

Lecture 2

Chapter 3

Describing Web Resources in RDF

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- <https://www.w3.org/RDF>
- <https://www.w3.org/TR/rdf-syntax-grammar/>

What's RDF?

- RDF stands for **Resource Description Framework**
- RDF is a framework for describing resources on the web
- RDF is designed to be read and understood by computers
- RDF is not designed for being displayed to people
- RDF is written in XML
- RDF is a part of the W3C's Semantic Web Activity
- RDF is a W3C Recommendation

What's RDF?

- RDF documents are written in XML. The XML language used by RDF is called RDF/XML.
- By using XML, RDF information can easily be exchanged between different types of computers using different types of operating systems and application languages.



Lecture Outline

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1. Basic Ideas of RDF

2. XML-based Syntax of RDF

3. RDF Graph Visualization

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Drawback of XML

- XML does not provide any means of talking about the semantics (meaning) of data.
- E.g., there is no intended meaning associated with the nesting of tags. It is up to each application to interpret the nesting.

Nesting of Tags in XML

David Billington is a lecturer of Discrete Maths

<course name="Discrete Maths">
 <lecturer>David Billington</lecturer>
</course>

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<lecturer name="David Billington">
 <teaches>Discrete Maths</teaches>
</lecturer>

Opposite nesting, same information!

Basic Ideas of RDF

Triple (statement) **object-attribute-value**

Triple (statement) **subject-predicator-object**

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– *David Billington is a lecturer of Discrete Maths*
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- RDF has been given a syntax in XML
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 - This syntax inherits the benefits of XML
 - Other syntactic representations of RDF possible

Basic Ideas of RDF (2)

- The fundamental concepts of RDF are:
 - resources
 - properties
 - statements

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Resources

- Resource: a “thing” we want to talk about.
 - E.g. authors, books, publishers, places, people, hotels
- Every resource has a URI (Universal Resource Identifier)
- A URI can be <https://powcoder.com>
 - a URL (Uniform Resource Locator), Web address, or
 - some other kind of unique identifier



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Which one is correct?
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- a) every URL is a URI
 - b) every URI is a URL

Properties

- Special kind of resources
- They describe relations between resources
 - E.g. “written by”, “age”, “title”, etc.
- Also identified by URIs

Two main advantages of using URIs:

- I. providing a global, worldwide unique naming scheme
- II. reducing the homonym problem of distributed data representation



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homonym problem

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Statements

- Statements assert the properties of resources
- A statement is an **object-attribute-value** triple
 - It consists of a resource, a property, and a value

- Values can be **resources or literals**

- Literals are atomic values (strings)

If instead of an attribute we use a **verb**, then we have

subject-predicate-object

Hence, both

object-attribute-value and

subject-predicate-object

as statements are correct.



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What feature can be borrowed from
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XML to uniquely identify the resources
and properties?

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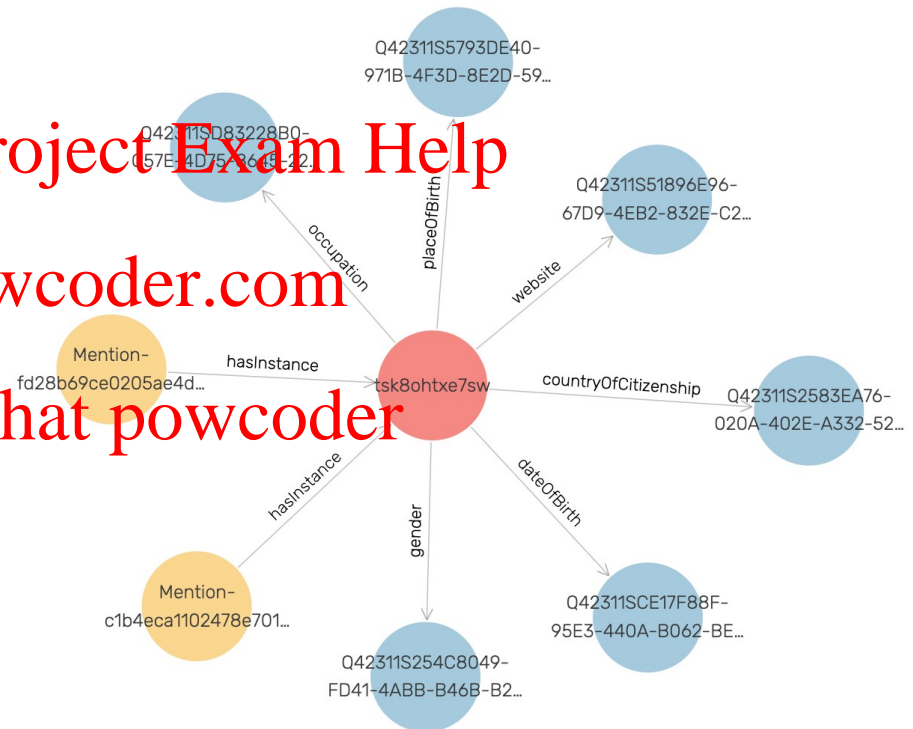
The Three Views of a Statement in RDF:

An RDF statement:

- I. A triple
- II. A piece of a graph
- III. A piece of XML code

An RDF document :


- a. A set of triples
- b. A graph (semantic net)
- c. An XML document



Statements as Triples

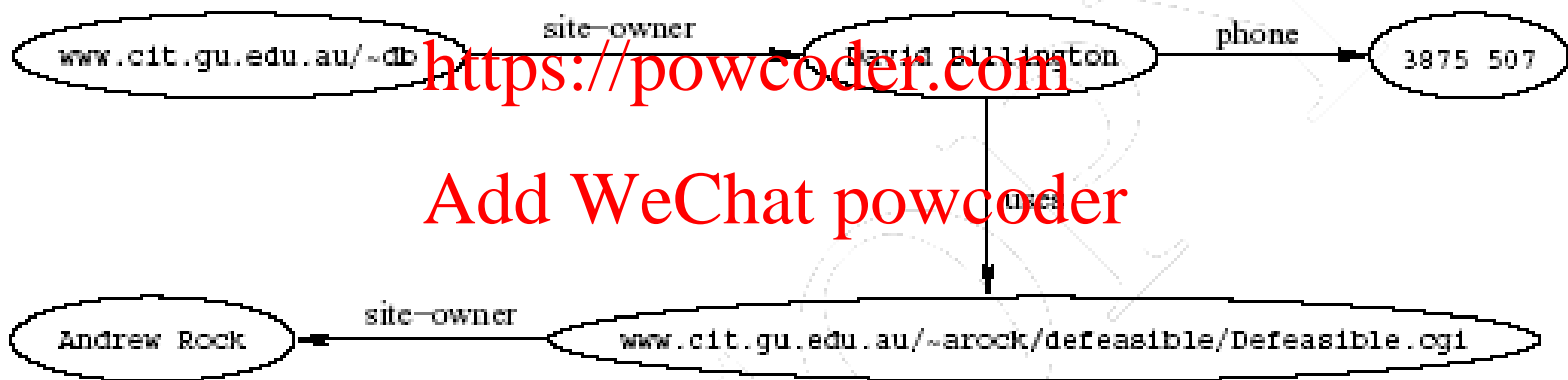
- The triple (x, P, y) can be considered as a logical formula, shown with $P(x, y)$ in which the binary predicate P relates object x to object y .
- RDF offers only binary predicates (properties)

XML Vocabularies

- A  | arcs
 - **from** the resource (the **subject** of the statement)
 - **to** the value (the **object** of the statement)
- Known in **AI** as a **semantic net**
- The **value** of a statement **may be a resource**
 - It may be **linked to other resources**

A Set of Triples as a Semantic Net

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How many statements?

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Statements in XML

<rdf:RDF

xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"

xmlns:mydomain="http://www.mydomain.org/my-rdf-ns">

<rdf:Description rdf:about="http://www.cit.gu.edu.au/~db">

<mydomain:site-owner rdf:resource="#David Billington"/>

</rdf:Description>

</rdf:RDF>

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rdf:about sets the object URI of a statement, **rdf:resource** sets the value URI of a statement.

in **"#David Billington"** indicates an ID defined in the same document

Statements in XML

- An RDF document is represented by an XML element with the tag **rdf:RDF**
- The content of this element is a number of descriptions, which use **rdf:Description** tags.
- Every description makes a statement about a resource, identified in 3 ways:
 - an **about** attribute, referencing an existing resource
 - an **ID** attribute, creating a new resource
 - without a name, creating an anonymous resource

Statements in XML

- The **rdf:Description** element makes a statement about the resource <http://www.cit.gu.edu.au/~db>
- Within the description
 - the **property** is used as a tag
 - the **content** is the value of the **property**

Data Types

- In RDF, typed literals are used, if necessary
- The main data types predefined by XML Schema are (i) booleans, (ii) integers, (iii) floating-point numbers, (iv) times, and (v) dates.

