MINISTÈRE
CHARGÉ
DES TRANSPORTS
Liberté
Égalité
Fraternité

STRMTG
SERVICE TECHNIQUE DES REMONTÉES MÉCANIQUES ET DES TRANSPORTS GUIDÉS

AI applied to automated road transport systems

OITAF

07/05/2025

SERVICE TECHNIQUE DES REMONTÉES MÉCANIQUES
ET DES TRANSPORTS GUIDES
http://www.strmtg.developpement-durable.gouv.fr

Léo MAISONOBE

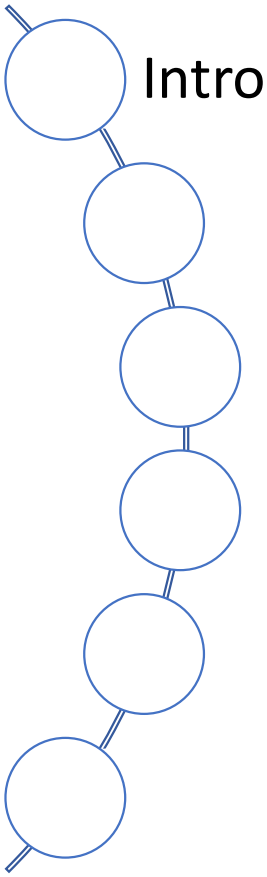
MINISTÈRE CHARGÉ DES TRANSPORTS
Liberté
Égalité
Fraternité

Overview

- Introduction
- Key notions
- ARTS and AI ?
- Dynamic driving task
- Validation of an AI system ?
- Current limits and open questions

MINISTÈRE
CHARGÉ
DES TRANSPORTS
Liberté
Égalité
Fraternité

Overview



Introduction

SERVICE TECHNIQUE DES REMONTÉES MÉCANIQUES
ET DES TRANSPORTS GUIDES
http://www.strmtg.developpement-durable.gouv.fr

MINISTÈRE CHARGÉ DES TRANSPORTS
Liberté
Égalité
Fraternité

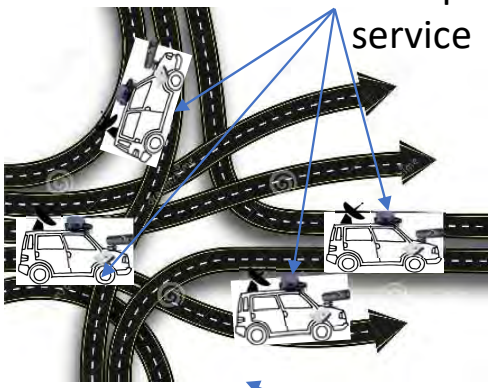
Definition of an Automated Road Transport System (ARTS)

STRMTG
SERVICE TECHNIQUE DES REMONTÉES MÉCANIQUES ET DES TRANSPORTS GUIDÉS

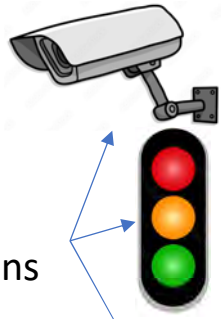
Operation center

Operational and maintenance rules

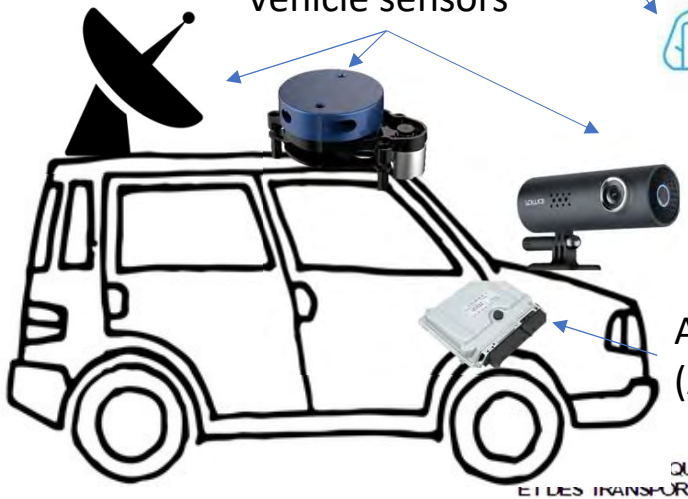
Transport service



Roadside installations



Vehicle sensors



Automated driving system (ADS)

Pathway

MINISTÈRE CHARGÉ DES TRANSPORTS
Liberté
Égalité
Fraternité

Under what form can you see an ARTS ?

STRMTG
SERVICE TECHNIQUE DES REMONTÉES MÉCANIQUES ET DES TRANSPORTS GUIDÉS

Robotaxi

Automated shuttle

Automated bus

Automated truck

SERVICE TECHNIQUE DES REMONTÉES MÉCANIQUES
ET DES TRANSPORTS GUIDES
http://www.strmtg.developpement-durable.gouv.fr

Delivery droid

MINISTÈRE CHARGÉ DES TRANSPORTS
Liberté
Égalité
Fraternité

Similarities between ropeways and ARTS

STRMTG
SERVICE TECHNIQUE DES REMONTÉES MÉCANIQUES ET DES TRANSPORTS GUIDÉS

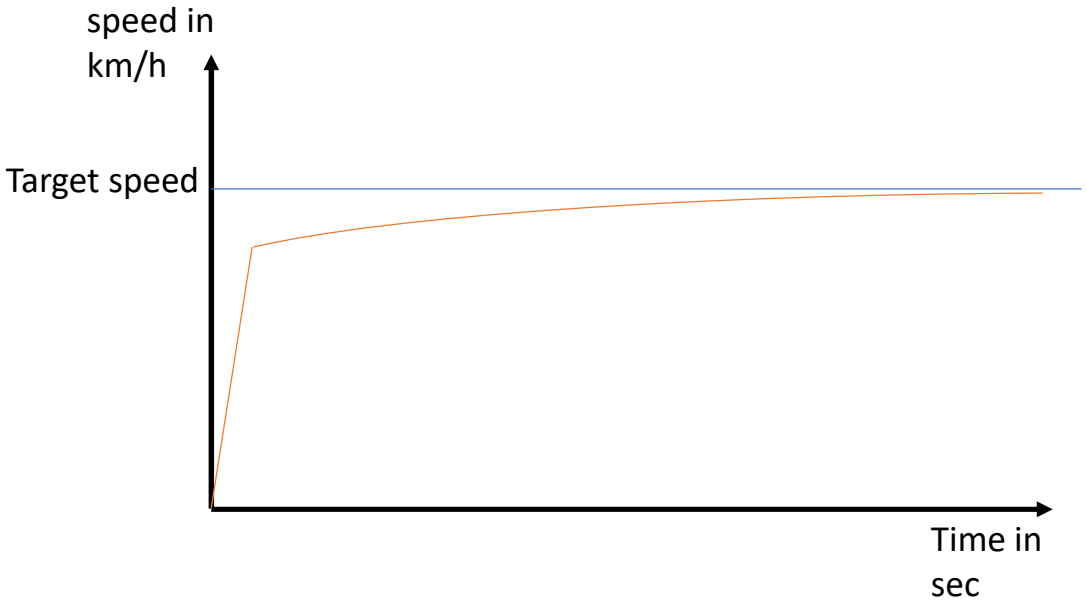
Transport system with passengers

SERVICE TECHNIQUE DES REMONTÉES MÉCANIQUES
ET DES TRANSPORTS GUIDES
http://www.strmtg.developpement-durable.gouv.fr

