exploration_ce

November 23, 2021

[1]:
```
import os
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
```

[2]:
```
for dirname, _, filenames in os.walk('../../
 ↪bigquery-geotab-intersection-congestion'):
    for filename in filenames:
        print(os.path.join(dirname, filename))
```

```
../../bigquery-geotab-intersection-congestion\BigQuery-Dataset-Access.md
../../bigquery-geotab-intersection-congestion\sample_submission.csv
../../bigquery-geotab-intersection-congestion\submission_metric_map
../../bigquery-geotab-intersection-congestion\submission_metric_map.json
../../bigquery-geotab-intersection-congestion\test.csv
../../bigquery-geotab-intersection-congestion\train.csv
```

[3]:
```
df_train = pd.read_csv('../../bigquery-geotab-intersection-congestion/train.
 ↪csv')
df_test = pd.read_csv('../../bigquery-geotab-intersection-congestion/test.csv')
```

[4]:
```
df_train.head()
```

[4]:
```
     RowId  IntersectionId   Latitude  Longitude  \
0  1921357               0  33.791659 -84.430032
1  1921358               0  33.791659 -84.430032
2  1921359               0  33.791659 -84.430032
3  1921360               0  33.791659 -84.430032
4  1921361               0  33.791659 -84.430032

               EntryStreetName                ExitStreetName EntryHeading  \
0  Marietta Boulevard Northwest  Marietta Boulevard Northwest           NW
1  Marietta Boulevard Northwest  Marietta Boulevard Northwest           SE
2  Marietta Boulevard Northwest  Marietta Boulevard Northwest           NW
3  Marietta Boulevard Northwest  Marietta Boulevard Northwest           SE
4  Marietta Boulevard Northwest  Marietta Boulevard Northwest           NW
```

```
  ExitHeading  Hour  Weekend  ...  TimeFromFirstStop_p40  \
0          NW     0        0  ...                    0.0
1          SE     0        0  ...                    0.0
2          NW     1        0  ...                    0.0
3          SE     1        0  ...                    0.0
4          NW     2        0  ...                    0.0

  TimeFromFirstStop_p50  TimeFromFirstStop_p60  TimeFromFirstStop_p80  \
0                   0.0                    0.0                    0.0
1                   0.0                    0.0                    0.0
2                   0.0                    0.0                    0.0
3                   0.0                    0.0                    0.0
4                   0.0                    0.0                    0.0

   DistanceToFirstStop_p20  DistanceToFirstStop_p40  DistanceToFirstStop_p50  \
0                      0.0                      0.0                      0.0
1                      0.0                      0.0                      0.0
2                      0.0                      0.0                      0.0
3                      0.0                      0.0                      0.0
4                      0.0                      0.0                      0.0

   DistanceToFirstStop_p60  DistanceToFirstStop_p80     City
0                      0.0                      0.0  Atlanta
1                      0.0                      0.0  Atlanta
2                      0.0                      0.0  Atlanta
3                      0.0                      0.0  Atlanta
4                      0.0                      0.0  Atlanta

[5 rows x 28 columns]
```

```
[5]: df_train.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 856387 entries, 0 to 856386
Data columns (total 28 columns):
 #   Column                   Non-Null Count   Dtype
---  ------                   --------------   -----
 0   RowId                    856387 non-null  int64
 1   IntersectionId           856387 non-null  int64
 2   Latitude                 856387 non-null  float64
 3   Longitude                856387 non-null  float64
 4   EntryStreetName          848239 non-null  object
 5   ExitStreetName           850100 non-null  object
 6   EntryHeading             856387 non-null  object
 7   ExitHeading              856387 non-null  object
 8   Hour                     856387 non-null  int64
 9   Weekend                  856387 non-null  int64
 10  Month                    856387 non-null  int64
 11  Path                     856387 non-null  object
 12  TotalTimeStopped_p20     856387 non-null  float64
 13  TotalTimeStopped_p40     856387 non-null  float64
 14  TotalTimeStopped_p50     856387 non-null  float64
 15  TotalTimeStopped_p60     856387 non-null  float64
 16  TotalTimeStopped_p80     856387 non-null  float64
 17  TimeFromFirstStop_p20    856387 non-null  float64
 18  TimeFromFirstStop_p40    856387 non-null  float64
 19  TimeFromFirstStop_p50    856387 non-null  float64
 20  TimeFromFirstStop_p60    856387 non-null  float64
 21  TimeFromFirstStop_p80    856387 non-null  float64
 22  DistanceToFirstStop_p20  856387 non-null  float64
 23  DistanceToFirstStop_p40  856387 non-null  float64
 24  DistanceToFirstStop_p50  856387 non-null  float64
 25  DistanceToFirstStop_p60  856387 non-null  float64
 26  DistanceToFirstStop_p80  856387 non-null  float64
 27  City                     856387 non-null  object
dtypes: float64(17), int64(5), object(6)
memory usage: 182.9+ MB
```

