No Trust without Regulation!

The European Challenge on Regulation, Liability and Standards

François Terrier

Program Director of List Institute

CEA's AI Senior Fellow

From where I talk...

cea

From Research to Industry

- ✓ **Low-carbon energy** (nuclear & renewable)
- ✓ **Digital technology**
- ✓ **Medicine of the future** (technology)
- ✓ **Defence and national security**

21 000 +
employees,
including 1,700 PhD and post-doctoral students

€5,6 billion
annual budget

Leading french organisation
registering the highest number of patents in France and Europe*

9
research centers

228 start-ups
set up since 1972

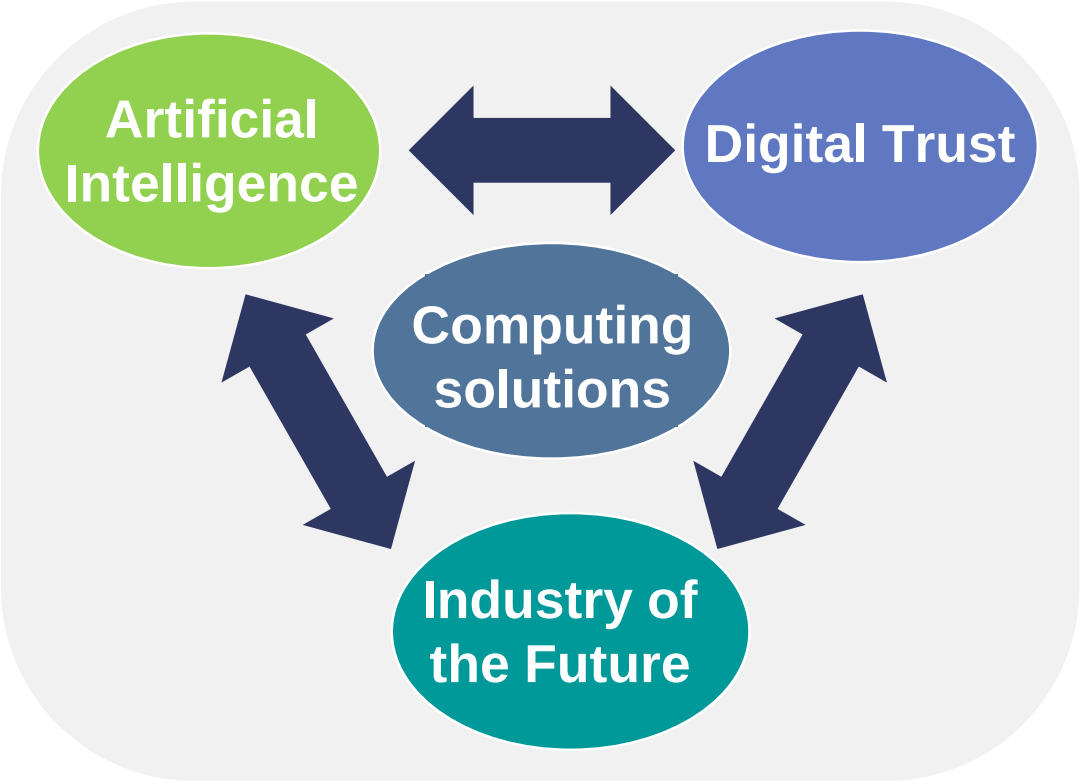
700+
industry partners

Smart Digital Systems Institute

Society

Environnement

Sovereignty



1 000+
employees

200+
PhD & Postdocs

200+
industrial partners

Main CEA List's axes of research in AI

~200 pers List

Science for AI

Algorithm frugality:
Data managment, optimisation embedded

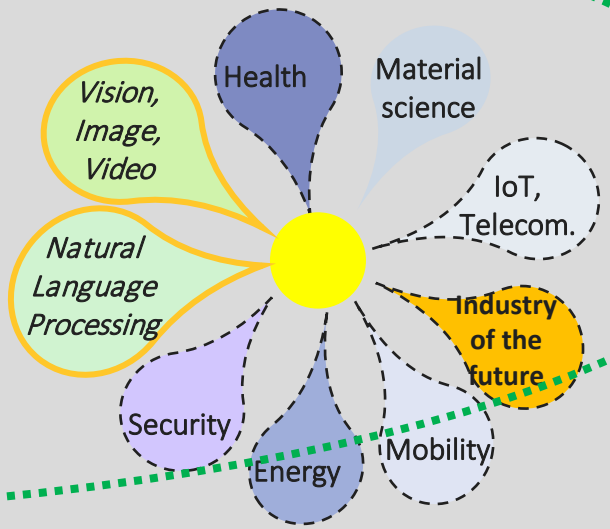
System Trust:
Methods and tools

Energy efficiency:
Components, board, architectures,

Microelectronics technologies

AI for Science and Society

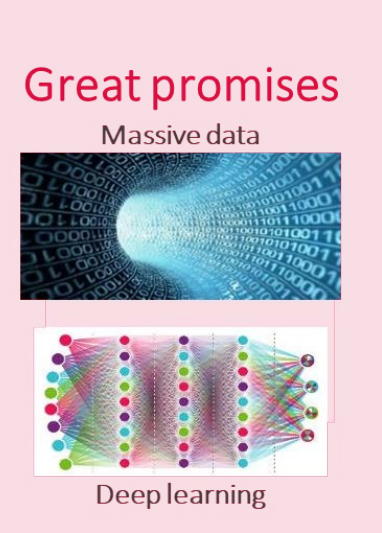
Applications focussed on our expertises



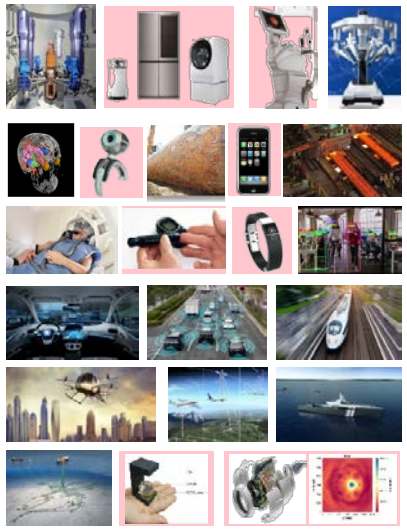
“ The well-known context...

