

Cornell Bowers CIS
Computer Science

61 ACL 2023

Rationale-based Approaches

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Part 7/7 of the ACL 2023 Tutorial

[*Complex Reasoning in Natural Language*](#)

What are rationales?

Rationale models may be Supervised / Unsupervised

- Zaidan et al. (2007) supervise models with rationales
- Lei et al. (2016) proposed self-rationalizing models without rationale supervision, making producing rationales possible for every dataset

Rationale models may be Faithful / Unfaithful

- Rationale models are faithful if they predict outputs given only the rationales
- Rationale models need to be faithful to be deemed as an explainable model

Rationale models may extract Tokens / Sentences

- Tokens for short inputs
- Sentences / paragraphs for long inputs
- Complex reasoning tasks often consist of long inputs, i.e., many (and potentially very long) documents

Rationale models may be Single-hop / Structured

- Single-hop rationale models predict sentences in a rationale independently
- Structured rationale models explicitly consider sentence structures

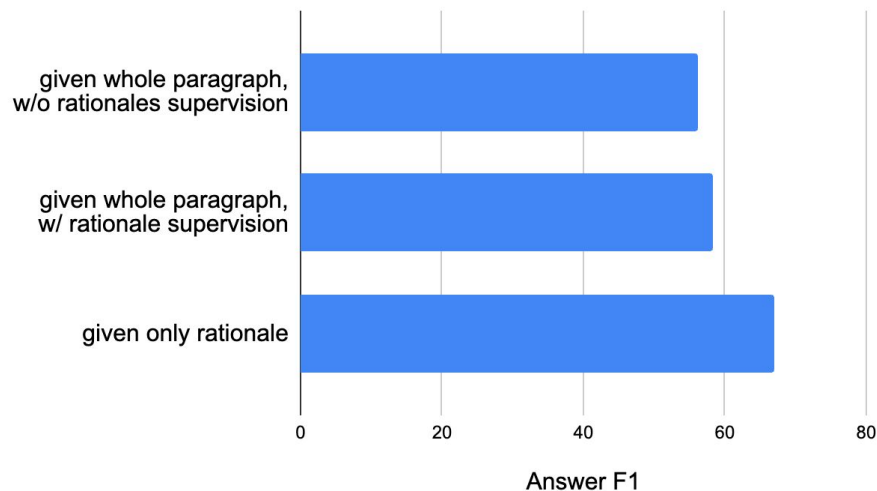
Rationale models are closely related to Retrieval

- Documents to be retrieved can be seen as rationales
- Better rationale models can lead to better retrieval models
- More retrieval work is covered in another ACL tutorial: Retrieval-based Language Models and Applications (2pm in the afternoon)

What are benefits and costs of rationale models?

