

Traitement automatique de données LiDAR 3D en milieu ferroviaire

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Jeudi, 28 mars, 2024 || 15:45 – 16:15



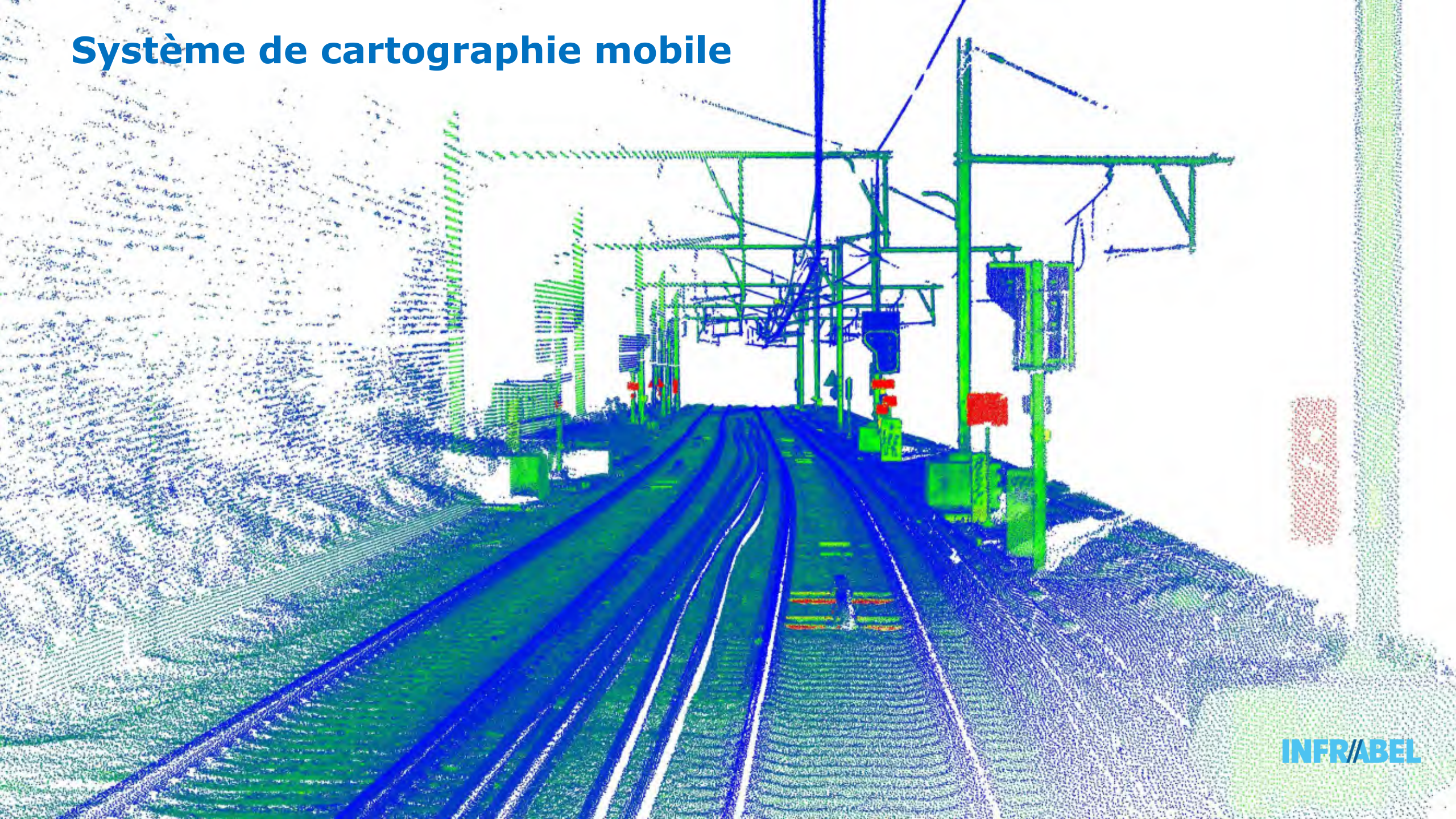
Université de Liège, Gembloux, Belgique

Les relevés des infrastructures



La topographie classique

Systeme de cartographie mobile



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 ?

