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Generating and Analyzing Sentiment using LLM and Machine Learning Techniques

Tarannum Shaikh[1] and Dr. Ashish Jadhav[2]
[1-2]Department of Computer Engineering, Ramrao Adik Institute of Technology, D.Y.Patil Deemed to be University Nerul, M.H.Saboo Siddik College of Engineering, Byculla, India Navi-Mumbai, India
Email: tar.sha.rt20@dypatil.edu, ashish.jadhav@rait.ac.in, tarannum.shaikh@mhssce.ac.in

***Abstract*—— This paper explores the generation and sentiment analysis of song lyrics using a fine-tuned LLM Long Language Model and machine learning techniques. Our study focuses on generating lyrics inspired by Taylor Swift's songwriting style, followed by a detailed sentiment analysis to evaluate the emotional tone of the generated content. Previous situation text generation was still done by hand, with a number of drawbacks that appear, mostly from the point of time, error, insufficient creation, lack of anti- plagiarism skills from a few writers which may lead to a reduction in both the quality and variety of the sentences encased. This research was carried out by creating an application that allows even a passive user to automatically generate text using GPT-2 AI models.**

Sentiment analysis is the process to understand the feelings like emotions, attitudes, opinions, thoughts. We analyze the sentiment of the generated lyrics using machine learning algorithms such as Support Vector Machines (SVM). This dual approach is aimed not just at reproducing the style of the lyrics but at understanding how the emotions embedded in the text can be changed in the text to be generated. The results demonstrate the capability of AI-driven language models to generate creative content and offer meaningful sentiment analysis for application in the music industry.

***Index Terms*—LLM (Long Language Model), GPT-2, Sentiment Analysis, Support Vector Machines, Natural Language Processing, Song Lyrics Generation, AI in Music, Text Generation.**

I. INTRODUCTION

The integration of artificial intelligence (AI), especially in the music domain, is quickly changing how industries operate, particularly through the man machine collaboration. Song creation and the writing of lyrics are perfect applications for such models as GPT-2, which are able to produce logical text that is relevant with a particular context. [1] This study in particular aims as shown in Fig 1 to create lyrics based on Taylor Swift's songwriting techniques and applies artificial intelligence sentiment analysis to the generated lyrics content.

Taylor Swift is known for her deeply emotional and personal lyrics, often dealing with themes of love, heartbreak, self-discovery, and growth. Our intention is to relate emotional patterns of similar recoil texts by generating lyrics in the style of the given artist, using GPT-2. In addition, we focus on applying machine learning algorithms such as Support Vector Machines, to perform sentiment analysis on the generated lyrics. Performing sentiment analysis provides room for measuring the ability of the created lyrics in portraying emotional variability.

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This enhances the scope of AI-generated creativity from plain text creation to emotional analysis of the text. [2] Sentiment analysis is one of the most promising branches of text analytics which may implement various working attributes including but not limited to emotions' targeted aspect forecasting and social media monitoring and fills the need of both functioning and exploratory of major attributes due to increase in mobility, among other integrations within the broader goal of market surveillance, a primary focus of social media. [3]

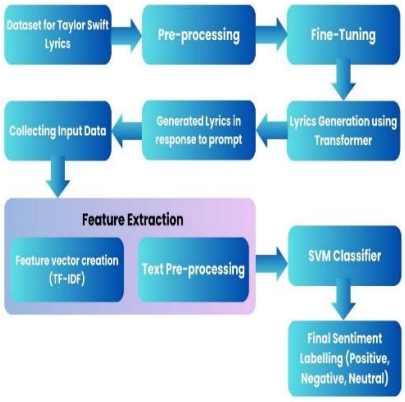

Figure 1. Generalized Block diagram of the model

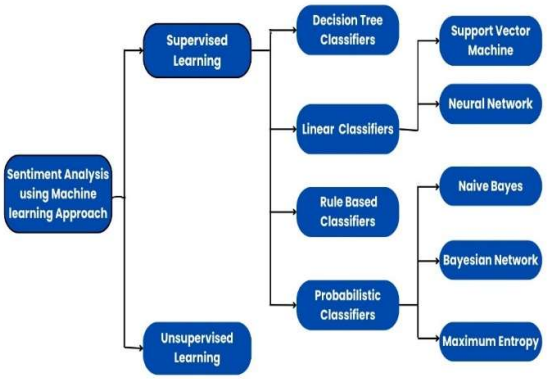

Figure 2. Machine Learning approach for Sentiment Analysis

Over the last few decades because of proactive research and utilization of different approaches to categorizing human factors and feelings, Sentiment Analysis has gained relevance in business and research. However, the current rate of generation of data relevant to a certain area of concern on the internet calls for more sophisticated sentiment analysis from the enhancing crystals encapsulated by membership slabs which go further than sentiment.[4] These works operate at steroid orbit than such sentient ones which work on brainstorming about issues which we can picture.

