

## Introduction to a Web of Linked Data

The RDF Data Model

Towards a Global Knowledge Graph

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## The RDF Data Model

1. Describing resources
2. A triple model and a graph model
3. Serialization syntaxes
4. Values, types and languages
5. Groups
6. Naming graphs
7. RDF schemas

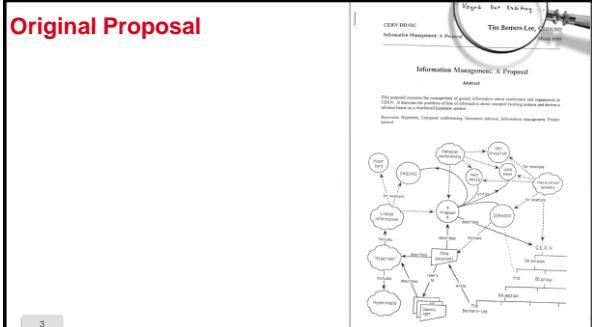
1

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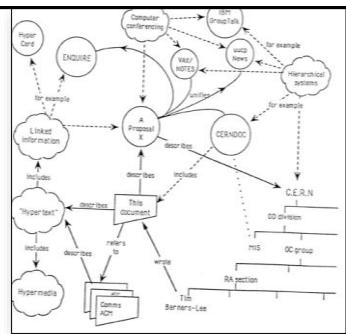
2

## Original Proposal



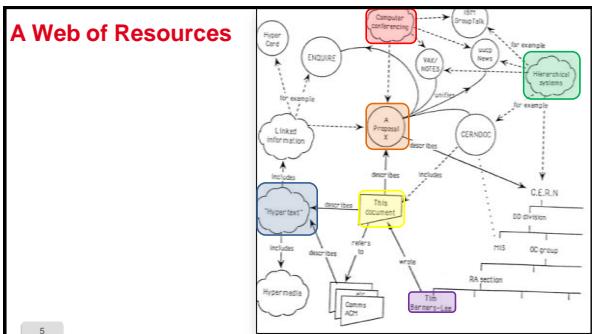
3

## Schema



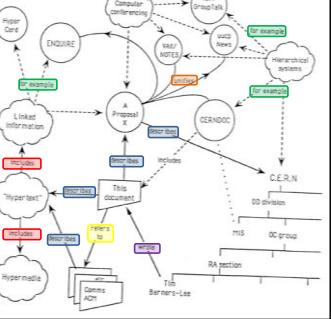
4

## A Web of Resources



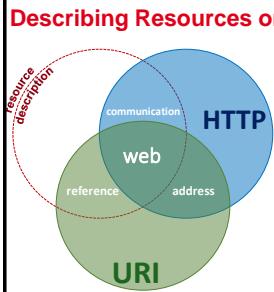
5

## Various Kinds of Links



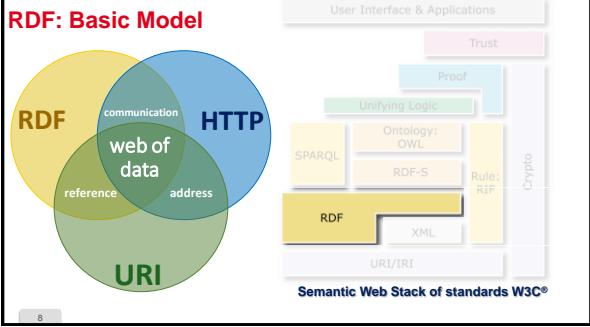
6

## Describing Resources on the Web



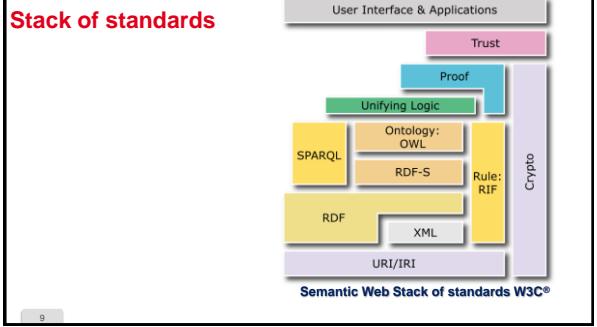
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## RDF: Basic Model



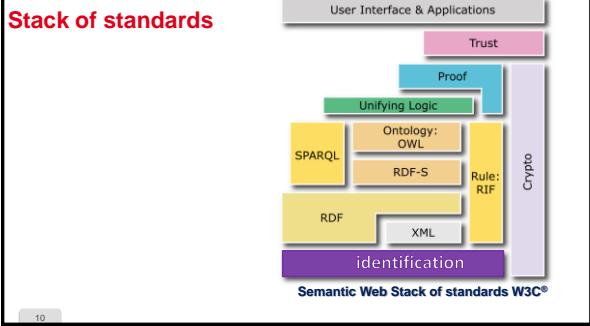
8

## Stack of standards



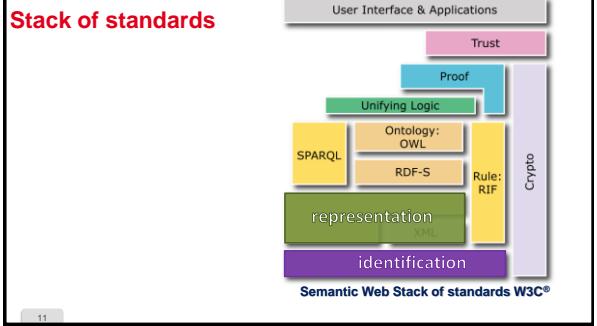
9

## Stack of standards

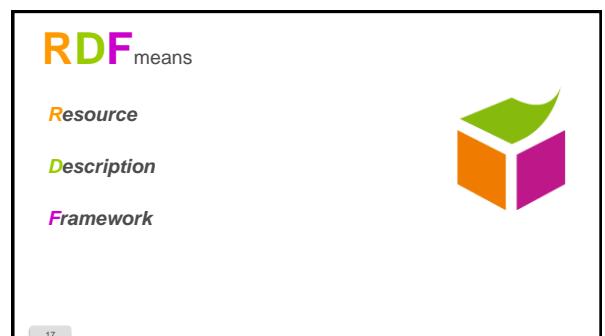
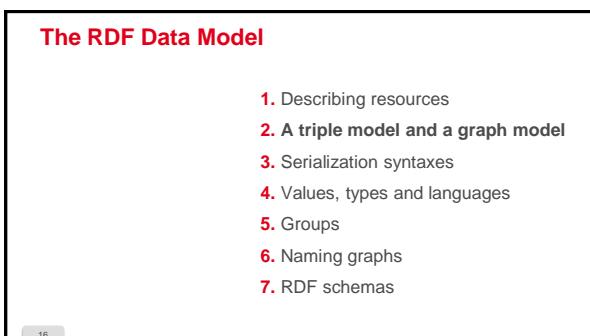
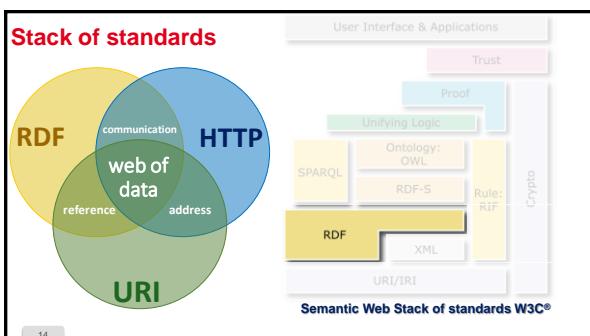
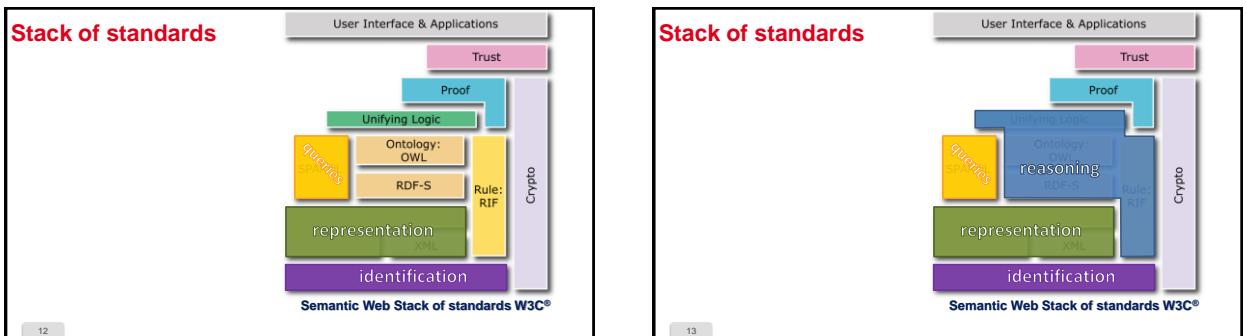


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## Stack of standards



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## RDF means

**Resource:** pages, chairs, persons, ideas...  
all that can have a URI

**Description**

**Framework**



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## RDF means

**Resource:** pages, chairs, persons, ideas...  
all that can have a URI

**Description:** attributes, characteristics,  
and relations between resources

**Framework**



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## RDF means

**Resource:** pages, chairs, persons, ideas...  
all that can have a URI

**Description:** attributes, characteristics,  
and relations between resources

**Framework:** model, language and  
syntaxes for these descriptions



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## RDF decomposes descriptions into triples

( subject , predicate , object )



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## RDF decomposes descriptions into triples

( subject , predicate , object )



E.g.: "doc.html has for authors Fabien,  
Catherine and Olivier and has for topic  
the Web of data"

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## RDF decomposes descriptions into triples

( subject , predicate , object )



E.g.: doc.html has for author Fabien  
doc.html has for author Catherine  
doc.html has for author Olivier  
doc.html has for topic Web of data

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**RDF** decomposes descriptions into triples

( subject , predicate , object )

```
( doc.html , author , Fabien )
(doc.html , author , Catherine )
(doc.html , author , Olivier )
(doc.html , topic , Web of data)
```

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**RDF**: triples are knowledge atoms

Predicate  
Object  
Subject

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**Composition Rules for RDF Triples**

1. The **subject** is always a resource (and not a literal)

( subject , , )

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**Composition Rules for RDF Triples**

1. The **subject** is always a resource (and not a literal)
2. The type of the **binary property** is identified by a URI

( subject , predicate , )

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**Composition Rules for RDF Triples**

1. The **subject** is always a resource (and not a literal)
2. The type of the **binary property** is identified by a URI
3. The **value** is a resource or a literal

( subject , predicate , object )

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**The RDF Data Model**

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6. Naming graphs
7. RDF schemas

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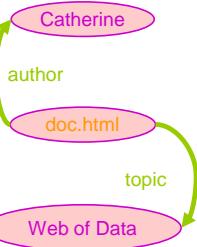
**RDF**: triples form graph edges

( subject , predicate , object )  
→  
(node, edge, node)



