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

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1. **Describing resources**
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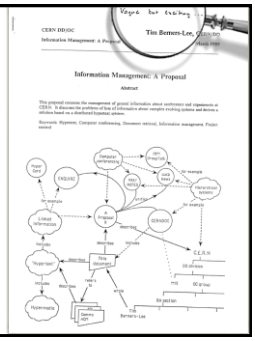
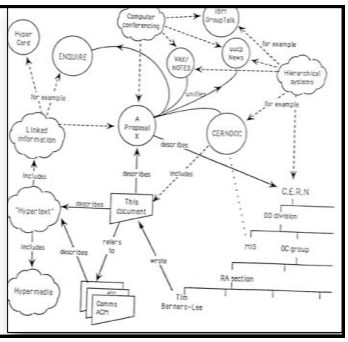
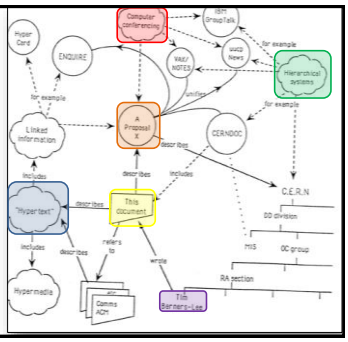
Original Proposal



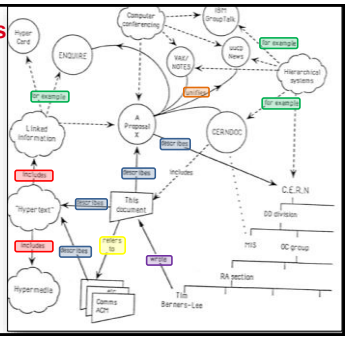
Schema



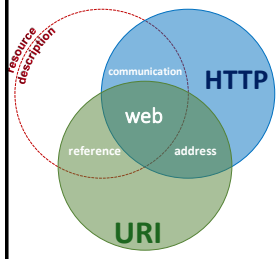
A Web of Resources



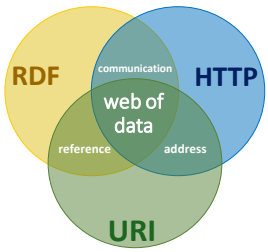
Various Kinds of Links

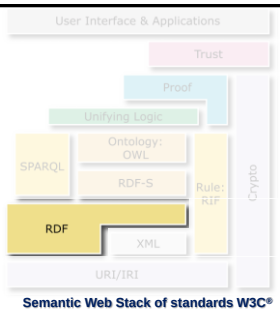


Describing Resources on the Web



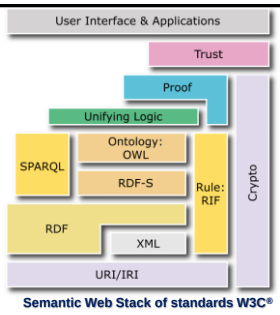
RDF: Basic Model





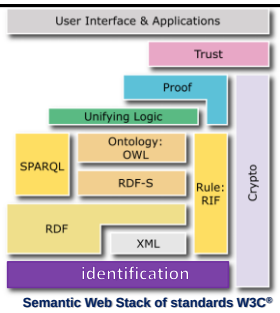
Semantic Web Stack of standards W3C®

Stack of standards



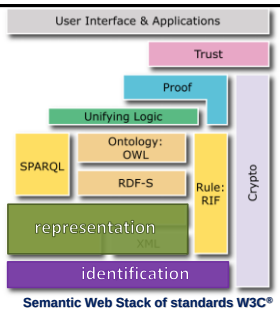
Semantic Web Stack of standards W3C®

Stack of standards



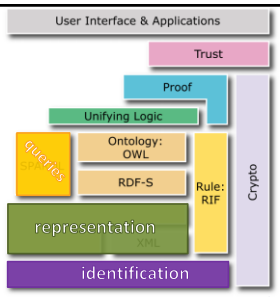
Semantic Web Stack of standards W3C®

Stack of standards



Semantic Web Stack of standards W3C®

Stack of standards



Semantic Web Stack of standards W3C®

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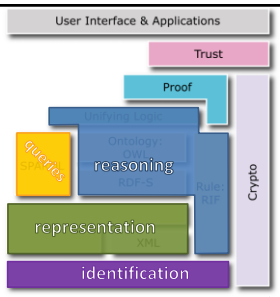
Stack of standards



