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Cartographie du changement à l'aide des nuages de points LiDAR

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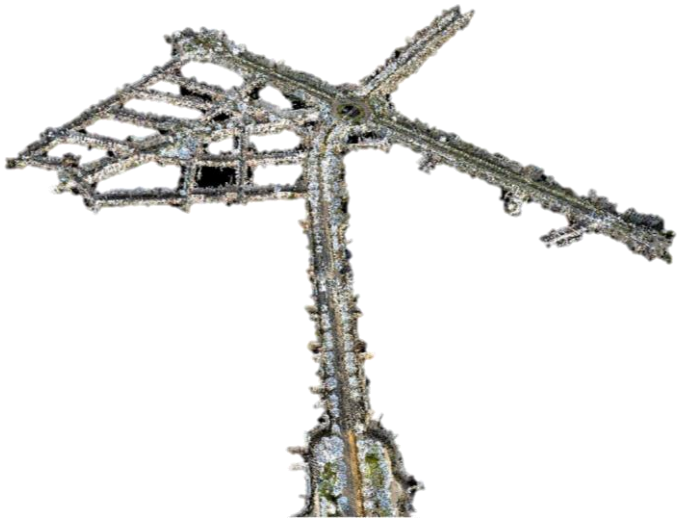
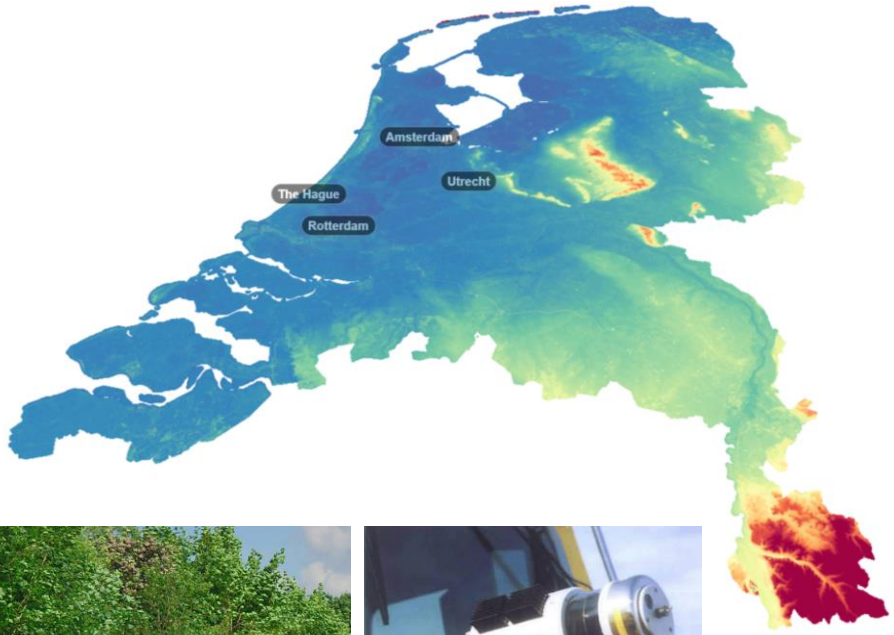
LIÈGE université
Geomatics

NGI Nationaal Geografisch Instituut
IGN Institut Géographique National

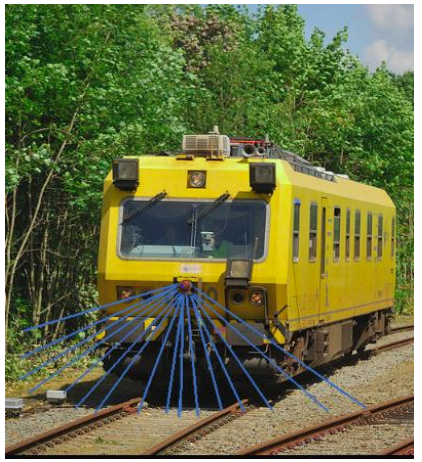
.AGORIA
CO-FOUNDING PARTNER

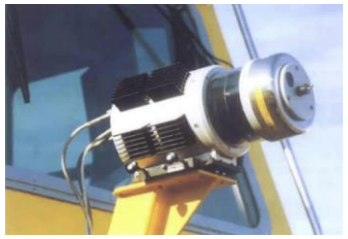
Context





Credit: Brussels urbis





Link: https://potree.entwine.io/data/ahn.html

3D Change detection

From a time-serie, detect locations where changes occurred over time, e.g:

- Man-made changes: appearance/disappearance of building,...
- Natural changes: vegetation growth, deforestation, flooding, fires,...
- Variations of terrain: glacier displacements, land subsidence,...

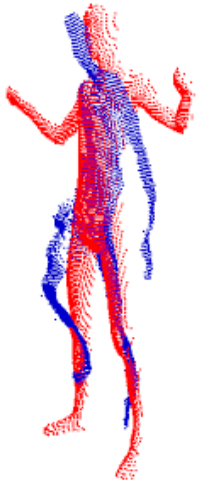
Change types

Seasonal changes

Credit: Matheus B. Vicari, al (2019)

Furniture moved
in between scans

Credit: Gianpaolo Palma, al (2015)



