Modelling User Experience Factors in Kids Mobile Gaming Application

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INDUSTRIAL ENGINEERING

By

Janhavi Prasad(06)

Prachi Metkar(34)

Sakshi Kale(61)

Samiksha Gijre(64)

Tarika Jaikalyani(65)

Guide

Prof. Mangesh Joshi

Department of Industrial Engineering

Shri Ramdeobaba College of Engineering and Management, Nagpur-440013

(An Autonomous Institute Affiliated to Rashtrasant Tukdoji Maharaj Nagpur University Nagpur)

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Shri Ramdeobaba College of Engineering and Management, Nagpur

(An Autonomous Institute Affiliated to Rashtrasant Tukdoji Maharaj Nagpur University Nagpur)

Department of Industrial Engineering

CERTIFICATE

This is to certify that the Thesis on **"Modelling User Experience Factors in Kids Mobile Gaming Application"** is a Bonafede work of **Janhavi Prasad, Prachi Metkar, Sakshi Kale, Samiksha Gijre, Tarika Jaikalyani** submitted to the Rashtrasant Tukdoji Maharaj Nagpur University, Nagpur in project completion in 6th semester of a BTech in Industrial Engineering has been carried out at the Department of Industrial Engineering, Shri Ramdeobaba College of Engineering and Management, Nagpur during the academic year 2023-24.

Date: 05/05/2024
Place: Nagpur

Prof. Mangesh Joshi
Project Guide
Department of Mechanical Engineering

Dr. M. M. Gupta
H.O.D.,
Department of Industrial Engineering

DECLARATION

We, hereby declare that the thesis titled **"Modelling User Experience Factors in Kids Mobile Gaming Application"** submitted herein, has been carried out in the Department of Industrial Engineering of Shri Ramdeobaba College of Engineering & Management, Nagpur. The work is original and has not been submitted earlier as a whole or part for the award of any degree / diploma at this or any other institution / University. Date: 05/05/2024

Place: Nagpur

Projectee

Janhavi Prasad

Prachi Metkar

Sakshi Kale

Samiksha Gijre

Tarika Jaikalyani

Approval Sheet

This thesis/dissertation/report entitled **Modelling User Experience Factors in Kids Mobile Gaming Applicatio** by **Janhavi Prasad, Prachi Metkar, Sakshi Kale, Samiksha Gijre, Tarika Jaikalyani** is approved for project completion in VI semester.

Name & signature of Project Guide(s)

Name & signature of HOD

Date: 05/05/2024

Place: Nagpur

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Projectee

Janhavi Prasad

Prachi Metkar

Sakshi Kale

Samiksha Gijre

Tarika Jaikalyani

ABSTRACT

This mini-project investigates user experience factors in children's mobile gaming applications, with a focus on sentiment analysis of user reviews of Angry Birds. The objective is to identify factors influencing the gaming experience and propose recommendations for game developers.

User reviews were manually collected and analyzed using Python programming in Jupyter Notebook. The sentiment analysis revealed a spectrum of emotions and opinions among players, highlighting the importance of tailoring game design to meet the preferences of young players.

The findings underscore the significance of understanding user sentiments in shaping game development practices. By leveraging computational tools, actionable insights were derived to inform game design decisions and enhance user experiences.

This study contributes to advancing knowledge in the field of user experience modeling in children's mobile gaming applications. Future research endeavors can build upon these findings to further explore and improve digital entertainment experiences for young audiences.

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CHAPTER I- INTRODUCTION

The exponential growth of the gaming industry has sparked significant interest in understanding user sentiments and preferences towards popular games. In this context, our mini project focused on conducting sentiment analysis on user reviews of multiple games, culminating in an in-depth analysis of the sentiment surrounding the renowned mobile game Angry Birds.

The rationale behind selecting Angry Birds for our sentiment analysis stemmed from its widespread popularity, enduring relevance, and diverse user base. As one of the most iconic mobile games of all time, Angry Birds has gained millions of downloads and amassed a dedicated community of players worldwide. This popularity, coupled with the rich variety of user-generated reviews available across different platforms, presented a compelling opportunity to explore sentiment dynamics within the gaming community.

Our study involved a meticulous process of manually collecting user reviews for a curated selection of five games, followed by the application of sentiment analysis techniques using Python programming.

By leveraging Python programming for sentiment analysis, we aimed to provide a comprehensive understanding of user sentiments within the context of this iconic mobile game.

In the project, we progress through various stages, each contributing to a deeper understanding of our topic. We begin by defining the problem statement, outlining the specific focus of our study. Following this, we conduct an extensive review of existing literature to contextualize our project within the broader academic landscape and to identify gaps and opportunities for investigation.

Subsequently, we delve into the implementation of sentiment analysis techniques, leveraging Python programming to analyze the sentiments expressed in user reviews of the selected games. This phase involves data collection, preprocessing, sentiment classification, and analysis, aimed at uncovering patterns and insights within the collected dataset.

