

Towards an Ontology for Vietnamese Water Puppetry

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Abstract—In this paper we propose the first steps for building a Vietnamese water puppetry ontology. The creation of the puppetry ontology would allow not only a more informed and productive professional training, but also the capability of preserving and promoting water puppetry. Gathering water puppetry expert knowledge requires a deep study of puppetry history, background knowledge and performance. Hence, we analyze stories, background knowledge and performance of the water puppetry in the context of the Vietnamese general culture and legends. Especially, we emphasize on the issue of inconsistencies - a key challenge in ontology building. We also present a specific case study using DL-Lite for representation, reasoning and querying in presence of inconsistencies.

Keywords—Water Puppetry, Ontologies, Knowledge Representation

I. INTRODUCTION

Vietnam is a country having a very rich, original and diverse folk culture heritage, for which preserving and promoting is an urgent request. Among Vietnamese folk art forms, water puppetry is really original and unique in the world. Its uniqueness is twofold: the stage for puppet performance shows is in and on water and puppets are controlled remotely using rods and strings. Puppet stories and scenes reflect comprehensively and clearly the rural life in Northern Vietnam. Water puppetry is also a good way to learn the history, culture and Buddhism religion in Vietnam.

In computer science, ontology, a formalism of describing entities, their properties and their relationships, offers a new approach to managing and sharing information using semantic metadata in the context of Intangible Cultural Heritage (ICH) [1]. Building ontologies for folk cultural heritage knowledge, especially building one for Vietnamese water puppetry (stories, characters, puppet scenes, puppet shows) is thus one of the most important and specific issues that can be dealt with immediately to meet practical demands in Vietnam¹.

Our objective is to build up an initial ontology for Vietnamese water puppetry, covering the main concepts and properties of water puppet stories, scenes and characters. This

ontology will help storing, retrieving, classifying, analyzing and modeling water puppet stories and scenes, as well as training for water puppet shows and performance. It can be used also to model puppet shows with advanced 3D-animation technology, hence contribute to preserving and promoting the water puppet heritage.

In this paper, we present the first stage in building Vietnamese water puppetry ontology. We determine the main concepts along with properties and build up a concept map, based on expert knowledge in the domain [2], [3], [4]. Some challenges and inconsistencies in building the ontology are discussed. Logical assertions, embedded in this ontology, will give inferred results, enhancing searching stories, characters and scenes.

This paper is organized as follows. Section 2 presents some backgrounds on water puppetry. Section 3 focuses on water puppetry ontology development, whereas Section 4 illustrates the building of an ontology for water puppetry with a logical representation and its expected features (queries, multi-sources, inconsistency managing, etc.) through a case study.

II. BACKGROUNDS AND RELATED WORKS

A. Vietnamese water puppetry

Water puppetry - an original folk art only present in Vietnam, has tightly been associated with the wet-rice culture in the Red River Delta since more than one millennium, fulfilled with many spiritual values linked to the awareness, society, education, entertainment, especially aesthetic values. First documents about Vietnamese water puppetry, engraved on ancient stele “Sùng Thiện Diên Linh”, at Đọi Sơn pagoda, described that puppet shows were firstly performed at the birthday celebration of King Lý Nhân Tông (Lý Dynasty, around 1121). As discussed in [5], at the beginning, the water puppetry was created by Vietnamese farmers for entertainment. Then, this type of folk performance has been gradually improved, becoming a perfect folk art performance, submitted to the King.

Unlike other puppets in the world, most water puppets have two parts - body and base, which are controlled remotely

¹Workshop on “Conservation and development of water puppetry in the integration period” taking place in Vietnam Puppet Theater, 22-7-2016

through rods and have some control units, attached with the bases. Puppets are made of fig wood (locally available and light) and laquered. Puppets have a simple shape, but each puppet has unique characteristic appearances, which distinguish itself from others. In shows, puppets become lively characters, familiar to spectators. Puppet characters are very varied, including not only human ones, representing different social strata, but also super-natural ones, such as Buddha and fairies, and animal ones. Tễu is a very typical and special character, with the role of presenter and animator.

