Research Article

Sentiment Analysis of Patient Reviews of Az-Zainiyah Clinic Services Using Neural Language Processing with the Naïve Bayes Method

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Abstract: In the research, the researcher evaluates analysis sentiment from review patients about services at the Az-Zainiyah clinic with the use Naïve Bayes method in Natural Language Processing (NLP). The dataset used consists of from review grouped patients become three categories of sentiment: positive, neutral, and negative. The Naïve Bayes model was trained and tested. To test its performance in classifying sentiment review patients. Research results show that the Naïve Bayes model achieves accuracy by 96%, Good macro average or weighted average shows high precision, recall, and f1-score values, around 0.97 and 0.96, respectively. These results show the effectiveness of the model in identifying sentiment review patients with high accuracy. Findings This gives valuable insights for increased quality services at the Az-Zainiyah clinic based on bait come back from patients, who in turn can increase satisfaction and experience patient.

Keywords: Naïve Bayes, sentiment analysis, patient reviews, clinical services, natural language processing

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1. Introduction

Quality health services are one of the main factors in improving the welfare and quality of life of the community. Az-Zainiyah Clinic, as one of the health service providers, strives to always provide the best service to its patients. However, to maintain and improve the quality of these services, the clinic needs to understand patient feedback accurately and precisely.

Patient reviews are one of the most valuable sources of data that can be used to evaluate the performance of services in a clinic. Through these reviews, patients can directly convey their experiences regarding various aspects of the service, such as the friendliness of the staff, the cleanliness of the facility, the speed of service, and the effectiveness of the treatment. However, given the increasing number of reviews, an effective method is needed to analyze these reviews automatically.

Sentiment analysis is one approach that can be used to evaluate patient reviews. This analysis aims to identify and categorize opinions expressed in text into positive, negative, or neutral sentiments. By using Natural Language Processing (NLP) techniques, the sentiment analysis process can be carried out more efficiently and accurately.

The Naïve Bayes method is one of the algorithms that is often used in text classification, including sentiment analysis. This method is known for its simplicity and its ability to provide good results even with a relatively small amount of training data. In the context of this study, the Naïve Bayes method will be used to classify patient review sentiments regarding services at the Az-Zainiyah Clinic. This study aims to collect and analyze patient reviews taken from Google Maps, process the data using NLP techniques, and classify review sentiments using the Naïve Bayes method. The results of this analysis are expected to provide valuable insights for Az-Zainiyah Clinic to improve the quality of its services.

Analysis sentiment is a technique used for extracting information from text data using method processing Language Natural (NLP) and learning machines. Some studies previously have done analyses deeply related to sentiment review service health. A study (Wardani & Erfina, 2021) titled "*Analysis of Public Sentiment Towards Service Doctor Consultation Using Naive Bayes Algorithm*" explained related system service health in Indonesia at the moment, but, there are several shortcomings that still exist many are found, including timetable inspection from the only doctor short and many queue patient. The presence application of service consultation doctors makes it easier to consult about health, services consultation doctors are one alternative in supporting health in the future covid 19 pandemic. Because of the many user service consultation doctors like *halodoc* app, *alodokter* and *click doctor* Comment public to service application This be one of consideration for user For know service application consultation best, according to nudge Twitter users.

Research This aims To analyze the sentiment public to user application service consultation doctor using the naive Bayes algorithm on Twitter. Research furthermore done by(Sri Widagdo et al., n.d.) with the title "*Analysis sentiment to Health services based on Google Maps review using BERT"* explains related utilization technology has developed in various fields of science without except Health sector. Hospitals, clinics, or Health clinics are part of the forced health sector and must keep going and develop adapted standards from Health Services. With the existence of standard Health services, measurement related to satisfaction with the patient or user service becomes something necessary to measure using sentiment analysis. One of the media that becomes a receptacle giving opinion to provider Health services is Google Maps. However, the anomaly between review and text given is sometimes Not correlated so that, utilization analysis sentiment use branch science intelligence artificial is Natural Language Processing (NLP) becomes effective way in conclude opinion.