Furthermore, to facilitate understanding and replication of our sentiment analysis methodology, we provide a detailed pseudo-code. This pseudo-code serves as a practical guide, outlining the step-by-step process of sentiment analysis implementation.

By systematically progressing through these stages, from problem identification to literature review, sentiment analysis, and pseudo-code generation, our thesis contributes to advancing knowledge and understanding in the field of sentiment analysis in gaming.

1.1 Background:

The background of the User Experience (UX) project for kids' mobile gaming applications is rooted in the growing significance of user-centric design and the challenges faced by children in engaging with these applications. As mobile gaming continues to gain popularity among kids, there is a need to ensure that these applications provide a seamless and enjoyable user experience that aligns with the unique needs and preferences of young users.

The motivation for this project stems from the complexity of designing mobile gaming applications for children that not only entertain but also provide educational value and adhere to safety and privacy standards. Existing research and design practices often fall short in addressing the specific requirements of kids' mobile gaming, leading to user experiences that may not fully cater to their developmental stages, cognitive abilities, and interests.

Furthermore, the project recognizes the critical importance of child safety and privacy in the digital age. Regulations and guidelines for children's online privacy protection necessitate a careful and thoughtful approach to designing and developing mobile gaming applications for kids, ensuring that their personal information is safeguarded and that the content is age-appropriate and suitable for young audiences.

The demand for engaging and meaningful experiences in kids' mobile gaming applications adds another layer to the project's background. Children expect interactive and entertaining gameplay, captivating storylines, and opportunities for learning and creativity. Designing for these expectations requires a deep understanding of children's cognitive and emotional development, as well as their preferences and behaviors in digital environments.

In response to these challenges, the User Experience project for kids' mobile gaming applications aims to blend research-based design principles with innovative technology solutions to create a user-centric and engaging experience for young users. By focusing on user needs and preferences, ensuring safety and privacy, and leveraging technology for interactive and educational content, the project endeavors to contribute to the advancement of user experience design for children's digital products.

Objectives:

- To conduct a comprehensive analysis of user feedback and reviews of kids' mobile gaming applications to identify prevalent issues and pain points affecting user experience.
- To investigate the underlying factors contributing to negative user experiences, considering aspects such as game design, usability, content appropriateness, and parental oversight.
- To propose evidence-based strategies and recommendations for developers to mitigate negative user experiences and enhance the overall quality of kids' mobile gaming applications.
- To explore the role of parental guidance, supervision, and involvement in shaping children's mobile gaming experiences and behaviors, and to provide insights for parents on fostering positive gaming habits and interactions.

1.2 Significance of the Study:

This study holds significant importance in several key areas:

1.Contribution to Knowledge:
By conducting a comprehensive analysis of user sentiments in popular mobile games, including Angry Birds, this study contributes to advancing knowledge within the field of sentiment analysis in gaming. The insights gained from our research offer a deeper understanding of the intricate relationship between user sentiments and gameplay experiences, shedding light on prevalent themes, patterns, and trends in user feedback.

2.Practical Implications:
The findings of this study have practical implications for various stakeholders in the gaming industry. Game developers can leverage the insights to inform game design decisions, prioritize feature development, and optimize player experiences. Publishers can utilize the findings to tailor marketing strategies, enhance user engagement initiatives, and foster community interaction. Community managers can benefit from understanding user sentiments to address concerns, facilitate discussions, and cultivate a positive gaming community environment. Ultimately, players stand to benefit from improved gaming experiences tailored to their preferences and feedback.

3.Innovation and Creativity:
Our research methodology incorporates innovative approaches to sentiment analysis, leveraging Python programming technique to analyze user-generated reviews effectively. By adopting a creative and rigorous approach to data analysis, this study offers novel insights into sentiment dynamics within gaming environments and showcases the potential of data-driven methodologies in understanding user behavior and preferences.

4.Relevance to Industry Trends:
In an era of rapid technological advancement and evolving player expectations, understanding user sentiments in gaming has become increasingly critical for industry stakeholders. This study aligns with current trends in the gaming industry, addressing pressing issues related to player engagement, community management, and user feedback analysis. By providing actionable insights derived from sentiment analysis, this research contributes to shaping industry practices and strategies for enhancing player experiences in mobile gaming platforms.

5.Broader Social and Cultural Impact:
Beyond the gaming industry, this study has broader implications for understanding digital culture, social interaction, and technological innovation. By examining user sentiments in digital gaming environments, we contribute to broader conversations about the role of technology in shaping social experiences, cultural practices, and community dynamics in the digital age

1.3 Research Design

1.Research Approach:

This study will adopt a mixed-methods approach, integrating both quantitative and qualitative methodologies to comprehensively investigate user experience factors in kids' mobile gaming applications. Quantitative methods, such as sentiment analysis of user reviews and statistical analysis of survey data, will provide quantitative insights into prevalent issues and trends. Qualitative methods, including thematic analysis of interview transcripts and content analysis of app features, will offer deeper contextual understanding and nuanced insights into user experiences.

