The Contribution of Carl Adam Petri to Our Understanding of 'Computing'

Giorgio De Michelis
University of Milano-Bicocca, Italy

Introduction

Carl Adam Petri is well known for introducing the nets having his name that are widely studied, discussed and applied in the field of concurrent system modeling. It is less known that net theory was, for Petri [4], the kernel of a radical shift in scientific knowledge. Carl Adam Petri has not written extensively during his life and this may have been an important reason that only the most applied part of his approach, the use of nets for designing concurrent systems, has become largely popular.

In this paper, I want to make one small step in trying to popularize in a larger community the radical novelty and the relevance of the approach Petri used for developing scientific knowledge of physical and social phenomena. This has, as we will see, much to do with the concept of computing and, indirectly, with the relations between science and philosophy.

This talk will summarize three aspects of Petri's thinking, which deserve a wider attention: the notion of model, the new algebraic foundations for a theory of modeling and its application to Pragmatics.

Modeling

In a lecture given in 2003 [9], as well as in several other occasions during the later phase of his life, Petri presented his viewpoint on the nature of models, where he detaches them from any ambition to be directly related to reality. His answer to the question "What is modeling?" claims that he prefers to the widespread view that it is a partial function from reality to model, the view that it is a translation from a shared informal model to a formal model.

It is a radical change with respect to standard scientific approaches as adopted, e.g., in physics, but also, frequently, in social sciences. Here modeling is characterized, without any reference to 'reality', as a way of changing the quality of what we know, from something informal, that we share but is incomplete, sometimes contradictory, and in any case rich of ambiguities, to a formal model that is, per se, fully sharable because it is reproducible. We can relate it, for example, to the 'phenomenological stance' discussed by Rorty [10] or to the debate raised by Bridgman operationalism in philosophy of science [2]. But Petri was not a philosopher and he always refused to discuss his work in philosophical terms: he was an engaged practitioner of scientific research. His viewpoint is therefore implicit in his scientific results and it must be evaluated as a contribution to science, and not to philosophy!

Concurrency

Modeling is, as said above, a translation from informal to formal knowledge, but it cannot forget that what we know is the outcome of an observation: we can't say "this thing is…", but only "this thing appears to be…". This is not something that philosophy adds to science as a warning to an absolute reading of it: it is what science itself must state, without ambiguities. For this reason, net theory breaks down equivalence relation (symmetric, reflexive and transitive) into two complementary relations: the first one is symmetric and reflexive, while the second is reflexive and transitive. These two relations, named respectively concurrency and causal dependency, underlie Petri's net theory. Concurrency can also be interpreted as indistinguishability, that is what remains of equality, if we remember that our statements (e.g.: a is b) always refer to our observations (e.g.: I can't distinguish a from b).

The basic math, underlying Petri nets, reflects the irreducible presence of the observer in scientific discourse. As a relation characterized by reflexivity and symmetry, concurrency can have different interpretations in different fields, all of which are related to qualities depending on observation procedures. As an example, recently it has been shown that saturation of local states and closure operations on particular classes of nets [1] generate sets with an orthomodular logical structure, like quantum logic.

Communication Disciplines

From the early seventies, Petri paid attention to human pragmatics. Within this framework, he introduced Communication Disciplines [5,6,3]. Again, this was a remarkably novel change, with respect to Shannon's Communication Theory, in viewing communication phenomena.

While Shannon point of view characterizes a communication medium in terms of its functions (from the traditional ones –transmitting, storing and disseminating– to the new ones originated by the computers – calculating and ordering), Petri is interested in how humans can manage communication. For this reason, he introduces a long list of functions that should be performed by a 'good' communication medium. These functions streamline the flow of information within a network of humans and not merely information exchange.

Let us briefly discuss some of the 12 communication disciplines (Figure 1).

Functions of a medium of communication ("Communication Disciplines")

Synchronization	Identification
Addressing	Naming
Copying	Cancelling
Composition	Modelling
Authorization	Valuation
Delegation	Re-organization

Criterion for a "good" medium: perform these functions

Figure 1

Some of them shape the basic communication phenomena in a network.

Synchronization is concerned with getting proper timing restraints for different activities.

Identification is concerned with well-known questions such as "identify the source of a letter" and with more sophisticated prob-

lems such as proving the competence of agencies with respect to certain actions.

Addressing is concerned with describing routes or systems of paths through a net of channels and agencies.

Others are of a higher level, since they involve roles of people within the network.

Authorization is concerned with access rights, scheduling obligations and supervision rules.

Valuation is concerned with the scarcity of resources and their exchangeability.

Re-organization is concerned with the rules through which a system can be changed without causing failures or disasters.

The list of communication disciplines should be considered as open ended, since it can be extended introducing other, higher, roles of actors in the communication network.

Conclusion

As I said above, Petri refused to discuss his ideas from a philosophy of science viewpoint: he considered himself as a scientist, and his theories had to be discussed for their capacity to enlighten natural and social phenomena. I think that his work should be studied by philosophers of science, because it offers a unique case of a theoretical work modifying the grounds of scientific assertions and the mathematical language through which they are formulated.

References

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