



UBMK'25

**Bildiriler Kitabı
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Editör Eşref ADALI

**10. Uluslararası Bilgisayar Bilimleri ve
Mühendisliği Konferansı**

**10th International Conference on
Computer Science and Engineering**

17-18-19 Eylül (September) 2025 İstanbul - Türkiye



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Bu elektronik kitabın içinde yer alan tüm bildirilerin telif hakları IEEE'ye devredilmiştir. Bu kitabın tamamı veya herhangi bir kısmı yayıncının izni olmaksızın yayımlanamaz, basılı veya elektronik biçimde çoğaltılamaz. Ters davranışta bulunanlara ABD Telif Hakkı Yasalarına göre ceza uygulanır.

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UBMK'2025'ye Hoşgeldiniz

Welcome to UBMK'2025

Sevgili Katılımcılar:

UBMK uluslararası nitelikli konferans serisi, 1990 yılından beri düzenli olarak yapılmakta olan Bilgisayar Mühendisliği Bölüm Başkanları toplantılarında alınan bir kararla on yıl önce başlamıştır. Konferansın 10.su IEEE-UBMK-2025 bu yıl 17-18-19 Eylül, 2025 günlerinde İstanbul Teknik Üniversitesinin ev sahipliğinde düzenlenmiştir.

IEEE-UBMK-2025 konferansına bu yıl Almanya, Amerika Birleşik Devletleri, Azerbaycan, Fransa, Irak, İngiltere, İsveç, İtalya, Kanada, Kazakistan, Kırım, Kırgızistan, Rusya, Özbekistan, Tataristan, Tayland, Ürdün ve Türkiye'den 610 dolayında bildiri gönderilmiş ve bu bildiriler Türk ve yabancı 250 hakem tarafından değerlendirilmiştir.

Her bildiri en az iki hakem tarafından incelenmiş ve uzlaşma olmadığı durumlarda üçüncü bir hakemin değerlendirmesine başvurulmuştur. Bildiri başına düşen ortalama hakemlik 2,3 olmuştur. Bu değerlendirmelerin sonunda 327 bildirinin sözlü olarak sunulması uygun bulunmuştur. Kabul edilen ve sunulan bildiriler içerik ve kalite ölçünlerini sağlaması durumunda IEEE Xplore'da yayımlanacaktır.

Konferans çalışmalarında, Bilgisayar Mühendisliği Bölüm Başkanları Danışma Kurulu olarak görev almışlardır. Bildirilerin değerlendirilmesi Bilim Kurulu üyeleri tarafından yapılmıştır. Konferansın düzenlenmesi ise Yürütme Kurulunun önerileri doğrultusunda, Düzenleme Kurulu tarafından yapılmıştır.

Son olarak, konferansın başarılı bir şekilde yürütülmesi için tüm olanaklarını sunan İstanbul Teknik Üniversitesi Rektörü Sayın Prof. Dr. Hasan Mandal'a teşekkür ediyoruz. Ayrıca Düzenleme Kuruluna, bildirileri titizlikle değerlendiren Bilim Kurulu Üyelerine ve değerli araştırmalarının sonuçlarını bilişim camiası ile paylaşan bildiri sahiplerine teşekkürlerimizi iletiriz.

Prof. Dr. Eşref ADALI
UBMK-2025 Konferans Başkanı ve Bildiri Kitabı Editörü

Dear Participants:

The UBMK international conference series started nine years ago with a decision taken at the Computer Engineering Department Heads (BMBB) meetings, which have been held regularly since 1990. The 10th edition of the conference, UBMK'25, was held this year on October 17-18-19, 2025, hosted by İstanbul Technical University.

This year, approximately 610 papers were submitted to the IEEE-UBMK-2025 conference from Germany, the United States, Azerbaijan, France, Iraq, the United Kingdom, Sweden, Italy, Canada, Kazakhstan, Crimea, Kyrgyzstan, Russia, Uzbekistan, Tatarstan, Thailand, Jordan, and Turkey, and these papers were evaluated by 250 Turkish and foreign referees.

Each paper was evaluated at least by two referees, and in cases where there was no consensus, a third referee was consulted. At the end of these evaluations, 327 papers were accepted for oral presentation. Accepted and presented papers will be submitted for inclusion into IEEE Xplore subject to meeting IEEE Xplore's scope and quality requirements.

