NYC Yellow Taxi Data

- EDA and visualization only with data from Jaunary in 2015
- Used data in BigQuery open data scource

In [2]:
```
import chart_studio.plotly as py
import cufflinks as cf
import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt
import warnings
warnings.filterwarnings("ignore")

plt.style.use('ggplot')
print(cf.__version__)

%config InlineBackend.figure_format = 'retina'
cf.go_offline()
```

```
0.17.3
```

1. Preprocessing

In [56]:
```
%%time
query = """
SELECT
    DATETIME_TRUNC(pickup_datetime, hour) as pickup_hour,
    count(*) as cnt
FROM `bigquery-public-data.new_york_taxi_trips.tlc_yellow_trips_2015`
WHERE EXTRACT(MONTH from pickup_datetime) = 1
GROUP BY pickup_hour
ORDER BY pickup_hour
"""

df = pd.read_gbq(query=query, dialect='standard', project_id='mobility-3
20516')
```

```
Downloading: 100%|██████████| 744/744 [00:00<00:00, 1631.80rows/s]

CPU times: user 45 ms, sys: 5.43 ms, total: 50.4 ms
Wall time: 2.14 s
```

In [57]:
```
df.tail(10)
```

Out[57]:

	pickup_hour	cnt
734	2015-01-31 14:00:00	25059
735	2015-01-31 15:00:00	25886
736	2015-01-31 16:00:00	23822
737	2015-01-31 17:00:00	25794
738	2015-01-31 18:00:00	30804
739	2015-01-31 19:00:00	32436
740	2015-01-31 20:00:00	27555
741	2015-01-31 21:00:00	27477
742	2015-01-31 22:00:00	29862
743	2015-01-31 23:00:00	29856