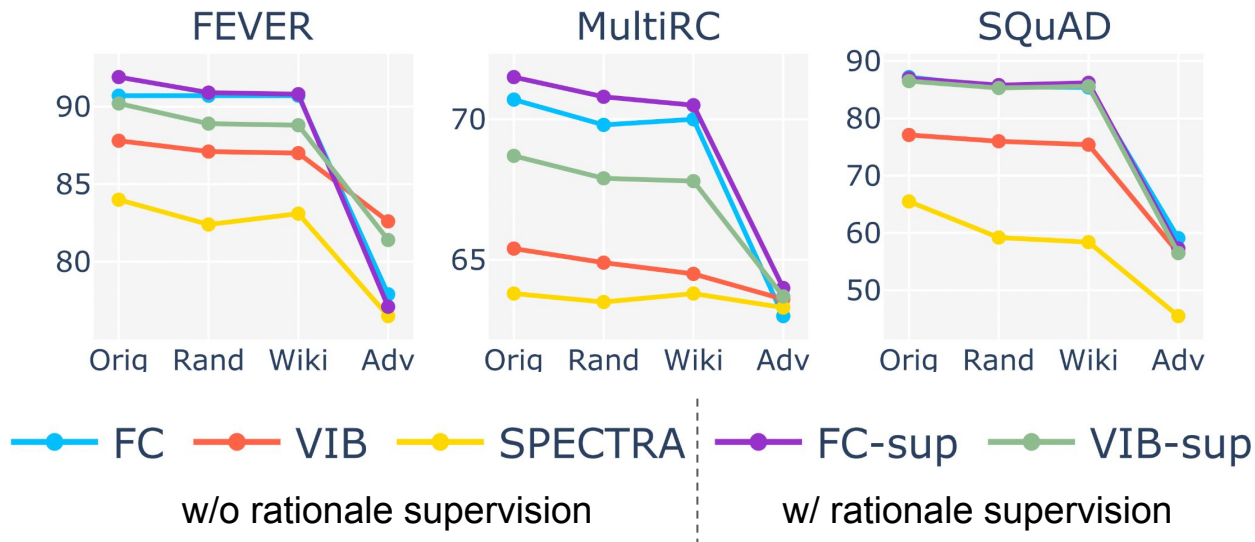
Benefits of supervised rationale models

- Rationale models can improve task performance



Benefits of supervised rationale models

- Rationale models are robust to adversarial attacks



Costs of supervising rationales

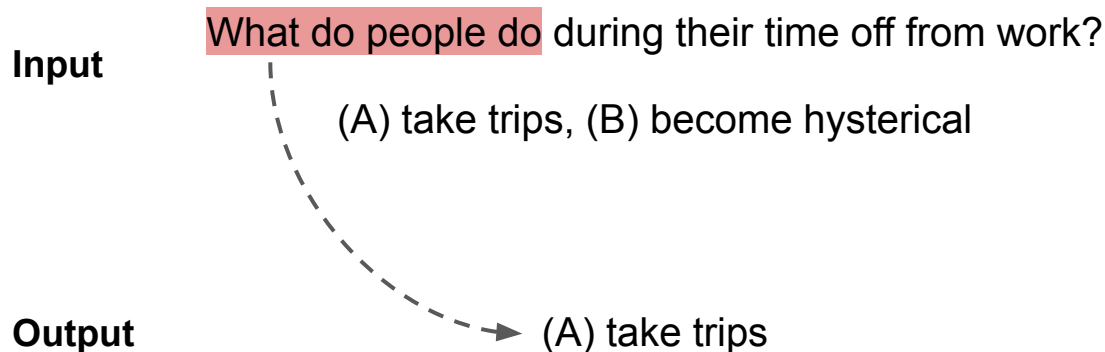
- Only 29 datasets have annotated rationales [Wiegrefe and Marasović, 2022]
- Rationale annotations are expensive to collect [Geva et al., 2021]
- Rationales can be subjective to annotate [Zhang et al., 2020]

Benefits and costs of structured rationale models

- Necessary to get reasoning correct for problems involve compositional structures
- However, there may be training and / or inference overhead

Benefits of faithful rationale models

- Faithful rationale models allow users to evaluate the trustworthiness of their predictions



Benefits of faithful rationale models

- Faithful rationale models allow users to debug datasets

Q: Watertown International Airport and Blue Grass Airport, are in which country?

Document A, Blue Grass Airport:

Blue Grass Airport is a public airport in Fayette County, Kentucky, 4 miles west of downtown Lexington.

Document B, Watertown International Airport:

