```python
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
%matplotlib inline
import warnings
warnings.filterwarnings('ignore')
```

```python
df = pd.read_excel('F:/simplilearn/projects/ml projects/employee
turnover analytics/dataset.xlsx')
```

```python
df
```

```
       satisfaction_level  last_evaluation  number_project  \
0                    0.38             0.53               2
1                    0.80             0.86               5
2                    0.11             0.88               7
3                    0.72             0.87               5
4                    0.37             0.52               2
...                   ...              ...             ...
14994                0.40             0.57               2
14995                0.37             0.48               2
14996                0.37             0.53               2
14997                0.11             0.96               6
14998                0.37             0.52               2

       average_montly_hours  time_spend_company  Work_accident
left  \
0                       157                   3              0     1

1                       262                   6              0     1

2                       272                   4              0     1

3                       223                   5              0     1

4                       159                   3              0     1

...                     ...                 ...            ...   ...

14994                   151                   3              0     1

14995                   160                   3              0     1

14996                   143                   3              0     1

14997                   280                   4              0     1

14998                   158                   3              0     1
```

```
       promotion_last_5years    sales  salary
0                          0    sales     low
1                          0    sales  medium
2                          0    sales  medium
3                          0    sales     low
4                          0    sales     low
...                      ...      ...     ...
14994                      0  support     low
14995                      0  support     low
14996                      0  support     low
14997                      0  support     low
14998                      0  support     low

[14999 rows x 10 columns]
```

```
df.shape
```

```
(14999, 10)
```

```
df=df.rename(columns={'average_montly_hours':'average_weekly_hours','s
ales':'department'})
df['average_weekly_hours']=df['average_weekly_hours']*12/52
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 14999 entries, 0 to 14998
Data columns (total 10 columns):
 #   Column                 Non-Null Count  Dtype
---  ------                 --------------  -----
 0   satisfaction_level     14999 non-null  float64
 1   last_evaluation        14999 non-null  float64
 2   number_project         14999 non-null  int64
 3   average_weekly_hours   14999 non-null  float64
 4   time_spend_company     14999 non-null  int64
 5   Work_accident          14999 non-null  int64
 6   left                   14999 non-null  int64
 7   promotion_last_5years  14999 non-null  int64
 8   department             14999 non-null  object
 9   salary                 14999 non-null  object
dtypes: float64(3), int64(5), object(2)
memory usage: 1.1+ MB
```

```
# no null values
df.isna().sum()
```

```
satisfaction_level       0
last_evaluation          0
number_project           0
average_weekly_hours     0
time_spend_company       0
Work_accident            0
```

```
left                     0
promotion_last_5years    0
department               0
salary                   0
dtype: int64
```

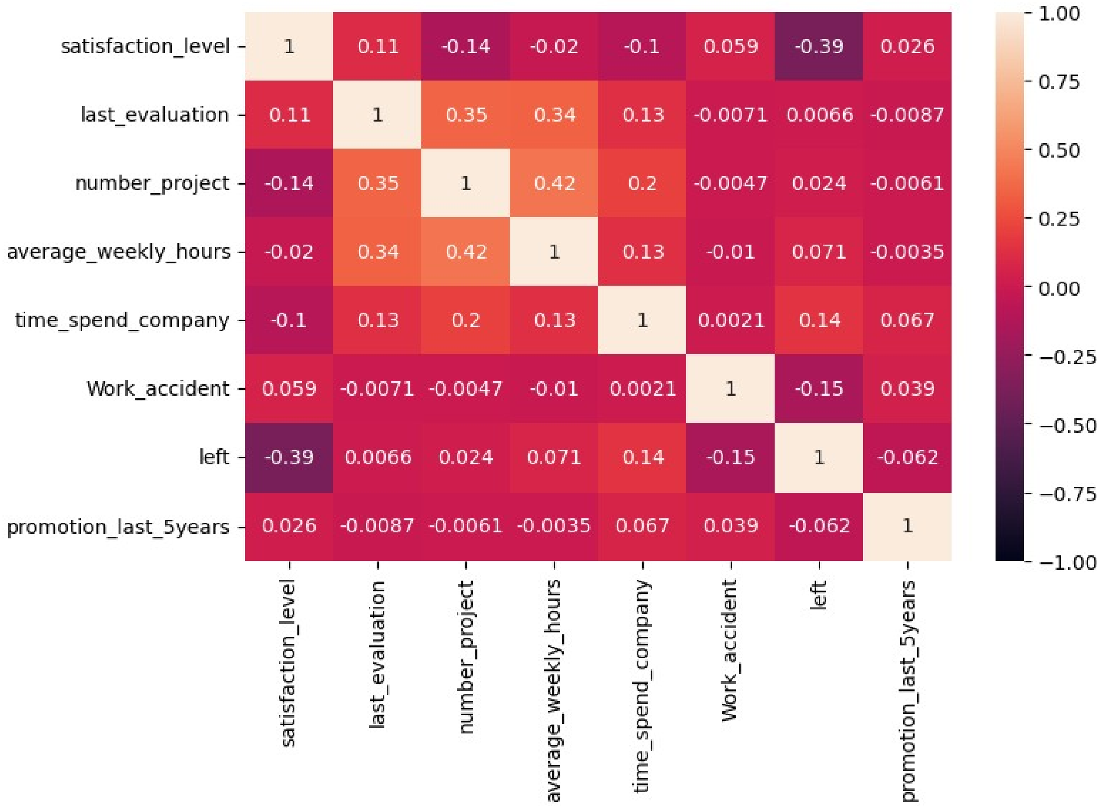
```
df = df.loc[:,~df.T.duplicated(keep='first')]
```

```
df.shape
```

```
(14999, 10)
```

```
# factors that contributed more to employee turn over
plt.figure(figsize=(8,5))
sns.heatmap(df.corr(),annot=True,vmin=-1,vmax=1)
plt.show()
```

```
<IPython.core.display.Javascript object>
```

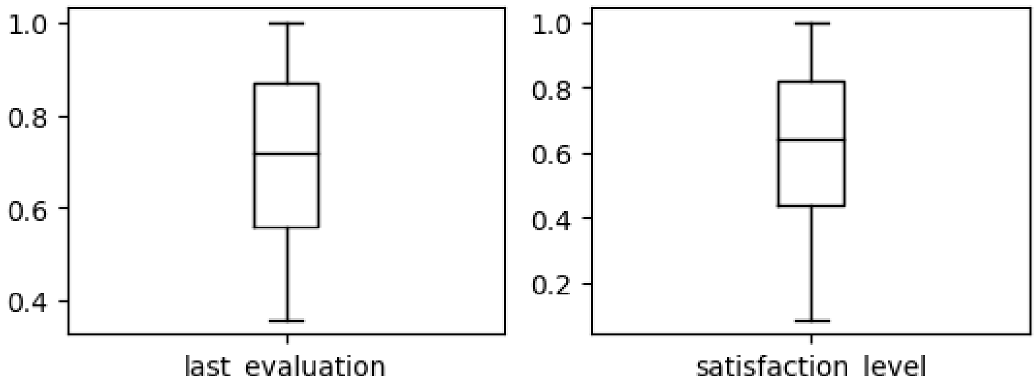



```
# only the satisfaction level shows some strong negetive releation
with ETO with a pearson correleation of -0.39
