

Temporal Knowledge Graph Completion: A Survey

Borui Cai et al

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1 What?

This paper is a survey paper which proposes a new taxonomy of existing TKGC methods based on how the temporal validity of facts is integrated for link prediction.

2 Why?

Many existing surveys are focusing make discussion about dynamic graph link prediction tasks, and rarely discuss techniques specifically designed for the multi-relational knowledge graphs.

3 How?

$\mathcal{G} = \{\mathcal{E}, \mathcal{R}, \mathcal{T}, \mathcal{D}\}$ where:

- $\mathcal{E}, \mathcal{R}, \mathcal{T}$ are the sets of entities, relations, and timestamps, respectively.
- $\mathcal{D} \in \mathcal{E} \times \mathcal{R} \times \mathcal{E} \times \mathcal{D}$ is the collection of facts contained in the knowledge graph.

A fact can be donated as (h, r, t, τ)

A factual score function, $q(s)$

Negative sampling methods

The collection of negative samples generated from s , can be donated as $\tilde{\mathcal{D}}_s$

Loss function aim to minimizing $q(s)$, and maximizing $q(s')$

Type of loss function:

- The margin ranking loss.

- The cross-entropy loss.
- The binary cross-entropy loss.

Evaluation protocol:

- MRR
- MR
- Hits@K

3.1 Time-included Tensor Decomposition

This method expresses a knowledge graph as a 4-way tensor, and learns latent representations by tensor decomposition/factorization techniques.

- Canonical Polyadic Decomposition
 - T-Simple adopts CP decomposition to decomposes KG 4-way tensor.
 - TNTComplex uses complex-valued representation vector in order to adapts with asymmetric relations.
 - TeLM moves beyond complex valued representations and learns multivector representations with CP decomposition.
- Tucker Decomposition
 - TuckERTNT adopts the Tucker decomposition, more flexible (embedding dimension is relaxed)

3.2 Time-based transformation

- Synthetic Time-dependent Relation
 - TTransE
 - SpliME
 - Ta-TransE
 - 3DRTE
- Linear Transformation
 - HyTE

- Hybrid-TE
- TDG₂E
- TeRo
- ChronoR
- ToKE

3.3 Dynamic embedding

- Representations as Functions of Time
 - ATiSE
 - DyERNIE
 - DE-Simple
 - BoxTE
- Representations as Hidden States of RNN
 - Know-Evolve
 - TeMP

3.4 Learning from knowledge graph snapshots

- Markov Process Models
 - RTFE
 - DBKGE
- Autoregressive Models
 - RE-NET
 - RE-GCN
 - EvoKG
 - NLSM
 - TANGO

3.5 Reasoning with historical context

- Attention-based Relevance
 - xERTE
 - T-GAP
- Heuristic-based Relevance
 - TPmod
 - CyGNet

3.6 Temporal logical rules

- AnyBURL
- StreamLearner
- TLogic
- TLmod