Exercise 3-2 Michelle Rice

November 16, 2021

[2]:

```
# import necessary libraries
import sqlite3
import pandas as pd
import numpy as np
import statsmodels.api as sm
import matplotlib.pyplot as plt
```

[3]:

```
#import the dataset
baseball = pd.read_csv("dodgers.csv")
```

[3]:

```
baseball.head()
```

[3]:

```
  month  day  attend day_of_week opponent  temp   skies day_night cap shirt  \
0   APR   10   56000     Tuesday  Pirates    67  Clear          Day  NO    NO
1   APR   11   29729   Wednesday  Pirates    58  Cloudy       Night  NO    NO
2   APR   12   28328    Thursday  Pirates    57  Cloudy       Night  NO    NO
3   APR   13   31601      Friday   Padres    54  Cloudy       Night  NO    NO
4   APR   14   46549    Saturday   Padres    57  Cloudy       Night  NO    NO

  fireworks bobblehead
0        NO         NO
1        NO         NO
2        NO         NO
3       YES         NO
4        NO         NO
```

[4]:

```
baseball.describe()
```

[4]:

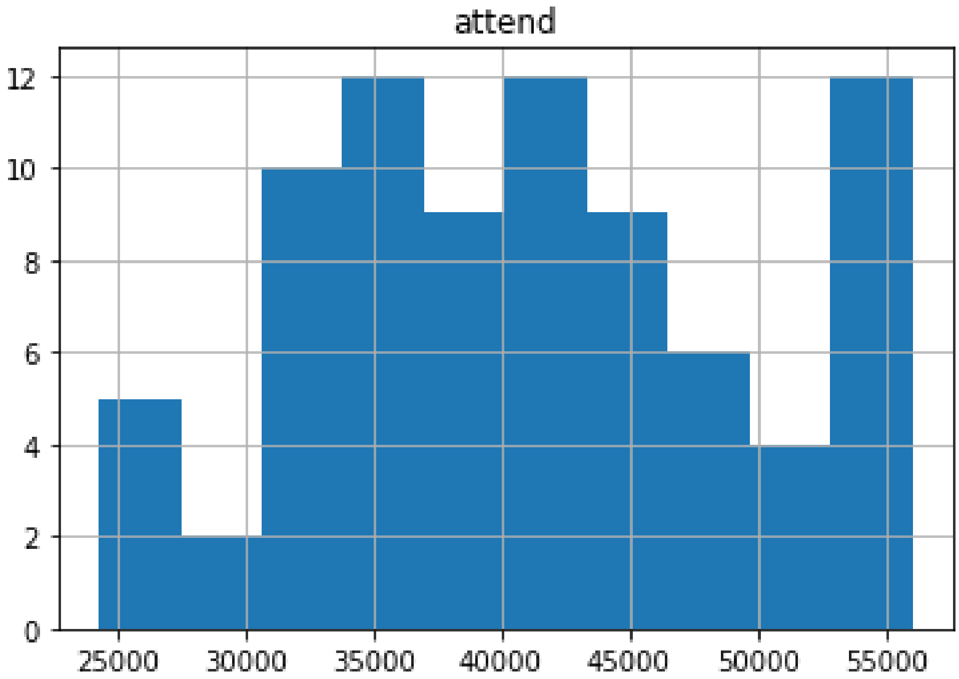
```
             day        attend       temp
count  81.000000     81.000000  81.000000
mean   16.135802  41040.074074  73.148148
std     9.605666   8297.539460   8.317318
min     1.000000  24312.000000  54.000000
25%     8.000000  34493.000000  67.000000
50%    15.000000  40284.000000  73.000000
75%    25.000000  46588.000000  79.000000
max    31.000000  56000.000000  95.000000
```

```
[5]: # I am going to drop the skies column as we would have no way to know or␣
      ↪predict that for a specific day
     baseball = baseball.drop(columns=['skies'])
```

Before breaking the attendance down, I would like to look at an overall histogram of attendance

```
[6]: baseball.hist(column='attend')
```

