Data Understanding Phase

Import libraries

In [1]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
sns.set(color_codes=True)
%matplotlib inline
```

Import data using pandas

In [2]:
```
df = pd.read_csv('HR_comma_sep.csv')
```

In [3]:
```
df.head()
```

Out[3]:

	satisfaction_level	last_evaluation	number_project	average_montly_hours	time_spend_compan
0	0.38	0.53	2	157	
1	0.80	0.86	5	262	
2	0.11	0.88	7	272	
3	0.72	0.87	5	223	
4	0.37	0.52	2	159	

Describe data

In [4]:
```
df.describe()
```

Out[4]:

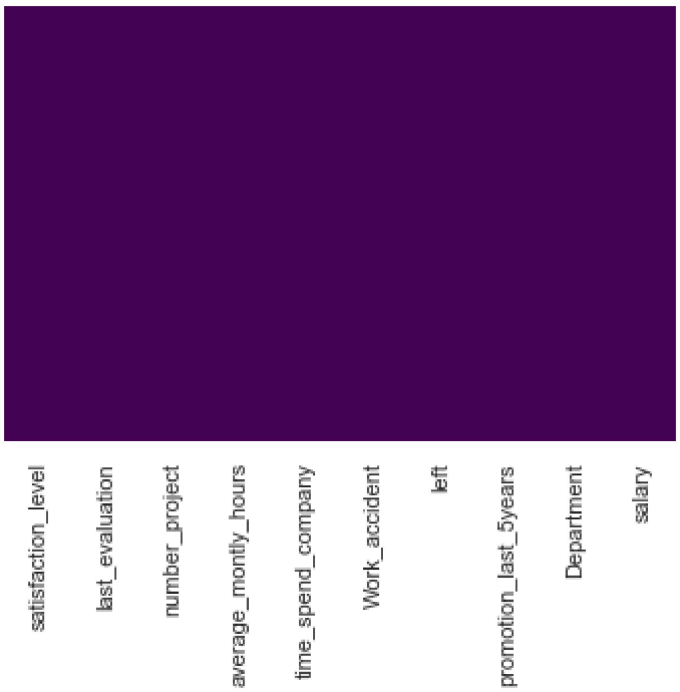
	satisfaction_level	last_evaluation	number_project	average_montly_hours	time_spend_con
count	14999.000000	14999.000000	14999.000000	14999.000000	14999.0
mean	0.612834	0.716102	3.803054	201.050337	3.4
std	0.248631	0.171169	1.232592	49.943099	1.4
min	0.090000	0.360000	2.000000	96.000000	2.0
25%	0.440000	0.560000	3.000000	156.000000	3.0
50%	0.640000	0.720000	4.000000	200.000000	3.0
75%	0.820000	0.870000	5.000000	245.000000	4.0
max	1.000000	1.000000	7.000000	310.000000	10.0

Explore Data

