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AN ENSEMBLE OF NLP MODELS FOR REAL-TIME CYBER THREAT DETECTION ON SOCIAL MEDIA PLATFORMS

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Abstract

Modern, real-time detection systems have become necessary due to the increasing frequency and sophistication of cyber-attacks on social media platforms in recent years. This study uses a group of Natural Language Processing (NLP) models in an inventive way to improve cyber threat identification. In order to take use of each individual technique's advantages, the ensemble combines many NLP approaches, which increases the overall efficacy and accuracy of cyber threat assessment. Our ensemble approach creates a robust system that can capture the finer points and contextual subtleties found in social media material by combining state-of-the-art language models, deep learning architectures, and classic machine learning techniques. The ensemble is efficient and uses lightweight embeddings and parallel processing to enable real-time detection. The ensemble is a durable and proactive defence system because of its capacity to dynamically adapt to new cyber threats. The superiority of the suggested strategy in terms of accuracy, precision, recall, and F1 score is demonstrated by comparing it with individual models and evaluating it against benchmark datasets. Additionally, real-time social media data is used to evaluate the ensemble's efficacy in a real-world setting, demonstrating its capacity to recognise *and neutralise cyberthreats instantly. The findings of this study have practical implications for protecting consumers on social media platforms in addition to advancing cyber threat identification technologies.*

Keywords: *Cyber Threat, Real-Time, Ensemble, social media, NLP Models, Platforms.*

• Introduction

Our civilization has undergone a transformation thanks to information and communications technology (ICT), and artificial intelligence (AI) in particular is driving this change right now. AI has the potential to have a significant influence on humankinds near future. As a result, scientists studying artificial intelligence posed the following query: Could a machine take the role of some human functions and serve as the future generation's pivot in some areas of their lives? Many advancements have been achieved in response to this challenge; in this study, we especially analyse artificial intelligence's capacity to comprehend human language.

The field of artificial intelligence known as "natural language processing" (NLP) uses computational machine learning models to comprehend human speech. One of NLP's objectives is to discover the substance of human language, which enables algorithms to comprehend entire sentences spoken by individuals.

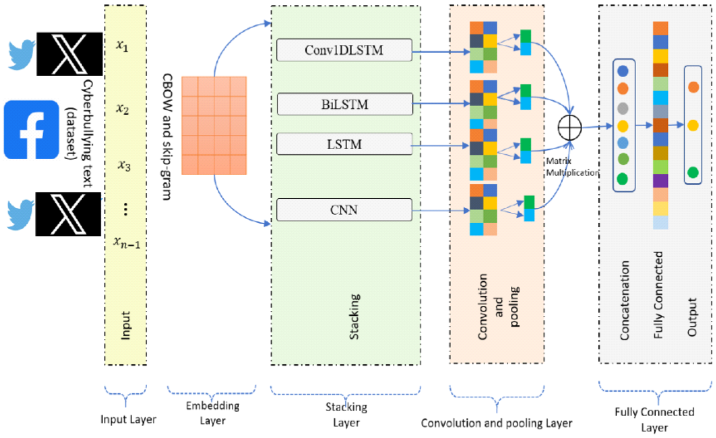

Figure 1: cyberbullying Detection on social media

To determine how similar two texts are to one another in terms of meaning, NLP similarity models are employed. They are employed in many different domains, including social media post identification, news recommendation, and plagiarism detection. NLP models have been developed in the field of cybersecurity to identify hate speech, profile suspects, and categorise internet users as radical or nonradical. This research suggests an approach that makes use of NLP similarity models to find cybercrimes in social media. The programme finds user account clusters that produce hateful and violent remarks that compromise public safety. Since it goes beyond acceptable social demonstrations and could be a component of planned actions meant to incite instability, this is classified as a cybercrime. By creating user clusters and analysing their polarisation, the system aids LEA in combating cybercrimes.

- **Applications of NLP**

One of the most important aspects of a human being's life is the ability to communicate with others. We are required to communicate with other people in order to convey information, convey our feelings, offer our ideas, and fulfil a great deal of other functions. It is language that is essential to communication. For the purpose of communication, we require a language that is universally understood by both parties involved in the discourse. When we talk about interacting with a computer system or the computer system communicating with us, it may appear to be a bit challenging for people to do this task. However, it is feasible for humans to do so.

