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Week 1

Introduction to AI and Disaster Management

W1 Lesson 1

Introduction to Disaster Management

AI and Disaster Management

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Welcome to AI and Disaster Management

Sierra Leone 2014

Source: WHO

Liberia 2007

Source: UNHCR

Hurricane Sandy 2012

Images by NOAA storm @ archive nhc.noaa.gov/data/

Haiti Earthquake 2010

Pakistan Floods 2010

Swat river soaring view in 2010 flood. Wikipedia

Covid-19 Pandemic, 2019 - Ongoing

Mission 4636

Mission 4636

“Fanm gen tranche pou fè yon pitit nan Delmas 31”

Medical team to 18.50, 72.32

Message translated, categorized & geolocated

Location is refined & actionable items are identified

Original: “Fanm gen tranche pou fè yon pitit nan Delmas 31”

Translation: Woman in labor having a child at Delmas 31

Location: 18.495746829274168, 72.31849193572998

Category: Emergency

Haiti Earthquake Topic Analysis

Course 3: AI and Disaster Management

Hurricane Harvey, 2017

AI for natural language processing

Haiti, 2010.

Haitian Kreyol

Moun kwense nan Sakre Kè nan Pòtoprens

English

People trapped in Sacred Heart Church, PauP

Translation

By UN Photo/Logan Abassi United Nations Development Programme - originally posted to Flickr as Haiti Earthquake, CC BY 2.0

AI for damage assessment

Houston area

Before Hurricane Harvey
(Undamaged)

After Hurricane Harvey
(Damaged)

Ethical Considerations

“Do no harm”

Everyone impacted by a project is improved or unchanged.

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What is a Disaster?

2021 Henan Floods

2021 Henan Floods

积水的郑大宿舍楼. Sxr369

Damage and casualties

200	1.5 million	$14 billion
deaths	people displaced	cost in damages

- Significant damage to infrastructure
- Disruption to transportation and communication network
- Significant economic losses

Camp Fire 2018

California, U.S.A., 2018.

Camp Fire 2018

The appearance of U.S. Department of Defense (DoD) visual information does not imply or constitute DoD endorsement.

What is a Disaster

> A **disaster** is a serious disruption of the functioning of a community or a society at any scale due to hazardous events interacting with conditions of exposure, vulnerability and capacity, leading to one or more of the following: human, material, economic and environmental losses and impacts.

United Nations Office for Disaster Risk Reduction (UNDRR)

Sudden-onset disasters

Kermanshah earthquake, 2018

Australia wildfire, 2020

Michelle Moore, Bureau of Land Management - National Interagency Fire Center

Hurricane Dorian, 2019

NASA

Slow-onset disasters

California Drought, 2009

COVID-19 Pandemic, 2019

California Drought Dry Lakebed 2009. National Oceanic and Atmospheric Administration

Political impacts of declaring a disaster

Why governments may not declare an event a disaster

- May be difficult to attract businesses or tourism
- May cause public panic
- May reflect poorly on political leadership or effectiveness

Why governments may declare an event a disaster

- Open up funding and response resources
- Circumvent due process or bypass certain legal procedures

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The Disaster Management Cycle

Pre-Disaster
Post-Disaster
Disaster Strikes
Preparation
Emergency plans
Training and drills
Response
Search & rescue,
Provide essential aid
Disaster Management Cycle
Mitigation
Resilient infrastructure
Early warning systems
Recovery
Assess damage
Financial assistance

Pre-Disaster

Preparation

Emergency plans
Training and drills

Mitigation

Resilient infrastructure
Early warning systems

Pre-Disaster
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Mitigation

Actions to prevent or reduce the **risks, impact, and consequences** of disasters.

Mitigation

Actions to prevent or **reduce the impact** of disasters

Example of a Sea Wall for flood prevention.
Oosterscheldekering, Netherlands.

By Donar Reiskoffer

Netherlands | **Flood**

- Building dikes and seawalls to protect low-lying areas from floods.

Disaster management: Preparation

Actions to **plan, train, and educate on procedures** in the event of a disaster.

