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Philosophy of Nature and Process Philosophy
Seventh annual meeting organized by The Whitehead Metaphysical Society
with the Philosophy of Nature and Natural Science Section of Polish Philosophical Society,
Ancient and Medieval Philosophy Department of the Pontifical Academy of Theology in
Krakow and the University of Silesia, Poland
8-9 May 2009

PROCESS CATEGORIES: THE METAPHYSICS, METHODOLOGY & MATHEMATICS

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EXTENDED ABSTRACT

To apply the metaphysical methodology of mathematics to the logic and form of process in natural philosophy requires a metaphysics above modelling, a methodology more than method and a mathematics beyond the set based topics of arithmetic, algebra, geometry and topology.

At the start of the twentieth century Alfred North Whitehead together with his former student Bertrand Russell was able to expound the form and logic of the mathematics of his day by the extensive treatment of axioms and theorems. The technical quality of this work found world acclaim and became the foundation for the advancement of science by the application of models still with us today.

Rather curiously the authors themselves were less impressed with their own work. Russell in the later editions of *Principia Mathematica* effectively renounced much of the foundation on which it is built. Whitehead recalls that when Frege's attention was first drawn to Russell's paradox, Frege's letter to Russell in response began, "Alas, arithmetic totters!" At the time they were in the midst of writing the *Principia Mathematica* and this event led Russell to introduce his notion of types. Whitehead concludes:

> Thus the number "three" as applied to entities of one type has a different meaning to the number "three" as applied to entities of another type. For example, if we are considering two types, there are two different meanings of the number "three". (*Essays in Science and Philosophy*, Rider 1948, page 79).

Thus while never showing quite the same explicit dissatisfaction as Russell, Whitehead seems only to stand by the earlier work where generally it is correct in some context. The significance for today is that any context of valid application is always extremely narrow, being confined to some retricted locality. The post-modern world of global interconnectivity, interoperation and open systems is well beyond any narrow validity. Degeneracy in the meaning of number is commonly ignored: the tottering nature of arithmetic hardly recognised. In physics ' measurement' as number is still paramount in the scientific method despite Gödel's proof that any system dependent that concept is undecidable. A recent

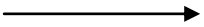
example where this has become apparent is the academic discipline of international economics. It is found wanting where it relies on a method of axioms and theorems.

Whitehead himself escalated his thoughts to a higher conceptual level with his metaphysics of process. However while he had a rich source to drawn on from the work of Grassmann, Frege and Hilbert to develop the form and logic of set theory in his *Principia Mathematic,* sadly he had no corresponding source to draw on for a formal presentation of *Process & Realiy.* This seems to have been no great problem for Whitehead but it may be for us. The history of thought well demonstrates that scientific ideas can only be widely disseminated, understood and applied when expressible in mathematical form.

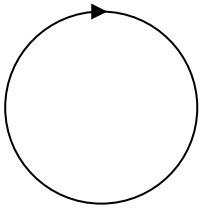
A mathematician of less calibre than Whitehead might have been tempted to pursue some formal primative representation of process but he made no attempt at this. Nevertheless since his time there has been advanced the subject of category theory relying on the concept of the arrow. More from historical reasons that subject has grown out of set theory and topology and therefore is based in the axioms of set theory. This is really rather restrictive because the underlying permanency inherent in the concept of the set is anti-process thinking. The application of categories in both pure and applied mathematics tends to proceed by way of the model approach from which Whitehead was able to escape into metaphysics. Metaphysics presupposes a top down approach and to treat that bottom-up, as in finitary category theory, proves rather awkward for it is contravariant.

A top-down approach begins with the Universe as process. The highest structure in category theory is the topos which can be identified as an arrow, itself containing distinguishable identity arrows. That is distinguishable in the manner that every entity in the Universe is different but related to every other entity. This identification of the Universe as process seems really self-evident in the sense that everything is process. This concept does not view the Universe as a container where things go on. Rather the Universe is just 'goings on'. This does not even need the concept of entity or 'thing'. Following Aristotle, types can be defined as categories. This is in effect only a label for a recursive process. Within the topos, arrows are components relating other identity arrows. Each identity arrow may itself be composed of arrows that relate other identity arrows.

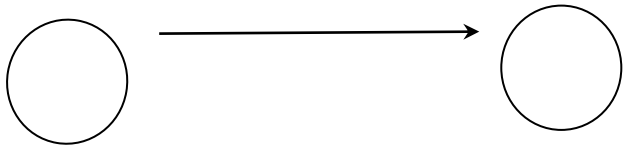
Therefore while sets are represenatable as number, process is representable as the arrow:



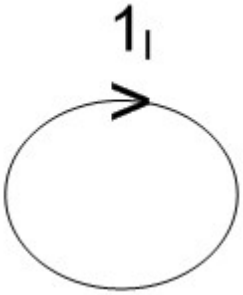
An arrow points in some ordered sense. That is it defines an ordering. At the highest level an arrow neither begins nor ends but just goes on. Alternatively this may be conceived as beginning with itself and ending with itself. In this situation the arrow identifies itself and is a 'being' or an 'object' which is the term used in finitary category theory.



