Course:: DSC630

Week:: 3

Assignment:: 3.2

Title:: Using Data to improve MLB Attendance

Date:: Dec 15, 2022

My assumption is Day of the week, Weather any kind of promotions offered would attract more people to attend the game. So I am going to explore the data and understand, On what day the attendence is more? Intention is to start more promotions to increase attendence. what are significant factors contributing to improve attendence? Other than pormotions are there any other factors to consider? Trying with two different approaches to solve this problem.

Approach 1 - Check the attendance count for day of the week and month and suggest day on which we could more run promotions to increase the attendence.

Approach 2 - Finding factors that impact attendance increase, correlating factors with attendance and see what are the different factors correlate and their strength and direction of correlation that impact the attendance.

In [1]:

```
#Import required libraries
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.preprocessing import LabelEncoder
```

In [2]:

```
# import the dodgers dataset fromm the assignment
dodgers = pd.read_csv("dodgers-2022.csv")
```

In [3]:

```
# verify the data from the imported data set: dodgers
dodgers.head()
```

Out[3]:

	month	day	attend	day_of_week	opponent	temp	skies	day_night	cap	shirt	fireworks	bobbl
0	APR	10	56000	Tuesday	Pirates	67	Clear	Day	NO	NO	NO	
1	APR	11	29729	Wednesday	Pirates	58	Cloudy	Night	NO	NO	NO	
2	APR	12	28328	Thursday	Pirates	57	Cloudy	Night	NO	NO	NO	

	month	day	attend	day_of_week	opponent	temp	skies	day_night	cap	shirt	fireworks	bobble
3	APR	13	31601	Friday	Padres	54	Cloudy	Night	NO	NO	YES	
4	APR	14	46549	Saturday	Padres	57	Cloudy	Night	NO	NO	NO	

Perform EDA - Exploratory Data Analysis

In [4]:

```
# statistical information about dataset.
dodgers.describe(include='all')
```

Out[4]:

	month	day	attend	day_of_week	opponent	temp	skies	day_night	cap	shi
count	81	81.000000	81.000000	81	81	81.000000	81	81	81	8
unique	7	NaN	NaN	7	17	NaN	2	2	2	
top	MAY	NaN	NaN	Tuesday	Giants	NaN	Clear	Night	NO	N
freq	18	NaN	NaN	13	9	NaN	62	66	79	7
mean	NaN	16.135802	41040.074074	NaN	NaN	73.148148	NaN	NaN	NaN	Na
std	NaN	9.605666	8297.539460	NaN	NaN	8.317318	NaN	NaN	NaN	Na
min	NaN	1.000000	24312.000000	NaN	NaN	54.000000	NaN	NaN	NaN	Na
25%	NaN	8.000000	34493.000000	NaN	NaN	67.000000	NaN	NaN	NaN	Na
50%	NaN	15.000000	40284.000000	NaN	NaN	73.000000	NaN	NaN	NaN	Na
75%	NaN	25.000000	46588.000000	NaN	NaN	79.000000	NaN	NaN	NaN	Na
max	NaN	31.000000	56000.000000	NaN	NaN	95.000000	NaN	NaN	NaN	Na

Observation: Based on above summary 1 Average attendance is about '41K'(41040.07) 2 Maximum attendance is '56K'(56000). 3 Also, 'Tuesday' seems to be the day on top and month is 'May'.

In [7]:

```
# Installing missingno package
pip install missingno
```

```
Collecting missingno
  Using cached missingno-0.5.1-py3-none-any.whl (8.7 kB)
Requirement already satisfied: numpy in c:\programdata\anaconda3\lib\site-packages (from
missingno) (1.20.3)
Requirement already satisfied: scipy in c:\programdata\anaconda3\lib\site-packages (from
missingno) (1.7.1)
Requirement already satisfied: matplotlib in c:\programdata\anaconda3\lib\site-packages
(from missingno) (3.4.3)
Requirement already satisfied: seaborn in c:\programdata\anaconda3\lib\site-packages (fr
om missingno) (0.11.2)
Requirement already satisfied: pyparsing>=2.2.1 in c:\programdata\anaconda3\lib\site-pac
kages (from matplotlib->missingno) (3.0.4)
Requirement already satisfied: python-dateutil>=2.7 in c:\programdata\anaconda3\lib\site
-packages (from matplotlib->missingno) (2.8.2)
Requirement already satisfied: pillow>=6.2.0 in c:\programdata\anaconda3\lib\site-packag
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s (from matplotlib->missingno) (0.10.0)
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ckages (from matplotlib->missingno) (1.3.1)
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ycler>=0.10->matplotlib->missingno) (1.16.0)
Requirement already satisfied: pandas>=0.23 in c:\programdata\anaconda3\lib\site-package
s (from seaborn->missingno) (1.3.4)
Requirement already satisfied: pytz>=2017.3 in c:\programdata\anaconda3\lib\site-package
s (from pandas>=0.23->seaborn->missingno) (2021.3)
Installing collected packages: missingno
Successfully installed missingno-0.5.1
Note: you may need to restart the kernel to use updated packages.
```

```
WARNING: Ignoring invalid distribution -ikit-learn (c:\programdata\anaconda3\lib\site-pa
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WARNING: Ignoring invalid distribution -arkupsafe (c:\programdata\anaconda3\lib\site-pac
kages)
```
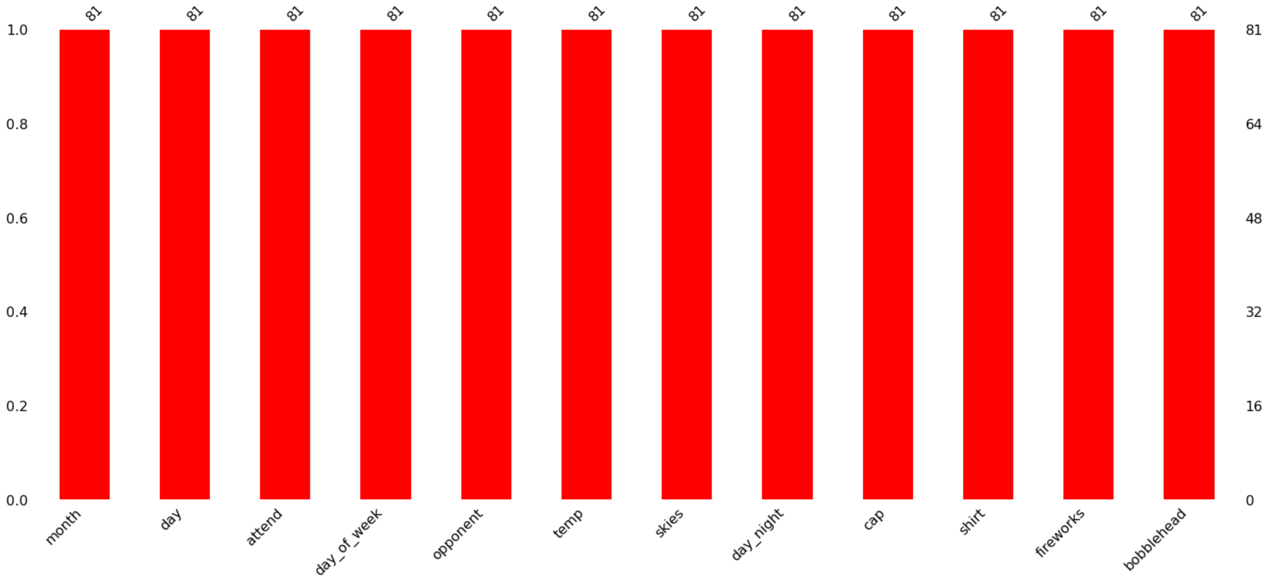