Disaster management: Preparation

Actions to **prepare procedures** in the event of a disaster

Earthquake Early Warning unit.
FM radio type

By Namazu-tron - Own work

Japan | **Earthquake**

- Advanced earthquake and tsunami warning system
- Public education on natural disaster awareness and risks

Disaster management: Response

Actions **immediately after** a disaster that **provide aid**.

Disaster management: Response

Actions **immediately after** a disaster that **provide aid**

Eruption of Pinatubo Volcano.
Philippines, 22 June 1991

Philippines | **Volcanic eruption**

- Search & rescue efforts
- Temporary shelters
- Relief centers
- Basic necessities (food and water)
- Medical Care

Disaster management: Recovery

Actions to **restore regular operations**.

Disaster management: Recovery

Actions to **restore regular operations.**

Damage from Hurricane Katrina to New Orleans. U.S.A, 2006

By Gregory Varnum - Own work

United States | **Hurricane**

- Financial assistance for businesses and individuals
- Rebuilding of damaged infrastructure
- Housing assistance program

- Provide timely and accurate information
- Optimize resources and logistics
- Reduce the impact of disasters on affected communities

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Cyclones Idai & Kenneth

Mozambique

Cyclone Idai

Mozambique. March, 2019.

Denis Onyodi: IFRC/DRK/Climate Centre.

Cyclone Kenneth

Cyclone Idai & Cyclone Kenneth

Damage and casualties

$3.2B USD
damage

>1,500
deaths

700,000
homes damaged

>160,000
people displaced

771,000
ha of crops damaged

DFID - UK Department for International Development

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Cyclones Idai & Kenneth
Response & Recovery

Pre-Disaster
Post-Disaster
Disaster Strikes
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Emergency plans
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Early warning systems
Recovery
Assess damage
Financial assistance

Phase: Response

Actions during the aftermath of the disaster

14 Mar 2019

Cyclone Idai

OCHA
Office for the Coordination of Humanitarian Affairs

MEDECINS SANS FRONTIERES

U-Report

Messaging tool led by **UNICEF** to provide information and respond to aid requests

Languages supported included

- Mozambique national language: Portuguese
- Local languages: Shona and Ndau

Phase: Response

Actions during the aftermath of the disaster

14 Mar 2019

Cyclone Idai

19 Mar 2019

State of emergency

Volunteers bring donated goods to affected areas by Cyclone Idai

Phase: Response

Actions during the aftermath of the disaster

14 Mar 2019
Cyclone Idai

19 Mar 2019
State of emergency

25 Mar 2019
WHO grade 3 emergency

World Health Organization

3 Grade

Emergency Shelters

The cyclone forced families displacement to overcrowded shelters.

Phase: Response

Actions during the aftermath of the disaster

14 Mar 2019
Cyclone Idai

19 Mar 2019
State of emergency

25 Mar 2019
WHO grade 3 emergency

27 Mar 2019
First cases of cholera

15 Apr 2019
4,000 cases of cholera

Phase: Response

Actions during the aftermath of the disaster

14 Mar 2019
Cyclone Idai

19 Mar 2019
State of emergency

25 Mar 2019
WHO grade 3 emergency

27 Mar 2019
First cases of cholera

Phase: Response

Restoration efforts

With help from international organizations,

- Treatment centers were established
- Emergency water and hygiene supplies distributed
- Community leaders played a crucial role in identifying specific needs

Phase: Recovery

Restoration efforts

1. Restore essential services
2. Rebuild infrastructure
3. Support affected communities to rebuild homes and livelihoods
4. Support disaster risk reduction efforts

Working with local organizations

- Communities can rebuild and recover sustainably and equitably
- Will lead to a more immediate and direct impact

Phase: Recovery

Restoration efforts

14 Mar 2019
Cyclone Idai

19 Mar 2019
State of emergency

25 Mar 2019
WHO grade 3 emergency

27 Mar 2019
First cases of cholera

15 Apr 2019
4,000 cases of cholera

25 Apr 2019
Cyclone Kenneth

Phase: Response

Actions during the aftermath of the disaster

14 Mar 2019
Cyclone Idai

19 Mar 2019
State of emergency

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First cases of cholera

15 Apr 2019
4,000 cases of cholera

25 Apr 2019
Cyclone Kenneth

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Cyclones Idai & Kenneth
Mitigation & Preparation

