Query Expansion with Semantic-based Ellipsis Reduction for Conversational IR

ASCFDA
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Agenda

1. Introduction
2. Coreference Query Reformation (CQR)
3. Semantic-based Ellipsis Reduction (SER)
4. Retrieve & Rerank
5. Manually rewritten utterance
6. Results & Conclusion
1. Introduction

“You're a wizard, Harry.”
1-1. Problem Definition

- Topic_number: 83

<table>
<thead>
<tr>
<th>Raw Query</th>
</tr>
</thead>
<tbody>
<tr>
<td>83-1 What are some interesting facts about bees?</td>
</tr>
<tr>
<td>83-2 Why doesn't it spoil?</td>
</tr>
<tr>
<td>83-3 Why are so many dying? <strong>subject missing</strong></td>
</tr>
<tr>
<td>83-4 What can be done to stop it?</td>
</tr>
<tr>
<td>83-5 What has happened to their habitat?</td>
</tr>
</tbody>
</table>
1-2. Query Ambiguity

- In a conversational system, the semantic ambiguity may come from:
  1. Expressing the same thing by various kinds of words
  2. Pronoun usage
  3. Omitting the repeating subjects

- The potential sources of supplement information to fix it:
  1. Historical queries
  2. Highly correlated passages
1-3. Pipeline (Baseline)

1st expansion + 1st retrieve

Rerank

Raw query → CQR → CQR query → BM25 → Retrieved passage → T5 reranker → Reranked passage
1st Expansion + 1st Retrieval

2nd Expansion + 2nd Retrieval

Reranking

Baseline

Query expansion
- RM3
- SER
- T5-squad

Expanded query

BM25

Retrieved passage

T5 reranker

Reranked passage

CQR query + retrieved passage

Raw query

CQR

CQR query

Passage

BM25

Retrieved passage
2. Coreference Query Reformation (CQR)

“Oh yes, the past can hurt. But you can either run from it, or learn from it.”
2-1. Coreference Query Reformation
2-2. Introduction of Transformers

**BERT**


**T5**

2-3. CQR model (T5-CQR)

- Pretrained model: T5-based
- Fine-tuning
  - Dataset: CANARD
  - Dialog with rewritten questions
- Inference
  - Input:
    - only use a query of each turn
  - Output:
    - rewritten query of the last one in input
Let’s see how fantastic the CQR is...

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<tr>
<th>Raw Query</th>
<th>CQR Query</th>
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<td>83-1 What are some interesting facts about bees</td>
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<td>83-3 Why are so many dying from bees?</td>
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</tbody>
</table>
3. Semantic-based Ellipsis Reduction (SER)

“Whoever you are— I have always depended on the kindness of strangers.”
3-2. SER Model
3-3. Historical Queries

- Transformer model: roberta-large
  - Trained on NLI + STSb
- Cosine Similarity Threshold: 0.8 ~ 0.9
  - Too high similarity is meaningless

| historical | 83-3 | Why are so many **dying from bees**? |
| current    | 83-4 | What can be done to stop **bees dying**? |
3-4. Topic Sentence

- Sentence + doc2query → latent query
- Transformer model: roberta-large
  - trained on NLI+STSb
- Cosine Similarity Threshold: 0.9
4. Retrieve & Rerank

“You will ride eternal, shiny and chrome.”
4-1. Retrieve & Rerank

CQR query + Okapi BM25
Retrieve 2000

SER query + Okapi BM25
Retrieve 1000

CQR query + T5 model

Two-step Retrieve

Rerank
4-1. Retrieve & Rerank

- Two-step Retrieve:
  - SER query + Okapi BM25 -> retrieve 1000.

- Rerank:
  - CQR query + T5 model
5. Manually rewritten utterance

“Just keep swimming.”
5-1. T5-SQuAD for Query Expansion

- **Purpose**
  - To extract the keywords of manual responses with queries information

- **Method description**
  - Use the **manual result** as the content of T5-squad pretrained model
  - And ask the **CQR utterance** to T5-SQuAD pretrained model
  - Expand CQR utterances with the answer of T5-squad pretrained model

**SQuAD Example**

Paragraph:
...These later laws had a low cost to society—the species were relatively rare—and little opposition was raised.

Question:
Which laws faced significant opposition?

Answer:
Later laws

**T5-SQuAD for QE**

Paragraph:
Manual_response_1

Question:
Query_1

Answer:
The QE materials

QE: Query_1 + QE materials
6. Results & Conclusion

Do Androids Dream of Electric Sheep?
6-1. Results

- Baseline model performs the best.
- QE(RM3) and QE(SER) reach higher recalls than baseline.

<table>
<thead>
<tr>
<th>Stage</th>
<th>Tree 2019 Retrieve</th>
<th>Rerank</th>
<th>Tree 2020 Retrieve + Rerank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw utterance only</td>
<td>mAP@1000</td>
<td>R@1000</td>
<td>mAP@1000</td>
</tr>
<tr>
<td>Raw queries</td>
<td>0.1077</td>
<td>0.4182</td>
<td>N/A</td>
</tr>
<tr>
<td>Baseline</td>
<td>0.2497</td>
<td>0.7628</td>
<td>N/A</td>
</tr>
<tr>
<td>QE(RM3)</td>
<td>0.2845</td>
<td>0.8024</td>
<td>0.3092</td>
</tr>
<tr>
<td>QE(SER)</td>
<td>0.2434</td>
<td>0.7674</td>
<td>0.3090</td>
</tr>
<tr>
<td>Manually rewritten utterance</td>
<td>mAP@1000</td>
<td>R@1000</td>
<td>mAP@1000</td>
</tr>
<tr>
<td>QE(T5-squad)</td>
<td>N/A</td>
<td>N/A</td>
<td>0.3102</td>
</tr>
</tbody>
</table>
6-2. Conclusion

- The mismatch between queries and documents is crucial in a conversational task.
- The considerable potential of a semantic-based relevance-feedback method.
- T5 domination. “When in doubt, C4!”
Cheers.
Thank you for your Attention!
## Result of the SER

<table>
<thead>
<tr>
<th>CQR Query</th>
<th>Top Sentence Extracted by SER</th>
</tr>
</thead>
<tbody>
<tr>
<td>95-6 Tell me more about biodegradable plastics.</td>
<td>Biodegradable plastics are plastics that decompose by the action of living organisms, usually bacteria.</td>
</tr>
<tr>
<td>102-9 How much of an increase is there in social security?</td>
<td>How much faster will it grow as a share of the economy? Social Security benefits amounted to 4.9 percent of GDP in 2014.</td>
</tr>
<tr>
<td>88-4 Why was slavery important? (in the Ottoman Empire)</td>
<td>Why was slavery so important to the American South during the period near the Civil War? ...</td>
</tr>
</tbody>
</table>
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- topic sentence
- current query
- historical queries
- Expanded Query

similarity