

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:

PureElectricVehicle \equiv ElectrifiedVehicle \sqcap \exists hasFuelType.{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.

The screenshot shows a web interface for a DL query. At the top, there's a yellow bar labeled 'DL query'. Below it, the 'Query (class expression)' is defined as 'ElectrifiedVehicle and (hasFuelType value Electricity)'. There are buttons for 'Execute' and 'Add to ontology'. Below the query, the 'Query results' section shows 'Instances (21 of 21)'. A list of 21 vehicle models is displayed, each preceded by a purple diamond icon. The models include Audi Q4 e-tron, Ford Explorer, Hyundai Ioniq 5, Jaguar I-Pace, Kia EV6, Mercedes-Benz EQS, Mitsubishi i-MiEV, Nissan LEAF, Nissan Leaf, Nissan Leaf 62 kW hr battery pack, Plymouth Voyager, Porsche Taycan, Rivian R1S, Rivian R1T, Scion iQ EV, Tesla Model S AWD, Tesla Model X, Volkswagen e-Golf, and smart fortwo electric drive convertible.

Vehicle Model
Audi_Q4_e-tron_2023_45983
Ford_Explorer_USPS_Electric_2002_18291
Hyundai_Ioniq_5_Long_range_RWD_2024_46960
Jaguar_I-Pace_2020_41413
Kia_EV6_Long_Range_AWD_20_inch_Wheels_2024_46970
Mercedes_Benz_EQS_580_4matic_SUV_2024_47851
Mitsubishi_i-MiEV_2012_31673
Nissan_LEAF_2024_46973
Nissan_Leaf_2012_32154
Nissan_Leaf_62_kW_hr_battery_pack_2019_41276
Plymouth_Voyager_Grand_Voyager_2WD_1999_30974
Porsche_Taycan_Turbo_Cross_Turismo_2023_46027
Porsche_Taycan_Turbo_S_Cross_Turismo_2024_47476
Rivian_R1S_Dual_Standard_Plus_22in_2024_47898
Rivian_R1T_21_inch_wheels_2023_46313
Scion_iQ_EV_2013_33307
Tesla_Model_S_AWD_85_kW_hr_battery_pack_2014_35994
Tesla_Model_X_2023_46208
Volkswagen_e-Golf_2016_36834
smart_fortwo_electric_drive_convertible_2013_33305
smart_fortwo_electric_drive_convertible_2014_34393

2. Finding Low Emission Vehicles

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

DL Formalization:

Vehicle $\sqcap \exists$ co2Emissions.(≤ 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.

The screenshot shows the Protege DL query interface. The query is: `Vehicle and (co2Emissions some xsd:decimal[≤ 100.0])`. The results show 702 instances, with the first 20 listed: Acura_RSX_2006_21706, Acura_TL_4WD_2012_31211, Alfa_Romeo_Spider_1993_09632, Aston_Martin_DB_7_GT_Coupe_2003_18341, Audi_100_1989_05656, Audi_100_quattro_Wagon_1993_10138, Audi_90_1994_10857, Audi_A4_2001_16576, Audi_A4_Avant_quattro_2004_19873, Audi_A4_Cabriolet_2009_25827, Audi_A4_Cabriolet_quattro_2006_21710, Audi_A4_Cabriolet_quattro_2007_23122, Audi_A4_quattro_1999_14948, Audi_A4_quattro_1999_14950, Audi_A4_quattro_2000_15748, Audi_A4_quattro_2009_25431, Audi_A5_quattro_2009_25404, Audi_A6_Avant_quattro_2010_28701, Audi_Q4_e_tron_2023_45983, and Audi_RS4_Cabriolet_2008_24774.

3. Identifying Luxury Sedans

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

DL Formalization:

SedanVehicle $\sqcap \exists$ hasMarketSegment.{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.

