Grounded and Transparent Response Generation for Conversational Information-Seeking Systems

Weronika Łajewska
Supervised by Krisztian Balog

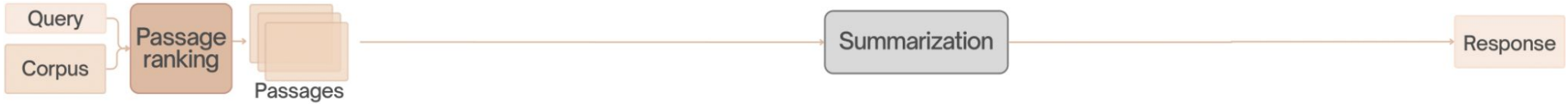
University of Stavanger, Norway

Challenges in CIS Systems

- Conversational search is a less transparent setting that SERP-based interface
- Users are mostly not aware of the working mechanism of the system, its capabilities, and limitations
- Detecting hallucinations, factual errors, and/or biases in extremely difficult for users without knowledge about the topic

Overview of our Approach to Conversational Response Generation

"A true teacher would never tell you what to do. But he would give you the knowledge with which you could decide what would be best for you to do."
— Christopher Pike, Sati



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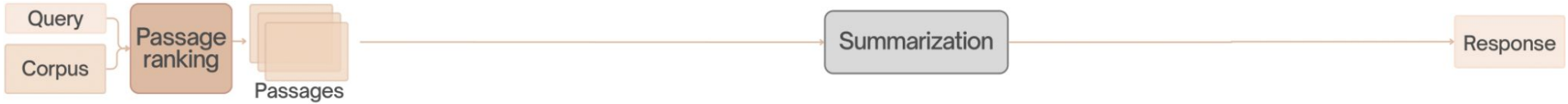

What can go wrong?

- System may fail to find the response
- The response may be biased
- Only part of the answer may be found
- Summarization with LLMs may introduce factual errors
- ...

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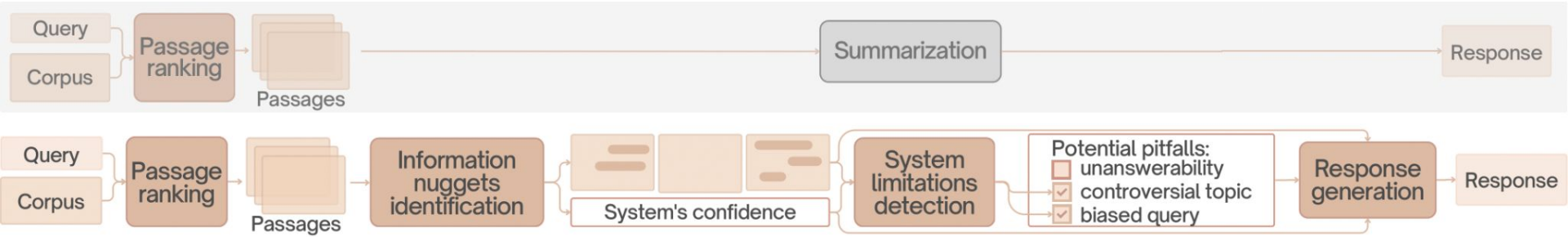

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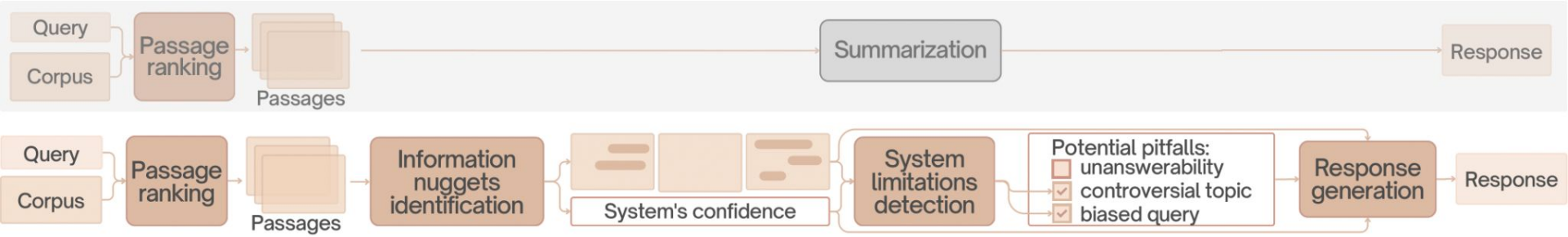

RQ1: How to obtain information nuggets that contain key pieces of information necessary to answer the user's question?