In [8]:

```
# Check for missing values in the data using missingno package
import missingno as msno
msno.bar(dodgers, color='r')
```

Out[8]:

```
<AxesSubplot:>
```



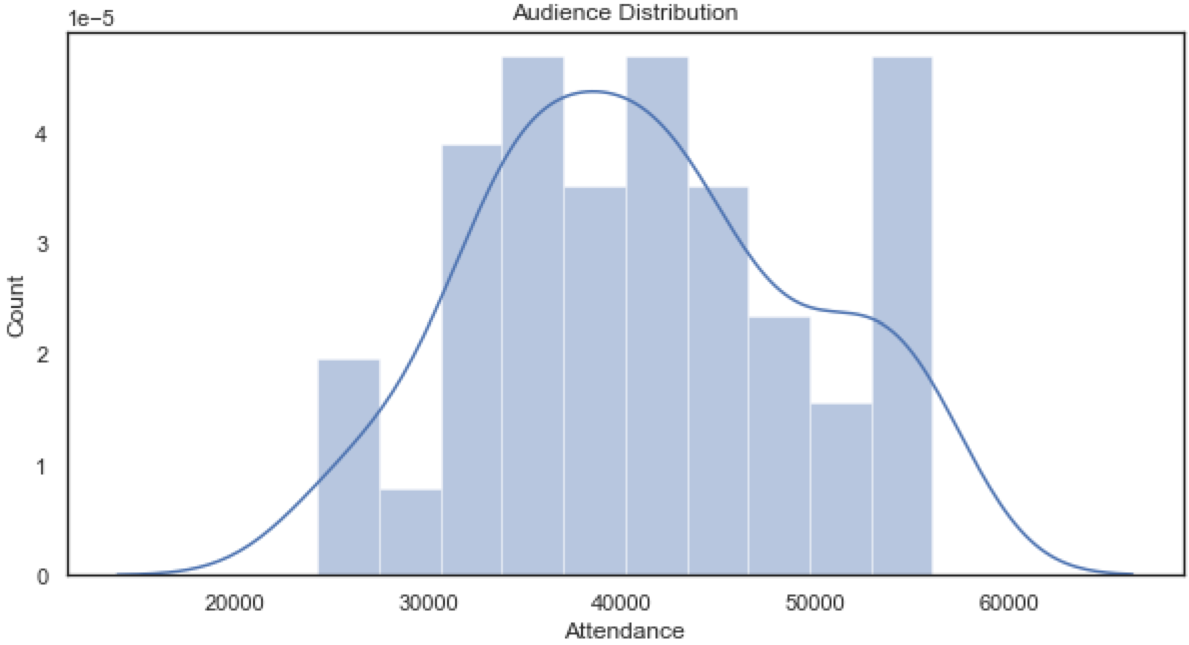
Observation: Based on above graph and check, there seems to be no missing values in the given data.

In [9]:

```
# Check audience distribution on attendance from the data set, the column name is 'atte
# x axis as Attendance and Y axis as count.
sns.set(style='white')
plt.figure(figsize=(10,5))
sns.distplot(a=dodgers['attend'],color='b', bins=10)
plt.title("Audience Distribution")
plt.xlabel('Attendance')
plt.ylabel('Count');
```

```
C:\ProgramData\Anaconda3\lib\site-packages\seaborn\distributions.py:2619: FutureWarning:
`distplot` is a deprecated function and will be removed in a future version. Please adap
t your code to use either `displot` (a figure-level function with similar flexibility) o
```

```
r `histplot` (an axes-level function for histograms).
  warnings.warn(msg, FutureWarning)
```

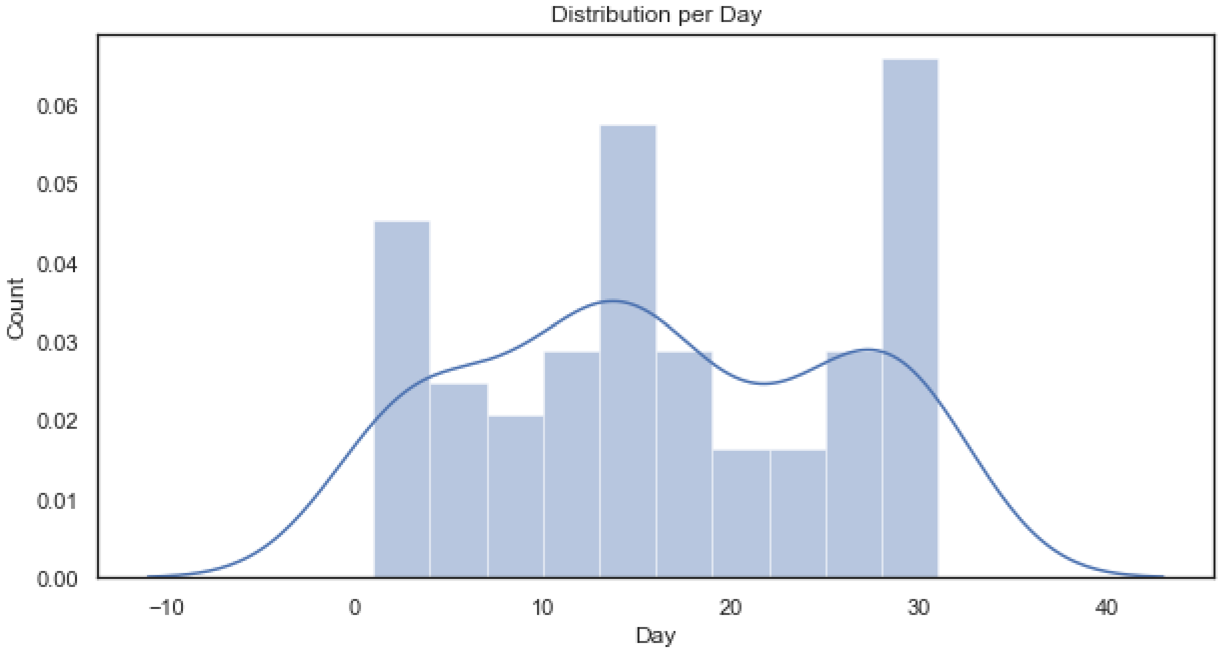


Observation: The distribution seems normal with average attendance being approxamtely 40000 per game with no real outliers.

