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Thesaurus and Ontology Construction for Contra Dance: Knowledge Organization of a North American Folk Dance Domain

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Abstract: This case study aims to preserve and disseminate cultural heritage information about the North American community folk dance tradition of contra dance through development of a thesaurus of choreographic terms and a domain ontology. A survey of dance resources was conducted, reviewing historic and modern examples of contra dance choreography notation and instructions, records of dance events, and recordings of dance performances. Domain and content analysis were performed on the resources to collect and organize concepts and themes regarding choreographic components and their relationships, the structure and function of cultural works, their creative expressions, and the evidence of those expressions in documents and recordings. Vocabulary used in the description of contra dance choreography was identified, classified, and notated to build a thesaurus, which was used as the basis of a domain ontology. Ontology building methodology and existing conceptual models for cultural heritage domains guided the ontology development and revision phases. The study also seeks to safeguard an intangible cultural heritage by applying knowledge organization and semantic approaches to folk dance in order to model such challenges as multiple, simultaneous modes of communication and forms of representation, modular conceptual components, descriptive sequences, differing levels of structured information, and complex cultural networks found at various levels of domain discourse.

1.0 Introduction and background

Country dancing is an intangible cultural heritage (ICH) of traditional social dance that spans European and North American history from (at least) the seventeenth century to the present day. Contra dance represents a currently active form of country dance performed mostly in the United States and Canada but also worldwide. Information about contra dance occurs in unstructured or semi-structured formats, but there are no standardized vocabularies or domain models in support of a knowledge base. This study, CONTRA (Contra dance ONtological and Thesaural Representation and Application), applied knowledge organization

(KO) approaches to safeguard contra dance as an ICH domain. It proposed: 1) creation of a Contra Dance Thesaurus; and, 2) construction of the Contra Ontology, adapting the IFLA *Library Reference Model* (*LRM*) as a general framework, along with aspects of the object-oriented *Functional Requirements for Bibliographic Records* (*FRBRoo*) model, the DOing REusable MUSic (DOREMUS) data model, and Linked Irish Traditional Music (LITMUS) Ontology.

This paper reports major steps and research findings of the study. Section 1 provides background for ICH safeguarding and the history of contra dance. Section 2 reviews previous research in using KO tools to structure ICH infor-

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mation and model ICH domains. Section 3 discusses the nature of contra dance information and methods used for domain and content analysis as well as thesaurus and ontology construction. Section 4 relates the results of the analysis and the development of the Contra Dance Thesaurus and Contra Ontology. Section 5 summarizes outcomes and insights gained regarding the application of KOS and semantic strategies to an ICH domain and shares avenues for future research.

1.1 ICH and the safeguarding paradigm

With the adoption of the 2003 *Convention for the Safeguarding of the Intangible Cultural Heritage*, the United Nations Educational, Scientific and Cultural Organization (UNESCO) (2014) acknowledged officially the importance of ICH through the paradigm of safeguarding. Lombardo et al. (2016, 3) argued that the ICH safeguarding paradigm required the "creation/sharing/dissemination of the metadata that express(es) knowledge." Mere documentation or digitization "does not contribute to the safeguarding of ... an ICH item" (3). This was echoed by Dimitropoulos et al. (2018, 3): "safeguarding and transmission of ICH ... goes beyond the mere digitization of ICH content;" and Aristidou et al. (2015, 2): "digitization alone is not sufficient to pass [ICH on to] newer generations." Preservation of ICH, unlike tangible heritage, is not independent of human-to-human transmission strategies; that is, to safeguard ICH, it must be communicated from one person to another and learned by subsequent generations.

1.2 Contra dance history and tradition

Contra dance is an active folk dance tradition with historical and cultural roots in the rural towns and settlements of the New England region of the United States. It is currently practiced by dance communities across the United States and Canada in addition to places outside North America. Dance communities host weekly or monthly dances and groups organize larger dance weekends, festivals, and dance camps that attract dancers regionally and nationally. Contra dance is part of a larger tradition of country dancing, a broad term for a style of community social dancing formed and popularized in England. When country dancing became fashionable in continental Europe in the late seventeenth century, the tradition of dances composed in long, or longways, lines, now influenced by the French, migrated back to England as *contredanse*, or, later, contra dance. These dances were then brought to North America by English colonists, where they took hold in the New England and Appalachian regions. Although its popularity ebbed and flowed throughout the nineteenth century, contra dance experienced important revivals in the early to mid-twentieth

century. Today, contra dance and its heritage are largely supported by the Country Dance and Song Society (CDSS), a national organization and a network of affiliated local organizations committed to preserving and continuing the traditions of American folk dance and music.

1.3 Contra dance structure

Country dances are characterized by groupings of dancers executing movements or "figures" in geometric patterns within the dance space. These movements are predetermined by existing choreography describing the included figures, who performs what figures, and how they are to be performed. Contra dancing traditionally consists of long lines of dancers organized into groups of four people/two couples (Figure 1). A caller teaches and prompts the choreography of a given dance, which follows a sixty-four-beat AABB structure (divided into eight-count phrases) matching accompanying folk tunes (Figure 2). As dancers perform the dance each time through, they move up or down the long line to "progress" to a new couple with whom they will interact. This series of figures and progressions keeps the dancers moving as they repeat the same patterns within the AABB structure.

1.4 Research aims and purpose

This study sought to examine KO as a means of preserving the history and traditions of an ICH domain, especially as KOSs and domain models are regarded as ICH safeguarding practices. It explored contra dance as a case study, using its rich vocabulary as the basis of a thesaurus of choreographic terms, which in turn served as the foundation for a domain ontology. It examined challenges and used KO to model an ICH characterized by multiple, simultaneous modes of communication and forms of representation for the same concepts as well as domain knowledge composed of modular conceptual components and descriptive sequences. The use of semantic enhancement strategies powered by ontological and linked data approaches was also investigated to address the challenge of organizing differing levels of structured information and complex cultural networks at various levels of domain discourse.

