

# Lab 05 – MATH 240 – Computational Statistics

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## Abstract

For the past 3 weeks we have been working towards answering the question of which of three bands, *The Front Bottoms*’s, *Manchester Orchestra*, or *All Get Out* contributed the most to the collaborative song *Allentown* (Ross, 2018). This week we completed our third lab dealing with this question. For this week’s lab we manipulated and used the data we collected last lab to finally come to a conclusion of which band contributed most to the song. In the end, we came to the conclusion that of the three bands, *Manchester Orchestra* contributed the most to the song.

**Keywords:** Data Analysis : Graphing : Tidyverse

## 1 Introduction

This lab is the culmination of the three part lab series which we have been completing for the past several weeks. Last week, we acquired and organized important music data from different sources to help us determine which band contributed the most to the song in this lab. This week, through analyzing the data collected in our prior labs we were able to come to the conclusion that *Manchester Orchestra* contributed the most to the song *Allentown*. Throughout this lab, we utilized the `stringr` (Wickham, 2023), `jsonlite` (Ooms, 2014), and `tidyverse` (Wickham et al., 2019) packages to complete the majority of our tasks. We also utilized both `ggplot2` (Wickham, 2016), and the `Shiny App` provided to us via The Data Science Collaboratory at Colgate University (The Data Science Collaboratory at Colgate University, 2024) to create all graphs seen later on. This lab report will go through how we analyzed our data, and how we used this analysis to make our final determination that *Manchester Orchestra* contributed the most to the song.

## 2 Methods

For this lab, we began by loading in the `Essentia` (Alonso-Jiménez et al., 2020) data which we collected last lab. Our first task to analyze this data was to use `tidyverse` to create a function which we could use to determine whether the song *Allentown* is out of range, unusual, or in range in regards to each band’s catalog of songs. The first feature of our function used the `summarize()` function from `tidyverse` to calculate the minimum, lower fence, upper fence, and maximum values that each band’s catalog had for every feature in

our `Essentia` data set. We then used the `mutate()` function from `tidyverse` to create three new columns, those being *out.of.range*, *unusual* and *description*. These new columns aimed to compare the values we calculated for every feature for each band’s catalog to the values of those same features for *Allentown*.

Specifically, *out.of.range* would come back as **TRUE** when the given feature’s value for *Allentown* was less than the minimum value or more than the maximum value for that same feature in relation to each band, and would come back as **FALSE** otherwise. *Unusual* would come back **TRUE** when a given feature’s value for *Allentown* was less than the lower fence (LF) or more than the upper fence (UF) for the given feature for each band, and would come back as **FALSE** otherwise. Finally, *description* would come back as **Out of Range** when *out.of.range* was **TRUE**, would come back as **Outlying** when *unusual* was **TRUE**, and would come back as **Within Range** otherwise.

Once we had all of this completed, we were able to run our function through a for loop which ran through every `Essentia` feature in our data set. We then filled an empty *tibble* we created with all of this data. I also decided to use `mutate()` once again to create a column which kept track of which feature each row of data was for. When running our loop, we decided to eliminate all columns from our `Essentia` data which had non numerical data. These columns ended up being *artist*, *album*, *track*, *chords scale*, *chords key*, *key*, and *mode*.

Next, we were able to go through our new *tibble* full of data and pick out specific features that would be useful to determining which band contributed most to the song. For this step, I specifically chose 10 features where the *description* for one band was **Within Range**, but the *description* for the other two bands were either **Outlying** or **Out of Range**. I chose to pick my specific features to analyze this way because if one band is in range to *Allentown* and two are not, it stands to reason that the band in range had more of an effect on the song.

To conclude, we created a `LaTeX` table that summarized our selected features we used to determine which band contributed most to the song. This table can be found in the **Appendix** section. We also finished off by creating a couple of graphs using both `ggplot2` and the `Shiny App`, which will all be in the **Appendix**.

### 3 Results

Table 1 in the **Appendix** section is the table which we created in L<sup>A</sup>T<sub>E</sub>X to summarize the selected features which we chose to analyze. Figure 1 in the **Appendix** section is a bar graph created using Shiny App. This graph shows the proportion of features for each band that were **Out of Range**, **Outlying** or **Within Range**. Figure 2 in the **Appendix** section is a bar graph created using ggplot2. This graph shows for each of our selected features, what proportion of each description **Out of Range**, **Outlying** or **Within Range** can be attributed to each band. Looking at both of the graphs and the table, it becomes apparent that *Manchester Orchestra* was always **Within Range** for our selected features while the other two bands were not.