The screenshot shows the Protege DL query interface. The query is: `SedanVehicle and (hasMarketSegment value PremiumMarket)`. The results show 33 instances, with the first 20 listed: Audi_RS4_Cabriolet_2008_24774, Audi_S4_2007_23170, Audi_S4_Cabriolet_2007_23123, Audi_S6_2007_23554, Audi_S8_quattro_2001_16742, BMW_530i_1994_10862, BMW_530i_1994_10863, BMW_540i_2002_17512, BMW_M8_Competition_Convertible_2022_43783, BMW_M8_Competition_Coupe_2025_47702, Bentley_Continental_GT_2013_32363, Chevrolet_Blazer_V1500_4WD_1990_07356, Chevrolet_Camaro_2022_44110, Chevrolet_K10_Blazer_4WD_1985_01079, Dodge_Dakota_Cab_Chassis_2WD_1987_04110, Dodge_Dakota_Cab_Chassis_2WD_1992_09622, Dodge_Ramcharger_4WD_1992_09558, Ferrari_456_MGT_MGA_1999_14860, Ferrari_456_MGT_MGA_2003_18403, and Ferrari_612_Scaglietti_2010_29858.

4. Finding All-Wheel Drive SUVs

Question: Which SUVs have all-wheel drive capability?

DL Formalization:

SUVVehicle $\sqcap \exists$ hasDriveType.{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.

The screenshot shows the Protege DL query interface. The query is: `SUVVehicle and (hasDriveType value AllWheelDrive)`. The results show 37 instances, with the first 20 listed: Acura_RDX_AWD_A_SPEC_2020_41411, Audi_Q5_2016_36420, Audi_Q7_2012_31604, BMW_X3_xDrive30e_2020_42524, BMW_X4_M_Competition_2023_45551, BMW_X4_xDrive30i_2021_42901, BMW_X5_M_2017_37998, BMW_X5_xDrive50i_2018_39521, Bentley_Bentayga_2023_45905, Ford_Flex_AWD_2015_35951, GMC_Terrain_AWD_2014_33880, Honda_CR_V_4WD_2015_35787, Honda_Pilot_AWD_2024_47182, Hyundai_Kona_AWD_2022_43786, Hyundai_Santa_Fe_Sport_AWD_2016_36213, Jeep_Renegade_Trailhawk_4WD_2022_44854, Kia_EV6_Long_Range_AWD_20_inch_Wheels_2024_46970, Kia_Sorento_AWD_2021_43279, Kia_Sorento_AWD_2023_46072, and Land_Rover_Discovery_Sport_2024_46453.

5. Identifying Fuel-Efficient Compact Cars

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

DL Formalization:

Vehicle $\sqcap \exists$ hasSizeClass.{CompactSize} $\sqcap \exists$ 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.

DL query:

Query (class expression)

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

Execute Add to ontology

Query results

Instances (11 of 11)

- Ford_Focus_FWD_2015_35962
- Honda_Civic_2014_34772
- Honda_Civic_2015_35668
- Honda_Civic_20r_2017_38238
- Jaguar_XE_2017_38089
- Jaguar_XE_2018_38864
- Mazda_2_2020_42449
- Toyota_Mirai_LE_2023_47283
- Toyota_Yaris_2016_36196
- Volkswagen_Golf_2014_33820
- Volkswagen_e_Golf_2016_36834

6. Finding Vehicles with Significant Consumer Savings

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

DL Formalization:

Vehicle $\sqcap \exists$ 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.