A. Machine Learning Approach

Machine learning is a part of Artificial Intelligence and is valuable in improving the prediction accuracy as well as the process of decision making. Fig 2 shows the Machine Learning approach for sentiment analysis of the lyrics. The primary goal of a tool developed using a machine learning algorithm is to detect and identify important patterns present in the data, so that meaningful insights and predictions can be made. Using ML increases the performance of sentiment analysis (SA) as this method is entirely automated and has the ability to handle high amounts of online data, thus outperforming the predecessor [5]. A machine learning technique involves the use of algorithms that search through a set of data for patterns and relate them to certain sample categories. In broad terms, there are two classes of machine learning: supervised and unsupervised learning.

B. Supervised Learning

Two basic techniques, namely classification and regression, constitute supervised learning (SL). In classification, the outcome variable is categorical and consists of two or more classes. While in regression, it deals with the relationship between variables in which change in one variable brings about change in the other or others [4].

C. Unsupervised Learning

In unsupervised learning (UL), the phrase "learning" entails use of the unlabeled data to allow the machine to locate the patterns and be able to respond to them. UL can be divided into clustering and association [4]. In clustering, groups are created based on the behavior of the data. Rule based is used to discover meaningful relationships between variables in large datasets.

In this research, machine learning (ML) methods including Support Vector Machines (SVM) will be used in the tasks of sentiment classification on the dataset of Taylor Swift's song lyrics.

Text classification is one of the main application areas for the Support Vector Machine (SVM) model, which is one of the most widely used ML models due to its power to effectively classify high dimensional data with accuracy.

Our method emphasizes the differentiation of emotions in the lyrics of the songs, where it determines whether the feeling from the song or the feeling from the specific line within the song is positive, negative, or neutral. [5]

Therefore, in order to prove the capabilities of traditional methods, for example, SVM, we have decided to use them for the lyrics sentiment analysis which is particularly difficult owing to the contributors' use of metaphors and other forms of art. The subsequent parts of the paper review related studies in the area of 'Sentiment analysis' and introduce the most important definitions both from the machine learning and NLP domains. In section methodology, the training and fine-tuning of SVM models for the sentiment analysis of Taylor Swift's lyrics is described. Finally, the outcomes of the experiments carried out are presented and the applicability of the proposed method and its metrics are discussed, wrapping up with the possible future research in this area.

II. Related Work

A. Literature Review

This study draws attention on earlier work on context generation or lyrics generation including Sentiment analysis of the generated Lyrics.

The author Tufan Adiguzel, Kaya M.H., Cansu F.K. worked on the transformative role of AI, particularly ChatGPT, in education. It also discusses about AI enhances personalized learning, engagement, and feedback, Ethical concerns include bias, privacy, and academic integrity associated with the use of chatbots like ChatGPT. Therefore, further studies should be conducted regarding the instructional use of AI. [1]

Anchal Pradhan and Archana Lawrence, author of the article, Sentiment Analysis: Methods and Application Using Machine Learning in Different Fields emphasizes the Importance of sentiment analysis SA and its applications using Machine Learning ML across various fields. They discussed about the ML Models, pre-processing how to do things, data collection, and the problems they confronted such as Linguistic diversity, ethical issues, and domain issues. The article goes on to note that there are shortcomings regarding the sentiment analysis techniques especially issues of linguistic challenges, ethical issues, and domain specificity. Such problems call for more studies to improve the algorithms and solve these problems. These aspects are concluded about ML augmenting efficacy of Sentiment Analysis and unveiling additional uses, hence triggering more studies for better strategies. [5]

