出租车运行时间预测项目

作者：Eeden Yin

目录

1. 提出问题

出租车的费用与行驶时间有很强的相关性。

此项目通过记录纽约市出租车行驶数据，以此预测单次的行驶时间。

2. 理解数据

2.1 导入数据

数据来自Kaggle:https://www.kaggle.com/c/nyc-taxi-trip-duration/data (https://www.kaggle.com/c/nyc-taxi-trip-duration/data)

In [1]:

```
import pandas as pd
import numpy as np
from sklearn.cluster import KMeans
from sklearn.decomposition import PCA
from haversine import haversine
from datetime import datetime
from sklearn.model_selection import train_test_split
from sklearn.ensemble import RandomForestRegressor
from sklearn.model_selection import GridSearchCV
import matplotlib.pyplot as plt
from matplotlib.pyplot import MultipleLocator
import seaborn as sns
import holidays
from datetime import timedelta
from pylab import mpl
mpl.rcParams['font.sans-serif'] = ['SimHei'] #解决seaborn无法显示中文的问题

%matplotlib inline
pd.options.display.max_rows=10
```

In [2]:

```
train=pd.read_csv(r'D:\nyc_taxi\train.csv')
test=pd.read_csv(r'D:\nyc_taxi\test.csv')
```

2.1 数据说明

id - 每次行驶的编号

vendor_id（卖方编号） - 行驶记录中旅途提供者（出租车公司）的编号

pickup_datetime(上车时间) - 出租车开始打表的时间

dropoff_datetime(下车时间) - 出租车停止打表的时间

passenger_count（乘客人数） - 车辆内的乘客人数（驾驶员输入）

pickup_longitude(上车经度) - 出租车开始打表时的经度

pickup_latitude（上车纬度） - 出租车开始打表时的纬度

dropoff_longitude(下车经度) - 出租车停止打表时的经度

dropoff_latitude（下车纬度） - 出租车停止打表时的纬度

store_and_fwd_flag（数据记录发送类别） - 改字段表示，该条旅行记录是直接发送到服务器还是先储存再发送到服务器。

- *Y=先储存，再发送=; N=直接发送*

trip_duration（行驶时长） - 单次旅程的行驶时间（以秒计）

3. 数据清洗

3.1 数据预处理

3.1.1 缺失值处理

In [3]:

```
train.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1458644 entries, 0 to 1458643
Data columns (total 11 columns):
id                    1458644 non-null object
vendor_id             1458644 non-null int64
pickup_datetime       1458644 non-null object
dropoff_datetime      1458644 non-null object
passenger_count       1458644 non-null int64
pickup_longitude      1458644 non-null float64
pickup_latitude       1458644 non-null float64
dropoff_longitude     1458644 non-null float64
dropoff_latitude      1458644 non-null float64
store_and_fwd_flag    1458644 non-null object
trip_duration         1458644 non-null int64
dtypes: float64(4), int64(3), object(4)
memory usage: 122.4+ MB
```

In [4]:

```
test.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 625134 entries, 0 to 625133
Data columns (total 9 columns):
id                    625134 non-null object
vendor_id             625134 non-null int64
pickup_datetime       625134 non-null object
passenger_count       625134 non-null int64
pickup_longitude      625134 non-null float64
pickup_latitude       625134 non-null float64
dropoff_longitude     625134 non-null float64
dropoff_latitude      625134 non-null float64
store_and_fwd_flag    625134 non-null object
dtypes: float64(4), int64(2), object(3)
memory usage: 42.9+ MB
```

没有缺失值

3.1.2 异常值处理

先将异常的数据类型进行转换

In [5]:

```
pd.set_option('display.float_format', lambda x: '%.3f' % x)
train.describe()
```

Out[5]:

	vendor_id	passenger_count	pickup_longitude	pickup_latitude	dropoff_longitude	di
count	1458644.000	1458644.000	1458644.000	1458644.000	1458644.000	
mean	1.535	1.665	-73.973	40.751	-73.973	
std	0.499	1.314	0.071	0.033	0.071	
min	1.000	0.000	-121.933	34.360	-121.933	
25%	1.000	1.000	-73.992	40.737	-73.991	
50%	2.000	1.000	-73.982	40.754	-73.980	
75%	2.000	2.000	-73.967	40.768	-73.963	
max	2.000	9.000	-61.336	51.881	-61.336	

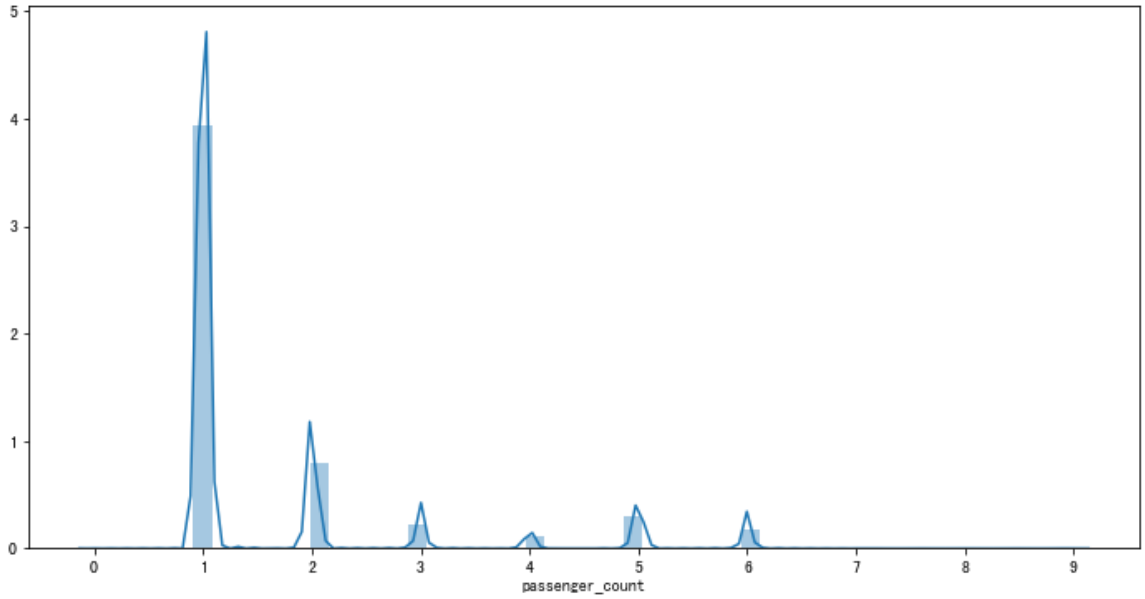
发现异常：

1. **passenger_count** 最小为0人
2. **passenger_count**最大为9人
3. **trip_duration** 标准差特别大
4. **trip_duration** 最小为1秒
5. **trip_duration** 最大将近41天

查看passenger_count分布

In [6]:

```
x_major_locator=MultipleLocator(1)
ax=plt.subplot(1,1,1)
sns.distplot(train.passenger_count,ax=ax)
ax.figure.set_size_inches(12,6)
ax.xaxis.set_major_locator(x_major_locator)
```



In [7]:

```
train.passenger_count.value_counts()
```

Out[7]:

```
1    1033540
2     210318
5      78088
3      59896
6      48333
4      28404
0         60
7          3
9          1
8          1
Name: passenger_count, dtype: int64
```

乘客数量0,7,8,9为明显的离群点

考虑到所占数据比例不大，作删除处理

In [8]:

```
train=train[(train.passenger_count>0)]
temp=train.passenger_count.apply(lambda x: x not in [7,8,9])
train=train[temp]
```