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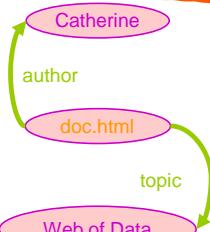
**RDF** is a graph model



( doc.html , author, Catherine )  
( doc.html , topic, Web of Data )

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**RDF** is an oriented labeled multigraph model



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**RDF** is an oriented labeled **multigraph** model



several edges can connect  
the same two nodes



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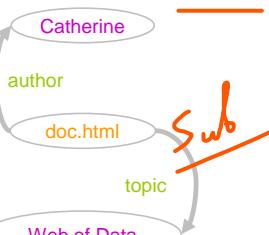
**RDF** is an **oriented** labeled multigraph model



edges are oriented:  
the head is the object  
the tail is the subject

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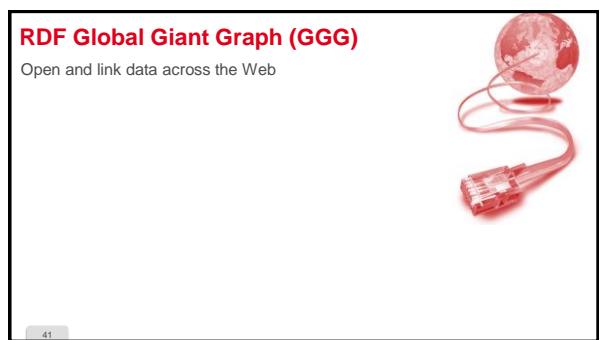
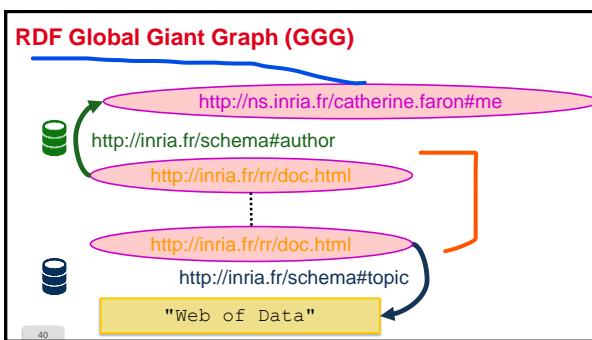
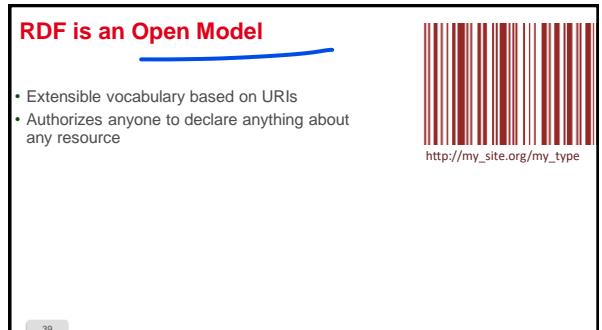
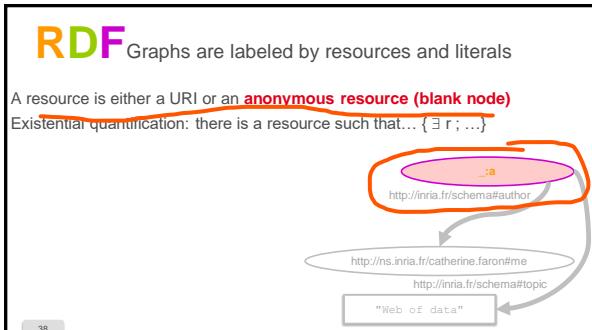
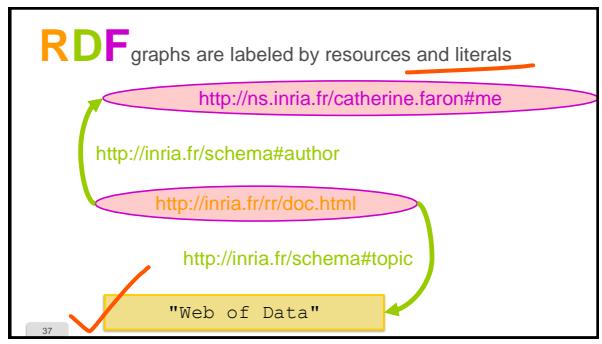
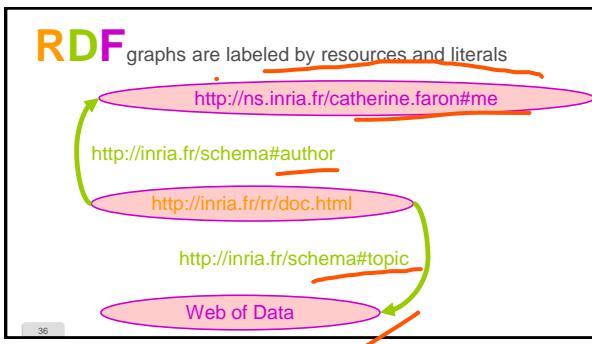
**RDF** is an oriented **labeled** graph multigraph model



edges and nodes  
are labeled

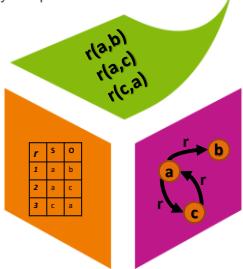


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## Several Views on a Graph

There are many ways to process RDF data



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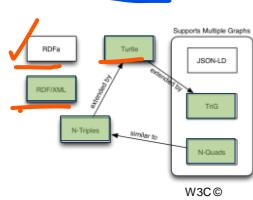
## The RDF Data Model

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7. **RDF Schemas**

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## RDF

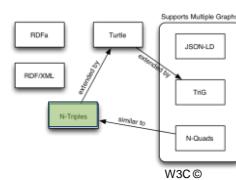
has a historical XML syntax and several other syntaxes: Turtle, TriG, JSON-LD, N-Triples, N-Quads



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## RDF

N-Triples: a minimalist syntax



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## RDF

N-Triples: easy parsing of triple lists

- URIs between less-than and greater-than signs
- Literal values between double quotes
- Triples separated by full stops

```
<http://inria.fr/rr/doc.html>
<http://inria.fr/schema#author>
<http://ns.inria.fr/catherine.faron#me> .
```

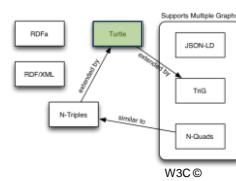
(circled dot)

```
<http://inria.fr/rr/doc.html>
<http://inria.fr/schema#topic> "Web of Data" .
```

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## RDF

Turtle: the most popular RDF syntax



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## RDF

Turtle: a very concise syntax

```
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>.  
@prefix inria: <http://inria.fr/schema#> .  
  
<http://inria.fr/rr/doc.html>  
inria:author <http://ns.inria.fr/catherine.faron#me> ;  
inria:topic "Web of data" .
```

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## RDF

Turtle: prefix declaration

```
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .  
@prefix inria: <http://inria.fr/schema#> .  
  
<http://inria.fr/rr/doc.html>  
inria:author <http://ns.inria.fr/catherine.faron#me> ;  
inria:topic "Web of data" .
```

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## RDF

Turtle: <URI> or qualified name

```
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>.  
@prefix inria: <http://inria.fr/schema#> .  
  
<http://inria.fr/rr/doc.html>  
inria:author <http://ns.inria.fr/catherine.faron#me> ;  
inria:topic "Web of data" .
```

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## RDF

Turtle: one (.) or several properties (;) or values (,)

```
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .  
@prefix inria: <http://inria.fr/schema#> .  
  
<http://inria.fr/rr/doc.html>  
inria:author <http://ns.inria.fr/catherine.faron#me> ;  
inria:topic "Web of data", "Semantic Web".
```

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## RDF

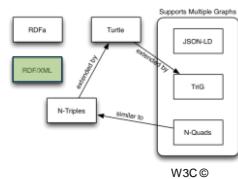
Turtle: [ anonymous resources ]

```
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>.  
@prefix inria: <http://inria.fr/schema#> .  
[ inria:author <http://ns.inria.fr/catherine.faron#me> ;  
inria:topic "Web of data" . ]
```

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## RDF

/XML: the historical XML syntax



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## RDF /XML: capturing graphs into trees

```
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-
syntax-ns#" xmlns:inria="http://inria.fr/schema#" >

<rdf:Description
rdf:about="http://inria.fr/rr/doc.html">
<inria:author rdf:resource=
"http://ns.inria.fr/catherine.faron#me"/>
<inria:topic>Web of Data</inria:topic>
</rdf:Description>

</rdf:RDF>
```

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## RDF /XML: a root

```
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-
syntax-ns#" xmlns:inria="http://inria.fr/schema#" >

<rdf:Description
rdf:about="http://inria.fr/rr/doc.html">
<inria:author rdf:resource=
"http://ns.inria.fr/catherine.faron#me"/>
<inria:topic>Web of Data</inria:topic>
</rdf:Description>

</rdf:RDF>
```

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## RDF /XML: descriptions of resources

```
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-
syntax-ns#" xmlns:inria="http://inria.fr/schema#" >

<rdf:Description
rdf:about="http://inria.fr/rr/doc.html">
<inria:author rdf:resource=
"http://ns.inria.fr/catherine.faron#me"/>
<inria:topic>Web of Data</inria:topic>
</rdf:Description>

</rdf:RDF>
```

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## RDF /XML: anonymous resources (blank nodes)

```
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-
syntax-ns#" xmlns:inria="http://inria.fr/schema#" >

<rdf:Description>
<inria:author rdf:resource=
"http://ns.inria.fr/catherine.faron#me"/>
<inria:topic>Web of Data</inria:topic>
</rdf:Description>

</rdf:RDF>
```

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## RDF /XML: links between resources

```
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-
syntax-ns#" xmlns:inria="http://inria.fr/schema#" >

<rdf:Description
rdf:about="http://inria.fr/rr/doc.html">
<inria:author rdf:resource=
"http://ns.inria.fr/catherine.faron#me"/>
<inria:topic>Web of Data</inria:topic>
</rdf:Description>

</rdf:RDF>
```

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## RDF /XML: literal values

```
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-
syntax-ns#" xmlns:inria="http://inria.fr/schema#" >

<rdf:Description
rdf:about="http://inria.fr/rr/doc.html">
<inria:author rdf:resource=
"http://ns.inria.fr/catherine.faron#me"/>
<inria:topic>Web of Data</inria:topic>
</rdf:Description>

</rdf:RDF>
```

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## RDF

/XML: many syntactic variations

```
<rdf:RDF (...) >
<rdf:Description rdf:about="http://inria.fr/rr/doc.html">
  <inria:author rdf:resource=
    "http://ns.inria.fr/catherine.faron#me"/>
</rdf:Description>
</rdf:RDF>
```

```
<rdf:RDF (...) >
<rdf:Description rdf:about="http://inria.fr/rr/doc.html">
  <inria:topic>Web of Data</inria:topic>
</rdf:Description>
</rdf:RDF>
```