DL query:

Query (class expression)

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

Execute Add to ontology

Query results

Instances (490 of 490)

- Acura_RDX_AWD_A_SPEC_2020_41411
- Acura_TLX_Type_S_2023_46128
- Acura_TL_4WD_2012_31211
- Alfa_Romeo_Spider_1993_09632
- Aston_Martin_DBS_2019_40865
- Aston_Martin_DB_7_GT_Coupe_2003_18341
- Audi_100_1989_05656
- Audi_100_quattro_Wagon_1993_10138
- Audi_90_1994_10857
- Audi_A4_2001_16576
- Audi_A4_Avant_quattro_2004_19873
- Audi_A4_Cabriolet_quattro_2006_21710
- Audi_A4_Cabriolet_quattro_2007_23122
- Audi_A4_quattro_1999_14948
- Audi_A4_quattro_1999_14950
- Audi_A4_quattro_2000_15748
- Audi_A4_quattro_2009_25431
- Audi_A5_quattro_2009_25404
- Audi_A6_Avant_quattro_2010_28701
- Audi_A8_L_2020_42241
- Audi_R8_2014_33443

7. Identifying Electric Vehicles with High Range

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

DL Formalization:

$\text{PureElectricVehicle} \sqcap \exists \text{cityElectricityConsumption} . (\leq 25)$

DL for Protege:

$\text{PureElectricVehicle} \text{ and } (\text{cityElectricityConsumption some xsd:decimal}[\leq 25.0])$

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

DL query:

Query (class expression)

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

Execute Add to ontology

Query results

Instances (1 of 1)

- Scion_iQ_EV_2013_33307

8. Finding Recent Hybrid Models

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

DL Formalization:

$\text{HybridElectricVehicle} \sqcap \exists \text{hasModelYear} . \text{ModelYear} \sqcap \exists \text{year} . (\geq 2020)$

DL for Protege:

$\text{HybridElectricVehicle} \text{ and } (\text{hasModelYear some ModelYear}) \text{ and } (\text{year some xsd:integer}[\geq 2020])$

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

DL query:

Query (class expression)

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

Execute Add to ontology

Query results

Instances (110 of 110)

- Acura_RDX_AWD_A_SPEC_2020_41411
- Acura_TLX_Type_S_2023_46128
- Alfa_Romeo_Giulia_2021_43352
- Audi_A4_quattro_2022_44112
- Audi_A8_L_2020_42241
- Audi_R8_2WD_2021_43323
- Audi_R8_AWD_2020_41395
- Audi_R8_Coupe_RWD_2023_45645
- BMW_228i_Gran_Coupe_2024_46654
- BMW_228i_xDrive_Gran_Coupe_2024_46653
- BMW_430i_Convertible_2022_44278
- BMW_430i_Convertible_2023_45602
- BMW_430i_Convertible_2025_47767
- BMW_540i_2020_42127
- BMW_840i_Gran_Coupe_2022_43834
- BMW_M440i_xDrive_Convertible_2024_46525
- BMW_M8_Competition_Convertible_2022_43783
- BMW_M8_Competition_Coupe_2025_47702
- BMW_X2_sDrive28i_2022_43833
- BMW_X3_xDrive30e_2020_42524
- BMW_X4_M_Competition_2023_45551

9. Identifying Vehicles with Turbochargers

Question: Which vehicles are equipped with turbocharger technology?

DL Formalization:

Vehicle $\sqcap \exists$ hasBoostSystem.{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.

DL query:

Query (class expression)
Vehicle and (hasBoostSystem value Turbocharger)

Execute

Add to ontology

Query results
Instances (216 of 216)

- ◆ Acura_RDX_AWD_A_SPEC_2020_41411
- ◆ Acura_TLX_Type_S_2023_46128
- ◆ Alfa_Romeo_Giulia_2021_43352
- ◆ Aston_Martin_DBS_2019_40865
- ◆ Audi_A4_Cabriolet_2009_25827
- ◆ Audi_A4_quattro_1999_14948
- ◆ Audi_A4_quattro_2022_44112
- ◆ Audi_A5_quattro_2013_32560
- ◆ Audi_A8_L_2014_33433
- ◆ Audi_A8_L_2020_42241
- ◆ Audi_Q5_2016_36420
- ◆ Audi_Q7_2012_31604
- ◆ Audi_S4_1992_08985
- ◆ Audi_TT_Coupe_quattro_2003_18348
- ◆ Audi_TT_Roadster_2001_16427
- ◆ BMW_228i_Gran_Coupe_2024_46654
- ◆ BMW_228i_xDrive_Gran_Coupe_2024_46653
- ◆ BMW_328i_2012_32175
- ◆ BMW_335ci_2008_24783
- ◆ BMW_335ci_xDrive_2010_29841
- ◆ BMW_430i_Convertible_2022_44278