In [10]:

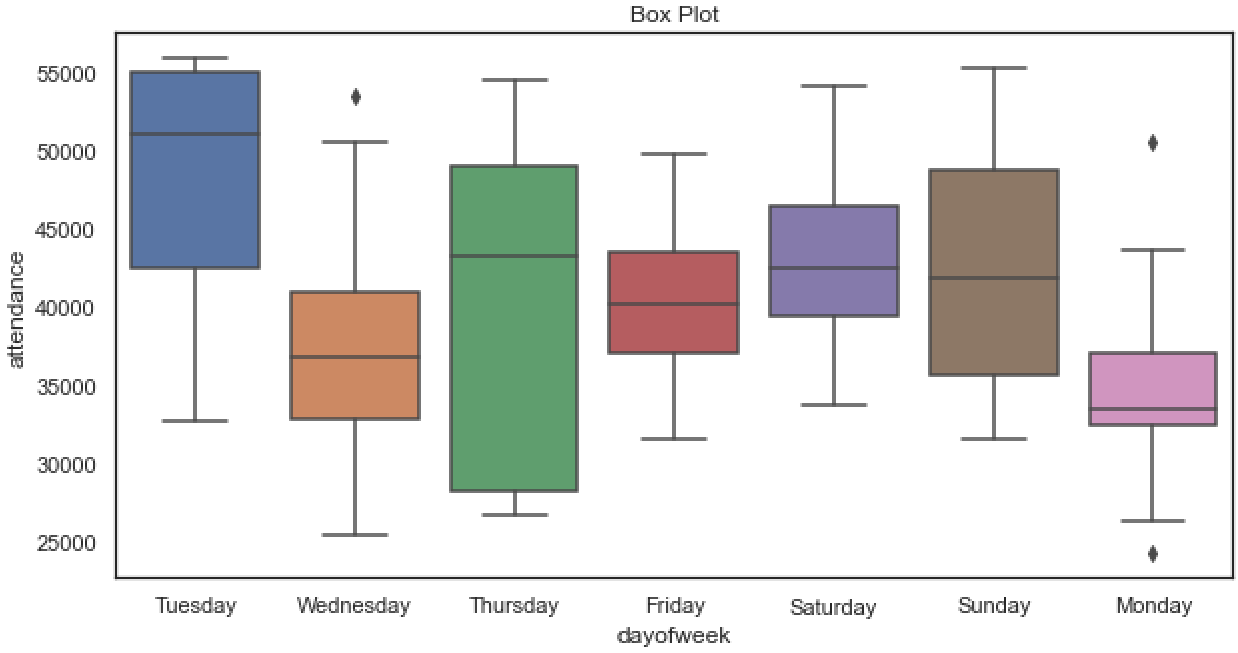
```
# Check distribution per day, column 'day'
# x axis as Day and Y axis as Count
sns.set(style='white')
plt.figure(figsize=(10,5))
sns.distplot(a=dodgers['day'],color='b', bins=10)
plt.title("Distribution per Day")
plt.xlabel('Day')
plt.ylabel('Count');
```

```
C:\ProgramData\Anaconda3\lib\site-packages\seaborn\distributions.py:2619: FutureWarning:
`distplot` is a deprecated function and will be removed in a future version. Please adap
t your code to use either `displot` (a figure-level function with similar flexibility) o
r `histplot` (an axes-level function for histograms).
  warnings.warn(msg, FutureWarning)
```



Observation: The distribution seems uniform with Day 30, 15 and 1 being the days where games happen most.

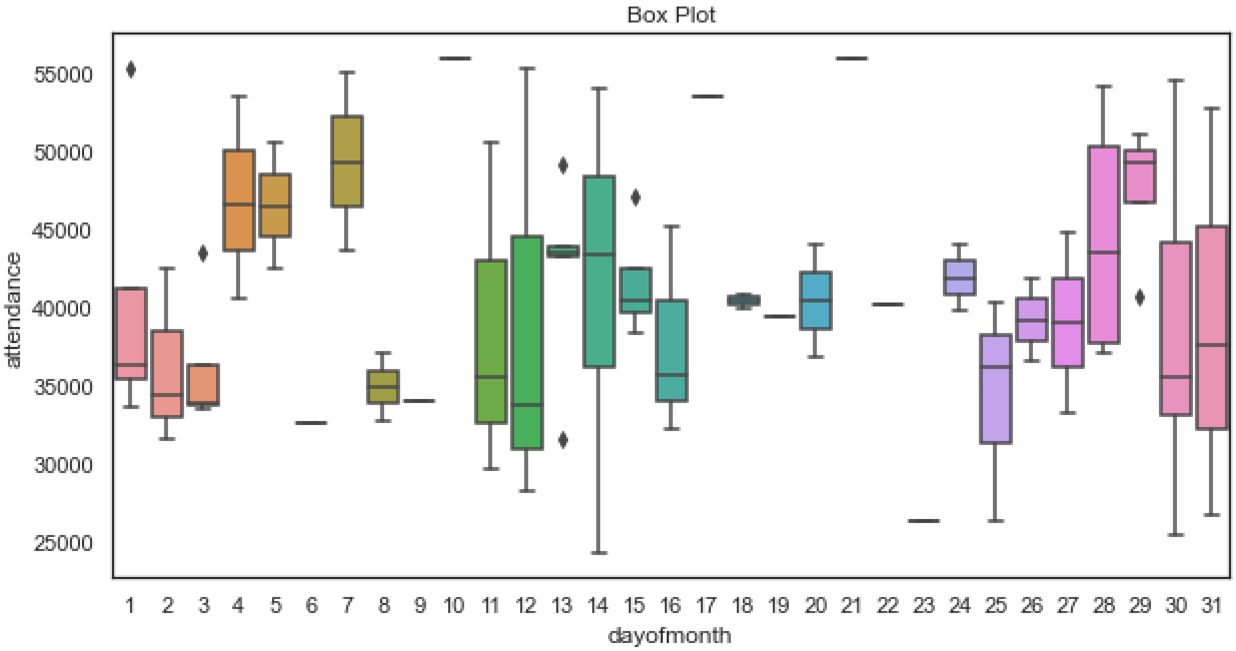
In [11]:
```
# Check attendance per day of the week, using box plot
# with x axis as day of week and y axis as attend
sns.set(style='white')
plt.figure(figsize=(10,5))
sns.boxplot(data=dodgers, x='day_of_week',y='attend')
plt.title("Box Plot")
plt.xlabel('dayofweek')
plt.ylabel('attendance');
```



Observation: 'Tuesday' is clearly the best day of the week in terms of overall attendance at 55000 and 'Monday' is the least.

In [12]:

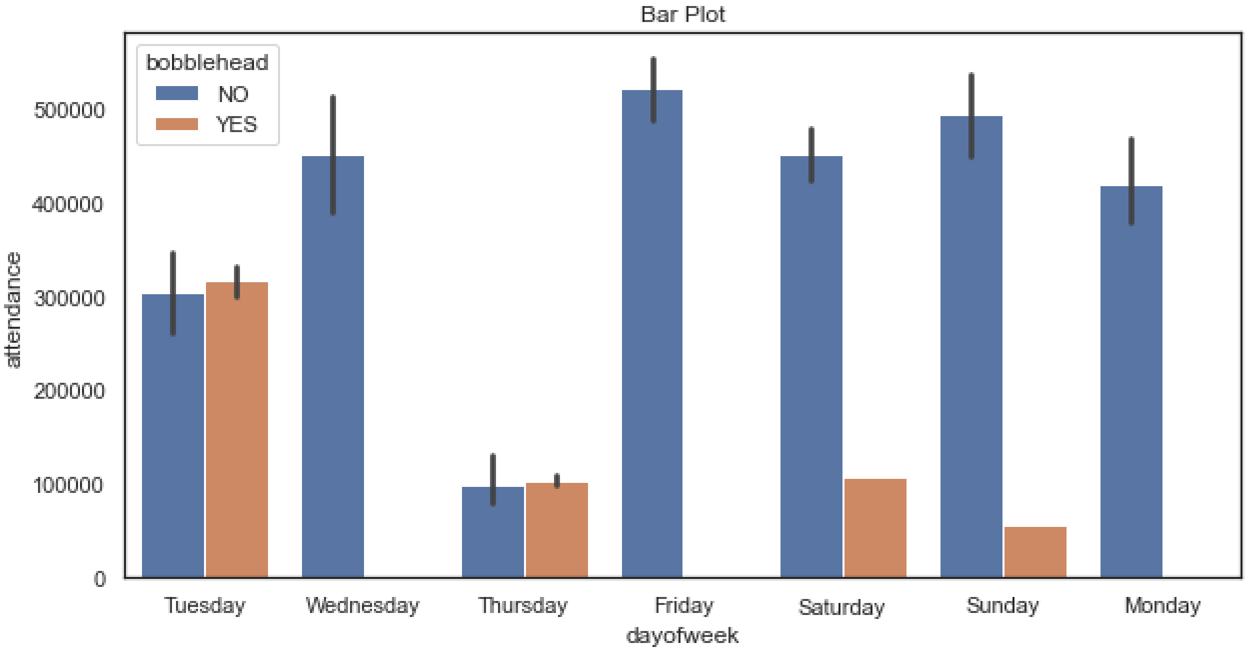
```
# Check attendance per day of the month
# with x axis as day of month and y axis as attend
sns.set(style='white')
plt.figure(figsize=(10,5))
sns.boxplot(data=dodgers, x='day',y='attend')
plt.title("Box Plot")
plt.xlabel('dayofmonth')
plt.ylabel('attendance');
```



