AKTivePSI

An Example of Semantc Web Data Integration for Government

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University of Southampton

Using advanced knowledge management technology to improve the delivery of policy and public services across Government

Office of PUBLIC SECTOR INFORMATION

Lewisham

Land Registry
Cymraeg

Camden

DH Department of Health

national STATISTICS

LONDON

CabinetOffice

defra
Department for Environment Food and Rural Affairs

Advanced Knowledge Technologies
Interdisciplinary Research Collaboration

www.aktors.org

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Making the Web Semantic…

http://
www2002.org

WWW2002

THE ELEVENTH INTERNATIONAL
WORLD WIDE WEB CONFERENCE

Sheraton Waikiki Hotel
Honolulu, Hawaii, USA
7-11 May 2002

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International World Wide Web Conference Committee

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On 7-11 May 2002, Honolulu, Hawaii will provide the backdrop for The Eleventh International World Wide Web Conference. This prestigious series of the International World Wide Web Conference Committee (IW^3C^2) attracts participants from around the world, and it provides a public forum for the World Wide Web Consortium (W3C) through the annual W3C track.

The conference is being organized by the International World Wide Web Conference Committee (IW^3C^2), the University of Hawaii and the Pacific Telecommunications Council (PTC).

FEATURED SPEAKERS (CONFIRMED)

Tim Berners-Lee, inventor of the World Wide Web and Director of the W3C who now holds the 3Com Founders chair at the Laboratory for Computer Science (LCS) at the Massachusetts Institute of Technology (MIT).

Richard A. DeMillo, vice president and chief technology officer for Hewlett-Packard Company.

Ian Foster, guru of "Grid Computing", associate

McArthur Prize Winner,

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via ontologies…

This is a type of object event and this is its title

This is the URL of the web page for the event

This is a type of object photograph and the photograph is of Tim Berners-Lee

Tim Berners-Lee is an invited speaker at the event

```
<owl:Class rdf:ID="Conference">
<rdfs:subClassOf rdf:resource="#Meeting-Taking-Place"/>
<rdfs:subClassOf rdf:resource="#Publication-Type-Event"/>
-<rdfs:subClassOf>
-<owl:Restriction>
<owl:onProperty rdf:resource="#published-proceedings"/>
<owl:allValuesFrom rdf:resource="#Conference-Proceedings-Reference"/>
</owl:Restriction>
```

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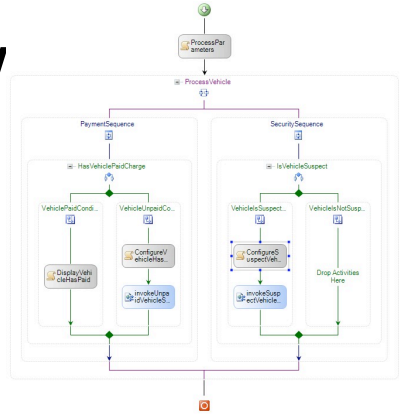
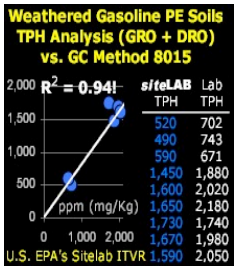
can semantically enrich anything…

- Web documents

- Workflow

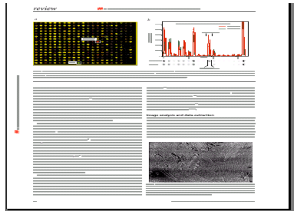


- Databases

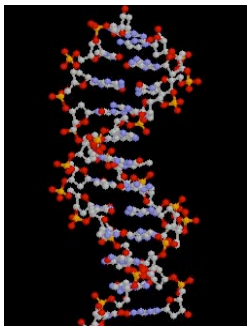


Web data set (XHTML)

- Publications



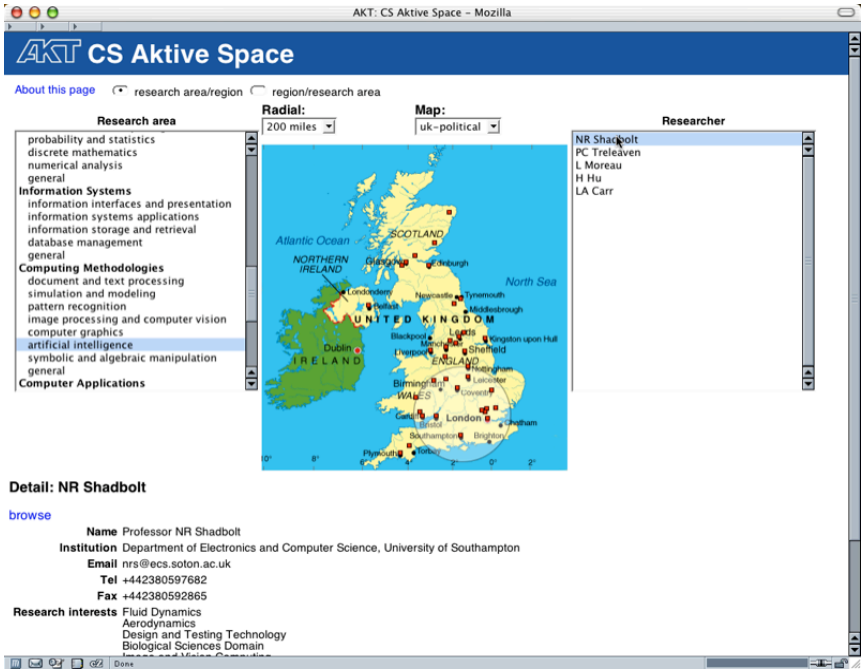
- Scientific structures



- People

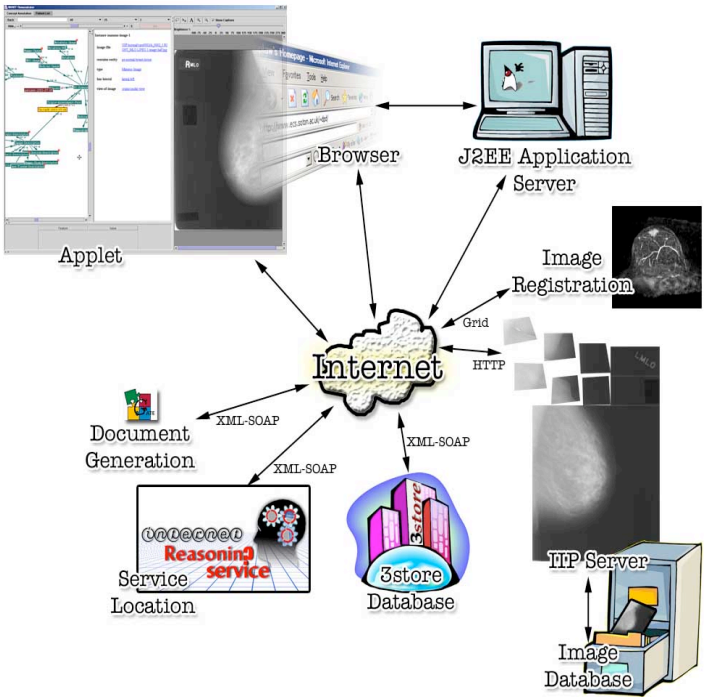
Integrated Information Spaces: CS AKTive

- Content harvested from multiple heterogeneous sources
  - Higher Education directories
  - 2001 RAE submissions
  - UK EPSRC project database
  - Info on personnel, projects and publications harvested for 5 or 5* CS departments in the UK

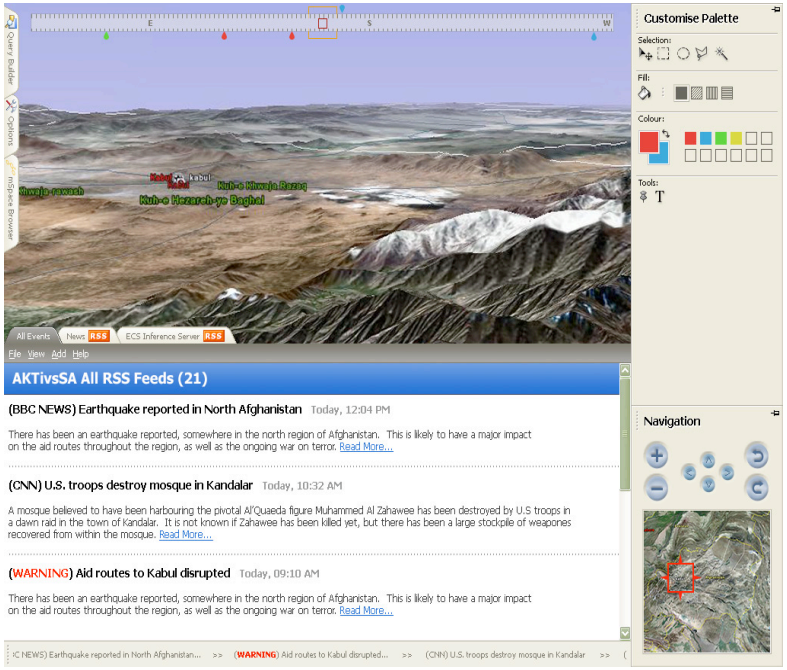


Other examples

- e-health



- e-defence



Aims of AKTivePSI

- Show *how* information in existing databases can be made available in scalable **semantic knowledge bases**
  - Using semantic web languages to represent and query the data
- Show *how* all this data can be **linked** to create an extended knowledge network
- Show *how* **ontologies** can represent the given data
- Demonstrate examples of **added value**
- Investigate the suitability of **IPSV** for representing government data
- Identify **knowledge gaps** between existing databases, and how such gaps can be filled
- Other Opportunities