Check data for missing values (data quality)

In [5]:
```
missing_values = df.isnull()
sns.heatmap(data = missing_values, yticklabels=False, cbar=False, cmap='viridis')
```

Out[5]: <matplotlib.axes._subplots.AxesSubplot at 0x101b5f198>



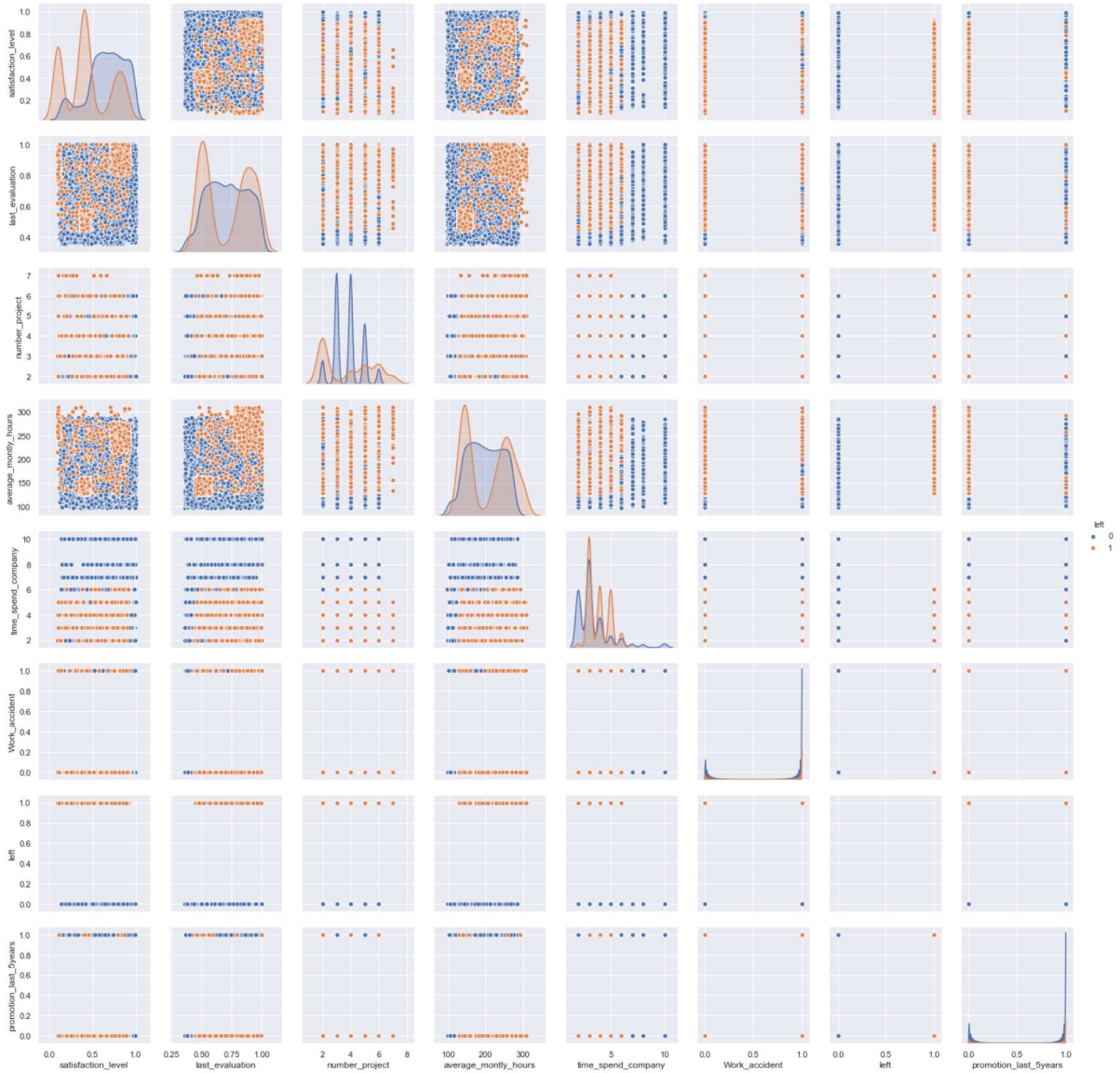
Since there is no missing data, we do not need to augment values

Seaborn pairplot of all features

In [6]:
```
sns.pairplot(df,  hue='left')
```

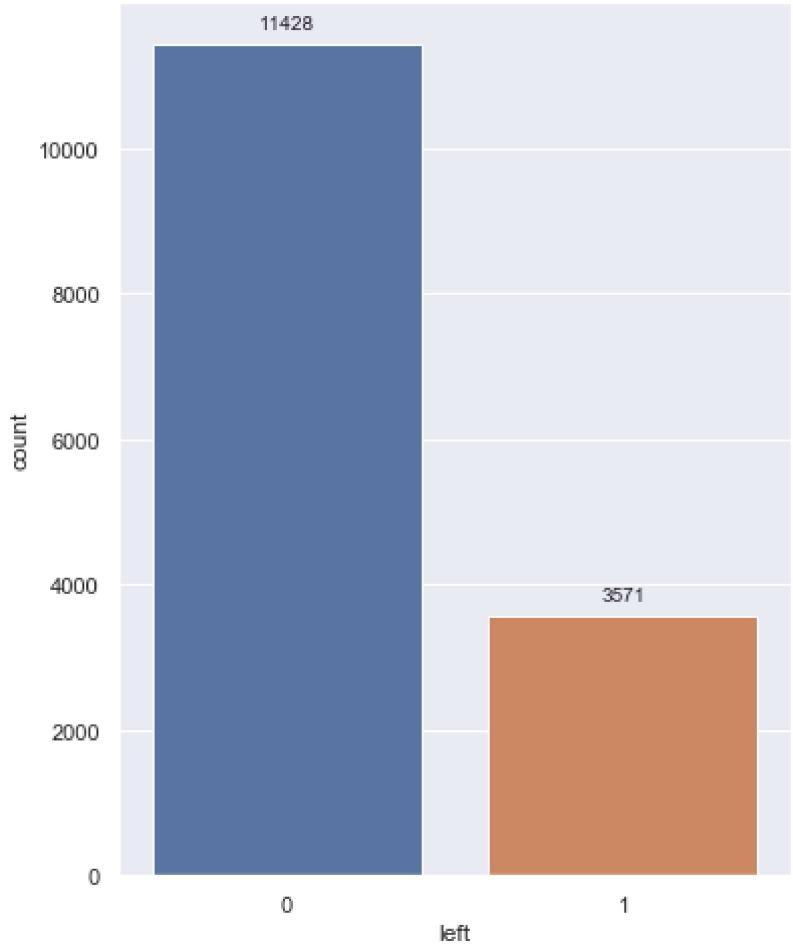
```
/Users/joshuasheriff/anaconda3/lib/python3.7/site-packages/statsmodels/nonpar
ametric/kde.py:487: RuntimeWarning: invalid value encountered in true_divide
  binned = fast_linbin(X, a, b, gridsize) / (delta * nobs)
/Users/joshuasheriff/anaconda3/lib/python3.7/site-packages/statsmodels/nonpar
ametric/kdetools.py:34: RuntimeWarning: invalid value encountered in double_s
calars
  FAC1 = 2*(np.pi*bw/RANGE)**2
```

Out[6]: <seaborn.axisgrid.PairGrid at 0x1a164c7128>



Display bar chart for # of employees that left vs stayed

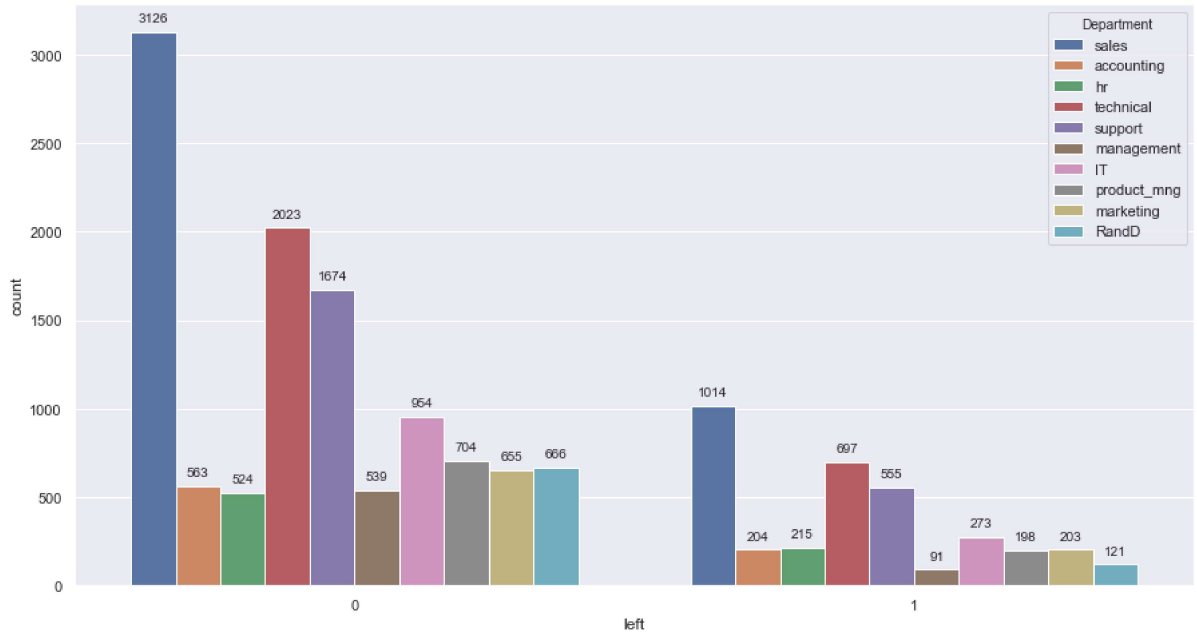
