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Retrospect on 1970: Looking back on the developments of computing archaeology in România since the Mamaia Conference

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19.1 Introduction

As a young researcher in Computing Archaeology, John Wilcock attended the Anglo-Romanian Conference on Mathematics in the Archaeological and Historical Sciences, which took place in the late summer of 1970 at the Black Sea resort of Mamaia (near Constanța, the ancient Roman port of Tomis, to which the poet Ovid was exiled). This conference was billed as a bi-national conference with international participation, and in many ways was like a *Computer Applications in Archaeology* conference, down to its archaeological trips (to Adamclisi, Histria and the Danube Delta). Papers were excessively statistical in nature, however, and Clive Orton, another young delegate, was applauded for what was almost the only slide of an archaeological site to be seen.

This, of course, was during the time of the communist government lead by Nicolai Ceaușescu, and politics intruded even into this academic conference. After 1970 development should have been stimulated by contacts and ideas gained at the conference, but this did not happen, and the Mathematics Institute of București was dissolved. Progress did not entirely cease, but it has been uneven after a period of stagnation. This paper will cover the main trends and developments in computing archaeology in România today, their relationship to past work, and hopes for the future.

19.2 The 1970 conference

Mathematics in the Archaeological and Historical Sciences

19.2.1 Context

The following description of the conference *Mathematics in the Archaeological and Historical Sciences*, held in România 16–24 September 1970, and organised by the Royal Society of London and the Academy of the

Socialist Republic of Romania, provides a commentary on many aspects of computing, statistics and archaeology which were not officially recorded in the subsequent book (Hodson *et al.* 1971).

This conference was in many ways the first conference to address archaeology as an application of mathematics and statistics, rather than being an archaeological conference at which some fringe analytical applications of the computer, mathematics and statistics were discussed. It was held in the resort of Mamaia and at archaeological sites on or near the Black Sea Littoral and Danube Delta. The conference was bi-national with international participation, the majority of delegates being from Britain or România, the remainder from USA, France, Germany, Sweden, Italy, The Netherlands and India.

The conference was opened in the Hotel International by a representative of the Academy of the Socialist Republic of România and by Professor David Kendall, who stated that in his opinion international conferences were generally too large, and that the delegates did not enjoy them, except insofar as they might enjoy the excursions. Bi-national conferences with international participation, on the other hand, were small enough for the delegate to get to know most of the other delegates personally. He thanked the Romanian organising committee for making it possible for the conference to be held in so delightful a place, where one could spend spare moments on the beach in the company of other delegates, and even indulge in a moonlit bathe, and where the atmosphere was conducive to those private discussions at the bar or on the shore which were so much more important than the formal proceedings of the conference. This indeed proved true, perhaps the greatest benefit deriving from being able to meet the authors of important papers one had previously read, and to discuss techniques with the world's experts in the field of mathematical archaeology, most of whom were gathered at Mamaia.

19.2.2 Typology and Taxonomy

The opening session on Typology and Taxonomy was a general review of statistical studies in archaeology given by Professor A. C. Spaulding (University of California, USA); topics particularly covered were seriation (the work of Brainerd & Robinson), correspondence matrices (Petrie; Kendall) and numerical taxonomy (Hodson & Doran).

Roy Hodson (Institute of Archaeology, University of London) was the first British delegate to present a paper, his remarks providing a broad coverage of numerical taxonomy in archaeology. It was fitting that a professional archaeologist, rather than a mathematician, should open the discussion on this very important topic. The paper gave a summary of the application of cluster analysis to archaeological problems. It was emphasised that there are two types of group which must be carefully distinguished — one a genuine archaeological association, and the other purely analytical, based on purely numerical concepts. The advantages and disadvantages of single-link, average-link and k-means cluster analysis were discussed. The paper concluded with an archaeological application, the typology of hand-axes in the British Isles, using data from D. A. Roe. Roe as an archaeologist had discriminated the bimodality of hand-axes into 'pointed' and 'blunted' types. Bordes had also discovered this bimodality, although he preferred 'thick' and 'thin' types. The computer analysis also supported a bimodal interpretation of the data.

H. Solomon (Stanford University, USA) completed the first day's papers with a discussion of recently-developed clustering techniques for the analysis of multivariate data. Almost all these techniques would have been impossible before the advent of the computer. Among the ideas put forward were the formulation of an index consisting of the ratio of the difference between groups and the difference within the groups themselves; and methods of reducing the number of variables by successive replacement of chosen pairs of variables by single new variables, consisting of the centroids of the original pairs.

Continuing with the theme of typology and taxonomy, M. Borillo (Centre d'Analyse Documentaire pour l'Archaeologie, Marseille, France) and P. Ihm (Institut für Medizinisch-Biologische Statistik und Dokumentation, Marburg/Lahn, W. Germany) described a classification method, using vector spaces, for artefacts with incomplete descriptions and structurally related features, with examples from a database concerning Greek Kouroi. They explained that omissions in data may be random (caused by non-exhaustive classification of features) or partly systematic because of the structural relationships of the features (*e.g.*, if an arm of a statue is missing there will be no data concerning the hand on that arm), and they commented that it was surprising that the problem of incomplete data had until then received so little attention.

Dr Robin Sibson (King's College Research Centre, Cambridge) described the manner in which cluster analysis programs may be designed for the computer. The restriction which large statistical programs came up against was the finite random-access storage of the computer, and hence the size of the problem which could be handled was limited. He described algorithms where it is only necessary to access part of the similarity matrix, giving great computational economies. His Group I algorithms gave access in lexicographic or some other predetermined order, Group II algorithms gave random access within a part-row, Group III random access within a finite number of part-rows, and Group IV algorithms complete random access. With hindsight, it is pertinent to note that Robin Sibson's ideas (that single-link clustering is the only mathematically-valid clustering procedure) were to provoke violent discussions in the literature between Australian and British academics in subsequent years.

