Introduction to Linked Data

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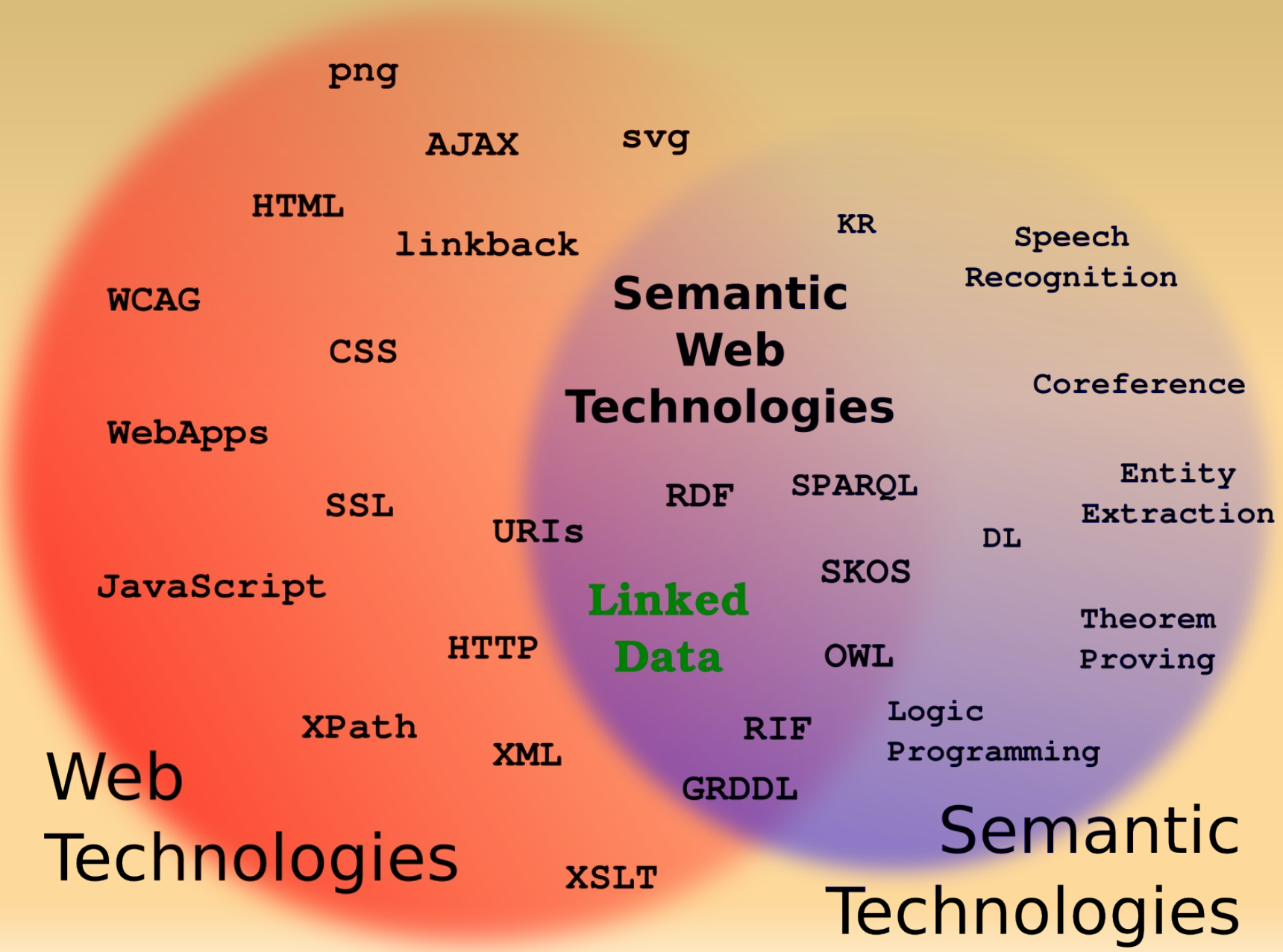
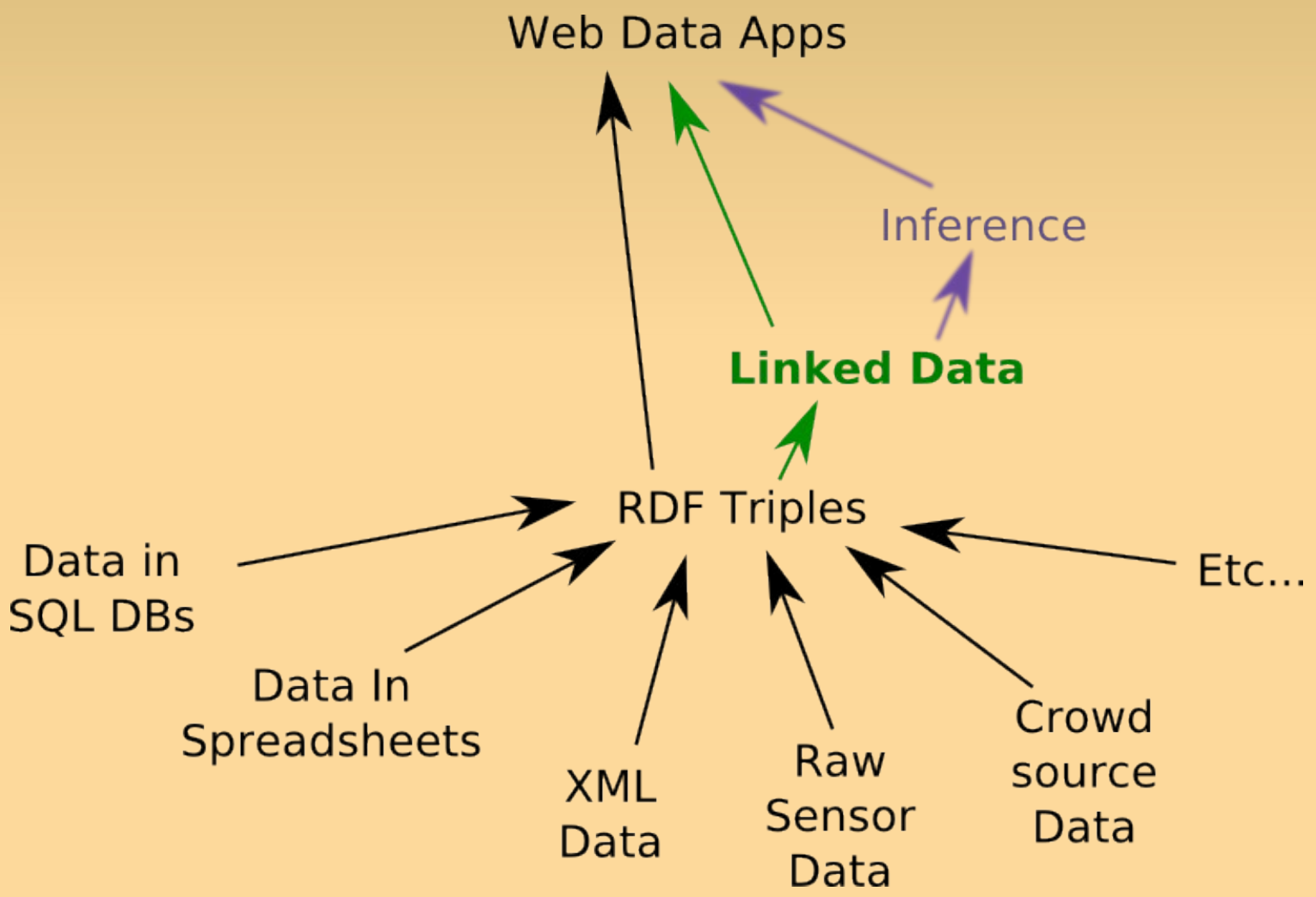
Outline

