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Semantic Access to Existing Archives

Using RDF and SPARQL

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The Idea

Use case

- Access and combine data from multiple sources
- Pose one query

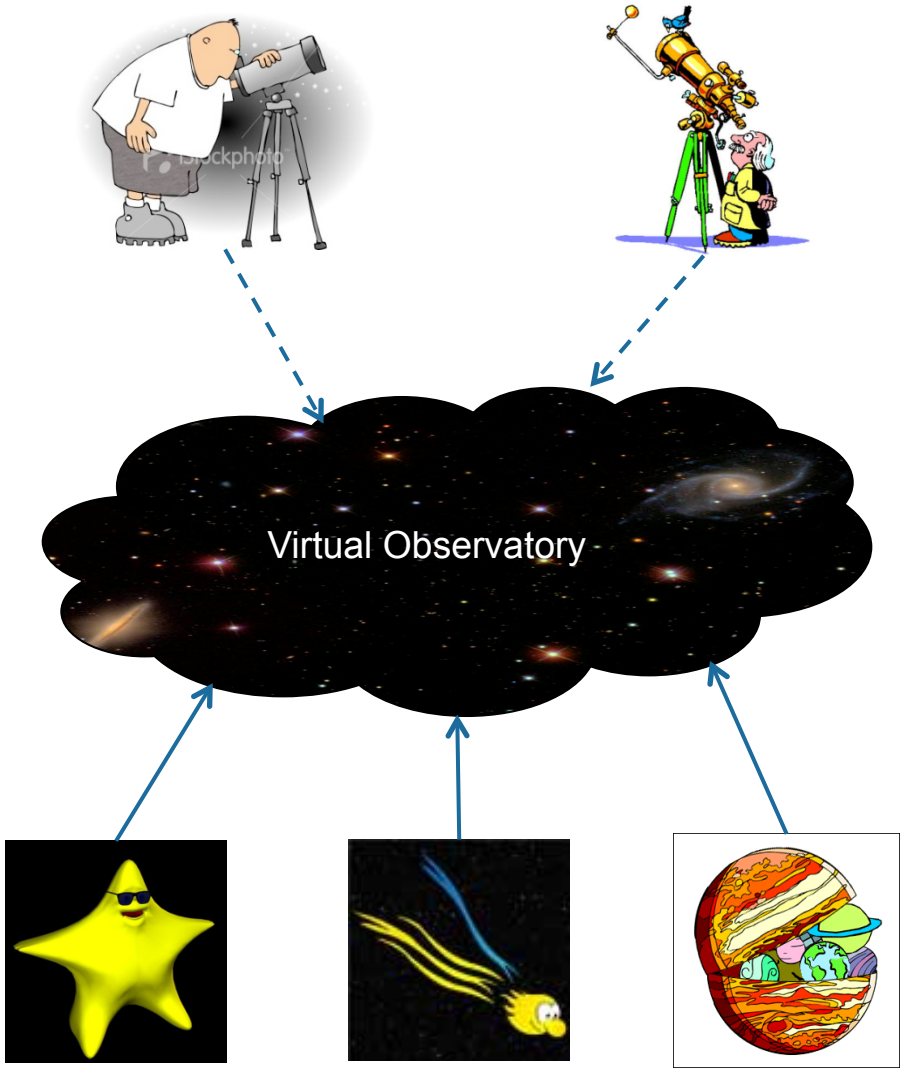
Issues

Archives exists

- Mostly relational
- Bespoke schemas

Relating data is hard

- Matching columns
