Traitement automatique de données LiDAR 3D en milieu ferroviaire

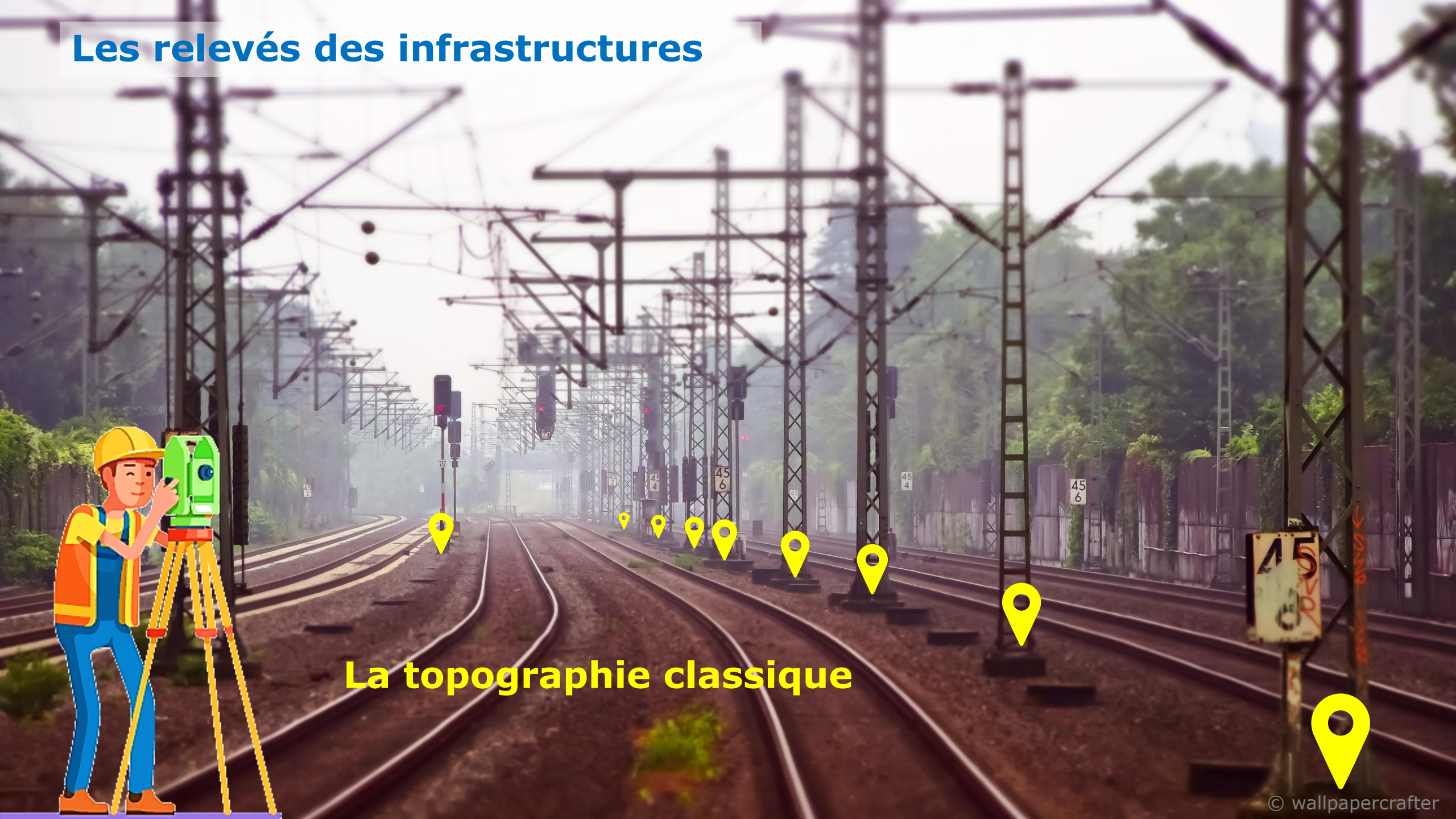
Abderrazzaq Kharroubi

GeoScITY, University of Liège, Allée du six Août 19, 4000 Liège, Belgium

Jeudi, 28 mars, 2024 || 15:45 – 16:15

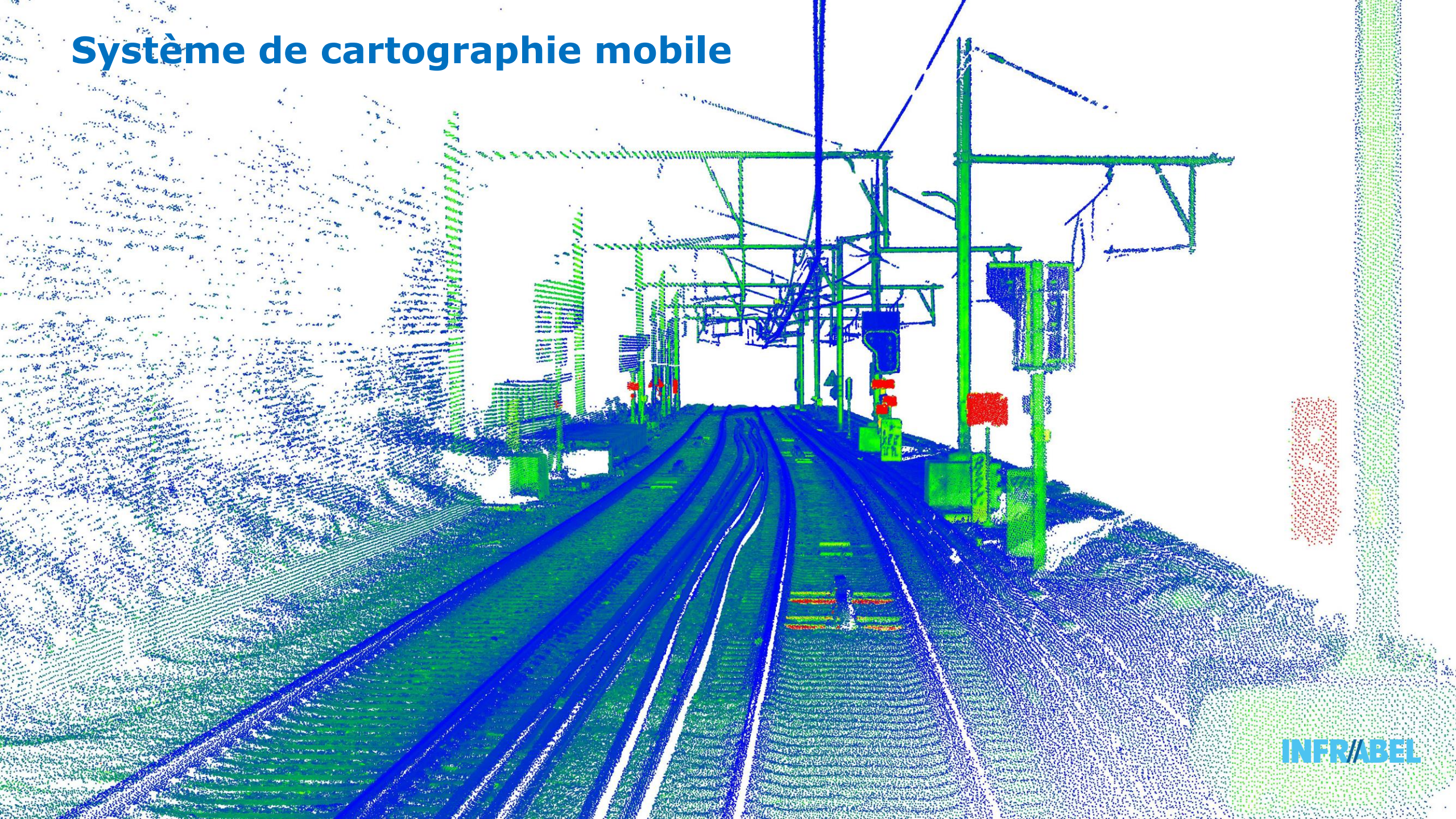
Université de Liège, Gembloux, Belgique

Les relevés des infrastructures



La topographie classique

Système de cartographie mobile



INFRABEL

Système de cartographie mobile

Exemple de MMS monté sur un train avec trois scanners laser et une unité de navigation.