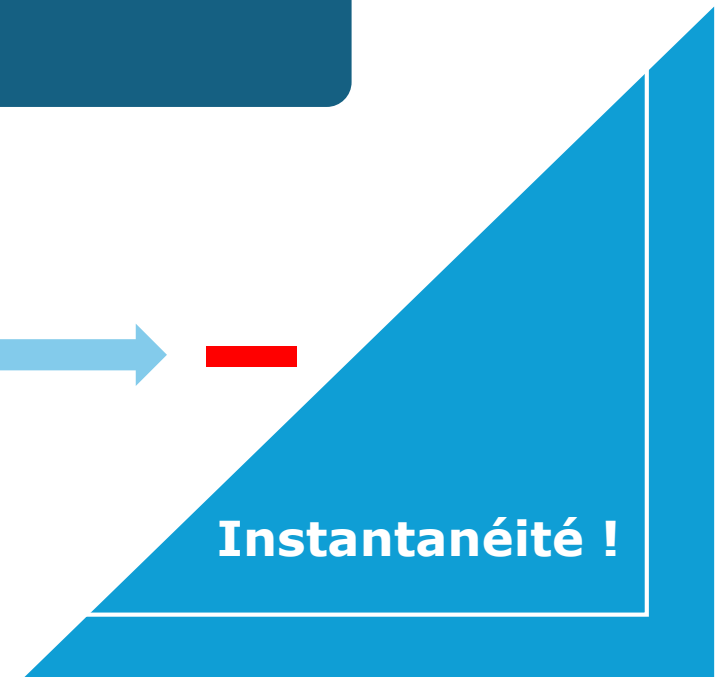
complète



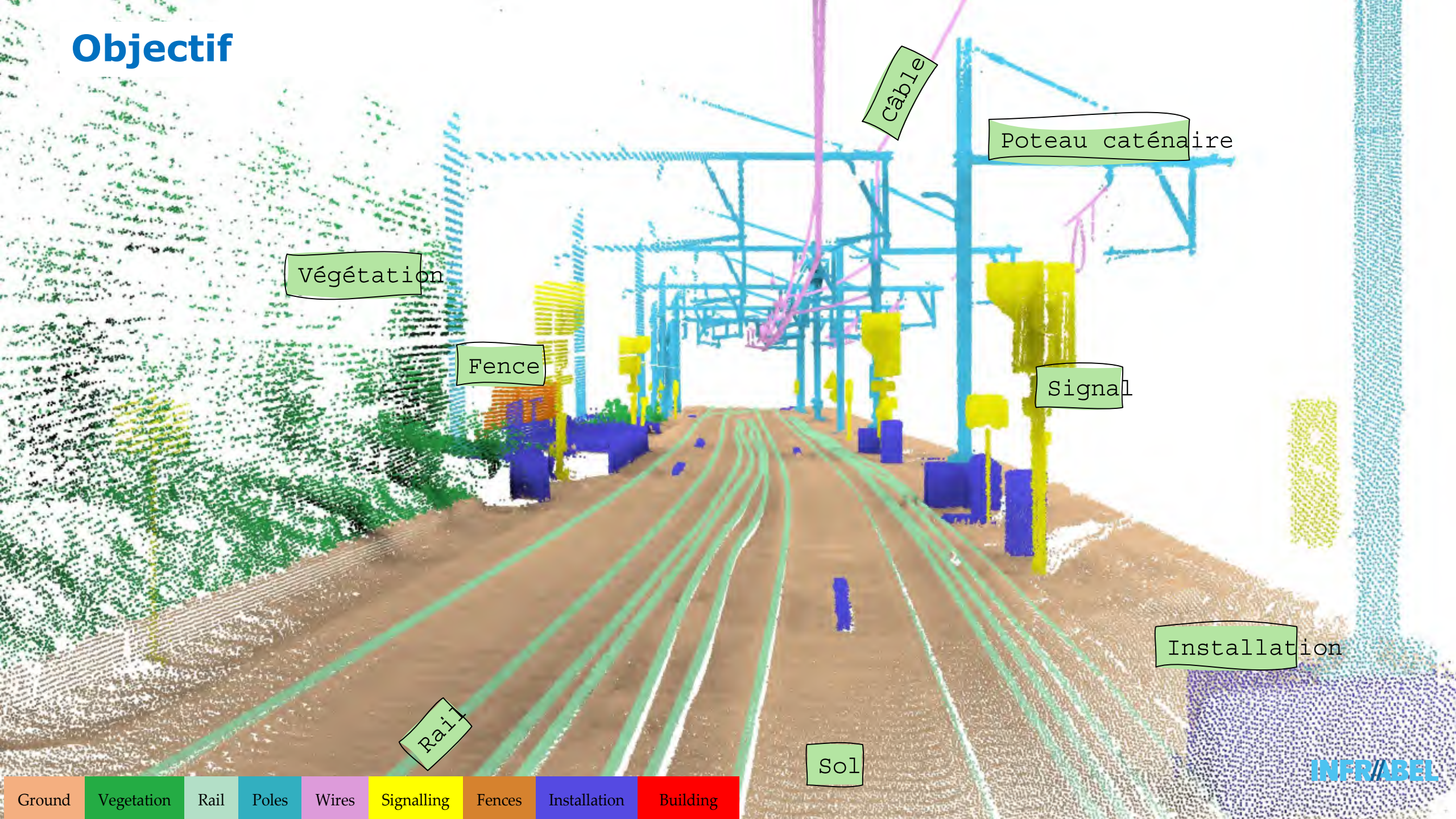
Rapidité



Instantanéité !