MINISTÈRE CHARGÉ DES TRANSPORTS
Liberté
Égalité
Fraternité

Similarities between ropeways and ARTS

STRMTG
SERVICE TECHNIQUE DES REMONTÉES MÉCANIQUES ET DES TRANSPORTS GUIDÉS



Control of the target speed

MINISTÈRE CHARGÉ DES TRANSPORTS
Liberté
Égalité
Fraternité

Similarities between ropeways and ARTS

STRMTG
SERVICE TECHNIQUE DES REMONTÉES MÉCANIQUES ET DES TRANSPORTS GUIDÉS

Environmental conditions monitoring

SERVICE TECHNIQUE DES REMONTÉES MÉCANIQUES
ET DES TRANSPORTS GUIDES
http://www.strmtg.developpement-durable.gouv.fr

MINISTÈRE CHARGÉ DES TRANSPORTS
Liberté
Égalité
Fraternité

Similarities between ropeways and ARTS

STRMTG
SERVICE TECHNIQUE DES REMONTÉES MÉCANIQUES ET DES TRANSPORTS GUIDÉS

Monitoring transport system users

SERVICE TECHNIQUE DES REMONTÉES MÉCANIQUES
ET DES TRANSPORTS GUIDES
http://www.strmtg.developpement-durable.gouv.fr

MINISTÈRE CHARGÉ DES TRANSPORTS
Liberté
Égalité
Fraternité

Similarities between ropeways and ARTS

STRMTG
SERVICE TECHNIQUE DES REMONTÉES MÉCANIQUES ET DES TRANSPORTS GUIDÉS

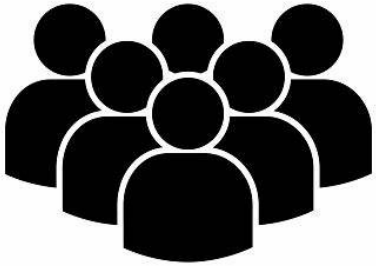
Operation and maintenance

SERVICE TECHNIQUE DES REMONTÉES MÉCANIQUES
ET DES TRANSPORTS GUIDES
http://www.strmtg.developpement-durable.gouv.fr

MINISTÈRE CHARGÉ DES TRANSPORTS
Liberté
Égalité
Fraternité

Similarities between ropeways and ARTS

STRMTG
SERVICE TECHNIQUE DES REMONTÉES MÉCANIQUES ET DES TRANSPORTS GUIDÉS



Safety and availability requirements

SERVICE TECHNIQUE DES REMONTÉES MÉCANIQUES
ET DES TRANSPORTS GUIDES
http://www.strmtg.developpement-durable.gouv.fr

MINISTÈRE CHARGÉ DES TRANSPORTS
Liberté
Égalité
Fraternité

Gap between ropeways and ARTS

STRMTG
SERVICE TECHNIQUE DES REMONTÉES MÉCANIQUES ET DES TRANSPORTS GUIDÉS

2D motion

1D motion

MINISTÈRE CHARGÉ DES TRANSPORTS
Liberté
Égalité
Fraternité

Gap between ropeways and ARTS

STRMTG
SERVICE TECHNIQUE DES REMONTÉES MÉCANIQUES ET DES TRANSPORTS GUIDÉS

Variety of actors

MINISTÈRE CHARGÉ DES TRANSPORTS
Liberté
Égalité
Fraternité

Gap between ropeways and ARTS

STRMTG
SERVICE TECHNIQUE DES REMONTÉES MÉCANIQUES ET DES TRANSPORTS GUIDÉS

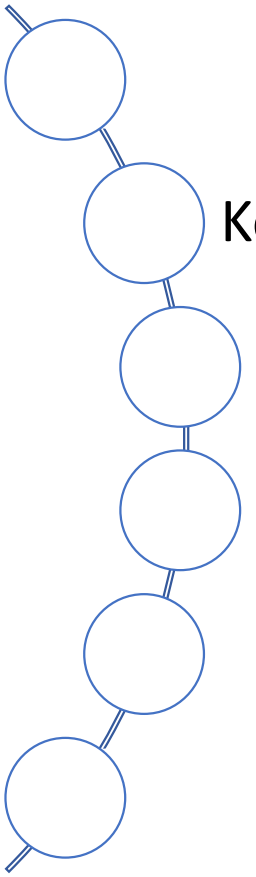




Variety of sceneries

MINISTÈRE CHARGÉ DES TRANSPORTS
Liberté
Égalité
Fraternité

Overview



Key notions

MINISTÈRE CHARGÉ DES TRANSPORTS
Liberté
Égalité
Fraternité

Definition of an AI system

STRMTG
SERVICE TECHNIQUE DES REMONTÉES MÉCANIQUES ET DES TRANSPORTS GUIDÉS

- Standard ISO IEC 22989_2022 - Artificial intelligence concepts and terminology

AI system :

