Integrating AI into Civil Protection

Whether by predicting the global spread of the novel coronavirus originating from China or detecting wildfires in California, the use of artificial intelligence in civil protection promises to improve the prevention of, response to, and recovery from disasters. However, getting there requires rethinking data silos and assessing high-risk applications.

By Kevin Kohler and Benjamin Scharte


In some countries, police forces use unmanned aerial vehicles in order to ensure safety compliance with measures taken by governments to prevent the spread of the coronavirus. *Irakli Gedenidze / Reuters*

Artificial Intelligence (AI) is an umbrella term for a field of research and applications. Today, the term is mostly used to refer to the subfield of machine learning, which describes a set of algorithms that rely on statistical learning. In recent years, advances in computing power, data availability, and scalable algorithms have led to a series of breakthroughs and AI has become an enabling technology with applications across all sectors. The focus of this analysis is the use of AI in civil protection. Civil protection encompasses the management of the whole spectrum of collective risks stemming from environmental, societal, and technical hazards, such as extreme weather events, pandemics, terrorist attacks or severe industrial accidents, in order to limit damage and protect the population and its livelihoods.

Successful applications of AI to civil protection can help to reduce deaths and economic losses from disasters and are, therefore, part of the “AI for Good” paradigm, which aims to leverage AI to achieve the UN’s Sustainable Development Goals. In September 2020, the International Telecommunications Union plans to host the fourth *AI for Good: Global Summit* in Geneva supported by the Swiss government. At the same time, the fact that wrong decisions in civil protection can potentially cost lives, accentuates the need for robustness, security, fairness, and interpretability of algorithmic decision-support and decision-making.

Broad Application Spectrum

Due to the enabling nature of AI and the breadth of civil protection, there are potential AI uses across numerous hazards and at all stages of the disaster management cycle. AI models are used for dynamic risk analyses that can help to identify vulnerabilities, detect hazards early on, and predict their development, for example. Instances of this are regularly updated local flood and landslide forecasts that enable the distribution of location-based and timely safety warnings. AI can also be applied in the management of critical infrastructures. Smart electricity grids, in particular, include applications for the distributed control and optimization in microgrids, the classification of the types and severity of grid breakdowns, as well as forecasts of electricity demand, the electricity price, and the electricity output of photovoltaic and wind energy.

Moreover, the combination of ubiquitous cameras with AI-enabled video analytics is rapidly increasing the legibility of crowds and public spaces. While this raises serious privacy concerns, the improved situational awareness has applications in the management of terror threats, pandemics, and mass migrations. AI can also support search and rescue efforts in the response to a disaster. For example, AI-enabled unmanned systems can safely provide high-resolution information of operating environments. At the same time, advances in natural language processing increasingly offer real-time translation capacities, which can help in situations involving linguistic minorities, tourists, or international aid missions.

It is beyond the scope of this analysis to provide an account of how AI is used across the whole spectrum of hazards. Given the global coronavirus pandemic and the recent devastating wildfires in California and Australia, these two types of hazards are used as main examples.

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AI in the Swiss Federal Office for Civil Protection (FOCP)

Microbiology laboratories have been among the first to adapt AI into their workflow by applying algorithms to tasks such as chromogenic detection or colony counting. The labs today need to provide timely results with limited resources and growing challenges to society as a whole, such as increased mobility of emerging pathogens and antibiotic-resistant bacteria. Spiez Laboratory, the Federal Institute for NBC Protection within the FOCP, currently uses AI in certain areas of analysis, detection and diagnostics, such as the selection of biomarkers in mass spectra, the differentiation and identification of pathogens or the identification of specific species of vectors in surveillance projects. In the medium term, the FOCP could use new possibilities for data processing for more efficient advisory services, optimizing the emergency call acceptance during crises or increasing the reliability and response-times of alarm-systems.

Hybrid Disease Surveillance

The nowcasting and forecasting of transmissible diseases traditionally relies on laboratory evidence, sentinel networks of doctors, death certificates, and medical claims. In 2008, Google launched Flu Trends, an attempt to predict the spread of seasonal influenza in a timelier way based on online searches. However, the data proved to contain too much meaningless or misleading noise, and the program ended in 2015. Hybrid systems that use traditional data as well as natural language processing of media signals are more promising. Companies like BlueDot and Metabiota as well as the HealthMap at Boston Children's Hospital offer global infectious disease surveillance based on mixes of AI-filtering of news articles, travel patterns, and expert assessments. All of them were able to alert their clients to the outbreak of a novel virus in Wuhan before the US Center for Disease Control and Prevention (CDC) and the World Health Organization (WHO). However, rumors amongst Chinese doctors also spread to the West through personal communications and human judgement was still needed to assess the severity of automated alerts.

