Semantic Web

Web as a communication infrastructure between human and machines

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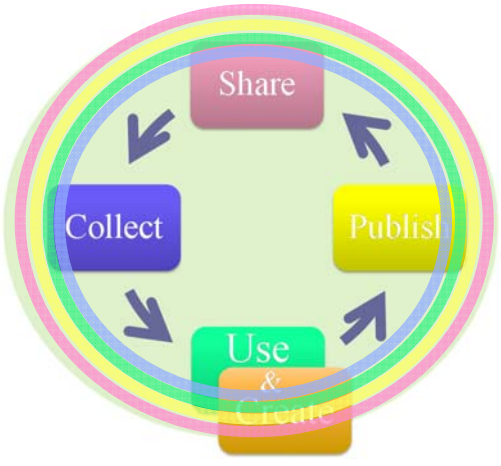
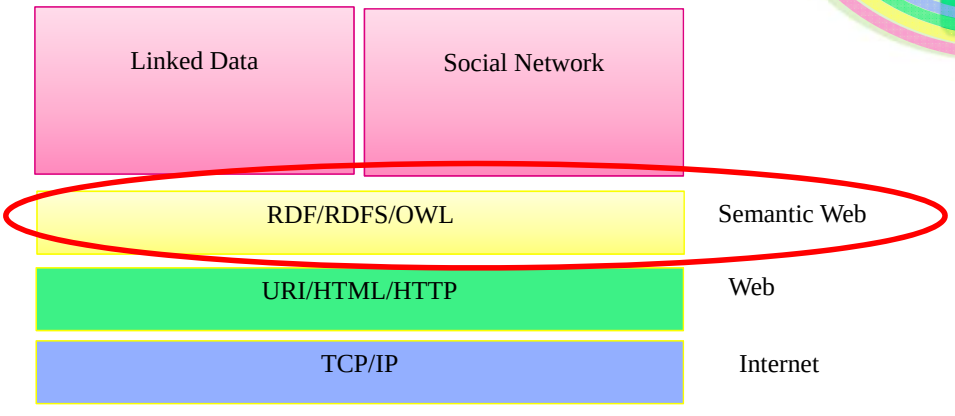
Layers for Information Cycle

- Internet
- Web
- Semantic Web
- Linked Data
- Social Network





Outline

- What is Semantic Web?
  - XML
- Realization of Semantic Web
  - Metadata
  - Dublin Core
  - RDF
  - RDF Schema
  - OWL

The Aim of The Semantic Web

- "The Semantic Web is an extension of the current web in which information is given well-defined meaning, better enabling computers and people to work in cooperation."

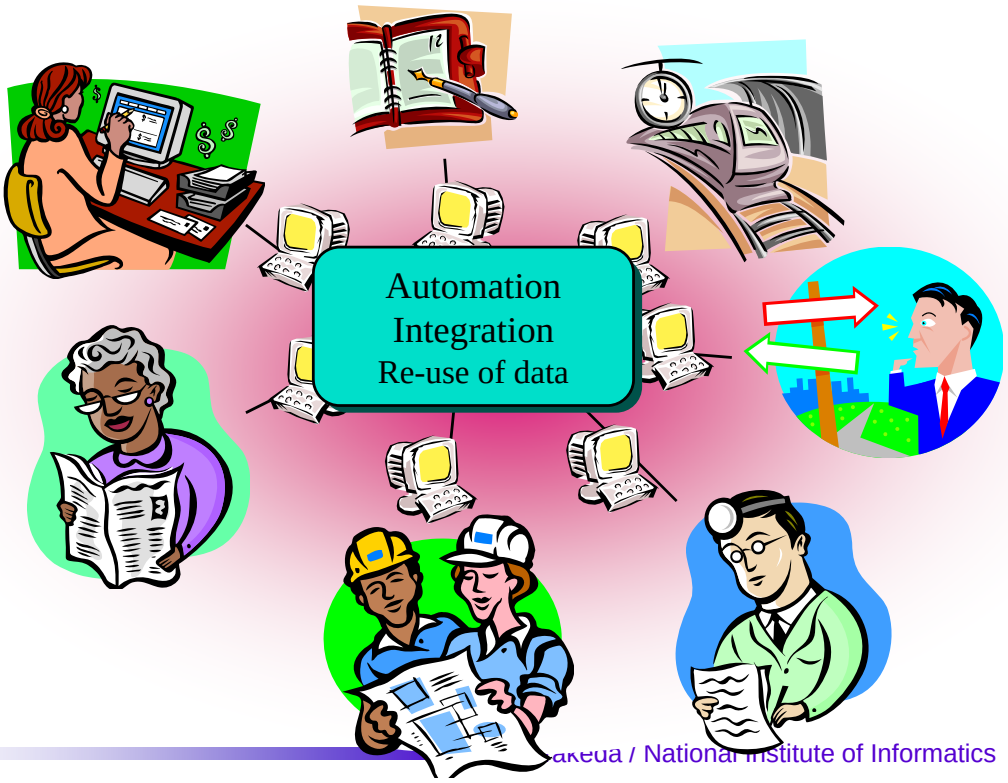
  *The **Semantic Web**, **Scientific American**, May 2001, Tim Berners-Lee, James Hendler and Ora Lassila*

- The Semantic Web is a vision: the idea of having data on the web defined and linked in a way that it can be used by machines not just for display purposes, but for automation, integration and reuse of data across various applications.

  http://www.w3.org/2001/sw/

Semantic Web

- Realization of various information exchanging via Web



Next Generation Web?

- Evolution of Web
  - HTML: Web for Display
  - XML: Web with Syntax
  - ?? : Web with Semantics

- Why should we embed semantics into Web?

