Meta-Path Learning for Multi-relational Graph Neural Networks

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LoG CONFERENCE

INTRODUCTION

Motivation:
Existing multi-relational GNNs for identifying informative relations reduce the problem to a low level weight learning or rely on chain of relations named meta-paths. Challenges arise with the former approach in the presence of many relations (e.g., knowledge graphs), while the latter requires substantial domain expertise.

Key idea:
A scoring function capable of assessing the potential informativeness of relations during the incremental construction of meta-paths. These selected meta-paths then exclusively guide the Meta-path Graph Neural Network.

MPGNN Learning

The complete architecture is summarized in Fig. 1

Scoring function:
Measures the potential informativeness of a relation towards predicting node labels using Eq. 1 (in the first iteration) and Eq. 2 (in the next iterations).

$$\tilde{y}_i^r = \Theta^T h_i^{(0)} \cdot \max_{j \in \mathcal{N}_i^r} w_j \quad \textbf{(1)}$$

$$\tilde{y}_{B(i)}^s = \max_{j \in B(i)} \left(\Theta^T h_j^{(0)} \cdot \max_{k \in \mathcal{N}_j^s} w_k \right) \quad \textbf{(2)}$$

Score for each relation is calculated minimizing MSE loss between predictions and true labels (Eq. 3)

$$s_r = \min_{\Theta, \mathbf{w}} \frac{1}{N} \sum_{i=1}^{N} (\tilde{y}_i^r - y_i)^2 \quad \textbf{(3)}$$

Meta-path Graph Neural Network:
Graph Neural Network where message passing is propagated only through relations of the meta-paths given by the Scoring function with Eq. 4.

$$h_i^{(l+1)} = \sigma \left(W_0^{(l)} h_i^{(l)} + \sum_{j \in \mathcal{N}_i^{r_{L-l+1}}} \frac{1}{|\mathcal{N}_i^{r_{L-l+1}}|} W^{(l)} h_j^{(l)} \right) \quad \textbf{(4)}$$

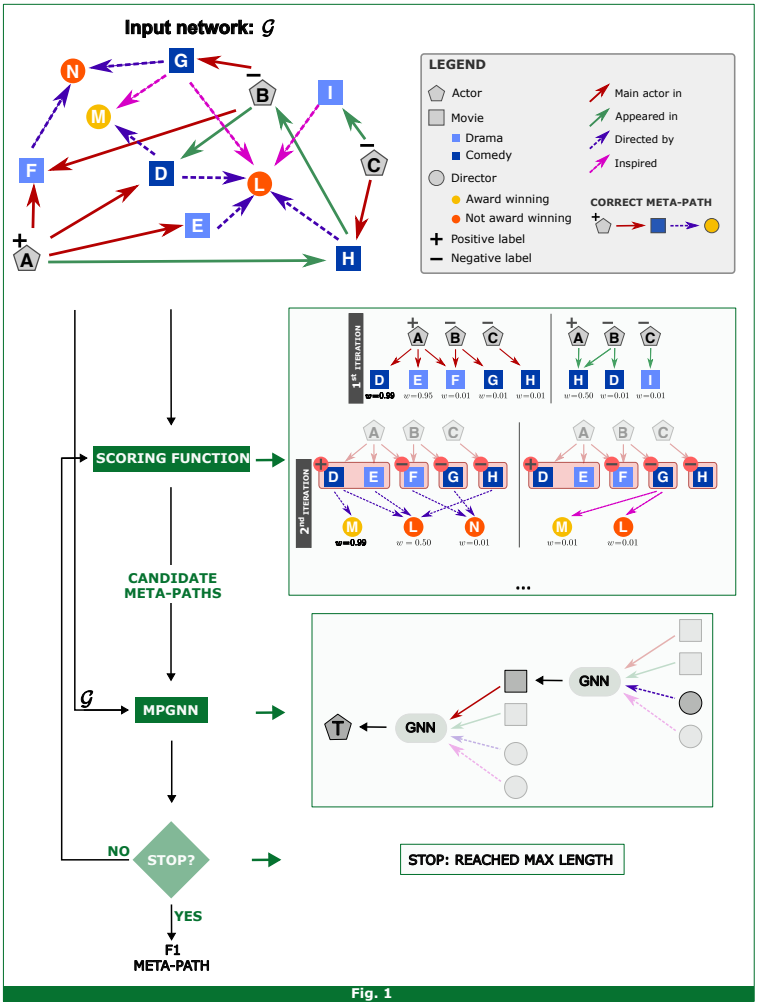
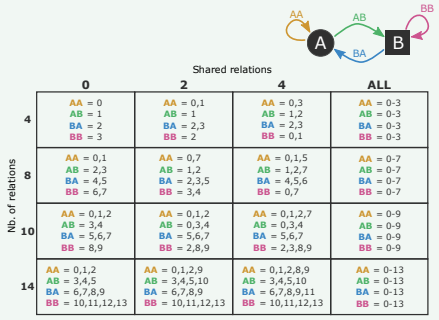
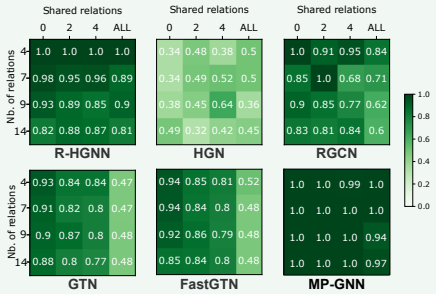


