Understanding Workplace Turnover with HR Analytics

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Topic

In HR, it is important to find and retain good employees. This project, Understanding Workplace Turnover with HR Analytics, exists to find the potential causes of turnover.

Business Problem

It is said that, "the best workers do the best and the most work. But many companies do an awful job of finding and keeping them" (Keller, 2021). Retaining employees can make or break a company. In fact, nearly a quarter of all US workers quit their jobs in 2006 (Allen, 2008). More than resulting in just low staffing levels; there are several causal factors to explain this.

Turnover is costly. The exact numbers vary between occupations and industries, but it can be 50-60% of a salary to directly hire with the total costs being as high as 200%. This can be as high as $133,000 for an HR professional or $150,000 for an accountant.

Turnover also affects performance. High turnover inhibits productivity and fosters low morale. However, reducing turnover shows immediate benefits. It has been shown that reducing turnover increases profitability and market value, in addition to improving workplace morale and sales growth. Thus, reducing turnover doesn't just save headaches; it saves companies.

Data Explanation

The dataset from Kaggle, https://www.kaggle.com/giripujar/hr-analytics, focused on human resources analytics. The columns are:

- Satisfaction Level – Representation of happiness within the employee's job.

- Last Evaluation - Representation of performance within their last assessment.
- Number of Projects – Number of projects managed by the employee concurrently.
- Average Monthly Hours – Amount of worked hours within a month.
- Time Spent with the Company – Amount of years employed by the company.
- Work Accident – Whether the employee experienced an accident at work.
- Left – The target variable describing if the employee left the job.
- Promotion with the Last Five Years - Represents if the employee was promoted within the last five years.
- Sales – A list of different departments including: sales, accounting, HR, technical, support, management, IT, product manager, marketing and research and development.
- Salary – How much the employee is paid. The unique values are: low, medium, high.

Work Accident, Left, and Promotion with the Last Five Years are categorical. Satisfaction Level, and Last Performance range between 0 and 1 - 1 as happiest and 0 as least happy. Sales categorizes several different departments. Salary is an ordinal value.

Methods

Steps were taken in order to find out what causes turnover. Firstly, the Salary column was converted to categorical integers. Secondly, Get Dummies was utilized to create columns for each department. A list was then created for all predictors, which was cross-referenced with the Left column with statistical processes such as Pearson's Correlation, feature selection, multicollinearity testing, logistic regression, ridge regression, and interaction term analysis.

Analysis

Correlation analysis was conducted between the target variable and all predictors, finding moderate relationships with Satisfaction Level (~ -0.388) and small relationships with Time Spent with the Company (~ 0.145), Work Accident (~-0.155) and Salary (~ 0.158)(Pawar, 2018). It was also done with each variable within one another to examine relationships.

Because the predictors seemed similar in nature, multicollinearity testing was also conducted. The following features had high VIF levels: Satisfaction Level (~ 6.503), Last Evaluation (~ 20.260), Number of Projects (~ 13.861), Average Monthly Hours (~ 19.324) and Time Spent with the Company (~ 6.714). The remaining two features had moderate VIF scores: Work Accident (~ 1.173), and Promotion with Five Years (~ 1.037).

Despite the multicollinearity, logistic regression was conducted due to the binary nature of the target variable along with ridge regression. Feature selection from logistic regression resulted in the most important features being Satisfaction Level, Work Accident, Salary, Accounting, HR, Marketing, Sales, Support and Technical. Ridge regression concluded resulted in a similar list as logistic regression, but did not consider Work Accident as important.

Logistic regression without interaction term analysis was done to find the following relationships, containing both coefficients (coef) and p values (p): Satisfaction Level (coef ~ 1.026, $p < .001$), Last Evaluation (coef ~ 0.013, $p < .001$), Number of Projects (coef ~ -0.384, $p < .001$), Average Monthly Hours (coef ~ 0.222, $p < .001$), Time Spent With the Company (coef ~ 0.386, $p < .001$), Work Accident (coef ~ -0.538, $p < .001$), Promotion Within Five Years (coef ~ -0.209, $p < .001$), Salary (coef ~ -0.439, $p < .001$), IT (coef ~ 0.362, p ~ 0.016), R and D (coef ~ -0.038, p ~ 0.823), Accounting (coef ~ 0.539, p ~ 0.001), HR (coef ~ 0.789, < .001), Marketing

(coef ~0.518, p ~ .001), Product Management (coef ~ 0.384, p ~ .015), Sales (coef ~ 0.502, p < .001), Support (coef ~ .589, p < .001), and Technical (coef ~.608, p < .001).