AI is coming with new and huge challenges

More and more expectations on trust and frugality

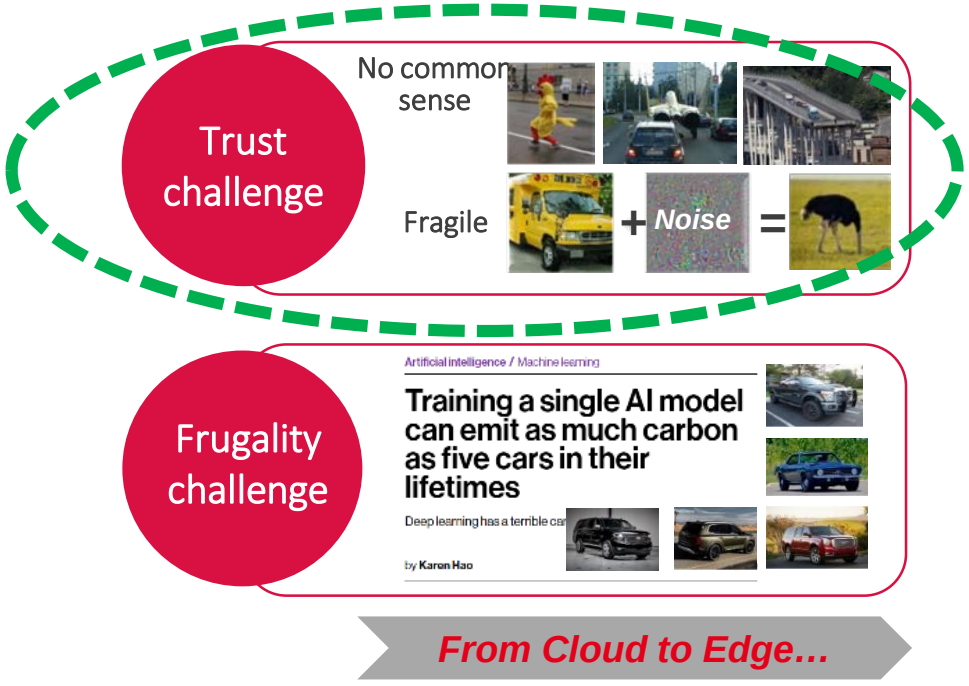


A lot of new applications



Automatization

A lot of data, computation



From Cloud to Edge…

ARTIFICIAL INTELLIGENCE

Efficient and impressing!!!

on elementary task as

- *Perception*
- *Reasoning*

But…

No common sense

« Chicken » or
« Pedestrian »

« Nothing (recognized) behind? »

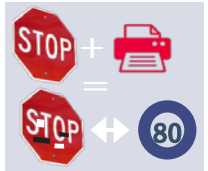
« Known known »
« Known unknown »
« Unknown unknown »

Fragile

Scolar bus

Ostrich

Attackable



Miss-used

Report on Tesla first accident – Recommendation

Incorporate system safeguards that limit the use of automated vehicle control systems to those conditions for which they were designed. (H-17-41)

Need of policy

Outside of Europe:
still at stage of recommandations...

NIST National Institute of Standards and Technology U.S. Department of Commerce

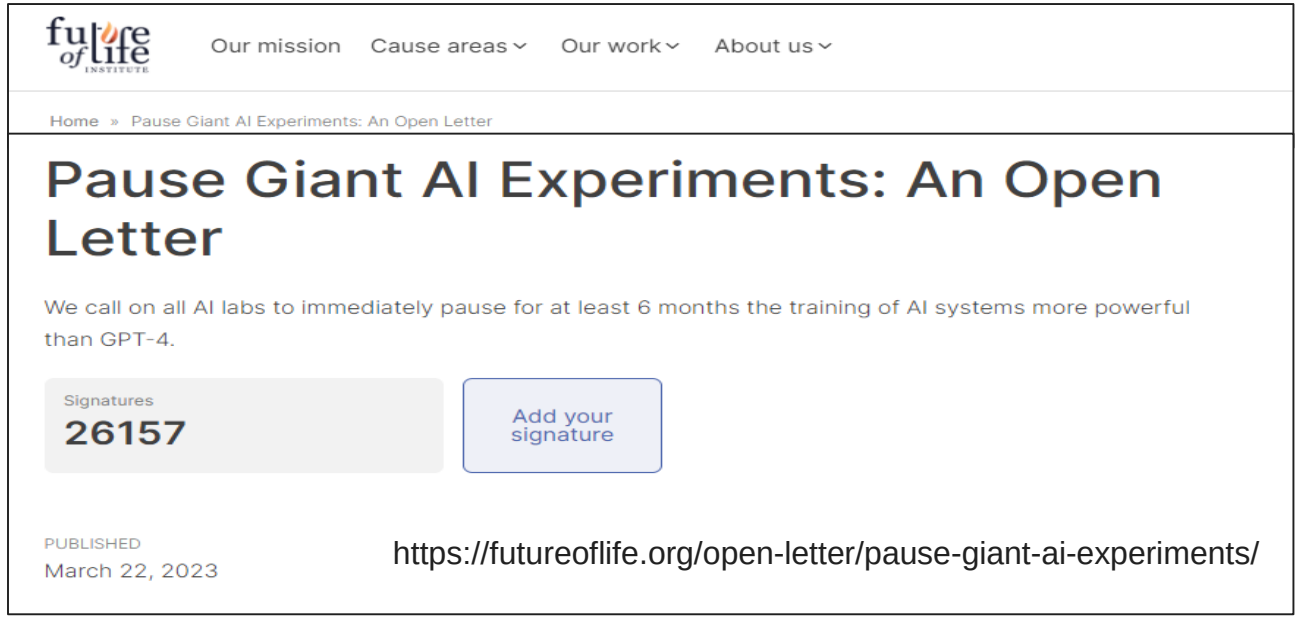
www.nist.gov/system/files/documents/2022/03/17/AI-RMF-1stdraft.pdf

The AI RMF is intended for voluntary use in addressing risks in the design, development, use, and evaluation of AI products, services, and systems.

OECD BETTER POLICIES FOR BETTER LIVES

https://oecd.ai/en/ai-principles

… innovative and trustworthy and that respects human rights and democratic values. (May 2019)



https://futureoflife.org/open-letter/pause-giant-ai-experiments/

European approach to ethics and regulation

Expert group analyse the subject of TRUST

2018

2019: refinement for key sectors

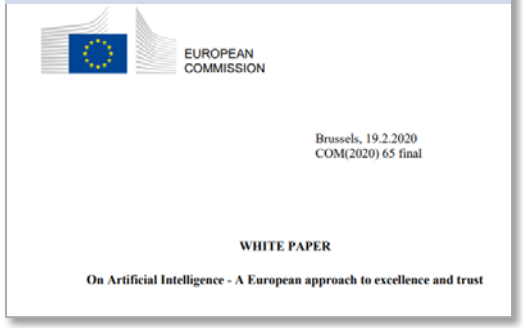
Manufacturing
Health
Justice
E-Government

Trustworthy AI should be:
(1) lawful - respecting all applicable laws & regulations
(2) ethical - respecting ethical principles and values
(3) robust - both from a technical perspective while taking into account its social environment

7 key requirements:
- Human agency and oversight
- Technical Robustness and safety.
- Privacy and data governance.
- Transparency.
- Societal and environmental well-being.
- Accountability.

European commission vision

2020: Approach for excellence and Trust


EUROPEAN COMMISSION

Brussels, 19.2.2020
COM(2020) 65 final

WHITE PAPER

On Artificial Intelligence - A European approach to excellence and trust

Human-centric AI:
- **AI system builder is responsible → robustness, safety, privacy, transparency…**
- **Human right must be respected and not subject to automated decision only**

Toward a european regulation

2021: Proposal to the parliament


EUROPEAN COMMISSION

Brussels, 21.4.2021
COM(2021) 206 final
2021/0106 (COD)

