



# Exploring cultural heritage repositories with creative intelligence. The Labyrinth 3D system <sup>☆</sup>



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## ARTICLE INFO

### Article history:

Received 11 January 2016

Revised 9 May 2016

Accepted 10 May 2016

Available online 12 May 2016

### Keywords:

3D visualization

Cultural heritage

Computational ontologies

## ABSTRACT

In cultural heritage, the use of ontologies makes the description of artworks clearer and self-explanatory, with advantages in terms of interoperability. The current shift towards semantic encoding opens the way to the creation of interfaces that allow the users to build personal paths in heritage collections by exploiting the relations over the artworks.

In the attempt to leverage this multiplicity of paths, we designed and implemented a system, called Labyrinth 3D, which integrates the semantic annotation of cultural objects with the interaction style of 3D games. The system immerses the user into a virtual 3D labyrinth, where turning points and paths represent the semantic relations over cultural objects, with the goal of engaging the user in the exploration of the collection.

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## 1. Introduction

In the last decade, the advent of connected, portable devices, and the evolution of the Web towards a participatory model have prompted cultural institutions to pursue new communication strategies that leverage the Web [1,2]. Cultural institutions have rushed to publish their collections online, with the goal of innovating their interaction with the audience through the help of personalization and social media [3,4].

In parallel with this trend, digital archives have moved towards semantic annotation, a paradigm where the items in the archive are described with reference to a computational ontology. The use of ontologies, implemented through logic-based languages [5], makes the description of artworks clearer and unambiguous, with advantages in terms of interoperability among systems [6,7]. Semantically annotated collections, then, lend themselves to personalization [4] and cross media integration of data sources, following the paradigm of Linked Open Data [8,9].

Despite the potential of the semantic representation, however, the search in heritage archives is still largely based on keywords

and/or tags, through which users can filter the archive contents to find what they need. As exemplified by the well known Europeana initiative, which provides a unified interface to a set of national digital collections [10], the search typically returns a list of items (books, pictures, videos, etc.) accompanied with personalized recommendations, but it does not contain an explicit representation of meaning relations over them. In contrast with this approach, [11] argues that, in order to meet the needs of the general audience, tools for supporting exploratory search are needed besides the traditional keyword-based interfaces. In cultural heritage, search interfaces are typically based on the metaphor of the “archive”, which mirrors the actual fruition of the physical cultural objects (see, for example, the web interface of the above mentioned Europeana system), although the trend of the 3D “visit” has emerged in online museum collections, as demonstrated by the well known Google Art Project.<sup>1</sup>

In this paper, we address the access to digital collections by proposing an approach that leverages semantic annotation to create a 3D environment where the user can explore the semantic relations over the items in a visual environment. Our approach combines the use of the 3D language, typical of new media – and video games in particular –, with the capability of semantic annotation to connect entities that are distant in space and time but share some common features at the cultural level. The use of 3D

<sup>☆</sup> This paper is part of the virtual special issue on “7th International Conference on Intelligent Technologies for Interactive Entertainment”, edited by Dr. Andrea Sanna and Dr. Matthias Rauterberg.

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<sup>1</sup> <https://www.google.com/culturalinstitute/u/0/project/art-project>.

for the interface is motivated by the goal of attaining a user experience characterized by high level of engagement and a sense of immersion [12]. As shown by an established line of research in information visualization [13], in fact, visual metaphors can convey a conceptual model in an immediate and engaging way.

The system we describe in this paper is part of a larger project, called Labyrinth,<sup>2</sup> aimed at the dissemination of cultural heritage archives to the general audience. In order to mediate between the point of view of the user and the heterogeneity of the items in heritage repositories, which usually differ by features such as media type, age and purpose but share some narrative features like stories and characters, the project relies on the notion of “archetypes” of narrative nature. Mainly inspired by the research in iconology and narratology [14,15], the term “archetype” is employed in Labyrinth to refer to a conceptual core set at the intersection of narrative motifs, iconological themes and classical mythology (the system itself is named after a well-known archetype).

The plan of the paper is the following: after describing the background of the project and discussing its motivations (Section 2), in Section 3 we provide a brief overview of the live system with a navigation example. Section 4 describes the components of the systems, namely the ontology (Section 4.1), the 3D environment (Section 4.2) and the core component of the system, i.e., the mapping of the ontology onto the 3D environment (Section 4.3). The system architecture, which combines these elements to create newer and newer paths through the repository, is described in Section 5. Discussion and conclusion end the paper.