### 4 Discussion

Analyzing our graphs, we can conclude that *Manchester Orchestra* contributed the most to the collaboratory song *Allentown*. For all of our selected features, they were **Within Range** while the *The Front Bottoms*'s and *All Get Out* were not. These findings support the idea that *Manchester Or-*

*chestra* had the greatest impact on the song, since that would cause the song to be **Within Range** for them and not for the other bands. Actually listening to *Allentown*, as a long time *The Front Bottoms*'s I can say for certain that this song sounds nothing like them. This lab allowed us to prove analytically that this song sounds nothing like them, which is extremely cool.

### References

Alonso-Jiménez, P., Bogdanov, D., Pons, J., and Serra, X. (2020). Tensorflow audio models in Essentia. In *ICASSP 2020-2020 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*, pages 266–270. IEEE.

Bogdanov, D., Wack, N., Gómez, E., Gulati, S., Herrera, P., Mayor, O., Roma, G., Salamon, J., Zapata, J., and Serra, X. (2013). Essentia: An audio analysis library for music information retrieval. In *Proceedings of the 14th International Society for Music Information Retrieval Conference (ISMIR)*, pages 493–498. ISMIR.

Ooms, J. (2014). The jsonlite package: A practical and consistent mapping between json data and r objects. *arXiv:1403.2805 [stat.CO]*.

Pennebaker, J. W., Boyd, R. L., Jordan, K., and Blackburn, K. (2015). *The Development and Psychometric Properties of LIWC2015*. LIWC.net.

Ross, A. R. (2018). Manchester orchestra and the front bottoms are finally together on "allentown".

The Data Science Collaboratory at Colgate University (2024). Collaboratory resources. Online Application. Retrieved from <https://www.colgate.edu/about/campus-services-and-resources/data-science-collaboratory>.

Wickham, H. (2016). *ggplot2: Elegant Graphics for Data Analysis*. Springer-Verlag New York.

Wickham, H. (2023). *stringr: Simple, Consistent Wrappers for Common String Operations*. R package version 1.5.1.

Wickham, H., Averick, M., Bryan, J., Chang, W., McGowan, L. D., François, R., Grolemund, G., Hayes, A., Henry, L., Hester, J., Kuhn, M., Pedersen, T. L., Miller, E., Bache, S. M., Müller, K., Ooms, J., Robinson, D., Seidel, D. P., Spinu, V., Takahashi, K., Vaughan, D., Wilke, C., Woo, K., and Yutani, H. (2019). Welcome to the tidyverse. *Journal of Open Source Software*, 4(43):1686.

### 5 Appendix

	feature	artist	out.of.range	unusual	description
1	spectral.skewness	All Get Out	FALSE	TRUE	Outlying
2	spectral.skewness	Manchester Orchestra	FALSE	FALSE	Within Range
3	spectral.skewness	The Front Bottoms	TRUE	TRUE	Out of Range
4	spectral.rolloff	All Get Out	TRUE	TRUE	Out of Range
5	spectral.rolloff	Manchester Orchestra	FALSE	FALSE	Within Range
6	spectral.rolloff	The Front Bottoms	TRUE	TRUE	Out of Range
7	spectral.kurtosis	All Get Out	FALSE	TRUE	Outlying
8	spectral.kurtosis	Manchester Orchestra	FALSE	FALSE	Within Range
9	spectral.kurtosis	The Front Bottoms	TRUE	TRUE	Out of Range
10	spectral.entropy	All Get Out	FALSE	TRUE	Outlying
11	spectral.entropy	Manchester Orchestra	FALSE	FALSE	Within Range
12	spectral.entropy	The Front Bottoms	TRUE	TRUE	Out of Range
13	spectral.energyband.middle.high	All Get Out	TRUE	TRUE	Out of Range
14	spectral.energyband.middle.high	Manchester Orchestra	FALSE	FALSE	Within Range
15	spectral.energyband.middle.high	The Front Bottoms	TRUE	TRUE	Out of Range
16	spectral.complexity	All Get Out	TRUE	TRUE	Out of Range
17	spectral.complexity	Manchester Orchestra	FALSE	FALSE	Within Range
18	spectral.complexity	The Front Bottoms	TRUE	TRUE	Out of Range
19	spectral.centroid	All Get Out	TRUE	FALSE	Out of Range
20	spectral.centroid	Manchester Orchestra	FALSE	FALSE	Within Range
21	spectral.centroid	The Front Bottoms	TRUE	FALSE	Out of Range
22	erbbands.skewness	All Get Out	TRUE	TRUE	Out of Range
23	erbbands.skewness	Manchester Orchestra	FALSE	FALSE	Within Range
24	erbbands.skewness	The Front Bottoms	TRUE	TRUE	Out of Range
25	dissonance	All Get Out	FALSE	TRUE	Outlying
26	dissonance	Manchester Orchestra	FALSE	FALSE	Within Range
27	dissonance	The Front Bottoms	TRUE	TRUE	Out of Range
28	barkbands.skewness	All Get Out	TRUE	TRUE	Out of Range
29	barkbands.skewness	Manchester Orchestra	FALSE	FALSE	Within Range
30	barkbands.skewness	The Front Bottoms	TRUE	TRUE	Out of Range

