Applied Linked Geo. Metadata

Samvera Connect 2019

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Getting Started

- GitHub (SSH Keys)
- git
- Ruby (RVM, unless you are using something else)
- Code Editors (Atom, VSCode, Sublime, vim, emacs, ed...)
- Browsers
  - Please use Chrome/Brave or Firefox
- Network Connection
  - VPNs should be fine, but please do not use Tor
- Slack

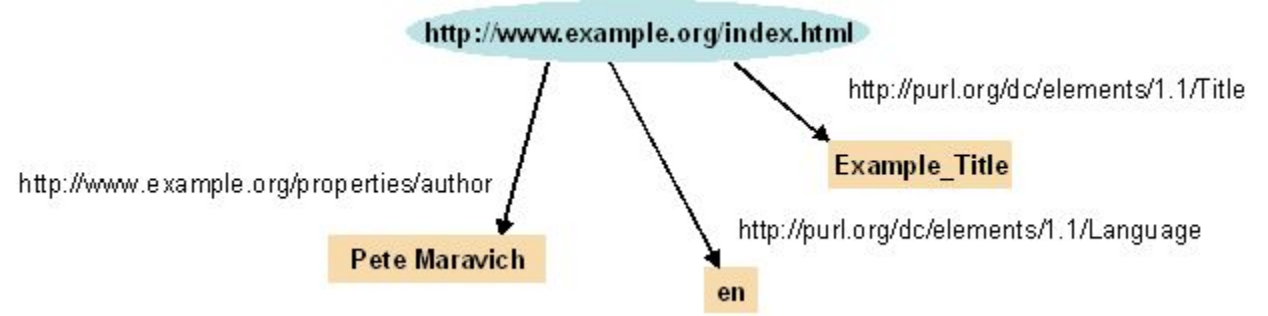
Overview of Samvera Applications

- Introduction to/Review of the Samvera Application Stack
- Fedora
- Solr
- Ruby on Rails
- ActiveFedora (or Valkyrie, but we will discuss that later)
- Hyrax/Avalon/CurationConcerns/Sufia/Custom App.

Linked Data

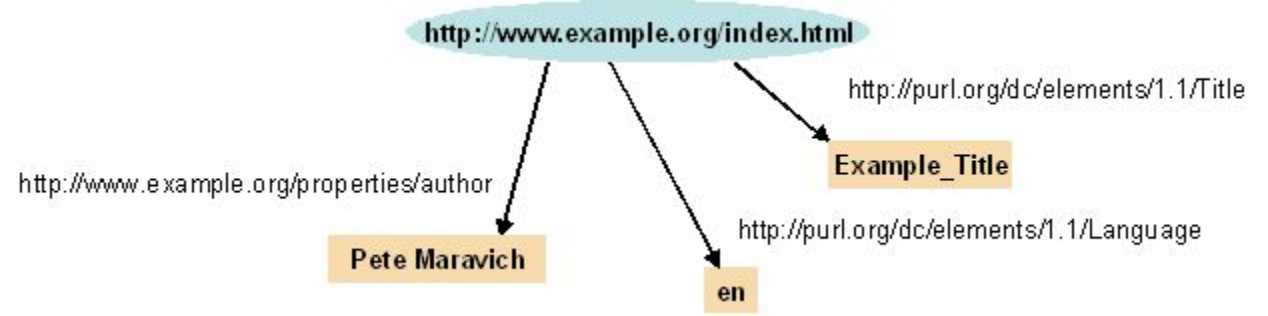
- What is linked data?
- Definitions vary, but we will focus on the Resource Description Framework
- RDF uses graphs (as in networks): Unidirectional and acyclic
- RDF Graphs are composed of **3-tuples (triples)**

```
<https://institution.edu/blog/1> <http://purl.org/dc/elements/1.1/Title> “Our Samvera Blog Post”
```



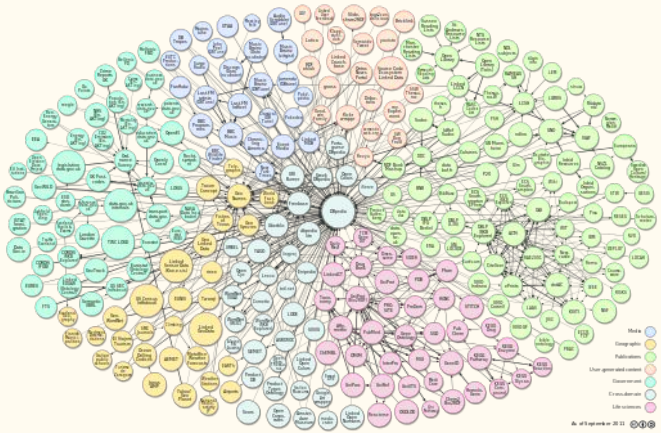
Linked Data

- **Triples** are logical assertions about entities with URL-like identifiers
  - These are generalized into URIs (Uniform Resource Identifiers) or IRIs (Internationalization)
- Syntax: Subject, Predicate, Object
- Triples are expressed using the Resource Description Framework (RDF)



Linked Data

- Why linked data?
- If we all use the same URIs for the same entities, we can all build off of shared data models
- **Global data interoperability**
- Published to the World Wide Web, linked data provides a semantic layer to browsing the WWW
- The WWW (ideally) becomes a global database
- **This becomes the semantic web**



Querying Linked Data

- Linked Data is stored in triple or quad stores (generalized as “graph stores”)
- In order to extract information, one uses the SPARQL query language
- SPARQL Protocol and RDF Query Language is a standard maintained by the World Wide Web consortium
- One uses it to extract information from graphs:

```
PREFIX foaf: <http://xmlns.com/foaf/0.1/>

SELECT ?name
WHERE {
    ?person foaf:name ?name .
    ?person foaf:knows ?friend .
}
```

Querying Linked Data

- RDF itself supports XML data structures
  - Strings
  - Integers
  - Date/Time stamps
- **It cannot be used to encode spatial information**

Querying Spatial Linked Data

- Support for encoding spatial information has been gradual
- **GeoSPARQL extends SPARQL for spatial querying**
- GeoSPARQL provides predicates and spatial data structures for triples

```
PREFIX dc11: <http://purl.org/dc/elements/1.1/>
PREFIX geo: <http://www.opengis.net/ont/geosparql#>

SELECT ?myMapUrl
WHERE {
    ?myMapUrl dc11:coverage ?fGeom .
        ?fGeom geo:sfWithin '''
        <http://www.opengis.net/def/crs/OGC/1.3/CRS84>
            Polygon ((-83.4 34.0, -83.1 34.0,
                      -83.1 34.2, -83.4 34.2,
                      -83.4 34.0))
        '''^^geo:wktLiteral
}
```

- Because GeoSPARQL is new, it requires graph stored which support it

GraphDB

- For this workshop, GraphDB will be hosted in the cloud
- **It consumes GBs of memory, please do not run it locally**
- It is currently deployed using a Docker image:
  - https://github.com/jrgriffiniii/graphdb-docker
  - https://hub.docker.com/r/jrgriffiniii/graphdb
- *If you want to run this locally, this *must* have CORS disabled*

What about Samvera?

- GraphDB and GeoSPARQL are not unique to Samvera
- Samvera repositories (Hyrax) use linked data for persistence
  - This is how metadata is stored and retrieved
- This is largely due to Fedora

Fedora

- Fedora, properly-speaking, is a repository itself
- It does not have a rich interface
  - (Demo here)
- Fedora builds off of the Linked Data Platform standard
- Basically, Fedora accomplishes the following using linked data:
  - Stores files
  - Stores metadata for the files
  - Performs fixity checks for the files
  - Captures “audit trails”
- Hyrax uses Fedora for storage, but then builds user-facing features (dashboards, user permission management, object viewers, derivative generation...)

Fedora

- Fedora is **not** a graph store (you cannot query it for data with SPARQL)
- Fedora **can** synchronize with a graph store
- For this workshop, we synchronize with GraphDB
- This work is also on GitHub:
  - https://github.com/jrgriffiniii/fcrepo-graphdb-docker
  - https://github.com/jrgriffiniii/linked-geo-metadata-docker
- **Let's take a look at Fedora triples in GraphDB**

Hyrax

- Hyrax is a Samvera repository solution bundle
- It is aimed towards serving as an institutional repository (theses and dissertations) or cultural heritage object repository (digitized manuscripts)
- Developed to handle a selection of media types
  - High resolution images (TIFFs, JPEGs, PNGs)
  - Documents (PDFs, Word Documents)
  - Audiovisual material (MPEG4)
- Provide support for self-deposit workflows
  - Users can review the submissions of others
- Provide extensible content modeling

Hyrax

- As mentioned, Fedora is used to store metadata and files for Hyrax
- What we store in Hyrax is accessible from Fedora
- What we store in Hyrax can be synchronized by Fedora with GraphDB
- **(This is accomplished using the fcrepo-camel-toolbox project)**

Hyrax and GraphDB

- The objective of the first set of these tasks in the workshop is to synchronize Hyrax Works with GraphDB
- *This will involve developing custom a custom content model with Hyrax*

Getting Started with Hyrax

- Starting Hyrax
- *Please find a custom Hyrax implementation at:* https://github.com/jrgriffiniii/vesconte
- We need to first use a supported version of Ruby (2.6.2)
- We need to connect to the Fedora and Solr servers in AWS
  - James will provide the IP addresses and ports
- Please start the Rails servers
- Please visit http://localhost:3000

Getting Started with Hyrax

- One should now see the landing page 🎉
- This is a Hyrax implementation branded *Vesconte*
- Hyrax itself is a framework
  - *We can revisit how Hyrax implementations are built later*
- A few more steps are needed to proceed
  - **Creating an Admin. Set**
  - **Signing Up**
  - **Granting yourself administrative privileges**

Pietro Vesconte, Genoese Cartographer from 14th century

Getting Started with Vesconte

Depositing a Scanned Map

- Please select “Deposit My Work”
- Please download a downsampled image from Google Drive
- (We will be using a Princeton map item as an example)
- *James will guide you through the metadata and ingestion form*

Getting Started with Vesconte

Depositing a Second Scanned Map

- Thank you for depositing a Scanned Map
- We are now going to proceed with a second example
- This is another Princeton map item
- Please download the image for this item also using Google Drive

Linked Data from Vesconte

- Hyrax has ingested these objects along with our metadata
- How do we access the linked data for these works?

GraphDB

- Please visit `http://[HOST_ADDRESS]:7200`
- You will now be faced with the GraphDB Workbench
- *James will guide through accessing the linked data for the works*

Linked Data from Vesconte

- Now that you have seen the linked data in GraphDB
- **Let's evaluate how this was enabled in Vesconte**

Adding a Work Type to Vesconte

- A practical example might suffice here
- *(Please prepare your code editors)*
- Let us generate a *RasterDataset* Work Type!

```
bundle exec rails generate hyrax:work RasterDataset
```

- This generates the necessary files in order to support a new content model
- **You will need to restart the Rails server here**

Adding a RasterDataset Type to Vesconte

- Let us add metadata fields for this new work type
- (Open `app/models/raster_dataset`)
- Add a new property for `coverage`:

```
property :coverage, predicate: ::RDF::Vocab::DC11.coverage, class_name: 'WellKnownTextLiteral'
```

- What is WellKnowTextLiteral?
- *James will explain how this works with Hyrax and Fedora*

Adding a Bounding Box to RasterDataset

- This was ported from GeoWorks
- The field is overridden in `app/views/records/edit_fields/_coverage.html.erb`
- *James will explain how this was integrated*

Depositing a RasterDataset

- From the landing page, deposit a new work
- For this example, we are going to use a Stanford dataset
- The raster for this item can be downloaded from Google Drive
- After depositing this data set, please return to the GraphDB workbench
- `http://[HOST_ADDRESS]:7200`

Querying for Spatial Data

- Now that we have our linked data indexed, let's try GeoSPARQL queries
- Please visit the query interface at `http://[HOST_ADDRESS]:7200/sparql`
- *We can craft a query for retrieving our data set*

Querying for Spatial Data

```
PREFIX geo: <http://www.opengis.net/ont/geosparql#>
PREFIX geof: <http://www.opengis.net/def/function/geosparql/>
PREFIX fcrepo: <info:fedora/fedora-system:def/model#>
PREFIX dc11: <http://purl.org/dc/elements/1.1/>
PREFIX dc: <http://purl.org/dc/terms/>
PREFIX hydra: <http://projecthydra.org/works/models#>

SELECT *
WHERE {
  ?subject a hydra:Work ;
     fcrepo:hasModel ?model ;
     dc:title ?title ;
     dc11:coverage ?coverage .
  OPTIONAL {
    ?subject  dc11:description  ?abstract
  }
  FILTER (geof:sfWithin(?coverage, '''
    <http://www.opengis.net/def/crs/OGC/1.3/CRS84>
      [...]
    '''^^geo:wktLiteral))
}
```

Let's explore the components of this

- PREFIX
- SELECT and WHERE ?subject
- dc11:coverage
- OPTIONAL
- FILTER
- geof:sfWithin
- geo:wktLiteral

Querying for Spatial Data

- Well-Known Text
  - Geospatial format for specifying points, lines, paths, and polygons
  - Varies in implementation, but generally standardized
  - Open Geospatial Consortium provided this in a specification
- CRS
  - Coordinate Reference System
  - How grid lines are mapped to a model of the globe
  - CRS84 references a standard model (geodetic datum) used commonly by GIS applications
  - RDF references a URI in order to link to this model

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Querying for Spatial Data

- Spatial functions
  - GeoSPARQL offers a set of predicates for querying spatial relationships
  - `geof:sfWithin` functions are just for a polygon or point within another spatial object
  - There are other functions for spatial relationships:
    - `geof:sfContains`
    - `geof:sfDisjoint`
    - `geof:sfEquals`
    - `geof:sfIntersects`
- Spatial predicates
  - There are also corresponding predicate forms used for making assertions (rather than for filtering through result sets: e. g. `geo:sfIntersects`)
- *Please reference the GeoSPARQL specification for more detail*

Consuming Spatial Data

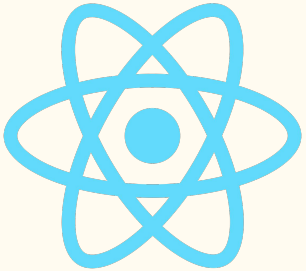
- A brief overview has been given of publishing spatial linked data
- This overview has attempted to also minimally address querying the data
  - These can be explored in greater depth
- **However, providing an example for consuming this data might be valuable**

Building a Linked Data Portal

Glitch

- Glitch is a hosting service for JavaScript applications
- Please visit https://glitch.com/edit/#!/mature-peony in your web browser
- *James will guide you in authenticating on Glitch*
- This Glitch project is a small React/Redux portal for linked data

Building a Linked Data Portal



- React
  - JavaScript framework developed by Facebook
  - Provides a component-driven approach to developing user interfaces
  - Lightweight and flexible, meant to be integrated with other JavaScript frameworks

Building a Linked Data Portal

- Redux
  - Open source JavaScript framework
  - Frequently paired with React
  - Addresses application layers below the user interface
  - *For our purposes, one uses Redux to query the GraphDB*

Building a Linked Data Portal

- Architecture of the Data Portal
  - Leaflet
  - React
  - Redux
  - GraphDB

Building a Linked Data Portal

- Leaflet
  - Geospatial and map visualization library (GeoBlacklight uses this)
  - Using Redux, we...
    - Retrieved Works from the GraphDB installation
    - Transform the spatial metadata elements into GeoJSON
    - Add the GeoJSON objects to the map

Building a Linked Data Portal

- Leaflet and React
  - React wraps the Leaflet map
- Leaflet, React, and Redux
  - React “listens” for application events using Redux
  - Redux emits actions and routes them to update the application state
  - Example: User moves the map, and a new search for the region is executed

Building a Linked Data Portal

- Redux and GraphDB
  - Redux is also responsible for querying the GraphDB installation
  - Within a Redux action is where on crafts the GeoSPARQL query
  - *James will guide through the GeoSPARQL integration for Redux*

Extending a Linked Data Portal

- This is a minimal linked data portal
  - Glitch permits you to “remix” a project
    - (Copy this project and add your own modifications)
    - *Please, experiment with this!*
  - Faceting, text search, authentication and user management are all possible
  - **Let’s retrieve some more metadata by editing our Glitch**

Reviewing the Stack

- Questions
  - About Fedora?
  - About GraphDB?
  - About Hyrax?
  - About React/Redux?
  - About other layers?

Geo Linked Data

Thank you for your time, attention, and patience!

Attributions

1. Richard CyganiakAnja Jentzsch, *LOD Cloud Diagram As of September 2011.*
2. Vladimir Agafonkin, CloudMade, *Leaflet logo.*
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