New York City Taxi Trip Duration

July 20, 2021

1 New York City Taxi Trip Duration

1.1 Table of Contents

1.2 1 Introduction

The evaluation metric for this competition is Root Mean Squared Logarithmic Error.

$\epsilon = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(\log(p_i + 1) - \log(a_i + 1))^2}$

The RMSLE is calculated as
ϵ is the RMSLE value
n is the total number of observations in the data set,
p_i is your prediction of trip duration, and

a_i is the actual trip duration for i.
log is the natural logarithm of x

1.3 1.1 Dataset- New York City Taxi Duration Dataset

Dataset is based on the 2016 NYC Yellow Cab trip record datamade available in Big Query on Google Cloud Platform. Thetraining set (contains 1458644 trip records) and the testing set(contains 625134 trip records). The attribute features of the datasetinclude:
* id - a unique identifier for each trip
* vendor_id - a code indicating the provider associated with the trip record
* pickup_datetime - date and time when the meter wasengaged.
* dropoff_datetime - date and time when the meter wasdisengaged.
* passenger_count – driver entered value of number ofpeople travelling in the taxi.
* pickup_latitude - the latitude where the meter wasengaged.
* dropoff_longitude - the longitude where the meter wasdisengaged.
* dropoff_latitude - the latitude where the meter wasdisengaged.
* store_and_fwd_flag - This flag indicates whether thetrip record was held in vehicle memory before sendingto the vendor because the vehicle did not have aconnection to the server - Y=store and forward; N=nota store and forward trip
* trip_duration - duration of the trip in seconds

1.4 1.2 Training and testing using XGBoost

XGBoost (eXtreme Gradient Boosting) is an advancedimplementation of gradient boosting algorithm. Boosting is asequential technique which works on the principle of **ensemble**. Itcombines a set of **weak learners** and delivers improved predictionaccuracy. At any instant t, the model outcomes are weighed basedon the outcomes of previous instant t-1. The outcomes predictedcorrectly are given a lower weight and the ones miss-classified areweighted higher. This technique is followed for a classificationproblem while a similar technique is used for regression.

1.5 2 Preparations

[1]:
```
# import packages
import os
import joblib
import numpy as np
import pandas as pd
import warnings

import matplotlib
import matplotlib.pyplot as plt
import matplotlib.gridspec as gridspec
import matplotlib.patches as mpatches
from matplotlib import ticker

import seaborn as sns

import calendar
```

```
import plotly.express as px
from colorcet import kbc, bmy, fire
import datashader.transfer_functions as tf
import datashader as ds
import plotly.express as px

from geopy.distance import geodesic
import swifter

from sklearn.model_selection import KFold
import xgboost as xgb
```

[2]:
```
# setting up options
pd.set_option('display.max_rows', None)
pd.set_option('display.max_columns', None)

train = pd.read_csv('train.csv')
test = pd.read_csv('test.csv')

train['pickup_datetime'] = pd.to_datetime(train['pickup_datetime']) # ␣
↪     datetime
train['dropoff_datetime'] = pd.to_datetime(train['dropoff_datetime'])
test['pickup_datetime'] = pd.to_datetime(test['pickup_datetime'])

train_df_copy = train.copy()
test_df_copy = test.copy()
```

1.6 3 Dataset Overview

[ ]:
```
train.head(5)
```

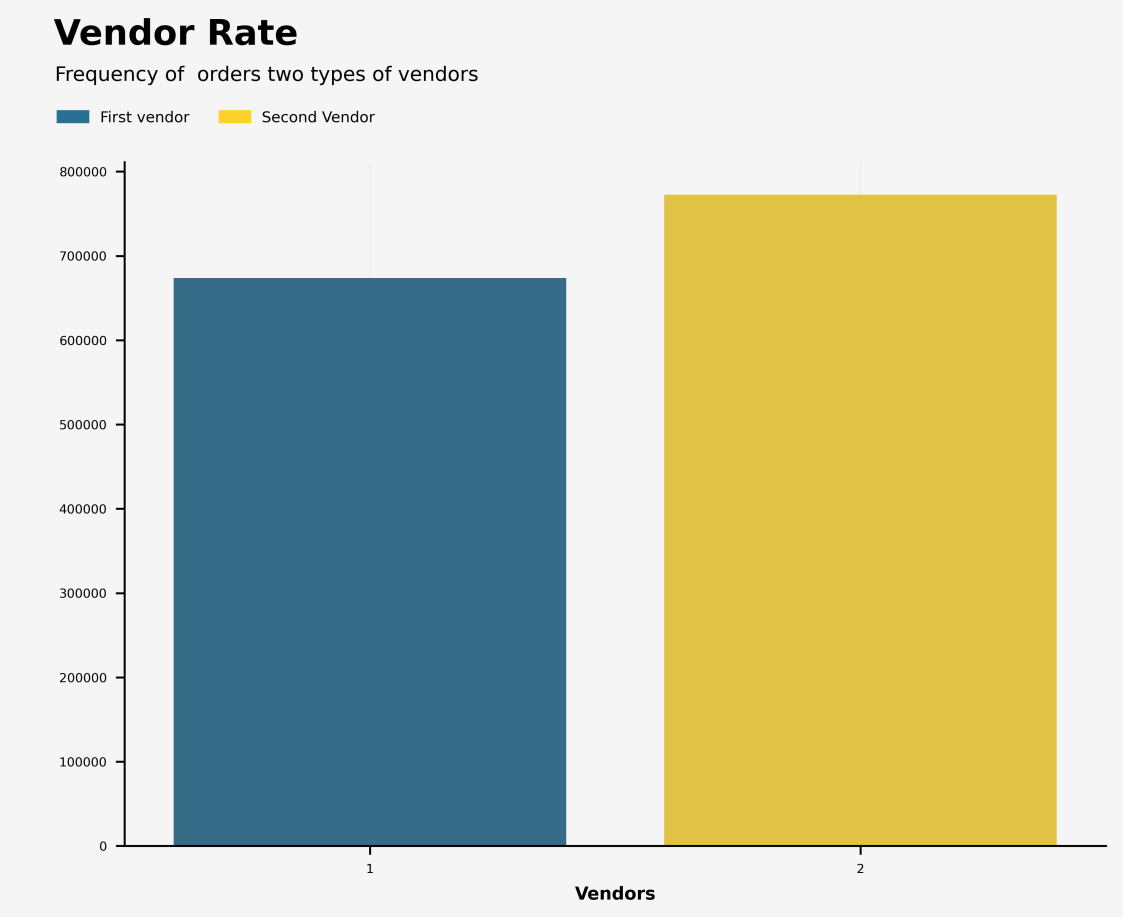
1.7 4 Data analysis

1.7.1 4.1 Vendor Rate

[3]:
```
targets = ["vendor_id", "trip_duration"]
plt.rcParams['figure.dpi'] = 600
fig = plt.figure(figsize=(7, 5), facecolor='#f6f5f5')
gs = fig.add_gridspec(1, 1)
gs.update(wspace=0.6, hspace=0.8)

background_color = "#f6f5f5"
color_map = ['#287094', '#fcd12a']
sns.set_palette(sns.color_palette(color_map))

train = train[(train['trip_duration'] < 3600)]
```

```
ax0 = fig.add_subplot(gs[0, 0])
for s in ["right", "top"]:
    ax0.spines[s].set_visible(False)
ax0.set_facecolor(background_color)
ax0_sns = sns.countplot(ax=ax0, x='vendor_id', data = train, zorder=2)
ax0_sns.grid(which='major', axis='x', zorder=2, color='#EEEEEE')
ax0_sns.tick_params(labelsize=5)
ax0_sns.set_xlabel('Vendors', fontsize=7, weight='bold')
ax0_sns.set_ylabel('')

fig.text(0.069, 1.01, 'Vendor Rate', fontsize=14, fontweight='bold')
fig.text(0.07, 0.97, 'Frequency of  orders two types of vendors', fontsize=8)
yellow = mpatches.Patch(color='#287094')
blue = mpatches.Patch(color='#fcd12a')
fig.legend(handles = [yellow, blue], labels = ['First vendor', 'Second␣
↪Vendor'], ncol=2, facecolor=background_color, edgecolor=background_color,␣
↪fontsize=6, loc='upper left', bbox_to_anchor=(0.035, 0.91))
```

