Never-Ending Learning for Open-Domain Question Answering over Knowledge Bases

Abdalghani Abujabal
Rishiraj Saha Roy, Mohamed Yahya and Gerhard Weikum

Question Answering over KB

“Which film awards was Bill Carraro nominated for?”

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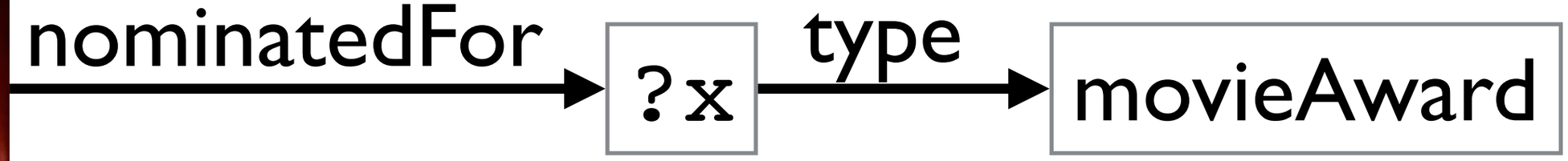

BillCarraro nominatedFor ?x

?x type movieAward

Question Answering over KB

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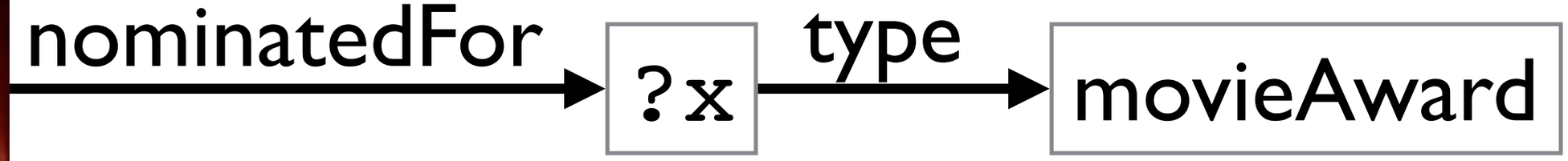

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Existing Approaches

- Require access to a large annotated training set
  - Massive annotation effort, in terms of cost, time and expertise

Existing Approaches

- Require access to a large annotated training set
  - Massive annotation effort, in terms of cost, time and expertise
- Static learning methods
  - No learning after deployment

NEQA: *N*ever *E*nding *QA*

- Initialized with a small training set
    - A handful of question-query pairs

NEQA: *N*ever *E*nding *QA*

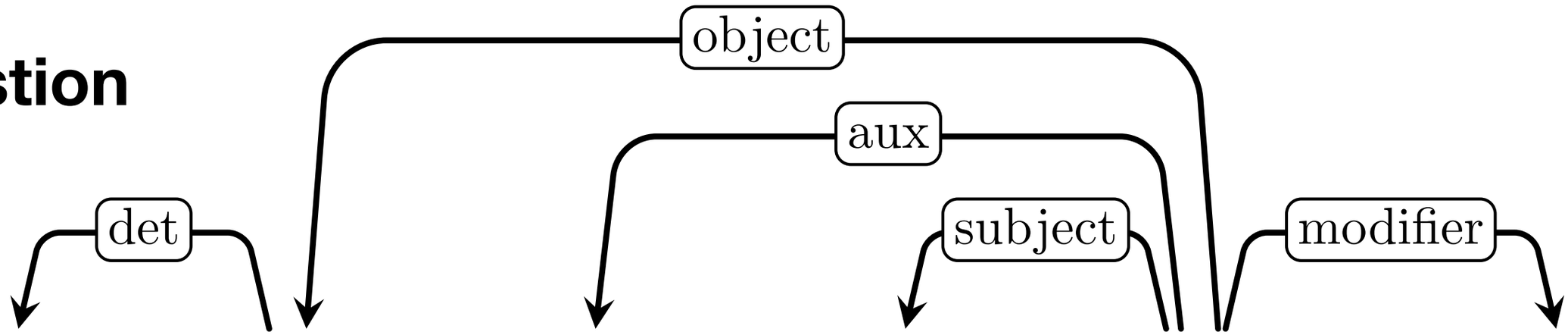
- Initialized with a small training set
- Supports continuous learning by harnessing non-expert user feedback
    - Gradually extends its template repository
    - Improves its performance over time