```

```
from sklearn.decomposition import PCA
from sklearn.cluster import KMeans
```

```
df[['last_evaluation','satisfaction_level']].plot(kind =
'box',subplots = True, layout = (2,2), sharex = False, sharey =
```

```
False,color='black')
plt.show()
```




```
df[['last_evaluation','satisfaction_level']].describe()
```

```
       last_evaluation  satisfaction_level
count     14999.000000        14999.000000
mean          0.716102            0.612834
std           0.171169            0.248631
min           0.360000            0.090000
25%           0.560000            0.440000
50%           0.720000            0.640000
75%           0.870000            0.820000
max           1.000000            1.000000
```

```
df['left'].value_counts()
# out of every 4 employees 1 employeee has left the company
```

```
0    11428
1     3571
Name: left, dtype: int64
```

```
df[['Work_accident']].value_counts()
```

```
Work_accident
0                12830
1                 2169
dtype: int64
```

```
# we can  say the following
# they have a relatively short tenure with the firm (average of 3.5
years, max of 10 years)
# they are generally more satisfied than not (.61 average satisfaction
level)
# they are generally above average performers (.716 average rating in
their last evaluation)
# 14.46% (approximately 1 in 7) of the people have had work accidents

df.describe()
```

```
       satisfaction_level  last_evaluation  number_project  \
count        14999.000000     14999.000000    14999.000000
mean             0.612834         0.716102        3.803054
std              0.248631         0.171169        1.232592
min              0.090000         0.360000        2.000000
25%              0.440000         0.560000        3.000000
50%              0.640000         0.720000        4.000000
75%              0.820000         0.870000        5.000000
max              1.000000         1.000000        7.000000

       average_weekly_hours  time_spend_company  Work_accident
left  \
count          14999.000000        14999.000000   14999.000000
