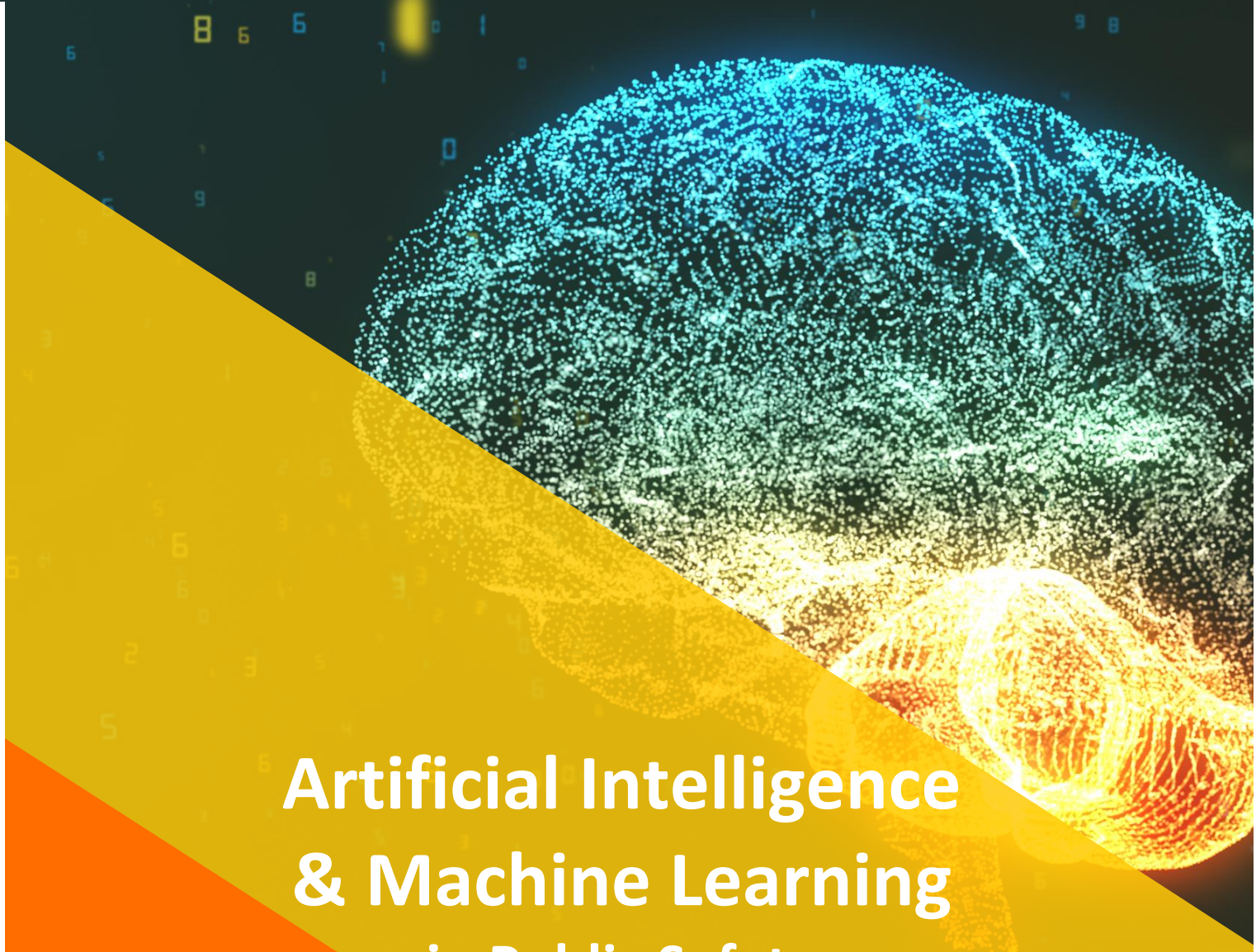
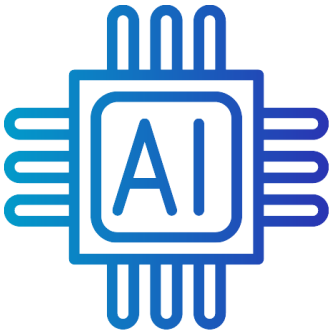


Artificial Intelligence & Machine Learning

in Public Safety

AI & ML have demonstrated their full potential in various areas of science and technology. The Public Safety domain is not an exception.

Artificial Intelligence & Machine Learning in Public Safety



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EXECUTIVE SUMMARY

2018 was definitely the year of Artificial Intelligence, after demonstrating its full potential in various areas of science and technology; the Public Safety domain is not an exception.

Artificial Intelligence (AI), and specifically Machine Learning (ML), are being tested in an increasing number of fields, including data-centric environments. Image or text analysis, speech recognition, chatbot interactions, custom machine learning models… all these are elements that could enable the AI journey of a public safety and security organisation.

This document dives into different aspects of integrating AI & ML in Public Safety activities, at different levels and in different domains of activity.

It presents ethical and regulatory considerations, real examples from Public Safety Answering Points (PSAPs) and Emergency Response Organisations (EROs), and also initiatives that can benefit the public sector greatly, with a series of recommendations at the end.

Artificial Intelligence (AI) is the science of making things Smart. It refers to the simulation of intelligent behaviour in computers which complete tasks based on a set of algorithms

Machine Learning (ML) means empowering computer systems to learn without being programmed; a method of training algorithms to develop new behaviours based on experience.

A **Neural Network** is an approach to machine learning inspired by the human brain.

Deep Learning (DL) is part of a family of Machine Learning methods based on neural networks

Robotic Process Automation (RPA) is about reducing repetitive & procedural activities currently done by humans.

1 | INTRODUCTION – WHY IS AI IMPORTANT IN PUBLIC SAFETY?

Can Artificial Intelligence help save more lives? Most people will answer yes, and some will ask at what cost, presenting concerns about privacy or people losing autonomy, for instance.

Let's use a simple example. The following image analysis leads to a simple conclusion: vision error rate for humans remains the same, while algorithms learn and drastically decrease their error rate.