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## RDF

/XML: many syntactic variations

```
<rdf:RDF (...) >
<rdf:Description rdf:about="http://inria.fr/rr/doc.html">
  <inria:author>
    <rdf:Description
      rdf:about="http://ns.inria.fr/catherine.faron#me"/>
    </inria:author>
  </rdf:Description>
</rdf:RDF>
```

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## RDF

/XML: many syntactic variations

```
<rdf:RDF (...) >
<rdf:Description rdf:about="http://inria.fr/rr/doc.html">
  <inria:author>
    <rdf:Description
      rdf:about="http://ns.inria.fr/catherine.faron#me">
        <inria:firstName>Catherine</firstName>
      </rdf:Description>
    </inria:author>
  </rdf:Description>
</rdf:RDF>
```

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## RDF

/XML: many syntactic variations

```
<rdf:RDF (...) >
<rdf:Description rdf:about="http://inria.fr/rr/doc.html"
  inria:topic="Web Of Data"/>
</rdf:RDF>
```

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## "XML Schema Datatypes" for Typing Literals

Literals are by default considered as character strings, of type xsd:string

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Literals are by default considered as character strings, of type xsd:string



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## "XML Schema Datatypes" for Typing Literals

Literals are by default considered as character strings, of type xsd:string

```
@prefix (...) Turtle  
<http://inria.fr/rr/doc.html>  
inria:date "1995-09-18"^^xsd:date .
```



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✓

## "XML Schema Datatypes" for Typing Literals

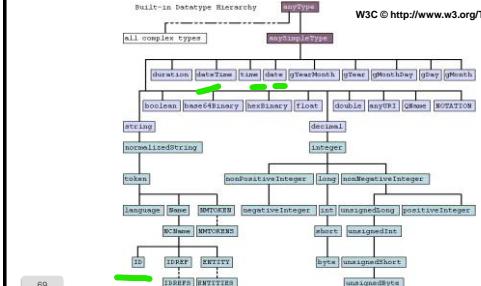
Literals are by default considered as character strings, of type xsd:string



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## "XML Schema Datatypes" for Typing Literals

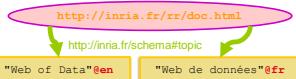
W3C © http://www.w3.org/TR/xmlschema-2/



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## Indicating the Language of Textual Values

Literals can be associated to a language

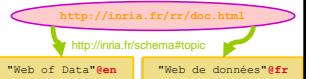


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## Indicating the Language of Textual Values

Literals can be associated to a language

```
@prefix (...) Turtle  
<http://inria.fr/rr/doc.html>  
inria:topic "Web of Data"@en ;  
inria:topic "Web de données"@fr .
```



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✗

## Indicating the Language of Textual Values

Literals can be associated to a language

```
@prefix (...) Turtle
<http://inria.fr/rr/doc.html>
  inria:topic "Web of data"@en ;
    inria:topic "Web de données"@fr .

<rdf:RDF (...)>          RDF/XML
<Rdf:Description rdf:about="http://inria.fr/rr/doc.html">
  <inria:topic xml:lang='en'>Web of Data</inria:topic >
  <inria:topic xml:lang='fr'>Web de données</inria:topic >
</Rdf:Description>
</rdf:RDF>
```

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## Typing Resources

Property **rdf:type** links the URIs of resources to the URIs of their classes

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## Typing Resources

Property **rdf:type** links the URIs of resources to the URIs of their classes

```
@prefix (...) Turtle
<http://ns.inria.fr/catherine.faron#me>
  a inria:Woman, inria:Researcher.
  http://inria.fr/schema#Woman
  http://inria.fr/schema#Researcher
```

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## Typing Resources

Property **rdf:type** links the URIs of resources to the URIs of their classes

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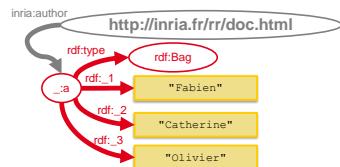
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## Bags (rdf:Bag) of Resources or Literals

Simple groups, without any order



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## Bags (rdf:Bag) of Resources or Literals

Simple groups, without any order

```
@prefix (...) turtle
<http://inria.fr/rr/doc.html> inria:author [ a rdf:Bag ;
  rdf:li "Fabien", "Catherine", "Olivier" . ] .
```

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## Bags (rdf:Bag) of Resources or Literals

Simple groups, without any order

```
@prefix (...) Turtle
<http://inria.fr/rr/doc.html> inria:author [ a rdf:Bag ;
  rdf:li "Fabien", "Catherine", "Olivier" . ] .

<rdf:RDF (...)> RDF/XML
<rdf:Description rdf:about="http://inria.fr/rr/doc.html">
  <inria:author>
    <rdf:Bag>
      <rdf:li>Fabien</rdf:li> <rdf:li>Catherine</rdf:li>
      <rdf:li>Olivier</rdf:li>
    </rdf:Bag>
  </inria:author>
</rdf:Description>
</rdf:RDF>
```

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## Sequences (rdf:Seq)

Ordered groups of resources or literals

```
@prefix (...) turtle
<http://inria.fr/rr/doc.html> inria:author [ a rdf:Seq ;
  rdf:li "Fabien", "Catherine", "Olivier" . ] .

<rdf:RDF (...)> RDF/XML
<rdf:Description rdf:about="http://inria.fr/rr/doc.html">
  <inria:author>
    <rdf:Seq>
      <rdf:li>Fabien</rdf:li> <rdf:li>Catherine</rdf:li>
      <rdf:li>Olivier</rdf:li>
    </rdf:Seq>
  </inria:author>
</rdf:Description>
</rdf:RDF>
```

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## Alternatives (rdf:Alt)

E.g. the same value in different languages

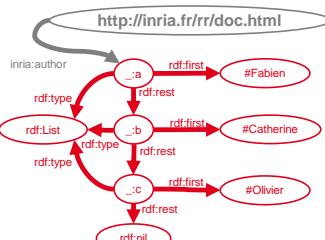
```
@prefix (...) Turtle
<http://inria.fr/rr/doc.html> inria:theme [ a rdf:Alt ;
  rdf:li "Web of data"@en, "Web de données"@fr . ] .

<rdf:RDF (...)> RDF/XML
<rdf:Description rdf:about="http://inria.fr/rr/doc.html">
  <inria:theme>
    <rdf:Alt>
      <rdf:li xml:lang='en'>Web of Data</rdf:li>
      <rdf:li xml:lang='fr'>Web de données</rdf:li>
    </rdf:Alt>
  </inria:theme>
</rdf:Description>
</rdf:RDF>
```

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## Collections

Exhaustive and ordered lists



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## Collections

Exhaustive and ordered lists

```
@prefix (...) Turtle
<http://inria.fr/rr/doc.html> inria:author
( <#Fabien> <#Catherine> <#Olivier> ) .

<rdf:RDF (...)> RDF/XML
<rdf:Description rdf:about="http://inria.fr/rr/doc.html">
  <inria:author rdf:parseType="Collection">
    <rdf:Description rdf:about="#Fabien"/>
    <rdf:Description rdf:about="#Catherine"/>
    <rdf:Description rdf:about="#Olivier"/>
  </inria:author>
</rdf:Description>
</rdf:RDF>
```

83

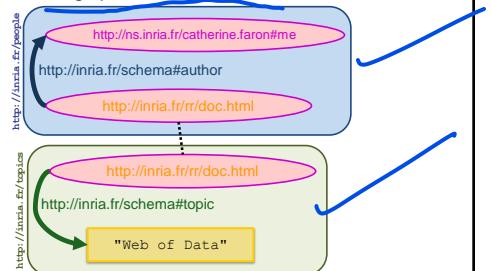
## The RDF Data Model

1. Describing resources
2. A triple model and a graph model
3. Serialization syntaxes
4. Values, types and languages
5. Groups
6. Naming graphs
7. RDF Schemas

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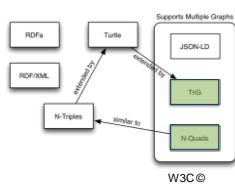
## Named Graphs

Grouping triples in subgraphs identified by URLs



85

**RDF** has the TriG and N-Quads syntaxes to enable the representation of contexts



86

## Named Graphs in TriG

```
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .  
@prefix inria: <http://inria.fr/schema#> .
```

```
GRAPH <http://inria.fr/people>  
{ <http://inria.fr/rr/doc.html>  
    inria:author  
    <http://ns.inria.fr/catherine.faron#me> .  
}  
  
GRAPH <http://inria.fr/topics>  
{ <http://inria.fr/rr/doc.html>  
    inria:topic  
    "Web of Data" .  
}
```

87

## Named Graphs in N-Quads

```
<http://inria.fr/rr/doc.html>  
<http://inria.fr/schema#author>  
<http://ns.inria.fr/catherine.faron#me>  
<http://inria.fr/people> .
```

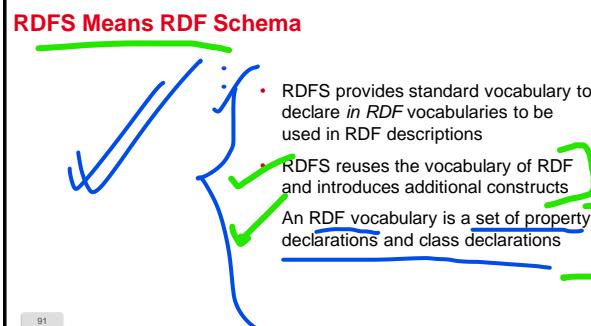
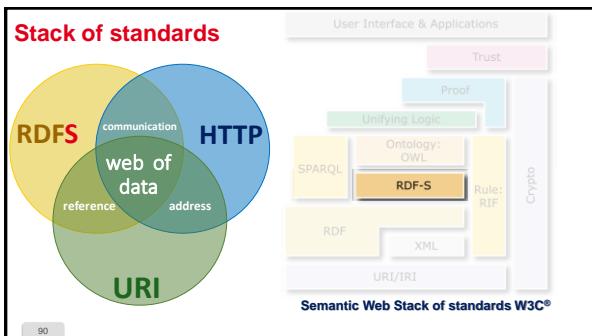
```
<http://inria.fr/rr/doc.html>  
<http://inria.fr/schema#topic>  
"Web of Data"  
<http://inria.fr/topics> .
```

88

## The RDF Data Model

1. Describing resources
2. A triple model and a graph model
3. Serialization syntaxes
4. Values, types and languages
5. Groups
6. Naming graphs
7. RDF schemas

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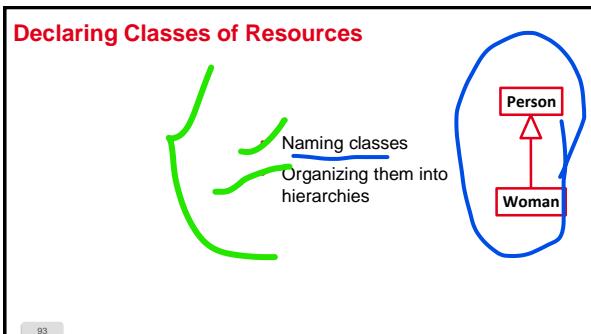


**Associating a Namespace to a Vocabulary**

```
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#>
@base <http://inria.fr/2005/humans.rdfs>

<rdf:RDF xml:base="http://inria.fr/2005/humans.rdfs"
  xmlns:rdf = "http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#">
  (...)
```

92



**Declaring Classes of Resources**

```
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#>
@base <http://inria.fr/2005/humans.rdfs>
<Woman> a rdfs:Class ;
  rdfs:subClassOf <Person>, <Female> .
```

94

**Declaring Classes of Resources**

```
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#>
@base <http://inria.fr/2005/humans.rdfs>
<Woman> a rdfs:Class ;
  rdfs:subClassOf <Person>, <Female> .
```

95

## Declaring Classes of Resources

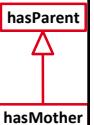
```
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#>
@base <http://inria.fr/2005/humans.rdfs>
<Woman> a rdfs:Class ;
    rdfs:subClassOf <Person>, <Female> .
```

The diagram shows a red box labeled "Person" at the top. Below it is a red box labeled "Woman". A red arrow points from "Person" down to "Woman". To the left of "Woman" is another red box labeled "Female". A red arrow points from "Woman" down to "Female". There are also green arrows pointing from the text "rdfs:subClassOf" and "Female" towards the corresponding parts of the diagram.

