

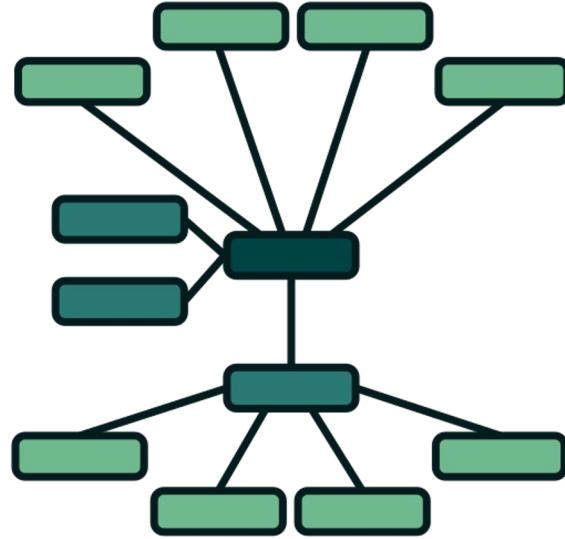
Enriching Ontologies with Disjointness Axioms using Large Language Models

SLYTHERIN

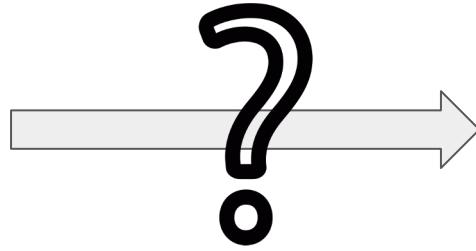
Alessia Pisu, Antonio De Santis, Elias Crum,
Jixin Pan, Manon Ovide, Nicolas Lazzari,
Sebastian Rudolph

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Problem/Introduction



Ontology



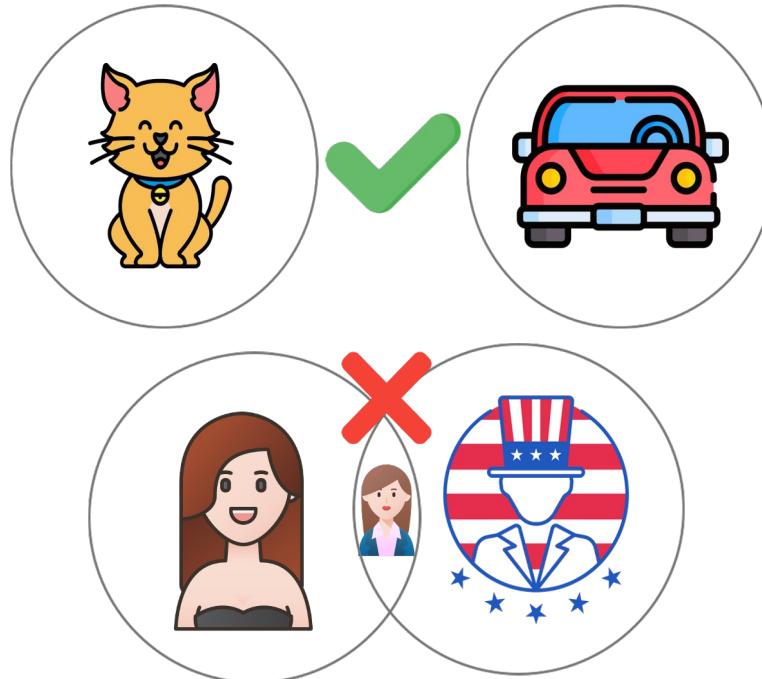
LLM

- ❖ Manual curation of Ontologies
- ❖ Use LLMs?



Disjointness

Two classes are considered "disjoint" if and only if their taxonomic overlap is empty.

