UNIVERSITY OF AMSTERDAM

Question Rewriting for Conversational Question Answering

Svitlana Vakulenko

Task: Conversational QA

Q: Where is Xi'an?

A: Shaanxi, China

Q: What is its GDP?

A: 95 Billion USD

Q: What is the share in the province GDP?

A: 41.8%

Task: Conversational QA

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A: Shaanxi, China

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Anaphora

Ellipsis

Approach: Question Rewriting

Q: Where is Xi'an?

A: Shaanxi, China

Q: What is its GDP?

A: 95 Billion USD

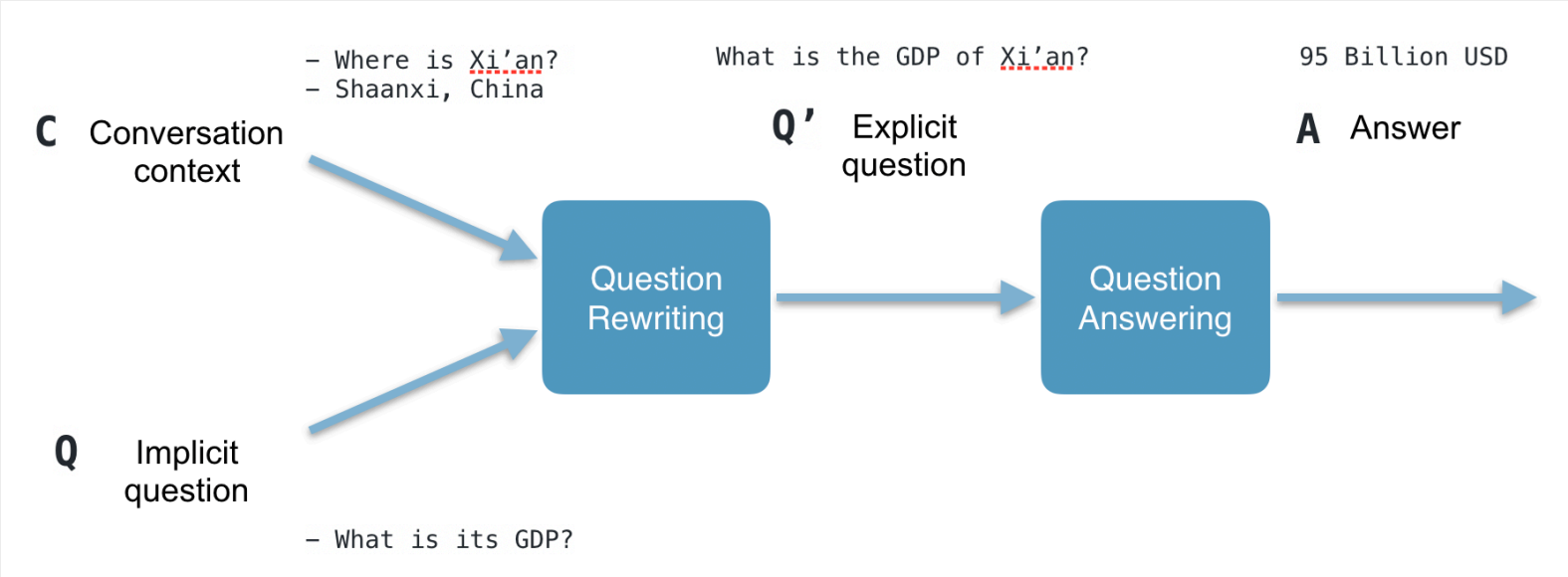
Q: What is the share in the province GDP?

A: 41.8%

What is Xi'an's GDP?

What is the share of Xi'an in the Shaanxi province GDP?

Architecture: Conversational QA



Approach: Unsupervised

- [Mele et al., 2020]

Input: Where is **Xi'an**? <SEP> Shaanxi, China <SEP> What is **its** GDP?
Output: (its, Xian)
QR: What is **Xi'an** GDP?

- co-reference resolution + heuristics
- identify topics as nouns in dependency parses
- identify topic shifts via lexical cues

Approach: Supervised Sequence Generation

- Transformer++ [Vakulenko et al., 2021]