Semantic Web Stack of standards W3C®

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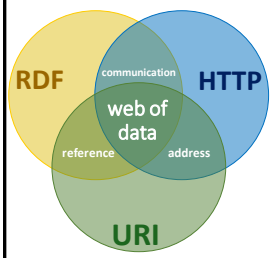
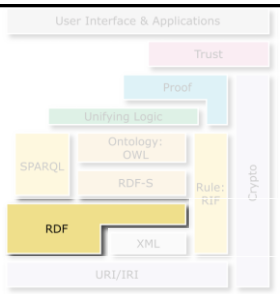
Stack of standards





Semantic Web Stack of standards W3C®

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The RDF Data Model

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2. **A triple model and a graph model**
3. Serialization syntaxes
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5. Groups
6. Naming graphs
7. RDF schemas

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RDF means

***R**esource*

***D**escription*

***F**ramework*

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RDF means

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

***D*escription**

***F*ramework**

RDF means

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***D*escription:** attributes, characteristics, and relations between resources

***F*ramework**

RDF means

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

***D*escription:** attributes, characteristics, and relations between resources

***F*ramework:** model, language and syntaxes for these descriptions

RDF decomposes descriptions into triples

(subject , predicate , object)

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(subject , predicate , object)

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

RDF decomposes descriptions into triples

(subject , predicate , object)

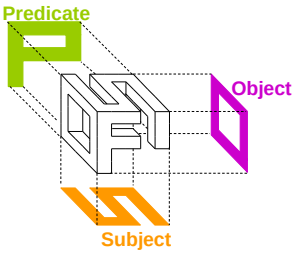
E.g.: doc.html has for author Fabien
doc.html has for author Catherine
doc.html has for author Olivier
doc.html has for topic Web of data

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)

RDF: triples are knowledge atoms



Composition Rules for RDF Triples

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

(subject , ,)

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 ,)

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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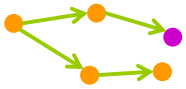
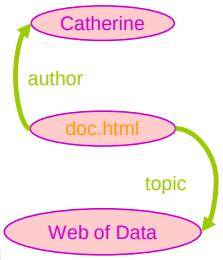
RDF: triples form graph edges

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

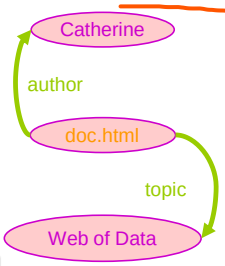


RDF is a graph model

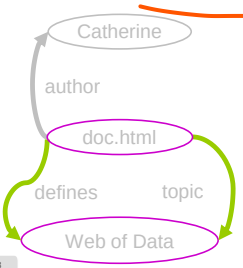


(doc.html , author, Catherine)
(doc.html , topic, Web of Data)

RDF is an oriented labeled multigraph model

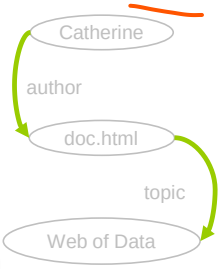


RDF is an oriented labeled **multigraph** model



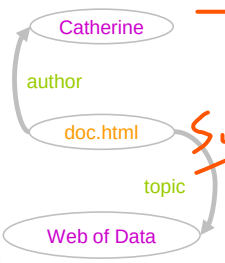
several edges can connect
the same two nodes

RDF is an **oriented** labeled multigraph model



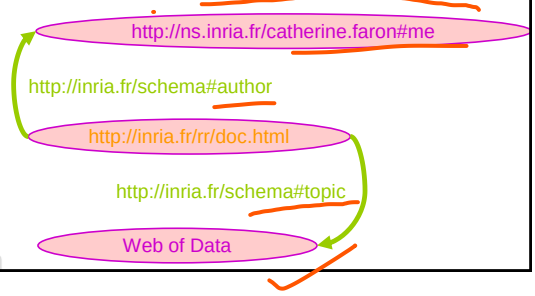
edges are oriented:
the head is the object
the tail is the subject

