CLARUSWAY

WAY TO REINVENT YOURSELF

CAPSTONE PROJECT-2

EMPLOYEE CHURN PREDICTION

Group-4

CONTENTS

GROUP MEMBERS

C8124-JACK

C8125-MUSTAFA

C8250-ONUR

C8278-ENGİN

C8292-KEN

C8301-SAM

C8307-HAKAN

C8315-HALİT

C8399-BENJAMIN

C8492-SEMİH

C9231-HÜSEYİN

MEETING SCHEDULE

10-13 December 2021 : Individual study

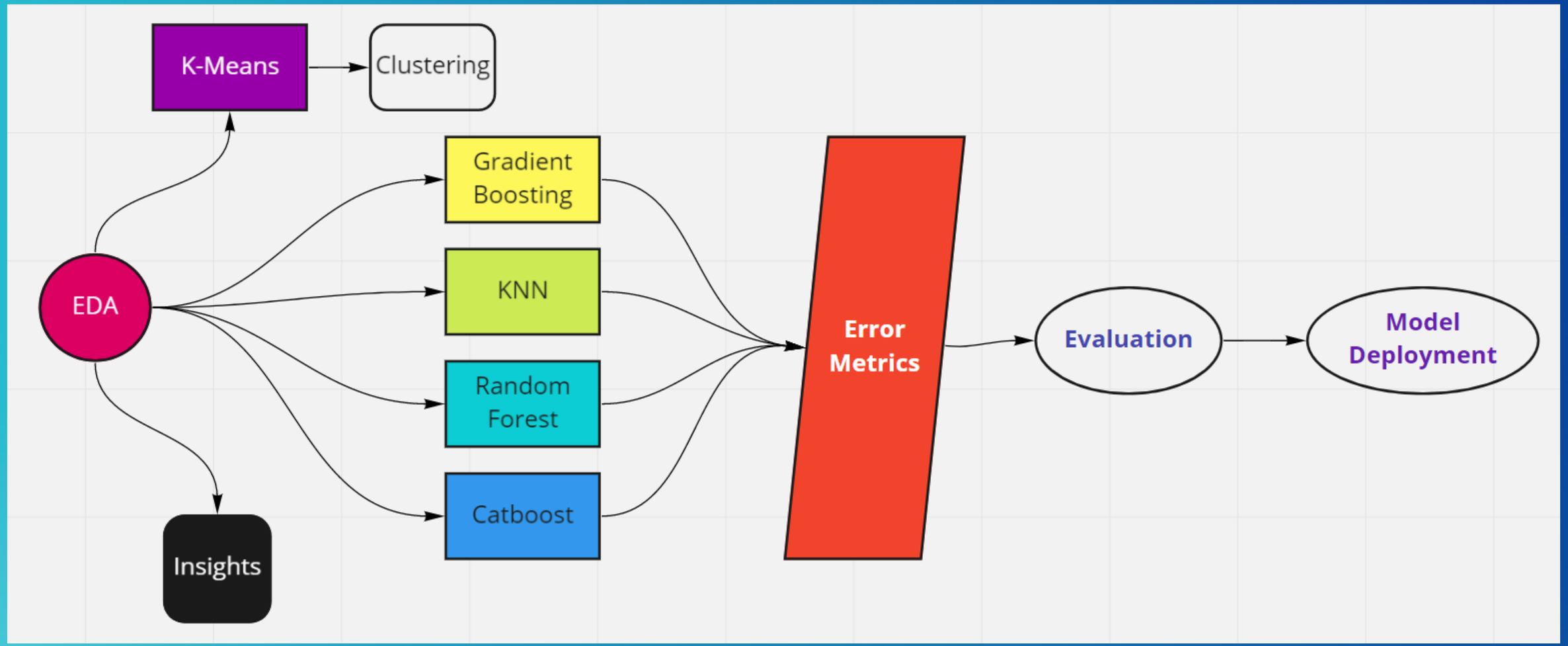
13 December 2021 : EDA & K-Means Modelling
20:00 (IST)

14 December 2021 : Gradient Boosting & KNN & Random Forest & Catboost
20:00 (IST)

15 December 2021 : Model Deployment
20:00 (IST)

16 December 2021 : Review
13:00 (IST)

METHODOLOGY



EDA
(EXPLORATORY DATA ANALYSIS)

Columns : 10 | Rows : 14.999 | Duplicated: 3.008 | Null: None

- ***satisfaction_level:*** It is employee satisfaction point, which ranges from 0-1.
- ***last_evaluation:*** It is evaluated performance by the employer, which also ranges from 0-1.
- ***number_projects:*** How many of projects assigned to an employee?
- ***average_monthly_hours:*** How many hours in averega an employee worked in a month?
- **time_spent_company:** time_spent_company means employee experience. The number of years spent by an employee in the company.
- ***work_accident:*** Whether an employee has had a work accident or not.
- ***promotion_last_5years:*** Whether an employee has had a promotion in the last 5 years or not.
- ***Departments:*** Employee's working department/division.
- ***Salary:*** Salary level of the employee such as low, medium and high.
- ***left:*** Whether the employee has left the company or not.

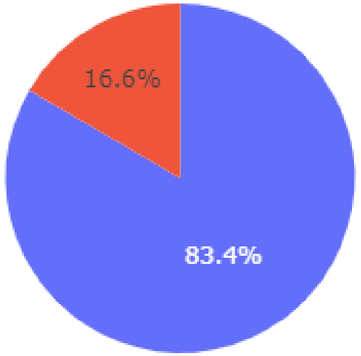
Number of Uniques:

satisfaction_level	92
last_evaluation	65
number_project	6
average_montly_hours	215
time_spend_company	8
Work_accident	2
left	2
promotion_last_5years	2
Departments	10
salary	3

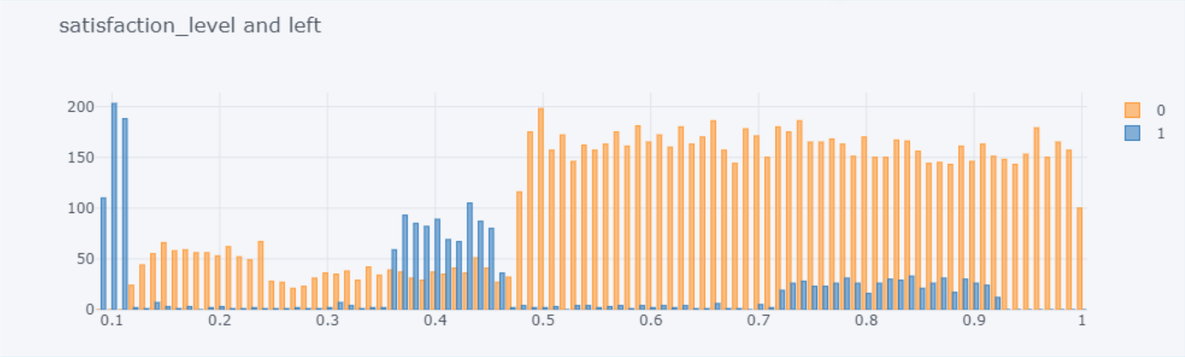
```
Percentage of left-1: % 16.6 --> (1991 observations for left-1)
Percentage of left-0: % 83.4 --> (10000 observations for left-0)
```

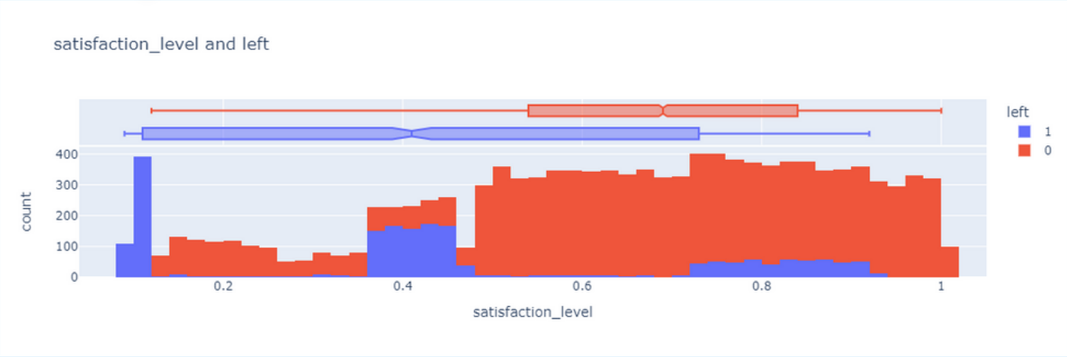
imbalanced

- 'left' column has binary type values.
- We have an imbalanced data.
- Almost 17% of the employees didn't continue with the company and left.
- 1991 employees left.
- Almost 83% of the employees continue with the company and didn't leave.
- 10000 employees didn't leave.



EDA
(satisfaction_level)





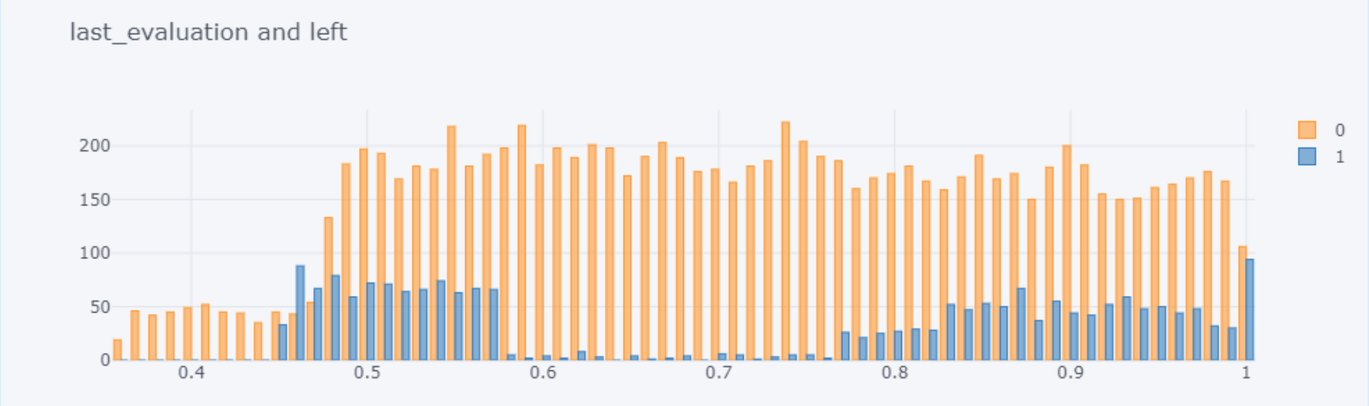
- Normally we expect a low satisfaction level for the employees who have left, so the part near 0 on the x-axis is make sense.
- Besides a group of employees who is not very decisive about their satisfaction level have also been left the company. This group may need extra motivation for employee loyalty. Because they are not so clear in their assessments about their future in the company.
- Also, a group of employees whose satisfaction level is above the average has been left the company. This does not make sense so this must be investigated deeply.
- There may be some other issues:

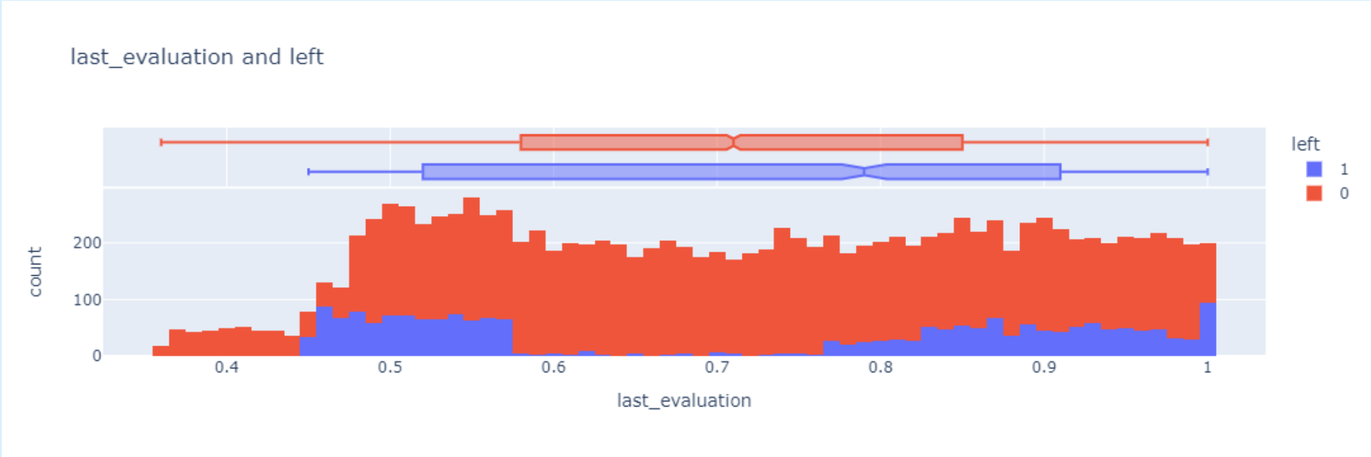
  a. The method of gathering this information may be wrong. So the assessment of satisfaction level and the resigning may not be directly proportional.

  b. The assessment may not be up to date. By the time the satisfaction level may be decreased so at the real-time the satisfaction level of all resigning employees may be close to 0.

  c. Some of the employees may have hidden their true feelings.