[3]: <matplotlib.legend.Legend at 0x1eb0b49a940>

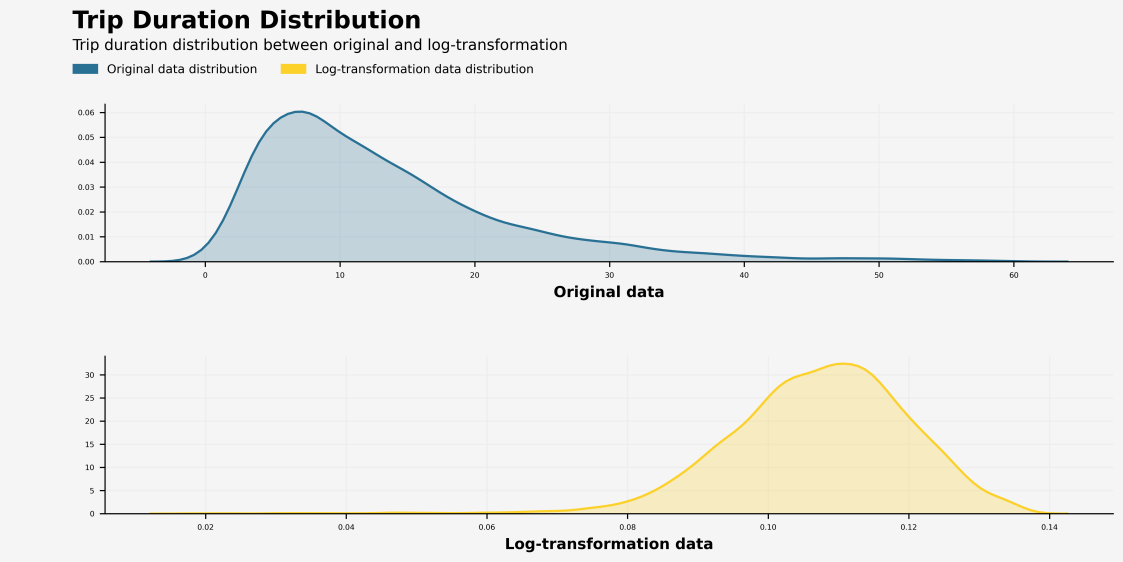


1.7.2 4.2 Trip Duration Distribution

[4]:
```
trip_duration_hist = train['trip_duration'].sample(n=10000, replace=True,␣
 ↪random_state=123) / 60
train['trip_duration_log'] = np.log(train['trip_duration'].values)
trip_duration_hist_log = train['trip_duration_log'].sample(n=10000,␣
 ↪replace=True, random_state=123) / 60
plt.rcParams['figure.dpi'] = 600
fig = plt.figure(figsize=(12, 5), facecolor = '#f6f5f5')
gs = fig.add_gridspec(2, 1)
gs.update(wspace=0.6, hspace=0.6)

background_color = "#f6f5f5"
color_map = ['#287094', '#fcd12a']
sns.set_palette(sns.color_palette(color_map))

ax0 = fig.add_subplot(gs[0, 0])
for s in ["right", "top"]:
    ax0.spines[s].set_visible(False)
ax0.set_facecolor(background_color)
ax0_sns = sns.kdeplot(ax=ax0, data = trip_duration_hist, zorder=2, shade=True)
ax0_sns.set_xlabel('Original data', fontsize=10, weight='bold')
ax0_sns.set_ylabel('')
ax0_sns.grid(which='major', axis='x', zorder=0, color='#EEEEEE')
ax0_sns.grid(which='major', axis='y', zorder=0, color='#EEEEEE')
ax0_sns.tick_params(labelsize=5)
ax0_sns.get_legend().remove()

color_map = ['#fcd12a']
sns.set_palette(sns.color_palette(color_map))
ax1 = fig.add_subplot(gs[1, 0])
for s in ["right", "top"]:
    ax1.spines[s].set_visible(False)
ax1.set_facecolor(background_color)
ax1_sns = sns.kdeplot(ax=ax1, data = trip_duration_hist_log, zorder=2,␣
 ↪shade=True)
ax1_sns.set_xlabel('Log-transformation data', fontsize=10, weight='bold')
ax1_sns.set_ylabel('')
ax1_sns.grid(which='major', axis='x', zorder=0, color='#EEEEEE')
ax1_sns.grid(which='major', axis='y', zorder=0, color='#EEEEEE')
ax1_sns.tick_params(labelsize=5)
ax1_sns.get_legend().remove()

fig.text(0.1, 1.02, 'Trip Duration Distribution', fontsize=16,␣
 ↪fontweight='bold')
```

```
fig.text(0.1, 0.98, 'Trip duration distribution between original and␣
 ↪log-transformation', fontsize=10)

blue = mpatches.Patch(color='#287094')
yellow = mpatches.Patch(color='#fcd12a')
fig.legend(handles = [blue, yellow], labels =  ['Original data distribution',␣
 ↪'Log-transformation data distribution'], ncol=2, facecolor=background_color,␣
 ↪edgecolor=background_color, fontsize=8, loc='upper left', bbox_to_anchor=(0.
 ↪048, 0.94))
```

