delhivery

February 9, 2025

1 Delhivery Data Analysis

1.1 Data

[1]:
```
import pandas as pd
import numpy as np
pd.set_option('display.max_columns', None)
```

[2]:
```
df = pd.read_csv('delhivery_data.csv')
df.head()
```

[2]:
```
       data          trip_creation_time  \
0  training  2018-09-20 02:35:36.476840
1  training  2018-09-20 02:35:36.476840
2  training  2018-09-20 02:35:36.476840
3  training  2018-09-20 02:35:36.476840
4  training  2018-09-20 02:35:36.476840

                              route_schedule_uuid route_type  \
0  thanos::sroute:eb7bfc78-b351-4c0e-a951-fa3d5c3…    Carting
1  thanos::sroute:eb7bfc78-b351-4c0e-a951-fa3d5c3…    Carting
2  thanos::sroute:eb7bfc78-b351-4c0e-a951-fa3d5c3…    Carting
3  thanos::sroute:eb7bfc78-b351-4c0e-a951-fa3d5c3…    Carting
4  thanos::sroute:eb7bfc78-b351-4c0e-a951-fa3d5c3…    Carting

                 trip_uuid source_center                 source_name  \
0  trip-153741093647649320  IND388121AAA  Anand_VUNagar_DC (Gujarat)
1  trip-153741093647649320  IND388121AAA  Anand_VUNagar_DC (Gujarat)
2  trip-153741093647649320  IND388121AAA  Anand_VUNagar_DC (Gujarat)
3  trip-153741093647649320  IND388121AAA  Anand_VUNagar_DC (Gujarat)
4  trip-153741093647649320  IND388121AAA  Anand_VUNagar_DC (Gujarat)

  destination_center              destination_name  \
0       IND388620AAB  Khambhat_MotvdDPP_D (Gujarat)
1       IND388620AAB  Khambhat_MotvdDPP_D (Gujarat)
2       IND388620AAB  Khambhat_MotvdDPP_D (Gujarat)
3       IND388620AAB  Khambhat_MotvdDPP_D (Gujarat)
4       IND388620AAB  Khambhat_MotvdDPP_D (Gujarat)
```

```
                 od_start_time                 od_end_time  \
0  2018-09-20 03:21:32.418600  2018-09-20 04:47:45.236797
1  2018-09-20 03:21:32.418600  2018-09-20 04:47:45.236797
2  2018-09-20 03:21:32.418600  2018-09-20 04:47:45.236797
3  2018-09-20 03:21:32.418600  2018-09-20 04:47:45.236797
4  2018-09-20 03:21:32.418600  2018-09-20 04:47:45.236797

   start_scan_to_end_scan  is_cutoff  cutoff_factor  \
0                    86.0       True              9
1                    86.0       True             18
2                    86.0       True             27
3                    86.0       True             36
4                    86.0      False             39

             cutoff_timestamp  actual_distance_to_destination  actual_time  \
0         2018-09-20 04:27:55                       10.435660         14.0
1         2018-09-20 04:17:55                       18.936842         24.0
2  2018-09-20 04:01:19.505586                       27.637279         40.0
3         2018-09-20 03:39:57                       36.118028         62.0
4         2018-09-20 03:33:55                       39.386040         68.0

   osrm_time  osrm_distance    factor  segment_actual_time  segment_osrm_time  \
0       11.0        11.9653  1.272727                 14.0               11.0
1       20.0        21.7243  1.200000                 10.0                9.0
2       28.0        32.5395  1.428571                 16.0                7.0
3       40.0        45.5620  1.550000                 21.0               12.0
4       44.0        54.2181  1.545455                  6.0                5.0

   segment_osrm_distance  segment_factor
0                11.9653        1.272727
1                 9.7590        1.111111
2                10.8152        2.285714
3                13.0224        1.750000
4                 3.9153        1.200000
```

[3]:
```
df.shape
```

[3]:
```
(144867, 24)
```

[4]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 144867 entries, 0 to 144866
Data columns (total 24 columns):
 #   Column                        Non-Null Count   Dtype
---  ------                        --------------   -----
 0   data                          144867 non-null  object
```

```
 1   trip_creation_time              144867 non-null  object
 2   route_schedule_uuid             144867 non-null  object
 3   route_type                      144867 non-null  object
 4   trip_uuid                       144867 non-null  object
 5   source_center                   144867 non-null  object
 6   source_name                     144574 non-null  object
 7   destination_center              144867 non-null  object
 8   destination_name                144606 non-null  object
 9   od_start_time                   144867 non-null  object
 10  od_end_time                     144867 non-null  object
 11  start_scan_to_end_scan          144867 non-null  float64
 12  is_cutoff                       144867 non-null  bool
 13  cutoff_factor                   144867 non-null  int64
 14  cutoff_timestamp                144867 non-null  object
 15  actual_distance_to_destination  144867 non-null  float64
 16  actual_time                     144867 non-null  float64
 17  osrm_time                       144867 non-null  float64
 18  osrm_distance                   144867 non-null  float64
 19  factor                          144867 non-null  float64
 20  segment_actual_time             144867 non-null  float64
 21  segment_osrm_time               144867 non-null  float64
 22  segment_osrm_distance           144867 non-null  float64
 23  segment_factor                  144867 non-null  float64
dtypes: bool(1), float64(10), int64(1), object(12)
memory usage: 25.6+ MB
```

[5]:
```
df['trip_creation_time'] = pd.to_datetime(df['trip_creation_time'])
df['od_start_time'] = pd.to_datetime(df['od_start_time'])
df['od_end_time'] = pd.to_datetime(df['od_end_time'])
df['cutoff_timestamp'] = pd.to_datetime(df['cutoff_timestamp'], format='mixed')
```

[6]:
```
df.isna().sum()
```

[6]:
```
data                            0
trip_creation_time              0
route_schedule_uuid             0
route_type                      0
trip_uuid                       0
source_center                   0
source_name                   293
destination_center              0
destination_name              261
od_start_time                   0
od_end_time                     0
start_scan_to_end_scan          0
is_cutoff                       0
cutoff_factor                   0
```

```
cutoff_timestamp                    0
actual_distance_to_destination      0
actual_time                         0
osrm_time                           0
osrm_distance                       0
factor                              0
segment_actual_time                 0
segment_osrm_time                   0
segment_osrm_distance               0
segment_factor                      0
dtype: int64
```

[7]:
```
df[df['segment_factor'].isna()]
```

[7]:
```
Empty DataFrame
Columns: [data, trip_creation_time, route_schedule_uuid, route_type, trip_uuid,
source_center, source_name, destination_center, destination_name, od_start_time,
od_end_time, start_scan_to_end_scan, is_cutoff, cutoff_factor, cutoff_timestamp,
actual_distance_to_destination, actual_time, osrm_time, osrm_distance, factor,
segment_actual_time, segment_osrm_time, segment_osrm_distance, segment_factor]
Index: []
```

We found `source_name` and `destination_name` have null values. As `source_name` and `destination_name` can be identified by `source_center` and `destination_center`, we can remove them.

[8]:
```
# # We need to check whether there exist one to one mapping between␣
 ↪source_center adn source_name
# def exists_one_one_mapping(x,y):
#     checker = {}
#     for center, name in df[[x,y]].values:
#         if not pd.isna(name):
#             if center in checker and checker[center]!=name:
#                 return False, {}
#             checker[center] = name
#     return True, checker
# source_map = exists_one_one_mapping('source_center','source_name')
# destination_map =␣
 ↪exists_one_one_mapping('destination_center','destination_name')
# print(source_map[0])
# print(destination_map[0])
# df['source_name'] = df['source_center'].map(source_map[1])
# df['destination_name'] = df['destination_center'].map(destination_map[1])
# # Check every common keys having common values
# # For every same key, both must have same value.
# common_keys = source_map[1].keys() & destination_map[1].keys()
# common_elements = {k for k, v in source_map[1].items() if k in␣
 ↪destination_map[1] and destination_map[1][k] == v}
```

```
# print(common_elements==common_keys)
# combined_map = source_map[1] | destination_map[1]
# df['source_name'] = df['source_center'].map(combined_map)
# df['destination_name'] = df['destination_center'].map(combined_map)
```

[9]:
```
df[df['trip_uuid']=='trip-153741093647649320']
```

[9]:

	data	trip_creation_time	route_schedule_uuid	route_type	trip_uuid	source_center	source_name	destination_center	destination_name
0	training	2018-09-20 02:35:36.476840	thanos::sroute:eb7bfc78-b351-4c0e-a951-fa3d5c3…	Carting	trip-153741093647649320	IND388121AAA	Anand_VUNagar_DC (Gujarat)	IND388620AAB	Khambhat_MotvdDPP_D (Gujarat)
1	training	2018-09-20 02:35:36.476840	thanos::sroute:eb7bfc78-b351-4c0e-a951-fa3d5c3…	Carting	trip-153741093647649320	IND388121AAA	Anand_VUNagar_DC (Gujarat)	IND388620AAB	Khambhat_MotvdDPP_D (Gujarat)
2	training	2018-09-20 02:35:36.476840	thanos::sroute:eb7bfc78-b351-4c0e-a951-fa3d5c3…	Carting	trip-153741093647649320	IND388121AAA	Anand_VUNagar_DC (Gujarat)	IND388620AAB	Khambhat_MotvdDPP_D (Gujarat)
3	training	2018-09-20 02:35:36.476840	thanos::sroute:eb7bfc78-b351-4c0e-a951-fa3d5c3…	Carting	trip-153741093647649320	IND388121AAA	Anand_VUNagar_DC (Gujarat)	IND388620AAB	Khambhat_MotvdDPP_D (Gujarat)
4	training	2018-09-20 02:35:36.476840	thanos::sroute:eb7bfc78-b351-4c0e-a951-fa3d5c3…	Carting	trip-153741093647649320	IND388121AAA	Anand_VUNagar_DC (Gujarat)	IND388620AAB	Khambhat_MotvdDPP_D (Gujarat)
5	training	2018-09-20 02:35:36.476840	thanos::sroute:eb7bfc78-b351-4c0e-a951-fa3d5c3…	Carting	trip-153741093647649320	IND388620AAB	Khambhat_MotvdDPP_D (Gujarat)	IND388620AAB	Khambhat_MotvdDPP_D (Gujarat)
6	training	2018-09-20 02:35:36.476840	thanos::sroute:eb7bfc78-b351-4c0e-a951-fa3d5c3…	Carting	trip-153741093647649320	IND388620AAB	Khambhat_MotvdDPP_D (Gujarat)	IND388620AAB	Khambhat_MotvdDPP_D (Gujarat)
7	training	2018-09-20 02:35:36.476840	thanos::sroute:eb7bfc78-b351-4c0e-a951-fa3d5c3…	Carting	trip-153741093647649320	IND388620AAB	Khambhat_MotvdDPP_D (Gujarat)	IND388620AAB	Khambhat_MotvdDPP_D (Gujarat)
8	training	2018-09-20 02:35:36.476840	thanos::sroute:eb7bfc78-b351-4c0e-a951-fa3d5c3…	Carting	trip-153741093647649320	IND388620AAB	Khambhat_MotvdDPP_D (Gujarat)	IND388620AAB	Khambhat_MotvdDPP_D (Gujarat)
9	training	2018-09-20 02:35:36.476840	thanos::sroute:eb7bfc78-b351-4c0e-a951-fa3d5c3…	Carting	trip-153741093647649320	IND388620AAB	Khambhat_MotvdDPP_D (Gujarat)	IND388620AAB	Khambhat_MotvdDPP_D (Gujarat)

```
3       IND388620AAB  Khambhat_MotvdDPP_D (Gujarat)
4       IND388620AAB  Khambhat_MotvdDPP_D (Gujarat)
5       IND388320AAA     Anand_Vaghasi_IP (Gujarat)
6       IND388320AAA     Anand_Vaghasi_IP (Gujarat)
7       IND388320AAA     Anand_Vaghasi_IP (Gujarat)
8       IND388320AAA     Anand_Vaghasi_IP (Gujarat)
9       IND388320AAA     Anand_Vaghasi_IP (Gujarat)

               od_start_time                od_end_time  \
0 2018-09-20 03:21:32.418600 2018-09-20 04:47:45.236797
1 2018-09-20 03:21:32.418600 2018-09-20 04:47:45.236797
2 2018-09-20 03:21:32.418600 2018-09-20 04:47:45.236797
3 2018-09-20 03:21:32.418600 2018-09-20 04:47:45.236797
4 2018-09-20 03:21:32.418600 2018-09-20 04:47:45.236797
5 2018-09-20 04:47:45.236797 2018-09-20 06:36:55.627764
6 2018-09-20 04:47:45.236797 2018-09-20 06:36:55.627764
7 2018-09-20 04:47:45.236797 2018-09-20 06:36:55.627764
8 2018-09-20 04:47:45.236797 2018-09-20 06:36:55.627764
9 2018-09-20 04:47:45.236797 2018-09-20 06:36:55.627764

   start_scan_to_end_scan  is_cutoff  cutoff_factor  \
0                    86.0       True              9
1                    86.0       True             18
2                    86.0       True             27
3                    86.0       True             36
4                    86.0      False             39
5                   109.0       True              9
6                   109.0       True             18
7                   109.0       True             27
8                   109.0       True             36
9                   109.0      False             43

           cutoff_timestamp  actual_distance_to_destination  actual_time  \
0 2018-09-20 04:27:55.000000                       10.435660         14.0
1 2018-09-20 04:17:55.000000                       18.936842         24.0
2 2018-09-20 04:01:19.505586                       27.637279         40.0
3 2018-09-20 03:39:57.000000                       36.118028         62.0
4 2018-09-20 03:33:55.000000                       39.386040         68.0
5 2018-09-20 06:15:58.000000                       10.403038         15.0
6 2018-09-20 05:47:29.000000                       18.045481         44.0
7 2018-09-20 05:25:58.000000                       28.061896         65.0
8 2018-09-20 05:15:56.000000                       38.939167         76.0
9 2018-09-20 04:49:20.000000                       43.595802        102.0

   osrm_time  osrm_distance    factor  segment_actual_time  segment_osrm_time  \
0       11.0        11.9653  1.272727                 14.0               11.0
1       20.0        21.7243  1.200000                 10.0                9.0
```

```
2       28.0         32.5395  1.428571                16.0                 7.0
3       40.0         45.5620  1.550000                21.0                12.0
4       44.0         54.2181  1.545455                 6.0                 5.0
5       11.0         12.1171  1.363636                15.0                11.0
6       17.0         21.2890  2.588235                28.0                 6.0
7       29.0         35.8252  2.241379                21.0                11.0
8       39.0         47.1900  1.948718                10.0                10.0
9       45.0         53.2334  2.266667                26.0                 6.0

   segment_osrm_distance  segment_factor
0                11.9653        1.272727
1                 9.7590        1.111111
2                10.8152        2.285714
3                13.0224        1.750000
4                 3.9153        1.200000
5                12.1171        1.363636
6                 9.1719        4.666667
7                14.5362        1.909091
8                11.3648        1.000000
9                 6.0434        4.333333
```

[10]:
```
df[df['trip_uuid']=='trip-153741093647649320'].nunique()
```

[10]:
```
data                            1
trip_creation_time              1
route_schedule_uuid             1
route_type                      1
trip_uuid                       1
source_center                   2
source_name                     2
destination_center              2
destination_name                2
od_start_time                   2
od_end_time                     2
start_scan_to_end_scan          2
is_cutoff                       2
cutoff_factor                   6
cutoff_timestamp               10
actual_distance_to_destination 10
actual_time                    10
osrm_time                       9
osrm_distance                  10
factor                         10
segment_actual_time             8
segment_osrm_time               7
segment_osrm_distance          10
segment_factor                 10
```

```
dtype: int64
```

[11]:
```
all(df.groupby('trip_uuid')['route_type'].nunique()==1)
```

[11]:
```
True
```

[12]:
```
all(df.groupby('trip_uuid')['route_schedule_uuid'].nunique()==1)
```

[12]:
```
True
```

[13]:
```
all(df.groupby('trip_uuid')['trip_creation_time'].nunique()==1)
```

[13]:
```
True
```

1.2 Feature Extraction

We found that for a partiular `trip_uuid`, `route_schedule_uuid`, `route_type` and `trip_creation_time` have only one value.

Here we are creating new features, like `destination_city`, `destination_place`, `destination_code`, `destination_state`, `destination_center_number`, `destination_center_code`, `source_city`, `source_place`, `source_code`, `source_state`, `source_center_number`, `source_center_code`, `trip_year`, `trip_month`, `trip_day`, `trip_week`, `trip_dayofweek`,`od_trip_time`

[14]:
```
import holidays
in_holidays = holidays.IN()
```

[15]:
```
# Adding new features
# Adding city, place, code for destination and source
for route in ['source', 'destination', ]:
    # df[[f'{route}_city', f'{route}_place', f'{route}_code',␣
 ↪f'{route}_state']] = df[f'{route}_name'].str.split(r'[_\s]+', n = 3,␣
 ↪expand=True)
    # Previous would work if pattern of name is of same format.

    df[f'{route}_city'] = df[f'{route}_name'].str.split('(').str[0].str.
 ↪split('_').str[0]
    df[f'{route}_place'] = df[f'{route}_name'].str.split('(').str[0].str.
 ↪split('_').str[1]
    df[f'{route}_code'] = df[f'{route}_name'].str.split('(').str[0].str.
 ↪split('_').str[2]
    df[f'{route}_state'] = df[f'{route}_name'].str.split('(').str[1].str[0:-1]
    df[f'{route}_center_number'] = df[f'{route}_center'].str[3:-3].astype(int)
    df[f'{route}_center_code'] = df[f'{route}_center'].str[-3:]

