Foundations of the Semantic Web
Lecture 4a
A Key Pattern and a Problem
Classes as Values

Alan Rector

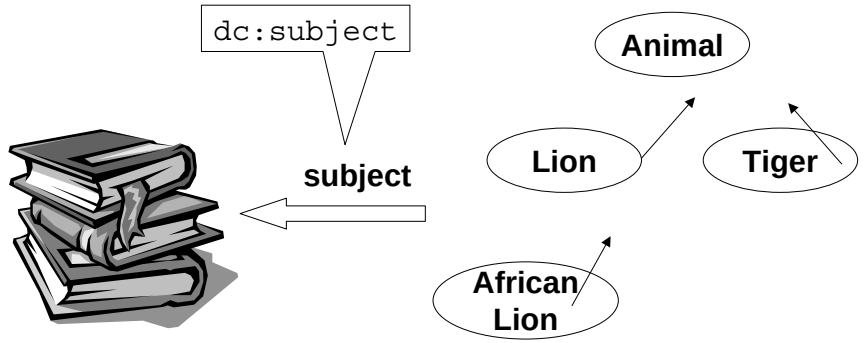
Part V – Patterns: Classes as values

- Upper ontologies & Domain ontologies
- Building from trees and untangling
- Using a classifier
- Closure axioms & Open World Reasoning
- Specifying Values
- n-ary relations
- *Classes as values – using the ontology*
- Part-whole relations

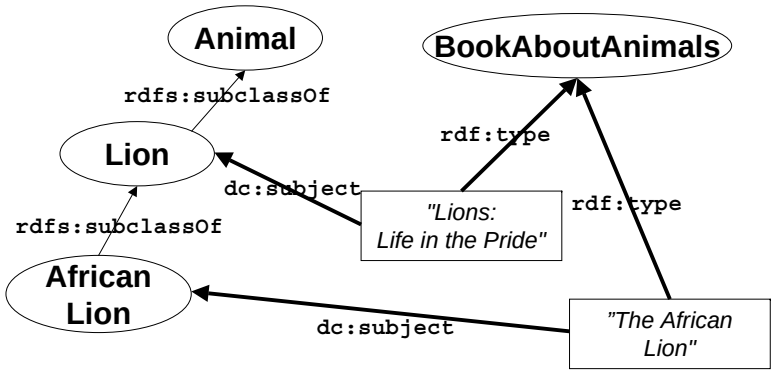
Why are Classes as Values as Problem?

- In OWL DL nothing can be both a class and an individual
  - In classic Protégé and most frame languages everything is an individual of something
    - The class MetaClass is an instance of itself.