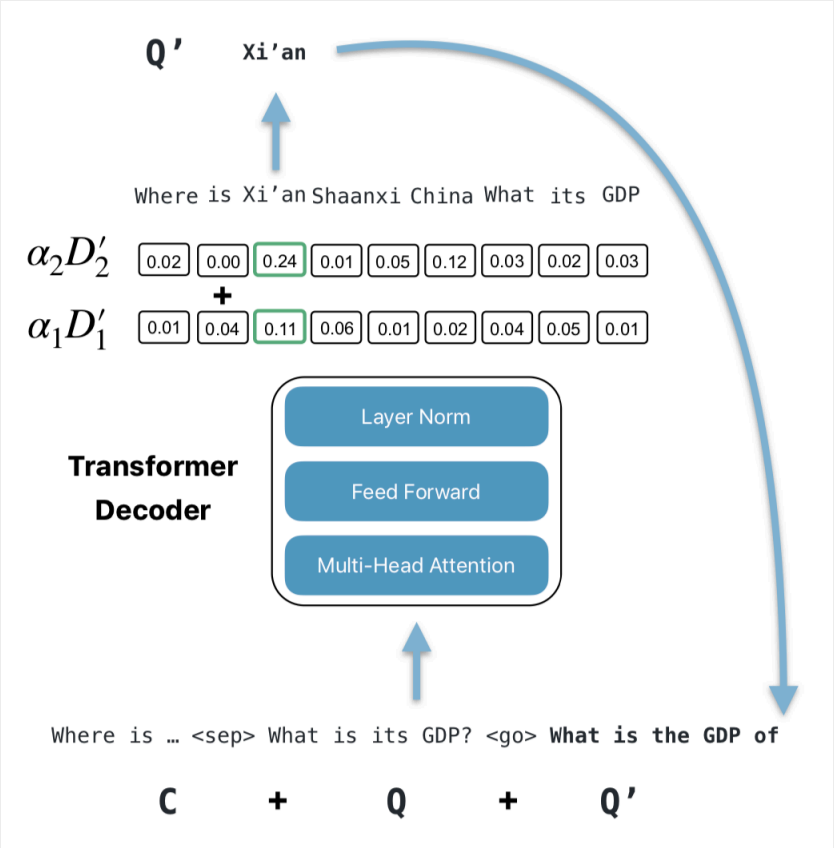
Input: Where is Xi'an? <SEP> Shaanxi, China <SEP> What is its GDP?
Output: What is Xi'an's GDP?

- CANARD 35K conversational questions + rewrites
- fine-tune GPT2

Approach: Supervised Sequence Generation

Transformer++

$$D' = \sum_{i=0}^{m} \alpha_i D'_i$$



Approach: Weakly Supervised Generation

- [Yu et al., 2020]

Input: Where is Xi'an? <SEP> Shaanxi, China <SEP> What is its GDP?
Output: What is Xi'an's GDP?

- MS MARCO 152K sessions -> rule-based/self-learn conversations
- fine-tune GPT2

Approach: Supervised Classification

- QuReTeC [Voskarides et al., 2020]

Input: Where is **Xi'an**? <SEP> Shaanxi, China <SEP> What is its GDP?
Output: 0 0 1 0 0
QR: What is its GDP? **Xi'an**

- CANARD 35K questions
- fine-tune BERT

Results: TREC CAsT 2019

- [Vakulenko et al., 2021]

Table 4: Comparison with the state-of-the-art results reported on the TREC CAsT test set.

Approach	NDCG@3
Mele et al. [21]	0.397
Voskarides et al. [37]	0.476
Yu et al. [41]	0.492
Ours	**0.529**

