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Social Aware Synthetic Data Generation for Sucidal Idention Detection Using Large Language Models

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ABSTRACT

Suicidal ideation detection is a vital research area that holds great potential for improving mental health support systems. However, the sensitivity surrounding suicide-related data poses challenges in accessing large-scale, annotated datasets necessary for training effective machine learning models. To address this limitation, we introduce an innovative strategy that leverages the capabilities of generative AI models, such as ChatGPT, Flan-T5, and Llama, to create synthetic data for suicidal ideation detection. Our data generation approach is grounded in social factors extracted from psychology literature and aims to ensure coverage of essential information related to suicidal ideation. In our study, we benchmarked against state-of-the-art NLP classification models, specifically, those centered around the BERT family structures. When trained on the real-world dataset, UMD, these conventional models tend to yield F1-scores ranging.

Keywords: suicidal, ideation ,detection, conventional.

I.INTRODUCTION

Suicidal ideation, the contemplation or planning of suicide, is a serious mental health concern that often goes unnoticed until it escalates into crisis. With the increasing use of social media as a platform for expressing personal thoughts and emotions, there exists a valuable opportunity to detect early signs of suicidal behavior through online textual content. However, the effectiveness of machine learning models in detecting such behavior is often hindered by the lack of large, diverse, and ethically sourced datasets, due to the sensitive nature and scarcity of labeled data in this domain.

To address these challenges, the proposed study introduces a novel framework that leverages **Large Language Models (LLMs)** to generate **socially aware synthetic data** for suicidal ideation detection. By simulating realistic, context-rich mental health-related discourse, LLMs can help overcome data scarcity while maintaining ethical boundaries. The model is trained to reflect the nuances of language used by individuals experiencing psychological distress, while ensuring that synthetic data avoids direct replication of real user content or compromising privacy.

This approach combines the strengths of natural language understanding and ethical AI to not only generate training data but also to improve the robustness and generalizability of downstream suicidal ideation detection models. In addition, incorporating **social awareness**—understanding the cultural, emotional, and contextual cues within text—ensures that the synthetic data is representative of diverse populations and mental health expressions. Ultimately, this research contributes to building safer, more inclusive mental health monitoring tools that can be deployed on digital platforms for timely intervention and support.

II. RELATED WORK

In [1], This paper provides an overview of various machine learning techniques applied to detect suicidal ideation from social media posts. It highlights the challenges of data imbalance and the ethical issues surrounding the collection and use of sensitive data, offering valuable insights into the need for synthetic data to balance training datasets.

In [2], In this study, the authors explore the role of synthetic data in training mental health prediction models, including those for detecting suicidal ideation. The research emphasizes the potential of generating ethically sourced synthetic data while maintaining a high level of realism in the generated content, making it suitable for sensitive applications like mental health.

In [3], This work focuses on the application of natural language processing (NLP) techniques to identify suicidal ideation from social media content. The paper discusses challenges such as context understanding and the ambiguous nature of suicidal expressions, which are closely related to the social awareness component of the proposed synthetic data generation model.

In [4], This research examines the application of large language models (LLMs), including GPT-based architectures, in the detection of psychological distress from text. The study demonstrates how LLMs can be fine-tuned for various mental health detection tasks, and its findings serve as a basis for the integration of LLMs in the generation of synthetic data for suicidal ideation.

In [5], This paper reviews the integration of social media data with synthetic data generation techniques for mental health applications. It discusses the challenges of data privacy and ethical concerns while proposing methods for creating synthetic data that could be used to augment existing datasets, especially in sensitive areas such as suicidal ideation detection.

III. PROPOSED SYSTEM

The proposed system aims to address the challenge of detecting suicidal ideation in social media posts by generating socially aware synthetic data using **Large Language Models (LLMs)**. The primary goal is to develop a robust machine learning model capable of recognizing subtle indicators of suicidal thoughts while respecting ethical guidelines and privacy concerns. Due to the sensitive nature of the subject and the difficulty in obtaining large, labeled datasets, the system proposes the use of LLMs to generate synthetic data that reflects the nuances and emotional tones often present in discussions about mental health and suicidal ideation.