# Adding year, month and day for trip creation
df['trip_year'] = df['trip_creation_time'].dt.year
```

```
df['trip_month'] = df['trip_creation_time'].dt.month
df['trip_day'] = df['trip_creation_time'].dt.day
df['trip_week'] = df['trip_creation_time'].dt.isocalendar().week
df['trip_dayofweek'] = df['trip_creation_time'].dt.dayofweek
df['trip_isHoliday'] = df['trip_creation_time'].apply(lambda x: x in␣
 ↪in_holidays)

df['start_scan_to_end_scan'] = df['start_scan_to_end_scan'].astype(int)
df['od_trip_time'] = ((df['od_end_time'] - df['od_start_time']).dt.
 ↪total_seconds()/60).round().astype(int)
df.head()
```

[15]:

	data	trip_creation_time	route_schedule_uuid	route_type	trip_uuid	source_center	source_name	destination_center	destination_name	od_start_time	od_end_time
0	training	2018-09-20 02:35:36.476840	thanos::sroute:eb7bfc78-b351-4c0e-a951-fa3d5c3…	Carting	trip-153741093647649320	IND388121AAA	Anand_VUNagar_DC (Gujarat)	IND388620AAB	Khambhat_MotvdDPP_D (Gujarat)	2018-09-20 03:21:32.418600	2018-09-20 04:47:45.236797
1	training	2018-09-20 02:35:36.476840	thanos::sroute:eb7bfc78-b351-4c0e-a951-fa3d5c3…	Carting	trip-153741093647649320	IND388121AAA	Anand_VUNagar_DC (Gujarat)	IND388620AAB	Khambhat_MotvdDPP_D (Gujarat)	2018-09-20 03:21:32.418600	2018-09-20 04:47:45.236797
2	training	2018-09-20 02:35:36.476840	thanos::sroute:eb7bfc78-b351-4c0e-a951-fa3d5c3…	Carting	trip-153741093647649320	IND388121AAA	Anand_VUNagar_DC (Gujarat)	IND388620AAB	Khambhat_MotvdDPP_D (Gujarat)	2018-09-20 03:21:32.418600	2018-09-20 04:47:45.236797
3	training	2018-09-20 02:35:36.476840	thanos::sroute:eb7bfc78-b351-4c0e-a951-fa3d5c3…	Carting	trip-153741093647649320	IND388121AAA	Anand_VUNagar_DC (Gujarat)	IND388620AAB	Khambhat_MotvdDPP_D (Gujarat)	2018-09-20 03:21:32.418600	2018-09-20 04:47:45.236797
4	training	2018-09-20 02:35:36.476840	thanos::sroute:eb7bfc78-b351-4c0e-a951-fa3d5c3…	Carting	trip-153741093647649320	IND388121AAA	Anand_VUNagar_DC (Gujarat)	IND388620AAB	Khambhat_MotvdDPP_D (Gujarat)	2018-09-20 03:21:32.418600	2018-09-20 04:47:45.236797

```
   start_scan_to_end_scan  is_cutoff  cutoff_factor  \
0                      86       True              9
1                      86       True             18
2                      86       True             27
3                      86       True             36
4                      86      False             39

            cutoff_timestamp  actual_distance_to_destination  actual_time  \
0 2018-09-20 04:27:55.000000                       10.435660         14.0
1 2018-09-20 04:17:55.000000                       18.936842         24.0
2 2018-09-20 04:01:19.505586                       27.637279         40.0
3 2018-09-20 03:39:57.000000                       36.118028         62.0
4 2018-09-20 03:33:55.000000                       39.386040         68.0

   osrm_time  osrm_distance    factor  segment_actual_time  segment_osrm_time  \
0       11.0        11.9653  1.272727                 14.0               11.0
1       20.0        21.7243  1.200000                 10.0                9.0
2       28.0        32.5395  1.428571                 16.0                7.0
3       40.0        45.5620  1.550000                 21.0               12.0
4       44.0        54.2181  1.545455                  6.0                5.0

   segment_osrm_distance  segment_factor source_city source_place source_code  \
0                11.9653        1.272727       Anand      VUNagar         DC
1                 9.7590        1.111111       Anand      VUNagar         DC
2                10.8152        2.285714       Anand      VUNagar         DC
3                13.0224        1.750000       Anand      VUNagar         DC
4                 3.9153        1.200000       Anand      VUNagar         DC

  source_state  source_center_number source_center_code destination_city  \
0      Gujarat                388121                AAA         Khambhat
1      Gujarat                388121                AAA         Khambhat
2      Gujarat                388121                AAA         Khambhat
3      Gujarat                388121                AAA         Khambhat
4      Gujarat                388121                AAA         Khambhat

  destination_place destination_code destination_state  \
0          MotvdDPP               D            Gujarat
1          MotvdDPP               D            Gujarat
2          MotvdDPP               D            Gujarat
3          MotvdDPP               D            Gujarat
4          MotvdDPP               D            Gujarat

   destination_center_number destination_center_code  trip_year  trip_month  \
0                     388620                     AAB       2018           9
1                     388620                     AAB       2018           9
2                     388620                     AAB       2018           9
3                     388620                     AAB       2018           9
```

```
4                    388620                    AAB       2018           9

   trip_day  trip_week  trip_dayofweek  trip_isHoliday  od_trip_time
0        20         38               3            True            86
1        20         38               3            True            86
2        20         38               3            True            86
3        20         38               3            True            86
4        20         38               3            True            86
```

[16]:
```
df.shape
```

[16]:
```
(144867, 43)
```

[17]:
```
df [['source_code', 'source_state', 'source_center_number',␣
 ↪'source_center_code']].drop_duplicates()
```

[17]:
```
        source_code source_state  source_center_number source_center_code
0                DC       Gujarat                388121                AAA
5                 D       Gujarat                388620                AAB
10               HB   Maharashtra                421302                AAG
15              NaN   Maharashtra                400011                AAA
17               H     Karnataka                562132                AAA
…              …           …                    …                   …
133966           D     Rajasthan                331701                AAA
134709         DPP     Rajasthan                335523                AAB
141475          DC       Gujarat                361335                AAA
142252           L     Karnataka                562132                AAC
142763           D    Tamil Nadu                639104                AAB

[1508 rows x 4 columns]
```

[18]:
```
x = df [['source_state', 'source_center_number']].drop_duplicates()
```

[19]:
```
df.nunique()
```

[19]:
```
data                          2
trip_creation_time        14817
route_schedule_uuid        1504
route_type                    2
trip_uuid                 14817
source_center              1508
source_name                1498
destination_center         1481
destination_name           1468
od_start_time             26369
od_end_time               26369
start_scan_to_end_scan     1915
```

```
is_cutoff                            2
cutoff_factor                      501
cutoff_timestamp                 93180
actual_distance_to_destination  144515
actual_time                       3182
osrm_time                         1531
osrm_distance                   138046
factor                            45641
segment_actual_time                 747
segment_osrm_time                   214
segment_osrm_distance            113799
segment_factor                      5675
source_city                         1262
source_place                        1154
source_code                           24
source_state                          31
source_center_number                1390
source_center_code                    37
destination_city                    1258
destination_place                   1130
destination_code                      27
destination_state                     32
destination_center_number           1384
destination_center_code               32
trip_year                              1
trip_month                             2
trip_day                              22
trip_week                              4
trip_dayofweek                         7
trip_isHoliday                         2
od_trip_time                        1903
dtype: int64
```

[20]:
```
select_states = ['Gujarat', 'Maharashtra', 'Karnataka', 'Punjab', 'Haryana',
       'Uttarakhand', 'Rajasthan', 'Telangana', 'Kerala', 'Bihar', 'Jharkhand',
       'Assam',  'Orissa', 'Delhi', 'Chandigarh', 'Chhattisgarh', 'Nagaland',␣
 ↪'Meghalaya',
       'Tripura', 'Mizoram',
       ]
df[~df['source_state'].isin(select_states)]
```

[20]:
```
            data         trip_creation_time  \
76          test 2018-09-27 14:16:14.819357
77          test 2018-09-27 14:16:14.819357
78          test 2018-09-27 14:16:14.819357
79          test 2018-09-27 14:16:14.819357
112     training 2018-09-25 08:53:04.377810
```

```
…          …                          …
144846  training 2018-09-26 19:50:29.657378
144854  training 2018-09-17 11:35:28.838714
144855  training 2018-09-17 11:35:28.838714
144856  training 2018-09-17 11:35:28.838714
144857  training 2018-09-17 11:35:28.838714

                                    route_schedule_uuid route_type  \
76      thanos::sroute:1283977c-889a-4e96-b632-5ba1a69…    Carting
77      thanos::sroute:1283977c-889a-4e96-b632-5ba1a69…    Carting
78      thanos::sroute:1283977c-889a-4e96-b632-5ba1a69…    Carting
79      thanos::sroute:1283977c-889a-4e96-b632-5ba1a69…    Carting
112     thanos::sroute:4460a38d-ab9b-484e-bd4e-f4201d0…        FTL
…                                                     …        …
144846  thanos::sroute:f6d1ba62-76a2-4dba-83ec-3ac0803…        FTL
144854  thanos::sroute:d8f74492-4484-412a-887a-61c8e6b…    Carting
144855  thanos::sroute:d8f74492-4484-412a-887a-61c8e6b…    Carting
144856  thanos::sroute:d8f74492-4484-412a-887a-61c8e6b…    Carting
144857  thanos::sroute:d8f74492-4484-412a-887a-61c8e6b…    Carting

                     trip_uuid source_center  \
76      trip-153805777481903807  IND600056AAB
77      trip-153805777481903807  IND600056AAB
78      trip-153805777481903807  IND600056AAB
79      trip-153805777481903807  IND600056AAB
112     trip-153786558437756691  IND342902A1B
…                          …           …
144846  trip-153799142965708367  IND457226AAA
144854  trip-153718412883843340  IND600056AAB
144855  trip-153718412883843340  IND600056AAB
144856  trip-153718412883843340  IND600056AAB
144857  trip-153718412883843340  IND600056AAB

                             source_name destination_center  \
76        MAA_Poonamallee_HB (Tamil Nadu)       IND600032AAB
77        MAA_Poonamallee_HB (Tamil Nadu)       IND600032AAB
78        MAA_Poonamallee_HB (Tamil Nadu)       IND600032AAB
79        MAA_Poonamallee_HB (Tamil Nadu)       IND600032AAB
112                                 NaN       IND302014AAA
…                                     …                 …
144846  Jaora_RtlamNka_D (Madhya Pradesh)       IND382430AAB
144854    MAA_Poonamallee_HB (Tamil Nadu)       IND600032AAB
144855    MAA_Poonamallee_HB (Tamil Nadu)       IND600032AAB
144856    MAA_Poonamallee_HB (Tamil Nadu)       IND600032AAB
144857    MAA_Poonamallee_HB (Tamil Nadu)       IND600032AAB

                  destination_name              od_start_time  \
```

```
76          Chennai_Hub (Tamil Nadu) 2018-09-27 14:16:14.819357
77          Chennai_Hub (Tamil Nadu) 2018-09-27 14:16:14.819357
78          Chennai_Hub (Tamil Nadu) 2018-09-27 14:16:14.819357
79          Chennai_Hub (Tamil Nadu) 2018-09-27 14:16:14.819357
112           Jaipur_Hub (Rajasthan) 2018-09-26 06:58:08.054001
…                                 …                        …
144846  Ahmedabad_East_H_1 (Gujarat) 2018-09-27 06:55:50.265761
144854      Chennai_Hub (Tamil Nadu) 2018-09-17 11:35:28.838714
144855      Chennai_Hub (Tamil Nadu) 2018-09-17 11:35:28.838714
144856      Chennai_Hub (Tamil Nadu) 2018-09-17 11:35:28.838714
144857      Chennai_Hub (Tamil Nadu) 2018-09-17 11:35:28.838714

                      od_end_time  start_scan_to_end_scan  is_cutoff  \
76     2018-09-27 17:16:11.083553                     179       True
77     2018-09-27 17:16:11.083553                     179       True
78     2018-09-27 17:16:11.083553                     179       True
79     2018-09-27 17:16:11.083553                     179      False
112    2018-09-26 15:54:14.280942                     536       True
…                             …                       …         …
144846 2018-09-27 17:18:35.292509                     622      False
144854 2018-09-17 13:32:21.128357                     116       True
144855 2018-09-17 13:32:21.128357                     116       True
144856 2018-09-17 13:32:21.128357                     116       True
144857 2018-09-17 13:32:21.128357                     116      False

        cutoff_factor           cutoff_timestamp  \
76                  9 2018-09-27 15:59:36.000000
77                 18 2018-09-27 15:32:36.000000
78                 27 2018-09-27 15:17:37.000000
79                 31 2018-09-27 15:08:46.000000
112                22 2018-09-26 14:09:19.000000
…                 …                         …
144846            265 2018-09-27 08:18:22.000000
144854              9 2018-09-17 12:57:20.000000
144855             18 2018-09-17 12:30:41.952774
144856             27 2018-09-17 12:15:17.000000
144857             31 2018-09-17 12:05:21.000000

        actual_distance_to_destination  actual_time  osrm_time  osrm_distance  \
76                            9.285856         42.0       10.0         9.9365
77                           18.094962         69.0       18.0        19.8934
78                           27.106207         84.0       26.0        29.6956
79                           31.157974         92.0       32.0        35.6749
112                          22.783440         48.0       34.0        37.7749
…                                  …            …          …             …
144846                      265.367032        484.0      290.0       387.9870
144854                        9.169115         32.0       10.0         9.9543
```

```
144855                      18.805313         58.0       19.0        20.8516
144856                      27.712143         74.0       27.0        30.5362
144857                      31.698687         84.0       33.0        36.7672

          factor  segment_actual_time  segment_osrm_time  \
76      4.200000                 42.0               10.0
77      3.833333                 27.0                7.0
78      3.230769                 14.0                8.0
79      2.875000                  8.0                5.0
112     1.411765                 48.0               34.0
…          …                     …                  …
144846  1.668966                  0.0                0.0
144854  3.200000                 32.0               10.0
144855  3.052632                 26.0                8.0
144856  2.740741                 15.0                8.0
144857  2.545455                  9.0                5.0

        segment_osrm_distance  segment_factor source_city source_place  \
76                     9.9365        4.200000         MAA  Poonamallee
77                     9.9569        3.857143         MAA  Poonamallee
78                     9.8021        1.750000         MAA  Poonamallee
79                     5.9794        1.600000         MAA  Poonamallee
112                   37.7749        1.411765         NaN          NaN
…                       …             …          …          …
144846                 0.0000       -1.000000       Jaora     RtlamNka
144854                 9.9543        3.200000         MAA  Poonamallee
144855                10.8973        3.250000         MAA  Poonamallee
144856                 9.6845        1.875000         MAA  Poonamallee
144857                 6.2310        1.800000         MAA  Poonamallee

       source_code    source_state  source_center_number source_center_code  \
76              HB       Tamil Nadu                600056                AAB
77              HB       Tamil Nadu                600056                AAB
78              HB       Tamil Nadu                600056                AAB
79              HB       Tamil Nadu                600056                AAB
112            NaN              NaN                342902                A1B
…            …              …                   …                  …
144846          D   Madhya Pradesh                457226                AAA
144854         HB       Tamil Nadu                600056                AAB
144855         HB       Tamil Nadu                600056                AAB
144856         HB       Tamil Nadu                600056                AAB
144857         HB       Tamil Nadu                600056                AAB

       destination_city destination_place destination_code destination_state  \
76              Chennai              Hub               NaN        Tamil Nadu
77              Chennai              Hub               NaN        Tamil Nadu
78              Chennai              Hub               NaN        Tamil Nadu
```

```
79              Chennai              Hub               NaN        Tamil Nadu
112              Jaipur              Hub               NaN         Rajasthan
…                  …                 …                 …                 …
144846        Ahmedabad              East                H           Gujarat
144854          Chennai              Hub               NaN        Tamil Nadu
144855          Chennai              Hub               NaN        Tamil Nadu
144856          Chennai              Hub               NaN        Tamil Nadu
144857          Chennai              Hub               NaN        Tamil Nadu

        destination_center_number destination_center_code  trip_year  \
76                         600032                      AAB       2018
77                         600032                      AAB       2018
78                         600032                      AAB       2018
79                         600032                      AAB       2018
112                        302014                      AAA       2018
…                           …                          …         …
144846                     382430                      AAB       2018
144854                     600032                      AAB       2018
144855                     600032                      AAB       2018
144856                     600032                      AAB       2018
144857                     600032                      AAB       2018

        trip_month  trip_day  trip_week  trip_dayofweek  trip_isHoliday  \
76               9        27         39               3           False
77               9        27         39               3           False
78               9        27         39               3           False
79               9        27         39               3           False
112              9        25         39               1           False
…              …        …          …                …               …
144846           9        26         39               2           False
144854           9        17         38               0           False
144855           9        17         38               0           False
144856           9        17         38               0           False
144857           9        17         38               0           False

        od_trip_time
76               180
77               180
78               180
79               180
112              536
…                  …
144846           623
144854           117
144855           117
144856           117
144857           117
```

