Volume 0 (1981), Number 0 pp. 1–4 COMPUTER GRAPHICS *forum*

Virtual Institutions for Preserving and Simulating the Culture of Mount Bego's Ancient People

M. Ancona[1], V. Mascardi[1], G. Quercini[2], A. Bogdanovych[3], H. De Lumley[4], L. Papaleo[1], S. Simoff[3], A. Traverso[5]

[1]Dipartimento di Informatica e Scienze dell'Informazione, Università di Genova, Genoa, Italy
[2]Institute for Advanced Computer Studies, University of Maryland, USA
[3]School of Computing and Mathematics, University of Western Sydney, Australia
[4]Laboratoire Départemental de Préhistoire du Lazaret, ADEVREPAM, Nice, France
[5]DARFICLET, Università di Genova, Genoa, Italy

Abstract

The Alps of southeastern France, better known as the Valley of Marvels, hide an impressive collection of engravings, mostly visible on the rocks around Mount Bego, which are irreplaceable witnesses of what life of the people who created them looked like. This calls for immediate action on promoting the awareness of this cultural treasure, which is hardly accessible by interested common men, as well as on helping domain experts to analyze these engravings and share their understanding and theories about them with other experts and with the mass.
In this position paper, we propose technologies and partially achieved results for preserving in digital form all kinds of available data about the region. The technology will allow domain experts to: (i) organize and structure data into an existing collaborative tool set, (2) process them, (3) make assumptions about the way of life of the ancient people based on them, and (4) make the results of such activities available in form of 3D Virtual Worlds.

1. Introduction

"It was a hellish place with pictures of demons and a thousand devils cut everywhere on the rocks". With these words Pierre de Montfort, a XV century French voyager, describes the rock engravings he run into while traveling through the area around Mount Bego, in southeastern France.

Far from being hell, Mount Bego is actually a heaven holding one of the most remarkable cultural treasures on Earth, whose "symbols" are marvelous rock engravings (up to 40,000 figurative carvings and 60,000 non-figurative carvings) which date back to protohistory [dLE09].

Mount Bego engravings are scattered over a large area at an altitude of 2,000 to 2,700 m brimmed with snow eight months a year. This calls for immediate action on promoting the awareness of this site, which is hardly accessible by interested common men, and on helping experts in sharing and comparing their theories about the inhabitants of this fashinating region.

In this position paper the accessibility of Mount Bego is addressed through the use of Virtual Reality technology (in particular 3D Virtual Worlds), thus providing an interactive and immersive cultural experience, likely to target a vast audience.

The framework outlined in this paper, whose components have mostly been implemented and only need to be integrated, will allow domain experts to

1. Create an interactive knowledge repository for storing and organizing the available data and knowledge about the Mount Bego Region collected by researchers over the years [Bic13, Bur29, dLE09].

2. Develop the 3D Virtual World simulating the life of the dwellers of Mount Bego region based on the knowledge from the above repository and expertise of the subject matter experts. This Virtual World will be populated by autonomous virtual agents that "live their lives", interact with one another according to their societal institution (defined by North as the "humanly devised constraints that structure human interaction" [Nor93]) and have a capability to interact with human visitors. The Virtual Institutions technology [Bog07] will be used to enable this in a similar way as we have done it in [BRSC09].

3. Make educated guesses for authentic reenactment of the life of ordinary people when not enough knowledge is available and providing tools for simplifying the formalization of

the Virtual Institution.

The remainder of the paper is organized as follows. The introduction to Mount Bego and its people is given in Section 2. Our approach to simulating it with Virtual Institutions is outlined in Section 3. The way we handle the available data and the description of the technological facilities for using it in order to create new knowledge are presented in Section 4. Finally, Section 5 concludes the presentation.

2. Mount Bego

No scientific study was carried out on the carved rocks until the end of XIX century, when Clarence Bicknell, British botanist, Esperantist and philantropist, came to the area and sketched 450 drawings on small sheets of paper. Between 1898 and 1910 Bicknell realized up to 13,000 drawings and reliefs, part of which were then published in [Bic13]. Since 1967 several teams led by Henry de Lumley have been surveying and mapping this important archaeological area. More than 100,000 graphic signs, of which 40,000 are figurative, were carved on around 4,000 rocks in the Mount Bego region.

Regarding the ancient population, the daggers, halberds and axes represented in the carvings make it possible to attribute it to Chalcolithic cultures, like the Remedello, or to early Bronze age cultures, like the Polada or the Rhodanian, and to date them between 3300 B.C. and 1800 B.C. [dLE09]. In that crucial era mankind went through considerable changes, as metals were discovered and used and agriculture techniques were refined introducing the plough, as witnessed by countless archaeological findings. As a result, societies evolved and became hierarchically structured, with remarkable social differences between the individuals either in terms of power or wealth.