Observation: Day '7' of the month is the best month with highest attendance. Also, minimum attendance on this day is higher than most of the median attendance on other days.

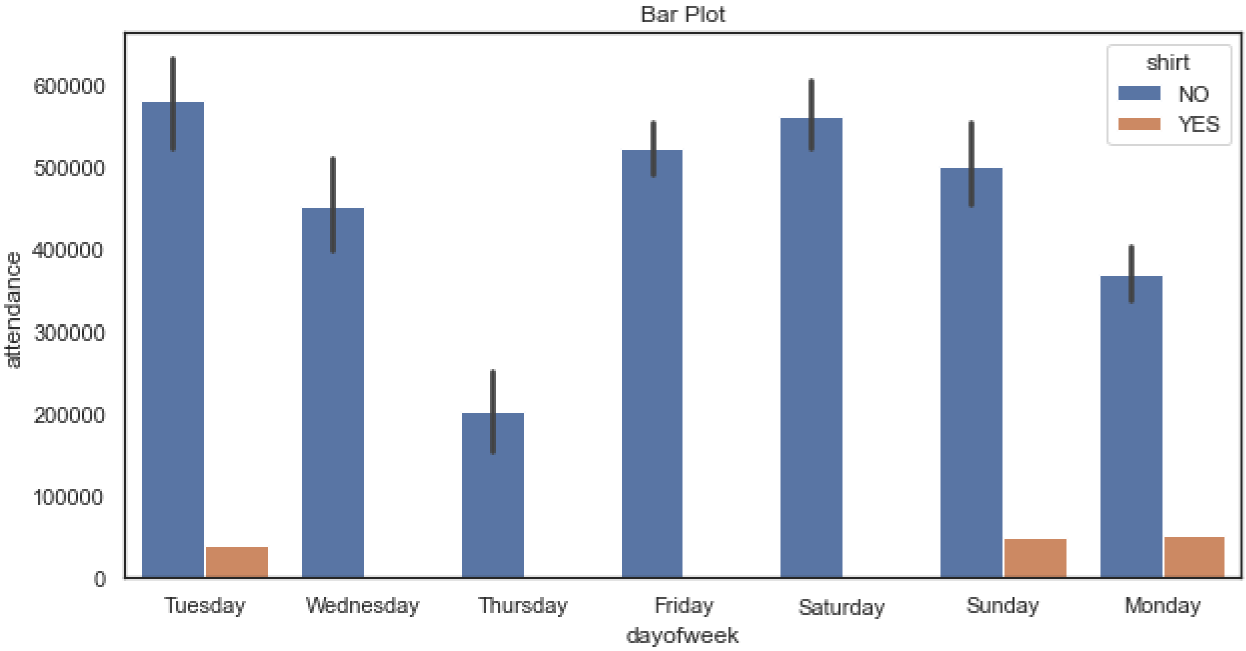
In [13]:

```
# Check day of week distribution to see attendance considering bobblehead

sns.set(style='white')
plt.figure(figsize=(10,5))

sns.barplot(data=dodgers, x='day_of_week',y='attend', hue='bobblehead',estimator=sum)
plt.title("Bar Plot")
plt.xlabel('dayofweek')
plt.ylabel('attendance');
```



In [14]:

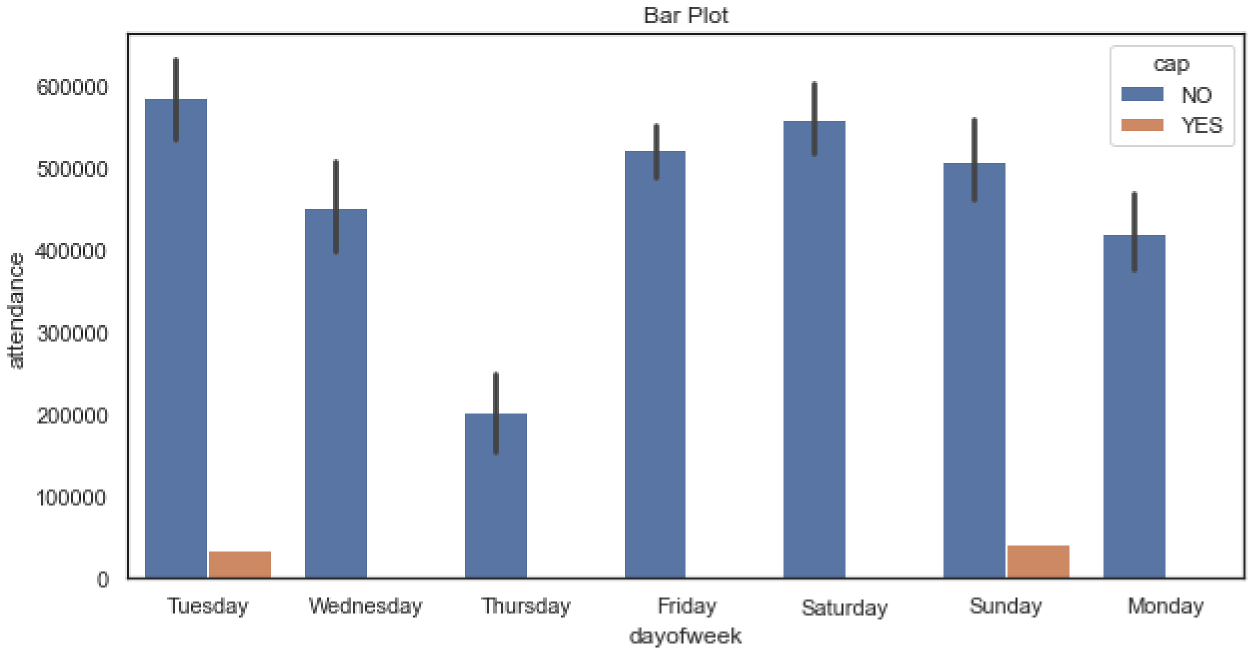
```
# Check day of week distribution to see attendance considering shirt

sns.set(style='white')
plt.figure(figsize=(10,5))

sns.barplot(data=dodgers, x='day_of_week',y='attend', hue='shirt',estimator=sum)
plt.title("Bar Plot")
plt.xlabel('dayofweek')
plt.ylabel('attendance');
```



In [15]:

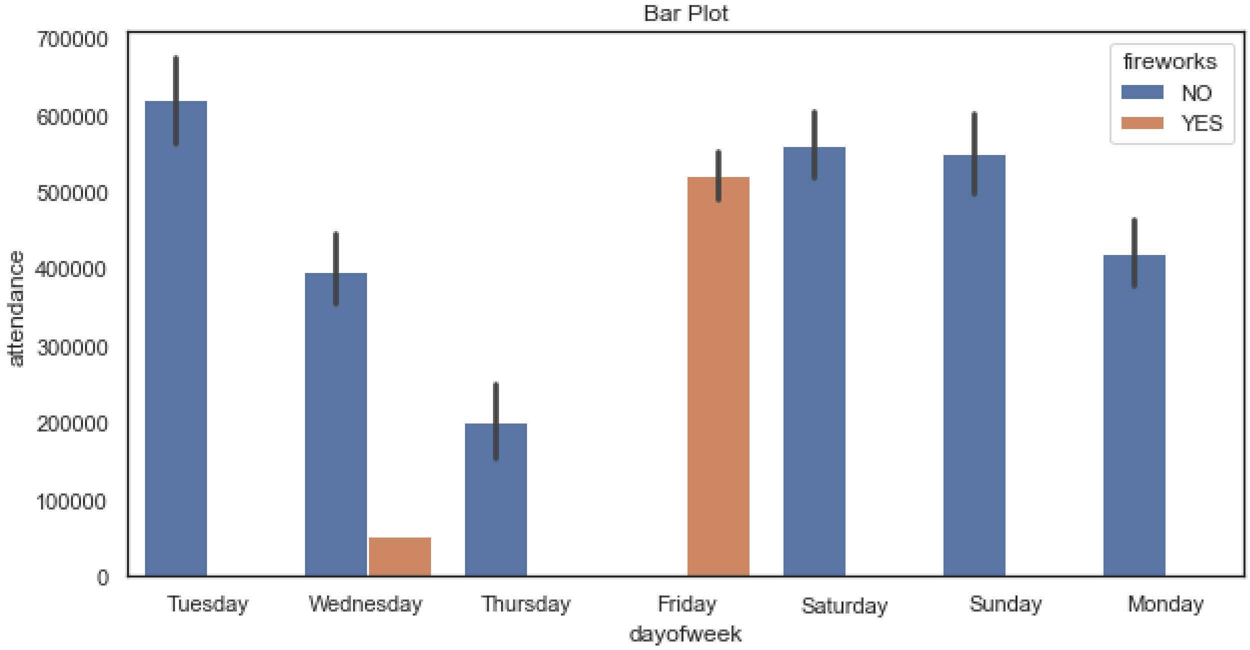
```
# Check day of week distribution to see attendance considering cap

sns.set(style='white')
plt.figure(figsize=(10,5))
```

```
sns.barplot(data=dodgers, x='day_of_week',y='attend', hue='cap',estimator=sum)
plt.title("Bar Plot")
plt.xlabel('dayofweek')
plt.ylabel('attendance');
```



In [16]:

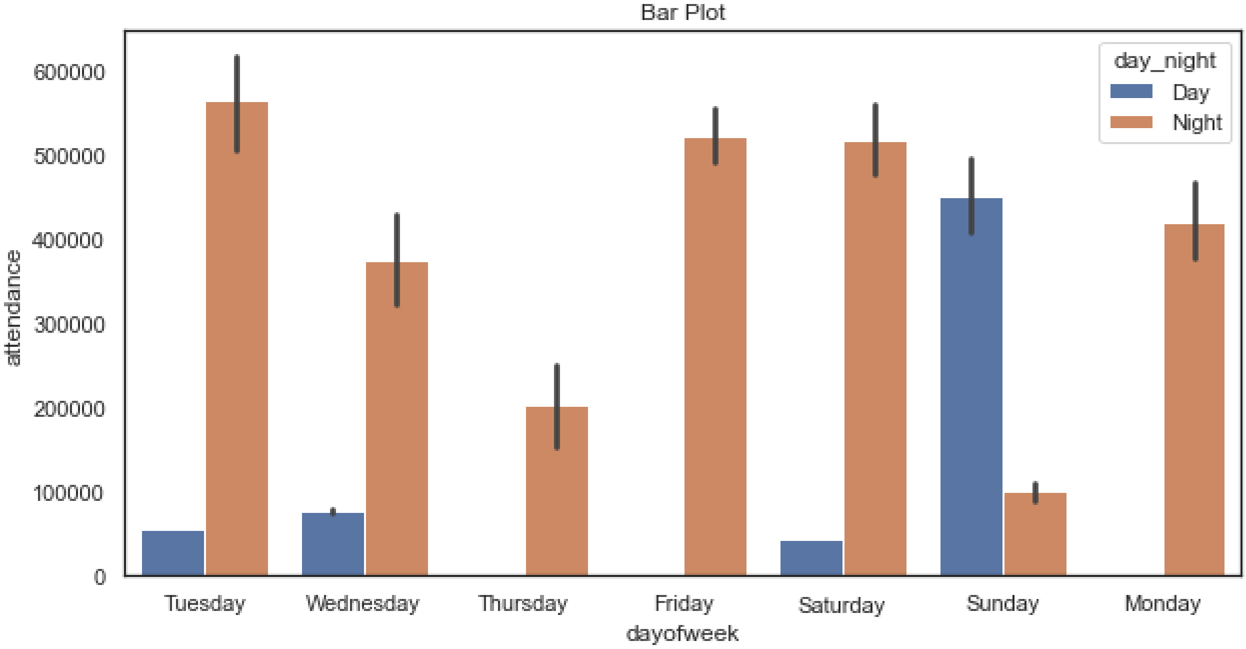
```
# Check day of week distribution to see attendance considering fireworks

sns.set(style='white')
plt.figure(figsize=(10,5))

sns.barplot(data=dodgers, x='day_of_week',y='attend', hue='fireworks',estimator=sum)
plt.title("Bar Plot")
plt.xlabel('dayofweek')
plt.ylabel('attendance');
```



Observation: Based on above 4 plots, we observe that the attendance especially on Tuesdays is high when 'Bobblehead' are being sold/promoted compared to others (cap, shirt, fireworks).

In [17]:

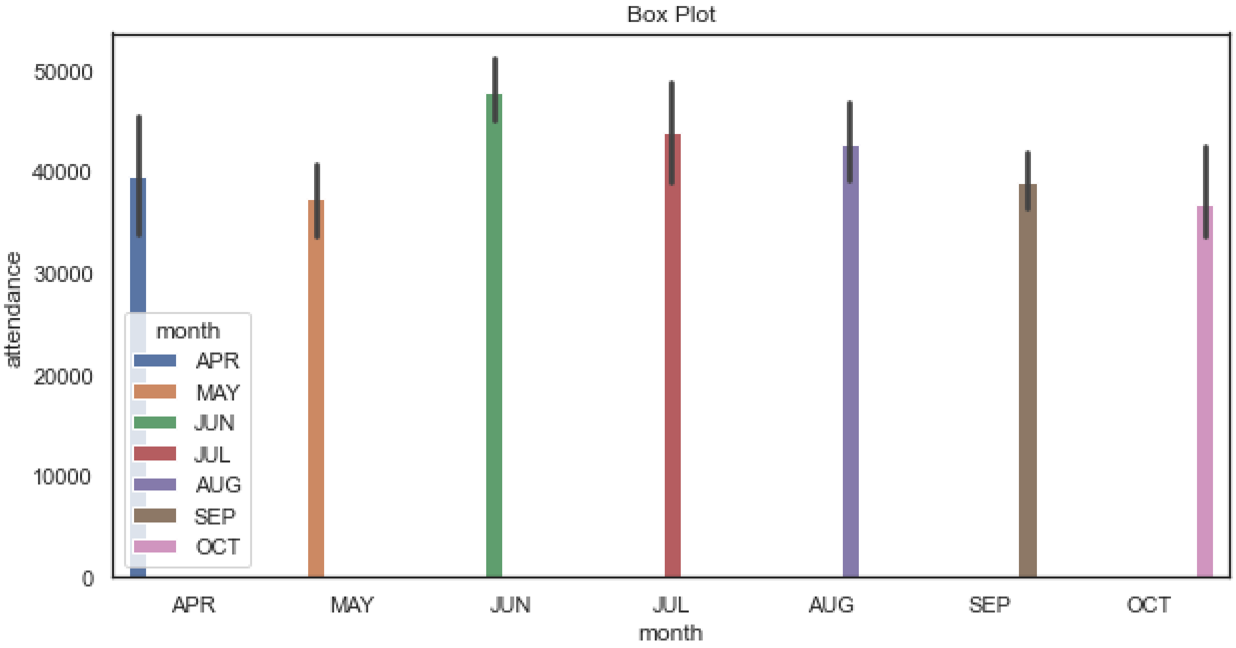
```
# Check day of week distribution to see attendance considering day or night game

sns.set(style='white')
plt.figure(figsize=(10,5))

sns.barplot(data=dodgers, x='day_of_week',y='attend', hue='day_night',estimator=sum)
plt.title("Bar Plot")
plt.xlabel('dayofweek')
plt.ylabel('attendance');
```



Observation: The attendance is cleary high on night games compared to day games and that's clearly higher on Tuesdays with highest attendance followed by Friday and Saturday closely.

In [18]:

```
# Check attendance per month with month nameon x axis and count on y axis.
sns.set(style='white')
plt.figure(figsize=(10,5))
sns.barplot(data=dodgers, x='month',y='attend', hue='month', estimator=np.mean)
plt.title("Box Plot")
plt.xlabel('month')
plt.ylabel('attendance');
```

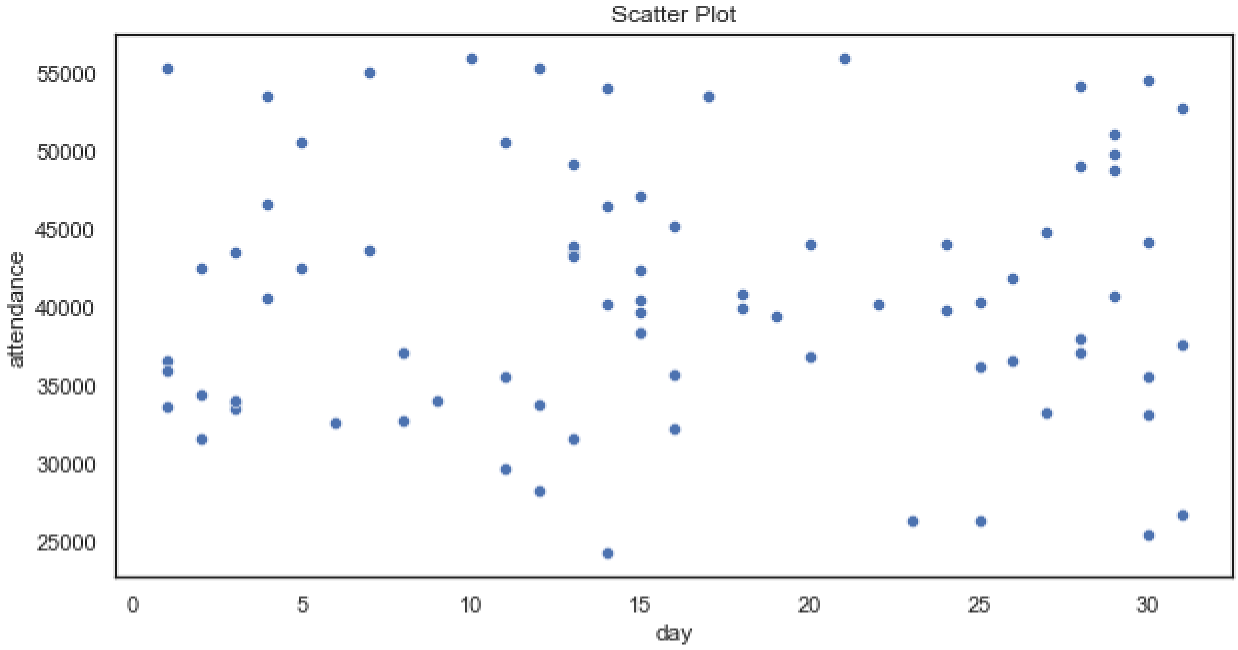


Observation: Based on above chart, it seems like in Summer months - June, July and August is pretty good with high mean attendance and ideal conditions for game closely followed by April and September.

Finding Correlations

In [19]:

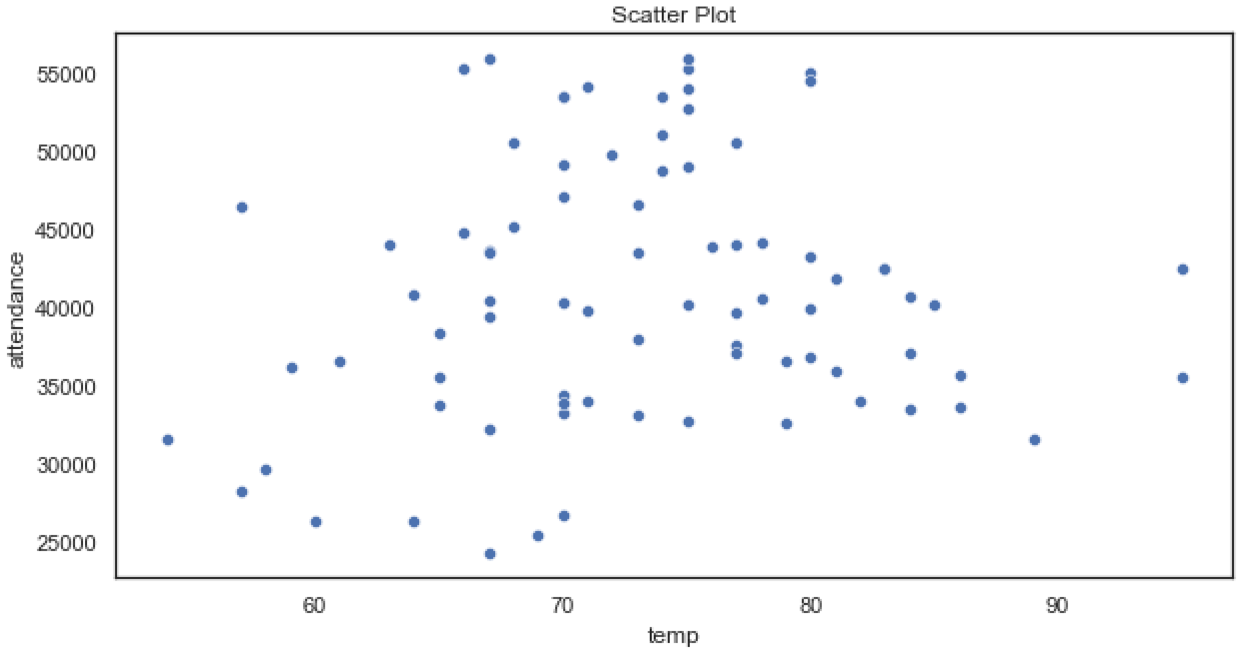
```
# scatter plot to see correlation. Day of month vs Attendance
# x-axis : Day of the month, Y-axis attendance
sns.set(style='white')
plt.figure(figsize=(10,5))

sns.scatterplot(data=dodgers, y='attend',x='day')
plt.title("Scatter Plot")
plt.ylabel('attendance')
plt.xlabel('day');
```



Observation: There is not much strong correlation but the attendance seems higher at mid and end of the month compared to the beginning of the month.

