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# BENCHTEMP: A General Benchmark for Evaluating Temporal Graph Neural Networks

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## Authors' Response to Reviewer J4Uw

### Opportunities For Improvement:

**W1.** The novelty and contributions of this work are somewhat limited. No new evaluation tasks or datasets are developed in this work. The evaluation tasks and settings, including the transductive and inductive settings, have been widely used by previous works. Also, the datasets included in the benchmark were created by previous works.

**W2.** The experiments section focuses a lot on presenting and discussing individual methods' performance. It'd be better to provide summaries of the state-of-the-art results and the limitations of existing methods, and in light of that, discuss future directions of TGNN research.

**W3.** This paper defines a temporal graph to be a sequence of temporal "user-item" interactions. However, this is a limited form of a temporal graph as this definition covers only a particular type of bipartite graphs with two types of nodes. I think using a more general definition without such conditions (in both the writing and the code) would be more suitable for a general TGNN benchmark.

**W4.** Datasets are not that large for efficiency evaluation. Most graphs used in the benchmark are not that large. The GPU memory usage for these graphs are mostly 1-3 GB. Larger temporal graphs would be more desirable for evaluating model efficiency. Constructing synthetic temporal graphs with increasing sizes could facilitate more systematic evaluations of TGNN models' efficiency.

**W5.** Node reindexing described in Figure 3 is confusing. In the homogeneous graph, why do two different nodes have the same id? For example, in the rightmost graph in Fig 3, there are a user with id 2 and an item with id 2. In general, nodes should have different ids as they are separate entities.

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### 2 General Response:

3 We appreciate your great feedback! We have included new datasets with up to several million  
4 edges and nodes. We have carefully through your comments and added *six* datasets (eBay-Small,  
5 eBay-Large, Taobal-Large, DGraphFin, YouTubeReddit-Small, YouTubeReddit-Large), including  
6 **four large-scale** datasets (eBay-Large, Taobao-Large, DGraphFin, YouTubeReddit-Large). We have  
7 reported the corresponding experiments and detailed discussions in the updated paper. The eBay  
8 datasets are a collection of the user transactions on **eBay's e-commerce platform**. We thank our  
9 industrial collaborator for sharing their datasets in our research. Considering user privacy and  
10 security, eBay datasets could only be shared among collaborators. Any researchers who are interested  
11 in the eBay datasets, please email our team. For easy access, all datasets have been hosted on  
12 the open-source platform zenodo (<https://zenodo.org/>) with a Digital Object Identifier (DOI)  
13 10.5281/zenodo.8267846 (<https://zenodo.org/record/8267846>).

14 We have updated the manuscript in section 4.4 to provide summaries of the state-of-the art results  
15 and the limitations of existing methods, and the future directions of TGNN research.

Submitted to the 37th Conference on Neural Information Processing Systems (NeurIPS 2023) Track on Datasets and Benchmarks. Do not distribute.

We have updated a general definition for temporal graph in section 3.1. A temporal graph can be represented as an ordered sequence of temporal interactions. Each interaction  $I_r = (u_r, i_r, t_r, e_r)$  happens at time  $t_r$  between node  $u_r$  and node  $i_r$  with edge feature  $e_r$ . Considering many real world applications and large-scale temporal graphs, we have added **the inference time** metric to evaluate the efficiency of methods.

We have changed the rightmost graph in Figure 3. In the homogeneous graph shown in Fig 3(b), the user with id 2 and the item with id 2 are the same node.

**We provide our response to each individual comment below:**

#### Comment 1

**W1.** The novelty and contributions of this work are somewhat limited. No new evaluation tasks or datasets are developed in this work. The evaluation tasks and settings, including the transductive and inductive settings, have been widely used by previous works. Also, the datasets included in the benchmark were created by previous works.

#### Response:

We thank the reviewer for the suggestions! We have included new datasets with up to several million edges and nodes. We have added *six* datasets (eBay-Small, eBay-Large, Taobao-Large, DGraphFin, YouTubeReddit-Small, YouTubeReddit-Large), including *four large-scale* datasets (eBay-Large, Taobao-Large, DGraphFin, YouTubeReddit-Large). The statistics of the new datasets are shown in Table 1. For easy access, all datasets have been hosted on the open-source platform zenodo (<https://zenodo.org/>) with a Digital Object Identifier (DOI) 10.5281/zenodo.8267846 (<https://zenodo.org/record/8267846>). In our paper, we present BENCHTEMP, a general benchmark for evaluating temporal graph neural network (TGNN) models over a wide range of tasks and settings. We extensively compare representative TGNN models on the benchmark datasets, regarding different tasks, settings, metrics, and especially model efficiency - **inference time**.

