

Using AI and Social Media for Social Good

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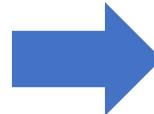
Hamad Bin Khalifa University

Qatar



Time-Critical Events and Information Gaps

Disaster event



Urgent needs of affected people

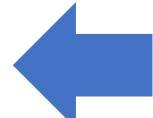


Urgent needs

- Food, water
- Shelter
- Medical assistance
- Donations
- Service and utilities

When information is most needed, information may be scarce

Relief operations



Humanitarian organizations and local administration



OCHA



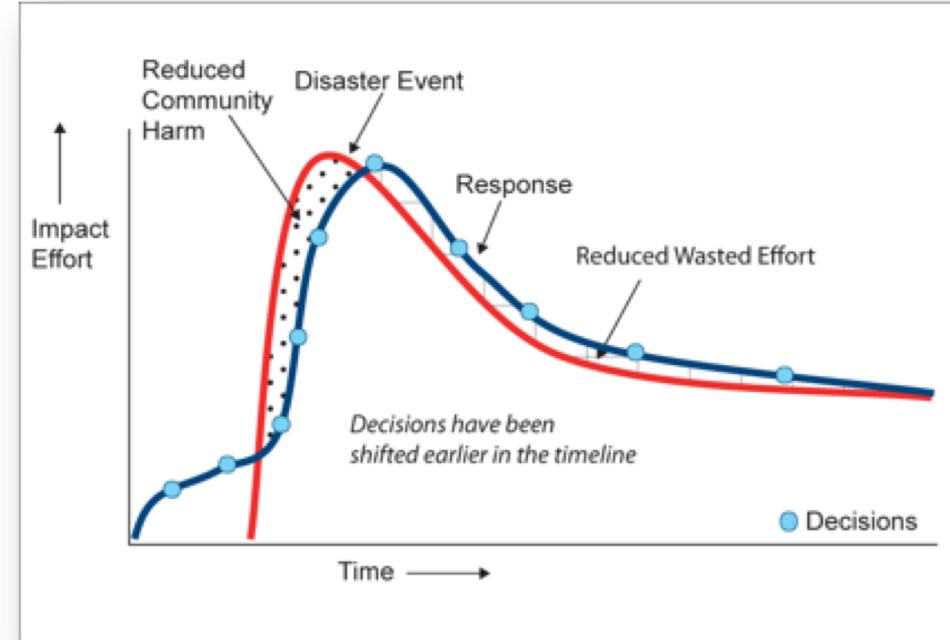
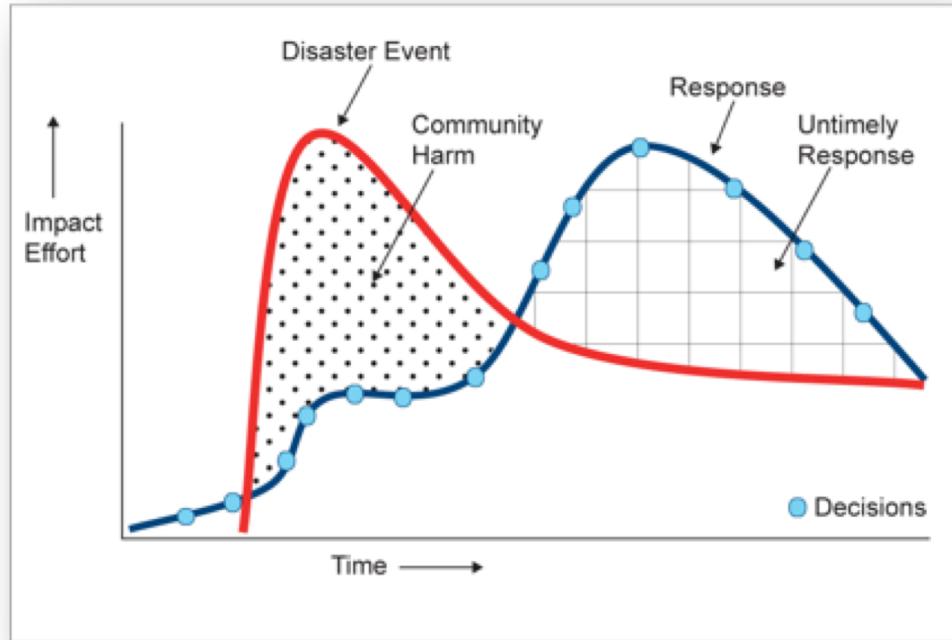
unicef



World Health Organization



Towards Rapid Decision-Making

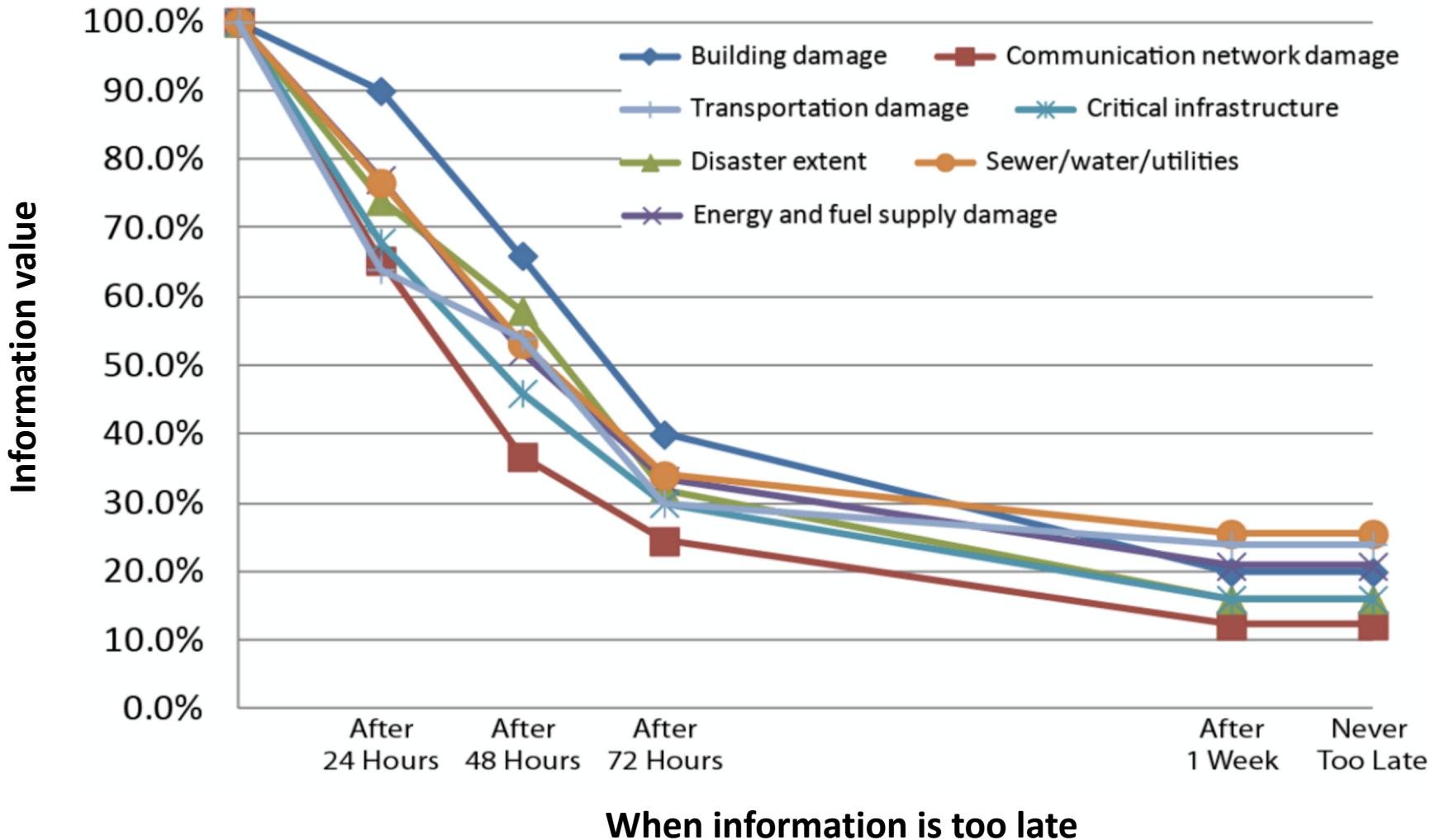


- Delayed decision-making
- Delayed actions
- High community harm

Target

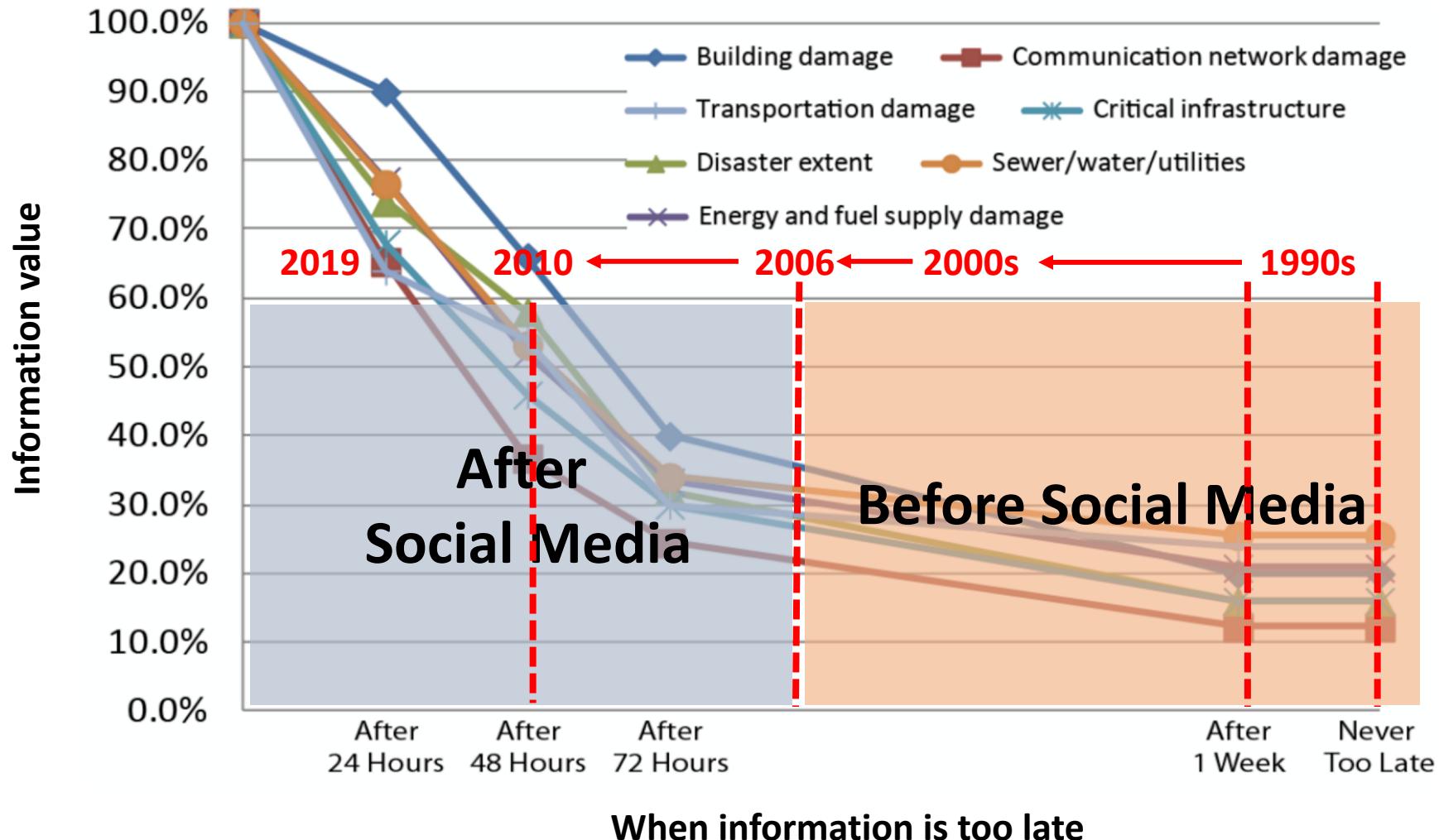
- Early decision-making
- Rapid actions
- Low community harm

