



The Indiana MAS research project aims at providing a framework for the digital protection and conservation of rock art natural and cultural heritage sites, by storing, organizing and presenting information about them in such a way to encourage scientific research and to raise the interest and sensibility towards them from the common people.

More specifically, the purpose of the project is to design and develop a working multi-agent system (MAS) supporting archaeologists and historians (the "domain experts") in

O1. integrating heterogeneous unstructured data (multilingual textual documents, pictures, and drawings) related to rock carvings into a single repository;

O2. normalizing data by recognizing those referring to the same object, correctly associating them with its digital representation, and removing duplicate data;

O3. classifying normalized data according to the "Indiana ontology" that will be extracted in a semi-automatic way from the unstructured data, and that will evolve as data will;

O4. organizing classified data into a Digital Library and making the library accessible thanks to a web-based, multilingual, user-friendly interface;

O5. interpreting data stored in the Digital Library, finding relations among them, and enriching them with the semantic information extracted thanks to this interpretation and relation retrieval stage.

The five objectives above will be pursued by intelligent agents that interact with domain experts in a user-friendly way, performing the tasks required to achieve their goals in a semi-automatic way. Domain experts will be required to supervise the agents' activities, but their intervention and involvement will be kept to the minimum possible, and will be always facilitated by means of tools that will prevent them to be exposed to the technical details.

The end users of our Indiana MAS will mainly be archaeologists and historians, but also teachers, scientists, students, directors of museums, and common people.

The MAS will be general enough to be used in any cultural heritage domain where rock carving is a central feature. However, in order to demonstrate the feasibility of our proposal and to measure its results in a quantifiable way, we will apply it to the preservation of the rock art of Mt. Bego.

Mt. Bego testbed

Project overview

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The choice of Mt. Bego testbed was made because, thanks to a consolidated collaboration between the University of Genova and the Laboratoire Départemental de Préhistoire du Lazaret, Nice, the University of Genova has free access to the Adevrepam database containing information about all the rock carving reliefs of that site (45.000 records). Also, the University of Genova owns an inedited and invaluable collection of up to 16.000 drawings and reliefs made by Clarence Bicknell between 1898 and 1910, in his campaigns on Mt. Bego. There are also historical and geological reasons for this choice: until 1947 Mt. Bego belonged to Italy, and it shows close relationships with carvings that we can find in Italian sites. A section of the engraved area of Mt. Bego still lies on the Italian side and is included in the Argentera Park.

The name "Mount Bego" derives from the Indoeuropean Beg, meaning Divine God. The same origin characterizes the name of "Mt. Beigua", in Liguria. And indeed, Mt. Beigua shows rock carvings similar to Mt. Bego's ones, as well as Monte Sagro in the Apuan Alps. This suggested that Mt. Bego, Mt. Beigua, and Mt. Sagro were three relevant sanctuaries for the ancient Ligures.

Strong relationships exist between Mt. Bego and Val Camonica rock art sites too: Val Camonica rock named "permian sandstone" has the same structure of Mt. Bego's one, named "pelite".

Expected results and measurable indicators for evaluating them

The concrete outcomes expected by the Indiana MAS (in a 1-to-1 correspondence with the project's objectives), are the following:

R1. Integration of Bicknell legacy, written documents (in English, Italian and French) and pictures into the Adevrepam database. As a measurable indicator, we assert that the Adevrepam database will increase its dimension, storing about 55,000 documents relevant for Mt. Bego rock art (among which, 10,000 new) by the end of the project.

R2. Bicknell legacy contains drawings and annotations of petroglyphs which are already stored in the Adevrepam database. The Indiana MAS needs to recognize duplicates in order to avoid the creation of multiple separate entries for the same object. We expect that the Indiana MAS will be able to automatically recognize duplicate or very similar documents (text and images) in 35% cases on average.

R3. We already developed an ontology, based on the taxonomy by de Lumley and Echassoux [dLE09], for tagging drawings with concepts taken from that ontology (namely, for classifying drawings according to the ontology); that ontology will be extended in a semi-automatic way in order to correctly classify multilingual documents and pictures, and not only drawings, and will be used to classify newly inserted documents according to it. As far as textual documents are concerned, we expect that at least 80% documents (in English, Italian and French) will be correctly classified according to the ontology. As far as drawings are concerned, the correct

Project overview

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classification will be at least 25%.

R4. A Digital Library will be developed according to the current standard formats and accessibility protocols in order to make a part of the knowledge on Mt. Bego rock art available to everyone. The Digital Library, named "Indiana GioNS" - Genoa, Nice, Salerno - will be hosted by DISI (Genova) and will be available, via a web- and agent-based interface, starting from the beginning of the project's second year.

R5. The Indiana MAS will integrate agents able to analyze and interpret drawings, agents able to reason on pictures, and agents able to understand natural language (in at least Italian, English, French). From the interaction among agents of these three different kinds, more sophisticated interpretations of documents and correlations among them will emerge. These results will be integrated into Indiana GioNS as well, thus implementing a dynamically growing repository of knowledge.

This outcome is much more difficult to measure in a quantifiable way than the previous ones; independent domain experts will be required to assess the quality of the interpretations and relationships resulting from this activity.

The principal investigator of the project collaborated with both professor de Lumley [AMQ+10,PQM+11] and the members of the research units in Genova [MLR10,BLMM10] and Salerno [CDM+08a,CDM+08b], for outlining the Indiana MAS vision and for developing some of its components that will be integrated in the actual MAS. This positive collaboration carried out in the last few years will be the basis for an even closer and more profitable collaboration inside the Indiana MAS project.

Applicability of the achieved results

The applicative potential of the Indiana MAS project is huge: a commercial tool extending the Indiana MAS prototype might be used for storing, organizing and presenting information on rock art sites spread all over the world, in such a way that scientific research would be encouraged and that the interest and sensibility towards these sites from the common people would be raised.

Italy is disseminated of rock art sites. We may mention Ciappo delle conche, Ciappo dei ceci, Ciappo del sale, Pietra delle coppelle, Monte Beigua in Liguria; Val Camonica and Valtellina in Lombardy; val Chisone, val di Susa, Val Sangone, Val Maira in Piedmont; Monte Sagro in Tuscany; Lillianes in Aosta Valley; Grotta del Genovese and Grotte dell'Addaura in Sicily. We expect that a commercial exploitation of the results of the Indiana MAS project might bring benefits to Italian tourism and research.

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Project overview

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Monday, 09 October 2006 07:49 - Last Updated Friday, 23 March 2012 13:14

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Project overview

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