  From
  - Web for Human

  To
  - Web for human and machines

  cf. Web for machines

A brief introduction of XML

- Limitation of HTML
  - Chaos by mixture of displaying and text structures
    - e.g.,
      - <h3></h3> should be used for “the third-level heading”, but are often used just for bigger fonts
      - is specifying “bold” , not “emphasis”.
  - Fixed Structure
    - e.g.,
      - If you need <h7></h7>….
      - I need a structure just for my data

```
<h1> A list of lectures</h1>
<h2> Knowledge Sharing Systems</h2>
<h3> Lecturer: Hideaki Takeda</h3>
<h3>Wednesday 3rd</h3>
```


XML

- XML(eXtensible Markup Language)
  - Can define original tags
  - Represent logical structures of data
    - DTD
  - Do not include style information
    - XST

```
<lecturelist>
<lecture>
<title id=1234> Knowledge Sharing Systems</title>
<lecturer> Hideaki Takeda</lecturer>
<schedule>
  <week>Wednesday</week>
  <time>3rd</time>
</lecture>
...
</lecturelist>
```

XML

- XML(eXtensible Markup Language)
  - A standard by W3C(The World Wide Web Consortium) (1998)
  - A subset of SGML
  - Features
    - Fixed character set
    - DTD is not mandatory
    - Should not omit end-tags
    - Style can be specified
- SGML(Standard Generalized Markup Language)
  - ISO8879 (1986)
  - Features
    - Can specify character set
    - DTD is mandatory
    - Can omit end-tags
    - Style can be specified

DTD

- DTD(Document Type Definition):
  - Specify elements and attributes for XML logical structures
    - Defining a specific markup language
      - XHTML
    - Logical structure can be specified
  - Should share DTD between document authors and users

```
<!DOCTYPE lecturelist [
<!ELEMENT lecturelist (lecture*)>
<!ELEMENT lecture (title, lecturer*, schedule)>
<!ELEMENT title (#PCDATA)>
<!ATTLIST title id ID #REQUIRED >
<!ELEMENT lecturer (#PCDATA)>
<!ELEMENT schedule (week, time)>
<!ELEMENT week (#PCDATA)>
<!ELEMENT time (#PCDATA)>
]>
```

DTD

- Element type declaration
  <!ELEMENT element-name (element-content) >
  - Element name
  - Element content
    - Data type
    - Children
    - Order
    - Number of appearance: *(0-), +(1-, ?(0-1)
- Attribute-list declaration
  <!ATTLIST element-name attribute-name attribute-type default-value>
- Entity declaration
  <!ENTITY entity-name “string to be replaced">
- Notation declaration

Style Sheet

- XSLT（eXtensible Stylesheet Language Transformations）
  - A language to describe rules to translate structures in XML
  - Originally a part of XML (eXtensible Stylesheet Language) which is a language to display or print XML data
  - Procedure
    - A template for each node in the source tree
    - Specify which node should be applied to a template with *match* attribute of *xsl:template* element
    - XSLT processor analyzes from the top-most node to down
    - Find a pattern of appearance of elements and attributes which is specified with *match* attribute of *xsl:template* element
    - Apply a rule of a template applied

```
<?xml version="1.0" encoding="shift_jis"?><xsl:stylesheet version="1.0"
xmlns:xsl="http://www.w3.org/1999/XSL/Transform">
  <xsl:output method="html" encoding="shift_jis"/>
  <xsl:template match="/">
    <html><body>
      <xsl:apply-templates/>
    </body></html>
  </xsl:template>
  <xsl:template match="lecturelist">
    <table border="1">
      <tr><td>Lecture name</td><td>Lecturer</td><td>Time</td></tr>
      <xsl:apply-templates /></table>
  </xsl:template>
 <xsl:template match="lecture">
    <tr><xsl:apply-templates/></tr>
  </xsl:template>
<xsl:template match="title">
 <td><xsl:value-of select="." /></td>
  </xsl:template>
 <xsl:template match="lecturer">
    <td><xsl:value-of select="." /></td>
  </xsl:template>
```

```
<xsl:template match="schedule">
    <td> <xsl:apply-templates /> </td>
  </xsl:template>
 <xsl:template match="week">
    <xsl:value-of select="." />/
  </xsl:template>
<xsl:template match="time">
    <xsl:value-of select="." />
  </xsl:template> </xsl:stylesheet>
```



```
<?xml version="1.0" encoding="shift_jis"?>
<?xml-stylesheet href="lecturelist.xsl" type="text/xsl" ?>
<!DOCTYPE lecturelist [
<!ELEMENT lecturelist (lecture*)>
<!ELEMENT lecture (title, lecturer*, schedule)>
<!ELEMENT title (#PCDATA)>
<!ELEMENT lecturer (#PCDATA)>
<!ELEMENT schedule (week, time)>
<!ELEMENT week (#PCDATA)>
<!ELEMENT time (#PCDATA)>
]>
<lecturelist>
<lecture>
<title id=1234> Knowledge Sharing
Systems</title>
<lecturer> Hideaki Takeda</lecturer>
<schedule>
  <week>Wednesday</week>
  <time>3rd</time>
</lecture>
</lecturelist>
```

```
<html>
<body>
<table border="1">
<tr>
<td>Lecture name</td>
<td>Lecturer</td>
<td>Time</td>
</tr>
<tr>
<td> Knowledge Sharing Systems </td>
<td> Hideaki Takeda</td>
<td>
  Wednesday/3rd
</td>
</tr>
</table>
</body>
</html>
```

Whey is XML not sufficient?

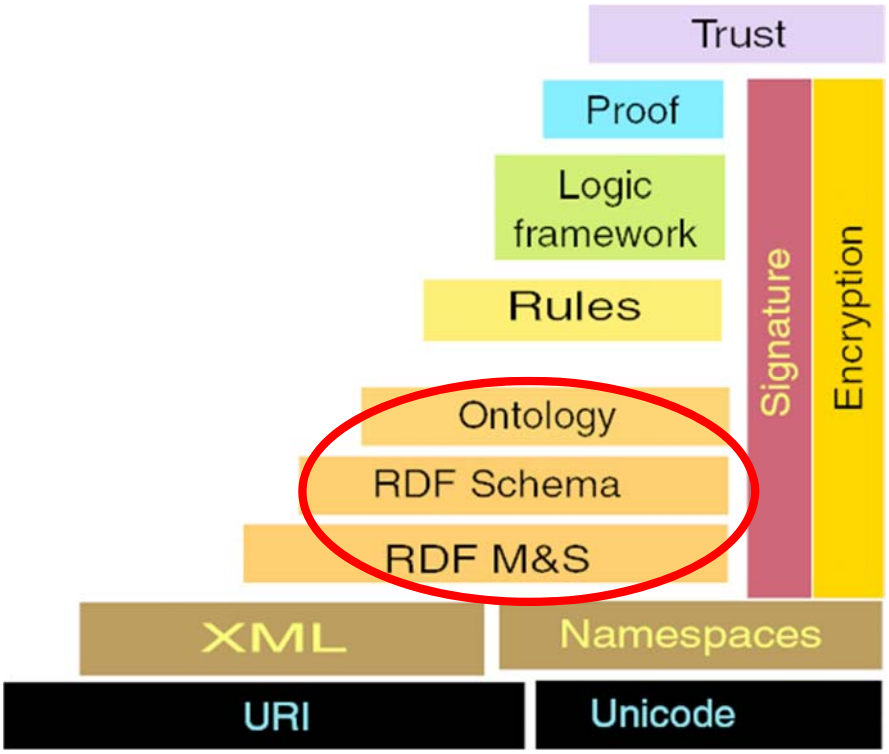
```
<person>
   <name> Hideaki Takeda</name>
   <age> 20</age>
</person>
```

```
<個人>
   <名前>Hideaki Takeda</名前>
   <年齢> 20</年齢>
</個人>
```