2.Data Collection Methods:

Data will be collected through multiple sources:

- User reviews and ratings from app stores will be collected using web scraping techniques, focusing on popular kids' mobile gaming applications.
- Surveys will be distributed to parents and children to gather demographic information, gaming habits, and subjective opinions on user experience factors.
- Semi-structured interviews will be conducted with a subset of parents and children to explore their perspectives, attitudes, and experiences in more depth.

3.Sampling Strategy:

Participants will be selected using purposive sampling, considering factors such as age, gender, geographic location, and frequency of mobile gaming. The sample will aim to include a diverse range of participants to capture a broad spectrum of experiences and perspectives. Parents' and children's consent will be obtained before participation in the study.

4.Data Analysis Techniques:

Quantitative data analysis will involve sentiment analysis of user reviews using natural language processing techniques and statistical analysis of survey data using software such as SPSS. Qualitative data analysis will include thematic analysis of interview transcripts and content analysis of app features using qualitative data analysis software like NVivo.

5.Timeline and Resources:

The research will be conducted over a period of 12 months, with data collection, analysis, and reporting phases. Resources required include access to web scraping tools, survey software, interview recording equipment, and qualitative analysis software.

6.Data Management Plan:

Data will be securely stored on encrypted servers and backed up regularly. Participants' personal information will be anonymized, and data will be stored in compliance with data protection regulations.

7.Potential Limitations:

Limitations may include sample bias due to self-selection, potential response bias in survey data, and generalizability of findings to broader populations of children and parents. Mitigation strategies will be implemented, such as careful participant recruitment and transparency in reporting limitations.

CHAPTER II- LITERATURE REVIEW

1. **Sentiment analysis algorithms and applications: A survey**
   The main contributions of this paper include the sophisticated categorizations of a large number of recent articles and the illustration of the recent trend of research in the sentiment analysis and its related areas**.**

2. **MoSa: A Modeling and Sentiment Analysis System for Mobile Application Big Data**
   By tracking sentiment changes, we can improve mobile apps, social media, and crowdfunding for everyone.

3. **A Comparative Study on Web Scraping**
   The outcome of this study offers a review on web scraping techniques and software which can be used to extract data from educational web sites.

4. **Sentiment Analysis: A Comparative Study on Different Approaches**
   Sentiment Analysis poses as a powerful tool for users to extract the needful information, as well as to aggregate the collective sentiments of the reviews.

5. **Techniques and applications for sentiment analysis**
   Sentiment Analysis poses as a powerful tool for users to extract the needful information, as well as to aggregate the collective sentiments of the reviews

6. **Sentimental Analysis on Web Scraping Using Machine Learning Method**
   In this study, the long short-term memory and deep learning convolutional neural network integrated with LSTM (CNN-LSTM) models were used to analyses the sentiment of reviews in the e-commerce market.

7. **Sentiment Analysis: A Combined Approach**
   Sentiment analysis is an important current research area. This paper combines rule-based classification, supervised learning and machine learning into a new combined method

8. **Social issues sentiment analysis using python**
   This paper explores sentiment analysis on Twitter data regarding women's social issues, employing Python for data scraping and cleaning, and machine learning for sentiment classification.

9. **Using appraisal groups for sentiment analysis**
   A new sentiment analysis method utilizing fine-grained semantic distinctions achieves state-of-the-art accuracy of 90.2% by integrating appraisal groups with standard bag-of-words features from movie reviews. Certain types of appraisal demonstrate greater significance for sentiment classification.

10. **Sentiment analysis in Twitter**
    In recent years, theinterest among the research community in sentiment analysis (SA) has grown exponentially. It is only necessary to see the number of scientific publications and forums or related conferences to understand that this is a field with great prospects for the future

CHAPTER III- PROBLEM STATEMENT

3.1 Problem Statement:

"Despite the popularity of mobile gaming applications among kids, there exists a significant challenge in identifying and addressing the key user experience factors that contributes to negative experiences. This study aims to identify these factors and propose solutions to enhance the overall user experience in kids' mobile gaming applications."

The current landscape of kids' mobile gaming applications presents a challenge in providing a user experience that is not only entertaining but also educational, safe, and engaging for children. Existing applications often struggle to balance these elements, leading to user experiences that may not fully cater to the developmental needs and preferences of young users. Additionally, ensuring child safety and privacy in the digital environment poses further complexities. The problem at hand is to develop a user experience framework for kids' mobile gaming applications that addresses these challenges by integrating educational content, interactive gameplay, safety features, and privacy measures. The framework aims to provide a holistic approach to user experience design, ensuring that children's cognitive, emotional, and developmental needs are met while also offering engaging and age-appropriate content.

3.2 Summary of the Project:

The project focuses on improving the user experience in kids' mobile gaming applications by identifying and addressing key factors contributing to negative experiences. It utilizes sentiment analysis on user reviews to understand the common pain points and proposes solutions to enhance the overall gaming experience.