Water puppet theatres, usually set up in villages, are tightly associated with the biggest pond in the village, becoming the most important event place of festivals and ceremonies. The stage is collapsible and built of wood and bamboo with a roof, painted to look like the tiled roofs of pagodas or temples. The show space, separated from the manipulating room by bamboo screens, is the surface of the pond.

The puppet shows, reflecting stories of daily life, festivals and folk tales, are performed by the water puppet troupes, founded by villagers themselves. In water puppet shows, there is no manuscript. Stories are illustrated in either grouped scenes or a single scene which are very familiar to Vietnamese people. The literary texts, given by puppet characters or the animator in water puppetry shows, mostly in the form of folk songs, folk verses and proverbs, are used mainly for introducing or annotating scenes. Live music (being strong, keeping the rhythm and stirring the noisy, boisterous atmosphere of the performance) is an important aspect to make the charm of water puppet. Percussion, especially drums, are the main and indispensable instrument in the performance.

B. Related works

In [6], authors showed the urgent need of preserving and promoting of the ICH. They also figured out the usefulness of a semantic wiki, the expressive power of ontologies, and the benefits of wikis. They are flexible methods allowing the community to participate in preserving ICH with public access. Recently, many significant ontologies for representing folk songs and dances have been developed. In [7], reported ontologies based on two different Basque folk song catalogs were reported. The author described a representation for folk song metadata based on Ontology Web Language (OWL). He also showed how complex queries could be expressed in OWL and solved using a description logic reasoner. In [8], dances were described and stored taking advantage of the expressivity of Description Logics. A dance ontology was built in OWL-2 to represent and archive dance choreographies. SPARQL queries were used to search within the ontology based on the steps and movements of dances. The semantics of the Labanotation system, using symbols to denote dance choreographies, was used to build elements of the ontology and their relationships. In [9], an approach for semantic annotation of movement, based on ontology model and semantic concept classifiers in the videos, was proposed, using OWL and the semantics of the Benesh Movement Notation (BMN) to define video movement ontology (VMO), including schema and data. The ontology concept was used to annotate video human movements with BMN. The proposed system allowed searching within the VMO by writing SPARQL queries.

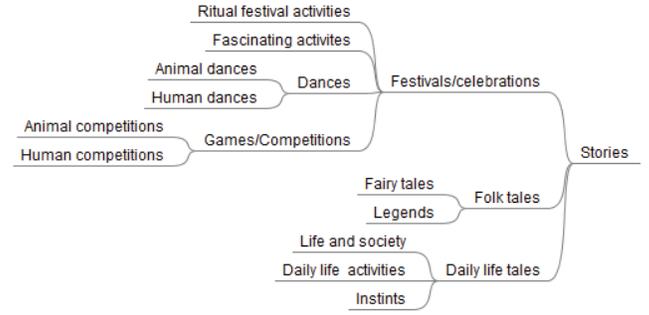


Fig. 1. Stories in water puppetry.

III. VIETNAMESE WATER PUPPETRY ONTOLOGY DEVELOPMENT

A. Expert knowledge gathering

Each water puppet performance session lasts from 45 minutes to 1 hour, including nearly 20 puppet shows. Each show includes single or grouped scenes, which reflect a legend, a meaningful story about life, a festival or a historical story. Stories and scenes of the water puppet are presented in details as follows.

a) Stories: Stories, depicted in water puppet shows, are classified in three types (Fig 1): (i) daily life stories, (ii) folk tales and (iii) festival ones. Daily life stories are narrated from daily farm working activities, associated with farmers in the Red river region delta, such as transplanting, plowing. There are also rural activities such as catching animals, raising fowls to supplement meats in meals, some animal instinct ones like fox catching ducks, mouse climbing a tree. We could observe scenes from daily life with peaceful images of pasturing buffalos, flying kites, blowing bamboo flutes. Folk tales include fairy tales, reflecting the ancients' understanding of natural phenomena, rustic aspirations and faith in the goodness. They tell also about historical legends, reproducing some national heroes' lives, such as the two sisters Trưng, the Lady Triệu and the King Lê Lợi. Festivals, reflected alive popularly in water puppet scenes, are always composed of two parts: the ceremonial part, giving homage to the local genies and deities, and the festival one to entertain the whole village. Flag hoisting, parasol hanging and firecrackers, often seen at the beginning of the puppet performance, are similar to any ceremony in a Vietnamese village. Games and shows, attracting all villagers, such as wrestling, swimming competitions, catching ducks, cooking rice competitions, swinging, human chess, are skillfully transmitted into water puppet shows.