查看vendor_id

In [9]:

```
train.vendor_id.value_counts()
```

Out[9]:

```
2    780268
1    678311
Name: vendor_id, dtype: int64
```

发现只有1,2两个数值

推测这表示出租车公司，且只有两家

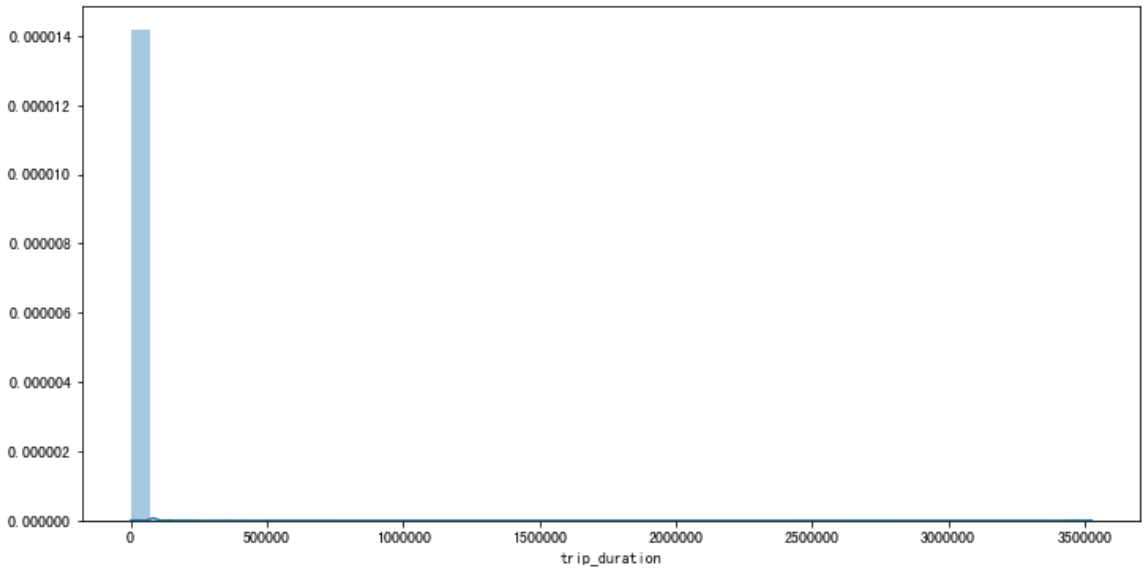
查看trip_duration分布

In [10]:

```
trip_duration=train[train.trip_duration.notnull()]['trip_duration']

plt.figure(figsize=(12,6))
sns.distplot(trip_duration)
```

Out[10]:

```
<matplotlib.axes._subplots.AxesSubplot at 0xc98b688>
```



由于异常值的数值过大，导致图形显示异常

先去除三个标准差之外的数值

In [11]:

```
trip_duration_drop=train[np.abs(train.trip_duration-train.trip_duration.mean())>3*train.trip_duration.std()]['trip_duration']
trip_duration=train[np.abs(train.trip_duration-train.trip_duration.mean())<=3*train.trip_duration.std()]['trip_duration']
```

In [12]:

```
len(trip_duration_drop)/len(trip_duration)
```

Out[12]:

0.0014225815598551878

异常值所占比率较小，因此做删除处理

In [13]:

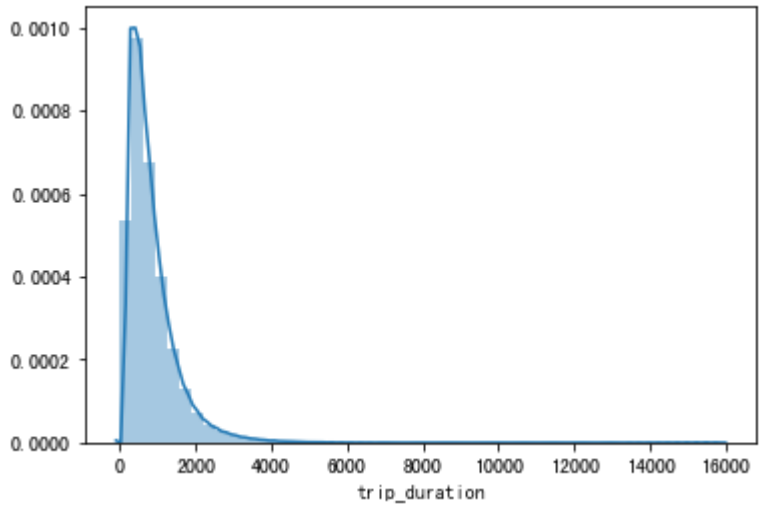
```
train=train[np.abs(train.trip_duration-train.trip_duration.mean())<=3*train.trip_duration.std()]
```

In [14]:

```
sns.distplot(a=trip_duration)
```

Out[14]:

<matplotlib.axes._subplots.AxesSubplot at 0x28f7a608>



看到偏斜依然明显，因此做log处理

In [15]:

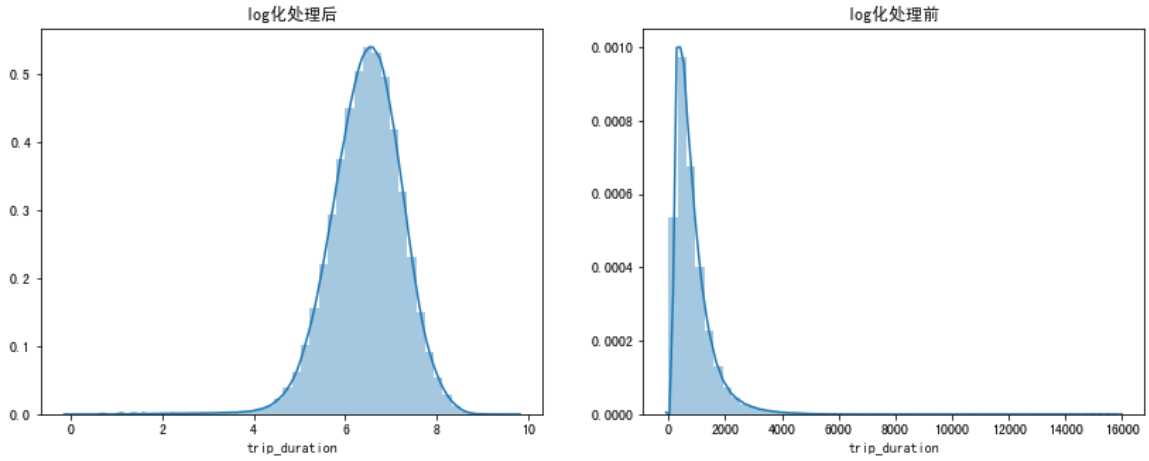
```
trip_duration_log=np.log(trip_duration)
```

In [16]:

```
fig,ax=plt.subplots(1,2)
fig.set_size_inches(14,5)

sns.distplot(trip_duration_log,ax=ax[0])
sns.distplot(trip_duration,ax=ax[1])

ax[0].set(title='log化处理后')
ax[1].set(title='log化处理前')
```

Out[16]:

```
[Text(0.5, 1.0, 'log化处理前')]
```



In [17]:

```
# 用log化的数值代替
train['trip_duration']=trip_duration_log
```

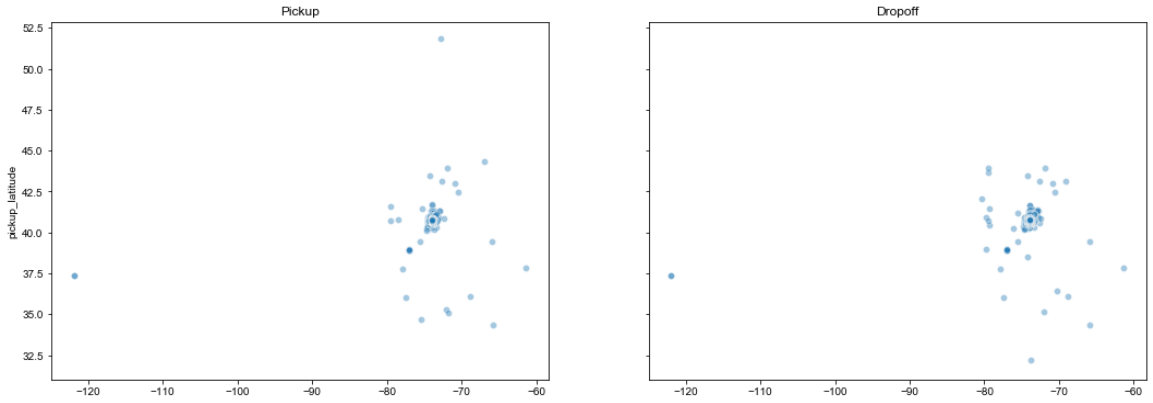
查看pickup_longitude、dropoff_longitude

In [18]:

```
fig,ax=plt.subplots(1,2,sharey=True,figsize=(18,6))

sns.scatterplot(train.pickup_longitude,train.pickup_latitude,ax=ax[0],alpha=0.4)
sns.scatterplot(train.dropoff_longitude,train.dropoff_latitude,ax=ax[1],alpha=0.4)
sns.set_style('dark')

ax[0].set(title='Pickup',xlabel='')
ax[1].set(title='Dropoff',xlabel='')
```