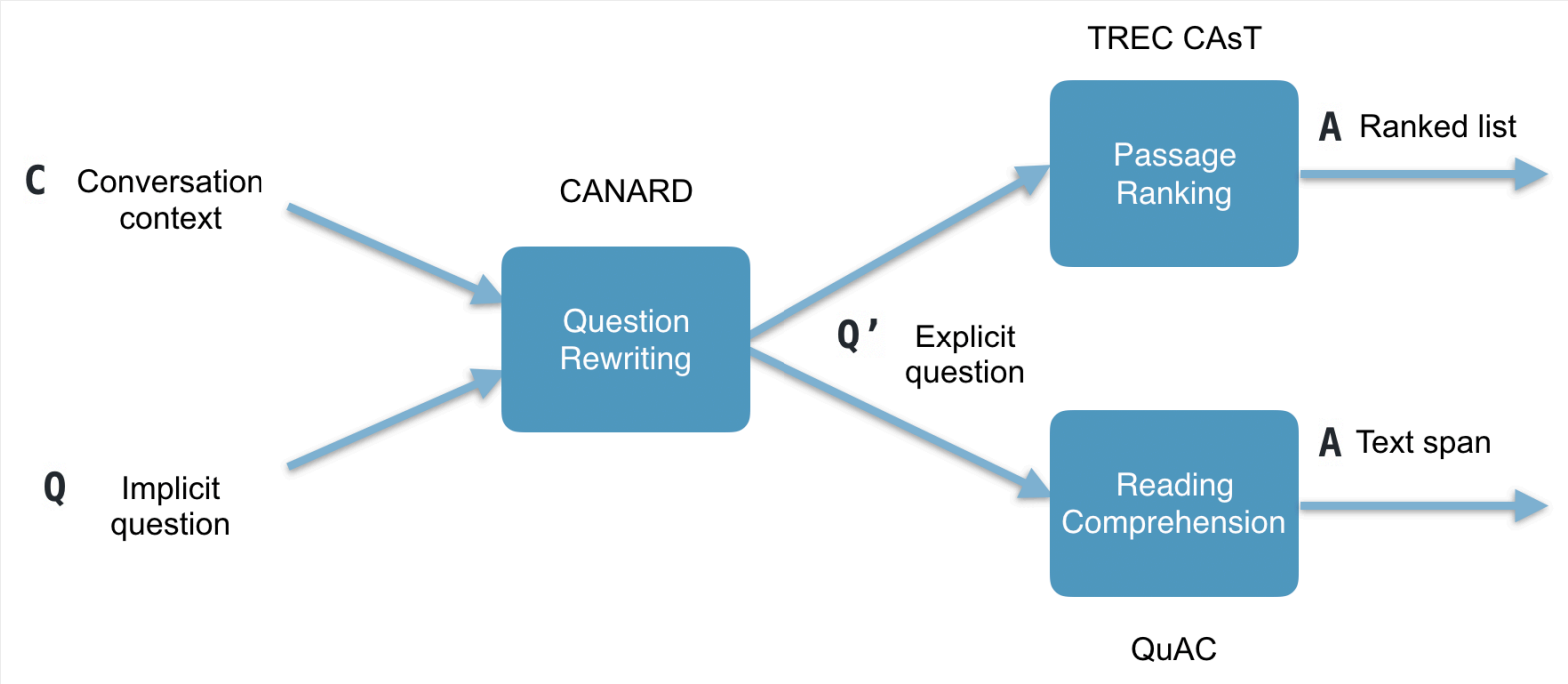
Results: TREC CAsT 2019

- [Vakulenko et al., 2021]

Table 3: Retrieval QA results on the TREC CAsT test set.

QA Input	QA Model	MAP	MRR	NDCG@3
Original	Anserini	0.172	0.403	0.265
Original + 1-DT*	+BERT	0.230	0.535	0.378
Original + 2-DT*		0.245	0.576	0.404
Original + 3-DT*		0.238	0.575	0.401
Co-reference		0.201	0.473	0.316
PointerGenerator		0.183	0.451	0.298
CopyTransformer		0.284	0.628	0.440
Transformer++		**0.341**	**0.716**	**0.529**
Human		0.405	0.879	0.589