During the conference, Heads of Information Engineering Departments took part in the Advisory Board. The evaluation of the papers was made by the members of the Scientific Committee. The conference was organized by the Organizing Committee in line with the recommendations of the Executive Committee.

Finally, we would like to thank İstanbul Technical University Rector Prof. Dr. Hasan Mandal for his continued support for the success of the conference. In addition, we would like to thank the Organizing Committee, the Scientific Committee Members who carefully evaluated the papers, and the owners of the papers who shared the results of their valuable research with the informatics community.

Prof. Dr. Esref ADALI
UBMK'25 Conference Chair and Proceedings Editor

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Stages of Sentiment Analysis of Uzbek Texts Using the ABSA Method

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Abstract—Aspect-Based Sentiment Analysis (ABSA) is one of the most actively studied directions in Natural Language Processing (NLP) today, as it enables a deeper understanding of user opinions. The volume of user-generated content on social media is vast, and manually analyzing such data requires substantial time and effort. Traditional sentiment analysis provides a general sentiment score for the entire text, which may overlook some important details and specific opinions. In contrast, ABSA identifies and evaluates each aspect mentioned in the text individually, allowing for a more fine-grained sentiment interpretation. This paper presents the global significance of ABSA, its stages of development, and the theoretical foundations for its application to texts written in the Uzbek language. Considering that ABSA research in Uzbek is still in its early stages, the focus of this study is primarily theoretical. It aims to systematically describe the ABSA process adapted to the linguistic characteristics of the Uzbek language. Each stage of the ABSA pipeline directly influences the overall performance and accuracy of the system. In particular, the complexity of Uzbek morphological structures, the language's free word order, and the frequent use of idioms and metaphors in context require customized analytical approaches. In such cases, it becomes essential to develop models tailored to the unique linguistic features of Uzbek.

Keywords—NLP, ABSA, stemming, lemmatization, lexicon-based method, machine learning-based method, hybrid approach, BERT, RoBERTa, XLM-R, mBERT.

I. INTRODUCTION

With the advancement of information technologies, a large volume of user opinions, comments, and reflections is expanding on the internet. These opinions express issues or viewpoints related to product or restaurant reviews, healthcare services, or educational platforms. Extracting these opinions and analyzing whether they are positive, negative, or neutral through sentiment analysis is one of the pressing issues in the fields of linguistics and natural language processing (NLP). Currently, various scientific studies are being conducted on sentiment analysis of texts in the Uzbek language. For instance, models for classifying Uzbek texts into binary and multi-class types for sentiment analysis have been explored

[1]; classification criteria for Uzbek texts in sentiment analysis have been proposed [2]; methods of filtering opinions using automated sentiment analysis systems based on social media comments have been described [3]; and the challenges of sentiment analysis of Uzbek texts have been examined [4].

The rich morphology of the Uzbek language, the abundance of synonyms, and the fact that certain expressions can be used in both negative and positive contexts present some challenges in accurately conducting sentiment analysis. Considering these linguistic characteristics, performing sentiment analysis of Uzbek texts step by step is a pressing scientific and practical issue today. This process is not only beneficial for academic research but also plays an important role in improving quality indicators in the commercial sector and enhancing the efficiency of public services by analyzing public opinion.

Today, sentiment analysis and its various forms are presented in multiple ways across the literature. As illustrated in Figure 1, Mayur Wankhade classifies sentiment analysis into several levels. [5]:

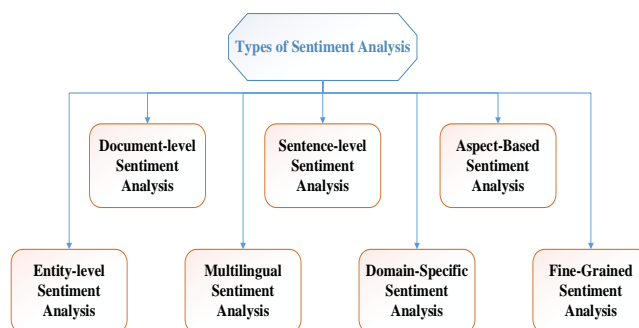


Fig. 1. Types of Sentiment Analysis

The main types of sentiment analysis, along with their descriptions and limitations, are summarized in Table I.