- Context
- Motivation
- Prerequisites (Web, RDF)
- Using Live URIs as Identifiers
- Related and Future Work
- Questions

Technology Context



The Flow of Data



Linked Data: Why?

- So apps can find data
- … without centralization:
  - No central bottlenecks
  - No central point-of-failure
  - No central policies (privacy? security)?
  - No need for permission
- Use existing social structures
- Use existing (Web) technology structures

Anyone Can Say Anything

- Whatever your business, projects, thoughts
- … and others can find/filter/analyze/reuse

http://www.flickr.com/photos/dalbera/2738451853/

http://www.flickr.com/photos/conlawprof/520329163

So How Do We Do It?

- **Be Linkable**

  (Good Website Design)
- **Show Your Triples**

  (Export as RDF)
- **Use Live URIs**

  (The Heart of Linked Data)

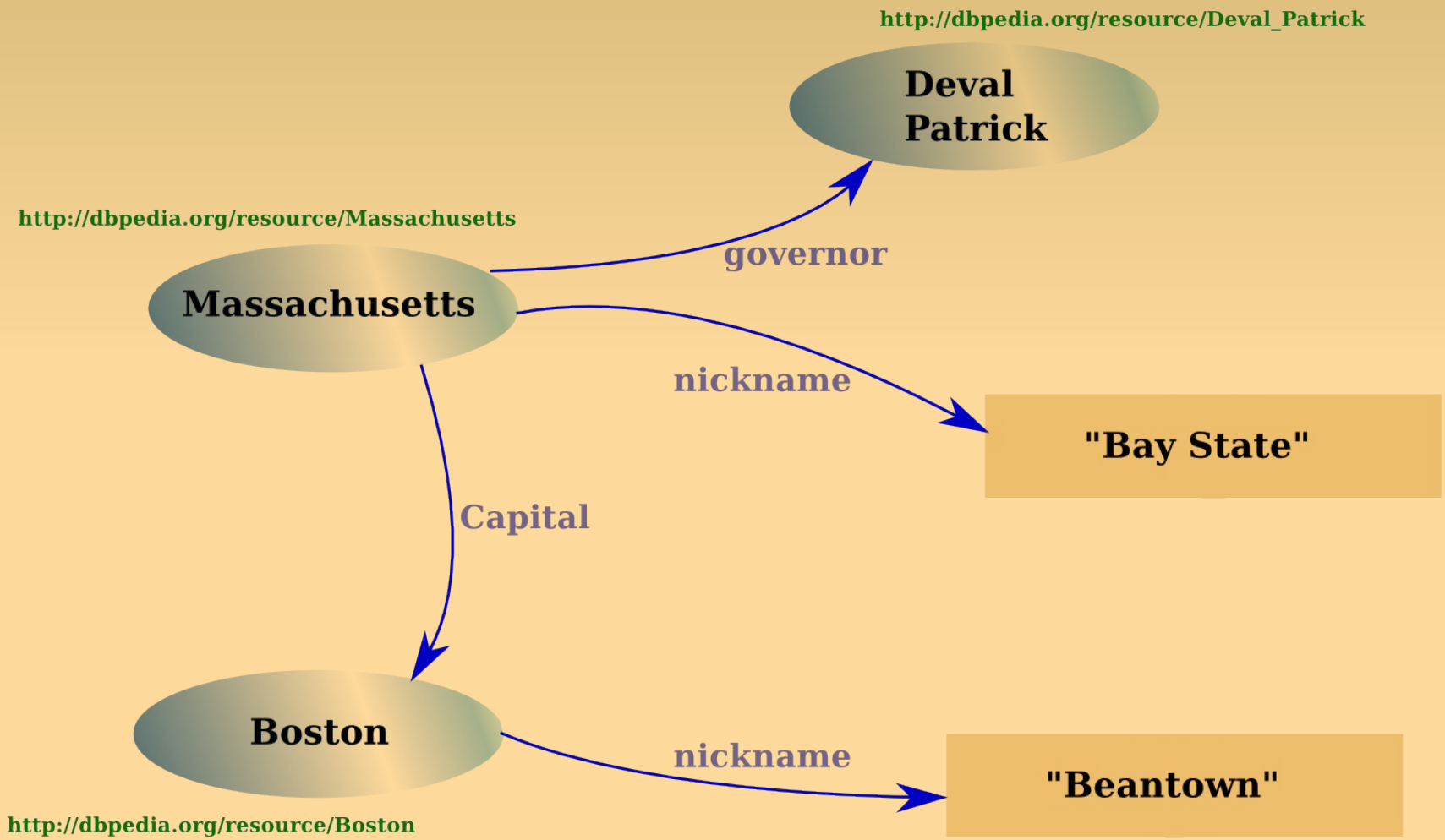
#1: Be Linkable

- Put your information on your website
- Invest in content management
- Consider offering public APIs
- Use Good URLs
  - Readable, Unambiguous, … even in 10 years
- Support caching
- Support content negotiation
- Publish your URL Survival Plan

#2: Show Your Triples

- Think of your data as RDF triples:
  - For each item of interest
  - For each question about that item
  - Supply the answer (if you have it)
- About Massachusetts:
  - Governor? Deval Patrick
  - Nickname? “Bay State”
  - Capital? Boston
- And Boston? Does it have a nickname? ...