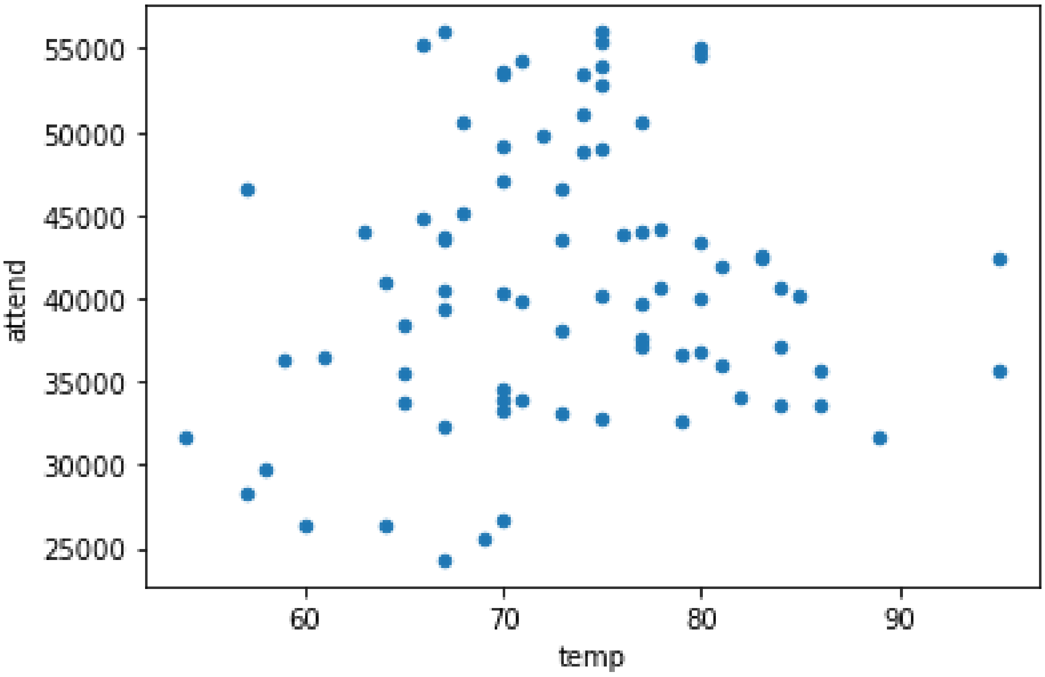
```
[6]: array([[<AxesSubplot:title={'center':'attend'}>]], dtype=object)
```



Most of the attendance falls between 30,000 - 50,000 with the highest nubers around 55,000 and the low end being 25,000.

```
[7]: # Although we can't predict a specific temp for a day, we could potentially use␣
      ↪average
     # temps to determine a month or week, so I will look at how attendance and temp␣
      ↪correlate
     baseball.plot.scatter('temp', 'attend')
```

```
[7]: <AxesSubplot:xlabel='temp', ylabel='attend'>
```

