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Max Urchs

COMMENTS ON ALDO BRESSAN'S PAPER

At a conference in Athen some time ago, I had the honour to comment on Aldo Bressan's lecture „On certain notions, partly extensional and partly modal, relevant for the semantics of general relativity". A version of this lecture constitutes the first part of his paper „Again on relativistic semantics". At Aldo Bressan's request, I will outline the criticism put forward at the Athens conference. My comment does not, however, pertain to the second part of the preceding publication. Bressan's considerations on time and causality — which in fact illustrate the capability of the previously explained technical apparatus — are enlightening and truly stimulating.

Bressan's work on modal logic is no part of what may be called the „mainstream" in this discipline. His highly original considerations on modal predicate logic and the results he obtains provide an amazing example of how a powerful and elegant formal theory can be developed by a single scientist. As far as I know, the most competent valuation of Bressan's account was given by Nuel Belnap. In the preface to Bressan's monograph *A General Interpreted Modal Calculus* (cf. [2]) Belnap greatly appreciates the clarity and powerful elegance of this „most important contribution to non fully extensional quantified modal logic".

However, Bressan's formal system is not merely and not even in the first line an outstanding contribution to formal logic, it was elaborated with far reaching methodological ambitions: it aspires to lay the ground for an axiomatic calculus of physics.

What Bressan aims at is the construction of a metamathematical framework based on an powerful and original system of modal predicate logic in order to handle formally the terminology of modern physics. More precisely, he seeks to construct a logical calculus which allows the definition of formal counterparts for basic notions of the language of contemporary physical theory. If he succeeds, then his project would enable us to enlarge considerably the realm of formally controlable language — it would include the terminology used in one of the most important empirical theories.

It is not my concern to judge whether Bressan has succeeded in his efforts or not. That question shall be answered by the physicists. His aim, however, seems very reasonable and cognates to my own interest in logic. Therefore I shall proceed with some methodological remarks concerning Bressan's account and his underlying attitude towards logical formalization in general.

One of the strongest recent trends in logical formalization of empirical theories concentrates on dynamic aspects of real world systems. Naturally, the motivation comes partly from Artificial Intelligence and Computer Engineering: how to model motion and change in an empirical system? Therefore the question might be interesting, whether an analogical modification is feasible within Bressan's formal framework. (I envision a conception as laid out by van Benthem, cf. [7].)

Another important problem is the implementation of an appropriate concept of causality, i.e. a formal explication of causal nexus which fits the intended physical applications of the account. His formal framework contains no explicit definition of causality. Other authors prefer to work e.g. with *point events* and *causal order* as basic notions (see [1]). Bressan decided to choose the natural (modally) absolute notions of *mass points*, *matter portions* and *event points* as primary. But anyway, one hardly can do without any formal counterpart of causal nexus.

First of all, it seems to me that the so-called „aletic" conception of causal relations, usually treated on the basis of relational structures, is most appropriate for his purpose. In case Bressan would like to implement a notion of causality, he is then — at least from a technical point of view — in a very comfortable position. In fact, his modal logical calculus allows for the adoption of many of the known accounts without any special problems. To that class belong the constructions of Mackey ([5]), David Lewis ([3]), and my own proposal ([6]). At least the last two conceptions are very flexible and thereby provide additional profit.

Let me briefly explain this. Formalizing causal nexus belongs to the realm of „causal logic". This discipline is in general directed towards applications outside of logic. In this respect it resembles e.g. discursive logic or deontic

logic. Any appropriate formalization of (parts of) the language of empirical sciences makes the formal apparatus of these logical disciplines available in the considered sciences, thereby rendering the formal analysis of definitions, test procedures for argumentations, etc. In this sense, causal logic can be understood as „applied logic", i.e. as a service discipline for users outside of logic.

Following the standard approach to logical formalization, logicians begin with „cleaning up" the area they intend to formalize. They feel free to decide what is the correct usage of the relevant part of the language. Next, they elucidate the rules, explain how to speak „correctly". Unfortunately, (or rather, „fortunately") logic itself has almost no ability to bring its constructions into the regular language, i.e. to execute obedience to the rules established by logic concerning the usage of these artificial linguistic creations. Therefore, the upshot of such an officious indoctrination is sometimes a more or less elegant formal calculus which appears to be fairly uninteresting for the target group of users of the formalization: they simply refuse to accept the resulting metamathematical construction as an appropriate formal counterpart of their terminology. Obviously, the success of a logical formalization depends on whether or not it meets the intuitive concept it intends to formalize. Otherwise the formalization turns out to be a failure. In order to meet precisely the desired target of the formalization one needs a reasonably precise description of the intuitive concept. Thus the circle is closed. (The linguistic creations of logic should be strictly limited to formal languages only.)