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## Declaring Types of Properties

- Naming types of properties
- Organizing them into hierarchies



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## Declaring Types of Properties

Class **Property** is in the RDF namespace since properties are the key of RDF triples

```
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#>
@base <http://inria.fr/2005/humans.rdfs>
<hasMother> a rdf:Property ;
    rdfs:subPropertyOf <hasParent> .
```

The diagram shows two red boxes: "hasParent" at the top and "hasMother" below it. A red arrow points from "hasParent" down to "hasMother". There are blue arrows pointing from the text "rdf:Property" and "rdfs:subPropertyOf" towards the corresponding parts of the diagram.

98

## Declaring Types of Properties

Class **Property** is in the RDF namespace since properties are the key of RDF triples

```
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#>
@base <http://inria.fr/2005/humans.rdfs>
<hasMother> a rdf:Property ;
    rdfs:subPropertyOf <hasParent> .
```

The diagram shows two red boxes: "hasParent" at the top and "hasMother" below it. A red arrow points from "hasParent" down to "hasMother".

99

## Declaring Types of Properties

Class **Property** is in the RDF namespace since properties are the key of RDF triples

```
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#>
@base <http://inria.fr/2005/humans.rdfs>
<hasMother> a rdf:Property ;
    rdfs:subPropertyOf <hasParent> .
```

The diagram shows two red boxes: "hasParent" at the top and "hasMother" below it. A red arrow points from "hasParent" down to "hasMother". There are blue arrows pointing from the text "rdf:Property" and "rdfs:subPropertyOf" towards the corresponding parts of the diagram.

100

## Declaring Property Signatures

```
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#>
@base <http://inria.fr/2005/humans.rdfs>
<hasMother> a rdf:Property ;
    rdfs:subPropertyOf <hasParent> ;
    rdfs:domain <Person> ;
    rdfs:range <Woman> .
```

For <hasMother>:

```
<rdf:Property rdf:ID="hasMother">
  rdfs:subPropertyOf rdf:resource="#hasParent" />
  <rdf:domain rdf:resource="#Person"/>
  <rdf:range rdf:resource="#Woman"/>
</rdf:Property>
```

The diagram shows four red ovals: "Person" on the left, "hasParent" at the top, "hasMother" below it, and "Mother" on the right. A red arrow points from "Person" to "hasParent". A red arrow points from "hasParent" down to "hasMother". A red arrow points from "hasMother" to "Mother".

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## Documenting Class and Property Declarations

```
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#>
@base <http://inria.fr/2005/humans.rdfs#>
<Woman> a rdfs:Class ;
  rdfs:label "woman"@en ;
  rdfs:comment "an adult female person"@en .

<hasMother> a rdf:Property ;
  rdfs:label "has for mother"@en ;
  rdfs:comment "to have a woman for mother"@en .
```

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## Referencing and Using Schemas

in the description of a resource

```
@prefix h: <http://inria.fr/2005/humans.rdfs#>
@base <http://inria.fr/2005/humans.rdfs-instances>
<Alice> a h:Woman; h:hasMother <Laura> .
```

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## Referencing and Using Schemas

in the description of a resource

```
@prefix h: <http://inria.fr/2005/humans.rdfs#>
@base <http://inria.fr/2005/humans.rdfs-instances>
<Alice> a h:Woman; h:hasMother <Laura> .
```

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## Referencing and Using Schemas

in the description of a resource

```
@prefix h: <http://inria.fr/2005/humans.rdfs#>
@base <http://inria.fr/2005/humans.rdfs-instances>
<Alice> a h:Woman; h:hasMother <Laura> .
```



```
<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:h="http://inria.fr/2005/humans.rdfs#"
  xml:base=" http://inria.fr/2005/humans.rdfs-instances" >
  <h:Woman rdf:id="Alice">
    <h:hasMother rdf:resource="#Laura"/>
  </h:Woman>
</rdf:RDF>
```

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## Introduction to a Web of Linked Data

Integration with Other Data Formats and Sources

Catherine Faron [faron@unice.fr](mailto:faron@unice.fr)

Slides from Fabien Gandon [fabien.gandon@inria.fr](mailto:fabien.gandon@inria.fr)

## A Web of "All" Data

The screenshot shows the W3C Data Activity website. The main content area features a large image of a globe with the text "Toward all forms of data on the web". To the right is a sidebar with sections for "ACTIVITY GROUPS", "MEMBERS", "DATA ACTIVITY BLOG", "DATA ACTIVITY NEWSLETTER", "DATA ACTIVITY WORKSHOPS", "DATA ACTIVITY AWARDS", "DATA ACTIVITY PUBLICATIONS", and "DATA ACTIVITY COORDINATOR, VICE". The sidebar also includes a "Content & Vision" section with a paragraph about the Data Activity's mission to facilitate the sharing of data across different domains.

Toward all forms of data on the web

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## Integration With Other Data Formats and Sources

1. RDFa: a RDF syntax inside HTML
2. GRDDL: extract RDF from X(HT)ML
3. JSON-LD: JSON syntax for RDF
4. Tabular data and metadata (CSV)
5. R2RML: integration with databases
6. LDP: a REST API to linked data

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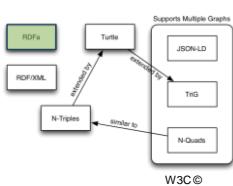
## Integration with other Data Formats and Sources

1. RDFa: an RDF syntax inside HTML
2. GRDDL: extract RDF from X(HT)ML
3. JSON-LD: JSON syntax for RDF
4. Tabular data and metadata (CSV)
5. R2RML: integration with databases
6. LDP: a REST API to linked data

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## RDF

has a historical XML syntax and several other syntaxes: Turtle, TriG, JSON-LD, N-Triples, N-Quads



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## A Lot of Data Inside HTML Pages



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## RDFa Means RDF in HTML Attributes

```
<body vocab="http://purl.org/dc/terms/">  
  <div resource="http://lib.com/books/0684853949">  
    <h2 property="title">The Man Who Mistook His  
      Wife For a Hat</h2>  
    <h3 property="creator">Oliver Sacks</h3>  
  ...
```

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## RDFa Light Attributes...

vocab: default vocabulary for a section  
prefix: declare other vocabularies  
resource: identify a resource  
typeof: type a resource using current voc  
property: link to a value or a resource

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## RDFa Core Additional Attributes...

**content:** provide a specific value  
**datatype:** to type values  
**about:** change the subject of a property  
**rel:** decompose object properties (list)

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## HTML+RDFa Content

```
(...)
<body vocab="http://purl.org/dc/terms/">
<div resource="/books/web_semantique">
<h2 property="title" lang="en">A Web of linked data</h2>
<p>Date: <span property="created">2012-05-01</span>
<span property="creator" resource="#fg">by</span></p>
</div>
<div vocab="http://xmlns.com/foaf/0.1/" resource="#fg" typeof="Person">
<p> <span property="name">Fabien Gandon</span>
  phone: <a property="phone" href="tel:+33492965170">+33492965170</a>
  mail: <a property="mbox"
        href="mailto:fabien.gandon@inria.fr">fabien.gandon@inria.fr</a></p>
</div>
<div>
```

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## HTML+RDFa Content (in Browser)

```
(...)
<body vocab="http://purl.org/dc/terms/">
<div resource="/books/web_semantique">
<h2 property="title" lang="en">A Web of linked data</h2>
<p>Date: <span property="created">2012-05-01</span>
<span property="creator" resource="#fg">by</span></p>
</div>
<div vocab="http://xmlns.com/foaf/0.1/" resource="#fg" typeof="Person">
<p> <span property="name">Fabien Gandon</span>
  phone: <a property="phone" href="tel:+33492965170">+33492965170</a>
  mail: <a property="mbox"
        href="mailto:fabien.gandon@inria.fr">fabien.gandon@inria.fr</a></p>
</div>
```

file:///C:/Users/201/ressources/... +  
file:///C:/Users/gandon/Documents/



A Web of linked data

Date: 2012-05-01 by  
Fabien Gandon, phone: +33492965170 mail: fabien.gandon@inria.fr

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## HTML+RDFa Content (Read by RDFA Parser)

```
(...)
<body vocab="http://purl.org/dc/terms/">
<div resource="/books/web_semantique">
<h2 property="title" lang="en">A Web of linked data</h2>
<p>Date: <span property="created">2012-05-01</span>
<span property="creator" resource="#fg">by</span></p>
</div>
<div vocab="http://xmlns.com/foaf/0.1/" resource="#fg" typeof="Person">
<p> <span property="name">Fabien Gandon</span>
  phone: <a property="phone" href="tel:+33492965170">+33492965170</a>
  mail: <a property="mbox"
        href="mailto:fabien.gandon@inria.fr">fabien.gandon@inria.fr</a></p>
</div>
<div>
```

117

## HTML+RDFa Content (Read by RDFA Parser)

```
(...)
<body vocab="http://purl.org/dc/terms/">
<div resource="/books/web_semantique">
<h2 property="title" lang="en">A Web of linked data</h2>
<p>Date: <span property="created">2012-05-01</span>
<span property="creator" resource="#fg">by</span></p>
</div>
<div vocab="http://xmlns.com/foaf/0.1/" resource="#fg" typeof="Person">
<p> <span property="name">Fabien Gandon</span>
  phone: <a property="phone" href="tel:+33492965170">+33492965170</a>
  mail: <a property="mbox"
        href="mailto:fabien.gandon@inria.fr">fabien.gandon@inria.fr</a></p>
</div>
<div>
  @prefix ns1: <http://purl.org/dc/terms/> .
  @prefix ns2: <http://xmlns.com/foaf/0.1/> .
</div>
<div vocab="http://purl.org/dc/terms/">
  ns1:title "A Web of linked data"@en ;
  ns1:created "2012-05-01" ;
  ns1:creator <#fg> .
```



<#fg> a ns2:Person;
ns2:mbox <mailto:fabien.gandon@inria.fr>;
ns2:mail "Fabien Gandon";
ns2:phone <tel:+33492965170> .