T. H. Hollingsworth (University of Glasgow) made some cautionary remarks concerning the use of statistical techniques on census data, *e.g.*, qualitative questions can have hundreds of different responses which do not readily transform into factors for cluster analysis; and the data is often imperfect because of missing or distorted observations.

Professor C. R. Rao (Indian Statistical Institute, New Delhi, India) spoke on taxonomy in anthropology. His data concerned head measurements for the various Indian races, and he presented methods of representing this taxonomic data on scattergrams.

Professor Grigore Moisil (Institutul de Matematică, București, România) presented some mathematical axioms concerning similarity relations between four items in a set of objects. This was an entirely theoretical treatment, and no archaeological examples were given.

M. Iosifescu and P. Tăutu (Centrul de Statistică Matematică, București, România) described an application of the Mosteller-Wallace method (used by the original authors to resolve the authorship of the Federalist papers) in the solution of an archaeological problem, *i.e.*, the attribution of cemeteries or settlements to one of two possible sub-cultures, in the same way that the original method had attributed the Federalist papers to one of two possible authors.

Finally in this section, Silviu Savu (Centrul de Statistică Matematică, București, România) described the statistical investigation of pottery styles, employing significance tests for removal of variates which were not useful in the discriminant analysis. The basic types considered were Rhodian (wild goat style) and Attic (black-figure style). It was deduced that Ionian style pottery had more affinity to Attic pottery than to Rhodian pottery.

19.2.3 Seriation

The next group of papers concerned problems of seriation. The first two papers were presented by Joseph Kruskal and Myron Wish (Bell Telephone Laboratories, New Jersey, USA), and concerned the use of multidimensional scaling techniques.

Next Professor David Kendall (Statistical Laboratory, University of Cambridge) spoke on seriation from abundance matrices, one of the most entertaining lectures at the conference. Following Flinders Petrie, graves containing assemblages of objects had been seriated. Professor Kendall remarked that the job of the mathematician is to remove from the archaeologist that part of the work which is mechanical, *not* that part which involves judgement. He defined a Petrie matrix with two axes, having rows for graves and columns for types, with binary ones showing occurrences of types in graves, and zeros showing non-occurrences. The process of creating such a Petrie matrix from grave data was described by David Kendall as *petrifaction*. The product of this matrix with its transform is a square matrix which may be expected to contain most of the information relevant to the recovery of the true chronological seriation. In practice this recovery can be carried out by performing multidimensional scaling in two dimensions on the square matrix, but normally the computer arranges the points in a horseshoe-shaped region (using the program HORSHU which has Kruskal/Williams arithmetic operations and Kruskal-designed input/output). The technique has been used on data from the La Tène cemetery at Münsingen-Rain. The seriation may be obtained by starting at one end of the horseshoe and then reading around the horseshoe in a polar manner until the other end is reached. This is usually no hardship, but David Kendall worked with his postgraduate student E. M. Wilkinson to 'unbend' the horseshoe, *i.e.*, to present the seriation as a straight line (in one dimension). The procedure DIMDROP reduced the two dimensions of the horseshoe to one. This was called 'Operation Speckled Band', a literary reference to Conan Doyle's story *The Speckled Band*, in which Sherlock Holmes unbends a poker.

D-na Alexandra Ștefan (Institutul de Arheologie, București, România) described the application of the Hole & Shaw (1967) method to the seriation of epigraphic materials of the Hellenistic and Roman periods discovered in România. The seriation was based on letter forms and alphabets, using a program developed by Ileana Kivu-Sculy (Facultatea de Matematică-Mecanică, Universitatea București, București, România), and yielded interesting information on the evolution of scripts in a defined geographical area.

Concluding the section, K. Goldmann (Museum für Vor- und Frühgeschichte, Berlin) pointed out that the chronological ordering of artefacts should be carried out not only by using criteria of similarity, but

also by considering key finds and by referring to the total database. The use of these other methods often prevents erroneous arrangements which could have occurred if only criteria of similarity had been used.

19.2.4 Population Genetics and Historical Demography

The discussion on population genetics and historical demography began with a paper by Professor L. L. Cavalli-Sforza (Istituto di Genetica, Pavia, Italy) and A. Moroni (Department of Genetics, University of Parma, Italy) which described the application of mathematics to population genetics. A typical method of recording the descendants of a particular man (labelled 1, say) is to give his children labels 11, 12, 13 etc., his grandchildren descended from child 12 the labels 121, 122, 123 etc. and so on, each generation adding a digit to the number. Parish registers played a great part in this research. Reference was made to the records held by the Mormons for parish registers from many parts of the world, particularly from Britain. These microfilmed and computerised facilities, at Salt Lake City, Utah, USA, exist because the Mormons have the custom of baptising their ancestors posthumously, providing that ancestry can be proved.