- What are specified by “person” and “name” ?
- Is “name” and “名前” the same?
- Is this description sufficient as a description for “person”?
- …

- In short, syntax alone cannot solve these problems

Architecture for the Semantic Web



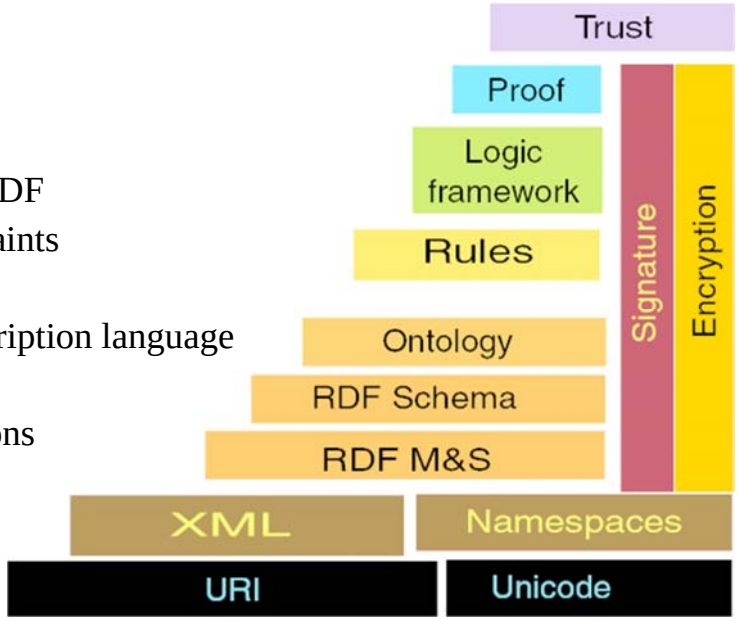
Tim Berners-Lee http://www.w3.org/2002/Talks/09-lcs-sweb-tbl/

How to describe “meaning”?

- Need to describe “information on information”
  - “Meaning of something” is a description (“meaning”) to a description (“something”) in computers
  - Metadata
    - Data about data
- Need to architecture for common understanding
  - Syntax (language or scheme)
  - Vocabulary (ontology)

A Layer model for Semantic Web

- RDF (Resource Description Framework)
  - The most primitive model for metadata description
    - SVO model
    - Entity-Relation Model
    - Semantic net
- RDF Schema
  - Addition of “concept” to RDF
    - class-subclass, constraints
- OWL
  - More general concept description language
    - Logical consistency
    - Various class expressions
    - Various constraints
- DAML-S
  - Descriptions on processes



Tim Berners-Lee http://www.w3.org/2002/Talks/09-lcs-sweb-tbl/

Two origin of Semantic Web

- From the viewpoint of Web Community
  - More meaning, more knowledge
  - HTML -> XML -> RDF -> RDF Schema -> OWL
    ->XML schema ->
- From the viewpoint of Knowledge Sharing Community (AI)
  - From closed knowledge presentation to open KR
    - Not for depth but for width
    - Not for completeness, but for possibility
  - KIF, Ontolinga -> OKBC -> OWL

TOC

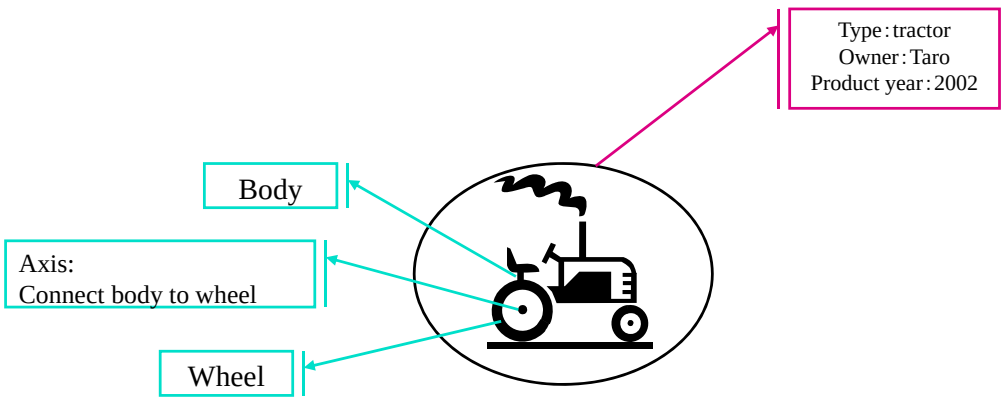
Metadata

- What is metadata?
  - Data about data
  - What one can say about any information object
- What is described as metadata?
  - Content relates to what the object contains or is about, and is *intrinsic* to an information object.
  - Context indicates the who, what, why, where, how aspects associated with the object's creation and is *extrinsic* to an information object.
  - Structure relates to the formal set of associations within or among individual information objects and can be *intrinsic* or *extrinsic*

Setting the State, Anne J.Gilliand-Swetland, Introduction to Metadata – Pathways to Digital Information, Murthsa Baca (ed.), Getty Information Institute.

