

ESWC 2005, Heraklion
Scripting Workshop, 30 May 2005

Semantic Web Toolkits for Scripting Languages

Chris Bizer, Freie Universität Berlin, Germany
Daniel Westphal, Freie Universität Berlin, Germany

Chris Bizer: Semantic Web Toolkits

Agenda

1. Survey of Semantic Web Toolkits
 - Evaluation Criteria
 - Evaluation Method
2. Toolkits for Classic Languages
 - Java, C, .Net
3. Toolkits for Scripting Languages
 - Python, PHP, Perl, JavaScript, Ruby
4. Summary

Chris Bizer: Semantic Web Toolkits

Survey of Semantic Web Toolkits

	Toolkit
Latest Release	
Number of Developers	
Downloads (01/2005)	
Active Mailing-List	
License	
API Paradigm	
Query-Languages	
Model Storage	
Supported Databases	
Supported Serialization Formats	
Reasoning Support	
RDF Server	
Other Features	
Comments	

- There are currently about 50 Semantic Web toolkits around.
- The toolkits are very diverse
 - in their focus (web-based data integration vs. knowledge representation and reasoning).
 - in the amount of work put into them (single developer vs. teams of 10 and more people).
- We surveyed all toolkits that have been mentioned on semtic-web@w3c.org and rdf-interest@w3c.org
 - The strength of the development effort?
 - The activity level of the toolkit's user community?
 - Which features are offered?
- Survey data from
 - toolkit documentation
 - toolkit author's self-evaluation

Chris Bizer: Semantic Web Toolkits

API Paradigms

- **Statement-centric APIs**
 - RDF data is manipulated as a set of RDF triples
 - Usual methods: `model.addStatement()`, `find(S,P,O)`
- **Resource-centric APIs**
 - RDF represented as resources having properties.
 - Usual methods are `resource.addProperty()` or `model.listResources()`
- **Ontology-centric APIs**
 - Offer direct support ontology objects classes (in a class hierarchy), properties (in a property hierarchy) and individuals.
 - Offer methods to list super- and sub-classes or instances of a class.
- **Quad-centric APIs**
 - Put RDF statements in some kind of „context“
 - Expose Quads, Named Graphs or RDF data sets.
 - Usual methods: `graphset.addQuad()` or `Statement.getContext()`

Chris Bizer: Semantic Web Toolkits

Storage and Query Languages

■ Storage

- Keep RDF graphs in memory
- Store graphs using proprietary file format
- Store graphs in relational database
- Store graphs in RDF-specific repository

■ Query Languages

- Simple Resource-oriented Languages
 - fetch(URI), describe(URI), getData(URI)
 - returning some kind of graph or CBD
- Pattern-Matching Languages
 - There are plenty of different languages around
 - Current defacto standard: RDQL
 - Ongoing standardization effort: W3C SPARQL QL

Chris Bizer: Semantic Web Toolkits

Serialization Formats and Reasoning Support

■ Serialization Formats

- XML formats: RDF/XML, GRDDL, XMP, TriX, RPV, RXR, OWL/XML
- Text formats: Turtle, N3, N-Triple, TriG

■ Reasoning Support

- RDF-S
- RDF-S plus owl:sameAs
- OWL Lite
- OWL DL
- F-Logic
- N3
- SWRL

Chris Bizer: Semantic Web Toolkits

RDF Server

- Provide a remote query facility for RDF models.
- Queries are transmitted over HTTP or Web Service calls.
- There are lots of proprietary solutions around.
- Ongoing standardization effort
 - W3C SPARQL Protocol
 - W3C SPARQL Variable Binding Results XML Format

Chris Bizer: Semantic Web Toolkits

Toolkits for Classic Languages

- Semantic Web Toolkits for Java
- Semantic Web Toolkits for C
- Semantic Web Toolkits for .net/Mono