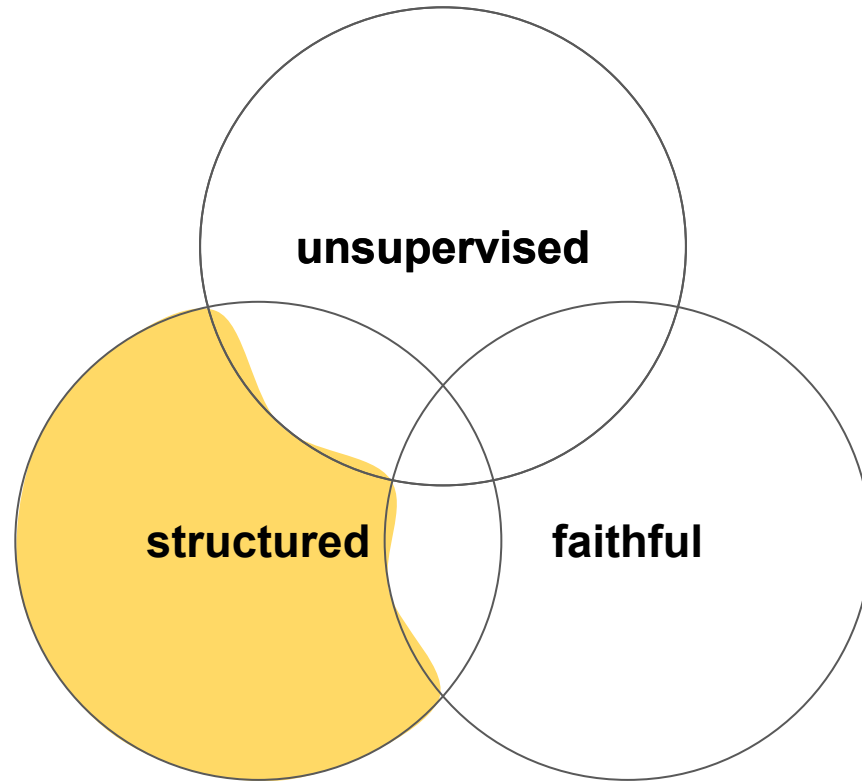
Watertown International Airport is a county owned, public use airport located in Jefferson County, New York, United States.

A: United States

Costs of faithful rationale models

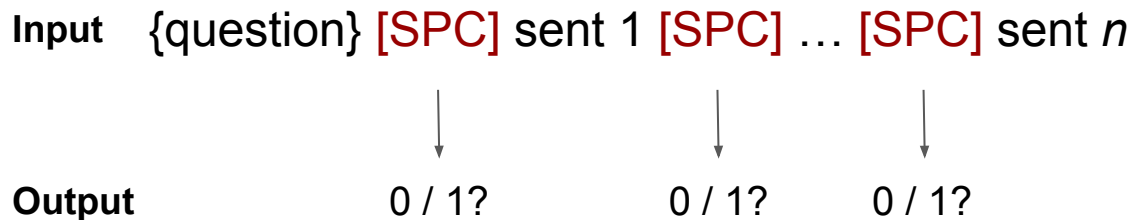
- Potentially more computationally expensive to train
- May not necessarily improve task accuracy

Overview of methods

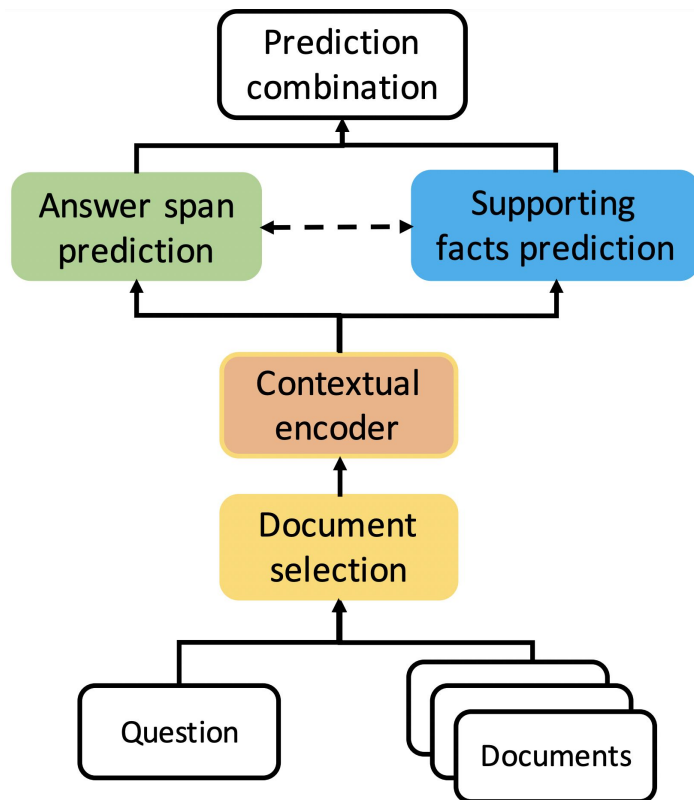


Transformer models that handle long inputs

- Feed the entire input into transformer models that handle long-form texts and directly predict a rationale from contextualized embeddings of [SPC] tokens
- Input: {question} [SPC] sent 1 [SPC] ... [SPC] sent n
- Predict on [SPC] tokens for whether a sentence is included



Handling long inputs with regular transformers



- First, a document selection module filters out answer-unrelated documents
- Then, an answer and explain module, trained with a multi-task loss, jointly predicts an answer and a rationale

Utilizing graph neural networks (GNNs)

- Use graph neural networks to capture the relationship between different hops
- Graphs are often built with entities

P1 Title: **Big Stone Gap**

S1 Big Stone Gap is a 2014 American drama romantic comedy film written and directed by **Adriana Trigiani** and produced by Donna Gigliotti for Altar Identity Studios, a subsidiary of Media Society.