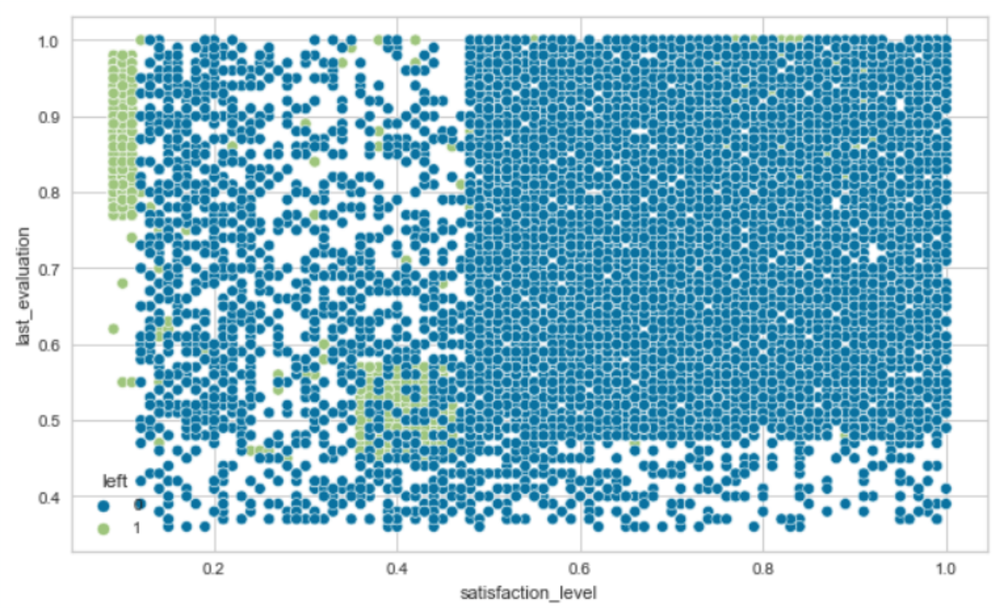
EDA
(last_evaluation)





- Most of the employees have been assessed above 0.45.
- The evaluation of the resigning employees is gathered in two groups. The first is around 0.5 and the second is between 0.8 and 1.0.
- Intensive work may cause the resign of high evaluated employees (second group). Because the employer will be happy with the performance of these staff, however, it will be a burden for employees.

EDA
(last_evaluation)



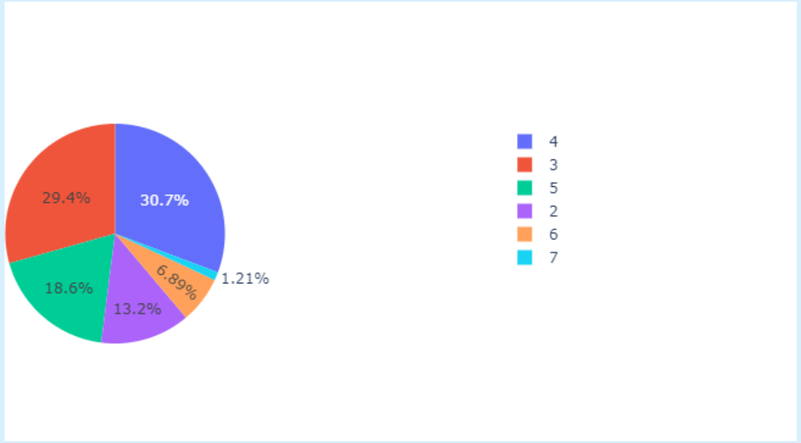
It becomes meaningful when the satisfaction level of employees and the evaluation of the employer brings together.

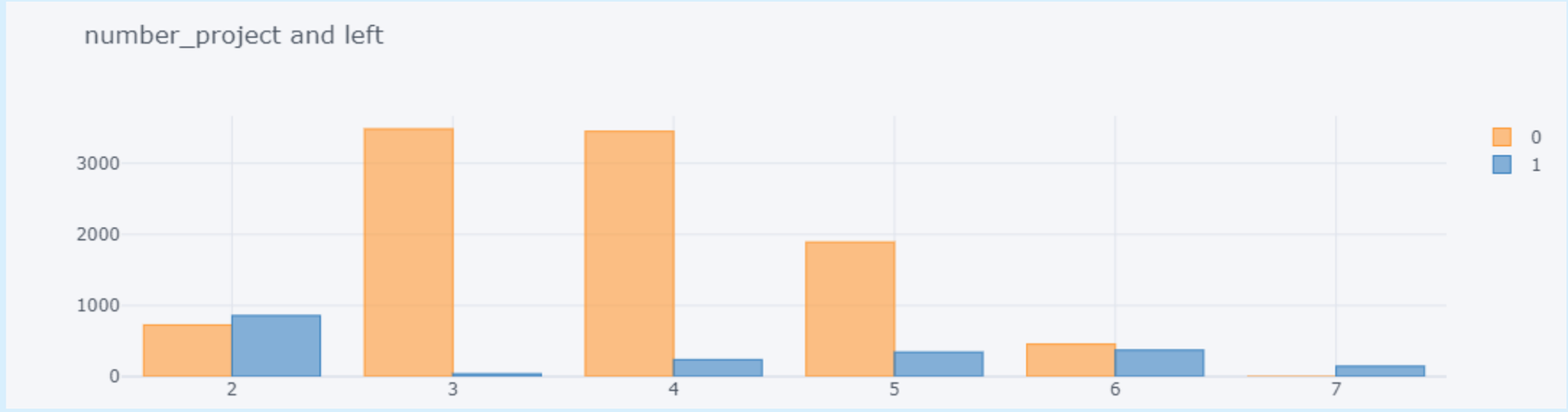
As seen in the graph; the resigning employees are grouped into two different clusters.

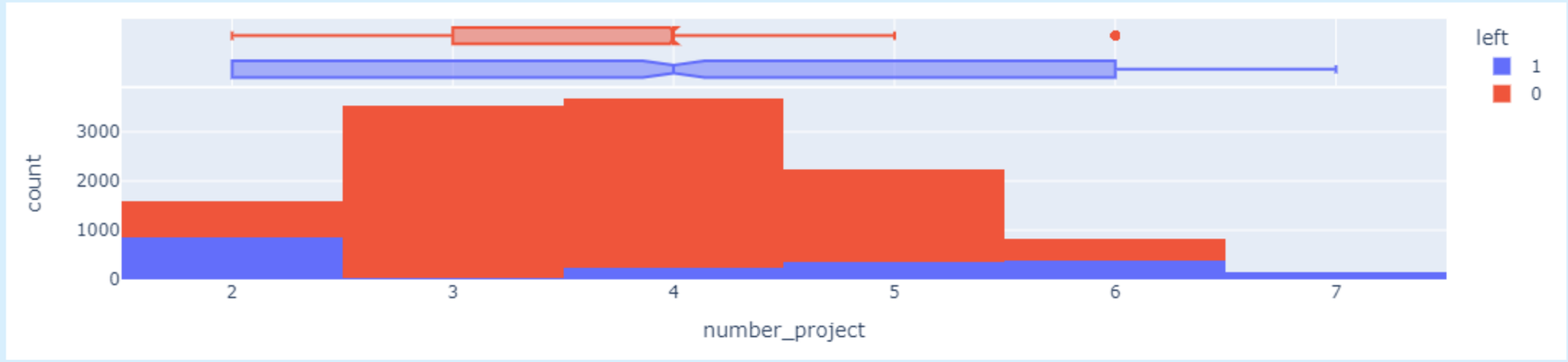
1. The first group has a satisfaction level of 0.4 and the last evaluation of 0.5. This group does not have a clear idea about the company and the employer does not have a clear assessment as well. Other features affecting this group have to be investigated. What are the main problems of this group? Why are they confusing? What are the pros and cons of the company for these groups? and so on...

2. The second group has low satisfaction even if the employer evaluated them with high degrees. Then what can be the main problem of this group? ***Intensive work with a low salary may affect this group. Or intensive work without promotion may cause. In the next steps, the workload and motivation factors of this group have to be investigated.***

EDA
(number_project)

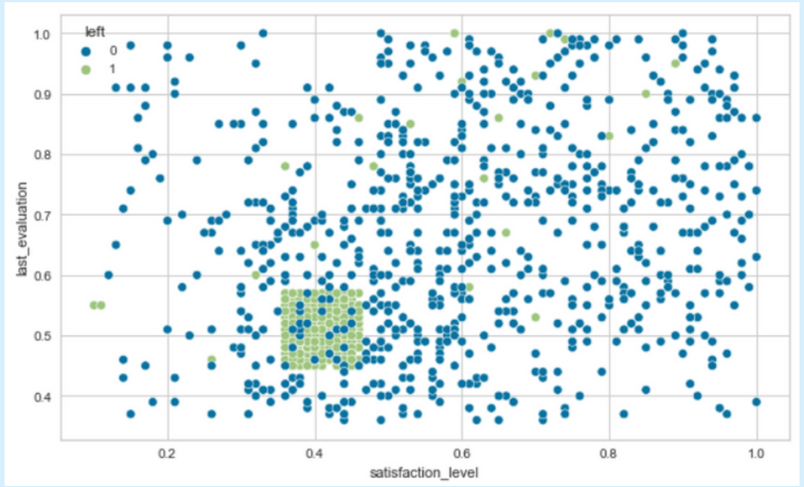




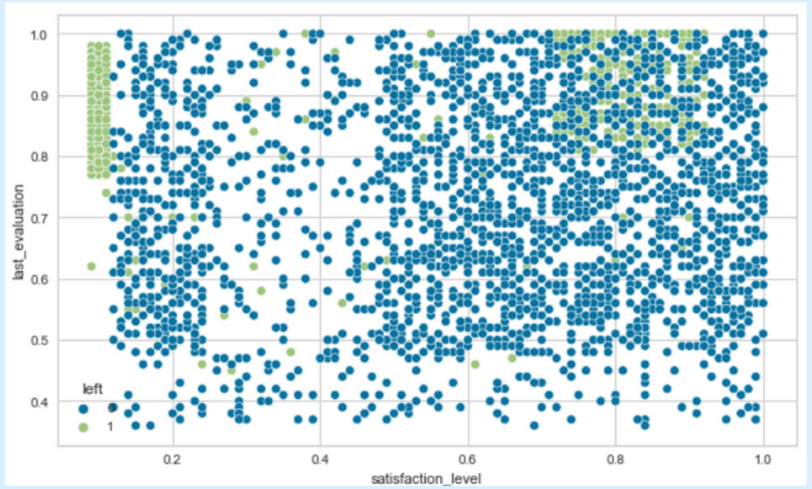


- The number of leaving employees is higher among those who have only two projects during the period. This can be summed up as: ***"the employees with only two projects feel worthless or emptied".*** Because most of the employees work on three or four projects.
- With the 6th project, the number of resignings is getting closer to the number of ongoings. There are no ongoing staff members who were assigned to 7 projects.
- Working on more projects may cause an intensive workload, regarding to this the satisfaction level may decrease with the insufficient motivators.