10. Finding Environmentally-Friendly Large Vehicles

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

DL Formalization:

Vehicle $\sqcap \exists$ hasSizeClass.{LargeSize} $\sqcap \exists$ ghgScore.(≥ 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.

DL query:

Query (class expression)
Vehicle and (hasSizeClass value LargeSize) and (ghgScore some xsd:decimal[≥ 7.0])

Execute

Add to ontology

Query results
Instances (7 of 7)

- ◆ BMW_X1_sDrive28i_2013_32961
- ◆ Honda_Accord_Hybrid_2019_40943
- ◆ Kia_Optima_2020_41464
- ◆ Porsche_Panamera_4S_e_Hybrid_Executive_2021_43917
- ◆ Porsche_Panamera_4_e_Hybrid_2019_41291
- ◆ Porsche_Panamera_4_e_Hybrid_ST_2020_42357
- ◆ Tesla_Model_S_AWD_85_kW_hr_battery_pack_2014_35994

11. Identifying Sport Utility Vehicles with Regular Fuel

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

DL Formalization:

$\text{SUVVehicle} \sqcap \exists \text{hasFuelType}.\{\text{Regular}\}$

DL for Protege:

$\text{SUVVehicle} \text{ and } (\text{hasFuelType} \text{ value Regular})$

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

DL query

Query (class expression)

$\text{SUVVehicle} \text{ and } (\text{hasFuelType} \text{ value Regular})$

Execute Add to ontology

Query results

Instances (100 of 100)

- Buick_Envision_FWD_2022_43958
- Cadillac_Escalade_2WD_2015_34679
- Cadillac_Escalade_ESV_AWD_2004_20259
- Cadillac_Escalade_Hybrid_2WD_2011_30511
- Cadillac_XT5_FWD_2022_44008
- Chevrolet_Avalanche_1500_2WD_2004_20154
- Chevrolet_Blazer_4WD_2004_20263
- Chevrolet_Blazer_FWD_2019_41171
- Chevrolet_Equinox_FWD_2008_24573
- Chevrolet_Tahoe_4WD_2021_44045
- Chevrolet_Tahoe_K1500_4WD_2017_37689
- Chevrolet_TrailBlazer_AWD_2009_25667
- Dodge_Durango_4WD_2000_16326
- Dodge_Durango_RWD_2017_37856
- Dodge_Durango_RWD_2021_43164
- Ford_Bronco_4WD_2023_46189
- Ford_Bronco_Sasquatch_4WD_2022_45000
- Ford_Edge_FWD_2012_31907
- Ford_Escape_2WD_2002_18064
- Ford_Escape_4WD_2003_19153
- Ford_Escape_FWD_2011_30736

12. Finding Economical Family Vehicles

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

DL Formalization:

$\text{Vehicle} \sqcap$
 $\exists \text{hasSizeClass}.\{\text{MidsizeSize}\} \sqcap$
 $\exists \text{cylinders}.\{ \geq 4 \} \sqcap$
 $\exists \text{epaFuelEconomyScore}.\{ \geq 6 \}$

DL for Protege:

$\text{Vehicle} \text{ and } (\text{hasSizeClass} \text{ value MidsizeSize}) \text{ and } (\text{cylinders} \text{ some xsd:decimal}[\geq 4.0]) \text{ and } (\text{epaFuelEconomyScore} \text{ some xsd:decimal}[\geq 6.0])$

DL query

Query (class expression)