Due to the unexpected negative relationship between the target variable and Work Accident, logistic regression was redone with interaction term analysis, with Time Spent with the Company as a mediator. There were negligible differences when interaction term analysis was implemented. The connection between Work Accident and the target variable resulted in a coef of ~ 0.511 and a p value of < .001. However, when connecting Work Accident to the suspected mediator, Time Spent with Company, the coef was ~ 0.003 and a p value of ~ .795.

Conclusion

Feature selection concluded that the features most important to the analysis are Satisfaction Level, Number of Projects, Salary and Work Accident. It seems clear that low satisfaction level, a larger number of projects, lower pay are linked factors that can lead to turnover. Evidently, having an accident at work shares a relationship with staying with the company. It was hypothesized that Time Spent at the Company had a close relationship between leaving the company and work accident, but this hypothesis was not supported.

Assumptions

There is no supplemental information that was included with the dataset that helps to explain the features or how this data was gathered. As a result, a lot of the analyses and conclusions that have been derived from this dataset came about as a result of assumptions. These analyses could not be possible without inference from potentially ambiguous data.

Limitations

The trinary nature of salary limited the ability to analyze the data further due to the lack of continuous data. As a result, we lost the ability to look into how important salary was. Furthermore, more analyses could have been done with more features such as reason for the departure including if they were terminated or left willingly as well as a review of the employee's impression of the job and management style. Recommendations were also limited because it is unknown if higher salaries would reduce turnover or if other benefits, such as better health insurance for instance, would be preferred.

Challenges

Some of the challenges posed in reference to this study included trying to parse the most reasonable conclusion given the lack of the data, adjusting labels on the x axis on graphics to ensure it looks professional as well as modeling the results of the data to ensure that the correct conclusions were reached. Furthermore, the study failed to understand why there was a close relationship between a work accident and the employee staying with the company.

Future Uses / Additional Applications

This project provided data that can indicate turnover. It also revealed departments that appeared most and least satisfied. This could be also used to adjust business modeling to optimize satisfaction level. Furthermore, this project empowers employers to properly incentivize their employees in order to discourage turnover.

Recommendations

Based on the conclusions of the project, it is recommended that greater incentives be placed to those unsatisfied, those with a large number of projects and those with a lesser salary.

Implementation Plan

Employees with lower salaries should likely experience a pay raise whereas other important features should receive a generalized increase in benefits, which could include a higher salary. Several non-pay benefits that are received well include paid time off, better health insurance, options to improve work-life balance, greater contributions for 401k plans and family benefits such as subsidized child care (Miller, 2019).

Ethical Assessment

The ethical concerns in this report appear to be negligible. No names, identifying features nor company information were included in this report. Were this an actual company with data provided, this would be subject to regulatory scrutiny from the EEOC, local unions (if applicable), and by law.

Ten Questions From The Audience

1. Why was Time Spent with the Company hypothesized to be a mediator between Work Accident and the target variable?
    a. *There is a logical argument to be made that the longer one spends with the company, the more that they are to leave the company as the mean of time within the company is only about six months from if they left or not. Furthermore, the longer someone is at a job, the more likely they are inherently to be involved in a work accident.*
2. Would the increased salary be more costly to an employer than the cost of turnover itself?
    a. *This answer varies greatly based on the job salary, which is unavailable from this dataset. However, with the costs of turnover being as high as 200% of the employee's salary, a raise of 4% of a salary would take fifty years to recover from the cost of turnover.*
3. What kind of benefits would be most helpful to employees?
    a. *This answer varies greatly based on several factors, but the most attractive benefits to potential employers are pay, stock options, paid time off, healthcare and a work-life balance (Miller, 2019).*
4. Do employees prefer greater pay or other benefits such as PTO or better health insurance?
    a. *Aside from job satisfaction, greater pay ranks as the greatest motivator for an employee to work at a specific company.*

