SPARQL, Named Graphs, Network Graphs

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Semantic Web

People and Knowledge Networks

SPARQL

- **S**PARQL **P**rotocol **a**nd **R**DF **Q**uery **L**anguage

- W3C Recommendation 15 January 2008
  - http://www.w3.org/TR/rdf-sparql-query/

- Standard query language for RDF
  - Native RDF knowledge bases
  - Knowledge bases viewed as RDF via middleware
- Language for querying for graph patterns
  - Includes unions, conjunctions and optional patterns
  - No support for inserts or updates
- Supports extensible testing for values and constraints

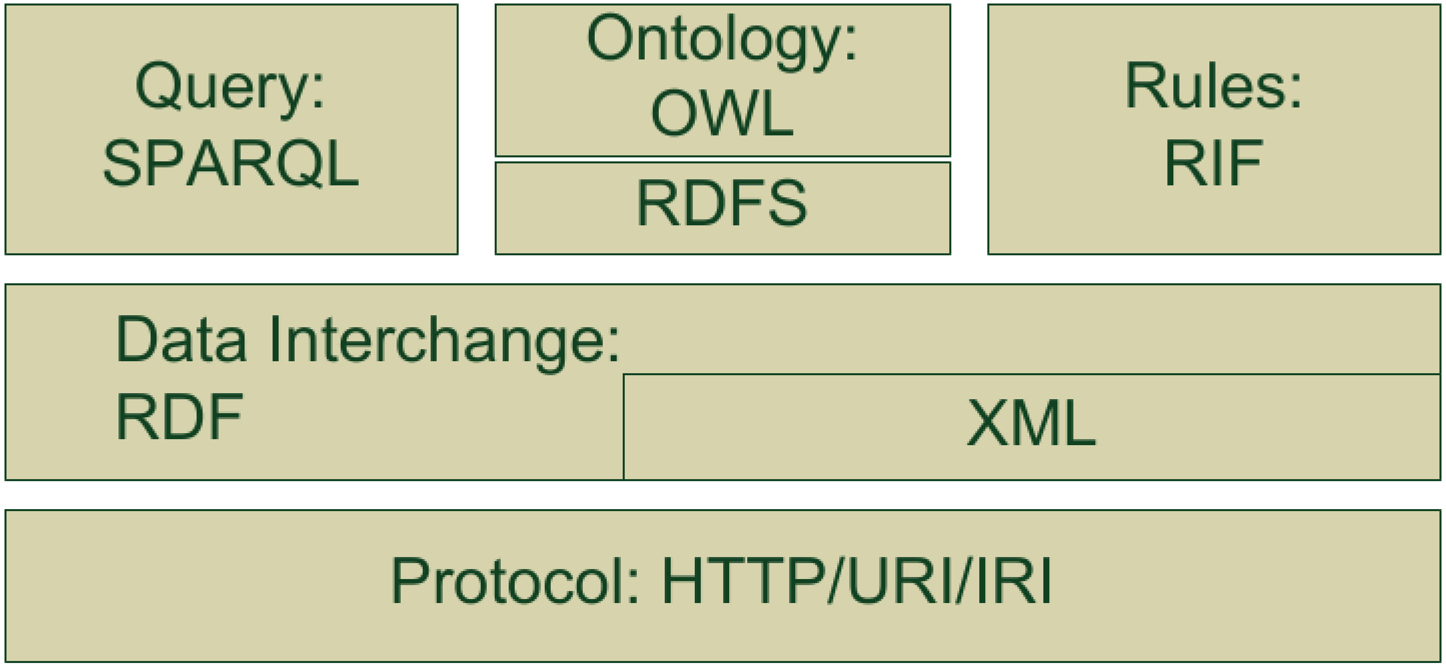
SPARQL 1.1

Revision and extension
http://www.w3.org/2009/sparql/wiki/Main_Page

Working Draft documents, 2010-01-26:

- SPARQL 1.1 Query - Adds support for aggregates, subqueries, projected expressions, and negation to the SPARQL query language.
- SPARQL 1.1 Update - Defines an update language for RDF graphs.
- SPARQL 1.1 Protocol - Defines an abstract interface and HTTP bindings for a protocol to issue SPARQL Query and SPARQL Update statements against a SPARQL endpoint.
- SPARQL 1.1 Service Description - Defines a vocabulary and discovery mechanism for describing the capabilities of a SPARQL endpoint.
- SPARQL 1.1 Uniform HTTP Protocol for Managing RDF Graphs - Describes the use of the HTTP protocol for managing named RDF graphs on an HTTP server.
- SPARQL 1.1 Entailment Regimes - Defines conditions under which SPARQL queries can be used with entailment regimes such as RDF, RDF Schema, OWL, or RIF.
- SPARQL 1.1 Property Paths - Defines a more succinct way to write parts of basic graph patterns and also extend matching of triple pattern to arbitrary length paths.

Semantic Web Language Layer Cake



Existing standards

SPARQL Query

Schemas used in query

```
PREFIX …
SELECT …
FROM …
WHERE { … }
```

Values to be returned

Identify source data to query

Triple patterns and other conditions to match the graph

SPARQL Query types

- **SELECT**
  - returns the set of variables bound in a query pattern match
- **CONSTRUCT**
  - returns an RDF graph constructed by substituting variables in a set of triple templates
- **DESCRIBE**
  - returns an RDF graph that describes the resources found
- **ASK**
  - returns whether a query pattern matches any triples or not
    True / False query

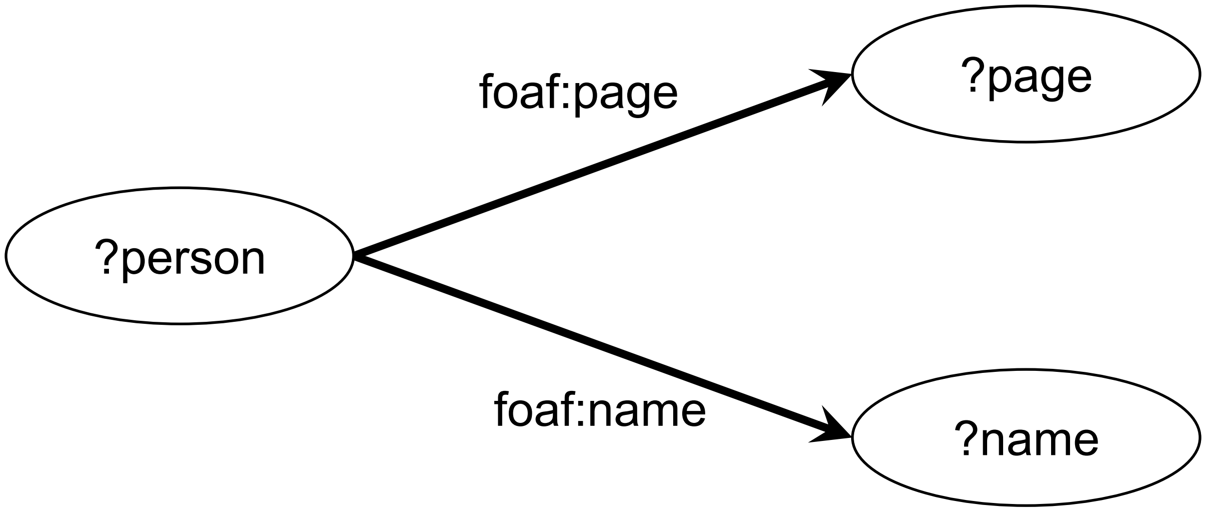
Basic SPARQL patterns

- Triple Pattern
  - Similar to an RDF Triple
    - `subject, predicate, object`
  - Any component can be a query variable
  - Any combination of variables in the query is allowed