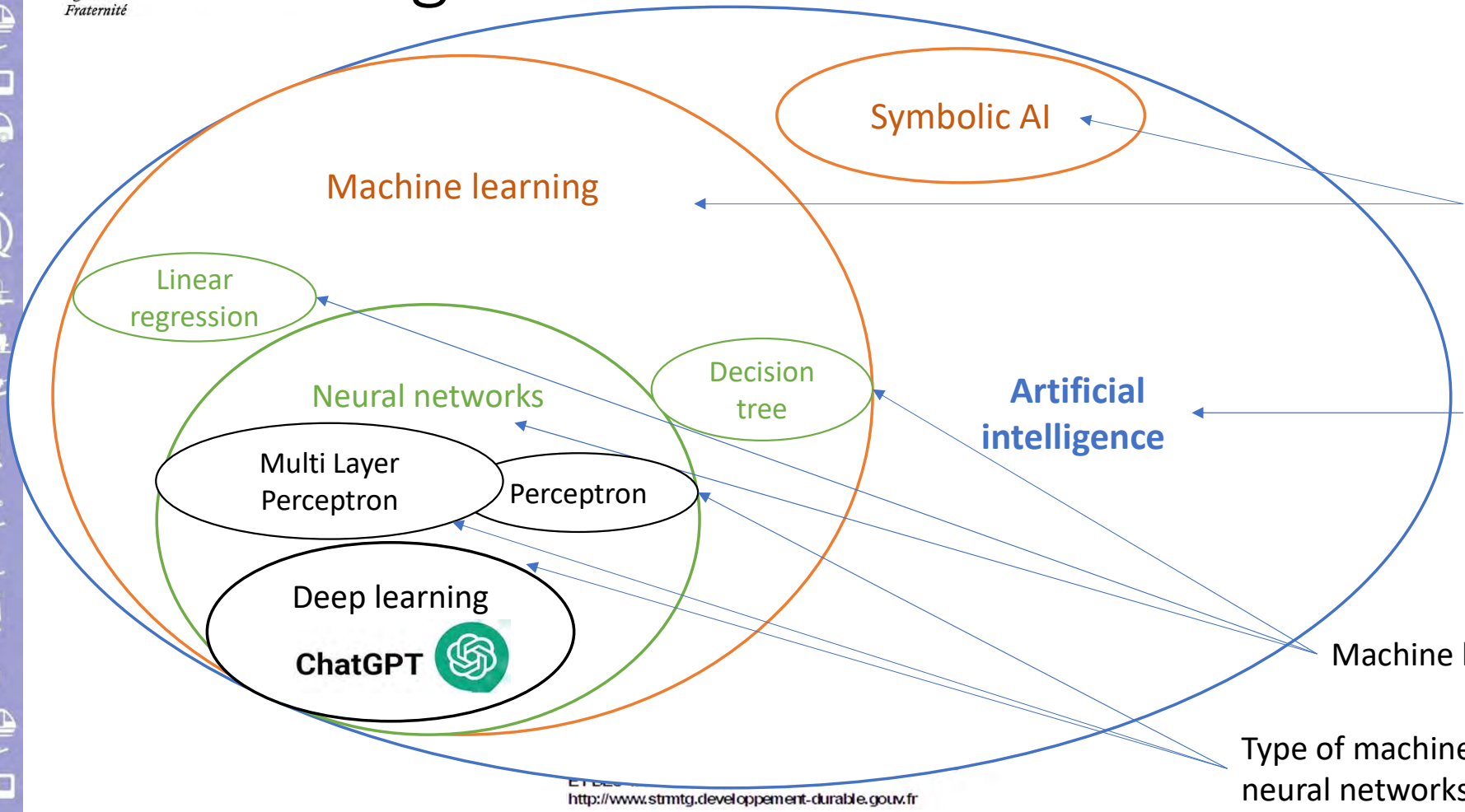
Technical system that generates outputs such as content, predictions, recommendations or decisions for a set of goals defined by human

- Several techniques and approaches
- Different levels of autonomy
- An AI system can handle one or several functions