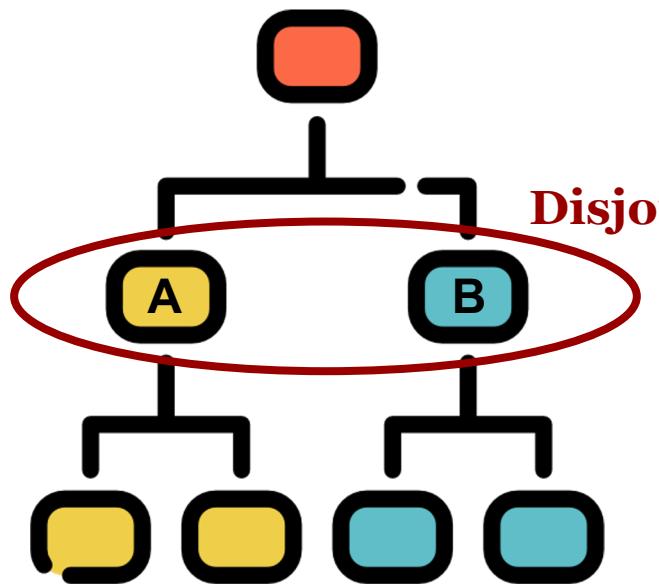


Research Questions

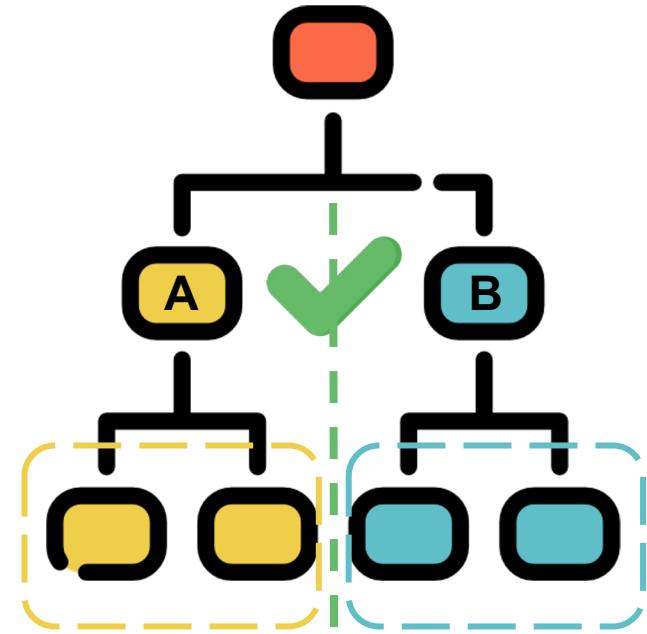
Q1: Can LLMs help enrich ontologies with class disjointness axioms?

Q2: Which LLM prompts work better for disjointness discovery?