Phase: Mitigation

Disaster prevention and reduction of damages

- Enhancement of early-warning systems
- Phone-based alerts supported multiple languages, including **Chew and Nyanja**
- Identify areas of high risk and rebuilt on areas of higher elevation
- Implemented wetlands
- 670,000 children vaccinated for cholera and measles

Phase: Preparation

Plans for education and preparation for future disasters

- Emergency preparedness and response plans
- Contingency stocks of essential relief items
- Hygiene and safe water promotion campaigns
- Trained communities on disaster risk reduction strategies

Cyclone Freddy 2023

Satellite animation of Tropical Cyclone Freddy off the coast of Mozambique on 11 March 2023. EUMETSAT's Meteosat-9

Damage and casualties

$500 million USD
damage

>1.7 million
people impacted

1,434
deaths in total

198
deaths in Mozambique

W1 Lesson 2

AI and Human-in-the-loop

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AI and Disaster Management

Search “Health clinic” in multiple languages

English

Spanish

Portuguese

Dutch

Search “Health clinic” in multiple languages

English

Spanish

Portuguese

Dutch

Low-resource languages

When most disease outbreaks are likely first discussed in a low resource language.

90% of ecological diversity

90% of linguistic diversity

Munro. From Big Data to Small Languages: communication and information processing in a newly connected world. http://robertmunro.com/research/unite_for_sight_languages_munro.pdf

Multi-hazard early warning system

Recovering from the Tbilisi flood.
Georgia, 2015

Artificial Intelligence for Disaster Risk Reduction: Opportunities, challenges, and prospects

Author(s): Monique Kuglitsch, Arif Albayrak, Raúl Aquino, Allison Craddock, Jaselle Edward-Gill, Rinku Kanwar, Anirudh Koul, Jackie Ma, Alejandro Marti, Mythili Menon, Ivanka Pelivan, Andrea Toreti, Rudy Venguswamy, Tom Ward, Elena Xoplaki, A. Rea & J. Luterbacher

Contact:

Theme: Disaster risk reduction

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Climate Change Adaptation. UNDP

Multi-hazard early warning system

- Trains on historical data from data-rich locations
- Extrapolates data to assist with areas with little on-site observation data
- Uses AI to automatically detect and trigger early warning alerts

Reconnecting displaced families

Adapted from Microsoft AI for Humanitarian Action projects. Using AI to help reunite displaced families.

Limitations of AI

- Need accurate data
- Has the potential for bias
- May have challenges related to communication with local communities
- May require significant resources and technical expertise
- Sensitivity around privacy and accountability

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Helping Communities Help Themselves

Search Medium

Write Sign up Sign In

You have 2 free member-only stories left this month. Sign up for Medium and get an extra one.

Member-only story

Research on Machine Learning for Disaster Response: what makes a good paper?

Robert (Munro) Monarch · Follow

Published in Towards Data Science · 15 min read · Aug 18, 2020

163

For the first time in 2021, a major Natural Language Processing conference will have a track devoted to disaster response. It is also the first Machine Learning or Linguistics conference to have this track! The 16th Conference of the European Chapter of the Association for Computational Linguistics (EACL 2021) has a track on "NLP Applications for Emergency Situations and Crisis Management".

I am delighted to be the Senior Area Chair for this track! I've worked in machine learning and disaster response for 20 years and I'm glad that more people are now looking into how machine learning can help people at the most critical times.

Search “Health clinic” in multiple languages

Low-resource languages

When most disease outbreaks are likely first discussed in a low resource language.

90% of ecological diversity

90% of linguistic diversity

Sierra Leone: Mande vs Temne

Broadcasts in Mande

Distrust

People avoided clinics

Ebola outbreak in Sierra Leone

For **every** person
who died from Ebola

10 people
died from a preventable disease

2000 volunteers globally, transferred to paid workers in Haiti

Haiti Earthquake 2010

Haiti, 2010.