In [58]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 744 entries, 0 to 743
Data columns (total 2 columns):
 #   Column       Non-Null Count  Dtype
---  ------       --------------  -----
 0   pickup_hour  744 non-null    datetime64[ns]
 1   cnt          744 non-null    int64
dtypes: datetime64[ns](1), int64(1)
memory usage: 11.8 KB
```

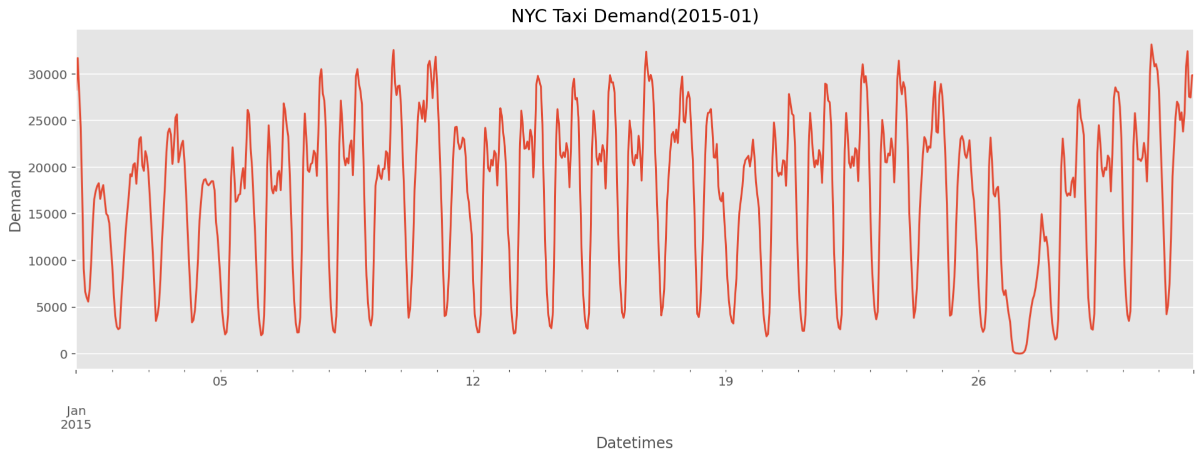
- There is no outliers

2. Pattern

In [59]:
```
df = df.set_index('pickup_hour')
```

In [60]:
```
df.plot(title='NYC Taxi Demand(2015-01)', figsize=(16,5), legend=False)
plt.xlabel('Datetimes')
plt.ylabel('Demand')
```

Out[60]: Text(0, 0.5, 'Demand')



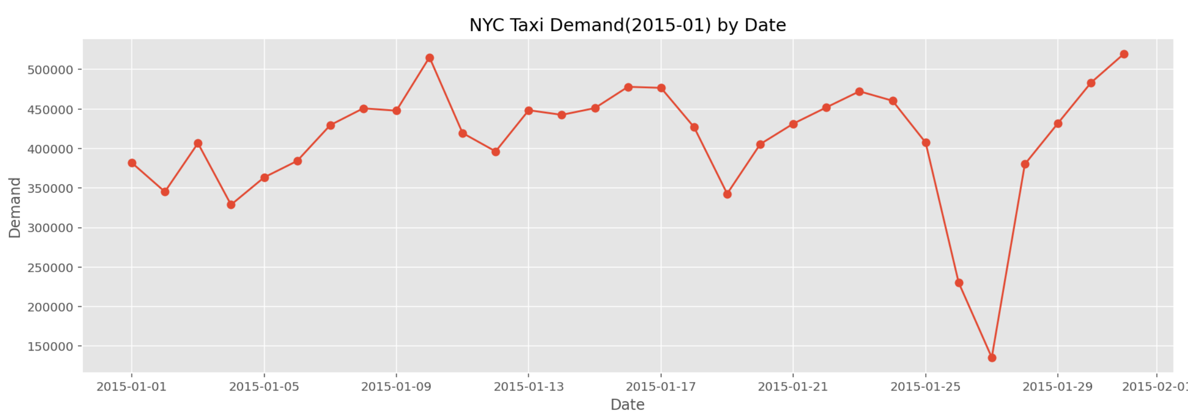
- **Lowest demand** on Jan 27, 2015 03:00
  - due to January 2015 blizzard

Demand by 'Date'

In [61]:
```
df['Date'] = df.index.date
```

In [67]:
```
df.groupby('Date')[['cnt']].sum().plot(title='NYC Taxi Demand(2015-01) b
y Date',
                                        style='-o', legend=False, figsize
=(16,5))
plt.ylabel('Demand')
```

Out[67]: Text(0, 0.5, 'Demand')



Demand by 'date' and by 'hour'

In [63]:
```
df['weekday'] = df.index.weekday