Research conducted by researchers concluded that the BERT model indobenchmark /indobert-base-p1 own good performance in the use of classification text Indonesian language with a dataset of 4228 data after the preprocessing process at the beginning of the data collection process getting 4748 data. A dataset is shared into 3 data, namely training data, validation data, and test data with a ratio of 70:30:30. Research This writer with Name (Muktafin et al., 2020) with the title " *Sentiment Analysis on Reviews Purchase Products in the Shopee Marketplace Using The Natural Language Processing Approach*" explains related review products in the marketplace are valuable information if processed with good. Sellers can do an analysis review of product to get information that can used in the evaluation of products and services. Activities analysis review product No Enough with see amount star, required to see all over Contents comment review For can know Meaning from review. If in amount A little can done manually, but in amount Lots more effective use system. Required capable system analyze Lots review with effective to make it easier in understanding Meaning review.

Moreover, this Research uses KNN and TF-IDF algorithms with an NLP approach to classify review "*instant hijab*" products into 2 classes (positive and negative). Classification using the NLP approach gets an accuracy of 76.92%, precision of 80.00%, and recall of 74.07%, while without NLP only gets an accuracy of 69.23%, precision of 80.00%, and recall of 64.52%. Frequently used words that appear in the review can describe evaluation buyers in a way common to products. In reviews of positive shows, the buyer was satisfied with the quality, speed of shipping, and price of goods, while in the review negative buyer was disappointed in the color, and quantity of items shipped not the same as what was ordered.

2. Theory

2.1 Sentiment Analysis

Sentiment analysis is natural language or phraseology used to track public opinion about events. Sentiment analysis focuses on sentiment analysis and display of text comments which aims to automatically analyze mood images related to social atmosphere, emotions, and issues. Sentiment analysis aims to identify the polarity of opinions whether positive, negative, or neutral. (Da et al., 2022)

2.2 Patient Reviews

This review data is usually used as a measure of customer satisfaction and as a source of information about services and features that need to be improved by the service provider (Adhiatma & Qoiriah, n.d.). Popular online platforms for providing patient reviews are specialty health websites, health apps, and medical discussion forums. These patient reviews cover a variety of aspects, including opinions regarding the quality of care, relationships with medical staff, effectiveness of treatment, wait times, and comfort of facilities. Patient reviews describe the patient's views, assessments, and feelings regarding the services they receive.

2.3 Natural Language Processing (NLP)

The NLP system must pay attention to the regulation of the language itself, including the words used, how the words combine to form sentences, the meaning of words, the function of words and sentences, and so on. Language and other things which have a very important role and which must be taken into account are the ability to understand people, and the ability to understand is obtained based on knowledge acquired continuously in life. (Dwijayanti , M., Hasan, et all., 2021).

2.4 Naïve Bayes Method

Naive Bayes is a method that has no rules and uses 3 branches of mathematics called probability theory to obtain the highest probability by looking at the frequency or number of occurrences of each classification in the training data. For database development, Naive includes Bayesian supervised mass learning and requires samples as label training data. (Khoirul et al., 2023) The Naive Bayes approach was used for data analysis. It is a basic probabilistic classifier that uses Bayes' theorem with high independence assumptions. The Naive Bayesian approach has the advantage of only using a small amount of training data to obtain parameter estimates needed for the classification process. Therefore, regardless of the independent variables considered, only the variance of the class variable is needed to determine classification, not the entire class variable.

2.5 Google Colab

Google Colab or Google Colaboratory, is a cloud platform provided by Google for running and compiling Python code through programs without requiring any additional settings. The platform leverages Google's cloud infrastructure and gives developers access to free GPUs and TPUs (tensor processing units) in a powerful development environment. With collaboration features that allow clients to share notebooks and work together progressively, Google Colab has become a popular choice for engineers, specialists, and students to run their Python projects. Google Colab makes collaboration easier by allowing users to share notebooks directly with others. The platform is accessible via a web browser, requires no additional software installation, and leverages Google's cloud infrastructure. Developers, researchers, and novice programmers can run Python projects on this platform without worrying about setting up hardware. (Nazar, 2024)

3. Method

3.1 Research Paradigm

This study uses a quantitative paradigm with an experimental approach to test the performance of the Naive Bayes algorithm in sentiment analysis of patient reviews. The quantitative paradigm is a research approach that emphasizes the measurement and analysis of numerical data to understand a particular phenomenon. This approach aims to test hypotheses and generate generalizations that apply to a wider population.

In the context of this study, a quantitative paradigm is used to evaluate the performance of the Naive Bayes algorithm in classifying patient review sentiments on Az-Zainiyah clinic services collected from Google Maps. The quantitative approach was chosen because it can provide objective and measurable results, which are important in determining the effectiveness of the Naive Bayes algorithm. Using numeric data from patient reviews, researchers can perform statistical analysis that allows for the evaluation of algorithm performance based on metrics such as accuracy, precision, recall, and f1-

score. This approach also allows for replication and validation of research results, which is important in ensuring the reliability and validity of findings.