Architecture: Conversational QA



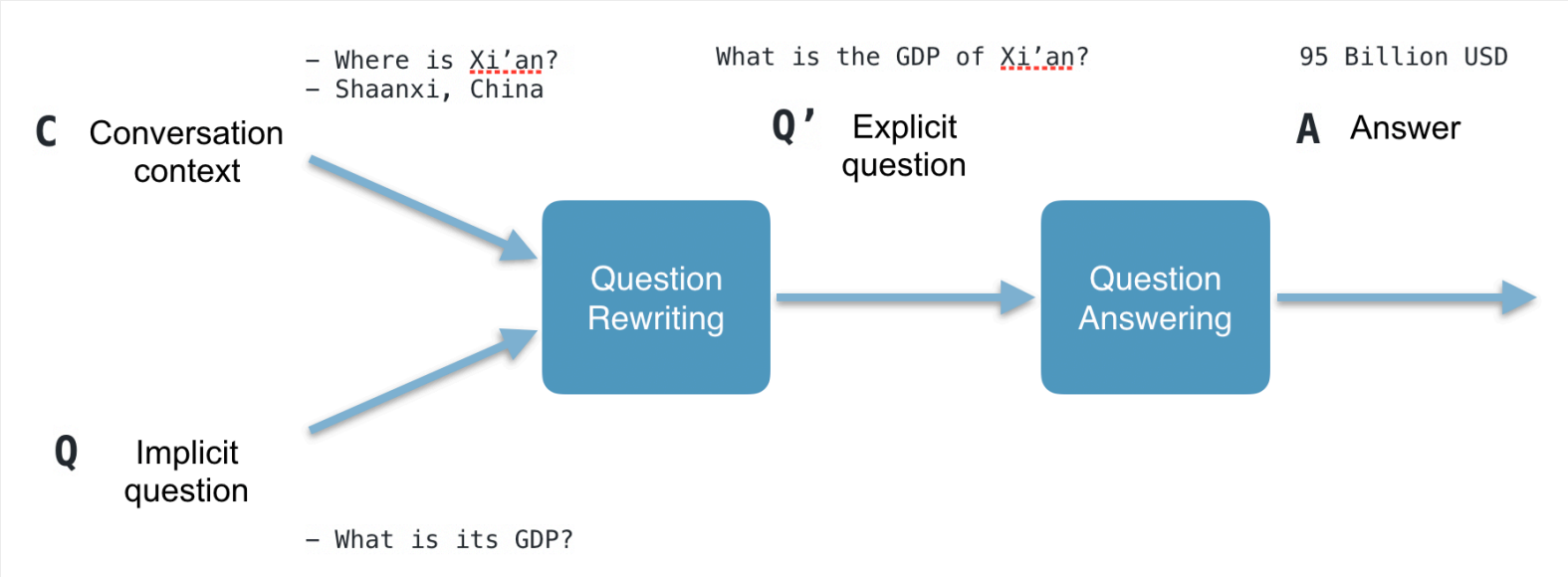
Results: TREC CAsT 2019 & CANARD

- [Vakulenko et al., 2021]

Table 5: Extractive QA results on the CANARD test set. F1 and EM is calculated for both answerable and unanswerable questions, while NA Acc only for unanswerable questions.

QA Input	Training Set	EM	F1	NA Acc
Original	MultiQA →	41.32	54.97	65.84
Original + 1-DT	CANARD-H	43.15	57.03	68.64
Original + 2-DT		42.20	57.33	69.42
Original + 3-DT		43.29	57.87	**71.50**
Co-reference		42.70	57.59	66.20
PointerGenerator		41.93	57.37	63.16
CopyTransformer		42.67	57.62	68.02
Transformer++		**43.39**	**58.16**	68.29
Human		45.40	60.48	70.55

Architecture: Conversational QA



Approach: Error Analysis

	NDCG@3
Original: What types does olive oil contain?	**0**
QR: What types of **fats** does olive oil contain?	**0.9**
Human: What types of **unsaturated fats** does olive oil contain?	**1**

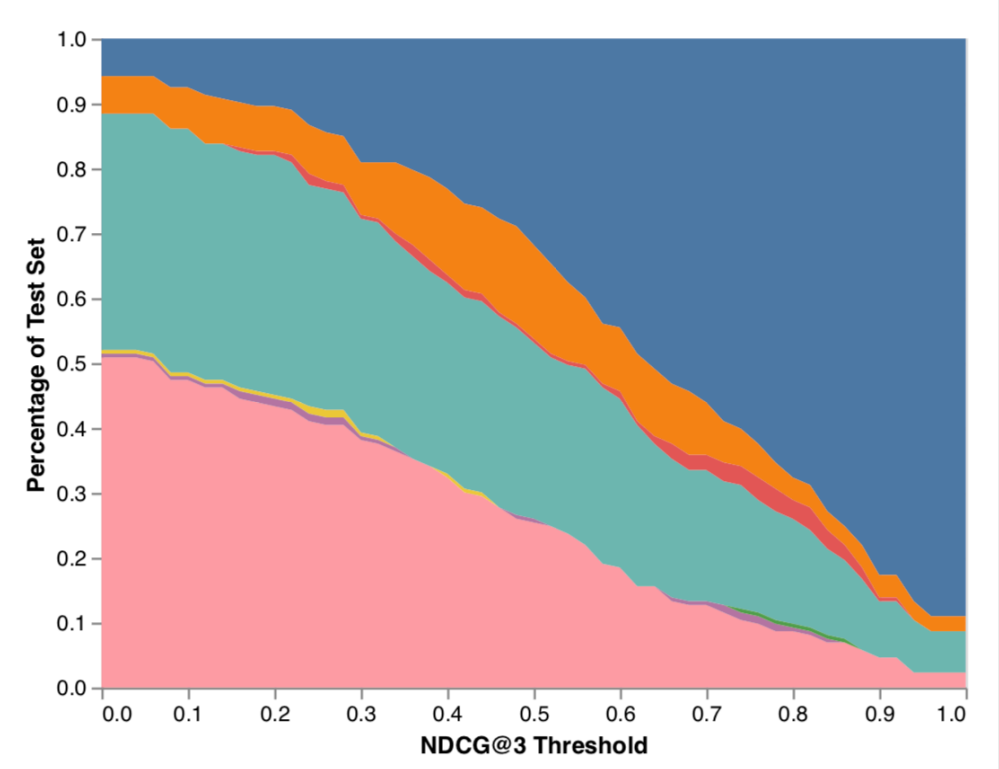
Approach: Error Analysis

Original	QR	Human
×	×	×
✓	×	×
×	✓	×
✓	✓	×
×	×	✓
✓	×	✓
×	✓	✓
✓	✓	✓

NDCG@3

- **Original:** What types does olive oil contain? **0**
- **QR:** What types of **fats** does olive oil contain? **0.9**
- **Human**: What types of unsaturated fats does olive oil contain? **1**

