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Advanced Machine Learning and Social Media For Natural Disasters Response

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Digital Innovators

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Hafiz Budi Firmansyah

- **Roles :**

- Lecturer and Researcher at Department of Informatics. **Sumatra Institute of Technology, Lampung - Indonesia**
- Professional Experiences : **United Nations Development Program, Indonesian Embassy in Bern, Indonesian Embassy in Paris, LKPP Republic of Indonesia, Orange Telecommunication France, PT. Pertamina (Persero) Indonesia,**
- Digital volunteer – Pemkot Bandar Lampung- Indonesia covid19.bandarlampungkota.go.id

- **Education :**

- PhD in Information Systems University of Geneva, **Switzerland (2020-present)**
- Master in Informatics Université de Paris, **France (2016)**
- Bachelor in Computer Science Universitas Gadjah Mada **Yogyakarta, Indonesia (2013)**



26 December 2004

230,000 people killed

500,000 people lost
their house

4.5 Mio USD
economic loss

Earthquake and Tsunami in Aceh, Indonesia

Natural disasters impacted
1.5 billion people in the world

(United Nations Office for Disaster Risk Reduction)

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[FAQ/Service Overview](#)

[Access to EMS data](#)



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Satellite

Advantages :

- High-resolution
- High-reliability
- Rapid damage assessment

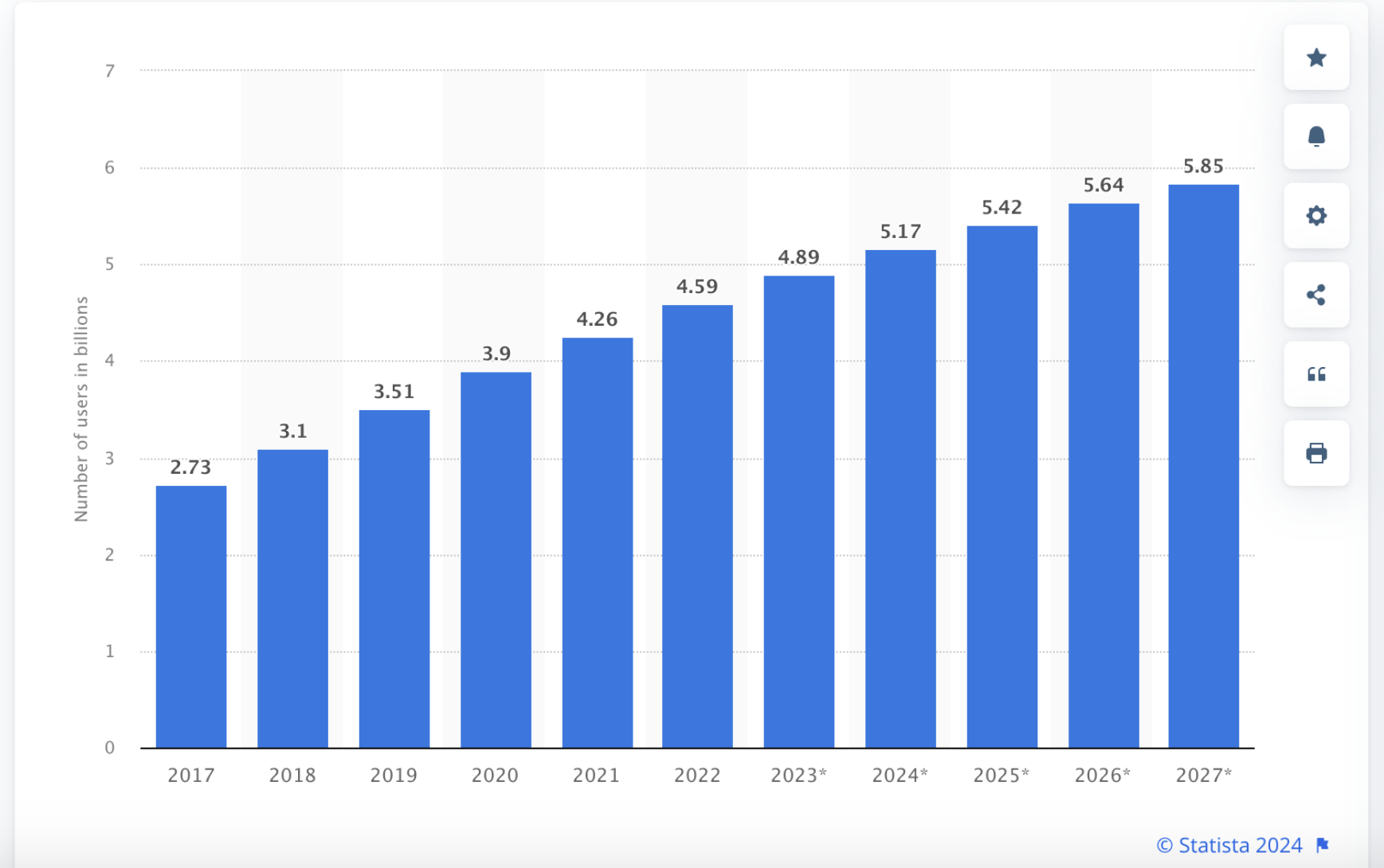
Limitations :

