Introduction

Ford GoBike is a regional public bicycle sharing system in the San Francisco Bay Area of California. It started in August 2013 as Bay Area Bike Share, before it established a partnership with Ford Motor Company and rebranded itself as Ford GoBike in June 2017.

The Ford GoBike system is an integral part of the Bay Area's transportation network. With more than 300 stations and 3,000 bikes on the ground across San Francisco, San Jose, Berkeley, Oakland and Emeryville, the system has generated over two million rides since launching in June 2017. At the forefront of bikeshare innovation, the system features the popular Ford GoBike Plus ebikes to help riders easily summit Bay Area hills as well as 200 dockless bikes in North San Jose. When completed, the 7,000-bike, 546-station Ford GoBike network will be the second-largest bike share system in North America, setting new national standards in density, convenience and equity. Ford GoBike is powered by Lyft, North America's bike share leader.

As of June 2019, the system rebranded itself again as Bay Wheels, after its partnership with Ford ended and Lyft absorbed Bay Area Bike Share. For this project, we will examine data from the most recent dataset prior to the system's new rebranding (i.e., April 2019).

Preliminary Wrangling

In [1]:

```
# import all packages and set plots to be embedded inline
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sb

%matplotlib inline
```

In [2]:

```
# load in the dataset into a pandas dataframe, print statistics
# We'll call our dataframe 'gobike'
gobike = pd.read_csv('201904-fordgobike-tripdata.csv')
```

In [3]:

```
# high-level overview of data shape and composition of the
# gobike dataframe
print(gobike.shape)
print(gobike.dtypes)
print(gobike.head(10))
```

```
(239111, 16)
duration_sec                int64
start_time                 object
end_time                   object
start_station_id          float64
start_station_name         object
start_station_latitude    float64
start_station_longitude   float64
end_station_id            float64
end_station_name           object
end_station_latitude      float64
end_station_longitude     float64
bike_id                     int64
user_type                  object
member_birth_year         float64
member_gender              object
bike_share_for_all_trip    object
dtype: object
```

dtype: object

	duration_sec	start_time	end_time
0	50305	2019-04-30 22:33:55.1550	2019-05-01 12:32:20.4540
1	53725	2019-04-30 20:43:41.6320	2019-05-01 11:39:06.9170
2	78072	2019-04-30 10:32:46.4890	2019-05-01 08:13:58.9750
3	78969	2019-04-30 10:00:51.5500	2019-05-01 07:57:01.2620
4	1128	2019-04-30 23:59:04.7390	2019-05-01 00:17:53.0910
5	1388	2019-04-30 23:53:05.9820	2019-05-01 00:16:14.3130
6	920	2019-04-30 23:57:56.3400	2019-05-01 00:13:16.4540
7	725	2019-04-30 23:56:11.2190	2019-05-01 00:08:16.9150
8	488	2019-04-30 23:59:00.6600	2019-05-01 00:07:08.9750
9	792	2019-04-30 23:53:37.6040	2019-05-01 00:06:50.4050

	start_station_id	start_station_name
0	368.0	Myrtle St at Polk St
1	246.0	Berkeley Civic Center
2	64.0	5th St at Brannan St
3	67.0	San Francisco Caltrain Station 2 (Townsend St...
4	124.0	19th St at Florida St
5	243.0	Bancroft Way at College Ave
6	202.0	Washington St at 8th St
7	44.0	Civic Center/UN Plaza BART Station (Market St ...
8	21.0	Montgomery St BART Station (Market St at 2nd St)
9	28.0	The Embarcadero at Bryant St

	start_station_latitude	start_station_longitude	end_station_id
0	37.785434	-122.419622	324.0
1	37.869060	-122.270556	241.0
2	37.776754	-122.399018	64.0
3	37.776639	-122.395526	89.0
4	37.760447	-122.410807	5.0
5	37.869360	-122.254337	247.0
6	37.800754	-122.274894	220.0
7	37.781074	-122.411738	121.0
8	37.789625	-122.400811	64.0
9	37.787168	-122.388098	126.0

	end_station_name	end_station_latitude
0	Union Square (Powell St at Post St)	37.788300
1	Ashby BART Station	37.852477
2	5th St at Brannan St	37.776754
3	Division St at Potrero Ave	37.769218
4	Powell St BART Station (Market St at 5th St)	37.783899
5	Fulton St at Bancroft Way	37.867789
6	San Pablo Ave at MLK Jr Way	37.811351
7	Mission Playground	37.759210
8	5th St at Brannan St	37.776754
9	Esprit Park	37.761634

	end_station_longitude	bike_id	user_type	member_birth_year
0	-122.408531	2749	Subscriber	1989.0
1	-122.270213	2608	Customer	NaN
2	-122.399018	258	Subscriber	1993.0
3	-122.407646	1974	Subscriber	1972.0
4	-122.408445	877	Subscriber	1973.0
5	-122.265896	3234	Customer	1997.0
6	-122.273422	3262	Subscriber	1976.0
7	-122.421339	2706	Customer	1973.0
8	-122.399018	860	Subscriber	1986.0
9	-122.390648	896	Subscriber	1995.0

	member_gender	bike_share_for_all_trip
0	Female	No
1	NaN	No
2	Male	No
3	Male	No
4	Male	No
5	Male	No
6	Male	Yes
7	Male	No
8	Male	No
9	Male	No

In [4]:

```
# Print out descriptive statistics, including mean, standard deviation, min, max, etc.
print(gobike.describe())
```

```
        duration_sec  start_station_id  start_station_latitude  \
count  239111.000000     239047.000000           239111.000000
mean      802.671199        141.836538               37.769536
std      1990.006091        116.289776                0.127698
min        61.000000          3.000000                0.000000
25%       349.000000         47.000000               37.770083
50%       558.000000        104.000000               37.780760
75%       876.000000        240.000000               37.797280
max     86114.000000        420.000000               37.880222

       start_station_longitude  end_station_id  end_station_latitude  \
count            239111.000000   239047.000000         239111.000000
mean               -122.352503      140.838099             37.766996
std                   0.277088      116.386168              0.343083
min                -122.453704        3.000000              0.000000
25%                -122.413004       44.000000             37.770407
50%                -122.398285      102.000000             37.780955
75%                -122.291209      239.000000             37.797320
max                   0.000000      420.000000             37.880222

       end_station_longitude        bike_id  member_birth_year
count          239111.000000  239111.000000      227912.000000
mean             -122.343420    3666.956493        1984.863250
std                 1.068144    2180.717333           9.953144
min              -122.453704      11.000000        1878.000000
25%              -122.411738    1720.000000        1980.000000
50%              -122.397437    3471.000000        1987.000000
75%              -122.291376    5749.000000        1992.000000
max                 0.000000    7108.000000        2001.000000
```

In [5]:

```
# Print out additional statistics
gobike.isnull().sum()
```

Out[5]:

```
duration_sec                 0
start_time                   0
end_time                     0
start_station_id            64
start_station_name          64
start_station_latitude       0
start_station_longitude      0
end_station_id              64
end_station_name            64
end_station_latitude         0
end_station_longitude        0
bike_id                      0
user_type                    0
member_birth_year        11199
member_gender            11199
bike_share_for_all_trip      0
dtype: int64
```

In [6]:

```
# Remove rows that do not have gender value
gobike_clean = gobike[gobike['member_gender'].isnull() == False]
```

In [7]:

```
# Print out the number of male and female riders
gobike_clean['member_gender'].value_counts()
```

Out[7]:

```
Male      168140
Female     55498
Other       4274
Name: member_gender, dtype: int64
```

In [8]:

```
# Print out the number of subscribers and customers to the Bay Wheels service
gobike_clean['user_type'].value_counts()
```

Out[8]:

```
Subscriber    198510
Customer       29402
Name: user_type, dtype: int64
```

In [9]:

```
# Remove rows that do not have start station id
gobike_clean = gobike_clean[gobike_clean['start_station_id'].isnull() == False]
gobike_clean.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 227848 entries, 0 to 239110
Data columns (total 16 columns):
 #   Column                   Non-Null Count   Dtype
---  ------                   --------------   -----
 0   duration_sec             227848 non-null  int64
 1   start_time               227848 non-null  object
 2   end_time                 227848 non-null  object
 3   start_station_id         227848 non-null  float64
 4   start_station_name       227848 non-null  object
 5   start_station_latitude   227848 non-null  float64
 6   start_station_longitude  227848 non-null  float64
 7   end_station_id           227848 non-null  float64
 8   end_station_name         227848 non-null  object
 9   end_station_latitude     227848 non-null  float64
 10  end_station_longitude    227848 non-null  float64
 11  bike_id                  227848 non-null  int64
 12  user_type                227848 non-null  object
 13  member_birth_year        227848 non-null  float64
 14  member_gender            227848 non-null  object
 15  bike_share_for_all_trip  227848 non-null  object
dtypes: float64(7), int64(2), object(7)
memory usage: 29.6+ MB
```

In [10]:

```
gobike_clean.duplicated().sum()
```

Out[10]:

```
0
```

In [11]:

```
# Change start_time and end_time to datetime format
gobike_clean.start_time = pd.to_datetime(gobike_clean.start_time)
gobike_clean.end_time = pd.to_datetime(gobike_clean.end_time)
```

In [12]:

```
# Extract dayofweek, hours information from the start_time
gobike_clean['start_time_dayofweek']= gobike_clean['start_time'].dt.strftime('%a')
gobike_clean['start_time_hour']= gobike_clean['start_time'].dt.hour
```

In [13]:

```
# Print the updated data
gobike_clean.info()
```

```
<class 'pandas.core.frame.DataFrame'>
```

```
Int64Index: 227848 entries, 0 to 239110
Data columns (total 18 columns):
 #   Column                   Non-Null Count   Dtype
---  ------                   --------------   -----
 0   duration_sec             227848 non-null  int64
 1   start_time               227848 non-null  datetime64[ns]
 2   end_time                 227848 non-null  datetime64[ns]
 3   start_station_id         227848 non-null  float64
 4   start_station_name       227848 non-null  object
 5   start_station_latitude   227848 non-null  float64
 6   start_station_longitude  227848 non-null  float64
 7   end_station_id           227848 non-null  float64
 8   end_station_name         227848 non-null  object
 9   end_station_latitude     227848 non-null  float64
 10  end_station_longitude    227848 non-null  float64
 11  bike_id                  227848 non-null  int64
 12  user_type                227848 non-null  object
 13  member_birth_year        227848 non-null  float64
 14  member_gender            227848 non-null  object
 15  bike_share_for_all_trip  227848 non-null  object
 16  start_time_dayofweek     227848 non-null  object
 17  start_time_hour          227848 non-null  int64
dtypes: datetime64[ns](2), float64(7), int64(3), object(6)
memory usage: 33.0+ MB
```

In [14]:

```
# Print the first ten rows of the updated dataframe
print(gobike_clean.head(10))
```

```
    duration_sec              start_time                end_time  \
0          50305 2019-04-30 22:33:55.155 2019-05-01 12:32:20.454
2          78072 2019-04-30 10:32:46.489 2019-05-01 08:13:58.975
3          78969 2019-04-30 10:00:51.550 2019-05-01 07:57:01.262
4           1128 2019-04-30 23:59:04.739 2019-05-01 00:17:53.091
5           1388 2019-04-30 23:53:05.982 2019-05-01 00:16:14.313
6            920 2019-04-30 23:57:56.340 2019-05-01 00:13:16.454
7            725 2019-04-30 23:56:11.219 2019-05-01 00:08:16.915
8            488 2019-04-30 23:59:00.660 2019-05-01 00:07:08.975
9            792 2019-04-30 23:53:37.604 2019-05-01 00:06:50.405
10           464 2019-04-30 23:56:44.386 2019-05-01 00:04:28.912

    start_station_id                                start_station_name  \
0              368.0                             Myrtle St at Polk St
2               64.0                             5th St at Brannan St
3               67.0  San Francisco Caltrain Station 2  (Townsend St...
4              124.0                           19th St at Florida St
5              243.0                  Bancroft Way at College Ave
6              202.0                      Washington St at 8th St
7               44.0  Civic Center/UN Plaza BART Station (Market St ...
8               21.0   Montgomery St BART Station (Market St at 2nd St)
9               28.0                  The Embarcadero at Bryant St
10              89.0                    Division St at Potrero Ave

    start_station_latitude  start_station_longitude  end_station_id  \
0                37.785434              -122.419622           324.0
2                37.776754              -122.399018            64.0
3                37.776639              -122.395526            89.0
4                37.760447              -122.410807             5.0
5                37.869360              -122.254337           247.0
6                37.800754              -122.274894           220.0
7                37.781074              -122.411738           121.0
8                37.789625              -122.400811            64.0
9                37.787168              -122.388098           126.0
10               37.769218              -122.407646            97.0

                            end_station_name  end_station_latitude  \
0          Union Square (Powell St at Post St)             37.788300
2                       5th St at Brannan St             37.776754
3                 Division St at Potrero Ave             37.769218
4   Powell St BART Station (Market St at 5th St)             37.783899
5                    Fulton St at Bancroft Way             37.867789
```

```
6                    San Pablo Ave at MLK Jr Way            37.811351
7                              Mission Playground           37.759210
8                           5th St at Brannan St            37.776754
9                                    Esprit Park            37.761634
10                         14th St at Mission St            37.768265

    end_station_longitude  bike_id   user_type  member_birth_year  \
0              -122.408531     2749  Subscriber             1989.0
2              -122.399018      258  Subscriber             1993.0
3              -122.407646     1974  Subscriber             1972.0
4              -122.408445      877  Subscriber             1973.0
5              -122.265896     3234    Customer             1997.0
6              -122.273422     3262  Subscriber             1976.0
7              -122.421339     2706    Customer             1973.0
8              -122.399018      860  Subscriber             1986.0
9              -122.390648      896  Subscriber             1995.0
10             -122.420110     3048  Subscriber             1984.0

   member_gender bike_share_for_all_trip start_time_dayofweek  start_time_hour
0         Female                     No                  Tue               22
2           Male                     No                  Tue               10
3           Male                     No                  Tue               10
4           Male                     No                  Tue               23
5           Male                     No                  Tue               23
6           Male                    Yes                  Tue               23
7           Male                     No                  Tue               23
8           Male                     No                  Tue               23
9           Male                     No                  Tue               23
10          Male                     No                  Tue               23
```

