

```
In [1]: import os, json, math, shutil
import numpy as np
import tensorflow as tf
!sudo apt install graphviz -y

# environment variables used by bash cells
PROJECT=!(gcloud config get-value project)
PROJECT=PROJECT[0]

REGION = 'us-central1'
BUCKET='{}-dsongcp'.format(PROJECT)
os.environ['ENDPOINT_NAME'] = 'flights'

os.environ['BUCKET'] = BUCKET
os.environ['REGION'] = REGION
os.environ['TF_VERSION']='2-' + tf.__version__[2:4]
```

2023-10-27 10:02:02.263989: I tensorflow/core/platform/cpu_feature_guard.cc:193] This TensorFlow binary is optimized with oneAPI Deep Neural Network Library (oneDNN) to use the following CPU instructions in performance-critical operations: AVX2 FMA

To enable them in other operations, rebuild TensorFlow with the appropriate compiler flags.

2023-10-27 10:02:09.227283: W tensorflow/compiler/xla/stream_executor/platform/default/dso_loader.cc:64] Could not load dynamic library 'libnvinfer.so.7'; dlerror: libnvinfer.so.7: cannot open shared object file: No such file or directory; LD_LIBRARY_PATH: /usr/local/cuda/lib64:/usr/local/nccl2/lib:/usr/local/cuda/extras/CUPTI/lib64

2023-10-27 10:02:09.229377: W tensorflow/compiler/xla/stream_executor/platform/default/dso_loader.cc:64] Could not load dynamic library 'libnvinfer_plugin.so.7'; dlerror: libnvinfer_plugin.so.7: cannot open shared object file: No such file or directory; LD_LIBRARY_PATH: /usr/local/cuda/lib64:/usr/local/nccl2/lib:/usr/local/cuda/extras/CUPTI/lib64

2023-10-27 10:02:09.229403: W tensorflow/compiler/tf2tensorrt/utils/py_utils.cc:38] TF-TRT Warning: Cannot dlopen some TensorRT libraries. If you would like to use Nvidia GPU with TensorRT, please make sure the missing libraries mentioned above are installed properly.

```
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following additional packages will be installed:
  fonts-liberation libann0 libcdt5 libcgraph6 libgts-0.7-5 libgts-bin libgvc6
    libgvpr2 liblab-gamut1 libpathplan4
Suggested packages:
  gsfonts graphviz-doc
The following NEW packages will be installed:
  fonts-liberation graphviz libann0 libcdt5 libcgraph6 libgts-0.7-5 libgts-bin
    libgvc6 libgvpr2 liblab-gamut1 libpathplan4
0 upgraded, 11 newly installed, 0 to remove and 2 not upgraded.
Need to get 3032 kB of archives.
After this operation, 11.5 MB of additional disk space will be used.
Get:1 https://deb.debian.org/debian bullseye/main amd64 fonts-liberation all 1:1.07.4-11 [828 kB]
Get:2 https://deb.debian.org/debian bullseye/main amd64 libann0 amd64 1.1.2+doc-7 [25.3 kB]
Get:3 https://deb.debian.org/debian bullseye/main amd64 libcdt5 amd64 2.42.2-5 [62.2 kB]
Get:4 https://deb.debian.org/debian bullseye/main amd64 libcgraph6 amd64 2.42.2-5 [85.5 kB]
Get:5 https://deb.debian.org/debian bullseye/main amd64 libgts-0.7-5 amd64 0.7.6+darcs121130-4+b1 [158 kB]
Get:6 https://deb.debian.org/debian bullseye/main amd64 libpathplan4 amd64 2.42.2-5 [64.3 kB]
Get:7 https://deb.debian.org/debian bullseye/main amd64 libgvc6 amd64 2.42.2-5 [695 kB]
Get:8 https://deb.debian.org/debian bullseye/main amd64 libgvpr2 amd64 2.42.2-5 [212 kB]
Get:9 https://deb.debian.org/debian bullseye/main amd64 liblab-gamut1 amd64 2.42.2-5 [221 kB]
Get:10 https://deb.debian.org/debian bullseye/main amd64 graphviz amd64 2.42.2-5 [632 kB]
Get:11 https://deb.debian.org/debian bullseye/main amd64 libgts-bin amd64 0.7.6+darcs121130-4+b1 [50.3 kB]
Fetched 3032 kB in 0s (6481 kB/s)
```

```
eselect previously unselected package fonts-liberation.
(Reading database ... 129966 files and directories currently installed.)
Preparing to unpack .../00-fon ts-liberation_1%3a1.07.4-11_all.deb ...
[Progress: [  0%] [.....] ] [Progress: [  2%] [#.....] ] Unpacking fonts-liberation (1:1.07.4-11) ...
[Progress: [  4%] [##.....] ] Selecting previously unselected package libann0.
Preparing to unpack .../01-libann0_1.1.2+doc-7_amd64.deb ...
[Progress: [  7%] [###.....] ] Unpacking libann0 (1.1.2+doc-7) ...
[Progress: [  9%] [#####.....] ] Selecting previously unselected package libcdt5:amd64.
Preparing to unpack .../02-libcdt5_2.42.2-5_amd64.deb ...
[Progress: [ 11%] [#####.....] ] Unpacking libcdt5:amd64 (2.42.2-5)
...
[Progress: [ 13%] [#####.....] ] Selecting previously unselected pac
```

```
kage libcgraph6:amd64.
Preparing to unpack .../03-libcgraph6_2.42.2-5_amd64.deb ...
[7]Progress: [ 16%] [#####.....] [8]Unpacking libcgraph6:amd64 (2.42.2-5) ...
[7]Progress: [ 18%] [#####.....] [8]Selecting previously unselected package libgts-0.7-5:amd64.
Preparing to unpack .../04-libgts-0.7-5_0.7.6+darcs121130-4+b1_amd64.deb ...
[7]Progress: [ 20%] [#####.....] [8]Unpacking libgts-0.7-5:amd64 (0.7.6+darcs121130-4+b1) ...
[7]Progress: [ 22%] [#####.....] [8]Selecting previously unselected package libpathplan4:amd64.
Preparing to unpack .../05-libpathplan4_2.42.2-5_amd64.deb ...
[7]Progress: [ 24%] [#####.....] [8]Unpacking libpathplan4:amd64 (2.42.2-5) ...
[7]Progress: [ 27%] [#####.....] [8]Selecting previously unselected package libgvc6.
Preparing to unpack .../06-libgvc6_2.42.2-5_amd64.deb ...
[7]Progress: [ 29%] [#####.....] [8]Unpacking libgvc6 (2.42.2-5) ...
[7]Progress: [ 31%] [#####.....] [8]Selecting previously unselected package libgvpr2:amd64.
Preparing to unpack .../07-libgvpr2_2.42.2-5_amd64.deb ...
[7]Progress: [ 33%] [#####.....] [8]Unpacking libgvpr2:amd64 (2.42.2-5) ...
...
[7]Progress: [ 36%] [#####.....] [8]Selecting previously unselected package liblab-gamut1:amd64.
Preparing to unpack .../08-liblab-gamut1_2.42.2-5_amd64.deb ...
[7]Progress: [ 38%] [#####.....] [8]Unpacking liblab-gamut1:amd64 (2.42.2-5) ...
[7]Progress: [ 40%] [#####.....] [8]Selecting previously unselected package graphviz.
Preparing to unpack .../09-graphviz_2.42.2-5_amd64.deb ...
[7]Progress: [ 42%] [#####.....] [8]Unpacking graphviz (2.42.2-5) ...
[7]Progress: [ 44%] [#####.....] [8]Selecting previously unselected package libgts-bin.
Preparing to unpack .../10-libgts-bin_0.7.6+darcs121130-4+b1_amd64.deb ...
[7]Progress: [ 47%] [#####.....] [8]Unpacking libgts-bin (0.7.6+darcs121130-4+b1) ...
[7]Progress: [ 49%] [#####.....] [8]Setting up liblab-gamut1:amd64 (2.42.2-5) ...
[7]Progress: [ 51%] [#####.....] [8]Setting up libgts-0.7-5:amd64 (0.7.6+darcs121130-4+b1) ...
[7]Progress: [ 56%] [#####.....] [8]Setting up libgts-bin (0.7.6+darcs121130-4+b1) ...
```

```
[#####.....] 8Setting up libpathplan4:amd64 (2.42.2-5) ...
[7Progress: [ 60% [#####.....] 8[7Progress: [ 62% [#####
[#####.....] 8Setting up libann0 (1.1.2+doc-7) ...
[7Progress: [ 64% [#####.....] 8[7Progress: [ 67% [#####
[#####.....] 8Setting up fonts-liberation (1:1.07.4-11) ...
[7Progress: [ 69% [#####.....] 8[7Progress: [ 71% [#####
[#####.....] 8Setting up libcdt5:amd64 (2.42.2-5) ...
[7Progress: [ 73% [#####.....] 8[7Progress: [ 76% [#####
[#####.....] 8Setting up libcgraph6:amd64 (2.42.2-5) ...
[7Progress: [ 78% [#####.....] 8[7Progress: [ 80% [#####
[#####.....] 8Setting up libgts-bin (0.7.6+darcs121130-4+b1) ...
[7Progress: [ 82% [#####.....] 8[7Progress: [ 84% [#####
[#####.....] 8Setting up libgvc6 (2.42.2-5) ...
[7Progress: [ 87% [#####.....] 8[7Progress: [ 89% [#####
[#####.....] 8Setting up libgvpr2:amd64 (2.42.2-5) ...
[7Progress: [ 91% [#####.....] 8[7Progress: [ 93% [#####
[#####.....] 8Setting up graphviz (2.42.2-5) ...
[7Progress: [ 96% [#####... 8Processing triggers for libc-bin (2.31-13+deb11u6) ...
ldconfig: /usr/local/cuda-11.3/targets/x86_64-linux/lib/libcudnn_ops_train.so.8 is not a symbolic link
```

```
ldconfig: /usr/local/cuda-11.3/targets/x86_64-linux/lib/libcudnn_ops_infer.so.8 is not a symbolic link
```

```
ldconfig: /usr/local/cuda-11.3/targets/x86_64-linux/lib/libcudnn_cnn_train.so.8 is not a symbolic link
```

```
ldconfig: /usr/local/cuda-11.3/targets/x86_64-linux/lib/libcudnn_adv_train.so.8 is not a symbolic link
```

```
ldconfig: /usr/local/cuda-11.3/targets/x86_64-linux/lib/libcudnn.so.8 is not a symbolic link
```

```
ldconfig: /usr/local/cuda-11.3/targets/x86_64-linux/lib/libcudnn_adv_infer.so.8 is not a symbolic link
```

```
ldconfig: /usr/local/cuda-11.3/targets/x86_64-linux/lib/libcudnn_cnn_infer.so.8 is not a symbolic link
```

```
ldconfig: /lib/libnvinfer.so.8 is not a symbolic link
```

```
ldconfig: /lib/libnvparsers.so.8 is not a symbolic link
```

```
ldconfig: /lib/libnvnparser.so.8 is not a symbolic link
```

```
ldconfig: /lib/libnvinfer_plugin.so.8 is not a symbolic link
```

```
Processing triggers for man-db (2.9.4-2) ...
```