[4]: <matplotlib.legend.Legend at 0x1eb03ffc4f0>

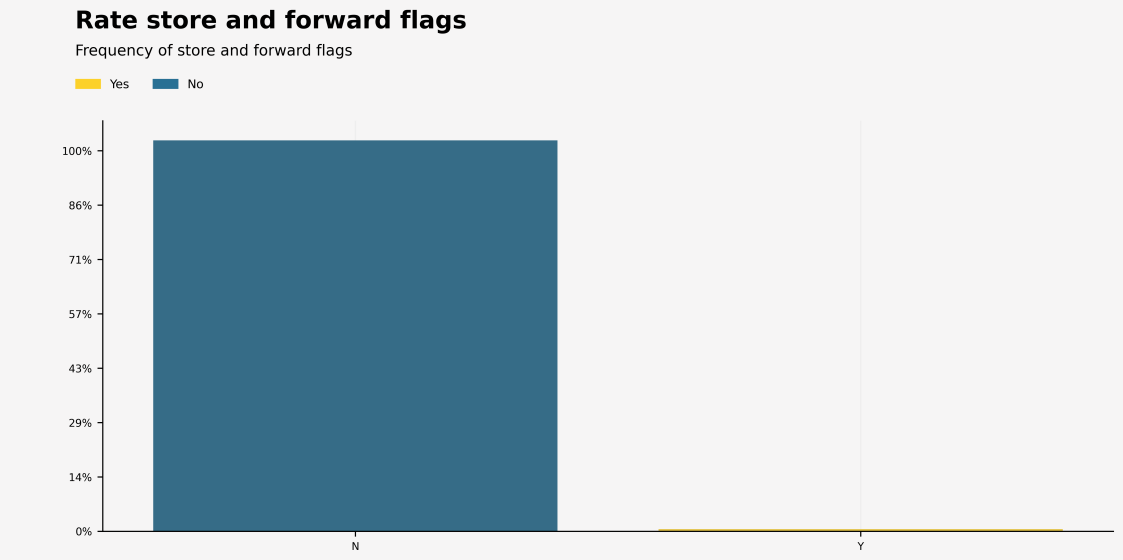


1.7.3 4.3 Rate store and forward flags

[5]:
```
plt.rcParams['figure.dpi'] = 600
fig = plt.figure(figsize=(12, 5), facecolor = '#f6f5f5')
gs = fig.add_gridspec(1, 1)
gs.update(wspace=0.6, hspace=0.8)

background_color = "#f6f5f5"
color_map = ['#287094', '#fcd12a']
sns.set_palette(sns.color_palette(color_map))

ax0 = fig.add_subplot(gs[0, 0])
for s in ["right", "top"]:
    ax0.spines[s].set_visible(False)
ax0.set_facecolor(background_color)
ax0_sns = sns.countplot(ax=ax0, x='store_and_fwd_flag', data = train, zorder=2)
```

```
ax0_sns.grid(which='major', axis='x', zorder=2, color='#EEEEEE')
ax0_sns.tick_params(labelsize=7)
ax0_sns.set_xlabel('', fontsize=9, weight='bold')
ax0_sns.set_ylabel('')
ax0.yaxis.set_major_formatter(matplotlib.ticker.PercentFormatter(1400000))

fig.text(0.104, 1.05, 'Rate store and forward flags', fontsize=16,␣
 ↪fontweight='bold')
fig.text(0.104, 1, 'Frequency of store and forward flags', fontsize=10)

yellow = mpatches.Patch(color='#287094')
blue = mpatches.Patch(color='#fcd12a')
fig.legend(handles = [blue, yellow], labels = ['Yes', 'No'], ncol=2,␣
 ↪facecolor=background_color, edgecolor=background_color, fontsize=8,␣
 ↪loc='upper left', bbox_to_anchor=(0.05, 0.91))
```

[5]: <matplotlib.legend.Legend at 0x1eb0779c7c0>



1.7.4 4.4 Times distribution

[6]:
```
def to_split_time(df):
    df['pickup_month'] = df.pickup_datetime.apply(lambda M : M.month)
    df['pickup_date'] = df.pickup_datetime.apply(lambda D : D.day)
    df['pickup_hour'] = df.pickup_datetime.apply(lambda h : h.hour)
    df['pickup_minute'] = df.pickup_datetime.apply(lambda m : m.minute)
    df['pickup_day'] = df.pickup_datetime.apply(lambda d : d.weekday())

to_split_time(train)
```

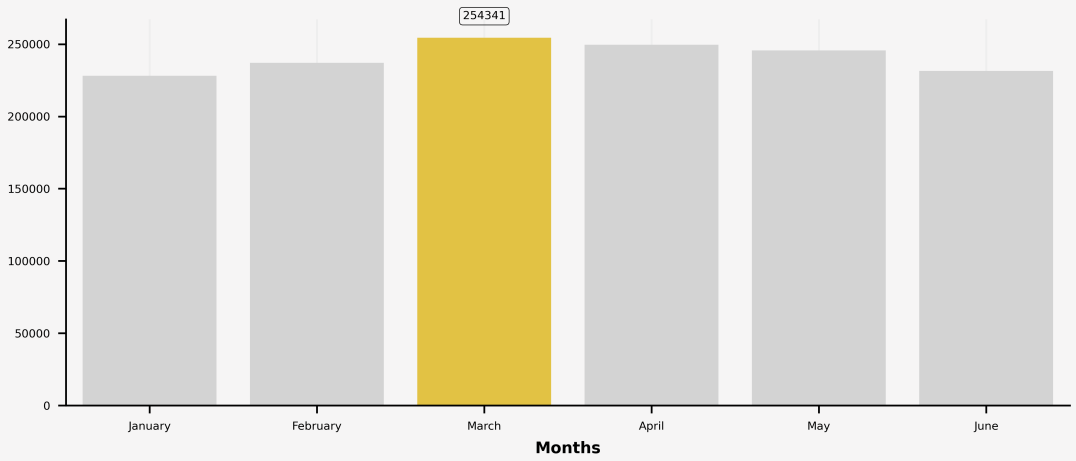
```
to_split_time(test)

names_month = list(dict(enumerate(calendar.month_name)).values())

plt.rcParams['figure.dpi'] = 600
fig = plt.figure(figsize=(8, 12), facecolor = '#f6f5f5')
gs = fig.add_gridspec(3, 1)
gs.update(wspace=0.6, hspace=0.4)

background_color = "#f6f5f5"
color_map_1 = ['#287094', '#fcd12a']

ax0 = fig.add_subplot(gs[0, 0])
color_map_0 = ['lightgray' for _ in range(6)]
color_map_0[2] = '#fcd12a'
for s in ["right", "top"]:
    ax0.spines[s].set_visible(False)
sns.set_palette(sns.color_palette(color_map_0))
ax0.set_facecolor(background_color)
ax0_sns = sns.barplot(ax = ax0, y = train['pickup_month'].value_counts().
 ↪sort_index().values, x = train['pickup_month'].value_counts().sort_index().
 ↪index, zorder = 2)
ax0_sns.grid(which='major', axis='x', zorder=2, color='#EEEEEE')
ax0_sns.tick_params(labelsize=5)
ax0_sns.set_xlabel('Months', fontsize=7, weight='bold')
ax0_sns.set_ylabel('')
ax0_sns.set_xticklabels(names_month[1:], rotation=0);
p = ax0.patches[2]
percentage = f'{p.get_height():.0f}'
x_p = p.get_x() + p.get_width() / 2
y_p = p.get_height() + 15000
ax0.text(x_p, y_p, percentage, ha='center', va='center', fontsize=5,
bbox=dict(facecolor='none', edgecolor='black', boxstyle='round', linewidth=0.3))


ax1 = fig.add_subplot(gs[1, 0])
color_map_1 = ['lightgray' for _ in range(24)]
color_map_1[19] = '#fcd12a'
for s in ["right", "top"]:
    ax1.spines[s].set_visible(False)
sns.set_palette(sns.color_palette(color_map_1))
ax1.set_facecolor(background_color)
ax1_sns = sns.barplot(ax = ax1, y = train['pickup_hour'].value_counts().
 ↪sort_index().values, x = train['pickup_hour'].value_counts().sort_index().
 ↪index +1, zorder = 2)
ax1_sns.grid(which='major', axis='x', zorder=2, color='#EEEEEE')
ax1_sns.tick_params(labelsize=5)
```