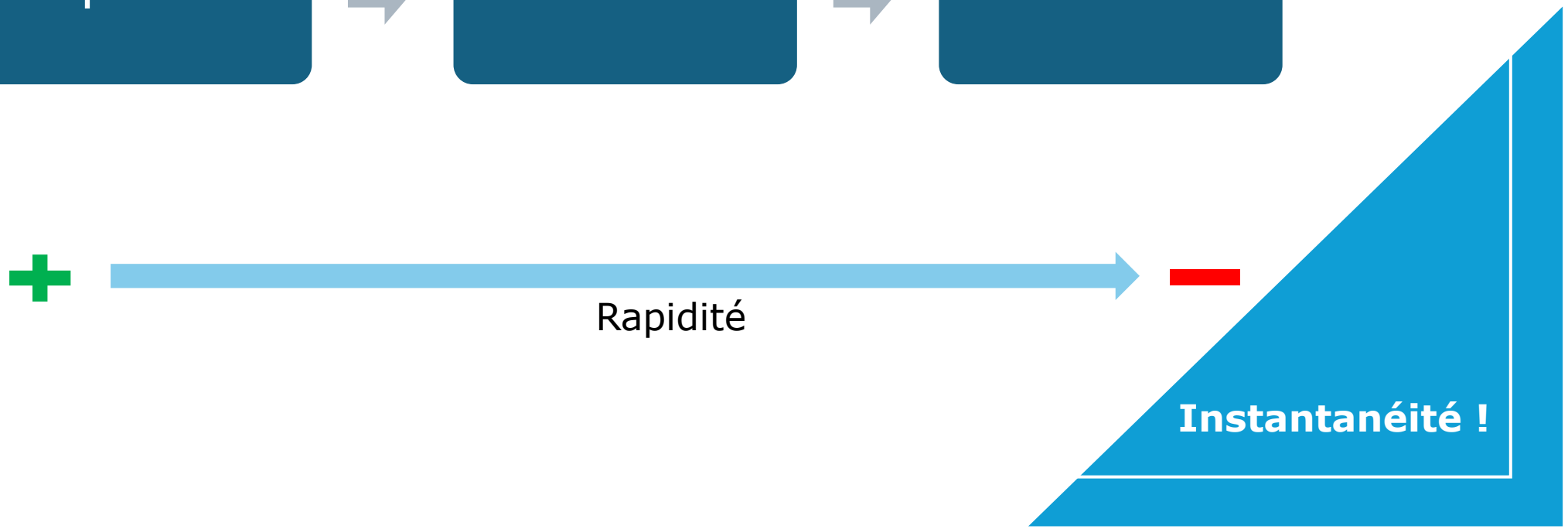
- Détermination précise des objets le long du rail
- Configuration flexible des capteurs
- Mesure jusqu'à 80 km/h
- Contrôle indirect de la voie

Adapted from Arastounia (2015)

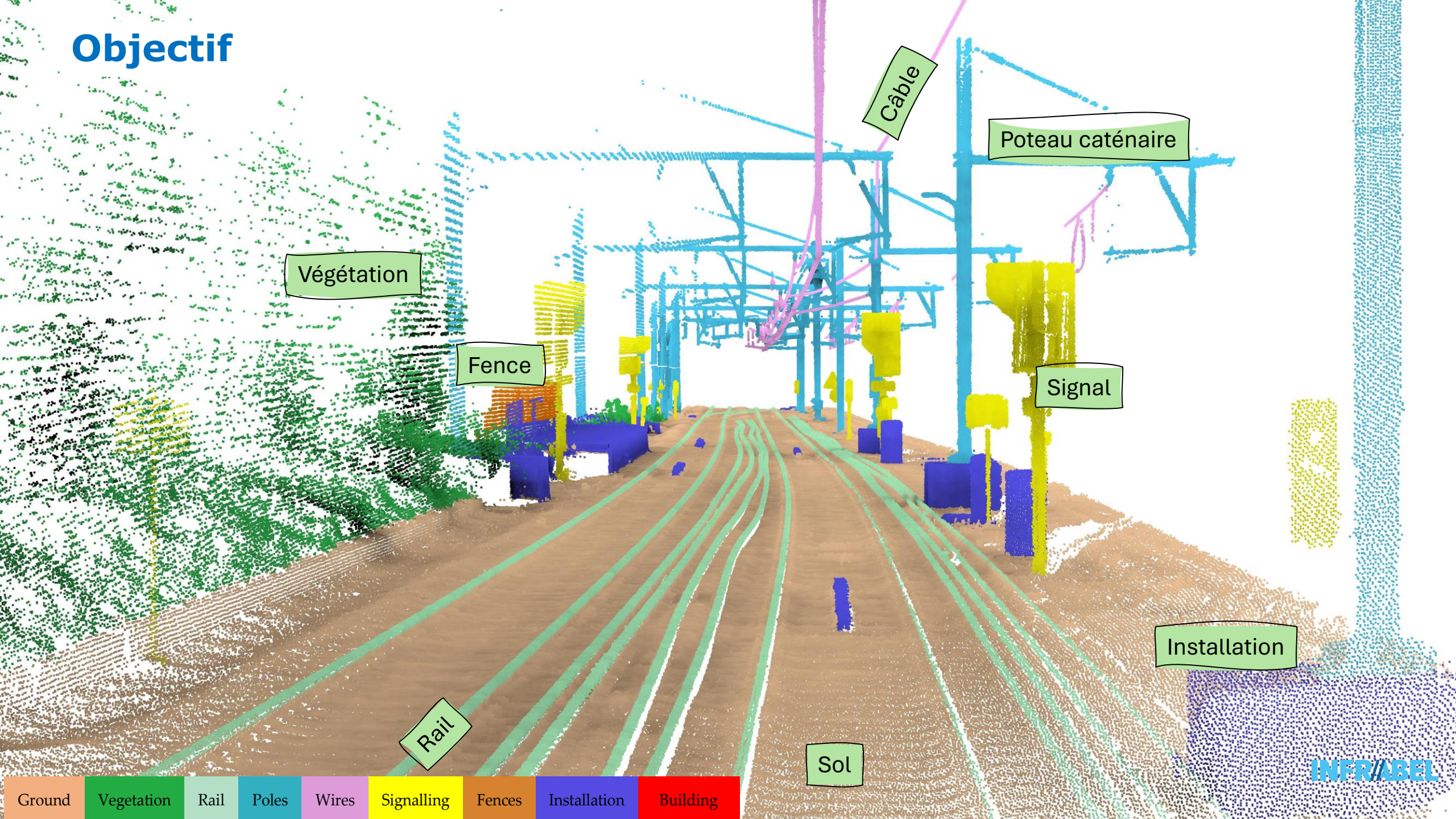
Véhicule EM202

LiDAR, la topographie instantanée ?

