Evidence Contextualization and Counterfactual Attribution For ConvQA over Heterogeneous Data with RAG Systems

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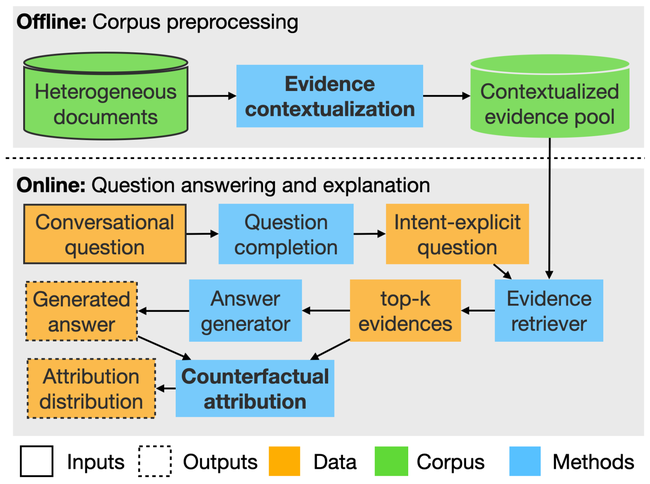
Extended version: https://arxiv.org/pdf/2412.10571
All artifacts: https://github.com/Fraunhofer-IIS/RAGonite

System overview



Heterogeneous corpus: Confluence pages

2024-10-02 Meeting Notes

Today we will talk about the progress of the project on retrieval augmented generation.

Agenda

- We'll first do a basic round of RAG team updates in this month's meeting
- Everyone will report what has been done, and the to-dos

Member	Task	Action items	Time needed	Notes
Bob	Basic FE and BE	Follow-up q in UI	3 days	Currently manual
Alice	Similarity function	Fine-tune with gpt4o*	1 week	Now w/ embed cos
Trudy	Verbalizations	Batch configs*	6 hours	Running superbly

* Alice and Trudy to fix long-standing embedding error with openxt strings

A new benchmark: ConfQuestions

ConfQuestions is suitable for evaluating

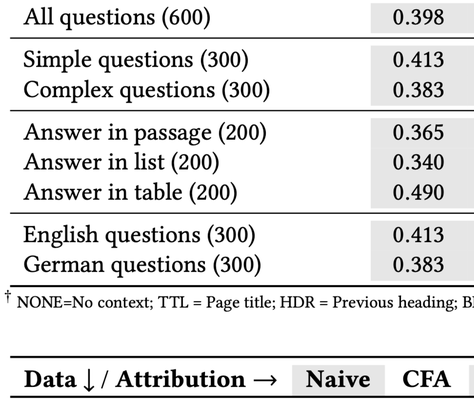
- ✓ Conversational question answering
- ✓ Complex question answering
- ✓ RAG on heterogeneous enterprise documents

ConfQuestions contains

- ✓ 50 human conversations with 300 questions
- ✓ Corresponding human-generated completed questions
- ✓ Gold URL and answers: entities, phrases, lists, passages
- ✓ Each question in English and German
- ✓ Metadata: Answer-source, Complexity type
- ✓ 215 Confluence pages as corpus

