Visual Artist Influential Relationship Ontology: a Methodology Report

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Introduction

In his 2001 Scientific American article Tim Berners-Lee et al. predicted and described the evolution of the web beyond randomly published documents to the Semantic Web where structured datasets encoded with semantic meaning and "inference rules that they can use to conduct automated reasoning" will be the norm and enable users to have more meaningful experience when researching for information or conducting personal business tasks on the web (Berners-Lee et al., 2001, n.pag.).

In recent years the semantic web has evolved and has been developed by collaborative communities associated with various disciplines such as broadcasting, health science and digital collections management looking to the bigger picture of open and "linked data" as a means for more meaningful information retrieval experiences (W3C, 2011, Abstract). The BBC has been one of the leads in this area by creating "ontology" vocabularies of bind-able concepts for programmes, wildlife and sport with an eye to supporting data journalism and relationship driven website content on their own websites (BBC 2009, 2010, 2011, n.pag.; Rayfield, 2012, n.pag.). How has "ontology" been defined in the literature in this context? Subject domain-centric vocabulary sets which are conceptualization and relationship systems are wired for the semantic web and are known as "ontologies". Guarino (2009) refers to ontologies as information objects and in line with that thought Gruber (1995) aptly defines ontologies as "…an explicit specification of a conceptualization", (Guarino, 2009, 2; Gruber, 1995, 1) where states of reality, or the world of the relevant domain's knowledge is represented and remains conceptually unchanged (Guarino, 2009, 2; Guarino, 2009, 8). Guarino also considers ontologies to be "computational objects" where Gruber supports this idea when he describes "… the ontology of a program by defining a set of representational terms… In such an ontology, definitions associate the names of entities in the universe of discourse (e.g. classes, relations, functions, or other objects) with human-readable text describing what the names are meant to denote, and formal axioms that constrain the interpretation and well-formed use of these terms" (Guarino, 2009, 2; Gruber, 1995, 2). Interestingly enough, Gruber was perhaps foreshadowing Guarino's idea that there is a potential expressiveness issue where the articulation of the domain vocabulary and the subsequent "structuring" and "scaffolding" of it into a program or language framework may affect the cultural context of the ontology during the transfer (Guarino, 2009, 12).

Ontologies, Web Standards and LIS

The heart of the semantic web revolves around the URI (Uniform Resource Indicator) which may resemble a URL or even be an URL, and is used to indicate which resource is being talked about so that we know whether or not we are all talking about the same resource, which may be a web document or specified vocabulary item (Allemang, 2011, 49). The URI is contextualized in a RDF (Resource Description Framework) document format in a semantic sentence structure consisting of a "subject, predicate, and object" called triples and is layered with a further level of expressiveness called OWL (Ontology Web Language) involving restrictions of "necessary and

sufficient" which articulates a vocabulary specification that may be re-used in its entirety or modularized for import into another vocabulary (Allemang 2011; W3C OWL2, 2009; W3C RDF, 2004). Web standards for RDF, OWL2 in addition to a query language called SPARQL (SPARQL Protocol and RDF Query Language) have been developed by the W3C for the purposes having of a common language that collaborators in the semantic web community may use so that the frameworks created will be consistently extensible and interoperable across the semantic web (W3C SPARQL, 2008, n.pag.). These frameworks are also consistent with linked data which "… refers to data published on the web in such a way that it is machine-readable, its meaning is explicitly defined, it is linked to other external data sets, and can be in turn linked from external datasets" (Bizer, Health, Berners-Lee, 2009, Par 4). Other new user-friendly standards have arisen in recent years such as HTML5, which introduces microdata markup that can be embedded in standard HTML to enhance interoperability on the web with a limited vocabulary such as reviews and products but is limited and lacks the flexibility of RDF/XML and OWL2 (W3C HTML5, n.d, n.pag.)

What do these semantic web standards mean to the LIS discipline? There has been a gradual evolution from flat cataloguing records, which originated as cataloguing paper cards in library science, to more interoperability as library collections migrate to digital formats and need to fit in with the semantic web for successful information retrieval. Efforts in this direction include the development of the Dublin Core Metadata Initiative and its extensible vocabulary specification which are often re-used in ontologies and the FRBR (Functional Requirements and Bibliographic Records) that are moving towards an extensible format of expressiveness (Coyle, 2010, 26-36) with regard to manifestation, expression, item and work and where it "… relates user tasks of retrieval and access in online library catalogues and bibliographic databases from a user's perspective … It represents a more holistic approach to retrieval and access as the relationships between the entities provide links to navigate through the hierarchy of relationships" ("Functional Requirements for Bibliographic Records", 2012 par.1).

Hierarchies are used in thesauri, which can be considered to be a type of taxonomy and are commonly used in databases. As ontologies include hierarchies of categories, the semantic relationships declared between concepts are of interest to library and information scientists for the purpose of information retrieval. However, "in general, those in computer science (CS) are concerned with how software and associated machines interact with ontologies. Librarians are concerned with how patrons retrieve information with the aid of taxonomies. Software developers and artificial intelligence scholars see hierarchies as logical structures that help machines make decisions, but for library science workers these information structures are about mapping out a topic for the benefit of patrons" (Adams, 2002, 22-23). Therefore there seems to be a gap between these various disciplines interests and there may be an issue of language expressiveness that may or may not meet the needs of end-users if the web languages and vocabulary specifications are not coordinated to adequately achieve a knowledge representation that expresses specific "world state" of the domain (Guarino 2009, 5). Indeed, Guarino (2009) indicates this is an issue when he asks the question "How can we make sure that such symbols are interpreted according to the conceptualization that we commit to?" and he

goes on to say that as we move from term definitions towards more “rigorous” logical structures there is a “tradeoff between expressiveness and efficiency when choosing the language” (descriptive logic) (Guarino, 2009, 13). Then we can conclude that when designing an ontology we should ask ourselves as to what extent can we adequately express intent in the framework of logical inheritance, and in particular how we may represent knowledge as a world reality (“exhausting all possible”) for the chosen domain (Guarino, 2009, 13)?

Ontology Project Background and Intent

Standard biographical information is complex and in an area, such as the visual arts which can be quite conceptual, an enriched retrieval system to track visual artists’ collaborations and influences would be useful for art history researchers for tracking the evolution of artists and their unique styles. Current thesauri in art databases use hierarchies of keywords, with a combination of cataloguing techniques for individual pieces and their creators. Often these biographies are fragmented and incomplete. What is lacking is the binding between concepts such as influence to create a way to augment records of art objects and biographies that reflect the informational threads of influence as the visual arts and the artists themselves evolve.

The Visual Artist Influential Relationship Ontology

The Visual Artist Influential Relationship Ontology (which we will refer to in this paper in its shortened version “The VA Influential Relationship Ontology”), developed for this project, is a top-level knowledge representation of influential relationships and connections between the visual artist, people, organization, style, movement and materials without becoming too granular in the categories so that the ontology will be fit to reuse other more detailed related ontologies. Influence is defined by the online ontology WordNet™ as both a noun and a verb whereas the noun influence is “(the effect of one thing (or person) on another) *‘the influence of mechanical action’”* and the verb influence is “(have and exert influence or effect) *‘The artist's work influenced the young painter’” (*http://wordnetweb.princeton.edu/perl/webwn*).*

Our intent can further be refined to include in our definition of influence, that which is notable about the visual artist’s work where what people have observed and documented in critiques regarding the produced art objects have some corroboration in the origins of the visual artists connections to people (which may be direct or indirect) and their artistic methodologies and affiliated organizations, where a visual artist may be exposed to other techniques or movements as a causal thread through the development of his or her own work.

The overall concept itself may be too abstract in some respects for articulation in an ontology, however; with current ontologies there seems to be a lack of an ability to “trace” the memes or threads of the evolution of artistic styles as pertaining to the individual artist as these influences pass from person-to-person (or artist-to-artist) in information retrieval systems. Consider how one visual artist to another visual artist might equate to or result in a particular art item, and would this influence be traceable? Often biographies imply influences, for example one might say that a particular artist is influenced by Picasso. What does this actually mean? It would imply that Picasso’s techniques are reminiscent in the visual artists’ work, meaning that it has been noted and recorded in some manner perhaps in a critique or article. It would also imply

that we know what is meant when one says that someone is influenced by Picasso, with the assumption that the techniques of Picasso are well known and exemplifies his work. In this case one can say that, as Picasso is known for cubism and was directly involved in this movement, this information is considered to be common knowledge and is therefore implied when we say that a visual artist is influenced by Picasso. Alternatively, if one says someone has studied cubism, is it implied that he or she is influenced by Picasso? If this idea is an "implied idea" how would this be expressed in an ontology? Perhaps the ontologist would need to go a step further at the instance development stage and articulate that which is implied, which may be akin to second –guessing and may require an SME (Subject Matter Expert) to take it to that next step. And further, concrete concepts such as birth, death, awards lack the nuances of these types of influential connections that are often not well articulated in biographical ontologies such as DBpedia's YAGO Ontology (Auer, 2007, Section 7 Par 1). In that regard the person-to-person and person-to-art trends (style, movement and school of art) were the most challenging to articulate in this ontology and required resolving at the top-most level. With that in mind, we sought to keep the ontology as a top-level ontology with abstract connections and concrete information objects which can be re-used and situated alongside other ontologies that deal with biographical information, the actual art objects (such as cataloging), and as an extension to outside of the notion of an exhibit (related group of related art objects).

This report will address several aspects of the Visual Artist Influential Relationship Ontology development cycle and will be presented as follows: the background information on related work and semantic web standards which were considered during the conceptual development of the ontology in terms of potential reuse upon which the subsequent ontology was built; ontology concept capture and clustering; representation and articulation of semantic relationships in terms of classes and properties; and an technical intrinsic evaluation of the ontology with regard to concept selection, property relationship definitions and ontology structure.

Ontology Development Methodology

The methodology for the development of the Visual Artist Influential Relationship Ontology included concept capture and clustering using a combination of brainstorming, VisuWords™ Online Graphical Dictionary and Thesaurus, knowledge-mapping software, the reuse of portions of existing ontologies where deemed appropriate, and the coding of the ontology using OWL-DL via the ontology editing open source software Protégé. Iterative evaluation techniques for the ontology concept development were also used including a manually implemented text analysis of mini corpora of biographical articles and a WordNet™ concept definition analysis upon which revisions to concepts and concept categories were based. These secondary phases of evaluation will be included in the "Ontology Evaluation" section. Two gold standard papers "*Ontology 101: A Guide to Creating Your First Ontology*" by N. Noy and L. McGuiness (2001) and "*A Practical Guide to Building OWL Ontologies Using the Protégé-OWL Plugin and CO-ODE Tools Edition 1.0*" by Mathew Horridge et al. (2004) which are introductory papers on ontology development, were also used to act as a guide to shape the articulation of the scope of the intended domain and the conceptual, encoding implementation workflow and evaluation.

This development methodology section of the report will focus on the initial stages of concept capture and clustering; related ontology and their re-use; and coding of the ontology with regard to the more prominent aspects of the structural design decisions made with expressiveness in mind as a key goal desired in the ontology as a finished product.