b) Scenes: Stories are reflected in puppet shows through scenes. Scenes give typical pictures of rural life, traditional festivals (Table I). In water puppet shows, there are two types of scenes: ritual scenes and single scenes. Ritual scenes are often presented when opening, closing performance shows. Each ritual scene usually corresponds to a puppet demonstration such as Tễu's prologue, flag hoisting. In shows, reflecting daily life stories, festival activities, scenes are easy to be recognized and classified because they are deepened as bold images in Vietnamese people's mind. Scene "plowing", for example, represents a man, in simple suits, holding a plow

TABLE I. SOME OF FESTIVAL SCENES.

Festivals			
Ritually festival activities	Fascinating scene	Game competitions	Dances
Flag raising	Fairy climbing a bridge	Wrestling	Dragon dance
Drum beating	Fairy creeping into a pipe	Swinging	Unicorn dance
Couplet raising	Dance of the fairies	human ladder	Snake dance

and following a buffalo. In historical legend shows, puppet characters appear in typical suits, corresponding to their social strata and holding objects, featuring their social position. For instance, the King Lê Lợi appears always with the dragon costume and the magic sword, as in “Legend of Returned Sword lake” show.

c) Challenges: To represent water puppet shows in an effectively expressive way, we need to understand clearly its required elements including name of stories (what), puppet characters (who), scenes (how) which are closely related to history, culture and Buddhism in Vietnam. Message in puppet shows is one of the most difficult qualitative feature to be captured as it is associated with scenes of the shows and character’s appearance rather than literary text. Trying to develop a universal model capable of describing a wide range of water puppetry, beside narrations and scenes, we have to study triangle of man-rice-water to understand the context wet-rice culture which is reflected in the water puppet performances. We also have to understand the art of puppet carving, performing techniques and two other related arts, called Tuồng and Chèo.

Besides, abnormal features are one of the factors that make the water puppetry attractive. The characters move, dance, sing on the water while the spectators do not know how they move; series of flags hoist from the water and they still dry. Dragon and dragon related objects often involve The King but, in “Dragon dance” show, the dragons make fun as other normal animals. Abnormal features, full of surprises, strangely magical, play an important role in the success of puppet shows. Abnormal features, however, are also the factor, causing difficulties in logical modeling while building ontology.

IV. A CASE STUDY: THE LEGEND OF THE RETURNED SWORD LAKE

We present in this section a logical representation of *The Legend of the Returned Sword Lake*, a classic show (Fig 2) appearing in water puppet performances. King Lê Lợi (1384 – 1433) is a famous character of Vietnamese history. He was the founder of the Later Lê dynasty and one of the most famous heroes of Vietnam, by his important role in the independence revolt against Ming Empire in China. A legend is born from the historical facts. According to this legend, Lê Lợi obtained from a local god a magic sword, Thuận Thiên (Will of Heaven), which gave him the power of one hundred men. Similarly to Arthurian legend, after his victory, the king had to give back the magic sword to the god, via Kim Quy, a golden turtle. This last part of the legend is illustrated in water puppet shows.

This case study is very characteristic of the richness, the heterogeneity and the depth of the different knowledge



Fig. 2. An image in “The Legend of the Returned Sword Lake” show.

tackled. It involves historical knowledge, general South-east Asian cultural knowledge and legend knowledge. All of these knowledge are essential to understand shows. Even if all these knowledge are common knowledge for oldest natives, their understanding is not trivial for uninitiated people.

A. Presentation of DL/DL-Lite

Let us first present DL-Lite, a Description Logic used to model the knowledge used in our case study.