14999.000000
mean              46.396232            3.498233       0.144610
0.238083
std               11.525331            1.460136       0.351719
0.425924
min               22.153846            2.000000       0.000000
0.000000
25%               36.000000            3.000000       0.000000
0.000000
50%               46.153846            3.000000       0.000000
0.000000
75%               56.538462            4.000000       0.000000
0.000000
max               71.538462           10.000000       1.000000
1.000000

       promotion_last_5years
count           14999.000000
mean                0.021268
std                 0.144281
min                 0.000000
25%                 0.000000
50%                 0.000000
75%                 0.000000
max                 1.000000
```

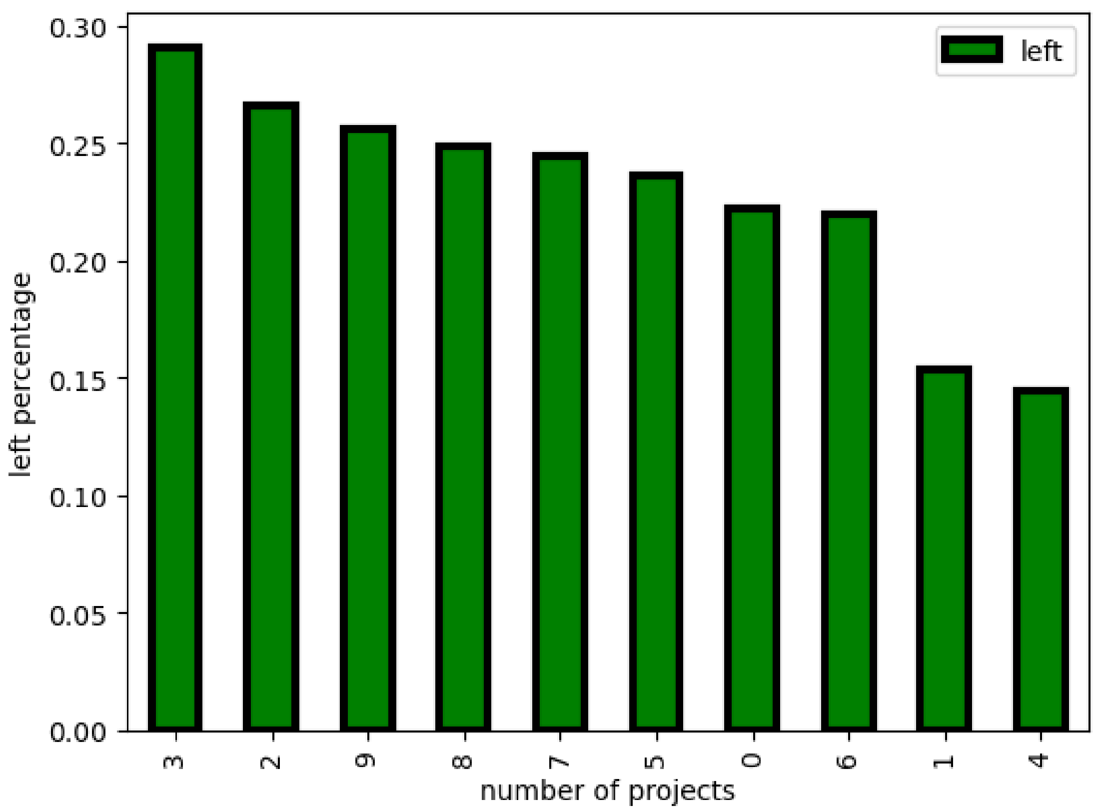
```
df.describe(include='O')
```

```
       department salary
count       14999  14999
unique         10      3
top         sales    low
freq         4140   7316
```

```
print(df[['department','left']].groupby('department',as_index=False).m
ean().sort_values(by=['left'],ascending=False))
df[['department','left']].groupby('department',as_index=False).mean().
sort_values(by=['left'],ascending=False).plot(kind='bar',color='g',edg
```

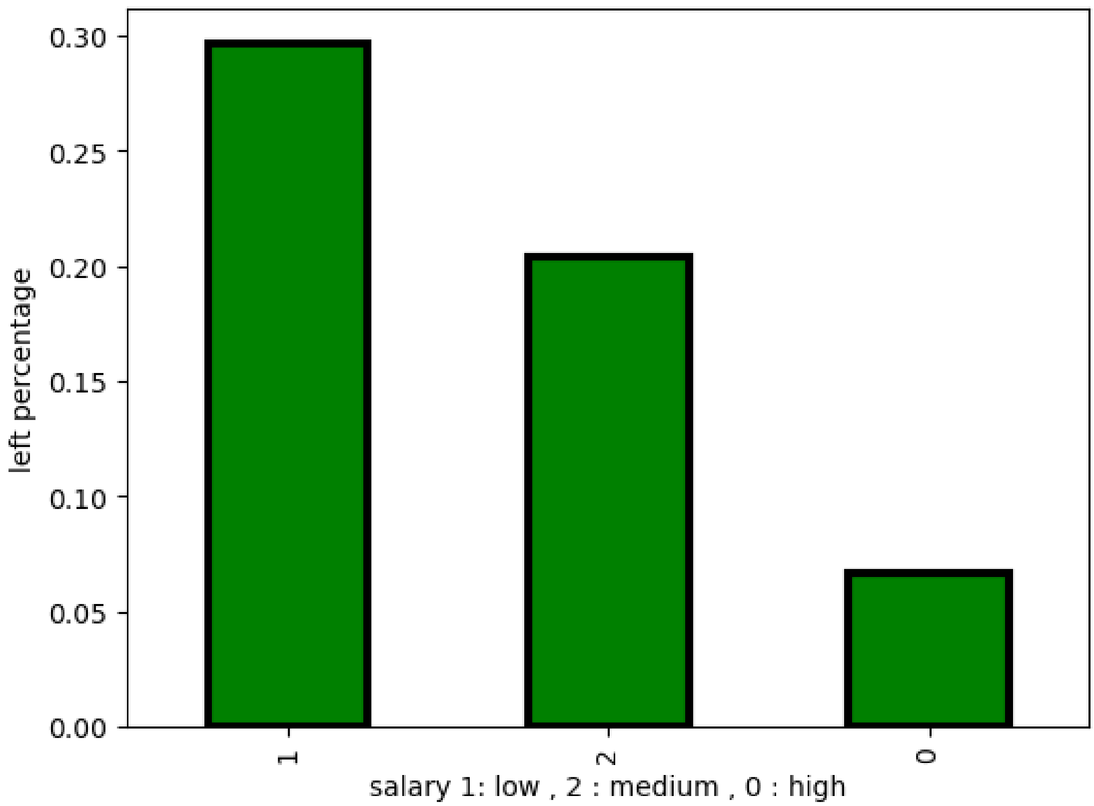
```
ecolor='black',linewidth=3)
plt.xlabel('number of projects')
plt.ylabel('left percentage')
plt.show()
```

```
    department      left
3           hr  0.290934
2   accounting  0.265971
9    technical  0.256250
8      support  0.248991
7        sales  0.244928
5    marketing  0.236597
0           IT  0.222494
6  product_mng  0.219512
1        RandD  0.153748
4   management  0.144444
```



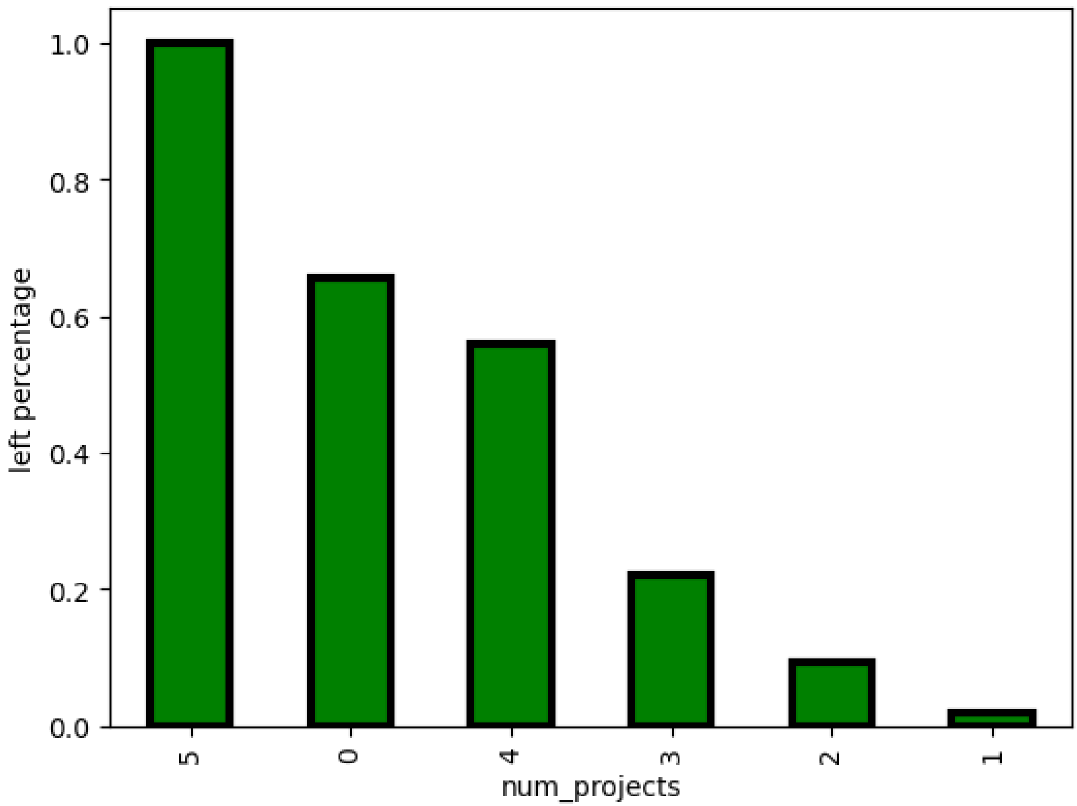

```
print(df[['salary','left']].groupby('salary',as_index=False).mean().so
rt_values(by=['left'],ascending=False))
df[['salary','left']].groupby('salary',as_index=False).mean().sort_val
ues(by=['left'],ascending=False)
['left'].plot(kind='bar',color='g',edgecolor='black',linewidth=3)
plt.xlabel('salary 1: low , 2 : medium , 0 : high')