Proposal for a

REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

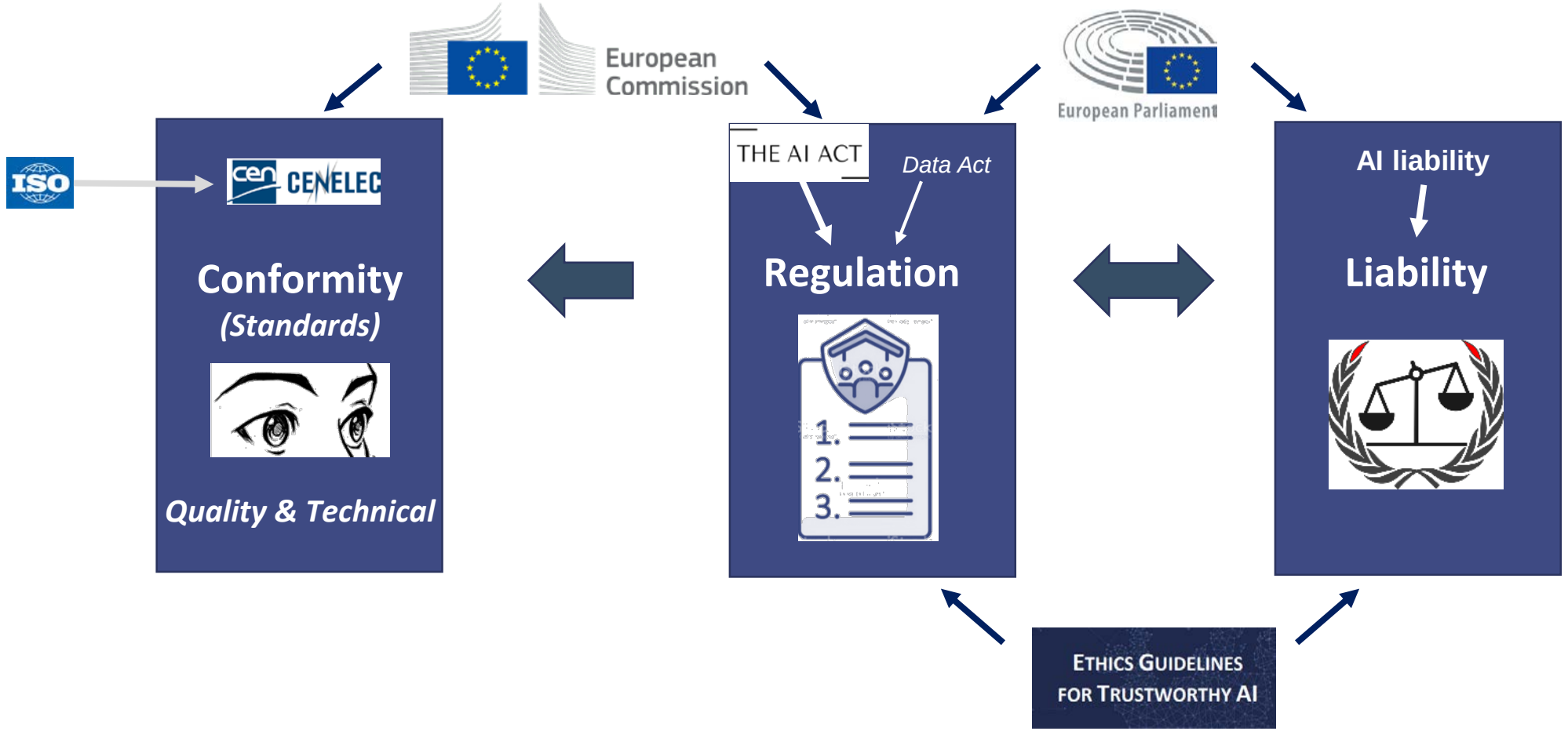
LAYING DOWN HARMONISED RULES ON ARTIFICIAL INTELLIGENCE (ARTIFICIAL INTELLIGENCE ACT) AND AMENDING CERTAIN UNION LEGISLATIVE ACTS

Ethics imperatives & defense

Europe makes a step forward!

A global policy set up by Europe

A complete approach with 3 pilars: regulation, liability, conformity

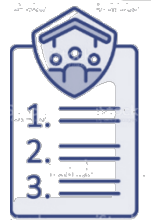


Toward an European regulation for AI deployment respecting the european values

European Parliament presentation: www.europarl.europa.eu/thinktank/en/document/EPRS_BRI(2021)698792
The act (108 pg) : https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52021PC0206

- A strong European legislation,
  (*i.e applicable as it is to any system or service provided in any EU country)*

Adopted by EU Parliament, on June 14th 2023:
499 votes in favour, 28 against and 93 abstentions
➔ Now it goes to each national parliaments



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- **List of prohibited AI**
- **Risk classification**
- **Rules for high risk AI systems**
- **Transparency obligations**
- **Support to innovation**

Technology neutral

Risk based approach

Market focuss
(preserve research)

Toward an European regulation: centered on the usage

FORBIDDEN USAGES

- **COGNITIVE BEHAVIOURAL MANIPULATION**
  - AI systems that deploy harmful manipulative 'subliminal techniques'
  - AI systems that exploit specific vulnerable groups (physical or mental disability)
- **SOCIAL SCORING & Cie by PUBLIC AUTHORITIES**
  - AI systems used by public authorities, or on their behalf, for social scoring purposes
  - Predictive policing systems (based on profiling, location or past criminal behavior)
  - Emotion recognition in law enforcement, border management, the workplace, educational institutions
- **REAL TIME & REMOTE BIOMETRIC IDENTIFICATION**
  - “Real-time” and “Post” remote biometric identification systems in publicly accessible spaces (except for serious crimes after judicial authorization)
  - Biometric categorization using sensitive characteristics (e.g. gender, race, ethnicity, citizenship status, religion, political orientation)
  - Untargeted scraping of facial images from internet or CCTV to create facial recognition databases (= violating human rights and right to privacy).

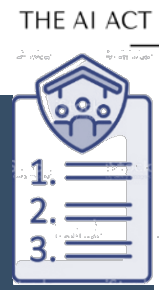
Toward an European regulation: centered on the usage and risk analysis...

3 levels of risks depending of the usage domain

+ 1 Specific case

- **High risk systems: *Safety obligations***
- **Generative AI: *Dedicated Transparency obligations***
- **Limited risk: *Transparency obligations***
- **Low or minimal risk: *No obligations***

Toward an European regulation...



High risk systems

- **FOR ALL DOMAINS WITH EXISTING REGULATIONS:**

  → General principles **+ requirement of corresponding EU regulations → strong req.**

  - *Ex. : transportation, health, energy, toys, lifts…*

+ SPECIFIC APPLICATIONS AREAS *(requiring registration)* **as:**

- *Biometry & person categorization;*
- *Management of critical infrastructure*
- *Essential public and private services;*
- *Education; Employment;*
- *Recommendation systems (social media >45M users);*
- *Democratic process influence;*
- *Law enforcement; Migration etc.;*
- *Administration of justice;*

- **For all others (**applications not already governed by European legislation) **→ self-assessment**

Requirements

High-risk AI based systems

- ***RISK ANALYSIS AND ESTIMATION (MAINTAINED REGULARLY) ACCORDING TO USE***
- *Data set pertinent, representative, free of errors and complete*
- *Technical documentation establishing conformity to requirements*
- ***Automatic recording of events ('logs')***
- *Sufficient transparency* ***TO INTERPRET OUTPUT AND USE IT APPROPRIATELY***

(→ continuously maintained during the system life)

Requirements

Generative AI based applications

- **Assess and mitigate possible risks** *(regarding to the possible uses and contexts of use)* (to health, safety, fundamental rights, the environment, democracy and rule of law)
- **Register** the models in the EU database before release on the EU market
- Comply with **transparency** requirements:
  - *Disclosing that the content was AI-generated*
  - *Ensure safeguards against generating illegal content*
  - *Provide publically detailed summaries of the copyrighted data used for training*
  - *Provide capabilities measuring and logging resource consumption* *(over their entire lifecycle)*

