# Multi-agent and Semantic Web Systems: RDF Models

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# TBL announcement reported by BBC

http://news.bbc.co.uk/1/hi/technology/8470797.stm

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## Tim Berners-Lee unveils government data project

**Web founder Sir Tim Berners-Lee has unveiled his latest venture for the UK government, which offers the public better access to official data.**

A new website, data.gov.uk, will offer reams of public sector data, ranging from traffic statistics to crime figures, for private or commercial use.

Sir Tim Berners-Lee was hired to work on the project last June

The target is to kickstart a new wave of services that find novel ways to make use of the information.

Sir Tim was hired by PM Gordon Brown in June 2009 to oversee the project.

Developers have already built a site that displays the location of schools according to the rating assigned to them by education watchdog Ofsted.

"It's such an untapped resource," Sir Tim told BBC News.

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RELATED INTERNET LINKS

- data.gov.uk
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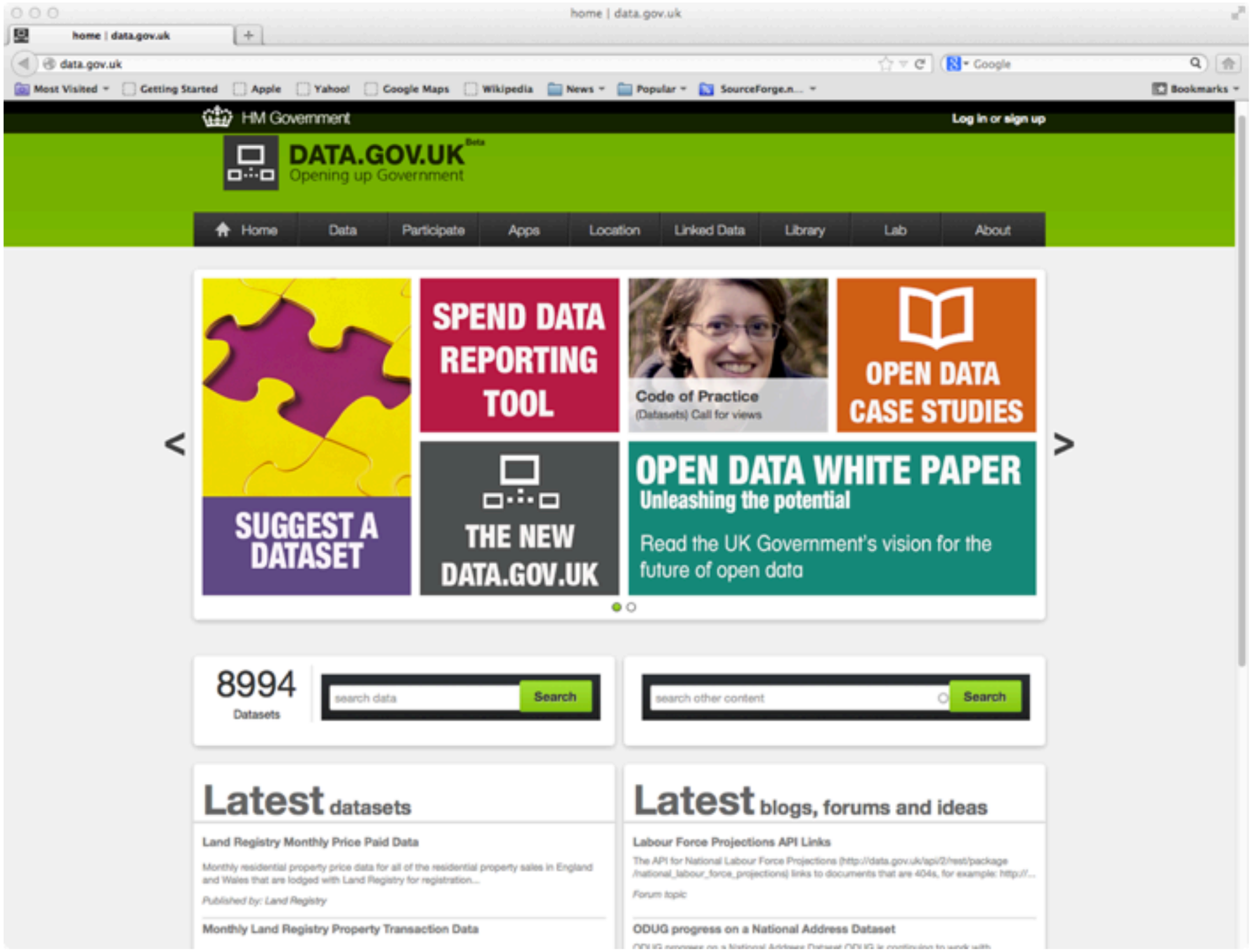
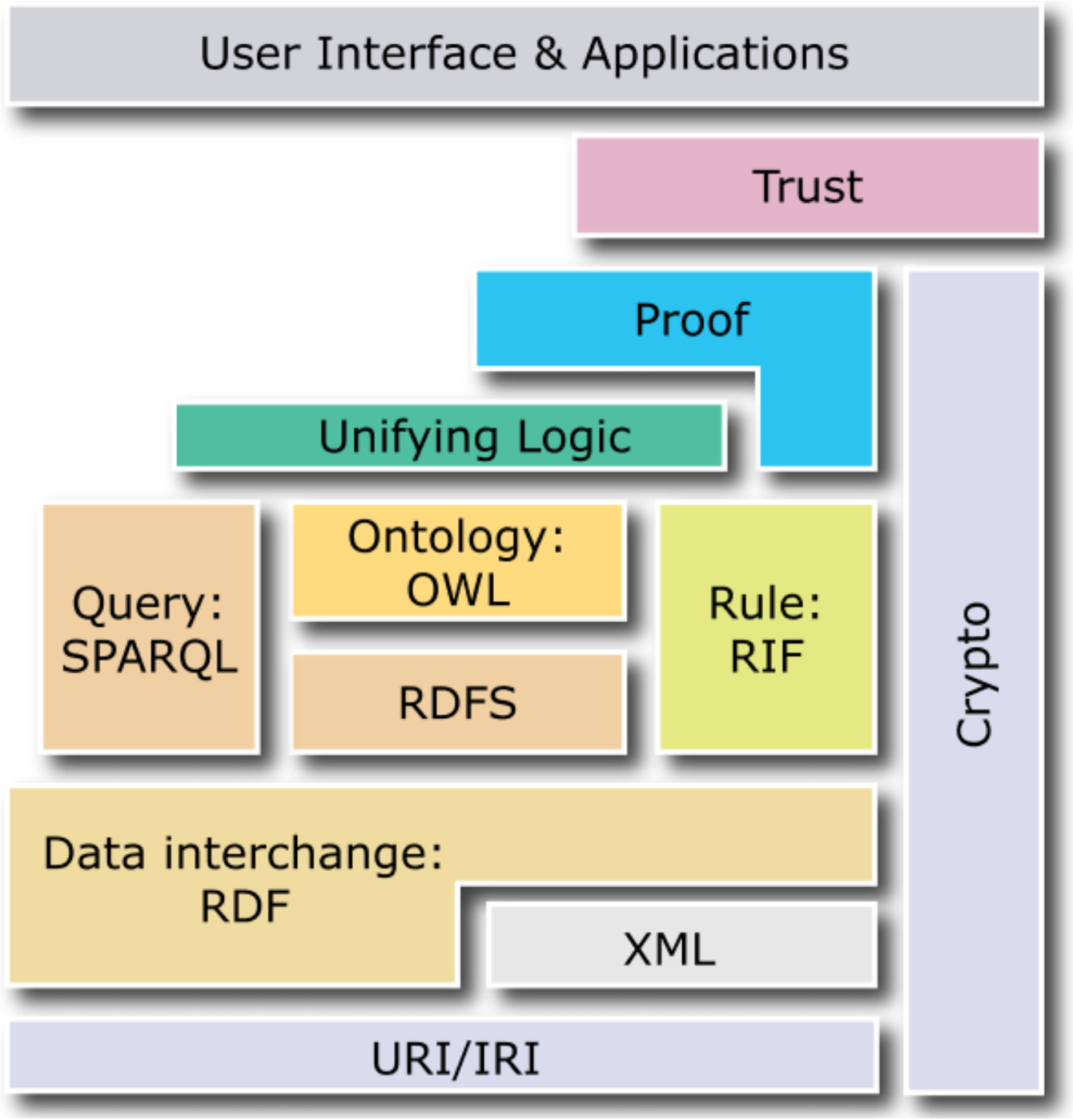
# data.gov.uk/

