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Sentiment Analysis on Amazon Reviews using Machine Learning Approach

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A B S T R A C T

The realm of sentiment analysis has been rapidly expanding in the field of computer science [1], making it difficult to keep abreast of all the activities within this domain [4]. Our research paper showcases the impact of opinion mining, text mining, and sentiment analysis on customer feedback reviews [2], which can significantly influence the public's perception of a particular product. Our study used online product reviews collected from diverse websites and conducted a comparative sentiment analysis of the retrieved data. To classify the reviews, we employed various models, including Naive Bayes and Decision Tree. Furthermore, we utilized recommendation engines, which are a specialized type of information filtering system that predicts a user's preferences or rating for an item. By understanding the customer's preferences, these engines can offer personalized results that cater to their needs.

Keyword: Amazon, Machine Learning, Product Recommendation, Reviews

1. Introduction

The mobile phone industry is experiencing rapid growth due to the burgeoning demand for smartphones. Consequently, it is imperative to conduct an extensive assessment of the phone's model and brand. The market comprises numerous brands, with some dominating and controlling a substantial part of the sector. Samsung and Apple are two globally renowned brands. E-commerce plays a significant role in augmenting mobile phone sales and shaping consumer purchasing tendencies. Reviews available on e-commerce platforms serve as an essential resource for consumers to make well-informed decisions. Online retail platforms, such as Amazon.com, offer diverse alternatives to reviewers for writing their reviews. [4] As there is an extensive range of products produced by various brands, providing pertinent reviews to consumers is crucial. The number of reviews associated with a product or brand is growing at an alarming rate, equivalent to managing enormous data. Categorizing reviews based on customer opinions into affirmative and negative delivers a sentiment perspective of the review, leading to better judgment. Thus, providing appropriate reviews to consumers is vital given the increasing number of products and reviews associated with them.[1][4]

2. Literature Survey

Sentiment Analysis for Amazon Reviews

Sentiment analysis has emerged as an increasingly popular research area in computational linguistics and text mining. Our study aims to investigate the relationship between Amazon product reviews and the corresponding product ratings provided by customers. We have employed various conventional machine learning algorithms like the Naive Bayes approach, Support Vector Machines, and the K-nearest neighbor method, along with advanced deep neural networks like Recurrent Neural Networks (RNNs) [4] to achieve our objectives. Through a comparative analysis of the results obtained from these techniques, we have obtained valuable insights into their respective advantages and disadvantages. Additionally, our discoveries can also serve as a useful supplement to other fraud detection approaches.

Amazon Review Classification and Sentiment Analysis

On Amazon, reviews aren't just about the product - they also pertain to the service rendered to customers. When the clients are provided with a clear segregation of product reviews and service reviews, decision-making is rendered simpler. In this document, we put forth a scheme that facilitates customer review classification by seeking out the review sentiment. We also execute a regulation-grounded extraction of product feature sentiment. Additionally, we furnish a display for summating our outcomes.

Sentiment Analysis of Product Reviews – A Survey

With the enlarging expansion of the web network, the clients produce an abundance of feedback in the form of social media posts, online portals, appraisals, evaluations, and reviews on a wide range of subjects like books, individuals, products, research, events, etc. While intended to be helpful, most of this user-generated content necessitates the use of sentiment analysis techniques. Sentiment Analysis is a discipline that deals with the study of feelings, opinions, and subjectivity of sentiments. This paper is a comparable exploration of several recently proposed algorithms' advancements and various sentiment analysis applications, primarily for product reviews. It highlights how sentiment analysis can be utilized to recommend products based on client reviews. The associated fields that have piqued the interest of experts lately are discussed. The main purpose of this literature review is to present a comprehensive analysis of sentiment analysis [3], its classification, and different types. This review paper provides an elaborate classification of recent research and also examines the present research trends in sentiment analysis and its associated fields. [3]

Sentiment analysis on large scale Amazon product reviews

In this modern era, the world is experiencing digitalization at an increasing rate. E-commerce has gained dominance in this digital world by bringing products to the customers' fingertips, eliminating the need to go out of their houses. As people increasingly rely on online shopping, the significance of product reviews has increased exponentially. A customer may need to sift through thousands of reviews to make an informed purchase decision. However, with the advent of machine learning, a model can be employed to analyze and classify these reviews, making the process much more efficient. In this study, we utilized a supervised learning approach on a large dataset of Amazon reviews to polarize them and obtain a satisfactory level of accuracy.