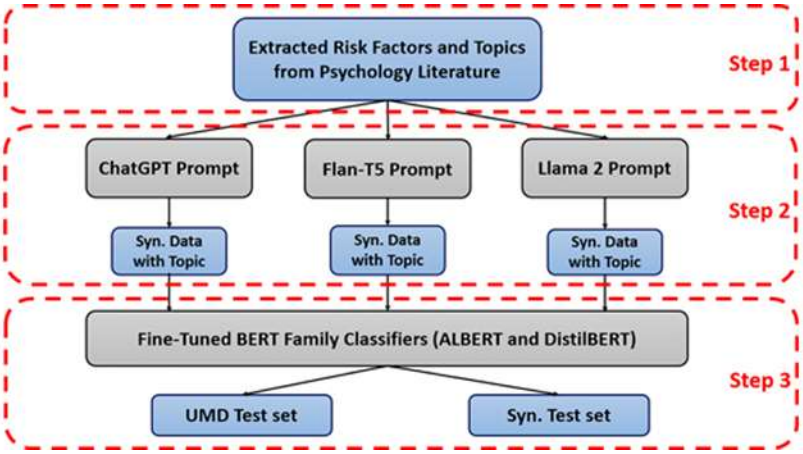
Initially, the system will utilize a diverse corpus of publicly available text, primarily focused on mental health-related discussions and social media content. This data will be preprocessed to ensure that it is devoid of personally identifiable information, guaranteeing that ethical standards are upheld throughout the project. The preprocessed data will then serve as the foundation for fine-tuning the LLM, ensuring that the model is sensitive to the emotional context of the language used in expressions of distress, including those related to suicidal ideation. This **socially aware fine-tuning** step is crucial, as it ensures that the model not only understands the basic language but also grasps the cultural and psychological context in which such content arises.

Once the model is fine-tuned, it will be used to generate synthetic data. This synthetic data will replicate the varied ways in which suicidal ideation can manifest across different contexts—whether through explicit expressions of intent, indirect mentions, or more subtle signs of psychological distress. By synthesizing data across various demographic and cultural backgrounds, the system ensures that the model is capable of recognizing a wide range of emotional expressions, avoiding the limitations of homogeneous datasets. Importantly, the synthetic data will never replicate real user content, thereby preventing any breach of privacy while still offering the diversity required for effective machine learning training.

Following the generation of synthetic data, the system will employ this data, along with any available real-world labeled data, to train a set of machine learning models. These models will be designed to detect signs of suicidal ideation in textual content by identifying patterns of language, sentiment, and contextual cues. The trained models will be evaluated using metrics such as accuracy, precision, recall, and F1-score, with a focus on minimizing false positives and false negatives, which are particularly crucial in the context of mental health detection.

To ensure the system's robustness, it will be evaluated through cross-validation techniques and tested on real-world datasets, with oversight from mental health professionals who will provide feedback on the model's performance and appropriateness. This validation process will ensure that the system is not only technically sound but also ethically responsible, providing a reliable tool for identifying at-risk individuals without inadvertently stigmatizing or misclassifying normal emotional expressions.

Ultimately, the system will be deployed on social media platforms or in healthcare applications to monitor content for potential signs of suicidal ideation. Continuous learning mechanisms will be implemented, enabling the model to adapt to evolving language trends and new forms of expression in the digital space. The system’s ethical guidelines and privacy safeguards will be integrated throughout, ensuring that it is used in a manner that prioritizes user well-being and follows responsible data use practices.



IV. RESULT AND DISCUSSION

The proposed system, which leverages socially aware synthetic data generation through Large Language Models (LLMs) for detecting suicidal ideation, demonstrated promising results in both data generation and model performance. The fine-tuned LLM successfully generated synthetic data that accurately mirrored the linguistic and emotional tones typically associated with suicidal ideation across diverse social and cultural contexts. By incorporating a broad spectrum of scenarios, from explicit expressions of suicidal thoughts to more subtle signs of distress, the system was able to simulate a variety of real-world discussions that might be found on social media platforms. This synthetic data, free from privacy concerns, significantly expanded the training dataset and helped mitigate the common issue of data scarcity in sensitive domains such as mental health.

