AI-Driven Sentiment Analysis in Social Media Content

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Abstract

Digitization of socio-economic relations leads to the evolution of interaction between users and companies, manifested in communications through innovative information technologies. Marketing strategies of companies are focused on the digital environment since a significant number of users actively use the Internet in everyday life. Interaction with users in the digital environment involves the use of different content related to the interests of different groups of potential customers. The dynamic life of the modern population in the world, especially representatives of the Z and Alpha generations, requires companies to post new relevant content on an ongoing basis. The presence of high-level competition between companies in the digital environment allows users to form demand by their own needs and quickly reorient from one brand to another. The main channel for communications with the target audience in the digital environment is social media, which allows interaction with different groups of consumers through relevant marketing strategies. The population's natural need for social orientation and interaction with other people in conditions of digitalization has led to a significant increase in the popularity of various social media. For each social media, certain distinctive features lead to the use of specialized thematic content and specific communications between subscribers. In the process of interacting with companies and discussing brands, users can use text messages, stylized graphic images (emoticons, emojis, memojis, animojis, etc.), as well as photos and video content. Optimizing the company's marketing strategy involves comprehensive research of the target audience and identification of user reactions to various actions of brands in the digital environment. Artificial intelligence algorithms make it possible to establish, based on comments, the general level of positive or negative perceptions of companies' actions. Modern mathematical algorithms make it possible to transform graphic objects and text messages into information that characterizes the relationship of users to brands, their products, and the implementation of marketing strategies. The obtained results are used to optimize the use of digital marketing tools and ensure a high level of the target audience's loyalty to the company and its products.

Keywords

Artificial intelligence, brand, communications, content, digital marketing, sentiment analysis, social media.

1. Introduction

The active development of machine learning algorithms and their integration into artificial intelligence allows for the development of new digital products. Advanced technologies are integrated into digital marketing tools and bring the effectiveness of interaction with the target audience to a qualitatively new level [1–5]. Competition between developers of modern software products with integrated artificial intelligence allows companies to choose the best solutions for improving

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marketing strategies in the digital environment. OpenAI, an American company, develops software based on artificial intelligence and has launched products such as Dall-E and ChatGPT. Dall-E allows the generation of graphical images based on text descriptions, while ChatGPT provides rich, text-based responses to user queries in natural language. OpenAI's latest product uses Dall-E 3 with integrated ChatGPT, which allows users to create complex images with a large number of interacting lenses based on a text description. Other tech giants have also developed their products with integrated artificial intelligence: Bard (Google), Bing AI (Microsoft), Bedrock (Amazon), etc. In September 2023, at the Meta Connect 2023 event, Meta AI, an innovative product based on artificial intelligence, which is integrated into Facebook Messenger, Instagram, and WhatsApp, was presented. The presented virtual assistant recognizes users' language thanks to the innovative LLaMA 2 artificial intelligence model and uses text queries to search for information in Microsoft Bing. Thanks to Meta AI, users were able to create their stickers based on text descriptions and use them to interact with other users on Instagram, Facebook, and WhatsApp. The presented tool is especially interesting for representatives of generations Z and Alpha, who actively use the digital environment for communication and are focused on unique content. The ability to express yourself and use unique stickers that are instantly generated by Meta AI in the process of communicating with peers in social media significantly increases the value of this innovative product for younger generations. The peculiarity of communications in the digital environment involves the discussion of any important issues for users, including the evaluation of brands and their products through the use of textual and visual information. The process of processing visualized information requires the use of specialized machine learning algorithms that allow to transform it into a digital form and identify user sentiments. AI-driven sentiment analysis in social media content is an important area of research that allows brands to optimize their marketing strategies in the digital environment to increase the level of economic indicators.

2. Related Works

In today's world, products with innovative features are constantly being introduced to the market, which quickly become obsolete due to the presence of a lot of competition between companies in the digital environment. Accordingly, the development of innovative information technologies and the directions of their integration into various types of economic activity arouses keen interest among scientists in different countries of the world. Machine learning algorithms make it possible to solve a large number of theoretical and practical problems, which contributed to the emergence of a significant number of research areas of the specified technology, its improvement, and integration into real economic processes. Artificial intelligence refers to an important scientific direction of applied research, which allows for improving modern products and endowing them with qualitatively new characteristics.

