Currency Conversion the Linked Data Way

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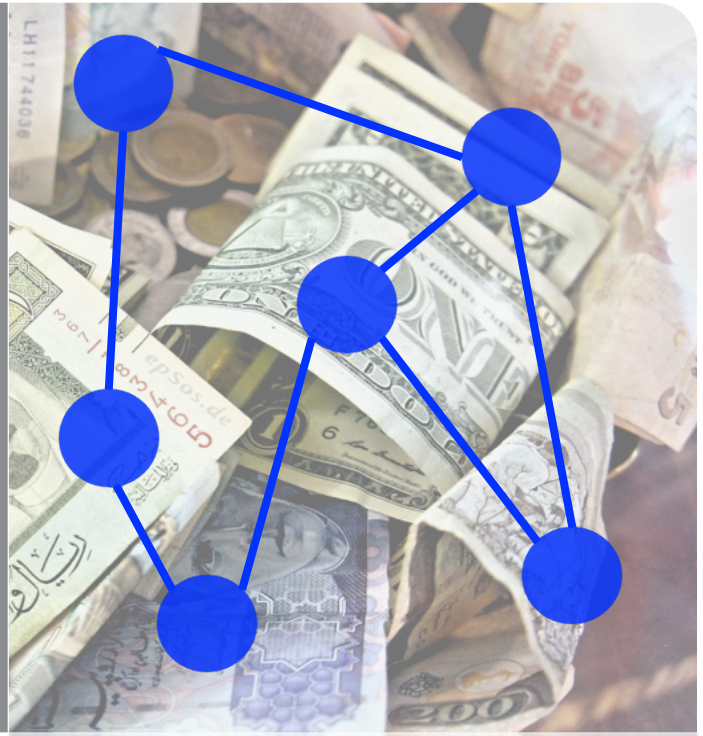

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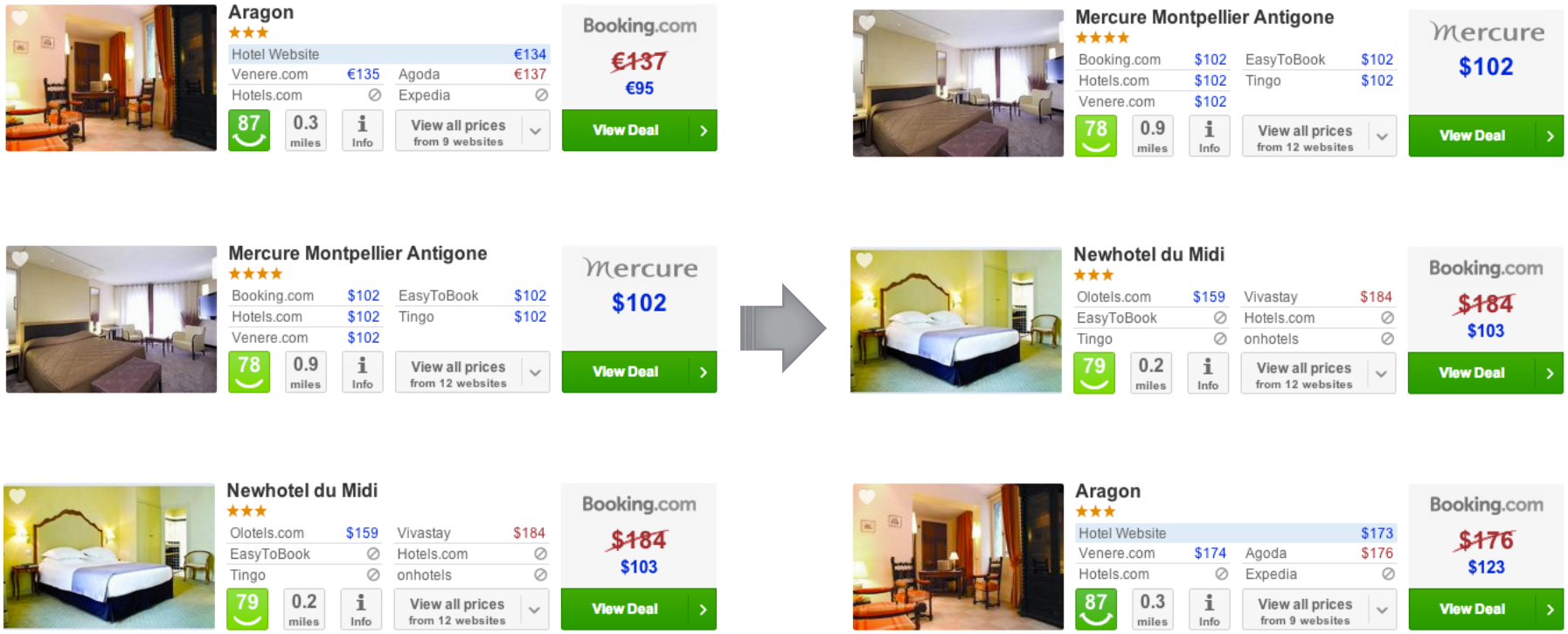
Motivation

