Layer-Neighbor Sampling — Defusing Neighborhood Explosion in GNNs

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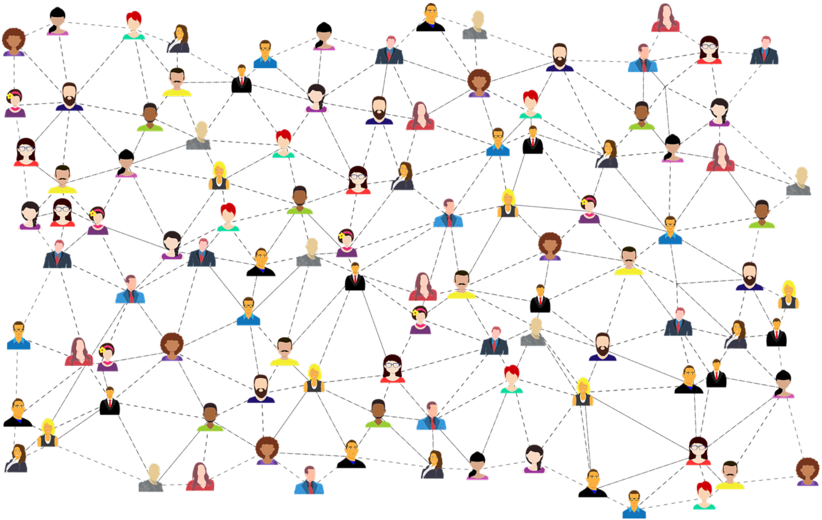
Applications of GNNs



- Online shopping
- Social media
- Content recommendation
- Showing relevant ads

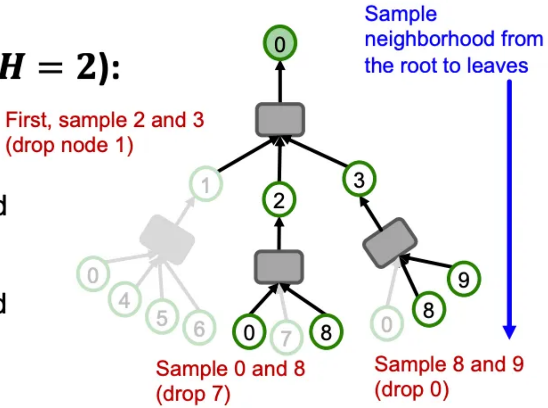
Source: `https://pixabay.com/vectors/social-media-connections-networking-3846597/`

Graph Neural Networks - Neighborhood Explosion

- **Example ($H = 2$):**

1st-hop neighborhood

2nd-hop neighborhood



Source: CS224W Lecture 17 (GNN Scaling)

Sampling Goals & Proposed Solution

Goals:

- Unbiased sampling

Solution:

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- Combine NS & LADIES to get best-of-both-worlds LABOR.
- Generalizes to any unbiased sampling method.

Layer-Neighbor Sampling

- LABOR-0: given s and $r_t \sim U(0, 1)$,
  sample $t \longrightarrow s$ if $r_t \leq \frac{k}{d_s}$,
  k is the fan-out, d_s is the in-degree.

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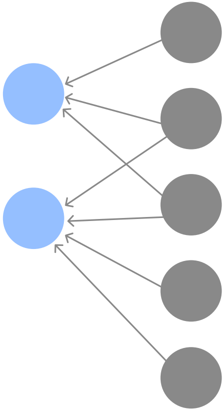
  k is the fan-out, d_s is the in-degree.
- k sampled items in expectation, matching NS.

LABOR-0 example

Blue: seed vertices, green: sampled, gray: not sampled



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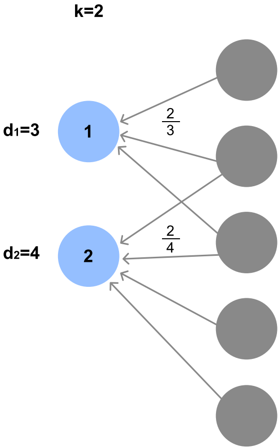

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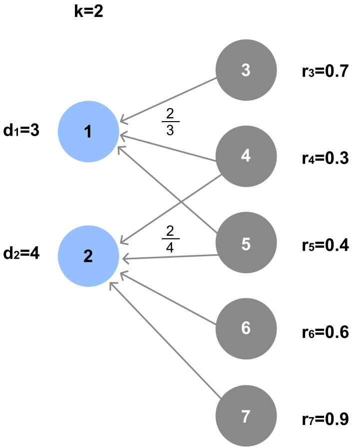

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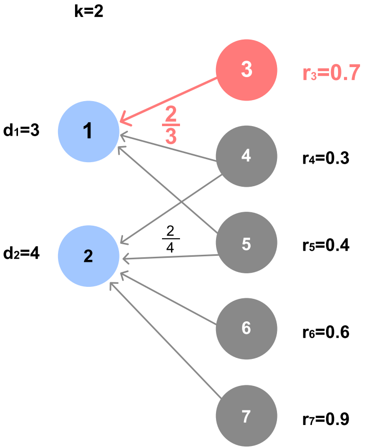

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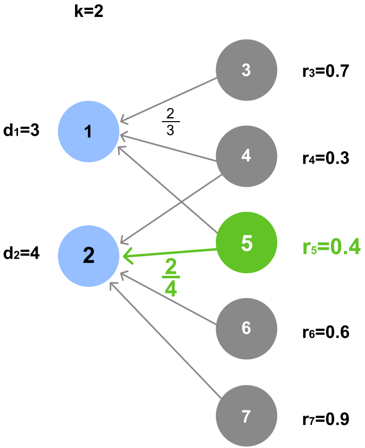

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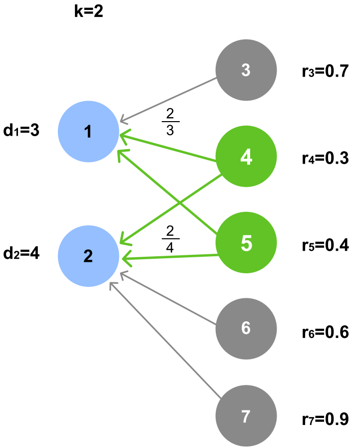
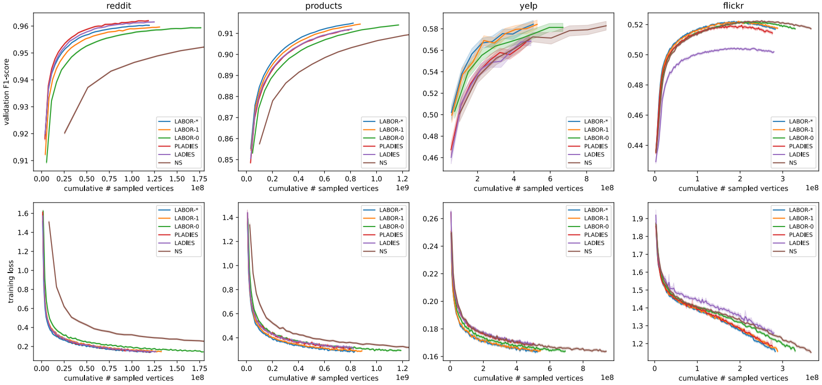


Datasets

Properties of the datasets used in experiments.

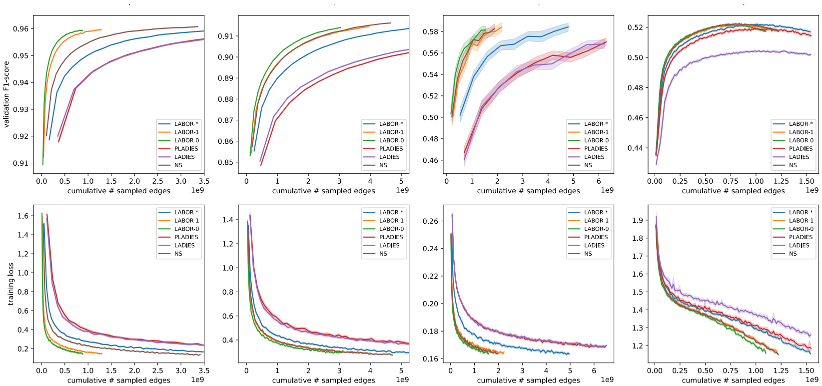
Dataset	$\|V\|$	$\|E\|$	$\frac{\|E\|}{\|V\|}$	**# feats.**	**train - val - test (%)**
reddit	233K	115M	493.56	602	66.00 - 10.00 - 24.00
products	2.45M	61.9M	25.26	100	8.00 - 2.00 - 90.00
yelp	717K	14.0M	19.52	300	75.00 - 10.00 - 15.00
flickr	89.2K	900K	10.09	500	50.00 - 25.00 - 25.00

Experiments - Vertex efficiency



The validation F1-score and training loss curves. The x-axis is scaled w.r.t. # cumulative sampled vertices.

Experiments - Edge efficiency



The validation F1-score and training loss curves. The x-axis is scaled w.r.t. # cumulative sampled edges.

Experiments - PLADIES and LABOR Evaluation

Dataset	Algo.	$\lvert V^3\rvert$	$\lvert E^2\rvert$	$\lvert V^2\rvert$	$\lvert E^1\rvert$	$\lvert V^1\rvert$	$\lvert E^0\rvert$	$\lvert V^0\rvert$	it/s	test F1-score
reddit	PLADIES	**24**	**2390**	14.1	927	6.0	33.2	1	**1.7**	96.21 ± 0.06
	LADIES	**25**	**2270**	14.5	852	6.0	32.5	1	**1.8**	96.20 ± 0.05
	LABOR-*	**24**	1070	13.7	435	6.0	26.9	1	4.1	96.23 ± 0.05
	LABOR-1	27	261	14.4	116	6.1	16.7	1	24.8	96.23 ± 0.06
	LABOR-0	36	**177**	17.8	67	6.8	9.6	1	**37.6**	96.25 ± 0.05
	NS	**167**	682	68.3	100	10.1	9.7	1	14.2	96.24 ± 0.05
products	PLADIES	**160**	**2380**	51.2	293	9.7	11.7	1	**4.1**	78.44 ± 0.24
	LADIES	**165**	**2230**	51.8	270	9.7	11.5	1	**4.2**	78.59 ± 0.22
	LABOR-*	**166**	1250	51.8	167	9.8	10.6	1	6.2	78.59 ± 0.34
	LABOR-1	178	799	53.4	136	9.8	10.5	1	21.3	78.47 ± 0.26
	LABOR-0	237	**615**	62.4	100	10.1	9.9	1	**32.5**	78.76 ± 0.26
	NS	**513**	944	95.4	106	10.6	9.9	1	24.6	78.48 ± 0.29
yelp	PLADIES	**100**	**1300**	29.5	183	6.2	6.9	1	**5.1**	61.55 ± 0.87
	LADIES	**102**	**1280**	29.7	182	6.2	6.9	1	**5.3**	61.89 ± 0.66
	LABOR-*	**105**	991	30.7	158	6.1	6.8	1	13.3	61.57 ± 0.67
	LABOR-1	109	447	31.0	96	6.2	6.8	1	**27.3**	61.71 ± 0.70
	LABOR-0	138	**318**	35.1	54	6.2	6.3	1	**27.2**	61.55 ± 0.85
	NS	**188**	392	42.5	55	6.3	6.3	1	23.0	61.50 ± 0.66
flickr	PLADIES	**55**	**309**	24.9	85	6.2	6.9	1	**10.2**	51.52 ± 0.26
	LADIES	**56**	**308**	25.1	85	6.2	6.9	1	**10.5**	**50.79 ± 0.29**
	LABOR-*	**57**	**308**	25.6	85	6.3	6.9	1	20.3	51.67 ± 0.27
	LABOR-1	58	242	25.9	73	6.3	6.9	1	**32.7**	51.66 ± 0.24
	LABOR-0	66	**219**	29.1	52	6.4	6.7	1	**33.3**	51.65 ± 0.26
	NS	**73**	244	32.8	52	6.4	6.7	1	**31.7**	51.70 ± 0.23

Importance Sampling Experiments - Fixed point iterations

Number of vertices (in thousands) in 3rd layer w.r.t # fixed point iterations (its). * denotes applying the fixed point iterations until convergence, i.e., LABOR-*, 1 its stands for LABOR-1 etc.

Dataset	NS	0	1	2	3	*
reddit	167	36	27	25	25	24
products	513	237	178	170	169	166
yelp	188	138	109	106	105	105
flickr	73	66	58	57	57	56

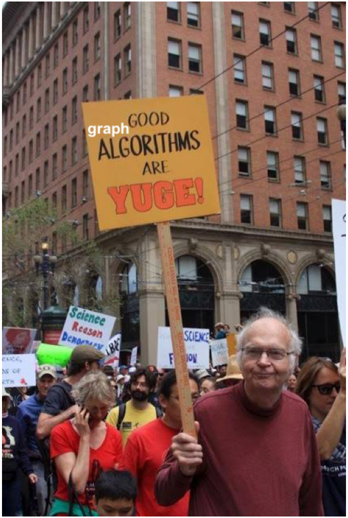
$$\pi_t^{(i+1)} = \pi_t^{(i)} \max_{t \to s} c_s(\pi^{(i)})$$

Thanks!

- For more information, scan:
  - Email: balin@gatech.edu
  - Visit: mfbal.in
  - Visit: tda.gatech.edu
- Acknowledgement of Support:

NSF

NVIDIA.



THANK YOU