Table 1: Summary of Selected Features

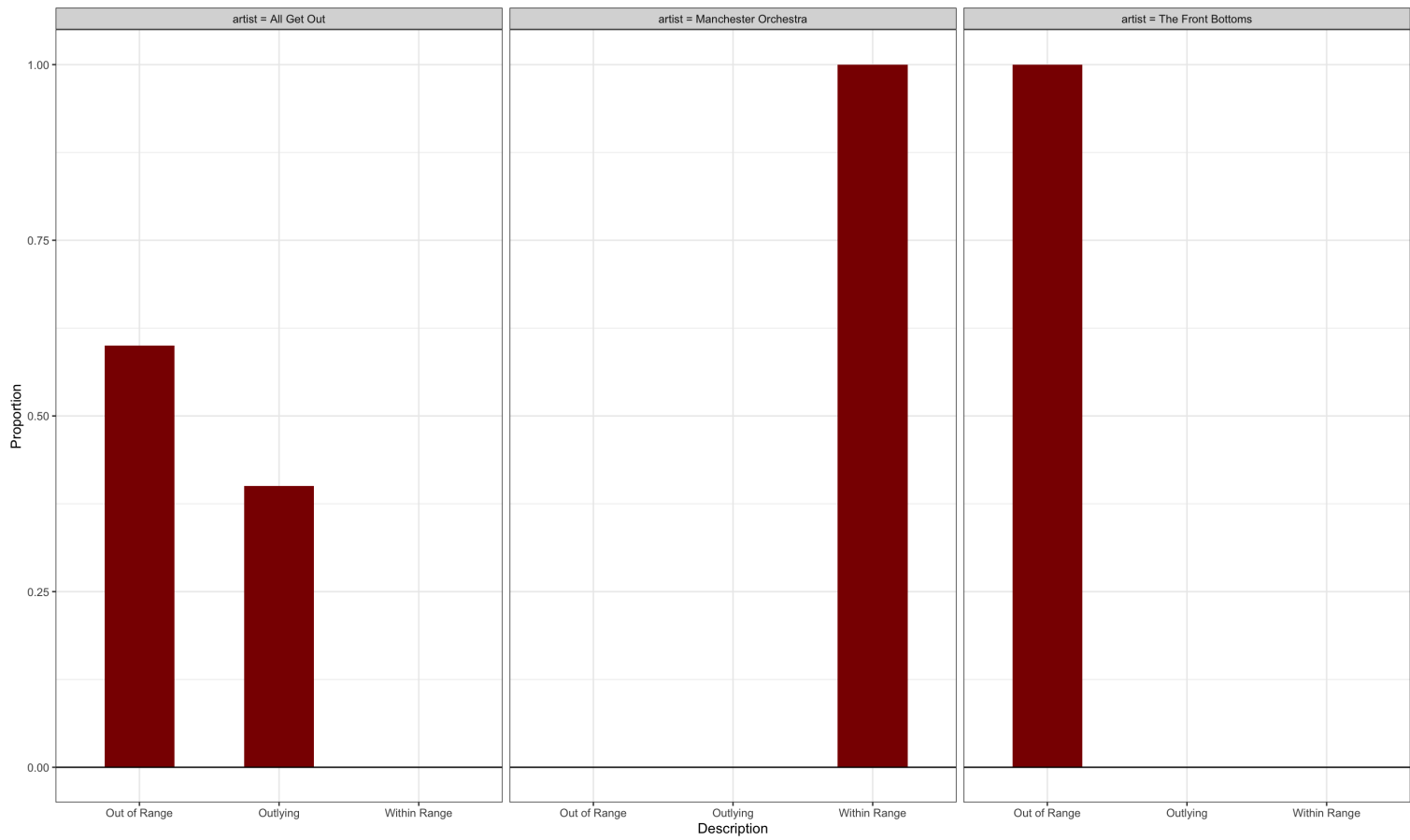


Figure 1: Proportion of Each Band's Description (Out of Range, Outlying, or Within Range) for Selected Features