S2 Based on Trigiani's 2000 best-selling novel of the same name, the story is set in the actual Virginia town of Big Stone Gap circa 1970s.

S3 The film had its world premiere at the Virginia Film Festival on November 6, 2014.

P2 Title: **Adriana Trigiani** ←

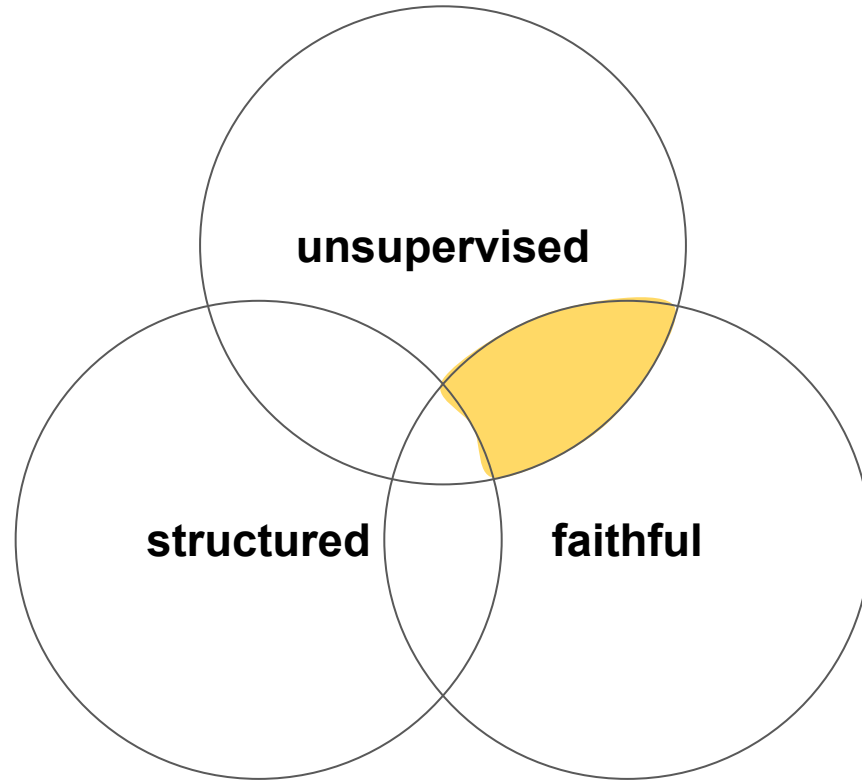
S4 Adriana Trigiani is an Italian American best-selling author of sixteen books, television writer, film director, and entrepreneur based in **Greenwich Village, New York City**.

S5 Trigiani has published a novel a year since 2000.