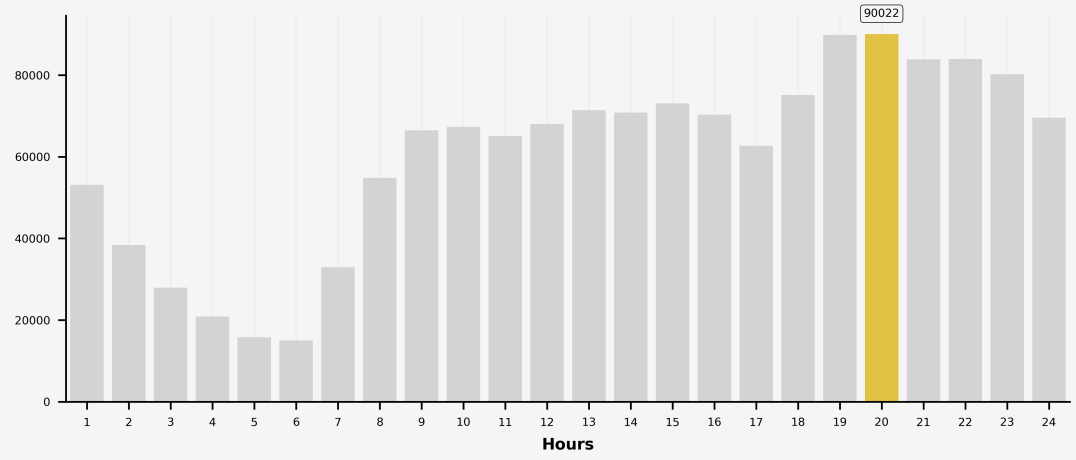
```
ax1_sns.set_xlabel('Hours', fontsize=7, weight='bold')
ax1_sns.set_ylabel('')
p = ax1.patches[19]
percentage = f'{p.get_height():.0f}'
x_p = p.get_x() + p.get_width() / 2
y_p = p.get_height() + 5000
ax1.text(x_p, y_p, percentage, ha='center', va='center', fontsize=5,
bbox=dict(facecolor='none', edgecolor='black', boxstyle='round', linewidth=0.3))

ax2 = fig.add_subplot(gs[2, 0])
color_map_2 = ['lightgray' for _ in range(7)]
color_map_2[4] = '#fcd12a'
for s in ["right", "top"]:
    ax2.spines[s].set_visible(False)
sns.set_palette(sns.color_palette(color_map_2))
ax2.set_facecolor(background_color)
ax2_sns = sns.barplot(ax = ax2, y = train['pickup_day'].value_counts().
 ↪sort_index().values, x = train['pickup_day'].value_counts().sort_index().
 ↪index +1, zorder = 2)
ax2_sns.grid(which='major', axis='x', zorder=2, color='#EEEEEE')
ax2_sns.tick_params(labelsize=5)
ax2_sns.set_xlabel('Days', fontsize=7, weight='bold')
ax2_sns.set_ylabel('')
ax2_sns.set_xticklabels(list(dict(enumerate(calendar.day_name)).values()),␣
 ↪rotation=0);
p = ax2.patches[4]
percentage = f'{p.get_height():.0f}'
x_p = p.get_x() + p.get_width() / 2
y_p = p.get_height() + 15000
ax2.text(x_p, y_p, percentage, ha='center', va='center', fontsize=5,
bbox=dict(facecolor='none', edgecolor='black', boxstyle='round', linewidth=0.3))

fig.text(0.104, 0.95, 'Times Distribution', fontsize=16, fontweight='bold')
fig.text(0.104, 0.93, 'Counts of orders between months, days and hours',␣
 ↪fontsize=10)

blue = mpatches.Patch(color='#fcd12a')
fig.legend(handles = [blue], labels = ['Top of the range'], ncol=2,␣
 ↪facecolor=background_color, edgecolor=background_color, fontsize=6,␣
 ↪loc='upper left', bbox_to_anchor=(0.052, 0.835))
```

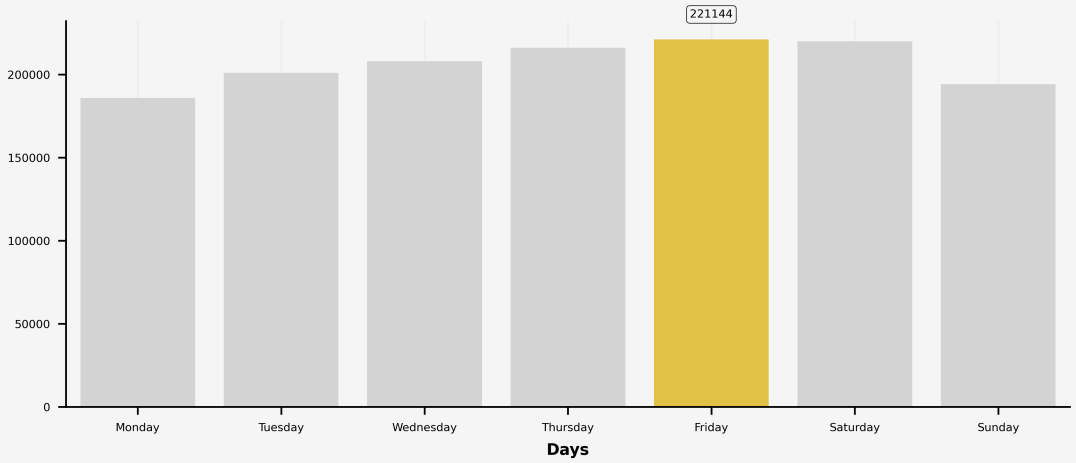
[6]: <matplotlib.legend.Legend at 0x1eb7c87f580>