MINISTÈRE CHARGÉ DES TRANSPORTS
Liberté
Égalité
Fraternité

Focus on machine learning algorithms

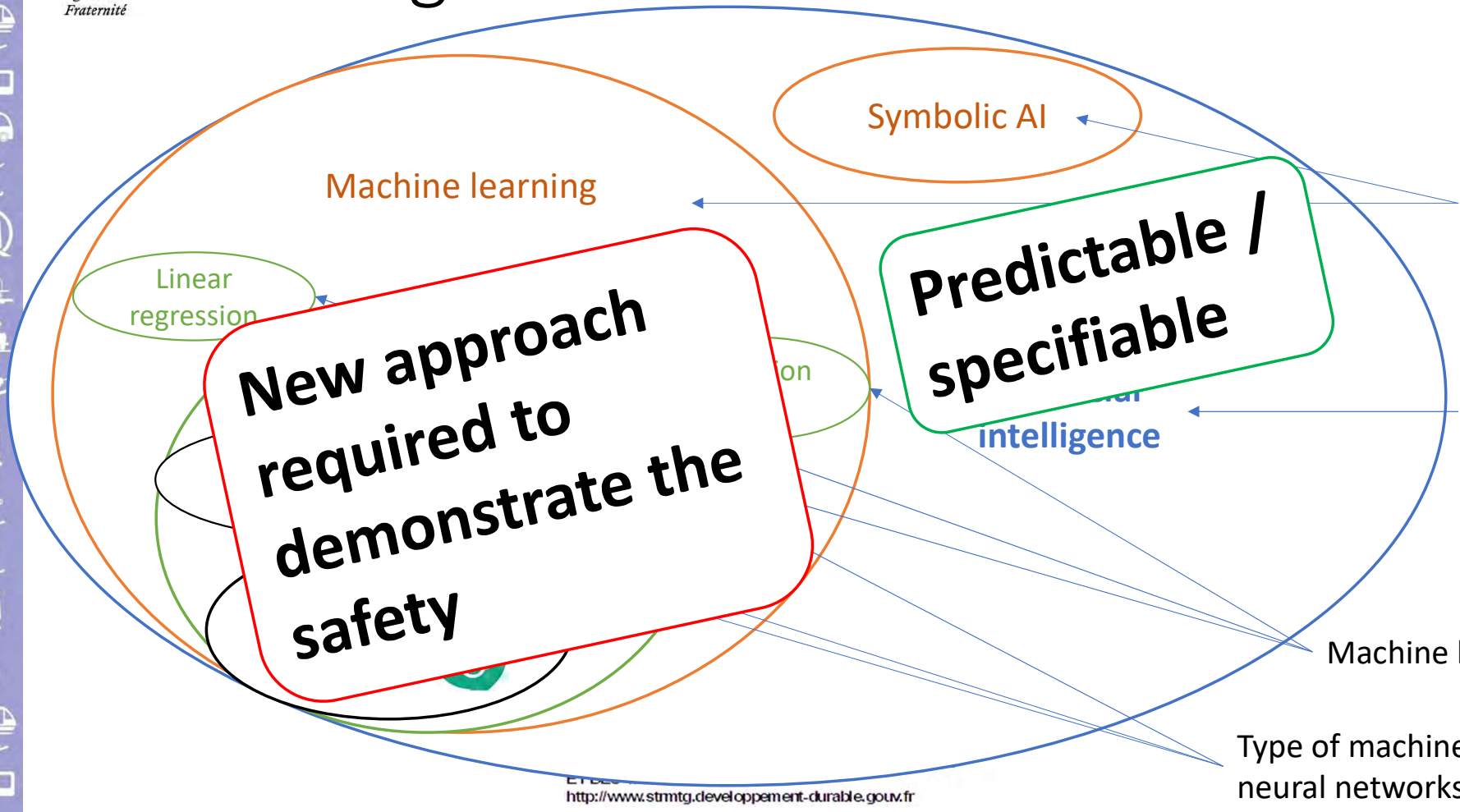
STRMTG
SERVICE TECHNIQUE DES REMONTÉES MÉCANIQUES ET DES TRANSPORTS GUIDÉS



MINISTÈRE CHARGÉ DES TRANSPORTS
Liberté
Égalité
Fraternité

Focus on machine learning algorithms

STRMTG
SERVICE TECHNIQUE DES REMONTÉES MÉCANIQUES ET DES TRANSPORTS GUIDÉS

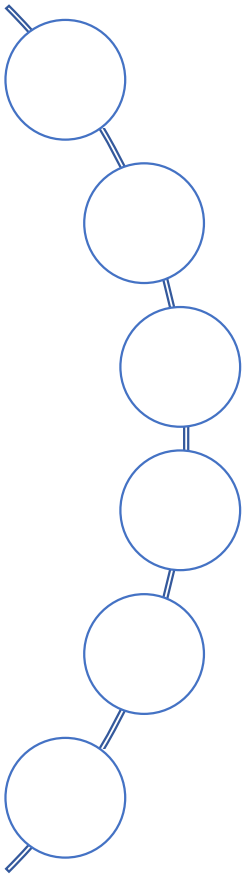


MINISTÈRE
CHARGÉ
DES TRANSPORTS

Liberté
Égalité
Fraternité

STRMTG

SERVICE TECHNIQUE DES REMONTÉES MÉCANIQUES ET DES TRANSPORTS GUIDÉS



ARTS and AI ?

SERVICE TECHNIQUE DES REMONTÉES MÉCANIQUES
ET DES TRANSPORTS GUIDES
http://www.strmtg.developpement-durable.gouv.fr

MINISTÈRE CHARGÉ DES TRANSPORTS
Liberté
Égalité
Fraternité

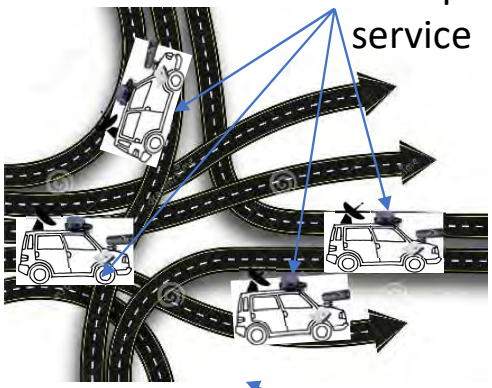
Definition of an Automated Road Transport System (ARTS)

STRMTG
SERVICE TECHNIQUE DES REMONTÉES MÉCANIQUES ET DES TRANSPORTS GUIDÉS

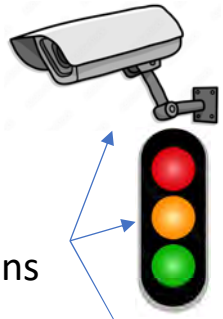
Operation center

Operational and maintenance rules

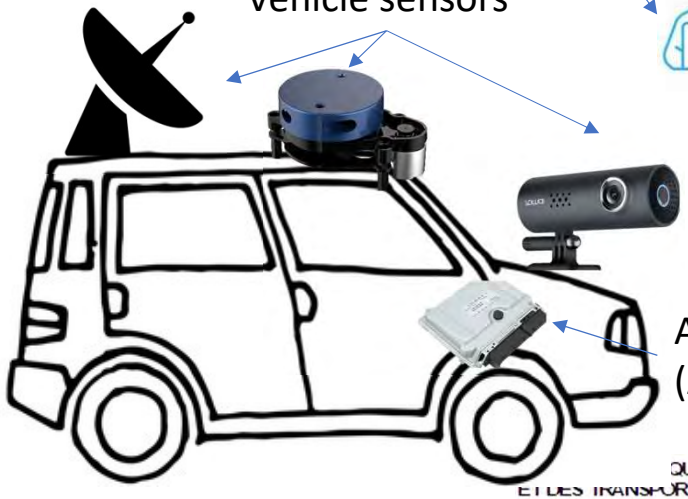
Transport service



Roadside installations



Vehicle sensors



Automated driving system (ADS)

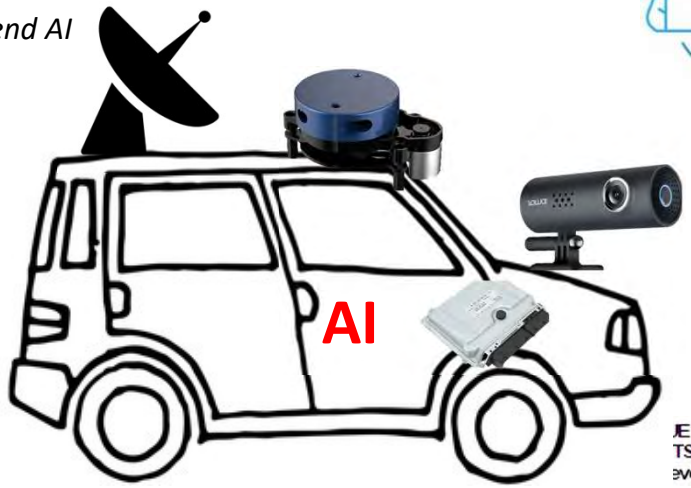
Pathway

MINISTÈRE CHARGÉ DES TRANSPORTS
Liberté
Égalité
Fraternité

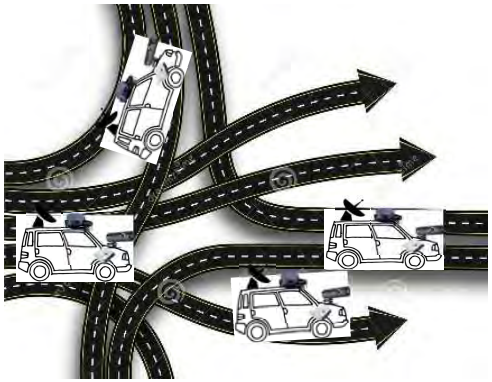
An Automated Road Transport System (ARTS) and its link with AI

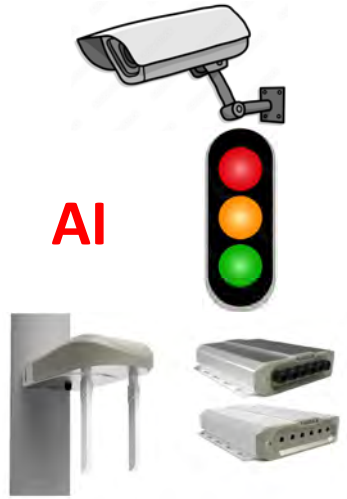
STRMTG
SERVICE TECHNIQUE DES REMONTÉES MÉCANIQUES ET DES TRANSPORTS GUIDÉS

- *Classifying objects*
- *Providing traffic information*
- *Recognizing weather conditions*
- *Selecting trajectory*
- *Detecting and recording an incident*
- *Anticipating object movements*
- *End to end AI*
- *…*