Out[18]:

```
[Text(0.5, 0, ''), Text(0.5, 1.0, 'Dropoff')]
```



可以看到有比较明显的离群点

进一步查看

In [19]:

```
position=train[['pickup_longitude','pickup_latitude','dropoff_longitude','dropoff_latitude']]
position.describe()
```

Out[19]:

	pickup_longitude	pickup_latitude	dropoff_longitude	dropoff_latitude
count	1456507.000	1456507.000	1456507.000	1456507.000
mean	-73.973	40.751	-73.973	40.752
std	0.071	0.033	0.071	0.036
min	-121.933	34.360	-121.933	32.181
25%	-73.992	40.737	-73.991	40.736
50%	-73.982	40.754	-73.980	40.755
75%	-73.967	40.768	-73.963	40.770
max	-61.336	51.881	-61.336	43.921

In [20]:

```
train[train.pickup_longitude<-110]
```

Out[20]:

	id	vendor_id	pickup_datetime	dropoff_datetime	passenger_count	pickup_l
1068810	id3777240	2	2016-01-27 18:26:40	2016-01-27 18:45:05	2	
1184454	id2854272	2	2016-02-26 13:50:19	2016-02-26 13:58:38	2	

In [21]:

```
train[train.pickup_latitude>50]
```

Out[21]:

	id	vendor_id	pickup_datetime	dropoff_datetime	passenger_count	pickup_lc
184925	id2306955	1	2016-05-07 18:58:53	2016-05-07 19:12:05	1	

发现以上旅途时间都仅有几秒，且上下车地点几乎一致

因此视作异常值删去

In [22]:

```
index_to_drop=train[(train.pickup_longitude<-110)|(train.pickup_latitude>50)].index
train=train.drop(index=index_to_drop,axis=0)
```

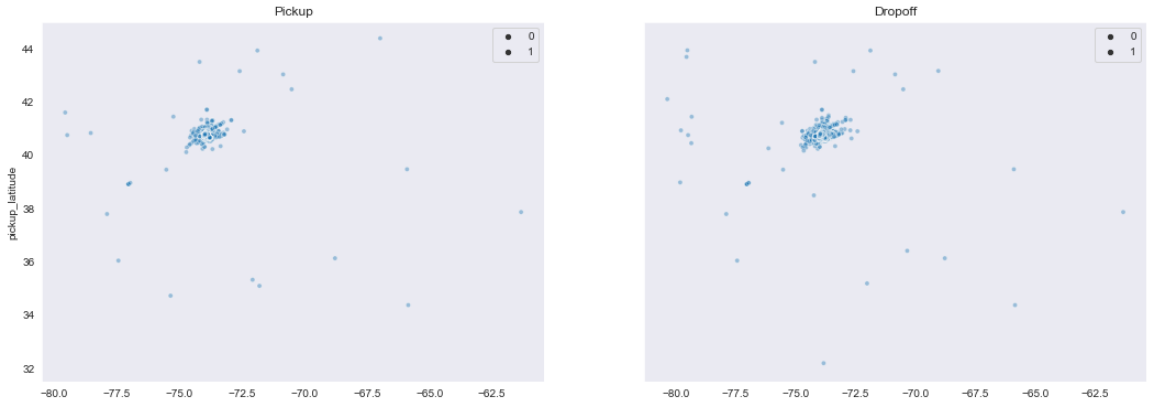
查看删去后的数据：

In [23]:

```
fig,ax=plt.subplots(1,2,sharey=True,figsize=(18,6))

sns.scatterplot(train.pickup_longitude,train.pickup_latitude,ax=ax[0],alpha=0.4,size=1)
sns.scatterplot(train.dropoff_longitude,train.dropoff_latitude,ax=ax[1],alpha=0.4,size=1)
sns.set_style('dark')

ax[0].set(title='Pickup',xlabel='')
ax[1].set(title='Dropoff',xlabel='')
```

Out[23]:

```
[Text(0.5, 0, ''), Text(0.5, 1.0, 'Dropoff')]
```



发现依然存在离群点，因此进行进一步修剪：

In [24]:

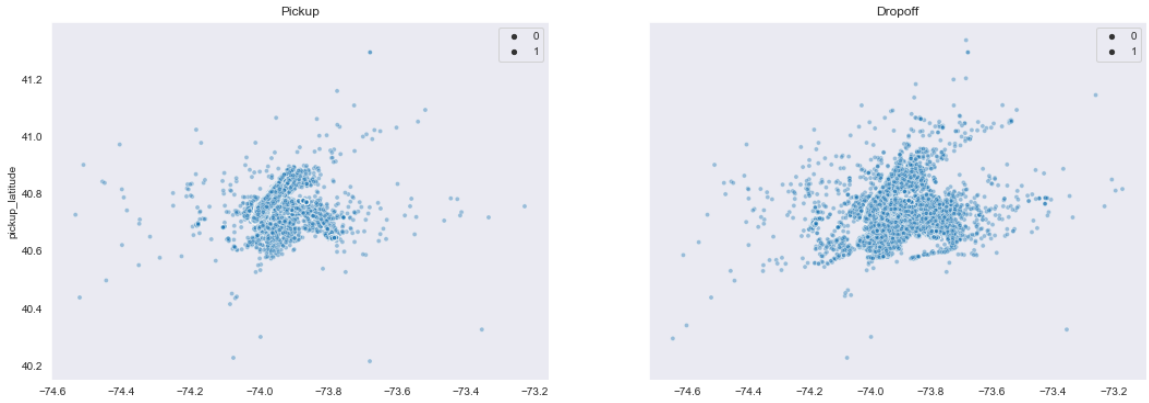
```
max_v=99.999
min_v=0.001
#求出边界
max_pick_lat=np.percentile(train.pickup_latitude,max_v)
min_pick_lat=np.percentile(train.pickup_latitude,min_v)
max_pick_long=np.percentile(train.pickup_longitude,max_v)
min_pick_long=np.percentile(train.pickup_longitude,min_v)
max_drop_lat=np.percentile(train.dropoff_latitude,max_v)
min_drop_lat=np.percentile(train.dropoff_latitude,min_v)
max_drop_long=np.percentile(train.dropoff_latitude,max_v)
min_drop_long=np.percentile(train.dropoff_latitude,min_v)
#移除离群点
train=train[train.pickup_latitude.between(min_pick_lat,max_pick_lat,inclusive=True)]
train=train[train.pickup_longitude.between(min_pick_long,max_pick_long,inclusive=True)]
train=train[train.dropoff_latitude.between(min_drop_lat,max_drop_lat,inclusive=True)]
train=train[train.dropoff_longitude.between(min_pick_long,max_pick_long,inclusive=True)]
```

In [26]:

```
fig,ax=plt.subplots(1,2,sharey=True,figsize=(18,6))
n=int(len(train)/3)
sns.scatterplot(train.pickup_longitude[:n],train.pickup_latitude[:n],ax=ax[0],alpha=0.4,size=1)
sns.scatterplot(train.dropoff_longitude[:n],train.dropoff_latitude[:n],ax=ax[1],alpha=0.4,size=1
)
sns.set_style('dark')

ax[0].set(title='Pickup',xlabel='')
ax[1].set(title='Dropoff',xlabel='')
```

Out[26]:

```
[Text(0.5, 0, ''), Text(0.5, 1.0, 'Dropoff')]
```



可以看出：

数据较为集中，且看得出纽约市大致轮廓

3.2 特征工程

3.2.1 特征提取

处理时间序列：

In [27]:

```
len(train.index)
```

Out[27]:

```
1456444
```

In [28]:

```
full=pd.concat([train,test],axis=0,ignore_index=True)
```

```
D:\anaconda\lib\site-packages\ipykernel_launcher.py:1: FutureWarning: Sorting beca
use non-concatenation axis is not aligned. A future version
of pandas will change to not sort by default.

To accept the future behavior, pass 'sort=False'.

To retain the current behavior and silence the warning, pass 'sort=True'.

  """Entry point for launching an IPython kernel.
```

In [29]:

```
full['pickup_datetime']=pd.to_datetime(full['pickup_datetime'])
full['dropoff_datetime']=pd.to_datetime(full['dropoff_datetime'])
```

In [30]:

```
#weekend列，1表示是周末；0表示不是
#只需要对pickup做处理
# 因为都是2016年的，因此不分离年
full['pickup_d']=full.pickup_datetime.dt.dayofweek
full['pickup_m']=full.pickup_datetime.dt.month
full['pickup_min']=full.pickup_datetime.dt.hour*60+full.pickup_datetime.dt.minute
full['pickup_weekend']=full.pickup_d.apply(lambda x: 1 if x>=5 else 0)
```