In [15]:

```
# Without the print statement
gobike_clean.head(10)
```

Out[15]:

	duration_sec	start_time	end_time	start_station_id	start_station_name	start_station_latitude	start_station_longitude
0	50305	2019-04-30 22:33:55.155	2019-05-01 12:32:20.454	368.0	Myrtle St at Polk St	37.785434	-122.419622
2	78072	2019-04-30 10:32:46.489	2019-05-01 08:13:58.975	64.0	5th St at Brannan St	37.776754	-122.399018
3	78969	2019-04-30 10:00:51.550	2019-05-01 07:57:01.262	67.0	San Francisco Caltrain Station 2 (Townsend St...	37.776639	-122.395526
4	1128	2019-04-30 23:59:04.739	2019-05-01 00:17:53.091	124.0	19th St at Florida St	37.760447	-122.410807
5	1388	2019-04-30 23:53:05.982	2019-05-01 00:16:14.313	243.0	Bancroft Way at College Ave	37.869360	-122.254337
6	920	2019-04-30 23:57:56.340	2019-05-01 00:13:16.454	202.0	Washington St at 8th St	37.800754	-122.274894
7	725	2019-04-30 23:56:11.219	2019-05-01 00:08:16.915	44.0	Civic Center/UN Plaza BART Station (Market St ...	37.781074	-122.411738
8	488	2019-04-30 23:59:00.660	2019-05-01 00:07:08.975	21.0	Montgomery St BART Station (Market St at 2nd St)	37.789625	-122.400811
9	792	2019-04-30 23:53:37.604	2019-05-01 00:06:50.405	28.0	The Embarcadero at Bryant St	37.787168	-122.388098
10	464	2019-04-30 23:56:44.386	2019-05-01 00:04:28.912	89.0	Division St at Potrero Ave	37.769218	-122.407646

In [16]:

```
gobike_clean['start_time_dayofweek'].value_counts()
```

Out[16]:

```
Tue    41856
Mon    39296
Thu    37234
Wed    37222
Fri    33733
Sat    21475
Sun    17032
Name: start_time_dayofweek, dtype: int64
```

In [17]:

```
# Convert the start_time_dayofweek to ordinal variables.
weekdays = ['Mon','Tue','Wed','Thu','Fri', 'Sat', 'Sun']
ordered_weekdays = pd.api.types.CategoricalDtype(ordered = True, categories = weekdays)
gobike_clean['start_time_dayofweek'] = gobike_clean['start_time_dayofweek'].astype(order
ed_weekdays)
```

In [18]:

```
# Print the updated datatypes for the clean gobike data
gobike_clean.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 227848 entries, 0 to 239110
Data columns (total 18 columns):
 #   Column                   Non-Null Count   Dtype
---  ------                   --------------   -----
 0   duration_sec             227848 non-null  int64
 1   start_time               227848 non-null  datetime64[ns]
 2   end_time                 227848 non-null  datetime64[ns]
 3   start_station_id         227848 non-null  float64
 4   start_station_name       227848 non-null  object
 5   start_station_latitude   227848 non-null  float64
 6   start_station_longitude  227848 non-null  float64
 7   end_station_id           227848 non-null  float64
 8   end_station_name         227848 non-null  object
 9   end_station_latitude     227848 non-null  float64
 10  end_station_longitude    227848 non-null  float64
 11  bike_id                  227848 non-null  int64
 12  user_type                227848 non-null  object
 13  member_birth_year        227848 non-null  float64
 14  member_gender            227848 non-null  object
 15  bike_share_for_all_trip  227848 non-null  object
 16  start_time_dayofweek     227848 non-null  category
 17  start_time_hour          227848 non-null  int64
dtypes: category(1), datetime64[ns](2), float64(7), int64(3), object(5)
memory usage: 31.5+ MB
```

In [19]:

```
# Calculate member_age from member_birth_year.
gobike_clean['member_age'] = 2019 - gobike_clean['member_birth_year']
gobike_clean['member_age'] = gobike_clean['member_age'].astype(int)
gobike_clean['member_birth_year'] = gobike_clean['member_birth_year'].astype(int)
```

In [20]:

```
gobike_clean.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 227848 entries, 0 to 239110
Data columns (total 19 columns):
 #   Column                   Non-Null Count   Dtype
---  ------                   --------------   -----
 0   duration_sec             227848 non-null  int64
 1   start_time               227848 non-null  datetime64[ns]
```

```
 1   start_time                 227848 non-null  datetime64[ns]
 2   end_time                   227848 non-null  datetime64[ns]
 3   start_station_id           227848 non-null  float64
 4   start_station_name         227848 non-null  object
 5   start_station_latitude     227848 non-null  float64
 6   start_station_longitude    227848 non-null  float64
 7   end_station_id             227848 non-null  float64
 8   end_station_name           227848 non-null  object
 9   end_station_latitude       227848 non-null  float64
 10  end_station_longitude      227848 non-null  float64
 11  bike_id                    227848 non-null  int64
 12  user_type                  227848 non-null  object
 13  member_birth_year          227848 non-null  int64
 14  member_gender              227848 non-null  object
 15  bike_share_for_all_trip    227848 non-null  object
 16  start_time_dayofweek       227848 non-null  category
 17  start_time_hour            227848 non-null  int64
 18  member_age                 227848 non-null  int64
dtypes: category(1), datetime64[ns](2), float64(6), int64(5), object(5)
memory usage: 33.2+ MB
```

In [21]:

```
gobike_clean.head(10)
```

Out[21]:

	duration_sec	start_time	end_time	start_station_id	start_station_name	start_station_latitude	start_station_longitude
0	50305	2019-04-30 22:33:55.155	2019-05-01 12:32:20.454	368.0	Myrtle St at Polk St	37.785434	-122.419622
2	78072	2019-04-30 10:32:46.489	2019-05-01 08:13:58.975	64.0	5th St at Brannan St	37.776754	-122.399018
3	78969	2019-04-30 10:00:51.550	2019-05-01 07:57:01.262	67.0	San Francisco Caltrain Station 2 (Townsend St...	37.776639	-122.395526
4	1128	2019-04-30 23:59:04.739	2019-05-01 00:17:53.091	124.0	19th St at Florida St	37.760447	-122.410807
5	1388	2019-04-30 23:53:05.982	2019-05-01 00:16:14.313	243.0	Bancroft Way at College Ave	37.869360	-122.254337
6	920	2019-04-30 23:57:56.340	2019-05-01 00:13:16.454	202.0	Washington St at 8th St	37.800754	-122.274894
7	725	2019-04-30 23:56:11.219	2019-05-01 00:08:16.915	44.0	Civic Center/UN Plaza BART Station (Market St ...	37.781074	-122.411738
8	488	2019-04-30 23:59:00.660	2019-05-01 00:07:08.975	21.0	Montgomery St BART Station (Market St at 2nd St)	37.789625	-122.400811
9	792	2019-04-30 23:53:37.604	2019-05-01 00:06:50.405	28.0	The Embarcadero at Bryant St	37.787168	-122.388098
10	464	2019-04-30 23:56:44.386	2019-05-01 00:04:28.912	89.0	Division St at Potrero Ave	37.769218	-122.407646

What is the structure of your dataset?

The Ford GoBike dataset contains over 200,000 entries of bike rides in the San Francisco Bay Area. Among the data included in this data set:

- **Start time and end time of bike ride**
- **Station IDs where the bike ride began and where it ended**

- Name of the stations where the bike ride began and where it ended
- The type of individual using the GoBike service (subscriber or customer)
- Birth years and genders of the subscribers or customers using the GoBike service

What is/are the main feature(s) of interest in your dataset?

For this project, we will investigate duration of bike rides.

What features in the dataset do you think will help support your investigation into your feature(s) of interest?

The features that will be of interest to us include the start time, end time, gender, and type of user.

Univariate Exploration

In [22]:

```
# Store the data for duration_min by calculating the time by 60 seconds
gobike_clean['duration_min'] = gobike_clean['duration_sec']/60
gobike_clean.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 227848 entries, 0 to 239110
Data columns (total 20 columns):
 #   Column                   Non-Null Count   Dtype
---  ------                   --------------   -----
 0   duration_sec             227848 non-null  int64
 1   start_time               227848 non-null  datetime64[ns]
 2   end_time                 227848 non-null  datetime64[ns]
 3   start_station_id         227848 non-null  float64
 4   start_station_name       227848 non-null  object
 5   start_station_latitude   227848 non-null  float64
 6   start_station_longitude  227848 non-null  float64
 7   end_station_id           227848 non-null  float64
 8   end_station_name         227848 non-null  object
 9   end_station_latitude     227848 non-null  float64
 10  end_station_longitude    227848 non-null  float64
 11  bike_id                  227848 non-null  int64
 12  user_type                227848 non-null  object
 13  member_birth_year        227848 non-null  int64
 14  member_gender            227848 non-null  object
 15  bike_share_for_all_trip  227848 non-null  object
 16  start_time_dayofweek     227848 non-null  category
 17  start_time_hour          227848 non-null  int64
 18  member_age               227848 non-null  int64
 19  duration_min             227848 non-null  float64
dtypes: category(1), datetime64[ns](2), float64(7), int64(5), object(5)
memory usage: 35.0+ MB
```

In [23]:

```
gobike_clean.head(10)
```

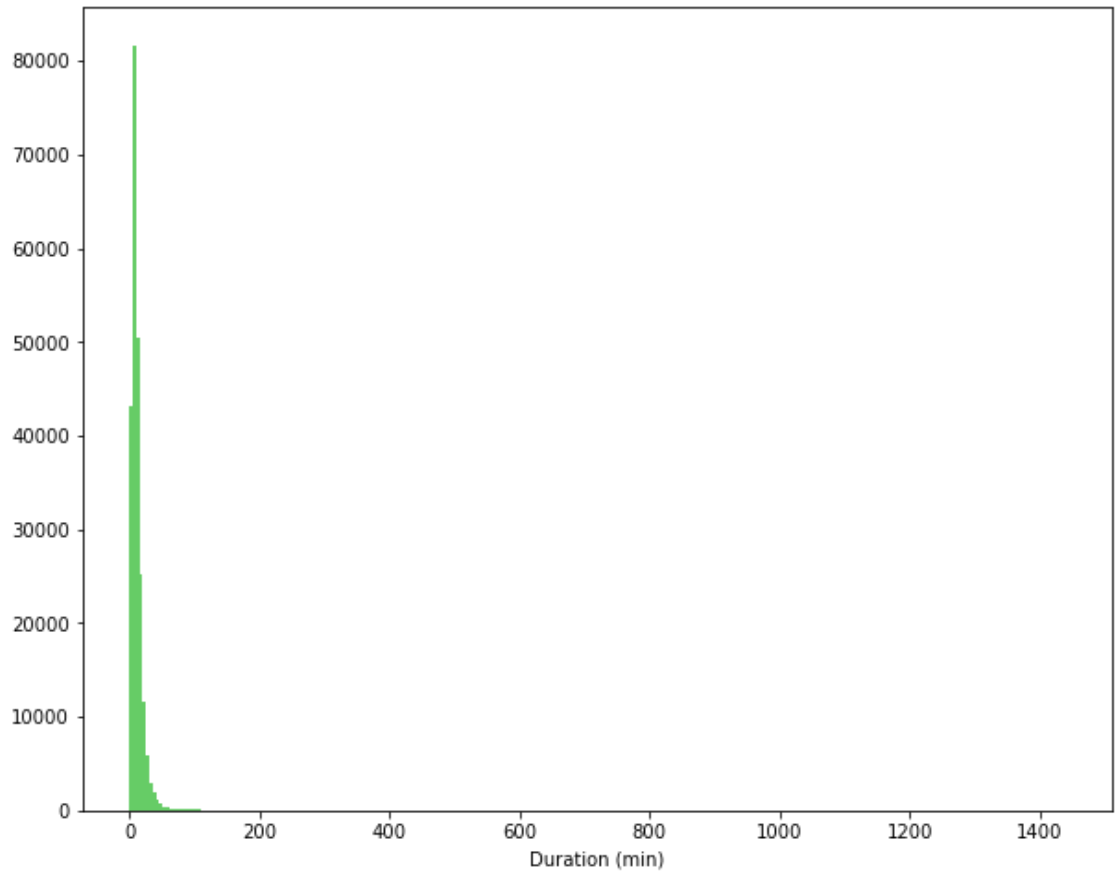
Out[23]:

	duration_sec	start_time	end_time	start_station_id	start_station_name	start_station_latitude	start_station_longitude
0	50305	2019-04-30 22:33:55.155	2019-05-01 12:32:20.454	368.0	Myrtle St at Polk St	37.785434	-122.419622
2	78072	2019-04-30 10:32:46.489	2019-05-01 08:13:58.975	64.0	5th St at Brannan St	37.776754	-122.399018
3	78969	2019-04-30 10:00:51.550	2019-05-01 07:57:01.262	67.0	San Francisco Caltrain Station 2	37.776639	-122.395526

	duration_sec	start_time	end_time	start_station_id	start_station_name (Townsend St ...	start_station_latitude	start_station_longitude
4	1128	2019-04-30 23:59:04.739	2019-05-01 00:17:53.091	124.0	19th St at Florida St	37.760447	-122.410807
5	1388	2019-04-30 23:53:05.982	2019-05-01 00:16:14.313	243.0	Bancroft Way at College Ave	37.869360	-122.254337
6	920	2019-04-30 23:57:56.340	2019-05-01 00:13:16.454	202.0	Washington St at 8th St	37.800754	-122.274894
7	725	2019-04-30 23:56:11.219	2019-05-01 00:08:16.915	44.0	Civic Center/UN Plaza BART Station (Market St ...	37.781074	-122.411738
8	488	2019-04-30 23:59:00.660	2019-05-01 00:07:08.975	21.0	Montgomery St BART Station (Market St at 2nd St)	37.789625	-122.400811
9	792	2019-04-30 23:53:37.604	2019-05-01 00:06:50.405	28.0	The Embarcadero at Bryant St	37.787168	-122.388098
10	464	2019-04-30 23:56:44.386	2019-05-01 00:04:28.912	89.0	Division St at Potrero Ave	37.769218	-122.407646