Sentiment Analysis on Amazon reviews

Opinion intel's vital for biz and makers. They wanna know what folks think of their goods and services pronto. But sifting through every post on a site by hand is not feasible. There's just too much data. That's where sentiment analysis comes in, allowing for cost-effective, large-scale data processing. To better understand the potential and drawbacks of this technology in the context of business, the author delves into the topic in this paper. Using Python and machine learning techniques like Naïve Bayes and logistic regression, a model was built to predict the sentiment of Amazon Alexa reviews. To deal with the unbalanced dataset, SMOTE was utilized, and AUC/ROC was used to compare and evaluate the effectiveness of the methods.

Opinion Mining and Sentiment Analysis for Amazon Product Reviews using Lexicon and Rule-Based Approach and Testing on Machine Learning Algorithms

As folks take to social media platforms like Twitter, Facebook, discussion forums, and blogs to voice their opinions, microblogging and text messaging have become the dominant means of expression over the internet. The viewpoints and attitudes of consumers towards the products they purchased are often expressed in Amazon reviews. The immense quantity of social content generated on Amazon presents opportunities for studying public opinion about various entities. In this study, we utilized Amazon data for sentiment classification, analyzing each review separately. We compared the words used in each review to those in other reviews that were previously labeled as "positive," "negative," or "neutral." [3] Using the likelihood of each possibility, the algorithm determined whether the text in the review had a positive, negative, or neutral sentiment. [3] The aim of this paper is to determine the sentiment of the text, categorizing it as positive, negative, or neutral, and to expand it to the intensity of polarity. We also employed this approach to identify significant features and examine the overall sentiment for each object using machine learning algorithms, such as Naïve Bayes and Support Vector Machines (SVM) [3].

3. Proposed System

Analyzing Amazon product reviews and generating valuable insights (positive and negative sentiments) to build a product recommendation engine is the main goal of our study. Our proposed methodology involves incorporating reflective aspects that are based on the product's attributes. We collect data from the Data World website and perform preprocessing tasks such as tokenization and stop-word removal from databases to extract valuable information such as positivity or negativity. The system for suggesting products based on the user's preferences is primarily driven by product similarity. When a user is browsing or searching for a particular product, similar products can be displayed, and new products can be recommended based on their preferences.

3.1 Advantages of Proposed System:

User friendly: The proposed system has been designed with the user's ease of use in mind, as it offers rapid data retrieval and storage while ensuring efficient data management. In addition, the inclusion of a graphical user interface makes the system more approachable and user-friendly. This interface enables users to interact with the system seamlessly and without difficulty.

Very less paperwork: The proposed system aims to reduce the amount of paperwork required by promptly digitizing all records for each field, thus enabling the generation of reports via computers. This approach also leads to a decrease in the need for hardware copies.

The proposed system includes computer operator control, which eliminates the possibility of errors. In addition, storing and retrieving information is made simple and straightforward, enabling speedy and timely completion of tasks.

4. Problem Statement

An important benefit of social media is its capacity to allow us to monitor favorable and unfavorable opinions regarding a specific brand or individual. As a company expands, it becomes progressively harder to manage the way in which people perceive the brand. For extensive organizations receiving thousands of daily mentions across social media platforms, news sites, and blogs, manual tracking of these comments becomes an arduous task.

To counteract this dilemma, the implementation of sentiment analysis software is imperative. These programs can be utilized to gauge public sentiment and emotional tone regarding a specific brand or individual.