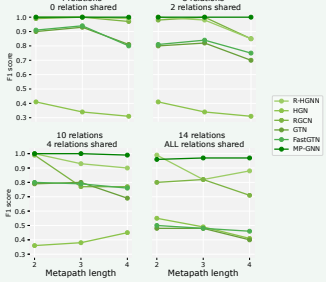
Fig. 1

RESULTS

SYNTHETIC DATASET





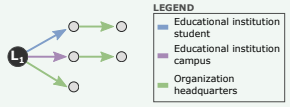


REAL-WORLD DATASET

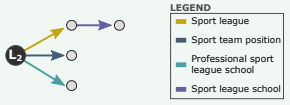
Dataset	Number of Nodes	Number of Relation types	Number of Edges	Number of Features	Number of Classes	Target nodes	R-HGNN	HGN	RGCN	GTN	FastGTN	MP-GNN
DBLP	18405	4	67496	334	4	4057	0,86	0,94	0,91	0,90	0,92	**0,94**
ACM	8994	4	25922	1902	3	3025	**0,64**	0,63	0,60	0,62	0,63	**0,64**
IMDB	12772	3	37288	1256	3	2939	0,90	0,92	0,90	0,91	**0,93**	**0,93**
FB15K-237 (PNC)	14951	236	306711	100	3	583	0,72	0,68	0,74	0,33	0,33	**0,83**
FB15K-237 (EDC)	14951	236	308201	100	6	481	0,60	0,75	0,71	0,12	0,12	**0,96**
FB15K-237 (EIC)	14951	236	305559	100	6	119	0,63	0,65	0,73	0,12	0,12	**0,80**
FB15K-237 (ECL)	14951	236	307017	100	6	361	0,47	0,74	0,72	0,12	0,15	**0,78**
FB15K-237 (FBC)	14951	236	315131	100	7	1471	0,45	0,48	0,42	0,14	0,14	**0,81**
FB15K-237 (GNC)	14951	236	305827	100	3	194	0,80	0,74	0,82	0,19	0,19	**0,90**
FB15K-237 (OC)	14951	236	307611	100	6	460	0,67	0,73	0,78	0,14	0,14	**0,93**
FB15K-237 (G)	14951	236	305557	100	2	4530	0,81	0,64	0,80	0,44	0,44	**0,84**
FB15K-237 (TS)	14951	236	453554	100	9	523	**0,67**	0,53	0,62	0,09	0,09	0,63
FB15K-237 (E)	14951	236	310742	100	9	134	0,89	0,80	**0,98**	0,07	0,07	0,96

EXTRACTED META-PATHS

L_1 = Education domestic currency



L_2 = Team sport



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