Processing triggers for fontconfig (2.13.1-4.2) ...

?7?8

In [2]:

```
%bigquery
CREATE OR REPLACE TABLE dsongcp.flights_train_data AS

SELECT
    IF(arr_delay < 15, 1.0, 0.0) AS ontime,
    dep_delay,
    taxi_out,
    distance,
    origin,
    dest,
    EXTRACT(hour FROM dep_time) AS dep_hour,
    IF (EXTRACT(dayofweek FROM dep_time) BETWEEN 2 AND 6, 1, 0) AS is_weekday,
    UNIQUE_CARRIER AS carrier,
    dep_airport_lat,
    dep_airport_lon,
    arr_airport_lat,
    arr_airport_lon
FROM dsongcp.flights_tzcorr f
JOIN dsongcp.trainday t
ON f.FL_DATE = t.FL_DATE
WHERE
    f.CANCELLED = False AND
    f.DIVERTED = False AND
    is_train day = 'True'
```

Query is running: 0%

Out[2]: -

In [3]:

```
%bigquery
CREATE OR REPLACE TABLE dsongcp.flights_eval_data AS

SELECT
    IF(arr_delay < 15, 1.0, 0.0) AS ontime,
    dep_delay,
    taxi_out,
    distance,
    origin,
    dest,
```

```
EXTRACT(hour FROM dep_time) AS dep_hour,
IF (EXTRACT(dayofweek FROM dep_time) BETWEEN 2 AND 6, 1, 0) AS is_weekday,
UNIQUE_CARRIER AS carrier,
dep_airport_lat,
dep_airport_lon,
arr_airport_lat,
arr_airport_lon
FROM dsongcp.flights_tzcorr f
JOIN dsongcp.trainday t
ON f.FL_DATE = t.FL_DATE
WHERE
f.CANCELLED = False AND
f.DIVERTED = False AND
is_train_day = 'False'
```

Query is running: 0% |

Out[3]: —

In [4]: %%bigquery

```
CREATE OR REPLACE TABLE dsongcp.flights_all_data AS

SELECT
IF(arr_delay < 15, 1.0, 0.0) AS ontime,
dep_delay,
taxi_out,
distance,
origin,
dest,
EXTRACT(hour FROM dep_time) AS dep_hour,
IF (EXTRACT(dayofweek FROM dep_time) BETWEEN 2 AND 6, 1, 0) AS is_weekday,
UNIQUE_CARRIER AS carrier,
dep_airport_lat,
dep_airport_lon,
arr_airport_lat,
arr_airport_lon,
IF (is_train_day = 'True',
IF(ABS(MOD(FARM_FINGERPRINT(CAST(f.FL_DATE AS STRING)), 100)) < 60, 'TRAIN', 'VALIDATE'),
'TEST') AS data_split
FROM dsongcp.flights_tzcorr f
JOIN dsongcp.trainday t
ON f.FL_DATE = t.FL_DATE
WHERE
```

```
f.CANCELLED = False AND  
f.DIVERTED = False
```

Query is running: 0% |

Out[4]: —

```
In [5]: %%bash  
PROJECT=$(gcloud config get-value project)  
for dataset in "train" "eval" "all"; do  
    TABLE=dsongcp.flights_${dataset}_data  
    CSV=gs://${BUCKET}/ch9/data/${dataset}.csv  
    echo "Exporting ${TABLE} to ${CSV} and deleting table"  
    bq --project_id=${PROJECT} extract --destination_format=CSV $TABLE $CSV  
    bq --project_id=${PROJECT} rm -f $TABLE  
done
```

Exporting dsongcp.flights_train_data to gs://qwiklabs-gcp-00-1faa2396f6a8-dsongcp/ch9/data/train.csv and deleting table

