# Encoded Archival Description for Numismatic Collections

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**Abstract**

Developed in the 1990s and revised in 2002, Encoded Archival Description (EAD) is an XML encoding standard commonly used in libraries and archives in the United States and Europe to describe collections of paper materials, for example, manuscripts and photographs. Numerous physical, organizational, and categorical facets of the collections can be described in EAD, including physical materials, genres, index terms, provenance, and essays of biographical or historical nature (complete with footnotes, bibliographies, figures, tables, etc.). These facets are not unique in their usefulness to the library and archival fields, and the descriptive standard's flexibility allows it to effectively describe collections of objects that are more commonly found within museums. Recently, the University of Virginia Library worked in conjunction with the University of Virginia Art Museum to digitize the museum's collection of nearly 600 coins of classical—predominantly Roman—origin. Coupled with Apache Solr for semantic search and faceted browsing, an interface was created as a research tool for students and scholars of numismatics. This paper details the process of the project and seeks to inform the reader of EAD's potential for encoding numismatic metadata.

***Keywords***: *numismatics, metadata, EAD, museums, semantic search*

## 1 INTRODUCTION

The growing demand for digital access is having a profound impact on the roles of institutions such as museums and special collections libraries. These institutions are repositories of objects of both historical and cultural significance that cannot be widely disseminated to the public through circulation in the way that regular library holdings, such as books, journals, and maps, are. As a result, museums and special collections libraries (which are ostensibly museums of a different type of object) are increasingly turning to digitization in their mission of providing access to their collections. In autumn of 2007, particular focus was given by the University of Virginia Library and Art Museum to digitize the museum's collection of coins, most of which are of ancient Greek and Roman origin, and provide access to them freely online. The project was completed by summer 2008 and launched publicly at http://coins.lib.virginia.edu.

Despite the perceived permanence of metallic coins, many of the objects in the collection are quite fragile and must be handled with the utmost care. Consequently, digitization impacts the conservation and preservation of collections as well. Most museums exhibit only a small portion of their entire collection at any given time. For scholars to view objects (in the case of this paper, ancient coins) that are not in the current public exhibition, special arrangements must often be made for a curator to select particular coins from the cabinet for the scholar to examine. The physical act of handling a coin ultimately leads to its degradation over time. Cotton gloves can leave minuscule fibers on the coins, while the natural oils from the hands can chemically corrode the metal. Digitization, then, is a way of circumventing the process of degradation. Scholars can access high resolution images of coins that yield greater detail than can be seen with the naked eye or even standard museum-issued magnifying glasses. As part of the University of Virginia Numismatic Project, a decision was made on the part of the University of Virginia Art Museum to image about 30 ancient Greek coins suffering from "bronze disease", a condition in which the coin begins to produce acid internally and disintegrate (fig 1).[1] The coins were deemed by museum officials to be too fragile to handle, and thus were never used for scholarly activities such as research or teaching. A risk was taken to handle them for digitization, but the reward is that the images can now be used for teaching purposes. Thus, the museum fulfillled its obligation to provide access to the collection while protecting its physical survival.

## 2 PROJECT BACKGROUND

The digitization project arose in October 2007 from a Roman numismatics graduate seminar taught by Professor John Dobbins of the Classical Art and Archaeology Department at the University of Virginia. The University of Virginia Art Museum is the

[1]Jason Sanchez and Ken Harl, "Bronze Disease: Understanding, Curing, and Preventative Treatment," paper presented at Crescent City Coin Club, New Orleans, Louisiana, August 2004, www.crescentcitycoinclub.org/ seminars_and_programs/ Bronze %20Disease.pdf.

custodian of the physical objects. A grant of $5,000 issued by the University of Virginia Library funded the digitization effort, so it became a joint project between two separate but similar institutions within the university. The library served as the caretaker of the intellectual content of the collection, i.e., the coins were scanned with library equipment and stored and maintained on library-run servers in its software environment. Thus, the grant money funded the imaging of the coin collection at 2000 pixels per inch using cameras generally employed to scan rare materials contained in the Harrison-Small Special Collections Library, e.g., manuscripts, photographs, and books.[1] Grant money also funded the employment of a graduate student studying numismatics to research and identify each of the coins (unless the coin was too physically degraded to allow for it) in the proper numismatic catalogs, and assign each coin a bibliographic reference number, thus enhancing the museum's own records of the collection.