Walking person

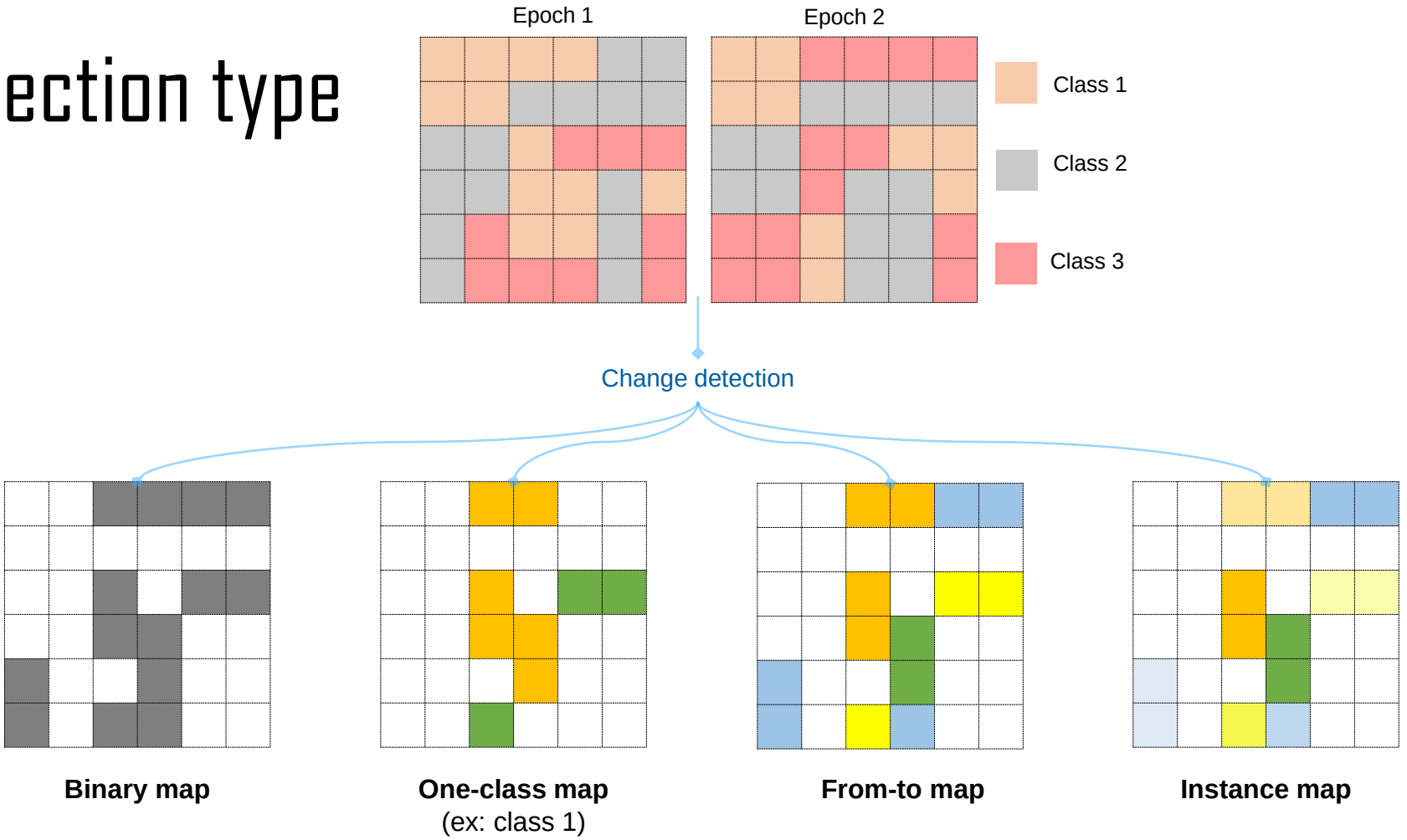
Credit: Mao Ye, al (2011)

Slow
long-term changes

Rigid and/or non-rigid

Fast
Short-term changes

3D Change detection type

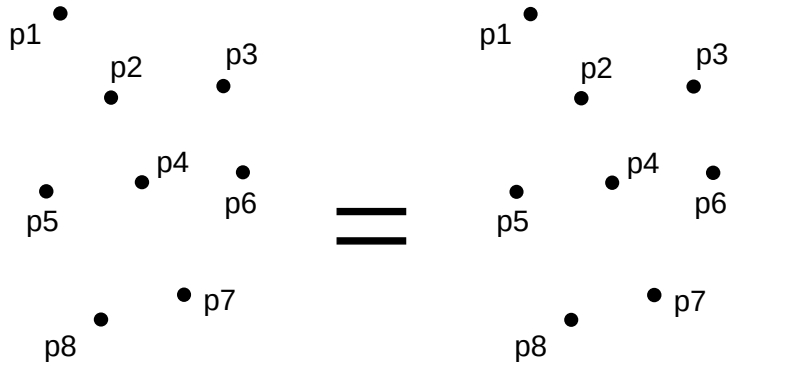


Pre-, during-, and post-classification change detection

Pre-classification	• No semantics • No change type
During-classification	• Interaction and refinement of classification process
Post-classification	• Results are highly impacted by the classification quality • Multiplicative errors

Thi Huong Giang Tran, al (2017)

