Conversational Question Answering on Heterogeneous Sources

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Conversational Question Answering

Who played Jaime Lannister in Game of Thrones?
Nikolaj Coster-Waldau

What about the dwarf?
Peter Dinklage

When was he born?
11 June 1969

Release date of first season?
17 April 2012

Duration of an episode?
50-82 minutes

⇒ Information left implicit
⇒ Must be derived from conversational context
Conversational Question Answering

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⇒ Heterogeneous information sources for broader coverage
⇒ Leverage redundancy of information sources
Incoming: Conversation History

Question Understanding (QU)

Current Question

Intent-explicit Representation

Evidence Retrieval and Scoring (ERS)

Top-\(e\) Evidences

Heterogeneous Answering (HA)

Outgoing: Answer

Examples:
- Who played Jaime Lannister in Game of Thrones?
  - Nikolaj Coster-Waldau
- Release date of first season?
Desiderata and Contributions

Leverage **heterogeneous** information sources for conversational QA
★ General 3-staged pipeline for this task

**No restriction to specific information source**
★ **CONVINSE**: Intent-explicit **structured representation** of questions

Make process **explainable**
★ **Intermediate** representations in **symbolic** space

Avoid expensive annotations
★ **Distant supervision** from **raw** sequences of **QA-pairs**
Structured Representation (SR)

⇒ Capture information need in a **structured** way, based solely on the conversation
⇒ Relaxed **categorization** into

\[
\langle \text{context} \mid \text{entity} \mid \text{relation} \mid \text{answer type} \rangle
\]

⇒ **Context** makes the entity more **explicit**

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Who played Jaime Lannister in Game of Thrones?

Nikolaj Coster-Waldau

What about the dwarf?

(Game of Thrones | the dwarf | who played | human)
Structured Representation (SR)

Who played Jaime Lannister in Game of Thrones?
- Nikolaj Coster-Waldau

What about the dwarf?
- Peter Dinklage

How old is he?
- 51

Context not always required
⇒ Relaxed notion of a relation

\{ \_ | Game of Thrones | release date of first season | date \}
Structured Representation Module

⇒ Sequence generation task

Who played Jaime Lannister in Game of Thrones?
Nikolaj Coster-Waldau

Release date of first season?

Conversational history

Fine-tuned BART [Lewis et al. ACL 2020]
for conditional sequence generation

⟨__ | Game of Thrones | release date of first season | date⟩

Structured representation
Conversational Flow Graph (CFG)

Who played Jaime Lannister in Game of Thrones?  
- Nikolaj Coster-Waldau

What about the dwarf?  
- Peter Dinklage

How old is he?  
- 51

Game of Thrones | release date of first season | date

⇒ Adds explainability to developers and end users
**System Overview**

- **Conversation History**
- **Current Question**
- **Question Understanding (QU)**
  - **Structured Representation (SR)**
    - **Evidence Retrieval and Scoring (ERS)**
      - **Top-e Evidences**
        - **Heterogeneous Answering (HA)**
          - **Answer**

*Who played Jaime Lannister in Game of Thrones?*

*Nikolaj Coster-Waldau*

*Release date of first season?*

*Game of Thrones | release date of first season | date*

*Release date of first season?*

*Nikolaj Coster-Waldau*

*Release date of first season?*
Evidence Retrieval

Structured representation
⟨ _ | Game of Thrones | release date of first season | date ⟩

CLOCQ
[Christmann et al. WSDM 2022]

Question entities

Entity-centric Wikipedia retrieval

KB-facts

Text-snippets
Table-records
Infobox-entries
**Game of Thrones**, instance of, television series

Ordered is March 2, 2010, Filming is Second half of 2010...

**Game of Thrones**, Season is Season 1, Ordered is March 2, 2010, Filming is Second half of 2010...

Game of Thrones, Genre, Fantasy, Serial drama, Tragedy
Evidence Retrieval and Scoring

Verbalized/processed form

Game of Thrones, instance of, **television series**

Game of Thrones, Game of Thrones is an American **fantasy drama** television series created by David Benioff and D. B. Weiss for HBO.

Game of Thrones, Season is **Season 1**, Ordered is **March 2, 2010**, Filming is Second half of **2010**...

