Innovations in Multi-Modal AI Technology for Emergency Management

PrepTech Talks

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March 2, 2023
National Alliance for Public Safety GIS (NAPSG) Foundation
napsgfoundation.org | @napsgfoundation
Webinar Prep

Due to the large attendance, all participants are muted for the duration of the session.

- Please use the Q&A functionality within Zoom for questions that are relevant to the whole group.
- We will address these Q&A at the end of the webinar.

A copy of the slides, associated links, and a recording of this webinar will be available on the NAPSG Foundation website next week.
About NAPSG Foundation

• 501(c)(3) non-profit organization established in 2005
• +20,000 members: Public Safety Officials, Operators, and GIS Staff
  Mostly in the US, but spans the globe
• All training, tools, best practices and other resources provided at no cost
Total Participants

164

*may include duplicates that attended multiple events or exclude those who did not provide location details.

Last update: 15 minutes ago

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<thead>
<tr>
<th>Sector Affiliation</th>
<th>Count</th>
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<tr>
<td>Emergency Management</td>
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<tr>
<td>Fire Service</td>
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<td>Law Enforcement</td>
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<td>EMS</td>
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<td>Public Works/Utilities</td>
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* sector affiliation chart with bar graph showing distribution of counts for each sector.
Innovations in Multi-Modal AI Technology for Emergency Management

Joel Tetreault
Dataminr, Inc.
March 2, 2023
Outline

• Real-time Event Detection and Alerting
• Introduction to AI
  • Examples of AI in the Real World
  • Brief History of AI
  • Developing an AI System
• AI for Real-Time Event Detection
Real-Time Event Detection & Alerting
Severe Weather in New Orleans, LA

Date: 22 - 23 March 2022
Source: Official Post & Reporter via Social Media; Government; Social Media; News Outlet
Original Language: English
Summary: Areas in and around New Orleans, LA, experienced severe thunderstorms and destruction from a tornado.

22 Mar - 15:13 CDT

22 Mar - 19:20 CDT

First major news coverage of event at 22 Mar - 20:19 CDT

Possible funnel cloud moving east of Lower Ninth Ward area of New Orleans, LA: Local Source Video via Social Media.
22 Mar - 19:38 CDT

Major tornado damage with house in middle of Prosperity Street in Arabi, LA following tornado: Reporter via Social Media.
22 Mar - 20:26 CDT

Multiple injuries and trapped people reported following tornado in Arabi, LA: Local News Outlet via NOLA.
22 Mar - 21:17 CDT

23 Mar - 12:28 CDT

Event Detection

- Online sources produce **billions and billions** of signals (messages) a day
- Across different **languages**
- Across different **modalities** (text, images, videos, sensor data, etc.)
- Rich source of information for detecting and alerting events in **real-time**
Event Detection

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“We are trapped with large amounts of surge outside our door. Downtown Ft Myers flooding from Hurricane IAN #flwx”

“My house surrounded by floods. In Long Fork!!!.”
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“**We are trapped with large amounts of surge outside our door. Downtown Ft Myers flooding from Hurricane IAN #flwx**”

“**A storm is coming! Bout to stream Taylor’s new album.**”

“**My house surrounded by floods. In Long Fork!!.”**
Dataminr: Detecting events in real-time

• Send real-time alerts on hundreds of event types to our clients
• Identify the who, what, where, when in a message, no matter the modality or language
• Like pulling a needle out of a haystack: combine AI (scale) with human expertise (domain knowledge)

Data Sources

Alerts to Customers
Dataminr: Detecting events in real-time

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Data Sources

500k sources spanning social media, news, blogs, sensor data, and more!
Brief Description of AI
Artificial Intelligence

The theory and development of computer systems able to perform tasks that normally require human intelligence, such as visual perception, speech recognition, decision-making, and translation between languages.
Breakdown of Artificial Intelligence
Natural Language Processing is Hard!

“I saw the man on the hill with the telescope”
"I saw the man on the hill with the telescope"

1. I saw the man. The man was on the hill. I was using a telescope.
2. I saw the man. I was on the hill. I was using a telescope.
3. I saw the man. The man was on the hill. The hill had a telescope.
4. I saw the man. I was on the hill. The hill had a telescope.
5. I saw the man. The man was on the hill. I saw him using a telescope.
Real World Applications
Cela constituerait une solution transitoire qui permettrait de conduire à terme à une charte à valeur contraignante.