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```
<?xml version="1.0"?>
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:ex="http://example.org/stuff/1.0/">
  <rdf:Description rdf:about="http://example.org/item01">
    <ex:size rdf:datatype="http://www.w3.org/2001/XMLSchema#int">123</ex:size>
  </rdf:Description>
</rdf:RDF>
```



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Write an RDF/XML representation for the following:

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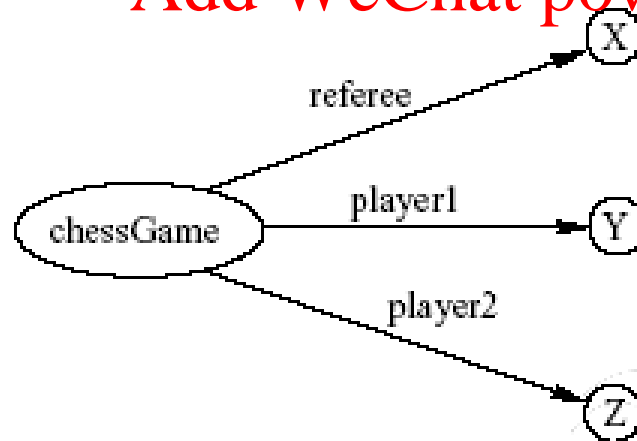
X is the referee in a chess game
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between players **Y** and **Z**

A Critical View of RDF: Binary Predicates

- RDF uses **only binary properties**
 - This is a **restriction** because often we use predicates with more than 2 arguments
 - But binary predicates can **simulate** these
- Example: **Referee(X,Y,Z)**
 - **X** is the referee in a chess game between players **Y** and **Z**

A Critical View of RDF: Binary Predicates

- We introduce:
 - a new **auxiliary resource** **chessGame**
 - the binary predicates **ref**, **player1**, and **player2**
- We can represent **referee(X,Y,Z)** as:



Reification

- In RDF it is possible to make statements about statements
 - Grigoris believes that David Billington is the creator of <http://www.cit.gu.edu.au/~rdb>
- Such statements can be used to describe belief or trust in other statements
- The solution is to assign a unique identifier to each statement
 - It can be used to refer to the statement



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1. Basic Ideas of RDF
2. XML-based Syntax of RDF
3. RDF Graph Visualization

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XML-Based Syntax of RDF

- An RDF document consists of an **rdf:RDF** element
 - The content of that element is a number of descriptions
- A namespace mechanism is used
 - Disambiguation
 - **Namespaces are expected** to be **RDF documents** defining resources that can be reused

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```

<?xml version="1.0"?>
<rdf:RDF
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:xsd="http://www.w3.org/2001/XMLSchema#"
  xmlns:uni="http://www.mydomain.org/uni-ns">
  <rdf:Description rdf:about="T949318">
    <uni:name>David Billington</uni:name>
    <uni:title>Associate Professor</uni:title>
    <uni:age rdf:datatype="xsd:integer">27</uni:age>
  </rdf:Description>
  <rdf:Description rdf:about="CIT1111">
    <uni:courseName>Discrete Maths</uni:courseName>
    <uni:isTaughtBy>David Billington</uni:isTaughtBy>
  </rdf:Description>
  <rdf:Description rdf:about="CIT2112">
    <uni:courseName>Programming III</uni:courseName>
    <uni:isTaughtBy>Michael Maher</uni:isTaughtBy>
  </rdf:Description>
</rdf:RDF>

```

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Note that "CIT1111", like its all similar resources, has been used for the simplicity purposes and in fact should be "<http://www.mydomain.org/uni-ns/#CIT1111>"

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A close-up photograph of a white ceramic cup filled with a dark brown liquid, likely tea. The cup is set against a dark background. In the upper left corner, a branch with small white flowers and green leaves is visible. The text is overlaid on the cup.

