L'INTELLIGENCE ARTIFICIELLE APPLIQUÉE À L'AUTOMOBILE

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Agenda

01 **AI introduction & global picture of Automotive applications**

02 *Delivering robust & safe autonomous vehicles*

03 *Big Data & Data Science*

04 *Conclusion and challenges*

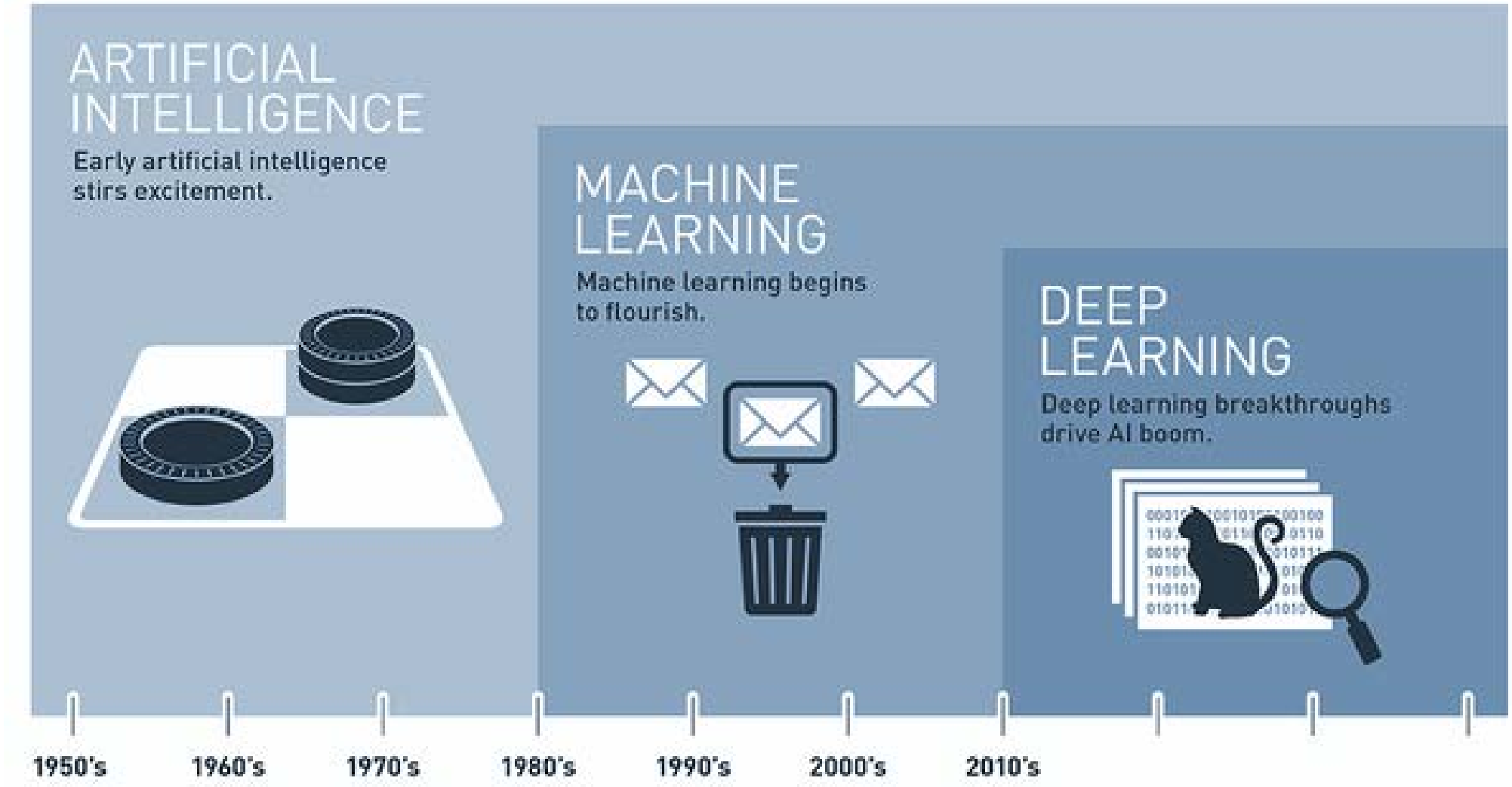
Tentatives de définition de l'IA

- Par référence à l'intelligence humaine
  - Test de Turing

- Par les caractéristiques des problèmes adressés
  - Pas d'algorithme connu
  - Une combinatoire (très) importante

- Une palette de techniques
  - Modélisation du raisonnement et des connaissances
  - Propagation de contraintes
  - Apprentissage
  - …

AI History


ARTIFICIAL INTELLIGENCE
Early artificial intelligence stirs excitement.
MACHINE LEARNING
Machine learning begins to flourish.
DEEP LEARNING
Deep learning breakthroughs drive AI boom.
1950's
1960's
1970's
1980's
1990's
2000's
2010's

