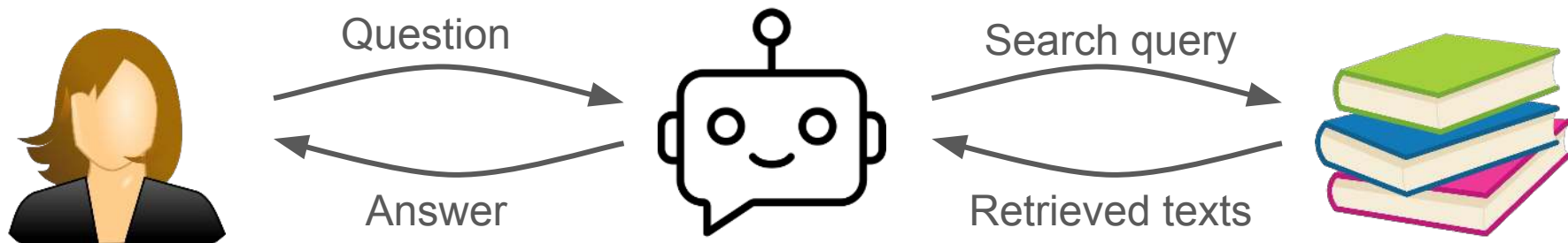


Retrieval-based Question Answering with Passage Expansion using a Knowledge Graph

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COLING 2024

Retrieval Augmented Generation (RAG)



Search methods:

- Keywords
(*sparse*)
- Embeddings
(*dense*)

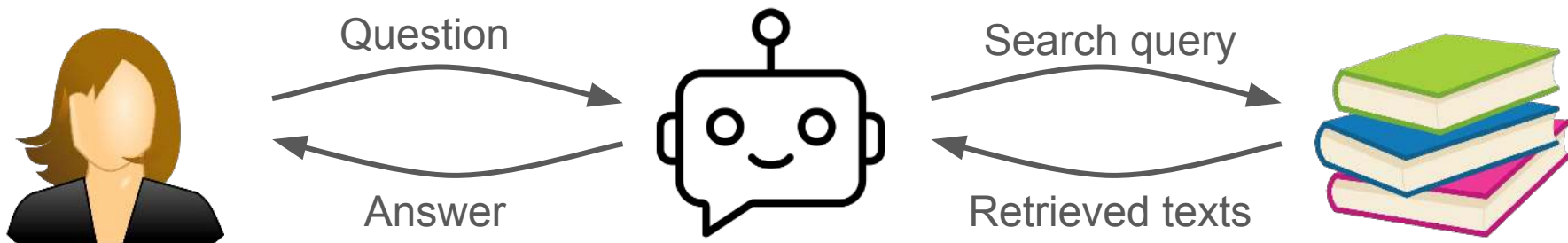


Works better for long-tail,
entity-centric questions?



Lots of research interest,
but underperforms on long tail!

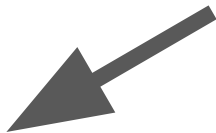
Our proposed solution



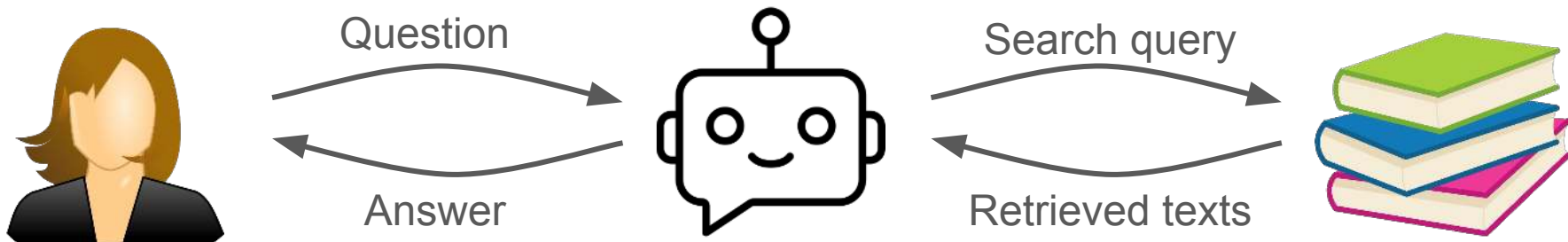
Search methods:

- Keywords
(*sparse*)
- Embeddings
(*dense*)
- **Knowledge Graph**
(*semantic*)

What if the answer is known in the KG?



Our proposed solution



Where did Ludwig Dill die?