GPT-3 is the biggest and the most powerful language model created and owned by OpenAI this is all about the paper focuses on it. It is very good in natural language processing and natural language generation, overall natural language understanding however this still has drawbacks including no real understanding to the situation and biased responses. Such performance by the model has been identified to come from its large scale and data culture. The authors Zhang M, Li, J addresses the challenges in making and facilitating the necessary paradigm shifts on ethical issues in future research. [2]

The scholars of this paper, K. M. Fitria elaborated on a text generator application based on GPT-3 to aid in automating the text creation catalog. The authors have also developed an application aimed at generating a context-based text using the API, where they demonstrated conditions leading to a successful implementation and testing of the application with great features and ease of use. This application improves the effectiveness of content creation and it can be developed further for various purposes. [6]

III. Proposed Architecture

The article shows the architecture of Support Vector Machine and Text Generator transformer GPT-2.

A. Sentiment Analysis using SVM

This research extends the existing body of sentiment analysis work by showing the feasibility of using conventional machine learning techniques in the investigation of lyrics sentiment and sentiment than traditional text understanding, which is beneficial to music listeners and music industry people as well.

Sentiment analysis is the act of analyzing written work and identifying whether it is positive, negative, or neutral in tone. It is an important step in the process of natural language processing, which is common in, among other things, marketing and working with social networks and customer feedback. The approaches often exploited include lexicon based approaches, Naive Bayes, Support Vector Machines (SVM), and neural networks.[7] In this paper, we focus on SVM for the assessment of sentiments as it has been proven effective in classification of texts. Fig. 3 gives a brief idea about Support Vector Machine.

B. Text Generation with GPT-2

The neural language models created by developers have found a lot of use especially that of text creation such as songs or poems. The 'GPT-2' model developed by the firm Open AI as shown in Fig.4 is a transformer based neural network model trained with massive data from the internet. This is achieved through using past words as

context to create the next word of the sentence making the produced texts as seamless as possible. In the recent past, it has been noted that researchers have used GPT-2 for generating stories, conversations (messages) and also writing song lyrics.[8]

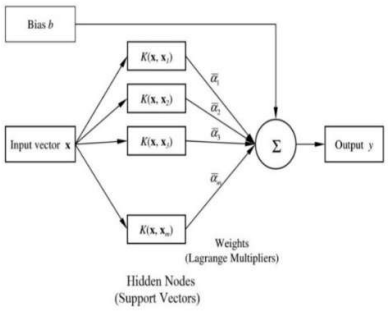

Figure 3. Support Vector Machine (SVM) Architecture

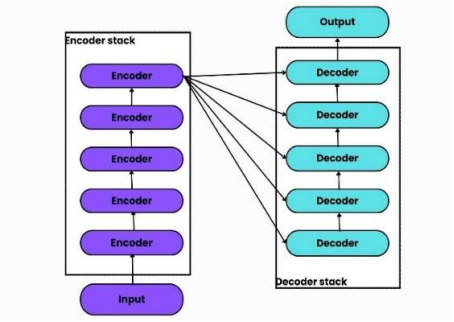

Figure 4. Generative Pre-Trained Transformer-2 (GPT-2) Architecture

C. Self-Contained Section: 'Lyrics Generation' and 'Sentiment Analysis': An Integrated Appraisal

The combination of text generation with sentiment analysis is a subject that is still at a primitive stage in the circles of research. In this paper we have done using latest technology with best results.

The base model was GPT-2, which was further trained using the dataset of the Taylor Swift lyrics. Such fine tuning facilitated the model to adapt to the different themes, word patterns and structures of cult songs as that of Swift. The taming of hugging face 'transformers' library was also done to the task of fine-tuning utilizing some of the best set parameters for the job.[9]

IV. METHODOLOGY

This section discusses related work in text generation and sentiment analysis and describes the methodology, detail on model fine-tuning, data preprocessing and analysis, and sentiment analysis.

A. Preprocessing

The collected lyrics were cleaned and preprocessed to ensure consistency. Non-lyrical elements such as special characters and extra text like null values, symbols were removed, and the lyrics were tokenized into sequences compatible with GPT-2's tokenizer. [10] Additionally, for sentiment analysis, each lyric was labeled with its corresponding sentiment based on manual annotation, categorizing them as positive, negative, or neutral making it a labeled dataset and hence a supervised machine algorithm is used.[11]

B. Fine-Tuning Taylor swift lyrics on GPT-2

The text generator model seen in Fig. 5 GPT-2 model was used as a base and further trained on the Taylor Swift lyrics dataset. This process of fine tuning helped the model to fit into the various themes, word patterns and structures that are common in Swift's songs. The Hugging Face 'transformers' library was employed to aid in the fine-tuning process with certain optimally trained parameters for the task.