As a result of the partnership between the two institutions and the University of Virginia Library's role as intellectual caretaker, common library standards and practices were to be employed in the description and dissemination of the digital data. While the museum's collection is small, containing approximately 600 coins, it is fairly broad with respect to Roman coins, featuring coins from nearly every era, from the mid-Republic to the Tetrachy (ca. 200 BC-AD 300). Thus, a site displaying the museum's collection is an invaluable tool not only for students at the University of Virginia, but also for anyone with access to the Internet and an interest in ancient numismatics.

**Figure 1.** *Unidentified Greek coin suffering bronze disease.*

## 3 Interface Requirements

Before considering a metadata format for describing the coins, it is necessary to consider the desired functionality of the website. Since the driving force of the project was the Roman numismatics seminar, the site would have to be designed to be a useful tool for numismatists and an element for teaching the class in future semesters. It would obviously need to incorporate and display the standard physical and descriptive attributes of coins, such as the material, denomination, legends, and type. The site would not only deliver content to the general public in the form of an item record, but would also include a feature for comparing two datasets side-by-side, which is useful for teaching classical portraiture. For example, one could compare the obverses of coins of Marcus Aurelius of the Antonine Dynasty with the coins of Titus of the Flavian Dynasty in order to teach the differences in engraving style between the two periods of Roman art. One of the most important features of the website would be to allow students to contribute their own research, thus enhancing the quality of the data in the digital collection and improving its relevance by adding historical context to individual coins or sub-collections within the museum's holdings.

Additional requirements include the ability to encode provenance and acquisition information, to index terms for connecting a coin with other coins related by people, places, subjects, and deities, and, importantly, to normalize Latin legends and expand abbreviations in order to enhance the searchability of the collection. For example, the Latin alphabet does not contain either the letter "J" or "U," but rather, "I" or "V," respectively, pronounced differently depending on their location within the word. A legend, transcribed IVL CAES PM, declares that Julius Caesar has the title of Pontifex Maximus, or the chief priest of Rome. Searching in legends for "*pontifex maximus*" or "Julius Caesar" will yield this coin. This is important because the site must employ standards for transcribing legends and describing the iconography of coins that were set when the first printed numismatic catalogs were published more than a century ago. With the requirements set, the process of examining metadata formats began.

## 4 Encoded Archival Description

After careful consideration of the interface requirements, it was determined that the XML standard Encoded Archival Description (EAD) was best suited for the description of coins.[2] EAD was one of several descriptive schemes considered; the advantages and

[1] A Hasselblad camera with a 45 megapixel Phase One digital back was employed for imaging and Capture One DB was utilized for processing.

[2] See Daniel Pitti, "Encoded Archival Description: An Introduction and Overview," *D-Lib Magazine* 5 (11) (1999); www.dlib.org/dlib/november99/11pitti.html (accessed May 1, 2009).

disadvantages of the others not chosen for this collection will be discussed in further detail later in this paper.

Encoded Archival Description has become the standard in special collections libraries and archives for describing collections of materials commonly found within those types of institutions, namely manuscripts, photographs, and other paper materials. While EAD is capable of describing other types of objects, it is rarely used outside of the library/archives context. Museums are similar to special collections libraries in many respects, particularly in their mission to provide public access to culturally or historically significant materials. These objects are not easily described within the framework of a relational database model, so an XML-based solution allows for greater flexibility in describing them. EAD is robust and flexible; it was easily adapted to accommodate the physical and categorical attributes of coins. Moreover—and unlike the other metadata formats considered—EAD is designed to describe the conceptual and/or literal organization of a collection of objects as well as the individual items themselves. It allows for not only the description of the individual items, but also the description of the collection as a whole.

