Report Title

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***Abstract*—This document is a model and instructions for LaTeX. This and the IEEEtran.cls file define the components of your paper [title, text, heads, etc.]. *CRITICAL: Do Not Use Symbols, Special Characters, Footnotes, or Math in Paper Title or Abstract.**

I. Introduction

A brief discussion of the problem context, motivation, analysis questions/aims and proposed methods and approaches used.

This document is a model and instructions for LaTeX. Please observe the 8 page limit.

II. Literature Review

An overview of related work of similar research in the domain.

The IEEEtran class file is used to format your paper and style the text. All margins, column widths, line spaces, and text fonts are prescribed; please do not alter them. You may note peculiarities. For example, the head margin measures proportionately more than is customary. This measurement and others are deliberate, using specifications that anticipate your paper as one part of the entire proceedings, and not as an independent document. Please do not revise any of the current designations.

III. Methodology

Includes a discussion of methods applied to address your questions/aims.

Before you begin to format your paper, first write and save the content as a separate text file. Complete all content and organizational editing before formatting. Please note sections III-A–III-B below for more information on proofreading, spelling and grammar.

Keep your text and graphic files separate until after the text has been formatted and styled. Do not number text heads—LaTeX will do that for you.

A. Example sub-section

Define abbreviations and acronyms the first time they are used in the text, even after they have been defined in the abstract.

Number equations consecutively. Use a long dash rather than a hyphen for a minus sign. Punctuate equations with commas or periods when they are part of a sentence, as in:

$$a + b = \gamma \tag{1}$$

Be sure that the symbols in your equation have been defined before or immediately following the equation. Use "(1)", not "Eq. (1)" or "equation (1)", except at the beginning of a sentence: "Equation (1) is . . ."

B. Some Common Mistakes

- The word "data" is plural, not singular.
- Do not use the word "essentially" to mean "approximately" or "effectively".
- In your paper title, if the words "that uses" can accurately replace the word "using", capitalize the "u"; if not, keep using lower-cased.
- Be aware of the different meanings of the homophones "affect" and "effect", "complement" and "compliment", "discreet" and "discrete", "principal" and "principle".
- Do not confuse "imply" and "infer".
- The prefix "non" is not a word; it should be joined to the word it modifies, usually without a hyphen.
- There is no period after the "et" in the Latin abbreviation "et al.".
- The abbreviation "i.e." means "that is", and the abbreviation "e.g." means "for example".

An excellent style manual for science writers is [7].

C. Figures and Tables

a) Positioning Figures and Tables: Place figures and tables at the top and bottom of columns. Avoid placing them in the middle of columns. Large figures and tables may span across both columns. Figure captions should be below the

figures; table heads should appear above the tables. Insert figures and tables after they are cited in the text. Use the abbreviation "Fig. **??**", even at the beginning of a sentence.

TABLE I
TABLE TYPE STYLES

Table Head	Table Column Head		
	Table column subhead	*Subhead*	*Subhead*
copy	More table copy[a]		

[a]Sample of a Table footnote.

Figure Labels: Use 8 point Times New Roman for Figure labels. Use words rather than symbols or abbreviations when writing Figure axis labels to avoid confusing the reader. As an example, write the quantity "Magnetization", or "Magnetization, M", not just "M". If including units in the label, present them within parentheses. Do not label axes only with units. In the example, write "Magnetization (A/m)" or "Magnetization {A[m(1)]}", not just "A/m". Do not label axes with a ratio of quantities and units. For example, write "Temperature (K)", not "Temperature/K".

D. References

Please number citations consecutively within brackets [1]. The sentence punctuation follows the bracket [2]. Refer simply to the reference number, as in [3]—do not use "Ref. [3]" or "reference [3]" except at the beginning of a sentence: "Reference [3] was the first ..."

Capitalize only the first word in a paper title, except for proper nouns and element symbols.