Converting price values from one currency to another is a much-needed functionality in business applications that could be built on Linked Data

- Shopping comparison websites and product search engines
- B2B across different countries and between different business parties
- Portals for events, tickets, or services
- etc.

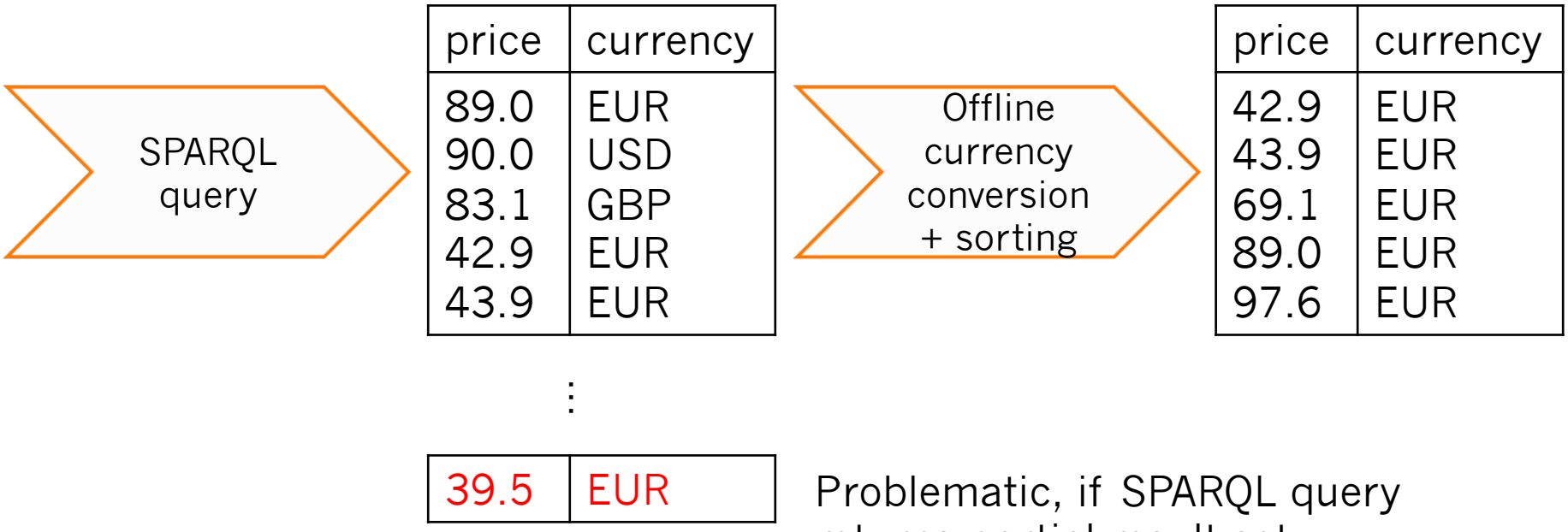
Motivation

Hotel comparison website at Web scale needs to compile a list of the *n* (*three*) cheapest hotel room offers relative to the currency ($) preferred by the user