2.0 Literature review

2.1 KO as a method for ICH safeguarding

The development of ontologies and semantic technologies has supported tools and services that transmit heritage and encourage knowledge building as a safeguarding strategy. For systems to teach Tsamiko and salsa dances, Chantas et al. (2018, 3) cited the efficacy of ontologies for ICH safe-
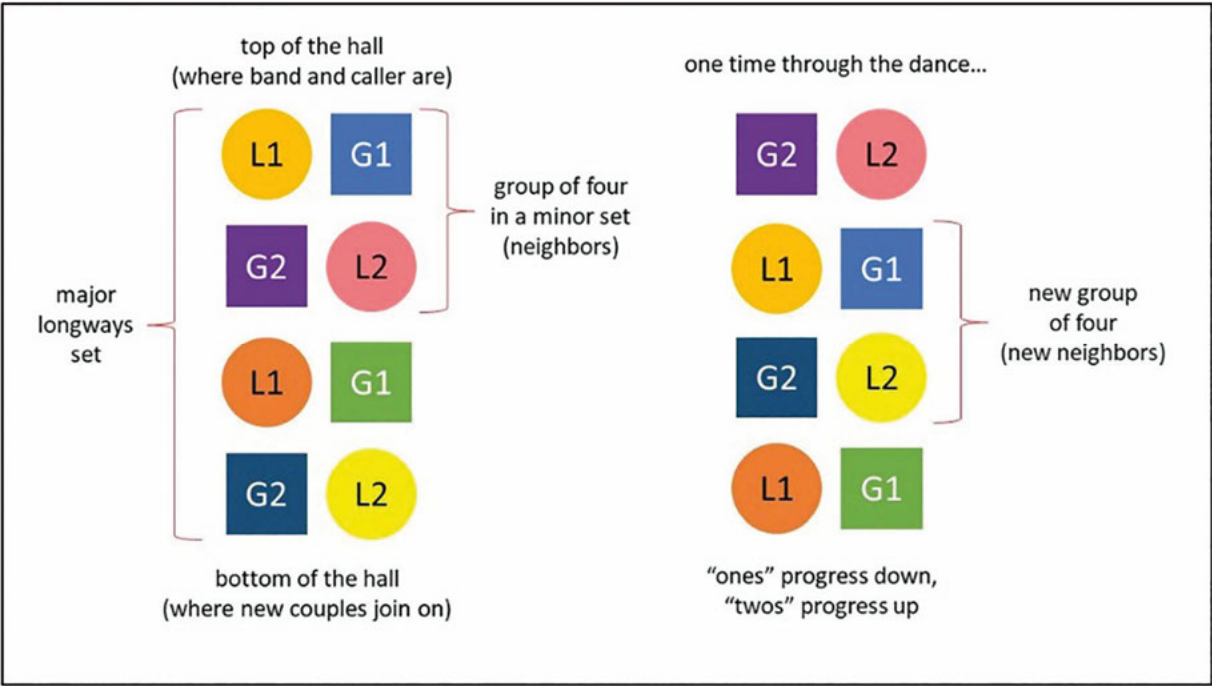
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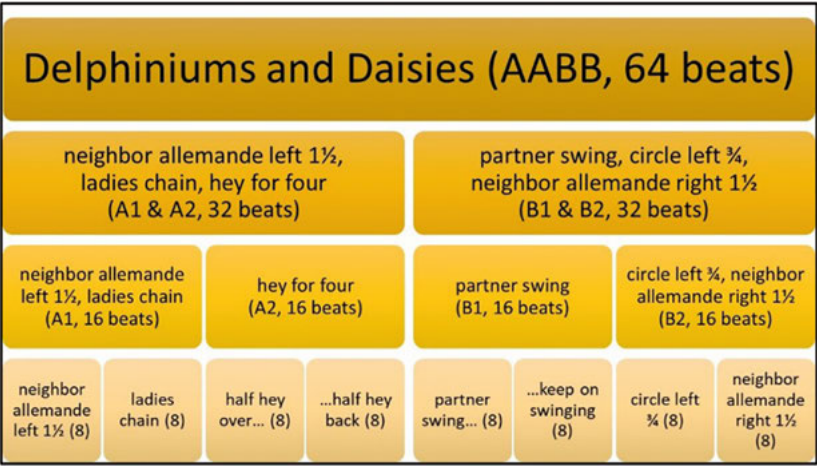*Figure 1.* Diagram of the formation and progression of contra dancers in lines and sets.

Figure 2. An example of choreography for the dance "Delphiniums and Daisies" within the sixty-four-beat AABB structure.

guarding as "platforms that ... manage to aggregate content of various CH domains in a large-scale database and provide convenient access to that data." Ontologies have also supported interactive educational systems like i-Treasures (Dimitropoulos et al. 2018) for European intangible culture, an augmented mobile application about Korean cultural heritage sites (Kim et al. 2016), a web application for the Manchu costume culture of China (Huang 2018), and a knowledge base repository for Indian classical dance (Mallik et al. 2011). Another important example, CultureSampo, used semantic technologies to aggregate cultural heritage contents from heterogeneous data sources into a semantic portal. Hyvönen et al. (2009) proposed such a portal for cultural heritage built on a cross-domain infrastructure of ontologies, metadata standards, and related services, resulting in a multilingual end-user application that facilitated exploration and visualization of Finnish heritage.

2.2 ICH domain KOS development

Systems and services for the transmission of ICH need to be supported by underlying KOSs. Classification schemes were proposed by Hu et al. (2014) to organize Taiwanese Indigenous folk dances and by Karavarsamis et al. (2016) for

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salsa dance steps. Huang and Huang (2013) used taxonomies in the classification of Taiwanese Indigenous cultural heritage. Furthermore, KO structures (Chansanam and Tuamsuk 2015; Kaewboonma and Tuamsuk 2016), taxonomies (Tuamsuk et al. 2016), and thesauri (Chansanam et al. 2015) have been developed as precursors or intermediate stages toward the construction of ICH domain ontologies. Existing cultural heritage thesauri—like the Art and Architecture Thesaurus (AAT)—have been cited by Alakus (2017) for their relevance in indexing cultural heritage objects with intangible aspects. Baca and Gill (2015) detailed the process of publishing AAT, along with other Getty vocabularies, as linked open data; AAT LOD was later employed by Wijesundara et al. (2016) in the enrichment of Sri Lankan cultural heritage information.

Furthermore, in elucidating potential requirements for systems to preserve dance information, like a dance ontology, Clarance (2015) enumerated aspects such as choreography, performance venue, related tangible objects, as well as meaning and representations in dance forms. Ceusters and Smith (2011) explicitly mention representing the domain in a machine-processable way and methods to support semantic analysis of domain content, including the successive moves in a contra dance.

Just as documentation and digitization alone do not address the safeguarding paradigm, the context-rich environments of cultural heritage domains may not be fully conceptualized by KOSs lacking well-defined semantic relationships. In her discussion on the role of thesauri in the age of the semantic web, Dextre Clarke (2016, 142) posed whether thesauri will evolve toward ontologies due to the "potential for establishing and exploiting differentiated relationships between concepts;" Hjørland (2016, 152) furthered the discussion by stressing the importance of semantic relations in KOS tools, in that "different kinds of relations have different importance in different domains." The need for highly structured semantic descriptions for art objects led Wielinga et al. (2001) to convert a relevant thesaurus, AAT, into an ontology. Moreover, Hyvönen (2009, 762) reminded that a traditional thesauri may not be "enough from a semantic viewpoint" since "its semantic relations have been constructed mainly to help the indexer in finding indexing terms, and understanding the relations needs implicit human knowledge."

Through more detailed structuring of semantic descriptions, ontologies present a bridge between human conceptualization of a domain and its representation as machine-processable information in the semantic web. Eide and Ore (2018, 182) defined an ontology in the context of cultural heritage as "a special kind of data model dealing with formalized conceptualizations." Doty (2013, 1) explained an ontology can "identify what is essential about a domain of knowledge and to distinguish among those essential elements ... to represent such knowledge in physical form."

This process of formalizing and representing ICH knowledge makes it tangible (insofar as it can be explored, shared, reused, and analyzed) outside of the minds and practices of practitioners and knowledge-bearers, thus supporting its safeguarding.