CIS dataset with Information Nuggets

- **Problem setting:** Conversational response generation
  - It extends beyond passage retrieval + summarization

Query: I remember Glasgow hosting COP26 last year, but unfortunately I was out of the loop. What was the conference about?

Passage: HOME - UN Climate Change Conference (COP26) at the SEC – Glasgow 2021 Uniting the world to tackle climate change. The UK will host the 26th UN Climate Change Conference of the Parties (COP26) in Glasgow on 1 – 12 November 2021. The COP26 summit will bring parties together to accelerate action towards the goals of the Paris Agreement and the UN Framework Convention on Climate Change. The UK is committed to working with all countries and joining forces with civil society, companies and people on the frontline of climate change to inspire climate action ahead of COP26. COP26 @COP26 · May 25, 2021 1397069926800654339 We need to accelerate the #RaceToZero Join wef, MPPindustry, topnigel & gmunozabogabir for a series of events demonstrating the need for systemic change to accelerate the global transition to net zero. Starting May 27th Learn more #ClimateBreakthroughs | #COP26 Twitter 1397069926800654339 COP26 COP26 · May 24, 2021 1396737733649846273 #TechForOurPlanet is a new challenge programme for #CleanTech startups to pilot and showcase their solutions at #COP26! Innovators can apply to six challenges focusing around core climate issues and government priorities.

- **Goal:** snippet-level annotations of relevant passages, to enable
  1. the training of response generation models that are able to ground answers in actual statements
  2. the automatic evaluation of the generated responses in terms of completeness

CAsT-snippets Dataset Summary

371 queries, top 5 passages per query ⇒ **1855 query-passage pairs** (each annotated by 3 crowd workers)

- Data quality
  - Inter-annotator agreement exceeds even that of expert annotators
- Comparison against other datasets
  - More snippets annotated per input text; also, snippets are longer

Dataset	Input text	Avg. snippets length (tokens)	# snippets per annotation
CAsT-snippets	Paragraph	39.6	2.3
SaaC [1]	Top 10 passages	23.8	1.5
QuaC [2]	Wikipedia article	14.6	1

[1] Pengjie Ren, Zhumin Chen, Zhaochun Ren, E. Kanoulas, Christof Monz, and M. de Rijke. 2021. Conversations with Search Engines: SERP-based Conversational Response Generation. ACM Transactions on Information Systems 39, 4 (2021), 1–29
[2] Eunsol Choi, He He, Mohit Iyyer, Mark Yatskar, Wen tau Yih, Yejin Choi, Percy Liang, and Luke Zettlemoyer. 2018. QuAC: Question Answering in Context. In Findings of the Association for Computational Linguistics: EMNLP 20 (EMNLP '18). 2174–2184.

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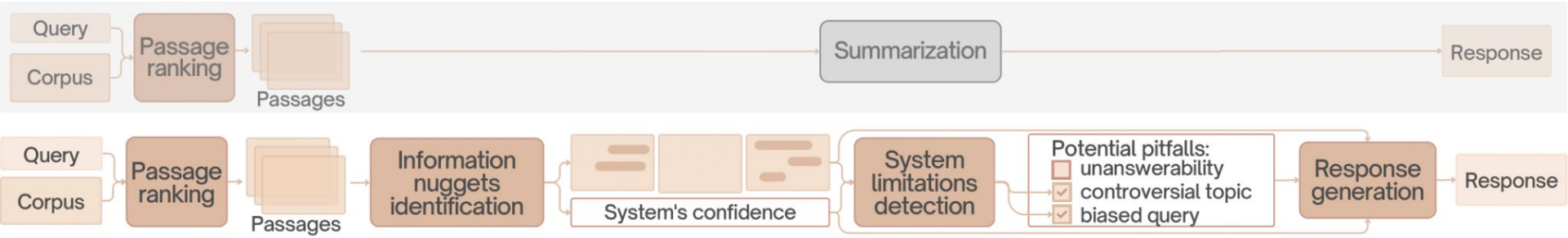


RQ2: How to detect factors contributing to incorrect, incomplete, or biased responses?