Objectif



Végétation

Fence

Câble

Poteau caténaire

Signal

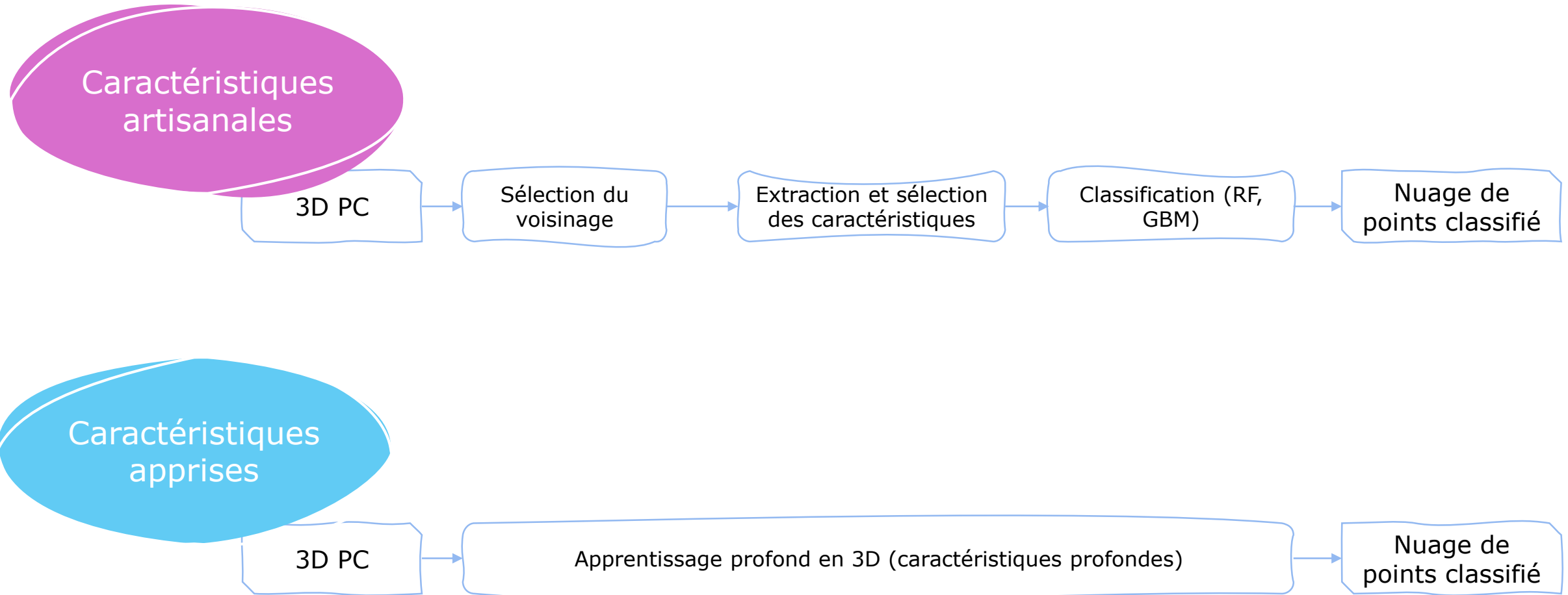
Installation

Rail

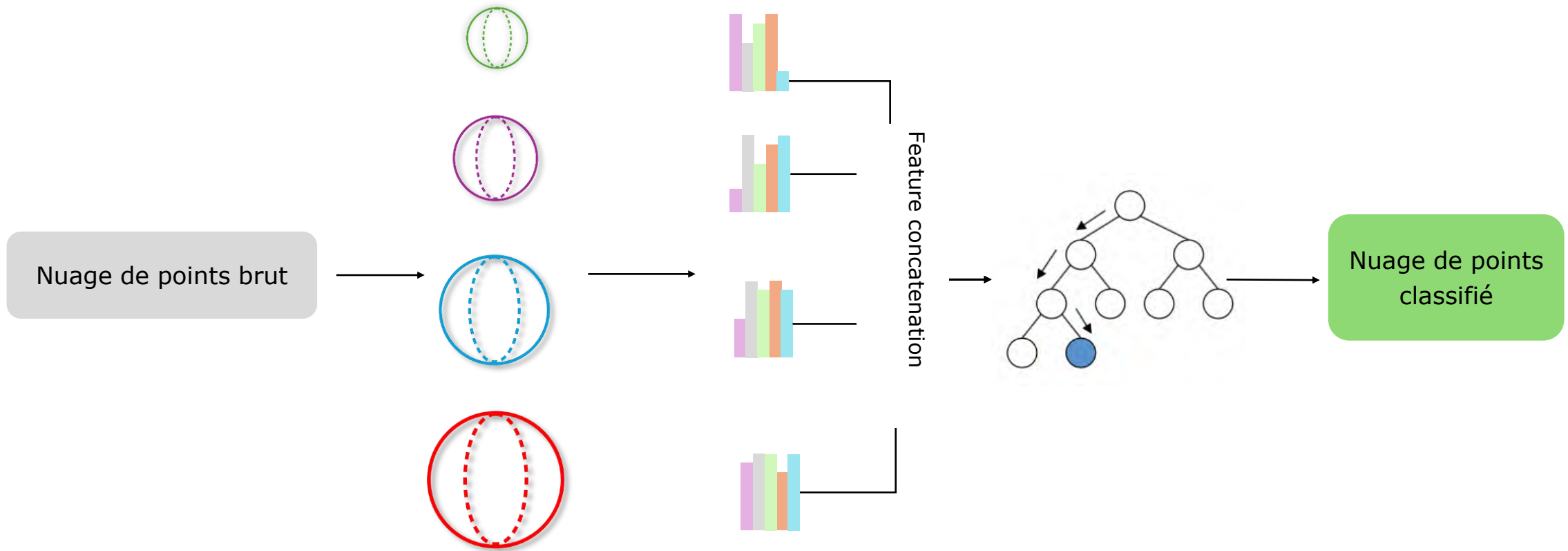
Sol

- Ground
- Vegetation
- Rail
- Poles
- Wires
- Signalling
- Fences
- Installation
- Building

Classification (RS)/ Segmentation sémantique (CV)