This would be a transitional solution that would allow eventually lead to a binding charter.
Examples of AI in Real-World Applications

Intents
An intent performs an action in response to natural language user input

Utterances
Spoken or typed phrases that invoke your intent

Slots
Slots are input data required to fulfill the intent

Fulfillment
Fulfillment mechanism for your intent
Examples of AI in Real-World Applications

Source: https://www.esri.com/about/newsroom/publications/wherenext/insurers-use-satellite-imagery-for-damage-assessment/
Examples of AI in Real-World Applications

- Diagnosis (medical imaging, patient data)
- Early detection
- Decision making
- Research
- Chatbots

Examples of AI in Real-World Applications
Brief History
Modern History of AI Systems

1950s-1980s

Expert Systems

1980s-2010s

Machine Learning

2012-

Deep Learning

2020++

Convergence?

Figure 4: Operating the computer
Modern History of AI Systems

1950s-1980s

Expert Systems

1980s-2010s

Machine Learning

2012-

Deep Learning

2020++

Convergence?
Modern History of AI Systems

1950s-1980s
- Expert Systems

1980s-2010s
- Machine Learning
- Deep Learning

2012-
- Convergence?

2020++
What does AI do well?

- Process extremely large amounts of heterogeneous data, from all over the world, in real time (text in different formats, languages, images, video, audio, sensor data, ...)

- Identify some “narrow” classes of events (i.e., structure fires, accidents, ..)

- Rank some things as more important than others

- Deliver the right content to the right places
Where does AI have problems?

- AI systems that are trained for one task (identifying disaster vehicles) have to be retrained for another task (identify natural disasters)
- Commonsense reasoning
- Complex tasks where the goalposts (rubric, definition) may change
Which approach is best?

• It really depends on your problem and the resources available!
• Good AI developers view the different approaches as tools in a tool chest, and can identify the right one(s) to use
• Rule-based approaches can be very effective in specific situations and also when the DL model makes systematic errors
• Most industrial deployments use DL models in conjunction with rule-based approaches
Developing an AI System
What makes an AI model successful in practice

- People usually think of the following:
  - Researchers
  - Compute
  - Data (unlabeled)
    - Ex: GPT-3 trained on 45TB of text data!
- But don’t realize that it takes more than that:
  - Data (labeled)
  - Experts in the domain
  - Close partnerships with Engineering for deployment and scaling in production environments
Developing an AI System

Data

AI Model

Scientists & Engineers

Compute
Developing an AI System

Data

AI Model

Compute

Scientists & Engineers

Experts
How do AI systems learn?

- Different architectures
- Data
- Tuning the architectures for the problem
How do AI systems learn?

• Different architectures
• Data
• Tuning the architectures for the problem
The importance of data

- "My house surrounded by floods. In Long Fork!!!"
- "We are trapped with large amounts of surge outside our door. Downtown Ft Myers flooding from Hurricane IAN #flwx"
- "Not enjoying the Fetterman OZ debate. Nope."
- "A storm is coming! Bout to stream Taylor’s new album."

Example: model which detects (in real-time) whether an incoming piece of text is potentially of interest to clients (alertable)

Alertable!
Alertable!
Not Alertable!
Not Alertable!

AI Model
The importance of data

- Recent deep learning models trained on as much millions (if not more) labeled examples
- Creating the data and process to itself and can take longer than developing the AI model!
- Underlines the importance of human experts in the AI development process
AI for Real-time Event Detection
AI Org at Dataminr

**SCALE THE BUSINESS**

**APPLIED RESEARCH**
*Scaling event detection & alert generation*

**AI MODELS & TOOLS**
NLP  CV  DL/ML

**AI ENGINEERING**
*Run & optimize models (< $)*

**OPERATIONS MODEL SERVING PLATFORM**

**DATA SCIENCE**
*Experiment & Expand*

**MODEL EXPANSION**

**INNOVATION**
*Design and build customer facing prototypes & internal tools*

* Multiplier Priority Principle: Scale (multiply) efforts

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**World Class Team**

**PhD**
- COMPUTER SCIENCE
- PHYSICS
- INDUSTRIAL ENGINEERING
- COGNITIVE BRAIN SCIENCE
- NEUROSCIENCE
- ELECTRICAL ENGINEERING

**MSc**
- DATA SCIENCE
- ELECTRICAL ENGINEERING
- COMPUTER SCIENCE

**AI ENGINEERS**
- DESIGNERS
- FRONT END ENGINEERS
- PRODUCT MANAGERS
What does an AI scientist do (at Dataminr)?

**Internal Impact**

- Build and deploy AI models
  - Problem scoping
  - Data collection
  - Rapid experimentation
  - Evaluation

- Research and develop novel algorithms (models) for our purposes

- Deploy models

- Internal thought leadership

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**The Life of a Mobile Model**

1. Collect
2. Train
3. Optimize
4. Convert
5. Protect
6. Deploy
7. Monitor
8. Collect

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What does an AI scientist do (at Dataminr)?

