HARNESSING DEEP LEARNING AND MICROBLOGS FOR REAL-TIME RESOURCE ALLOCATION IN EMERGENCY SCENARIOS

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Abstract

During disasters, **efficient allocation of emergency resources** is critical. Our research explores how **deep-learning and social media** can be used to identify resource needs in real-time learning. We developed a comprehensive framework that **classifies disaster-related tweets into multiple information categories** and extracts critical details about **resources, locations, and quantities**.

The project implemented state-of-the-art deep learning models, including BERT-based encoders with attention mechanisms, to analyze the **TREC-IS dataset containing over 40,000 disaster-related tweets across 25 information types.** Our models successfully identified actionable tweets and extracted relevant information to support resource allocation decisions.

While the implementation of actual resource allocation algorithms remains future work, our research establishes a robust foundation for developing predictive models that can anticipate resource needs during emergencies, potentially transforming how disaster response is coordinated.

Intro: State Key Problem

Critical Challenge:

During disasters, efficiently allocating emergency resources requires **real-time identification** of needs and resources.

Social Media Opportunity:

Platforms like Twitter provide valuable real-time information during disasters but require automated processing

Three Primary Challenges:

- Identifying relevant tweets from massive streams of data.
- Extracting specific information.
- Developing mechanisms for efficient resource allocation.

Methods: State Methods

1. Data Selection:

Utilized TREC-IS dataset containing 30,000+ training and 10,000+ testing examples across 25 information types

2. Tweet Classification Pipeline:

- Preprocessing: Removing URLs, mentions, special characters; tokenization
- BERT-based encoder with entity masking to mitigate event-specific biases
- Multi-task learning approach combining classification at multiple hierarchy levels

3. Information Extraction Techniques:

1. Part of Speech (POS) tagging and dependency tree construction
2. Named Entity Recognition (NER) for identifying locations and quantities
3. Priority-level estimation for ranking urgency of resource needs

Model Architecture:

Implemented attention-based CNN-BiLSTM model with Graph Attention Networks (GAT) to capture word-entity correlations.

Evaluation:

Replicated state-of-the-art models and evaluated on comprehensive classification of disaster-related information types.

Informativeness		
	Text	Image
Informative	11509	9374
Not informative	4549	8708
Total	16058	18082
Humanitarian		
Affected individuals	472	562
Infrastructure and utility damage	1210	3624
Injured or dead people	486	110
Missing or found people	40	14
Not humanitarian	4549	8708
Other relevant information	5954	2529
Rescue volunteering or donation effort	3293	2231
Vehicle damage	54	304
Total	16058	18082

Intent Type	Information Type	Description
REQUEST	GoodServices	Request for a particular service or physical good
	SearchAndRescue	The user is requesting a rescue for themselves or others
	InformationWanted	The user is requesting information
REPORT	Weather	Weather report
	FirstPartyObservation	The user is giving an eyewitness account
	ThirdPartyObservation	The user is reporting information from someone else
	EmergingThreats	Problems that cause loss or damage
	ServiceAvailable	Someone is providing a service
	SignificantEventChange	New occurrence to which officers need to respond
	MultimediaShare	Shared images or video
	Factoid	The user is reporting some facts, typically numerical
	Official	Report by a government or public representative
	CleanUp	Report of the cleanup after an event
	Hashtags	Report with hashtags correspond to each event
CALLTOACTION	Volunteer	Call for volunteers to help in response efforts
	Donations	Call for donations of goods or money
	MovePeople	Call to leave an area or go to another area
OTHER	PastNews	The post is reporting an event that has occurred
	ContinuingNews	The user is providing/linking to a continuous event
	Advice	Provide some advice to the public
	Sentiment	The post is expressing some sentiments about an event
	Discussion	Users are discussing an event
	Irrelevant	The post is irrelevant

Results: Key Finding Summary

1. **Multi-Class Classification Success:** Successfully implemented BERT-based models that classify tweets into 25 information types with high accuracy
2. **Reduced Event-Specific Bias:** Entity masking technique improved model performance across different disaster types.
3. **Effective Information Extraction:** Successfully extracted resources, quantities, and locations from tweets using POS tagging and dependency parsing.
4. **Dataset Impact:** TREC-IS dataset (30,000+ tweets) provided comprehensive coverage of actionable categories compared to alternatives.
5. **Enhanced Performance Through Multi-Task Learning:** Joint learning of hierarchical tweet categories improved overall classification accuracy.
6. **Robust Foundation:** Created pipeline ready for future implementation of resource allocation and predictive modeling components

Conclusions: Key Takeaway

Our research successfully developed a **deep learning pipeline** that **identifies and classifies** disaster-related tweets **while extracting critical resource information in real-time.** This framework establishes the foundation for **predictive resource allocation** systems that can transform emergency response from reactive to proactive, ultimately improving disaster management efficiency when resources are scarce, and time is critical.

References

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