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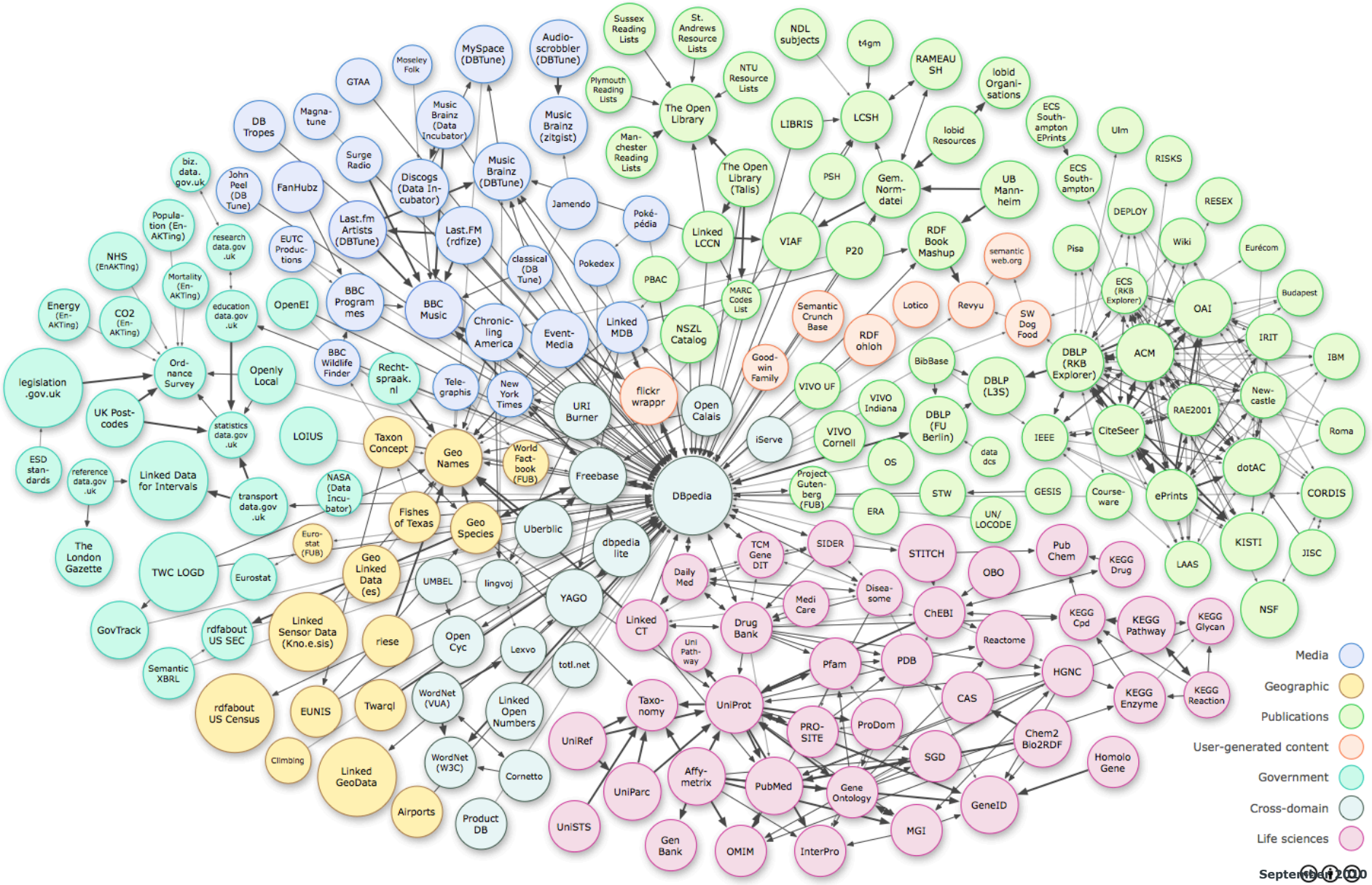
Consuming multiple sources of Linked Data: *Challenges & Experiences*

Ian Millard, Hugh Glaser, Manuel Salvadores, Nigel Shadbolt

8th November 2010


Media
Geographic
Publications
User-generated content
Government
Cross-domain
Life sciences
September 2010
Richard Cyganiak and Anja Jentzsch
http://lod-cloud.net/