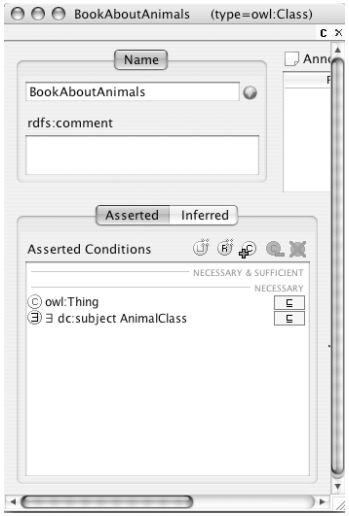
Using Classes as Property Values



Using Classes Directly As Values



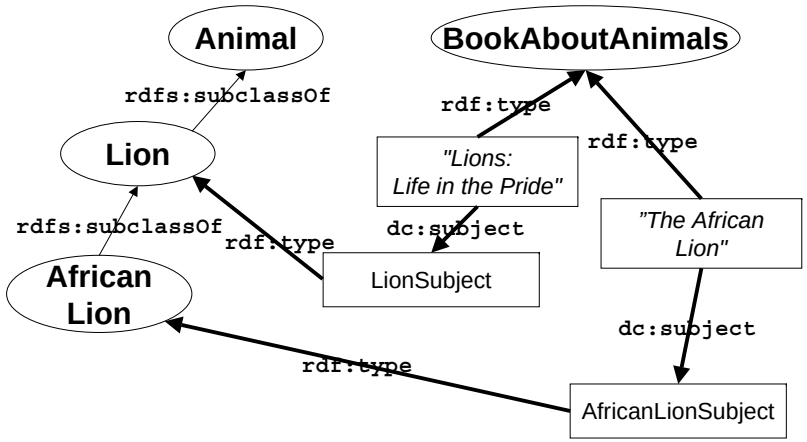
Representation in Protégé



Approach 1: Considerations

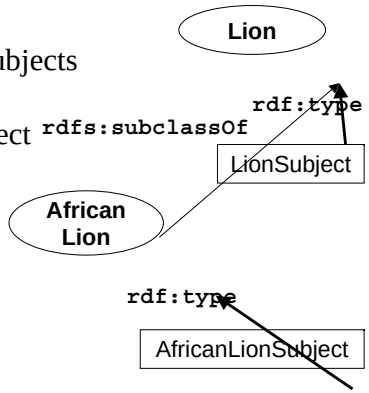
- Compatible with OWL Full and RDF Schema
- Outside OWL DL
  - Because classes cannot be values in OWL-DL
    - Nothing can be both a class and and instance

Approach 2: Hierarchy of Subjects

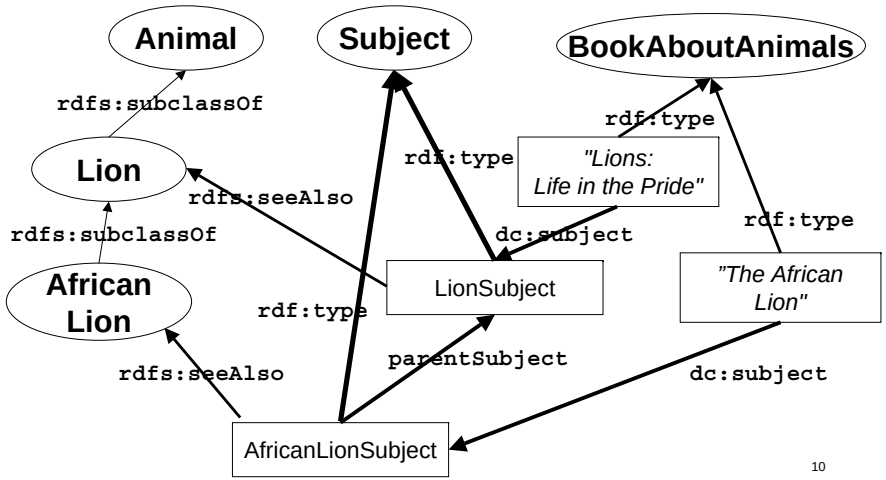


Hierarchy of Subjects: Considerations

- Compatible with OWL DL
- Instances of class Lion are now subjects
- No direct relation between LionSubject and AfricalLionSubject
- Maintenance penalty

