On the Feasibility of Simple Transformer for Dynamic Graph Modeling

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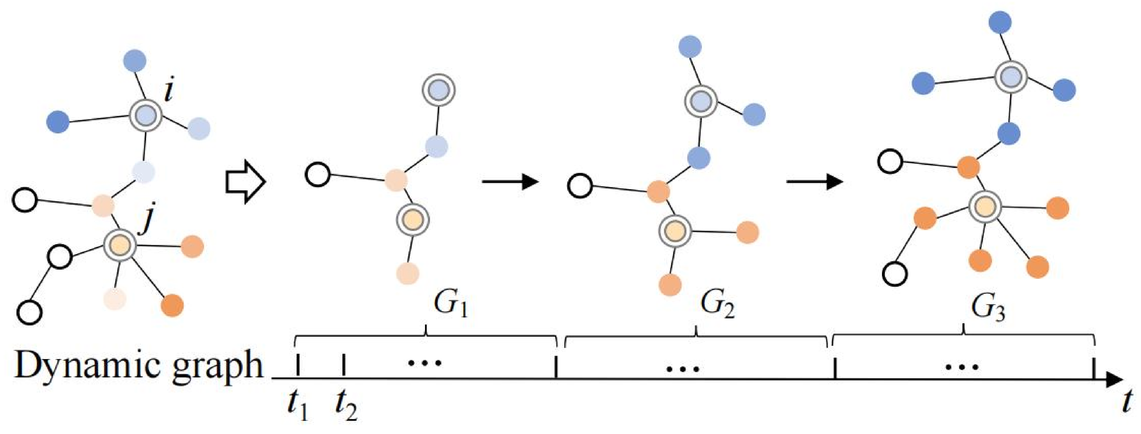
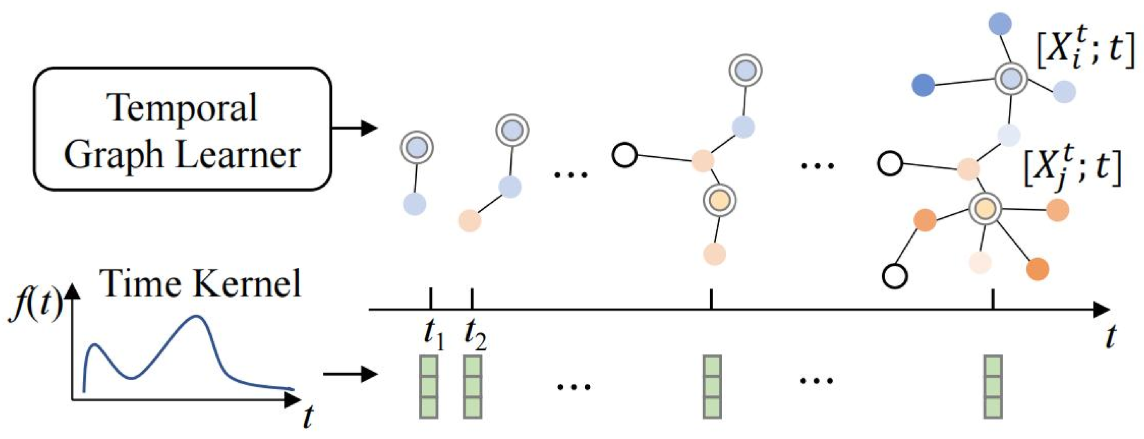
Motivation



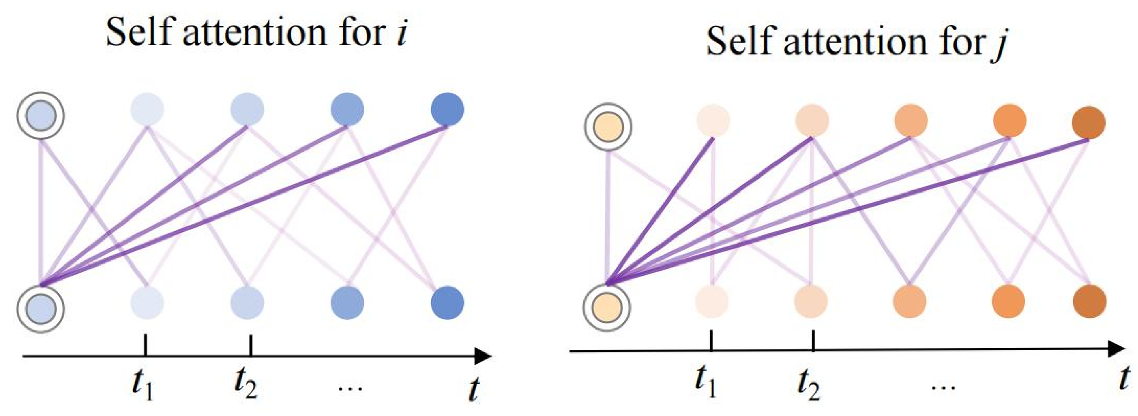
(a) Discrete-time approaches

Discard the fine-grained temporal information within the snapshot



(b) Continuous-time approaches

Difficult for capturing long-term dependency within historical graph data



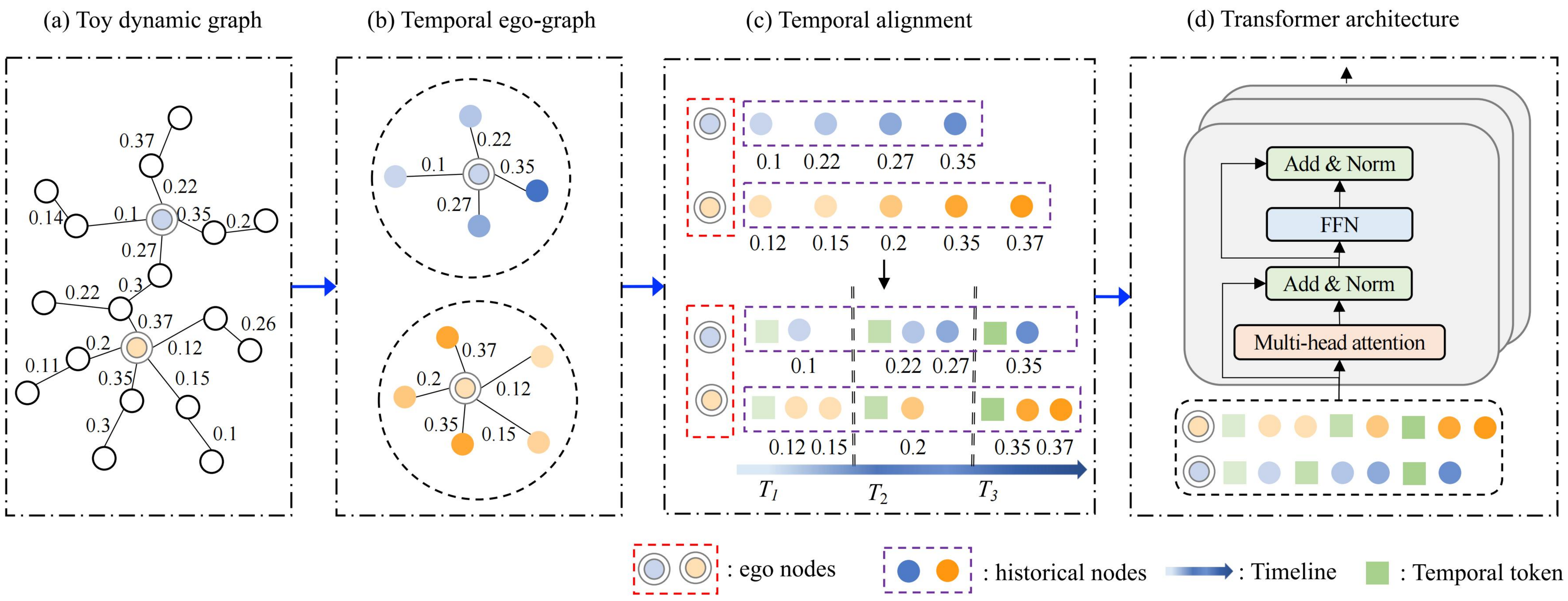
(c) Self-attention in Transformer

Naturally support continuous sequence
Self-attention --> long-term dependency

Contribution:

- ❖ We explore the potential of the Transformer architecture for modeling dynamic graphs
- ❖ We propose a simple yet effective Transformer-based approach for dynamic graphs without complex modifications
- ❖ We introduce a novel strategy to map a dynamic graph into a set of sequences with special tokens to improve the scalability

Framework: SimpleDyG



Dynamic graph

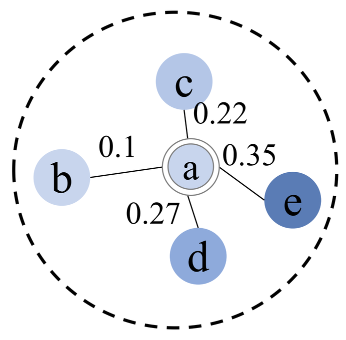
$\mathcal{G} = (\mathcal{V}, \mathcal{E}, \mathcal{T}, \mathcal{X})$

$\mathcal{V}$: nodes

$\mathcal{E}$: edges

$\mathcal{T}$: time domain

$\mathcal{X}$: input feature matrix



Temporal Ego-graph

❑Temporal ego-graph for one node:

$$w_i = \langle b, c, d, e \rangle$$

❑Training sample:

- Input: $x_i = \langle |hist| \rangle, a, b, c, d, e, \langle |endofhist| \rangle$
- Output: $y_i = \langle |pred| \rangle, f, g, \cdots, \langle |endofpred| \rangle$

Temporal Alignment

❑Segment the time domain into T time steps

$$S_i^1 = \langle b \rangle \quad S_i^2 = \langle c, d \rangle \quad S_i^3 = \langle e \rangle$$

❑Training sample:

- Input: $x_i' = \langle |hist| \rangle, a, \langle |time1| \rangle, b, \langle |time2| \rangle, c, d, \langle |time3| \rangle, e, \langle |endofhist| \rangle$
- Output: $y_i' = \langle |pred| \rangle \langle |time4| \rangle S_i^4 \langle |endofpred| \rangle$

Experiment

Datasets

Dataset	UCI	ML-10M
Domain	Social	Rating
# Nodes	1,781	15,841
# Edges	16,743	48,561

Dataset	Hepth	MMConv
Domain	Citation	Conversation
# Nodes	4,737	7,415
# Edges	14,831	91,986

Results

	UCI		ML-10M		Hepth		MMConv	
	NDCG@5	*Jaccard*	*NDCG@5*	*Jaccard*	*NDCG@5*	*Jaccard*	*NDCG@5*	*Jaccard*
DySAT [37]	0.010±0.003	0.010±0.001	0.058±0.073	0.050±0.068	0.007±0.002	0.005±0.001	0.102±0.085	0.095±0.080
EvolveGCN [32]	0.064±0.045	0.032±0.026	0.097±0.071	0.092±0.067	0.009±0.004	0.007±0.002	0.051±0.021	0.032±0.017
DyRep [40]	0.011±0.018	0.010±0.005	0.064±0.036	0.038±0.001	0.031±0.024	0.010±0.006	0.140±0.057	0.067±0.025
JODIE [20]	0.022±0.023	0.012±0.009	0.059±0.016	0.020±0.004	0.031±0.021	0.011±0.008	0.041±0.016	0.032±0.022
TGAT [49]	0.061±0.007	0.020±0.002	0.066±0.035	0.021±0.007	0.034±0.023	0.011±0.006	0.089±0.033	0.058±0.021
TGN [36]	0.041±0.017	0.011±0.003	0.071±0.029	0.023±0.001	0.030±0.012	0.008±0.001	0.096 ±0.068	0.066±0.038
TREND [44]	0.067±0.010	0.039±0.020	0.079±0.028	0.024±0.003	0.031±0.003	0.010±0.002	0.116±0.020	0.060±0.018
GraphMixer [6]	**0.104±0.013**	0.042±0.005	0.081±0.033	0.043±0.022	0.011±0.008	0.010±0.003	0.172±0.029	0.085±0.016
SimpleDyG	**0.104±0.010**	**0.092±0.014**	**0.138±0.009**	**0.131±0.008**	**0.035±0.014**	**0.013±0.006**	**0.184±0.012**	**0.169±0.010**

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