In [7]:
```
plt.figure(figsize=(6, 8))
count_left = sns.countplot(x='left', data=df)
for p in count_left.patches:
    count_left.annotate(format(p.get_height()), (p.get_x() + p.get_width() /
2., p.get_height()), ha = 'center', va = 'center', xytext = (0, 10), textcoord
s = 'offset points')
```



Display bar chart for employee status by department

In [8]:
```
#sns.countplot(x='left', data=df, hue='Department')
```

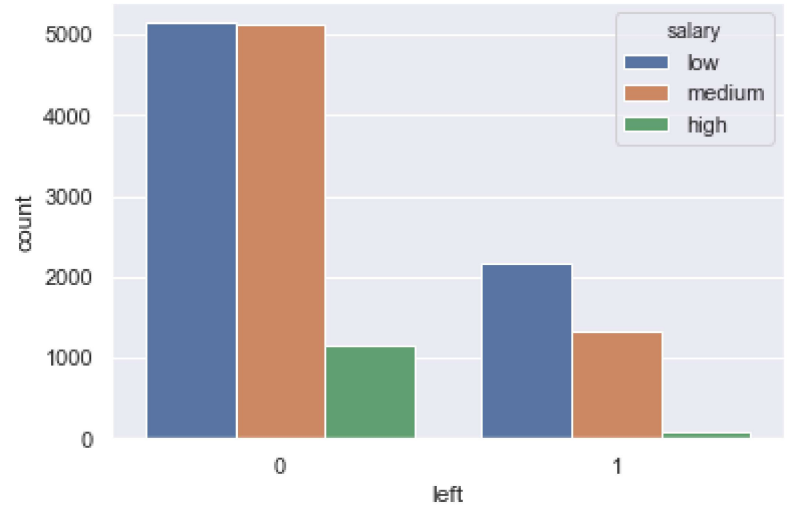
In [9]:
```
plt.figure(figsize=(15, 8))
count_left_dept = sns.countplot(x='left', data=df, hue='Department')
for p in count_left_dept.patches:
    count_left_dept.annotate(format(p.get_height()), (p.get_x() + p.get_width
() / 2., p.get_height()), ha = 'center', va = 'center', xytext = (0, 10), text
coords = 'offset points')
```



Display bar chart for employee status by salary category

In [10]:
```
sns.countplot(x='left', data=df, hue='salary')
```

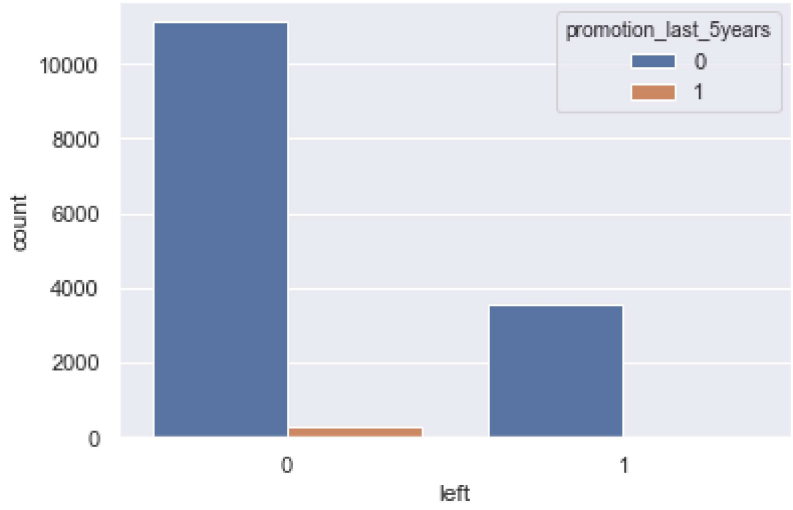
Out[10]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x1a16dad160>
```



