO:tensorflow:loss = 46.9502, step = 13601 (0.776 sec)
INFO:tensorflow:Saving checkpoints for 13667 into ./housing_trained/
model.ckpt.
INFO:tensorflow:Calling model_fn.
INFO:tensorflow:Calling model_fn.
INFO:tensorflow:Done calling model_fn.
INFO:tensorflow:Done calling model_fn.
INFO:tensorflow:Starting evaluation at 2020-04-14T20:06:14Z
INFO:tensorflow:Graph was finalized.
INFO:tensorflow:Restoring parameters from ./housing_trained/model.ck
pt-13667
INFO:tensorflow:Running local_init_op.
INFO:tensorflow:Done running local_init_op.
INFO:tensorflow:Finished evaluation at 2020-04-14-20:06:15
INFO:tensorflow:Saving dict for global step 13667: average_loss = 0.
3803295, global_step = 13667, label/mean = 2.0660067, loss = 1267.63
82, prediction/mean = 2.0959156, rmse = 61670.855
INFO:tensorflow:Saving 'checkpoint_path' summary for global step 136
67: ./housing_trained/model.ckpt-13667
INFO:tensorflow:Loss for final step: 78.156624.
```

In [14]:

```
from google.datalab.ml import TensorBoard
pid = TensorBoard().start(OUTDIR)
```

```
---------------------------------------------------------------------
-------
ModuleNotFoundError                          Traceback (most recent cal
l last)
<ipython-input-14-03885c9bfafa> in <module>
----> 1 from google.datalab.ml import TensorBoard
      2 pid = TensorBoard().start(OUTDIR)

ModuleNotFoundError: No module named 'google.datalab'
```

In [ ]:

```

```