Waiting on bqjob_r63f5f7ac56417e58_0000018b7097f9ab_1 ... (34s) Current status: DONE

Exporting dsongcp.flights_eval_data to gs://qwiklabs-gcp-00-1faa2396f6a8-dsongcp/ch9/data/eval.csv and deleting table

Waiting on bqjob_r7ea951322f14834_0000018b70988ffd_1 ... (23s) Current status: DONE

Exporting dsongcp.flights_all_data to gs://qwiklabs-gcp-00-1faa2396f6a8-dsongcp/ch9/data/all.csv and deleting table

Waiting on bqjob_r777d14432461d498_0000018b7098fb00_1 ... (85s) Current status: DONE

```
In [6]: !gsutil ls -lh gs://${BUCKET}/ch9/data
```

```
445.01 MiB 2023-10-27T10:07:13Z gs://qwiklabs-gcp-00-1faa2396f6a8-dsongcp/ch9/data/all.csv  
115.19 MiB 2023-10-27T10:05:47Z gs://qwiklabs-gcp-00-1faa2396f6a8-dsongcp/ch9/data/eval.csv  
296.96 MiB 2023-10-27T10:05:24Z gs://qwiklabs-gcp-00-1faa2396f6a8-dsongcp/ch9/data/train.csv  
TOTAL: 3 objects, 898801258 bytes (857.16 MiB)
```

```
In [7]: DEVELOP_MODE = True  
NUM_EXAMPLES = 5000*1000
```

```
In [8]: training_data_uri = 'gs://{}//ch9//data//train*'.format(BUCKET)  
validation_data_uri = 'gs://{}//ch9//data//eval*'.format(BUCKET)
```

```
In [9]: NBUCKETS = 5  
NEMBEDS = 3  
TRAIN_BATCH_SIZE = 64  
DNN_HIDDEN_UNITS = '64,32'
```

```
In [10]: if DEVELOP_MODE:  
    train_df = tf.data.experimental.make_csv_dataset(training_data_uri, batch_size=5)  
    for n, data in enumerate(train_df):  
        numpy_data = {k: v.numpy() for k, v in data.items()}  
        print(n, numpy_data)  
        if n==1: break
```

```
2023-10-27 10:08:22.562178: W tensorflow/compiler/xla/stream_executor/platform/default/dso_loader.cc:64] Could not load dynamic library 'libcuda.so.1'; dlerror: libcuda.so.1: cannot open shared object file: No such file or directory;  
LD_LIBRARY_PATH: /usr/local/cuda/lib64:/usr/local/nccl2/lib:/usr/local/cuda/extras/CUPTI/lib64  
2023-10-27 10:08:22.562237: W tensorflow/compiler/xla/stream_executor/cuda/cuda_driver.cc:265] failed call to cuInit: UNKNOWN ERROR (303)  
2023-10-27 10:08:22.562267: I tensorflow/compiler/xla/stream_executor/cuda/cuda_diagnostics.cc:156] kernel driver does not appear to be running on this host (instance-20231027-115841): /proc/driver/nvidia/version does not exist  
2023-10-27 10:08:22.567470: I tensorflow/core/platform/cpu_feature_guard.cc:193] This TensorFlow binary is optimized with oneAPI Deep Neural Network Library (oneDNN) to use the following CPU instructions in performance-critical operations: AVX2 FMA  
To enable them in other operations, rebuild TensorFlow with the appropriate compiler flags.
```

```

0 {'ontime': array([1, 1, 1, 1, 1], dtype=int32), 'dep_delay': array([-7, -5, -11, -7, -3], dtype=int32), 'taxi_out': array([6, 9, 12, 10, 14], dtype=int32), 'distance': array([139, 399, 817, 352, 772], dtype=int32), 'origin': array([b'MLI', b'BOI', b'PDX', b'GPT', b'TYS'], dtype=object), 'dest': array([b'ORD', b'SEA', b'BUR', b'ATL', b'DFW'], dtype=object), 'dep_hour': array([22, 0, 20, 18, 15], dtype=int32), 'is_weekday': array([1, 1, 1, 1, 1], dtype=int32), 'carrier': array([b'EV', b'OO', b'OO', b'DL', b'MQ'], dtype=object), 'dep_airport_lat': array([41.448334, 43.564445, 45.58861, 30.407223, 35.810833]), 'dep_airport_lon': array([-90.5075, -116.22278, -122.59695, -89.07, -83.99416], dtype=float32), 'arr_airport_lat': array([41.979443, 47.45, 34.200554, 33.636665, 32.896946], dtype=float32), 'arr_airport_lon': array([-87.9075, -122.31167, -118.35861, -84.42778, -97.038055], dtype=float32)}
1 {'ontime': array([1, 1, 1, 1, 1], dtype=int32), 'dep_delay': array([-4, 12, 6, -5, -4], dtype=int32), 'taxi_out': array([17, 7, 12, 7, 10], dtype=int32), 'distance': array([1482, 519, 651, 735, 763], dtype=int32), 'origin': array([b'BOI', b'BOI', b'SFO', b'BOI', b'PDX'], dtype=object), 'dest': array([b'IAH', b'LAS', b'PHX', b'PHX', b'LAS'], dtype=object), 'dep_hour': array([13, 0, 20, 19, 2], dtype=int32), 'is_weekday': array([0, 1, 1, 0, 1], dtype=int32), 'carrier': array([b'OO', b'WN', b'WN', b'WN', b'NK'], dtype=object), 'dep_airport_lat': array([43.564445, 43.564445, 37.61889, 43.564445, 45.58861], dtype=float32), 'dep_airport_lon': array([-116.22278, -116.22278, -122.375, -116.22278, -122.59695], dtype=float32), 'arr_airport_lat': array([29.984444, 36.08, 33.434166, 33.434166, 36.08], dtype=float32), 'arr_airport_lon': array([-95.34139, -115.15222, -112.011665, -112.011665, -115.15222], dtype=float32)}

```

```

In [11]: def features_and_labels(features):
    label = features.pop('ontime')
    return features, label

def read_dataset(pattern, batch_size, mode=tf.estimator.ModeKeys.TRAIN, truncate=None):
    dataset = tf.data.experimental.make_csv_dataset(pattern, batch_size, num_epochs=1)
    dataset = dataset.map(features_and_labels)
    if mode == tf.estimator.ModeKeys.TRAIN:
        dataset = dataset.shuffle(batch_size*10)
        dataset = dataset.repeat()
    dataset = dataset.prefetch(1)
    if truncate is not None:
        dataset = dataset.take(truncate)
    return dataset

if DEVELOP_MODE:
    print("Checking input pipeline")
    one_item = read_dataset(training_data_uri, batch_size=2, truncate=1)
    print(list(one_item)) # should print one batch of 2 items

