Diversified Query Generation Guided by Knowledge Graph

Xinyao Shen, Jiangjie Chen, Jiaze Chen, Chun Zeng, Yanghua Xiao

Shanghai Key Laboratory of Data Science, School of Computer Science, Fudan University

ByteDance AI Lab

Fudan-Aishu Cognitive Intelligence Joint Research Center

Outline

- Query Generation
- Knowledge-Enhanced Diversified QuerY Generator (KEDY)
- Experiments
- Summary

Query Generation

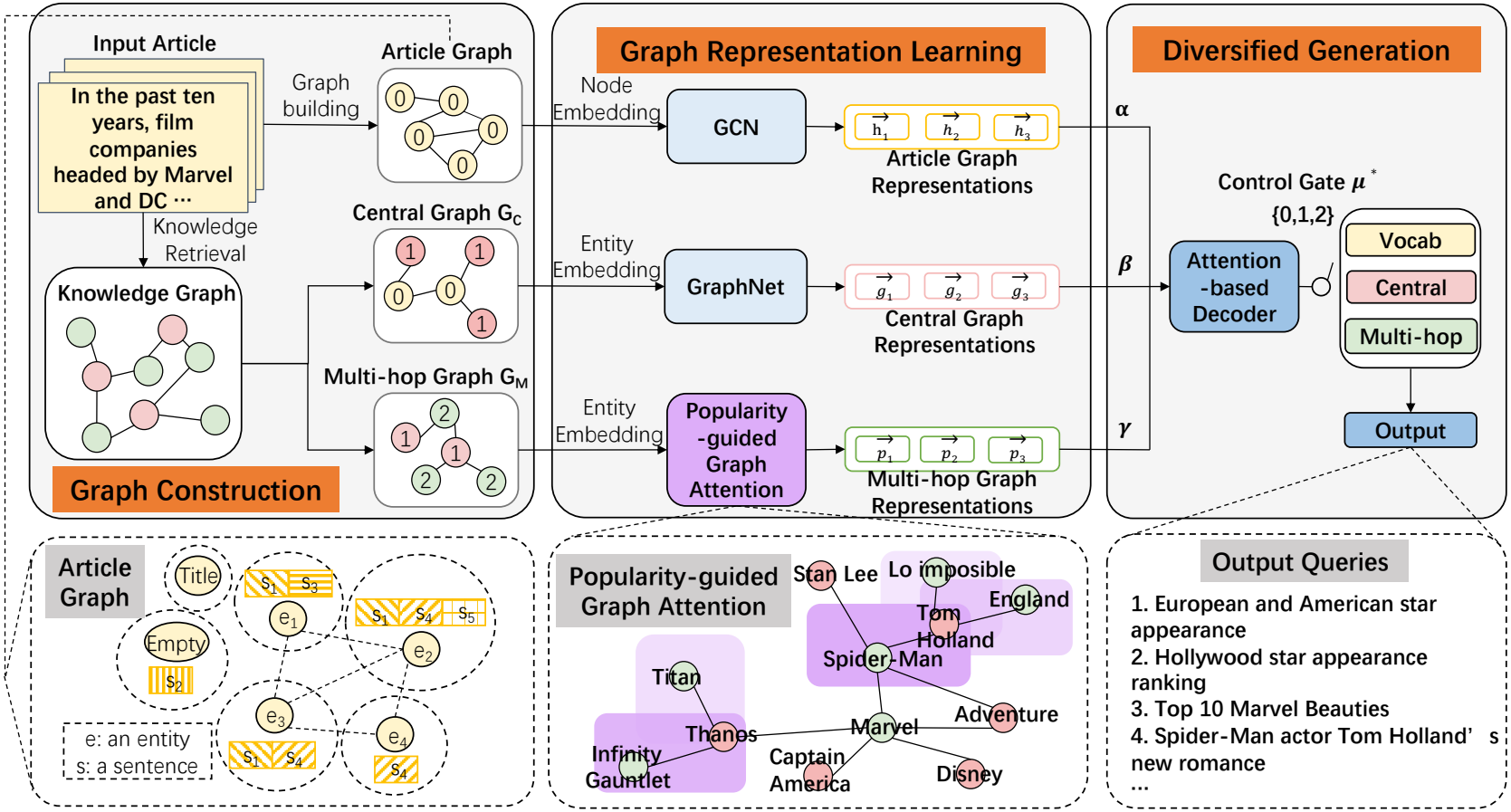
- Input: article and title
- Output: queries
- Query
  - Related
  - Fluency
  - Diversity
  - Popularity