Should be technology agnostic…

Challenge is how to adopt a risk oriented approach when usages are not known in advance

Requirements

Limited-risk AI based systems *(not based on Generative AI)*

- Such as systems that interacts with humans (i.e. chatbots), emotion recognition systems, biometric categorisation systems, and AI systems that generate or manipulate image, audio or video content (i.e. deepfakes) → ***limited set of transparency obligations****:*

- Interacting with natural persons: ensure natural persons are informed of the AI nature
- Disclose that the content has been artificially generated or manipulated

AI liability: a more protective law

The specific characteristics of AI
make it particularly difficult to meet the burden of proof for a successful claim
(e.g. opacity/lack of transparency, explainability,
autonomous behaviour, continuous adaptation, limited predictability)

➔ **Adaptation of law to allow for compensation for damages without the need to prove a fault**

- *Reduce liability rules uncertainty and risk of legal fragmentation*
- *Causality not mandatory*
  (except for High Risk AI because they have to provide transparency and thus give the means to establish causality links)

➔ **Responsability to the provider of product and services (depending on context of use)**

❖ **Will depend to impact analysis depending of the risks entailed by the uses**

❖ **Will depend to quality of development, transparency, effective oversight by natural persons**

Trust → Certification → Regulation ➔ Standards

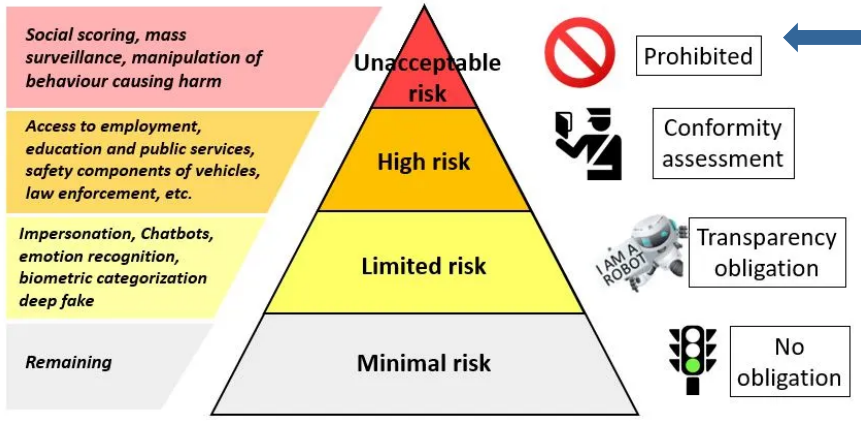
2018 « HLEG » → *2021 « AI Act »* → *2022 Normalisation* ➔ *2024… !*

A very fast process

European AI Regulation

THE AI ACT

EU Artificial Intelligence Act: Risk levels



Will influence regulations of the other countries
➔ *« the RGPD effect… »*

October 2022, request for: Producing standards supporting the regulation

December 2024: Agreed and harmonized standard

End of « technical work: December 2023!

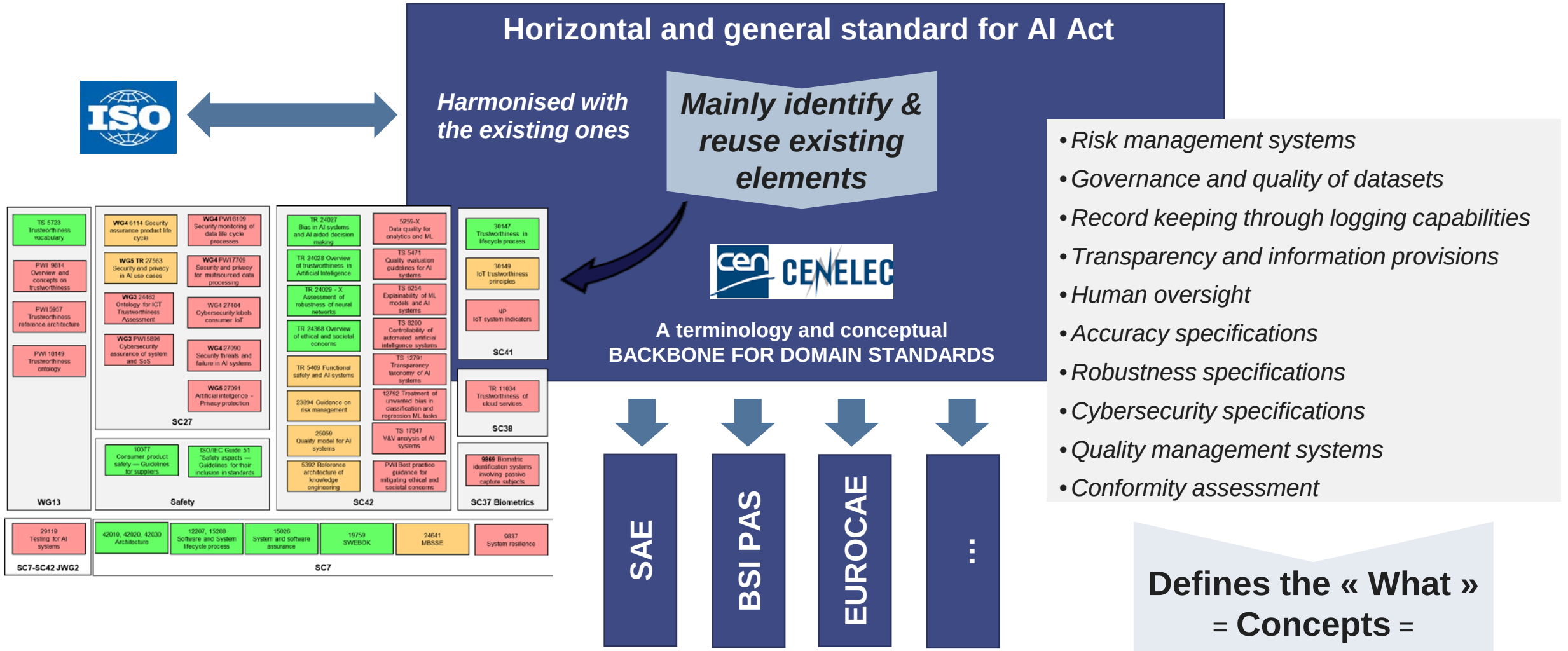
Standardisation

Coordinate French contributions — afnor — AI national commission

CEN CENELEC — European organism

ISO

Standards organization



- *Risk management systems*
- *Governance and quality of datasets*
- *Record keeping through logging capabilities*
- *Transparency and information provisions*
- *Human oversight*
- *Accuracy specifications*
- *Robustness specifications*
- *Cybersecurity specifications*
- *Quality management systems*
- *Conformity assessment*

Defines the « What »
= Concepts =
Not the « How »

Credits: Henri Sohier, Co-project leader, "AI Trustworthiness characterization", CEN-CENELEC JTC21 WG4