Chris Bizer: Semantic Web Toolkits

Semantic Web Toolkits for Java

	JENA 2.2	Sesame 1.2-RC2	Kowari 1.1.0
Latest Release	01/2005	5/2005	12/2004
Number of Developers	11	12	8
Downloads (01/2005)	→ 24600	6100	1300
Active Mailing-List	+	+	+
License	BSD	LGPL	Mozilla Public License
API Paradigm	Statement-centric Resource-centric Ontology-centric	Statement-centric Resource-centric	Statement-centric Resource-centric Ontology-centric
Query-Languages	RDQL → SPARQL	RDQL RQL SeRQL	iTQL
Model Storage	Memory DB File	Memory DB File	Native RDF Repository
Supported Databases	MySQL PostgreSQL Oracle BerkeleyDB MS SQL Server DB2	MySQL PostgreSQL Oracle MS SQL	→ XA Triplestore
Supported Serialization Formats	RDF/XML N-Triples N3 Turtle	RDF/XML N-Triples N3 Turtle	RDF/XML N-Triples
Reasoning Support	RDFS OWL-Lite DIG 1.1 Interface	RDFS OWL-Lite	RDFS OWL-Lite
RDF Server	NetAPI	+	+
Other Features			→ Web-based Query UI JENA Connectivity
Comments	Josaki RDF Server is a separate download. External contributions page.	Various extensions available	Uses SOFA

- Java is the most popular language for implementing SemWeb applications.
- There are 11 different toolkits for Java.
- The toolkits are mature and feature rich.
- Jena
 - best known toolkit,
 - backed by huge HP-funded development effort.

Chris Bizer: Semantic Web Toolkits

Semantic Web Toolkits for Java

	YARS	KAON 2.0	NG4J 0.4
Latest Release	1/2005	05/2005	2/2005
Number of Developers	2	?	3
Downloads (01/2005)	?	?	?
Active Mailing-List	-	-	-
License	BSD	Commercial, free for academic purposes	BSD
API Paradigm	Model-centric	Ontology-centric	NamedGraph-centric Triple-centric Quad-centric Statement-centric
Query-Languages	N3QL	-	→ TriQL
Model Storage	→ Native RDF Repository	Memory	Memory DB
Supported Databases	-	-	MySQL
Supported Serialization Formats	RDF/XML N-TRIPLE N3	RDF/XML OWL/XML Syntax	RDF/XML N-Triples, N3 → TriX TriG
Reasoning Support	-	→ OWL-Lite, partial OWL-DL, SWRL	RDFS OWL-Lite
RDF Server	+	+	-
Other Features			Provenance-enabled Jena statements, Digital signatures using SWP
Comments		Reasoning based on disjunctive datalog	Based on Jena

- New technologies are usually picked up first by the Java toolkits.
- SPARQL QL
- Fast native RDF repositories
- Named Graphs and RDF Data Set
- Semantic Web Rules Language

Chris Bizer: Semantic Web Toolkits

Semantic Web Toolkits for C

	Redland 1.0.0	3Store 2.2.18	RDFStore 0.50
Latest Release	02/2005	11/2004	08/2004
Number of Developers	1	5	3
Downloads (01/2005)	?	420	?
Active Mailing-List	+	+	-
License	GPL, LGPL, Apache	GPL	BSD
API Paradigm	Statement-centric	Model-centric	Model-centric
Query-Languages	RDQL SPARQL ←	RDQL OKBC	RDQL SPARQL ←
Model Storage	Memory DB File	DB	Memory DB File Remote
Supported Databases	Berkeley DB MySQL SQLite	MySQL	Berkeley DB
Supported Serialization Formats	RDF/XML N-Triples Turtle RSS	?	RDF/XML N-Triples XML (using SPARQL DAWG/XML format)
Reasoning Support	-	-	RDFS owl:sameAs
RDF Server	-	+	+
Other Features	Language bindings for C#, Java, Obj-C, Perl, PHP, Python, Ruby and Tcl ←		Language bindings for Perl →
Comments			Native DB support for xsd:date, xsd:dateTime, xsd:integer, xsd:double

- The toolkits claim to be fast.
- Redland and RDFStore offer language bindings for scripting languages.