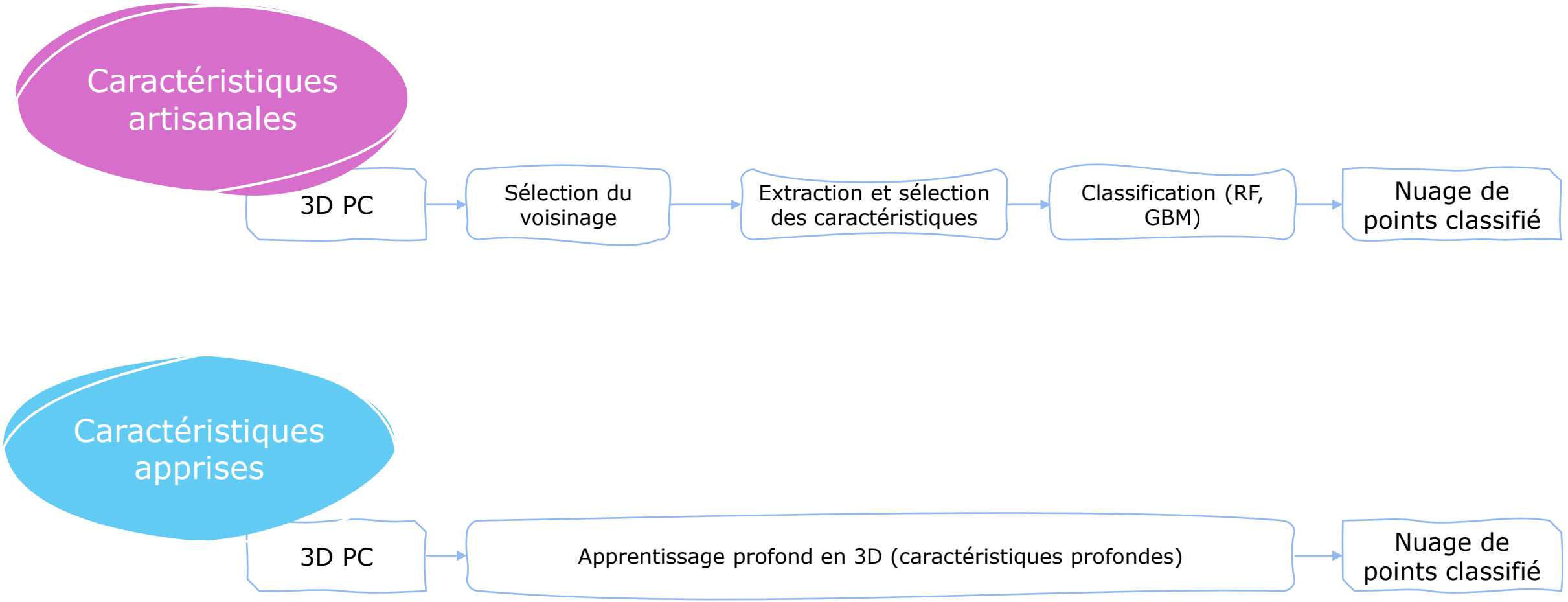
complète



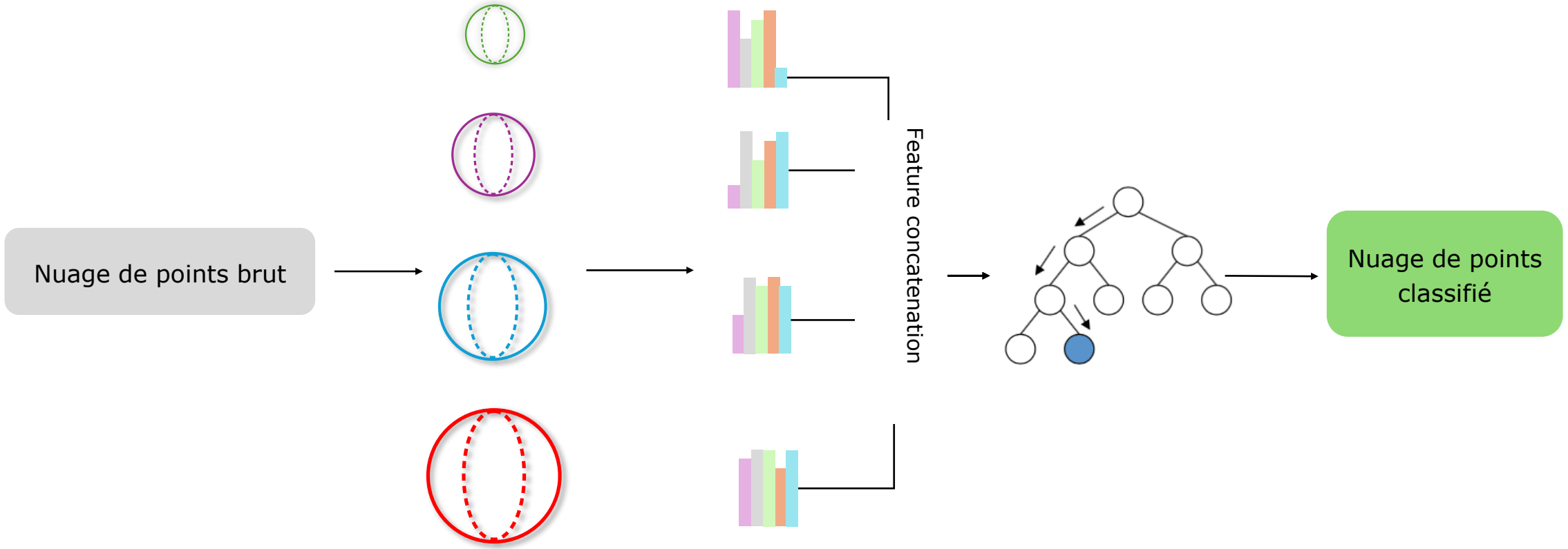
Objectif


Câble
Poteau caténaire
Végétation
Fence
Signal
Installation
Rail
Sol
Ground
Vegetation
Rail
Poles
Wires
Signalling
Fences
Installation
Building

Classification (RS)/ Segmentation sémantique (CV)



Apprentissage automatique



Sélection de plusieurs échelles

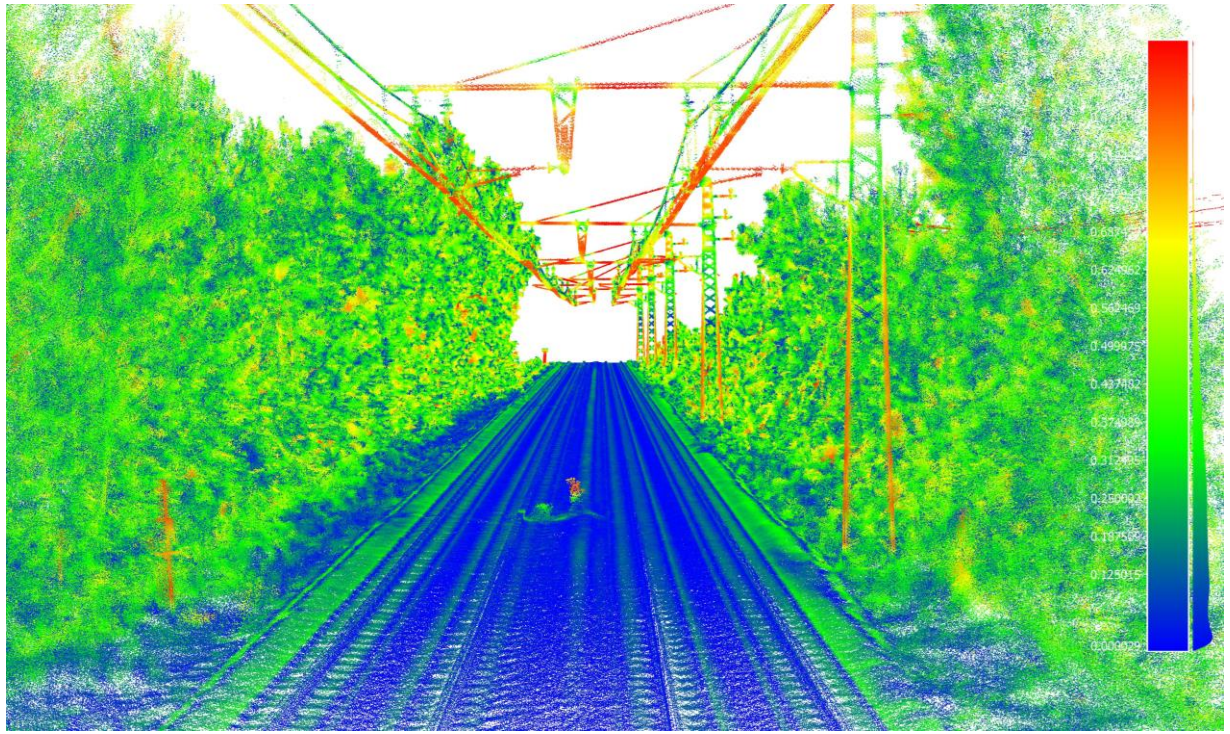
Nous avons utilisé des diamètres de 0,5 m, 1 m, 1,5 m et 2 m.