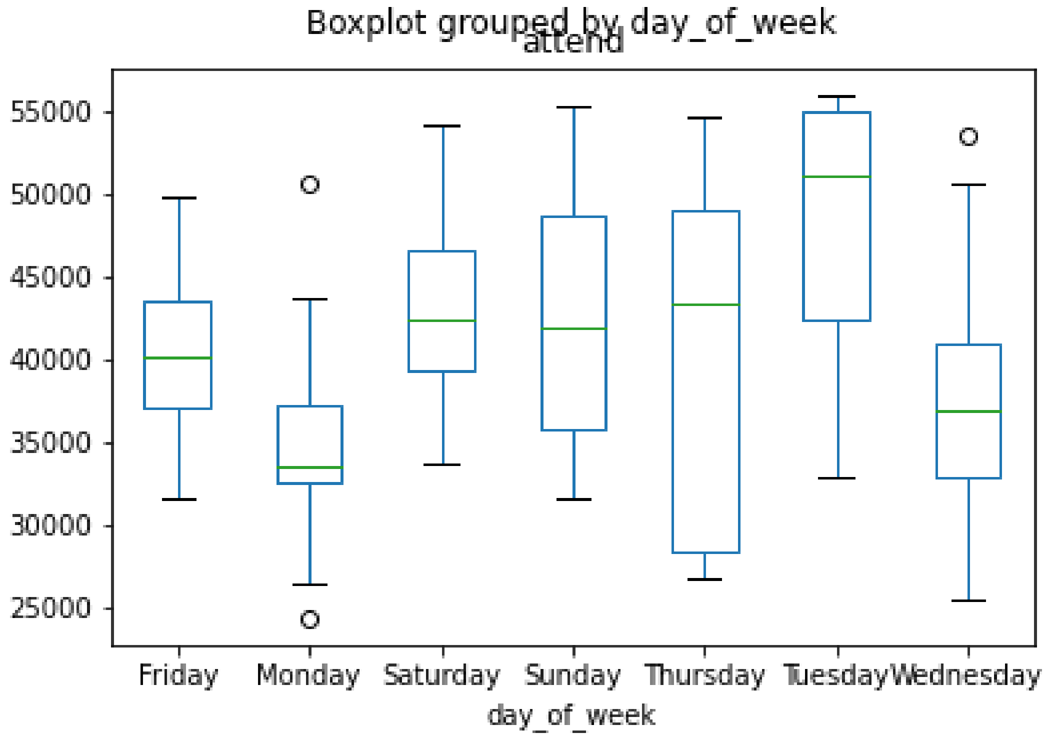


The highest attendance is when temps are in the 70-80 degree range

Now I will plot attendance per days of the week

```
[8]: # plot attendance by day of week
     baseball.boxplot(by ='day_of_week', column =['attend'], grid = False)
```

```
[8]: <AxesSubplot:title={'center':'attend'}, xlabel='day_of_week'>
```

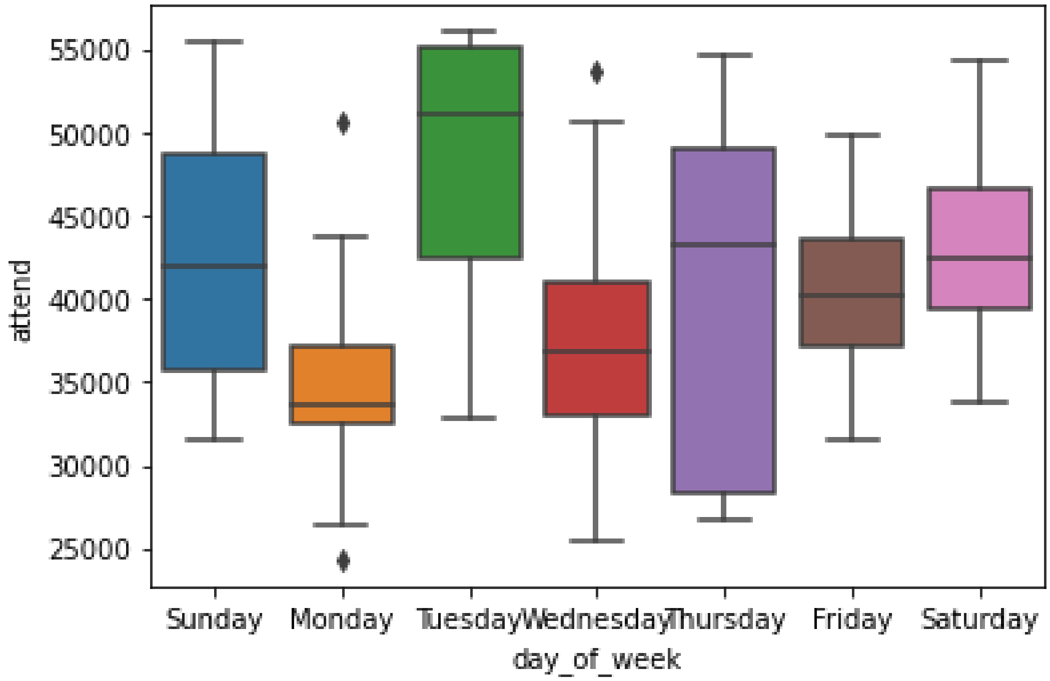


I would like to make this a bit easier to read by ordering the days

```
[9]: # create order for days
     day_order = ['Sunday', 'Monday', 'Tuesday', 'Wednesday', 'Thursday', 'Friday',␣
      ↪'Saturday']
```

```
[10]: # rerun the plot with days in order
      import seaborn as sns
      sns.boxplot(x=baseball.day_of_week, y=baseball.attend, order=day_order)
```

```
[10]: <AxesSubplot:xlabel='day_of_week', ylabel='attend'>
```



The highest attendance is recorded on Tuesdays with Mondays having low attendance