df['hour'] = df.index.hour
df['weeknum'] = df.index.week
```

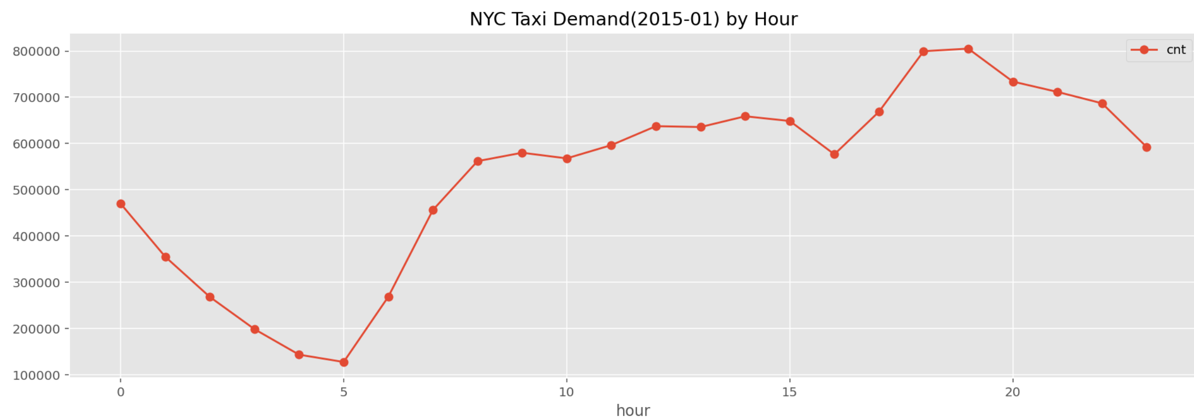
In [64]:
```
df.head(2)
```

Out[64]:

	cnt	Date	weekday	hour	weeknum
pickup_hour					
2015-01-01 00:00:00	28312	2015-01-01	3	0	1
2015-01-01 01:00:00	31707	2015-01-01	3	1	1

In [65]:
```
df.groupby('hour')[['cnt']].sum().plot(title='NYC Taxi Demand(2015-01) b
y Hour', style='-o', figsize=(16,5))
```

Out[65]: <matplotlib.axes._subplots.AxesSubplot at 0x7f8b3e747d00>

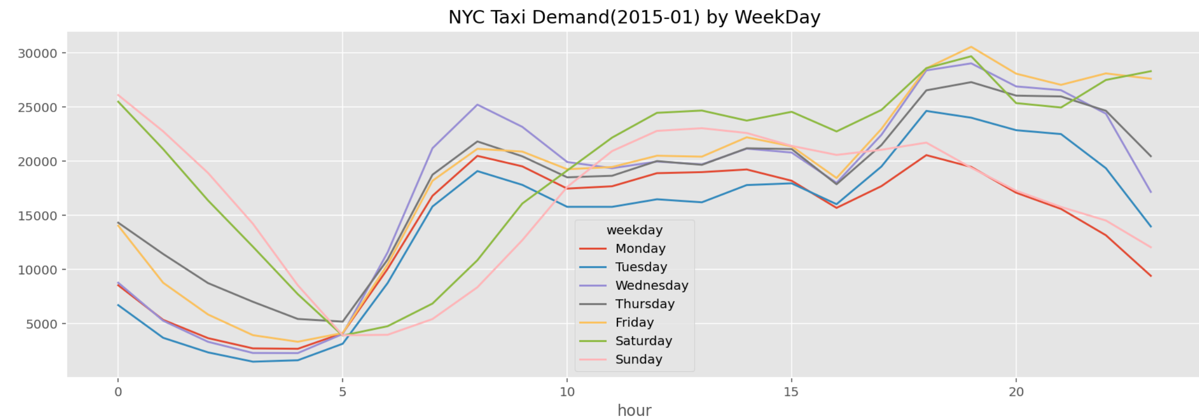


- **Peak Hour**: 18:00 - 19:00
- **Off-peak**: 05:00

In [68]:
```
week_col = {0:"Monday",
            1:"Tuesday",
            2:"Wednesday",
            3:"Thursday",
            4:"Friday",
            5:"Saturday",
            6:"Sunday"
           }
```

In [79]:
```
df[['cnt', 'hour', 'weekday']].pivot_table('cnt', index='hour', columns='weekday', aggfunc='mean')\
                                    .rename(columns=week_col).plot(title='NYC Taxi Demand(2015-01) by WeekDay',
                                                                   figsize=(16,5))
```