- Difficult to analyse
- Noise-prone from cloud and fog
- Risk of uncovered area



Number of social media users worldwide from 2017 to 2027

(in billions)



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Why Social Media Can Make Or Break A Crisis Response Plan

YEC COUNCIL POST | Membership (Fee-Based)

Aug 15, 2023, 07:00am EDT

Deloitte. Who we are | What we do | Our thinking | Careers

Perspective | 03 May 2023 | 5 minute read

Revolutionising disaster response

Natural Language Processing presents game changing opportunity

techxplore Topics Week's top Latest news

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Credit: Unsplash/CC0 Public Domain Editors' notes

Researchers design tools to automatically detect natural disasters using images on social media

by Universitat Oberta de Catalunya

English Search

EU Science Hub

Home > JRC news and updates > A new, open-source software that decrypts social media messages to help manage risks and disasters

NEWS ARTICLE | 20 June 2022 | Joint Research Centre

A new, open-source software that decrypts social media messages to help manage risks and disasters

The European Commission's new algorithm developed by the Joint Research Centre (JRC) can segment social media messages to identify, verify and help manage disaster events -such as floods, fires or earthquakes- in real-time.

Home > News > Detecting natural disasters using social media

6/28/23 · RESEARCH

Researchers design tools to automatically detect natural disasters using images on social media

CORDIS EU research results English EN

HOME THEMATIC PACKS PROJECTS & RESULTS VIDEOS & PODCASTS NEWS DATALAB ABOUT US

News > Scientific advances

Exploiting the potential of social media and crowdsourcing for better disaster resilience in Europe

An EU-backed project is developing a suite of learning materials on the use of social media and crowdsourcing (SMCS) in disasters. The resources will improve European resilience.

Trend on Social Media Data for Natural Disasters



Social media

Opportunities :

1. Rapid production of content
2. Real-time information
3. Public participation

Challenges :

1. Noise of Information
2. Location limitation

How can advanced machine learning improve
classification and **geolocation**
of social media content during natural disasters?

Research focuses



Filter out irrelevant information (Classification)



Classify new disaster (Adaptability)



Address location limitation (Geolocation)