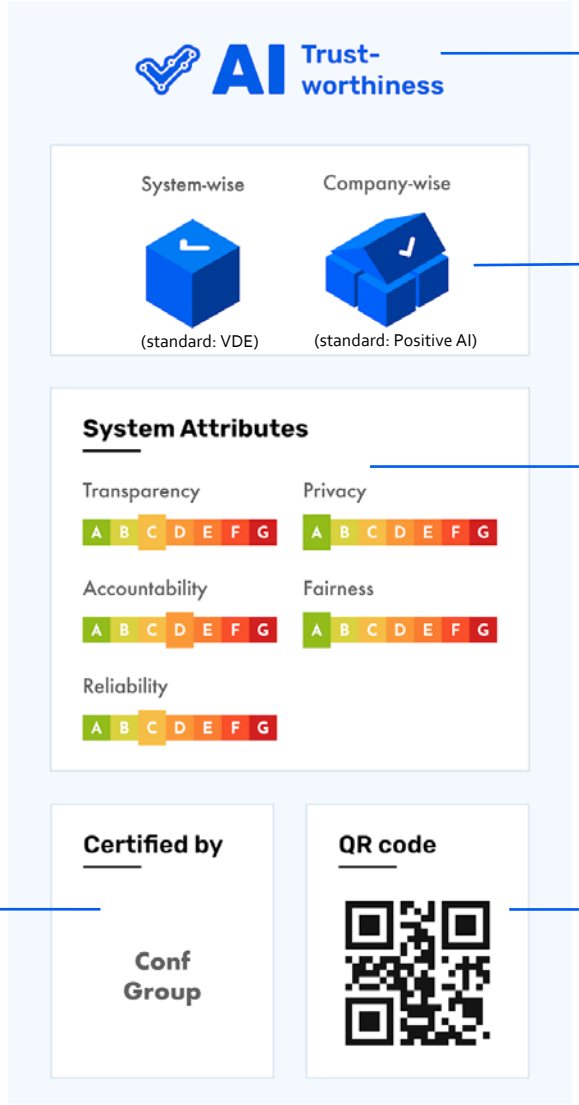
Labelling approach to complete certification

VDE

POSITIVE AI

IEEE

Confiance AI



A virtual example

Label for system trust and/or company trust (or more)
Name of the original labels or standards

System attributes in case of system trust

Optional if it can be a self-declaration

Link to more information (the summary can never show everything)

What about safety?

TRUST challenge: a set of characteristics

ENGINEERING VIEW POINT

USAGE VIEW POINT

Safety community see AI components as (physical) systems

SAFETY, CERTIFICATION,

Quality, Reliability,

Security, Privacy

Robustness, Accuracy

Traceability, Interpretability,

Ethics, Societal Impact,

Accountability,

Fairness, Explainability

TRANSPARENCY

AI community see AI components as SW

AI Act

Mastering the process

- → the specification

Operational Design Domain

« Operating conditions under which a given system is specifically designed to function »
(including environmental, time-of-day restrictions)

« Operating conditions under which a given driving automation system or feature thereof is specifically designed to function, including, but not limited to, environmental , geographical, and time-of-day restrictions, and/or the requisite presence or absence of certain traffic or roadway characteristic. » SAE-j3016

Various definitions and naming depending on the domains
(concept being refined and integrated by the related standards)

- E.g. : SAE J3016, BSI PAS 1883, SAE AIR6988 (2021), {ConOps} EASA (2021), {SOD, OSED, ODD} SAE AS6983 / EUROCAE ED-xxx (Draft 3a – June 2022)

✓ *from the outside of the system*

Voluntary restriction within which the expected nominal functioning of an AI-based system is ensured.

E.g.: « Very heavy rainfall »

✓ *from the inside of the system*

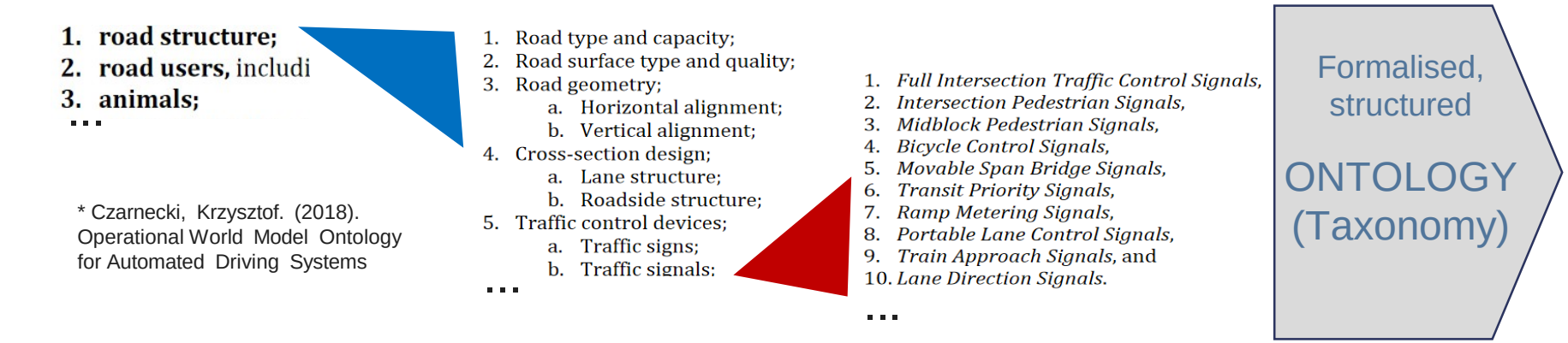
Description of measurable foreseeable operating conditions within which a AI-based component must operate.

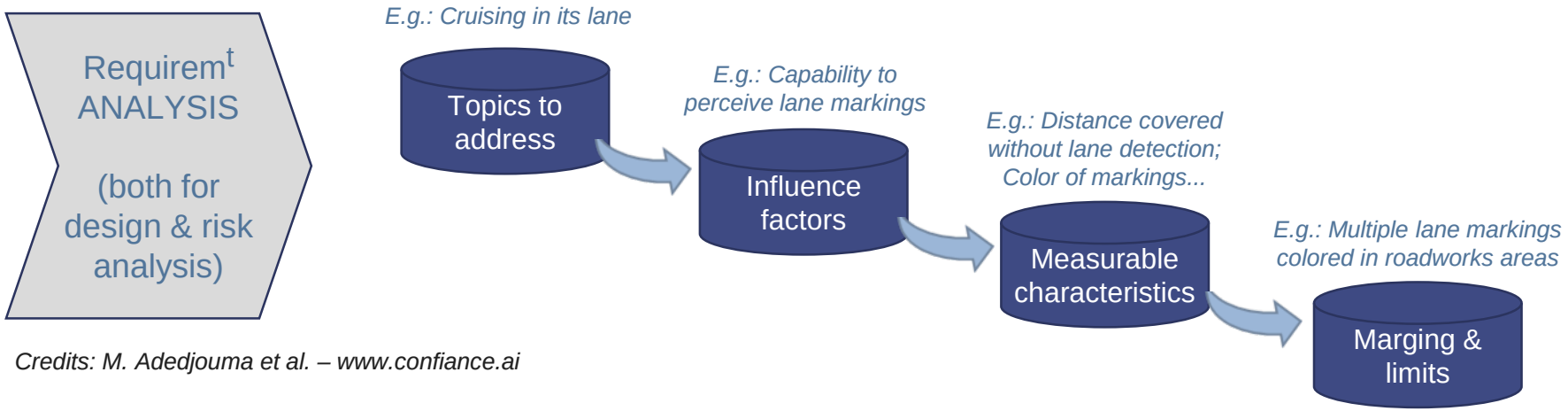
E.g.: « Signal variation from rain detection sensor »