3.2 Research approach

This research approach uses a quantitative method with deep learning-based sentiment analysis. This method was chosen because the focus of the research is on the use of the Naive Bayes model to classify patient review sentiments regarding Az-Zainiyah clinic services.

The research stages include several steps. First, data collection was carried out through web scraping techniques from the Google Maps application with keywords related to the Az-Zainiyah clinic, resulting in 150 datasets. Second, the collected data was processed to ensure quality and consistency through several preprocessing stages, including case folding to convert all text to lowercase; tokenization to break sentences into separate words; stopword removal to remove common words that do not have significant meaning; and stemming to change words to their basic form.

After preprocessing, the data is labeled using Vader lexicon, a rule-based lexical tool designed for sentiment analysis in social media. Vader Lexicon assigns a sentiment score to each review based on the polarity of the words contained in the text. After the data is labeled, TF-IDF (Term Frequency-Inverse Document Frequency) weighting is used to transform the review text into a numeric representation that can be analyzed by machine learning algorithms. TF-IDF measures the importance of a word in a document relative to a collection of documents (corpus).

The dataset is divided into 80% for training and 20% for testing. The Naive Bayes model is trained with the pre-processed training data and then tested with the testing data to evaluate the performance. The evaluation is carried out using the accuracy, precision, recall, and F1-score metrics to measure the extent to which the model can classify sentiment correctly. The evaluation results show the performance of the Naive Bayes model in sentiment analysis based on evaluation metrics to determine the effectiveness of the model in classifying patient review sentiment.

The research data consists of primary data taken from the Google Maps application related to the Az-Zainiyah clinic through web scraping and secondary data that includes literature and references related to sentiment analysis methods, Naive Bayes models, and text data preprocessing techniques. The source of research funding comes from personal funds and support from supervisors at Nurul Jadid University, which is used for the publication of scientific articles in accredited journals as well as for data access costs and computing tools needed in the research.

This research approach integrates several interrelated stages to ensure comprehensive and accurate sentiment analysis. From data collection to algorithm performance evaluation, each stage is designed to address challenges that arise in text analysis and provide useful insights for Az-Zainiyah clinic developers. This approach is expected to help improve the quality of clinic services based on more structured and informative patient feedback.

3.3 Research Stages

This research was conducted through several stages, namely data collection, data processing, data labeling, data sharing, training data, testing data, and Naïve Bayes classifier. The detailed research stages can be seen in Figure 1.

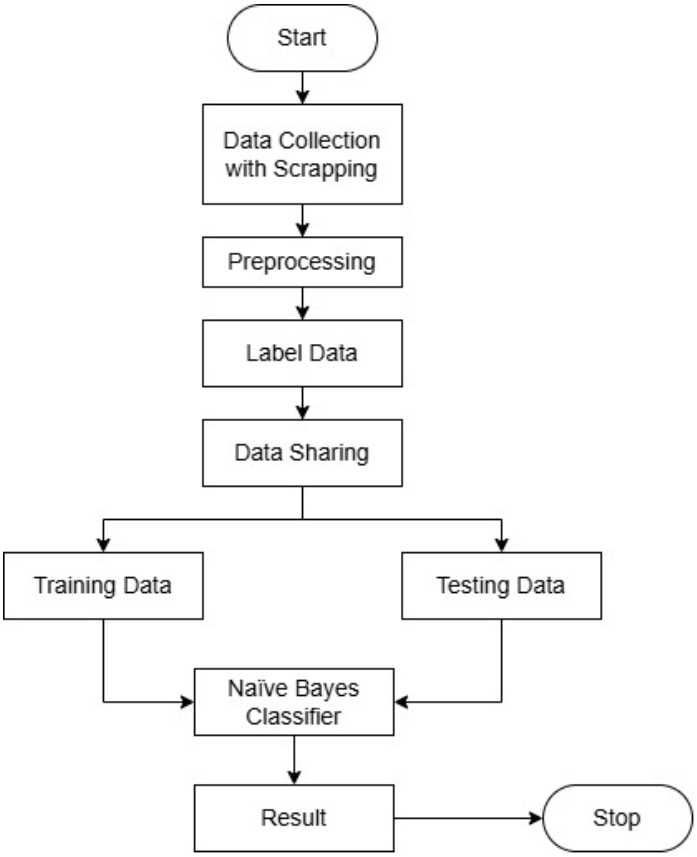

Figure 1. Research Stage

3.3.1 Collecting Data by Scrapping

The data of this study were collected from online sources including review platforms such as Google Maps on the official website of Az-Zainiyah Clinic. This data was collected from 150 user reviews who have used Az-Zainiyah Clinic services and also obtained from Google Maps. Data collection was carried out using the Google Maps API and scraping techniques. Automatically retrieve patient reviews from data source websites using scraping technology. The scraping script was developed using the Python programming language using the BeautifulShop and Request libraries.