Extraction des caractéristiques

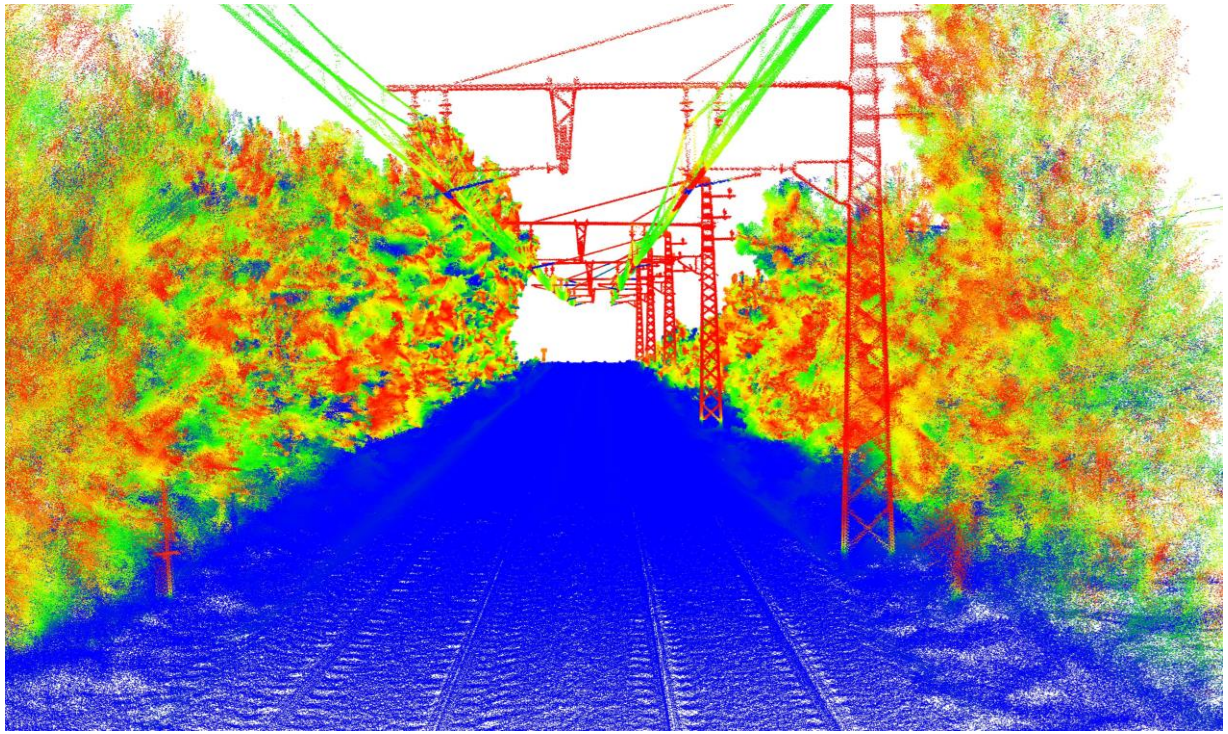
Classification

via le classificateur LightGBM/Forêt aléatoire

Example de caractéristiques artisanales

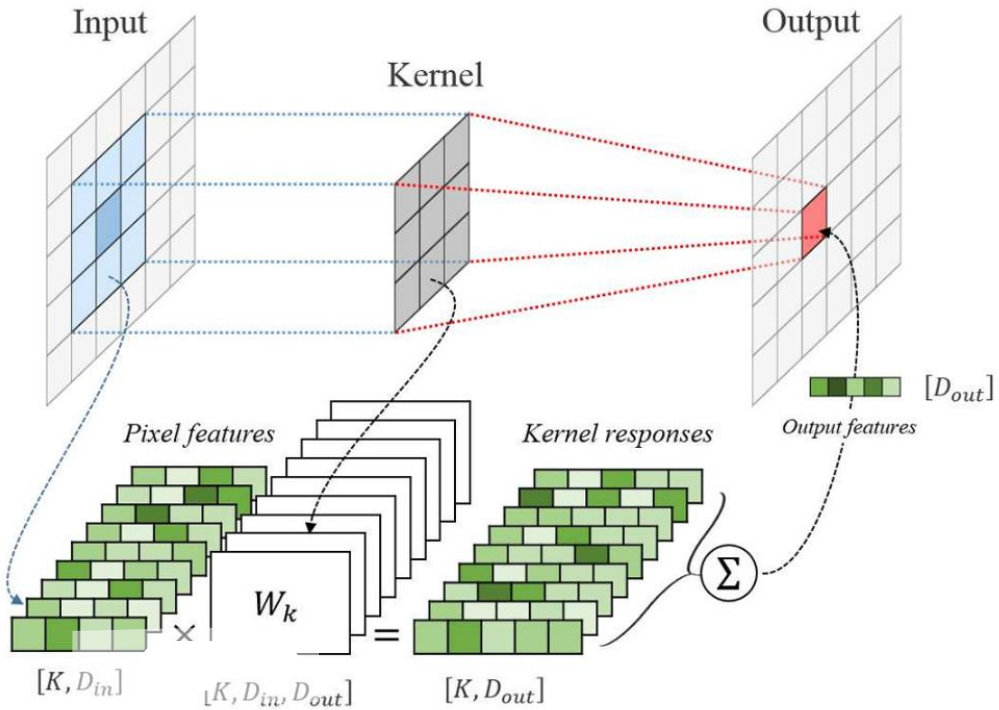


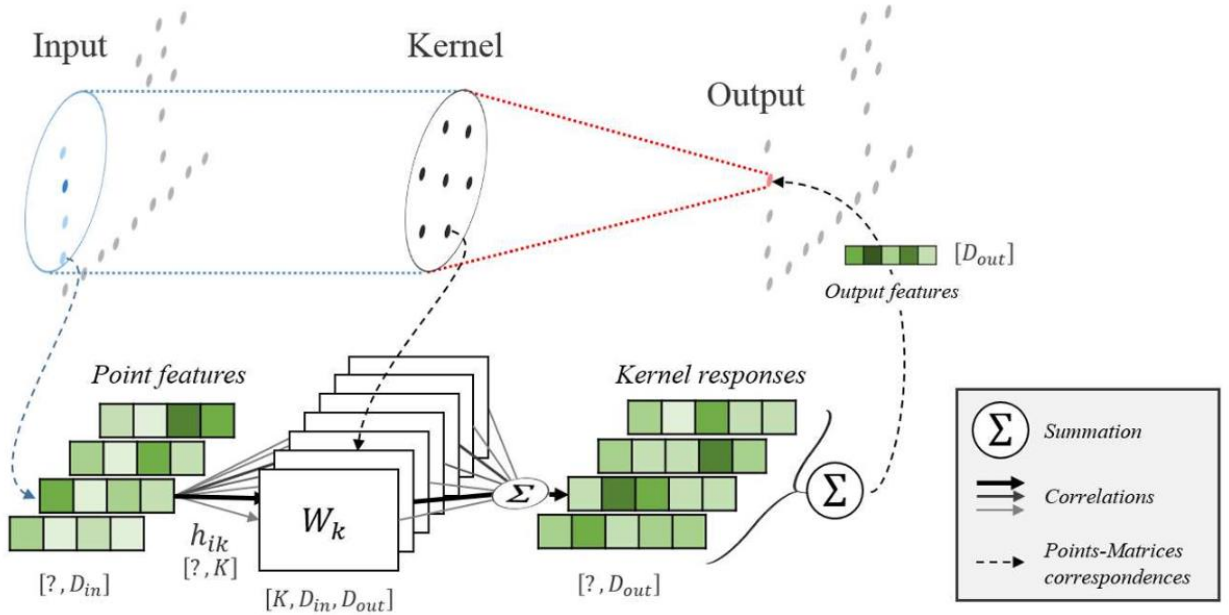
Ex: Linéarité à un rayon de 0,5 m



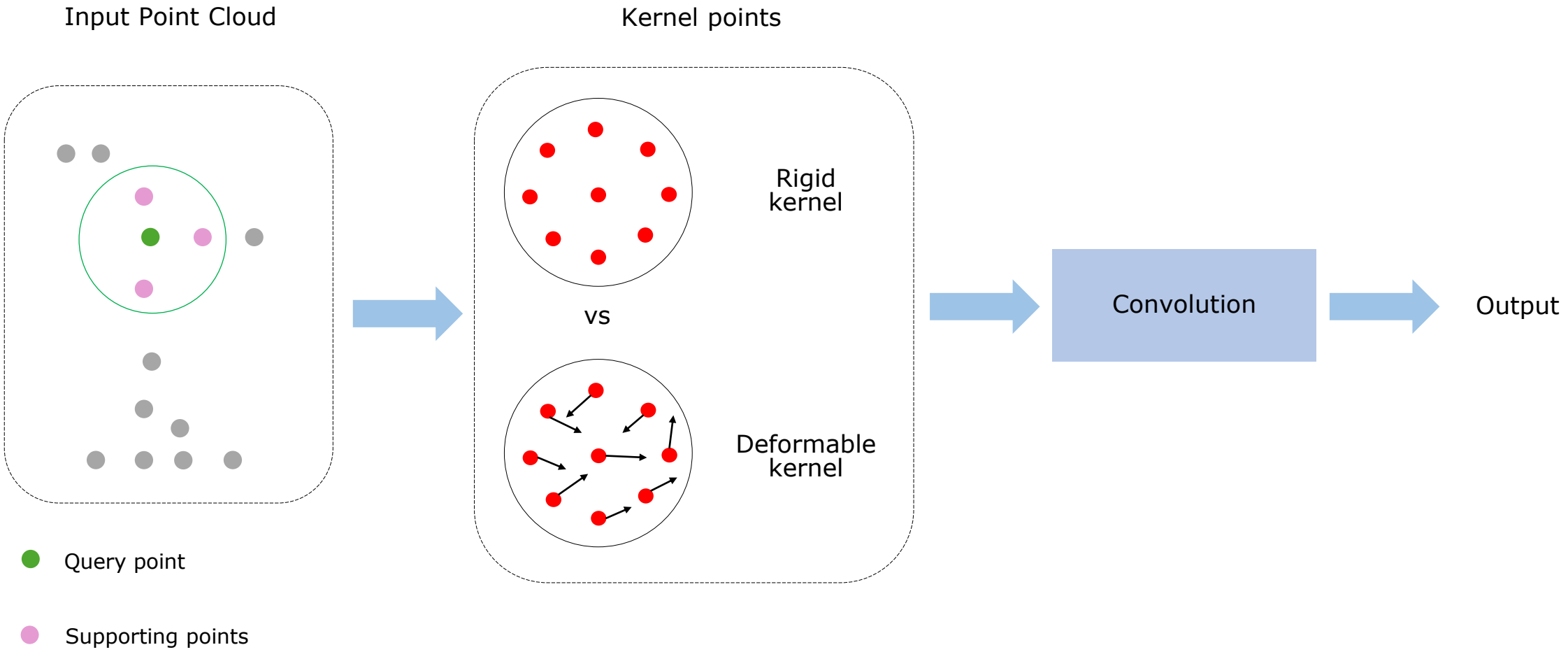
Ex: Verticalité à 1 m de rayon

Apprentissage profond 2D vs 3D



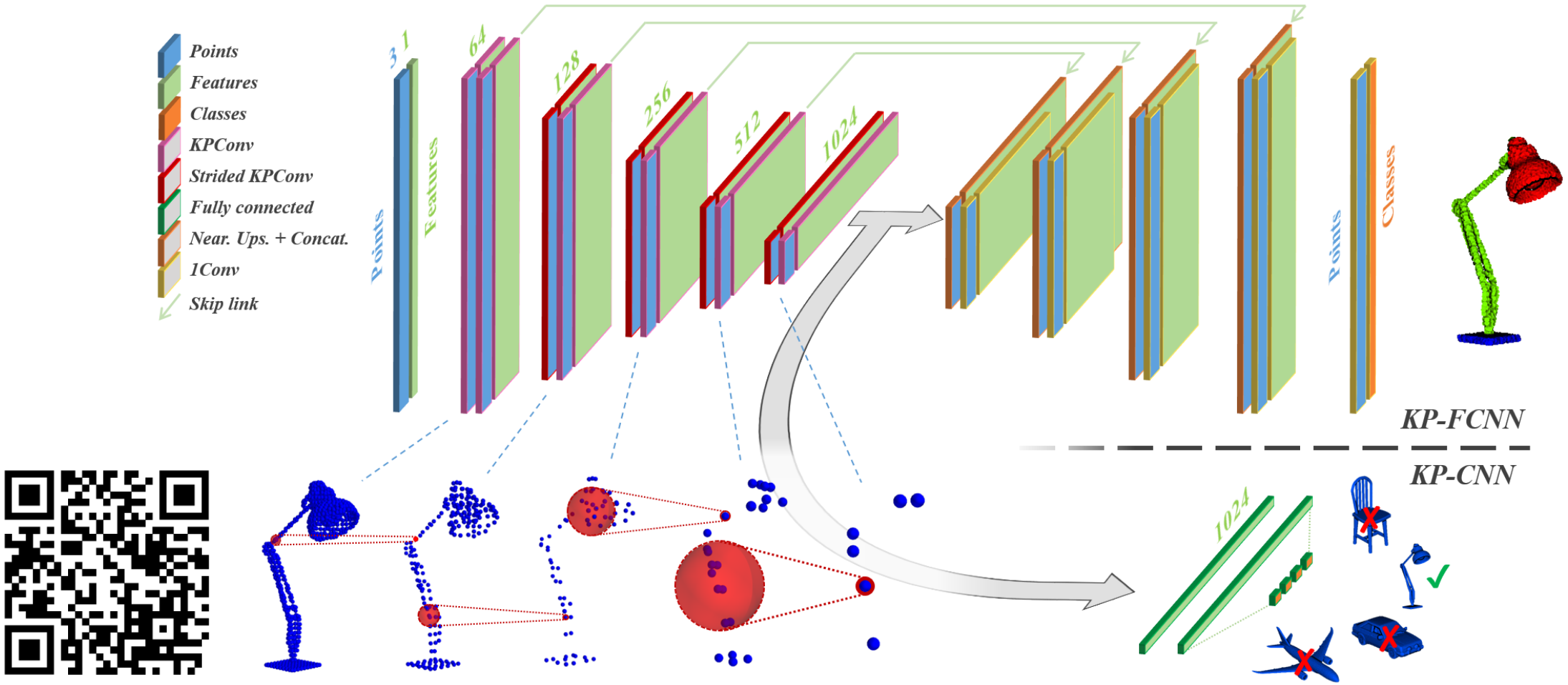


Kernel Point Convolution



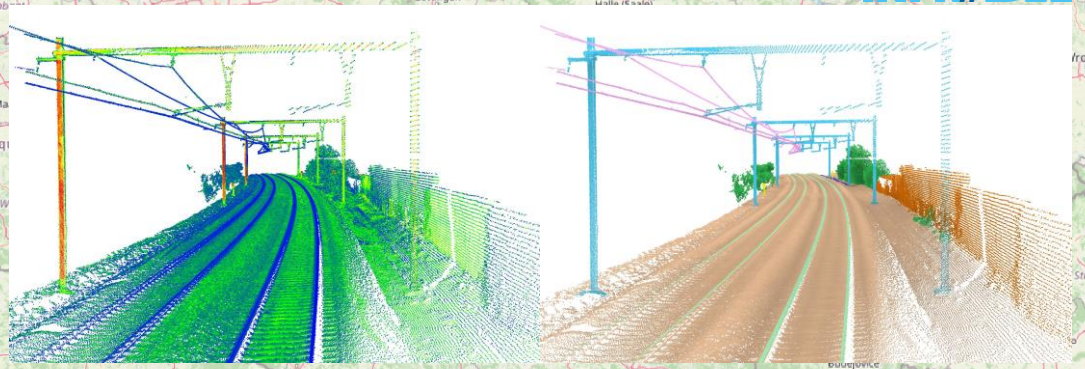