Apprentissage automatique



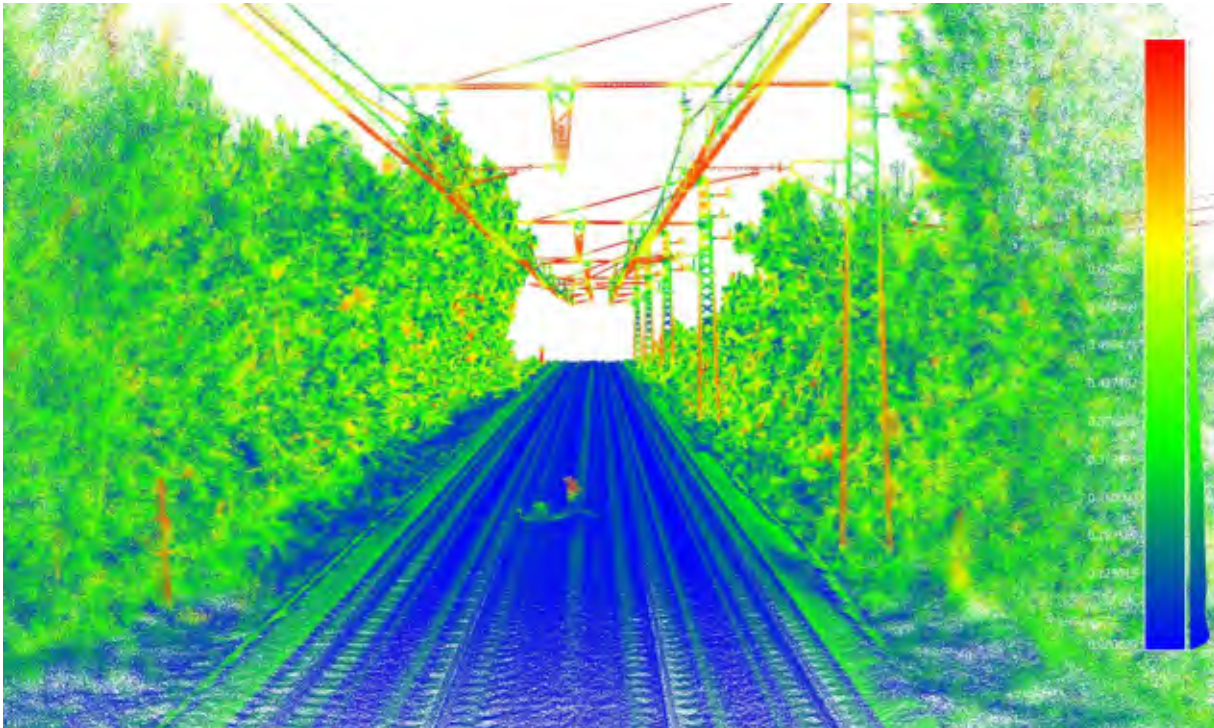
Sélection de plusieurs échelles

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

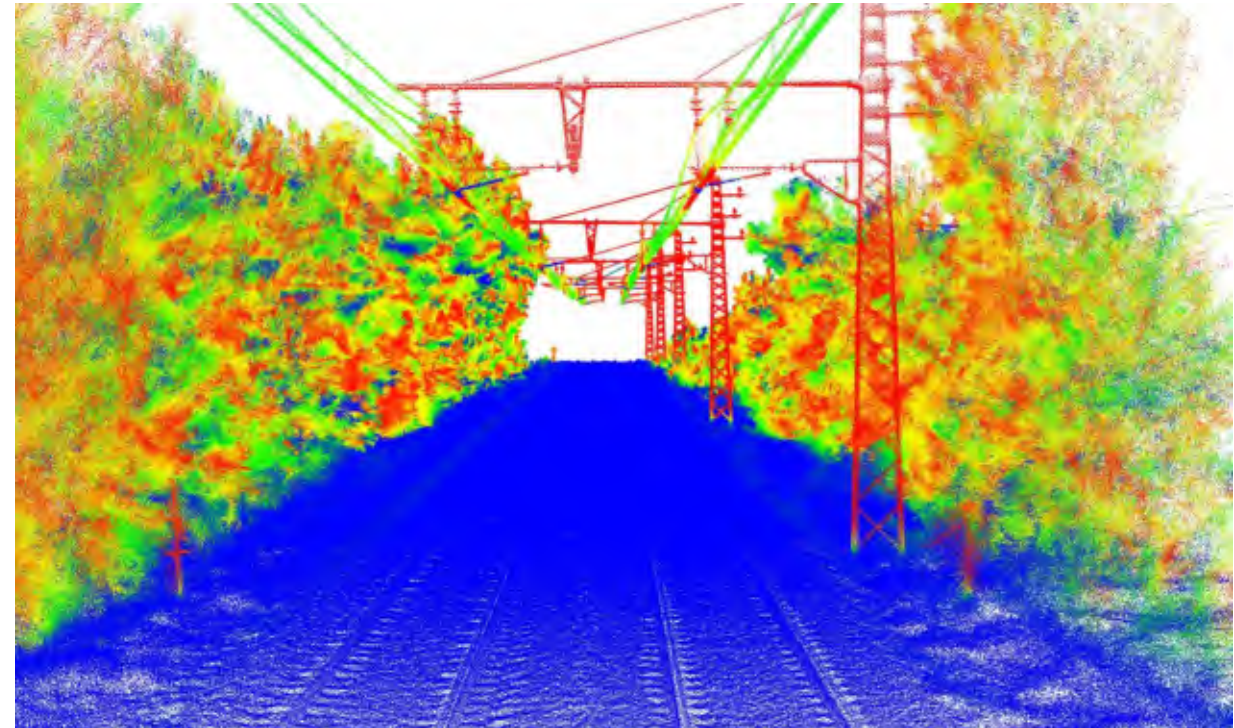
Extraction des caractéristiques

Classification
via le classificateur
LightGBM/Forêt aléatoire

Exemple de caractéristiques artisanales

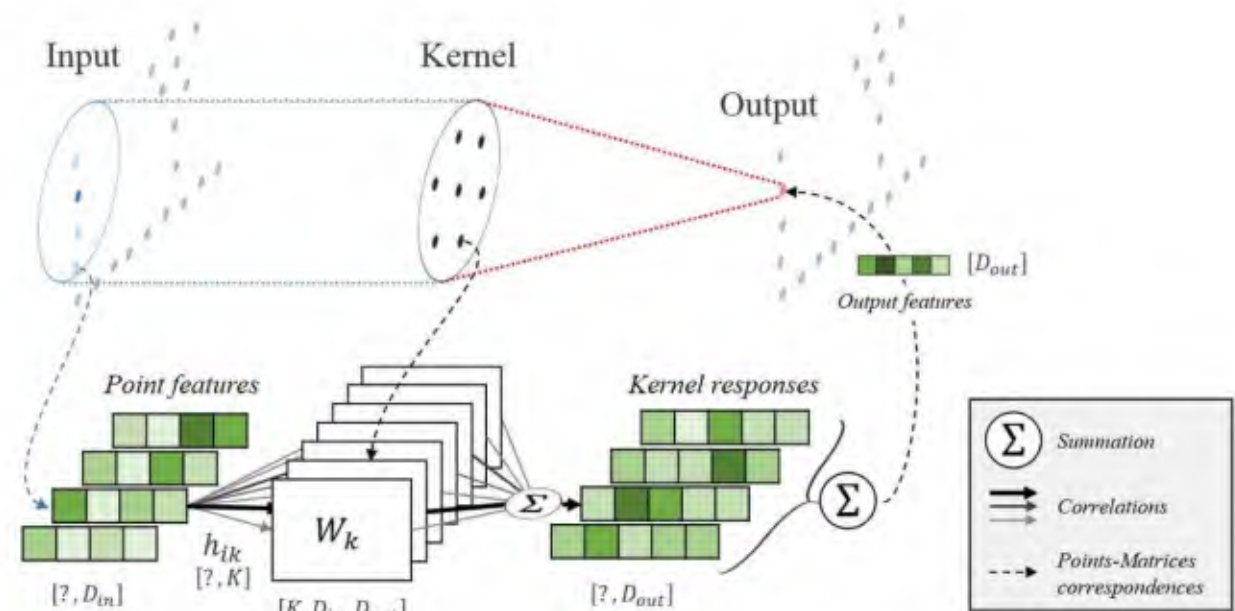
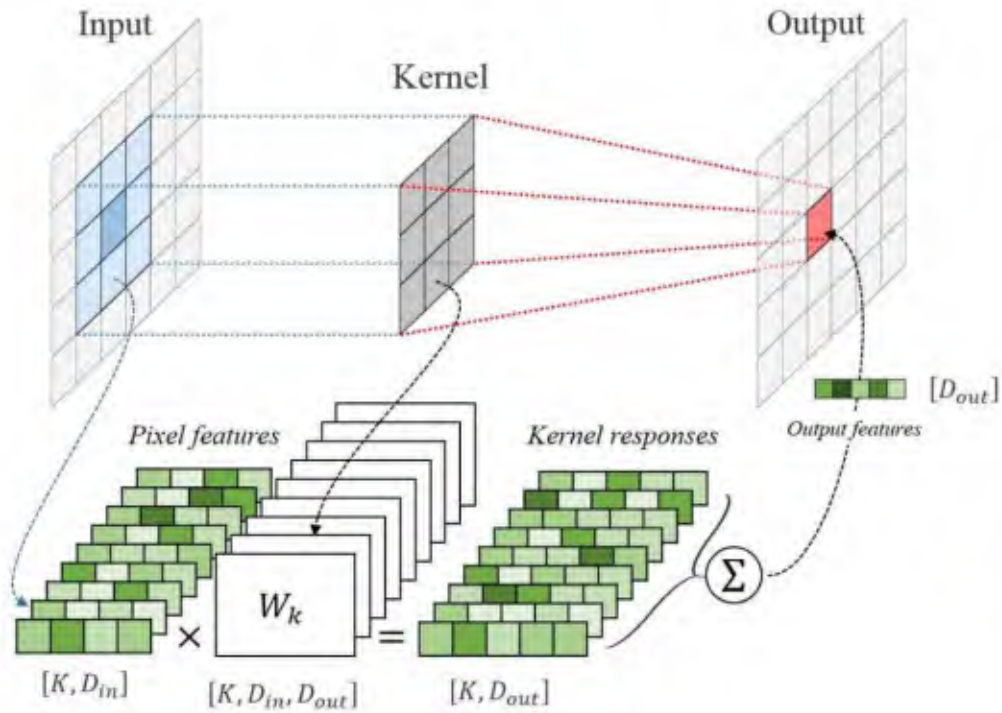


