Enabling Grids for E-sciencE

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ArchaeoGRID, a GRID for Archaeology

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Modern archaeology, between the historical, anthropological and social sciences, is the more suitable and mature for the application of the Grid technologies. In fact, archaeology is a multidisciplinary historical science, using data and methods from many of the natural and social sciences. Archaeological research do and has done large use of computers and digital technologies for data acquisition and storage, for quantitative and qualitative data analysis, for data visualisation, for mathematical modeling and simulation. The Web also is intensively used for results exchange, for communication and for accessing to large database by the Web Services technology. The interest of archaeologist for such methods is today more than a temporal interest. There are many computational archaeologists through the world and specialised quantitative archaeology laboratories experimenting new methods in spatial analysis, geostatistics, geocomputation, artificial intelligence applications to archaeology, etc.

In fact any material remains, artifacts and ecofacts, macro and microscopic, present on the earth surface, representing the material culture of the past societies is relevant for the archaeology, independently from its esthetical or economical value. Remains should be described according to their basic properties (shape, size, texture, composition, spatial and temporal location), which implies the use of sophisticated procedures for its computer representation: 3D geometry and realistic rendering, among them.

Furthermore, data should be related spatially and temporally in complex ways. In so doing, an archaeological site should be understood as a complex sequence of finite states of a spatio-temporal trajectory, where an original entity (ground surface) is modified successively, by accumulating things on it, by deforming a previous accumulation or by direct physical modification (building, excavation). This spatio-temporal representation must be considered as continuum made up of discrete, irregular, discontinuous geometrical shapes (surfaces, volumes) defined by additional characteristics (shape, texture, composition, as dependent variables of the model) which in turn influence the variation of every archaeological feature. The idea is that interfacial boundaries represent successive phases, and are dynamically constructed. Within them, there should be some statistical relationship between the difference in value of the dependent regionalised variable which defines the discontinuity at any pair of points and their distance apart.

The complexities of archaeological data processing are more demanding when we consider that archaeological analysis cannot be constrained to the study of a single site. In recent years archaeological research teams are very much interested in doing extended projects involving the study of many different sites at very large geographic regions during very long time spans. This work is specially relevant in the case of the study of paleoclimatic human adaptations, hunter-gatherer societies mobility and the study of the origins of cities and early state formation. In these cases, archaeological data produced by excavation and field survey or retrieved from different types of available archives, are not only huge in quantity but also in diversity and complexity, and the computing power needed for their analysis, simulation and visualisation is very large. The purpose is then working towards a landscape archaeology which should reconstruct the evolution of

settlement organization on the studied region with a low or high spatio-temporal resolution in relation with the analysed level, intersite, intrasite or regional. For such a precise reconstruction of geomorphology, hydrology, climate, landcover and landuse of the region, based on known data, must be done using models and simulation. Moreover, as a social and historical science, such a simulation cannot stops at the physical elements, but it should include the study of demographic variation, including demographic models, settlement and urban dynamics and production and exchange models.

All that means that archaeology is a computer intensive discipline. Model building is time consuming and resource intensive, and archaeological data are huge. They also are unique in character, so they cannot be substituted, because they need care to preserve. Everything in our analysis has to be preserved and stored, but also the information about them. The results of simulated data must be preserved for a long time because they represent the status of the data interpretation at some date and will be useful for future analysis.("Crisis of Curation"). For the previous reasons the archaeology need to exploit the GRID technology for data access, storage and management, for data analysis, for simulation, for archaeological knowledge circulation : from WEB to GRID. ArchaeoGRID will offer the unique opportunity to share data, processing and model building opportunities with other branches of science and create synergy with other GRID projects.(Earth Sciences, Digital Library, Astrophysics GRID projects, etc.)
The starting project proposes to begin with the study of the origin of the city in Mediterranean area between XI and VIII Centuries B.C. using the GILDA t-Infrastructure. The study will provide a functional framework for broad studies of the interactions of humans in ancient urban societies and with the environment . During the past fifteen years, archaeologists in the Mediterranean have accumulated large amounts of computerized data that have remained trapped in localized and often proprietary databases. It is now possible to change that situation. ArchaeoGRID will be made to facilitate ways in which such data might be brought together and shared between researchers, students, and the general public. Archaeological data always includes an intrinsic geographic component, and the compilation and sharing of geographic data through GIS has become increasingly important in the governmental, private sector and academic worlds during the past years. New GRID technologies for spatial data, expansion of the Web Services and development of open GIS technology now make it possible to share geographic information quickly, widely and effectively.
The first application running on the GILDA be will be related with paleoclimate and weather simulation in the regions where the urban centers originate around the IX and VIII centuries B.C. In fact weather phenomena, climate and climate changes produced effects on individuals and societies in the past. In the next future, GILDA will be used to explore the possibilities of different computational methodologies insiting of the tools for the analysis of spatio-temporal data. Classical statistical analysis of spatio-temporal series will be used, but also we intend to develop new methods for the analysis of longitudinal analysis, based on neural networks technology.
Simulation programs and data available on the web and free will be used for application. Such data could be integrated with data from archaeological excavation and survey. The complexity and the dimension of program code and data require the use of MPI library for parallel calculation on GILDA computers using Linux OS. Open source GRASS GIS and package R for statistical analysis installed on GILDA will give the possibility to prepare the input data for the full Mediterranean area and for the territories of the urban centers.
A schematic architecture of the ArchaeoGRID showing the relevant parts and their links will be presented. Given the intrinsic nature of archaeological field work, the communication and the information exchange between groups on site and groups working in distant laboratories, museums and universities need fast and efficient communication ways. Telearchaeology lies at the real nature of archaeological endeavor and could be very useful also for education and for diffusion of the archaeological knowledge. A multicast architecture for advanced videoconferencing

specially tailored for large scale persistent collaboration could be used.
The added value, linked with new perspectives of the archaeological and historical research, with the management of the archaeological heritage, with the media production, with the territory management and with tourism, will be discussed.

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