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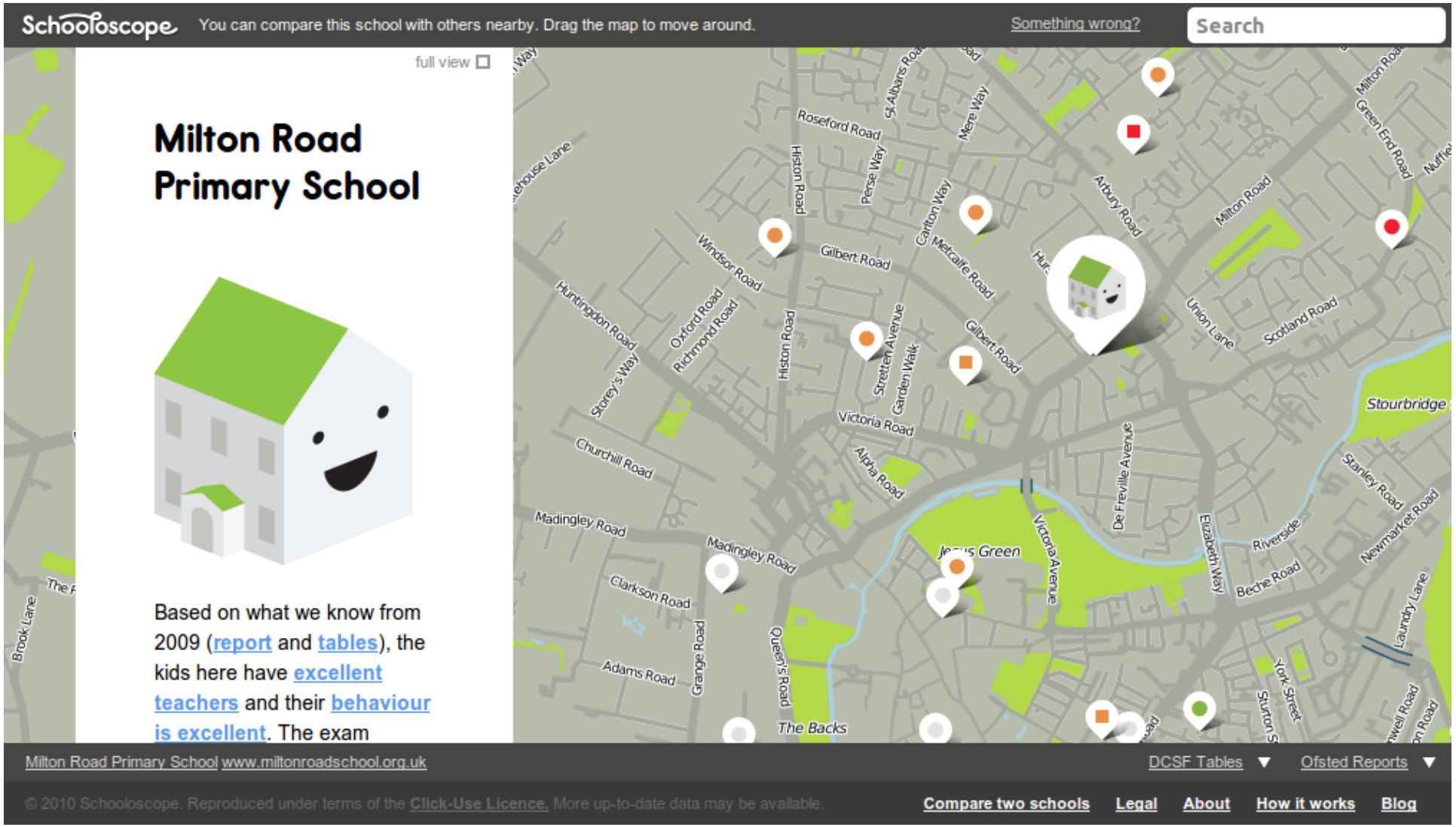
But where are all the apps?

- Continued growth in the quantity of Linked Open Data
  - Particularly government & public sector info
- But has Linked Data had any impact on Joe Public?
- What about the promises of data aggregation & interoperability?
- It is still hard to use Linked Data in real applications
  - especially when using multiple datasets



