Web-Scale Querying through Linked Data Fragments

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What good is a **Web of Linked Data** if we cannot **reliably query it?**

MORE THAN HALF

of public SPARQL endpoints

<95%

AVAILABILITY

Buil-Aranda – Hogan – Umbrich – Vandenbussche
SPARQL Web-Querying Infrastructure: Ready for Action?

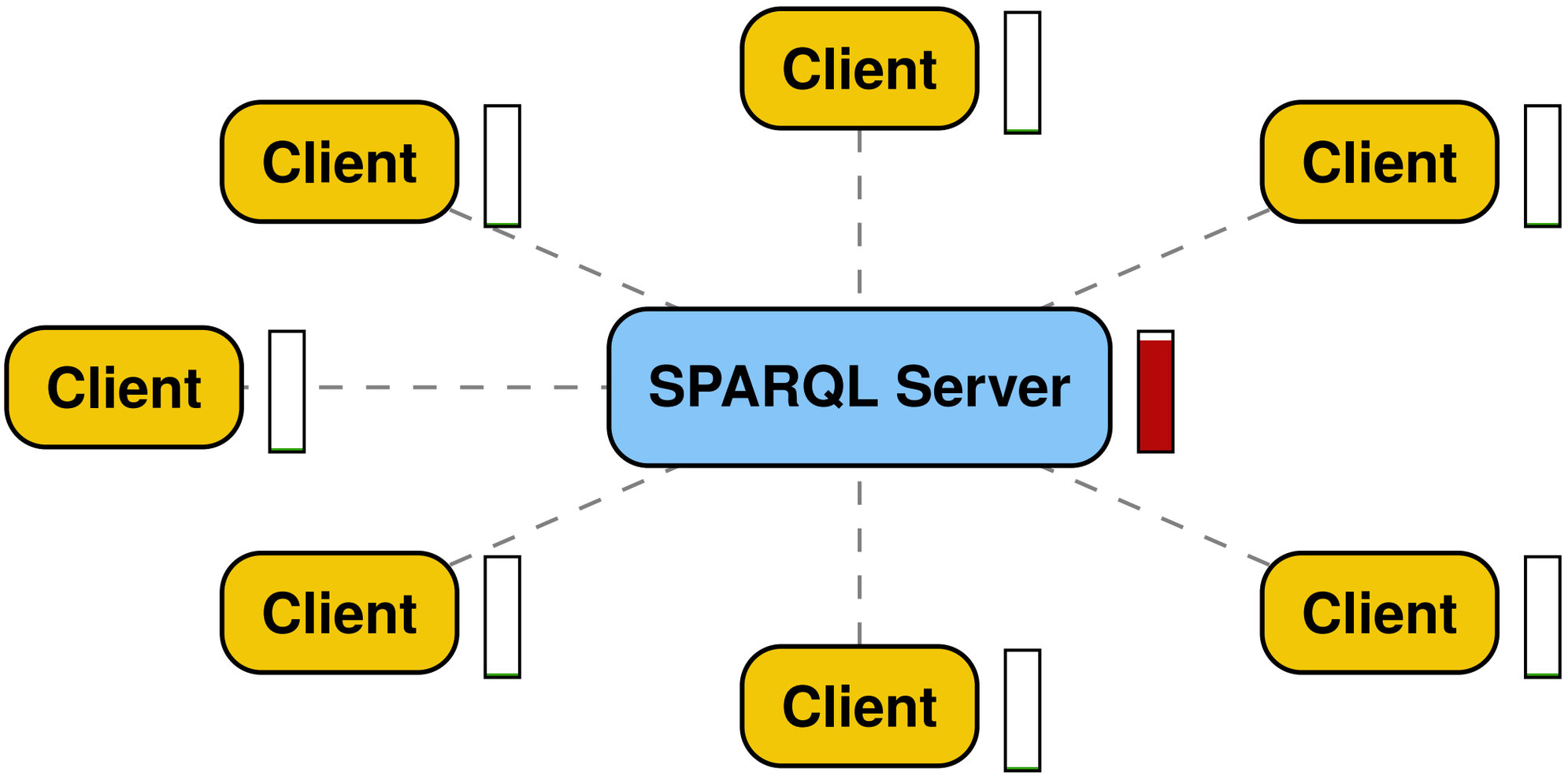
WE CANNOT QUERY

public Linked Data reliably.