plt.ylabel('left percentage')
plt.show()
```

```
   salary      left
1     low  0.296884
2  medium  0.204313
0    high  0.066289
```



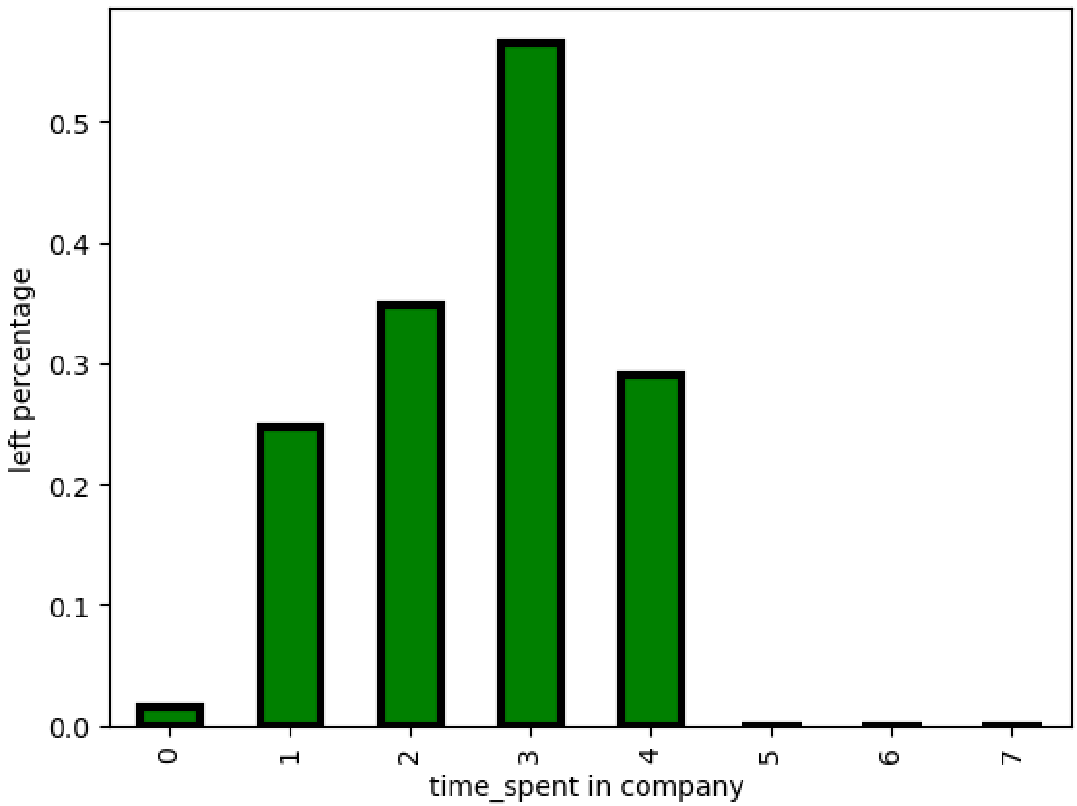

```
print(df[['number_project','left']].groupby('number_project',as_index=
False).mean().sort_values(by=['left'],ascending=False))
df[['number_project','left']].groupby('number_project',as_index=False)
.mean().sort_values(by=['left'],ascending=False)
['left'].plot(kind='bar',color='g',edgecolor='black',linewidth=3)
plt.xlabel('num_projects')
plt.ylabel('left percentage')
plt.show()
```

```
   number_project      left
5               7  1.000000
0               2  0.656198
4               6  0.557922
3               5  0.221659
2               4  0.093700
1               3  0.017756
```




```
print(df[['time_spend_company',
'left']].groupby(['time_spend_company'],
as_index=False).mean().sort_values(by='time_spend_company'))
df[['time_spend_company', 'left']].groupby(['time_spend_company'],
as_index=False).mean().sort_values(by='time_spend_company')
['left'].plot(kind='bar',color='g',edgecolor='black',linewidth=3)

plt.xlabel('time_spent in company ')
plt.ylabel('left percentage')
plt.show()
```

```
   time_spend_company      left
0                   2  0.016338
1                   3  0.246159
2                   4  0.348064
3                   5  0.565513
4                   6  0.291086
5                   7  0.000000
6                   8  0.000000
7                  10  0.000000
```

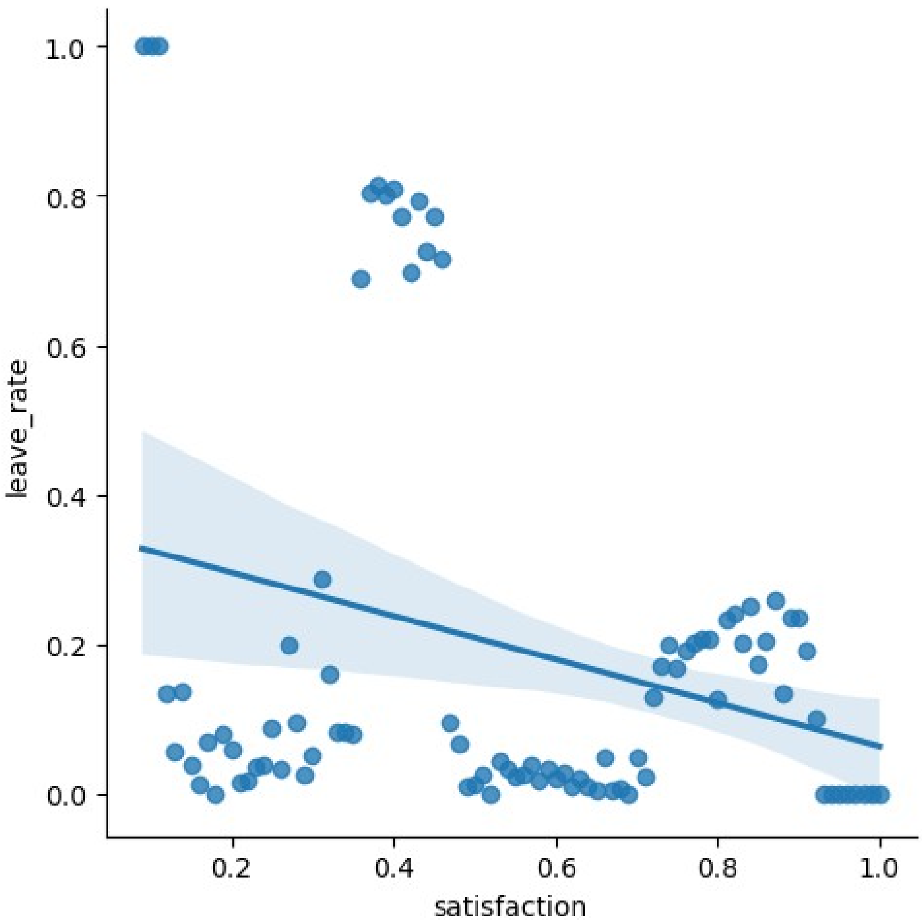



```
df[['average_weekly_hours','number_project']].corr()

                      average_weekly_hours  number_project
average_weekly_hours              1.000000        0.417211
number_project                    0.417211        1.000000

# Observations:

# We observe that lower satisfaction levels are associated with higher
levels of turnover, as expected
# Regarding evaluation scores, it's interesting to note the two
"clusters" that form; the people who leave tend to either have
received low scores (.6 and below) or very high scores (.8 and above).
