Assignment -Week3

Exercise 3.2 - Using Data to Improve MLB Attendance

Course: DSC630 - Predictive Analytics
Instructor: Fadi Alsaleem

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'''Date :06-26-2022'''

'''In this assignment, you will be using data on the Los Angeles Dodgers Major League Baseball (MLB) team located here: dodgers.csv. Use this data to make a recommendation to management on how to improve attendance. Tell a story with your analysis and clearly explain the steps you take to arrive at your conclusion. This is an open-ended question, and there is no one right answer. You are welcome to do additional research and/or use domain knowledge to assist your analysis, but clearly state any assumptions you make.

You can use R or Python to complete this assignment. Submit your code and output to the submission link. Make sure to add comments to all your code and to document your steps, process, and analysis.'''

In [1]:

```python
# Importing necessary libraries

import numpy as np
import pandas as pd
# Plots
import matplotlib.pyplot as plt
import seaborn as sns
from scipy.stats import norm
# Scikit learn
from sklearn.model_selection import train_test_split
from sklearn.metrics import mean_squared_error, r2_score, mean_absolute_error
import sklearn.metrics as metrics
from sklearn.linear_model import LinearRegression
#ignore warnings
import warnings
warnings.filterwarnings("ignore")
```

In [3]:

```python
# Create a from the given csv dodgers dataframe
dodg_df = pd.read_csv('dodgers-2022.csv')
dodg_df.head(10)
```

Out[3]:

	month	day	attend	day_of_week	opponent	temp	skies	day_night	cap	shirt	fireworks	b
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	

	month	day	attend	day_of_week	opponent	temp	skies	day_night	cap	shirt	fireworks	b
4	APR	14	46549	Saturday	Padres	57	Cloudy	Night	NO	NO	NO	
5	APR	15	38359	Sunday	Padres	65	Clear	Day	NO	NO	NO	
6	APR	23	26376	Monday	Braves	60	Cloudy	Night	NO	NO	NO	
7	APR	24	44014	Tuesday	Braves	63	Cloudy	Night	NO	NO	NO	
8	APR	25	26345	Wednesday	Braves	64	Cloudy	Night	NO	NO	NO	
9	APR	27	44807	Friday	Nationals	66	Clear	Night	NO	NO	YES	

In [4]:

```
# dispaly the data type of the data frame
dodg_df.dtypes
```

Out[4]:

```
month          object
day             int64
attend          int64
day_of_week    object
opponent       object
temp            int64
skies          object
day_night      object
cap            object
shirt          object
fireworks      object
bobblehead     object
dtype: object
```

In [5]:

```
# Verify the shape of the data frame
dodg_df.shape
```

Out[5]:

```
(81, 12)
```

In [6]:

```
# Summary description of your data frame
dodg_df.describe()
```

Out[6]:

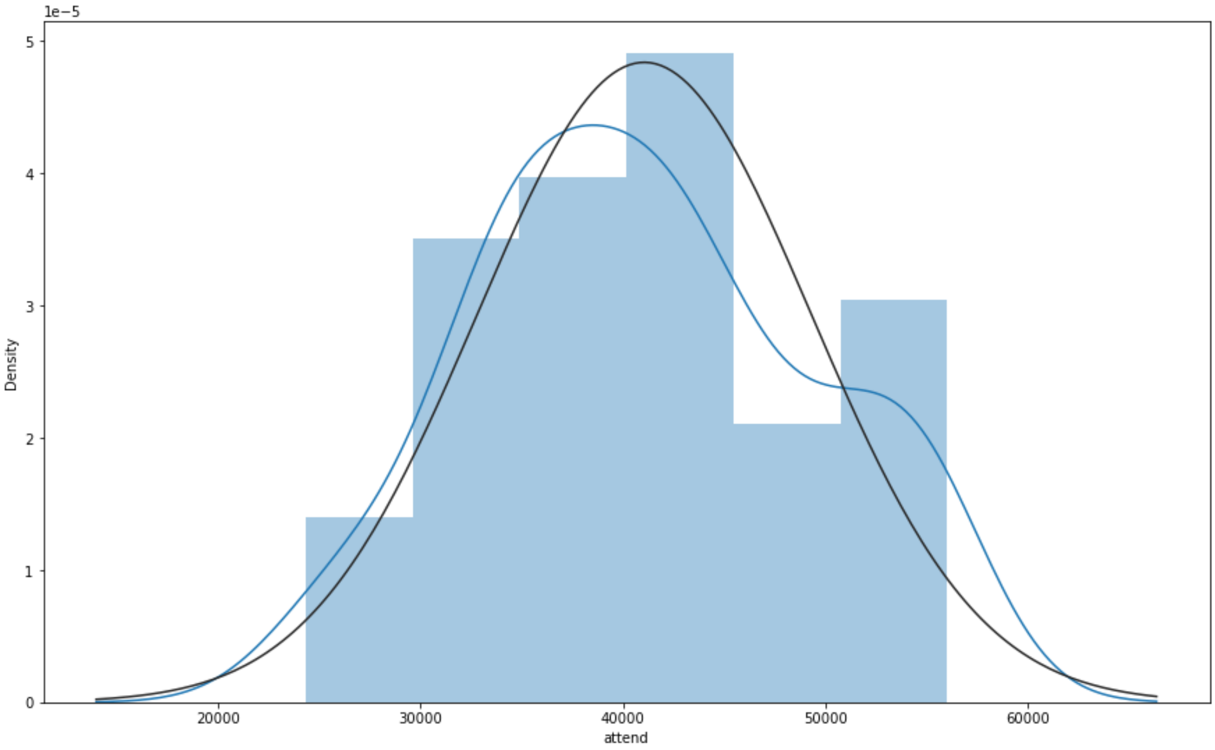
	day	attend	temp
count	81.000000	81.000000	81.000000
mean	16.135802	41040.074074	73.148148
std	9.605666	8297.539460	8.317318
min	1.000000	24312.000000	54.000000
25%	8.000000	34493.000000	67.000000
50%	15.000000	40284.000000	73.000000
75%	25.000000	46588.000000	79.000000
max	31.000000	56000.000000	95.000000

Visualizations

In [7]:

```
# Basic plot of probability histogram and bell curve
```

```
plt.figure(figsize=(15,9))
sns.distplot(dodg_df['attend'], fit=norm);
fig = plt.figure()
```



```
<Figure size 432x288 with 0 Axes>
```

In [10]:

```
# Verify and display the  kurtosis

print("Kurtosis: %f" % dodg_df['attend'].kurt())

'''Kurtosis is a measure of whether the data are heavy-tailed or light-tailed relati
```

```
Kurtosis: -0.753389
```

Out[10]:

```
'Kurtosis is a measure of whether the data are heavy-tailed or light-tailed relative
to a normal distribution.'
```

In [11]:

```
# Verify and display the  skewness


print("Skew %f" % dodg_df['attend'].skew())

'''Skewness is a measure of the asymmetry of a distribution. A distribution is asymm
```

```
Skew 0.137615
```

Out[11]:

```
'Skewness is a measure of the asymmetry of a distribution. A distribution is asymmet
rical when its left and right side are not mirror images. A distribution can have ri
ght (or positive), left (or negative), or zero skewness'
```