5. What kind of laws could exist in ethical considerations of this type of report?
    a. *There are several factors that could pose legal issues. Among them are guidelines from the federal government that show a preference for protected classes such as race, sex, and religion (Prohibited Employment Policies/Practices | U.S. Equal Employment Opportunity Commission, n.d.). Furthermore, no personal information can be disclosed without consent (Lesiuk, 2022). Therefore, most employees tend to release data by omitting personal information and/or releasing them in aggregate.*
6. Why wasn't mediation analysis done with all tests and with all predictors?
    a. *Mediation analysis was done when an anomaly was noticed in the data that doesn't match up with assumptions. It seems unusual that someone staying with a company is significantly more likely when they encounter a work accident, so further analysis was warranted. To do this for all variables within one another is not only burdensome, but also increases the risk of human error when interpreting the results.*
7. Why was logistic regression done despite the multicollinearity?
    a. *Logistic regression specializes in and can uncover more information about an unknown binary variable than ridge regression. Because of this, it felt important to include both. It should be noted that the results of both types of regressions did not yield much difference.*
8. Could this dataset be somehow combined with another dataset that looks at other potential causes of turnover? Why was this not done?

   a. *The main issue with combining this dataset with another dataset is that every row represents a single person. Because there was no other known dataset to connect to these same employees, such collaboration is nearly impossible.*

9. It seems that the amount of hours worked has a close relationship with turnover. Why was this variable not identified as such through either logistic or ridge regression?
   a. *Amount of hours worked was not identified as an important feature because it was seen as a cause for multicollinearity and there was no large disparity between the mean of both those who stayed with and left the company. The difference in the means was less than eight hours. To put this into perspective, one standard deviation of both groups was nearly fifty hours.*
10. Could this dataset be used to make potential inferences to describe the work culture?
   a. *It could possibly give indications as to how to make inferences, however it's important to know that one big assumption about the dataset used is that this is recording one employer. For most research studies, the suggested minimum sample size is thirty. This is important because it is unknown if this employer is an outlier for any of the quantitatively-based variables researched.*