Idea sketch: Evidence contextualization

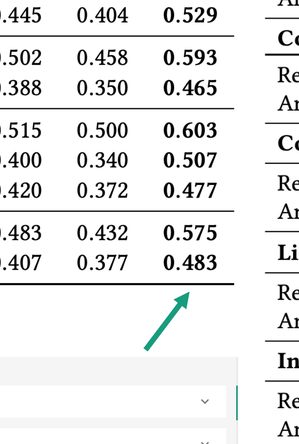
Traditional RAG on heterogeneous data



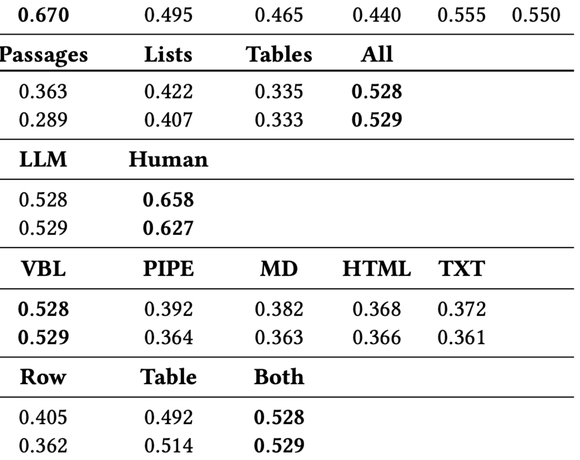
Proposed RAG with evidence contextualization

Idea sketch: Counterfactual attribution

Traditional attribution in RAG pipelines



Proposed RAG with counterfactual attribution



LLM prompts

1. Question completion
2. Answer generation

1

```
{{ document_database.prompt_prefix.en|default("You are a helpful assistant.")
}} The following dialog was conducted with the user:

{% for message in history %}
{{ message.author }}: {{ message.content }}
{%- endfor %}
User: {{ query }}

Rephrase the user's last statement into an independent question or statement.

Question/Statement:
```

2

```
{%- set stop_sequences = ["User:"] -%}

{{ document_database.prompt_prefix.en|default("You are a helpful assistant.")
}} You are specialized in answering conversational questions in a
retrieval-augmented generation (RAG) setup. Please provide as precise and
concise an answer to the input question as possible (less than 50 words if
possible), using the retrieved evidences in this prompt as sources for
answering. There is no need to provide additional information beyond the
requested answer, and also no need for supporting explanations. If the
requested information cannot be found in the provided evidences, please state
exactly: "The desired information cannot be found in the retrieved pool of
evidence." Please use only the information presented in the evidences, and mark
the sources used in your answering within square brackets, like [Source 2] or [
Source 5]. Please do not use your parametric memory and world knowledge.
These are the available document evidences:
```

```
----------
{% for document in documents %}
### Source {{ loop.index }} ###
{{ document.content }}
{% endfor %}
----------

As part of your answer, indicate in square brackets for each statement which
sources were used. Don't use knowledge that wasn't part of the sources. You
don't have to use all sources.

{% for message in history %}
{{ message.author }}: {{ message.content }}
{%- endfor %}
User: {{ query }}
Assistant:
```

Contextualization, attribution, and overall RAG results on ConfQuestions

Metric →	Retrieval precision@1						Answer relevance					
Data ↓ / Contextualization† →	NONE	+TTL	+HDR	+BEF	+AFT	+ALL	NONE	+TTL	+HDR	+BEF	+AFT	+ALL
All questions (600)	0.398	0.483	0.448	0.453	0.460	**0.528**	0.388	0.477	0.435	0.445	0.404	**0.529**
Simple questions (300)	0.413	0.470	0.477	0.450	0.483	**0.510**	0.423	0.537	0.482	0.502	0.458	**0.593**
Complex questions (300)	0.383	0.497	0.420	0.457	0.437	**0.547**	0.352	0.417	0.388	0.388	0.350	**0.465**
Answer in passage (200)	0.365	0.410	0.390	0.415	0.420	**0.445**	0.430	0.547	0.460	0.515	0.500	**0.603**
Answer in list (200)	0.340	0.475	0.440	0.435	0.490	**0.560**	0.328	0.422	0.390	0.400	0.340	**0.507**
Answer in table (200)	0.490	0.565	0.515	0.510	0.470	**0.580**	0.405	0.460	0.455	0.420	0.372	**0.477**
English questions (300)	0.413	0.500	0.467	0.480	0.483	**0.563**	0.407	0.530	0.472	0.483	0.432	**0.575**
German questions (300)	0.383	0.467	0.430	0.427	0.437	**0.493**	0.368	0.423	0.398	0.407	0.377	**0.483**