- Matching patterns in the **WHERE** clause
  - Matching conjunction of Triple Patterns
  - Matching a triple pattern to a graph
    - Finding bindings between variables and RDF Terms
  - Underneath use of reasoners
    - Infering triples originally not present in the knowledge base

Simple SPQRQL Query

```
PREFIX foaf: <http://xmlns.com/foaf/0.1/>
SELECT ?name ?page
WHERE {
 ?person foaf:page ?page .
 ?person foaf:name ?name
}
```



Query example

Data

```
@prefix foaf: <http://xmlns.com/foaf/0.1/> .
 _:a foaf:name “Steffen Staab" .
 _:a foaf:homepage <http://www.uni-koblenz.de/~staab> .
 _:b foaf:name “Maciej Janik" .
 _:b foaf:homepage <http://www.uni-koblenz.de/~janik> .
```

```
PREFIX foaf: <http://xmlns.com/foaf/0.1/>
SELECT ?name ?page
WHERE {
 ?person foaf:homepage ?page .
 ?person foaf:name ?name
}
```

Query

Query Result

name	page
“Steffen Staab"	<http://www.uni-koblenz.de/~staab>
“Maciej Janik"	<http://www.uni-koblenz.de/~janik>

Querying for blank nodes

Data

```
@prefix foaf: <http://xmlns.com/foaf/0.1/> .
 _:a foaf:name “Steffen Staab" .
 _:a foaf:homepage <http://www.uni-koblenz.de/~staab> .
 _:b foaf:name “Maciej Janik" .
 _:b foaf:homepage <http://www.uni-koblenz.de/~janik> .
```

Query

```
PREFIX foaf: <http://xmlns.com/foaf/0.1/>
SELECT ?person ?name ?page
WHERE {
 ?person foaf:homepage ?page .
 ?person foaf:name ?name
}
```

Query Result

person	name	homepage
_:c	“Steffen Staab"	<http://www.uni-koblenz.de/~staab>
_:d	“Maciej Janik"	<http://www.uni-koblenz.de/~janik>

Filters

- **FILTER**
  - Further constrain graph patterns
  - Applies to the **whole group** of triple patterns

- **FILTER** clause
  - Support for AND and OR logic operators
  - Extensive applications for testing literals
  - Support for numerical operations
  - Support for math equality operators for literals
    - Less than …equal … greater than
  - Use of regular expressions
  - Support for datatypes defined in XSL
    - e.g. comparison of dates, time
  - Possible comparison of resources
    - Equal or not equal
  - Even possible user extensions

Filter – Value Constraints

Data

```
@prefix dc: <http://purl.org/dc/elements/1.1/> .
@prefix ex: <http://example.org/book/> .
@prefix ns: <http://example.org/ns#> .
ex:book1 dc:title "SPARQL Tutorial" .
ex:book1 ns:price 42 .
ex:book2 dc:title "The Semantic Web" .
ex:book2 ns:price 23 .
```

```
PREFIX dc: <http://purl.org/dc/elements/1.1/>
PREFIX ns: <http://example.org/ns#>
SELECT ?title ?price
WHERE { ?x ns:price ?price .
        FILTER ?price < 30 .
        ?x dc:title ?title }
```

Query

Query Result

title	price
"The Semantic Web"	23

Scope of filters

- Filters are applied to the whole group of patterns where it appears

```
{ ?x foaf:name ?name .
  ?x foaf:homepage ?page .
  FILTER regex(?name, “Steffen")  }
```

```
{ ?x foaf:name ?name .
  FILTER regex(?name, “Steffen") .
  ?x foaf:homepage ?page  }
```

```
{ FILTER regex(?name, “Steffen") .
  ?x foaf:name ?name .
  ?x foaf:homepage ?page   }
```

- These patterns are equivalent – have the same solution.

Filter – regular expression

Data

```
@prefix foaf: <http://xmlns.com/foaf/0.1/> .
 _:a foaf:name “Steffen Staab" .
 _:a foaf:homepage <http://www.uni-koblenz.de/~staab> .
 _:b foaf:name “Maciej Janik" .
 _:b foaf:homepage <http://www.uni-koblenz.de/~janik> .
```

```
PREFIX foaf: <http://xmlns.com/foaf/0.1/>
SELECT ?name ?page
WHERE {
 ?person foaf:homepage ?page .
 ?person foaf:name ?name .
 FILTER regex(?name, “Steffen")
}
```

Query

Query Result

name	page
“Steffen Staab"	<http://www.uni-koblenz.de/~staab>

Filter – regular expression

Data

```
@prefix foaf: <http://xmlns.com/foaf/0.1/> .
 _:a foaf:name “Steffen Staab" .
 _:a foaf:homepage <http://www.uni-koblenz.de/~staab> .
 _:b foaf:name “Maciej Janik" .
 _:b foaf:homepage <http://www.uni-koblenz.de/~janik> .
```

Query

```
PREFIX foaf: <http://xmlns.com/foaf/0.1/>
SELECT ?name ?page
WHERE {
 ?person foaf:homepage ?page .
 ?person foaf:name ?name .
 FILTER regex(?name, “i”, “janik")
}
```

Case insensitive

Query Result

name	page
“Maciej Janik"	<http://www.uni-koblenz.de/~janik>

Optional patterns

- **OPTIONAL**
  - Include optional triple patterns to the match
  - Optional is a pattern itself – can include further constraints

```
SELECT
WHERE {
    …
    OPTIONAL { … }
}
```

- OPTIONAL is left-associative

  `pattern OPTIONAL { pattern } OPTIONAL { pattern }`

  is the same as

  `{ pattern OPTIONAL { pattern } } OPTIONAL { pattern }`

Query example

Data

```
@prefix foaf: <http://xmlns.com/foaf/0.1/> .
 _:a foaf:name “Steffen Staab" .
 _:a foaf:homepage <http://www.uni-koblenz.de/~staab> .
 _:b foaf:name “Maciej Janik" .
 _:b foaf:mbox <janik@uni-koblenz.de> .
```

```
PREFIX foaf: <http://xmlns.com/foaf/0.1/>
SELECT ?name ?page
WHERE {
  ?person foaf:name ?name .
  ?person foaf:homepage ?page
}
```

Query

Query Result

name	page
“Steffen Staab"	<http://www.uni-koblenz.de/~staab>

Query example - OPTIONAL

Data

```
@prefix foaf: <http://xmlns.com/foaf/0.1/> .
 _:a foaf:name “Steffen Staab" .
 _:a foaf:homepage <http://www.uni-koblenz.de/~staab> .
 _:b foaf:name “Maciej Janik" .
 _:b foaf:mbox <janik@uni-koblenz.de> .
```

```
PREFIX foaf: <http://xmlns.com/foaf/0.1/>
SELECT ?name ?page
WHERE {
  ?person foaf:name ?name .
  OPTIONAL (?person foaf:homepage ?page)
}
```

Query

Query Result

name	page
“Steffen Staab"	<http://www.uni-koblenz.de/~staab>
“Maciej Janik"	

Union of graph patterns

- **UNION**
  - Combining alternative graph patterns
  - If more than one of the alternatives matches, all the possible pattern solutions are included in result

```
SELECT
WHERE {
    { pattern }
    UNION
    { pattern }
}
```