IV. Data Description / Preparation

A. Data Description

The dataset used in this project is from Dr. Marie Anderson, Machine Learning Engineer, Chief Data and Analytics Office, Lloyds Banking Group, Bristol. The raw transaction data provides a record of customer interactions, including date, time, amount, mode, and associated location. For reasons of confidentiality, the raw transaction data is subjected to agent-based simulations to generate artificial transactional data at the individual level. Our research is based on this dataset.

In the initial release of the dataset, there are 1,048,575 rows of transaction data and four variables: 'from_totally_fake_account', 'monopoly_money_amount', 'to_randomly_generated_account', and 'not_happened_yet_date'. The following is a detailed description of the variables:

- **from_totally_fake_account:** Virtual transfer out account. Character variable representing the trading account.
- **monopoly_money_amount:** Virtual transaction amount. Numeric variable representing the spend/transfer amount.
- **to_randomly_generated_account:** Virtual to account. Character variable representing the transaction merchant/virtual personal account.
- **not_happened_yet_date:** Virtual transaction date. Date type variable from 1 January 2025 to 31 December 2025.

B. Data Quality

The initial dataset has few variables, so the data preprocessing part is simpler. We firstly performed the operations of removing duplicate values and checking for missing values on the dataset. After that, we preprocessed the raw data based on the characteristics of the two columns: 'to_randomly_generated_account' and 'not_happened_yet_date'.

- **Removing Duplicate Values:** We removed duplicate values in the dataset considering that in the exact same transaction data (same time, place, amount) is unlikely in real life. The de-duplicated dataset contains 10,148,280 pieces of data.
- **Handling Missing Values:** After checking, there are no missing values in the de-duplicated dataset.
- **Data Inconsistency:** We observed that the 'to_randomly_generated_account' column contains both merchant names, e.g., CAFÉ, DVD_SHOP, and personal accounts (five digits), so in the subsequent exploratory analyses, we categorized the consumer accounts and classified the personal accounts as "person" for ease of follow-up.
- **Parse Dates:**We note that we can extract the transaction month from the date to see which months of the year are more active. We also plan to convert the transaction dates to Monday to Sunday so that we can further analyze the weekly trading patterns and get more valuable information.

V. Results and Discussion

A. Transaction Venue Analysis

We can gain insights into consumer behavior and develop banking strategies based on data visualization at each transaction location.

From Fig.1 we can clearly see that both bars and supermarkets are the venues where the total transaction value is higher, but in combination with Fig.2 and Fig.3, it can be seen that in bars the frequency of transactions is higher but the average transaction value is lower, and the bank needs to ensure that the payment system in these venues is stable. Comparatively, supermarkets have a lower frequency of transactions and a large average transaction value, suggesting that customers at these venues have high purchasing power and make mostly larger purchases and that banks need to provide payment services at these locations that can efficiently process large transactions and may need to target these merchants with points or rewards programs to promote more frequent spending.

Transactions at e-shops have a large average transaction value, but the total transaction value and frequency are not necessarily high, suggesting that customers are spending more per transaction when purchasing electronic products. Banks may need to provide high-security payment solutions for such shops, taking into account that large transactions are usually accompanied by a higher risk of fraud.In contrast,