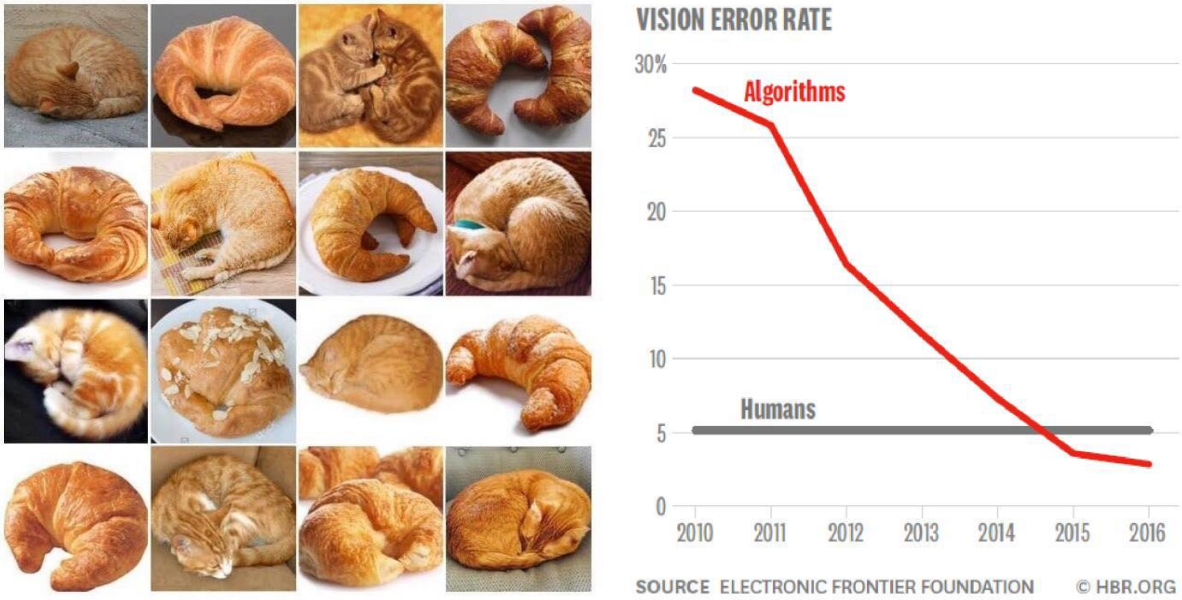


Image 1 – Cats vs Croissants

The same principle can be applied to other fields like text analysis or speech recognition (i.e. for improving voice recognition for people with impaired speech, or even foreign language detection), so with more and more text-based emergency communications, and more and more global mobility of people, using algorithms to automate certain tasks can greatly help PSAPs and EROs. And this is just a simple example.

AI & ML are concepts that with no doubt any organisation should care about, regardless of their practical effectiveness nowadays (since they are quite new). Innovative technology and a data-centric approach provide advantages like intelligence, and within Public Safety specifically, AI can provide humans with facilities that we cannot handle.

In the context of an emergency, where increased physiological and environmental pressure as well as many other factors interact every second, we must make sure that we use all of our resources in the most efficient way to obtain the best possible outcome. Machines can process huge amounts of data faster that humans can, and also learn to constantly improve.

In addition to this, emotions play a very important role during an emergency. These emotions may not allow a human to be objective with the situation, whereas the use of AI could help to improve this issue. When it comes to preventing emergencies from occurring and when they do, improving outcomes and saving lives, we must ensure that we are open and prepared to innovate with new tools and methodologies, while making sure that we surround them with a sound ethical framework that reduces bias but also protects explainability.

Combined with major breakthroughs such as the advances in machine learning and deep learning, increased computing power, and huge datasets to leverage full potential of AI together with open platforms and databases, the introduction of AI and ML in public safety can bring benefits to several areas:

- First of all, it can reduce repetitive and procedural activities currently done by people. These solutions called RPA (Robotic Process Automation) have already been applied in different areas like finance, procurement, and personnel services/human resources
- Secondly it can process huge amount of data that people could not, finding patterns and new insights that would otherwise be lost. By way of an example, this can help in video and voice recognition which was normally done by people.
- AI and ML can assist in cybersecurity and monitoring cyberspace, such as fraud detection and helping to find information on the various layers of the web.
- Finally, we must consider the broad expansion of IoT devices and the opportunity to integrate those sensors into the PSAP; better sensor integration, coupled with edge analytics, can increase the visibility and understanding (situational awareness) on what is occurring.

All of this is helping make our world a safer place, however there are potential ethical implications that these new technologies also bring. Therefore, it is important to define guidance to ensure trustworthy, unbiased, fair and ethical AI.

2 | KEY ASPECTS TO CONSIDER

There is no doubt that ethics in AI is a complex and time-consuming issue, with some of the most evident ethical considerations linked for instance to issues around fairness, transparency and accountability. There is a clear need to explore appropriate governance frameworks that take AI and ML into consideration.

It is necessary to highlight the importance of having a solid ethical framework around the use of this technology. Ethics must be injected into the algorithms, and an algorithm must never be biased by gender, racial or social status[1]. Also, the autonomy of people must always prevail over artificial autonomy, and the "super-system administrator" must remain human.