- *Modifying the route*
- *Detecting, reporting incident and organizing first aid*
- *Proposing maneuvers*
- *…*





- *Classifying objects*
- *Providing traffic information*
- *Recognizing weather conditions*
- *Detecting, reporting incident*
- *Anticipating object movements*
- *…*

MINISTÈRE CHARGÉ DES TRANSPORTS
Liberté
Égalité
Fraternité

An Automated Road Transport System (ARTS) and its link with AI

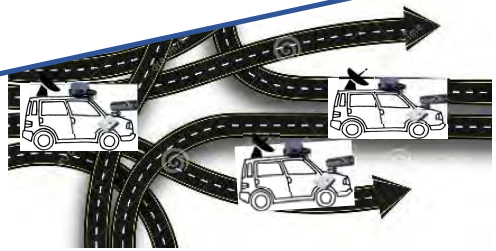
STRMTG
SERVICE TECHNIQUE DES REMONTÉES MÉCANIQUES ET DES TRANSPORTS GUIDÉS

- *Classifying objects*
- *Providing traffic information*
- *Recognizing weather conditions*
- *Selecting trajectory*
- *Detecting and reporting incident*
- *Anticipating object movements*
- *End to end AI*
- *…*

- *Modifying the route*
- *Detecting, reporting incident and organizing first aid*
- *Proposing maneuvers*
-

Level of autonomy of AI ?

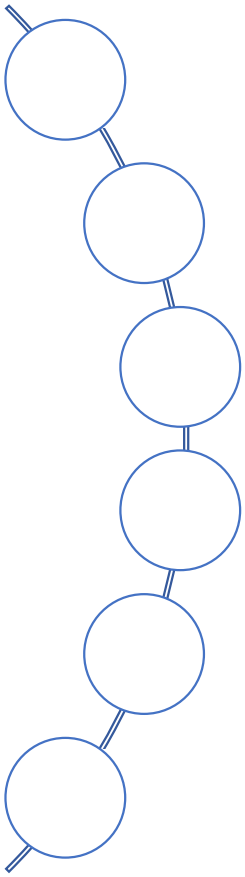
Safe AI?



- *Classifying objects*
- *Providing traffic information*
- *Recognizing weather conditions*
- *Detecting, reporting incident*
- *Anticipating object movements*
- *…*

MINISTÈRE
CHARGÉ
DES TRANSPORTS
Liberté
Égalité
Fraternité

STRMTG
SERVICE TECHNIQUE DES REMONTÉES MÉCANIQUES ET DES TRANSPORTS GUIDÉS



Dynamic driving task

SERVICE TECHNIQUE DES REMONTÉES MÉCANIQUES
ET DES TRANSPORTS GUIDES
http://www.strmtg.developpement-durable.gouv.fr

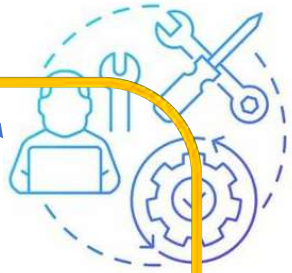
MINISTÈRE CHARGÉ DES TRANSPORTS
Liberté
Égalité
Fraternité

Focus on the dynamic driving task

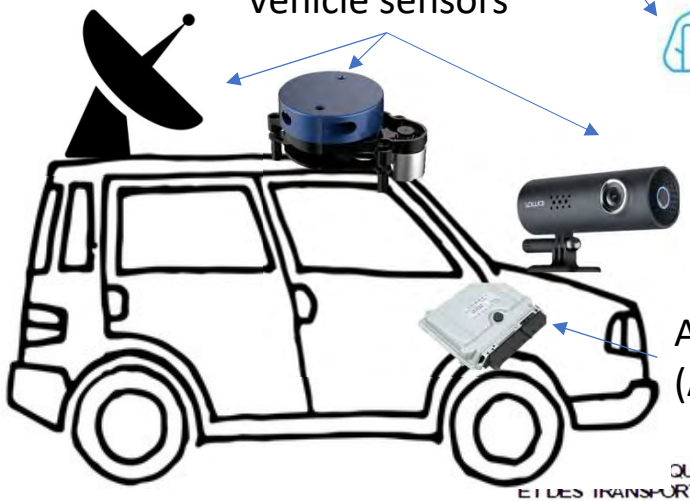
STRMTG
SERVICE TECHNIQUE DES REMONTÉES MÉCANIQUES ET DES TRANSPORTS GUIDÉS

Operation center

Operational and maintenance rules

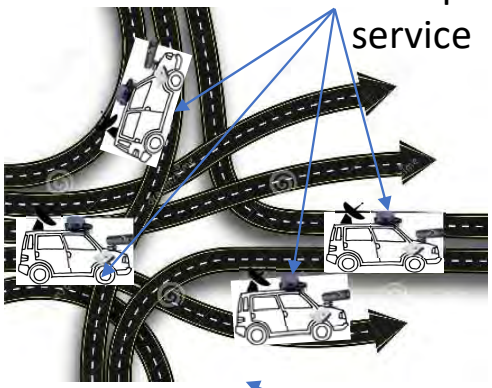


Vehicle sensors



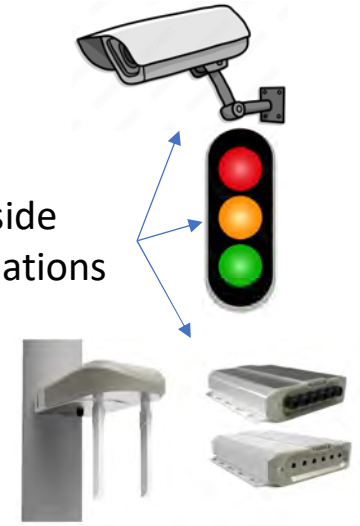
Automated driving system (ADS)

Transport service



Pathway

Roadside installations



MINISTÈRE CHARGÉ DES TRANSPORTS
Liberté
Égalité
Fraternité

How to handle the dynamic driving task ?

