Knowledge representation - Project

Introduction

This document provides detailed information about the vehicle ontology, which models various attributes of vehicles including propulsion types, body styles, drive types, and environmental characteristics. The ontology is designed to classify vehicles according to their properties and enable complex queries about vehicle specifications and relationships.

Dataset Source

The ontology is populated with data from the OpenDataSoft vehicle dataset:

- Source URL:

https://public.opendatasoft.com/explore/embed/dataset/all-vehicles-model/table/?sort=modifiedon

- Dataset Contents: Comprehensive vehicle specifications including make, model, year, fuel type, drivetrain, emissions data, and economy ratings.
- Format: CSV data structured with multiple vehicle attributes across numerous columns.

Competency questions and DL Formalization

Below are 14 competency questions that can be addressed by the vehicle ontology, along with their formalization in Description Logic (DL) notation and Protege syntax.

1. Identifying Pure Electric Vehicles

Question: Which vehicles are purely electric-powered without using any conventional fuels?

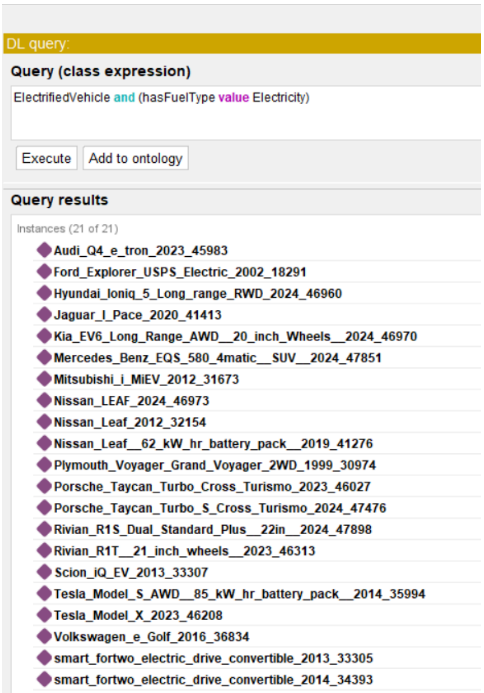
DL Formalization:

$\text{PureElectricVehicle} \equiv \text{ElectrifiedVehicle} \sqcap \exists \text{hasFuelType}.\{\text{Electricity}\}$

DL for Protege:

ElectrifiedVehicle and (hasFuelType value Electricity)

Explanation: This query identifies vehicles that are classified as electrified and specifically use electricity as their fuel type, distinguishing them from hybrid vehicles.



2. Finding Low Emission Vehicles

Question: Which vehicles have CO2 emissions below 100 grams per kilometer?

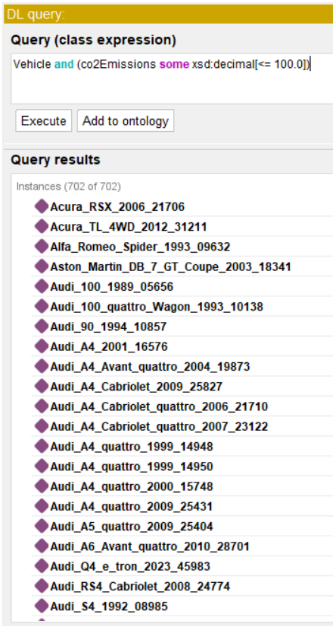
DL Formalization:

$\text{Vehicle} \sqcap \exists \text{co2Emissions}.(\leq 100)$

DL for Protege:

Vehicle and (co2Emissions some xsd:decimal[<= 100.0])

Explanation: This query finds all vehicles with a CO2 emissions value less than or equal to 100 units, targeting environmentally-friendly options.



3. Identifying Luxury Sedans

Question: Which sedan vehicles are in the premium market segment?