Union of graph patterns

Data

```
@prefix dc10: <http://purl.org/dc/elements/1.0/> .
@prefix dc11: <http://purl.org/dc/elements/1.1/> .
:book1 dc10:title "SPARQL Tutorial" .
:book1 dc10:creator “Alice” .
:book2 dc11:title "The Semantic Web" .
:book2 dc11:creator “Robert .
```

Query

```
PREFIX dc10: <http://purl.org/dc/elements/1.0/>
PREFIX dc11: <http://purl.org/dc/elements/1.1/>
SELECT ?title
WHERE { { ?x dc10:title ?title }
        UNION
        { ?x dc11:title ?title } }
```

Query Result

title
“SPARQL Tutorial”
"The Semantic Web"

Modification to the result set

Result of SPARQL query can be further modified

- ORDER BY
  - Sort results alphabetically / numerically by specific variable
- LIMIT
  - Limit number of returned results (only top n results)
- OFFSET
  - Skip n top results, and return the rest

These expressions can be combined in one query

Sequencing and limiting results

Results 11 to 30 sorted by name

```
PREFIX foaf: <http://xmlns.com/foaf/0.1/>
SELECT ?name ?page
WHERE {
 ?person foaf:homepage ?page .
 ?person foaf:name ?name
}
ORDERBY ?name
LIMIT 20
OFFSET 10
```

Bound variables

- One of the FILTER expressions
- Supports testing if a variable in a query can be bound to an instance in the knowledge base
- Mostly used for negation as failure

```
PREFIX foaf: < http://xmlns.com/foaf/0.1/>
SELECT ?name
WHERE {
  ?person foaf:name ?name .
  ?person foaf:knows ?x .
  FILTER ( ! bound(?x))
}
```

Tricky negation

Find people who do not know Steffen

```
PREFIX foaf: < http://xmlns.com/foaf/0.1/>
SELECT ?name
WHERE {
  ?person foaf:name ?name .
  ?person foaf:knows ?x .
  FILTER ( ?x != “Steffen” )
}
```

… we know that …

```
      “Maciej” foaf:knows “Steffen”
      “Maciej” foaf:knows “Sergej”
```

… so “Maciej” is still a valid answer, and we do not want it.

Negation with bound

Find people who do not know Steffen

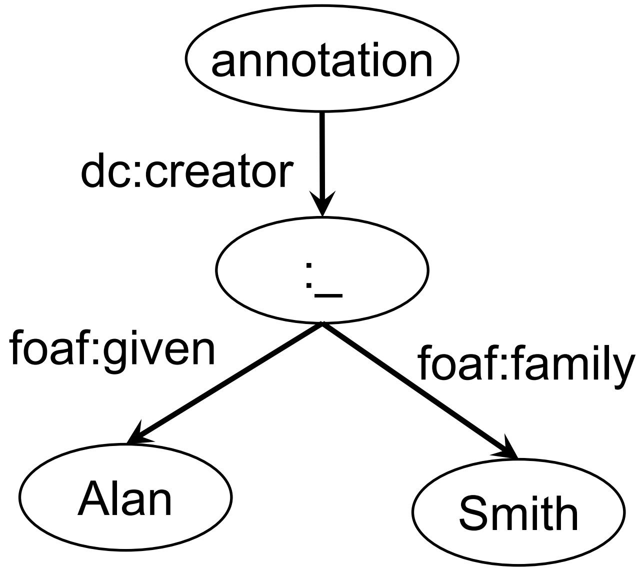
- now the correct way using bound expression and optional graph pattern

```
PREFIX foaf: < http://xmlns.com/foaf/0.1/>
SELECT ?name
WHERE {
  ?person foaf:name ?name .
  OPTIONAL { ?person foaf:knows ?x .
             FILTER ( ?x = “Steffen” ) }
  FILTER ( ! bound(?x) ) }
}
```

Other SPARQL filter expressions

- **isBlank**
  - Testing if bounded variable is a blank node

```
SELECT ?given ?family
WHERE { ?annot  dc:creator ?c .
          OPTIONAL {
           ?c foaf:given ?given .
           ?c foaf:family ?family }.
          FILTER isBlank(?c) }
```



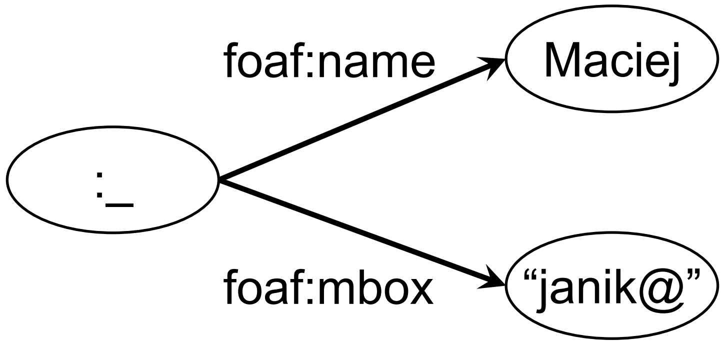
- **lang**
  - Accessing the language of a literal

```
SELECT ?name ?mbox
WHERE { ?x foaf:name ?name .
        ?x foaf:mbox ?mbox .
        FILTER ( lang(?name) = "DE" ) }
```

Other SPARQL filter expressions

- **isLiteral**
  - Testing if bounded variable is a literal (not a resource)

```
SELECT ?name ?mbox
WHERE { ?x foaf:name ?name .
        ?x foaf:mbox ?mbox .
        FILTER isLiteral(?mbox) }
```



- **str**
  - Converting resource URI to string for regular expression matching

```
SELECT ?name ?mbox
WHERE { ?x foaf:name ?name .
        ?x foaf:mbox ?mbox .
        FILTER regex(str(?mbox), "@uni-koblenz.de") }
```

Equal terms and same terms

- Check if two terms are equal or if they describe the same entity
  - Same entity can have even different URIs, but conneced with owl:sameAs

```
term1 = term2
```

or

```
sameTerm(term1, term2)
```

Returns true, if

- terms are of the same type (URI, literal, blank node)
- two terms represent URIs are equivalent
- two terms represent literals are equivalent
- two terms are bound by the same blank node

Equal terms

- Find people who have the same email address, but use different names

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

```
PREFIX foaf: <http://xmlns.com/foaf/0.1/>
SELECT ?name1 ?name2
WHERE {
  ?x foaf:name ?name1 .
  ?x foaf:mbox ?mbox1 .
  ?y foaf:name ?name2 .
  ?y foaf:mbox ?mbox2 .
  FILTER ( sameTerm(mbox1, ?mbox2) && ?name1 != ?name2) }
```

User-defined functions

- FILTER enables using user-defined expressions

```
PREFIX aGeo: <http://example.org/geo#>
SELECT ?neighbor WHERE {
  ?a aGeo:placeName “Koblenz" .
  ?a aGeo:location ?axLoc .
  ?a aGeo:location ?ayLoc .
  ?b aGeo:placeName ?neighbor .
  ?b aGeo:location ?bxLoc .
  ?b aGeo:location ?byLoc .
  FILTER
   ( aGeo:distance(?axLoc, ?ayLoc, ?bxLoc, ?byLoc) < 5 )
}
```