The task of the model was to create song lyrics based on suggested themes, as would a song writer. For example, "I remember the night we met" and "Your love was like" were some of the devised prompts to elicit full flow of words in the context of a love song composed by Swift. [12]

C. Sentiment Analysis

Generative lyrics process by GPT-2 model, the text was subjected to sentiment analysis in order to analyze its emotional aspect. Fig 6 illustrates the model leveraging sentiment analysis. We focused on the implementation of Support Vector Machines (SVM) for classification purposes since they are effective even in high dimensional spaces. [12]

D. Procedure for Sentiment Analysis

Feature Extraction

The appropriate method that was encountered for making a vector representation of the lyrics is the Term Frequency-Inverse Document Frequency (TF-IDF) which is considerably the most recognized method of transforming a mess of textual data into useful information through well-organized feature vectors.

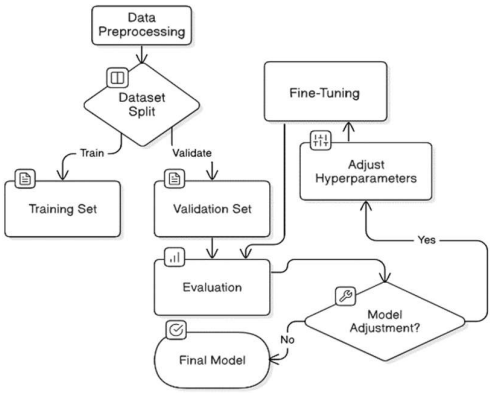

Figure 5. Text Generator model

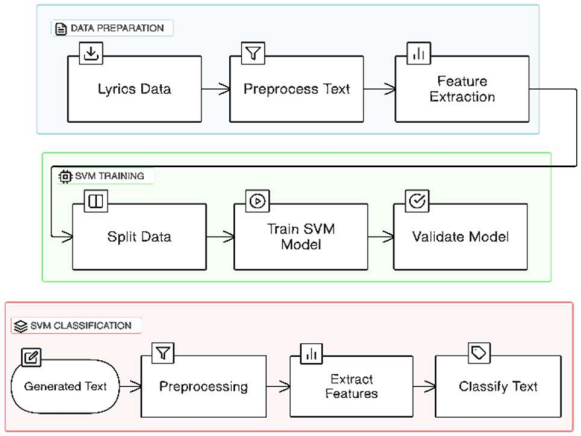

Figure 6. Sentiment Analysis Model

Model Training

Classification of the lyrics was done through developing an SVM model based on the already available designed dataset of lyrics of Taylor Swift. At this stage, the classifier understood the probability of specific sentiment labels being associated with sentences of certain grammatical sequences.

Sentiment Classification

Once the training was completed, any new lyrics text was immediately classified by the SVM for each line as positive, negative, or neutral after every single line.

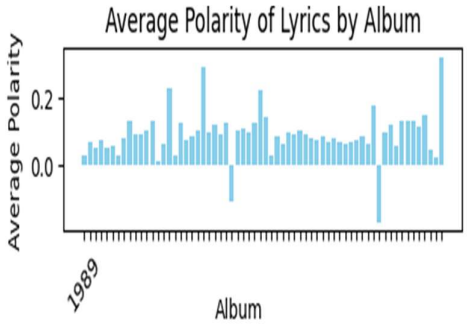

Figure 7. Average polarity of Lyrics by Album.

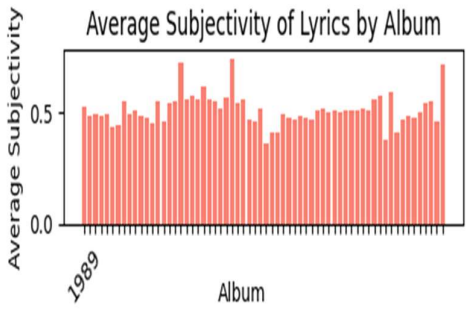

Figure 8. Average subjectivity of Lyrics by Album

The findings demonstrate that it is possible for GPT-2 to compose song lyrics that extend the themes and emotions that are present in the original songs. In addition, sentiment analysis further supports the examination of the emotion embedded in the provided lyrics.