- Matching types
- Maintaining semantics



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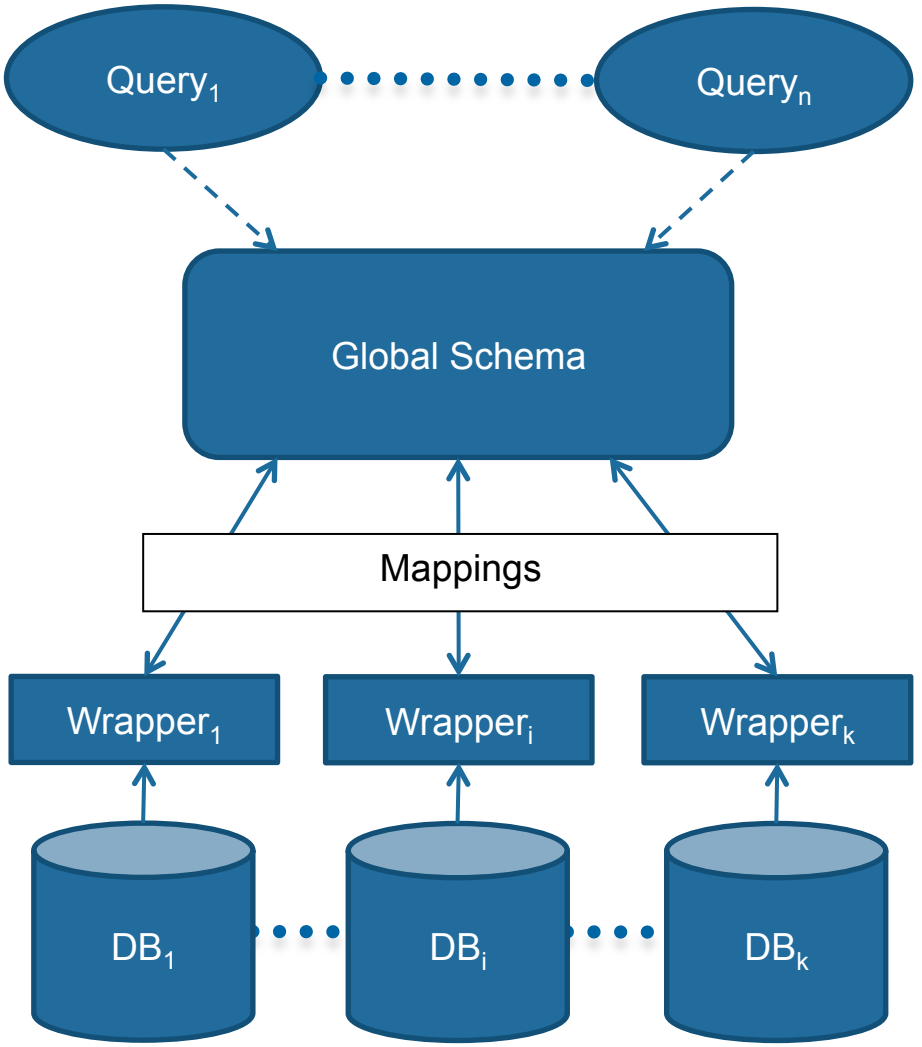
Abstract Computer Science Approach

Data Integration

- Autonomous Sources
  - Maintain own schema
- One Global Schema
  - Pre-agreed by all
  - Limits available data
- Mappings are relational views
  - Global as View (GAV)
  - Local as View (LAV)