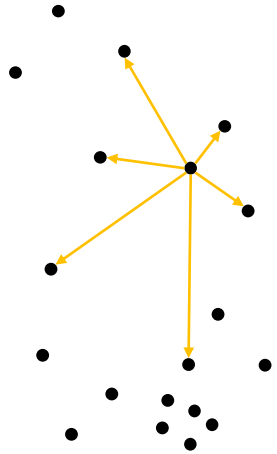
Change detection problem



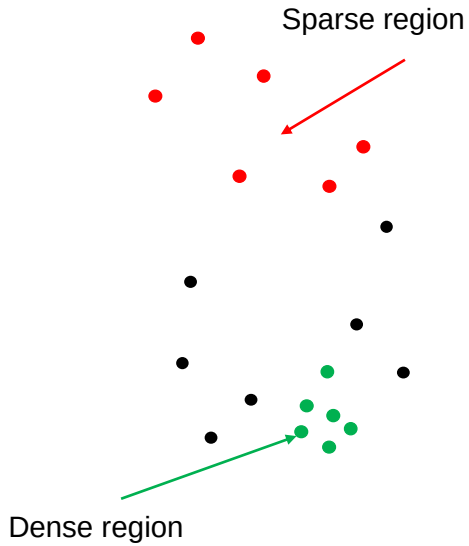
{p1, p2, p3, p4, p5, p6, p7, p8}

{p5, p8, p4, p3, p6, p2, p1, p7}

Unordered



Unstructured

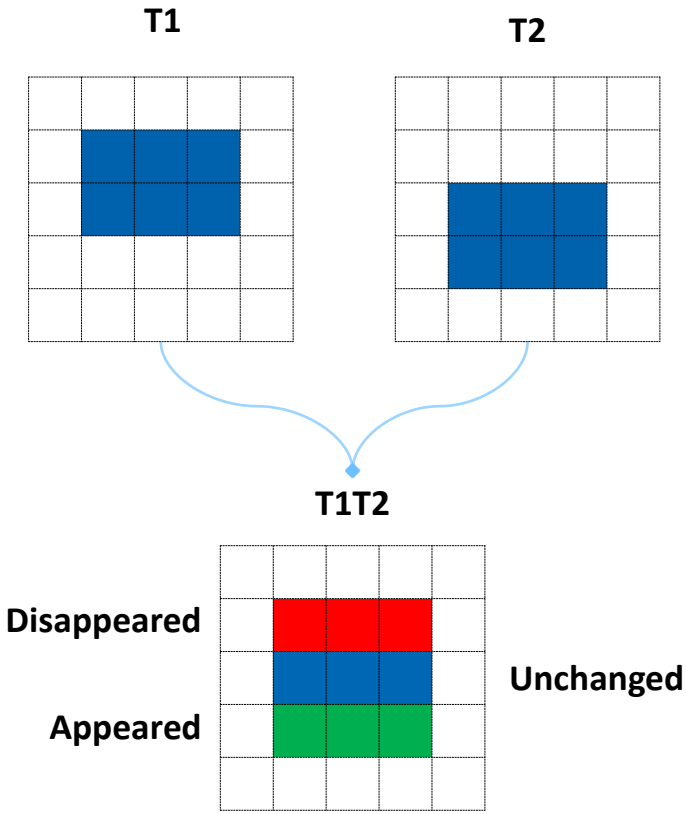


Irregular

Sensitive to: Clutter Noise, Occlusion, Co-Registration error
Specifities: Multi-direction and multi-view