Steps

1. Link subject entity
2. Predict relation
3. Look up object in KG
4. Add texts about object

Ludwig Dill → Q880914

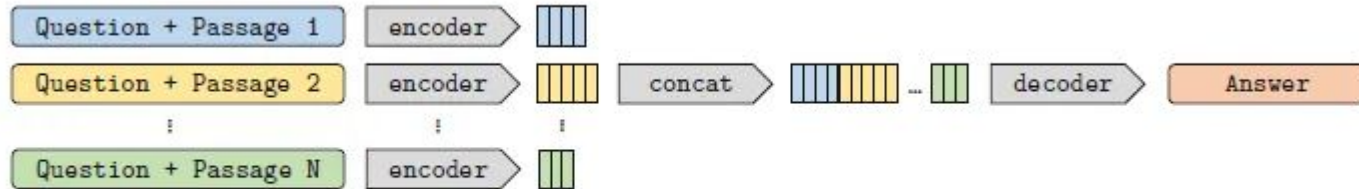
→ place of death (P20)

⟨Q880914, P20, Q1040⟩ → Karlsruhe

Wilhelm Franz Karl Ludwig Dill (2 February 1848, [Gernsbach](#) - 24 October 1940, [Karlsruhe](#)) was a German ship and landscape painter who was a founding member of the [Munich Secession](#).

Experimental Details

- **Entity Linking:** Entity Linking in Questions (ELQ; Meta AI @ EMNLP 2020)
- **Relation Extraction** (distantly supervised BERT classifier)
- **Dense Passage Retrieval (DPR)**
- **KG-based Retrieval**
 - WAT: Wikipedia Article Title = add passages in object's article
 - WHY: Wikipedia Hyperlink = add passages that link to object
- **Fusion in Decoder (FiD)**



Dataset:

Natural Questions

Example 1

Question: what color was john wilkes booth's hair

Wikipedia Page: John_Wilkes_Booth

Long answer: Some critics called Booth “the handsomest man in America” and a “natural genius”, and noted his having an “astounding memory”; others were mixed in their estimation of his acting. He stood 5 feet 8 inches (1.73 m) tall, had jet-black hair , and was lean and athletic. Noted Civil War reporter George Alfred Townsend described him as a “muscular, perfect man” with “curling hair, like a Corinthian capital”.

Short answer: jet-black

Example 2

Question: can you make and receive calls in airplane mode

Wikipedia Page: Airplane_mode

Long answer: Airplane mode, aeroplane mode, flight mode, offline mode, or standalone mode is a setting available on many smartphones, portable computers, and other electronic devices that, when activated, suspends radio-frequency signal transmission by the device, thereby disabling Bluetooth, telephony, and Wi-Fi. GPS may or may not be disabled, because it does not involve transmitting radio waves.

Short answer: BOOLEAN:NO

Example 3

Question: why does queen elizabeth sign her name elizabeth r

Wikipedia Page: Royal_sign-manual

Long answer: The royal sign-manual usually consists of the sovereign's regnal name (without number, if otherwise used), followed by the letter R for Rex (King) or Regina (Queen). Thus, the signs-manual of both Elizabeth I and Elizabeth II read Elizabeth R. When the British monarch was also Emperor or Empress of India, the sign manual ended with R I, for Rex Imperator or Regina Imperatrix (King-Emperor/Queen-Empress).

Short answer: NULL

Dataset: PopQA

1. Sampling knowledge triples

2. Converting triples to questions

▲ (Louisiana, capital of, Baton Rouge)



Q: What is the capital of Louisiana?

A: Baton Rouge

▲ (Kathy Saltzman, occupation, politician)

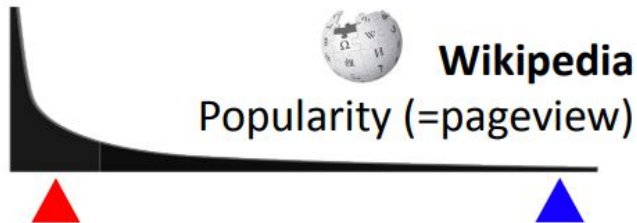


Q: What is Kathy Saltzman's occupation?