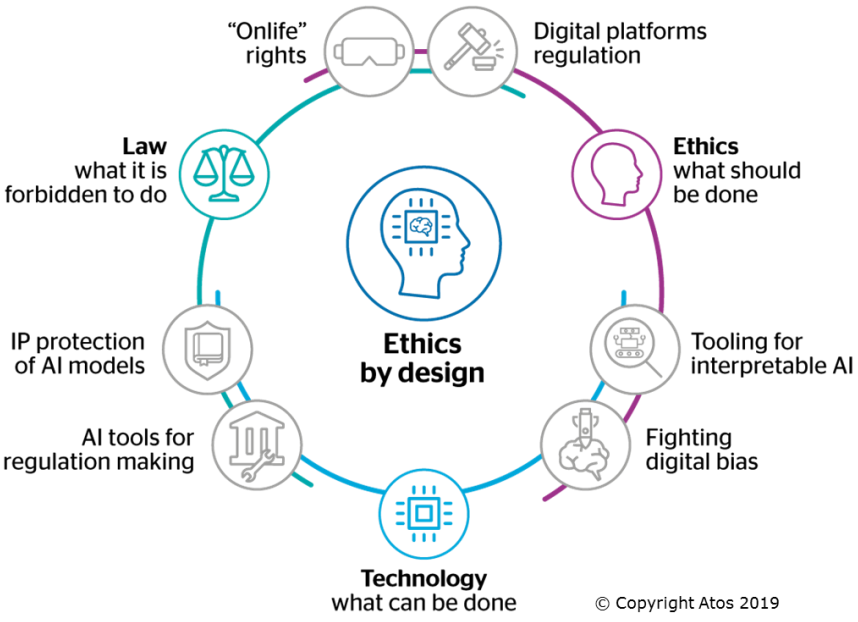
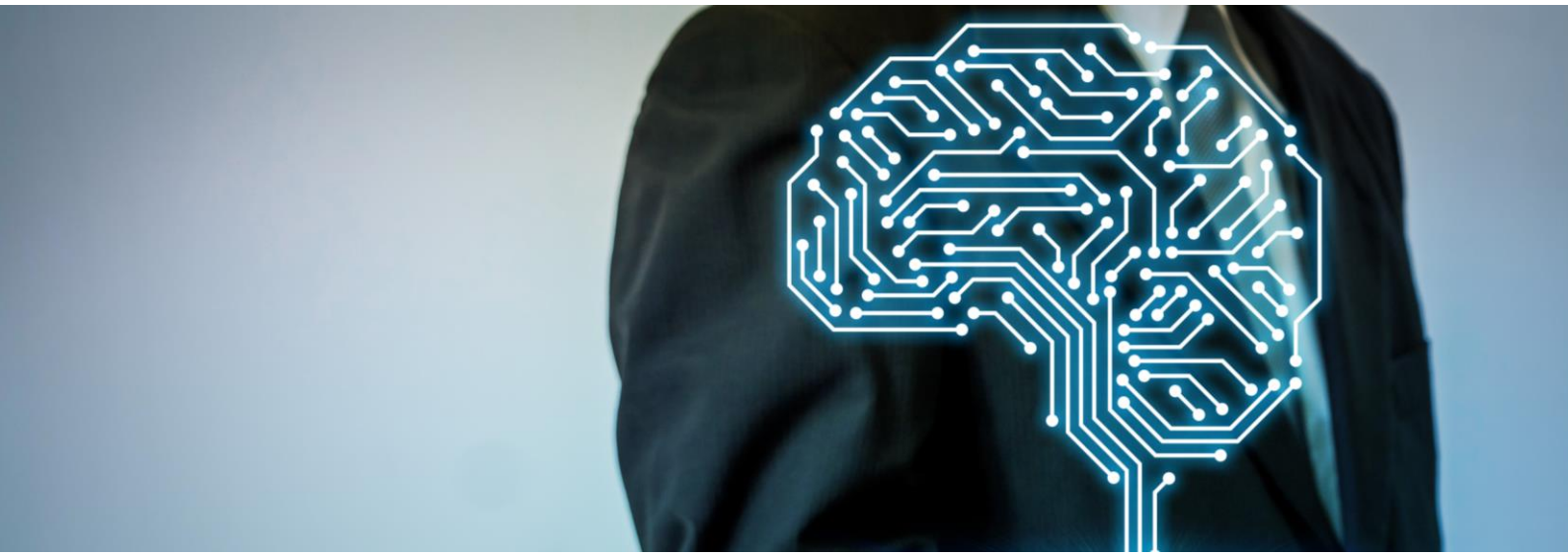


Image 2 – Ethics by Design (©Atos)

[1] *https://atos.net/en/blog/artificial-intelligence-need-ethical-code*



In 2018, the European Commission selected 52 "Human Intelligences" to face the ethical challenge of artificial intelligence, and on April 2019, the High Level Expert Group on Artificial Intelligence (AI HLEG) presented the Ethics Guidelines for Trustworthy AI[2]. Based on fundamental rights and ethical principles, the Guidelines define seven key requirements that AI systems should meet in order to be trustworthy:

- Human agency and oversight;
- Technical robustness and safety;
- Privacy and Data governance;
- Transparency;
- Diversity, non-discrimination and fairness;
- Societal and environmental well-being;
- Accountability.

For each requirement, an assessment list is defined aimed at operationalising key requirements, which needs to be tailored to the specific use case of the AI system.

Linked to transparency, we must also talk about explainability, a key concern in Machine Learning and even more in Deep Learning, as some of the ML algorithms are explainable by nature whereas DL algorithms are not. In emergency situations where lives depend on the decisions that are made and the response that is provided, it is important that users that rely on ML algorithms to take decisions understand the reasoning behind the decisions made by the algorithms.

[2] *https://ec.europa.eu/digital-single-market/en/european-ai-alliance, https://ec.europa.eu/futurium/en/ai-alliance-consultation/guidelines#Top*

And let's not forget that even if AI is a valuable tool/resource for Public Safety, there must be a human in the loop making the final determination. AI shall augment, not replace human decision-making, and the concept of Augmented Intelligence has already been presented[3].

Furthermore, it is quite possible that in an emergency the public would not easily accept directions from an algorithm, but they would most likely accept algorithms assiting PSAP operators in making better and quicker decisions.

In line with this, the UK Government Department of Health and Social Care have recently updated their "Code of conduct for data-driven health and care technology"[4], which includes provisions for AI techniques: "*If we do not think about issues such as transparency, accountability, liability, explicability, fairness, justice and bias, it is also possible that the increasing use of data-driven technologies, including AI, within the health and care system could cause unintended harm*". It's also worth mentioning that the NHS has standardised a sort of safety by design approach in conjunction with the agile guidance for the deployment and use of Health IT systems[5].

There are also strong ethical considerations with regards to AI-enabled facial recognition technology, alleging that the technology needs a lot of improvement. The San Francisco Board of Supervisors recently voted to ban the use of facial-recognition technology for public safety and security purposes[6]. Some say this is to prevent a real-time surveillance enabled by AI that may lead to an automation of biases, if not performing in an ethical way. The California State Assembly also passed a ban on facial recognition and other biometric surveillance in police body cameras.[7]

Earlier this year, the joint IJIS Institute and International Association of Chiefs of Police Task Force published a whitepaper: "Facial Recognition Use Case Catalog for Law Enforcement"[8], with a clear recommendation to adopt anti-bias safeguards. Industry stakeholders such as Microsoft are also taking a clear stance on the use of facial recognition in law enforcement, with 6 principles summarised in a blog entry:[9] fairness, transparency, accountability, non-discrimination, notice and consent, and lawful surveillance.