2.3 Conceptual models for cultural heritage and their use in ICH domain ontologies

2.3.1 *CIDOC CRM*

CIDOC CRM is a "formal ontology intended to facilitate the integration, mediation and interchange of heterogeneous cultural heritage information" (Doerr 2009, 468), extensively used in modeling various ICH domains. It was the basis of ontologies developed by Dou et al. (2018) for the 24 Solar Terms of China, Goienetxea et al. (2012) for folk song metadata, Hu et al. (2014) for the Pang Wang Festival of the Yao people of China, Martini et al. (2016) for the personal narrative ontology OntoMP (Ontology for The Museum of the Person), and Tan et al. (2009) for the Funeral Dance of the Tujia people of China. As an event-based conceptual model, *CIDOC CRM* also influenced the development of local ontologies like the drama ontology Drammar (Lombardo et al. 2016). The Linked Art Data Model (2020) used a "streamlined" version of *CIDOC CRM* with the Getty Vocabularies as value vocabularies. Despite its ubiquity, some studies have criticized the model for being too "museum-centric" (Brownlow et al. 2015, 5), citing the limited use and relevance of its expansive number of entities and a lack of concepts that would be important in modeling particular ICH domains (Pramartha and Davis 2016).

2.3.2 *FRBR*

FRBR is a conceptual entity-relationship model "that identifies and clearly defines the entities of interest to users of bibliographic records, the attributes of each entity, and the types of relationships that operate between entities" (IFLA Study Group on the Functional Requirements for Bibliographic Records 2009, 3). Doerr (2009, 471) described its "innovation ... to cluster publications and other items around the notion of a common conceptual origin—the 'Work', in order to support information retrieval." This conceptual structure of group one entities (Work, Expression, Manifestation, Item, or collectively, WEMI), represent a hierarchy of "products of intellectual or artistic endeavour" (IFLA Study Group on the Functional Requirements for Bibliographic Records 2009, 13). In terms of ICH domain research, it has been applied extensively to the performing arts, like the Music Ontology (Raimond et al. 2007), and a metadata standard for Greek folk dance (Giannoulakis et al. 2018).

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2.3.3 *FRBRoo*

In an effort to improve the organization of cultural heritage information between museum and library communities, a harmonization project between *CIDOC CRM* and *FRBR* led to the creation of *FRBRoo*, a "formal ontology intended to capture and represent the underlying semantics of bibliographic information and to facilitate the integration, mediation, and interchange of bibliographic and museum information" (Working Group on FRBR/CRM Dialogue 2016, 12). Doerr (2009, 472) described it as "a realistic, explicit model of the intellectual creation process" well-suited for the performing arts, as it differentiates and connects creative works, interpretations of those works, and their recordings with their symbolic forms and physical carriers. *FRBRoo* was utilized by Marolt et al. (2009) for the EthnoMuse project of Slovenian folk music and dance, El Raheb and Ioannidis (2014) for an ontology to model digital libraries of dance information, Monika et al. (2017) for the Kecak dance of Indonesia, and Park et al. (2019) for modeling traditional performing arts archives in South Korea. Le Boeuf (2012) also suggested its use in linked data applications for performing arts; two such implemented examples included the work of Lisena et al. (2018) in the DOREMUS project for the enrichment and reuse of music datasets, and the LITMUS ontology by Weissenberger (2017) for traditional Irish music.

2.3.4 *LRM*

In 2017, IFLA consolidated and updated, and thus deprecated, the FR family of models through the creation of *LRM* (Riva et al. 2017). *LRM* enhanced the conceptual entity-relationship model in *FRBR* through its WEMI framework, indicating degrees of flexibility in defining entity requirements and attributes. Although there has not yet been a direct alignment of *LRM* in modeling an ICH domain (its intended community is library-centric), the creators of the DOREMUS model noted that their conceptions of Work and Expression (in their extension of *FRBRoo*) were actually closer in alignment to those same entities as presented in *LRM* (Lisena et al. 2018).

3.0 Materials and methods

3.1 Contra dance historical and choreographic resources

No standardized resources or definitive compendiums of choreographic instructions exist for contra dance. Information regarding contra dance terminology, creative works, and cultural history is diffuse and unstructured, existing in many forms and formats, such as printed texts, online sources, audio and video recordings, dance cards collected by dance callers, and even in the minds and memories of domain practitioners. The difficulty of gathering information about contra dance choreography is further compounded by the very nature of it being an actively practiced, intangible heritage. Organizing the domain is challenging because of differences in dance vocabulary and inconsistencies in traditional terms used among communities and regions (Murphy and Murphy 2019). Some historical or traditional dances, called "chestnuts" (Millstone 2002), may be well-documented or reprinted in many places, but those instructions or notations have not always been written or recorded in the same way, or may have been altered over time by the folk process. Moreover, new dance works and new elements of choreography are being written even into the present. The practice of adding new examples to an existing repertoire makes a definitive accounting of the totality of contra dance choreography an impossible task.

Notwithstanding the complexity present in the addition and evolution of dance works, there are significant challenges related to vocabulary control with regard to domain knowledge, especially when written choreography for the same dance can appear markedly different depending on the nature or audience of a given resource. A choreographer may write detailed instructions that would be valuable to teachers and dance callers. These same instructions might then be shortened or notated to be collected and anthologized. Choreography may be even further abbreviated to fit on a caller's index card or notated to match their calling style. As a result, contra dance choreographic information and its accompanying vocabulary, even for the same dance work, can appear notated in a variety of ways and at varying levels of detail throughout the domain discourse.

With those relative complications in mind, this study looked to apply KO methods and systems to mitigate the difficulties inherent in safeguarding the ICH due to the heterogeneous nature of contra dance information. In the development of a contra dance thesaurus and subsequent ontology, the study took its literary warrant (Barité 2018) for establishing choreographic terms and domain entities through a variety of available resources. These resources included: 1) the digitized syllabi and the index compiled by Smukler (2014) for the Ralph Page Dance Legacy Weekend Collection, 1988-2017; 2) printed and edited anthologies and histories by Dart (1995), Gunzenhauser (1996), Smukler and Millstone (2008), and Pittman et al. (2009); 3) choreography published in *CDSS News* between 2010 and 2019; 4) online databases, glossaries, and indexes, like those compiled by Owen (2003) and Gascon (2015), as well as the crowdsourced ContraDB (https://contradb.com) and The Caller's Box (http://www.ibiblio.org/contradance/thecallersbox), compiled by Chris Page and Michael Dyck; 5) various monographs and manuals by well-known choreogra-

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phers and callers; 6) electronic mailing lists and blog posts; 7) video recordings of performances and events on social media websites like YouTube; 8) research articles studying contra dance as a historic, folkloric practice; and, 9) research articles on the application of other disciplines, such as mathematics, to the study of country dance.

3.2 Methods of analysis

3.2.1 Domain and content analysis

Domain and content analysis of contra dance involved an examination of domain discourse within historical documents (texts, recordings, etc.) with an iterative process of analysis rooted in grounded theory (Thornberg and Charmaz 2014), to identify, contextualize, and refine conceptualization of the vocabulary, works, expressions, identities, and entities that were important parts of the dance tradition. Domain analysis was guided by Hjørland and Albrechtsen (1995) and refined further through Tennis (2003) by identifying its areas of modulation, or extension and name (the history, tradition, practices, and evidence of contra dance as an ICH), and its degrees of specialization, or focus and intersection (contra dance as a primarily North American form of country dance but distinct from other forms like English country dance, traditional square dance, and modern western square dance). Domain analysis toward ontology building for an ICH domain was also considered to meet the following criteria of Hjørland's (2002) approaches by: 1) providing access to information sources as a gateway to an ICH subject; 2) constructing a special classification system to organize an ICH domain in order to understand semantic concepts; 3) supporting information retrieval; 4) contributing to the historical study of ICH through organization of traditions and forms of expression; 5) developing information architecture that represents the domain's inherent organization; 6) organizing ICH knowledge in a paradigmatic way; 7) studying discourse, language, and semantics within an ICH community; and, 8) revealing mental or cognitive models of an ICH domain.