Problem

- Prices are indicated in different currencies ($, €, ...)
- SPARQL processors provide no *standard* means to integrate currency conversion APIs into operations over RDF data
- Typical workflow:

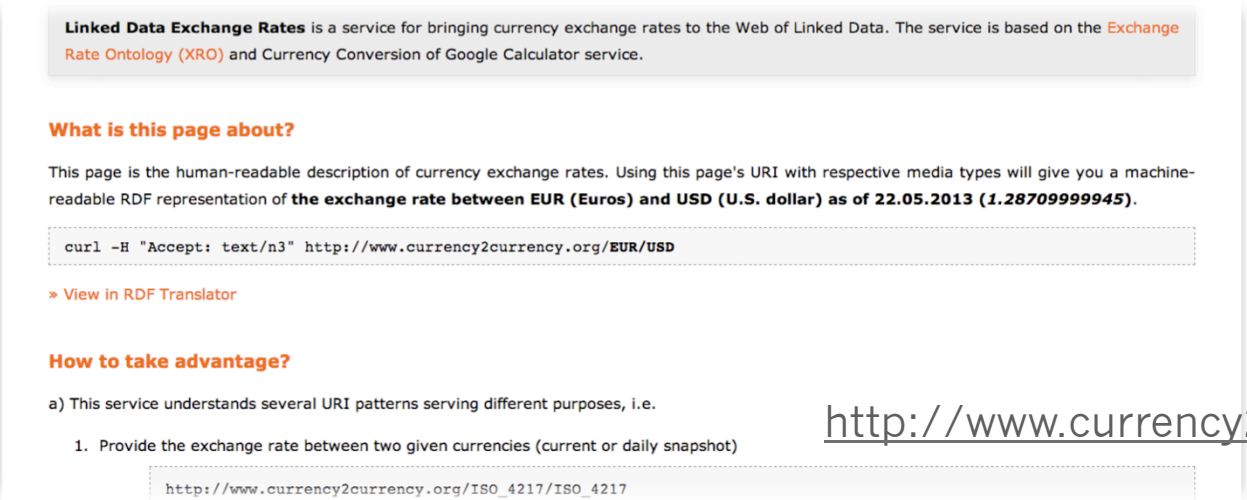


Problematic, if SPARQL query returns partial result set (5 results out of 100)

