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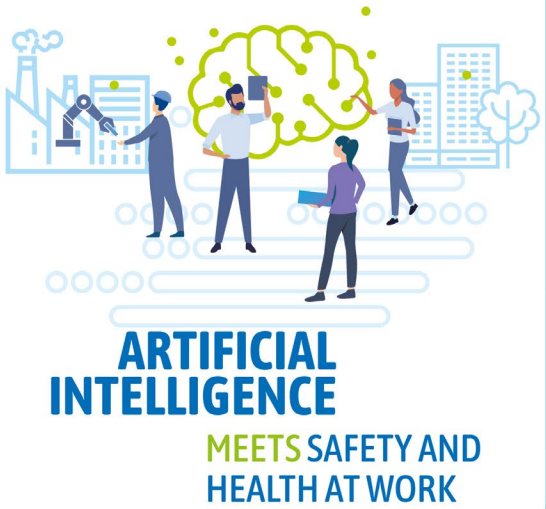
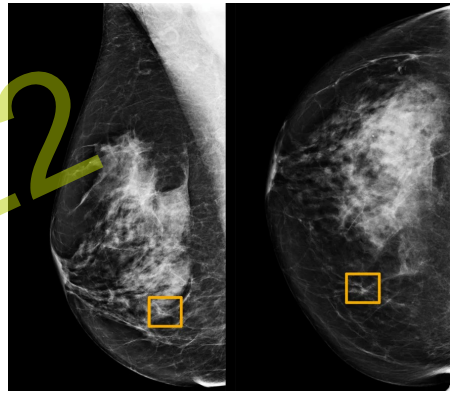


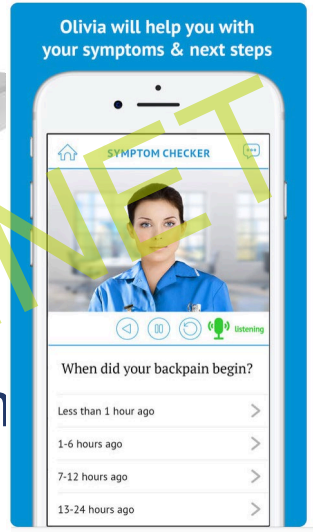
Foundations, Methods, Applications and Limitations of Artificial Intelligence

Raja Chatila
Institute of Intelligent Systems and Robotics (ISIR)
Faculty of Sciences and Engineering, Pierre and Marie Curie Campus
Sorbonne University, Paris, France
Raja.Chatila@sorbonne-universite.fr

Multiple Applications of AI And Robotics

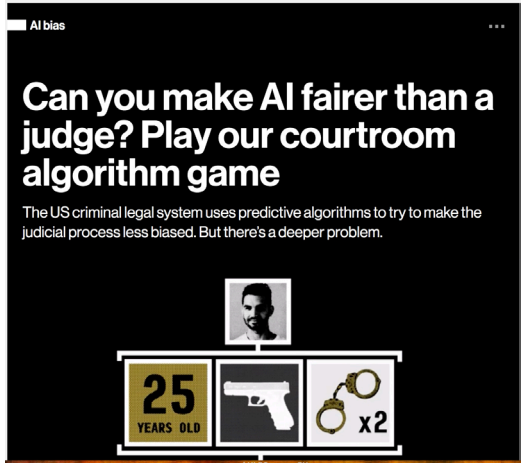
- Transportation, logistics, delivery
- Healthcare
- Manufacturing
- Agriculture
- Personal services & assistance
- Security
- Recommender systems, advertisen
- Recruitment & management
- Insurance & finance
- Justice
- Warfare
- …





A face-scanning algorithm increasingly decides whether you deserve the job

HireVue claims it uses **artificial intelligence** to decide who's best for a job. Outside experts call it 'profoundly disturbing.'



