CLIMB-3D: Class-Incremental Imbalanced 3D Instance Segmentation

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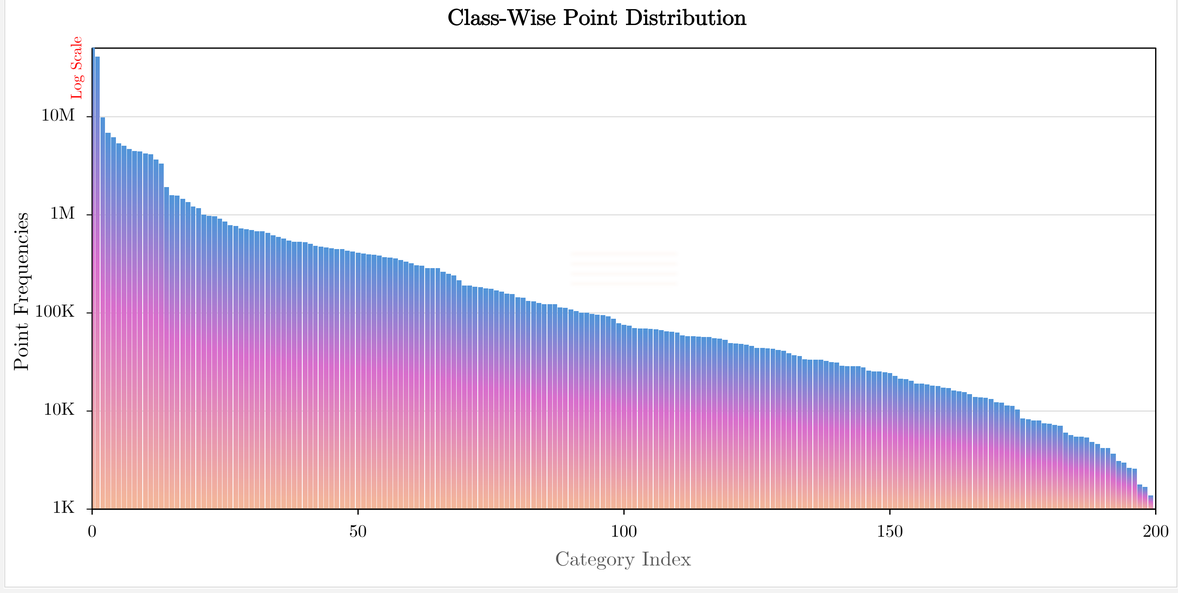
Why Continual 3D Segmentation?

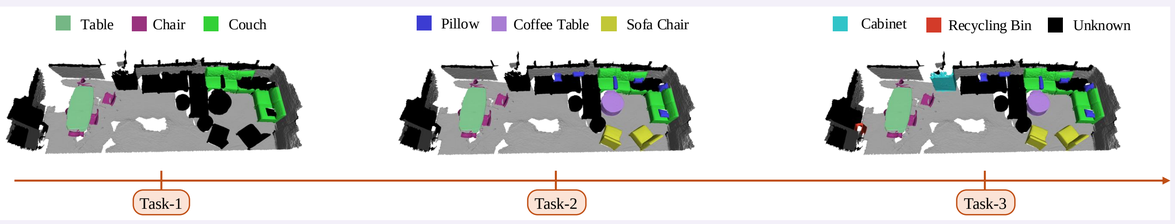
- Evolving 3D environments with naturally long-tailed classes
- New object categories require continual adaptation
- Existing 3DIS methods assume static, balanced data



Long-tailed category distribution in real 3D datasets.

