# Yet Another Version of Minerva: The Isola Comacina Virtual Museum

**Francesco Amigoni**[1] and **Stefano Della Torre**[2] and **Viola Schiaffonati**[3]

**Abstract.** It is widely accepted that artificial intelligence tools can promote new ways of experiencing cultural contents. In this paper, we present a new version of a system, called *Minerva*, that offers to users the possibility of creating their own personalized virtual museums. The proposed system works on some archeological finds from the Isola Comacina, an island of the Como Lake in Northern Italy. The virtual museums created with our *Minerva Isola Comacina* system enhance the experience of the physical museum in which a limited number of archeological finds can be displayed. Preliminary experimental activities, conducted in cooperation with museum specialists, validated this new version of Minerva.

## 1 INTRODUCTION

Computational tools allow to enhance the experience in the fruition of museums, art exhibitions, and, more generally, cultural contents [6]. In this paper we present a new implementation of the *Minerva* system that, by exploiting artificial intelligence techniques, offers to users the possibility of creating their own personalized virtual museums. This new version of Minerva works on some archeological finds from the Isola Comacina, an island of the Como Lake in Northern Italy. The *Minerva Isola Comacina* system has been developed in parallel with the design of a physical museum in Ossuccio (the coast town closest to Isola Comacina) that is being set up. This physical museum will not display all the archeological objects found on the island both because the space available in its rooms is limited and because the finds are mostly fragments with little or no relevance for generic visitors. The Minerva Isola Comacina system is intended to display all the archeological finds in virtual museums that can be created by users. These virtual museums blend together specific information about the Isola Comacina finds and more general information about how they are connected to the surrounding territory. In this sense, the Minerva Isola Comacina system provides the users the unconventional and original possibility to build several *stories* starting from few objects and to learn about the connections between these objects and other "objects" (like buildings and archeological sites) spread in the Como Lake area. These stories can make fragments interesting also for generic visitors. The virtual museums created with the proposed system play as bridges between the archeological objects displayed in the physical museum and the knowledge they carry with (e.g., about excavation techniques).

[1] Dipartimento di Elettronica e Informazione, Politecnico di Milano, Italy, email: amigoni@elet.polimi.it
[2] Building Environment Sciences and Technology Department, Politecnico di Milano, Italy, email: stefano.dellatorre@polimi.it
[3] Dipartimento di Elettronica e Informazione, Politecnico di Milano, Italy, email: schiaffo@elet.polimi.it

We explicitly note that the system presented here is a prototype and, in its present form, it is not ready to be intensively used. For example, more efforts are required to improve the user interface and, in general, the interaction between the system and users. However, the results produced by our prototype and its internal architecture have been validated in a number of preliminary experimental tests, conducted in cooperation with museum specialists.

The Minerva Isola Comacina prototype is a new version of Minerva. Minerva is a software system we developed over the last years able to automatically organize virtual museums, starting from the collections of objects and the environments in which they must be displayed [1, 2, 3]. By organization we mean the arrangement of objects in conceptually relevant ordered groups and their placement in a given geometrical space. All the versions of Minerva share the same general architecture. The main differences between the version of Minerva presented here and the previous ones follow.

- The version of Minerva presented here addresses a new application scenario, related to Isola Comacina, different from those addressed by the previous versions (the organization of archeological finds from the Archeological Museum of Milan and of some Italian design objects).
- The version of Minerva presented here produces two-dimensional representations of virtual museums displayed as HTML pages, different from the three-dimensional representations displayed as VRML environments of the previous versions. In the Isola Comacina case, a two-dimensional representation is adequate given the initial stage of development of the project and the large amount of textual information conveyed to users.
- The version of Minerva presented here is intended for generic users, different from expert users of previous versions.

The main original contribution of this version of Minerva is the possibility for users to easily create their own virtual museums following their cultural interests and curiosity. Users do not directly select the single objects to be inserted in virtual museums; instead they select general themes, that are used by the system to retrieve the specific objects to be inserted in virtual museums.