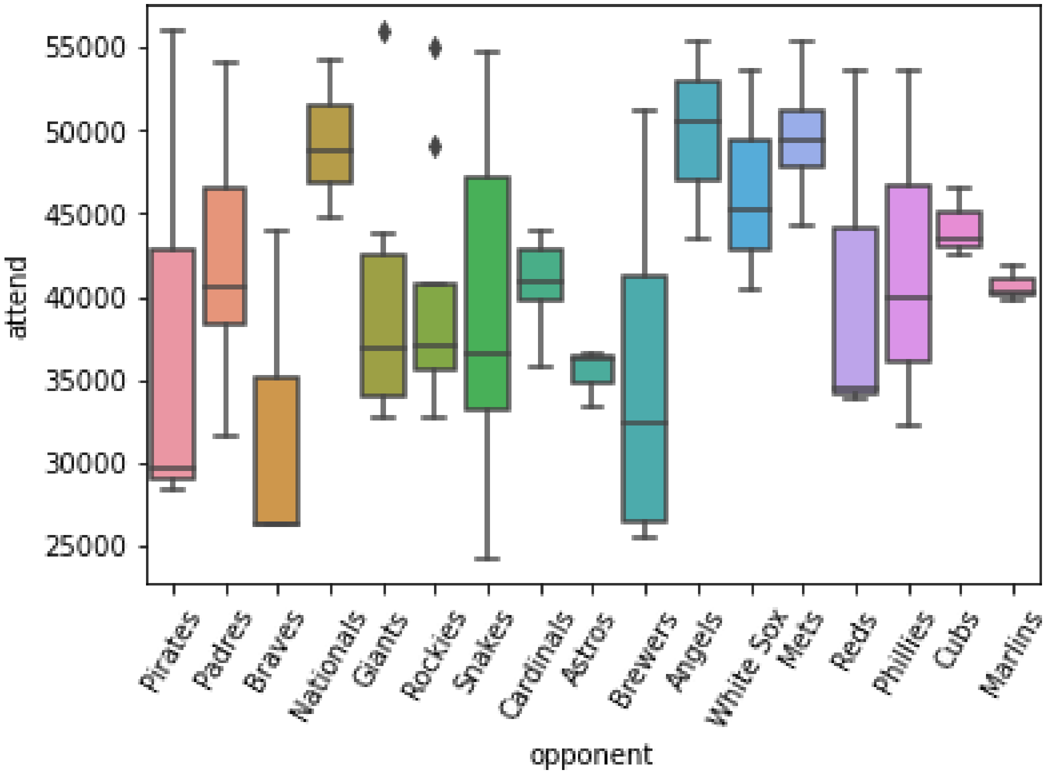
I feel as though attendance would be impacted by who the opponent is, so I will plot opponent to attendance

[11]:

```
# plot attendance by opponent
import seaborn as sns
opponent = sns.boxplot(x=baseball.opponent, y=baseball.attend)
opponent.set_xticklabels(opponent.get_xticklabels(),rotation = 60)
```

[11]:

```
[Text(0, 0, 'Pirates'),
 Text(1, 0, 'Padres'),
 Text(2, 0, 'Braves'),
 Text(3, 0, 'Nationals'),
 Text(4, 0, 'Giants'),
 Text(5, 0, 'Rockies'),
 Text(6, 0, 'Snakes'),
 Text(7, 0, 'Cardinals'),
 Text(8, 0, 'Astros'),
 Text(9, 0, 'Brewers'),
 Text(10, 0, 'Angels'),
 Text(11, 0, 'White Sox'),
 Text(12, 0, 'Mets'),
 Text(13, 0, 'Reds'),
 Text(14, 0, 'Phillies'),
 Text(15, 0, 'Cubs'),
 Text(16, 0, 'Marlins')]
```



It does appear that there are higher attendance numbers while playing the Pirates and Giants and very low attendance numbers when playing the Braves, Brewers and Snakes. I'm not sure that this will really be useful though if we are simply looking for a day without knowing the schedule and who they would be playing. This would be valuable information to know prior to making a final decision.

I would like to create a new column that simply identifies if the game had a promotion or not, I will call it promo_game with a YES/NO value. I will then add another column to identify in one column which promo (if any) was run.