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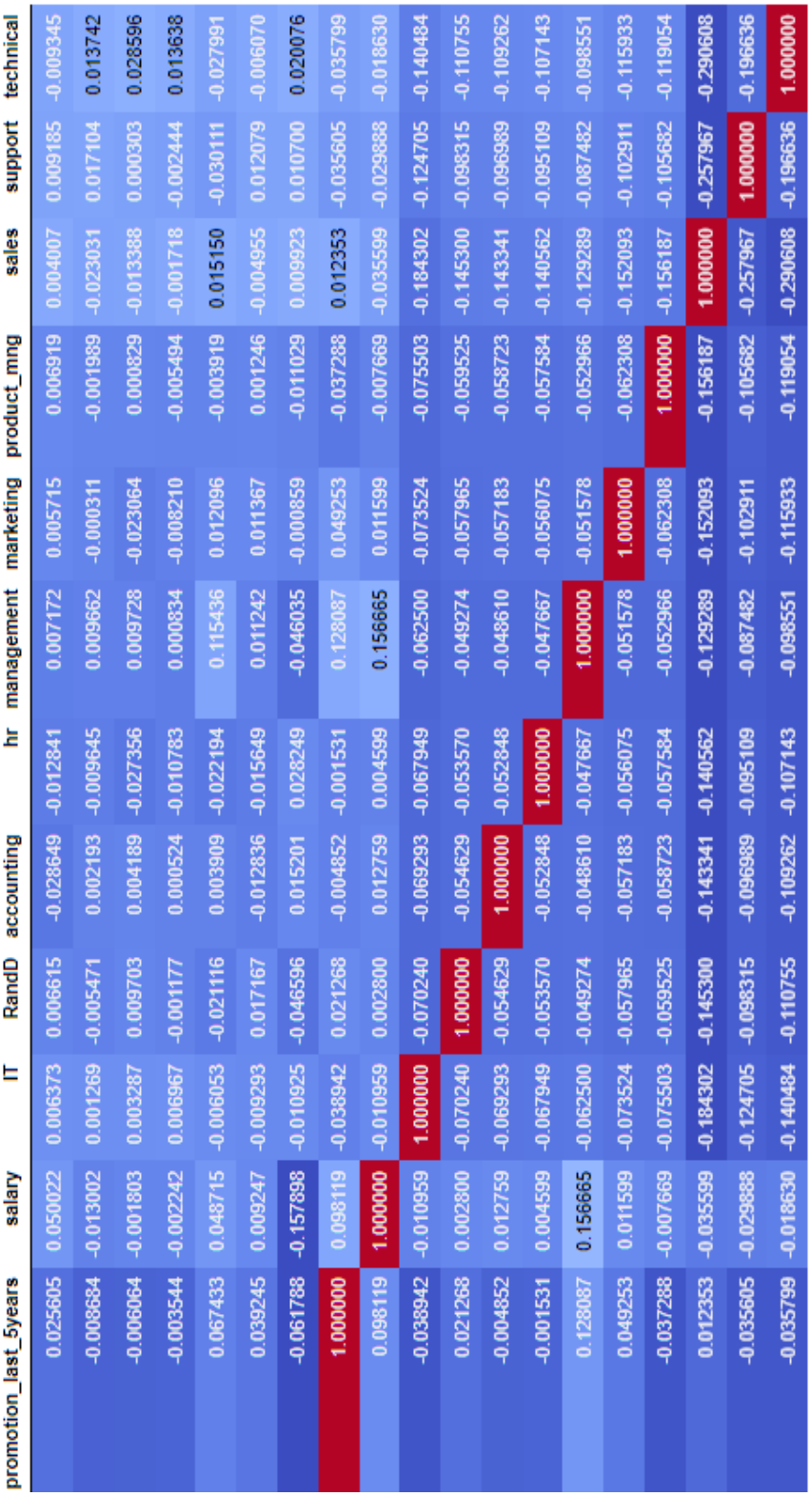
https://medium.com/analytics-vidhya/effect-of-multicollinearity-on-linear-regression-1cf7cfc5e8eb

Appendix



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promotion_last_5years	0.025605	0.050022	0.006373	0.006615	-0.028649	-0.012841	0.007172	0.005715	0.006919	0.004007	0.009185	-0.009345
	-0.008684	-0.013002	0.001269	-0.005471	0.002193	-0.009645	0.009662	-0.000311	-0.001989	-0.023031	0.017104	0.013742
	-0.006064	-0.001803	0.003287	0.009703	0.004189	-0.027356	0.009728	-0.023064	0.000829	-0.013388	0.000303	0.028596
	-0.003544	-0.002242	0.006967	-0.001177	0.000524	-0.010783	0.000834	-0.008210	-0.005494	-0.001718	-0.002444	0.013638
	0.067433	0.048715	-0.006053	-0.021116	0.003909	-0.022194	0.115436	0.012096	-0.003919	0.015150	-0.030111	-0.027991
	0.039245	0.009247	-0.009293	0.017467	-0.012836	-0.015649	0.011242	0.011367	0.001246	-0.004955	0.012079	-0.006070
	-0.061788	-0.157898	-0.010925	-0.046596	0.015201	0.028249	-0.046035	-0.000859	-0.011029	0.009923	0.010700	0.020076
	1.000000	0.098119	-0.038942	0.021268	-0.004852	-0.001531	0.128087	0.049253	-0.037288	0.012353	-0.035605	-0.035799
	0.098119	1.000000	-0.010959	0.002800	0.012759	0.004599	0.156665	0.011599	-0.007669	-0.035599	-0.029888	-0.018630
	-0.038942	-0.010959	1.000000	-0.070240	-0.069293	-0.067949	-0.062500	-0.073524	-0.075503	-0.184302	-0.124705	-0.140484
	0.021268	0.002800	-0.070240	1.000000	-0.054629	-0.053570	-0.049274	-0.057965	-0.059525	-0.145300	-0.098315	-0.110755
	-0.004852	0.012759	-0.069293	-0.054629	1.000000	-0.052848	-0.048610	-0.057183	-0.058723	-0.143341	-0.096989	-0.109262
	-0.001531	0.004599	-0.067949	-0.053570	-0.052848	1.000000	-0.047667	-0.056075	-0.057584	-0.140562	-0.095109	-0.107143
	0.128087	0.156665	-0.062500	-0.049274	-0.048610	-0.047667	1.000000	-0.051578	-0.052966	-0.129289	-0.087482	-0.098551
	0.049253	0.011599	-0.073524	-0.057965	-0.057183	-0.056075	-0.051578	1.000000	-0.062308	-0.152093	-0.102911	-0.115933
	-0.037288	-0.007669	-0.075503	-0.059525	-0.058723	-0.057584	-0.052966	-0.062308	1.000000	-0.156187	-0.105682	-0.119054
	0.012353	-0.035599	-0.184302	-0.145300	-0.143341	-0.140562	-0.129289	-0.152093	-0.156187	1.000000	-0.257967	-0.290608
	-0.035605	-0.029888	-0.124705	-0.098315	-0.096989	-0.095109	-0.087482	-0.102911	-0.105682	-0.257967	1.000000	-0.196636
	-0.035799	-0.018630	-0.140484	-0.110755	-0.109262	-0.107143	-0.098551	-0.115933	-0.119054	-0.290608	-0.196636	1.000000