Display bar chart for employee status by whether they had a promotion in the last 5 years

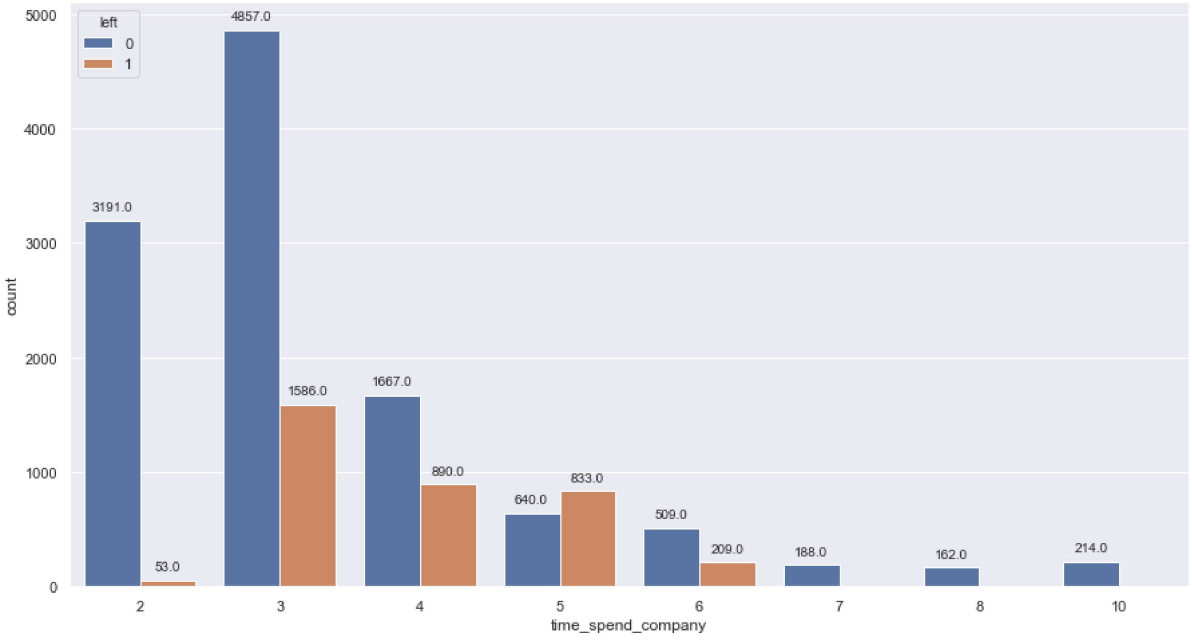
In [11]:
```
sns.countplot(x='left', data=df, hue='promotion_last_5years')
```