Ex: Linéarité à un rayon de 0,5 m

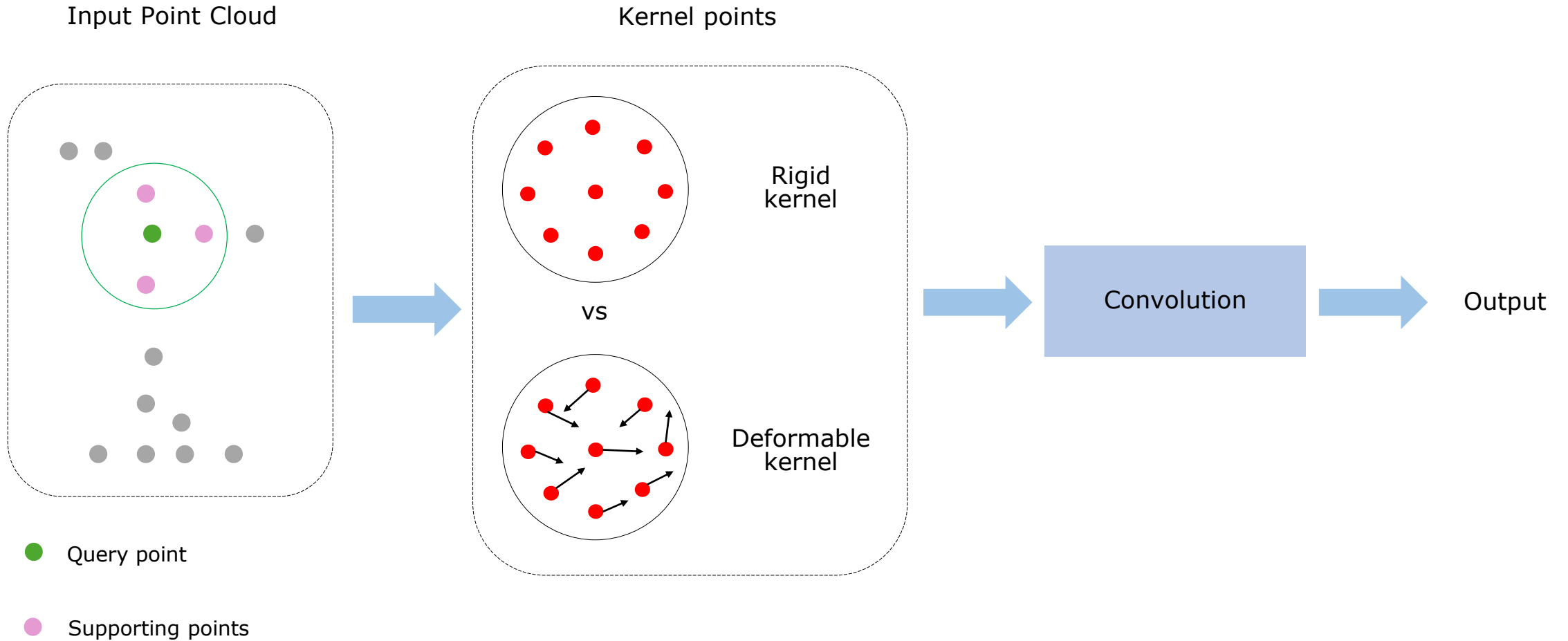


Ex: Verticalité à 1 m de rayon

Apprentissage profond 2D vs 3D

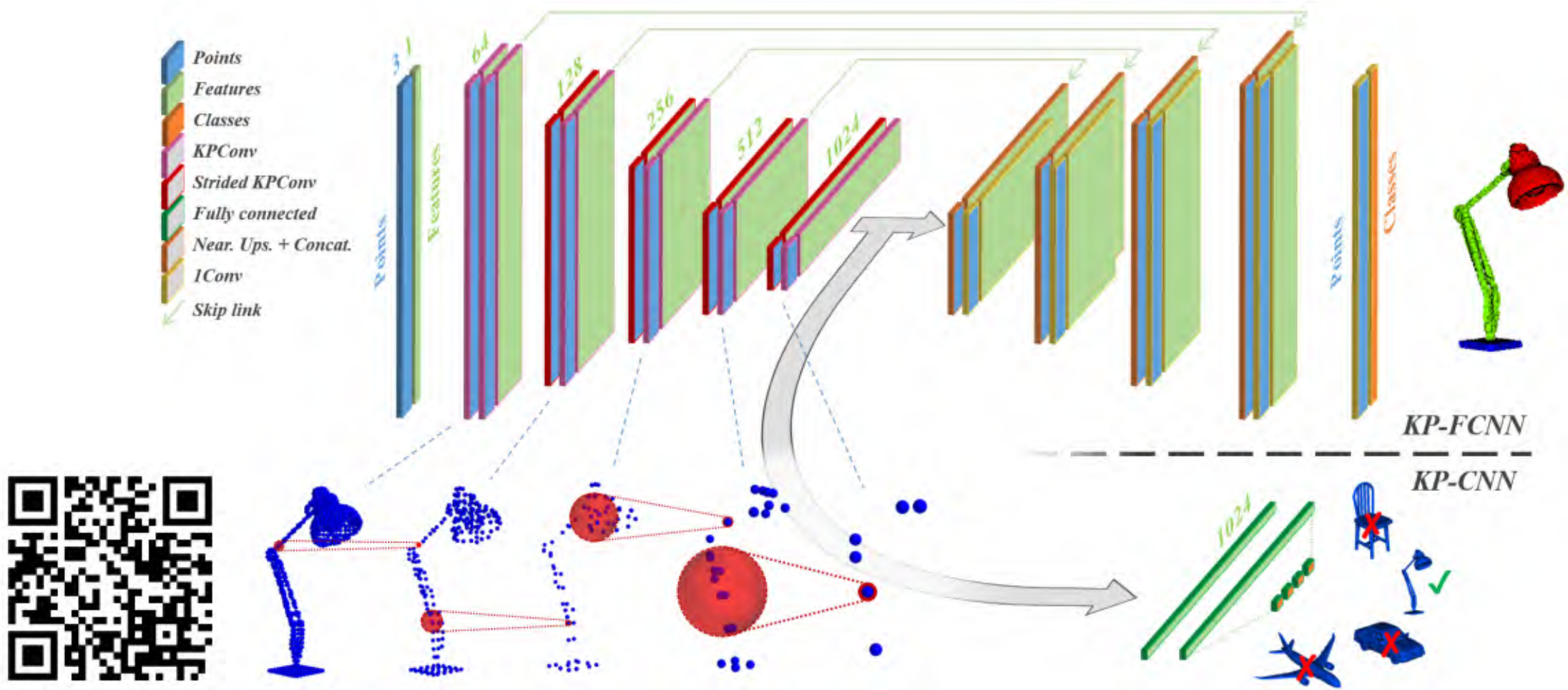


Kernel Point Convolution

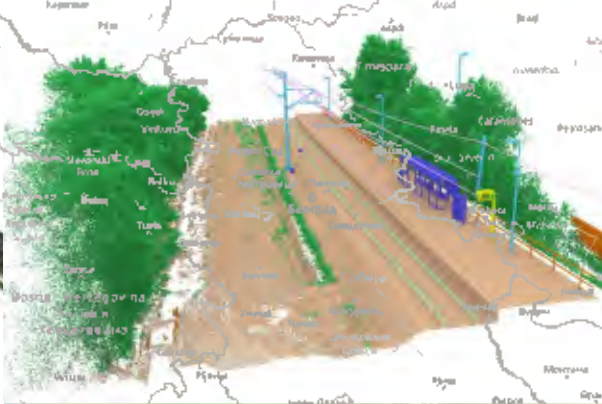
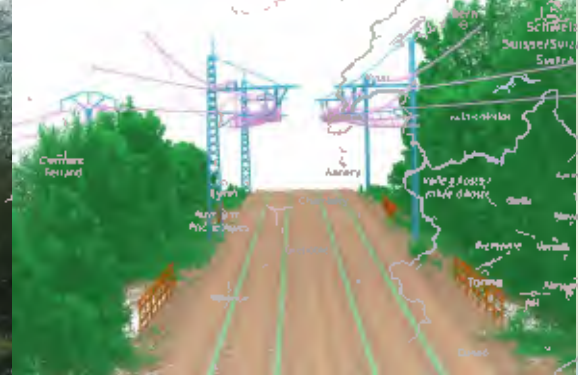
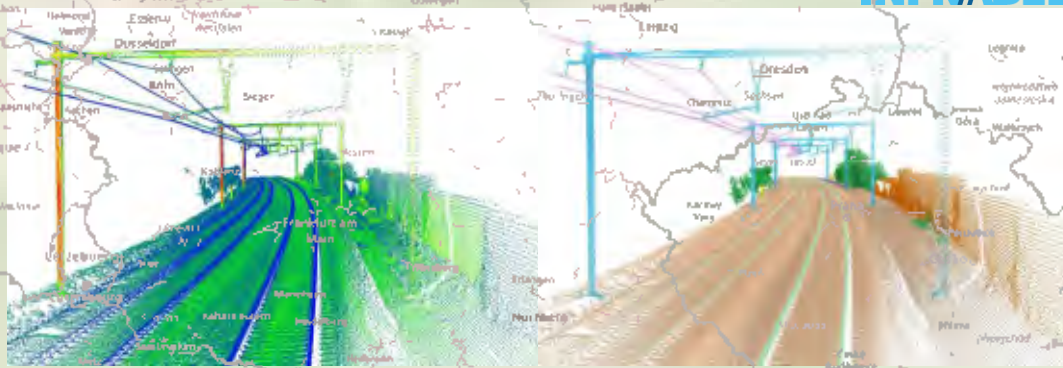
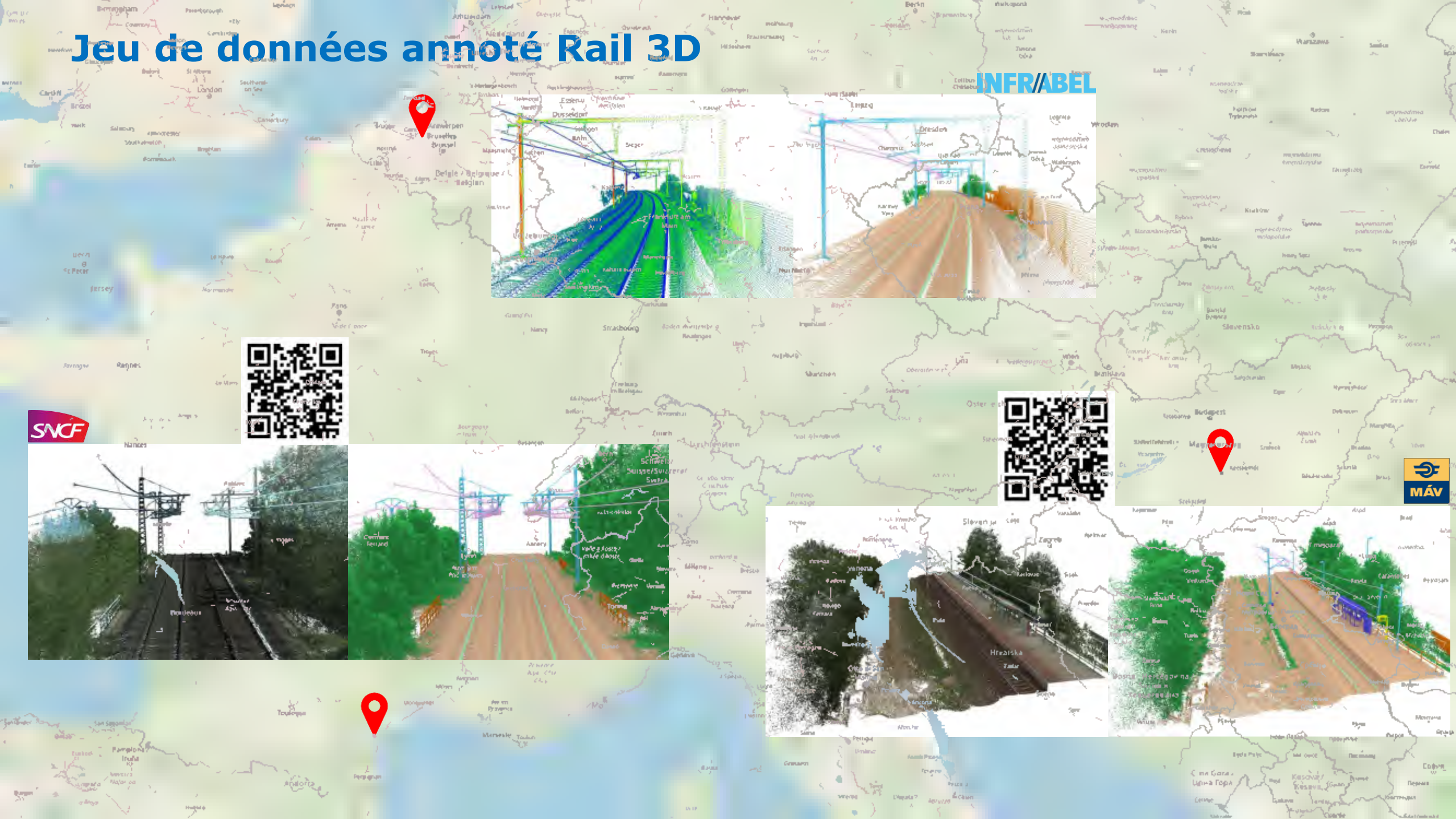


Edité de: Thomas Hugues et al, 2019

Kernel Point Convolution



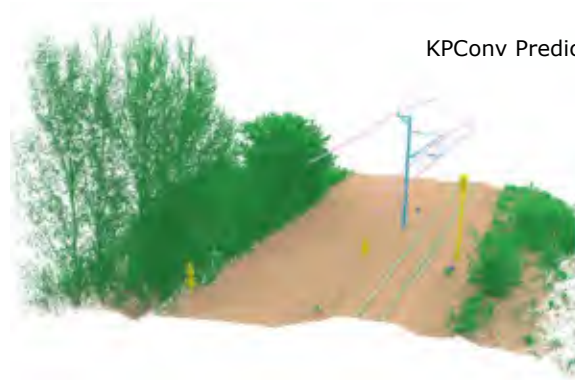
Jeu de données annoté Rail 3D



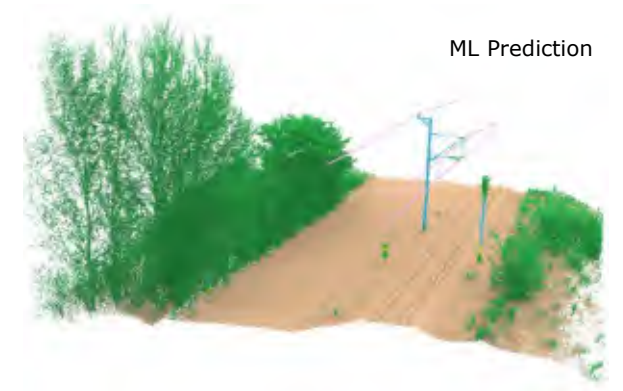