The work [6] revealed the essence of machine learning and presented the main algorithms used to process large arrays of heterogeneous information. The author presents the key differences between the groups of methods that use Supervised Learning and Unsupervised Learning. The expediency of using certain machine learning algorithms by the characteristics of the primary data, reliability coefficients, and the needs of the end users of the obtained models has been proven.

Features of artificial intelligence use in digital marketing are presented in the work [7]. The authors have proven the effectiveness of using various artificial intelligence algorithms in the implementation of digital marketing tools, which will allow optimizing the process of identifying the target audience and establishing close long-term relationships. Scientific research allows us to conclude the significant potential of using big data processing algorithms in digital marketing. Optimization of marketing strategies thanks to the integration of artificial intelligence allows to ensure a high level of conversion and retention of users on the web resources of companies.

The work [8] is devoted to the combination of artificial intelligence and sentiment analysis.

Along with this, the work [9] revealed the features of increasing the efficiency of business processes thanks to the use of sentiment analysis and artificial intelligence. The authors revealed the essence of the algorithms' work in the process of processing natural language, which allows for identifying the moods of users. Identification of trends in users' attitudes allows the implementation of a set of measures to ensure the optimal level of loyalty of the target audience to the company.

The image can be used as a valuable source of information about the behavior of users in the digital environment, among scientific works in this direction it is advisable to pay attention to the following article [10]. The authors researched the use of the confusion matrix of emotion classification and sentiment analysis when analyzing a large number of graphic objects.

The work [11] reveals the features of using deep learning-based sentiment analysis emojis in social media. Scientists have proven the importance of comprehensive analysis of chats in which users demonstrate their reactions using emojis. Data vectorization and an emoji-text integrated bidirectional LSTM (ET-BiLSTM) model for sentiment analysis make it possible to identify the real situation regarding brand attitudes with a high level of accuracy.

3. The Aim

Protecting the company's strategic positions in the digital environment requires the use of modern information technologies, which must be integrated into its activities and used to optimize key processes. Thanks to powerful server technologies, companies have the opportunity to generate large volumes of information about various processes continuously. Social media is an important way of increasing interaction with users, which allows companies to constantly provide the target audience with relevant content about the company's activities and its products. The specificity of communications in social media involves receiving feedback from followers through likes, comments, emoticons, etc. Companies try to assess the real situation regarding user perception of marketing strategies in the digital environment, posted content, conducted information campaigns, and other actions [12, 13]. Along with statistical methods, various machine learning algorithms are actively used in modern conditions. The presented methods are constantly being improved thanks to the development of technologies and the introduction of modern software for the processing of various information on the market. It should be noted the gradual increase in the popularity of artificial intelligence methods, which are characterized by high efficiency and the ability to learn from big data by the action of external and internal environmental factors. The presented algorithms make it possible to evaluate the reactions of users in social media, which are presented in text and graphic form. However, the development of artificial intelligence algorithms involves conducting comprehensive research on increasing the level of accuracy of potential customers' perception of companies' marketing strategies in social media in general, as well as individual measures in particular. The prerequisites for the development of new methods of AI-driven sentiment analysis are also the transformation of user behavior patterns, which is associated with demographic processes and the growing influence of representatives of generations Z and Alpha [14]. Younger generations in many cases use specific slang and specific images to express their attitude towards brands and their marketing activities on social media. The effectiveness of machine learning algorithms allows companies to adapt to the specifics of the data and identify the characteristic features that are inherent in the reactions of different age groups in chats on social media [15].

4. Models and Methods

The development of sentiment analysis occurs due to the evolution of science and information technologies. In the first stages, methods that did not require significant computing power were used. Lexicon-based analysis refers to the simplest of methods, allowing to identification of the sentiments of users, but it allows to estimate of the relationship of the audience only according to a basic set of words. Along with this, the presented approach does not allow taking into account the context of statements and sarcasm. Statistical methods allow more efficient processing of text messages

by calculating various characteristics and classifying user utterances. AI-driven sentiment analysis includes such techniques as machine learning and deep learning. Hybrid methods allow to combination of various approaches in the process of sentiment analysis, using their advantages and obtaining the optimal result. Fig. 1 presents the basic techniques of centimeter analysis.

