Chair of Computational Modeling and Simulation
TUM School of Engineering and Design
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## Master thesis

# 3D Object Detection in Dense Laser Scanner Point Clouds

### Motivation

Object detection and instance segmentation in 3D point clouds of indoor scenes are crucial for automated scene understanding. Modern approaches utilize transformer-based neural networks with self- and cross-attention mechanisms to tackle challenges like occlusions, cluttered environments, and varying object scales. These methods aim to address technical hurdles, including complex geometries, semantic diversity, and noise sensitivity while combining multiple learning objectives to create more robust embedding spaces.

This project aims to develop a robust 3D object detection model for analyzing indoor LiDAR point clouds, focusing on detecting architectural elements (doors, windows, columns) and furniture for building information modeling applications. The work should begin with a state-of-the-art transformer-based architecture such as UniDet3D [1] as a baseline, followed by adapting existing implementation (i.e. SphericalMask [2] or OneFormer3D [3]) for 3D instance segmentation. This will include developing an extension to the chosen instance segmentation models by incorporating an object detection head as a feature encoding regularizer.

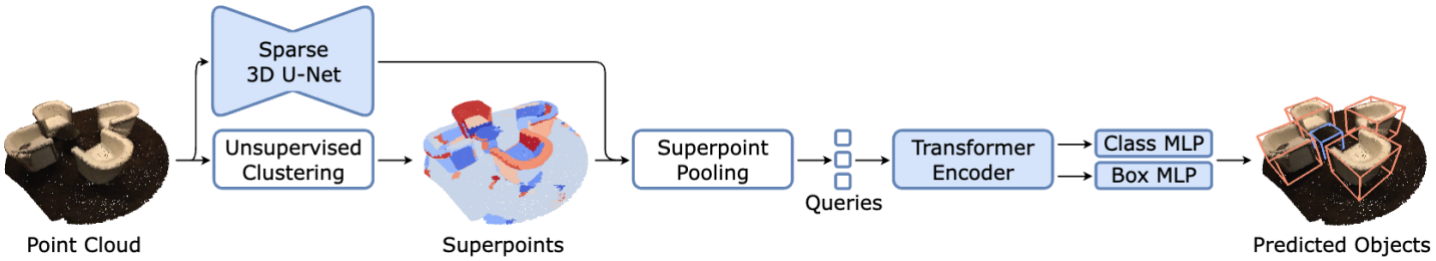


Figure 1: Overview of UniDet3D method for 3D object detection, from [1].

### Task

- Literature research on state-of-the-art point cloud instance segmentation and object detection methods.
- Work with existing implementations of instance segmentation methods and extend by an object detection head.
- Implementation with a prototypical case study and evaluation of results.

### Prerequisites

Necessary: Solid knowledge of programming and Machine Learning

Good to have: Experience with point clouds

### Supervisors

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### References

[1] Kolodiazhnyi, M., Vorontsova, A., Skripkin, M., Rukhovich, D., & Konushin, A. (2024). UniDet3D: Multi-dataset Indoor 3D Object Detection. arXiv preprint arXiv:2409.04234.

[2] Shin, S., Zhou, K., Vankadari, M., Markham, A., & Trigoni, N. (2024). Spherical Mask: Coarse-to-Fine 3D Point Cloud Instance Segmentation with Spherical Representation. In Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (pp. 4060-4069).

[3] Kolodiazhnyi, M., Vorontsova, A., Konushin, A., & Rukhovich, D. (2024). Oneformer3d: One transformer for unified point cloud segmentation. In Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (pp. 20943-20953).