**External Impact**

- Publish peer-reviewed research papers
- Organize AI conferences and workshops
- Academic collaborations
- Research talks

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**Multimodal Categorization of Crisis Events in Social Media**

**Abstract**

Recent development in image classification and natural language processing coupled with the rapid growth in social media data provides an opportunity to automatically identify and classify crisis events. This paper presents an approach for developing a model that automatically identifies crisis-related events from social media images and text. The approach involves using a multimodal classifier that combines image and text features to achieve high classification accuracy. The developed model was tested on a dataset of crisis-related events, and the results showed promising performance. The model has the potential to be used in various applications, such as emergency response and disaster management. The proposed framework can be extended to incorporate additional features and improve the overall performance of the system.
Real-Time AI at Dataminr

<table>
<thead>
<tr>
<th>Computer Vision</th>
<th>Natural Language Processing</th>
<th>Audio &amp; Speech Processing</th>
<th>Machine &amp; Sensor Data</th>
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<tbody>
<tr>
<td><img src="image1.png" alt="Computer Vision Image" /></td>
<td><img src="image2.png" alt="Natural Language Processing Image" /></td>
<td><img src="image3.png" alt="Audio &amp; Speech Processing Image" /></td>
<td><img src="image4.png" alt="Machine &amp; Sensor Data Image" /></td>
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Computer Vision

CLASSIFICATION
- Photograph
- Fire

DETECTION & EXTRACTION

LOGO
- McDonald's

OCR (TEXT)
- www.vanfire.org

OBJECTS
- Fire truck
- Firefighter
- Fire
- Smoke
Real-Time AI at Dataminr

- Models to detect whether an event is alertable
- Models to detect the topic of the event
- Models to detect the location of the event
- Models to generate a concise summary of the event
- Models to link events together
- Models to recognize mentions of entities
“Dispatch officers to site of reported explosion on south side of town”

“I just heard an explosion south of town, anyone else?”

Smoke visible in photos posted to social media

FlightAware shows abrupt end to flight path
Exponential: AI 10 Year Archive

Continuous Deployment of New AI Features

Our rapid deployment enables nimble response, ensuring that our alerts are always using state-of-the-art AI (includes content expansion and QA improvements)

Robust Alert Data & KG

We have an archive spanning millions of alerts over our 10+ year history, serving as reference data as we train and build new AI models

Human-AI Interaction

Constant and real-time feedback between our users, alerting team, AI, and engineering teams allow us to identify improvements

AI Models and Tools

Alerting trends and practices help inform what AI models and tools are most impactful to build

10 Year Cycle ... and Ongoing

Untouchable Advantage

Human-AI Loop
Summary
Real-Time Event Detection

- Dataminr develops state-of-the-art **AI techniques** with expert **humans-in-the-loop** to detect and alerts on meaningful events in real-time
  - AI is key for scaling and speed
  - Human experts are key for high-stakes events, training and more
- Works across disparate languages and modalities
- First Alert product works for Public Sector (ie. crisis response management)
- AI has been pivotal for scaling the number of alerts we send out and empowering clients
  - But there’s no free lunch...real-time event detection is one of the most challenging problems!
Dataminr has expanded its social good efforts with a new Crisis Response program created to support nonprofits on the front lines of emergency response operations. Learn more:

dataminr.com

Dataminr Launches Crisis Response Program to Support Nonprofits
Dataminr’s Crisis Response program will provide free, limited-term access to its alerting to support nonprofits on the front lines of emergency response.
Real-time breaking news alerts allow you to respond quickly and act confidently.

First Alert’s pioneering Artificial Intelligence delivers the earliest sign of breaking news and events to you, as they happen.
Questions?

jtetreault@dataminr.com  |  @Tetreault_NLP
THANKS!

Do you have any questions? porourke@publicsafetygis.org napsgfoundation.org/

@napsgfoundation