In truth, police organisations may be preventing crime by sending police officers to a location and in a timeframe predicted by AI systems through dynamic patrolling that considers live and historic data, but there is no crime if it does not happen (although proper algorithms should provide a reliable probability). This is a kind of a chicken and egg situation.

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[3] https://www.youtube.com/watch?v=j98rY3vhPhE (IBM CEO Ginni Rometti's point on Augmented Intelligence is around the 9 minute mark).
[4] https://www.gov.uk/government/publications/code-of-conduct-for-data-driven-health-and-care-technology/initial-code-of-conduct-for-data-driven-health-and-care-technology
[5] https://digital.nhs.uk/data-and-information/information-standards/information-standards-and-data-collections-including-extractions/publications-and-notifications/standards-and-collections/dcb0160-clinical-risk-management-its-application-in-the-deployment-and-use-of-health-it-systems
[6] https://www.wired.com/story/san-francisco-bans-use-facial-recognition-tech/
[7] http://leginfo.legislature.ca.gov/faces/billStatusClient.xhtml?bill_id=201920200AB1215
[8] https://www.ijis.org/resource/collection/93F7DF36-8973-4B78-A190-0E786D87F74F/Law_Enforcement_Facial_Recognition_Use_Case_Catalog.pdf
[9] https://blogs.microsoft.com/on-the-issues/2018/12/17/six-principles-to-guide-microsofts-facial-recognition-work/

Let's also look at the example of autonomous vehicles and the responsibility over accidents. New minimum EU vehicle safety requirements were approved by the European Parliament on April 2019, but are there any provisions for self-driving cars? Whose responsibility is it if an autonomous vehicle causes an accident?[10] If a car had to decide between two collisions, who is accountable? There is still no clear answer to these questions, because the answers could be multiple. An appropriate governance framework is therefore necessary not only to guarantee an adequate level of safety, but also to make the definition of the related responsibilities after an incident possible. Again, we can extrapolate this to other fields in which AI & ML are being used in critical services.

Of course, another aspect not to forget is the impact of GDPR on efforts to implement AI & ML in Public Safety. During the 2019 EENA Conference in Dubrovnik, a clear statement was made during one of the presentations in the session devoted to the use of AI: GDPR has come to stay.[11] With an increase in data-driven ways of working, the adaptation to new requirements needs to go hand-in-hand with the regulations, but without preventing improvements in public safety and security (more information about GDPR can be found in the EENA document on GDPR & Public Safety[12]).

[10] *https://atos.net/en/blog/autonomous-vehicle-safe*
[11] *https://tinyurl.com/y3ce2235*
[12] *https://eena.org/document/gdpr-public-safety/*

Yet another element to consider, related with the previous point, is that large data sets are key elements for building accurate Machine Intelligence and Deep Learning models; data is first required to pre-train DL models, and then to improve such models to domain specificities.

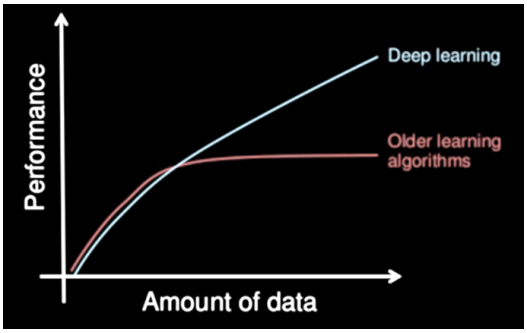


Image 3 – Amount of data needed in DL (©Atos)

Last, but not least, with hoaxes and misinformation being an issue Emergency Response Organisations often face (malitious intent, including potential data contamination, becomes an important variable in AI for Public Safety), the emergence of deepfakes[13] ("deep learning" + "fake") in this era of fake news poses a new threat for Public Safety. This is a technique for an extremely realistic human image synthesis based on AI, and it is not far-fetched to think that deepfakes could be used to create malicious hoaxes that put lives at risk. Technology to face this threat is still being developed, and we can already find interesting initiatives such as the InVID platform[14] or the Witness Media Lab project.[15] Nevertheless, as a Wired article[16] about the Deepfake era of web video advises, we will definitely "*have to be skeptical viewers [and] build the media literacy that will deal with this latest generation of manipulation*".

[13] *https://en.wikipedia.org/wiki/Deepfake*
[14] *https://www.invid-project.eu/description/*
[15] *https://lab.witness.org/projects/synthetic-media-and-deep-fakes/*
[16] *https://www.wired.com/story/prepare-deepfake-era-web-video/*

3 | DOMAIN-SPECIFIC EXAMPLES

This section presents a series of examples of initiatives involving the use of AI & ML in different areas within the Public Safety domain.

PSAPs

At the end of 2017, the Association of Public-Safety Communications Officials (APCO International) and IBM announced[17] that APCO International's new guide card software (APCO IntelliCommä) would be using IBM Watson Speech-to-Text and Watson Analytics to significantly enhance the scripted criteria guidance used by 911 emergency telecommunicators in the USA. The first live installation in a 911 PSAP of this new system was announced a year later.[18]

Another element to consider is that social media and other publicly available information sources have fundamentally changed the way EROs prepare, mobilise, and respond to emergencies and other risks to public safety. In today's dynamic environment, the first sign of a breaking event often comes from eyewitness posts on social media platforms and/or information sensors. But with the sheer volume of data posted to social media every day, emergency personnel can't easily or quickly distill relevant information. That's where AI comes in, with AI-enabled real-time event detection and risk management platforms like the one provided by Dataminr.[19]

Also, during the EENA Conference 2019:

- In May 2018, Corti and EENA launched a project[20] on the use of AI to make the identification of out of hospital cardiac arrests quicker and more accurate, reducing the rate of human error. During the pilot testing, the AI worked alongside emergency call handlers and assisted in detecting out-of-hospital cardiac arrests by analysing the conversations in real time. The efficacy study focused on whether Corti technology could predict out-of-hospital cardiac arrests with a performance that is at least comparable to that of human call-takers. The AI system is a support tool; it is intended as an aid to improve decision-making, not a replacement of human call-takers.

  In April 2019, Corti provided updated information about the project.[21] The AI-powered system, which listens in on emergency calls to help dispatchers detect acute illnesses, was being tested in several European PSAPs.
- Huawei presented their AI-enabled collaborative public safety solution framework[22] and their experience in 112 & 911 PSAPs with AI-enabled Communication, Command & Control, Surveillance and Cloud.