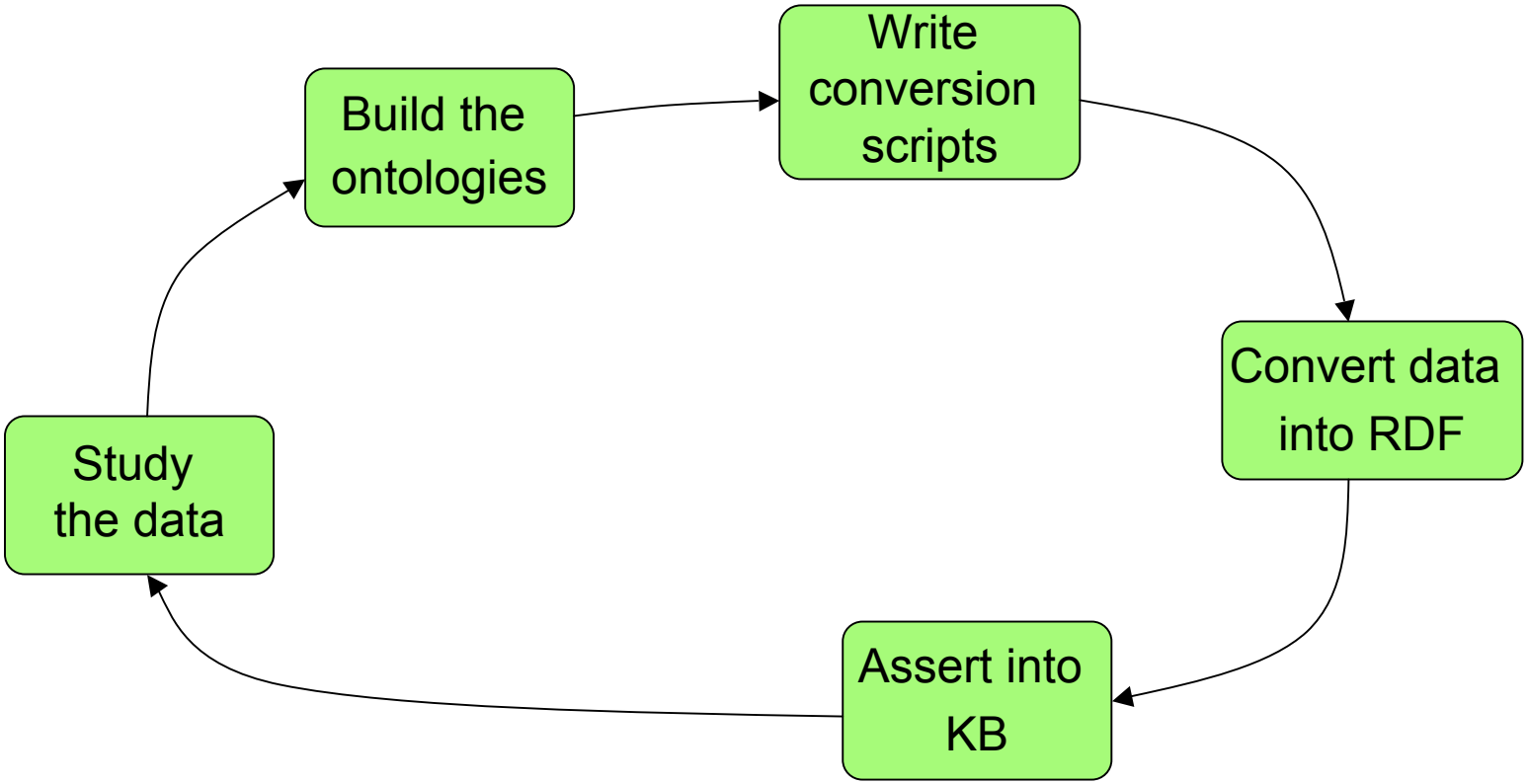
Key Working Assumptions

- Decided to follow an approach that simulates a real-life scenario
  - Minimum disruption to existing data flows and models
  - With minimum or no cost to the participants
- One dataset at a time
  - No preparations are needed
  - Give us the data as it is, in any format and delivery method
- Convert databases into focused ontologies using simple scripts
  - Use as much automation as possible to extract the necessary metadata from existing databases and documents
  - No data is to be handled manually!
    - E.g. when inserting into knowledge bases, linking to other data, merging duplications
- Practical ontologies!
  - Keep the ontologies small and manageable whenever possible
  - Ontologies are to be constructed to represent the data in a given database, not to represent an entire domain
  - Larger ontologies will be required later for integration
    - Not something to worry about from the start

Trust and Provenance

- It is important to maintain the provenance of the data we collect
- Each dataset is stored in a separate Knowledge Base, using a dedicated ontology
  - E.g.. Camden would have its own knowledge base, and Lewisham would have theirs
  - To minimise risk of contaminating one dataset with another
  - To make sure that the source of the data can be fully traced
- Each ontology clearly shows who provided the data and when
  - We can also represent who is the data owner, distributor, creator, etc
  - The data in the KB sometimes directly points to its source
- Ontologies are separate, but mapped/linked to each other

Creating the Knowledge Bases



Datasets

- Camden Council
  - Land & Property Gztt.
  - Food premises
  - Local Businesses
  - Licences
  - Councillors and Committees
  - Some meeting minutes
- Lewisham Council
  - Land & Property Gztt.
  - LBL
- Ordnance Survey
  - Points of Interest
  - MasterMap
  - Address Layers 1 and 2
- London Gazette
  - All database records 1998 onwards

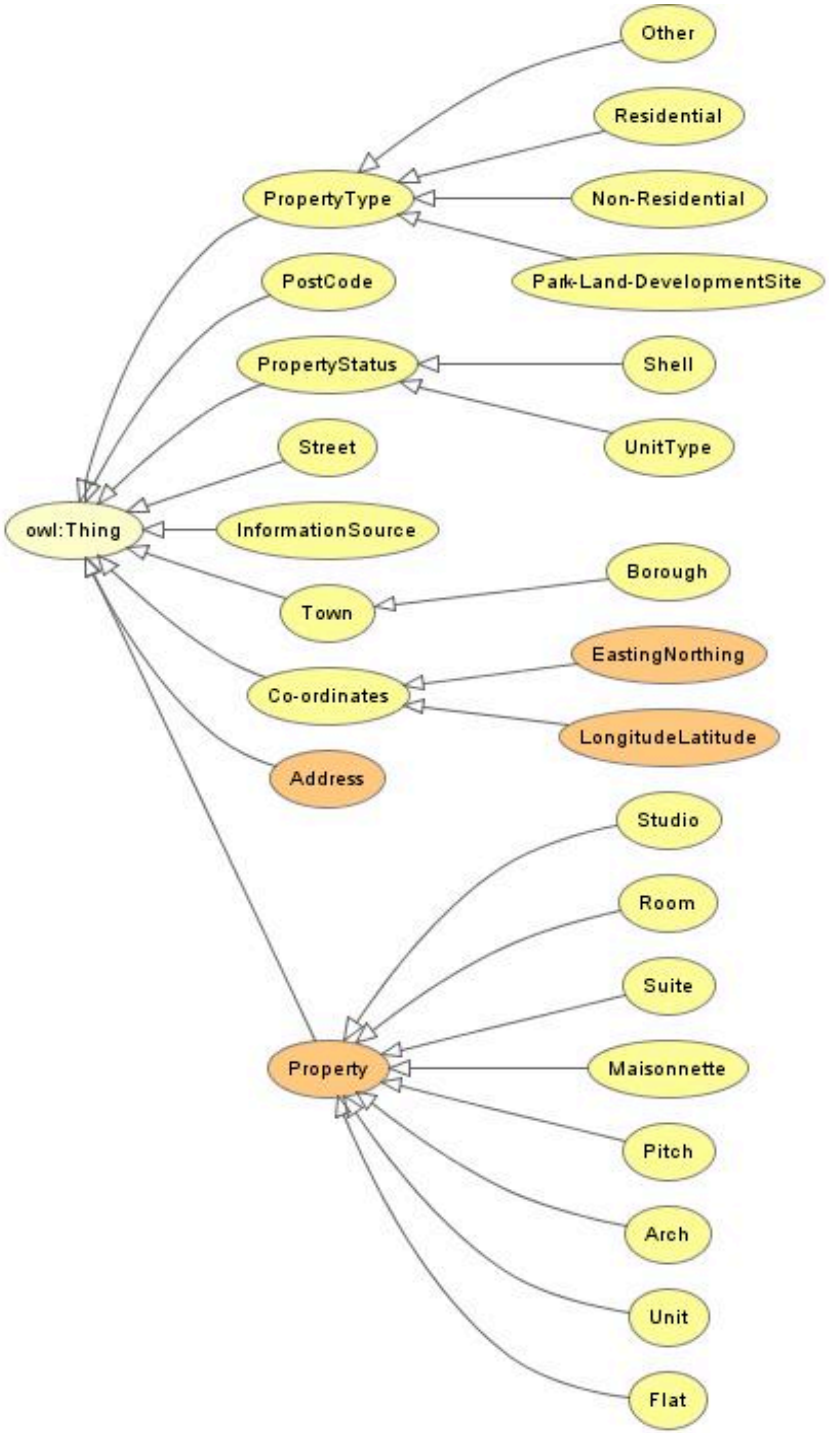
Camden Borough Council

Camden's LPG Dataset

- Camden has provided the Land & Property Gazetteer
  - Contains info about properties in Camden, full address, coordinates, flag for residential/non-residential/mixed.
  - Provided as a CSV file
  - Contains over 125K records

	A	B	D	E	H	I	J	K	L	M	N	O
1	UID	Desc	UPRN	ParentUpri	UNIT	BuildingName	Build	Street	Postcode	Town	EASTING	NORTHINC
2	46526	Residential (Unit)	5014096	5105271	Flat 43	Holly Lodge Mansions		Oakeshott Avenue	N6 6DS	London	528418.8	186856.3
3	46532	Residential (Unit)	5014102	5105271	Flat 29	Holly Lodge Mansions		Oakeshott Avenue	N6 6DS	London	528418.8	186856.3
4	46533	Residential (Unit)	5014103	5105271	Flat 28	Holly Lodge Mansions		Oakeshott Avenue	N6 6DS	London	528418.8	186856.3
5	46538	Residential (Unit)	5014108	5105271	Flat 51	Holly Lodge Mansions		Oakeshott Avenue	N6 6DS	London	528418.8	186856.3

- Does not include more info for non-residential or mixed properties, eg type of business



Camden LPG Ontology

26 Concepts

9 Object properties

- Links between concepts
- eg Address --has-post-code--> PostCode

17 Datatype properties

- Links between concepts and non-concepts (eg strings, numbers)
- Eg PostCode –post-code-> String