Dr R. W. Hiorns (Department of Biomathematics, University of Oxford) spoke about statistical studies in migration. The genetic consequences of migration patterns had been studied for a group of parishes in the Otmoor region of Oxfordshire, using parish registers from 1600 to the present. The movements between parishes for the purposes of marriage had been studied, and also social class change. A marked tendency for people to marry within their own parish, or alternatively to go to the neighbouring City of Oxford was found, and there was little movement between parishes. One parish, Weston, showed little relationship with the other parishes of the group studied. It was concluded that there is unlikely to exist any stratification for genes in the parishes studied, other than for those genes affecting behavioural or appearance traits taken into account during mate selection. Professor Kendall had submitted Dr Hiorn's data to multidimensional scaling, producing a tolerable two-dimensional map of the geographical distribution of the parishes solely from the migration figures. In exceptionally favourable circumstances it might be possible to locate deserted Medieval villages recorded in the domicile entries of extant parish registers.

19.2.5 Unusual applications (for 1970)

Under the heading *Miscellanea* were discussed several applications of computers, mathematics and statistics which were unusual at the time.

R. E. M. Moore (Anatomy Department, Guy's Hospital Medical School, London) gave a fascinating

description of his analysis of classical mosaics. In these mosaics stones are usually laid in rows, the dimensions measured transversely, *i.e.*, across the rows, being more constant than the dimensions measured longitudinally. Nine different standard widths of stones had been found, and experimental trials had indicated that it would be advantageous for mosaicists to make patterns of widths that could be made up from more than one standard width of stone, *e.g.*, a width of 9.6cm could be made up from eight 1.2cm stones or twelve 0.8cm stones. Theoretically there are 78 pattern sizes up to 110cm each of which could be made up from at least five of the nine standard widths of stone. Furthermore, 66 of these favourable pattern widths are multiples of an almost perfect Fibonacci series of dimensions 1.2, 2.4, 3.6, 6.0, 9.6cm *etc.* Mr Moore claimed that here has been detected the system of actual units, corresponding to a certain Greek type of foot, used by ancient mosaicists.

J. D. Wilcock (then of North Staffordshire Polytechnic, Stafford, UK) discussed non-statistical applications of the computer in archaeology, showing that the majority of computer usage in industry and commerce was non-statistical, and it was to be expected that computer applications in archaeology would show a similar bias away from statistics. Three types of information retrieval in archaeology (large bodies of specialist data, museum records and excavation records) were described, with reference to IRGMA (UK) and the Museum Computer Network (USA). Routine reduction of readings from resistivity meters and proton gradiometers, used to explore sites, was reviewed. Certain graphics devices were described, and the basic features of a computer graphics language for archaeologists were listed. The recognition and classification of artefact profiles using pattern recognition principles also received mention. A future integrated computer system for archaeological use was seen to be a basic operating system using facilities to control information retrieval, graphics, recognition and classification of artefacts, site survey data reduction, and statistics. Thus statistics was seen to be only one of a number of tools in the workshop of the computing archaeologist.

S. Comănescu (Institutul de Arhitectura, Bucureşti, România) described a device which could be used to measure the volume and record the dimensions of archaeological features, *e.g.*, pits, where the original outline cannot be preserved during excavation. A metal stake of square section was inserted at the lowest point of the feature, and secured by guy-lines. A horizontal platform was fixed at any height, measured by a scale engraved on the stake, and radial distances at this level were taken in predetermined directions to the walls of the feature. Eventually a family of closed curves was built up representing the feature, and the volume was calculated using plain mathematical formulae.

19.2.6 Linkage and Multidimensional Scaling

The next group of papers concerned methods of linkage and multidimensional scaling. A. W. F. Edwards (Gonville and Caius College, University of Cambridge) reviewed developments in the applications of the computer to the investigation of the phylogenetic relationships of the races of man. To perform an objective mathematical analysis it is necessary to make the study independent of the model for evolutionary change which is in current use. The study had attempted to base the estimation of recent human phylogeny on a simple explicit model of gene-frequency change. Phylogenetic trees were also described.

Professor L. L. Cavalli-Sforza and K. Kidd (Istituto di Genetica, Pavia, Italy) spoke on genetic linkage and gene frequencies. Extensive data exists for both man and domestic cattle. The evolutionary trees reconstructed from the data are in agreement with linguistic, anthropomorphic and geographic distances between the breeds studied. Icelandic and Norwegian cattle breeds had been confirmed to be of common origin. Assuming from historical records that the separation occurred 1000 years ago, Swedish cattle are estimated to have separated from Norwegian about 1250 years ago, and Jersey and Spanish cattle to have separated from Scandinavian at least 3000 years ago.

J. Haigh (University of Sussex) discussed manuscript linkage problems, where several manuscripts exist which are all ostensibly copies of the same work, and the problem is to arrange the manuscripts in hierarchical order. One model used to help with this problem is that a copy will be made from a manuscript selected at random from all the manuscripts extant at the time. The method used is to construct a tree by comparing scripts. If for three manuscripts A, B and C, A and C agree and B does not, then any tree in which the path from A to C contains B is rejected. Once a compatible linkage has been set up, it is impossible to tell which is the root, but the method of maximum likelihood may be used to predict the most likely root. In some cases it may be necessary to postulate missing scripts to account for the evolution of various versions.

19.2.7 New techniques (for 1970)

The final day of the conference was concerned with what in 1970 were perceived as new techniques in data analysis of possible importance in archaeology and history.

J. B. Kruskal (Bell Telephone Laboratories, New Jersey, USA) spoke about glottochronology, a technique for determining the relationship between languages by studying cognate forms.

J. C. Gower (Statistics Department, Rothamsted Experimental Station) made some remarks on the comparison of different multivariate analyses of the same data by statistical methods.