[17] *https://www-03.ibm.com/press/us/en/pressrelease/53000.wss*
[18] *https://psc.apcointl.org/2018/08/06/apco-launches-apco-intellicomm-in-an-ohio-9-1-1-center/*
[19] *https://www.dataminr.com/blog/multi-modal-understanding-and-summarization-of-critical-events-for-emergency-response*
[20] *eena.org/artificial-intelligence*
[21] *https://youtu.be/V3LCe2tGCac*
[22] *https://tinyurl.com/y5bpwo8x*

EMERGENCY MEDICAL SERVICES

The Israeli startup MDGO suggests a novel approach for real time injury diagnosis by using advanced Artificial Intelligence technology. In a car crash, the data regarding the forces applied on the passenger - including its duration, moment and vector - are generated by their algorithm. According to the force's characteristics, the data is translated into an actionable Abbreviated Injury Scale (AIS) through the appropriate biomechanical formula allocated by a different Machine Learning algorithm. Their technology is now being utilised by more than 250,000 vehicles in Israel. Meaning, that in a case of a car crash, data is being transmitted and translated into a medical report in real time, which is in turn being sent automatically to the Israeli EMS (MDA) via API. In fact, Israel became the first country in the world in which ambulances are being dispatched automatically according to the occupant's injuries type and severity by using AI-based technology. The detail of this use case is included in Annex 1.

LAW ENFORCEMENT

A clear use case in the law enforcement domain is linked to video-protection, specially in situations involving crowd movements, abandoned objects, searches of persons of interest, and so on.

For instance, an AI-enabled human & object detection and tracking combined with a knowledge-base and behaviour analysis could make video surveillance much more effective, and even help prevent crime.

Both the London MET police and the South Wales Police have tested the use of automated facial recognition technology (AFR), with trials in public events like concerts, festivals, and soccer matches. Controversy comes from those that consider AFR a "*threat to privacy, freedom of expression and right of association.*"[23]

[23] *https://bigbrotherwatch.org.uk/all-campaigns/face-off-campaign/*

FIREFIGHTING

The Mid and West Wales Fire and Rescue Service employs over 1100 staff of which over 900 are operational responders either working full time or as on-call firefighters. The Service has over 10,000 assets which have been tagged using UHF Radio Frequency Identification tags. These assets include all operational equipment carried on front line fire appliances and newly introduced multi-function personal protective equipment (PPE). Currently, a process to procure new structural firefighting PPE is underway for delivery during mid 2019. This procurement will add an additional 5,000 tagged assets to the existing inventory.

They are gradually incorporating AI and ML into the intelligent management of their operational assets. Within the PPmE solution the software will monitor the CAD system, external weather and news sources, their resource management system and social media to identify potential increased demands on PPE stocks in certain locations and automatically predict additional PPE requirements, then informing the PPE logistics team who will deliver the increased stock for that period. In relation to wider operational assets, the system will monitor usage and effectiveness of operational assets with a view to providing rich data to inform future operational asset disposition be it temporary or permanent. More detail of this use case can be found in Annex 1.

The London Fire Brigade (LFB) has also completed a series of projects using ML to predict likelihoods of false alarms, using Natural Language Processing (NLP) to ingest and digest fire investigation free-text reports and join up datasets that were previously unobtainable to understand fire risk, like the energy performance of a building. Apollo Gerolymbos of the LFB team states: "*we have seen huge potential in the rise of these technologies but we are treading carefully. Proof of concepts are fantastic opportunities to evidence value and explore use cases but we have to get this right. Explainability of AI systems, fairness and ethics are top priorities and they should be for anyone setting out on this journey*."

Another example in this domain comes from Catalonia (Spain), with the Prometeo initiative being announced as winners of the Call for Code 2019 Global Challenge.[24] The wining team created an AI-based platform to monitor and act on firefighter health and safety in real-time and over the long-term, and they will soon start field tests with firefighters.

[24] *https://developer.ibm.com/callforcode/blogs/call-for-code-2019-finalist-prometeo*

And of course, another very relevant use case in this domain is AI-enabled early fire detection and decision support. For example, Bee2FireDetection,[25] a solution developed in Portugal and implemented in Europe, the Brazilian Amazon region and available in the United States, uses Visual Recognition AI on captured images from surveillance cameras and other data sources to detect fires in forests, natural parks and even mining areas and industrial facilities.

Historically, in Croatia like in all the Mediterranean area (and more and more in other areas), the threat of wildfire has been high, but in the last couple of years it has increased significantly, particularly due to climate change. In the summer seasons, several coastal counties of Croatia are permanently exposed from high to very high wildfire risks. Apart from preventive measures, early fire detection on one side and quick and appropriate intervention on the other, are measures of vital importance for wildfire damage minimisation. This led to developing advanced automatic wildfire surveillance and monitoring systems and networks in order to identify wildfires early enough; the University of Split Centre for Wildfires Research developed the iForestFire[26] solution based on computer vision and ML algorithms, which is in currently used along the Croatian coastline.

CRISIS MANAGEMENT / DISASTER RESILIENCE

AI has undoubtedly an important role in identifying, prioritising and mitigating crisis and disasters. There are 7 big areas for disaster impact (economic and loss of life) globally based on the International Disaster Database EM-DAT[27]: storms, floods, earthquakes, drought, extreme heat, epidemics and wildfires.

Although severe storms such as typhoons, hurricanes and tornados are not as prevalent in Europe as in other parts of the world, floods, droughts, earthquakes and extreme heat are more common in parts of Europe.

The use of AI & ML for severe weather forecasting is being applied for instance by the World Meteorological Organisation,[28] as presented in the AI for Good Global Summit[29] earlier this year by the WMO Secretary-General Petteri Taalas: "*In about 10 years, typical operational weather prediction and climate projection workloads with high-resolution, coupled Earth-system model ensembles will lead to at least a factor of 1000 larger computing and data handling needs compared to today. In the past, this growth in cost was mostly compensated by a comparable growth in computing and data handling capabilities. This is no longer the case. AI therefore offers a potential solution to computing and data handling challenges and the drastic increase in demand for data usability and fast access by users. The emergence of AI methods sponsored has created opportunities for contributing to the much-needed efficiency gains*".