The ongoing coronavirus crisis has also led to a flurry of new AI applications, whose effectiveness is still difficult to determine at this point. For example, AI-systems are being applied to triage and diagnosis. Companies like Infervision, YITU, and AliBaba have built AI-systems to diagnose coronavirus disease (COVID-19) in CT scans and thereby support overworked medicine personnel. Babylon Health, which works with the National Health Service in the UK, and many other start-ups have incorporated the diagnostic criteria of COVID-19 into their medical chatbots. However, due to a lack of accurate training data on COVID-19, these symptom checkers currently rely on handcrafted rules rather than machine learning. Furthermore, AI is also deployed in the quest for therapeutics. Deepmind has released computational predictions of protein structures related to the novel coronavirus to help researchers to better understand it. SRI International and Itkos announced a partnership to use generative modelling AI technology for automated anti-viral drug discovery.

Lastly, states such as China, Russia, and Israel, have turned to their domestic surveillance systems to enforce physical distancing and trace the contacts of suspected or confirmed COVID-19 cases. Chinese facial recognition companies, such as SenseTime and Megvii, have adapted their AI-systems to identify persons despite wearing facemasks, as well as to detect persons who do not wear facemasks or have a fever. In some Chinese cities, police forces even wear "smart helmets" to identify persons with fever and the app Health Code uses the mobile location history of individuals to assign green, yellow, or red risk codes to them, based on which they are allowed to enter buildings and public spaces or forced to quarantine. Given the enormous economic costs and the drastic reduction of individual liberties caused by an indiscriminate lockdown, it is likely that more societies will consider some form of automated and fine-grained monitoring of significant parts of the population. However, such measures can be controversial, as they double as a means of social control and governments might be tempted to prolong them beyond an initial state of exception. Hence, in democratic societies, any such program has to be accompanied by a political debate on privacy, data protection, and civil rights.

Taming Wildfires

In the context of wildfires, analytics of satellite pictures, unmanned aerial vehicles, or webcams can help to automatically detect unplanned fires, thereby reducing the response time and increasing the chance that the fire can still be extinguished. Furthermore, firefighters rely on modelling tools such as FARSITE to predict the development of wildfires based on topography, weather, and fuel, which can help them to plan managed fires and to place fuel-free fire lines that limit the extent of unplanned fires. In California, the WIFIRE project by the National Science Foundation and the San Diego Supercomputer Center has built Firemap, a web platform for the real-time and data-driven simulation, prediction and visualization of wildfire behavior, which is used by the Los Angeles Fire Department and more than a hundred local rescue services. It is important to note that machine learning is not the only approach within this set of digital tools. For example, both NASA and the European Forest Fire Information System (EFFIS) rely on handcrafted algorithms for active fire detection from satellite data. However, AI is particularly used to classify land cover, to detect smoke and fire perimeter on web cameras, to predict fuel build-up and dangerous weather conditions, as well as, more experimentally, to mine radio communications and social media posts.

Accentuated Risks

Notwithstanding the opportunities AI provides, it also creates new or accentuates existing risks for society. Generic risks of AI applications include concerns about data privacy, the perpetuation of racial and gender biases contained in training sets, the robust and secure performance of classifiers, the interpretability and auditability of the decision-logic of AI, as well as the accountability and liability for algorithmic decision-making. The same risks apply to the use of AI in civil protection, but they are often pronounced more strongly due to the decision environment. For example, search and rescue teams operate in a high-stress and high-stakes environment and, therefore, require reliable and tested technologies. Many AI-enabled unmanned systems are not yet at the technology readiness level to perform well under degraded communication conditions and extreme weather. Hence, the human-machine teaming needs to be stress-tested in simulated disasters.

> A lack of training data is particularly pronounced for low probability, high impacts events.

Moreover, the use of AI in the public sector arguably comes with heightened demands for transparency, the prevention of discrimination, and integrity, as governments derive their legitimacy from serving the public good. Most AI applications in civil protection provide services to professionals rather than the broader public. Still, in cases where public algorithmic decision-support and decision-making has considerable consequences for individuals, it is important to provide comprehensible information about their decision logic.

In addition, critical infrastructures need to be resilient under exceptional circumstances. As highlighted in the December 2019 report of the Swiss interdepartmental working group on AI (IDAG KI), the increasing complexity and opacity of AI systems also creates the threat of skill and knowledge erosion among employees within critical infrastructures. Particularly, a reliance on AI systems for monitoring and regulating systems, such as the energy grid, turns humans into more passive system elements. However, human personnel will still need a comprehensive understanding of the system for the active handling and competent reaction to malfunctions, which is particularly relevant in the unlikely yet consequential scenario of a large-scale cyberattack on critical infrastructure.

