



## Characteristics of Property

- ❖ Can restrict domain and range to particular classes (often very general)
  - maritalStatus applies only to people
  - mass applies only to physical objects
- ❖ Properties can be
  - Functional or inverse functional
  - Total (every instance of domain participates)
    - enrolledInProgram total for student
  - Surjective (every instance of range participates)
    - Lecturer teaches Course is surjective

INFS3101/INFS7100 week 10, 22 November, 2005

Bob Colomb

7

## Characteristics of Property

- ❖ Properties can be
  - Injection (one-to-one)
    - Purchaser to Supplier productID correspondence
    - Inverse of functional is inverseFunctional
  - If domain and range are the same
    - Symmetric (reads in both directions)
      - coAuthor, competesWith
    - Transitive
      - partOf (sometimes), laterThan

INFS3101/INFS7100 week 10, 22 November, 2005

Bob Colomb

8

## Cardinality Restrictions on Property

- ❖ OWL cardinality: given an instance of the domain
  - Maximum number of instances of the range it is associated with
  - Minimum number of instances of the range it is associated with
  - Functional: max = 1
  - Forbidden: max = 0
  - Total: min = 1
  - Partial: min = 0

INFS3101/INFS7100 week 10, 22 November, 2005

Bob Colomb

9

## Cardinality Interacts with Subclass

- ❖ Cardinality can be strengthened on a subclass
  - Min increased or max decreased
- ❖ gradePointAverage: Student -> Real
  - Min = 0, Max = 1
  - On GraduatedStudent Min = 1
  - On NewStudent, Max = 0 (no gpa)

INFS3101/INFS7100 week 10, 22 November, 2005

Bob Colomb

10

## OWL Cardinality is a Class

- ❖ MinCardinality on gradePointAverage = 1
- ❖ Is the subclass of instances of the domain associated with at least 1 instance of the range
- ❖ To say that GraduatedStudent has min cardinality 1 on gradePointAverage
- ❖ Declare GraduatedStudent a subclass of the restriction class
- ❖ A restriction class can be named using owl:equivalentClass
  - WithGradePointAverage owl:equivalentClass (MinCardinality on gradePointAverage = 1)

INFS3101/INFS7100 week 10, 22 November, 2005

Bob Colomb

11

## Restrictions Generally Classes

- ❖ Owl:maxCardinality, owl:minCardinality, owl:cardinality
- ❖ One restriction to a restriction class
- ❖ Multiple restrictions intersect restriction classes
- ❖ Owl:cardinality is both max and min the same value.
  - Owl:cardinality = 1 on property P is the subclass of the domain of P consisting of instances associated with exactly one instance of the range.
  - The subclass of the domain on which P is both total and functional.

INFS3101/INFS7100 week 10, 22 November, 2005

Bob Colomb

12

## OWL Range Restrictions

- ❖ Also define subclasses of a property's domain, but involving the range.
- ❖ Owl:hasValue X on property P is the subclass of the domain of P associated with range instance X
- ❖ Owl:hasValue INFS3101 on property enrolledIn is the subclass of Student consisting of students enrolled in at least INFS3101.
- ❖ Class MarketForINFS3101ReadingBrick is a subclass of that restriction class.
- ❖ As is EnrolledInTutorialINFS3101T1

INFS3101/INFS7100 week 10, 22 November, 2005

Bob Colomb

13

## OWL Range Restrictions

- ❖ Owl:SomeValuesFrom C on P is the subclass of the domain of P linked to at least one instance of C by P.
- ❖ Owl:someValuesFrom ITCourses on enrolledIn is the subclass of Student enrolled in at least one IT course.
- ❖ ValidITLabSwipeCardAccess is a subclass of that restriction class.
- ❖ ITAdvisingClient is also a subclass of that restriction class

INFS3101/INFS7100 week 10, 22 November, 2005

Bob Colomb

14

## OWL Range Restrictions

- ❖ Owl:AllValuesFrom C on P is the subclass of the domain of P linked to all instances of C by P.
- ❖ Program like MInfTech has a defined Schedule of courses.
- ❖ Owl:AllValuesFrom MInfTechSchedule on enrolledIn is the subclass of Student who is/was enrolled in only courses on the schedule.
- ❖ Intersection of MInfTech subclass of Student with restriction class is NormalMInfTechStudent.
- ❖ Intersection of MInfTechStudent with complement of NormalMInfTechStudent is class of students needing special permission SpecialPermMInfTechSt

