

### The Need for a Theory of Historical Computing [1991]

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*Manfred Thaller:*

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## The Need for a Theory of Historical Computing [1991]

Manfred Thaller\*

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**Abstract:** »Über die Notwendigkeit einer Theorie für History Computing«. The early phases of computer supported research in history have been characterized by enthusiasm about the many possibilities opened. Possibilities, which go beyond just one methodological paradigm as the recent discussions about the relative importance of quantitative studies within computer applications in history show. A deeper discussion about these developments is necessary, necessary for pure intellectual reasons as well as for ones within the politics of academia. This requires a theory of historical computing, which starts from an analysis of the differences between computing in history and computers' applications to other disciplines. To illustrate that, a number of examples are given, which show that the information presented by historical sources is inherently different from the one processed by information systems directed at current times.

**Keywords:** Epistemology, relationship history and computer science, source criticism.

The application of computers in history can be seen in two ways: as part of a distinct methodology, or as a purely technical collection of recipes for the performance of specific tasks. Today we probably need not emphasise that the second of these approaches requires no defense: there is, in text processing, simple statistics, data retrieval and many other fields an increasing number of tools, the application of which results in such immediate gains in efficiency that they are best left to themselves to explain why they should be used. This author is of the opinion, however, that there are many reasons why we should not stop here: that there are indeed reasons why we should strive towards a consistent formulation of the ways in which information as contained in historical source material – or describing historical phenomena – differs from the information cropping up in contemporary administrative processes, or, indeed, the academic study of contemporary phenomena as well.

In pleading why this would be so we will follow three different lines of argument. We need a theory of historical computing because:

- 1) We need it to structure our own academic discourse.
- 2) There simply *are* properties of history which make it different from other disciplines intellectually.

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- 3) It is needed to defend our requirements against academic competitors for funds which are becoming constantly less ample – and, indeed, against the academic bureaucracies themselves.

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## 1. Academic Discourse

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Computing in history has in its early years had many similarities to a sectarian endeavour: the need to defend the small group of people engaging in it against an overwhelmingly sceptical majority led to a situation where at most conferences about the subject, almost everybody was so happy to meet other people with the same interest that there was not very much argument about the advantages of a specific approach<sup>1</sup>. We need not be ashamed of that: every new intellectual and/or academic movement has to run through this phase, where a kind of collective brainstorming is undertaken, everybody being welcome who is ready to accept very basic common concepts. Such is the case with other developments in history as well. Women's history is a material example; even more so oral history, to quote a methodological one. Computing in history has a tradition longer than both of them: so it is very appropriate that the almost messianic utterances of the early years have in general given way to a much more sober evaluation of the subject by practitioners. Beyond being sober, the next step has to be the development of a common ground on which all those problems can be discussed, which are not as self-explanatory as might sometimes appear. To mention just a few points on which this author is in disagreement with some of the arguments presented at this year's Westfield conference: I would *disagree* with the assumption that quantitative studies are the most appropriate way to use a computer as a methodologically relevant tool in history; I would *disagree* with the assumption that the relational data model is the most appropriate one for the design of historical databases; I would, finally, *disagree* with the notion that present artificial intelligence techniques hold a promise, if they are taken over unchanged.

This is by no means to be understood as a blanket rejection of the proposals brought forward by colleagues. It is to be taken rather as call for discussion of the specificity of historical research with respect to avenues of enquiry. And the necessity for an academic sub-discipline which is coming of age to provide a framework for precisely this kind of discussion is the first reason why a theory of historical computing is needed. In order to explore what such a framework would have to provide for, we will mention some of the background to the disagreements noted above. Of course this author *himself* considers his arguments valid; he admits, that

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<sup>1</sup> A comment of a participant of one of the earliest of these conferences: 'That is, though some of the projects described may have seemed confusing, superficial, inconsequential, or just plain long to a number of onlookers, even the most suspect of the undertakings explained could hardly have been called diabolical'. (Edmund A. Bowles (ed.), *Computers in Humanistic Research*, Englewood Cliffs, 1967, vii).

he does not see a methodological framework, however, in which to prove that conclusively.