- **eBay-Small** is a subset of the eBay-Large dataset. We sample 38,427 nodes and 384,677 edges from eBay-Large graph according to edge timestamps.
- **YouTubeReddit-Small** is a collection of massive visual contents on YouTube and long-term community activity on Reddit. This dataset covers a 3-month period from January to March 2020. Each row in the dataset represents a YouTube video  $v_i$  being shared in a subreddit  $s_j$  by some user  $u_k$  at time  $t$  [1]. Nodes are YouTube videos and subreddits, edges are the users' interactions between videos and subreddits. This dynamic graph has 264,443 nodes and 297,732 edges.
- **eBay-Large** is a million-scale dataset consisting of 1.3 million nodes and 1.1 million edges, which comprises the selected transaction records from the eBay e-commerce platform over a two-month period. eBay-Large is modeled as a user-item graph, where items are heterogeneous entities which include information such as phone numbers, addresses, and email addresses associated with a transaction. We select one month of transactions as seed nodes and then expand each seed node

Table 1: Dataset statistics of the new datasets.

	Domain	# Nodes	# Edges
eBay-Small	E-commerce	38,427	384,677
YouTubeReddit-Small [1]	Social	264,443	297,732
eBay-Large	E-commerce	1,333,594	1,119,454
DGraphFin [2]	E-commerce	3,700,550	4,300,999
Youtube-Reddit-Large [1]	Social	5,724,111	4,228,523
Taobao-Large [3, 4]	E-commerce	1,630,453	5,008,745

Table 2: ROC AUC results of new datasets on the *dynamic link prediction task*. The best and second-best results are highlighted as **bold red** and underlined blue. We do not highlight the second-best if the gap is  $> 0.05$  compared with the best result.