This explains why a lot of effort has been (and still is) devoted to decoding the engravings around Mount Bego, that give us a precious insight into what societies looked like in that era. What we know about Mount Bego does not come only from the engravings, but also from other archaeological sites and finds dating back to the same period. As far as the Chalcolithic period is concerned, one famous example is Ötzi the Iceman, a well-preserved natural mummy of a man who lived in that period, which helped archaeologists to identify the clothes and shoes people in that era and place used to wear, the arms they relied on, and even the food they ate.

The most occurring figure in Mount Bego engravings is a reference to a horned animal, which either recalls agriculture and livestock farming, typical activities of the Alpine populations in protohistory, or refers to the bull god or goddess earth, when represented as an anthropomorphic figure. Many engravings are detailed descriptions of rites used to propitiate the rain, which the prosperity of the society heavily depended on, and show that people cared a lot about the movements of the stars. Finally, from those engravings we can extract the social stratification, as there is always a predominant figure (a sorcerer) leading the rituals.

3. Our Approach via Virtual Institutions

Recent research has extensively proved the effectiveness of Virtual Institutions (VIs in the sequel) in the Cultural Heritage domain [BRSC09, BPA*09]. In this section we show how this technology can be exploited in our framework. Without lack of generality we simplified the institution to only cover the interactions in relation to participants living in their homes, using the fire place, herding, hunting and performing the rain propitiation ritual.

The Institution for Mount Bego. To illustrate the key elements of VIs and show how this technology is used in the Mount Bego context, Figure 1 outlines the Performative Structure, the roles of participants and gives an example of a Norm and a Scene. The Performative Structure shown in Figure 1a is a graph defining the role flow of participants among various activities. The nodes of this graph feature the identified scenes and the arcs define the permission of participants playing a given role to access certain scenes. Arcs labelled with *new* define which participants are initializing the scene, so that no other participants can enter it before the initialization occurs.

The *root* and *exit* scenes are associated with no patterns of behavior and simply define the state of entrance and exit of participants into the institution. Apart from them each of the scenes in the Performative Structure is associated with a Finite State Machine defining the interaction protocol for the participants that are accepted into the scene. To change the scene state a participant has to perform an action accepted by the institutional infrastructure. Figure 1c defines the role hierarchy and indicates that the institution can be accessed by the agents playing the following roles: Visitor, Sorcerer, Tribesman, Hunter and Shepherd. Here Shepherd and Hunter are two subroles of the role Tribesman. The Visitor role represents a human visitor that acts as an external observer.

Figure 1b illustrates how a scene protocol is formalized. The scene protocol here defines in which sequence agents must perform the actions, at which point they can join and leave the scene and what they should do to change the scene state. As an example, Figure 1b outlines the institutional formalization of the RainRitual Scene (the formalization of the bull sacrifice ritual being performed to request rain [dLE09]). Once a scene is initialized, its initial state becomes "W0". While the scene is in this state a Sorcerer agent and multiple Hunters can join the scene. As the scene participants (agents) perform their actions, the scene evolves to a different state (from W1 to W7). Only the actions that are shown on an arc leading from the current state to some other state can make the scene state evolve. Other actions would either be blocked or will be ignored as irrelevant. In our example the protocol evolves as the result of the sorcerer an-