A: British

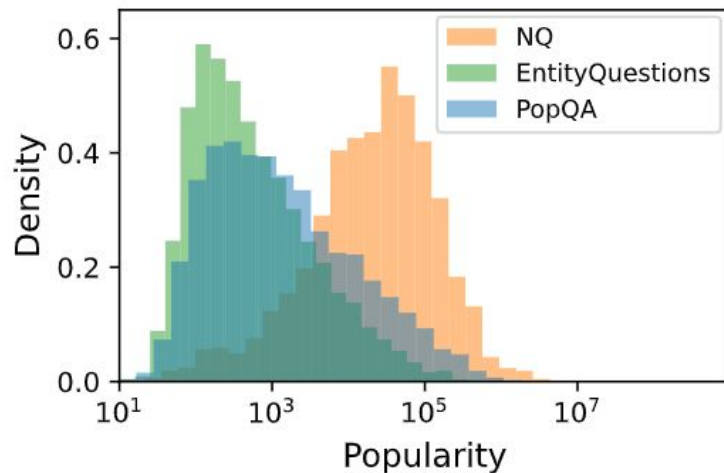


Knowledge triples from Wikidata



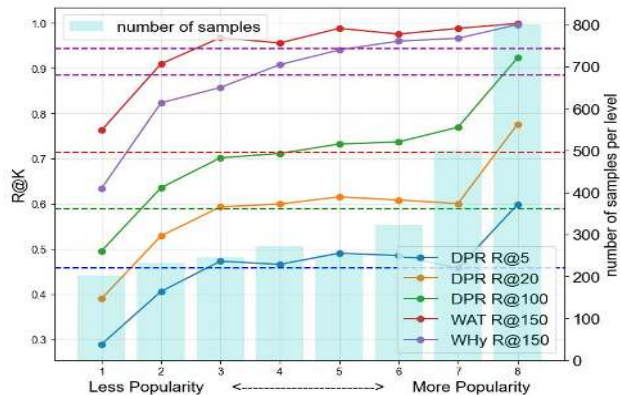
Benchmark Datasets & Relation Extraction

Datasets	Relations	Train	Test	Dev	RE data	RE labels	RE Acc.
PopQA	16	9,997	2,856	1,429	99.8%	16 (no DS)	97%
EntityQuestions	24	176,560	22,075	22,068	70.8%	62 / 149	79%
NaturalQuestions	(natural)	79,168	3,610	8,757	19.3%	63 / 272	74%

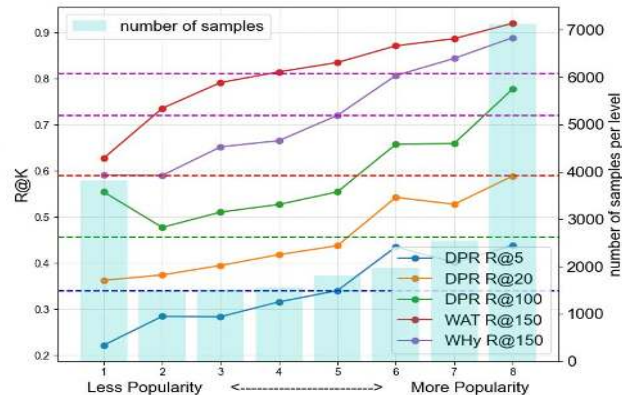


Retrieval performance

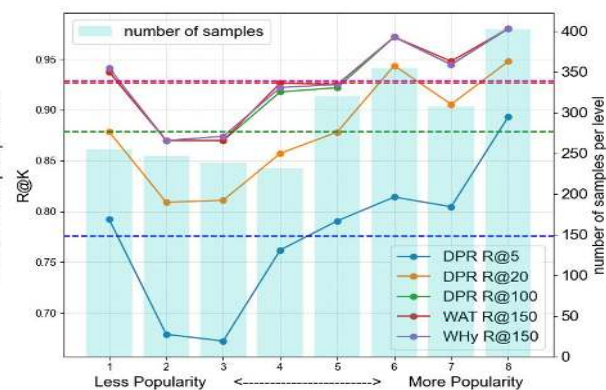
- Mostly, the correct text about popular entities is easier to retrieve
- Our approach only improves performance on the artificial benchmarks