Edité de: Thomas Hugues et al, 2019

Kernel Point Convolution

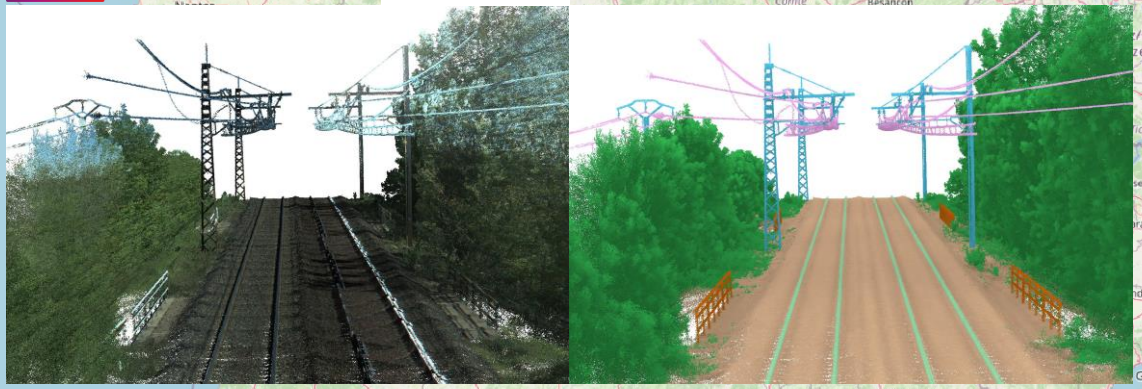


Jeu de données annoté Rail 3D

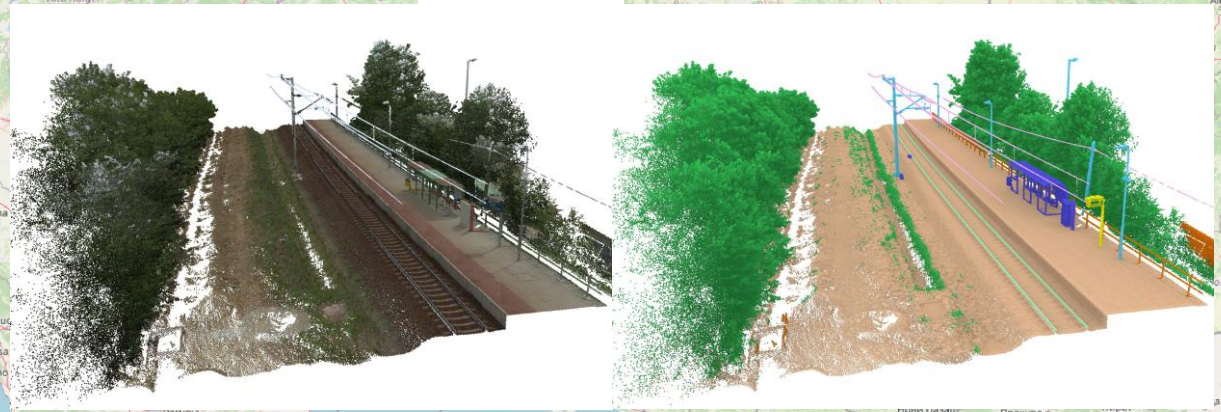
INFRABEL



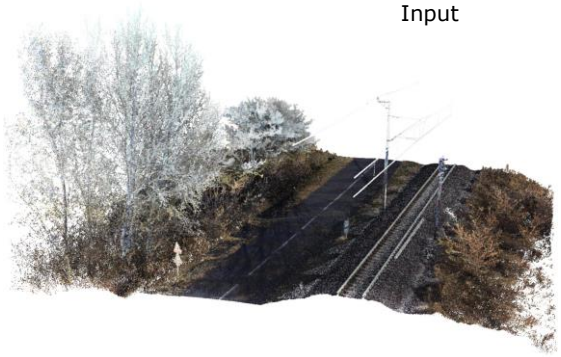
SNCF

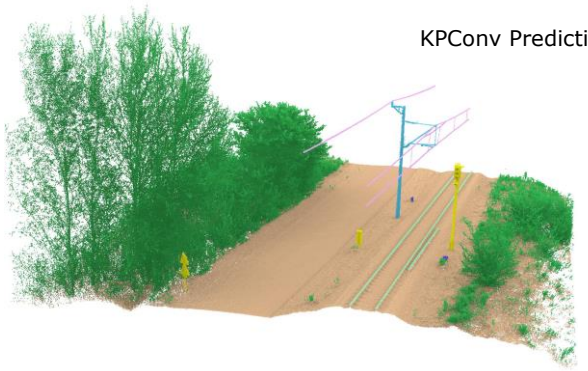


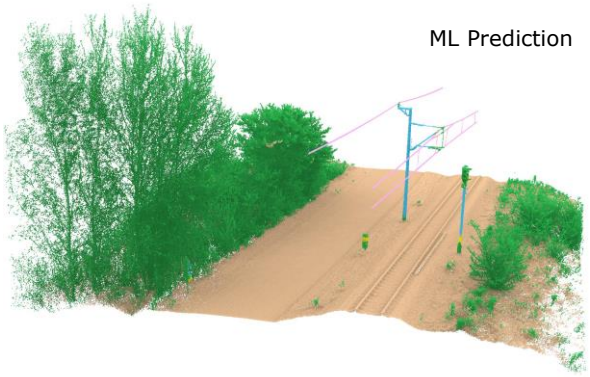
MÁV

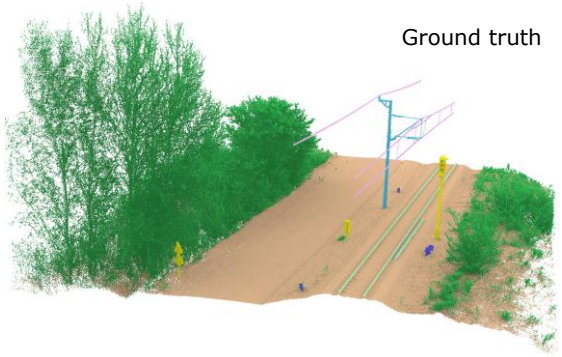


Experiments


Input


KPConv Prediction


ML Prediction


Ground truth


KPConv Errors

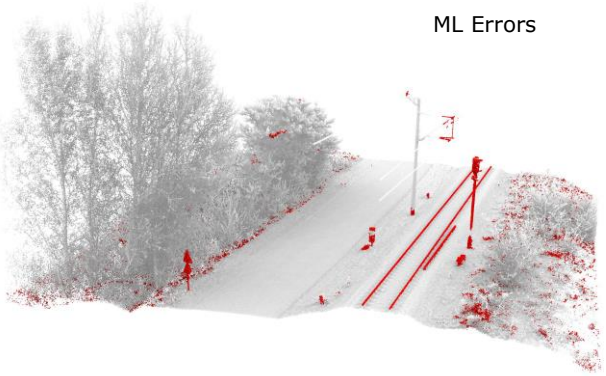
