# RMIT-ADM+S at the SIGIR 2025 LiveRAG Challenge
# G-RAG: Generation-Retrieval-Augmented Generation

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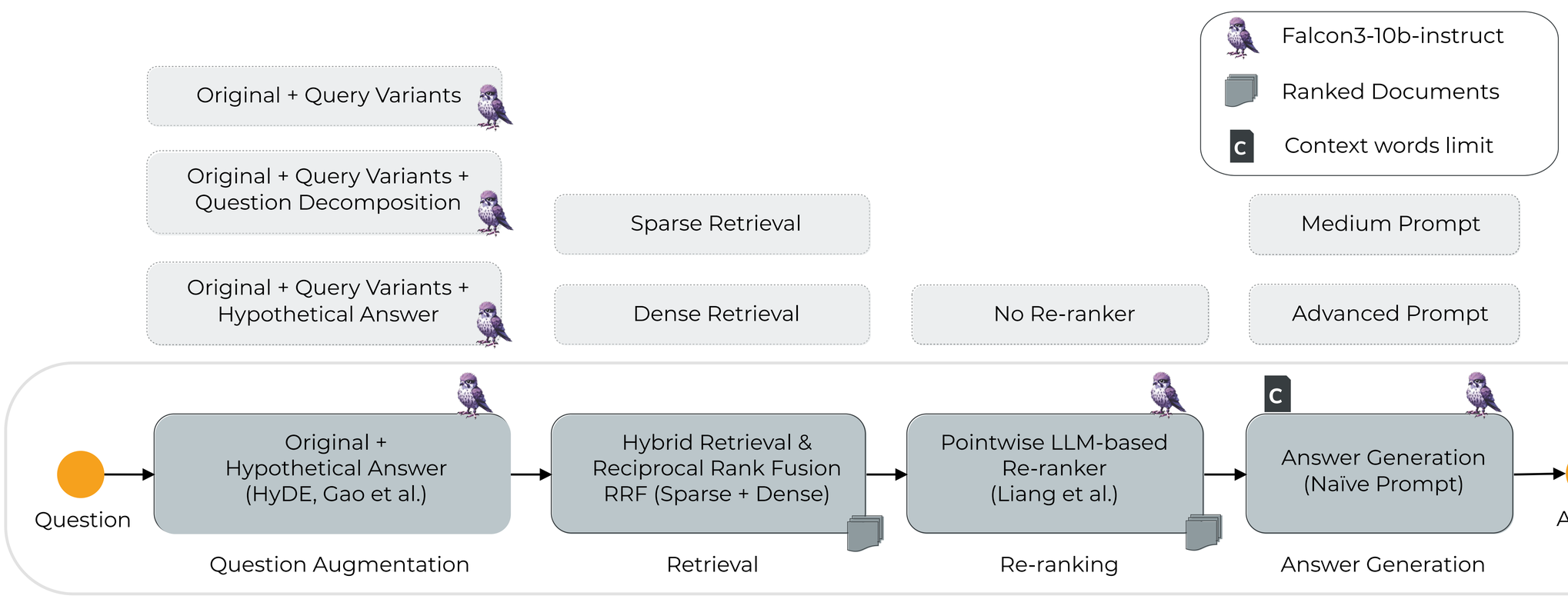
SIGIR 2025 LiveRAG Challenge

github.com/rmit-ir/GRAG-LiveRAG


## In-House Evaluation

### Question-Answer (QA) Pairs Generation

- QA pairs are generated by **DataMorgana**.
- Questions are based on **up to two** documents.
- Generated varying size Q&A sets.

### Manual Examination

- Reviewing Q&A pairs manually revealed some general challenges, such as "ryse" being mis-corrected to "rise." It was also used to adjust the evaluation prompts to agree with our (human) judgments.