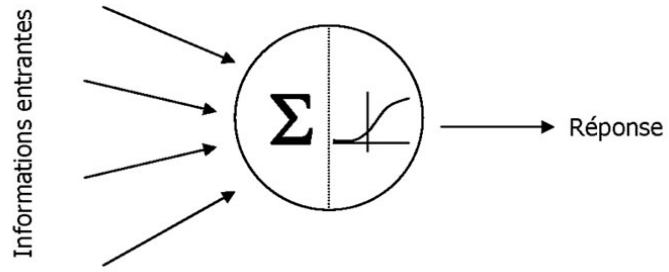
Apprentissage

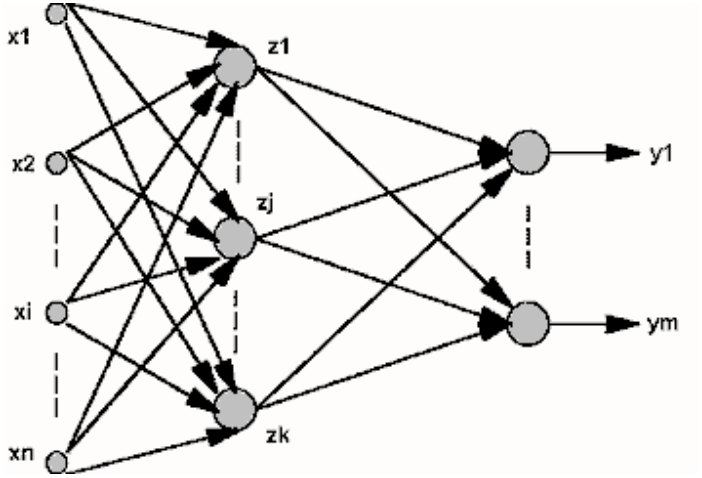
- Utiliser des exemples de solutions comme références
  (‘*Machine Learning is the ability…*’ A. Samuel - 1959)

- Apprentissage ‘symbolique’
  - Concepts, règles

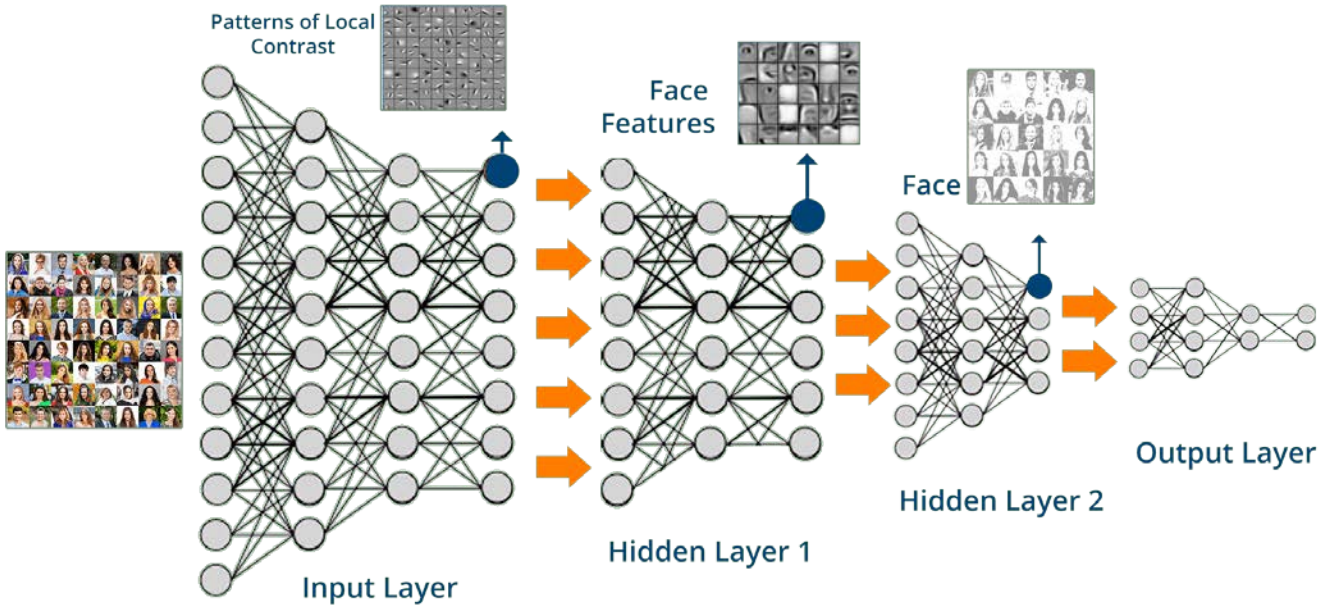
- Réseaux de neurones
  - Un modèle (très) simplifié du neurone humain
  - Neurones assemblés en réseau
  - Un algorithme d’apprentissage (la rétropropagation du gradient)

Figure 1 – Neurone artificiel (McCullogh et Pitts, 1943)