Out[79]: <matplotlib.axes._subplots.AxesSubplot at 0x7f8b43362d30>



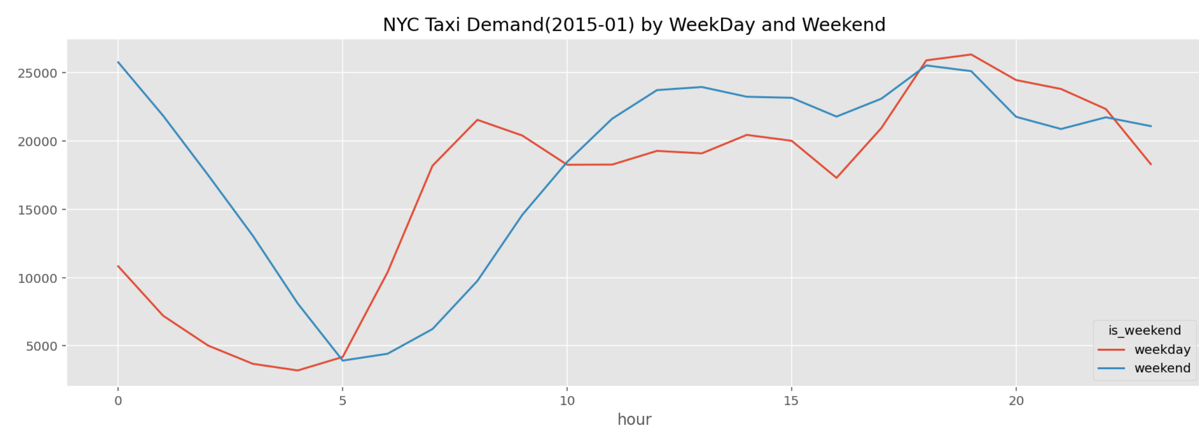
- There are two different trend lines between **weekday and weekend**

Demand 'Weekday' and 'Weekend'

In [80]:
```
df['is_weekend'] = ((pd.DatetimeIndex(df.index).dayofweek) // 5 == 1).astype(int)
```

In [82]:
```
df.groupby(['hour', 'is_weekend'])['cnt'].mean().unstack().rename(columns={0:"weekday", 1:"weekend"})\
                  .plot(title='NYC Taxi Demand(2015-01) by WeekDay and Weekend', figsize=(16,5))
```

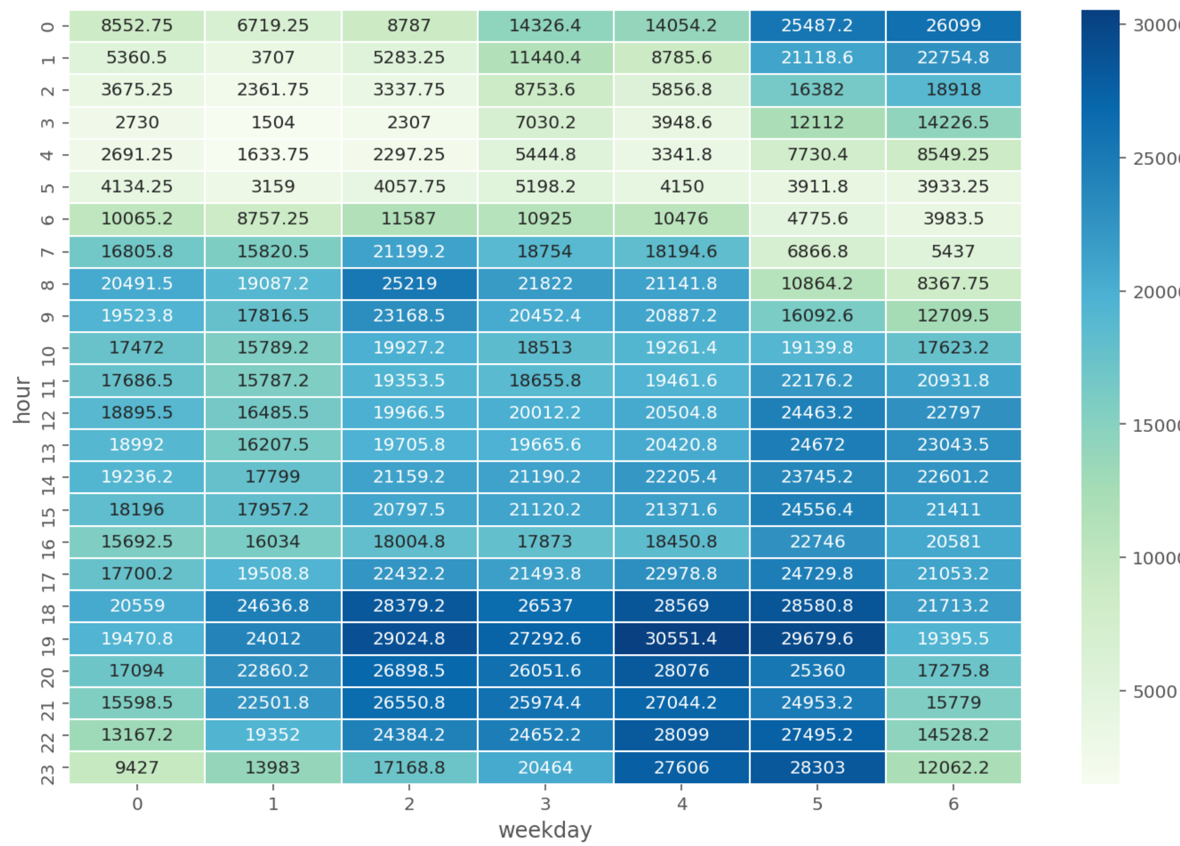
Out[82]: <matplotlib.axes._subplots.AxesSubplot at 0x7f8b38e17490>



- **In weekday**, The demands were rapidly increased during **05:00 - 8:00**
- **In weekend**, the demands were gradually increased during **07:00 - 12:00**
    - Highest demand on midnight

Heatmap by 'day' and 'hour'

In [83]:
```
plt.figure(figsize=(12,8))
sns.heatmap(df.groupby(['hour', 'weekday'])['cnt'].mean().unstack(),
            lw=.5, annot=True, cmap='GnBu', fmt='g', annot_kws={'size':10
});
```



- Demand increased at **Fiday night** and **Saturday night**

3. Geographical EDA

In [90]:

```
%%time

query = """
WITH base_data AS (
  SELECT
    *
  FROM `bigquery-public-data.new_york_taxi_trips.tlc_yellow_trips_2015`
  WHERE EXTRACT(MONTH from pickup_datetime) = 1
), temp AS (
  SELECT nyc_taxi.*, gis.*
  FROM (
    SELECT *
    FROM base_data
    WHERE pickup_latitude  <= 90 and pickup_latitude >= -90
    ) as nyc_taxi
  JOIN (
    SELECT zip_code, state_code, state_name, city, county, zip_code_geom
    FROM `bigquery-public-data.geo_us_boundaries.zip_codes`
    WHERE state_code='NY'
    ) as gis
  ON st_contains(zip_code_geom, st_geogpoint(pickup_longitude, pickup_la
titude))
)

SELECT
  zip_code,
  city,
  ST_ASTEXT(zip_code_geom) as zip_code_geom,
  DATETIME_TRUNC(pickup_datetime, hour) as pickup_hour,
  count(*) as cnt
FROM temp
GROUP BY zip_code, city, zip_code_geom, pickup_hour
ORDER BY pickup_hour

"""

df = pd.read_gbq(query=query, dialect='standard', project_id='mobility-3
20516')
```

```
Downloading: 100%|██████████| 87020/87020 [04:52<00:00, 297.23rows/s]

CPU times: user 7.19 s, sys: 987 ms, total: 8.18 s
Wall time: 5min 22s
```

In [91]:
```
df.head()
```

Out[91]:

	zip_code	city	zip_code_geom	pickup_hour	cnt
0	11218	New York city	POLYGON((-73.991929 40.642205, -73.991734 40.6...	2015-01-01	14
1	11225	New York city	POLYGON((-73.964786 40.662054, -73.965025 40.6...	2015-01-01	10
2	10024	New York city	POLYGON((-73.98814 40.781409, -73.987414 40.78...	2015-01-01	869
3	11514	Carle Place CDP	POLYGON((-73.624059 40.755152, -73.623723 40.7...	2015-01-01	1
4	10010	New York city	POLYGON((-73.993739 40.741617, -73.994028 40.7...	2015-01-01	1045

In [92]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 87020 entries, 0 to 87019
Data columns (total 5 columns):
 #   Column         Non-Null Count  Dtype
---  ------         --------------  -----
 0   zip_code       87020 non-null  object
 1   city           87020 non-null  object
 2   zip_code_geom  87020 non-null  object
 3   pickup_hour    87020 non-null  datetime64[ns]
 4   cnt            87020 non-null  int64
dtypes: datetime64[ns](1), int64(1), object(3)
memory usage: 3.3+ MB
```

Highest demand by 'zip code'

In [93]:
```
zip_code_agg_df = df.groupby(['zip_code', 'zip_code_geom'])[['cnt']].sum
().reset_index()
```

In [94]:
```
zip_code_agg_df.head()
```

Out[94]:

	zip_code	zip_code_geom	cnt
0	10001	POLYGON((-74.00828 40.750272, -74.008255 40.75...	627563
1	10002	POLYGON((-73.997504 40.714069, -73.9973 40.713...	234527
2	10003	POLYGON((-73.999366 40.731323, -73.999604 40.7...	704598
3	10004	MULTIPOLYGON(((-74.018008 40.705935, -74.01801...	59700
4	10005	POLYGON((-74.012508 40.706767, -74.0124 40.706...	52454

In [95]:
```
zip_code_agg_df['percent'] = (zip_code_agg_df[['cnt']]/df[['cnt']].sum
()).round(3).rename(columns={'cnt':'percent'})\

.reset_index()['percent']
```

In [96]:
```
zip_code_agg_df.tail()
```

Out[96]:

	zip_code	zip_code_geom	cnt	percent
369	13656	POLYGON((-76.067267 44.140696, -76.067236 44.1...	1	0.0
370	13691	POLYGON((-75.88536 44.23349, -75.88501 44.2310...	1	0.0
371	14072	MULTIPOLYGON(((-78.935536 42.965442, -78.93553...	1	0.0
372	14527	MULTIPOLYGON(((-77.121905 42.624718, -77.12188...	1	0.0
373	14801	POLYGON((-77.442016 42.140918, -77.44193 42.14...	1	0.0

In [97]:
```
filter_agg_df = zip_code_agg_df[zip_code_agg_df['percent'] > 0.000]
```

- Omit 0 percent (unnecessary)

In [98]:
```
filter_agg_df.sort_values(by='cnt', ascending=False)
```

Out[98]:

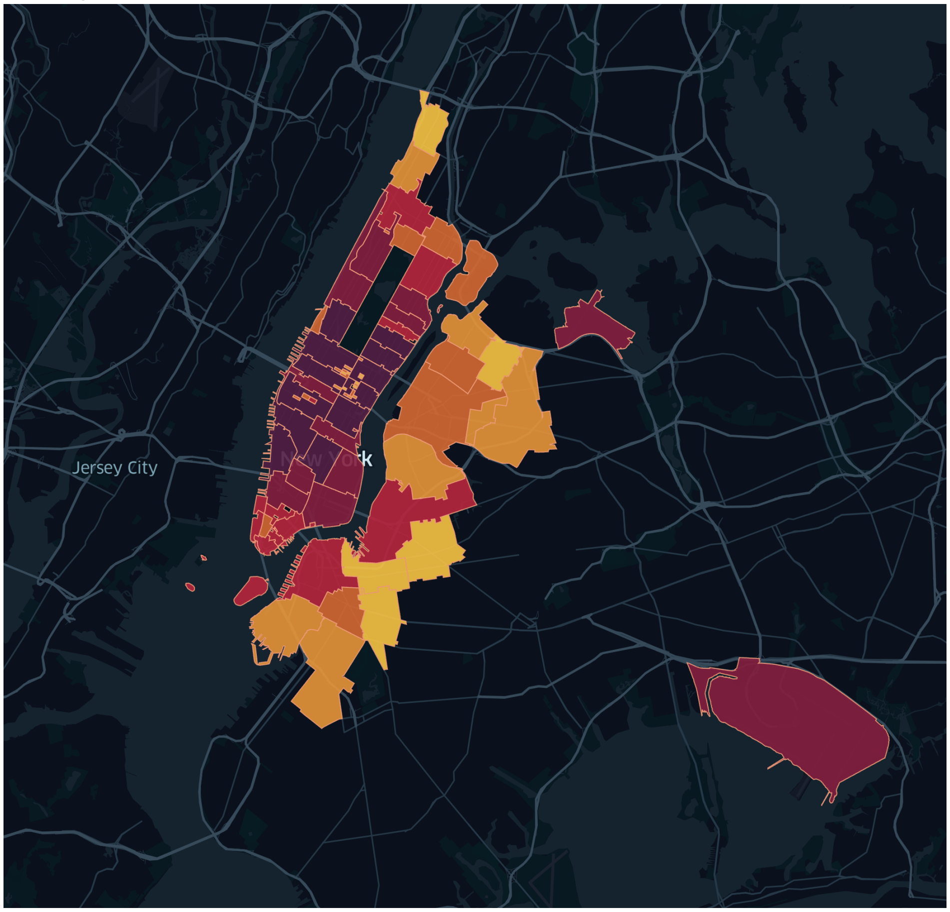
	zip_code	zip_code_geom	cnt	percent
16	10019	POLYGON((-74.003568 40.763799, -74.003767 40.7...	817267	0.066
2	10003	POLYGON((-73.999366 40.731323, -73.999604 40.7...	704598	0.057
19	10022	POLYGON((-73.977201 40.758538, -73.977655 40.7...	679831	0.055
13	10016	POLYGON((-73.987298 40.744682, -73.987746 40.7...	663540	0.054
9	10011	POLYGON((-74.012285 40.74387, -74.012359 40.74...	647831	0.053
...	...	...	...	...
194	11205	POLYGON((-73.980649 40.701561, -73.980729 40.7...	8437	0.001
54	10167	POLYGON((-73.975352 40.755303, -73.975807 40.7...	8186	0.001
45	10112	POLYGON((-73.980426 40.759899, -73.980886 40.7...	8135	0.001
60	10173	POLYGON((-73.979937 40.754783, -73.980395 40.7...	7966	0.001
44	10111	POLYGON((-73.97845 40.759065, -73.978039 40.75...	6898	0.001

72 rows × 4 columns

In [99]:
```
filter_zip_code = filter_agg_df['zip_code'].to_list()
```

In [100]:
```
filter_agg_df.to_csv("zip_code_ratio.csv", index=False)
```

- Visualization using Kepler.gl
- Darker color means higher demand



4. Finding pattern

boxplot for demand by 'zip code'

