

## **HEPIC séminaire session: Computation in the sciences- the science of computation**

**Arianna Borrelli** (Centre for Advanced Study on Media Cultures of Computer Simulations, Leuphana University, Lüneburg, Germany)

**Title:** *Code, drawings and causality: early computer-aided data analysis in high energy physics*

**Abstract:** In the early 1950s a growing number of research institutions, especially in the U.S.A., started building electronic, digital computers following the guidelines and ideas expounded in the EDVAC report. One of such machines was the MANIAC, build in Los Alamos by the group led by Nicholas Metropolis. While Metropolis was primarily interested in exploring the potentialities of the new kind of machines, nuclear and particle physicists with good connections to Los Alamos saw the device also as a potentially helpful computing tool for solving research problems. Among them was Enrico Fermi, theorist working in Chicago and former member of the Manhattan project, who often spent part of his summer in Los Alamos.

In 1952 Fermi was involved in analyzing the data produced by the new particle accelerator operating in Chicago, trying to solve the question whether a phenomenon called "particle resonance" was had manifested itself or not. Given the complexity of the computation and the small number of data points, though, no conclusive answer could be found with analytical methods, and so Fermi came to the idea of using the MANIAC. Soon he set down to write and run a code - and the MANIAC's answer was that no resonance was present.

The computer had spoken, but that was not the end of the story. Semi-quantitative physical arguments by Hans Bethe and the results of a graphic method for approximatively solving the equations suggested that the resonance was there after all. In the following months, further attempts to fit a growing number of experimental data with the help of the MANIAC took place, and they suggest that the computing machine was not regarded as a reliable tool to execute pre-determined algorithms, but rather as one of a range of methods that could be combined to interpret experimental data. Using numerical computing, graphical methods, plausible physics assumptions and more, two distinct groups led respectively by Fermi and Bethe reached opposite conclusion on the existence of the resonance. Eventually, the final decision was made not by numerical methods, but by recourse to the principle of causality.

**David Nofre** (independent researcher)

**Title:** *"Content is meaningless, and structure is all important": The making of computer science in the age of high modernism*

**Abstract:** How does the emergence of computer science reflect the broader cultural trends of the 1950s? This the question which I will try to address during my talk. As is well-known, since its early days computer science has been largely concerned with the development of abstract models of computation rather than with the study of actual computers. On the other hand, this profound distancing from the computer was foundational for computer science and partly arose from the response of university computer centers in the United States to the challenges posed by the rapid commercialization of computing. Yet this move towards abstraction was not specific for computer science. The representation of all sorts of objects of study, whether machines, brains, natural languages, or human organizations, as fundamental equivalent systems defined by their common underlying structures, became a prevalent way of knowing in the United States during the age of high modernism. I will argue in my talk that computer science also flowed in a similar vein from explorations on the fundamental equivalence between the common underlying structures of

programming notations, natural languages, the formal languages of logic, and the Turing machine—with the human mind not far away from this overarching perspective.

**Sébastien Plutniak** ([Centre Émile Durkheim](#), Bordeaux and [TRACES Laboratory](#), Toulouse, France)

**Title:** *Three models to shape the relationships between computer scientists and domain specialists: a case study from archaeology in France, 1950s–2000s*

**Abstract:** Computer science developed in an essential tension between a universal aim towards domain-free procedures and knowledge, and pragmatic and specific applications to fulfill administrative, commercial, industrial, and scientific needs. Considering science, I will address the social and epistemological relationships between domain specialists and computer scientists: this aspect is related to the old problem of the applicability of mathematics, but has been constantly renewed and extended in the second half of the 20th century through the growth of computer science. The current and fast development of AI and, consequently, AI-related institutions, policies, and fundings, despite its assumed radical novelty, raises organisational and also epistemological issues similar to those experienced since the 1950s by scientists from various fields. This claim will be defended from an examination of the case of archaeology in France. Archaeology has three interests in this regard: 1) it has been shaped as a discipline during the same period as computer science; 2) it is part of the humanities, in which the use of quantification and automated computation was less evident to the practitioners than in the so-called “hard” sciences, so raising particular epistemological and social issues; however, 3) archaeology was one of the pioneering domains of the humanities and social science to develop computer application. Two questions will be addressed. First, the conditions of emergence of a speciality related to the use of quantitative methods or computers. Despite early applications of computing, and contrary to other fields such as ecology, biology, or neurology, there is no computer-based disciplinary speciality in archaeology (contra numerical ecology, biostatistics, neurocomputing, respectively). Second, the collective form of organisation to make computer scientists and domain specialists collaborate. Publications and archive documents were used to reconstruct the social space of these interdisciplinary relationships in France and its evolution. On the one hand, a general picture is given using a dataset with the participation of 1057 actors to 59 conferences, identifying three active groups of researchers. Archives and interviews were used for an in-depth analysis of these groups, illustrating three models of policies and socio-epistemic relationships between computers scientists and archaeologists.

**Franck Varenne** (Université de Rouen/IHPST)

**Title:** *"On some influences of programming paradigms on modeling practices in science - The case of Object-Oriented Programming in social sciences"*

**Abstract:** Several authors have shown that agent-based simulations have explanatory power regarding their target systems for two main reasons: because, thanks to these kinds of simulations, computational systems can be made more analogous to the target system, and because an abduction (rather than an induction) can then be used that allows for a return to the target system based on this analogy (Elsenbroich, 2012; Boge, 2020). However, as they themselves are based on object programming, agent-based simulations allow for multiple and simultaneous representations of different aspects, mechanisms, behaviours, or scales of the target system and its elements. For this reason, it is in fact particularly difficult, if not impossible, to formulate a global analogy between the entire state of the computational system and the simulated target system. Moreover, as it has

often been noticed, the practice of abduction requires access to information about the context or to certain representations of this context of the target system but also, in our case, to representations of this context within the simulation itself. In this talk, I suggest showing in a first step that the finer interpretation of computational simulations *via* the analysis of their systems of symbols and of their various chains of reference (Goodman, 1981; Phan, Varenne, 2008 ; Varenne, 2013) is more appropriate to interpret the epistemic power of object-oriented modelling: it allows to clarify some of the obscurities that remain persistent in these analogistic interpretations of agent-based simulations. In a second step, I propose to show how the value of parsimony continues to operate here to render a “possible mechanism” hypothesis first due to exploratory agent simulations the most probable one. Finally, I will suggest that this apparently paradoxical search for parsimony for these complex simulations still operates today but in a finer, more differentiated, and more graduated way than before, in particular in computational geography (Schmitt et al. 2015 ; Cottineau et al. 2015).