[6]:

```
df_train.dropna()
df_test.dropna()

summary_table = df_train.describe()
summary_table
```

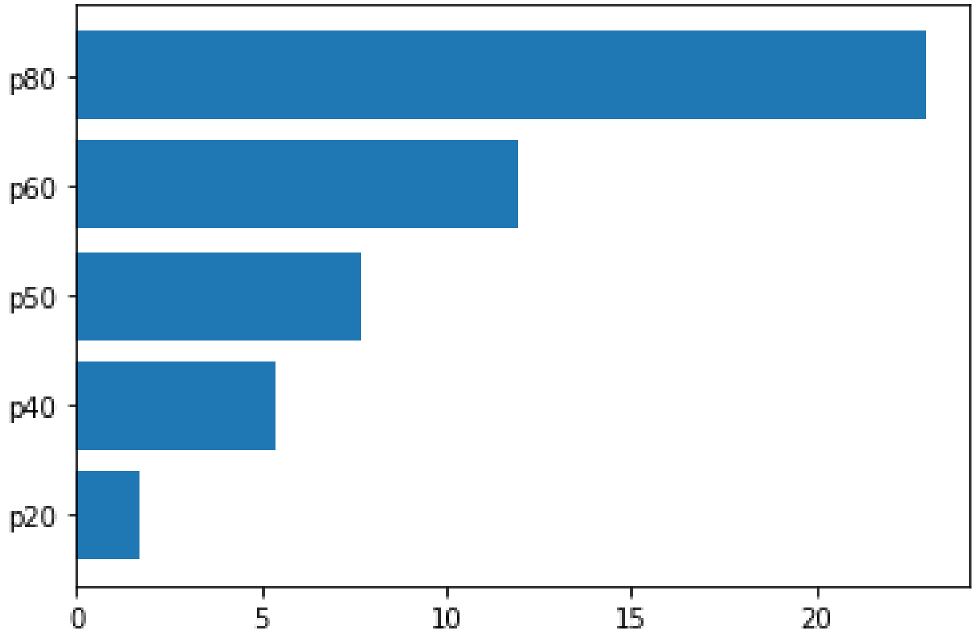
[6]:

```
              RowId  IntersectionId       Latitude      Longitude  \
count  8.563870e+05   856387.000000  856387.000000  856387.000000
mean   2.349550e+06      833.283384      39.618965     -77.916488
std    2.472178e+05      654.308913       2.935437       5.952959
min    1.921357e+06        0.000000      33.649973     -87.862288
25%    2.135454e+06      291.000000      39.936739     -84.387607
50%    2.349550e+06      679.000000      39.982974     -75.175055
75%    2.563646e+06     1264.000000      41.910047     -75.100495
max    2.777743e+06     2875.000000      42.381782     -71.025550

                Hour        Weekend          Month  TotalTimeStopped_p20  \
count  856387.000000  856387.000000  856387.000000         856387.000000
mean       12.431234       0.277880       9.104808              1.755596
std         6.071843       0.447954       1.991094              7.146549
min         0.000000       0.000000       1.000000              0.000000
25%         8.000000       0.000000       7.000000              0.000000
50%        13.000000       0.000000       9.000000              0.000000
75%        17.000000       1.000000      11.000000              0.000000
max        23.000000       1.000000      12.000000            298.000000

       TotalTimeStopped_p40  TotalTimeStopped_p50  ...  TimeFromFirstStop_p20  \
count         856387.000000         856387.000000  ...          856387.000000
```

```
mean               5.403592              7.722655  ...               3.181096
std               12.981674             15.685910  ...              11.835994
min                0.000000              0.000000  ...               0.000000
25%                0.000000              0.000000  ...               0.000000
50%                0.000000              0.000000  ...               0.000000
75%                0.000000             10.000000  ...               0.000000
max              375.000000            375.000000  ...             337.000000

       TimeFromFirstStop_p40  TimeFromFirstStop_p50  TimeFromFirstStop_p60  \
count          856387.000000          856387.000000          856387.000000
mean                9.162174              12.722165              18.926085
std                20.446568              24.219271              29.851797
min                 0.000000               0.000000               0.000000
25%                 0.000000               0.000000               0.000000
50%                 0.000000               0.000000               0.000000
75%                 0.000000              22.000000              31.000000
max               356.000000             356.000000             357.000000

       TimeFromFirstStop_p80  DistanceToFirstStop_p20  \
count          856387.000000            856387.000000
mean               34.201656                 6.765856
std                41.130668                29.535968
min                 0.000000                 0.000000
25%                 0.000000                 0.000000
50%                27.000000                 0.000000
75%                49.000000                 0.000000
max               359.000000              1901.900000

       DistanceToFirstStop_p40  DistanceToFirstStop_p50  \
count            856387.000000            856387.000000
mean                 20.285128                28.837113
std                  59.202108                75.217343
min                   0.000000                 0.000000
25%                   0.000000                 0.000000
50%                   0.000000                 0.000000
75%                   0.000000                53.100000
max                2844.400000              2851.100000

       DistanceToFirstStop_p60  DistanceToFirstStop_p80
count             856387.00000            856387.000000
mean                  44.27231                83.991313
std                  102.03225               160.709797
min                    0.00000                 0.000000
25%                    0.00000                 0.000000
50%                    0.00000                60.400000
75%                   64.20000                85.950000
max                 3282.40000              4079.200000
```

```
[8 rows x 22 columns]
```