schooloscope.com

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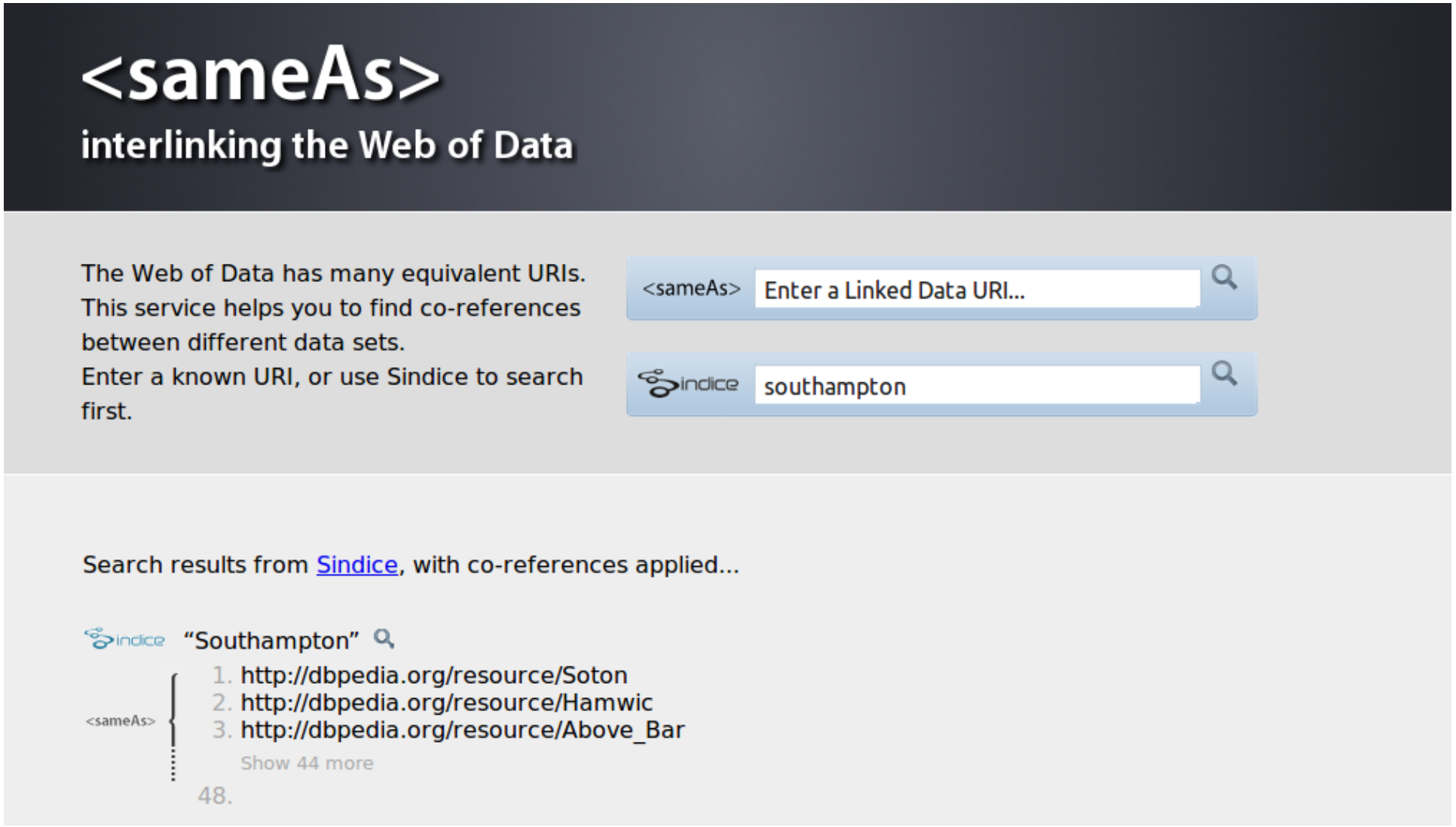
Challenge 1: Co-reference

- Lots of data in the 'cloud'
- Lots of duplication
- Relatively few links
  - the last, often overlooked step?
- However there are a variety of tools and frameworks which are now beginning to address these issues


<sameAs>
interlinking the Web of Data
The Web of Data has many equivalent URIs.
This service helps you to find co-references
between different data sets.
Enter a known URI, or use Sindice to search
first.
<sameAs> Enter a Linked Data URI...
indice southampton
Search results from Sindice, with co-references applied...
indice "Southampton"
<sameAs>
1. http://dbpedia.org/resource/Soton
2. http://dbpedia.org/resource/Hamwic
3. http://dbpedia.org/resource/Above_Bar
Show 44 more
48.

sameAs.org

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Challenge 2: heterogeneity of vocabularies

- As the cloud has grown, so to have the number of emerging vocabularies used to model the structure of that data
- Starting to see some convergence
  - but how many ways to describe a book, journal article or a place?
- Automated ontology alignment / mapping has been a research topic for many years
  - but on-the-fly translation services are not readily available to easily facilitate data interoperation

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Challenge 3: Discovery of resources

- Finding data in LOD Cloud is hard
  - Index of the Cloud?
  - Search engines?
- Even if we have a known triple pattern, there can be issues of asymmetry

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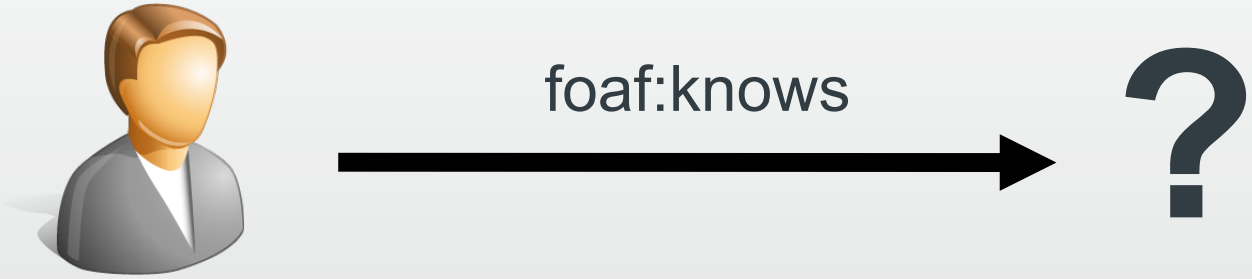