The project utilizes the ParseHub software to scrape user review data from the Angry Birds app on the Google Play Store. The extracted data is then saved in an Excel (.xlsx) file for further analysis. Python is used as the primary programming language for sentiment analysis. The TextBlob library is employed for sentiment analysis, allowing for the classification of reviews into positive, negative, or neutral sentiments based on the polarity of the text.

The sentiment analysis code is structured as follows:

Installation of TextBlob: The code begins with the installation of the TextBlob library using the pip package manager (!pip install textblob).

Importing Libraries: The necessary libraries, including pandas for data manipulation and TextBlob for sentiment analysis, are imported.

Sentiment Analysis Function: A function analyze_sentiment is defined to perform sentiment analysis on each review. The function takes a text input, creates a TextBlob object, calculates the sentiment polarity score, and classifies the sentiment as positive, negative, or neutral.

Reading the Data: The code reads the previously extracted user review data from the Excel file into a pandas DataFrame.

Applying Sentiment Analysis: The sentiment analysis function is applied to each review in the DataFrame, and the results are stored in two new columns: "Sentiment" and "Sentiment Score".

Saving the Results: The DataFrame with the sentiment analysis results is saved to a new Excel file for further analysis and visualization.

Printing the Output: The code prints a message indicating the completion of the sentiment analysis process and the location of the output file.

This sentiment analysis code serves as a foundational step in the thesis project, providing valuable insights into the user experience factors that contribute to negative sentiments in kids' mobile gaming applications. The findings from this analysis can be used to inform the development of strategies and solutions to enhance the overall user experience in these applications.

3.3 Research Questions:

1. What are the key user experience factors that contribute to negative experiences in kids' mobile gaming applications?

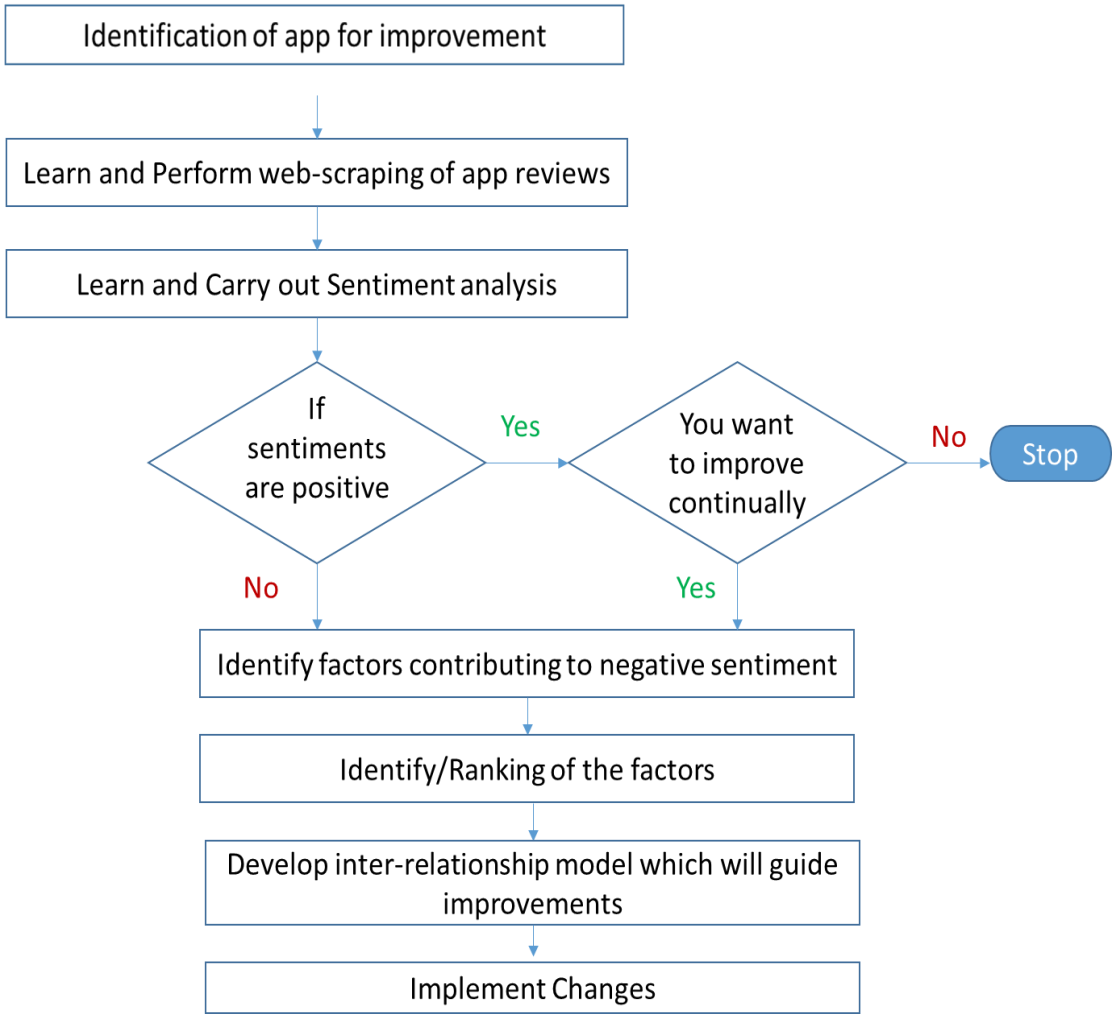
2. How do these factors vary across different age groups, demographics, and gaming genres?