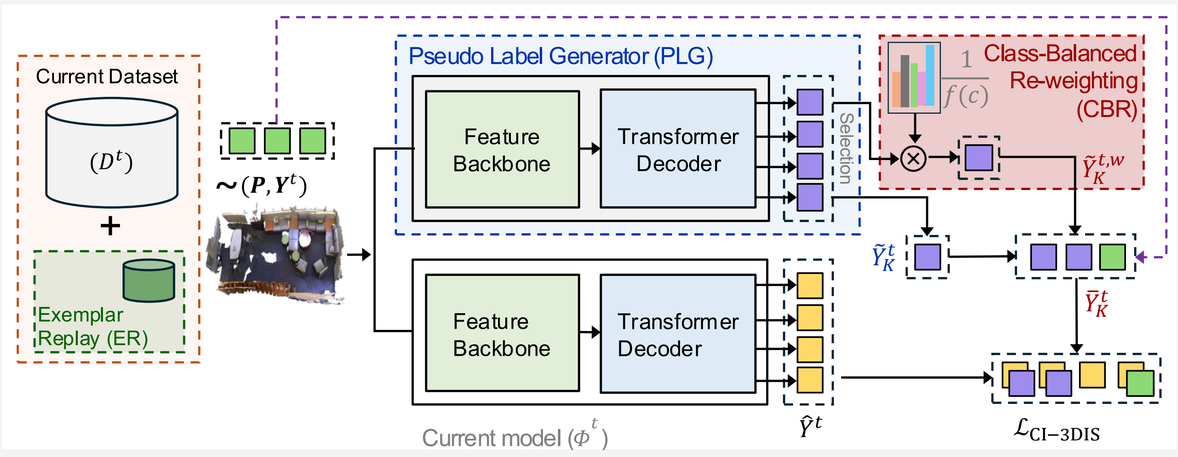
From CIL to CI-3DIS

- **Concept:** Extend class-incremental learning [1] to continual 3D instance segmentation
- **Goal:** Segment new object categories while retaining prior segmentation knowledge



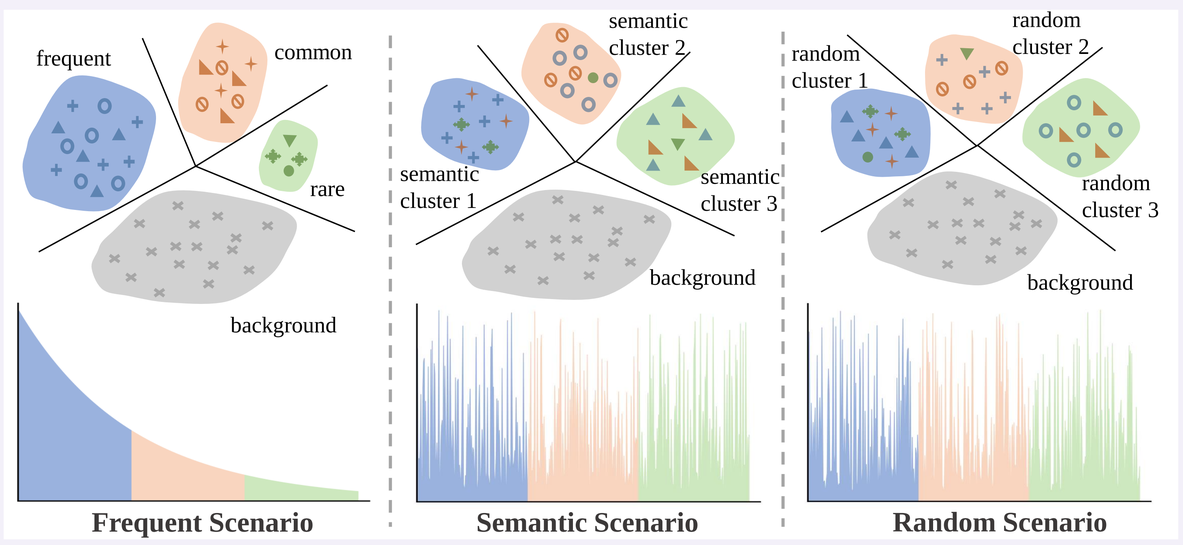
Continually segmenting new classes while preserving past knowledge.