In employing content analysis, this study also looked toward Mayring (2000) in conducting a qualitative analysis that focused on the manifest content of recorded material within the domain, as well as its themes, main ideas, contextual information, and formal aspects. Communicative content was broken down into component parts and categorized for further analysis, identifying the occurrence and frequencies of terms (word counts) to situate concepts in context (Drisko and Maschi 2016). Ultimately, three broad areas were found within the domain: 1) choreography (vocabulary, components, and sequences); 2) creative works and their evidence (dances, notations, documents, and performances); and, 3) cultural networks and history (people,

groups, places, timelines, and events). Notably, similar methods for identifying key concepts within ICH domain resources for KOS development have also been employed by Lombardo et al. (2018) in representing drama and dramatic narrative and by Kaewboonma and Tuamsuk (2018) and Tuamsuk et al. (2016) to organize folk traditions of the Greater Mekong Subregion.

3.2.2 Faceted analysis toward thesaurus development

Within the process of domain analysis, broad yet mutually exclusive categories, or facets, may also emerge. The process of faceted analysis and classification used in this study generally followed those delineated by Vickery (1966), Mills (2004), and La Barre (2010), as elucidated by Hjørland (2013). Faceted analysis was previously utilized in the KO of ICH by Madalli et al. (2015) for a music domain and Scaturro (2013) for performing arts. Additionally, Dai et al. (2014) applied a theory of knowledge classification to ICH in order to express semantic relationships using a faceted structure more popularly recognized as the five Ws: 1) when; 2) where; 3) what; 4) why; and, 5) how. Construction of a faceted thesaurus for choreographic terms in this study was also guided by design approaches and insights from Aitchison et al. (2002), Broughton (2006), and Tudhope and Binding (2008).

3.3 Ontology building methodology

Although ontology building methodologies vary (Gómez-Pérez et al. 2004, Stuart 2016), ontologies and linked data projects for ICH domains developed by Kaewboonma and Tuamsuk (2018), Pattuelli et al. (2015), Tuamsuk et al. (2018), and Weissenberger (2017) have employed strategies based on those defined by Noy and McGuinness (2001). In their primer for ontology development using Protégé software (Musen, 2015), which was used in this study, Noy and McGuinness (2001, 4) proposed a "simple knowledge-engineering methodology," acknowledging that ontology construction is an "iterative process" and may include "viable alternatives." Using stages similar to those from Noy and McGuinness and previous ICH ontology studies, the following steps were taken: 1) determination of the scope and domain; 2) selection of data sources; 3) analysis to establish potential vocabularies and authority files, as well as initial constraints of a domain model; 4) identification of key concepts and relationships through the use of KOS like taxonomies, thesauri, and semantic networks to aid model building; 5) examining other cultural heritage ontologies for reuse, extension, or adaptation; 6) formally naming and defining classes, their properties, as well as domains, ranges, and data types of properties; 7) population of the ontology with collected sample data to create instances; 8) revaluation
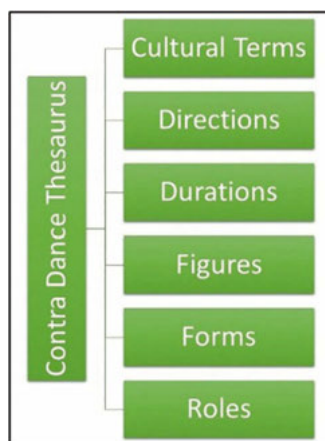
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Figure 3. Top level classes/facets of
the Contra Dance Thesaurus.

and revision of the ontology prompted by the integration of instances; and, 9) testing using simple SPARQL (SPARQL Protocol and RDF Query Language) queries to determine basic anticipated functionality.

4.0 Results

4.1 Contra Dance Thesaurus construction

The first stage of the study resulted in a thesaurus for contra dance choreographic and cultural terms. In describing her process of teaching dances efficiently within the limitations for a walkthrough (the introduction to a dance's instructions before the music and calling begins), nationally known dance caller Beth Molaro explained (Merritt 2014) the following structure: "who you're doing something with, what you're going to do with them, and where you end up." Notably, this same type of faceted classification was used by Scaturro (2013), citing Ackoff (1989), through the fundamental questions (what? when? where? who?) to be answered in transforming data into information; thus, forming facets as answers to these "W" questions closely followed Molaro's own evaluation of the faceted essence of contra dance choreography. Consequently, the vocabulary of dance instructions fell into one of these structural areas: roles (who), figures (what), durations (when or how), and directions or distances (where or how). From these facets, superclasses were formed (Figure 3) and terms were classified to create a controlled vocabulary for concepts belonging to: 1) particular figures or movements; 2) the roles performed by individual dancers and groups of dancers; 3) the directions indicating where dancers move or how to execute a figure; and, 4) the standard durations, fractional portions, number of places, or lengths of (musical) time a dancer will perform a figure. Further hierarchical classifications were

made based on similarities in structure and function, as well as relationships to other facets. For instance, figures were ordered by the maximum number of dancers involved in the execution of a particular movement (a figure's relationship to "who"), and then by the nature of their movement ("where" or "how"), such as directionality. In contrast, durational and distance terms were classified by the convention used in counting or marking that information (e.g., fractions of a full figure, number of beats of music, or number of places moved on the dance floor). Additionally, other classes were necessary for organizing vocabulary that described structural elements like choreographic formations and methods of progression, as well as cultural terminology. The thesaurus was then finalized by delineating associative relationships between related terms, defining scope notes for preferred terms (Figure 4), notating terms, and implementing both an alphabetical index and a classified schedule.

4.1.1 Challenges and limitations of thesaural representation

Although the thesaurus defined relationships between terms, these relationships lacked the semantic complexity and specificity necessary for a full conceptualization of the domain. For example, it was found that single axis classification was a challenge in organizing terms for figures that captured comparative similarities and differences in their attributes (Figure 5). Because contra dance choreography is based heavily on the relative positions of dancers and their direction of momentum, the domain model required definition of these attributes to properly structure the relationships between figures, the roles involved, and valid applicable terms for modifying direction, duration, or distance. Choreographers and callers, in particular, need to under-

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four facing four *FM1.1.04*
SN   Minor set of four couples, in lines of two couples facing two couples (for a total of eight dancers per minor set)
UF   double contras
           Portland Fancy
BT   minor *FM1.1*
NT   Tempest *FM1.1.04.01*
RT   trail buddies *RL1.8*

four potatoes *CT2.2.01*
SN   Four strong beats of music to establish tempo and to alert dancers to the start of the dance
BT   Cultural Terms *CT*

foursomes
USE   groups of four *FM4.2*

Figure 4. Examples of the structuring of terms in the Contra Dance Thesaurus.