In [20]:

```
# scatter plot to see correlation. Temperature vs Attendance
# X axis: Temperature, Y axis : attendance
sns.set(style='white')
plt.figure(figsize=(10,5))

sns.scatterplot(data=dodgers, y='attend',x='temp')
plt.title("Scatter Plot")
plt.ylabel('attendance')
plt.xlabel('temp');
```



Observation: Attendance seems to be high with tempreatures at 70F and 80F. However, with higher temperatures > 80F, attendance seems to decrease, simillary low attendance with the temperature at lessthan 70F

Calculate Correlation Coefficient

In [21]:

```
# Create new variable by combining day of the week and month as well as bobblehead and
# to find any specific observations
# 1. day_of_week_month and 2. bobblehead_fireworks
dodgers['day_of_week_month'] = dodgers['month']+'-'+dodgers['day_of_week']
dodgers['bobblehead_fireworks'] = dodgers['bobblehead']+'-'+dodgers['fireworks']
dodgers.head()
```

Out[21]:

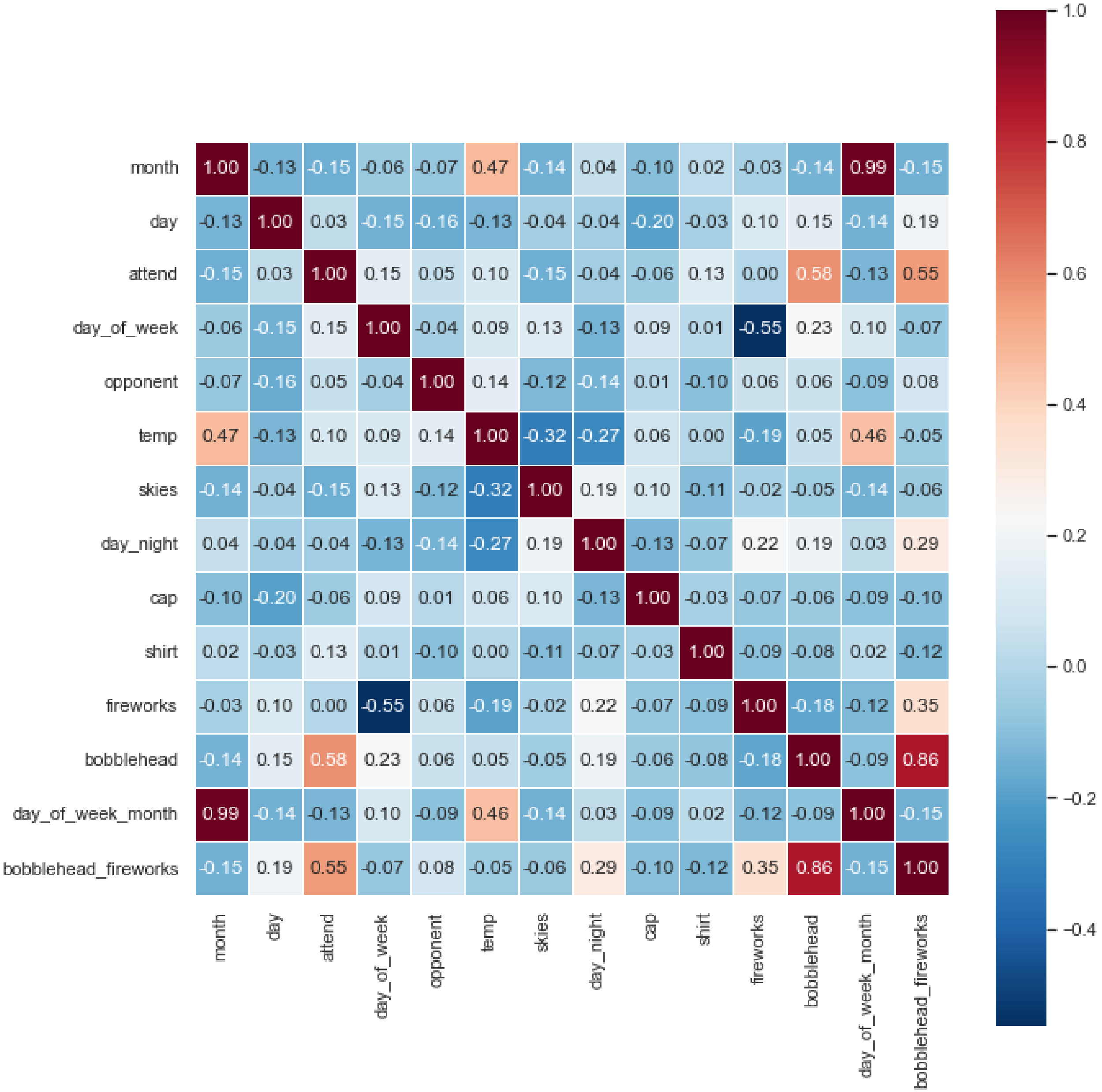
	month	day	attend	day_of_week	opponent	temp	skies	day_night	cap	shirt	fireworks	bobble
0	APR	10	56000	Tuesday	Pirates	67	Clear	Day	NO	NO	NO	
1	APR	11	29729	Wednesday	Pirates	58	Cloudy	Night	NO	NO	NO	
2	APR	12	28328	Thursday	Pirates	57	Cloudy	Night	NO	NO	NO	
3	APR	13	31601	Friday	Padres	54	Cloudy	Night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

In [22]:

```
# Encode the categorical features to generate heat map

from sklearn.preprocessing import StandardScaler, OrdinalEncoder
enc = OrdinalEncoder()
sc = StandardScaler()
cat_cols = ['month', 'day_of_week', 'opponent', 'skies',
       'day_night', 'cap', 'shirt', 'fireworks', 'bobblehead','day_of_week_month','bobb

for col in cat_cols:
    dodgers[col] = enc.fit_transform(dodgers[[col]])
```