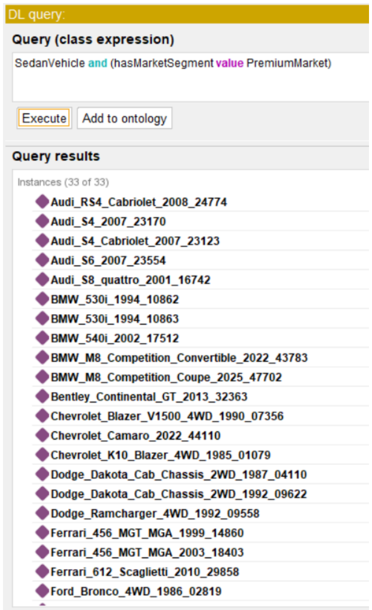
DL Formalization:

$\text{SedanVehicle} \sqcap \exists \text{hasMarketSegment}.\{\text{PremiumMarket}\}$

DL for Protege:

SedanVehicle and (hasMarketSegment value PremiumMarket)

Explanation: This identifies all vehicles that are both sedans (by body style) and positioned in the premium market segment, typically representing luxury models.



4. Finding All-Wheel Drive SUVs

Question: Which SUVs have all-wheel drive capability?

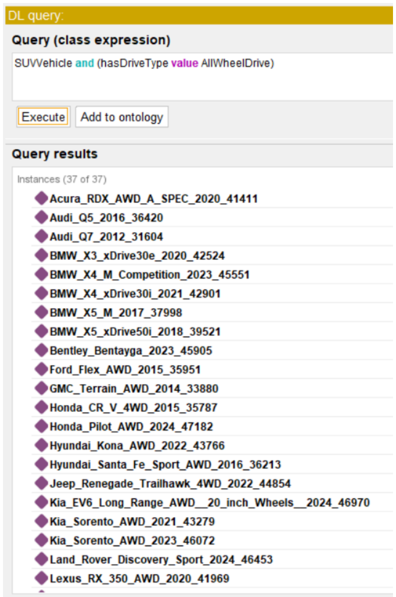
DL Formalization:

$\text{SUVVehicle} \sqcap \exists \text{hasDriveType}.\{\text{AllWheelDrive}\}$

DL for Protege:

SUVVehicle and (hasDriveType value AllWheelDrive)

Explanation: This query identifies SUVs (defined by body style) that specifically have all-wheel drive capabilities, useful for off-road or adverse weather conditions.



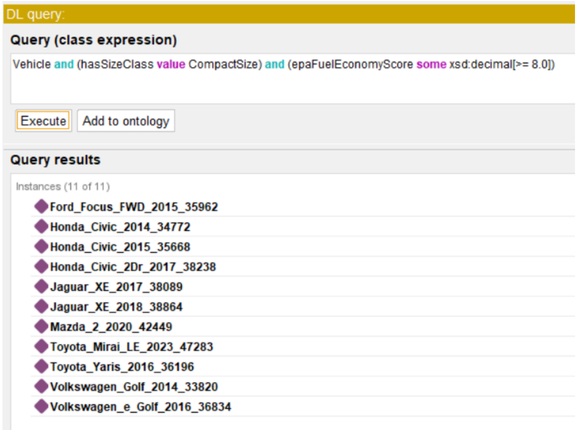
5. Identifying Fuel-Efficient Compact Cars

Question: Which compact cars have an EPA Fuel Economy Score of 8 or higher?

DL Formalization:

Vehicle ⊓ ∃ hasSizeClass.{CompactSize} ⊓ ∃ epaFuelEconomyScore.(≥ 8)

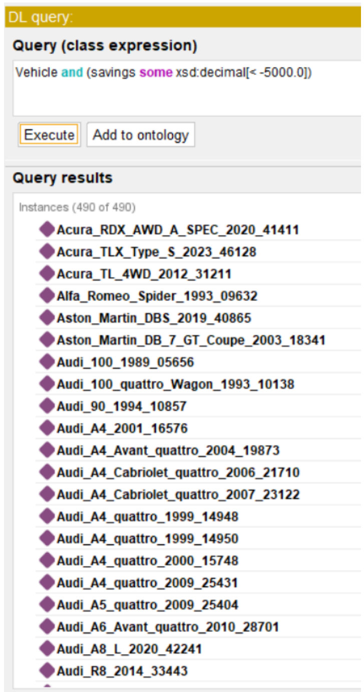
DL for Protege:



Vehicle and (hasSizeClass value CompactSize) and (epaFuelEconomyScore some xsd:decimal[>= 8.0])

Explanation: This finds compact-sized vehicles with high fuel efficiency ratings, optimal for budget-conscious and environmentally-aware consumers.

6. Finding Vehicles with Significant Consumer Savings



Question: Which vehicles provide consumer savings greater than $5000?