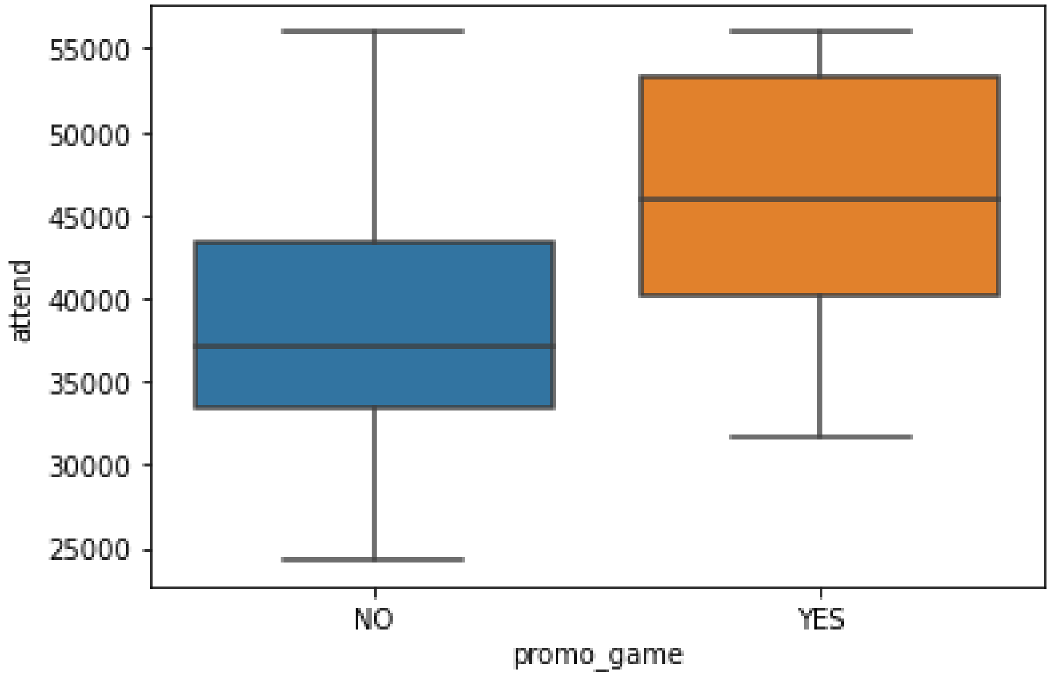
[12]:
```
# create new column promo_game
baseball['promo_game'] = baseball[['cap','shirt','fireworks','bobblehead']].
 ↪max(axis=1)
```

[13]:
```
conditions = [
    (baseball['cap'] == 'YES'),
    (baseball['shirt'] == 'YES'),
    (baseball['fireworks'] == 'YES') ,
    (baseball['bobblehead'] == 'YES')
    ]

# create a list of the values we want to assign for each condition
values = ['cap', 'shirt', 'fireworks', 'bobblehead']

# create a new column and use np.select to assign values to it using our lists␣
 ↪as arguments
baseball['promo'] = np.select(conditions, values)
baseball['promo'] = baseball['promo'].replace(['0'],['none'])

# display updated DataFrame
baseball.head()
```

```
[13]:   month  day  attend day_of_week opponent  temp day_night cap shirt fireworks  \
      0   APR   10   56000     Tuesday  Pirates    67       Day  NO    NO        NO
      1   APR   11   29729   Wednesday  Pirates    58     Night  NO    NO        NO
      2   APR   12   28328    Thursday  Pirates    57     Night  NO    NO        NO
      3   APR   13   31601      Friday   Padres    54     Night  NO    NO       YES
      4   APR   14   46549    Saturday   Padres    57     Night  NO    NO        NO

        bobblehead promo_game      promo
      0         NO         NO       none
      1         NO         NO       none
      2         NO         NO       none
      3         NO        YES  fireworks
      4         NO         NO       none
```

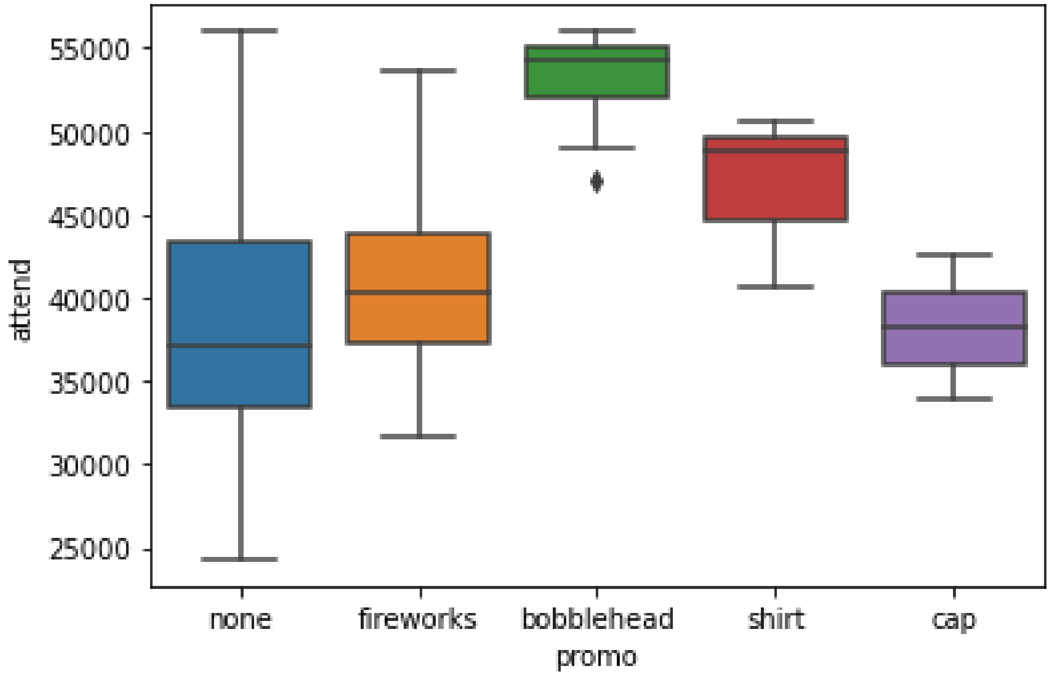
I would like to plot attendance for promo vs non-promo games and then also plot attendance per type of promo

```
[14]: # plot attendance for promo_game vs non promo-game
      promo_attend = sns.boxplot(x=baseball.promo_game, y=baseball.attend)
```