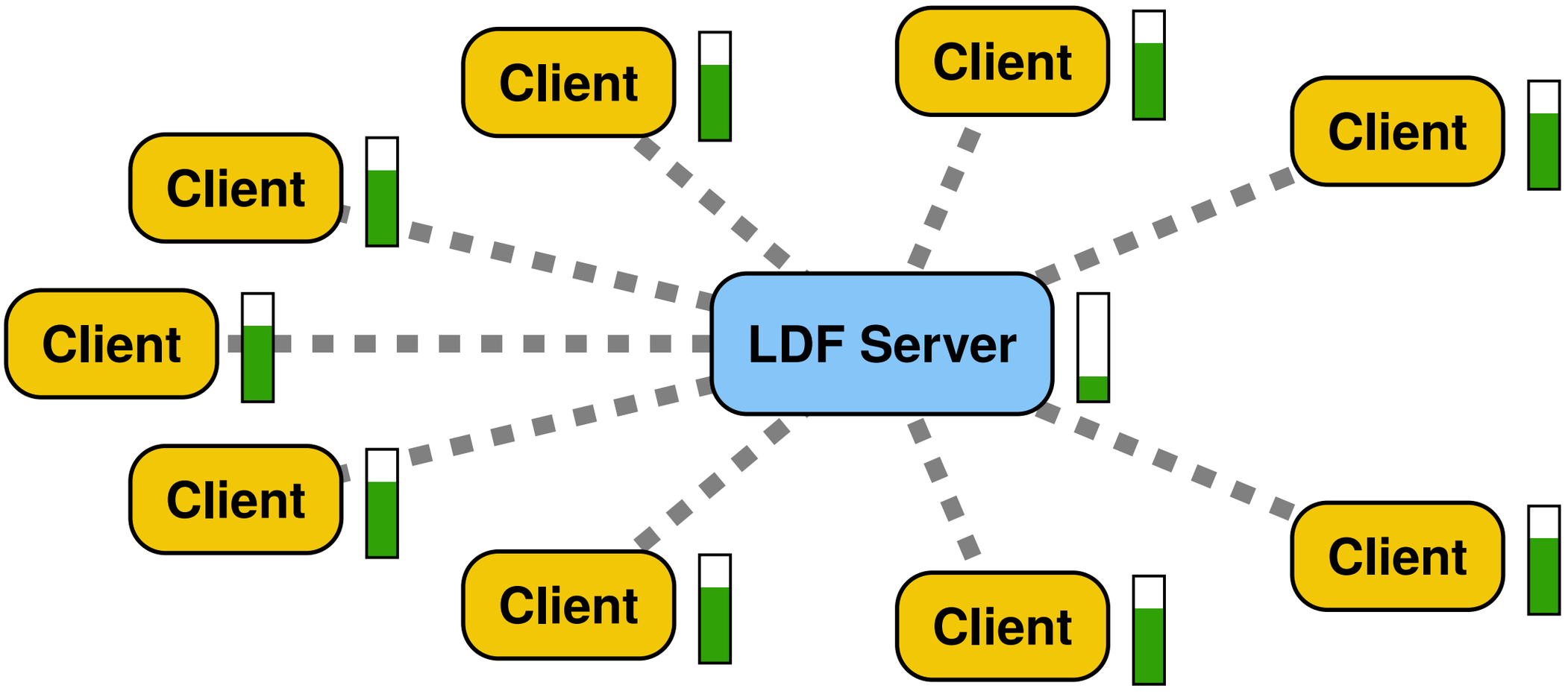
WE CANNOT BUILD

applications on top of public queryable data.

It's *not* a performance issue, it is an architectural problem.



An architectural problem requires an architectural solution.



We developed an approach
to **query Linked Data**
in a **scalable and reliable** way
by **moving intelligence**
from the server **to the client.**

#LD Web-Scale Querying through Linked Data Fragments

What Linked Data Fragments are.

How clients can execute queries.

Taking querying to the next level.

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What Linked Data Fragments are.

How clients can execute queries.