Approach: Error Analysis

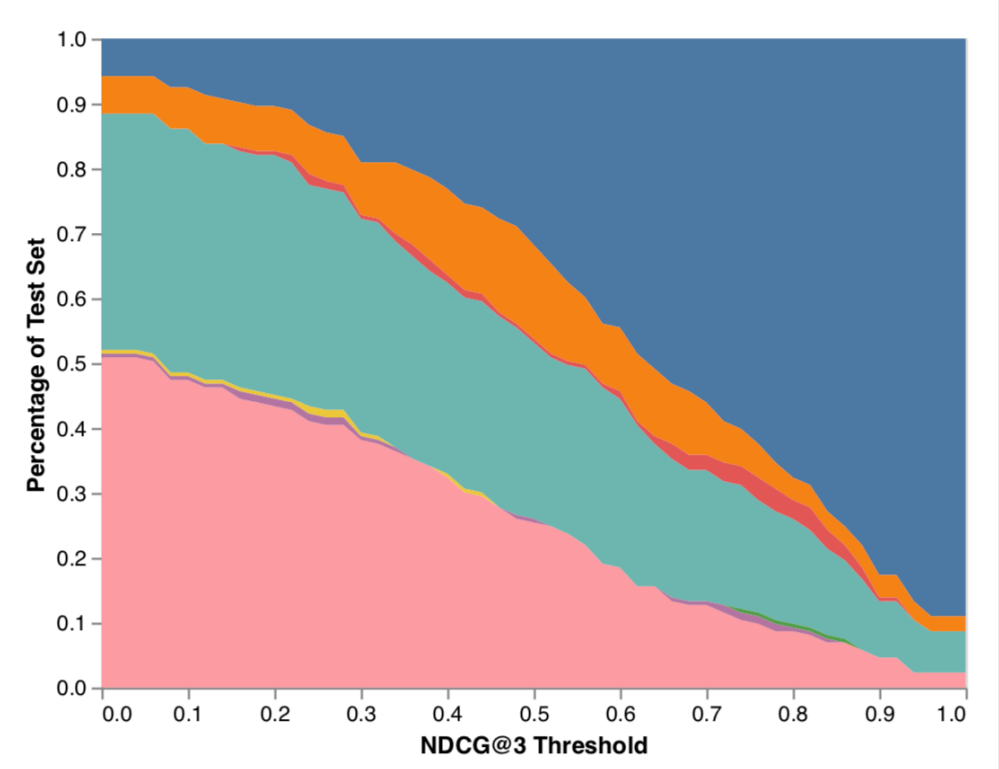


Incorrect ranking

Incorrect resolution

Correct resolution

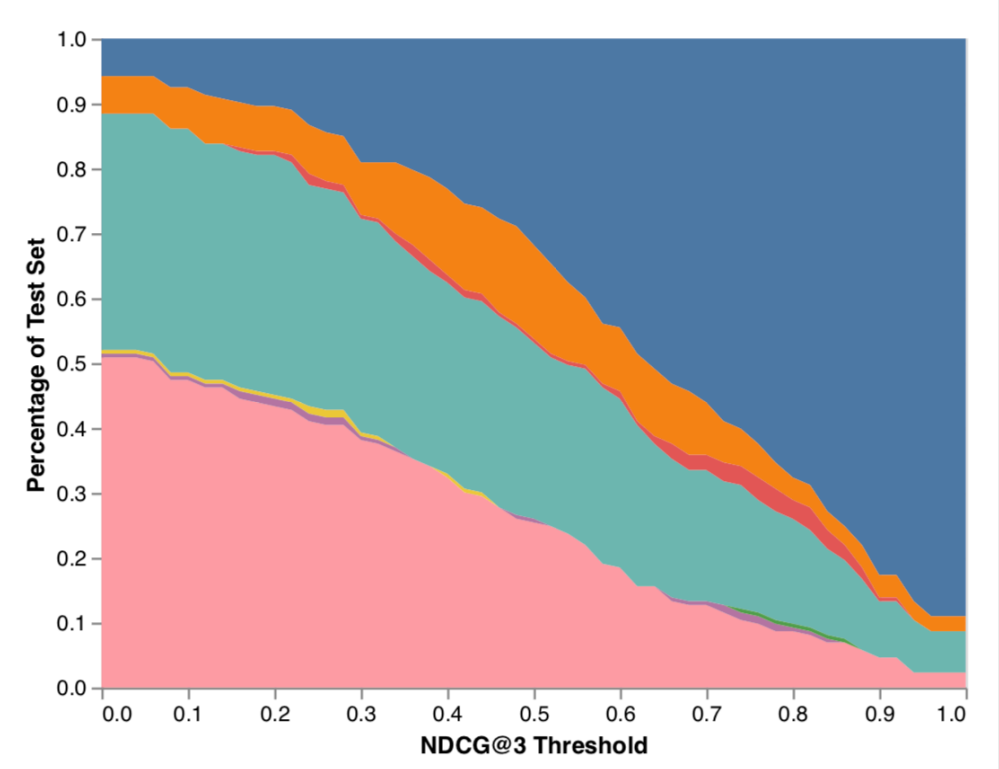
Approach: Error Analysis



Incorrect no resolution

Correct no resolution

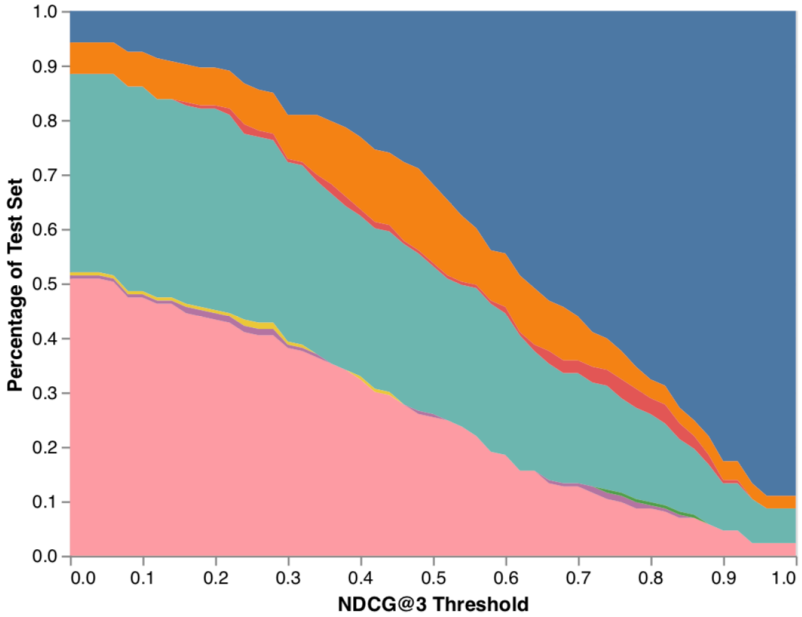
Approach: Error Analysis



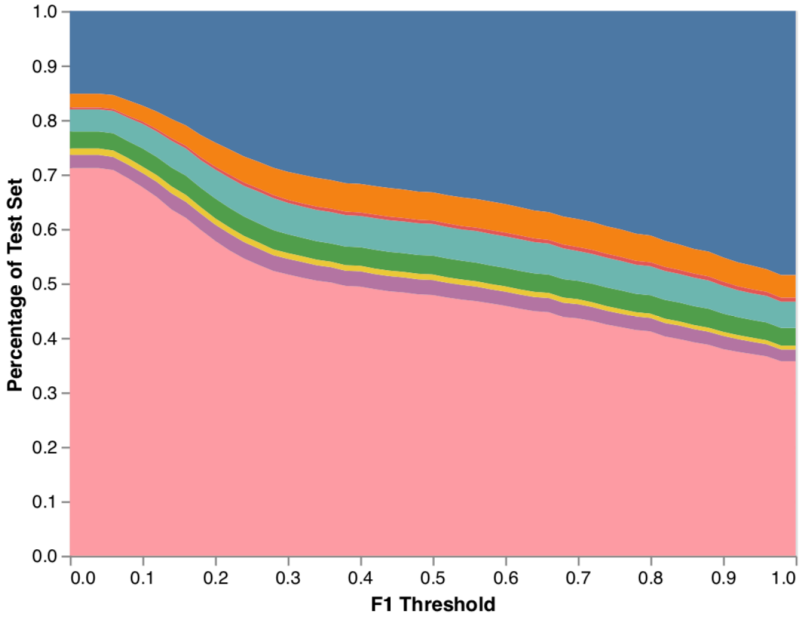
Superhuman resolution