[25] *https://www.ceb-solutions.com/products/bee2firedetection/*
[26] *www.researchgate.net/publication/228918665_Advanced_automatic_wildfire_surveillance_and_monitoring_network*
[27] *https://www.emdat.be*
[28] *https://public.wmo.int/en/media/news/artificial-intelligence-good*
[29] *https://aiforgood.itu.int*

4 | ONGOING INITIATIVES THAT COULD IMPROVE PUBLIC SAFETY

FIGHTING DEEPFAKES

- The US Government Defense Advanced Research Projects Agency (DARPA) has launched a specific media forensics programme, including an AI-based MedFor platform,[30] to tackle the threat posed by deepfakes. If successful, such technology could be very useful to fight dangerous hoaxes before, during and after emergency and crisis situations.

- Facebook's initiative to counter Deep Fakes is called the "Deep Fake Challenge." The goal of the challenge is to produce technology that everyone can use to better detect when AI has been used to alter a video in order to mislead the viewer. The Deepfake Detection Challenge will include a data set and leaderboard, as well as grants and awards, to spur the industry to create new ways of detecting and preventing media manipulated via AI from being used to mislead others. The governance of the challenge will be facilitated and overseen by the Partnership on AI's new Steering Committee on AI and Media Integrity, which is made up of a broad cross-sector coalition of organisations including Facebook, WITNESS, Microsoft, and others in civil society and the technology, media, and academic communities.

[30] *https://www.darpa.mil/program/media-forensics*

ACCESSIBILITY

- The Google Project Euphonia[31] is about accessibility: using AI to improve voice recognition for people with impaired speech (speech impairments caused by neurologic conditions such as stroke, ALS, multiple sclerosis, traumatic brain injuries and Parkinson's). In emergency communications, tools that support voice recognition can be a great asset for PSAPs' call takers.

- Facebook also leverages AI/ML for accessibility. A good example of that would be their automatic alternative text technology,[32] a feature that uses object recognition technology to describe photos to people who are blind or have low vision and use screen readers.

SEVERE WEATHER FORECASTING

- IBM, through The Weather Company,[33] are already delivering AI-driven decision-making tools like their advanced forecasting engine based on IoT and ML. These are tools to be used daily that can contribute to preparedness in the face of severe weather situations.

SUICIDE PREVENTION

- Facebook is using AI & ML extensively in suicide prevention.[34] They recently announced an expansion of their existing suicide prevention tools that use AI to identify posts with language expressing suicidal thoughts. They were able to use posts previously reported to Facebook by friends and family, along with the decisions made by their trained reviewers (based on their community standards) as their training data set, and they used their internally developed ML engine to train a classifier to recognise posts that include keywords or phrases indicating thoughts of self-harm. Needless to say, collaboration with Public Safety organisations in these situations is essential.

  Facebook published an article[35] that details the ethical considerations and the delicate tradeoffs they are asked to make when leveraging AI to improve our suicide prevention features. That article showcases how profound philosophical and ethical questions can be mapped all the way to specific and concrete product decisions. They thus listed the ethical questions that were discussed, the underlying competing values animating each of those questions, and the thought process and approach leading to their resolution. They encourage other industry actors to engage in this level of analysis and to increase the transparency of their own internal procedures, explaining—for products and services that raised important ethical questions—how they reached and justified their answers (in Ethics and Artificial Intelligence - Suicide Prevention on Facebook).

[31] *https://blog.google/outreach-initiatives/accessibility/impaired-speech-recognition/*
[32] *https://www.facebook.com/accessibility/videos/automatic-alternative-text/1082033931840331/*
[33] *https://newsroom.ibm.com/the-weather-company?item=30634*
[34] *https://ai.facebook.com/blog/under-the-hood-suicide-prevention-tools-powered-by-ai/*
[35] *https://link.springer.com/article/10.1007/s13347-018-0336-0*

MORE IMPACTFUL INITIATIVES

- Since 2018, Atos and Google Cloud have opened joint AI labs[36] in London, Paris Dallas and Munich, as part of the global partnership between both companies. These labs have been created to enable clients, businesses and public organisations to identify practical cases for which AI could provide innovative and effective solutions. As an example, several Law Enforcement organisations have been working on their AI & ML strategy with experts and infrastructure from these joint labs.

- At Unblur, they work on solving the main challenges that First Responders face when it comes to any kind of emergency, ending with the saturation coming from too much information (and the lack of coordination this may create) by unifying all the tools in a way that they can empower the incident commanders with specific added value. They analyse integrated data to understand it and to provide valuable recommendations, and they are creating an intelligent assistant[37] that will complement humans. One feature is data processing: i.e. in one second, a machine can read through all the SOP potentially used in the field and decide which is the right one. It is all about saving time to act faster and safer. Another way to use AI is to predict future events: in the case of a fire, having data of the wind (such as direction, pressure and speed) they can advise Incident Commanders when the fire is arriving at "sector 1" in 5 minutes, allowing the optimisation of the task periodisation and reducing risks.

- Systems like Alexa, Amazon's AI agent, could be used during emergencies and could help in investigations. Two examples can be mentioned: the first one is how Amazon Rekognition helped fighting child sexual abuse and trafficking[38] and the second one showed how public warning could be improved by using AI and ML to ingest data and turn alerts on and off in geo-targeted areas based on information from the alerting authority.[39]

[36] *https://atos.net/wp-content/uploads/2019/07/atos-idc-inside-atos-ai-lab-making-ai-real-for-businesses.pdf*
[37] *http://www.unblur.co/iris.html*
[38] *https://aws.amazon.com/blogs/machine-learning/thorn-partners-with-amazon-rekognition-to-help-fight-child-sexual-abuse-and-trafficking/*
[39] *https://aws.amazon.com/blogs/publicsector/fia-recognized-for-saving-lives-with-artificial-intelligence-its-ceo-tells-us-why/*

5 | CONCLUSION AND RECOMMENDATIONS

AI & ML are new technologies evolving very fast, and they are here to stay, so Public Safety and Security organisations should take advantage of them in order to provide a more efficient service; yet the autonomy of people must always prevail over artificial autonomy. Scepticism and resistance to this type of innovation may arise, mostly due to lack of understanding of the technology. Proofs of concept are a way to tackle that, through a collaboration between Public Safety organisations and industry/researcher: the most common way to approach this is with joint research projects (i.e. H2020) in which public safety organisations take the role of users of new methodologies and technology.