	satisfaction_level	last_evaluation	number_project	average_montly_hours	time_spend_company	Work_accident	left
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number_project	-0.142970	0.349333	1.000000	0.417211	0.196786	-0.004741	0.023787
average_montly_hours	-0.020048	0.339742	0.417211	1.000000	0.127755	-0.010143	0.071287
time_spend_company	-0.100866	0.131591	0.196786	0.127755	1.000000	0.002120	0.144822
Work_accident	0.058697	-0.007104	-0.004741	-0.010143	0.002120	1.000000	-0.154622
left	-0.388375	0.006567	0.023787	0.071287	0.144822	-0.154622	1.000000
promotion_last_5years	0.025605	-0.008684	-0.006064	-0.003544	0.067433	0.039245	-0.061788
salary	0.050022	-0.013002	-0.001803	-0.002242	0.048715	0.009247	-0.157898
IT	0.006373	0.001269	0.003287	0.006967	-0.006053	-0.009293	-0.010925
RandD	0.006615	-0.005471	0.009703	-0.001177	-0.021116	0.017167	-0.046596
accounting	-0.028649	0.002193	0.004189	0.000524	0.003909	-0.012836	0.015201
hr	-0.012841	-0.009645	-0.027356	-0.010783	-0.022194	-0.015649	0.028249
management	0.007172	0.009662	0.009728	0.000834	0.115436	0.011242	-0.046035
marketing	0.005715	-0.000311	-0.023064	-0.008210	0.012096	0.011367	-0.000859
product_mng	0.006919	-0.001989	0.000829	-0.005494	-0.003919	0.001246	-0.011029
sales	0.004007	-0.023031	-0.013388	-0.001718	0.015150	-0.004955	0.009923
support	0.009185	0.017104	0.000303	-0.002444	-0.030111	0.012079	0.010700
technical	-0.009345	0.013742	0.028596	0.013638	-0.027991	-0.006070	0.020076