DL Formalization:

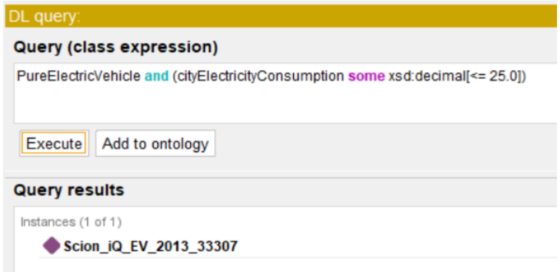
Vehicle ⊓ ∃ savings.(< -5000)

DL for Protege:

Vehicle and (savings some xsd:decimal[< -5000.0])

Explanation: Note that in the dataset, savings are represented as negative values, so savings greater than $5000 are represented as values less than -5000.

7. Identifying Electric Vehicles with High Range



Question: Which electric vehicles have low electricity consumption, indicating higher range?

DL Formalization:

PureElectricVehicle ⊓ ∃ cityElectricityConsumption.(≤ 25)

DL for Protege:

PureElectricVehicle and (cityElectricityConsumption some xsd:decimal[<= 25.0])

Explanation: Lower electricity consumption values indicate more efficient use of battery capacity and thus potentially higher range.

8. Finding Recent Hybrid Models

Question: Which hybrid electric vehicles were manufactured in or after 2020?

DL Formalization:

HybridElectricVehicle ⊓ ∃ hasModelYear.ModelYear ⊓ ∃ year.(≥ 2020)

DL for Protege:

HybridElectricVehicle and (hasModelYear some ModelYear) and (year some xsd:integer[>= 2020])

Explanation: This query identifies newer hybrid models, which typically incorporate more advanced technologies and efficiencies.

9. Identifying Vehicles with Turbochargers

Question: Which vehicles are equipped with turbocharger technology?

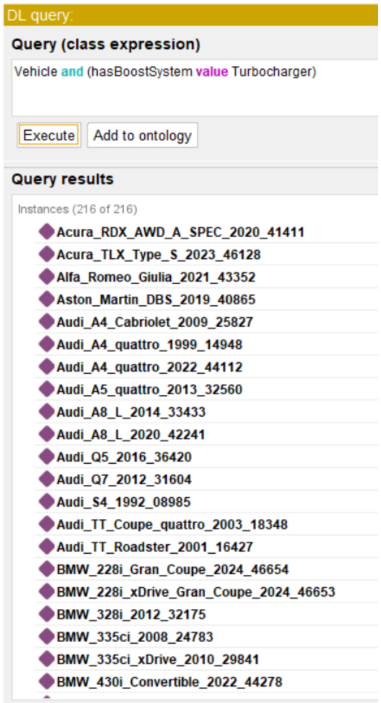
DL Formalization:

$\text{Vehicle} \sqcap \exists\, \text{hasBoostSystem}.\{\text{Turbocharger}\}$

DL for Protege:

Vehicle and (hasBoostSystem value Turbocharger)

Explanation: This finds vehicles with turbocharging technology, which can provide better performance and sometimes improved fuel efficiency.



10. Finding Environmentally-Friendly Large Vehicles

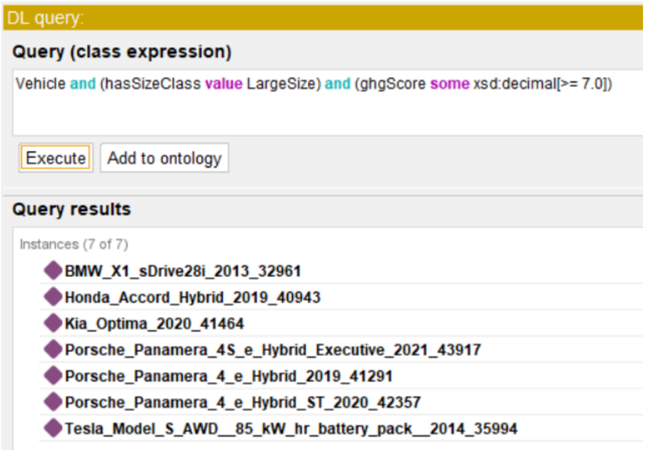
Question: Which large vehicles have a high GHG (Greenhouse Gas) Score?