Resistance is often linked to not knowing who is responsible and how it works. Who is responsible of making sure firefighters are safe? Whose job is to prioritise first responders' safety so they can prioritise citizens' lives? Why are certain decisions made? Explainability and overall transparency are key.

With the available technology that we have nowadays and the advantages of AI & ML, we need to work on how to allocate it to protect humans. We are in a technology and data-centric era, and there are more people willing to help in that sense. Making AI fair, unbiased, responsible and explainable will boost its adoption in public safety but also in other domains.

For technology to improve, a collaboration between public and private organisations is crucial. This way relevant data that are needed to be collected and fed into the system could be available and the AI systems could learn and become effective.

Recommendations:

- **National regulators**: Work with public safety & security organisations in exploring appropriate governance models for the use of AI and ML, considering the Ethics Guidelines for Trustworthy AI from the European Commission.
- **Public safety & security organisations**: Be open to new tech and to speaking with AI companies and sharing needs and concerns with them, and make sure to have an ethical checklist for AI & ML. Get involved in research projects, and let your staff test new things to prevent resistance. Make data available for trials (in compliance with privacy regulations, of course).
- **Technology providers**: Listen to the needs and concerns of public safety organisations, so that they offer solutions that are applicable to these very specific organisations. Test and validate new tech with end users. Inject ethics into the algorithms, and make sure they are never biased by racial or social status.
- **EENA**: Foster exchange of ideas between public safety & security organisations and technology providers, liaise between them.

ANNEXES

ANNEX 1 | Intelligent management of operational assets of the Mid and West Wales Fire and Rescue Service

Exploiting RFID Tag Data for Improved Decision-Making & Efficiencies

An Overview of Mid and West Wales Fire and Rescue Service

The Service covers over 4,500 square miles and has 58 fire stations providing 97 fire appliances. We employ over 1100 staff of which over 900 are operational responders either working full time or as on-call firefighters. The Service has over 10,000 assets which have been tagged using UHF Radio Frequency Identification tags. These assets include all operational equipment carried on frontline fire appliances and newly introduced multi-function personal protective equipment (PPE).

Current Situation Overview

Following the RFID asset-marking exercise, the Service has implemented the RedKite Asset management software solution to enable the monitoring and management of all operational assets. The Service is also looking to introduce the Transman fleet management solution within our Transport Department who undertake the repair and replacement of all operational equipment.

To date, the Service does not have a reliable or robust mechanism to enable real time knowledge discovery through the management of PPE (PPmE) and operational assets to inform future decisions on the disposition, suitability, reliability, and effectiveness/need for operational assets.

The Challenge

The Service is keen to gain a greater understanding on the use and effectiveness of its operational assets including monitoring and managing the whole life of its PPE. Questions we are looking to answer through the provision of 'knowledge discovery' are:

- Do we have the right equipment in the right locations?

- What equipment can we rationalise, what is the potential impact and space/time creation for on-call colleagues who have very limited training/maintenance time available?
- Where and why is equipment getting damaged or lost, what is the correlation between incident types, location, frequency of use and damage/loss?
- Storage space and permissible weight of fire appliances is now becoming an issue! How can we safely and effectively remove equipment without impacting operational capability?
- What is the optimal PPE profile for the organisation and each station/response area to minimise capital expenditure on PPE?
- How can we ensure a consistent and balanced use of PPE across the organisation, so all assets are 'sweated' fully to provide asset holding efficiency?

Desired Outcomes

The outcomes we are looking for is an integrated solution which provides real-time reliable analytical data to inform future strategy and decision-making to allow for greater efficiencies both in regard to procurement, repair and replacement of operational equipment and PPE, but also in identifying where legacy items of operational equipment can be rationalised without any detrimental impact of fire-fighter safety and operational capabilities.

Current Progress

The T20 programme has secured £30k R&D grant funding and access of up to £12 million interest free loan to implement the final solution. Working with Y Lab and NESTA the T20 team have just completed phase 1 where they have developed the three key elements required for the improved management of PPE utilising the 'PPmE' size issue solution. The three elements are; real time scanning of PPE assets using RFID technology; enhanced data modelling to determine the optimal ratio of PPE to end users based on historic PPE user and wash data; end user interface applications based on 'click and collect' consumer principles.

Technical Solution

Through R&D we have opted for industry standard RFID fixed scanner technology which will be built into bespoke office furniture within each station location and training centre. These will monitor stock held and will report back to stores when items of PPE are allocated to end users allowing for the stock to be refreshed potentially within 48hrs (currently a 2-6 week turn-around time for personal issue PPE).

The end users will interface with the PPmE solution using a hand-held RFID / bar code scanner which will also be able to be used as a standalone smart phone device which will allow it to be used as part of the 'digitised fire ground solution' we have developed within the service.

The end user interface will be via an intelligent app developed with Microsoft Office365 PowerApps platform which will provide seamless PPE submission for wash or repair and then also indicate where the next replacement PPE item is of their size.

Data Modelling to secure solution adoption

Within the data modelling we are looking to optimise the number and location of spare PPE to be available for end users based on their size, role station activity and previous wash and repair profile. The current ratio of PPE to users is 3.5:1, initial projections look likely to achieve a ratio of 1.8:1.

The data modelling demonstrated a conservative saving of £500k on an initial £1.8 million investment to replace the current PPE 'like for like', with potential year on year savings of circa £70k.

Future Development (AI and ML)

The second phase of the development is to incorporate AI and ML into the intelligent management of our operational assets. Within the PPmE solution the software will monitor our CAD system, external weather and news sources, our resource management system and social media to identify potential increased demands on PPE stocks in certain locations and automatically predict additional PPE requirements and inform the PPE logistics team who will then deliver the increased stock for that period.

In relation to wider operational assets, the system will monitor usage and effectiveness of operational assets with a view to providing rich data to inform future operational asset disposition, be it temporary or permanent.

Lessons Learned

We have been surprised and disappointed by the level of scepticism and resistance to this innovation proof of concept from internal stakeholders and issue owners.

We recognised early into the process that stakeholders could see the potential benefits but needed to see evidence before fully buying into the concept.

The programme has had to rely on the support and expertise of external partners such as Y Lab and Cardiff University to provide continued encouragement and reassurance to enable us to successfully develop and deliver this proof of concept.

