# Recontextualize, Revise and Retrieve

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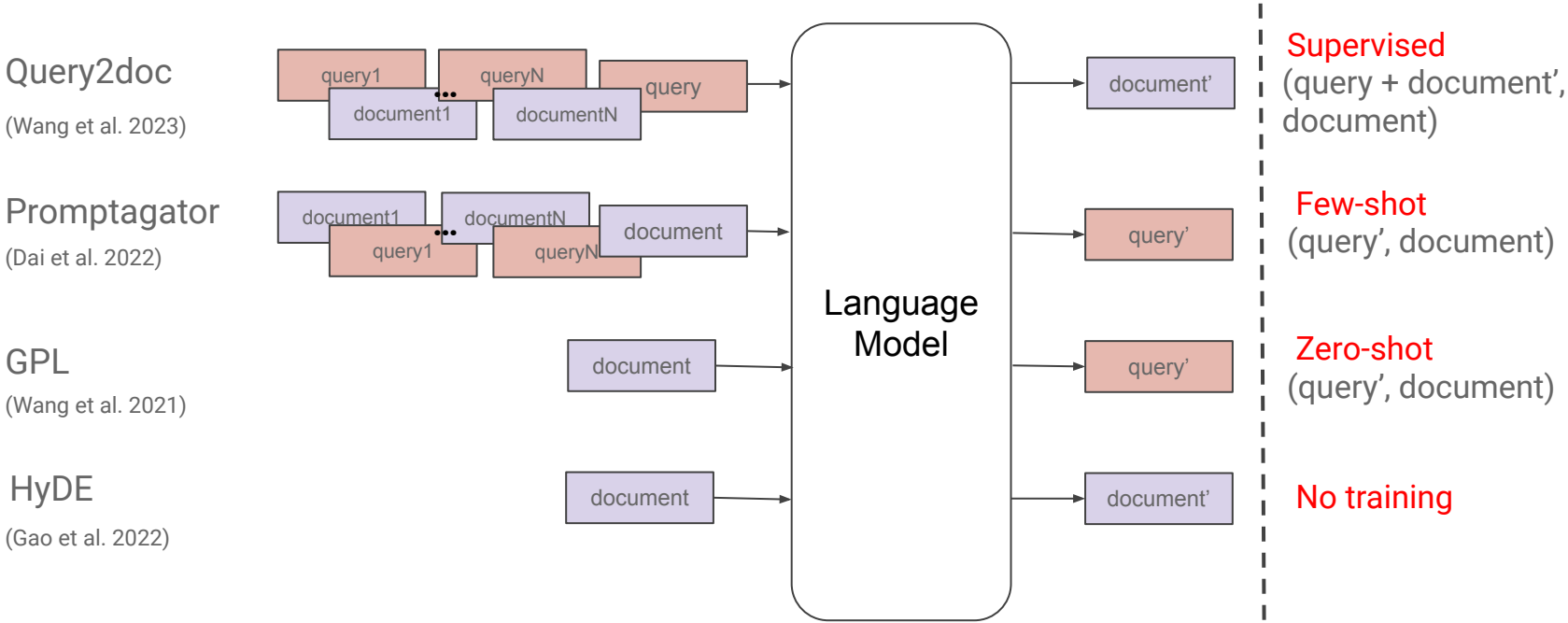
# Problem Formulation

# LM-based Retrieval

- Recent studies involve language models in retrieval
  - Applied before training retriever models
  - Query expansion / Data augmentation / Domain Transfer



# Reliability on generated outputs

- Several papers report the errors in generated outputs of language model

| | |
|---|---|
| query | who sings monk theme song |
| LLM generation | The theme song for the television show Monk is entitled "**It's a Jungle Out There**" and is sung by American singer-songwriter **Randy Newman**. The song was written specifically for the show, and *it has been used as the theme song since the series premiered in 2002*. It has been praised by critics and fans alike and is often regarded as one of the best theme songs in television history. |
| Groundtruth | exists and is an alternate of. The Monk theme song is **It's a Jungle Out There** by **Randy Newman**. The Monk theme song is **It's a Jungle Out There** by **Randy Newman**. |