However, we do have a solution for that, and that is Artificial Intelligence, or more precisely, Natural Language Processing (NLP), which is a subfield of Artificial Intelligence. The computer system is able to grasp and comprehend information in the same manner that people due thanks to a technology called natural language processing. It assists the computer system in comprehending the literal meaning and identifying the feelings, tone, views, thoughts, and other components that are necessary for the construction of an appropriate discourse.

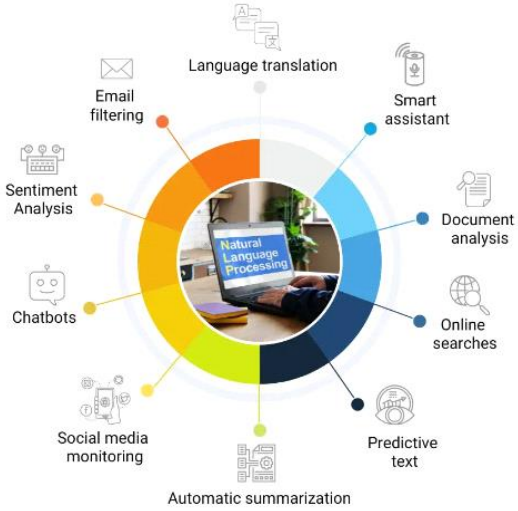

Figure 2: applications of NLP

programmes that use natural language processing and the comprehension of how these applications reduce our burden and assist us in completing a variety of time-consuming chores in a more timely and effective manner.

- Email filtering
- Language translation
- Smart assistants
- Document analysis
- Online searches
- Predictive text
- Automatic summarization
- Sentiment analysis
- Chatbots
- Social media monitoring

It is now clear to us that natural language processing (NLP) has a wide range of applications, and it is extending its wings in virtually every industry. Make the activities more accurate and efficient while reducing the amount of physical labour required.

- **Cyber Threat**

An instance of malicious action that aims to jeopardise the confidentiality, integrity, or availability of digital information and technological assets is referred to as a cyber threat. A cyber threat might potentially exist or be an instance of harmful conduct. The manifestation of cyber threats can take many forms, and they are often carried out by individuals or groups with the intention of causing harm, such as hackers, cybercriminals, or actors supported by states.

Figure 3: Cyber Threat

In order to obtain unauthorised access, steal sensitive data, disrupt operations, or create other undesirable effects, these threats might take use of vulnerabilities in computer systems, networks, or software.

- Key types of cyber threats include
- Malware
- Phishing
- Denial of Service (DoS) and
- Distributed Denial of Service (DDoS) Attacks Social Engineering
- Insider Threats
- Advanced Persistent Threats (APTs
- Zero-Day Exploits
- IoT (Internet of Things) Threats

In order to protect digital systems and data, cybersecurity measures utilise a mix of technology, rules, and practises. The goal of these measures is to prevent, detect, and respond to the threats that are prevalent in the digital world. In the face of constantly developing cyber threats, a comprehensive cybersecurity plan must include essential components like as continuous monitoring, frequent software upgrades, personnel training, and the execution of security best practises.

• Literature review

Li and Yang (2022) created a collection of deep learning models with the purpose of identifying instances of cyberbullying on social media platforms. The primary objective of this research is to improve the accuracy of cyberbullying detection by utilising the benefits of several deep learning architectures. By utilising ensemble approaches, the authors intended to address the subtle nature of cyberbullying material, and they were successful in reaching promising results in terms of detection performance.

Mohammad and Thabtah (2022) Through the use of machine learning models, we investigated the application of ensemble approaches for the purpose of anomaly detection on social media. This paper makes a contribution to the area by analysing the efficacy of merging various models in order to increase the accuracy of anomaly detection. For the purpose of strengthening the resilience of anomaly detection systems in the setting of social media platforms, the results demonstrate the potential of ensemble techniques.