Game of Thrones, Genre, **Fantasy, Serial drama, Tragedy**

⇒ Bag-of-words retrieval
⇒ **Query**: Structured representation
⇒ **Documents**: Evidences
Evidence Retrieval and Scoring

CLOCQ
[Christmann et al. WSDM 2022]

Question entities
Entity-centric Wikipedia retrieval

KB-facts
Text-snippets
Table-records
Infobox-entries

Evidences
BM25 scoring

Top-e Evidences

⟨_
Game of Thrones
release date of first season
date⟩

Game of Thrones
A song of ice and fire

SR
System Overview

- **Conversation History**
- **Current Question**
- **Question Understanding (QU)**
- **Structured Representation (SR)**
- **Evidence Retrieval and Scoring (ERS)**
- **Heterogeneous Answering (HA)**
- **Answer**

Who played Jaime Lannister in Game of Thrones?
Nikolaj Coster-Waldau

Release date of first season?

Who played Jaime Lannister in Game of Thrones?
Nikolaj Coster-Waldau

Release date of first season?

Top-e Evidences

Top-e Evidences

( _ | Game of Thrones | release date of first season | date )
**Fusion-in-Decoder** [Izacard et al. EACL 2021]

- **Generative answering**: seq2seq model that encodes evidence-SR pairs
- Decodes **autoregressively** to generate answer
- We **normalize to KB** for comparability

Structured representation

```
( _ | Game of Thrones | release date of first season | date )
```

Fusion-in-Decoder

17 April 2011
System Overview

Question Understanding (QU)

Structured Representation (SR)

Evidence Retrieval and Scoring (ERS)

Heterogeneous Answering (HA)

Answer 17 April 2011
Distant Supervision

Only raw sequence of QA-pairs given
⇒ But SRs required!

Idea:
⇒ Augment follow-up with parts from history
⇒ Check whether this makes the information need complete
Distant Supervision

Only **raw** sequence of **QA-pairs** given
⇒ But **SRs required**!

**Idea:**
⇒ Augment follow-up with parts from history
⇒ Check whether this makes the information need **complete**
⇒ Detect **expansions** that trigger **new answering evidences**
⇒ **Merge** such expansions to get ‘gold’ **structured representation**

Using our **entity-centric retrieval**, we understand ‘why’ evidences are retrieved
⇒ For which entity (all evidences), for which KB-item (KB-facts)
⇒ Allows for **structuring** the target **SR**
ConvMix

First dataset for conversational QA over heterogeneous sources

⇒ 3,000 conversations
⇒ 16,000 questions
⇒ 5 domains: Books, Movies, Music, TV series, Soccer

Collected data:
★ Completed (intent-explicit) forms
★ Paraphrases
★ Question entities
★ Answers (free-text and normalized)
★ Answer source
ConvMix

Heterogeneity

★ Let users **detect answers** to their questions naturally

★ **Collect information source** they found the answer in
  ⇒ Wikidata; Wikipedia Text, Table, or Infobox

★ Only ensure that users cover **each information source at least once** per task (5 conversations)
Experimental Setup

**Baselines:** Question Understanding

- Prepend *initial* turn
- Prepend *last* turn
- Prepend *initial* and *last* turn
- Prepend *all* previous turns

- **Question Resolution** – Add relevant terms from history to query  [Voskarides et al. SIGIR 2020]
- **Question Rewriting** – Rewrite to full-fledged grammatical question  [Raposo et al. ECIR 2022]

⇒ **ERS and HA** kept static across baselines (adapting baselines to task)
Results – Precision at 1

CONVINSE outperforms baselines significantly

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Results – Precision at 1

Still huge scope for improvement

- Prepend init
- Prepend prev
- Prepend init+prev
- Prepend all
- Question Resolution
- Question Rewriting
- CONVINSE

Still huge scope for improvement
Adding additional input sources always helps

Results – Per Information Source(s)

P@1

KB: 0.251
Text: 0.220
Table: 0.062
Info: 0.258
ALL: 0.342

CONVINSE
Anecdotal Example

In which year was the first X-Men movie released?

2000

What actor portrayed Magneto?

Intent-explicit forms

☆ Question Resolution  What actor portrayed Magneto? x-men movie
☆ Question Rewriting  Which actor played the character Magneto in the X-Men movie?
★ CONVINSE  ⟨ X-Men | Magneto | actor portrayed | human ⟩
CONVINSE: First method for ConvQA over heterogeneous sources
★ Propose a general 3-staged pipeline for this task
★ Intent-explicit structured representation of questions
★ Distant supervision from raw sequences of QA-pairs
★ Intermediate representations can add explainability

ConvMix: First ConvQA benchmark for heterogeneous sources
★ 3,000 conversations
★ 16,000 questions

Code&Data: convinse.mpi-inf.mpg.de

Thank you!