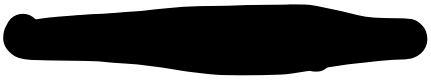
Artificial Intelligence
Laboratory 2: Air Company Ontology



1 Introduction

This report will describe the process followed to create an ontology for an air company, which will help to organise all its structure and elements. An ontology contains, essentially a formal representation of entities and relations between them. Therefore, it is a good solution for the company to keep track on every element involved in a flight: all of its aircrafts, employees, customers...

2 Vocabulary

The company was asked about all the elements that would like to have present in the ontology. That not only implies the ones that take part when a flight is planned, but also the elements referred to the people who work in the company, and the actions that may take place when the flight finishes. These were the elements given by the company:

- Flight: one of the main elements, represents the relation between an origin and a destination.
- National flight: these are the ones that take place inside the same country.
- International flight: fly between two different countries, so some restrictions may apply.
- Flight plan: contains the instructions for a particular flight, and details such as the number of flight.
- Airport: it is always a place of departure and arrival for each flight, and they both have to be different.
- Route: always part of a flight plan, it determines the key points that the aircraft has to cover in order to achieve its destination.
- Aircraft: represents each one that the company has. A flight needs to be operated by one.
- Brand: the company has aircrafts of the two most important brands in the industry: Airbus and Boeing.

- Large distance aircraft: these are the ones that can cover routes across an ocean.
- Short distance aircraft: only can fly inside a continent.
- Model: there are only four models, which have its own categories of aircrafts.
- 737: aircraft model of Boeing which can cover short distance routes.
- 747: aircraft model of Boeing which can cover large distance routes.
- A300: aircraft model of Airbus which can cover short distance routes.
- A330: aircraft model of Airbus which can cover large distance routes.
- Passenger: represents the customers of the company, who can make reservations for a flight.
- Standard passenger: every normal customer will belong to this category, having the usual taxes at the moment of making a reservation.
- Premium passenger: if a user belongs to this category, for example because of being a regular passengers, may enjoy special discounts and other facilities.
- Seat: they are contained inside an aircraft, and are related to a flight.
- Tourist seat: available for every passenger, has no special features.
- Business seat: only reserved for premium passengers, can have extra amenities, such as longer space for legs.
- Employee: person who works on the company, playing a particular role.
- Pilot: employee that is responsible for piloting an aircraft in a particular flight.
- Main pilot: has the highest responsibility at the moment of flying an aircraft.
- First officer: can assume the same tasks that a main pilot could do, but the level of responsibility is lower.
- Cabin crew member: helps to organise the passengers during a flight, and to comply with the security rules.
- Technicians: can make the necessary inspections to the aircrafts.
- Inspection: contains the details of a reparation made to a particular aircraft by a technician.
- Complaint: it is created by a user if he or she is not happy after a particular flight.

3 Developing the ontology

Once all the data was retrieved, the process to develop the ontology can begin. Most of the elements above can be defined as classes, as they have the enough weight to be considered like that.