PopQA



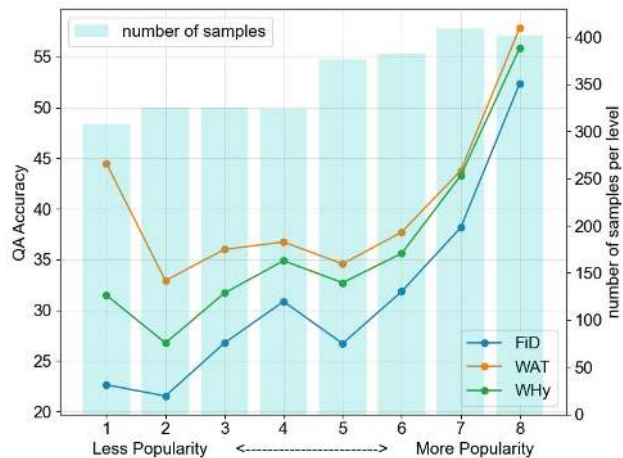
EntityQuestions



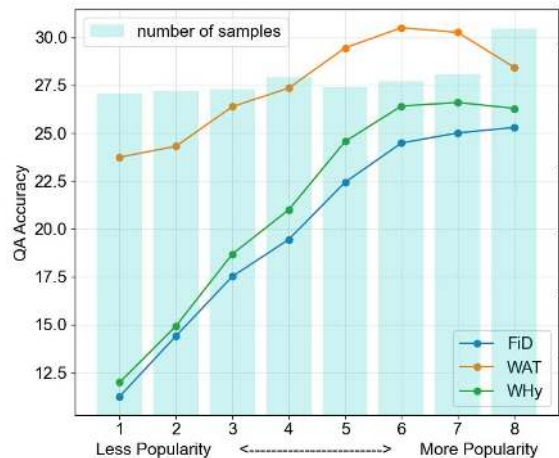
Natural Questions

Impact on decoder performance

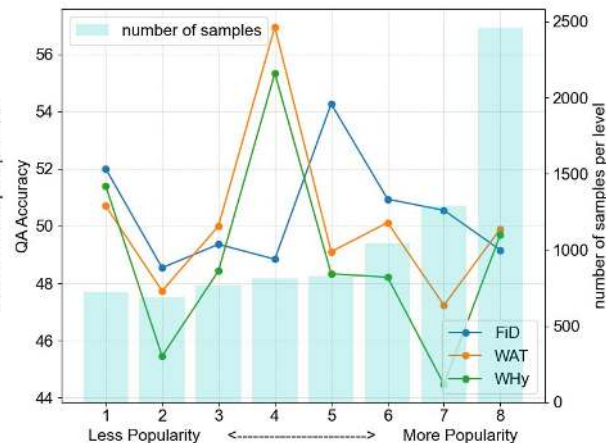
- Mostly, the correct answer about popular entities is easier to generate
- Our approach only improves performance on the artificial benchmarks