Problem

No global schema in astronomy



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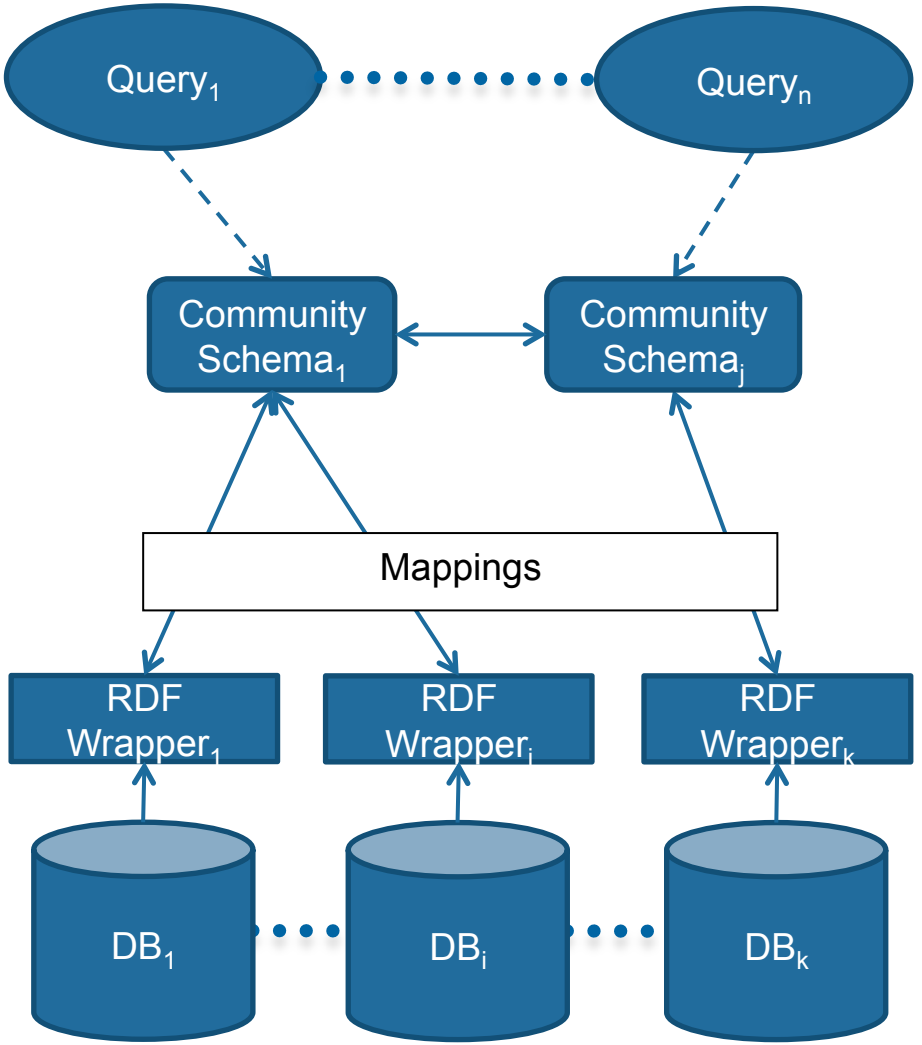
A Semantic Web Approach

Use RDF

- Expose source as RDF model
- Allow multiple *"access"* models
- Semantic mappings between models
- Query using SPARQL

Two approaches

- Replicate data in RDF Store
  - Consistency issues
- On-the-fly translation
  - SPARQL to SQL
  - Relational data to RDF