Artificial Intelligence

Machine Learning

Deep Learning

Reinforcement Learning

Robotics

Control Theory

Mechanical Design

Real-time Systems

“Symbolic AI”

Knowledge Representation;

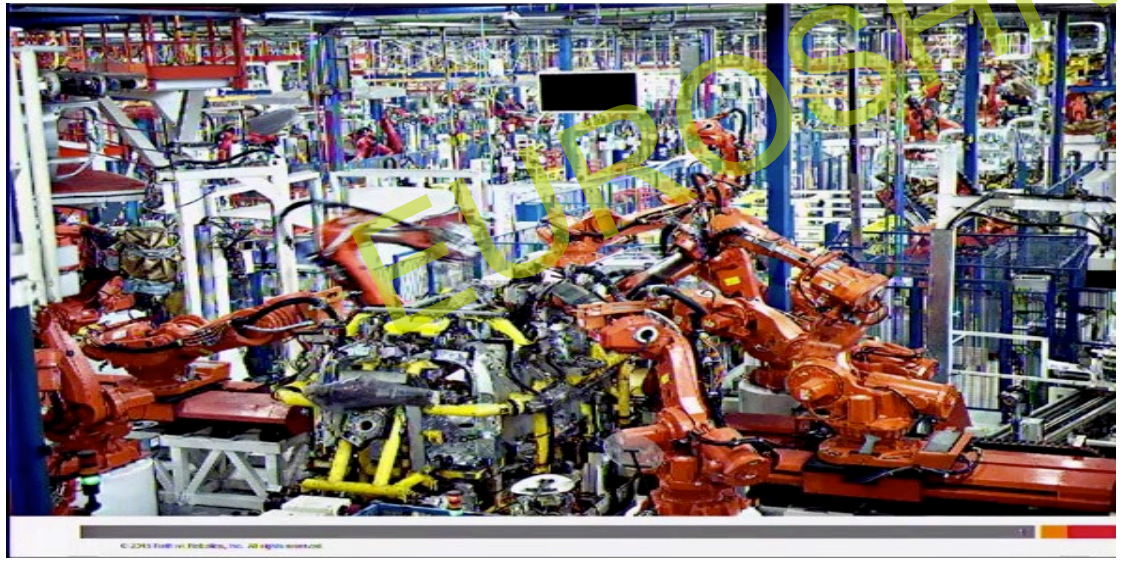
Logical inference and Probabilistic Reasoning;

Problem Solving and Search; Planning

What is an Computational “Intelligent” System?

- A computational intelligent system is a set of **algorithms designed by humans**, using data (big/small/sensed) to solve [more or less] complex problems in [more or less] complex situations.
- The system might include deductive inference, as well as machine learning processes, *i.e.*, the capability of improving its performance based on data classification to build **statistical models** from data (*e.g.*, deep learning), or on evaluating previous decisions (*e.g.*, reinforcement learning).
- Such systems could be regarded as “autonomous” in a **given domain** and for **specific tasks**, as long as they are capable of accomplishing these tasks despite environment variations within this domain.
- Difference between automated and autonomous systems is related to **complexity** of task and domain, and **importance** of variations