Experiments



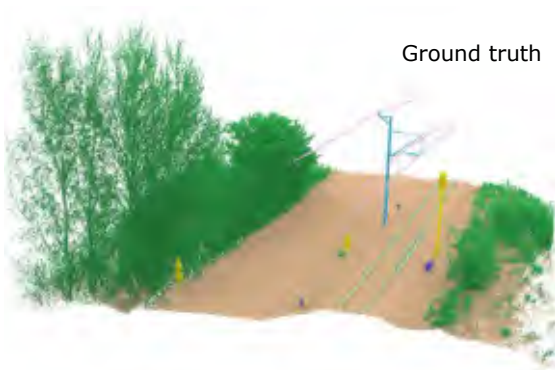
Input



KPCnv Prediction



ML Prediction



Ground truth



KPCnv Errors



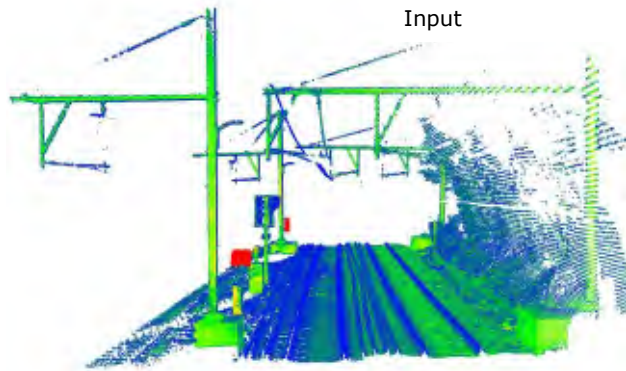
ML Errors

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
KPCnv	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



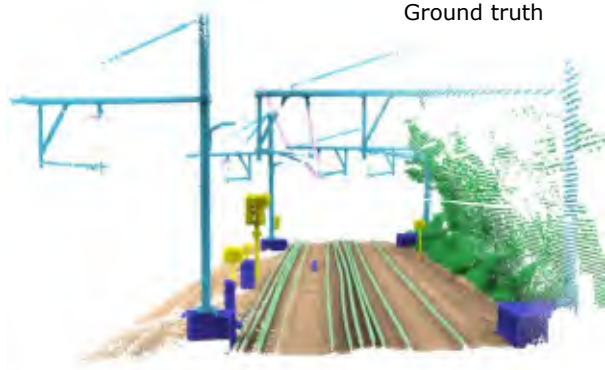
Input



KPCnv Prediction



ML Prediction



Ground truth



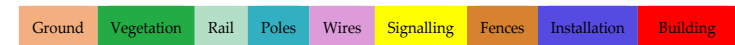
KPCnv Errors



ML Errors

Table 3. Quantitative experimental results on the INFRABEL dataset.