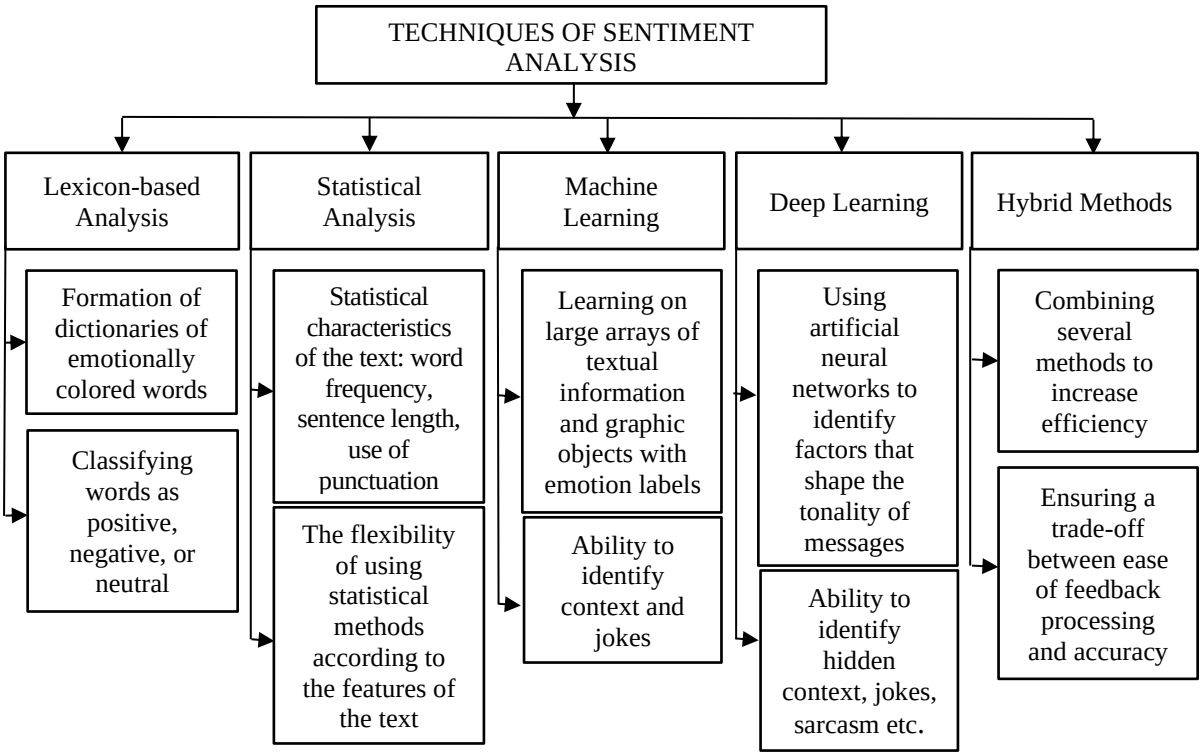

Figure 1: Main techniques of sentiment analysis [16, 17]

AI-driven sentiment analysis is the most effective way of identifying audience sentiments in social media and, thanks to the further evolution of machine learning and deep learning algorithms, will ensure the effectiveness of marketing strategies of companies in social media and the digital environment. Fig. 2 presents a comparison of Machine Learning and Deep Learning sentiment analysis techniques, which were proposed by Nhan Cach Dang, María N. Moreno-García, and Fernando De la Prieta.

