Distribution Guidance Network for Weakly Supervised Point Cloud Semantic Segmentation

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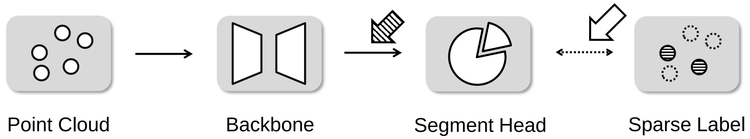
NEURAL INFORMATION PROCESSING SYSTEMS

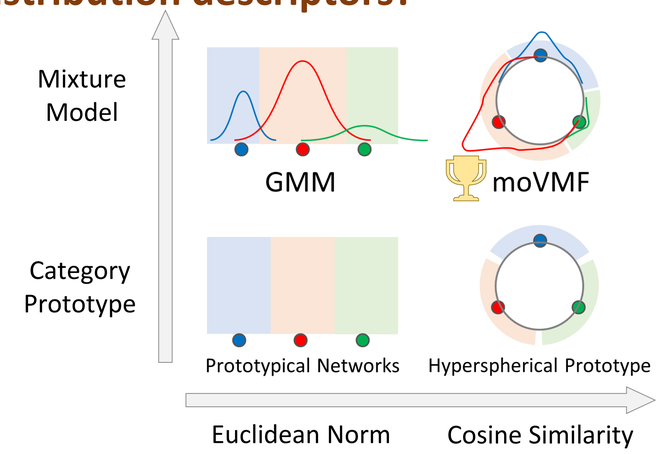
Our contributions compared to previous methods



Background: Existing weakly supervised point cloud semantic segmentation methods usually compensate supervised signals for the predictions after segment head.

Our Contributions: Constraints on the distribution of semantic features before segment head are imposed to provide an accurate and efficient supervised signal.

How to construct and evaluate feature distribution descriptors?



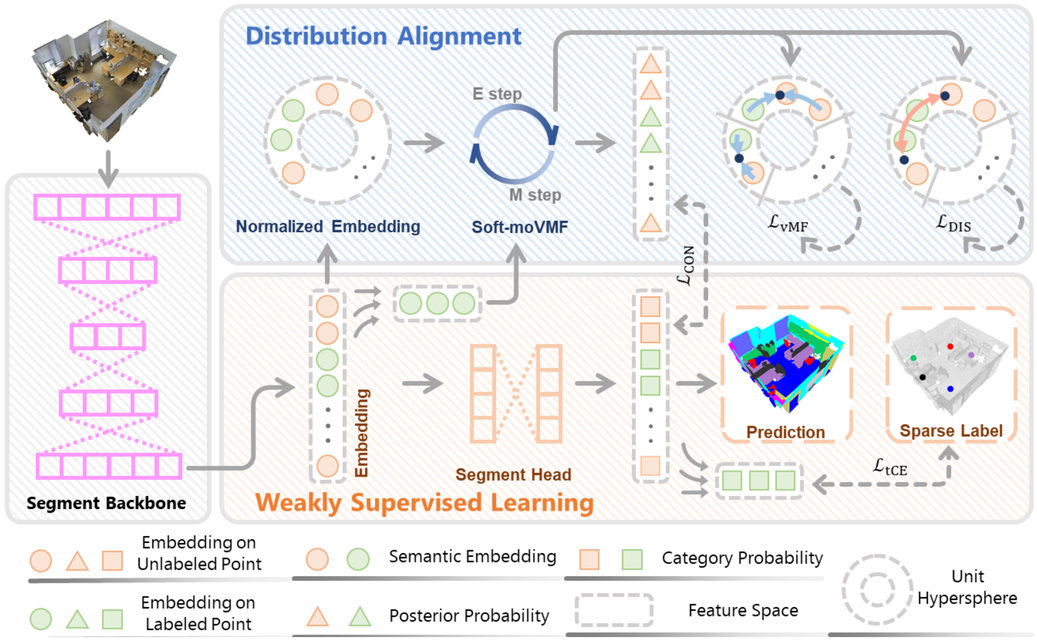
The reason why mixture of von Mises-Fisher Distributions (moVMF) is better than other candidate distributions:

① Better adaptation of segment head;

② Better avoidance of the curse of dimensionality;

③ Stronger fitting capabilities.

Supervise a segmentation network with moVMF



Weakly Supervised Learning

The truncated cross-entropy loss function in this branch prevents overfitting on sparse annotations.

Average semantic features on labeled points provide reliable initialization for the EM algorithm in the distribution alignment branch.

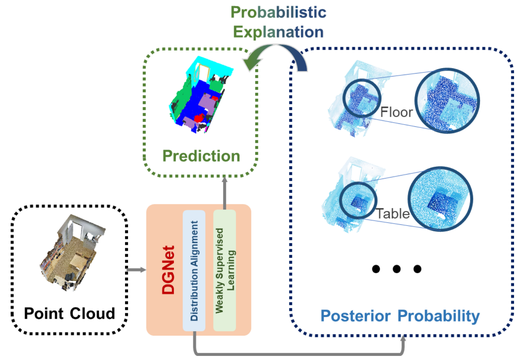
Distribution Alignment

Nested EM algorithms are proposed to solve the three-parameter optimization problem in this branch.

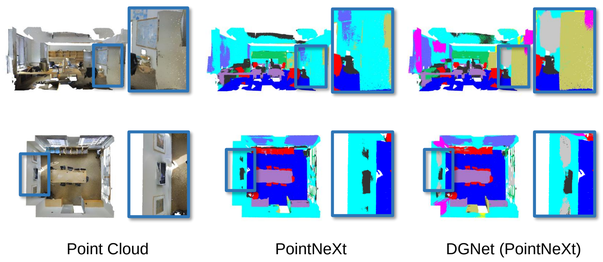
The soft-moVMF algorithm achieves more accurate parameter updates by considering inter-cluster similarities. The vMF loss function is designed based on the maximum likelihood estimation.

A discriminative loss is imposed to get distinct decision boundaries.

Probabilistic explanation



Visual comparisons



Ablation on distributions

Distribution Modeling	Distance Metric: Euclidean Norm	Distance Metric: Cosine Similarity	mIoU (%)
Category Prototype	✓	○	59.9
	○	✓	60.3
Mixture Models	✓	○	61.3
	○	✓	**62.4**

Comparisons on S3DIS

Setting	Method	mIoU (%)
0.1%	DeepGCN	43.9
	DGNet (DeepGCN)	58.4
	PointNeXt	65.0
	DGNet (PointNeXt)	**67.8**
0.01%	DeepGCN	35.9
	DGNet (DeepGCN)	52.8
	PointNeXt	58.4
	DGNet (PointNeXt)	**62.4**