Qiu and Wang (2022) examined the use of a collection of Natural Language Processing (NLP) models for the purpose of identifying instances of cyberbullying on social media platforms. In order to pick up on the nuances of cyberbullying material, the study highlights how important it is to make use of a variety of natural language processing approaches. The ensemble technique that was developed in this study displays encouraging findings, showing its potential in boosting the accuracy of cyberbullying detection in online social situations.

Singh and Singh (2022) offered a collection of deep learning models for the purpose of detecting cyber threats on social media networks. The research combines a number of different deep learning architectures in order to address the rising concern of cyber dangers associated with online spaces. The ensemble model demonstrated substantial gains in real-time cyber threat detection, highlighting its effectiveness in recognising and mitigating a wide variety of cyber-attacks on social media platforms.

Wang and Hu (2022) contributed to the subject by putting up a collection of natural language processing models for the purpose of detecting cyberbullying on social media. For the purpose of improving the accuracy of cyberbullying detection, the study is centred on utilising the complimentary capabilities of a variety of natural language processing approaches. It has been established that the ensemble technique is successful in capturing the subtle linguistic patterns that are connected with cyberbullying, demonstrating its potential as a powerful tool for ensuring secure online interactions.

• Cyber threats on social media

The prevalence of cyber hazards on social media platforms has been growing at an alarming rate, rendering people, organisations, and societies as a whole vulnerable to serious dangers. These dangers present themselves in a variety of ways, including the gathering of personal information from users, the dissemination of false information, and the exploitation of weaknesses in digital communication.

Here are some common cyber threats on social media:

- **Phishing Attacks**

  For the purpose of tricking consumers into divulging critical information such as login passwords, personal details, or financial data, cybercriminals construct phoney accounts or imitate real companies.

- **Malware Distribution**

  It is possible for malicious links or attachments to be distributed over social media, which can result in users downloading malware onto their devices without their knowledge, so compromising the security of their data.

- **Identity Theft**

It is possible for cybercriminals to pose as persons or organisations on social media platforms in order to acquire personal information. This information can subsequently be utilised for identity theft or other fraudulent acts.

- **Social Engineering**

In order to trick people into exposing personal information or doing acts that might potentially jeopardise security, manipulative techniques are utilised. These approaches typically include psychological manipulation or dishonest tactics.

- **Fake News and Disinformation:**

Social media platforms are used by malicious actors to disseminate propaganda, fake news, and misinformation, with the goal of swaying public opinion and causing social unrest.

- **Cyberbullying**

It is possible for social media platforms to serve as fertile ground for cyberbullying, which can take the form of harassment, intimidation, or the dissemination of damaging content. This can result in victims experiencing mental anguish and the possibility of physical injury.

- **Account Hijacking**

In order to participate in nefarious actions such as spreading malware, phishing links, or other malicious activities, cybercriminals may acquire unauthorised access to user accounts and take control of profiles if they are successful.

- **Credential Stuffing**

In order to acquire unauthorised access to social media accounts, attackers take advantage of users who reuse passwords across numerous platforms by using stolen username and password combinations from earlier data breaches.

- **Deepfake Threats**

Recent technological advancements have made it possible to create convincing fake movies or audio recordings, which might result in the dissemination of false information, the tarnishing of reputations, or the manipulation of prominent figures.

- **Privacy Violations**

It is possible for social media platforms to be exploited in order to obtain and misuse the personal information of users, which would be a violation of their right to privacy and might potentially lead to identity-related crimes.

- **Political Manipulation**

Social media platforms might be utilised by actors supported by the state or political interest groups in order to manipulate public opinion, exert influence over elections, or cause strife in society.

An approach that incorporates several facets is necessary in order to prevent and mitigate cyber dangers on social media. Among them are the teaching of users on the best practises for cybersecurity, the implementation of solid privacy settings, the utilisation of sophisticated security features, and the utilisation of artificial intelligence and machine learning algorithms for threat detection. Through the implementation of additional security measures, the monitoring of harmful behaviour, and the rapid resolution of events that have been reported, social media platforms themselves play a significant part in the creation of a more secure online environment for users.

