



ONTOLOGY REPORT

IA 301 Course: Logics and Symbolic AI

Urban transport ontology: a recommendation system relying on day-to-day time constraints

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The ontology can be found in the githubs of each participant of the project:

David Carteau : <https://github.com/david-carteau/IA301/tree/master/UrbanTransportOntology>

Axel Veillas : <https://github.com/AVeillas/IA301-urban-transport-ontology>

Karen Hubert : <https://github.com/karen-hubert/IA301/tree/main/Projet>

Introduction

Urban transport and mobility have always been and remain great challenges for large cities. In Paris, urban transport issue has been present since the middle of the 18th century, through the transformation of the city by Baron Haussmann until now with the creation of the “Grand Paris”. Urban transport is also a major concern for sustainable development recognized by the United Nations since 1992:

“Over the next twenty years, transportation would be expected to be the major driving force behind a growing world demand for energy (...) it is now the largest end-use of energy in developed countries and the fastest growing one in most developing countries.”¹

The United Nations defined several goals to solve Sustainable Development Problem. The Goal 11 is to make cities and human settlements inclusive, safe, resilient and sustainable, and dedicated to it a topic on Sustainable transport.

We decided to build our ontology on the topic of urban transports to understand the stakes of building a better urban transport network to sustainable development, but also to link ourselves to everyday life concepts for the creation of the ontology. We built a recommendation system of transport depending on users’ constraints.

Description of the ontology

The ontology is designed to support a decision-making transport choice and relies on characteristics of the different transport modes taking into account users’ choices, constraints or limits such as economic or ecological ones.

Shape of the ontology

Initial classes



Figure 1 : The two main classes of the ontology

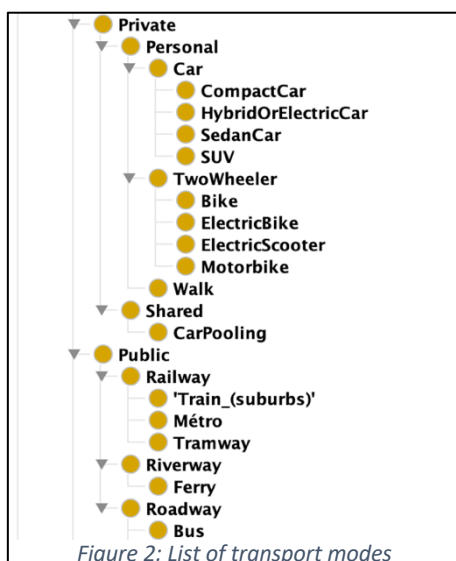


Figure 2: List of transport modes

We defined two important *classes* **DomainThing** and **ValuePartition** (cf. figure 1).

We listed the different transport modes that exist in a structured way (cars, two-wheelers, public transports) and classified them in the *class* **DomainThing** (cf. figure2). These transport modes correspond to the *domains* of the defined object properties (cf. Object properties part).

To define the characteristics of the transport modes, we established the *sub-class* **TransportModeProperty** in the *class* **ValuePartition**. These characteristics reflect the economic, ecological or personal constraints of users:

¹ Sustainable transport topic of Goal 11 of the United nations: <https://sdgs.un.org/topics/sustainable-transport>

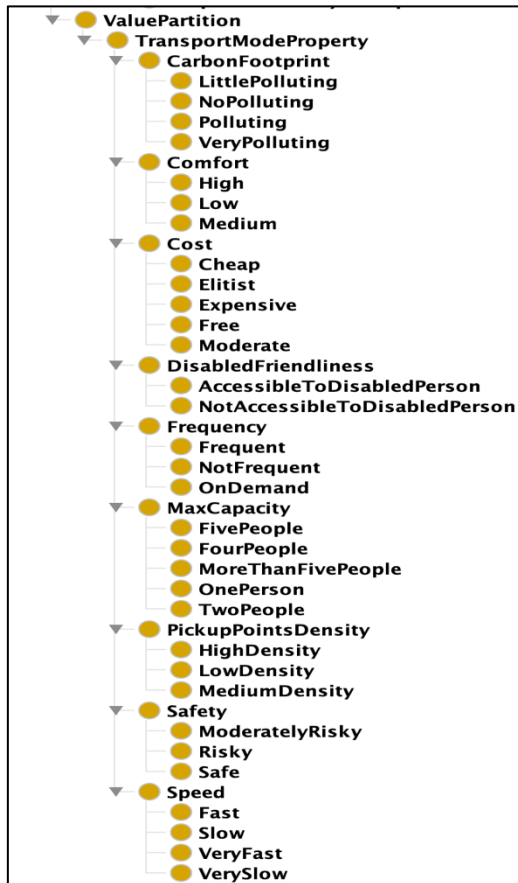


Figure 3: TransportModeProperty class

- Carbon footprint
- Comfort
- Cost
- Density of the pick-up points
- Disabled Friendliness
- Frequency
- Maximum capacity of passengers
- Safety
- And Speed.