Case 1: moving objects

Same object but change detected

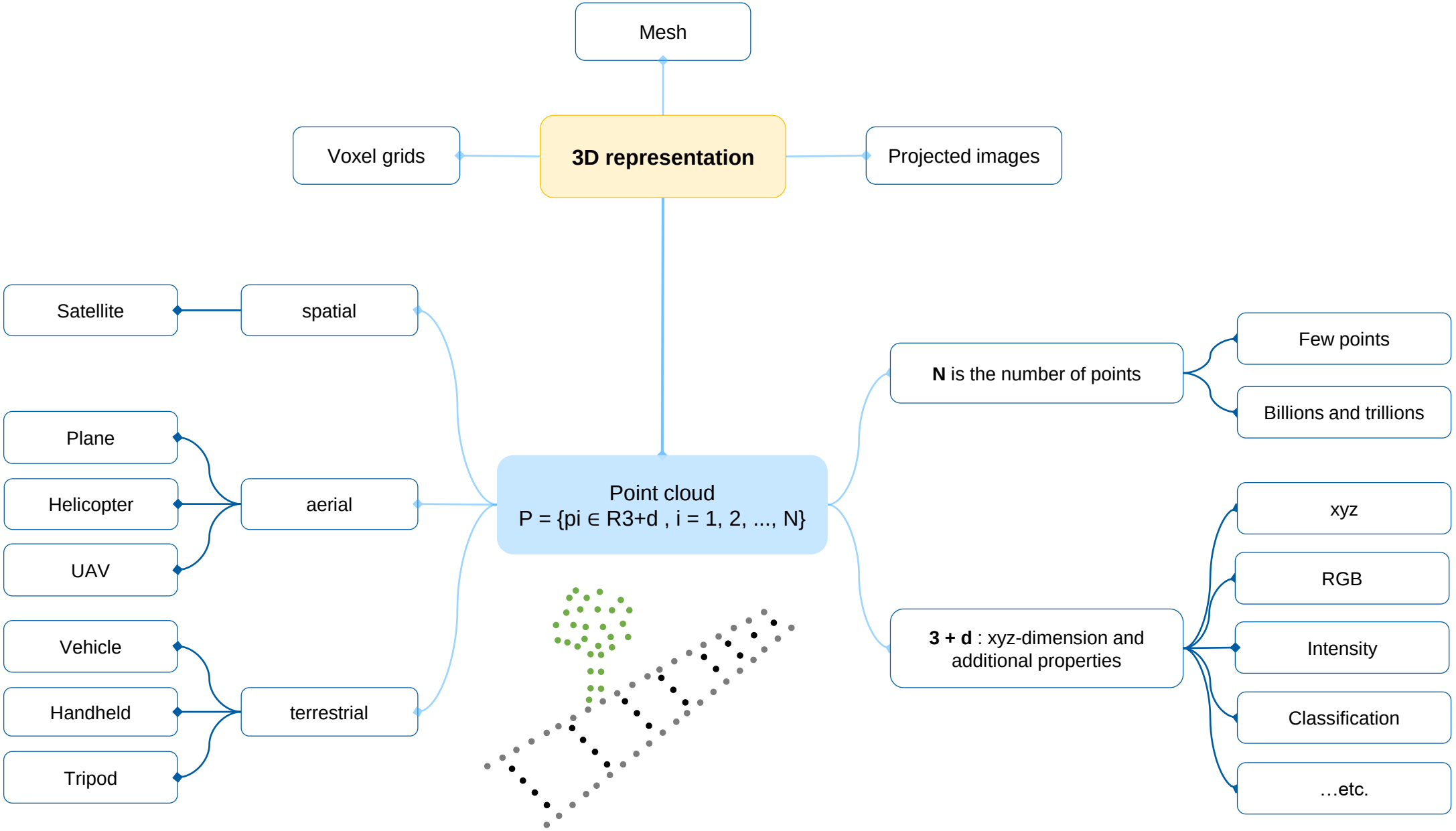


Case 2: Similar objects

Different object but no change detected

Credit : Evan Herbst, al (2011)

Essentially you must MINIMIZE changes due to characteristics you are NOT interested in, in order to IDENTIFY changes you ARE interested in.


Mesh
Voxel grids
3D representation
Projected images
Satellite
spatial
Plane
Helicopter
UAV
aerial
Vehicle
Handheld
Tripod
terrestrial
Point cloud
P = {pi ∈ R3+d , i = 1, 2, ..., N}
N is the number of points
Few points
Billions and trillions
3 + d : xyz-dimension and additional properties
xyz
RGB
Intensity
Classification
…etc.

Standard approach