User's Ability to Detect Response Inaccuracies

Goal: Investigating user's ability to effectively recognize the problems of:

1. query answerability resulting in hallucinations or invalid sources
2. multiple viewpoints leading to incomplete or biased response

... as well as impact of inaccurate, incomplete, and/or biased responses on user experience

User studies:

Response variant	Answerability Study	Viewpoints Study
Accurate	factually correct with valid source	multiple viewpoints covered to the same extent
Flawed	factually incorrect with no/invalid source	single point of view covered

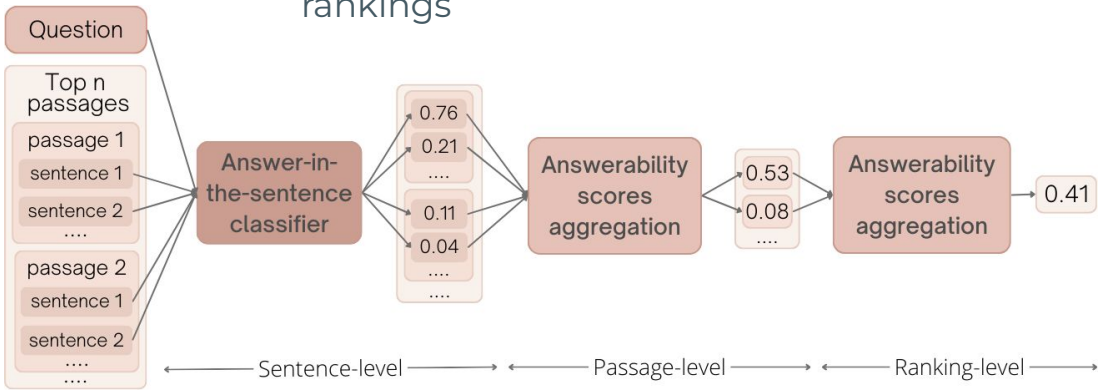
Main finding:

simple source attribution is not enough to ensure effective interaction with the system

Answerability Detection in CIS

- **Goal:** mechanism for detecting unanswerable questions for which the correct answer is not present in the corpus or could not be retrieved
- **Main contributions:**
  1. A dataset with answerability labels on three levels: (1) sentences, (2) paragraphs, and (3) rankings

	Answerable?	
	Yes	**No**
#question-sentence pairs (train+test)	6,395	19,043
#question-passage pairs (train+test)	1,778	1,932
#question-ranking pairs (test)	4,035	504



2. A baseline approach for predicting answerability based on the top retrieved results.

⇒ LLMs have a limited ability to detect answerability without additional guidance

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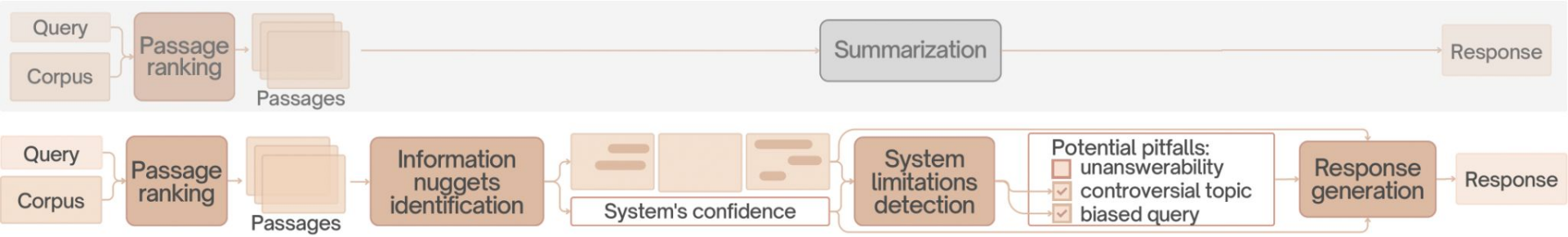
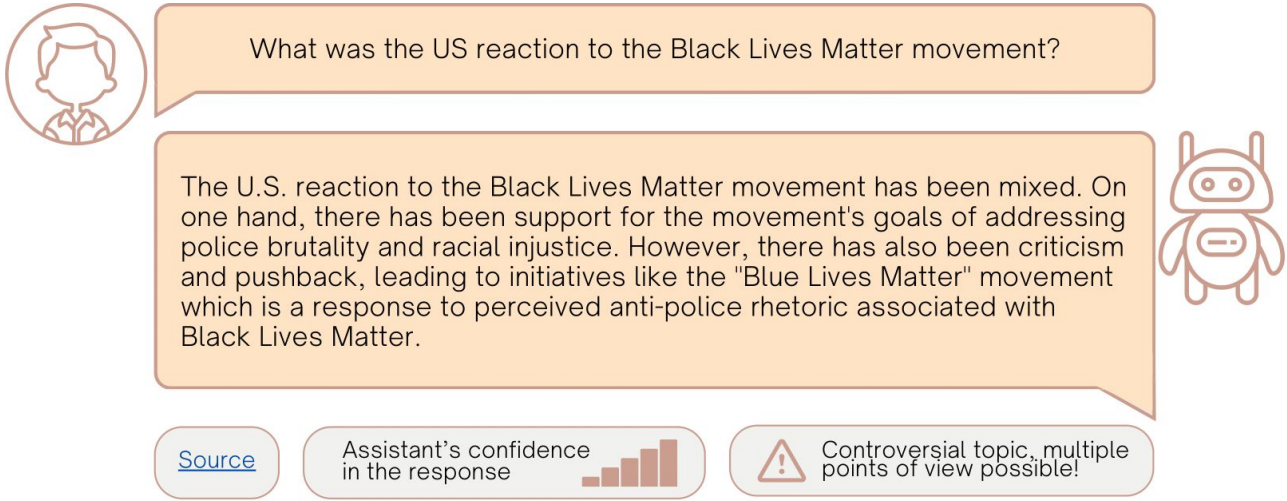