STRMTG
SERVICE TECHNIQUE DES REMONTÉES MÉCANIQUES ET DES TRANSPORTS GUIDÉS

Understand the environment:
On-board sensors which may integrate AI models

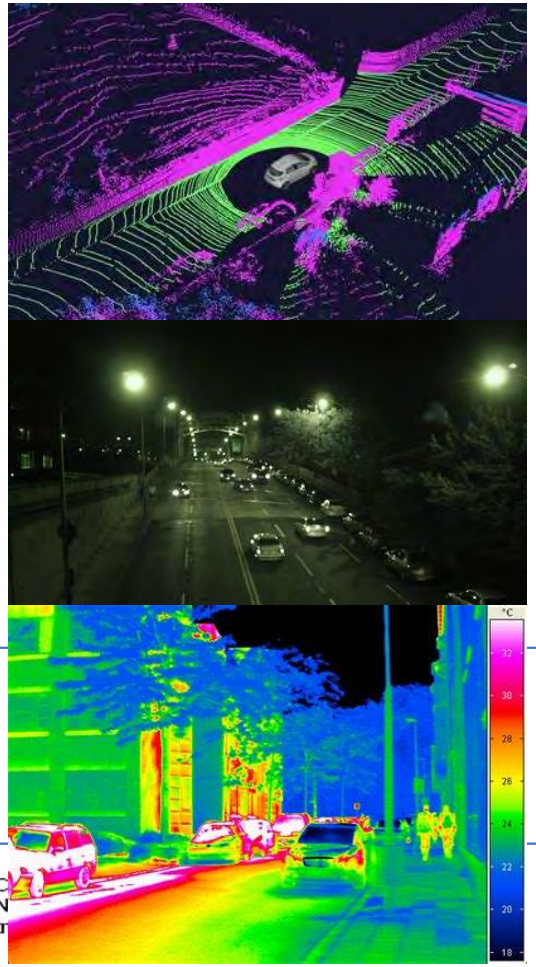
MINISTÈRE CHARGÉ DES TRANSPORTS
Liberté
Égalité
Fraternité

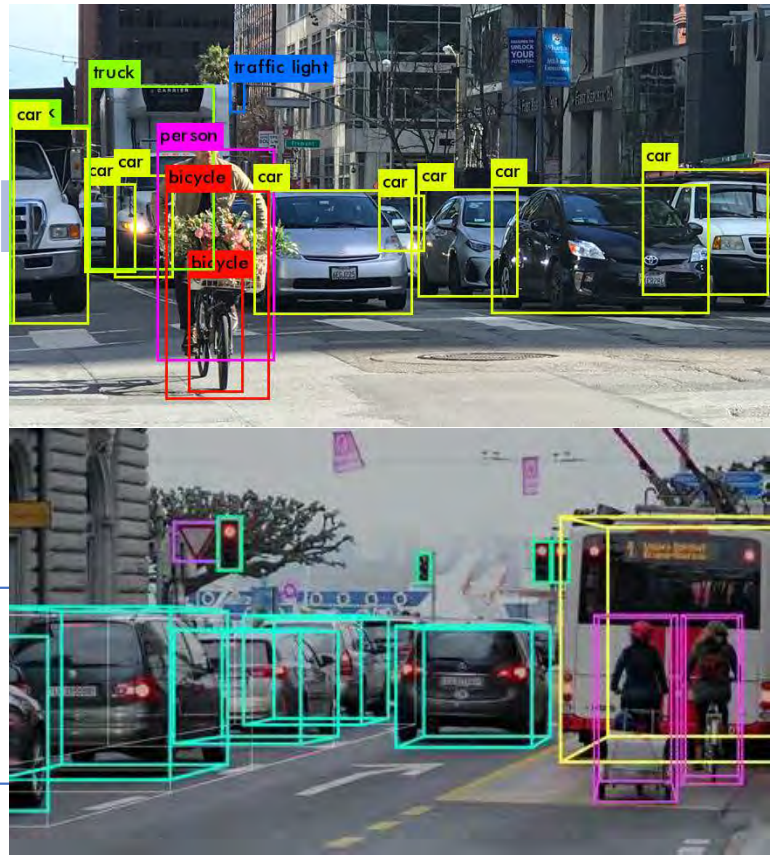
How to handle the dynamic driving task ?

STRMTG
SERVICE TECHNIQUE DES REMONTÉES MÉCANIQUES ET DES TRANSPORTS GUIDÉS

Sense

Understand the environment:
On-board sensors which may integrate AI models





MINISTÈRE CHARGÉ DES TRANSPORTS
Liberté
Égalité
Fraternité

How to handle the dynamic driving task ?

STRMTG
SERVICE TECHNIQUE DES REMONTÉES MÉCANIQUES ET DES TRANSPORTS GUIDÉS

Understand the environment:
On-board sensors which may integrate AI models

Analyse data and planify the driving strategy :
AI models

MINISTÈRE CHARGÉ DES TRANSPORTS
Liberté
Égalité
Fraternité

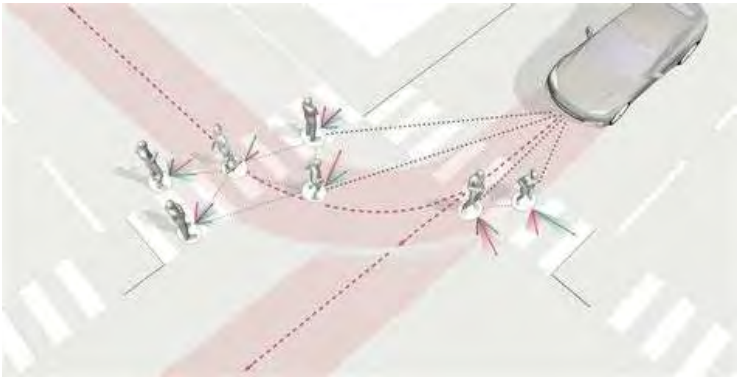
How to handle the dynamic driving task ?

