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Analysing Child Sexual Abuse Activities in the Dark Web based on an Efficient CSAM Detection Algorithm

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Abstract: *Child sexual abuse material (CSAM) activities are prevalent on the Dark Web to evade detection, posing a global challenge for law enforcement. Our objective is to analyze CSAM discussions in this concealed space using a Support Vector Machine model, achieving an accuracy of 87.6%. Across eight forums, approximately 28.4% of posts contained CSAM, with victim ages most commonly reported as 12, 14, 13, and 11 years old for YouTube, Skype, Instagram, and Facebook, respectively. Additionally, in forums discussing boys, the most frequently mentioned nationalities in CSAM posts were English, German, and American, accounting for 12%, 7.8%, and 6% of all nationalities, respectively.*

Keywords: CSAM analysis, supervised learning, Dark Web post, social media and mental health

1. Background: Producing, distributing or discussing child sexual abuse materials (CSAM) is often committed through Dark Web to be hidden from search engines and regular users [1]. The large volume of CSAM in Dark Web is a global social problem and a significant challenge for law enforcement agencies [2].

2. **Objective:** To identify CSAM discussions on the Dark Web and uncover associated metadata, our goal is to gain insights into the characteristics, behaviors, and motivations of perpetrators, ultimately contributing to a more comprehensive understanding of the illicit activities occurring in these hidden online spaces.

3. **Method:** We developed a set of supervised learning models using classical and deep learning techniques for identifying CSAM user text posts in Dark Web forums. The supervised models have implemented several ML and DL algorithms, including NB, LR, SVM, CNN, LSM and BERT algorithms. These were trained and applied to eight Dark Web forums that are associated with CSAM activity, using forum posts in 2022. The forum names are *boyvidsV6*, *pedosupport*, *amorzinho*, *resistance*, *boysrus*, *naughtykids*, *pharos* and *nymphetomania*, such as Table 1.

Table 1. Site names and their post total.

| | | | | |
|------------------------|------------|--------------|-----------|---------------|
| Site | boyvids-V6 | pedo-support | amorzinho | resistance |
| Number of posts | 132,274 | 18,617 | 21,588 | 23,695 |
| Site | boysrus | naughtykids | pharos | nymphetomania |
| Number of posts | 18,166 | 5,508 | 1,641 | 387 |

4. Result:

The CSAM classifier based on Support Vector Machine model performed the best in terms of classification performance with an accuracy of 87.6% and a prediction time of 0.3 milliseconds for a post in our laptop. Across the eight forums, approximately 28.4% of the posts were found to contain CSAM. The analysis revealed several meaningful relationships, such as forum usage, platforms used to distribute CSAM, victim nationalities and ages. For example:

- The forums with the highest proportions of CSAM posts were “pedo-support” (45.4%), “anorzinho” (29.4%) and “boyvids-v6” (28.1%).
- In forums discussing boys, the most commonly discussed nationalities in CSAM posts were English, German, and American, with 12%, 7.8%, and 6% of all nationalities, respectively. Figure 1 displays distribution

of CSAM posts based on the percentages per victim age, ranging from 1 to 17 years old, for the top 18 victim nationalities. Among these nationalities, victims at the age of 12 were most frequently mentioned in 12 out of 18.

- There are many popular platforms used to distribute CSAM in Dark Web, such as YouTube, Skype, Instagram, Facebook, Twitter, TikTok and others. The most common victim ages were 12, 14, 13 and 11 year olds for YouTube, Skype, Instagram and Facebook, respectively. Figure 2 presents the distribution of CSAM posts mentioning different social media platforms, specifically focusing on the 22 most active CSAM creators of these platforms. The analysis encompasses famous social media platforms, e.g. Facebook, Instagram, Skype, TikTok, Twitter, WhatsApp and YouTube. Certain CSAM creators exhibit a significant concentration of their CSAM posts on a specific social media platform, accounting for over 80% of their total CSAM posts.