Model \ Dataset	Transductive						
	JODIE	DyRep	TGN	TGAT	CAWN	NeurTW	NAT
eBay-Small	0.9946 $\pm$ 0.0002	0.9941 $\pm$ 0.0006	0.9984 $\pm$ 0.0003	0.9838 $\pm$ 0.0006	0.9985 $\pm$ 0.0	<b>0.9991 <math>\pm</math> 0.0</b>	<u>0.9978 <math>\pm</math> 0.0003</u>
YouTubeReddit-Small	<u>0.8519 <math>\pm</math> 0.0007</u>	0.8499 $\pm$ 0.0012	0.8432 $\pm$ 0.0032	0.8441 $\pm$ 0.0014	0.7586 $\pm$ 0.0031	<b>0.9003 <math>\pm</math> 0.0031</b>	0.8259 $\pm$ 0.005
eBay-Large	0.9614 $\pm$ 0.0	0.9619 $\pm$ 0.0001	<u>0.9642 <math>\pm</math> 0.0003</u>	0.5311 $\pm$ 0.0003	0.9442 $\pm$ 0.0003	0.9608 $\pm$ 0.0	<b>0.9658 <math>\pm</math> 0.0002</b>
DGraphFin	0.8165 $\pm$ 0.0024	0.8171 $\pm$ 0.0016	<b>0.8683 <math>\pm</math> 0.0023</b>	0.6112 $\pm$ 0.0165	0.5466 $\pm$ 0.0103	<u>0.8611 <math>\pm</math> 0.0035</u>	0.8258 $\pm$ 0.0001
Youtube-Reddit-Large	0.8532 $\pm$ 0.0003	0.8529 $\pm$ 0.0006	0.8458 $\pm$ 0.0025	0.8536 $\pm$ 0.0026	0.7466 $\pm$ 0.0012	<b>0.916 <math>\pm</math> 0.0025</b>	<u>0.8605 <math>\pm</math> 0.0009</u>
Taobao-Large	0.7726 $\pm$ 0.0005	0.7724 $\pm$ 0.001	<u>0.8464 <math>\pm</math> 0.0008</u>	0.5567 $\pm$ 0.0047	0.7771 $\pm$ 0.0068	<b>0.859 <math>\pm</math> 0.0091</b>	0.8188 $\pm$ 0.001
Model \ Dataset	Inductive						
	JODIE	DyRep	TGN	TGAT	CAWN	NeurTW	NAT
eBay-Small	0.9696 $\pm$ 0.0007	0.9674 $\pm$ 0.0018	0.9913 $\pm$ 0.0004	0.9698 $\pm$ 0.0006	0.9964 $\pm$ 0.0001	<u>0.9982 <math>\pm</math> 0.0</u>	<b>0.9998 <math>\pm</math> 0.0001</b>
YouTubeReddit-Small	0.7582 $\pm$ 0.0003	0.7545 $\pm$ 0.0009	0.7276 $\pm$ 0.0033	0.7436 $\pm$ 0.0006	0.7533 $\pm$ 0.0016	0.8978 $\pm$ 0.0032	<b>0.9876 <math>\pm</math> 0.0049</b>
eBay-Large	0.7536 $\pm$ 0.0014	0.7515 $\pm$ 0.0006	0.7657 $\pm$ 0.0026	0.5224 $\pm$ 0.0003	0.9459 $\pm$ 0.0001	<u>0.9608 <math>\pm</math> 0.0</u>	<b>0.9999 <math>\pm</math> 0.0001</b>
DGraphFin	0.6884 $\pm$ 0.0051	0.6876 $\pm$ 0.001	0.6439 $\pm$ 0.0089	0.5677 $\pm$ 0.0184	0.5479 $\pm$ 0.009	<b>0.8635 <math>\pm</math> 0.0021</b>	<u>0.7955 <math>\pm</math> 0.0201</u>
Youtube-Reddit-Large	0.7539 $\pm$ 0.0005	0.7554 $\pm$ 0.0003	0.7243 $\pm$ 0.0016	0.7501 $\pm$ 0.0019	0.7327 $\pm$ 0.0016	<u>0.9128 <math>\pm</math> 0.0031</u>	<b>0.9863 <math>\pm</math> 0.006</b>
Taobao-Large	0.7075 $\pm$ 0.0009	0.7042 $\pm$ 0.0006	0.6812 $\pm$ 0.0032	0.5222 $\pm$ 0.0041	0.7787 $\pm$ 0.0103	<u>0.869 <math>\pm</math> 0.010</u>	<b>0.9933 <math>\pm</math> 0.0008</b>
Model \ Dataset	Inductive New-Old						
	JODIE	DyRep	TGN	TGAT	CAWN	NeurTW	NAT
eBay-Small	0.9862 $\pm$ 0.0003	0.9836 $\pm$ 0.0016	0.9947 $\pm$ 0.0009	0.9712 $\pm$ 0.002	0.9985 $\pm$ 0.0	<u>0.9988 <math>\pm</math> 0.0</u>	<b>0.9999 <math>\pm</math> 0.0</b>
YouTubeReddit-Small	0.7695 $\pm$ 0.001	0.7655 $\pm$ 0.0018	0.7396 $\pm$ 0.0034	0.7242 $\pm$ 0.0004	0.7573 $\pm$ 0.0022	<u>0.922 <math>\pm</math> 0.0002</u>	<b>0.9967 <math>\pm</math> 0.0014</b>
eBay-Large	0.6109 $\pm$ 0.0244	0.5906 $\pm$ 0.0087	0.8134 $\pm$ 0.0105	0.6363 $\pm$ 0.0605	<u>0.9569 <math>\pm</math> 0.0007</u>	0.8973 $\pm$ 0.0	<b>1.0 <math>\pm</math> 0.0</b>
DGraphFin	0.5768 $\pm$ 0.0071	0.5735 $\pm$ 0.0007	0.5564 $\pm$ 0.0021	0.5742 $\pm$ 0.013	0.5646 $\pm$ 0.0244	<u>0.7702 <math>\pm</math> 0.0043</u>	<b>0.8693 <math>\pm</math> 0.0066</b>
Youtube-Reddit-Large	0.7844 $\pm$ 0.0015	0.7894 $\pm$ 0.0017	0.7623 $\pm$ 0.0031	0.7457 $\pm$ 0.0062	0.7511 $\pm$ 0.0022	<u>0.9356 <math>\pm</math> 0.0004</u>	<b>0.9958 <math>\pm</math> 0.0025</b>
Taobao-Large	0.7023 $\pm$ 0.0015	0.6953 $\pm$ 0.0022	0.6771 $\pm$ 0.0055	0.5104 $\pm$ 0.0106	0.7674 $\pm$ 0.005	<u>0.8458 <math>\pm</math> 0.0043</u>	<b>0.9965 <math>\pm</math> 0.0005</b>
Model \ Dataset	Inductive New-New						
	JODIE	DyRep	TGN	TGAT	CAWN	NeurTW	NAT
eBay-Small	0.9388 $\pm$ 0.0009	0.9366 $\pm$ 0.0037	0.9838 $\pm$ 0.0007	0.9556 $\pm$ 0.0007	0.9937 $\pm$ 0.0	<u>0.9975 <math>\pm</math> 0.0</u>	<b>0.9997 <math>\pm</math> 0.0004</b>
YouTubeReddit-Small	0.7436 $\pm$ 0.0015	0.7436 $\pm$ 0.0018	0.7265 $\pm$ 0.0055	0.749 $\pm$ 0.0011	0.7479 $\pm$ 0.004	<u>0.864 <math>\pm</math> 0.0071</u>	<b>0.9868 <math>\pm</math> 0.0049</b>
eBay-Large	0.7526 $\pm$ 0.0013	0.7500 $\pm$ 0.0005	0.7639 $\pm$ 0.0027	0.5196 $\pm$ 0.0002	0.9542 $\pm$ 0.0003	<u>0.9615 <math>\pm</math> 0.0</u>	<b>0.9999 <math>\pm</math> 0.0001</b>
DGraphFin	0.7307 $\pm$ 0.0007	0.7323 $\pm$ 0.0002	0.6843 $\pm$ 0.0131	0.5649 $\pm$ 0.0248	0.5417 $\pm$ 0.0099	<b>0.9051 <math>\pm</math> 0.0028</b>	<u>0.7584 <math>\pm</math> 0.0323</u>
Youtube-Reddit-Large	0.6932 $\pm$ 0.0026	0.7022 $\pm$ 0.0007	0.6703 $\pm$ 0.0024	0.7269 $\pm$ 0.0	0.6942 $\pm$ 0.0028	<u>0.8716 <math>\pm</math> 0.0077</u>	<b>0.9796 <math>\pm</math> 0.0103</b>
Taobao-Large	0.7243 $\pm$ 0.0001	0.7247 $\pm$ 0.0001	0.6885 $\pm$ 0.0024	0.5256 $\pm$ 0.0054	0.7922 $\pm$ 0.0118	<u>0.8906 <math>\pm</math> 0.0088</u>	<b>0.9969 <math>\pm</math> 0.0002</b>