As an example of its use in an archive, EAD may be used to describe numerous facets of the collection—its creator, its dates, its scope and content, etc. A collection of papers may be contained in a box, which is considered a top level component in a physical organization of the collection. The box may contain many folders that are sub-components of the box. These folders may contain individual manuscripts, which can be described in full detail with a wide variety of XML elements. While many institutions utilize EAD for describing their rare materials in a literal box-folder-item sense, museum collections may be better described in a conceptual organization. The art museum's numismatic holdings are physically in the same coin cabinet, but are conceptually organized into groups, referred to by the museum as "collections." Approximately 300 of the nearly 600 coins in the museum's holdings were acquired in 1991 from the Oliver's Orchard Hoards, excavated near Colchester, England in the 1980s. Another group, called the Caltagirone Collection, was donated in 1989. The Oliver's Orchard Hoards has a conceptual sub-collection of coins of the Gallic emperor Postumus. Metadata describing the Oliver's Orchard Hoards as a whole are applied to its subparts, which makes maintenance of the data substantially easier. The provenance of the Oliver's Orchard Hoards series is encoded one time in the XML document, but applied to all 300 coins that are part of its series. In this way, EAD differs significantly from other schemes that could be used to describe coins; EAD maintains the important collection-item relationship that cannot be described otherwise. In addition to the standard's ability to establish this relationship, EAD contains functionality for describing all the necessary physical and categorical attributes as well as enabling the attachment of complex, publication-quality historical and biographical essays, complete with multiple sections, font formatting, figure images, tables, lists, end notes, and bibliographies—all of the features one might see in a journal article.

Moreover, an XML standard such as EAD can describe complex, hierarchical data, such as attributes that contain sub-categories, much more easily than a relational database. Two such examples can be found in describing the physical material of the coin or its academic department. It is not difficult to describe a coin's material in a database, but it is more difficult to break down an alloy's metallic components and the percentage that component comprises of the whole. For example, an institute may perform a chemical or physical analysis (such as X-ray diffraction or X-ray fluorescence) on an item that is billon, an alloy defined by numismatists as containing less than 70% silver content. With XML, the percentage of silver, copper, zinc, lead, etc. can be described as material sub-categories of billon. With regard to academic departments, a Greek-Bactrian coin may be defined as a sub-department of Greek and/or Central Asian coinage. Similarly, coins of Julius Caesar and the emperor Hadrian both belong to the Roman department, while the former can also be defined as Roman Republic and the latter, Roman Empire. Therefore, both coins can be found when browsing Roman coins, but can also be found through narrower searches in different, distinct eras in Roman history and coinage.

Although much of Encoded Archival Description can be used in the same manner for coins as with manuscripts and other traditional archival materials, some elements of the standard must be adapted to describe the particular physical characteristics of coins to make the site as useful and academically relevant as possible. EAD is flexible in that it allows for a generalizable physical descriptor—an element called <physfacet>. A type attribute allows for a definition of the physical characteristic. The most common characteristics described in the University of Virginia Numismatic Project are material, legend, iconography (often referred to as "type" in numismatics), denomination (using the EAD element, <genreform>), weight, diameter (encoded with the <dimensions> element), and die axis (see fig. 2 for the XML).