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Take a break 😊

rdf:about versus rdf:ID

- An element **rdf:Description** has
 - an **rdf:about** attribute indicating that the resource has been “defined” elsewhere
 - An **rdf:ID** attribute indicating that the resource is defined now

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Property Elements

- Content of rdf:Description elements

```
<rdf:Description rdf:about="CIT3116">  
  <uni:courseName>Knowledge Representation</uni:courseName>  
  <uni:isTaughtBy>Grigorios Antoniou</uni:isTaughtBy>  
</rdf:Description>
```

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- uni:courseName and uni:isTaughtBy define two property-value pairs for CIT3116 (two RDF statements)
 - read conjunctively

Data Types

- The attribute `rdf:datatype="&xsd:integer"` is used to indicate the data type of the value of the age property

```
<rdf:Description rdf:about="949318">  
  <uni:name>David Billington</uni:name>  
  <uni:title>Associate Professor</uni:title>  
  <uni:age rdf:datatype="&xsd:integer">27</uni:age>  
</rdf:Description>
```

The rdf:resource Attribute

- The relationships between courses and lecturers (in the example) were not formally defined but existed implicitly through the use of the same name
- The use of the same name may just be a coincidence for a machine
- We can denote that two entities are the same using the **rdf:resource** attribute

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The rdf:resource Attribute

```
<rdf:Description rdf:about="CIT1111">  
  <uni:courseName>Discrete Mathematics</uni:courseName>  
  <uni:isTaughtBy rdf:resource="T949318"/>  
</rdf:Description>
```

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```
<rdf:Description rdf:about="T949318">  
  <uni:name>David Billington</uni:name>  
  <uni:title>Associate Professor</uni:title>  
</rdf:Description>
```

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As you notice, T949318 is for the simplicity purposes and in fact should be
"<http://www.mydomain.org/uni-ns/#T949318>"

Nested Descriptions: Example

```
<rdf:Description rdf:about="CIT1111">
  <uni:courseName>Discrete Maths</uni:courseName>
  <uni:isTaughtBy>
    <rdf:Description rdf:ID="T949318">
      <uni:name>David Billington</uni:name>
      <uni:title>Associate Professor</uni:title>
    </rdf:Description>
  </uni:isTaughtBy>
</rdf:Description>
```

Note:

rdf:ID attribute for creating a new resource

rdf:about attribute for referencing an existing attribute

Introducing some Structure to RDF Documents using the rdf:type Element