- Co-registration
- Resampling
- Errors estimation

- Reducing noise
- Handling missed data

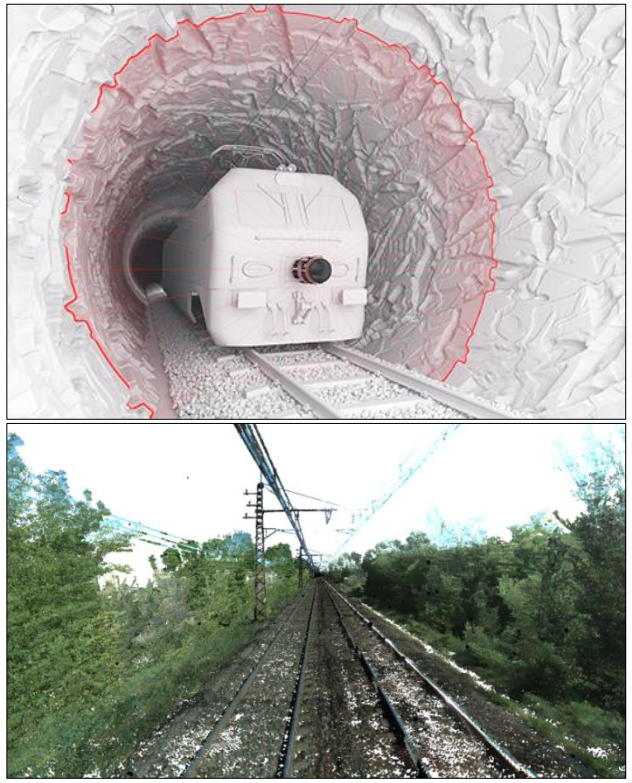
- Reference scene
- Moving scene

Point to point differencing

Approaches

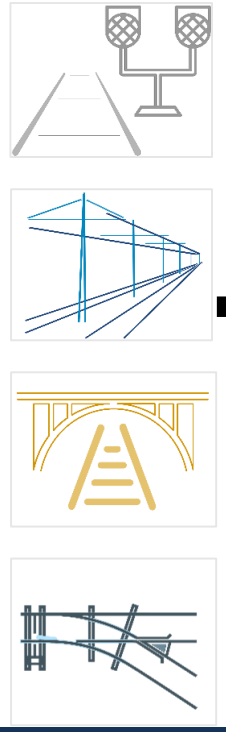
- Image differencing methods
  - Subtract High value of one date from another
  - Select a threshold to identify change
  - Results in positive and negative values areas of change and zero (in theory) in areas of no change
- C2C (Cloud to cloud)
- M3C2 (Multiscale Model to Model Cloud Comparison)
- Machine learning with handcrafted features
- Deep learning

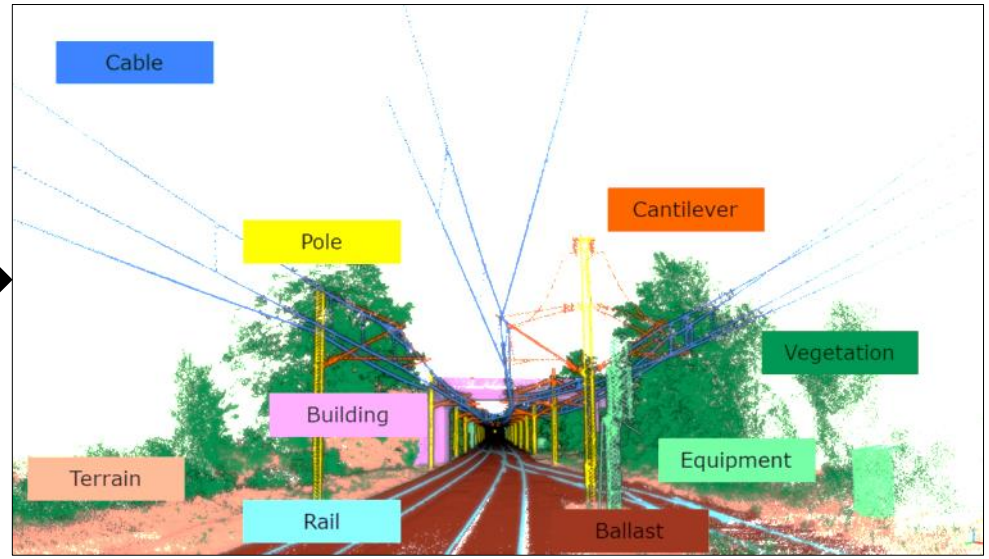
Make sense of the captured data !