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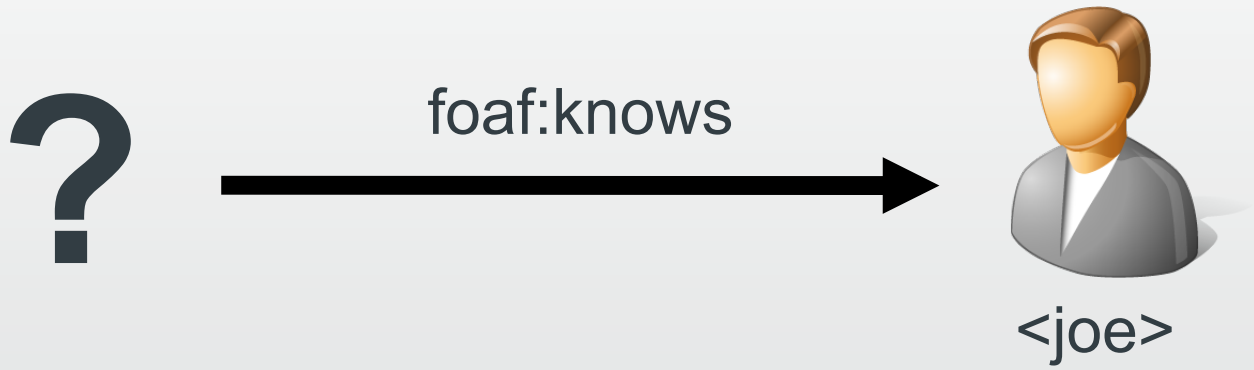

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Challenge 3: Discovery of resources

- voiD documents describe datasets
- Effort to collect sets of descriptions into a repository or 'voiD store'
- Enables many useful discovery services
- CKAN
- Back-link services, search engines

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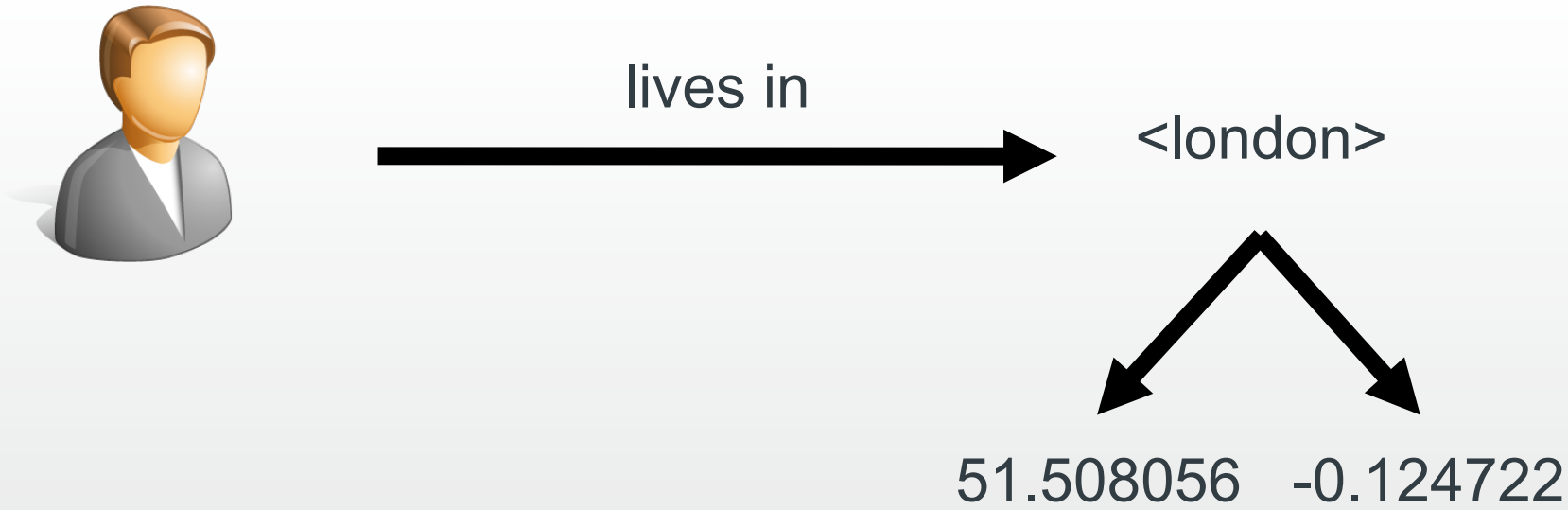
Challenge 4: Using multiple datasets

- Example – find coordinate location of users



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Challenge 4: Using multiple datasets

- Example – find coordinate location of users

lives in

<london>

51.508056 -0.124722

```
SELECT ?lat ?lng WHERE {
  <joe> eg:lives_in ?place .
  ?place geo:lat ?lat .
  ?place geo:long ?lng
}
```