```
[32098 rows x 43 columns]
```

[21]:
```
df[df['trip_uuid']=='trip-153741093647649320'].head()
```

[21]:

	data	trip_creation_time	route_schedule_uuid	route_type
0	training	2018-09-20 02:35:36.476840	thanos::sroute:eb7bfc78-b351-4c0e-a951-fa3d5c3…	Carting
1	training	2018-09-20 02:35:36.476840	thanos::sroute:eb7bfc78-b351-4c0e-a951-fa3d5c3…	Carting
2	training	2018-09-20 02:35:36.476840	thanos::sroute:eb7bfc78-b351-4c0e-a951-fa3d5c3…	Carting
3	training	2018-09-20 02:35:36.476840	thanos::sroute:eb7bfc78-b351-4c0e-a951-fa3d5c3…	Carting
4	training	2018-09-20 02:35:36.476840	thanos::sroute:eb7bfc78-b351-4c0e-a951-fa3d5c3…	Carting

	trip_uuid	source_center	source_name
0	trip-153741093647649320	IND388121AAA	Anand_VUNagar_DC (Gujarat)
1	trip-153741093647649320	IND388121AAA	Anand_VUNagar_DC (Gujarat)
2	trip-153741093647649320	IND388121AAA	Anand_VUNagar_DC (Gujarat)
3	trip-153741093647649320	IND388121AAA	Anand_VUNagar_DC (Gujarat)
4	trip-153741093647649320	IND388121AAA	Anand_VUNagar_DC (Gujarat)

	destination_center	destination_name
0	IND388620AAB	Khambhat_MotvdDPP_D (Gujarat)
1	IND388620AAB	Khambhat_MotvdDPP_D (Gujarat)
2	IND388620AAB	Khambhat_MotvdDPP_D (Gujarat)
3	IND388620AAB	Khambhat_MotvdDPP_D (Gujarat)
4	IND388620AAB	Khambhat_MotvdDPP_D (Gujarat)

	od_start_time	od_end_time
0	2018-09-20 03:21:32.418600	2018-09-20 04:47:45.236797
1	2018-09-20 03:21:32.418600	2018-09-20 04:47:45.236797
2	2018-09-20 03:21:32.418600	2018-09-20 04:47:45.236797
3	2018-09-20 03:21:32.418600	2018-09-20 04:47:45.236797
4	2018-09-20 03:21:32.418600	2018-09-20 04:47:45.236797

	start_scan_to_end_scan	is_cutoff	cutoff_factor
0	86	True	9
1	86	True	18
2	86	True	27
3	86	True	36
4	86	False	39

```
            cutoff_timestamp  actual_distance_to_destination  actual_time  \
0 2018-09-20 04:27:55.000000                       10.435660         14.0
1 2018-09-20 04:17:55.000000                       18.936842         24.0
2 2018-09-20 04:01:19.505586                       27.637279         40.0
3 2018-09-20 03:39:57.000000                       36.118028         62.0
4 2018-09-20 03:33:55.000000                       39.386040         68.0

   osrm_time  osrm_distance    factor  segment_actual_time  segment_osrm_time  \
0       11.0        11.9653  1.272727                 14.0               11.0
1       20.0        21.7243  1.200000                 10.0                9.0
2       28.0        32.5395  1.428571                 16.0                7.0
3       40.0        45.5620  1.550000                 21.0               12.0
4       44.0        54.2181  1.545455                  6.0                5.0

   segment_osrm_distance  segment_factor source_city source_place source_code  \
0                11.9653        1.272727       Anand      VUNagar         DC
1                 9.7590        1.111111       Anand      VUNagar         DC
2                10.8152        2.285714       Anand      VUNagar         DC
3                13.0224        1.750000       Anand      VUNagar         DC
4                 3.9153        1.200000       Anand      VUNagar         DC

  source_state  source_center_number source_center_code destination_city  \
0      Gujarat                388121                AAA         Khambhat
1      Gujarat                388121                AAA         Khambhat
2      Gujarat                388121                AAA         Khambhat
3      Gujarat                388121                AAA         Khambhat
4      Gujarat                388121                AAA         Khambhat

  destination_place destination_code destination_state  \
0          MotvdDPP                D            Gujarat
1          MotvdDPP                D            Gujarat
2          MotvdDPP                D            Gujarat
3          MotvdDPP                D            Gujarat
4          MotvdDPP                D            Gujarat

   destination_center_number destination_center_code  trip_year  trip_month  \
0                     388620                     AAB       2018           9
1                     388620                     AAB       2018           9
2                     388620                     AAB       2018           9
3                     388620                     AAB       2018           9
4                     388620                     AAB       2018           9

   trip_day  trip_week  trip_dayofweek  trip_isHoliday  od_trip_time
0        20         38               3            True            86
1        20         38               3            True            86
2        20         38               3            True            86
3        20         38               3            True            86
```

4	20	38	3	True	86

Observation 1.

$$factor = \frac{actual\_time}{osrm\_time}$$

1.

$$segment\_factor = \frac{segment\_actual\_time}{segment\_osrm\_time}$$

[22]:
```
df.isna().sum()
```

[22]:
```
data                                0
trip_creation_time                  0
route_schedule_uuid                 0
route_type                          0
trip_uuid                           0
source_center                       0
source_name                       293
destination_center                  0
destination_name                  261
od_start_time                       0
od_end_time                         0
start_scan_to_end_scan              0
is_cutoff                           0
cutoff_factor                       0
cutoff_timestamp                    0
actual_distance_to_destination      0
actual_time                         0
osrm_time                           0
osrm_distance                       0
factor                              0
segment_actual_time                 0
segment_osrm_time                   0
segment_osrm_distance               0
segment_factor                      0
source_city                       293
source_place                     2400
source_code                     14943
source_state                      293
source_center_number                0
source_center_code                  0
destination_city                  261
destination_place                2702
destination_code                15829
destination_state                 261
destination_center_number           0
destination_center_code             0
trip_year                           0
```

```
trip_month                      0
trip_day                        0
trip_week                       0
trip_dayofweek                  0
trip_isHoliday                  0
od_trip_time                    0
dtype: int64
```

[23]:
```
# check_cols = [ 'destination_code', 'destination_name']
# df[df['destination_code'].isna()][check_cols].drop_duplicates().head(20)
```

[24]:
```
df['destination_center'].sort_values()
```

[24]:
```
52207     IND000000AAL
117319    IND000000AAL
105331    IND000000AAL
105330    IND000000AAL
85987     IND000000AAL
              …
112923    IND854335AAA
112924    IND854335AAA
56914     IND854335AAA
2608      IND854335AAA
56913     IND854335AAA
Name: destination_center, Length: 144867, dtype: object
```

[25]:
```
df[df['source_name'].isna()].sample(10)
```

[25]:
```
            data         trip_creation_time  \
12707   training 2018-09-25 09:18:45.016913
118     training 2018-09-25 08:53:04.377810
40479       test 2018-09-30 08:52:12.386239
25014   training 2018-09-24 19:55:43.343760
138241      test 2018-09-28 09:39:45.964332
21893       test 2018-09-28 08:39:25.552881
70272       test 2018-09-30 00:04:33.479862
70215   training 2018-09-26 08:04:34.523772
47195   training 2018-09-25 05:55:37.124078
63186       test 2018-10-03 21:27:10.106145

                                    route_schedule_uuid route_type  \
12707   thanos::sroute:cbef3b6a-79ea-4d5e-a215-b558a70…        FTL
118     thanos::sroute:4460a38d-ab9b-484e-bd4e-f4201d0…        FTL
40479   thanos::sroute:88f3c4f2-ba7c-4817-8dff-e181ba3…        FTL
25014   thanos::sroute:da7a341a-ba3d-436d-b4b5-607d1a0…        FTL
138241  thanos::sroute:cbef3b6a-79ea-4d5e-a215-b558a70…        FTL
21893   thanos::sroute:88f3c4f2-ba7c-4817-8dff-e181ba3…        FTL
```

```
70272   thanos::sroute:0fe10045-cf65-4c70-8115-4e4cf80…        FTL
70215   thanos::sroute:4460a38d-ab9b-484e-bd4e-f4201d0…        FTL
47195   thanos::sroute:3c657b6b-38e9-437f-a02f-1cd0a27…        FTL
63186   thanos::sroute:d0ebdacd-e09b-47d3-be77-c9c4a05…        FTL

                    trip_uuid source_center source_name destination_center  \
12707   trip-153786712501643905  IND282002AAD         NaN       IND474003AAA
118     trip-153786558437756691  IND342902A1B         NaN       IND302014AAA
40479   trip-153829753238591840  IND342902A1B         NaN       IND302014AAA
25014   trip-153781894334349262  IND509103AAC         NaN       IND518002AAA
138241  trip-153812758596408063  IND282002AAD         NaN       IND474003AAA
21893   trip-153812396555262982  IND342902A1B         NaN       IND302014AAA
70272   trip-153826587347960527  IND505326AAB         NaN       IND505425AAA
70215   trip-153794907452350443  IND342902A1B         NaN       IND302014AAA
47195   trip-153785493712368255  IND282002AAD         NaN       IND205001AAB
63186   trip-153860203010589724  IND577116AAA         NaN       IND577101AAA

                         destination_name              od_start_time  \
12707   Gwalior_HrihrNgr_I (Madhya Pradesh) 2018-09-25 16:20:44.535746
118                 Jaipur_Hub (Rajasthan) 2018-09-26 06:58:08.054001
40479               Jaipur_Hub (Rajasthan) 2018-10-01 07:31:52.272795
25014   Kurnool_AbbasNgr_I (Andhra Pradesh) 2018-09-25 03:57:33.697991
138241  Gwalior_HrihrNgr_I (Madhya Pradesh) 2018-09-28 15:46:15.559430
21893               Jaipur_Hub (Rajasthan) 2018-09-29 07:47:07.334137
70272     DhrmpuriTS_HanumDPP_D (Telangana) 2018-09-30 04:43:06.470149
70215               Jaipur_Hub (Rajasthan) 2018-09-27 06:37:22.876732
47195   Mainpuri_Agraroad_I (Uttar Pradesh) 2018-09-25 13:55:07.683990
63186            Chikmagalur_DC (Karnataka) 2018-10-04 02:22:05.094096

                     od_end_time  start_scan_to_end_scan  is_cutoff  \
12707  2018-09-25 21:48:34.841192                     327       True
118    2018-09-26 15:54:14.280942                     536       True
40479  2018-10-01 15:57:12.640082                     505      False
25014  2018-09-25 07:11:24.207222                     193       True
138241 2018-09-28 20:52:17.857170                     306       True
21893  2018-09-29 16:02:15.342805                     495       True
70272  2018-09-30 05:19:15.957561                      36       True
70215  2018-09-27 15:38:54.541001                     541       True
47195  2018-09-25 17:58:15.820606                     243       True
63186  2018-10-04 03:06:59.840874                      44       True

        cutoff_factor    cutoff_timestamp  actual_distance_to_destination  \
12707              44 2018-09-25 19:53:16                       45.109568
118               154 2018-09-26 09:43:23                      154.305625
40479             207 2018-10-01 08:41:36                      207.134112
25014              22 2018-09-25 05:07:27                       23.871983
138241             66 2018-09-28 19:08:20                       66.727930
```

```
21893            110 2018-09-29 11:32:55                    110.229990
70272             22 2018-09-30 04:47:32                     22.233598
70215            154 2018-09-27 08:26:45                    154.180578
47195             66 2018-09-25 15:38:24                     66.099966
63186             22 2018-10-04 02:38:30                     25.836968

        actual_time  osrm_time  osrm_distance    factor  segment_actual_time  \
12707          68.0       45.0        47.7471  1.511111                 39.0
118           314.0      138.0       186.5238  2.275362                 47.0
40479         422.0      183.0       242.9349  2.306011                 20.0
25014         123.0       19.0        27.2136  6.473684                123.0
138241         93.0       71.0        72.2389  1.309859                 24.0
21893         236.0       89.0       125.3077  2.651685                 38.0
70272          31.0       19.0        26.8409  1.631579                 31.0
70215         335.0      137.0       186.3377  2.445255                 32.0
47195         129.0       61.0        74.1232  2.114754                 50.0
63186          27.0       22.0        29.4138  1.227273                 27.0

        segment_osrm_time  segment_osrm_distance  segment_factor source_city  \
12707                23.0                24.2325        1.695652         NaN
118                  21.0                29.9673        2.238095         NaN
40479                 7.0                 8.2181        2.857143         NaN
25014                19.0                27.2136        6.473684         NaN
138241               57.0                53.1821        0.421053         NaN
21893                16.0                22.9299        2.375000         NaN
70272                19.0                26.8409        1.631579         NaN
70215                17.0                24.5338        1.882353         NaN
47195                19.0                27.1664        2.631579         NaN
63186                22.0                29.4138        1.227273         NaN

       source_place source_code source_state  source_center_number  \
12707           NaN         NaN          NaN                282002
118             NaN         NaN          NaN                342902
40479           NaN         NaN          NaN                342902
25014           NaN         NaN          NaN                509103
138241          NaN         NaN          NaN                282002
21893           NaN         NaN          NaN                342902
70272           NaN         NaN          NaN                505326
70215           NaN         NaN          NaN                342902
47195           NaN         NaN          NaN                282002
63186           NaN         NaN          NaN                577116

       source_center_code destination_city destination_place destination_code  \
12707                 AAD          Gwalior          HrihrNgr                I
118                   A1B           Jaipur              Hub              NaN
40479                 A1B           Jaipur              Hub              NaN
25014                 AAC          Kurnool          AbbasNgr                I
```

```
138241               AAD          Gwalior          HrihrNgr               I
21893                A1B           Jaipur              Hub             NaN
70272                AAB       DhrmpuriTS          HanumDPP               D
70215                A1B           Jaipur              Hub             NaN
47195                AAD         Mainpuri          Agraroad               I
63186                AAA      Chikmagalur               DC             NaN

       destination_state  destination_center_number destination_center_code  \
12707     Madhya Pradesh                     474003                     AAA
118            Rajasthan                     302014                     AAA
40479          Rajasthan                     302014                     AAA
25014     Andhra Pradesh                     518002                     AAA
138241    Madhya Pradesh                     474003                     AAA
21893          Rajasthan                     302014                     AAA
70272          Telangana                     505425                     AAA
70215          Rajasthan                     302014                     AAA
47195      Uttar Pradesh                     205001                     AAB
63186          Karnataka                     577101                     AAA

        trip_year  trip_month  trip_day  trip_week  trip_dayofweek  \
12707        2018           9        25         39               1
118          2018           9        25         39               1
40479        2018           9        30         39               6
25014        2018           9        24         39               0
138241       2018           9        28         39               4
21893        2018           9        28         39               4
70272        2018           9        30         39               6
70215        2018           9        26         39               2
47195        2018           9        25         39               1
63186        2018          10         3         40               2

        trip_isHoliday  od_trip_time
12707            False           328
118              False           536
40479            False           505
25014            False           194
138241           False           306
21893            False           495
70272            False            36
70215            False           542
47195            False           243
63186            False            45
```

1.3 Can we predict City and State for those missing values?

1.3.1 State Prediction

[26]:
```
from sklearn.preprocessing import OrdinalEncoder
```

[27]:
```
column_names = lambda x: [ 'data',f'{x}_center_number', f'{x}_center_code',␣
 ↪f'{x}_state']
df1 = df[ column_names('source') ]
df1.columns = column_names('common')
df2 =  df[ column_names('destination') ]
df2.columns = column_names('common')
df_new = pd.concat([df1, df2]).dropna().drop_duplicates().reset_index(drop=True)
df_new.head()
```

[27]:

	data	common_center_number	common_center_code	common_state
0	training	388121	AAA	Gujarat
1	training	388620	AAB	Gujarat
2	training	421302	AAG	Maharashtra
3	training	400011	AAA	Maharashtra
4	training	562132	AAA	Karnataka

[28]:
```
df_new.shape
```

[28]:
```
(2862, 4)
```

[29]:
```
encoder = OrdinalEncoder(handle_unknown='use_encoded_value', unknown_value=-1)
df_new['common_center_code'] = encoder.
 ↪fit_transform(df_new[['common_center_code']])
df_new.head()
```

[29]:

	data	common_center_number	common_center_code	common_state
0	training	388121	0.0	Gujarat
1	training	388620	1.0	Gujarat
2	training	421302	6.0	Maharashtra
3	training	400011	0.0	Maharashtra
4	training	562132	0.0	Karnataka

[30]:
```
df_new_train = df_new[df_new['data']=='training'].drop('data', axis=1)
df_new_test = df_new[df_new['data']!='training'].drop('data', axis=1)
```

[31]:
```
from sklearn.tree import DecisionTreeClassifier
dt = DecisionTreeClassifier()
dt.fit(df_new_train[['common_center_number',        'common_center_code']],␣
 ↪df_new_train['common_state'])
```

[31]:
```
DecisionTreeClassifier()
```

[32]:
```
dt.score(df_new_train[['common_center_number',        'common_center_code']],␣
 ↪df_new_train['common_state'])
```

[32]:
```
1.0
```

[33]:
```
dt.score(df_new_test[['common_center_number',        'common_center_code']],␣
 ↪df_new_test['common_state'])
```

[33]:
```
0.9976617303195635
```

[34]:
```
y_pred = dt.predict(df_new_test[['common_center_number', 'common_center_code']])
```

[35]:
```
# Number of Correct, Error Count
print("Correct: ", (df_new_test['common_state']== y_pred).sum())
print("Incorrect: ",(df_new_test['common_state']!= y_pred).sum())
```