Outline

- Template-based QA
- NEQA
- Experiments
- Conclusion

Automated Template Generation

question

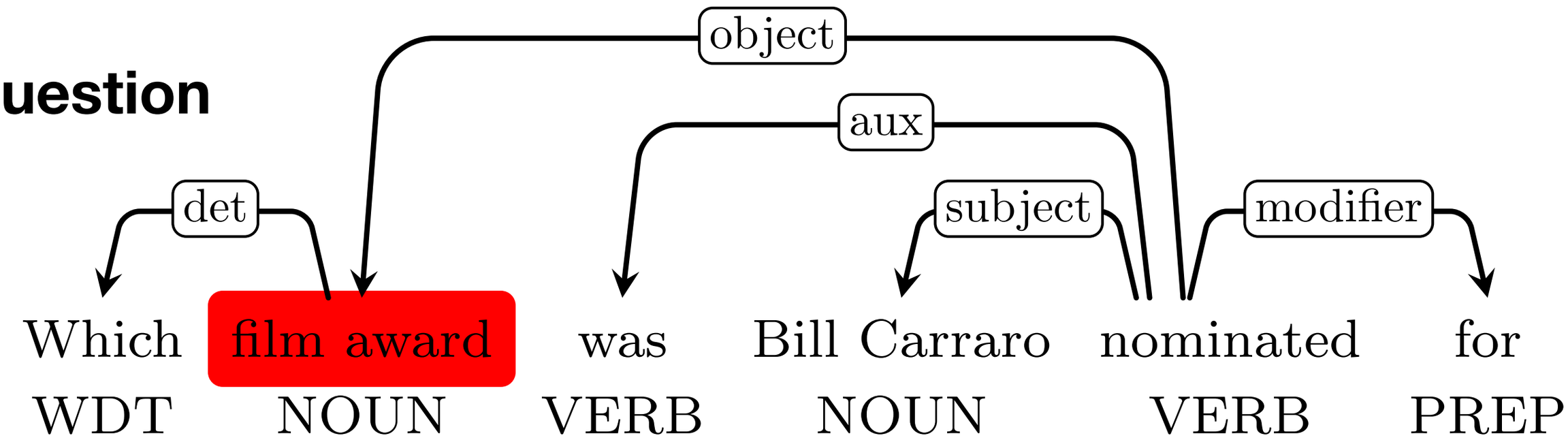


query

BillCarraro nominatedFor ?x
?x type movieAward

Alignment

question



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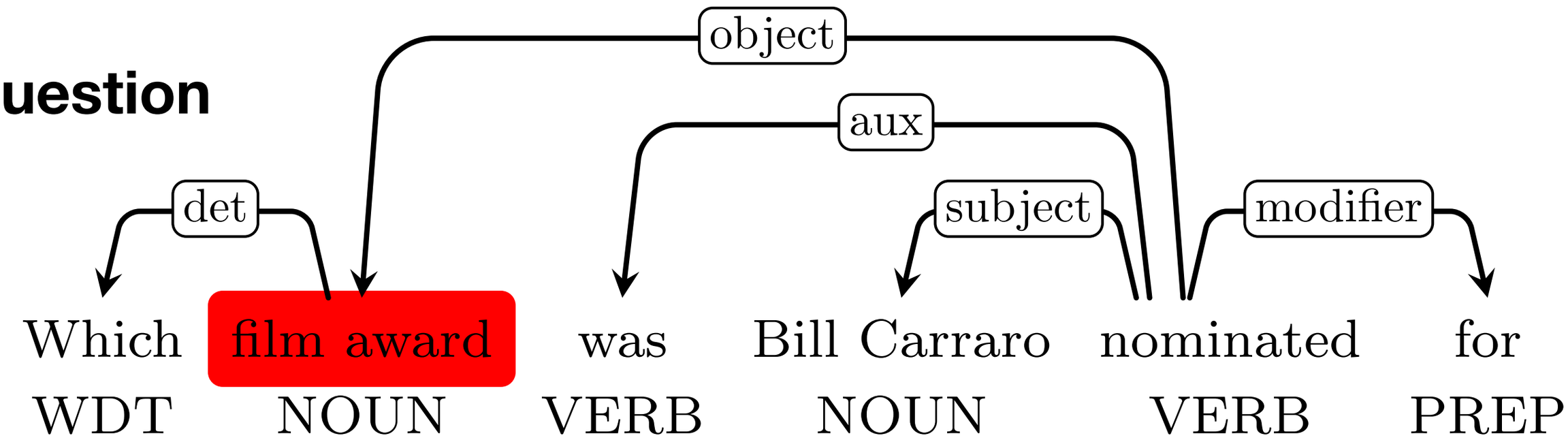

ILP

query

BillCarraro nominatedFor ?x

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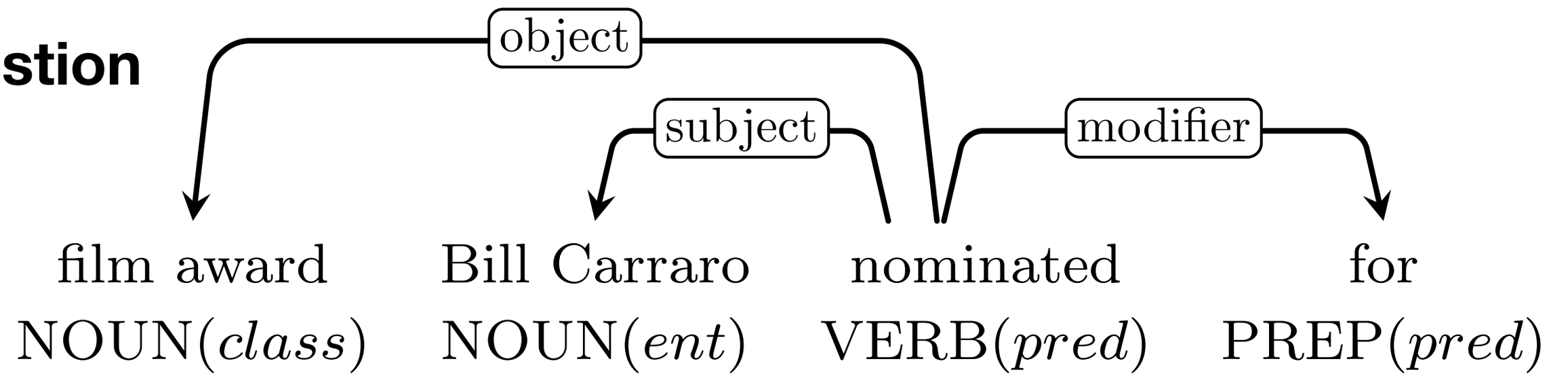
Role-aligned Question-Query Pair

question

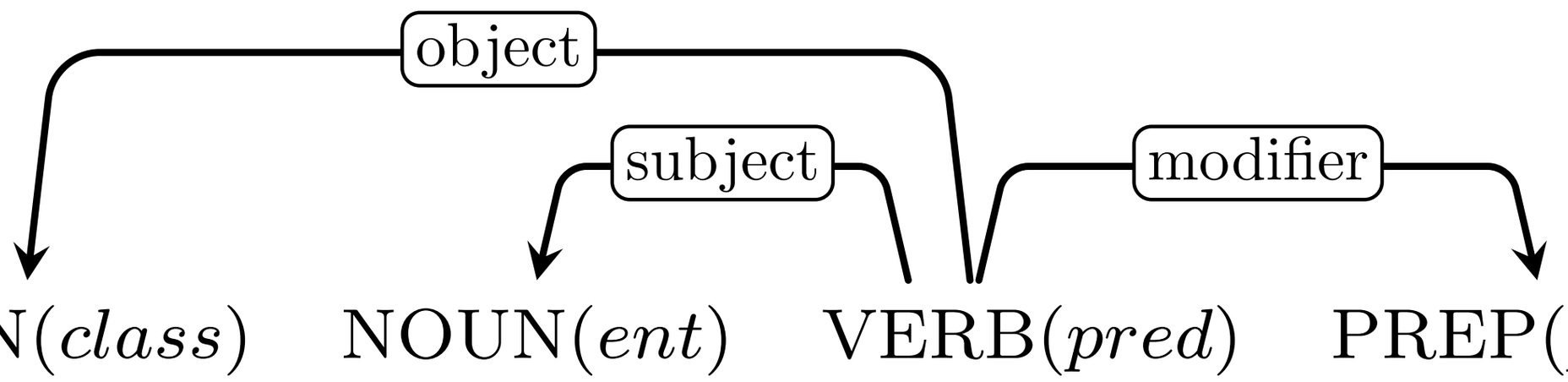


query

BillCarraro$_{ent}$ nominatedFor$_{pred}$?x
?x type movieAward$_{class}$

Role-aligned Template

question template



query template

ent pred ?x
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NEQA

Question-query bank

"Which film awards was Bill Carraro nominated for?"

