Why did that happen?

OWL and Inference: Practical examples
Inference and Classes

• The *people and pets* example ontology contains a number of classes and properties intended to illustrate particular aspects of reasoning in OWL.

• We can make inferences about relationships between those classes, in particular subsumption between classes.
Inference and Individuals

• In addition, the ontology contains a number of individuals

• We can make inferences about the individuals, in particular inferring that particular individuals must be instances of particular classes
  – because of subsumption relationships between classes, or
  – because of the relationships between individuals.
Classes

- The following examples illustrate reasoning with classes
- We look at why particular classes can be inferred to be subsumed by (more specific than) other classes
- We also look at why particular classes can be inferred to be inconsistent
Bus Drivers are Drivers

A bus driver is a person that drives a bus

A bus is a vehicle

A bus driver drives a vehicle, so must be a driver

The subclass is inferred due to subclasses being used in existential quantification.
Cat Owners like Cats

- Cat owners have cats as pets
- has pet is a subproperty of likes, so anything that has a pet must like that pet.
- Cat owners must like a cat.
- The subclass is inferred due to a subproperty assertion
Drivers are Grown Ups

- Drivers are defined as persons that drive cars (complete definition)
- We also know that drivers are adults (partial definition)
- So all drivers must be adult persons (e.g. grownups)
- An example of axioms being used to assert additional necessary information about a class. We do not need to know that a driver is an adult in order to recognize one, but once we have recognized a driver, we know that they must be adult.
Sheep are Vegetarians

- Sheep only eat grass
- Grass is a plant
- Plants and parts of plants are disjoint from animals and parts of animals
- Vegetarians only eat things which are not animals or parts of animals
- **Note the complete definition, which means that we can recognise when things are vegetarians.**
Giraffes are Vegetarians

- Giraffes only eat leaves
- Leaves are parts of trees, which are plants
- Plants and parts of plants are disjoint from animals and parts of animals
- Vegetarians only eat things which are not animals or parts of animals
- Similar to the previous example with the additional inference provided by the existential restriction in the definition of leaf

```
Class(a:giraffe partial a:animal
  restriction(a:eats allValuesFrom (a:leaf)))
Class(a:leaf partial restriction(a:part_of someValuesFrom (a:tree))
Class(a:tree partial a:plant)
DisjointClasses(unionOf(restriction(a:part_of someValuesFrom (a:animal)) a:animal)
  unionOf(a:plant restriction(a:part_of someValuesFrom (a:plant))))
Class(a:vegetarian complete intersectionOf(
  restriction(a:eats allValuesFrom (complementOf(restriction(a:part_of someValuesFrom (a:animal)))))
  restriction(a:eats allValuesFrom (complementOf(a:animal)) a:animal))
```
Old Ladies own Cats

Class(a:old+lady complete intersectionOf(a:person a:female a:elderly))

Class(a:old+lady partial intersectionOf(
  restriction(a:has_pet allValuesFrom (a:cat))
  restriction(a:has_pet someValuesFrom (a:animal))))

Class(a:cat+owner complete intersectionOf(a:person restriction(a:has_pet someValuesFrom (a:cat)))))

• Old ladies must have a pet.
• All pets that old ladies have must be cats.
• An old lady must have a pet that is a cat.
• An example of the interaction between an existential quantification (asserting the existence of a pet) and a universal quantification (constraining the types of pet allowed).
• This also illustrates that an ontology is one view on the world – you may disagree with my modelling but I am being explicit about it.
Mad Cows are inconsistent

- Cows are naturally vegetarians
- A mad cow is one that has been eating sheep's brains
- Sheep are animals
- Thus a mad cow has been eating part of an animal, which is inconsistent with the definition of a vegetarian.
Individuals

• The following examples illustrate reasoning with individuals.

• We look at why particular individuals can be inferred to be members of particular classes.
The Daily Mirror is a Tabloid

- Mick drives a white van
- Mick must be a person and an adult, so he is a man
- Mick is a man who drives a white van, so he’s a white van man
- A white van man only reads tabloids, and Mick reads the Daily Mirror, thus the Daily Mirror must be a tabloid
- Here we see interaction between complete and partial definitions plus a universal quantification allowing an inference about a role filler.
Pete is a Person, Spike is an Animal

- Spike is the pet of Pete
- So Pete has pet Spike
- Pete must be a PetOwner and hence a Person
- Spike must be a Pet and hence an Animal
- Here we see an interaction between an inverse relationship and domain and range constraints on a property.
Walt loves animals

- Walt has pets Huey, Dewey and Louie
- Huey Dewey and Louie are all distinct individuals
- Walt has at least three pets and is thus an animal lover.
- Note that in this case, we don’t actually need to include person in the definition of animal lover (as the domain restriction will allow us to draw this inference).
Tom is a Cat

- Minnie is elderly, female and has a pet, Tom
- Minnie must be a person
- Minnie is be an old lady
- All Minnie’s pets must be cats.
- Here the domain restriction gives us additional information which then allows us to infer a more specific type. The universal quantification then allows us to infer information about the role filler.