

Analyzing the NYC Subway Dataset

Questions

Overview

This project consists of two parts. In Part 1 of the project, you should have completed the questions in Problem Sets 2, 3, 4, and 5 in the Introduction to Data Science course.

This document addresses part 2 of the project. Please use this document as a template and answer the following questions to explain your reasoning and conclusion behind your work in the problem sets. You will attach a document with your answers to these questions as part of your final project submission.

Section 0. References

Please include a list of references you have used for this project. Please be specific - for example, instead of including a general website such as stackoverflow.com, try to include a specific topic from Stackoverflow that you have found useful.

http://en.wikipedia.org/wiki/Mann%E2%80%93U_test

<http://docs.scipy.org/doc/scipy/reference/generated/scipy.stats.mannwhitneyu.html>

http://stattrek.com/statistics/dictionary.aspx?definition=coefficient_of_determination

Section 1. Statistical Test

1.1 Which statistical test did you use to analyze the NYC subway data? Did you use a one-tail or a two-tail P value? What is the null hypothesis? What is your p-critical value?

I used the Mann-Whitney U test to analyze the NYC subway data, comparing the distribution of ridership for samples with rain vs. those without rain. I used a one-tail P value. My null hypothesis was that ridership would be the same with rain as without. My p-critical value was 0.05.

1.2 Why is this statistical test applicable to the dataset? In particular, consider the assumptions that the test is making about the distribution of ridership in the two samples.

The Mann-Whitney U test is a nonparametric test well-suited to comparing non-normal distributions, and is robust in the face of outliers. The NYC subway data is both skewed and full of outliers, so the U test is a good match.

1.3 What results did you get from this statistical test? These should include the following numerical values: p-values, as well as the means for each of the two samples under test.

The computed P value was 0.025, with a mean of 1105.44 for samples with rain, and 1090.28 for samples without rain.

1.4 What is the significance and interpretation of these results?

I would classify these results as being statistically significant, with a P value approximately half of the designated P-critical value. My interpretation is that the mean ridership varies between the two groups because more people ride the subway when it's raining.

Section 2. Linear Regression

2.1 What approach did you use to compute the coefficients theta and produce prediction for `ENTRIESn_hourly` in your regression model:

- a. Gradient descent (as implemented in exercise 3.5)
- b. OLS using Statsmodels
- c. Or something different?

I used OLS using Statsmodel to compute the coefficients and generate predictions.

2.2 What features (input variables) did you use in your model? Did you use any dummy variables as part of your features?

I used the following continuous/numeric features:

rain, precipi, fog, mintempi, maxtempi, meanwindspdi

I used dummy variables to represent each unique value for Hour.

I used dummy variables to represent each unique value for UNIT.

2.3 Why did you select these features in your model? We are looking for specific reasons that lead you to believe that the selected features will contribute to the predictive power of your model.

- Your reasons might be based on intuition. For example, response for fog might be: “I decided to use fog because I thought that when it is very foggy outside people might decide to use the subway more often.”
- Your reasons might also be based on data exploration and experimentation, for example: “I used feature X because as soon as I included it in my model, it drastically improved my R^2 value.”

UNIT is a categorical variable which is effectively a unique location identifier. The dummy variables for UNIT were included because I think it's safe to assume that ridership will vary based on the location of a given subway stop. Stops will be surrounded by populations of varying densities, and may also be used more frequently at different times of day due to surrounding public facilities, etc.

Hour looks like a continuous variable at first glance, but I assumed that certain times of day would have radically different usage patterns than others (morning rush hour, lunch time, etc.). Because of this, I thought it would make more sense to give each hour its own input weight, thus I treated Hour as a categorical variable and created dummy variables to represent each distinct value. My assumption in this case was borne out by increased R^2 when treating Hour as categorical.