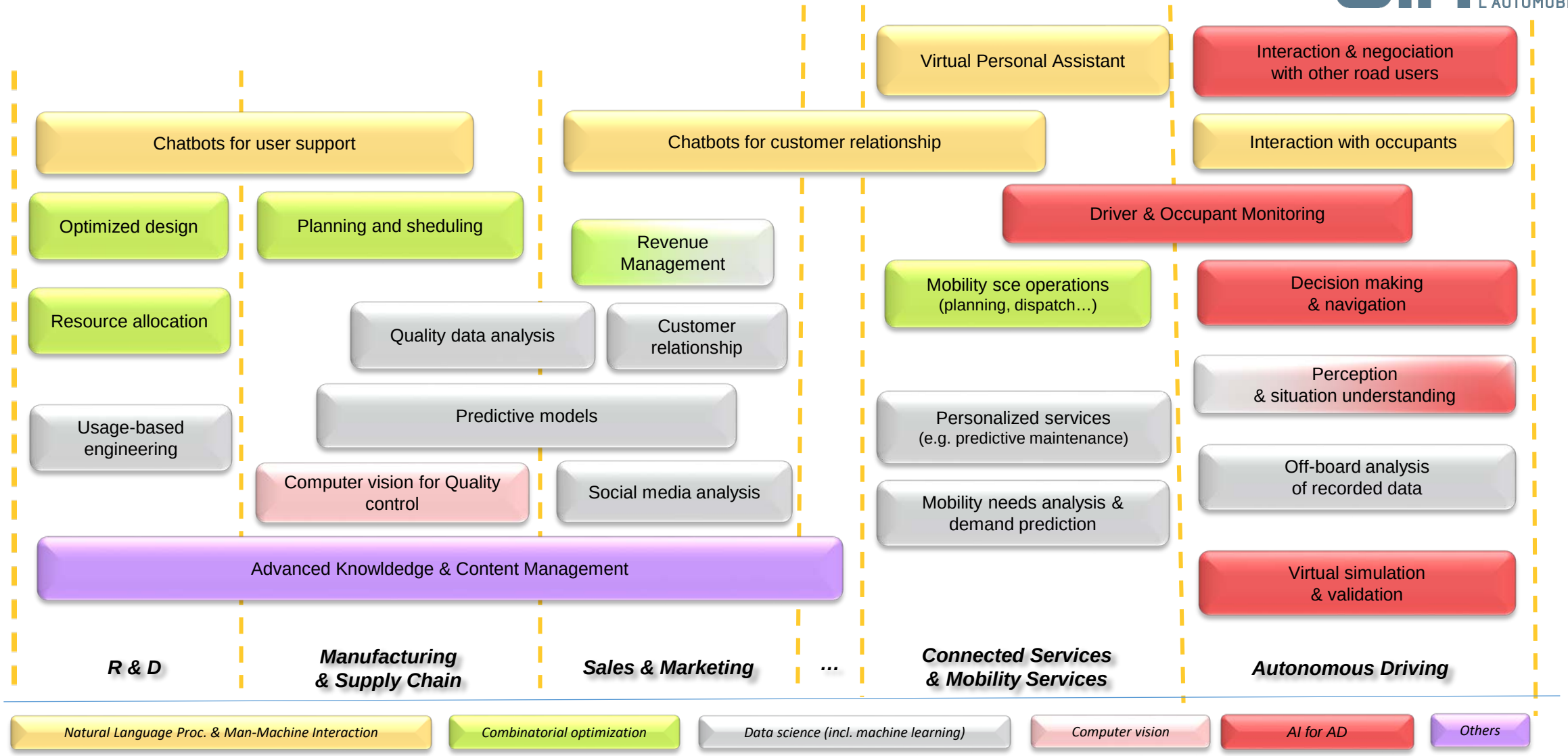
Deep Learning



- La grande révolution des dernières années !
- Rendue possible par :
  - Les masses de données disponibles
  - La puissance de calcul (ex GPU)

- Tâches de perception
  - Véhicule autonome (ex Mobileye)
- Mais pas que !

AI Landscape: AI is everywhere



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Autonomous vehicles: why is it very difficult ?

	Non-critical applications	***Critical applications***
Autonomous systems	e.g. Go game	**Autonomous Vehicles**
Decision-support systems	e.g. customer analysis	e.g. medical diagnosis

- **Technology challenge: robustness is more important than performance - and has to be assessed** (resilient to condition disturbances, that cannot be fooled…)
- **Business challenge: value / cost**

Why and where is AI required for Autonomous Vehicles ?

Interaction & negociation with other road users	• Intention prediction • Negociation with other road users
Interaction with occupants	• Explanation of vehicle decision to ensure trust
Driver & occupant monitoring	• Cognitive attention assessment before take over • Behavior monitoring for safety of people and goods
Decision making & navigation	• Propose decisions that are safe, robust, explainable, ethical…
Perception & situation understanding	• Object recognition • Driving scene understanding
Off-board analysis of recorded data	• Automatic analysis & labelling of data • Situation clustering & scenario building
Virtual simulation & validation	• Realistic models for driving & traffic simulation

AI for Autonomous Vehicle

- AI techniques are the best techniques for image recognition

- AI techniques are promising candidates to control the AV
  - ✓ Traditional (analytical) methods are expected be too limited for complex driving scenarios (urban; Level 4+)
  - ✓ Need AI techniques to overcome the lack of driving model in a complex environment