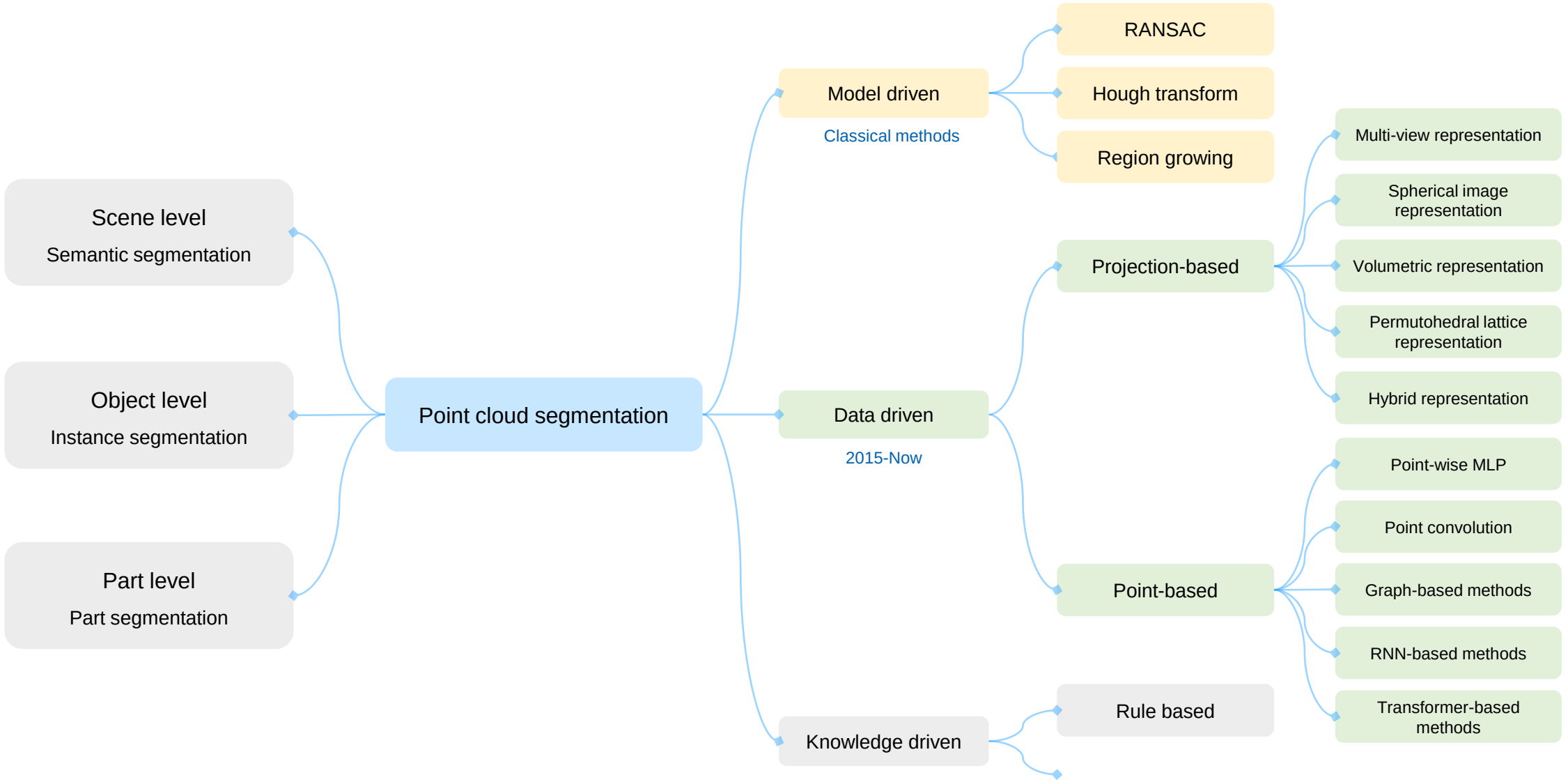
Raw 3D data (1),(2)

Semantics



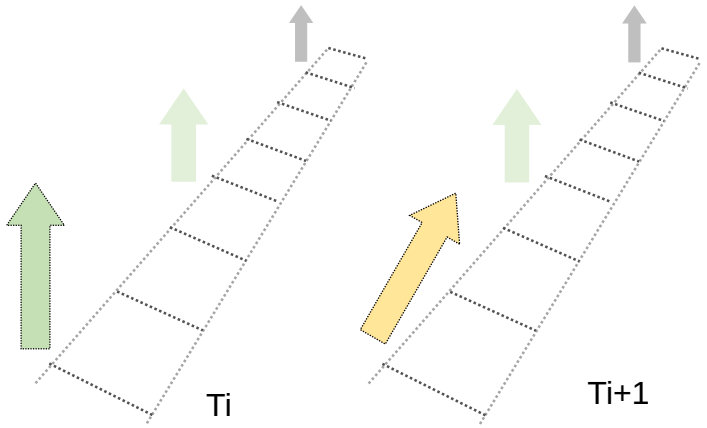


Our goal: Turning data into information (3)