In [24]:

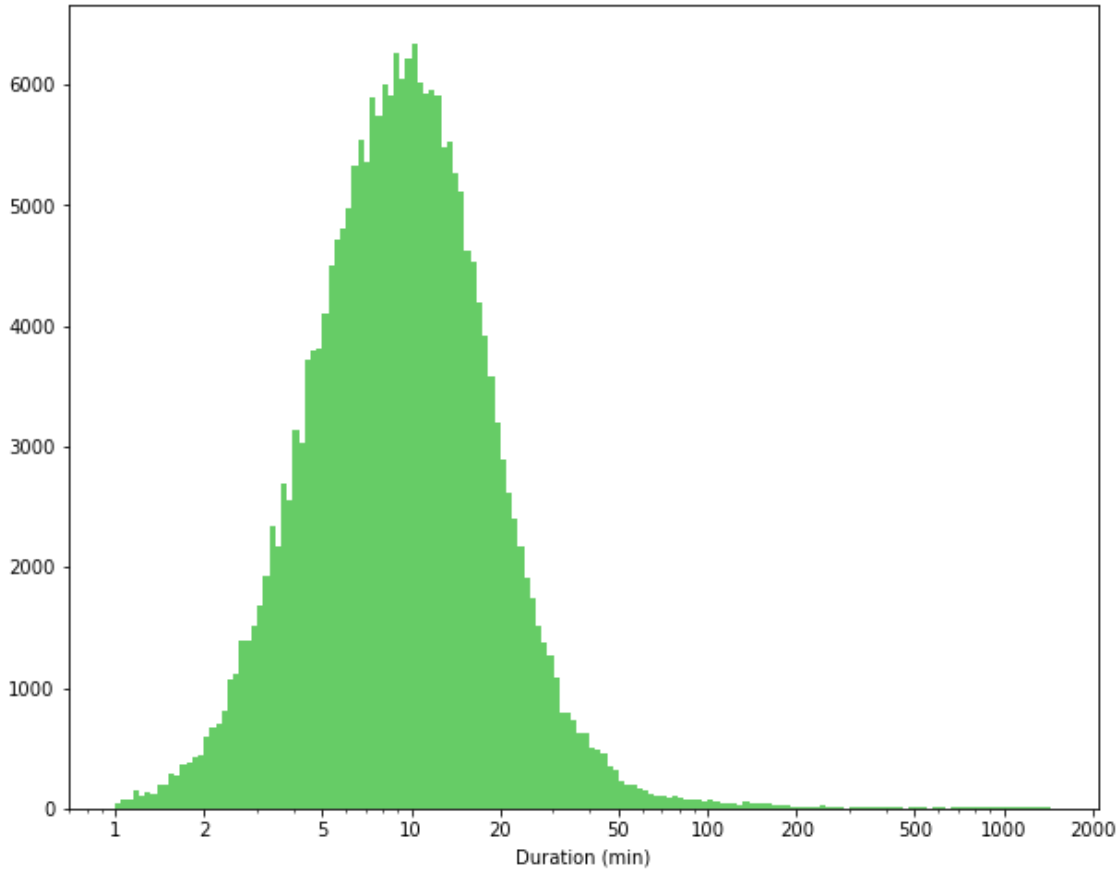
```
# start with a standard-scaled plot
binsize = 5
bins = np.arange(0, gobike_clean['duration_min'].max()+binsize, binsize)

plt.figure(figsize=[10, 8])
plt.hist(data = gobike_clean, x = 'duration_min', bins=bins, color="#66CC66");
plt.xlabel('Duration (min)')
plt.show()
```



In [25]:

```
# there's a long tail in the distribution, so let's put it on a log scale instead
log_binsize = 0.020
bins = 10 ** np.arange(0, np.log10(gobike_clean['duration_min'].max())+log_binsize, log_
```

```
binsize)

plt.figure(figsize=[10, 8]);
plt.hist(data = gobike_clean, x = 'duration_min', bins = bins, color="#66CC66");
plt.xscale('log');
plt.xticks([1, 2, 5, 10, 20, 50, 100, 200, 500, 1000, 2000], [1, 2, 5, 10, 20, 50, 100,
200, 500, 1000, 2000]);
plt.xlabel('Duration (min)');
plt.show()
```



In [26]:

```
gobike_clean = gobike_clean[gobike_clean['duration_min'] <= 100]
gobike_clean.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 226804 entries, 4 to 239110
Data columns (total 20 columns):
 #   Column                   Non-Null Count   Dtype
---  ------                   --------------   -----
 0   duration_sec             226804 non-null  int64
 1   start_time               226804 non-null  datetime64[ns]
 2   end_time                 226804 non-null  datetime64[ns]
 3   start_station_id         226804 non-null  float64
 4   start_station_name       226804 non-null  object
 5   start_station_latitude   226804 non-null  float64
 6   start_station_longitude  226804 non-null  float64
 7   end_station_id           226804 non-null  float64
 8   end_station_name         226804 non-null  object
 9   end_station_latitude     226804 non-null  float64
 10  end_station_longitude    226804 non-null  float64
 11  bike_id                  226804 non-null  int64
 12  user_type                226804 non-null  object
 13  member_birth_year        226804 non-null  int64
 14  member_gender            226804 non-null  object
 15  bike_share_for_all_trip  226804 non-null  object
 16  start_time_dayofweek     226804 non-null  category
 17  start_time_hour          226804 non-null  int64
 18  member_age               226804 non-null  int64
 19  duration_min             226804 non-null  float64
dtypes: category(1), datetime64[ns](2), float64(7), int64(5), object(5)
memory usage: 34.8+ MB
```

In [27]:

```
gobike_clean['member_age'].describe()
```

Out[27]:

```
count    226804.000000
mean         34.137008
std           9.954496
min          18.000000
25%          27.000000
50%          32.000000
75%          39.000000
max         141.000000
Name: member_age, dtype: float64
```

Something doesn't look quite right. The maximum age cannot be 141.

In [28]:

```
# Remove outliers and keep those entries with member_age below 70.
gobike_clean = gobike_clean[gobike_clean['member_age'] <= 70]
```

In [29]:

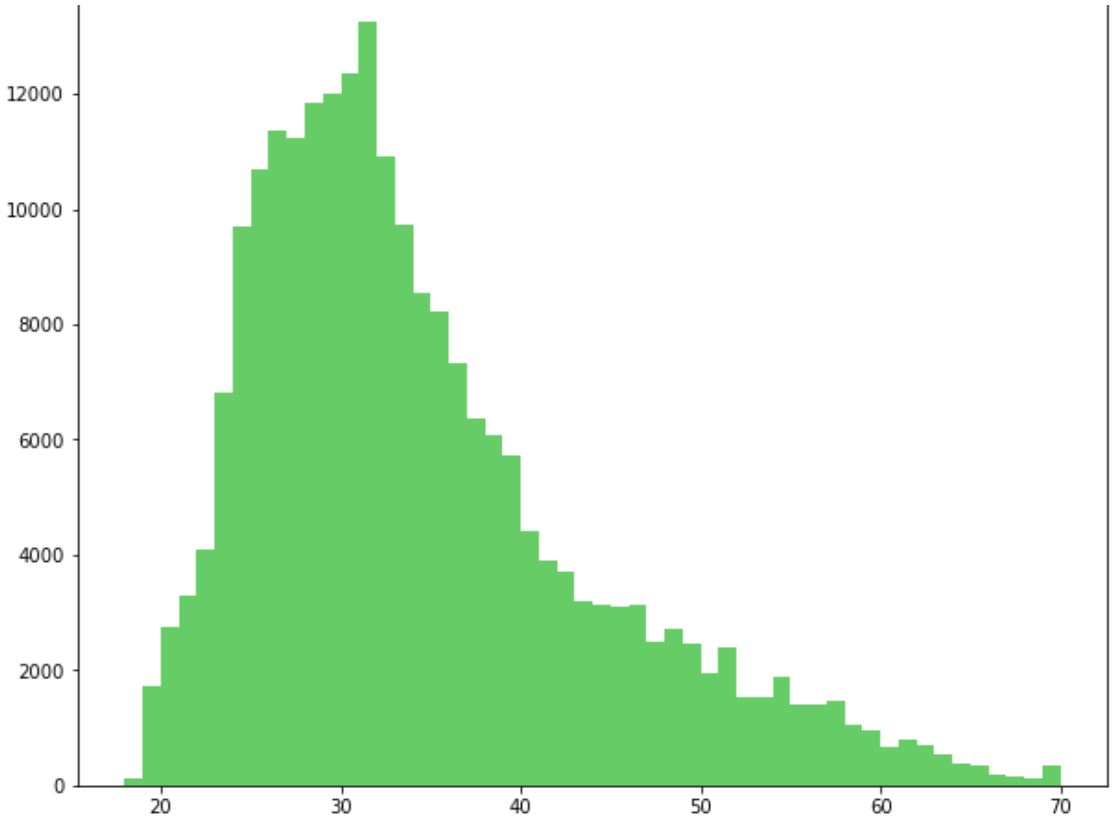
```
gobike_clean.head(10)
```

Out[29]:

	duration_sec	start_time	end_time	start_station_id	start_station_name	start_station_latitude	start_station_longitude
4	1128	2019-04-30 23:59:04.739	2019-05-01 00:17:53.091	124.0	19th St at Florida St	37.760447	-122.410807
5	1388	2019-04-30 23:53:05.982	2019-05-01 00:16:14.313	243.0	Bancroft Way at College Ave	37.869360	-122.254337
6	920	2019-04-30 23:57:56.340	2019-05-01 00:13:16.454	202.0	Washington St at 8th St	37.800754	-122.274894
7	725	2019-04-30 23:56:11.219	2019-05-01 00:08:16.915	44.0	Civic Center/UN Plaza BART Station (Market St ...	37.781074	-122.411738
8	488	2019-04-30 23:59:00.660	2019-05-01 00:07:08.975	21.0	Montgomery St BART Station (Market St at 2nd St)	37.789625	-122.400811
9	792	2019-04-30 23:53:37.604	2019-05-01 00:06:50.405	28.0	The Embarcadero at Bryant St	37.787168	-122.388098
10	464	2019-04-30 23:56:44.386	2019-05-01 00:04:28.912	89.0	Division St at Potrero Ave	37.769218	-122.407646
11	782	2019-04-30 23:50:49.144	2019-05-01 00:03:51.847	311.0	Paseo De San Antonio at 2nd St	37.333798	-121.886943
12	775	2019-04-30 23:49:05.388	2019-05-01 00:02:00.545	86.0	Market St at Dolores St	37.769305	-122.426826
13	424	2019-04-30 23:52:57.431	2019-05-01 00:00:02.294	223.0	16th St Mission BART Station 2	37.764765	-122.420091

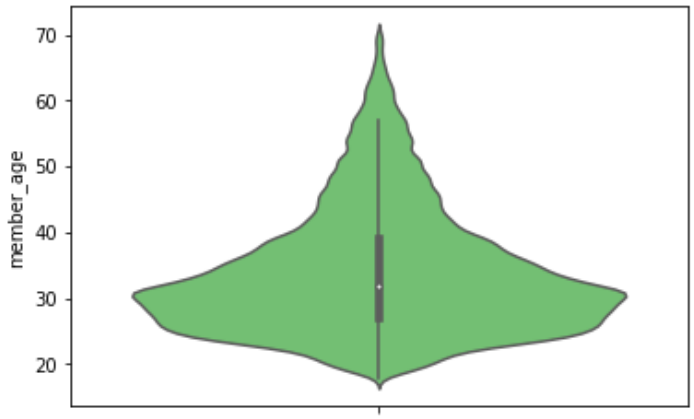
In [30]:

```
binsize = 1
bins = np.arange(18, gobike_clean['member_age'].max()+binsize, binsize)
plt.figure(figsize=[10, 8]);
plt.hist(data = gobike_clean, x = 'member_age', bins = bins, color="#66CC66");
```



In [31]:

```
sb.violinplot(data = gobike_clean, y = 'member_age', color="#66CC66");
```

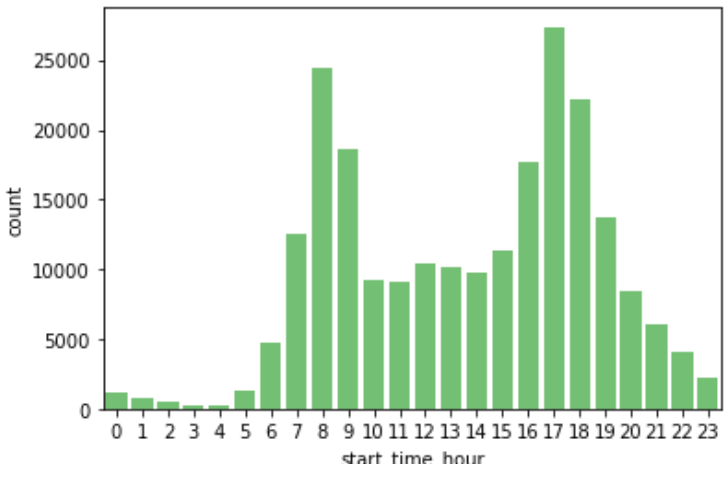


In [32]:

```
# save cleaned data
gobike_clean.to_csv('gobike_clean_master.csv', index=False)
```

In [33]:

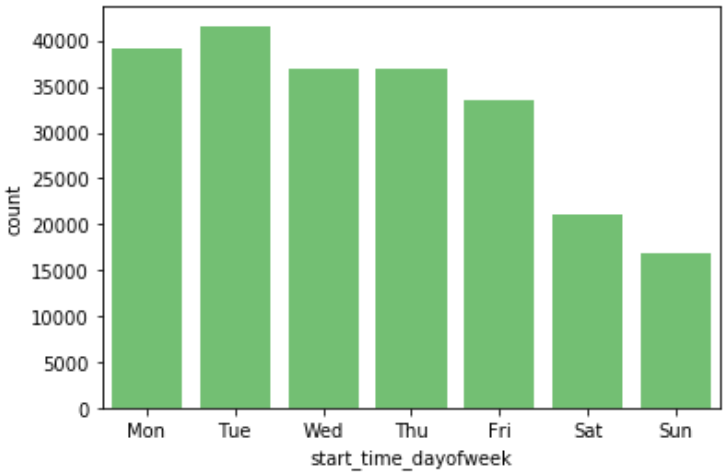
```
# Determining times which have the highest and lowest number of riders
sb.countplot(data = gobike_clean, x = 'start_time_hour', color = "#66CC66");
```



According to the above graph, riding times at 8:00 AM and 5:00 PM are the highest and have the most riders; riding time at 4:00 AM is the lowest with the fewest riders.