CLIMB-3D Framework



*Built on **Mask3D** [2] as the segmentation backbone. ER [3], PLG, and CBR together enable continual 3D segmentation on evolving, long-tailed data with minimal forgetting.*

CI-3DIS Scenarios



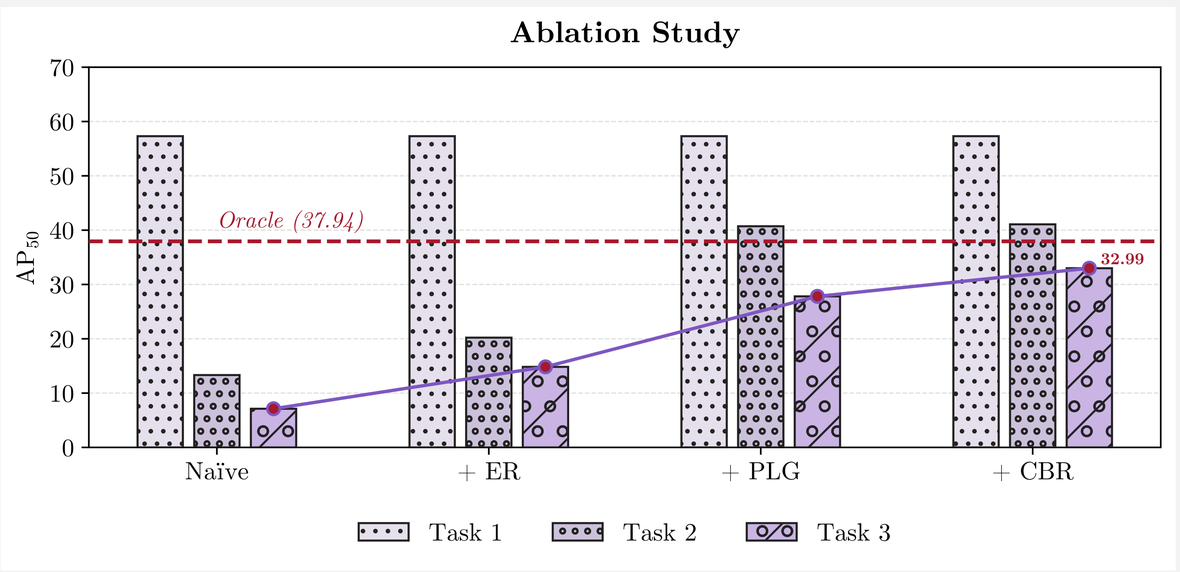
Three incremental splits — Frequency, Semantic, and Random — reflecting the evolution of real-world 3D scenes.