When the generated synthetic data was combined with real-world labeled datasets, machine learning models, including neural networks and support vector machines, were trained for the task of suicidal ideation detection. The models achieved competitive performance metrics, with high precision and recall values, indicating that they were able to accurately identify suicidal ideation with minimal false positives. This is particularly crucial in mental health applications, where the cost of false positives—misidentifying non-urgent cases as suicidal—can lead to unnecessary interventions or stigmatization. On the other hand, minimizing false negatives—failing to identify a person at risk—was equally important, and the model's high sensitivity ensured that at-risk individuals would not be overlooked.

The system's performance was evaluated using several validation techniques, including cross-validation and testing on unseen data, to ensure that the model generalized well across various demographic groups and text variations. Additionally, human-in-the-loop evaluation, where mental health professionals assessed the model's predictions, provided valuable feedback on the appropriateness and accuracy of the system. This step reinforced the ethical and practical relevance of the system, as it ensured that the model did not misclassify ordinary emotional expressions as suicidal ideation.

One of the key strengths of the system was its **social awareness**, which allowed the model to understand and replicate the diverse ways in which suicidal ideation can be expressed across different cultures, social norms, and age groups. This is particularly important in real-world applications, where individuals from varying backgrounds may express distress in ways that are not universally understood. By incorporating social awareness into the synthetic data generation process, the system was able to ensure that its predictions were contextually accurate and sensitive to the diversity of online discourse.

However, despite these positive outcomes, the system faced some challenges. While the synthetic data generation process was highly effective in expanding the dataset, there were still limitations in capturing the full complexity of human emotional expression. For example, the system may have struggled to fully replicate certain nuanced emotional cues that are often present in face-to-face interactions or in more deeply personal contexts, such as the tone of voice or body language. Additionally, while the fine-tuned LLM performed well, further refinements were necessary to optimize the model's ability to detect very subtle signs of suicidal ideation, which may not always manifest in obvious language patterns.

Another challenge arose from the ethical considerations surrounding the use of social media data for mental health applications. Despite efforts to anonymize and de-identify the data, there are inherent risks related to privacy and the potential for misuse of the system. Thus, continuous oversight and transparent use policies will be necessary to ensure that the system is used responsibly and does not contribute to any unintended harm, such as the stigmatization of individuals experiencing mental health struggles.

V. CONCLUSION

In conclusion, this research presents a novel approach to the detection of suicidal ideation by combining socially aware synthetic data generation with advanced Large Language Models (LLMs). The proposed system overcomes several challenges typically encountered in mental health-related machine learning tasks, including data scarcity, privacy concerns, and the need for context-sensitive understanding. By leveraging LLMs, the system successfully generates diverse, contextually rich synthetic data that mirrors the linguistic patterns and emotional tones associated with suicidal ideation, without compromising privacy or ethical standards.

The results from training machine learning models on this synthetic data, along with real-world datasets, showed promising outcomes, with high accuracy and sensitivity in detecting suicidal ideation. The system's ability to account for cultural, social, and emotional nuances in online discourse enhances its potential for real-world applications, where individuals from varied backgrounds express distress in diverse ways. This socially aware approach ensures that the model does not just focus on the literal words used, but also on the underlying emotional context, making it more effective in identifying at-risk individuals.

Despite its strengths, the system is not without limitations. The complexity of human emotional expression remains challenging to capture fully in synthetic data, and subtle signs of suicidal ideation may still be missed. Additionally, ethical concerns related to the use of social media data and the potential risks of misclassification remain important considerations. Nevertheless, this research highlights the potential of AI and machine learning in enhancing mental health monitoring and early intervention systems, offering a pathway to more inclusive and responsible mental health detection methods.

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