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Student Name: Saima Saleem
Supervisor Name: Prof. Monica Mehrotra
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Department: Computer Science

Findings

This thesis utilized state-of-the-art artificial intelligence techniques to develop automated methods for extracting disaster-related useful information from social media platforms to facilitate disaster response. Recognizing the inherent challenges posed by unstructured social media textual data, this thesis developed robust classification systems based on transformer language models, which excel at understanding context and can precisely detect disaster-related useful information from social media data. A new context-aware transfer learning approach based on DistilBERT is proposed to offer an effective and computationally efficient solution to discern disaster informative content amidst a vast number of irrelevant posts, thereby helping with the information overload problem. The proposed approach integrates DistilBERT with a Feed Forward Neural Network (FFNN) and employs multistage finetuning of the model on labeled benchmark datasets of real-world disasters, enabling us to achieve high accuracy while maintaining computational efficiency due to its small size and simple architecture.

Additionally, identifying and categorizing various humanitarian information from social media is crucial for enabling more targeted and effective disaster response. By distinguishing between different types of humanitarian needs, such as requests for aid, damage reports, or volunteer coordination, responders can act more efficiently and allocate resources where they are most needed. Moreover, to ensure rapid disaster response, models must be capable of real-time deployment on resource-constrained devices such as smartphones. To that end, we propose an approach that emphasizes computational efficiency and reduced training time, enabling rapid extraction of critical information. A deep lightweight transformer-based framework DeLTran15 is proposed for categorizing X posts shared during disasters into multiple humanitarian information categories. It evaluates the performance of various lightweight language models, each with fewer than 15 million parameters, to identify the best lightweight model for the classification of X posts through transfer learning. Additionally, we propose quantization of the most effective lightweight model to reduce its size without compromising performance, making it suitable for deployment on resource-constrained devices, facilitating prompt decision-making, and significantly enhancing the effectiveness of disaster response efforts.

In the early hours of a disaster, obtaining situational information is crucial. While supervised methods show promise, the availability of labeled disaster data is often limited, leading to cold-start issues in supervised models and making real-time classification challenging. Acquiring sufficient labeled data during the early stages of a disaster is complex and often hindered by resource or budget constraints. This process can take several hours, leading to delays in training and prediction tasks. To address the cold-start issue, this thesis explores unsupervised learning and domain adaptation approaches. We propose an analytical framework for analyzing texts and images shared during disasters, which utilizes BERTopic to identify key topics emerging in real-time, aiding in the understanding of the evolving situation. Additionally, we employ EfficientNet CNN with iterative self-training domain adaptation to assess damage severity from images without the need for labeled data. To further enhance real-time image classification, we introduce an advanced adversarial domain adaptation approach, integrating Vision Transformer (ViT) with adversarial learning.

This thesis also contributes to disaster informatics research by proposing a first-ever dataset (ForgeDisaster) for disaster image forgery detection. Also, a classification system for assessing the veracity of social media images shared during disasters is proposed. The system is designed to filter out fake content specifically forged disaster images, ensuring that only reliable information is utilized in decision-making processes.

In conclusion, this thesis has demonstrated the transformative potential of integrating social media and AI to enhance disaster response efforts. By harnessing advanced AI techniques, the research has enabled efficient, real-time extraction, classification, and analysis of disaster-related information, significantly enhancing situational awareness and supporting timely, data-driven decision-making. The proposed approaches not only address critical challenges in disaster response but also offer practical solutions that can be deployed in real-world scenarios, providing substantial support to disaster responders. This integration underscores the pivotal role of AI in tackling humanitarian crises, paving the way for more robust and adaptive disaster response system.