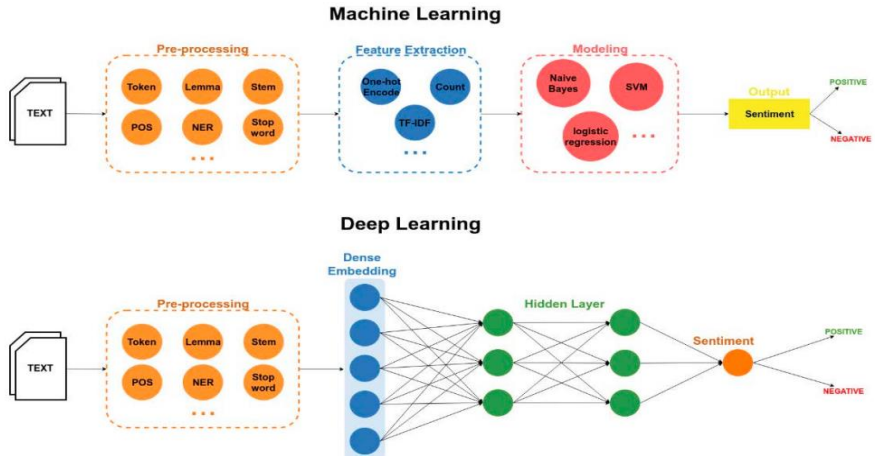

Figure 2: Comparison of Machine Learning and Deep Learning sentiment analysis techniques [18]

At the current stage of development in sentiment analysis, an approach that involves the use of emoticons and pictures in the implementation of machine learning and deep learning approaches is becoming widespread. The use of text information, emoticons, and pictures as an information base for analyzing the audience in social media allows for a

significant increase in the accuracy of identifying the company's emotional perception and its marketing actions. Machine learning and deep learning approaches are characterized by significant power and productivity, which contributes to increasing the effectiveness of the company's marketing strategy in social media and allows the establishment of close communications with the target audience in the long term.

When using standard methods of sentiment analysis, dictionaries of emoticons are formed, which are grouped according to specific emotional reactions. This approach involves grouping and marking with the involvement of employees. In the case of the implementation of machine learning algorithms, the use of a certain set of data is assumed, which involves the analysis of messages with the identification of polarity and the establishment of emoticons present in the text. In the process of identifying the emotional outline of emoticons, they are converted into numerical values, which allows the implementation of appropriate mathematical algorithms. Among the methods of converting emoticons into digital form, it is advisable to pay attention to the following approaches:

1. One-Hot Encoding. According to the presented method, each emoticon is transformed into a binary vector. The index for the corresponding emoticon takes the value 1, and the other indices are equal to 0. For example:

🙂 – [1, 0, 0] 😄 – [0, 1, 0] 😎 – [0, 0, 1]

Depending on the available data, the position of emoticons in the text and encoding of the vectors will differ, since according to this method it is assumed to be assigned to the appropriate index. For the new database, the vectors will be different, which will be reflected in the unique order of index placement. The disadvantage of the presented approach is the large dimension when used for the needs of sentiment analysis of emoticons in user reviews on social media.

Fig. 3 shows an example of using One-Hot Encoding for a large number of emoticons, which involves the formation of a corresponding data array. The resulting vector can be used to implement various algorithms, including machine learning, which will allow identifying the sentiments of the target audience in social media.

(	)	^		...	@
1	0	0	0	...	0
0	0	1	0	...	0
0	0	1	0	...	0
0	1	0	0	...	0
...	...	...	...	...	...
0	0	0	0	...	0

Figure 3: Convert emoticons into character one-hot vector [19]

2. Count-Based Features. This approach involves the calculation of certain statistical indicators of the use of appropriate emoticons in text messages. Count-based features allow to transformation of visualized emotional objects into useful information used in solving machine learning tasks: classification, regression, and pattern recognition [20].

The presented approach involves the calculation of the following indicators:

A. The total number of emoticons in a certain text message, without taking into account the content of the emotion expressed by a specific graphic object.
B. The density of emoticons in a text message characterizes the ratio.
C. The number of emoticons by emotion. Classification systems provide for the separation of three groups of emoticons based on emotions: positive, neutral, and negative for the needs of centimeter analysis.

Fig. 4 shows the basic emoticons that represent each of the three groups of emotions. It should be noted that the list of emoticons may be updated during research, as there are differences in the selection of emoticons for different social media and specific consumer groups. Along with this, the study of reactions in different countries of the world also involves studying the features of communication models in the digital environment and identifying the most popular emoticons among the target audience.