3. What strategies can be employed to address these factors and enhance the overall user experience in kids' mobile gaming applications?

4. How do parents' perceptions and concerns regarding mobile gaming influence their children's gaming experiences and behaviors?

CHAPTER IV- METHODOLOGY

The following flowchart represents the methodology and flow of the project:



Methodology for the project:

1)Manual Review Collection: Objective: Gather a diverse set of reviews from various game apps to ensure comprehensive coverage and representativeness.

- Identify and select five different game apps from relevant platforms (e.g., google play store).
- Manually read and extract reviews for each selected app.

Manually identified general contributing factors are as follows:

Identifying user experience (UX) factors in children mobile gamming application

- It contains constant interruptions.
- In paid version ads problem remain same.
- Too much focus on making money with content
- Its voice is so cringe and it yawns and is hungry in every 5 min
- very slow in downloading
- There is too much ads (in every 1-2 min)in it.
- lip of tom does not open properly (3.6.3 version app was ok)
- playing at 3AM it gets creepy and this is hacked

- Nothing designed properly features are same after updation
- this app is for child not for adults but show too many ads
- oldest version is better than this (new) version.
- Cat's mouth doesn't match with child word when he repeat that
- Nothing interesting and no kind of good upgradation
- not working properly in phone
- kids touch screen and adds starts running
- This game doesn't have updates
- After installed and opening the game does not work
- app draw on the screen(overlay permission)
- every 10 sec there's an ad of minimum 25 sec.
- In cat eyes we see our reflection faintly.

Likewise done for the 4 different games such as angry birds, hill climb racing, project makeover and bubble shoot for kids.

2) App Selection for Sentiment Analysis: Objective: Choose one app from the manually collected reviews(selected angry birds) for detailed sentiment analysis.

- Evaluate the collected reviews based on criteria such as relevance, popularity, and diversity.
- Select the app that best aligns with the research objectives and provides a sufficient volume of reviews for analysis

3) Reviews Collection Using ParseHub: Objective: Automate the process of gathering review for the selected app using ParseHub, a web scraping tool.

- Set up ParseHub to extract reviews from online sources (e.g.google play store) for the selected game app.
- Configure ParseHub to capture relevant data fields such as review text, rating, date, and reviewer information.
- Run the ParseHub scraper to collect a substantial number of reviews while adhering to ethical guidelines and platform terms of service.

An elucidation of the structural framework of ParseHub software will be presented given below:

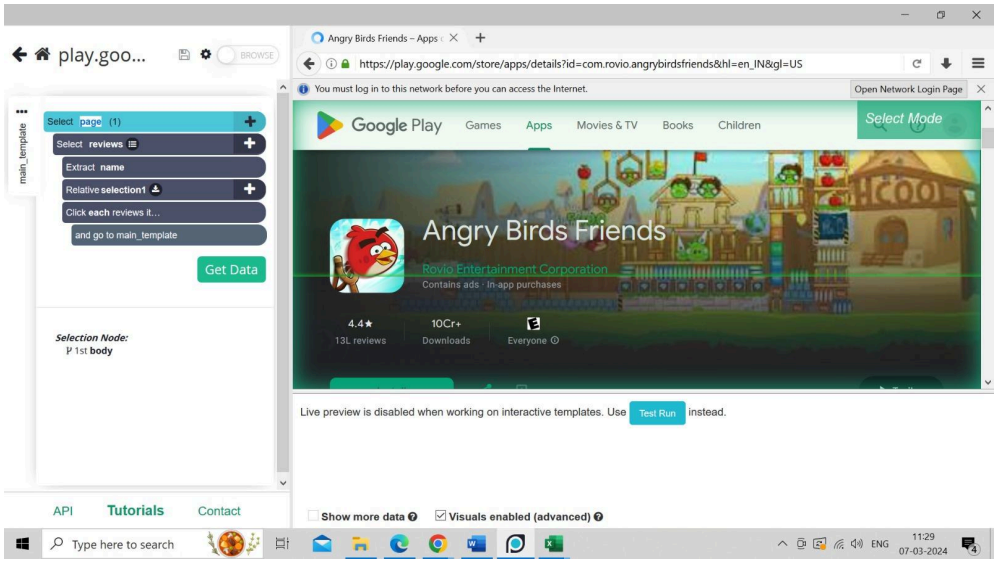


Fig 4.1: Gathering of reviews using ParseHub Software

4) Exporting Data in Excel CSV Format:

Once the web scraping process is complete, export the extracted review data from ParseHub into an Excel CSV (Comma-Separated Values) format file. This file format is widely compatible and facilitates seamless data manipulation and analysis using various tools.