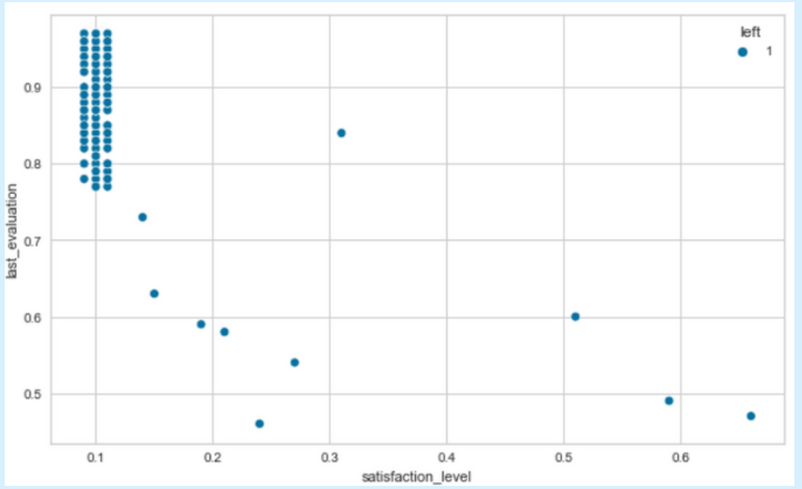
EDA
(number_project)



number_project = 2



number_project > 4

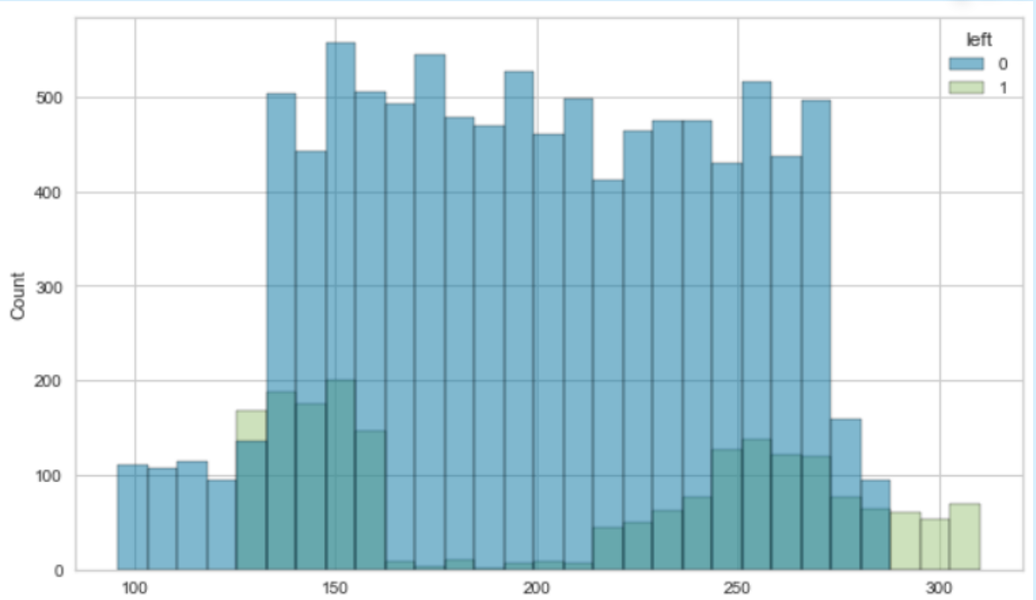


number_project = 7

If we look at the satisfaction level, evaluation score, and the number of projects together;

1. The group of undecideds who were evaluated as 0.5 is the group who worked on the only ***two projects***. As a result, our hypothesis about this group is becoming more clear. As the employer does not assign enough projects to this group, he/she cannot evaluate their performance and they feel worthless. Therefore, they are unsure about their future in the company. This may lead them to leave.
2. The leaving employees who worked on more than four projects are the ***second group of the last_evaluation section***.
3. The second group of last_evaluation section are mostly worked on seven projects and left the company. So again our hypothesis about this group is now more definite.

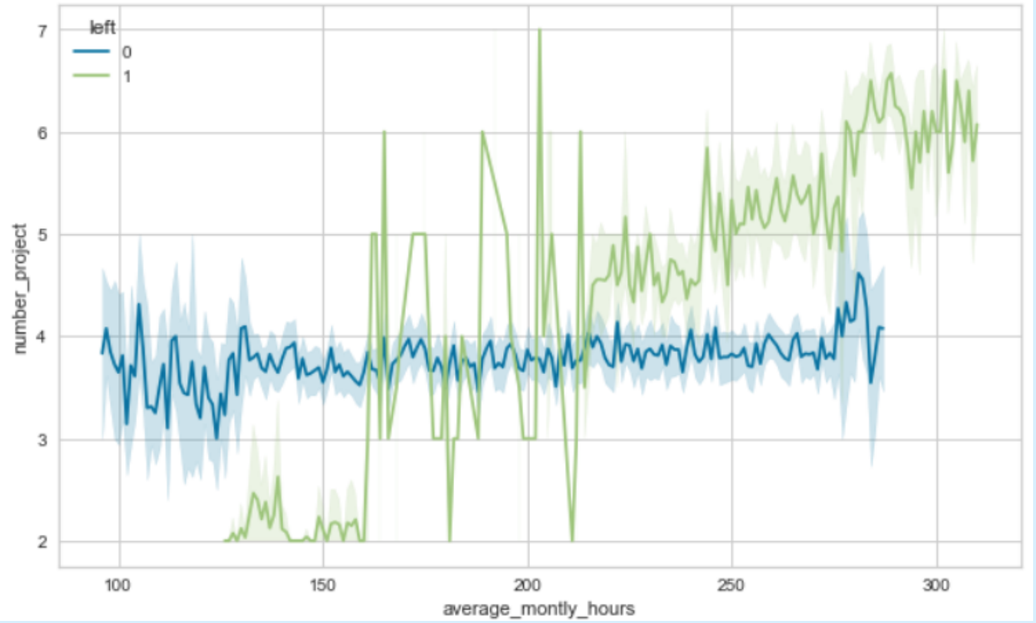
EDA
(average_montly_hours)



According to average monthly working hours again we have two peaks. One is around 140 hours and the other is around 260 hours.

More than 280 hours there is no ongoing staff.

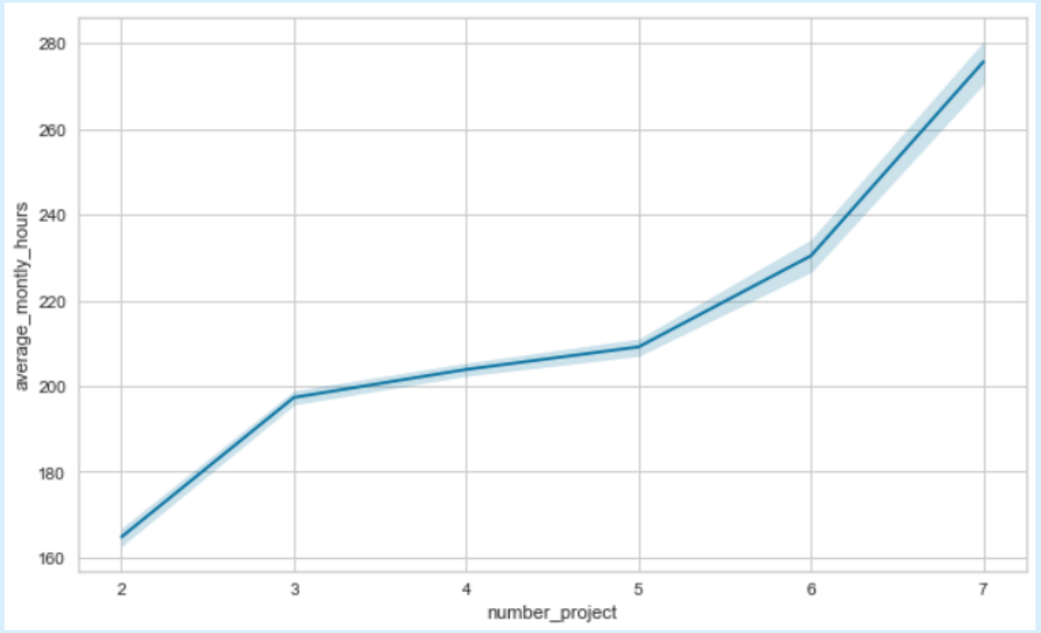
So the next question is "The average monthly working hours are related to project number or not?"



In the graph, it is seen that the group working on two projects is working nearly 130-160 hours monthly. It can be assessed that they have only two simple projects that they don't need to work hard, so their loyalty is weak.

Most of the employees are working 135-275 hours monthly. In this group usually, the employees who get two or more than five projects leave the company. With the increasing number of projects, the average monthly working hours and the number of resigning are increasing.

EDA
(average_montly_hours)

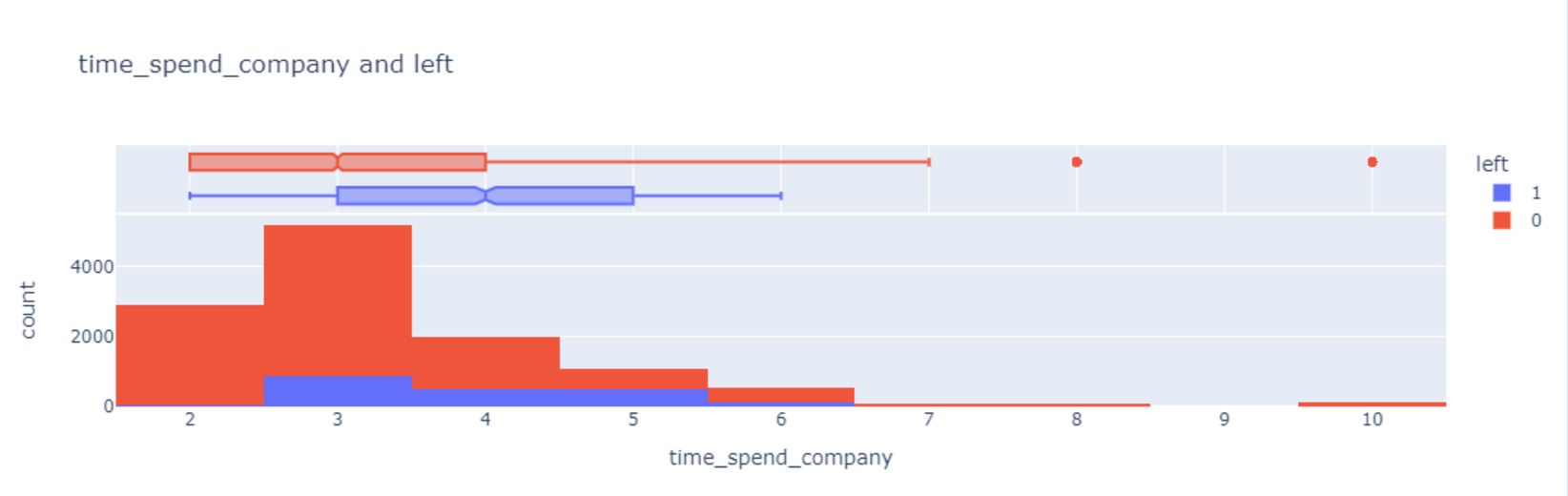


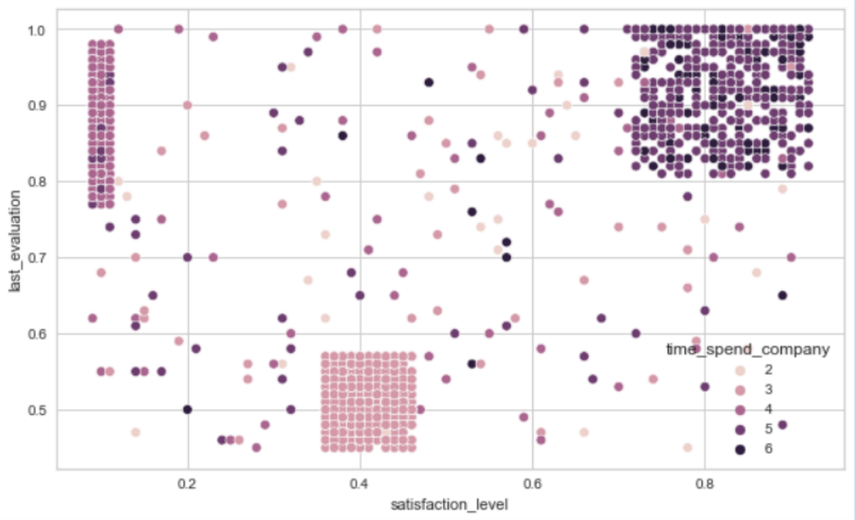
The increase of the average monthly hours according to the number of projects is seen on the graph.

The rate of increase is higher between two and three projects, and after five projects. So it clearly defines the number of resigning due to the working hours.

There needs to be an adjustment about the project numbers, working hours, and workload. The projects must be assigned to more employees. Also, better incentives must be offered to staff who are working hard.