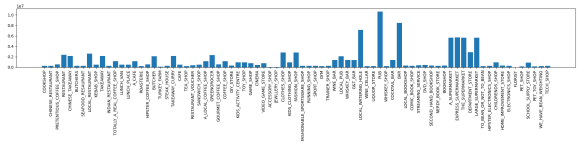

Fig. 1. Total amount of transactions per trading venue

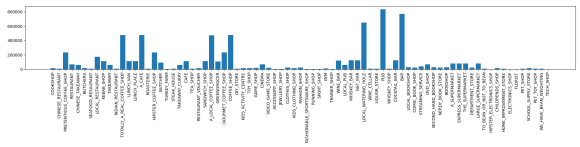

Fig. 2. Number of transactions per trading venue

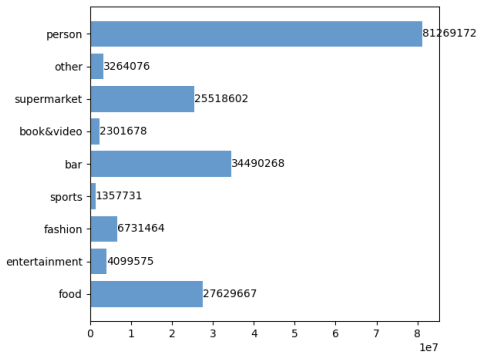

Fig. 4. The total value of transactions under different trading categories

the total amount of transactions at coffee shops and fast food outlets may not be high, but the number of transactions is frequent, suggesting that customers tend to make small but high-frequency transactions at these locations. Banks need to ensure that transaction costs at these locations are low to keep services affordable, and need to offer fast and convenient payment methods to accommodate the fast-paced consumer environment.

Summarizing the above, we have divided it into 9 categories as shown in Fig.4, and banks need to take into account their respective transaction characteristics in processing the 9 categories of the 79 trading venues. As shown, the market for everyday consumer goods, particularly supermarkets, bars, and food, accounted for the majority of total transactions, reflecting the trend toward consumer concentration. E-shops, on the other hand, show transactions characterized by occasional large purchases. Fig.4 emphasizes the significantly high transaction value of personal transfers, highlighting the importance of personal money flows. Therefore, banks should provide flexible payment solutions that can effectively handle small, high-frequency transactions while ensuring the security of large-value transactions, as well as strengthen personal transfer services and anti-money-laundering monitoring, to adapt to diversified market demands and maintain market competitiveness.

B. Monthly Transaction Trend Analysis

To further understand the trend of customers' transaction behavior, we generated line graphs such as Fig.5 and Fig.6 for the fluctuation of the total number of transactions and the number of transactions from January 2025 to January 2026.

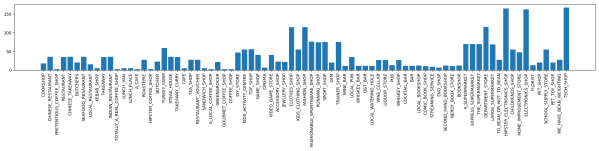

Fig. 3. Average value of transactions per venue

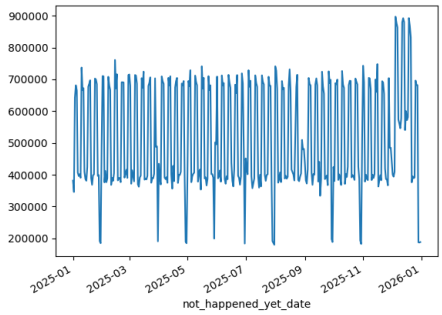

Fig. 5. Total amount of transactions on different dates

According to Fig.5 we can clearly see that most of the time the transaction value fluctuates between 400,000 and 700,000, but at the beginning of some of these months the lowest range interval of the transaction value decreases to 200,000, perhaps we can conclude that customers reduce the number of times they spend money at these times, but in combination with Fig.6 we will surprisingly find that the number of transactions at these times does not change significantly, which remain between 15,000 and 45,000 as usual, so this phenomenon may be caused by large holidays or merchant promotions. Banks need to carefully assess the impact of these changes on