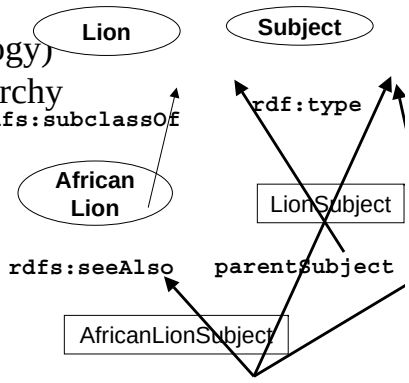


Hierarchy of Subjects

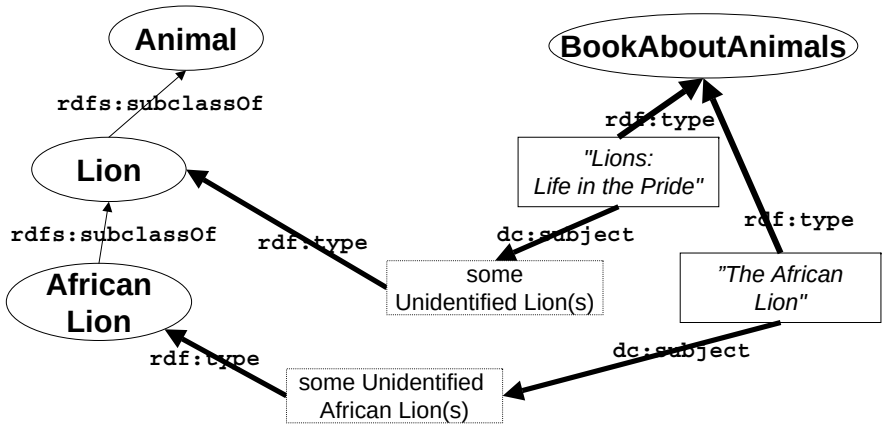


Hierarchy of Subjects: Considerations

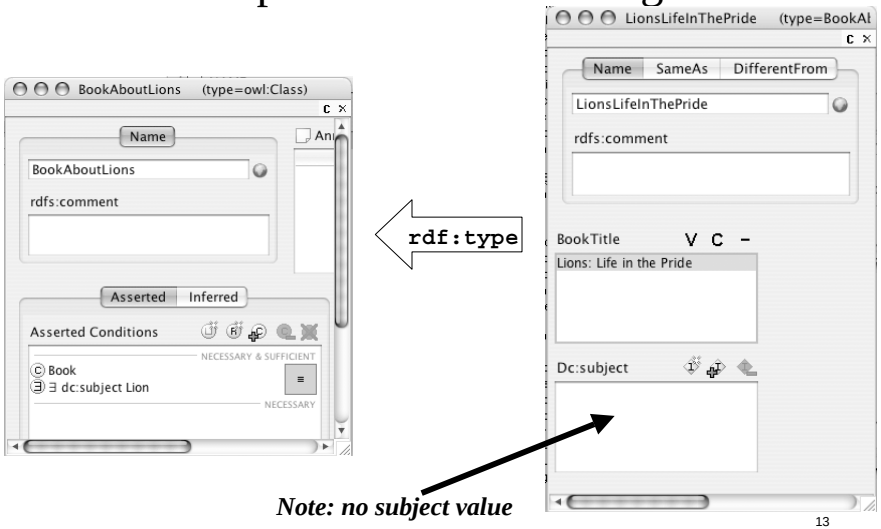
- Compatible with OWL DL
- Subject hierarchy (terminology) is independent of class hierarchy (rdfs:seeAlso)
- Maintenance penalty



Using members of a class as values



Representation in Protege



Considerations

- Compatible with OWL DL
- Interpretation: the subject is one or more specific lions, rather than the Lion class
- Can use a DL reasoner to classify specific books

Foundations of the Semantic Web
Lecture 4a
A Ridiculously Brief Glance at Representing Time & Space

Alan Rector

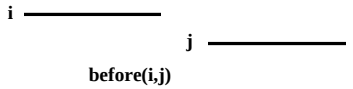
Extents, Intervals, and Ordering

- "Extent" is general term for a point, interval, area, volume, etc. in space and/or time
- Time comes with natural coordinates
  - Many spatial measures are also laid out with coordinates
- Timed is concerned with points and interval
  Space with points, intervals, areas, and volumes
- Most temporal and spatial reasoning beyond OWL

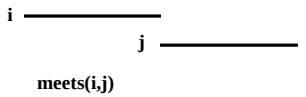
A few things you should know
Axioms of Ordering of time or lines

- For points in an ordered one-dimensional space
  - Anti-symmetry
    $X<Y \rightarrow \neg(Y<X)$
  - Transitivity
    $X<Y \ \& \ Y<Z \rightarrow X<Z$
  - Totality
    $X<Y \vee Y<X \vee X=Y$

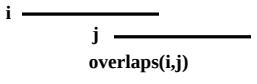
For an Ordered One Dimensional Space
Relations between Intervals



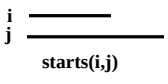
before(i,j)



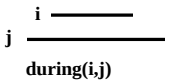
meets(i,j)



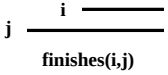
overlaps(i,j)



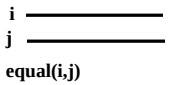
starts(i,j)



during(i,j)



finishes(i,j)



equal(i,j)

The "Allen Calculus" specifies the results of combining intervals.
There are precisely 13 possible combinations including symmetries (6 * 2 + 1)

Exercise

- Write down the axioms that should apply to the relations between intervals
  - r1(X,Y) & r2(Y,Z) → r?(X,Z)
    - e.g.
      before(X,Y) & before(Y,Z) → before(X,Z)

Points and Intervals

- Time representations are either point based or interval based
  - A point can be viewed as:
    - An interval of zero length
    - One of the set of ordered things that make up an interval.
  - Points can be:
    - Contained in intervals
    - The start or end of the interval
      - start(I) or end(I)

Classic Situation Calculus
Time, Situations, and Fluents

- Situation = a cross section of time
- Representation as parameter
  - "The radio was on at 9:00"
    on(radio, S9:00)
- Representation by fluents (things that can be true in situations)
  - "the radio was on at 9:00"
    true_in(s9:00, on(radio))