Metadata

- Metadata to individual information objects
  - Bibliography, Dublin Core
- Metadata to part or structure of information objects
  - Drawings, RDF, RDFS, OWL

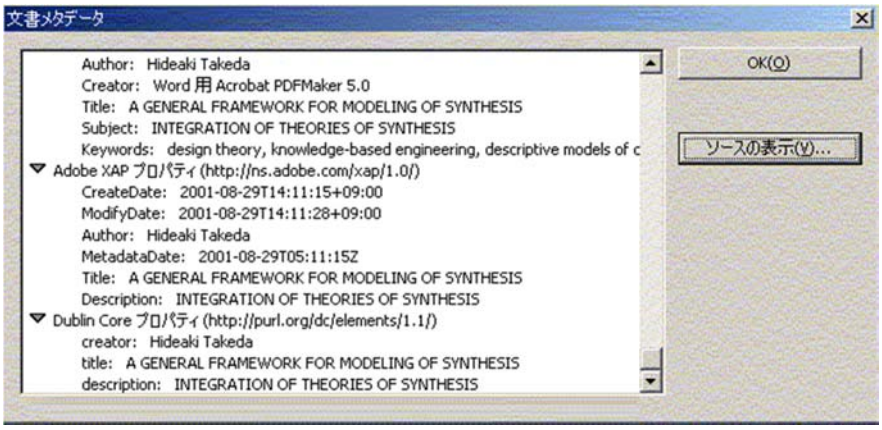


Dublin Core

- Framework for “bibliographic” style metadata
- Simplicity “Pidgins”
  - A few vocabulary
  - A simple structure
- 15 elements: Dublin Core Metadata Element Set
  - Creator, Title, Subject/Keywords, Description, Publisher, Contributor, Date, Resource Type, Format, Resource Identifier, Source, , Language, Relation, Coverage, Rights Management
  - All elements can be omitted and duplicated in any order

Dublin Core

- An example by PDF




```
<rdf:Description about=''
  xmlns='http://purl.org/dc/elements/1.1/'
  xmlns:dc='http://purl.org/dc/elements/1.1/'>
  <dc:creator>Hideaki Takeda</dc:creator>
  <dc:title>A GENERAL FRAMEWORK FOR MODELING
OF SYNTHESIS</dc:title>
  <dc:description>INTEGRATION OF THEORIES OF
SYNTHESIS</dc:description>
 </rdf:Description>
```

RDF (Resource Description Framework)

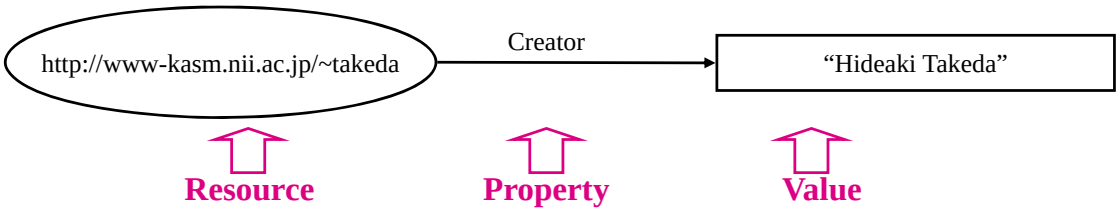
- A framework to describe metadata
- Separation of model and syntax
- W3C Recommendation (2004)

RDF Model

- Element
  - Resource:
    - URI(Universal Resource Identifier)
    - Literal(string)
      - No need to be specified by Web
  - Property:
    - Attribute when describing resources
    - URI or Literal just as Resource
  - Statement: triad of resource, property, and resource

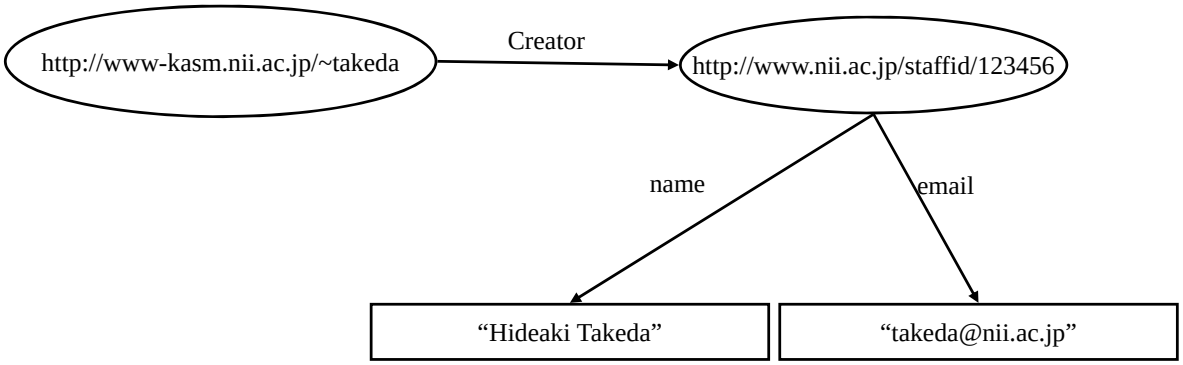
RDF model

- Statement
  - Creator of http://www-kasm.nii.ac.jp/~takeda is “Hideaki Takeda”
- Structure
  - Resource (subject): http://www-kasm.nii.ac.jp/~takeda
  - Property (predicate): Creator
  - Value (object): “Hideaki Takeda”



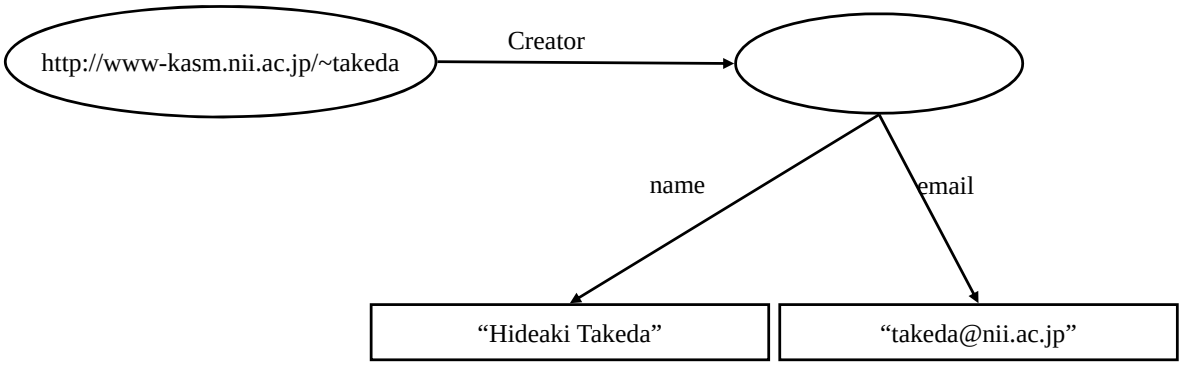
RDF model

- Creator of http://www-kasm.nii.ac.jp/~takeda is http://www.nii.ac.jp/staffid/123456 which has name “Hideaki Takeda” and email “takeda@nii.ac.jp” .