Presentation outline

Part 1 : Content dimension

Relevance

In Distribution

ML classification for
disaster management

Article 1

Out of Distribution

ML adaptability on
disaster management

Article 2

Part 2 : Spatial dimension

Geolocation

Text

Inherent location
from image

Article 3

Text+Image

Combine text and
image for
geolocating

Article 4

ML+Crowd

ML+Crowdsourcing
help geolocating

Article 5 and 6

Content dimension

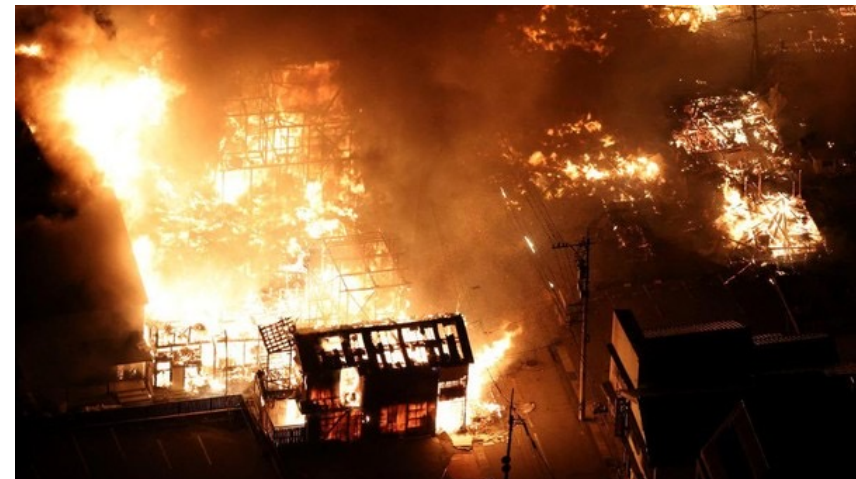


Earthquake

can cause

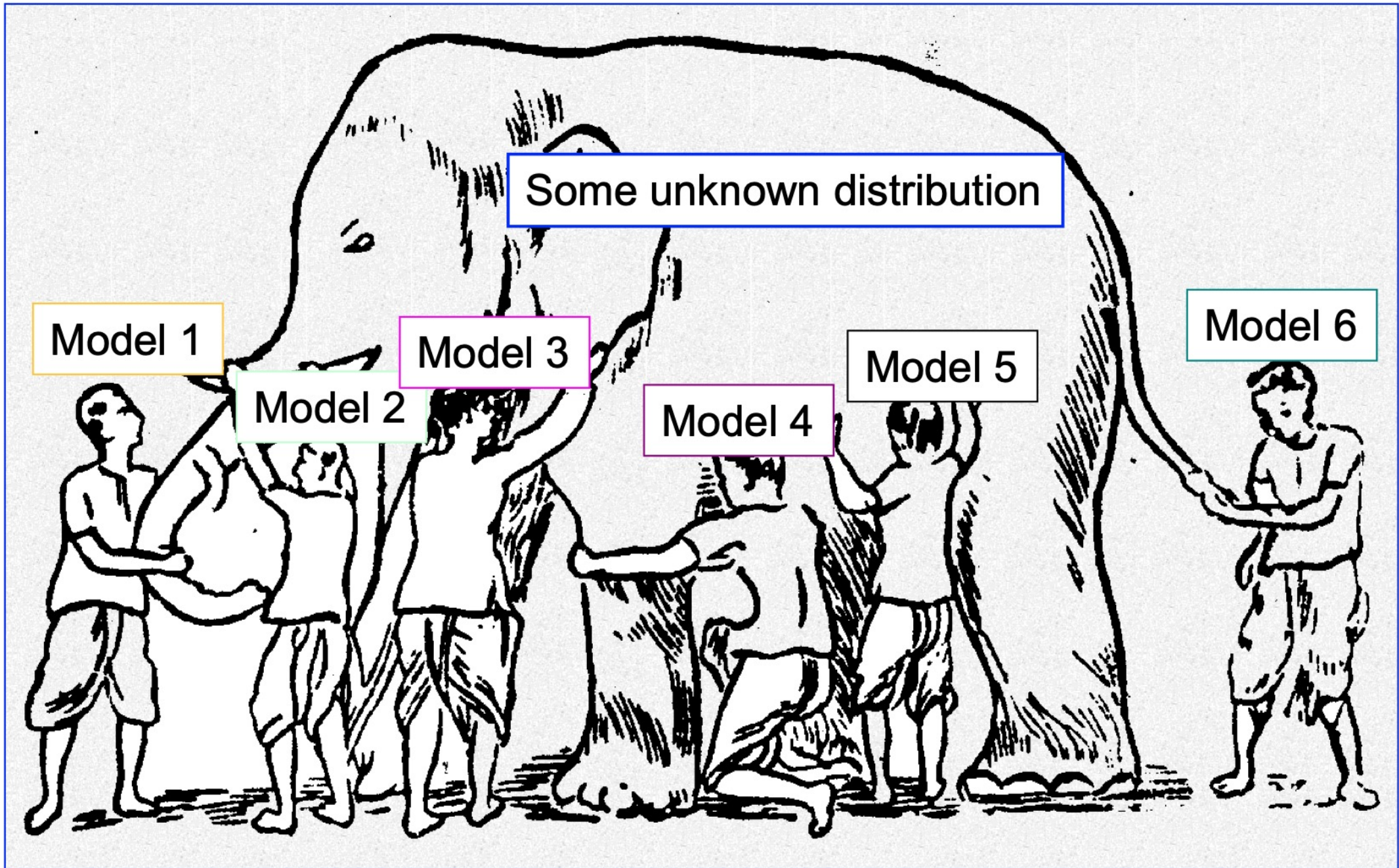


Tsunami



Fires

Natural disaster is not isolated



Ensemble

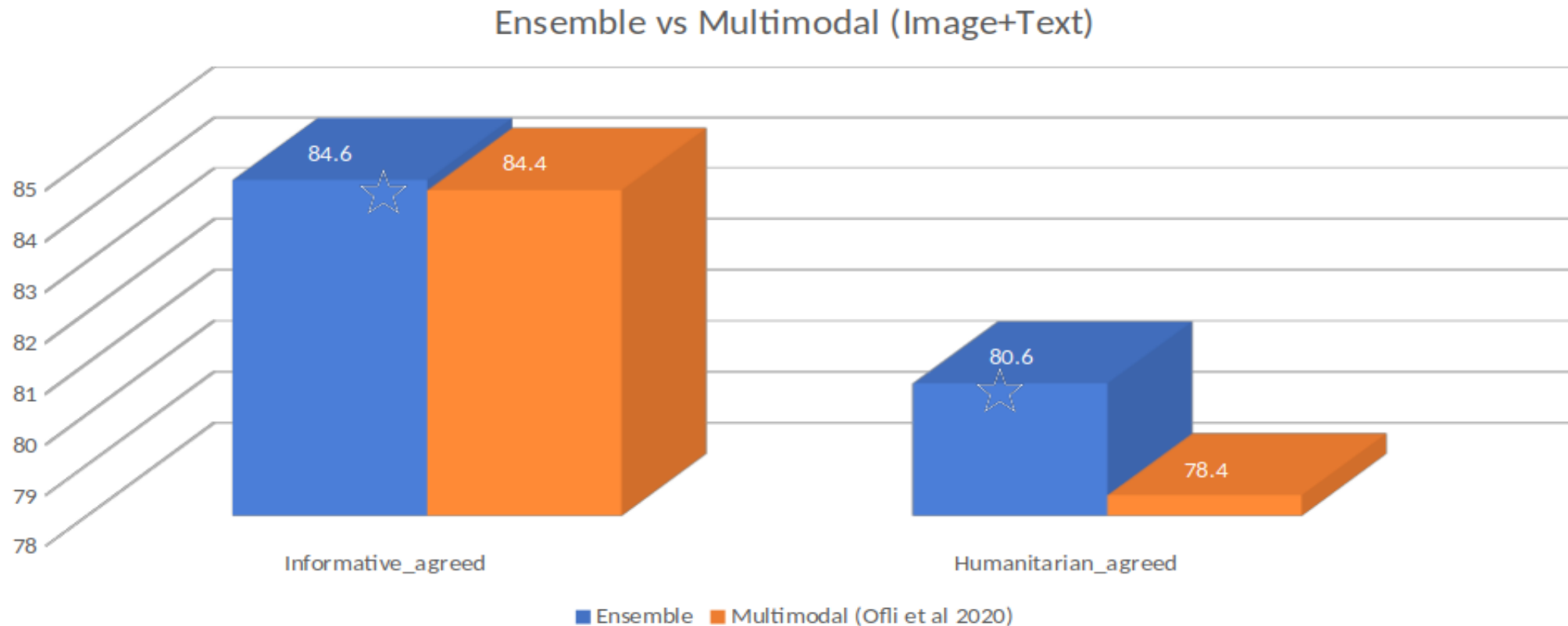


Technology



Expertise

RQ1 : Can ensemble learning be a valuable technology for improving the accuracy of the classification ?