4.1 Objective

- The proposed approach involves several steps, starting with the scrapping of product reviews from a range of websites, with a specific focus of Amazon.com.
- One of the critical steps in processing review data is to categorize and analyze it effectively [4]. This involves performing sentiment analysis at the document level, which enables us to identify the overall sentiment expressed in the reviews.
- The sentiment analysis aims to categorize or classify opinion sentiments into three categories, including positive, negative, and recommendations for the product to potential users.

5. Challenges

- The development of web technology has led to the availability of a vast amount of data online, primarily from social media platforms and online shopping websites.
- The data includes individuals' views and opinions on various subjects expressed through daily interactions, as well as evaluations and ratings on online shopping websites.
- Sentiment analysis is used to automate the analysis of such data, but the data undergoes several pre-processing techniques before the analysis.
- The pre-processing techniques include the identification of opinion data present in the reviews, followed by the classification of the data based on its polarity confidence - whether it is positive, negative, or neutral.
- Sentiment analysis can provide valuable insights into customer opinions and preferences, which can be used by businesses to make informed decisions and improve their products or services.

6. Existing System

The current system employs an approach based on the initial expansion of words to determine the sentiment process based on the topics they have adopted. In the initial iteration of the current system, a process of iteration is conducted where, for example, 100 comments are taken, and the methodology used in this study involves identifying the comments and adding them to the corresponding category for sentiment analysis [6]. This is done in an iterative process, where the most frequent words associated with positive or negative sentiment [6] are identified and added to the respective category [2]. However, this approach has limitations in terms of accuracy as it only considers the words immediately identified and does not take into account the words that may be left out in the comments.

6.1 Disadvantages of existing system

- The process takes up a significant amount of time
- The precision and correctness of the results obtained are relatively low

7. TECHNOLOGIES USED

7.1 SOFTWARE REQUIRMENTS

- The process takes up a significant amount of time
- The precision and correctness of the results obtained are relatively low
- Anaconda
- Jupyter Notebook

- Python Programming Language
- Machine Learning / Deep Learning
- Operating System: Windows/ Ubuntu/ MAC

7.2 HARDWARE REQUIREMENTS

- The minimum system requirements per user in terms of memory and disk space are as follows: 512MB of RAM, 1GB of disk space, and 0.5 CPU core.
- Intel Core i5 processor or higher.

7.3 Software and Language used

PYTHON

Python, a programming language, functions as an interpreted, high-level, and broadly applicable tool. Its inception traces back to 1991 when it was initially devised by Guido van Rossum, and it has since evolved into the most frequently utilized language for programming purposes. Python has been devised with a philosophy that prioritizes the significance of code readability by integrating significant whitespace as a central component. Moreover, Python provides structures that streamline programming on both a minor and major scale. In the system, the logistic regression mechanism has been incorporated through Jupyter, while the algorithm itself has been scripted using the Python language.

In due course, you'll most likely desire to store your Python scripts, or at the very least your function declarations, in a document that you produce and modify with a textual content redactor, then subsequently import it into Python. This conserves the labor of having to re-enter all the code each instance you execute it.

ANACONDA

Anaconda is a software package that merges the programming languages Python and R, aiming to streamline scientific computing tasks like data science, predictive analytics, large-scale data processing, and machine learning [1]. The objective of Anaconda is to provide a simple and efficient way to manage and deploy packages. It includes a collection of data science packages, and the Anaconda distribution comes with more than 250 packages pre-installed. Furthermore, Anaconda provides support for installing more than 7,500 open-source packages from PyPI, in addition to the conda package and virtual environment manager. Anaconda Navigator, a graphical user interface, is also available as an alternative to the command line interface. [1]

JUPYTER

Jupyter is an unfastened-source platform devised for designing software and allowing interactive computing in different programming languages. This online application authorizes users to initiate and distribute documents and live code, making it a prized instrument for tidying data, transformation, numerical simulation, statistical modeling, machine learning, and other utilities. One of the crucial gains of Jupyter is its proficiency to ease collaborative development of unfastened standards and utilities. We applied Jupyter to carry out our algorithm.

