On Caesar=0

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§ 1 Abstract

- Frege found it problematic that his logicist project did not rule out the identification of Caesar with the number zero.
- Since the logicist project must be given up on, the problem in its original formulation is no longer of interest.
- We nevertheless treat the question ‘Is Caesar=0?’.
- We show the perhaps surprising result that it is perfectly consistent with our best scientific theories that Caesar is 0.
- More generally, we show that any “abstract object” may be identified with a space-time object; furthermore, the number of abstracts objects that may be simultaneously identified with space-time objects is equal to the cardinality of the set of space-time objects.

§ 2 Quine on arithmetic

Here is what Quine has to say:[1]

> The subtle point is that any progression will serve as a version of number so long and only so long as we stick to one and the same progression. Arithmetic is, in this sense, all there is to number: there is no saying absolutely what the numbers are; there is only arithmetic.

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[1] Quine, W.V. (1968), Ontological relativity, The Journal of Philosophy, volume 65, number 7, pages 185-212.

§ 3 Expanding on Quine's observation

- Science needs natural numbers, in one form or another.
- The only requirement on the natural numbers is that they form a progression.
- That progression may start with Julius Caesar.
- That progression may just as well start with any other object.
- In particular, the progression may start with a “postulated” object about which very little else is assumed.

§ 4 Abstract and concrete objects

- In philosophical contexts, it is often assumed that numbers are distinct from concrete objects such as tables, chairs, and Roman dictators.
- Why assume that?
- We grant that our best theory of the world does not identify Caesar with the number zero.
- It does not follow that said theory distinguishes Caesar from zero.
- Unless a theory T is complete

  $$T \nvdash a = b$$

  does not imply

  $$T \vdash a \neq b.$$

§ 5 Incompleteness

- By Gödel incompleteness, no one can be expected to provide a theory that decides every question about natural numbers, not even questions about how they relate to each other.
- Presumably, even less so for questions regarding their relation to Caesar!
- We take it that, if T is our best theory of the world, we have both

$$T \nvdash \text{Caesar} = o$$

and

$$T \nvdash \text{Caesar} \neq o$$

§ 6 What about the other numbers?

- If we identify 0 with Caesar, we cannot---on pain of contradicting our best scientific theories---simultaneously identify 1 with Caesar.
- According to our best scientific theories, there are infinitely many numbers.
- Thus, in order for us to simultaneously identify each of them with a concrete object, there has to be at least as many concrete objects as there as numbers.
- Are there infinitely many concrete objects?

§ 7 Consistency and empirical equivalence

- That ‘Caesar=o’ is consistent with one of our best theories T does not imply that adding ‘Caesar=o’ yields a theory T' that is empirically equivalent to T: T' might prove more statements about concrete objects than T does.

- For a simple counterexample, suppose that C and D are logically independent claims about concrete objects, that A is a non-tautological claim about abstract objects, and that the theory T consists of the claims C and (A → D).

  Although T ⊬ A and T ⊬ ¬A, we have T+A ⊢ D but T ⊬ D.

  One could say that, relative to T, the hypothesis A has empirical consequences.

- We believe, however, that adding the assumption that Caesar is o to our best scientific theories has no such consequences.

§ 8 Science without numbers?

- Nominalism is the thesis that everything is a concrete (space-time) object.
- In Science without numbers, Hartry Field famously argued that, provided that the concrete universe consists of infinitely many space-time regions, one can formulate a nominalist and empirically equivalent version of modern physics without postulating the existence of numbers.
- Our point is that---provided that space-time does indeed contain infinitely many concrete objects---a nominalist version of modern physics can be obtained by simply identifying numbers with some of these objects.

§ 9 Nominalism for free

- It can be shown that, for any axiomatizable first-order theory postulating infinitely many concrete objects, one can easily construct a nominalist rival agreeing with the first as far as concrete objects are concerned.[1]

- Essentially, the nominalist rival states that the concrete universe contains a "map" of itself[2] satisfying a trivial translation of the original theory into "map-language" (obtained by simply replacing each predicate with its "map-counterpart").

- Insofar as the original theory postulates abstract objects, the rival only postulates objects that are not part of the map.

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[1] Johannesson, Eric (2022, pp. 14-15), On the indispensability of theoretical terms and entities, Synthese 200, 136, doi.org/10.1007/s11229-022-03683-1

[2] In technical terms, an isomorphic substructure.