In [34]:

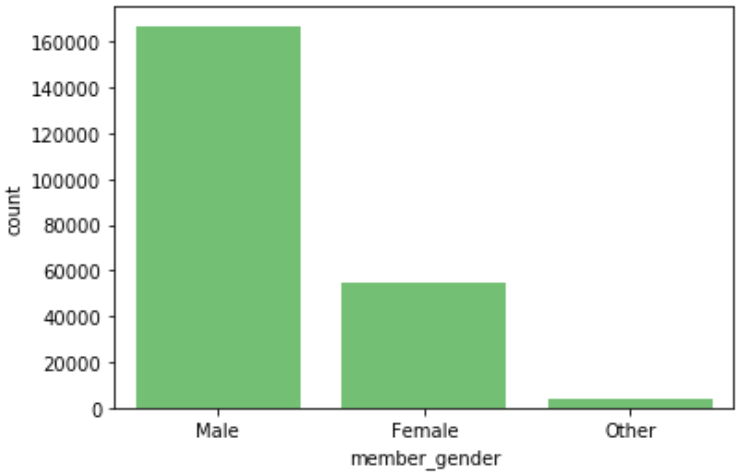
```
# Determining which days of the week have the most riders
sb.countplot(data = gobike_clean, x = 'start_time_dayofweek', color = "#66CC66");
```



According to the above graph, one would think Saturday or Sunday has the most riders. It turns out, Tuesday has the most riders (whereas Sunday has the fewest).

In [35]:

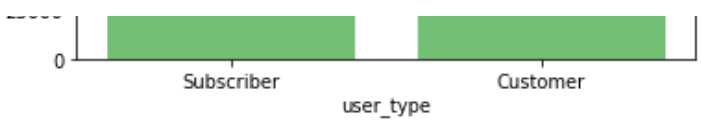
```
# Determining which gender has the most riders
sb.countplot(data = gobike_clean, x = 'member_gender', color = "#66CC66");
```



The graph above shows that of the total number of riders, the majority of them are male.

In [36]:

```
# Determining subscribers versus customers
sb.countplot(data = gobike_clean, x = 'user_type', color = "#66CC66");
```



There are more subscribers than customers. Almost 200,000 subscribers of the GoBike program, versus 25,000 customers.

Bivariate Exploration

To start off with, I want to look at the pairwise correlations present between features in the data.

In [37]:

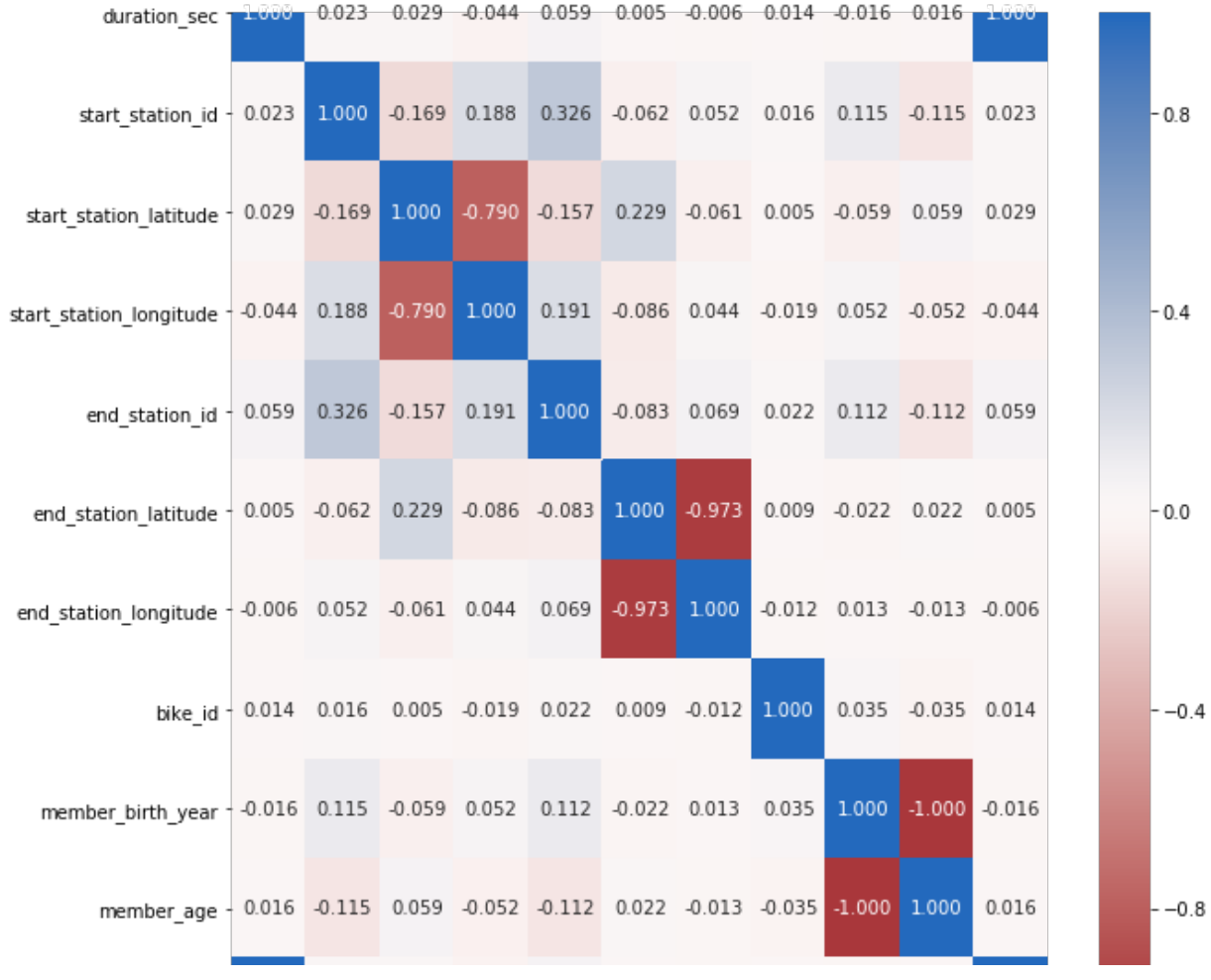
```
customer = gobike_clean.query('user_type == "Customer"')['bike_id'].count()
subscriber = gobike_clean.query('user_type == "Subscriber"')['bike_id'].count()

customer_proportion = customer / gobike_clean['bike_id'].count()
subscriber_proportion = subscriber / gobike_clean['bike_id'].count()
```

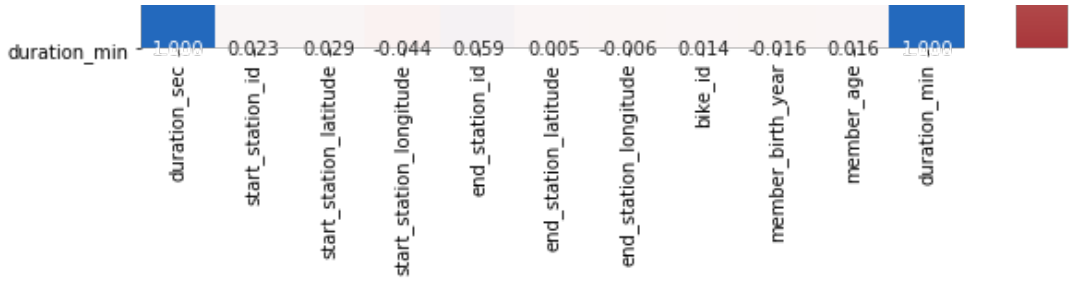
In [38]:

```
all_numeric_vars = ['duration_sec', 'start_time', 'end_time', 'start_station_id', 'start
_station_latitude', 'start_station_longitude', 'end_station_id', 'end_station_latitude',
'end_station_longitude', 'bike_id', 'member_birth_year', 'member_age', 'duration_min']
numeric_vars = ['duration_min', 'member_age']
categoric_vars = ['start_time_dayofweek', 'start_time_hour', 'member_gender', 'user_type
']
```

In [39]:

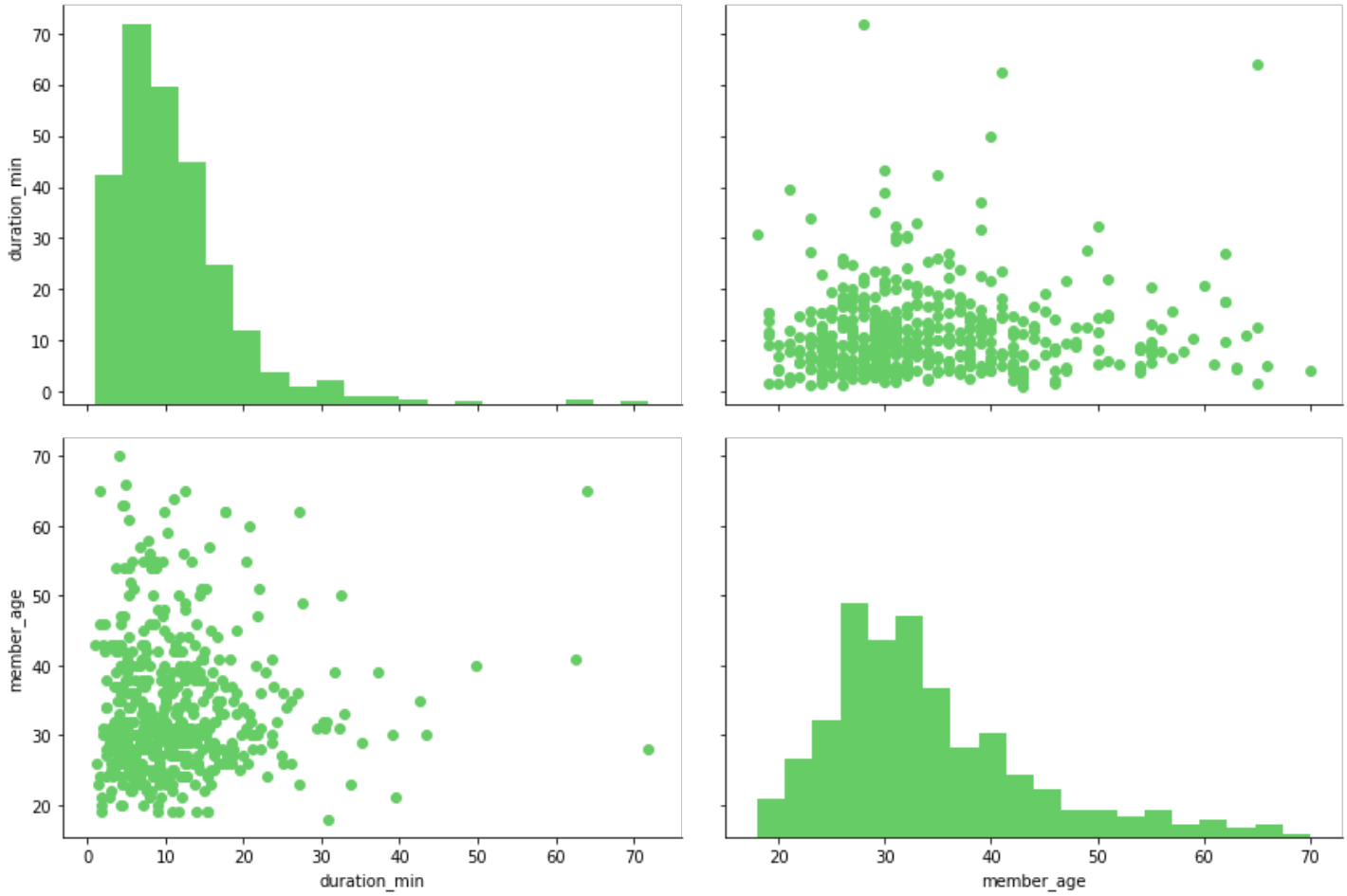
```
# correlation plot
plt.figure(figsize = [10, 10])
sb.heatmap(gobike_clean[all_numeric_vars].corr(), annot = True, fmt = '.3f', cmap = 'vla
g_r', center = 0);
plt.show()
```