Exchange Rates for Linked Data

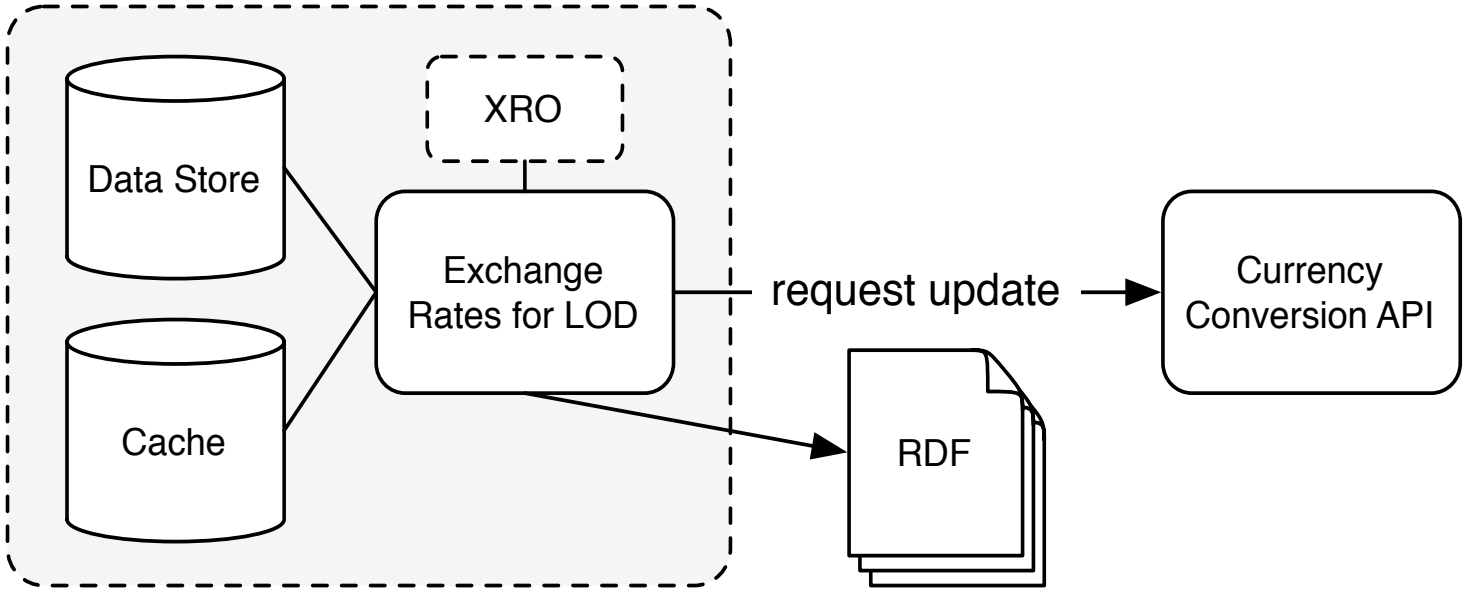
RESTful Web service for the delivery of currency exchange rates in RDF, that

- adheres to the Linked Open Data (LOD) design principles
- removes the need for proprietary code
- can be accessed from client-side JavaScript
- works with any standard SPARQL processor able to retrieve RDF by dereferencing a resource URI



http://www.currency2currency.org/

Conceptual Overview



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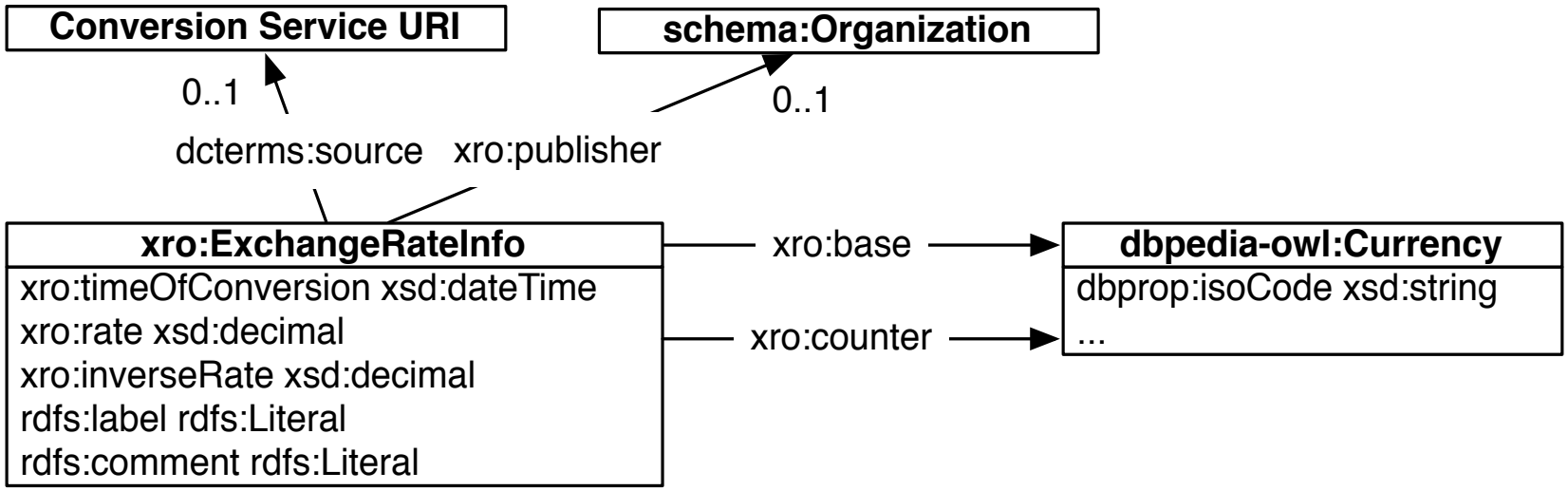
Exchange Rate Ontology (XRO)



