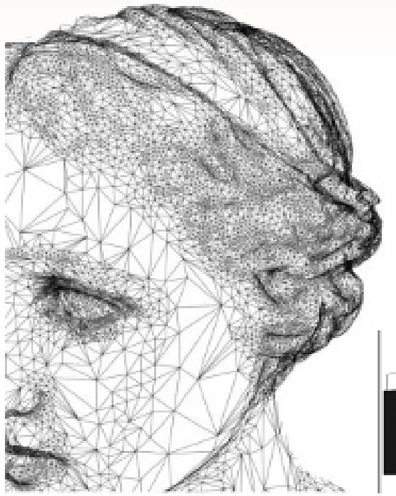

LTTM

THESIS PROPOSALS

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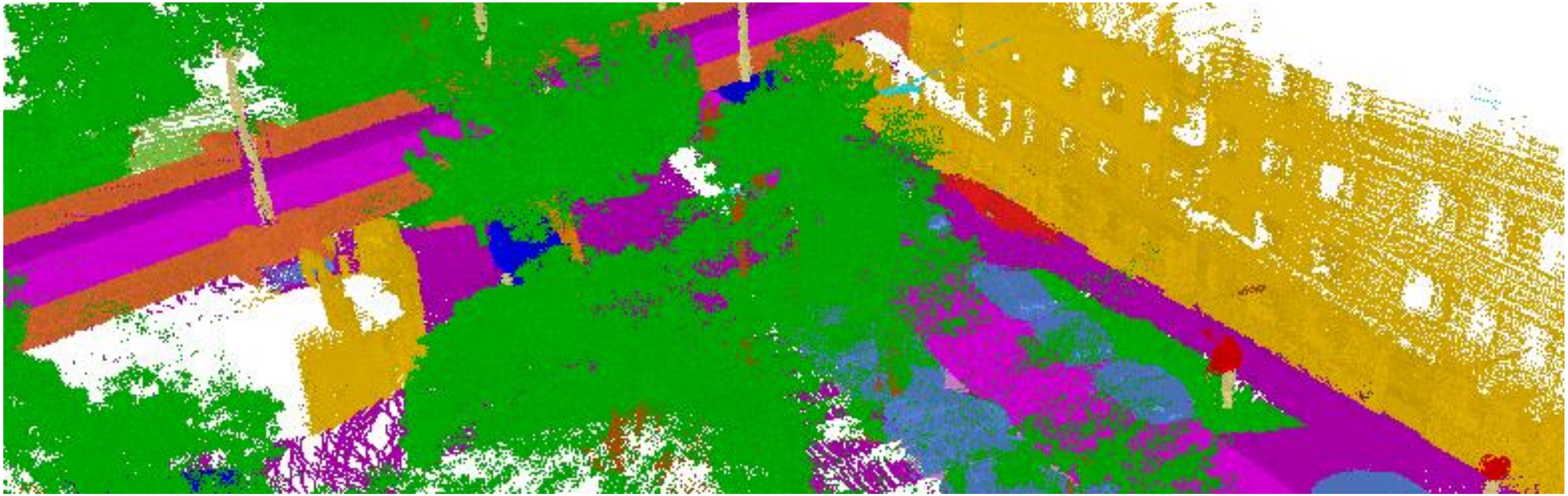


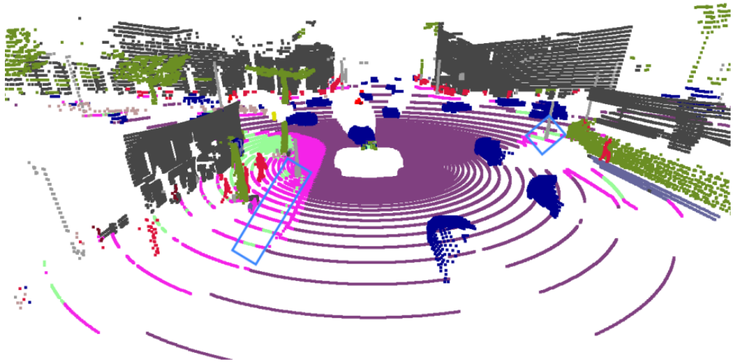
POINT CLOUD SEMANTIC SEGMENTATION

DEEP LEARNING, SCENE UNDERSTANDING

CO-SUPERVISOR: **ELENA CAMUFFO** (*PHD STUDENT*) elena.camuffo@unipd.it

TOPIC #1: Synthetic Data Transfer Learning in PCSS

Programming in Python (+Pytorch)



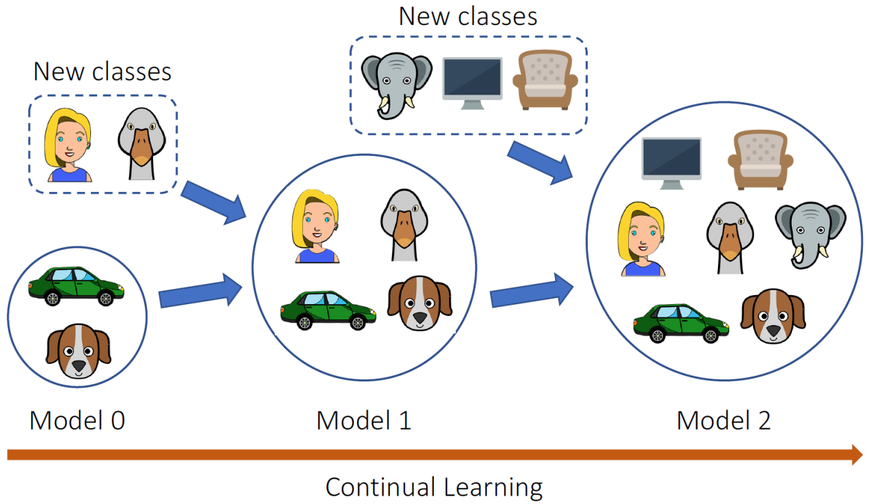
- Point Cloud Semantic Segmentation (PCSS) is the computer vision task of **recognize objects inside a three-dimensional scene**, assigning to each 3D point a label that determines to which object the point belongs.
- Point Clouds are data that can be obtained with different acquisition methods [1,2] and depending on that present peculiar characteristics. Especially, **synthetic point clouds** present different data distributions with respect to real data.
- State-of-the-art models (RandLA-Net, RangeNet++, Cylinder3D etc.) usually benchmark on popular real static/dynamic datasets (e.g., SemanticKITTI, S3DIS etc.) but not yet many examples exist on synthetic data, as they **need the network to adapt** to learn such data.
- The objective of this thesis is to make use of learning strategies, such as **Domain Adaptation** (a special case of *Transfer Learning*), to make the network able to deal both with real and synthetic point clouds.
- State-of the-art models and data will be used, together with **our dataset SELMA** [3] (https://scanlab.dei.unipd.it/selma-dataset).

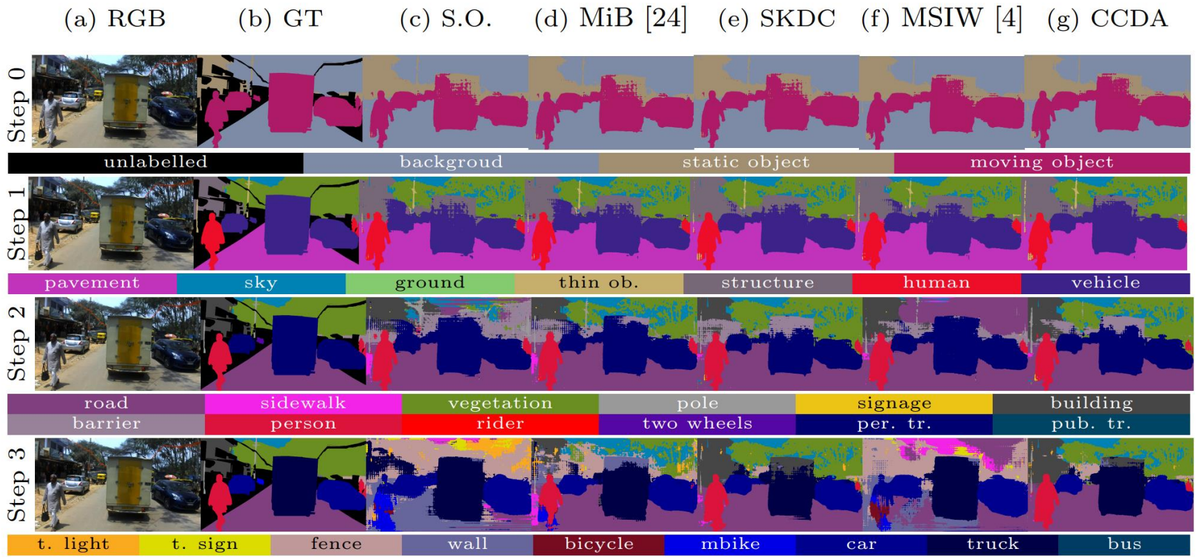
[1] Camuffo et al. "Recent Advancements in Learning Algorithms for Point Clouds", 2022.
[2] Gao et al. "Are We Hungry for 3D LiDAR Data for Semantic Segmentation? A Survey and Experimental Study", 2021.
[3] Testolina et al. "SELMA: SEmantic Large-scale Multimodal Acquisitions in Variable Weather, Daytime and Viewpoints", 2022.

TOPIC #2: Coarse-to-fine Continual Learning in PCSS

Programming in Python (+Pytorch)

- Point Cloud Semantic Segmentation (PCSS) is the computer vision task of **recognize objects inside a three-dimensional scene**, assigning to each 3D point a label that determines to which object the point belongs.
- **Class-Incremental Continual Learning (CL)** is a well-known problem in Deep Learning aiming at developing artificially intelligent systems that can continuously learn to address new tasks from new data while preserving knowledge learned from previously learned tasks [2,3].
- Incremental Learning has been widely applied to images, but no previous literature exists in its application to point clouds. The different nature of such data [1] implies to rethink the concepts established for images.
- The objective of this thesis to adapt some well-known state-of-the-art schemes of CL to point cloud domain, with a special focus to **coarse-to-fine** learning strategy [4]. State-of-the-art architectures and a popular **autonomous driving** dataset will be exploit for the task.



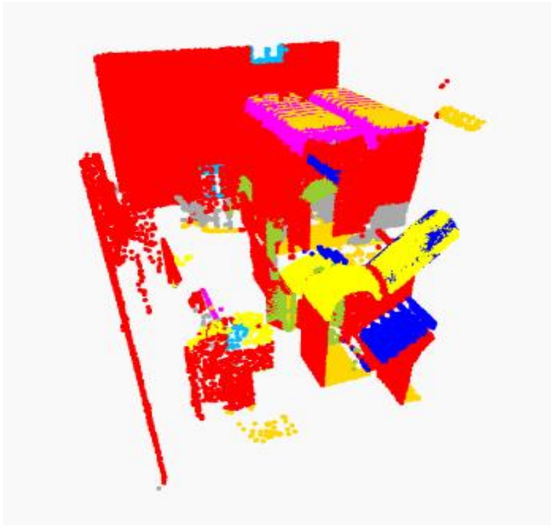


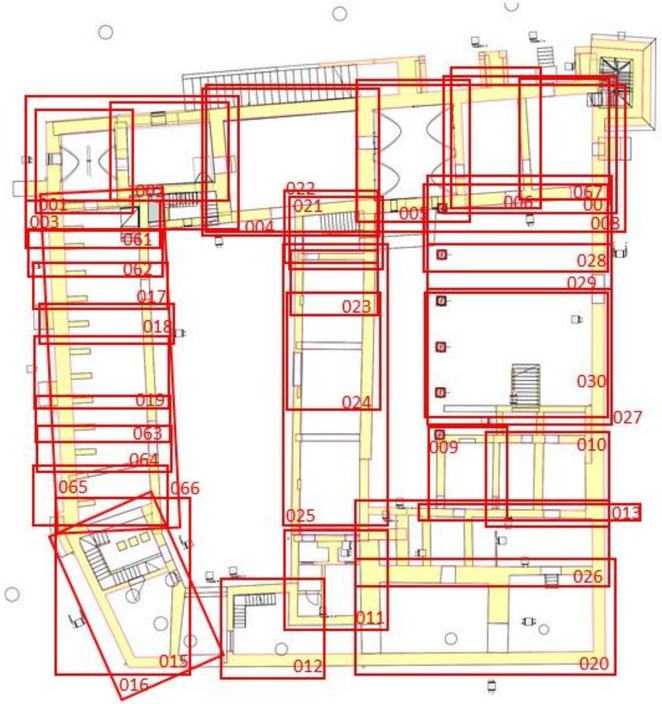
[1] Camuffo et al. "Recent Advancements in Learning Algorithms for Point Clouds", 2022.
[2] Michieli et al. "Incremental Learning Techniques for Semantic Segmentation", 2019.
[3] Klingner et al. "Class-Incremental Learning for Semantic Segmentation Re-Using Neither Old Data Nor Old Labels", 2020.
[4] Shenaj et al. "Continual coarse-to-fine domain adaptation in semantic segmentation", 2022.

TOPIC #3: Instance Segmentation for Scan-to-BIM

Programming in Python (+Pytorch)

- Point Cloud Instance Segmentation (PCIS) is the task of **recognize objects inside a three-dimensional scene**, assigning to each point a label that determine to which object the point belongs, differentiating among enitities [1].
- This project is born on a collaboration with **DICEA** (Civil Engineering Department at Unipd). The dataset is composed of scenes extracted from *Castello Banfi* and *Eremitani* church. Other popular dataset such as S3DIS [2] and **Arch** [3], build by Politecnico di Torino, will be investigated to have comparisons and a wider investigation of the topic.
- The whole objective of the project is to obtain a BIM reconstruction of an acquired point cloud (**Scan-to-BIM** procedure) that provides also the classes of the various elements and also differentiate among entities.
- Up to now, the procedure is done using PCSS with ad hoc lightweight architectures and algorithms like RANSAC to separate instances. Tho objective of the thesis is to **unify and optimize** the procedure performing instance segmentation.





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[1] Camuffo et al. "Recent Advancements in Learning Algorithms for Point Clouds", 2022.
[2] Armeni et al. "3D Semantic Parsing of Large-Scale Indoor Spaces", 2016.
[3] Matrone et al. "A Benchmark for large-scale heritage point cloud segmentation", 2020.