```

```
Checking input pipeline
```

```
[OrderedDict([('dep_delay', <tf.Tensor: shape=(2,), dtype=int32, numpy=array([-10, -4], dtype=int32>)), ('taxi_out', <tf.Tensor: shape=(2,), dtype=int32, numpy=array([15, 10], dtype=int32>)), ('distance', <tf.Tensor: shape=(2,), dtype=int32, numpy=array([257, 190], dtype=int32>)), ('origin', <tf.Tensor: shape=(2,), dtype=string, numpy=array([b'RIC', b'AEX'], dtype=object>)), ('dest', <tf.Tensor: shape=(2,), dtype=string, numpy=array([b'CLT', b'IAH'], dtype=object>)), ('dep_hour', <tf.Tensor: shape=(2,), dtype=int32, numpy=array([0, 10], dtype=int32>)), ('is_weekday', <tf.Tensor: shape=(2,), dtype=int32, numpy=array([0, 1], dtype=int32>)), ('carrier', <tf.Tensor: shape=(2,), dtype=string, numpy=array([b'US', b'EV'], dtype=object>)), ('dep_airport_lat', <tf.Tensor: shape=(2,), dtype=float32, numpy=array([37.50528, 31.3275 ], dtype=float32>)), ('dep_airport_lon', <tf.Tensor: shape=(2,), dtype=float32, numpy=array([-77.319725, -92.548615], dtype=float32>)), ('arr_airport_lat', <tf.Tensor: shape=(2,), dtype=float32, numpy=array([35.21361 , 29.984444], dtype=float32>)), ('arr_airport_lon', <tf.Tensor: shape=(2,), dtype=float32, numpy=array([-80.949165, -95.34139 ], dtype=float32>)])], <tf.Tensor: shape=(2,), dtype=int32, numpy=array([1, 1], dtype=int32>)])]
```

```
In [12]: import tensorflow as tf
```

```
real = {
    colname : tf.feature_column.numeric_column(colname)
    for colname in
    (
        'dep_delay,taxi_out,distance,dep_hour,is_weekday,' +
        'dep_airport_lat,dep_airport_lon,' +
        'arr_airport_lat,arr_airport_lon'
    ).split(',')
}
sparse = {
    'carrier': tf.feature_column.categorical_column_with_vocabulary_list('carrier',
        vocabulary_list='AS,VX,F9,UA,US,WN,HA,EV,MQ,DL,OO,B6,NK,AA'.split(',')),
    'origin' : tf.feature_column.categorical_column_with_hash_bucket('origin', hash_bucket_size=1000),
    'dest'   : tf.feature_column.categorical_column_with_hash_bucket('dest', hash_bucket_size=1000),
}
```

```
In [13]:
```

```
inputs = {
    colname : tf.keras.layers.Input(name=colname, shape=(), dtype='float32')
    for colname in real.keys()
}
inputs.update({
    colname : tf.keras.layers.Input(name=colname, shape=(), dtype='string')
    for colname in sparse.keys()
})
```

```
In [14]: latbuckets = np.linspace(20.0, 50.0, NBUCKETS).tolist() # USA
lonbuckets = np.linspace(-120.0, -70.0, NBUCKETS).tolist() # USA
disc = {}
disc.update({
    'd_{}'.format(key) : tf.feature_column.bucketized_column(real[key], latbuckets)
        for key in ['dep_airport_lat', 'arr_airport_lat']
})
disc.update({
    'd_{}'.format(key) : tf.feature_column.bucketized_column(real[key], lonbuckets)
        for key in ['dep_airport_lon', 'arr_airport_lon']
})

# cross columns that make sense in combination
sparse['dep_loc'] = tf.feature_column.crossed_column(
    [disc['d_dep_airport_lat'], disc['d_dep_airport_lon']], NBUCKETS*NBUCKETS)
sparse['arr_loc'] = tf.feature_column.crossed_column(
    [disc['d_arr_airport_lat'], disc['d_arr_airport_lon']], NBUCKETS*NBUCKETS)
sparse['dep_arr'] = tf.feature_column.crossed_column([sparse['dep_loc'], sparse['arr_loc']], NBUCKETS ** 4)

# embed all the sparse columns
embed = {
    'embed_{}'.format(colname) : tf.feature_column.embedding_column(col, NMBEDS)
        for colname, col in sparse.items()
}
real.update(embed)

# one-hot encode the sparse columns
sparse = {
    colname : tf.feature_column.indicator_column(col)
        for colname, col in sparse.items()
}

if DEVELOP_MODE:
    print(sparse.keys())
    print(real.keys())

dict_keys(['carrier', 'origin', 'dest', 'dep_loc', 'arr_loc', 'dep_arr'])
dict_keys(['dep_delay', 'taxi_out', 'distance', 'dep_hour', 'is_weekday', 'dep_airport_lat', 'dep_airport_lon', 'arr_airport_lat', 'arr_airport_lon', 'embed_carrier', 'embed_origin', 'embed_dest', 'embed_dep_loc', 'embed_arr_loc', 'embed_dep_arr'])
```

```
In [15]: output_dir='gs://{}/ch9/trained_model'.format(BUCKET)
os.environ['OUTDIR'] = output_dir # needed for deployment
print('Writing trained model to {}'.format(output_dir))

Writing trained model to gs://qwiklabs-gcp-00-1faa2396f6a8-dsongcp/ch9/trained_model

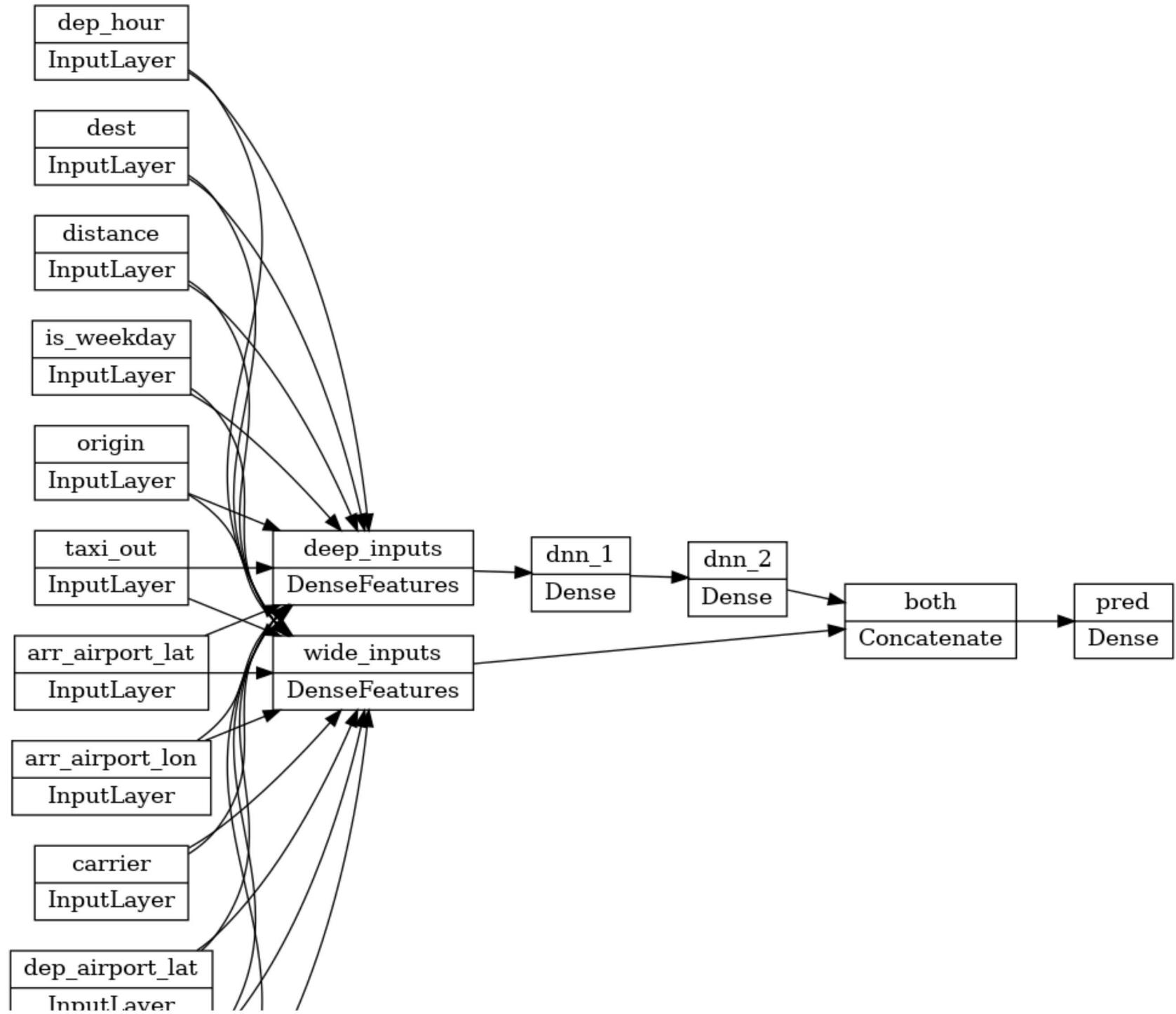
In [16]: !gsutil -m rm -rf $OUTDIR

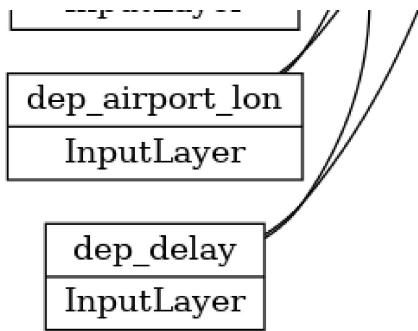
CommandException: 1 files/objects could not be removed.

In [17]: # Build a wide-and-deep model.
def wide_and_deep_classifier(inputs, linear_feature_columns, dnn_feature_columns, dnn_hidden_units):
    deep = tf.keras.layers.DenseFeatures(dnn_feature_columns, name='deep_inputs')(inputs)
    layers = [int(x) for x in dnn_hidden_units.split(',')]
    for layerno, numnodes in enumerate(layers):
        deep = tf.keras.layers.Dense(numnodes, activation='relu', name='dnn_{}'.format(layerno+1))(deep)
    wide = tf.keras.layers.DenseFeatures(linear_feature_columns, name='wide_inputs')(inputs)
    both = tf.keras.layers.concatenate([deep, wide], name='both')
    output = tf.keras.layers.Dense(1, activation='sigmoid', name='pred')(both)
    model = tf.keras.Model(inputs, output)
    model.compile(optimizer='adam',
                  loss='binary_crossentropy',
                  metrics=['accuracy'])
    return model

model = wide_and_deep_classifier(
    inputs,
    linear_feature_columns = sparse.values(),
    dnn_feature_columns = real.values(),
    dnn_hidden_units = DNN_HIDDEN_UNITS)
tf.keras.utils.plot_model(model, 'flights_model.png', show_shapes=False, rankdir='LR')
```