Analysis of above Skewness & Kurtosis

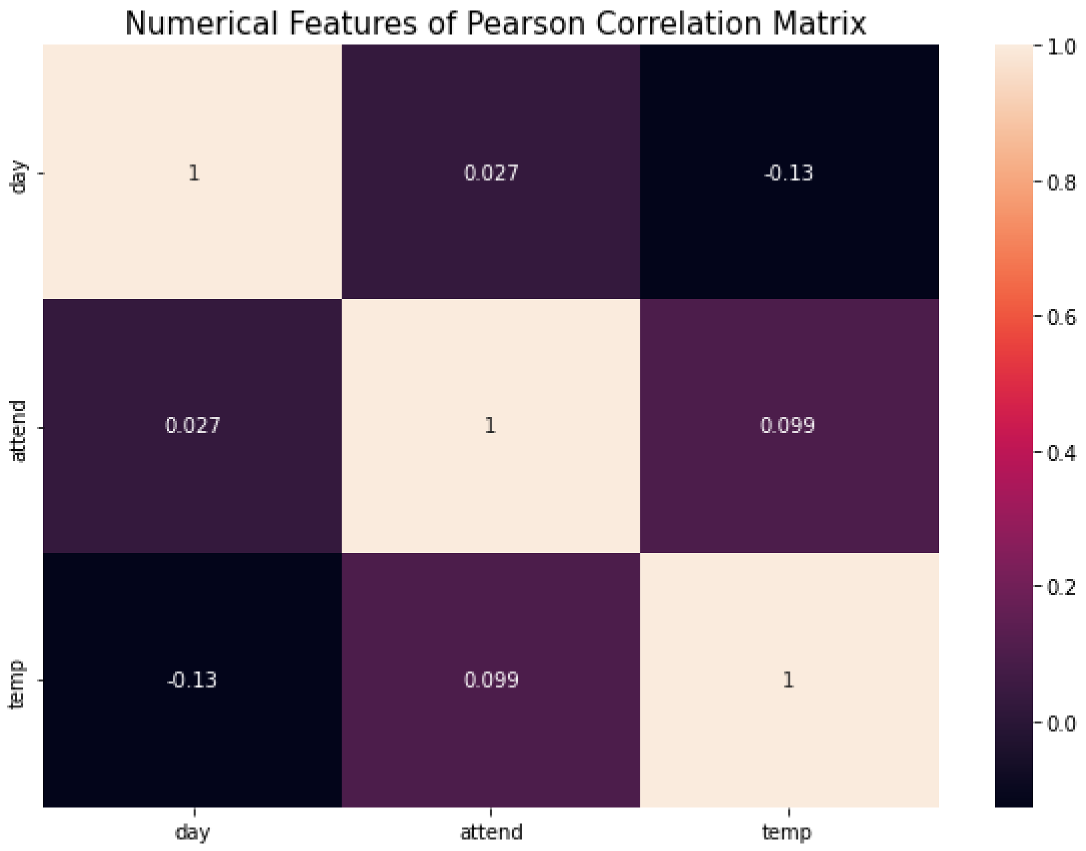
''' The value of skewness is 0.13716 which is between -0.5 and 0.5 . Hence, the distribution is approximately symmetric. The value for Kurtosus is -0.753389 and is less than 3.Hence ,the dataset has lighter tails than a normal distribution '''

In [12]:

```
# Correlation and numerical Variables
```

```
co_mat = dodg_df.corr()

#  perfom the heatmap using the co_mat created in the previous step
plt.figure(figsize=(10,7))
sns.heatmap(co_mat, annot = True)
plt.title(' Numerical Features of Pearson Correlation Matrix', fontsize=15)
plt.show()
```



Findings

''' This is to display the relation between numerical or non-categorical variables present in the data set , We could see the attendance is postively correlated to temperature. Hence anything with increase in temperature results in increase in head count

The day of the month is also positively correlated to the temperature,which means that people not interested much to go to match during initial days of the months

''' People interested to go out to see the match when temperature is good, also they are interested to go out during mid and end of the month.

In [22]:

```
# Categorical Variables & dataframe
pd.set_option('display.max_columns', None)
catCols = ['month', 'day_of_week', 'opponent','skies','day_night', 'cap', 'shirt', '
cat_dodg_df = pd.get_dummies(dodg_df, columns=catCols)
cat_dodg_df.head(10)
```

Out[22]:

	day	attend	temp	month_APR	month_AUG	month_JUL	month_JUN	month_MAY	month_OCT
0	10	56000	67	1	0	0	0	0	0

	day	attend	temp	month_APR	month_AUG	month_JUL	month_JUN	month_MAY	month_OCT
1	11	29729	58	1	0	0	0	0	0
2	12	28328	57	1	0	0	0	0	0
3	13	31601	54	1	0	0	0	0	0
4	14	46549	57	1	0	0	0	0	0
5	15	38359	65	1	0	0	0	0	0
6	23	26376	60	1	0	0	0	0	0
7	24	44014	63	1	0	0	0	0	0
8	25	26345	64	1	0	0	0	0	0
9	27	44807	66	1	0	0	0	0	0

In [25]:

```
# Perfom a a Spearman Correlation Matrix to understand the relation between the cate
cat_dodg_df.corr('spearman').style.background_gradient(cmap="Blues")
```