1) Language: For the sake of simplicity, we only present $DL-Lite_{core}$ the core fragment of all the $DL-Lite$ family [10] and we will simply use $DL-Lite$ instead of $DL-Lite_{core}$. However, we could use for this paper $DL-Lite_R$ and $DL-Lite_F$, two important members of the $DL-Lite$ family, without extra computing cost. The $DL-Lite$ language is defined as follows:

$$R \longrightarrow P|P^- \quad B \longrightarrow A|\exists R \quad C \longrightarrow B|\neg B$$

where A is an atomic concept, P is an atomic role and P^- is the inverse of P . B (*resp.* C) is called basic (*resp.* complex) concept and role R is called basic role. A $DL-Lite$ knowledge base (knowledge base) is a pair $\mathcal{K}=(\mathcal{T}, \mathcal{A})$ where \mathcal{T} is the TBox and \mathcal{A} is the ABox. The TBox \mathcal{T} includes a finite set of inclusion assertions of the form $B \sqsubseteq C$ where B and C are concepts. The ABox \mathcal{A} contains a finite set of assertions on atomic concepts and roles of the form $A(a)$ and $P(a, b)$ where a and b are two individuals.

Example 1: Let us consider the following atomic concepts: King, Queen, Man, Woman and the atomic role WifeOf. The following rules encode the fact that a King is a man, a Queen is a woman and that WifeOf links a Woman and a Man. These rules encode generic knowledge, without assertion. These rules compose a TBox.

Tbox \mathcal{T}_{hist} :

```
King  $\sqsubseteq$  Man
Queen  $\sqsubseteq$  Woman
 $\exists$ WifeOf  $\sqsubseteq$  Woman
 $\exists$ WifeOf*  $\sqsubseteq$  Man
```

Now, we can add some atomic concepts to build the following ABox, retrieved from historic knowledge.

ABox \mathcal{A}_{hist} :

King("Lê Lợi")
 Queen("Phạm Ngọc Trân")
 WifeOf("Phạm Ngọc Trân", "Lê Lợi")

Tbox \mathcal{T}_{leg} :

God \sqsubseteq \neg Man
 Fairy \sqsubseteq \neg Woman

2) *Semantics*: The semantics of a *DL-Lite* knowledge base is given in term of interpretations. An interpretation $\mathcal{I} = (\Delta^{\mathcal{I}}, \cdot^{\mathcal{I}})$ consists of a non-empty domain $\Delta^{\mathcal{I}}$ and an interpretation function $\cdot^{\mathcal{I}}$ that maps each individual a to $a^{\mathcal{I}} \in \Delta^{\mathcal{I}}$, each A to $A^{\mathcal{I}} \subseteq \Delta^{\mathcal{I}}$ and each role P to $P^{\mathcal{I}} \subseteq \Delta^{\mathcal{I}} \times \Delta^{\mathcal{I}}$. Furthermore, the interpretation function $\cdot^{\mathcal{I}}$ is extended in a straightforward way for complex concepts and roles: $(\neg B)^{\mathcal{I}} = \Delta^{\mathcal{I}} \setminus B^{\mathcal{I}}$, $(P^-)^{\mathcal{I}} = \{(y, x) | (x, y) \in P^{\mathcal{I}}\}$ and $(\exists R)^{\mathcal{I}} = \{x | \exists y \text{ s.t. } (x, y) \in R^{\mathcal{I}}\}$. An interpretation \mathcal{I} is said to be a model of a concept inclusion axiom, denoted by $\mathcal{I} \models B \sqsubseteq C$, iff $B^{\mathcal{I}} \subseteq C^{\mathcal{I}}$. Similarly, we say that \mathcal{I} satisfies a concept (*resp.* role) assertion, denoted by $\mathcal{I} \models A(a)$ (*resp.* $\mathcal{I} \models P(a, b)$), iff $a^{\mathcal{I}} \in A^{\mathcal{I}}$ (*resp.* $(a^{\mathcal{I}}, b^{\mathcal{I}}) \in P^{\mathcal{I}}$).