Results & Insights

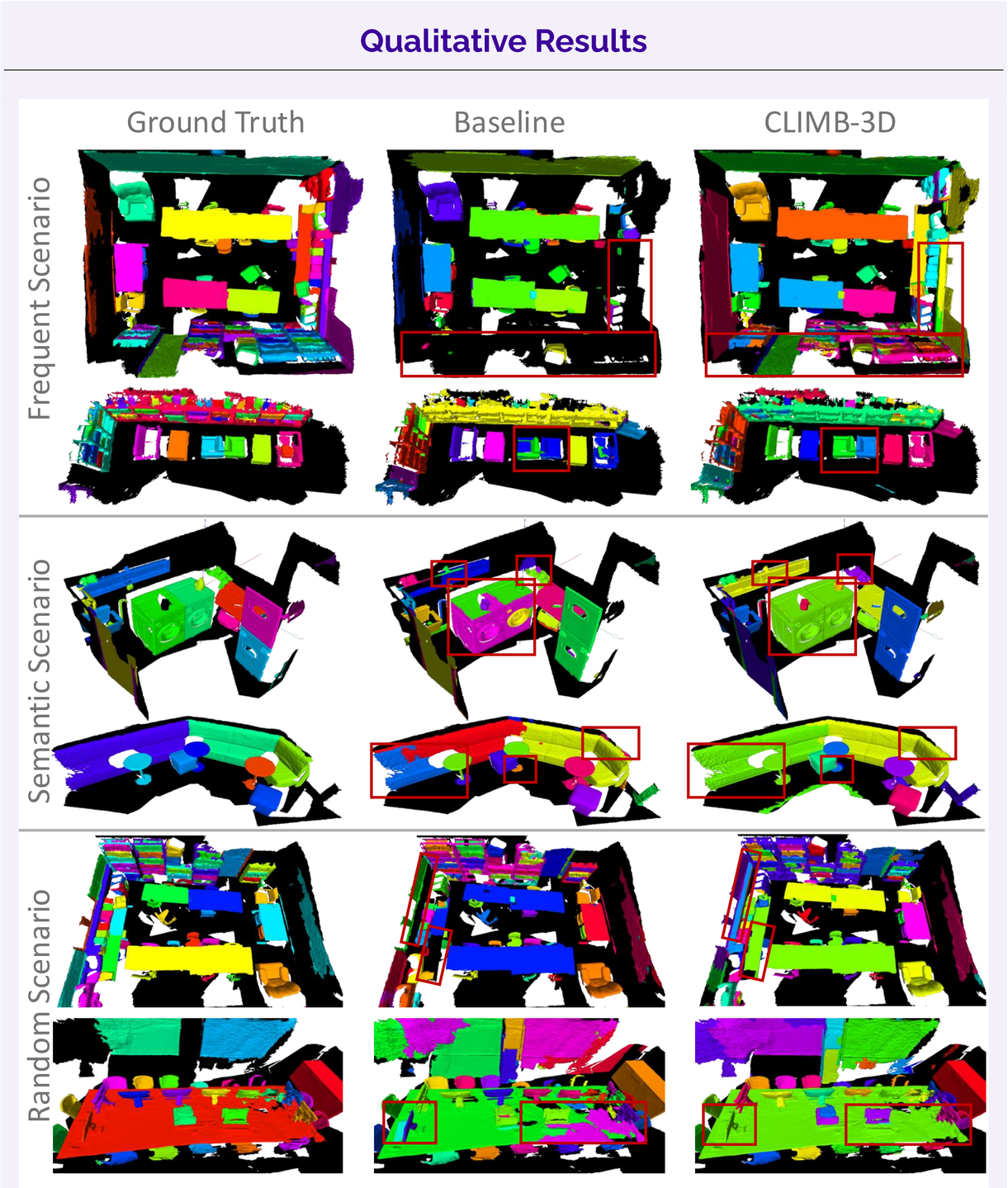
Scenarios	Methods	Average Precision ↑ AP_{25}	AP_{50}	AP	FPP ↓ AP_{25}	AP_{50}
Frequency	baseline	32.28	27.81	20.60	21.78	20.18
	ours	**37.51**	**32.99**	**24.23**	**14.21**	**12.41**
Semantic	baseline	30.75	26.49	19.71	25.77	25.76
	ours	**32.46**	**28.32**	**21.75**	**23.64**	**23.98**
Random	baseline	24.37	22.49	16.85	12.01	12.48
	ours	**25.99**	**23.87**	**17.52**	**11.45**	**11.09**

Baseline: Standard Mask3D fine-tuning without Class-Balanced Reweighting (CBR).

Ablation over three incremental tasks showing how ER, PLG, and CBR progressively reduce forgetting and enhance final performance.



Qualitative Results



Improved segmentation continuity and stability across incremental phases.

References

[1] Da-Wei Zhou, Qi-Wei Wang, Zhi-Hong Qi, Han-Jia Ye, De-Chuan Zhan, and Ziwei Liu. Class-incremental learning: A survey. *IEEE TPAMI*, 2024.

[2] Jonas Schult, Francis Engelmann, Alexander Hermans, Or Litany, Siyu Tang, and Bastian Leibe. Mask3d: Mask transformer for 3d semantic instance segmentation. In *IEEE ICRA*, pages 8216--8223, 2023.

[3] Pietro Buzzega, Matteo Boschini, Angelo Porrello, Davide Abati, and Simone Calderara. Dark experience for general continual learning: a strong, simple baseline. *NeurIPS*, 33:15920--15930, 2020.