$\text{Vehicle} \text{ and } (\text{hasSizeClass} \text{ value MidsizeSize}) \text{ and } (\text{cylinders} \text{ some xsd:decimal}[\geq 4.0]) \text{ and } (\text{epaFuelEconomyScore} \text{ some xsd:decimal}[\geq 6.0])$

Execute Add to ontology

Query results

Instances (25 of 25)

- Acura_RLX_Hybrid_2017_37920
- Alfa_Romeo_Giulia_2021_43352
- BMW_X2_sDrive28i_2022_43833
- Buick_LaCrosse_eAssist_2016_36460
- Buick_Regal_2015_35003
- Chevrolet_Cruze_Hatchback_2018_39231
- Chevrolet_Malibu_2017_37928
- Dodge_Dart_2016_36404
- Honda_Accord_2017_37626
- Honda_Civic_4Dr_2018_39567
- Hyundai_Elantra_2019_40371
- Kia_Forte_2013_32610
- Kia_Forte_FE_2022_44562
- Lexus_GS_450h_2016_37148
- Lexus_UX_200_2022_44472
- Mazda_6_2014_33400
- Nissan_Kicks_2023_45766
- Subaru_Impreza_4_Door_2017_38329
- Subaru_Impreza_Sport_4_Door_2020_42010
- Toyota_Camry_Hybrid_LE_2017_37828
- Toyota_Camry_Hybrid_SE_XLE_XSE_2023_45727

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:

Vehicle $\sqcap \exists$ hasFuelType.{Premium} $\sqcap \exists$ cylinders.(≥ 8) $\sqcap \exists$ hasMarketSegment.{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.

DL query

Query (class expression)

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

Execute Add to ontology

Query results

Instances (54 of 54)

- Aston_Martin_DBS_2019_40865
- Aston_Martin_DB_7_GT_Coupe_2003_18341
- Audi_R8_2014_33443
- Audi_R8_2WD_2021_43323
- Audi_R8_AWD_2020_41395
- Audi_R8_Coupe_RWD_2023_45645
- Audi_RS4_Cabriolet_2008_24774
- Audi_S4_2007_23170
- Audi_S4_Cabriolet_2007_23123
- Audi_S6_2007_23554
- Audi_S8_quattro_2001_16742
- BMW_530i_1994_10862
- BMW_530i_1994_10863
- BMW_540i_2002_17512
- BMW_M8_Competition_Convertible_2022_43783
- BMW_M8_Competition_Coupe_2025_47702
- BMW_X5_M_2017_37998
- BMW_X5_xDrive50i_2018_39521
- Bentley_Bentayga_2023_45905
- Cadillac_Escalade_2WD_2021_42616
- Chevrolet_Camaro_2022_44110

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:

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

DL for Protege:

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

DL query

Query (class expression)

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

Execute Add to ontology

Query results

Instances (19 of 19)

- BMW_228i_Gran_Coupe_2024_46654
- BMW_228i_xDrive_Gran_Coupe_2024_46653
- BMW_430i_Convertible_2022_44278
- BMW_430i_Convertible_2023_45602
- BMW_430i_Convertible_2025_47767
- BMW_840i_Gran_Coupe_2022_43834
- BMW_M440i_xDrive_Convertible_2024_46525
- BMW_M8_Competition_Convertible_2022_43783
- BMW_M8_Competition_Coupe_2025_47702
- BMW_X2_sDrive28i_2022_43833
- BMW_X4_M_Competition_2023_45551
- BMW_X4_xDrive30i_2021_42901
- BMW_Z4_M40i_2025_47764
- Mercedes-Benz_AMG_GLA35_4matic_2021_43059
- Mercedes-Benz_CLS450_4matic_2022_44623
- Mercedes-Benz_E450_4matic_Convertible_2023_46047
- Mercedes-Benz_E450_Convertible_2023_46216
- Mercedes-Benz_EQS_580_4matic_SUV_2024_47851
- Mercedes-Benz_GLS600_4matic_Maybach_2024_47208

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.