Archeologia e Calcolatori
Supplemento 6, 2014, 11-14

PREFACE

ARCHEOSEMA (AS), a meta-disciplinary project of theoretical, analytical and experimental archaeology, has been recently awarded by La Sapienza University of Rome. The project title is an acronym which sums up its two main theoretical foundations: the openness of modern archaeology (ARCHEO) to the analysis of physical, historical, linguistic signs (SEMA) underlying natural and cultural systems reconstructed and simulated through Artificial Sciences (Fig. 1).

The project is therefore connected to the construction of models conceived as both epistemological and methodological tools: indeed, on the epistemological level, ARCHEOSEMA is an interdisciplinary research program founded on the constructive dialogue between theoretical and experimental Archaeology with Physics, Mathematics, Statistics, Geography and Linguistics (Ramazzotti 2010); on the methodological level, it aims to solve problems of classification, organisation and structure of alphanumeric data; to implement dynamic simulation of the variables that constitute natural organic systems and/or cultural systems; to identify new rules for spatial organisation and, in addition, to explore the physical, aesthetical, linguistic and cognitive phenomena underlying isomorphism, self-organisation, entropy, learning and translation (Ramazzotti 2012, 2013a, 2013b, 2013c, 2013d).

The design of these models is based on a computer-programmed architecture that integrates relational capabilities of Database Management Systems (DBMS), Geographic Information Systems (GIS) and Artificial Adaptive Systems (AAS). Analysis, applications and experiments are currently being conducted by a team of young archaeologists, physics, geographers and linguists at the LAA&AAS: Laboratory of Analytical Archaeology and Artificial Adaptive Systems (Luca Deravignone, Alessandro Di Ludovico, Benedetta Panciroli, Irene Viaggiu, Claudia Di Fede, Juliette Wayenberg, Massimiliano Capriotti). The LAA&AAS has been inaugurated in the Faculty of Letters and Philosophy of La Sapienza University of Rome thanks to the joint institutional efforts of the Department of Sciences of Antiquity, Department of European, American and Intercultural Studies, Physic Department and Semeion Reserch Center. The disciplines involved in the research programme are those of Artificial Intelligence and Mathematical Biology (prof. Paolo Massimo Buscema and dr. Massimiliano Capriotti), Physics of Complex Systems (prof. Vittorio Loreto and prof. Alessandro Londei), Computational Linguistics and Dynamic Philology (prof. Paolo Canettieri and prof. Simone Celani), Economical Geography and Spatial Analysis (prof. Armando Montanari and prof. Barbara Staniscia), Physical Anthropology and Human Population Genetics

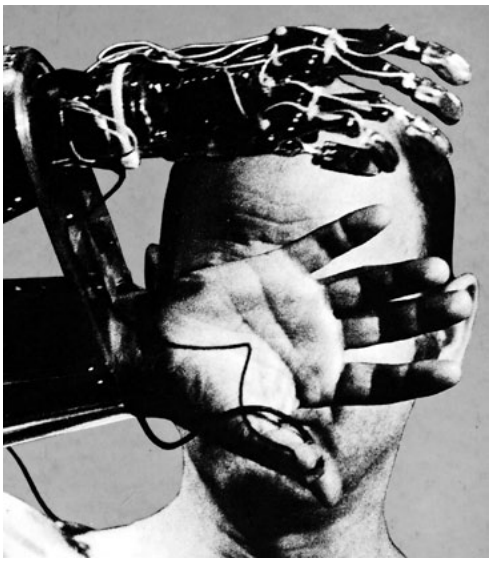

Fig. 1 – Photo by G. Azali (de Kerchove 1996).

(prof. Alfredo Coppa, prof. Franz Manni and prof. Francesca Candilio) and Mathematical and Multivariate Statistics (prof. Giorgio Alleva, prof. Maria Felice Arezzo and prof. Filippo Belloc). Finally, it is worth mentioning that this experimental integration between Analytical Archaeology, Geographic Information Systems and Artificial Adaptive Systems has become a core of two European projects of the 7th Framework Programme (FP7) recently acquired by La Sapienza University of Rome: the contribution of the LAA&AAS to the achievement of the objectives of these two international research projects was recently published (Ramazzotti 2013b, 2013c).

This Supplement to «Archeologia e Calcolatori» is a special issue dedicated to the memory of the English archaeologist David Leonard Clarke (3 November 1937-27 June 1976), and is a further attempt to collect some applicative studies of complex natural and cultural phenomena following the Artificial Intelligence computational models through the lens of *Analytical Archaeology* (Clarke 1968). In fact, these complex phenomena are essentially understood to be the product of cognitive behaviour, in other words systems and ideal-types which represent it and can be analysed on a formal logical level. This preface leads the historiographical tribute to Clarke's reasons of his "collected papers" (Clarke 1979) and a syntactic classification of the main logical inferences to trace archaeological reasoning back to the simulation of cognitive complexity. Artificial Adaptive Systems, as new mathematical tools

expressing the emulative properties of such cognitive complexity, motivated the "connectionist" reaction to "behaviourism" and therefore could effectively impact on the epistemic nature of contemporary archaeological thought, since systems complexities are developed by our brains and analysed by simulating variables nets with non-linear and dynamic computational models of Artificial Intelligence, Computer Science and Computer Semiotics.

During the 1970s Cybernetics, introduced by D.L. Clarke in the archaeological research essentially as Systems Theory, contributed to consolidate, in the UK, in the USA and in Europe, the idea that the archaeological, linguistic and anthropological cultures work as natural organisms and that their organic-biological function could be simulated as a mechanical operation of interconnected parts, driven by an input. These parts would be able to report the whole process that caused the balance alteration, and such alteration would not be that different from those observable in the so-called cultural systems.

However, this mechanisation of cultural complexity has turned the research away from other possible analogies that could contribute to resolve highly complex problems, and has especially radicalised a single meaning of complexity, as a factual dimension outside the man, a cognitive nature independent of human existence itself. But since the late 1980s, a large number of studies have been conducted in an attempt to understand the complexity of archaeological, linguistic and anthropological contexts not as being external to the human being, not as passive objects of his research, but rather as a dynamic expression of his own perceptual constructs. In this sense, this complexity has been almost subtracted from the uncontested historiographical domain of being interpreted as an external object investigable through mechanical and linear systems, and has become the subject of specific researches that are traced back to the cognitive capacity of man to create it.

There is thus the possibility to organise, by analogy between cultural and cognitive complexity, a new apparatus of theoretical knowledge, methods and applications that connects analytical research and Artificial Intelligence (Ramazzotti 2010, 171-198). The researcher who simulates the dynamic behaviour of a complex system through these models of Artificial Intelligence will therefore explore the configuration data (which have been learned) as a hypersurface of trained connections. Therefore, instead of describing the purely systemic complexity of a given context, the researcher will tend to act on that context translated in alphanumeric matrices and trained by means of Artificial Adaptive Systems in order to test every possible combination of the trained hypersurface. An analytical and computational study of archaeological complex systems that would benefit from Artificial Intelligence is, ultimately, a study that evaluates the "meaning" of data relationships as an essentially human learning, physically connected to the computational capacity of the neural networks.

This type of study would therefore repeat a still strong Analytical Archaeology position but would also update this position to the progresses made by Artificial Intelligence in surpassing the limits imposed by Systems Theory, on the basis of the progresses achieved every day by Cognitive Sciences in recognition, in play, in simulation and classification of some of the principles governing memory, orientation and language.

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