The Jupyter Notebook is a potent instrument for reciprocal computation [1], empowering users to fashion documents that contain real-time code, interactive widgets, diagrams, expository text, equations, images, and multimedia [1]. These documents yield a comprehensive and self-sufficient account of computations, which can be exported to an array of formats such as HTML, PDF, and Markdown [2]. Furthermore, these notebooks can be circulated among others through electronic mail, Dropbox, version control systems like Git and GitHub, or scrutinized online employing the nbviewer.jupyter.org website [2]. The Jupyter Notebook supports an assortment of programming dialects, encompassing Python, R, and Julia [3], and is extensively employed in scientific exploration, data scrutiny, and pedagogy [4].

Components

The Jupyter Notebook [7] integrates three elements:

The notebook web application: is a web-based interactive platform designed for producing and executing code interactively, as well as generating notebook documents [7]. This online application facilitates live coding, providing a collaborative environment that allows users to create, edit and share their code and computational outputs. The platform's interactive nature enables real-time code editing and execution, thereby streamlining the coding process. Furthermore, the application produces notebook documents that can be saved and shared with others.

Kernels: The notebook's web application launches distinct subprocesses that run the user's code in a designated programming language and return the results to the notebook's web application. The kernel also governs tasks such as computations for interactive widgets, tab completion, and inspection.

Notebook documents: A notebook document serves as an autonomous archive comprising a depiction of all content discernible within the Jupyter web application. This encompasses the inputs and outputs of calculations, expository text, equations, images, and multimedia illustrations of entities [7]. Each notebook document functions autonomously with its individual kernel, fostering separation and self-reliance.

HTML, CSS, JSCRIPT

These are the frequently employed languages for developing webpages. The user interface of the prediction system has been created using these programming languages. The website functions as an intermediary that receives input in the form of different constraints from users and passes them on to the program for processing

MACHINE LEARNING

Machine learning is defined as an artificial intelligence technique that enables systems to enhance their performance without explicit programming [3]. This research area aims to develop computer programs that can analyze data and alter their actions based on the knowledge acquired, without being explicitly instructed to do so.

The process of acquiring knowledge starts by obtaining observations or data, such as direct experience, examples, or instruction [3]. The objective of machine learning is to recognize regularities in data and utilize them to make sound judgments in the future based on the provided examples. The primary aim of machine learning is to enable computer systems to learn automatically and modify their actions accordingly without the necessity for human intervention or aid. There exist diverse techniques of machine learning. [3][5]

Machine learning algorithms [5] are frequently sorted into two categories: supervised or unsupervised. [3][5]

Supervised machine learning algorithms learn from labeled data to make predictions about new data based on past knowledge. These algorithms generalize from a known training dataset to make predictions about the output values. After the system is trained, it can provide outputs for new input. If the output is not correct, the learning algorithm can identify errors and adjust the model accordingly. There are several supervised machine learning algorithms that can be used for predictive modeling, such as linear regression, logistic regression, decision trees, random forests, and support vector machines (SVM). These algorithms are trained on labeled data to learn the patterns and relationships between input and output variables.[3][7]

unsupervised machine learning algorithms utilize a learning methodology that interacts with its environment through action execution and recognition of errors or rewards [1]. The primary characteristics of reinforcement learning are trial and error exploration and delayed gratification [2]. Examples of unsupervised machine learning algorithms include k-means clustering, hierarchical clustering, principal component analysis (PCA), independent component analysis (ICA), and autoencoders. This technique enables machines and software agents to autonomously determine the optimal behavior within a given context to maximize their performance [1]. The agent's proficiency in learning the best action is dependent on receiving simple feedback in the form of a reinforcement signal [2].