Ontology built using namespace
http://www.camden.gov.uk/propertyOntology

- Easy to trace URI in knowledge base to it's origin

Produced 2.3 million RDF triples

LPG Data Conversion

	A	B	D	E	H	I
1	UID	Desc	UPRN	ParentUpr	UNIT	BuildingName
2	46526	Residential (Unit)	5014096	5105271	Flat 43	Holly Lodge Mansions

	K	L	M	N	O
d	Street	Postcode	Town	EASTING	NORTHING
	Oakeshott Avenue	N6 6DS	London	528418.8	186856.3

```
@prefix : <http://www.camden.gov.uk/propertyOntology#>.
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>.
@prefix owl: <http://www.w3.org/2002/07/owl#>.

:infoSourceCamdenLondon rdf:type :InformationSource.
:infoSourceCamdenLondon :has-source "Camden's Land and
        Property Gazetteer".
:infoSourceCamdenLondon :when-data-obtained '2004-04-23'.

:property5014096 rdf:type :Flat.
:property5014096 :has-info-source :infoSourceCamdenLondon.
:property5014096 :local-ID "46526".
:property5014096 :has-UPRN "5014096".
:property5014096 :has-address
      [:has-building-name "Holly Lodge Mansions";
       :has-building-number "";
       :has-unit "Flat 43";
       :has-post-code :postcodeN66DS].

:street20400028 rdf:type :Street.
:street20400028 :street-name "Oakeshott Avenue".
:street20400028 :has-USRN "20400028".
:street20400028 :located-in :townLondon.

:postcodeN66DS rdf:type :PostCode.
:postcodeN66DS :for-street :street20400028.
:postcodeN66DS :post-code "N6 6DS".

:east528418.8north186856.3 rdf:hastype :EastingNorthing.
:east528418.8north186856.3 :has-easting "528418.8".
:east528418.8north186856.3 :has-northing "186856.3".
:property5014096 :has-coordinates :east528418.8north186856.3.
```

Food Premises

- Dataset contains information on premises in Camden that produces, handles, or serves food
  - E.g restaurants, schools kitchens, canteens
- Includes business name, results of last food hygiene and standards inspection checks, addresses, premises type (eg restaurant, school, bar)
- Data provided in xls spreadsheet,
  - 2.8 thousand records
  - Produced over 84K RDF triples
  - Ontology stats: 165 classes, 17 object properties, 15 datatype properties

Ordnance Survey

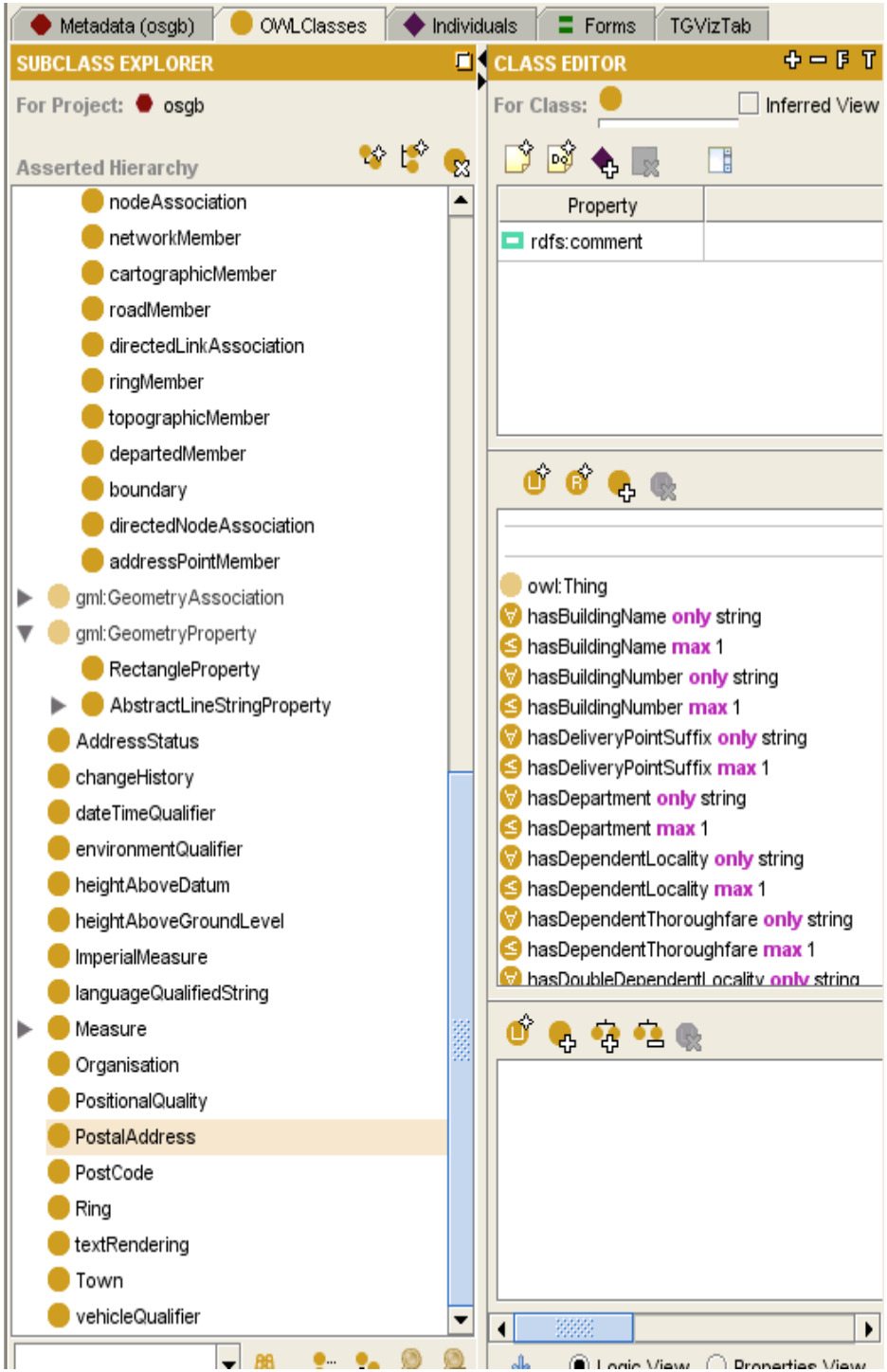
Ordnance Survey

- Data provided:
  - Master maps for Camden and Lewisham
    - GIS maps showing land boundaries and borders
  - Address Layer 1
    - Data about buildings, addresses, coordinates
  - Address Layer 2
    - Buildings are classified into types (eg hospital, university, hotel)
  - Ontology for Address Layer dataset (osgb.owl)
    - Written in OWL to represent the data in this dataset

Address Layer 1

- Added minor extensions to osgb.owl
  - To represent few extra concepts
  - To facilitate mapping to other ontologies

- Converted this xml dataset to RDF and stored in 3Store against the extended OS ontology
  - Produced 758 thousand triples
  - Mainly buildings, addresses, and coordinates



OS Ontology

- 93 Concepts
- 80 Object properties
  - Links between concepts
- 72 Datatype properties
  - Links between concepts and non-concepts (eg strings, numbers)
- Ontology built using namespace http://www.ordnancesurvey.co.uk/xml/namespaces/osgb
  - Extends a standard ontology http://www.opengis.net/gml

Address Layer Conversion

```
- <osgb:addressPointMember>
  - <osgb:AddressPoint fid="osgb1000002148475495">
      <osgb:version>1</osgb:version>
      <osgb:versionDate>2002-08-17</osgb:versionDate>
      <osgb:theme>Address</osgb:theme>
    - <osgb:addressStatus>
        <osgb:matchStatus>Matched</osgb:matchStatus>
        <osgb:physicalStatus>Existing</osgb:physicalStatus>
        <osgb:positionalQuality accuracy="Surveyed">Final</osgb:positionalQuality>
        <osgb:structureType>Permanent Building</osgb:structureType>
      </osgb:addressStatus>
      <osgb:OSAPR>APKEBA8H52C45WT0QT</osgb:OSAPR>
    - <osgb:point>
      - <gml:Point srsName="osgb:BNG">
          <gml:coordinates>537960.700,176636.300</gml:coordinates>
        </gml:Point>
      </osgb:point>
    - <osgb:postalAddress>
        <osgb:buildingNumber>1</osgb:buildingNumber>
        <osgb:thoroughfare>ROBINSCROFT MEWS</osgb:thoroughfare>
        <osgb:postTown>LONDON</osgb:postTown>
        <osgb:postCode type="Small">SE10 8DN</osgb:postCode>
        <osgb:deliveryPointSuffix>1A</osgb:deliveryPointSuffix>
      </osgb:postalAddress>
      <osgb:postalAddressDate>2002-07-19</osgb:postalAddressDate>
      <osgb:referenceToTopographicArea xlink:href="#osgb1000041793793" />
    </osgb:AddressPoint>
  </osgb:addressPointMember>
```

conversion scripts

```
:AddressPointosgb1000002148475495
      :hasPostalAddress
      :PostalAddressosgb1000002148475495.
:PostalAddressosgb1000002148475495 rdf:type
      :PostalAddress.
:PostalAddressosgb1000002148475495
      :hasDeliveryPointSuffix '1A'.
:PostalAddressosgb1000002148475495
      :hasThoroughfare ‘ROBINSCROFT MEWS'.
:PostalAddressosgb1000002148475495 :hasRoad
      [rdf:type :Thoroughfare; :hasThoroughfareName
      ‘ROBINSCROFT MEWS’].
:PostalAddressosgb1000002148475495
      :hasPostTown :TownLONDON.
:TownLONDON rdf:type :Town.
:TownLONDON :hasName 'LONDON'.
:PostalAddressosgb1000002148475495
      :hasPostCode :PostCodeSE10_8DN.
:PostCodeSE10_8DN rdf:type :PostCode.
:PostCodeSE10_8DN :hasPostCodeValue 'SE10
      8DN'.
:PostalAddressosgb1000002148475495
      :hasCoordinates
      :PostalCoordinatesosgb1000002148475495.
:PostalCoordinatesosgb1000002148475495 rdf:type
      gml:Coordinates.
:PostalCoordinatesosgb1000002298732392
      gml:hasDecimal '537960.700,176636.300'.
```