转换store_and_fwd_flag列

In [31]:

```
# 转换store_and_fwd_flag列
def is_stored(x):
    if x=='Y':
        return 1
    if x=='N':
        return 0

k=full.store_and_fwd_flag.apply(is_stored)
full['store_and_fwd_flag']=k
```

添加holiday栏

In [32]:

```
#如果是假日，则为1；不是，则为0
ny_holidays=holidays.US(state='NY')
def is_holiday(x):
    if x in ny_holidays:
        return 1
    else:
        return 0
full['holiday']=full.pickup_datetime.apply(is_holiday)
```

查看靠近假日的日期，观察其载客时间的变化

In [33]:

```
# 以天为单位重组
resample_day=full.set_index('pickup_datetime').resample('d').mean().trip_duration
```

In [34]:

```
resample_holiday=resample_day[ny_holidays.keys()]
# 数据范围没有覆盖所有的节日，删去未覆盖的节日
resample_holiday=resample_holiday.dropna()
```

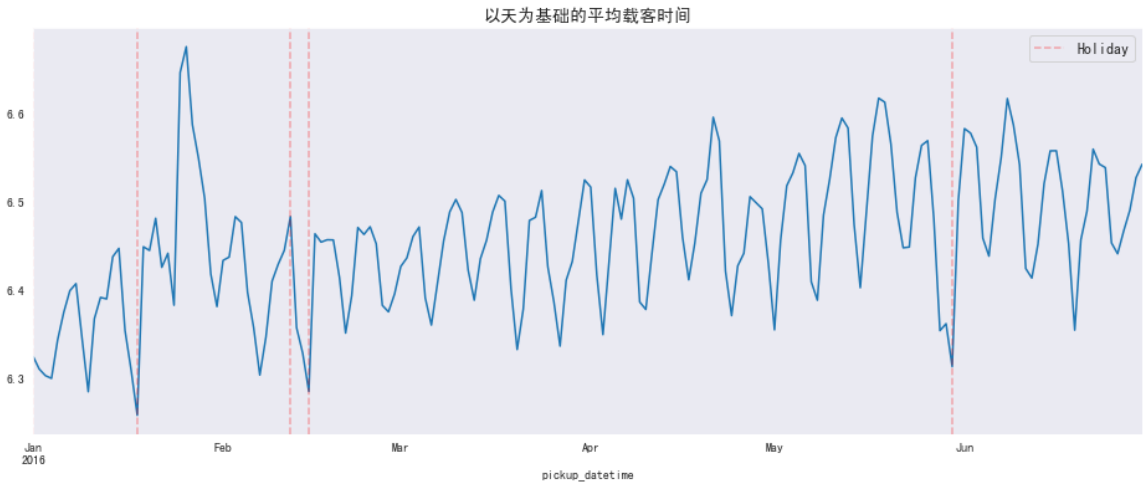
```
D:\anaconda\lib\site-packages\pandas\core\series.py:1152: FutureWarning:
Passing list-likes to .loc or [] with any missing label will raise
KeyError in the future, you can use .reindex() as an alternative.

See the documentation here:
https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#deprecate-loc-reindex-listlike
  return self.loc[key]
```

In [35]:

```
from pylab import mpl
mpl.rcParams['font.sans-serif'] = ['SimHei']

plt.figure(figsize=(16,6))
resample_day.plot(kind='line')
plt.title("以天为基础的平均载客时间",fontsize=14)
for i in resample_holiday.index:
    plt.axvline(i,linestyle='--', color='r',alpha=0.3)
#设置风格和图例
plt.style.use('tableau-colorblind10')
lin1, =plt.plot(resample_holiday.index,resample_holiday.values,linestyle='--', color='r',alpha=0.3)
plt.legend(handles=[lin1],labels=['Holiday'],fontsize=12)
```

Out[35]:

```
<matplotlib.legend.Legend at 0x55d1f88>
```



发现：

1. 靠近假期的载客时间有明显变化
2. 正向及负向作用同时存在

In [36]:

```
near_holiday=[]
for i in (resample_holiday.index-timedelta(days=1)).values:
    near_holiday.append(i)
for i in (resample_holiday.index+timedelta(days=1)).values:
    near_holiday.append(i)

def is_near_holiday(x):
    if x in near_holiday:
        return 1
    else:
        return 0
```

In [37]:

```
full['near_holiday']=full.pickup_datetime.apply(is_near_holiday)
```

用k均值对时间进行聚类，对高峰和非高峰期作区分

以k均值按24个质心分类比直接按小时分类更有区分度

In [38]:

```
temp=KMeans(n_clusters=24,random_state=5).fit_predict(full.pickup_min.values.reshape(-1,1))
full['pickup_h_cluster']=temp
```

处理地点序列：

由于不同的地区，路况不同，其通行时间也不同

因此接下来要对地区进行分块

In [39]:

```
full['pickup_cluster']=KMeans(n_clusters=20,random_state=5).fit_predict(full[['pickup_latitude',
'pickup_longitude']])
full['dropoff_cluster']=KMeans(n_clusters=20,random_state=5).fit_predict(full[['dropoff_latitud
e','dropoff_longitude']])
```

In [40]:

```
# 为了将所有的店呈现出来，因此要先进行转化（seaborn对于数字的hue显示不完全）
map_trans={1:'one',2:'two',3:'three',4:'four',5:'five',6:'six',7:'seven',8:'eight',9:'nine',10:
'ten',11:'eleven',12:'twelve',
           13:'thirteen',14:'fourteen',15:'fifteen',16:'sixteen',17:'seventeen',18:'eighteen',19
:'nineteen',20:'twenty'}
hue_trans=full.pickup_cluster.map(map_trans)

n=int(len(full)/2)
fig,ax=plt.subplots(1,2,sharey=True,figsize=(18,6))
sns.scatterplot(x=full.pickup_longitude[ :n],y=full.pickup_latitude[:n],hue=hue_trans[ :n],palet
te='Set2',ax=ax[0])
sns.scatterplot(x=full.dropoff_longitude[ :n],y=full.dropoff_latitude[:n],hue=hue_trans[ :n],pal
ette='Set2',ax=ax[1])
ax[0].set(xlabel='',ylabel='')
ax[1].set(xlabel='',ylabel='')
ax[0].set_title(label='Pick Up',fontsize=16)
ax[1].set_title(label='Drop Off',fontsize=16)
ax[0].legend().remove()
ax[1].legend().remove()
```

```
D:\anaconda\lib\site-packages\matplotlib\backends\backend_agg.py:211: RuntimeWarni
ng: Glyph 8722 missing from current font.
  font.set_text(s, 0.0, flags=flags)
D:\anaconda\lib\site-packages\matplotlib\backends\backend_agg.py:180: RuntimeWarni
ng: Glyph 8722 missing from current font.
  font.set_text(s, 0, flags=flags)
```

可以发现上车地点的区块集中度更高；下车地点则较为分散

这说明多数出租车行程是：在纽约市内坐车向四周出发

平面距离:

In [41]:

```
full['distance'] = np.sqrt(np.power(full.dropoff_longitude - full.pickup_longitude, 2) +
                           np.power(full.dropoff_latitude - full.pickup_latitude, 2))
```

球体距离：

In [42]:

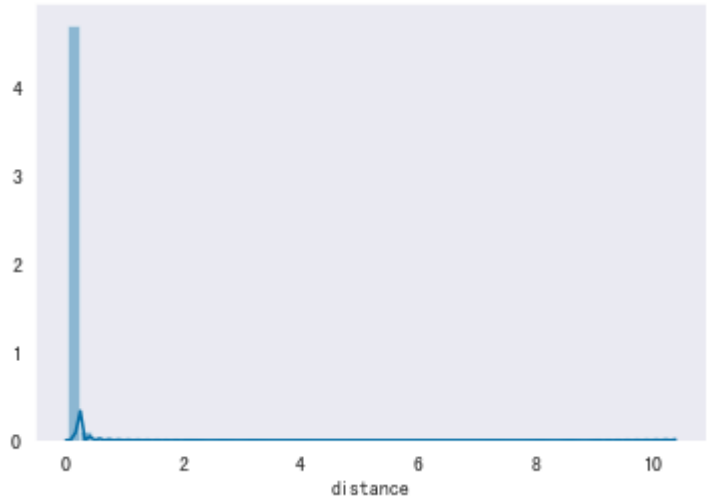
```
# 利用haversine公式：计算一个球体两点之间的表面距离
def haver_distance(x):
    return haversine((x.pickup_latitude,x.pickup_longitude),(x.dropoff_latitude,x.dropoff_longitude))

full['haver_distance']=full.apply(haver_distance,axis=1)
```