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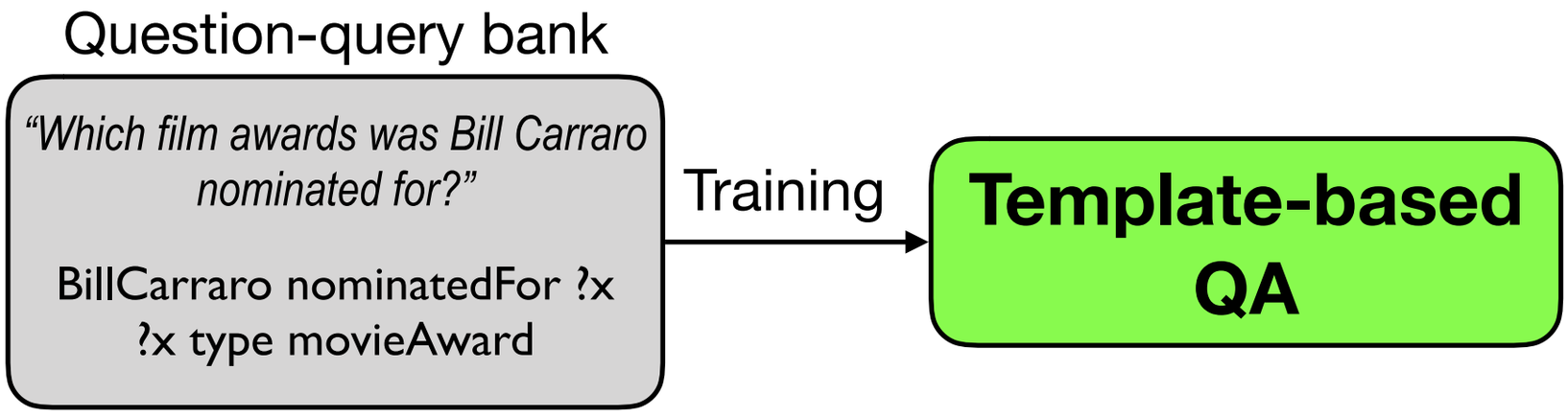
Initial Training



Initial Training

Question-query bank

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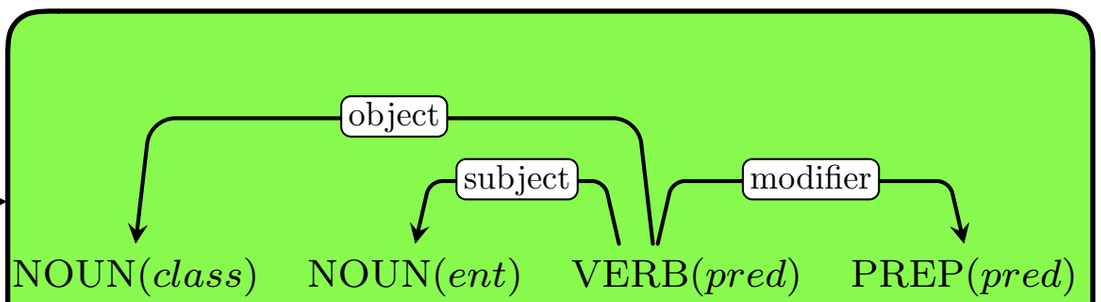
Training

Template-based QA

Template bank



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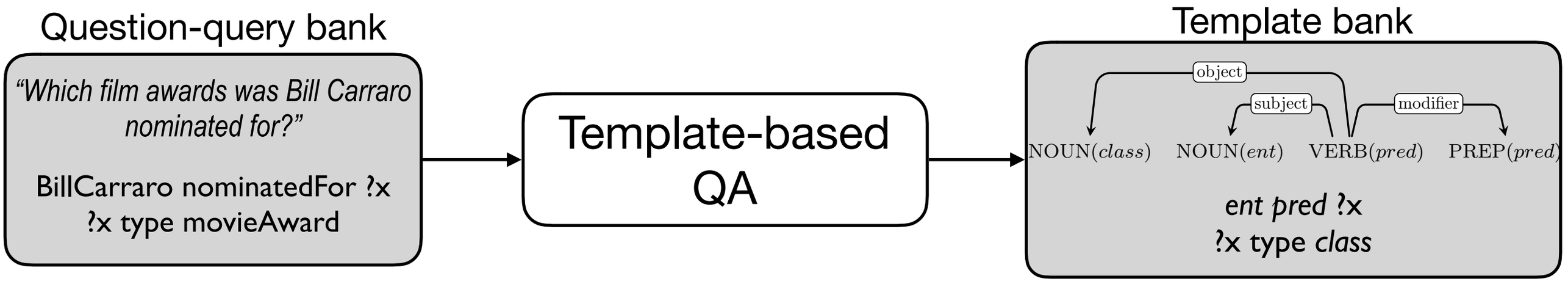
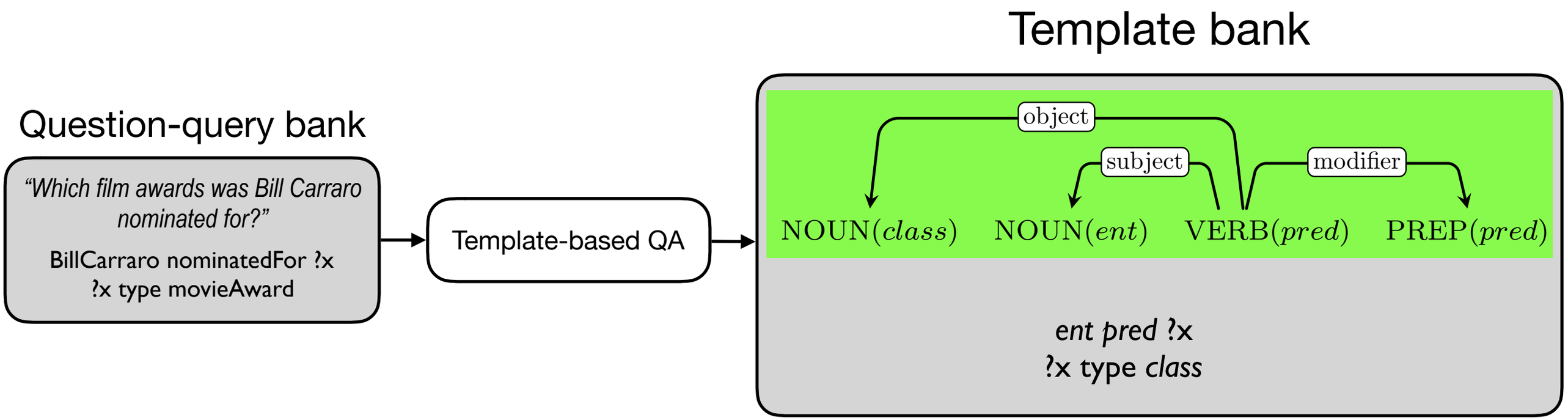
Answering with Templates