In [23]:

```
plt.figure(figsize=(10,10))
sns.heatmap(dodgers._get_numeric_data().astype(float).corr(),
            square=True, cmap='RdBu_r', linewidths=.5,
            annot=True, fmt='.2f').figure.tight_layout()
plt.show()
```



	month	day	attend	day_of_week	opponent	temp	skies	day_night	cap	shirt	fireworks	bobblehead	day_of_week_month	bobblehead_fireworks
month	1.00	-0.13	-0.15	-0.06	-0.07	0.47	-0.14	0.04	-0.10	0.02	-0.03	-0.14	0.99	-0.15
day	-0.13	1.00	0.03	-0.15	-0.16	-0.13	-0.04	-0.04	-0.20	-0.03	0.10	0.15	-0.14	0.19
attend	-0.15	0.03	1.00	0.15	0.05	0.10	-0.15	-0.04	-0.06	0.13	0.00	0.58	-0.13	0.55
day_of_week	-0.06	-0.15	0.15	1.00	-0.04	0.09	0.13	-0.13	0.09	0.01	-0.55	0.23	0.10	-0.07
opponent	-0.07	-0.16	0.05	-0.04	1.00	0.14	-0.12	-0.14	0.01	-0.10	0.06	0.06	-0.09	0.08
temp	0.47	-0.13	0.10	0.09	0.14	1.00	-0.32	-0.27	0.06	0.00	-0.19	0.05	0.46	-0.05
skies	-0.14	-0.04	-0.15	0.13	-0.12	-0.32	1.00	0.19	0.10	-0.11	-0.02	-0.05	-0.14	-0.06
day_night	0.04	-0.04	-0.04	-0.13	-0.14	-0.27	0.19	1.00	-0.13	-0.07	0.22	0.19	0.03	0.29
cap	-0.10	-0.20	-0.06	0.09	0.01	0.06	0.10	-0.13	1.00	-0.03	-0.07	-0.06	-0.09	-0.10
shirt	0.02	-0.03	0.13	0.01	-0.10	0.00	-0.11	-0.07	-0.03	1.00	-0.09	-0.08	0.02	-0.12
fireworks	-0.03	0.10	0.00	-0.55	0.06	-0.19	-0.02	0.22	-0.07	-0.09	1.00	-0.18	-0.12	0.35
bobblehead	-0.14	0.15	0.58	0.23	0.06	0.05	-0.05	0.19	-0.06	-0.08	-0.18	1.00	-0.09	0.86
day_of_week_month	0.99	-0.14	-0.13	0.10	-0.09	0.46	-0.14	0.03	-0.09	0.02	-0.12	-0.09	1.00	-0.15
bobblehead_fireworks	-0.15	0.19	0.55	-0.07	0.08	-0.05	-0.06	0.29	-0.10	-0.12	0.35	0.86	-0.15	1.00

Observation: Based on above correlation/heat map, 1.The correlation is strong (0.58) between attendance and bobblehead. followed by sale/promotion. 2.Second highest correlation (0.45) between attendance and bobblehead+fireworks combo. 3.There is also a good correlation (0.47) between temp and month which is also evident from earlier plots and observations.

In [24]:

```
# Calculate correlation coef. of attendance feature

dodgers.corr(method='pearson').iloc[2].sort_values(ascending=False)
```

Out[24]:

```
attend                  1.000000
bobblehead              0.581895
bobblehead_fireworks    0.554772
day_of_week             0.147216
shirt                   0.133269
temp                    0.098951
opponent                0.045021
day                     0.027093
fireworks               0.002094
```

```
day_night              -0.043544
cap                    -0.055002
day_of_week_month      -0.128691
skies                  -0.150963
month                  -0.152777
Name: attend, dtype: float64
```

Observation: The correlation coeff is clearly high for bobblehead and the next one being the bobblehead+fireworks combo. Also, day_of_week has good positive coeff with Tuesday being the day with highest attendance which is also evident from earlier plots/observations.

Fit into the model

In [25]:
```
# Split data into independent features and dependent feature (attend)

X = dodgers[['month', 'day', 'day_of_week', 'opponent', 'temp', 'skies',
       'day_night', 'cap', 'shirt', 'fireworks', 'bobblehead','day_of_week_month','bobb
y = dodgers['attend']
```

In [26]:
```
feature_variables = ['month', 'day', 'day_of_week', 'opponent', 'temp', 'skies',
       'day_night', 'cap', 'shirt', 'fireworks', 'bobblehead','day_of_week_month','bobb
```

In [27]:
```
# Transform the data to standard scaler
X = sc.fit_transform(X)
y = sc.fit_transform(y.values.reshape(-1,1))
```

In [28]:
```
X_features = pd.DataFrame(X,columns=feature_variables)
```

In [29]:
```
# Using statsmodel to run regression model
import statsmodels.api as sm
model = sm.OLS(y, sm.add_constant(X_features)).fit()
```

```
C:\ProgramData\Anaconda3\lib\site-packages\statsmodels\tsa\tsatools.py:142: FutureWarnin
g: In a future version of pandas all arguments of concat except for the argument 'objs'
will be keyword-only
  x = pd.concat(x[::order], 1)
```

In [30]:
```
# Print the model results
model.summary()
```

Out[30]:

OLS Regression Results

Dep. Variable:	y	**R-squared:**	0.455
Model:	OLS	**Adj. R-squared:**	0.358
Method:	Least Squares	**F-statistic:**	4.724
Date:	Sun, 18 Dec 2022	**Prob (F-statistic):**	1.49e-05
Time:	17:46:41	**Log-Likelihood:**	-90.377
No. Observations:	81	**AIC:**	206.8

```
      Df Residuals:          68          BIC:    237.9
          Df Model:          12
   Covariance Type:   nonrobust

                           coef  std err          t  P>|t|  [0.025  0.975]
                const 1.457e-16    0.090   1.63e-15  1.000  -0.179   0.179
                month    0.6911    1.591      0.434  0.665  -2.485   3.867
                  day   -0.1015    0.099     -1.030  0.307  -0.298   0.095
          day_of_week    0.2089    0.266      0.786  0.435  -0.321   0.739
             opponent   -0.0598    0.097     -0.620  0.537  -0.252   0.133
                 temp    0.0574    0.136      0.423  0.674  -0.214   0.329
                skies   -0.0951    0.112     -0.849  0.399  -0.319   0.128
            day_night   -0.1682    0.105     -1.606  0.113  -0.377   0.041
                  cap   -0.0479    0.095     -0.504  0.616  -0.238   0.142
                shirt    0.1655    0.094      1.760  0.083  -0.022   0.353
            fireworks    0.0508    0.099      0.512  0.610  -0.147   0.249
          bobblehead    0.3282    0.064      5.146  0.000   0.201   0.455
    day_of_week_month   -0.8062    1.567     -0.514  0.609  -3.934   2.322
  bobblehead_fireworks   0.3390    0.055      6.168  0.000   0.229   0.449

        Omnibus:  1.977     Durbin-Watson:     2.080
  Prob(Omnibus):  0.372  Jarque-Bera (JB):     1.955
           Skew:  0.360          Prob(JB):     0.376
       Kurtosis:  2.753          Cond. No.  9.22e+15
```

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
[2] The smallest eigenvalue is 2.51e-30. This might indicate that there are
strong multicollinearity problems or that the design matrix is singular.

Observation: Based on above results, the R-squared value is 0.46 indicating that the features considered account for 46% variation in attendance and there are still other factors which might influence/improve the attendance. The variables/features such as month, day_of_week, temp, shirt, fireworks, bobblehead and bobblehead+fireworks combo all have positive coeff indicating that these are factors that can influence the overall attendance. Considering p-value, bobblehead and bobblehead+fireworks has value < 0.05 indicating that these features have significant contribution to this model.

Conclusion

Overall, it is safe to say that based on the Dodgers game data, the attendance is higher on Tuesdays and mean attendance is higher in summer months - June, July and August where temperatures are warmer and ideal for games. The regression model results also support the same analysis along with the sales/promotions of bobblehead, fireworks and shirts. Finally, to improve MLB attendance, more games can be set on Tuesdays when temperatures are warmer in Summer and running sales/promotions around bobblehead, fireworks, shirt etc.