Initial Phase of Concept Capture and Clustering

Guizzardi points out that "we can articulate a domain abstraction (i.e. a mental model) of certain facts in reality …" by using a group of connected concepts (Guizzardi, 2007, Section 2, par 1) to express a "world state" (Guarino, 2009, 5). The approach taken for concept capture in this project included the development of an articulation of the domain and scope of the ontology which acted as a guideline for concept capture, clustering and analysis in addition to using a "middle-out" approach (a combination of top-down and bottom-up) for concept capture where top level concepts are articulated and candidate subject and object property (predicates) concepts are selected with an eye to keeping the level of granularity at a shallow enough level to allow the developed ontology to be conducive to potential re-usability with or to work alongside other ontologies (Noy and McGuiness, 2001, 6). It is the objective of the development of this ontology to enable the "reuse of domain knowledge" within the collaborative communities of the semantic web movement.

Noy and McGuiness (2001) suggest brainstorming and formulating a set of competency questions as a means to guide the articulation of the scope of the ontology as a means of determining if there is enough relevant information in the ontology to answer end-users' anticipated questions and if the subsequent "…answers require a particular level of detail or representation in a particular area" (Noy and McGuiness, 2001, p.5). They also suggest that these questions may be used to test the ontology once developed in an ontology editor with query capabilities (Noy and McGuiness, 2001, 5), which for this iteration will be SPARQL (SPARQL Protocol and RDF Query Language). The small sampling of query questions, developed for this project, include:

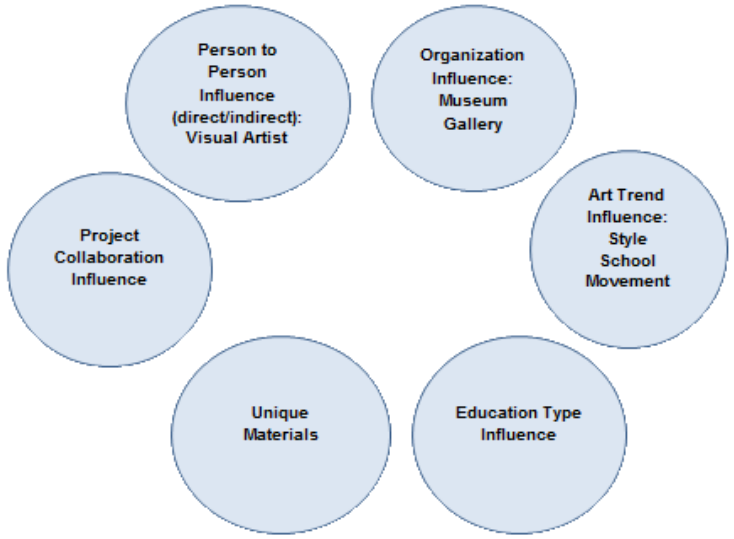
- Which visual artists are said to have studied a particular art movement?
- Which visual artists were indirectly influenced by another category of visual artists (i.e. Painters)?
- Which galleries exhibited which visual artists said to be influenced by Mark Tobey?
- Which visual artists were involved in Schools of Art and what type of schools were they (i.e. the Group of Seven/Algonquin School)?
- Which visual artists were involved in a long-term collaboration exhibit?
- Which visual artists studied cubism? (and therefore influenced by it, perhaps Picasso himself?)
- Which visual artists were also teachers and what schools did they teach at? Did any visual artists attend Institutes specifically as students? What were they called?
- Which visual artists did the National Gallery of Canada exhibit?
- What can I find out about a particular artist? (i.e. Emily Carr)

These initial stages of concept capture, which involved brainstorming with colleagues and subject matter experts via informal conversations, in addition to the competency questions about the possible influential connections of visual artists which shaped the conceptual structure of our ontology, where candidate top-level terms or classes were identified and grouped with relevant nouns and relationship verbs. The initial top-level "influence" concepts identified

included: person-to-person, organizations, art trends, collaborations, and education from which the rest of the categories, derived from the brainstorming sessions, were grouped under (see figure 1). The online dictionary VisuWords™ was also used to harvest a list of types of visual artists to create a sub-class under “person-to-person” influence. The conceptual knowledge mapping software C-Map™ was used for the brainstorming and concept clustering tasks also is also suitable for handling revisions while developing the conceptual model to visualize and elucidate concepts and their connections in addition to identifying potential overlapping concepts prior to encoding into OWL-DL. Key considerations when selecting candidate terms were:

- Definitions: What is our intent when we select the concept or property term?
- Selection: Is this term the best fit to our explicit intent? Would another synonym be appropriate?
- Set Inclusion: Why does a term belong in a particular category? Does it adequately fit to our conceptualization of the selected top term/class?

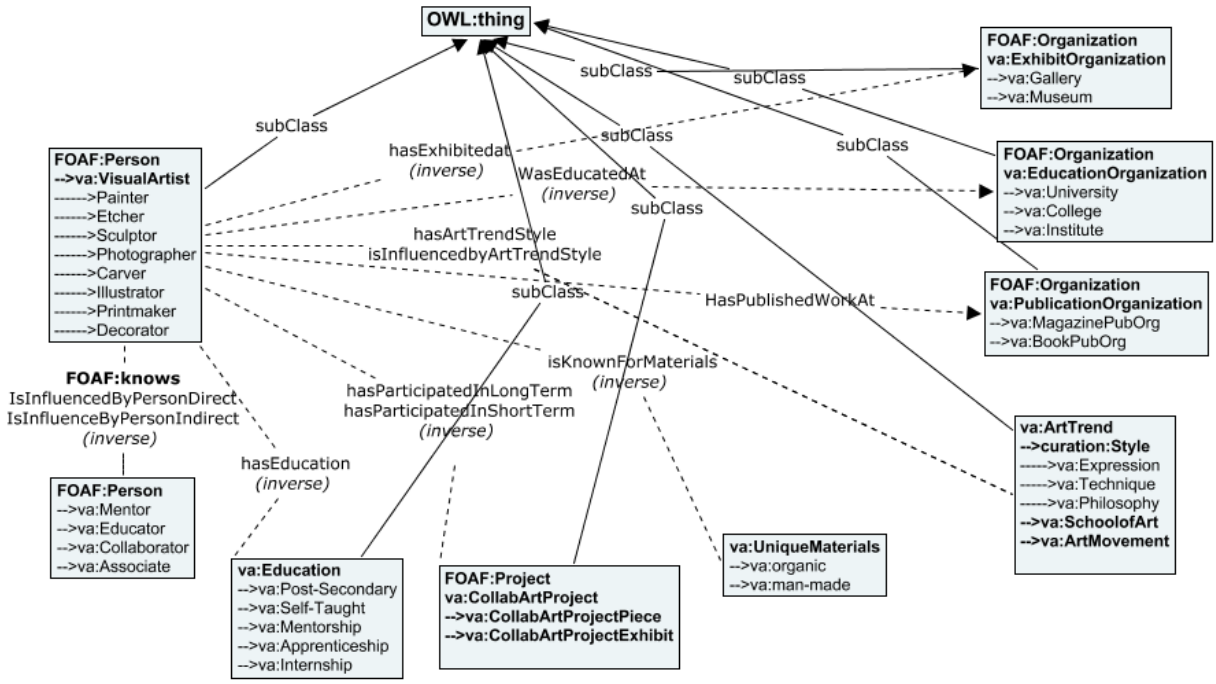
Figure 1 - Initial Top-Level Categories for the VA Influential Relationship Ontology



The scope of the selected domain will not include concepts already commonly used in biography ontologies (such as Biography Light Ontology based on LODE event ontology and DBpedia’s YAGO) (Ramos, 2009; DBPedia.org, n.pag.) which denote biography facts such as birth, date, residence, specific event and award information, but will include the more abstract concept of direct and indirect influence acting as an informational thread of the observed evolution of a visual artist’s style in his or her work, materials and affiliated organizations, and the style itself as it moves from one visual artist to the next individual or group of visual artists. The emphasis will be placed on object properties as a means to express the influences, and bind concrete concepts which will act as anchors for the object properties. The ontology will also

not cover the actual items, works or specific exhibitions created by the visual artists, which are often covered by web interoperable bibliographic encoding vocabularies such as the Dublin Core Metadata Initiative or the FRBR (Functional Requirements and Bibliographic Records). The VA Influential Relationship Ontology may however be aligned with these or other vocabularies to enhance information retrieval.

Figure 2 - Initial Phase of Knowledge Mapping of Ontology – Properties and Classes



Second Phase of Concept Capturing and Clustering – Evaluating Concepts.

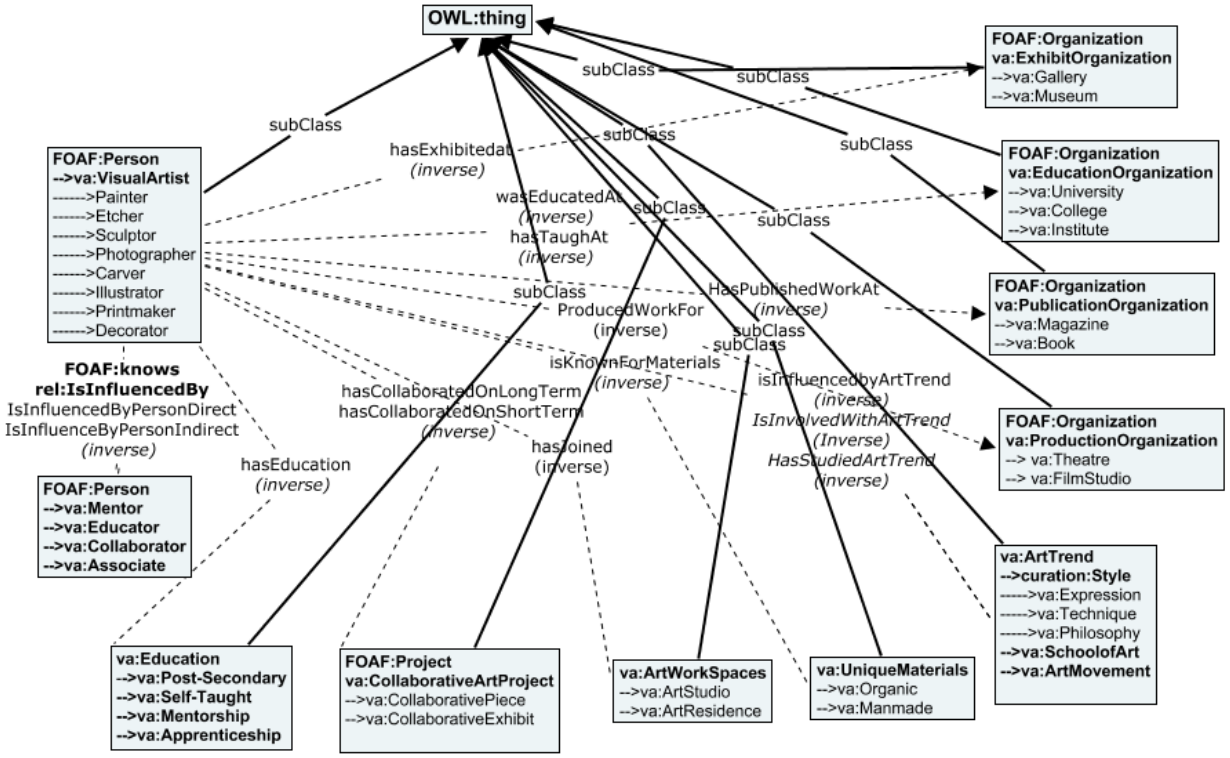
As a contextual measure of the quality of the selected concepts, where "context can be viewed as an interplay between general cultural and community structures (language, norms, conventions, social networks, and relationships)" (Stvilia, 2007, n. pag., Par 18) a text analysis of domain-relevant open access documents was conducted. A small corpora of eight web documents pertaining to the biographies of eight visual artists were selected with the intention to evaluate the "lexical and vocabulary layer" of the ontology (Brank, Grobelnik and Dunja Mladenic, 2005, 1). This evaluation was done manually by identifying nouns and verbs for candidate concepts/classes and properties in the text (see Appendix A), taking note of how often each noun or verb appeared, when there was a similarity in expression. They were then grouped and compared against the original groups (see Figure 1) for brain-storming for confirmation of the correct grouping and any new groups that arose from this investigation. The additions to the original configuration included:

- A new class: Artist Workspaces, with the sub-classes of Artist Studio and Artist Residence
- The addition of two subclasses to "organization" , namely "Publication Organization" (with sub-classes of "magazine" and "book") and "Production Organization (with sub-

classes “theatre” and “film”). The sub-categories will not be disjoint as some instances may fall into both categories.