Type 1 : External error

| | |
|---|---|
| query | trumbull marriott fax number |
| LLM generation | The fax number for the Trumbull Marriott Shelton is **203-378**-*4444*. |
| Groundtruth | Business name: Trumbull Marriott Merritt Parkway; Address: 180 Hawley Lane Trumbull, Connecticut 06611; Phone number: 203-378-4958; Fax number: **203-378**-1400; Business hours: 24; Credit cards accepted: Yes; Number of employees: 10-19; Map: |

Type 2 : Internal error

- Hyde: The generated document *is not* real, can and is likely to be ungrounded factually. We *only* require it to capture **relevance pattern**.
- Query2doc: Although such errors may appear subtle and difficult to verify, they pose a significant challenge to building **trustworthy systems** using LLMs.

💡 Can't we revise the generated output by looking the input again, precisely?

# Thorough Examination

- Language Model can capture internal errors and revise

FLAN-T5-xl

Input

T prompt

Revise query if it contains errors based on passage. passage: Business name: Trumbull Marriott Merritt Parkway; Address: 180 Hawley Lane Trumbull, Connecticut 06611; Phone number: 203-378-4958; Fax number: 203-378-1400; Business hours: 24; Credit cards accepted: Yes; Number of employees: 10-19; Map: query: The fax number for the Trumbull Marriott Shelton is 203-378-4444.

Prompt to send to FLAN-T5.

Output

The fax number for the Trumbull Marriott Merritt Parkway is 203-378-1400.

Generated in 1.70 seconds

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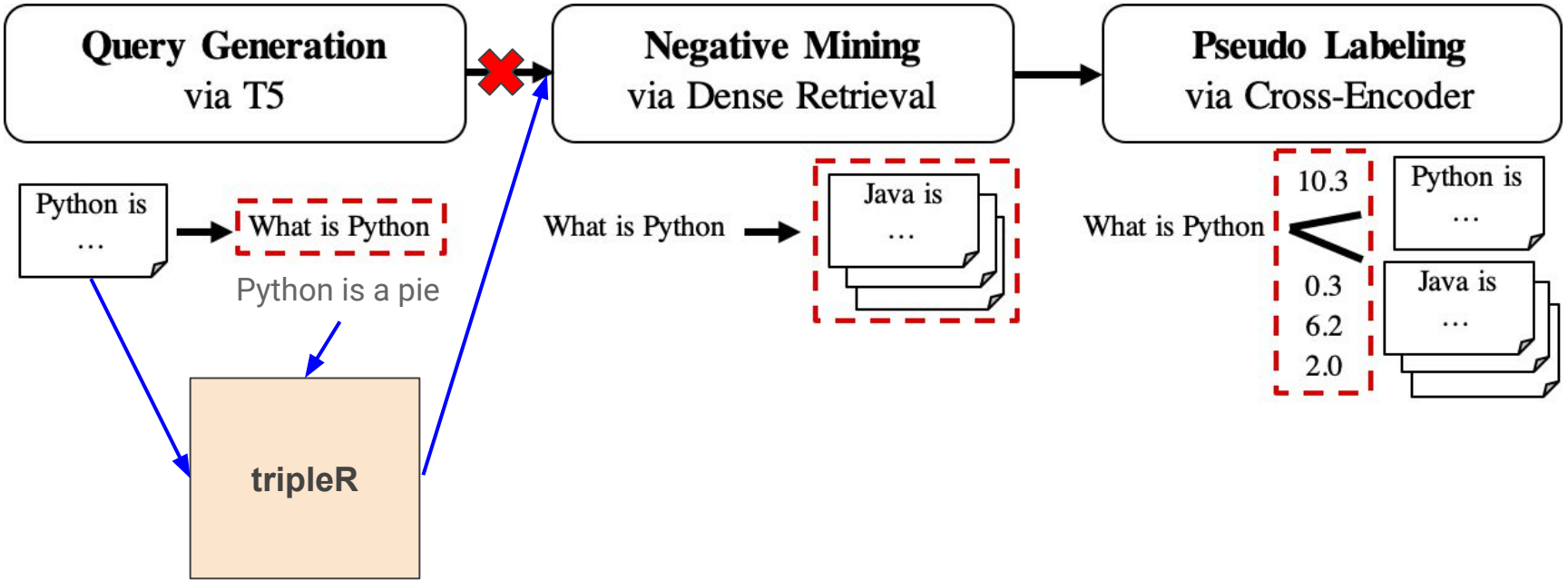
ChatGPT