Out[11]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x1a1b273b00>
```



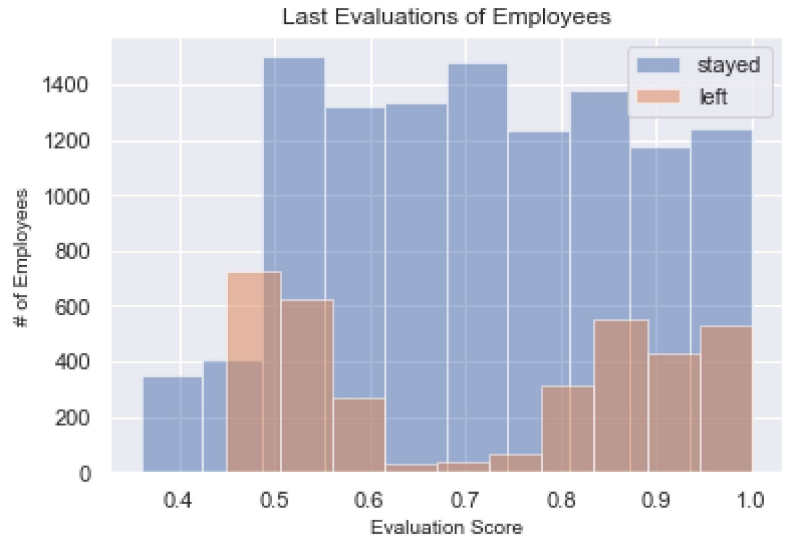
Display bar chart for employee status by the # of years they spent at the company

In [12]:
```
plt.figure(figsize=(15, 8))
count_time_spent_company = sns.countplot(x='time_spend_company', data=df, hue='left')
for p in count_time_spent_company.patches:
    count_time_spent_company.annotate(format(p.get_height()), (p.get_x() + p.get_width() / 2., p.get_height()), ha = 'center', va = 'center', xytext = (0, 10), textcoords = 'offset points')
```



Display dual histogram of Last Evaluation and employee status

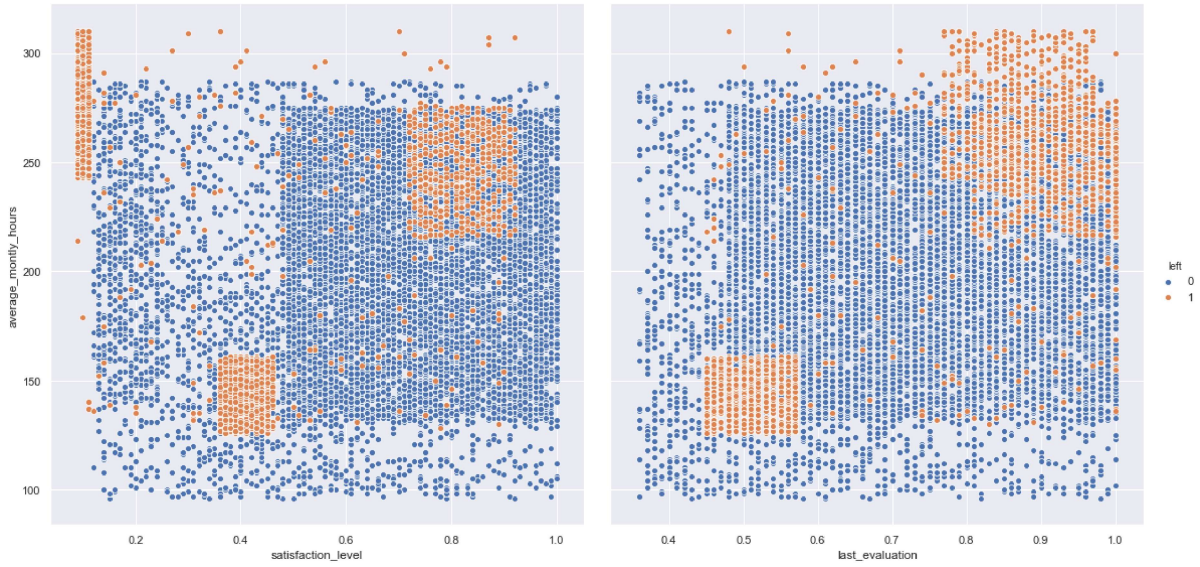
In [13]:
```
left_last_eval = df[df.left == 1]
stayed_last_eval = df[df.left == 0]