The Value of Timely Information



This chart is based on a large-scale survey of emergency management professionals in the US by FEMA

Information Access in the age of Social Media



This chart is based on a large-scale survey of emergency management professionals in the US by FEMA

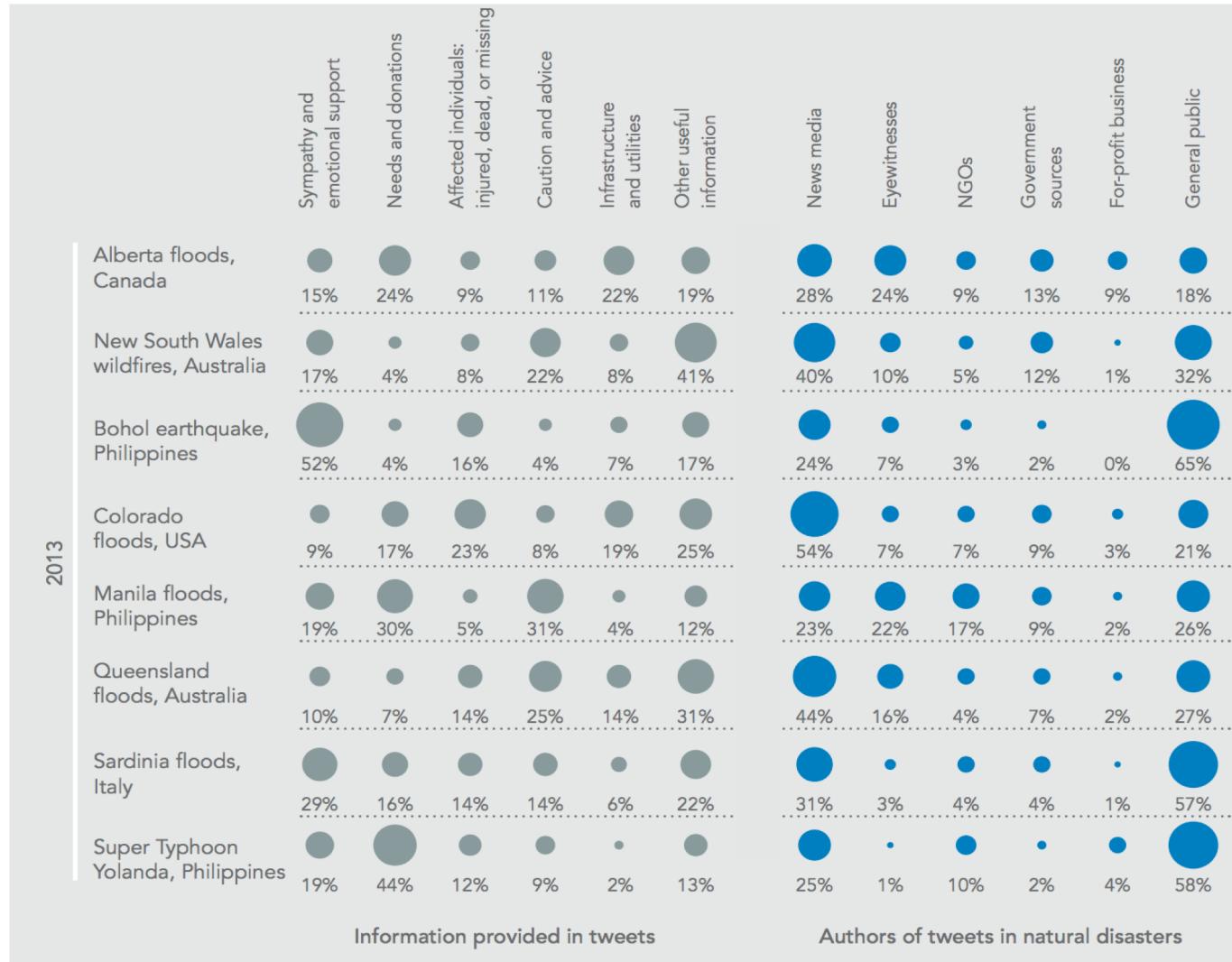
Disaster Data Analysis on Twitter

Information types

- Injured or dead people
- Need and donations
- Infrastructure damage
- Sympathy & support
- Other useful information

Information sources

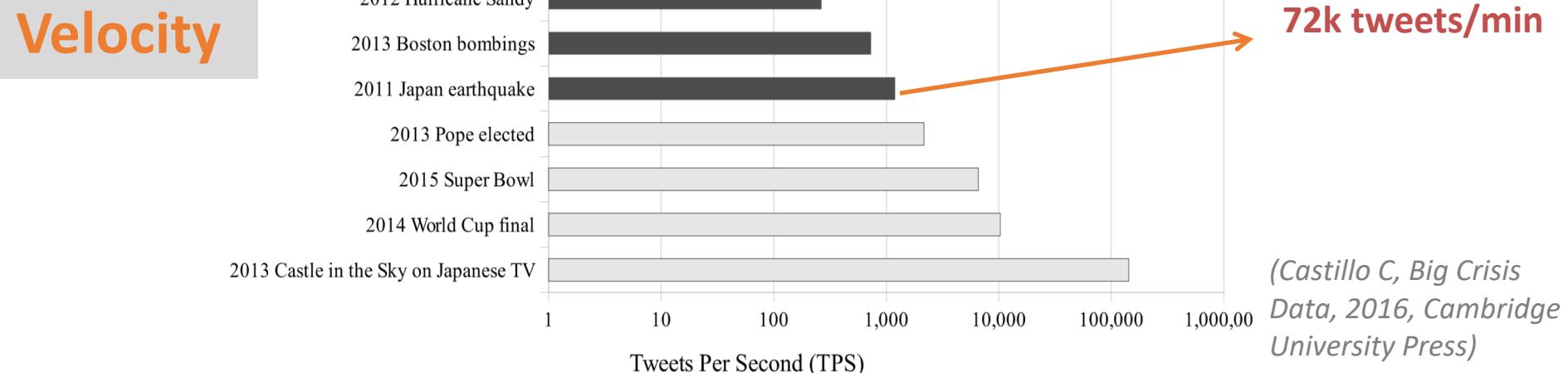
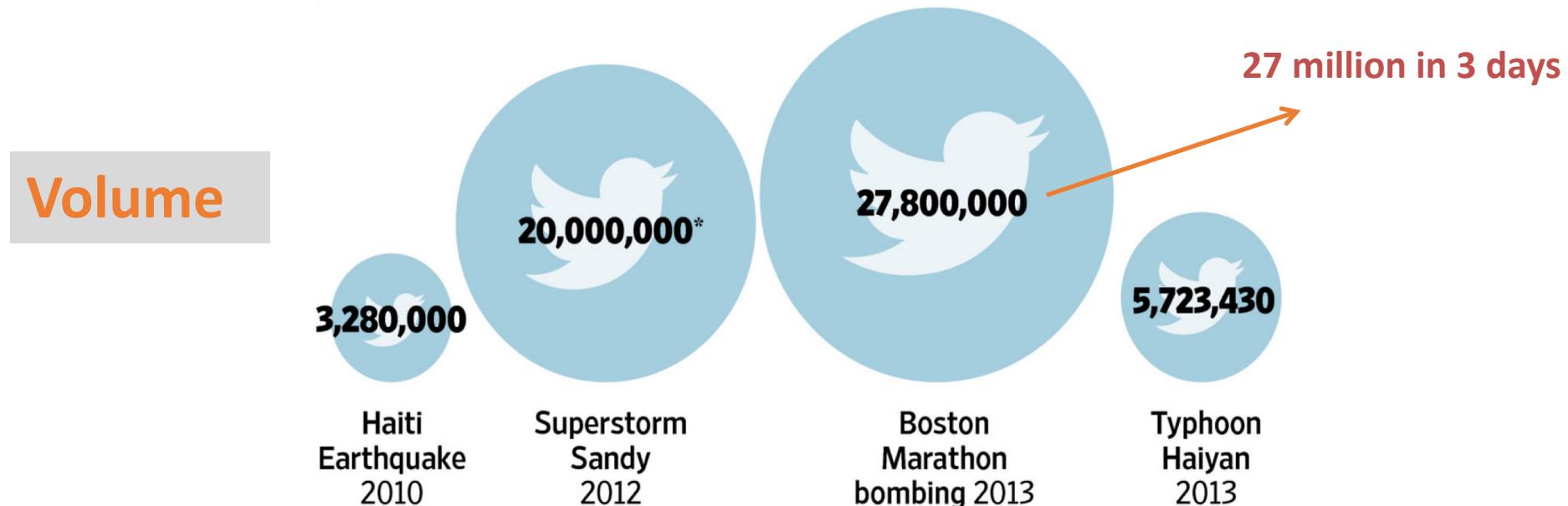
- News media
- Eyewitness
- General public
- Government sources
- ...



Twitter data from **13 crises**; Analyzed over **100,000 tweets**; Information types and sources

Source: Qatar Computing Research Institute - Published in World Humanitarian Data and Trends 2014 (UN OCHA)

Twitter Storms during Disasters



Processing High-volume/velocity Data

Goal: To find relevant and actionable information in near real-time.