While other attributes such as edge type or mint marks could easily be adapted to elements in EAD, they were not, simply because the collection did not contain samples of coins exhibiting those physical features large enough to warrant their encoding. Crosswalks to and from the Numismatic Database Standard (NUDS) exchange format will address this issue and will be discussed further in a review of NUDS later in the paper. The <materialspec> element was adopted to encode the departments and scripts of coins. Material Specific Details are defined in EAD as “data which are unique to a particular class or form of material and which are not assigned to any other element of description.”[1]

```
<physdesc>
   <physfacet
type=“material”>billon</physfacet>
   <physfacet
 type=“obverse_legend”><abbr expan=“imp
imperator gallienus aug
augustus”>IMP(ERATOR) GALLIENVS
AVG(VSTVS)</abbr> </physfacet>
   <physfacet
type=“reverse_legend”><abbr
expan=“victoria aug augusti”>VICTORIA
AVG(VSTI)</abbr></physfacet>
   <physfacet type=“obverse_iconography”>Radiate
bust, right, cuirassed.</physfacet>
   <physfacet
 type=“reverse_iconography”>Victory
walking left, holding wreath
in right hand and palm in left.</physfacet>
   <genreform>antoninianus</genreform>
 <physfacet
type=“weight”>3.41</physfacet>
   <dimensions>22</dimensions>
   <physfacet
type=“axis”>6:00</physfacet>
</physdesc>
```

**Figure 2.** *A block of XML describing the physical characteristics of a particular coin.*

The encoding of script and language of coins has been ignored by several other online numismatic databases. While the script is often implied by the department (for example, Greek coins typically contain legends in the Greek language), one encounters Roman or Jewish coinage minted in the Greek script, the *lingua franca* of the ancient Orient. Figure 3 presents examples of the use of <materialspec>:

```
<materialspec
type=“department”>Roman<materialspec
type=“department”>Roman
Empire</materialspec></materialspec>

<materialspec
type= “script”>Greek</materialspec>
```

**Figure 3.** *Examples of <materialspec>.*

The importance of integrating index terms into the record for each coin cannot be overemphasized, for it is a major avenue for locating related coins in a variety of categories, including associated personal names (e.g., moneyer, artist, or ruler), dynasties, subjects, political identities, depicted deities, or geographical locations: city, region, and modern nation of origin. The common name for each category is used in the text node in the element and is the name visible on the website.

A “normal” attribute encoded in the XML element enables the name to be normalized for indexing purposes. This allows the emperor referred to as Philip the Arab to retain his common name for display purposes, but searching for his proper Latin name and title, Marcus Julius Philippus Arabus, will return results as well. This framework also applies to the city of Istanbul, which is also normalized for its ancient Greek and Roman names, Byzantium and Constantinople, respectively. Index terms come within the Controlled Access Headings (<controlaccess>) element, which can contain elements for sub-categories of terms, as listed below in figure 3:

```
<controlaccess>
   <persname role=“king”>Demetrios
     Poliorcetes</persname>
   <famname>Antigonid</famname>
   <corpname>Macedonian Kingdom</corpname>
   <persname role=“deity”>Nike
   </persname>
   <persname role=“deity”>Poseidon
   </persname>
   </controlaccess>
   <geogname role=“city”>Salamis
   </geogname>
   <geogname role=“region”>Saronic Gulf
   </geogname>
   <geogname role=“state”>Greece
   </geogname>
</controlaccess>
```

**Figure 3.** *Controlled access headings.*

The process of developing the website began with a small subset of data as a proof of concept, and as the graduate student continued to identify coins as they were scanned and encode them in EAD, the new data were integrated into the site, gradually increasing the size of the digital collection and improving the interlinking between records on a wide variety of query facets. A collection of objects needs not be digitized completely before the development of a delivery framework; instead, it is much easier to build the site from a small collection of XML records and develop an efficient workflow for ingesting more data into the site. As mentioned above, since the University of Virginia Library is the caretaker of the digital data, many library standards were employed in the development of the project. Encoded Archival Description was just one of the few standards used. In addition to a traditional library/archive approach to the metadata, a number of common software applications were utilized in the delivery of the data to the public.

[1]Network Development and MARC Standards Office, “EAD Elements-<materialspec> Material Specific Details,” Library of Congress, www.loc.gov/ead/tglib/elements/materialspec.html.