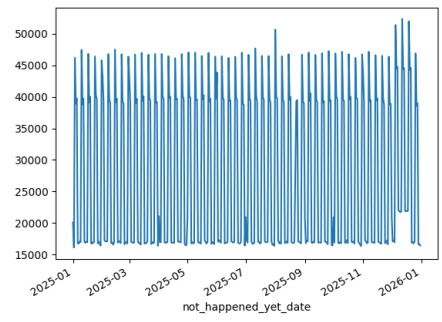

Fig. 6. Number of transactions on different days

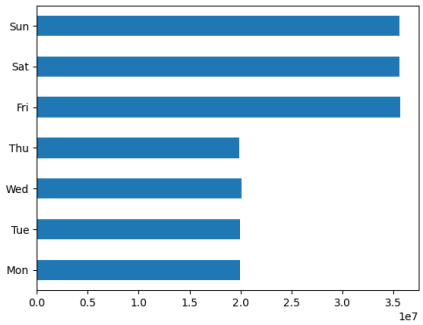

Fig. 7. Total amount of transactions on different business days

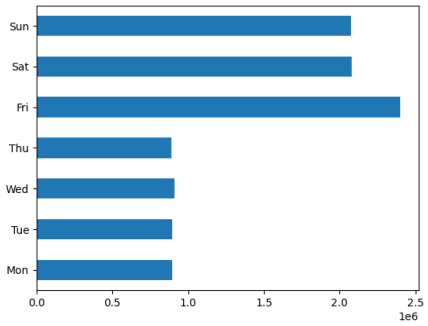

Fig. 8. Number of transactions on different working days

their revenues and services and consider whether they need to adjust their payment strategies accordingly to maintain stable business operations.

On the other hand, throughout December 2025, there was a significant rise in both the value of transactions and the number of transactions, most likely due to the fact that spending is boosted by grand holidays such as Christmas and New Year's, as well as by the fact that many companies pay out bonuses before the end of the year, which increases disposable incomes for individuals and thus increases spending activity. Banks can offer special promotions or financial products at such times to meet consumer demand and strengthen risk management measures to ensure the security and stability of transactions during this period.

C. Weekday Transaction Pattern Analysis

In addition to analyzing the consumer macro from one year to the next, gaining an in-depth understanding of trading trends on different days of the week is vital.

For Fig.7 and Fig.8, we note that the total amount of transactions and the number of transactions are significantly lower from Monday to Thursday than from Friday to Sunday. This may be due to the fact that people have more time for financial transactions and shopping activities during weekends.

Next, Fig.9 and Fig.10 show the total amount and frequency of transactions in different venues over the weekend. We see that in bars and entertainment venues, the total value and

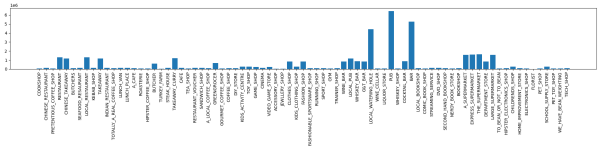

Fig. 9. Total amount traded on different venues during the weekend (Friday - Sunday)

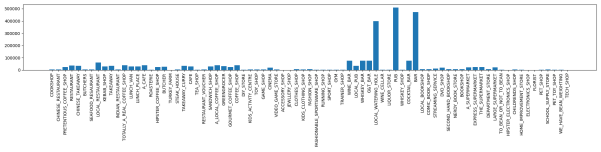

Fig. 10. Frequency of transactions on different venues over the weekend (Friday - Sunday)

frequency of transactions may increase, while in other places such as supermarkets or electronic shops, the total value and frequency of transactions are relatively stable. This suggests that people are more likely to spend their money in places such as bars and restaurants during the weekend, while shopping activity in supermarkets or electronic shops is relatively stable.

In summary, banks should adjust their service strategies according to the transaction patterns on different weekdays and weekends to improve transaction processing efficiency and enhance customer experience and market competitiveness through differentiated services. Banks need to adjust their strategies in a timely manner to adapt to changes in market demand and customer behaviour in order to maintain a competitive edge.

VI. Further Work and Improvement

Explore what can be done further based on the discussed insights and ways to improve.

VII. Conclusion

A brief summary of the key insights in your report.

References

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APPENDIX

The document up to this section should be no more than 8 pages. The appendix section is optional. You can include additional material here, but it will not be marked.