Instrumental Devices

A central and unifying theme in formal philosophy of the twentieth century was the study of purely instrumental uses of language in different fields. Roughly put, this can be understood as the focus on linguistic expressions that are viewed as formal or non-representational but nevertheless as theoretically indispensable or at least instrumentally useful for certain purposes.

In this talk, I will present a general study of such *instrumental devices* and their logical properties as exemplified in three different philosophical debates. In particular, the focus will be on the introduction of such devices in the following contexts: (a) the use of non-representational forms of language in the foundations of mathematics, most importantly, in the formalism related to Hilbert's program of the 1920s and 1930s (Hilbert 1926, 1928) as well as in subsequent instrumentalist philosophies of mathematics, e.g. in Field's reconstruction of applied mathematics in *Science without Numbers* (1980). (b) Roughly at the time of Hilbert's program, instrumental devices were also first studied in formal philosophy of science in the wake of logical empiricism. This has led to different contributions to the logic of science (or *Wissenschaftslogik*), including a focus on theoretical languages and theoretical terms in the so-called "syntactic view" of theories in work by Carnap and Hempel (cf. Carnap 1956, 1958). (c) Finally, starting with Tarski's seminal work on the formal definition of the notion of truth in 1933/1935, philosophers and logicians have investigated the logical behaviour of a truth predicate both from a model-theoretic and an axiomatic perspective. This study of truth languages has been accompanied with a more philosophical investigation of the minimal or lightweight nature of truth, leading to different forms of deflationism in the recent literature on truth theories (cf. Cieśliński 2017).

These philosophical debates clearly differ from each other, both in terms of their subject matter and the reasons for the instrumentalist views defended in them. For instance, talk of the purely formal character of mathematical and theoretical terms was usually motivated by a general empiricist outlook or a critical attitude towards metaphysical assumptions, e.g., concerning the existence of abstract objects or a realist understanding of theoretical languages. Another (yet related) motivation, most explicitly developed in Hilbert's program, is a form of epistemic foundationalism and the aim of grounding some field of theoretical inquiry on a secure basis. Finally, an underlying motivation for an instrumentalist account of truth theories is the deflationist conception of truth mentioned above, viz., the view that the notion of truth is merely a logico-linguistic device without substantial content (cf. Fischer 2015).

Nonetheless, there are also interesting points of contact between these philosophical debates. In particular, what connects them is the shared focus on the role of instrumental devices in a given theoretical context. Thus, what is shared is the introduction of terms or expressions without a specified meaning or semantic interpretation, solely based on their usefulness in the respective field of inquiry. Moreover, there are striking similarities between these debates on a more abstract level, concerning the metatheoretic justification of such instrumental uses of language. This concerns the justification of "ideal" logico-mathematical expressions (as opposed to "real" ones) in mathematical

reasoning in Hilbert's program, and similarly, the general role of mathematical languages in application to physical theories in Field's nominalistic program. Analogously, a central thread in Carnap's writings on the logic of science concerns the indispensability of the theoretical terms in addition to the observational vocabulary for the formulation of general scientific laws. Finally, deflationists about truth discuss the proper axiomatic specification a truth predicate and its instrumental role with respect to an interpreted base theory (usually some form of Peano arithmetic).

Based on a closer comparison of these debates and the mentioned similarities, we will present a general framework for the study of instrumental devices, their possible roles in a theoretical context, and their philosophical justification. Specifically, the focus in the talk will be twofold. First, to analyze different ways in which the introduction of such a device to a given theoretical language can be justified. This relates to the question how the concepts of *reliability* or *adequacy* of the use of such linguistic expressions can be characterized formally. To address this, it will be important to note that instrumental devices are usually specified relative to a given theoretical background. Thus, the notion of instrumental devises is inherently *theory relative*. Take, for instance, Carnap's mature work on logical theory reconstruction where the introduction of theoretical terms is always specified relative to a set of theoretical postulates and correspondence laws connecting the terms to the observational vocabulary of a theory. Similarly, in the context of axiomatic truth theories, the introduction of a truth predicate to a language of arithmetic usually comes with the specification of certain truth axioms that function as "meaning postulates" for the predicate. Consequently, criteria of adequacy or reliability for such instrumental devices are to be specified as *intertheoretic relations*, that is, as metatheoretically defined relations between axiomatic theories expressed in formal languages. In the talk, we will introduce three general metatheoretic concepts suggested for the explication of the reliability of instrumental devices, namely (semantic and syntactic) *conservativity*, *relative interpretability*, and *proof-theoretic reducibility* (cf. Feferman 1988, 1998). Given a brief presentation of these concepts and several metatheoretic results concerning them, we will discuss how they are used in the philosophical contexts mentioned above.

The second general topic addressed in the talk concerns the proper semantic analysis of instrumental linguistic devises. As mentioned above, expressions such as theoretical or mathematical terms have often been characterized as non-representational or formal or as without semantic content. Nonetheless, the recent philosophical literature on the topic contains several systematic proposals how a proper yet non-classical semantics for such terms can look like. This includes, in particular, recent work on a supervaluationist or "modal" semantics and a *Ramsey* semantics for both theoretical and mathematical terms (cf. Andreas 2010, Leitgeb 2022). In the talk, we will briefly survey these general proposals and see how they connect to the discussion of instrumental devises in the mentioned philosophical debates.