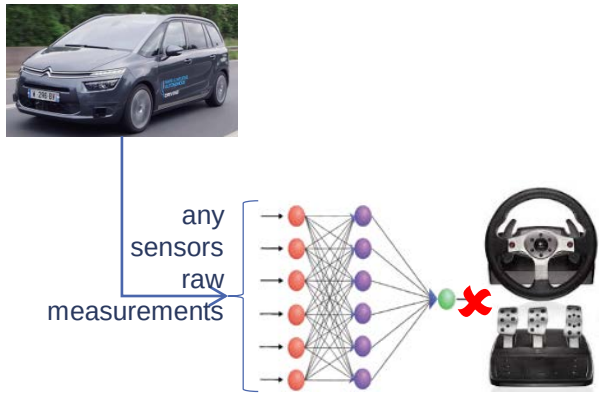
- Questions are:
  - ✓ What AI techniques?
    - ✓ Classic AI
    - ✓ Machine learning
  - ✓ What level of integration in the Vehicle's functional architecture?

How to design IF … THEN …ELSE… based system to drive on the place de l'Etoile??

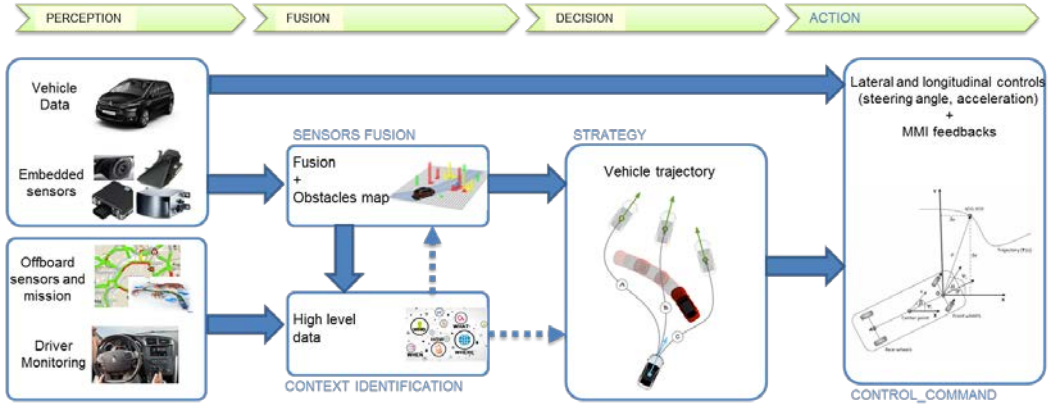
AI for Autonomous Vehicle

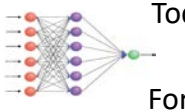
- Two possible functional architectures
  - End-to-end approach
  - Distributive approach

