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Analytic Method

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ABSTRACT: This paper proposes a non-trivial definition of the notion of analytic method. Working within the so-called instructional model of method, I distinguish three kinds of instructions which occur in methods: *selective, executive*, and *declarative* instructions. I discuss the relation between each of these and the analyticity of a method. Then I define the notions of an *analytic use* of an instruction and of an *analytic instruction*, which are at the basis of the proposed definition of an analytic method. Finally, I discuss the issue of circularity in the presented model which arises if we consider a finite agent testing a method for analyticity.

KEYWORDS: Analytic method – analytic proposition – closure – instruction – knowledge base.

0. Introduction

The notion of an analytic method is widely used but rarely characterized.[1] Methods such as defining, explication or conceptual analysis are often considered analytic, but it is not clear which specific features lead to analyticity. The aim of this article is to provide a definition of *analytic method*. The defi-

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nition should be non-trivial, i.e., not all methods should turn out to be analytic but at least one should.

I assume that an analytic method can be used without undertaking empirical research as a necessary component of any of the steps prescribed by the method.[2] Thus the use of an analytic method enlarges the researcher's knowledge without traversing the logical closure of such knowledge. In other words, one uses an analytic method to obtain, decode or make explicit information which is hidden, encoded or entailed by the information in a preexisting knowledge base.

The paper is divided into the following sections. Section 1 contains a brief specification of my theoretical framework. In Section 2, three types of instructions are introduced. In Sections 3 and 4, I further deal with selective instructions and the problems of information gain they present for the instructional model of methods. The roots of the problem are described in Section 5 and the role of information access is discussed there as well. In Section 6, I deal with the role of information access by distinguishing three different kinds of knowledge bases. Section 7 proposes definitions of analytic instruction and analytic method. Section 8 discusses the role of declarative instructions. It is followed by a case study about the analyticity of the method of explication in Section 9. In Section 10, I discuss the problems of a finite agent testing a method for analyticity. The paper ends with a brief concluding summary.

1. The framework

I presuppose some features of the instructional model of method presented in Bielik – Kosterec – Zouhar (2014a; 2014b; 2014c; 2014d) and exemplified, e.g., in Halas (2015a; 2015b). This model views a method as a systematic guide for reaching some epistemic goal. More precisely, any method is an ordered set of instructions which, when followed, lead one to a given goal. The use of a method is usually driven by a problem that cannot be resolved within one's knowledge base, i.e., the set of knowledge the agent uses. Hence, a method can be used to change that knowledge base in

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2 Analytic methods can, of course, be used to analyze the results of a *previous* empirical research.

order to resolve the problem. For example, one might not know whether a formula of propositional logic is a tautology. She can use the truth table method for solving this problem.

A method usually prescribes a series of steps. When following any of the steps, we are involved in a process specified by the method. Methods and processes are therefore closely related. There are a variety of systems used to model processes in general, like procedural models (see, e.g., Duží – Číhalová – Menšík 2014) or Petri nets (cf. Murata 1989). The instructional model views methods as composed of instructions, usually expressed by imperatives. I take imperatives to have semantic content *sui generis*. In general, they denote a relation between input states and output states. Below, I examine instructions that denote relations among states of knowledge. The features of a method are studied using the compositionality principle in the following form: The relevant features of the method are determined by its instructions and their composition. Thus the definition of *analytic method* shall specify some constraints on instructions and/or their composition. In the next section, I present a typology of instructions which will be later used to specify these constraints.

2. A typology of instructions

According to the instructional model, a method is an ordered set of instructions. In the context of the AMESH research project,[3] several methods have been studied within this framework – modeling, defining, explication, idealization, conceptual analysis, etc. Instructional models were developed for the methods of explication and sampling (Bielik – Kosterec – Zouhar 2014d), as well as abstraction and idealization (Halas 2015a) or definition (Zouhar 2015). The methods were specified in an idealized form (i.e., without context of use)[4] and their use was described in some case studies. For the purposes of the present paper, the main result of this previous work is that

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[3] See http://www.amesh.sk/english.