```
Correct:  1280
Incorrect:  3
```

[36]:
```
df_new_test[df_new_test['common_state']!= y_pred]
```

[36]:

	common_center_number	common_center_code	common_state
2254	811307	0.0	Bihar
2465	0	14.0	West Bengal
2744	396210	0.0	Daman & Diu

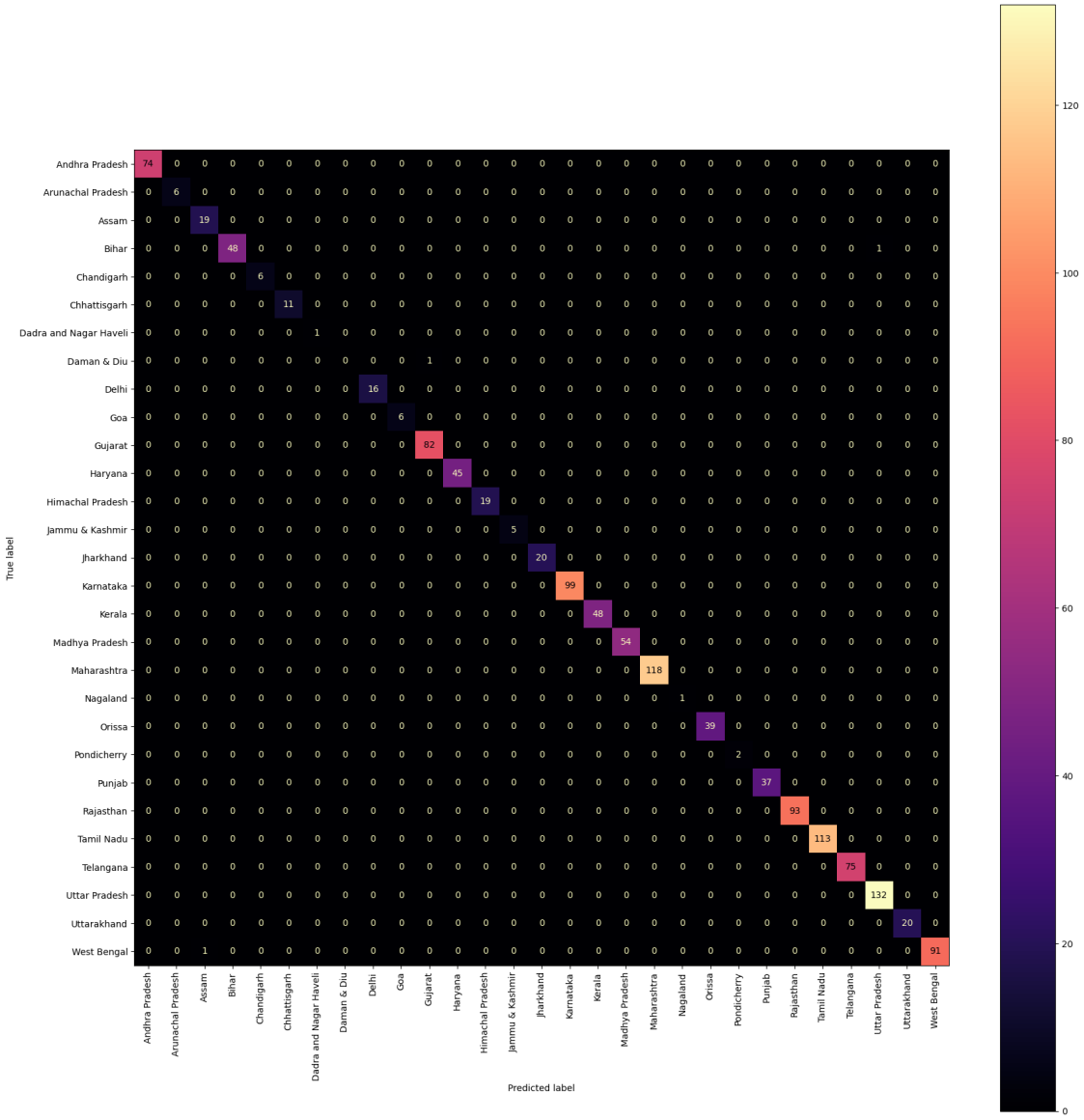
[37]:
```
from sklearn.metrics import ConfusionMatrixDisplay,confusion_matrix,␣
 ↪classification_report, accuracy_score, f1_score

conf_matrix = confusion_matrix(df_new_test[['common_state']], y_pred.
 ↪reshape(-1,1))
conf_matrix
```

[37]:
```
array([[ 74,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
          0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
          0,   0,   0],
       [  0,   6,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
          0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
          0,   0,   0],
       [  0,   0,  19,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
          0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
          0,   0,   0],
       [  0,   0,   0,  48,   0,   0,   0,   0,   0,   0,   0,   0,   0,
          0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
          1,   0,   0],
       [  0,   0,   0,   0,   6,   0,   0,   0,   0,   0,   0,   0,   0,
          0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
          0,   0,   0],
```

```
[  0,   0,   0,   0,   0,  11,   0,   0,   0,   0,   0,   0,   0,
   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
   0,   0,   0],
[  0,   0,   0,   0,   0,   0,   1,   0,   0,   0,   0,   0,   0,
   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
   0,   0,   0],
[  0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   1,   0,   0,
   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
   0,   0,   0],
[  0,   0,   0,   0,   0,   0,   0,   0,  16,   0,   0,   0,   0,
   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
   0,   0,   0],
[  0,   0,   0,   0,   0,   0,   0,   0,   0,   6,   0,   0,   0,
   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
   0,   0,   0],
[  0,   0,   0,   0,   0,   0,   0,   0,   0,   0,  82,   0,   0,
   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
   0,   0,   0],
[  0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,  45,   0,
   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
   0,   0,   0],
[  0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,  19,
   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
   0,   0,   0],
[  0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
   5,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
   0,   0,   0],
[  0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
   0,  20,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
   0,   0,   0],
[  0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
   0,   0,  99,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
   0,   0,   0],
[  0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
   0,   0,   0,  48,   0,   0,   0,   0,   0,   0,   0,   0,   0,
   0,   0,   0],
[  0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
   0,   0,   0,   0,  54,   0,   0,   0,   0,   0,   0,   0,   0,
   0,   0,   0],
[  0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
   0,   0,   0,   0,   0, 118,   0,   0,   0,   0,   0,   0,   0,
   0,   0,   0],
[  0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
   0,   0,   0,   0,   0,   0,   1,   0,   0,   0,   0,   0,   0,
   0,   0,   0],
[  0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
   0,   0,   0,   0,   0,   0,   0,  39,   0,   0,   0,   0,   0,
```

```
   0,   0,   0],
[  0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
   0,   0,   0,   0,   0,   0,   0,   0,   2,   0,   0,   0,   0,
   0,   0,   0],
[  0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
   0,   0,   0,   0,   0,   0,   0,   0,   0,  37,   0,   0,   0,
   0,   0,   0],
[  0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,  93,   0,   0,
   0,   0,   0],
[  0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0, 113,   0,
   0,   0,   0],
[  0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,  75,
   0,   0,   0],
[  0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
 132,   0,   0],
[  0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
   0,  20,   0],
[  0,   0,   1,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
   0,   0,  91]])
```

[38]:
```
import matplotlib.pyplot as plt
plt.rcParams['figure.figsize'] = (18, 18)
labels = sorted(df_new_test['common_state'].unique())
# plt.figure(figsize=(4, 20))
disp = ConfusionMatrixDisplay(conf_matrix,
                              display_labels=labels
                              )
# magma, plasma, cividis
disp.plot(cmap='magma')
plt.xticks(rotation=90)  # Rotate x-axis labels for readability
plt.tight_layout()
plt.show()
```



1.3.2 Imputation of State

[39]:
```
for route in ['source', 'destination']:
    df_ = df[[f'{route}_center_number',        f'{route}_center_code'        ]].
↪copy()
    df_.columns = ['common_center_number',        'common_center_code']
    df_['common_center_code'] = encoder.transform(df_[['common_center_code']])
    imputed_values = dt.predict(df_)
    df.loc[df[f'{route}_state'].isna(), f'{route}_state'] =␣
↪imputed_values[df[f'{route}_state'].isna()]
```

1.3.3 City prediction

[40]:
```
# column_names = lambda x: [ 'data',f'{x}_center_number', f'{x}_center_code',␣
 ↪f'{x}_state',f'{x}_city']
column_names = lambda x: [ 'data',f'{x}_center_number',␣
 ↪f'{x}_center_code',f'{x}_city']
df1 = df[ column_names('source') ]
df1.columns = column_names('common')
df2 =  df[ column_names('destination') ]
df2.columns = column_names('common')
df_new = pd.concat([df1, df2]).dropna().drop_duplicates().reset_index(drop=True)
df_new.head()
```

[40]:

	data	common_center_number	common_center_code	common_city
0	training	388121	AAA	Anand
1	training	388620	AAB	Khambhat
2	training	421302	AAG	Bhiwandi
3	training	400011	AAA	LowerParel
4	training	562132	AAA	Bangalore

[41]:
```
encoder = OrdinalEncoder(handle_unknown='use_encoded_value', unknown_value=-1)
# df_new[['common_center_code', 'common_state']] = encoder.
 ↪fit_transform(df_new[['common_center_code', 'common_state']])
df_new[['common_center_code']] = encoder.
 ↪fit_transform(df_new[['common_center_code']])
df_new.head()
```

[41]:

	data	common_center_number	common_center_code	common_city
0	training	388121	0.0	Anand
1	training	388620	1.0	Khambhat
2	training	421302	6.0	Bhiwandi
3	training	400011	0.0	LowerParel
4	training	562132	0.0	Bangalore

[42]:
```
df_new.shape
```

[42]:
```
(2862, 4)
```

[43]:
```
df_new_train = df_new[df_new['data']=='training'].drop('data', axis=1)
df_new_test = df_new[df_new['data']!='training'].drop('data', axis=1)
```

[44]:
```
dt = DecisionTreeClassifier()
# dt.fit(df_new_train[['common_center_number',        'common_center_code',␣
 ↪'common_state']], df_new_train['common_city'])
dt.fit(df_new_train[['common_center_number',        'common_center_code', ]],␣
 ↪df_new_train['common_city'])
```

[44]:
```
DecisionTreeClassifier()
```

[45]:
```
# dt.score(df_new_train[['common_center_number',        'common_center_code',␣
 ↪'common_state']], df_new_train['common_city'])
dt.score(df_new_train[['common_center_number',        'common_center_code']],␣
 ↪df_new_train['common_city'])
```

[45]: 1.0

[46]:
```
# dt.score(df_new_test[['common_center_number',        'common_center_code',␣
 ↪'common_state']], df_new_test['common_city'])
dt.score(df_new_test[['common_center_number',        'common_center_code', ]],␣
 ↪df_new_test['common_city'])
```

[46]: 0.9579111457521434

[47]:
```
# 0.9579111457521434
# Number of Correct, Error Count
print("Correct: ", (df_new_test['common_city']== y_pred).sum())
print("Incorrect: ",(df_new_test['common_city']!= y_pred).sum())
```

```
Correct:  24
Incorrect:  1259
```

[48]:
```
#  We can retrain the data
dt.fit(df_new[['common_center_number',        'common_center_code', ]],␣
 ↪df_new['common_city'])
```

[48]: DecisionTreeClassifier()

[49]:
```
print(dt.
 ↪score(df_new_train[['common_center_number',        'common_center_code']],␣
 ↪df_new_train['common_city']))
print(dt.
 ↪score(df_new_test[['common_center_number',        'common_center_code', ]],␣
 ↪df_new_test['common_city']))
```

```
1.0
1.0
```

1.3.4 Imputation of City

[50]:
```
for route in ['source', 'destination']:
    df_ = df[[f'{route}_center_number',        f'{route}_center_code'        ]].
 ↪copy()
    df_.columns = ['common_center_number',        'common_center_code']
    df_['common_center_code'] = encoder.transform(df_[['common_center_code']])
    imputed_values = dt.predict(df_)
    df.loc[df[f'{route}_city'].isna(), f'{route}_city'] =␣
 ↪imputed_values[df[f'{route}_city'].isna()]
```

[51]:
```
df = df.fillna('Unknown')
```

1.4 Data Splitting

[52]:
```
df[df['trip_uuid']=='trip-153741093647649320']
```

[52]:

	data	trip_creation_time	route_schedule_uuid	route_type	trip_uuid	source_center	source_name	destination_center	destination_name
0	training	2018-09-20 02:35:36.476840	thanos::sroute:eb7bfc78-b351-4c0e-a951-fa3d5c3…	Carting	trip-153741093647649320	IND388121AAA	Anand_VUNagar_DC (Gujarat)	IND388620AAB	Khambhat_MotvdDPP_D (Gujarat)
1	training	2018-09-20 02:35:36.476840	thanos::sroute:eb7bfc78-b351-4c0e-a951-fa3d5c3…	Carting	trip-153741093647649320	IND388121AAA	Anand_VUNagar_DC (Gujarat)	IND388620AAB	Khambhat_MotvdDPP_D (Gujarat)
2	training	2018-09-20 02:35:36.476840	thanos::sroute:eb7bfc78-b351-4c0e-a951-fa3d5c3…	Carting	trip-153741093647649320	IND388121AAA	Anand_VUNagar_DC (Gujarat)	IND388620AAB	Khambhat_MotvdDPP_D (Gujarat)
3	training	2018-09-20 02:35:36.476840	thanos::sroute:eb7bfc78-b351-4c0e-a951-fa3d5c3…	Carting	trip-153741093647649320	IND388121AAA	Anand_VUNagar_DC (Gujarat)	IND388620AAB	Khambhat_MotvdDPP_D (Gujarat)
4	training	2018-09-20 02:35:36.476840	thanos::sroute:eb7bfc78-b351-4c0e-a951-fa3d5c3…	Carting	trip-153741093647649320	IND388121AAA	Anand_VUNagar_DC (Gujarat)	IND388620AAB	Khambhat_MotvdDPP_D (Gujarat)
5	training	2018-09-20 02:35:36.476840	thanos::sroute:eb7bfc78-b351-4c0e-a951-fa3d5c3…	Carting	trip-153741093647649320	IND388620AAB	Khambhat_MotvdDPP_D (Gujarat)	IND388620AAB	Khambhat_MotvdDPP_D (Gujarat)
6	training	2018-09-20 02:35:36.476840	thanos::sroute:eb7bfc78-b351-4c0e-a951-fa3d5c3…	Carting	trip-153741093647649320	IND388620AAB	Khambhat_MotvdDPP_D (Gujarat)	IND388620AAB	Khambhat_MotvdDPP_D (Gujarat)
7	training	2018-09-20 02:35:36.476840	thanos::sroute:eb7bfc78-b351-4c0e-a951-fa3d5c3…	Carting	trip-153741093647649320	IND388620AAB	Khambhat_MotvdDPP_D (Gujarat)	IND388620AAB	Khambhat_MotvdDPP_D (Gujarat)
8	training	2018-09-20 02:35:36.476840	thanos::sroute:eb7bfc78-b351-4c0e-a951-fa3d5c3…	Carting	trip-153741093647649320	IND388620AAB	Khambhat_MotvdDPP_D (Gujarat)	IND388620AAB	Khambhat_MotvdDPP_D (Gujarat)
9	training	2018-09-20 02:35:36.476840	thanos::sroute:eb7bfc78-b351-4c0e-a951-fa3d5c3…	Carting	trip-153741093647649320	IND388620AAB	Khambhat_MotvdDPP_D (Gujarat)	IND388620AAB	Khambhat_MotvdDPP_D (Gujarat)

```
2       IND388620AAB  Khambhat_MotvdDPP_D (Gujarat)
3       IND388620AAB  Khambhat_MotvdDPP_D (Gujarat)
4       IND388620AAB  Khambhat_MotvdDPP_D (Gujarat)
5       IND388320AAA     Anand_Vaghasi_IP (Gujarat)
6       IND388320AAA     Anand_Vaghasi_IP (Gujarat)
7       IND388320AAA     Anand_Vaghasi_IP (Gujarat)
8       IND388320AAA     Anand_Vaghasi_IP (Gujarat)
9       IND388320AAA     Anand_Vaghasi_IP (Gujarat)

               od_start_time                od_end_time  \
0 2018-09-20 03:21:32.418600 2018-09-20 04:47:45.236797
1 2018-09-20 03:21:32.418600 2018-09-20 04:47:45.236797
2 2018-09-20 03:21:32.418600 2018-09-20 04:47:45.236797
3 2018-09-20 03:21:32.418600 2018-09-20 04:47:45.236797
4 2018-09-20 03:21:32.418600 2018-09-20 04:47:45.236797
5 2018-09-20 04:47:45.236797 2018-09-20 06:36:55.627764
6 2018-09-20 04:47:45.236797 2018-09-20 06:36:55.627764
7 2018-09-20 04:47:45.236797 2018-09-20 06:36:55.627764
8 2018-09-20 04:47:45.236797 2018-09-20 06:36:55.627764
9 2018-09-20 04:47:45.236797 2018-09-20 06:36:55.627764

   start_scan_to_end_scan  is_cutoff  cutoff_factor  \
0                      86       True              9
1                      86       True             18
2                      86       True             27
3                      86       True             36
4                      86      False             39
5                     109       True              9
6                     109       True             18
7                     109       True             27
8                     109       True             36
9                     109      False             43

           cutoff_timestamp  actual_distance_to_destination  actual_time  \
0 2018-09-20 04:27:55.000000                       10.435660         14.0
1 2018-09-20 04:17:55.000000                       18.936842         24.0
2 2018-09-20 04:01:19.505586                       27.637279         40.0
3 2018-09-20 03:39:57.000000                       36.118028         62.0
4 2018-09-20 03:33:55.000000                       39.386040         68.0
5 2018-09-20 06:15:58.000000                       10.403038         15.0
6 2018-09-20 05:47:29.000000                       18.045481         44.0
7 2018-09-20 05:25:58.000000                       28.061896         65.0
8 2018-09-20 05:15:56.000000                       38.939167         76.0
9 2018-09-20 04:49:20.000000                       43.595802        102.0

   osrm_time  osrm_distance    factor  segment_actual_time  segment_osrm_time  \
0       11.0        11.9653  1.272727                 14.0               11.0
```