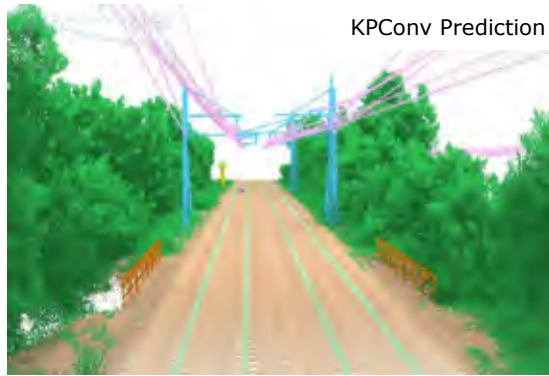
Approach	OA	mIoU	Ground	Vegetation	Rail	Poles	Wires	Signalling	Fences	Installation
RF	0.96	0.70	0.96	0.84	0.85	0.88	0.99	0.22	0.56	0.28
KPCnv	0.99	0.84	0.99	0.84	0.95	0.97	0.99	0.40	0.69	0.89
LightGBM	0.97	0.71	0.97	0.86	0.87	0.89	0.98	0.25	0.63	0.26



Experiments



Input



KPCnv Prediction



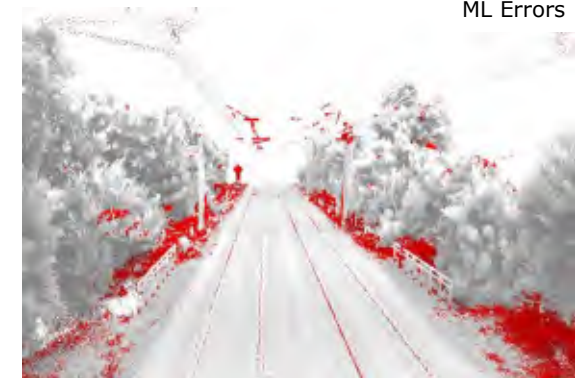
ML Prediction



Ground truth



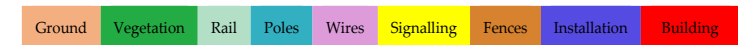
KPCnv Errors



ML Errors

Table 2. Quantitative experimental results on the SNCF dataset.

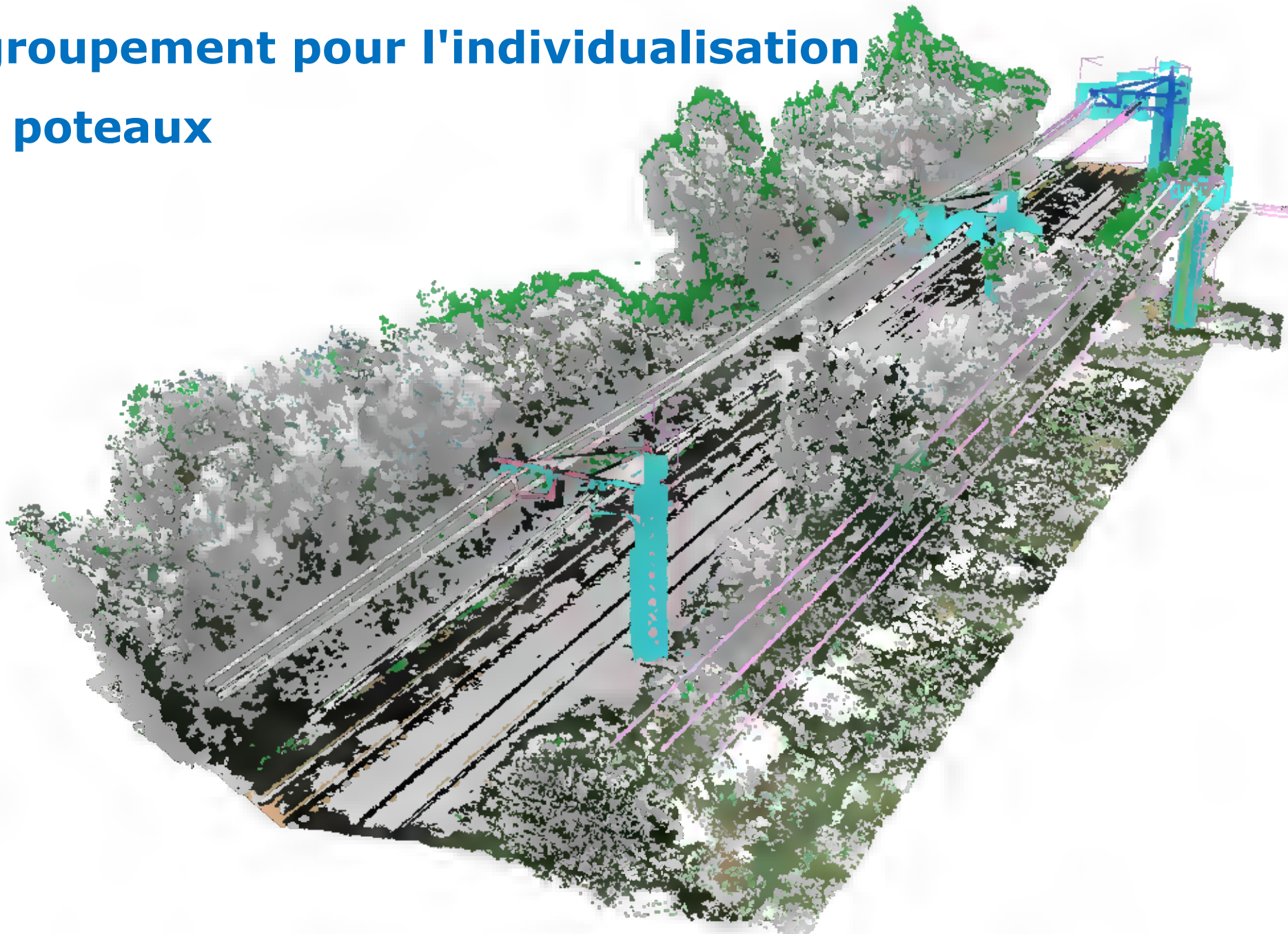
Approach	OA	mIoU	Ground	Vegetation	Rail	Poles	Wires	Signalling	Fences	Installation
RF	0.91	0.64	0.62	0.90	0.82	0.77	0.89	0.08	0.94	0.08
KPCnv	0.97	0.81	0.92	0.96	0.79	0.96	0.99	0.67	0.97	0.23
LightGBM	0.93	0.67	0.68	0.92	0.86	0.78	0.88	0.16	0.85	0.20