Inclusion of the remaining features was based on various assumptions made on my part, which are:

rain - that more people will tend to ride the subway when it rains

precipi - that greater amounts of precipitation will tend to increase ridership

fog - that the presence of fog, which reduces driving visibility, will tend to increase ridership

mintempi, maxtempi - that extreme temperatures in either direction will probably increase ridership

meanwindspdi - that higher winds will lead to increased ridership

2.4 What are the coefficients (or weights) of the non-dummy features in your linear regression model?

The final weights for each of the non-dummy features were:

rain	10.89542321
precipi	-36.49361112
fog	101.95790174

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mintempi      -93.81507513
maxtempi       21.48953927
meanwindspdi  64.16958098
```

2.5 What is your model's R^2 (coefficients of determination) value?

My model's R^2 value was 0.527281120806.

2.6 What does this R^2 value mean for the goodness of fit for your regression model? Do you think this linear model to predict ridership is appropriate for this dataset, given this R^2 value?

It means that my regression model fits, or is able to predict, about 52.7% of the variability in ridership. I think that's rather a low number in this context, and assume that a more complex, non-linear predictive model would do a better job.

Section 3. Visualization

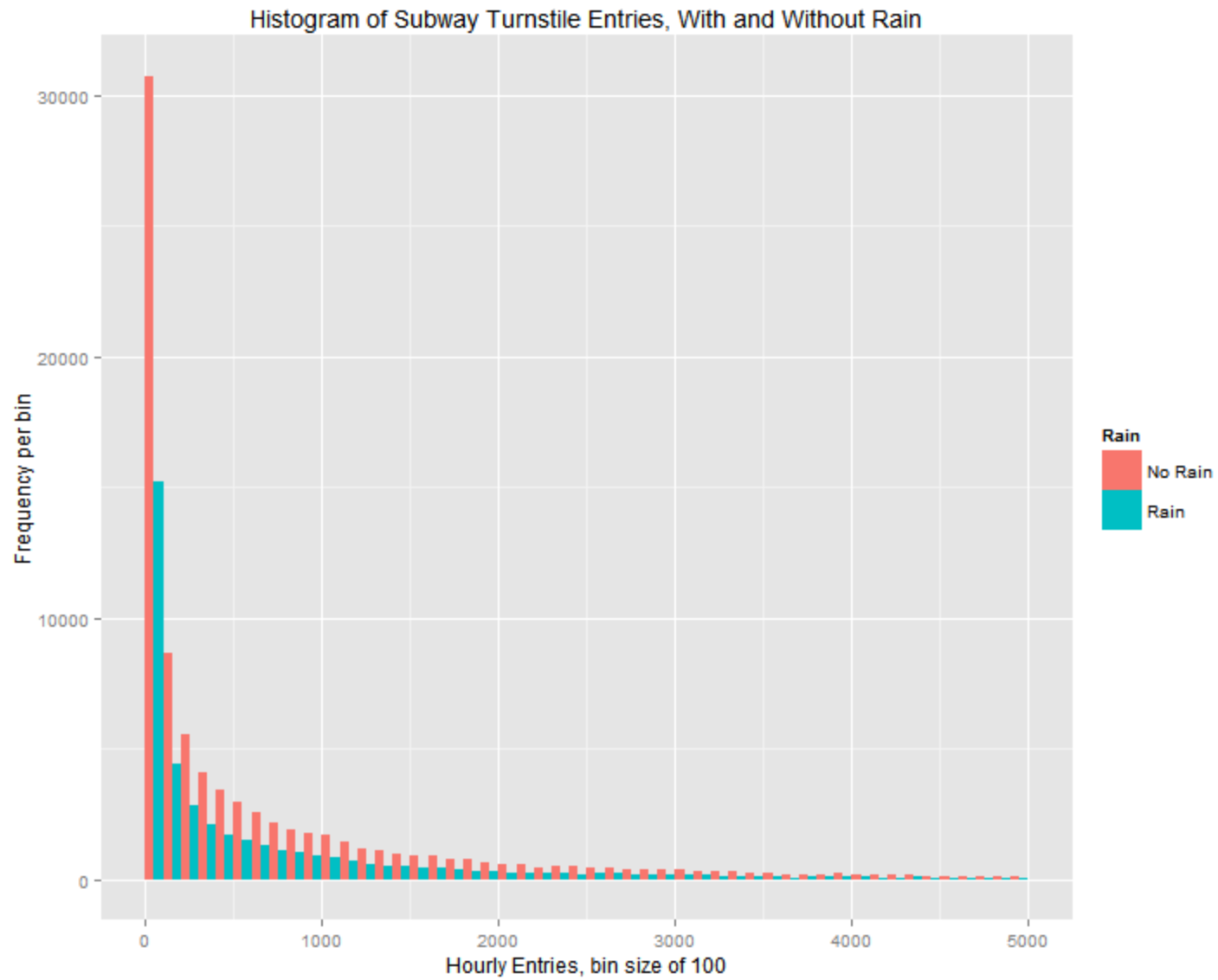
Please include two visualizations that show the relationships between two or more variables in the NYC subway data.

Remember to add appropriate titles and axes labels to your plots. Also, please add a short description below each figure commenting on the key insights depicted in the figure.

3.1 One visualization should contain two histograms: one of `ENTRIESn_hourly` for rainy days and one of `ENTRIESn_hourly` for non-rainy days.

- You can combine the two histograms in a single plot or you can use two separate plots.
- If you decide to use two separate plots for the two histograms, please ensure that the x-axis limits for both of the plots are identical. It is much easier to compare the two in that case.