Out[25]:

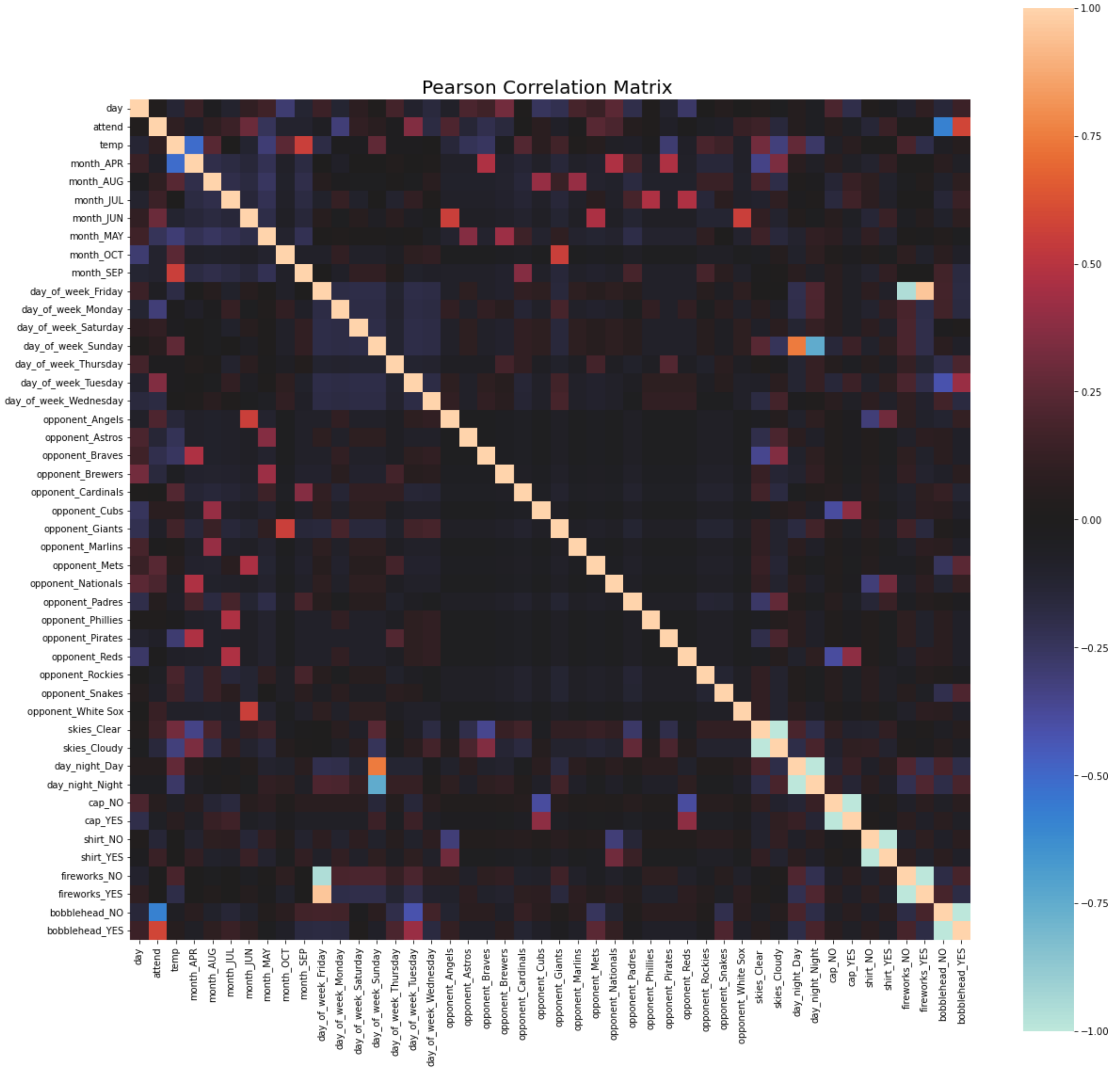
	day	attend	temp	month_APR	month_AUG	month_JUL	mor
day	1.000000	0.063626	-0.123692	0.104875	-0.028569	-0.079586	0
attend	0.063626	1.000000	0.090628	-0.055739	0.101270	0.096614	0
temp	-0.123692	0.090628	1.000000	-0.495820	0.296848	0.012656	-0
month_APR	0.104875	-0.055739	-0.495820	1.000000	-0.198811	-0.173913	-0
month_AUG	-0.028569	0.101270	0.296848	-0.198811	1.000000	-0.198811	-0
month_JUL	-0.079586	0.096614	0.012656	-0.173913	-0.198811	1.000000	-0
month_JUN	0.108461	0.314192	-0.132964	-0.147442	-0.168550	-0.147442	1
month_MAY	0.153172	-0.223536	-0.337159	-0.222911	-0.254824	-0.222911	-0
month_OCT	-0.293820	-0.109043	0.268880	-0.081786	-0.093495	-0.081786	-0
month_SEP	-0.113057	-0.109991	0.527833	-0.173913	-0.198811	-0.173913	-0
day_of_week_Friday	0.134612	-0.030209	-0.167878	0.007013	0.051309	-0.087664	0
day_of_week_Monday	-0.119007	-0.325514	-0.024568	-0.076087	-0.019881	0.119565	-0
day_of_week_Saturday	0.083503	0.128028	-0.044672	0.007013	-0.035275	-0.087664	0
day_of_week_Sunday	0.035273	0.051787	0.237768	0.007013	-0.035275	0.007013	-0
day_of_week_Thursday	0.172376	-0.008776	0.014286	0.037438	0.009782	-0.106966	0
day_of_week_Tuesday	-0.090701	0.333736	-0.020895	0.007013	-0.035275	0.101690	-0
day_of_week_Wednesday	-0.165867	-0.167959	0.010423	0.021739	0.069584	0.021739	-0
opponent_Angels	-0.106335	0.204106	-0.184855	-0.081786	-0.093495	-0.081786	0
opponent_Astros	0.179090	-0.156575	-0.226868	-0.081786	-0.093495	-0.081786	-0
opponent_Braves	0.141313	-0.167758	-0.278683	0.470270	-0.093495	-0.081786	-0