Out[17]:





```
In [18]: # training and evaluation dataset
train_batch_size = TRAIN_BATCH_SIZE
if DEVELOP_MODE:
    eval_batch_size = 100
    steps_per_epoch = 3
    epochs = 2
    num_eval_examples = eval_batch_size*10
else:
    eval_batch_size = 100
    steps_per_epoch = NUM_EXAMPLES // train_batch_size
    epochs = 10
    num_eval_examples = eval_batch_size * 100
train_dataset = read_dataset(training_data_uri, train_batch_size)
eval_dataset = read_dataset(validation_data_uri, eval_batch_size, tf.estimator.ModeKeys.EVAL, num_eval_examples)

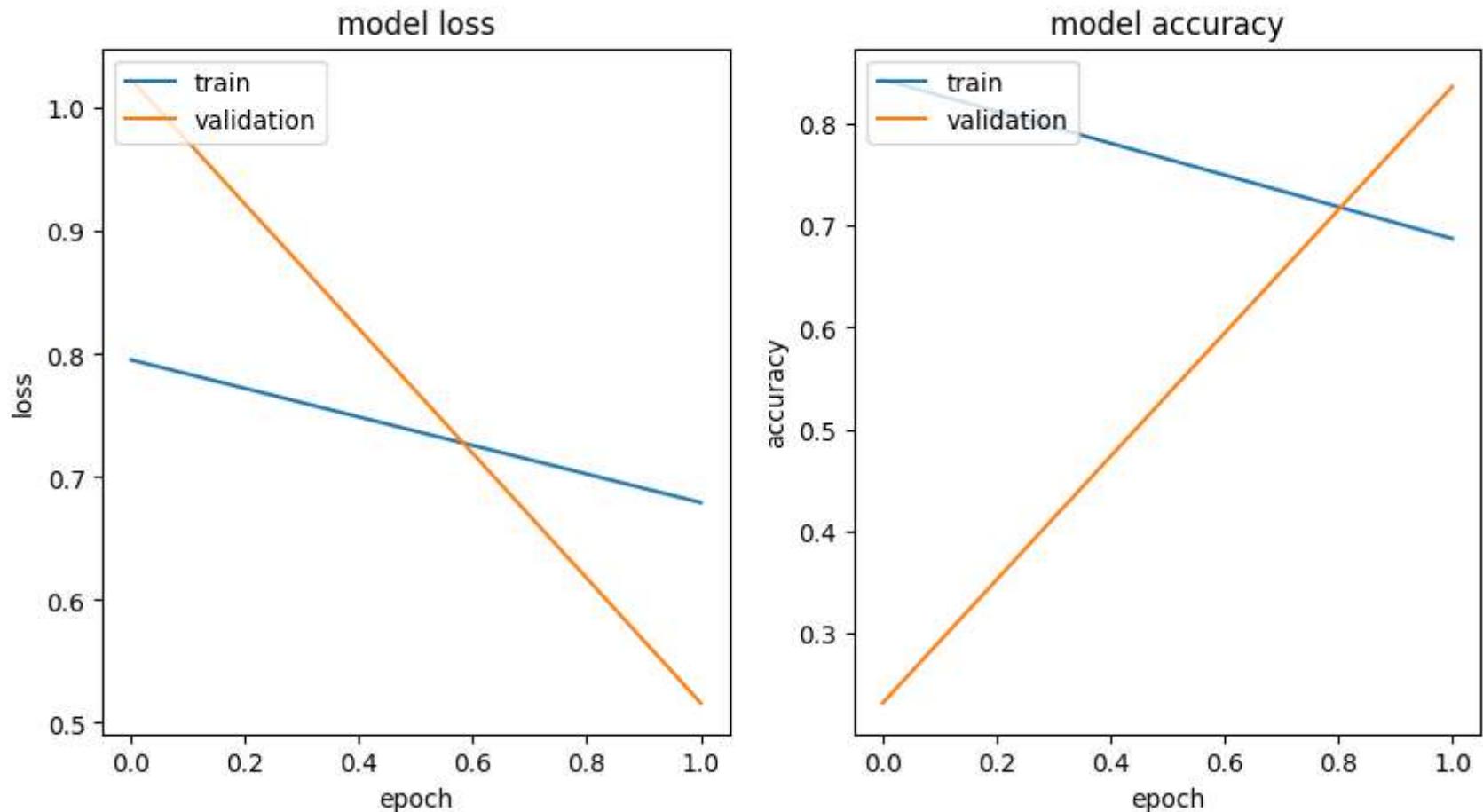
checkpoint_path = '{}/checkpoints/{}flights.cpt'.format(output_dir)
shutil.rmtree(checkpoint_path, ignore_errors=True)
cp_callback = tf.keras.callbacks.ModelCheckpoint(checkpoint_path,
                                                save_weights_only=True,
                                                verbose=1)

history = model.fit(train_dataset,
                    validation_data=eval_dataset,
                    epochs=epochs,
                    steps_per_epoch=steps_per_epoch,
                    callbacks=[cp_callback])
```

```
Epoch 1/2
1/3 [=====>.....] - ETA: 10s - loss: 1.2093 - accuracy: 0.8281
Epoch 1: saving model to gs://qwiklabs-gcp-00-1faa2396f6a8-dsongcp/ch9/trained_model/checkpoints/flights.cpt
3/3 [=====] - 21s 8s/step - loss: 0.7954 - accuracy: 0.8438 - val_loss: 1.0234 - val_accuracy: 0.2312
Epoch 2/2
1/3 [=====>.....] - ETA: 0s - loss: 0.8833 - accuracy: 0.4531
Epoch 2: saving model to gs://qwiklabs-gcp-00-1faa2396f6a8-dsongcp/ch9/trained_model/checkpoints/flights.cpt
3/3 [=====] - 8s 4s/step - loss: 0.6793 - accuracy: 0.6875 - val_loss: 0.5163 - val_accuracy: 0.8370
```

```
In [20]: import matplotlib.pyplot as plt
nrows = 1
ncols = 2
fig = plt.figure(figsize=(10, 5))

for idx, key in enumerate(['loss', 'accuracy']):
    ax = fig.add_subplot(nrows, ncols, idx+1)
    plt.plot(history.history[key])
    plt.plot(history.history['val_{}'.format(key)])
    plt.title('model {}'.format(key))
    plt.ylabel(key)
    plt.xlabel('epoch')
    plt.legend(['train', 'validation'], loc='upper left');
```



```
In [21]: import time
export_dir = '{}/export/flights_{}'.format(output_dir, time.strftime("%Y%m%d-%H%M%S"))
print('Exporting to {}'.format(export_dir))
tf.saved_model.save(model, export_dir)

Exporting to gs://qwiklabs-gcp-00-1faa2396f6a8-dsongcp/ch9/trained_model/export/flights_20231027-101122
WARNING:absl:Found untraced functions such as _update_step_xla while saving (showing 1 of 1). These functions will no
t be directly callable after loading.
INFO:tensorflow:Assets written to: gs://qwiklabs-gcp-00-1faa2396f6a8-dsongcp/ch9/trained_model/export/flights_2023102
7-101122/assets
INFO:tensorflow:Assets written to: gs://qwiklabs-gcp-00-1faa2396f6a8-dsongcp/ch9/trained_model/export/flights_2023102
7-101122/assets
```

