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# Sentiment Analysis in Adolescents' Online Communication: An AI/ML Approach for Early Mental State Assessment

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## 1. Abstract

### 1.1 Motivation:

The surge in mental health issues among adolescents in the digital age, coupled with a lack of studies on individuals unaware of their mental status, propels our research. We emphasize the need for large-scale screening through natural language processing and machine learning, given the limitations of conventional methods in understanding the intricacies of online interactions.

### 1.2 Problem Statement:

Our project addresses the challenge of understanding adolescents' mental states by using machine learning to scrutinize text-based conversations on social media platforms. Focused on the critical adolescence period, our research captures intricacies overlooked by conventional methods. Integrating the AI model into a website enables real-time data input, providing dynamic analysis reflecting current trends.

### 1.3 Approach:

Our project develops a software program using machine learning algorithms to train an AI model and construct a website for real-time analysis of text-based conversations among adolescents.

## 2. Methodology

### 2.1 Engineering Goal

The primary objective is to develop a machine learning-based software program capable of analyzing text-based conversations from public platforms and real-time data input through a website. The goal is to assess the mental states of adolescents based on their online communication, with a focus on early detection of mental health conditions.

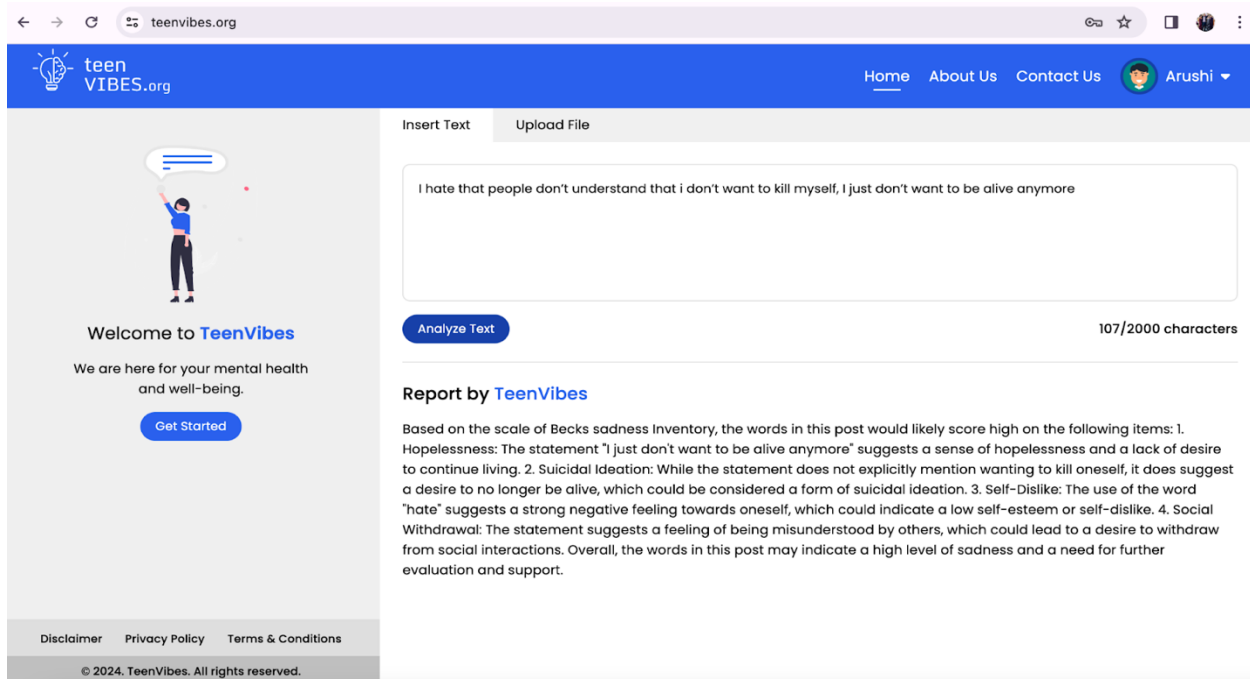
### 2.2 Design Criteria

The software was developed with the below design criteria in mind. To test and ensure data integrity and bias:

1. **Data cleaning:** This involves removing any duplicate or irrelevant data, and ensuring that the data is in a consistent format.
2. **Data validation:** This involves checking the data for errors, such as missing values or outliers, and correcting or removing any invalid data.
3. **Data Sourcing:** To scrape data from Reddit, we will use a Python library such as PRAW (Python Reddit API Wrapper) to access the Reddit API and extract data such as post titles, text, and upvote count. It is important to source data from this subreddit because it is a community of individuals who have shared experiences, providing a valuable source of first-hand information and insights on the subject. Based on our understanding of Reddit's [user agreement](#), we are in compliance with their copyright and intellectual property agreements by not specifically acquiring any ownership rights whatsoever by using parts of their content for our engineering project. Additionally, per the [Fair Use Guidelines](#), we believe the use of a portion of reddit's data collected from their online communication platform is in alignment with the guidelines.
4. **Data normalization:** This involves transforming the data so that it conforms to a common scale, such as converting all values to a 0-1 range.
5. **Data augmentation:** This involves creating new data based on the existing data, such as adding noise to images or rotating objects in the data.
6. **Data anonymization:** This involves removing any personally identifiable information (PII) from the data, such as names or addresses, to protect the privacy of individuals.
7. **Data partitioning:** This involves dividing the data into different subsets, such as training, validation, and testing sets, to ensure that the model is not overfitting or underfitting. We wrote a program to scrape the reddit posts to extract and clean the comments. This scraped data was used to train the model.
8. **Data Versioning:** This involves keeping track of different versions of data set to keep track of changes made to the data, and to be able to revert to previous versions if needed.
9. **Data documentation:** This involves keeping detailed documentation of the data, such as the source, processing steps, and any issues that were encountered, to ensure that the data can be easily understood and used by others.
10. **Data security:** This involves protecting the data from unauthorized access, such as by encrypting the data or restricting access to certain individuals, to ensure that the data is not compromised.