The field of machine learning [3] facilitates analysis of voluminous datasets. While it usually yields expedited and precise outcomes to spot lucrative prospects or precarious hazards, Incorporating machine learning with artificial intelligence and cognitive technologies can enhance its effectiveness in examining large volumes of data, although it may require additional time and resources to train it proficiently. [7][3]

8. System Design

8.1 System Architecture

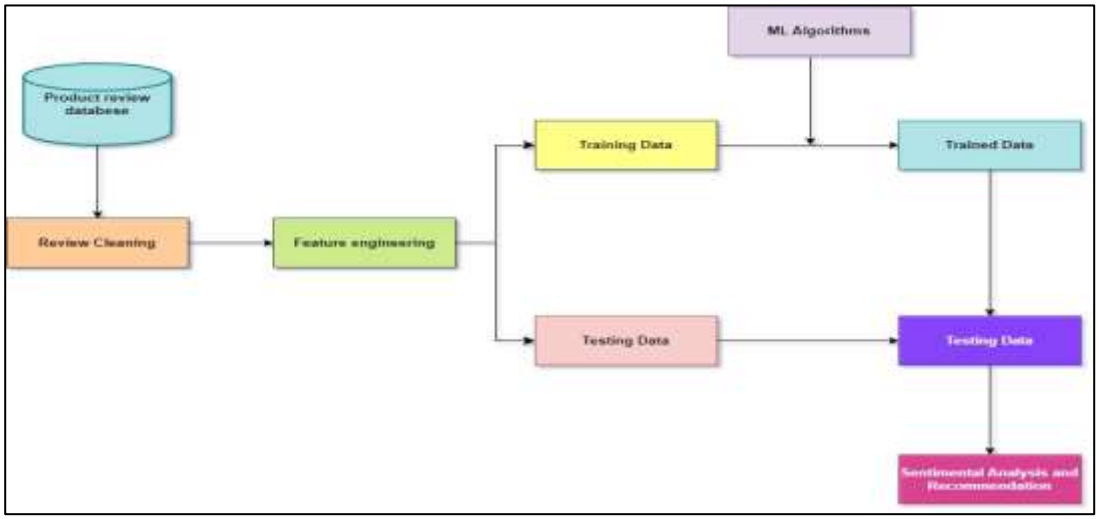

Fig. 1 – System Architecture of Product Reviews

DATA COLLECTION

The dataset sourced from data. World website comprises the Amazon corpus, which is a highly sought-after resource for data analysis. Amazon.com is renowned for its extensive collection of user feedback, and the dataset we have selected is a randomized sample of 28,000 such feedbacks. These reviews are ranked on a scale of 1 to 5, reflecting the quality of the products and services provided by Amazon.com. In order to conduct our sentiment classification experiments, we have segregated 1 and 2 as negative feedback and 4 and 5 as positive feedback. A rating of 3 is considered neutral, and we have extracted feedback accordingly. For our 3-polarity sentimental classification tests, we have designated 1 and 2 as negative, 3 as neutral, and 4 and 5 as positive. [7] For our 5-polarity emotion research, we have categorized 1 as significantly positive, 2 as negative, 3 as neutral, 4 as positive, and 5 as strongly positive. [7]

DATA PREPROCESSING

In the realm of real-world data, incompleteness, noisiness, and inconsistency are common issues that must be addressed. Proper handling of missing values is crucial to ensure accurate inferences can be drawn from the data. Failure to handle missing values appropriately can lead to inaccurate results that differ from those obtained when missing values are present. One common technique used in data preprocessing is to delete rows or columns that contain null values or a large percentage of missing values. However, caution must be exercised to prevent the introduction of bias and loss of critical information that could negatively impact the accuracy of the predictive output. Therefore, careful consideration must be given to the appropriate handling of missing values in order to ensure the validity and reliability of the results.[5]

DROP THE MISSIONG VALUE

One way to handle missing values in data is to apply a technique called imputation, which involves estimating the missing values based on available data. This method can be applied to a feature that has numerical data, such as the year column or the home team goal column. The mean, median, or mode of the feature can be calculated and used to replace the missing values. However, this method can introduce some variability into the dataset. Imputation is a statistical approach to handling missing data that is also known as data leakage during training. Another approach is to approximate missing values by using the deviation of neighboring values, which can work well for linear data. Using these methods can help mitigate the loss of data caused by missing values and improve the accuracy of predictions.