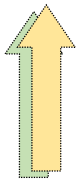

Scene level
Semantic segmentation
Object level
Instance segmentation
Part level
Part segmentation
Point cloud segmentation
Model driven
Classical methods
RANSAC
Hough transform
Region growing
Data driven
2015-Now
Projection-based
Multi-view representation
Spherical image representation
Volumetric representation
Permutohedral lattice representation
Hybrid representation
Point-based
Point-wise MLP
Point convolution
Graph-based methods
RNN-based methods
Transformer-based methods
Knowledge driven
Rule based

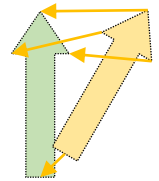
Make sense of the captured data !

P= $\{P_k \in R^{3*N_k}\}_K$ Q= $\{Q_l \in R^{3*M_l}\}_L$



T(p) = R*p + t
where t ∈ R3 is the translation and
R ∈ SO(3) is the rotation



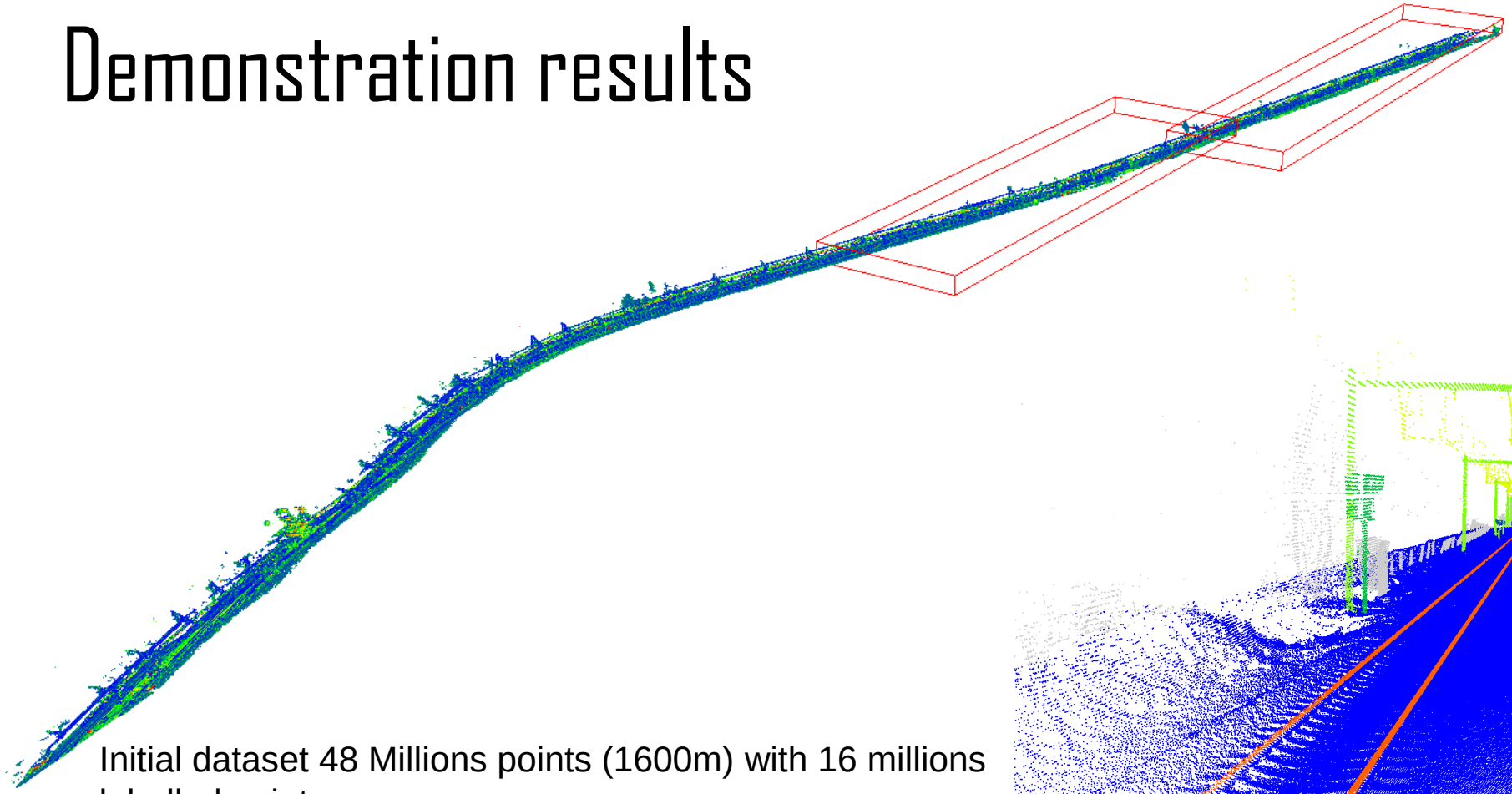


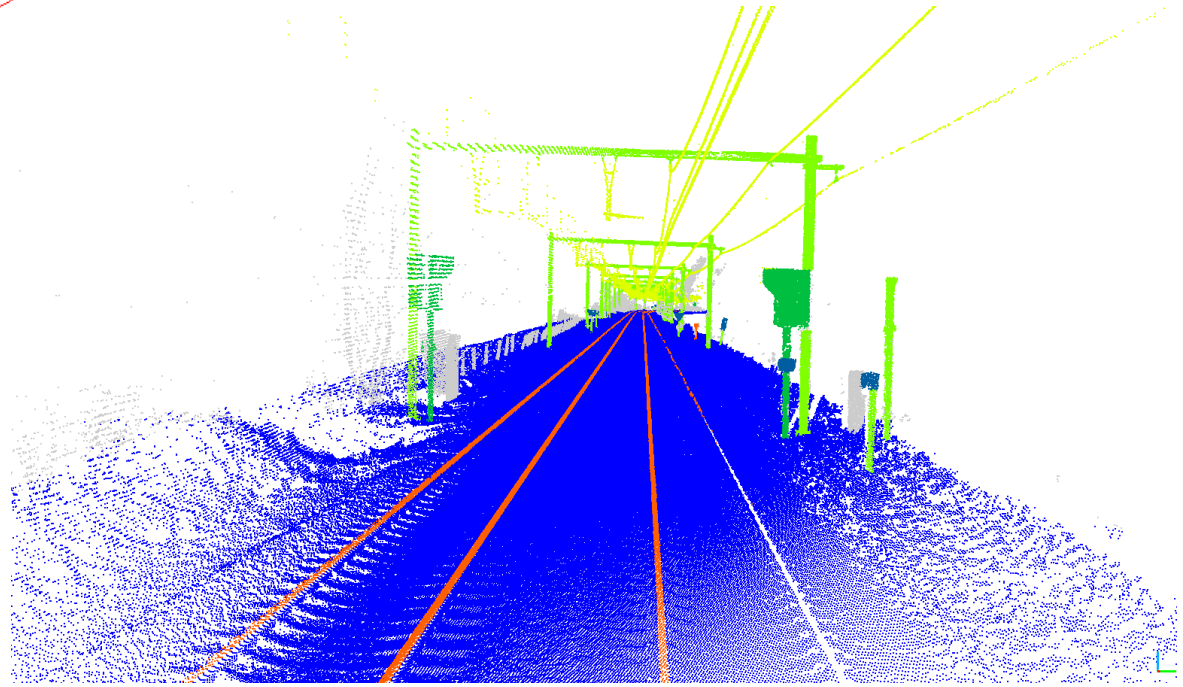
1. Enriched point clouds (object level)