An interpretation \mathcal{I} is said to be a model of $\mathcal{K} = \langle \mathcal{T}, \mathcal{A} \rangle$, denoted by $\mathcal{I} \models \mathcal{K}$, iff $\mathcal{I} \models \mathcal{T}$ and $\mathcal{I} \models \mathcal{A}$ where $\mathcal{I} \models \mathcal{T}$ (*resp.* $\mathcal{I} \models \mathcal{A}$) means that \mathcal{I} is a model of all axioms in \mathcal{T} (*resp.* \mathcal{A}). A knowledge base \mathcal{K} is said to be consistent if it admits at least one model, otherwise \mathcal{K} is said to be inconsistent. A *DL-Lite* TBox \mathcal{T} is said to be incoherent if there exists at least a concept C such that for each interpretation \mathcal{I} which is a model of \mathcal{T} , we have $C^{\mathcal{I}} = \emptyset$. Note that within a *DL-Lite* setting, the inconsistency problem is always defined with respect to some ABox since a TBox may be incoherent but never inconsistent.

Example 2: (continued) Let us consider again \mathcal{T}_{hist} and \mathcal{A}_{hist} . The following interpretation \mathcal{I} is a model of $\mathcal{K} = \langle \mathcal{T}_{hist}, \mathcal{A}_{hist} \rangle$

{King = {Lê Lợi}, Queen = {Phạm Ngọc Trân},
 WifeOf = {(Phạm Ngọc Trân, Lê Lợi)},
 Man = {Lê Lợi}, Woman = {Phạm Ngọc Trân}}

3) *Operations on Knowledge Bases*: Different operations can be performed on Knowledge Bases represented in *DL-Lite*. The first operations are querying and reasoning [11]. This allows us to derive implicit knowledge from the base. For instance, according to Example 1, the query

$q(x) \leftarrow \text{Woman}(x)$

will return Phạm Ngọc Trân, even if the fact $\text{Woman}(\text{"Phạm Ngọc Trân"})$ does not belong to the ABox. For lack of space, we will not detail the procedure of inference, but, by focusing on *DL-Lite*, and supposing that the knowledge bases are coherent, it can be noted that this type of query are very efficient [10].

Another operation is the merging. The aim of the merging process is to combine different knowledge bases [12]. Such a combining can lead to some inconsistencies and/or incoherences (see for instance [13] for the case of *DL-Lite*). For example, we can consider the legend of the Dragon King Lạc Long Quân and his wife, the Water Fairy Âu Cơ, the first legendary King and Queen of Vietnam.

ABox \mathcal{A}_{leg} :

King("Lạc Long Quân")
 Queen("Âu Cơ, Lạc Long Quân")
 WifeOf("Phạm Ngọc Trân", "Lê Lợi")
 God("Lạc Long Quân")
 Fairy("Fairy Âu Cơ")

It is not possible to directly consider a new Knowledge Base $\langle \mathcal{T}_{leg} \cup \mathcal{T}_{hist}, \mathcal{A}_{leg} \cup \mathcal{A}_{hist} \rangle$. Indeed, in this case, we can deduce $\neg \text{Man}(\text{"Lạc Long Quân"})$ and $\text{Man}(\text{"Lạc Long Quân"})$, which is contradictory. We absolutely need to manage this contradiction, by merging or by considering reasoning in the presence of inconsistencies.

B. Modelling the Legend Of the Returned Sword Lake

We present now some fragments of 3 different ontologies, encoded in *DL-Lite*, to represent the scene of The Legend of the Returned Sword in water puppetry, namely:

- General Cultural Context
- Legends
- Puppetry performance

a) *General Cultural Context*: The first one states about the general cultural context. It focuses on common sacred creatures and some generic knowledge.

\mathcal{T}_{leg}
 Turtle \sqsubseteq SacredCreature
 Unicorn \sqsubseteq SacredCreature
 Dragon \sqsubseteq SacredCreature
 Phoenix \sqsubseteq SacredCreature
 ...
 SacredCreature \sqsubseteq \neg Animal
 ...
 Turtle \sqsubseteq Animal
 ...
 King \sqsubseteq VIP

b) *Legends*: We present here a fragment of an ontology on legends. It focuses on the Legend Of the Returned Sword.