http://data.gov.uk/



# Semantic Web 'layer cake'



# Tabular Data

| Name | Location | Stars | LovedBy |
|---|---|---|---|
| Elephant & Bagel | Central | **** | Bea, Amy |
| Artisan Roast | East End | ***** | Stuey, Rod |
| Peter's Yard | Central | **** | Amy |
| Himalaya Art & Craft | Southside | *** | Rod |
| Vittorio | Central | **** | Stuey |

# Relational Data

**Cafes**

| ID | Name | Location | Stars |
|---|---|---|---|
| 1 | Elephant & Bagel | Central | **** |
| 2 | Artisan Roast | East End | ***** |
| 3 | Peter's Yard | Central | **** |
| 4 | Himalaya Art & Craft | Southside | *** |
| 5 | Vittoria | Central | **** |

**LovedBy**

| CafeID | Person |
|---|---|
| 1 | Bea |
| 1 | Amy |
| 2 | Stuey |
| 2 | Rod |
| 3 | Amy |
| 4 | Rod |
| 5 | Stuey |

# Schema Modification

As we add more data, we might want to extend the schema:

**Cafes & Restaurants**

| ID | Name | Cuisine | Location | Stars |
|---|---|---|---|---|
| 1 | Elephant & Bagel | | Central | **** |
| 2 | Artisan Roast | | East End | ***** |
| 3 | Peter's Yard | | Central | **** |
| 4 | Himalaya Art & Craft | | Southside | *** |
| 5 | Vittoria | Italian | Central | **** |
| 6 | Kalpna | Indian | Southside | ***** |
| 7 | Nile Valley | African | Central | *** |
| 8 | Olive Branch | Mediterranean | East End | ** |

# Distributed data: simplified relational table

**Cafes**

| ID | Name | Location | Stars |
|---|---|---|---|
| 1 | Elephant & Bagel | Central | **** |
| 2 | Artisan Roast | East End | ***** |
| 3 | Peter's Yard | Central | **** |
| 4 | Himalaya Art & Craft | Southside | *** |
| 5 | Vittoria | Central | **** |

# AAA (Tim Berners-Lee)

## Anyone can say Anything about Anything

The Web works though anyone being (technically) allowed to say anything about anything.

*What the Semantic Web isn't but can represent* (1998)

# Distributed data: rows

Server1

| | | | |
|---|---|---|---|
| 1 | Elephant & Bagel | Central | **** |
| 2 | Artisan Roast | East End | ***** |

Server2

| | | | |
|---|---|---|---|
| 3 | Peter's Yard | Central | **** |

Server3

| | | | |
|---|---|---|---|
| 4 | Himalaya Art & Craft | Southside | *** |
| 5 | Vittoria | Central | **** |

# Distributed data: columns

Server1

| Name |
| --- |
| Elephant & Bagel |
| Artisan Roast |
| Peter's Yard |
| Himalaya Art & Craft |
| Vittoria |

Server2

| Location |
| --- |
| Central |
| East End |
| Central |
| Southside |
| Central |

Server3

| Stars |
| --- |
| **** |
| ***** |
| **** |
| *** |
| **** |

# AAA (Tim Berners-Lee)

## Anyone can say Anything about Anything

The Web works though anyone being (technically) allowed to say anything about anything.