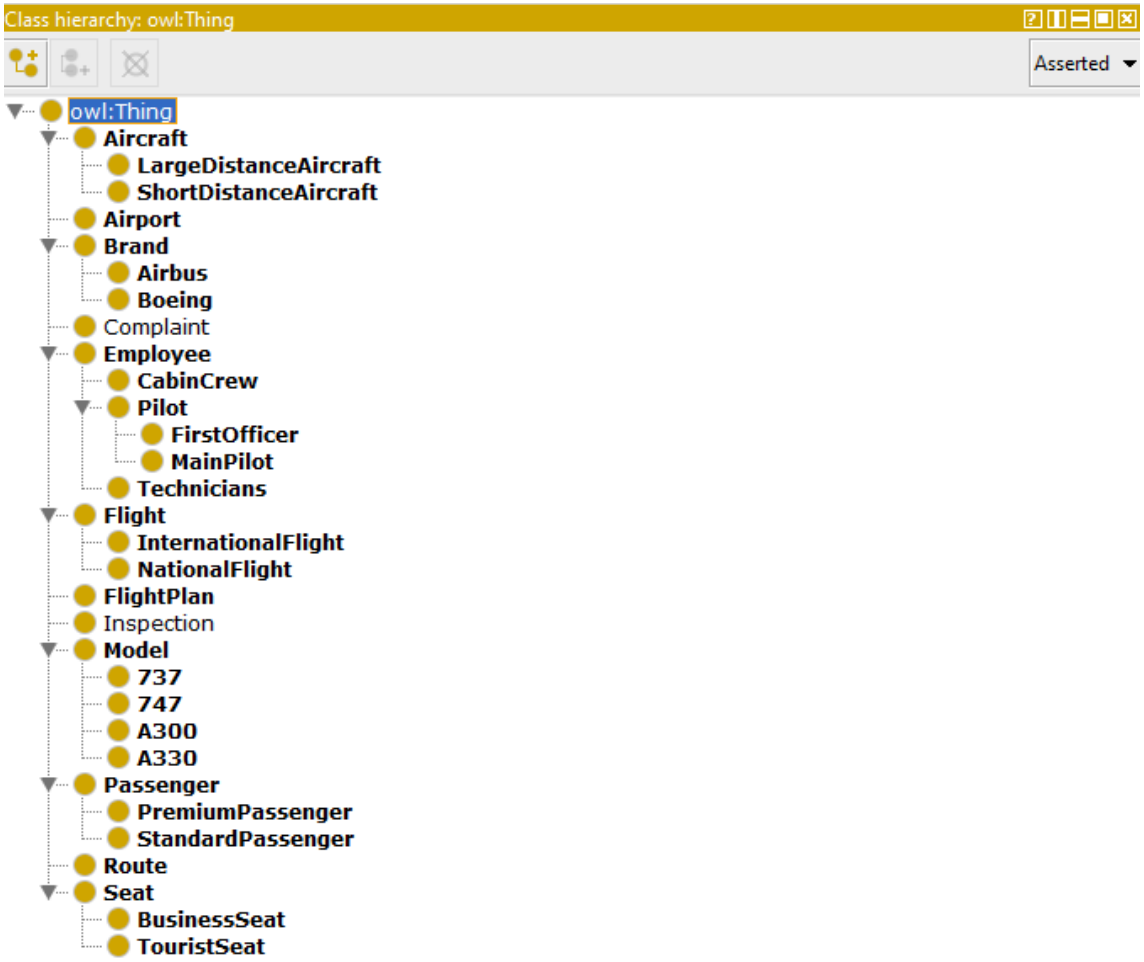


Figure 1: Class hierarchy

Figure 1 shows the classes defined to represent each element. It is true that both large and short distance aircraft could be considered as properties, but it was not considered in the end. This is because they should be able to be linked directly with either national or international flights respectively, as they have to be operated by them. Apart from that, it will make the queries easier.

Object Property	Func	Sym	Inv...	Tra...	AS...	Refl	Irrefl	Domain	Range	Inv...
owl:topObjectProperty										
isInspected								Aircraft	Inspection	
hasReservedPremium								PremiumPassenger	BusinessSeat	
isOperated								Flight	Aircraft	
hasPlan								Flight	FlightPlan	
makeInspection								Technicians	Inspection	
isPart								Route	FlightPlan	
hasAssociated								Complaint	Flight	
isModelOfAirbus								A330, A300	Airbus	
assists								FirstOfficer	Flight	
hasSeats								Aircraft	Seat	
hasLongDistanceAircraft								InternationalFlight	LargeDistanceAircraft	
pilots								MainPilot	Flight	
takesPart								CabinCrew	Flight	
isModelOfBoeing								737, 747	Boeing	
createsComplain								Passenger	Complaint	
isDestination								Airport	Flight	
hasReservation								Passenger	Flight	
hasShortDistanceAircraft								NationalFlight	ShortDistanceAircraft	
hasBrand								Aircraft	Brand	
hasBusinessSeat								PremiumPassenger	BusinessSeat	

Figure 2: Properties

In figure 2 the properties defined for the elements can be seen. All the relationships between the classes specified in the vocabulary are established with them. One example is the `hasLongDistanceAircraft` described above, which only joins the `InternationalFlight` class with `LargeDistanceAircraft`.

