

Activity Exemplar__ Course 4 Automatidata project lab

January 7, 2024

1 Automatidata project

Course 4 - The Power of Statistics

You are a data professional in a data consulting firm, called Automatidata. The current project for their newest client, the New York City Taxi & Limousine Commission (New York City TLC) is reaching its midpoint, having completed a project proposal, Python coding work, and exploratory data analysis.

You receive a new email from Uli King, Automatidata's project manager. Uli tells your team about a new request from the New York City TLC: to analyze the relationship between fare amount and payment type. You also discover follow-up emails from three other team members: Deshawn Washington, Luana Rodriguez, and Udo Bankole. These emails discuss the details of the analysis. A final email from Luana includes your specific assignment: to conduct an A/B test.

A notebook was structured and prepared to help you in this project. Please complete the following questions.

2 Course 4 End-of-course project: Statistical analysis

In this activity, you will practice using statistics to analyze and interpret data. The activity covers fundamental concepts such as descriptive statistics and hypothesis testing. You will explore the data provided and conduct A/B and hypothesis testing.

The purpose of this project is to demonstrate knowledge of how to prepare, create, and analyze A/B tests. Your A/B test results should aim to find ways to generate more revenue for taxi cab drivers.

Note: For the purpose of this exercise, assume that the sample data comes from an experiment in which customers are randomly selected and divided into two groups: 1) customers who are required to pay with credit card, 2) customers who are required to pay with cash. Without this assumption, we cannot draw causal conclusions about how payment method affects fare amount.

The goal is to apply descriptive statistics and hypothesis testing in Python. The goal for this A/B test is to sample data and analyze whether there is a relationship between payment type and fare amount. For example: discover if customers who use credit cards pay higher fare amounts than customers who use cash.

This activity has four parts:

Part 1: Imports and data loading * What data packages will be necessary for hypothesis testing?

Part 2: Conduct EDA and hypothesis testing * How did computing descriptive statistics help you analyze your data?

- How did you formulate your null hypothesis and alternative hypothesis?

Part 3: Communicate insights with stakeholders

- What key business insight(s) emerged from your A/B test?
- What business recommendations do you propose based on your results?

Follow the instructions and answer the questions below to complete the activity. Then, you will complete an Executive Summary using the questions listed on the PACE Strategy Document.

Be sure to complete this activity before moving on. The next course item will provide you with a completed exemplar to compare to your own work.

3 Conduct an A/B test

4 PACE stages

Throughout these project notebooks, you'll see references to the problem-solving framework PACE. The following notebook components are labeled with the respective PACE stage: Plan, Analyze, Construct, and Execute.

4.1 PACE: Plan

In this stage, consider the following questions where applicable to complete your code response:

1. What is your research question for this data project? Later on, you will need to formulate the null and alternative hypotheses as the first step of your hypothesis test. Consider your research question now, at the start of this task.

Exemplar response: The research question for this data project: "Is there a relationship between total fare amount and payment type?"

Complete the following steps to perform statistical analysis of your data:

4.1.1 Task 1. Imports and data loading

Import packages and libraries needed to compute descriptive statistics and conduct a hypothesis test.

Hint:

Before you begin, recall the following Python packages and functions that may be useful:

Main functions: `stats.ttest_ind(a, b, equal_var)`

Other functions: `mean()`

Packages: pandas, stats.scipy

```
[2]: import pandas as pd
      from scipy import stats
```

Note: As shown in this cell, the dataset has been automatically loaded in for you. You do not need to download the .csv file, or provide more code, in order to access the dataset and proceed with this lab. Please continue with this activity by completing the following instructions.

```
[3]: taxi_data = pd.read_csv("2017_Yellow_Taxi_Trip_Data.csv", index_col = 0)
```

4.2 PACE: Analyze and Construct

In this stage, consider the following questions where applicable to complete your code response: 1. Data professionals use descriptive statistics for Exploratory Data Analysis. How can computing descriptive statistics help you learn more about your data in this stage of your analysis?

Exemplar response: In general, descriptive statistics are useful because they let you quickly explore and understand large amounts of data. In this case, computing descriptive statistics helps you quickly compare the average total fare amount among different payment types.

4.2.1 Task 2. Data exploration

Use descriptive statistics to conduct Exploratory Data Analysis (EDA).

Hint:

Refer back to *Self Review Descriptive Statistics* for this step-by-step process.

Note: In the dataset, `payment_type` is encoded in integers: * 1: Credit card * 2: Cash * 3: No charge * 4: Dispute * 5: Unknown

```
[4]: # descriptive stats code for EDA
      taxi_data.describe(include='all')
```

```
[4]:
```

	VendorID	tpep_pickup_datetime	tpep_dropoff_datetime	\
count	22699.000000	22699	22699	
unique	NaN	22687	22688	
top	NaN	07/03/2017 3:45:19 PM	10/18/2017 8:07:45 PM	
freq	NaN	2	2	
mean	1.556236	NaN	NaN	
std	0.496838	NaN	NaN	
min	1.000000	NaN	NaN	
25%	1.000000	NaN	NaN	
50%	2.000000	NaN	NaN	
75%	2.000000	NaN	NaN	
max	2.000000	NaN	NaN	

	passenger_count	trip_distance	RatecodeID	store_and_fwd_flag	\
count	22699.000000	22699.000000	22699.000000	22699	
unique	NaN	NaN	NaN	2	
top	NaN	NaN	NaN	N	
freq	NaN	NaN	NaN	22600	
mean	1.642319	2.913313	1.043394	NaN	
std	1.285231	3.653171	0.708391	NaN	
min	0.000000	0.000000	1.000000	NaN	
25%	1.000000	0.990000	1.000000	NaN	
50%	1.000000	1.610000	1.000000	NaN	
75%	2.000000	3.060000	1.000000	NaN	
max	6.000000	33.960000	99.000000	NaN	

