

Figure 1: Performance of UPGNET and other baselines. X-axis represents ϵ and y-axis represents test accuracy (%).

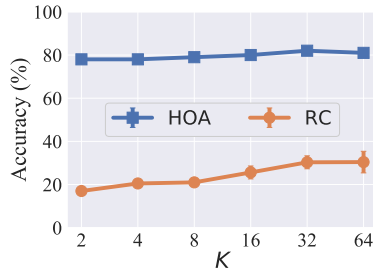


Figure 2: Comparison of HOA and Residual Connection (RC) (Dataset: Cora, $\epsilon = 0.01$). HOA demonstrates significantly better classification accuracy in private graph learning compared to Residual Connection.

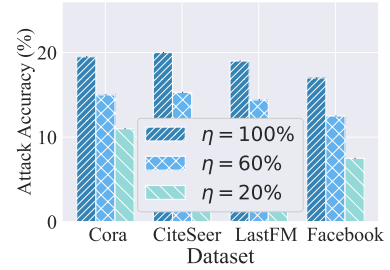


Figure 3: Attack accuracy with varying proportions (η) of neighboring information accessible to the attacker. When η is small (a more realistic scenario), UPGNET demonstrates stronger defense performance.

Table 1: Hyperparameters and optimization settings for LPGNN.

Hyperparameter	Value Range	Hyperparameter	Value Range
optimal parameter selection	grid search	optimizer	Adam optimizer
privacy budget	{0.01, 0.1, 1.0, 2.0, 3.0}	learning rate	{ 10^{-4} , 10^{-3} , 10^{-2} , 10^{-1} , 0}
KProp step	{0, 2, 4, 6, 8, 16}	weight decay	{ 10^{-4} , 10^{-3} , 10^{-2} , 10^{-1} , 0}
GNN	GCN, GraphSAGE, GAT	dropout rate	{ 10^{-4} , 10^{-3} , 10^{-2} , 10^{-1} , 0}

Table 2: Statistics of heterophilic graph datasets.

Dataset	#Classes	#Nodes	#Edges	#Features
Flickr	7	89,250	899,756	500
Reddit	41	232,965	114,615,892	602

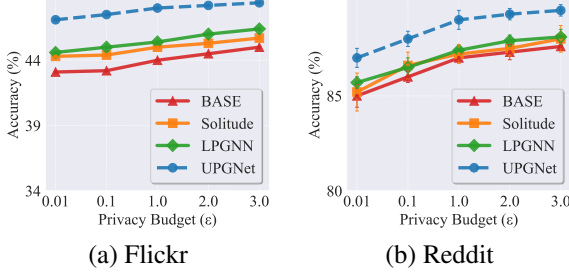


Figure 4: Performance comparison of UPGNET and other baselines on Flickr and Reddit. X-axis represents ϵ and y-axis represents test accuracy (%). UPGNET exhibits superior performance compared to other baselines.

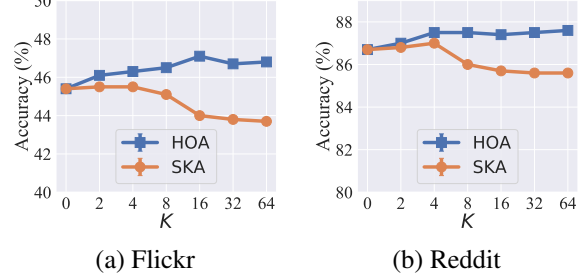


Figure 5: Effect of HOA vs. SKA on graph learning performance across various steps $K \in \{2, 4, 8, 16, 32, 64\}$. HOA demonstrates its superior denoising capability on heterophilic datasets (Flickr and Reddit).

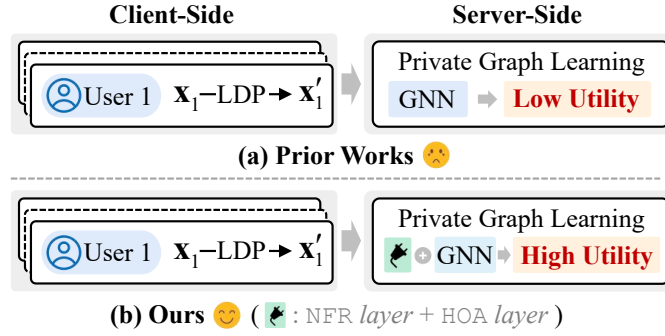


Figure 6: Comparison of (a) **prior works** and (b) **ours** in the locally private graph learning scenario. The scenario comprises a cloud server and multiple users situated across different clients. Users' sensitive node features \mathbf{x} are perturbed to \mathbf{x}' using LDP before uploading to the cloud server for graph learning. Our approach achieves higher utility by integrating \star than prior works.

Table 3: Comparison of our NFR (without HOA) with dropout and group Lasso ($\epsilon = 0.01$, GCN). The values in the table represent accuracy (%). NFR demonstrates significantly better learning utility compared to other sparsity-inducing techniques.

BASELINE	CORA	CITESeer	LASTFM	FACEBOOK
DROPOUT	63.4	52.7	61.3	77.6
GROUP LASSO	57.6	50.5	57.1	78.9
OURS	71.3	57.2	67.1	84.9

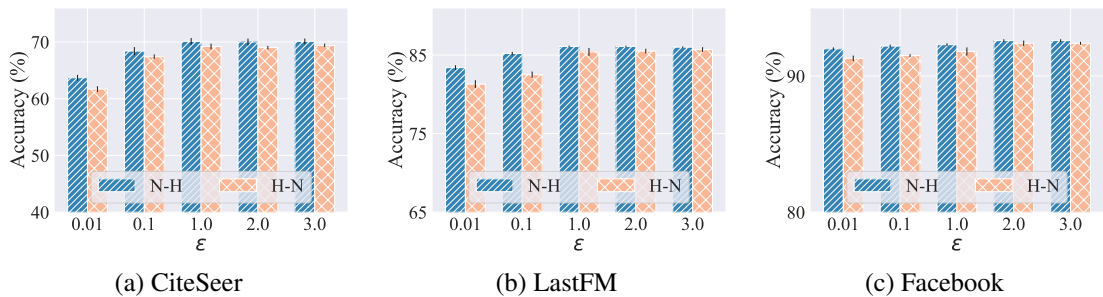


Figure 7: Performance of UPGNET in H-N vs. N-H architectures.