## 5 Tying the pieces together: Open source applications

In the realm of a large Association of College and Research Libraries (ACRL) institution, such as the UVa. Library, one sees a growing awareness of the open source development community and greater involvement by institutions in contributing to that community. Many universities have been heavily reliant on Unix-based software (Solaris/Linux) for web servers for years, and one sees a variety of Apache products involved in web development. Applications such as Apache Tomcat and Cocoon are used for delivery of content, as well as open source PHP/MySQL-based platforms, and there has been an increasing demand for Ruby on Rails applications. This particular project utilizes the Java servlet, Cocoon, for handling pipelines and dynamically transforming the Encoded Archival Description data into HTML using XSLT stylesheets when the user requests a record from the XML document.

For indexing, Apache Solr, a powerful search engine based on the Lucene Java library that features hit-highlighting, faceting, caching, replication, and a variety of administrative front-end features is used. Solr runs in a Java servlet container, such as Tomcat. It communicates with Cocoon or Rails applications, and is able to return query results in XML, Ruby hashes, and JSON for processing in a variety of programming languages. It is highly customizable, and, like many successful open source packages, has a large support community.[1] It also supports Unicode, which makes it especially valuable for storing non-Latin legends. Solr has been adopted by a growing number of ACRL institutions, both for large and small amounts of data. The search engine sees use in the private industry as well, with Netflix and CNET as its most widely-recognized corporate users. In 2007, Netflix reported that they received 1.2 million queries a day on an index of 250,000 objects.

Solr is also an integral part of a project called Blacklight at the University of Virginia Library, created to replace the proprietary SirsiDynix Open Public Access Catalog. Blacklight serves as an aggregate index of more than four million total objects. Physical collections (books, journals, maps, CDs, DVDs, etc.) are located through the same interface as electronic materials, such as image collections, ebooks, databases, EAD Finding Aids, and individual coins within the University of Virginia Art Museum Numismatic Collection website. Solr's flexibility enables data from a variety of sources to be mapped to a schema of common fields necessary for search and faceted browsing, such as title, date, collection name, and subject.[2]

While Blacklight focuses on mapping all four million documents to a fairly generalized index to facilitate searching of traditional library and archival fields, the Solr index for the U. Va. coin website was defined in a much more localized way in order to focus particularly on fields that are vital in searching, browsing, and sorting numismatic information. As a result, there are more than 40 fields in the index. Some fields are used exclusively for keyword searches, such as the full-text search that queries the entire set of text nodes for each coin in the collection, including associated essays. In addition to the full-text search, one can submit text searches specifically for normalized names, geographic locations, legends, iconography, deities, subjects, and accession numbers. Like many other search engines, Solr allows for wildcard searches. Some fields contain strings used for display purposes only, such as the titles or human-readable dates of coins, for example, "A.D. 263–265." Other fields are used as facets. Facets are an incredibly important element of Solr. These are strings describing categories of a coin that provide important context and allows it to be grouped with other coins with the same facet. A coin that is a silver denarius is ingested into the Solr index with numerous facets, including material and denomination. This allows one to locate the coin by browsing for silver coins or denarii. When viewing the record of a coin of the emperor Nero, the user may seamlessly locate other coins of Nero by clicking the link that is generated from the object's EAD-encoded index terms.

Currently, there are fourteen browsable categories: century, city, collection, deity, denomination, department, dynasty, institution, material, name, region, script, state, and subject. Numerous facets may also be used in conjunction with keyword searches to refine queries and target more specific selections of coins. Search results may also be sorted by a variety of facets. Many, but not all, of the browse categories are used for sorting results. Sortable facets include: accession number, collection, date, deity, denomination, department, diameter, dynasty, institution, material, name, obverse legend, origination, reverse legend, script, and weight. While some of the sortable facets are strings of alphanumeric characters, some are sortable integer or floating point numbers. The sortable numeric fields—year, weight, and diameter—are also available in the search form, allowing for precise or range matches in those categories.

Overall, the robustness of Solr enables a search index to be customized specifically for numismatic

[1] "Apache Solr," The Apache Foundation, http://lucene.apache.org/solr.