```
<rdf:Description rdf:ID="CIT1111">
  <rdf:type rdf:resource="http://www.mydomain.org/uni-
    ns#course"/>
  <uni:courseName>Discrete Maths</uni:courseName>
  <uni:isTaughtBy rdf:resource="#949318"/>
</rdf:Description>
<rdf:Description rdf:ID="949318">
  <rdf:type rdf:resource="http://www.mydomain.org/uni-
    ns#lecturer"/>
  <uni:name>David Billington</uni:name>
  <uni:title>Associate Professor</uni:title>
</rdf:Description>
```

Because 949318 has been defined in the same document, we have used #. Otherwise we needed to write the name of the document followed by #

Abbreviated Syntax

- Simplification rules:

1. Childless property elements within description elements may be replaced by XML attributes
2. For description elements with a typing element we can use the name specified in the `rdf:type` element instead of `rdf:Description`

These two rules create syntactic variations of the same RDF statement.



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Applying the two simplification rules you learned, convert the following RDF to its abbreviated syntax.

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<https://www.w3.org/RDF/Validator/>

1. `<?xml version="1.0"?>`
2. `<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#" xmlns:dc="http://purl.org/dc/elements/1.1/" xmlns:uni="http://www.mydomain.org/unins">`
3. `<rdf:Description rdf:ID="CIT1111">`
4. `<rdf:type rdf:resource="http://www.mydomain.org/unins#course"/>`
5. `<uni:courseName>Discrete Maths</uni:courseName>`
6. `<uni:isTaughtBy rdf:resource="#1949318"/>`
7. `</rdf:Description>`
8. `<rdf:Description rdf:ID="1949318">`
9. `<rdf:type rdf:resource="http://www.mydomain.org/unins#lecturer"/>`
10. `<uni:name>David Billington</uni:name>`
11. `<uni:title>Associate Professor</uni:title>`
12. `</rdf:Description>`
13. `</rdf:RDF>`

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Application of First Simplification Rule

1. `<?xml version="1.0"?>`
2. `<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"`
3. `xmlns:dc="http://purl.org/dc/elements/1.1/"`
4. `xmlns:uni="http://www.mydomain.org/unins">`
5. `<rdf:Description rdf:ID="CIT1111" uni:courseName="Discrete Maths">`
6. `<rdf:type rdf:resource="http://www.mydomain.org/unins#course"/>`
7. `<uni:isTaughtBy rdf:resource="#T949318"/>`
8. `</rdf:Description>`
9. `<rdf:Description rdf:ID="T949318" uni:name="David Billington"`
`uni:title="Associate Professor">`
10. `<rdf:type rdf:resource="http://www.mydomain.org/unins#lecturer"/>`
11. `</rdf:Description>`
12. `</rdf:RDF>`

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Application of Second Simplification Rule

1. `<?xml version="1.0"?>`
2. `<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#" xmlns:dc="http://purl.org/dc/elements/1.1/" xmlns:uni="http://www.mydomain.org/uni#">`
3. `<uni:course rdf:ID="CIT1111" uni:courseName="Discrete Maths">`
4. `<uni:isTaughtBy rdf:resource="#t949318"/>`
5. `</uni:course>`
6. `<uni:lecturer rdf:ID="t949318" uni:name="David Billington" uni:title="Associate Professor">`
7. `</uni:lecturer>`
8. `</rdf:RDF>`

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Container Elements

- Collect a number of resources or attributes about which we want to make statements as a whole
- E.g., we may wish to talk about the courses given by a particular lecturer
- The content of container elements are named `rdf:_1`, `rdf:_2`, etc.
 - Alternatively `rdf:li`

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Three Types of Container Elements

- **rdf:Bag** an unordered container, allowing multiple occurrences
 - E.g. members of the faculty board, documents in a folder
- **rdf:Seq** an ordered container, which may contain multiple occurrences
 - E.g. modules of a course, items on an agenda, an alphabetized list of staff members (order is imposed)
- **rdf:Alt** a set of alternatives
 - E.g. translations of a document in various languages

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Example for a Bag

```
<uni:lecturer rdf:ID="T949352" uni:name="Grigoris Antoniou"  
  uni:title="Professor">  
  <uni:coursesTaught>  
    <rdf:Bag>  
      <rdf:_1 rdf:resource="#CIT1112"/>  
      <rdf:_2 rdf:resource="#CIT3116"/>  
    </rdf:Bag>  
  </uni:coursesTaught>  
</uni:lecturer>
```

Example for Alternative

```
<uni:course rdf:ID="CIT1111" uni:courseName="Discrete Mathematics">
  <uni:lecturer>
    <rdf:Alt>
      <rdf:li rdf:resource="#T949352"/>
      <rdf:li rdf:resource="#T949318"/>
    </rdf:Alt>
  </uni:lecturer>
</uni:course>
```

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Rdf:ID Attribute for Container Elements

```
<uni:lecturer rdf:ID="949318" uni:name="David Billington">
  <uni:coursesTaught>
    <rdf:Bag rdf:ID="DBcourses">
      <rdf:_1 rdf:resource="#CIT1111"/>
      <rdf:_2 rdf:resource="#CIT3112"/>
    </rdf:Bag>
  </uni:coursesTaught>
</uni:lecturer>
```

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RDF Collections

Shorthand syntax:

- "Collection" value for the `rdf:parseType` attribute:

```
<rdf:Description rdf:about="#CIT2112">  
  <uni:isTaughtBy rdf:parseType="Collection">  
    <rdf:Description rdf:about="#949111"/>  
    <rdf:Description rdf:about="#949352"/>  
    <rdf:Description rdf:about="#949318"/>  
  </uni:isTaughtBy>  
</rdf:Description>
```

Reification

- As mentioned sometimes we wish to make statements about other statements
- We must be able to refer to a statement using an identifier
- RDF allows such reference through a reification mechanism, which turns a statement into a resource.

Reification

- **rdf:subject**, **rdf:predicate** and **rdf:object** allow us to access the parts of a statement
- The **ID** of the statement can be used to refer to it, as can be done for any description
- We write an **rdf:Description** if we don't want to talk about a statement further
- We write an **rdf:Statement** if we wish to refer to a statement

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Perform reification on the following
statement and give it the ID of
StatementAbout949352.
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validate your answer here:
<https://www.w3.org/RDF/Validator/>

1. `<?xml version="1.0"?>`
2. `<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#" xmlns:dc="http://purl.org/dc/elements/1.1/" xmlns:uni="http://www.mydomain.org/uni#">`
3. `<rdf:Description rdf:about="#T949352">`
4. `<uni:name>Grigoris Antoniou</uni:name>`
5. `</rdf:Description>`
6. `</rdf:RDF>`

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Reified

1. `<?xml version="1.0"?>`