Times Distribution

Counts of orders between months, days and hours





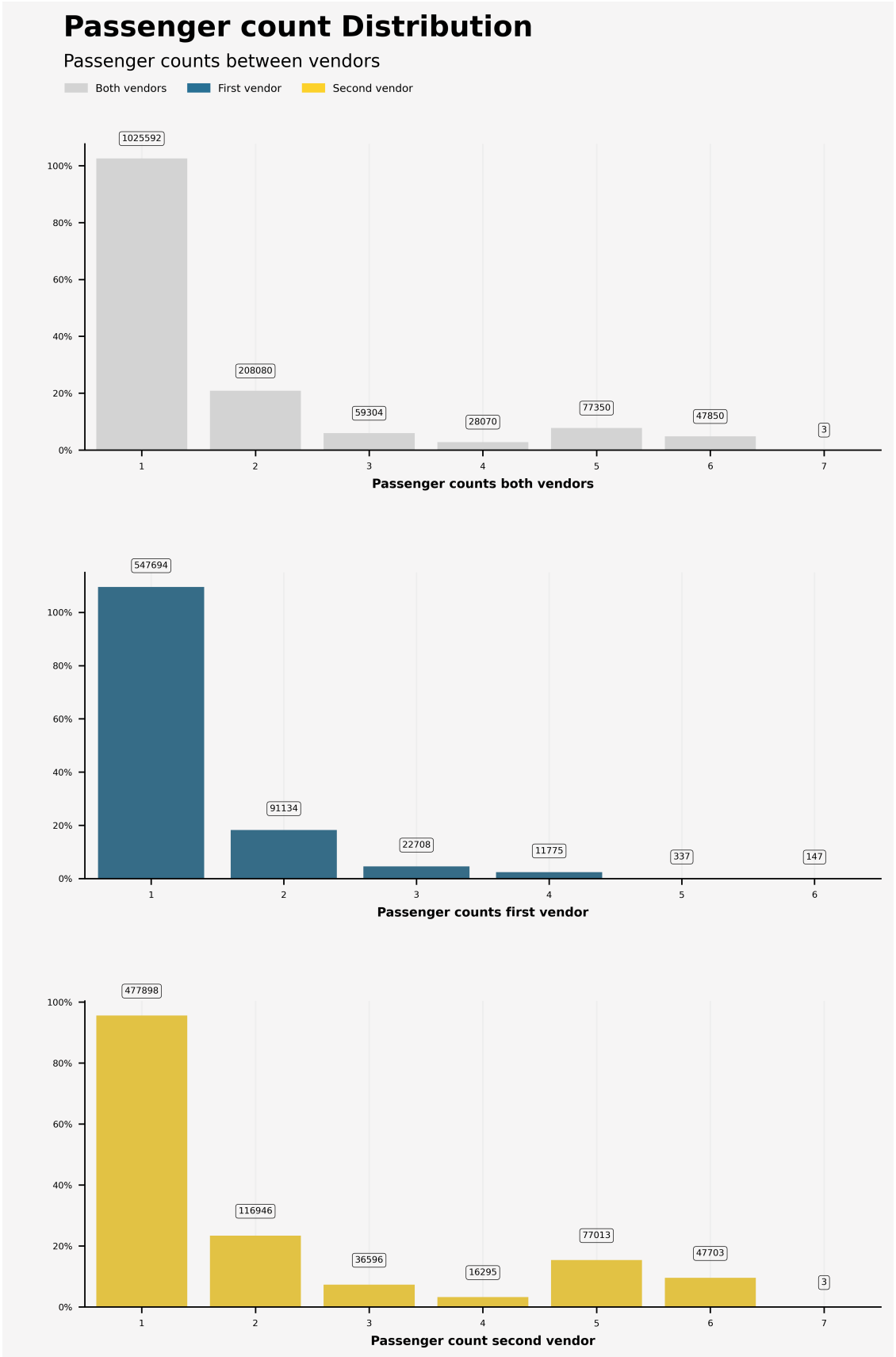


1.7.5 4.5 Passenger distribution

[7]:
```
train = train[(train['passenger_count'] < 8) & (train['passenger_count'] > 0)]

plt.rcParams['figure.dpi'] = 600
fig = plt.figure(figsize=(8, 12), facecolor = '#f6f5f5')
gs = fig.add_gridspec(3, 1)
gs.update(wspace=0.6, hspace=0.4)

background_color = "#f6f5f5"
color_map_1 = ['#287094', '#fcd12a']

ax0 = fig.add_subplot(gs[0, 0])
color_map_0 = ['lightgray' for _ in range(7)]
for s in ["right", "top"]:
    ax0.spines[s].set_visible(False)
sns.set_palette(sns.color_palette(color_map_0))
ax0.set_facecolor(background_color)
ax0_sns = sns.countplot(ax = ax0, x='passenger_count', data=train, zorder = 2)
ax0_sns.grid(which='major', axis='x', zorder=2, color='#EEEEEE')
ax0_sns.tick_params(labelsize=5)
ax0_sns.set_xlabel('Passenger counts both vendors', fontsize=7, weight='bold')
ax0_sns.set_ylabel('')
ax0.yaxis.set_major_formatter(matplotlib.ticker.PercentFormatter(1000000))
for p in ax0.patches:
    percentage = f'{p.get_height():.0f}'
    x = p.get_x() + p.get_width() / 2
    y = p.get_height() + 70000
    ax0.text(x, y, percentage, ha='center', va='center', fontsize=5,
           bbox=dict(facecolor='none', edgecolor='black', boxstyle='round',␣
 ↪linewidth=0.3))

ax1 = fig.add_subplot(gs[1, 0])
color_map_1 = ['#287094' for _ in range(6)]
for s in ["right", "top"]:
    ax1.spines[s].set_visible(False)
sns.set_palette(sns.color_palette(color_map_1))
ax1.set_facecolor(background_color)
ax1_sns = sns.countplot(x='passenger_count', data=train[train['vendor_id'] ==␣
 ↪1], zorder = 2)
ax1_sns.grid(which='major', axis='x', zorder=2, color='#EEEEEE')
ax1_sns.tick_params(labelsize=5)
ax1_sns.set_xlabel('Passenger counts first vendor', fontsize=7, weight='bold')
ax1_sns.set_ylabel('')
```

```
ax1.yaxis.set_major_formatter(matplotlib.ticker.PercentFormatter(500000))
for p in ax1.patches:
    percentage = f'{p.get_height():.0f}'
    x = p.get_x() + p.get_width() / 2
    y = p.get_height() + 40000
    ax1.text(x, y, percentage, ha='center', va='center', fontsize=5,
           bbox=dict(facecolor='none', edgecolor='black', boxstyle='round',␣
 ↪linewidth=0.3))

ax2 = fig.add_subplot(gs[2, 0])
color_map_2 = ['#fcd12a' for _ in range(7)]
for s in ["right", "top"]:
    ax2.spines[s].set_visible(False)
sns.set_palette(sns.color_palette(color_map_2))
ax2.set_facecolor(background_color)
ax2_sns = sns.countplot(x='passenger_count', data=train[train['vendor_id'] ==␣
 ↪2], zorder = 2)
ax2_sns.grid(which='major', axis='x', zorder=2, color='#EEEEEE')
ax2_sns.tick_params(labelsize=5)
ax2_sns.set_xlabel('Passenger count second vendor', fontsize=7, weight='bold')
ax2_sns.set_ylabel('')
ax2.yaxis.set_major_formatter(matplotlib.ticker.PercentFormatter(500000))
for p in ax2.patches:
    percentage = f'{p.get_height():.0f}'
    x = p.get_x() + p.get_width() / 2
    y = p.get_height() + 40000
    ax2.text(x, y, percentage, ha='center', va='center', fontsize=5,
           bbox=dict(facecolor='none', edgecolor='black', boxstyle='round',␣
 ↪linewidth=0.3))

fig.text(0.104, 0.95, 'Passenger count Distribution', fontsize=16,␣
 ↪fontweight='bold')
fig.text(0.104, 0.93, 'Passenger counts between vendors', fontsize=10)

blue = mpatches.Patch(color='#287094')
gray = mpatches.Patch(color='lightgray')
yellow = mpatches.Patch(color='#fcd12a')
fig.legend(handles = [gray, blue, yellow], labels = ['Both vendors', 'First␣
 ↪vendor', 'Second vendor'], ncol=3, facecolor=background_color,␣
 ↪edgecolor=background_color, fontsize=6, loc='upper left', bbox_to_anchor=(0.
 ↪052, 0.835))
```

[7]: <matplotlib.legend.Legend at 0x1eb64673970>


Passenger count Distribution
Passenger counts between vendors
Both vendors
First vendor
Second vendor
1025592
208080
59304
28070
77350
47850
3
Passenger counts both vendors
547694
91134
22708
11775
337
147
Passenger counts first vendor
477898
116946
36596
16295
77013
47703
3
Passenger count second vendor

1.7.6 4.6 Taxi request map

[8]:
```
pick_up_df = train[['pickup_datetime', 'pickup_longitude', 'pickup_latitude']]
drop_off_df = train[['dropoff_datetime', 'dropoff_longitude',␣
↪'dropoff_latitude']]
pick_up_df.columns = ['Date/Time','Lon','Lat']
drop_off_df.columns = ['Date/Time','Lon','Lat']
def create_map(df, color):
    plt.figure(figsize=(20, 20))
    dff = df.query('Lat < 40.82').query('Lat > 40.70').query('Lon > -74.02').
↪query('Lon < -73.91')

    cvs = ds.Canvas(plot_width=1440, plot_height=1440);
    agg = cvs.points(dff, x='Lon', y='Lat')
    coords_lat, coords_lon = agg.coords['Lat'].values, agg.coords['Lon'].values
    coordinates = [[coords_lon[0], coords_lat[0]],
                   [coords_lon[-1], coords_lat[0]],
                   [coords_lon[-1], coords_lat[-1]],
                   [coords_lon[0], coords_lat[-1]]]

    img = tf.shade(agg, cmap=color, how='eq_hist')[::-1].to_pil()
    fig = px.scatter_mapbox(dff[:1], lat='Lat', lon='Lon', zoom=11);
    fig.update_layout(mapbox_style="carto-darkmatter",
                      mapbox_layers = [
                     {
                         "sourcetype": "image",
                         "source": img,
                         "coordinates": coordinates
                     }]
    )
    fig.show()
create_map(pick_up_df, bmy);
create_map(pick_up_df, kbc);
```

```
<Figure size 12000x12000 with 0 Axes>
```

```
<Figure size 12000x12000 with 0 Axes>
```