	day	attend	temp	month_APR	month_AUG	month_JUL	mor
opponent_Brewers	0.319518	-0.134038	-0.059812	-0.095050	-0.108657	-0.095050	-0
opponent_Cardinals	0.038556	0.015034	0.181659	-0.128262	-0.146625	-0.128262	-0
opponent_Cubs	-0.237854	0.109043	0.082625	-0.081786	0.411377	-0.081786	-0
opponent_Giants	-0.216080	-0.086529	0.196922	-0.147442	0.134840	-0.147442	-0
opponent_Marlins	0.159502	0.002796	0.032210	-0.081786	0.411377	-0.081786	-0
opponent_Mets	0.130490	0.248580	0.076901	-0.095050	-0.108657	0.065347	0
opponent_Nationals	0.225262	0.204106	-0.079824	0.470270	-0.093495	-0.081786	-0
opponent_Padres	-0.188335	0.038644	-0.010099	0.184302	-0.168550	0.184302	-0
opponent_Phillies	0.053167	-0.011184	-0.025208	-0.081786	-0.093495	0.470270	-0
opponent_Pirates	-0.131519	-0.082481	-0.273081	0.470270	-0.093495	-0.081786	-0
opponent_Reds	-0.264438	-0.030756	-0.092428	-0.081786	-0.093495	0.470270	-0
opponent_Rockies	-0.021860	-0.082328	0.161577	-0.147442	0.134840	-0.147442	-0
opponent_Snakes	0.052969	-0.089049	0.167468	-0.147442	0.134840	0.073721	-0
opponent_White Sox	0.029382	0.139799	-0.102230	-0.081786	-0.093495	-0.081786	0
skies_Clear	0.054252	0.144553	0.259024	-0.343251	0.188903	-0.097204	0
skies_Cloudy	-0.054252	-0.144553	-0.259024	0.343251	-0.188903	0.097204	-0
day_night_Day	0.052377	0.031944	0.249189	0.069584	0.018182	-0.019881	0
day_night_Night	-0.052377	-0.031944	-0.249189	-0.069584	-0.018182	0.019881	-0
cap_NO	0.194109	0.051039	-0.066466	0.066354	-0.128951	-0.157591	0
cap_YES	-0.194109	-0.051039	0.066466	-0.066354	0.128951	0.157591	-0
shirt_NO	0.037777	-0.139799	-0.011203	-0.102233	0.093495	0.081786	-0
shirt_YES	-0.037777	0.139799	0.011203	0.102233	-0.093495	-0.081786	0
fireworks_NO	-0.091546	-0.015361	0.178363	0.006808	-0.034245	0.006808	-0
fireworks_YES	0.091546	0.015361	-0.178363	-0.006808	0.034245	-0.006808	0
bobblehead_NO	-0.141919	-0.544860	-0.074884	0.063872	-0.089337	-0.139015	-0
bobblehead_YES	0.141919	0.544860	0.074884	-0.063872	0.089337	0.139015	0