## 2.3 Project Design

This involves protecting the data from unauthorized access, such as by encrypting the data or restricting access to certain individuals, to ensure that the data is not compromised. The project design involved developing a web platform, [TeenVIBES.org](https://TeenVIBES.org), where users can input text or files. The website utilizes an API to call the software program, which employs machine learning algorithms to analyze the input data. The model returns an assessment of the user's mental state based on their communication.



The screenshot displays the TeenVIBES.org website. The header includes the logo, navigation links (Home, About Us, Contact Us), and a user profile for Arushi. The main content area features a 'Welcome to TeenVibes' message with a 'Get Started' button. The central tool has two tabs: 'Insert Text' and 'Upload File'. The 'Insert Text' tab is active, showing a text input field with the text: "I hate that people don't understand that i don't want to kill myself, i just don't want to be alive anymore". Below the input field is an 'Analyze Text' button and a character count of '107/2000 characters'. The 'Report by TeenVibes' section provides a detailed analysis based on the Beck's Sadness Inventory, listing four items: 1. Hopelessness, 2. Suicidal Ideation, 3. Self-Dislike, and 4. Social Withdrawal, each with a brief explanation of how the user's text relates to that item. The footer contains links for Disclaimer, Privacy Policy, and Terms & Conditions, along with a copyright notice for 2024.

## 3. Quality Assurance

To ensure the accuracy and reliability of the model, the following methods were employed.

1. **Sensitivity: Acceptance Criteria:** The model should be able to detect early signs of a condition or event with a high degree of sensitivity (90+%), in order to catch potential issues as early as possible.

*Test Steps:*

1. Use 10+ comments
2. Run through the model

*Success Criteria:* 90%+ comments should closely identify the mental state of the individual

2. **Specificity:** *Acceptance Criteria:* The model should have a high degree of specificity, meaning it should be able to accurately distinguish between different types of conditions or events.

*Test Steps:*

1. Take 20 comments
2. Run through the model

*Success Criteria:* False positives should be less than 10%

3. **Speed:** *Acceptance Criteria:* The model should be able to process data and provide results in a timely manner, as early detection is often critical for effective intervention.

*Test Steps:*

1. Run 50+ comment through the model

*Success Criteria:* The results should be displayed instantly.

4. **Accuracy:** The model should be able to accurately predict the likelihood of a condition or event occurring, to minimize false positives or false negatives.

*Test Steps:*

1. Run 10 comment through the model
2. Review the assessment output

*Success Criteria:* 100% of the output should accurately indicate the mental state of the individual.

5. **Scalability:** *Acceptance Criteria:* The model should be able to handle large amounts of data and be able to adapt to new data sources over time.

*Test Steps:*

1. Run 100+ comment through the model

*Success Criteria:* The model should be able to handle the data set without errors

6. **Robustness:** *Acceptance Criteria:* The model should be able to handle missing or incomplete data and be resistant to noise or bias in the data.

*Test Steps:*

1. Edit 10 comments to emulate missing/ incomplete data
2. Run those comments through our model

*Success Criteria:* >50% of results could be accurate

7. **Explainability:** *Acceptance Criteria:* The model should be able to provide clear explanations for its predictions, in order to facilitate understanding and trust in the system.

*Test Steps:*

1. Run 20+ comments through our model

*Success Criteria:* Explanation from our model using Beck's Inventory should be clear and aligned to predicted results

8. **Integration with existing systems:** *Acceptance Criteria:* The model should be able to integrate with our website, in order to simulate seamless implementation and use.

*Test Steps:*

1. Use our website that is integrated with our model to enter comments

*Success Criteria:* We can get similar results as we would through the model when run directly (Pass/ Fail).

9. **Website performance:** *Acceptance Criteria:* The website should be able to integrate with the AI model and ingest text or text files that will be processed by the model in the backend. Files of .txt format and size less than 1MB or text < 2000 characters should be accepted by the website.

*Test Steps:*

1. Use Test website by ingesting same comments as used to test the AI Model
  - a. as text in a textbox
  - b. as text file upload

2. Check for file format and size and character limits for textbox

*Success Criteria:* We can get similar results as we would through the model when run directly (Pass/ Fail).

10. **Website security and compliance:** *Acceptance Criteria:* The website should be able to integrate with the AI model and ingest text or text files that will be processed by the model in the backend. Files of .txt format and size less than 1MB or text < 2000 characters should be accepted by the website.

*Test Steps:*

1. Test login in page and it should be able to create new login usernames and passwords
2. Check Disclaimer, Terms & Conditions and Privacy Policy pages

*Success Criteria:* We should be able to create user, login, review policy pages and logout (Pass/ Fail)

#### 4. Discussion

The findings from this study highlight the potential of using AI/ML models for early detection of mental health issues in adolescents. The high sensitivity and specificity of the model suggest that it can be an effective tool for mental health professionals and educators. However, the study also emphasizes the importance of addressing ethical considerations, such as data privacy and consent, in the deployment of such technologies.

#### 5. Conclusion

This research demonstrates the feasibility of using AI/ML to analyze adolescents' online communication for early assessment of their mental state. The developed software meets the design criteria and operates within the defined constraints, offering a scalable

and robust solution. Future work could involve expanding the dataset, refining the algorithms, and exploring real-time implementation in educational settings.

## 6. References

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