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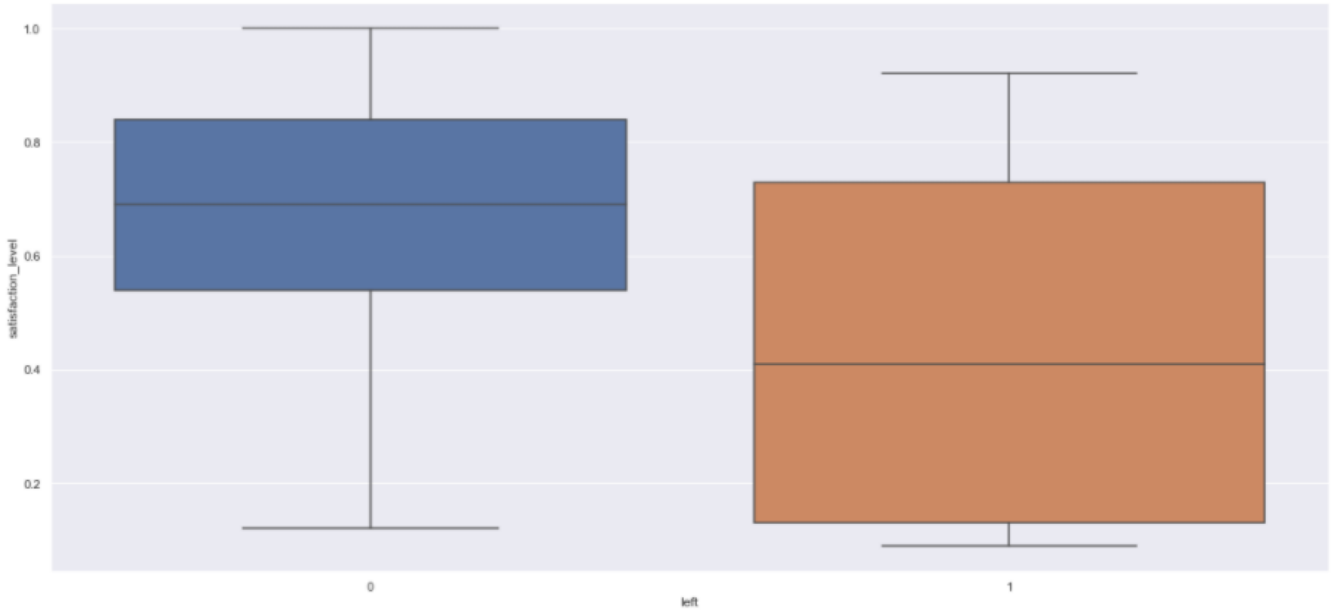

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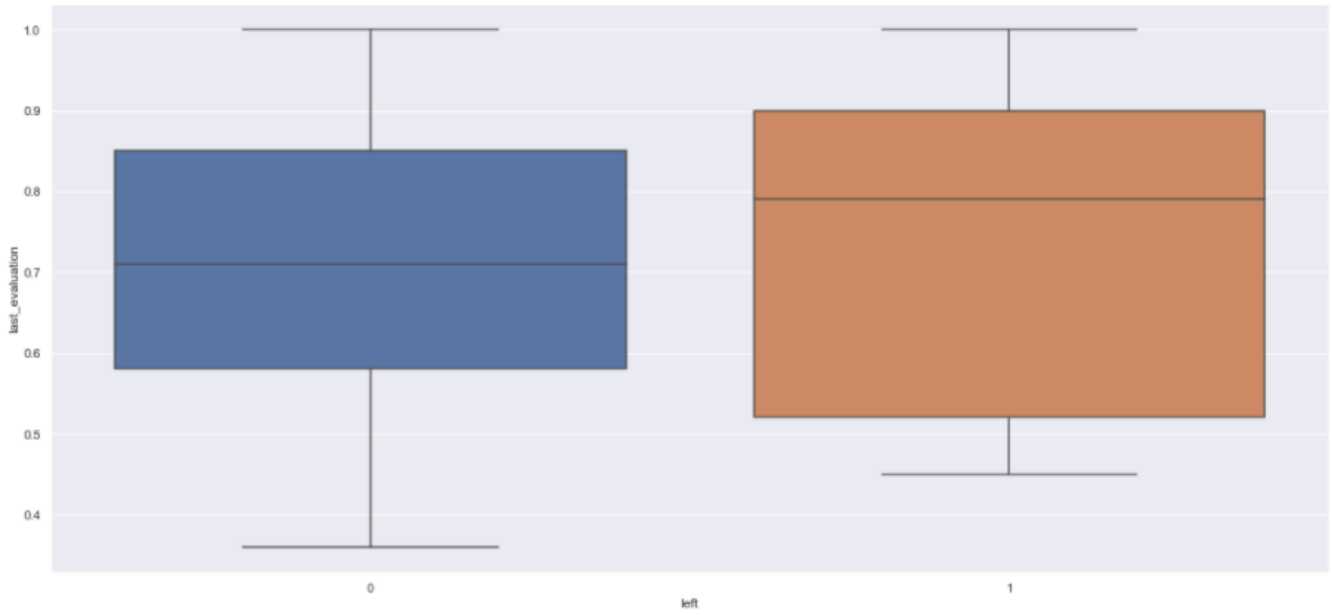