5)Python Code for Sentiment Analysis: Objective: Develop Python code to perform sentiment analysis on the collected reviews.

- Utilize the TextBlob library for natural language processing (NLP) to process and analyze textual data efficiently.
- Implement sentiment analysis algorithms provided by TextBlob to classify each review as positive, negative, or neutral based on its content.
- Fine-tune the sentiment analysis model as needed to account for domain-specific language and context present in gaming app reviews.

Python code for sentiment analysis is as follows:

```
import pandas as pd
from textblob import TextBlob

def analyze_sentiment(text):
    # Create a TextBlob object
    blob = TextBlob(text)

    # Perform sentiment analysis
    sentiment_score = blob.sentiment.polarity

    # Classify sentiment
    if sentiment_score > 0:
        sentiment = "Positive"
    elif sentiment_score < 0:
        sentiment = "Negative"
    else:
        sentiment = "Neutral"

    return sentiment, sentiment_score

# Read the .xlsx file into a DataFrame
file_path = r"C:\Users\ADMIN\Downloads\run_results1.xlsx"
df = pd.read_excel(file_path)

# Apply sentiment analysis to each review
sentiments = []
for review in df["Reviews_name"]:
    sentiment, sentiment_score = analyze_sentiment(review)
    sentiments.append((sentiment, sentiment_score))

# Add sentiment analysis results to the DataFrame
df["Sentiment"], df["Sentiment Score"] = zip(*sentiments)

# Save the DataFrame with sentiment analysis results to a new .xlsx file
output_file_path = "D:/reviews_sample.xlsx"
df.to_excel(output_file_path, index=False)

print("Sentiment analysis completed and saved to", output_file_path)
```

OUTPUT:
Sentiment analysis completed and saved to D:/reviews_sample.xlsx

6) Generation of Sentiment Scores: Objective: Calculate sentiment scores for each review and export the results to an Excel file.

- Implement the sentiment analysis code on the collected reviews dataset to derive sentiment scores for each review.
- Assign numerical values or labels to represent the sentiment polarity (e.g., positive = 1, negative = -1, neutral = 0) based on the analysis outcomes.
- Download the resultant file to the specified location in the D drive, where the sentiment scores are aggregated for further analysis and visualization.

Listed below are the reviews with their sentiment score and sentiment:

Reviews_name	Sentiment	Sentiment Score
Garbage.so many glitches	Negative	-0.00555555555555556
Its super cool and awesome	Positive	0.367363478535354
Taking long time to load	Negative	-0.150428571428571
Recent update sucks	Negative	-0.00218253968253967
Older version was better	Negative	-0.0039141414141414
This game is now laughable	Positive	0.05
Overly Complicated	Negative	-0.169166666666667
All time favourite	Positive	0.1
Terrible new update	Negative	-0.119530303030303
Great game	Positive	0.0835

By using the above methodology, we have systematically collected, analyzed, and interpreted user reviews of gaming application Angry Birds Friends to uncover valuable insights into user sentiment and preferences.

CHAPTER V-APPLICATIONS OF SENTIMENT ANALYSIS/WEB SCRAPPING

5.1 Usefulness of Sentiment analysis and Web-scrapping

The proposed solution for the project " Modelling User Experince Factors in Kids Mobile Gaming Application "involves identifying factors contributing to negative sentiment through web scraping of app reviews and conducting sentiment analysis.

1. Market Research: Companies can scrape customer reviews from e-commerce platforms, review websites, and social media to understand customer sentiment about their products and competitors. Sentiment analysis helps identify trends, strengths, and weaknesses in products or services.

2. Brand Monitoring: Brands can monitor online reviews and social media conversations to gauge public opinion about their products or services. Sentiment analysis helps track brand perception and identify potential PR issues or areas for improvement.

3. Product Development: By analyzing customer feedback from reviews, companies can gain insights into features that customers appreciate or dislike about their products. This information can inform product development and help prioritize new features or improvements.

4. Customer Feedback Analysis: Web scraping and sentiment analysis can be used to analyze customer feedback surveys, online forums, and support tickets to understand common issues, pain points, and areas for improvement in customer service.

5. Competitor Analysis: Businesses can scrape reviews and sentiment data from competitors' websites and social media to compare product offerings, customer satisfaction levels, and brand perception. This information can inform competitive strategies and identify opportunities for differentiation.

6. Market Trends Analysis: Web scraping of reviews and sentiment analysis can help identify emerging trends, popular products, and consumer preferences in specific markets or industries. This information can inform marketing strategies, product positioning, and investment decisions.

5.2 Further advantages:

In addition to the core advantages mentioned earlier, the project "Modelling User Experince Factors in Kids Mobile Gaming Application" offers several other benefits:

1. Data-driven Decision Making: By extracting and analyzing large volumes of data from various sources, organizations can make informed decisions based on factual evidence rather than intuition or guesswork.