Title
Appearance comparison photos of Hollywood stars
Content
In the past ten years, movie companies headed by Marvel and DC have almost maintained a tempo of 2-4 movies a year. They have also brought us such box office and good word-of-mouth double-harvest works as "Iron Man", "Avengers", "Aquaman" and "Spider-Man" further sweeping the American comics super hero craze to every corner of the world. In today's issue, I will bring you the appearance comparison photos of the actors starring in the American comics super hero movies so that you can understand the connotation of talent excellence. The appearance of Hollywood stars changes such as Jason Momoa who starred in "Aquaman". Jason's sturdy figure does not need to be said, and his performance in "Aquaman" has really shone the audience...
Query
(1) European and American star appearance (2) Hollywood star appearance ranking (3) Top 10 Marvel beauties (4) Spider-Man actor Tom Holland's new romance

Query Generation

- Click-through data
  - Long-tail
  - Diversity
- Seq2Seq model
- Graph model
  - Long article
- KG Enhanced Model
  - Spider-Man actor Tom Holland's new romance

KEDY


Input Article
In the past ten years, film companies headed by Marvel and DC ···
Graph building
Article Graph
Knowledge Retrieval
Knowledge Graph
Central Graph G_C
Multi-hop Graph G_M
Graph Construction
Graph Representation Learning
Node Embedding
GCN
Article Graph Representations
Entity Embedding
GraphNet
Central Graph Representations
Entity Embedding
Popularity -guided Graph Attention
Multi-hop Graph Representations
Diversified Generation
α
β
γ
Attention -based Decoder
Control Gate μ*
{0,1,2}
Vocab
Central
Multi-hop
Output
Article Graph
Title
Empty
e: an entity
s: a sentence
Popularity-guided Graph Attention
Stan Lee
Lo imposible
England
Tom Holland
Spider-Man
Titan
Thanos
Infinity Gauntlet
Marvel
Captain America
Adventure
Disney
Output Queries
1. European and American star appearance
2. Hollywood star appearance ranking
3. Top 10 Marvel Beauties
4. Spider-Man actor Tom Holland's new romance
...

(details)

Graph Construction

- Article Graph
  - Node: keyword + sentences
- Central Graph
- Multi-hop Graph

Algorithm 1: Construct Entity Interaction Graph

Input: Title T and Article A
Output: Entity Interaction Graph

Do word segmentation of Title T and Article A ;
Do Named Entity Recognition(NER) and keywords extraction algorithm of Article A and get the entity set E ;
while *not at end of this article* **do**
    read current sentence s;
    if *s contains* $e \in E$ **then**
        Add s to node n_e ;
    else
        Add s to node n_{empty};
    end
end
Assign Title T as node n_t ;
for *node* n_i *and* n_j **do**
    Edge Weight w_{ij} = number of shared sentences of n_i and n_j
end

(details)

Graph Representation Learning

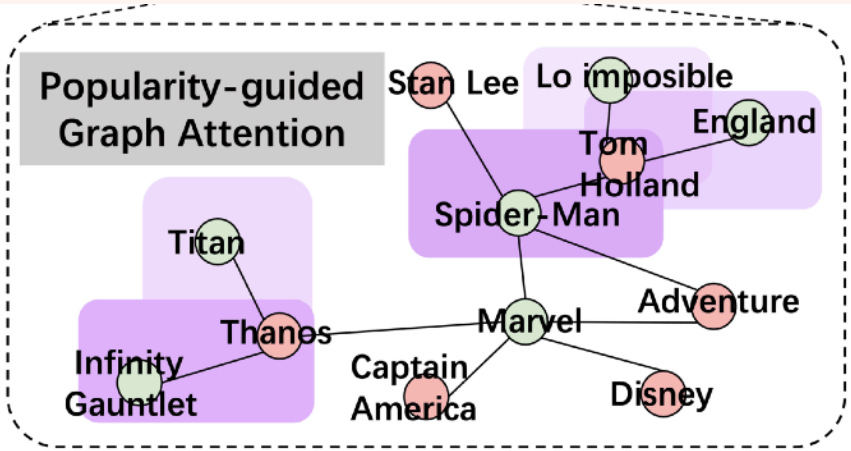
- Article Graph Encoding
- Knowledge Sub-graph Encoding
  - Central Graph Encoding
  - Popularity-guided Graph Attention

$$\eta_r^{e_q} = \sigma(\mathbf{P}^T \cdot \tanh(\mathbf{W}_p \cdot \mathbf{e}_p + \mathbf{W}_q \cdot \mathbf{e}_q))$$

$$\mathbf{P} = \mathbf{W}_r \cdot \lambda_{e_q} \mathbf{r}$$

$$\lambda_{e_q} = \frac{e_{vt} - s_k}{n \cdot \tau} + \frac{k}{n}$$

$$\mathbf{p}_{\mathbf{e}_p} = \sum_{e_q} \eta_r^{e_q} \cdot [\mathbf{e}_p \circ \mathbf{e}_q]$$



(details)

Diversified Generation

- Context Representation
  - Attention

$$\mathbf{c}_{t-1}^{A} = \sum_{i=1}^{n} \alpha_{t-1}^{i} \cdot \mathbf{h}_i$$

$$\mathbf{c}_{t-1}^{C} = \sum_{e_i \in \mathbb{G}_C} \beta_{t-1}^{e_i} \cdot \mathbf{g}_{e_i}$$

$$\mathbf{c}_{t-1}^{M} = \sum_{e_p \in \mathbb{G}_M \cap V^1} \gamma_{t-1}^{p} \cdot \mathbf{p}_{e_p}$$

- Diversified Token Generation
  - Control Gate

$$q_t = \begin{cases} \sigma(\mathbf{s}_t \cdot \mathbf{w}), & \mu^* = 0 \\ \sigma(\mathbf{s}_t \cdot \mathbf{g}_{e_i}), & \mu^* = 1 \\ \sigma(\mathbf{s}_t \cdot \mathbf{e}_q), & \mu^* = 2 \end{cases}$$

Experiments

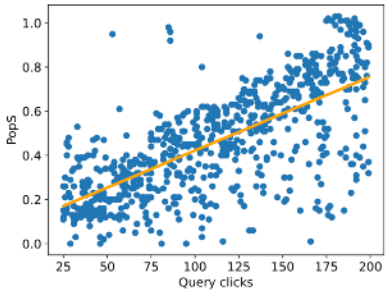
Model	Entertainment					Sport				
	B-1	B-2	B-4	R-1	R-L	B-1	B-2	B-4	R-1	R-L
TextRank [22]	22.6	11.6	0.9	26.3	22.5	22.5	11.4	0.8	26.1	22.4
PtrGen [21]	49.5	38.4	18.1	42.5	41.3	49.4	38.3	18.1	42.3	41.2
Transformer [28]	50.6	39.7	19.0	44.3	42.9	50.7	39.7	19.1	44.4	42.9
Transformer+KG [28]	50.9	39.9	19.2	44.3	43.0	50.8	39.7	19.1	44.6	43.0
CVAE [39]	50.7	39.7	19.1	44.1	42.9	50.7	39.9	19.1	43.8	42.6
DP-GAN [34]	51.0	39.9	19.0	44.2	42.9	50.9	39.8	18.8	44.2	42.8
BART [13]	51.7	40.6	20.8	46.5	44.2	51.7	40.6	20.7	46.5	44.1
BART+KG [13]	52.2	40.9	21.0	46.8	44.5	52.1	41.0	20.9	46.8	44.7
M-CNTRL [35]	52.7	41.2	20.9	47.1	44.8	52.9	41.3	21.2	47.4	45.1
Graph2Seq [17]	52.8	41.2	20.9	47.2	45.7	52.7	41.1	20.9	47.0	45.6
G-S2A [6]	53.1	41.3	20.5	47.5	46.1	53.0	41.2	20.5	47.3	46.1
G-S2A+KG [6]	53.8	41.6	20.8	47.8	46.2	53.6	41.5	20.8	47.7	46.3
KEDY (Ours)	**56.9***	**44.7***	**23.9***	**50.2**	**48.6**	**56.6***	**44.6***	**23.6***	**50.5**	**48.5**

Model	Entertainment						Sport					
	Cor	Div	Info	Flu	Nov	Avg	Cor	Div	Info	Flu	Nov	Avg
PtrGen [31]	4.76	2.63	3.82	4.16	3.65	3.80	4.75	2.64	3.77	4.18	3.68	3.80
Transformer+KG [28]	**4.83**	2.65	3.87	4.04	3.71	3.83	**4.84**	2.65	3.95	4.01	3.64	3.82
CVAE [39]	4.75	3.02	3.95	4.08	3.73	3.91	4.77	3.03	4.01	4.03	3.81	3.93
DP-GAN [34]	4.76	3.01	3.92	4.11	3.71	3.90	4.75	3.05	4.04	4.05	3.79	3.94
BART+KG [13]	4.81	3.15	4.15	4.28	3.80	4.04	4.82	3.18	4.14	4.30	3.85	4.06
M-CNTRL [35]	4.80	3.24	4.13	4.52	3.81	4.10	4.82	3.25	4.12	4.55	3.86	4.12
Graph2Seq [17]	4.81	3.01	4.12	4.60	3.80	4.07	4.82	3.03	4.11	4.58	3.82	4.07
G-S2A+KG [6]	4.81	3.10	4.20	4.59	3.82	4.11	4.80	3.12	4.21	4.60	3.82	4.11
KEDY (Ours)	4.82	**4.03**	**4.31**	**4.65**	**4.08**	**4.35**	**4.84**	**4.05**	**4.33**	**4.62**	**4.08**	**4.36**

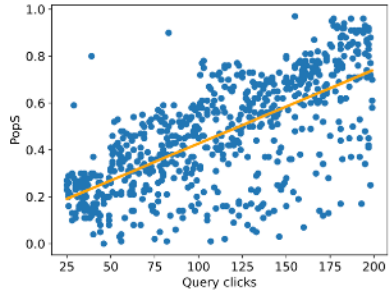
Experiments

- Diversity Evaluation
  - Correlation between Popularity and Query Clicks
  - Effectiveness of Popularity Knowledge Incorporation

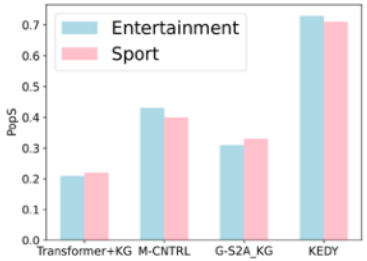
Model	Self-BLEU-2	Dist-1	Dist-2	Ent-2
Transformer+KG	35.8	0.027	0.125	6.26
M-CNTRL	28.2	0.056	0.312	7.52
G-S2A+KG	27.5	0.067	0.321	7.23
KEDY	**21.7**	**0.186**	**0.521**	**8.68**



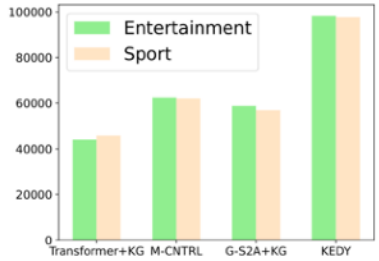
(a) Real data.



(b) Generated data.



(a) The popularity score.



(b) "Unique words".

Summary

- Diversity: knowledge graphs
- Popular: popularity-guided graph attention
- Future work
  - User preferences
  - Semantic feature

Thank you