This means that a relationship between two objects may be stored apart from any other information about the two objects.

*What the Semantic Web isn't but can represent* (1998)

# Distributed data: cells

Server1

| | Name |
|---|---|
| 1 | Elephant & Bagel |

Server2

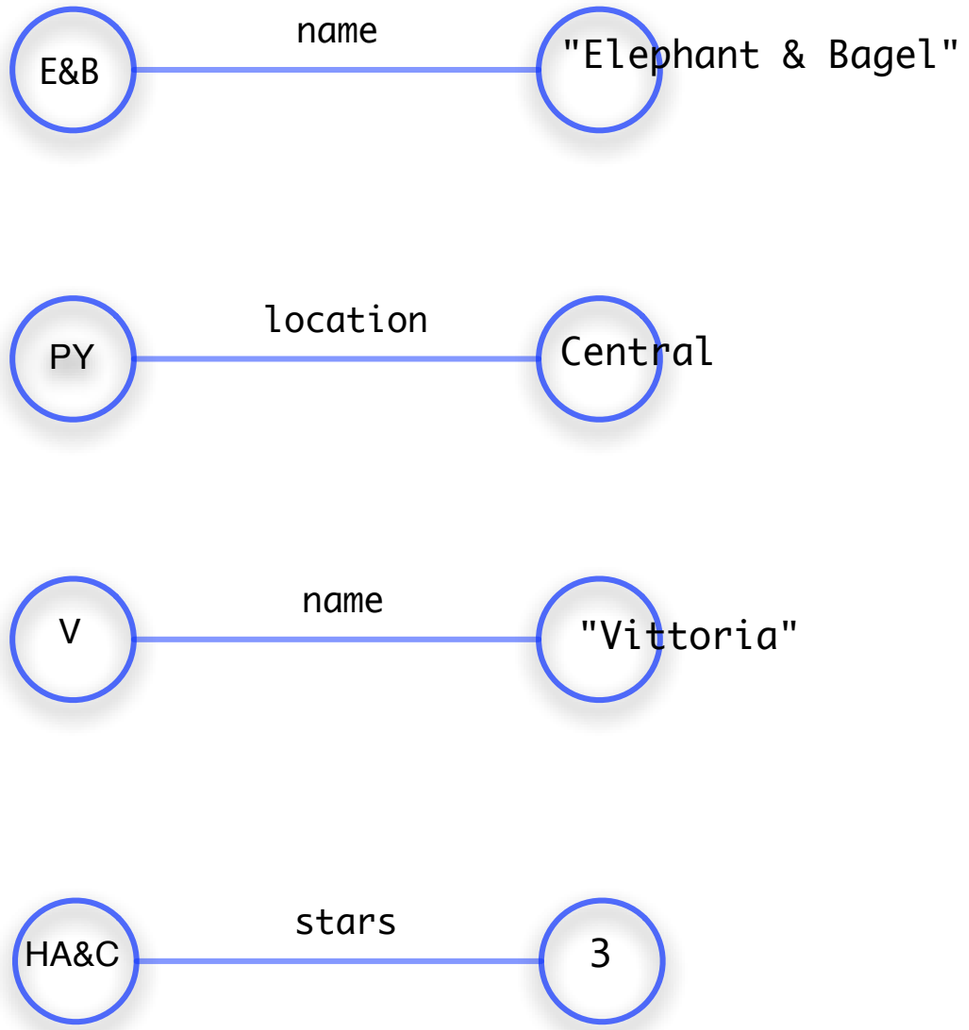
| | Stars |
|---|---|
| 4 | *** |

| | Location |
|---|---|
| 3 | Central |

Server3

| | Name |
|---|---|