Results: Error Analysis

Passage ranking

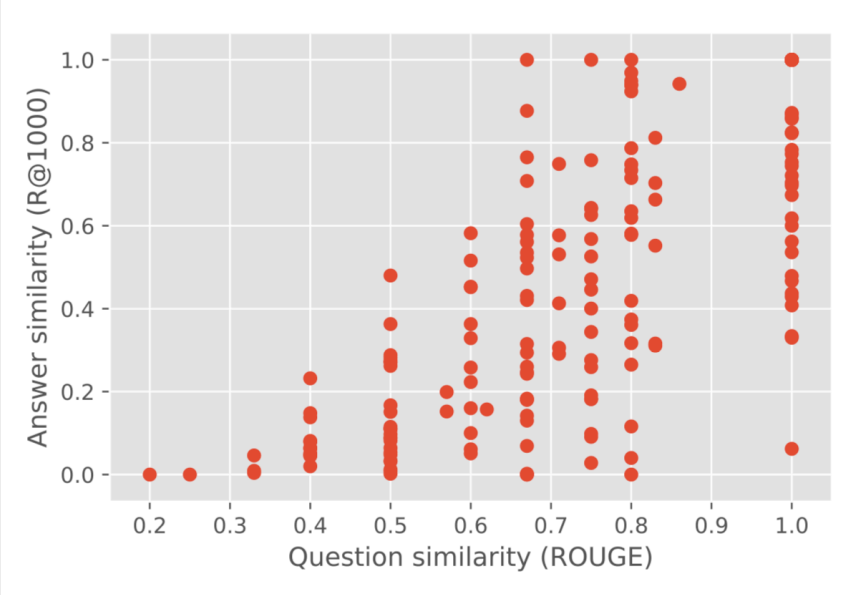


Reading comprehension

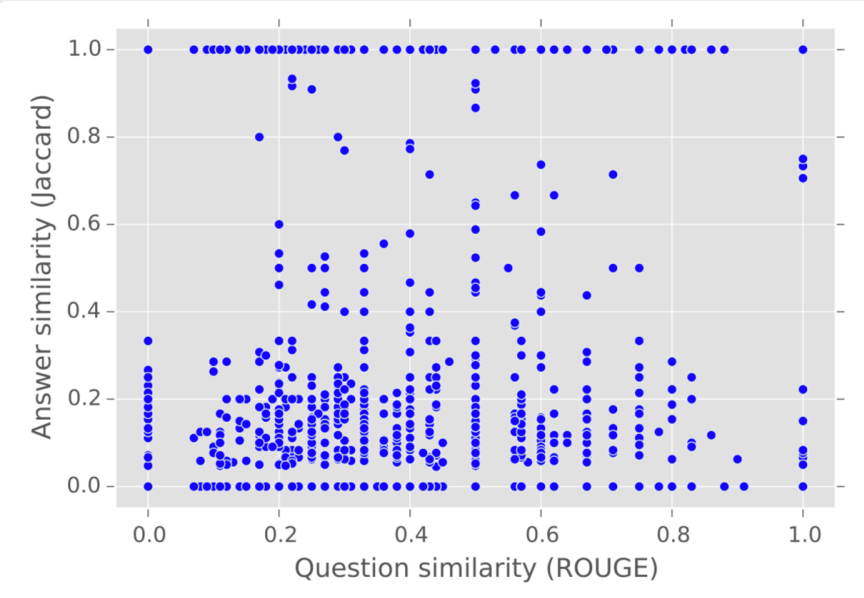


Results: Error Analysis

Passage ranking



Reading comprehension



Results: Error Analysis

QR	Human	ROUGE-1 R	R@1000
How is intermittent fasting related to keto *diet*	How is intermittent fasting related to keto?	1	0.48