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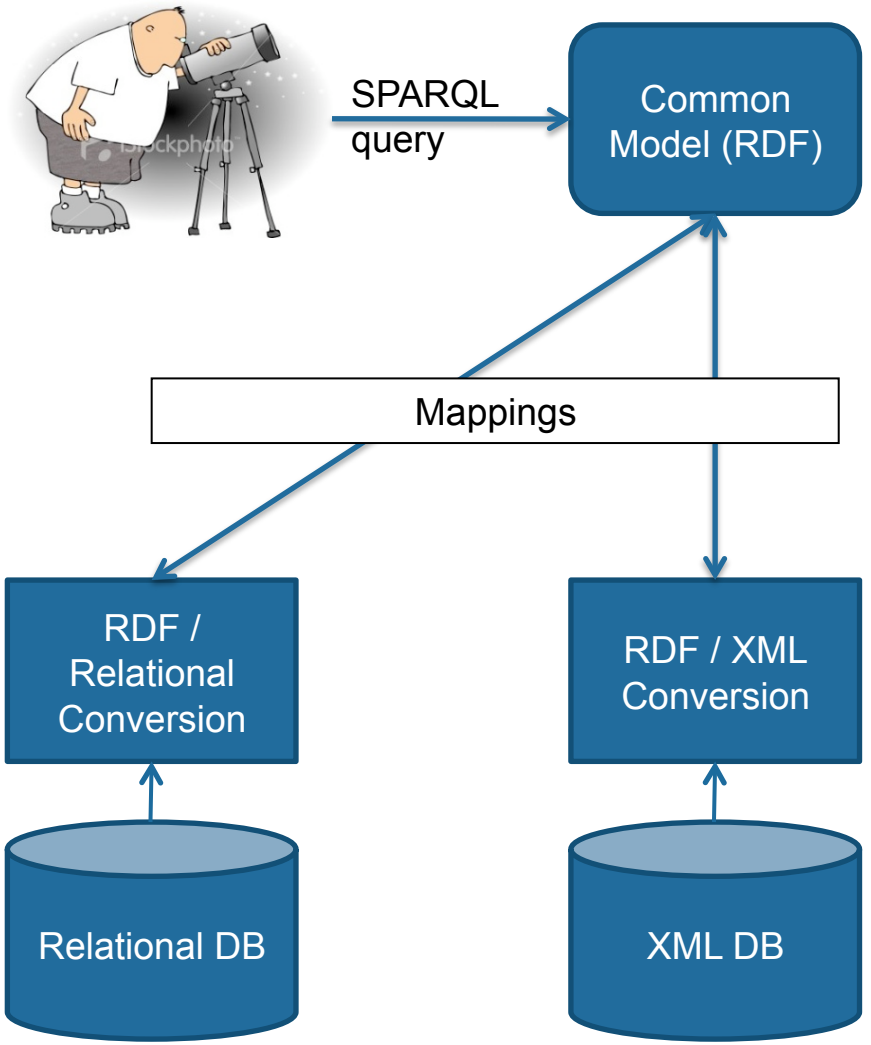
System Hypothesis

Is it viable to perform *on-the-fly* conversions from existing science archives to RDF to facilitate data access from a data model that a scientist is familiar with?



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Test Data

SuperCOSMOS Science Archive (SSA)

Data extracted from scans of Schmidt plates

Stored in a relational database

About 4TB of data, detailing 6.4 billion objects

Fairly typical of astronomical data archives

Schema designed using 20 real queries

Personal version contains

Data for a specific region of the sky

About 0.1% of the data, ~500MB

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Real Science Queries

Query 5

Find the positions and (B,R,I) magnitudes of all star-like objects within delta mag of 0.2 of the colours of a quasar of redshift 2.5 < z < 3.5

```
SELECT TOP 30 ra, dec,
sCorMagB, sCorMagR2,
sCorMagI

FROM ReliableStars

WHERE (sCorMagB-
sCorMagR2 BETWEEN 0.05
AND 0.80) AND
(sCorMagR2-sCorMagI
BETWEEN -0.17 AND 0.64)
```

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Analysis of Test Queries

Query Feature	Query Numbers
Arithmetic in body	1-5, 7, 9, 12, 13, 15-20
Arithmetic in head	7-9, 12, 13
Ordering	1-8, 10-17, 19, 20
Joins (including self-joins)	12-17, 19
Range functions (e.g. Between, ABS)	2, 3, 5, 8, 12, 13, 15, 17-20
Aggregate functions (including Group By)	7-9, 18
Math functions (e.g. power, log, root)	4, 9, 16
Trigonometry functions	8, 12
Negated sub-query	18, 20
Type casting (e.g. Radians to degrees)	7, 8, 12
Server functions	10, 11

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Expressivity of SPARQL

Features

- Select-project-join
- Arithmetic in body
- Conjunction and disjunction
- Ordering
- String matching
- External function calls (extension mechanism)