| 5 | Vittoria |

# Cells as triples

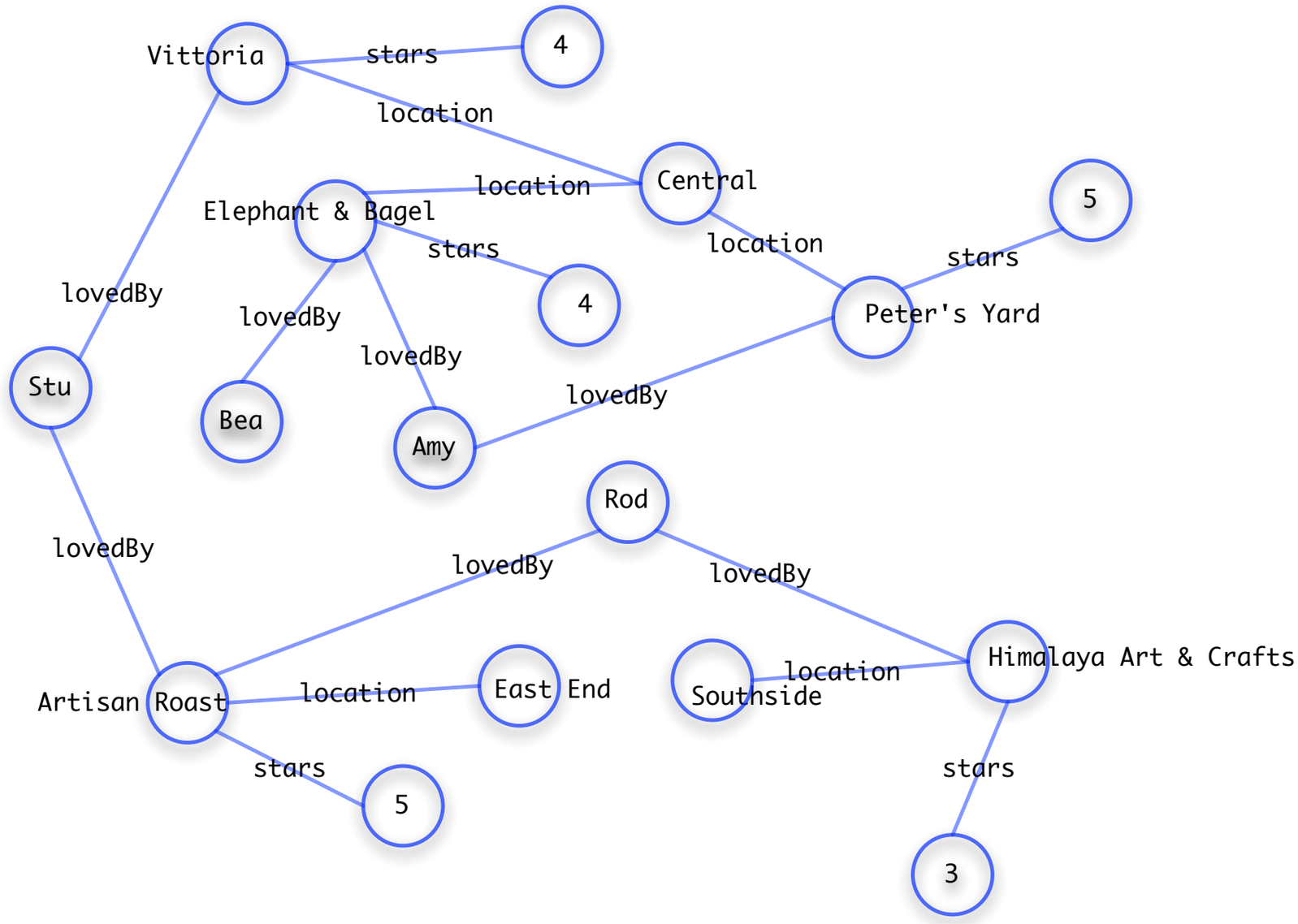


# Cafe relation again

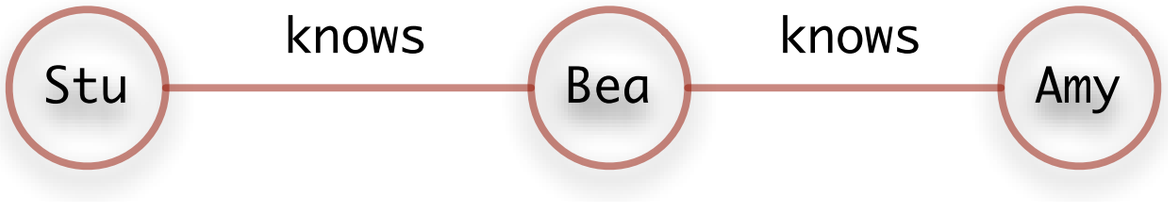
**Cafes**

| ID | Name | Location | Stars |
|---|---|---|---|
| 1 | Elephant & Bagel | Central | **** |
| 2 | Artisan Roast | East End | ***** |
| 3 | Peter's Yard | Central | **** |
| 4 | Himalaya Art & Craft | Southside | *** |
| 5 | Vittoria | Central | **** |