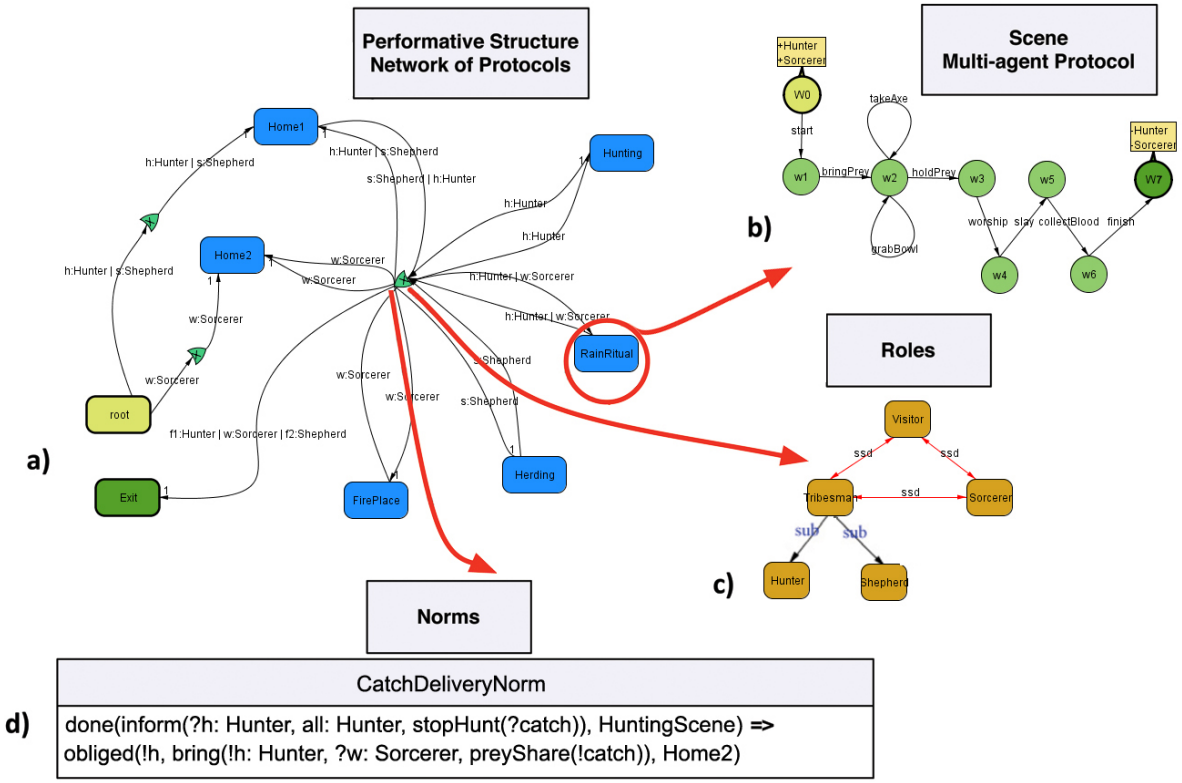

Figure 1: *Some components of the Mount Bego institution.*

nouncing the start of the ceremony (W1), after this a hunter must select a pray and bring it (W2). While the scene is in W2 the sorcerer must take an axe and one of the hunters must grab a bowl. After this, one of the hunters must hold the pray (W3) and the sorcerer would perform a worship ritual (W4). After this ritual, the pray will be slaughtered (W5) and its blood will be collected into the bowl (W6). The scene is finalized by the sorcerer who announces the end of the ritual.

Similar to the RainRitual scene the interaction protocols are specified for other scenes in the Performative Structure. Note, that the scene protocol does not define all precise details of the actual ritual, but simply structures it and provides the key states within the scene so that the agents can have a formal understanding of the performed actions.

Figure 1d shows an example of a norm (i.e., the inter-scene obligations acquired by the agents as the result of performing some actions in the institution) that instructs a hunter agent to share his catch with a sorcerer once the "stopHunt" illocution is sensed within the Hunting scene.

Agents, Visitors and Experts. Once the institution is formalized we can design the corresponding virtual world and let it be accessed by our agents, humans visitors and experts. The virtual world in our case is modeled manually within Second Life (http://secondlife.com) and is connected with the normative layer that maintains the state of our institution through the Causal Connection Server component of the VIs Technology (see [Bog07] for details).

In a virtual world all participants are embodied as avatars and can freely move within the virtual world, interact with other participants and change the virtual world itself (very often in a dynamic manner using in-world building facilities). Therefore, we also extensively rely on the direct participant involvement in the process of recreating the heritage site as well as in populating it with virtual humans.

4. Using the Data and Creating New Knowledge

Realizing the 3D Virtual World and the collaborative environment for the domain experts would not be possible if we did not possess a thorough collection of data about the Mount Bego area. A PostgreSQL database, equipped with the PostGIS module to manage geographical objects and accessed though the PyGreSQL module, manages up to 45,000 elements of data, including images, texts and cards obtained from reliefs. Each carved rock has a unique identifier number and precise GPS coordinates along with details about the engravings on it, including semi-structured descriptions.

The *University of Genova* also owns a precious collection already in digital form, although not included in the PostgreSQL database yet, of up to 16,000 original drawings and reliefs realized by Bicknell, each one equipped with personal

annotations by Bicknell himself.

In order to support the construction of complex synthetic environments and manage the data they rely on we will use Medulla [FKP09], an open source collaborative framework created by the Federation of American Scientists.

Creating New Knowledge through Educated Guess. From our past experience in the Uruk project [BRSC09] we have learned that making an educated guess is often the only way to proceed in the situations when the knowledge is not directly available. To illustrate it on an example, we had to simulate the fishing process, but there was not enough knowledge about the fishing process itself. Our subject matter experts were unable to provide us with an immediate description. Although it became soon clear that fishing was conducted in a boat, where one person would be navigating the boat itself and the other person would be catching fish with a spear, how the boat was navigated (rowing with two paddles or using just one paddle canoe-style) remained unclear. For making our educated guess about this process we came up with the following chain of reasoning based on the known facts: Uruk was located in a desert-like area with very little vegetation, so timber was quite expensive. We know that ordinary fishermen were quite poor and couldn't afford having many expensive objects. The boat itself was made out of reed (not wood) that also partially confirmed the fact that timber was expensive. So, we came to a conclusion that having two paddles wasn't practical, thus, our fisherman agent would be using just one paddle.