Human Intelligence + Machine Learning



Filter-failure

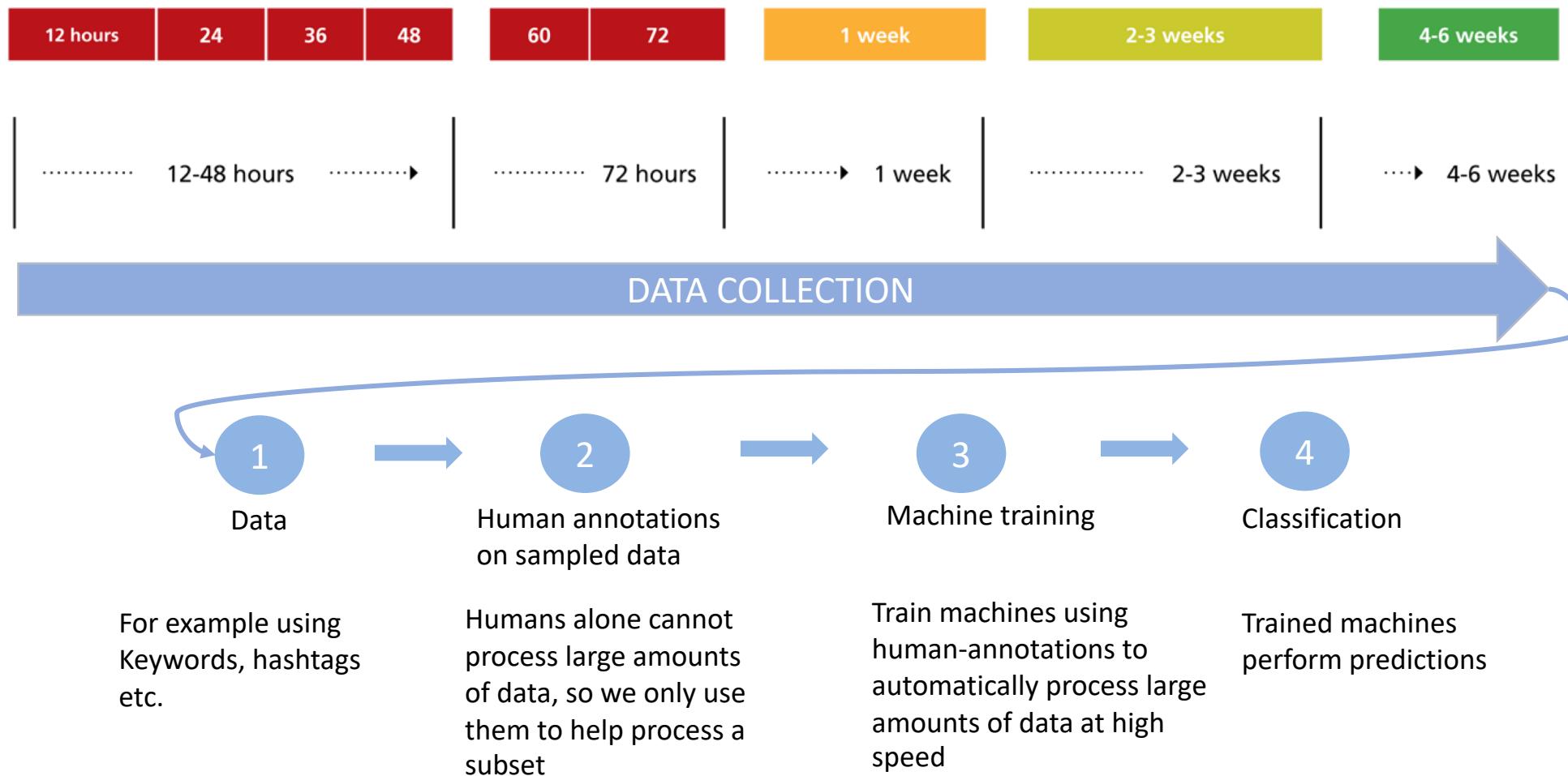
Growing stack of data



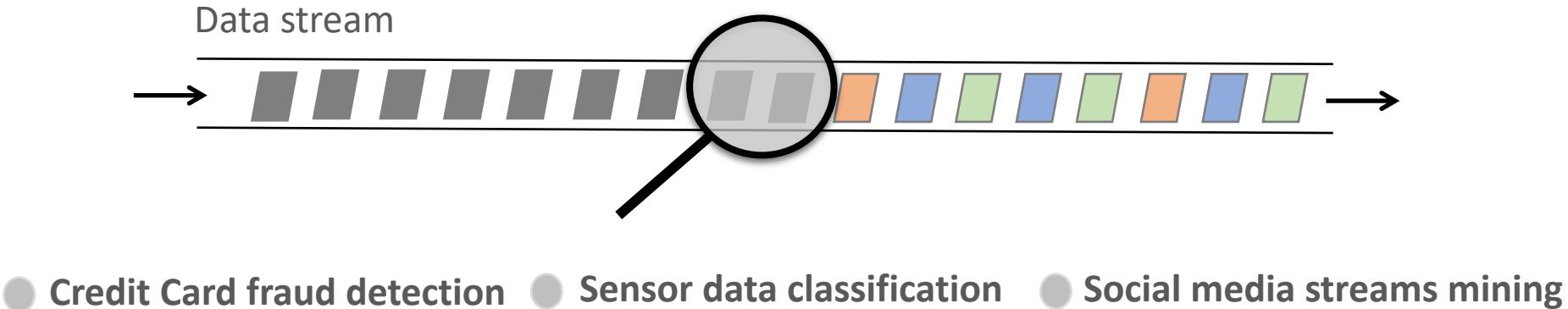
Need human-labeled examples

Data Processing Using Supervised ML Techniques

Disaster Timeline:



Data Stream Processing

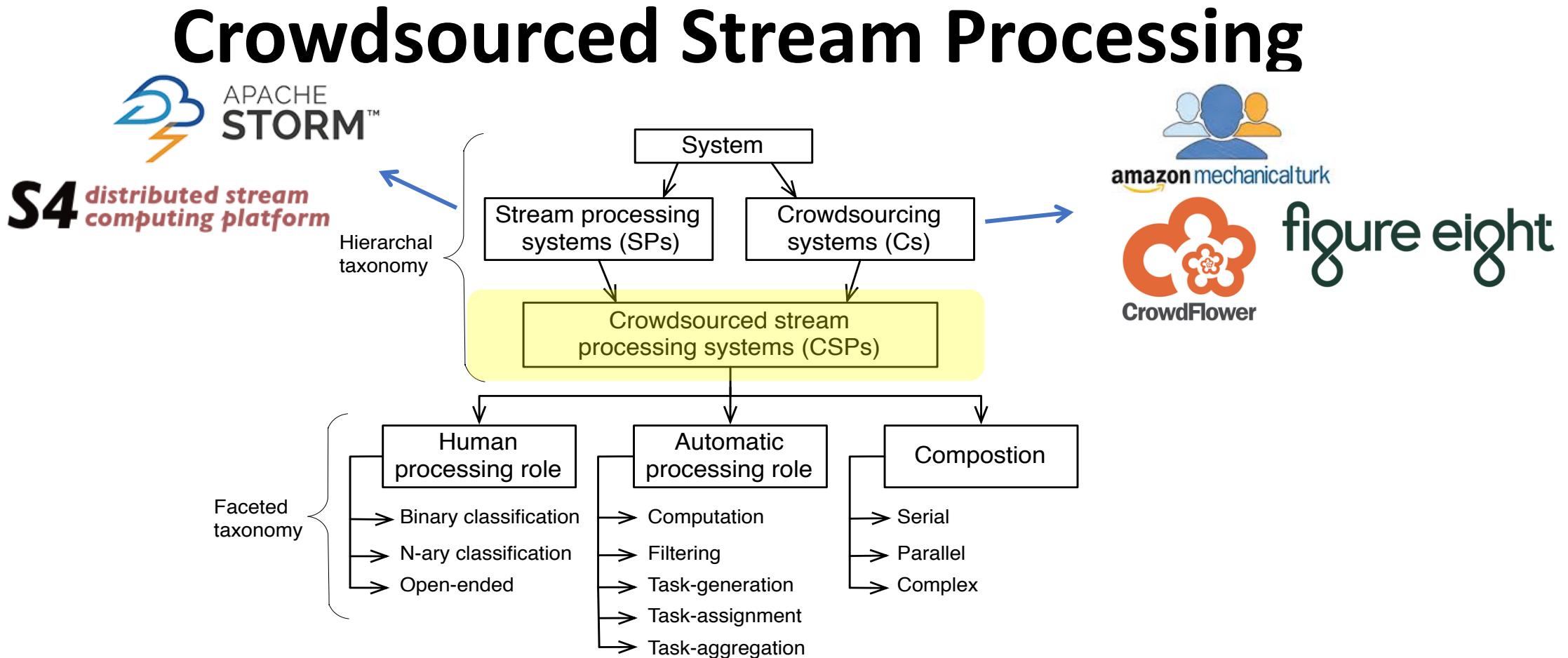


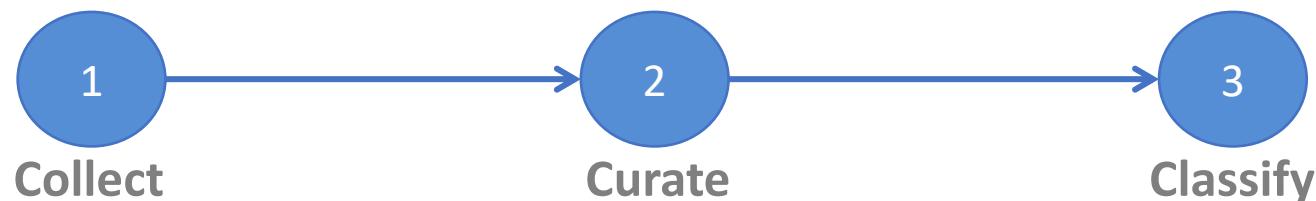
1. Data items arrive online
2. Streams have infinite length and unbounded in size
3. No control over the order in which data items arrive
4. Processed items are either discarded or archived
5. No retrieval unless stored in memory (often small size)

Traditional vs. Stream Processing

Property	Traditional System	Stream Processing System
Number of passes	Multiple	Single
Memory availability	Unlimited	Restricted
Processing time	Unlimited	Restricted
Results availability	Delayed	Real-time
Results reliability	Accurate	Improvable

In scenarios where **critical**—in terms of cost, time or reliability—**decision-making** is needed in **real-time** using streaming data potentially **noisy and unseen**, fully automated stream processing systems do not meet the needs.





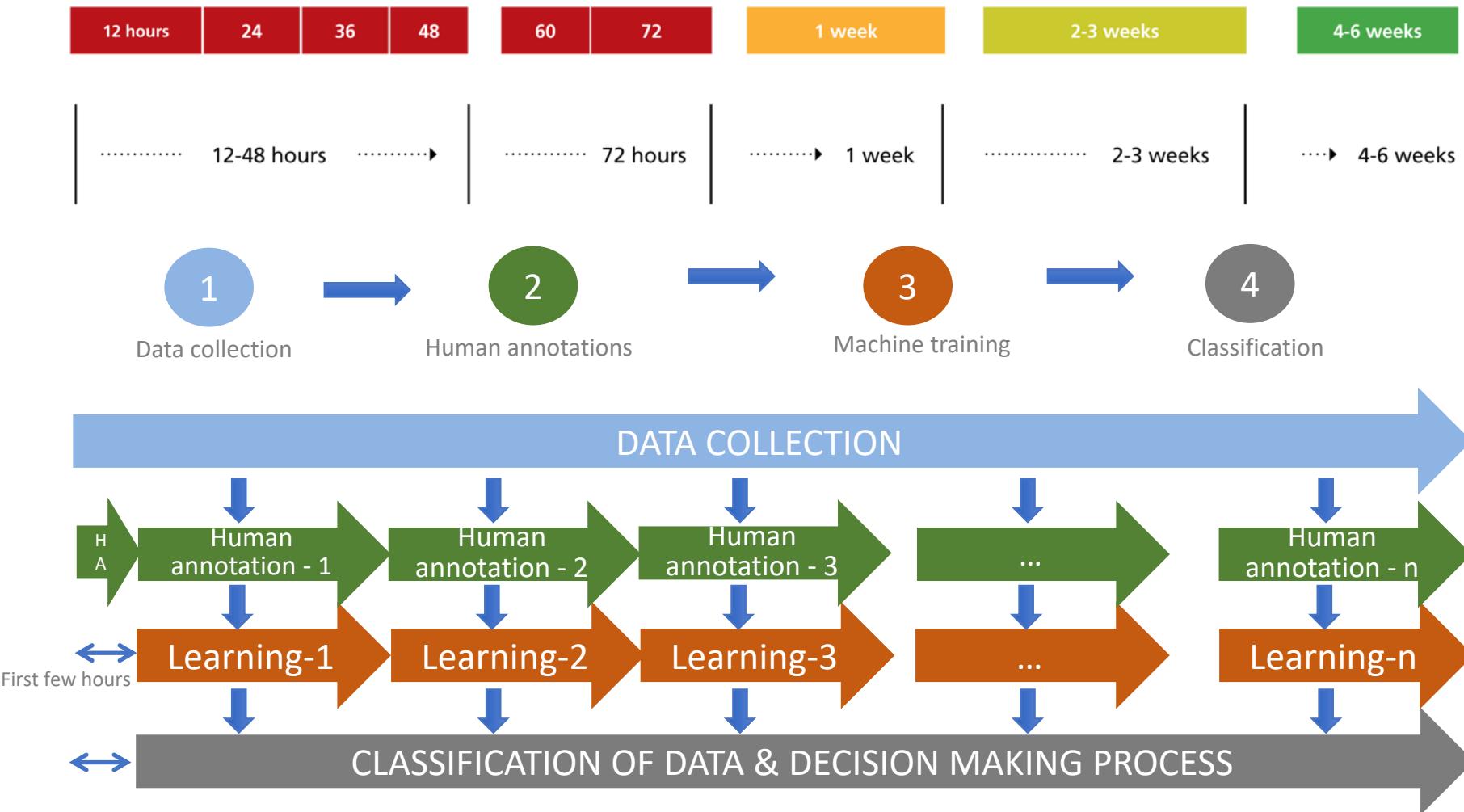
AIDR —Artificial Intelligence for Disaster Response— is a free, open, and easy-to-use platform to automatically filter and classify relevant tweets posted during humanitarian crises.

