

Linked Data and IIIF: Integrating Taxonomy Management with Image Annotation

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Linked Data provides a natural platform for taxonomy management, and when working in concert with IIIF (International Image Interoperability Framework) for accessing image resources, result in an architecture that is suited to an image annotation application. Linked Data and IIIF specifications can be integrated to produce an extensible discovery tool, based on the Semantic Web Stack and other manifestations of ubiquitous W3C standards, protocols, and data models, such as JSON-LD, Web Annotation, and its predecessor, Open Annotation.

The underlying graph data structure of a Linked Data application enables relationship paths to be established between any elements or primary resources within a taxonomy and any corresponding resources within a collection of images.

A taxonomy management system, is typically used to create controlled vocabularies which comprises ontologies (relationships and properties) and concepts (terms). Editors and subject matter experts define concepts that form vocabularies, and assign relationships defined by their respective ontological rules, from simple associative relationships to complex hierarchical structures. A Linked Data application may adopt an RDF (Resource Description Framework) triplestore as the underlying database, allowing inference rules to be embedded, simplifying queries and greatly improving graph pattern matching performance, which in turn facilitates visualisation and discovery of large datasets. Vocabularies in a Linked Data environment can be published in various RDF formats, enabling interoperability with other Linked Data applications.

Interoperable functionality is also provided in IIIF for digital image repositories. Traditional URI links to images over HTTP is extended to include metadata encapsulated by the IIIF Presentation API data model, and images can be accessed or referenced in full, in part, or transformed, using the IIIF Image API.

Linked Data serves as a bridge between controlled vocabularies and images on a IIIF platform. A concept in a vocabulary, defined as a primary resource, can reference other primary resources defined in IIIF; Manifest, Sequence, Canvas, Content, etc, in a Presentation API manifest, or any URI defined in the IIIF Image API. Conversely, any URI contained within a manifest using the IIIF Presentation API data model can reference primary resources via links within a taxonomy. This interoperability enables entire collections, and sub-component resources, as defined in the IIIF Presentation API, to be represented in a taxonomy management system, which can therefore be used as a repository for all Presentation API resources.

Practical applications can be developed on a Linked Data taxonomy management system which leverages IIIF-compliant front-end manifest and deep-zoom image platforms to produce extensible and interoperable image annotation systems. Furthermore, such applications are able to define sub-image regions, or points of interest, of various shapes (polygons, circles, markers, etc) to be indexed against concepts in sets of controlled vocabularies.

Search and reporting features would then enable visual discovery beyond results of immediate associative relationships, to include inferred results defined in rules within ontologies, and expansion of relationship paths by walking the interconnected graph between primary resources in Linked Data vocabularies and IIIF images.

Core to interoperability is the adoption of Linked Data principles, both in the architecture of software applications as well as the development of vocabularies within a taxonomy management system. Since Linked Data applications often employ RDF triplestores as their primary database, data models are inherently developed using URI links. Every data row has three elements; a subject, predicate, and object, often referred to as a triple. Each row can further be assigned to a named graph, which can be used for data segmentation. Data represented as triples inherit graph model properties when a relationship is established with the object element in a triple.

Graph models are natural structures on which controlled vocabularies can be built upon, since concepts are defined not only by their string literal properties like label and description, but also by relationships to other concepts or resources, internal or external to each vocabulary. These relationship links form a natural connected graph which can then be queried using the standard

RDF query language, SPARQL. Interoperability is a cornerstone of a Linked Data application since the underlying Linked Data Protocol is standard across any SPARQL endpoints.

Any application for viewing and manipulating digital images compliant with IIIF Image and Presentation API specifications benefit from the adoption of an RDF triplestore backend which can be used to return IIIF manifests, and also to augment interoperability features, like describing IIIF resources in RDF formats. IIIF image viewers will ingest a manifest, defined by the Presentation API, which describes the properties of one or more images, including their corresponding links on a IIIF image server.

The data model prescribed in the Presentation API tie together a series of resources which extends from a manifest to an annotation. Each resource is loaded in sequence via their corresponding URI with resulting content returned in JSON-LD. A front-end viewer is able to represent the collection or membership of images for user interaction; select, pan-and-zoom, and perform annotation on regions within an image. The resulting data set can then be saved to a triplestore using Linked Data Protocol.

A Linked Data and IIIF compliant image annotation application opens the door for yet to be discovered ancillary applications which can be readily integrated, either via Linked Data or IIIF endpoints.

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