Firmansyah, H. B., Cerquides, J., Fernandez-Marquez, J. L. (2022). Ensemble learning for the classification of social media data in disaster response. ISCRAM 2022 Conference Proceedings – 19th International Conference on Information Systems for Crisis Response and Management 2022



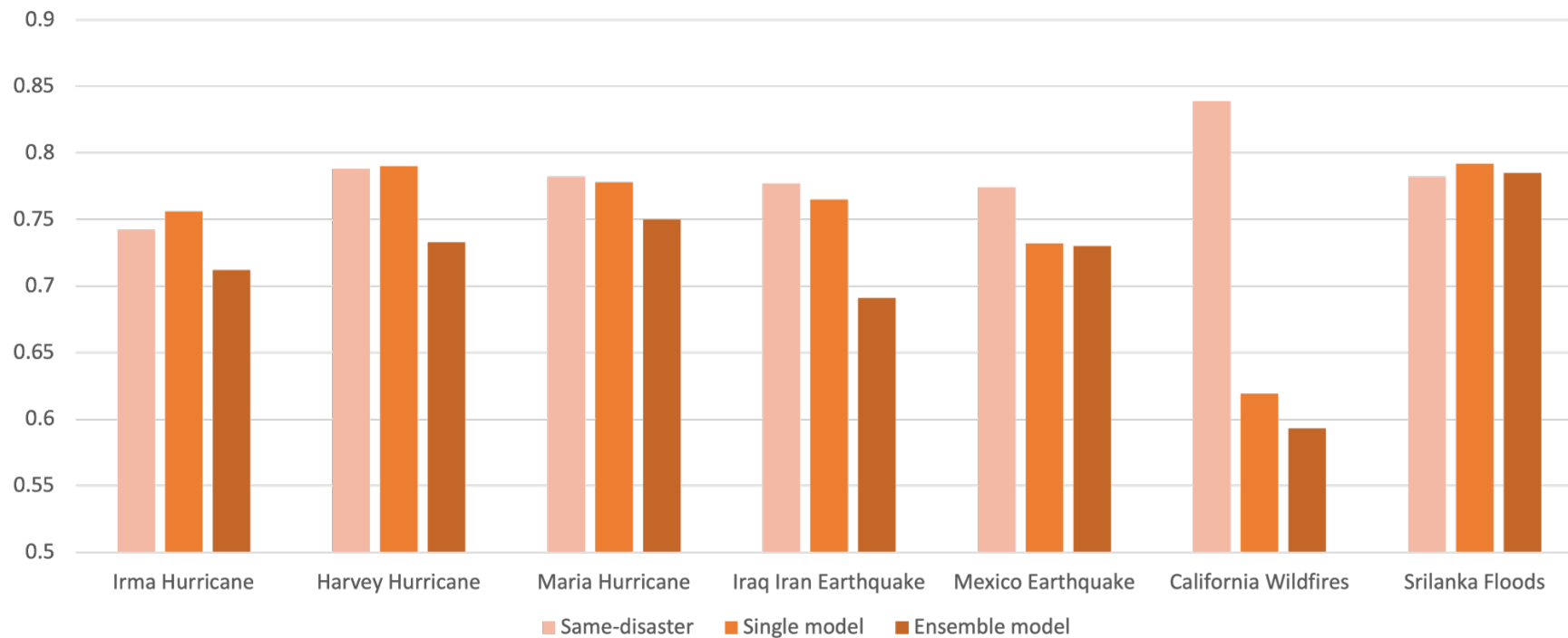
Train data



Severe damage

How can we address this problem ?

- RQ2a : How well does a of machine learning model perform in unseen disasters?
- RQ2b : Is an ensemble model or a single model a better technique to classify a social media image in unseen disasters?