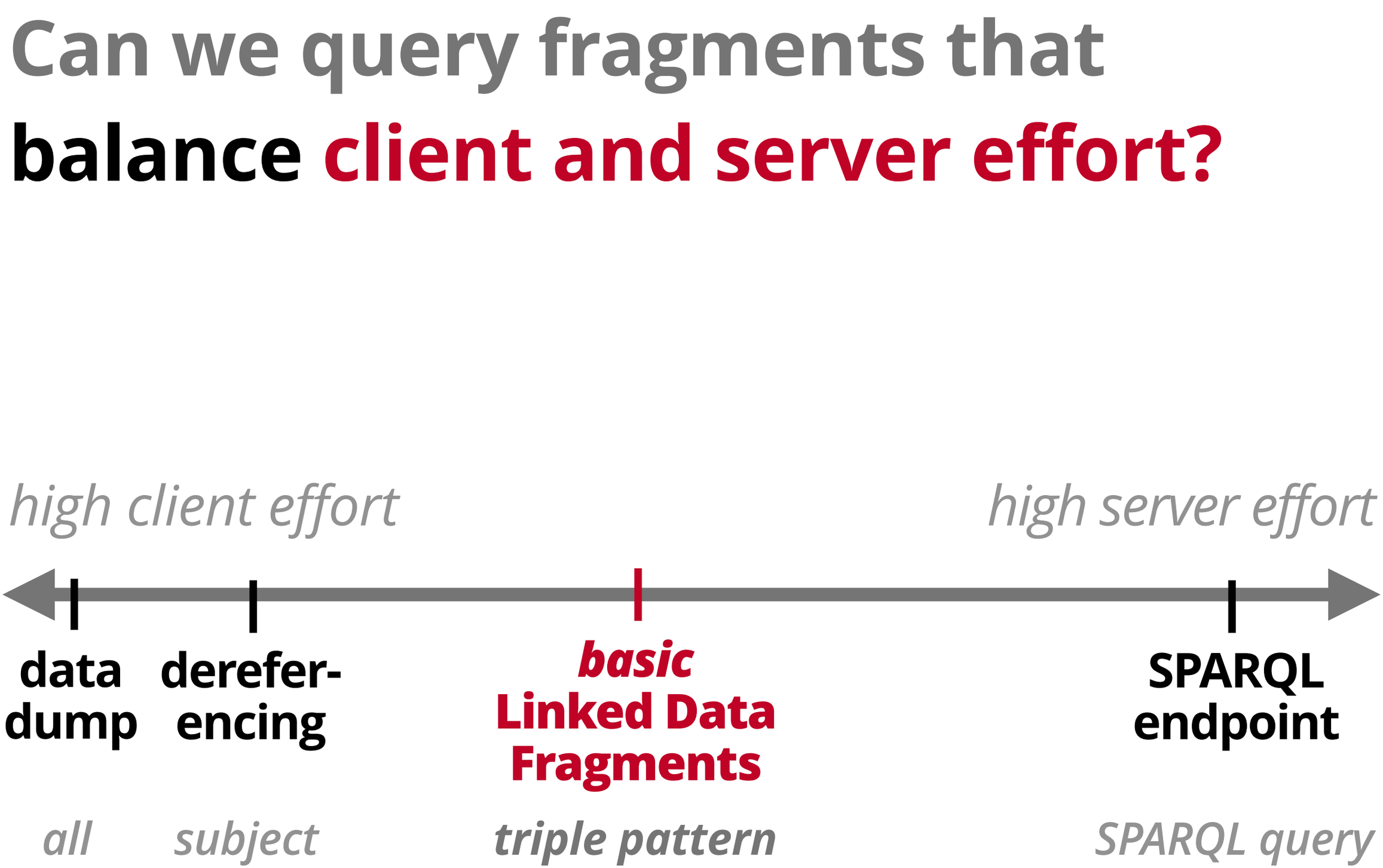
Taking querying to the next level.

Currently, there are three ways to query a Linked Data set.

They offer fragments of a dataset.

Any fragment of a Linked Data set is called a Linked Data Fragment.

Can we query fragments that balance client and server effort?



A *basic* LDF is **easy to generate** yet **enables efficient querying.**

data *(in pages)*

basic triple pattern { ?s ?p ?o. }

metadata

count of total matches

controls

retrieve other basic LDFs

Linked Data Fragments Ser

data.linkeddatafragments.org/dbpedia?subject=&predicate=…

Linked Data Fragments Server

#LD
Linked Data Fragments

Data source *dbpedia*

Query *dbpedia-virtuoso* by triple pattern

controls *(other basic LDFs)*

subject:

predicate: `rdf:type`

object: `dbpedia-owl:Artist`

Find matching triples

Total matches: ±61,073

metadata *(total count)*

```
Aamir_Zaki   type   Artist.
Ahmad_Morid   type   Artist.
Al_Milgrom   type   Artist.
Alejandro_Sanz   type   Artist.
Alexander_Hacke   type   Artist.
Alina_Orlova   type   Artist.
Alla_Pugacheva   type   Artist.
```

data *(first 100)*

How can a server **publish** basic Linked Data Fragments?

open-source server

choose your back-end

(private) SPARQL endpoint
HDT binary triple format
Turtle file
…

#LD Web-Scale Querying through Linked Data Fragments

What Linked Data Fragments are.

How **clients** can execute **queries.**

Taking querying to the next level.