u_{new} = *"Which president was Lincoln succeeded by?"*

Answering with Templates



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Template-based QA

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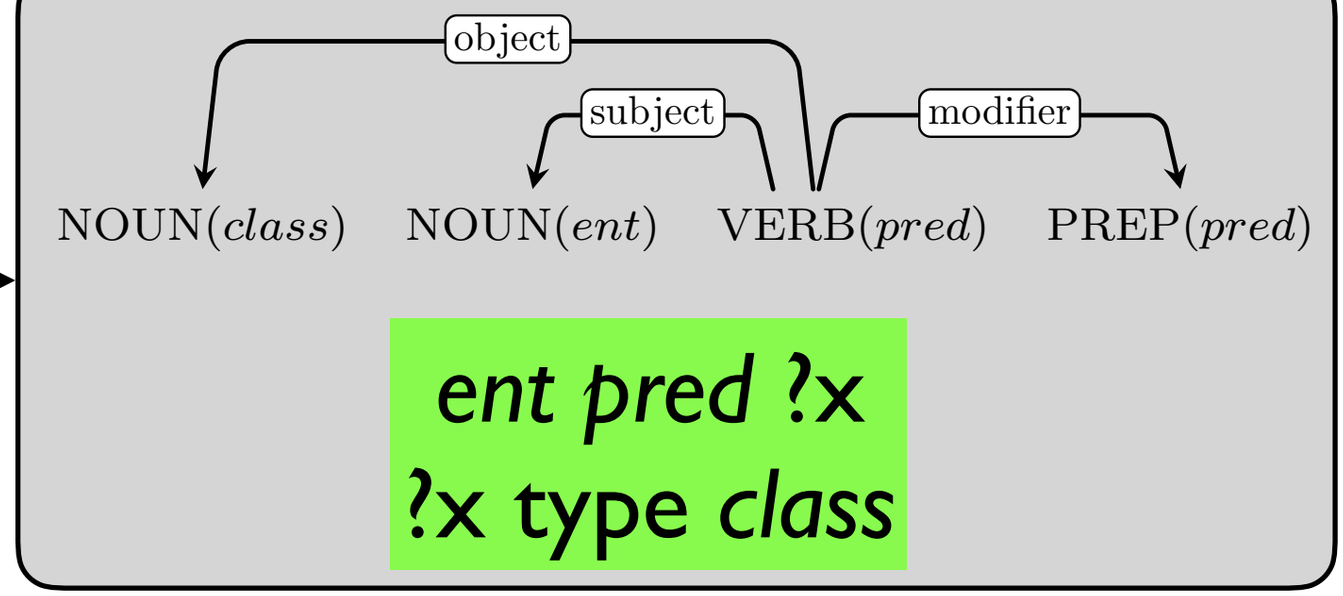

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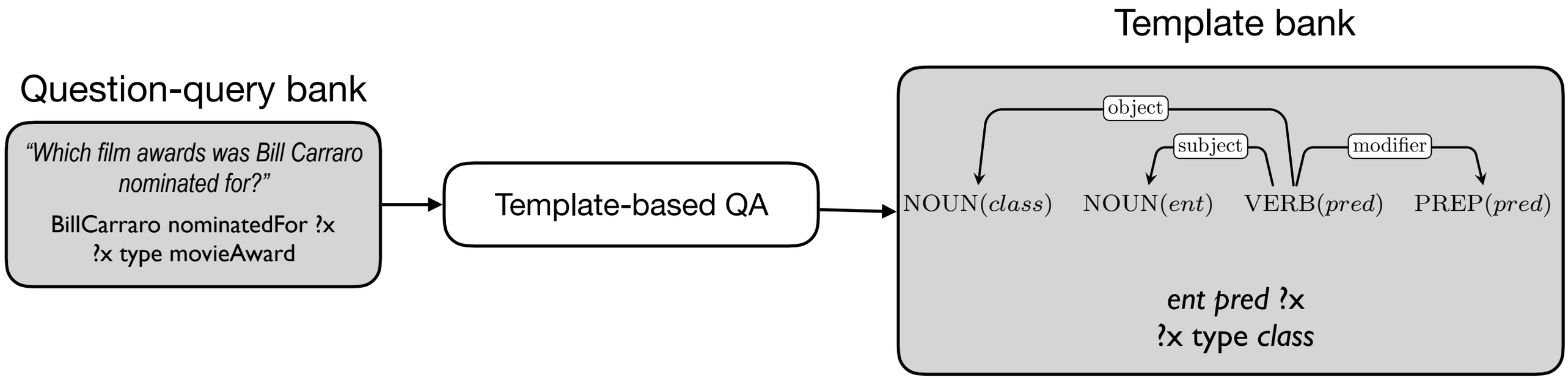

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Answering with Templates

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Template-based QA

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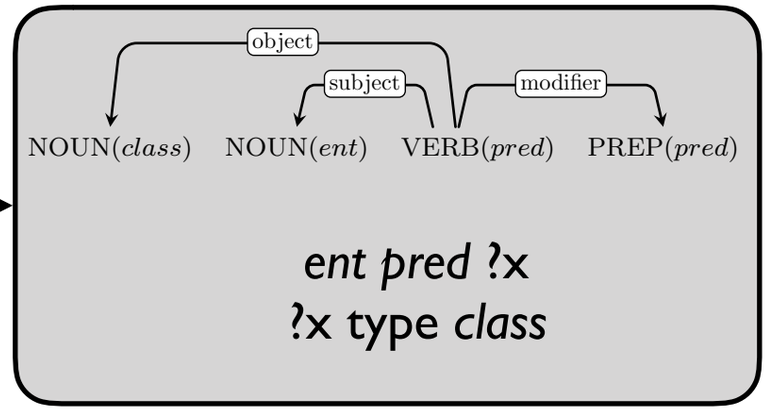

Answering with Similarity Function

Question-query bank

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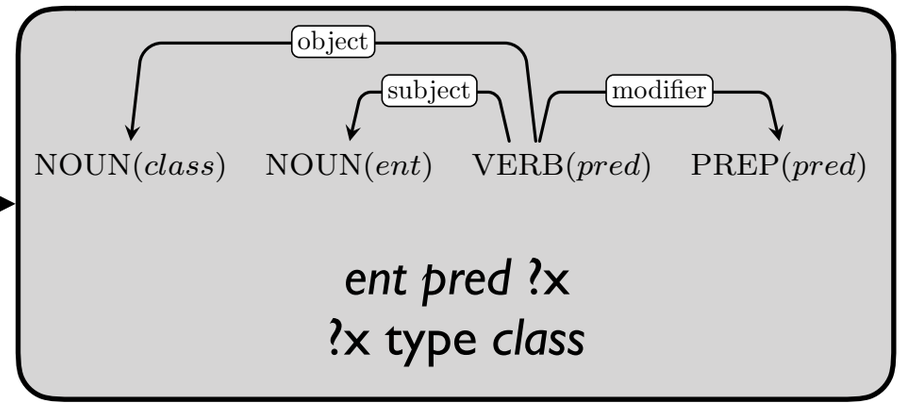