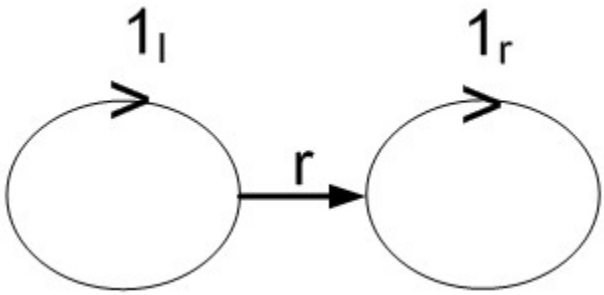
The arrow may begin on one entity and end on another.



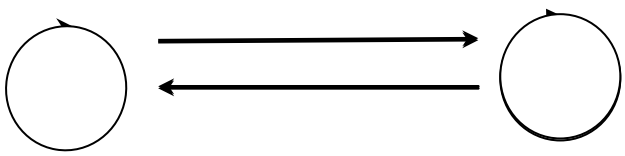
When the two beings are indistinguishable this is an isomorphism and would be given the same name.



Here the unit **1** indicates an identity and the subscript is an arbitrary label. If the beings are distinguishable then some other label is also needed.



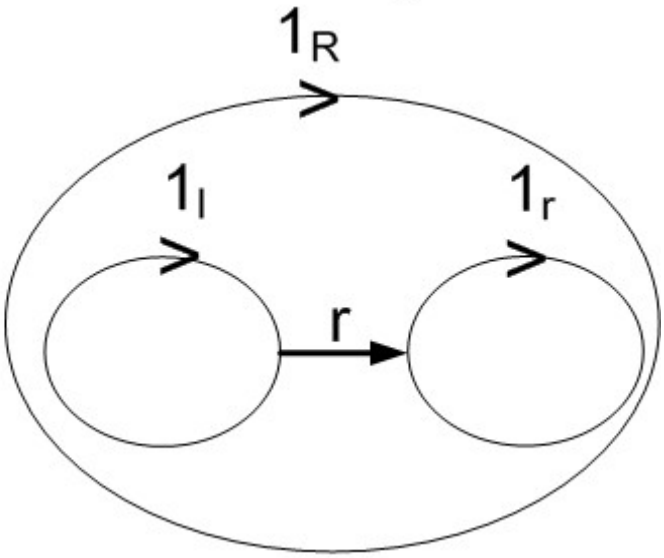
There the left hand being maps on to the right hand being. It would then be appropriate to give the arrow the label **r (**as like a function) it takes the values of the right hand being. Alternatively this can be viewed as a typing in the direction of the arrow. Here the left types the right. In process there is only one arrow and this arrow is just a subprocess where the left and right beings are really just the beginning and ending of the subprocess. An isomorphism is a special case of adjointness There is always an implied reiprocal arrow in the opposite direction:



This is Whitehead's 'prehension' where a being 'feels' another. In finitary category theory

the term used is ‘adjointness’. For an isomorphism each arrow will be the inverse of the other. The more general adjointness amounts to an equivalence equipped with two measures the unit and co-unit of adjunction. For an isomorphism these are respectively just the initial and final process. Otherwise they are values in the preorder between the initial and the final. A being is an intension for which there is any possible extension, adjoint to it.

Category theory is not retricted by the constraints of set membership. It therefore avoids the problems of independence and atomicity of elements. It avoids too the undecidability of Gödel as well as Russell’s paradox. It therefore has the the property of recursion to be found in the real world



It is recursive up (or down) to four levels, that is across three layers. There is closure at the fourth level because any higher level is an alternative equivalent level. These four levels in finitary category theory are known as ‘topos’, ‘natural transformation’ ‘functor’ and ‘category’. Thus the topos is the identity natural transformation or the top ‘being’. This can be identified with Whitehead’s ‘category of the ultimate’. It is the metaphysical universe which consists of relations between relations between physical entities. Perhaps more correctly it should be termed Meta-meta-physics.

It turns out that the topos has general properties that might have been predicted from our experience of the physical Universe. The logic is intuistionistic—Heyting not Boolean. The topos has no intrinsic number system although a natural number object can be defined if desired. It needs no axioms but can be freely generated by induction without assumptions or approximations.

This demonstrates the methodological strength of metaphysics over modelling. A model is by its nature always an inferior theory whereas the metaphysics is either superior or at least co-extensive with it. A model is a microcosm within the Universe whereas the Universe is an instantiation of the metaphysics. Consequently the mathematics of process categories is co-extensive with ultimate closure.