http://purl.org/xro/

Currency Exchange Rate (EUR→USD) in N3

```
@prefix dbpedia: <http://dbpedia.org/resource/> .
@prefix dcterms: <http://purl.org/dc/terms/> .
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
@prefix xch_EUR: <http://www.currency2currency.org/EUR#> .
@prefix xro: <http://purl.org/xro/ns#> .
@prefix xsd: <http://www.w3.org/2001/XMLSchema#> .

xch_EUR:USD a xro:ExchangeRateInfo;
 rdfs:label "Euros to U.S. dollar"@en;
 rdfs:comment "1 EUR = ? USD"@en;
 xro:base dbpedia:Euro;
 xro:counter dbpedia:United_States_dollar;
 xro:rate "1.31010"^^xsd:decimal;
 xro:inverseRate "0.7633010"^^xsd:decimal;
 dcterms:source <http://www.google.com/ig/calculator?hl=en&q=1EUR=?USD>;
 xro:timeOfConversion "2013-04-11T00:00:02Z"^^xsd:dateTime .
```

base and *counter* currency instances from DBPedia are obtained using *dbprop:isoCode*

Calculating Exchange Rates

Google Calculator service:

- http://www.google.com/ig/calculator?hl=en&q=1USD=?EUR
- http://www.google.com/ig/calculator?hl=en&q=1USD=?GBP
- ...

For *n* currencies, only *n* requests are necessary in order to compute all possible exchange rate combinations

- USD→EUR is inverse of EUR→USD
- EUR→GBP is EUR→USD→GBP (transitive)

$$rate_{A2B} = \frac{rate_{A2BASE}}{rate_{B2BASE}}$$

URI Patterns

base and *counter* currencies represented by 3-letter currency codes according to the ISO 4217 standard, e.g. EUR, USD, ...

- Cool URIs
  - http://www.currency2currency.org/<base>/<counter>
  - http://www.currency2currency.org/<base>
  - http://www.currency2currency.org/
- Timestamps (archiving functionality):
  - <uri>/YYYYMMDD
  - E.g. http://www.currency2currency.org/USD/EUR/20130526
- Entity URIs for exchange rates:
  - E.g. http://www.currency2currency.org/USD#EUR

Content Negotiation

$ curl –H “Accept: text/n3;q=1.0” http://www.currency2currency.org/CHF

```
HTTP/1.1 200 OK
Content-Location: http://www.currency2currency.org/CHF
Access-Control-Allow-Origin: *
Vary: Accept
Cache-Control: max-age=3600, must-revalidate
Content-Type: text/n3
Content-Length: 31602
Date: Thu, 11 Apr 2013 10:31:55 GMT
```

Allow for client-side (JavaScript) cross-origin requests using CORS-header:

```
Access-Control-Allow-Origin: *
```

Content Negotiation

Serialization format	**Media types accepted** ***Accept:***	**Content type delivered** ***Content-Type:***
HTML	*not available* text/html application/xhtml+xml	text/html
RDF/XML	application/rdf+xml application/xml	application/rdf+xml
N3	text/n3 text/rdf+n3 application/n3	text/n3
Turtle	text/turtle application/x-turtle	text/turtle
RDF/JSON	application/json text/rdf+json text/javascript	application/json
N-Triples	text/plain	text/plain

Caching

- http://www.currency2currency.org → File store
- http://www.currency2currency.org/EUR → Memcache
- http://www.currency2currency.org/EUR/USD → Client cache

