Bachelor Thesis Defense:

**Building Complex Queries in Conversational Search**

Xiaoni Cai

Advisor: Johannes Kiesel
Referees: Prof. Benno Stein, Jr. Prof. Jan Ehlers
Build Queries

Traditional Search v.s. Conversational Search

**Global research on coronavirus disease (COVID-19)**

www.who.int › Emergencies › Diseases › Coronavirus disease (COVID-19) ›

... and the addition of other expert-referred scientific articles. This database represents a comprehensive multilingual source of current literature on the topic.

COVID-19 technology access › R&D Blueprint › WHO Solidarity clinical trials

**Hi! Can you please get me news on COVID-19?**

I found some news. Here you are: ...

**I found some news about COVID-19. Here you are ...**

**just about vaccination.**

**Here are the news about COVID-19 and vaccination ...**
Complex Queries

Hi! Can you please get me news on COVID-19?

I found some news about COVID-19. Here you are ...

just about vaccination.

Here are the news about COVID-19 and vaccination ...

or treatments.

Here are the news I found ...

only replace COVID-19 with SARS-CoV-2.
Complex Queries

content=SARS-CoV-2 AND (content=vaccination OR content=treatment)
Question

How will seekers formulate their queries while interacting with a system in a multi-turn conversational search?
Contribution

1. Conduct a study to collect human utterances
2. Analyze the collected utterances and recognize patterns
3. Build the interaction model as front-end of a prototype
Crowdsourcing Study

• Mechanical Turk
• 5 countries (Australia, Canada, India, the United Kingdom, the United States)
• 4 scenarios (argument, book, news, trip)
• 1 ‘ready’ task + 12 query reformulation tasks
• 20*4*5 = 400 participants
• 400*12 = 4800 human natural language utterances
• 8 pilot studies for news scenario
## Tasks of Crowdsourcing Study

### CRUD operations

<table>
<thead>
<tr>
<th>Operation</th>
<th>Query</th>
<th>Part</th>
<th>Literal</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Create</strong></td>
<td><em>Show me news about COVID-19.</em></td>
<td><em>Show me news that contain NCD, NI or WHO in the headline.</em></td>
<td><em>Is there any news for its treatment?</em></td>
</tr>
<tr>
<td><strong>Read</strong></td>
<td><em>What do I have so far?</em></td>
<td><em>What filters did I set for the headline?</em></td>
<td><em>What was the last filter?</em></td>
</tr>
<tr>
<td><strong>Update</strong></td>
<td><em>Please start a new search on flu.</em></td>
<td><em>Remove my criteria for headline and search any news about economy.</em></td>
<td><em>I don’t mean North Ireland by NI.</em></td>
</tr>
<tr>
<td><strong>Delete</strong></td>
<td><em>No, let’s start again.</em></td>
<td><em>Remove the word filters vaccination and treatment.</em></td>
<td><em>Remove news about treatment.</em></td>
</tr>
</tbody>
</table>

### Query Reformulation Intent: Operation + Target

- **ReadQuery**: Memorization & Navigation
- **UpdateLiteral**: e.g., Negative Feedback
- **DeleteQuery**: start v.s. restart
### Curation of Crowdsourcing Study