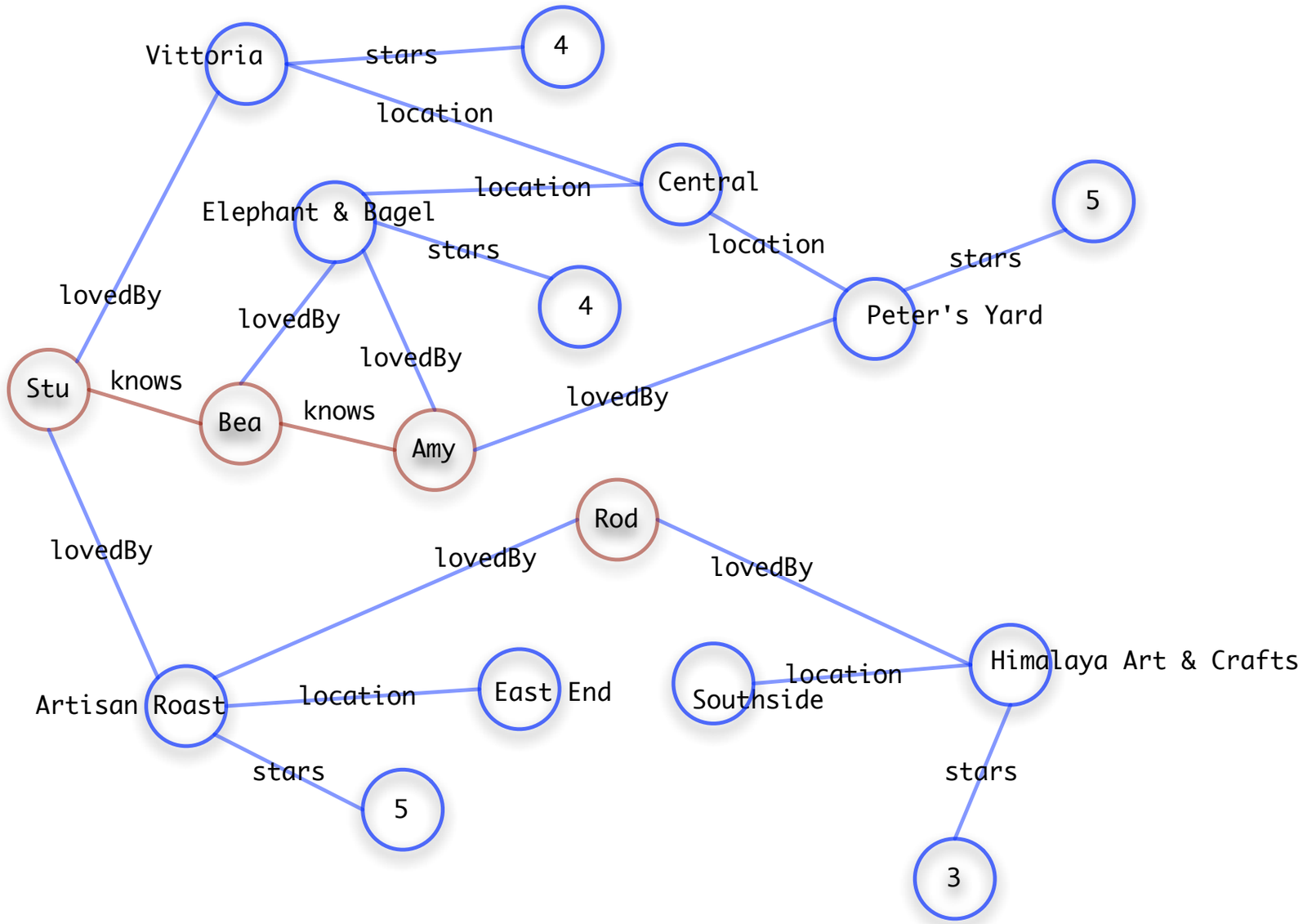
# Cafe graph


Vittoria
stars
4
location
Central
location
Elephant & Bagel
stars
4
location
5
stars
Peter's Yard
lovedBy
lovedBy
lovedBy
lovedBy
Stu
Bea
Amy
Rod
lovedBy
lovedBy
lovedBy
Artisan Roast
location
East End
stars
5
Southside
location
Himalaya Art & Crafts
stars
3

# Knows graph



# Merging two graphs



# What do HTTP URIs identify?

- In RDF, URIs identify resources, they do not retrieve them.
- Not every resource has a digital representation.
- http://homepages.inf.ed.ac.uk/ewan/index.html — does this identify
  - Ewan Klein
  - a document about Ewan Klein?
- Alternative suggestion (cf. assignment 1):
http://homepages.inf.ed.ac.uk/ewan/foaf.rdf#ehk
- http://www.inf.ed.ac.uk/ontology#hip-hop

will trigger a 404 Not Found response, but it is a valid URI.

# URI References and Fragment Identifiers, I

A URI Reference (URIref) is a URI with an optional fragment identifier at the end:

**URI with Fragment Identifier**

# URI References and Fragment Identifiers, 2

Fragment identifiers commonly used to identify specific locations in HTML documents:

**Fragments in HTML Pages**

```
http://www.example.com/index.html
http://www.example.com/index.html#Section2
```

In RDF, the two URIs above are independent identifiers.

URIs with fragment identifiers commonly called hash URIs

# XML QNames

Tedious to have to write out complete URIs.

Alternative: XML Qualified Names (QNames)

1. Associate a prefix with a URI;
2. follow it with a colon (:) and a local name

## Some Prefixes

| Prefix | Namespace URI |
|---|---|
| edstaff | http://www.ed.ac.uk/staffid# |
| infcourses | http://www.inf.ed.ac.uk/teaching/courses/ |
| dc | http://purl.org/dc/elements/1.1/ |
| dbpedia | http://dbpedia.org/resource/ |

# XML QNames, 2

**Example QNames**

```
edstaff:9888
infcourses:masws
dc:creator
dbpedia:In_the_Heart_of_the_Moon
```

- *Cf.* namespaces in XML.
- Qnames are not URIs.
- How do we convert QNames back to full URIs?
  - First, replace the prefix plus colon by the Namespace URI;
  - then append the local name.