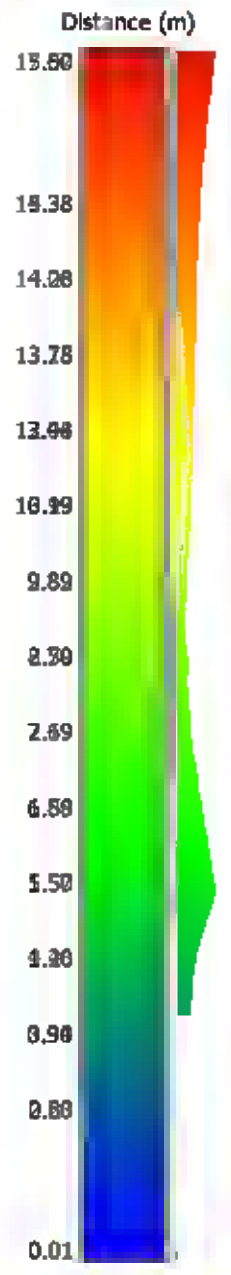
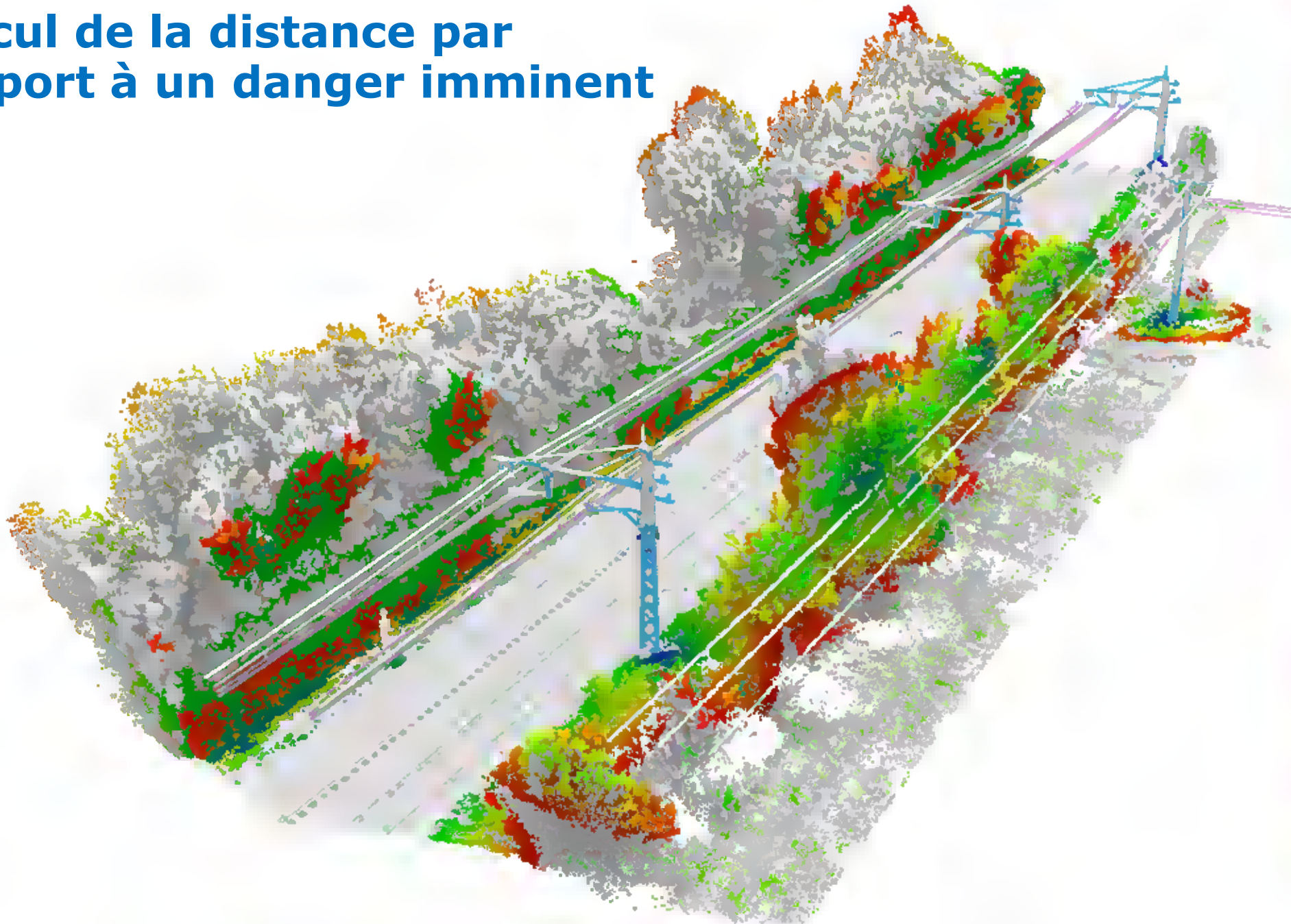


**Le nuage de points classifié n'est pas
le livrable en soi, mais facilite le
processus de création de celui-ci.**

Regroupement pour l'individualisation des poteaux



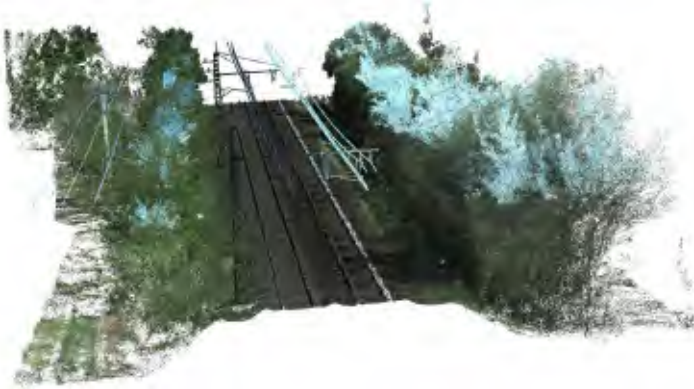
Calcul de la distance par rapport à un danger imminent



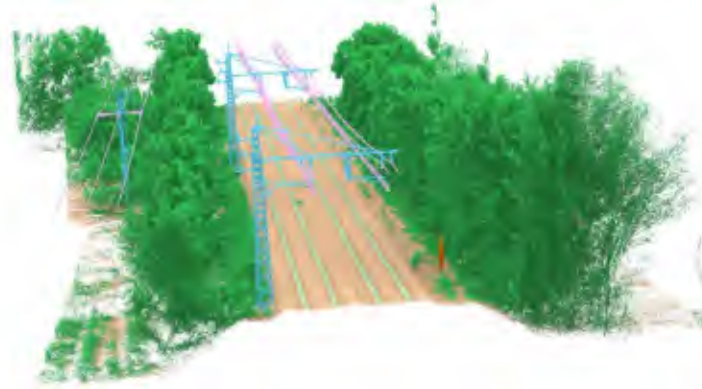
Travaux futurs et conclusion



- 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 Francisco 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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