[15]:
```
# plot attendance per promo type
sns.boxplot(x='promo', y='attend', data=baseball)
```

[15]:
```
<AxesSubplot:xlabel='promo', ylabel='attend'>
```



We can see that the promotions do have a positive affect on attendance with bobbleheads clearly having the largest correlation to higher attendance

I would like to now look at attendance by month and day of the week together

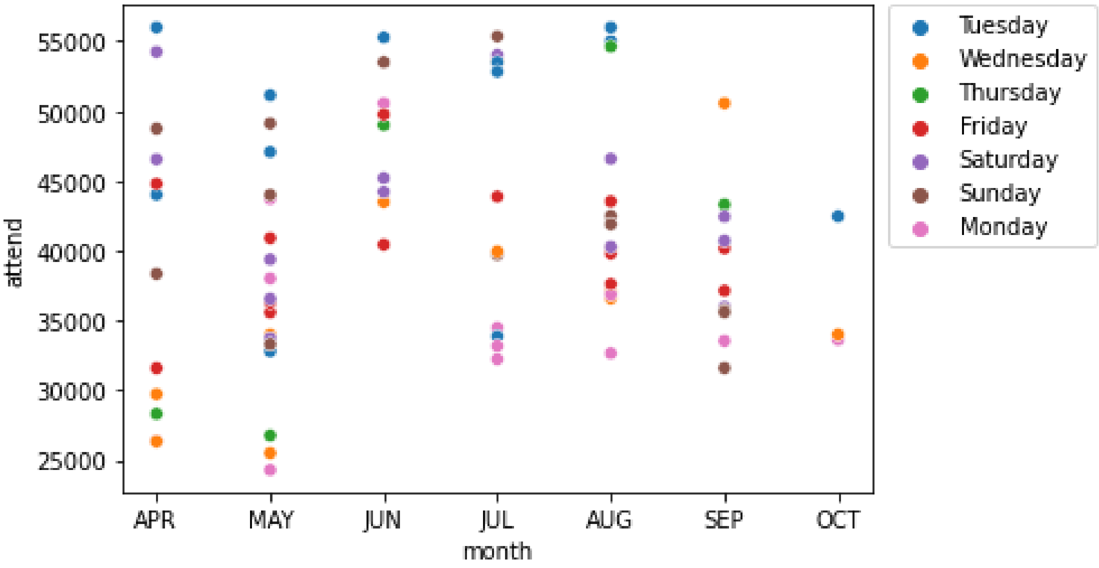
[16]:

```python
# plot attendance by month and day of week
import seaborn as sns
sns.scatterplot('month', 'attend', data=baseball, hue='day_of_week')
plt.legend(bbox_to_anchor=(1.02, 1), loc='upper left', borderaxespad=0)
```

```
/opt/anaconda3/lib/python3.8/site-packages/seaborn/_decorators.py:36:
FutureWarning: Pass the following variables as keyword args: x, y. From version
0.12, the only valid positional argument will be `data`, and passing other
arguments without an explicit keyword will result in an error or
misinterpretation.
  warnings.warn(
```

[16]:

```
<matplotlib.legend.Legend at 0x7fd250fbb640>
```



We can see again that Tuesdays have high attendance days, the lowest attendance days are seen in April and May with Mondays and Wednesdays have lower numbers, especially in those months. This made me interested to see what days promos were run, so I plotted each promo type with the day of the week against attendance.