Employees scoring in the middle rarely left.
# A similar clustering effect is shown for the weekly hours graph as
well. People tend to leave when they are overworked or underworked. We
also observe that the pattern we see for the weekly hours feature is
similar to that of the number of projects feature.
# Conclusions:

# Use the satisfaction_level feature in our model
# We may need to do some data wrangling on the last_evaluation
feature. Consider creating two bands, exceptional scores (both really
good and really bad evaluations) vs. the rest.
# Given that both the weekly hours feature and number of projects
```

*feature exhibit a comparable clustering effect and that there is a moderate correlation between these variables (.417, as calculated earlier), I will only use the number of projects feature in my model and discard the weekly hours feature for simplicity.*

```
leave_sat=df.groupby('satisfaction_level').agg({'left': lambda x: 
len(x[x==1])})
leave_sat['total']=df.groupby('satisfaction_level').agg({'left': len})
leave_sat['leave_rate']=leave_sat['left']/leave_sat['total']
leave_sat['satisfaction']=df.groupby('satisfaction_level').agg({'satis
faction_level': 'mean'})
g=sns.lmplot('satisfaction', 'leave_rate',data=leave_sat)
```

```
<IPython.core.display.Javascript object>
```

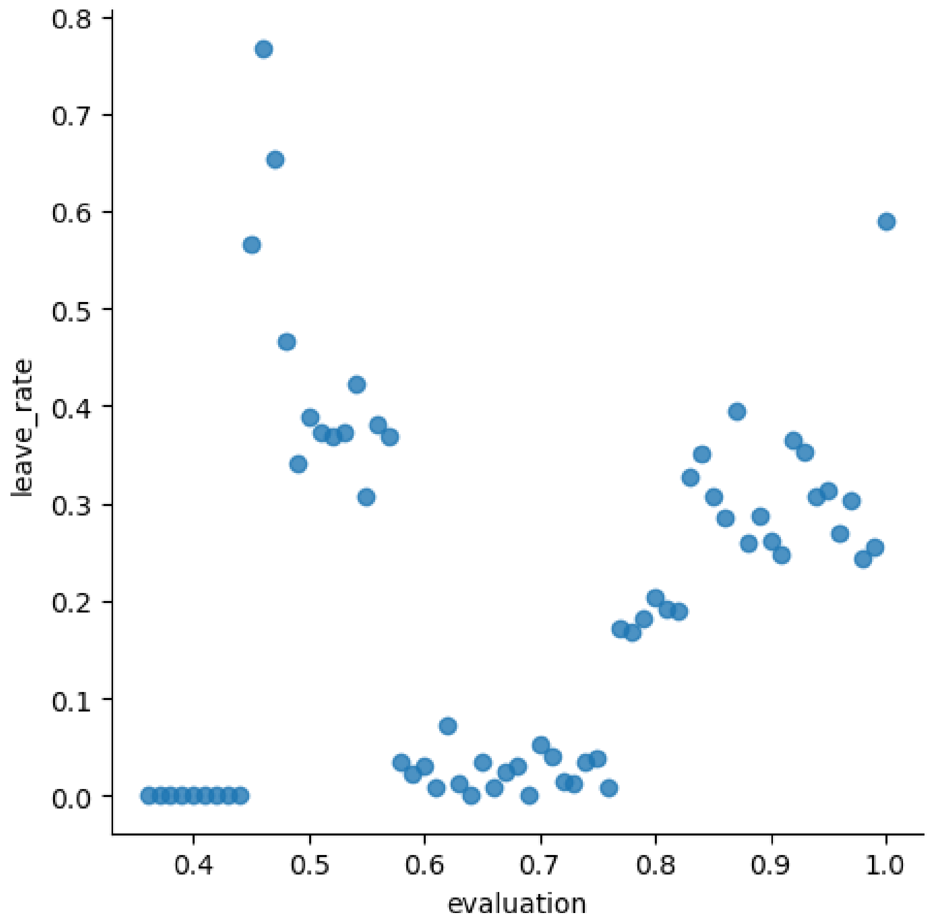



```
# the more the satisfaction is the lesser is hte leaving rate
```

```
leave_eval=df.groupby('last_evaluation').agg({'left': lambda x: 
len(x[x==1])})
leave_eval['total']=df.groupby('last_evaluation').agg({'left': len})
leave_eval['leave_rate']=leave_eval['left']/leave_eval['total']
leave_eval['evaluation']=df.groupby('last_evaluation').agg({'last_eval
uation': 'mean'})
```

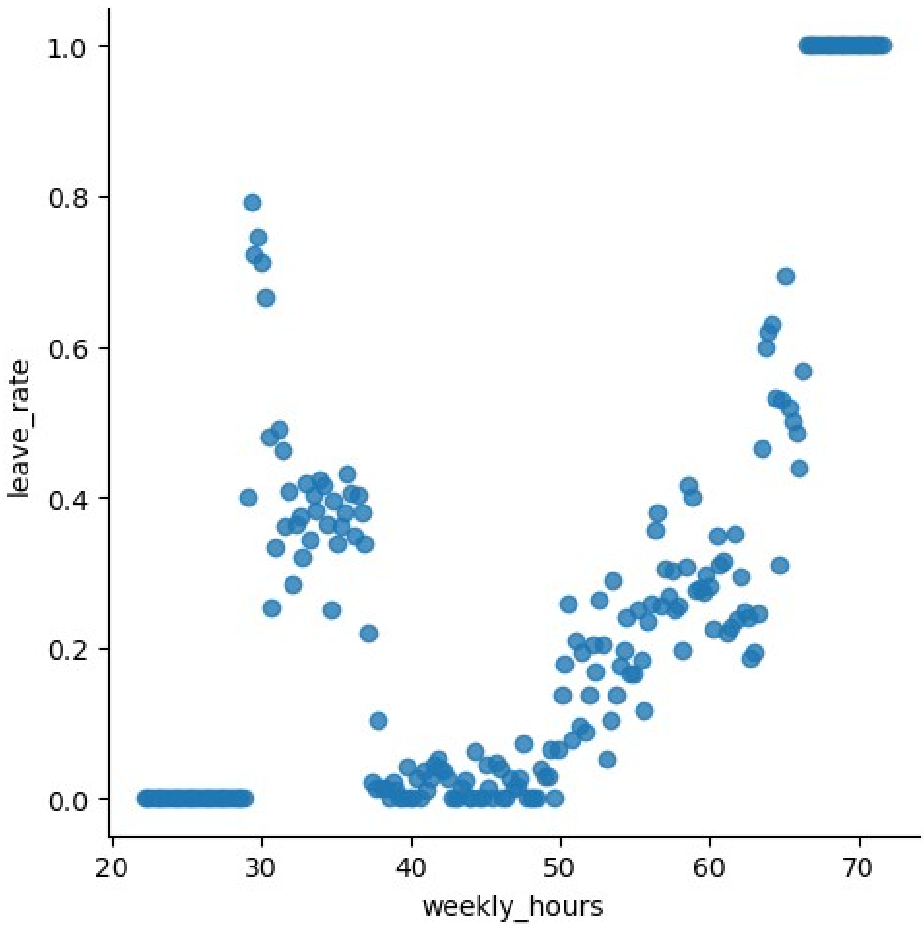
```python
gr=sns.lmplot('evaluation',
'leave_rate',data=leave_eval,fit_reg=False)
```

```
<IPython.core.display.Javascript object>
```




```python
# employees at a evalation score between 0.55 to 0.78 tend to leave
less

leave_hours=df.groupby('average_weekly_hours').agg({'left': lambda x:
len(x[x==1])})
leave_hours['total']=df.groupby('average_weekly_hours').agg({'left':
len})
leave_hours['leave_rate']=leave_hours['left']/leave_hours['total']
leave_hours['weekly_hours']=df.groupby('average_weekly_hours').agg({'a
verage_weekly_hours': 'mean'})
grid=sns.lmplot('weekly_hours',
'leave_rate',data=leave_hours,fit_reg=False)
```

```
<IPython.core.display.Javascript object>
```




```
df[['department', 'average_weekly_hours']].groupby(['department'],
as_index=False).mean().sort_values(by='average_weekly_hours',
ascending=False)
```

```
    department  average_weekly_hours