Property	Swing values	Allemande values	Gypsy values	Circle values	Star values	Basket Swing values	Swinging Star values
hasPosition	SwingPosition	NoPosition	NoPosition	NoPosition	NoPosition	BasketPosition	NoPosition
hasFootwork	WalkingStep, BuzzStep, PivotStep,	WalkingStep	WalkingStep	WalkingStep	WalkingStep	BuzzStep	BuzzStep
hasHandhold	SwingHold	AllemandeStyleHandhold	NoHandhold	CircleHandhold	instance of StarHandhold	BasketHold	instance of StarHandhold
hasDanceRole	Dancer instance (e.g., Neighbor, Partner, Ones, Twos, Threes)	Dancer instance (Neighbor, Partner, Gents, Ladies, Ones, Twos, Threes)	Dancer instance (Neighbor, Partner, Gents, Ladies, Ones, Twos, Threes)	DancerUnit instance (OnesAndTwos, OnesAndThrees, TwosAndThrees, RingOfFour)	DancerUnit instance (OnesAndTwos, OnesAndThrees, TwosAndThrees, RingOfFour)	DancerUnit instance (OnesAndTwos, OnesAndThrees, TwosAndThrees, RingOfFour)	DancerUnit instance (OnesAndTwos, OnesAndThrees, TwosAndThrees, RingOfFour)
hasDirection	Clockwise	RightHand, LeftHand	RightShoulder, LeftShoulder	ToTheLeft, ToTheRight	RightHand, LeftHand	Clockwise	Clockwise
hasDistance	NoDistance	NoDistance	NoDistance	DistanceByPlaces instance	DistanceByPlaces instance	NoDistance	NoDistance
hasDuration	DurationInCounts instance: EightCounts... SixteenCounts	FractionalDuration instance	FractionalDuration instance	FractionalDuration instance	FractionalDuration instance	DurationInCounts instance: EightCounts... SixteenCounts	DurationInCounts instance: EightCounts... SixteenCounts
numberOfDancers	2	2	2	4	4	4	4
dancersFacing	true	true	true	true	false	true	false
dancersJoinedHands	true	true	false	true	true	true	true

Figure 5. Multiaxial comparison of examples of properties for instances of Figure and their eligible values.

stand these attributes to make creative decisions about how dance movements fit together and how to build satisfying dance programs; therefore, a vocabulary classified along any single property axis or using a sole characteristic would be incomplete. Additionally, choreographic dance works themselves possessed complex links to other entities such as formations, levels of difficulty, sequences of calls, matching or suggested tunes, agents like choreographers, and other contextual domain information that could only be repre-

sented as properties of these works through ontological modeling.

     There were also challenges that arose in the presence of multiple preferred terms and the absence of preferred terms. The use of gendered language in the contra dance community for the dance roles traditionally performed by men and women has been increasingly disputed, especially by dancers who identify as LGBTQ and those who believe the explicit gendering of roles is irrelevant to the performance of the
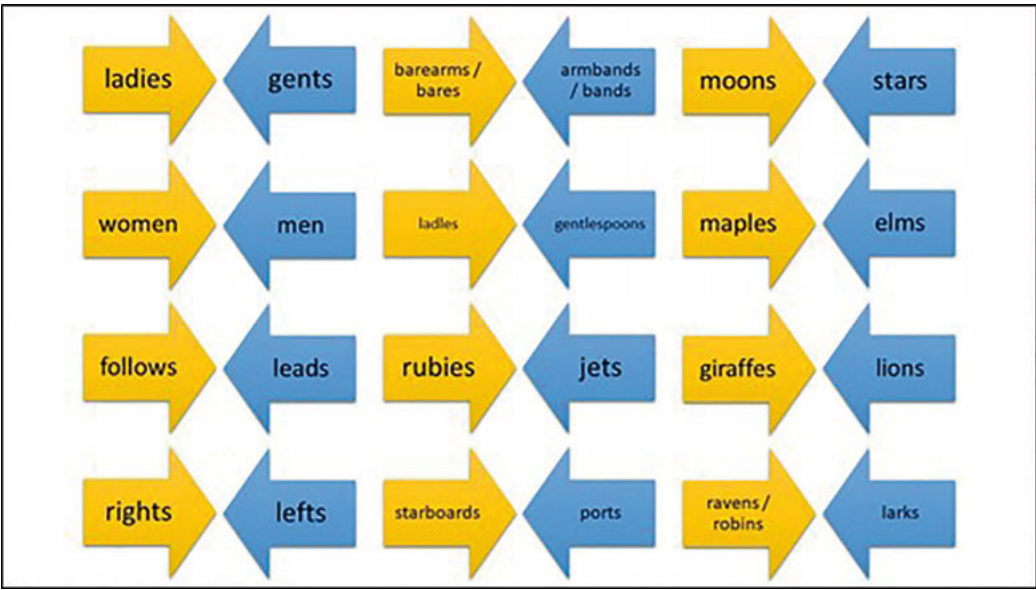
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Figure 6. Pairs of names for traditional gendered dance role terms and gender-neutral terms.
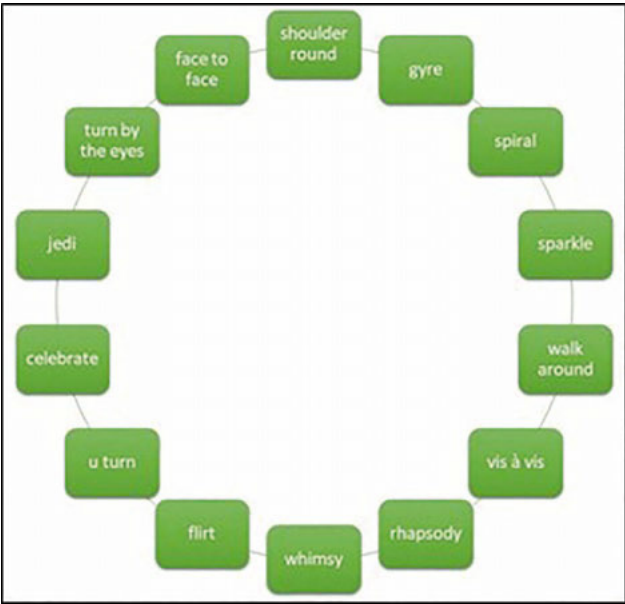

Figure 7. Proposed alternate terms for the term "gypsy."

dance or exclusionary to those who wish to dance both roles. This has led to the adoption of different gender-neutral terms for the same role concepts (Figure 6). The use of these terms, however, can differ between local communities, and in fact, within the same community, as some communities support the use of multiple pairs of terms by allowing whatever role convention a particular caller prefers or by designating some dance events as gender neutral. Conversely, use of the term "gypsy," which is used as the traditional descriptor for a particular figure, has been deeply criticized of late for its racist history as an ethnic slur. Some call-

ers, organizers, and communities have prohibited the term while others have defended it. At present, many alternatives have been proposed (Figure 7), but no consensus has been reached. It has been left to individual callers and local communities to make ad hoc decisions whether to retain the traditional term or to adopt a different one (German et al. 2019). As a result of these gender- and race-based critiques of traditional terminology, it was found that a KOS for contra dance needed to support the simultaneous use of multiple terms for the same concept and to contextualize the history of these terms within the tradition.

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4.2 Contra Ontology construction

4.2.1 Classes and properties

The second stage of the study resulted in the development of a domain ontology. In addition to the choreographic vocabulary, entities like dance works, notated or written dance instructions, people and organizations, performances and events, and other concepts endemic to the domain were gathered for inclusion and placement into the ontology. Addition to and refinement of classes from the thesaurus also took place at this stage (Figure 8). The process then moved to the assignment of properties for class entities and their attributes, along with delineating valid class domains for properties and class ranges for acceptable values of properties to support ontological inference. The resulting ontology described attributes/properties of choreographic elements, components, and sequences, dance works, versions of notation of dances, called versions of dances, dance performances, evidence/documentation of performances, cultural events, and cultural practitioners and organizations. It also described relationships between entities by linking and connecting creative works to other works, works to their various forms of expression, expressions to their various forms of documentation, works, expressions, and documentation to people, places, and events, people to other people, people to groups, groups to other groups, people and groups to events, and events to other events.