[17]:

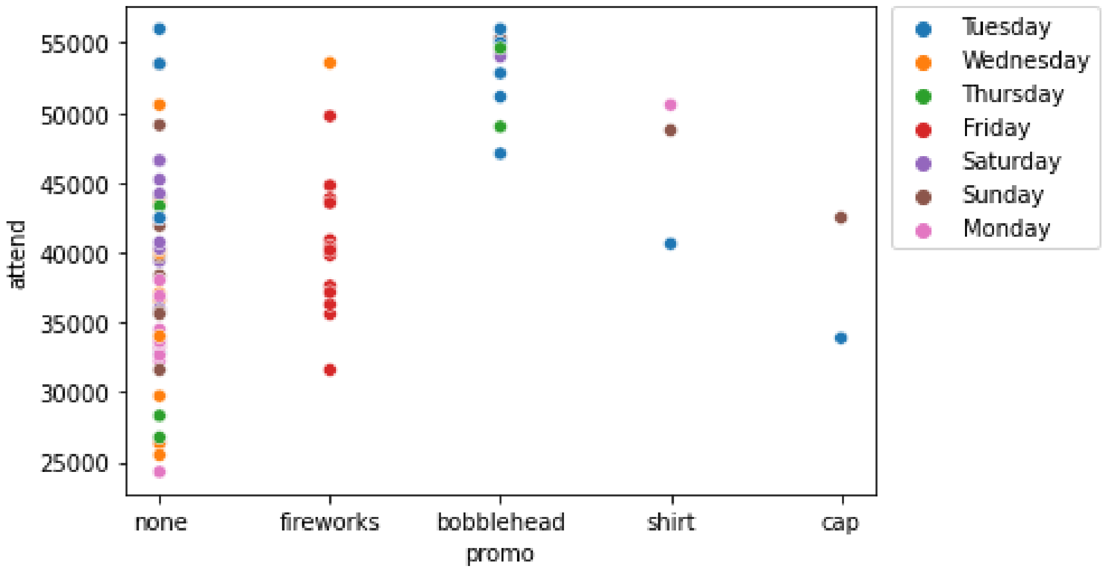
```python
# plot attendance by promo and day of week
import seaborn as sns
```

```
sns.scatterplot('promo', 'attend', data=baseball, hue='day_of_week')
plt.legend(bbox_to_anchor=(1.02, 1), loc='upper left', borderaxespad=0)
```

```
/opt/anaconda3/lib/python3.8/site-packages/seaborn/_decorators.py:36:
FutureWarning: Pass the following variables as keyword args: x, y. From version
0.12, the only valid positional argument will be `data`, and passing other
arguments without an explicit keyword will result in an error or
misinterpretation.
  warnings.warn(
```

[17]:

```
<matplotlib.legend.Legend at 0x7fd250ffc6a0>
```



We can see again that bobblehead games had high attendance, and most of those were Tuesdays and Thursdays, which could be related to Tuesdays having the highest numbers that we saw earlier. Also, there are not a lot of promotions on Mondays, which we previously noted had low attendance.

Now I will run a linear regression with attendance as the dependent variable and month, day of the week and each promotion types as predictor variables.

[18]:

```
model = sm.GLM.from_formula("attend ~ month + day_of_week + cap + shirt +␣
 ↪fireworks + bobblehead", data=baseball)
result = model.fit()
result.summary()
```