In [40]:

```
# plot matrix: sample 500 records so that plots are clearer and
# they render faster
# note: .loc is no longer supported in Python 3; this has to be changed to .iloc
# in order for the function to work

samples = np.random.choice(gobike_clean.shape[0], 500, replace = False)
gobike_samp = gobike_clean.iloc[samples, :]

g = sb.PairGrid(data = gobike_samp, vars = numeric_vars, height = 4, aspect = 1.5)
g = g.map_diag(plt.hist, bins = 20, color="#66CC66");
g.map_offdiag(plt.scatter, color="#66CC66");
```



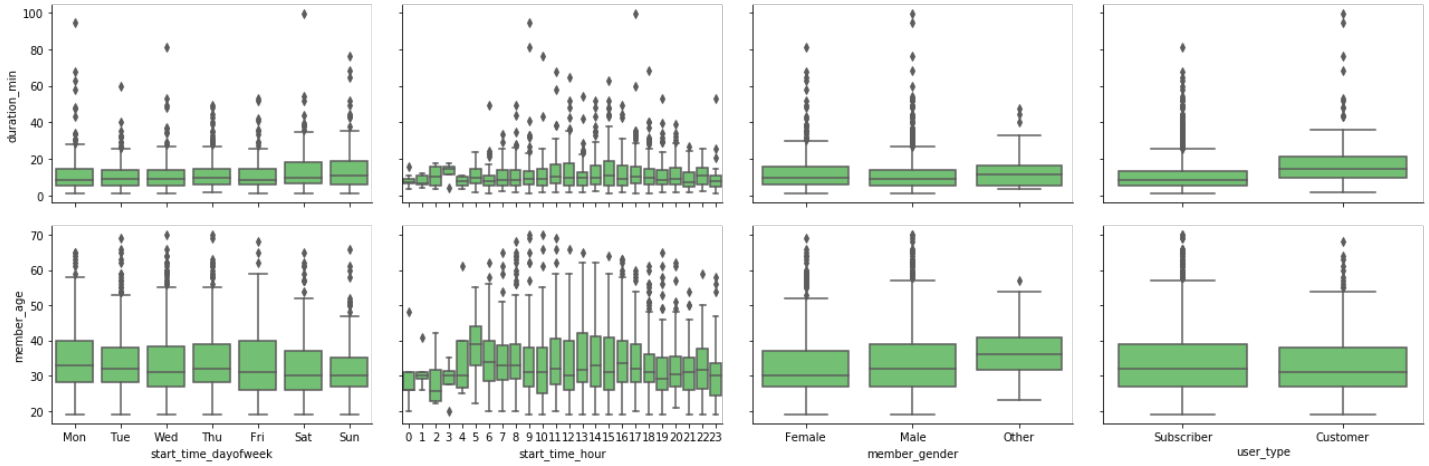
The charts on the left show something of a correlation when the duration is 20 minutes and member age is 30. However, the two attributes are not linear with one another, and there is overall no correlation.

In [41]:

```
# plot matrix of numeric features against categorical features.
# can use a larger sample since there are fewer plots and they're simpler in nature.

samples = np.random.choice(gobike_clean.shape[0], 2000, replace = False);
gobike_samp = gobike_clean.iloc[samples, :];

def boxgrid(x, y, **kwargs):
    """ Quick hack for creating box plots with seaborn's PairGrid. """
    #default_color = sb.color_palette()[0];
    sb.boxplot(x, y, color = "#66CC66");
```

```
plt.figure(figsize = [15, 15]);
g = sb.PairGrid(data = gobike_samp, y_vars = ['duration_min', 'member_age'], x_vars = ca
tegoric_vars, height = 3, aspect = 1.5);
g.map(boxgrid);
```

```
<Figure size 1080x1080 with 0 Axes>
```

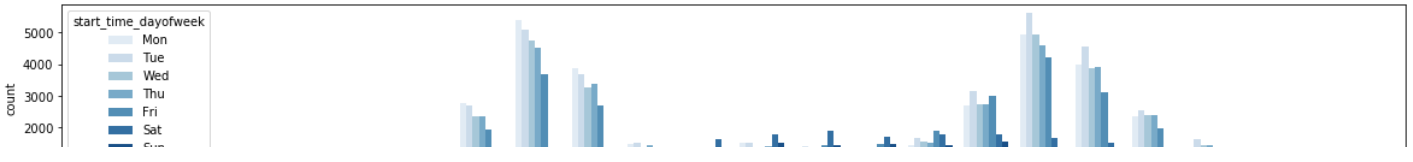


Observations

1. **Earlier I had mentioned that Saturday and Sunday had fewer riders than other days in the week. Saturday and Sunday have fewer riders, but the durations of the bike rides are much longer.**
2. **The average age of male bikers is greater than the average age of female bikers, but females bike longer than males. This is probably expected because of the age differences between the two genders.**
3. **The average age of Subscribers is greater than the average age of Customers, but Customers bike longer than Subscribers.**

In [42]:

```
plt.figure(figsize = [20, 20]);

plt.subplot(6, 1, 1);
sb.countplot(data = gobike_clean, x = 'start_time_hour', hue = 'start_time_dayofweek', p
alette = 'Blues');

ax = plt.subplot(6, 1, 2);
sb.countplot(data = gobike_clean, x = 'start_time_hour', hue = 'member_gender', palette
= 'Blues');
ax.legend(ncol = 2); # re-arrange legend to reduce overlapping

ax = plt.subplot(6, 1, 3);
sb.countplot(data = gobike_clean, x = 'start_time_hour', hue = 'user_type', palette = 'G
reens');
ax.legend(loc = 1, ncol = 2); # re-arrange legend to remove overlapping

ax = plt.subplot(6, 1, 4);
sb.countplot(data = gobike_clean, x = 'start_time_dayofweek', hue = 'member_gender', pal
ette = 'Greens');

ax = plt.subplot(6, 1, 5);
sb.countplot(data = gobike_clean, x = 'start_time_dayofweek', hue = 'user_type', palette
= 'autumn');

ax = plt.subplot(6, 1, 6);

sb.countplot(data = gobike_clean, x = 'member_gender', hue = 'user_type', palette = 'spr
ing');
```

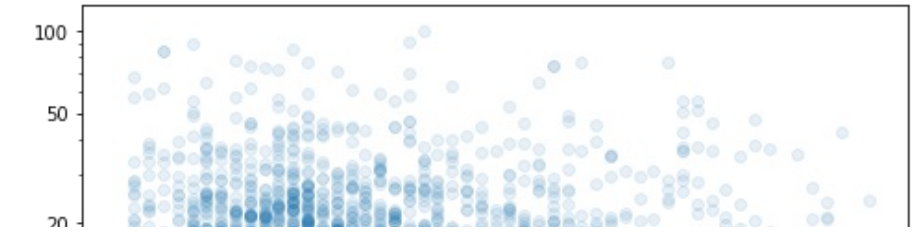


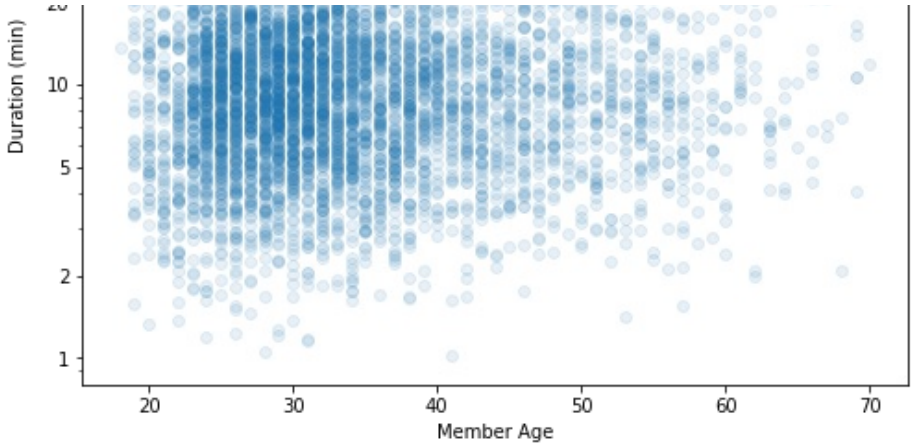
Observations

1. **Most Subscribers and Customers are male.**
2. **Most Subscribers bike on Tuesday than any other day in the week; most Customers bike on Saturday.**
3. **8:00 AM and 5:00 PM are peak bike riding times for both Subscribers and Customers.**
4. **Males and females bike ride on Tuesday (with more males than females).**

In [43]:

```
# scatter plot of duration_min vs. member_age, with log transform on duration_min axis
samples = np.random.choice(gobike_clean.shape[0], 5000, replace = False)
gobike_samp = gobike_clean.iloc[samples,:]

plt.figure(figsize = [8, 6]);
plt.scatter(data = gobike_samp, x = 'member_age', y = 'duration_min', alpha = 1/10);
#plt.xlim([0, 3.5])
plt.xlabel('Member Age');
plt.yscale('log');
plt.yticks([1, 2, 5, 10, 20, 50, 100], [1, 2, 5, 10, 20, 50, 100]);
plt.ylabel('Duration (min)');
```



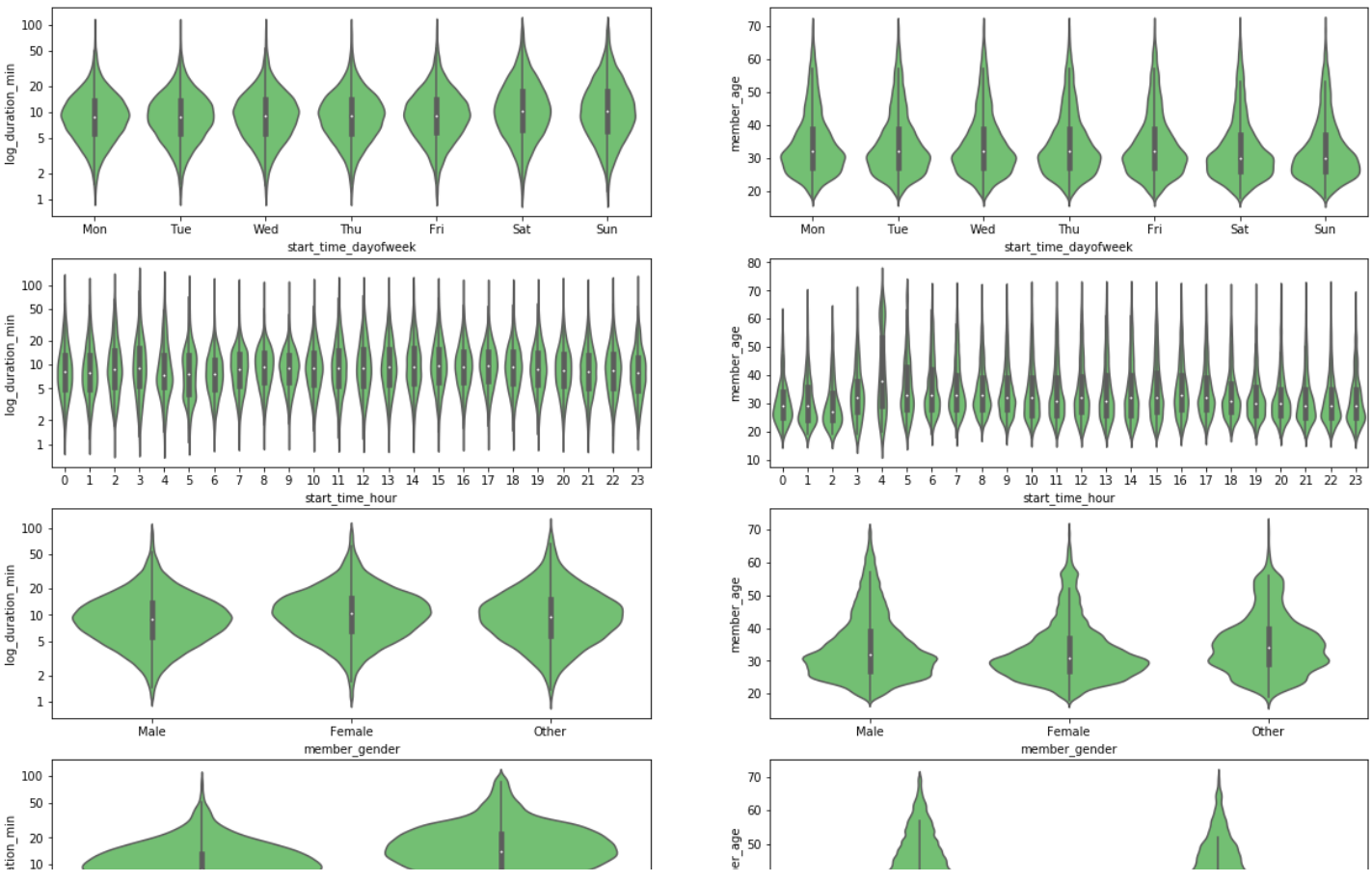


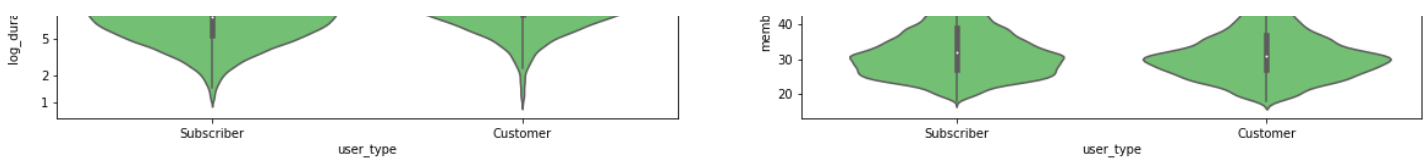
In [44]:

```
# compute the logarithm of price to make multivariate plotting easier
def log_trans(x, inverse = False):
    """ quick function for computing log and power operations """
    if not inverse:
        return np.log10(x)
    else:
        return np.power(10, x)

gobike_clean['log_duration_min'] = gobike_clean['duration_min'].apply(log_trans)
```

In [45]:

```
# plot the categorical variables against duration_min and member_age again, this time
# with full data and variable transforms
fig, ax = plt.subplots(ncols = 2, nrows = 4 , figsize = [20,15])

for i in range(len(categoric_vars)):
    var = categoric_vars[i]
    sb.violinplot(data = gobike_clean, x = var, y = 'log_duration_min', ax = ax[i,0], co
lor = "#66CC66");
    ax[i,0].set_yticks(log_trans(np.array([1, 2, 5, 10, 20, 50, 100])));
    ax[i,0].set_yticklabels([1, 2, 5, 10, 20, 50, 100]);
    sb.violinplot(data = gobike_clean, x = var, y = 'member_age', ax = ax[i,1], color =
"#66CC66");
```





Talk about some of the relationships you observed in this part of the investigation. How did the feature(s) of interest vary with other features in the dataset?

