Activity_ Course 4 Automatidata project lab

March 6, 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. A follow-up 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 demostrate 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.

Does a relationship exist between payment type and fare amount?

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 numpy as np
import seaborn as sns
import pandas as pd
from scipy import stats
import matplotlib.pyplot as plt
```

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]:

```
# Load dataset into dataframe
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?

By applying descriptive statistics, you can acquire information regarding outliers, missing data, pinpointing key variables, their distributions and measures of central tendancy/variability. Additionally, the use of visual representations through Histograms, Box Plots and Scatterplots can better communicate this information.

In the case of this project, it allowed for the team to quickly compare and understand the average total fare amount per payment type.

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 proccess.

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

[4]:

```
# Initial look at the dataset

#taxi_data.head()
#taxi_data.tail()
taxi_data.describe(include='all')

# Check for missing values

#null_values = taxi_data.isnull().sum()
```

```
#print(null_values)

# Drop missing values if necessary

#taxi_data = taxi_data.dropna()
```

[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.

[5]:

```
# Group the DataFrame by 'payment_type' and calculate descriptive statistics␣
 ↪for 'fare_amount'
payment_type_summary = taxi_data.groupby('payment_type')['fare_amount'].
 ↪describe()

# Print the summary
payment_type_summary
```

[5]:

```
                count       mean        std    min  25%  50%     75%     max
payment_type
1             15265.0  13.429748  13.848964    0.0  7.0  9.5  15.000  999.99
2              7267.0  12.213546  11.689940    0.0  6.0  9.0  14.000  450.00
3               121.0  12.186116  14.894232   -4.5  2.5  7.0  15.000   65.50
4                46.0   9.913043  24.162943 -120.0  5.0  8.5  17.625   52.00
```

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. Consider your hypotheses for this project as listed below.

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.

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 signficance level
3. Find the p-value
4. Reject or fail to reject the null hypothesis

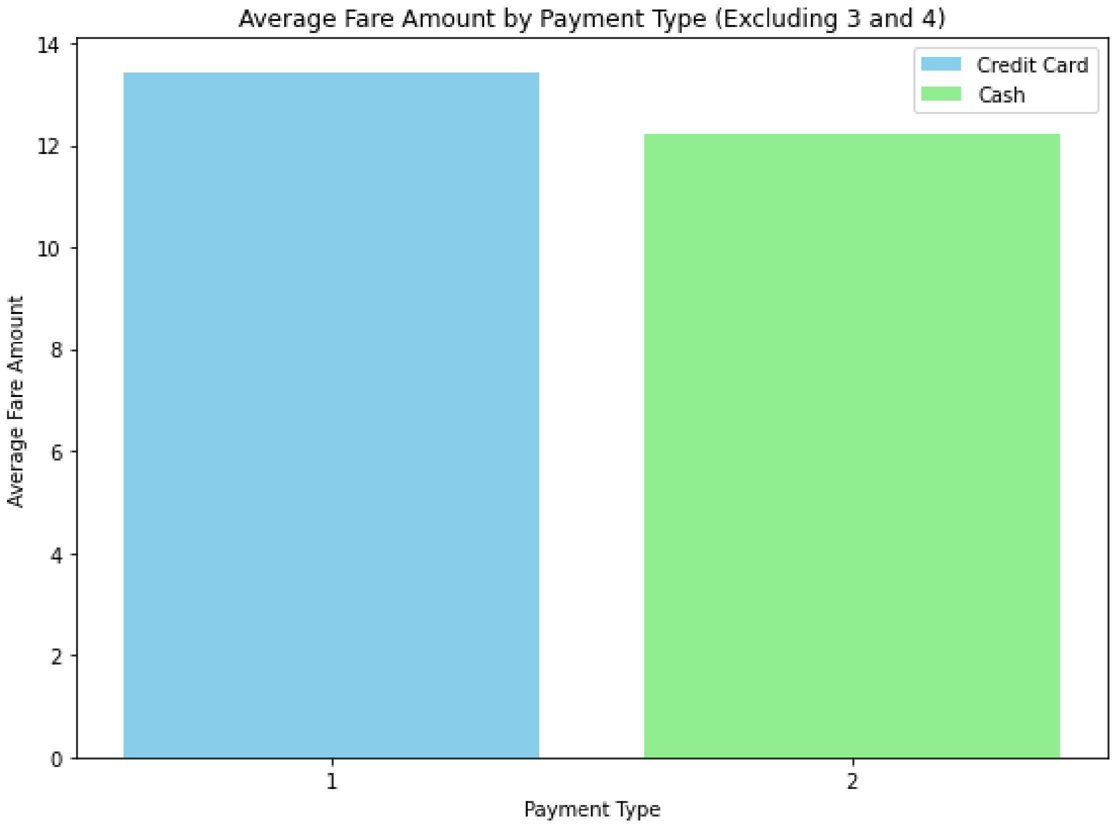
Note: For the purpose of this exercise, your hypothesis test is the main component of your A/B test.

