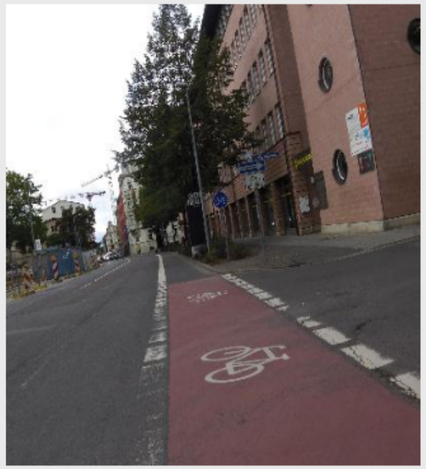
On the road to 3D semantic segmentation

FOSS4G 2022 - Firenze (and elsewhere…)

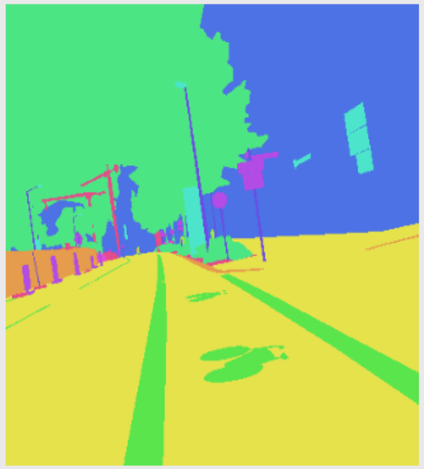
Introduction

Semantic segmentation

Raw image

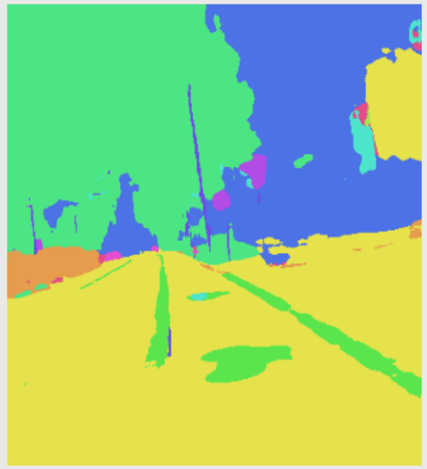


Ground-truth



barrier flat human
marking nature object
structure support
traffic-sign vehicle void

Prediction



barrier flat human
marking nature object
structure support
traffic-sign vehicle void

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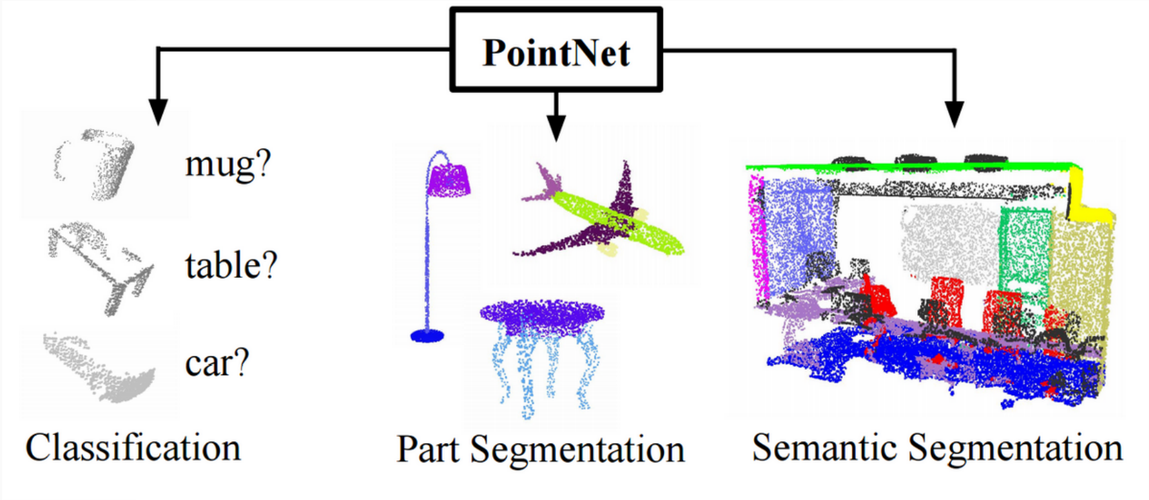
Methodology

⚠️ Focus on semantic segmentation ⚠️



(source: Pointnet)

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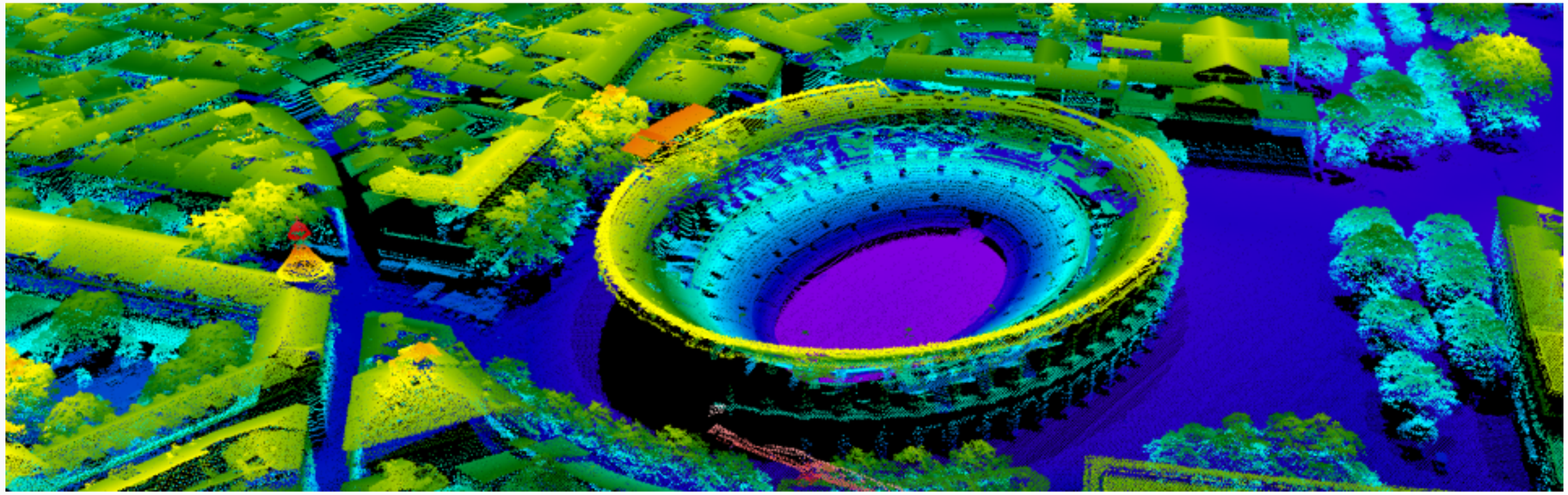
3D Data



LidarHD program (France, IGN)

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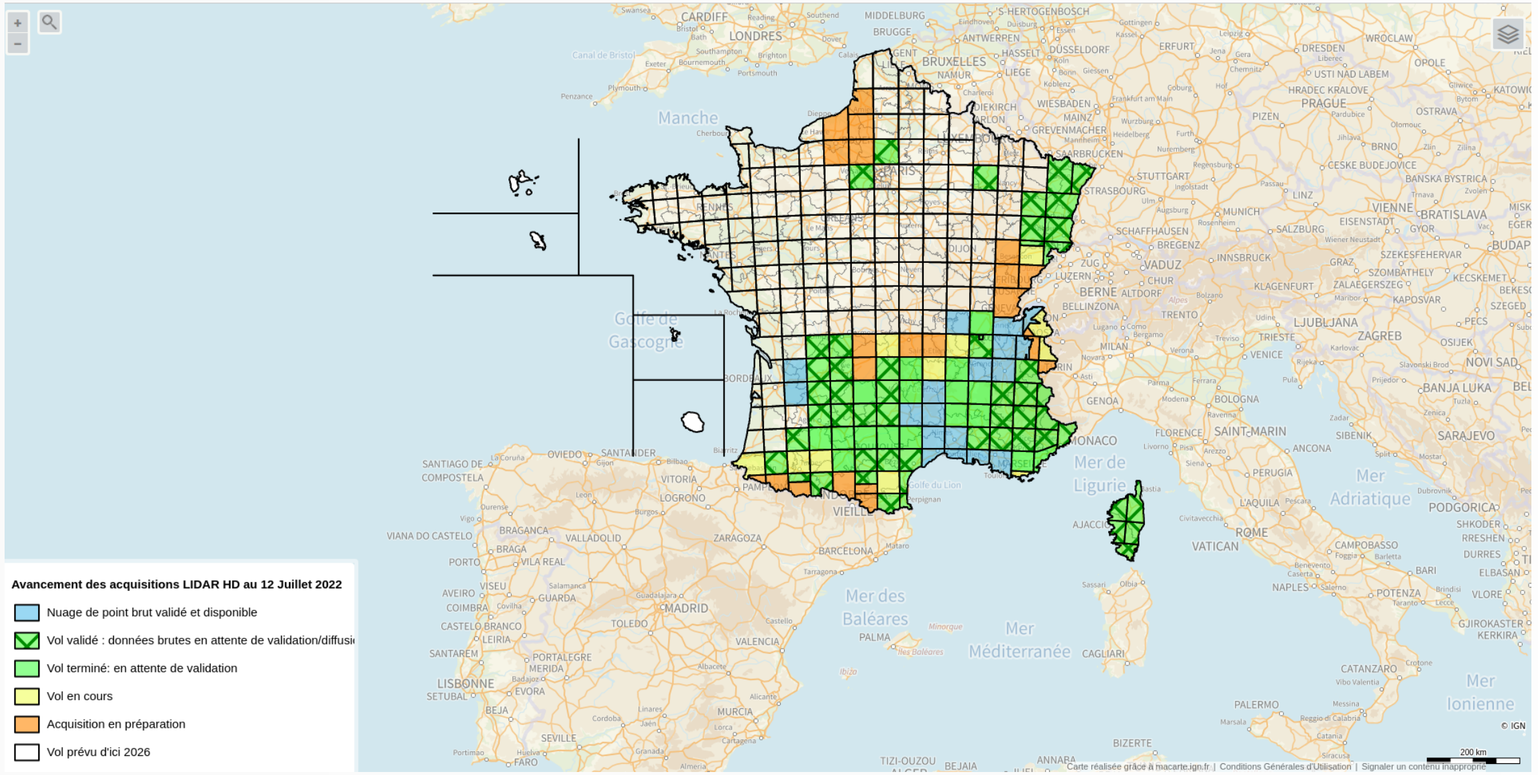
3D Data



LidarHD program (France, IGN)

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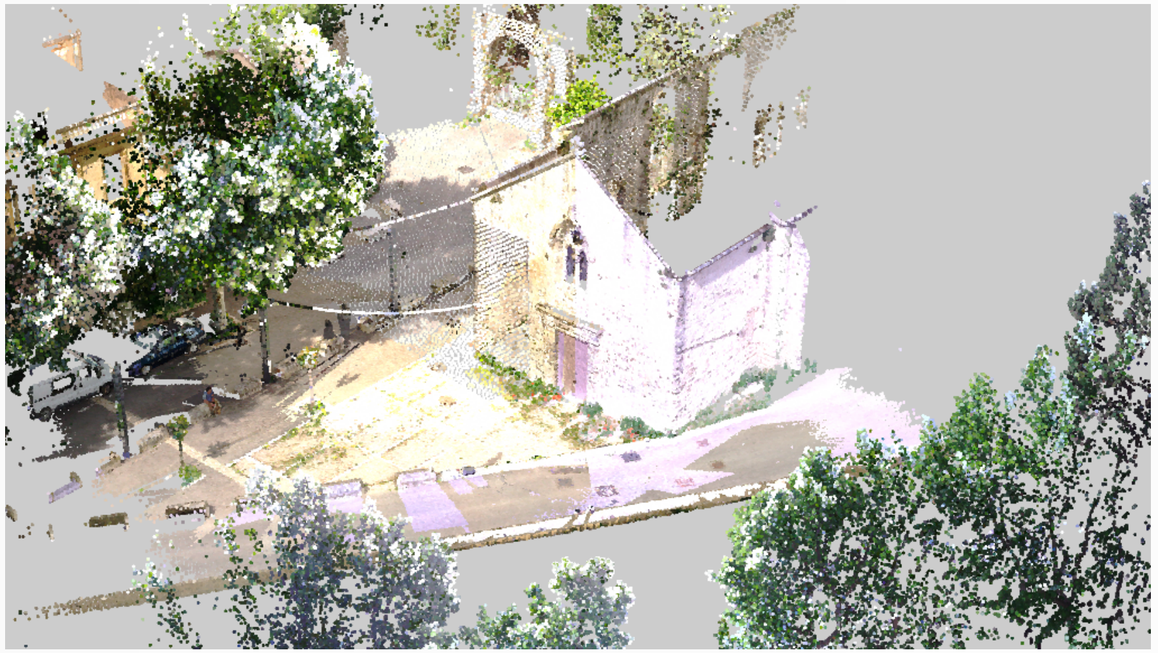
Methodology

⚠️Focus on point clouds⚠️



(source: Giro3d)

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Outline

- 3D semantic segmentation state of the art
- Case study: geo3dfeatures
- Go deeper towards BIM applications
- Conclusion

3D semantic segmentation state of the art

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Geometric structures

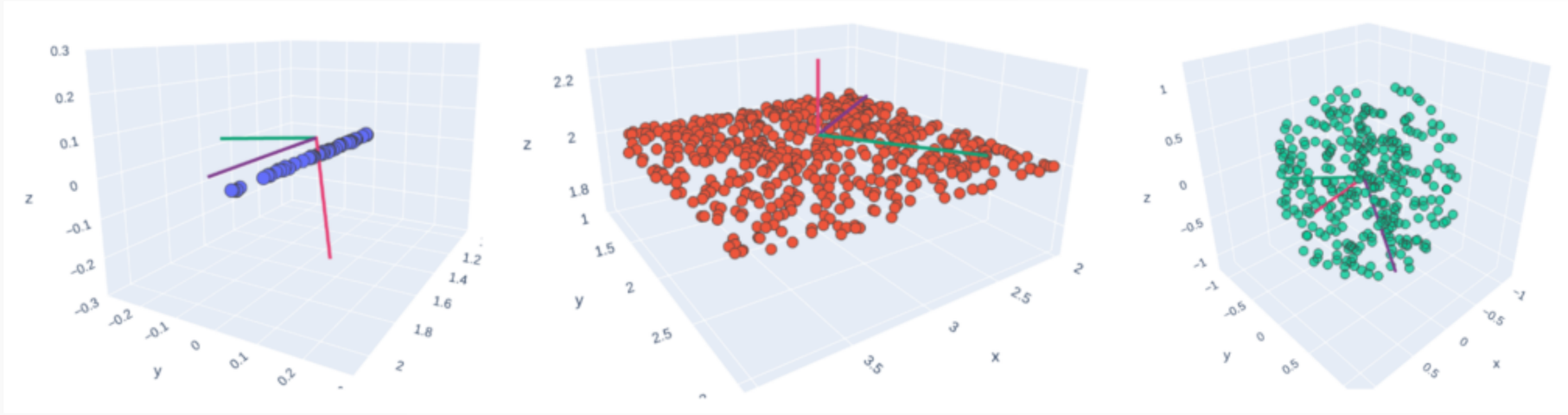
Do this local point cloud samples represent walls? a roads? a trees? …?

Quite hard to decide only with colors (like in 2D)…

Geometric structures

The key point of 3D semantic segmentation: local geometric structures! (Weinmann et al, 2015)

- Notions: Normal, eigenvalues, eigenvectors
- Methods: `KD-Tree`, PCA, …



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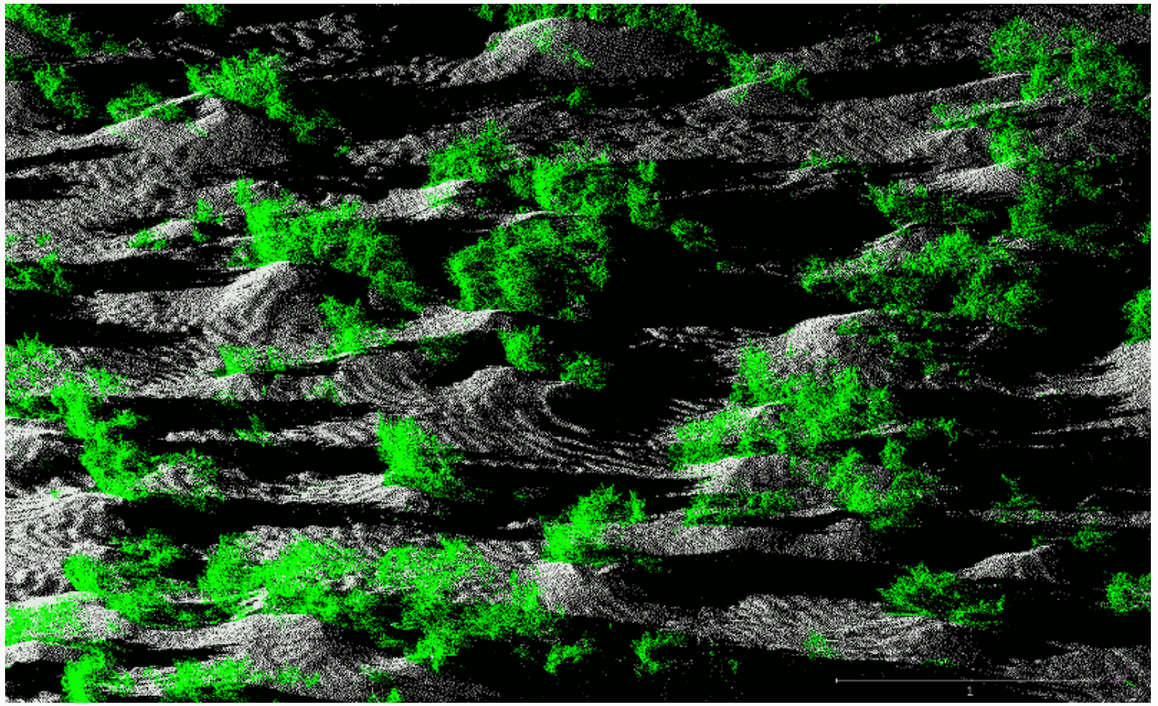
Geometric structures



(source: Canupo, bonus: CloudCompare plugin)

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Simple semantic segmentation

How to exploit a point cloud, starting from `(x, y, z)` coordinates?

Let’s apply machine learning!

… hum, wait… Have we got a labelled dataset?

Simple segmentation methods

Raw point cloud
Clustering (K-Means)
Classification (Logistic regression)

(Source: geo3dfeatures)

Neural networks

Many approaches!

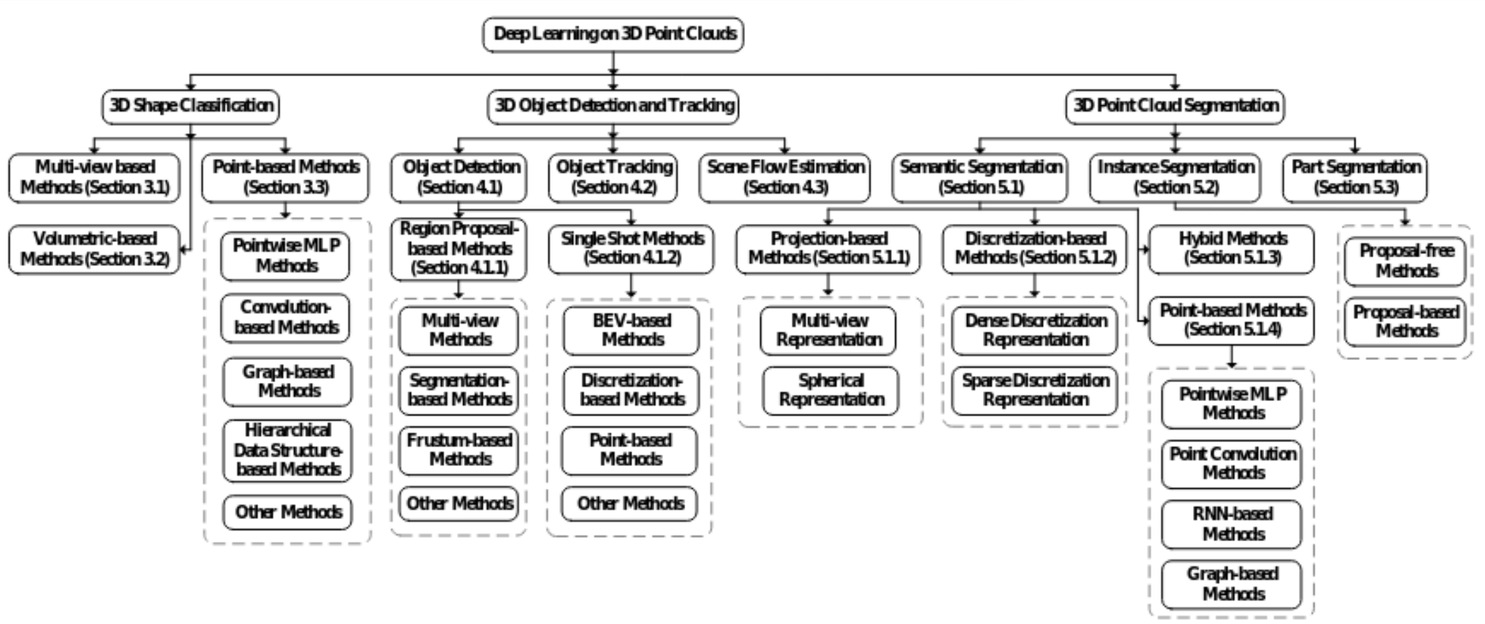

Fig. 1: A taxonomy of deep learning methods for 3D point clouds.

(source: Guo et al, 2019)

Neural networks

Amongst other approaches:

- 2D-3D conversions (Tchapmi et al, 2017)
- Point-wise methods (PointNet++, 2017)
- 3D Convolutions (Thomas et al, 2019)
- More recent methods:
  - PointMixer (Choe et al, 2021)
  - PointTransformer (Zhao et al, 2021)
  - Weak supervision (Xu et al, 2020)

Case study 1: geo3dfeatures

Context

Univers challenge #1 (fr) (2017-2019)

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Results

Raw point cloud
Clustering (K-Means)

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Results

Raw point cloud
Clustering (K-Means)
Classification (Logistic regression)

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An open project!

gitlab.com/Oslandia/geo3dfeatures

Case study 2: IASBIM

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IASBIM project

- Ongoing R&D project
- Goal: use AI for semantic segmentation into BIM datasets?

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What’s this, BIM?

- Building Information Modelling (geometry, information and documentation data)
- Still hard to adopt:
    - tool complexity and costs
    - data collection cost

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IASBIM project

- Make the scan-to-BIM process easier

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Conclusion

Conclusion and perspectives

- Really challenging topic!
- Quite mature in a research perspective… it’s time for building industrial solutions!
- Ongoing work at Oslandia with R&D efforts

Snow

Thank you for your attention!

rdelhome/delhomer

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(Oslandia on-site: stand 25)

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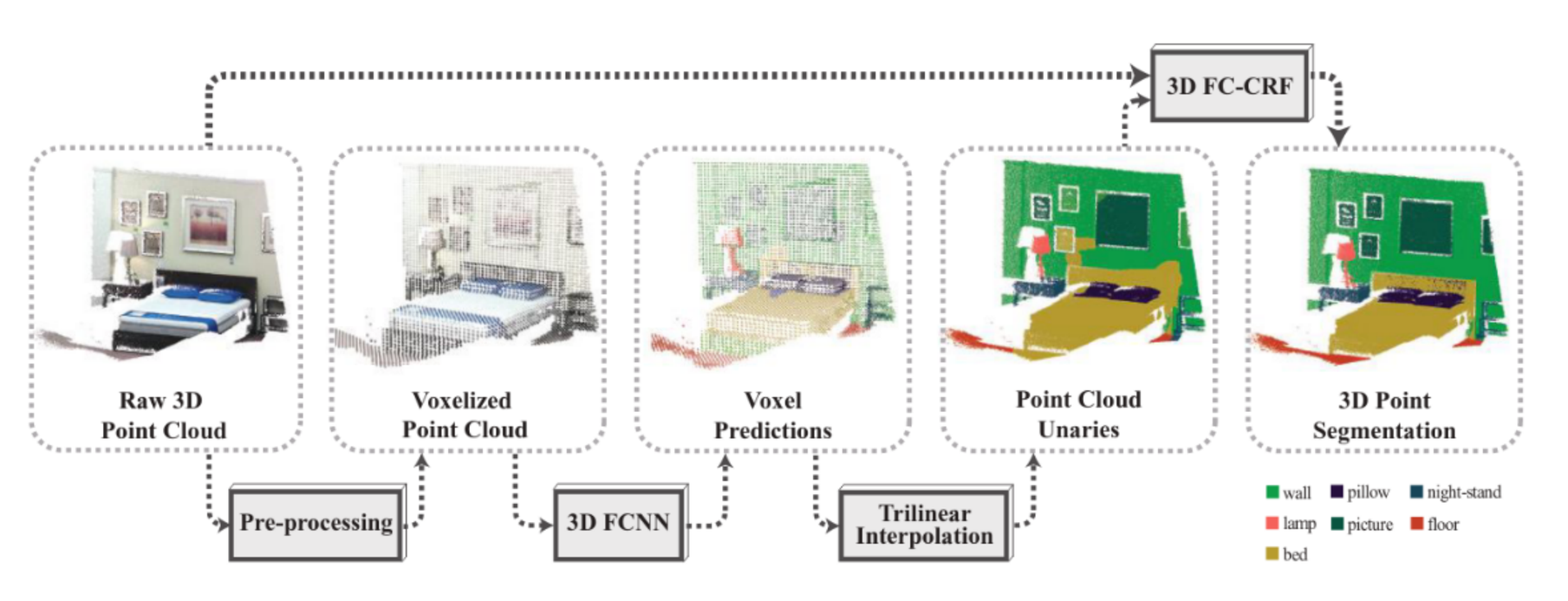
2D-3D conversions



(Source : Tchapmi et al, 2017)

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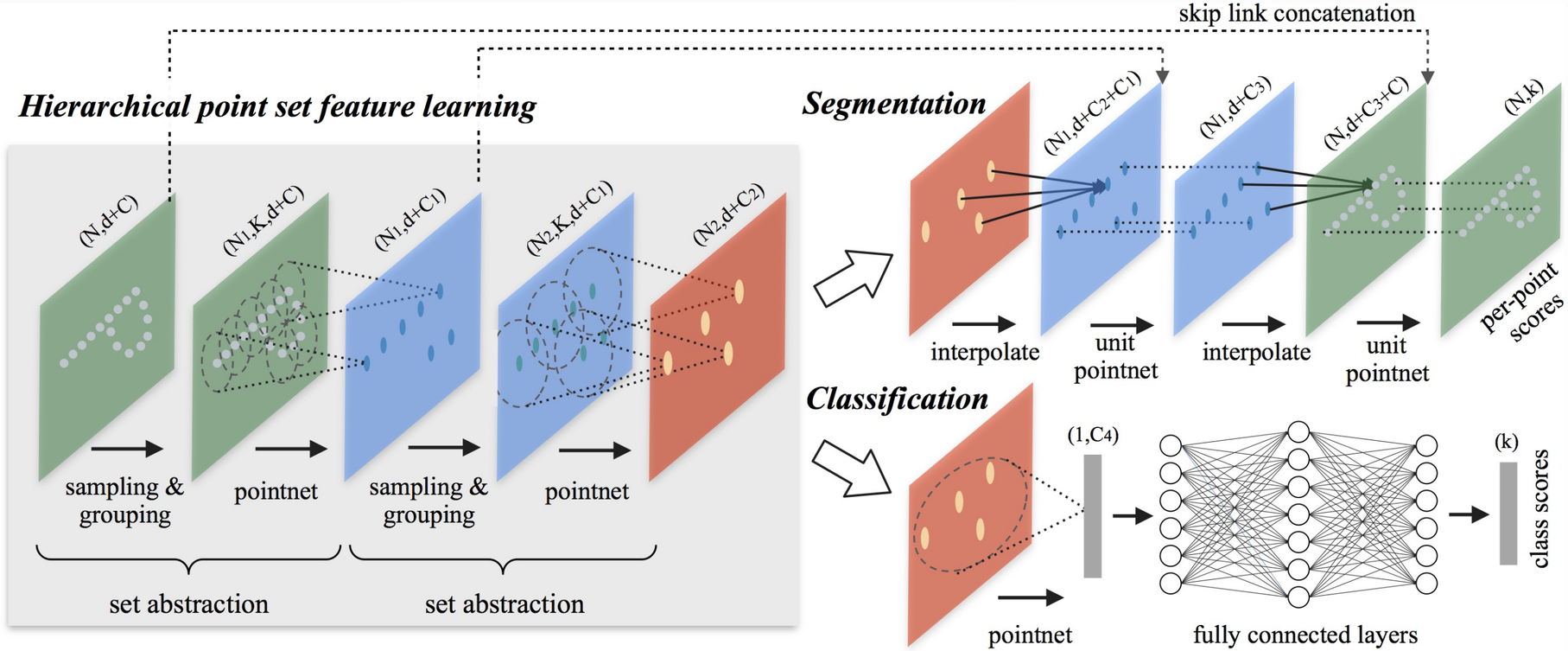
Point-wise methods



(Source: PointNet++, 2017)

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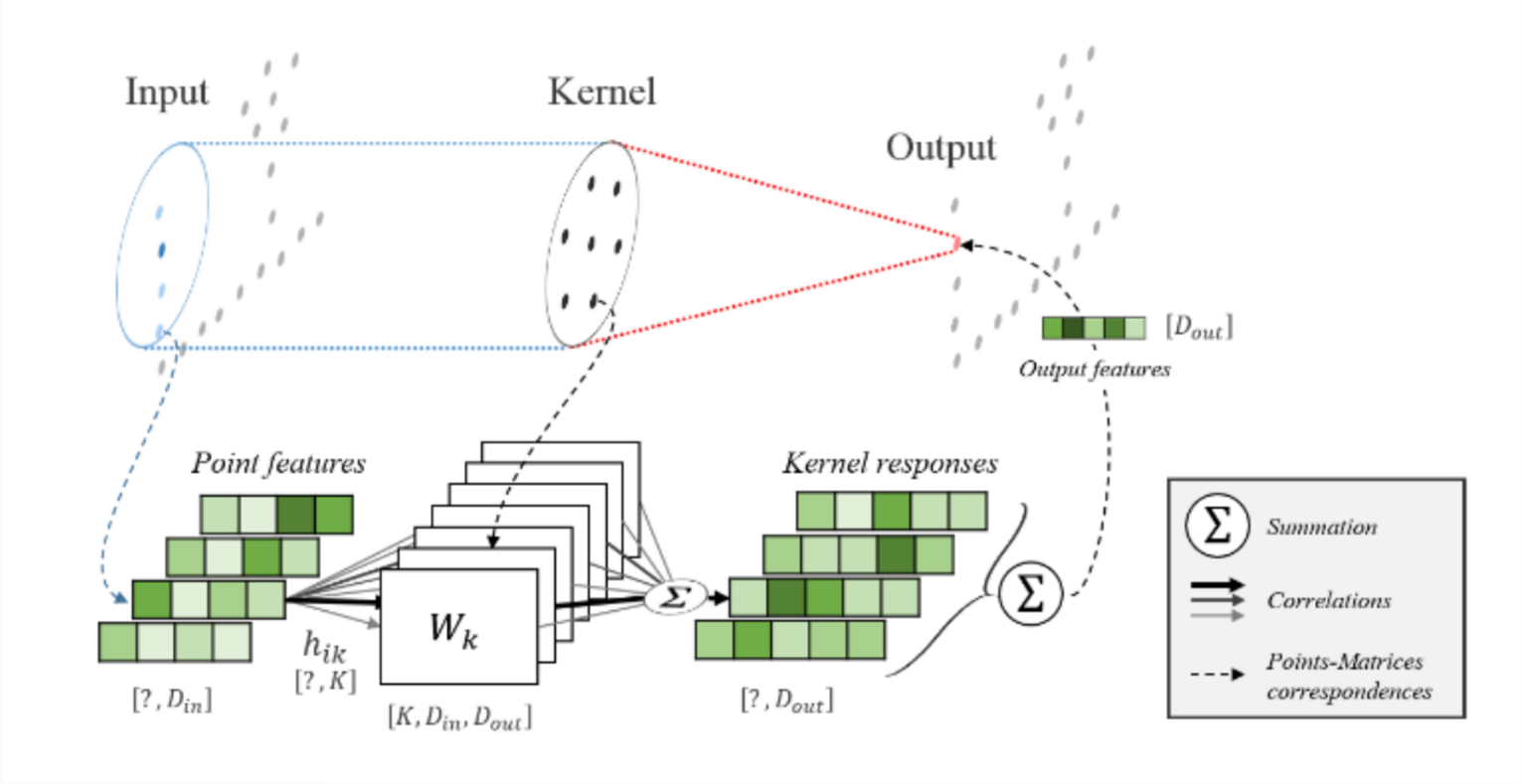
Exploit convolutions



(Source: Thomas et al, 2019)

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