Definition of user function

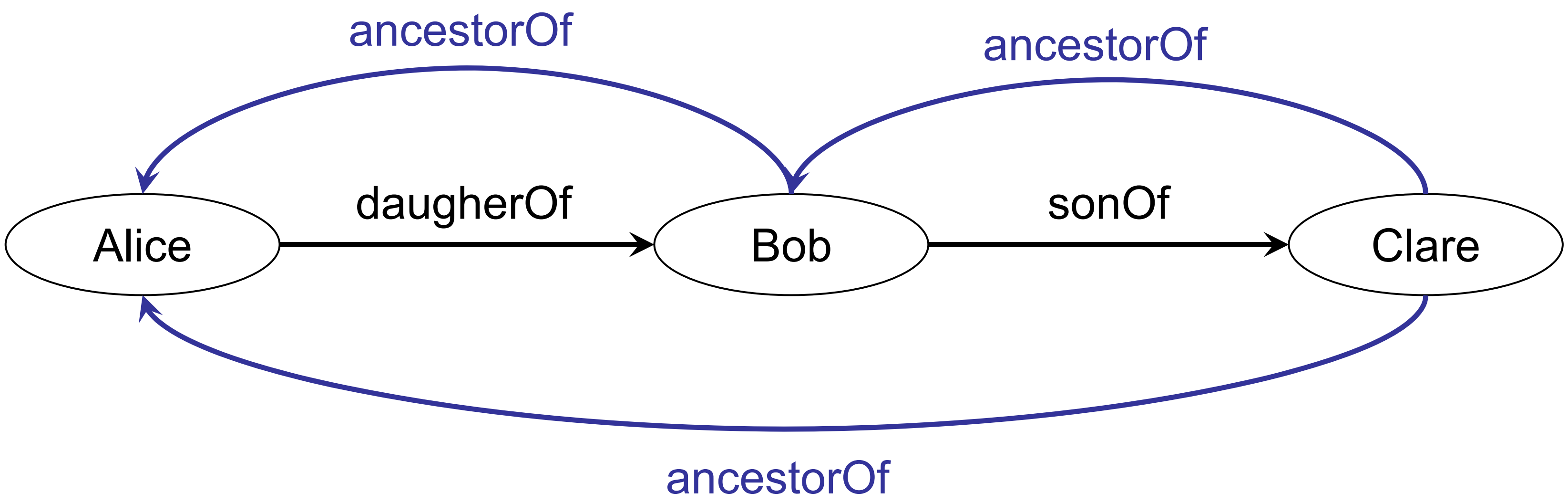
Geometric distance between two points described by (x, y) coordinates

```
  xsd:double   aGeo:distance (numeric x1, numeric y1,
                              numeric x2, numeric y2)
```

Querying for inferred knowledge

- SPARQL do not have specific constructs for accessing inferred knowledge
  - Underlying knowledge base is responsible for supporting inference, e.g.
    - Class hierarchy
    - Property hierarchy
    - Transitive or symmetric properties
    - OWL restrictions
    - Defining classes by unions and/or intersections
- Different knowledge bases can offer different level of support
  - Same knowledge in different knowledge bases may return different results for the same query, depending on **supported entailment**

Query example



ancestorOf = owl:transitiveProperty + union (inverse(daugherOf), inverse(sonOf))

Find ancestors of Alice

Query

```
SELECT ?x
WHERE ?x ancestorOf “Alice”
```

Result

“Clare”

“Bob”

CONSTRUCT queries

- Special type of query to construct a new RDF graph from the existing knowledge base

```
PREFIX ……
CONSTRUCT
{
    … graph pattern …
    … definition of triples …
}
WHERE
{
    constraint triple patterns, filters, etc
}
```

Constructing graphs

- **Data:**

```
@prefix foaf:
<http://xmlns.com/foaf/0.1/> .
_:a foaf:givenname "Alice" .
_:a foaf:family_name "Hacker" .
_:b foaf:firstname "Bob" .
_:b foaf:surname "Hacker" .
```

- **Query:**

```
PREFIX foaf:
<http://xmlns.com/foaf/0.1/>
PREFIX vcard:
<http://www.w3.org/2001/vcard-
rdf/3.0#>
CONSTRUCT
{
?x vcard:N _:v .
_:v vcard:givenName ?gname .
 _:v vcard:familyName ?fname
}
WHERE
{
 { ?x foaf:firstname ?gname }
   UNION
 { ?x foaf:givenname ?gname } .
 { ?x foaf:surname ?fname }
   UNION
 { ?x foaf:family_name ?fname }
}
```

- **Result:**

```
@prefix vcard:
<http://www.w3.org/2001/vcard-rdf/3.0#>
_:v1 vcard:N          _:x .
 _:x vcard:givenName  "Alice" .
 _:x vcard:familyName "Hacker" .
 _:v2 vcard:N          _:z .
 _:z vcard:givenName  "Bob" .
_:z vcard:familyName "Hacker" .
```

ASK queries

- True / false queries – checks if given set of triple patterns have at least one match in knowledge base
- Does not include ORDER BY, LIMIT or OFFSET

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

```
PREFIX foaf: <http://xmlns.com/foaf/0.1/>
ASK { ?x foaf:name "Alice" .
      ?x foaf:mbox ?y }
```

Answer: NO

DESCRIBE queries

- Returns a graph that includes description of specific resources

- Results of DESCRIBE query reveal metainformation not returned by standard SELECT query
  - Type of bounded resources
  - Types of relationships used in query pattern

- Exact description of resources is determined by the query service
  - No common standard of description
  - Can even include information about related resources

DESCRIBE query example

```
PREFIX ent: <http://org.example.com/employees#>
DESCRIBE ?x
WHERE { ?x ent:employeeId "1234" }
```

```
@prefix foaf: <http://xmlns.com/foaf/0.1/> .
@prefix vcard: <http://www.w3.org/2001/vcard-rdf/3.0> .
@prefix exOrg: <http://org.example.com/employees#> .
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
@prefix owl: <http://www.w3.org/2002/07/owl#>

_:a    exOrg:employeeId "1234" ;
       foaf:mbox_sha1sum "ABCD1234" ;
       vcard:N
          [ vcard:Family "Smith" ;
            vcard:Given "John" ] .

foaf:mbox_sha1sum rdf:type owl:InverseFunctionalProperty
```