PopQA



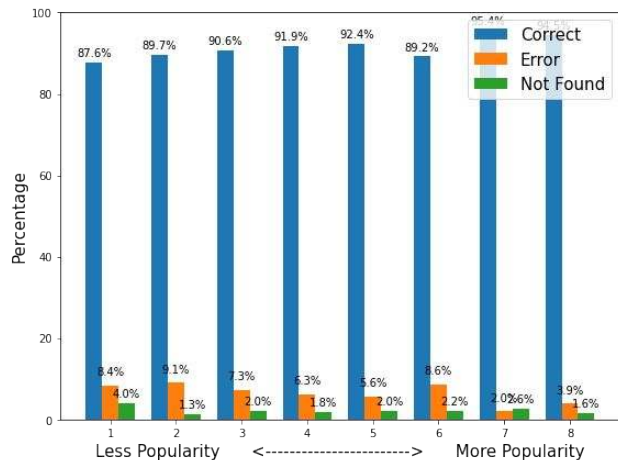
EntityQuestions



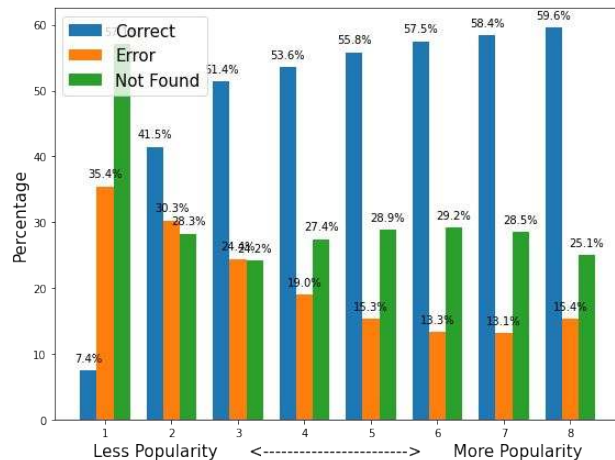
Natural Questions

Performance of object retrieval from KG

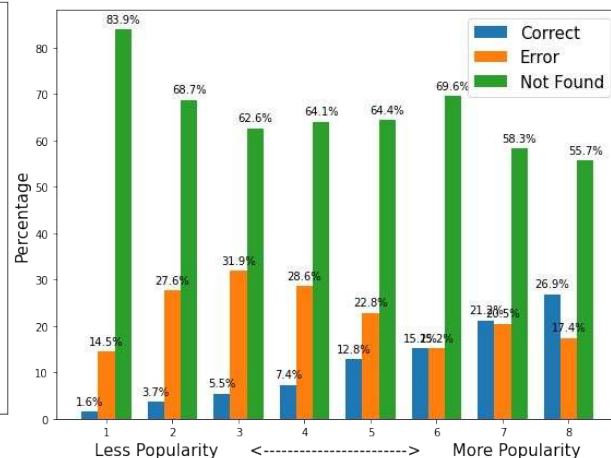
- Mostly, the correct object is easier to retrieve when it's popular
- Our approach only works on the artificial benchmarks



PopQA



EntityQuestions



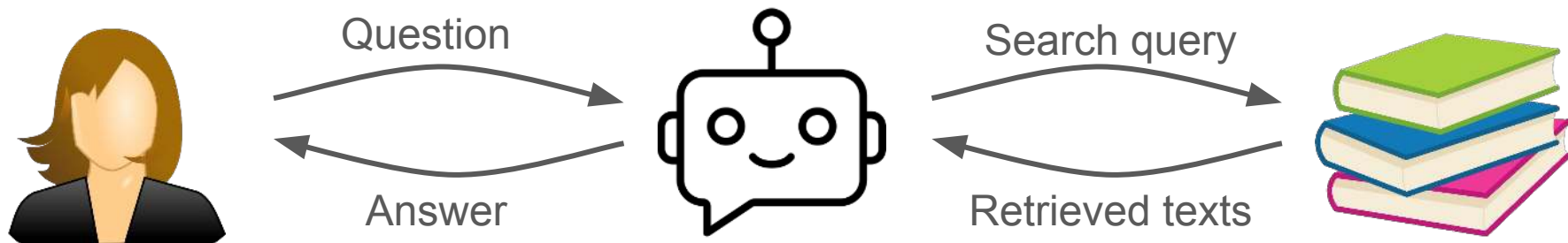
Natural Questions

Error analysis

	Question	Correct Answer	Baseline Answer	Triple	Our Answer	Error Type
1	What music label is You Got My Attention represented by?	Fervent Records	Fervent Records ✓	s: You Got My Attention r: record label o: Fervent Records ✓	eMusic ✗	noisy
2	Who is the author of Before?	Gael Baudino	Gael Baudino ✓	s: Before r: author o: Gael Baudino ✓	Franz Kafka ✗	noisy
3	Who is the author of Black Orchids?	Rex Stout Rex Todhunter Stout	Neil Gaiman ✗	s: Black Orchids r: author o: Rex Stout ✓	Neil Gaiman ✗	weak reader
4	Who sings I want to dance with you?	George Strait	Baby K ✗	s: I Just Want to Dance with You r: performer o: George Strait ✓	Baby K ✗	weak reader
5	Where did the battle of bonhomme richard take place ?	near Flamborough Head	the Isle of Wight ✗	s: Battle of Damme ✗ r: location o: Damme ✗	France ✗	wrong subject
6	Who sings love me tender in princess diaries 2?	Norah Jones Adam Levy	Julie Andrews ✗	s: Prince + Princess 2 ✗ r: cast member o: Dylan Kuo ✗	Julie Andrews ✗	wrong subject
7	When did i'm like a bird come out? (NaturalQuestions)	October 24, 2000	2001 ✗	s: I'm Like a Bird r: performer ✗ o: Nelly Furtado ✗	2001 ✗	wrong relation
8	Where is wake forest located in north carolina? (NaturalQuestions)	78.51889°W, in Franklin and Wake counties, 35.97333°N	Wake Forest, North Carolina ✗	s: Wake Forest, North Carolina r: located in the administrative territorial entity o: Wake County, North Carolina	Wake Forest ✗	complex answer
9	When was the first book made into a movie? (NaturalQuestions)	1924	1952 ✗	s: When Were You Born ✗ r: cast member ✗ o: Margaret Lindsay, Anna May Wong ✗	1952 ✗	general question

Retrieval-based **QA** with Passage Expansion using a **KG**

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Our contribution:

- Evaluation of adding **KG retrieval** to off-the-shelf QA system
- Depends on **Entity Linking & Relation Prediction** components
- Helps **long-tail** performance on **artificial** benchmarks

Future work:

- Better Entity Linking
- Detect entity-centric questions in natural data

Thank you!