INFS3101/INFS7100 week 10, 22 November, 2005

Bob Colomb

15

## Names

- ❖ Two different names in OWL can refer to the same object (not satisfy the Unique Names Assumption).
  - A set of names can't reliably be used to count objects
- ❖ A sameIndividualAs B says A and B name the same object
- ❖ A differentFrom B says A and B name different objects
- ❖ AllDifferent C says that all names in C are differentFrom each other

INFS3101/INFS7100 week 10, 22 November, 2005

Bob Colomb

16

## Open World

- ❖ Information systems supporting organisations making speech acts tend to be definitive
- ❖ If the records don't show something is true, then we can conclude that it is false
- ❖ Called closed world assumption
- ❖ Supported by SQL (not exists, etc.) as default
- ❖ OWL defaults to open world
- ❖ If the records don't show something is true, then we can conclude only that we don't know it is true

INFS3101/INFS7100 week 10, 22 November, 2005

Bob Colomb

17

## Open World

- ❖ Weak typing in OWL is also open world
- ❖ That a property is mandatory doesn't mean we know its value
- ❖ *Has-colour* can be a mandatory property of *horse*
- ❖ In an information system this would mean if we record a horse, we also record its colour
- ❖ In OWL, this would mean that a horse has a colour, but we might not know what it is.
- ❖ OWL name system is open world, too

INFS3101/INFS7100 week 10, 22 November, 2005

Bob Colomb

18

## Class Descriptions

- ❖ **OneOf**: enumerates the instances
  - Workdays oneOf {Monday, Tuesday, Wednesday, Thursday, Friday}
- ❖ **IntersectionOf, UnionOf, ComplementOf, disjointWith**
  - Nothing complementOf Thing

## Limitations of OWL Class Descriptions

- ❖ Not every SQL predicate has an OWL equivalent
- ❖ Consider class Rectangle domain of properties length and width both having range Real
- ❖ Obvious subclass
  - Square = Rectangle where length = width
- ❖ Can't define in OWL
- ❖ OWL a variant of description logic

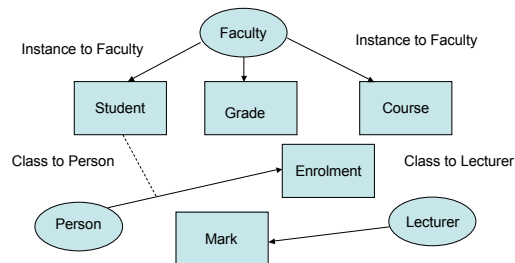
## Ontology as Object

- ❖ Can name an RDF description as ontology
- ❖ Ontology can have properties
  - versionInfo
  - priorVersion
  - incompatibleWith
  - backwardCompatibleWith
  - Can declare others using owl:ontologyProperty
  - Can import one ontology into another
    - (RDF just refers from one resource to another)

## Flavours of OWL

- ❖ **OWL Full** classes and properties are individuals, as are literals
  - Classes of classes, classes of properties, object and datatype properties are equivalent
- ❖ **OWL DL (Description Logic)**
  - Classes, properties, individuals, literals are disjoint
- ❖ **OWL Lite**
  - Not support one of, hasValue, disjointWith, unionOf, complementOf
  - cardinality limited to 0 or 1
  - Only named classes can be intersected

## Uses for OWL Full



## Strangeness of OWL Full

- ❖ **Russell's paradox**
  - The set of sets which are not members of themselves. Is it a member of itself?
- ❖ UML, ER, SQL prevent statement of Russell's paradox by type separation
- ❖ OWL Full can nearly do it. Only not because of weak predicate language.
  - Can't say  $X \text{ rdf:type } X$
  - but can say  $\text{rdfs:Class rdf:type rdfs:Class}$
- ❖ So need to be careful with OWL Full reasoners.

## Summary: Key Terms



- ❖ **OWL extends RDFS. Object and datatype properties.** Universal class **Thing**. **Restrictions** are subsets of property domains. Names not satisfy unique names assumption. Class descriptions can be **enumeration** or **boolean combination** of classes. **Ontology properties. OWL Full, OWL DL, OWL Lite.**

## Resources

### ❖Essential

- Notes chapter 11 Web Ontology Language OWL

### ❖Further

- OWL Web Ontology Language Overview (on web site)
- OWL Web Ontology Language Guide (on web site)
- Ontology 101 Tutorial from Stanford (on web site)