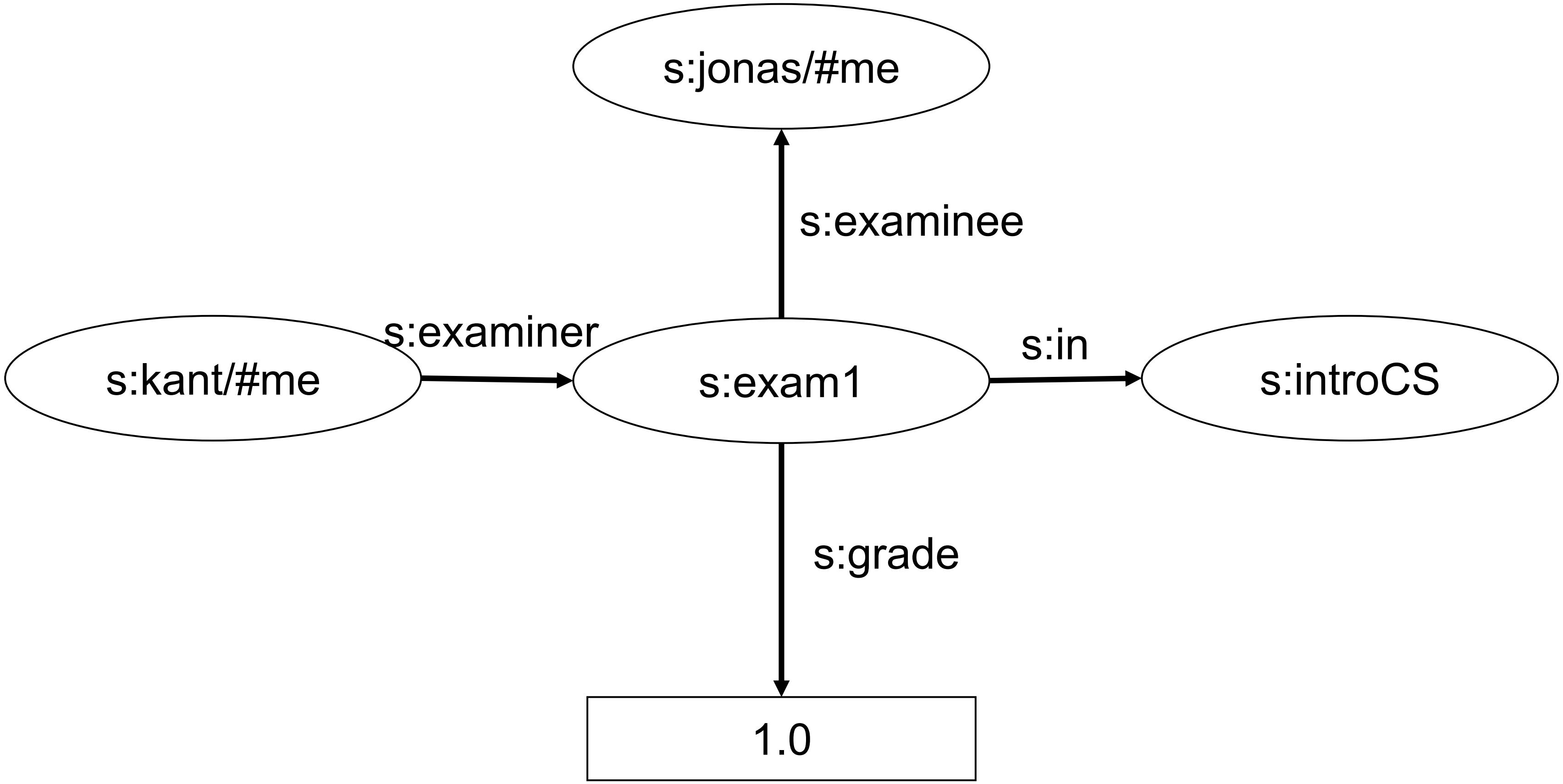
Named Graphs

- RDF data stores may hold multiple RDF graphs:
  - record information about each graph
  - queries that involve information from more than one graph
  - default graph (does not have a name)
  - multiple named graphs (identified by URI reference)
  - direct implementation for reification

- Accessing named graphs
  - FROM
    - access knowledge in default graph
  - FROM NAMED
    - access information from specific named graph

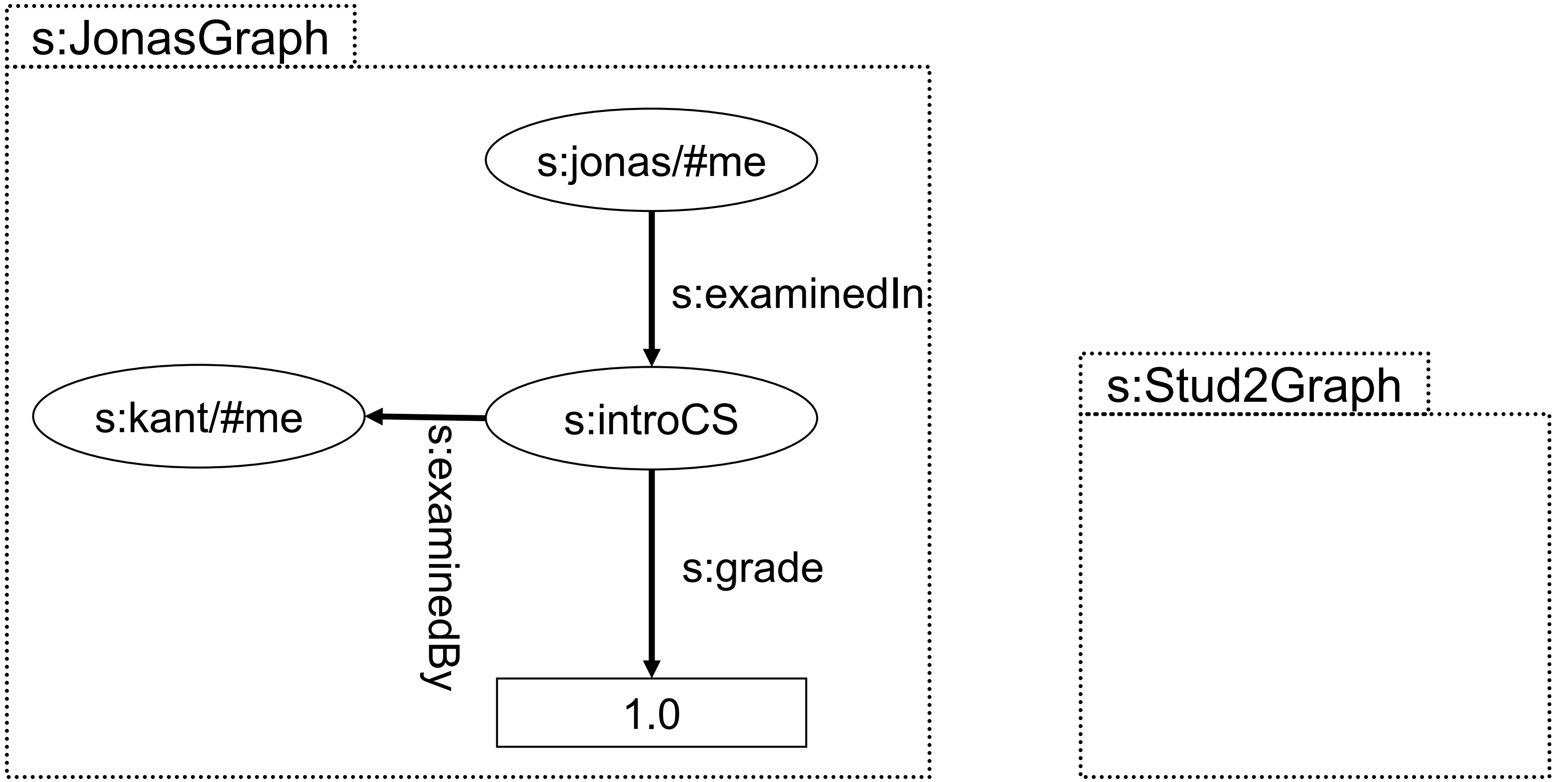
Ad hoc-Reification (direct)

„Kant“ examined „Jonas“ in „Introduction to CS“ and gave him grade „1.0“



Named Graph as reification

„Kant“ examined „Jonas“ in „Introduction to CS“ and gave him grade „1.0“



Named graph examples

```
# Default graph (http://example.org/friends)
@prefix dc: <http://purl.org/dc/elements/1.1/> .
<http://example.org/bob> dc:publisher "Bob" .
<http://example.org/alice> dc:publisher "Alice" .
# 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.org> .

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

Relationships between named graphs

```
# Default graph
@prefix foaf: <http://xmlns.com/foaf/0.1/> .
_:y foaf:name "Alice" .
_:y foaf:mbox <mailto:alice@work.example.org> .
_:y foaf:mbox <mailto:alice@oldcorp.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.org> .
```

```
# Graph: http://example.org/alice_prev
@prefix foaf: <http://xmlns.com/foaf/0.1/> .
_:a foaf:name "Alice" .
_:a foaf:mbox <mailto:alice@oldcorp.org> .
```

Accessing named graphs