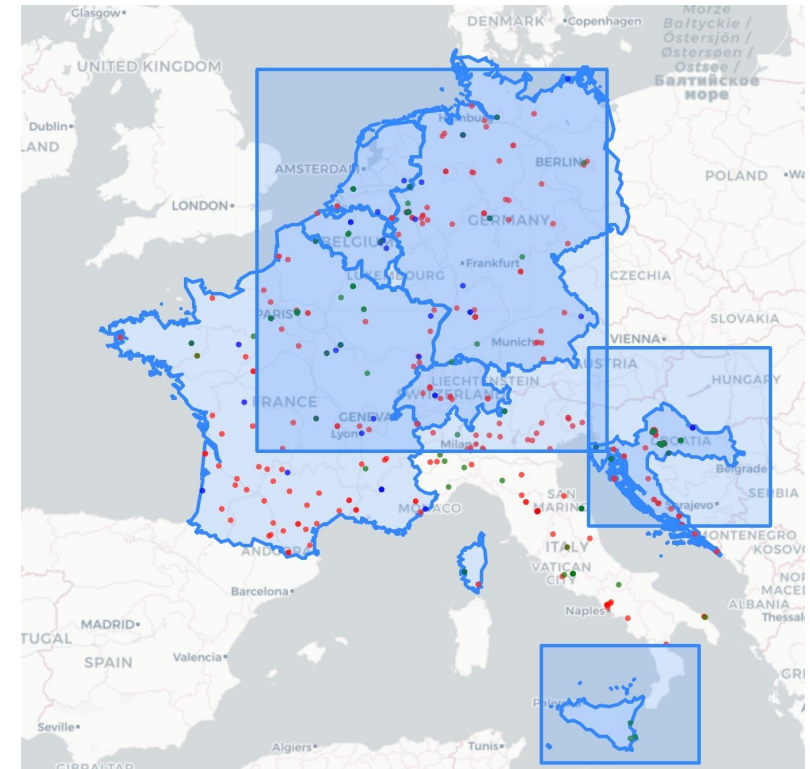
Firmansyah, H. B., Cerquides, J., Fernandez-Marquez, J. L., Serugendo, G.D.M (2023). Single or ensemble model ? A study on social media images classification in disaster response. MISNC 2023 Conference Proceedings – The 10th Multidisciplinary International Social Networks Conference 2023

Spatial dimension



RQ3 : Can a social media image provide location ?

Number of items	CIME Lang	CIME NoLang	Nominatim and NER
(1) Images	533	533	533
(2) Text fragments	1422	1422	1422
(3) Location candidates	734	679	3032
(4) Within country	113	106	524
(5) After majority	108	99	370
(6) Within bounding box	89	77	284
(7) Posts	61	50	59



Firmansyah, H. B., Cerquides, J., Fernandez-Marquez, J.L., Cerquides, J., Lorini, V., Bono, C. A., Pernici, B (2023). Enhancing Disaster Response with Automated Text Information Extraction from Social Media Images. IEEE BDS 2023 Conference Proceedings – The 9th IEEE International Conference on Big Data Computing Service and Machine Learning Applications 2023