## 2. Background

In the last decade, the use of ontologies for the access to cultural heritage collections has been investigated by several projects. A pioneering contribution was given by the Finnish Culture Sampo project [16]. In this project, a number of domain ontologies provide the background against which cultural objects (including artworks, artists, traditional practices, etc.), encoded in different media formats (e.g., images and videos), can be explored, tracking the underlying relations over them. In CultureSampo, once a certain artifact (e.g., a painting) has been retrieved, it is possible to explore the relations over the objects (and characters) represented therein. The system has recently evolved towards a linked data approach with the release of a new application, War Sampo, focused on the Second World War [9]. The Agora system [17] frames the exploration of a digital collection into historically relevant episodes, supported by a semantic account of the notion of event [18]. For example, the user can choose a historical episode (e.g., “German occupation of Poland in the Second World War”) and navigate among the cultural objects related to this event.

A line of research in ontology-based systems has specifically explored the use of narrative models in cultural heritage dissemination. Stories not only represent an effective way to convey information in a compact format, as argued by [19], but, according to the research in cognitive psychology, they are a primary means for the conceptualization of reality [20]. In cultural heritage, many artworks have, by and large, some type of narrative content. In visual arts, for example, paintings often display story episodes while statues immortalize characters; even non representational artworks often refer to narrative elements, despite the abstract nature of their visual content. Stories are narrated by textual media such as tales and novels, but also – though in nonverbal terms – by different kinds of musical works, from operas to symphonic poems. Narrative is

the focus of the Bletchley Park Text system [21], a semantic system designed with the goal of supporting the users in the exploration of online museum collections. Designed with the notion of the “guided visit” in mind, the system encompasses an ontology of story, taken from the Story Fountain project [22]. The stories represented in the system are employed in a web interface to create relations over entities in online collections; based on this knowledge, the user can ask the system to find a narrative connection between different entities. More recently, the Decypher EU project leverages stories to address the curatorial side of cultural heritage dissemination [23]. In Decipher, a story ontology is the basis of a system that supports the creation of story-based collections by museum curators. Finally, Europeana also uses some simple narrative features to describe the items they contain. In Europeana, it is possible, for example, to navigate among the artifacts representing a given action or displaying a certain character, across a large number of indexed objects; the system does not provide, however, a story-level navigation.

The Labyrinth project extends the approaches described above by integrating the use of a narrative model to connect the items in a collection with the use of a visual environment for the exploration of these connections. The system relies on an ontology of narrative archetypes to describe the items in the collection; the 3D interface of system is inspired to a well known narrative archetype, the “labyrinth”. The notion of labyrinth is not only deeply rooted in the Western Culture, dating back to Greek Myths and witnessed by several archaeological locations across Europe [24], but also, thanks to the graph like nature of the notion of labyrinth [25], it lends itself well to representing the many-to-many relations among artworks encoded in the ontology. The goal of the visual design of the 3D interface is twofold: on the one side, it is aimed at engaging the users to explore the repository through an immersive experience; on the other side, it is aimed at making the system usable by the large majority of users by integrating information giving and entertainment in a familiar environment. The labyrinth, or maze, is a genre of video games most users are familiar with, thanks to classic 2D games such as Atari’s Pacman<sup>3</sup> and recent 3D titles such as Imangi’s Temple Run<sup>4</sup> or PlayFirst’s Dream Chronicles.<sup>5</sup>

In cultural heritage, the use of 3D visualization is normally intended as a support for study and dissemination activities. 3D projects in cultural heritage can be roughly divided into two types: virtual equivalents of physically existing locations, such as museums and historical buildings, and reconstructions of physical environments that have disappeared, such as archaeological locations or temporary art works. Google Art Project<sup>6</sup> and Arounder<sup>7</sup> are examples of the first type, where 3D is often obtained through PMVR techniques that integrate high definition images of artworks in the 3D environments. Rome Reborn [26], the 3D reconstruction of Rome as it appeared in the IV century, is an example of the second type. In this project, the use of 3D is integrated with animated characters of ancient Romans, who interact with the users. A similar approach is proposed by [27], who present a framework for 3D real time applications in web browsers, employed to develop virtual reconstructions of Rome (Virtual Rome project) and other Italian locations [28]. Labyrinth differentiates from these approaches since the 3D representation is not employed to reconstruct real environments or to create virtual ones, but as a tool to convey semantic relations through a visual environment. For this reason, the system does not

<sup>3</sup> <https://en.wikipedia.org/wiki/Pac-Man>.

<sup>4</sup> <http://www.imangistudios.com>.

<sup>5</sup> <http://www.playfirst.com/games/view/dream-chronicles>.

<sup>6</sup> [www.google.com/culturalinstitute/project/art-project](http://www.google.com/culturalinstitute/project/art-project).

<sup>7</sup> [www.arounder.com](http://www.arounder.com).

<sup>2</sup> <http://app.labyrinth-project.it:8080/LabyrinthTest/>.

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