In [24]:

```
# Plotting heat map matrix for the correlation

fig, ax = plt.subplots(figsize=(20, 20))
sns.heatmap(cat_dodg_df.corr(), center=0,
            vmin=-1, vmax=1,  square=True)
# title
plt.title('Pearson Correlation Matrix ', fontsize=20)
plt.show()
```



In [26]:

```
# Verify the variables correlationg with attend Pearson correlation is used
df_correlations = cat_dodg_df.corr().stack().reset_index().sort_values(0, ascending=
df_correlations.loc[df_correlations['level_0'] == 'attend'].sort_values(0, ascending
```

Out[26]:

	level_0	level_1	0
47	attend	attend	1.000000
91	attend	bobblehead_YES	0.581895
61	attend	day_of_week_Tuesday	0.355316
52	attend	month_JUN	0.295853
71	attend	opponent_Mets	0.236213
63	attend	opponent_Angels	0.207796
72	attend	opponent_Nationals	0.195667
80	attend	skies_Clear	0.150963
51	attend	month_JUL	0.143837
87	attend	shirt_YES	0.133269
79	attend	opponent_White Sox	0.127046

	level_0	level_1	0
58	attend	day_of_week_Saturday	0.107788
48	attend	temp	0.098951
50	attend	month_AUG	0.098944
68	attend	opponent_Cubs	0.075310
59	attend	day_of_week_Sunday	0.065153
84	attend	cap_NO	0.055002
73	attend	opponent_Padres	0.045111
82	attend	day_night_Day	0.043544
46	attend	day	0.027093
74	attend	opponent_Phillies	0.020380
89	attend	fireworks_YES	0.002094
88	attend	fireworks_NO	-0.002094
67	attend	opponent_Cardinals	-0.006967
70	attend	opponent_Marlins	-0.008912
76	attend	opponent_Reds	-0.009301
60	attend	day_of_week_Thursday	-0.019679
83	attend	day_night_Night	-0.043544
56	attend	day_of_week_Friday	-0.048948
85	attend	cap_YES	-0.055002
77	attend	opponent_Rockies	-0.060404
75	attend	opponent_Pirates	-0.071849
49	attend	month_APR	-0.073237
78	attend	opponent_Snakes	-0.073943
69	attend	opponent_Giants	-0.074763
54	attend	month_OCT	-0.103132
55	attend	month_SEP	-0.105443
86	attend	shirt_NO	-0.133269
64	attend	opponent_Astros	-0.134533
81	attend	skies_Cloudy	-0.150963
66	attend	opponent_Brewers	-0.157030
62	attend	day_of_week_Wednesday	-0.174723
65	attend	opponent_Braves	-0.209171
53	attend	month_MAY	-0.239471
57	attend	day_of_week_Monday	-0.307198
90	attend	bobblehead_NO	-0.581895

In [27]:

```
# perfrom the same steps for spearman correlation
df_correlations = cat_dodg_df.corr('spearman').stack().reset_index().sort_values(0,
df_correlations.loc[df_correlations['level_0'] == 'attend'].sort_values(0, ascending
```