J. E. Doran (then of Atlas Computer Laboratory, Chilton) reviewed his by then almost classic study of artefacts from the cemetery site at Münsingen-Rain carried out in collaboration with Professor D. G. Kendall and Dr F. R. Hodson. The starting point was an incidence matrix showing the occurrence of artefact types in graves. First, an archaeologist must define the criterion (score) for ordering the matrix, and then a mathematician must carry out this ordering by computer to give the best value of the score. Consequences of the use of artefact types in the analysis are that the types must be defined, and there may be a loss of detail (*e.g.*, the fact that the same decorative motif occurs on both a brooch and a finger-ring is lost if only brooches as a whole, or finger-rings as a whole are studied). The procedure for analysing the archaeological data is first of all to define the set of hypotheses and conditions, and then to use a variety of mathematical and heuristic techniques to search the space; the computer decides which information may be discarded, under control of the algorithms. During the discussion of this paper, K. Goldmann remarked that the difficulty of the loss of detail such as the same motif on different classes of artefact may be resolved by specifying the motif itself as a type. Professor Kendall remarked that not all the data should be analysed by computer, since some must be retained as a control. R. W. Hiorns gave his opinion that the seriation of graves by computer may lead not solely to an arrangement in chronological order, but to an arrangement influenced by social class as well as time. He remarked that the archaeologist *must* understand the techniques available, and their suitability or otherwise, for analysis of the data.

Clive Orton (then of the Ministry of Agriculture, Fisheries and Food) discussed the statistical sorting and reconstruction of the pottery from a Romano-British kiln site in Highgate Wood, London. Clive had recently won £1000-worth of computer access time in a competition organised by the *New Scientist* and the GEIS Dial-a-Computer Service (now part of Honeywell), and he later continued his computer analysis by remote terminal. Such had been the concentration on mathematical and statistical techniques during the conference that it was a relief when Clive showed, albeit on the final day of the formal conference, the only slide of an archaeological site to be seen during the whole proceedings! The first stage of the analysis was to discover the degree of association between sherds of particular types of base and types of rim. Clive illustrated this by pie charts for the various archaeological layers. The second stage was to discover how base diameters were related for different sizes of a particular type of pot, and hence to deduce how shape was related to this. Finally, the forms of the vessels were reconstructed by curve-fitting. Professor Kendall asked at this stage what the mathematical equation for the curves would be, and received the reply that the technique was entirely experimental at the present state of

the work. Clive has of course subsequently published the results of this work on many occasions.

19.2.8 Round-Table Discussions

A number of round-table discussions lasting several hours were held during the course of the conference. One concerned the definition of a 'model' in statistical archaeology, and achieved little beyond the realisation that people meant several different things by the term, ranging from highly experimental techniques, through hypotheses, to fully-fledged theories.

The final round-table discussion ranged widely over the topics covered, and included not a little criticism. P. Ihm commented that some topics had been tackled by several people with a diversity of techniques and some standardisation seem desirable. R. W. Hiorns suggested that the aim for those wishing to proselytise the archaeologists should be to make all archaeologists numerate, and to teach them to understand the purpose of mathematical techniques. Both Professor R. Loynes and J. D. Wilcock commented that non-statistical techniques should not be neglected, since they constituted the majority usage in general industry, commerce and computing. R. W. Hiorns admirably summed-up the general feeling by another quotation from Conan Doyle. Sherlock Holmes believed it necessary to hunt in pairs, and did so with Dr Watson, the intellect which was superior in any particular case solving the problem. Archaeologists and mathematicians or computer scientists should do likewise.

19.2.9 Closing Addresses

The closing address was given by Professor Karl Axel Moberg (Institutionen för Nordisk Och, Göteborgs Universitet, Sweden), the 'grand old man' of the conference, and one of the handful of archaeologists present among the host of mathematicians. He began by recalling milestones in the development of mathematical techniques applied to archaeology. First there was the work of Flinders Petrie, which was developed by Professor Spaulding and presented at a symposium in 1959. Then followed in 1966 the Rome symposium for the use of computers in the social sciences. The most important meeting before the 1970 Mamaia conference was the 1969 Marseilles Symposium on Computers in Archaeology (but this dealt with analysis of data before input to the computer). Professor Moberg stated that he could not presume to sum up the 1970 conference, but felt rather that he had been selected from among the archaeologists present as an animal prepared for dissection, 'to see what he looks like after all these inoculations'. He deplored the prevalent use of jargon, and proceeded to reel off a list of technical terms bandied about at the conference, which would indeed have been mostly unintelligible to the archaeologist without technical training. He followed on with a

review of all the archaeological topics during the conference, varied both in geographical distribution and in time. Professor Moberg then expressed a wish that the conference publication would be spread all over the world, and he concluded with some suggestions for the future. He felt that analog or hybrid computers might have some use for the simulation of archaeological trends (this has not been followed-up since 1970 to the knowledge of the authors). The problems of incomplete data, missing data, cleaning-up and weighting of data, so prevalent in archaeology, needed some attention. Non-statistical methods should be investigated. Finally, there should be good publicity for the new methods, and above all archaeologists should be *taught* the new procedures. The conference had been a tutorial with many capable teachers but very few students — and he hoped that the epitaph for the conference would not be ‘had it not been for those archaeologists and historians it would have been quite a nice statistical meeting’.

Professor Kendall in closing the conference thanked Professor Moberg for his brilliant and scintillating address containing home truths which ought not to go unnoticed, Professor Moisil for the original idea for the conference, and the Royal Society for some financial assistance. He thanked all the delegates for attending and making the conference a success, and he was particularly pleased by the large number of young people present, which gave him great hope for the future; some of the most remarkable papers had been presented by young people. Finally, he thanked the organisers, Dr Tăutu and Dr Hodson, who had carried the heaviest burdens, and without whom the conference would not have been possible.