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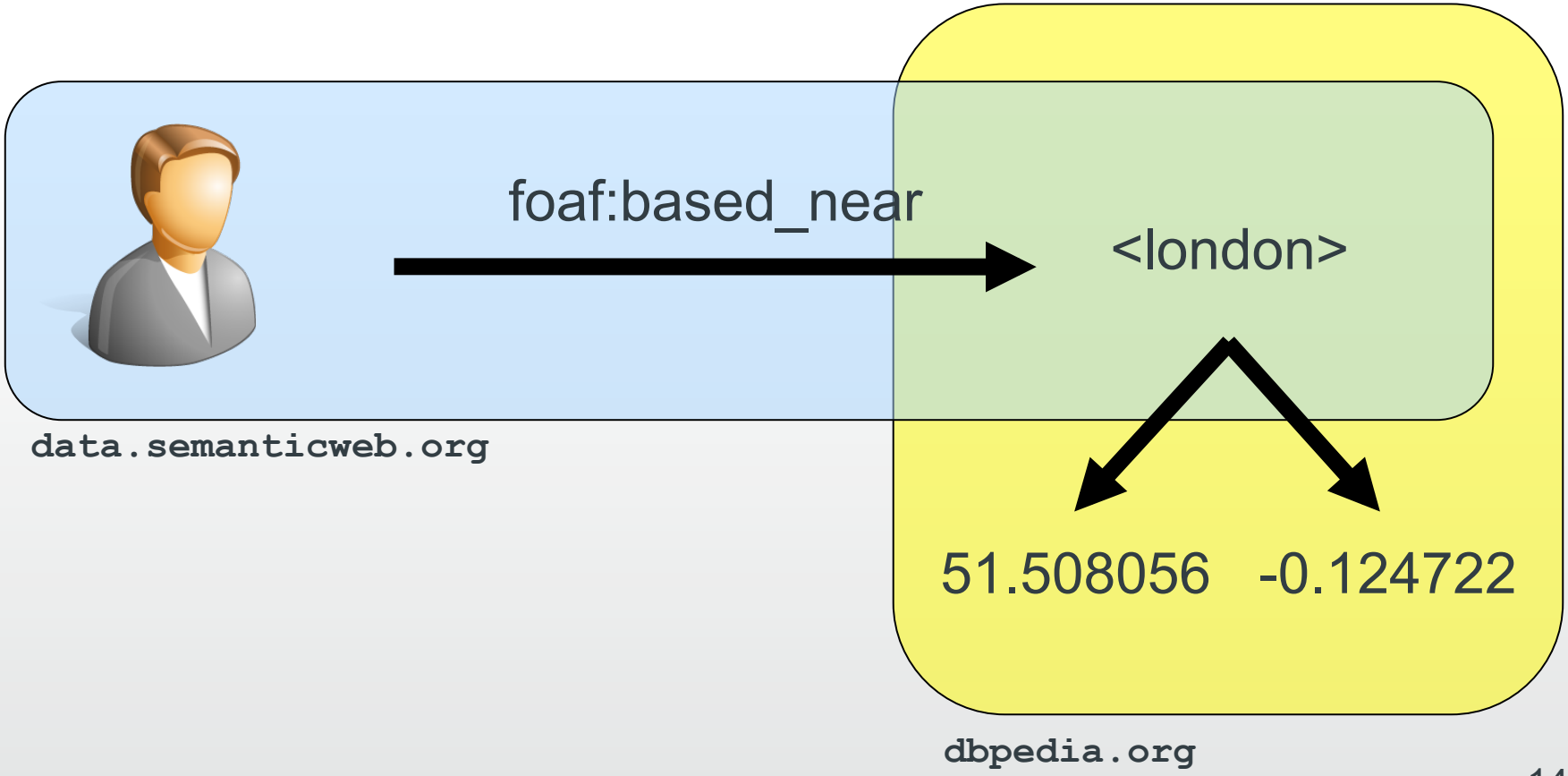
Challenge 4: Using multiple datasets

- Example – find location of users with foaf profiles



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Related Work: SemWeb Client Library

- URI resolution based approach to answering queries across the Web of Data
- Given one or more bound predicates in a query, the required URIs are resolved and cached into a local store before the query is then executed

\+ can answer almost any query, incl multiple datasets

– performance can be very slow, can incur large amounts of redundant data retrieval and processing

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Related Work: DARQ

- Distributed SPARQL query engine
- Accesses known endpoints directly, breaking down query, executing part-by-part, handling result joins

\+ simple queries can sometimes be executed efficiently

– requires detailed statistical information about each predicate for every endpoint to be compiled before queries can be made

– round-robin approach where repositories share common predicates does not scale well

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RKB Explorer: Overview

- Application with simple user interface to help researchers highlight and discover new relationships in the field of Resilient Systems and Dependable Computing
- Many data sources, one of the first applications to try and fully embrace a distributed data model – each held in a separate LOD/SPARQL store, each with a CRS
- Hybrid query approach utilising combination of SPARQL, co-reference expansion, and URI resolution

RKBExplorer » People » Hugh Davis

http://www.rkbexplorer.com/explorer/#display=person-%7Bhttp%3A//southampton.rkbexplorer.com/id/perso