TABLE I. KEY CHARACTERISTICS OF SENTIMENT ANALYSIS TYPES

Type	Description
Document-level Sentiment Analysis	In this type, individuals express their opinions in large volumes on a specific topic, and regardless of the number of sentences in the text, a single overall sentiment label (positive, negative, or neutral) is assigned to the entire text. One of the main drawbacks of this type of sentiment analysis is that, even if both positive and negative opinions are present within the text, it still produces a single final sentiment judgment.
Sentence-level Sentiment Analysis	In this type of analysis, each sentence within a text is analyzed separately. Compared to document-level sentiment analysis, this approach is considered more accurate and precise. However, if a sentence is compound and its clauses express differing sentiments—one positive and the other negative—the analysis may produce incorrect results. For example, in the sentence “The food at this restaurant is very delicious, and the prices are also affordable, which made me happy,” both clauses express positive sentiment, so the sentiment evaluation is correct. However, in the sentence “The restaurant’s food is very tasty, but the service quality is quite poor,” because there are two opposing sentiments, the final result may be inaccurate.
Aspect-Based Sentiment Analysis	This method avoids the shortcomings of sentence-level sentiment analysis, as it analyzes each aspect mentioned in the sentence along with its associated sentiment. In the sentence “The restaurant’s food is very tasty, but the service quality is quite poor,” for instance, <i>food</i> is the aspect, <i>tasty</i> is the positive sentiment; <i>service quality</i> is another aspect, and <i>poor</i> reflects a negative sentiment. The final output is a combination of each aspect and its corresponding sentiment. Analysis using the ABSA method stands out from other types of sentiment analysis due to its higher accuracy and precision.
Entity-level Sentiment Analysis	It analyzes texts about specific subjects—such as individuals, companies, or brands. For example, in the sentence “Google is superior to Yandex due to being used more frequently,” <i>Google</i> and <i>Yandex</i> are the entities, and the sentiment expressed toward <i>Google</i> is positive.
Multilingual Sentiment Analysis	When reviews about restaurants or other services are written in multiple languages (e.g., Russian, English, and others), the system first identifies the language, then translates the text, and finally determines the sentiment. Although this is a somewhat complex process, it is currently being studied as one of the most relevant and important topics in the field.
Domain-Specific Sentiment Analysis	This type of analysis is designed to evaluate texts within a particular domain. For example, by selecting a specific field such as finance, restaurants, or hotels, the system determines sentiment based on the vocabulary and expressions commonly used in that domain.
Fine-Grained Sentiment Analysis	This type of analysis goes beyond simply labeling online reviews or comments as positive, negative, or neutral. Instead, it evaluates the intensity of sentiment on a scale, for example from -1 to +5. By providing a more detailed assessment of emotional strength, it differs from other types of sentiment analysis through its deeper and more nuanced interpretation.

The process of determining whether a text is positive, negative, or neutral involves many complexities. For example, some expressions may contain sarcastic remarks. Consider the sentence: “Today I planned to visit the restaurant that has become famous on the internet.” In this case, the opinion about the restaurant is expressed ambiguously—the restaurant could be famous either in a positive or negative sense. Additionally, some sentences may express conflicting opinions on different aspects. For instance: “I was satisfied with the online class, the teacher was very skilled, but the class schedule didn’t work for me.” In such sentences, assigning a single overall sentiment label (positive, negative, or neutral) to the entire text would be

inaccurate. This is where the aspect-based approach becomes crucial. It is more appropriate to extract all aspects mentioned in the sentence separately and then assign a sentiment label to each aspect individually.

- “Online class (aspect) satisfied me (sentiment)” – positive
- “The teacher (aspect) was very skilled (sentiment)” – positive
- “The class schedule (aspect) didn’t suit me (sentiment)” – negative

II. LITERATURE REVIEW

Analyzing comments, forums, and posts on social media using the aspect-based approach is one of the most extensively studied directions. This type of analysis has been proposed as a new approach since 2010 and has gained popularity over time. In this regard, several scholars in the field of linguistics worldwide have conducted research. The importance of ABSA, its current challenges, areas of application, and recent advancements are being actively studied [6]. For implementing ABSA based on movie review data, aspect and sentiment identification is carried out using manually developed rules and keywords that point to aspects [7].

A new three-stage task decomposition has been proposed for ABSA. It includes aspect term extraction, aspect term aggregation, and sentiment classification for each aspect term. New evaluation metrics have been introduced for these stages, and they have been proven to be more effective compared to previous evaluation methods [8].