In [43]:

```
sns.distplot(full.distance)
```

Out[43]:

<matplotlib.axes._subplots.AxesSubplot at 0xc84b848>



发现：

1. 有零值
2. 有过大值

作进一步查看

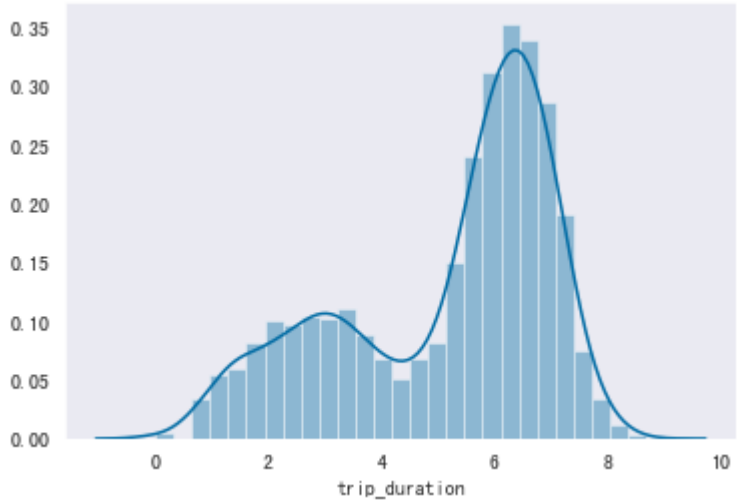
零值：

In [44]:

```
# 查看上、下车地点一直的数据的旅行时间
sns.distplot(full[(full.pickup_latitude==full.dropoff_latitude)&(full.pickup_longitude==full.dropoff_longitude)&(full.index<=len(train.index))]['trip_duration'])
```

Out[44]:

```
<matplotlib.axes._subplots.AxesSubplot at 0xc83aa48>
```



发现上下车地点相同的旅行时间均在10之内，符合实际情况

因此不算作异常值

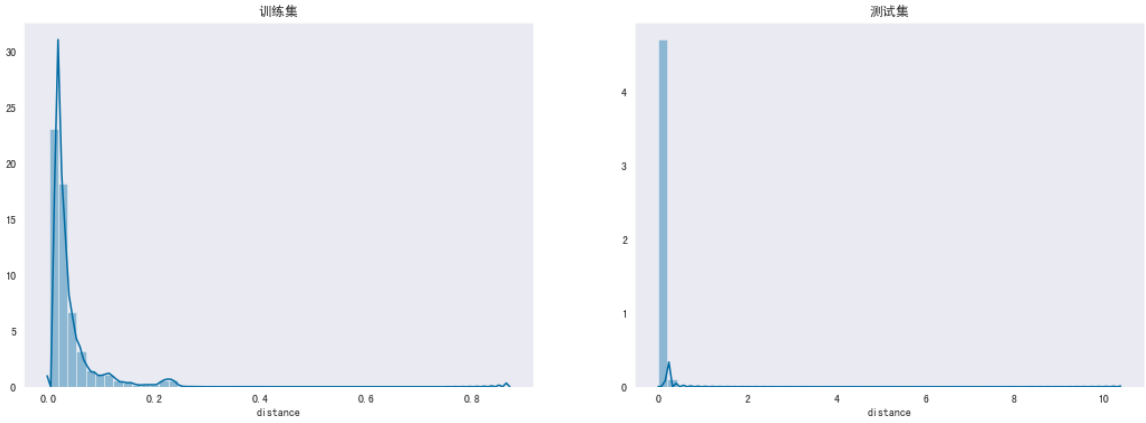
过大值：

In [45]:

```
fig,ax=plt.subplots(1,2)
fig.set_size_inches(18,6)
sns.distplot(full[full.index<=(len(train)-1)]['distance'],ax=ax[0])
sns.distplot(full[full.index>(len(train)-1)]['distance'],ax=ax[1])
ax[0].set_title('训练集',fontsize=12)
ax[1].set_title('测试集',fontsize=12)
```

Out[45]:

```
Text(0.5, 1.0, '测试集')
```



可以看出过大值为测试集的数据，因此这里不作删除处理

因之前距离数据斜较大，在此log化

In [46]:

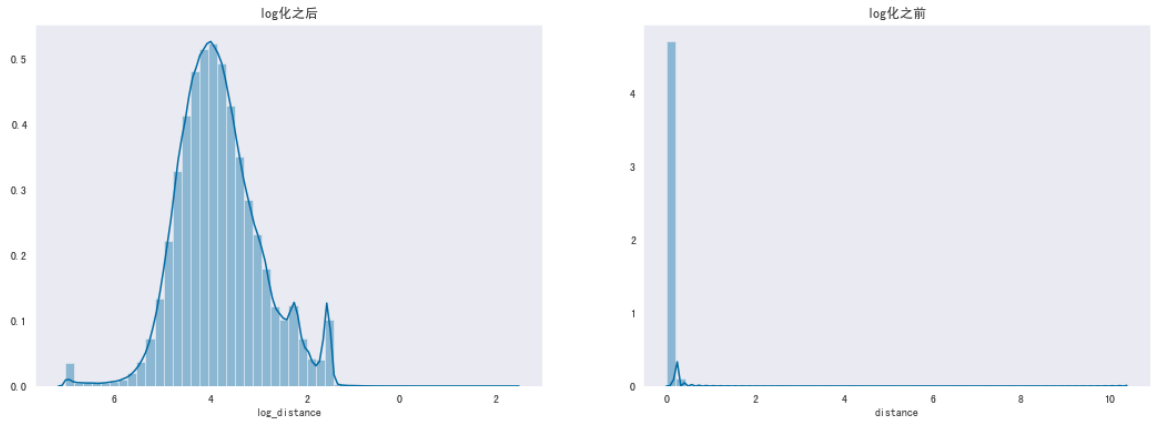
```
#单位为km，且为避免零值log化引发的错误加上1m为0.001
full['log_distance']=np.log(full.distance+0.001)
```

In [47]:

```
fig,ax=plt.subplots(1,2)
fig.set_size_inches(18,6)
sns.distplot(full.log_distance,ax=ax[0])
sns.distplot(full.distance,ax=ax[1])
ax[0].set_title('log化之后',fontsize=12)
ax[1].set_title('log化之前',fontsize=12)
```

Out[47]:

Text(0.5, 1.0, 'log化之前')



最后对经纬度进行合并，利用PCA的降维功能

In [48]:

```
combine=PCA(n_components=1)

full['pickup']=combine.fit_transform(full[['pickup_latitude','pickup_longitude']])
full['dropoff']=combine.fit_transform(full[['dropoff_latitude','dropoff_longitude']])
```

其余字段

提取字段“乘客数量分类”

In [49]:

```
k=pd.cut(full.passenger_count.values,[0,1,4,10],
         labels=['few','noraml','large'],right=True,include_lowest=True)
full['passenger_class']=k
```

3.2.2 特征选择

特征选择为三步：

1. 需要one-hot编码的字段
2. 需要丢弃的字段
3. 贡献度高的字段

1.one-hot编码：

In [50]:

```
feature_to_dummy=['pickup_h_cluster', 'pickup_cluster', 'dropoff_cluster', 'passenger_class','vendor_id','pickup_d', 'pickup_m']

dummies=pd.DataFrame()
for i in feature_to_dummy:
    k=pd.get_dummies(full[i],prefix=i)
    dummies=pd.concat([dummies,k],axis=1)
```

In [51]:

```
full=pd.concat([full,dummies],axis=1)
```

2.丢弃不用的字段：

In [52]:

```
feature_to_drop=['dropoff_datetime', 'passenger_count', 'pickup_min','pickup_datetime','id',
                 'pickup_h_cluster', 'pickup_cluster', 'dropoff_cluster', 'passenger_class','vendor_id','pickup_d', 'pickup_m']

full=full.drop(feature_to_drop,axis=1)
```

3.调试模型后贡献度高的字段

由于本数据集的字段比较紧凑，没有过多的冗余字段

因此这里不进行进一步的舍弃

4. 构建模型

4.1 模型选择

在训练之前先进行数据标准化

In [53]:

```
for i in full.columns[:12]:
    if i=='trip_duration':
        continue
    mean,std=full[i].mean(),full[i].std()
    full[i]=(full[i]-mean)/std
```