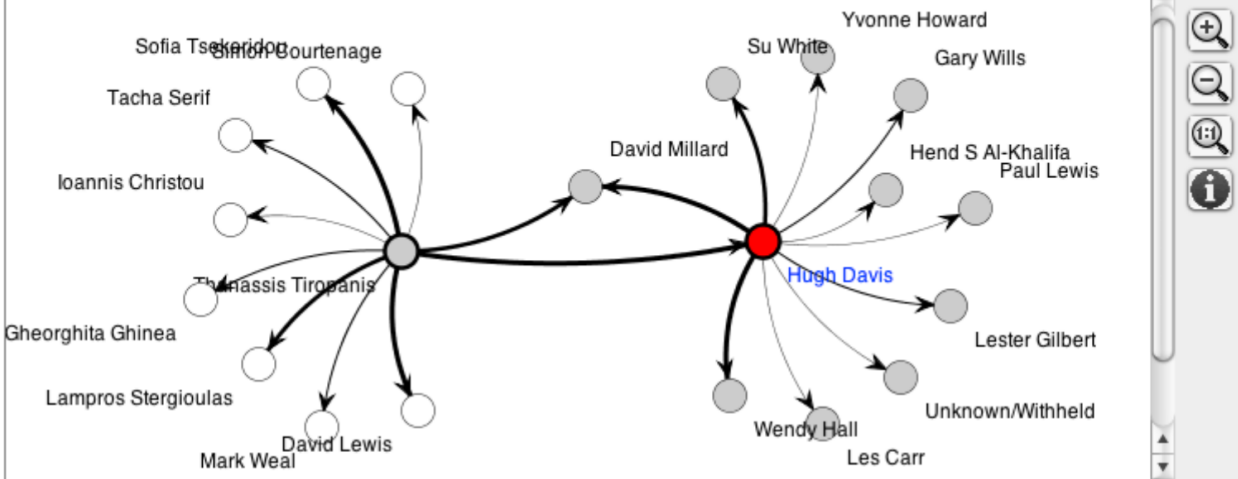
Google

RKBExplorer » People » Hugh Davis

Search... Search

about · system requirements · help · data sources · contact · acknowledgements

Related people



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- Su White
- Lester Gilbert
- Gary Wills
- Les Carr
- Yvonne Howard
- Paul Lewis

Organisations

- School of Electronics and Computer Science
- Intelligence, Agents and Multimedia
- Learning Societies Lab

Publications

- Making it rich and personal: meeting institutional challenges from next generation learning environments
- A (multi'domain'sional) Scrutable User Modelling Infrastructure for Enriching Lifelong User Modelling
- A Framework for Semantic Group Formation in Education
- A roadmap for semantic technology adoption in UK higher education
- AN E-LEARNING

Research Areas

- Computer Science
- H.5.1. Multimedia Information Systems
- H.5.4. Hypertext/Hypermedia
- I.7.2. Document Preparation
- hypertext
- H.5.2. User Interfaces
- web science
- www

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RKB Explorer: Query Heuristic

- All SPARQL queries fed through a middleware layer which employs very simple heuristic for best effort results
  - If all bound subjects and objects originate from a single known dataset with available SPARQL endpoint, execute against endpoint directly
  - Else resolve all bound URIs into local cache repository then execute query over that endpoint
- Originally used manual configuration, can now use voiD store to discover appropriate datasets/endpoints

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RKB Explorer: CoP Engine

- "Community of Practice" usually refers to group of related people, often with similar interests
- RKB Explorer computes associated groups of resources of a particular type related to a specific input resource, eg find papers related to this person
- Pairwise source_type/target_type configuration files, akin to rules specifying the important features relating instances of those two types of resource
- Each "rule" is expressed in at most two query stages, combined with sameAs expansion