9    technical             46.730175
0           IT             46.665225
4   management             46.442125
2   accounting             46.422224
7        sales             46.364158
1        RandD             46.338579
8      support             46.328813
6  product_mng             46.145915
5    marketing             46.012103
3           hr             45.850317
```

```
ll =
df[['promotion_last_5years','left']].groupby('promotion_last_5years').
sum(['left'])
ll['value_counts'] = df['promotion_last_5years'].value_counts()
ll
```

```
# we can see addning prmotion in our predictions doesnt make it
meaningful
```

```
                       left  value_counts
promotion_last_5years
0                      3552         14680
1                        19           319
```

```
df[['department','average_weekly_hours']].groupby(['department']).mean
(['average_weekly_hours'])
# it doesnt make sense to use the working hours as all show close mean
```

```
             average_weekly_hours
department
IT                      46.665225
RandD                   46.338579
accounting              46.422224
hr                      45.850317
management              46.442125
marketing               46.012103
product_mng             46.145915
sales                   46.364158
support                 46.328813
technical               46.730175
```

```
df=df.drop(['Work_accident','department','average_weekly_hours','promo
tion_last_5years'],axis=1)
```

```
df.columns
```

```
Index(['satisfaction_level', 'last_evaluation', 'number_project',
       'time_spend_company', 'left', 'salary'],
      dtype='object')
```

```
df.head()
```

```
   satisfaction_level  last_evaluation  number_project
time_spend_company  \
0                0.38             0.53               2
3
1                0.80             0.86               5
6
2                0.11             0.88               7
4
3                0.72             0.87               5
5
4                0.37             0.52               2
3

   left  salary
0     1     low
1     1  medium
```

```
2     1  medium
3     1     low
4     1     low
```

```python
df['salary'] =
df['salary'].map({'low':0,'medium':1,'high':2}).astype('int')
```

```python
df
```

```
       satisfaction_level  last_evaluation  number_project  \
0                    0.38             0.53               2
1                    0.80             0.86               5
2                    0.11             0.88               7
3                    0.72             0.87               5
4                    0.37             0.52               2
...                   ...              ...             ...