2. `<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#" xmlns:dc="http://purl.org/dc/elements/1.1/"`
3. `xmlns:uni="http://www.mydomain.org/unins">`
4. `<rdf:Statement rdf:ID="StatementAboutT949352">`
5. `<rdf:subject rdf:resource="#T949352"/>`
6. `<rdf:predicate rdf:resource="http://www.mydomain.org/unins#name"/>`
7. `<rdf:object>Grigoris Antoniou</rdf:object>`
8. `</rdf:Statement>`
9. `</rdf:RDF>`



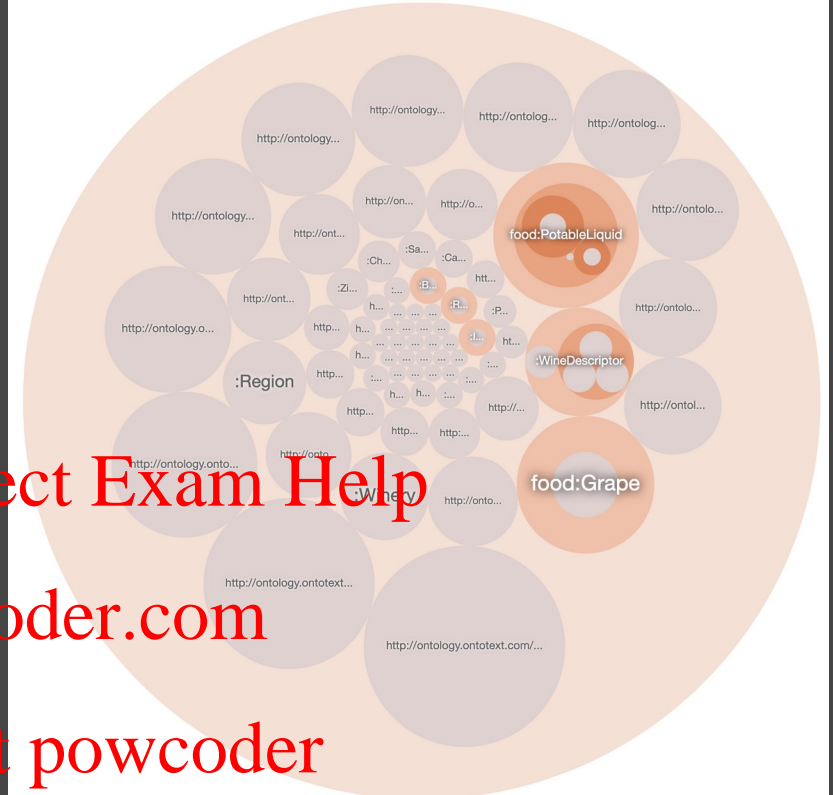
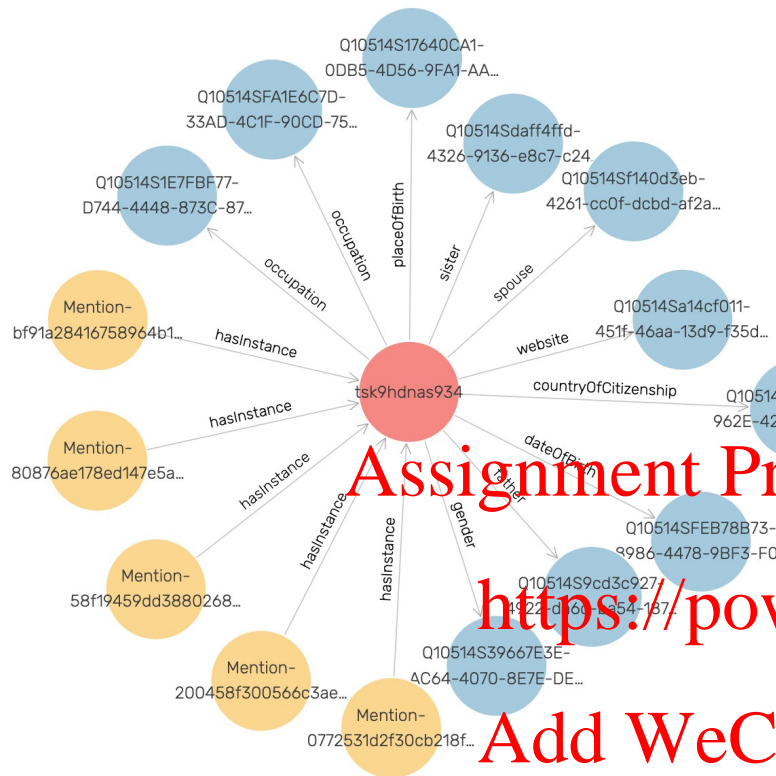
Lecture Outline

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1. Basic Ideas of RDF
2. XML-based Syntax of RDF
3. RDF Graph Visualization

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RDF Graph Visualization

Example, RDF/XML

1. <?xml version="1.0"?>
2. <rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#" xmlns:dc="http://purl.org/dc/elements/1.1/"
3. xmlns:uni="http://www.mydomain.org/unins">
4. <rdf:Description rdf:ID="CIT1111">
5. <rdf:type rdf:resource="http://www.mydomain.org/unins#course"/>
6. <uni:courseName>Discrete Maths</uni:courseName>
7. <uni:isTaughtBy rdf:resource="#T949318"/>
8. </rdf:Description>
9. <rdf:Description rdf:ID="T949318">
10. <rdf:type rdf:resource="http://www.mydomain.org/unins#lecturer"/>
11. <uni:name>David Billington</uni:name>
12. <uni:title>Associate Professor</uni:title>
13. </rdf:Description>
14. </rdf:RDF>

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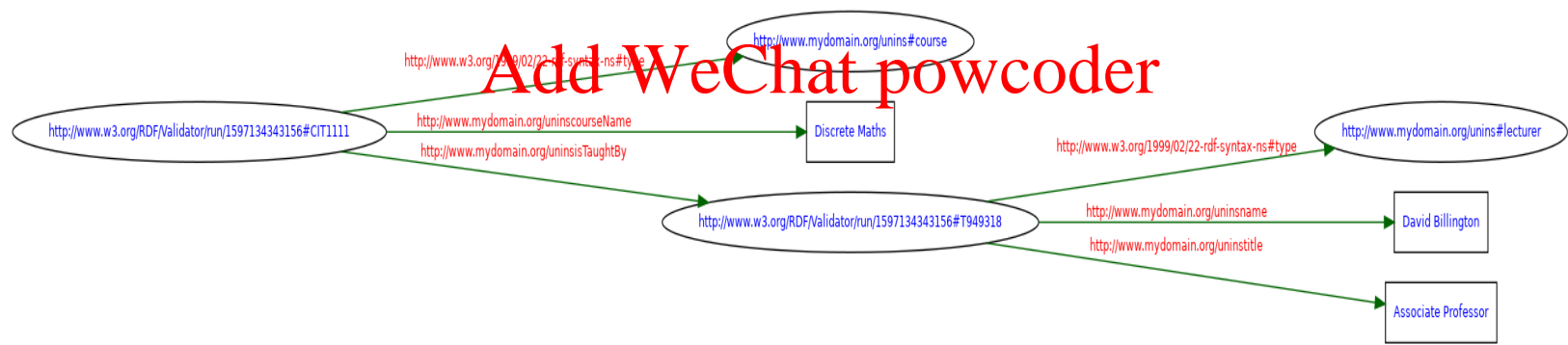
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Example, Graph of the Data Model



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