# Using URIs in RDF

- RDF uses URIs for identifying resources.
- Predicate meanings are also resources!
- So URIs also used for identifying the predicates of RDF triples.

RDF and First Order Logic

- `ex:index.html dc:creator ex:ewan.`
- *triple*(`ex:index.html`,`dc:creator, ex:ewan`)
- So subject, predicate and object are all individuals.
- Contrast with framebased and OO approaches.

# RDF syntax: N3

- Various forms of syntax for expressing RDF.
- Although XML is the recommended standard, it is not very intuitive.
- N3 (or Notation 3) developed as a simpler human-readable syntax; see http://www.w3.org/2000/10/swap/Primer.
- I've been implicitly using a N3-style syntax so far.
  - A sequence of three URIs, terminated by a period.
  - Various syntactic abbreviations ...

# RDF syntax: Turtle

- N3 has been largely superseded by Turtle (Terse RDF Triple Language), which is a cleaned-up subset of N3:
  - http://www.w3.org/TeamSubmission/turtle/
- Originally developed by Dave Beckett, now in the process of becoming a W3C Recommendation.
- Usable within SPARQL RDF queries.

**N3/Turtle: RDF Triples with Prefix**

```
@prefix dc: <http://http://purl.org/dc/elements/1.1/> .
@prefix geo: <http://www.w3.org/2003/01/geo/wgs84_pos#> .
@prefix : <http://inf.ed.ac.uk/ont#> .

:E&Bagel dc:title ”Elephant and Bagel” .
:E&Bagel geo:location geo:Central .
:E&Bagel :stars 4 .
```

# RDF vocabulary

- An RDF vocabulary is a set of URIs, not words.
- An organization can define its own vocabulary, using its own URI prefix.
- Example: Dublin Core elements (`dc:title`, `dc:creator`, `dc:date`, `...`).
- But RDF doesn't analyse URIs and doesn't give special interpretation of common prefix.
- Often a URI will point to, or redirect to, a location where informative content about the resource can be be found.

**Shared Vocabularies**

Using URIs for subjects, predicates and objects in RDF is intended to encourage the development of shared vocabularies on the web.

# Example: FOAF vocabulary

- FOAF (Friend of a Friend) Project (`http://www.foaf-project.org/`): defines terms (in RDF) for machine-readable Web homepages for people, groups, companies, etc.
- Initial focus on the description of people, since they link together most other things on the Web:
  - they make documents,
  - attend meetings,
  - are depicted in photos, etc
- FOAF Vocabulary: `http://xmlns.com/foaf/0.1/`
- Early example of linked data.

**Some FOAF Relations**

`foaf:name`
`foaf:knows`
`foaf:homepage`
`foaf:weblog`
`foaf:mbox`

# Summary

- RDF: "Anyone can say Anything about Anything",
  - but only using binary relations.
- RDF only specifies the syntax of subject-predicate-object triples; it doesn't ascribe fixed meaning to any vocabulary (with a small number of exceptions).
- RDF Vocabulary consists of URIs, not ordinary words.
- How do I specify that I'm using 'creator' in the same sense as Dublin Core?
  - I use dc:creator
- How do you know if my myvocab:author is the same as dc:creator?
  - In general, you don't. But there might be a mapping between my vocabulary and Dublin Core.

# Review Questions

- Where does RDF allow literal values to occur?
- What is the difference between a URI and a URL?
- What is a fragment identifier?
- What convention is used to abbreviate URIs in informal presentations of RDF?
- What are the main differences between Dublin Core elements and RDF?
- What is an RDF Vocabulary?
- Can a general-purpose RDF processor be expected to know the meaning of dc:creator?

# Reading and Task

- Read
  - SWWO Chapter 3
  - Also worth reading: W3Cs RDF Primer (http://www.w3.org/TR/rdf-primer/), up to and including Section 2.2

  with the following question in mind:
  - Why is RDF currently the most common representation used on the Semantic Web?
- write a 0.5-1 page summary