<http://aidr.qcri.org/>

Grand Prize Winner from the Open Source Software World Challenge 2015

Near Real-time Processing

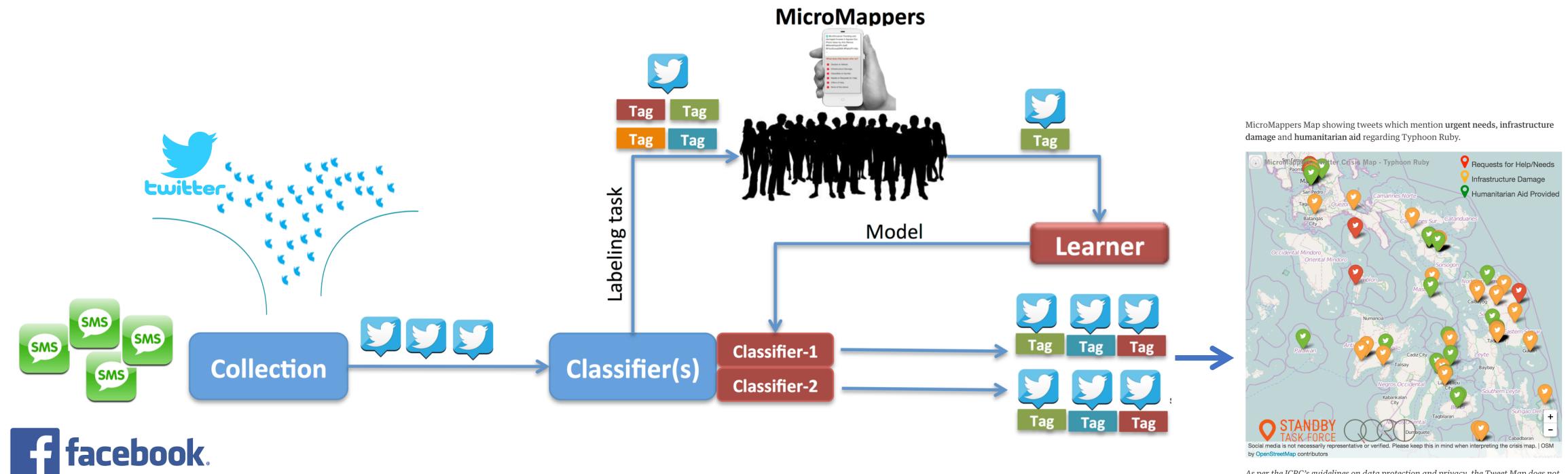
ONLINE APPROACH



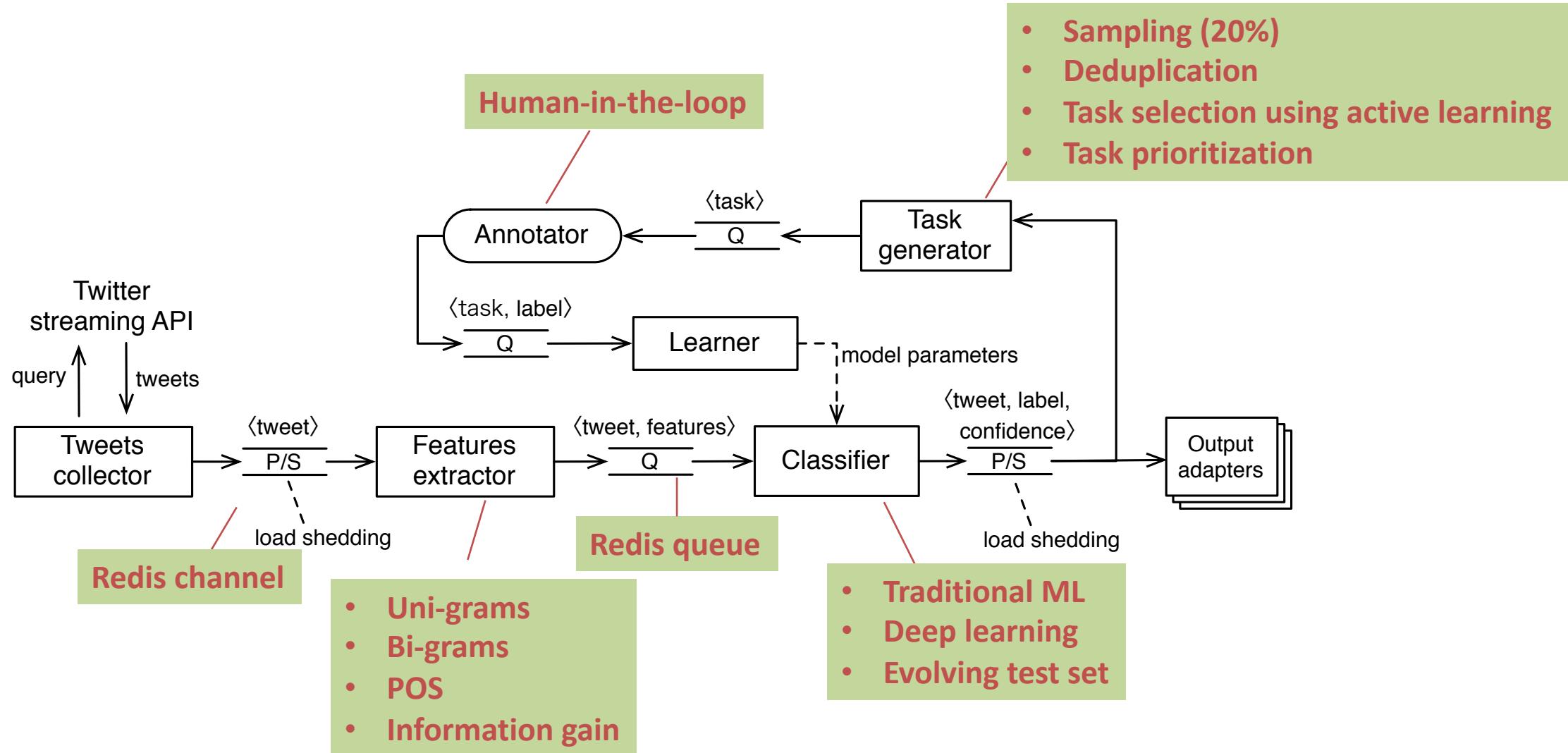
How AIDR Works?

Combining human-intelligence and machine-computation

<http://aidr.qcri.org/>



AIDR Architecture

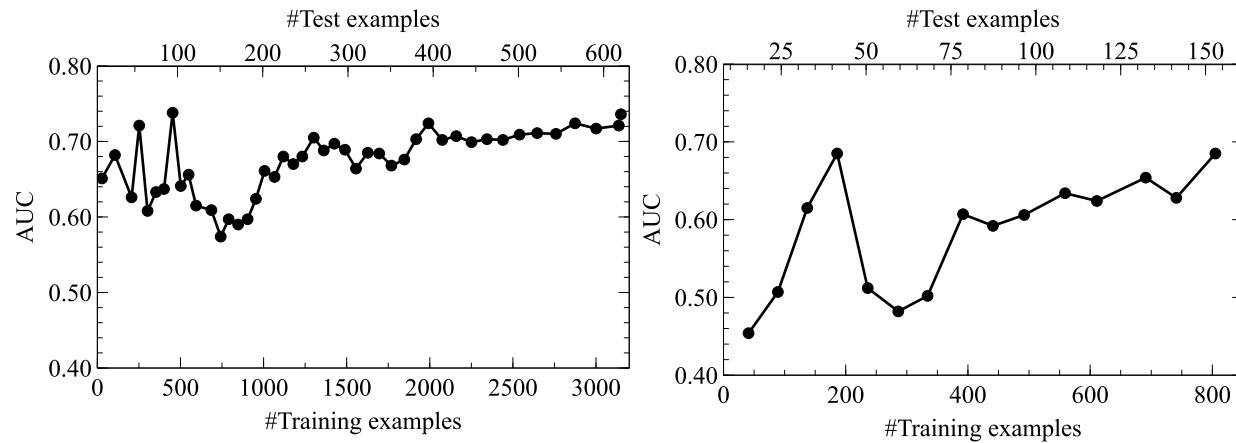


Quality vs. Cost in AIDR

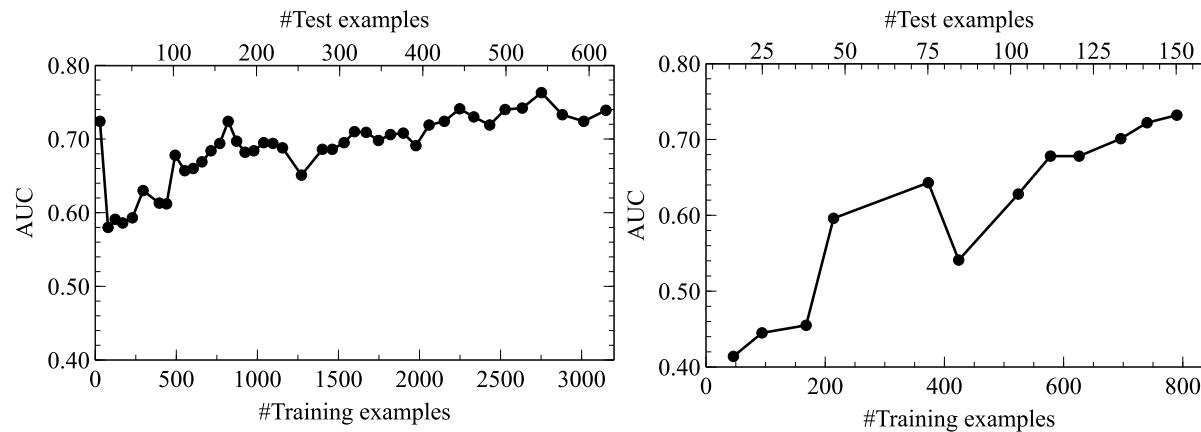
Goal: Maximize quality (machine) & minimize cost (human labeling)

- **Quality**
 - Classification accuracy
 - Precision/AUC
- **Cost to obtain labeled data**
 - Monetary in case of paid-workers
 - Time in case of volunteers