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## Anatomy of HTML+RDFa Content (Vocabularies)

```
(...)
<body vocab="http://purl.org/dc/terms/">
<div resource="/books/web_semantique">
<h2 property="title" lang="en">A Web of linked data</h2>
<p>Date: <span property="created">2012-05-01</span>
<span property="creator" resource="#fg">by</span></p>
</div>
<div vocab="http://xmlns.com/foaf/0.1/" resource="#fg" typeof="Person">
<p> <span property="name">Fabien Gandon</span>
  phone: <a property="phone" href="tel:+33492965170">+33492965170</a>
  mail: <a property="mbox"
        href="mailto:fabien.gandon@inria.fr">fabien.gandon@inria.fr</a></p>
</div>
<div>
```

119

schemas used

### Anatomy of HTML+RDFa Content (Subjects)

```
(...)
<body vocab="http://purl.org/dc/terms/">
<div resource="/books/web_semantique">
<h2 property="title" lang="en">A Web of linked data</h2>
<p>Date: <span property="created">2012-05-01</span>
<span property="creator" resource="#fg">by</span></p>
</div>
<div vocab="http://xmlns.com/foaf/0.1/" resource="#fg" typeof="Person">
  <p> <span property="name">Fabien Gandon</span>
  phone: <a property="phone" href="tel:+33492965170">+33492965170</a>
  mail: <a property="mbox"
        href="mailto:fabien.gandon@inria.fr">fabien.gandon@inria.fr</a></p>
</div>
(...)
```

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subjects of triples

### Anatomy of HTML+RDFa Content (Typing)

```
(...)
<body vocab="http://purl.org/dc/terms/">
<div resource="/books/web_semantique">
<h2 property="title" lang="en">A Web of linked data</h2>
<p>Date: <span property="created">2012-05-01</span>
<span property="creator" resource="#fg">by</span></p>
</div>
<div vocab="http://xmlns.com/foaf/0.1/" resource="#fg" typeof="Person">
  <p> <span property="name">Fabien Gandon</span>
  phone: <a property="phone" href="tel:+33492965170">+33492965170</a>
  mail: <a property="mbox"
        href="mailto:fabien.gandon@inria.fr">fabien.gandon@inria.fr</a></p>
</div>
(...)
```

121

type

### Anatomy of HTML+RDFa Content (Literals)

```
(...)
<body vocab="http://purl.org/dc/terms/">
<div resource="/books/web_semantique">
<h2 property="title" lang="en">A Web of linked data</h2>
<p>Date: <span property="created">2012-05-01</span>
<span property="creator" resource="#fg">by</span></p>
</div>
<div vocab="http://xmlns.com/foaf/0.1/" resource="#fg" typeof="Person">
  <p> <span property="name">Fabien Gandon</span>
  phone: <a property="phone" href="tel:+33492965170">+33492965170</a>
  mail: <a property="mbox"
        href="mailto:fabien.gandon@inria.fr">fabien.gandon@inria.fr</a></p>
</div>
(...)
```

122

properties & values

### Anatomy of HTML+RDFa Content (Objects)

```
(...)
<body vocab="http://purl.org/dc/terms/">
<div resource="/books/web_semantique">
<h2 property="title" lang="en">A Web of linked data</h2>
<p>Date: <span property="created">2012-05-01</span>
<span property="creator" resource="#fg">by</span></p>
</div>
<div vocab="http://xmlns.com/foaf/0.1/" resource="#fg" typeof="Person">
  <p> <span property="name">Fabien Gandon</span>
  phone: <a property="phone" href="tel:+33492965170">+33492965170</a>
  mail: <a property="mbox"
        href="mailto:fabien.gandon@inria.fr">fabien.gandon@inria.fr</a></p>
</div>
(...)
```

123

properties & objects

### Anatomy of HTML+RDFa Content (Resource)

```
(...)
<body vocab="http://purl.org/dc/terms/">
<div resource="/books/web_semantique">
<h2 property="title" lang="en">A Web of linked data</h2>
<p>Date: <span property="created">2012-05-01</span>
<span property="creator" resource="#fg">by</span></p>
</div>
<div vocab="http://xmlns.com/foaf/0.1/" resource="#fg" typeof="Person">
  <p> <span property="name">Fabien Gandon</span>
  phone: <a property="phone" href="tel:+33492965170">+33492965170</a>
  mail: <a property="mbox"
        href="mailto:fabien.gandon@inria.fr">fabien.gandon@inria.fr</a></p>
</div>
(...)
```

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property & resource

### Anatomy of HTML+RDFa Content (href)

```
(...)
<body vocab="http://purl.org/dc/terms/">
<div resource="/books/web_semantique">
<h2 property="title" lang="en">A Web of linked data</h2>
<p>Date: <span property="created">2012-05-01</span>
<span property="creator" resource="#fg">by</span></p>
</div>
<div vocab="http://xmlns.com/foaf/0.1/" resource="#fg" typeof="Person">
  <p> <span property="name">Fabien Gandon</span>
  phone: <a property="phone" href="tel:+33492965170">+33492965170</a>
  mail: <a property="mbox"
        href="mailto:fabien.gandon@inria.fr">fabien.gandon@inria.fr</a></p>
</div>
(...)
```

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property & href

## Schema.org: Vocabulary by Major Search Engines and Applications

The screenshot shows the Schema.org vocabulary page for the 'Person' schema. It includes a search bar, navigation links for Home, Schema.org, Documentation, and Help, and a sidebar with links to other schema types like 'Organization', 'Event', 'Product', 'Service', 'Thing', 'Image', 'MediaObject', 'Text', 'List', 'TableOfContents', and 'FAQPage'. The main content area displays the 'Person' schema definition with its properties: 'name', 'sameAs', 'url', 'id', 'isAccessibleForFree', 'dateCreated', 'dateModified', 'datePublished', 'description', 'image', 'mainEntityOfPage', 'name', 'about', 'address', 'alumniOf', 'awardReceived', 'category', 'contactPoint', 'deathDate', 'deathPlace', 'disambiguatingDescription', 'educationLevel', 'employment', 'genre', 'image', 'inLanguage', 'interactionStatistic', 'isAccessibleForFree', 'isFamilyFriendly', 'isInLanguage', 'isPartOf', 'itemOffered', 'mainEntity', 'name', 'parentOrganization', 'potentialAction', 'productOffer', 'subjectOf', 'taxon', 'text', 'url', and 'workExperience'. Below the properties is a note: 'Usage: Over 1,000,000 documents.'

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## Example of RDFa Using schema.org

```
<div vocab="http://schema.org/" typeof="Product">
  
  <span property="name">Dell UltraSharp 30" LCD Monitor</span>
  <div rel="hasAggregateRating" >
    <div typeof="http://schema.org/AggregateRating">
      <span property="ratingValue" >87</span>
      out of <span property="bestRating" >100</span>
      based on <span property="ratingCount" >24</span> user ratings
    </div>
  </div>
  <div rel="offers" >
    <div typeof="http://schema.org/AggregateOffer">
      <span property="lowPrice" >$1250</span>
      to <span property="highPrice" >$1495</span>
      from <span property="offerCount" >8</span> sellers
    </div>
  </div> (...)
```

127

## Example of RDFa Using schema.org

The screenshot shows an Amazon product page for a 'Pilot Vanishing Point Collection Retractable Fountain Pen, Black with Rhodium Accents, Blue Ink, Medium Nib (60242)'. The page includes a large image of the pen, its name, price (\$130.50), shipping information, and a 4.8-star rating. A red arrow points to the 'Offers' section where it says 'Cook' and 'Like' buttons are present.

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## Facebook OGP Code / "Like" button

```
<html xmlns="http://www.w3.org/1999/xhtml" dir="ltr" lang="en-US"
  xmlns:fb="https://www.facebook.com/2008/fbml">
<head>
  <meta property="og:title" content="YOUR_APP_ID" />
  <meta property="og:type" content="YOUR_NAMESPACE:recipe" />
  <meta property="og:image" content="stuffed Cookies" />
  <meta property="og:description" content="The Turducken of Cookies" />
  <meta property="og:url" content="http://example.com/cookie.html" />
<script type="text/javascript">
  function postCook() {
    FB.api('/me/YOUR_NAMESPACE:cook', { 'recipe': 'http://example.com/cookie.html', 'post': (...) });
  }
</script>
</head>
<body>
  (...)

  <form>
    <input type="button" value="Cook" onclick="postCook()" />
  </form>
</body>
</html>
```

129

## RDFa Core Initial Context

Predefined prefixes that can be used without defining them

<https://www.w3.org/2011/rdfa-context/rdfa-1.1>

csvw, dcat, qb, grddl, ma, org, owl, prov, rdf, rdfs, rif, rr, sd, skos, skosxl, wdr, void, wdrs, xviv, xml, xsd, cc, ctag, dc, dcterms, dc11, foaf, gr, ical, og, rev, sioc, v, vcard, schema,...

130

## Linked Data in HTML

- <http://rdfa.info/play/>

The screenshot shows the rdafainfo play tool interface. It features a top navigation bar with 'Home', 'Recent', 'Search', and 'Help'. Below is a 'New' button and a 'File' menu with options like 'Open', 'Save', 'Save As...', 'Print', 'Print Preview', 'Exit', and 'Help'. The main area contains a 'Resource' input field with 'http://www.w3.org/2007/05/pat/test/linked-data.html' and a 'Format' dropdown set to 'Turtle'. A 'Run' button is next to the format dropdown. To the right is a 'Results' panel with a 'Resource' input field containing 'http://www.w3.org/2007/05/pat/test/linked-data.html#R1'. Below are sections for 'Properties', 'Subjects', and 'Objects'. At the bottom is a 'Feedback' section with a 'Send Feedback' button.