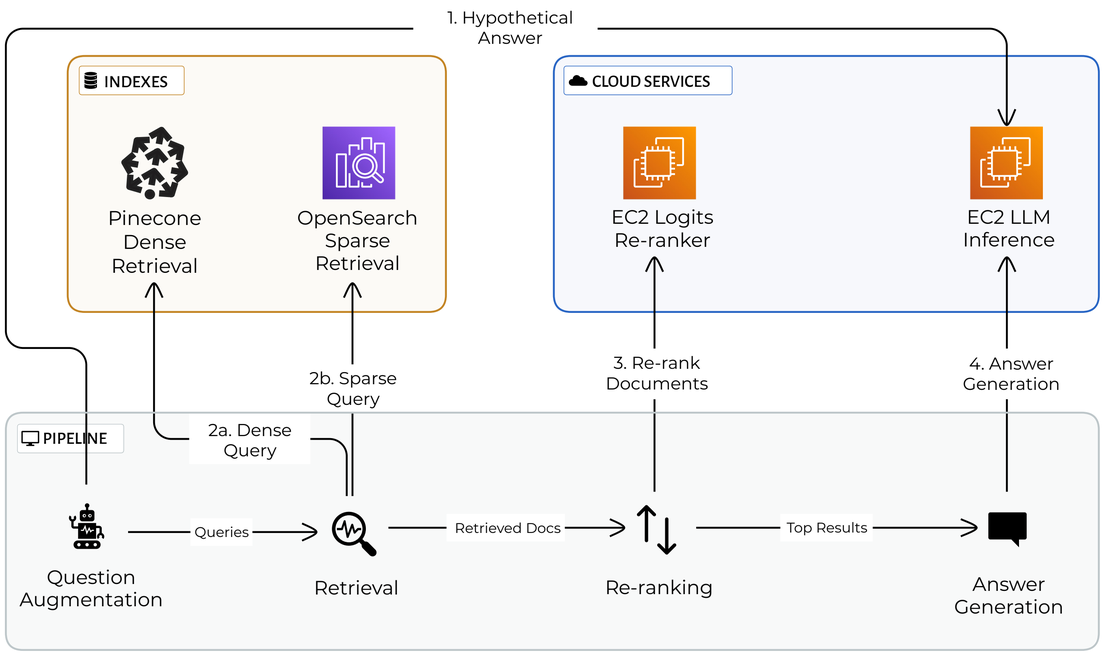
### LLM-as-a-Judge

- Inline with the challenge evaluation, we used **Claude Sonnet-3.5**.
- To assess **Correctness** (Relevance), reference answers from DataMorgana were used.

### Automated Evaluation Pipeline

- **Grid of Points (GoP)** for obtaining *champion* system configuration.
- **ANOVA** for directing the further *system optimization*.

## Pipeline and Services




- Parallelization: Parallel point-wise re-ranker for faster retrieval.
- Modular architecture: Each component is configurable and replaceable.
- Portable Components: An LLM re-ranker based on FastAPI and Transformers, and a vLLM-based LLM inference service deployed on an EC2 instance.
- All scripts and code are available.

## Results Analysis

### N-Way ANOVA Result

| Factor | SumSq | DF | MeanSq | F | PR(>F) | Partial $\omega^2$ |
|---|---|---|---|---|---|---|
| Question Augmentation | 0.319 | 2 | 0.160 | 125.692 | **<0.001*** | 0.757 |
| Query Variants Generation Prompt : Retrieval | 0.006 | 1 | 0.006 | 4.910 | **0.030*** | 0.047 |
| Query Variants Generation Prompt | 0.003 | 1 | 0.003 | 2.389 | 0.126 | 0.017 |
| Context Words Length Limits | 0.003 | 1 | 0.003 | 2.005 | 0.161 | 0.013 |
| Retrieval | 0.002 | 1 | 0.002 | 1.863 | 0.176 | 0.011 |
| Number of Documents Retrieved : Retrieval | 0.002 | 1 | 0.002 | 1.610 | 0.208 | 0.008 |
| Answer Generation Prompt | 0.001 | 1 | 0.001 | 1.106 | 0.296 | 0.001 |
| Context Words Len. Limits : Question Augmentation | 0.001 | 2 | 0.000 | 0.326 | 0.723 | -0.017 |
| Answer Gen. Prompt : Question Augmentation | 0.000 | 2 | 0.000 | 0.157 | 0.855 | -0.022 |
| Context Words Len. Limits : Answer Gen. Prompt | 0.000 | 1 | 0.000 | 0.049 | 0.825 | -0.012 |
| Query Var. Gen. Prompt : Num. of Docs. Retrieved | 0.000 | 1 | 0.000 | 0.023 | 0.881 | -0.013 |
| Number of Documents Retrieved | 0.000 | 1 | 0.000 | 0.012 | 0.914 | -0.013 |
| Residual | 0.098 | 77 | 0.001 | – | – | – |

* indicates statistically significant differences

- The 'Question Augmentation' component **significantly** impacts system performance.
- 'Query Variants Gen. Prompt' and 'Retrieval' jointly affect performance, but individually, neither has a significant effect.
- *No augmentation* is included in the *Champion* configuration based on GoP.
- Optimizing the system focused on improving mechanisms related to 'Question Augmentation.'

### HyDE Implementation

| RAG System | Correctness (Relevance) | Faithfulness |
|---|---|---|
| G-RAG (Champion + HyDE) | **8** | 12 |
| GoP Champion | 7 | **14** |
| Ties | 85 | 74 |

## Key Takeaways

- Test driven design
  - Fit for purpose: alignment with the goal
  - Statistical analysis through all stages
  - Enabled to prioritize parameter optimization
- Diverse team with complementary skills

Future work:
- Dynamic question augmentation
- Distillation and fine-tuning of smaller LLMs

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