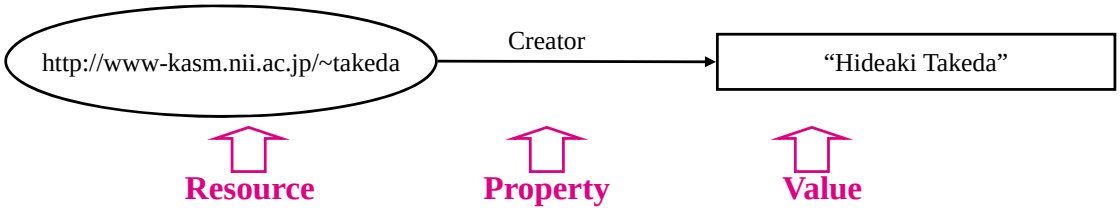
RDF model

- Creator of http://www-kasm.nii.ac.jp/~takeda has name “Hideaki Takeda” email “takeda@nii.ac.jp” .



RDF syntax

- Creator of http://www-kasm.nii.ac.jp/~takeda is “Hideaki Takeda”

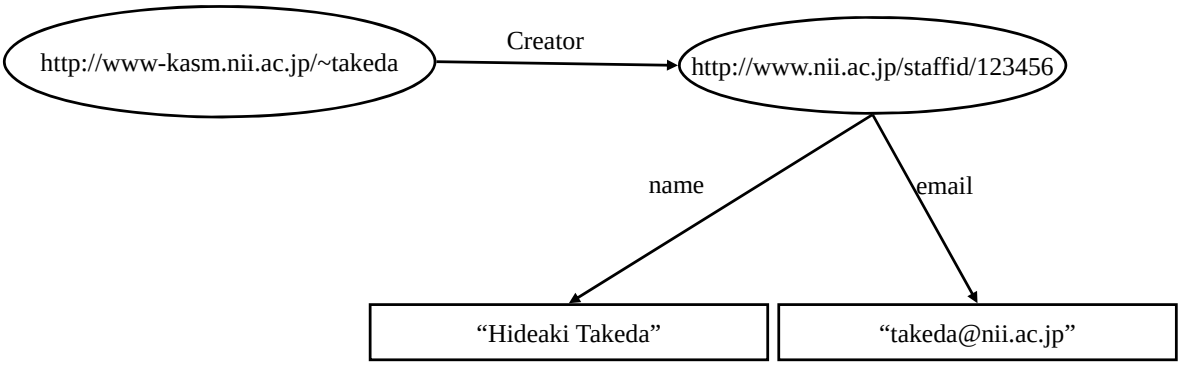



```
<?xml version="1.0"?>
<rdf:RDF
    xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
    xmlns:dc="http://dublincore.org/2001/08/14/dces#">
   <rdf:Description about="http://www-kasm.nii.ac.jp/~takeda">
      <dc:Creator>Hideaki Takeda</dc:Creator>
   </rdf:Description>
</rdf:RDF>
```

```
<rdf:RDF>
   <rdf:Description about="http://www-kasm.nii.ac.jp/~takeda">
      <dc:Creator rdf:resource=“Hideaki Takeda” />
   </rdf:Description>
</rdf:RDF>
```

RDF syntax

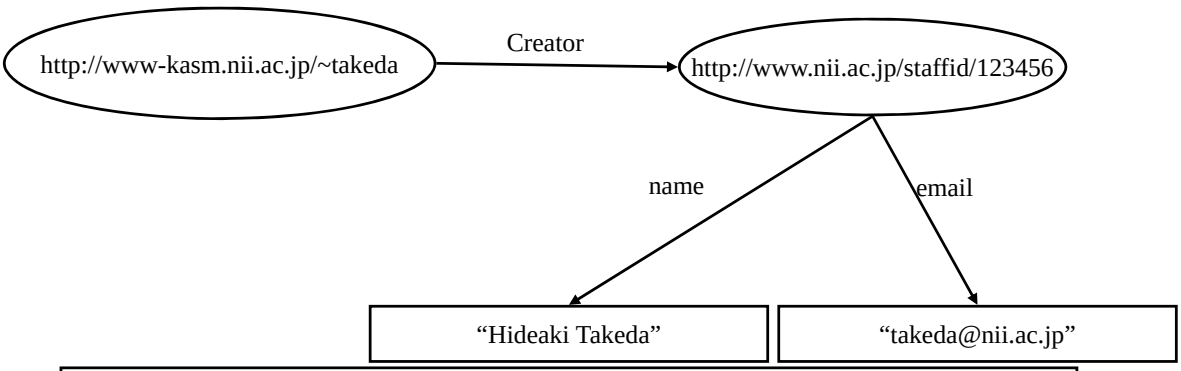
- Creator of http://www-kasm.nii.ac.jp/~takeda is http://www.nii.ac.jp/staffid/123456 which has name “Hideaki Takeda” and email “takeda@nii.ac.jp”




```
<rdf:RDF>
   <rdf:Description about="http://www-kasm.nii.ac.jp/~takeda">
      <dc:Creator>http://www.nii.ac.jp/staffid/123456</dc:Creator>
   </rdf:Description>
   <rdf:Description about=" http://www.nii.ac.jp/staffid/123456 ">
      <p:name>Hideaki Takeda</p:name>
      <p:email>takeda@nii.ac.jp</p:email>
   </rdf:Description>
</rdf:RDF>
```


RDF syntax

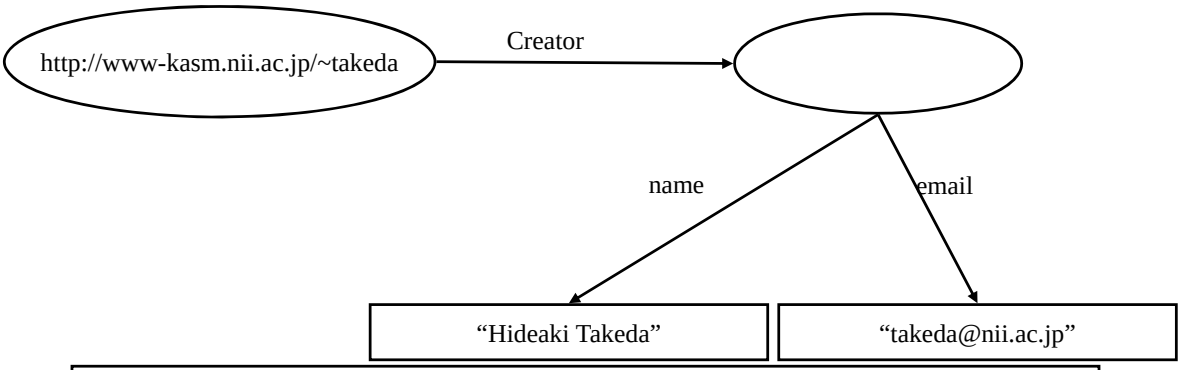
- Creator of http://www-kasm.nii.ac.jp/~takeda is http://www.nii.ac.jp/staffid/123456 which has name “Hideaki Takeda” and email “takeda@nii.ac.jp” .




```
<rdf:RDF>
   <rdf:Description about="http://www-kasm.nii.ac.jp/~takeda">
      <dc:Creator>
         <rdf:Description resource = " http://www.nii.ac.jp/staffid/123456 " >
            <p:name>Hideaki Takeda</p:name>
            <p:email>takeda@nii.ac.jp</p:email>
         </rdf:Description>
      </dc:Creator>
   </rdf:Description>
</rdf:RDF>
```