[9]:
```
def get_distance(source_lat, source_long, dest_lat, dest_long):
    # Returns the distance in Miles between the source and the destination.

    distance = geodesic((source_lat, source_long),
                        (dest_lat, dest_long)).miles
```

```
    return distance

train['distance'] = train.swifter.apply(lambda x: get_distance(x.
 ↪pickup_latitude, x.pickup_longitude,x.dropoff_latitude, x.
 ↪dropoff_longitude), axis=1)
test['distance'] = test.swifter.apply(lambda x: get_distance(x.pickup_latitude,␣
 ↪x.pickup_longitude,x.dropoff_latitude, x.dropoff_longitude), axis=1)
train['speed'] = train['distance'] / (train['trip_duration'] /3600)

train = train[(train.pickup_longitude > -100)]
train = train[(train.pickup_latitude < 50)]
train = train[(train.dropoff_longitude < -70) & (train.dropoff_longitude > -80)]
train = train[(train.dropoff_latitude < 50)]
train = train[(train.distance < 200)]
train = train[(train.speed < 30)]
```

```
HBox(children=(FloatProgress(value=0.0, description='Dask Apply', max=8.0, style=ProgressStyle
```

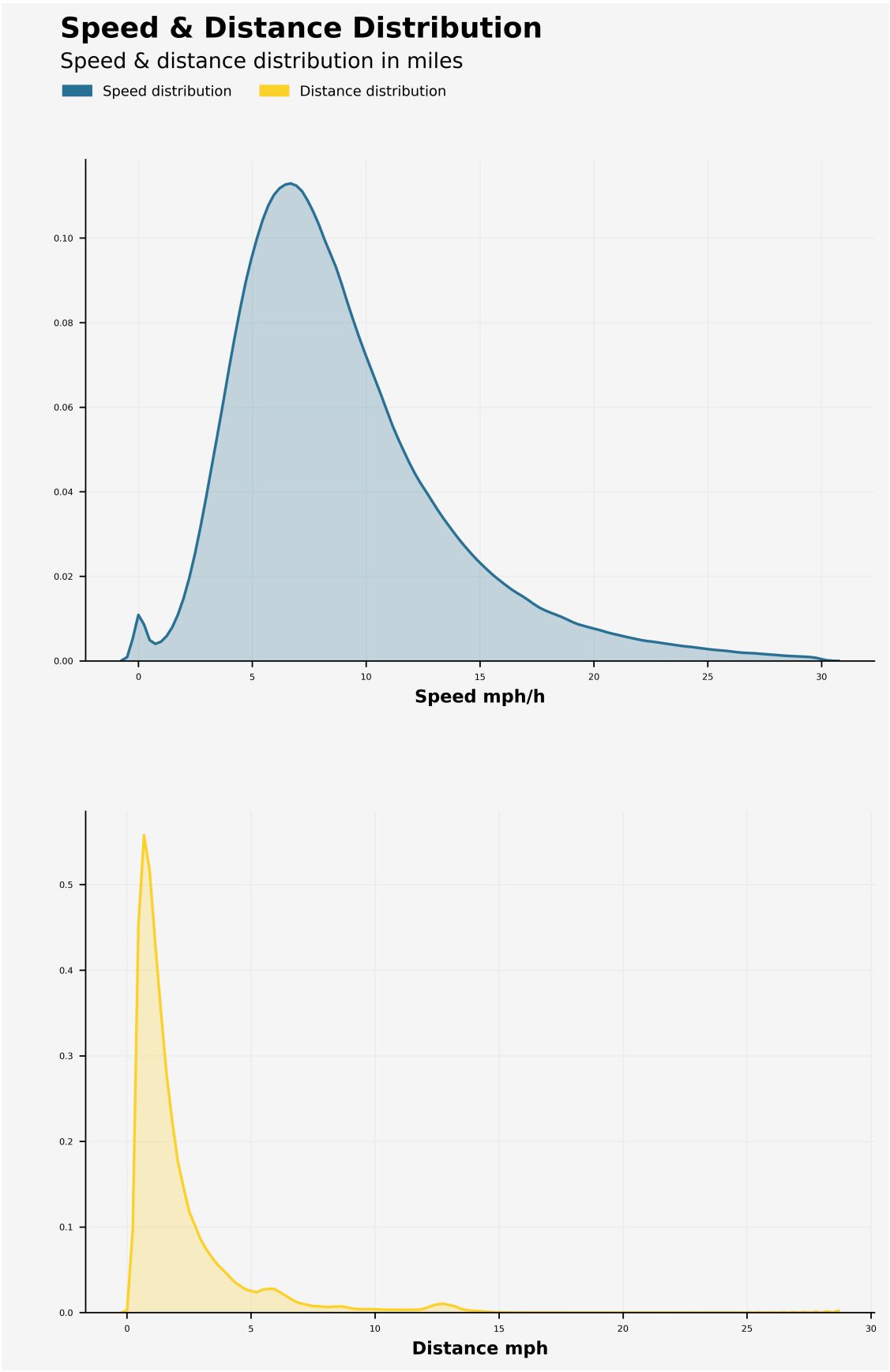
```
HBox(children=(FloatProgress(value=0.0, description='Dask Apply', max=8.0, style=ProgressStyle
```

1.7.7 4.7 Speed and Distance distribution

[10]:
```
trip_duration_hist = train['trip_duration'].sample(n=10000, replace=True,␣
 ↪random_state=123) / 60
plt.rcParams['figure.dpi'] = 600
fig = plt.figure(figsize=(8, 12), facecolor = '#f6f5f5')
gs = fig.add_gridspec(2, 1)
gs.update(wspace=0.6, hspace=0.3)

background_color = "#f6f5f5"
color_map = ['#287094']
sns.set_palette(sns.color_palette(color_map))

ax0 = fig.add_subplot(gs[0, 0])
for s in ["right", "top"]:
    ax0.spines[s].set_visible(False)
ax0.set_facecolor(background_color)
ax0_sns = sns.kdeplot(ax=ax0, data = train['speed'].values, zorder=2,␣
 ↪shade=True)
ax0_sns.set_xlabel('Speed mph/h', fontsize=10, weight='bold')
ax0_sns.set_ylabel('')
ax0_sns.grid(which='major', axis='x', zorder=0, color='#EEEEEE')
ax0_sns.grid(which='major', axis='y', zorder=0, color='#EEEEEE')
```

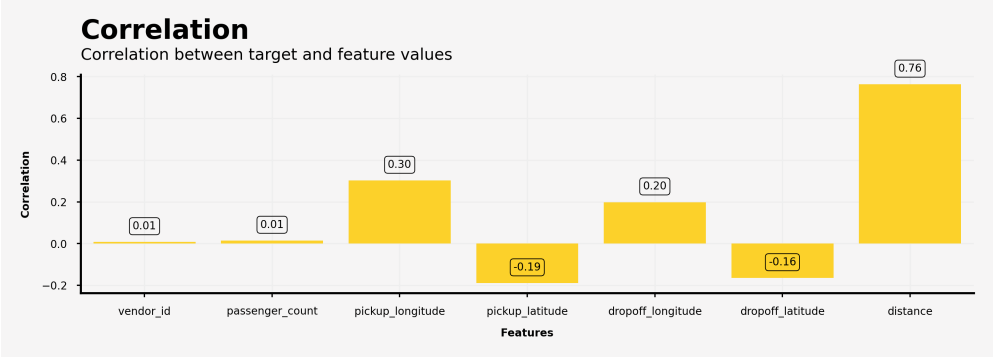
```
ax0_sns.tick_params(labelsize=5)


color_map = ['#fcd12a']
sns.set_palette(sns.color_palette(color_map))
ax1 = fig.add_subplot(gs[1, 0])
for s in ["right", "top"]:
    ax1.spines[s].set_visible(False)
ax1.set_facecolor(background_color)
ax1_sns = sns.kdeplot(ax=ax1, data = train['distance'].values, zorder=2,␣
↪shade=True)
ax1_sns.set_xlabel('Distance mph', fontsize=10, weight='bold')
ax1_sns.set_ylabel('')
ax1_sns.grid(which='major', axis='x', zorder=0, color='#EEEEEE')
ax1_sns.grid(which='major', axis='y', zorder=0, color='#EEEEEE')
ax1_sns.tick_params(labelsize=5)


fig.text(0.1, 0.96, 'Speed & Distance Distribution', fontsize=16,␣
↪fontweight='bold')
fig.text(0.1, 0.94, 'Speed & distance distribution in miles', fontsize=12)

blue = mpatches.Patch(color='#287094')
yellow = mpatches.Patch(color='#fcd12a')
fig.legend(handles = [blue, yellow], labels =  ['Speed distribution','Distance␣
↪distribution'], ncol=2, facecolor=background_color,␣
↪edgecolor=background_color, fontsize=8, loc='upper left', bbox_to_anchor=(0.
↪048, 0.85))
```