Seen as a “Graph”



In Turtle (N3)

```
@prefix db: <http://dbpedia.org/resource/>
db:Massachusetts db:Governor db:Deval_Patrick;
                 db:Nickname "Bay State";
                 db:Capital db:Boston.
db:Boston        db:Nickname "Beantown".
```

In RDF/XML

```
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
         xmlns:db="http://dbpedia.org/resource/">
  <rdf:Description rdf:about="http://dbpedia.org/resource/Massachusetts">
    <db:Governor>
      <rdf:Description rdf:about="http://dbpedia.org/resource/Deval_Patrick" />
    </db:Governor>
    <db:Nickname>Bay State</db:Nickname>
    <db:Capital>
      <rdf:Description rdf:about="http://dbpedia.org/resource/Boston">
         <db:Nickname>Beantown</db:Nickname>
      </rdf:Description>
    </db:Capital>
  </rdf:Description>
</rdf:RDF>
```

Working with RDF

- Several ways to write down triples
- Lots of software, libraries
- Query language (SPARQL)
- Works over HTTP
- Use Content Negotiation if necessary

But how do you find these triples?

(imagine a web without links)

#3a: Use URLs

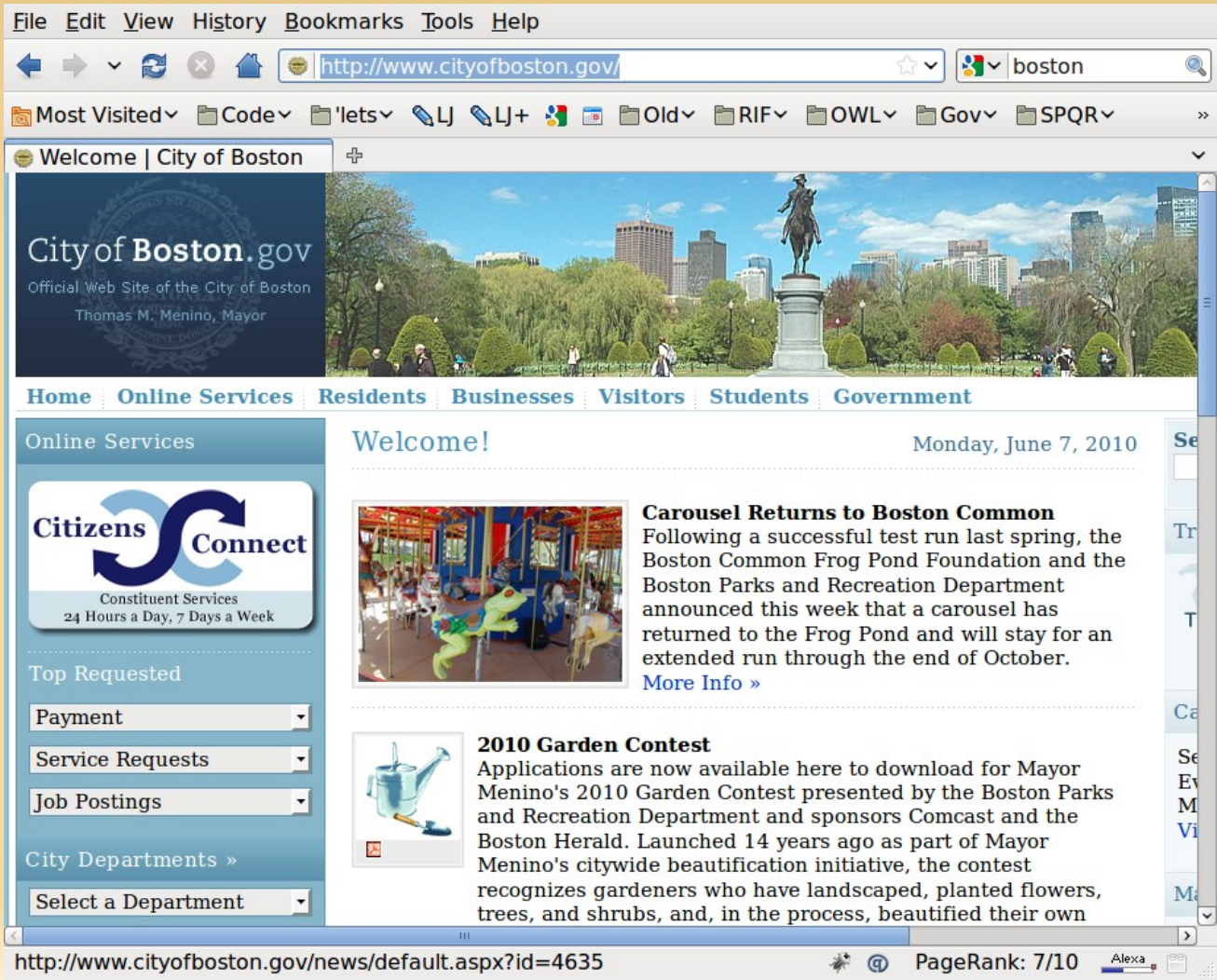
- A first use case for RDF was website metadata
  - City of Boston website: http://www.cityofboston.gov

Subject:
http://www.cityofboston.gov
(City of Boston govt site)

Property:
When was it created?