```
# Graph: http://example.org/alice
_:a foaf:name “Alice" .
_:a foaf:mbox <mailto:alice@work.example.org> .
# Graph: http://example.org/alice_prev
_:a foaf:name "Alice" .
_:a foaf:mbox <mailto:alice@oldcorp.org> .
```

```
SELECT ?src ?mbox
WHERE {
  GRAPH ?src
  { ?x foaf:name “Alice” .
    ?x foaf:mbox ?mbox
  }
}
```

Result:

src	mbox
http://example.org/alice	mailto:alice@work.example.org
http://example.org/alice_prev	mailto:alice@oldcorp.org

Restricting access by graph name

```
# Graph: http://example.org/alice
_:a foaf:name “Alice" .
_:a foaf:mbox <mailto:alice@work.example.org> .
# Graph: http://example.org/alice_prev
_:a foaf:name "Alice" .
_:a foaf:mbox <mailto:alice@oldcorp.org> .
```

```
PREFIX ex: <http://example.org/>
SELECT ?mbox
WHERE {
  GRAPH ex:alice
  { ?x foaf:mbox ?mbox }
}
```

Result:

mbox
mailto:alice@work.example.org

Networked Graphs

Simon Schenk and **Steffen Staab**.

“Networked Graphs: A Declarative Mechanism for SPARQL Rules, SPARQL Views and RDF Data Integration on the Web”, Proceedings of the 17th International World Wide Web Conference, **WWW2008**, Bejing, China. 2008.

People and Knowledge Networks

Networked Graphs

Basic Idea: Define RDF graphs

- *extensionally* by listing statements or
- *intensionally* using *views*
  - possible to have view within a view (recursion)

Integrate with existing SemWeb infrastructure

Easy *exchange*

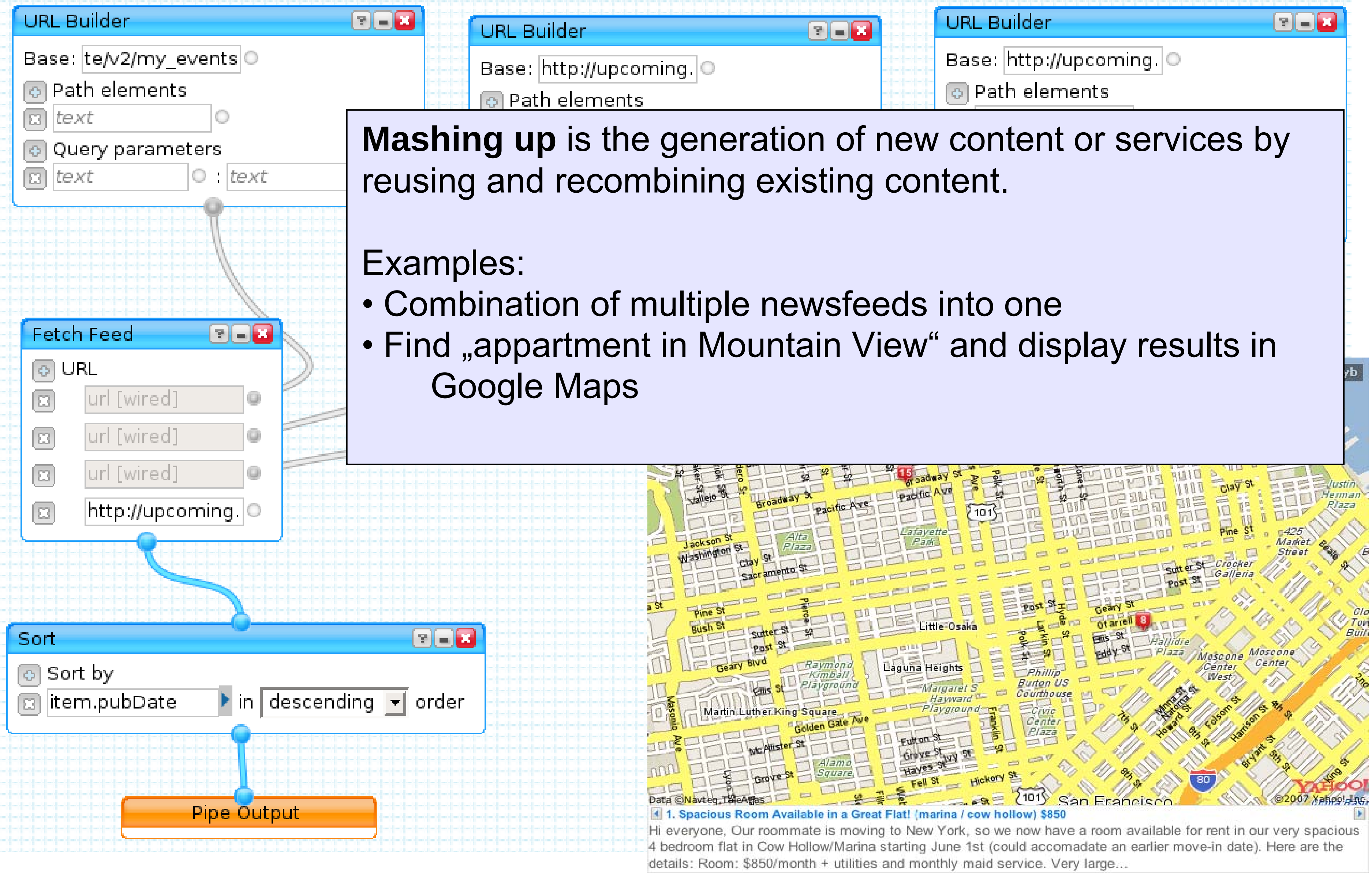
Use *existing data sources*

Mashups

Mashing up is the generation of new content or services by reusing and recombining existing content.

Examples:

- Combination of multiple newsfeeds into one
- Find „appartment in Mountain View“ and display results in Google Maps



Dominating Mashup-Modell:

- ***Hack-and-Hope***

Disadvantages:

- **Screen-Scraping**
- No agreed-upon data model
- Sometimes one cannot help:
  - **Google Web Service**
  - **Amazon Web Service**

Dominating Semantic Web-Model:

- ***Crawl-Integrate-and-Reason***

Disadvantages:

- Data are **stale**,
- Data integration is **not declarative**, but given by programmes with only implicit semantics
- Lack of **scalability** of one server
- **Access rights**: Not all data may be copied
- **Provenance** of data becomes unclear

FOAFer

Please enter a FOAF-Resource: http://www.uni-koblenz.de/~ssche [1]

go [2]

Make your own FOAF-file [3]!
What [4] is [5] FOAF [6]?

-> http://www.uni-koblenz.de/~sschenk/foaf.rdf

Name:	Simon Schenk
Givenname:	Simon
Family Name:	Schenk
MBOX_SHA1SUM:	14c0da3c553cc8f7866a1
	homepage [7]
	workplace-homepage [8]
	school-homepage [9]

knows:

Steffen Staab
-> browse [10]

Thomas franz
-> browse [11]

Carsten Saathoff

dblp.uni-trier.de

DBLP

Simon Schenk

List of publications from the DBLP Bibliography Server - FAQ

Coauthor Index - Ask others: ACM DL - ACM Guide - CiteSeer - CSB - Google

		2006
3	EE	Steffen Staab, Thomas Franz, Olaf Görlitz, Carsten Saathoff, Simon Schenk, Sergej Sizov: Lifecycle Knowledge Management: Getting the Semantics Across in X-Media. ISMIS 2006: 1-10
		2005
2		Simon Schenk: Introducing Social Aspects to Search in Peer-to-Peer Networks. Wissensmanagement 2005: 217-221
1	EE	Simon Schenk: Introducing Social Aspects to Search in Peer-to-Peer Networks. Wissensmanagement (LNCS Volume) 2005: 234-242

Coauthor Index

1	Thomas Franz	[3]
2	Olaf Görlitz	[3]
3	Carsten Saathoff	[3]
4	Sergej Sizov	[3]
5	Steffen Staab	[3]

Fertig

RDF Mashups

- Declarative, dynamic semantic mashups facilitate the generation of mashups