[2] For more information on Blacklight, see Bess Sadler, "Project Blacklight: A Next Generation Library Catalog at a First Generation University," *Library Hi Tech* 27 (2009): 57–67. The search interface is in a public beta phase currently, and can be seen at http://virgobeta.lib.virginia.edu/.

information, and since it communicates with Cocoon, allows query results not only to be integrated into traditional search and browse pages, but also allows for linking to results from the record page for a coin, using many of the facets that are contained within the EAD-encoded index terms, physical attributes, and collection/institution information. This facilitates the user's ability to navigate from a single coin to many other coins in a wide variety of categories. This is a useful feature for users of the website, and the search, sort, and browse mechanisms are more powerful in the University of Virginia Art Museum Numismatic Collection than many other numismatic sites online. As a result, this improves the site's ability to function as a useful research tool for students and scholars of numismatics, which was, as previously mentioned in this paper, the primary goal of the project.

In summation, an interface is only as effective as the metadata allow it to be, and the metadata are only as useful as the interface built to take advantage of them. Therefore, since attention was given to hiring a graduate subject specialist to encode the categorical and physical attributes of the coins, transcribe and expand Latin and Greek legends, and include index terms to give them additional context, the metadata for the University of Virginia Art Museum Numismatic Collection is at least as rich as many other numismatic sites online. This allows for the design of a useful environment for studying the discipline. Encoded Archival Description delivered on all of the interface requirements, but several other metadata standards were reviewed and are detailed in the following section. Figure A (located at the end of this paper) shows the ways in which a coin of Emperor Alexander Severus is connected to other coins in the collection through a variety of browsable facets and text searches.

## 6 A Review of Other Metadata Standards

Several other approaches to describing coins were reviewed and ultimately decided against. One was a column-oriented database model—the Numismatic Database Standard (NUDS)—and the other two were XML standards—Visual Resources Association (VRA) Core and the Categories for the Description of Works of Art (CDWA). Each has its strengths and weaknesses, but all three lack the ability to encode complex contextual data, such as essays, which was the largest disqualifier from consideration for this project. All three also lack appropriate measures to record organizational hierarchy of the collection, which was deemed to be important.

The Numismatic Database Standard is an attempt to define the categories that are fundamental in describing numismatic objects. It is part of the Digital Coins Network, which is coordinated by Andrew Meadows and Sebastian Heath of the American Numismatic Society.[1] What separates NUDS from the aforementioned XML standards is that it was developed by numismatists and written in an ontology that is specific to the discipline. It contains more than a hundred fields, including many descriptors that are useful in numismatics that were not implemented in the adaptation of EAD to numismatics, such as thickness, height and width of the object, fields for denoting countermarks or symbols on either side of the coin. NUDS is an attempt to define all possible fields across all eras or departments of numismatics, while the adaptation of EAD took into consideration objects in the University of Virginia Art Museum's collection, which is predominately composed of Roman and Greek coinage, although it would be useful for other departments.

In many cases, the granularity of NUDS is not needed to describe Roman or Greek coins; it is rare that an artist or engraver is known, though they can be encoded in the index terms. Edge types, symbols, or countermarks can be effectively described in the Physical Description or Physical Characteristics or Technical Requirements (<phystech>) element in EAD. Although the University of Virginia Numismatic Project's implementation of EAD is perhaps not as granular in some cases as NUDS, EAD can be expanded to include more fields from NUDS if necessary, and an XSLT crosswalk has been created to convert from the NUDS-exchange XML format to EAD and vice versa.

The weaknesses of NUDS are similar to the weaknesses of other database standards (as compared to XML) in describing complex, hierarchical data. Like EAD, references can be recorded, but multiple references must be separated by a special character, such as a pipe, "|", which makes proper display or migration to another metadata format potentially problematic. The database format allows for the encoding of provenance, but only as simple text, and not in a more complex manner, such as a chronological list. The largest drawback to NUDS is its inability to provide important contextual data to give meaning to particular objects in the collection and allow them to be connected in various ways to other objects. The encoding of publication-quality research papers is impossible, and there are no fields for associating subjects or other index terms to coins, although the artist, engraver, issuer, mint, etc. fields may help supplement that. However, it is difficult to effectively describe multiple entries for these fields in a database.