分离训练集、验证集和测试集

In [54]:

```
# 分离训练集和测试集
train_clean=full.iloc[:len(train),]
test_clean=full.iloc[len(train):,]
test_clean=test_clean.drop('trip_duration',axis=1)
```

In [55]:

```
# 受到设备性能限制，因此选取部分数据集作为调参数据
train_to_adjust=train_clean.sample(frac=0.08,random_state=5)
# 分离训练集和验证集
train_x,train_ver_x,train_y,train_ver_y=train_test_split(train_to_adjust.drop('trip_duration',1
),
                                                         train_to_adjust.trip_duration,
                                                         test_size=0.2,
                                                         random_state=5)
```

考虑到既有数值类字段也有分类字段

选择随机森林模型

4.2 调参

需要调整的参数：

- n_estimators
- max_depth
- max_features
- max_leaf_nodes

首先调整过程影响类参数

随机森林的过程影响类参数为n_estimators

In [56]:

```
estimator=RandomForestRegressor(criterion='mse',
                                max_depth=None,
                                min_samples_split=2,
                                min_samples_leaf=1,
                                min_weight_fraction_leaf=0.0,
                                max_features='auto',
                                max_leaf_nodes=None,
                                min_impurity_decrease=0.0,
                                min_impurity_split=None,
                                bootstrap=True,
                                oob_score=False,
                                n_jobs=None,
                                random_state=None,
                                verbose=0,
                                warm_start=False,)
param_grid={'n_estimators':list(range(10,171,40))}
grid_search=GridSearchCV(estimator=estimator,
                         param_grid=param_grid)
```

In [57]:

```
grid_search.fit(train_x,train_y)
```

```
D:\anaconda\lib\site-packages\sklearn\model_selection\_split.py:1978: FutureWarnin
g: The default value of cv will change from 3 to 5 in version 0.22. Specify it exp
licitly to silence this warning.
  warnings.warn(CV_WARNING, FutureWarning)
```

Out[57]:

```
GridSearchCV(cv='warn', error_score='raise-deprecating',
             estimator=RandomForestRegressor(bootstrap=True, criterion='mse',
                                             max_depth=None,
                                             max_features='auto',
                                             max_leaf_nodes=None,
                                             min_impurity_decrease=0.0,
                                             min_impurity_split=None,
                                             min_samples_leaf=1,
                                             min_samples_split=2,
                                             min_weight_fraction_leaf=0.0,
                                             n_estimators='warn', n_jobs=None,
                                             oob_score=False, random_state=None,
                                             verbose=0, warm_start=False),
             iid='warn', n_jobs=None,
             param_grid={'n_estimators': [10, 50, 90, 130, 170]},
             pre_dispatch='2*n_jobs', refit=True, return_train_score=False,
             scoring=None, verbose=0)
```

In [58]:

```
result_n_estimator=pd.DataFrame(grid_search.cv_results_)
```

In [59]:

```
result_n_estimator
```

Out[59]:

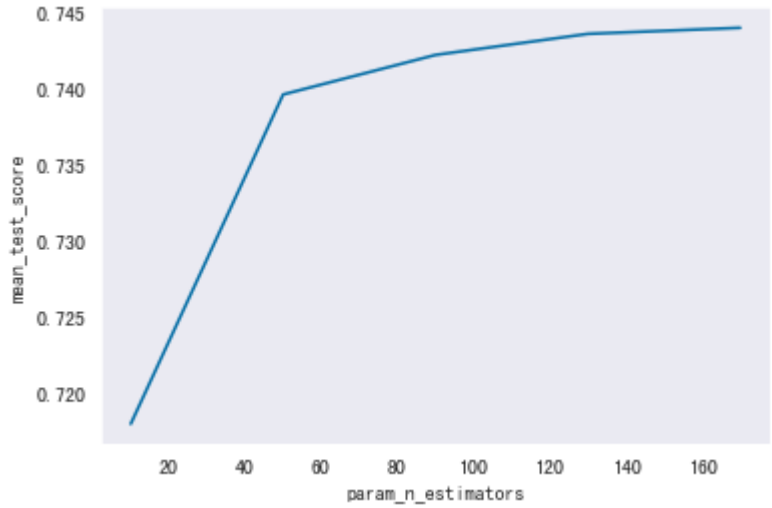
	mean_fit_time	std_fit_time	mean_score_time	std_score_time	param_n_estimators	
0	17.259	0.389	0.191	0.008	10	{'n_esti
1	84.178	0.448	0.832	0.003	50	{'n_esti
2	150.976	0.723	1.470	0.004	90	{'n_esti
3	217.162	1.520	2.080	0.028	130	{'n_esti
4	282.792	1.515	2.713	0.034	170	{'n_esti

In [60]:

```
sns.lineplot(x='param_n_estimators',y='mean_test_score',
             data=result_n_estimator[['param_n_estimators','mean_test_score']])
```

Out[60]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x3044e108>
```



可以看到：

1. 随着n_estimator的数量增加，模型得分越高
2. 得分增量在n_estimator达到30之后开始放缓

因此我们将n_estimator定为170

调整子模型影响类参数

先调整maxfeature

In [61]:

```
# maxfeature默认为'auto',其值为总特征数的开方
np.sqrt(len(train_x.columns))
```

Out[61]:

9.746794344808963

In [62]:

```
estimator=RandomForestRegressor(n_estimators=100,
                                criterion='mse',
                                max_depth=None,
                                min_samples_split=2,
                                min_samples_leaf=1,
                                min_weight_fraction_leaf=0.0,
                                max_leaf_nodes=None,
                                min_impurity_decrease=0.0,
                                min_impurity_split=None,
                                bootstrap=True,
                                oob_score=False,
                                n_jobs=None,
                                random_state=None,
                                verbose=0,
                                warm_start=False,)
param_grid={'max_features':list(range(9,26,4))}
grid_search=GridSearchCV(estimator=estimator,
                         param_grid=param_grid)
```

In [63]:

```
grid_search.fit(train_x,train_y)
```

```
D:\anaconda\lib\site-packages\sklearn\model_selection\_split.py:1978: FutureWarnin
g: The default value of cv will change from 3 to 5 in version 0.22. Specify it exp
licitly to silence this warning.
  warnings.warn(CV_WARNING, FutureWarning)
```

Out[63]:

```
GridSearchCV(cv='warn', error_score='raise-deprecating',
             estimator=RandomForestRegressor(bootstrap=True, criterion='mse',
                                             max_depth=None,
                                             max_features='auto',
                                             max_leaf_nodes=None,
                                             min_impurity_decrease=0.0,
                                             min_impurity_split=None,
                                             min_samples_leaf=1,
                                             min_samples_split=2,
                                             min_weight_fraction_leaf=0.0,
                                             n_estimators=100, n_jobs=None,
                                             oob_score=False, random_state=None,
                                             verbose=0, warm_start=False),
             iid='warn', n_jobs=None,
             param_grid={'max_features': [9, 13, 17, 21, 25]},
             pre_dispatch='2*n_jobs', refit=True, return_train_score=False,
             scoring=None, verbose=0)
```

In [64]:

```
result_maxfeature=pd.DataFrame(grid_search.cv_results_)
```

In [65]:

```
result_maxfeature
```

Out[65]:

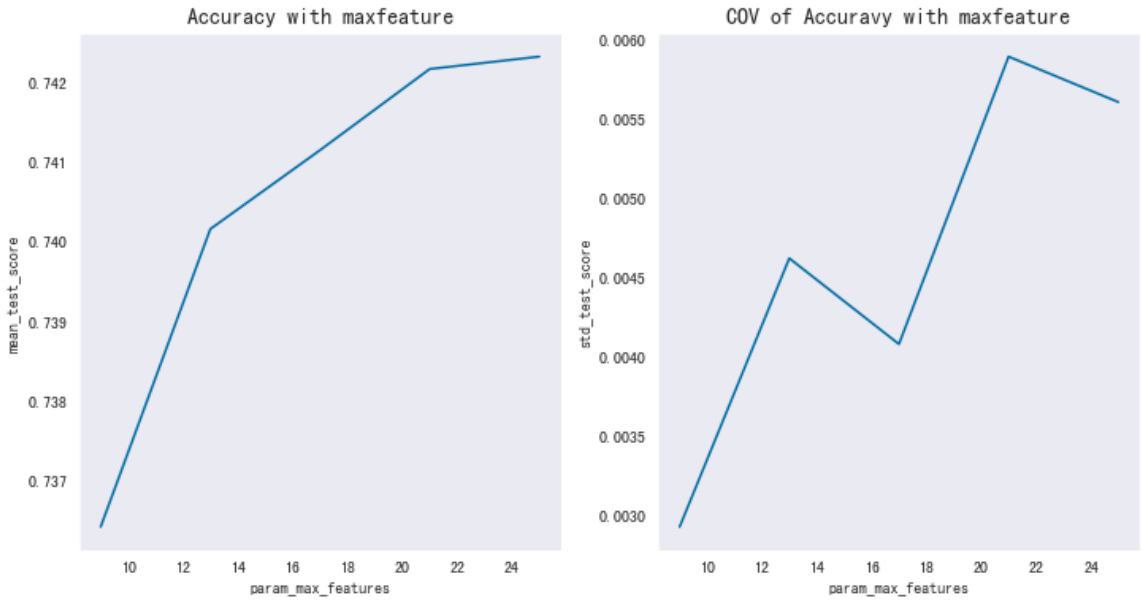
	mean_fit_time	std_fit_time	mean_score_time	std_score_time	param_max_features	
0	28.669	3.026	1.655	0.025	9	{'max_
1	34.169	0.749	1.737	0.117	13	{'max_
2	40.554	0.085	1.666	0.007	17	{'max_
3	47.136	0.166	1.657	0.008	21	{'max_
4	53.861	0.040	1.664	0.007	25	{'max_

In [66]:

```
fig,ax=plt.subplots(1,2)
fig.set_size_inches(12,6)
sns.lineplot(x='param_max_features',y='mean_test_score',data=result_maxfeature[['param_max_features','mean_test_score']],ax=ax[0])
sns.lineplot(x='param_max_features',y='std_test_score',data=result_maxfeature[['param_max_features','std_test_score']],ax=ax[1])
ax[0].set_title('Accuracy with maxfeature',fontsize=14)
ax[1].set_title('COV of Accuravy with maxfeature',fontsize=14)
```

Out[66]:

```
Text(0.5, 1.0, 'COV of Accuravy with maxfeature')
```



可见随着最大特征数量增大：

1. 准确度增大
2. 方差在一开始下降后开始震荡

maxfeature取值26

调整maxdepth

In [67]:

```
estimator=RandomForestRegressor(n_estimators=100,
                                criterion='mse',
                                max_features=26,
                                min_samples_split=2,
                                min_samples_leaf=1,
                                min_weight_fraction_leaf=0.0,
                                max_leaf_nodes=None,
                                min_impurity_decrease=0.0,
                                min_impurity_split=None,
                                bootstrap=True,
                                oob_score=False,
                                n_jobs=None,
                                random_state=None,
                                verbose=0,
                                warm_start=False,)
param_grid={'max_depth':list(range(10,111,20))}
grid_search=GridSearchCV(estimator=estimator,
                         param_grid=param_grid)
```

In [68]:

```
grid_search.fit(train_x,train_y)
```

```
D:\anaconda\lib\site-packages\sklearn\model_selection\_split.py:1978: FutureWarnin
g: The default value of cv will change from 3 to 5 in version 0.22. Specify it exp
licitly to silence this warning.
  warnings.warn(CV_WARNING, FutureWarning)
```

Out[68]:

```
GridSearchCV(cv='warn', error_score='raise-deprecating',
             estimator=RandomForestRegressor(bootstrap=True, criterion='mse',
                                             max_depth=None, max_features=26,
                                             max_leaf_nodes=None,
                                             min_impurity_decrease=0.0,
                                             min_impurity_split=None,
                                             min_samples_leaf=1,
                                             min_samples_split=2,
                                             min_weight_fraction_leaf=0.0,
                                             n_estimators=100, n_jobs=None,
                                             oob_score=False, random_state=None,
                                             verbose=0, warm_start=False),
             iid='warn', n_jobs=None,
             param_grid={'max_depth': [10, 30, 50, 70, 90, 110]},
             pre_dispatch='2*n_jobs', refit=True, return_train_score=False,
             scoring=None, verbose=0)
```

In [69]:

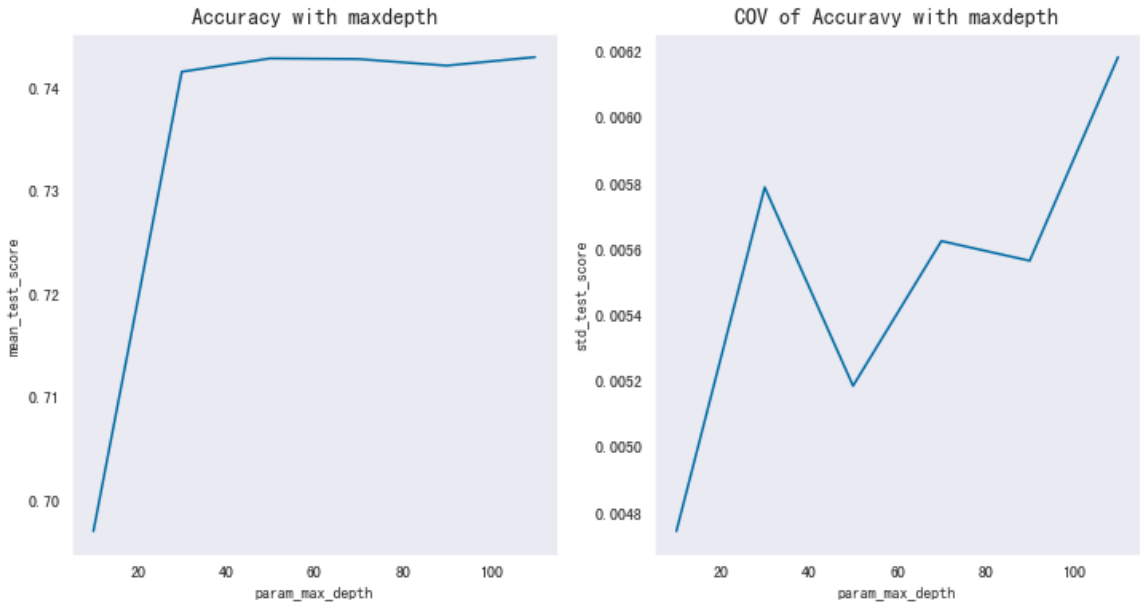
```
result_maxdepth=pd.DataFrame(grid_search.cv_results_)
```

In [70]:

```
fig,ax=plt.subplots(1,2)
fig.set_size_inches(12,6)
sns.lineplot(x='param_max_depth',y='mean_test_score',data=result_maxdepth[['param_max_depth','mean_test_score']],ax=ax[0])
sns.lineplot(x='param_max_depth',y='std_test_score',data=result_maxdepth[['param_max_depth','std_test_score']],ax=ax[1])
ax[0].set_title('Accuracy with maxdepth',fontsize=14)
ax[1].set_title('COV of Accuravy with maxdepth',fontsize=14)
```

Out[70]:

```
Text(0.5, 1.0, 'COV of Accuravy with maxdepth')
```



max_depth取90

调整max_leaf_nodes

In [71]:

```
estimator=RandomForestRegressor(n_estimators=100,
                                criterion='mse',
                                max_depth=90,
                                max_features=26,
                                min_samples_split=2,
                                min_samples_leaf=1,
                                min_weight_fraction_leaf=0.0,
                                min_impurity_decrease=0.0,
                                min_impurity_split=None,
                                bootstrap=True,
                                oob_score=False,
                                n_jobs=None,
                                random_state=None,
                                verbose=0,
                                warm_start=False,)
param_grid={'max_leaf_nodes':list(range(100,3101,500))}
grid_search=GridSearchCV(estimator=estimator,
                         param_grid=param_grid)
```

In [72]:

```
grid_search.fit(train_x,train_y)
```

```
D:\anaconda\lib\site-packages\sklearn\model_selection\_split.py:1978: FutureWarnin
g: The default value of cv will change from 3 to 5 in version 0.22. Specify it exp
licitly to silence this warning.
  warnings.warn(CV_WARNING, FutureWarning)
```

Out[72]:

```
GridSearchCV(cv='warn', error_score='raise-deprecating',
             estimator=RandomForestRegressor(bootstrap=True, criterion='mse',
                                             max_depth=90, max_features=26,
                                             max_leaf_nodes=None,
                                             min_impurity_decrease=0.0,
                                             min_impurity_split=None,
                                             min_samples_leaf=1,
                                             min_samples_split=2,
                                             min_weight_fraction_leaf=0.0,
                                             n_estimators=100, n_jobs=None,
                                             oob_score=False, random_state=None,
                                             verbose=0, warm_start=False),
             iid='warn', n_jobs=None,
             param_grid={'max_leaf_nodes': [100, 600, 1100, 1600, 2100, 2600,
                                            3100]},
             pre_dispatch='2*n_jobs', refit=True, return_train_score=False,
             scoring=None, verbose=0)
```

In [73]:

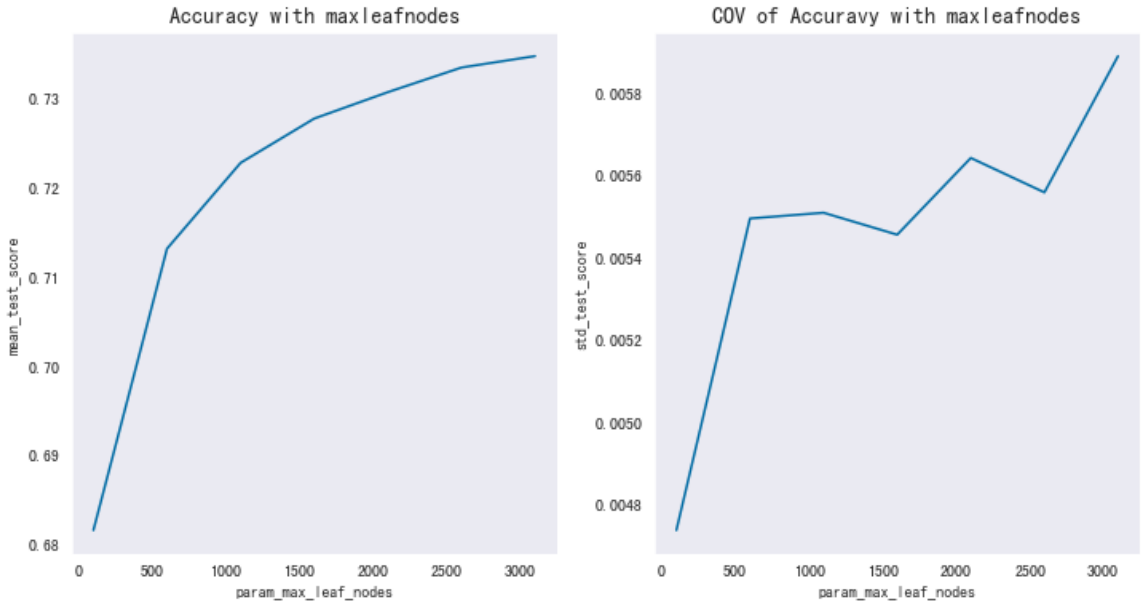
```
result_max_leaf_nodes=pd.DataFrame(grid_search.cv_results_)
```

In [74]:

```
fig,ax=plt.subplots(1,2)
fig.set_size_inches(12,6)
sns.lineplot(x='param_max_leaf_nodes',y='mean_test_score',data=result_max_leaf_nodes[['param_max_leaf_nodes','mean_test_score']],ax=ax[0])
sns.lineplot(x='param_max_leaf_nodes',y='std_test_score',data=result_max_leaf_nodes[['param_max_leaf_nodes','std_test_score']],ax=ax[1])
ax[0].set_title('Accuracy with maxleafnodes',fontsize=14)
ax[1].set_title('COV of Accuravy with maxleafnodes',fontsize=14)
```

Out[74]:

```
Text(0.5, 1.0, 'COV of Accuravy with maxleafnodes')
```



调整参数max_leaf_nodes发现：在现有的取值下，准确度最大值低于之前的参数下的准确度

因此max_leaf_nodes取默认值

5. 方案实施

In [75]:

```
train_clean_x=train_clean.drop('trip_duration',axis=1).sample(int(len(train_clean)/2.5))
train_clean_y=train_clean.loc[train_clean_x.index,'trip_duration']
```

In [76]:

```
model=RandomForestRegressor(n_estimators=170,max_features=26,max_depth=90)
model.fit(train_clean_x,train_clean_y)
```

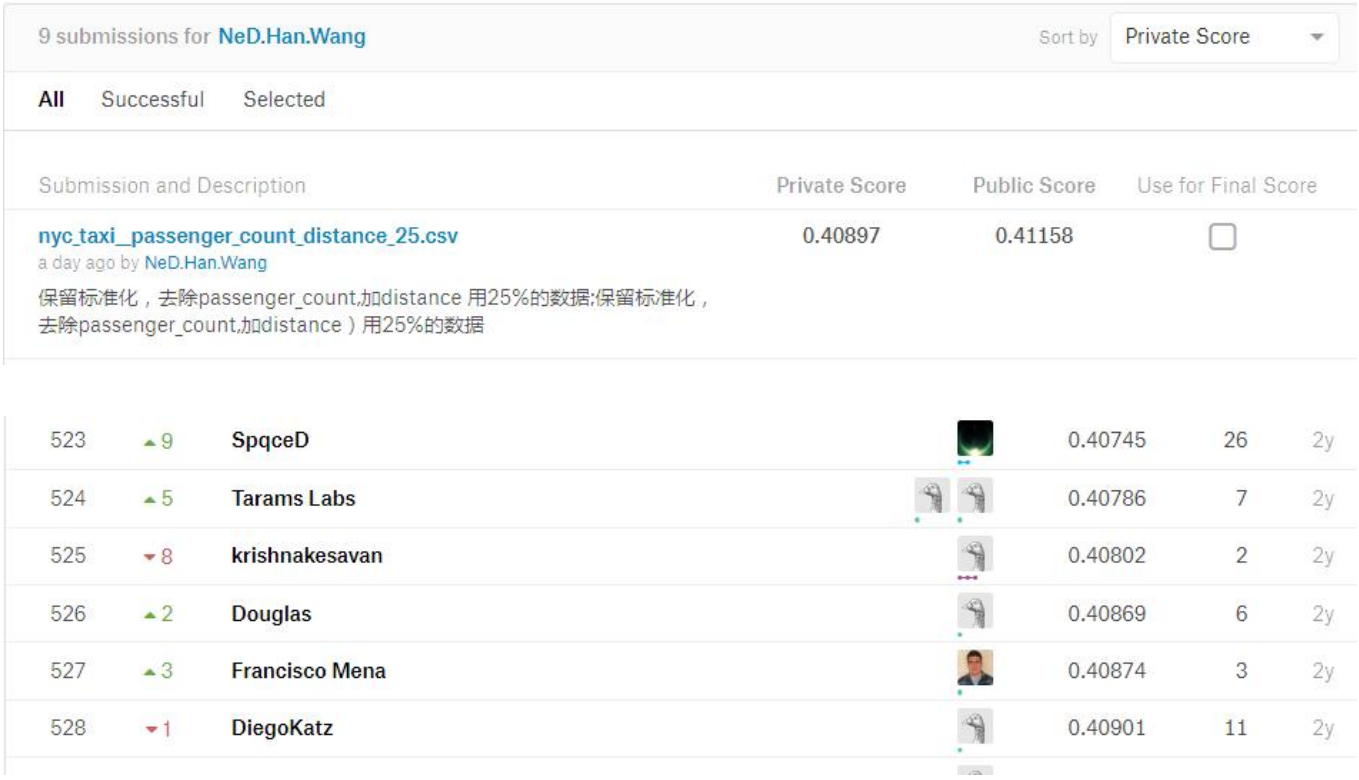
Out[76]:

```
RandomForestRegressor(bootstrap=True, criterion='mse', max_depth=90,
                      max_features=26, max_leaf_nodes=None,
                      min_impurity_decrease=0.0, min_impurity_split=None,
                      min_samples_leaf=1, min_samples_split=2,
                      min_weight_fraction_leaf=0.0, n_estimators=170,
                      n_jobs=None, oob_score=False, random_state=None,
                      verbose=0, warm_start=False)
```

In [77]:

```
predict_pre=model.predict(test_clean)
predict=np.exp(predict_pre)
result=pd.DataFrame({'Id':test.id,'trip_duration':predict})
result.to_csv(r'D:\nyc_taxi__passenger_count_distance_25.csv',index=False)
```

结果



由于是项目以完结，没有直接显示百分位排名

根据分数，排名为528

总人数为1257，为前42%