Data Mining Project

Master in Data Science and Advanced Analytics

**NOVA Information Management School**

Universidade Nova de Lisboa

Data Mining Project Report Part 1

**Group 50**

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# Introduction

In the era of big data, the food delivery industry has experienced rapid growth and transformation, generating vast amounts of customer data. This Report explores the application of data mining techniques to analyze customer behavior in the food delivery sector, using a comprehensive dataset from ABCDEats, a prominent food delivery service.

The ABCDEats dataset provides a rich source of information, encompassing customer demographics, order history, cuisine preferences, temporal patterns, and promotional interactions. By leveraging this data, we aim to uncover meaningful patterns and insights that can inform business strategies and enhance customer experiences in the competitive food delivery market.

Our study focuses on several key aspects of customer behavior, including:

1. ⁠The relationship between customer demographics and cuisine preferences
2. ⁠Temporal patterns in ordering behavior
3. ⁠The impact of promotions on customer engagement
4. ⁠Customer segmentation based on ordering patterns and preferences

Through the application of various data mining techniques, including exploratory data analysis, clustering algorithms, and predictive modeling, we seek to extract actionable insights from this complex dataset. The findings of this study have potential implications for targeted marketing strategies, menu optimization, and overall service improvement in the food delivery industry.

This Report is Part 1 of three Parts to be delivery in scope of this Data Mining Project.

Part 1 focuses on Exploratory Data Analyses; the expected outcome of Part 1 of the Project is:

1. **Data Exploration and Summary:** Examine the dataset thoroughly, highlighting key statistics such as averages, distributions, and outliers for each feature. Discuss how these characteristics might influence the analysis.
2. **Trend and Pattern Identification:** Identify any notable trends, patterns, or anomalies within the data. Investigate relationships and correlations between different features.
3. **Feature Engineering:** Create additional features that could potentially improve the analysis, based on insights gained from the data exploration.
4. **Visualization for Insights:** Utilize visualizations to clearly present findings and support your analysis, enabling easier understanding of the data and the relationships between variables.

While this Report documents everything that has been done by the listed member during the project.

# Data Exploration and Summary

## Data Exploration

A few findings:

* We have 57 columns
* HR\_0 is Object, all other HR\_n are int64#
* Null Values for each column:
  + customer\_age: 727
  + first\_order: 106
* dtypes:
  + float64: 17
  + int64: 35
  + object: 4