In [22]:

```
%%bash
# note TF_VERSION and ENDPOINT_NAME set in 1st cell
# TF_VERSION=2-6
# ENDPOINT_NAME=flights

TIMESTAMP=$(date +%Y%m%d-%H%M%S)
MODEL_NAME=${ENDPOINT_NAME}-${TIMESTAMP}
EXPORT_PATH=$(gsutil ls ${OUTDIR}/export | tail -1)
echo $EXPORT_PATH

# create the model endpoint for deploying the model
if [[ $(gcloud beta ai endpoints list --region=$REGION \
    --format='value(DISPLAY_NAME)' --filter=display_name=${ENDPOINT_NAME}) ]]; then
    echo "Endpoint for $MODEL_NAME already exists"
else
    echo "Creating Endpoint for $MODEL_NAME"
    gcloud beta ai endpoints create --region=${REGION} --display-name=${ENDPOINT_NAME}
fi

ENDPOINT_ID=$(gcloud beta ai endpoints list --region=$REGION \
    --format='value(ENDPOINT_ID)' --filter=display_name=${ENDPOINT_NAME})
echo "ENDPOINT_ID=$ENDPOINT_ID"

# delete any existing models with this name
for MODEL_ID in $(gcloud beta ai models list --region=$REGION --format='value(MODEL_ID)' --filter=display_name=${MODEL_NAME})
do
    echo "Deleting existing $MODEL_NAME ... $MODEL_ID"
    gcloud ai models delete --region=$REGION $MODEL_ID
done

# create the model using the parameters docker container image and artifact uri
gcloud beta ai models upload --region=$REGION --display-name=$MODEL_NAME \
    --container-image-uri=us-docker.pkg.dev/vertex-ai/prediction/tf2-cpu.${TF_VERSION}:latest \
    --artifact-uri=$EXPORT_PATH
MODEL_ID=$(gcloud beta ai models list --region=$REGION --format='value(MODEL_ID)' --filter=display_name=${MODEL_NAME})
echo "MODEL_ID=$MODEL_ID"

# deploy the model to the endpoint
gcloud beta ai endpoints deploy-model $ENDPOINT_ID \
```

```
--region=$REGION \
--model=$MODEL_ID \
--display-name=$MODEL_NAME \
--machine-type=e2-standard-2 \
--min-replica-count=1 \
--max-replica-count=1 \
--traffic-split=0=100
```

```
gs://qwiklabs-gcp-00-1faa2396f6a8-dsongcp/ch9/trained_model/export/flights_20231027-101122/
```

```
Using endpoint [https://us-central1-aiplatform.googleapis.com/]
```

```
WARNING: The following filter keys were not present in any resource : display_name
```

```
Creating Endpoint for flights-20231027-101205
```

```
Using endpoint [https://us-central1-aiplatform.googleapis.com/]
```

```
Waiting for operation [4608902536022196224]....
```

```
.....done.
```

```
Created Vertex AI endpoint: projects/909412657992/locations/us-central1/endpoints/32037569810137088.
```

```
Using endpoint [https://us-central1-aiplatform.googleapis.com/]
```

```
ENDPOINT_ID=32037569810137088
```

```
Using endpoint [https://us-central1-aiplatform.googleapis.com/]
```

```
WARNING: The following filter keys were not present in any resource : display_name
```

```
Using endpoint [https://us-central1-aiplatform.googleapis.com/]
```

```
Waiting for operation [780842852757274624]....
```

```
.....done.
```

```
Using endpoint [https://us-central1-aiplatform.googleapis.com/]
```

MODEL_ID=1221801510040502272

Using endpoint [https://us-central1-aiplatform.googleapis.com/]

Waiting for operation [5482600863732072448]...