Value:
2001-02-01

Possible RDF triple in page



Links to Data

- This works great:
  - You're given the URL of a Web page
  - You do an HTTP GET on that URL
  - You get the content
  - … and you get the metadata
- This didn't catch on, but....

URLs and URIs

- Web Addresses
  - Uniform Resource Locator (URL)
  - Uniform Resource Identifier (URI)
- Beyond http, Web Addresses:
  - mailto:sandro@hawke.org
  - mid:1276004540.10196.1.camel@waldron
- Maybe everything is a “Resource”?
  - Maybe everything can have a URI!

#3b: Use Live URIs

- We want identifiers for things
  - People, places, governments, companies, products, songs, musicians, concerts, speeches, courses, schools, buildings, walkways, individual plants, species of plants, species of animals, …
- All the things we might have questions about
- All the questions themselves
- All the answers (when the answer is another thing)

The Problem

- So what URI do we use for Boston itself?
- Boston is not a Web Page
  - Boston was created in 1630
  - cityofboston.gov was created in 2001
- Requirements:
  - Get data via existing protocols (http, https)
  - Don't confused Boston with cityofboston.gov
- … a challenge!

Solution 1: Hash URIs

- Use the “fragment” syntax
  - http://www.w3.org/People/Berners-Lee/#Bio
    - Points to a section in the middle of that Web page
- The URI spec gives us a loophole
  - If URI has hash (#), see spec for Content-Type
  - http://www.w3.org/People/Berner-Lee/data
    - Content-Type is RDF, not HTML, so:
  - http://www.w3.org/People/Berners-Lee/data#I
    - identifies Tim, not a section of a Web page
- Oldest approach
  - Used in most W3C Recommendations

Solution #2: Slash URIs

- Uses a loophole in the HTTP spec:
  - GET http://dbpedia.org/**resource**/Boston
  - Server responds with redirect
    - **303 SEE OTHER**
    - LOCATION: http://dbpedia.org/**page**/Boston
  - GET http://dbpedia.org/**page**/Boston
- Again, we have two URIs:
  - A URI for the thing itself (Boston)
  - A URI for a Web page/information source about it
- Used for big URI sets (dbpedia, gov't data)

Solution 3?

- TopicPage URLs
  - Use http://www.cityofboston.gov but remember it's indirect
  - Details still need to be worked out
  - This is the kind of URL that Facebook's OpenGraphProtocol uses

The Result?

- Given a URI for Boston
  - http://dbpedia.org/resource/Boston
- An app can find out the mayor's name
  - (assuming that's in the data)
- And the mayors of associated cities
  - (assuming that's in the data)
- And the people associated with those mayors
  - (assuming that's in the data)
- … etc

A Web of Data

- Everyone can publish triples
- Everyone can read the public ones
- Read all the ones you want
- Follow URI links to other interesting data

- As always, it all depends on the data

Related Work

- RDFS/OWL (Schemas, Ontologies)
  - Helps in defining sensible properties/classes
  - Helps with automated reasoning about the data
- SKOS (Controlled Vocabularies)
  - Simple way to document concepts
- RIF (Rules)
  - Translate between vocabularies
- SPARQL (Query)
  - Query language/protocol for data in RDF triples

Open Issues

- Expected harvesting diameter?
- Expected inference behavior?
- Finding good sources, vocabularies?
- Establishing backlinks, crosslinks?
- Easy-to-use generalized client?
- Smooth integration with HTML web?
- Business models?

Summary

- Linked Data
  - Allows data apps to find/merge data
  - Builds on existing social & Web systems
- Be Linkable
  - Use best practices for publishing on the Web
- Show Your Triples
  - Publish your data as subject/property/value triples in one or more RDF formats, and maybe SPARQL
- Use Live URIs
  - Identify everything with working Hash or Slash URIs