3.3.2 Preprocessing

After the patient research data is collected, a data preprocessing process is carried out to remove noise from the text and convert it into a format that can be processed by the NLP algorithm. Preprocessing steps include tokenization, punctuation removal, text normalization, and stopword removal.

3.3.3 Label Data

After all the data is cleaned with the word processor mentioned above, the next step is to label the data. If the process is done by reading each review individually and seeing words that contain sentiment, they are marked as negative sentiment and vice versa, if there are words of praise, they are marked as positive emotions.(Khoirul et al., 2023)

3.3.4 Data Sharing

After data collection is complete, the data is divided into 3 groups, namely training data, validation data, and test data. Training data consists of 70% of the total, which is 105 data collected and used to train the Naive Bayes model. Test data and validation data each represent 15% of the total, which is 22 data (rounded up from

22.5), and are used to evaluate model performance during the training process and to test model performance after training is complete.

3.3.5 Training Data

Training data consisting of 105 reviews was used to train the Naive Bayes model to analyze patient review sentiments towards Az-Zainiyah Clinic services using Natural Language Processing with the Naive Bayes method.

3.3.6 Testing Data

The test data consists of 22 reviews randomly sampled from the collected data sources. This check is not used during the model training process. However, it is used to test the model's performance after training is complete. This test data is important to assess how well the model generalizes and accurately predicts sentiment from previously unheard patient reviews.

3.3.7 Naïve Bayes Classifier

The naïve Bayesian approach has the advantage of using only a small amount of training data to obtain the parameter estimates required for the classification process. Therefore, regardless of the independent variables considered, only the variance of the class variable is required to determine the classification, not the entire class variable. Pebdika, A., Herdiana, R., & Solihudin, D. (2023) The main process supporting this research involves collecting data from online sources, namely Google Maps, and Az-Zainiyah Clinic. The collection of emotions obtained from Google Maps Az-Zainiyah Clinic is categorized into positive emotions, negative emotions, and neutral emotions.

4. Result and Analyzes

4.1 Research Results

This study uses a dataset of 150 data taken through web scraping techniques from the Google Maps application related to the Az-Zainiyah clinic. From the total data collected, there is a significant proportion of neutral sentiment compared to positive and negative sentiment.

The preprocessing process is carried out to clean and prepare the data so that it is ready to be used in the Naive Bayes model. Preprocessing steps include case folding to change all text to lowercase; tokenization to break sentences into separate words; stopword removal to remove common words that do not have significant meaning; and stemming to change words to their basic form. After preprocessing, the data is labeled using Vader lexicon, a rule-based lexical tool designed for sentiment analysis in social media. Vader Lexicon assigns a sentiment score to each review based on the polarity of the words contained in the text.

The results of this study show a comparison of the performance of the Naive Bayes model in classifying patient review sentiments towards Az-Zainiyah clinic services. The evaluation was conducted to assess the effectiveness of the model in classifying patient review sentiments. These results were measured using several performance metrics, namely accuracy, precision, recall, and f-measure. The Naive Bayes model showed good performance results in all measured metrics.

The results of this study indicate that the Naive Bayes model can consistently provide good performance in patient review sentiment analysis, with accuracy, precision, recall, and f-measure indicating the effectiveness of the model in classifying review sentiment accurately.

4.2 Research Discussion

4.2.1 Data Collection

Patient review data was collected using scraper technology that takes information directly from Google Maps review pages related to Az-Zainiyah Clinic. This data is stored in CSV format and used as a basis for sentiment analysis. Data is divided into 3 categories, namely positive, negative, and neutral. In the data collection process,

data was pulled from Google Maps, 150 data were taken with details of 105 training data and 22 data each for validation and test data.