Credits: M. Adedjouma et al. – www.confiance.ai

ODD definition through Ontology and Analysis

A general domain analysis completed during design

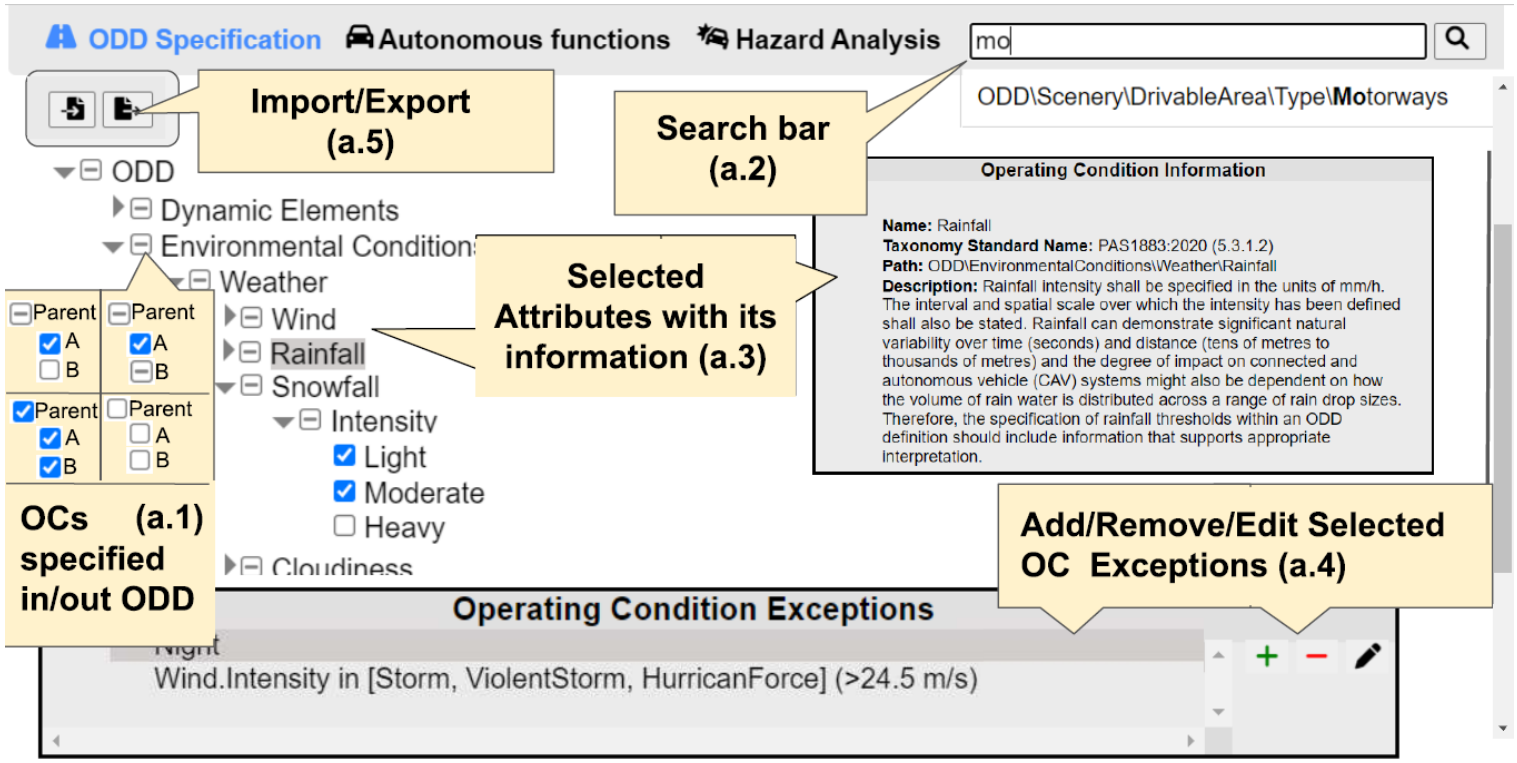


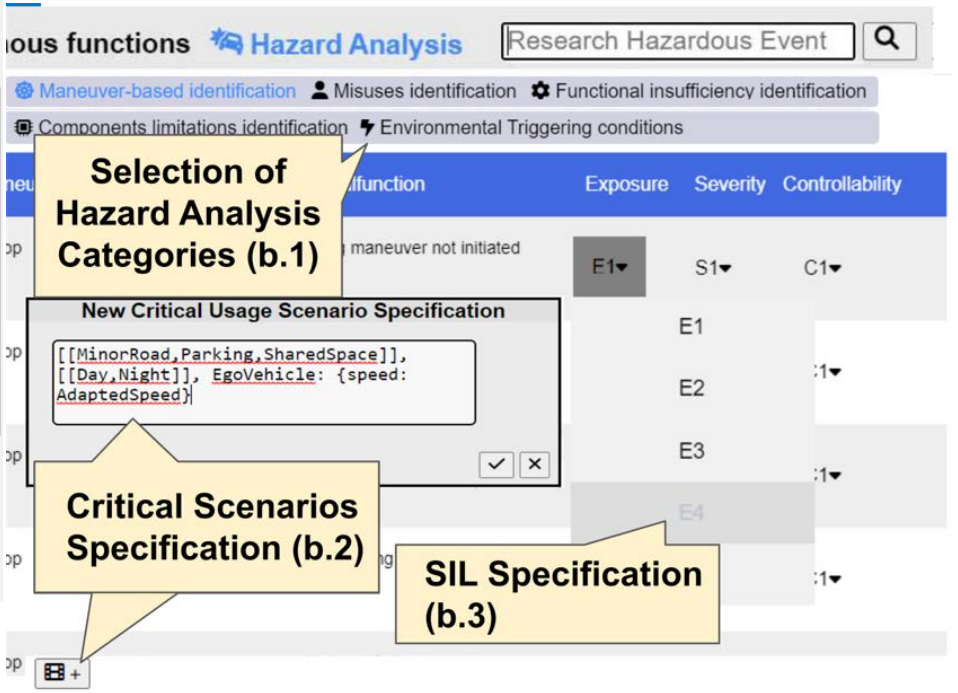


Credits: M. Adedjouma et al. – www.confiance.ai

ODD-based Hazard Identification

*A **tool-supported framework** to **automate the hazard identification** process using an ontological model and a specification of the AI-based system **ODD***