- The property “taught at” and “employed by” (inverse) were added with the usage of an axiom where a visual artist will have taught at a particular education organization (or have been employed by them). This is important because a visual artist may hold more than one role thereby potentially influencing another visual artist. This will have causal effects when looking at the potential influential threads through the ontology system.

Figure 3 - Final Iteration of Knowledge Map – Properties and Classes



The final step for evaluating the vocabulary was to compare our core classes and properties vocabularies against WordNet™ definitions, synonyms and hyponyms to ascertain that the words selected were the best candidates to what we were looking for in terms of context. This is to generate “natural-language glosses for multiple-word terms” and to verify that words that are close in meaning are discerned and the closest match to intent is selected for the ontology (see Appendix B for a chart detailing the candidate concepts and object properties with their definitions) (Brank, Grobelnik, Mladenic 2005, 2, PAR 9). Two areas of issue illuminated itself during the process where the terms needed to be discerned so that the best candidate was selected so that it made the most sense in the context of the selected domain:

- The terms motivate, inspiration and influence are similar but differ in intent and meaning.
- Educator, teacher and instructor all essentially have similar meanings, and may be used interchangeably. Culturally the meaning is understood by the user whichever one is used in any particular given situation.

Related Work and Reuse of Ontology Fragments

The evolution of the semantic web is dependent on the extensibility and re-usability of ontologies to develop enriched information retrieval experiences for the end-user and with that in mind our ontology re-uses some aspects of similar already composed ontologies. In addition, similar ontologies are examined and discussed in this section that challenged our current domain, scope, class and property definitions as a means to nail down and adequately articulate what our intent is when we are talking "artistic influence" for this ontology. In this section we will illustrate our considerations in this regard with FOAF, the Relationship Ontology and the Museum Curation Ontology during the initial development phase of the VA Influential Relationship Ontology prior to concept and structural evaluation.

FOAF

According to the FOAF project documentation FOAF (Friend of a Friend) is about "… creating a Web of machine-readable pages describing people, the links between them and the things they create and do; it is a contribution to the linked information system known as the Web. FOAF defines an open, decentralized technology for connecting social Web sites, and the people they describe" (FOAF-Project.Org , n.d. n.pag.). This inference-enabled RDF Schema and OWL compliant vocabulary specification revolves around a unique ID for a person (such as an URI or email) ,who may be real or imaginary, enabling the information system to say "anything about anyone" and allows for the system to evolve due to its extensibility and as it is re-used in other collaborative ontology structures (Allemang, 2011, 49; FOAF-Project.Org, n.d. n.pag.; Brickley and Miller, 2010, n.pag.).

In our project the FOAF core classes identified for re-use included foaf:person, foaf:organization, and foaf:project under which we could create our own sub-classes relevant to our identified top-level categories in this ontology in addition to the FOAF property "knows" which will have more specific sub-properties relevant to indirect and direct influences associated with it. Foaf:people is a sub-class of "agent" and is disjoint with "organization" and "project" and is paired with the property "knows", (Brickley and Miller, 2010, n.pag.) which will also be the case in our ontology project. Foaf: project, which can be "may be formal or informal, collective or individual" and is disjoint from "organization" is conducive to our ontology's requirement to express the existence of collaborative projects whether having short-term or long-term properties and connecting them to visual artists (Brickley and Miller, 2010, n.pag.). Where available web documents may be associated with both foaf:project and foaf:person. Under foaf:organization there will be sub-categories added that will specify education, exhibition, publishing, and production organizations that will follow along the thread of potential influences coming from professional affiliations in both working and teaching scenarios. These entities, also known as "primitives" when first declared during the encoding phase will comprise part of the initial build of the ontology where "the first layer contains the declaration of domain terminology and relations in the form of OWL entities (*owl:Class; owl:ObjectProperty; owl:DatatypeProperty*)" (Dumontier and Villanueva-Rosales 2007, Section 2.1 par.1).

There are several ways that these classes can be "borrowed" and implemented into an ontology. The first method is to import the whole ontology into an ontology editor. The drawback

is that it imports the whole ontology, and because its structure must be maintained to operate there is an inability to edit out the parts you do not want. Modularization is another methodology; however, at the time of the development of this ontology the online module extractor (http://owl.cs.manchester.ac.uk/modularity/) was having server issues. However, because we were only borrowing 4 classes and 2 properties it was decided that the ontology would use the URI (Uniform Resource Indicators) of each of these concepts where the URI of the relevant ontology was added to the namespace of the ontology editor and the classes re-declared within the ontology being developed.

The Relationship Ontology

The "Relationship Ontology" is a property-centric ontology with the objective of having a general and flexible language to describe relationships of all types and to be re-used with other ontologies and has also built upon foaf to increase its interoperability (Davis and Vitiello, 2010, n.pag.). Notably, there has been an issue and some property language adjustment around "foaf:knows" where the authors considered the fact that "foaf:knows" allows for or assumes reciprocity and that there are situations where the inverse may not be allowable where a person may know of someone else but the other person in the relationship may not know the other person, such as a "distant ancestor "(Davis and Vitiello, 2010, n.pag.). Davis and Vitiello took a number of approaches to resolve this. They used the property class owl:differentFrom to differentiate between individuals, and included the property "rel:knowsOf" to indicate the softer relationship declaration of one person knowing of another person but it not being "reciprocated" "(Davis and Vitiello, 2010, n.pag.). This is indeed a difficult concept to articulate and they attempted to describe further layers or nuances of these types of relationships by introducing the properties "rel:knowsInPassing" and "rel:knowsByReputation" (Davis and Vitiello 2010, n.pag.) Again, it should be noted that the reciprocal relationship may not work in these cases either particularly with "knowsByReputation". They also used the property of "influencedBy", but without defining what they meant by influence or the nature of the relationship (is the influence documented or speculated?) "(Davis and Vitiello, 2010, n.pag.).

For the purposes of the VA Influential Relationship ontology we took a slightly different approach as our objectives specified a more descriptive approach to the concept of influence. To better reflect a person "knowing" the person that influenced them or "knowing of" a person in the person-to-person influence scenario where the "knowing of" may or may not be reciprocated (the "knowing of" may be one-way or two-way), the property "rel:influencedBy" was reused with the two sub-categories of "influencedByPersonDirect" and "influencedByPersonIndirect" being created to express the variations in the "influencedBy" relationship where a documented influence was considered to be "direct" or "in-direct" in terms of person-to-person influences. In the case of a visual artist being influenced by another visual artist, such as Picasso who is renowned for a particular artistic style it would be useful to articulate the influence as direct (come in contact with) or indirect (where the visual artist may have come in contact, as in knows of, another visual artists' style, for example). This is a challenging concept to capture into a structured system where there are a number of subtle nuances in the related concepts of "knowing" and "influence" and where it could be considered to be somewhat beneficial for collaborative communities to continue to develop such vocabularies to achieve re-usable solutions.

The “rel:InfluencedBy” was also considered for usage in the other key influence nodule for art trends (art movements, style and school of art), but it seemed less of a good fit as it would not be contextualized by the sub-category of “foaf:knows” and needed an articulation of the different type of influential relationship without going too granular. It was felt that going to granular would make it less re-usable with other ontologies and perhaps water down the idea of “influence” making it too concrete for something considered to be abstract; however, it did inspire the idea to express this relationship as “va:influencedByArtTrend” with the sub-categories of “va:InvolvedWithArtTrend” and “va:StudiedArtTrend” (in addition to their corresponding inverses). This in fact is a re-articulation of the idea of “direct” and “indirect” but with more expressiveness in relation to the type of influences that a visual artist will have when he or she is affiliated with art trends in different ways.

The Curate Ontology

According to its website “The Curate Ontology” is described as depicting “aspects of curatorial narratives and their underlying conceptual structure … The ontology draws on structuralist theories that distinguish between story (i.e. what can be told), plot (i.e. an interpretation of the story) and narrative (i.e. its presentational form)” (curate/introduction, 2012, n.pag.). This ontology vocabulary builds on the LODE event ontology and “storyspace” created by the Cipher Project “to model museum narratives” (curate/introduction, 2012, n.pag.). While this particular domain focuses around the stories or narratives around groupings of exhibition items there are some interesting usages of the terms “influence”, “motivation” and “inspiration” which are considered to be important concepts that are interwoven in the art item narratives. In this case “influence”, “motivation” and “inspiration” are used in relation to an event-to-event causal relationship in addition to consequence or outcome in regards to events as they relate to the exhibition collection (curate/introduction, 2012, n.pag.).