For each *sub-classes* of the TransportModeProperty, we listed the possible *ranges* of the defined *object properties* (cf. Object properties part). The ranges are quite explicit (cf. figure 3) and permit us to define the *inferred classes* (cf. figure 4).

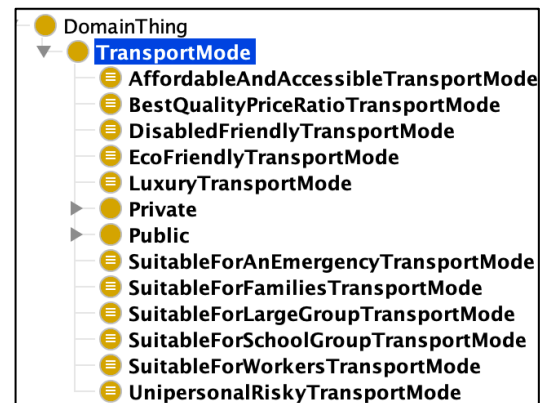


Figure 4: Classification classes

Object properties

The object properties are defined to characterize the different modes of transport and built in a mirror-like manner with the **ValuePartition** class.

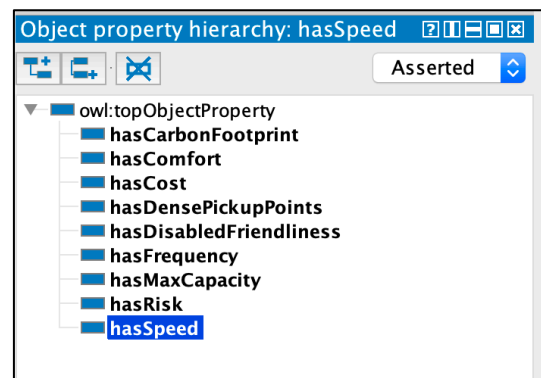


Figure 5: object properties hierarchy

The inferred classes

The class **DomainThing** is also composed of 11 other *classes* which are completed after running the reasoner. These classes are the basis of our recommendation system and can be seen as categorization / inferred classes (cf. figure 4).

Summary of the organization: The class **DomainThing** contains the *sub-class* **TransportMode** corresponding to a list of transport modes and the inferred classes necessary to the recommendation which relied on the *object properties*.

The class **ValuePartition** is composed of *sub-classes* which permit to define the *object properties*.

Using the object properties, we defined these *classes* taking into account different type of users:

- AffordableAndAccessibleTransportMode: for a significant proportion of townspeople and city-travelers who seek for the highest density of pickup points and the lowest possible cost, and defined as:

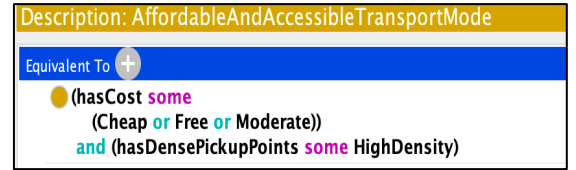


Figure 6: description of AffordableAndAccessibleTransportMode

- BestQualityPriceRatioTransportMode: for people who seek for the best quality/price ratio i.e. the most comfortable and fastest transport mode at the lowest price, and defined as:

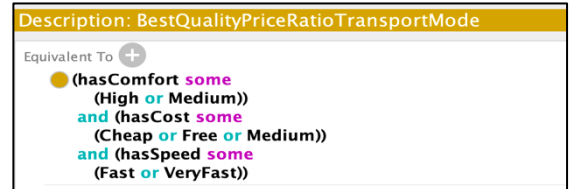


Figure 7: description BestQualityPriceRatioTransportMode

- DisabledFriendlyTransportMode: for disabled people who need adapted transport modes, and defined as:



Figure 8: description of DisabledFriendlyTransportMode

- EcoFriendlyTransportMode: for people who want a transport mode which respects the environment and contributes to a sustainable development of the city, and defined as:

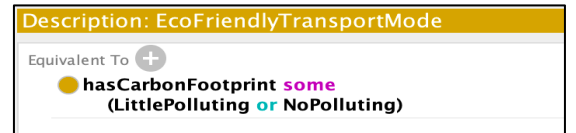


Figure 9: description of EcoFriendlyTransportMode

- LuxuryTransportMode: for VIPs, business(wo)men, people who want to underline their social status or just married people who want to show their love to the world (!), and defined as

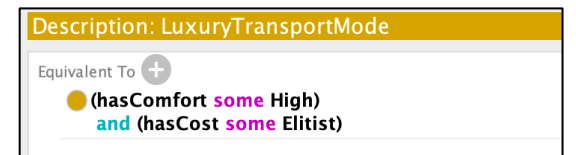


Figure 10: description of LuxuryTransportMode

- SuitableForAnEmergencyTransportMode: for emergencies (e.g. medical) which requires high frequency and speed, as well as safety, and defined as:

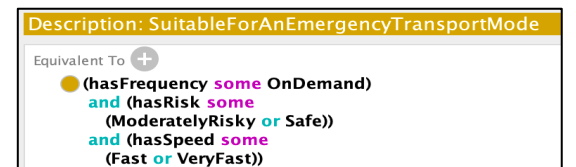


Figure 11: description of SuitableForAnEmergencyTransportMode

- SuitableForFamiliesTransportMode: for families who may want a secure transport mode with a certain level of comfort, and which is able to accept up to five people, and defined as:

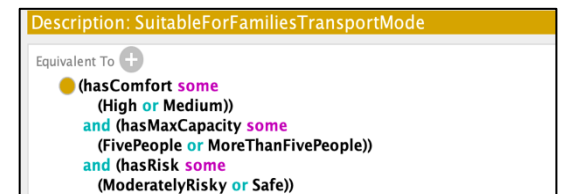


Figure 12: description of SuitableForFamiliesTransportMode

- SuitableForAnLargeGroupTransportMode: for a large groupe (more than 5 people) e.g. a group of tourists who may participate in an organized trip, and defined as:

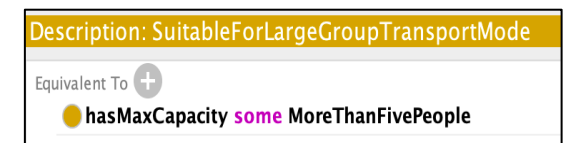


Figure 13: Description of SuitableForAnLargeGroupTransportMode

- SuitableForSchoolGroupTransportMode: for a school group where safety is crucial and the cost must be relatively low, and defined as:

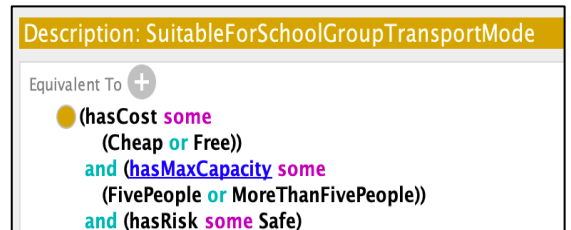


Figure 14: description of SuitableForSchoolGroupTransportMode

- SuitableForWorkersTransportMode: for employees who need to go to work and rely on a quite frequent transport mode at a reasonable cost, and defined as:

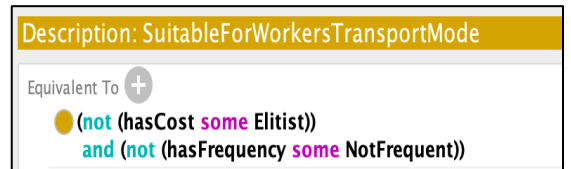


Figure 15: description of SuitableForWorkersTransportMode

- UnipersonalRiskyTransportMode: for young people who don't care to take risks or tourists who may want to discover the city using an exotic transport mode.