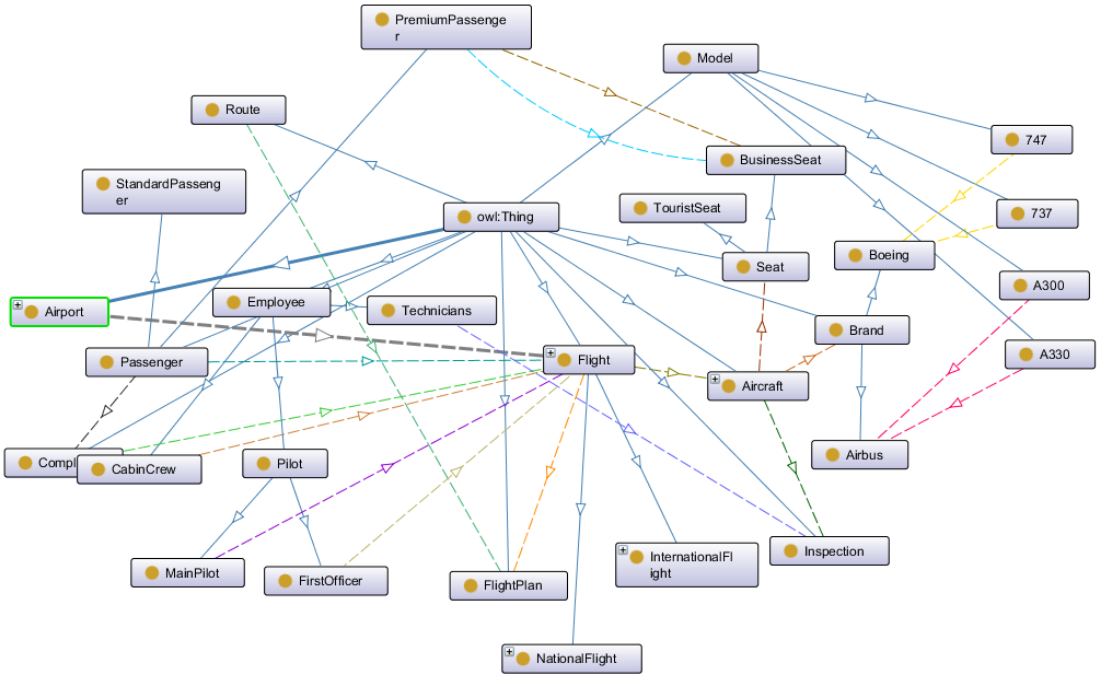


Figure 3: Ontograph

The ontograph, which is displayed in figure 3, contains all the relationships seen in figure 2, as well as the class hierarchy represented graphically.

4 Ontology checking

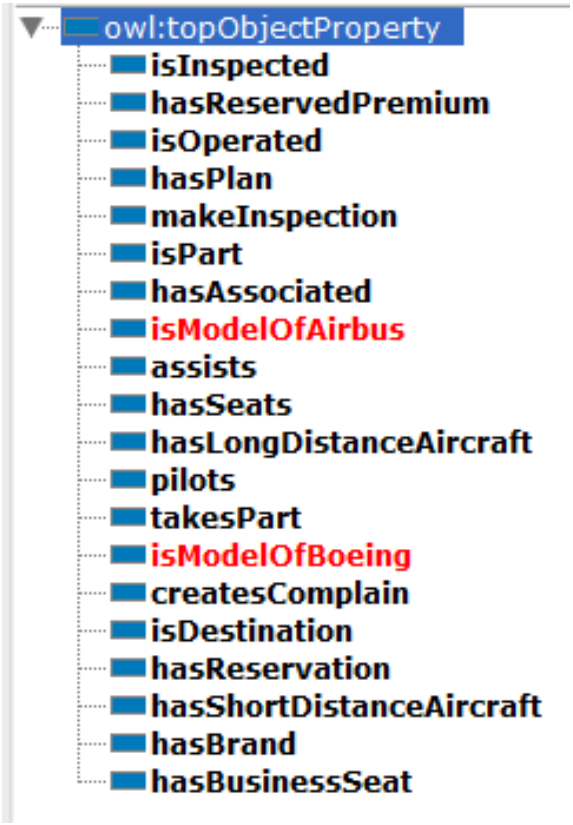


Figure 4: Errors after running HermiT

To test the ontology, two reasoners were run. The first one was HermiT, which threw two errors, seen in figure 4. This was because these properties had two elements in their domain.