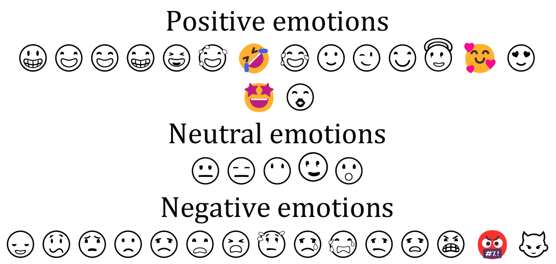

Figure 4: Basic emoticons list [21]

3. Embeddings. The presented method allows to transformation of emoticons into numerical vectors of large dimensions and uses the obtained data to implement various machine-learning algorithms. Thanks to the evaluation of the distances between the vectors characterizing the corresponding emoticons, their similarity in terms of emotional reactions is carried out. Embeddings make it possible to establish the essence of the emotional characteristic of an emoticon according to the context of the text in which this visualized object is presented [22].

A. Pre-trained models. Natural language processing models based on embeddings are used in a large number of modern products (Alexa, Google Assistant, Google Translate, Siri, etc.). The presented concept has evolved significantly thanks to the increase in the efficiency of neural media. Among innovative models, it is advisable to pay attention to BERT (Bidirectional Encoder Representations from Transformers) (see Fig. 5) and GPT (Generative Pre-trained Transformer), which allow to representation of words in vector form and take into account the context of messages. Among the machine learning models, it is necessary to pay attention to Word2Vec, GLOVE, FastText, and Baseline, because the natural language processing methods presented allow analyzing emoticons integrated into the text and identifying the emotional direction of messages, as well as graphic elements.

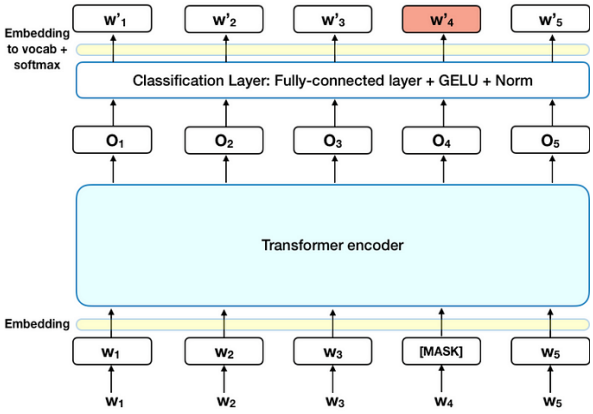

Figure 5: BERT model [23]

B. Custom embeddings. The creation of its objects is expected by the specifics of the company's marketing strategy implementation in social media. According to the emoticons used, high-dimensional vectors are constructed. The following custom embeddings for emoticons are highlighted:

- Using textual data. If the company has its database, which contains emoticons with a description of the content of the text messages used, in certain cases it is advisable to use the custom embedding approach. Thanks to the application of certain machine learning algorithms, it is possible to train custom embeddings with a high level of probability to accurately identify the context of graphic objects in the text.
- Unicode or numeric representation. By the numerical code of a specific emoticon, it is possible to independently create unique representations with a specific vector. It should be noted that to create vectors in this case it is advisable to use both one-hot encoding and learned embeddings.
- Independent approach. This approach involves the independent creation of embeddings for emoticons thanks to the application of techniques for vectorization (one-hot encoding, frequency-based representation, Unicode indexing) and techniques for distributed representations (word embeddings, sequence models, attention mechanisms, dimensionality reduction techniques). The flexibility and adaptability of the independent approach allow to adjust the presentation of emoticons by the company by the characteristics of the target audience in the relevant social media in certain periods.

C. Transfer learning. Digital transformation is expected in the case of emoji embeddings due to the use of pre-trained models or embeddings [24]. To achieve optimal results, it is necessary to accumulate a large amount of data that will allow training of the model using the appropriate mathematical algorithm. The process involves the implementation of the following steps:

- Pre-trained embeddings. Based on large volumes of text messages with emoticons, embeddings are taught. A variety of texts with integrated emoticons allows us to recognize the context and semantics of graphic objects.
- Fine-tuning. The embeddings obtained at the previous stage must be configured by

social media, characteristics of the target audience, and other factors of the internal and external environment. The optimization process involves the use of test data sets that can be generated by the probabilistic principles of constructing sample populations. Along with this, test sets can be formed based on targeting a certain group of consumers.