Revise query if it contains errors based on passage. passage: Business name: Trumbull Marriott Merritt Parkway; Address: 180 Hawley Lane Trumbull, Connecticut 06611; Phone number: 203-378-4958; Fax number: 203-378-1400; Business hours: 24; Credit cards accepted: Yes; Number of employees: 10-19; Map: query: The fax number for the Trumbull Marriott Shelton is 203-378-4444.

Query: The fax number for the Trumbull Marriott Merritt Parkway is 203-378-1400.

# Recontextualize, Revise and Retrieve

- To revise the pseudo-document, we need the original document
- GPL as our baseline, since it doesn't involve LLM, which is limited for project



# Methods

# Training Details

- BeIR : Widely used benchmark containing 18 IR datasets
- We use 3 dataset which have the smallest corpus sizes
  - Arguana : Argument retrieval (argument : counter argument)
  - NFCorpus : Bio-Medical IR (article : query)
  - Scifact : Scientific fact-checking (passage : finding)

- We modify GPL training step from 140K to 70K
- We modify |corpus_size| x qpp from 250K to 100K
- We don't use TSDAE nor TAS-B method

- We report nDCG@10 and MRR@10 as evaluation metric, following Wang et al. 2023

- All codes and results are publicly available (https://github.com/lilys012/tripleR)

# Proposed Methods (T5)

- Query Expansion by Prompting LLMs (Jagerman et al. 2023)
  - Larger FLAN-T5 models yield better performance in sparse retrieval; flan-ul2 (20B)
  - v1) Generate with FLAN-T5-xl + task-specific prompt following Dai et al. 2022
- LMCor (Vernikos et al. 2023)
  - T5-base (250M) can correct grammatical errors in outputs of LLM; PaLM (62B)
  - v2) Generate with T5-base, then revise with FLAN-T5-xl

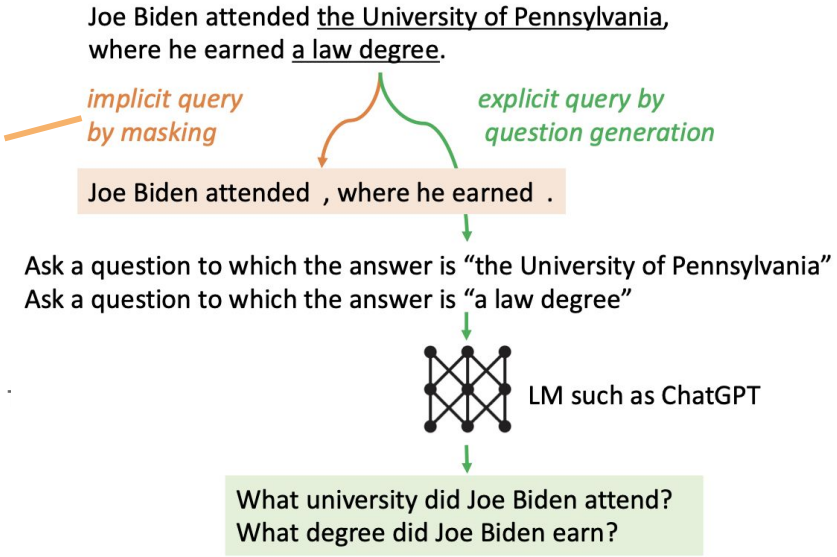
| Dataset | Arguana | | NFCorpus | | Scifact | |
|---|---|---|---|---|---|---|
| Method | nDCG@10 | MRR@10 | nDCG@10 | MRR@10 | nDCG@10 | MRR@10 |
| GPL | **49.6** | **41.1** | **32.8** | 51.8 | 64.1 | 60.9 |
| v1 | 49.7 | 41.0 | 32.0 | **52.1** | **65.9** | **63.0** |
| v2 | 36.0 | 27.5 | - | - | 57.2 | 53.7 |