Quality vs. Cost in AIDR

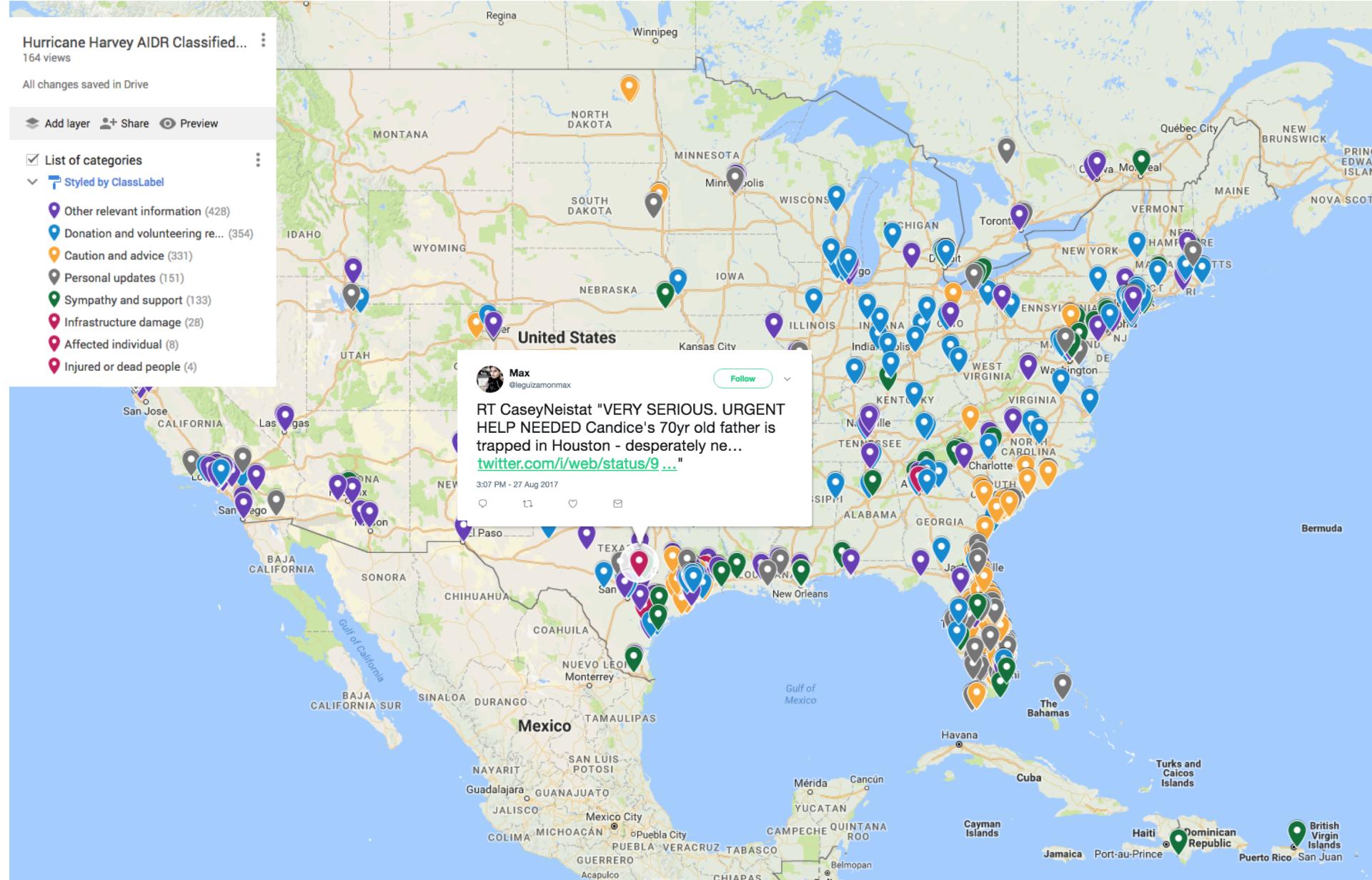


Quality vs. cost using **passive learning** and **with/without de-duplication**



Quality vs. cost using **active learning** and **with/without de-duplication**

AIDR Deployment during Hurricane Harvey 2017



Typhoon Hagupit (2014)

the guardian
Winner of the Pulitzer prize

UK world sport football opinion culture economy lifestyle fashion environment tech money travel

home > world europe US americas asia australia africa middle east

Typhoon Hagupit

Typhoon Hagupit: UN using crowdsourcing platform to help assess damage

The United Nations is working with crowdsourcing platform, MicroMappers, to assess how much destruction has been caused by the latest typhoon to hit the Philippines



Fishermen dock their boats at Manila Bay as Typhoon Hagupit (locally known as Ruby) approaches on 7 December 2014, Pasay City, Philippines. Photograph: Mark Cristino / Barcroft Media/Mark Cristino / Barcroft Media

At least 27 people have been killed and a million people evacuated after Typhoon Hagupit (locally known as Ruby) made landfall in the Philippines on Saturday night. Though Hagupit appears to be weakening as it approaches the Philippines capital, Manila, it's thought to have destroyed around 80% of all the homes along some coastal areas.

Like Typhoon Haiyan, last year, technology is again being used to help identify damage and needs assessment on the ground. The [United Nations Office for the Coordination of Humanitarian Affairs](#) (OCHA) in Manila has requested support

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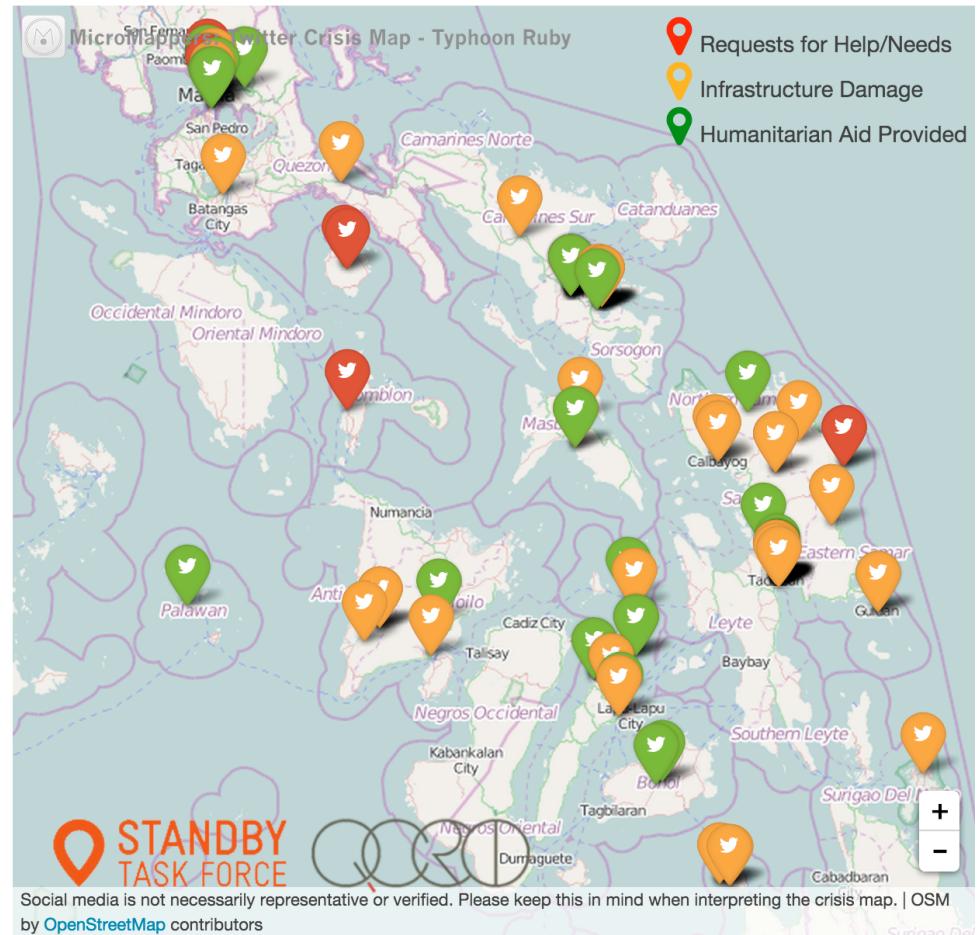


Harrison Ford hospitalised after crashing his plane on golf course



Nasa finds evidence of a vast ancient ocean on Mars

MicroMappers Map showing tweets which mention urgent needs, infrastructure damage and humanitarian aid regarding Typhoon Ruby.



As per the ICRC's guidelines on data protection and privacy, the Tweet Map does not include any personal identifying information (PII). This PII along with the raw tweets are only shared with the United Nations.

- Killed 27 people
- A million evacuated
- \$114 million of damage

Deployments (selected)



Hurricane Matthew

October 2016
Haiti & Humanitarian Agencies: Damage Assessment



Ecuador Earthquake

April 2016
Local government: Recovery & Reconstruction



Nepal Earthquake

September 2015
UN OCHA: Damage assessment & Rescue
8 lives were saved



Vanuatu Cyclone Pam

March 2015
World Bank: Damage assessment & Post disaster development planning



Philippines Typhoon Ruby

December 2014
UN OCHA: Damage assessment & Rescue



Philippines Coconut Expedition

December 2014
Local government: Assess damaged coconut trees



Namibia Wildlife Expedition

September 2014
Kuzikus Wildlife Reserve: protect animals from poachers and other threats



Balkan Floods

May 2014
UN OCHA: Damage Assessment



Chile Earthquake

April 2014
UN OCHA: Damage Assessment



Philippines Typhoon Haiyan

November 2013
UN OCHA: Damage Assessment



Pakistan Earthquake

September 2013
UN OCHA: Damage Assessment

"I would like to thank MicroMappers volunteers for the generous way in which they have committed their time to rapidly assess the damage to the buildings using the images captured, [...] for] mobilizing quickly and producing information that is useful particularly for the housing sector in a situation where due to the geographical nature of the area, many are difficult to be reached. [...] I hope that this will be the beginning of a fruitful collaboration that can be scaled up in future response missions in other parts of the world." – World Bank

Catherine, the Head of the UN's Information Management Unit in the Philippines had this to say: "I would like to thank all the volunteers [...] for their invaluable contribution over the past few days. We are lucky that Hagupit [Ruby] made less damages than expected and that the emergency quickly scaled down."

"The UN wants to find tweets that refer to infrastructure damage as well as needs and requests for help.

Our efforts are directly in response to clearly articulated information needs. In contrast, the response to Haiti was "supply based" in that we simply pushed out all information that we figured might be of use to humanitarian responders."

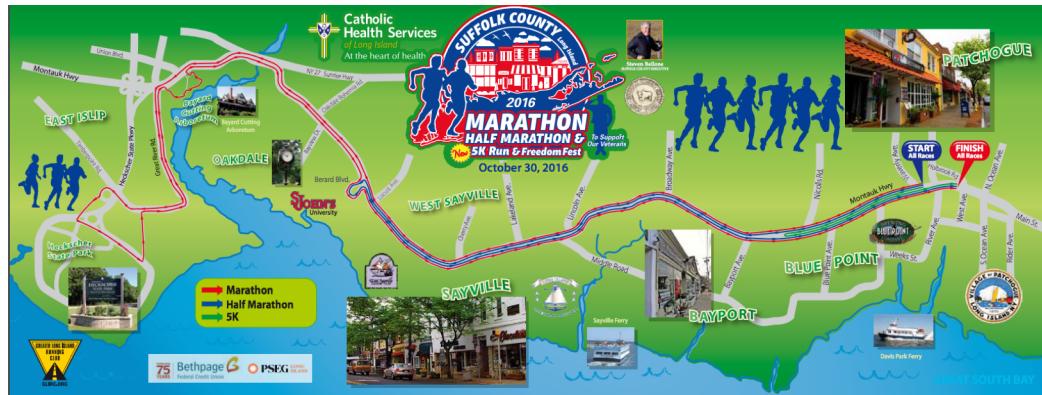
"At one point, volunteers tagged some 1,500 tweets in just 10 minutes. In parallel, we used machine learning classifiers to automatically identify tweets referring to both urgent needs and offers of help. In sum, the response to Typhoon Yolanda is the first to make full use of advanced computing, i.e., both human computing and machine computing to make sense of Big (Crisis) Data." – Philippines Typhoon Haiyan

"I donate to National Geographic and also make purchases that benefit conservation of land and the animals that inhabit them [...]. It was always my dream to go to Africa to help the wildlife in any way I could, but realistically that is not possible for most. So thank you so much for helping me to participate in this program, and giving us, the public, an opportunity to help, hopefully this can be another step towards stopping the Poachers." – Volunteer, USA

"The purpose of our web-based microtasking apps (we call them Clickers) is to quickly make sense of all the user-generated, multi-media content posted on social media during disasters. How? By using microtasking and making it as easy as a single click of the mouse to become a digital humanitarian volunteer. This is how volunteers with Zooniverse were able to click-and-thus-tag well over 2,000,000 images in under 48-hours."