Figure 16: description of UnipersonalRiskyTransportMode

Graph of the ontology

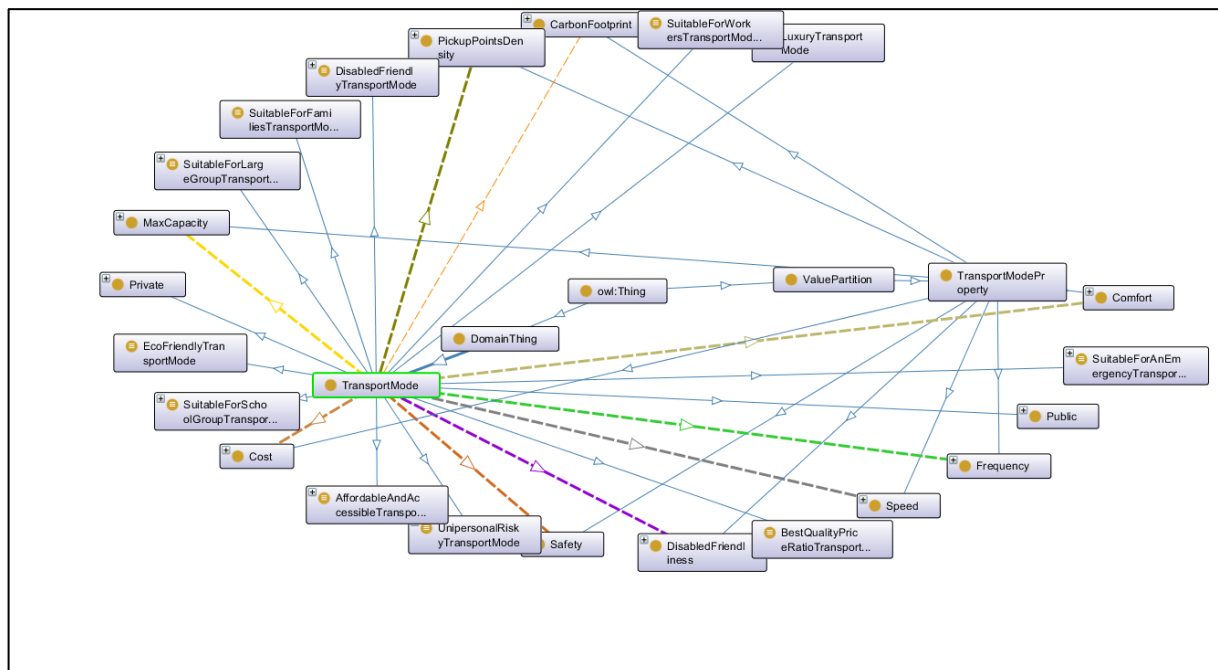


Figure 17: Graph of the ontology

The ontology before and after running the reasoner

To highlight the classification power of our ontology, please see the screenshots of the definitions and the ontology before and after running the reasoner.

Before running the reasoner

The inferred *classes* are empty before running the reasoner.