- Domain-specific training. Implementation of unique models of communication with certain groups of consumers in social media involves setting the appropriate context for emoticons. It is advisable to use the resulting patterns of content load and context for learning embeddings [25].
- Transfer knowledge. The speed of transformation of the behavior of modern users in the digital environment requires the use of pre-trained embeddings for the identification of a new context and meaningful load in emoticons. Along with this, the trained models allow for analyzing the existing context of emoticons, which may not change for a long time [26].

Evaluate and adjust. Constant testing of emoticons thanks to the use of pre-trained embeddings allows the company to understand its customers and optimize the communication process to ensure an economically justified level of conversion. Performance improvement due to hyperparameter tuning should be done according to the evaluation of the resources spent and the results obtained.

4. Hybrid Approaches. Thanks to the combination of several techniques for identifying the content and context of emoticons, it is possible to increase the accuracy of determining the reactions of the target audience to the company's actions in the digital environment and optimize marketing strategies for establishing effective communications in the long term [27]. Due to the multiplicative effect and using the advantages of each of the involved approaches, it is possible to obtain rich emoticon representations.

It is advisable to use the following approaches for emoji embeddings:

A. Symbolic and distributional representations.
B. Pre-trained embeddings and custom training.
C. Multi-modal fusion.
D. Attention mechanisms and sequence modeling.
E. Ensemble of models.

Sentiment analysis is one of the effective approaches that companies should use to identify the reactions of the target audience to certain actions within the framework of marketing strategies in social media. However, achieving optimal results is possible only if scientific approaches are followed at all stages of evaluating the attitude of users to the brand, its marketing strategy, posted content, etc. The main stages of analyzing the sentiments of the target audience in social media are:

1. Data collection. Social media act as an important digital marketing tool to interact with the target audience and promote the company's products. The specificity of social media functioning involves the generation of large volumes of heterogeneous information that can be used by companies to optimize marketing strategies. Thanks to the use of web analytics tools, it is possible to accumulate data on the activity of users in the relevant social media on an ongoing basis. For sentiment analysis, it is also advisable to collect data through the use of APIs and scrapers.

2. Pre-processing of data. At this stage, text messages and emoticons are transformed into a mathematical form thanks to the application of various approaches.

3. Processing of data from social media. Data processing methods in sentiment analysis are divided into rule-based approaches and machine learning algorithms. AI-driven sentiment analysis is more flexible and effective for identifying the judgments of the target audience in social media, as it allows a company to quickly process large amounts of disparate information and identify hidden relationships. Fig. 6 presents machine learning algorithms for sentiment analysis.