Out[27]:

	level_0	level_1	0
47	attend	attend	1.000000
91	attend	bobblehead_YES	0.544860
61	attend	day_of_week_Tuesday	0.333736
52	attend	month_JUN	0.314192
71	attend	opponent_Mets	0.248580
72	attend	opponent_Nationals	0.204106
63	attend	opponent_Angels	0.204106
80	attend	skies_Clear	0.144553
79	attend	opponent_White Sox	0.139799
87	attend	shirt_YES	0.139799
58	attend	day_of_week_Saturday	0.128028
68	attend	opponent_Cubs	0.109043
50	attend	month_AUG	0.101270
51	attend	month_JUL	0.096614
48	attend	temp	0.090628
46	attend	day	0.063626
59	attend	day_of_week_Sunday	0.051787
84	attend	cap_NO	0.051039
73	attend	opponent_Padres	0.038644
82	attend	day_night_Day	0.031944
89	attend	fireworks_YES	0.015361
67	attend	opponent_Cardinals	0.015034
70	attend	opponent_Marlins	0.002796
60	attend	day_of_week_Thursday	-0.008776
74	attend	opponent_Phillies	-0.011184
88	attend	fireworks_NO	-0.015361
56	attend	day_of_week_Friday	-0.030209
76	attend	opponent_Reds	-0.030756
83	attend	day_night_Night	-0.031944
85	attend	cap_YES	-0.051039
49	attend	month_APR	-0.055739
77	attend	opponent_Rockies	-0.082328
75	attend	opponent_Pirates	-0.082481

	level_0	level_1	0
69	attend	opponent_Giants	-0.086529
78	attend	opponent_Snakes	-0.089049
54	attend	month_OCT	-0.109043
55	attend	month_SEP	-0.109991
66	attend	opponent_Brewers	-0.134038
86	attend	shirt_NO	-0.139799
81	attend	skies_Cloudy	-0.144553
64	attend	opponent_Astros	-0.156575
65	attend	opponent_Braves	-0.167758
62	attend	day_of_week_Wednesday	-0.167959
53	attend	month_MAY	-0.223536
57	attend	day_of_week_Monday	-0.325514
90	attend	bobblehead_NO	-0.544860

In [28]:

```
# Linear Regression and Setting the value for X and Y
df = cat_dodg_df.copy()
y = df['attend']
x = df.drop('attend',1)
```

In [29]:

```
# display x
x.head(10)
```

Out[29]:

	day	temp	month_APR	month_AUG	month_JUL	month_JUN	month_MAY	month_OCT	month_
0	10	67	1	0	0	0	0	0	
1	11	58	1	0	0	0	0	0	
2	12	57	1	0	0	0	0	0	
3	13	54	1	0	0	0	0	0	
4	14	57	1	0	0	0	0	0	
5	15	65	1	0	0	0	0	0	
6	23	60	1	0	0	0	0	0	
7	24	63	1	0	0	0	0	0	
8	25	64	1	0	0	0	0	0	
9	27	66	1	0	0	0	0	0	

In [30]:

```
#display y
y.head(10)
```

Out[30]:

```
0     56000
```

```
1    29729
2    28328
3    31601
4    46549
5    38359
6    26376
7    44014
8    26345
9    44807
Name: attend, dtype: int64
```

In [31]:

```
# Regression,Split the dataframe for  test and train
x_train, x_test, y_train, y_test = train_test_split(x, y, test_size = 0.3, random_st
mlr = LinearRegression()
mlr.fit(x_train, y_train)
```

Out[31]:

```
LinearRegression()
```

In [32]:

```
#Display the Intercept and Coefficient
print("Intercept: ", mlr.intercept_)
print("Coefficients:")
list(zip(x, mlr.coef_))
```

```
Intercept:  48020.11016548952
Coefficients:
```