RDF syntax

Creator of http://www-kasm.nii.ac.jp/~takeda has name “Hideaki Takeda” email “takeda@nii.ac.jp” .



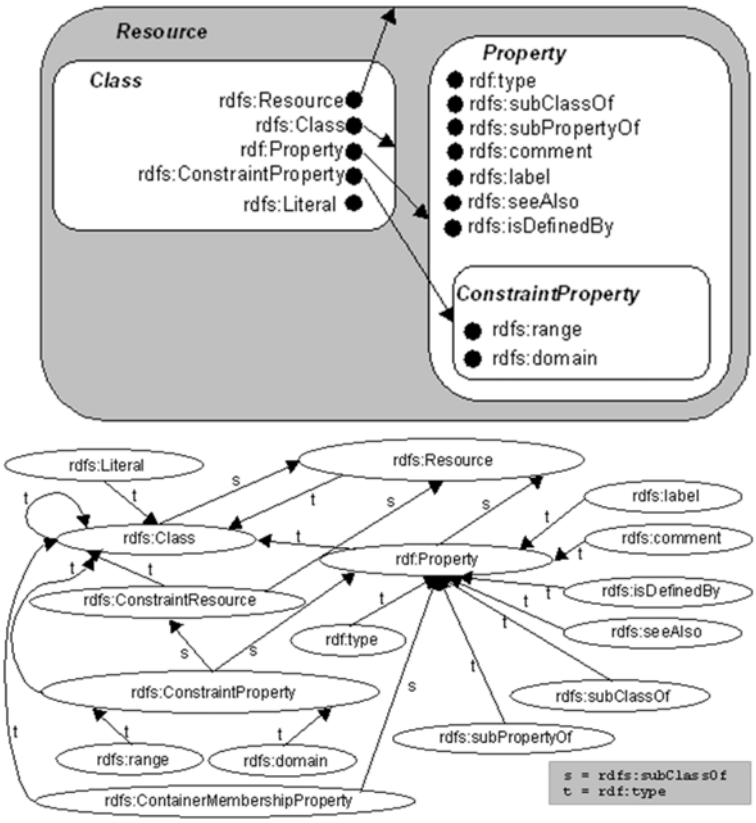

```
<rdf:RDF>
   <rdf:Description >
      <dc:Creator>
         <rdf:Description >
           <p:name>Hideaki Takeda</p:name>
           <p:email>takeda@nii.ac.jp</p:email>
         </rdf:Description>
      </dc:Creator>
   </rdf:Description>
</rdf:RDF>
```


RDFS (RDF Schema)

- Stronger knowledge representation model
  - RDF: ER model, semantic net
  - RDF Schema: Frame model, object-oriented paradigm
    - Minimal definition
    - Property-centered approach
- RDFS is defined as extension of RDF
- RDFS gives definitions of RDF descriptions

RDFS

- Class Definition
  - rdfs:Resource
  - rdfs:Class
  - rdf:Property
  - rdfs:ConstraintProperty
  - rdfs:Literal
- Property Definition
  - rdf:type
  - rdfs:subClassOf
  - rdfs:subPropertyOf
  - rdfs:comment
  - rdfs:label
  - rdfs:seeAlso
  - rdfs:isDefinedBy
- ConstraintProperty Definition
  - rdfs:range
  - rdfs:domain



RDFSのClass階層

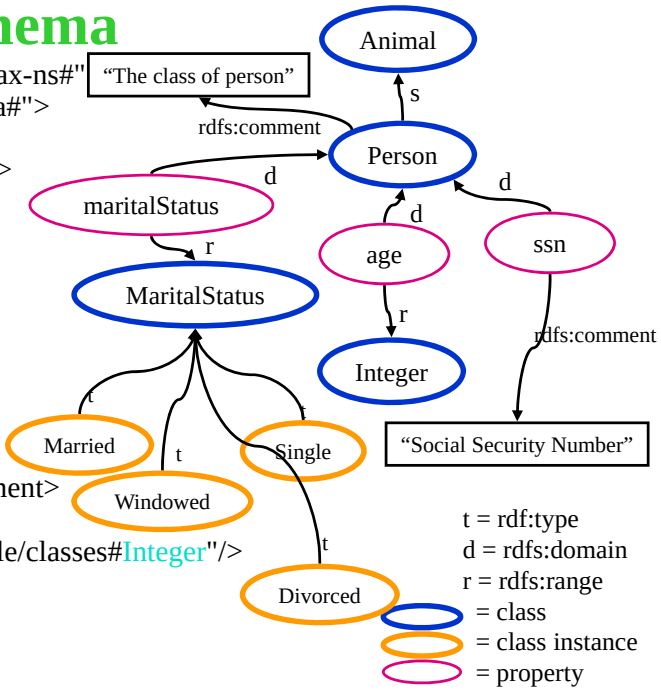
Resource Description Framework(RDF) Schema Specification 1.0
http://www.w3.org/TR/2000/CR-rdf-schema-20000327/

RDF Schema

- rdfs:Class
- rdfs:SubclassOf
  - Detailed class
  - Multiple
  - Transivity
- rdf:type
  - Indicate an instance of a class
- rdf:property
  - Attribute
- rdfs:subPropertyOf
  - Detailed property
  - Transivity
- Range
  - Only one
    - No cardinality
- Domain
  - Multiple (or)