plt.hist(stayed_last_eval['last_evaluation'], label='stayed', bins=10, alpha=
0.5)
plt.hist(left_last_eval['last_evaluation'], label='left', bins=10, alpha=0.5)
plt.legend(loc='best')
plt.xlabel('Evaluation Score',fontsize=10)
plt.ylabel('# of Employees',fontsize=10)
plt.title('Last Evaluations of Employees',fontsize=12)
plt.show()
```



Pairplot of Average Monthly Hours by Satification Level and Last Evaluation Score

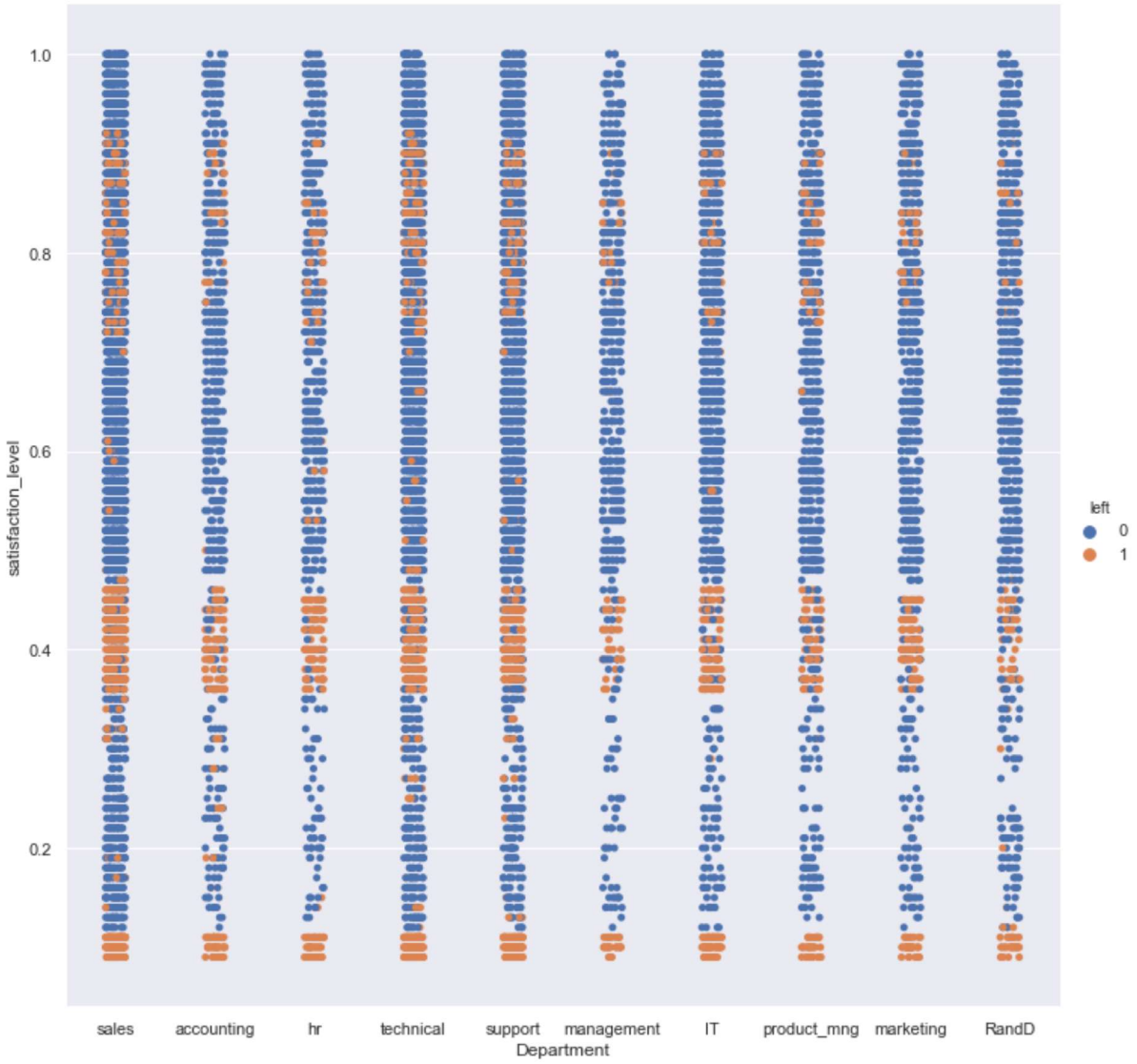
In [14]:
```
sns.pairplot(df, x_vars=['satisfaction_level', 'last_evaluation'], y_vars=['average_montly_hours'], hue='left', height=8)
```

Out[14]: <seaborn.axisgrid.PairGrid at 0x1a1b3dae48>



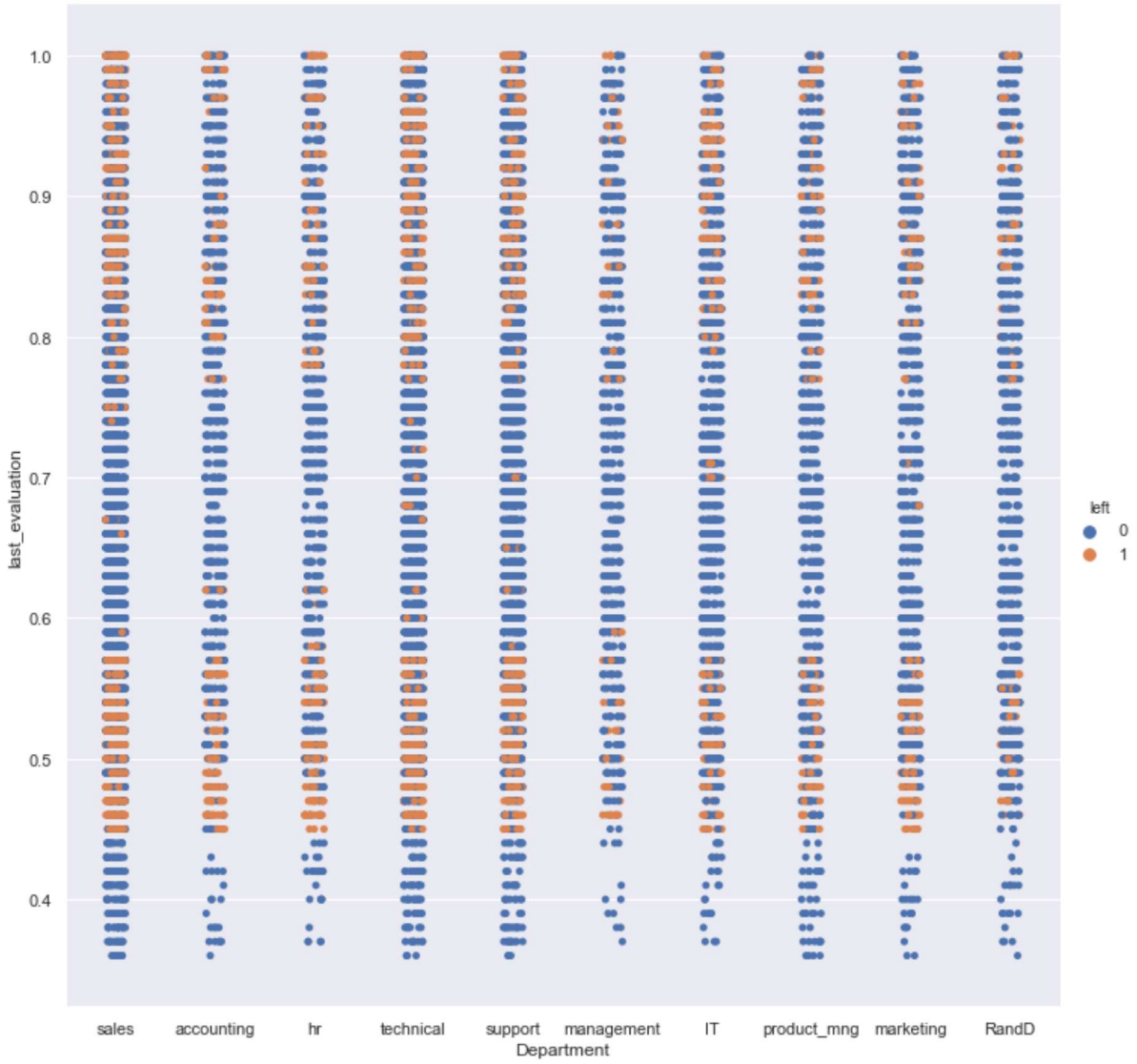
Employee Category Status plot of Satisfaction Level by Department

In [15]:
```
sns.catplot(x="Department", y="satisfaction_level", hue="left", data=df, heigh
t = 10);
```



Employee Category Status plot of Last Evaluation by Department

In [16]:
```
sns.catplot(x="Department", y="last_evaluation", hue="left", data=df, height = 10);
```



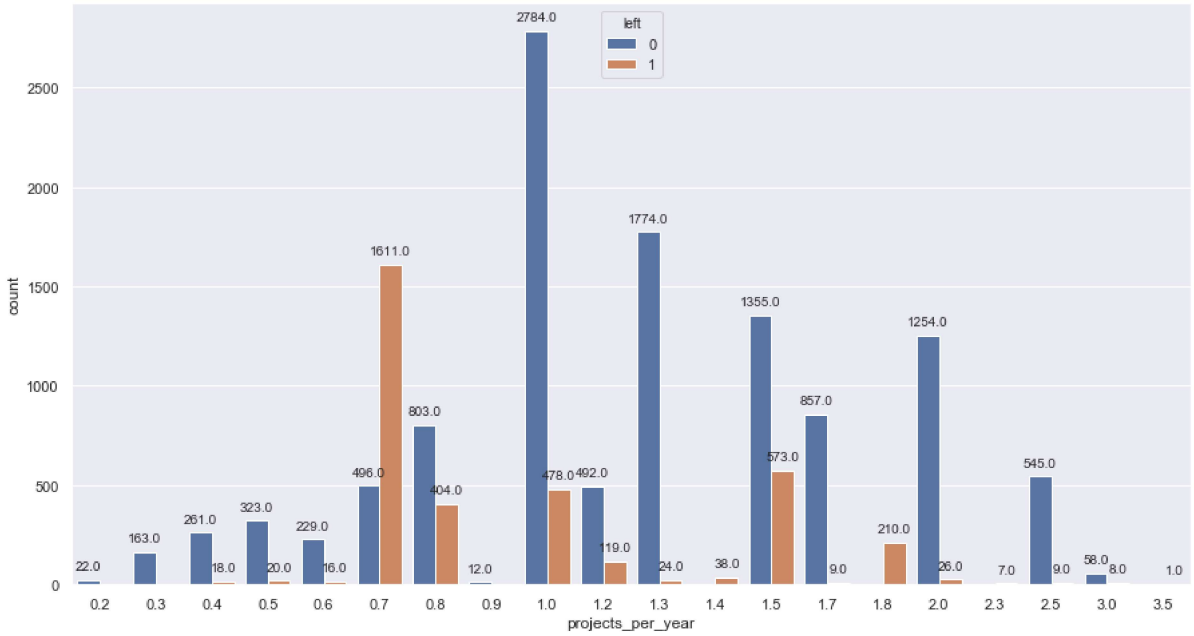
Data Preparation Phase

Construct new dervived feature based on number of projects and time spent at company

In [17]:
```
df['projects_per_year'] = df.apply(lambda row: round(row.number_project / row.time_spend_company,1), axis=1)
```

Plotting of new derived feature: # of projects per year by employee status

In [18]:
```
plt.figure(figsize=(15, 8))
count_project_time_ratio = sns.countplot(x='projects_per_year', data=df, hue='left')
for p in count_project_time_ratio.patches:
    count_project_time_ratio.annotate(format(p.get_height()), (p.get_x() + p.get_width() / 2., p.get_height()), ha = 'center', va = 'center', xytext = (0, 10), textcoords = 'offset points')
```



Modelling Phase

In [19]:
```
#Factorize department and salary
```

In [20]:
```
#df["DepartmentID"] = pd.factorize(df.Department)[0]
#df["SalaryID"] = pd.factorize(df.salary)[0]
```

Transpose Department column with prefix 'Dept'

In [21]:
```
dept = pd.get_dummies(df['Department'], prefix='Dept')
```

Transpose Salary column with prefix 'Salary'

