ApeGNN: Node-Wise Adaptive Aggregation in GNNs for Recommendation

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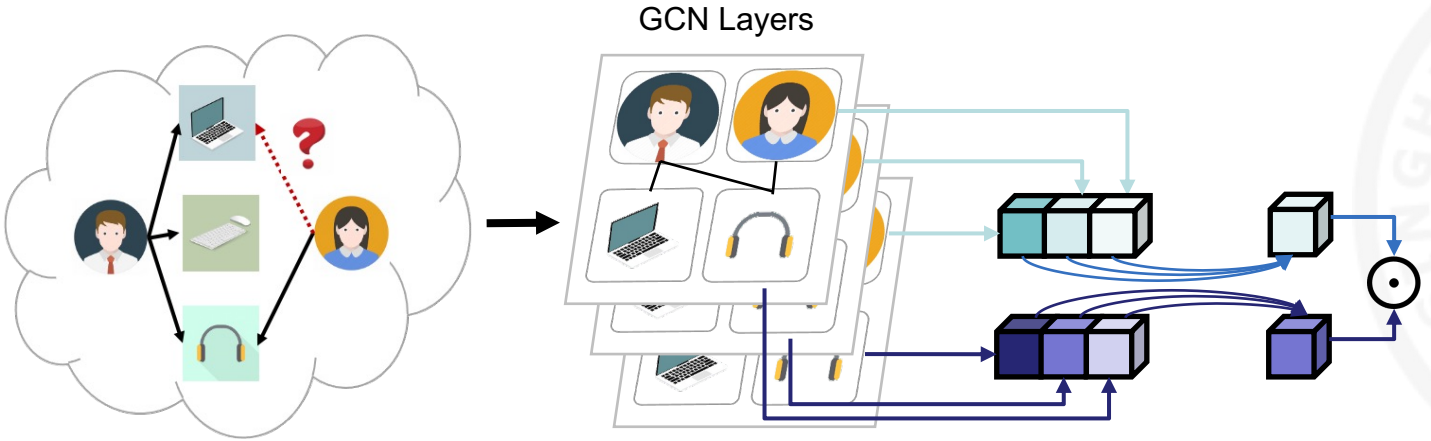
Code & Data: https://github.com/THUDM/ApeGNN

ApeGNN

- Background
  - ➢ User-item interactions can be constructed as a bipartite graph.
  - ➢ Graph neural networks（GNNs）have been widely used and produced remarkable performance in recommender system.
  - ➢ GNNs perform the message passing to iteratively aggregate neighborhood information.



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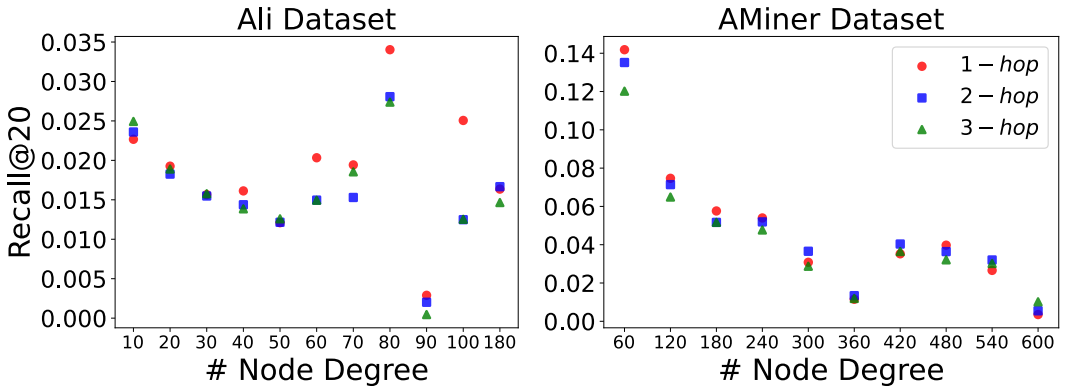
Why is **ApeGNN**?

- Motivation
  - ➢ Node types are not distinguished, GNNs-based models equally treat user and item type
  - ➢ Do not differentiate the local diverse pattern of each node



A motivating example. Local structures of users are diverse and node-wise aggregation is important in GNNs-based recommendation scenario.