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

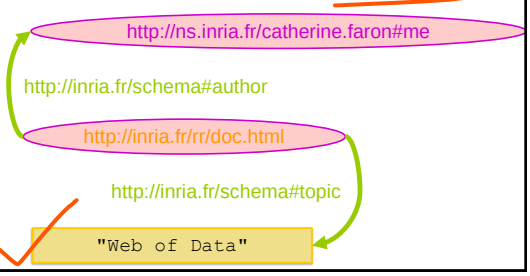


edges and nodes
are labeled

RDF graphs are labeled by resources and literals



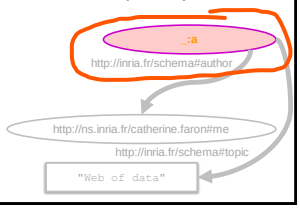
RDF graphs are labeled by resources and literals



RDF Graphs are labeled by resources and literals

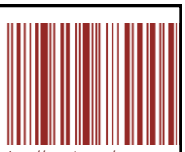
A resource is either a URI or an **anonymous resource (blank node)**

Existential quantification: there is a resource such that… { ∃ r ; …}

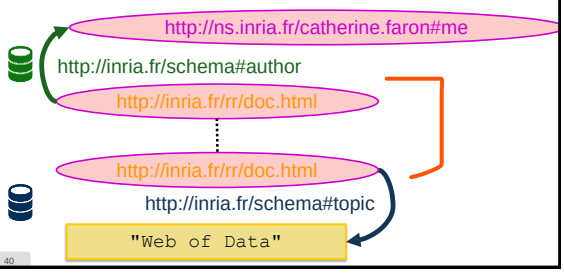


RDF is an Open Model

- Extensible vocabulary based on URIs
- Authorizes anyone to declare anything about any resource



RDF Global Giant Graph (GGG)

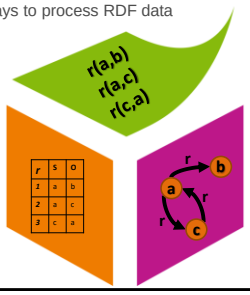


RDF Global Giant Graph (GGG)

Open and link data across the Web

Several Views on a Graph

There are many ways to process RDF data



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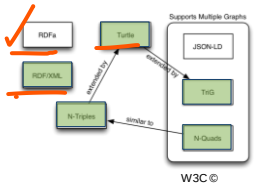
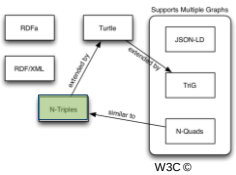
RDF has a historical XML syntax and several other syntaxes: Turtle, TriG, JSON-LD, N-Triples, N-Quads



RDF N-Triples: a minimalist syntax



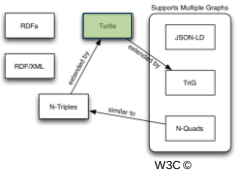
RDF N-Triples: easy parsing of triple lists

- 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> .

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


RDF Turtle: the most popular RDF syntax



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" .
```


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" .
```


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" .
```


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

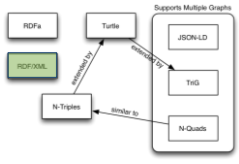
```
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
@prefix inria: <http://inria.fr/schema#> .

<http://inria.fr/rr/doc.html>
 inria:author <http://ns.inria.fr/catherine.faron#me> ;
 inria:topic "Web of data", "Semantic Web".
```


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" . ]
```


RDF/XML: the historical XML syntax



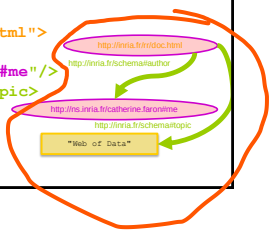
W3C ©

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>
```

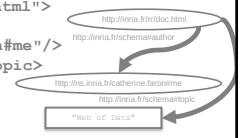


RDF/XML: a root