While NUDS allows for more than one issuer or authority (e.g., issuer1, issuer2, authority1, authority2, etc.), it is impossible to differentiate between the roles of the issuers or authorities. While the granularity of the Numismatic Database Standard and its

[1] "NUDS:Fields–Digital Coins Network," Digital Coins Network, www.digitalcoins.org/index.php/NUDS:Fields.

attentiveness to the terminology of the discipline can be useful to those wishing to create a catalog of coins and display their attributes online, it is difficult to create the rich environment that was desired in a teaching tool, especially with regard to the requirement of allowing students in Roman numismatic seminars to attach their own research to coins in the collection.

Next we turn our attention to the XML standards not chosen—VRA Core, developed by the Visual Resources Association, and the Categories for the Description of Works of Art, developed by the J. Paul Getty Museum. They are similar in many respects, and crosswalks can be found to and from each of the standards. Both are adapted to terminology common to art museums, and therefore any type of object one may find in an art museum can be described, whether it be paintings, sculpture, drawings, or smaller artifacts such as coins. The weakness in these two, like NUDS, is the lack of contextual descriptors. VRA Core and CDWA allow for descriptive note fields, but not with the richness afforded by EAD, i.e. figures, tables, footnotes, sections, etc.

While much thought has obviously been put into developing a schema to describe many of the categories that may be used to describe artistic objects, the XML of CDWA itself lacks attributes that can help identify elements in a machine-readable way, which can aid in the indexing of objects into a search engine. CDWA lacks normalization of names for authority and indexing purposes. A coin's legend can be described with the <inscriptions> element in CDWA, but <inscriptions> seems incapable of accommodating common attributes, such as "label" or "type" that allows the inscription to be identified by a processor and be displayed in a controlled way. If one wants to search for or display the obverse and reverse legends separately, there is no way to attach an attribute to the <inscriptions> element to identify it as being either an obverse or reverse legend. This is problematic when designing the layout of the website, especially when one may wish to display the legend of the obverse side of a coin below an image of the obverse.

While CDWA and VRA Core are well-suited to describing a museum's holdings as individual objects, the standards were ultimately unable to provide for the desired interface functionality, and thus the project proceeded in its adaption of Encoded Archival Description to encode the University of Virginia Art Museum's collection of Roman and Greek coins. For many art museums' digital collections, CDWA and VRA Core are sufficient. As mentioned previously in this paper, the choice of metadata scheme is largely dependent on what that scheme can allow one to accomplish in terms of interface design. Open standards are highly recommended, as well as an ability to easily map to other standards without loss of data.

## 7 CONCLUSIONS AND VISION FOR FURTHER DEVELOPMENT

Since the official release of the University of Virginia Art Museum Numismatic Collection website in early October 2008, the project can be considered to be a success. A variety of metadata formats were carefully considered, and adaptation of Encoded Archival Description to numismatic collections evolved over a number of phases from its inception in October 2007 to the current period. This evolution is not complete; additional changes can be made as needed or as other institutions request it. More than 500 coins were properly identified and encoded by a graduate student funded by the library-issued grant over a period of several months in the spring of 2008. As the development of the metadata description has evolved over time, so has the website itself. Recent advancements in the framework include releasing the platform freely and openly through sourceforge.org. The framework not only includes code for indexing and displaying the data, but also for creating and editing EAD XML records using XForms in the open source Tomcat application, Orbeon. (http://sourceforge.net/projects/numishare/). Improvements will continue to be made as long as the site remains in use. What the project's role is in advancing numismatic description remains to be seen.