```
1       20.0        21.7243  1.200000                10.0                 9.0
2       28.0        32.5395  1.428571                16.0                 7.0
3       40.0        45.5620  1.550000                21.0                12.0
4       44.0        54.2181  1.545455                 6.0                 5.0
5       11.0        12.1171  1.363636                15.0                11.0
6       17.0        21.2890  2.588235                28.0                 6.0
7       29.0        35.8252  2.241379                21.0                11.0
8       39.0        47.1900  1.948718                10.0                10.0
9       45.0        53.2334  2.266667                26.0                 6.0

   segment_osrm_distance  segment_factor source_city source_place source_code  \
0                11.9653        1.272727       Anand      VUNagar         DC
1                 9.7590        1.111111       Anand      VUNagar         DC
2                10.8152        2.285714       Anand      VUNagar         DC
3                13.0224        1.750000       Anand      VUNagar         DC
4                 3.9153        1.200000       Anand      VUNagar         DC
5                12.1171        1.363636    Khambhat     MotvdDPP          D
6                 9.1719        4.666667    Khambhat     MotvdDPP          D
7                14.5362        1.909091    Khambhat     MotvdDPP          D
8                11.3648        1.000000    Khambhat     MotvdDPP          D
9                 6.0434        4.333333    Khambhat     MotvdDPP          D

  source_state  source_center_number source_center_code destination_city  \
0      Gujarat                388121                AAA         Khambhat
1      Gujarat                388121                AAA         Khambhat
2      Gujarat                388121                AAA         Khambhat
3      Gujarat                388121                AAA         Khambhat
4      Gujarat                388121                AAA         Khambhat
5      Gujarat                388620                AAB            Anand
6      Gujarat                388620                AAB            Anand
7      Gujarat                388620                AAB            Anand
8      Gujarat                388620                AAB            Anand
9      Gujarat                388620                AAB            Anand

  destination_place destination_code destination_state  \
0          MotvdDPP                D            Gujarat
1          MotvdDPP                D            Gujarat
2          MotvdDPP                D            Gujarat
3          MotvdDPP                D            Gujarat
4          MotvdDPP                D            Gujarat
5           Vaghasi               IP            Gujarat
6           Vaghasi               IP            Gujarat
7           Vaghasi               IP            Gujarat
8           Vaghasi               IP            Gujarat
9           Vaghasi               IP            Gujarat

   destination_center_number destination_center_code  trip_year  trip_month  \
```

```
0                    388620                    AAB       2018           9
1                    388620                    AAB       2018           9
2                    388620                    AAB       2018           9
3                    388620                    AAB       2018           9
4                    388620                    AAB       2018           9
5                    388320                    AAA       2018           9
6                    388320                    AAA       2018           9
7                    388320                    AAA       2018           9
8                    388320                    AAA       2018           9
9                    388320                    AAA       2018           9

   trip_day  trip_week  trip_dayofweek  trip_isHoliday  od_trip_time
0        20         38               3            True            86
1        20         38               3            True            86
2        20         38               3            True            86
3        20         38               3            True            86
4        20         38               3            True            86
5        20         38               3            True           109
6        20         38               3            True           109
7        20         38               3            True           109
8        20         38               3            True           109
9        20         38               3            True           109
```

[53]:
```
# Seggregating the unique features
df_unique = df[[ 'data', 'trip_uuid',␣
 ↪'trip_creation_time',        'route_schedule_uuid',        'route_type',
                'trip_year', 'trip_month', 'trip_day', 'trip_week',␣
 ↪'trip_dayofweek', 'trip_isHoliday',
               ]].drop_duplicates()
df_unique.head()
```

[53]:
```
        data                trip_uuid         trip_creation_time  \
0   training  trip-153741093647649320 2018-09-20 02:35:36.476840
10  training  trip-153768492602129387 2018-09-23 06:42:06.021680
15  training  trip-153693976643699843 2018-09-14 15:42:46.437249
17  training  trip-153687145942424248 2018-09-13 20:44:19.424489
35      test  trip-153825970514894360 2018-09-29 22:21:45.149226

                                route_schedule_uuid route_type  trip_year  \
0   thanos::sroute:eb7bfc78-b351-4c0e-a951-fa3d5c3…    Carting       2018
10  thanos::sroute:ff52ef7a-4d0d-4063-9bfe-cc21172…        FTL       2018
15  thanos::sroute:a16bfa03-3462-4bce-9c82-5784c7d…    Carting       2018
17  thanos::sroute:76951383-1608-44e4-a284-46d92e8…        FTL       2018
35  thanos::sroute:0904e75c-b3ac-4278-96cf-802835a…        FTL       2018

    trip_month  trip_day  trip_week  trip_dayofweek  trip_isHoliday
0            9        20         38               3            True
```

```
10          9        23        38              6          False
15          9        14        37              4          False
17          9        13        37              3          False
35          9        29        39              5          False
```

[54]:
```
# Seggregating cumulative features
agg_dict = {
    'start_scan_to_end_scan' : ['sum', 'mean'],
    'od_trip_time' : ['sum', 'mean'],
}
df_cum = df[[ 'trip_uuid', 'start_scan_to_end_scan', 'od_trip_time']].
 ↪drop_duplicates()\
            .groupby('trip_uuid').agg(agg_dict).reset_index()
df_cum
```

[54]:
```
                    trip_uuid start_scan_to_end_scan         od_trip_time  \
                                                  sum    mean          sum
0      trip-153671041653548748                    2259  1129.5         2261
1      trip-153671042288605164                     180    90.0          182
2      trip-153671043369099517                    3933  1966.5         3935
3      trip-153671046011330457                     100   100.0          100
4      trip-153671052974046625                     717   239.0          719
…                          …                     …      …            …
14812  trip-153861095625827784                     257   128.5          258
14813  trip-153861104386292051                      60    60.0           61
14814  trip-153861106442901555                     421   210.5          422
14815  trip-153861115439069069                     347    69.4          348
14816  trip-153861118270144424                     353   176.5          354


              mean
0      1130.500000
1        91.000000
2      1967.500000
3       100.000000
4       239.666667
…              …
14812   129.000000
14813    61.000000
14814   211.000000
14815    69.600000
14816   177.000000

[14817 rows x 5 columns]
```

[55]:
```
df.nunique()
```

[55]:
```
data                                2
trip_creation_time              14817
route_schedule_uuid              1504
route_type                          2
trip_uuid                       14817
source_center                    1508
source_name                      1499
destination_center               1481
destination_name                 1469
od_start_time                   26369
od_end_time                     26369
start_scan_to_end_scan           1915
is_cutoff                           2
cutoff_factor                     501
cutoff_timestamp                93180
actual_distance_to_destination  144515
actual_time                      3182
osrm_time                        1531
osrm_distance                  138046
factor                           45641
segment_actual_time                747
segment_osrm_time                  214
segment_osrm_distance           113799
segment_factor                     5675
source_city                      1262
source_place                     1155
source_code                        25
source_state                       31
source_center_number             1390
source_center_code                 37
destination_city                 1259
destination_place                1131
destination_code                   28
destination_state                  32
destination_center_number        1384
destination_center_code            32
trip_year                           1
trip_month                          2
trip_day                           22
trip_week                           4
trip_dayofweek                      7
trip_isHoliday                      2
od_trip_time                     1903
dtype: int64
```

1.5 Some More Analysis

1.5.1 Correlation between cutoff_factor and actual_distance_to_destination

[56]:
```
df[['cutoff_factor', 'actual_distance_to_destination']]
```

[56]:

	cutoff_factor	actual_distance_to_destination
0	9	10.435660
1	18	18.936842
2	27	27.637279
3	36	36.118028
4	39	39.386040
…	…	…
144862	45	45.258278
144863	54	54.092531
144864	63	66.163591
144865	72	73.680667
144866	70	70.039010

[144867 rows x 2 columns]

[57]:
```
df[['cutoff_factor', 'actual_distance_to_destination']].corr().iloc[0,1]
```

[57]:
```
np.float64(0.9999859454678397)
```

1.5.2 Correlation between start_scan_to_end_scan and od_trip_time

[58]:
```
df[['start_scan_to_end_scan', 'od_trip_time']].corr().iloc[0,1]
```

[58]:
```
np.float64(0.9999998837669541)
```

1.5.3 Top Exporters

[59]:
```
x = df[['trip_uuid', 'source_state']].drop_duplicates()
x['source_state'].value_counts()
```

[59]:
```
source_state
Maharashtra       2748
Karnataka         2325
Haryana           1839
Tamil Nadu        1109
Uttar Pradesh      904
Telangana          827
Delhi              793
Gujarat            774
West Bengal        682
Punjab             643
Rajasthan          551
```

```
Andhra Pradesh             516
Madhya Pradesh             409
Bihar                      382
Kerala                     297
Assam                      273
Jharkhand                  175
Orissa                     170
Uttarakhand                164
Chandigarh                 123
Himachal Pradesh           103
Goa                         65
Arunachal Pradesh           44
Chhattisgarh                43
Jammu & Kashmir             24
Pondicherry                 19
Dadra and Nagar Haveli      15
Meghalaya                   12
Nagaland                     5
Mizoram                      5
Tripura                      1
Name: count, dtype: int64
```

1.5.4 Top Importers

[60]:
```
x = df[['trip_uuid', 'destination_state']].drop_duplicates()
x['destination_state'].value_counts()
```

[60]:
```
destination_state
Maharashtra               2637
Karnataka                 2426
Haryana                   1805
Tamil Nadu                1097
Uttar Pradesh              910
Telangana                  857
Gujarat                    791
West Bengal                713
Punjab                     693
Delhi                      675
Rajasthan                  575
Andhra Pradesh             522
Madhya Pradesh             432
Bihar                      384
Kerala                     303
Assam                      249
Jharkhand                  197
Orissa                     187
Uttarakhand                159
```

```
Himachal Pradesh           101
Chandigarh                  91
Goa                         74
Chhattisgarh                43
Arunachal Pradesh           42
Jammu & Kashmir             25
Pondicherry                 24
Dadra and Nagar Haveli      17
Meghalaya                   11
Mizoram                      7
Tripura                      1
Daman & Diu                  1
Nagaland                     1
Name: count, dtype: int64
```

1.5.5 Top Intra Trading

When source and destination is same state

[61]:
```
x = df[['trip_uuid', 'source_state', 'destination_state']].drop_duplicates()
x = x[x['source_state']==x['destination_state']]
x['destination_state'].value_counts()
```

[61]:
```
destination_state
Maharashtra          2487
Karnataka            2130
Tamil Nadu           1048
Haryana               811
Uttar Pradesh         713
Gujarat               697
Telangana             684
West Bengal           610
Rajasthan             457
Punjab                421
Andhra Pradesh        381
Bihar                 361
Madhya Pradesh        306
Kerala                275
Assam                 214
Delhi                 189
Jharkhand             157
Uttarakhand           126
Orissa                106
Himachal Pradesh       74
Chhattisgarh           43
Chandigarh             39
Goa                    31
Jammu & Kashmir        24
```

```
Arunachal Pradesh      15
Mizoram                 4
Meghalaya               2
Tripura                 1
Name: count, dtype: int64
```

1.5.6 Top Inter Trading

Source and destination state are different.

[62]:
```
x = df[['trip_uuid', 'source_state', 'destination_state']].drop_duplicates()
x = x[x['source_state']!=x['destination_state']]
x['source_state'].value_counts()
```

[62]:
```
source_state
Haryana                   1043
Delhi                      604
Maharashtra                310
Uttar Pradesh              302
Karnataka                  287
Punjab                     242
Andhra Pradesh             170
Telangana                  165
Madhya Pradesh             149
Gujarat                    122
Chandigarh                 121
Rajasthan                  115
Tamil Nadu                 102
Assam                       76
Orissa                      72
West Bengal                 72
Himachal Pradesh            69
Uttarakhand                 56
Kerala                      45
Goa                         43
Bihar                       37
Jharkhand                   32
Arunachal Pradesh           31
Pondicherry                 19
Dadra and Nagar Haveli      15
Meghalaya                   11
Jammu & Kashmir             10
Nagaland                     5
Mizoram                      1
Name: count, dtype: int64
```

[63]:
```
x['destination_state'].value_counts()
```

[63]:
```
destination_state
Haryana                   1009
Delhi                      486
Karnataka                  339
Punjab                     322
Uttar Pradesh              322
Telangana                  223
Maharashtra                218
Andhra Pradesh             176
Madhya Pradesh             157
Rajasthan                  146
Gujarat                    122
West Bengal                103
Himachal Pradesh            87
Chandigarh                  84
Orissa                      84
Tamil Nadu                  79
Assam                       58
Uttarakhand                 54
Goa                         43
Bihar                       42
Jharkhand                   40
Arunachal Pradesh           37
Kerala                      29
Pondicherry                 24
Dadra and Nagar Haveli      17
Meghalaya                   11
Jammu & Kashmir              8
Mizoram                      3
Tripura                      1
Daman & Diu                  1
Nagaland                     1
Name: count, dtype: int64
```

[64]:
```
source_counts = x['source_state'].value_counts().rename('source_count')
destination_counts = x['destination_state'].value_counts().
 ↪rename('destination_count')

# Combine both into a single DataFrame
state_counts = pd.concat([source_counts, destination_counts], axis=1).fillna(0)

# Convert to integer if needed
state_counts = state_counts.astype(int)

print(state_counts)
```

```
                    source_count  destination_count
Haryana                     1043               1009
```

Delhi	604	486
Maharashtra	310	218
Uttar Pradesh	302	322
Karnataka	287	339
Punjab	242	322
Andhra Pradesh	170	176
Telangana	165	223
Madhya Pradesh	149	157
Gujarat	122	122
Chandigarh	121	84
Rajasthan	115	146
Tamil Nadu	102	79
Assam	76	58
Orissa	72	84
West Bengal	72	103
Himachal Pradesh	69	87
Uttarakhand	56	54
Kerala	45	29
Goa	43	43
Bihar	37	42
Jharkhand	32	40
Arunachal Pradesh	31	37
Pondicherry	19	24
Dadra and Nagar Haveli	15	17
Meghalaya	11	11
Jammu & Kashmir	10	8
Nagaland	5	1
Mizoram	1	3
Tripura	0	1
Daman & Diu	0	1

1.5.7 Which state imports more and exports more?

[65]:
```
state_counts['trade_diff'] = state_counts['source_count' ] -␣
↪state_counts['destination_count']
state_counts.sort_values('trade_diff', ascending = False)
```

[65]:

	source_count	destination_count	trade_diff
Delhi	604	486	118
Maharashtra	310	218	92
Chandigarh	121	84	37
Haryana	1043	1009	34
Tamil Nadu	102	79	23
Assam	76	58	18
Kerala	45	29	16
Nagaland	5	1	4
Jammu & Kashmir	10	8	2

Uttarakhand	56	54	2
Goa	43	43	0
Meghalaya	11	11	0
Gujarat	122	122	0
Daman & Diu	0	1	-1
Tripura	0	1	-1
Mizoram	1	3	-2
Dadra and Nagar Haveli	15	17	-2
Bihar	37	42	-5
Pondicherry	19	24	-5
Arunachal Pradesh	31	37	-6
Andhra Pradesh	170	176	-6
Madhya Pradesh	149	157	-8
Jharkhand	32	40	-8
Orissa	72	84	-12
Himachal Pradesh	69	87	-18
Uttar Pradesh	302	322	-20
Rajasthan	115	146	-31
West Bengal	72	103	-31
Karnataka	287	339	-52
Telangana	165	223	-58
Punjab	242	322	-80

1.5.8 Trip Creation Frequency

[66]:
```
trip_df = df[['trip_uuid','trip_creation_time']].drop_duplicates().
 ↪sort_values('trip_creation_time')\
    .reset_index(drop=True)
trip_df['time_diff'] = trip_df['trip_creation_time'].diff()
trip_df = trip_df.drop(0).reset_index(drop=True)
trip_df['time_diff'] = pd.to_timedelta(trip_df['time_diff']).dt.total_seconds()
trip_df
```

[66]:

	trip_uuid	trip_creation_time	time_diff
0	trip-153671042288605164	2018-09-12 00:00:22.886430	6.350689
1	trip-153671043369099517	2018-09-12 00:00:33.691250	10.804820
2	trip-153671046011330457	2018-09-12 00:01:00.113710	26.422460
3	trip-153671052974046625	2018-09-12 00:02:09.740725	69.627015
4	trip-153671055416136166	2018-09-12 00:02:34.161600	24.420875
…	…	…	…
14811	trip-153861095625827784	2018-10-03 23:55:56.258533	37.827869
14812	trip-153861104386292051	2018-10-03 23:57:23.863155	87.604622
14813	trip-153861106442901555	2018-10-03 23:57:44.429324	20.566169
14814	trip-153861115439069069	2018-10-03 23:59:14.390954	89.961630
14815	trip-153861118270144424	2018-10-03 23:59:42.701692	28.310738

[14816 rows x 3 columns]

[67]:
```
avg_waiting_time = trip_df['time_diff'].mean()
avg_waiting_time
```

[67]:
```
np.float64(128.29145288546167)
```

[68]:
```
trip_df[['time_diff']].describe().T
```

[68]:
```
              count        mean         std       min        25%        50%  \
time_diff  14816.0  128.291453  164.911181  0.007974  30.173704  75.35047