From Full Robotization to Human-Robot collaborative tasks



Machine Learning

Statistical data processing and classification

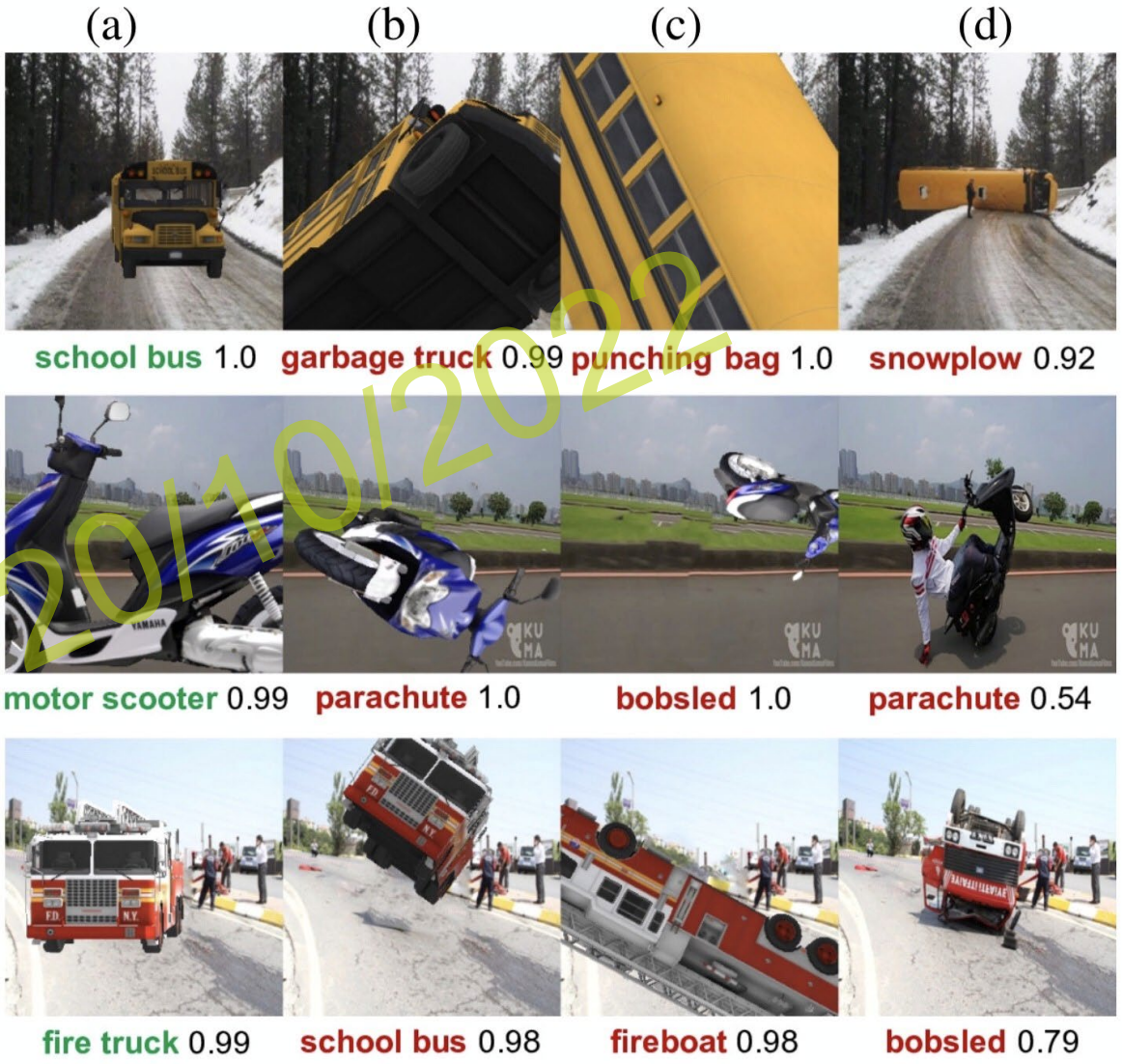
- Use of probability distributions, correlations, …
- Use of artificial neural nets as classifiers
- Optimization algorithms

- Supervised learning: correct answer provided by a truth model.
- Unsupervised learning: search for regularities in the data
- Reinforcement Learning: select the most promising action based on rewards

Deep Learning Limi Robustness

Targeted physical perturbation experiment
The misclassification target was Speed Limit 45.

Robust Physical-World Attacks on Deep Learning Models K. Eykholt et al. CVPR 2018.



Strike (with) a Pose: Neural Networks Are Easily Fooled by Strange Poses of Familiar Objects. Michael A. Alcorn et al., CVPR 2019

Issues with Statistical Machine Learning

- Black box: millions/billions of parameters, optimization algorithms, un certified off-the-shelf components
- No solid verification and validation processes or qualification of results
- Quality and representativeness of data. Data Bias
- Bias due to design and architecture choices
- Inappropriate correlations, absence of causality between data and results
- No explicability
- Computational level: No semantics, no understanding of manipulated symbols, no context awareness
- Environmental cost

Risks and Trustworthiness of AI Systems

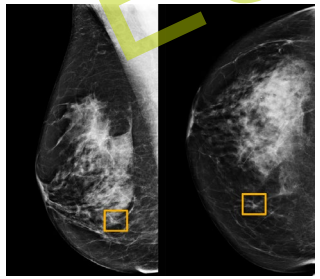
- No ethical rules in academic AI research
- Advanced AI research in industry without ethical oversight
- Applications in critical domains (healthcare, transport, security…)
- Applications potentially threatening human rights and values (surveillance, opinion manipulation, policing, justice, access to jobs and education, …)

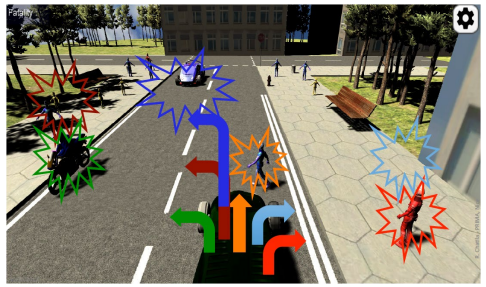
→ **Need for robustness and safety**

→ **Need for ethics and governance**

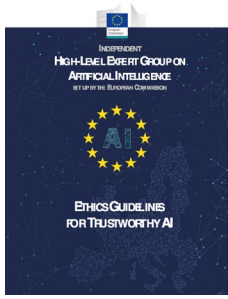
} Transparency

} Explainability





Key Requirements for Trustworthy AI
High-Level Expert Group on AI (EU) - April 2019