131

## These Data are Available to Everyone

If you apply an RDFa parser to these pages you will obtain these data



132

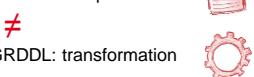
## Integration With Other Data Formats and Sources

1. RDFa: an RDF syntax inside HTML
2. GRDDL: extract RDF from X(HT)ML
3. JSON-LD: JSON syntax for RDF
4. Tabular data and metadata (CSV)
5. R2RML: integration with databases
6. LDP: a REST API to linked data

133

## GRDDL Algorithmic Alternative to RDFa

- Means "Gleaning Resource Descriptions from Dialects of Languages"
- RDFa: markup
- GRDDL: transformation



134

## GRDDL Transformations

- Indicate a document can be transformed into RDF data (**profile**)
- Reference an RDF extraction algorithms from inside documents (**transformation**)
- Works for HTML and XML

135

## Simple Example in HTML:

```
<head profile="http://www.w3.org/2003/g/data-view">
<title>The man who mistook his wife for a hat</title>
<link rel="transformation"
      href="http://www.w3.org/2000/06/ dc-extract/dc-extract.xsl" />
<meta name="DC.Subject" content="clinical tales" />
(...)
```

136

## Simple Example in HTML:

```
<head profile="http://www.w3.org/2003/g/data-view">
<title>The man who mistook his wife for a hat</title>
<link rel="transformation"
      href="http://www.w3.org/2000/06/ dc-extract/dc-extract.xsl" />
<meta name="DC.Subject" content="clinical tales" />
(...)
```

137

### Simple Example in XML: e.g. Excel XML Spreadsheet

```
<?xml version="1.0"?>
<mso-application progid="Excel.Sheet"?>
<Workbook xmlns="urn:schemas-microsoft-com:office:spreadsheet"
  xmlns:grddl="http://www.w3.org/2003/g/data-view#"
  grddl:transformation="excel2rdf.xsl">
(...)
```

138

### Simple Example in XML: e.g. Excel XML Spreadsheet

```
<?xml version="1.0"?>
<mso-application progid="Excel.Sheet"?>
<Workbook xmlns="urn:schemas-microsoft-com:office:spreadsheet"
  xmlns:grddl="http://www.w3.org/2003/g/data-view#"
  grddl:transformation="excel2rdf.xsl">
(...)
```

139

### GRDDL Agent Process: Direct Transformation

```
<head profile="http://www.w3.org/2003/g/data-view">
<title>The man who mistook his wife for a hat</title>
<link rel="transformation"
  href="http://www.w3.org/2000/06/ dc-extract/dc-extract.xsl" />
<meta name="DC.Subject" content="clinical tales" />
(...)
```



source

140

### GRDDL Agent Process: Direct Transformation

```
<head profile="http://www.w3.org/2003/g/data-view">
<title>The man who mistook his wife for a hat</title>
<link rel="transformation"
  href="http://www.w3.org/2000/06/ dc-extract/dc-extract.xsl" />
<meta name="DC.Subject" content="clinical tales" />
(...)
```



source      GRDDL source document

141

### GRDDL Agent Process: Direct Transformation

```
<head profile="http://www.w3.org/2003/g/data-view">
<title>The man who mistook his wife for a hat</title>
<link rel="transformation"
  href="http://www.w3.org/2000/06/ dc-extract/dc-extract.xsl" />
<meta name="DC.Subject" content="clinical tales" />
(...)
```



detect profile



transform.



source and transformation

142

### GRDDL Agent Process: Direct Transformation

```
<head profile="http://www.w3.org/2003/g/data-view">
<title>The man who mistook his wife for a hat</title>
<link rel="transformation"
  href="http://www.w3.org/2000/06/ dc-extract/dc-extract.xsl" />
<meta name="DC.Subject" content="clinical tales" />
(...)
```



source      GRDDL source document



apply transform.



RDF

143

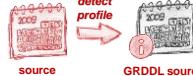
### GRDDL Agent Process: Indirect Transformation



source

144

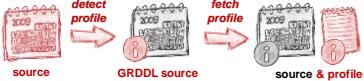
### GRDDL Agent Process: Indirect Transformation



GRDDL source document

145

### GRDDL Agent Process: Indirect Transformation



GRDDL source document

146

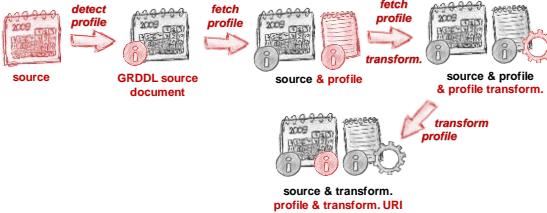
### GRDDL Agent Process: Indirect Transformation



GRDDL source document

147

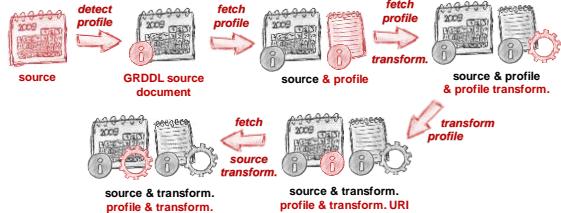
### GRDDL Agent Process: Indirect Transformation



source & transform.  
profile & transform. URI

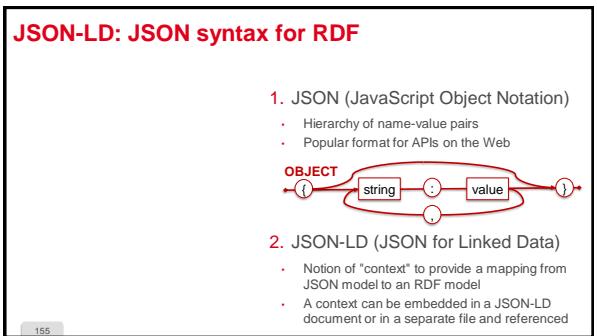
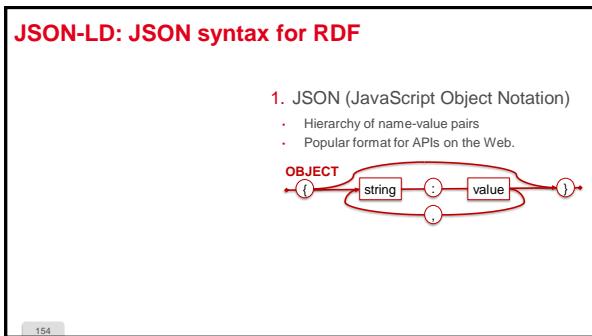
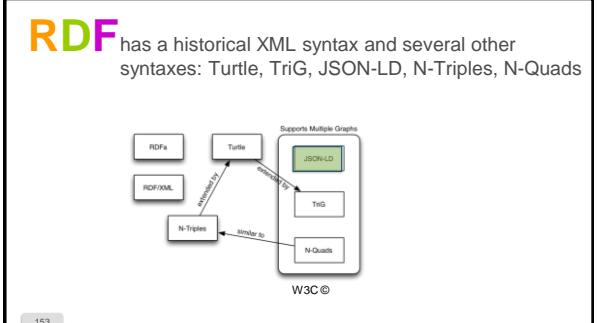
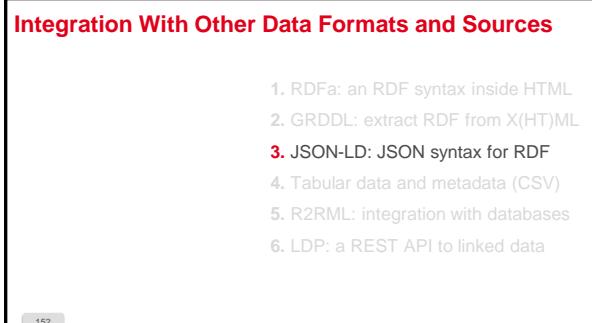
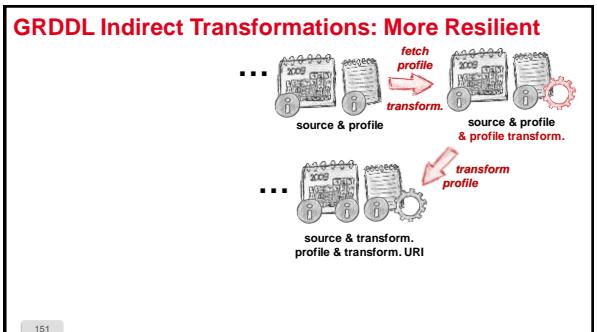
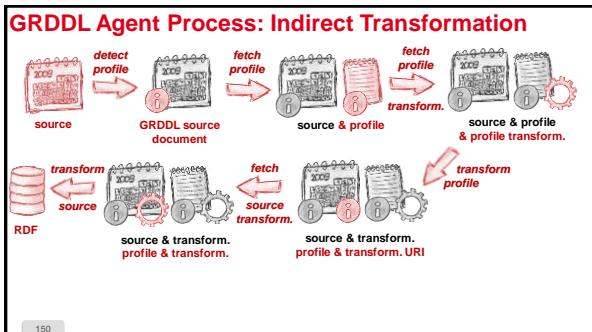
148

### GRDDL Agent Process: Indirect Transformation



source & transform.  
profile & transform. URI

149



## Specific Reserved Names Prefixed by @

```
@context : define short names used in the document.  
@id : identify resources with IRIs or blank nodes.  
@value: specify the data value of a property  
@language: specify the language for a string or the document.  
@type: set the type of a value or a resource.  
@vocab: prefix IRI to expand properties and values in @type.  
@base: used to set the base IRI  
@container: used to set the default container type for a term.  
@index: specify a container is used to index information  
@list: an ordered set of data.  
@set: an unordered set of data  
@reverse: express reverse properties.  
@graph: indicate a graph.
```

156

## Specific Reserved Names Prefixed by @

```
@context : define short names used in the document.  
@id : identify resources with IRIs or blank nodes.  
@value: specify the data value of a property  
@language: specify the language for a string or the document.  
@type: set the type of a value or a resource.  
@vocab: prefix IRI to expand properties and values in @type.  
@base: used to set the base IRI  
@container: used to set the default container type for a term.  
@index: specify a container is used to index information  
@list: an ordered set of data.  
@set: an unordered set of data  
@reverse: express reverse properties.  
@graph: indicate a graph.
```

157

## Example with these Data in Turtle

```
@prefix foaf: <http://xmlns.com/foaf/0.1/> .  
@prefix xsd: <http://www.w3.org/2001/XMLSchema#> .  
<http://ns.inria.fr/fabien.gandon#me> a foaf:Person ;  
foaf:family_name "Gandon"@fr ;  
foaf:givenname "Fabien"@fr ;  
foaf:age 40 ;  
foaf:birthday "-07-31"^^xsd:gMonthDay ;  
foaf:homepage <http://fabien.info> ;  
foaf:knows [ a foaf:Person ; foaf:name "Olivier Corby" ],  
[ a foaf:Person ; foaf:name "Catherine Faron" ].
```

158

## Example with these Data in Turtle

```
@prefix foaf: <http://xmlns.com/foaf/0.1/> .  
@prefix xsd: <http://www.w3.org/2001/XMLSchema#> .  
<http://ns.inria.fr/fabien.gandon#me> a foaf:Person ;  
foaf:family_name "Gandon"@fr ;  
foaf:givenname "Fabien"@fr ;  
foaf:age 40 ;  
foaf:birthday "-07-31"^^xsd:gMonthDay ;  
foaf:homepage <http://fabien.info> ;  
foaf:knows [ a foaf:Person ; foaf:name "Olivier Corby" ],  
[ a foaf:Person ; foaf:name "Catherine Faron" ].
```

properties & values

159

## Example with these Data in Turtle

```
@prefix foaf: <http://xmlns.com/foaf/0.1/> .  
@prefix xsd: <http://www.w3.org/2001/XMLSchema#> .  
<http://ns.inria.fr/fabien.gandon#me> a foaf:Person ;  
foaf:family_name "Gandon"@fr ;  
foaf:givenname "Fabien"@fr ;  
foaf:age 40 ;  
foaf:birthday "-07-31"^^xsd:gMonthDay ;  
foaf:homepage <http://fabien.info> ;  
foaf:knows [ a foaf:Person ; foaf:name "Olivier Corby" ],  
[ a foaf:Person ; foaf:name "Catherine Faron" ].
```

160

## Example with these Data in Turtle

```
@prefix foaf: <http://xmlns.com/foaf/0.1/> .  
@prefix xsd: <http://www.w3.org/2001/XMLSchema#> .  
<http://ns.inria.fr/fabien.gandon#me> a foaf:Person ;  
foaf:family_name "Gandon"@fr ;  
foaf:givenname "Fabien"@fr ;  
foaf:age 40 ;  
foaf:birthday "-07-31"^^xsd:gMonthDay ;  
foaf:homepage <http://fabien.info> ;  
foaf:knows [ a foaf:Person ; foaf:name "Olivier Corby" ],  
[ a foaf:Person ; foaf:name "Catherine Faron" ].
```

list of b-nodes  
values

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## Simple JSON-LD Version

```
{
  "@id": "http://ns.inria.fr/fabien.gandon#me",
  "@type": "http://xmlns.com/foaf/0.1/Person",
  "http://xmlns.com/foaf/0.1/age": 40,
  "http://xmlns.com/foaf/0.1/birthDay": {
    "@type": "http://www.w3.org/2001/XMLSchema#gMonthDay", "@value": "-07-31" },
  "http://xmlns.com/foaf/0.1/family_name": { "@value": "Gandon" , "@language": "fr" },
  "http://xmlns.com/foaf/0.1/givenName": { "@value": "Fabien" , "@language": "fr" },
  "http://xmlns.com/foaf/0.1/homepage": { "@id": "http://fabien.info" },
  "http://xmlns.com/foaf/0.1/knows": [
    { "@type": "http://xmlns.com/foaf/0.1/Person",
      "http://xmlns.com/foaf/0.1/name": "Catherine Faron" },
    { "@type": "http://xmlns.com/foaf/0.1/Person",
      "http://xmlns.com/foaf/0.1/name": "Olivier Corby" }
  ]
}
```

162

a resource  
and its type

## Simple JSON-LD Version

```
{
  "@id": "http://ns.inria.fr/fabien.gandon#me",
  "@type": "http://xmlns.com/foaf/0.1/Person",
  "http://xmlns.com/foaf/0.1/age": 40,
  "http://xmlns.com/foaf/0.1/birthDay": {
    "@type": "http://www.w3.org/2001/XMLSchema#gMonthDay", "@value": "-07-31" },
  "http://xmlns.com/foaf/0.1/family_name": { "@value": "Gandon" , "@language": "fr" },
  "http://xmlns.com/foaf/0.1/givenName": { "@value": "Fabien" , "@language": "fr" },
  "http://xmlns.com/foaf/0.1/homepage": { "@id": "http://fabien.info" },
  "http://xmlns.com/foaf/0.1/knows": [
    { "@type": "http://xmlns.com/foaf/0.1/Person",
      "http://xmlns.com/foaf/0.1/name": "Catherine Faron" },
    { "@type": "http://xmlns.com/foaf/0.1/Person",
      "http://xmlns.com/foaf/0.1/name": "Olivier Corby" }
  ]
}
```

163

## Simple JSON-LD Version

```
{
  "@id": "http://ns.inria.fr/fabien.gandon#me",
  "@type": "http://xmlns.com/foaf/0.1/Person",
  "http://xmlns.com/foaf/0.1/age": 40,
  "http://xmlns.com/foaf/0.1/birthDay": {
    "@type": "http://www.w3.org/2001/XMLSchema#gMonthDay", "@value": "-07-31" },
  "http://xmlns.com/foaf/0.1/family_name": { "@value": "Gandon" , "@language": "fr" },
  "http://xmlns.com/foaf/0.1/givenName": { "@value": "Fabien" , "@language": "fr" },
  "http://xmlns.com/foaf/0.1/homepage": { "@id": "http://fabien.info" },
  "http://xmlns.com/foaf/0.1/knows": [
    { "@type": "http://xmlns.com/foaf/0.1/Person",
      "http://xmlns.com/foaf/0.1/name": "Catherine Faron" },
    { "@type": "http://xmlns.com/foaf/0.1/Person",
      "http://xmlns.com/foaf/0.1/name": "Olivier Corby" }
  ]
}
```

164

a property and its  
value in native datatype

## Simple JSON-LD Version

```
{
  "@id": "http://ns.inria.fr/fabien.gandon#me",
  "@type": "http://xmlns.com/foaf/0.1/Person",
  "http://xmlns.com/foaf/0.1/age": 40,
  "http://xmlns.com/foaf/0.1/birthDay": {
    "@type": "http://www.w3.org/2001/XMLSchema#gMonthDay", "@value": "-07-31" },
  "http://xmlns.com/foaf/0.1/family_name": { "@value": "Gandon" , "@language": "fr" },
  "http://xmlns.com/foaf/0.1/givenName": { "@value": "Fabien" , "@language": "fr" },
  "http://xmlns.com/foaf/0.1/homepage": { "@id": "http://fabien.info" },
  "http://xmlns.com/foaf/0.1/knows": [
    { "@type": "http://xmlns.com/foaf/0.1/Person",
      "http://xmlns.com/foaf/0.1/name": "Catherine Faron" },
    { "@type": "http://xmlns.com/foaf/0.1/Person",
      "http://xmlns.com/foaf/0.1/name": "Olivier Corby" }
  ]
}
```

165

verbose property names

## JSON-LD with Context (Prefixes)

```
{
  "@context": {
    "foaf": "http://xmlns.com/foaf/0.1/",
    "xsd": "http://www.w3.org/2001/XMLSchema#"
  },
  "@graph": [
    { "@id": "http://ns.inria.fr/fabien.gandon#me", "@type": "foaf:Person",
      "foaf:age": 40,
      "foaf:birthDay": { "@type": "xsd:gMonthDay", "@value": "-07-31" },
      "foaf:family_name": { "@value": "Gandon" , "@language": "fr" },
      "foaf:givenName": { "@value": "Fabien" , "@language": "fr" },
      "foaf:homepage": { "@id": "http://fabien.info" },
      "foaf:knows": [ { "@type": "foaf:Person", "foaf:name": "Olivier Corby" },
        { "@type": "foaf:Person", "foaf:name": "Catherine Faron" }
      ]
    }
  ]
}
```

166

## JSON-LD with Context (Qnames)

```
{
  "@context": {
    "foaf": "http://xmlns.com/foaf/0.1/",
    "xsd": "http://www.w3.org/2001/XMLSchema#"
  },
  "@graph": [
    { "@id": "http://ns.inria.fr/fabien.gandon#me", "@type": "foaf:Person",
      "foaf:age": 40,
      "foaf:birthDay": { "@type": "xsd:gMonthDay", "@value": "-07-31" },
      "foaf:family_name": { "@value": "Gandon" , "@language": "fr" },
      "foaf:givenName": { "@value": "Fabien" , "@language": "fr" },
      "foaf:homepage": { "@id": "http://fabien.info" },
      "foaf:knows": [ { "@type": "foaf:Person", "foaf:name": "Olivier Corby" },
        { "@type": "foaf:Person", "foaf:name": "Catherine Faron" }
      ]
    }
  ]
}
```

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## JSON-LD with Context (Types)

```

  "context": {
    "foaf": "http://xmlns.com/foaf/0.1/" ,
    "xsd": "http://www.w3.org/2001/XMLSchema#"
  },
  "graph": [
    {
      "@id": "https://ns.inria.fr/fabien.gandon#me", "@type": "foaf:Person",
      "foafage": "40",
      "foafbirthday": { "@type": "xsd:gMonthDay", "@value": "-07-31" },
      "foaffamilyname": { "@value": "Gandon", "@language": "fr" },
      "foafgivenname": { "@value": "Fabien", "@language": "fr" },
      "foahomepage": { "@id": "http://fabien.info" },
      "foafknows": [ { "@type": "foaf:Person", "foaf:name": "Olivier Corby" },
        { "@type": "foaf:Person", "foaf:name": "Catherine Faron" }
      ]
    }
  ]
}

```

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## JSON-LD with Context (Language)

```

{ "@context": [
    { "foaf": "http://xmlns.com/foaf/0.1/" },
    { "xsd": "http://www.w3.org/2001/XMLSchema#" }
], "@graph": [
    { "@id": "http://ns.inria.fr/fabien.gandon#me", "@type": "foaf:Person",
      "foaf:surname": "Gandon", "foaf:age": 40,
      "foaf:birthday": { "@type": "xsd:MonthDay", "@value": "-07-31" },
      "foaf:family_name": { "@value": "Gandon", "@language": "fr" },
      "foaf:givenname": { "@value": "Fabien", "@language": "fr" },
      "foaf:homepage": { "@id": "http://fabien.info" },
      "foaf:knows": [ { "@type": "foaf:Person", "foaf:name": "Olivier Corby" },
        { "@type": "foaf:Person", "foaf:name": "Catherine Faron" }
      ]
    }
]
}

```

169

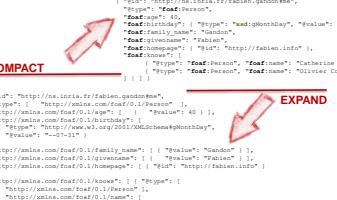
## JSON-LD with Context (Blank Nodes)

```
( "context": {
    "foaf": "http://xmlns.com/foaf/0.1/" ,
    "xsd": "http://www.w3.org/2001/XMLSchema#"
},
"graph": [
    { "@id": "http://ns.inria.fr/fabien.gandon#me", "@type": "foaf:Person",
        "foafage": 40,
        "foaf:birthday": { "@type": "xsd:MonthDay", "@value": "--07-31" },
        "foaf:family_name": { "@value": "Gandon", "@language": "fr" },
        "foaf:givenname": { "@value": "Fabien", "@language": "fr" },
        "foaf:homepage": { "@id": "http://fabien.info" },
        "foaf:knows": [ { "@type": "foaf:Person", "foaf:name": "Olivier Corby" } ],
        { "@type": "foaf:Person", "foaf:name": "Catherine Faron" }
    ]
}
]
```

170

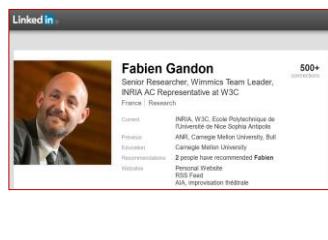
**Compact / Expand = Add / Remove Context**

```
        "formats": [
            { "type": "http://www.w3.org/2001/XMLSchema#string" },
            { "type": "http://www.w3.org/2001/XMLSchema#date" }
        ],
        "spans": [
            { "type": "http://www.oria.fr/fabien.pandoreName", "start": 0, "end": 10 },
            { "type": "http://www.oria.fr/fabien.lastName", "start": 10, "end": 15 },
            { "type": "http://www.oria.fr/fabien/birthDay", "start": 15, "end": 20 },
            { "type": "http://www.oria.fr/fabien/familyName", "start": 20, "end": 25 },
            { "type": "http://www.oria.fr/fabien/firstName", "start": 25, "end": 30 },
            { "type": "http://www.oria.fr/fabien/homePage", "start": 30, "end": 35 },
            { "type": "http://www.oria.fr/fabien/sex", "start": 35, "end": 40 },
            { "type": "http://www.oria.fr/fabien/Person", "start": 40, "end": 45 },
            { "type": "http://www.oria.fr/fabien/Person", "start": 45, "end": 50 }
        ]
    },
    {
        "id": "http://www.oria.fr/fabien.pandoreName",
        "type": "http://www.oria.fr/fabien/Person",
        "formats": [
            { "type": "http://www.w3.org/2001/XMLSchema#string" },
            { "type": "http://www.w3.org/2001/XMLSchema#date" }
        ],
        "spans": [
            { "type": "http://www.oria.fr/fabien.pandoreName", "start": 0, "end": 10 },
            { "type": "http://www.oria.fr/fabien.lastName", "start": 10, "end": 15 },
            { "type": "http://www.oria.fr/fabien/birthDay", "start": 15, "end": 20 },
            { "type": "http://www.oria.fr/fabien/familyName", "start": 20, "end": 25 },
            { "type": "http://www.oria.fr/fabien/firstName", "start": 25, "end": 30 },
            { "type": "http://www.oria.fr/fabien/homePage", "start": 30, "end": 35 },
            { "type": "http://www.oria.fr/fabien/sex", "start": 35, "end": 40 },
            { "type": "http://www.oria.fr/fabien/Person", "start": 40, "end": 45 },
            { "type": "http://www.oria.fr/fabien/Person", "start": 45, "end": 50 }
        ]
    },
    {
        "id": "http://www.oria.fr/fabien/Person",
        "type": "http://www.oria.fr/fabien/Person",
        "formats": [
            { "type": "http://www.w3.org/2001/XMLSchema#string" },
            { "type": "http://www.w3.org/2001/XMLSchema#date" }
        ],
        "spans": [
            { "type": "http://www.oria.fr/fabien/Person", "start": 0, "end": 10 },
            { "type": "http://www.oria.fr/fabien/Person", "start": 10, "end": 15 },
            { "type": "http://www.oria.fr/fabien/Person", "start": 15, "end": 20 },
            { "type": "http://www.oria.fr/fabien/Person", "start": 20, "end": 25 },
            { "type": "http://www.oria.fr/fabien/Person", "start": 25, "end": 30 },
            { "type": "http://www.oria.fr/fabien/Person", "start": 30, "end": 35 },
            { "type": "http://www.oria.fr/fabien/Person", "start": 35, "end": 40 },
            { "type": "http://www.oria.fr/fabien/Person", "start": 40, "end": 45 },
            { "type": "http://www.oria.fr/fabien/Person", "start": 45, "end": 50 }
        ]
    }
]
}


```

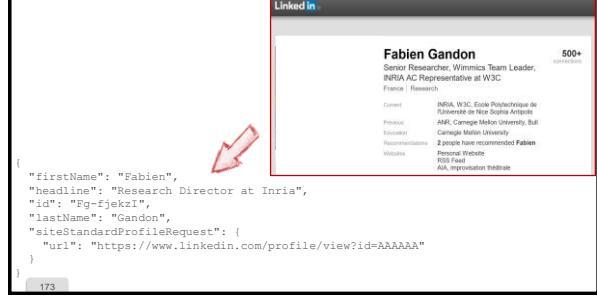
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## Contextualizing JSON from APIs e.g. "LinkedIn"



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## E.g. LinkedIn in JSON



### E.g. LinkedIn in JSON (with Context)

```
{  
  "@context": {  
    "@vocab": "http://schema.org/",  
    "@base" : "http://data.org/",  
    "id" : "@id",  
    "firstName": "givenName",  
    "lastName": "familyName",  
    "headline": { "@id": "jobTitle", "@language": "en" },  
    "siteStandardProfileRequest" : null ,  
  
    "firstName": "Fabien",  
    "headline": "Research Director at Inria",  
    "id": "Fg-fjekzI",  
    "lastName": "Gandon",  
    "siteStandardProfileRequest": {  
      "url": "https://www.linkedin.com/profile/view?id=AAAAAA"  
    }  
  }  
}
```

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### E.g. LinkedIn in JSON (Voc & Base)

```
{  
  "@context": {  
    "@vocab": "http://schema.org/",  
    "@base" : "http://data.org/",  
    "id" : "@id",  
    "firstName": "givenName",  
    "lastName": "familyName",  
    "headline": { "@id": "jobTitle", "@language": "en" },  
    "siteStandardProfileRequest" : null ,  
  
    "firstName": "Fabien",  
    "headline": "Research Director at Inria",  
    "id": "Fg-fjekzI",  
    "lastName": "Gandon",  
    "siteStandardProfileRequest": {  
      "url": "https://www.linkedin.com/profile/view?id=AAAAAA"  
    }  
  }  
}
```

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### E.g. LinkedIn in JSON (Map Properties)

```
{  
  "@context": {  
    "@vocab": "http://schema.org/",  
    "@base" : "http://data.org/",  
    "id" : "@id",  
    "firstName": "givenName",  
    "lastName": "familyName",  
    "headline": { "@id": "jobTitle", "@language": "en" },  
    "siteStandardProfileRequest" : null ,  
  
    "firstName": "Fabien",  
    "headline": "Research Director at Inria",  
    "id": "Fg-fjekzI",  
    "lastName": "Gandon",  
    "siteStandardProfileRequest": {  
      "url": "https://www.linkedin.com/profile/view?id=AAAAAA"  
    }  
  }  
}
```

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### E.g. LinkedIn in JSON (Specify the Language)

```
{  
  "@context": {  
    "@vocab": "http://schema.org/",  
    "@base" : "http://data.org/",  
    "id" : "@id",  
    "firstName": "givenName",  
    "lastName": "familyName",  
    "headline": { "@id": "jobTitle", "@language": "en" },  
    "siteStandardProfileRequest" : null ,  
  
    "firstName": "Fabien",  
    "headline": "Research Director at Inria",  
    "id": "Fg-fjekzI",  
    "lastName": "Gandon",  
    "siteStandardProfileRequest": {  
      "url": "https://www.linkedin.com/profile/view?id=AAAAAA"  
    }  
  }  
}
```

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### E.g. LinkedIn in JSON (Ignore)

```
{  
  "@context": {  
    "@vocab": "http://schema.org/",  
    "@base" : "http://data.org/",  
    "id" : "@id",  
    "firstName": "givenName",  
    "lastName": "familyName",  
    "headline": { "@id": "jobTitle", "@language": "en" },  
    "siteStandardProfileRequest" : null ,  
  
    "firstName": "Fabien",  
    "headline": "Research Director at Inria",  
    "id": "Fg-fjekzI",  
    "lastName": "Gandon",  
    "siteStandardProfileRequest": {  
      "url": "https://www.linkedin.com/profile/view?id=AAAAAA"  
    }  
  }  
}
```

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### E.g. LinkedIn in JSON to RDF

```
@prefix : <http://schema.org/> .  
@prefix fb : <http://data.org/Fg-fjekzI> .  
  
{  
  "@context": {  
    "@vocab": "http://schema.org/",  
    "@base" : "http://data.org/",  
    "id" : "@id",  
    "firstName": "givenName",  
    "lastName": "familyName",  
    "headline": { "@id": "jobTitle", "@language": "en" },  
    "siteStandardProfileRequest" : null ,  
  
    "firstName": "Fabien",  
    "headline": "Research Director at Inria",  
    "id": "Fg-fjekzI",  
    "lastName": "Gandon",  
    "siteStandardProfileRequest": {  
      "url": "https://www.linkedin.com/profile/view?id=AAAAAA"  
    }  
  }  
}
```

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**E.g. Google Knowledge Graph Search API**

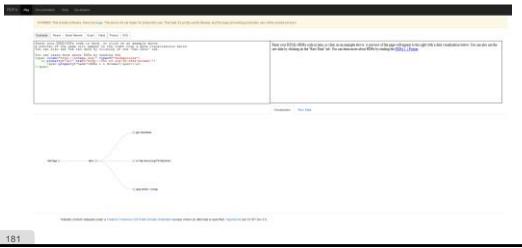
```
( "context": {
    "@vocab": "http://schema.org/",
    "goog": "http://schema.googleapis.com",
    "resultScore": "goog:resultScore",
    "detailedScore": "goog:detailedScore",
    "entitySearchResult": "goog:entitySearchResult",
    "kg": "http://kg.g.co/kg"
  },
  "types": "ItemList",
  "itemListElement": [
    {
      "name": "Taylor Swift",
      "url": "https://www.genius.com/images/thumb/amhsqo/1000x1000/20120411uphapp25121w_rhainigfru.jpg?1434450000",
      "image": "https://www.genius.com/images/thumb/amhsqo/1000x1000/20120411uphapp25121w_rhainigfru.jpg?1434450000",
      "label": "Image result for Taylor Swift",
      "text": "Taylor Swift",
      "contentUrl": "https://genius.com/images/thumb/amhsqo/1000x1000/20120411uphapp25121w_rhainigfru.jpg?1434450000",
      "license": "https://creativecommons.org/licenses/by-nd/2.0",
      "isSimilar": true,
      "detailedDescription": "American singer-songwriter and actress. Raised in Wyomissing, Pennsylvania, who moved to Nashville, Tennessee, at the age of 14 to pursue a career in country music.",
      "url": "https://en.wikipedia.org/wiki/Taylor_Swift",
      "license": "https://creativecommons.org/licenses/by-nd/2.0",
      "label": "Wikipedia result for Taylor Swift"
    }
  ],
  "itemCount": 1,
  "searchTerms": "Breathe"
}
```



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## Linked Data in HTML

- <http://rdfa.info/play/>



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## JSON for Linking Data

- <https://json-ld.org/playground/>



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## Google Knowledge Graph Search API

<https://developers.google.com/knowledge-graph/>

"The Knowledge Graph Search API lets you find entities in the Google Knowledge Graph. The API uses standard [schema.org](#) types and is compliant with the [JSON-LD](#) specification."

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## Integration With Other Data Formats and Sources

1. RDFa: a RDF syntax inside HTML
  2. GRDDL: extract RDF from X(HT)ML
  3. JSON-LD: JSON syntax for RDF
  4. Tabular data and metadata (CSV)
  5. R2RML: integration with databases
  6. LDP: a REST API to linked data

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