8.2 Dataflow Diagram:

1. A data flow diagram (DFD) is a graphical representation that illustrates the flow of data within an information system. This type of diagram is commonly used to depict the processing of data as part of a structured design. By presenting a clear and concise overview of how data moves through an information system, a DFD can be a valuable tool for understanding, analyzing, and improving system performance. It is customary for designers to draft a DFD [7][5]at the contextual level, which displays the relationship between the system and external entities. DFDs provide an overview of how data flows from external entities into the system, its movement between processes, and its logical storage. Only four symbols are employed to illustrate the components of a DFD
2. Squares symbolize extrinsic entities, which act as origins and termini of information that enter and exit the system. These entities can be human or non-human, and their interactions with the system are depicted in the data flow diagram. The external entities provide input to the system, and the system provides output to the external entities. These interactions can be physical or virtual in nature, and they are critical for the functioning of the system. By using squares to represent these entities, the data flow diagram provides a clear and concise visual representation of the flow of data within the system.
3. In the context of data flow diagrams, processes are illustrated using rounded rectangles. Other methodologies may refer to these processes as "Activities," "Actions," "Procedures," "Subsystems," or similar terms. Processes are responsible for taking input data, performing various operations on it, and ultimately producing an output.
4. Depicting the data flux are pointed projectiles, signifying either digital information or tangible entities. The transmission of data between data repositories sans a process is an implausible feat, and direct access to data stores by external entities is strictly prohibited.
5. The level three-edged parallelogram, serving as an icon for data repositories, ought to both acquire and furnish information to facilitate future processing.

8.3 LEVEL0 DATA FLOW DIAGRAM:

The Level0 DFD illustrates the partitioning of the system into sub-systems (i.e., processes) that handle one or more data streams originating from or destined for an external agent. These sub-systems work in tandem to deliver the entire gamut of system functionalities

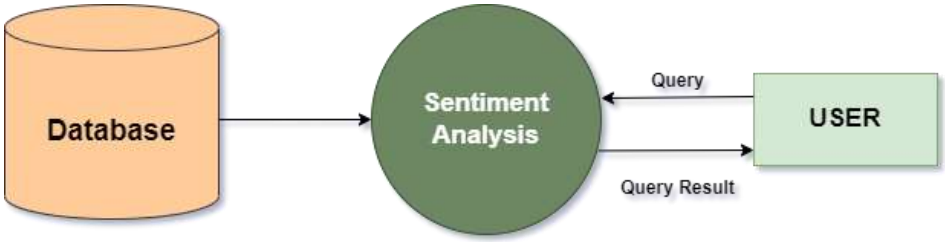

Fig. 2- LEVEL0 DATA FLOW DIAGRAM OF PRODUCT REVIEWS

The Figure 2 depicts the Level 0 DFD and identifies the necessary internal data repositories for the system to function. It also shows how data flows between different components of the system, and the intermediate nodes that facilitate the processes. Eventually, the system will provide the requested data output. The requesting node embodies the entire process in a concise and straightforward procedure. It consists of two nodes: the source node that transmits the data packet to the intended node, and the destination node that receives the packet and acquires the requested data.

8.4 LEVEL1 DATA FLOW DIAGRAM:

The Level 1 Data Flow Figure 3 involves selecting a file and transferring it to the server. The server receives the file details and generates a Message Digest. Once the MD file is created, it retrieves all the public keys associated with the user group. Then, it combines the MD and public key to generate a secure MD, which is then encrypted with the user's private keys to create a Ring-Signature. Finally, the server sends a mail to all users containing the Ring-Signature.