DL Formalization:

$\text{Vehicle} \sqcap \exists\, \text{hasSizeClass}.\{\text{LargeSize}\} \sqcap \exists\, \text{ghgScore}.(\geq 7)$

DL for Protege:

Vehicle and (hasSizeClass value LargeSize) and (ghgScore some xsd:decimal[>= 7.0])



Explanation: This identifies larger vehicles that still maintain good environmental performance regarding greenhouse gas emissions.

11. Identifying Sport Utility Vehicles with Regular Fuel

Question: Which SUVs use regular gasoline rather than premium or diesel?

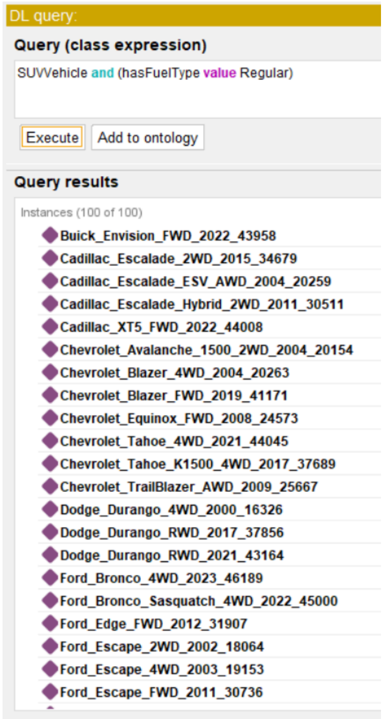
DL Formalization:

SUVVehicle ⊓ ∃ hasFuelType.{Regular}

DL for Protege:

SUVVehicle and (hasFuelType value Regular)

Explanation: This finds SUVs that run on regular gasoline, which is typically less expensive than premium or diesel fuels.



12. Finding Economical Family Vehicles

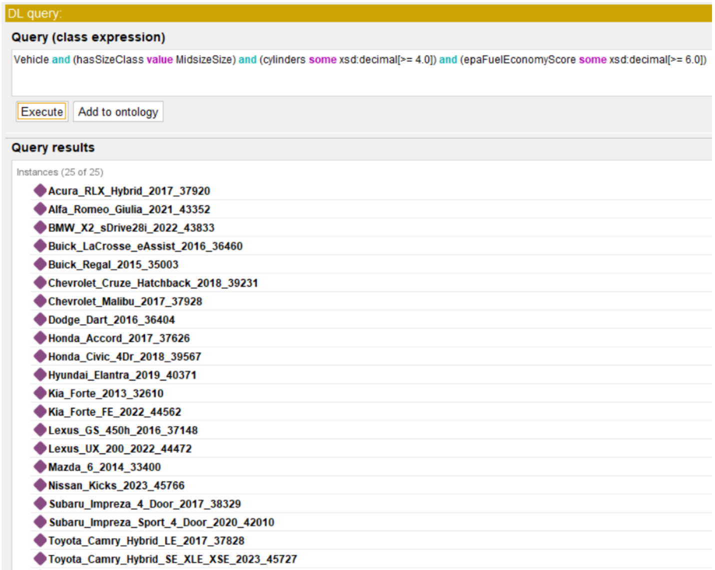
Question: Which midsize vehicles with four or more cylinders have good fuel economy?

DL Formalization:

Vehicle ⊓
∃ hasSizeClass.{MidsizeSize} ⊓
∃ cylinders.(≥ 4) ⊓
∃ epaFuelEconomyScore.(≥ 6)

DL for Protege:

Vehicle and (hasSizeClass value MidsizeSize) and (cylinders some xsd:decimal[>= 4.0]) and (epaFuelEconomyScore some xsd:decimal[>= 6.0])



Explanation: This identifies practical family-sized vehicles that balance power needs with fuel efficiency.