Suffolk County New York Marathon 2015

Marathon surveillance through social media



Task: Suspicious reports/images and accidents detection

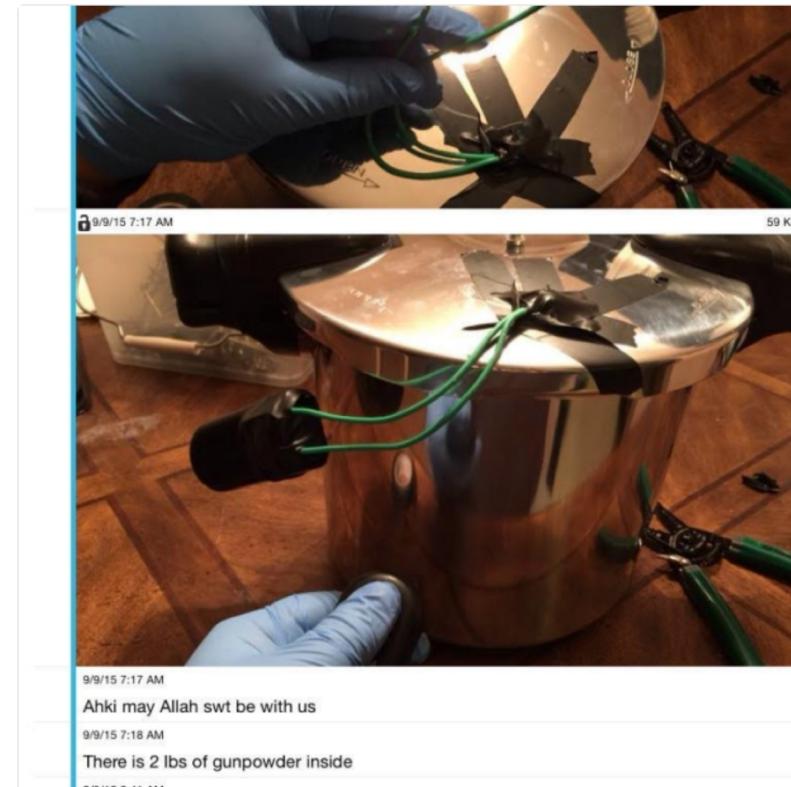


Refaatesque

@ThisIsGaZa

Follow

device appears to resemble a "pressure cooker bomb", similar to the type of explosive used in Boston Marathon attack



11:39 AM - 11 Sep 2015

14 Retweets 3 Likes



Social Media Image Processing for Social Good

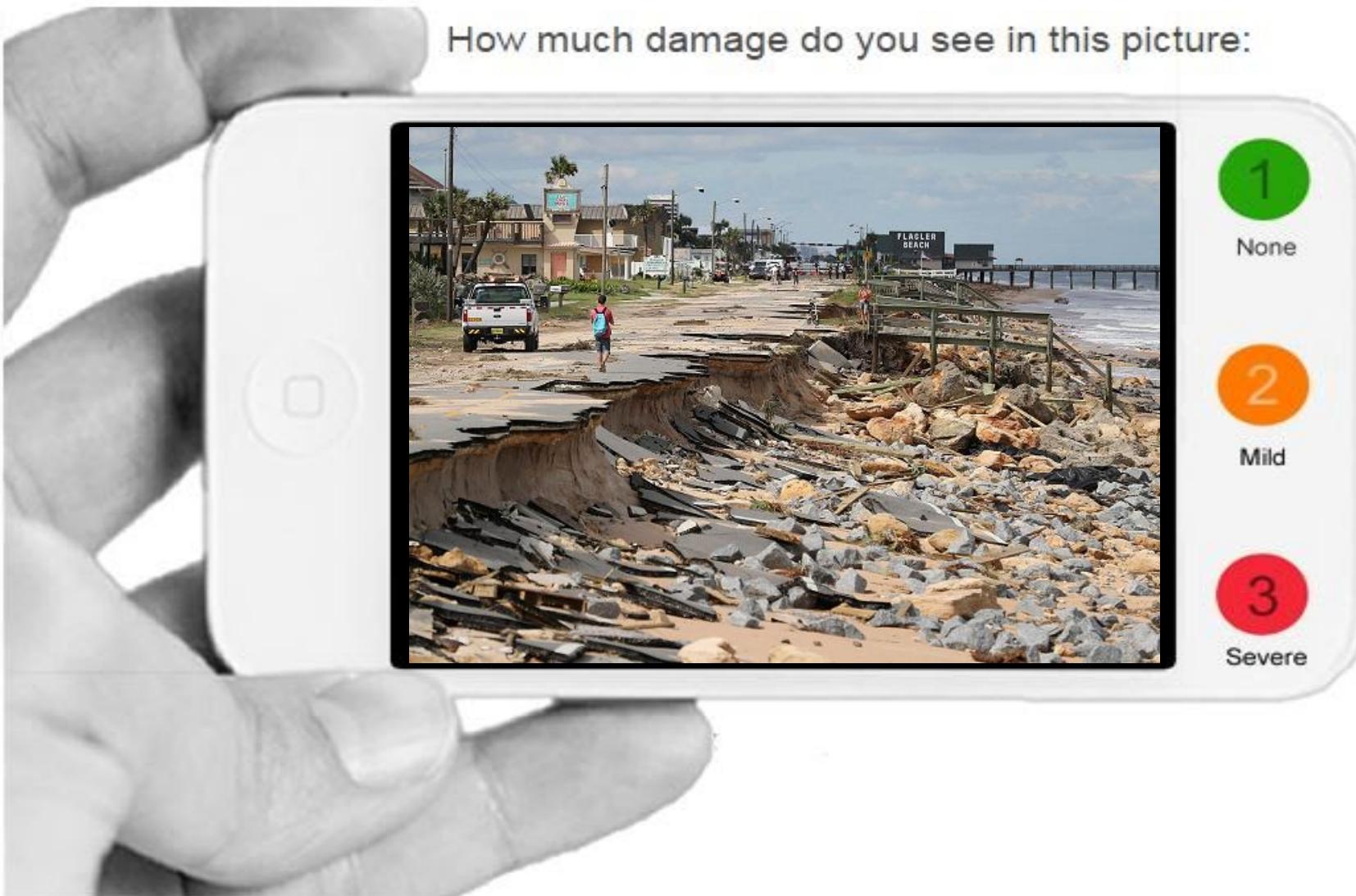
“A picture is worth a thousand words.”

Hurricane Matthew Ecuador Earthquake Nepal Earthquake



Damage Assessment from Images

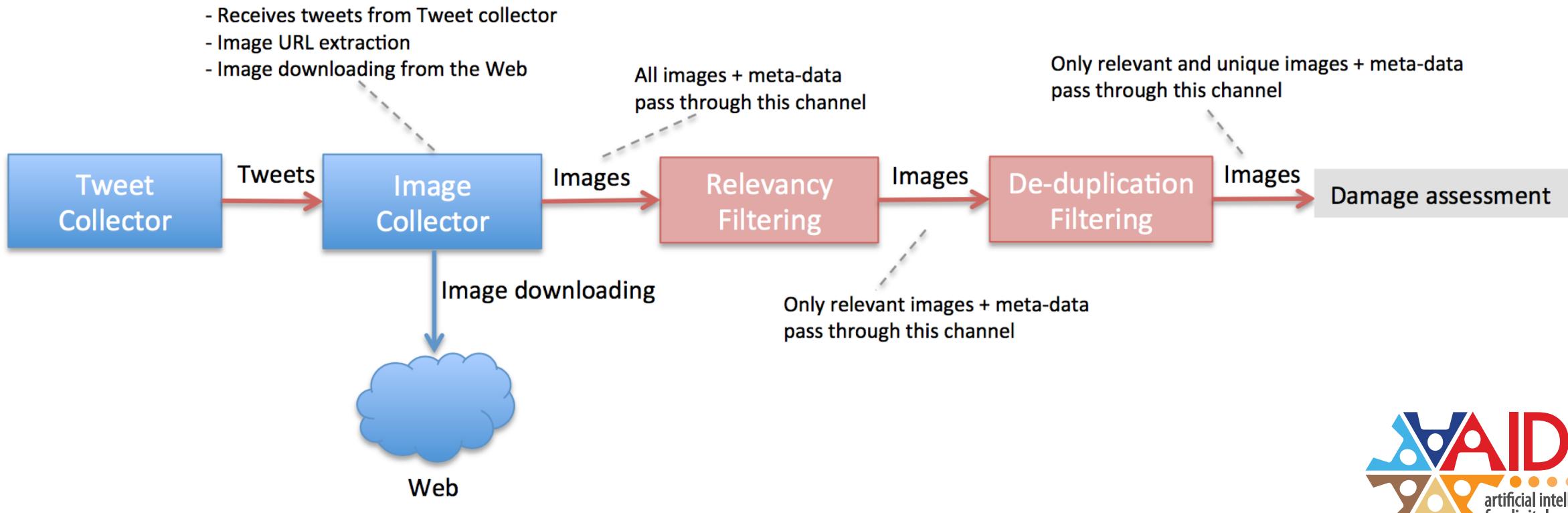
How much damage do you see in this picture:



A hand wearing a white long-sleeved shirt is holding a white smartphone. The screen of the phone displays a photograph of a coastal area after a storm. The foreground shows a large amount of dark, jagged debris and rubble on a sandy beach. In the middle ground, a person wearing a red backpack walks away from the camera towards a road. On the road, there is a white pickup truck. In the background, there are several buildings, including what appears to be a gas station and a sign for "FLAGLER BEACH". The sky is clear and blue.

- 1 None
- 2 Mild
- 3 Severe

Automatic Image Processing Pipeline



- [1] D. T. Nguyen, F. Alam, F. Ofli, M. Imran, "Automatic image filtering on social networks using deep learning and perceptual hashing during crises", ISCRAM 2017.
- [2] D. T. Nguyen, F. Ofli, M. Imran, P. Mitra "Damage Assessment from Social Media Imagery Data During Disasters", ASONAM 2017.
- [3] F. Alam, M. Imran, F. Ofli, "Image4Act: Online Social Media Image Processing for Disaster Response", ASONAM 2017.

Relevancy Filtering



Examples of irrelevant images showing cartoons, banners, advertisements, celebrities, etc.