[7]:
```
names = ['TotalTimeStopped_p20',
         'TotalTimeStopped_p40',
         'TotalTimeStopped_p50',
         'TotalTimeStopped_p60',
         'TotalTimeStopped_p80']
x = [summary_table[name]['mean'] for name in names]
labels = [name[-3:] for name in names]

plt.barh(labels, x)

plt.show()
```



[8]:
```
numerical_cols = [col for col in summary_table.columns]
categorical_cols = [col for col in df_train.columns if col not in␣
 ↪numerical_cols]

for col in categorical_cols:
    print(col)
```

```
EntryStreetName
ExitStreetName
EntryHeading
ExitHeading
```

```
Path
City
```

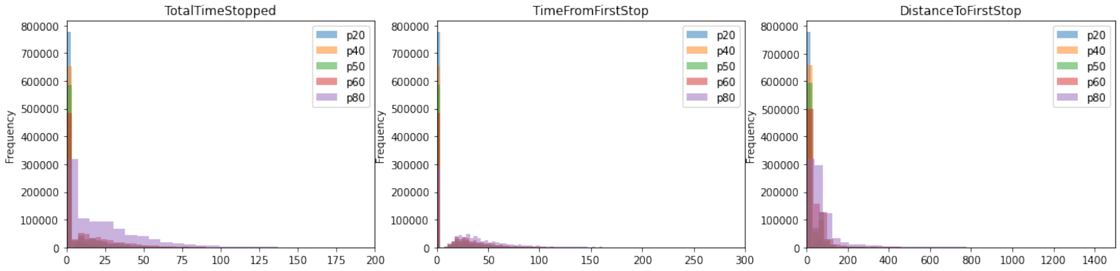
[9]:
```
# Dummy variables

# Training
df_train = pd.concat([df_train, pd.get_dummies(df_train['EntryHeading'],
                                               prefix='entry')],
                     axis=1)
df_train = pd.concat([df_train, pd.get_dummies(df_train['ExitHeading'],
                                               prefix='exit')],
                     axis=1)
df_train = pd.concat([df_train, pd.get_dummies(df_train['City'],
                                               prefix='c')],
                     axis=1)
# Test
df_test = pd.concat([df_test, pd.get_dummies(df_test['EntryHeading'],
                                               prefix='entry')],
                     axis=1)
df_test = pd.concat([df_test, pd.get_dummies(df_test['ExitHeading'],
                                               prefix='exit')],
                     axis=1)
df_test = pd.concat([df_test, pd.get_dummies(df_test['City'],
                                               prefix='c')],
                     axis=1)
```