Address Layer 2

- Similar to Address Layer 1, but with more place related information
  - E.g. name and category (hospital, school)

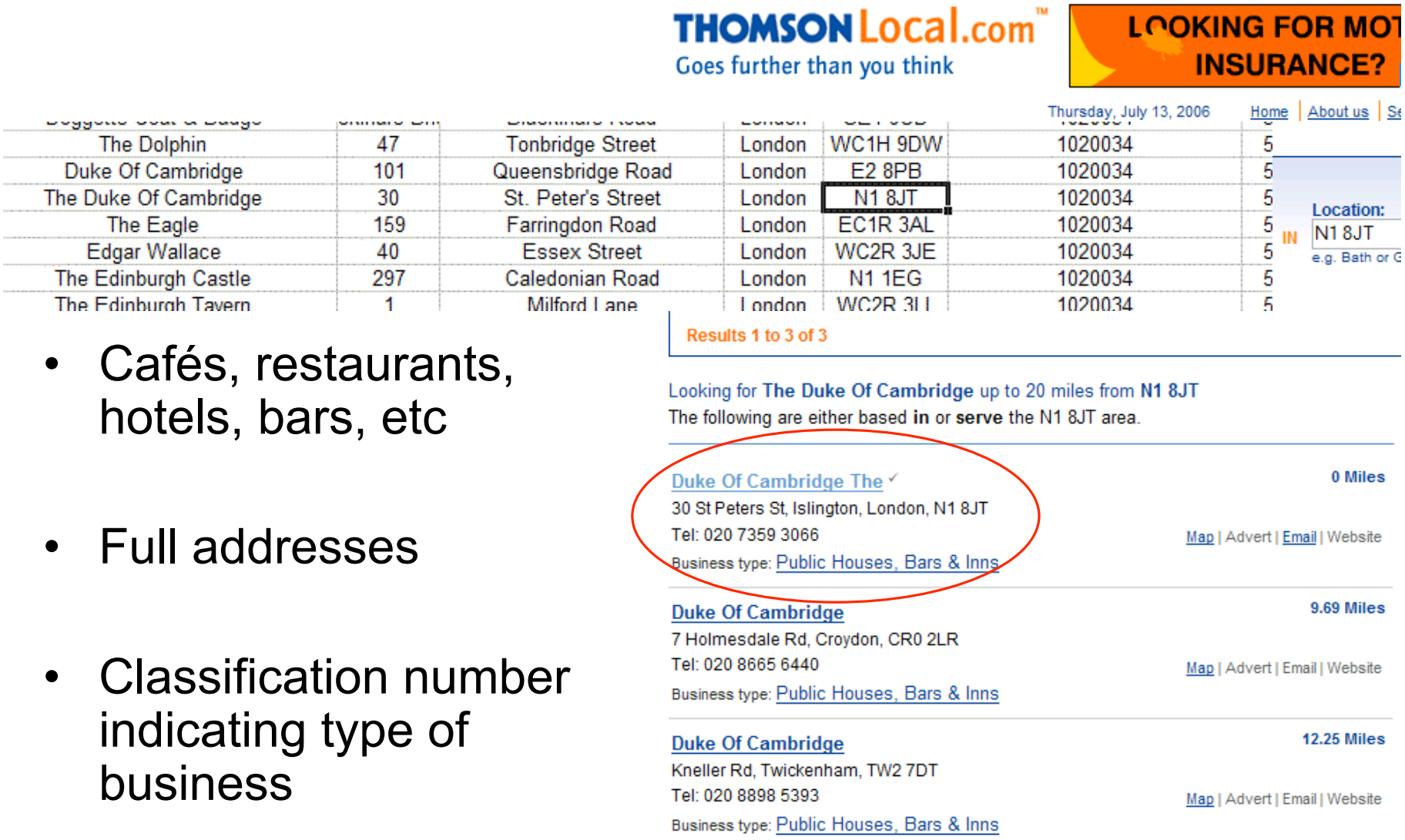
- Provided in xml format
  - Contained information about around 35K places
  - Converted into 11.7M RDF triples in 3Store
  - Ontology has 98 classes, 84 object properties, and 89 datatype properties
  - Most of this ontology is not used or needed for this data, but are inherited from standard geographical representations

Points of Interest Data

PointX

- PointX, founded in 2001, is a joint venture company owned by the Ordnance Survey and Landmark Information Group
- PointX offers a “Comprehensive, up-to-date and accurate Points of Interest data for Great Britain“
- Distributed by OS
- Relies on various data supplier
  - Eg OS, thomsonlocal.com, experian.com, and many others
- OS provided PointX data for Camden and Lewisham
  - Over 22.5 thousand records
  - Create an ontology for PointX with 10 classes and 24 properties
  - Produced nearly 467 thousand RDF triples

Points of Interest data



- Cafés, restaurants, hotels, bars, etc
- Full addresses
- Classification number indicating type of business

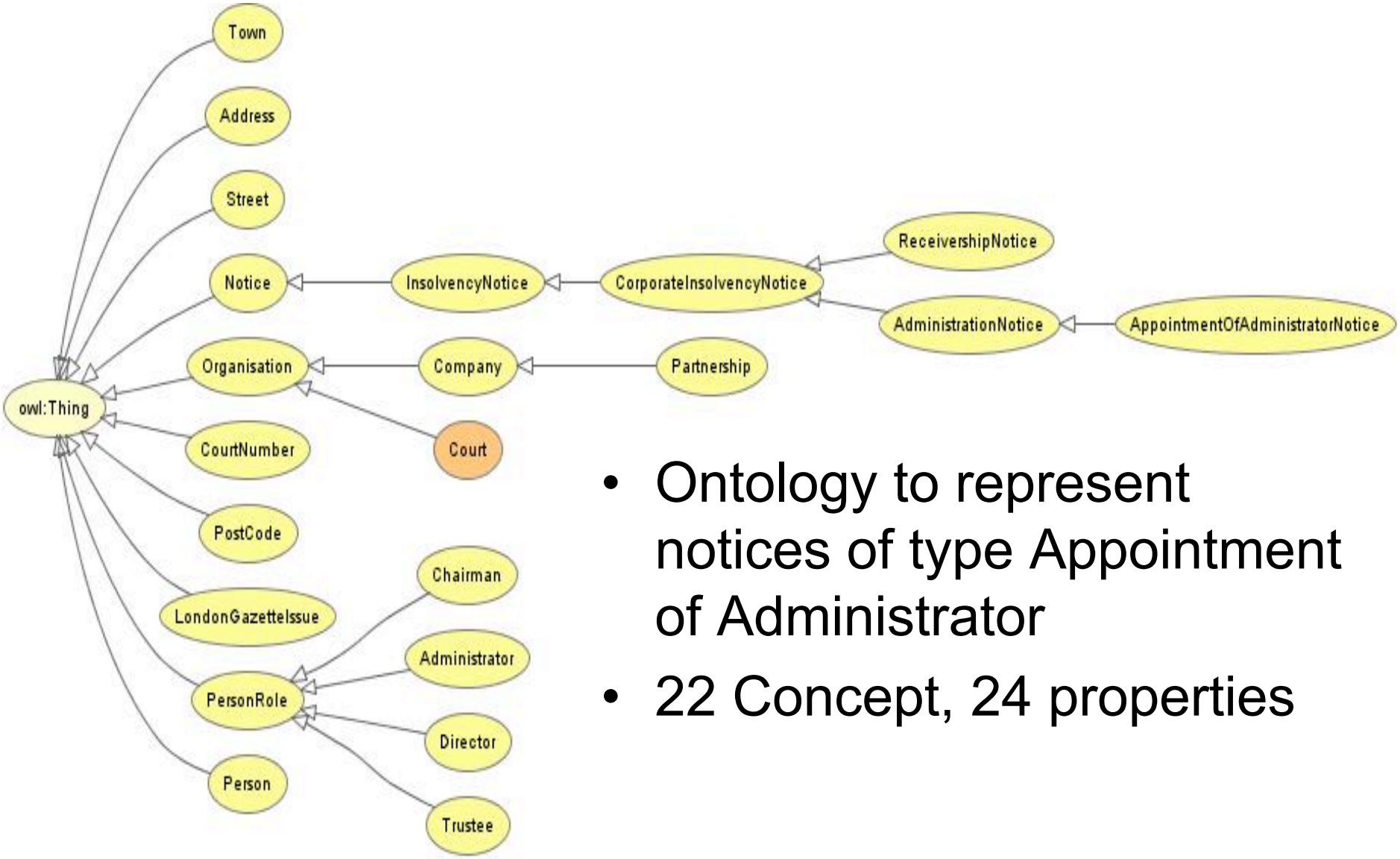
London Gazette

London Gazette

- The entire LG is made available for this project
  - Contains all the info since they started digitising their data in 1998
  - Large database, many different type of notices
  - Current data structure is difficult to parse
  - TSO is currently redesigning the database

- We focussed on insolvency and deceased person notices
  - So far, we converted 4550 Appointment of Administrator notices for Corporate Insolvencies
    - However, many of the addresses were not parsed correctly!
    - Actual address of businesses are usually not available
      - Historical council data might be useful to fill this gap
    - Resulted in 120 thousand RDF statement
  - For the deceased person data
    - 3.2 million RDF statements were created