[4] The papers cited also abstract from the explicit notion of an agent. Although here, when speaking informally, I sometimes mention an agent, I do not presuppose one explicitly in the instructions. There are different ways of viewing knowledge base: information in the set can be considered in relation to an agent, but also without regard to an agent, simply as a problem base.

one may roughly distinguish three types of instructions which occur in methods: *selective*, *executive* and *declarative*.[5]

Selective instructions order an agent to pick one of the possible ways to proceed further in a process. For example, the agent may be instructed to choose the number of samples which will be studied later. Selective instructions can also task an agent with picking an arbitrary value which is required for subsequent steps of the method – e.g., with picking a natural number from a range as an initial guess which is later improved upon.

This selection is seldom completely arbitrary. Usually some filtering features are specified. For example, consider the following two selective instructions:

A) Pick a natural number!
B) Pick an even natural number!

Instruction B is more specific than instruction A. Selective instructions are the main source of indeterminacy of methods. Hence even though a method is stated as a set of instructions, its result may nevertheless be undetermined.

The second type of instructions is *executive instructions*. As providers of the actual computation steps of the procedure formulated in the method, they form the core of a method. While selective instructions order an agent to acquire input parameters from her environment, execution instructions specify a computation using these parameters. Usually, selective instructions provide the material, so to speak, and executive instructions build further on that material.[6] Some examples of executive instructions are:

Find the greatest common divisor of numbers *a* and *b*!
Solve the equation *E*!
Compute the median value of the measurement data!

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5 These are types of *simple* instructions. *Complex* instructions contain other instructions.

6 Of course, selective instructions are not the only providers of material for executive instructions – one executive instruction can provide material for another one as well.

Similarly to a practice common in programming, where existing code is often reused as part of a larger task, or in logic, where proofs are used within other proofs, a method can itself serve as an executive instruction within another method.

The third type of instructions is *declarative instructions*. They prompt an agent to publicly declare her results. Some examples of declarative instructions are:

Declare that there is no largest prime!
Declare the number of inhabitants of the capital city!

The term "public" as used here is very general. It covers cases such as a classroom full of students or the set of readers of an academic journal. It may also simply be the agent herself. From a general point of view, the nature of the audience can be disregarded. The important feature of these instructions is that the agent assumes the declared results as true in further work.

3. The information value of selection

Assuming the instructional model of method, a specific kind of instructions often occurs (among others) in the methods thus reconstructed. These instructions have at least one common feature: they instruct the agent to pick an object. The object may be a material or an abstract entity or even a set of such entities. Usually, the agent chooses from various possibilities provided either by her knowledge or by her actions using that knowledge. In general, these instructions are a source of indeterminacy in the method. One cannot determine, at least not solely on the basis of the instructions themselves, which object will be selected.[7]

[7] One way of looking at this is as a branching of the ways in which the knowledge of an agent can be enhanced, if she follows the method. A selective instruction prescribes a choice, not the object to be chosen. Different choices may thus provide different ways of enhancing knowledge of the researcher. This can be modeled, for example, in a tree. Another kind of branching occurs when a method includes complex instructions, i.e., instructions composed of sub-instructions (e.g., "Stand up and shut the door!"). In Bielik – Kosterec – Zouhar (2014b; 2014c) we modeled only hypothetical instructions of the form "*if … then … else*" as leading to branching.

The notion of selection from many possibilities is closely related to the notion of probability. The theory of information assigns information value to selections (cf. Shannon 1948). Roughly stated, the lower the probability, the higher the information gain, if there is some at all. The notion of information is also closely related to the notion of knowledge (see Abramsky 2008). My aim here is to argue that, contrary to intuitions, selective instructions do not present any relevant information gain. From this point of view, not all of the information about an agent's progress is relevant. What matters are the changes of the information states of the knowledge base.

4. The problem of selective instructions

If we include information provided by selective instructions into our model, we face indeterminate changes in the knowledge base.[8] To avoid this, we could exclude that piece of information, but this should not be a simple *ad hoc* adaptation. I shall now show that the problem of indeterminacy due to selective instructions arises from neglecting the role of information access in the instructional model.

Bielik – Kosterec – Zouhar (2014a; 2014b; 2014c; 2014d) did not state any conditions for the analyticity of method. One of the reasons was the very problem of selective instructions. On the one hand, it was clear that they do not present any relevant information or knowledge gain. On the other hand, all instructions were modeled as possible knowledge changers. The original model did not deal with the indeterminacy brought about by selective instructions. Therefore, it faces the problem that the use of a selective instruction surpases the logical closure of the initial explicit knowledge base. Hence, any method containing a selective instruction wouldn't fit our intuitions about an analytic method.

One way to solve this problem is to simply leave out the selective instructions when testing the method for analyticity. The main problem of this approach is that of justifying it in a non-*ad hoc* way. Another solution would be to pick out some relevant part of the knowledge base and test the analyticity of a method only with respect to the logical closure of the selected part of the

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[8] These changes are indeterminate in the way that a) they are not constant and b) they are not entailed and cannot be exactly predicted.

base. But again, the problem is how to justify such an approach in a non-*ad hoc* way.

In testing methods for analyticity, the analyticity of instructions should be the key indicator.[9] The first approach disregards selective instructions, but for no good reason. The second approach views the information gain provided by selective instructions as irrelevant, but again, for no good reason. Both approaches assume that selective instructions ought to be left out. But is that so?

5. Information access

The main piece missing in the instructional model of method is a model of the flow of information between the agent, her explicit knowledge base and her operational knowledge base. The difference between the explicit and the operational base can be described as follows. Imagine yourself using a notebook computer. Its hard drive contains some explicit data. It certainly does not contain all the logical consequences of those data. After you sign into your account, not even all of your explicit data are accessed all at once. They are only *accessible*, not *accessed*. You first pick some of the information stored on your hard drive to access it, and then proceed to make changes to it. Afterwards you may save the changes or cancel your work. The hard drive here is analogous to the explicit knowledge base. The information you accessed – e.g., documents opened, music played, etc. – is analogous to the operational base.

The instructional model of method does not presuppose this difference between information that is accessible and information that is actually accessed and worked with.[10] However, there occurs an important flow of information between them. A model that is able to capture this would not be *ad hoc*.

[9] Further analysis would be required as to whether the analyticity of instructions is similar or related in some way to the analyticity of propositions.

[10] The dividing line between accessible information and information actually accessed requires a more detailed examination which must be postponed to a different occasion. Of course, at a closer look, the dividing line could appear much less strict than it is supposed here.

Below, I shall model information access connected with instructions. The main idea is as follows: selective instructions provide access to information from the explicit knowledge base. They therefore do not change the information state of this base. One does not modify information merely by accessing it. Selective instructions simply retrieve some of the information already included in the knowledge base and provide it to the operational base. Consider, again, the analogy with one's work on a computer: one does not change a document by opening it. Similarly, in the context of a method, the change of information may only be due to executive instructions.

6. Executive instructions vs. selective instructions

A common feature of all three types of instructions is that they describe steps between the states of some knowledge base. It is important, however, to distinguish between three different knowledge bases.[11]

The *explicit knowledge base* of an agent can be viewed as a base of all information accessible by selection. In other words, an agent need not provide any thoughtful step to obtain information from this base.[12] The *operational knowledge base* represents the information already accessed. This base contains the propositions the agent is currently working with (e.g., a finite set of axioms when proving a theorem). The *implicit knowledge base* represents the bounds of analyticity of the initial explicit knowledge base. We can think of it as a logical closure of the explicit knowledge base.[13] A selective instruction

[11] For the purposes of this paper, knowledge base can be viewed simply as a pair of a universe (a set of objects) and a set of propositions.

[12] Of course, selection may require *some* work in advance (e.g. an agent will have to pick some information within a specific range).

[13] The need to differentiate between explicit information and its closure is well established in epistemology (see, e.g., Dretske 2005) and computer science (cf. Vardi 1989). The consensus is that an agent need not know all of the logical consequences of her knowledge (see also Jago 2014, Ch. 6). The difference between logical entailment and knowledge closure is discussed in the approach of relevant alternatives (see Holliday 2012; 2015). From a technical point of view, the set is closed on an operation if it contains the results of the application of that operation on all its members. For example, the set of natural numbers is closed on the operation of addition. The closure of explicit initial knowledge base presupposed here is the union of the *validity*

provides a step from a state of the explicit knowledge base to a state of the operational knowledge base. It may also provide a step between states of the operational base (e.g., the agent selects a possible way of proceeding further). A declarative instruction provides a step from a state of the operational base to a state of the explicit base.[14] Finally, an executive instruction provides a step between states of the operational base.

I shall now clarify the difference between selective and executive instructions. It seems that the intersection of these two sets is not empty: selective instructions may apparently provide steps between states of the operational base, such as when one chooses from several possibilities during computation. However, I propose to model selective instructions exclusively as steps from states of the implicit knowledge base to states of the operational base.[15] In the previous section, I argued why we need not consider the information provided by a selective instruction as relevant. When a selective instruction serves as a step between two states of the operational base, this means that we are at a point of the process where previous executive instructions have already provided us with some results. The following steps of the method require us to select from these preliminary results. This selection is not predetermined. But as long as the possibilities were obtained by analytic instructions,[16] they should be included in the implicit knowledge base of the agent, i.e., the logical closure of the explicit knowledge base. Thus, in the case of

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closure, the *closure on logical entailment* and the *closure on semantic analysis*. I also presuppose that the explicit initial knowledge base contains all of the relevant mathematical theories. The validity closure of the explicit base contains all sentences which are true whenever all sentences of the explicit base are true. The logical closure of the explicit base contains all the logical consequences of sentences included in the initial explicit knowledge base. The closure on semantic analysis of the explicit base contains all relevant semantic parts of the sentences in the explicit base.

[14] The result of a declarative instruction (i.e. declaration) possibly enriches the explicit base. Therefore, it possibly changes its state.

[15] In some methods, perhaps, an executive instruction has to be executed to make a step from the implicit base to the explicit base possible. I do not consider such cases in this paper.

[16] I define this term in Section 7. Simply put, the execution of an analytic instruction (which possibly results in a change of the operational knowledge by some proposition) never results in a proposition which is not included in the implicit knowledge base.

analytic methods, we can model selective instructions as steps from states of the implicit knowledge base to states of the operational base. Therefore, the set of selective instructions and that of executive instructions are disjoint.

But how can we know whether this is in fact possible? The possibility hinges on the assumption that all of the executive instructions preceding the given selective instruction are analytic. If the method is not analytic, it is because it contains at least one non-analytic executive instruction (i.e., an instruction which provides us with a proposition that is not in the implicit knowledge base and by doing so broadens our initial knowledge). In this latter case, the proposed transformation of selective instructions may not work. Thus, when testing a method for analyticity, we need to look no further than at the executive instructions which can be clearly differentiated from the selective instructions.

7. Analytic instruction and analytic method

Until now, I have distinguished three types of instructions, arguing that only executive instructions should play a role when checking a method's analyticity. The difference between selective and executive instructions has been based on the notion of *analytic instruction*. This section aims to specify this notion.

A useful distinction that will be important later is one between an instruction and its manifold uses. The same instruction can accept different inputs and it can also be used more than once within the same method. Generally, the use of instruction is the application of the instruction to some input.

Now, let me introduce the notion of the *descriptive result of the executive instruction* (DRE):

> The DRE of the executive instruction *I*, which provides the output *b* for the input *a*, is *a-I-b*.

a-I-b is a structured description of instruction *I* accepting input *a* and leading to the result *b*. The structure is very simple. Its only use is in distinguishing the input of the use of instruction (*a*), the instruction itself (*I*), and the result of the use of instruction (*b*). For every use of the instruction there is a corresponding description. However, the DRE is not a proposition – it is just a structure. In methods used in science, the input is an object from the state of knowledge base (the reader is reminded that the base is a pair of a set of objects and a set of propositions). The use of an instruction (i.e., its execution accepting a given input) provides us with an object (*b*) which enriches the universe of the knowledge base.[17] The use of an instruction also enriches the set of propositions of the knowledge base by a descriptive proposition.[18] Therefore, the use of an instruction possibly changes the state of the operational knowledge base of the scientist.

There is one specific proposition that can be assigned to each DRE. The proposition is obtained in the following way. The semantic analysis of an instruction reveals a semantic operator which is central to the instruction. For example, the main operation of the instruction

I) Add numbers *a* and *b*!

is the operation of addition (*add*). My task here is not to specify the method for identifying main operation of an instruction. I simply presuppose that there is such an operation for every instruction. Of course, this strong assumption may appear incorrect due to the vast number of kinds of imperatives. A more detailed justification of this assumption would require a thorough investigation into the semantics of imperatives. The main reason for making this assumption here is the semantic principle of compositionality. According to this principle, for every complex semantic unit[19] there is a tree structure which represents how simpler semantic units are composed to form the complex unit. Any tree has a single root node which is the result of the application of the last operation to combine the simpler semantic parts into the final, complex one.

Further, I presuppose that for every main operation in an imperative there is another closely related operation. In my example, the main operation was *add*, and the corresponding other operation is +. This needs closer examination. Let us compare the two structures:

a) Add 2 and 3!

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[17] That is, operational knowledge base.

[18] I shall return to this shortly. Here it suffices to state that the descriptive proposition conveys information about the result of an instruction accepting some input.

[19] From the structuralist point of view, a proposition is a structured semantic unit. Imperatives are structured semantic units as well.

b) 2 + 3

I argue that *add* and + have different semantic contents. This is readily seen from the fact that in structure a), *add* is unary (it applies to the complex *2 and 3*), while in b), + is binary. Another difference is that by combining the operation *add* with its argument we compose an imperative, whereas by combining + and its arguments we compose a number (or a construction of a number), but certainly not a proposition. Therefore it is reasonable to consider the semantic content of *add* and + as different.

Nevertheless, there is a close connection between these two operations. The main semantic operation of the imperative (*imperation*) prescribes some action on its input. The result of the prescribed imperation is exactly the same object which is denoted by the corresponding complex structure b). I use the DRE to explain the connection:

The DRE of imperative a) is: 2, 3-Add x and y!-5.

We can describe the result of b) as follows:

c) 2 + 3 = 5

We obtain this proposition from the DRE as follows. We first obtain the input of the DRE (2, 3). Then we obtain the imperation of the instruction of the DRE (*add*). This imperation is closely connected to the operation (+). We apply the operation to the input arguments and obtain the result (5). This is described by the proposition c). In a similar way, *any* DRE can be assigned a *descriptive proposition*.[20]

Finally, I can turn to formulating the definitions. First, let me define *the analytic use of an instruction*:

Def 1: The use of instruction *I* is *analytic* iff its descriptive proposition is analytic.[21]

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[20] Of course, this needs further investigation. At the moment, if the assumption of a close connection between imperations and operations is correct, then the acquisition of a descriptive proposition from any DRE is a straightforward process.

[21] This paper does not specify the notion of *analytic proposition* and simply presupposes it. Some models of analytic propositions are provided, e.g., by Duží (2010 and 2013).

The descriptive proposition is assigned to a particular input-output pair provided by the use of the instruction. The instruction usually generates a whole relation and not only one such pair. A more general definition is thus required:

Def 2: The instruction *I* is *analytic* iff all its uses are analytic.

Here, the distinction between the analytic use of an instruction and the analyticity of the instruction itself is crucial, simply because for some instructions only some of their uses are analytic.[22]

Testing an instruction for analyticity is by no means an easy task. I discuss some features and possible problems of such testing later. With the two previous definitions at hand, I can now specify the conditions of analyticity of methods viewed as ordered sets of instructions:

Def 3: The method *M* is *analytic* iff all uses of its executive instructions are analytic.

How does one go about testing a method for analyticity? One has to analyze uses of its executive instructions. Sometimes it is possible to generalize about them. One then has to check whether all executive instructions included in the method lead to analytic descriptive propositions. DREs can be used for this purpose.

8. Declarative instructions

Selective instructions provide access to accessible information, while executive instructions prescribe actual computations of the method. The last

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[22] Consider the following instruction inspired by Cmorej (1996): Test whether *x* is as old as Peter! The result of this test for some object is either *True* or *False*. Consider an object, *A*, different from Peter. Suppose we made the testing and the result was *False* (e.g., *A* is younger than Peter *at the time of testing*.). The DRE is: "A-Test whether *x* is as old as Peter!-*False*". The descriptive proposition is: "Test whether (*A*) is as old as Peter = *False*". But this proposition is not analytic. It is possible (perhaps in some other world) that *A* is as old as Peter. On the other hand, if we use this instruction with respect to Peter, then the result will always be *True*. Hence, for some instructions, only some of their uses are analytic.

type of instructions is declarative instructions. Should they be tested for analyticity?

The general scheme for a declarative instruction is:

Declare *A* to be in relation *R* with *B*!

A semantic analysis reveals that the main operator (besides exclamation), is *to declare*. Therefore, the main operation provided by a declarative instruction is declaration or public announcement. The field of public announcement logics is already well established (see Baltag – Moss – Solecki 1998; Wang 2013). A common view is that the public announcement of a proposition changes the situation of an agent in that after the announcement, she takes the proposition to be true. What happens is an update of the agent's knowledge base. Above, I discussed the closures on initial explicit knowledge base of the agent. Consider now the operator of declaration. It does not seem to be analytic, necessary or determined – one cannot predict what will be declared.

If we include declarative instructions among instructions tested for analyticity, the results will be practically trivial. All methods containing a declarative instruction will not be analytic. This situation is similar to the one we have seen above, with selective instructions. On the one hand, it seems that declarative instructions are part and parcel of methods. On the other hand, their inclusion seems to leads to surpassing the limits of the closures of the initial explicit knowledge base.

The remedy could be seen, again, in considering the role of the information access. The difference between selective and executive instruction was that executive instructions do not operate on the explicit knowledge base. They do not access information – what they do is computation (in a very general sense) using information already accessed. Now, consider declarative instructions. Rather than providing computation using accessed information, they provide updating of the explicit knowledge base with respect to the results obtained by executive instructions. In our computer analogy, what they do is saving changes. Declarative instructions usually provide a statement which explicitly names or labels some element. Could we leave these instructions out of testing for the analyticity of methods? Again, a positive answer based on non-*ad hoc* reasons is required.

The role of declarative instruction is to declare a result obtained by previous instructions. The declaration of result is not a result in itself. If a result of some executive instruction is not analytic, the announcement of the result can do nothing to change that. Thus the analyticity of a result is independent of the announcement. In other words, it would be strange to consider a proof as non-analytic just because it was published or announced. Therefore, the testing a declarative instruction for analyticity is redundant.

9. Case study

Bielik – Kosterec – Zouhar (2014d) proposed a model of the method of explication. Here is its simplified version:

1. Select the content, A, which does not provide the required theoretical functions!
2. Declare the content A to be the explicandum!
3. Select the contents, B, C, D, which are to be used!
4. If the contents are not clear enough, then clarify them, else construct the content, E, out of B, C, D!
5. Test whether the constructed content is theoretically valuable!
6. Declare the content E to be the explicans of the content A!

The first step in testing this method for analyticity is dividing the instructions involved into selective, executive and declarative. Obviously, instructions 2 and 6 are declarative. These will not be tested for analyticity. Instructions 1 and 3 are selective. They presuppose availability and accessibility of the contents A, B, C and D, and they merely provide us with access to these contents. Instructions 4 and 5 are executive. Let me now describe their testing.