STRMTG
SERVICE TECHNIQUE DES REMONTÉES MÉCANIQUES ET DES TRANSPORTS GUIDÉS

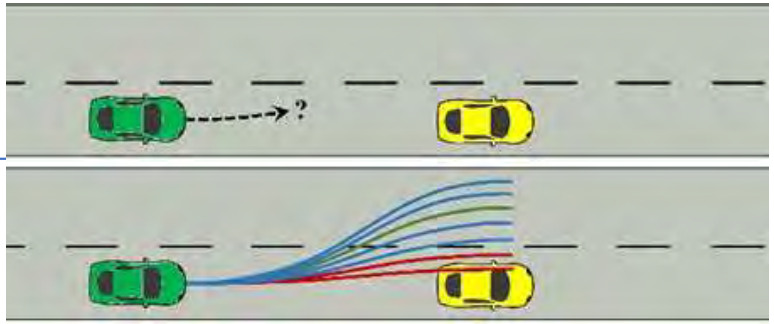
Sense

Understand the environment:
On-board sensors which may integrate AI models

Plan



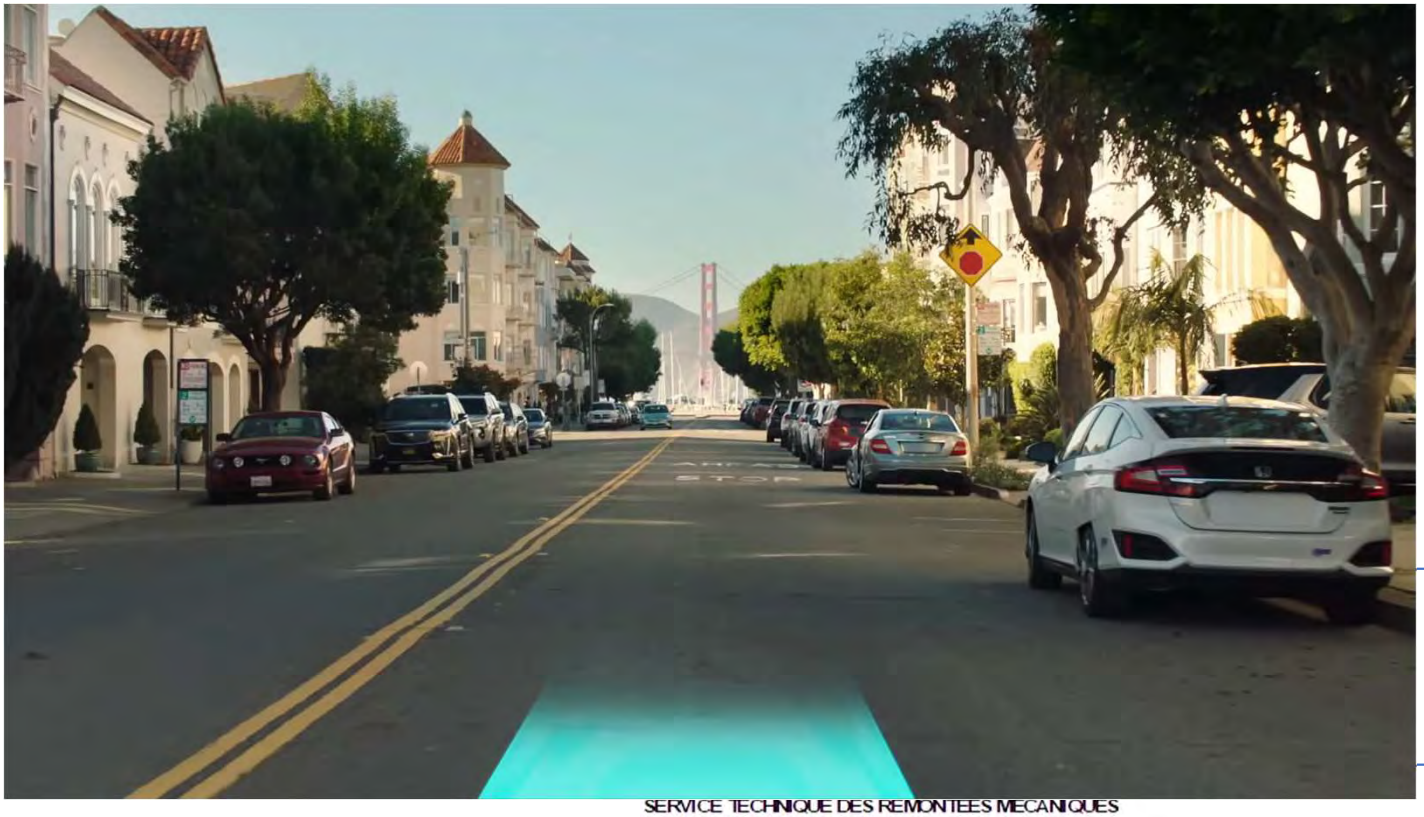
Analyse data and planify the driving strategy :
AI models



MINISTÈRE CHARGÉ DES TRANSPORTS
Liberté
Égalité
Fraternité

How to handle the dynamic driving task ?

STRMTG
SERVICE TECHNIQUE DES REMONTÉES MÉCANIQUES ET DES TRANSPORTS GUIDÉS



SERVICE TECHNIQUE DES REMONTEES MECANIQUES
ET DES TRANSPORTS GUIDES
http://www.strmtg.developpement-durable.gouv.fr

Act

Use the actuators of the system :
Accelerate / brake / steer

MINISTÈRE CHARGÉ DES TRANSPORTS
Liberté
Égalité
Fraternité

How to handle the dynamic driving task ?

STRMTG
SERVICE TECHNIQUE DES REMONTÉES MÉCANIQUES ET DES TRANSPORTS GUIDÉS

Understand the environment:
On-board sensors which may integrate AI models

Analyse data and planify the driving strategy :
AI models

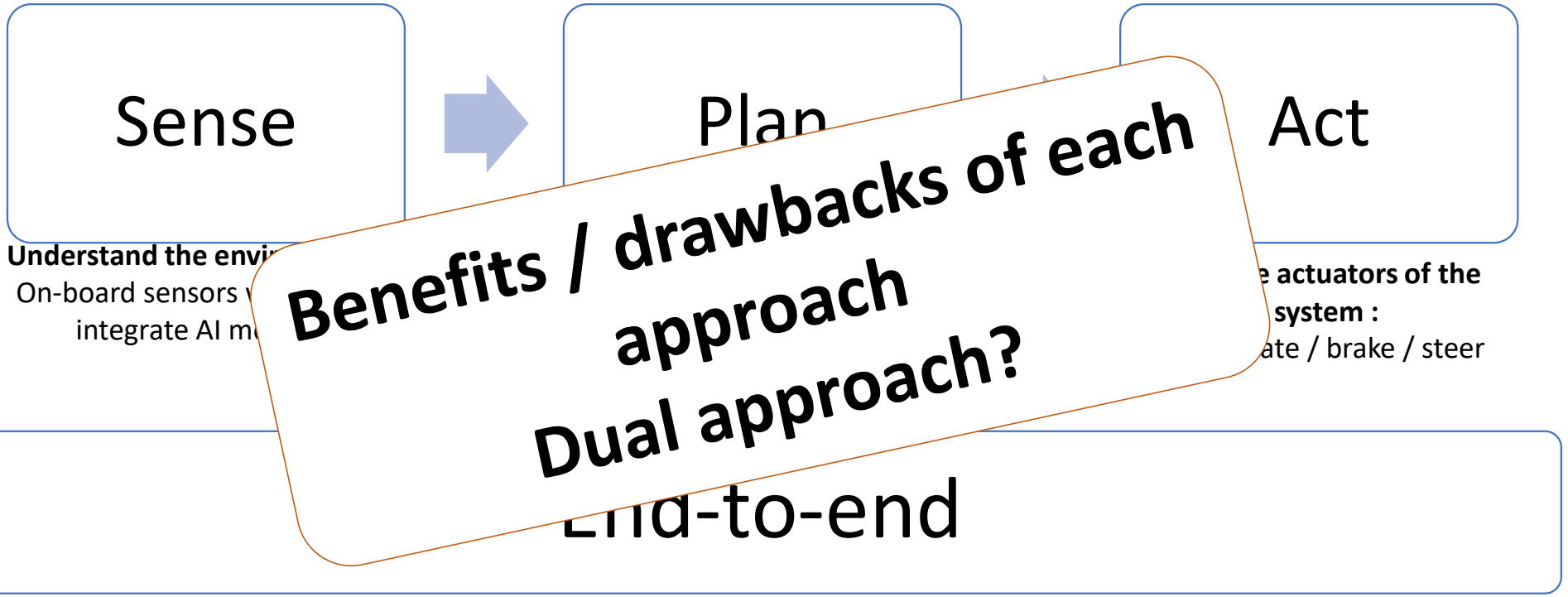
Use the actuators of the system :
Accelerate / brake / steer

End-to-end

MINISTÈRE CHARGÉ DES TRANSPORTS
Liberté
Égalité
Fraternité

How to handle the dynamic driving task ?