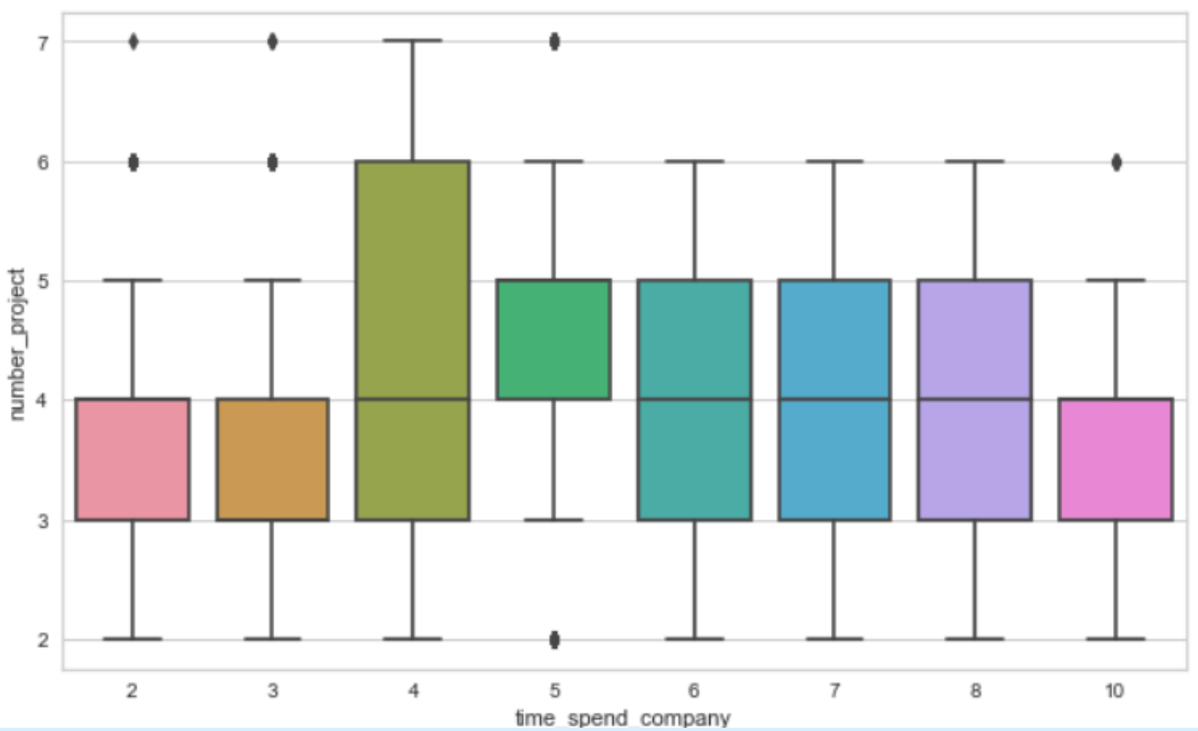
EDA
(time_spend_company)

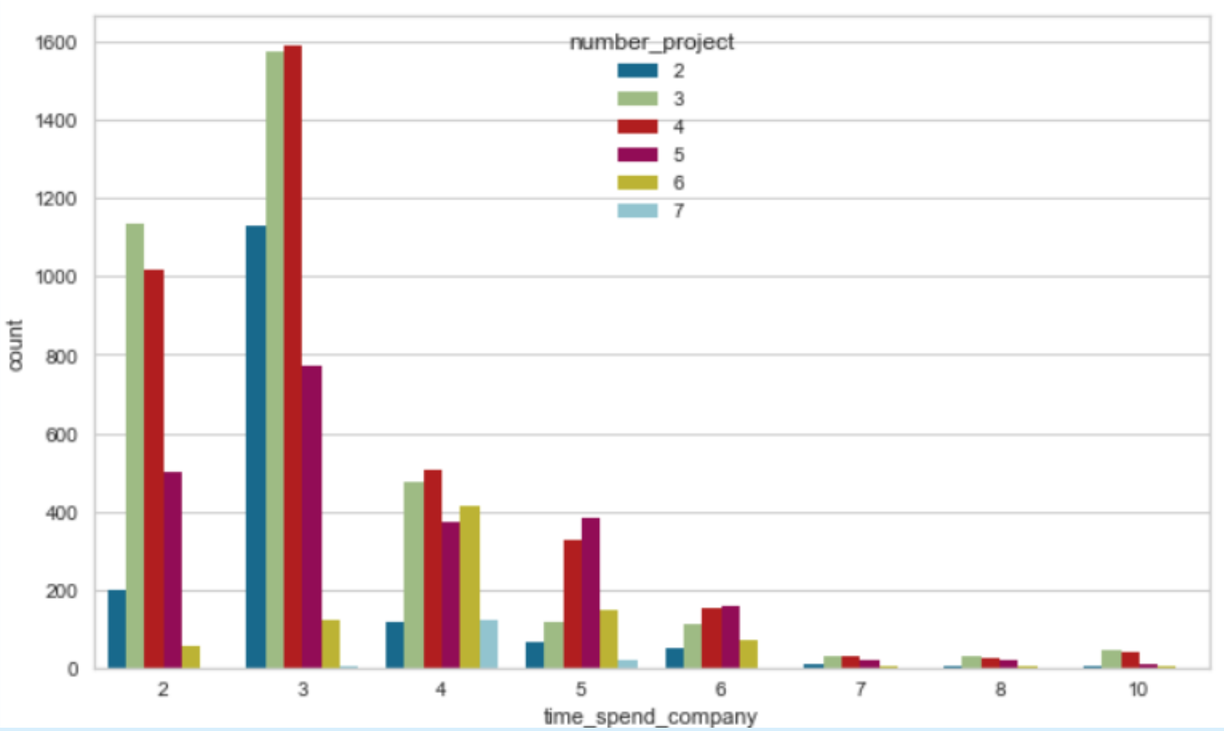




- Most of the resigning employees are in their third year. By the time their intention to resign is being decreased.
- As can be seen on the graph, the employees are not able to make a clear assessment of the company during the first three years of their employment. This, coupled with the other factors, tends to lead to leaving the company after three years.
- By the fourth year, their workload increases and their satisfaction decreases.
- After the fifth year, they make an assessment, "they will leave or not".
- If they decide to continue in the company, they never consider leaving after the sixth year.

EDA
(time_spend_company)

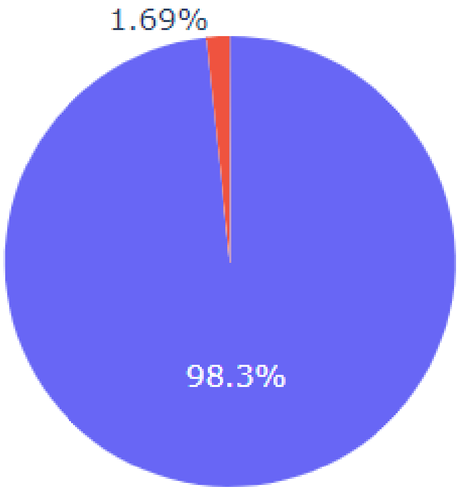


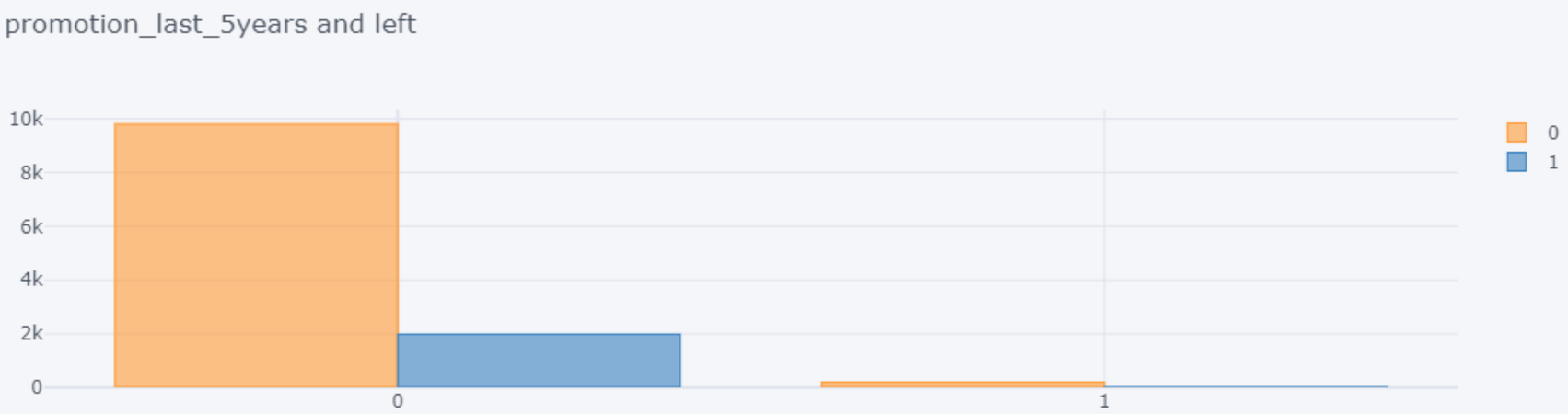


Then how is the relationship between workload and time spent in the company?

The third-year staff has the most workload. After that year number of participating projects is decreasing stepped. It makes sense. The experienced staff becoming team leader or manager position. That's why fewer of them can be assigned to projects.

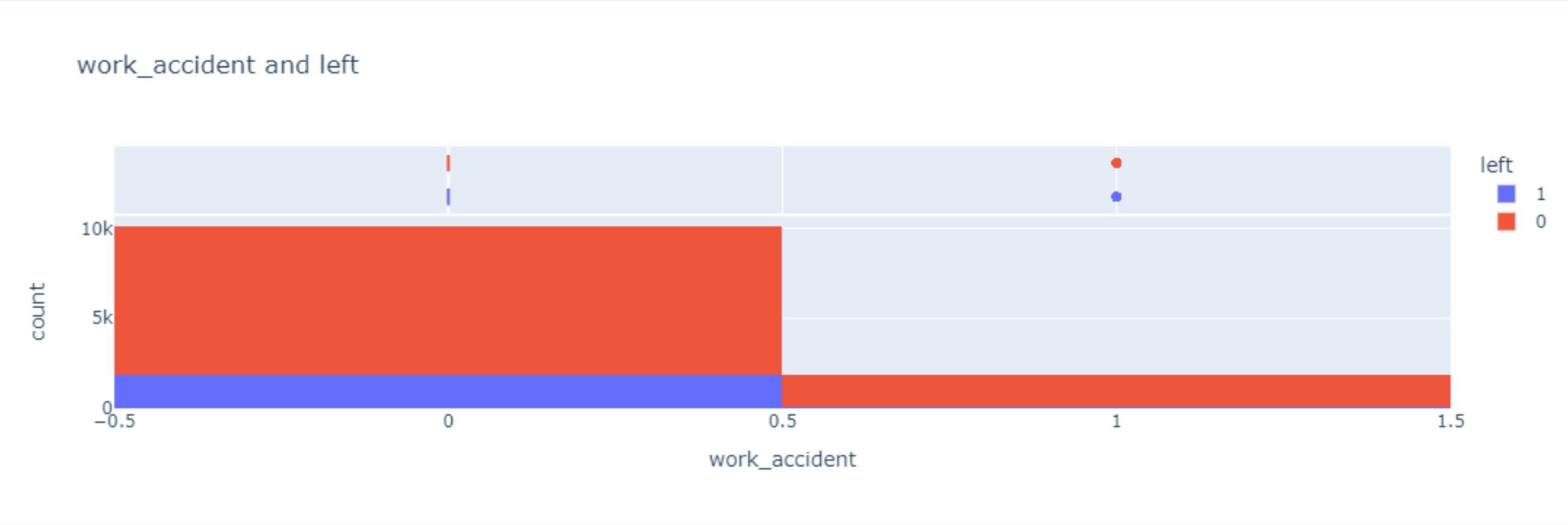
EDA
(promotion_last_5years)





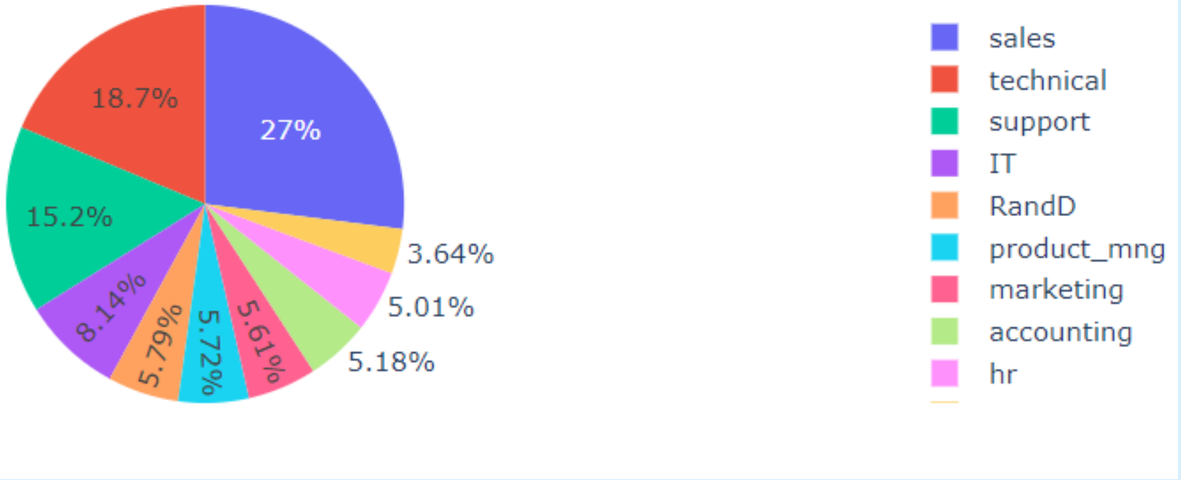
- Receiving a promotion in the last 5 working years is not determinative in terms of leaving or continuing to work.
- However, the percentage of those who receive promotions, even if it is small, is higher than those who do not.
- Resigning rates do not have a strict relation with getting promoted.