This paper is structured as follows. The next section describes how users can interact with the Minerva Isola Comacina prototype. Section 3 discusses some technical details of the system implementation. Section 4 compares Minerva with other computational tools for virtual museums. Section 5 concludes the paper.

## 2 USING THE PROTOTYPE

A user interacts with the system via a web browser, navigating HTML pages. Basically, the virtual museums created by users are displayed

as HTML pages showing the items of the museums. The *items* are the archeological finds, like capitals and plaster fragments. Currently, the pages are in Italian, since the system is intended for Italian users. In the figures presented here, we added the English translations of the most important wordings.

Initially, a user is presented a planimetry of the physical Isola Comacina museum that is going to be built inside the remains of a Medieval hospital in Ossuccio (Fig. 1). The planimetry shows the icons of the objects as they will be displayed in the physical museum. At the current stage of development of the prototype, only a single object is displayed: a Byzantine capital.

Clicking on the Byzantine capital, the user is displayed a new page (Fig. 2) with a short description of the capital and with the panel from which a new virtual museum can be created. All the contents about the archeological finds of our prototype have been provided by museum specialists. In order to create a personalized virtual museum starting from the Byzantine capital, the user selects what items to display and how to group these items when shown.

- To select the items, the user selects one or more *themes* related with the Byzantine capital. Examples are reported in Fig. 3. In the virtual museum that is going to be created, all the items in the database related to the selected themes will be displayed.
- To select the groups in which the items will be shown in the virtual museum, the user selects a *criterion*. So far, we defined four criteria: chronological, topographic, find type, and finding conditions. For example, by selecting the find type criterion, items are grouped in architectural items, decorative items, covering items, and so on. Similarly, by selecting the finding conditions criterion, items are grouped in first excavation campaign, second excavation campaign, fourth underwater campaign, and so on.

For example, in the case shown in Fig. 3, a user, starting from the Byzantine capital, creates a virtual museum with the items related to the following themes (selected by the corresponding check-boxes): "Roman Architecture and Color: Precious Hidden Traces", "The Musso Marble", and "The Myth of Magistri Comacini". The criterion selected by the user to view the items is the chronological one.

According to the user-selected themes and criterion, the system builds a corresponding virtual museum that is displayed to the user. For example, Fig. 4 shows the virtual museum created according to the selections of Fig. 3. On the left top of the page, the description of the Byzantine capital is reported (this is basically the same description of Fig. 2) to recall the item from which the creation of this virtual museum started. On the left hand side, below this description, the "rooms" of the virtual museum are displayed; these *virtual rooms* are labeled according to the values of the criterion selected by the user (the chronological criterion, in our example). In Fig. 4 a virtual room with items from I-VI century A.D. and a virtual room with items from IX-XII century A.D. are visible. Note that the items in the virtual rooms are further organized in *virtual showcases* that group similar items. For example, the stone fragments with decorations are displayed in the same virtual showcase, while the painted plaster fragments are displayed in another one. On the right hand side of the page, the textual descriptions of the themes selected by the user are shown.

From the HTML page representing the virtual museum, a user can (1) start the creation of a new virtual museum, (2) select an item (by clicking on it), or (3) read a theme. In the first case, the user is presented a panel similar to that of Fig. 3. In the second case, the user is presented a HTML page similar to that in Fig. 2, but relative to the selected item. Since the themes related to different items are, in general, different, a personalized story can be built by navigating from one theme to another. In the third case, the user can read the description of a theme (e.g., "The Musso Marble") and access further information with the possibility to reach external web sites (e.g., about Como's cathedral that is built with Musso marble, Fig. 5). In this way, descriptions of themes contribute to enrich the knowledge of the user.