Moun kwense nan Sakre Kè nan Pòtoprens

Haitian Kreyol

People trapped in Sacred Heart Church, PauP

English Translation

AI and Disaster Management

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Working Toward Impactful Solutions

ML technology to improve data entry

RESEARCH-ARTICLE

Designing adaptive feedback for improving data entry accuracy

Authors: Kuang Chen, Joseph M. Hellerstein, Tapan S. Parikh Authors Info & Claims

UIST '10: Proceedings of the 23nd annual ACM symposium on User interface software and technology • October 2010 • Pages 239–248 • https://doi.org/10.1145/1866029.1866068

Published: 03 October 2010 Publication History

Check for updates

[Chen, et al. (2010). Designing adaptive feedback for improving data entry accuracy. *UIST '10: Proceedings of the 23nd annual ACM symposium on User interface software and technology*]

Toyota Land Cruisers

- Most commonly-used vehicle in emergency situations globally
- Many technicians are able to repair
- Spare parts are readily available

Toyota Land Cruiser: used for predictability and reliability.
Source: Wikimedia Commons.

Laboratory solution

- Should not be deployed for the first time in a response situation
- Spare parts are not plentiful
- Few technicians would have the knowledge to repair

Image generated by DALL-E

Software prototypes can *inform* science and should be used in **controlled environments** during **non-critical** periods

Use **reliable software** during **time-critical periods**.

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Data Privacy and Related Risks

Arab Spring

Arab Spring

Regular people were associated with the UN and foreign powers

What is the **impact** of recontextualizing the data or model by you or an organization republishing it?

1. Research into **personal information**
    - Ethnicity
    - Religion
    - Gender
    - Political Preference
2. Consider the **use case**
3. Consider if your project can be as a **human rights violation** in the wrong hands.

Democracy index

Social media and political agendas

Should You Open-Source Your Model?
Ethical questions for open-sourcing Machine Learning models

Robert Munro
Independent Researcher
San Francisco, CA
rmunro@alumni.stanford.edu

Do not trust research that identifies people who **complain about governments** or **express political preference** through **social media**.

Munro. Should You Open-Source Your Model? Ethical questions for open-sourcing Machine Learning models.

Speaking **English** is typically associated with higher education

English speaking individuals may be political opponents

Typhoon Haiyan 2013

Philippines **Typhoon**

Small number of **English-speaking** responders were in danger of reprisals from the government

Devastation on the Philippine island of Binuluanguan caused by Typhoon Haiyan in November 2013. LPHOT Keith Morgan

How to use social media effectively

DO

Use social media as a **broadcast medium** for disaster response organizations to communicate with crisis-affected populations

How to use social media effectively

DO NOT

Use social media as a **direct communication channel** for disaster response populations

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Getting Involved and Doing no Harm

Personally identifiable information (PII)

any piece of information that can be used to identify an individual

Name

Phone Number

Address

Biometric Identifiers

Birth date

Credit Card Number

Secure PII data to avoid information being leaked or stolen

Pre-Disaster
Post-Disaster
Disaster Strikes
Disaster Management Cycle

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Begin work during the recovery, mitigation, or preparation phase.

Your most valuable skill may be manual labor or data entry

Contributing to disaster management

5 Ways Data Scientists Can Help Respond to COVID-19 and 5 Actions to Avoid

Robert (Munro) Monarch · Follow

Published in Towards Data Science · 16 min read · Apr 1, 2020

Munro. 5 Ways Data Scientists Can Help Respond to COVID-19 and 5 Actions to Avoid.

Consider projects that

- Support low-resource languages
- Aid in information extraction from semi-structured documents

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Week 1 Summary

Disasters

Kermanshah earthquake, 2018

California Drought, 2009

Hurricane Dorian, 2019
NASA

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1. Work on general-purpose technologies to help communities help themselves
2. Support low-resource languages with better technologies like translation and search
3. Default to private data practices. Aggregate data and ML models can amplify privacy risks
4. Avoid projects that involve analysis of social media data and work funded by oppressive governments
5. Engage with impacted communities