How to answer this query using *only* basic Linked Data Fragments?

```
SELECT  ?person  ?city  WHERE {
   ?person  a  dbpedia-owl:Artist.
   ?person  dbpedia-owl:birthPlace  ?city.
   ?city  foaf:name  "York"@en.
}
```

Get the corresponding fragments

?person a dbpedia-owl:Artist.

dbpedia:Aamir_Zaki a dbpedia-owl:Artist.

dbpedia:Ahmad_Morid a dbpedia-owl:Artist.

…

?person dbpedia-owl:birthPlace ?city.

dbpedia:Ganesh_Ghosh …:birthPlace dbpedia:Bengal_Presidency.

dbpedia:Jacques_L'enfant …:birthPlace dbpedia:Beauce.

…

?city foaf:name "York"@en.

dbpedia:York foaf:name "York"@en.

dbpedia:York,_Ontario foaf:name "York"@en.

…

Get the corresponding fragments and read the **count** metadata.

?person a dbpedia-owl:Artist. **±61,000**

dbpedia:Aamir_Zaki a dbpedia-owl:Artist.

dbpedia:Ahmad_Morid a dbpedia-owl:Artist.

...

?person dbpedia-owl:birthPlace ?city. **±470,000**

dbpedia:Ganesh_Ghosh ...:birthPlace dbpedia:Bengal_Presidency.

dbpedia:Jacques_L'enfant ...:birthPlace dbpedia:Beauce.

...

?city foaf:name "York"@en. **12**

dbpedia:York foaf:name "York"@en.

dbpedia:York,_Ontario foaf:name "York"@en.

...

Start with the **smallest fragment.**

Start with the **first match.**

?person a dbpedia-owl:Artist **±61,**

dbpedia:Aamir_Zaki

dbpedia:Ahmad_Morid a dbpedia-owl:Artist.

…

?person dbpedia-owl:birthPlace **±470,**

dbpedia:Ganesh_Ghosh …:birthPlace dbpedia:Bengal_Presidency.

dbpedia:Jacques_L'enfant …:birthPlace dbpedia:Beauce.

…

?city foaf:name "York"@en. **12**

dbpedia:York foaf:name "York"@en.

dbpedia:York,_Ontario foaf:name "York"@en.

…

How to **answer this query** using *only* basic Linked Data Fragments?

```
SELECT   ?person  WHERE {
   ?person   a   dbpedia-owl:Artist.
   ?person   dbpedia-owl:birthPlace   dbpedia:York.
   dbpedia:York   foaf:name   "York"@en.
}
```

Get the corresponding fragments

?person a dbpedia-owl:Artist.

dbpedia:Aamir_Zaki a dbpedia-owl:Artist.

dbpedia:Ahmad_Morid a dbpedia-owl:Artist.

…

?person dbpo:birthPlace dbpedia:York.

dbpedia:John_Flaxman dbpo:birthPlace dbpedia:York.

dbpedia:Joseph_Hansom dbpo:birthPlace dbpedia:York.

…

Get the corresponding fragments and read the **count** metadata.

?person a dbpedia-owl:Artist. **±61,000**

dbpedia:Aamir_Zaki a dbpedia-owl:Artist.

dbpedia:Ahmad_Morid a dbpedia-owl:Artist.

...

?person dbpo:birthPlace dbpedia:York. **75**

dbpedia:John_Flaxman dbpo:birthPlace dbpedia:York.

dbpedia:Joseph_Hansom dbpo:birthPlace dbpedia:York.

...

Start with the smallest fragment.

Start with the first match.

?person a dbpedia-owl:Artist **±61,**

dbpedia:Aamir_Zaki

dbpedia:Ahmad_Morid a dbpedia-owl:Artist.

…

?person dbpo:birthPlace dbpedia:York. **75**

dbpedia:John_Flaxman dbpo:birthPlace dbpedia:York.

dbpedia:Joseph_Hansom dbpo:birthPlace dbpedia:York.

…

How to **answer this query** using *only* basic Linked Data Fragments?

```
ASK {
  dbp:John_Flaxman  a  dbpo:Artist.
  dbp:John_Flaxman  dbpo:birthPlace  dbp:York.
  dbp:York  foaf:name  "York"@en.
}
```

Get the corresponding fragment and read the **count** metadata.

dbpedia:John_Flaxman a dbpedia-owl:Artist. **1**

dbpedia:John_Flaxman a dbpedia-owl:Artist.

Output the match:

?person = *dbpedia:John_Flaxman*

?city = *dbpedia:York*

Recursively repeat the process for all bindings.