➔ FLAN-T5-xl is not enough to capture context of long passages

➔ Maybe we need to enlarge our model to 20B~175B, unrealistic 😭

# Proposed Methods (BERT)

- FLARE (Jiang et al. 2023)
  - Use confidence of output tokens to revise generated texts for text generation
  - v3) mask if confidence < 0.8 and random < 0.4
  - v4) replace random 1 token with [MASK]
  - v5) replace tokens with [MASK]
    - Then feed (pseudo-doc, [SEP], document) to BERT
    - Fill [MASK] to recontextualize



# Proposed Methods (Ensemble)

- Query2doc (Wang et al. 2023)
  - pseudo-document / recontextualized pseudo-document
  - Revise ~~original query~~ by concatenating ~~pseudo-document~~
  - v6) initial pseudo-document + v3 (erase)
  - v7) initial pseudo-document + v5 (replace)

> **Dense Retrieval** The new query $q^+$ is a simple concatenation of the original query $q$ and the pseudo-document $d'$ separated by [SEP]:
>
> $$q^+ = \text{concat}(q,\ [\text{SEP}],\ d') \quad (2)$$

- v8) v3 (erase) + v2 (flan-t5-xl revision)
  - Only experimented on arguana dataset due to resource issue

# Results

- Retrieve results
  - Arguana : v8 emphasizes important terms for counter argument
    - why are animals less eco friendly [SEP] less eco friendly
  - NFCorpus : specific nouns are critical, so doesn't depend on particular method
    - apobec3g is an innate virus. [SEP] apobec3g innate virus.
  - Scifact : transfers msmarco query-like style to finding-like style
    - what mri is used to measure white matter -> diffusion defects in preterm cerebral white matter

| Dataset | Arguana | | NFCorpus | | Scifact | |
|---|---|---|---|---|---|---|
| Method | nDCG@10 | MRR@10 | nDCG@10 | MRR@10 | nDCG@10 | MRR@10 |
| GPL | 47.9 | 39.4 | 32.2 | 51.1 | 64.1 | 60.9 |
| v3 | 48.5 | 39.9 | **32.3** | 51.5 | 64.5 | 61.3 |
| v4 | 49.1 | 40.5 | 32.2 | **52.1** | 64.2 | 61.0 |
| v5 | 48.3 | 39.7 | 32.0 | 51.7 | **65.2** | **61.9** |
| v6 | 51.6 | 43.2 | 32.2 | 51.7 | 64.2 | 60.6 |
| v7 | 50.1 | 41.5 | 31.9 | 51.8 | 64.6 | 61.7 |
| v8 | **53.9** | **45.2** | - | - | - | - |

# Conclusion

- Our contributions are as follows:
  - We addressed current problems on LM based retrieval
  - We proposed tripleR, novel methods on recontextualizing and revising for dense retrieval
  - We conducted extensive experiments and achieved better performance than the original paper
- Future study
  - Exploit large language models
  - Word-level masking
  - Experiment on other retrieval models or dataset
  - Domain transfer

# References


- Query2doc (Wang, Liang et al. “Query2doc: Query Expansion with Large Language Models.” *ArXiv*abs/2303.07678 (2023): n. pag.)
- Promptagator (Dai, Zhuyun et al. “Promptagator: Few-shot Dense Retrieval From 8 Examples.” *ArXiv*abs/2209.11755 (2022): n. pag.)
- GPL (Wang, Kexin et al. “GPL: Generative Pseudo Labeling for Unsupervised Domain Adaptation of Dense Retrieval.” *ArXiv* abs/2112.07577 (2021): n. pag.)
- HyDE (Gao, Luyu et al. “Precise Zero-Shot Dense Retrieval without Relevance Labels.” *ArXiv*abs/2212.10496 (2022): n. pag.)
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- BEIR (Thakur, Nandan et al. “BEIR: A Heterogenous Benchmark for Zero-shot Evaluation of Information Retrieval Models.” *ArXiv* abs/2104.08663 (2021): n. pag.)