

Multimodal Social Media Data Learning and Visualization for Hurricanes

Chenxiao (Atlas) Guo, Qunying Huang

ABSTRACT:

The recent advancements in spatial analytics and geospatial artificial intelligence (GeoAI) have unveiled new horizons for leveraging social media data in realm of natural disaster management. Focusing on Twitter (now X), a widely recognized platform, this research highlights how user-generated textual contents and associated images can offer invaluable spatiotemporal insights, aiding in disaster response efforts and bolstering community resilience. Despite the acknowledged potentials of social media data in emergency management, there is an evident gap in comprehensive studies that integrate GeoAI and cartographic visualizations to swiftly mine and utilize this data for enhancing situational awareness.

The advent of cutting-edge machine learning technologies, especially those facilitating the processing of multimodal data, suggest significant prospects for enriching disaster management applications. A prime example of such innovation is the Contrastive Language–Image Pre-training (CLIP) model developed by OpenAI, which synergizes text and image analysis in a unified framework, thus enabling emergency responders and decision makers to gain a deep and more nuanced understanding of crises for timely and adaptive interventions.

This study employs multiple hurricane incidents to evaluation and compare the effectiveness of various machine learning models in processing and integrating Twitter’s text and image data. The findings affirm that the multimodal approach, particularly through the use of the CLIP model, excels in performing crucial tasks relevant to disaster management such as informativeness evaluation, humanitarian category classification, and damage severity assessment. After the validation process, the proposed multimodal method is then implemented to extract disaster relevant information from a distinct Twitter dataset collected during Hurricane Harvey in 2017. The enumerated results of tweets, integrated with spatiotemporal information, are utilized to generate a suite of static and dynamic cartographic visualizations, which serve to reveal a more comprehensive understanding of the complex dynamics in this disaster event.

In conclusion, this research demonstrates that the application of CLIP multimodal data mining method stands out as a powerful tool for integrating the user-generated texts and images in social media, enhancing the disaster management capabilities by offering crucial information extractions and cartographic visualizations, paving the way for future advancements in the field of natural disaster management.

KEYWORDS: *social media, multimodal machine learning, geoAI, hurricane, natural disaster, cartographic visualization*

Atlas (Chenxiao) Guo, Ph.D. Student, Department of Geography, University of Wisconsin-Madison, Madison, WI, USA

Qunying Huang, Professor, Department of Geography, University of Wisconsin-Madison, Madison, WI, USA