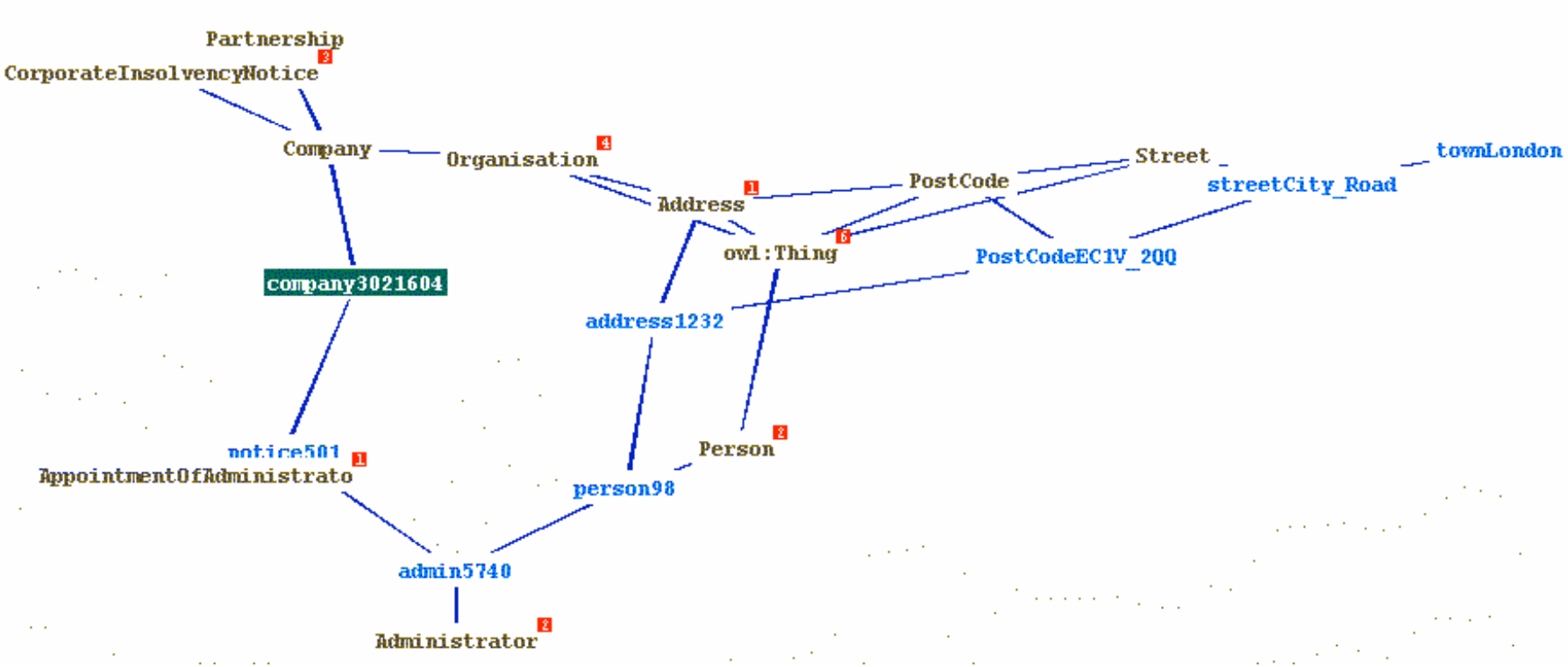
Insolvency Ontology



- Ontology to represent notices of type Appointment of Administrator
- 22 Concept, 24 properties

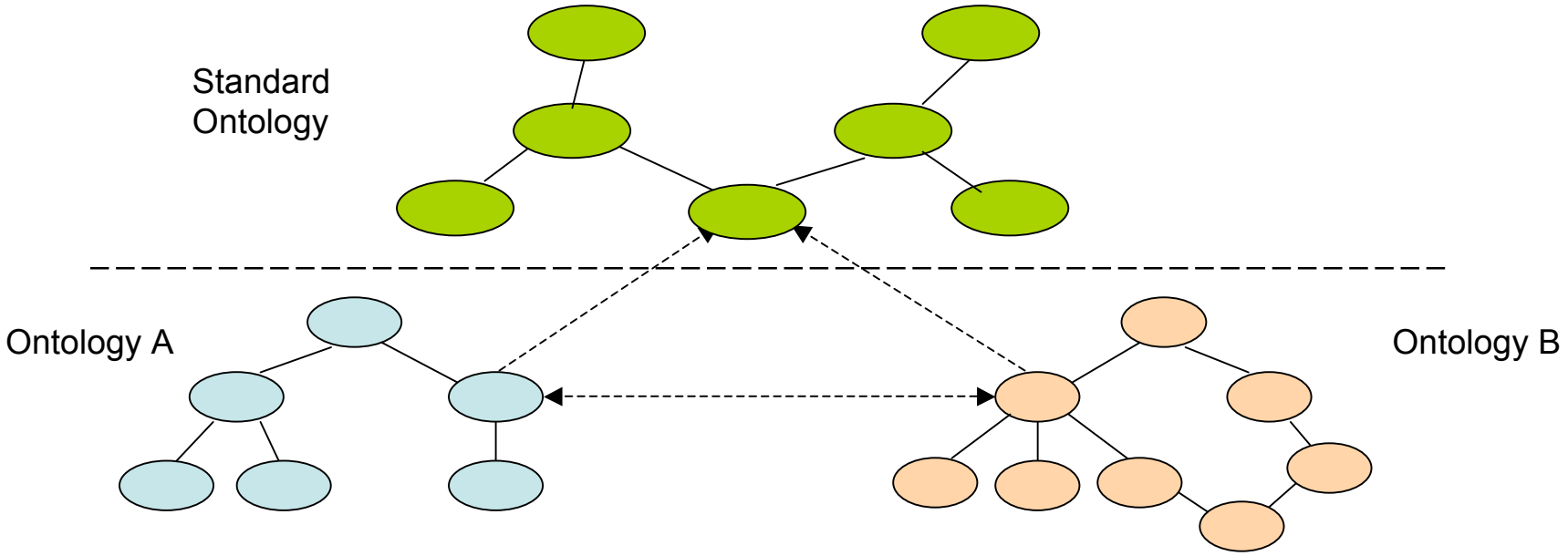
Data Conversion

"PLACEFINE LTD (t/a Church St Recruitment) (Registered No. 3021604) Nature of Business: Employment Bureau. Trade Classification: 46. Administration Order Made: 13th July 1998. Name of Administrator: Laurence J. Baehr (Office Holder No. 5740). Address of Administrator: Baehr Lubbock Fine, Russell Bedford House,City Forum, 250 City Road, London EC1V 2QQ. L. J. Baehr, Administrator (501)"



Integration

- Integrating or mapping ontologies together improves cross-KB querying and understanding
  - But is not necessary to utilise the data
- Each ontology can be linked:
  - Directly to other local ontologies
  - Directly to other external ontologies, or via a shared reference ontology (such as IPSV)
- No need to be restricted to any given standard taxonomies
  - Such standards can never detail all types of data!
  - Use your own ontologies to represent your own data
    - Or reuse or modify an existing one to fit your data
  - Map your ontologies to the standards (eg IPSV)



Integration

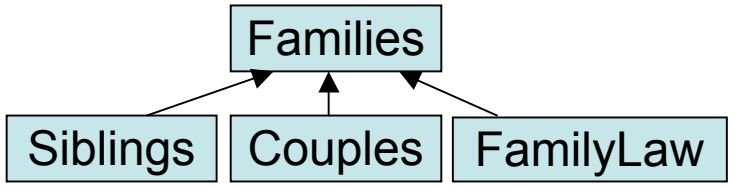
- Three types of mapping and integration was applied:
  - Mapping of ontologies
    - Using CROSI – an AKT ontology mapping tool
  - Mapping of instance data
    - Scripts to search for duplications
    - Insertion of owl:sameAs in 3Store to link duplicated objects
  - Mapping of ontologies to IPSV
    - Had to be done manually

IPSV

- Integrated Public Sector Vocabulary
- “IPSV now covers internal-facing as well as public-oriented topics”
- “Stay with IPSV if your purpose is to populate Subject metadata”
- 3080 preferred terms and 4843 non-preferred

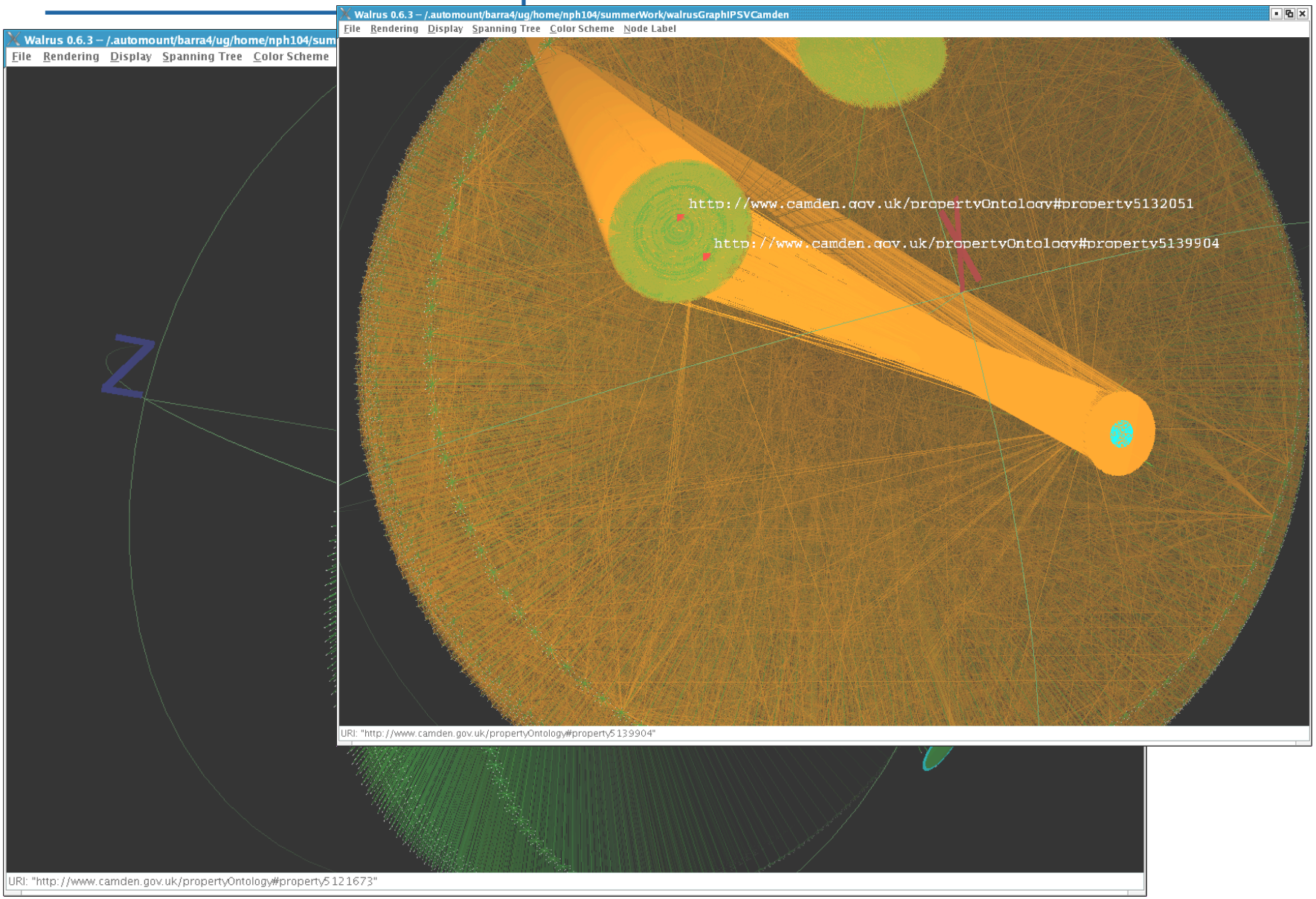
Observations on IPSV

- Mainly designed to represent "topics" not "data"
  - Good for describing documents
  - Bad for describing data!
    - You can find metadata about housing topics, but there isn't a 'House' class
- Not enough comments are given to explain the choice and meaning of Terms
- Some topics are scattered in many places
  - E.g licences are placed in many different IPSV branches
- The taxonomy can not be used as class hierarchy
  - Causes problems when using RDF/OWL inference
  - IPSV isA relations are for topics, not concepts