                  75%         max
time_diff  164.057606  4584.50296
```

[69]:
```
trip_df ['time_diff_category'] = pd.cut(trip_df['time_diff'], bins = [0,60,␣
↪120, 300, 600, 1200,5000])
trip_df ['time_diff_category'].value_counts()
```

[69]:
```
time_diff_category
(0, 60]          6346
(120, 300]       3660
(60, 120]        3307
(300, 600]       1194
(600, 1200]       277
(1200, 5000]       32
Name: count, dtype: int64
```

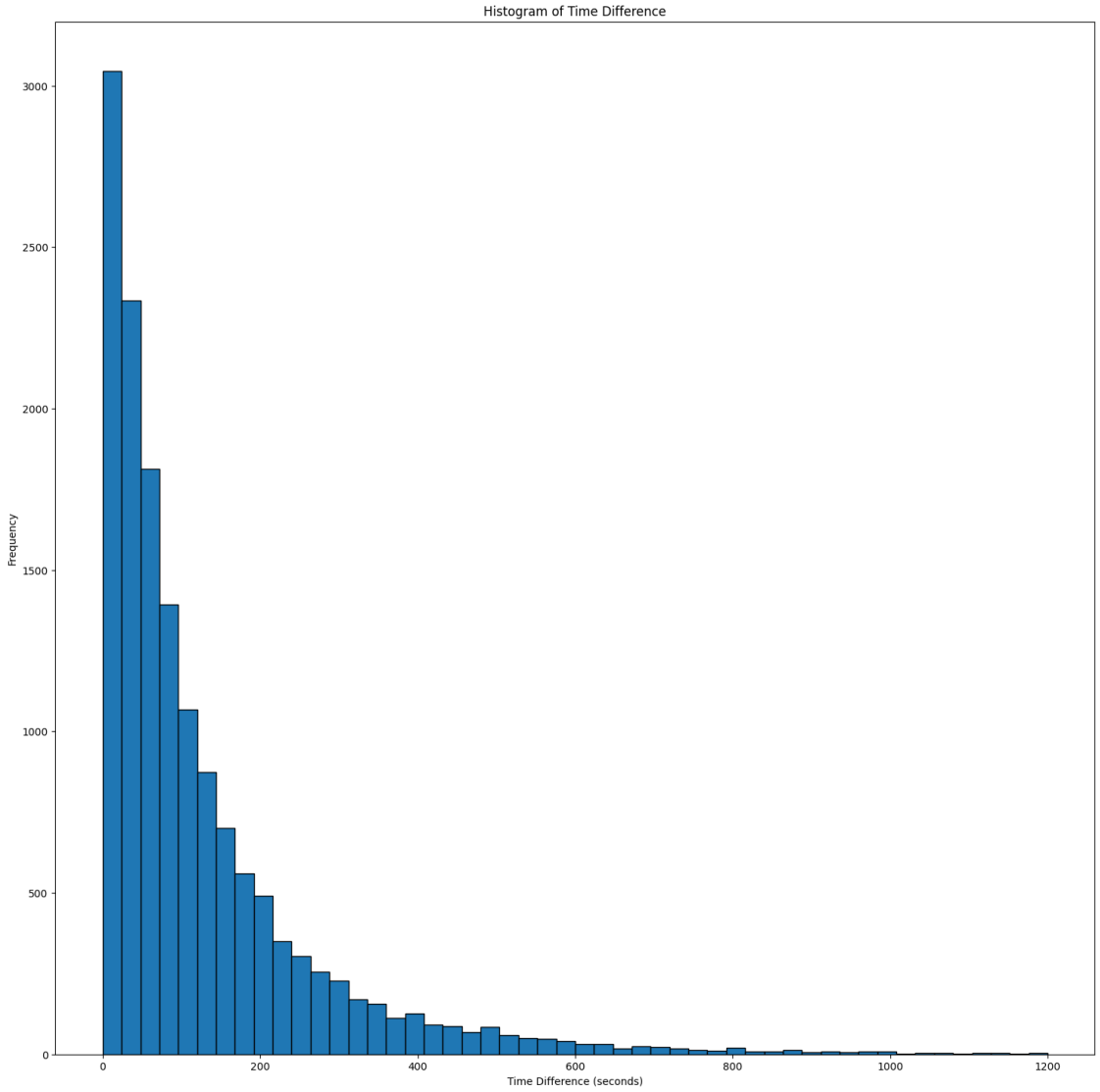
[70]:
```
IQR = trip_df['time_diff'].quantile(.75)-trip_df['time_diff'].quantile(.25)
time_median = trip_df['time_diff'].median()
higher_bound = time_median + 1.5*IQR
higher_bound
```

[70]:
```
np.float64(276.17632137500004)
```

[71]:
```
time_diff = trip_df['time_diff'][trip_df['time_diff']<=1200]
time_diff
```

[71]:
```
0          6.350689
1         10.804820
2         26.422460
3         69.627015
4         24.420875
             ...
14811     37.827869
14812     87.604622
14813     20.566169
14814     89.961630
14815     28.310738
Name: time_diff, Length: 14784, dtype: float64
```

[72]:
```
plt.hist(time_diff, bins=50, edgecolor='black')  # Adjust bins as needed
plt.xlabel('Time Difference (seconds)')
plt.ylabel('Frequency')
plt.title('Histogram of Time Difference')
plt.show()
```

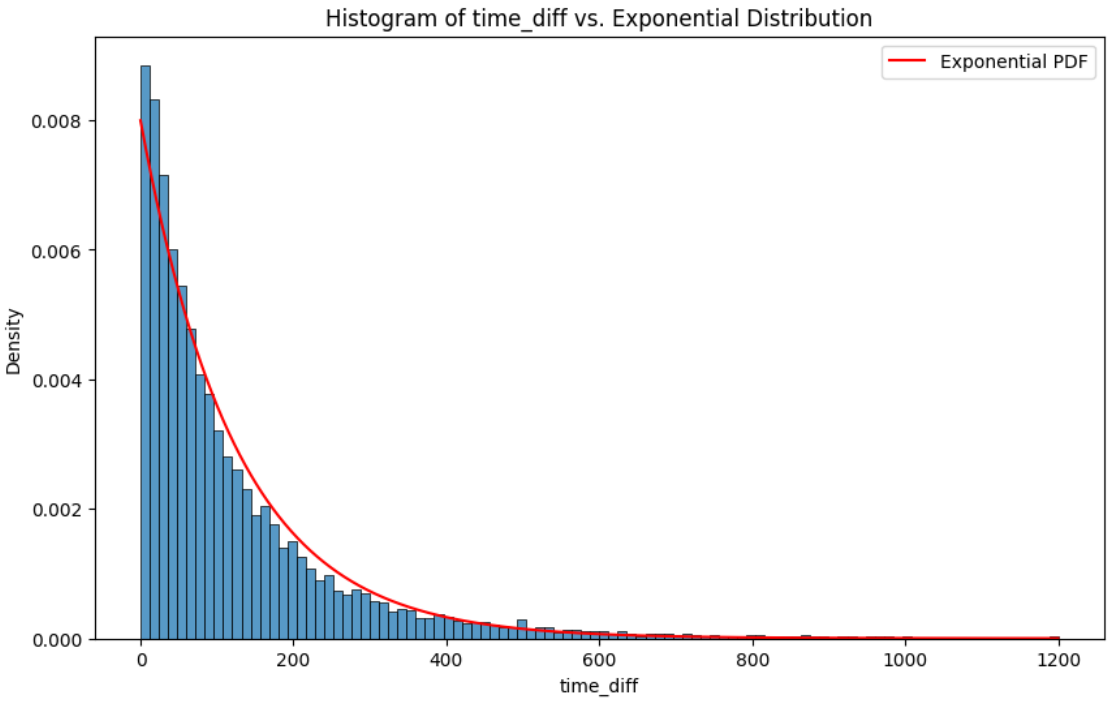


[73]:
```
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from scipy import stats
from statsmodels.graphics.gofplots import qqplot
from statsmodels.stats.diagnostic import acorr_ljungbox
from statsmodels.graphics.tsaplots import plot_acf
```

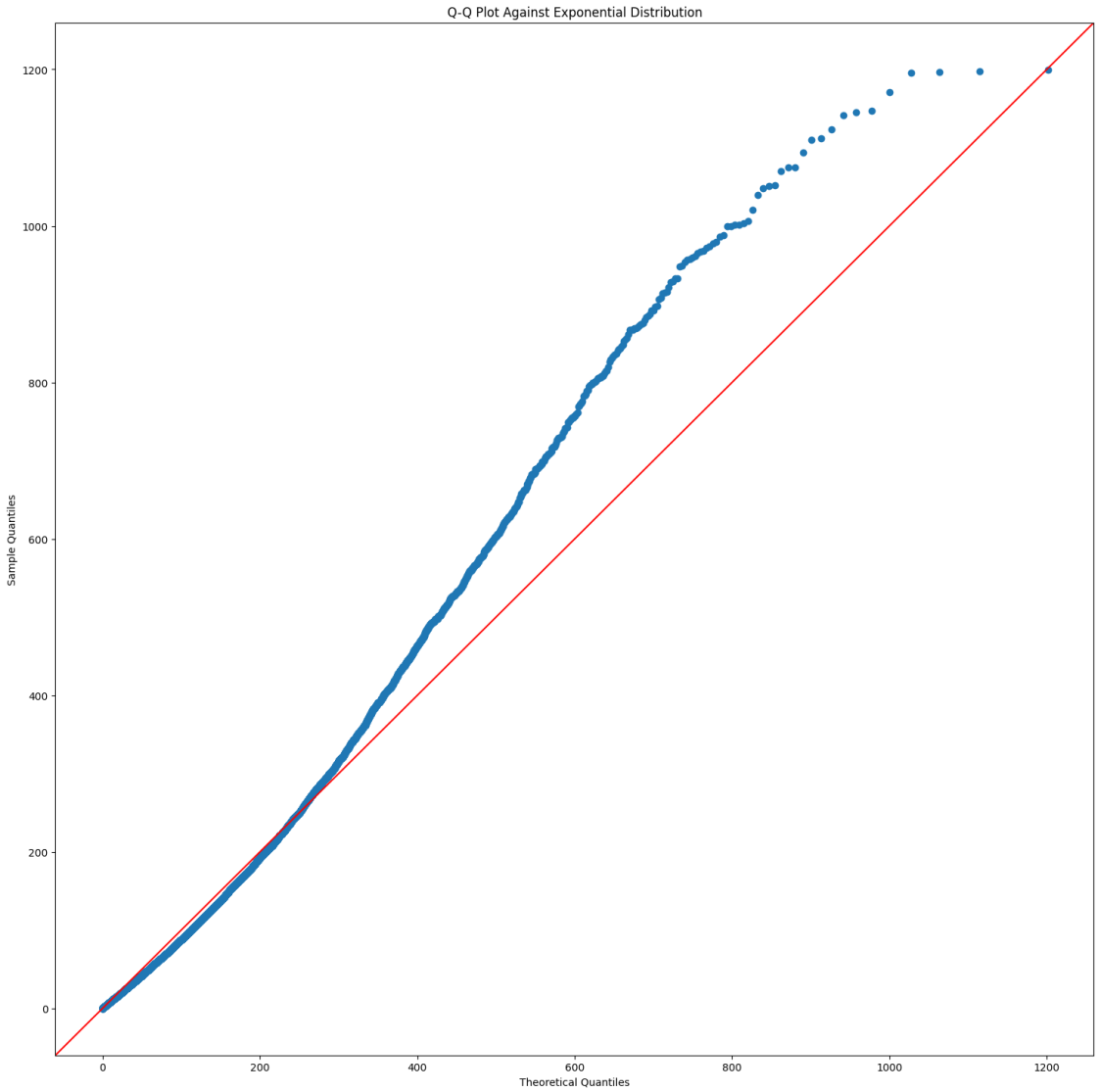
```python
# ----------------------------------------
# 1. Check Exponential Distribution
# ----------------------------------------

# a. Mean and Variance Check
mean_td = time_diff.mean()
var_td = time_diff.var()
print(f"Mean: {mean_td:.4f}, Variance: {var_td:.4f}")
print(f"Mean²: {mean_td**2:.4f} (should be  variance)")

# b. Histogram vs. Exponential PDF
plt.figure(figsize=(10, 6))
sns.histplot(time_diff, stat='density', kde=False, bins=100)
x = np.linspace(0, time_diff.max(), 1000)
plt.plot(x, stats.expon.pdf(x, scale=mean_td), 'r-', label='Exponential PDF')
plt.title('Histogram of time_diff vs. Exponential Distribution')
plt.legend()
plt.show()

# c. Q-Q Plot
plt.figure(figsize=(10, 6))
qqplot(time_diff, dist=stats.expon, loc=0, scale=mean_td, line='45')
plt.title('Q-Q Plot Against Exponential Distribution')
plt.show()

# d. Kolmogorov-Smirnov Test
ks_stat, ks_p = stats.kstest(time_diff, 'expon', args=(0, mean_td))
print(f"KS Test: Statistic = {ks_stat:.4f}, p-value = {ks_p:.4f}")

# e. Anderson-Darling Test (requires normalization)
normalized_td = time_diff / mean_td  # Scale to match  =1
ad_result = stats.anderson(normalized_td, dist='expon')
print(f"AD Test: Statistic = {ad_result.statistic:.4f}")
print("Critical Values:")
for cv, sl in zip(ad_result.critical_values, ad_result.significance_level):
    print(f"  {sl}%: {cv:.4f}")

# ----------------------------------------
# 2. Check Independence
# ----------------------------------------

# a. Autocorrelation Plot
plot_acf(time_diff, lags=20, zero=False, alpha=0.05)
plt.title('Autocorrelation Plot')
plt.show()
```

```
# b. Ljung-Box Test (for lags=10)
lb_test = acorr_ljungbox(time_diff, lags=[10, 20, 30, 40, 50], return_df=True)
print("\nLjung-Box Test (H0: No autocorrelation):")
print(lb_test)
```

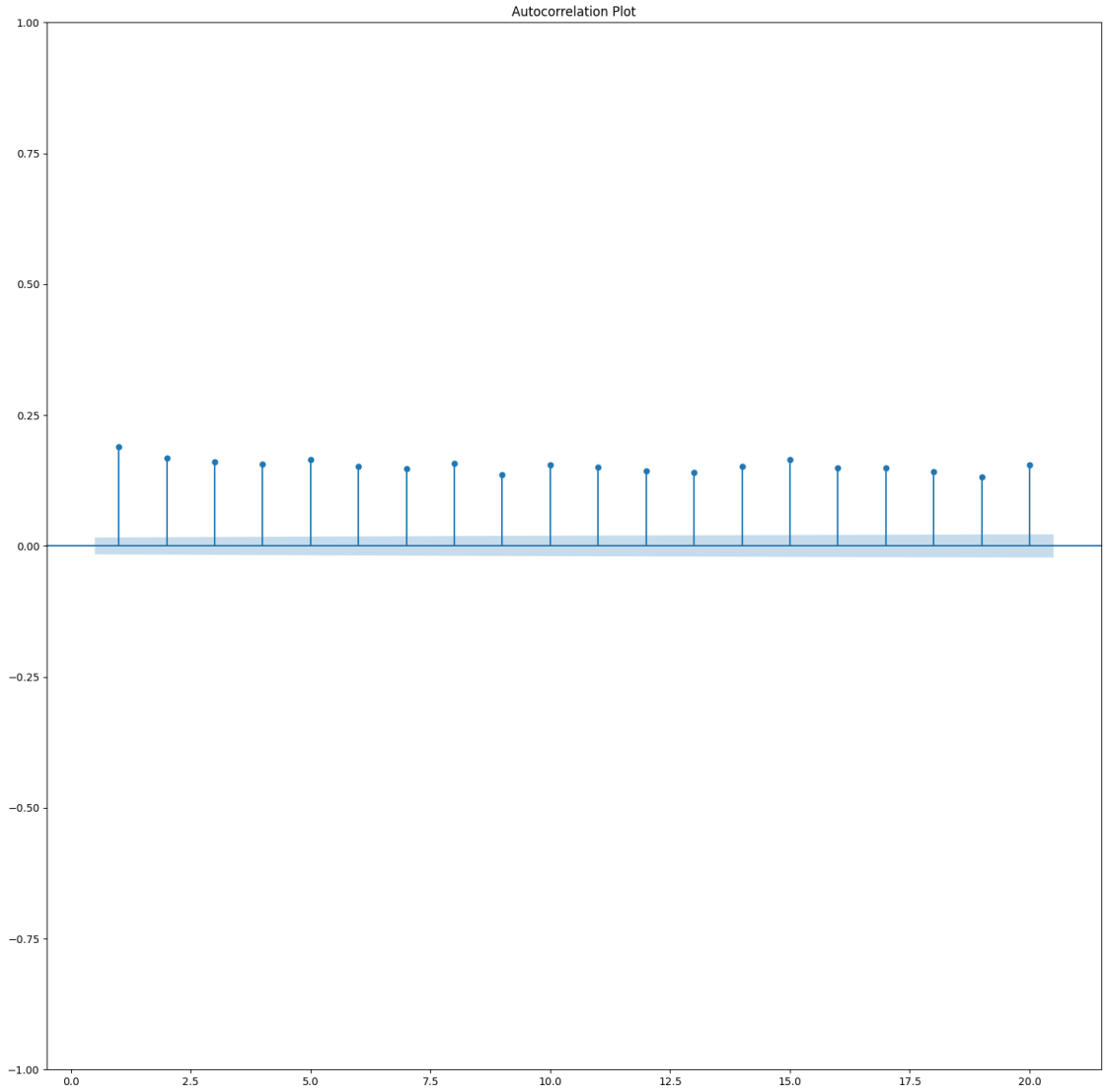
```
Mean: 125.1147, Variance: 21672.7861
Mean²: 15653.6799 (should be   variance)
```