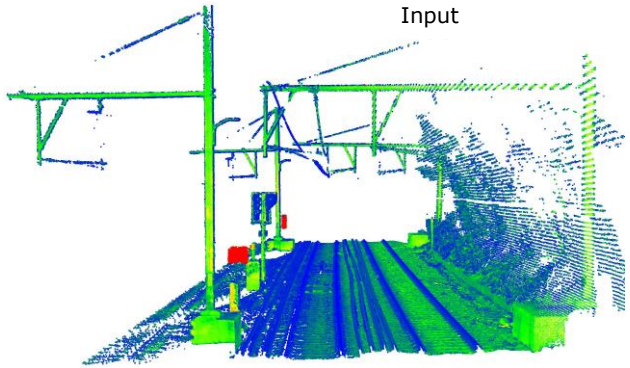

ML Errors

Table 1. Quantitative experimental results on the HMLS dataset.

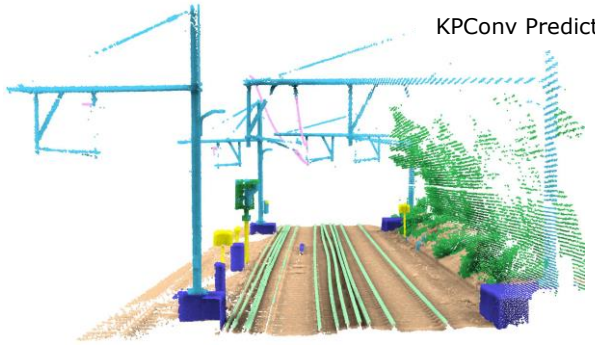
Approach	OA	mIoU	Ground	Vegetation	Rail	Poles	Wires	Signalling	Fences	Installation	Building
RF	0.93	0.57	0.82	0.89	0.46	0.72	0.96	0.09	0.33	0.08	0.80
KPConv	**0.97**	**0.86**	**0.95**	**0.91**	**0.94**	**0.93**	**0.99**	**0.96**	**0.90**	0.13	**0.99**
LightGBM	0.94	0.60	0.83	0.91	0.48	0.75	0.97	0.20	0.30	**0.15**	0.85