	PULocationID	DOLocationID	payment_type	fare_amount	extra	\
count	22699.000000	22699.000000	22699.000000	22699.000000	22699.000000	
unique	NaN	NaN	NaN	NaN	NaN	
top	NaN	NaN	NaN	NaN	NaN	
freq	NaN	NaN	NaN	NaN	NaN	
mean	162.412353	161.527997	1.336887	13.026629	0.333275	
std	66.633373	70.139691	0.496211	13.243791	0.463097	
min	1.000000	1.000000	1.000000	-120.000000	-1.000000	
25%	114.000000	112.000000	1.000000	6.500000	0.000000	
50%	162.000000	162.000000	1.000000	9.500000	0.000000	
75%	233.000000	233.000000	2.000000	14.500000	0.500000	
max	265.000000	265.000000	4.000000	999.990000	4.500000	

	mta_tax	tip_amount	tolls_amount	improvement_surcharge	\
count	22699.000000	22699.000000	22699.000000	22699.000000	
unique	NaN	NaN	NaN	NaN	
top	NaN	NaN	NaN	NaN	
freq	NaN	NaN	NaN	NaN	
mean	0.497445	1.835781	0.312542	0.299551	
std	0.039465	2.800626	1.399212	0.015673	
min	-0.500000	0.000000	0.000000	-0.300000	
25%	0.500000	0.000000	0.000000	0.300000	
50%	0.500000	1.350000	0.000000	0.300000	
75%	0.500000	2.450000	0.000000	0.300000	
max	0.500000	200.000000	19.100000	0.300000	

	total_amount
count	22699.000000
unique	NaN
top	NaN
freq	NaN
mean	16.310502
std	16.097295
min	-120.300000

25%	8.750000
50%	11.800000
75%	17.800000
max	1200.290000

You are interested in the relationship between payment type and the fare amount the customer pays. One approach is to look at the average fare amount for each payment type.

```
[7]: taxi_data.groupby('payment_type')['fare_amount'].mean()
```

```
[7]: payment_type
1    13.429748
2    12.213546
3    12.186116
4     9.913043
Name: fare_amount, dtype: float64
```

Based on the averages shown, it appears that customers who pay in credit card tend to pay a larger fare amount than customers who pay in cash. However, this difference might arise from random sampling, rather than being a true difference in fare amount. To assess whether the difference is statistically significant, you conduct a hypothesis test.

4.2.2 Task 3. Hypothesis testing

Before you conduct your hypothesis test, consider the following questions where applicable to complete your code response:

1. Recall the difference between the null hypothesis and the alternative hypotheses. What are your hypotheses for this data project?

Exemplar response: Null hypothesis: There is no difference in average fare between customers who use credit cards and customers who use cash. **Alternative hypothesis:** There is a difference in average fare between customers who use credit cards and customers who use cash

Your goal in this step is to conduct a two-sample t-test. Recall the steps for conducting a hypothesis test:

1. State the null hypothesis and the alternative hypothesis
2. Choose a significance level
3. Find the p-value
4. Reject or fail to reject the null hypothesis

Note: For the purpose of this exercise, your hypothesis test is the main component of your A/B test.

H_0 : There is no difference in the average fare amount between customers who use credit cards and customers who use cash.

H_A : There is a difference in the average fare amount between customers who use credit cards and customers who use cash.

You choose 5% as the significance level and proceed with a two-sample t-test.

```
[8]: #hypothesis test, A/B test
    #significance level

    credit_card = taxi_data[taxi_data['payment_type'] == 1]['fare_amount']
    cash = taxi_data[taxi_data['payment_type'] == 2]['fare_amount']
    stats.ttest_ind(a=credit_card, b=cash, equal_var=False)
```

```
[8]: Ttest_indResult(statistic=6.866800855655372, pvalue=6.797387473030518e-12)
```

Exemplar response: Since the p-value is significantly smaller than the significance level of 5%, you reject the null hypothesis.

Notice the ‘e-12’ at the end of the pvalue result.

You conclude that there is a statistically significant difference in the average fare amount between customers who use credit cards and customers who use cash.

4.3 PACE: Execute

Consider the questions in your PACE Strategy Document to reflect on the Execute stage.

4.3.1 Task 4. Communicate insights with stakeholders

In conclusion, ask yourself the following questions:

1. What business insight(s) can you draw from the result of your hypothesis test?
2. Consider why this A/B test project might not be realistic, and what assumptions had to be made for this educational project.

Exemplar responses: 1. The key business insight is that encouraging customers to pay with credit cards can generate more revenue for taxi cab drivers.

2. This project requires an assumption that passengers were forced to pay one way or the other, and that once informed of this requirement, they always complied with it. The data was not collected this way; so, an assumption had to be made to randomly group data entries to perform an A/B test. This dataset does not account for other likely explanations. For example, riders might not carry lots of cash, so it’s easier to pay for longer/farther trips with a credit card. In other words, it’s far more likely that fare amount determines payment type, rather than vice versa.

Congratulations! You’ve completed this lab. However, you may not notice a green check mark next to this item on Coursera’s platform. Please continue your progress regardless of the check mark. Just click on the “save” icon at the top of this notebook to ensure your work has been logged.