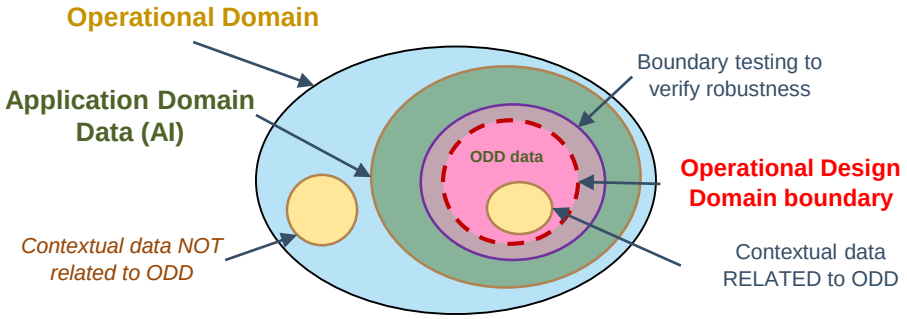


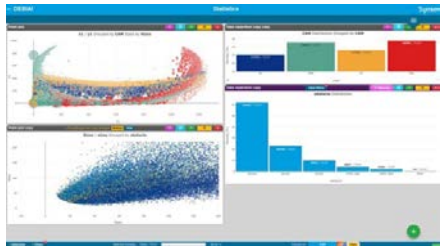


G. Ollier et al., Using Operational Design Domain in Hazard Identification, EDCC 2022

ODD: Data definition for Machine Learning

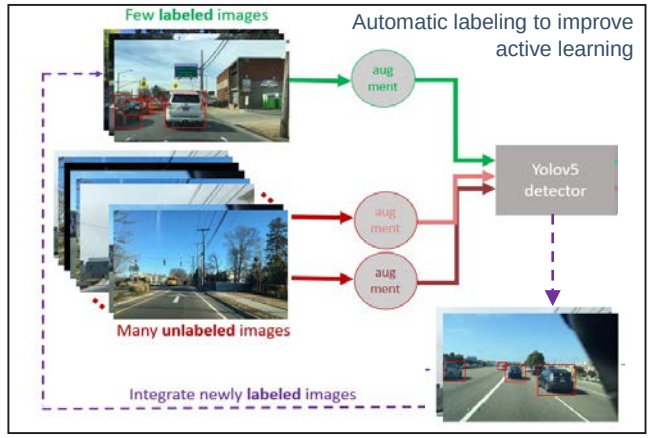
Example on ongoing work on dataset collection, labeling, classification vs the ODD





Data distribution analysis according specification characteristics

Sparcity anomaly detection



Credits: M. Addejouma, P. Toukam, F.-M. Ngole Mboula et al. – www.confiance.ai

. Formal methods...

SAFETY: FORMAL METHODS AND AI... ???

Credits: Z. Chihani, www.aisafetyw.org - 2022

Formal methods a long time ago: The prophecy

1979:"Program verification is bound to fail. We can't see how it's going to be able to affect anyone's confidence about programs", in *Social processes and proofs of theorems and programs*", Communications of ACM.

The prophets By Richard De Millo, Richard Lipton, and Alan Perlis.

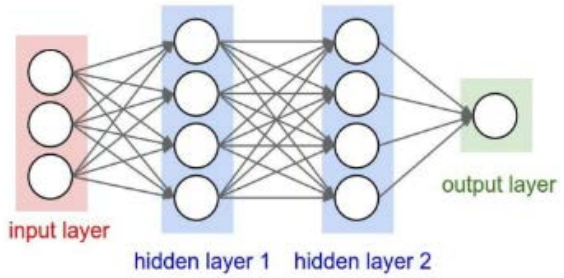
- Distinguished Professor of Computing at the Georgia Tech
- VP and CTO of Hewlett-Packard
- Yale, Berkeley, Princeton, Georgia Tech
- Knuth Prize winner
- ACM, Carnegie Mellon, Yale, Purdue
- First Turing Award recipient

Fast forward a few decades

Astrée Software, PolySpace, bugseng, MODELICA, frama C, ANSYS, ESTEREL, z3, Research, CompCert

IRSN, AIRBUS, DGA, ALSTOM, IBM, AMD, THALES, EDF, intel, SIEMENS, NASA, Schneider Electric, SAFRAN

What about AI and the hardest = ML: we have been here before...



Machine learned code ⟷ ?

Formal methods

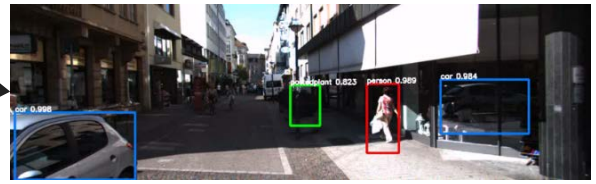
- Symbolic AI
- Perturbation robustness
- Properties verification
- Model interpretation

Performances versus Validation

Advanced research: best algorithm!

Industrial partnership

An industrial use case



Failure ISO 26262: <10^{-4}

≠

Performance : > 99,99% ! (<10^{-4})

TESTS

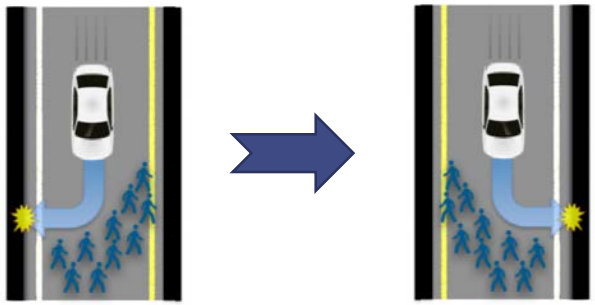
- Performance tests could be safety tests only if they are well defined regarding to the risks and their probabilities…
- What happens when a test fails from a safety point of view?
  → usually we ask to correct it, but it seems not applicable in ML...

➔ ***The key question is: how are they defined & what is the coverage?***

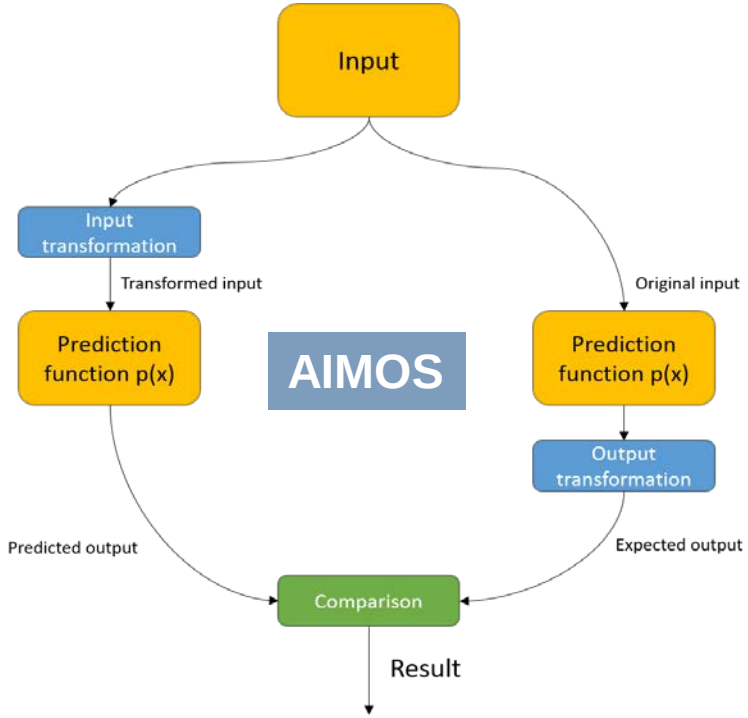
ML based AI, testing robustness

Goal: evaluate the AI component against perturbations

- AI component as a black box
- Formalised perturbations according ODD
- Automatic test generation (sample)
- Compare output with the expected one
  - E.g: « Metamorphism »
    (geometric transformation =
    « any computable math formulae »)

