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What Is (Modern) Logic Taken to Be About and What It Is About

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ABSTRACT: Since Antiquity, logic has always enjoyed a status of something crucially important, because it shows us how to reason, if we are to reason correctly. Yet the twentieth century fostered an unprecedented boost in logical studies and delivered a wealth of results, most of which are not only not understandable by non-specialists, but their very connection with the original agenda of logic is far from clear. In this paper, I survey how the achievements of modern logic are construed by non-specialists and subject their construals to critical scrutiny. I argue that logic cannot be taken as a theory of the limits of our world and that its *prima facie* most plausible construal as a theory of reasoning is too unclear to be taken at face value. I argue that the viable construal of logic takes it to be explicative of the constitutive (rather than strategic) rules of reasoning, not of the rules that tell us *how* to reason, but rather of rules that make up the tools *with which* (or *in terms of which*) we reason.

KEYWORDS: Logic – mathematical logic – philosophical logic – reasoning.

1. The word "logic"

Logic, in the traditional sense of the word, is taken to be something general and universal, and though there have been disputes over some logical principles (e.g. the principle of the excluded middle, which states that either *A* or

not-*A* must be the case; see Church 1928), and sometimes it even seems that these disputes augur a split of logic into different kinds (such as, in the context of the twentieth century, classical and intuitionist logic; see Mancosu et al. 2009), it still seems a contradiction in terms to say that everybody can help themselves to their own logics or that logic can be changed according to the subject matter it is applied to. Our traditional notion remains that the bulk of logic must be general, universal and topic-neutral.

However, if we examine how the word "logic" is actually applied in practice, we soon see that its usage does not really conform to this notion. When we search the British National Corpus (http://www.natcorp.ox.ac.uk/) – a representative set of electronic texts ("of written and spoken language from a wide range of sources, designed to represent a wide cross-section of current British English, both spoken and written"), we discover that (leaving aside the idiosyncratically technical contexts, and those conforming to the above delimitation of logic) there are many examples of usages of the following kind:

AK6 323 *If sport carries on combining with showbiz at the present rate, this dingy logic will eventually be hard to resist.*

CEP 3274 *Apart from the effect on the playing side, Strudwick sees another benefit with his typically straightforward brand of Aussie logic.*

CGF 963 *And the logic they sought was the logic of sexual difference and male superiority.*

CR9 160 *If not, the logic of the threats made so far is that bombing must follow; threats may have been unwise, but it would be even less wise to make them and fail to carry them out.*

CRY 647 *The particular towns on the list thus had no obvious logic.*

CTY 371 *To characterize only recent French thought as 'the logic of disintegration', as Peter Dews has recently done, masks over the fact that such a logic is fundamental to Marxism itself, the unassimilable dark other to its 'primacy of the category of totality'.*

ED6 435 *Everything is worked out, every detail of orchestration and balance, and there always seems to be an inner logic to the composition – there isn't a bar that isn't absolutely essential.*

EDA 1188 *Why this should have been thought evidence of scurrility was known only to Joyce's peculiar logic.*

FA0 569 *That theory's notion of a world economy is, in its simplest form, based on the view that, since the inception of capitalism in Europe, every part of the globe is linked together through a world market and, thereafter, all that happens obeys the logic of that world market so as to generate profits for enterprises in the advanced capitalist countries.*

FP2 473 *What is the logic that dictates that the shareholders should be entitled to the corporate surplus, instead for instance of the employees or management, with the entitlement of the shareholders reduced to a fixed return on capital?*

G0D 120 *Environmentalism in its first phase had advanced its hegemony through a grandiose moral and scientific logic.*

G12 945 *It was strange; everything he had done on the programme had seemed at the time to be imbued with an exact sense of logic and purposiveness, but now that he looked back on it, all the logical connections had disappeared, like secret writing when the special lamp is taken away.*

G13 739 *I stole a look at Conchis as he gazed up at the picture; he had, by no other logic than that of cultural snobbery, gained a whole new dimension of respectability for me, and I began to feel much less sure of his eccentricity and his phoniness, of my own superiority in the matter of what life was really about.*