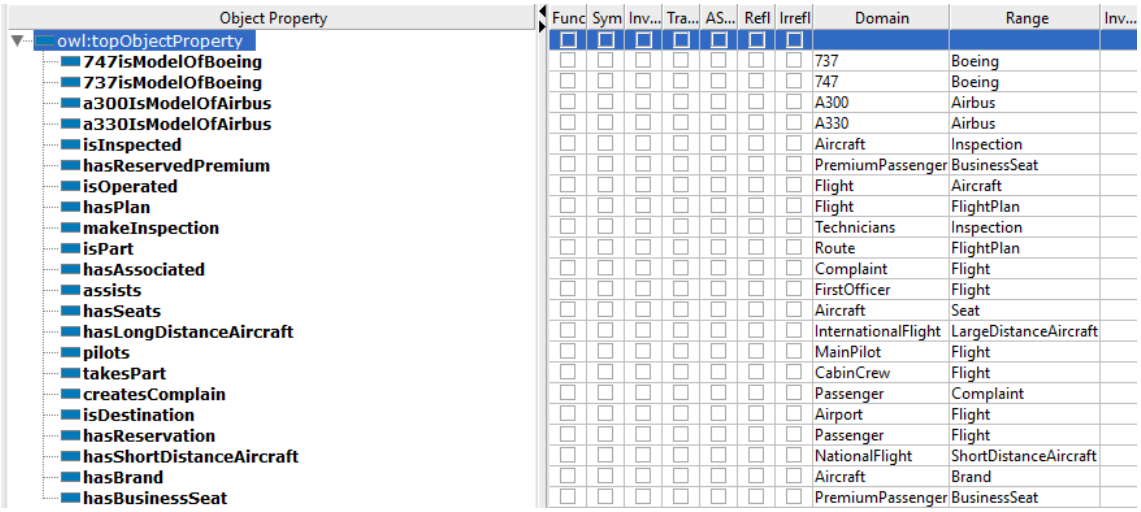


Figure 5: New table of properties

The errors could be fixed by creating two new properties for each model, resulting in the new properties table seen in figure 5. After this change, HermiT was started again. After that, the Pellet reasoner was run, giving no errors either. Therefore, it was concluded that the ontology had no significant errors.

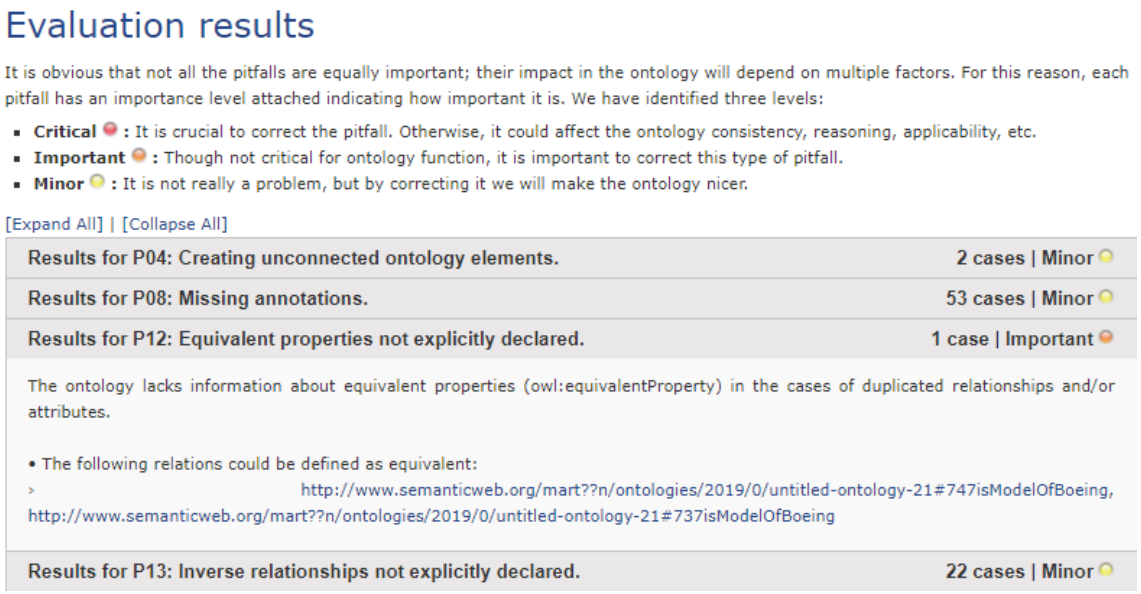


Figure 6: OOPS tool results

Using the OOPS! web tool, the ontology was analysed, which results are shown in figure 6. The minor errors were not fixed due to the fact that most of them are missing annotations, but the elements are already explained in this PDF file. The important warning was not considered because the explanation was not convincing enough, as there are another two equivalent relations joining two elements in the same way as `747isModelOfBoeing` and `737isModelOfBoeing` do. This relations are `A300IsModelOfAirbus` and `A330IsModelOfAirbus`. Therefore, no further changes were made to the ontology.

5 SPARQL

Although no actual data was provided by the company to introduce in the ontology, SPARQL queries can be created in order to retrieve particular data that is of interest. Below there are presented some examples with the pertinent elements that would be returned.

```
SELECT ?Flight WHERE { ?Airport rdfs:range ?JFK }
```

This query would return all the flights that have the New York JFK airport as origin or destination.

```
SELECT ?Technicians WHERE { ?Inspection rdfs:range ?Aircraft }
```

This query would return the technicians that have made an inspection to all the inspected aircrafts.

```
SELECT ?Complaint WHERE { ?Complaint rdfs:range ?Flight }
```

This query would return the complaints made in a particular flight.

```
SELECT ?CabinCrew WHERE { ?CabinCrew rdfs:range ?NationalFlight }
```

This query would return the cabin crew members that take part on national flights.

```
SELECT ?PremuiumPassenger WHERE { ?PremiumPassenger rdfs:range
↪  ?BusinessSeat }
```

This query would return the premium passengers that have reserved a business seat on any flight.