Disagreement with the concept of quantitative studies being the primary use for computers in history does not imply that these methods should not be used at all: indeed, students of history trained in quantitative methods are usually better able to adapt to other techniques than colleagues without such a background. One could argue, however, that there is an inbuilt problem in the whole philosophy of quantitative methodology, as developed in the social sciences, which makes their application in history difficult beyond a certain point. One of the problems is that all present-day studies make, often implicitly and tacitly, the assumption that for many aspects of the problems they are dealing with, authoritative expert knowledge exists, which is readily available. Large parts of modern linguistics assume that if you want to know what a phrase in a given language really means, all you have to do is to go and ask a native speaker – which in itself makes their methods useless for the treatment of any language-related phenomenon before 1880. In the social sciences many studies assume that for important areas of information – such as for occupation for example – there are experts able to relate surface information (the occupation in a questionnaire) to the underlying reality (the social position). So they are trying to produce hypotheses about what is going on between observable phenomena, testing hypotheses about the interrelationship between established facts. Historians have to become experts of the systems they are exploring themselves; indeed that is, what history is all about. So a statistical treatment of phenomena of a past society deals with hypotheses about the way an assumed reality was projected into the surviving source material. The whole concept of falsification has to change, therefore, if applied to the past: indeed, one might argue, we cannot falsify any hypothesis to begin with, as we never can isolate it completely for testing. What we *can* do, however, is finding out about the consistency of a certain number of interrelated hypotheses.<sup>2</sup> A theoretical background for such an evaluation procedure would be one example of what a theory of historical computing should be about; and a prerequisite for the decision as to which quantitative methods are appropriate at which times. This should not discourage interdisciplinary discourse with the Social Sciences: rather it should make it more fruitful.

In disagreeing with the proposition that the relational data model<sup>3</sup> is the best tool for database work in history, I do not wish to imply that it is wrong to use database management systems which implement it for historical studies. While no one doubts, however, that such current systems as dBASE can make one's life very much easier, I would like to emphasise that structural restrictions of existing soft-

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<sup>2</sup> See the more extensive treatment of this point in Manfred Thaller, *Ungefähre Exaktheit. Theoretische Grundlagen und praktische Möglichkeiten einer Formulierung historischer Quellen als Produkte "unscharfer" Systeme*, Helga Nagl-Docekal und Franz Wimmer (eds.), *Neue Ansätze in der Geschichtswissenschaft*, Vienna, 1984 (= *Conceptus Studien 1*), pp. 77-100. Reprinted in this HSR Supplement 29, 138-159.

<sup>3</sup> Indeed the author suspects that there are a few historians who tend to think that the relational model is the only one around: a more sophisticated introduction can be found in Dionysios C. Tsihritzis and Frederick H. Lochovsky, *Data Models*, Englewood Cliffs, 1982.

ware are no substitute for methodological reasoning. So another example of the kind of discussion for which a background is needed, and which we will have to undertake as a discipline some day, is the following. Are there not properties of our data which simply do not fit into the clean rectangular tables of relational software? And what alternatives are there for the organisation of data?<sup>4</sup> This is not intended to belittle the gains to be had from current commercial software; but we should look also to provide the base upon which to build software tailored for historical use.

Nor does my disagreement with some notions relating to the applicability of artificial intelligence imply a denial that this is one of the most fascinating developments in the information sciences of today. There is a split in present-day computing, however. On the one hand, there is database technology,<sup>5</sup> doing wonders with the administration of extremely large, but inherently trivial, data structures like lists of spare parts or patients in hospitals. On the other hand we have artificial intelligence,<sup>6</sup> providing the background for the simulation of extremely complex reasoning on the computer, but with amounts of data, which, for the not-so-enthusiastic spectator, border upon the ridiculous. Historians may be singularly well positioned to help to find the means to bridge this gap, since their data, being considerably more plentiful than that used nowadays by artificial intelligence, and definitely beyond the complexity administered by current database technology, can provide problems of a kind for which both techniques, if successfully combined, might yield a solution. To help in defining the basis for such a combination would be a third example of the kind of discussion that should be undertaken within the framework provided by a future theory of historical computing. It is not suggested that historians should teach computer scientists, but they should approach them with problems of sufficient interest to justify interdisciplinary research, with profit to both sides, instead of looking to them as providers of black boxes to be mechanically applied.

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## 2. Intellectual Requirements

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Is there indeed something about historical data which makes it different from other data processed by computers?<sup>7</sup>

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<sup>4</sup> As a lengthy example of this kind of problem constitutes the second section of this paper, none is provided at this point.

<sup>5</sup> William Kent, *Data and Reality*, Amsterdam, etc. 1978, is a very good introduction for some of the less trivial properties of databasing.

<sup>6</sup> Challenging reading for an historian, but a very good introduction into the less superficial links between traditional computer applications and AI techniques: J. F. Sowa, *Conceptual Structures: Information Processing in Mind and Machine*, Reading, Mass., 1984, pp. 310-18.