Approach

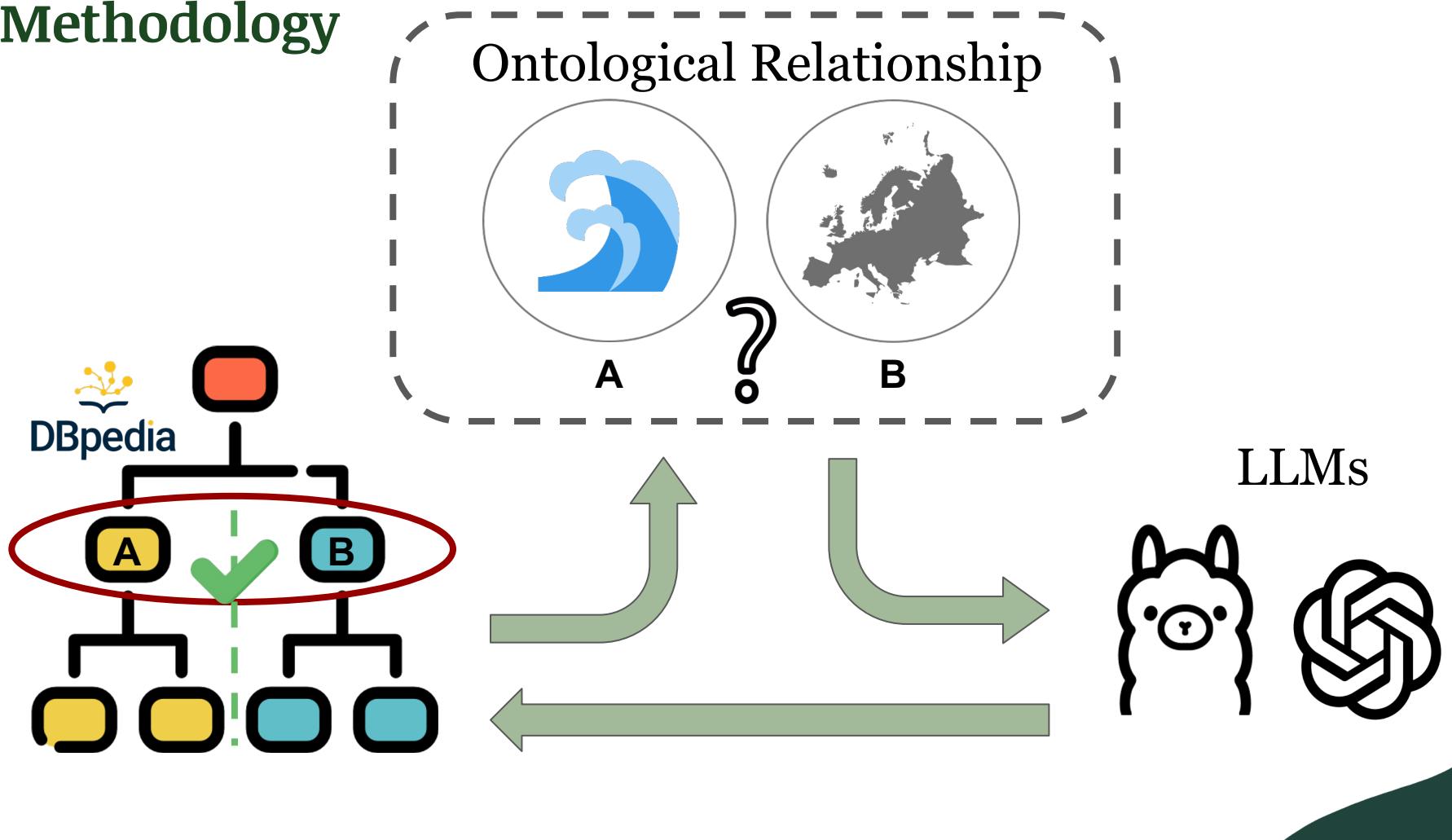


Class Relationship
Determination



Subclasses **must** be
disjoint

Methodology



Class Relationships

Negative



Beauty queen



US president

Positive



Sea



Continent

Prompt strategies

- **Zero-shot naive**

Can a "Place" be a "Person"? Answer only with "yes" or "no".

- **Zero-shot + Task description**

This is a question about ontological disjointness, answer only with "yes" or "no". Are the classes "Continent" and "Sea" ontologically disjoint?

Prompt strategies

- **One-shot + Task description**

Example of ontological disjointness is Q: Are the classes "Cat" and "Car" ontologically disjoint? A: Yes. """ Please answer the following question only with "yes" or "no". Q: Are the classes "Basketball Player" and "Baseball Player" ontologically disjoint?

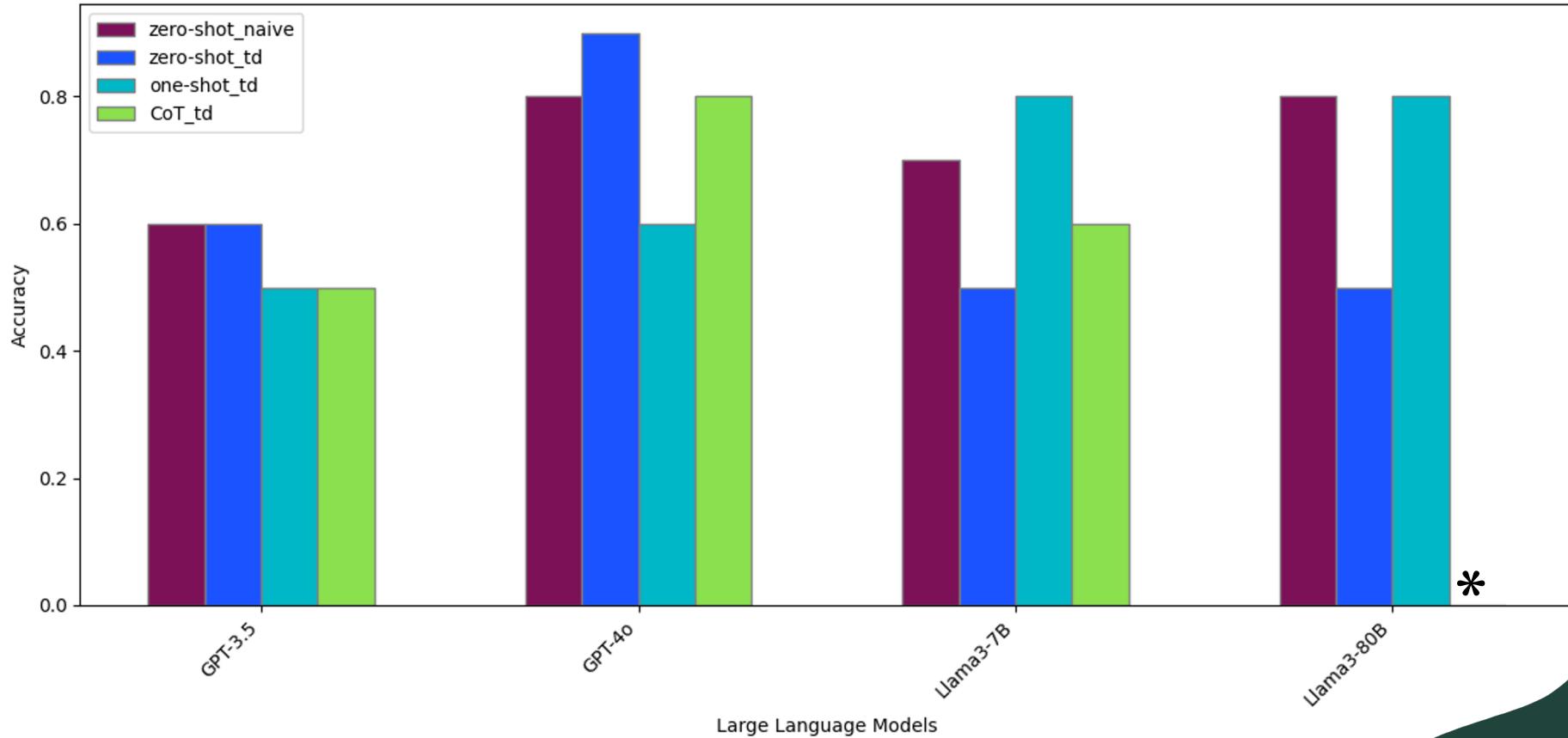
- **Chain-of-Thought + Task description**