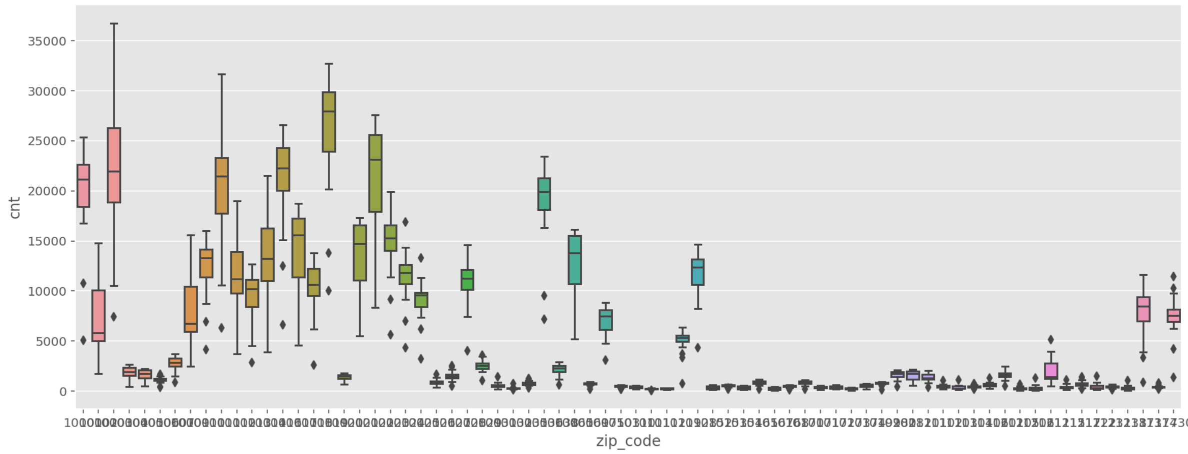
In [101]:
```
zip_df = df[['zip_code', 'zip_code_geom', 'pickup_hour', 'cnt']]
```

In [102]:
```
zip_df['date'] = zip_df['pickup_hour'].dt.date
```

In [103]:
```
filter_zip_df = zip_df[zip_df['zip_code'].isin(filter_zip_code)]
```

In [104]:
```
filter_zip_daily_df = filter_zip_df.groupby(['zip_code','date'])[['cnt'
]].sum().reset_index()
```

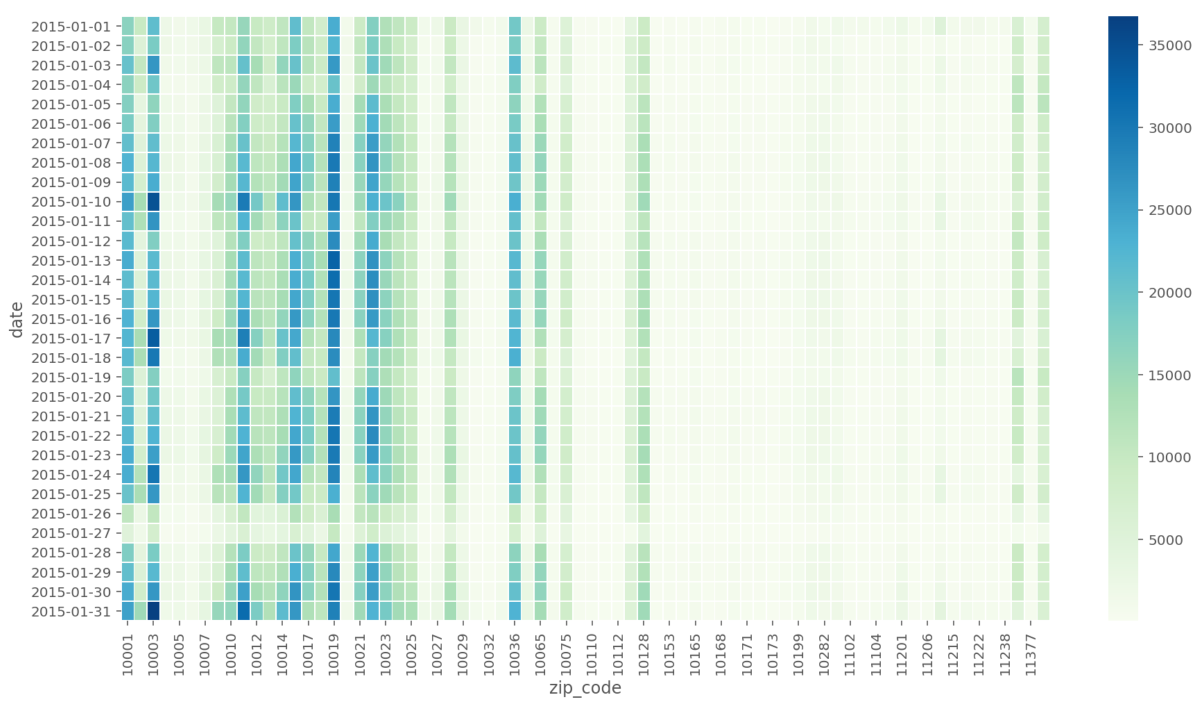
In [110]:
```
plt.figure(figsize=(16, 6));
sns.boxplot(x='zip_code', y='cnt', data=filter_zip_daily_df);
```