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

[10]:

```
# Acquire Credit Card and Cash Fares.

credit_card_fares = taxi_data[taxi_data['payment_type'] == 1]['fare_amount']
cash_fares = taxi_data[taxi_data['payment_type'] == 2]['fare_amount']

#print(credit_card_fares)

# Simulate Random Sampling
sampled_credit_card_fares = credit_card_fares.sample(n=500, replace = True,␣
 ↪random_state=13490)
sampled_cash_fares = cash_fares.sample(n=500, replace = True,␣
 ↪random_state=13490)

# Compute Sample Means
credit_card_average_fares = sampled_credit_card_fares.mean()
cash_average_fares = sampled_cash_fares.mean()
print("Credit Card Fare Average:", f"{credit_card_average_fares:.2f}")
print("Cash Fare Average:", f"{cash_average_fares:.2f}")
print()

# Create a Bar plot to visualize mean fare payment per payment type

# Filter out payment types 3 and 4
filtered_df = taxi_data[taxi_data['payment_type'] != 3]
filtered_df = filtered_df[taxi_data['payment_type'] != 4]

# Calculate average fare amount by payment type
average_fare_by_payment_type = filtered_df.
 ↪groupby('payment_type')['fare_amount'].mean()

# Create a bar chart
plt.figure(figsize=(8, 6))  # Adjust figure size for better visualization
bars = plt.bar(average_fare_by_payment_type.index, average_fare_by_payment_type.
 ↪values, color=['skyblue', 'lightgreen'])

# Labels and customization
plt.xlabel('Payment Type')
plt.ylabel('Average Fare Amount')
plt.title('Average Fare Amount by Payment Type (Excluding 3 and 4)')
plt.xticks(average_fare_by_payment_type.index)
plt.tight_layout()

# Add legend
plt.legend(bars, ['Credit Card', 'Cash'])

plt.show()

# Conduct a T-Test
t_statistic, p_value = stats.ttest_ind(credit_card_fares, cash_fares,␣
 ↪equal_var=False)

print("T-Statistic:", t_statistic)
print("P-Value:", p_value)
```

```
Credit Card Fare Average: 13.42
Cash Fare Average: 11.99
```



```
T-Statistic: 6.866800855655372
P-Value: 6.797387473030518e-12
```

Due to the extremely small P-Value, we reject the null hypothesis in favour of the alternative, there is a statistically significant difference in the fare amount between those that pay with credit card and those that pay with 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

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.

1. Due to the results of the Hypothesis test, riders that pay with credit card, on average, pay an average larger fare than those that pay with cash. Due to this conclusion, there is sufficient

reason to investigate further and determine methods to promote credit card payments over cash.

2. For the purpose of conducting an A/B test, we made certain assumptions. Firstly, we assumed that customers were randomly selected and then divided into two groups, namely those who paid with credit card and those who paid with cash. Secondly, we assumed that each customer in the respective groups only used the payment method assigned to them, and did not switch between credit card and cash. Thirdly, we assumed that customers had access to only one payment method and not both.

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.