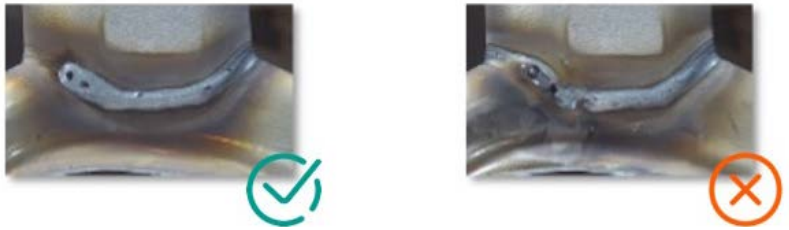


Credits: Z. Chihani, www.aisafetyw.org - 2022



Metamorphic testing, example

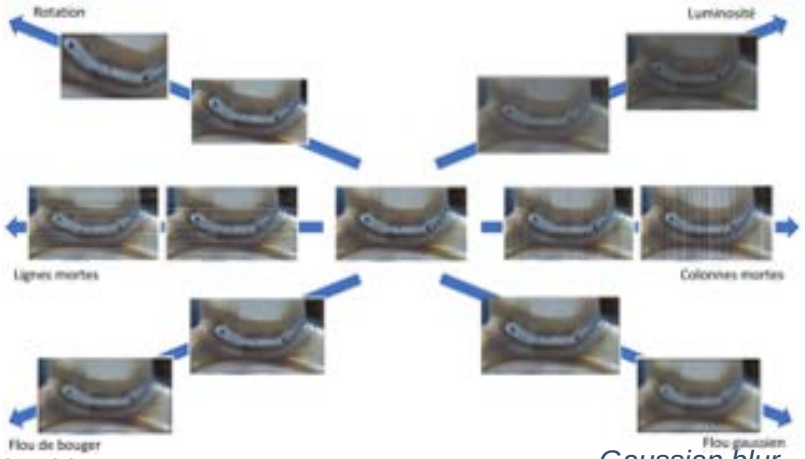
Welding control



How the application is robust against image degradations?

Rotation

Brightness

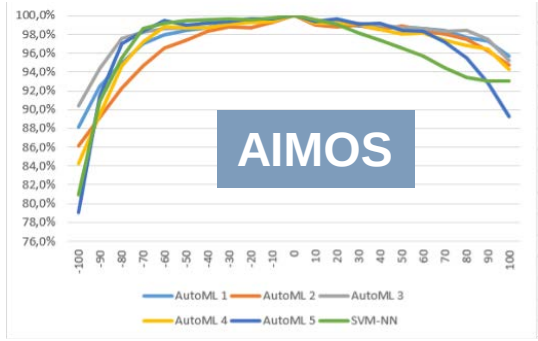


Motion blur

Gaussian blur

Credits: Confiance.ai – AIMOS - www.confiance.ai/ia-a-epreuve-du-bruit

E.g.: evaluate robustness against luminosity variations

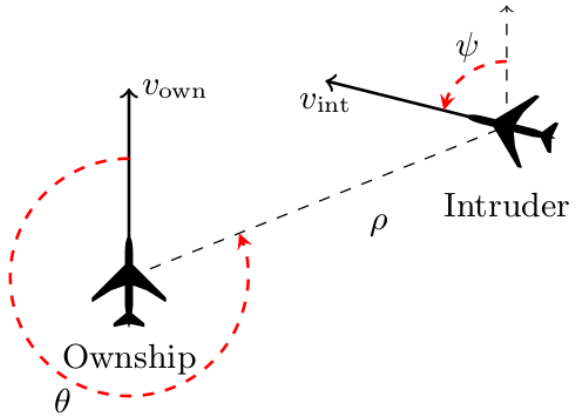


Proof of safety properties on neural networks

ACAS-XU: a complex problem (15 M of states)
→ function as set of 45 connected neural networks

Is tractable through formal methods analysing the NN

- E.g. PyRAT: pyrat-analyzer.com

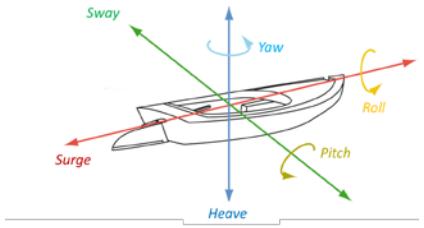


If the intruder is near and approaching from the left, the system advises « strong right ».

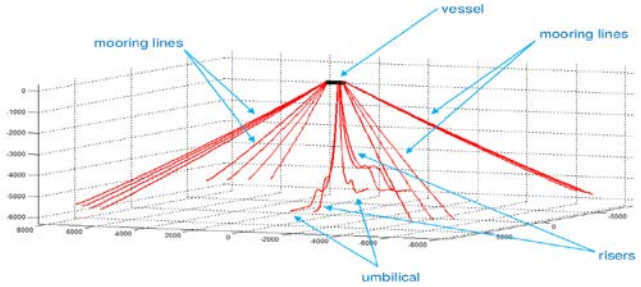
Input constraints:
$250 \leq \rho \leq 400$
$0.2 \leq \theta \leq 0.4$
$-3.141592 \leq \psi \leq -3.141592 + 0.005$
$100 \leq v_{own} \leq 400$
$0 \leq v_{int} \leq 400$

Formal verification of ML based systems

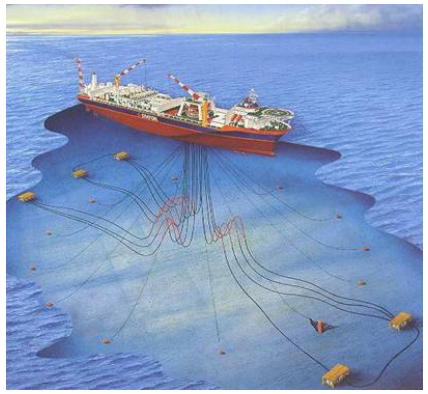
A use case: Detection of mooring line breaks



Analysis of ship's movements



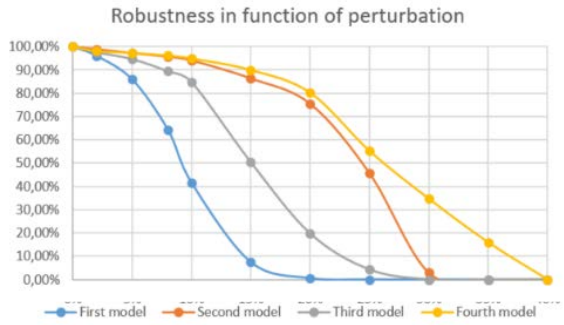
4 groups of mooring lines



1) Formal verification of safety properties *(safe operating domain)*
   → exhaustive computation of input domains
   for which the system detects failures

2) Robustness evaluation of the sensitivity to disturbances on the inputs:
   - Global approach: computation of interval of acceptable perturbations

Fake example: always safe with waves under 5 m



Credits: Z. Chihani, A. Lemesle et al., pyrat-analyzer.com, https://caisar-platform.github.io/website/

Formal methods challenges

They require initial « formalisation » of properties or test objectives (ODD)
If properties are not formalised (e.g. « recognize a pedestrian »),
we need to go to internal robustness properties (e.g. « metamorphism »)

For global verification : OK with structured data (leading to « small » models)

- E.g.: command and control, tabular approaches...

But for « large » models, very huge computation is needed.

They apply well on **local verification** = around a particular data input

- E.g.: welding control application, the image size lead to a large NN,
  → practical computation allowed to explore until 5% of variation around any given input data

Research is very active and provides continuously new results to deal with more and more complex AI components

Thanks!

Imagine new usages & understand real needs

Applications

Design, V&V Certification

Deployment technologies HW/SW

New tools
New process

Performance
Cost

TRUST & FRUGALITY

will make the difference

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