```
<Figure size 1000x600 with 0 Axes>
```



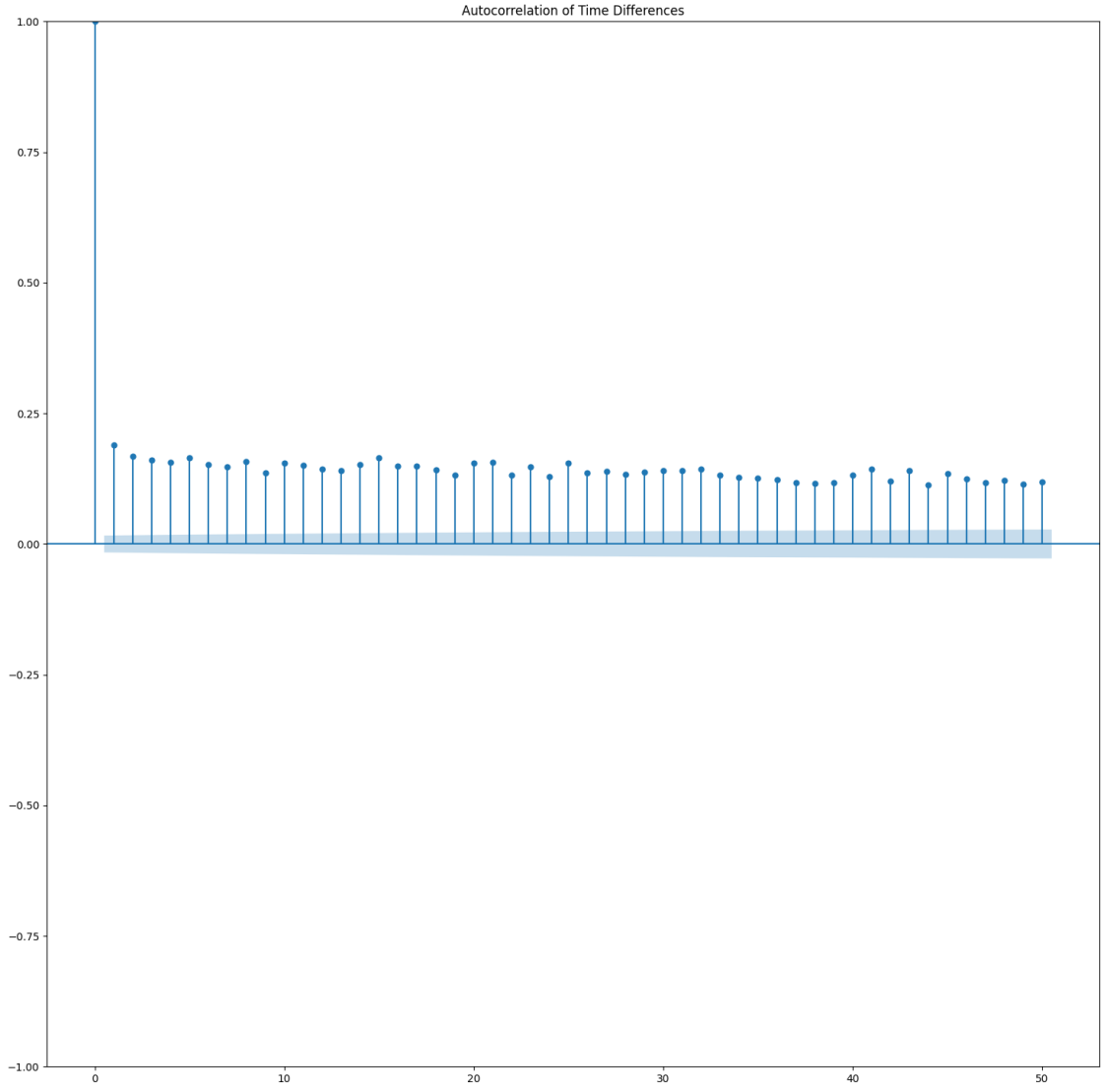

```
KS Test: Statistic = 0.0503, p-value = 0.0000
AD Test: Statistic = 82.8628
Critical Values:
  15.0%: 0.9220
  10.0%: 1.0780
  5.0%: 1.3410
  2.5%: 1.6060
  1.0%: 1.9570
```




```
Ljung-Box Test (H0: No autocorrelation):
         lb_stat  lb_pvalue
10   3751.221498         0.0
20   6994.376118         0.0
30   9927.251180         0.0
40  12339.686524         0.0
50  14663.157012         0.0
```

[74]:
```
from statsmodels.graphics.tsaplots import plot_acf

plot_acf(time_diff, lags=50)
plt.title('Autocorrelation of Time Differences')
```

```
plt.show()
```



1.5.9

[75]:
```
pd.DataFrame({ 'Significance Level':ad_result.significance_level, 'Critical␣
↪Values':ad_result.critical_values,})
```

[75]:

	Significance Level	Critical Values
0	15.0	0.922
1	10.0	1.078
2	5.0	1.341
3	2.5	1.606
4	1.0	1.957

1.5.10 Testing our given empirical formula

1. $$factor = \frac{actual\_time}{osrm\_time}$$
2. $$segment\_factor = \frac{segment\_actual\_time}{segment\_osrm\_time}$$

[76]:
```
np.corrcoef(df['factor'], df['actual_time']/df['osrm_time'])
```

[76]:
```
array([[1., 1.],
       [1., 1.]])
```

[77]:
```
dx = df[['segment_actual_time', 'segment_osrm_time', 'segment_factor']].copy()
dx['segment_factor_est'] = np.
 ↪where(dx['segment_osrm_time']==0,-1,dx['segment_actual_time']/
 ↪(dx['segment_osrm_time']))
```

[78]:
```
dx.isna().sum()
```

[78]:
```
segment_actual_time    0
segment_osrm_time      0
segment_factor         0
segment_factor_est     0
dtype: int64
```

[79]:
```
np.corrcoef(dx['segment_factor'], dx['segment_factor_est'])
```

[79]:
```
array([[1., 1.],
       [1., 1.]])
```

1.5.11 How are factors dependent on holidays?

For each factor (`factor` and `segment_factor`):

- Null Hypothesis (H_0): The mean of the factor on holidays and non-holidays is the same.
- Alternative Hypothesis (H_1): The mean of the factor on non-holidays is significantly higher than on holidays.

Mathematically:

$$H_0 : \mu_{non-holiday} = \mu_{non-holiday}$$
$$H_1 : \mu_{non-holiday} > \mu_{non-holiday}$$

[80]:
```
df[['trip_isHoliday', 'factor', 'segment_factor']].groupby('trip_isHoliday').
 ↪agg({
    'factor': ['mean', 'std'],
    'segment_factor': ['mean', 'std'],
},).reset_index()
```

[80]:

	trip_isHoliday	factor		segment_factor	
		mean	std	mean	std
0	False	2.121669	1.727765	2.223451	4.966922
1	True	2.103883	1.581457	2.165565	3.364993

[81]:
```
holiday = df[df['trip_isHoliday'] == True]
non_holiday = df[df['trip_isHoliday'] == False]

# Perform Welch's t-test (one-tailed) for `factor`
t_stat_factor, p_value_factor = stats.ttest_ind(
    non_holiday['factor'], holiday['factor'], equal_var=False,␣
 ↪alternative='greater'
)

# Perform Welch's t-test (one-tailed) for `segment_factor`
t_stat_segment, p_value_segment = stats.ttest_ind(
    non_holiday['segment_factor'], holiday['segment_factor'], equal_var=False,␣
 ↪alternative='greater'
)

# Print results
print(f"Factor T-test: t-statistic = {t_stat_factor:.4f}, p-value =␣
 ↪{p_value_factor:.4f}")
print(f"Segment Factor T-test: t-statistic = {t_stat_segment:.4f}, p-value =␣
 ↪{p_value_segment:.4f}")

# Interpretation
alpha = 0.05  # Significance level

if p_value_factor < alpha:
    print("Factor: Non-holiday values are significantly higher than holiday␣
 ↪values (Reject H0).")
else:
    print("Factor: No significant difference (Fail to reject H0).")

if p_value_segment < alpha:
    print("Segment Factor: Non-holiday values are significantly higher than␣
 ↪holiday values (Reject H0).")
else:
    print("Segment Factor: No significant difference (Fail to reject H0).")
```

```
Factor T-test: t-statistic = 1.2013, p-value = 0.1148
Segment Factor T-test: t-statistic = 1.7640, p-value = 0.0389
Factor: No significant difference (Fail to reject H0).
Segment Factor: Non-holiday values are significantly higher than holiday values
(Reject H0).
```

[ ]:

1.5.12 Segment Analysis

[82]:
```
df['segment_key'] = df['trip_uuid'] + df['source_center'] +␣
 ↪df['destination_center']

segment_cols = ['segment_actual_time', 'segment_osrm_distance',␣
 ↪'segment_osrm_time']

for col in segment_cols:
    df[col + '_sum'] = df.groupby('segment_key')[col].cumsum()


df[[col + '_sum' for col in segment_cols]]
```

[82]:
```
        segment_actual_time_sum  segment_osrm_distance_sum  \
0                          14.0                    11.9653
1                          24.0                    21.7243
2                          40.0                    32.5395
3                          61.0                    45.5619
4                          67.0                    49.4772
…                           …                          …
144862                     92.0                    65.3487
144863                    118.0                    82.7212
144864                    138.0                   103.4265
144865                    155.0                   122.3150
144866                    423.0                   131.1238

        segment_osrm_time_sum
0                        11.0
1                        20.0
2                        27.0
3                        39.0
4                        44.0
…                         …
144862                   94.0
144863                  115.0
144864                  149.0
144865                  176.0
144866                  185.0

[144867 rows x 3 columns]
```

[83]:
```
create_segment_dict = {

    'trip_uuid'     : 'first',
```

```
    'trip_year'     : 'first',
    'trip_month'    : 'first',
    'trip_day'      : 'first',
    'trip_week'     : 'first',
    'trip_dayofweek': 'first',
    'trip_isHoliday': 'first',

    # 'source_center' : 'first',
    # 'source_name'   : 'first',
    'source_city'   : 'first',
    'source_place'  : 'first',
    'source_code'   : 'first',
    'source_state'  : 'first',

    # 'destination_center'    : 'last',
    # 'destination_name'      : 'last',
    'destination_city'      : 'last'  ,
    'destination_place'     : 'last',
    'destination_code'      : 'last',
    'destination_state'     : 'last',

    'od_start_time'         : 'first',
    'od_end_time'           : 'first',
    'start_scan_to_end_scan': 'first',
    'od_trip_time'          : 'first',


    'actual_distance_to_destination' : 'last',
    'actual_time' : 'last',
    'osrm_time' : 'last',
    'osrm_distance' : 'last',

    'segment_actual_time_sum' : 'last',
    'segment_osrm_time_sum' : 'last',
    'segment_osrm_distance_sum' : 'last',

    }
```

[84]:
```
segment = df.groupby('segment_key').agg(create_segment_dict).
 ↪reset_index(drop=True)
segment
```

[84]:

	trip_uuid	trip_year	trip_month	trip_day	trip_week	\
0	trip-153671041653548748	2018	9	12	37	
1	trip-153671041653548748	2018	9	12	37	
2	trip-153671042288605164	2018	9	12	37	
3	trip-153671042288605164	2018	9	12	37	

```
4      trip-153671043369099517       2018           9        12         37
…                          …        …         …       …        …
26363  trip-153861115439069069       2018          10         3         40
26364  trip-153861115439069069       2018          10         3         40
26365  trip-153861115439069069       2018          10         3         40
26366  trip-153861118270144424       2018          10         3         40
26367  trip-153861118270144424       2018          10         3         40

       trip_dayofweek  trip_isHoliday source_city source_place source_code  \
0                   2           False      Kanpur      Central           H
1                   2           False      Bhopal     Trnsport           H
2                   2           False  Doddablpur     ChikaDPP           D
3                   2           False      Tumkur     Veersagr           I
4                   2           False     Gurgaon     Bilaspur          HB
…                 …             …          …          …         …
26363               2           False  Tirchchndr     Shnmgprm           D
26364               2           False    Peikulam    SriVnktpm           D
26365               2           False        Eral     Busstand           D
26366               2           False      Sandur     WrdN1DPP           D
26367               2           False     Hospet       Unknown     Unknown

         source_state destination_city destination_place destination_code  \
0       Uttar Pradesh          Gurgaon          Bilaspur              HB
1      Madhya Pradesh           Kanpur           Central               H
2           Karnataka       Chikblapur          ShntiSgr               D
3           Karnataka       Doddablpur          ChikaDPP               D
4             Haryana       Chandigarh          Mehmdpur               H
…               …              …                …              …
26363      Tamil Nadu    Thisayanvilai          UdnkdiRD               D
26364      Tamil Nadu      Tirunelveli          VdkkuSrt               I
26365      Tamil Nadu       Tirchchndr          Shnmgprm               D
26366       Karnataka          Bellary               Dc           Unknown
26367       Karnataka           Sandur          WrdN1DPP               D

      destination_state             od_start_time               od_end_time  \
0               Haryana 2018-09-12 16:39:46.858469 2018-09-13 13:40:23.123744
1         Uttar Pradesh 2018-09-12 00:00:16.535741 2018-09-12 16:39:46.858469
2             Karnataka 2018-09-12 02:03:09.655591 2018-09-12 03:01:59.598855
3             Karnataka 2018-09-12 00:00:22.886430 2018-09-12 02:03:09.655591
4                Punjab 2018-09-14 03:40:17.106733 2018-09-14 17:34:55.442454
…                  …                          …                          …
26363         Tamil Nadu 2018-10-04 02:29:04.272194 2018-10-04 03:31:11.183797
26364         Tamil Nadu 2018-10-04 04:16:39.894872 2018-10-04 05:47:45.162682
26365         Tamil Nadu 2018-10-04 01:44:53.808000 2018-10-04 02:29:04.272194
26366          Karnataka 2018-10-04 03:58:40.726547 2018-10-04 08:46:09.166940
26367          Karnataka 2018-10-04 02:51:44.712656 2018-10-04 03:58:40.726547
```

```
       start_scan_to_end_scan  od_trip_time  actual_distance_to_destination  \
0                        1260          1261                      383.759164
1                         999          1000                      440.973689
2                          58            59                       24.644021
3                         122           123                       48.542890
4                         834           835                      237.439610
…                         …             …                         …
26363                      62            62                       33.627182
26364                      91            91                       33.673835
26365                      44            44                       12.661945
26366                     287           287                       40.546740
26367                      66            67                       25.534793

       actual_time  osrm_time  osrm_distance  segment_actual_time_sum  \
0            732.0      329.0       446.5496                    728.0
1            830.0      388.0       544.8027                    820.0
2             47.0       26.0        28.1994                     46.0
3             96.0       42.0        56.9116                     95.0
4            611.0      212.0       281.2109                    608.0
…            …          …           …                           …
26363         51.0       41.0        42.5213                     49.0
26364         90.0       48.0        40.6080                     89.0
26365         30.0       14.0        16.0185                     29.0
26366        233.0       42.0        52.5303                    233.0
26367         42.0       26.0        28.0484                     41.0

       segment_osrm_time_sum  segment_osrm_distance_sum
0                      534.0                   670.6205
1                      474.0                   649.8528
2                       26.0                    28.1995
3                       39.0                    55.9899
4                      231.0                   317.7408
…                      …                        …
26363                   42.0                    42.1431
26364                   77.0                    78.5869
26365                   14.0                    16.0184
26366                   42.0                    52.5303
26367                   25.0                    28.0484

[26368 rows x 26 columns]
```

[85]:
```
np.corrcoef(segment['actual_time'], segment['segment_actual_time_sum'])[0][1]
```

[85]:
```
np.float64(0.999988189643451)
```

[86]:
```
np.corrcoef(segment['osrm_time'], segment['segment_osrm_time_sum'])
```

[86]:
```
array([[1.        , 0.99226893],
       [0.99226893, 1.        ]])
```

[87]:
```
np.corrcoef(segment['osrm_distance'], segment['segment_osrm_distance_sum'])
```

[87]:
```
array([[1.        , 0.99431094],
       [0.99431094, 1.        ]])
```

[88]:
```
create_trip_dict = {
    'trip_month'    : 'first',
    'trip_day'      : 'first',
    'trip_week'     : 'first',
    'trip_dayofweek': 'first',
    'trip_isHoliday': 'first',

    # 'source_center' : 'first',
    # 'source_name'   : 'first',
    'source_city'   : 'first',
    'source_place'  : 'first',
    'source_code'   : 'first',
    'source_state'  : 'first',

    # 'destination_center'    : 'last',
    # 'destination_name'      : 'last',
    'destination_city'      : 'last'  ,
    'destination_place'     : 'last',
    'destination_code'      : 'last',
    'destination_state'     : 'last',

    'od_start_time'         : 'first',
    'od_end_time'           : 'last',
    'start_scan_to_end_scan': 'sum',
    'od_trip_time'          : 'sum',

    'actual_distance_to_destination': 'sum',
    'actual_time'                   : 'sum',
    'osrm_time'                     : 'sum',
    'osrm_distance'                 : 'sum',