End-to-end approach



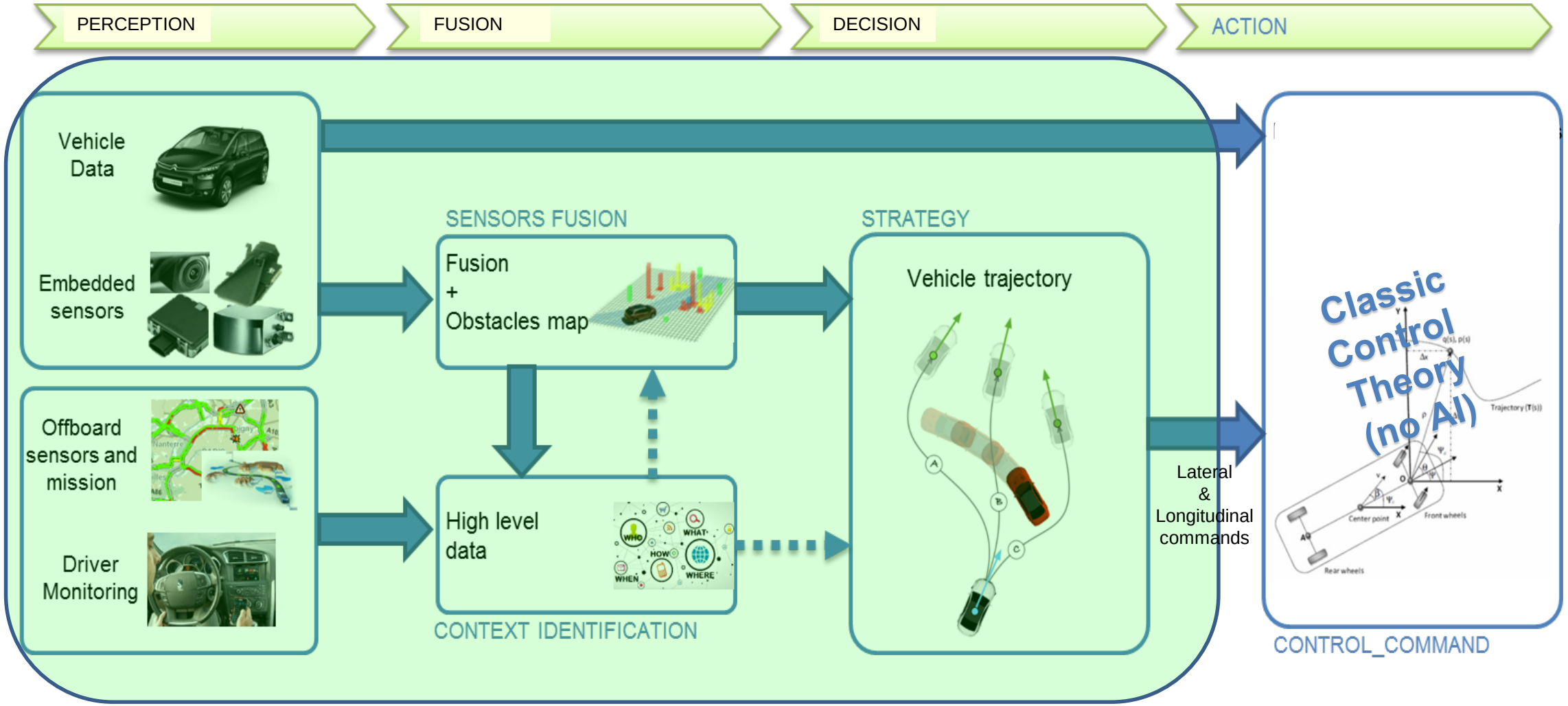
Multi-techniques distributed approach





Today	✓	✗	✗	✗
Foreseen	✓	✓	✓	✗

AI for Autonomous Vehicle



AI techniques expected perimeter

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Robo-taxis: why is it different from AD ?

- A shift from car ownership to MAAS (Mobility as-a-service)
- A new business for OEM: operating mobility services
- Driverless cars
- A different business model enabling more embedded technology
- Localized services: cooperation with territories, public transport operators & the infrastructure

AI For New Mobility Services

- Example : **Car sharing free floating**

- How to :
  - ✓ Optimize the size of the vehicle pool
  - ✓ Optimize the vehicle usage all along the day
  - ✓ Adapt the vehicle position in the cities dynamically with several constraints

- AI technics :
  - ✓ Data mining & Visualization
  - ✓ Machine Learning
  - ✓ Optimization

- Big Data from:
  - ✓ Clients using the service
  - ✓ Competitors (Ex: Car2Go etc…)
  - ✓ Cities (Open Data)

How to develop this kind of services in a new city (with minimum of datas) ?

AI will predict where are the best place to locate our vehicle in the city all along the day.

AI & New Mobility platforms – the next step

- Providing a global **multimodal mobility service**
- Will become **the unique contact** point with mobility customers
- A system of systems, integrating various services & data sources
- With ‘AI inside’:
  - mobility need forecasts
  - planning & dynamic replanning
  - understanding user preferences
  - ...

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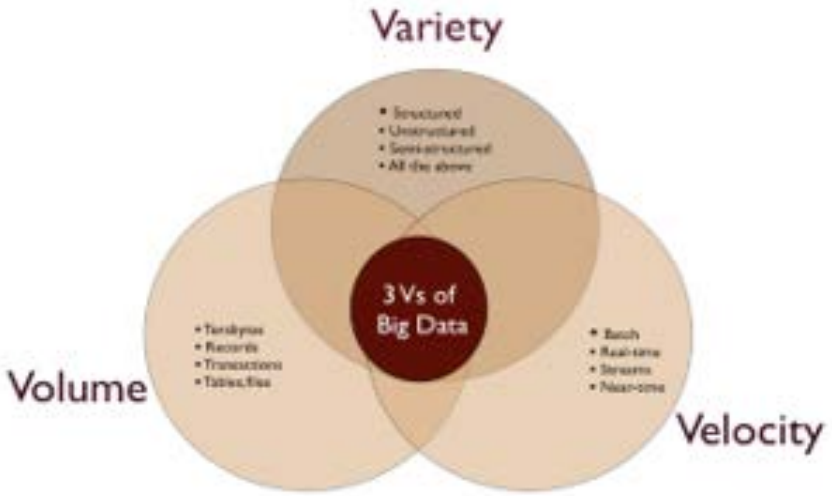
BIG DATA & DATA SCIENCE

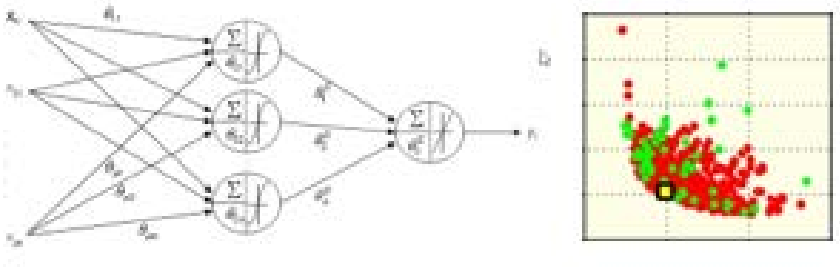
- BIG DATA 3V
  - ✓ Volume > 1 Téra Byte
  - ✓ Variety of Datas : every types (including videos)
  - ✓ Velocity : real time treatment

  ⇒Need IT specific architecture and technologies



- Data Science & Artificial Intelligence
  - ✓ Computing power growing up
  - ✓ Large use of machine learning methods