This is a question about ontological disjointness, final answer only can be "yes" or "no". Are the classes "Castle" and "Prison" ontologically disjoint? Also, include your reasoning step-by-step.

Results:

* = no CoT prompt tested

Accuracy of Different Models



Limitations

Can a "Reptile" be a "Means of Transportation"?
Answer coming up...



"Means of Transportation" and "Reptile" are ontologically disjoint because they belong to entirely separate categories or classes of objects. "Means of Transportation" includes vehicles like cars, trains, and planes, while "Reptile" includes animals like snakes, lizards, and turtles. There is no overlap between these categories; they represent distinct and unrelated concepts.

why can't I use crocodile as a means of transportation?



While it might be theoretically possible to use a crocodile as a means of transportation in some imaginative scenarios, it's not practically feasible or advisable in reality. Crocodiles are wild animals and using them as transportation would be dangerous, unethical, and likely ineffective. Additionally, crocodiles are not typically trained or domesticated for transportation purposes, and they lack the characteristics and suitability for such use compared to vehicles specifically designed for transportation. Therefore, while there might be some hypothetical situations where a crocodile could be used for transportation, it's not a practical or common occurrence, and it doesn't negate the ontological disjointness between the categories of "Means of Transportation" and "Reptile."

Conclusion

- ❖ LLMs, especially GPT-4o, can identify and assert disjointness axioms in ontologies (relatively well).
- ❖ Prompt structure and strategy can have a significant impact on the results.
- ❖ LLMs struggle with some disjointness classifications.
 - Especially those without discrete real-world examples.

Future Work



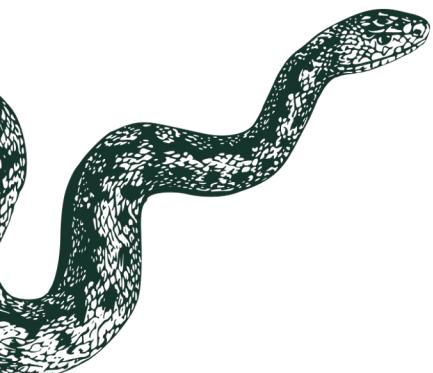
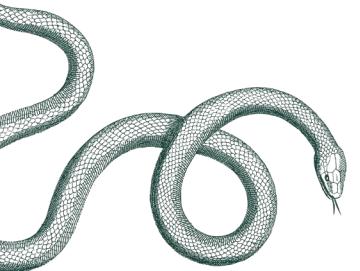
Immediate future work:

- ❖ Assess how LLM classifications are integrated with logical reasoning to minimize LLM prompts needed.
- ❖ Evaluate the proposed approach on various ontologies, LLMs and a larger dataset.
- ❖ Involve human domain experts to evaluate the results.

Further enhancements:

- ❖ Develop heuristics for selecting promising candidate pairs for disjointness.
- ❖ Explore testing classes with few non-disjoint instances to identify potential errors.
- ❖ Refine prompts with role descriptions and elements like “at the same time” or “theoretically” for improved responses.

Thank you!



Pairs

positive examples	negative examples
(Place, Person)	(BasketballPlayer, BaseballPlayer)
(Continent, Sea)	(Garden, HistoricPlace)
(Gene, Movie)	(President, BeautyQueen)
(Planet, Star)	(MeanOfTransportation, Reptile)
(BaseballLeague, BowlingLeague)	(Castle, Prison)

in <https://DBpedia.org/ontology/>