Experiments

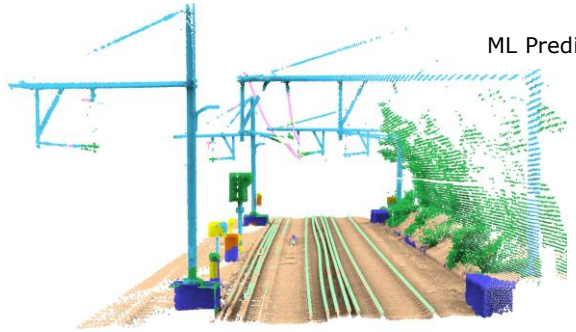
Input



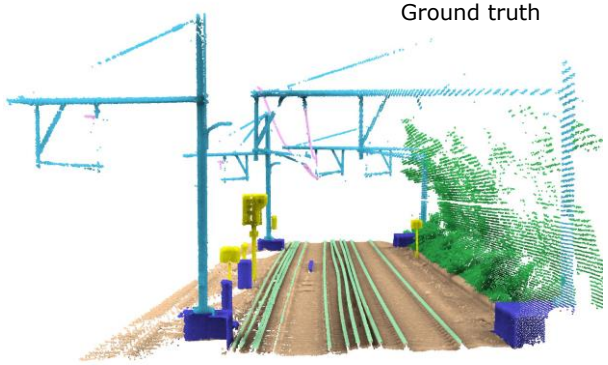
KPConv Prediction



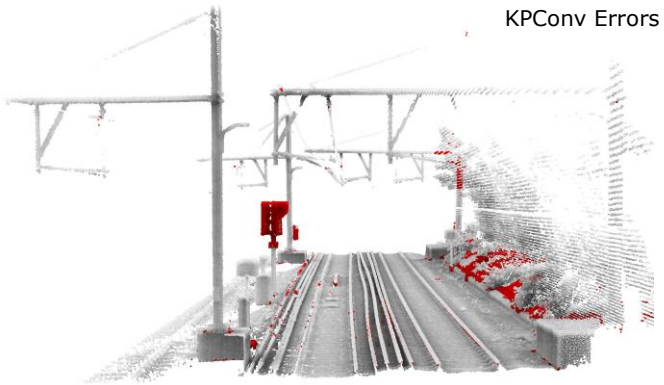
ML Prediction



Ground truth



KPConv Errors



ML Errors

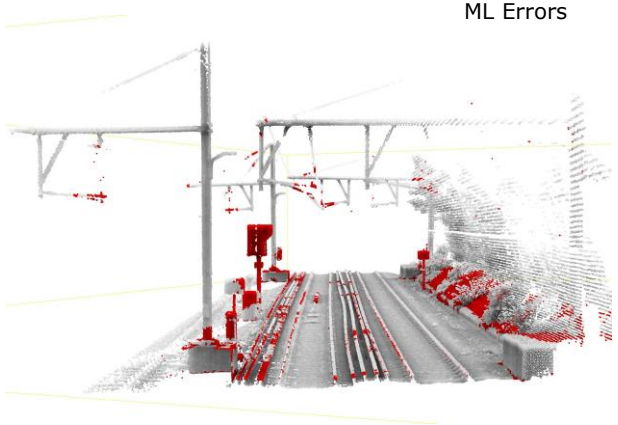
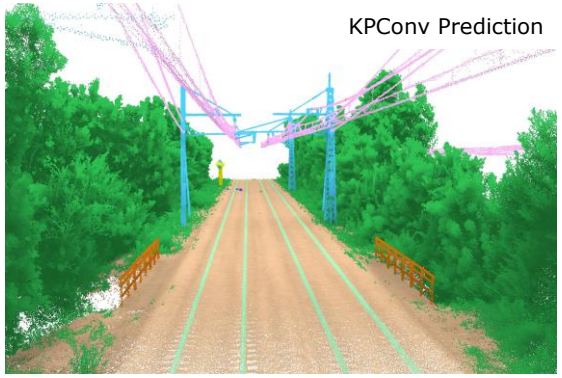
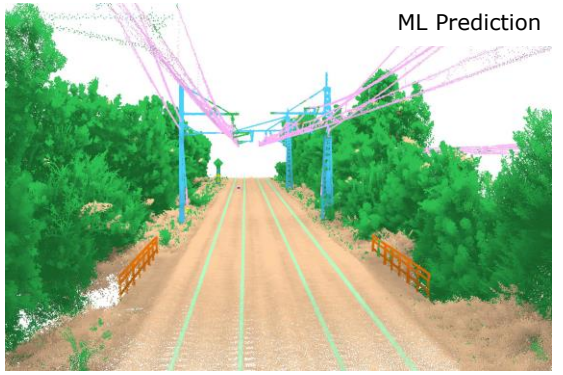


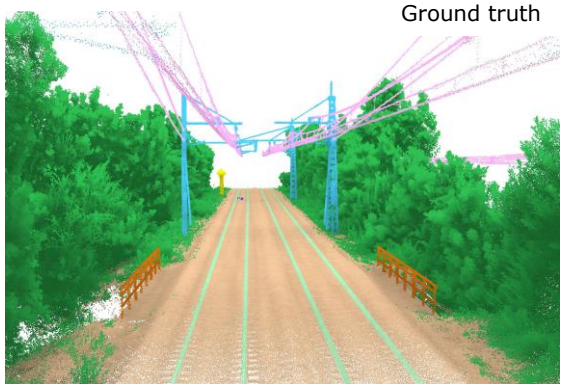
Table 3. Quantitative experimental results on the INFRABEL dataset.

Approach	OA	mIoU	Ground	Vegetation	Rail	Poles	Wires	Signalling	Fences	Installation
RF	0.96	0.70	0.96	0.84	0.85	0.88	0.99	0.22	0.56	0.28
KPConv	**0.99**	**0.84**	**0.99**	0.84	**0.95**	**0.97**	**0.99**	**0.40**	**0.69**	**0.89**
LightGBM	0.97	0.71	0.97	**0.86**	0.87	0.89	0.98	0.25	0.63	0.26

Experiments







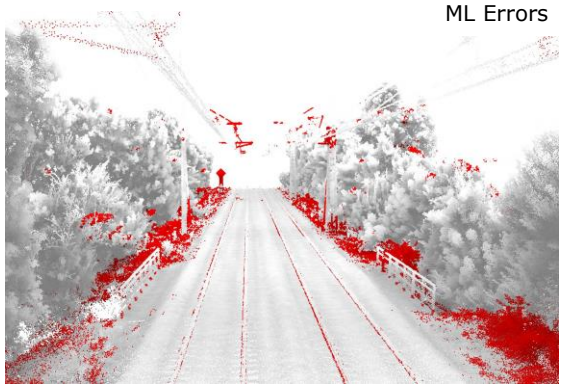
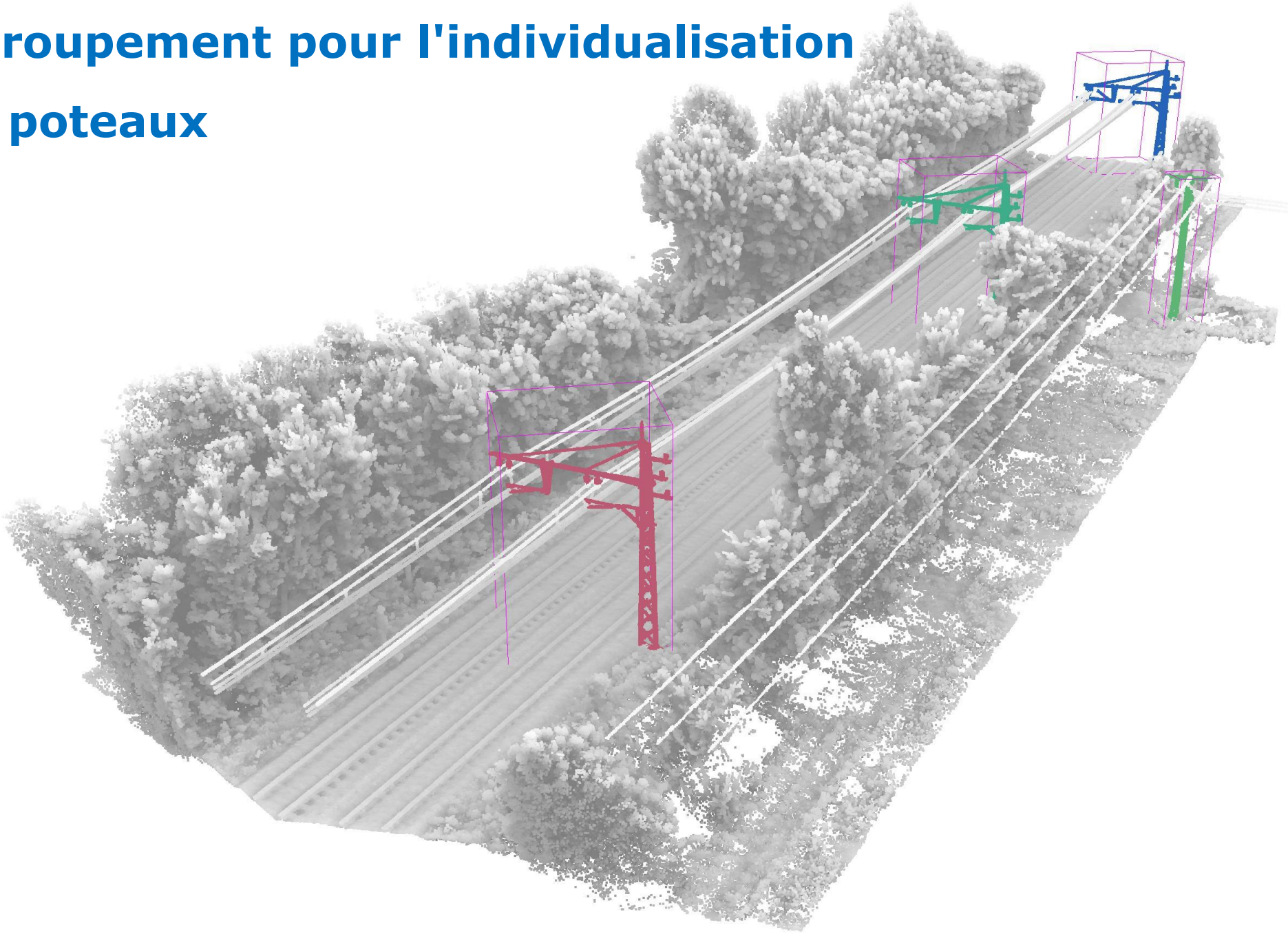


Table 2. Quantitative experimental results on the SNCF dataset.