Chris Bizer: Semantic Web Toolkits

Semantic Web Toolkits for .Net/Mono

	Drive 3.3	EulerSharp 1.1.33	SemPlan.RdfLib 0.21 / Carp 2.0
Latest Release	10/2003	02/2005	01/2005
Number of Developers	1	4	2
Downloads (01/2005)	?	1037	500
Active Mailing-List	+	-	-
License	LGPL	W3C License	MIT License
API Paradigm	Statement-centric	Model-centric	Resource-centric Ontology-centric
Query-Languages	-	N3QL	-
Model Storage	Memory	Memory	Memory DB
Supported Databases	-	-	MySQL
Supported Serialization Formats	RDF/XML N3	N3	RDF/XML N-Triples
Reasoning Support	-	RDFS OWL	RDFS
RDF Server	-	-	-
Other Features	RDF toolbar for Internet Explorer		Built-in support for FOAF, RSS and RdfCal
Comments	Written in C#	Written in C#	Written in C#

- Microsoft officially doesn't support the Semantic Web, but develops WinFS as part of Longhorn.
- The existing toolkits are not too mature compared to Java or C.
- Drive is outdated.
- Ongoing development effort around SemPlan.RdfLib.
- EulerSharp focused on logic proofs.

Chris Bizer: Semantic Web Toolkits

Toolkits for Scripting Languages

- Semantic Web Toolkits for Python
- Semantic Web Toolkits for PHP
- Semantic Web Toolkits for PERL
- Semantic Web Toolkits for JavaScript
- Semantic Web Toolkits for Ruby

Chris Bizer: Semantic Web Toolkits

Semantic Web Toolkits for Python

	Cwm	Pychinko 0.1	Pyrple
Latest Release	01/2005	01/2005	06/2004
Number of Developers	7	3	1
Downloads (01/2005)	?	?	?
Active Mailing-List	+	-	-
License	W3C Software License	Custom Open Source	?
API-Paradigm	Model-centric	Model-centric Statement-centric	Statement-centric
Query-Languages	N3 ←	N3	N3
Model Storage	Memory ←	Memory	Memory
Supported Databases	-	-	-
Supported Serialization Formats	RDF/XML N3 N-Triples	N3	RDF/XML N3 N-Triples
Reasoning Support	Generic FOPL forward reasoner	N3 RDFS OWL XSD ←	-
RDF Server	-	-	-
Other Features		Rete-based Rule engine	
Comments		Uses RDFLib+CWM	

- Two groups of toolkits
 - data integration-centric
 - rules- and inference-centric toolkits around N3 and cwm
- Cwm (Tim Berners-Lee)
- Pyrple (Sean B. Palmer)
- Pychinko (Bijan Parsia)

Chris Bizer: Semantic Web Toolkits

Semantic Web Toolkits for Python

	RDFLib 2.1.1	Sparta 0.6	4Suite 1.0a4
Latest Release	05/2005	2004	11/2004
Number of Developers	1	1	5
Downloads (01/2005)	?	?	?
Active Mailing-List	-	-	-
License	Custom Open Source	Custom Open Source	Apache Software License
API-Paradigm	Statement-centric	Resource-centric	Statement-centric
Query-Languages	-	-	Versa
Model Storage	Memory DB	RdfLib TripleStore	Memory DB File
Supported Databases	Berkeley DB	-	PostgreSQL
Supported Serialization Formats	RDF/XML N-Triples N3	RDF/XML N-Triples	RDF/XML N-Triples
Reasoning Support	-	-	-
RDF Server	↓	-	+
Other Features	TripleStore with support for contexts	Wrapper for RDFLib	
Comments			

- Data-integration-centric toolkits.
- RDFLib used by the FOAF community.
- 4Suite also supports a wide range of XML technologies.

Chris Bizer: Semantic Web Toolkits

Semantic Web Toolkits for PHP

	RAP 0.9.1	appmosphere RDF classes	PEAR:RDF 0.1.0
Latest Release	12/2004	4/2005	09/2004
Number of Developers	5	1	2
Downloads (01/2005)	2200	?	400
Active Mailing-List	+	-	-
License	LGPL	W3C license	LGPL
API-Paradigm	Statement-centric Resource-centric Ontology-centric	Statement-centric	Statement-centric
Query-Languages	RDQL	-	RDQL
Model Storage	Memory DB	Memory	Memory DB
Supported Databases	ADOdb compliant Databases (30+)	-	PEAR:MDB compliant RDBMS
Supported Serialization Formats	RDF/XML N-Triples N3 GRDDL	RDF/XML parser N3 serializer	RDF/XML N-Triples N3
Reasoning Support	RDFS some OWL Rules	-	-
RDF Server	+	-	-
Other Features	GUI for managing database-backed RDF models		
Comments			Based on RAP 0.8.1