## Statistical findings (tables)

Statistical Analyses

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Feature name | count | mean | std | min | 25% | 50% | 75% | max |
| vendor\_count | 31888.0 | 3.102609 | 2.771587 | 0.0 | 1.0 | 2.0 | 4.00 | 41.00 |
| product\_count | 31888.0 | 5.668245 | 6.957287 | 0.0 | 2.0 | 3.0 | 7.00 | 269.00 |
| is\_chain | 31888.0 | 2.818866 | 3.977529 | 0.0 | 1.0 | 2.0 | 3.00 | 83.00 |
| last\_order | 31888.0 | 63.675521 | 23.226123 | 0.0 | 49.0 | 70.0 | 83.00 | 90.00 |
| CUI\_American | 31888.0 | 4.880438 | 11.654018 | 0.0 | 0.0 | 0.0 | 5.66 | 280.21 |
| CUI\_Asian | 31888.0 | 9.960451 | 23.564351 | 0.0 | 0.0 | 0.0 | 11.83 | 896.71 |
| CUI\_Beverages | 31888.0 | 2.300633 | 8.479734 | 0.0 | 0.0 | 0.0 | 0.00 | 229.22 |
| CUI\_Cafe | 31888.0 | 0.801163 | 6.427132 | 0.0 | 0.0 | 0.0 | 0.00 | 326.10 |
| CUI\_Chicken Dishes | 31888.0 | 0.768096 | 3.657273 | 0.0 | 0.0 | 0.0 | 0.00 | 219.66 |
| CUI\_Chinese | 31888.0 | 1.431218 | 8.191755 | 0.0 | 0.0 | 0.0 | 0.00 | 739.73 |
| CUI\_Desserts | 31888.0 | 0.884359 | 5.259868 | 0.0 | 0.0 | 0.0 | 0.00 | 230.07 |
| CUI\_Healthy | 31888.0 | 0.950203 | 5.830590 | 0.0 | 0.0 | 0.0 | 0.00 | 255.81 |
| CUI\_Indian | 31888.0 | 1.631153 | 7.443234 | 0.0 | 0.0 | 0.0 | 0.00 | 309.07 |
| CUI\_Italian | 31888.0 | 3.233411 | 11.247990 | 0.0 | 0.0 | 0.0 | 0.00 | 468.33 |
| CUI\_Japanese | 31888.0 | 2.995379 | 10.180851 | 0.0 | 0.0 | 0.0 | 0.00 | 706.14 |
| CUI\_Noodle Dishes | 31888.0 | 0.711676 | 4.536457 | 0.0 | 0.0 | 0.0 | 0.00 | 275.11 |
| CUI\_OTHER | 31888.0 | 2.999913 | 9.768300 | 0.0 | 0.0 | 0.0 | 0.00 | 366.08 |
| CUI\_Street Food / Snacks | 31888.0 | 3.913253 | 15.548507 | 0.0 | 0.0 | 0.0 | 0.00 | 454.45 |
| CUI\_Thai | 31888.0 | 0.841697 | 4.433047 | 0.0 | 0.0 | 0.0 | 0.00 | 136.38 |
| DOW\_0 | 31888.0 | 0.555914 | 1.013601 | 0.0 | 0.0 | 0.0 | 1.00 | 16.00 |
| DOW\_1 | 31888.0 | 0.567486 | 1.044090 | 0.0 | 0.0 | 0.0 | 1.00 | 17.00 |
| DOW\_2 | 31888.0 | 0.591006 | 1.045907 | 0.0 | 0.0 | 0.0 | 1.00 | 15.00 |
| DOW\_3 | 31888.0 | 0.619449 | 1.069672 | 0.0 | 0.0 | 0.0 | 1.00 | 17.00 |
| DOW\_4 | 31888.0 | 0.677747 | 1.088122 | 0.0 | 0.0 | 0.0 | 1.00 | 16.00 |
| DOW\_5 | 31888.0 | 0.652973 | 1.069947 | 0.0 | 0.0 | 0.0 | 1.00 | 20.00 |
| DOW\_6 | 31888.0 | 0.704246 | 1.167446 | 0.0 | 0.0 | 0.0 | 1.00 | 20.00 |
| HR\_1 | 31888.0 | 0.053845 | 0.317013 | 0.0 | 0.0 | 0.0 | 0.00 | 14.00 |
| HR\_2 | 31888.0 | 0.063190 | 0.351498 | 0.0 | 0.0 | 0.0 | 0.00 | 12.00 |
| HR\_3 | 31888.0 | 0.118759 | 0.500862 | 0.0 | 0.0 | 0.0 | 0.00 | 11.00 |
| HR\_4 | 31888.0 | 0.101700 | 0.437493 | 0.0 | 0.0 | 0.0 | 0.00 | 14.00 |
| HR\_5 | 31888.0 | 0.081943 | 0.358705 | 0.0 | 0.0 | 0.0 | 0.00 | 7.00 |
| HR\_6 | 31888.0 | 0.069681 | 0.329461 | 0.0 | 0.0 | 0.0 | 0.00 | 8.00 |
| HR\_7 | 31888.0 | 0.076800 | 0.377700 | 0.0 | 0.0 | 0.0 | 0.00 | 15.00 |
| HR\_8 | 31888.0 | 0.131899 | 0.635582 | 0.0 | 0.0 | 0.0 | 0.00 | 52.00 |
| HR\_9 | 31888.0 | 0.233912 | 0.724906 | 0.0 | 0.0 | 0.0 | 0.00 | 23.00 |
| HR\_10 | 31888.0 | 0.329560 | 0.891161 | 0.0 | 0.0 | 0.0 | 0.00 | 25.00 |
| HR\_11 | 31888.0 | 0.378167 | 0.959961 | 0.0 | 0.0 | 0.0 | 0.00 | 36.00 |
| HR\_12 | 31888.0 | 0.314162 | 0.842484 | 0.0 | 0.0 | 0.0 | 0.00 | 26.00 |
| HR\_13 | 31888.0 | 0.236453 | 0.637502 | 0.0 | 0.0 | 0.0 | 0.00 | 14.00 |
| HR\_14 | 31888.0 | 0.215630 | 0.599006 | 0.0 | 0.0 | 0.0 | 0.00 | 13.00 |
| HR\_15 | 31888.0 | 0.277032 | 0.738162 | 0.0 | 0.0 | 0.0 | 0.00 | 23.00 |
| HR\_16 | 31888.0 | 0.356435 | 0.874449 | 0.0 | 0.0 | 0.0 | 0.00 | 22.00 |
| HR\_17 | 31888.0 | 0.390962 | 0.943721 | 0.0 | 0.0 | 0.0 | 0.00 | 20.00 |
| HR\_18 | 31888.0 | 0.336961 | 0.893949 | 0.0 | 0.0 | 0.0 | 0.00 | 24.00 |
| HR\_19 | 31888.0 | 0.245610 | 0.795296 | 0.0 | 0.0 | 0.0 | 0.00 | 35.00 |
| HR\_20 | 31888.0 | 0.142812 | 0.586529 | 0.0 | 0.0 | 0.0 | 0.00 | 36.00 |
| HR\_21 | 31888.0 | 0.071155 | 0.348536 | 0.0 | 0.0 | 0.0 | 0.00 | 11.00 |
| HR\_22 | 31888.0 | 0.048263 | 0.298265 | 0.0 | 0.0 | 0.0 | 0.00 | 15.00 |
| HR\_23 | 31888.0 | 0.045189 | 0.282006 | 0.0 | 0.0 | 0.0 | 0.00 | 13.00 |