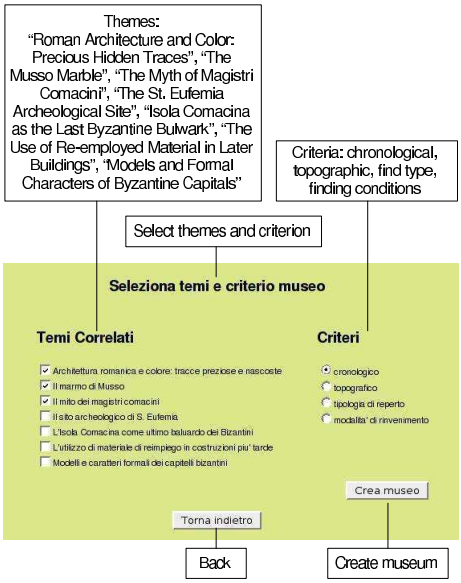


**Figure 3.** Selection of themes and criterion for creating a virtual museum


**Figure 5.** Further information about Como's cathedral

The Minerva Isola Comacina prototype has been tested by a group of 8 PhD students in "Technology and Design for Cultural Heritage" at the Politecnico di Milano (Italy). All of them positively judged the possibility of creating personalized virtual museums by selecting themes and criteria. Moreover, they emphasized the interesting opportunity, triggered by our system, of creating a wider virtual museum of the Como Lake territory, where information about artifacts and archeological finds is mixed together with naturalistic information. The main drawback they evidenced is relative to the user interface that, as already said, has not been a major concern in this initial stage of development of the project.

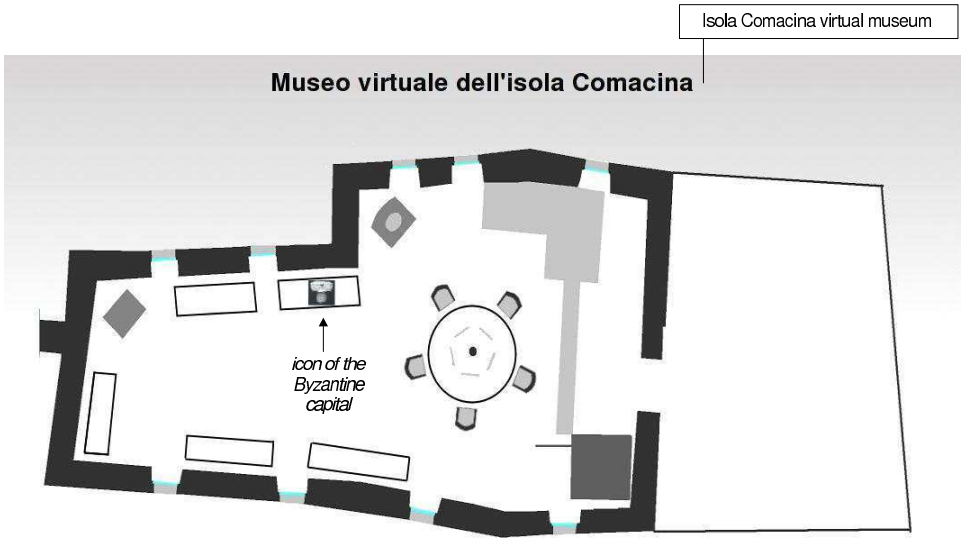


**Figure 1.** The initial HTML page presented to the user that reproduces the physical museum in Ossuccio


**Figure 2.** The HTML page relative to the Byzantine capital


**Figure 4.** The virtual museum created according to the selections of Fig. 3

## 3 IMPLEMENTING THE PROTOTYPE

In this section, we describe the architecture and the implementation of the Minerva Isola Comacina prototype. The architecture of the system is sketched in Fig. 6. As said, this architecture is similar to that of the previous versions of Minerva [1, 2, 3]. The Minerva Isola Comacina prototype is implemented as a multiagent system, a modern paradigm and technology of artificial intelligence. The prototype has been coded in JAVA exploiting the JADE framework. JADE is compliant with FIPA specifications, that are a widely-used collection of standards for multiagent systems. Agents in JADE communicate by exchanging messages in ACL (Agent Communication Language). ACL-based communications are represented by single arrows in Fig. 6. In the following we briefly illustrate the agents composing the system and the modularity provided by our multiagent architecture; space limitation prevents a more detailed description.

