FedSDR: Federated Graph Learning with Structural Noise Detection and Reconstruction

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Code: github.com/Subtleazure/FedSDR

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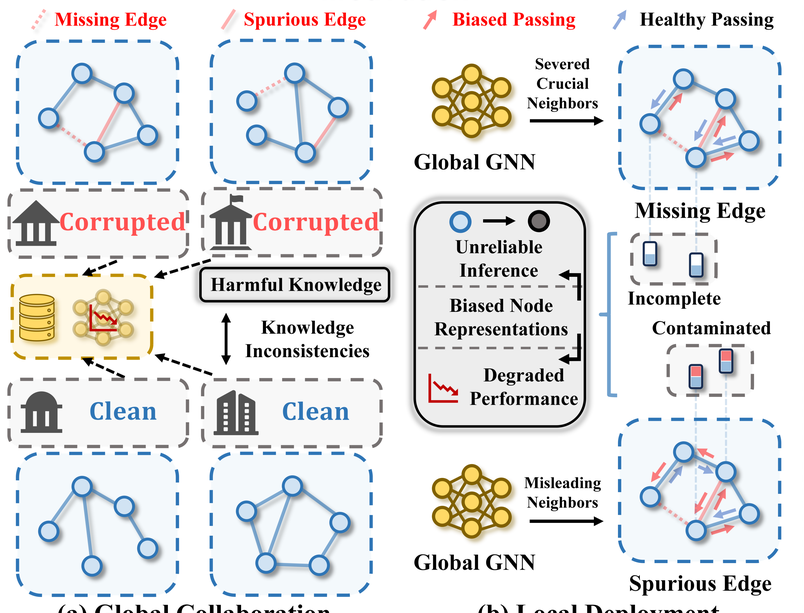
Overview

- **Background:** Structural noise (large-scale, random topology corruption including **missing** and **spurious edges**) severely disrupts local graph integrity, undermining collaborative training in FGL.
- **FedSDR:** Detects structurally corrupted clients from a **spectral** perspective and mitigates their adverse impact through dynamic **reweighting** and **structure reconstruction**.

Motivation



(a) Global Collaboration (b) Local Deployment

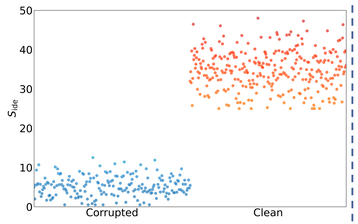
- (a) Globally, structural noise damages the message-passing of clients, introducing **harmful knowledge** that causes **inconsistencies**.
- (b) Locally, biased propagation paths yield **biased representations**.

Proposed Method

- The limitations of existing methods prompt two questions for us:
  - How to detect and mitigate the adverse impact of corrupted clients?
  - How to repair corrupted structure while keeping valuable knowledge?

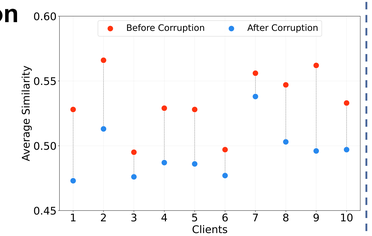
Structural Noise-Aware Aggregation

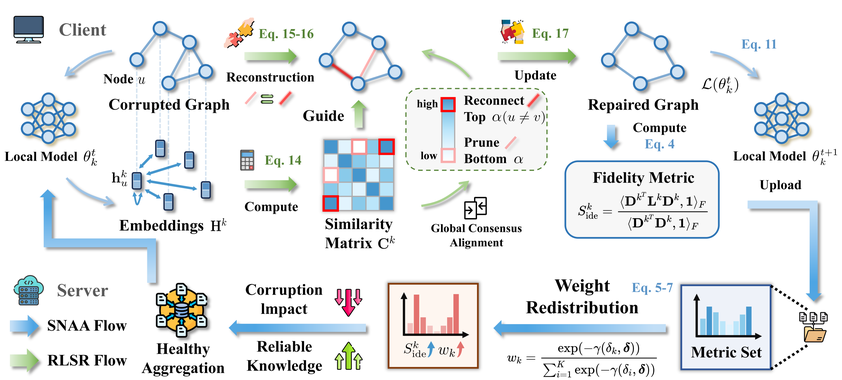
- The **spectral** fidelity is significantly **lower** for corrupted clients.
- Dynamically reweight client contributions based on locally computed structural fidelity metric.



Robust Local Structure Reconstruction

- The local average **feature similarity** is significantly **lower** after the introduction of structural noise.
- Prune spurious edges with low similarity and reconnect missing edges with high similarity.

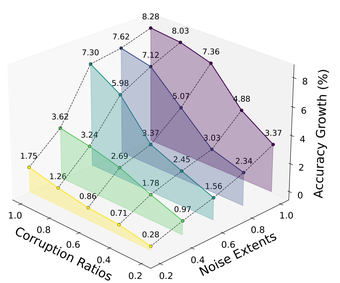




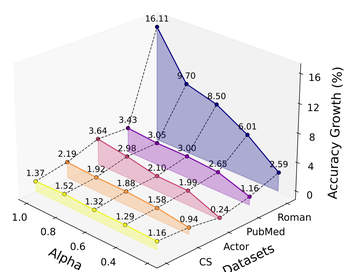
Experiments

- We conducted experiments under various structural noise scenarios to validate the superiority of FedSDR.

Methods	PubMed	Coauthor-CS	Coauthor-Phy	Actor	Roman-empire
FedAvg [ASTAT17]	78.41 ± 0.36	82.01 ± 0.49	86.37 ± 0.27	31.28 ± 0.77	41.72 ± 0.39
FedProx [arxiv18]	77.82 ± 0.97	74.94 ± 0.36	86.19 ± 0.20	31.27 ± 0.50	41.76 ± 0.71
Scaffold [ICML20]	41.76 ± 0.83	43.00 ± 3.23	77.41 ± 1.75	23.52 ± 1.35	18.08 ± 0.33
MOON [CVPR21]	68.55 ± 2.27	75.91 ± 0.29	88.14 ± 0.16	31.14 ± 0.55	42.51 ± 0.30
FedProto [AAAI22]	75.24 ± 0.17	67.26 ± 0.40	84.42 ± 0.23	22.38 ± 0.33	19.42 ± 0.18
FGSSL [IJCAI23]	77.65 ± 0.41	81.05 ± 0.63	84.78 ± 1.61	31.20 ± 0.64	37.41 ± 0.51
FedTAD [IJCAI24]	77.92 ± 1.02	68.90 ± 0.93	OOM	31.13 ± 0.74	41.29 ± 0.40
FedGTA [VLDB24]	78.04 ± 0.58	81.24 ± 0.61	85.77 ± 0.16	31.03 ± 0.93	41.65 ± 0.21
FedSDR (ours)	**82.57 ± 0.64**	**82.29 ± 0.32**	**89.37 ± 0.24**	**32.36 ± 0.59**	**48.33 ± 0.28**



➢ Varying Corruption



➢ Pruning Proportion

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