```
<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>
```

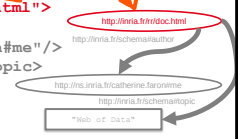


RDF/XML: descriptions of resources

```
<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>
```

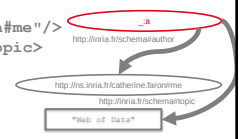


RDF/XML: anonymous resources (blank nodes)

```
<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>
```

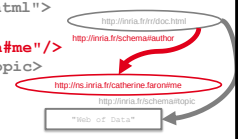


RDF/XML: links between resources

```
<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>
```

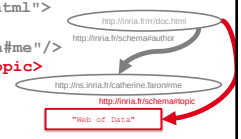


RDF/XML: literal values

```
<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>
```



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>
```

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>
```


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>
```


RDF/XML: many syntactic variations

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


The RDF data model

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"XML Schema Datatypes" for Typing Literals

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

"XML Schema Datatypes" for Typing Literals

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

http://inria.fr/rr/doc.html

http://inria.fr/schema#date

"1995-09-18"^^xsd:date

"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 .
```

http://inria.fr/rr/doc.html

http://inria.fr/schema#date

"1995-09-18"^^xsd:date

"XML Schema Datatypes" for Typing Literals

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

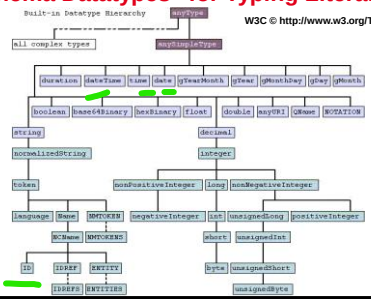
```
@prefix (…)          Turtle
<http://inria.fr/rr/doc.html>
  inria:date "1995-09-18"^^xsd:date .

<rdf:RDF (…)>        RDF/XML
<rdf:Description rdf:about="http://inria.fr/rr/doc.html">
  <inria:date rdf:datatype="http://www.w3.org/2001/XMLSchema#date">
   1995-09-18</inria:date>
</rdf:Description>
</rdf:RDF>
```

http://inria.fr/rr/doc.html

http://inria.fr/schema#date

"1995-09-18"^^xsd:date

"XML Schema Datatypes" for Typing Literals



Indicating the Language of Textual Values

Literals can be associated to a language

http://inria.fr/rr/doc.html

http://inria.fr/schema#topic

"Web of Data"@en

"Web de données"@fr

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 .
```

http://inria.fr/rr/doc.html

http://inria.fr/schema#topic

"Web of Data"@en

"Web de données"@fr

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>
```

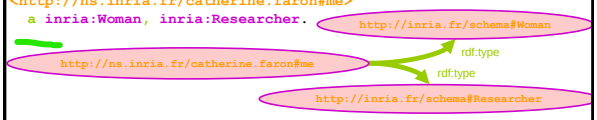
Typing Resources

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

Typing Resources

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

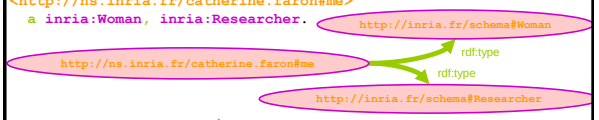
```
@prefix (…)          Turtle
<http://ns.inria.fr/catherine.faron#me>
  a inria:Woman, inria:Researcher.
```



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.
```




```
<rdf:RDF (…)>        RDF/XML
<inria:Researcher rdf:about="http://ns.inria.fr/catherine.faron#me">
  <rdf:type rdf:resource="http://www.inria.fr/schema#Woman" />
</inria:Researcher>
</rdf:RDF>
```


The RDF Data Model

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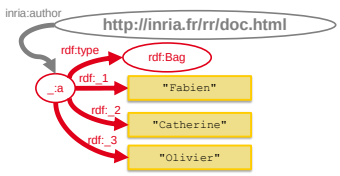
Bags (rdf:Bag) of Resources or Literals

Simple groups, without any order



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" . ] .
```


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>
```


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>
```


Alternatives (rdf:Alt)

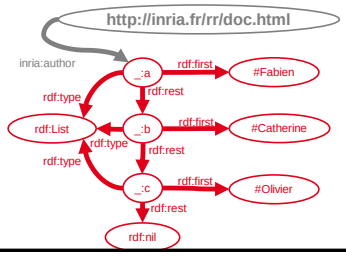
E.g. the same value in different languages

```
@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>
```


Collections

Exhaustive and ordered lists



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>
```

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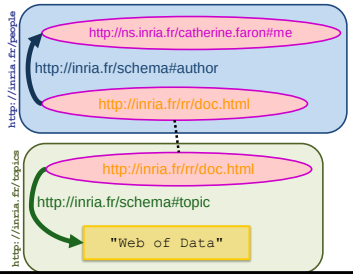
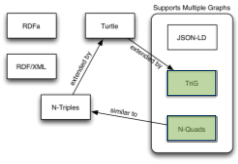
Named Graphs

Grouping triples in subgraphs identified by URIs



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



W3C ©

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" .
}
```


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> .
```


The RDF Data Model

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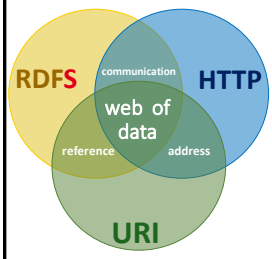
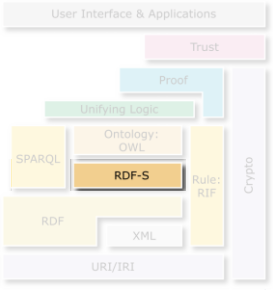
7. **RDF schemas**

Stack of standards





Semantic Web Stack of standards W3C®

RDFS Means RDF Schema

- RDFS provides standard vocabulary to declare *in RDF* vocabularies to be used in RDF descriptions
- RDFS reuses the vocabulary of RDF and introduces additional constructs

An RDF vocabulary is a set of property declarations and class declarations

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#">
(…)
</rdf:RDF>
```


Declaring Classes of Resources

- Naming classes
- Organizing them into hierarchies

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> .
```

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> .
```

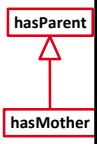
Declaring Classes of Resources

```
@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> .
```


```
<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#">
 <rdfs:Class rdf:ID="Woman">
  <rdfs:subClassOf rdf:resource="#Person"/>
  <rdfs:subClassOf rdf:resource="#Female"/>
 </rdfs:Class>
</rdf:RDF>
```


Declaring Types of Properties

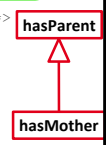
- Naming types of properties
- Organizing them into hierarchies



Declaring Types of Properties

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

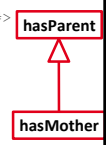
```
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#>
@base <http://inria.fr/2005/humans.rdfs>
<hasMother> a rdf:Property ;
  rdfs:subPropertyOf <hasParent> .
```



Declaring Types of Properties

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

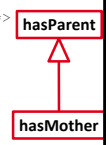
```
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#>
@base <http://inria.fr/2005/humans.rdfs>
<hasMother> a rdf:Property ;
  rdfs:subPropertyOf <hasParent> .
```



Declaring Types of Properties

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

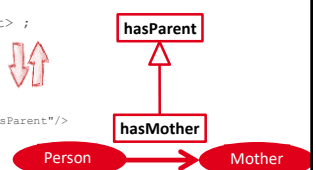
```
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#>
@base <http://inria.fr/2005/humans.rdfs>
<hasMother> a rdf:Property ;
  rdfs:subPropertyOf <hasParent> .
```




```
<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#">
 <rdf:Property rdf:ID="hasMother">
  <rdfs:subPropertyOf rdf:resource="#hasParent"/>
 </rdf:Property>
</rdf:RDF>
```


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> .
```




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

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 .
```


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> .
```


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> .
```


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>
```

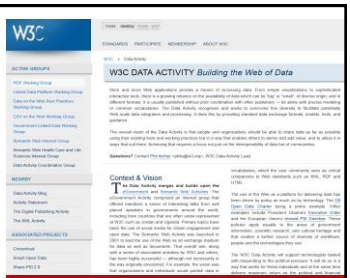

Introduction to a Web of Linked Data

Integration with Other Data Formats and Sources

Catherine Faron faron@unice.fr

Slides from Fabien Gandon fabien.gandon@inria.fr

A Web of "All" Data



Toward all forms of data on the web

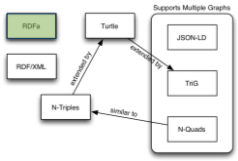
Integration With Other Data Formats and Sources

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

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

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

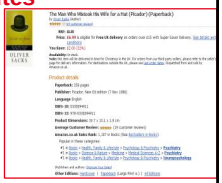


W3C ©

A Lot of Data Inside HTML Pages

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>
...
```



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

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)

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>

(…)
```


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>

(…)
```

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>

(…)
```


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>

(…)
```

```
@prefix ns1: <http://purl.org/dc/terms/> .
@prefix ns2: <http://xmlns.com/foaf/0.1/> .

</books/web_semantique>
     ns1:title "A Web of linked data"@en ;
     ns1:created "2012-05-01" ;
     ns1:creator <#fg>.

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


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>

(…)
```

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>

(…)
```

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>

(…)
```

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>

(…)
```

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>

(…)
```

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>

(…)
```

property & resource

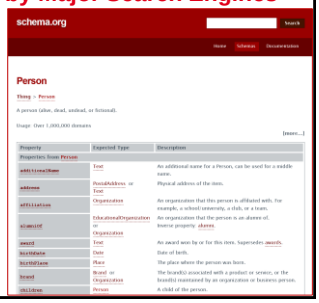
Anatomy of HTML+RDFa Content (href)

```
(…)
<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>

(…)
```

property & href

Schema.org: Vocabulary by Major Search Engines and Applications



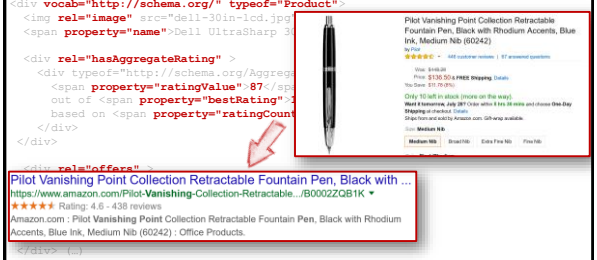
Example of RDFa Using schema.org

```
<div vocab="http://schema.org/" typeof="Product">
  <img rel="image" src="dell-30in-lcd.jpg" />
  <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> (…)
```


Example of RDFa Using schema.org



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 prefix="og: http://ogp.me/ns# fb: http://ogp.me/ns# YOUR_NAMESPACE:
               http://ogp.me/ns/apps/YOUR_NAMESPACE#">
    <meta property="fb:app_id" content="YOUR_APP_ID" />
    <meta property="og:type" content="YOUR_NAMESPACE:recipe" />
    <meta property="og:title" content="Stuffed Cookies" />
    <meta property="og:image" content="http://example.com/cookie.jpg" />
    <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>
```

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, rdfa, rdfs, rif, rr, sd, skos, skosxl, wdr, void, wdrs, xhv, xml, xsd, cc, ctag, dc, dcterms, dc11, foaf, gr, ical, og, rev, sioc, v, vcard, schema,…

Linked Data in HTML

- http://rdfa.info/play/

These Data are Available to Everyone

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

Web Page *Data Source*

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

GRDDL Algorithmic Alternative to RDFa

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

≠

- GRDDL: transformation

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

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" />
 (…)
```


Simple Example in HTML:

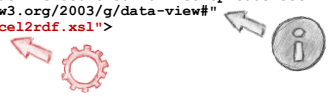
```
<head profile="http://www.w3.org/2003/g/data-view">
 <title>The man who mistook his wife for a hat</title>
 <link rel="transformation"
  href="http://www.w3.org/2000/06/ dc-extract/dc-extract.xsl" />
 <meta name="DC.Subject" content="clinical tales" />
 (…)
```

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">
(…)
```

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">
(…)
```



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" />
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 (…)
```

source

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"
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 <meta name="DC.Subject" content="clinical tales" />
 (…)
```

source

GRDDL source document

GRDDL Agent Process: Direct Transformation

```
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 <title>The man who mistook his wife for a hat</title>
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 (…)
```

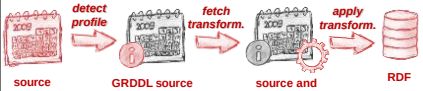
source

GRDDL source document

source and transformation

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

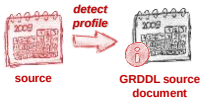
GRDDL source document

source and transformation

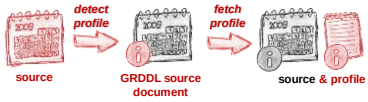
RDF

GRDDL Agent Process: Indirect Transformation

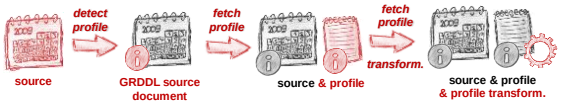
GRDDL Agent Process: Indirect Transformation



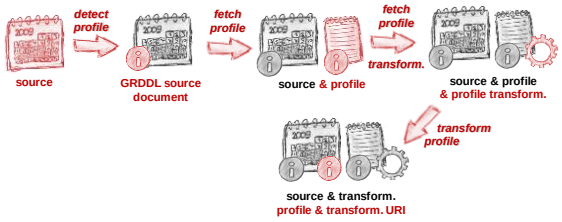
GRDDL Agent Process: Indirect Transformation



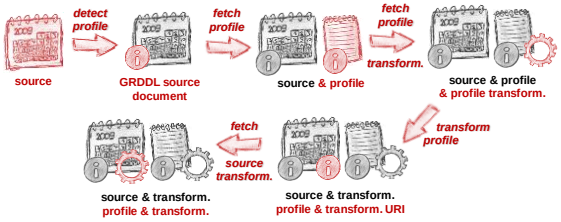
GRDDL Agent Process: Indirect Transformation



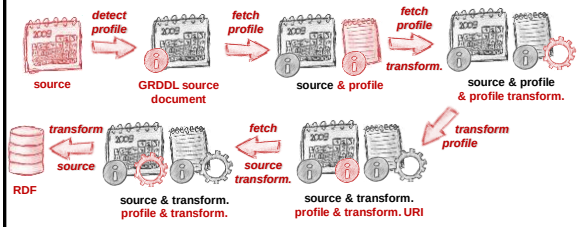
GRDDL Agent Process: Indirect Transformation



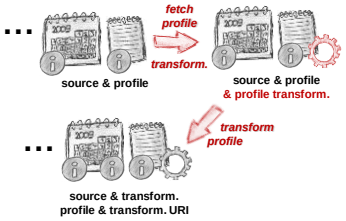
GRDDL Agent Process: Indirect Transformation



GRDDL Agent Process: Indirect Transformation



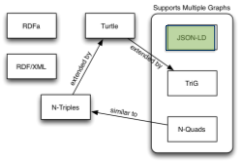
GRDDL Indirect Transformations: More Resilient



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

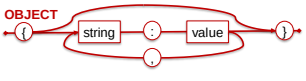
RDF has a historical XML syntax and several other syntaxes: Turtle, TriG, JSON-LD, N-Triples, N-Quads



W3C ©

JSON-LD: JSON syntax for RDF

1. JSON (JavaScript Object Notation)
   - Hierarchy of name-value pairs
   - Popular format for APIs on the Web.



JSON-LD: JSON syntax for RDF

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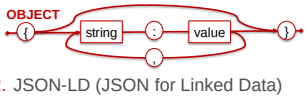

2. JSON-LD (JSON for Linked Data)
   - Notion of "context" to provide a mapping from JSON model to an RDF model
   - A context can be embedded in a JSON-LD document or in a separate file and referenced

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.

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@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.

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" ].
```


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

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" ].
```

link to another resource

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

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" }
 ]
}
```


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" }
 ]
}
```

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" }
 ]
}
```

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" }
 ]
}
```

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"}
          ]
    }
  ]
}
```


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"}
          ]
    }
  ]
}
```

JSON-LD with Context (Types)

```
{ "@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"}
            ]
    }
  ]
}
```


JSON-LD with Context (Language)

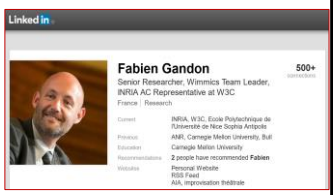
```
{ "@context": {
    "foaf": "http://xmlns.com/foaf/0.1/" ,
    "xsd": "http://www.w3.org/2001/XMLSchema#"
  },
  "@graph": [
    { "@id": "http://ns.inria.fr/fabien.gandon#me",  "@type": "foaf:Person",
      "foaf:age": 40,
      "foaf:birthday": { "@type": "xsd:gMonthDay", "@value": "--07-31" },
      "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"}
            ]
    }
  ]
}
```


JSON-LD with Context (Blank Nodes)

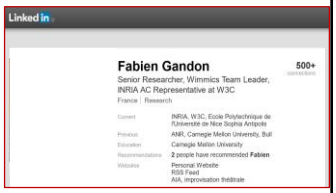
```
{ "@context": {
    "foaf": "http://xmlns.com/foaf/0.1/" ,
    "xsd": "http://www.w3.org/2001/XMLSchema#"
  },
  "@graph": [
    { "@id": "http://ns.inria.fr/fabien.gandon#me",  "@type": "foaf:Person",
      "foaf:age": 40,
      "foaf:birthday": { "@type": "xsd:gMonthDay", "@value": "--07-31" },
      "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"}
            ]
    }
  ]
}
```


Compact / Expand = Add / Remove Context

Contextualizing JSON from APIs e.g. "LinkedIn"



E.g. LinkedIn in JSON




```
{
  "firstName": "Fabien",
  "headline": "Research Director at Inria",
  "id": "Fg-fjekzI",
  "lastName": "Gandon",
  "siteStandardProfileRequest": {
    "url": "https://www.linkedin.com/profile/view?id=AAAAAA"
  }
}
```

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"
  }
}
```


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"
  }
}
```


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"
  }
}
```


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"
  }
}
```


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"
  }
}
```


E.g. Linked in JSON to RDF

```
@prefix : <http://schema.org/> .

<http://data.org/Fg-fjekzI> :familyName "Gandon" ;
    :givenName "Fabien" ;
    :jobTitle "Research Director at Inria"@en .
```

```
{
  "@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"
  }
}
```

E.g. Google Knowledge Graph Search API


```
{ "@context": {
    "@vocab": "http://schema.org/",
    "goog": "http://schema.googleapis.com/",
    "resultScore": "goog:resultScore",
    "detailedDescription": "goog:detailedDescription",
    "EntitySearchResult": "goog:EntitySearchResult",
    "kg": "http://g.co/kg"
  },
  "@type": "ItemList",
 "itemListElement": [
   {
     "@type": "EntitySearchResult",
     "result": { "@id": "kg:/m/0dl567", "name": "Taylor Swift",
       "@type": [ "Thing", "Person" ],
       "description": "Singer-songwriter",
       "image": {
         "contentUrl": "https://t1.gstatic.com/images?q=tbn:ANd9GcQmVDAhjhWnN2OWys2ZMO3PGAhupp5tN2LwF_BJmiHgi19hf8Ku",
         "url": "https://en.wikipedia.org/wiki/Taylor_Swift",
         "license": "http://creativecommons.org/licenses/by-sa/2.0"
       },
       "detailedDescription": {
         "articleBody": "Taylor Alison Swift is an American singer-songwriter and actress. Raised in Wyomissing,
             Pennsylvania, she moved to Nashville, Tennessee, at the age of 14 to pursue a career in country music. ",
         "url": "http://en.wikipedia.org/wiki/Taylor_Swift",
         "license":
        "https://en.wikipedia.org/wiki/Wikipedia:Text_of_Creative_Commons_Attribution-ShareAlike_3.0_Unported_License"
       },
       "url": "http://taylorswift.com/"
     },
     "resultScore": 896.576599
   }
 ]
}
```


Linked Data in HTML

- http://rdfa.info/play/

JSON for Linking Data

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

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."

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