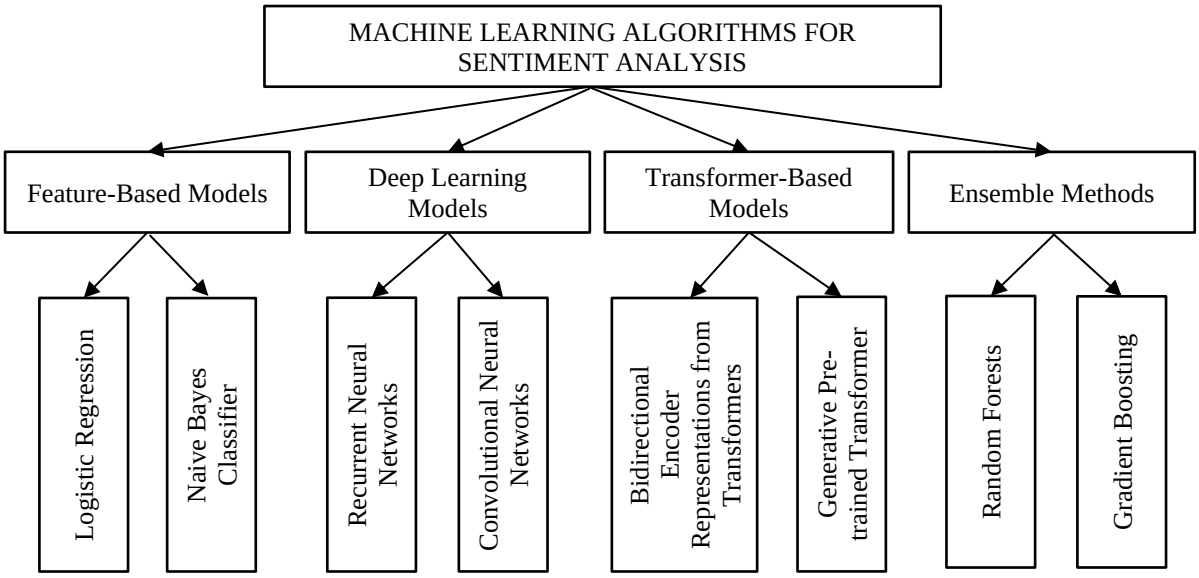

Figure 6: Machine learning algorithms for sentiment analysis [28, 29]

4. Analysis of the obtained results. Evaluating the effectiveness of the obtained results and determining the expediency of the model for monitoring the sentiments of the target audience in social media. In the case of determining opportunities for retraining models based on machine learning algorithms and obtaining more accurate results, return to the previous steps.

5. Monitoring in real time. Derivation of the obtained model for AI-driven sentiment analysis. The results are used on an ongoing basis to improve the company's marketing strategy in social media. Continuous assessment of sentiment is related to the specifics of changing user behavior, first of all, we are talking about Generation Z and Alpha. These generations quickly adapt to the factors of the digital environment and actively change their behavior in social media, which requires companies to constantly monitor the mood of the target audience.

6. Improvement of approaches. The development of information technologies and the introduction of new approaches to the development of artificial intelligence encourage companies to apply advanced scientific achievements to implement sentiment analysis. More productive machine learning algorithms will allow to identification of irony, context, and features of the expression of emotions by consumers in different countries of the world, which leads to the implementation of new approaches in improving the marketing strategies of companies in social media.

5. Further Research

The specifics of the construction of text messages by different generations of users and socio-cultural features in different countries of the world do not ensure 100% accuracy of sentiment analysis. The presented study testifies to the effectiveness of using machine learning algorithms in the identification of consumer sentiments and the use of the obtained results to optimize the marketing strategies of companies in the digital environment. The evolution of artificial intelligence will make it possible to increase the effectiveness of the use of sentiment analysis in the field of digital marketing, allowing companies to interact with users on a qualitatively new level of communication. Due to the consideration of the peculiarities of different languages and cultures, multilingual approaches will be used in sentiment analysis in the future. The process of communication in social media involves the use of various types of content, which will allow in the future to expand opportunities for a comprehensive analysis of customer sentiments by building complex models involving audio, video, and visualized materials. The use of more effective deep learning approaches (convolutional neural media, recurrent neural media, transformers, etc.) in combination with cloud technologies will not only improve the quality of identification and interpretation of the results of sentiment analysis but will also allow for real-time data processing.

6. Conclusion

Increasing competition between companies in the digital environment and the rapid reorientation of consumers to brands that offer more attractive integrated products requires companies to constantly improve their marketing strategies. To ensure long-term communications with the target audience, companies use innovative digital marketing tools and other advanced approaches that allow to achieve a multiplier effect. Achieving the set tasks involves the use of artificial intelligence to process heterogeneous information. When researching sentiments on social media, it is advisable to use AI-driven sentiment analysis. The presented approach has proven to be effective, as it allows for identifying consumer sentiment, context, and irony based on text data and emoticons with a high level of probability. Thanks to the integration of machine learning algorithms into the system of automated collection and processing of data from social media, the company gets the opportunity to identify in real time the change in the attitude of the target audience towards the company and its activity in social media. Monitoring the effectiveness of the implementation of the marketing strategy in social media allows a company to promptly adapt communication models with the target audience to the needs of consumers, which positively affects the achievement of an economically justified level of conversion and allows to ensure a high level of loyalty of the target audience.

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