The final stage of phase 1 for PPmE will be delivered at a demonstration event fully supported by external partners on Tuesday 7th May. It is hoped the outcome of this event will be stakeholder and strategic approval of the solution.

ANNEX 2 | AI Technology for Real Time Injury Prediction in Motor Vehicle Crashes

Objectives

Estimation of injuries at motor vehicle scenes is a key component in establishing triage necessity, urgency and destination. Attempts to estimate the severity of injuries by means of vehicle telemetry are underway, though estimations are rough with up to 85% under triage[40]. Here, we suggest a novel approach for real time injury diagnosis by using advanced Artificial Intelligence technology.

In a car crash, the data regarding the forces applied on the passenger; including its duration, moment and vector are generated by our algorithm. According to the force's characteristics, the data is translated into actionable Abbreviated Injury Scale (AIS) through the appropriate biomechanical formula allocated by a different Machine Learning algorithm.

Here we present the developmental steps and technology accuracy in proof of concept experiments.

Data and methods

Labeled data of vehicle 3-axis acceleration and crash test dummies outcomes from car crash tests were obtained. Car crash simulations were then used to amplify the data and increase the parameter diversity, for example: crash velocity, angle, dummies characteristics, car model, etc. (Finite Element modeling) (Figure 1).

Next, we developed a Deep Neural Network to create "Virtual sensors"; each represents the forces applied on one axis of a body region, using only the existing vehicle 3-axis accelerometer.

Once our algorithm achieved 70% accuracy in predicting maximum acceleration applied for a duration of 3 milliseconds on a body region (figure 2.), we proceeded to testing it on retrospective car crashes data that includes both vehicle data and bodily injuries. This data was provided by car manufacturers and insurance companies.

[40] *STITZEL, J. D. et al. An Injury Severity-, Time Sensitivity-, and Predictability-Based Advanced Automatic Crash Notification Algorithm Improves Motor Vehicle Crash Occupant Triage. J Am Coll Surg, v. 222, n. 6, p. 1211-1219.e6, 06 2016. ISSN 1879-1190*

Results

Thirty-one patients from 25 different car crashes were selected in 2 different proof of concept experiments, all were drivers or front seat passengers, ages 18-65 years.

Our algorithm was 75% (n=12 patients) and 87% (n=19 patients) accurate in predicting the AIS for each body region compared with medical records.

Conclusion

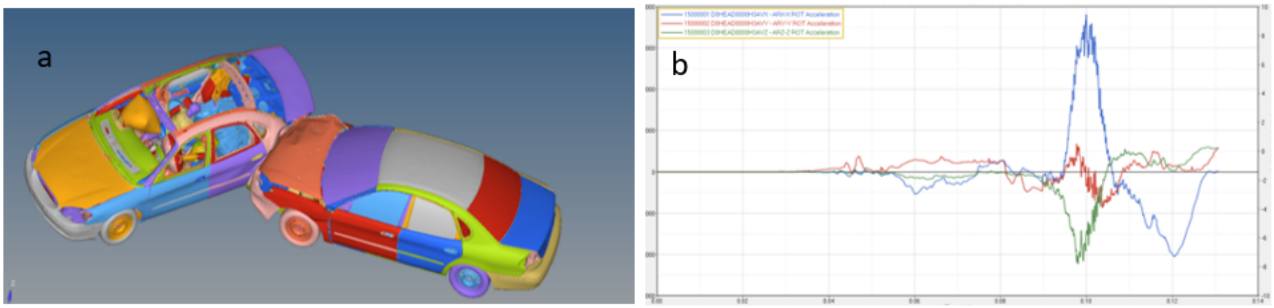
Our algorithm was successful in predicting injuries type and severity in motor vehicle crashed by using only telemetry data. Our algorithm can serve as an objective tool for real time medical report.

Technology implementation

Our technology is now being utilised by more than 250,000 vehicles in Israel. Meaning that in a case of a car crash, data is being transmitted and translated into a medical report in real time, which in turn is being sent automatically to the Israeli EMS (MDA) via API. In fact, Israel became the first country in the world in which ambulances are being dispatched automatically according to the occupant's injuries type and severity by using AI based technology.

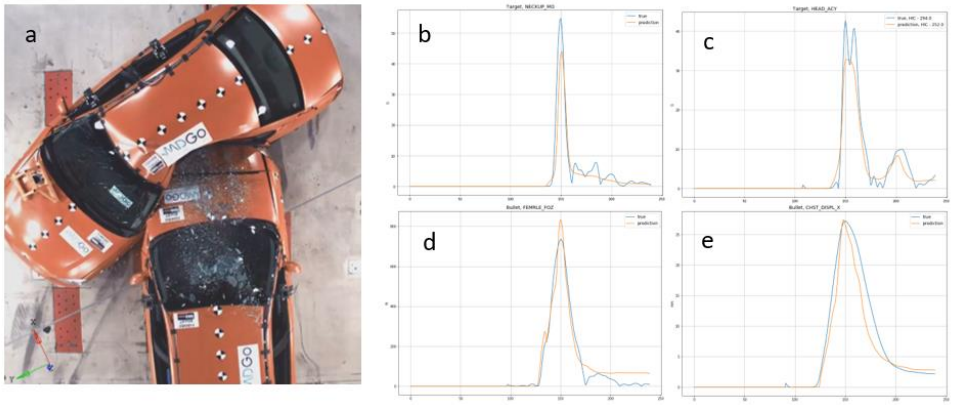
Figures

Figure 1. *A car crash simulation and corresponding forces applied on driver's head*



a.150°, 40 kilometer per hour, partial rear mechanism crash simulation. **b.** Corresponding forces applied to the impacted vehicle driver's head as a function of time (milliseconds), left and right Y axes represent angular acceleration and angular velocity, respectively. Spatial axes x in blue curve, y in red and z in green.

Figure 2. *G-force predictions and measurements in a car crash test*



a. 60°, 70 kilometer per hour, side impact crash test. **(b-e)** impacted car driver acceleration (G-force) as a function of time (ms), from crash test dummies sensors, orange and blue curves represents the prediction for the applied forces, and measurement of the crash test dummies sensors, respectively **b.** lateral rib. **c.** lateral head. **d.** bullet axial force on left femur. **e.** bullet chest displacement