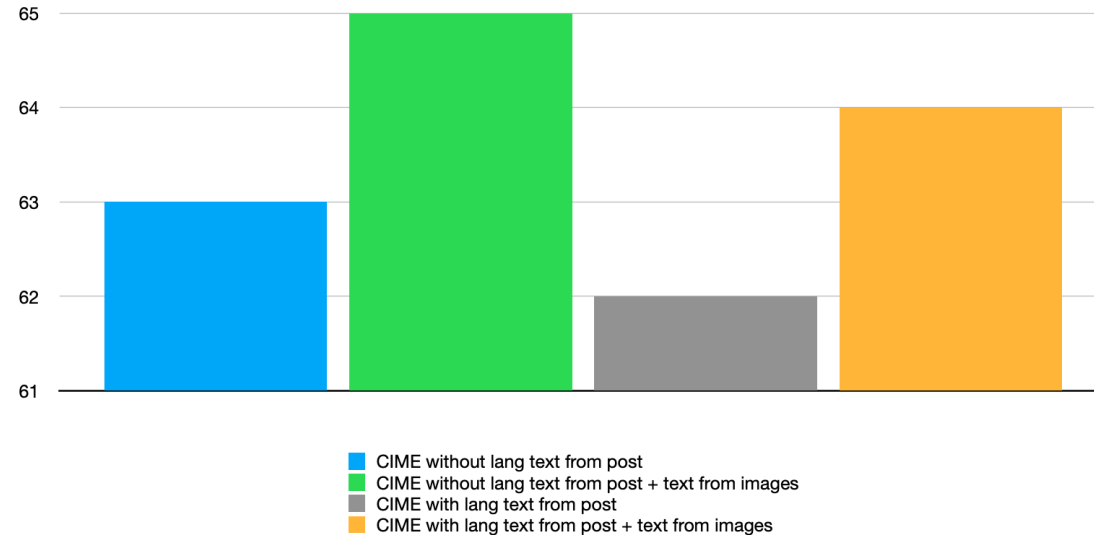
What if



+

*Sel bon nouvel sou Saut Mathurine
se dlo ki tounen nan chut la men
aprè...*

RQ4 : Can combining social media text and image improve location prediction?



Firmansyah, H. B., Bono, C, A., Lorini, V., Cerquides, J., Fernandez-Marquez, J.L. (2023). Improving Disaster Response by Combining Automated Text Information Extraction from Images and Text on Social Media. CCIA 2023 Conference Proceedings – The 25th International Conference of the Catalan Association for Artificial Intelligence 2023. Included in IOS Press Book

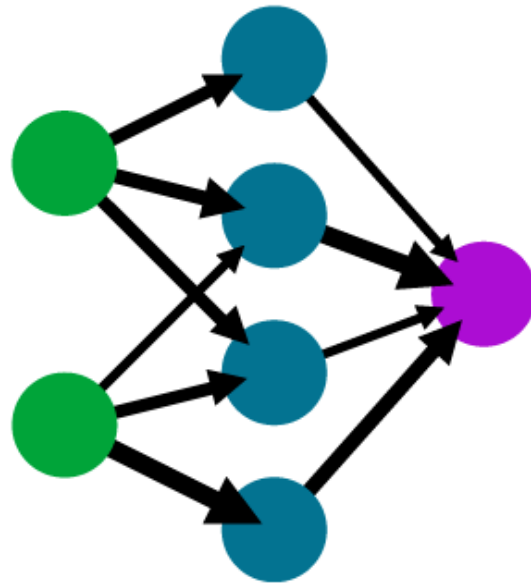
Geolocating an image takes time



RQ5a : Can an automatic classifier predict the difficulty of geolocating an image ?