1. Saturday and Sunday had fewer riders, but longer durations of bike rides
2. More Customers rode bikes on Saturday than other days of the week
3. Females bike longer than males; the mean bike durations demonstrate this
4. Mean bike durations are longer for Customers than Subscribers

Did you observe any interesting relationships between the other features (not the main feature(s) of interest)?

1. Tuesday has the following: Highest bike counts, most Subscribers, highest mean age of bikers, most bikers among males and females
2. Saturday has the following: Most Customers
3. Sunday has the following: Lowest mean age of bikers
4. The time in which has the most male bikers, most Subscribers, most Customers, most males and females: 5:00 PM

Multivariate Exploration

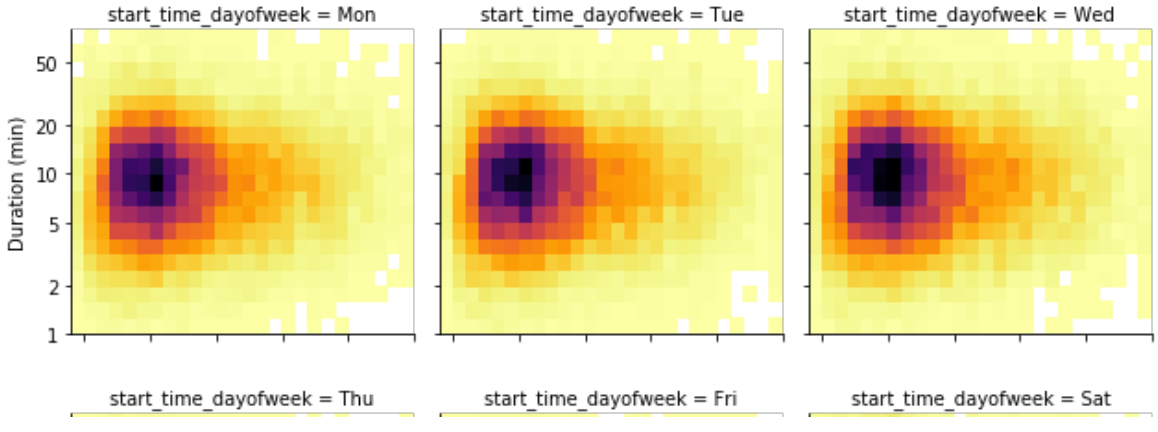
The main thing I want to explore in this part of the analysis is how the three categorical measures of quality play into the relationship between Member Age and Duration.

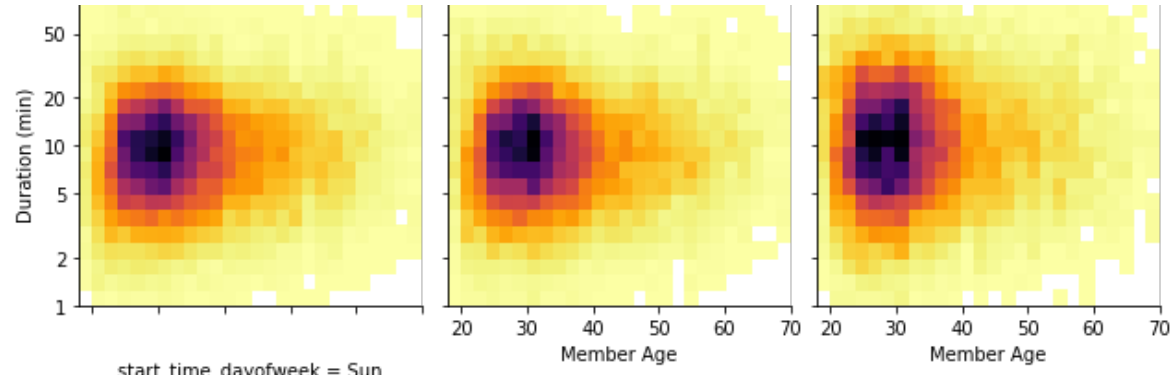
In [46]:

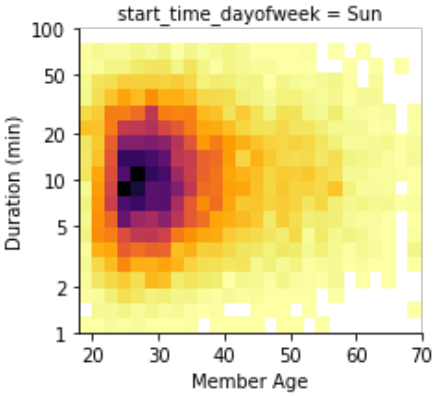
```
def hist2dgrid(x, y, **kwargs):
    """ Quick hack for creating heat maps with seaborn's PairGrid. """
    palette = kwargs.pop('color');
    bins_x = np.arange(18, gobike_clean['member_age'].max()+2, 2);
    bins_y = np.arange(0, 2, 0.1);
    plt.hist2d(x, y, bins = [bins_x, bins_y], cmap = palette, cmin = 0.5);
    plt.yticks(log_trans(np.array([1, 2, 5, 10, 20, 50, 100])),
               [1, 2, 5, 10, 20, 50, 100]);
```

In [47]:

```
# create faceted heat maps on levels of the cut variable
g = sb.FacetGrid(data = gobike_clean, col = 'start_time_dayofweek', col_wrap = 3, height
= 3);
g.map(hist2dgrid, 'member_age', 'log_duration_min', color = 'inferno_r');
g.set_xlabels('Member Age');
g.set_ylabels('Duration (min)');
```





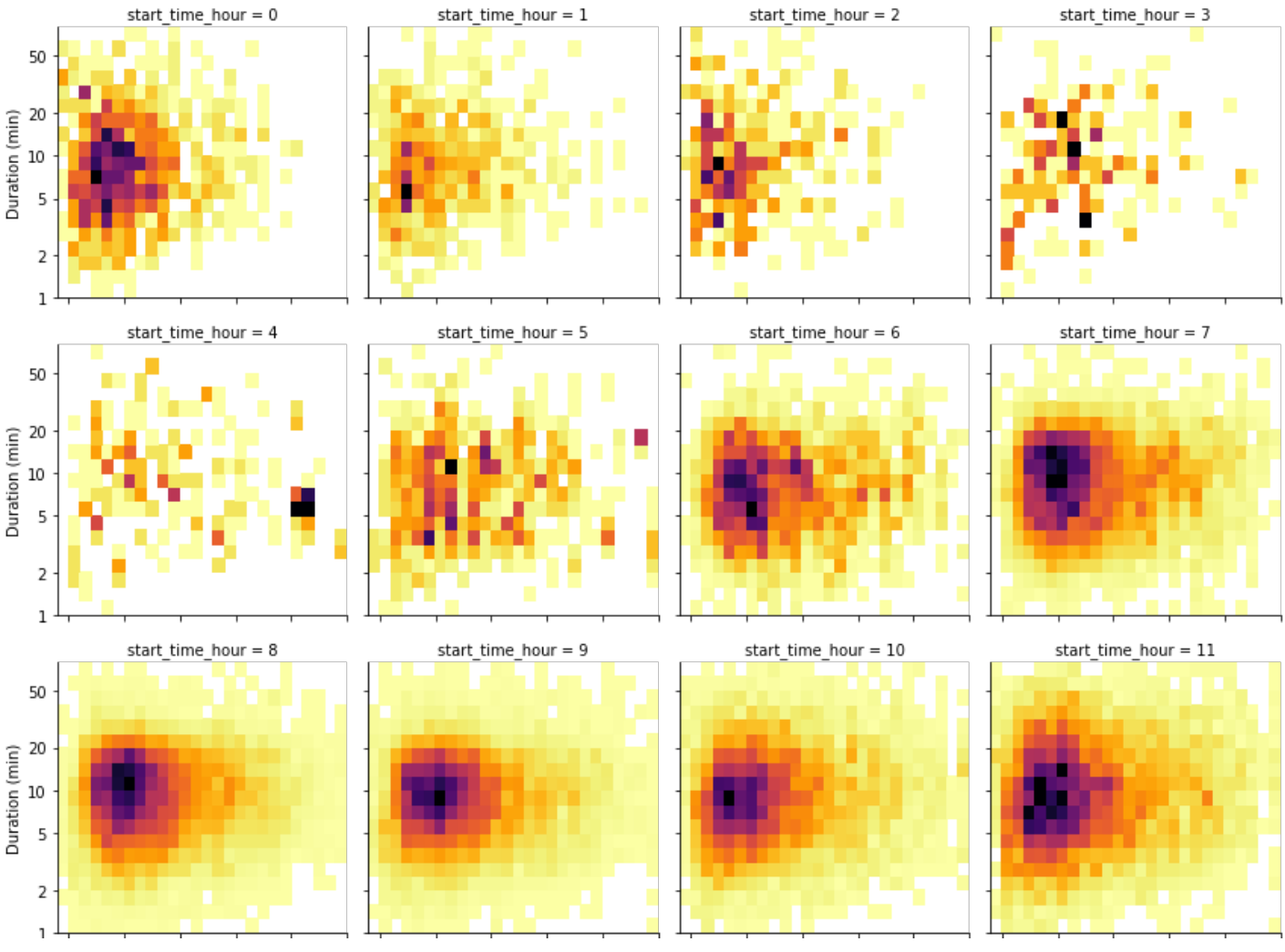


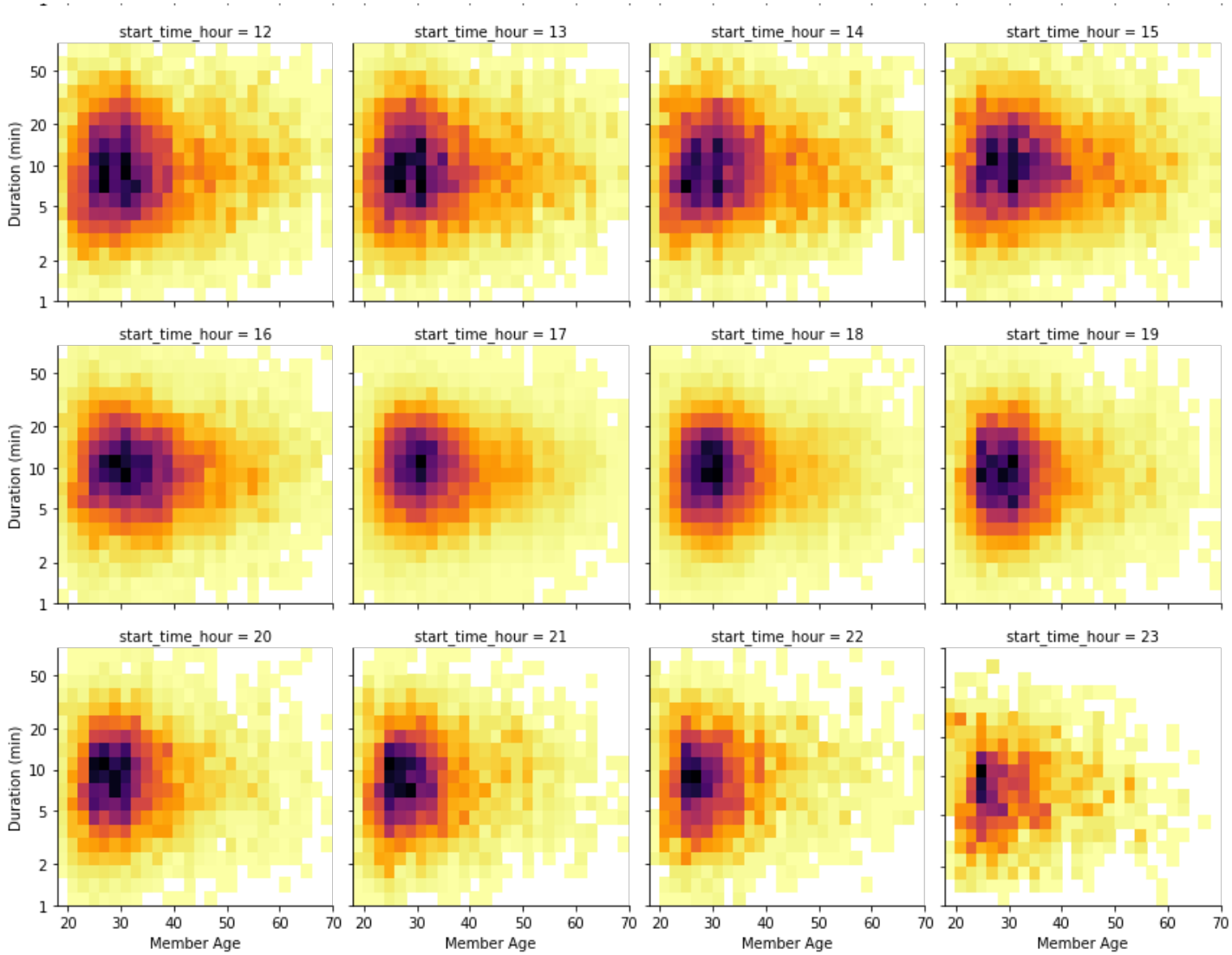
Observations

Bike rides on Saturday and Sunday have longer durations than other days of the week.