```
:DBLP

:NetGraphs dc:creator :Simon
:NetGraphs d :creator :Steffen
```

```
:SteffenFOAF

:Steffen foaf:name „Steffen Staa
:Steffen foaf:currentProject K-S
:K-Space foaf:fundedBy :EU
```

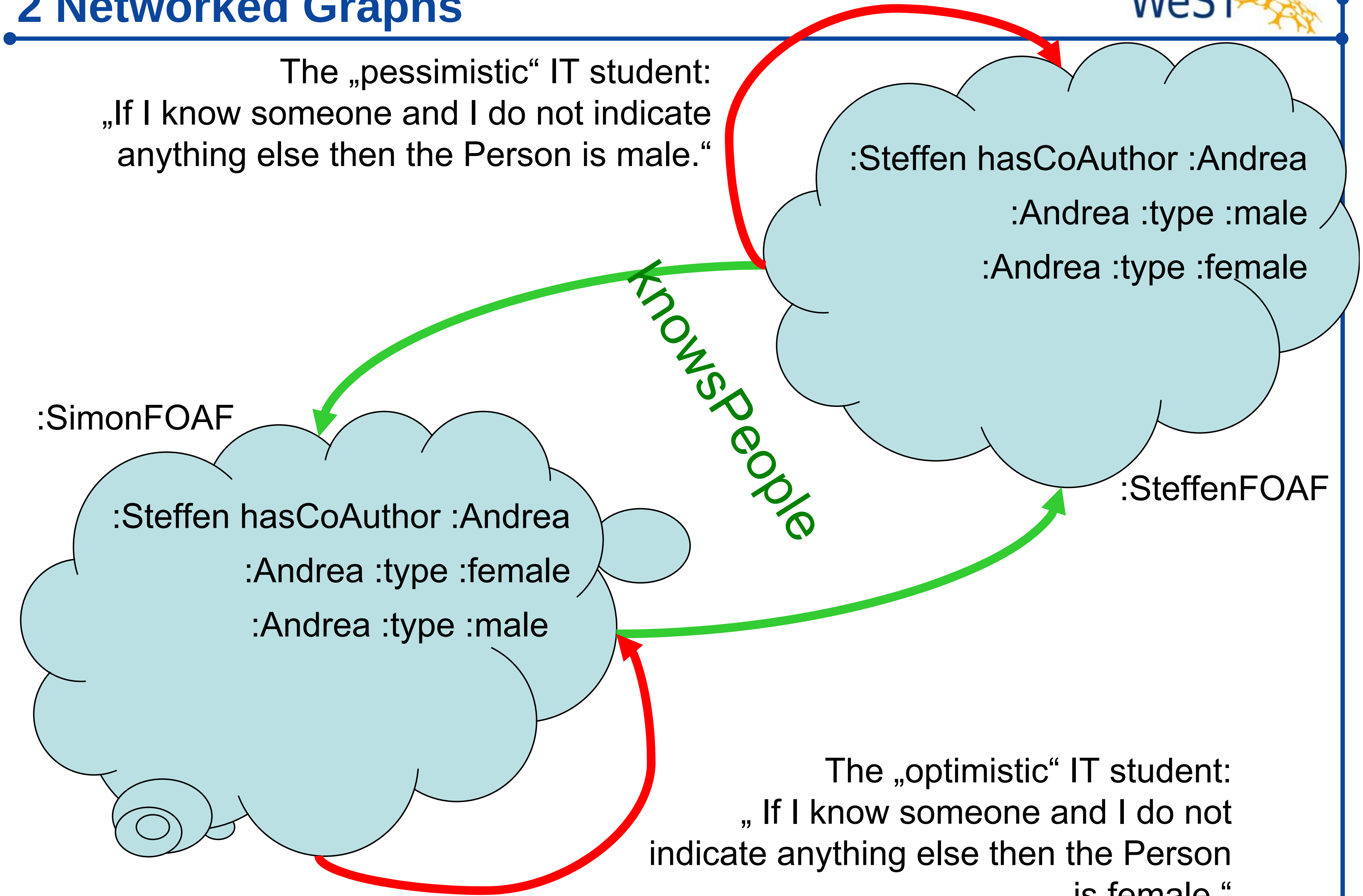
```
CONSTRUCT {:Simon foaf:knows ?x}
FROM DBLP
WHERE
{?p dc:creator :Simon.
 ?p dc:creator ?x.}
```