There are three main approaches to aspect-based sentiment analysis: lexicon-based, machine learning-based, and deep learning-based methods. The effectiveness and evaluation metrics of deep learning approaches have been comparatively studied [9]. The National Research Council of Canada applied a Multi-Class SVM and lexicon-based approach to ABSA as an experiment, achieving an F1-Measure of 88,57%. In a study conducted by Xerox, a symbolic parser was developed and combined with SVM, resulting in a high performance score of 82,28% [10].

A new model for sentiment analysis and ABSA, called KnowMIS-ABSA, has been proposed. The superiority of this model lies in its acknowledgment that emotion, affect, feeling, and opinion are fundamentally different, and it is incorrect to apply the same measurement and technique to all of them [11].

In one study, 12,396 customer reviews related to service quality and products in hotels were analyzed using the aspect-based sentiment analysis method on the booking.com platform. For ABSA, data was collected through web scraping techniques from November 11 to November 21, 2019. The results showed that applying this technology in hotel management positively influenced customer satisfaction. Furthermore, ABSA demonstrated positive outcomes in enhancing hotel quality and remaining competitive with other providers [12]. Several researchers have also worked on ABSA, including Arya (2008) [13], Haasbroek (2010) [14], Zhang (2023) [15], and Kitema (2021) [16]. S. Mohamad et al. conducted aspect-based sentiment analysis using the Naïve Bayes algorithm. Their research was carried out in three stages:

Data preprocessing – In this stage, they used the restaurant reviews from the SemEval-2014 Task 4 dataset and performed part-of-speech (POS) processing.

Aspect extraction – Aspects were identified using the Chi-Square method.

Sentiment classification – The sentiment polarity related to each aspect was determined using the Naïve Bayes classifier.

According to the evaluation results, the Naïve Bayes system successfully performed aspect-based sentiment analysis and achieved a highest F1-score of 78,12% [17].

III. STAGES OF ASPECT-BASED SENTIMENT ANALYSIS

Aspect-Based Sentiment Analysis (ABSA) is one of the Natural Language Processing (NLP) tasks that identifies whether opinions expressed about specific features (aspects) of a product or service are positive, negative, or neutral. In ABSA, three core concepts are distinguished:

- Entity (object or item) – The general object or type of service that the user is commenting on. For example, in the sentence "The food at the restaurant is very delicious", the entity is the restaurant.
- Component (aspect) – A specific feature of the entity that is being evaluated by the user. In the sentence above, food is considered an aspect.
- Sentiment relation – The emotional evaluation expressed toward the aspect, which can be positive, negative, or neutral. The phrase very delicious indicates that the sentiment toward the aspect is positive.

In some sentences, if restaurant is the object, then service, food, and price are analyzed as aspects. In their study, Zhang et al. [18] consider the object and its component together as an aspect. Similarly, in our research, both the object and its evaluated feature are treated as an aspect within the ABSA framework.

The aspect-based sentiment analysis (ABSA) pipeline for Uzbek is structured into several stages, each addressing specific linguistic challenges. An overview of these stages is presented in Figure 2.

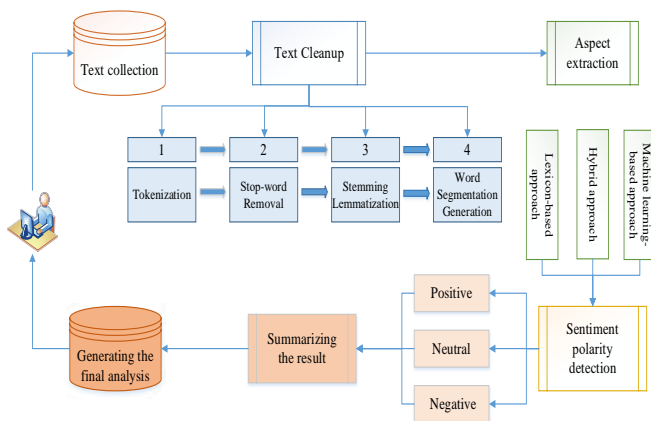


Fig. 2. The Process of Aspect-Based Sentiment Analysis

In the data collection stage, posts, comments, and reviews from social networks related to various fields are gathered. The collected large-scale text is then classified according to different domains – for example, into sectors such as

restaurants, hotels, household appliances, healthcare, education, and others. This is because when determining the aspect and its sentiment in the text, if a domain-specific lexical dictionary is manually created and used for analysis, the analysis becomes considerably more accurate and precise.