- For the histograms, you should have intervals representing the volume of ridership (value of `ENTRIESn_hourly`) on the x-axis and the frequency of occurrence on the y-axis. For example, each interval (along the x-axis), the height of the bar for this interval will represent the number of records (rows in our data) that have `ENTRIESn_hourly` that falls in this interval.
- Remember to increase the number of bins in the histogram (by having larger number of bars). The default bin width is not sufficient to capture the variability in the two samples.

VISUALIZATION ON FOLLOWING PAGE

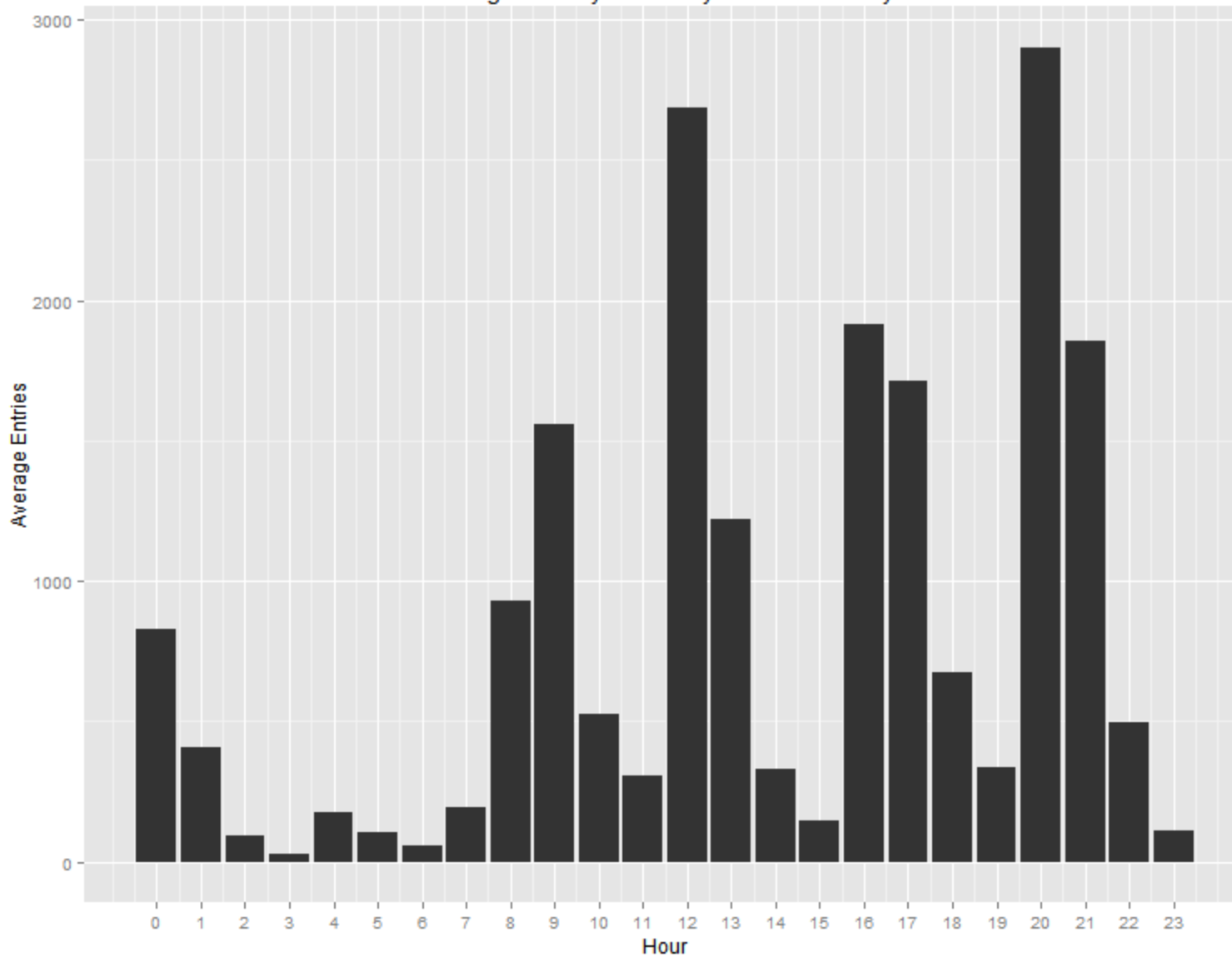


3.2 One visualization can be more freeform. You should feel free to implement something that we discussed in class (e.g., scatter plots, line plots) or attempt to implement something more advanced if you'd like. Some suggestions are:

- Ridership by time-of-day
- Ridership by day-of-week

VISUALIZATION ON FOLLOWING PAGE

Average Subway Entries by Hour on Mondays



Section 4. Conclusion

Please address the following questions in detail. Your answers should be 1-2 paragraphs long.

4.1 From your analysis and interpretation of the data, do more people ride the NYC subway when it is raining or when it is not raining?

I think it's clear that more people ride the subway when it's raining. The effect is not as pronounced as I had expected, but the various analyses performed definitely indicate that there is an effect. I was surprised in particular by the relatively small difference between the mean of turnstile entries for rows with rain vs. those without rain.

4.2 What analyses lead you to this conclusion? You should use results from both your statistical tests and your linear regression to support your analysis.