19.2.10 Archaeological visits

Most delegates took advantage of the delightful Romanian autumn weather to visit some of the most important archaeological sites in the vicinity. Nearby Constanța was visited for its large Roman mosaic (which R. E. M. Moore measured using his portable measuring kit), the walls of ancient Tomis and the archaeological museum with its fine collection of items such as the Cernavoda figurines, Greek antiquities from Histria, Tomis and Callatis, and incomparable Roman sculptures from Tomis, among them a fantastic serpent.

By coach was visited the beautiful lakeside Greek site of Histria, with its impressive walls, basilicas, temples and later Roman baths. Most impressive of all, the Roman triumphal monument of Tropaeum Traiani at Adamclisi, erected to the God Mars after the war against the Dacians, and depicting battle scenes on its metopes and crenels similar to those on Trajan's Column, spoke of the Roman domination of Dacia in the second century. The nearby Roman town was also visited.

Nor was this all, for some delegates were able to visit in București the archaeological museum and the

Village Museum, a collection of reconstructed buildings from all parts of România. Thus ended a very successful event, in which it was hoped that a considerable axis had developed between Britain and România in the field of statistical archaeology. The degree to which this was indeed to be the case is explored below.

19.2.11 The publication

The Editors of the conference publication, a weighty hard-back book, were Dr F. R. Hodson, Lecturer at the London University Institute of Archaeology at the time, Professor D. G. Kendall FRS, Director of the Statistical Laboratory at University of Cambridge, and Dr P. Tăutu, Head of the Division of Stochastic Processes & Biometry in the Centrul de Statistică Matematică, București (Hodson *et al.* 1971).

In the publication three main sections were devoted to cluster analysis, seriation, and tree structures, the theoretical papers being accompanied by discussions on the practical aspects of the problems and illustrations of the uses of some of the algorithms. This was followed by a miscellany of papers which did not fit into these simple three divisions, many of them breaking new ground, which had been referred to in the summing-up sessions.

19.2.12 Romanian participation and perspectives

The Mamaia Conference had as its central theme the relations between mathematics and the disciplines of archaeology and history. The conference was dominated by the personality of the Academician Grigore Moisil. This may have been one of the first occasions at which Romanian archaeologists were exposed to the ‘exact sciences’ which have helped provide clarity in archaeological analysis, and it may have been a shock, for many commented that the meeting was excessively statistical in nature. Far from being a large round table at which all the ‘knights’ were equal, in retrospect there was the impression that there had been two round tables, one for the archaeologists/historians and the other for the mathematicians/statisticians, which were pulling away from each other (Fig. 19.1). So much for ‘hunting in pairs’!

19.3 The 1970s and 1980s

A Romanian perspective on the 1970s–1980s period of work has been given by Virgil Mihăilescu-Bîrliba and Vasile Chirica (1996). Before the Second World War, Romanian archaeology had developed after the pattern of archaeology elsewhere in Europe. After the Second World War, with the creation of the communist system, the relationship with the West was

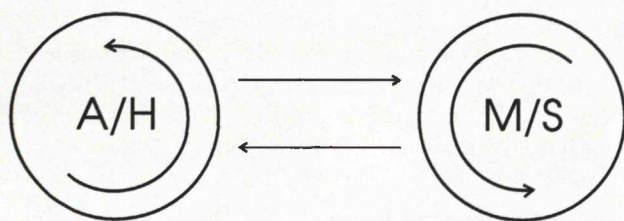


Figure 19.1: Was this the true situation at the Mamaia Conference? — not one large round table at which all the 'knights' were equal, but one table for the archaeologists/historians (A/H) and another for the mathematicians/statisticians (M/S), in reality pulling away from each other? The two horizontal arrows indicate the planned interaction, which may not have been achieved.

broken, and this natural development stopped. Furthermore, after Nicolae Ceaușescu took power, contacts even with other socialist countries were largely cut. However, some individual work continued, particularly for the classification of large numbers of similar artefacts such as coins (Mihăilescu-Birliba 1969).

Around the end of the 1960s, Professor Grigore Moisil started a course in mathematical methods for archaeologists and numismatists at the Institutul de Matematică, București. Joint projects between mathematicians and archaeologists were undertaken, and fruitful collaboration was beginning. It was on the initiative of Professor Moisil that the 1970 Mamaia Conference came to pass, with help from the Romanian Academy and the Royal Society of London. This entailed much behind-the-scenes work by the Romanian and British organisers on the political cadres, who had to be convinced that this conference would be good for România. Politics did intrude on the conference: a television broadcast by leading members (with a real Ionic capital in the background imported to give an archaeological atmosphere) was entirely dubbed in Romanian, but no doubt emphasised the recognition for România which the conference was giving by its presence; and in one of the papers a graduate student's scattergram allegedly showing similarities between countries on political grounds (unwisely including România and several other socialist and non-socialist countries) produced some interminable argument mostly concerned with political correctness. However, 14 Romanian papers were successfully presented involving 20 authors (see section 19.6). Some of the topics moved beyond mathematical methods to solve real archaeological problems.

It was naturally hoped that the Mamaia Conference would provide stimulus for the further development of mathematical/statistical/computing archaeology in România. However, this did not happen, because politics interfered again. After Professor Moisil's death in 1973 the Institutul de Matematică of București was closed, the buildings and computers given to other organisations, and the researchers were dispersed. This was a sort of mini-Cultural Revolution on the Chinese pattern. The stagnation lasted for more than a decade.

A resurgence began when a strong team of workers was set up at the Centrul de Informatică și Memorie Culturală (CIMEC) in București, now led by Dan Matei and Irina Oberländer-Târnoveanu, responsible

for the development and administration of the National Cultural Information System.

At Cluj-Napoca archaeologists from the Museum of the History of Transylvania started collaborating with mathematicians and physicists from the Institute of Isotopic and Molecular Technology, Cluj, the Faculty of Mathematics and Physics, Cluj, and the Institute of Nuclear Engineering, București-Măgurele. This resulted in two conferences on the applications of physics and mathematics in archaeology being held at Cluj-Napoca in 1987 (Frangopol & Morariu 1988) and 1989 (Frangopol & Morariu 1990).

Research by individuals in the areas of statistics (numismatics, Mihăilescu-Birliba 1981, 1981–82; seriation of Greek inscriptions, Ștefan unpublished), cluster analysis, factor analysis, principal components analysis, correspondence analysis, multidimensional scaling, pottery profile analysis, derivation of human groups in time, astronomical alignment of stones, and orientation of graves), expert systems, and cultural information systems (Bloșiu 1972–73) continued in a small way, but it was not until the revolution of 1989 that there really was a new beginning.

19.4 Attendance at RECOMDOC 1992

In 1992 CIMEC organised the Conference *Eastern and Central European Regional Conference on Museum and Cultural Heritage Documentation* (RECOMDOC 4–6 May 1992) in Sinaia, a mountain resort 160 km from București. Eighty specialists attended (curators, librarians, art critics, historians, archaeologists, engineers, programmers and analysts) from ten countries (România, Republica Moldova, Hungary, Slovenia, Czechoslovakia, Denmark, Greece, UK, Canada and USA). There were three sessions, on national, European and international collaborative projects; on documentation and collections management projects; and on standards and interchange formats in museum documentation. The proceedings have been published with the assistance of the Getty Art History Information Program (Matei 1992). CIMEC's large computer-based projects AAT (Art and Architecture Thesaurus), BRANCUSI (Interactive Multimedia Project), CAMUS (Ethnography), SI-PCN (Archaeology), STAR (Theatre History) and ZEUS (Archaeology) were presented, being the work of 28 individuals.

The Romanian National Cultural System (SI-PCN) is the largest archaeological/cultural database in south-eastern Europe and the fourth largest in the world, having 740,000 entries already on the system, and a similar quantity of card-based records awaiting entry, including records about museum services, collections and professionals, a Romanian theatre history database, and a sites and monuments database (Oberländer-Târnoveanu 1996). Paper publications based on these records have also been produced. The National Database includes an archaeological database (ARH) and a numismatic database (NUM), based on thesauri of terms. Since 1989 CIMEC has used IBM-compatible microcomputers.

Few westerners might be aware that to hold a conference such as RECOMDOC '92 within the Eastern Bloc was practically impossible during the communist period, and it had to wait until after the Revolution. In 1992 it was hoped that the countries of Eastern Europe could immediately find ways to cooperate, on archaeological databases in particular. This was found not to be the case, and more time, communication and reflection is still necessary for this to be achieved. Inevitably, shortage of funds *was* found to be something on which all could agree!

The RECOMDOC '92 Conference was seen as encouraging and coordinating initiatives for common standards in România, for promotion of international standards, and for communication and information sharing between România and Slovenia, Czechoslovakia (now two separate countries, the Czech Republic and Slovakia) and Hungary.

19.5 The present day in România

There is now the free circulation of people, information and technology, and individual initiative is both possible and rewarding. The main areas of research are the development of archaeological databases and the application of statistical methods. However, the computers generally available are uncommon and old, software is also mostly old and not suitable for archaeological research, and map data are unavailable. Hopefully modernisation, with a consequent realisation of the Romanian potential in computing archaeology, is not too far distant, but it will depend on closer contacts and collaboration with the rest of Europe.

In Bucureşti, besides CIMEC, workers at the Institute of Archaeology 'Vasile Pârvan' use IBM-compatible PCs for databases, seriation, clustering, classification and graphics; analysts in the Romanian National History Museum have databases for archaeological material, topography, and numismatics; and workers at the Romanian Institute of Thracology have a database of archaeological and anthropological materials.

The National Conferences on Archaeometry at Cluj-Napoca continue, organised by archaeologists from Cluj, and scientists from the Institute of Nuclear Engineering, Bucureşti-Măgurele, and the Institute of Isotopic and Molecular Technology, Cluj-Napoca.

Other projects in România are a database at the Museum of Constanţa, and the analysis of cemeteries at Cerneachov-Sântana de Mureş by the Institute of Archaeology in Iaşi.

Irina Oberländer-Târnoveanu commented during the presentation of this paper at Iaşi that in her youth she had a teacher (Moisil) in computing archaeology, and that there were no such teachers in România at the present time. What was to be done about educating the current students about the 30-year backlog of developments in computing archaeology? Clearly there is a need to develop a corps of such teachers in România, but in the mean time perhaps distance learning methods, electronic mail and the Internet can be resorted to, so as to use the computing archaeology tuition resources available in Europe. However, for this strategy to be effective, funds would have to be made available for the translation of the resources from English, and possibly other languages, into Romanian.

19.6 Attendance at the 1970 Mamaia Conference

The following is a list of Romanian participants at the 1970 conference, together with their presented paper titles where applicable, and pagination within the conference publication (Hodson *et al.* 1971).