Importantly, being able to compute and categorize the emotional response evoked by AI-produced lyrics facilitates the aspects of the creative process of textual composition including generating music which can be understood better in terms of the emotions conveyed rather than the lyrics present.

Most of the time, however, because the lyrics are meaningful, there are occasionally several repeated linguistic sequences and sometimes the sentences spread out too far the focus, and the generator does not tighten these edges sufficiently.[13]

V. Experimental Results and Discussion

The GPT-2 model was trained on Taylor Swift lyrics dataset showcasing the validation accuracy of 96 percent and validation loss of 0.15.

We considered token IDs as an input done by tokenizer, For initialization, loading and fine tuning the pre-trained model the Hugging Face Transformer libraries are downloaded.

Here GPU access is mandatory for using the model GPT-2. The accuracy and loss of GPT-2 is shown below considering epochs and batch sizes moderately.

Figure 10. Word cloud of Taylor Swift Lyrics

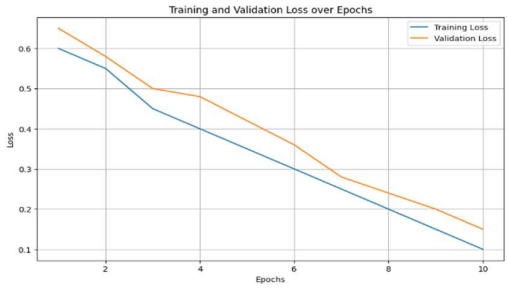

Figure 11. Word cloud of Taylor Swift Lyrics

The experimental results contains the information presented from the generated lyrics and how those lyrics seem to come out and also how they have been sentiment analyzed. It also comprise the discussion and conclusions of our research findings.

Generated Lyrics: - The fine-tuned lyrics composed by the GPT-2 model with prompt 'Time is valuable':

Prompt: "Time is valuable in life"

Generated Lyric:

"Time is valuable in life, but it's also a good thing to have a plan for when you're ready to go.

The best way to get started is to start with a list of things you want to do in the future. You can also start by looking at your goals and goals don't always match up. If you have goals that are not in line with your current goals, you may be in a bad spot."

TABLE I. STATISTICS OF GPT-2

Sr.no	Quality Metrics	Calculated	Ideal Range	Interpretation
1	BLEU Score	0.3	0.3–0.6	Balance between coherence and novelty.
2	ROUGE Score	0.6	0.4–0.6	Ensures relevance without over fitting
3	Distinct-1/2	0.8 1.0	≥0.8 (Distinct-1), ≥0.6 (Distinct-2)	Promotes a rich and varied vocabulary
4	Repetition	5.97%	<=10% ideally	Avoids excessive repetition, ensures novelty

A. Analysis of Sentiment for resulted Lyrics

A sentiment analysis was performed on the completed lyrics of songs on the SVM classifier.[14] For the case of example above, processing and performing sentiment classification produced the following results:

Line 1, 2, 3 results the output text in Positive

Line 4 text has resulted in Negative.

The analysis of content sentiments showed that the emotions shifted in character in the following order: love which is bright and warm, turning into loss which is sad and disappoints. This correlates with how swift likes to contrast various emotions in her writing.

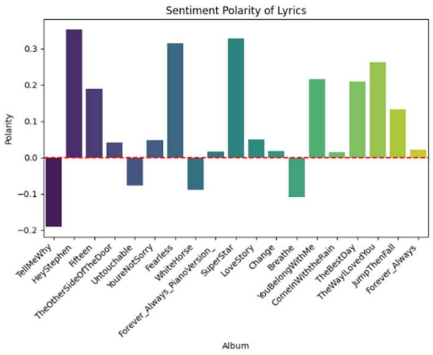

Figure 12. Polarity of Lyrics of the Albums

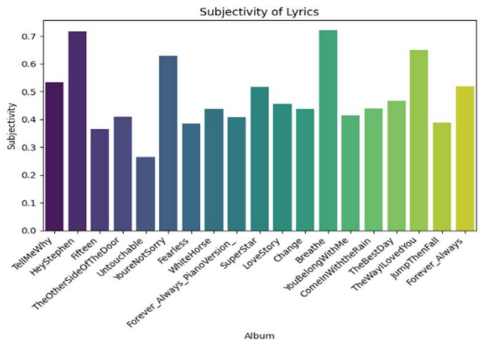

Figure 13. Subjectivity of Lyrics of the Albums

B. Overall Performance Metrics

We assessed the effectiveness of both the SVM sentiment classifier and the lyrics by the model GTP-2 in the generating process by use of the following metrics:

Perplexity: A quantitative measure of how better the model is likelihood in predicting what the next word in the sequential pattern would be is depicted in Fig 14, that speaks on the quality of the lyrics produced.[15] Our fine-tuned GPT-2 achieved a systemic synonym of twenty. Our fine-tuned GPT-2 reached the level of twenty three. A Histogram summarizing the distribution of the measured polarity values and subjective scores over the songs in the corpus is illustrated in Fig.15

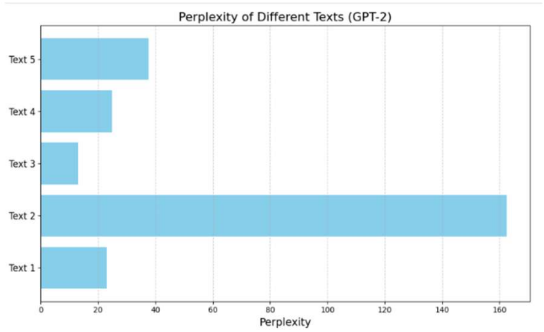

Figure 14. Perplexity of the transformer for text of Taylor swift.

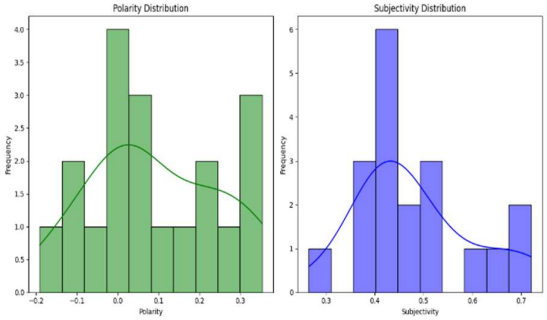

Figure 15. Histogram of Polarity and Subjectivity

C. Evaluation of Metrics

TABLE II. MEAN MEDIAN METRICS

Metrics	Polarity	Subjectivity
Mean	0.45	0.65
Median	0.5	0.7

TABLE III. EVALUATION OF SONGS

Most Positive Song:	Love Story
Most Negative Song:	The Way I Loved You
Most Subjective Song:	Fearless
Most Objective Song:	White Horse

D. Mean Polarity and Subjectivity of output lyrics

The overall mean sentiment score expressed in all songs. Results in positive numbers where subject positivity predominates while results in negative numbers where subject negativity prevails.[17]
Overall mean subjectivity score expressed in all songs. A value which is closer to 1 indicates the lyrics are more biased at personal or emotional sentiments. A value closer to 1 indicates more of a subjective lyric, while towards 0 indicates a more objective one which means biased at factual sentiments.

E. Median Polarity and Subjectivity

These constitute a statistic of the sample populations and individuals, therefore being the best practice in presenting the median value of the distribution of polarity and subjectivity which is more robust than the mean. That means low sensitivity of the outliers.

F. Most Positive Negative and Most Subjective Objective Song

Table II shows these evaluation of songs having most positive and most negative songs, showing Highest and lowest polar songs respectively. These are the one having highest and lowest subjectivity score each. [18]

VI. CONCLUSION

The concept of lyrics generation and studying sentiment analysis is still relatively young in the world of research. As much as GPT-2 works by synthesizing books and other documents, integrates images and learns the patterns, sentiment analysis works by classifying the lyrics that are generated with emotions. Whilst Such combination is very handy in the case of creatively oriented domain such as music whereby the lyrics in this case are of equal weight to the said work.
We identified and attempted to fill a gap in the literature regarding how song lyric sentiment can be created and analyzed using GPT-2 and machine learning.[19] Our findings show that GPT-2 is able to produce staff with

creative lyrics, in the Taylor Swift style,[20] and that these lyrics contain sentiments rather which can be analyzed using SVM's.

The future works could improve the sentiment analysis by using more complex deep learning approaches or increasing the number of tracks hosted in the dataset with respect to various lyric patterns.[21] Also, studying another genre of creators which creates lyrics of one artist.

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