RQ3: How to generate responses transparent about the system's confidence and limitations?

Explainability for Transparent CIS



1. Lower user ratings for noisy explanations.
2. A significant effect of familiarity with the topic on response assessment.
3. Not conclusive results about the preferred way of presenting explanations to the user.
4. An effort-gain trade-off that needs to be taken into account when enhancing the response with additional information.

Overview of Contributions

- **Datasets:**
  - CAsT-snippets - snippet level answer annotations
  - CAsT-annotation - answerability labels on sentence, passage and ranking levels
  - Manually curated dataset of CIS responses and explanations, with noise incorporated in a controlled manner
- **Methods:**
  - Detecting unanswerable questions in CIS
  - Crowdsourcing task design and protocol to collect high-quality answer annotations
- **Findings:**
  - LLMs have a limited ability to detect answerability in CIS setting without additional guidance.
  - CIS response should explicitly inform users about potential inaccuracies
  - User-perceived usefulness of explanations vary based on their quality

Thank you for your attention!

Questions?

Open Challenges

- Granular nature of answerability → *How to address snippets partially answering the question?*
- Response completeness in the light of the fact that “the system is not aware of what it does not know” → *How can the system articulate its confidence in the identified snippets without information about the scope of the complete response?*
- Holistic view on system's limitations → *Should we focus on identifying more limitations or delve deeper into specific ones?*
- Response evaluation → *What other aspects of response in addition to transparency and grounding should be considered in the evaluation?*

Challenges Identified

Challenges pointed out by the crowd workers that need to be addressed in conversational response generation:

- Only a partial answer is present
- Temporal considerations
  - Spans may need to be excluded given the time constraints in the query
  - Assessing temporal validity can be challenging based on the paragraph alone (without larger context)
- Subjectivity of the passages originating from blogs or comments
- Indirect answers that require reasoning and background knowledge
- Determining the appropriate amount of context to include in each span
  - Balancing between being concise and being self-contained
- Determining whether the evidence or additional information is needed or an entity alone is sufficient as an answer

Results

- Data augmentation helps answerability detection only on sentence and answer levels
- *Max* aggregation on the passage level followed by *mean* aggregation on the ranking level gives the best results
- LLMs have a limited ability to detect answerability without additional guidance.

Classifier	Sentence	Passage		Ranking	
	Acc.	**Aggr.**	**Acc.**	**Aggr.**	**Acc.**
CAsT-answerability	0.752	Max	0.634	Max	0.790
				Mean	**0.891**
		Mean	0.589	Max	0.332
				Mean	0.829
CAsT-answerability augmented with SQuAD 2.0	**0.779***	Max	0.676*	Max	0.810*
				Mean	0.848*
		Mean	0.639*	Max	0.468*
				Mean	0.672*
ChatGPT passage-level (zero-shot)			**0.787***	T=0.33	0.839*
				T=0.66	0.623*
ChatGPT ranking-level (zero-shot)					0.669*
ChatGPT ranking-level (two-shot)					0.601*

Answerability Study

Query: I like hiking and Malbec wine. You mentioned some high peaks. How can I hike some high mountains and visit some wineries famous for Malbec?