    'segment_actual_time_sum'   : 'sum',
    'segment_osrm_time_sum'     : 'sum',
    'segment_osrm_distance_sum' : 'sum',
}
```

[89]:
```
trip = segment.groupby('trip_uuid').agg(create_trip_dict).reset_index(drop =␣
 ↪True)
trip.head()
```

[89]:

	trip_month	trip_day	trip_week	trip_dayofweek	trip_isHoliday
0	9	12	37	2	False
1	9	12	37	2	False
2	9	12	37	2	False
3	9	12	37	2	False
4	9	12	37	2	False

	source_city	source_place	source_code	source_state	destination_city
0	Kanpur	Central	H	Uttar Pradesh	Kanpur
1	Doddablpur	ChikaDPP	D	Karnataka	Doddablpur
2	Gurgaon	Bilaspur	HB	Haryana	Gurgaon
3	Mumbai Hub	Unknown	Unknown	Maharashtra	Mumbai
4	Bellary	Dc	Unknown	Karnataka	Sandur

	destination_place	destination_code	destination_state
0	Central	H	Uttar Pradesh
1	ChikaDPP	D	Karnataka
2	Bilaspur	HB	Haryana
3	MiraRd	IP	Maharashtra
4	WrdN1DPP	D	Karnataka

	od_start_time	od_end_time
0	2018-09-12 16:39:46.858469	2018-09-12 16:39:46.858469
1	2018-09-12 02:03:09.655591	2018-09-12 02:03:09.655591
2	2018-09-14 03:40:17.106733	2018-09-14 03:40:17.106733
3	2018-09-12 00:01:00.113710	2018-09-12 01:41:29.809822
4	2018-09-12 00:02:09.740725	2018-09-12 03:54:43.114421

	start_scan_to_end_scan	od_trip_time	actual_distance_to_destination
0	2259	2261	824.732854
1	180	182	73.186911
2	3933	3935	1927.404273
3	100	100	17.175274
4	717	719	127.448500

	actual_time	osrm_time	osrm_distance	segment_actual_time_sum
0	1562.0	717.0	991.3523	1548.0
1	143.0	68.0	85.1110	141.0
2	3347.0	1740.0	2354.0665	3308.0
3	59.0	15.0	19.6800	59.0
4	341.0	117.0	146.7918	340.0

	segment_osrm_time_sum	segment_osrm_distance_sum
0	1008.0	1320.4733
1	65.0	84.1894
2	1941.0	2545.2678
3	16.0	19.8766

```
4                    115.0                    146.7919
```

[90]:
```
trip['trip_month'].value_counts()
```

[90]:
```
trip_month
9     13029
10     1788
Name: count, dtype: int64
```

[91]:
```
trip['trip_week'].value_counts()
```

[91]:
```
trip_week
38    5004
39    4417
37    3608
40    1788
Name: count, dtype: Int64
```

[92]:
```
np.corrcoef(trip['start_scan_to_end_scan'], trip['od_trip_time'])
```

[92]:
```
array([[1.        , 0.99999912],
       [0.99999912, 1.        ]])
```

[93]:
```
trip['trip_isHoliday'].value_counts()
```

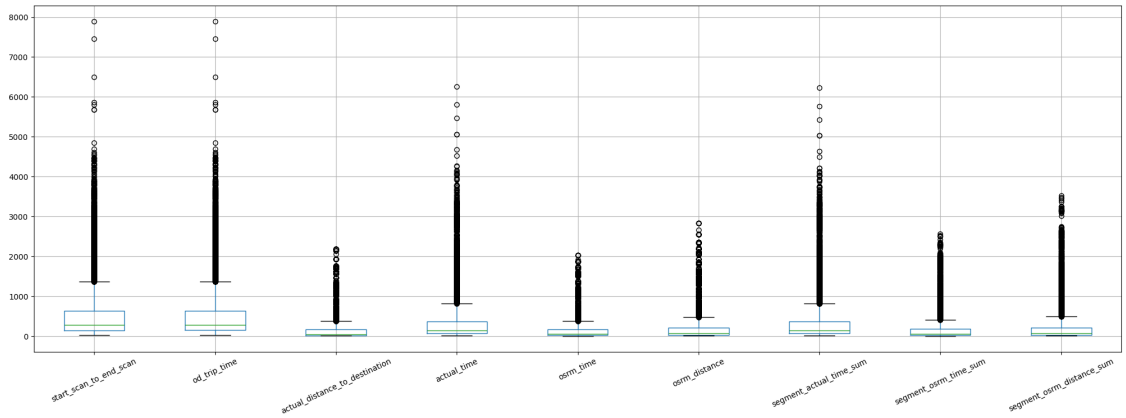
[93]:
```
trip_isHoliday
False    13561
True      1256
Name: count, dtype: int64
```

1.5.13 Numerical Analysis

[94]:
```
num_cols = [␣
 ↪'start_scan_to_end_scan',        'od_trip_time',        'actual_distance_to_destination',
            ␣
 ↪'osrm_time',        'osrm_distance',        'segment_actual_time_sum',        'segment_osrm
             ]
```

[95]:
```
trip[num_cols].boxplot(rot=25, figsize=(25,8))
```

[95]:
```
<Axes: >
```



[96]:
```
# percentiles= [.5, .25, .33, .67, .75, .95]
percentiles= [25, .75]
d = trip[num_cols].describe().drop('count').T
d['IQR'] = d['75%'] - d['25%']
# d['L.B.'] = d['50%'] - 1.5*d['IQR']
d['H.B.'] = d['50%'] + 1.5*d['IQR']
d
```

[96]:

	mean	std	min	25%	50%	75%	max	IQR	H.B.
start_scan_to_end_scan	530.810016	658.705957	23.000000	149.000000	280.000000	637.000000	7898.000000	488.000000	1012.000000
od_trip_time	531.699602	658.872369	23.000000	150.000000	281.000000	638.000000	7899.000000		
actual_distance_to_destination	164.477838	305.388147	9.002461	22.837239	48.474072	164.583208	2186.531787		
actual_time	357.143754	561.396157	9.000000	67.000000	149.000000	370.000000	6265.000000		
osrm_time	161.384018	271.360995	6.000000	29.000000	60.000000	168.000000	2032.000000		
osrm_distance	204.344689	370.395573	9.072900	30.819200	65.618800	208.475000	2840.081000		
segment_actual_time_sum	353.892286	556.247965	9.000000	66.000000	147.000000	367.000000	6230.000000		
segment_osrm_time_sum	180.949787	314.542047	6.000000	31.000000	65.000000	185.000000	2564.000000		
segment_osrm_distance_sum	223.201161	416.628374	9.072900	32.654500	70.154400	218.802400	3523.632400		

```
od_trip_time                      488.000000  1013.000000
actual_distance_to_destination    141.745969   261.093025
actual_time                       303.000000   603.500000
osrm_time                         139.000000   268.500000
osrm_distance                     177.655800   332.102500
segment_actual_time_sum           301.000000   598.500000
segment_osrm_time_sum             154.000000   296.000000
segment_osrm_distance_sum         186.147900   349.376250
```

[97]:
```
d['H.B.']
```

[97]:
```
start_scan_to_end_scan            1012.000000
od_trip_time                      1013.000000
actual_distance_to_destination     261.093025
actual_time                        603.500000
osrm_time                          268.500000
osrm_distance                      332.102500
segment_actual_time_sum            598.500000
segment_osrm_time_sum              296.000000
segment_osrm_distance_sum          349.376250
Name: H.B., dtype: float64
```

[98]:
```
filtered_trip = trip[(trip[num_cols]<=d['H.B.']).all(axis=1)]
filtered_trip.head()
```

[98]:
```
   trip_month  trip_day  trip_week  trip_dayofweek  trip_isHoliday  \
1           9        12         37               2           False
3           9        12         37               2           False
4           9        12         37               2           False
5           9        12         37               2           False
6           9        12         37               2           False

   source_city  source_place source_code source_state destination_city  \
1   Doddablpur      ChikaDPP           D    Karnataka       Doddablpur
3  Mumbai Hub        Unknown     Unknown  Maharashtra           Mumbai
4      Bellary            Dc     Unknown    Karnataka           Sandur
5      Chennai  Poonamallee     Unknown   Tamil Nadu          Chennai
6      Chennai      Chrompet         DPC   Tamil Nadu          Chennai

  destination_place destination_code destination_state  \
1          ChikaDPP                D         Karnataka
3            MiraRd               IP       Maharashtra
4          WrdN1DPP                D         Karnataka
5       Poonamallee          Unknown        Tamil Nadu
6          Vandalur               Dc        Tamil Nadu

               od_start_time                od_end_time  \
```

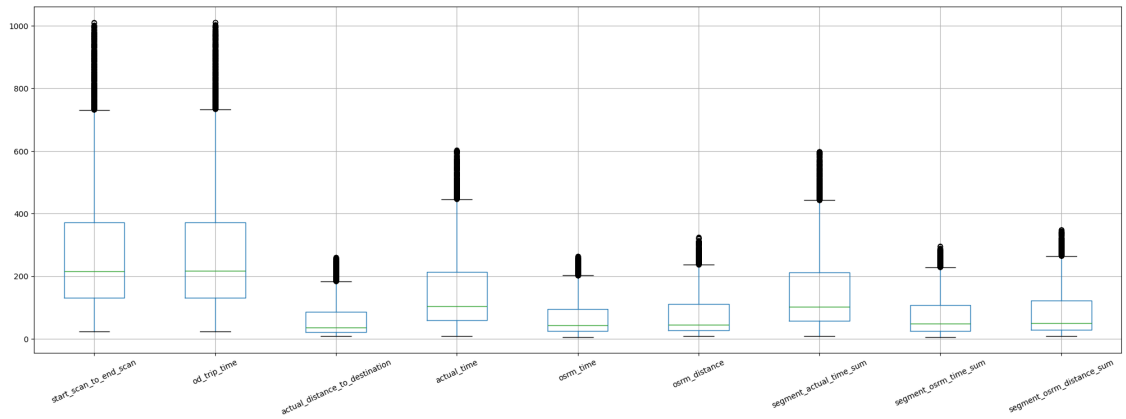
```
1 2018-09-12 02:03:09.655591 2018-09-12 02:03:09.655591
3 2018-09-12 00:01:00.113710 2018-09-12 01:41:29.809822
4 2018-09-12 00:02:09.740725 2018-09-12 03:54:43.114421
5 2018-09-12 02:12:10.755603 2018-09-12 02:12:10.755603
6 2018-09-12 00:04:22.011653 2018-09-12 01:42:22.349694

   start_scan_to_end_scan  od_trip_time  actual_distance_to_destination  \
1                     180           182                       73.186911
3                     100           100                       17.175274
4                     717           719                      127.448500
5                     189           191                       24.597048
6                      98            98                        9.100510

   actual_time  osrm_time  osrm_distance  segment_actual_time_sum  \
1        143.0       68.0        85.1110                    141.0
3         59.0       15.0        19.6800                     59.0
4        341.0      117.0       146.7918                    340.0
5         61.0       23.0        28.0647                     60.0
6         24.0       13.0        12.0184                     24.0

   segment_osrm_time_sum  segment_osrm_distance_sum
1                   65.0                    84.1894
3                   16.0                    19.8766
4                  115.0                   146.7919
5                   23.0                    28.0647
6                   13.0                    12.0184
```

[99]:
```
filtered_trip.shape
```

[99]: (11853, 24)

[100]:
```
filtered_trip[num_cols].boxplot(rot=25, figsize=(25,8))
```

[100]: <Axes: >



[101]:
```
from sklearn.preprocessing import MinMaxScaler
scaler = MinMaxScaler()
filtered_trip.loc[:,num_cols] = scaler.fit_transform(filtered_trip[num_cols])
filtered_trip[num_cols]
```

```
C:\Users\USER\AppData\Local\Temp\ipykernel_34204\1703240805.py:3: FutureWarning:
Setting an item of incompatible dtype is deprecated and will raise in a future
error of pandas. Value '[0.15890688 0.07793522 0.70242915 … 0.40283401
0.32793522 0.3340081 ]' has dtype incompatible with int64, please explicitly
cast to a compatible dtype first.
  filtered_trip.loc[:,num_cols] = scaler.fit_transform(filtered_trip[num_cols])
C:\Users\USER\AppData\Local\Temp\ipykernel_34204\1703240805.py:3: FutureWarning:
Setting an item of incompatible dtype is deprecated and will raise in a future
error of pandas. Value '[0.16093117 0.07793522 0.70445344 … 0.40384615
0.32894737 0.33502024]' has dtype incompatible with int64, please explicitly
cast to a compatible dtype first.
  filtered_trip.loc[:,num_cols] = scaler.fit_transform(filtered_trip[num_cols])
```

[101]:

	start_scan_to_end_scan	od_trip_time	actual_distance_to_destination	\
1	0.158907	0.160931	0.256059	
3	0.077935	0.077935	0.032605	
4	0.702429	0.704453	0.472531	
5	0.168016	0.170040	0.062213	
6	0.075911	0.075911	0.000391	
…	…	…	…	
14812	0.236842	0.237854	0.194523	
14813	0.037449	0.038462	0.025976	
14814	0.402834	0.403846	0.118415	
14815	0.327935	0.328947	0.501555	
14816	0.334008	0.335020	0.227712	

	actual_time	osrm_time	osrm_distance	segment_actual_time_sum	\
1	0.225589	0.240310	0.240377	0.224109	
3	0.084175	0.034884	0.033532	0.084890	
4	0.558923	0.430233	0.435366	0.561969	
5	0.087542	0.065891	0.060038	0.086587	
6	0.025253	0.027132	0.009312	0.025467	
…	…	…	…	…	
14812	0.124579	0.217054	0.203554	0.123939	
14813	0.020202	0.023256	0.022177	0.020374	
14814	0.459596	0.162791	0.157529	0.461800	
14815	0.429293	0.670543	0.512244	0.422750	
14816	0.447811	0.240310	0.226049	0.449915	

	segment_osrm_time_sum	segment_osrm_distance_sum
1	0.203448	0.221207

```
3                    0.034483                    0.031815
4                    0.375862                    0.405562
5                    0.058621                    0.055928
6                    0.024138                    0.008674
…                         …                           …
14812                0.193103                    0.164270
14813                0.017241                    0.020659
14814                0.282759                    0.282157
14815                0.741379                    0.631551
14816                0.210345                    0.210574

[11853 rows x 9 columns]
```

[102]:
```
filtered_trip[num_cols].describe().T
```

[102]:

	count	mean	std	min	25%	\
start_scan_to_end_scan	11853.0	0.258409	0.202703	0.0	0.109312	
od_trip_time	11853.0	0.259210	0.202986	0.0	0.109312	
actual_distance_to_destination	11853.0	0.209971	0.232170	0.0	0.047305	
actual_time	11853.0	0.239860	0.207226	0.0	0.084175	
osrm_time	11853.0	0.236918	0.221437	0.0	0.073643	
osrm_distance	11853.0	0.217837	0.226064	0.0	0.058061	
segment_actual_time_sum	11853.0	0.239360	0.207407	0.0	0.083192	
segment_osrm_time_sum	11853.0	0.233177	0.218460	0.0	0.068966	
segment_osrm_distance_sum	11853.0	0.218919	0.223094	0.0	0.057221	

	50%	75%	max
start_scan_to_end_scan	0.195344	0.352227	1.0
od_trip_time	0.196356	0.353239	1.0
actual_distance_to_destination	0.105162	0.307583	1.0
actual_time	0.159933	0.345118	1.0
osrm_time	0.147287	0.348837	1.0
osrm_distance	0.111799	0.324009	1.0
segment_actual_time_sum	0.159593	0.344652	1.0
segment_osrm_time_sum	0.148276	0.348276	1.0
segment_osrm_distance_sum	0.122829	0.335398	1.0

1.6 Observation:

1. `cutoff_factor` and `actual_distance_to_destination` are highly correlated.
2. `start_scan_to_end_scan` and `od_trip_time` are highly correlated.
3. Top 3 exorters: `Maharashtra` (2748), `Karnataka` (2325), `Haryana` (1839)
4. Top 3 importers: `Maharashtra` (2637), `Karnataka` (2426), `Haryana` (1805)
5. Top 3 intra exporters-importers: `Maharashtra` (2487), `Karnataka` (2130), `Tamil Nadu` (1048)
6. Top 3 inter exporters: `Haryana` (1043), `Delhi` (604),`Maharashtra` (310)
7. Top 3 inter importers: `Haryana` (1009), `Delhi` (486), `Karnataka` (339)
8. Top 3 States which exports more than imports: `Delhi`, `Maharashtra`, `Chandigarh`
9. Top 3 States which imports more than exports: `Punjab`, `Telengana`, `Karnataka`

10. 3 State which imports as much exports: `Goa`, `Meghalaya` and `Gujrat`.
11. Every trip happened in 2018.
12. `Time interverval between two consecutive trip creation` almost follows Poisson Distribution/ Exponential distribution (histogram plot) but when we tried for hypothesis testing, it failed. Also we found strong evidence of autocorrelation at different lags.
13. We found for certain columns, `segment_osrm_time` is zero, for those case, `segment_factor` is given -1, if we want to use these feature, we need to remove those particular rows.
14. We can see that our estimated formula for `factor` and `segment_factor` aligns perfectly with the data, as the correlation coefficient is 1.
15. We found for `segment_factor` that non-holiday values are significantly higher than holiday values.
16. September month has more number of trips than October.
17. 38th week (September month) has more number of trips than October.

1.7 Future Scope:

1. Top export, import analysis can be done for each city wise, like state we did here.
2. Search engine should be optimized for better prediction.