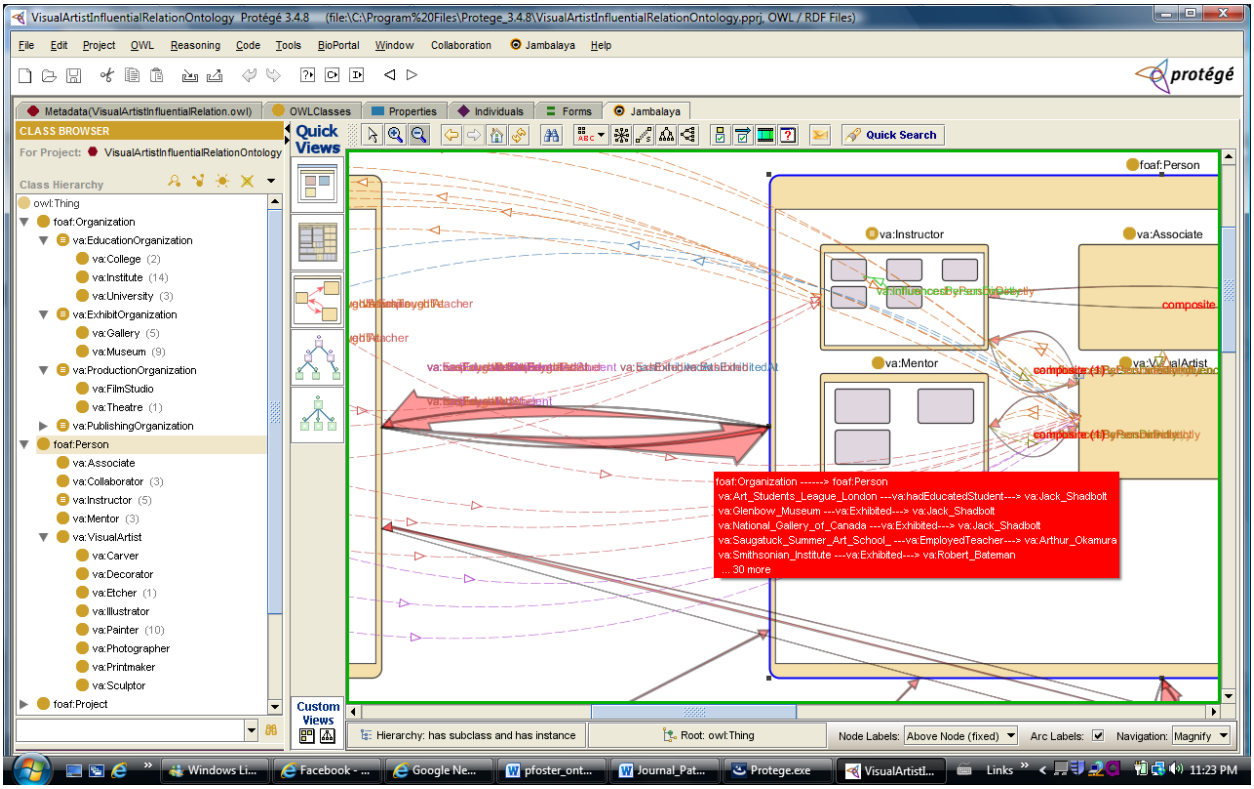
The VA Influential Relationship Ontology as a top level ontology deals more directly with the visual artist as an individual and expressing influences as a thread in the development of style and techniques as opposed to expressing specific date and time events which are covered by other ontologies; however, the subtle differences between influence, motivation and inspiration can be challenged by exploring other ontologies as a means to refine our articulation and definition of what is meant by “influence”. WordNet™ was consulted and the concepts explored where “motivation” infers that a person is spurred on or mentally pushed forward by another person or event that is inspiring (wordnetweb.princeton.edu). Inspiration and influence had the subtlest differences where “inspiration” or “inspire” inferred getting an idea from another person or event but that influence was where there was a noticeable “exert influence or effect” on something (wordnetweb.princeton.edu) and in the VA Influential Relationship Ontology’s we would be able to further exemplify it by adding that “influence” or the “effect” requires documentation that the influence was noticed such as a critique or review by another person or group. For the reasons described, the museum narrative vocabulary for “influence” will not fit our premise, however the concept “curate:style” will be reused as it points to an off-site (non-web accessible) taxonomy which would be useful for expression of style influences, and with this concept we will add our own sub-categories of “va:Philosophy”, va:Expression, and va:Technique which were extracted from an online article about differences in artistic techniques (Boddy-Evans, n.d., n.pag.). In addition to “curation:style” the other sister classes included

“va:SchoolofArt” and “va:Movement” (Boddy-Evans, n.d., n.pag.). Note, that as this is a top-level ontology with an intention for re-use granularity only went to this level under the top-level class “va:artTrend”.

Ontology Classes and Properties: Encoding in Protégé

The ontology editor selected for this project was Protégé which is an open source Java tool produced by Stanford University for ontology development and includes plug-ins for reasoners, queries and visualizations (protégé/standard.eu, n.pag.). The language OWL-DL was selected for this project due to the availability of Description Logics which are “… a decidable fragment of First Order Logic and therefore amenable to automatic reasoning” and therefore with the reasoner “Pellet”, which comes with Protégé, we were able to check for concept and property satisfiability (that the ontology is consistent and that instances are allowable) by classifying the ontology and articulating its inferential hierarchy (Horridge et al., 2004, 12). Protégé also comes with the visualization tool Jambalaya which acts as an alternative interface to the traditional hierarchy list of classes and properties and allows the user to more closely examine the ontology, allowing for editability of disjoints, domains and ranges of classes within the visual interface and also allows for “analyze first, show the important, zoom, filter and analyze further” allowing the user to isolate different aspects of the visualization for examination known as “brushing” (Kiem, 2008; Gotz et al., 2008, p.128). The visualization during this project was found to be most useful for detecting keying or class mis-assignment errors when composing the domain, ranges and restrictions of the classes and properties while the ontology was being built. The weaknesses in the Jambalaya plug-in include that the re-fresh feature does not always take into account new information added to the ontology, some relationship lines do not always show in certain views and not others, and that a thorough user manual is not included. A user will also need to have to a large computer screen to get the most out of the visualization feature.

Figure 4 - Jambalaya Visualization of Relationships, classes and instances of the VA Influential Relationship Ontology



OWL allows for expressiveness by the ability to add domain, ranges and restrictions to an ontology's properties (predicates). The VA (visual artist) conditions used a combination of these conditions and restrictions to bind the classes together. For example, domains and ranges were encoded so that the "visual artist" instance would act as the subject, the relational statement as the predicate (such as va:hasJoined), and the receiving class instances as the object (such as the class va:ArtistWorkspace) so that triples could be formed when instances are subsequently created. In modeling notation format for OWL and RDF Schema, it can be expressed this way:

:VisualArtist a owl:Class.
:ArtistWorkSpace a owl:Class.
:hasJoined rdfs:domain :VisualArtist
:hasJoined rdfs:range :ArtistWorkSpace.

Note that the domains and ranges declared for properties act as reasoning axioms to assist and guide the builders of the ontologies for instance placement and for the reasoner during the classification phase to check for inconsistencies in the hierarchies within the ontology (Horridge et al. 2004, p.50-64).

The design for this ontology is that domain and ranges will be declared originating from the class :VisualArtist, which is the l'etoile or domain of the ontology and is connected via

properties to the other classes acting as ranges to express the influences and connections of each visual artist instance. This aspect will not receive restrictions as biographies are often incomplete and potential connections to different people , organizations and projects may be multiple or even incomplete (more instances may be added as more information becomes available). However, necessary and sufficient conditions were applied to inverse properties in the VA Influential Relationship Ontology where a related class or subclass thereof such as foaf:organization or foaf:project had restrictions placed on them where the existential rule of someValuesFrom was used in conjunction with :VisualArtist where at least one of the class of :VisualArtist must be included it would then fulfil the set condition and then it “must be a member of this class” (Horridge et al. 2004, 57). These existential restrictions were used on all non-person classes using the :VisualArtist class as a necessary and sufficient condition (which creates an equivalent class) for each of these classes and its relevant inverse property. For example for the class “:ArtistWorkspace” we can declare the following existential restriction, in modeling notation format, which will be inherited by its sub-classes “:ArtistStudio” and “:ArtistResidence” :

```
[a owl:Restriction;
   owl:onProperty :hasMember;
   owl:someValuesFrom :VisualArtist]
```

In this case, the RDF/OWL-DL code for this equivalent class (existential restriction) would be:

```
<owl:Class rdf:ID="ArtistWorkSpace">
      <owl:equivalentClass>
         <owl:Restriction>
            <owl:onProperty rdf:resource="#hasMember"/>
            <owl:someValuesFrom rdf:resource="#VisualArtist"/>
         </owl:Restriction>
      </owl:equivalentClass>
```

Figure 5 - Classes and Subclasses in Protégé

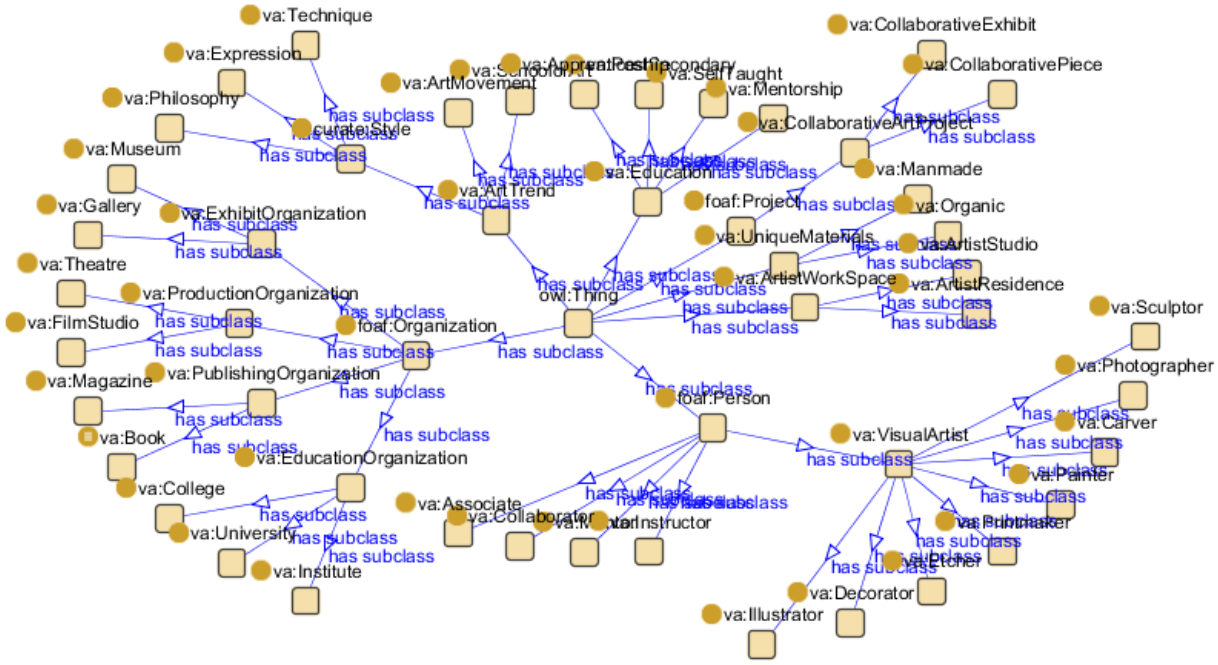
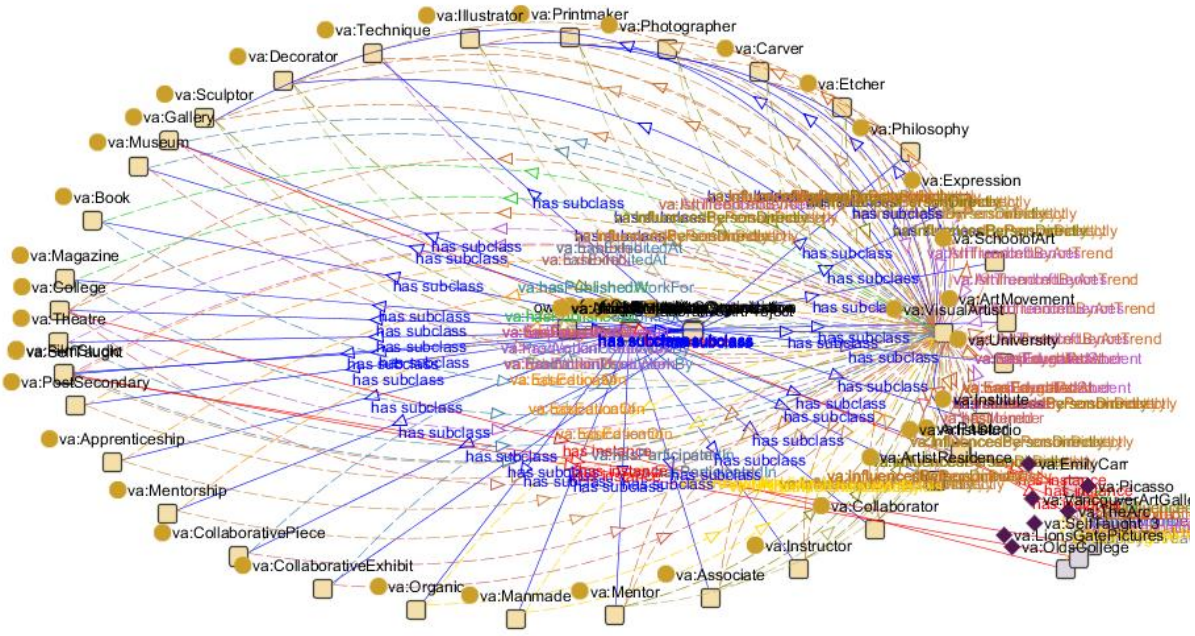


Figure 6 - Domains and Ranges (Axioms) in Protégé



Ontology Evaluation

During the late 2000s the literature indicated that there were a number free online metrics-based ontology tools for validation such as OntoClean, OntoQA or Abraxus (for “Golden Standard” ontology comparison) and although they were located online by the author of this report it was noted that many of them have been discontinued or are no longer maintained by their developers.

Current trends seem to be moving more towards heuristics with a greater emphasis on intrinsic or technical evaluation prior to the release of an ontology into an application. In regards to intrinsic evaluation specifically, “… the model needs to measure how completely, consistently, or accurately the ontology represents the domain concepts in relation to the general cultural context and the context of a particular activity system” (Stvilia, 2007, n.pag., Par 22), where this evaluation of the selection of the ontology entities is iterative and involves evaluating the candidate concepts and terms against an ontology standard such as WordNet™, other similar ontologies and the testing of competency questions against the entity structure of the ontology to determine if the scope and structure of the term sets and hierarchies have sufficient detail to represent the knowledge of the selected domain (Stvilia, 2007, par 22; Noy and McGuiness 2001, 5). Gruber (1995) suggests the five design criteria of clarity, coherence, extendibility, minimal encoding bias and minimal ontological commitment with the acknowledgement that there are often some tradeoffs to be considered during the design decision-making process (Gruber, 1995, 3-4; Gomez-Perez, A., 1994, 3). In this section of the report an evaluation on relation definitions, which are the “heart” of this ontology, and the ontology structure itself will be conducted keeping Gruber’s design criteria in mind.

In this case, an extrinsic evaluation, which deals with end-user testing of an application, on this ontology was not conducted as it is not currently being applied to an outside application.

Evaluation of Influential Predicate Definitions

There are several aspects in the structure of the relationships and its definitions in the ontology which are not consistent in articulation and natural language expression throughout the structure in naming conventions but can be considered to have clarity, coherence and extensibility and avoids coding bias in an attempt to retain expressiveness both at the natural language level and at the OWL level. In particular, the properties and subproperties of foaf:knows/rel:influencedBy and va:influencedByArtTrend where it was challenging to articulate the nuances of influence and resolve the language in different scenarios in the RDF/OWL structure to preserve intent without going too granular to keep it at the class level of the rest of the ontology which used a more basic version of vocabulary for the other properties. These features work well as examples in the evaluation of the ontology when considering definitions in the ontology as a whole.

Foaf:knows
    rel:influencedBy

va:influencedByPersonDirectly
va:influencedByPersonIndirectly

Va:influencedByArtTrend
va:involvedinArtTrend
va:studiedArtTrend

Clarity: Although these naming conventions of these property/sub-property sets are articulated in a more complex manner than the other properties in the ontology (such as “exhibitedAt” or “publishedArt”) they can be considered to be “in-text” documentation in natural language, and this alone may justify the break from these naming conventions where it is more readable for the user and it is supported by underlying logical axioms and formal definitions where each of these properties are aligned with a subject and its inverse an existential (necessary and sufficient) restriction of “someValues of VisualArtist” creating a complete definition for each of these properties. The sub-properties depend on the inheritance of the necessary and sufficient conditions from their parent classes and do not rule out the possibility of new information from being encountered at the sub-class level (Allemang, 2011, 118). The clarity of the “foaf:knows/rel:influencedBy” is somewhat more questionable as “PersonIndirect” and PersonDirect” are lacking in semantics to define the relationship more precisely (but as a top-level ontology may be incorporated in another iteration by another party).In addition, It should be noted that there is no conflict between the informal (natural language) definitions included in “rdfs:comments” and formal definitions (existential restrictions and axiom logics), which are consistent throughout the vocabulary specifications (see Appendix C).

Coherence: Due to the transitive nature of these properties the appropriate inferencing is achieved, in that, for example “va:influencedByPersonDirectly”, infers the property “foaf:knows” which is loosely defined and lacks context. These aspects of these properties are in agreement with Gruber (1995) who states that “it should sanction inferences that are consistent with the definitions” and that there should be consistency in the domain and range declarations (Gruber, 1995, 3). This is achieved by setting them at the property-level so that they are inherited at the sub-property level, and with the domain always being set with “va:VisualArtist” and the relevant object for the property being set at the range level (the reverse for the inverse property). The design of the axioms and the existential restrictions in this ontology between concepts and properties therefore, are not contradictory and can be considered to be coherent.

Extendibility: Extendibility has been anticipated for this vocabulary where the level of granularity in the classes levels were kept low to allow for reuse and to allow for the addition of further semantics as required. Axioms and existential restrictions are inheritance dependent and allows for the discovery of new items at the lower leafs in the hierarchy where if they were articulated at the lower levels would restrict this discovery at the sub-class or sub-property level(s). A concern at the design stage was that the “influence” properties were difficult to articulate and anticipate all types of influential relationships, and in fact the generalization at the upper level will allow for more extendibility allowing for sequential development of the “tree” of new classes and properties where it “…does not require the revision of the existing definitions” and property articulations” (Gruber, 1995, 3).

Minimal Encoding Bias: The selection of the language used to express the sub-properties "va:InfluencedByPersonDirectly/Indirectly" and "va:InfluencedByArtTrend/involvedInArtTrend/studiedArtTrend" breaks with the naming convention of the more simpler properties (such as "hasStudied" or "hasExhibited") but were made at the "knowledge level" (Gruber, 1995, 3) and without considering the encoding aspect in dealing with them. The aim at the knowledge level was to select the best expression of intent without generalizing it so much that it would lose its context once encoded. The drawback of being a bit more specific than just "isInfluenced" or "knows", which was done at the sub-property level is that it may suffer from being too specialized and limit its reusability. It can be argued that in the case of our domain of "visual artist's influences" that it does warrant some specialization to get at that "context" that would be needed in which case our ontology can be concerned to be less than over generalized. In terms of our "ontological commitment" it may have legitimately made a few general claims about the world, but is amendable to "changes" in the world "being modeled" (Gruber, 1995, 3).

Evaluation of Ontology Structure

A consistency and class satisfiability evaluation was conducted iteratively as the ontology was built in Protégé 3.48 using the Pellet reasoner that comes bundled with the program. The Pellet reasoner calculates inferred hierarchies, locates inconsistencies and classifies the taxonomy structure of the ontology. In addition, SPARQL queries were built on the initial competency questions as a means to explore the structure of the ontology and as a "litmus test" (See Appendix D for the list of questions and SPARQL notations. Note that the namespace prefix for the ontology is "va") on instances added to the ontology for testing purposes (Noy and McGuiness, 2001, 5).

As existential (necessary and sufficient) relationships were added to the inverse properties against relevant classes, which converted them from primitive to defined classes, several anomalies appeared during implementation:

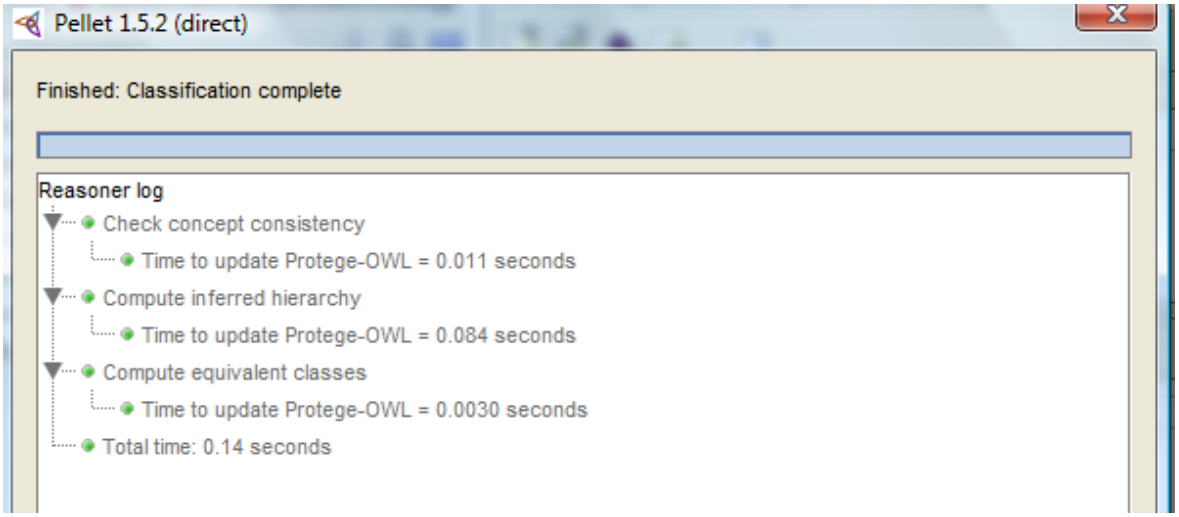
- Where some disjoint declarations between some of the lower sub-classes such as the production organizations or person roles where it was important that some instances may legitimately be part of more than one "is-a" relationship needed to "not" be disjoint creating inconsistencies throughout the ontology. This essentially meant the ontology had been broken, and classes were unsatisfiable where they would not be able to carry instances. As this evaluation was done iteratively it was relatively easy to find the issue, but it would have been more difficult in a large complex ontology.
- An incorrect usage (match) of a property, such as accidentally inserting "va:educatedAt" instead of "va:taughtAt", in creating an existential restriction that went against an already established axiom (domain and range) created an inconsistency throughout the system and required debugging. This demonstrates that the axiom rules added in the first build of the ontology were in fact successful where they acted as a guide for placement of subjects, predicates and objects (triples).
- Where a visual artist also needed to have the role of instructor there was an issue where a new sub-category was created. Adding to "instructor" an instance (visual artist) as a secondary role caused it to be "reclassified" to be included under "visual artist" as a

category. This was caused by a conflict in an axiom declared for the property/inverse: “has taught at/employed teacher” which needed “instructor” added to the domain in addition to visual artist which as a “union” depicting an “or” statement became an equivalent class in OWL.

After these corrections class satisfiability was achieved (see figure 7) and instances were allowable at the lower sub-classes/categories for testing purposes with SPARQL.

SPARQL proved useful for exploring the classes and properties to get a sense of the structure prior to formulating more complicated queries to pull information from the instances in the ontology and acted as a means of verifying constraints and how subject and objects are bound together. SPARQL queries pattern themselves after the triple graphs of subject-object-predicate and can be articulated to focus on specific individual instances and filter out characteristics. In the case of this particular ontology the queries worked well with the inferred content, and this is perhaps because it is a top-level ontology and with its lack of granularity and additional semantics it is relatively easy to query. I was therefore able to successfully use the competency questions as a basis for the SPARQL queries and was able to gather information from the instances to answer them. This fact confirms that the ontology is satisfiable and that triples are accurately articulated in the structure so that the sample instances loaded into the system are retrievable by a structured query language.

Figure 7 - Pellet Reasoner Concept Consistency, Inferred Hierarchy and Equivalent Classes Validation



Conclusion

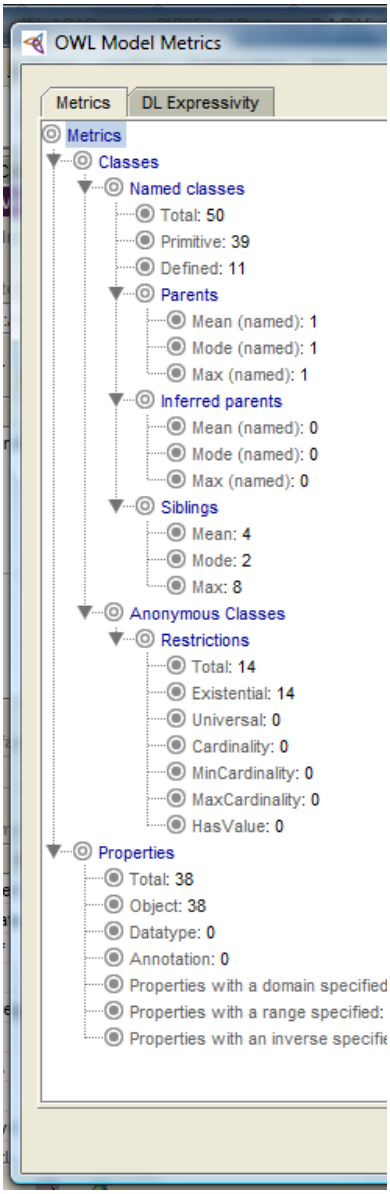
The underlying structures and layers of RDF, RDF Schema and OWL of a semantic-web ready ontology can be considered to be elegant code. The base layer of the simple structure of the triple (subject-predicate-object) is simple in nature, but very effective as a base upon which to build layers of expressivity. There are challenges, however, in translating real world conceptualizations into these structures without losing cultural context. It takes due dilligence on

the part of the ontologist to stay focused on the domain and its users and not to get lost in the "problem-solving" that is inherent at the software application level and keeping in mind that the "gap" between the LIS practitioner and software developer needs to be resolved. As with any information retrieval system, to use it we must learn the system and to work within its boundaries when conducting searches. Key considerations in ontology development include:

- The resolution between the concept and property definitions done at the OWL level and whether or not it corroborates with the definition articulated at the vocabulary specification level.
- Whether or not the inference of the planned hierarchy results in expected connections (and the elimination of "errors" or incorrect inference assumptions)
- How well the articulation of predicates gets at the intended meaning of the properties without getting too granular which would potentially have a "watering down effect" on how one could use the property (the question then is: how broad shall we go).
- At the domain/cultural level one needs to carefully take into consideration the intended users of the domain whether by researching with subject matter experts (SME) or by conducting an analysis of domain-specific text corpora to get the best concept capture one can in the spirit of completeness.

Moreover, perhaps the best chance for an ontology to be useful the best starting point will be to approach the development phase from the cultural perspective of the chosen domain and leave the considerations for the encoding once the conceptualization relationships have been adequately developed. One of the more successful and perhaps brilliant approaches reviewed in this study was the museum "Curate Ontology", which drew on "structuralist theories that distinguish between story (i.e. what can be told), plot (i.e. an interpretation of the story) and narrative (i.e. its presentational form)" as a means of approaching and informing "describing and understanding museum narratives" by means of a developed ontology (Mulholland et al., 2011, Abstract). Their intention was to be able to describe collections of exhibits and their interconnectivity that went beyond the cataloguing data for individual items (Mulholland et al, 2011, 1). This approach falls in line with the objectives of the LIS practioners and librarians' perspective of developing controlled vocabularies that serve the task-based needs of the user, which is perhaps often overlooked by developers who have taken on the ontologist role but one also needs to recognize that at some point the ontology will need to be slotted into these web standard structures for accessiblity and may lose some of its cultural context along the way. The beauty of the iterative development of ontologies and the re-use of them means that through the collaborative nature of the semantic web communities refinements may occur as each iteration of an ontology is used or adapted for other uses while allowing for the creative "human" input in its development which will (hopefully) deal with conceptualization issues.

Figure 8 - Final Protégé Metrics for Ontology



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Appendix A – Mini-Text Corpora Harvest

	Mini-Text Corpora: Visual Artists Influences and Connections - Nouns and Verbs		
Visual Artist	**Candidate Nouns/Concepts**	**Candidate Verbs/Properties**	**Resource**
Arthur Okamura	Tradition of, Modernism, Japanese Heritage, knowledge of styles, impressionism, surrealism, an influence, experiences, American culture, friend, collaborator, gallery, institutional venues, museum of art, handmade books, designed sets, collection, painter	Exposed to, worked at, pursue, attended the university, he met, taught at, is represented,	http://www.spanierrmanmodern.com/inventory/O/Arthur-Okamura/okamura_BIO.htm
Emily Carr	Painter, role models, school of design, instruction, conservative models, new art, studio, private study, experiments in cubism, Picasso, Braque, post-impressionist, native peoples, ethnologist, exhibition, Group of Seven influence, mentor,	Study art at, taught children, classes at,	http://www.thecanadianencyclopedia.com/articles/emily-carr
Jack Shadbolt	Artist, teacher, painting, drawing, influential teacher and advisor, exhibitions, museums, calligraphy (influence), op-art (influence), costume, theatre	Influenced art and artists, teaching art to, conducted workshops, juried exhibitions,	http://www.thecanadianencyclopedia.com/articles/jack-leonard-shadbolt
Robert Bateman	Naturalist, painting, drawing, studied geography, abstract, semi-abstract, Group of Seven (influenced), realism, modern abstractionists (Mark Rothko, Emile Bourdas – influences), traditional Japanese and Chinese Art (influence),	Explored style, taught,	http://www.thecanadianencyclopedia.com/articles/robert-mclellan-bateman
Alessandro Papetti	Italian painter, self-taught artist, Francis Bacon and Alberto Giocometti (influences), Italian, styles of the past,	Exhibiting,	http://en.wikipedia.org/wiki/Alessandro_Papetti
Robert Doisneau	engraving, lithography, creative graphics studio, photographer, *Excelsior* magazine, *Life* and other international magazines, studio, *Group XV*	Influenced by the work of, "taking a job as an assistant with the modernist photographer Andre Vigneau", worked with writers and poets, credited Prevert with giving him the confidence	http://en.wikipedia.org/wiki/Robert_Doisneau
David Smith	Abstract expressionism, sculptor, painter, Picasso, Mondrian, Kandinsky, Russian constructivists, "studio, wood, wire, coral, soldered metal and other found materials", museum, *Arts* magazine, National Council on the Arts, Surrealism, modernist period,	Among his teachers were, met avant-garde artists such as, "which led to an increasing interest in combining painting and construction", participating in symposia, was appointed, heavily influenced by	http://en.wikipedia.org/wiki/David_Smith_(sculptor)
Henri Matisse	Painter, printmaker, sculptor, classical tradition in French painting, modern art, plastic arts (he influenced a movement), Japanese art, impressionism, Van Gogh, art student, Divisionist technique, clay, Fauvism (movement), gallery, neo-impressionists	study art at, became a student of, influenced by the works of earlier masters, he worked beside, "immersed himself in the work of others", working in "clay", "Matisse instructed young artists"	http://en.wikipedia.org/wiki/Henri_Matisse

Appendix B – WordNet Evaluation

Nouns and Verbs: WordNet™ (http://wordnetweb.princeton.edu/perl/webwn) Evaluation

Candidate Term	Synonyms Hyponyms/ Tryponyms	Noun	Verb	Class Candidate	Object Property Candidate	WordNet Definition	Domain Fit?
Influence	consequence, effect, outcome, result, event, issue, upshot	Y				"the effect of one thing (or person) on another" → abstract definition concept,.	Y - verb is closer to intent for predicate
Influence	Affect, outcome, impact, bear upon, manipulate, pull strings		Y		Y	"have and exert influence or effect"	Y
Motivation	Rational motive, irrational motive, urge, impulse, psychic energy, mental energy	Y		Y		"the psychological feature that arouses an organism to action toward a desired goal; the reason for the action; that which gives purpose and direction to behavior" → note to differentiate from "influence"	N -related, influence more precise
Motivate	Actuate, propel, move, prompt, incite, cause, do, make		Y		Y	"give an incentive for action"	N -related, influence more precise
Inspiration	Source, seed, germ, mother, afflatus	Y		Y		"arousal of the mind to special unusual activity or creativity"	N -related, influence more precise
Inspire	Animate, invigorate, enliven, exalt, give occasion to, prompt, instigate		Y		Y	"heighten or intensify, supply the inspiration for, serve as the inciting cause of"	N -related influence more precise
Educator	Academician, faculty member, lecturer	Y		Y		"someone who educates young people, ie. University/college"	N - related instructor better fit
Teacher	Coach, private instructor, tutor	Y		Y		"a person whose occupation is teaching"	N - related, Instructor better fit
Instructor	Coach, private instructor, teacher, tutor	Y		Y		"a person whose occupation is teaching" - covers more types of educators/teachers/instructors	Y
Teach/Instruct	Learn, train, master, prepare, mentor, develop, tutor, lecture, talk		Y		Y	"impart skills or knowledge to"	Y - Teach stronger term?
Art Movement	Pointillism, art	Y		Y		"a group of artists who agree	Y

	nouveau…					on general principles"	
Style (Art)	Classical style, renaissance ..	Y		Y		"a way of expressing something (in language or art or music etc.) that is characteristic of a particular person or group of people or period. the style of a particular artist or school or movement"	Y
Collaboration		Y		Y		"act of working jointly "→ argue can refer to the finished product	Y
Collaborate	Join forces, cooperate, get together, work, play along, get along		Y		Y	"work together on a common enterprise of project"	Y
Associate	Companion, comrade, fellow, adjunct, affiliate, friend	Y		Y		"a person who joins with others in some activity or endeavor"	Y
Mentor	Wise man, sage	Y		Y		"a wise and trusted guide and advisor"	Y
Mentor	Teach, learn, instruct		Y		Y	"serve as a teacher or trusted counselor"	Y - overlap with teach, less formal though
Apprenticeship	Position, situation, berth	Y		Y		"The position of apprentice (works for an expert to learn a trade)"	Y
Apprentice	Train, prepare		Y		Y	"be or work as an apprentice"	N
Internship	Position, situation, berth	Y				"Position of a medical intern" - not a good fit here although culturally "intern" is use more loosely in other disciplines	N
Exhibit	Showing, display		Y		Y	"something shown to the public"	Y
Exhibition	Showing, display	Y		Y		"a collection of things (goods or works of art etc.) for public display"	Y
Organization	Institution, establishment, enterprise	Y		Y		"a group of people who work together"	Y
Study	Learn, read, take, train, prepare, drill, exercise, practice		Y		Y	"be a student of a certain subject"	Y
Workspace	Space	Y		Y		"space allocated for your work (as in an office)"	Y
Studio	Artists' workroom, atelier	Y		Y		"workplace for the teaching or practice of an art"	Y
Residence	Abode, domicile, legal residence, home, place	Y		Y		"any address at which you dwell more than temporarily"	Y
Production	Theatrical Production, staging	Y		Y		"a presentation for the stage or screen or radio or television"	Y
Theatre	Playhouse, stage	Y		Y		"a building where theatrical performances" ; "the art of writing and producing plays"	Y

Film	Movie, moving picture, motion picture, flick, picture show, pic	Y		Y		"a form of entertainment that enacts a story by sound and a sequence of images giving the illusion of continuous movement"	Y

From: The Difference Between Art Styles, Schools and Movements, by Marion Boddy-Evans (n.d.)
http://painting.about.com/cs/paintinghistory/a/artstyles.htm

Three classes and a few subclasses can be gleaned from this article that visual artists can be related to.

Style
→ Technique (i.e. Pointillism)
→ Philosophy (i.e. Arts for the People)
→ Expression (i.e. Metaphysical Painting)

Schools of Art (i.e. Venetian School)

Movement (i.e. Pop Art)

Appendix C: Visual Artist Influential Relationship Vocabulary

Classes

Class: foaf:Person
Definition: The FOAF person class represents people.
Subclass of: owl:Thing
URI: http://xmlns.com/foaf/0.1/Person

Class: va:VisualArtist
Definition: A class of person that creates visual artistic pieces for display, sale or critique
Subclass of: foaf:Person

Class: va:Painter
Definition: A painter is asubclass of visual artist of a person who creates visual art pieces using media such as oil paints, acrylic paints etc.. with the application of tools such as brushes, sponges, fingers etc..
Subclass of: va:VisualArtist

Class: va:Etcher
Definition: An Etcher is a subclass of visual artist of a person who draws or etches visual art pieces using various mediums such as pencil, ink, chalk etc...
Subclass of: va:VisualArtist

Class: va:Illustrator
Definition: An illustrator is a subclass of visual artist of a person who creates visual graphic art for magazines, books or electronic media.
Subclass of: va:VisualArtist

Class: va:Printmaker
Definition: A printmaker subclass of visual artist of a person who creates prints using a variety of techniques such as silkscreening using a variety of coloured pigments such as ink or paint to imprint images on paper or cloth.
Subclass of: va:VisualArtist

Class: va:Photographer
Definition: A photographer is a subclass of visual artist who is a person who take photography professionally.
Subclass of: va:VisualArtist

Class: va:Decorator
Definition: A Decorator is a subclass of visual artist of a person who creates artistic visual displays.
Subclass of: va:VisualArtist

Class: va:Sculptor
Definition: A Sculptor is a subclass of visual artist of a person who models realistic and abstract objects in wood, stone or clay.
Subclass of: va:VisualArtist

Class: va:Mentor
Definition: A class of a person that advises another person in their area of expertise.
Subclass of: foaf:Person

Class: va:Instructor
Definition: Class of a person who teaches and imparts knowledge on a student
Subclass of: foaf:Person

Class: va:Collaborator
Definition: A class of a person that you combine efforts and talents with in a project.
Subclass of: foaf:Person

Class: va:Associate
Definition: A class of a person in a business relationship.
Subclass of: foaf:Person

Class: foaf:Organization
Definition: The FOAF Organization class corresponds to social institutions such as companies etc...
Subclass of: owl:Thing
http://xmlns.com/foaf/0.1/Organization

Class: va:ExhibitOrganization
Definition: an organization that typically has exhibits. It's a generated sub-category of FOAF:organization. It will include any gallery or museum that houses visual art exhibits, or a gallery or museum that may exists as such inside an institution (i.e. an art gallery in a university).
Subclass of: foaf:Organization

Class: va:Gallery
Definition: The Gallery class infers an exhibiting organization that displays artistic works of current or historical artists individually and in a collection.
Subclass of: va:ExhibitOrganization

Class: va:Museum
Definition: The Museum class infers an exhibiting organization that displays artistic works of current or historical artists individually and in a collection in addition to historical or cultural artifacts.
Subclass of: va:ExhibitOrganization

Class: va:EducationOrganization
Definition: education organization, sub-category created under FOAF:Organization. Refers to any education organization with certificate, diploma or degree granting status.
Subclass of: foaf:Organization

Class: va:University
Definition: The University class refers to a post-secondary institution that grants degrees and advanced degrees.
Subclass of: va:EducationOrganization

Class: va:College
Definition: The class post-secondary institution which is a sub-class of EducationOrganization, that grants certificates and diplomas.
Subclass of: va:EducationOrganization

Class: va:Institute
Definition: The class institute refers to an education institute which teaches technical skills and that grants its own certificates, degrees or diplomas but is not classified as a college or university.
Subclass of: va:EducationOrganization

Class: va: ProductionOrganization
Definition: A production organization is one that may use a visual artists work as part of the production work and management aspect of a theatrical or film production or the visual artists work may be featured in one of these productions.
Subclass of: foaf:organization

Class: va:filmStudio
Definition: A sub-class of the production organization, referring to film or movie productions where the visual artist may have created special effects, set pieces or costumes. The visual artists' original work may have also been featured in the production.
Subclass of: va:ProductionOrganization

Class: va:theatre
Definition: A sub-class of the production organization, referring to theatrical productions where the visual artist may have created set pieces or costumes. The visual artists' original work may have also been featured in the production.
Subclass of : va:ProductionOrganization

Class: va:PublishingOrganization
Definition: The class publishing organization that may publish in print or electronic form a visual artists work for the purpose of distribution.
Subclass of: foaf:organization

Class: va:book
Definition: The book class infers a publishing organization that publishing visual artists' works in print or electronic book format.
Subclass of: va:PublishingOrganization

Class: va:magazine
Definition: The magazine class infers a publishing organization that publishes visual artists' works in print

or electronic magazine format which are usually published monthly, bi-monthly, quarterly or yearly.
Subclass of: va:PublishingOrganization

Class: va:Education
Definition: Classes of education type.
Subclass of : owl:Thing

Class: va:SelfTaught
Definition: Self-taught is a subclass of education where the visual artist has taught him or herself techniques from observing or self-study from texts in addition to experimentation in the medium of his or her choice.
Subclass of: va:Education

Class: va:Post-Secondary
Definition: PostSecondary is a subclass of education, which is completed after highschool and is a diploma, certificate, or degree granting institution.
Subclass of: va:Education

Class: va:Apprenticeship
Definition: Apprenticeship is a subclass of education where a visual artist has worked under an expert in a specific art field.
Subclass of: va:Education

Class: va:Mentorship
Definition: Mentorship is a subclass of Education, which is where a visual artist recieves advising from an expert in a specific area of career interest.
Subclass of: va:Education

Class: va:ArtTrend
Definition: The Art Trend classes refers to known styles, art movements and schools of art (such as the Algonquin School) of visual artists.
Subclass of: owl:Thing

Class: curate:Style
Definition: Curate style is a artistic style taxonomy with sub-classes of expression, philosophy and technique. It was re-used from the Museum Curate Ontology.
Subclass of: va:ArtTrend
URI: **http://decipher.open.ac.uk/curate/ontology/Style**

Class: Philosophy
Definition: Philosophy behind the art piece. (ie. Art for the People -- arts and crafts) http://painting.about.com/cs/paintinghistory/a/artstyles.htm
Subclass of: curate:Style

Class: Expression
Definition: A characteristic appearance in art pieces. (i.e. Metaphysical Painting). http://painting.about.com/cs/paintinghistory/a/artstyles.htm

Subclass of: curate:Style

Class: Technique
Definition: The subsequent taxonomy attached to this sub-class may include techniques that are culturally influenced such as Sumi-E which originates in Japan, as is accomplished using special brushes, ink and shaped strokes..
Subclass of: curate:Style

Class: va:SchoolofArt
Definition: "A school is a group of artists who follow the same style, share the same teachers, or have the same aims. They are typically linked to a single location" i.e. The Algonquin School (Boddy-Evans, n.d. n.p.) **http://painting.about.com/cs/paintinghistory/a/artstyles.htm**
Subclass of: va:ArtTrend

Class: va:ArtMovement
Definition: "A group of artists who have a share a common style, theme, or ideology towards their art. Unlike a school, these artists need not be in the same location, or even in communication with each other" i.e. Pop Art (Boddy-Evans, n.d., n.p.)
http://painting.about.com/cs/paintinghistory/a/artstyles.htm
Subclass of: va:ArtTrend

Class: va:UniqueMaterials
Definition: The unique materials class refers to materials that are unique to that artist which he or she uses and is known to use in visual art pieces.
Subclass of: owl:Thing

Class: va:OrganicMaterials
Definition: Organic Unique Materials is a subclass of UniqueMaterials and denotes materials that are organic or natural, such as dried wheatgrass, used in a visual art piece and for which the visual artist is known for.
Subclass of: va:UniqueMaterials

Class: va:ManMadeMaterials
Definition: The class Manmade is a subclass of Unique Materials, and are from manmade products such as plastic.
Subclass of: va:UniqueMaterials

Class: va:ArtistWorkspace
Definition: A class that refers to a workspace within which an artist may create visual art pieces usually alongside other others in the same workspace.
Subclass of: owl:Thing

Class: va:ArtistStudio
Definition: ArtistStudio is a sub-class of ArtistWorkSpace. An artist studio is (usually) a shared workspace for visual artists and may include shared equipment used in creating visual art pieces.
Subclass of: va:ArtistWorkspace

Class: va:ArtistResidence
Definition: ArtistStudio is a sub-class of ArtistWorkSpace. An artist studio is (usually) a shared workspace for visual artists and may include shared equipment used in creating visual art pieces.
Subclass of: va:ArtistWorkspace

Class: foaf:project
Definition: FOAF Project is a “collective endeavor”.
Subclass of: owl:Thing
URI: http://xmlns.com/foaf/0.1/project

Class: va:CollaborativeArtProject
Definition: A collaborative art project is a subclass of project, which is a collective endeavour of two or more visual artists to produce an art project.
Subclass of: foaf:project

Class: va:CollaborativeExhibit
Definition: A Collaborative Exhibit is a subclass of Collaborative Art Project which is a collective endeavour of two or more visual artists to produce a series of art projects for a cohesive exhibit.
Subclass of: va:CollaborativeArtProject