<sup>7</sup> The following example is discussed in much greater detail – including aspects of a possible solution – in: Manfred Thaller, 'Warum brauchen die Geisteswissenschaften fachspezifische datentechnische Lösungen? Das Beispiel kontextsensitiver Datenbanken in der Geschichtswissenschaft', in Albert Müller und Manfred Thaller (eds.), *Computer in den Geisteswissenschaften*, Frankfurt/New York, 1989 (= *Studien zur Historischen Sozialwissenschaft* 7).

One of the most frequent uses made of computers in historical studies is the ordering of information, to find specific documents by some information retrieval technology. A typical example for such an application could be to ask a database management system for the processing of records within a suitable database dealing with persons

- *Coming from Prussia,*
- *Being fifty or younger and*
- *Having a fortune of 100 or more units of a currency 'x'.*

Straightforward as such a request may seem to be at first glance, we (or a natural language shell, if we apply a very sophisticated software system) would have to rephrase it first, somewhat along the lines of:

- Provide information about entries in the database, where
- *the field 'country of origin' contains the string 'Prussia',*
  - *the field 'age' contains a number smaller than '50'.*
  - *the field 'fortune' contains a number greater than '100' ('x').*

In principle, these statements are sufficiently formal for processing by a computer. The problem, however, is, that this is still not what we really want: if we stick to the letter, we would, for example, always have to enter a field 'country' of origin to make such a question feasible, even if our source contains the relevant information in some other form such as 'place' of origin. What we want to express with the first of our three conditions in our query is actually something like the following:

*I'm interested in entities where the field 'place of origin' contains a string which can be looked up in a table of place names. If that is done, the 'places of origin' I'm interested in shall in that table be connected with a pair of geographical coordinates, which fulfil the following condition: in the same table the string 'Prussia' is assumed to be associated with a polygon coded in the form of geographical coordinates; the coordinates of the 'place of origin' we started from, have to be contained within the polygon describing 'Prussia'.*

Incidentally just the possibility of making a query system able to replace a single term of comparison (like 'Prussia') with a chain of alternative search terms (like place names being located within Prussia) more or less automatically, has been heralded in one session of the annual conference of the AHC in Westfield 1987 as a major advantage of the use of artificial intelligence techniques. This author, coming from a database background, would disagree with that, and would suggest that this kind of substitution rule is a tool which any decent DBMS has to provide. Be that as it may, with formulations like that we are very close to the limits of what present-day DBMS-oriented software makes possible.

For an historian it is immediately clear, however, that what we asked for can intellectually just be the starting-point. 'Prussia' was taken as an example, not because it is assumed to be a particularly popular country, but because it has a property *in extremis*, which all geographical terms in historical research have inherently to some degree: its meaning fluctuates over time. To decide, if a particular place is located 'in Prussia', we have to know of what period that question is being asked, for example in 1730, 1794, 1811, 1830 or 1868. More generally, what we actually mean by the query we are discussing would have to be augmented by something like:



*Assume that 'Prussia' is actually described not by one polygon, but by a whole series of such. To decide which one has actually to be used, proceed as follows. Take the field 'date of record' and subtract from it the content of the field 'age': then compare the resulting date with the timeframe that shows to which period the various polygons representing Prussia are applicable, and choose the appropriate one.*

In any in-depth treatment of the subject, we would have to go on much further from this. For the purpose of the present paper, it may suffice to introduce a first statement about the intellectual requirements put up for any software that is supposed to be truly historical in nature:

Thesis I:

*Any software system able to accommodate inherent properties of historical data has to be able to make all processes of deduction dependent on the temporal context within which the items of data upon which the deductive process is based occur.*

Looking now at the second of our questions (*the field 'age' contains a number smaller than '50'*) we encounter a different problem. Our forefathers, while virtuous in many respects, never paid much interest to precision in questions that seemed superficial to them; it is a well-known fact that sources as late as the nineteenth century censuses contain information about seemingly hard facts like the age of a person, which are just an approximation. Indeed, one could reasonably argue that *all* information supplied in historical sources is inherently vague or *fuzzy*, to use the term employed in the relevant literature<sup>8</sup> of information science.