4.2.2 Data Pre-Processing for Sentiment Analysis

Before applying the Naïve Bayes method, patient review data is processed through a preprocessing step to optimally compile the text, the process is as follows:

a. *Case folding*: at this stage, all letters in the text are changed to lowercase. This aims to eliminate differences in meaning caused by differences in capitalization.
b. *Tokenization*: at this stage, the evaluation text is broken down into individual tokens or words.
c. *Remove stop words*: At this stage, words that do not have significant meaning, such as "and", "the", "this" and "that", are removed from the text.
d. *Stemming*: changing a word to its base form to reduce word variation.

	ulasan.1	case_folded_column	tokenize	filtering/stopword removal	stemming_data	preprocessed_review	label
0	Pelayanan di klinik sangat nyaman dari segi te...	pelayanan di klinik sangat nyaman dari segi te...	['pelayanan', 'di', 'klinik', 'sangat', 'nyama...	['pelayanan', 'klinik', 'nyaman', 'segi', 'yng...	layan klinik nyaman segi yng bersih asri jugaa...		positif
1	Pelayanan sangat baik	pelayanan sangat baik	['pelayanan', 'sangat', 'baik']	['pelayanan']	layan		positif
2	Pelayanan sangat baik dan obatnya ampuh	pelayanan sangat baik dan obatnya ampuh	['pelayanan', 'sangat', 'baik', 'dan', 'obatny...	['pelayanan', 'obatnya', 'ampuh']	layan obat ampuh		positif
3	Pelayanan bagus, cepat , tanggap,. Oabtnya jug...	pelayanan bagus, cepat , tanggap,. oabtnya jug...	['pelayanan', 'bagus,', 'cepat', ',', 'tanggap...	['pelayanan', 'bagus,', 'cepat', ',', 'tanggap...	layan bagus cepat tanggap oabtnya mutu keren deh		positif
4	pelayanan sangat baik dan obatnya ampuh	pelayanan sangat baik dan obatnya ampuh	['pelayanan', 'sangat', 'baik', 'dan', 'obatny...	['pelayanan', 'obatnya', 'ampuh']	layan obat ampuh		positif

Figure 2. Preprocessing Results

4.2.3 Implementation of Naïve Bayes Method for Sentiment Analysis

The naïve Bayes method in this context is used to classify patient reviews into different sentiment categories such as negative, positive, and neutral. The "naïve" approach assumes that each feature (word in the text) is independent of each other. Implementation step of text vectorization: before training the model, the validation text is converted into a numeric representation using the CountVectorizer technique.

1. *Model Training*
   After vectorization, the processed training data is used to train the naïve Bayes model.
2. *Model Evaluation*
   The trained model is evaluated on previously unseen test data. This evaluation includes measuring performance metrics such as accuracy, precision, recall, and f1-score for each specified category.

4.2.4 Interpretation of Results

Based on the results of the analysis of patient review data using the naïve Bayes method, several sentiments were obtained regarding the Az-Zainiyah Clinic's services.

a. Positive Sentiment

Positive reviews indicate that patients are satisfied with the quality of services provided by Az-Zainiyah Clinic, the friendliness of the medical staff, and the effectiveness of the treatment. Most positive reviews emphasize the comfort of the facilities and the cleanliness of the waiting room.

b. Neutral Sentiment

Neutral reviews contain helpful comments without strong emotional expressions, either positive or negative. They often contain constructive suggestions for improving the service, and there is no evidence of significant dissatisfaction.

c. Negative Sentiment

These reviews offer constructive feedback to improve service, while not showing any obvious disappointments. These suggestions focus on efforts to better meet customer expectations.