A simple neural network

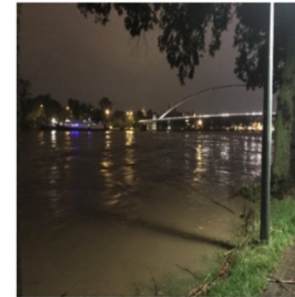
input layer hidden layer output layer



Difficult



Easy



Difficult



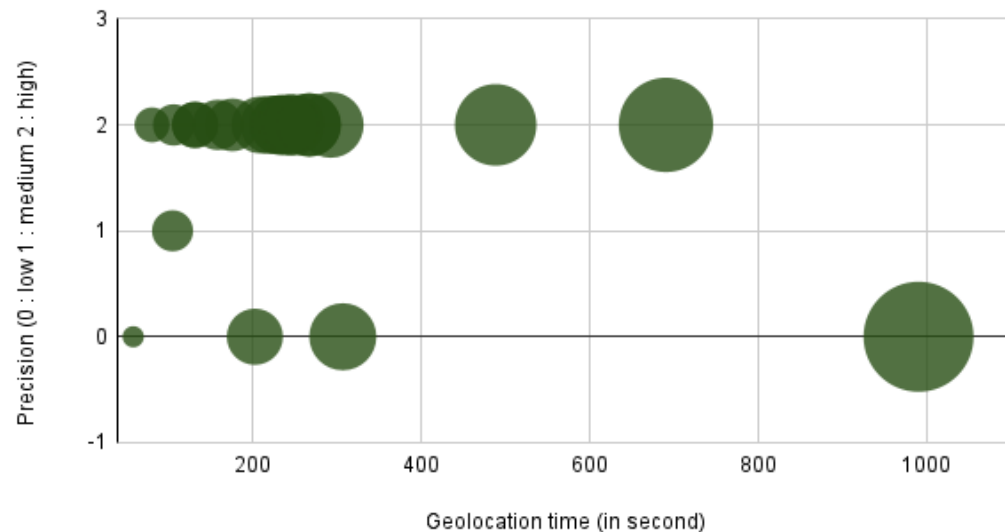
Difficult



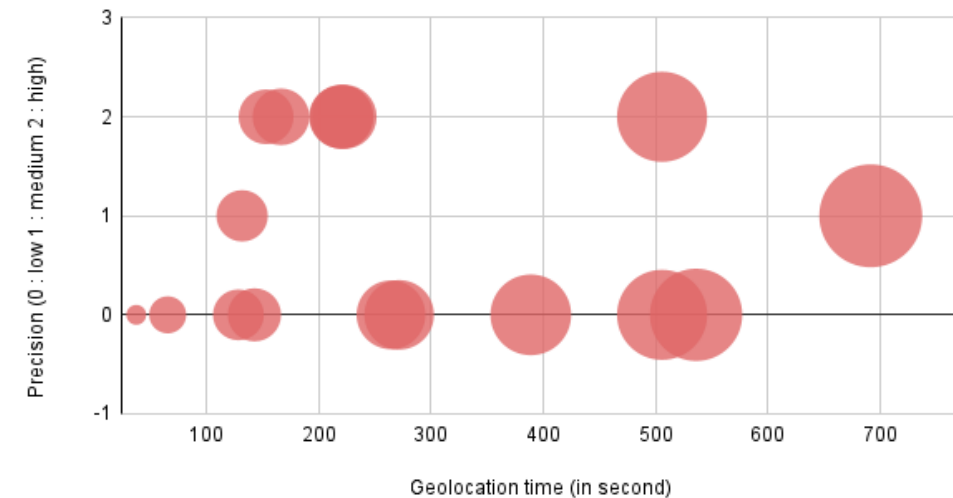
87 % accuracy
88 % precision
88 % recall

RQ5b : Does favoring image easy-to-locate improve overall geolocation process ?

Predicted easy



Predicted difficult

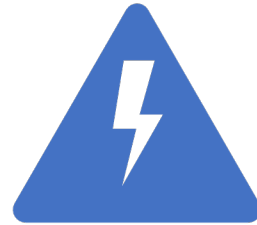


Firmansyah, H. B., Fernandez-Marquez, J.L., Mulayim, M.O., Gomes, J., Lorini, V (2024). Empowering Crisis Response Efforts : A Novel Approach to Geolocating Social Media Images for Enhanced Situational Awareness. ISCRAM 2024 Conference – 21st International Conference on Information Systems for Crisis Response and Management 2024 (Accepted)

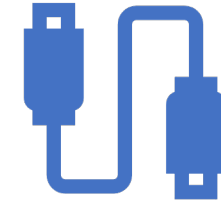
Limitations



Data reliability



More computational
power



Depend on internet and
electricity

Conclusion



1. Advanced ML helps policy maker and practitioner to get better information



2. Advanced ML improves classification and geolocation of social media content



3. Automated information classification contributes minimizing the number of irrelevant information

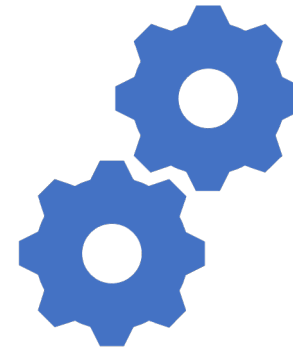


4. Location prediction enhances situational awareness by creating disaster maps

Future work



Evaluate using larger dataset
(i.e. Incidents1M)



Implement the approach as an integrated
platform



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Thank you !

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