The way to a formalisation of this problem is unfortunately thornier than in the previous case, so here I sketch it out even more roughly. The solution requires that we arrive at some estimate of the imprecision inherent in the age information of our source. This could be gained if we collect information on such things as whether the source contains vague expressions ('Approximately fifty years of age', 'an octogenarian' etc.). How many expressions does it contain, and how vague are they? And when we bring together information from different sources, how great is the observed difference between the age of one and the same person as given in different sources? Out of items such as these, we should ultimately be able to arrive at a statistical estimate of the distribution of errors in the age-related items of a single source or collection of sources. Using this, we could reformulate our original condition somewhat along the lines of:

*The field 'age' has to contain a value which is smaller than  $x$ , where  $x$  is defined as the threshold one obtains by adding to 50 the standard deviation of 'age'-related errors. When the database in question has come into existence over a longer stretch of time, take into account its inherent context sensitivity: that is, when computing the error distribution for age, weight the terms entered into the distribution proportional to their temporal distance from the value of 'age' with which the comparison is made.*

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<sup>8</sup> Good introductory reading: Lotfi A. Zadeh, 'The Concept of a Linguistic Variable and its Application to Approximate Reasoning', *Information Sciences*, 8 (1975), pp. 199-249, 301-57 and 9 (1975) pp. 43-80. B. R. Gaines, 'Foundations of Fuzzy Reasoning', *International Journal of Man-Machine Studies*, 81 (1976), pp. 623-68.

While the practical implementation of this example may be one of the most complicated to be solved by specifically historical computing, we note, as a second hypothesis, what requirements software has to fulfil to be – on a theoretical level – appropriate for information derived from historical sources:

Thesis 2:

*Any software system able to accommodate inherent properties of historical data has to provide means to take account of the inherently fuzzy character of the information contained within historical source material.*

So context-sensitivity and fuzziness are two inherent properties of historical data. We keep that in mind when we continue to look at the third of our original conditions, that *the field 'fortune' contains a number that is larger than 100 currency units 'x'*.

The first refinement to our initial formulation has obviously to assume that 'x' is a term that is contained as a character string both in the database and in the query posed to the retrieval system. So we could start with the reformulation:

*I'm interested in persons, where the field 'fortune' contains a string, which, when converted to a numerical entity, yields a value that is greater than the one that results when the string '100 x' is undergoing the same conversion process.*

Having been alerted to the fact that the interpretation of the terminology of a source is dependent on the moment in time at which that source has come into existence, we can immediately add:

*Start this conversion process by computing out of the field 'date of record' the timeframe within which the currency has been quoted. If the 'fortune' given has been recorded at a time other than that at which the record as such was written, take this into account.*

Now, 'x' obviously stands for a currency. The exchange values of currencies change over time; they change also, however, when one moves from one territory to another one, coins being struck under the same name at different places having quite different values. So we have to add:

*Continue the conversion process by examining which spatial frame might be appropriate. To get at that, take into account where the source has been written; check also, however, whether the information given in the field 'fortune' might have been originally recorded somewhere else.*

After that we come to:

*Now use the timeframe and the spatial frame obtained to decide which of the varying exchange rates between the currency used in the source and the 'x' used in the query apply in our case. For this purpose consult an independent database, which contains exchange rates for variant currency denoting terms.*

Bearing in mind that historical sources are inherently fuzzy, we add, finally:

*When comparing the temporal and spatial frames derived from the source with the entries in the currency database, check whether these frames are close to a point where different ones would apply (i.e. whether the exchange rate changed shortly before or after our information was fixed in writing, or the place where it was recorded lies very close to a border between two territories with different coinage). If so, consider the original conditions to be already fulfilled if it is fulfilled within a wider margin, to take care of the discovered ambiguity.*

It should be emphasised again and again that considerations like these are just the beginning. In the case of spatial terms, for example, one would have to consider *where* the term was written down in order to discover which area is covered by it; in the case of temporal information, one might have to consider *when* it was fixed in writing in order to understand what date is actually meant by the feast of a particular saint, used as a temporal reference point. Both observations imply that our context-sensitivity is something which has to be applied recursively,<sup>9</sup> that is, to itself. It will not always be as simple, as in our example, to discover which temporal and spatial frames apply: this information will very often be hidden in parts of the data to which a conventional data model does not necessarily provide any connection.

At the same time the question of the level at which such considerations should be implemented is open to argument. The author is in favour of solutions where some reference mechanism<sup>10</sup> is built into the data by the researcher collecting them – or even by the person developing the software. So we could discuss means which would guarantee that historical software ‘knows’, for each definition, that it is necessary to look for a ‘place of origin’ if a ‘country of origin’ is not within the data. On the other hand it is obviously important that these reference mechanisms have to remain under control of the user, the user has to have the possibility to redefine some of the implicative mechanisms. And some historians are, indeed, afraid, that the user would lose control over the source material on which they are basing their reasoning, if that source material is administered by a database with a very enhanced reference mechanism which remains oblique.