- RAP
 - feature rich toolkit
- Appmoshere
 - less features than RAP
 - but faster (see SFSW paper)
- PEAR:RDF
 - RAP 0.8.1 port to PEAR
- Ongoing joined effort to implement SPARQL

Chris Bizer: Semantic Web Toolkits

Semantic Web Toolkits for PERL

	PerIRDF 0.31	CARA pre0.001
Latest Release	03/2002 ←	03/2001 ←
Number of Developers	?	2
Downloads (01/2005)	?	162
Active Mailing-List	+	-
License	GPL, Mozilla	GPL
API-Paradigm	Statement-centric Resource-centric Ontology-centric	Resource-centric
Query-Languages	Resource-centric query language	-
Model Storage	Memory DB File	Memory
Supported Databases	PostgreSQL	-
Supported Serialization Formats	RDF/XML N3	RDF/XML N-Triples
Reasoning Support	-	-
RDF Server	-	-
Other Features		
Comments		

- Pure PERL toolkits are outdated.
- But C toolkits offer language bindings for PERL
 - RDFStore
 - Redland

Chris Bizer: Semantic Web Toolkits

Semantic Web Toolkits for JavaScript

	EulerMoz	Jibbering rdf-parser 0.14
Latest Release	01/2005	03/2002 ←
Number of Developers	7	1
Downloads (01/2005)	?	?
Active Mailing-List	+	-
License	Mozilla, W3C License	Custom Open Source
API-Paradigm	Model-centric	Statement-centric
Query-Languages	-	-
Model Storage	Memory	Memory
Supported Databases	-	-
Supported Serialization Formats	N3 ←	RDF/XML
Reasoning Support	RDFS OWL	-
RDF Server	-	-
Other Features		
Comments		Expected to work in Adobe SVG Viewer, Batik's Squiggle, Internet Explorer 5.5+ and Mozilla

- Jibbering is outdated.
- EulerMoz is N3 reasoning- and proof-oriented.
- RDF and Javascript are heavily used within Mozilla.
- Up-to-date, small, browser-independent RDF toolkit is missing!

Chris Bizer: Semantic Web Toolkits

Semantic Web Toolkits for Ruby

	Rena 0.0.4	Samizdat 0.5.4	RubyRDF
Latest Release	07/2004	10/2004	04/2003 ←
Number of Developers	1	2	1
Downloads (01/2005)	?	?	?
Active Mailing-List	-	-	-
License	Ruby	GPL	W3C
API-Paradigm	Statement-centric Resource-centric	Resource-centric	Model-centric
Query-Languages	Some RDQL	Squish	Squish
Model Storage	Memory	DB	DB
Supported Databases	-	PostgreSQL	PostgreSQL MySQL
Supported Serialization Formats	RDF/XML N-Triples	-	RDF/XML N-Triples
Reasoning Support	-	-	-
RDF Server	-	-	-
Other Features			
Comments			No longer under active development

- Toolkits are not too mature.
- RubyRDF by Dan Brickley is retired.
- No sights of ongoing development around Rena.
- Samizdat looks a bit more active.

Chris Bizer: Semantic Web Toolkits

Summary

- Mature Semantic Web support in Python, PHP
- PERL is supported through C toolkits
- No up-to-date toolkits for Ruby, JavaScript
- No toolkits at all for ColdFusion and Flash-ActiveScript
- Different focuses of the toolkits
 - Web Data Integration: PHP, PERL, Ruby
 - Logic: Python
- Current trends for Semantic Web toolkit authors
 - Implement the DAWG SAPRQL query language and protocol
 - Move up the OWL reasoning stack
 - Have an eye on the starting W3C work on rules

Chris Bizer: Semantic Web Toolkits

Thanks :-)

- Slides online

- <http://www.wiwiss.fu-berlin.de/suhl/bizer/pub/bizer-sfsw-toolkits.ppt>

- Developers Guide to Semantic Web Toolkits for different Programming Languages

- <http://www.wiwiss.fu-berlin.de/suhl/bizer/toolkits/>