In [22]:
```
salary = pd.get_dummies(df['salary'], prefix='Salary')
```

Combine Department and Salary dataframes into new dataframe for training

In [23]:
```
df2 = pd.concat([df, dept, salary], axis=1)
```

Drop insignificant features from the new combined dataframe

In [24]:
```
df2.drop(['Department', 'salary'], axis=1, inplace=True)
```

In [25]:
```
df2.dtypes
```

Out[25]:
```
satisfaction_level       float64
last_evaluation          float64
number_project             int64
average_montly_hours       int64
time_spend_company         int64
Work_accident              int64
left                       int64
promotion_last_5years      int64
projects_per_year        float64
Dept_IT                    uint8
Dept_RandD                 uint8
Dept_accounting            uint8
Dept_hr                    uint8
Dept_management            uint8
Dept_marketing             uint8
Dept_product_mng           uint8
Dept_sales                 uint8
Dept_support               uint8
Dept_technical             uint8
Salary_high                uint8
Salary_low                 uint8
Salary_medium              uint8
dtype: object
```

Training the Logistic Regression Model (all features)

In [26]:
```
# Split data into 'X' features and 'y' target label sets
x=df2[['satisfaction_level', 'last_evaluation', 'number_project', 'average_mon
tly_hours', 'time_spend_company',
    'Work_accident', 'promotion_last_5years', 'projects_per_year', 'Dept_IT',
'Dept_RandD', 'Dept_accounting', 'Dept_hr', 'Dept_marketing', 'Dept_product_mn
g', 'Dept_sales',
    'Dept_support', 'Dept_technical', 'Salary_high', 'Salary_low', 'Salary_med
ium']]
y=df2['left']
```

In [27]:
```
# Import module to split dataset
from sklearn.model_selection import train_test_split
from sklearn.metrics import classification_report
from sklearn.metrics import confusion_matrix
# Split data set into training and test sets
x_train, x_test, y_train, y_test = train_test_split(x, y, test_size=0.3, rando
m_state = 42)
```

In [28]:
```
# Import LogisticRegression model from sklearn
from sklearn.linear_model import LogisticRegression