- Alexandrescu-Dersca-Bulgaru, Matilda-Maria, Institutul de Istorie, Bucureşti.
- Bordenache, Gabriela, Institutul de Arheologie, Bucureşti 'Some mathematical aspects of taxonomy and diagnosis in archaeology' (with Manolescu, Mircea) p. 113.
- Bulgaru, V., Centrul de Statistică Matematică, Bucureşti 'The theory of historical series formulated by A.D. Xenopol as a mathematical approach to history' pp. 482-491.
- Buzatu, G., Institutul de Istorie şi Arheologie, Iaşi.
- Comănescu, S., Institutul de Arhitectura, Bucureşti 'Measurement and presentation of archaeological features excavated' (with Mateescu, C.N.) pp. 415-421.
- Guiăşu, S., Institutul de Matematică, Bucureşti 'On an algorithm for recognition' pp. 96-102.
- Ionitã, Ion, Institutul de Istorie şi Arheologie, Iaşi.
- Iosifescu, M., Centrul de Statistică Matematică, Bucureşti 'Bayesian inference in an archaeological problem' (with Tăutu, P.) pp. 82-84.
- Kivu-Sculy, Ileana, Facultatea de Matematică-Mecanică, Universitatea Bucureşti, Bucureşti 'On

- the Hole-Shaw method of permutation search' pp. 253-254 (Hole & Shaw 1967).
- Liveanu, V., Institutul de Istorie, București 'Coefficients of correlation in historical research' (with 4 co-authors) pp. 505-515.
- Malița, Mircea, Ministerul Invățămîntului, București 'A model of Michael the Brave's decision in 1595' pp. 516-523.
- Manolescu, Mircea, București 'Some mathematical aspects of taxonomy and diagnosis in archaeology' (with Bordenache, Gabriela) p. 113.
- Mateescu, C. N., Institutul de Arheologie, București 'Measurement and presentation of archaeological features excavated' (with Comănescu, S.) pp. 415-421.
- Mihoc, G., Centrul de Statistică Matematică, București.
- Moisil, Grigore C., Institutul de Matematică, București 'The axiom systems of similarity relations' p. 113.
- Niță, S., Centrul de Calcul al Comitetului de Stat al Planificării, București 'Establishing the linkage of different variants of a Romanian chronicle' pp. 401-409.
- Opreșcu, N., Institutul de Construcții, Facultatea de Drumuri și Poduri, București 'Some possibilities for using the volume of information in archaeology and history' p. 529.
- Postelnicu, T., Centrul de Statistică Matematică, București.
- Sâmboan, Anca, Centrul de Statistică Matematică, București.
- Savu, Silvia, Centrul de Statistică Matematică, București 'Discrimination and classification of certain types of ancient pottery' p. 113.
- Ștefan, Alexandra, Institutul de Arheologie, București 'Applications of mathematical methods to epigraphy' 267-275.
- Ștefan, S., Institutul de Arheologie, București.
- Tăutu, P., Centrul de Statistică Matematică, București 'Bayesian inference in an archaeological problem' (with Iosifescu, M.) pp. 82-84; also co-editor, 1971, with Hodson, F. R. and Kendall, D. G., of the conference publication *Mathematics in the Archaeological and Historical Sciences*, Edinburgh University Press, Edinburgh.
- Vaduva, I., Centrul de Calcul al Universității București, București 'On computer generation of conditional data' pp. 524-528.
- Voinescu, Rodica, Facultatea de Matematică-Mecanică, Universitatea București, București.
- Anghelescu, Victoria, Muzeul National Cotroceni, București 'Public Cot' [Statistical study of the public visiting the Cotroceni National Museum]
- Boroianu, Radu, Secretary of State, Ministerul Culturii, București
- Burlacu, Anisoara, Centrul de Informatică și Memorie Culturală (CIMEC), București 'Nouvelles possibilités dans la gestion de la base de données pour les musées'
- Busila, Daniela, Centrul de Informatică și Memorie Culturală (CIMEC), București
- Cetean, Mihai, Universitatea 1 Decembrie, Alba Iulia
- Cioran, Dorana, Muzeul Civilizației Populare din România, Sibiu
- Cios, Irina, Centrul de Informatică și Memorie Culturală (CIMEC), București 'Romanian art thesaurus — Structures, hierarchies and correspondences with the AAT' [Art and Architecture Thesaurus]
- Ciotoiu, Iuliana, Muzeul Satului, București 'Information system of the Village Museum: CAMUS programme' [Ethnography]
- Costoae, Muzeul Politehnic, Iași
- Cristodorescu, Cristian, Muzeul Satului, București
- Cruceanu, Codruta, Muzeul National de Arta al României, București
- Cusnir, Lucia, Muzeul Civilizației Populare din România, Sibiu 'Computerised management for photo and slide collections'
- Dâmbu, Mihaela, Muzeul Satului, București 'Information system of the Village Museum: CAMUS programme' [Ethnography]
- Danga, Mihaela, Muzeul National de Arta al României, București
- Dimulete, Adriana, Muzeul de Istorie, Brașov
- Farcasiu, Carmen Smaranda, Muzeul de Arta Peles, Sinaia
- Geber, Ecaterina, Centrul de Informatică și Memorie Culturală (CIMEC), București 'CIMEC — Information Centre for Culture and Heritage — Short- and long-term ideas based on our recent experience' 'SI-PCN: The National Cultural Heritage Information System in România' "An answer to 'Why the BRANCUSI Interactive Multimedia Project?'" 'RECOMDOC '92 — Closing remarks'
- Giurescu, Dinu C., Museums and Collections Commission, București
- Godea, Ion, Muzeul Satului, București.
- Hanea, Gabriela, Muzeul Brukenthal, Sibiu.
- Hurdubaie, Laura, Documentation Department, Ministerul Culturii, București.
- Iova, Mariana, Centrul de Informatică și Memorie Culturală (CIMEC), București 'Le système de traitement automatique des livres anciens'.
- Iuga, Georgeta-Maria, Muzeul Judetean Maramures, Baia Mare.
- Jurma, Mariana, Centrul de Perfectionare al Personalului din Cultura și Arta, București.