How much data do we need so that the results we gain will actually be markedly different from the ones we get by conventional software, when compared to inference mechanisms like the ones discussed here? If we ever reach a stage where the large collections of printed editions are available as databases, we will obviously have to provide mechanisms in the direction to which I have pointed. Do we further our aims better if we start to develop the necessary tools now, testing them with smaller amounts of material – or should we, for the time being, concentrate mainly on the rough-and-ready provision of data, leaving the refinements for a later stage?

None of these questions can be answered off-hand; none of them can be answered by anybody from the information sciences, as all of them are completely, or at least have components which are inherently, historical. And my purpose here was not to *answer* such questions, but to show that they are there and that they constitute an intellectual and theoretical challenge for the historian discussing the application of computers to his or her field.

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<sup>9</sup> More precisely we would need tools to perform the varieties of lookup simultaneously. On recursion as an artefact, derived from the current hardware architecture, see Stoyan O. Kableshkov, *The Anthropocentric Approach to Computing and Reactive Machines*, Chichester etc. 1983, pp. 25–27.

<sup>10</sup> Here, indeed, AI techniques, which tend to blur the differences between data and rules, might be applied very profitably: see Richard Ennals, *Artificial Intelligence: Applications to Logical Reasoning and Historical Research*, Chichester et al. 1986.

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### 3. Institutional Requirements

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Intellectual problems, and the tackling of them, are a delightful part of the academic historians experience; dealing with funding agencies is an equally integral, though far less exciting, part of the same. This second part of the historian's experience, has, at least during the last few years, been dominated by the so-called 'micro-revolution'. In most parts of Europe, historians encountered the strange phenomenon that bureaucrats of the local research administration, while very hard to convince to spend money on historical research as such, were much more easily persuaded to provide funds for the introduction of computing into historical research and/or teaching. Indeed, in a few European countries, historians, like other academic teachers of the humanities, have been asked to provide the inclusion of some data processing knowledge into the curricula they offer. Now when I argue that historians should explore possibilities to assure their access to these funding possibilities for the future, I do not consider that we are working towards a policy of a sellout of history to some other discipline. It is a fact, however, that at many universities there exists already the necessity to provide some kind of teaching on the use of computers in history; it is a fact, furthermore, that in the near future the number of students who enter university with quite a bit of working knowledge of computing will increase. Today it is of course possible to teach, under the heading of *computer-literacy*, word processing skills (and it is possible to improve ones funding position by that). But this teaching is going to become pointless as soon as the various projects to emphasise computing in secondary education become successful. So historians should try to avoid dependence on developments which are likely to become redundant in a relatively short time. It would be much wiser to move to a higher intellectual plane and show what a computer can do specifically for the historian.

I repeat, we should *not* advocate any sell-out of the historical disciplines, I am against exchanging 'a truly historical education' for the possibilities of acquiring funds. One should see realistically, however, that for every history student today who ends up with a job as historian, there are at least four who find themselves in professions where they are paid for having acquired the ability to argue according to some intellectual standard, to express themselves easily in writing, and for other abilities which somehow come as a windfall profit from the classical historical education. If we accept the view that the universities' role in teaching history consists also of training people for the society in a number of skills, which are very valuable intellectually, but not necessarily and inherently linked to the chronology of the Saxon kingdoms, we will have to think seriously about how far and in what ways a specific understanding of formal reasoning has to be introduced into our dealings with our past.

This quest for what is specific about computing in history should also be undertaken for the sake of another aspect of funding. Right now it is relatively easy to convince the administration of a university that it is a major methodological innovation if an historical department starts using standard programs on standard computers. Already now, however, there have been cases in Europe where historians applying for computers have had a rude awakening, when the funding bodies

approached for some project told them that, while their projects would certainly hold great historical merit, from the data processing point of view they were not innovative at all, and therefore it would not be possible to provide any additional money for a project which would have to be paid out of the regular budget. Interdisciplinary cooperation with the information sciences, if inaugurated by a historical discipline from the basis of a secure knowledge about one's own need for innovative solutions, can in some cases produce very material rewards.

To conclude: I think that we need a theory of historical computing. Because computer usage is an established fact for many historical departments, and in order to exchange our knowledge about it, we need a firm conceptual and theoretical base. Because there *is* a difference between data in historical sources and those in the accounting books of a hospital. It has been said that history as an academic profession consists of interpreting the past in the light of the knowledge and the conceptions of the present. If we take this seriously, and notice that formal reasoning, as it accompanies the advance of computing, seems to be destined to become much more important in the general intellectual background of our society, it is indeed hard to see how we can avoid the problem of creating some conceptual framework, just to come to grips with these developments in our discipline's eternal confrontation with our heritage.