[10]:
```
numerical_cols = [col for col in summary_table.columns]
categorical_cols = [col for col in df_train.columns if col not in␣
 ↪numerical_cols]

for col in categorical_cols:
    print(col)
```

```
EntryStreetName
ExitStreetName
EntryHeading
ExitHeading
Path
City
entry_E
entry_N
entry_NE
entry_NW
entry_S
entry_SE
entry_SW
entry_W
exit_E
```

```
exit_N
exit_NE
exit_NW
exit_S
exit_SE
exit_SW
exit_W
c_Atlanta
c_Boston
c_Chicago
c_Philadelphia
```

[11]:
```python
targets = ['TotalTimeStopped', 'TimeFromFirstStop', 'DistanceToFirstStop']
percentiles = ['p20', 'p40', 'p50', 'p60', 'p80']

plt.figure(figsize=(16, 4))
kwargs = dict(alpha=0.5, bins=100)
xlims = [200, 300, 1500]

i = 1
for target in targets:
    plt.subplot(int('13' + str(i)), label=target)
    for percentile in percentiles:
        plt.hist(df_train[target+'_'+percentile], **kwargs, label=percentile)
    plt.gca().set(title=target, ylabel='Frequency')
    plt.xlim(0, xlims[i-1])
    plt.legend()
    i += 1

plt.subplots_adjust(right = 1)
plt.show()
```



[12]:
```python
from sklearn import metrics
from sklearn.model_selection import train_test_split
from sklearn.multioutput import MultiOutputRegressor as MOR

from sklearn.ensemble import GradientBoostingRegressor
from sklearn.ensemble import RandomForestRegressor
from sklearn.linear_model import LinearRegression
```

[13]:

```
X = df_train[["IntersectionId","Hour","Weekend","Month",'entry_E', 'entry_N',␣
 ↪'entry_NE',
              'entry_NW', 'entry_S', 'entry_SE', 'entry_SW', 'entry_W',␣
 ↪'exit_E', 'exit_N',
              'exit_NE', 'exit_NW', 'exit_S', 'exit_SE', 'exit_SW', 'exit_W',
              'c_Atlanta', 'c_Boston', 'c_Chicago', 'c_Philadelphia']]
y = pd.concat([df_train[f'{targets[0]}_{perc}'] for perc in percentiles],␣
 ↪axis=1)

X_train, X_val, y_train, y_val = train_test_split(X, y, test_size=.2)

X_test = df_test[["IntersectionId","Hour","Weekend","Month",'entry_E',␣
 ↪'entry_N', 'entry_NE',
                  'entry_NW', 'entry_S', 'entry_SE', 'entry_SW', 'entry_W',␣
 ↪'exit_E', 'exit_N',
                  'exit_NE', 'exit_NW', 'exit_S', 'exit_SE', 'exit_SW',␣
 ↪'exit_W',
                  'c_Atlanta', 'c_Boston', 'c_Chicago', 'c_Philadelphia']]
```

[15]:

```
# TODO research good regressors for this data
models = {
    'gbr': GradientBoostingRegressor,
    'rfr': RandomForestRegressor,
    'lr': LinearRegression
}
# TODO research hyperparameters for the models
# params = {
#     'gbr': {
#         'loss': ['squared_error', 'absolute_error', 'huber', 'quantile'],
#         'learning_rate': [.01, .1,]
#     }
# }
# TODO: Normalization, pipelining
```

[16]:

```
preds = {}
for model in models:
    preds[model] = np.asarray(MOR(models[model]()).fit(X_train, y_train).
 ↪predict(X_val))
```

[17]:

```
for model in models:
    print(model)
    i = 0
    for col in y_val:
        print(metrics.mean_squared_error(y_val[col].values, preds[model].T[i],␣
 ↪squared=False))
```

```python
        i += 1
    print()
```

```
gbr
7.054760286217763
12.579387954820882
15.004284745473528
18.78764257177234
26.54303354817789

rfr
6.135557352863927
9.365125300660246
10.639747714059608
12.829687150920739
18.07481494270436

lr
7.200918975835944
13.036677664109
15.6153572658614
19.594620751784458
27.776653280428995
```

[ ]:

```python
# I set up test but never used it
```