19.7 Attendance at RECOMDOC 1992

Romanian attendees at this conference, with the titles of their papers, are listed below.

- König, Carol, Museums and Collections Commission, București.
- Lung, Ecaterina Gabriela, Muzeul Taranului Roman, București.
- Marin, Catalina, Centrul de Informatică și Memorie Culturală (CIMEC), București.
- Marinescu, Floricel, Museums and Collections Commission, București.
- Matei, Dan, Centrul de Informatică și Memorie Culturală (CIMEC), București 'A software system for Romanian museums'.
- Maxim, Zoia, Muzeul de Istorie al Transilvaniei, Cluj.
- Mogos, Lorena Adriana, Muzeul Taranului Roman, București.
- Nemteanu, Ruxandra, Directia Monumentelor Ansamblurilor și Siturilor Istorice, București.
- Nicolae, Diana Angelica, Muzeul Taranului Roman, București.
- Nitulescu, Virgil Stefan, Cultural Heritage Department, Ministerul Culturii, București 'RECOMDOC '92 — A necessary effort toward convergence'.
- Oberländer-Târnoveanu, Ernest, Muzeul National de Istorie a României, București 'Realisation d'un catalogue numismatique sur l'ordinateur'.
- Oberländer-Târnoveanu, Irina, Centrul de Informatică și Memorie Culturală (CIMEC), București 'SI-PCN: The National Cultural Heritage Information System in România'.
- Onofrei, Codrut Mihai, Centrul de Informatică și Memorie Culturală (CIMEC), București.
- Oroveanu, Mihai, Oficiul National de Documentare și Expozitii de Arta, București.
- Papadopol, Rodica, Ministerul Culturii, București.
- Patrascu, Florin, Royal Ordnance, București 'Information system of the Village Museum: CAMUS programme' [Ethnography].
- Popa, Gabriela, Ministry of Culture, București.
- Radu, Mariuca, Muzeul de Istorie, Brașov 'Considération concernant l'évidence sur ordinateur des collections de cartes anciennes (XVI^e-XVIII^e siècles) de la collection du Musée de Brașov'.
- Rucai, Alina, Muzeul National Cotroceni, București 'Public Cot' [Statistical study of the public visiting the Cotroceni National Museum].
- Rusti, Dorel Marian, Muzeul de Istorie Naturala 'Grigore Antipa', București 'Fauna database from the 'Grigore Antipa' Natural History Museum'.
- Savu, Camelia, Centrul de Informatică și Memorie Culturală (CIMEC), București 'Système informatique pour le répertoire Théâtral National'.
- Scorpan, Constantin, Centrul de Informatică și Memorie Culturală (CIMEC), București 'Computer assistance in archaeological chronology: Realities and prospects'.
- Serbanescu, Victor, Muzeul de Istorie, Brașov.
- Sitov, Petru, Muzeul de Istorie, Brașov.
- Ștefan, Mariana, Centrul de Informatică și Memorie Culturală (CIMEC), București.
- Stroe, Adriana, Directia Monumentelor Ansamblurilor și Siturilor Istorice, București.
- Suceveanu, Simona, Muzeul de Istorie Nationala și Arheologie, Constanța 'Proposals for setting up a computer network for the National History and Archaeology Museum of Constanța'.
- Tarcea, Lucian, Muzeul de Istorie al Transilvaniei, Cluj.
- Toma, Marian, Centrul de Informatică și Memorie Culturală (CIMEC), București.
- Varga, Lena, Muzeul National Cotroceni, București 'Public Cot' [Statistical study of the public visiting the Cotroceni National Museum].
- Velicu, Mariana, Muzeul National Cotroceni, București 'Public Cot' [Statistical study of the public visiting the Cotroceni National Museum].

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- MATEI, D. (ed.) 1992. *RECOMDOC '92: Eastern and Central European Regional Conference on Museum and Cultural Heritage Documentation*, București. Centrul de Informatică și Memorie Culturală (CIMEC).
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MIHĂILESCU-BÎRLIBA, V. 1981. 'Un problème de statistique mathématique: la réforme de Septime sévère et les trésors monétaires romains au-delà des frontières de l'Empire.' *In* C. Carcassonne & T. Hackens (eds.), *Statistique et numismatique*, PACT, pp. 324-333, Strasbourg. Conseil de l'Europe, Assemblée Parlementaire.

MIHĂILESCU-BÎRLIBA, V. 1981-82. 'O problemă de statistică numismatică: reforma lui Septimus Severus și tezaurele monetare de dincolo de frontierele imperiului.' *Cercetări Istorice New Series* 12-13: 159-167.

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MIHĂILESCU-BÎRLIBA, V. & V. CHIRICA 1996. 'A survey of the development of computer applications in Romanian archaeology.' *In* Kamermans & Fennema (1996), pp. 525-30. *Analecta Praehistorica Leidensia* 28.

OBERLÄNDER-TÄRNOVEANU, I. 1996. 'A statistical view of the archaeological sites database.' *In* Kamermans & Fennema (1996), pp. 47-50. *Analecta Praehistorica Leidensia* 28.

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