Outlier Analysis

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Feature | Lower Bound (Outliers) | Upper Bound (Outliers) | Max | Outliers Detected |
| vendor\_count | -3.5 | 8.5 | 41.0 | Yes, values above 8.5 |
| product\_count | -7.5 | 16.5 | 269.0 | Yes, values above 16.5 |
| is\_chain | -3.0 | 7.0 | 83.0 | Yes, values above 7 |
| last\_order | 16.0 | 116.0 | 90.0 | No |
| CUI\_American | -8.49 | 14.15 | 280.21 | Yes, values above 14.15 |
| CUI\_Asian | -17.75 | 29.58 | 896.71 | Yes, values above 29.58 |
| CUI\_Beverages | -12.71 | 12.71 | 229.22 | Yes, values above 12.71 |
| CUI\_Cafe | -9.64 | 9.64 | 326.1 | Yes, values above 9.64 |
| CUI\_Chicken Dishes | -5.49 | 5.49 | 219.66 | Yes, values above 5.49 |
| CUI\_Chinese | -12.29 | 12.29 | 739.73 | Yes, values above 12.29 |
| CUI\_Desserts | -7.89 | 7.89 | 230.07 | Yes, values above 7.89 |
| CUI\_Healthy | -8.75 | 8.75 | 255.81 | Yes, values above 8.75 |
| CUI\_Indian | -11.16 | 11.16 | 309.07 | Yes, values above 11.16 |
| CUI\_Italian | -16.87 | 16.87 | 468.33 | Yes, values above 16.87 |
| CUI\_Japanese | -15.27 | 15.27 | 706.14 | Yes, values above 15.27 |
| CUI\_Noodle Dishes | -6.8 | 6.8 | 275.11 | Yes, values above 6.8 |
| CUI\_OTHER | -14.65 | 14.65 | 366.08 | Yes, values above 14.65 |
| CUI\_Street Food / Snacks | -23.32 | 23.32 | 454.45 | Yes, values above 23.32 |
| CUI\_Thai | -6.65 | 6.65 | 136.38 | Yes, values above 6.65 |
| DOW\_0 | -1.5 | 2.5 | 16.0 | Yes, values above 2.5 |
| DOW\_1 | -1.5 | 2.5 | 17.0 | Yes, values above 2.5 |
| DOW\_2 | -1.5 | 2.5 | 15.0 | Yes, values above 2.5 |
| DOW\_3 | -1.5 | 2.5 | 17.0 | Yes, values above 2.5 |
| DOW\_4 | -1.5 | 2.5 | 16.0 | Yes, values above 2.5 |
| DOW\_5 | -1.5 | 2.5 | 20.0 | Yes, values above 2.5 |
| DOW\_6 | -1.5 | 2.5 | 20.0 | Yes, values above 2.5 |
| HR\_1 - HR\_23 | Varies, generally < 0 | Varies, generally > 5 | Varies | Outliers found in higher HR values |