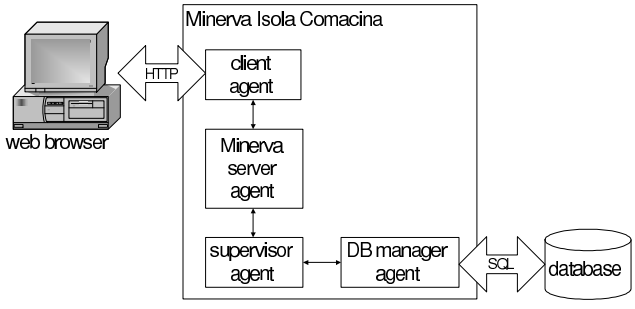


**Figure 6.** The architecture of the Minerva Isola Comacina prototype

The *client agent* manages the interaction with the web browser of a user. In Fig. 6 a single client agent is shown; in principle, however, more client agents may be active to manage the interactions with more users. The client agent receives the commands from the user and sends the appropriate ACL messages to the Minerva server agent. Similarly, the client agent receives the ACL messages from the Minerva server agent and sends the appropriate HTML pages to the user's web browser. A client agent includes a servlet to communicate with the web browser. A comprehensive discussion on how a user interacts with a client agent has been presented in Section 2. The main advantage of having client agents is that, since they build the HTML pages, only these agents have to be modified to change the layout of the pages.

The *Minerva server agent* is the "gateway" of the Minerva system and is the only agent a client agent views. It routes the ACL message flow between the client agents and the other agents of Minerva. Introducing this agent enhances the modularity of Minerva: other agents can be added to Minerva (or the current agents can be modified) without touching the client agents.

The *supervisor agent* receives (via the Minerva server agent) the ACL messages sent by the client agents and decides what to do on the basis of the content of the messages. For example, if a client agent $C$ requests to build a virtual museum given some themes and a criterion, the supervisor agent retrieves from the DB manager agent the items related to the given themes, groups them according to the criterion, and then sends the data back to $C$.

The *DB manager agent* is the only interface to the database of Minerva. It translates the requests of the other agents, formulated as ACL query messages in SQL queries for the databases. The database is implemented with MYSQL. Basically, the database of Minerva contains the items, the themes, and their relations. Currently, we have inserted about 50 items and 10 themes.

To preliminary assess the efficiency of our architecture, we performed some tests running the system on a single computer. We

compared performances using 1.5GHz Pentium M (with Linux and Windows) and 1.5GHz G4 (with Mac OS) computers. On the top of Fig. 7, the time to produce a virtual museum is shown; the values are averaged over a dozen of museum creations selecting different themes and criteria. The differences between operating systems are mainly due to the different implementations of the JAVA virtual machine. The pie chart on the bottom of Fig. 7 shows that, in percentage, the most expensive activity is retrieving the items from the database.

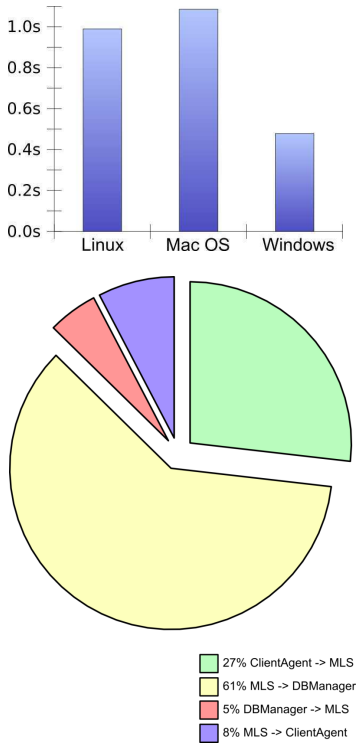


**Figure 7.** Preliminary performance analysis (MLS represents both the Minerva server agent and the supervisor agent)

## 4 RELATED WORKS

In the context of computational tools for virtual museum applications, Minerva plays a very original role, even if it is still at a prototypical stage of development. The innovation of Minerva lies in the possibility to create virtual museums tailored on the users' cultural curiosity. Moreover, the high degree of automation of the process of composing a virtual museum distinguishes Minerva from other applications, which are basically database management systems that manage collections and allow creation of virtual museums by hand.