STRMTG
SERVICE TECHNIQUE DES REMONTÉES MÉCANIQUES ET DES TRANSPORTS GUIDÉS

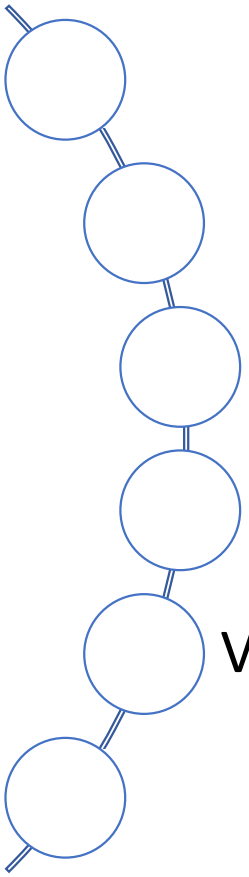


MINISTÈRE
CHARGÉ
DES TRANSPORTS

Liberté
Égalité
Fraternité

STRMTG

SERVICE TECHNIQUE DES REMONTÉES MÉCANIQUES ET DES TRANSPORTS GUIDÉS



Validation of an AI system?

SERVICE TECHNIQUE DES REMONTÉES MÉCANIQUES
ET DES TRANSPORTS GUIDES
http://www.strmtg.developpement-durable.gouv.fr

MINISTÈRE CHARGÉ DES TRANSPORTS
Liberté
Égalité
Fraternité

How to validate AI systems ?

STRMTG
SERVICE TECHNIQUE DES REMONTÉES MÉCANIQUES ET DES TRANSPORTS GUIDÉS

Millions of miles driven

Real environment

Hundreds of miles driven

Billions of miles driven

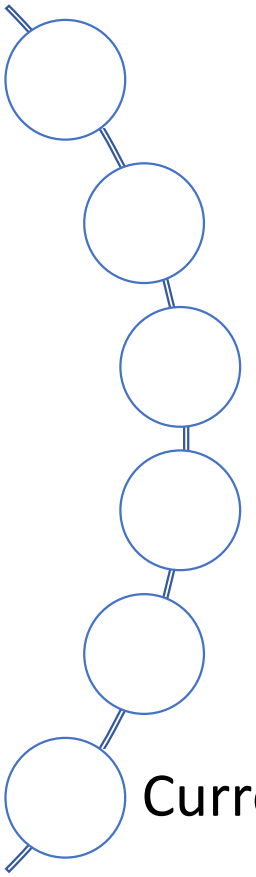
Simulated environment

Controlled environment

I3 leo.maisonobe; 28.02.2025

MINISTÈRE
CHARGÉ
DES TRANSPORTS
Liberté
Égalité
Fraternité

STRMTG
SERVICE TECHNIQUE DES REMONTÉES MÉCANIQUES ET DES TRANSPORTS GUIDÉS



Current limits and open questions

SERVICE TECHNIQUE DES REMONTÉES MÉCANIQUES
ET DES TRANSPORTS GUIDES
http://www.strmtg.developpement-durable.gouv.fr

MINISTÈRE CHARGÉ DES TRANSPORTS
Liberté
Égalité
Fraternité

Current limits and open questions

STRMTG
SERVICE TECHNIQUE DES REMONTÉES MÉCANIQUES ET DES TRANSPORTS GUIDÉS

- Representativeness of the data 
- Meeting the safety and security objectives 
- Repeatability of the results 
- Explainability of the results 
- Non-regression 
- Expertise of the system assessors 
- ….

MINISTÈRE CHARGÉ DES TRANSPORTS
Liberté
Égalité
Fraternité

EU regulatory framework

STRMTG
SERVICE TECHNIQUE DES REMONTÉES MÉCANIQUES ET DES TRANSPORTS GUIDÉS

- AI act (2024/1689) considers both cableway installations and cars as high-risk systems by mentioning both regulations :
  - Regulation (EU) 2016/424 of the European Parliament on cableway installations
  - Regulation (EU) 2019/2144 of the European Parliament on type-approval requirements for motor vehicles and their trailers, and systems, components and separate technical units intended for such vehicles, as regards their general safety and the protection of vehicle occupants and vulnerable road users

- AI act requirements for high-risk AI system point out some similar topics/ questions :
  - Data and data governance
  - Transparency and provision of information to deployers
  - Accuracy, robustness and cybersecurity
  - Risk management system
  - Technical documentation
  - Record-keeping
  - Human oversight

MINISTÈRE CHARGÉ DES TRANSPORTS
Liberté
Égalité
Fraternité

Sources

STRMTG
SERVICE TECHNIQUE DES REMONTÉES MÉCANIQUES ET DES TRANSPORTS GUIDÉS

Website :

- https://prissma.univ-gustave-eiffel.fr/
- https://waymo.com/
- https://carla.readthedocs.io/en/0.9.14/
- https://www.strmtg.developpement-durable.gouv.fr/en/administrative-regulations-for-automated-road-a62.html
- CVPR 2024 Tutorial: Embracing End-to-End Autonomy for Autonomous Driving - Wayve

Norm and regulation :

- Standard ISO IEC 22989_2022 - Artificial intelligence concepts and terminology
- ECE/TRANS/WP.29/2024/39 Guidelines and recommendations for Automated Driving System safety requirements, assessments and test methods to inform regulatory development 25–28 June 2024
- Regulation (EU) 2024/1689 of the European Parliament and of the council laying down harmonised rules on artificial intelligence and amending Regulations (EC) No 300/2008, (EU) No 167/2013, (EU) No 168/2013, (EU) 2018/858, (EU) 2018/1139 and (EU) 2019/2144 and Directives 2014/90/EU, (EU) 2016/797 and (EU) 2020/1828 (Artificial Intelligence Act)

Research paper:

- *You Only Look Once: Unified, Real-Time Object Detection* (2016)
  Joseph Redmon, Santosh Divvala, Ross Girshick, Ali Farhadi University of Washington, Allen Institute for AI, Facebook AI Research