Models	Explicit Degree Info.	Linear Propagation	Node-wise
GAT [33][1]	✗	✗	✓
LightGCN [9][2]	✓	✓	✗
ADC [47][3]	✓	✓	✗
ApeGNN	✓	✓	✓

[1] Veličković P, Cucurull G, Casanova A, et al. Graph attention networks[J]. arXiv preprint arXiv:1710.10903, 2017.
[2] He X, Deng K, Wang X, et al. Lightgcn: Simplifying and powering graph convolution network for recommendation[C]//SIGIR. 2020: 639-648.
[3] Zhao J, Dong Y, Ding M, et al. Adaptive diffusion in graph neural networks[J]. NeurIPS, 2021, 34: 23321-23333.

Node-wise Adaptive Aggregation

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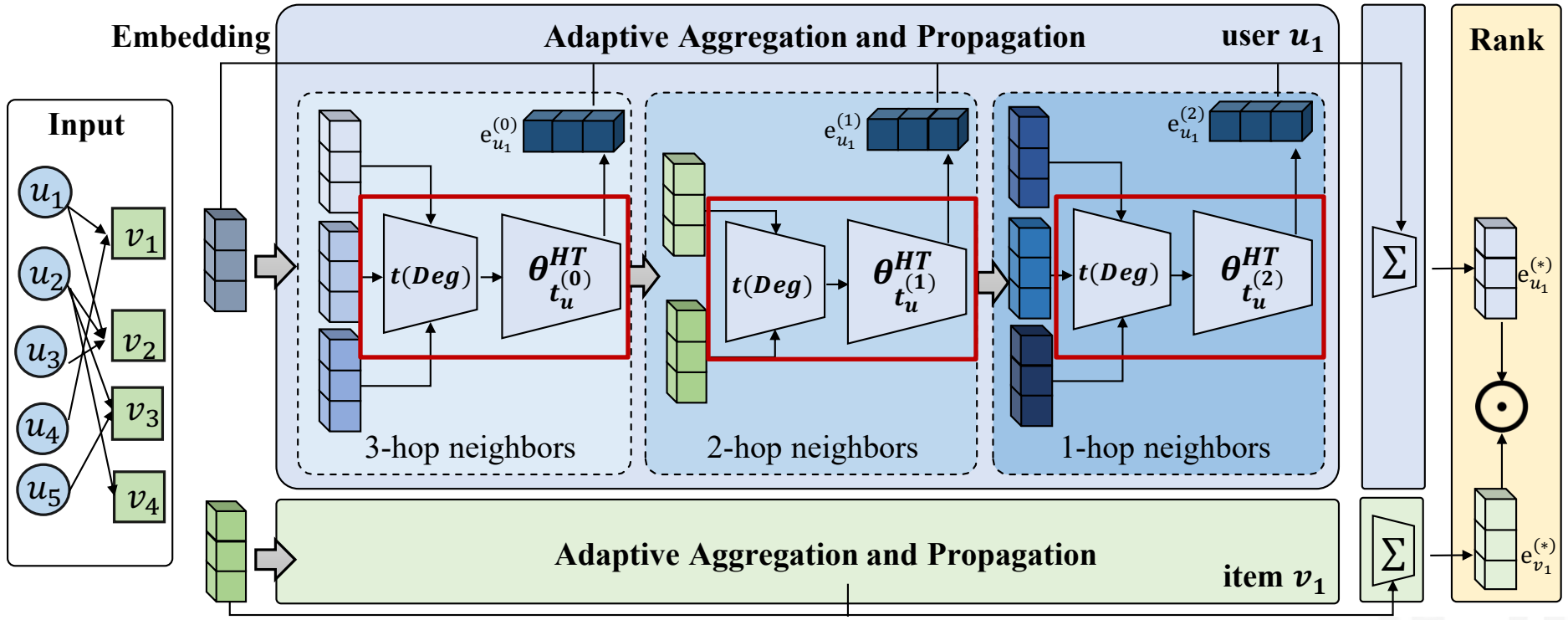
What is **ApeGNN**?

Node-wise Adaptive Aggregation



- Method
  - ➢ Develop node-wise adaptive diffusion mechanism
    - ➢ Assign unique weight for each node to all neighborhoods
    - ➢ Differentiate information of different GNN layers

What is **ApeGNN**?
Node-wise Adaptive Aggregation

- Diffusion mechanism
  - The heat kernel. $\theta^{HT}_{(t_{u_i}^{(l)})} = \frac{t_{u_i}^{l} e^{-t_{u_i}}}{l!}.$
  - Personalized PageRank (PPR). $\theta^{PPR}_{(t_{u_i}^{(l)})} = t_{u_i}^{(l)}(1 - t_{u_i}^{(l)})^{l}.$
- Centrality importance t

$$t_{u_i}^{(0)} = \varphi(D(u_i)) = \sigma(log(D(u_i) + \epsilon)),$$

- Propagation process
  - Adding each embedding layer to propagation layers to mine higher-order connectivity information.
- Pooling & Optimization
  - Modeling the hop-wise semantic differences and optimizing the ApeGNN via BPR loss.

How is **ApeGNN**?

Node-wise Adaptive Aggregation

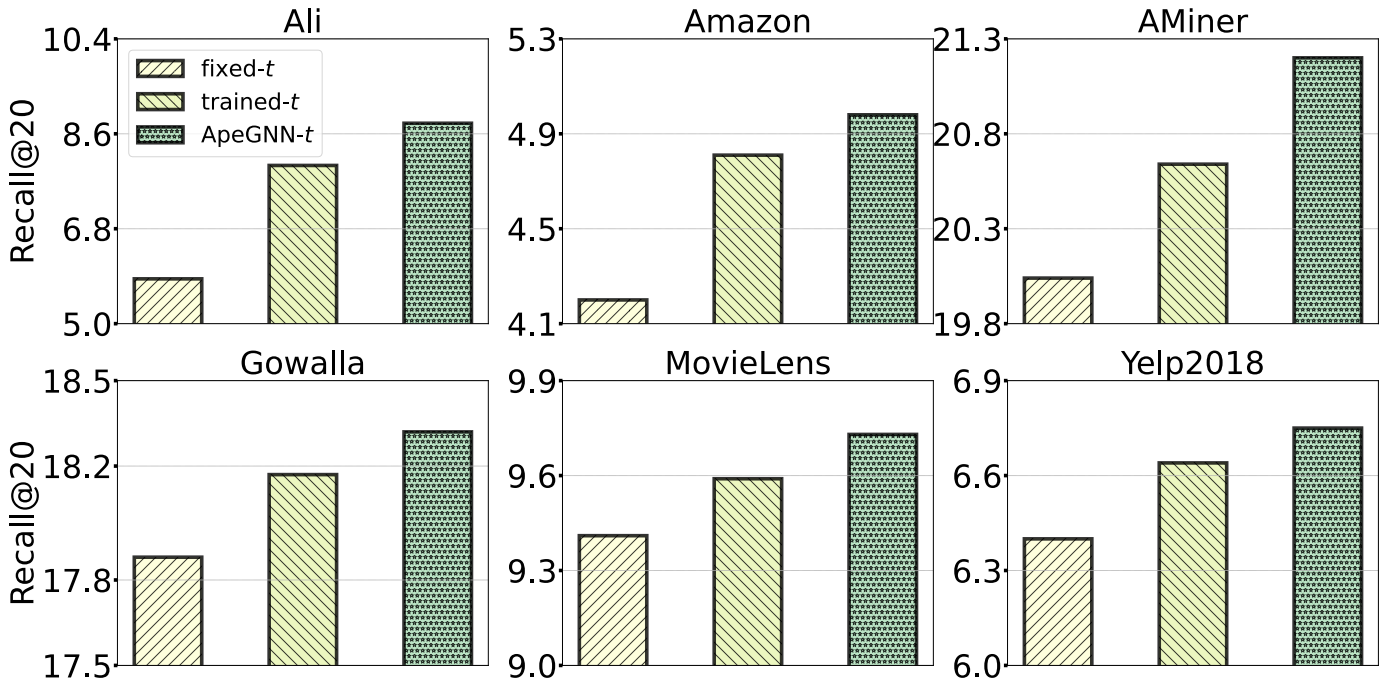
- Overall results

  - ApeGNN outperforms SOTA GNNs-based methods on six datasets

Dataset	Ali		Amazon		AMiner		Gowalla		MovieLens		Yelp2018	
Metrics	Recall	NDCG	Recall	NDCG	Recall	NDCG	Recall	NDCG	Recall	NDCG	Recall	NDCG
BPR-MF	1.03	0.46	1.65	0.76	18.42	9.38	14.17	12.04	8.20	10.75	4.72	3.84
NeuMF	0.87	0.37	1.51	0.58	16.84	8.65	13.97	11.63	7.05	9.31	3.88	3.14
Mult-VAE	2.60	0.78	2.30	0.82	17.89	9.81	15.49	11.98	6.18	5.23	5.94	4.64
GF-CF	4.20	1.84	2.38	1.08	18.77	9.81	17.80	14.61	8.23	11.52	6.32	5.16
NGCF	4.26	1.97	2.94	1.23	17.66	9.11	14.22	11.88	9.31	11.37	5.77	4.69
LightGCN	6.13	2.86	4.11	1.86	19.69	9.87	17.75	15.22	9.41	11.36	6.61	5.39
ApeGNN_HK	8.80	4.29	4.98	**2.36**	**21.20**	**10.69**	**18.32**	**15.35**	9.73	11.91	**6.75**	**5.56**
%Improv.	43.56%	50.00%	21.17%	26.88%	7.67%	8.31%	3.21%	0.85%	3.40%	4.84	7.48%	7.96%
ApeGNN_PPR	**9.13**	**4.41**	**5.10**	2.33	20.88	10.29	17.88	15.17	**9.77**	**12.09**	6.59	5.44
%Improv.	48.94%	54.20%	24.09%	25.27%	6.04%	4.26%	0.73%	-	3.83%	6.43%	-	0.93%

How is **ApeGNN**?
Node-wise Adaptive Aggregation

- Ablation study
  - It demonstrates the importance and effectiveness of node-wise aggregation mechanism



Thanks & QA!

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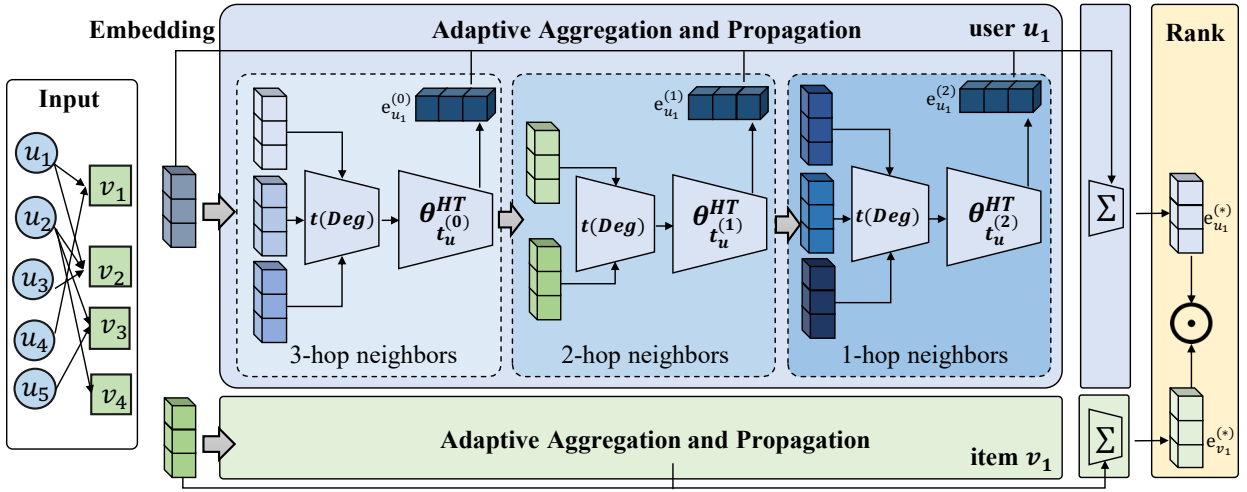

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