But now, imagine you are going to hit a target which is poorly visible. Under such conditions, it would be much more efficient to throw a handful of pebbles at this target rather than one single dart. Here we have a close analogy to our present situation. Namely, the vision of the target, i.e. the concept of causality to be formalized, still remains somewhat fuzzy. No precise and adequate definition of e.g. event causation which is generally accepted by the representatives of an empirical theory seems to be actually available.

There are some positive, as well as negative properties of causality, usually deeply hidden in the background knowledge of the specialists working in the field. The logicians trying to formalize the respective concept should elucidate all these properties as precisely as possible. Somewhat optimistically I hope that this can be accomplished in cooperation between logicians and scientists from the theory in question. (Perhaps one should invite some philosophers of science to serve as translators between the parties.) However, as long as there is no object available which is appropriate for immediate logical formalization, one should strictly prefer constructions

which produce manifolds of metamathematical counterparts of the considered concept, rather than pointwise definitions. Those constructions should be flexible, as well as manipulable, in order to allow the production of an outcome which meets all the gradually spelled out requirements.

Hence, in order to formalize, say, the causal terminology of an empirical theory, it is necessary to proceed very carefully. One should describe the real usage of causal terminology in the language of the theory in question, i.e. to figure out the properties of the respective causal relations. Next, one has to formalize these properties. The result will be a catalogue of formulas representing the frame of positive (and of negative) conditions which all the potential formal counterparts of causal relations should fulfil (respectively omit). Finally, one arrives at a position to construct, so to say, „in stock" connectives falling into this realm[1].

Bressans „definitorial ambition" reaches far outside the realm which seems the only appropriate one for a logician. He is not satisfied to merely formalize the real usage of language in the physical theory under consideration. He aims much higher: Bressan intends to give nominal definitions of the basic notions of the relevant language. Therefore his efforts can be authoritatively evaluated only by physicists (including, of course, Bressan himself), making use [or not] of the accomplished definitions. We thus arrive at the classical situation when logical formalization is performed „full of energy" and thus becomes ontologically creative.

To conclude, Aldo Bressan presented certain formalized notions which are without doubt relevant to the semantics of general relativity. Let me consciously misuse the modal character of these concepts in order to ask: Apart from the technical elegance of Bressan's constructions and despite their (methodological) necessity — what about their (again, general methodological) possibility? That reminds me of the history of Jan Łukasiewicz's classical essay „Analysis and Construction of the Notion of Cause" from 1906 ([4]). It was written as a competition paper. The jury asked him for the „proof of reality" of the defined concept. Or, to put the problem in more pragmatic way: Is this notion accepted by the scientists working in the field in which the formal concept is supposed to function. Later on, Łukasiewicz

[1] The famous Polish author Stanisław Lem found a nice expression for that situation. In one of his novels he compared the work of a mathematician to that of a mad tailor sewing all possible silly kinds of suits, with 7 sleeves or with 3 flaps, and then waiting for the right client to come in and buy one. Our logician is a bit less crazy: he leans out of the window, watching the creatures hanging around as closely as he can, and then he sews suits suitable for the beings he has observed. Thus he obviously increases his chances of selling some of his products.

had serious difficulties with this question. Nevertheless, it was he who won first prize in the competition.

Some time has passed since the Athens conference. My comment at that time, as well as the subsequent discussion, concentrated on the missing proof of reality of Bressan's construction, on the request for further explanation of how his proposal is related to what is really expressed in physical terminology by the notions he exploits. Today I am not sure whether these objections were to the point. Perhaps, what Bressan really does is to juggle with these notions, to combine them in order to build his own theory.

One may question whether this is good philosophy or sophisticated science fiction — yet for sure it demonstrates technically powerful and appealing applied logic. Compared with alternative efforts in grounding the mathematical apparatus of physics on a clear and sufficiently rich logical basis, Bressan's approach appears to be remarkably mature. The present volume contains one more paper dealing with logico-terminological foundations of physics (Zdzisław Augustynek's „Realism: Temporal and Spatial"), a further article on the same issue (Roman Stanisław Ingarden: „Modalities in Physics and in Linguistics") appears in one of the forthcoming volumes. The fact that there is a growing number of alternative approaches shows the need for such a kind of work. The goal should be accomplished in cooperation on terminological matters between physicists and philosophers of science assisted by logicians. One needs no prophecy to see that this enterprise shall be a thorny one. So all that remains for the commentator is to hope that these ideas will spread and burgeon.

References

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[5] J. L. Mackie: *The Cement of the Universe*, Oxford University Press, Oxford 1974.

[6] M. Urchs: „On the logic of Event-causation. Jaśkowski-style Systems of Causal Logic", Studia Logica, 1994, 551–578.

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MAX URCHS
Department of Logic
N. Copernicus University
ul. Asnyka 2
87-100 Toruń, POLAND
e-mail: max@mat.uni.torun.pl