EDA
(work_accident)

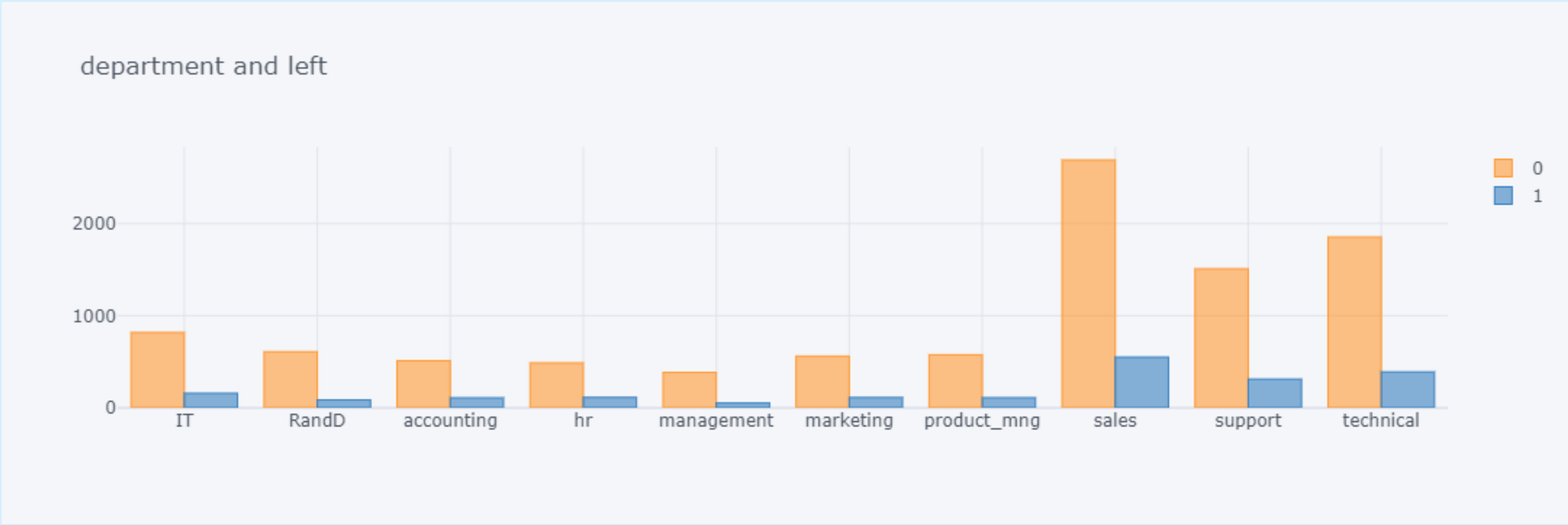


- Left ratios are similar between those who have had a work accident and those who have not.
- It does not appear to be a determining factor. In fact, it can be said that the left rate of those who have had a work accident is proportionally lower.
- Resigning rates do not have a strict relation with work accidents.

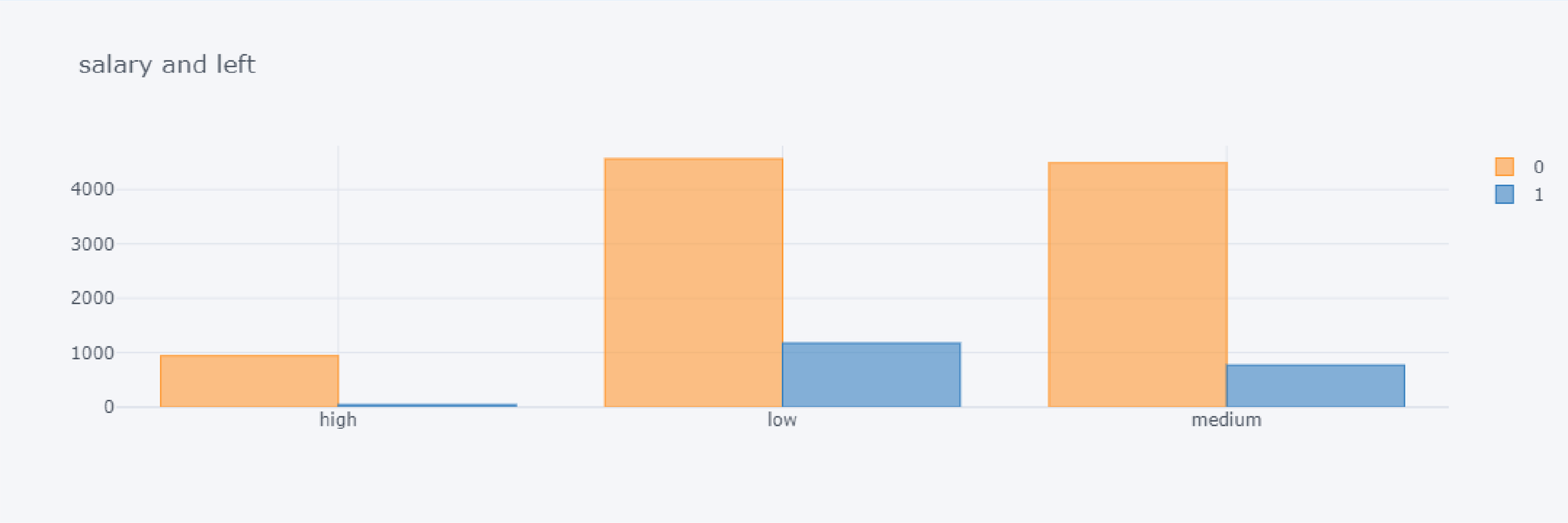
EDA
(Departments)



- It is not observed that the departments worked alone have an effect on the left decision.
- It is seen that the left percentages of the departments are similar.
- Resigning rates do not have a strict relation with work accidents.

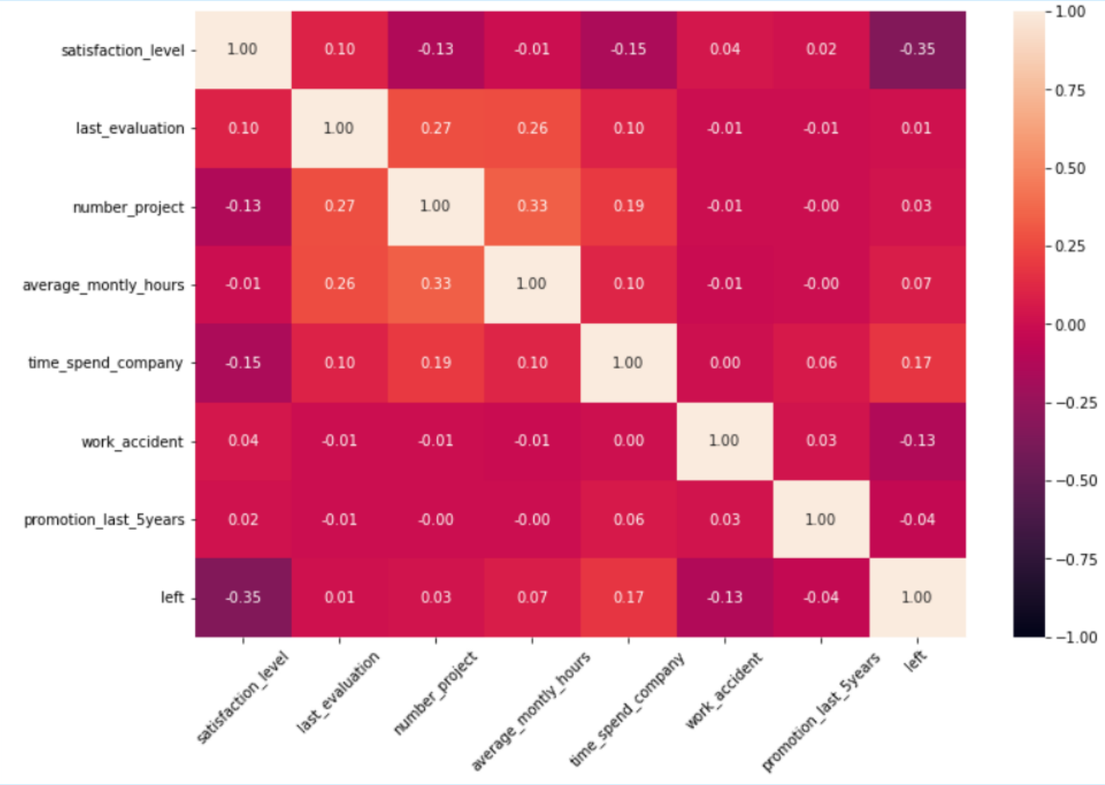


EDA
(salary)

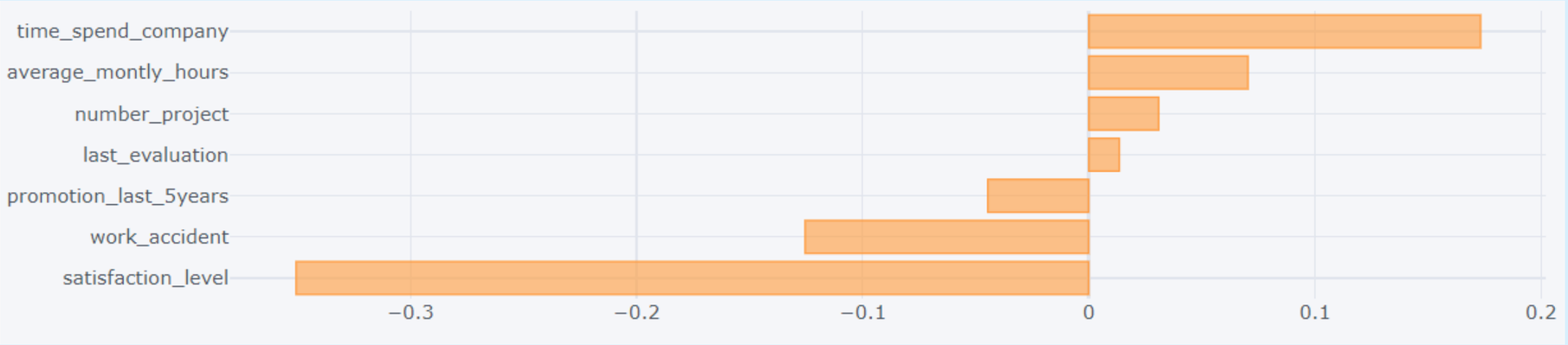


- Nearly 1/3 of the employees who have a salary level of low has left.
- It is seen that the left percentages of the salary are similar.
- Even if it is small, there is an increase in the form of high-medium-low according to the salary status.

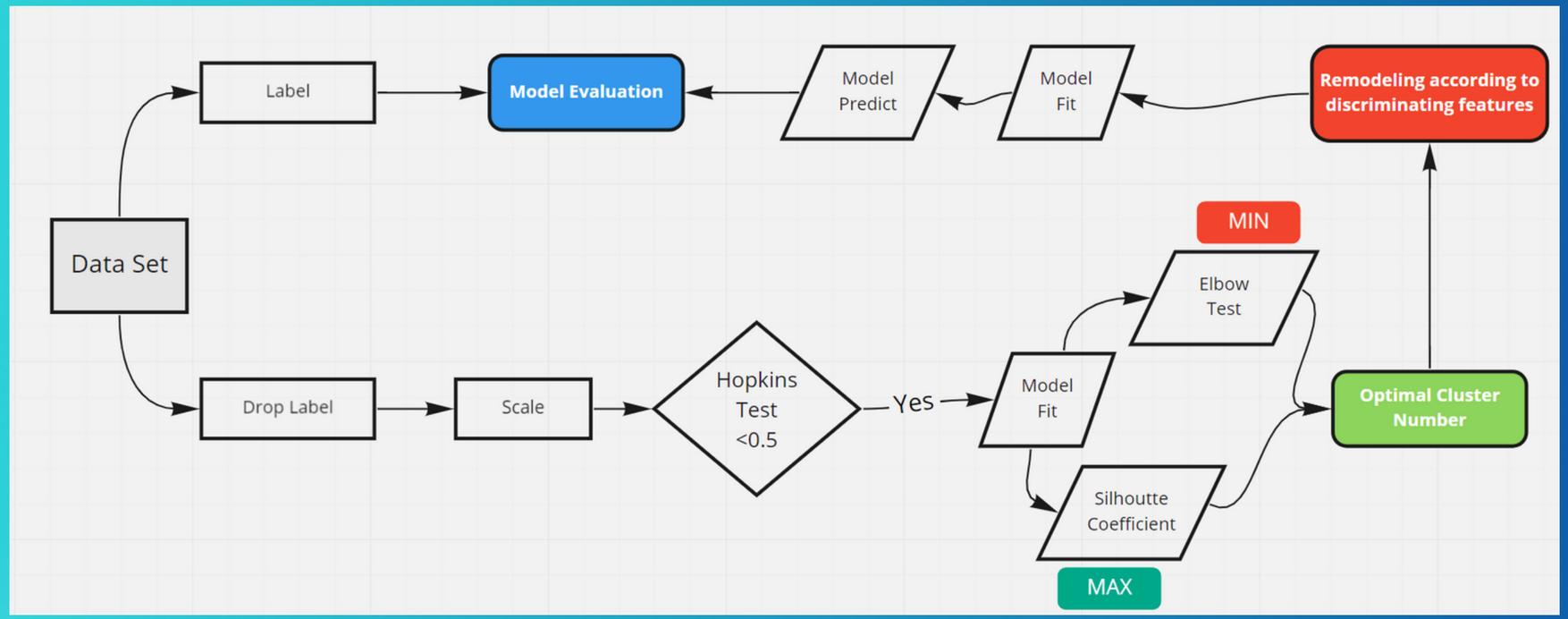
EDA
(CONCLUSION)



- There is no multicollinearity problem among the features.
- We have weak level correlation between the numerical features and the target column.
- Also there is weak level correlation between the columns.