While in our previous work there was no automatic support of making these educated guesses, here we are developing facilities for simplifying this process and, most importantly, ensuring its correctness. Our work is inspired by [FGP10].

Simplifying the Formalization of a VI. Due to the VI complexity, specifying roles, norms, protocols, scenes, and all the other components requires technical skills which historians or archaeologists are unlikely to have. To support them in formalizing the VI we developed the *Role Ontology Extractor*, which extracts from a given text the most relevant concepts that may be used in the institutional specification as well as relationships among them [BLMM10]. To exemplify the potential of the Role Ontology Extractor, we run it on the Abstract of [dLE09].

Meaningful relationships between the concepts, automatically extracted by the Role Ontology Extractor from that text, are listed below.

Quality → concept relationships

bull → god ; pastoral → population; agricultural → population; southern → alps; ancient → bronze age; daily → preoccupation; cosmogonic → myth; high → goddess; mother → goddess; goddess → earth.

Concept → action → concept relationships

bull → brandish → lightning; god → brandish → lightning; population → need → rain; population → need → source; population → need → lake; source → fertilize → field; lake → fertilize →field; rain → bring → abundance.

5. Concluding Remarks

Mount Bego with its impressive collection of carved rocks offers a unique chance to learn about life of our (European) remote ancestors. In this paper we presented our approach to structuring, preserving and sharing a large collection of data about Mount Bego region through VIs. We also outlined the key technologies that allow domain experts to better find relevant facts in the knowledge base and help to design the resulting virtual world and ensure its authenticity. In contrast to the majority of existing work in virtual heritage, the VIs approach focuses on modelling complex human behaviour rather than recreating destroyed architecture, which is perfectly suitable for simulating the culture of Mount Bego region that is best known by its people rather than buildings or artefacts they produced.

It is part of our future work integating the components of the system described in this paper, since most of them are still available as standalone applications, and supplying agents with chat facilities along the lines of [FGP10].

References

[Bic13] BICKNELL C. M.: *A Guide to the Prehistoric Rock Engravings in the Italian Maritime Alps*. Tip. G. Bessone, 1913.

[BLMM10] BOZZANO M., LOCORO A., MARTELLI M., MASCARDI V.: Trattamento del Linguaggio Naturale Tramite Prolog: un Approccio Promettente per Generare Istituzioni Virtuali da Testi Scritti. In *Proc. of CILC* (2010). In Italian.

[Bog07] BOGDANOVYCH A.: *Virtual Institutions*. PhD thesis, University of Technology, Sydney (UTS), 2007.

[BPA*09] BOGDANOVYCH A., PAPALEO L., ANCONA M., MASCARDI V., QUERCINI G., SIMOFF S., COHEN A., TRAVERSO A.: Integrating Agents and Virtual Institutions for Sharing Cultural Heritage on the Web. In *Proc. of AI*IA Workshop On Intelligent Cultural Heritage* (2009).

[BRSC09] BOGDANOVYCH A., RODRIGUEZ J. A., SIMOFF S., COHEN A.: Virtual Agents and 3D Virtual Worlds for Preserving and Simulating Cultures. In *Proc. of the 9th Int. Conf. on Intelligent Virtual Agents* (2009), Springer-Verlag, pp. 257–271.

[Bur29] BURIKITT M. C.: Rock Carvings in the Italian Alps. *Antiquity 3*, 10 (1929), 155–164.

[dLE09] DE LUMLEY H., ECHASSOUX A.: The Rock Carvings of the Chalcolithic and Ancient Bronze Age from the Mont Bego Area. The Cosmogonic Myths of the Early Metallurgic Settlers in the Southern Alps. *L'Anthropologie 113*, 5P2 (2009), 969–1004.

[FGP10] FURBACH U., GLÖCKNER I., PELZER B.: An application of automated reasoning in natural language question answering. *AI Communications 23*, 2-3 (2010), 241–265.

[FKP09] FOX M. R., KELLY H., PATIL S.: Medulla: A cyberinfrastructure-enabled framework for research, teaching, and learning with virtual worlds. In *Online Worlds: Convergence of the Real and the Virtual* (2009), Springer-Verlag, pp. 87–100.

[Nor93] NORTH D. C.: Nobel Prize Lecture, December 9 1993.