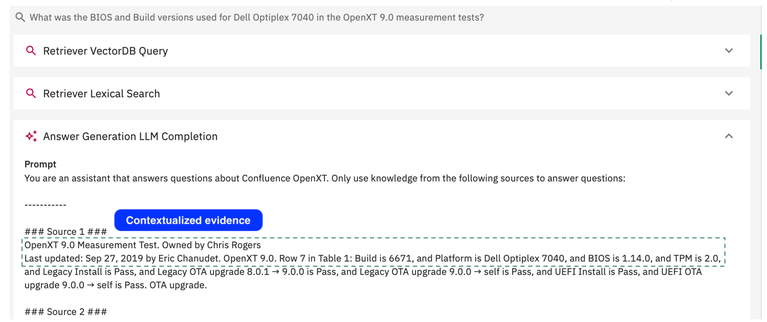
† NONE=No context; TTL = Page title; HDR = Previous heading; BEF = Evidence before; AFT = Evidence after; ALL = All context

Turns →	1	2	3	4	5	6-10
Retr. P@1	**0.660**	0.530	0.500	0.430	0.490	0.560
Ans. relevance	**0.670**	0.495	0.465	0.440	0.555	0.550
Corpus →	**Passages**	**Lists**	**Tables**	**All**		
Retr. P@1	0.363	0.422	0.335	**0.528**		
Ans. relevance	0.289	0.407	0.333	**0.529**		
Completion →	**LLM**	**Human**				
Retr. P@1	0.528	**0.658**				
Ans. relevance	0.529	**0.627**				
Linearizer† →	**VBL**	**PIPE**	**MD**	**HTML**	**TXT**	
Retr. P@1	**0.528**	0.392	0.382	0.368	0.372	
Ans. relevance	**0.529**	0.364	0.363	0.366	0.361	
Indexing →	**Row**	**Table**	**Both**			
Retr. P@1	0.405	0.492	**0.528**			
Ans. relevance	0.362	0.514	**0.529**			
LLM →	**GPT-4o**	**Llama3.1**				
Retr. P@1	**0.528**	0.480				
Ans. relevance	**0.529**	0.449				
Embeddings →	**BGE**	**OpenAI**				
Retr. P@1	**0.528**	0.525				
Ans. relevance	0.529	**0.538**				
Ranking →	**Lexical**	**Dense**	**Hybrid**			
Retr. P@1	0.430	0.465	**0.528**			
Ans. relevance	0.417	0.443	**0.529**			
Reranking →	**BGE+RRF**	**RRF**				
Retr. P@1	**0.528**	0.417				
Ans. relevance	**0.529**	0.507				

† VBL=Verbalization; PIPE = Piped; MD = Markdown; HTML = HTML format; TXT = Plaintext

Data ↓ / Attribution →	Naive	CFA	CFA w/ Clusters
All questions (364)	0.772	0.791	**0.799**
Simple questions (175)	0.771	0.811	**0.817**
Complex questions (189)	0.772	0.772	**0.783**
Answer in passage (98)	0.816	**0.847**	0.806
Answer in list (123)	0.756	0.780	**0.821**
Answer in table (143)	0.755	0.762	**0.776**
English questions (192)	**0.807**	0.765	0.786
German questions (172)	0.733	**0.820**	0.814

```
Answer explanation with counterfactual attribution:
        * Attributed 67.32%     to cluster 1 [Evidence 1, 2]
        * Attributed 15.13%     to cluster 2 [Evidence 3, 4, 7]
        * Attributed 9.34%      to cluster 3 [Evidence 5, 8]
        * Attributed 7.59%      to cluster 4 [Evidence 6]
        * Attributed 0.34%      to cluster 6 [Evidence 9]
        * Attributed 0.28%      to cluster 7 [Evidence 10]
```



Find all info here 👉

Take-home message: Contextualizing evidence with surrounding document text, and explaining answers with counterfactual attribution, are vital RAG add-ons