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Template-based QA

✗

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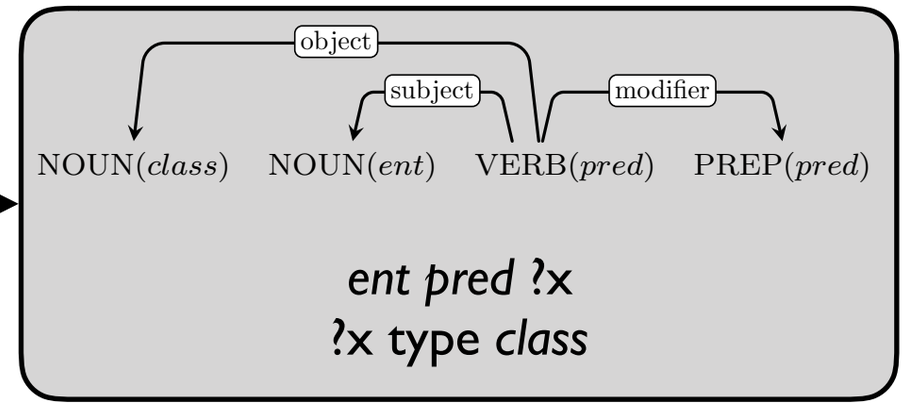

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Template-based QA

Similarity-based Answering

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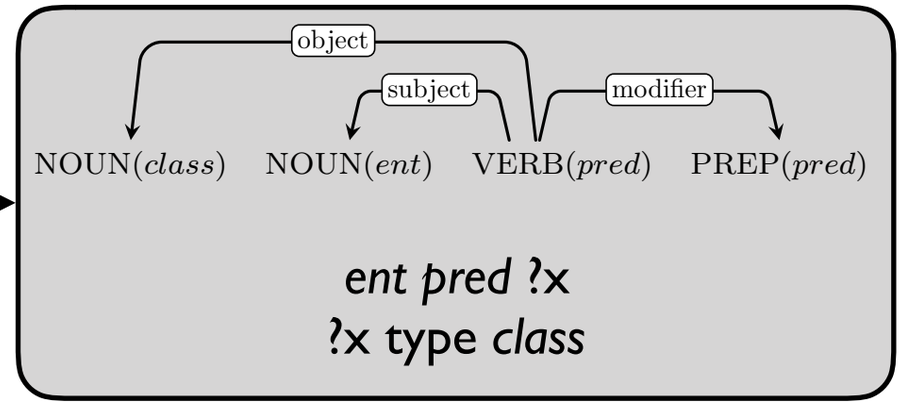

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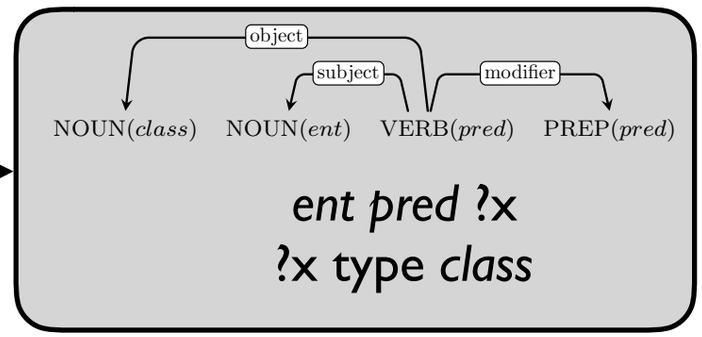

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Similarity-based Answering

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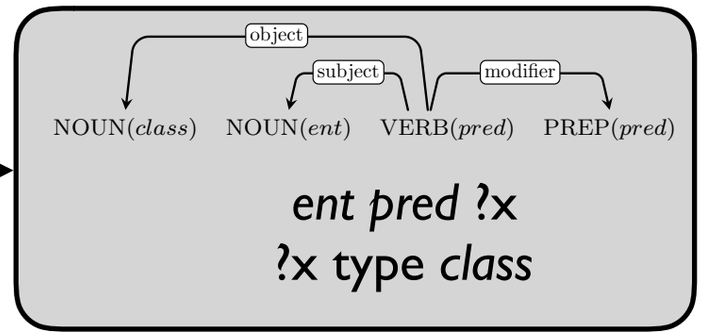

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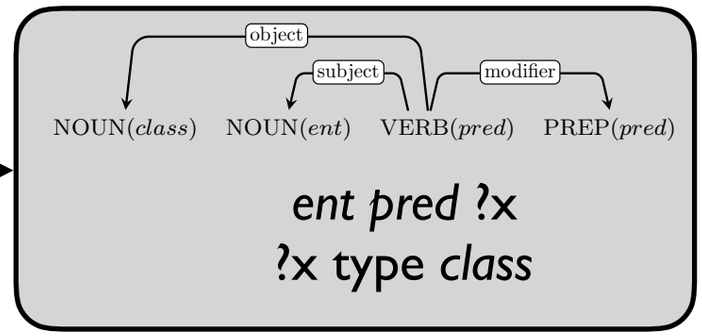

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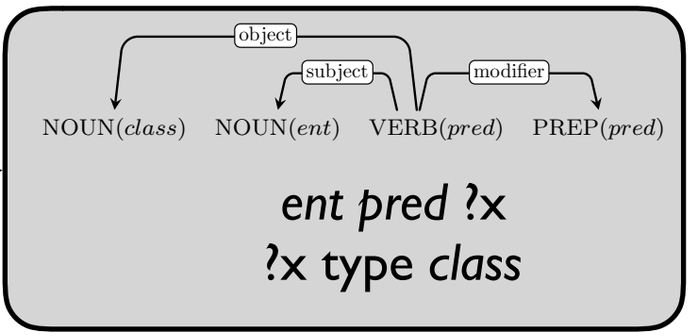

Top-k similar wrt u

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Answering with Similarity Function