The first analytical technique to provide support for my conclusion was the Mann-Whitney U test, which yielded a P value of 0.025 when comparing ridership with rain vs. ridership without rain; well below my designated P-critical value of 0.05. The positive coefficient for the 'rain' feature (10.89542321) in my linear regression model also supported my conclusion. However, as with the unexpectedly small difference in mean of entries for the two samples, I was expecting a larger coefficient here. The 'rain' feature actually had the smallest absolute value of any of the coefficients, which further indicates that the effect isn't terribly pronounced.

Section 5. Reflection

Please address the following questions in detail. Your answers should be 1-2 paragraphs long.

5.1 Please discuss potential shortcomings of the methods of your analysis, including:

1. Dataset,
2. Analysis, such as the linear regression model or statistical test.

Dataset - I think the most obvious shortcomings of the dataset are its seasonal scope and its limited size. The entire dataset is from May of 2011. For a lot of people, spring is a nice time to be outside, which might impact ridership regardless of, or in spite of, the presence of rain.

There could also be a variety of socio-political events at work, relative to that particular date range. A much larger dataset, preferably one spanning multiple years rather than a single month, would provide a more robust analysis in the face of unknown factors affecting ridership. It would allow us to smooth out variability based on seasonal trends and one-time events, which would improve the analysis considerably.

Analysis - The statistical tests used seem adequate to the task of establishing correlation between rain and increased ridership in the dataset provided. I was a little confused by the coefficients yielded by the linear regression model I used. The contrasting positive and negative values yielded for 'rain' and 'precipi', respectively, were particularly interesting. I expected positive coefficients for both, and am not entirely sure why *the presence of rain* would increase ridership, while *greater amounts of rain* would appear to decrease it. This leads me to believe that a non-linear model with additional features would provide better results.

5.2 (Optional) Do you have any other insight about the dataset that you would like to share with us?