

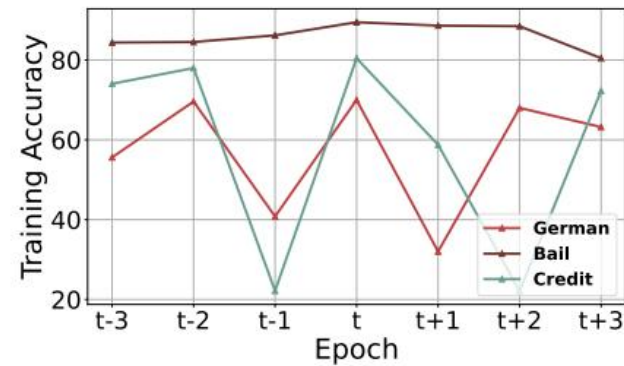
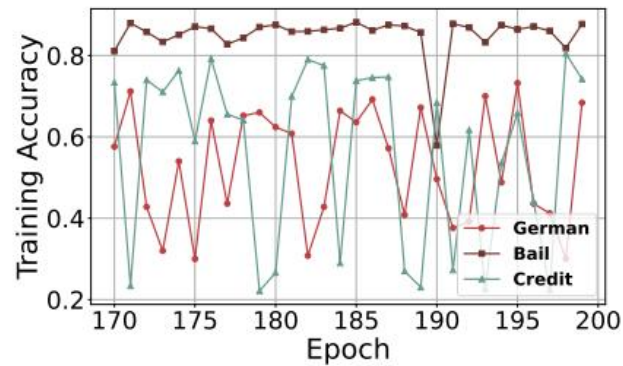
Stable Fair Graph Representation Learning with Lipschitz Constraint

2025.6.15

Motivation

1. Training instability

2. Loose Lipschitz bound

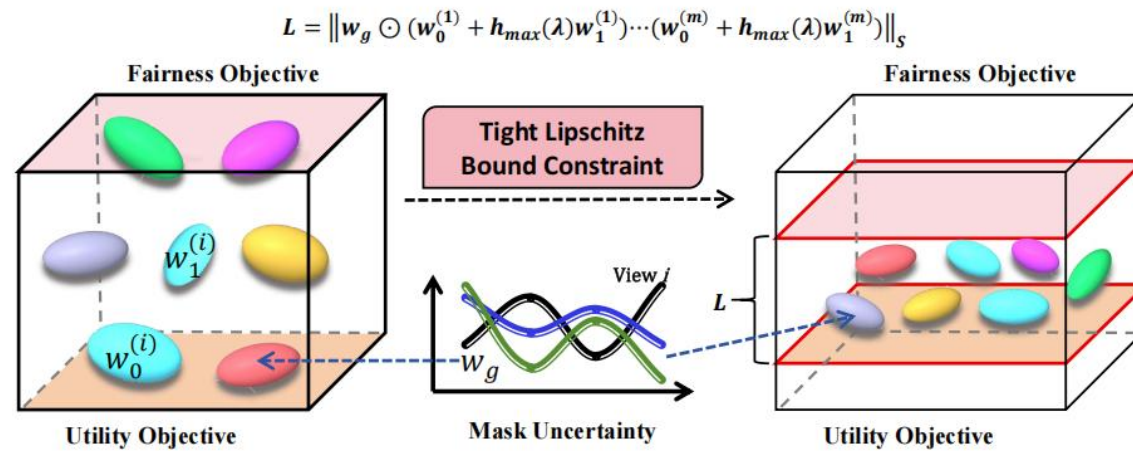


$$\prod_{i=1}^m \| w_0^{(i)} + h_{max}(\lambda) w_1^{(i)} \|_S$$

Method

1. Tight Lipschitz Bound

$$\left\| w_g(w_0^{(1)} + h_{\max}(\lambda)w_1^{(1)}) \cdots (w_0^{(m)} + h_{\max}(\lambda)w_1^{(m)}) \right\|_S \leq \|w_g\|_S \prod_{i=1}^m \|w_0^{(i)} + h_{\max}(\lambda)w_1^{(i)}\|_S$$



Recent Research

2. Weight Update

$$\left\| w_g(w_0^{(1)} + h_{max}(\lambda)w_1^{(1)}) \cdots (w_0^{(m)} + h_{max}(\lambda)w_1^{(m)}) \right\|_S \leq \|w_g\|_S \prod_{i=1}^m \|w_0^{(i)} + h_{max}(\lambda)w_1^{(i)}\|_S$$

projected stochastic subgradient

non-convex to multi-convex

$$\left\| A_{old}^{(i,t)} W^{(i,t)} B_{new}^{(i,t)} \right\|_S \leq \tau$$

$$B_{new}^{(i,t)} = [I_{N_{i-1}}, I_{N_{i-1}}] W^{(i-1, \textcolor{red}{t}+1)} \cdots [I_{N_0}, I_{N_0}] \odot w_g$$

$$A_{old}^{(i,t)} = [I_{N_m}, I_{N_m}] W^{(m,t)} \cdots W^{(i+1,t)} [I_{N_i}, I_{N_i}]$$

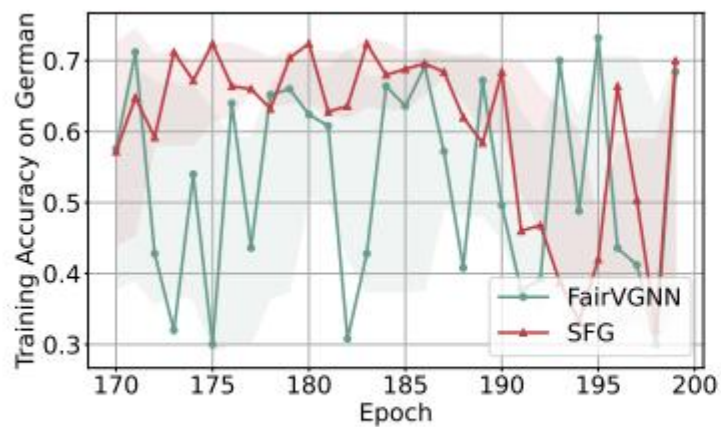
Method

3. Multi-view DRO

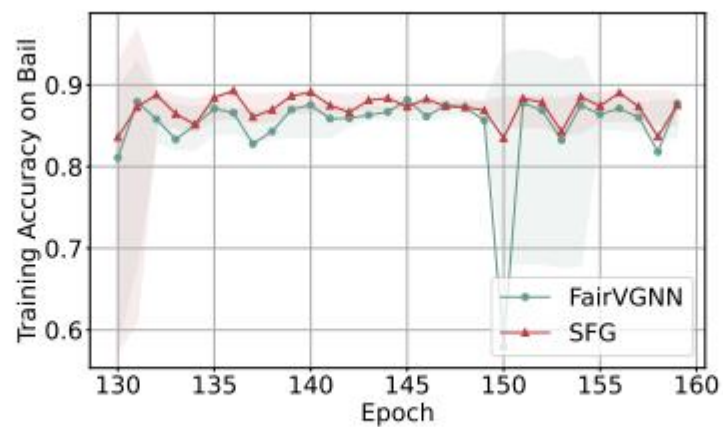
Multi-view DRO prevent unstable training by dropping some overfitting nodes caused by chasing fairness.

$$R_{sfg}(f) = \sum_{i=1}^{\mu} \boldsymbol{v}_i (C(E_{P_i}[[l(f(G_v), y_v) - \eta]_+^2])^{1/2} + \eta)$$

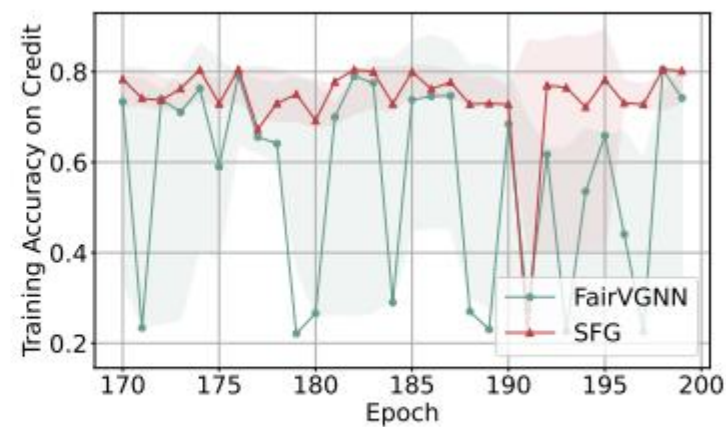
Results



(a) German



(b) Bail



(c) Credit

Results

Dataset	Metric	GCN	Nifty	FairGNN	FairVGNN	FairSAD	SFG
German	Acc	68.72 ± 2.38	69.92 ± 0.81	71.32 ± 0.16	69.84 ± 0.74	68.29 ± 2.80	<u>70.32 ± 0.46</u>
	AUC	67.64 ± 6.49	72.05 ± 2.15	69.30 ± 8.60	66.74 ± 4.08	72.20 ± 3.42	<u>69.38 ± 4.77</u>
	Δ_{DP}	13.91 ± 12.24	4.21 ± 2.51	7.12 ± 8.25	2.54 ± 1.75	0.00 ± 0.00	<u>1.36 ± 2.61</u>
	Δ_{EO}	11.01 ± 11.16	2.66 ± 2.17	5.67 ± 5.16	3.06 ± 1.50	0.00 ± 0.00	<u>0.54 ± 0.74</u>
Bail	Acc	82.01 ± 0.24	77.38 ± 1.65	83.59 ± 0.86	<u>89.24 ± 0.49</u>	83.73 ± 1.22	89.49 ± 1.74
	AUC	85.91 ± 0.12	80.43 ± 0.39	87.55 ± 0.60	<u>91.99 ± 0.34</u>	88.46 ± 0.81	93.98 ± 1.41
	Δ_{DP}	9.21 ± 0.16	5.74 ± 0.38	6.51 ± 0.76	4.39 ± 0.96	2.08 ± 1.24	<u>3.55 ± 0.58</u>
	Δ_{EO}	6.29 ± 0.04	4.07 ± 1.28	4.50 ± 1.09	2.49 ± 1.06	<u>2.14 ± 1.18</u>	1.11 ± 0.43
Credit	Acc	73.67 ± 0.03	69.63 ± 0.75	76.16 ± 1.82	<u>80.13 ± 0.32</u>	77.41 ± 0.78	80.34 ± 0.11
	AUC	73.87 ± 0.02	69.08 ± 0.15	74.62 ± 0.87	<u>74.17 ± 0.54</u>	71.72 ± 0.51	74.37 ± 0.37
	Δ_{DP}	12.86 ± 0.09	10.34 ± 1.15	6.87 ± 5.01	5.74 ± 1.44	2.39 ± 2.43	<u>5.44 ± 1.04</u>
	Δ_{EO}	10.63 ± 0.13	9.36 ± 1.23	5.14 ± 5.35	3.18 ± 1.02	1.39 ± 1.66	<u>2.71 ± 0.58</u>

Thanks for Listening

2025.6.15