  ⇒Data valorization for user



Big Data: making value from the data avalanche

Various data sources

- **Our internal processes**
  - Design, Manufacturing IoT, After-Sales…
- **Our customers**
  - CRM, Corp. web sites, social media…
- **Our connected cars**
  - vehicule data, driving environment, usage…
- **The infrastructure**
  - V2X, smart cities…

For multiple purposes

- **Enhancing internal processes & agility**
  - Design, Quality, Marketing…
- **Building new services**
  - Personalized services (e.g. predictive maintenance)
  - Mobility services
- **Monetizing (car) data**
  - Car Data Market Place

Predictive Maintenance Principle (for Client)

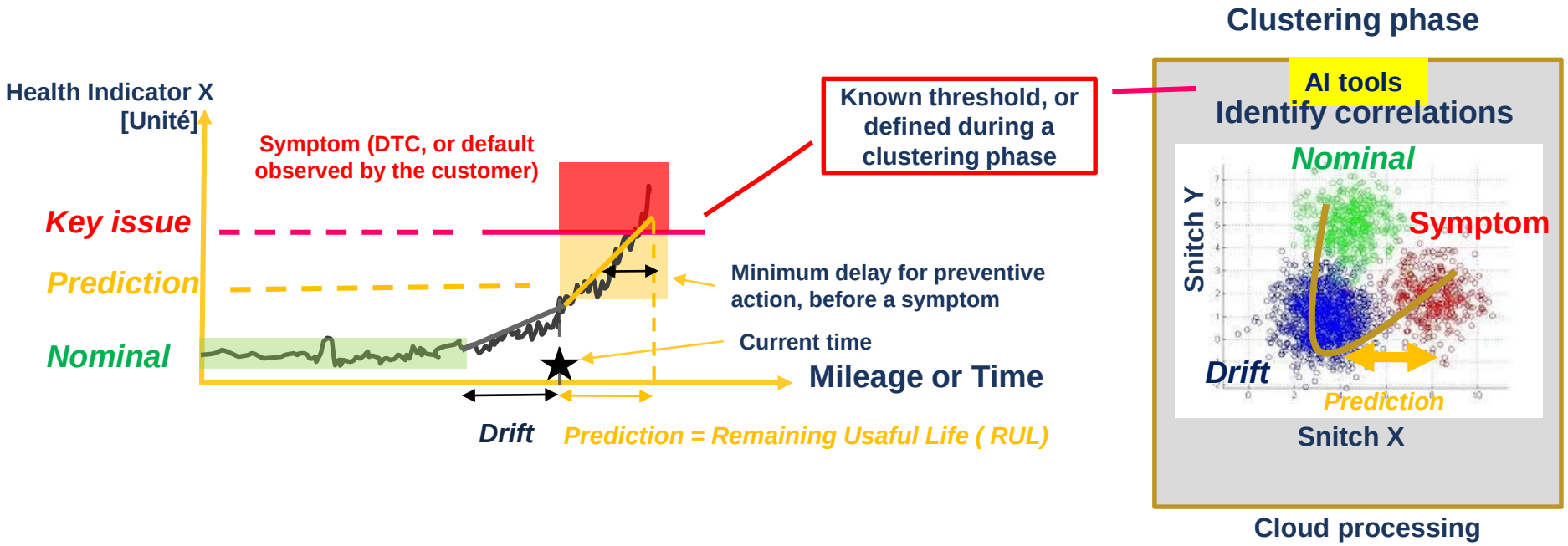
- WHAT IS PREDICTIVE MAINTENANCE ?
  - ✓Component health indicators time monitoring
  - ✓Predict component life evolution (or Remaining Useful Life) Ex: wear, failure, …

- WHY ?
  - ✓For client :
    - o Adapt / anticipate the maintenance step: to reduce cost & immobilization of the vehicle
  - ✓For car manufacturer:
    - o DTC (Default Trouble Code) indicators can be used to predict failure component. However, these indicators have 2 weaknesses:
      - By design the defect code appears too late = when the problem is there and is considered critical ≠ prediction => it is necessary to use a “ramp up” indicator
      - A defect code does not guarantee 100% that the component is defective: there are risks of incorrect deposits, called “No Trouble Found” (NTF) => generate warranty costs

To achieve a good prediction it’s mandatory to improve the diagnosis by designing good health indicators

Monitoring over time health's statistics for prognostic

- Monitor snitch values (between a nominal and risk area) = monitor a "health indicator"
- Predict a time limit that requires preventive action



The quality of the correlations (between time prediction and symptom), will allow to define actions of a predictive nature (i.e. not scheduled), and could replace scheduled maintenance