Deployed a model to the endpoint 32037569810137088. Id of the deployed model: 2801443477387214848.

```
In [23]: %%writefile example input.json
```

```
{"instances": [  
    {"dep_hour": 2, "is_weekday": 1, "dep_delay": 40, "taxi_out": 17, "distance": 41, "carrier": "AS", "dep_airport_lat":
```

```
{"dep_hour": 22, "is_weekday": 0, "dep_delay": -7, "taxi_out": 7, "distance": 201, "carrier": "HA", "dep_airport_lan  
]}
```

Writing example_input.json

In [24]:

```
%%bash  
ENDPOINT_ID=$(gcloud beta ai endpoints list --region=$REGION \  
    --format='value(ENDPOINT_ID)' --filter=display_name=${ENDPOINT_NAME})  
echo $ENDPOINT_ID  
gcloud beta ai endpoints predict $ENDPOINT_ID --region=$REGION --json-request=example_input.json
```

```
Using endpoint [https://us-central1-aiplatform.googleapis.com/]  
32037569810137088
```

```
Using endpoint [https://us-central1-prediction-aiplatform.googleapis.com/]  
[[0.926890075], [0.957278]]
```

In [25]:

```
%%bash  
PROJECT=$(gcloud config get-value project)  
ENDPOINT_ID=$(gcloud beta ai endpoints list --region=$REGION \  
    --format='value(ENDPOINT_ID)' --filter=display_name=${ENDPOINT_NAME})  
  
curl -X POST \  
    -H "Authorization: Bearer $(gcloud auth application-default print-access-token)" \  
    -H "Content-Type: application/json; charset=utf-8" \  
    -d @example_input.json \  
    "https://${REGION}-aiplatform.googleapis.com/v1/projects/${PROJECT}/locations/${REGION}/endpoints/${ENDPOINT_ID}:pr
```

```
Using endpoint [https://us-central1-aiplatform.googleapis.com/]  
% Total    % Received % Xferd  Average Speed   Time     Time      Time  Current  
                                  Dload  Upload  Total  Spent  Left  Speed  
100     831      0    288   100     543    6545  12340 --:--:-- --:--:-- --:--:-- 19325
```

```
{  
    "predictions": [  
        [  
            0.926890075  
        ],  
        [  
            0.957278  
        ]  
    ],  
    "deployedModelId": "2801443477387214848",  
    "model": "projects/909412657992/locations/us-central1/models/1221801510040502272",  
    "modelDisplayName": "flights-20231027-101205",  
    "modelVersionId": "1"  
}
```

In [26]:

```
%%bash  
model_dir=$(gsutil ls ${OUTDIR}/export | tail -1)  
echo $model_dir  
saved_model_cli show --tag_set serve --signature_def serving_default --dir $model_dir
```

```
gs://qwiklabs-gcp-00-1faa2396f6a8-dsongcp/ch9/trained_model/export/flights_20231027-101122/
```

```
2023-10-27 10:31:39.693814: I tensorflow/core/platform/cpu_feature_guard.cc:193] This TensorFlow binary is optimized with oneAPI Deep Neural Network Library (oneDNN) to use the following CPU instructions in performance-critical operations: AVX2 FMA
```

```
To enable them in other operations, rebuild TensorFlow with the appropriate compiler flags.
```

```
2023-10-27 10:31:41.014657: W tensorflow/compiler/xla/stream_executor/platform/default/dso_loader.cc:64] Could not load dynamic library 'libnvinfer.so.7'; dlerror: libnvinfer.so.7: cannot open shared object file: No such file or directory; LD_LIBRARY_PATH: /usr/local/cuda/lib64:/usr/local/nccl2/lib:/usr/local/cuda/extras/CUPTI/lib64
```

```
2023-10-27 10:31:41.015095: W tensorflow/compiler/xla/stream_executor/platform/default/dso_loader.cc:64] Could not load dynamic library 'libnvinfer_plugin.so.7'; dlerror: libnvinfer_plugin.so.7: cannot open shared object file: No such file or directory; LD_LIBRARY_PATH: /usr/local/cuda/lib64:/usr/local/nccl2/lib:/usr/local/cuda/extras/CUPTI/lib64
```

```
2023-10-27 10:31:41.015110: W tensorflow/compiler/tf2tensorrt/utils/py_utils.cc:38] TF-TRT Warning: Cannot dlopen some TensorRT libraries. If you would like to use Nvidia GPU with TensorRT, please make sure the missing libraries mentioned above are installed properly.
```