One of the challenging aspects to model was the nature and structure of the choreographic instructions, both conceptually and in practice. Although information for figures, roles, directions, and distances/durations were organized separately in the thesaurus, in actuality, these vocabulary components are (re-)combined for the purposes of constructing a dance call, or the complete string of instructions for executing a portion of the dance. A figure is a necessary component of a call, but it is also modified or clarified by terms from the other component classes. Keeping in mind Molaro's faceted calling instructions, the basic structure for a call is a combination of a figure + dance role + direction + distance/duration, depending on the nature of the call and the valid types of components that can be used as values for the properties of a given figure. A class of entities Call was developed to house the various combinations of choreographic concepts that compose specific strings of instructions by assigning those components as values of properties of Call (Figure 9).

Another challenge was representing the order and duration of calls in a dance work, as the execution of a piece of choreography must correspond with the accompanying music (sixty-four-beat tunes in AABB structure). To capture the basic AABB sequences, properties a1, a2, b1, and b2 were created for Dance entities. If more detailed se-
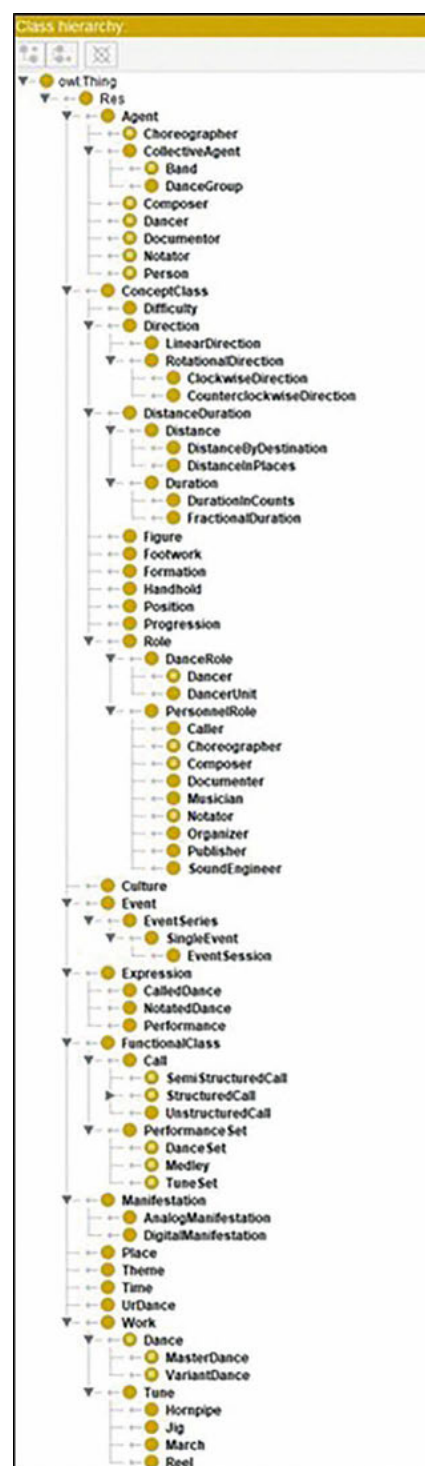

Figure 8. Contra Ontology class hierarchy in Protégé.

quence information was required, two possibilities were posited for different circumstances: 1) if the exact duration of the calls was unknown or estimated, instructions would be subdivided as a1.1, a1.2, a1.3, etc., to show the order of calls without regard to the number of beats; and, 2) sections could be further subdivided as a1.1-2, a1.1-4, a1.1-6, up to
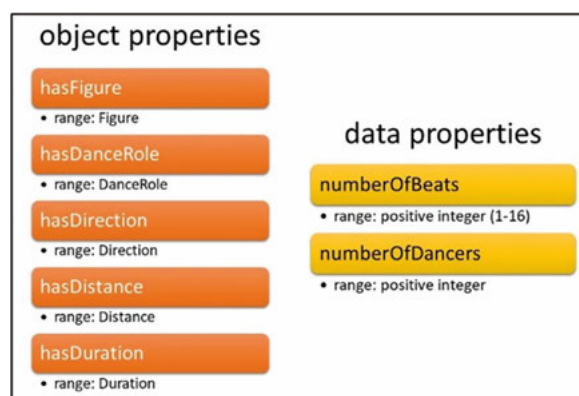
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Figure 9. Available properties for entities of class Call.

a1.1-16, etc., to show the range or number of beats that would be taken up by that particular Call.

4.2.2 Reuse of existing conceptual models and alignment to other domain ontologies

As the bottom-up analysis identified entities and their relationships through thesaurus construction and the initial stages of ontology development, a top-down approach concurrently looked at established models that would clarify and refine the domain ontology with an eye toward future interoperability. Three considerations emerged when evaluating the applicability of existing models to the domain: 1) ease of use through structural equivalence; 2) semantic interoperability through very close or exact matching of domain entities to the definitions of their counterparts in an existing model; and, 3) use of current models and standards, including novel approaches. From these perspectives, *CIDOC CRM* was indeed found to be too unwieldy and expansive to be wholly applicable to contra dance, yet two existing conceptual models, *FRBRoo* and *LRM*, were well-suited to the overall structuring of the ontology. Two additional domain ontologies based on *FRBRoo*, DOREMUS and LITMUS, aided in the development of specific domain classes (Figure 10).

4.2.2.1 Structural equivalence with *FRBRoo* and *LRM* classes

FRBRoo contributed domain classes for works, expressions, and performances, and *LRM* reinforced integration of the WEMI structure. The classes (and subclasses) of CRM reconfigured in *FRBRoo* to define and classify works, expressions, and performances were deemed appropriately equivalent. Work and Expression in *LRM* matched domain classes for conceptual works of choreography and their various forms of expression (whether written/notated, spoken, or physically performed), respectively. Manifestation was suit-

able to classify documentation or recordings of domain expressions. *LRM* also provided a generic Agent, with subclasses for individual people (Person) and groups or organizations (Collective Agent), both of which exist in contra dance.

4.2.2.2 Semantic interoperability with *LRM* and with *FRBRoo* and its domain extensions DOREMUS and LITMUS

The contra dance domain also included entities semantically aligned to those in *LRM* and *FRBRoo*. In *LRM*, the Work entity is the "intellectual or artistic content of a distinct creation" (Riva et al. 2017, 21) which comes into existence by virtue of a first Expression. Dances and Tunes, as subclasses of Works, come into being through the notated instructions of NotatedDances or as Performances (expressed by human movement or by sound). These forms dovetailed with LRM-E3 Expression, which is a "distinct combination of signs conveying intellectual or artistic content" (23), which includes "visual, aural or gestural signs." Expressions are then captured onto a carrier known as a Manifestation (LRM-E4), classified in the domain by either AnalogManifestation or DigitalManifestation. Although the contra dance model did not need to extend down to the Item (LRM-E5) level, in some cases a specific Manifestation (e.g., a caller's dance card) could be both an Item, as well as a one-of-a-kind Manifestation (again, the carrier of the dance card itself) of an Expression (a NotatedDance) of a Work (Dance), thus adhering to the same semantic structure for those entities as *LRM*.