In [48]:

```
g = sb.FacetGrid(data = gobike_clean, col = 'start_time_hour', col_wrap = 4, height = 3)
g.map(hist2dgrid, 'member_age', 'log_duration_min', color = 'inferno_r');
g.set_xlabels('Member Age');
g.set_ylabels('Duration (min)');
```



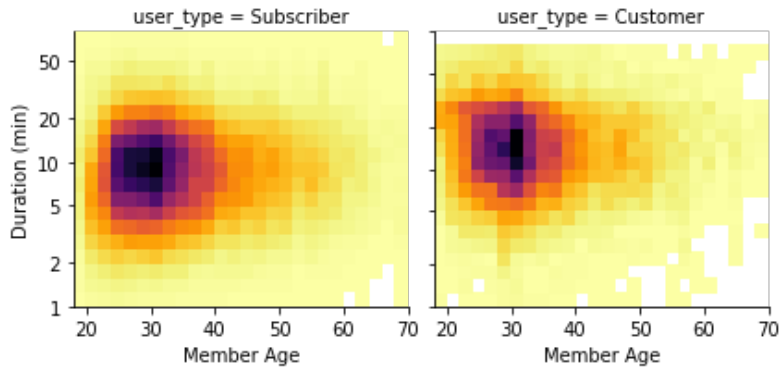


Observations

4:00 AM has the fewest bike riders; 5:00 PM has the most bike riders.

In [49]:

```
g = sb.FacetGrid(data = gobike_clean, col = 'user_type', height = 3);
g.map(hist2dgrid, 'member_age', 'log_duration_min', color = 'inferno_r');
g.set_xlabels('Member Age');
g.set_ylabels('Duration (min)');
```



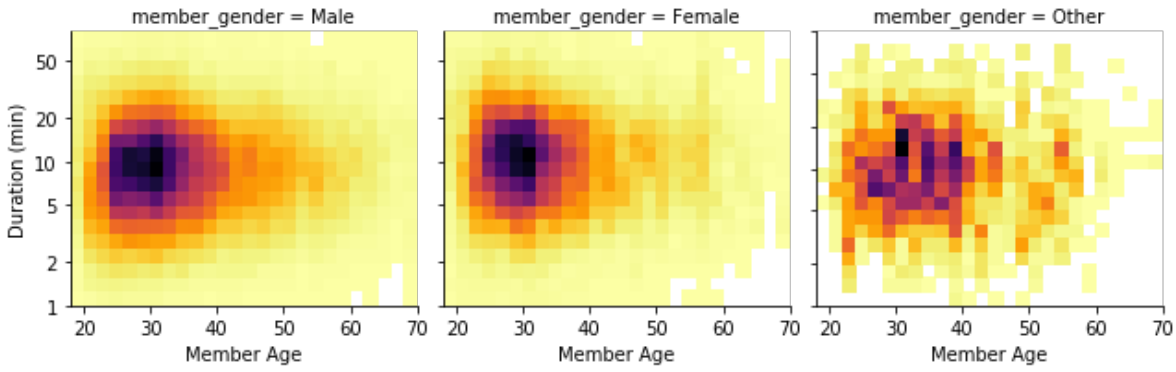
Observations

Customers bike longer than Subscribers.

In [50]:

```
g = sb.FacetGrid(data = gobike_clean, col = 'member_gender', height = 3);
```

```
g.map(hist2dgrid, 'member_age', 'log_duration_min', color = 'inferno_r');
g.set_xlabels('Member Age');
g.set_ylabels('Duration (min)');
```

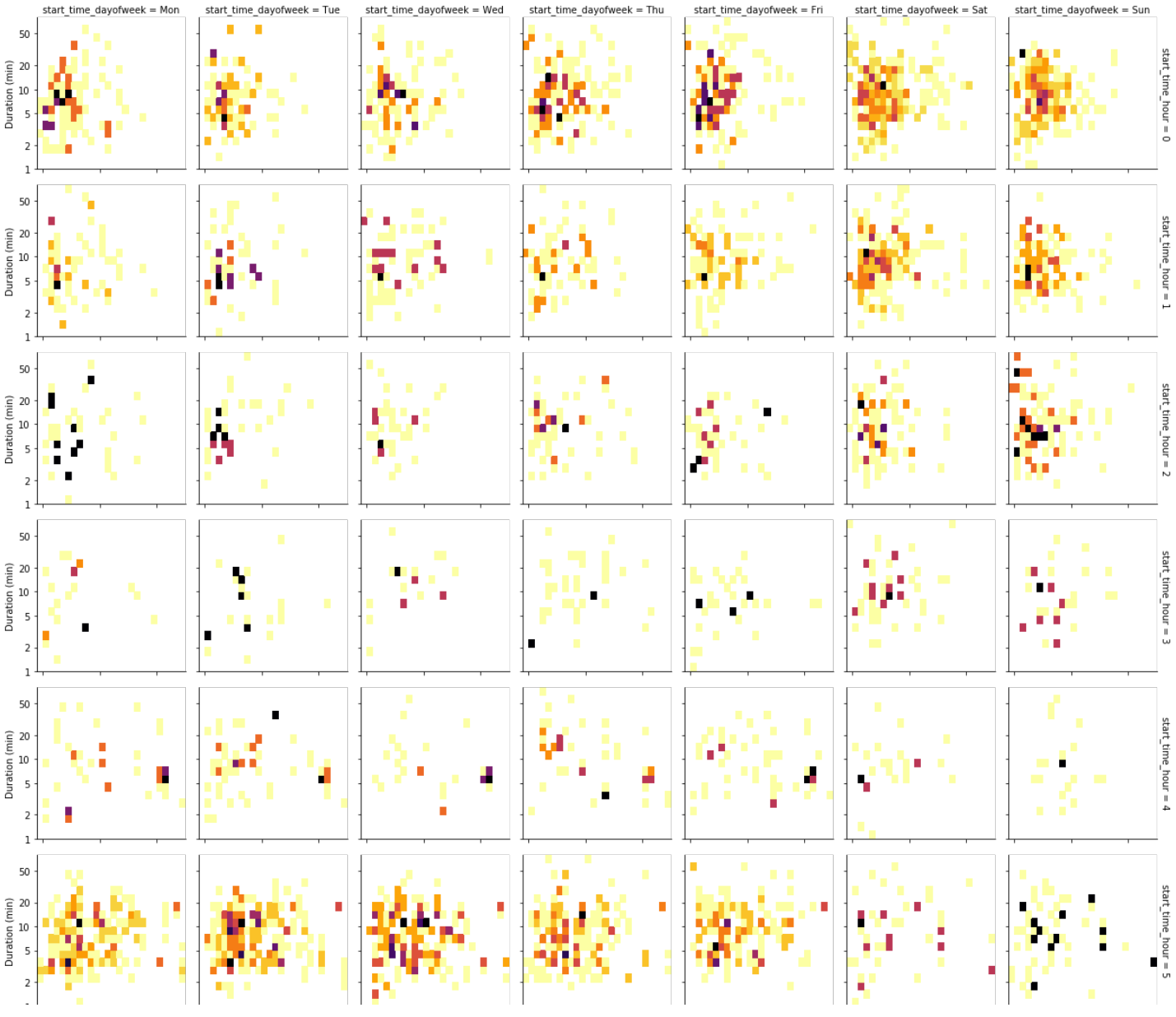


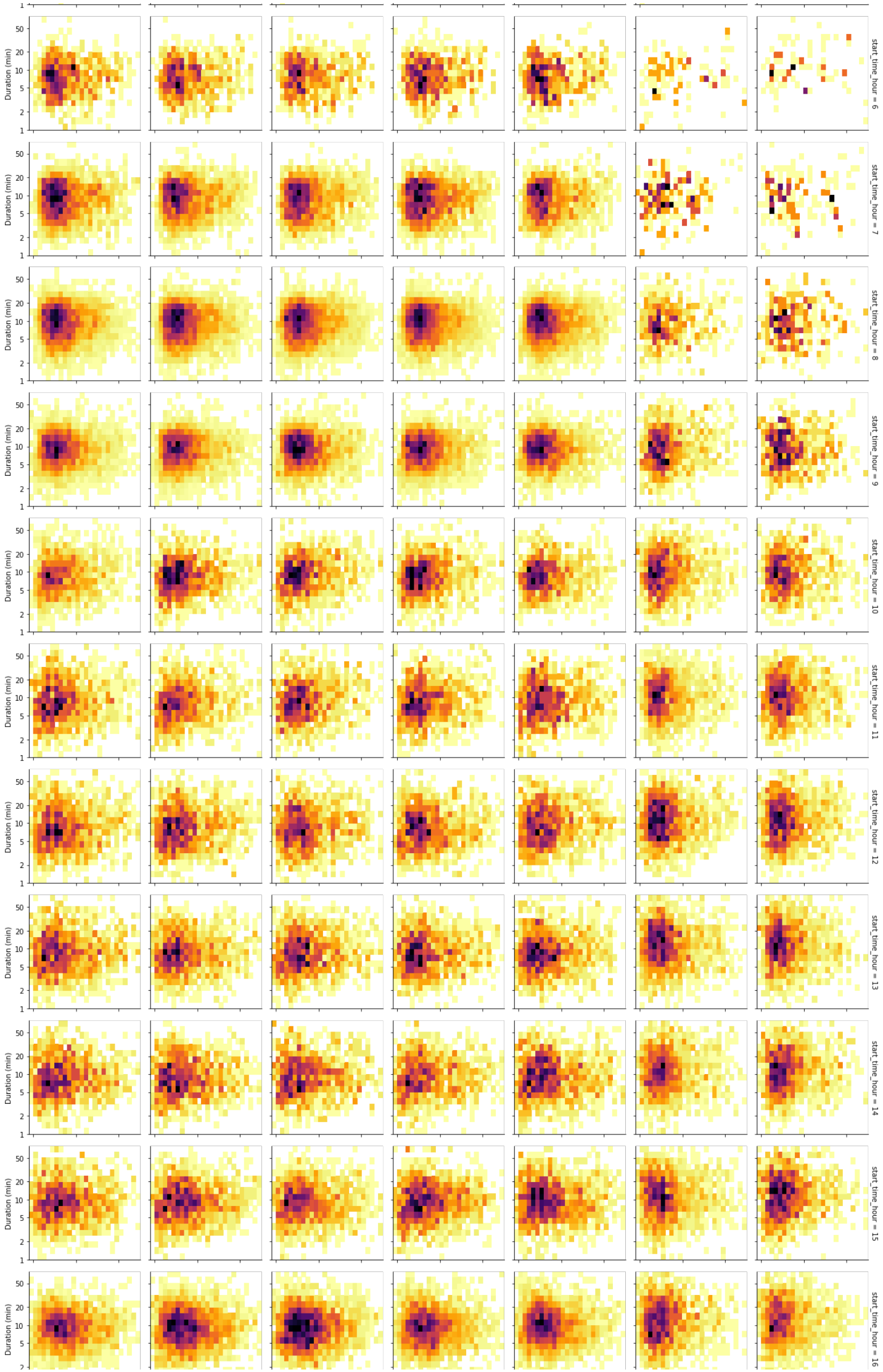
Observations

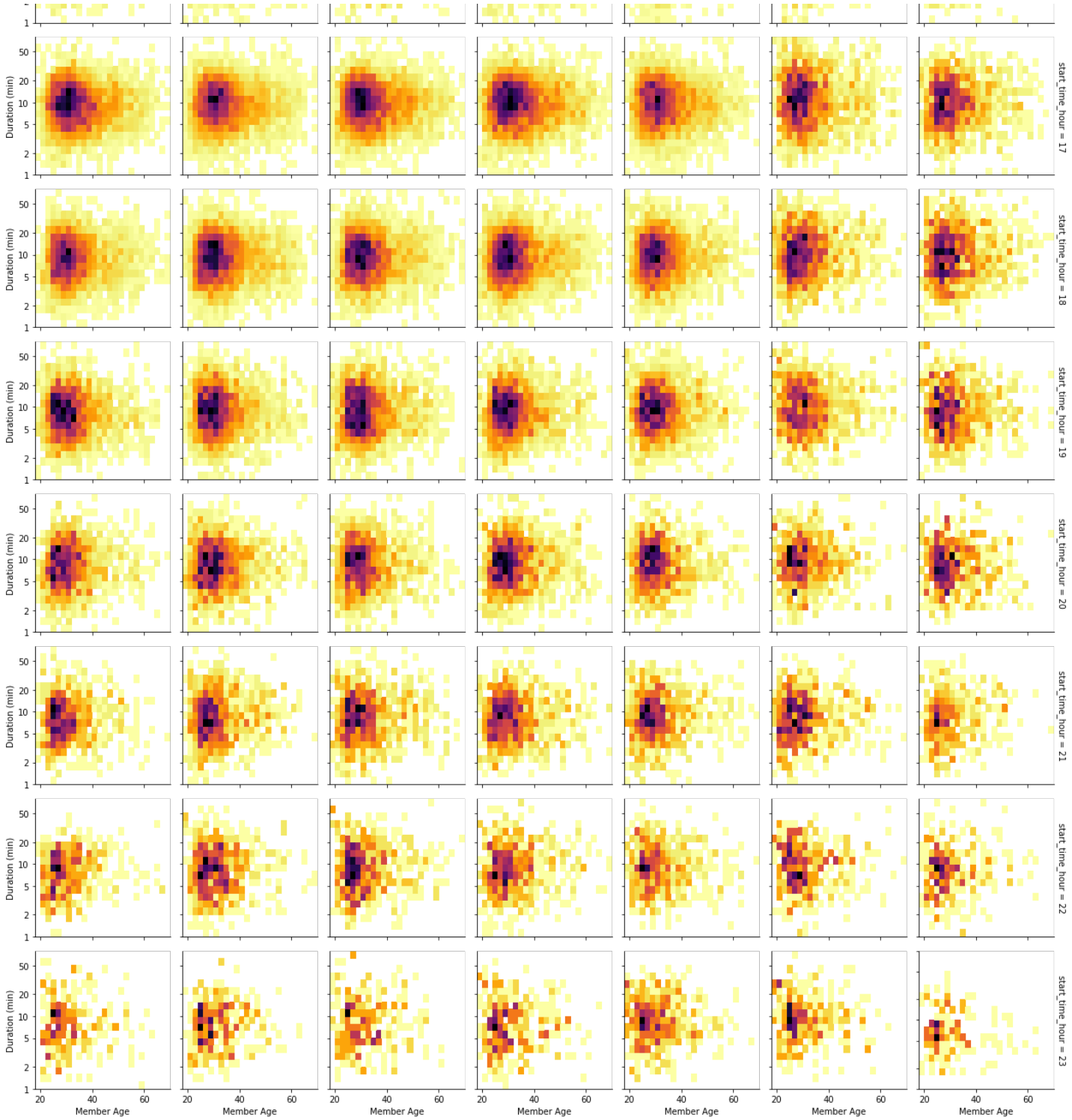
More females bike longer than males.