Basic Assumptions

- There is an integral measure *clock time*
  - The differential measure of clock time is *duration*
- Intervals of clock times are sets of clock times
  - "Kenedy was president throughout 1962"
    S Î year_1962 « kennedy=value_in(S, president(us))

Events, States and Fluents

- Fluents refer to time points and may be of three types:
  - Things that can have values - *states*
    - NB "state" is used differently by other authors!
  - Things that can occur - *events*
  - Things that change things - *processes*
    - Davis defines processes as a special case of state which can be *active* or *inactive*

Processes and *Events*
Alternative View

- *Processes* have duration and correspond to intervals and have positive duration.
- *Events* correspond to points and have zero duration.
- *States* have values and may hold those values and have a duration but the duration may be zero.
  - In most ontologies states must correspond to intervals, though the intervals may be of zero length.

What is an event? A process?

- He sat down at three o'clock sharp.
- He sat down slowly and carefully.
- He was so stiff that it took him nearly a half a minute to sit down
- He sat down before the meeting.

- The birthday party took place on Tuesday
- The birthday party lasted three hours.
- The birthday party was the biggest event of the season

Situations and OWL/DLs

- Full situation calculus beyond OWL or DLs
  - and even to attempt it need concrete data types
- Can use the idea of a situation
  - If using an event-based view of time
    - The class of situations in which someone is sitting down at 18:00
    - Sitting_at_1800 ≅
      Situation and
      (hasFluent someValuesFrom SittingProcess) and
      (occursAt someValuesFrom
      (Event and occursAt value 1800)))

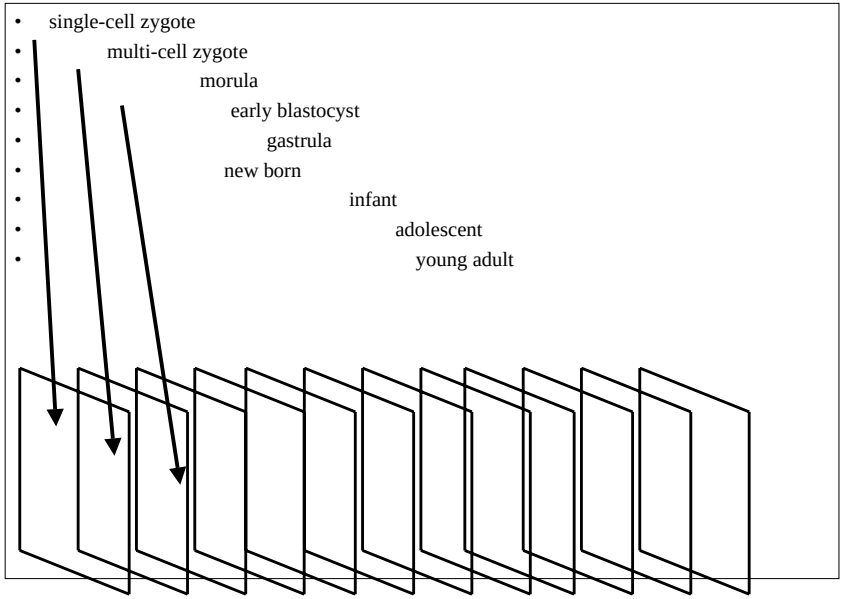
Situations and OWL/DLs (cont)

- if using an interval based view of time
  - Sitting_between_1800_and_1801 ≅
    Situation and
    (hasFluent someValuesFrom SittingProcess) and
    (occurs_during someValuesFrom
    (Interval and (hasStartTime value 1800)
    and (hasEndTime value 1801)))

Snaps and Spans 3D and 4D views Yet another View

- Another version is to index by time
  - A "span" is entire history of an entity through time
    - Spans are intrinsically four dimensional
  - A "snap" is a cross section of a span at a point in time.
    - Qualities of continuants are dependent on the SNAP and change in the course of a SPAN
      - e.g. an Apple can be green in one SNAP and red in a later SNAP
  - A "situation" is a piece of situated information in a 4-D universe; a "Snap" is a three D section of a 4 d entity

Due to Barry Smith et al
(google "Barry Smith")



The Future of Time in OWL

- Might also represent ordering of time or intervals, but
  - most useful applications require both concrete domains and individuals
  - highly speculative at this time
  - but description logics are closely related to formally to temporal logics, so …