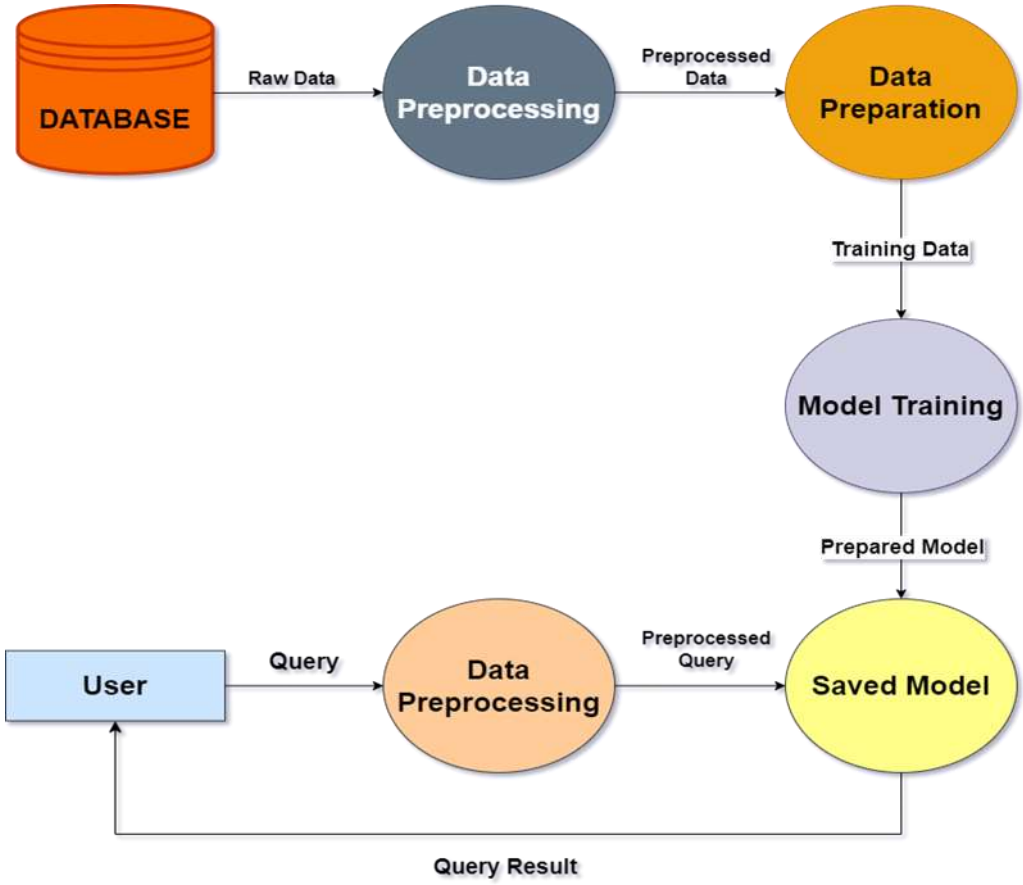

Fig. 3 – LEVEL1 DATA FLOW DIAGRAM OF PRODUCT REVIEWS

8.5 LEVEL2 DATA FLOW DIAGRAM:

Process involved in system design:

The procedural outline for designing our proposed web recommender application encompasses the subsequent stages:

I. Initiate the procedure

II. The active user presents a request to the system based on search criteria and visitor classifications such as lone, couple, or corporate.

III. The system conducts a search in its database for the prior users' data, comprising evaluations, positions, and commentaries that are akin to the request.

IV. The system sifts the request data by matching it with external web sources.

V. Should the request match, the system procures metadata.

VI. Next, the metadata is archived in a NoSQL database.

VII. In case the request does not align, it is discarded.

VIII. Steps 4-7 are repeated until all matched metadata is found. [7]

IX. Conclude the procedure.

9. Conclusion

Sentiment analysis is a process that involves the classification of text based on the emotions and attitudes conveyed within the text. The present study employs a conventional sentiment analysis model, which involves three primary stages: data preparation, review analysis, and sentiment classification [2]. The paper also details the methods used in each of these stages. Sentiment analysis is a rapidly advancing field in text mining and computational linguistics, and it has attracted significant attention in recent years [5]. Further research in this area should focus on the development of more sophisticated techniques for extracting opinions and product features, as well as novel classification models that can account for the ordered labels property in rating inference and product recommendation systems [2][7].

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