RDF Schema

```
<rdf:RDF xml:lang="en"
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#">
<rdfs:Class rdf:ID="Person">
 <rdfs:comment>The class of people.</rdfs:comment>
 <rdfs:subClassOf rdf:resource="http://www.w3.org/
     2000/03/example/
  classes#Animal"/>
</rdfs:Class>
<rdf:Property ID="maritalStatus">
 <rdfs:range rdf:resource="#MaritalStatus"/>
 <rdfs:domain rdf:resource="#Person"/>
</rdf:Property>
<rdf:Property ID="ssn">
 <rdfs:comment>Social Security Number</rdfs:comment>
 <rdfs:range
    rdf:resource="http://www.w3.org/2000/03/example/classes#Integer"/>
 <rdfs:domain rdf:resource="#Person"/>
</rdf:Property>
<rdf:Property ID="age">
 <rdfs:range
    rdf:resource="http://www.w3.org/2000/03/example/classes#Integer"/>
 <rdfs:domain rdf:resource="#Person"/>
</rdf:Property>
<rdfs:Class rdf:ID="MaritalStatus"/>
<MaritalStatus rdf:ID="Married"/>
<MaritalStatus rdf:ID="Divorced"/>
<MaritalStatus rdf:ID="Single"/>
<MaritalStatus rdf:ID="Widowed"/>
</rdf:RDF>
```



Resource Description Framework(RDF) Schema Specification 1.0
http://www.w3.org/TR/2000/CR-rdf-schema-20000327/

OWL(Web Ontology Language)

- More general knowledge representation
- Based on Description Logics
- Features
  - Class
    - Necessary condition / necessary and sufficient condition
    - Class expression:
      - Constraint by property
        - Like slot definition of a class
        - Type constraint (all/some), cardinality, typed cardinality
      - Logical operation of classes: union, intersection, negation
  - Property
    - Multiple ranges and domains
    - Specifying meta-property
  - Import of definitions

Class descriptions

- a class identifier (a URI reference)
- an exhaustive enumeration of individuals that together form the instances of a class
- a property restriction
- the intersection of two or more class descriptions
- the union of two or more class descriptions
- the complement of a class description

OWL: Enumeration

- **`owl:oneOf`** [instance]+

```
<owl:oneOf parseType="owl:collection">
  <owl:Thing rdf:about="#Eurasia"/>
  <owl:Thing rdf:about="#Africa"/>
  <owl:Thing rdf:about="#North_America"/>
  <owl:Thing rdf:about="#South_America "/>
  <owl:Thing rdf:about="#Australia"/>
 <owl:Thing rdf:about="#Antarctica"/> </oneOf>
```

OWL

- Property restriction
  - A special kind of class description. It describes an anonymous class, namely a class of all individuals that satisfy the restriction

OWL: Value constraints

- A restriction class to either a class description or a data range
- **`owl:allValuesFrom`**
  - All individuals must satisfy the specific condition (class or data range)

```
<owl:Restriction>
  <owl:onProperty rdf:resource="#hasParent" />
  <owl:allValuesFrom rdf:resource="#Human" />
</owl:Restriction>
```

- **`owl:someValuesFrom`**
  - At least one property value must satisfy the specific condition

```
<owl:Restriction>
  <owl:onProperty rdf:resource="#hasParent" />
  <owl:someValuesFrom rdf:resource="#Physician" />
</owl:Restriction>
```

- **`owl:hasValue`**
  - Constrain the value as the specific individual

```
<owl:Restriction>
  <owl:onProperty rdf:resource="#hasParent" />
  <owl:hasValue rdf:resource="#Clinton" />
</owl:Restriction>
```

OWL: Cardinality constraints

- to allow only a specific number of values
- **`owl:maxCardinality`**
  - A restriction containing an **`owl:maxCardinality`** constraint describes a class of all individuals that have at most N semantically distinct values

```
<owl:Restriction>
 <owl:onProperty rdf:resource="#hasParent" />
 <owl:maxCardinality rdf:datatype="&xsd;nonNegativeInteger">2</owl:maxCardinality>
</owl:Restriction>
```

- **`owl:minCardinality`**
- **`owl:cardinality`**

OWL: Boolean Operators

- **`owl:intersectionOf`** *[class-expression]+*
  - a class for which the class extension contains precisely those individuals that are members of the class extension of all class descriptions in the list.
- **`owl:unionOf`** *[class-expression]+*
  - an anonymous class for which the class extension contains those individuals that occur in at least one of the class extensions of the class descriptions in the list
- **`owl:complementOf`** *class-expression*
  - a class for which the class extension contains exactly those individuals that do not belong to the class extension of the class description that is the object of the statement

```
<complementOf>
 <Class>
  <unionOf parseType="owl:collection">
   <Class rdf:resource="#meat"/>
   <Class rdf:resource="#fish"/>
  </unionOf>
 </Class>
</complementOf>
```

OWL

- Class axioms
  - **owl:Class** *class-name(URI)*
  - **owl:subClassOf** *class-expression*
  - **owl:disjointWith** *class-expression*

  ] necessary condition
  - **owl:equivalentClass** *class-expression* — necessary and sufficient condition

```
<owl:Class rdf:about="#Opera">
  <rdfs:subClassOf>
    <owl:Restriction>
      <owl:onProperty rdf:resource="#hasLibrettist" />
      <owl:minCardinality rdf:datatype="&xsd;nonNegativeInteger">1</owl:minCardinality>
    </owl:Restriction>
  </rdfs:subClassOf>
</owl:Class>
```


OWL: Property elements

- RDF/RDFS Constraints
  - **rdf:Property** *property-name*
  - **rdfs:subPropertyOf**
  - **rdfs:domain** *class-exprssion*
    - If there are multiple descriptions, they express intersections
  - **rdfs:range** *class-expression*
    - If there are multiple descriptions, they express intersections
- Restrictions to other properties
  - **owl:equivalentProperty** *propery-name*
  - **owl:inverseOf** *propery-name*
- Global cardinality constraints
  - **owl:FunctionalProperty**
  - **owl:InverseFunctionalProperty**
- Logical characteristics
  - **owl:SymmetricProperty**
  - **owl:TransitiveProperty**

OWL: Instances

- Instance
  - Instance for a class or property
  - **`rdf:type`**

```
<continent rdf:ID="Asia"/>

<rdf:Description rdf:ID="Asia">
  <rdf:type>
    <rdfs:Class rdf:about="#continent"/>
  </rdf:type>
</rdf:Description>

<rdf:Description rdf:ID="India">
  <is_part_of rdf:resource="#Asia"/>
</rdf:Description>
```