In the very last years virtuality has been a core topic in the application of computational tools to museums. Currently all the most important museums offer web-accessible virtual tours to promote their contents. These virtual tours exhibit different degrees of interactivity and personalization. For example, in [8] a user can follow a personalized path to view the 2D representations of the works of art. In [7], the addition of a map of the physical museum connects the works of art with the rooms in which they are actually displayed. Another way to create this connection is to use webcams [5] or, more often, VRML representations [4]. However, in all these systems just slight customizations are available to users who can only visit predetermined museums.

In addition to promotional aims, virtuality can be adopted when artifacts cannot be exhibited to the public due to space limitations or to their fragility. Moreover, virtual museums enable different audiences to access and interact with objects and information distributed among various localities. In this scenario, to the best of our knowledge only few systems are somehow closer to the philosophy lying behind Minerva, in that they offer the opportunity to users to choose the works of art to be displayed in personalized virtual museums. For example, in [9] both a generic user and an exhibition designer can manually create and manage virtual museum exhibitions. Even if this tool offers to users a high degree of interactivity, Minerva exhibits more powerful automatic features. As the Minerva Isola Comacina prototype shows, users do not manually place the archeological finds in the virtual environment, neither they choose directly the visual features of the environment. Instead, users select themes and criteria in order to determine what items to display and how to show them. The system then automatically builds a corresponding virtual museum that is eventually displayed.

## 5 CONCLUSIONS

In this paper we have presented a new implementation of Minerva devoted to organize archeological finds from Isola Comacina. The system, implemented as a multiagent system, offers to users the possibility of visiting their personal museums, created according to their creativity and the "paths of knowledge" they desire. Preliminary experimental results validated both the cultural relevance and the technical effectiveness of the prototype presented in this paper.

Future works will address adding more items to the current prototype in order to cover all the objects found on the Isola Comacina. Moreover, user interface should be improved before deploying the system for intensive use.

## ACKNOWLEDGEMENTS

We would like to thank Riccardo Andretta, Gianluigi Calcaterra, Gabriele Erba, and Massimo Franzosi for implementing the system presented in this paper. We also thank Andrea Bonavita for the fundamental contribution in shaping the contents of the system.

## REFERENCES

[1] F. Amigoni and V. Schiaffonati, 'The Minerva Multiagent System for Supporting Creativity in Museums Organization', in *Proceedings of the IJCAI2003 Workshop on Creative Systems: Approaches to Creativity in AI and Cognitive Science*, pp. 65–74, (2003).

[2] F. Amigoni and V. Schiaffonati, 'A New Version of Minerva for Organizing Archeological Museums', in *Proceedings of the AI*IA Workshop on Cultural Heritage*, (2005).

[3] F. Amigoni, V. Schiaffonati, and M. Somalvico, 'Minerva: An Artificial Intelligent System for Composition of Museums', in *Proceedings of the International Cultural Heritage Informatics Meeting (ICHIM01)*, volume 2, pp. 389–398, (2001).

[4] Cardiac Virtual Museum, last access April 2006. `http://arrhythmia.hofstra.edu/vrml/museumn/museumn.html`.

[5] Centre Pompidou, Paris, France, last access April 2006. `http://www.cnac-gp.fr`.

[6] E. Edmonds and L. Candy, *Explorations in Art and Technology*, Springer-Verlag, London, UK, 2002.

[7] Museo Nacional del Prado, Madrid, Spain, last access April 2006. `http://museoprado.mcu.es`.

[8] The British Museum, London, UK, last access April 2006. `http://www.thebritishmuseum.ac.uk`.

[9] K. Walczak, W. Cellary, and M. White, 'Virtual Museum Exhibitions', *IEEE Computer*, **39**(3), 93–95, (2006).