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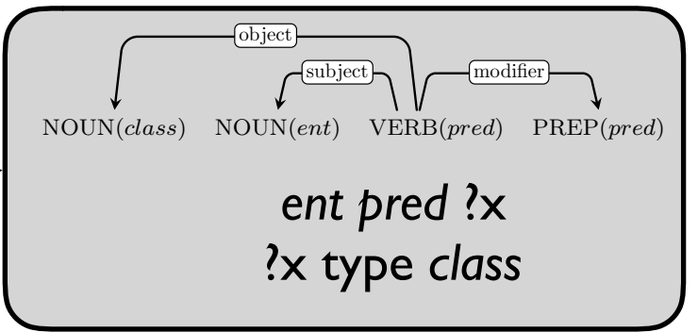
Template-based QA

Similarity-based Answering

Template bank



Top-k similar wrt u

Language model
Word2Vec

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Answering with Similarity Function

Question-query bank

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Template-based QA

Similarity-based Answering

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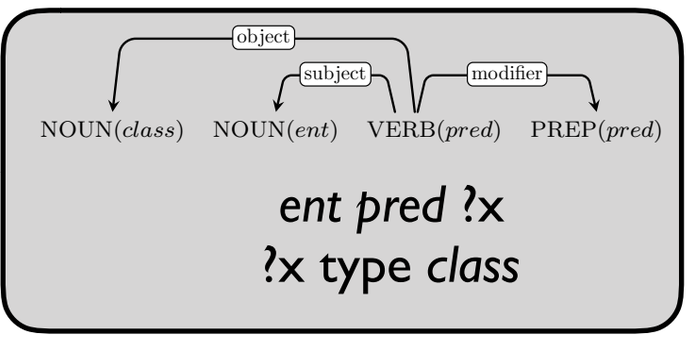

Instantiate paired query

u = "What are the film award nominations that <E> received?"

Answering with Similarity Function

Question-query bank

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Template-based QA

Similarity-based Answering

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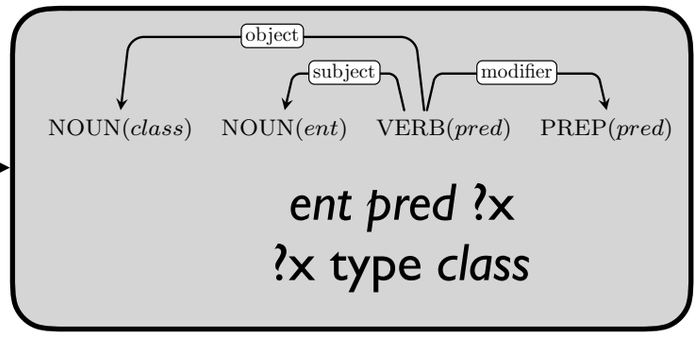

BradPitt nominatedFor ?x
?x type movieAward

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Answering with Similarity Function

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Template-based QA

Similarity-based Answering

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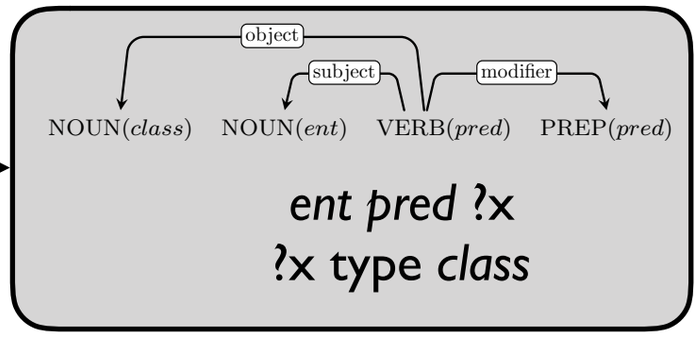

BAFTA Award

u = "What are the film award nominations that <E> received?"

User Feedback

Question-query bank

"Which film awards was <E> nominated for?"

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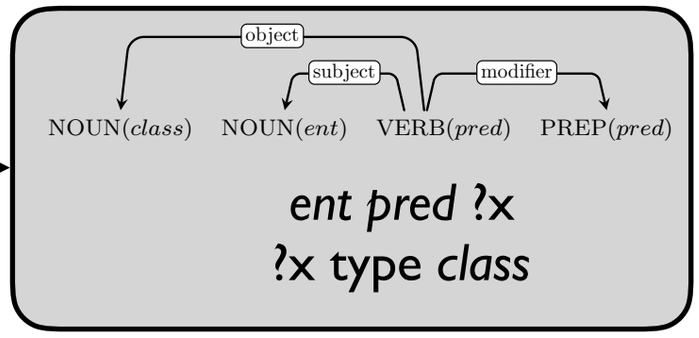
Template-based QA

Similarity-based Answering

Template bank



User feedback on answers

BAFTA Award

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User Feedback

Question-query bank

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Template-based QA

Similarity-based Answering

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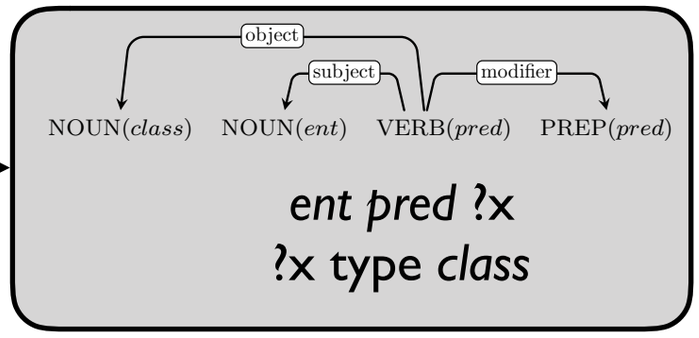

User feedback on answers

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Answering with Similarity Function

Question-query bank

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Template-based QA

Similarity-based Answering

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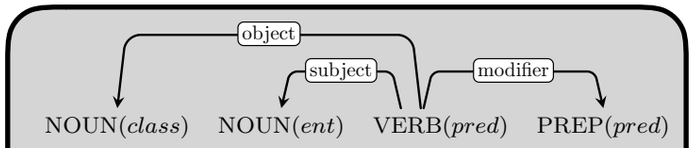

ent pred ?x
?x type class

Add (question, query) to question-query bank

Template Generation

Question-query bank

"Which film awards was <E> nominated for?"

<E> nominatedFor ?x
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.....