[10]: <matplotlib.legend.Legend at 0x1eb64748850>


Speed & Distance Distribution
Speed & distance distribution in miles
Speed distribution
Distance distribution
0.10
0.08
0.06
0.04
0.02
0.00
0
5
10
15
20
25
30
Speed mph/h
0.5
0.4
0.3
0.2
0.1
0.0
0
5
10
15
20
25
30
Distance mph

1.7.8 4.8 Correlation between Features&Target

[11]:
```
features = ['vendor_id', 'passenger_count', 'pickup_longitude',␣
 ↪'pickup_latitude' ,'dropoff_longitude' ,'dropoff_latitude' ,'distance']
chart_df = pd.DataFrame(train[features].corrwith(train['trip_duration']))
chart_df.columns = ['corr']

plt.rcParams['figure.dpi'] = 600
fig = plt.figure(figsize=(6, 1.5), facecolor='#f6f5f5')
gs = fig.add_gridspec(1, 1)
gs.update(wspace=0.4, hspace=0.1)

background_color = "#f6f5f5"
sns.set_palette(['#00A4CCFF']*6)

ax = fig.add_subplot(gs[0, 0])
for s in ["right", "top"]:
    ax.spines[s].set_visible(False)
ax.set_facecolor(background_color)
ax_sns = sns.barplot(ax=ax, x=chart_df.index, y=chart_df['corr'],␣
 ↪color='#fcd12a',
                     zorder=2, linewidth=0, alpha=1, saturation=1)
ax_sns.set_xlabel("Features",fontsize=4, weight='bold')
ax_sns.set_ylabel("Correlation",fontsize=4, weight='bold')
ax_sns.grid(which='major', axis='x', zorder=0, color='#EEEEEE', linewidth=0.4)
ax_sns.grid(which='major', axis='y', zorder=0, color='#EEEEEE', linewidth=0.4)
ax_sns.tick_params(labelsize=4, width=0.5, length=1.5)
ax.text(-0.5, 1.08, 'Correlation', fontsize=10, ha='left', va='top',␣
 ↪weight='bold')
ax.text(-0.5, 0.94, 'Correlation between target and feature values',␣
 ↪fontsize=6, ha='left', va='top')
# data label
for p in ax.patches:
    percentage = f'{p.get_height():.2f}'
    x = p.get_x() + p.get_width() / 2
    y = p.get_height() + 0.05
    ax.text(x, y, percentage, ha='center', va='bottom', fontsize=4,
            bbox=dict(facecolor='none', edgecolor='black', boxstyle='round',␣
 ↪linewidth=0.3))

plt.show()
```



1.8 5 XGBoost

1.8.1 5.1 Feature engeering

[12]:
```
train['store_and_fwd_flag'] = train['store_and_fwd_flag'].map(lambda x: 0 if x␣
↪== 'N' else 1)
test['store_and_fwd_flag'] = test['store_and_fwd_flag'].map(lambda x: 0 if x ==␣
↪'N' else 1)
features = ['vendor_id', 'passenger_count', 'pickup_longitude',␣
↪'pickup_latitude', 'dropoff_longitude', 'dropoff_latitude', 'distance',␣
↪'pickup_month', 'pickup_date', 'pickup_hour', 'pickup_minute', 'pickup_day',␣
↪'store_and_fwd_flag']
y = np.log(train['trip_duration'].values + 1)
train.drop(["trip_duration"], axis=1, inplace=True)
train.drop(['id'], axis=1, inplace=True)
X = train[features]
```

[13]:
```
X = train[features].values
```

1.8.2 5.2 Cross-validation

[15]:
```
kf = KFold(n_splits=10)
kf.get_n_splits(X)

print(kf)

KFold(n_splits=10, random_state=42, shuffle=False)
for train_index, test_index in kf.split(X):
    print("TRAIN:", train_index, "TEST:", test_index)
    X_train, X_test = X[train_index], X[test_index]
    y_train, y_test = y[train_index], y[test_index]
```

```
KFold(n_splits=10, random_state=None, shuffle=False)
TRAIN: [ 144226  144227  144228 … 1442256 1442257 1442258] TEST: [     0
1      2 … 144223 144224 144225]
```

```
TRAIN: [      0       1       2 … 1442256 1442257 1442258] TEST: [144226
144227 144228 … 288449 288450 288451]
TRAIN: [      0       1       2 … 1442256 1442257 1442258] TEST: [288452
288453 288454 … 432675 432676 432677]
TRAIN: [      0       1       2 … 1442256 1442257 1442258] TEST: [432678
432679 432680 … 576901 576902 576903]
TRAIN: [      0       1       2 … 1442256 1442257 1442258] TEST: [576904
576905 576906 … 721127 721128 721129]
TRAIN: [      0       1       2 … 1442256 1442257 1442258] TEST: [721130
721131 721132 … 865353 865354 865355]
TRAIN: [      0       1       2 … 1442256 1442257 1442258] TEST: [ 865356
865357  865358 … 1009579 1009580 1009581]
TRAIN: [      0       1       2 … 1442256 1442257 1442258] TEST: [1009582
1009583 1009584 … 1153805 1153806 1153807]
TRAIN: [      0       1       2 … 1442256 1442257 1442258] TEST: [1153808
1153809 1153810 … 1298031 1298032 1298033]
TRAIN: [      0       1       2 … 1298031 1298032 1298033] TEST: [1298034
1298035 1298036 … 1442256 1442257 1442258]
```

1.8.3 5.3 Using XGBoost module

[104]:
```
dtrain = xgb.DMatrix(X_train, label=y_train, feature_names = features)
dvalid = xgb.DMatrix(X_test, label=y_test, feature_names = features)
dtest = xgb.DMatrix(test[features].values, feature_names = features)
watchlist = [(dtrain, 'train'), (dvalid, 'valid')]

# Try different parameters! My favorite is random search :)
xgb_pars = {'min_child_weight': 1, 'eta': 0.5, 'colsample_bytree': 0.9,
            'max_depth': 6, 'subsample': 0.9, 'lambda': 1., 'nthread': -1,␣
 ↪'booster' : 'gbtree', 'silent': 1,
'eval_metric': 'rmse', 'objective': 'reg:linear'}
```