In the text cleaning stage, several processes are performed. If the text is written in uppercase letters, it is converted to lowercase. It is then tokenized, where punctuation marks or emojis expressing emotions are separated as individual tokens. The next step is to remove auxiliary words that do not carry significant meaning in the text. Special attention should be paid when removing stop words, as some words may hold important sentiment in certain sentences. Once stop words are removed, the process moves to stemming and lemmatization. In this step, words are converted into their root form (stem) and their dictionary base form (lemma). After converting to stem and lemma forms, the part of speech of each word is determined.

After the text is cleaned and preprocessed, the aspect extraction stage is carried out. For aspect extraction, it is advisable to use a hybrid approach that combines lexicon-based methods and machine learning-based methods. This is because each method has its own specific advantages and disadvantages [19]. Aspects are mainly extracted from nouns, some pronouns, verbal nouns, and other certain words. Once the aspects are identified, the process of determining the sentiment expressed toward them begins. In this process, adjectives (e.g., “good,” “bad”) and verbs (e.g., “liked,” “disliked”) convey sentiment. Adjectives are classified according to whether they denote possession or absence of a quality, including derivational suffixes that form adjectives. For example, the words mazali (tasty) and bemaza (tasteless) indicate positive and negative sentiment, respectively. To accurately determine sentiment, it is essential to compile a lexicon of such words and then identify their synonyms and antonyms – this ensures a higher level of accuracy in analysis. Although sentiment-expressing verbs are relatively few in number, creating a manual lexicon for them also contributes significantly to the success of the research. If the sentiment expressed toward an aspect is not found in the lexicon of positive or negative words, it is then considered neutral. Once the sentiment is determined, the aspect and its evaluation are summarized. For example, the sentence “The hotel conditions are very good, only the price is a bit high” is analyzed and summarized as: conditions (aspect) – good (positive), price (aspect) – high (negative).

Of course, when analyzing texts in Uzbek using the ABSA method, certain challenges may arise. This is because natural language is variable, and Uzbek is one of the languages rich in expressions and metaphors. In our future research, solutions to such issues will be explored, and methods and models tailored to the rules of the Uzbek language will be developed.

IV. METHODOLOGY

Several research works on ABSA have also been conducted in the Uzbek language. In particular, the UzABSA dataset developed by S. Matlatipov and others is considered one of the important resources in the fields of linguistics and computer science. The dataset includes 3500 document-level reviews and 6100 sentence-level online reviews of Uzbek restaurants [20]. Likewise, in our study as well, the morphological analyzer corpus developed by the “Computational Linguistics and Digital Technologies”

department researchers of Tashkent State University of the Uzbek Language named after Alisher Navoi serves as a programmatic tool for implementing the text preprocessing stages in sentiment analysis using the ABSA method [21]. This analyzer allows for morphological analysis of the text, lemmatization, and affix separation. This analyzer enables morphological analysis of the text, lemmatization and affix separation. In addition, the UzbStemming algorithm has been used to address issues such as the homonymy of roots and affixes, the stemming of new words, and the identification of named entities (NER), achieving a high performance rate of 97,5% [22]. Due to the widespread use of slang and jargon in social media comments, analyzing them can present certain challenges. To avoid confusion in the analysis of such elements, a Bayes algorithm has been proposed for the automatic tagging of jargon. This method has been thoroughly studied for its ability to produce accurate results during text analysis and its significance in distinguishing lexical units in the language corpus [23].

In aspect extraction, using a hybrid approach yields good results, in which lexicon-based and machine learning-based methods are integrated. However, sarcasm, connotative expressions, idiomatic units, and metaphors in our language may lead to some misinterpretations in the analysis. For example, “Excellent service! I waited for two hours!” – here, the word “excellent” conveys a positive meaning, but the context contains sarcasm, expressing a negative meaning. Detecting sarcasm is one of the most difficult and pressing issues for ABSA and general sentiment analysis. In analyzing such sentences, simple bag-of-words or TF-IDF approaches are not sufficient, as they do not understand the semantic relationships and irony in the context. Therefore, transformer-based models such as BERT, RoBERTa, XLM-R, and mBERT are recommended. These models analyze tone, contradiction, and pragmatic meaning in the text deeply, thus showing good performance in sarcastic sentences. In addition, emojis in the text, punctuation marks, and capitalization used to express sentiment provide additional assistance in detecting sarcasm.