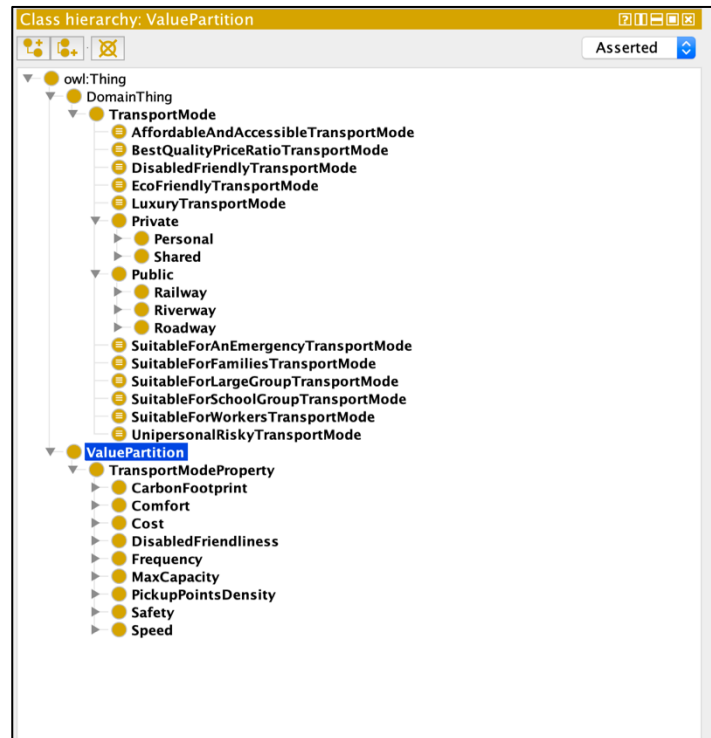
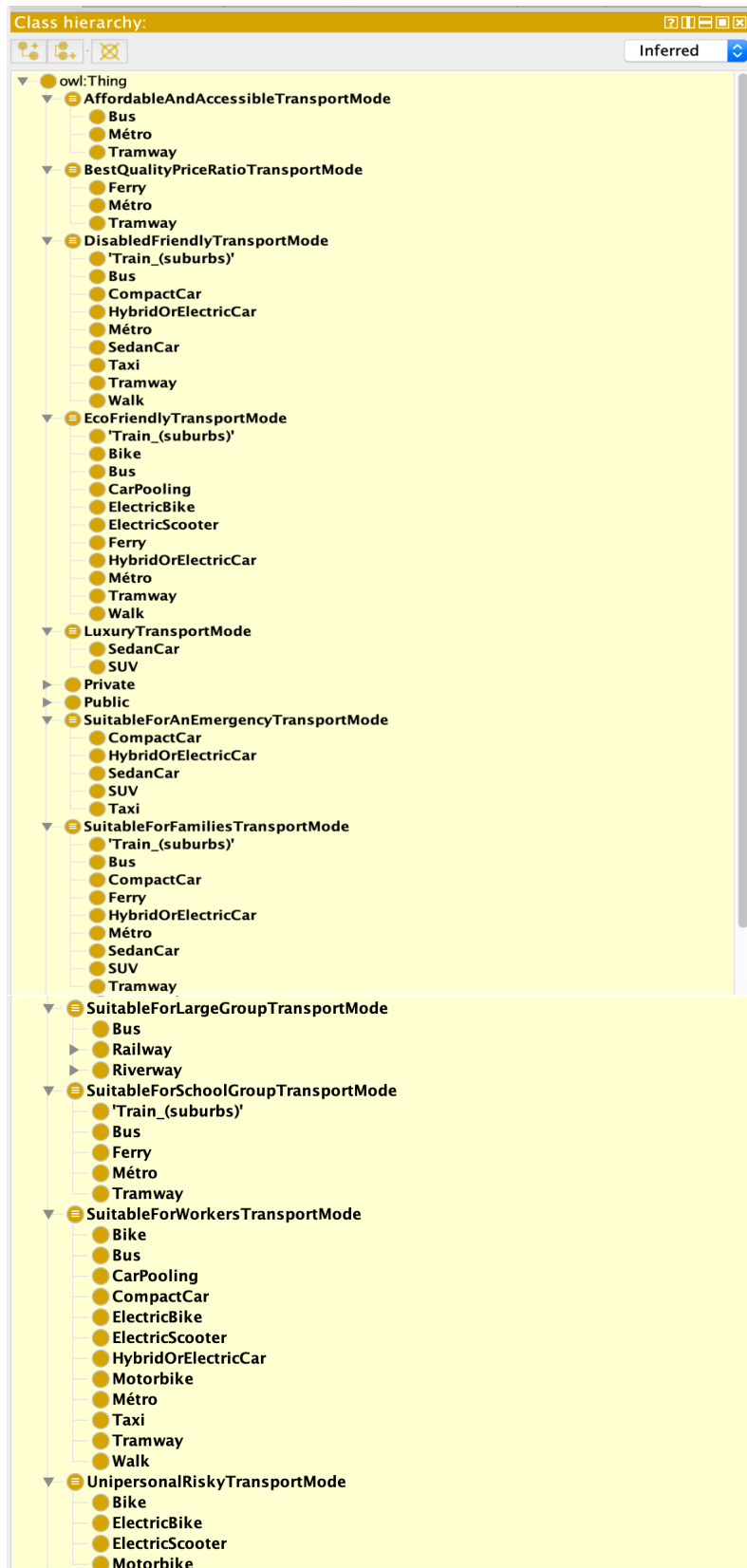


Figure 18: screenshot of the ontology before running the reasoner

After running the reasoner



After running the reasoner, we can see that each inferred class is now filled with transport modes.

The inferred classes permit the classification of each transport mode in the different inferred classes. For instance, each transport that is either unpolluted or with little polluting impact is included in the inferred class: `EcoFriendlyTransportMode`.

Conclusion

This ontology is a knowledge base that can be used to respond to one sub-issue of the goal 11 of the United Nations: sustainable transport; and can be seen as a recommendation system of transport modes for people who have economic, ecological and/or personal constraints.

This project allowed us to have a hands-on experience on the Protégé tool and to understand how it works based on a day-to-day life example: urban transport. However, we faced some difficulties to build this ontology, in particular regarding the many possibilities in terms of definition of properties but also in terms of transport modes available. For this exercise, we limited ourselves to urban transport modes i.e. transport modes to go from point A to point B in the same city (we took Paris as an example) and generic constraints that we all have in mind when choosing between transport modes: cost, comfort, speed, safety, etc.

This transport mode ontology could be enriched with a lot of specialized properties such as:

- Type of oil used for thermic cars: gasoline, unleaded petrol,
- Type of alternative sources of energy: biogas, dihydrogen, etc.
- Recharging time and means of electric cars: use of specific electric devices such as high-power charging, DC or AC, etc.