K-MEANS

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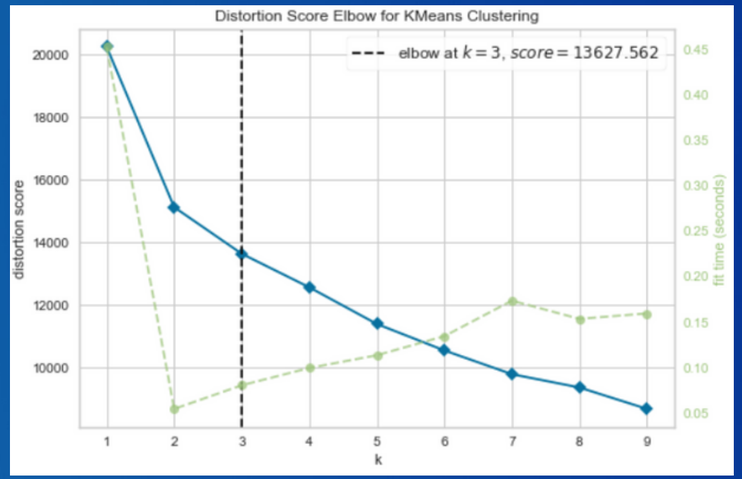
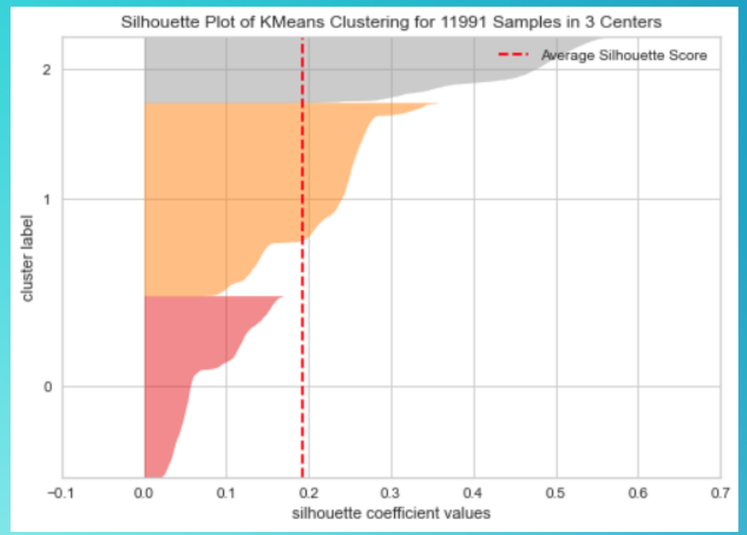
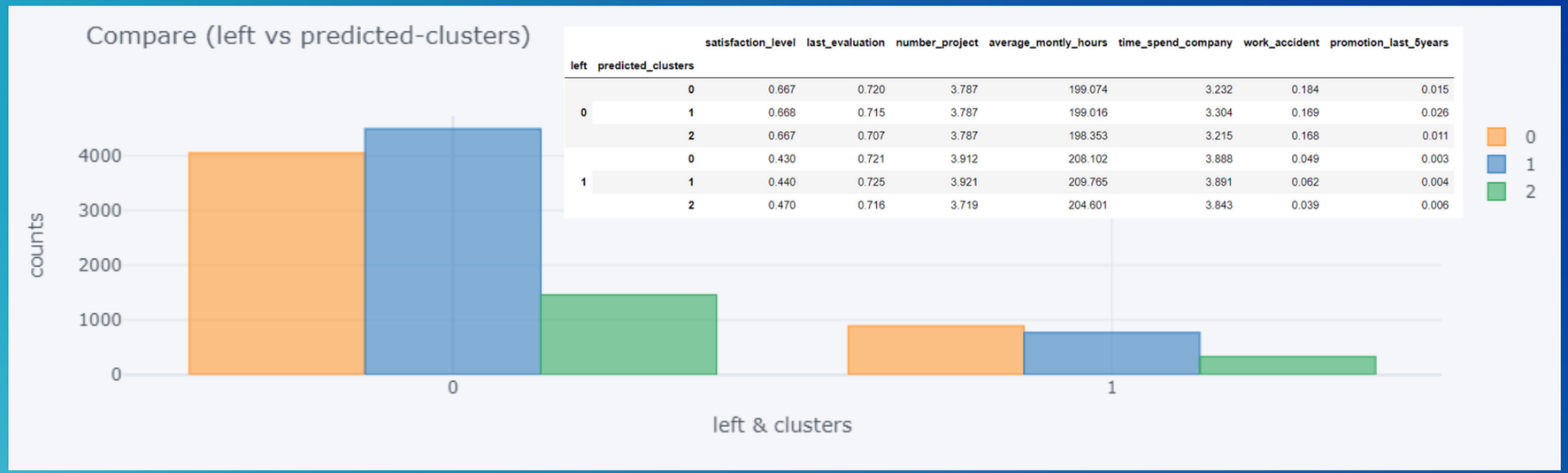
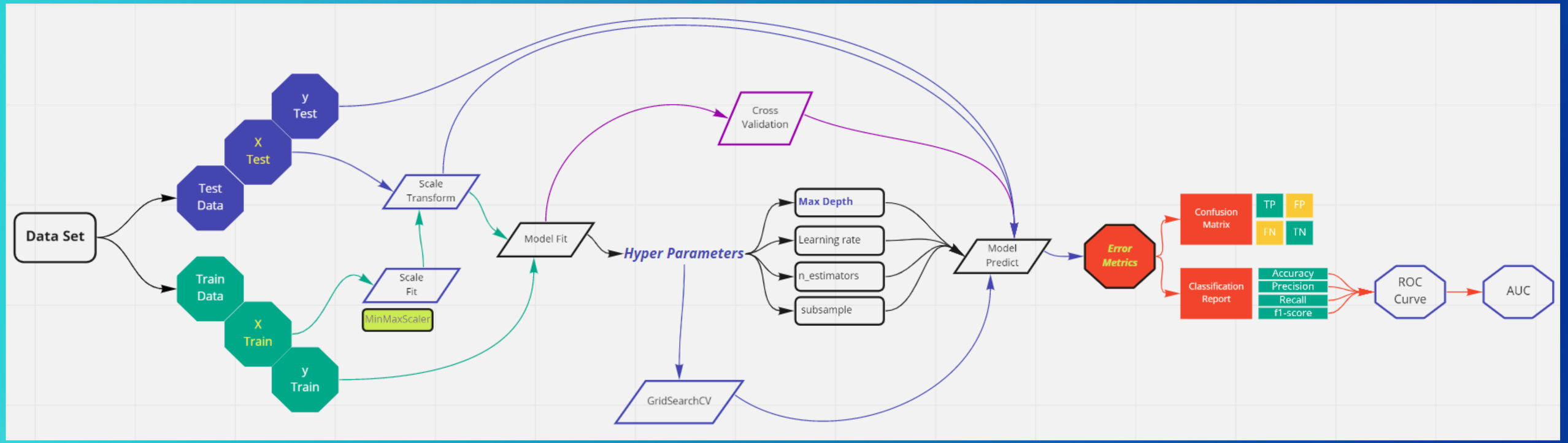






left	predicted_clusters	satisfaction_level	last_evaluation	number_project	average_montly_hours	time_spend_company	work_accident	promotion_last_5years
0	0	0.667	0.720	3.787	199.074	3.232	0.184	0.015
	1	0.668	0.715	3.787	199.016	3.304	0.169	0.026
	2	0.667	0.707	3.787	198.353	3.215	0.168	0.011
1	0	0.430	0.721	3.912	208.102	3.888	0.049	0.003
	1	0.440	0.725	3.921	209.765	3.891	0.062	0.004
	2	0.470	0.716	3.719	204.601	3.843	0.039	0.006

GRADIENT BOOSTING



	train_set	test_set
Accuracy	0.983	0.980
Precision	0.969	0.953
Recall	0.928	0.925
f1	0.948	0.939

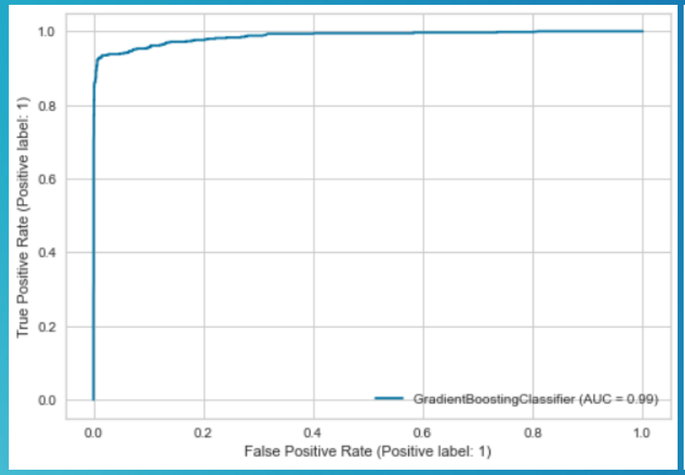
GB Model

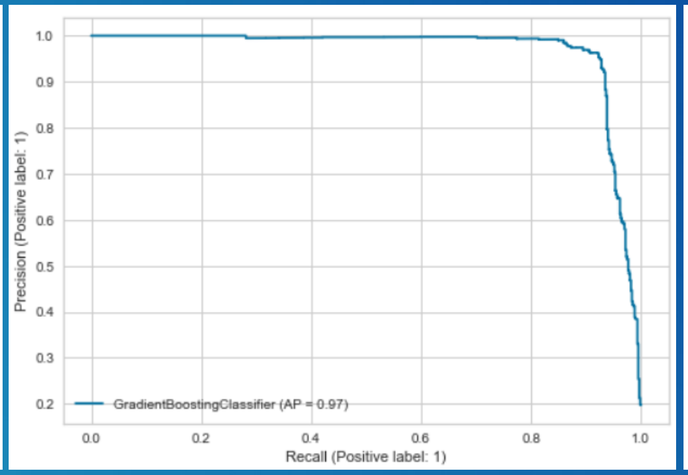
	train_set	test_set
Accuracy	0.986	0.985
Precision	0.989	0.987
Recall	0.926	0.920
f1	0.957	0.952

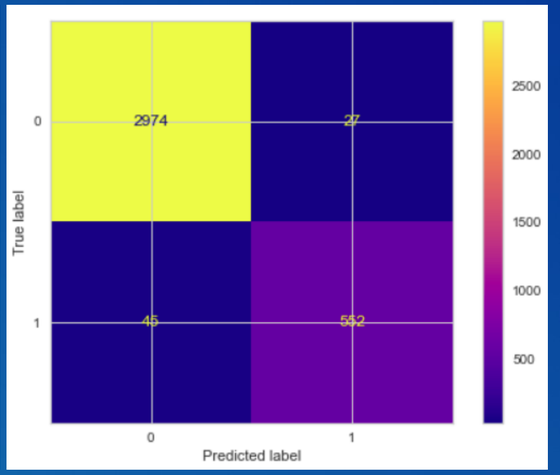
Gridsearch CV

test_accuracy	0.981
test_precision	0.965
test_recall	0.922
test_f1	0.943
test_roc_auc	0.985