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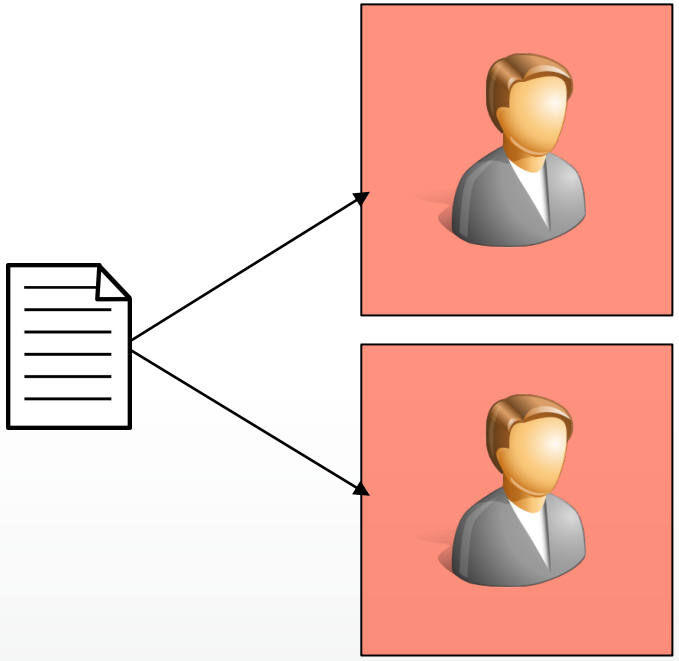
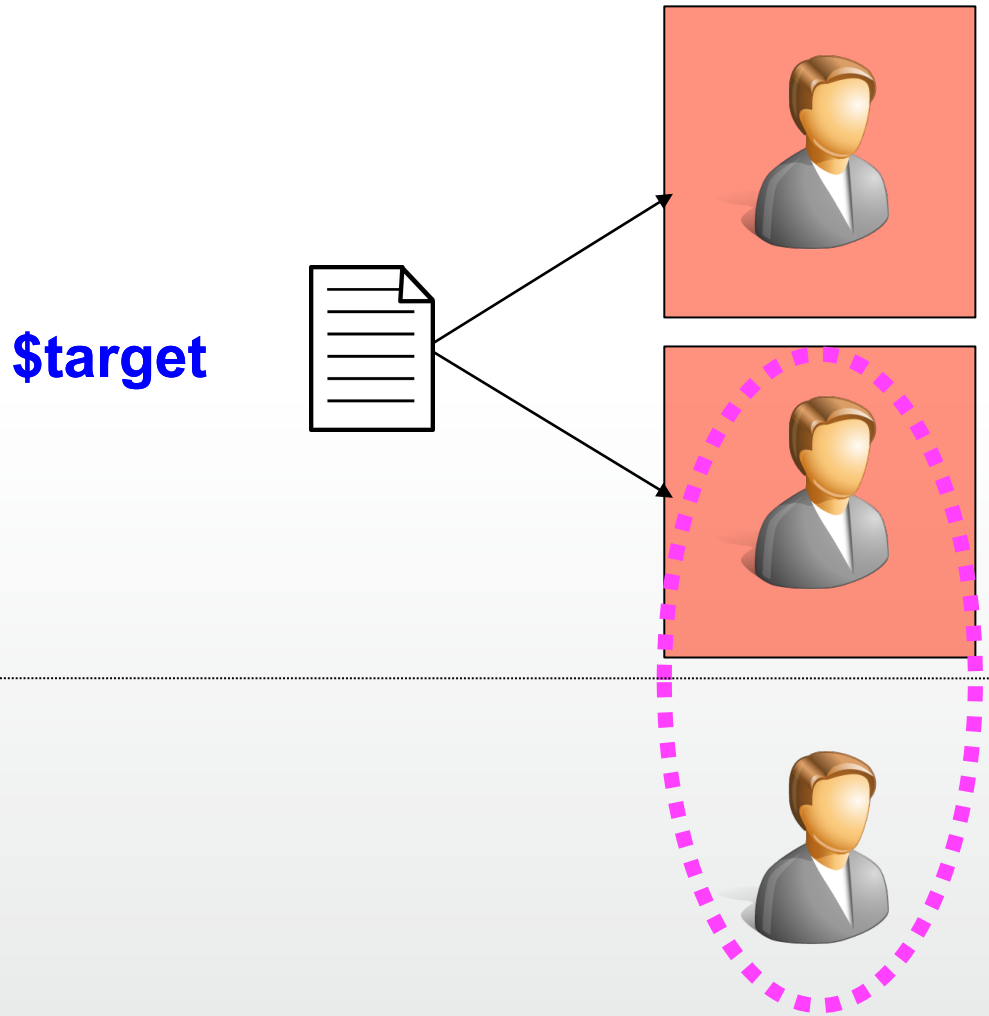
RKB Explorer: CoP Query Example

- Find other papers related to a given article, based upon commonality of author(s)

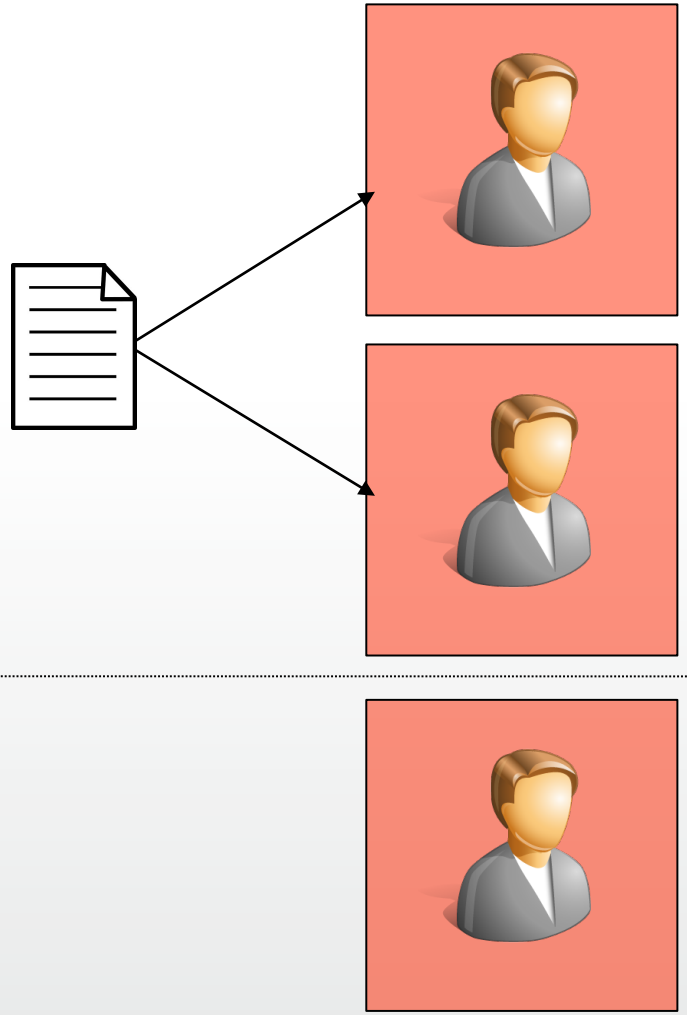
```
doCOP(
    "<$targetURI> eg:hasAuthor ?intermediate" ,
    "?result eg:hasAuthor <$intermediate>" ,
    1
)
```