two hops back in time to enrich the topology while maintaining consistency in the distribution of seed nodes.

- **DGraphFin** is a collection of large-scale dynamic graph datasets, consisting of interactive objects, events and labels that evolve with time. It is a directed, unweighted dynamic graph consisting of millions of nodes and edges, representing a realistic user-to-user social network in financial industry. Nodes are users, and an edge from one user to another means that the user regards the other user as the emergency contact person [2].
- **Youtube-Reddit-Large** dataset covers **54** months of YouTube video propagation history from January 2018 to June 2022 [1]. This dataset has 5,724,111 nodes and 4,228,523 edges.
- **Taobao-Large** is a collection of the Taobao user behavior dataset intercepted based on the period 8:00 to 18:00 on 26 November 2017 [4]. Nodes are users and items, and edges are behaviors between users and items, such as favor, click, purchase, and add an item to shopping cart. This public dataset has 1,630,453 nodes and 5,008,74 user-item interaction edges.

## A Experiments

We conduct extensive experiments on the tasks of *dynamic link prediction* and *dynamic node classification*. The experimental setup is the same as in the paper.

### A.1 Link Prediction Task

We run the link prediction task on 7 TGNN models and the new datasets under different settings (Transductive, Inductive, Inductive New-Old, and Inductive New-New). The AUC and AP results for each new datasets are shown in Table 2 and Table 3, respectively. For the four large-scale datasets (eBay-Large, Taobao-Large, DGraphFin, YouTubeReddit-Large), we observe the similar results as in the paper. Specifically, NAT and NeurTW achieve the top-2 performance on almost all datasets under transductive and inductive settings.

Table 3: AP results of new datasets on the *dynamic link prediction task*. The best and second-best results are highlighted as **bold red** and underlined blue. We do not highlight the second-best if the gap is  $> 0.05$  compared with the best result.

		Transductive						
Model \ Dataset	JODIE	DyRep	TGN	TGAT	CAWN	NeurTW	NAT	
eBay-Small	0.9938 ± 0.0004	0.9936 ± 0.0006	<u>0.9983 ± 0.0003</u>	0.9819 ± 0.0009	0.9981 ± 0.0	<b>0.9991 ± 0.0</b>	0.9975 ± 0.0002	
YouTubeReddit-Small	<u>0.8612 ± 0.0009</u>	0.8594 ± 0.0012	0.8421 ± 0.0041	0.8515 ± 0.0012	0.7625 ± 0.0042	<b>0.9112 ± 0.0021</b>	0.8325 ± 0.0068	
eBay-Large	0.9318 ± 0.0002	0.9322 ± 0.0002	<u>0.9357 ± 0.0006</u>	0.5239 ± 0.0002	0.9144 ± 0.0004	0.9307 ± 0.0	<b>0.9398 ± 0.0004</b>	
DGraphFin	0.7705 ± 0.0009	0.7705 ± 0.0024	<u>0.8571 ± 0.0009</u>	0.6441 ± 0.0123	0.5431 ± 0.0095	<b>0.8637 ± 0.0014</b>	0.7956 ± 0.0012	
Youtube-Reddit-Large	0.8622 ± 0.0007	<u>0.8632 ± 0.0004</u>	0.8476 ± 0.0022	0.8591 ± 0.0026	0.7475 ± 0.0017	<b>0.9222 ± 0.0013</b>	0.8628 ± 0.0015	
Taobao-Large	0.7164 ± 0.0003	0.7142 ± 0.0008	<u>0.844 ± 0.0011</u>	0.5761 ± 0.0023	0.7616 ± 0.0069	<b>0.8568 ± 0.016</b>	0.7904 ± 0.0008	
		Inductive						
eBay-Small	0.9638 ± 0.0007	0.9619 ± 0.0017	0.9898 ± 0.0005	0.9675 ± 0.0007	0.9953 ± 0.0002	<u>0.9982 ± 0.0</u>	<b>0.9998 ± 0.0001</b>	
YouTubeReddit-Small	0.7866 ± 0.0007	0.7833 ± 0.0009	0.7387 ± 0.0069	0.7551 ± 0.0002	0.7568 ± 0.0031	<u>0.9086 ± 0.0022</u>	<b>0.9872 ± 0.0056</b>	
eBay-Large	0.6989 ± 0.0018	0.6973 ± 0.0007	0.7096 ± 0.0030	0.518 ± 0.0002	0.9174 ± 0.0001	<u>0.9308 ± 0.0</u>	<b>0.9999 ± 0.0001</b>	
DGraphFin	0.6563 ± 0.002	0.6567 ± 0.0009	0.624 ± 0.006	0.5866 ± 0.0123	0.5428 ± 0.0082	<b>0.8626 ± 0.0012</b>	<u>0.7053 ± 0.0185</u>	
Youtube-Reddit-Large	0.7796 ± 0.0009	0.7818 ± 0.0009	0.73 ± 0.0029	0.7587 ± 0.0025	0.7353 ± 0.0022	<u>0.9192 ± 0.0022</u>	<b>0.9849 ± 0.0071</b>	
Taobao-Large	0.6763 ± 0.0011	0.6746 ± 0.0011	0.6664 ± 0.0012	0.5315 ± 0.0027	0.7533 ± 0.011	<u>0.8596 ± 0.0205</u>	<b>0.9941 ± 0.0007</b>	
		Inductive New-Old						
eBay-Small	0.9849 ± 0.0007	0.9836 ± 0.0013	0.9931 ± 0.0008	0.9682 ± 0.0028	0.9985 ± 0.0001	<u>0.999 ± 0.0</u>	<b>0.9999 ± 0.0</b>	
YouTubeReddit-Small	0.7963 ± 0.0013	0.7937 ± 0.0014	0.729 ± 0.0086	0.7296 ± 0.0013	0.762 ± 0.0041	<u>0.9244 ± 0.0015</u>	<b>0.9966 ± 0.0016</b>	
eBay-Large	0.5670 ± 0.0186	0.5870 ± 0.0074	0.8024 ± 0.0060	0.6504 ± 0.0385	<u>0.9592 ± 0.0008</u>	0.8458 ± 0.0	<b>1.0 ± 0.0</b>	
DGraphFin	0.6005 ± 0.0048	0.5872 ± 0.0059	0.5753 ± 0.0062	0.5927 ± 0.0058	0.5669 ± 0.0269	<u>0.7572 ± 0.0025</u>	<b>0.8184 ± 0.0088</b>	
Youtube-Reddit-Large	0.808 ± 0.0014	0.8142 ± 0.0019	0.7472 ± 0.0043	0.7526 ± 0.0097	0.7553 ± 0.0025	<u>0.9368 ± 0.0009</u>	<b>0.9953 ± 0.0028</b>	
Taobao-Large	0.7009 ± 0.0013	0.698 ± 0.0014	0.6879 ± 0.0008	0.5254 ± 0.0074	0.7597 ± 0.0053	<u>0.8459 ± 0.0103</u>	<b>0.9969 ± 0.0004</b>	
		Inductive New-New						
eBay-Small	0.923 ± 0.001	0.9226 ± 0.0024	0.98 ± 0.0007	0.9505 ± 0.0009	0.991 ± 0.0001	<u>0.9973 ± 0.0</u>	<b>0.9997 ± 0.0004</b>	
YouTubeReddit-Small	0.7578 ± 0.0015	0.7582 ± 0.0021	0.7564 ± 0.0043	0.7718 ± 0.0023	0.7498 ± 0.004	<u>0.8868 ± 0.0034</u>	<b>0.9861 ± 0.0063</b>	
eBay-Large	0.6976 ± 0.0016	0.6957 ± 0.0007	0.7078 ± 0.0031	0.5154 ± 0.0001	0.93 ± 0.0003	<u>0.9318 ± 0.0</u>	<b>0.9999 ± 0.0001</b>	
DGraphFin	0.6802 ± 0.0005	0.6811 ± 0.0002	0.6526 ± 0.0098	0.5831 ± 0.0184	0.5379 ± 0.0071	<b>0.8977 ± 0.0014</b>	0.6529 ± 0.0249	
Youtube-Reddit-Large	0.7038 ± 0.0024	0.7115 ± 0.0007	0.6979 ± 0.002	0.7414 ± 0.0012	0.6965 ± 0.004	<u>0.8848 ± 0.0023</u>	<b>0.9761 ± 0.0134</b>	
Taobao-Large	0.6738 ± 0.0005	0.6742 ± 0.0005	0.6611 ± 0.0011	0.53 ± 0.0023	0.7521 ± 0.0127	<u>0.8738 ± 0.0145</u>	<b>0.9973 ± 0.0001</b>	

Table 4: ROC AUC results for the *dynamic node classification task* on the eBay datasets. The top-2 results are highlighted as **bold red** and underlined blue.

Model \ Dataset	JODIE	DyRep	TGN	TGAT	CAWN	NeurTW	NAT
eBay-Small	0.9274 $\pm$ 0.0017	0.8677 $\pm$ 0.0356	0.913 $\pm$ 0.0025	<u>0.9342 <math>\pm</math> 0.0002</u>	0.9305 $\pm$ 0.0001	<b>0.9529 <math>\pm</math> 0.0002</b>	0.6797 $\pm$ 0.0115
eBay-Large	0.7244 $\pm$ 0.0002	0.7246 $\pm$ 0.0	0.6586 $\pm$ 0.0129	0.672 $\pm$ 0.0016	<u>0.7710 <math>\pm</math> 0.0002</u>	<b>0.7859 <math>\pm</math> 0.0</b>	0.5304 $\pm$ 0.0011

## 72 A.2 Node Classification Task

73 The eBay-Small and eBay-Large datasets have node labels, so we conduct dynamic node classification  
74 experiments on both the eBay-Small and eBay-Large datasets. The AUC results are shown in Table 4.  
75 We can observe the similar results as in the paper. NeurTW achieves the best performance on both  
76 eBay-Small and eBay-Large datasets. NAT performs poorly on the node classification task.

## 77 A.3 Efficiency

78 Considering many real world applications and , we add **the inference time** metric to evaluate the  
79 efficiency of models. The inference time comparison per 100,000 edges is shown in Figure 1.  
80 According to the figure, we can observe the similar model efficiency results as in the paper. In  
81 terms of the inference time, JODIE, DyRep, TGN and TGAT are faster, while CAWN and NeurTW  
82 are much slower. NAT is relatively faster than temporal walk-based methods through caching and  
83 parallelism optimizations, *achieving a good trade-off between model quality and efficiency.*

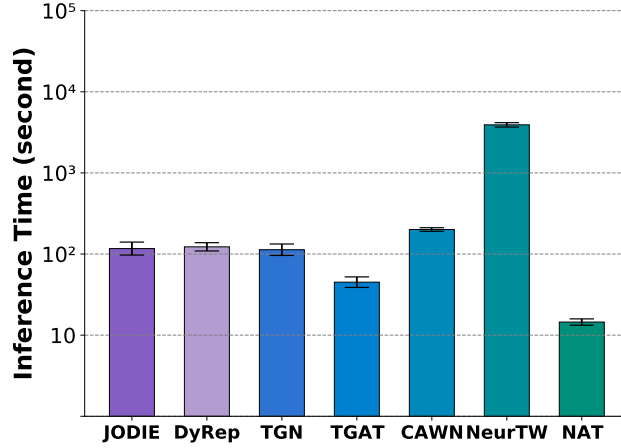


Figure 1: Inference time comparison per 100,000 edges.

#### Comment 2

**W2.** The experiments section focuses a lot on presenting and discussing individual methods' performance. It'd be better to provide summaries of state-of-the-art results and the limitations of existing methods, and in light of that, discuss future directions of TGNN research.

84

#### Response:

85

86 We appreciate this suggestion! We have updated the paper (<https://openreview.net/pdf?id=rnZm2vQq31>) in section 4.4 to provide the summaries of the state-of-the-art results and the limitations  
87 of existing methods, and the future directions of TGNN research.  
88

#### Comment 3

**W3.** This paper defines a temporal graph to be a sequence of temporal "user-item" interactions. However, this is a limited form of a temporal graph as this definition covers only a particular type of bipartite graphs with two types of nodes. I think using a more general definition without such conditions (in both the writing and the code) would be more suitable for a general TGNN benchmark.

89

#### Response:

90

91 Thanks for your comment! We have updated a general definition for temporal graph in section 3.1.  
92 A temporal graph can be represented as an ordered sequence of temporal interactions. The  $r$ -th  
93 interaction  $I_r = (u_r, i_r, t_r, e_r)$  happens at time  $t_r$  between the source node  $u_r$  and the destination  
94 node  $i_r$  with edge feature  $e_r$ .

#### Comment 4

**W4.** Datasets are not that large for efficiency evaluation. Most graphs used in the benchmark are not that large. The GPU memory usage for these graphs are mostly 1-3 GB. Larger temporal graphs would be more desirable for evaluating model efficiency. Constructing synthetic temporal graphs with increasing sizes could facilitate more systematic evaluations of TGNN models' efficiency.

95

96 **Response:**

97 Thanks for this valuable comment!

98 We have included new datasets with up to several million edges and nodes. We have added *six* datasets  
99 (eBay-Small, eBay-Large, Taobao-Large, DGraphFin, YouTubeReddit-Small, YouTubeReddit-Large),  
100 including *four* **large-scale** datasets (eBay-Large, Taobao-Large, DGraphFin, YouTubeReddit-Large).  
101 The statistics of the new datasets are shown in Table 1. For easy access, all datasets have been hosted  
102 on the open-source platform zenodo (<https://zenodo.org/>) with a Digital Object Identifier (DOI)  
103 10.5281/zenodo.8267846 (<https://zenodo.org/record/8267846>). Furthermore, considering  
104 many real world applications and large-scale temporal graphs, we have added **the inference time**  
105 metric to evaluate the efficiency of TGNN models. See Section A for details.

**Comment 5**

**W5.** Node reindexing described in Figure 3 is confusing. In the homogeneous graph, why do  
two different nodes have the same id? For example, in the rightmost graph in Fig 3, there are  
a user with id 2 and an item with id 2. In general, nodes should have different ids as they are  
separate entities.

106

107 **Response:**

108 We appreciate the suggestion and totally agree. In the homogeneous graph shown in Figure 3(b), the  
109 user with id 2 and the item with id 2 are the same node. Therefore, we have updated the Figure 3(b)  
110 in the paper by replacing the labels "user" and "item" with "node".

## References

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