NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE

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TAGON: Temporal Attention Graph-Optimized Networks
for Sequential Recommendation Systems

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Introduction

As the digital world evolves, sequential recommendation systems are becoming crucial for enhancing user engagement by personalizing the digital experience. These systems analyze a user's interaction history and context, predicting future actions with high relevance. Utilizing deep learning techniques, such as Graph Neural Networks, these models handle complex user-item relationships effectively, especially when integrated with temporal data.

This research introduces Temporal Attention Graph-Optimized Networks, a robust architecture that incorporates temporal dynamics into graph-based models. By capturing the sequence and timing of interactions, the proposed model aims to provide more accurate predictions, significantly improving the performance of recommendation systems in various domains like e-commerce and social networking.

TAGON Framework

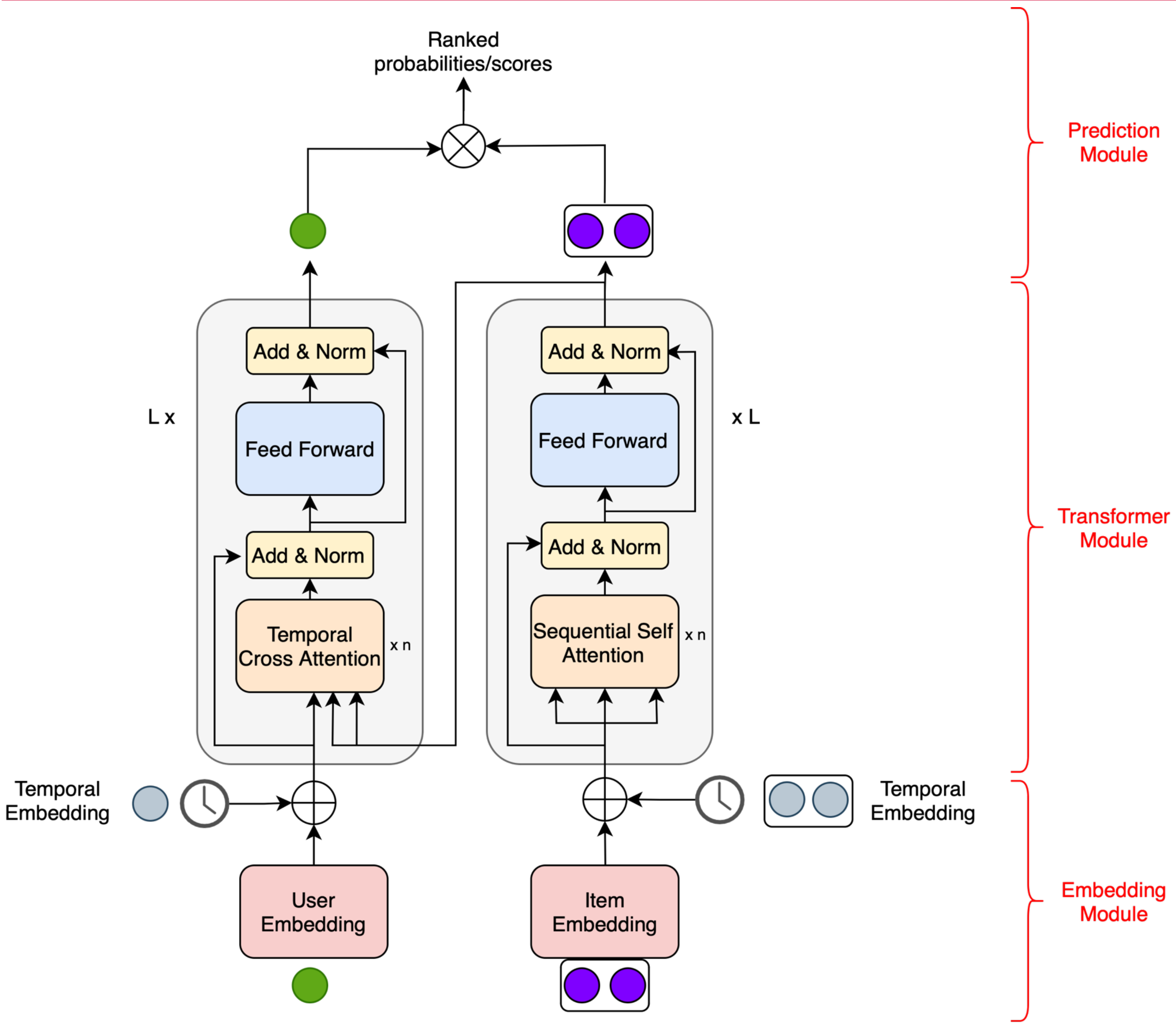

Figure 1: Proposed architecture for TAGON

Continuous-Time User-Item Bipartite Graph

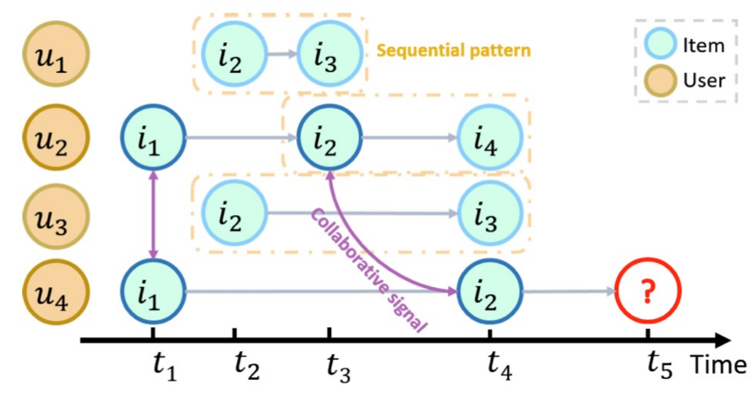

Figure 2: Continuous Time Bipartite Graph (CTBG)

In our study, we introduce the Continuous Time Bipartile Graph (CTBG), an innovative graph structure that records user-item interactions along with their exact timestamps. By capturing the temporal sequence of these interactions, the CTBG enables more nuanced modeling of dynamic user behaviors, significantly enhancing predictive accuracy in sequential recommendation systems.

Datasets Used

Dataset	Toys	Baby	Tools	Music	ML-100K
No. of Users	17,946	17,739	15,920	4,652	943
No. of Items	11,639	6,876	10,043	3,051	1,682
No. of Edges	154,793	146,775	127,784	54,932	48,569
Sparsity	99.93%	99.88%	99.92%	99.62%	93.70%
Avg. Interval	85 days	61 days	123 days	104 days	4.8 hours
# Train	134,632	128,833	107,684	51,765	80,003
# Validation	11,283	10,191	10,847	2,183	1,516
# Test	8,878	7,751	9,523	984	1,344

Table 1: Dataset Statistics

Results and Conclusion

TAGON exhibits outstanding performance across multiple datasets, with the Toys, Baby, Music, Tools, and the ML-100K datasets, demonstrating its versatility and effectiveness in recommendation tasks (Table 2). The range and variance of results for the ML-100K and the Music dataset will be relatively different compared to the other datasets due to lack of training instances. We also conducted rigorous ablation studies and fine-tuned it using hyperparameter optimization on various settings to answer our research questions.

As the encoding strategies vary from Empty to Positional to Temporal, there is a discernible trend indicating enhanced model performance, particularly with the incorporation of time sensitive information. Temporal Encoding enhances prediction accuracy by capturing interaction timing, confirming the importance of temporal context in modeling user behavior. (Figures 2, 3)

This research enhances sequential recommendation systems by integrating graph neural networks and attention mechanisms, significantly improving accuracy and contextual relevance across diverse datasets.

Model	Toys	Baby	Tools	Music	ML-100K
BPR	0.0024	0.0019	0.0057	0.0026	0.0213
LightGCN	0.0018	0.0024	0.0064	0.0023	0.0252
SR-GNN	0.0018	0.0024	0.0028	0.0028	0.0012
GRU4Rec	0.0201	0.0028	0.0540	0.0051	0.0938
Caser	0.0082	0.0071	0.0106	0.0068	0.0147
CDTNE	0.0025	0.0157	0.0037	0.0191	0.0162
TAGON	**0.0204**	**0.0167**	**0.0617**	**0.0202**	**0.0982**
Improve(%)	**1.49%**	**5.93%**	**12.42%**	**5.35%**	**4.49%**

Table 2: Performance Evaluation on five datasets using MRR

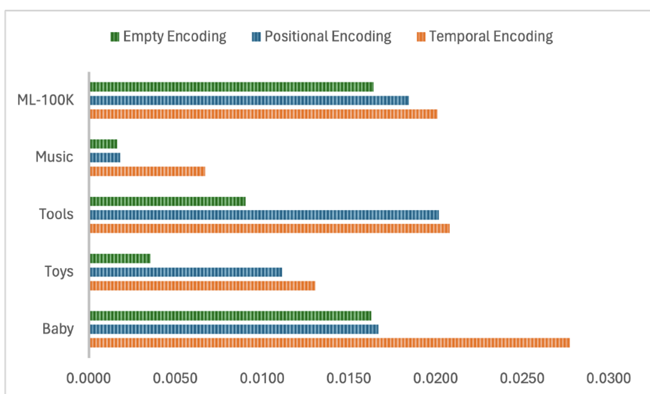

Figure 2: MRR comparison for different encoding algorithms

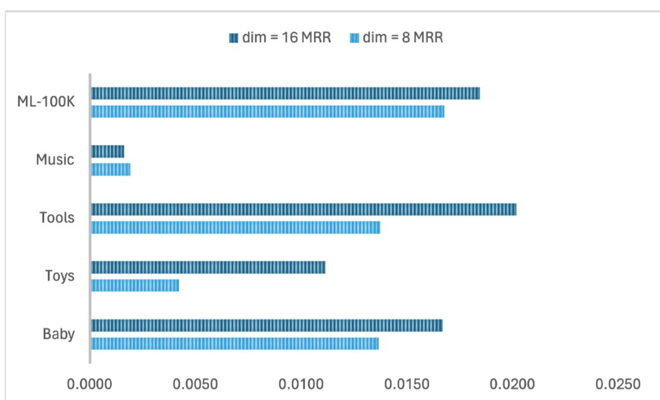

Figure 3: MRR comparison for different embedding dimensions