Class: va:CollaborativePiece
Definition: A Collaborative piece is a subclass of Collaborative Art Project which is a collective endeavour of two or more visual artists to produce a single artistic piece.
Subclass of: va: CollaborativeArtProject

Object Properties

Property: foaf:knows
Definition: A property representing an acknowledgement between two or more people.
URI: http://xmlns.com/foaf/0.1/knows
Subproperty: rel:InfluencedBy
Inverse: foaf:knows

Property: rel:InfluencedBy
Definition: A property representing an influence of a person on another person.
Subproperty of: foaf:knows
URI: http://purl.org/vocab/relationship/influencedBy
Subproperties: va:IsInfluencedByPersonDirectly and va:IsInfluencedByPersonIndirectly
Inverse: va: Influences

Property: IsInfluencedByPersonDirectly
Definition: A property representing a direct influence of a person on another person (visual artist). In this case a person has met and “knows” the other person.
Subproperty of: rel:InfluencedBy

Domain: va:VisualArtist
Range: va:Mentor; va:Instructor; va:Associate; va:Collaborator; va:VisualArtist (painter, etcher, carver, sculptor, photographer, decorator, illustrator, printmaker)
Inverse: InfluencesPersonDirectly

Property: IsInfluencedByPersonIndirectly
Definition: A property representing an indirect influence of a person on another person (visual artist). As in “knows of” a person but the “knows of” may not be reciprocated.
Subproperty of: rel:InfluencedBy
Domain: va:VisualArtist
Range: va:Mentor; va:Instructor; va:Associate; va:Collaborator; va:VisualArtist (painter, etcher, carver, sculptor, photographer, decorator, illustrator, printmaker)
Inverse: InfluencesPersonIndirectly

Property: va:IsInfluencedByArtTrend
Definition: A property representing the relationship between a person (visual artist) and the influence of an art trend on that person.
Subproperties: va:hasStudiedArtTrend and va:WasInvolvedInArtTrend
Inverse: va:ArtTrendInfluences

Property: va:hasStudiedArtTrend
Definition: A sub-property of "IsInfluencedByArtTrend, the property represents the relationship between a visual artist and the art trends (style, school, movement) that he or she studied either formally or informally. The nature of which may be indicated with the addition of further semantic detail.
Domain: va:VisualArtist
Range: va:ArtMovement; va:SchoolofArt; va:Philosophy; va:Expression; va:Technique
Subproperty of: va:IsInfluencedByArtTrend
Inverse: va:ArtTrendWasStudiedBy

Property: va:WasInvolvedInArtTrend
Definition: A sub-property of “IsInfluencedByArtTrend”;, this property represents the relationship between a visual artist and the art trend (style, school, movement) he or she was involved with. The nature of which may be indicated by the further addition of semantic detail.
Domain: va:VisualArtist
Range: va:ArtMovement; va:SchoolofArt; va:Philosophy; va:Expression; va:Technique
Subproperty of: va:IsInfluencedByArtTrend
Inverse: va:ArtTrendHadInvolvementBy

Property: va:hasEducation
Definition: A property representing a type of education received by a person (visual artist)
Domain: va:VisualArtist
Range: va:SelfTaught; va:PostSecondary; va:Mentorship; va:Apprenticeship
Inverse: va:Educationof

Property: va:HasTaughtAt
Definition: A property representing that a person (visual artist) taught at an educational post-secondary institution
Domain: va:VisualArtist
Range: va:College; va:University; va:Institute

Inverse: va:EmployedTeacher

Property: va:hasExhibitedAt
Definition: A property representing the relationship between a person (visual artist) and an exhibition organization he or she exhibited at.
Domain: va:VisualArtist
Range: va:Museum; va:Gallery
Inverse: va:Exhibited

Property: va:wasEducatedAt
Definition: A property representing the relationship between a person (visual artist) and an educational post-secondary institution that he or she was educated at.
Domain: va:VisualArtist
Range: va:College; va:University; va:Institute
Inverse: va:hadEducatedStudent

Property: va:hasCollaboratedOn
Definition: A property representing the relationship between a person (visual artist) and an art project he or she collaborated on.
Domain: va:VisualArtist
Range: va:CollaborativePiece; va:CollaborativeExhibit (va:CollaborativeArtProject)
Inverse: va:hasCollaborator

Property: va:hasCollaboratedOnShortTerm
Definition: A property representing the relationship between a person (visual artist) and a short term art project he or she collaborated on.
Subproperty of: va:hasCollaboratedOn
Domain: va:VisualArtist
Range: va:CollaborativePiece; va:CollaborativeExhibit
Inverse: va:hasCollaboratorShortTerm

Property: va:hasCollaboratedOnLongTerm
Definition: A property representing the relationship between a person (visual artist) and a long term art project he or she collaborated on.
Subproperty of: va:hasCollaboratedOn
Domain: va:VisualArtist
Range: va:CollaborativePiece; va:CollaborativeExhibit
Inverse: va:hasCollaboratorLongTerm

Property: va:hasJoined
Definition: A property representing a relationship between a person (visual artist) and an artists' workspace he or she joined.
Domain: va:VisualArtist
Range: va:ArtistStudio; va:ArtistResidence
Inverse: va:HasMember

Property: va:hasPublishedAt
Definition: A property representing the relationship between a person (visual artist) and a publication

organization that he or she published work with.
Domain: va:VisualArtist
Range: va:Book; va:Magazine
Inverse: va:hasPublishedWorkFor

Property: va:hasWorkinProduction
Definition: A property representing the relationship between a person (visual artist) and a production organization that she or he had their work used by.
Domain: va:VisualArtist
Range: va:theatre; va:film
Inverse: va:ProductionUsedWorkBy

Property: va:isKnownForUniqueMaterials
Definition: A property representing the relationship between a person (visual artist) and the knowledge that he or she used unique materials and is especially known for that.
Domain: va:VisualArtist
Range: va:Organic; va:ManMade
Inverse: va:UniqueMaterialsAreAssociatedWith

Appendix D - SPARQL Queries

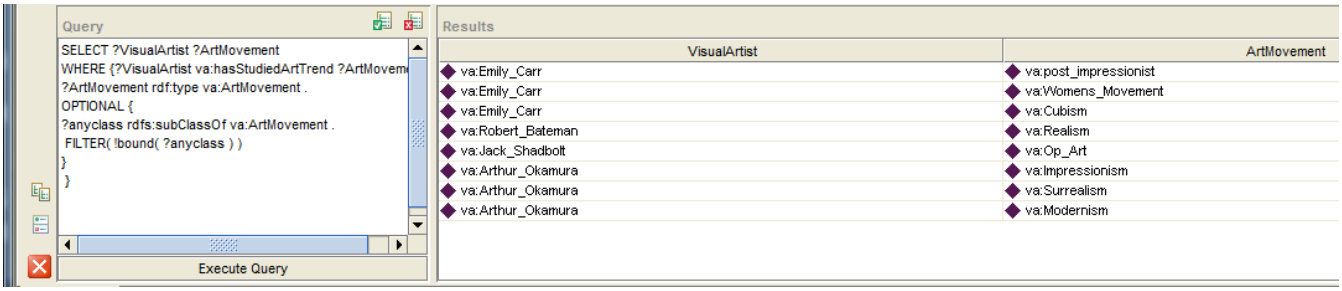
Competency Questions and SPARQL notation

** note: “OPTIONAL” prevents the query from failing if no match is available.

1. Which Visual Artists are said to have studied a particular art movement?

```
        SELECT ?VisualArtist ?ArtMovement
WHERE {?VisualArtist va:hasStudiedArtTrend ?ArtMovement .
?ArtMovement rdf:type va:ArtMovement .
OPTIONAL {
?anyclass rdfs:subClassOf va:ArtMovement .
 FILTER( !bound( ?anyclass ) )
}
 }
```

Figure 9 - Sample Retrieval Results from Protégé



2. Which visual artists were Directly influenced by another category of visual artists? (i.e. Painter)

```
SELECT ?VisualArtist ?Painter
WHERE {?VisualArtist va:InfluencedbyPersonDirectly ?Painter .
?Painter rdf:type va:Painter .
OPTIONAL {
?anyclass rdfs:subClassOf va:Painter .
```

```
 FILTER( !bound( ?anyclass ) )
}
 }
```

3. Which galleries exhibited which visual artists said to be influenced by Mark Tobey?

```
SELECT ?VisualArtist ?Gallery
WHERE {?VisualArtist va:InfluencedbyPersonDirectly va:Mark_Tobey .
va:Mark_Tobey rdf:type va:Painter .
?VisualArtist va:hasExhibitedAt ?Gallery .
OPTIONAL {
?anyclass rdfs:subClassOf va:Mark_Tobey .
?anyclass rdf:subClassOf va:ExhibitionOrganization .
 FILTER( !bound( ?anyclass ) )
}
}
```

4. Which visual artists were involved in Schools of Art and what type of schools were they (i.e. the Group of Seven/Algonquin School)?

```
SELECT ?VisualArtist ?SchoolofArt
WHERE {?VisualArtist va:hasStudiedArtTrend ?SchoolofArt .
?SchoolofArt rdf:type va:SchoolofArt .
OPTIONAL {
?anyclass rdfs:subClassOf va:SchoolofArt .
 FILTER( !bound( ?anyclass ) )
}
 }
```

5. Which visual artists were involved in a long-term collaboration exhibit?

```
SELECT ?VisualArtist ?CollaborativeExhibit
WHERE {?VisualArtist va:hasCollaboratedOn_LongTerm ?CollaborativeExhibit .
?CollaborativeExhibit rdf:type va:CollaborativeExhibit .
OPTIONAL {
?anyclass rdfs:subClassOf va:CollaborativeExhibit .
 FILTER( !bound( ?anyclass ) )
}
 }
```

6. Which visual artists studied cubism?

```
SELECT ?VisualArtist
WHERE {?VisualArtist va:hasStudiedArtTrend va:Cubism . }
```

7. Which visual artists were also teachers and what schools did they teach at? Did any visual artists attend Institutes specifically as students? What were they called?

```
SELECT ?VisualArtist ?School
WHERE {?VisualArtist va:hasTaughtAt ?School.
?School rdf:type va:University.
OPTIONAL {
?anyclass rdfs:subClassOf va:EducationOrganization .
 FILTER( !bound( ?anyclass ) )
}
 }
```

```
SELECT ?VisualArtist ?School
WHERE {?VisualArtist va:wasEducatedAt ?School.
?School rdf:type va:Institute .
```

```
OPTIONAL {
?anyclass rdfs:subClassOf va:EducationOrganization .
 FILTER( !bound( ?anyclass ) )
}
 }
```

8. Which visual artists did the National Gallery of Canada exhibit?

```
SELECT ?VisualArtist
WHERE {?VisualArtist va:hasExhibitedAt va:National_Gallery_of_Canada . }
```

9. What can I find out about a particular artist? (i.e. Emily Carr) – this one gives all the information about associations and influences for a particular artist. This acts as a good starting place to explore the ontology.

```
SELECT ?property ?value
WHERE {va:Emily_Carr ?property ?value . }
```