Graph vs. No graph

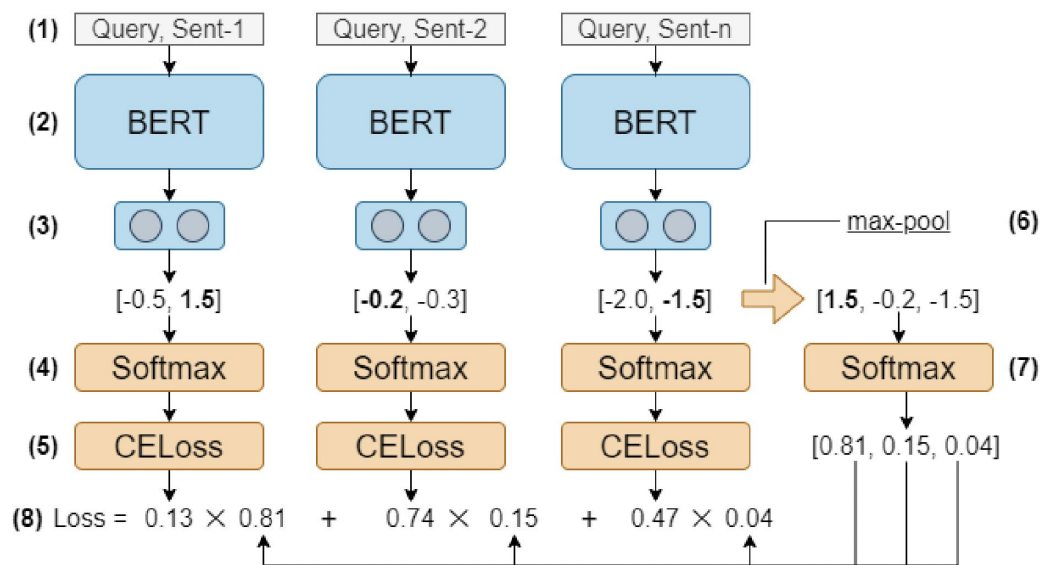
Model	Answer	Rationale	Joint
w/o Graph	80.58	85.83	71.02
Hier. Graph	82.22	88.58	74.37