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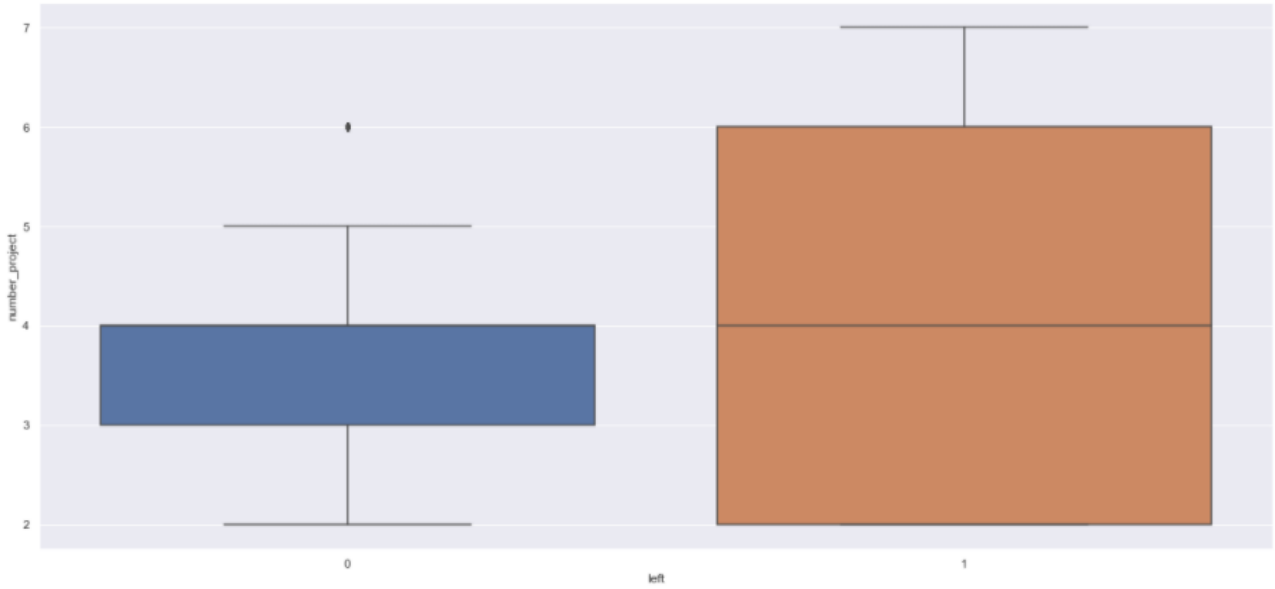