	Data store	**Client cache**	**Memcache**	**File store**[7]
Type	NoSQL (schemaless) object data store	Local cache of client application	Distributed memory object caching system	Data object store for large files
Expiry	Never	After 1 hour	After 6 hours	Never
Update frequency	Daily	Cache lifetime expired	Cache limits or lifetime reached	Daily
Memory limits	Limited to storage capacity of used data type	Unlimited, application-dependent	1 Megabyte	Limited to data transfer limit
Intended usage	Daily updated list of exchange rates	Downloaded page contents	Small-sized, partial RDF serializations	Complete RDF dumps

Adherence to Linked Data Guidelines

1. Every exchange rate entity obtains a named URI
2. Exchange rates can be looked up easily because relying on HTTP URIs
3. When someone looks up a URI of an exchange rate, useful information is displayed to humans and machines alike (content negotiation)
4. Links to other datasets, e.g. to currency instances of DBPedia, allow for discovering additional things

Example of a Currency Conversion in SPARQL

Simplifying assumptions:

- DBPedia currency instances are preloaded on the SPARQL endpoint
- Web shop data and exchange rates related to *U.S. dollar* are available

```
PREFIX gr: <http://purl.org/goodrelations/v1#>
PREFIX xro: <http://purl.org/xro/ns#>
PREFIX dbpedia: <http://dbpedia.org/resource/>
PREFIX dbpprop: <http://dbpedia.org/property/>

SELECT DISTINCT ?price ?code (?price/?rate AS ?base_price) ?base_code
WHERE {
  ?s a gr:Offering; gr:hasPriceSpecification ?pspec .
  ?pspec gr:hasCurrency ?code; gr:hasCurrencyValue ?price .
  ?xrate xro:rate ?rate;
    xro:base ?base_currency; xro:counter ?counter_currency .
  ?base_currency dbpprop:isoCode ?base_code .
  ?counter_currency dbpprop:isoCode ?counter_code .
  FILTER(str(?counter_code) = str(?code))
}
ORDER BY ?base_price LIMIT 5
```

Tabular Results of SPARQL Query

price	code	base_price	base_code
0.0	USD	0.0	USD
1.29	RON	0.38123885	USD
1.93	RON	0.5703806	USD
2.58	RON	0.7624777	USD
3.13	RON	0.92502147	USD

$$price_{BASE} = \frac{price_A}{rate_{A2BASE}} = \frac{1.29}{3.382^*} = 0.381$$

* Currency conversion based on USD exchange rates as of 10.04.2013: http://www.currency2currency.org/USD/20130410

Comparison with Related Work

Existing approaches for currency conversion on the Semantic Web:

- No RDF-based Web services
- Approaches with data models for expressing currencies
  - QUDT (for SPIN functions)
  - Dataset for exchange rates in the European LOD2 project (exposed as a SPARQL endpoint)
- Ontology for Units of Measure and Related Concepts (no currencies)

Our approach:

- Fully-fledged framework for currency conversions
  - Schema for exchange rates
  - Web service for RDF
  - JavaScript-friendly
  - Linked-Data-compliant
- Currency exchange rates in RDF, so SPARQL queries can take advantage

Future Extensions

- Conceptual improvements:
  - Extend Exchange Rate Ontology model by additional, domain-related properties and concepts (place of trade, type of transaction, type of market, etc.)

- Technical improvements:
  - Set up a RDF store with SPARQL 1.1 Query Federation capability to serve most up-to-date currency exchange rates
  - Make our service operable with different Web services (with respective provenance information to enhance trust aspect of service)

Conclusion

We proposed a RESTful Web service for currency exchange rates in RDF

- based on open Web APIs for currency conversion
- ensuring interoperability across diverse data sources on the Web of Data
- usable with SPARQL queries and standard SPARQL processors

Our service can serve as a generic pattern for integrating other open and dynamic Web APIs and making them available in the LOD cloud, such as unit conversion, product review data, weather information, etc.

Thank You!

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Project page:
http://www.currency2currency.org/

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Bundesministerium
für Bildung
und Forschung

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