A Survey on Temporal Knowledge Graph Completion: Taxonomy, Progress, and Prospects

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1 What?

This is a survey paper about the task of temporal knowledge graph completion.

2 Why?

TKGs or KG in general, ften suffer from incompleteness for three main reasons:

- the continuous emergence of new knowledge.

- he weakness of the algorithm for extracting structured information from unstructured data.

- the lack of information in the source dataset.

3 How?

The temporal knowledge graph completion task can be divided into two main kinds:

- Interpolation: estimates and predicts the missing elements or set of elements through the relevant available information.

- Extrapolation: focuses on continuous TKGs and predicts future events, and then classifies all extrapolation methods based on the algorithms they utilize.
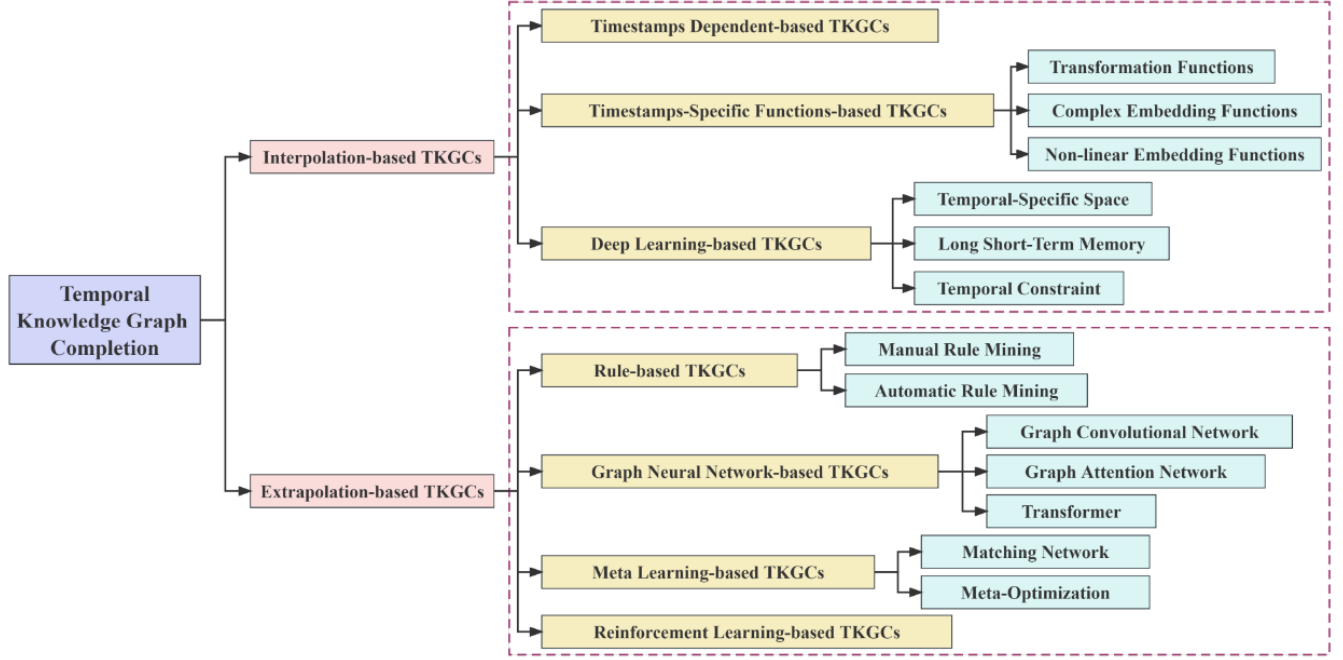
Fig. 2. Fine-grained categorization of *Temporal Knowledge Graph Completion (TKGC)* methods.

Figure 1: Tổng quan hướng tiếp cận bài toán hoàn thiện đồ thị tri thức động.

3.1 Interpolation-based TKGCs

3.1.1 Timestamps dependent-based TKGC methods

These methods typically do not perform operations on timestamps. They just simply associate the timestamps with the corresponding entity or relation to accomplish the evolution of entities and relations.

- TuckERTNT (Shao et al. 2022)

- TTransE, ST-TransE

- T-SimplE

- TKGFrame

- TBDRI

3.1.2 Timestamps-specific functions-based TKGC methods

These methods typically exploit the specific function to learn the embeddings of timestamps or the evolution of entities and relations.

There are various useful functions can be used:

- Diachronic embedding functions

- Gaussian functions

- Transformation functions

Transformation functions: encoding timestamps via one/ or some transformation functions

- TransE-ILP (Jiang et al. 2016) utilize the time-aware embedding model and Integer Linear Programming (ILP) to encode temporal order information and temporal consistency information.

- HTTR utilize Householder transformation

- BoxTE -> model-agnostic based on BoxTE

- SPLIME

- TARGCN

- TASTER

- Time-LowFER

- DE-SimplE, DE-DistMult

- DEGAT

Complex functions: using complex spaces or special coordinate system to capture various relational patterns.

- ChronoR (an extended version of RotatE)

- TComplEx and TNTComplEx

- TeRo

- TGeomE (using hypercomplex space, i.e., quaternion)

- TeLM (based on TGeomE)

- RotateQVS (quaternion space)

- ST-NewDE (Dihedron algebra)

- BiQCap

- HA-TKGE

- STKE (spherical coordinate system)

- HTKE

Non-linear embedding functions: tilize non-linear functions, such as Gaussian and non-Euclidean functions, to embed TKGs.

- DyERNIE, HERCULES

- ATiSE

- TKGC-AGP

3.1.3   Deep learning-based TKGC methods

Timestamps-specific space

- HyTE, HTKE, TRHyTE, BTHyTE

- ToKEi

- SANe

- QDN

Long short-term memory

- TA-TransE, TA-DistMult

- TDG2E

- TRHyTE

- CTRIEJ

- TeCre

Temporal constraint

- Kgedl

- T-GAP

- TempCaps

- RoAN

- TAL-TKGC

3.2 Extrapolation-based TKGCs

3.2.1 Rule-based TKGC methods

- ALRE-IR

- TLogic

- TILP

- TFLEX

3.2.2 Graph neural network-based TKGC methods

Graph convolutional network

- RE-NET

- Glean

- TeMP

- DACHA

- RE-GCN

- CyGNet

- TiRGN

- HiSMatch

- SPA

- TANGO

- HGLS

Graph attention network

- TPmod

- EvoKG

- DA-Net

- TAE

- EvoExplore

- CRNet

- CENET

- MP-KD

- Know-Evolve

- RTFE

- CyGNet

- xERTE

- T-GAP

Transformers

- HSAE

- rGalT

- GHT

3.2.3 Meta learning-based TKGC methods

Matching network

- FTAG

- FTMF

- TFSC

Meta-optimization

- MOST

- MetaTKG

- MetaTKGR

3.2.4 Reinforcement learning-based TKGC methods

- TAgent

- TPath

- TITer

- CluSTeR

- DREAM

- RLAT

References

Jiang, Tingsong et al. (Dec. 2016). "Towards Time-Aware Knowledge Graph Completion". In: *Proceedings of COLING 2016, the 26th International Conference on Computational Linguistics: Technical Papers*. Ed. by Yuji Matsumoto and Rashmi Prasad. Osaka, Japan: The COLING 2016 Organizing Committee, pp. 1715–1724. URL: https://aclanthology.org/C16-1161.

Shao, Pengpeng et al. (2022). "Tucker decomposition-based temporal knowledge graph completion". In: *Knowledge-Based Systems* 238, p. 107841.