Limitations

- Range shorthands
- Arithmetic in head
- Math functions
- Trigonometry functions
- Sub queries
- Aggregate functions
- Casting

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Analysis of Test Queries

Query Feature	Query Numbers	
Arithmetic in body	1-5, 7, 9, 12, 13, 15-20	✓
Arithmetic in head	7-9, 12, 13	✗
Ordering	1-8, 10-17, 19, 20	✓
Joins (including self-joins)	12-17, 19	✓
Range functions (e.g. Between, ABS)	2, 3, 5, 8, 12, 13, 15, 17-20	✓
Aggregate functions (including Group By)	7-9, 18	✗
Math functions (e.g. power, log, root)	4, 9, 16	✗
Trigonometry functions	8, 12	✗
Negated sub-query	18, 20	✗
Type casting (e.g. radians to degrees)	7, 8, 12	✗
Server functions	10, 11	✗

Expressible queries: 1, 2, 3, 5, 6, ~~14, 15, 17, 19~~

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Experimental Setup

Machine

Quad Core Intel Xeon 2.4GHz
64 bit processor

4GB RAM

100 GB Disc

Linux

Java 1.6

Software

Database

- MySQL 5.1.25

Triple Stores

- Jena 2.5.6 with SDB 1.1
- Sesame 2.1.3

RDB2RDF Convertors

- D2RQ 0.5.2
- SquirrelRDF 0.1

Only 5 queries completed within 2 hours

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Performance Results

Query Execution (ms)

Query	1	2	3	5	6
JDBC/MySQL (Views)	34	38	33	34	1
D2RQ (Views)	352	5,339	2,733	4,090	7,468
D2RQ	39,374		40,021	153,392	
SquirrelRDF (Views)	613	21,492	837	1,307	19,984
Jena SDB (Views)	3,450	485,932	7,229	17,793	372,561
Sesame (Views)	39	83	69	65	56
Sesame	88		122	128	

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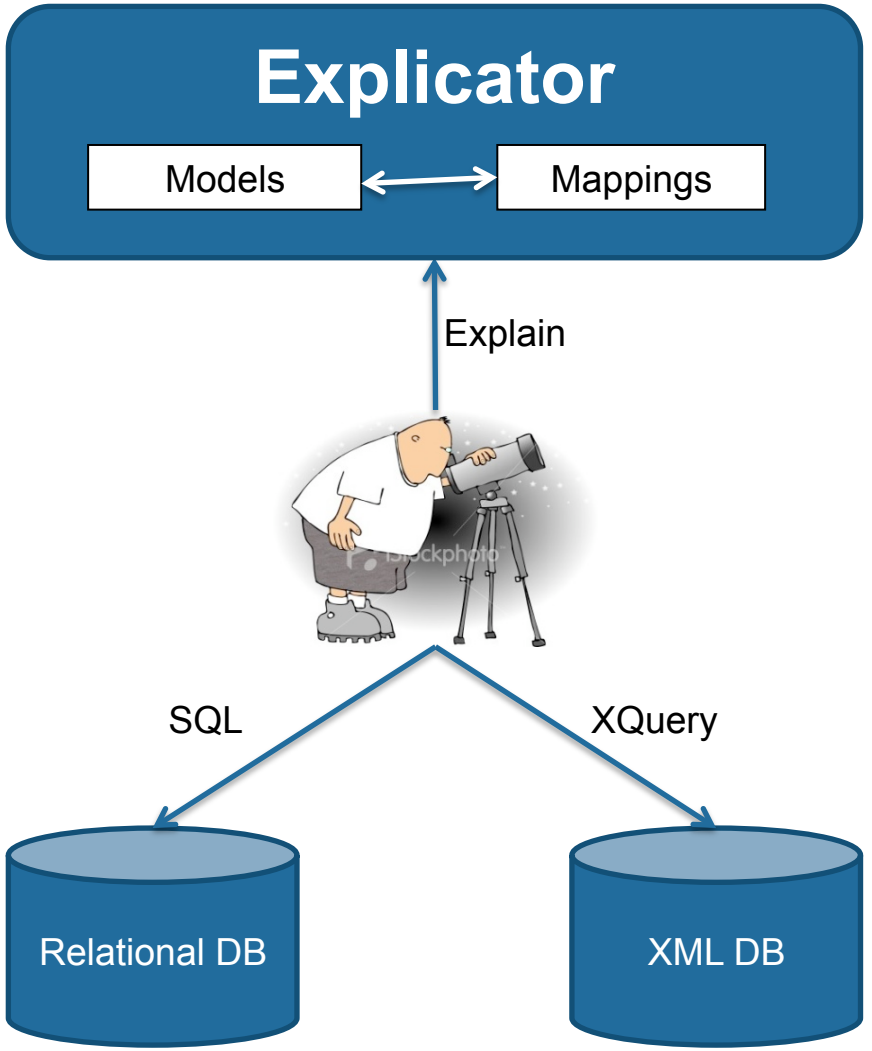
A New Approach