2. Real-time Insights: Web scraping and sentiment analysis allow businesses to monitor and analyze online conversations, trends, and feedback in real time, enabling them to respond promptly to emerging issues or opportunities.

3. Cost-effectiveness: Compared to traditional methods of data collection and analysis, such as surveys or focus groups, web scraping and sentiment analysis can be more cost-effective, especially when dealing with large datasets and frequent updates.

4. Scalability: Web scraping and sentiment analysis techniques can scale to handle large volumes of data from multiple sources, allowing organizations to analyze trends and patterns across diverse datasets.

5. Customization: Organizations can customize web scraping and sentiment analysis workflows to suit their specific needs and objectives, tailoring data collection methods, analysis techniques, and reporting formats accordingly.

6. Predictive Insights: By analyzing historical data and trends, web scraping and sentiment analysis can provide predictive insights into future market developments, customer behavior, and business opportunities.

7. Predictive Insights: By analyzing historical data and trends, web scraping and sentiment analysis can provide predictive insights into future market developments, customer behavior, and business opportunities.

5.3 Code Description:

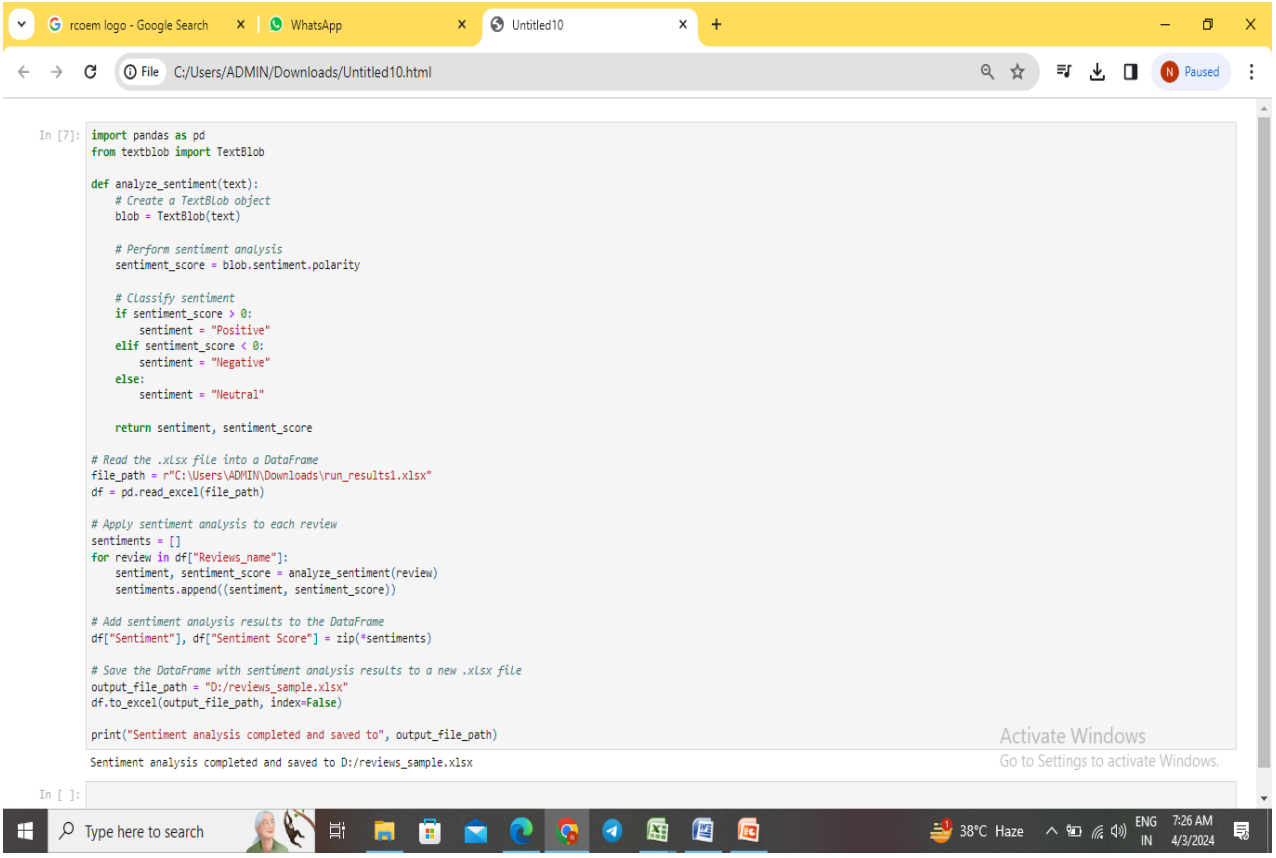


Fig 5.1: Sentiment Analysis python code

We applied sentiment analysis with web scraping by performing it on extracted data. For this, we used a few Python libraries:

1. textblob(): we convert the text into a TextBlob object and use a few of its text-processing utilities. However, we are only interested in the sentiment analysis. We can see that TextBlob provided two values for the sentiment analysis:

Polarity: A score between -1 and 1. A higher value means positive text, while a lower one means negative.