Overview of methods



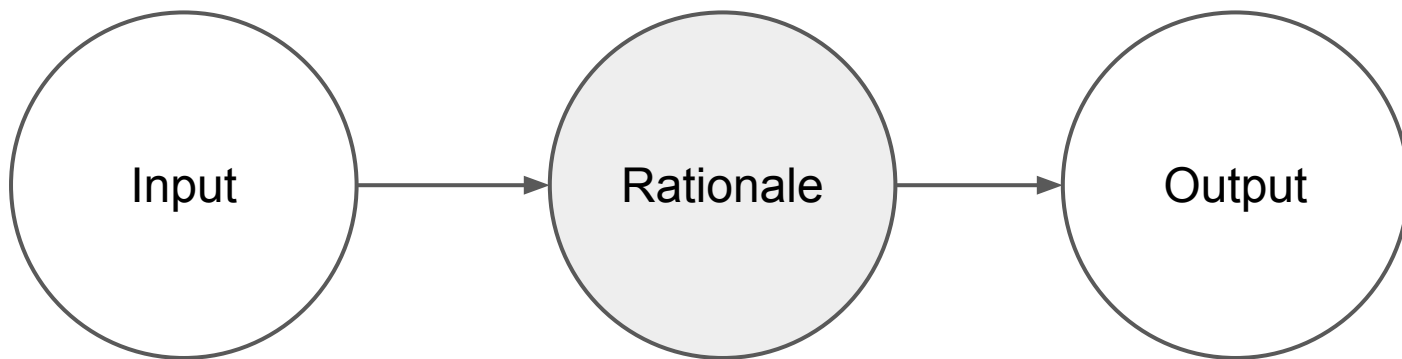
Prediction confidence

- Treat which part leads to highest prediction confidence as rationale

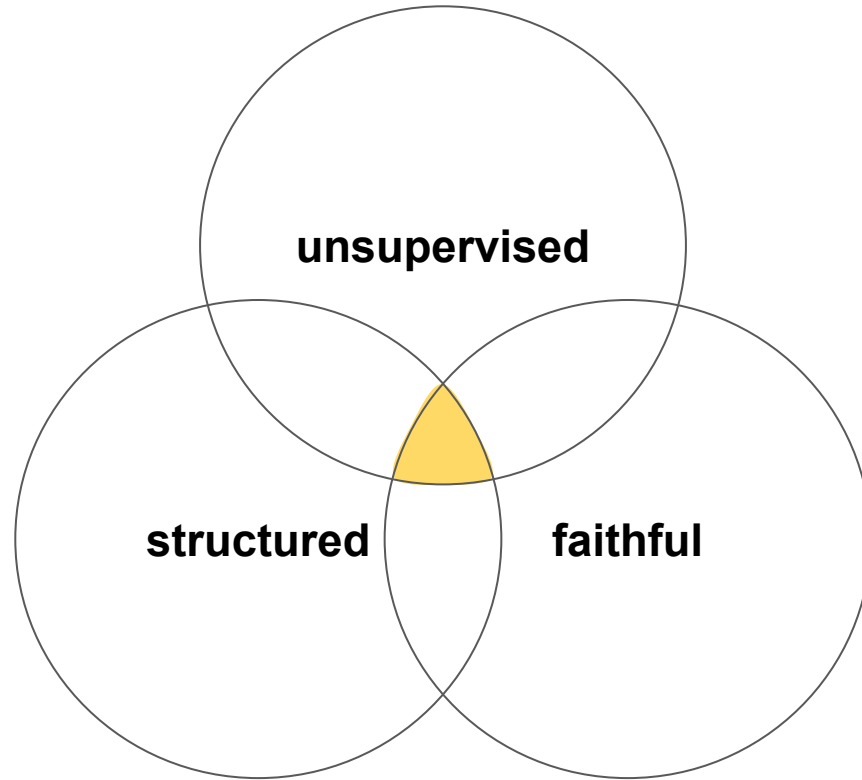


Latent rationales

- Models a single document as a latent variable
- Easy to build: This model is on [HuggingFace](#)

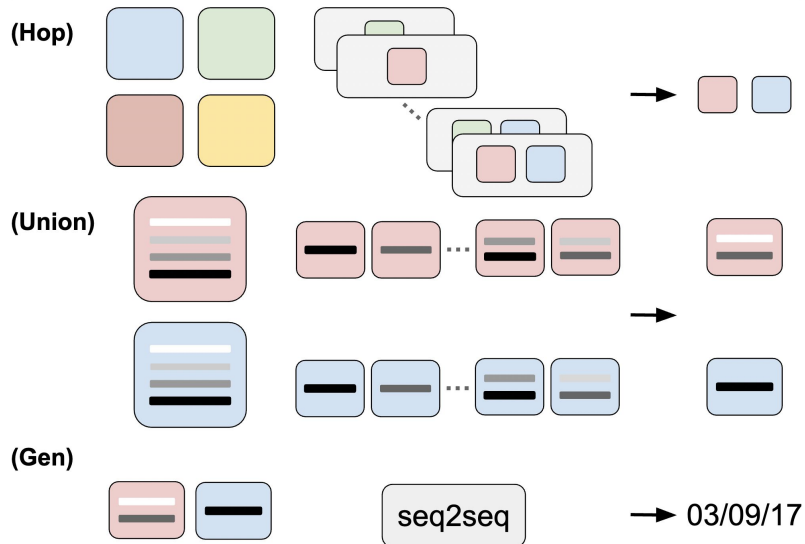


Overview of methods



Latent set rationales

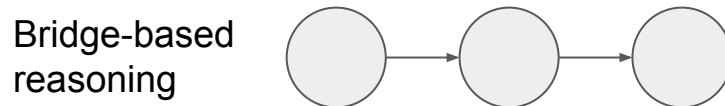
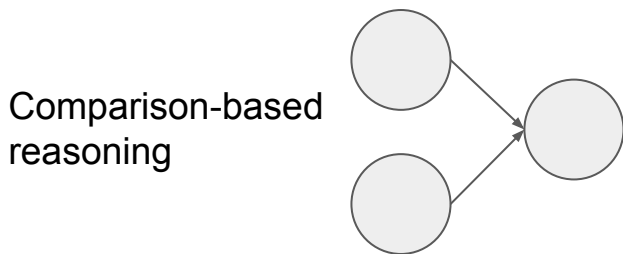
Emily Beecham is best known for her role in a television series whose second season premiered on what date?



- Explicitly models multi-hop reasoning as set-prediction problems

Modeling documents sets vs. single documents

- HUG: models interdependency between documents and sentences
- HUG-ind: models documents and sentences independently

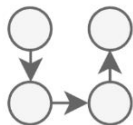


		Sent F1	Doc F1	Ans F1
Comparison	HUG-Ind	78.9	92.9	64.8
	HUG	78.1	91.1	69.7
Bridge	HUG-Ind	55.2	68.6	71.6
	HUG	71.0	87.3	75.7

Conclusions & directions for rationale-based approaches

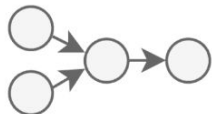
- There are options for the specific use scenarios
- Rationale selection doesn't automatically solved by larger, better language models, due to long input lengths
- How to scale up unsupervised rationale selection to open-domain setting?