In [51]:

```
# create faceted heat maps on start_time_dayofweek and start_time_hour
g = sb.FacetGrid(data = gobike_clean, col = 'start_time_dayofweek', row = 'start_time_hour', height = 2.5, margin_titles = True);
g.map(hist2dgrid, 'member_age', 'log_duration_min', color = 'inferno_r');
g.set_xlabels('Member Age');
g.set_ylabels('Duration (min)');
```




Duration (min)
50
20
10
5
2
1
start_time_hour = 6
start_time_hour = 7
start_time_hour = 8
start_time_hour = 9
start_time_hour = 10
start_time_hour = 11
start_time_hour = 12
start_time_hour = 13
start_time_hour = 14
start_time_hour = 15
start_time_hour = 16



Observations

The timeframe between 3:00 AM and 4:00 AM has the fewest riders. Conversely, Saturday and Sunday has the fewest riders (but as we have already observed, more Customers than Subscribers)

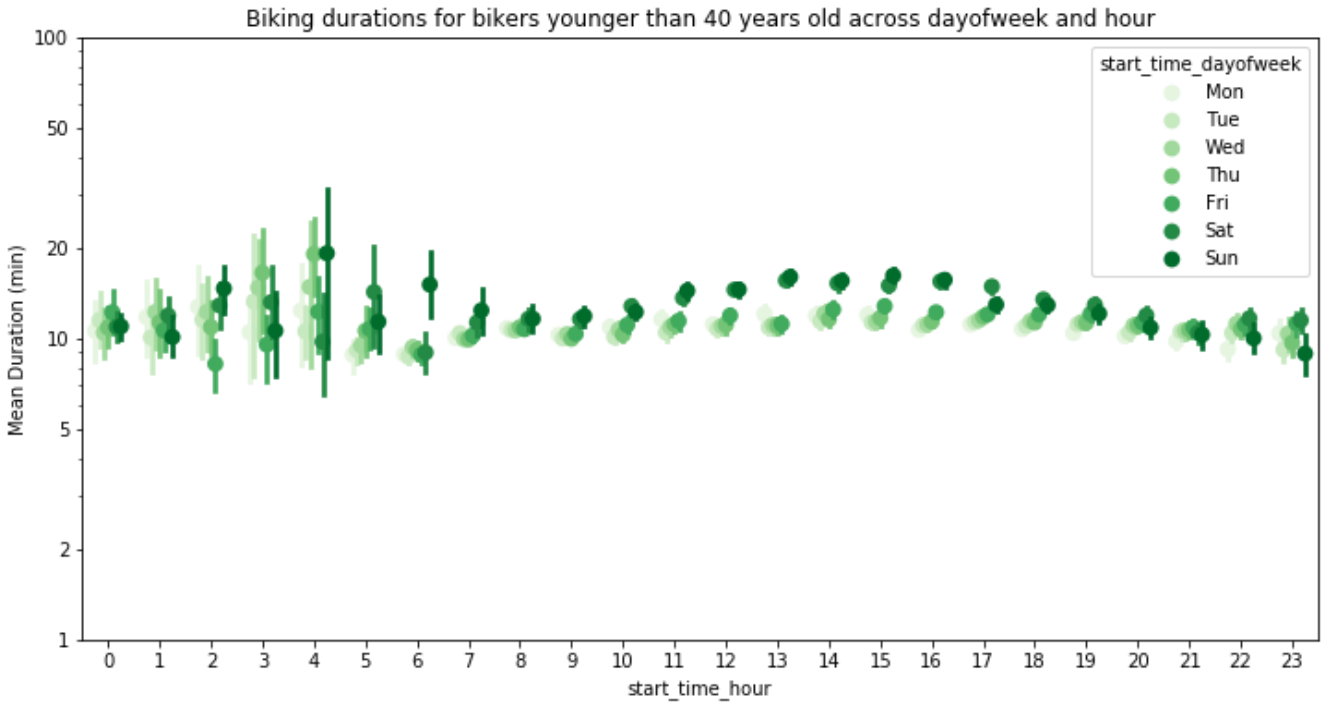
In [52]:

```
age_flag1 = (gobike_clean['member_age'] < 40)
age_below_forty = gobike_clean.loc[age_flag1,:]

age_flag2 = (gobike_clean['member_age'] >= 40)
age_above_forty = gobike_clean.loc[age_flag2,:]
```

In [53]:

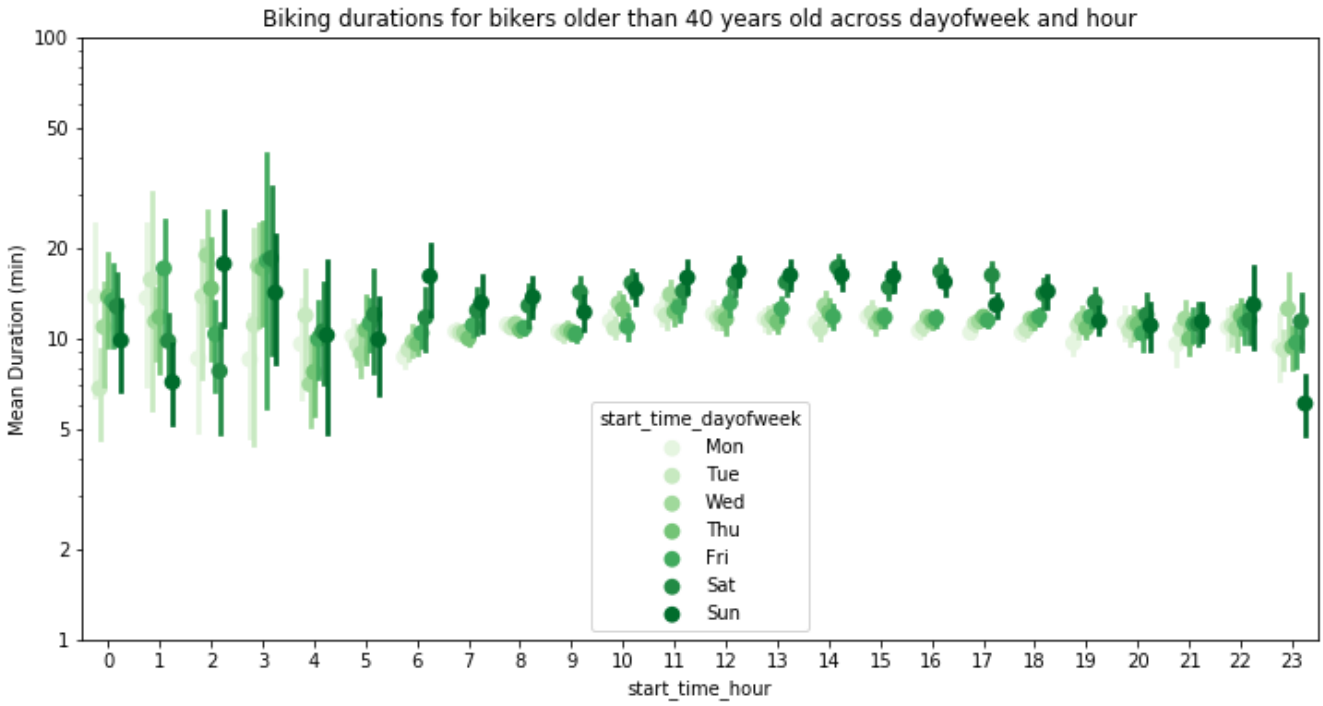
```
fig = plt.figure(figsize = [12,6])

ax = sb.pointplot(data = age_below_forty, x = 'start_time_hour', y = 'duration_min', hue
= 'start_time_dayofweek',
```

```
            palette = 'Greens', linestyles = '', dodge = 0.5);

plt.title('Biking durations for bikers younger than 40 years old across dayofweek and hou
r');
plt.ylabel('Mean Duration (min)');
plt.yscale('log');
plt.yticks([1, 2, 5, 10, 20, 50, 100], [1, 2, 5, 10, 20, 50, 100]);
ax.set_yticklabels([],minor = True);
```



In [54]:

```
fig = plt.figure(figsize = [12,6])

ax = sb.pointplot(data = age_above_forty, x = 'start_time_hour', y = 'duration_min', hue
= 'start_time_dayofweek',
            palette = 'Greens', linestyles = '', dodge = 0.5);

plt.title('Biking durations for bikers older than 40 years old across dayofweek and hour'
);
plt.ylabel('Mean Duration (min)');
plt.yscale('log');
plt.yticks([1, 2, 5, 10, 20, 50, 100], [1, 2, 5, 10, 20, 50, 100]);
ax.set_yticklabels([],minor = True);
```



Observations

There are more bike riders under the age of 40 spanning across the week

In [ ]:

```
fig = plt.figure(figsize = [10,8]);

ax = sb.pointplot(data = age_below_forty, x = 'start_time_dayofweek', y = 'duration_min'
, hue = 'member_gender',
                  palette = 'Greens', linestyles = '', dodge = 0.4);

plt.title('Biking durations for bikers younger than 40 years old across dayofweek and gen
der');
plt.ylabel('Mean Duration (min)');
plt.yscale('log');
plt.yticks([1, 2, 5, 10, 20, 50, 100], [1, 2, 5, 10, 20, 50, 100]);
ax.set_yticklabels([],minor = True);
```

In [ ]:

```
fig = plt.figure(figsize = [10,8]);

ax = sb.pointplot(data = age_above_forty, x = 'start_time_dayofweek', y = 'duration_min'
, hue = 'member_gender',
                  palette = 'Greens', linestyles = '', dodge = 0.4);

plt.title('Biking durations for bikers older than 40 years old across dayofweek and gende
r');
plt.ylabel('Mean Duration (min)');
plt.yscale('log');
plt.yticks([1, 2, 5, 10, 20, 50, 100], [1, 2, 5, 10, 20, 50, 100]);
ax.set_yticklabels([],minor = True);
```

Observations

Between the two graphs above, there are fewer bike riders older than the age of 40. Female bike longer than males.

In [ ]:

```
fig = plt.figure(figsize = [10,8])
ax = sb.pointplot(data = age_below_forty, x = 'start_time_dayofweek', y = 'duration_min'
, hue = 'user_type',
            palette = 'Purples', linestyles = '', dodge = 0.3);
plt.title('Biking durations for bikers who are younger than 40 years old across dayofweek
and user type');
plt.ylabel('Mean Duration (min)')
plt.yscale('log');
plt.yticks([1, 2, 5, 10, 20, 50, 100], [1, 2, 5, 10, 20, 50, 100]);
ax.set_yticklabels([],minor = True);
```

In [ ]:

```
fig = plt.figure(figsize = [10,8]);
ax = sb.pointplot(data = age_above_forty, x = 'start_time_dayofweek', y = 'duration_min'
, hue = 'user_type',
            palette = 'Purples', linestyles = '', dodge = 0.3);
plt.title('Biking durations for bikers who are older than 40 years old across dayofweek a
nd user type');
plt.ylabel('Mean Duration (min)');
plt.yscale('log');
plt.yticks([1, 2, 5, 10, 20, 50, 100], [1, 2, 5, 10, 20, 50, 100]);
ax.set_yticklabels([],minor = True);
```

Observations

Observations

Between the two graphs above, there are fewer bikers older than 40. Customers bike longer than Subscribers.

Summary of highlights

1. **Riding times at 8:00 AM and 5:00 PM are the highest and have the most riders**
2. **Riding times at 3:00 AM and 4:00 AM are the lowest and have the fewest riders**
3. **Saturday and Sunday have fewer riders during the week, but bike rides are longer**
4. **Tuesday has the most riders; also has the highest mean age of riders**
5. **Female riders bike longer than male riders**
6. **Customer riders bike longer than Subscriber riders (and on Saturday more than Sunday or other days of the week)**
7. **Most Customer riders are male; this is also true about Subscriber riders**

In [ ]: