

Semantic Web Technologies

SPARQL

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Outline

Turtle Syntax for RDF

SPARQL

Basic SPARQL Queries

Query Answer

Terse RDF Triple Language

- ▶ RDF/XML language hard to read
- ▶ Notation 3 (N3)
 - ▶ Syntax for RDF
 - ▶ Logical language for RDF
- ▶ Turtle
 - ▶ Refinement of N3
 - ▶ Just RDF representation
- ▶ Basis for parts of SPARQL
 - ▶ Graph patterns

Basic Turtle

- ▶ Plain text syntax for RDF
- ▶ Based on **Unicode**
- ▶ Mechanisms for namespace abbreviation
- ▶ Allows grouping of triples according to **subject**
- ▶ Shortcuts for collections
- ▶ In short:
 - ▶ Takes good things of RDF/XML
 - ▶ and leaves out angle brackets

Prefixes

- ▶ Mechanism for namespace abbreviation

- ▶ Syntax:

```
@prefix abbr: <URI> .
```

- ▶ Example:

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

- ▶ Default:

```
@prefix : <URI> .
```

- ▶ Example:

```
@prefix : <http://example.org/myOntology#> .
```

Identifiers in Turtle

- ▶ URIs: $\langle URI \rangle$
 $\langle \text{http://www.w3.org/1999/02/22-rdf-syntax-ns\#} \rangle$
- ▶ QNames: $namespace\text{-abbr?}:localname$
 $rdf:type$ $dc:title$ $:hasName$
- ▶ Literals: $"string"(@lang)?(\wedge\wedge type)?$
 $"John"$ $"Hello"@en-GB$ $"1.4"\wedge\wedge xs:decimal$
- ▶ Typed literal shortcuts
 - ▶ integer: 2 45
 - ▶ decimal: 2.4 5.67
 - ▶ boolean: $true$ $false$

Triples in Turtle

- ▶ Simple triple: *subject predicate object* .

```
:john rdf:label "John"
```

- ▶ Grouping triples: *subject predicate object ; predicate object*
... .

```
:john  
  rdf:label "John" ;  
  rdf:type ex:Person ;  
  ex:homePage <http://example.org/johnspage/> .
```

Blank Nodes in Turtle

- ▶ Simple blank node: `[]`

```
:john ex:hasFather [] .
```
- ▶ Blank node as subject: `[predicate object ; predicate object ...] .`

```
[ ex:hasName "John" ] .
[ ex:authorOf :lotr ;
  ex:hasName "Tolkien" ] .
```
- ▶ Collections: `(object1 ... objectn)`
 - ▶ `:doc1 ex:hasAuthor (:john :mary) .`
 - ▶ is short for:


```
:doc1 ex:hasAuthor
  [ rdf:first :john;
    rdf:rest [ rdf:first :mary;
              rdf:rest rdf:nil ]
  ] .
```

Example

```
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
@prefix dc: <http://purl.org/dc/elements/1.1/> .
@prefix : <http://example.org/#> .

<http://www.w3.org/TR/rdf-syntax-grammar>
  dc:title "RDF/XML Syntax Specification (Revised)" ;
  :editor [
    :fullName "Dave Beckett";
    :homePage <http://purl.org/net/dajobe/>
  ] .
```

Turtle vs. RDF/XML

- ▶ Copies many features from RDF/XML
 - ▶ Namespace abbreviations (QNames)
 - ▶ Grouping of triples
 - ▶ Blank node treatment
- ▶ Differences
 - ▶ No ugly angle brackets
 - ▶ Compact (**Terse**) syntax
 - ▶ Abbreviations for typed literals
- ▶ Standard for SPARQL query patterns
- ▶ Not a standard for RDF

Querying RDF

- ▶ SPARQL
 - ▶ RDF Query language
 - ▶ Based on RDQL
 - ▶ Uses SQL-like syntax

- ▶ Example:

```
PREFIX dc: <http://purl.org/dc/elements/1.1/>
```

```
SELECT ?title
```

```
WHERE { <http://example.org/book/book1> dc:title  
?title }
```

SPARQL Queries

- ▶ PREFIX
 - ▶ Prefix mechanism for abbreviating URIs
- ▶ SELECT
 - ▶ Identifies the variables to be returned in the query answer
- ▶ (FROM)
 - ▶ Name of the graph to be queried
- ▶ WHERE
 - ▶ Query pattern as a list of triple patterns

URI abbreviation: PREFIX

- ▶ Mechanism for namespace abbreviation
- ▶ Syntax:

```
PREFIX abbr: <URI>
```

- ▶ Example:

```
PREFIX rdf:  
<http://www.w3.org/1999/02/22-rdf-syntax-ns#>
```

- ▶ Default:

```
PREFIX : <URI>
```

- ▶ Example:

```
PREFIX : <http://example.org/myOntology#>
```

Selecting variables: SELECT

- ▶ Filtering variables to return
- ▶ Variables: *?string*
`?x ?title ?name`
- ▶ Syntax:
`SELECT var_1, \dots, var_n`
`SELECT ?x,?title`
`SELECT ?name`
- ▶ Variables in SELECT are **distinguished** variables

Query patterns: WHERE

- ▶ Graph pattern to **match**
- ▶ Set of triples:
 $\{ (subject\ predicate\ object\ \cdot)^* \}$
 - ▶ Subject: URI, QName, Blank node **Literal**, Variable
 - ▶ Predicate: URI, QName, Blank node, Variable
 - ▶ Object: URI, QName, Blank node **Literal**, Variable
- ▶ Example:

```
{  
  _:author ex:hasName ?name .  
  _:author ex:authorOf :lotr .  
}
```
- ▶ Optional triples: `OPTIONAL triple .`
`OPTIONAL :john ont:hasAge ?age`

Example RDF Dataset (Turtle)

```
@prefix : <http://example.org/data#> .  
@prefix ont: <http://example.org/myOntology#> .  
@prefix vcard: <http://www.w3.org/2001/vcard-rdf/3.0#> .
```

```
:john
```

```
  vcard:FN "John Smith" ;  
  vcard:N [  
    vcard:Given "John" ;  
    vcard:Family "Smith" ] ;  
  ont:hasAge 32 ;  
  ont:marriedTo :mary .
```

```
:mary
```

```
  vcard:FN "Mary Smith" ;  
  vcard:N [  
    vcard:Given "Mary" ;  
    vcard:Family "Smith" ] ;  
  ont:hasAge 29 .
```

SPARQL Queries: all full names

“Return the full names of all people in the graph”

```
PREFIX vCard: <http://www.w3.org/2001/vcard-rdf/3.0#>
SELECT ?fullName
WHERE {?x vCard:FN ?fullName}
```

result:

```
fullName
```

```
=====
```

```
"John Smith"
```

```
"Mary Smith"
```

SPARQL Queries: properties

“Return the relation between John and Mary”

```
PREFIX : <http://example.org/data#>
```

```
SELECT ?p
```

```
WHERE { :john ?p :mary }
```

result:

```
p
```

```
=====
```

```
<http://example.org/myOntology#marriedTo>
```

SPARQL Queries: complex patterns

“Return the spouse of a person by the name of John Smith”

```
PREFIX vCard: <http://www.w3.org/2001/vcard-rdf/3.0#>
PREFIX ont: <http://example.org/myOntology#>
SELECT ?y
WHERE {?x vCard:FN "John Smith".
       ?x ont:marriedTo ?y}
```

result:

```
y
=====
<http://example.org/data#mary>
```

SPARQL Queries: blank nodes

“Return the name and the first name of all people in the KB”

```
PREFIX vCard: <http://www.w3.org/2001/vcard-rdf/3.0#>
SELECT ?name, ?firstName
WHERE {?x vCard:N ?name .
      ?name vCard:Given ?firstName}
```

result:

```
name      firstName
=====
_:a "John"
_:b "Mary"
```

SPARQL Queries: optional patterns (OPTIONAL)

“Return all people and (optionally) their spouses”

```
PREFIX ex: <http://example.org/#>
SELECT ?person, ?spouse
WHERE {?person ex:hasAge ?age .
      OPTIONAL { ?person ex:marriedTo ?spouse } }
```

result:

?person	?spouse
<http://example.org/#mary>	
<http://example.org/#john>	<http://example.org/#mary>

Filters in Query Patterns

- ▶ Conditions on literal values
- ▶ Syntax: `FILTER expression`

```
FILTER (?age > 30) FILTER isIRI(?x) FILTER  
!BOUND(?y)
```

- ▶ Different forms
 - ▶ Value comparison, e.g., `>`, `!=`, `>=`
 - ▶ Numeric functions, e.g., `+`, `*`
 - ▶ SPARQL test, e.g., `BOUND(?x)`, `isIRI(?x, isLITERAL(?y))`
 - ▶ **Negation**, e.g., `!BOUND(?x)`

SPARQL Tests

- ▶ `BOUND(var)`
 - ▶ **true** if *var* is bound in query answer;
 - ▶ **false**, otherwise
 - ▶ Together with negation `!`, enables **negation-as-failure**
- ▶ Testing types
 - ▶ `isIRI(A)`
 - ▶ `isBLANK(A)`
 - ▶ `isLITERAL(A)`
- ▶ Comparing RDF terms
 - ▶ `A = B`
 - ▶ `A != B`
- ▶ Boolean AND/OR
 - ▶ `A && B`
 - ▶ `A || B`

XQuery Functions

- ▶ Numeric, Date comparison

- ▶ $A = B$
- ▶ $A \neq B$
- ▶ $A \leq B$
- ▶ $A \geq B$
- ▶ $A < B$
- ▶ $A > B$

- ▶ Basic arithmetic

- ▶ $A + B$
- ▶ $A - B$
- ▶ $A * B$
- ▶ A / B

SPARQL Queries: constraints

“Return all people over 30 in the KB”

```
PREFIX ont: <http://example.org/myOntology#>
SELECT ?x
WHERE {?x ont:hasAge ?age .
       FILTER(?age > 30)}
```

result:

```
x
=====
<http://example.org/data#john>
```

RDF Datasets: FROM

- ▶ Dataset = RDF Graph
- ▶ Select graph to be queried
- ▶ In case of multiple FROM clauses, graphs are **merged**

SPARQL Queries: FROM clause

Graph:

```
@prefix foaf: <http://xmlns.com/foaf/0.1/> .  
  
_:a foaf:name      "Alice" .  
_:a foaf:mbox      <mailto:alice@work.example> .
```

Query:

```
PREFIX foaf: <http://xmlns.com/foaf/0.1/>  
SELECT ?name  
FROM      <http://example.org/foaf/aliceFoaf>  
WHERE     { ?x foaf:name ?name }
```

Named Graphs: FROM NAMED

- ▶ Graphs may be **named**
- ▶ Named graphs not in RDF
- ▶ Associate **name** with a particular graph
- ▶ Specify named graph: FROM NAMED <URI>
- ▶ Allow to query based on name: GRAPH *name* { *triples* }
GRAPH ?src { ?x foaf:name ?name }

SPARQL Queries: FROM NAMED I

Graph `http://example.org/bob:`

```
@prefix foaf: <http://xmlns.com/foaf/0.1/> .
```

```
_:a foaf:name "Bob" .
```

```
_:a foaf:mbox <mailto:bob@oldcorp.example.org> .
```

Graph `http://example.org/alice:`

```
@prefix foaf: <http://xmlns.com/foaf/0.1/> .
```

```
_:a foaf:name "Alice" .
```

```
_:a foaf:mbox <mailto:alice@work.example> .
```

SPARQL Queries: FROM NAMED II

```
PREFIX foaf: <http://xmlns.com/foaf/0.1/>
```

```
SELECT ?src ?name
```

```
FROM NAMED <http://example.org/alice>
```

```
FROM NAMED <http://example.org/bob>
```

```
WHERE
```

```
{ GRAPH ?src { ?x foaf:name ?name } }
```

```
result:
```

src	name
<http://example.org/bob>	"Bob"
<http://example.org/alice>	"Alice"

SPARQL Query answers

- ▶ Variable substitution

- ▶ Assigning values to variables

e.g. [?x=<http://www.example.org/#john>,?name=_:a,
?firstName="John"]

- ▶ Not all variables need to be bound

e.g. [?person=<http://example.org/#mary>,?spouse=]

- ▶ Query answer

- ▶ Substitute variables in graph pattern

```
<http://www.example.org/#> vCard:N _:a .  
_:a vCard:Given "John"
```

- ▶ If resulting graph pattern is **simple-entailed by** original graph, the variable substitution is a query answer

Summary

Turtle Syntax for RDF

SPARQL

Basic SPARQL Queries

Query Answer

Required reading

- ▶ Jena SPARQL tutorial:
<http://jena.sourceforge.net/ARQ/Tutorial/>

Further reading

- ▶ SPARQL Query Language for RDF:
<http://www.w3.org/TR/rdf-sparql-query/>
- ▶ Turtle - Terse RDF Triple Language:
<http://www.dajobe.org/2004/01/turtle/>