Task: Build a binary classifier

Approach: Transfer learning

(fine-tune a pre-trained convolutional neural network, e.g., VGG16*)

Performance of the relevancy filtering

AUC	Precision	Recall	F1
0.98	0.99	0.97	0.98

* Simonyan, K. and Zisserman, A. (2014). "Very deep convolutional networks for large-scale image recognition". In: arXiv preprint arXiv:1409.1556

Duplicate Filtering

Blurred and unblurred



With and without text



Cropped



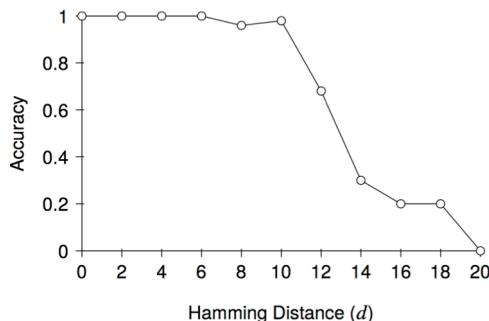
Re-sized



Examples of near-duplicate images

Task: Compute similarity between a pair of images

Approach: Perceptual Hash* + Hamming Distance (w/ threshold)

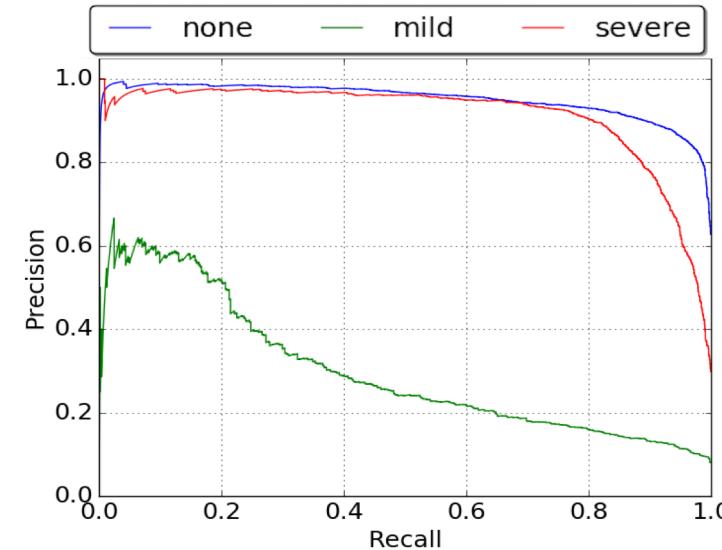


* Lei, Y. et al. (2011). "Robust image hash in Radon transform domain for authentication". In: Signal Processing: Image Communication 26.6, pp. 280–288.

Infrastructure Damage Assessment

- Three-class classification
 - Categories: severe, mild & little-to-none
 - Distinction between categories is ambiguous.
 - Agreement among human annotators is low.
 - in particular for *mild* category
 - Fine-tuning a pre-trained CNN (VGG16)

	AUC	Pre.	Rec.	F1
None	0.95	0.86	0.95	0.91
Mild	0.30	0.55	0.14	0.23
Severe	0.91	0.86	0.85	0.86
Avg.	0.72	0.76	0.65	0.67



AIDR Twitter Image Analysis --- Hurricane Dorian 2019

Total number of images collected: 252089

Choose a date: [2019-08-30](#) [2019-08-31](#) [2019-09-01](#) [2019-09-02](#) [2019-09-03](#) [2019-09-04](#) [2019-09-05](#) [2019-09-06](#) [2019-09-07](#) [2019-09-08](#)

Duplicate Filter: ON OFF

Relevancy Filter: ON OFF

Damage Filter: No damage Mild Severe

Apply Filters

Selected date: 2019-09-08 (Total number of images collected on the selected date: 5547)

Number of images meeting the selected criteria: 108

*All times are shown in UTC.

Please [refresh](#) the page to see the latest images.

<p>ID: 1170724829328216064_0 Time: Sun Sep 08 15:45:24 +0000 2019 Text: The tree has fallen. #Dorian #StephenvilleNL #nlwx @CBCNL Tweet link</p>	<p>ID: 1170724108449013761_0 Time: Sun Sep 08 15:42:33 +0000 2019 Text: Dorian hits Canada's Atlantic coast, knocks out power, downs a crane #Canada #Dorian Tweet link</p>	<p>ID: 1170723040512135170_3 Time: Sun Sep 08 15:38:18 +0000 2019 Text: Point Pleasant Park in #Halifax lost two stalwart trees at its tip during #HurricaneDorian , but at least they didn't fall on that nice #gazebo. Literally tons of rocks also on path by water. Tweet link</p>	<p>ID: 1170722346111340544_0 Time: Sun Sep 08 15:35:32 +0000 2019 Text: A crane collapsed onto buildings in Nova Scotia because of high winds from Dorian via @USATODAY Tweet link</p>	<p>ID: 1170719561919934475_0 Time: Sun Sep 08 15:24:29 +0000 2019 Text: 'A rough night': Cleanup begins in wake of Hurricane Dorian: Tweet link</p>
<p>ID: 1170718618419650562_1 Time: Sun Sep 08 15:20:44 +0000 2019 Text: Hurricane Dorian: Update from the Bahamas at the start of their recovery via @YouTube @RedCross Tweet link</p>	<p>ID: 1170718198628519938_0 Time: Sun Sep 08 15:19:04 +0000 2019 Text: Video: Storm Dorian: Canada issues warnings, Bahamas clean up Tweet link</p>	<p>ID: 1170716996641665026_1 Time: Sun Sep 08 15:14:17 +0000 2019 Text: Was able to survey damage of The #Bahamas hardest hit areas on my way in to #Abaco today. @USAID is working around the clock to respond to those needing life saving assistance in the wake of #HurricaneDorian. Tweet link</p>	<p>ID: 1170716015090720768_0 Time: Sun Sep 08 15:10:23 +0000 2019 Text: Does This Image Really Show A Bahamian Town Destroyed By Hurricane Dorian? - Tweet link</p>	<p>ID: 1170715535451074560_3 Time: Sun Sep 08 15:08:29 +0000 2019 Text: Last night the marines of 21 Raiding Squadron arrived with the KDC-10 of the Royal Netherlands Airforce @Kon_Luchtmacht at Sint Maarten. They are going to help the people of the Bahamas. #HurricaneDorian @korpsmariniers Tweet link</p>

Hurricane Dorian Deployment

End users:

- 1- FEMA
- 2- Montgomery County's Community Emergency Response Team (CERT)
- 3- DisasterLogistics
- 4- GISCorps
- 5- The National Alliance for Public Safety GIS
- 6- SBTF
- 7- UN OCHA
- 8- Pacific Disaster Center-Humanitarian AI

Large-Scale Crowdsourcing MCCERT and GISCorps

M Community Projects Create About imran ▾

Hurricane Dorian Damage Image Labeling

Please look at the image and select the label(s) that represent the image. If you have any confusion, please take a look at the [tutorial](#).

Total number of tasks: **29556**

You have completed: **827**

Remaining number of tasks: **2315**

30,000 images labeled
in two days



Identify Damage Label

Damage

No Damage

Don't know or can't judge

Other labels (comma separated)

Identify Damage Severity Level

Mild

Severe

Other labels (comma separated)

Submit

“Data in the Extreme Wild”



- Infrastructure types and places
 - Roads, bridges, communication lines, government buildings, bus/train stations, power plants, etc.
- Natural or human-induced disasters
 - Earthquakes, wildfires, hurricanes, snowstorms, floods, accidents, explosions, chemical spills, etc.

A LARGE-SCALE DISASTER IMAGE DATASET

Disasters in Places Database



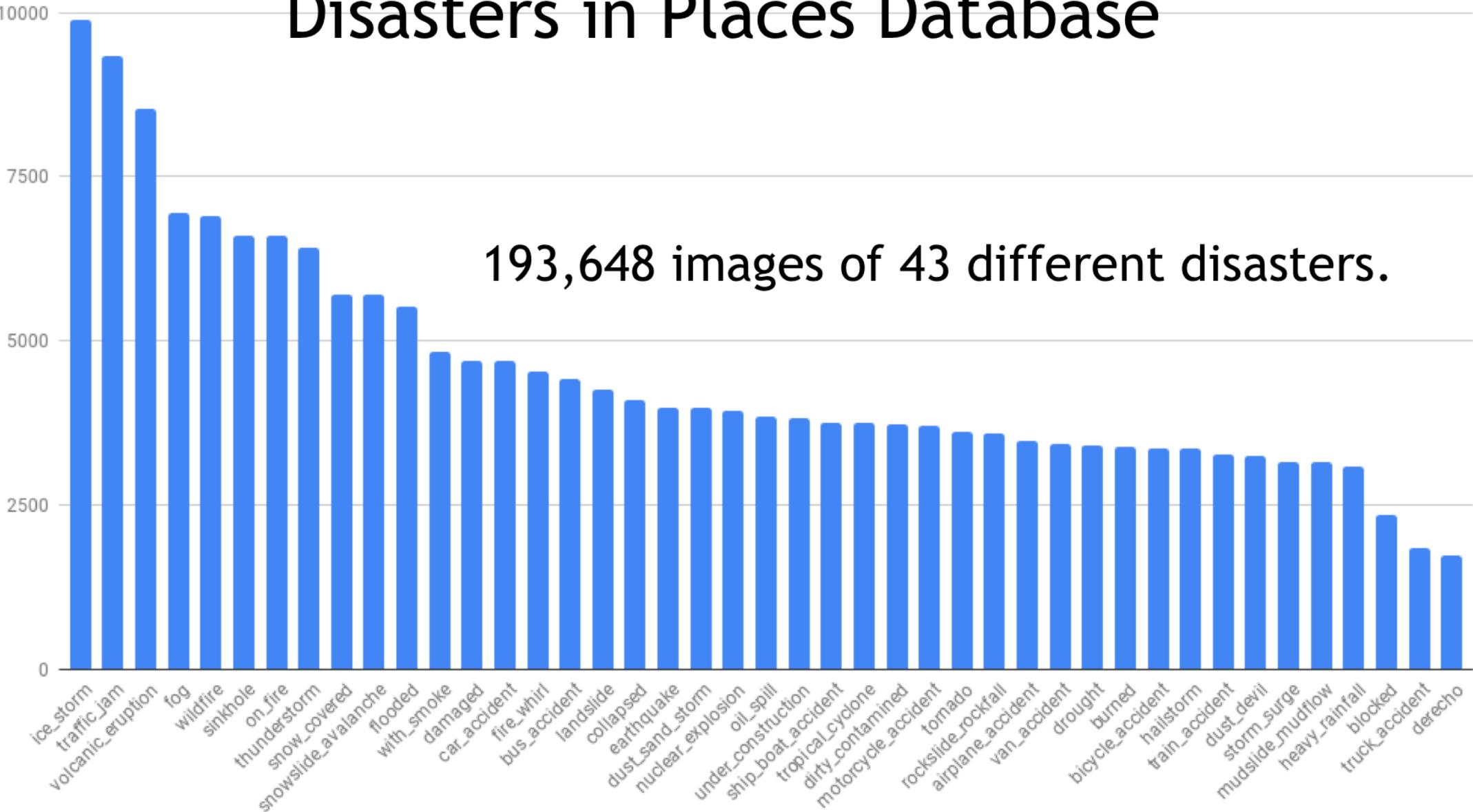
In collaboration with



Massachusetts
Institute of
Technology

Disasters in Places Database

193,648 images of 43 different disasters.



Text + Image



Severe damage, but where exactly?

Text + Image



RT @MikeTheiss: Latest report in **Rockport, Texas #HurricaneHarvey**

Text + Image

**6.1-magnitude earthquake,
but what is the actual damage?**

Southern Mexico rocked by **6.1-magnitude** earthquake...