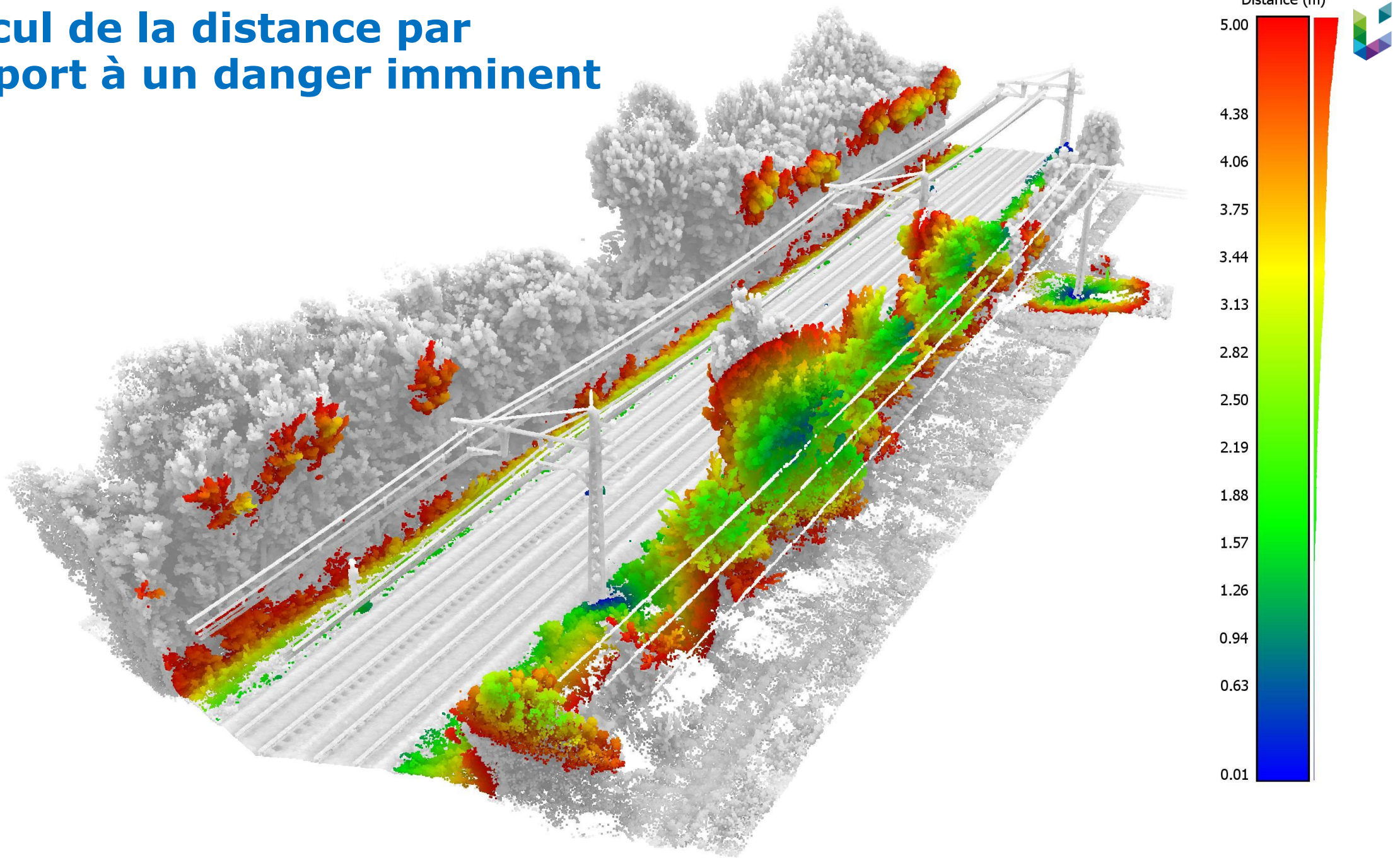
Approach	OA	mIoU	Ground	Vegetation	Rail	Poles	Wires	Signalling	Fences	Installation
RF	0.91	0.64	0.62	0.90	0.82	0.77	0.89	0.08	0.94	0.08
KPConv	**0.97**	**0.81**	**0.92**	**0.96**	**0.79**	**0.96**	**0.99**	**0.67**	**0.97**	**0.23**
LightGBM	0.93	0.67	0.68	0.92	0.86	0.78	0.88	0.16	0.85	0.20

Le nuage de points classifié n'est pas le livrable en soi, mais facilite le processus de création de celui-ci.

Regroupement pour l'individualisation des poteaux

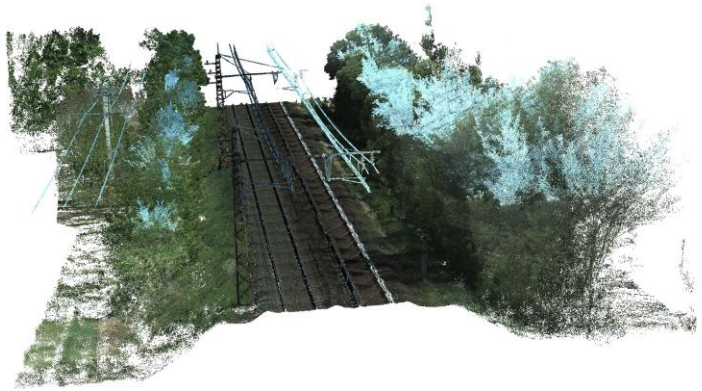


Calcul de la distance par rapport à un danger imminent

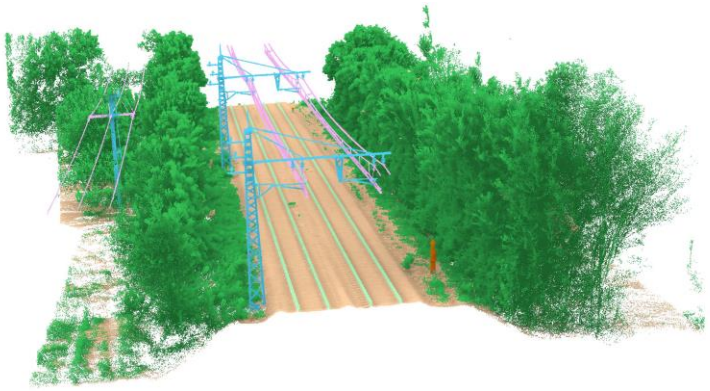


Travaux futurs et conclusion

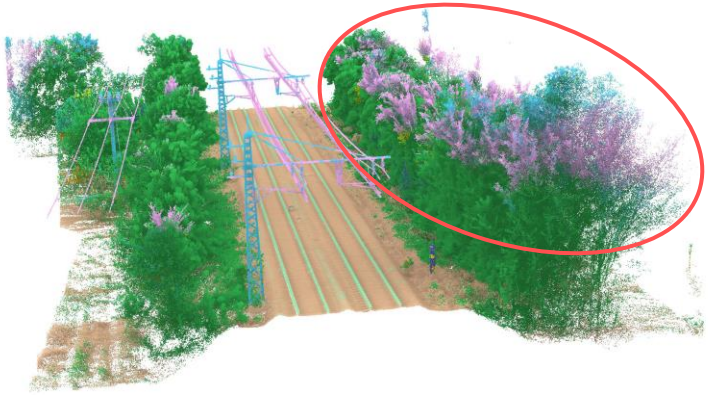
- Inclure d'autres classes comme les ponts, les gares, les trains en mouvement...
- Corriger les points colorés par le ciel et utiliser la couleur pour la segmentation sémantique.
- Application de la détection des changements basée sur la sémantique (PhD en cours)



Input



Predictions without colours



Predictions with colours

20 startups d'IA ayant un impact sur l'industrie ferroviaire (2024)

Railspire
USA

AXO Track
Germany

Apital
USA

Rail State
USA

Safety4Rails
Germany

RailVision Analytics
Canada

4AI Systems
Australia

Ci4Rail
Germany

upBUS
Germany

Cervello
Israel

RMT
Italy

Lunarlight
Ukraine

Hawk System
Slovakia

ONYX
USA

The Cross Product (TCP)
France

Dweepi
India

Dynamic Rail Utilities Monitoring
Austria

Xpdeep
France

AllRead
Spain

Eyeflow.AI
Brazil

403 Startups analyzed

London · New York City · Bangalore · San Fransisco · Mumbai

The

Data provided by StartUs insights · December 2023

Merci !

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- akharroubi@uliege.be

- https://github.com/akharroubi/Rail3D

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- *Damien Paque from Infrabel for his review of this presentation.*
- *Roland Billen, mon promoteur de thèse.*