[18]:

```
<class 'statsmodels.iolib.summary.Summary'>
"""
                 Generalized Linear Model Regression Results
```

```
==============================================================================
Dep. Variable:                 attend   No. Observations:                   81
Model:                            GLM   Df Residuals:                       64
Model Family:                Gaussian   Df Model:                           16
Link Function:               identity   Scale:                      3.3007e+07
Method:                          IRLS   Log-Likelihood:                -806.54
Date:                Mon, 28 Jun 2021   Deviance:                   2.1125e+09
Time:                        00:55:37   Pearson chi2:                 2.11e+09
No. Iterations:                     3
Covariance Type:            nonrobust
================================================================================
============
                               coef    std err          z      P>|z|      [0.025
0.975]
--------------------------------------------------------------------------------
------------
Intercept                 2.223e+04   6583.340      3.377      0.001    9329.675
3.51e+04
month[T.AUG]              3341.0703   2304.295      1.450      0.147   -1175.265
7857.406
month[T.JUL]              2564.2583   2555.919      1.003      0.316   -2445.252
7573.768
month[T.JUN]              6933.3521   2573.781      2.694      0.007    1888.835
1.2e+04
month[T.MAY]             -1924.7543   2175.756     -0.885      0.376   -6189.158
2339.649
month[T.OCT]               221.8223   3825.941      0.058      0.954   -7276.884
7720.529
month[T.SEP]              -102.9399   2367.346     -0.043      0.965   -4742.852
4536.972
day_of_week[T.Monday]     1.093e+04   6802.780      1.607      0.108   -2401.773
2.43e+04
day_of_week[T.Saturday]   1.788e+04   6658.360      2.686      0.007    4833.815
3.09e+04
day_of_week[T.Sunday]     1.823e+04   6712.865      2.715      0.007    5068.239
3.14e+04
day_of_week[T.Thursday]   1.225e+04   6947.409      1.763      0.078   -1371.459
2.59e+04
day_of_week[T.Tuesday]    1.935e+04   6811.893      2.841      0.004    6000.942
3.27e+04
day_of_week[T.Wednesday]  1.246e+04   6241.486      1.997      0.046     230.656
2.47e+04
cap[T.YES]               -5784.5577   4467.996     -1.295      0.195   -1.45e+04
2972.554
shirt[T.YES]              5964.5286   3633.482      1.642      0.101   -1156.965
1.31e+04
fireworks[T.YES]          1.631e+04   6268.591      2.602      0.009    4023.002
```

```
2.86e+04
bobblehead[T.YES]          1.07e+04   2346.479      4.560      0.000    6101.130
1.53e+04
================================================================================
============
"""
```

I also want to see the linear regression with month and day of the week without the impact of current promotions

[19]:
```
model = sm.GLM.from_formula("attend ~ month + day_of_week", data=baseball)
result = model.fit()
result.summary()
```

[19]:
```
<class 'statsmodels.iolib.summary.Summary'>
"""
                 Generalized Linear Model Regression Results
==============================================================================
Dep. Variable:                 attend   No. Observations:                   81
Model:                            GLM   Df Residuals:                       68
Model Family:                Gaussian   Df Model:                           12
Link Function:               identity   Scale:                      4.7708e+07
Method:                          IRLS   Log-Likelihood:                -823.91
Date:                Mon, 28 Jun 2021   Deviance:                   3.2442e+09
Time:                        00:55:38   Pearson chi2:                 3.24e+09
No. Iterations:                     3
Covariance Type:            nonrobust
================================================================================
============
                               coef    std err          z      P>|z|      [0.025
0.975]
--------------------------------------------------------------------------------
------------
Intercept                 3.805e+04   2661.948     14.293      0.000    3.28e+04
4.33e+04
month[T.AUG]              3965.9784   2681.525      1.479      0.139   -1289.714
9221.670
month[T.JUL]              4768.3867   2868.802      1.662      0.096    -854.361
1.04e+04
month[T.JUN]              8753.4054   3057.367      2.863      0.004    2761.076
1.47e+04
month[T.MAY]             -1957.7296   2583.531     -0.758      0.449   -7021.358
3105.899
month[T.OCT]             -1500.1929   4561.773     -0.329      0.742   -1.04e+04
7440.717
month[T.SEP]              -692.4947   2839.495     -0.244      0.807   -6257.803
4872.814
```

```
day_of_week[T.Monday]    -4991.2625   2826.580     -1.766      0.077   -1.05e+04
548.733
day_of_week[T.Saturday]   3314.3441   2717.208      1.220      0.223   -2011.286
8639.975
day_of_week[T.Sunday]     2816.8071   2727.510      1.033      0.302   -2529.015
8162.629
day_of_week[T.Thursday]    347.0261   3643.149      0.095      0.924   -6793.415
7487.468
day_of_week[T.Tuesday]    7931.2545   2762.345      2.871      0.004    2517.157
1.33e+04
day_of_week[T.Wednesday] -2468.0392   2805.030     -0.880      0.379   -7965.797
3029.719
================================================================================
============
"""
```

Looking at the p values in both of these models, we can see that September has the highest p value, indicating that the month of September does not have a strong correlation to higher attendance numbers. Looking at the days of the week, in the model with the promotions included, Mondays had the least positive correlation. However, when removing current promotions, we see that Thursday has lower correlation. I looked at the data specifically for Thursday and discovered that there were only 4 Thursday games and 2 of the 4 had a bobblehead promotion, which we have seen has a strong relationship to higher attendance, so that explains the difference in the p value when including the bobblehead promotion vs not including it. Based on this analysis, I would conclude that a Thursday game in the month of September would be the best time to run a marketing promotion.

```
[ ]:
```