14994                0.40             0.57               2
14995                0.37             0.48               2
14996                0.37             0.53               2
14997                0.11             0.96               6
14998                0.37             0.52               2

       time_spend_company  left  salary
0                       3     1       0
1                       6     1       1
2                       4     1       1
3                       5     1       0
4                       3     1       0
...                   ...   ...     ...
14994                   3     1       0
14995                   3     1       0
14996                   3     1       0
14997                   4     1       0
14998                   3     1       0

[14999 rows x 6 columns]
```

```python
df['number_project'].unique()
```

```
array([2, 5, 7, 6, 4, 3], dtype=int64)
```

```python
# pd.cut for number_projects
probin = [0,2,5,10]
proname=[1,2,3]
df['cut_projects'] = pd.cut(df['number_project'],bins = probin ,
labels = proname )
# pd.cut for years at company
yearbin = [0,1,2,3,4,5,6,100]
yearlab = [1,2,3,4,5,6,7]
df['cut_year'] =
pd.cut(df['time_spend_company'],bins=yearbin,labels=yearlab)
```

```
#banding last_evaluation
evalbin=[0,.6,.8,1]
evalname=[0,1,2]
df['cut_eval']=pd.cut(df['last_evaluation'],bins =
evalbin,labels=evalname)
df.head()
```

```
   satisfaction_level  last_evaluation  number_project
time_spend_company  \
0                0.38             0.53               2
3
1                0.80             0.86               5
6
2                0.11             0.88               7
4
3                0.72             0.87               5
5
4                0.37             0.52               2
3

   left  salary cut_projects cut_year cut_eval
0     1       0            1        3        0
1     1       1            2        6        2
2     1       1            3        4        2
3     1       0            2        5        2
4     1       0            1        3        0
```

```
df =
df.drop(['number_project','time_spend_company','last_evaluation'],axis
=1)
df.head()
```

```
   satisfaction_level  left  salary cut_projects cut_year cut_eval
0                0.38     1       0            1        3        0
1                0.80     1       1            2        6        2
2                0.11     1       1            3        4        2
3                0.72     1       0            2        5        2
4                0.37     1       0            1        3        0
```

```
df.dtypes
```

```
satisfaction_level     float64
left                     int64
salary                   int32
cut_projects          category
cut_year              category
cut_eval              category
dtype: object
```

```
df[['cut_projects','cut_year','cut_eval']] =
df[['cut_projects','cut_year','cut_eval']].astype('int64')
```

```
df.head()
```

```
   satisfaction_level  left  salary  cut_projects  cut_year  cut_eval
0                0.38     1       0             1         3         0
1                0.80     1       1             2         6         2
2                0.11     1       1             3         4         2
3                0.72     1       0             2         5         2
4                0.37     1       0             1         3         0
```

```
df.dtypes
```

```
satisfaction_level    float64
left                    int64
salary                  int32
cut_projects            int64
cut_year                int64
cut_eval                int64
dtype: object
```

## models using different techniques

```
from sklearn.linear_model import LogisticRegression as lr_
from sklearn.svm import SVC as svc_
from sklearn.neighbors import KNeighborsClassifier as knn_
from sklearn.naive_bayes import GaussianNB as gnb_
from sklearn.tree import DecisionTreeClassifier as dtc_
```

```
from sklearn.model_selection import train_test_split
x_train, x_test, y_train, y_test =
train_test_split(df,df['left'],test_size=.2)
x_train = x_train.drop('left',axis=1)
x_test = x_test.drop('left',axis=1)
print (x_train.shape, y_train.shape)
print (x_test.shape, y_test.shape)
```

```
(11999, 5) (11999,)
(3000, 5) (3000,)
```

```
models = [lr_(),knn_(),dtc_(),gnb_(),svc_()]
model_names = ['log reg','KNN','DTC','GNB','SVC']
for i in range(len(models)):
    ind_model = models[i].fit(x_train,y_train)
    print(f'{model_names[i]}  ::::  training score  :
{round(ind_model.score(x_train,y_train)*100,1)}      test score :
{round(ind_model.score(x_test,y_test)*100,1)}')
```

```
log reg  ::::  training score  :  78.9      test score :  78.8
KNN  ::::  training score  :  97.5      test score :  96.3
DTC  ::::  training score  :  98.5      test score :  97.3
GNB  ::::  training score  :  83.8      test score :  83.1
SVC  ::::  training score  :  94.9      test score :  95.1
```

```python
models_scores = pd.DataFrame()
models = [lr_(),knn_(),dtc_(),gnb_(),svc_()]
model_names = ['log reg','KNN','DTC','GNB','SVC']
train_scores=[]
test_scores= []
for i in range(len(models)):
    ind_model = models[i].fit(x_train,y_train)
    models_scores['model name'] = model_names[i]
    train_scores.append(ind_model.score(x_train,y_train))
    test_scores.append(ind_model.score(x_test,y_test))
```

```python
models_scores = pd.DataFrame()
models_scores['model name'] = model_names
models_scores['train scores'] =train_scores
models_scores['test scores'] = test_scores
```

```python
models_scores
```

| | model name | train scores | test scores |
|---|---|---|---|
| 0 | log reg | 0.789399 | 0.787667 |
| 1 | KNN | 0.974665 | 0.963333 |
| 2 | DTC | 0.985415 | 0.972667 |
| 3 | GNB | 0.837986 | 0.831000 |
| 4 | SVC | 0.949329 | 0.951000 |