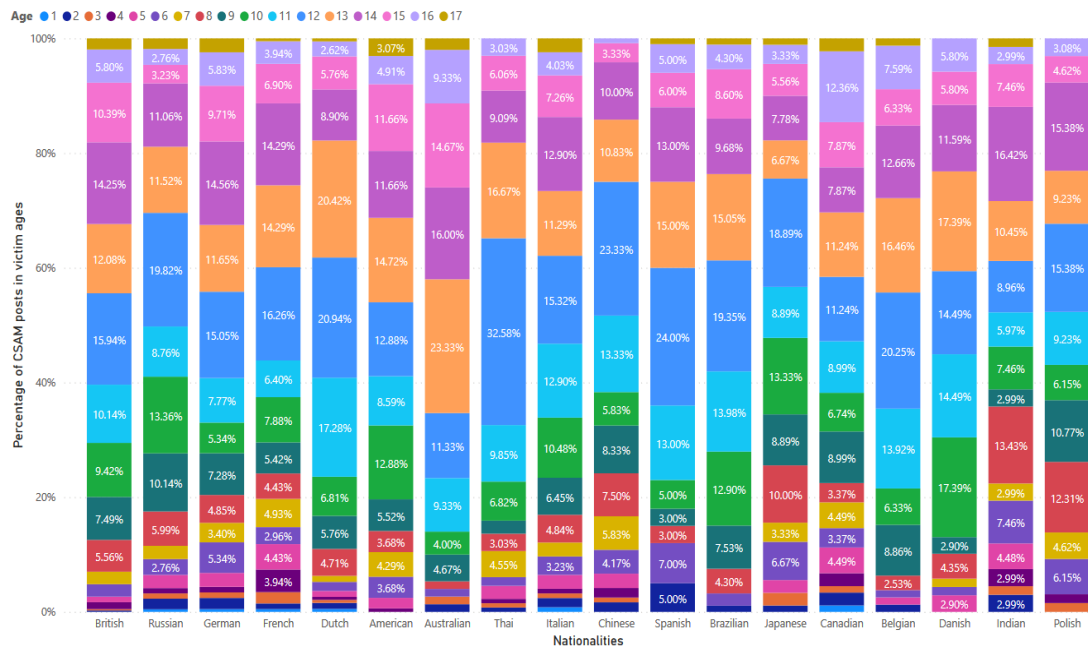


Figure 1. Percentages of CSAM posts per victim age in the top 18 victim nationalities described in the posts

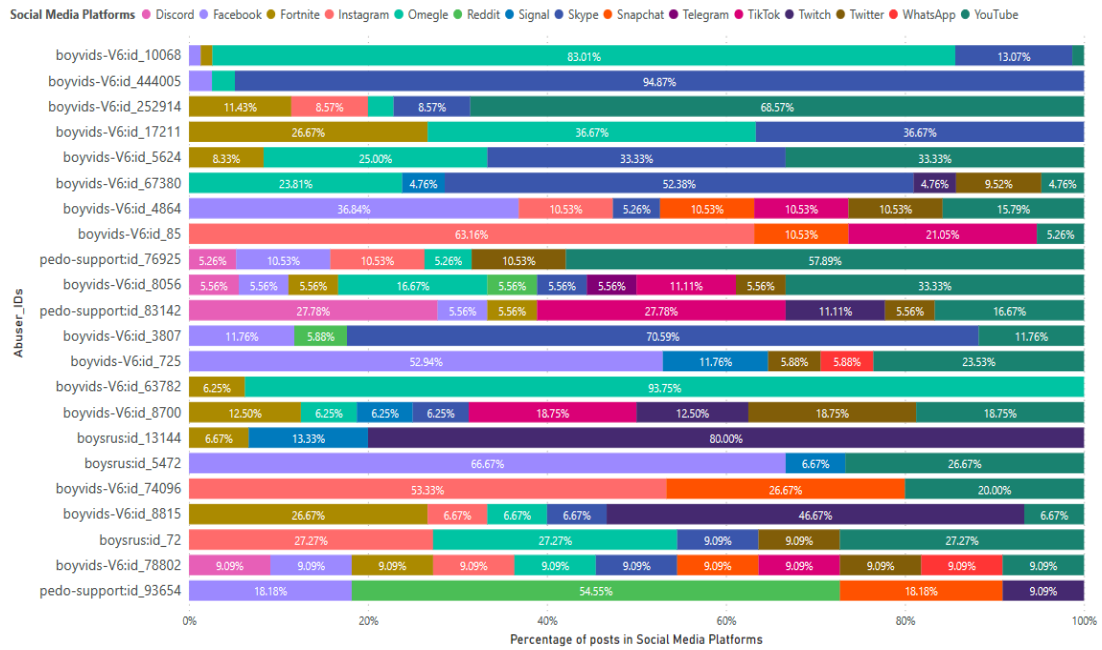


Figure 2. Percentages of the CSAM posts in social media platforms mentioned by the 22 most active CSAM creators of the platforms in 2022

5. Conclusion: Our model can enable a real-time monitoring of CSAM in social network platforms, extracting valuable and unique insights from CSAM posts using statistical methods which are beneficial to national hotlines and child agencies.

6. Future work: As part of our upcoming initiatives, we will concentrate on identifying named entities [3], synonyms [4], and opinions [5] within CSA text. This endeavor aims to extract essential concepts that will significantly contribute to the development of our machine learning models [6]. Furthermore, there are plans to utilize a data warehouse [7] for storing CSAM data collected from various sources.

Biography:

Vuong M. Ngo received a B.E, M.E and Ph.D. degrees in Computer Science from HCMC University of Technology in 2004, 2007 and 2013 respectively. Currently, he is a Senior Researcher in Data Science at School of Computer Science, TU Dublin. Previously, he was a Researcher in Free University of Bozen/Bolzano, University College Dublin and Trinity College Dublin.

Christina Thorpe graduated with a B.Sc. in Computer Science from University College Dublin in 2005, and Ph.D. in Computer Science from University College Dublin in 2011. She is currently the Head of Cybersecurity in the Technological University Dublin.

Susan McKeever is a senior lecturer at TU Dublin School of Computer Science. She holds a Bachelor of Engineering from TCD, an MSc from TU Dublin and a PhD from UCD in 2011. Her main research areas are in the area of machine learning including deep learning, activity recognition, text mining, evidence theory and the general domain area of data analytics. She is also a collaborator in the CeADAR research group (Centre for Applied Data Analytics). Prior to joining TU Dublin, Susan worked in IT sector, including Accenture as an IT Consultant, and as a contract project manager.

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