**News scenario**: 5 countries (AU, CA, GB, IN, US)

**Argument, news and book scenarios**: 3 countries (CA, GB, US)

**Number of approved participants**: 284

**Three categories**: “good”, “bad”, “very bad”

**2919 “good” utterances (85.65%), 1434 patterns**

---

**Table**

<table>
<thead>
<tr>
<th>Status</th>
<th>Time</th>
<th>add</th>
<th>add ‘or’ treatment</th>
<th>delete two filters (so results should include all articles about virus whether they are related to both filters or not)</th>
<th>specify headline with NCD, NI, WHO</th>
<th>say not North Ireland (indicate the error made by chatbot)</th>
<th>say National Insurance</th>
<th>say not COVID-19 but SARS-CoV-2</th>
<th>ask chatbot to repeat your query</th>
<th>replace NCD, NI, WHO (headline filters) with economy</th>
<th>change to flu</th>
<th>ask flu but not about COVID-19</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>reject</td>
<td>11:11</td>
<td>ask for COVID-19</td>
<td>good bad very bad</td>
<td>I want to know about vaccination and treatment of this disease good</td>
<td>bad very bad</td>
<td>FULL Form of NI IS NORTH IRELAND? good</td>
<td>very bad</td>
<td>How COVID-19 is related to SARS-CoV-2 disease? good</td>
<td>bad very bad</td>
<td>I want to know about flu good</td>
<td>bad very bad</td>
<td>You know about flu good</td>
<td>bad very bad</td>
</tr>
<tr>
<td>reject</td>
<td>36:56</td>
<td>show the news about COVID-19 good</td>
<td>bad very bad</td>
<td>show me the news articles that are not on vaccination or treatment. good bad very bad</td>
<td>show me the articles that contain NCD or NI or WHO as headline. good</td>
<td>bad very bad</td>
<td>show me the articles that has discussions about National Insurance in the headline. good</td>
<td>bad very bad</td>
<td>show me the articles about SARS-CoV-2 which should contain at least NCD or NI means National Insurance or WHO as headline. good</td>
<td>bad very bad</td>
<td>You know about flu good</td>
<td>bad very bad</td>
<td>show me only those articles that are not about COVID-19 good</td>
</tr>
<tr>
<td>reject</td>
<td>12:35</td>
<td>hey, show me news articles about the pandemic good</td>
<td>bad very bad</td>
<td>filter those article having details about vaccination or treatment details good</td>
<td>bad very bad</td>
<td>display article which doesn’t have vaccination or treatment details good</td>
<td>bad very bad</td>
<td>hey you misunderstood NI doesn’t mean North Ireland good</td>
<td>bad very bad</td>
<td>now filter article which doesn’t have vaccination or treatment details good</td>
<td>bad very bad</td>
<td>show me news articles about flu good</td>
<td>bad very bad</td>
</tr>
</tbody>
</table>
Analysis of Crowdsourcing Study

Ambiguity

Hi! Can you please get me news on COVID-19?

I found some news about COVID-19. Here you are...

Just about vaccination.

Here are the news about COVID-19 and vaccination...

Or treatments.

Here are the news I found...

Only replace COVID-19 with SARS-CoV-2.
Analysis of Crowdsourcing Study

Ambiguity

A. mix up with other tasks due to the existence of overlapping patterns
• Task 2 (createQuery) v.s. Task 3 (createLiteral) v.s. Task 4 (updatePart)
• Task 7 (rejectLiteral) v.s. Task 13 (createNegLiteral)
• Task 2 (createQuery) v.s. Task 12 (updateQuery)

B. misunderstood by participants
• Task 5 (deletePart)
• Task 11 (updatePart)
A. mix up with other tasks due to the existence of overlapping patterns

Imagine I would show you the list of all news articles about COVID-19 as you asked for.

You now want the list to contain fewer articles: It should contain just the news articles

- about COVID-19 (you already told me)
- that are about a vaccination

How would you ask me to change the list?

Assume I changed the list accordingly.

You now want the list to contain more articles: It should contain the news articles

- about COVID-19 (you already told me)
- that are about either:
  - vaccination (you already told me), or
  - treatment (as a new alternative to vaccination).

How would you ask me to change the list?

Task 2 Create(COVID-19): start a search for main-topic COVID-19
Task 3 Create(vaccination): add subtopic vaccination to filter previously obtained results

- just show me news about vaccination.
  ⇒ Create(vaccination) OR Update(COVID-19, vaccination)

- show me news that are only about vaccination.
  ⇒ Update(COVID-19, vaccination) OR Update (COVID-19, COVID-19 V vaccination)

Task 4 Update(vaccination, vaccination V treatment): add another subtopic treatment as an alternative to vaccination

- please also add news about treatment to the list.
  ⇒ Update(vaccination, vaccination V treatment) OR Create(treatment)

- show me news about treatment.
  ⇒ Update(vaccination, vaccination V treatment) OR Update(COVID-19 \ vaccination, treatment)
Unambiguous patterns for Task 3

1. Use pronouns (co-reference):
   • can you [only|just] [show|give] [me|] [ones|those] [about|on] vaccination?
   • which [of|] [these|ones] [include|relate to] vaccination?