- Mapping to IPSV or similar broad ontologies is useful
  - Facilitates integration of distributed KBs
  - Helps to disambiguate local terminology
    - Eg insolvencyOntology:Court → ipsv:Courts of law (ie not a tennis court!)
    - foodPremises:Alternative_Medicine → ipsv:Complementary medecine
- Not enough abstract terms in IPSV
  - eg no term to represent Road or Street, but it has 15 road related terms, such as Road Accident, Road Works, Road Signs, Road Safety
  - nothing to map Addresses to

Integration Overview



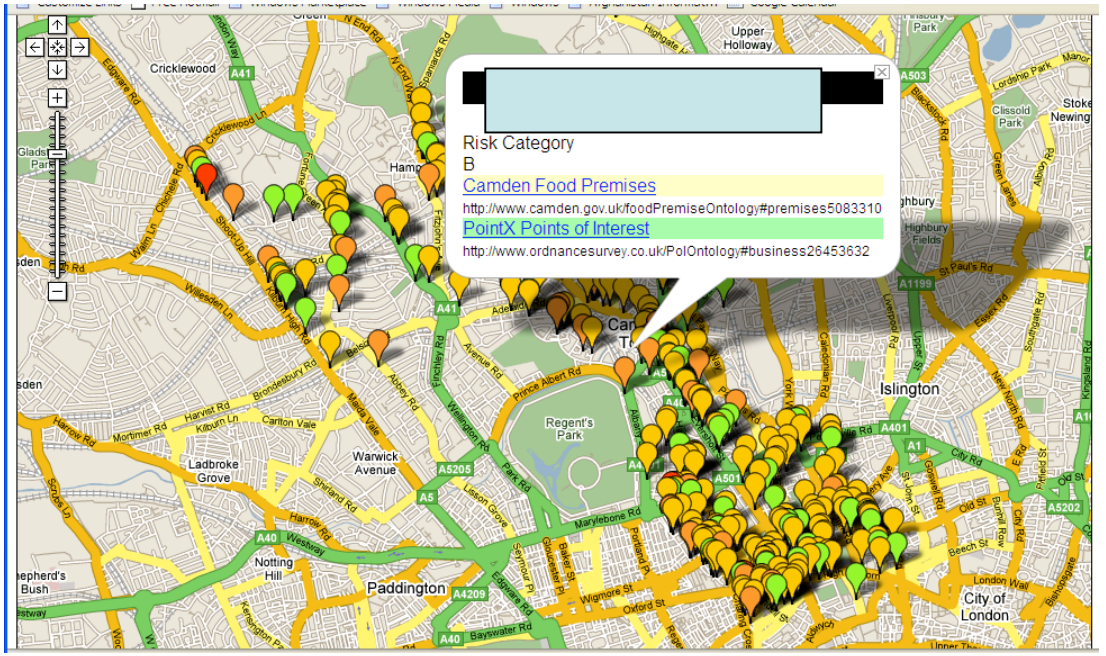
Example Mashups

1. Camden's food premises + OS Address Layer 2 + PointX

2. Lewisham's Land & Property Gazetteer + Address Layer 2 + PointX

Camden Food Premises

- Food premises db provides food hygiene check results
  - But does not have coordinates
- This was *mashed up* with AddressLayer 2 and PointX to retrieve coordinates
- Result is a map with locations of food premises in Camden, coloured according to their total score of hygiene



Public Awareness

- [redacted] received very good reviews from the public
  - Scoring 9.3 Food, 8.2 Service, 8.2 Atmosphere, and 9 Value out of 10 in http://www.london-eating.co.uk/[redacted]
  - Top ratings in http://www.timeout.com/london/restaurants/reviews/[redacted]

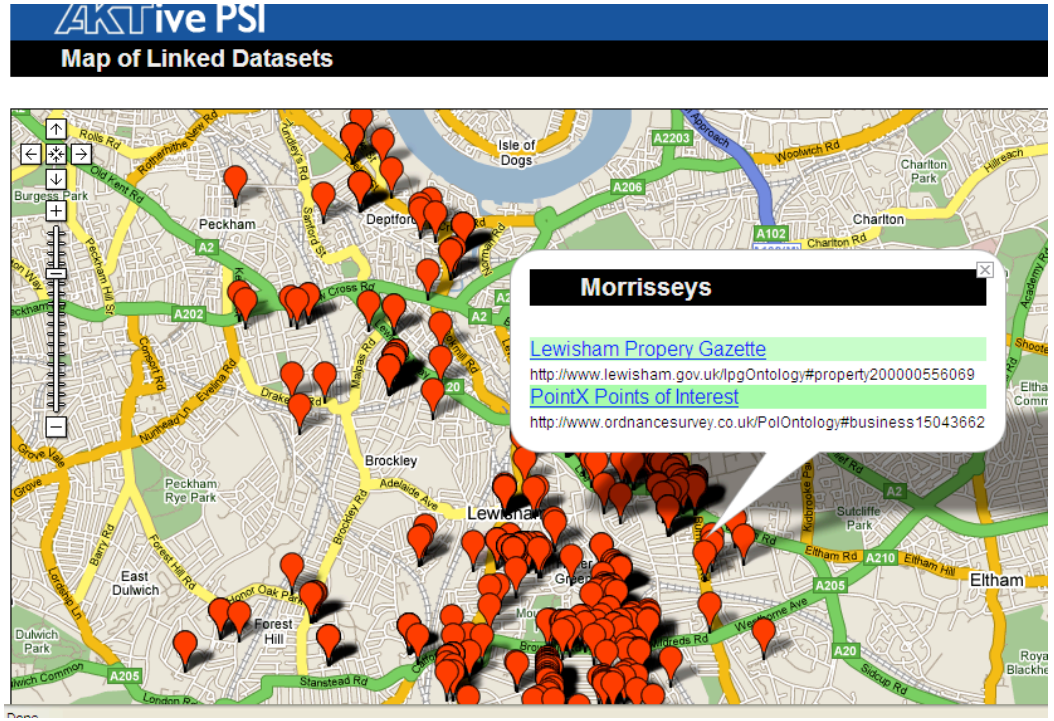
- While it scored quite badly in Camden's health checks:

has-name	[redacted]
has-potential-hazard-handling-value	Preparation_High
has-potential-hazard-method-value	LowRiskActivity
has-consumers-at-risk-value	Few
has-hygiene-and-safety-compliance-value	ImprovementNeeded
has-structural-compliance-value	ImprovementNeeded
has-confidence-in-management-value	ImprovementNeeded
hasE-coli-0157Risk	NotSignificant
has-risk-band	A
has-risk-total	100
has-telephone-number	[redacted]
date-last-review	14/01/2008

- Easy access to these results can act as a great incentive for businesses to stay "clean"

Lewisham's LPG

- LPG gives addresses and coordinates of Lewisham properties
  - But has no information about what the property is (e.g. residential, business, restaurant)
- Mashed up with AddressLayer 2 and PointX to retrieved more info about the property



Some Observations

- Lack of temporal data
  - E.g. when a business was established, closed down
- No detail for why a record was changed
  - E.g. some dbs have dates of changes, but not clear what has changed
- No commonly used unique property numbers:
  - E.g. Bento Café:
    - PointX ID: 21012114
    - Camden UPRN: 5087738
    - OS2 UDPRN: 17647957
    - OS address key: 27172769
- Data does not distinguish between single and multi business premises
  - Camden food premises:
    - **Bento Café** 9 NW1 7PG
  - OS2
    - **Bento Café** 9 NW1 7PG
  - PointX
    - **Bento Café** 9 NW1 7PG.
      Perennis Ltd 9 NW1 7PG
  - Is this an error? Is it a business that replaced/ got replaced by Bento Café? Is it a company that is located above Bento Cafe and using the same address?
  - Answer: it is a large building with several businesses!
  - Perennis Ltd is not in any of *our* Camden's datasets

Conclusions

- Small ontologies can do the job
  - Ontologies to limited domains
  - Can be integrated in various ways
- Use of ontologies
  - Data mapping and integration made easier
  - Helped to understand the data models
  - Flexibility of representation
  - Overall, we created around 19 million RDF statements
- Much can be gained when the data is integrated
  - Data about the same place or object is distributed across several databases and organisations
  - Data enrichment, consistency checks, better analysis
  - Better to integrate data from various sources, rather to duplicate it!
- Data access can be made easier
  - Mashups can be generated relatively easily
  - Search and retrieval across databases
  - Data can be published in “machine understandable” formats