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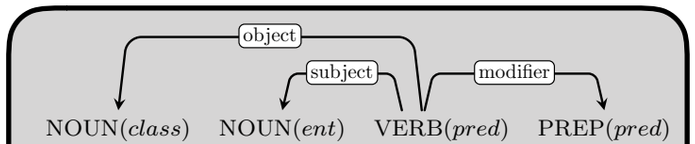
Template-based QA

Similarity-based Answering

Template bank



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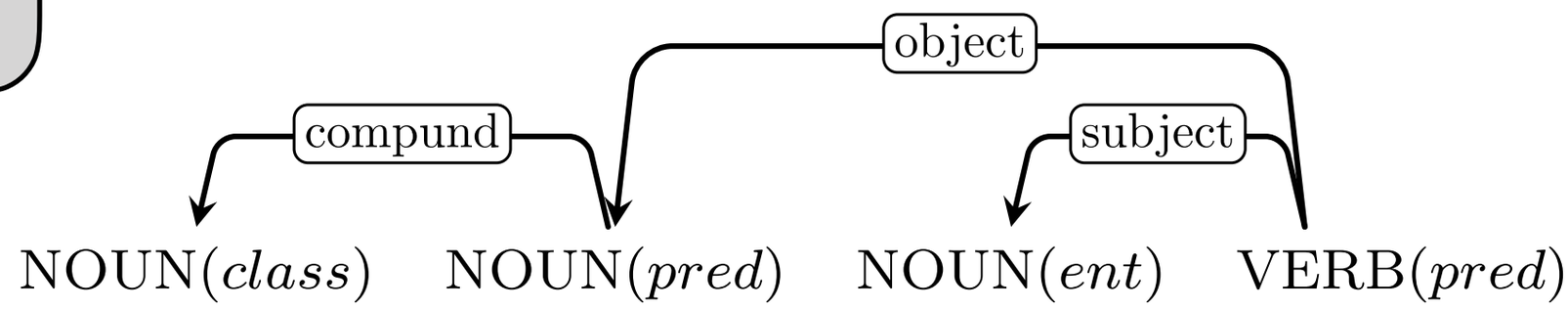
Generate a template



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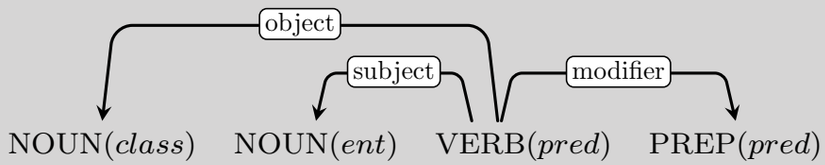
Template-based QA

Similarity-based Answering

Template bank



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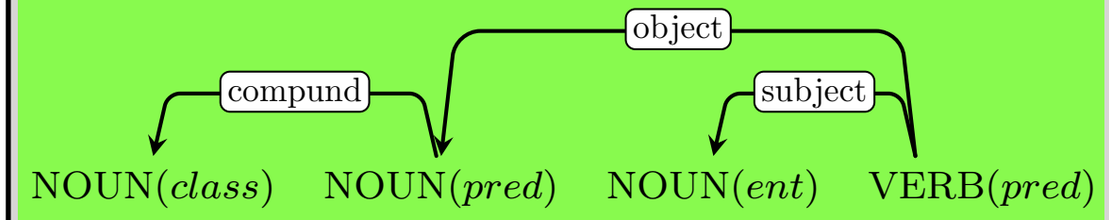

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Outline

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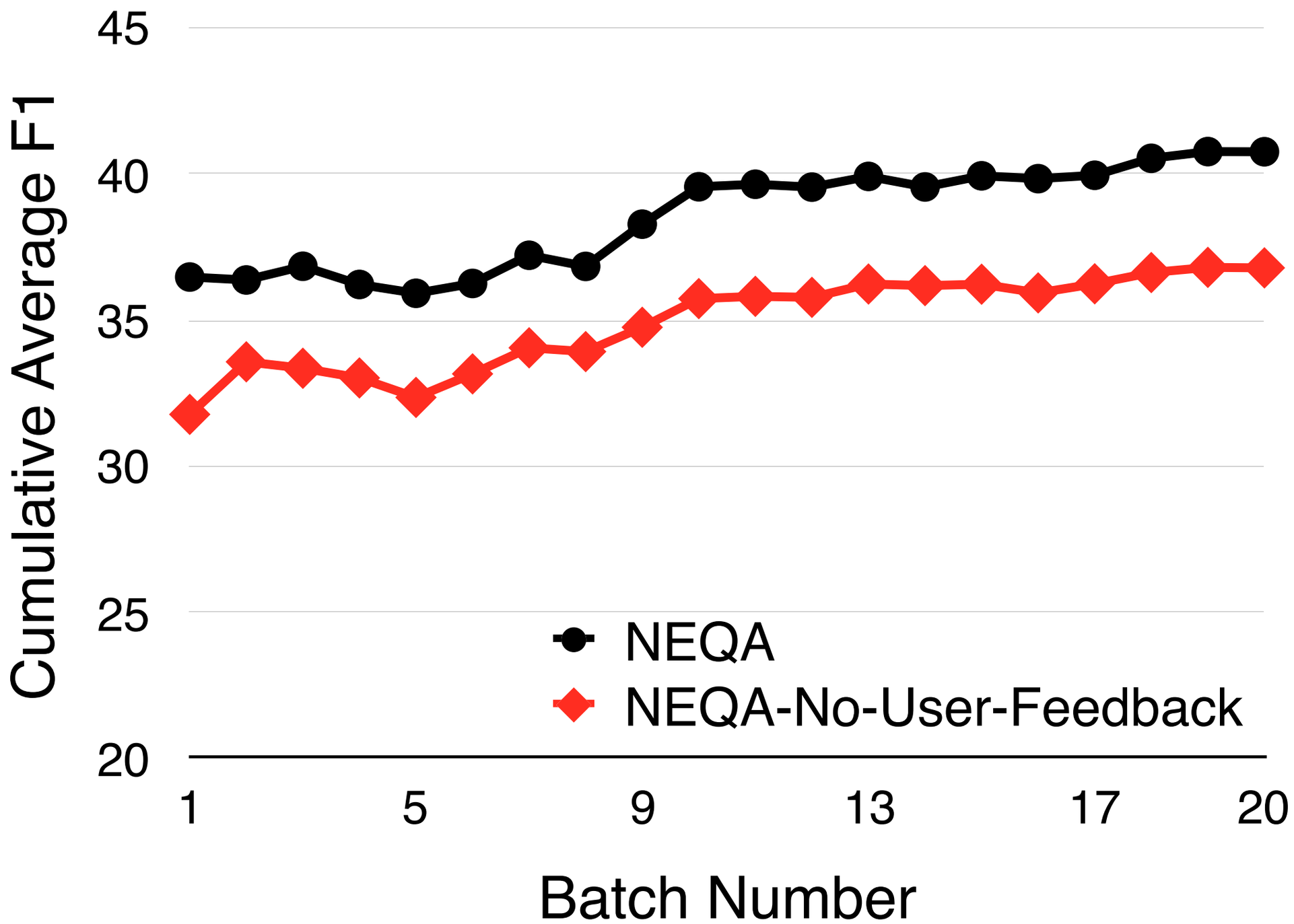
Setup