Experimental Condition	Response Dimension		CIS System Response	Source
	Factual Corr.	Source		
Factually correct + valid source	✓	✓	*You can combine your love for hiking and Malbec wine by visiting Mendoza, Argentina. This picturesque city is nestled in the Andes and is renowned for its vineyards...*	https://wanderingtrader.com/argentina/top-5-argentina-tourist-attractions/
Factually correct + no source	✓	×	Same as above	–
Factually incorrect + invalid source	×	✓ (invalid)	*To combine hiking and Malbec wine, plan a trip to the Penedès region in Catalonia. You can explore the Montserrat mountain range, which offers fantastic hiking opportunities, and then visit renowned wineries in the Penedès, known for its exceptional Malbec wine production…*	https://www.winetourism.com/wine-tasting-tours-in-penedes/ (The link is valid but the article is a website with Wine Tasting & Tours in Penedès, Spain where Malbec wine is not produced.)
Factually incorrect + no source	×	×	Same as above	–

Viewpoints Study

Query: What effects did the Watergate scandal have on President Nixon's legacy?

Experimental Condition	Response Dimension: Diversity	Response Dimension: Balance	CIS System Response
Multiple viewpoints covered to the same extent	✓	✓	*The Watergate scandal initially had a severely damaging effect on President Nixon's legacy, tarnishing his image as a corrupt politician and overshadowing his accomplishments. However, in later years, Nixon's reputation underwent a degree of rehabilitation, with recognition of his roles in civil rights and diplomacy. He transitioned from being primarily associated with scandal to being acknowledged as a respected elder statesman, although his legacy remains marked by the shadow of Watergate.*
Multiple viewpoints mentioned, one covered in detail	✓	×	*The Watergate scandal had a profoundly negative impact on President Nixon's legacy, overshadowing many of his domestic achievements. It tarnished his reputation as a corrupt politician, making him a symbol of political scandal and misconduct in both American politics and popular culture. While he did enact significant legislation like creating the Environmental Protection Agency, his presidency is primarily remembered for the scandal, leading to his resignation and becoming synonymous with political corruption and disgrace.*
Single viewpoint mentioned and covered	×	×	*The Watergate scandal had a profoundly negative impact on President Nixon's legacy. It tarnished his reputation as a corrupt politician, making him a symbol of political scandal and misconduct in both American politics and popular culture. Nixon's resignation and the scandal's fallout reinforced public skepticism and criticism of the presidency, leaving a lasting impression as one of the most Shakespearean and disgraceful episodes in presidential history.*

Findings

- **Quantitative analysis →** users find it easier to identify problems with diversity and balance of viewpoints rather than factual errors and source validity in the responses
- **Analysis of a user experience →** self-reported overall satisfaction scores are not necessarily associated with the main response dimensions
- **Qualitative analysis of free-text comments →** credibility of the sources, as well as completeness, usefulness, and subjectivity of provided information impact the overall satisfaction of the users

Dependent Variable	Independent Variable(s)	F	*p*-value	Unbalanced Estimator	Effect Size
Answerability Study					
Factual Correctness	Experimental Condition	1.330	0.264	0.003	–
Confidence in Answer Accuracy		0.721	0.540	−0.002	–
Overall Satisfaction		1.190	0.313	0.002	–
Viewpoints Study					
Diversity	Experimental Condition	**31.774**	**0.000**	**0.186**	**L**
Transparency		**21.751**	**0.000**	**0.133**	**M**
Balance		**17.514**	**0.000**	**0.109**	**M**
Overall Satisfaction		**17.687**	**0.000**	**0.110**	**M**

Dependent Variable	Explanatory Variables	*p*-value
Answerability Study		
Overall Satisfaction	Familiarity	0.248
	Factual Correctness	0.069
	Confidence in Answer Accuracy	**0.012**
Viewpoints Study		
Overall Satisfaction	Familiarity	0.972
	Diversity	0.209
	Transparency	0.436
	Balance	**0.003**

⇒ simple source attribution is not enough to ensure effective interaction with the system