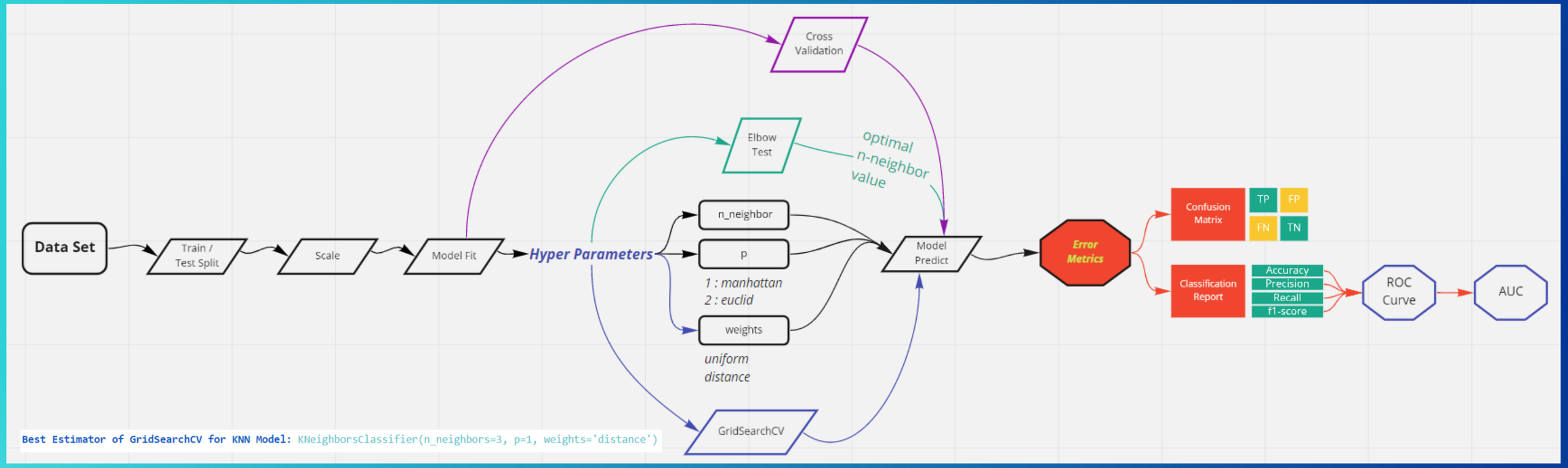
CV







KNN



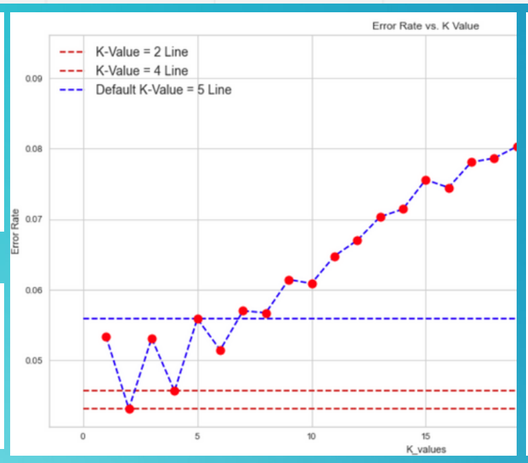

```
Best Estimator of GridSearchCV for KNN Model: KNeighborsClassifier(n_neighbors=3, p=1, weights='distance')
```

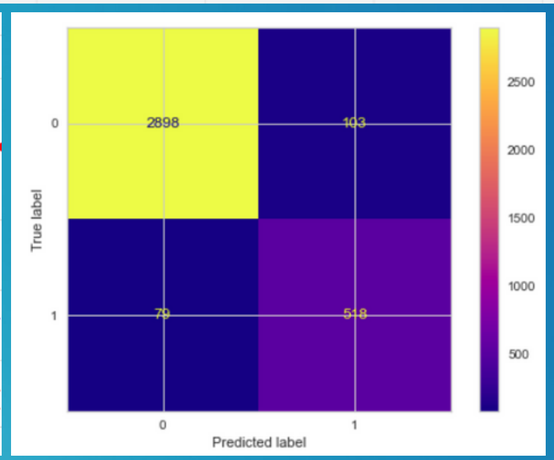
	train_set	test_set
Accuracy	0.960	0.944
Precision	0.879	0.813
Recall	0.878	0.861
f1	0.879	0.836

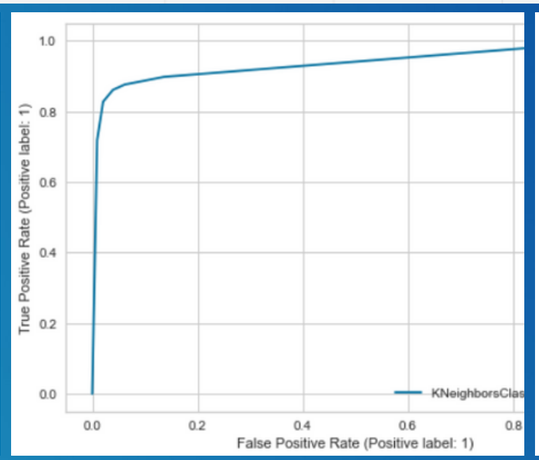
KNN Model

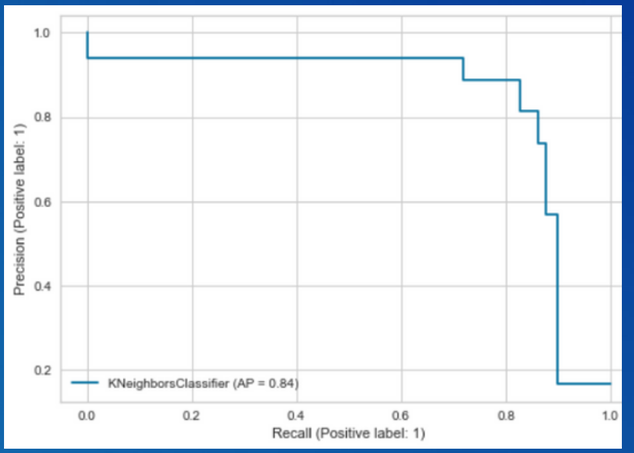
test_accuracy	0.948
test_precision	0.835
test_recall	0.859
test_f1	0.846
test_roc_auc	0.943

CV

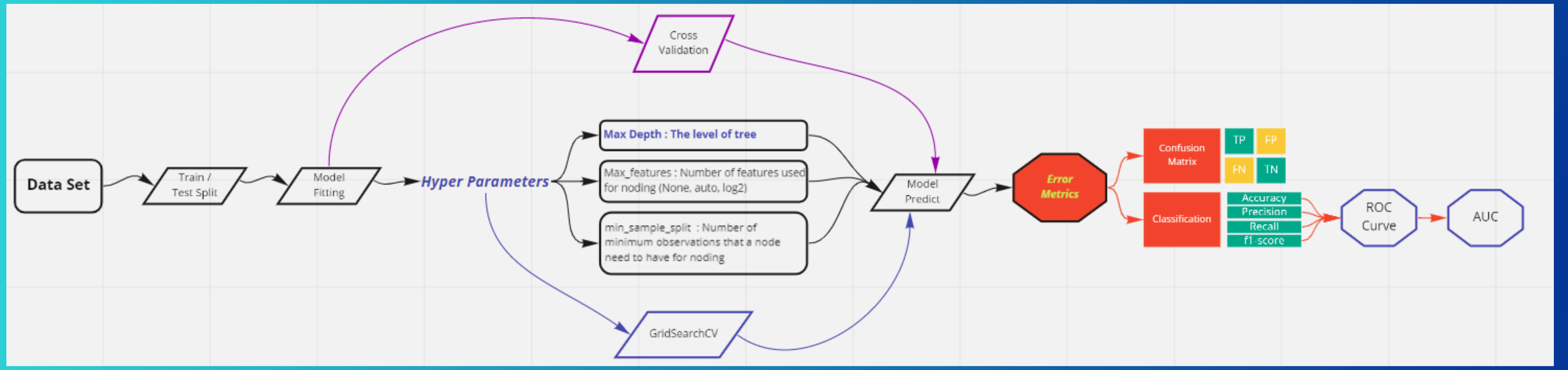








RANDOM FOREST



	train_set	test_set
Accuracy	1.000	0.982
Precision	1.000	0.991
Recall	1.000	0.903
f1	1.000	0.945

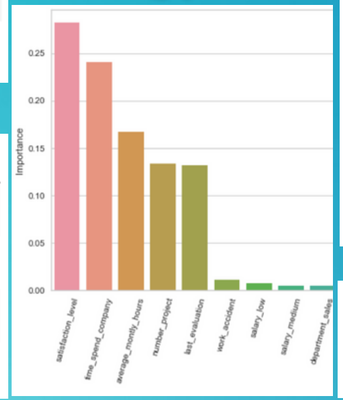
Random Forest

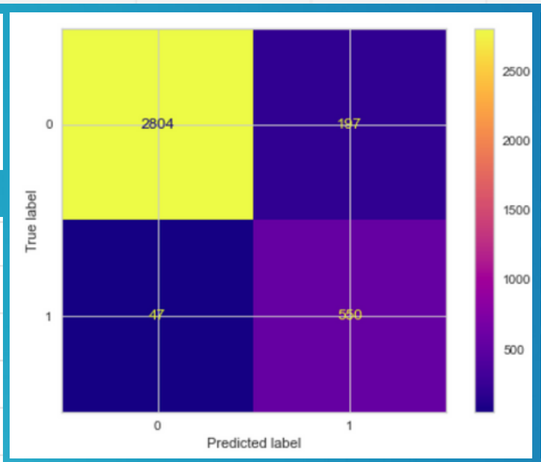
	train_set	test_set
Accuracy	0.932	0.932
Precision	0.731	0.736
Recall	0.937	0.921
f1	0.821	0.818

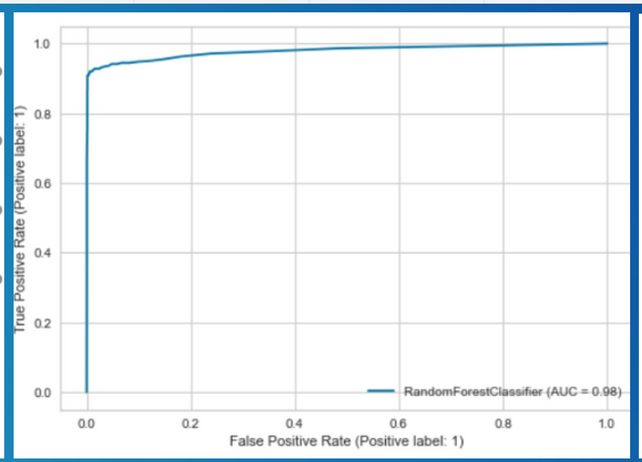
Gridsearch CV

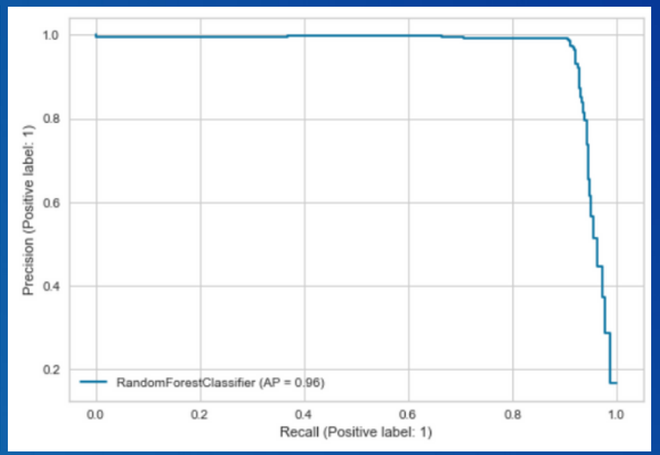
test_accuracy	0.982
test_precision	0.988
test_recall	0.905
test_f1	0.944
test_roc_auc	0.980

CV





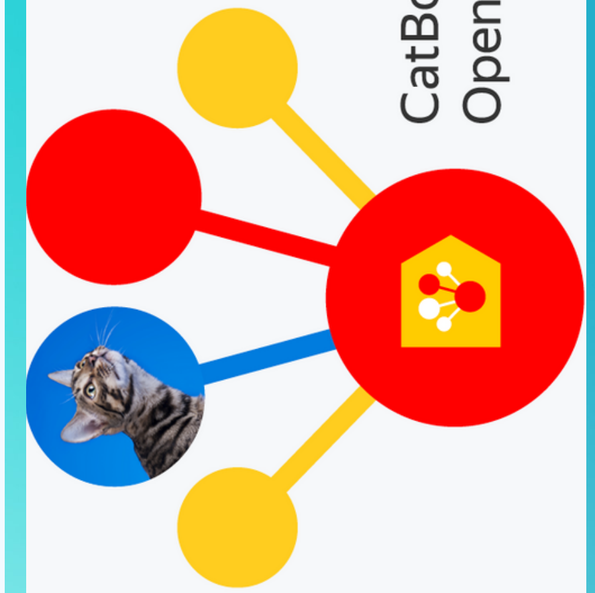




Best Estimator of GridSearchCV for Random Forest Model: RandomForestClassifier(class_weight='balanced', max_depth=3, max_features=4,
n_estimators=300, random_state=101)

CATBOOST

CatBoost
Open-source ML library

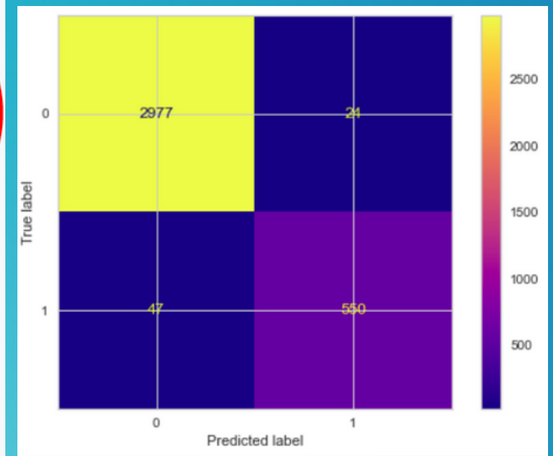


	train_set	test_set
Accuracy	0.994	0.980
Precision	0.977	0.958
Recall	0.987	0.921
f1	0.982	0.939