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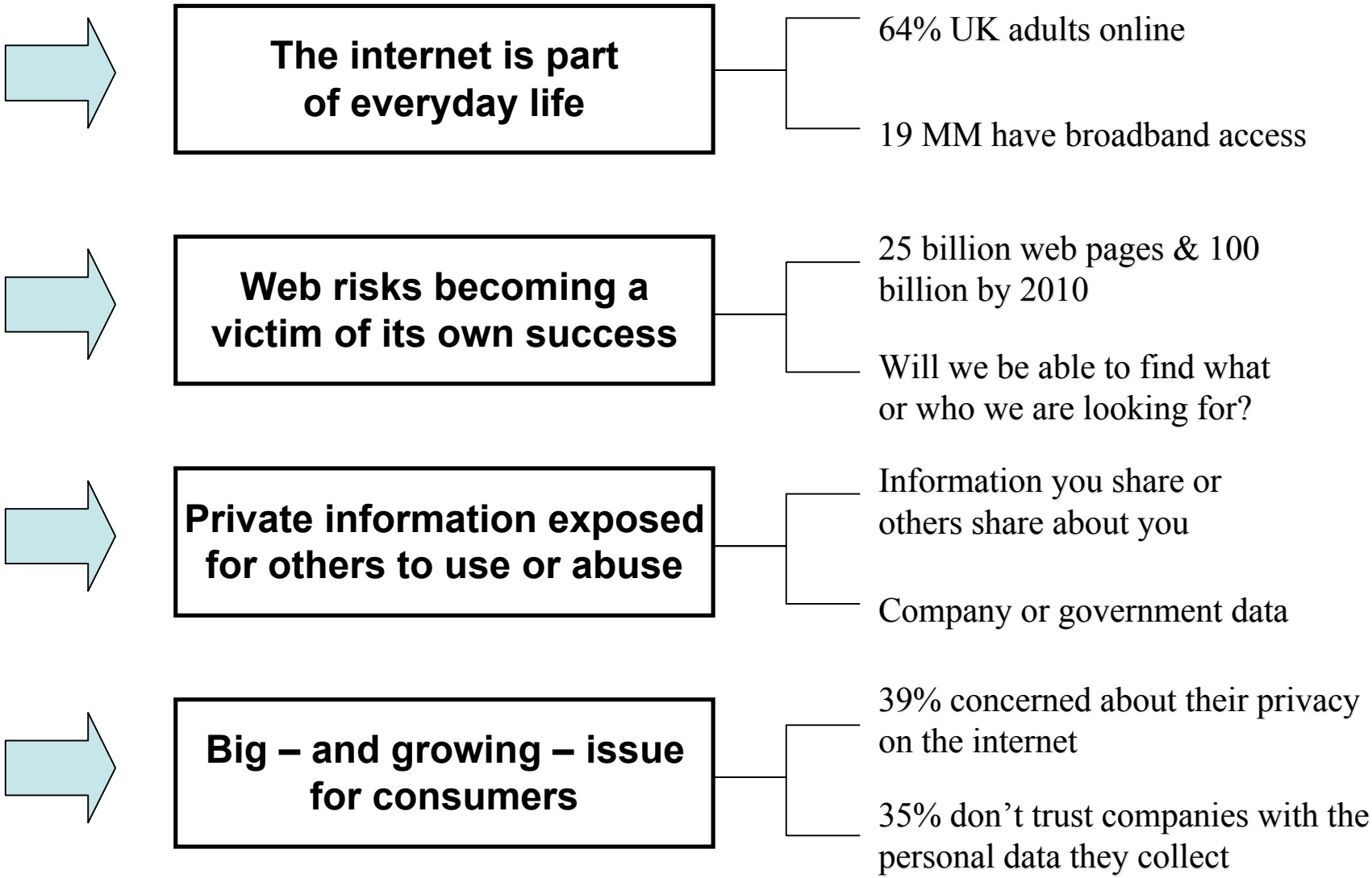
The Management Team

Tom Ilube,
Chief Executive Officer
Previously, Tom was Chief Information Officer & Executive Committee member of Egg plc, the world's largest pure online bank.

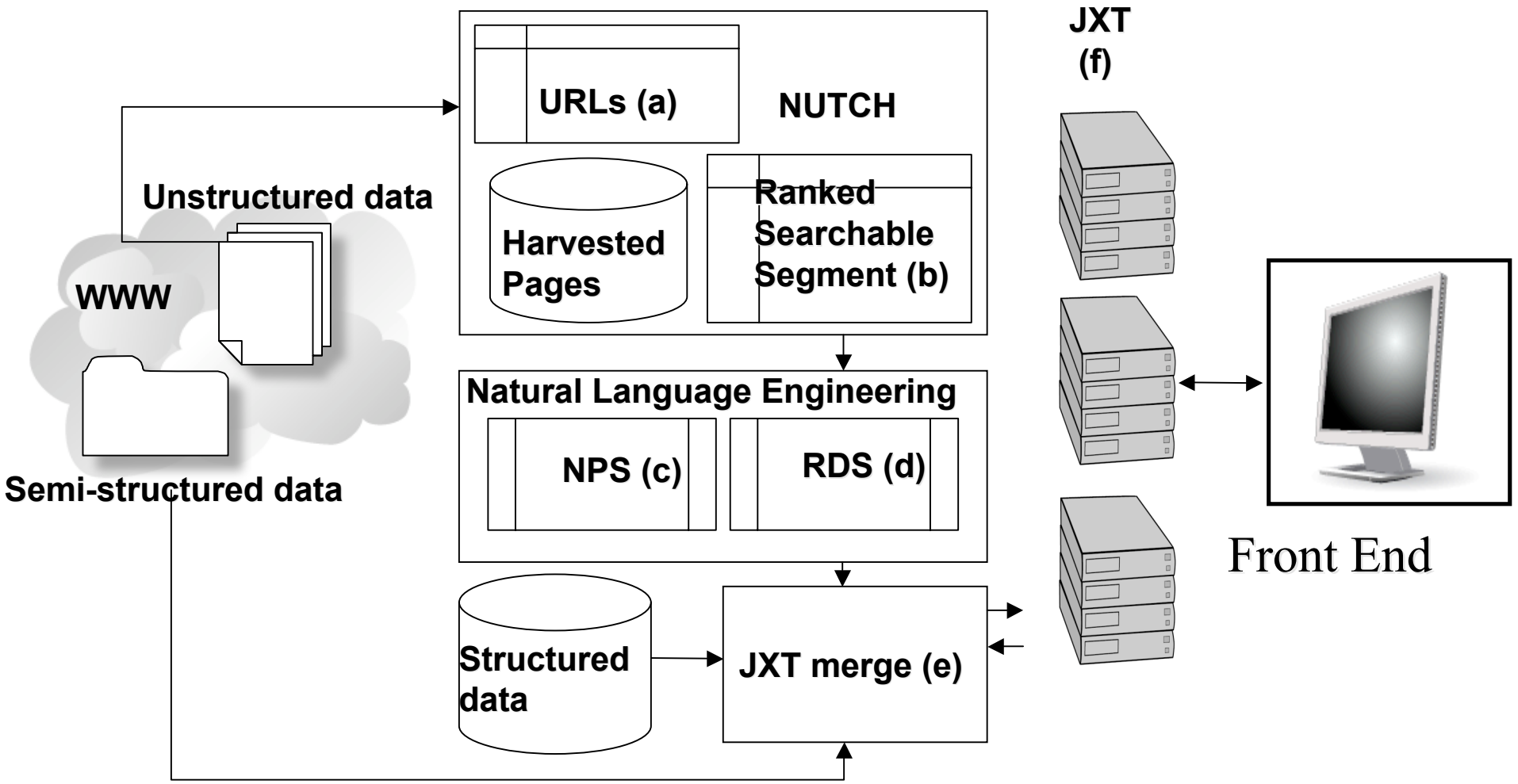
Mike Harris,
Executive Chairman
As founding Chief Executive Officer of Egg plc, Mike took Egg from concept to a £1bn public company within 3 years.

Nigel Shadbolt,
Chief Technology Officer
Nigel is a Professor in the School of Electronics & Computer Science at University of Southampton, His current research focus is the Semantic Web.