What's the biggest great whites *ever caught*	What about for great whites?	0.6	1

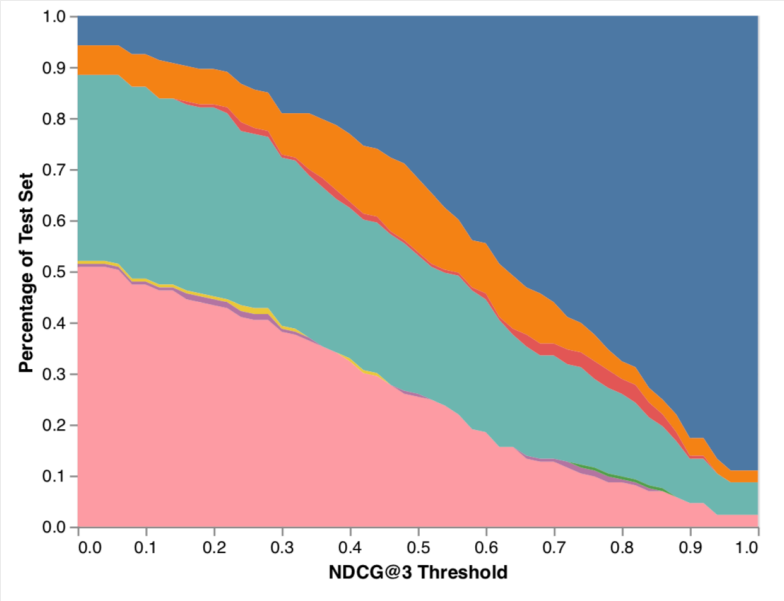
QR	Human	ROUGE-1 R	Jaccard
was *kick out the jams* well received?	was Kick Out the Jams well received?	1	0.03
did *he do anything else*?	did Guy Lombardo have any other career highlights besides racing and the restaurant?	0.08	1