Implementation Challenges

AI is no silver bullet. The current wave of AI relies on statistical learning from large datasets. While it has many exciting applications, it is also severely restricted in its ability to learn abstract concepts from a small number of examples, to understand causality, to transfer learning between domains, to deal with hierarchical structures, and to exhibit common-sense reasoning. If no suitable historical data or virtual training environments exist, AI systems cannot be expected to perform well. For example, the accuracy and resolution of electricity grid demand forecasting depends on the availability of granular data from smart meters. Such a lack of training data is particularly pronounced for low probability, high impact events as well as risks from emerging technologies.

Another key challenge is data aggregation and standardization. Data about hazards or civil protection services is often held in data silos. In order to create training sets with sufficient quantity and quality of data, data needs to be shared as well as labelled in standardized ways. As an example of efforts to overcome compartmentalized data structures, the Western Fire Chiefs Association in the United States provides 29 fire departments serving over 20 million people with a software platform to conduct performance analysis in a common framework with a centralized and normalized data set with clear workflows. The integrated data set is anonymized and shared through the cloud-based Fire Data Lab.

Lastly, there is an undersupply of data science and machine learning skills. The AI talent is concentrated at big tech firms and universities, whereas governments lack the in-house capacities to build their own AI models. Hence, the public sector needs to collaborate with universities and the private sector, which might include making relevant data sets accessible to these actors. Due to the heightened requirements for robustness, transparency, and resilience, off-the-shelf solutions are not always a viable option. If they are, procurement might still require the ability to test and understand market solutions, such as in the facial recognition vendor tests by the US National Institute of Standards and Technology.

Switzerland: Stronger Together

The challenges of data availability and public sector AI expertize are both particularly pronounced in the context of decentralized political structures. In Switzerland, civil protection is organized between the partner organizations of police, fire brigades, health services, operators of critical infrastructures, and civil defense. As in Germany and Austria, a lot of the responsibility for peacetime disaster management falls on subnational levels. However, the federal government is responsible for research and development and in agreement with the cantons, it may take over the coordination and, if necessary, the leadership of disaster management.

The IDAG KI report particularly highlights the need for the cross-departmental recording of processes and comprehensive data access within the federal administration. In the context of civil protection, es-

Further Readings

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Simonsen, L., Gog, J., Olson, D. & Viboud, C. (2016). Infectious Disease Surveillance in the Big Data Era: Towards Faster and Locally Relevant Systems. *The Journal of Infectious Diseases,* 214(4),380–385.

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tablishing shared and normalized data sets between local partner organizations, the cantons, the federal government, and international partners is arguably even more important.

The technical competence gap in the public administration can be filled through pooling expertize, close collaboration with universities as well as private-public partnerships. The IDAG KI report particularly recommends the evaluation of a competence network for the application of AI in the federal administration. As most research and development linked to civil protection occurs in academia, this collaboration is crucial as well to test and expand applications in promising areas. Once an application reaches maturity, public-private partnerships are a good alternative to off-the-shelf products.

Finally, safety and security are more important than deployment speed in the context of critical infrastructure. The white paper on AI by the European Commission suggests that a regulatory approach should include mandatory standards for high-risk applications with regards to training data, keeping of records and data, information provision, robustness and accuracy, and human oversight. Whether Switzerland will consider similar regulations for sensitive AI applications in civil protection remains to be seen.

Towards Global Data Commons

On the international level, the last decades have seen a focus on building up comparable structures and establishing a global data set of disaster outcomes. Specifically, the Sendai Framework for Disaster Risk Reduction 2015–2030 includes the national reporting of economic losses, deaths, strategies, and development aid related to disasters. Switzerland actively supports these efforts as a voluntary donor to the UN Office for Disaster Risk Reduction, and the Sendai monitoring is important to track progress and to nudge states into action. However, governments also find it difficult to gainfully use this data to predict how hazards evolve or what preparations and interventions are most effective.

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The global coronavirus pandemic has once more highlighted the value of international data sharing and scientific collaboration to protect populations. Ad hoc cooperation efforts, such as the COVID-19 open research dataset (CORD-19), can make a difference. However, the systematic build-up of global hazard datasets before the next disaster is equally important. Hence, the post-Sendai agenda for disaster risk reduction should prioritize sharing data about hazards themselves as well as the public policy responses to them. The initiative to conceptualize, build, and scale global data commons by the AI for Good community might be a vehicle for such efforts.

For more on Socio-technical Resilience and Disaster Preparedness, see CSS core theme page.

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