```
:SimonFOAF

:Simon foaf:name „Simon Sche k“
:Simon foaf:currentProject K
:K-Space foaf:fundedBy :EU
:Simon foaf:knows :Steffen
:SimonFOAF g:definedBy „CONSTRU T {:Simon...“
```

2 Networked Graphs

The „pessimistic“ IT student:
„If I know someone and I do not indicate anything else then the Person is male.“



The „optimistic“ IT student:
„ If I know someone and I do not indicate anything else then the Person is female.“

Networked RDF Graphs

- Im Semantic Web: Recursion and Negation unavoidable
- Solution:
  Mapping of RDF Graphs and SPARQL Queries to logic programmes
  - Evaluation using three valued Well-founded Semantics or four valued stable model semantics
  - Non-monotonic logics with fixed point semantics
  - Conflicts with OWL Tarski-Semantik

Mashups and Semantic Web

Dominating Mashup-Modell:

- ***Hack-and-Hope***

Disadvantages:

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- No agreed-upon data model

- Sometimes one cannot help:
  - **Google Web Service**
  - **Amazon Web Service**

Dominating Semantic Web-Model:

- ***Crawl-Integrate-and-Reason***

Disadvantages:

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Improvements:

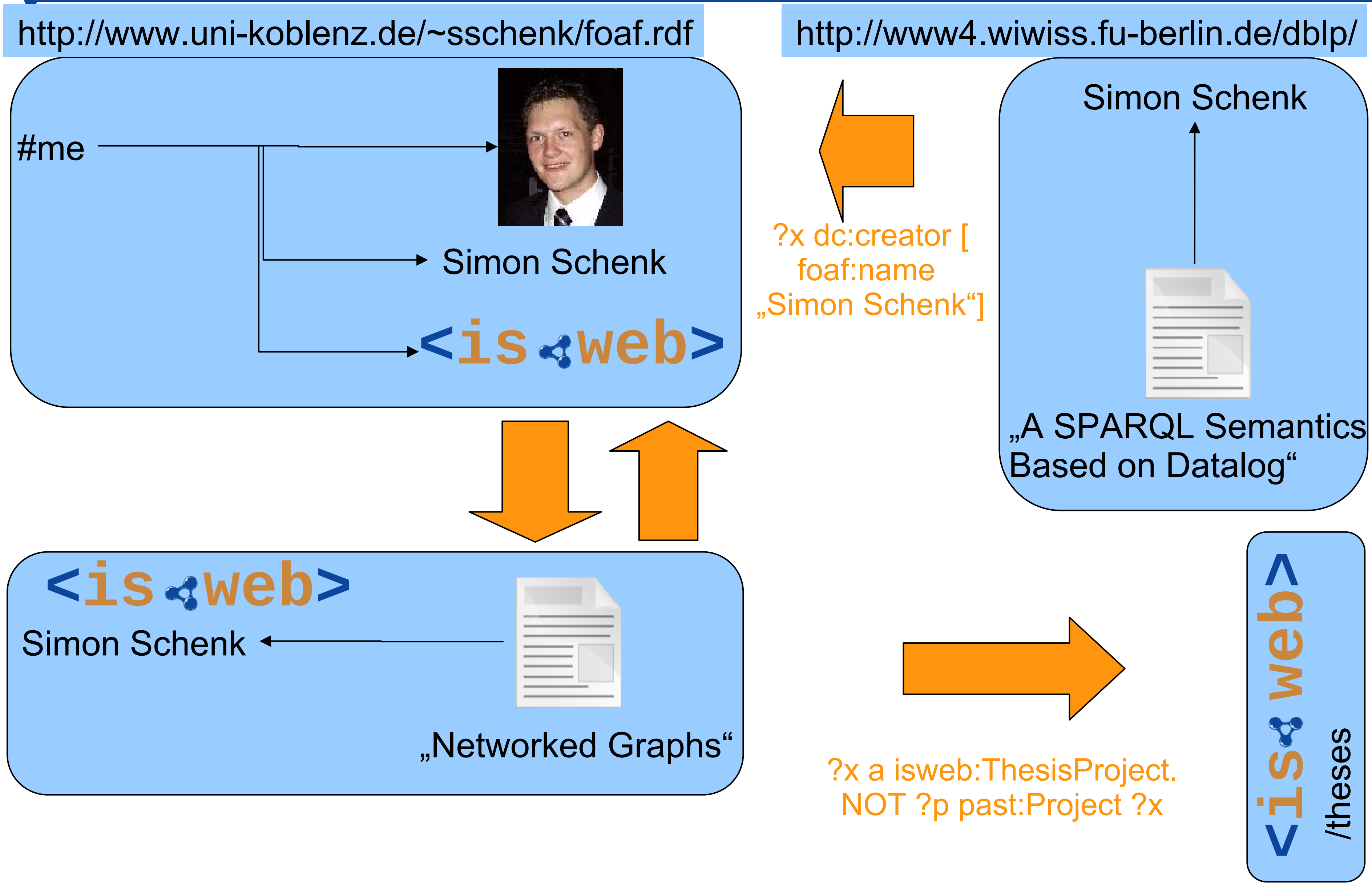
- Reuse of data (telefone numbers!) instead of screen-scraping
- fresh views
- Definition of data integration may be exchanged as graph
- Evaluation possible on sources or on client sides
- Networked, dynamic Semantic Web

Networked Graphs

Formally: $G^N=(n, G, [G^N_1, \ldots, G^N_n], v)$

- G: RDF Graph
- G^N_i: Networked Graphs
- v: view definition

Motivation scenario



Networked Graphs Syntax

- Based on named graphs and SPARQL

foaf.rdf { n

#me foaf:name „Simon Schenk“.

#me foaf:depiction  .

foaf.rdf ng:definedBy

„CONSTRUCT {

G

?paper dc:creator #me; dc:title ?title; rdfs:seeAlso ?cr }

V

FROM DBLP

FROM ISWEB

$[G^N_1, G^N_2]$

WHERE {

?paper dc:creator dblp:person/352836; dc:title ?title

OPTIONAL {?paper dblp:crossref ?cr} .

?paper dc:date ?date}“^^ng:Query.

foaf.rdf ng:definedBy „CONSTRUCT ...“^^ng:Query.

V

...

}

Networked Graphs Semantics (sketch)

- Graph $G^N{}_1$ *depends on* $G^N{}_2$, if $G^N{}_1$ is defined by a view, which has $G^N{}_2$ in it's dataset.
- *Interdependence Set* of G^N: contains G^N and all graphs in the transitive closure of the depends on relation for $G^{N.}$

- Semantics of an interdepedece set:
  - Iteratively evaluate all views in all graphs until a fixpoint is reached.

Problems:

- Need to prove termination
- Need to deal with negation

KI07: Map SPARQL to non-recursive Datalog with negation

Networked Graphs can be mapped to Datalog with negation

Evaluated under Well Founded Semantics (Gelder et al.)

SPARQL Protocol

People and Knowledge Networks

SPARQL protocol

- Protocol is used to send queries and results over the network
  - Query
    - HTTP binding
    - SOAP binding
  - XML result binding

SPARQL query binding

HTTP binding

```
GET /sparql/?query=<encoded query> HTTP/1.1
Host: www.uni-koblenz.de
User-agent: neon-sparql-client/0.1
```

SOAP binding

```
<?xml version="1.0" encoding="UTF-8"?>
<soapenv:Envelope
   xmlns:soapenv="http://www.w3.org/2003/05/soap-envelope/“
   xmlns:xsd="http://www.w3.org/2001/XMLSchema"
   xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
 <soapenv:Body>
  <query-request xmlns="http://www.w3.org/2005/09/sparql-
   protocol-types/#">
   <query>SELECT ?x ?y WHERE {?x isRelatedTo ?y}</query>
  </query-request>
 </soapenv:Body>
</soapenv:Envelope>
```

SPARQL result XML binding

```
<?xml version="1.0"?>
<sparql xmlns="http://www.w3.org/2005/sparql-results#">

  <head>
    <variable name="name"/>
    <variable name="mbox"/>
    <link href="metadata.rdf"/>
  </head>

  <results>
    <result>...
    </result>
    <result>...
    </result>
    ...
   </results>

</sparql>
```

Binding types inside result

```
<result>
  <binding name="x">
    <bnode>r2</bnode>
  </binding>
  <binding name="hpage">
    <uri>http://work.example.org/bob/</uri>
  </binding>
  <binding name="name">
    <literal xml:lang="en">Bob</literal>
  </binding>
  <binding name="age">
    <literal
      datatype="http://www.w3.org/2001/XMLSchema#integer">30
    </literal>
  </binding>
  <binding name="mbox">
    <uri>mailto:bob@work.example.org</uri>
  </binding>
</result>
```

SPARQL results XML binding

```
<?xml version="1.0"?>
<sparql xmlns="http://www.w3.org/2005/sparql-results#">
  <head>
    <variable name=“name"/>
    <variable name=“mbox"/>
  </head>

  <results>
    <result>
      <binding name=“name"> ... </binding>
      <binding name=“mbox"> ... </binding>
    </result>

    <result>
      <binding name=“name"> ... </binding>
      <binding name=“mbox"> ... </binding>
    </result>
    ...
  </results>
</sparql>
```

SPARQL extensions

(partially) discussed in the SPARQL-2 working group

People and Knowledge Networks

Some examples of SPARQL extensions

http://esw.w3.org/topic/SPARQL/Extensions/

- Aggregate functions
  - COUNT, SUM, MIN, MAX, GROUP_BY, HAVING
- Paths expressions and property chains
  - Extend SPARQL beyond set of individual connected triples, allow variable length
  - PSPARQL SPARQLeR, SPARQ2L
- Imprecise matching
  - Use similarity measures to access triples
  - Similar idea as Soudex in relational database
  - iSPARQL

Summary

- SPARQL
  - Standard query language for RDF
    - **SELECT, CONSTRUCT**, ASK, DESCRIBE
    - Extensive filters, optional and alternative patterns
  - Protocol for queries and results
  - Based on triples model (subject-predicate-object)
    - No logic inference in language, only in underlying knowledge base
  - Named graphs
    - Separate or specialized knowledge
  - Networked graphs
    - Presenting (recursive) views of RDF data
    - Connecting external graphs over the network