OWL

- Object and datatype
  - datatype domain: defined in XML Schema
  - object domain: defined in OWL

Three OWL Languages

- OWL-Full
  - OWL-DL + all RDFS expressions
  - Logically very complicated
- OWL-DL
  - The basic OWL
  - Full use of OWL language constructs
- OWL-Lite
  - Intended to be used in simple applications
  - Restrictions of OWL language constructs
    - E.g, No use of these constructs
      - owl:oneOf
      - owl:unionOf
      - owl:complementOf
      - owl:hasValue
      - owl:disjointWith
      - owl:DataRange

OWL example

```
<?xml version="1.0"?>
<!DOCTYPE rdf:RDF [
    <!ENTITY owl  "http://www.w3.org/2002/07/owl#" >
    <!ENTITY xsd  "http://www.w3.org/2001/XMLSchema#" >
  ]>

<rdf:RDF
   xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
   xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
   xmlns:owl="http://www.w3.org/2002/07/owl#"
   xmlns:xsd = "http://www.w3.org/2001/XMLSchema#"
   xmlns="http://www.example.com/person.owl#"
   xml:base="http://www.example.com/person.owl">

  <owl:Ontology rdf:about="">
  <rdfs:comment>
   An example ontology by Takeda, with data types taken from XML Schema
  </rdfs:comment>
</owl:Ontology>
```

OWL Example

```
<owl:Class rdf:ID="Animal">
  <rdfs:label>Animal</rdfs:label>
  <rdfs:comment>
    This class of animals is illustrative of
      a number of ontological idioms.
  </rdfs:comment>
</owl:Class>

<owl:ObjectProperty rdf:ID="name">
  <rdfs:domain rdf:resource="#Animal"/>
  <rdfs:range rdf:resource="&xsd;string" />
</owl:ObjectProperty>

<owl:DatatypeProperty rdf:ID="age">
  <rdfs:comment>
    age is a DatatypeProperty whose range is
xsd:decimal.   age is also a UniqueProperty
(can only have one age)
  </rdfs:comment>
  <rdf:type rdf:resource=
            "&owl;FunctionalProperty" />
  <rdfs:domain rdf:resource="#Animal" />
  <rdfs:range rdf:resource=
            "&xsd;positiveInteger" />
</owl:DatatypeProperty>
```

```
<owl:Class rdf:ID="Person">
  <rdfs:subClassOf rdf:resource="#Animal"/>
  <rdfs:subClassOf>
    <owl:Restriction>
      <owl:onProperty rdf:about="#name" />
      <owl:minCardinality rdf:datatype=
      "http://www.w3.org/2001/XMLSchema#int">
              1
      </owl:minCardinality>
    </owl:Restriction>
  </rdfs:subClassOf>
</owl:Class>

<Person rdf:ID="Hideaki">
  <rdfs:label>Hideaki</rdfs:label>
  <rdfs:comment>Hideaki is a person. His name is
Hideaki Takeda and his age is
100.</rdfs:comment>
  <name>Hideaki Takeda</name>
  <age rdf:datatype="&xsd;positiveInteger">
    100</age>
</Person>
</rdf:RDF>
```


The *Secret* of Semantic Web

- Why can Semantic Web work?
  - URI, URI, URI
    - The global identifier
    - If two people refer the single URL, it is assumed that they share concepts *implicitly* and *optimistically*
  - But it may be to optimistic
    - More various sharing ways are needed

Tasks for Semantic Web

- Developing languages and processing systems (SW people)
- Propagation of SW (SW people, Application People, Users)
- Providing ontologies (SW people, Application People)
- Applying domains (Application People)

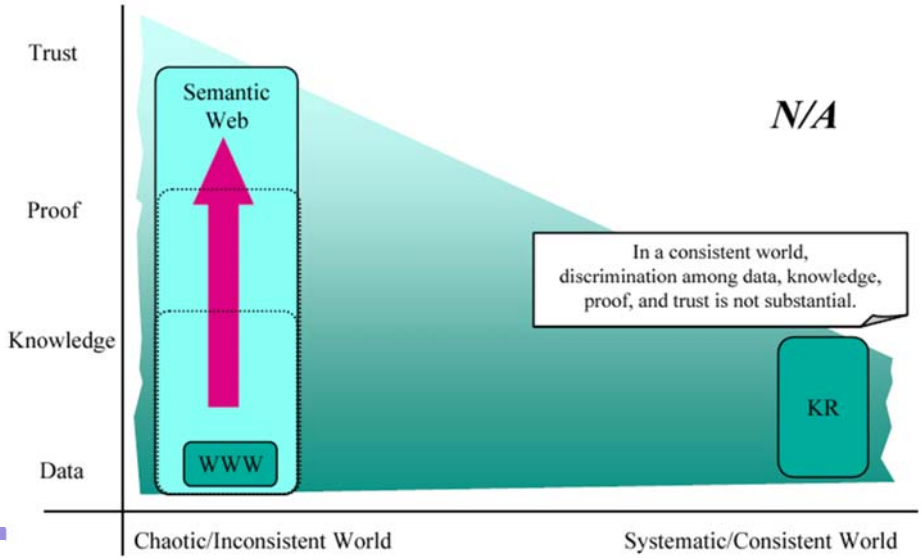
- Loop between specification developers and users is common problem.
- But the problem is crucial in Semantic Web
  - Ontologies are meaningful *if-and-only-if* they are shared
    - C.f. XML is useful even if it is used in a small community

Semantic Web and Knowledge Representation

- Is Semantic Web just “re-inventing a wheel”?
  - Renewal of existing DL-based languages?
  - No…The Environment is different!
    - KR is based on the ideal environment
    - WWW is a real-world environment
- Openness of Knowledge
- Human-in-the-Loop in Knowledge Creation

Openness of Knowledge

- Knowledge on WWW is *always* inconsistent and incomplete
- Traditional KR assumes consistence and completeness ideally
  - Tasks
    - Incomplete and inconsistent KR



Human-in-the-Loop in Knowledge Creation

- Building very large knowledge bases
  - In-house or made in laboratories
    - Small experts
    - e.g, Cyc and EDR
    - Not so successful
  - Open development
    - Like Linux
    - Everyone can contribute
    - Quality?
    - e.g, Open Directory Project, OpenMind project, MusicBrainz