The given SavedModel SignatureDef contains the following input(s):

```
inputs['arr_airport_lat'] tensor_info:  
  dtype: DT_FLOAT  
  shape: (-1)  
  name: serving_default_arr_airport_lat:0  
inputs['arr_airport_lon'] tensor_info:  
  dtype: DT_FLOAT  
  shape: (-1)  
  name: serving_default_arr_airport_lon:0  
inputs['carrier'] tensor_info:  
  dtype: DT_STRING  
  shape: (-1)  
  name: serving_default_carrier:0  
inputs['dep_airport_lat'] tensor_info:  
  dtype: DT_FLOAT  
  shape: (-1)  
  name: serving_default_dep_airport_lat:0  
inputs['dep_airport_lon'] tensor_info:  
  dtype: DT_FLOAT  
  shape: (-1)  
  name: serving_default_dep_airport_lon:0  
inputs['dep_delay'] tensor_info:  
  dtype: DT_FLOAT  
  shape: (-1)  
  name: serving_default_dep_delay:0  
inputs['dep_hour'] tensor_info:  
  dtype: DT_FLOAT  
  shape: (-1)  
  name: serving_default_dep_hour:0  
inputs['dest'] tensor_info:  
  dtype: DT_STRING  
  shape: (-1)  
  name: serving_default_dest:0  
inputs['distance'] tensor_info:  
  dtype: DT_FLOAT  
  shape: (-1)  
  name: serving_default_distance:0  
inputs['is_weekday'] tensor_info:  
  dtype: DT_FLOAT  
  shape: (-1)  
  name: serving_default_is_weekday:0  
inputs['origin'] tensor_info:
```

```
dtype: DT_STRING
shape: (-1)
name: serving_default_origin:0
inputs['taxi_out'] tensor_info:
    dtype: DT_FLOAT
    shape: (-1)
    name: serving_default_taxi_out:0
The given SavedModel SignatureDef contains the following output(s):
outputs['pred'] tensor_info:
    dtype: DT_FLOAT
    shape: (-1, 1)
    name: StatefulPartitionedCall:0
Method name is: tensorflow/serving/predict
```

```
In [27]: cols = ('dep_delay,taxi_out,distance,dep_hour,is_weekday,' +
              'dep_airport_lat,dep_airport_lon,' +
              'arr_airport_lat,arr_airport_lon,' +
              'carrier,origin,dest')
inputs = {x: {"inputTensorName": "{}".format(x)}
          for x in cols.split(',')}

expl = {
    "inputs": inputs,
    "outputs": {
        "pred": {
            "outputTensorName": "pred"
        }
    }
}
print(expl)
with open('explanation-metadata.json', 'w') as ofp:
    json.dump(expl, ofp, indent=2)
```

```
{"inputs": {'dep_delay': {'inputTensorName': 'dep_delay'}, 'taxi_out': {'inputTensorName': 'taxi_out'}, 'distance': {'inputTensorName': 'distance'}, 'dep_hour': {'inputTensorName': 'dep_hour'}, 'is_weekday': {'inputTensorName': 'is_weekday'}, 'dep_airport_lat': {'inputTensorName': 'dep_airport_lat'}, 'dep_airport_lon': {'inputTensorName': 'dep_airport_lon'}, 'arr_airport_lat': {'inputTensorName': 'arr_airport_lat'}, 'arr_airport_lon': {'inputTensorName': 'arr_airport_lon'}, 'carrier': {'inputTensorName': 'carrier'}, 'origin': {'inputTensorName': 'origin'}, 'dest': {'inputTensorName': 'dest'}}, 'outputs': {'pred': {'outputTensorName': 'pred'}}}
```

```
In [28]: !cat explanation-metadata.json
```

```
{  
    "inputs": {  
        "dep_delay": {  
            "inputTensorName": "dep_delay"  
        },  
        "taxi_out": {  
            "inputTensorName": "taxi_out"  
        },  
        "distance": {  
            "inputTensorName": "distance"  
        },  
        "dep_hour": {  
            "inputTensorName": "dep_hour"  
        },  
        "is_weekday": {  
            "inputTensorName": "is_weekday"  
        },  
        "dep_airport_lat": {  
            "inputTensorName": "dep_airport_lat"  
        },  
        "dep_airport_lon": {  
            "inputTensorName": "dep_airport_lon"  
        },  
        "arr_airport_lat": {  
            "inputTensorName": "arr_airport_lat"  
        },  
        "arr_airport_lon": {  
            "inputTensorName": "arr_airport_lon"  
        },  
        "carrier": {  
            "inputTensorName": "carrier"  
        },  
        "origin": {  
            "inputTensorName": "origin"  
        },  
        "dest": {  
            "inputTensorName": "dest"  
        }  
    },  
    "outputs": {  
        "pred": {  
            "outputTensorName": "pred"  
        }  
    }  
}
```

```
    }
}
}
```

```
In [29]: %%bash
# note ENDPOINT_NAME is being changed

ENDPOINT_NAME=flights_xai

TIMESTAMP=$(date +%Y%m%d-%H%M%S)
MODEL_NAME=${ENDPOINT_NAME}-${TIMESTAMP}
EXPORT_PATH=$(gsutil ls ${OUTDIR}/export | tail -1)
echo $EXPORT_PATH

# create the model endpoint for deploying the model
if [[ $(gcloud beta ai endpoints list --region=$REGION \
        --format='value(DISPLAY_NAME)' --filter=display_name=${ENDPOINT_NAME}) ]]; then
    echo "Endpoint for $MODEL_NAME already exists"
else
    # create model endpoint
    echo "Creating Endpoint for $MODEL_NAME"
    gcloud beta ai endpoints create --region=${REGION} --display-name=${ENDPOINT_NAME}
fi

ENDPOINT_ID=$(gcloud beta ai endpoints list --region=$REGION \
        --format='value(ENDPOINT_ID)' --filter=display_name=${ENDPOINT_NAME})
echo "ENDPOINT_ID=$ENDPOINT_ID"

# delete any existing models with this name
for MODEL_ID in $(gcloud beta ai models list --region=$REGION --format='value(MODEL_ID)' --filter=display_name=${MODEL_NAME})
do
    echo "Deleting existing $MODEL_NAME ... $MODEL_ID"
    gcloud ai models delete --region=$REGION $MODEL_ID
done

# upload the model using the parameters docker container image, artifact URI, explanation method,
# explanation path count and explanation metadata JSON file `explanation-metadata.json`.
# Here, you keep number of feature permutations to `10` when approximating the Shapley values for explanation.
gcloud beta ai models upload --region=$REGION --display-name=$MODEL_NAME \
    --container-image-uri=us-docker.pkg.dev/vertex-ai/prediction/tf2-cpu.${TF_VERSION}:latest \
    --artifact-uri=$EXPORT_PATH \
```

```
--explanation-method=sampled-shapley --explanation-path-count=10 --explanation-metadata-file=explanation-metadata.json  
MODEL_ID=$(gcloud beta ai models list --region=$REGION --format='value(MODEL_ID)' --filter=display_name=${MODEL_NAME})  
echo "MODEL_ID=$MODEL_ID"  
  
# deploy the model to the endpoint  
gcloud beta ai endpoints deploy-model $ENDPOINT_ID \  
  --region=$REGION \  
  --model=$MODEL_ID \  
  --display-name=$MODEL_NAME \  
  --machine-type=e2-standard-2 \  
  --min-replica-count=1 \  
  --max-replica-count=1 \  
  --traffic-split=0=100
```

```
gs://qwiklabs-gcp-00-1faa2396f6a8-dsongcp/ch9/trained_model/export/flights_20231027-101122/  
Using endpoint [https://us-central1-aiplatform.googleapis.com/]  
Creating Endpoint for flights_xai-20231027-103206  
Using endpoint [https://us-central1-aiplatform.googleapis.com/]  
Waiting for operation [5201125887021416448]...  
.....done.  
Created Vertex AI endpoint: projects/909412657992/locations/us-central1/endpoints/3002161524060979200.  
Using endpoint [https://us-central1-aiplatform.googleapis.com/]  
ENDPOINT_ID=3002161524060979200
```

```
Using endpoint [https://us-central1-aiplatform.googleapis.com/]
Using endpoint [https://us-central1-aiplatform.googleapis.com/]
Waiting for operation [7506968896235110400]....
```

```
.....done.  
Using endpoint [https://us-central1-aiplatform.googleapis.com/]  
MODEL_ID=7641682778857144320
```

```
Using endpoint [https://us-central1-aiplatform.googleapis.com/]
Waiting for operation [6047802616967069696]...
```

Deployed a model to the endpoint 3002161524060979200. Id of the deployed model: 9219072946390171648.

```
In [30]: %%bash
PROJECT=$(gcloud config get-value project)
ENDPOINT_NAME=flights_xai
ENDPOINT_ID=$(gcloud beta ai endpoints list --region=$REGION \
--format='value(ENDPOINT_ID)' --filter=display_name=${ENDPOINT_NAME})
curl -X POST \
-H "Authorization: Bearer "$(gcloud auth application-default print-access-token) \
-H "Content-Type: application/json; charset=utf-8" \
-d @example_input.json \
"https://$REGION-aiplatform.googleapis.com/v1/projects/${PROJECT}/locations/${REGION}/endpoints/${ENDPOINT_ID}:e"
```

Using endpoint [https://us-central1-aiplatform.googleapis.com/]

% Total	% Received	% Xferd	Average Speed	Time	Time	Time	Current	
			Dload	Upload	Total	Spent	Left	Speed
100	2565	0	2022	100	543	1084	291	0:00:01 0:00:01 --:--:-- 1374

```
{
  "explanations": [
    {
      "attributions": [
        {
          "baselineOutputValue": 0.4814104437828064,
          "instanceOutputValue": 0.92689007520675659,
          "featureAttributions": {
            "arr_airport_lat": 0.012236481904983521,
            "is_weekday": 7.8344345092773443e-05,
            "dep_hour": -0.00032297968864440922,
            "carrier": -0.0042679339647293093,
            "taxi_out": 0.01464505195617676,
            "dest": -0.0044649451971054081,
            "origin": 0.002099451422691345,
            "arr_airport_lon": 0.22734341621398929,
            "distance": -0.01111119985580444,
            "dep_delay": -0.019465786218643189,
            "dep_airport_lat": -0.036380970478057863,
            "dep_airport_lon": 0.26509070098400123
          },
          "outputIndex": [
            0
          ],
          "approximationError": 0.0073992277309606674,
          "outputName": "pred"
        }
      ]
    },
    {
      "attributions": [
        {
          "baselineOutputValue": 0.4814104437828064,
          "instanceOutputValue": 0.95727801322937012,
          "featureAttributions": {
            "dest": -0.0013206243515014649,
            "taxi_out": 0.0040607839822769162,
            "arr_airport_lat": -0.00035924315452575691,
            "is_weekday": 0,
            "dep_delay": 0.0033104181289672851,
            "dep_airport_lat": -0.019813460111618039,
            "dep_airport_lon": 0.22744063735008241,
            "arr_airport_lon": 0.22734341621398929
          }
        }
      ]
    }
  ]
}
```

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"arr_airport_lon": 0.24395929872989661,  
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"origin": 0.0038990139961242671,  
"carrier": -0.0043752372264862062  
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"outputIndex": [  
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"approximationError": 0.0077874558835109289,  
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"deployedModelId": "9219072946390171648",  
"predictions": [  
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]  
}
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In []: