



# Joint Linking of Entity and Relation for Question Answering over Knowledge Graphs

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# Task

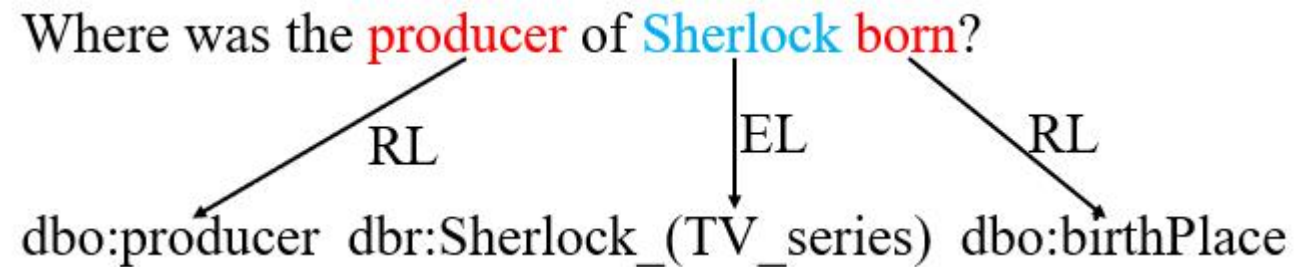
Question Answering over Knowledge Graph(KGQA)

Entity Linking(EL)

Relation Linking(RL)

Joint Entity and Relation Linking

- EARL(2018)
- Falcon(2019)
- MDP-Parser(2020)



# Motivation

## Mention Recognition

- Extract entity and relation mentions jointly in a sequence labeling model

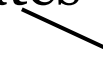
## Disambiguation

- Entity words and relation words have different characteristic
- How to exploit correlation between entity and relation candidates

independent feature



joint feature



# Model

## Joint Linker of Entity And Relation (JLEAR)

- Mention Recognition
- Candidate Generation
- Candidate Ranking

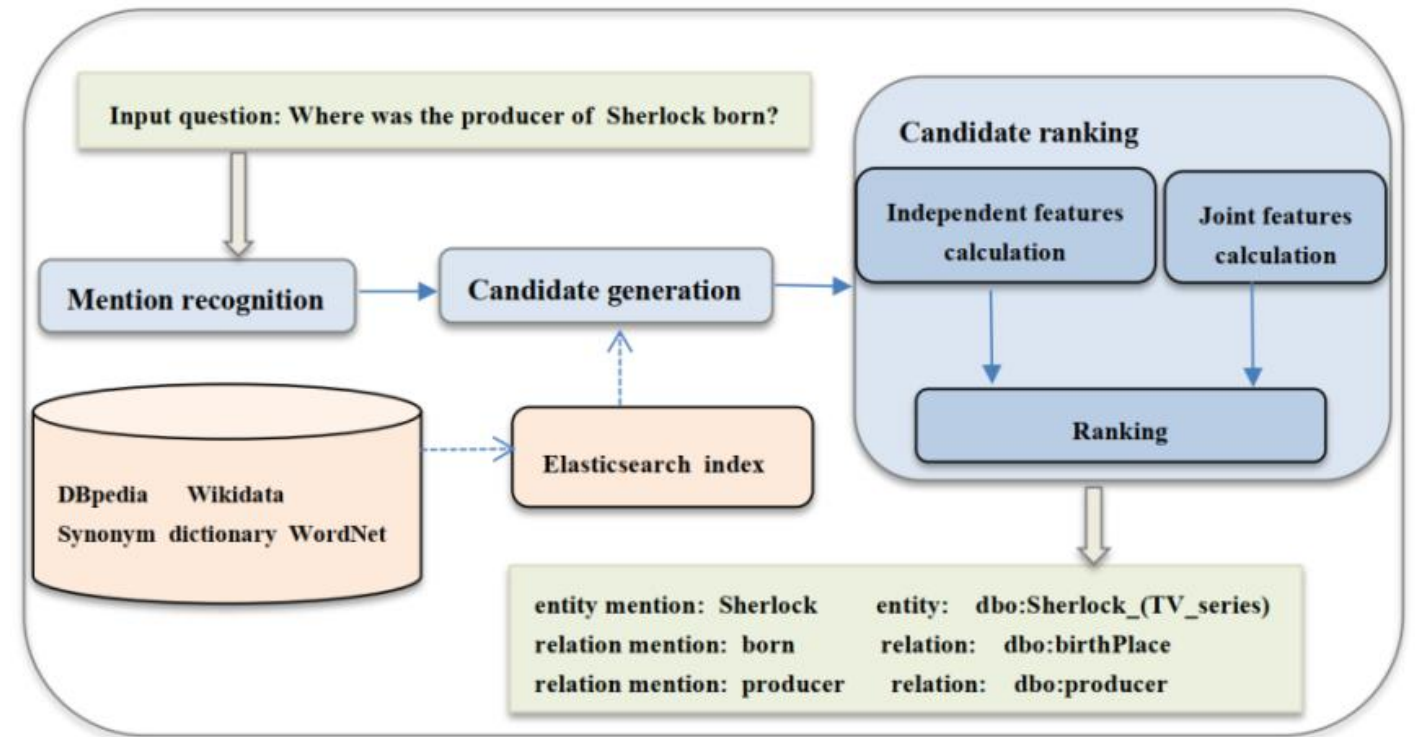


Fig. 1. Overview of our framework JLEAR.

# Mention Recognition

- Sequence labeling problem

When was **University of Edinburgh** founded?

O O B-Entity I-Entity E-Entity S-Relation

- BIOES labeling scheme

Nine types of label: B-Entity B-Relation I-Entity I-Relation .... O

- Model

BILSTM+SoftMax BILSTM+CRF Bert+BILSTM+CRF

# Candidate List Generation

## Entity mention-URI mapping dictionary

- collect entity labels and redirection information in DBpedia and entity aliases in Wikidata to construct entity dictionary.

## Relation mention-URI mapping dictionary

- utilize linguistic resources such as Thesaurus dictionary, WordNet to get synonyms, derived word forms

Create Elasticsearch index for entity and relation dictionary

# Candidate Ranking

## Independent entity feature

- $s_{Epp}$  :entity popularity
- $s_{El t}$  :literal similarity between entity mention and entity candidate name

## Independent relation feature

- $s_{Rl t}$  :literal similarity between relation mention and relation candidate name
- $s_{Rem}$  :semantic similarity between relation mention and relation candidate name

# Candidate Ranking

## Joint Feature for Disambiguation

- construct query graph
- calculate similarity between query graph and the question
- calculate the final joint feature score for each candidate

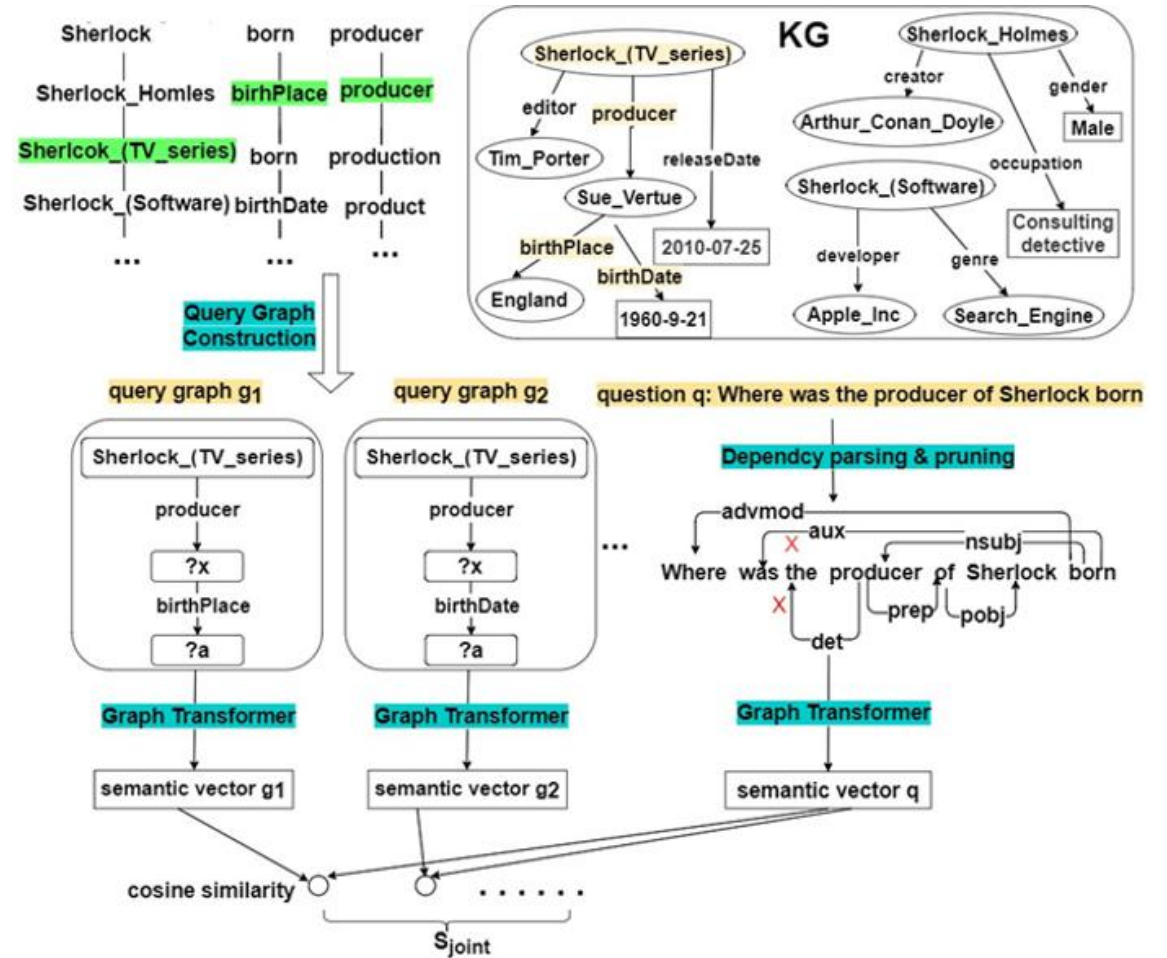


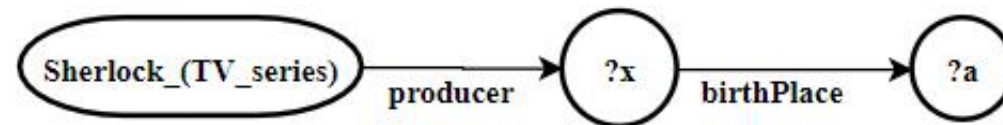
Fig. 2. Joint feature calculation.



# Candidate Ranking

## Construct Query Graph

- construct one-hop or two-hop query graphs according to the relation candidates of the question



- verify query graph in the knowledge graph by SPARQL endpoint
- supplement relation candidates to regenerate valid query graph according to the neighbor relations of the entity candidate

# Candidate Ranking

Transform question into graph structure

- use spaCy's dependency analyzer to generate dependency tree for each question
- remove the redundant part in dependency tree by pruning

Graph encoding

- Graph Transformer: additional mechanisms for capturing **global** patterns of graph

# Candidate Ranking

Similarity calculation

$$\text{sim}(q, g) = \cos(h^q, h^g)$$

Two ways to calculate joint feature for each candidate

- take the **highest** similarity score as  $s_{j \circ h}$
- take the **average** of all similarity scores as  $s_{j \circ h}$

# Candidate Ranking

Entity candidate score

$$s_E = \alpha s_{Epp} + \beta s_{El t} + \gamma s_{j \dot{t}h}$$

Relation candidate score

$$s_R = \alpha' s_{Rl t} + \beta' s_{Rem} + \gamma' s_{j \dot{t}h}$$

$\alpha, \beta, \gamma$  and  $\alpha', \beta', \gamma'$  are hyper-parameters trained in the model

# Experiments

Knowledge graph: DBpedia

## Datasets

Datasets	Train	Test	Average question length
LC-QuAD	4,000	1,000	12.29
QALD-7	215	50	7.41

Evaluation metric: Accuracy

# Experiments

**Table 1.** Accuracy for entity linking task.

Approach	LC-QuAD	QALD-7
TagMe	0.30	0.41
DBpedia Spotlight	0.54	0.62
EARL	0.60	0.56
Falcon	0.74	0.38
MDP-Parser	0.76	0.69
JLEAR	0.83	0.73

**Table 2.** Accuracy for relation linking task.

Approach	LC-QuAD	QALD-7
SIBKB	0.14	N/A
Rematch	0.16	N/A
EARL	0.26	0.15
Falcon	0.38	0.13
MDP-Parser	0.45	0.25
JLEAR	0.46	0.42

# Experiments

**Table 3.** Evaluation for mention recognition task on LC-QuAD with different models.

Model	Entity mention recognition	Relation mention recognition
BiLSTM+softmax	0.83	0.68
BiLSTM+CRF	0.84	0.69
BERT+BiLSTM+CRF	0.89	0.70

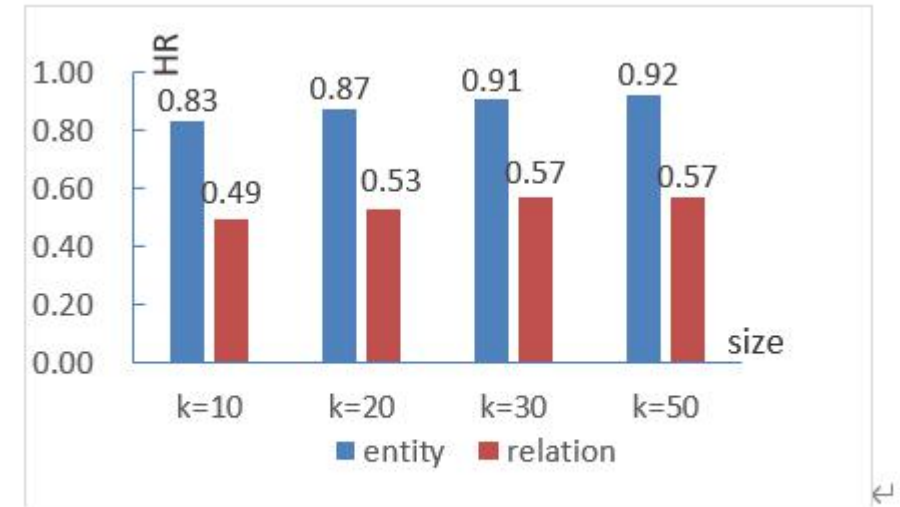


Fig.3. Evaluation of candidate list generation on LC-QuAD.

# Ablation Study

**Table 4.** Ablation experiments for JLEAR on LC-QuAD.

Model	Entity	Relation
JLEAR	0.83	0.46
Only independent features	0.76	0.38
Only joint feature (Max)	0.79	0.41
Only joint feature (Average)	0.78	0.38



# Conclusion

## Contribution

- We extracted entity and relation mentions jointly in a sequence labeling model
- We designed a new strategy to exploit both independent and joint features of candidates for disambiguation

## Future work

- Adopt distant supervision approach to improve the candidate generation phase
- Add constraint vertices in the query graph to calculate the joint feature score.

Thank you!  
Q&A