# Apply training data to svc model
model_svc = LogisticRegression(solver='lbfgs', max_iter=2000)
model_svc.fit(x_train,y_train)
```

Out[28]:
```
LogisticRegression(C=1.0, class_weight=None, dual=False, fit_intercept=True,
                   intercept_scaling=1, l1_ratio=None, max_iter=2000,
                   multi_class='warn', n_jobs=None, penalty='l2',
                   random_state=None, solver='lbfgs', tol=0.0001, verbose=0,
                   warm_start=False)
```

Print Model Classification Report and Accuracy Score (all features)

In [29]:
```
y_pred = model_svc.predict(x_test)
print(classification_report(y_test, y_pred))
```

```
              precision    recall  f1-score   support

           0       0.87      0.93      0.90      3428
           1       0.71      0.57      0.63      1072

    accuracy                           0.84      4500
   macro avg       0.79      0.75      0.76      4500
weighted avg       0.83      0.84      0.84      4500
```

In [30]:
```
print(model_svc.score(x_test,y_test))
```

```
0.8415555555555555
```

Training the Logistic Regression Model (4 features)

In [31]:
```
# Split data into 'X' features and 'y' target label sets
x2=df2[['satisfaction_level', 'last_evaluation', 'average_montly_hours', 'Dept
_IT', 'Dept_RandD', 'Dept_accounting', 'Dept_hr', 'Dept_marketing', 'Dept_prod
uct_mng', 'Dept_sales',
    'Dept_support', 'Dept_technical']]
y2=df2['left']
```

In [32]:
```
# Import module to split dataset
from sklearn.model_selection import train_test_split
# Split data set into training and test sets
x2_train, x2_test, y2_train, y2_test = train_test_split(x2, y2, test_size=0.3,
random_state=42)
```

In [33]:
```
# Import LogisticRegression model from sklearn
from sklearn.linear_model import LogisticRegression

# Apply training data to svc model
model_svc2 = LogisticRegression(solver='lbfgs', max_iter=1000)
model_svc2.fit(x2_train,y2_train)
```

Out[33]:
```
LogisticRegression(C=1.0, class_weight=None, dual=False, fit_intercept=True,
                   intercept_scaling=1, l1_ratio=None, max_iter=1000,
                   multi_class='warn', n_jobs=None, penalty='l2',
                   random_state=None, solver='lbfgs', tol=0.0001, verbose=0,
                   warm_start=False)
```

Print Model Classification Report and Accuracy Score (4 features)

In [34]:
```
y2_pred = model_svc2.predict(x2_test)
print(classification_report(y2_test, y2_pred))
```

```
              precision    recall  f1-score   support

           0       0.80      0.93      0.86      3428
           1       0.51      0.25      0.33      1072

    accuracy                           0.76      4500
   macro avg       0.66      0.59      0.59      4500
weighted avg       0.73      0.76      0.73      4500
```

In [35]:
```
print(model_svc2.score(x2_test,y2_test))
```

```
0.7648888888888888
```