2. Object registration

3. Correspondence

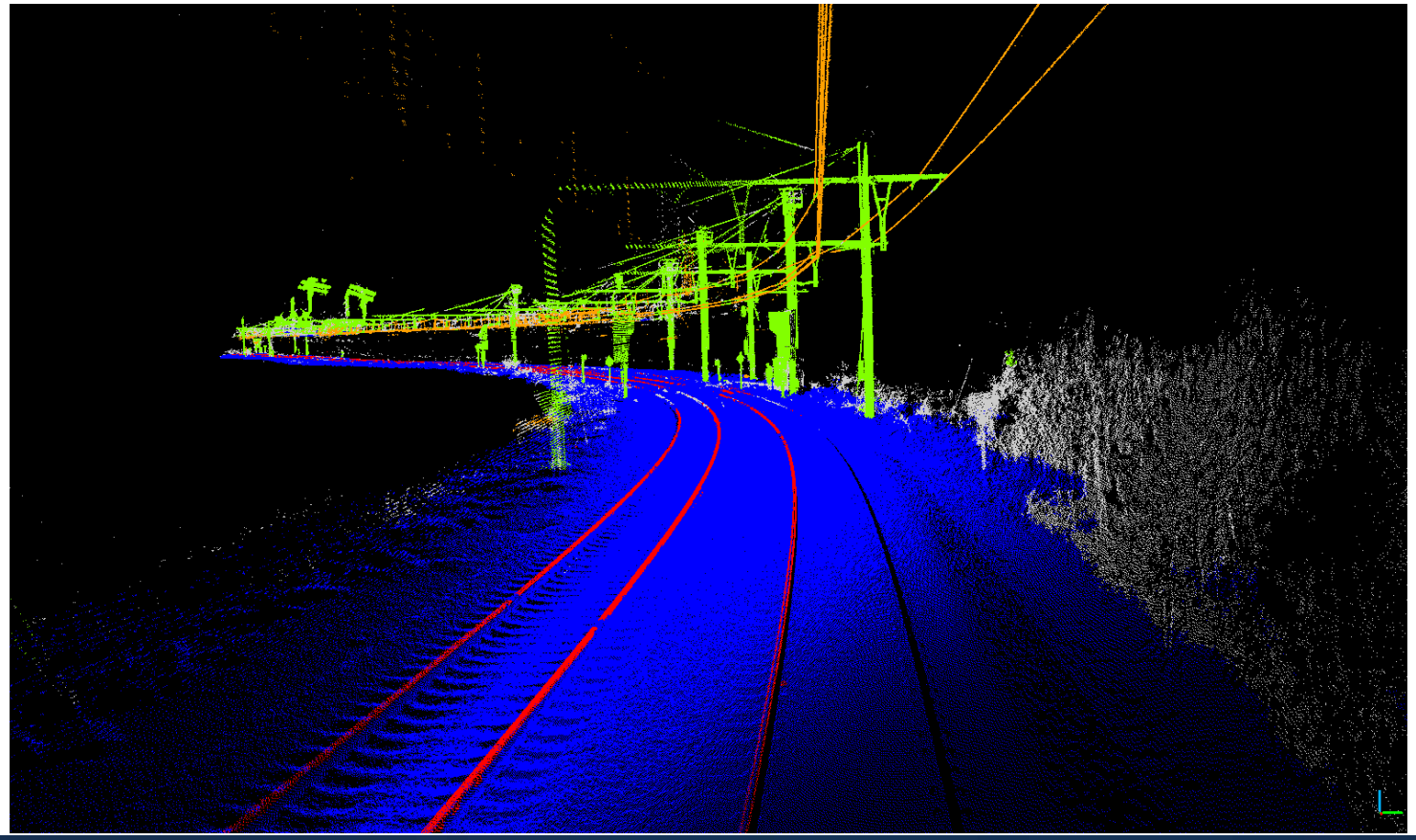
Demonstration results





Initial dataset 48 Millions points (1600m) with 16 millions labelled points

Demonstration results



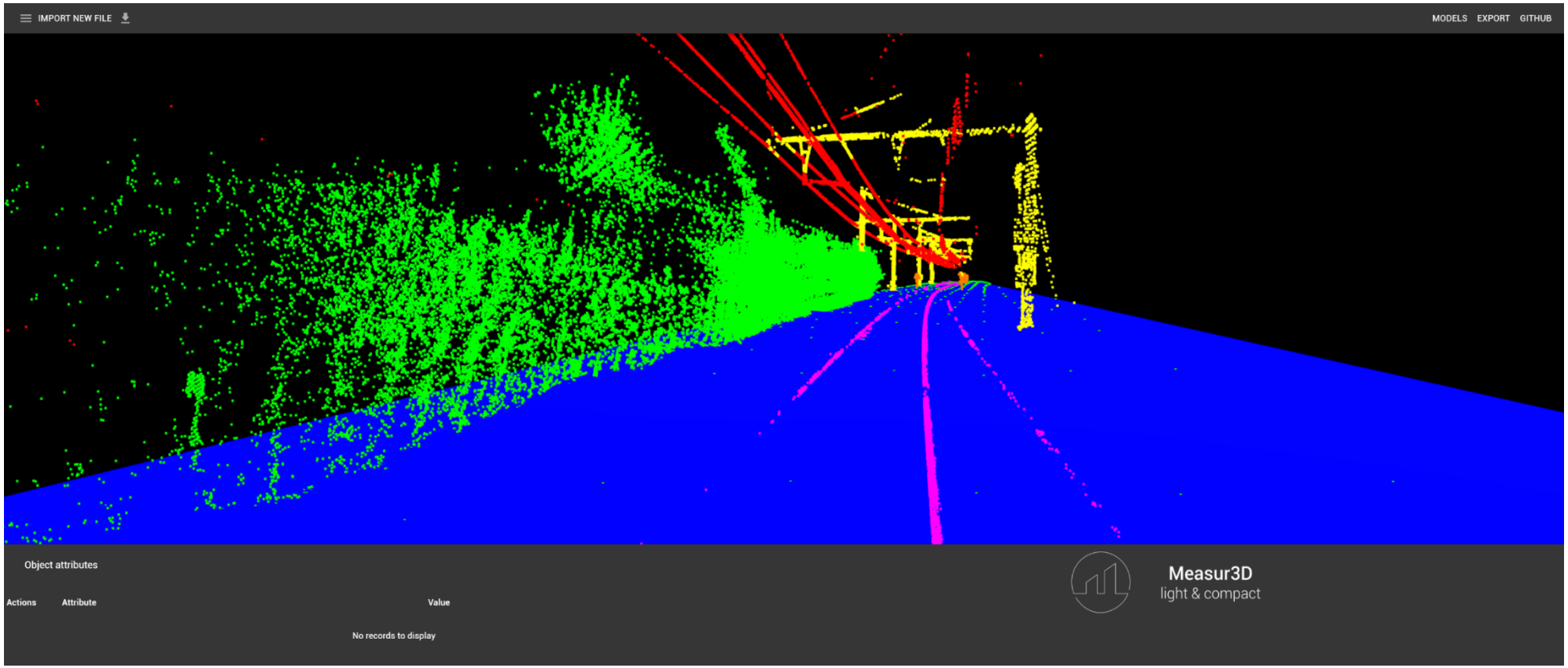
Semantic segmentation for railways using RandLA-Net

CityJSON extension for point cloud

CityGML is an open data model and XML-based format for the storage and exchange of virtual 3D city models.

CityJSON is an open data format for distributing 3D city models (also known as digital twins), and a JSON-encoding of the CityGML data model.

Point Cloud and 3D GIS for web



Gilles Antoine Nys:
https://ganys.github.io/Measur3D/

Do not hesitate to contact me !

Abderrazzaq Kharroubi

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My Publications

1. Abderrazzaq Kharroubi, Rafika Hajji, Roland Billen, Florent Poux. **Classification and integration of massive 3d points clouds in a virtual reality VR environment**. ISPRS - International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences. (**2019**).
2. Abderrazzaq Kharroubi, Roland Billen, Florent Poux. **Marker-less mobile augmented reality application for massive 3d point clouds and semantics**. ISPRS - International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences. (**2020**).
3. Abderrazzaq Kharroubi, Line Van wersh, Roland Billen, Florent Poux. **Tesserae3d: a benchmark for tesserae semantic segmentation in 3D point clouds**. ISPRS - International Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences. (**2021**).
4. Gilles-Antoine Nys, Abderrazzaq Kharroubi, Florent Poux, Roland Billen. **An extension of CityJSON for the support of 3D point clouds**. ISPRS - International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences. (**2021**).
5. Rafika Hajji, Abderrazzaq Kharroubi, Youssef Benbrahim, Zidane Bahhane and Adil El Ghazouani. **Integration of BIM and Mobile Augmented Reality in the AECO Domain**. ISPRS - International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences. (**2021**).