Graph rationales



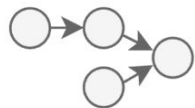
When did Napoleon occupy the city where the mother of the woman who brought Louis XVI style to the court died? **1805**

1. Who brought Louis XVI style to the court? **Marie Antoinette**
2. Who's mother of **Marie Antoinette**? **Maria Theresa**
3. In what city did **Maria Theresa** die? **Vienna**
4. When did Napoleon occupy **Vienna**? **1805**



How many Germans live in the colonial holding in Aruba's continent that was governed by Prazeres's country? **5 million**

1. What continent is Aruba in? **South America**
2. What country is Prazeres? **Portugal**
3. Colonial holding in **South America** governed by **Portugal**? **Brazil**
4. How many Germans live in **Brazil**? **5 million**



When did the people who captured Malakoff come to the region where Philipsburg is located? **1625**

1. What is Philipsburg capital of? **Saint Martin**
2. **Saint Martin** is located on what terrain feature? **Caribbean**
3. Who captured Malakoff? **French**
4. When did the **French** come to the **Caribbean**? **1625**

Conclusions & directions for rationale-based approaches

- There are options for the specific use scenarios
- Rationale selection doesn't automatically solved by larger, better language models, due to long input lengths
- How to scale up unsupervised rationale selection to open-domain setting?
- Is it possible to learn rationale graphs?

Conclusion for the tutorial

- Complex reasoning tasks still remains unsolved even with LLMs
- Making reasoning explicit is a promising direction to build NLP systems that generalize and can be trusted by users
- Some of the explicit reasoning systems are easy to implement with open-source tools --- start building today!

Paper list

[Rajani et al., 2019] Nazneen Fatema Rajani, Bryan McCann, Caiming Xiong, and Richard Socher. 2019. [Explain Yourself! Leveraging Language Models for Commonsense Reasoning](#). In *Proceedings of the 57th Annual Meeting of the Association for Computational Linguistics*, pages 4932–4942, Florence, Italy. Association for Computational Linguistics.

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[Chen et al., 2022] Howard Chen, Jacqueline He, Karthik Narasimhan, and Danqi Chen. 2022. [Can Rationalization Improve Robustness?](#). In *Proceedings of the 2022 Conference of the North American Chapter of the Association for Computational Linguistics: Human Language Technologies*, pages 3792–3805, Seattle, United States. Association for Computational Linguistics.

Max Glockner, Ivan Habernal, and Iryna Gurevych. 2020. [Why do you think that? Exploring Faithful Sentence-Level Rationales Without Supervision](#). In *Findings of the Association for Computational Linguistics: EMNLP 2020*, pages 1080–1095, Online. Association for Computational Linguistics.

Paper list

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[Thayaparan et al., 2019] Mokanarangan Thayaparan, Marco Valentino, Viktor Schlegel, and André Freitas. 2019. [Identifying Supporting Facts for Multi-hop Question Answering with Document Graph Networks](#). In *Proceedings of the Thirteenth Workshop on Graph-Based Methods for Natural Language Processing (TextGraphs-13)*, pages 42–51, Hong Kong. Association for Computational Linguistics.

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[Qiu et al., 2019] Lin Qiu, Yunxuan Xiao, Yanru Qu, Hao Zhou, Lei Li, Weinan Zhang, and Yong Yu. 2019. [Dynamically Fused Graph Network for Multi-hop Reasoning](#). In *Proceedings of the 57th Annual Meeting of the Association for Computational Linguistics*, pages 6140–6150, Florence, Italy. Association for Computational Linguistics.

[Lewis et al., 2020] Lewis, P., Perez, E., Piktus, A., Petroni, F., Karpukhin, V., Goyal, N., Küttler, H., Lewis, M., Yih, W.T., Rocktäschel, T. and Riedel, S., 2020. Retrieval-augmented generation for knowledge-intensive nlp tasks. *Advances in Neural Information Processing Systems*, 33, pp.9459-9474.