Catboost Classifier

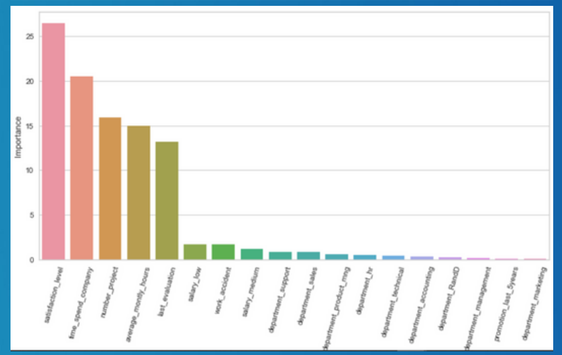
test_accuracy	0.980
test_precision	0.952
test_recall	0.924
test_f1	0.938
test_roc_auc	0.983

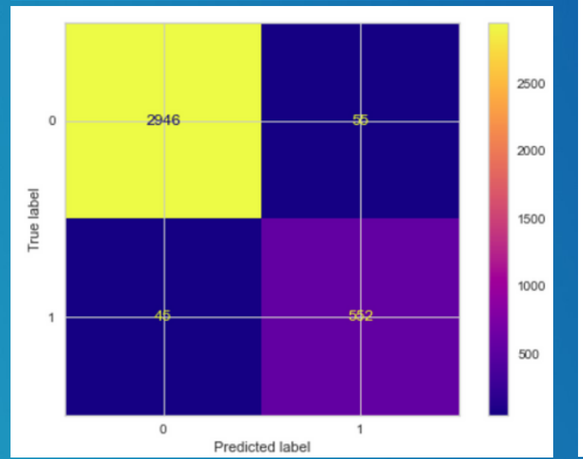
CV

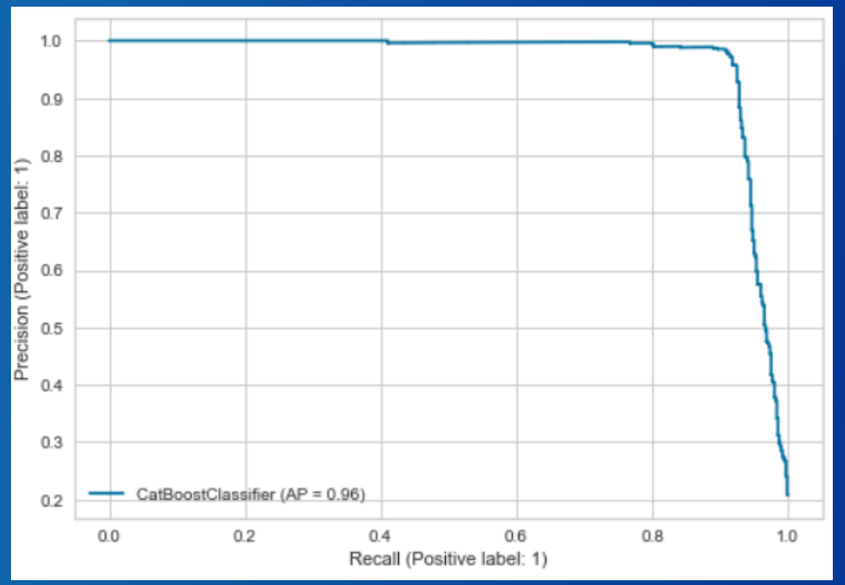


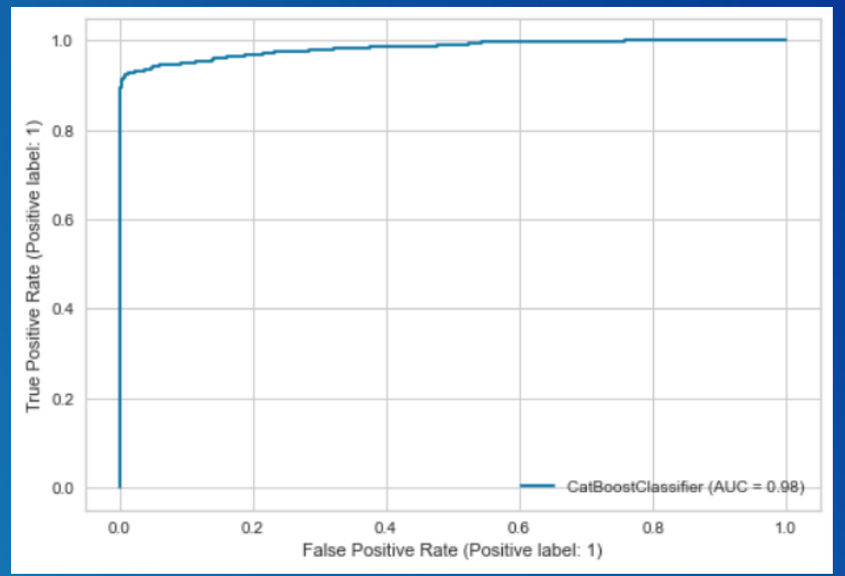
Best Parameters of GridSearchCV for Random Forest Model: {'depth': 4, 'l2_leaf_reg': 3, 'learning_rate': 0.01}

	train_set	test_set
Accuracy	0.977	0.972
Precision	0.923	0.909
Recall	0.940	0.925
f1	0.931	0.917

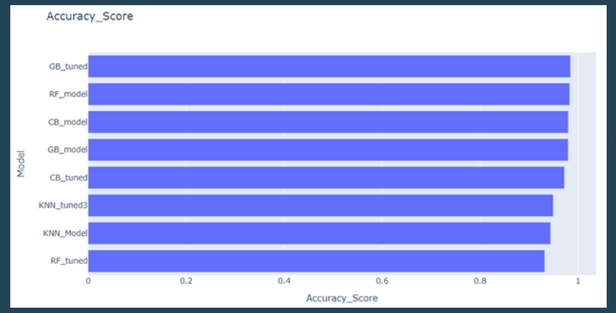




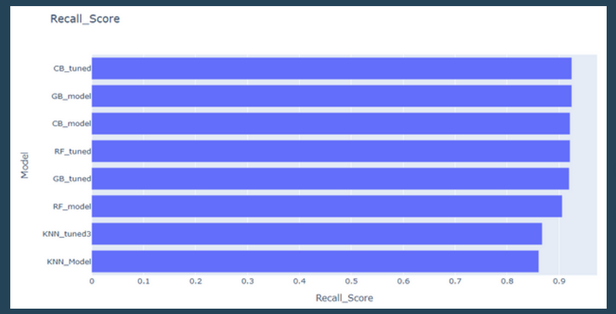




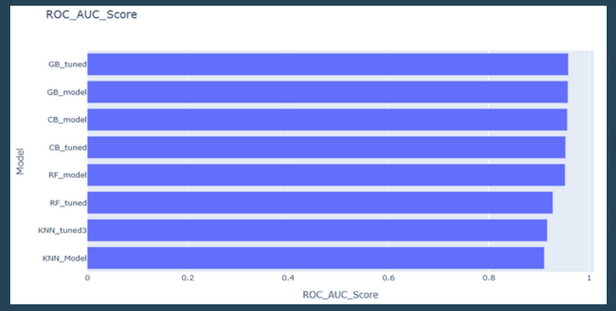
MODEL EVALUATION



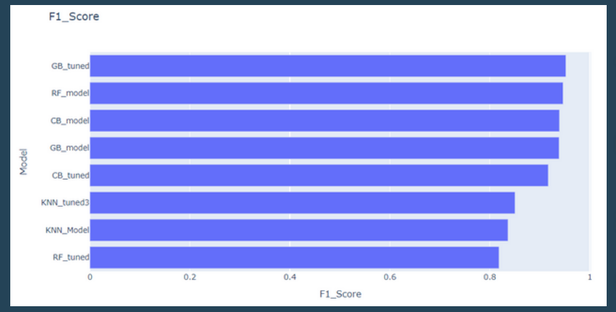
Gradient Boosting GridSearch CV



Catboost GridSearch CV



Gradient Boosting GridSearch CV



Gradient Boosting GridSearch CV

	Actual	GB_Pred	KNN_Pred	RF_Pred	CB_Pred
8392	0	0	0	0	0
3803	0	0	0	0	0
8829	0	0	0	0	0
4734	0	0	0	0	0
3804	0	0	0	0	0
701	1	1	1	1	1
2475	0	0	0	1	0
1836	1	0	1	0	0
6925	0	0	0	1	0
10369	0	0	0	0	0

Model	F1_Score	Accuracy_Score	Recall_Score	ROC_AUC_Score
KNN_Model	0.836	0.944	0.861	0.911
KNN_tuned3	0.851	0.949	0.868	0.917
RF_tuned	0.818	0.932	0.921	0.928
RF_model	0.947	0.983	0.906	0.952
CB_tuned	0.917	0.972	0.925	0.953
CB_model	0.939	0.980	0.921	0.957
GB_model	0.939	0.980	0.925	0.958
GB_tuned	0.952	0.985	0.920	0.959

True Positive
Predicted:True
Actual:True

False Positive
Predicted:True
Actual:False

True Negative
Predicted:False
Actual:False

False Negative
Predicted:False
Actual:True

Accuracy — How often the model correct?

$$\frac{TP + TN}{Total}$$

Recall — When it actually is a positive case, how often is it correct?

$$\frac{TP}{Total\ Actual\ Pos.}$$

Precision — When prediction is positive, how often is it correct?

$$\frac{TP}{Total\ Predicted\ Pos.}$$

F1-Score — Harmonic mean of the precision and recall.

$$\frac{2 * Precision * Recall}{Precision + Recall}$$

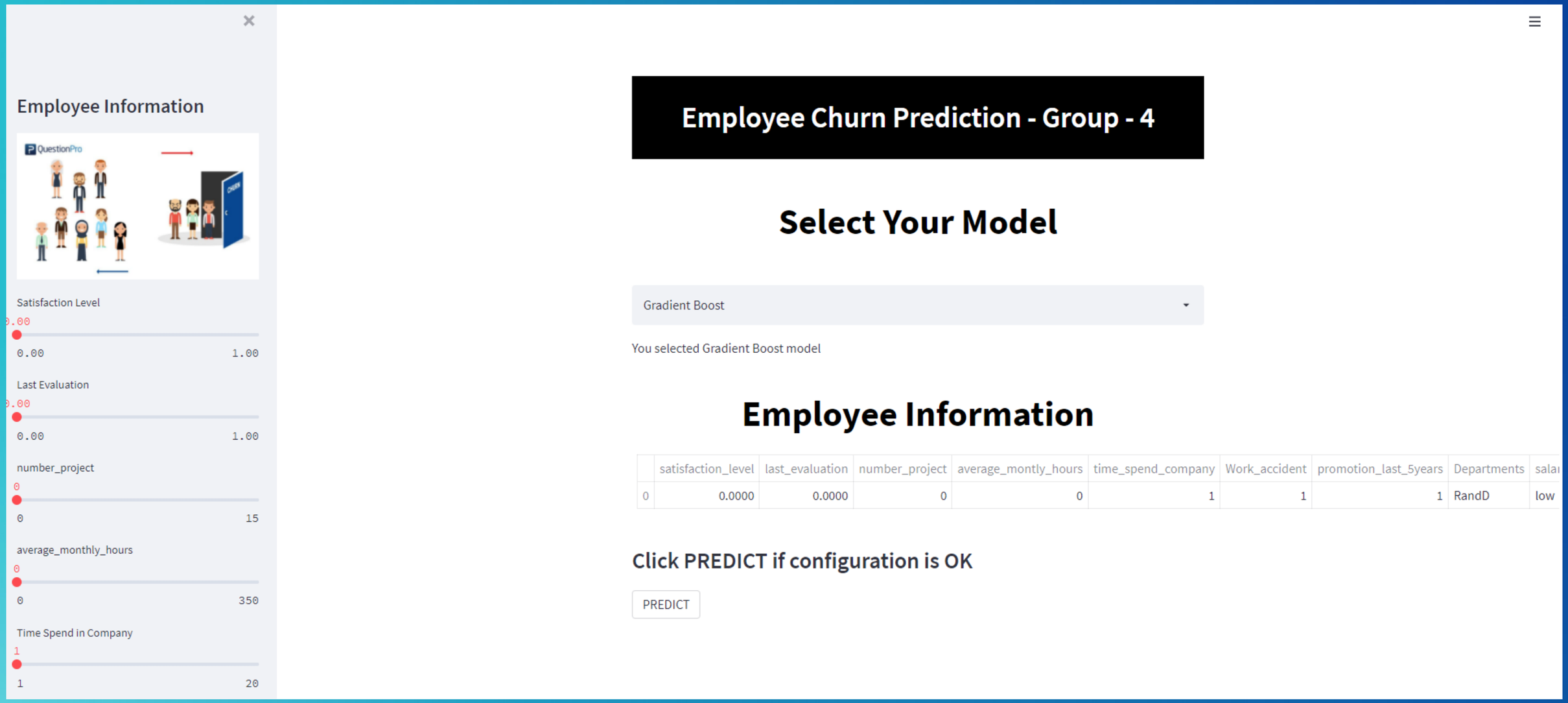
MODEL DEPLOYMENT

Streamlit

amazon web services

EC2

http://18.217.58.206:8501/



THANK YOU FOR YOUR PATIENCE...