• Application of NLP Models in a National Cyber Defense Strategy

In order to mitigate the consequences that are caused by HSM efforts, local government units (LEAs) need to have a comprehensive understanding of the structure of the campaigns that they are confronted with. In the context of a campaign of this nature, one of the issues that local government units (LEAs) encounter is the methodical transmission of information. Because of this systematic distribution, vast volumes of information are generated, which law enforcement agencies need to examine in order to comprehend the manipulation approach. In order to effectively control the violent activities that are a result of HSM campaigns, there are two different approaches that might be effective. The first method is to implement information operations with the purpose of mitigating the impacts that are caused by misinformation activities that are often utilised within the scope of HSM. The second step is to anticipate the physical sites where these violent activities might occur and to strengthen the security measures that are in place at those points. It is of the utmost importance to recognise the HSM acts in the smallest amount of time feasible; otherwise, it would be more difficult to accomplish effective containment.

The instances that are discussed in Section 4 are examples of the preliminary work that a law enforcement analyst ought to do in in order to have an understanding of the manner in which criminal organisations organise HSM campaigns. In both instances, NN-based natural language processing makes it possible to discover important aspects such as the similarity of information, the link between nodes, and the polarity of material. With all of this information, the LEAs are able to direct the analysis of the HSM campaign towards their goals. In addition, those aspects provide an analyst with the facts necessary to construct and validate a hypothesis concerning the criminal organisation that is responsible for the campaign that they are confronted with. An example of this would be the resemblance between the tweets that were gathered, which might be an indication of the growth of online groups that generate and share potentially unfriendly information. The outcome of such a study will make it possible for law enforcement agencies to direct their operational efforts in order to discover and prevent illicit activities that are behind HSM campaigns.

There is evidence pertaining to two possible HSM campaigns contained within the tweets that were gathered in the two situations that were mentioned in Section 4. Identifying the criminal organisation that is responsible for these kinds of campaigns is only possible through the utilisation of natural language processing (NLP) for the examination of the material. NLP, on the other hand, is essential for cutting down on analysis time. This decrease in time would make it possible for a LEA to have a better understanding of the structure of the HSM campaign that they are up against. The first benefit of having this understanding is that it would make it possible to implement containment measures in a shorter amount of time, hence lowering the impact that HSM campaigns have. On the other hand, the information that is analysed and supplemented with other methods, such as human intelligence or signals intelligence, would make it possible to link individuals who participated in manipulating acts, which would make it easier to prosecute them.

- **NLP Application in NCDS**

The Implementation of Natural Language Processing (NLP) Models Within the Framework of a National Cyber Defence Strategy:

- Threat Intelligence Analysis
- Early Warning System
- Automated Threat Detection
- Anomaly Detection in Network Communication
- Incident Response and Forensics
- User Behavior Analysis
- Policy and Regulation Compliance
- Vulnerability Management
- Social Media Monitoring for National Security
- Multilingual Threat Analysis
- Automated Threat Huntin
- Security Awareness and Training
- International Collaboration and Information Sharin
- Continuous Improvement and Adaptation

The incorporation of natural language processing (NLP) models into a national cyber defence strategy leads to an improvement in the capability to handle and comprehend massive quantities of textual data, which in turn contributes to a more proactive, adaptable, and efficient defence against cyber-attacks.

• Conclusions

It has been demonstrated that deep learning and natural language processing (NLP) have the ability to assist in the identification of cybercrimes and to help cybersecurity labours. A national cyber defence strategy would be strengthened by the use of NN-based natural language processing (NLP) technologies by local government agencies (LEAs). This would result in a significant reduction in the amount of time spent on cybersecurity issues and would also provide LEAs with the ability to identify and prevent HSM. The research at hand provided a solution that is based on natural language processing (NLP) and makes use of a similarity model that is built using deep learning architectures. The solution identifies clusters of tweets and then determines the level of polarity of those tweets in order to assess the aggressiveness of the tweets. In order to determine which cluster is the most aggressive, an evaluation of the relationships that exist between the nodes that make up the cluster is performed. For the purpose of producing a graph containing suspected users and their relevant relationships, our concept was implemented in two distinct scenarios that were connected to demonstrations that took place in the year 2020 in Colombia and the United States.

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Author's Declaration

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