Instruction 4 is a complex instruction of the form "*if … then … else …*". The instructions in each of the clauses need to be tested individually – the entire instruction is analytic only if all the instructions in all clauses are analytic. The first clause includes the method of clarification. This is an example of a method being used as an executive instruction in another method. Thus, the analyticity of the method of explication depends on the analyticity of the method of clarification.[23] The second clause contains an instruction that leads us to construct content out of some specified building blocks. The main op-

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[23] The method of explication is therefore a complex method which has another method as its subpart.

erator of this instruction is *to construct* and the associated operation is construction. The construction of content out of specified parts seems unproblematic. Therefore, the corresponding descriptive proposition can be considered analytic. Instruction 4 is therefore analytic if the method of clarification used is analytic.

Instruction 5 is a testing instruction. It assumes that some criteria of theoretical value are specified. A constructed content enters as input and the output is a positive or negative answer. Let BCD be the content constructed in the previous instruction. The DREs are

BCD-(Test for value)-is valuable.

or

BCD-(Test for value)-is not valuable.

The descriptive propositions are:

BCD is valuable according to the test.

or

BCD is not valuable according to the test.

The analyticity of this instruction obviously depends on the analyticity of the method of testing.

To summarize, we can see that the method of explication as stated here contains other methods. The analyticity of the former therefore depends on analyticity of the latter. If all the methods contained are analytic, then the whole method is analytic. In this section, I described using the proposed definitions. First we have to select the executive instructions. Then we have to check their uses. If an executive instruction is method in itself, then we must check this method for analyticity.

10. The problem of analytic test

So far, I have discussed the kinds of instructions involved in methods and their influence on analyticity of methods. I argued that only executive instructions should be taken into consideration. Let me now turn to one more possible source of problems.

The definition of analytic instruction is ultimately based on the notion of analytic proposition. Thus, the ability to distinguish analytic and non-analytic propositions enables one to distinguish analytic and non-analytic instructions (at least within the model proposed here). The crucial question here is *how we test propositions for analyticity*. The simple, off the cuff answer seems to be that we apply some testing methods. This, however, raises another question. Should we use analytic methods in order to tell analytic propositions from non-analytic? A negative answer seems strange. If non-analytic tests were used in testing for analyticity of propositions, this would make our knowledge of analyticity dependent on empirical factors. It seems that the tests must be analytic. But this makes our knowledge of analyticity of propositions dependent on analyticity of some method. Have we come full circle?

The issue is related to the cardinalities of the set of analytic methods and the set of analytic propositions. It is clear that if there were only one analytic method and only one analytic proposition, our model of analytic methods would be circular. The method would be analytic because the proposition is analytic, and we would only ever know that the proposition is analytic because the method is considered analytic. But what if the number of methods is not finite? Once again, after a while, we get circularity. After using up all analytic propositions from the finite set we would need another to support the analyticity of some testing method. So it seems that we should presuppose that both sets, the set of analytic methods and the set of analytic propositions, are infinite. This then need not lead to the circularity mentioned. The drawback here is that we are finite entities which can only provide finite tests. We therefore have to consider some method or proposition to be analytic without justification prescribed by the presented model of analyticity of the methods.

The reason for the circularity is that the testing methods for analyticity of propositions should be analytic. I call this *the problem of analytic test*, which is due to our notion of analytic method presupposing that we, as finite agents, know at least some analytic propositions beforehand without any test.

11. Conclusion

The main aim of this paper was to provide a definition of the notion of analytic method. Using the instructional model of methods, I distinguished three different types of instruction. Selective instructions are used to access information or to provide steps undetermined by the method itself. Executive instructions provide the actual computation steps of the method. Declarative instructions serve to declare the results obtained by the method.

I conditioned the analyticity of method by the analyticity of executive instructions involved. An executive instruction is analytic if descriptive propositions obtained from the descriptive result are analytic. I therefore conditioned the analyticity of methods by the analyticity of propositions. However, as soon as we consider the role of finite agents in testing of methods for analyticity, the problem of analytic test arises.

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