Subjectivity: A score between 0 and 1. A higher value means an opinionated text, while a lower one means factual information.

2. Pandas: A data analysis toolkit we'll use for analyzing the sentiment analysis data.

3.Sentiment analysis(): we use the sensitive analysis function to perform the sentiment analysis on the we got. It iterates over each review, converts it into a TextBlob and saves its raw polarity and subjectivity values with the human-readable text representation. Finally, we save the sentiment analysis result into D drive.

5.4 Output

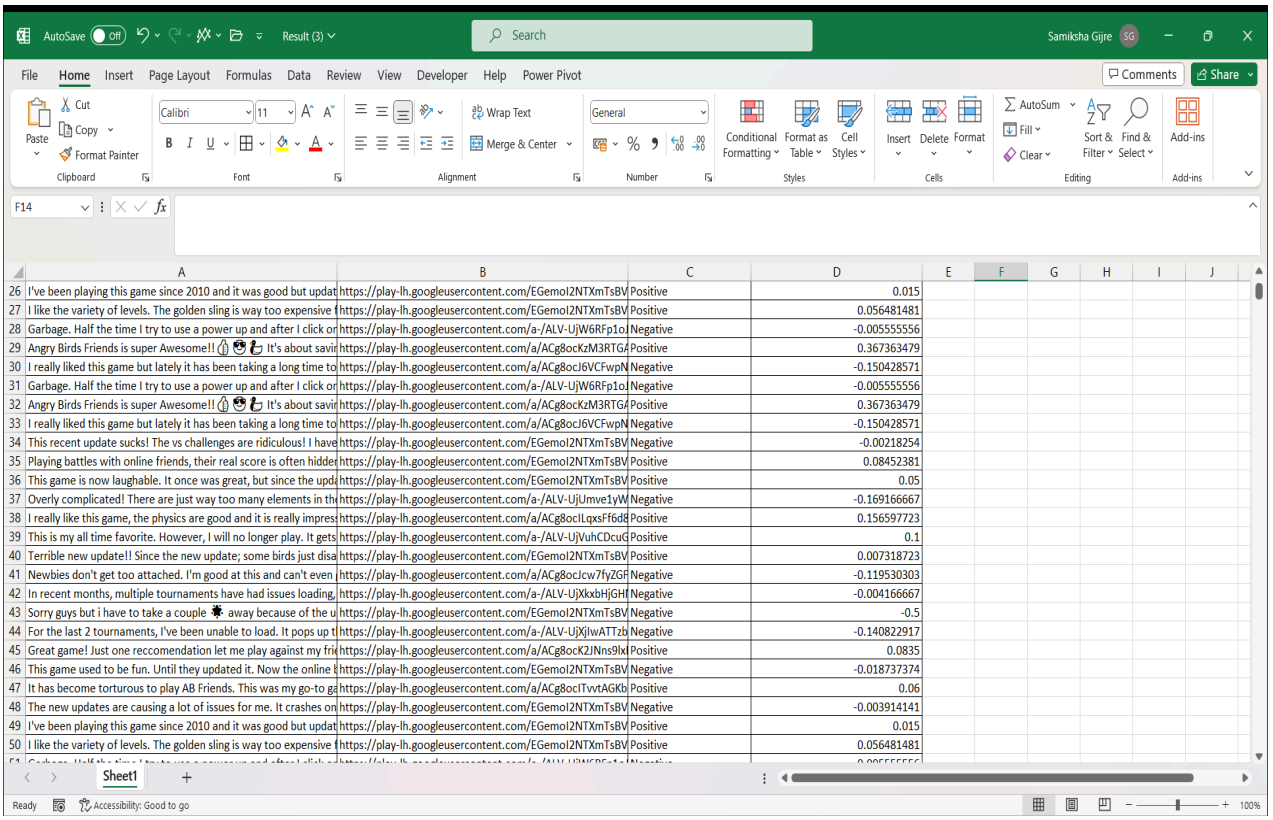


Fig 5.2: Output of Python code

CHAPTER V-CONCLUSION

In this mini-project Modelling User Experience Factors in Kids Mobile Gaming Application, we embarked on a journey to delve into the intricate realm of user experience factors in kids' mobile gaming applications, with a particular focus on the renowned game Angry Birds. Our approach involved a meticulous process of manual review collection, sentiment analysis utilizing Python programming in Jupyter Notebook, and insightful analysis of the obtained results.

By understanding and addressing the factors that impact player satisfaction, game developers can optimize game design to create more enjoyable and fulfilling experiences for young players. By continuing to explore and refine our understanding of user sentiments, we can contribute to the ongoing evolution of digital entertainment experiences, ensuring that they remain engaging, enriching, and accessible to young audiences worldwide.

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Apache Spark: An open-source distributed computing system that provides an interface for programming and processing big data. It offers fast data processing capabilities, support for various programming languages (including Python), and a rich ecosystem of libraries and tools.