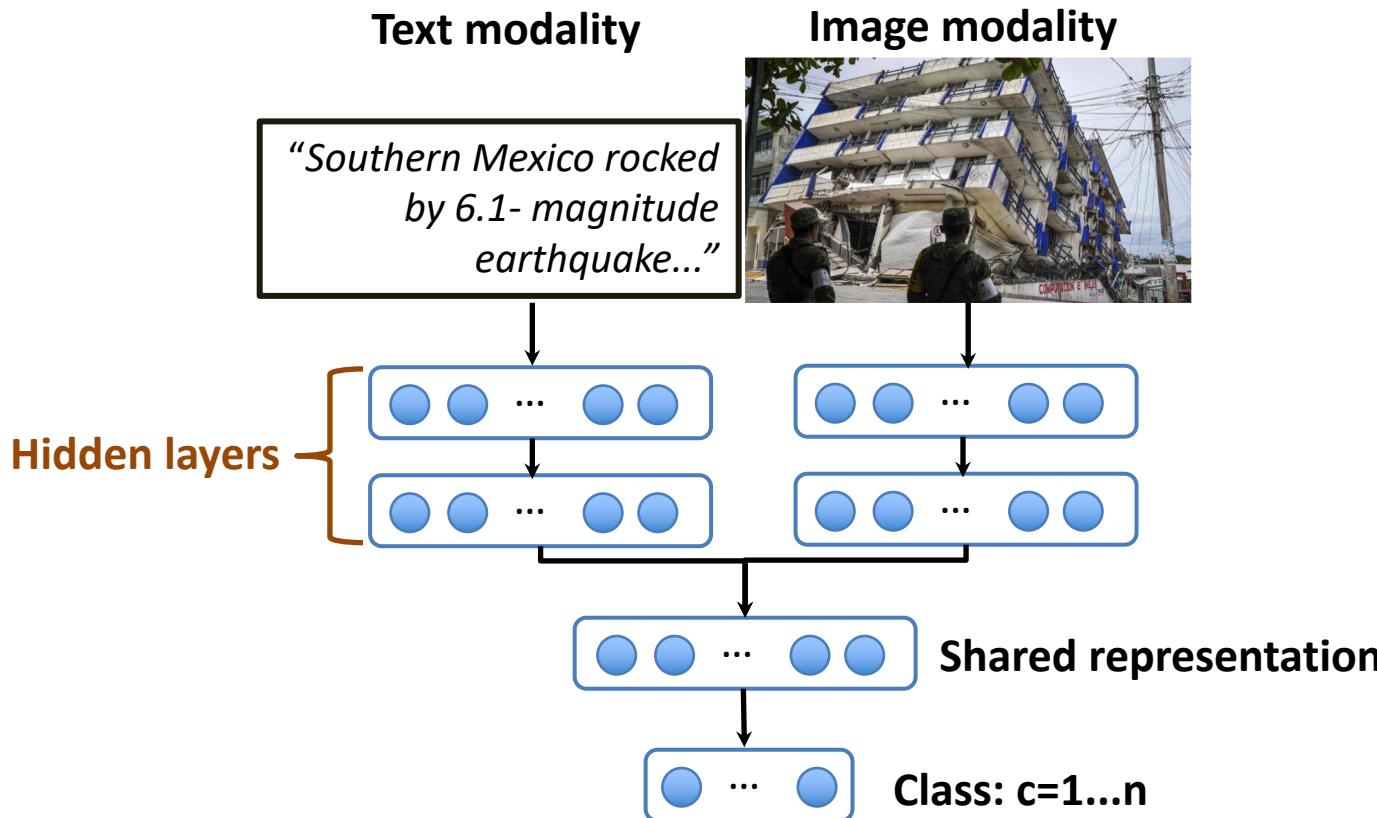
Text + Image



Southern Mexico rocked by **6.1-magnitude** earthquake...

CrisisMMD: Multimodal Annotated Dataset for Crisis Computing

Our goal is to develop a **robust system** that can exploit multimodal data and **extract highly accurate information.**



Ongoing & Future work

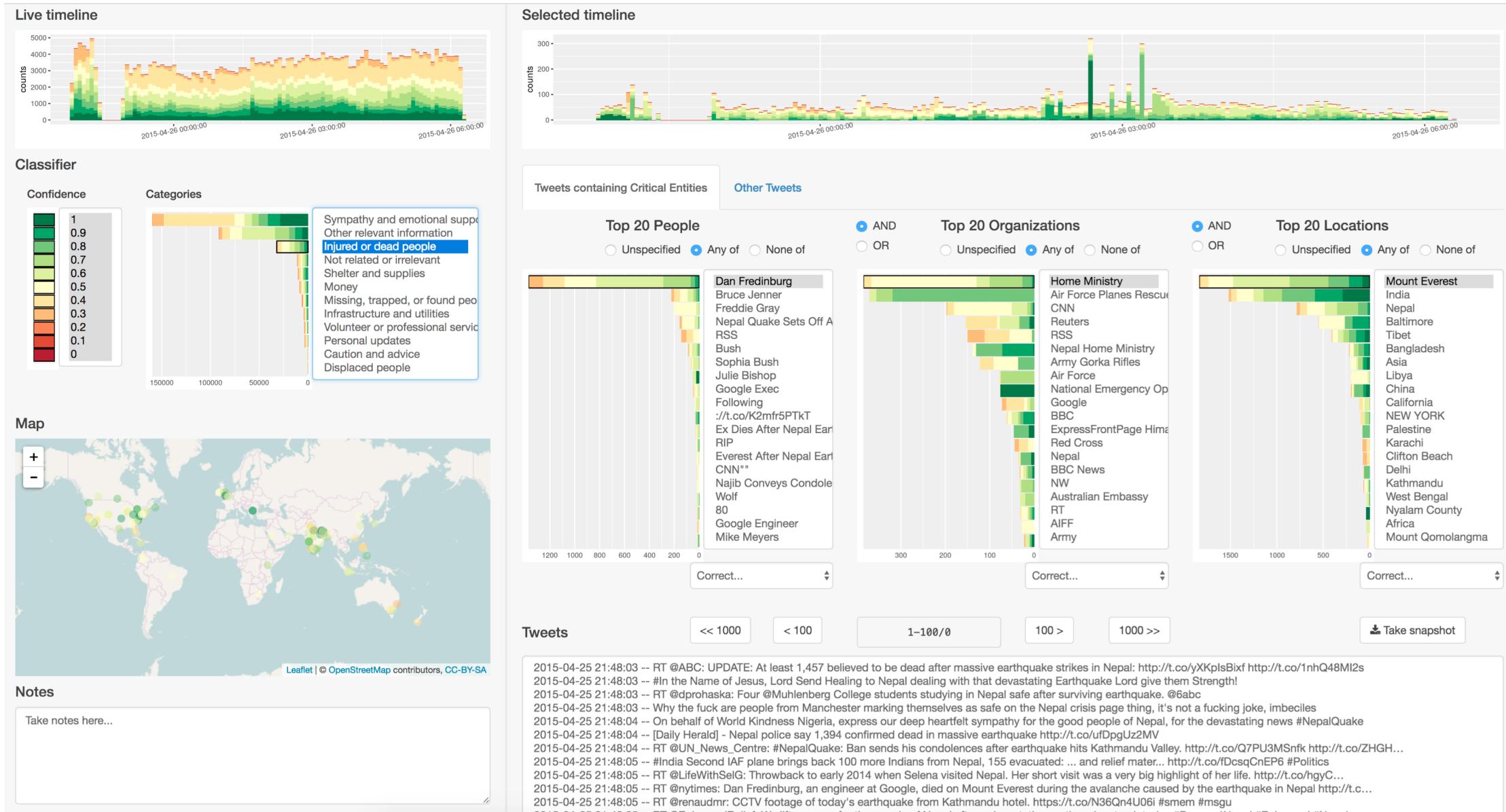
Applications:

- Automatic identification of eyewitness reports on Twitter
- Finding missing people during disasters
- Actionable information extraction

Methods:

- Multimodal learning using text and images
- Domain adaptation and transfer learning across languages
- Real-time text summarization
- Geo-location inference from tweets
- ...

Real-time Monitoring of Situational Information



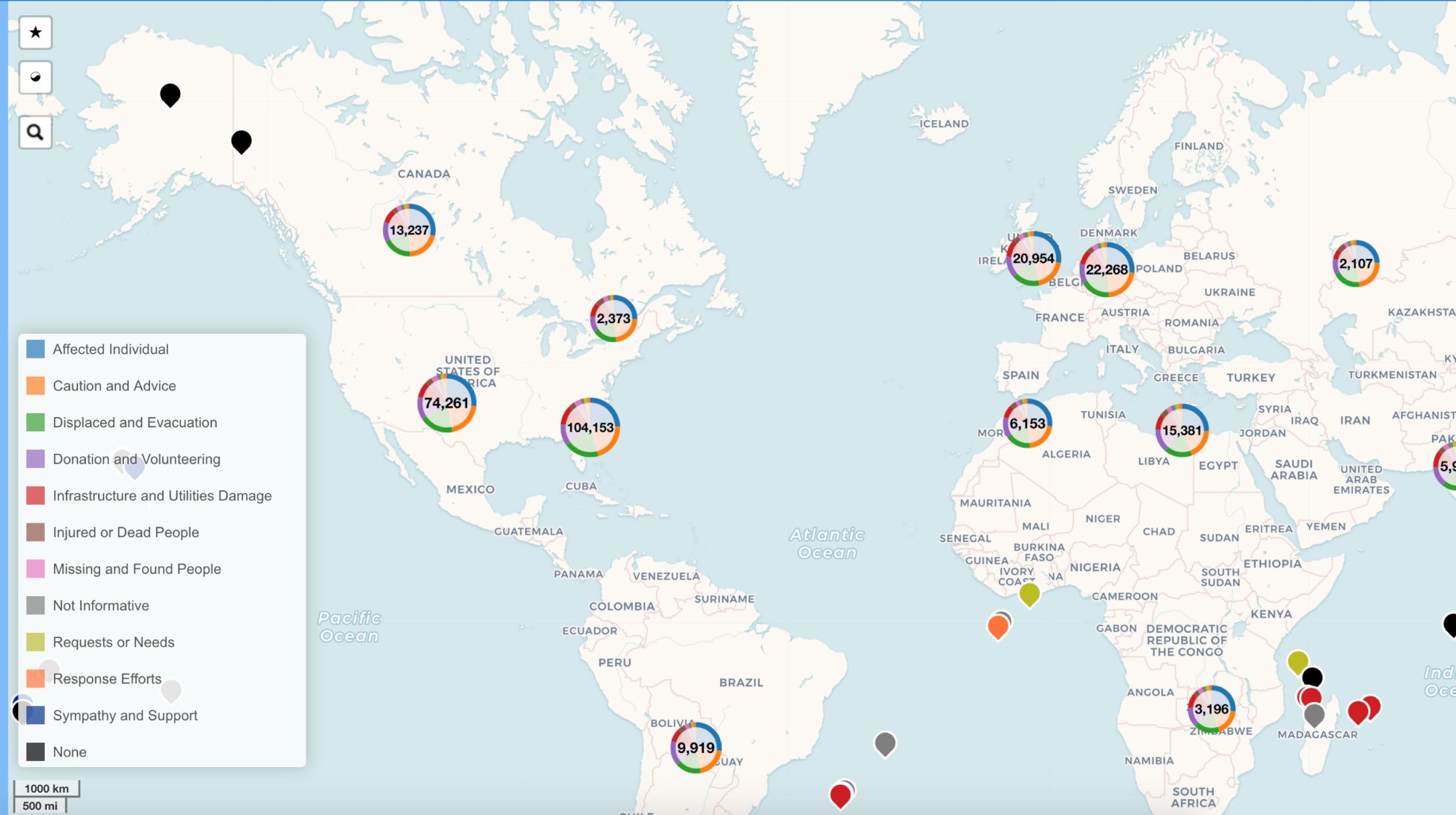


Geotagged tweets: 304,053 Total tweets: 4,231,510

Hurricane Dorian 2019

CLASSIFIERS INFORMATION

- All Tweets



Crisis-related Social Media Datasets



- Million of disaster-related tweets (ids)
- Around 50k labeled tweets into humanitarian categories
- Word2vec embeddings trained on 52m crisis-related tweets

CrisisNLP.qcri.org

Media Coverage

nature Forbes



Mashable WIRED.CO.UK



BROOKINGS



THANK YOU!

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Twitter: @mimran15

Web: <https://mimran.me/>

<http://crisiscomputing.qcri.org>



<http://aidr.qcri.org/>

Twitter: @aidr_qcri



<https://CrisisNLP.qcri.org/>

Twitter: @NLP4Crisis