Exploit query engines and data structure of underlying data sources

Aid user query generation by *explaining* source data model in terms of known data model

Data extracted in native model



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Conclusions

RDF	Relational
Ragged data	Structured data
Small to medium data volumes	Large data volumes
Reasoning over the data	Extracting specific data

SPARQL: Not expressive enough for science

Query Converters: Poor performance

Exploring a new approach

RDF to understand data models

Native query engines for data extraction

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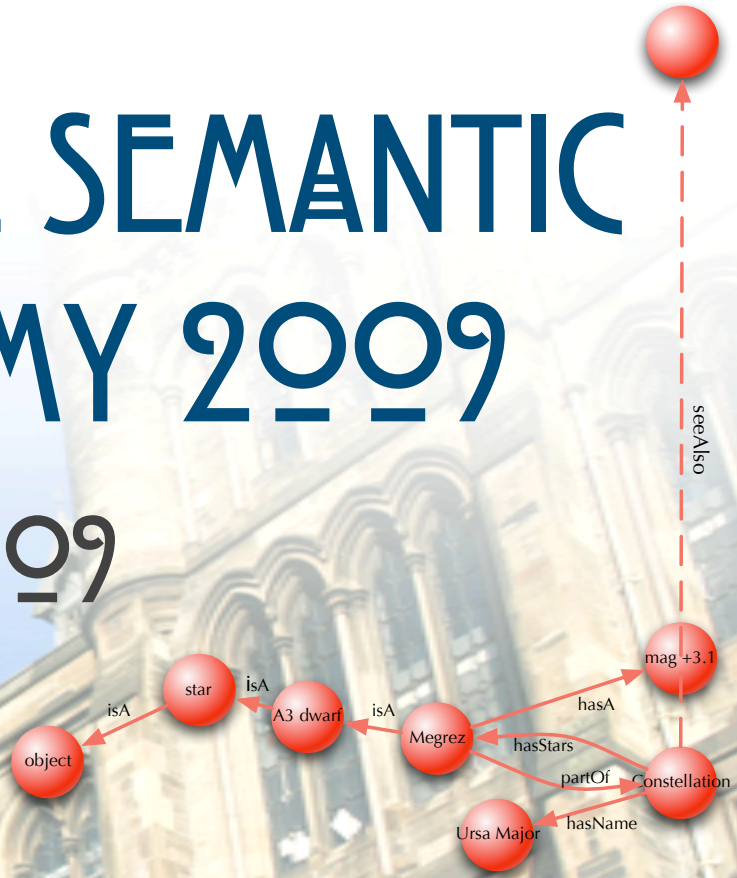
PRACTICAL SEMANTIC ASTRONOMY 2009

2-5 MARCH 2009

GLASGOW, UK



http://www.dcs.gla.ac.uk/workshops/semast09/