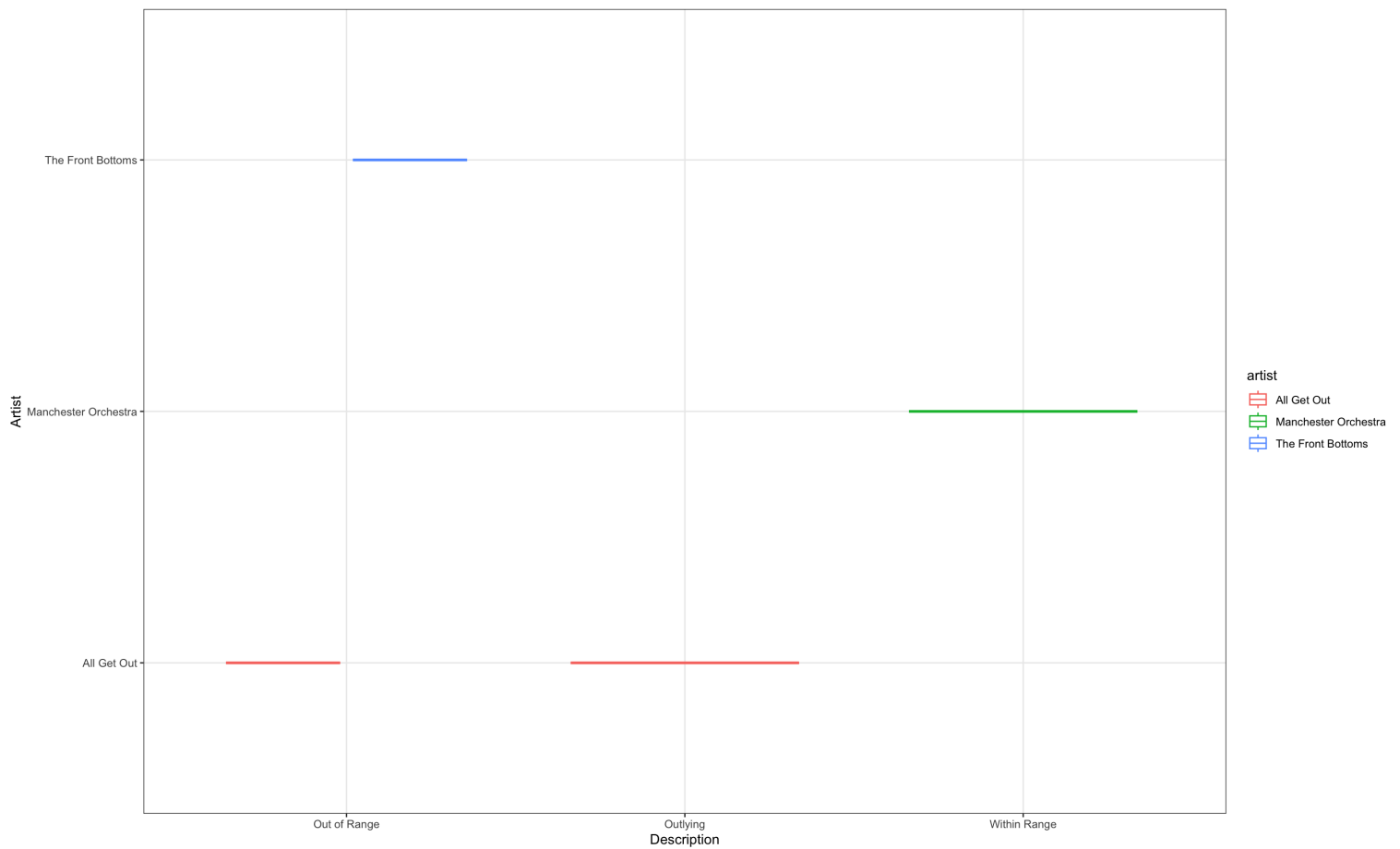


Figure 2: Comparison of Whether Each Artist was Out of Range, Outlying, or Within Range for Selected Features