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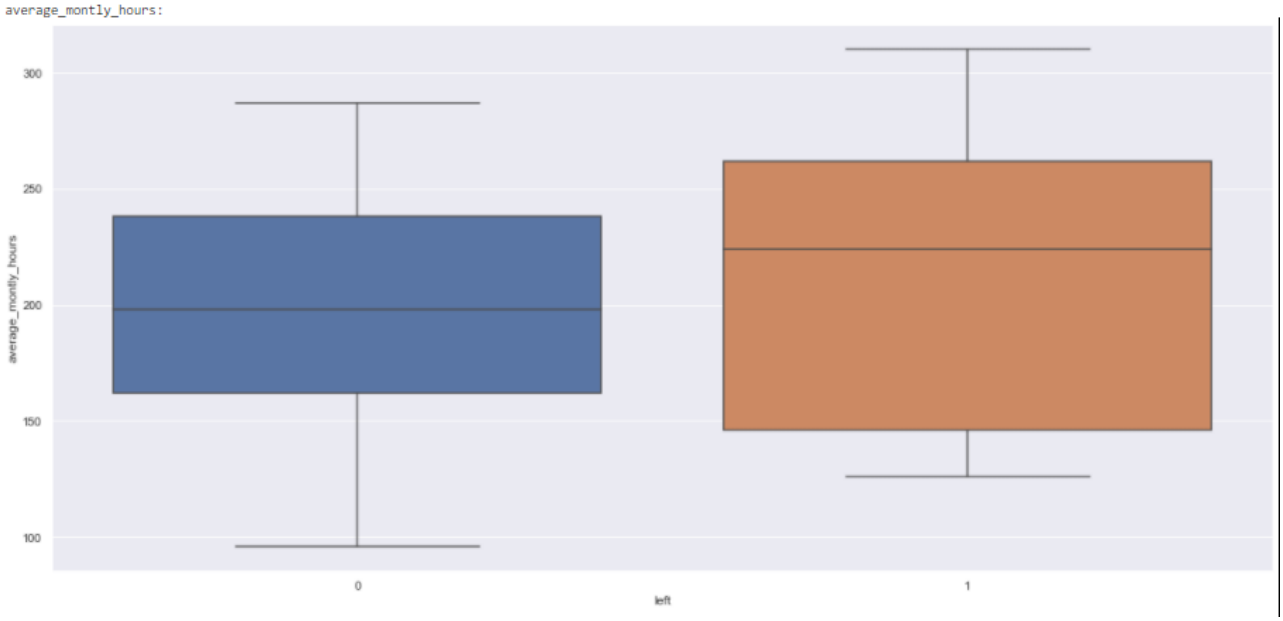

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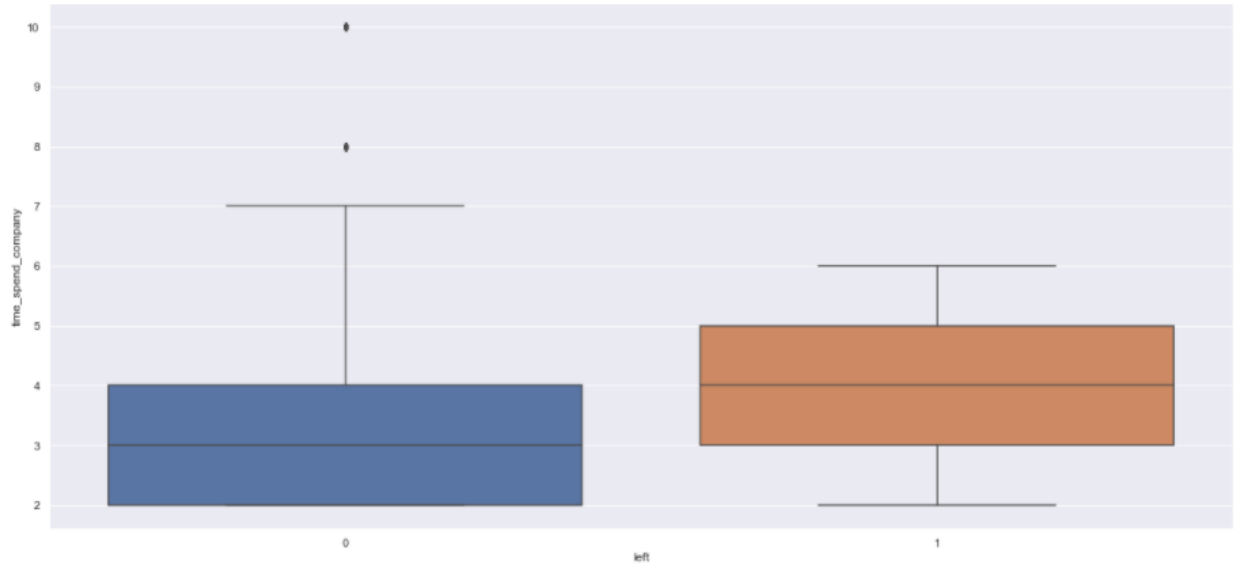

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