[106]:
```
model = xgb.train(xgb_pars, dtrain, 240, watchlist, early_stopping_rounds=241,
                  maximize=False, verbose_eval=15)
print('Modeling RMSLE %.5f' % model.best_score)
```

```
[21:22:19] WARNING: C:/Users/Administrator/workspace/xgboost-
win64_release_1.4.0/src/objective/regression_obj.cu:171: reg:linear is now
deprecated in favor of reg:squarederror.
[21:22:19] WARNING: C:/Users/Administrator/workspace/xgboost-
win64_release_1.4.0/src/learner.cc:573:
Parameters: { "silent" } might not be used.

  This may not be accurate due to some parameters are only used in language
bindings but
  passed down to XGBoost core.  Or some parameters are not used but slip through
this
  verification. Please open an issue if you find above cases.
```

```
[0]     train-rmse:3.02217      valid-rmse:3.02321
[15]    train-rmse:0.37537      valid-rmse:0.37957
[30]    train-rmse:0.36380      valid-rmse:0.37019
[45]    train-rmse:0.35748      valid-rmse:0.36590
[60]    train-rmse:0.35102      valid-rmse:0.36197
[75]    train-rmse:0.34855      valid-rmse:0.36151
[90]    train-rmse:0.34455      valid-rmse:0.35925
[105]   train-rmse:0.34121      valid-rmse:0.35829
[120]   train-rmse:0.33870      valid-rmse:0.35773
[135]   train-rmse:0.33610      valid-rmse:0.35629
[150]   train-rmse:0.33361      valid-rmse:0.35543
[165]   train-rmse:0.33110      valid-rmse:0.35472
[180]   train-rmse:0.32905      valid-rmse:0.35430
[195]   train-rmse:0.32705      valid-rmse:0.35428
[210]   train-rmse:0.32482      valid-rmse:0.35378
[225]   train-rmse:0.32295      valid-rmse:0.35311
[239]   train-rmse:0.32157      valid-rmse:0.35300
Modeling RMSLE 0.35295
```

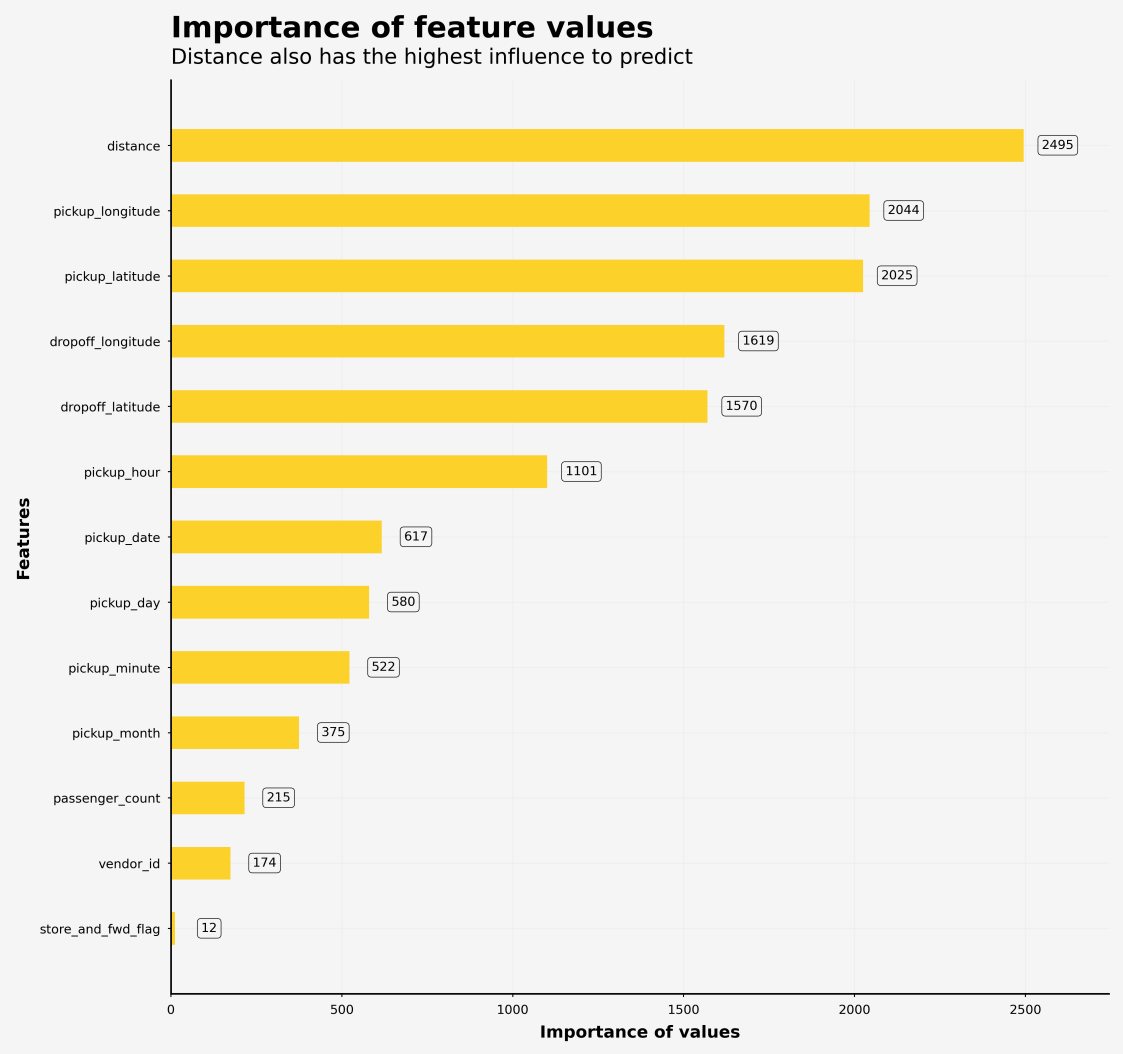
1.8.4 5.4 The submission

[107]:
```
ytest = model.predict(dtest)
y_pred = np.exp(ytest) - np.ones(len(ytest))
my_submission = pd.DataFrame({'id': test.id, 'trip_duration': y_pred})
my_submission.to_csv("submission.csv", index=False)
```

1.8.5 5.5 Plot Importance

[111]:
```
plt.rcParams['figure.dpi'] = 600
fig = plt.figure(figsize=(8, 8), facecolor='#f6f5f5')
gs = fig.add_gridspec(1, 1)
gs.update(wspace=0.4, hspace=0.3)

background_color = "#f6f5f5"
sns.set_palette(['#00A4CCFF'])

ax = fig.add_subplot(gs[0, 0])
for s in ["right", "top"]:
    ax.spines[s].set_visible(False)
ax.set_facecolor(background_color)

plot = xgb.plot_importance(model,ax = ax,height =0.5, color='#fcd12a',␣
 ↪zorder=2, linewidth=0, show_values = False)
plot.grid(which='major', axis='x', zorder=0, color='#EEEEEE', linewidth=0.4)
plot.grid(which='major', axis='y', zorder=0, color='#EEEEEE', linewidth=0.4)
```

```
plot.set_xlabel("Importance of values",fontsize=8, weight='bold')
plot.set_ylabel("Features",fontsize=8, weight='bold')
plot.set_title("")
plot.tick_params(labelsize=6, width=0.5, length=1.5)

ax.text(0, 14, 'Importance of feature values', fontsize=14, ha='left',␣
 ↪va='top', weight='bold')
ax.text(0, 13.5, 'Distance also has the highest influence to predict',␣
 ↪fontsize=10, ha='left', va='top')

for p in ax.patches:
    percentage = f'{p.get_width():.0f}'
    x = p.get_x() + p.get_width() + 100
    y = p.get_y() + p.get_height() - 0.34
    ax.text(x, y, percentage, ha='center', va='bottom', fontsize=6,
            bbox=dict(facecolor='none', edgecolor='black', boxstyle='round',␣
 ↪linewidth=0.3))

plt.show();
```


Importance of feature values
Distance also has the highest influence to predict
distance
pickup_longitude
pickup_latitude
dropoff_longitude
dropoff_latitude
pickup_hour
pickup_date
pickup_day
pickup_minute
pickup_month
passenger_count
vendor_id
store_and_fwd_flag
2495
2044
2025
1619
1570
1101
617
580
522
375
215
174
12
Features
0
500
1000
1500
2000
2500
Importance of values