Ultimate Technologies Inc. Take-Home Challenge

Part 2 – Experiment and metrics design

The Context of the Problem:

Ultimate Technologies, Inc, is a transportation service that serves two neighboring cities, Gotham and Metropolis. Their services are mostly requested during the weekday nights in Gotham, while they are requested more during the day in Metropolis on weekdays. The requested transportation services are equivalent during the weekends. Separating the two cities is a two-way toll bridge that tends to keep drivers to service one particular city. Ultimate Technologies would like to have the drivers serve both cities, so managers within the Ultimate Technologies company from both companies have suggested an experiment to reimburse the drivers for the fees of the toll. The ultimate goal would be

Criteria for success

To determine if the proposed experiment is a success, a metric that determines if the drivers' service area changes before and after the experiment would need to be determined. Possible measurements could be:

- the number of rides each driver gives in each city per day
- the length of each ride, which includes the city the driver started and ended in
- the amount of time each driver spends in each city
- the number of times a driver passes through the toll each day
    - the total reimbursement cost could also be determined from this

The goal of Ultimate technologies is to have the drivers serve both cities. By examining any changes in the drivers' service areas before and after the experiment, they will be able to determine if reimbursing the drivers incentivizes them to expand their services areas.

The experiment

The proposed experiment would be to provide each driver with a device that determines the following:

- the number and times of rides each driver gives in each city per day
- the amount of time each driver spends in each city
- the number of times a driver passes through the toll each day

We can collectively refer to these measurements as measurements in driver service area. The reason the first 2 variables will be determined is because the company wants to encourage drivers to be available in both cities, so the amount of time each driver spends in the cities is important. However, it is important to note that the cities have differing daily times of requested service (one in the weekday evenings and one during the weekday days). A driver could spend their "day" time in the city that is more active at night and their "night" time in the city is more active during the day, but they could get minimal service requests. Their time could therefore be better spent focused in one city, depending on the time of day. In other words, their services would be more profitable for the company.

The third measurement of number of times the driver passes through the toll each day would provide information regarding whether or not the driver is available in each city at particular times of the day, as well as how much the company would spend in reimbursement costs.

If only one of the measurements could be takes, the first one (the number and times of rides each driver gives in each city per day) would be of higher priority, given the caveats and constraints discussed above.

The experiment could also be performed as a randomized control study, which aids in determining if a cause and effect relationship exists between an experimental manipulation and the results of that manipulation. In this case, the drivers' service area would be monitored before and after announcement of reimbursement. In addition, the drivers would be divided into two groups: 1) those that are told they would receive toll reimbursement and 2) those that will not be told they will receive toll reimbursement. In this case the only expected difference between groups 1 (control group) and 2 (experimental group) would be the outcome variable, which would be the measurements discussed above.

We could have our null hypothesis be that there would be no changes in measurements between the control and experimental groups. However, if reimbursing the drivers' toll expenses alters the number of rides given in each city by drivers in the experimental group relative to the control group, we could hypothesize that reimbursing the toll expenses motivates the drivers to be available for service in both cities.

Statistical tests for the experiment

The type of statistical test performed depends on the type of data acquired. Is the data continuous? binary? categorical? etc. We would also want to check if the data is normally distributed.

The proposed measurements would all be continuous. If driver behavior before and after reimbursement is normally distributed, then a paired t-test could be performed to see if any changes are statistically significant. This is because we are comparing the same group of drivers. If they are not normally distributed, then a Wilcoxon signed-rank test, which is a non-parametric test, could be performed. When performing statistical tests for potentially significant differences in service area behaviors between group 1 and group 2, we would want to use an unpaired t-test with normally distributed data, as the two groups are independent of one another. If the measurements between the two groups is not normally distributed, we could perform the Mann Whitney test.

Interpretations of the results and recommendations to the city operation teams

To determine if there are changes in the service area of the drivers, we will use the statistical tests to see if we should accept or reject our null hypotheses. The null hypotheses would be that there is no difference between:

- driver service area before and after toll reimbursement announcement

- driver service area between group 1 (those told they would receive toll reimbursement) and group 2 (those not told they would receive toll reimbursement)

If we assume the standard p-value of 0.05 as being statistically significant, then with any p-values less than 0.05, we would reject the null hypothesis. This would suggest that there is a statistically significant difference in driver service area before and after announcement of toll reimbursement and/or between the 2 groups of drivers. We would then suggest to the city operation teams that the toll reimbursement is altering the availability of drivers in the different service areas.

If the p-values are greater than 0.05, we would accept the null hypothesis. We would suggest that the toll reimbursement is not changing driver service area availability to the city operation teams.

There are a few caveats that need to be considered when interpreting the data and making recommendations to the city operation teams:

- Day of the week and time of day: we know that the weekends have equivalent amounts of activity in the two cities. However, the two cities differ in their activity, where one city is more active at night and the other more active during the day. As previously mentioned, driver availability may not be necessary if there is not a demand for drivers at particular times during the day.
- Overall expenses: While the ultimate goal of the managers experiment is to make more drivers available in the two cities, they should consider the overall expenses of reimbursing for toll expenses. If increasing driver availability does not lead to an increase in services provided, and thus increase in profit, then the city operation teams may need to stop the experiment. In addition, reimbursing drivers the toll expenses could lead to a decrease in profits even if they see a concomitant increase in driver availability and services provided.