13. Identifying Advanced Performance Vehicles

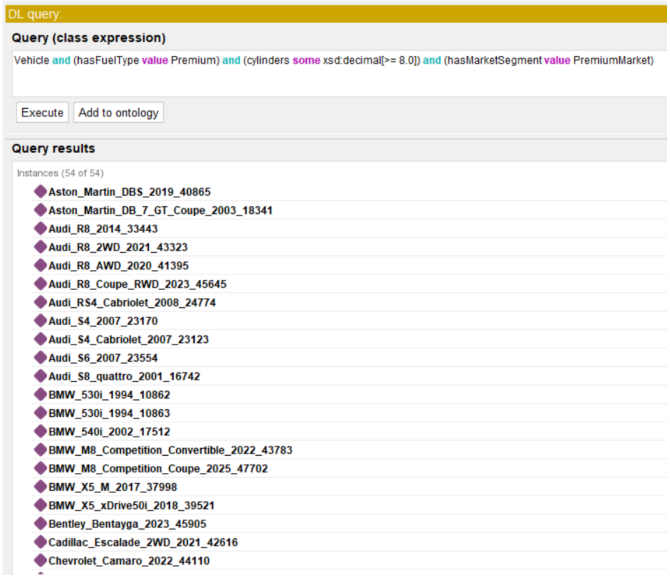
Question: Which vehicles have both high-performance characteristics (premium fuel, 8+ cylinders) and are classified in the premium market segment?

DL Formalization:

$$\text{Vehicle} \sqcap \exists\,\text{hasFuelType}.\{\text{Premium}\} \sqcap \exists\,\text{cylinders}.(\geq 8) \sqcap \exists\,\text{hasMarketSegment}.\{\text{PremiumMarket}\}$$

DL for Protege:

Vehicle and (hasFuelType value Premium) and (cylinders some xsd:decimal[>= 8.0]) and (hasMarketSegment value PremiumMarket)



Explanation: This query finds high-performance luxury vehicles that typically represent the premium end of automotive engineering.

14. Identifying Vehicles from Specific Manufacturers After 2020

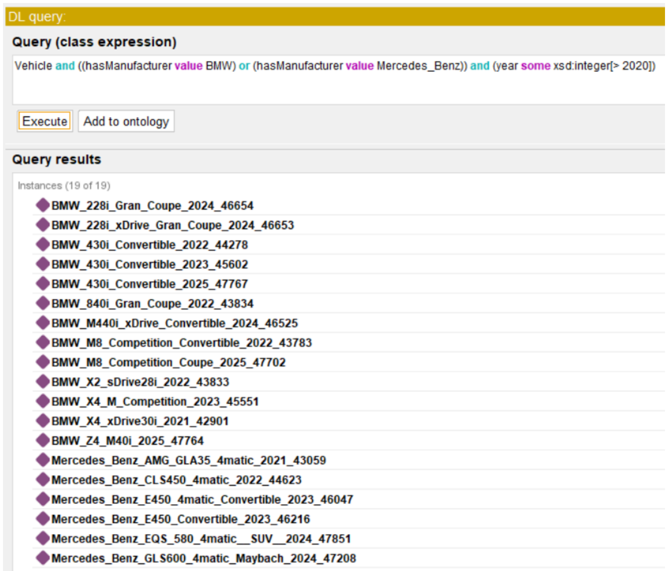
Question: Which vehicles manufactured by luxury brands (e.g., BMW, Mercedes-Benz) were produced after 2020?

DL Formalization:

$$\text{Vehicle} \sqcap \exists\,\text{hasManufacturer}.(\{\text{BMW}\} \sqcup \{\text{Mercedes-Benz}\}) \sqcap \exists\,\text{year}.(> 2020)$$

DL for Protege:

Vehicle and ((hasManufacturer value BMW) or (hasManufacturer value Mercedes_Benz)) and (year some xsd:integer[> 2020])



Explanation: This finds newer luxury vehicles from specific manufacturers, targeting recent premium offerings.

Implementation notes

The vehicle ontology is structured to work with automated reasoning, where vehicles are initially classified only as instances of the Vehicle class but are automatically categorized into appropriate subclasses when a reasoner is activated.

The population script explicitly creates instances only of the root Vehicle class and sets their properties. When the reasoner runs, it automatically classifies these instances into the appropriate subclasses based on the property restrictions defined in the ontology.

This approach follows the open-world assumption of OWL ontologies and leverages the power of Description Logic reasoning to infer class membership rather than requiring manual classification.

Conclusion

This vehicle ontology provides a comprehensive framework for modeling and querying vehicle data across multiple dimensions including propulsion type, body style, drive type, and environmental impact. The competency questions demonstrate the range of queries that can be formalized and answered using this ontology structure, from simple classification queries to complex multi-faceted inquiries about vehicle characteristics.