Dataset: TREC CAsT 2020

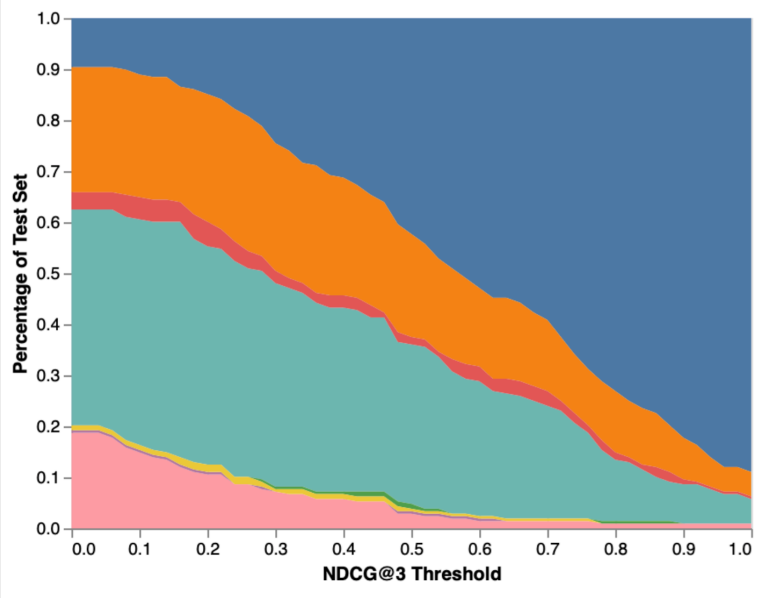
https://www.treccast.ai

CAsT Evolution

Transformer++ on CAsT 2019



QuReTeC on CAsT 2020



https://github.com/svakulenk0/QRQA

Results: QuReTeC on CAsT 2020

Question	QR	Answer
Who are some of the well-known Information Retrieval researchers?	-	Bruce Croft formed the Center for Intelligent Information Retrieval (CIIR) in 1991, since when he and his students have worked with more than 90 industry and government partners on research and technology projects and have produced more than 900 papers. Bruce Croft has made major contributions to most areas of information retrieval, including pioneering work in clustering, passage retrieval, sentence retrieval, and distributed search. One of the most important areas of work for Croft relates to ranking functions and retrieval models, where he has led the development of one of the major approaches to modeling search: language modelling. In later years, Croft also led the way in the development of feature-based ranking functions. Croft and his research group have also developed a series of search engines: InQuery, the Lemur toolkit, Indri, and Galago. These search engines are open source and offer unique capabilities that are not replicated in other research retrieval platforms source – consequently they are downloaded by hundreds of researchers world wide. As a consequence of his work, Croft is one of the most cited researchers in information retrieval.
What did he work on?	What did he work on? croft bruce	

References

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- Svitlana **Vakulenko**, Shayne Longpre, Zhucheng Tu, Raviteja Anantha: A Wrong Answer or a Wrong Question? An Intricate Relationship between Question Reformulation and Answer Selection in Conversational Question Answering. **SCAI@EMNLP** 2020: 7-16.
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- Shi **Yu**, Jiahua Liu, Jingqin Yang, Chenyan Xiong, Paul Bennett et al. Few-Shot Generative Conversational Query Rewriting. **SIGIR** 2020: 1933-1936.
- Ida **Mele**, Cristina Ioana Muntean, Franco Maria Nardini, Raffaele Perego et al. Topic Propagation in Conversational Search. **SIGIR** 2020: 2057-2060.

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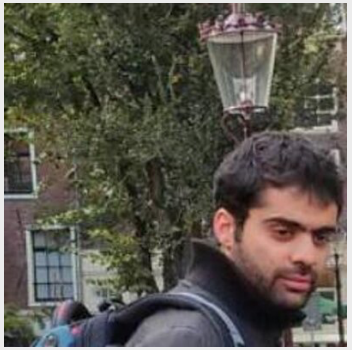

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Conclusions: Question Rewriting

- Modular
- Reusable
- Debuggable
- Cheap