2. Use verbs like filter, trim down, narrow down, reduce, shorten
   • can you [filter|shorten|trim down|reduce] list to [those|ones|] about vaccination?
   • filter [these|this list] [with|for] vaccination [only|].

3. Elimination
   • [please|] [remove|filter out] {collection} that are not [relate to|about|] vaccination.
Ambiguity
B. misunderstood by participants
• Task 5 (deletePart)

Assume I changed the list accordingly.

You now want the list to contain more articles: It should again contain all news articles
• about COVID-19 (you already told me, but now again with those news articles that are not about vaccination or treatment)

How would you ask me to change the list?

Task 5a delete(\textit{vaccination} V \textit{treatment}): remove part of filters

• \textit{add back all news that are not about vaccination or treatment to the list.}
• \textit{can you show me all news not just the ones about vaccination or treatment?}
• \textit{please remove filters vaccination and treatment.}

Task 5b update(\textit{vaccination} V \textit{treatment}, ¬\textit{vaccination} V ¬\textit{treatment}): update part of filters to negation of filters

• \textit{now please show me news that are not about vaccination or treatment.}
• \textit{please remove all news about vaccination or treatment.}
Front-end of Prototype
Interaction Model

<table>
<thead>
<tr>
<th>Task</th>
<th>Intent</th>
<th>Utterances</th>
<th>Slots</th>
<th>Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>CreateQueryIntent</td>
<td>274</td>
<td>2</td>
<td>Seekers start a search session for collection about a main-topic.</td>
</tr>
<tr>
<td>3</td>
<td>CreateLiteralIntent</td>
<td>82</td>
<td>2</td>
<td>Seekers add a subtopic to filter previously obtained result list.</td>
</tr>
<tr>
<td>4</td>
<td>UpdatePartIntent</td>
<td>55</td>
<td>3</td>
<td>Seekers add an alternative subtopic.</td>
</tr>
<tr>
<td>5</td>
<td>DeletePartIntent</td>
<td>70</td>
<td>3</td>
<td>Seekers remove part of filters.</td>
</tr>
<tr>
<td>6</td>
<td>CreatePartIntent</td>
<td>262</td>
<td>5</td>
<td>Seekers specify certain field with part of filters.</td>
</tr>
<tr>
<td>7</td>
<td>RejectLiteralIntent</td>
<td>155</td>
<td>4</td>
<td>Seekers indicate a error made by the system and reject the unexpected filter.</td>
</tr>
<tr>
<td>9</td>
<td>UpdateLiteralIntent</td>
<td>258</td>
<td>4</td>
<td>Seekers replace a existing filter with a new filter.</td>
</tr>
<tr>
<td>10</td>
<td>ReadQueryIntent</td>
<td>189</td>
<td>1</td>
<td>Seekers ask for system to recall the search history.</td>
</tr>
<tr>
<td>11</td>
<td>UpdatePartFieldIntent</td>
<td>133</td>
<td>6</td>
<td>Seekers replace part of filters for certain field with another new filter.</td>
</tr>
<tr>
<td>12</td>
<td>UpdateQueryIntent</td>
<td>140</td>
<td>2</td>
<td>Seekers replace the entire query with a new filter.</td>
</tr>
<tr>
<td>13</td>
<td>CreateNegLiteralIntent</td>
<td>263</td>
<td>2</td>
<td>Seekers add a negation of existing filter.</td>
</tr>
</tbody>
</table>

- 11 custom Intents
- Max. 6 custom Slot Types
- Replace patterns with human annotations as sample utterances
- Bad generalizability for different scenarios
Front-end of Prototype Evaluation

- Prove the existence of ambiguous patterns (explicit)
- Figure out the implicit ambiguity
Future Work

• Implement back-end of the prototype
  • Detect ambiguity of human utterances
  • Minimize ambiguity
    • Check correlation between different filters in the documents (semantic, occurrence etc.)
  • Reasoning & Memorization (e.g. Negative Feedback)

• Follow-up studies
  • Test for resolving ambiguity
  • Test for prototype
Thank you for your attention!

Question Time