FRBRoo was also semantically interoperable, beginning with F1 Work, comprising artistic and intellectual concepts/ideas, emphasizing the role of people or collective agents in the execution or elaboration of a Work, especially through Expressions (Working Group on FRBR/CRM Dialogue 2016). The F20 Performance Work was also applicable as a set of "concepts for rendering a particular or a series

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Contra Ontology classes	LRM classified entities	Classified entities from FRBRoo (F) / CRM (E) and FRBRoo extensions through DOREMUS (M) and LITMUS (T)
Work	LRM-E2 Work	F1 Work
Dance		F14 Individual Work or F20 Performance Work M44 Performed Work T14 Dance
Tune		F14 Individual Work or F20 Performance Work M44 Performed Work T10 Instrumental Tune
Expression	LRM-E3 Expression	F2 Expression or F22 Self-Contained Expression
NotatedDance		F25 Performance Plan

Performance		F31 Performance
		  T16 Dance Performance
		  T36 Music Performance
		M42 Performed Expression Creation
		  M43 Performed Expression

TuneSet		T11 Instrumental Tune Set
Call (subclass of FunctionalClass)		F23 Expression Fragment T17 Dance Component
Manifestation	LRM-E4 Manifestation	F3 Manifestation Product Type or F4 Manifestation Singleton
Agent	LRM-E6 Agent	E39 Actor
Person	LRM-E7 Person	F10 Person / E21 Person
CollectiveAgent	LRM-E8 Collective Agent	F11 Corporate Body
Band		T32 Band
PersonnelRole (subclass of ConceptClass)		T27 Role (equivalent to / subclass of F10 Person)
Event		F8 Event
Place	LRM-E10 Place	F9 Place / E53 Place
Time	LRM-E11 Time-span	E52 Time-Span

Figure 10. Contra Ontology classes mapped to their semantic and structural equivalent classes from *LRM*, *FRBRoo*, DOREMUS, and LITMUS (Coladangelo 2020, 94).

of like performances" (67), which encapsulated the abstract content of a Dance used to guide future Performances. Much as in *LRM*, F2 Expression comprised "the intellectual or artistic realisations of works ... such as texts ... musical or choreographic notations, movement pattern, sound pattern...or any combination of such forms" (55). This definition accorded with NotatedDances as Expressions, which give choreographic instructions for Dance concepts. A NotatedDance also qualified as an F25 Performance Plan, which comprised "sets of directions to which individual

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performances ... should conform" (71). Furthermore, an F31 Performance involved "activities that follow the directions of a performance plan" (75), included in the domain model through a property of Expression that related one Expression to another (relatedExpression), allowing the NotatedDance to be connected to a related Performance.

A Performance in the domain model, then, was an Expression of a Work situated at the nexus of Works, Expressions, Events, and Agents. In contra dance, a Performance is not a demonstration for an audience, but the realization of a dance work within a communal setting in which conceptual dance instructions are expressed as physical signs by the dancers' movements, a caller's words, and accompanied by live music. The physical movements mark the Performance, but the translation of dance concepts into movement is not the sole component (even if it is the defining element), because the realization of contra dance performances includes the efforts of callers, musicians, and others taking place in a certain time and space. Alignment to other models meant that Performance needed to be linked to (or classified as) events, which accorded with F8 Event, where Events and Performances occur in Places (F9 Place, CRM E53 Place, and LRM-E10 Place). This usage was confirmed by applying the same logic of the M43 Performed Expression class in the DOREMUS model, which reinforced the Work-Expression-Event relationship and explicitly advanced the notion that a performance could give rise to or constitute an expression and an event, sharing properties of each of those classes.

The DOREMUS and LITMUS models furthered understanding of the relationship between expressions, performances, and related entities. This was structured through F28 Expression Creation in its intermediary role creating an F22 Self-Contained Expression and as a realization of an F14 Individual Work, consisting of an E7 Activity carried out by a E21 Person with an M31 Actor's Function and/or M32 Actor's Responsibility. This accorded with a Person (or Agent) that inhabits or performs a particular PersonnelRole in the domain ontology, for which LITMUS provided analogs (e.g., T27_Role class, with instances like I11_Dance_Caller, I23_Composer, and I30_Musician). LITMUS bolstered the domain conceptualization of choreographic elements with class T17_Dance_Component (as in elements or portions of dance choreography) which aligned with instances of the Figure, Role, Direction, and DistanceDuration classes composing a Call. The LITMUS representation of sets of Tunes played together (T11_Instrumental_Tune_Set) was appropriated in the domain ontology as the TuneSet class and was extended to address the challenge of the existence of PerformanceSets by describing groups of dances called within the same session (a DanceSet), or in a single performance of dances called one right after another (a Medley).

4.4.2.3 Novel approach in leveraging *LRM* Res and Nomen classes

Lastly, the domain ontology proposed ways to leverage the innovations of the *LRM* Res and Nomen classes to model and trace the lineage of tradition and thematic content. Res is "any entity in the universe of discourse" (Riva et al. 2017, 20), providing a superclass to represent any other entity or concept that will be important to capture but has not been classed or named. One of the attributes available to Res is a Category (LRM-E1-A1), which is "a type to which the res belongs" (40). Res and its Category attribute addressed the challenge of representing lineage, like a "family" of dances, to group entities that share some historical or traditional conceptual source. Using this framework, the ontology was revised to identify a class for linking Works that at one time shared an origin, provenance, or common root. A second challenge surmounted by the Res class would be representation of thematic content or subject matter not structurally related to dances but important to the history of choreography development. This could be represented through the Category attribute or by a more structured version of the Res attribute Note (LRM-E1-A2), which provides information that "is not recorded through the use of specific attributes and/or relationships" (40), such as detailed narrative or descriptive information. This contextual information would be useful to callers and organizers planning dance programs and events. It may also encourage historians and researchers to study trends of cultural interest to the contra community.

Moreover, the Nomen entity (LRM-E9) can be linked to other entities by appellation relationships, meaning that a Nomen can be related as a name or label for an entity but can also possess its own attributes. This flexibility would support multilingual representation in the broadest sense of the term, in that a Nomen can have its own attributes (or properties) for language and script, but can also be represented and described by various levels of abstraction, signs or symbols, verbal utterances, physical gestures or movements, or clips of recorded media. A Nomen could further support tradition and lineage by having associated authority files, as well as attributes for the Place, Event, or Time in which it was actively used. Because contra dance possesses a rich choreographic vocabulary, the Nomen for each instance of a dance component could provide a wealth of contextual information regarding the cultural history of each vocabulary term.

4.2.3 Support for different levels of domain discourse

A significant challenge was the ontological representation of the different kinds of discourse inherent in the concepts and relationships between dance works, the notation of

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Notations for the StructuredCalls / choreographic concepts found in NotatedDance versions of the A1 section of "Delphiniums and Daisies"	
Neighbor+Allemande+LeftHand+OnceAndAHalf	**Ladies+Chain+Across+ToPartner**
N Allemande Left 1.5	Ladies chain (to Partner)
N Aleman L 1.5	Ravens chain (to P)
Neighbors allemande left 1 1/2	Ladies chain
Neighbor allemande left 1 & 1/2	Ladies chain
Allemande left the one below once and a half	Ladies chain
Allemande left neighbor 1 1/2	Ladies chain across
Allemande left neighbor 1½	Ladies chain across
Neighbor allemande left 1.5	Ladies chain to partner

Figure 11. Examples of differently notated versions for the same choreographic concepts (Coladangelo 2020, 63-4).

dance instructions, the verbal cues of dance calling, and the physical performance of dances. As a result, the ontology was revised to include distinct but related types of expressions (NotatedDance, CalledDance, and Performance) of a Dance, which are documented through examples of manifestations. A NotatedDance represents instructions in a written form. Examples of dance notation for the same set of instructions can vary significantly (Figure 11), but the manner of notation represents an important aspect of cultural communication within the domain. Similarly, in a CalledDance, the spoken/verbal instructions from a caller represent another vital form of discourse that shows personal styling and cultural influences in the choice of both instructional language and supplemental phrases or "patter" (Parkes 2012). Furthermore, a Performance is a form of discourse as a physical or bodily expression connecting practitioners, creative works, related expressions, locations, time periods, and events. These forms of expression also leave behind evidence of their cultural practices or manifestations of the cultural heritage that can be examined as part of the domain discourse. To provide a complete understanding of these levels of cultural representation and communication, the ontology needed to account for the conceptual, practical, and evidential levels of heritage as signified in the domain.

4.2.4 Semantic annotation of Calls

Another challenge was ontologically representing different levels of specificity in the structuring of Calls. For example, natural language, alternate vocabulary, or implied or omitted instructions were found in CalledDances and NotatedDances, so that information was conceptually identical to its original work but practically different. Because these expressions form an important part of the domain discourse, it would have been inappropriate to control their vocabulary or standardize their language to make them conform to a single structure. Instead, it was found that these less structured expressions could be semantically enhanced by annotating their constituent Calls by assigning values to properties for named/known components of Figures, DanceRoles, Direction, and Distance/Duration. This led to ontological modeling of different subclasses of Calls (UnstructuredCall, SemiStructuredCall, and StructuredCall) depending on the presence of certain levels of semantic specificity (Figure 12). Semantic annotation addressed the challenge of preserving important historical and cultural variations in domain discourse while enhancing disparate or less structured forms of dance information to be connected meaningfully in the ontology through equivalence assertion or ontological inference.

4.2.5 Domain knowledge base support and future testing

Once the ontology was populated with sample instances, ontological inference and simple SPARQL queries were used to test its basic potential to support a knowledge base. With properly structured class definitions, domains and ranges for object and data properties, and assigned property values, an ontological reasoner was able to properly classify examples of instances by inference. Examples of these included inferring classifications of figures for two dancers and tune sets as well as an intersection class for dances in duple improper formation. SPARQL, by contrast, only queries asserted, not inferred, knowledge, meaning that data in RDF triples must be explicit to be returned as results. Examples of SPARQL queries conducted included finding the name of a dance ("Chorus Jig") that is set to a tune that has an alternate title "The Glen Road to Carrick" and returning a list of choreographers based in Ohio, where the ontology was populated with four asserted instances of choreographers (Don Armstrong, Becky Hill, Carol Kopp, and Tanya Rotenberg) and three instances of Agent based in Ohio
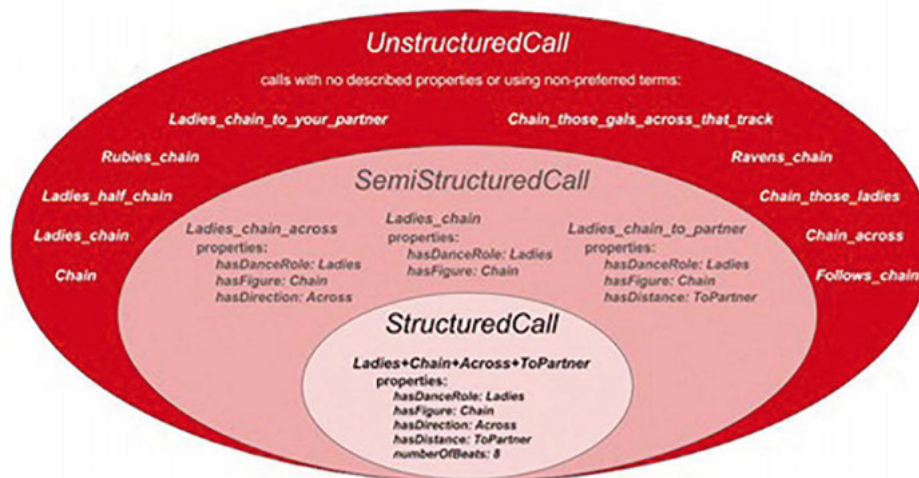
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Figure 12. Levels of semantic structuring of Calls (Coladangelo 2020, 102).

(Becky Hill, Carol Kopp, and Dick Swain). Although additional population with instances and more complex SPARQL querying would enhance its future usability, the ontology showed valid, basic functionality as a nascent domain knowledge base. Further research into functionality and knowledge base support would include evaluation of the ontology with different user groups of domain practitioners like choreographers and callers, as well organizations like CDSS, to encourage revision and refinement of the ontology to meet needs related to information retrieval and historical preservation.

5.0 Conclusion

The CONTRA study applying KO approaches to the community folk dance tradition of contra dance resulted in the construction of a choreographic thesaurus and a domain ontology. The study concluded that vocabulary control, ontological modeling, and semantic technologies were well-suited to structure information about contra dance, and the ontology would serve as the infrastructure for a knowledge base to safeguard and disseminate contra dance history and culture. The safeguarding paradigm would be met through organization, storage, search, and retrieval of domain knowledge, including dance vocabulary, choreographic instructions and notations; performance details, name authorities for titles, people, and corporate bodies, places, and events, contextual information, and cultural concepts. The ontology posited a structured data core to which less structured data could be linked, semantically enhancing and annotating the unstructured and semi-structured data that characterizes the domain. In this way, the model addressed the challenge of representing different levels of cultural expression while maintaining structured representation of the domain. Future interoperability was supported by semantically structuring domain information in a linked data environment and through alignment with existing cultural heritage conceptual models and other domain ontologies.

Insights were also gained regarding the unique requirements of ICH domains with avenues for future KOS research toward ICH safeguarding. Concepts that emerged from this study identified important representational benchmarks or guidance for KOS development for ICH domains with the following aspects: 1) modularity of components from the most basic to the highest aggregated level, including intermediary stages or combinations of components; 2) sequences, timelines, or the order of events or entities, 3) differing levels of conceptualization, instantiation, and domain discourse; 4) simultaneous support or validation of multiple, alternate forms of signs, languages, or notations for similar or identical concepts; and, 5) complex contextual information, relationships, and networks of meaning.

Semantic strategies used in KOS construction for the formalization of the unstructured and disparate information of contra dance could be applied to adjacent and related folk dance domains, especially the choreography and cultural networks of other country dance domains. This same work could be extended to models related to North American folk music traditions like old-time music or traditional Quebecois music. It could also model cultural domains marked by prescribed, performative, and ritual movement, such as narrative choreography, martial arts, exercise routines, or religious ceremonies. KO of country dance and sequential movement-based ICH would support future implementation of knowledge bases, metadata schemas, semantic analysis tools, linked data approaches, and mapping to other notation methods and domain models. KOSs for these do-

mains would also further safeguarding practices like educational training and evaluation systems, remote interaction with cultural performances, augmented and virtual reality applications, and enhancement of user experiences and knowledge building activities for ICH.

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