Based on the above, conducting ABSA research effectively in the Uzbek language requires morphological analysis, detection of sarcasm and irony, as well as the application of modern contextual models, all of which are considered important methodological directions.

V. EXPERIMENTAL EVALUATION

In recent years, aspect-based sentiment analysis (ABSA) has gained increasing attention not only globally but also within the context of Turkic languages. For instance, in Turkish, Qıvanç Bayraktar et al. conducted an experimental study using the Turkish restaurant dataset developed for the SemEval 2016 challenge. In the first stage of their approach, aspects were extracted using LDA (Latent Dirichlet Allocation), C-value, and WSBFE (Weighted Semantic-Based Feature Extraction) methods. Then, aspect terms were refined using a rule-based technique, and sentiment polarities were aggregated accordingly. Their results demonstrated an aspect extraction accuracy of 56,28%, while sentiment polarity alignment achieved 52,05% accuracy[24].

While such studies showcase the feasibility of ABSA in morphologically rich Turkic languages, research on ABSA for the Uzbek language remains largely in the theoretical phase. The following section presents a preliminary experiment

aimed at evaluating the applicability and effectiveness of ABSA for Uzbek texts by tailoring the pipeline to the language’s unique linguistic features.

A preliminary experiment was conducted to explore how aspect-based sentiment analysis (ABSA) performs on Uzbek-language texts. The experiment used a dataset containing 6,100 restaurant reviews, each manually annotated for four predefined aspects: food quality, price, service quality, and environment. Initially, the textual data underwent standard preprocessing steps, including tokenization, stemming, and stop-word removal. These steps are particularly crucial for morphologically rich and low-resource languages such as Uzbek. In the next phase, sentiment polarity for each aspect was determined using a Naïve Bayes classifier. The results indicate that even with a simple model like Naïve Bayes, it is possible to obtain satisfactory outcomes when the ABSA pipeline is tailored to the linguistic characteristics of the Uzbek language. The average F1-score achieved was 78,2%, confirming the viability of the ABSA approach for low-resource, agglutinative languages like Uzbek. Precision, recall, and F1-score for each aspect are presented in Table II.

TABLE II. ASPECT-BASED SENTIMENT CLASSIFICATION RESULTS USING NAÏVE BAYES

Aspect	Precision (%)	Recall (%)	F1-score (%)
Food	85.2	82.5	83.8
Service	80.4	78.0	79.2
Price	73.1	76.2	74.6
Environment	77.5	72.9	75.1
Average	79.1	77.4	78.2

This preliminary experiment serves as a foundation for future work, paving the way for the development of more advanced systems through the application of lexicon-based, machine learning-based, and hybrid approaches.

VI. CONCLUSION

Today, with the development of digital technologies, the automatic identification of opinions expressed by people on social networks is becoming increasingly widespread. Of course, such advancement in modern information technologies helps people save time and serves as a tool for making important decisions for future purchases. Aspect-Based Sentiment Analysis (ABSA) is considered one of the most effective methods for conducting deep, accurate, and precise analysis of texts in the Uzbek language. This article discussed the types of sentiment analysis and specifically the importance and study of ABSA. In addition, the ABSA stages implemented in the analysis of texts in the Uzbek language were reviewed. It was substantiated that the results of each stage directly affect the accuracy and efficiency of the ABSA system. In the future, it is considered essential to further deepen aspect-based sentiment analysis and develop approaches adapted to the specifics of texts in the Uzbek language.

Moreover, this study offers several important scientific insights. Firstly, it presents a systematic ABSA pipeline tailored to the linguistic characteristics of the Uzbek language – including its complex morphology, flexible word order, and rich use of idiomatic and metaphorical expressions. Secondly, the study identifies and discusses the main challenges encountered when applying ABSA to Uzbek texts, such as sarcasm, sentiment shifts depending on context, and ambiguity in aspect expressions. Thirdly, although large-scale

experimental evaluation remains a task for future research, a preliminary experiment was conducted using a basic Naïve Bayes classifier, and encouraging results were obtained. These findings indicate that even basic models can perform effectively when the ABSA pipeline is adapted to the linguistic features of the Uzbek language. This study is among the first to propose a complete ABSA system specifically adapted to Uzbek and integrates both linguistic theory and computational approaches.

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