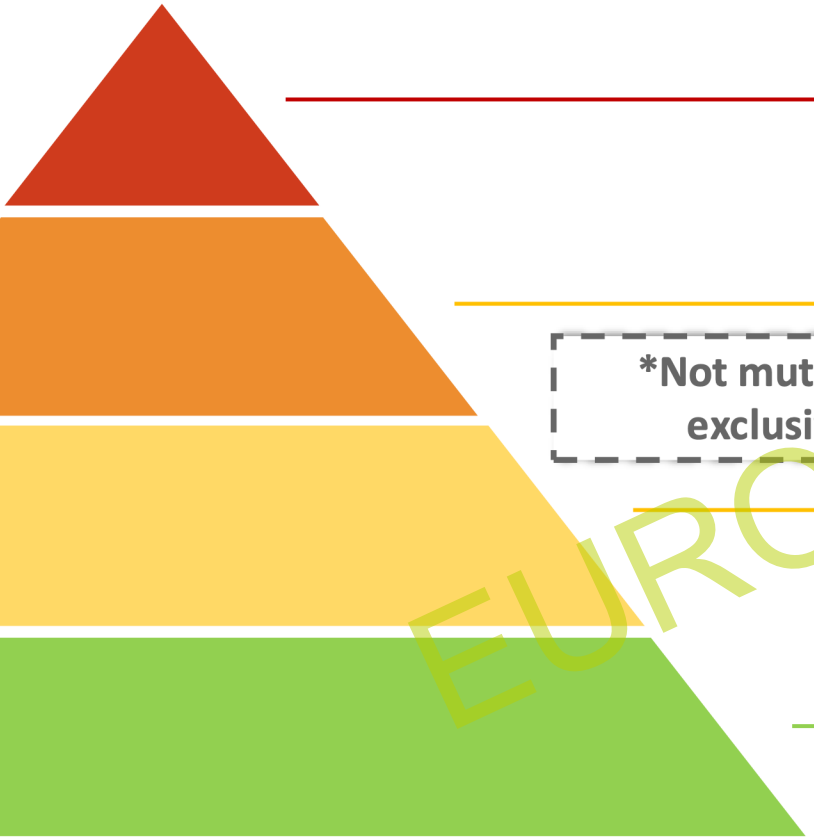
1. **Human agency and oversight**- Including respect tof fundamental rights, human control
2. **Technical robustness and safety** - Including resilience to attack and security, fall back plan and general safety, accuracy, reliability and reproducibility
3. **Privacy and data governance** - Including respect for privacy, quality and integrity of data, and access to data
4. **Transparency** - Including traceability, **explainability** and communication
5. **Diversity, non-discrimination and fairness** - Including the avoidance of unfair bias, accessibility and universal design, and stakeholder participation
6. **Societal and environmental wellbeing** - Including sustainability and environmental friendliness, social impact, society and democracy
7. **Accountability** - Including auditability, minimisation and reporting of negative impact, trade-offs and redress.

Tool: Assessment List for Trustworthy AI - ALTAI

https://ec.europa.eu/digital-single-market/en/high-level-expert-group-artificial-intelligence

A risk-based approach to regulation

EU Legislative proposal (21/04/2021)



Unacceptable risk
e.g. social scoring

High risk
e.g. recruitment, medical devices

*Not mutually exclusive

AI with specific transparency obligations
'Impersonation' (bots)

Minimal or no risk

Prohibited
Permitted subject to compliance with AI requirements and ex-ante conformity assessment
Permitted but subject to information/transparency Obligations
Permitted with no restrictions

Courtesy L. Sioli

European Commission

Courtesy L. Sioli

Main Takeaways

- AI and Robotics contributes ot increase productivity through physical process or software automation
- They enable to achieve tasks that are too repetitive, or were not achievable before (too dangerous, too costly, too difficult for humans) and create new services
- Exploit available massive data (images, scientific data, text, …)
- But AI is no silver bullet for many application. Avoid technical solutionism.
- AI systems using machine learning need to be made robust and resilient
- Explainability is essential to build trust in AI systems
- Appropriate design approaches, governance frameworks, auditing and certification of AI systems are necessary.