\mathcal{T}_{leg}
 DragonBoat \sqsubseteq Boat
 GoldenTurtle \sqsubseteq Turtle
 GoldenTurtle \sqsubseteq SacredCreature
 ...
 MagicSword \sqsubseteq Sword
 MagicSword \sqsubseteq MagicObject
 MagicObject \sqsubseteq Object
 ...
 $\exists \text{ObjectOf} \sqsubseteq$ Object
 $\exists \text{ObjectOf}^- \sqsubseteq$ Legend
 $\exists \text{CharacterOf}^- \sqsubseteq$ Legend

```

 $\mathcal{A}_{leg}$ 
Legend("Legend Of the Returned Sword Lake")
King("Lê Lợi")
DragonBoat("Thuyền Rồng")
Site("Green Water Lake")
GoldenTurtle("Kim Quy")
MagicSword("Thuận Thiên")

CharacterOf("Lê Lợi", "Legend Of the Returned Sword Lake")
CharacterOf("Kim Quy", "Legend Of the Returned Sword Lake")
ObjectOf("Thuyen Rong",
"Legend Of the Returned Sword Lake")
ObjectOf("Will of Heaven",
"Legend Of the Returned Sword Lake")
SiteOf("Green Water Lake",
"Legend Of the Returned Sword Lake")

```

c) *Puppetry performance*: Finally, the following ontology describes puppetry performance in its material aspects.

```

 $\mathcal{T}_{pup}$ 
Show("Legend Of the Returned Sword Lake")
Puppet("id1")
Sword("id2")

 $\exists$ ObjectOf  $\sqsubseteq$  Object
 $\exists$ ObjectOf  $\sqsubseteq$  Show
 $\exists$ CharacterOf  $\sqsubseteq$  Show

```

```

 $\mathcal{A}_{pup}$ 
Show("Legend Of the Returned Sword Lake")
Puppet("vip 1")
Sword("object 1")
Puppet("yellow turtle")
CharacterOf("object 1",
"Legend Of the Returned Sword Lake")
ObjectOf("object 1",
"Legend Of the Returned Sword Lake")

```

C. Example of query

What can a spectator, unaware of South-east Asian culture, see? He sees a VIP on a boat that gives a sword to a turtle. His first questions could be "who is this VIP?" and "what is the associated legend?" These questions can be encoded with the following query:

```

Q(x, y, z, t, u)  $\leftarrow$ 
VIP(x)  $\wedge$  Turtle(y)  $\wedge$  Sword(z)  $\wedge$  Boat(t)  $\wedge$  Legend(u)  $\wedge$ 
CharacterOf(x, u)  $\wedge$  ObjectOf(z, u)  $\wedge$  ObjectOf(t, u)
 $\wedge$  AnimalOf(y, u).

```

The answer, derived from the merging of the 3 presented ontologies, should explain the ignoring spectator that the VIP is Lê Lợi in the context of "Lê Lợi and the Legend of the Returned Sword". In order to do this, the considered method of querying/reasoning has to face different challenges: managing multisources of ontologies and dealing with inconsistencies.

V. CONCLUSION

The preservation and the promotion of Vietnamese water puppetry require to understand the underlying messages and cultural references of the shows and not only to watch puppet performance for entertainment. For this purpose, we need to

combine different expert knowledge such as puppet characters, performance techniques, history, legends... In this paper, we presented briefly water puppetry and the related knowledge in order to build up different ontologies. We analyzed the difficulties, especially the inconsistencies involved in water puppetry ontology construction. A case study of a specific puppet show "Legend Of the Returned Sword" and its related context was illustrated using description logic (DL-Lite).

The work presented in this paper is the first stage in a longer-term effort to create a universal water puppetry repository with advanced storage, indexing, search and analysis capabilities. Our plans for future work include enhancement and extension of the puppetry ontology and development of applications based on ontology such as 3D puppet show modeling for preservation, training and creation.

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