?person dbpo:birthPlace dbpedia:York.

dbpedia:John_Flaxman dbpo:birthPlace dbpedia:York.

dbpedia:Joseph_Hansom dbpo:birthPlace dbpedia:York.

…

?city foaf:name "York"@en.

dbpedia:York foaf:name "York"@en.

dbpedia:York,_Ontario foaf:name "York"@en.

…

Chrome File Edit View History Bookmarks Window Help Mon 7 Apr 20:37

Linked Data Fragments cli

client.linkeddatafragments.org

Linked Data Fragments client

Enter a basic graph pattern query below and see how your browser solves it using only Basic Linked Data Fragments.

#LD
Linked Data Fragments

Enter a SPARQL query **...or choose an example** Artists from all places named "York"

```
SELECT ?p, ?c WHERE {
  ?p a <http://dbpedia.org/ontology/Artist>.
  ?p <http://dbpedia.org/ontology/birthPlace> ?c.
  ?c <http://xmlns.com/foaf/0.1/name> "Seoul"@en.
}
```

Answer using Web data **data source** DBpedia Basic Linked Data Fragments

Query results

#LD Web-Scale Querying through Linked Data Fragments

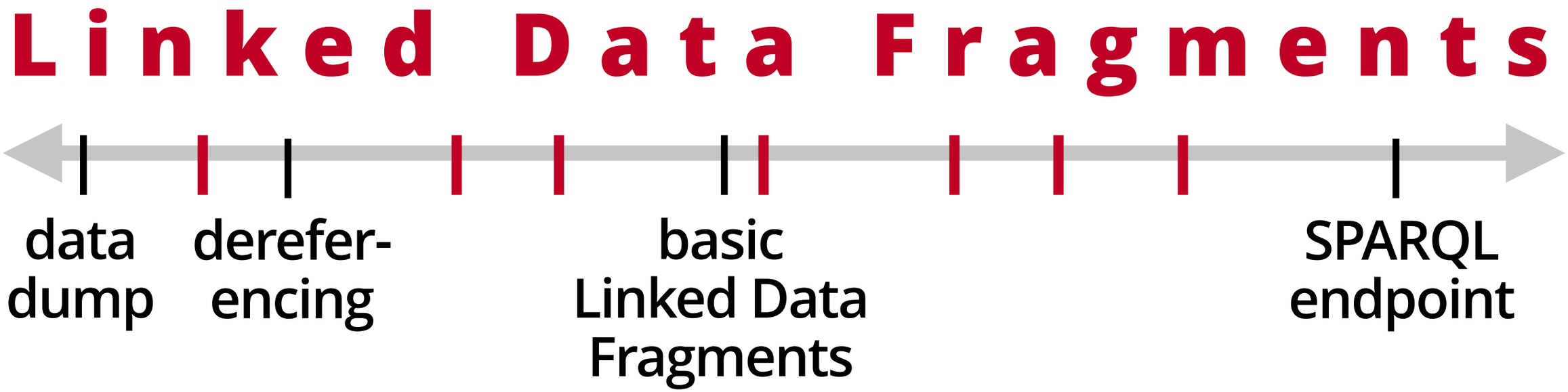
What Linked Data Fragments are.

How clients can execute queries.

Taking **querying** to the **next level.**

Linked Data Fragments **is a vision,**
not just a single technology.

How can clients query the Web
in a scalable way?



We want to **query different servers,**
with many **different kinds of fragments.**

Linked Data Fragments

Find **suitcases on Amazon** and their cost.

```
SELECT   ?label   ?cost   WHERE {
    ?suitcase schema:keywords "suitcase";
              prov:wasDerivedFrom <http://amazon.com/>;
              rdfs:label ?label;
              schema:cost ?cost.
}
```

Find suitcases on **Amazon** and see **how much they cost on eBay**.

```
SELECT   ?label   ?costA   ?costE   WHERE {
   ?suitcaseA schema:keywords "suitcase";
              prov:wasDerivedFrom <http://amazon.com/>;
              rdfs:label ?label;
              schema:cost ?costA.
   ?suitcaseE schema:keywords ?label;
              prov:wasDerivedFrom <http://ebay.com/>;
              schema:cost ?costE.
}
```

bash

```
MacRuben:client$
```

The Linked Data Fragments vision allows **clients** to query the Web.

If we want to see **intelligent clients,** we must stop building intelligent servers.

Linked Data Fragments is the quest to design servers that ***enable*** clients to query.

All software is **available**
as **open source.**

linkeddatafragments.org

***data*.linkeddatafragments.org**

***client*.linkeddatafragments.org**

linkeddatafragments.org

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