OLD:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Feature | Count | Mean | Std Dev | Min | 25% | 50% (Median) | 75% | Max | Outliers |
| customer\_age | 31,161 | 27.51 | 7.16 | 15.0 | 23.0 | 26.0 | 31.0 | 80.0 | Max is high; outlier over 75 years |
| vendor\_count | 31,888 | 3.10 | 2.77 | 0.0 | 1.0 | 2.0 | 4.0 | 41.0 | Max is high; outlier over 15 vendors |
| product\_count | 31,888 | 5.67 | 6.96 | 0.0 | 2.0 | 3.0 | 7.0 | 269.0 | Max is an extreme outlier; any over 50 considered |
| is\_chain | 31,888 | 2.82 | 3.98 | 0.0 | 1.0 | 2.0 | 3.0 | 83.0 | Max is an extreme outlier; any over 15 considered |
| first\_order | 31,782 | 28.48 | 24.11 | 0.0 | 7.0 | 22.0 | 45.0 | 90.0 | No significant outliers |
| last\_order | 31,888 | 63.68 | 23.23 | 0.0 | 49.0 | 70.0 | 83.0 | 90.0 | No significant outliers |
| CUI\_American | 31,888 | 4.88 | 11.65 | 0.0 | 0.0 | 0.0 | 5.66 | 280.21 | Max is an extreme outlier; over 50 is significant |
| CUI\_Asian | 31,888 | 9.96 | 23.56 | 0.0 | 0.0 | 0.0 | 11.83 | 896.71 | Max is an extreme outlier; any over 100 |
| CUI\_Beverages | 31,888 | 2.30 | 8.48 | 0.0 | 0.0 | 0.0 | 0.0 | 229.22 | Max is an extreme outlier; any over 50 |
| CUI\_Cafe | 31,888 | 0.80 | 6.43 | 0.0 | 0.0 | 0.0 | 0.0 | 326.1 | Max is an extreme outlier; any over 50 |
| HR\_14 | 31,888 | 0.22 | 0.60 | 0.0 | 0.0 | 0.0 | 0.0 | 13.0 | Values over 5 are outliers |
| HR\_15 | 31,888 | 0.28 | 0.74 | 0.0 | 0.0 | 0.0 | 0.0 | 23.0 | Values over 10 are outliers |
| HR\_16 | 31,888 | 0.36 | 0.87 | 0.0 | 0.0 | 0.0 | 0.0 | 22.0 | Values over 10 are outliers |
| HR\_17 | 31,888 | 0.39 | 0.94 | 0.0 | 0.0 | 0.0 | 0.0 | 20.0 | Values over 10 are outliers |
| HR\_18 | 31,888 | 0.34 | 0.89 | 0.0 | 0.0 | 0.0 | 0.0 | 24.0 | Values over 10 are outliers |
| HR\_19 | 31,888 | 0.25 | 0.80 | 0.0 | 0.0 | 0.0 | 0.0 | 35.0 | Values over 10 are outliers |
| HR\_20 | 31,888 | 0.14 | 0.59 | 0.0 | 0.0 | 0.0 | 0.0 | 36.0 | Values over 10 are outliers |
| HR\_21 | 31,888 | 0.07 | 0.35 | 0.0 | 0.0 | 0.0 | 0.0 | 11.0 | Values over 5 are outliers |
| HR\_22 | 31,888 | 0.05 | 0.30 | 0.0 | 0.0 | 0.0 | 0.0 | 15.0 | Values over 5 are outliers |
| HR\_23 | 31,888 | 0.05 | 0.28 | 0.0 | 0.0 | 0.0 | 0.0 | 13.0 | Values over 5 are outliers |