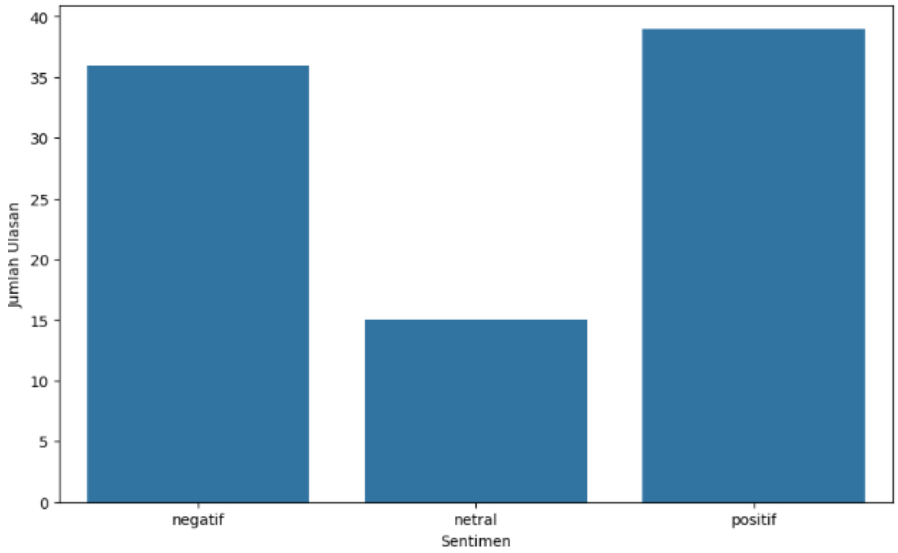

Figure 3. Sentiment Distribution in Dataset

Figure 3 shows the distribution of feelings or sentiments in the collection of reviews. From the figure, it can be seen that neutral feelings are the most numerous, followed by positive and negative feelings.

4.3 Model Performance Metrics

In this study, the evaluation of sentiment analysis techniques using patient reviews of clinic services shows that the trained naïve Bayes model can provide quite good results with an accuracy of 96%. Both the macro average and the weighted average show high precision, recall, and f1-score values, around 0.97 and 0.96, respectively. This indicates that this model can be an effective alternative for conducting sentiment analysis on patient reviews of clinic services.

Table 1. Results of text classification model evaluation

Actual Values	Precision	Recall	F1-score	Support
Negative	0.90	1.00	0.95	9
Neutral	1.00	1.00	1.00	5
Positive	1.00	0.92	0.96	13
Accuracy			0.96	27
Macro avg	0.97	0.97	0.97	27
Weighted avg	0.97	0.96	0.96	27

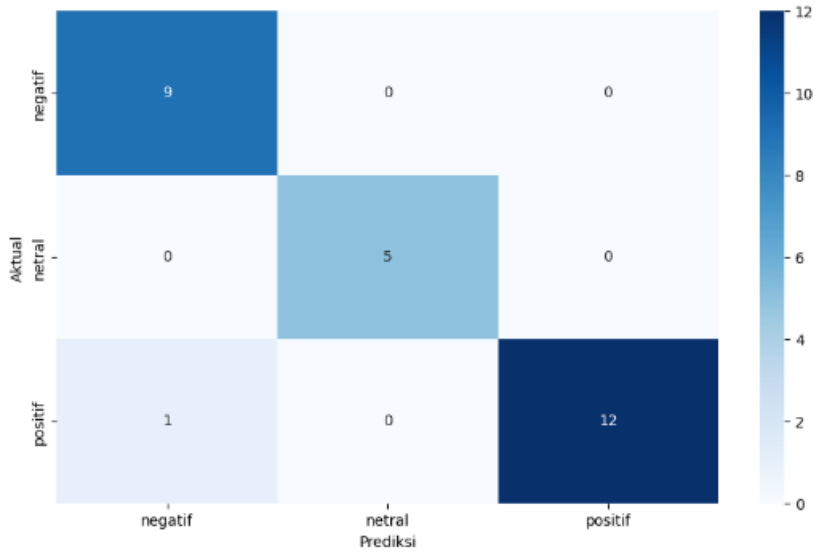

Figure 4. Confusion Matrix results

Figure 4 shows the performance of the classification model in distinguishing between types between different classes. This matrix consists of rows and columns that represent different classes. Each cell in the matrix shows the number of model predictions for a particular class that belongs to a different class. The main diagonal of the matrix shows the number of correct predictions, while the cells outside the diagonal show the number of incorrect predictions. From the figure, it can be seen that the classification model in this figure has quite good performance. This can be seen from the number of correct predictions (in the main diagonal) compared to the number of incorrect predictions (outside the diagonal).

5. Conclusions

Based on the evaluation metrics provided for the sentiment analysis model using patient reviews of clinic services, the Naïve Bayes model demonstrates strong performance: The model achieved an accuracy of 96%. The macro average and weighted average values for precision, recall, and F1-score are all around 0.97 and 0.96, indicating high performance. Specifically, the model's precision, recall, and F1-score for predicting negative sentiments were 0.90, 1.00, and 0.95, respectively. For neutral sentiments, the model achieved a perfect precision, recall, and F1-score of 1.00. For positive sentiments, the precision was 1.00, the recall was 0.92, and the F1 score was 0.96. Overall, these metrics suggest that the Naïve Bayes model can effectively perform sentiment analysis on patient reviews of clinic services, making it a suitable choice for this task.

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Additional Information: No Additional Information from the authors.

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