The adaptation of EAD to describe collections of coins was engaged by one who is not a professional numismatist, but one who is fairly knowledgeable about the subject and realizes what features might be useful to other students and scholars in the field. Encoded Archival Description allows for the encoding of complexly arranged data, but is not too difficult for an archaeologist or museum specialist to learn and use. While Roman and Greek coins were considered in the project's implementation of EAD, coins of other eras and fields may require additional or different categorical or physical descriptors.

The documentation section of the website contains a draft of the best practices guidelines used for encoding the numismatic data in EAD as well as preliminary crosswalks between the NUDS-exchange XML format and EAD. Over time, more crosswalks and documentation will be added. It is hoped that this project will foster new collaborations between institutions in creating a standardized framework for the description of collections of coins. The first institution to adopt EAD for their numismatic collection after the University of Virginia Art Museum is the Kittredge Numismatic Foundation, located in Massachusetts. The University of Virginia Numismatic Project can be seen as a successful demonstration of the robustness and flexibility of EAD as a descriptive standard whose potential is much wider than the archival context in which it is commonly used.

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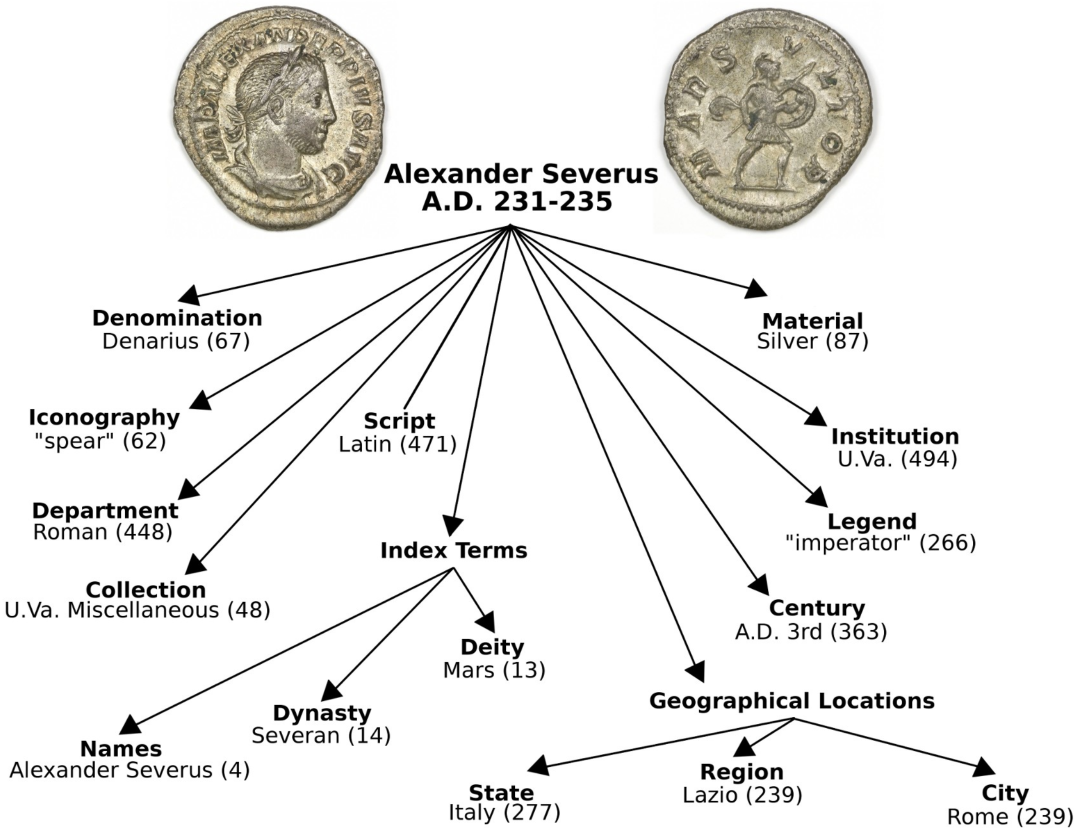


**Figure A.** *Associations via Solr facets and search.*