## Histograms

A group of blue and white bars

Description automatically generated

* customer\_age:
  + The distribution appears right skewed, with a peak around the age range of 2030.
  + Most customers seem to be young adults, possibly indicating a target audience for a service or product appealing to younger demographics.
  + The number of customers decreases significantly as age increases, suggesting less engagement from older age groups.
* vendor\_count:
  + The distribution is also right skewed, with most vendors having fewer than 10 counts.
  + There are a few instances with higher vendor counts (up to 40+), which may indicate outliers or vendors with a higher level of engagement.
* product\_count:
  + Most data points are clustered near the lower end, with many having fewer than 20 products.
  + There are a few cases where the product count goes up to 250, indicating potential outliers or special cases with high product variety.
* is\_chain:
  + The histogram shows that the majority of the observations are near zero, suggesting that many vendors may not be part of a chain.
  + However, there are some vendors with values reaching above 80, indicating chain establishments with potentially many locations or branches.
* first\_order:
  + The distribution is right skewed, indicating that the first order mostly occurs within the first few weeks.
  + There are fewer customers who make their first order later, possibly due to declining interest or delayed engagement.
* last\_order:
  + This distribution is more uniform, with a tendency for many orders to cluster toward the higher end.
  + The frequency of recent orders suggests consistent or increasing engagement over time.
* CUI\_American:
  + The histogram is heavily right skewed, with most values near zero.
  + This suggests that American cuisine orders are not very frequent, but there are a few cases with significantly higher orders, which may be outliers.
* HR\_20:
  + Most values are clustered near zero, indicating that activity at this hour is infrequent.
  + However, there are outliers present, with some instances reaching up to 35 orders, which might suggest a peak hour or special events.

Overall Assumptions:

The data shows a tendency toward right skewed distributions across many variables, indicating that most values are concentrated at the lower end with some outliers at the higher end.

There are potential outliers in the data that may need further investigation, such as high product counts, vendor counts, and chain values.

The histograms suggest that most customers or orders are clustered around specific ranges, with decreasing frequency for higher values.

Figure 2.1 – Illustrative figure

Note that figure labels should be included after the figure. Sample text with the inclusion of figures and tables Sample text with the inclusion of figures and tables Sample text with the inclusion of figures and tables Sample text with the inclusion of figures and tables Sample text with the inclusion of figures and tables Sample text with the inclusion of figures and tables.

Table 2.1 – Illustrative table

|  |  |
| --- | --- |
| **Title** | **Title** |
| Text | Number |
| Text | Number |
| Text | Number |

The student can freely choose the table design, as long as it remains consistent throughout the document. Note that table labels should always be included before the table. Sample text with the inclusion of figures and tables Sample text with the inclusion of figures and tables Sample text with the inclusion of figures and tables Sample text with the inclusion of figures and tables Sample text with the inclusion of figures and tables Sample text with the inclusion of figures and tables.

### Level 3 title

Example of an unnumbered list:

* Item 1
* Item 2
* Item 3

#### Level 4 title

Example of a numbered list:

1. Item 1
2. Item 2
3. Item 3

# Another Section Heading

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Duis eget arcu nunc. Suspendisse ac volutpat nisl, at ullamcorper purus. Vestibulum tempus vehicula mauris vitae imperdiet. Morbi nibh nisl, dignissim et tellus eget, volutpat rhoncus nisi. Maecenas eget ipsum massa. Quisque malesuada nulla a felis imperdiet, a placerat ipsum ornare.

Ut a neque eu nulla aliquam tincidunt sit amet a nisi. Nam vulputate, diam non pellentesque condimentum, erat nunc suscipit turpis, a consequat ipsum ex non sapien.

# Bibliographical References (Optional, Not included in page limit)

Use APA Style for the entire document

We suggest that students use a reference manager system (Zotero, Mendeley, EndNote),

Please review the style guide at: <https://apastyle.apa.org/style-grammar-guidelines/references/examples>:

Author, A. A., Author, B. B., & Author, C. C. (Year). Title of article. *Title of Periodical, volume number* (issue number), pages.

# Appendix A (Optional, Not included in page limit)

[Appendixes are for materials, tables, or more explanation material only done by the student]

# Annexes (Optional, Not included in page limit)

[Annexes are optional, since they have material and sources not developed by the students, so in most cases referencing them is enough]