- WebQuestions dataset
  - 3775 question-answer training pairs
  - 2032 testing questions, streamed in batches of size 100
  - After each batch, models are retrained

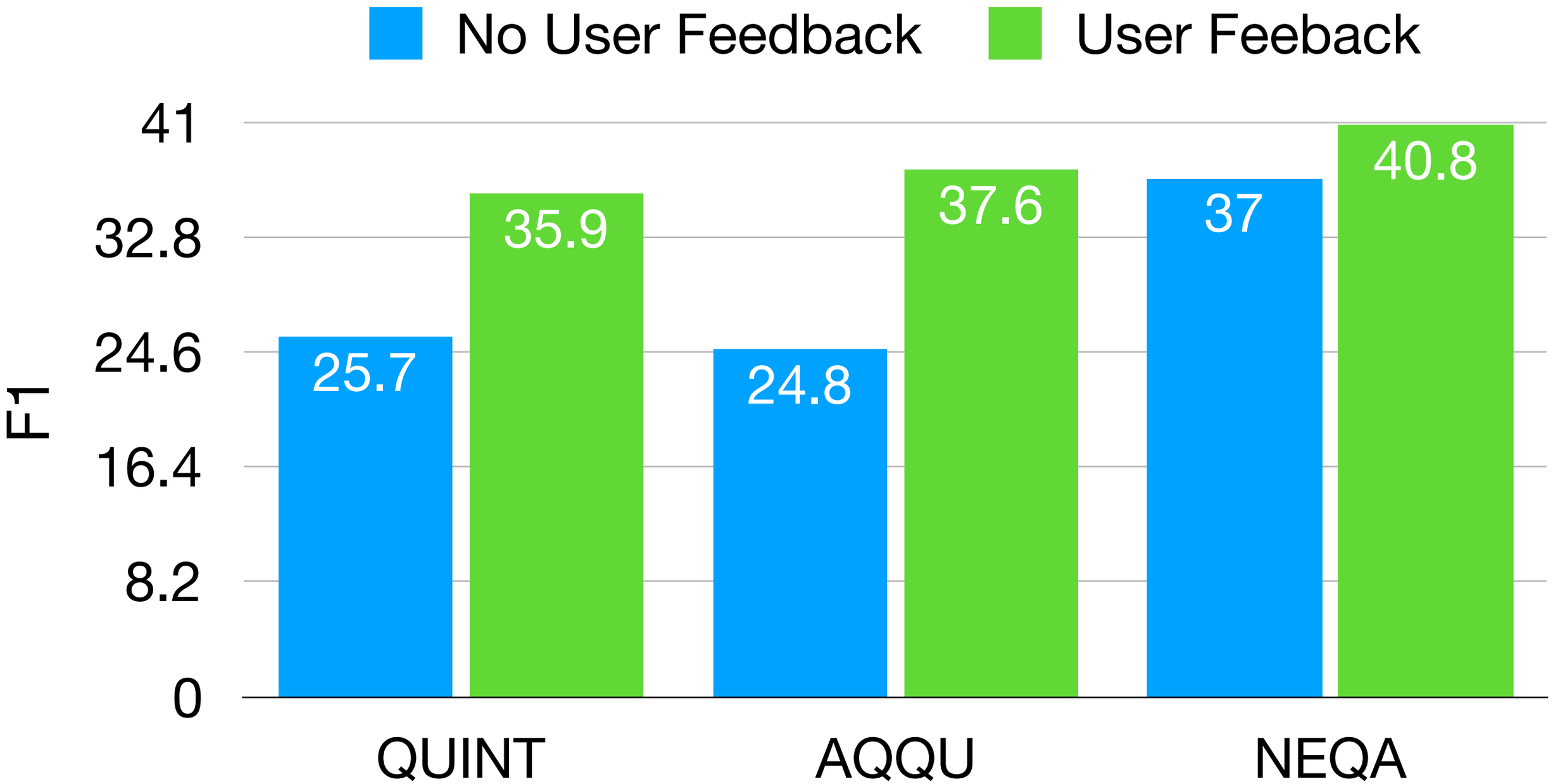
Setup (contd.)

- Initial training
  - Only 300 question/query (out of 3775)
    - 223 question-query templates
- Two feedback configurations:
  - User feedback: simulated with gold answers with K = 5
  - No user feedback: top-1 answer/query deemed correct

Answering Performance over Time



Comparison with baselines



Conclusion

- We presented NEQA, a KB-QA system that
- Initialized with a small training set
- Extends coverage of template-based methods using a similarity function
- Introduces scope for user feedback in KB-QA

Backup Slides

Similarity Function

Given a new utterance u_{new} and a question u_i from our bank:

$$score_{sim}(u_{new}, u_i) = \alpha \cdot score_{LM}(u_{new}, u_i) + (1 - \alpha) \cdot score_{w2v}(u_{new}, u_i)$$

Similarity Function

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$$score_{LM}(u_{new}, u_i) = \prod_{w \in u_{new}} [(1-\lambda) \cdot P_{ml}(w|u_i) + \lambda \cdot P_{ml}(w|C)]$$

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$$score_{LM}(u_{new}, u_i) = \prod_{w \in u_{new}} [(1-\lambda) \cdot P_{ml}(w|u_i) + \lambda \cdot P_{ml}(w|C)]$$

$$score_{w2v}(u_{new}, u_i) = \frac{1}{|\mathcal{P}|} \sum_{(w_j, w_k) \in \mathcal{P}} cos(w2v(w_j), w2v(w_k))$$

Comparison with Baselines

Method	Avg. Precision	Avg. Recall	Avg. F1
Berant et al. (2013)	48.0	41.3	35.7
AQQU	49.8	60.4	49.4
Yih et al. (2015)	**52.8**	**60.7**	**52.5**
Savenkov et al. (2016) (w/o text)	49.8	60.4	49.4
Xu et al. (2016) (w/o text)	—	—	47.1
NEQA (No cont. learning)	52.1	60.3	51.0

Open-domain QA

- Removed training examples belong to: sports and government
- Tested on questions belong to above domains

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Method	Avg. F1
AQQU	20.3
NEQA	**50.3**

Questions Answered via Templates Learned Online

- what is the name of the currency used in italy?
- what is the head judge of the supreme court called?
- where did the battle of waterloo occur?

Question Answered via Similarity Function

Question: what films has [scarlett johansson] been in?

Most similar: what movies did [zoe saldana] play in?

Question: what was [sir isaac newton]'s inventions?

Most similar: what inventions did [robert hooke] made?