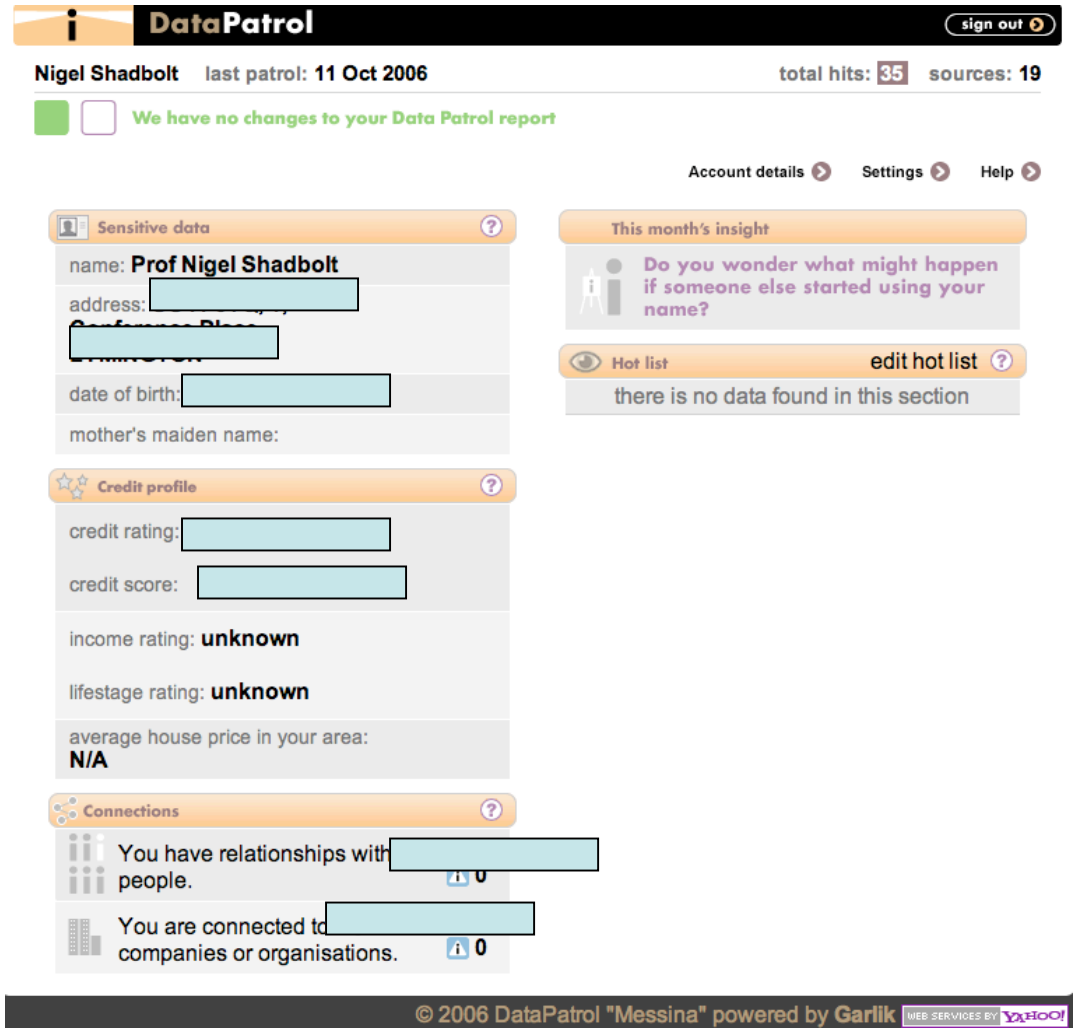
The Opportunity



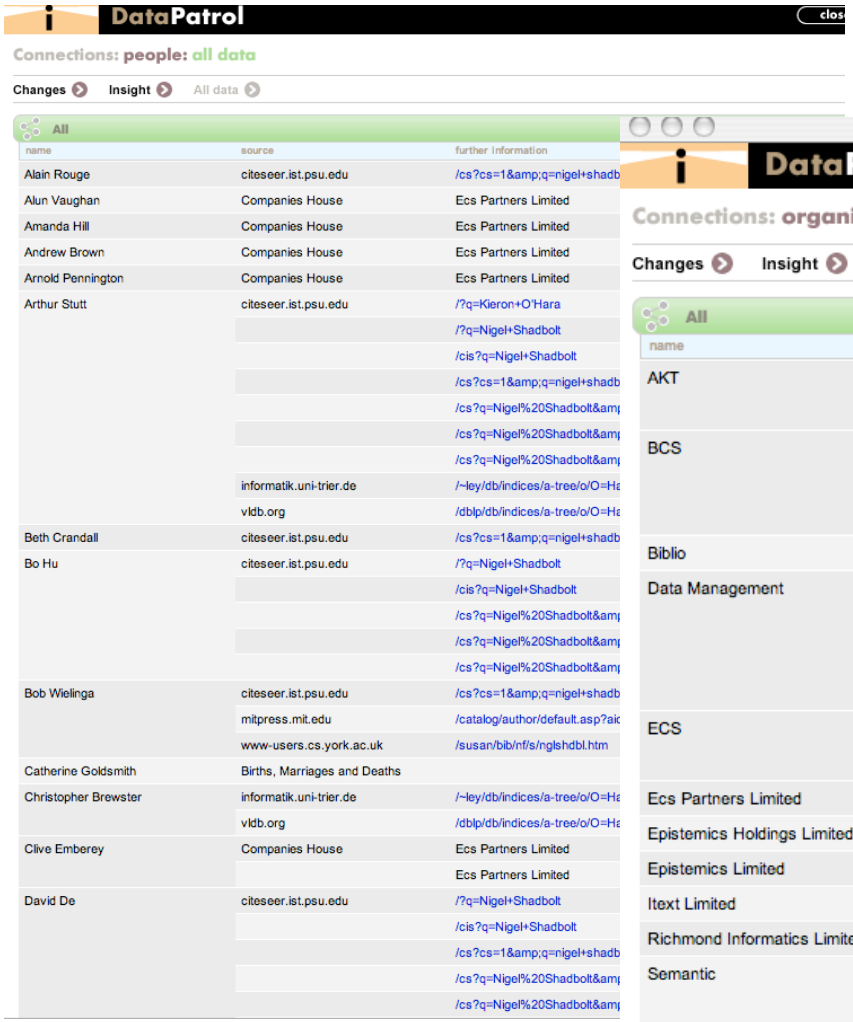
Technical Architecture



Data Patrol - Overview



Data Patrol People and Organisations



name	source	further information
Alain Rouge	citeseer.ist.psu.edu	/cs?cs=1&q=nigel+shadb
Alun Vaughan	Companies House	Ecs Partners Limited
Amanda Hill	Companies House	Ecs Partners Limited
Andrew Brown	Companies House	Ecs Partners Limited
Arnold Pennington	Companies House	Ecs Partners Limited
Arthur Stutt	citeseer.ist.psu.edu	/?q=Kieron+O'Hara
		/?q=Nigel+Shadbolt
		/cis?q=Nigel+Shadbolt
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		/cs?q=Nigel%20Shadbolt&amp
	informatik.uni-trier.de	/~ley/db/indices/a-tree/o/O=Ha
	vldb.org	/dblp/db/indices/a-tree/o/O=Ha
Beth Crandall	citeseer.ist.psu.edu	/cs?cs=1&q=nigel+shadb
Bo Hu	citeseer.ist.psu.edu	/?q=Nigel+Shadbolt
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		/cs?q=Nigel%20Shadbolt&amp
		/cs?q=Nigel%20Shadbolt&amp
Bob Wielinga	citeseer.ist.psu.edu	/cs?cs=1&q=nigel+shadb
	mitpress.mit.edu	/catalog/author/default.asp?aic
	www-users.cs.york.ac.uk	/susan/bib/nf/s/nglshdbl.htm
Catherine Goldsmith	Births, Marriages and Deaths	
Christopher Brewster	informatik.uni-trier.de	/~ley/db/indices/a-tree/o/O=Ha
	vldb.org	/dblp/db/indices/a-tree/o/O=Ha
Clive Emberey	Companies House	Ecs Partners Limited
		Ecs Partners Limited
David De	citeseer.ist.psu.edu	/?q=Nigel+Shadbolt
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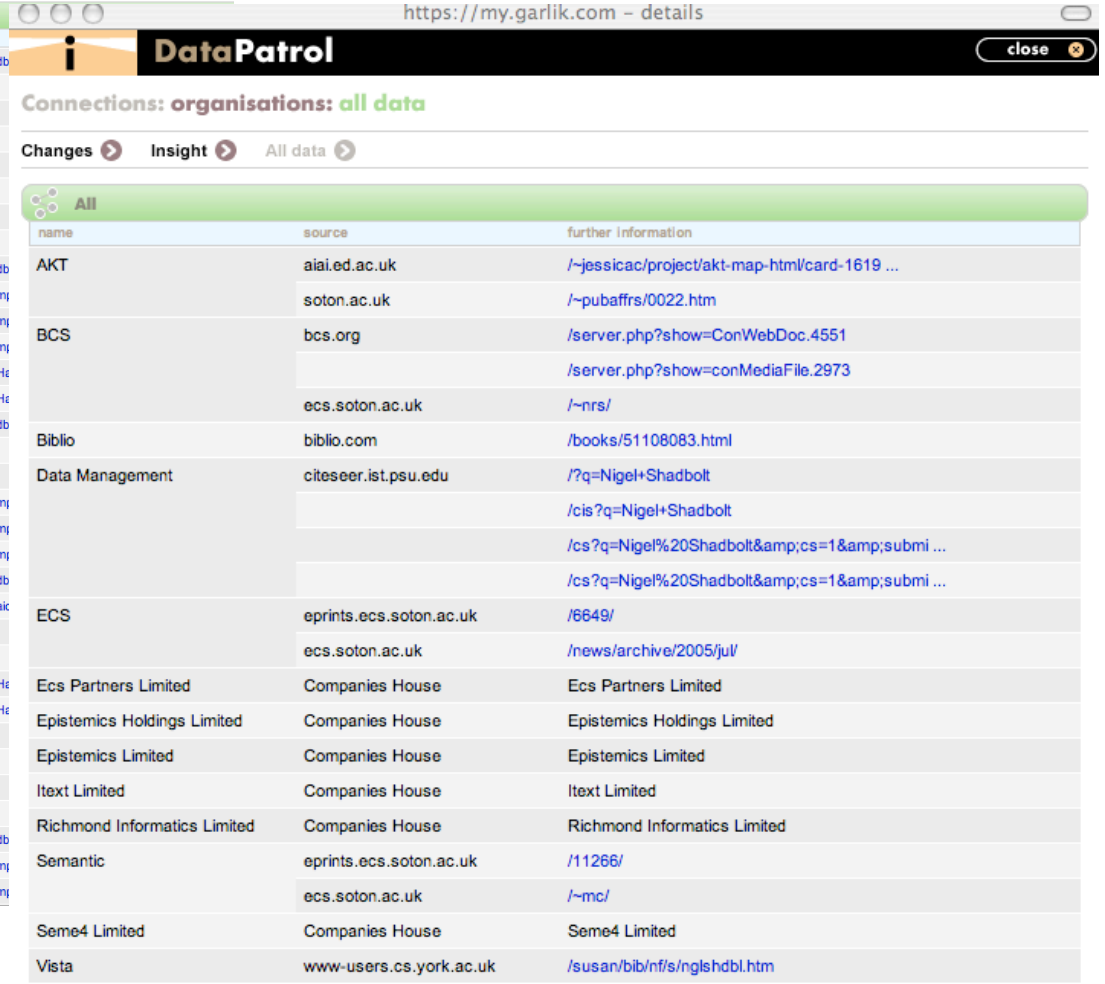

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AKT	aiai.ed.ac.uk	/~jessicac/project/akt-map-html/card-1619 ...
	soton.ac.uk	/~pubaffrs/0022.htm
BCS	bcs.org	/server.php?show=ConWebDoc.4551
		/server.php?show=conMediaFile.2973
	ecs.soton.ac.uk	/~nrs/
Biblio	biblio.com	/books/51108083.html
Data Management	citeseer.ist.psu.edu	/?q=Nigel+Shadbolt
		/cis?q=Nigel+Shadbolt
		/cs?q=Nigel%20Shadbolt&cs=1&submi ...
		/cs?q=Nigel%20Shadbolt&cs=1&submi ...
ECS	eprints.ecs.soton.ac.uk	/6649/
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Ecs Partners Limited	Companies House	Ecs Partners Limited
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