Out[32]:

```
[('day', 434.355000341727),
 ('temp', -53.287021631316165),
 ('month_APR', -5162.524705009922),
 ('month_AUG', 3252.9679797869258),
 ('month_JUL', -3729.480132314526),
 ('month_JUN', 1766.7257588288994),
 ('month_MAY', -3893.943253506471),
 ('month_OCT', 8168.691053597412),
 ('month_SEP', -402.436701382114),
 ('day_of_week_Friday', -13352.694193805717),
 ('day_of_week_Monday', -3978.044194345805),
 ('day_of_week_Saturday', 5313.480535971897),
 ('day_of_week_Sunday', -554.3668989426267),
 ('day_of_week_Thursday', 2490.266593191436),
 ('day_of_week_Tuesday', 10399.83674737709),
 ('day_of_week_Wednesday', -318.47858944643565),
 ('opponent_Angels', 4135.503696219865),
 ('opponent_Astros', -3366.4059260586882),
 ('opponent_Braves', -2421.7729629577757),
 ('opponent_Brewers', -6672.283749237911),
 ('opponent_Cardinals', -2123.0602836752814),
 ('opponent_Cubs', 7205.264409220857),
 ('opponent_Giants', -4713.739008370041),
 ('opponent_Marlins', -10059.067173755366),
 ('opponent_Mets', -2415.7500528278333),
 ('opponent_Nationals', 3409.813331805797),
 ('opponent_Padres', 7695.221367732398),
 ('opponent_Phillies', 4448.522568210216),
 ('opponent_Pirates', 2382.713377431897),
 ('opponent_Reds', 8256.531731823246),
 ('opponent_Rockies', -581.9926495306664),
 ('opponent_Snakes', -5226.47079146744),
 ('opponent_White Sox', 46.97211543675491),
 ('skies_Clear ', 3254.0753663718147),
 ('skies_Cloudy', -3254.075366371839),
 ('day_night_Day', 3642.87028091717),
 ('day_night_Night', -3642.870280917145),
 ('cap_NO', 4624.466183277177),
 ('cap_YES', -4624.466183277177),
 ('shirt_NO', -5253.564759752588),
 ('shirt_YES', 5253.56475975259),
 ('fireworks_NO', -7190.4004079002725),
 ('fireworks_YES', 7190.400407900244),
 ('bobblehead_NO', -2838.518579606259),
 ('bobblehead_YES', 2838.518579606262)]
```

In [33]:

```
# Test data set Predictions
y_pred_mlr= mlr.predict(x_test)
print("Prediction of test set: {}".format(y_pred_mlr))
```

```
Prediction of test set: [61112.14490535 50688.62495422 44441.81566532 49289.03661167
 42609.46252332 35508.12736722 36392.42139352 34985.92659206
 31947.84512894 45389.80584226 62754.08093432 50082.63692479
 37093.74548468 30701.01392035 32388.56614008 38632.25077381
 25695.74880189 45075.814302   57797.75681378 23857.82578383
 30606.84261022 34062.68411605 47054.54832527 35442.43761246
 37055.79617209]
```

In [34]:

```
# Actual value and the predicted value
mlr_diff = pd.DataFrame({'Actual value': y_test, 'Predicted value': y_pred_mlr})
mlr_diff.head()
```

Out[34]:

	Actual value	Predicted value
11	48753	61112.144905
77	35607	50688.624954
25	33306	44441.815665
5	38359	49289.036612
62	40284	42609.462523

In [35]:

```
#Model prediction and evaluations

meanAbErr = metrics.mean_absolute_error(y_test, y_pred_mlr)
meanSqErr = metrics.mean_squared_error(y_test, y_pred_mlr)
rootMeanSqErr = np.sqrt(metrics.mean_squared_error(y_test, y_pred_mlr))
print('Mean Absolute Error:', meanAbErr)
print('Mean Square Error:', meanSqErr)
print('Root Mean Square Error:', rootMeanSqErr)
print('R squared: {:.2f}'.format(mlr.score(x,y)*100))
```

```
Mean Absolute Error: 9637.865409141374
Mean Square Error: 128425071.68335876
Root Mean Square Error: 11332.478620467755
R squared: 32.04
```

In [36]:

```
    # My observationa and recommendations to be considerd to improve MLB attendance

    ''' More games played in the summer has highly positively correlated, hence havi
```

Out[36]:

```
' More games played in the summer has highly positively correlated, hence having mor
e games in summer will help to gather more crowd.  Games over the weekends especiall
y on sauterday has positive corelation, however tuesday also has positive correlatio
n.  Considering this we cant have more games on the same days and they can try to ar
range schedules accordingly to get more attendance. Cubs , Angesl, White sox and nat
```

```
ionals has positive correlation hence it would be better to have those team schedule
frequently will increase more audiance. Free giveaway goodies as t-shirt bobbleheads
are positively corelated hence continue giving them will improve more audience. '
```

```
In [ ]:
```