Machine Learning phase to create health indicator

1. Data base creation

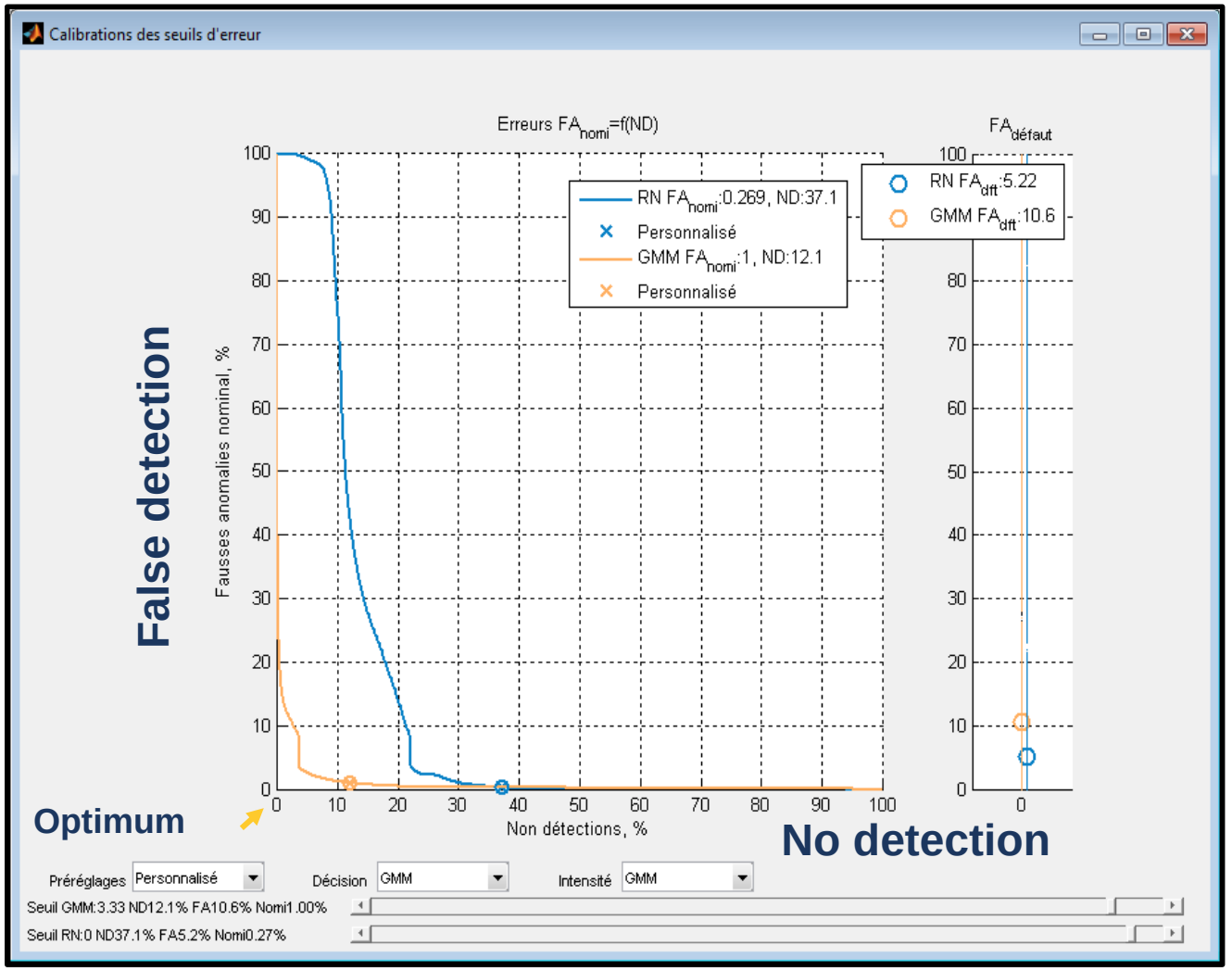
Supervised or not
Nominal data &/or default data

2. Learning methodology

Ex: NN, GMM, etc

3. Validation

- **Ratio No detection vs False detection**
- **During, this phase, conceptor choises the quality of the detection, by the level of « false detection », based on the norminal data set**



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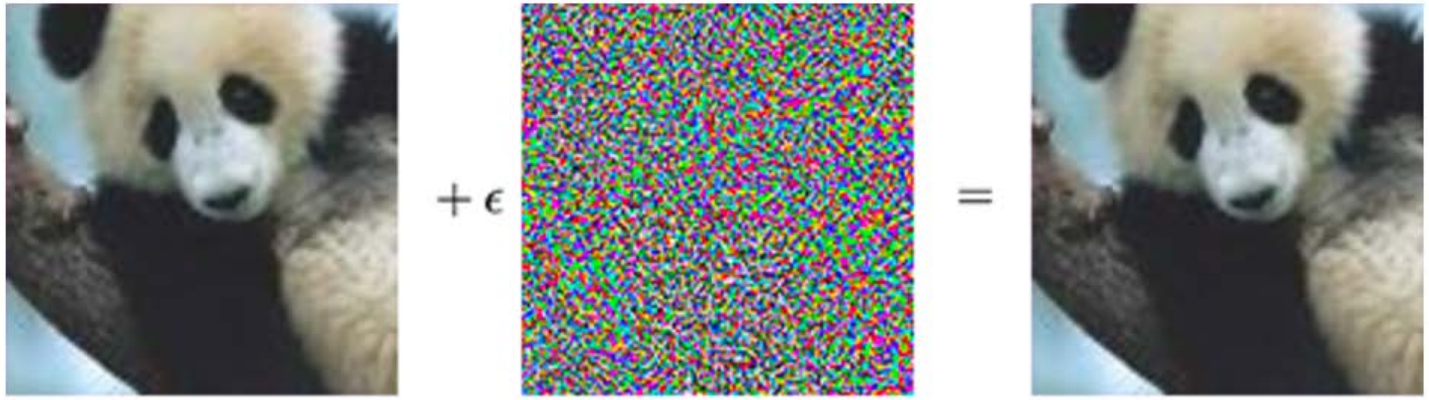
How to fool a neural network



An adversarial input, overlaid on a typical image, can cause a classifier to miscategorize a panda as a gibbon.