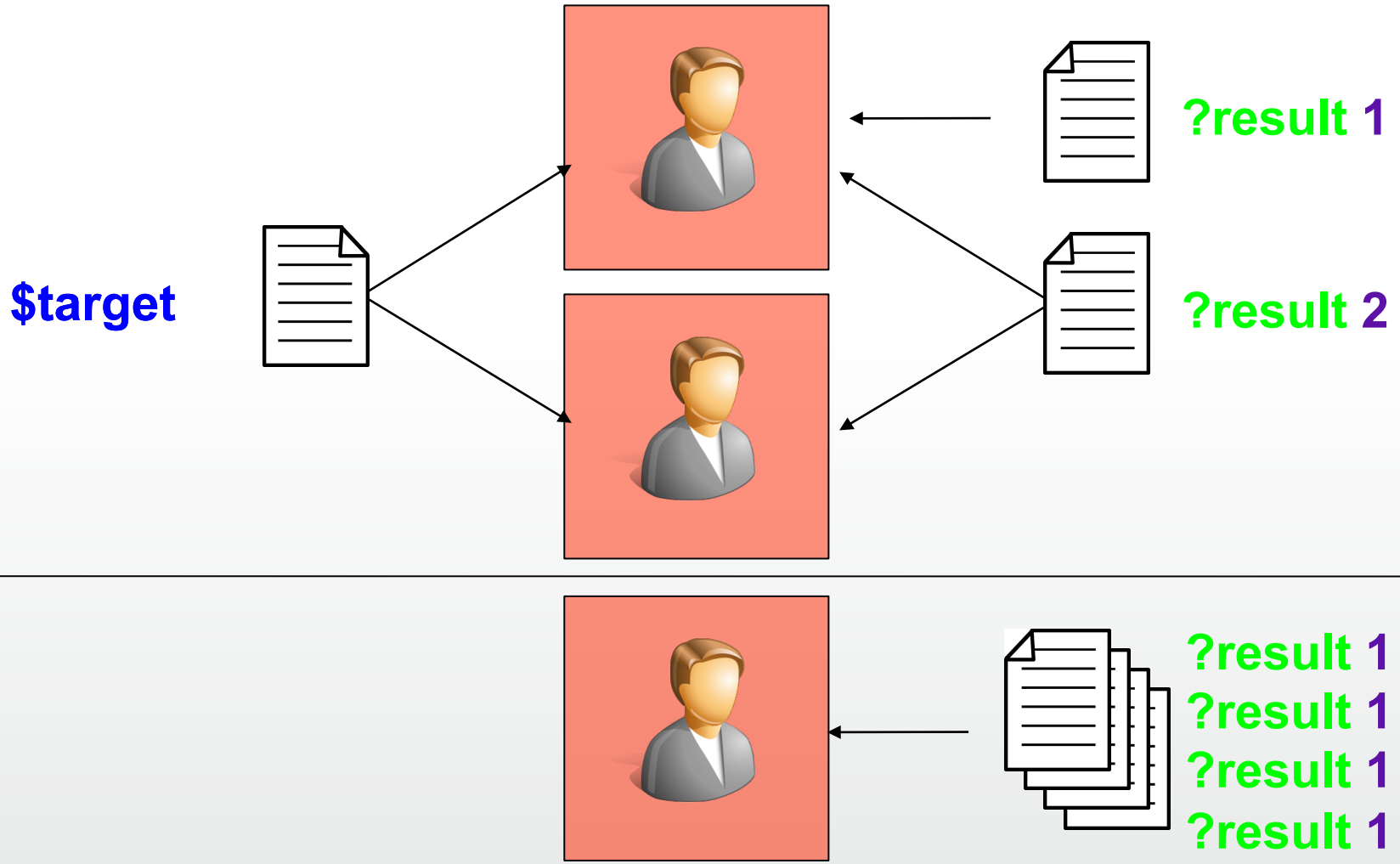
$target




$target

$target




$target
?result 1
?result 2
?result 1
?result 1
?result 1
?result 1

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CoP Engine: Summary

- Not solved generic distributed query problem yet!
- Two-phase execution with sameAs expansion of intermediate results allows a degree of execution over multiple sources
  - Need to bear limitations in mind with authoring
- Careful summation of results (again, co-reference issues)
- Mostly simple SPARQL queries, executed efficiently against appropriate endpoint(s)

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CoP Engine: Future work

- Would like to relax constraint of two-phase approach to enable arbitrary queries to be processed
  - Then faced with similar problems to DARQ
  - Work on rdfstats, and next version of voiD introducing better statistical information
  - Heuristic metrics based on evaluating commonly occurring predicates over typical datasets
- Already extensive low-level caching; further investigation
- May benefit by threading CoP engine execution

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Conclusions

- Exciting growth in Linked Open Data
  - Government, PSI, Life sciences
- However still number of hurdles wrt ease of use
  - Coreference, vocabularies, discovery, query
- Summarised how RKB Explorer addresses these
  - CRS, mapping, voiD store, hybrid CoP engine
- Still important work to be done in enabling applications to easily use full potential of the Web of Data

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Thanks. Any questions?

http://sameAs.org

http://rkbexplorer.com

http://schooloscope.com

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