Heatmap by 'date' and 'zip code'

In [94]:
```
plt.figure(figsize=(15,8))
sns.heatmap(filter_zip_daily_df.pivot_table('cnt', index='date', columns
='zip_code'),
            lw=.5, cmap='GnBu')
```

Out[94]: <matplotlib.axes._subplots.AxesSubplot at 0x7fc6ee38a610>



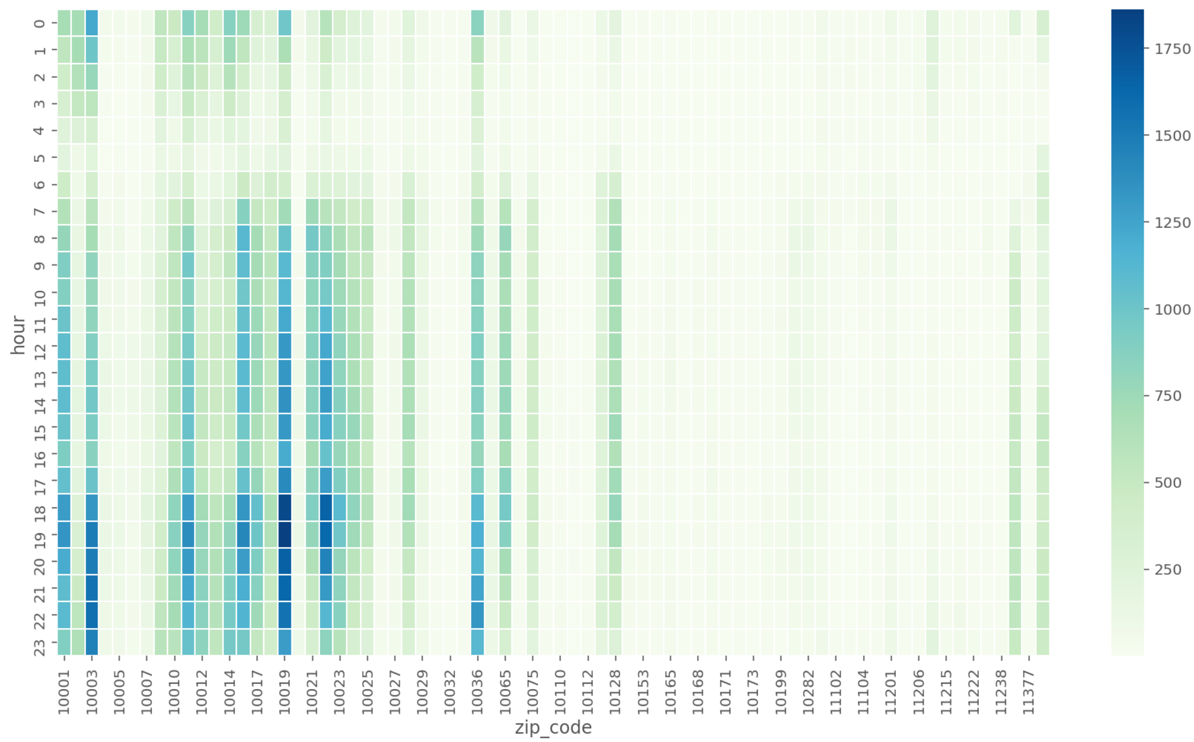
- Highest demand : 10019
- Next zip code : 10001, 10003, 10011, 10015, 10022
- There are pattern in 2015-01-10, 01-17, 01-24, 01-31

Trips per zip code by hours

In [96]:
```
filter_zip_df['hour'] = filter_zip_df['pickup_hour'].dt.hour
```

In [97]:
```
plt.figure(figsize=(15,8))
sns.heatmap(filter_zip_df.pivot_table('cnt', index='hour', columns='zip_code', aggfunc='mean'),
            lw=.5, cmap='GnBu')
```

Out[97]: <matplotlib.axes._subplots.AxesSubplot at 0x7fc6ee4d54f0>



- Higher demand between 18:00 - 22:00
- Higher demand by 'zip code' : 10001, 10003, 10011, 10015, 10019, 10022, 10036