How to fool a neural network (cont.)

Slight physical perturbations cause a neural network to misclassify stop as speed limit 45 signs or yield signs (*Robust Physical-World Attacks on Deep Learning Models - Univ. Washington – July 2017*)

AI Partnership

- France has very strong competencies in AI: INRIA, CNRS, CEA, Universities…
  - PSA Open Lab with INRIA
  - Renault SIVALAB with UTC & CNRS
- Other collaboration worldwide

C.Villani Report & 3IA

- AI For Humanity – Ethic priority

- Research National Strategy
  - 100M€ dedicated to institutes
  - 4 institutes announced:
    - Paris – PRAIRIE
    - Toulouse – ANITI
    - Grenoble – MIAI@Grenoble Rhône Alpes
    - Nice Sophia – 3IA Côte d'Azur

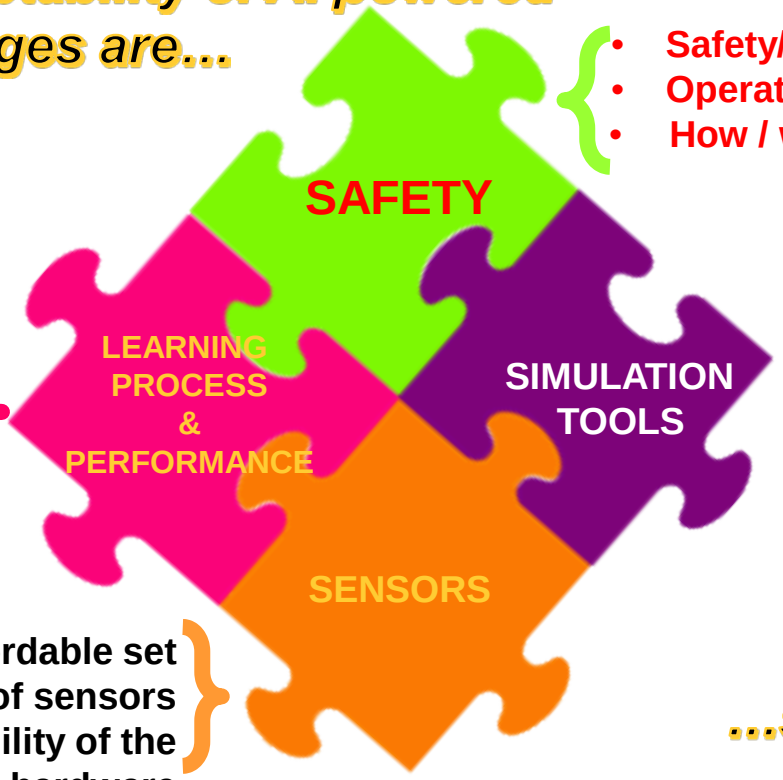
- With 3 Industrial priorities
  - Transportation system
  - Health
  - Energy / Environment

AI – Main Challenges

Beyond the acceptability of AI powered Systems, challenges are…

- Safety/SOTIF/reliability demonstrations
- Operational Validation
- How / why / when do they work?

(SOTIF: Safety Of The Intended Functionality)
(SIL: Software-in-the-loop)



- Minimal data base
- Data / Ground truth collection / storage
- Labelling effort
- Advanced unsupervised AI-NN techniques

- SIL simulation for efficient:
  - functional design,
  - Learning phase
  - Validation
  - Safety demonstration

- Minimized and affordable set of sensors
- Embeddability of the hardware

…such a long way to go!

Synthesis: recommendations

- Engineering networking
  - ⇒ Avoid centralized organization, engineering needs before
- Transversal DATA engineering
  - ⇒ New functions valorization
  - ⇒ Skills well positionned inside engineering structure
- Data Governance
  - ⇒ DATA access
  - ⇒ DATA Quality (« Good Data » more than « Big Data »)
  - ⇒ GDPR constraints
- Prepare future
  - ⇒ Specify / validate thinking « Data » (Services, and not only product)

High mindset evolution: must have high support of managers

And final remarks

AI is raising hype (again)…

Some conditions for a successful deploiement of AI

- We need to **develop a ‘trustable’ AI** (explainable, transparent, robust…) that probably requires to combine deep learning with other kinds of reasonning
- We need to **build competencies**, within **ecosystems**
- We need to **explain opportunities and limitations** – to avoid hype & desillusion..


HOW
WHY
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WHAT
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HOW
WHO
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WHY
HOW

THANK YOU

MOVING FORWARD TOGETHER*

*PROGRESSONS ENSEMBLE

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