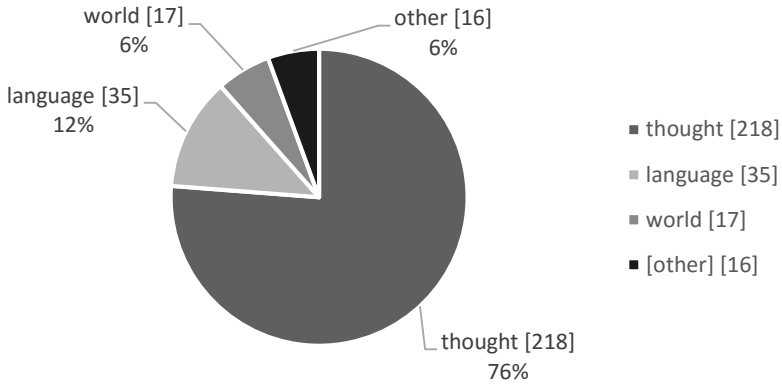
Such quotations suggest that the term "logic" is actually used in multifarious ways. It would seem that one of the most frequent uses of the term is as denoting "the bulk of organizing principles behind an institution, an activity or a domain", or "a set of reasons for a standpoint", or perhaps "a way of conceiving of a matter". This usage would entail that different things may indeed have different logics, and in fact it sometimes seems that it is precisely what is called a "logic" that captures the peculiar "essence" of a thing.

Of course, if we concentrate on logic as a doctrine, as that which is taught in schools and universities, the variability of understandings narrows down significantly. But does this narrowing down lead to something consistent? Is there a general agreement on what logic is and how it should help us? I am afraid not.

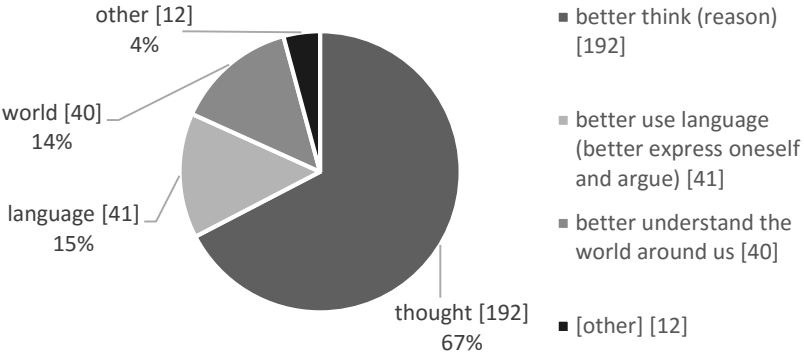
2. Logic as a tool

The following survey was undertaken at the Philosophy Faculty of the University of Hradec Králové (Czech Republic). 286 students took part; of which 114 had taken a course in elementary logic; none of them had studied logic at an advanced level. The participants were asked to express their personal opinions, uncontaminated by what they might think would be "correct" in any other sense.

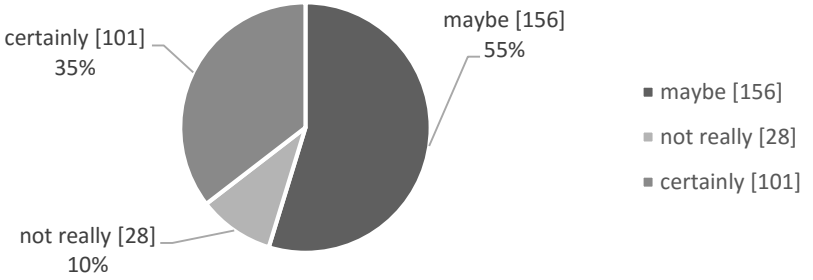
Logic is primarily interested in:



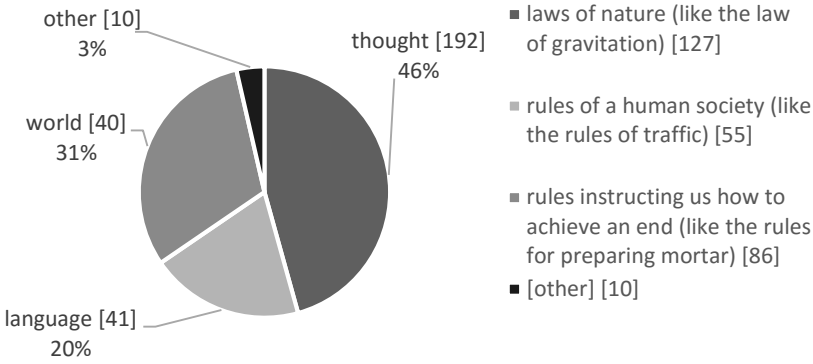
Logic should primarily help us:



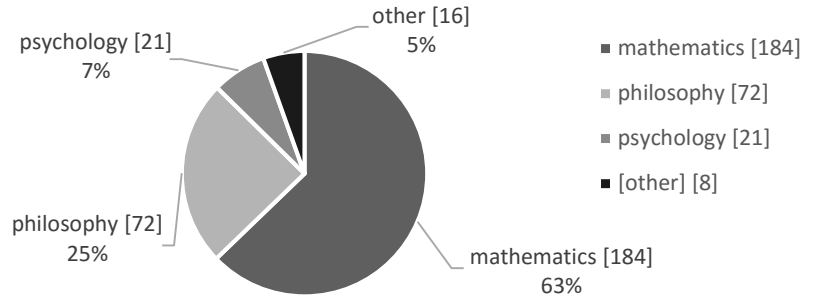
Do you think that logic really helps us in this way?



The laws of logic are, according to their nature, most similar to:



Which of the disciplines below is closest to logic?



In some respects, these results are unsurprising. The first two questions document that the prevailing notion of logic is very traditional: according to this, logic is some kind of a theory of correct thinking, or correct reasoning. But the results for the fourth question are more interesting: the majority of students are convinced that the laws of logic are best compared with the laws of nature, and hence perhaps they are those laws of nature which govern how we think; or they are those which get reflected by our minds in some peculiar way. Now the results of the fifth question indicate that the great majority of students assume that logic falls into the province of mathematics. Taken together, this seems to indicate that it is mathematics that is competent to study those natural laws that govern human thought – and this is a result which would call for some elucidation (for though to elucidate reasoning, as well as almost any other phenomenon, we may conceivably make use of mathematics, it is not quite clear how mathematics alone could be its theory).

In general, it seems that the most popular understanding of logic is its construal as the science (art?) of correct reasoning. This much seems to be clear and this, it would seem, is what was directly imprinted into the answers to the first two questions. What is no longer so clear is what the sense of "correct" is in the "correct reasoning". Does it amount to simply "successful" or "effective"? The majority of respondents appear to deny this – they probably feel that there must be some more substantial notion of correctness, something more akin to the correctness expressed by natural laws.

Now it would seem that if logic is to teach us to reason correctly, then we can also reason incorrectly – indeed logical training should make us abandon any possible habits of incorrect reasoning in favor of reasoning following the canons of logic. Hence, in what sense could it be that the laws of logic, that spell out the ways how we *should* reason *correctly*, are akin to natural laws, which specify how things happen *inevitably*?

Moreover, what is the nature of the close connection between logic and mathematics? True, many kinds of science use mathematical tools to build various models of their domains, compute their parameters etc.; but the relationship between logic (especially modern logic) and mathematics appears to have become more intimate. But if the task of logic is to instruct us which mental processes open to us warrant our engagement, why is it more intimately connected with mathematics than with psychology, the discipline devoted to studying mental processes?

3. Logic and mathematics

In the late nineteenth and early twentieth centuries, Aristotelian logic, which had been the paradigm of logic for more than two millennia, was superseded by a wholly new paradigm: a paradigm that was created by thinkers such as George Boole, Gottlob Frege, Giuseppe Peano and Bertrand Russell (see Grattan-Guiness 2000; or Haaparanta 2009), and which soon led logic into the embrace of mathematics. The idea was that just as physics was able to move to a wholly new level once it was learned how to formulate its problems so that they were amenable to mathematical treatments, so logic might expect a similar acceleration by opening itself to mathematics. However, although the mathematical logic of the twentieth century undoubtedly supplied logicians with a huge number of problems of kinds never dreamed of by previous generations of logicians, the relevance of these problems for logic, in the original sense of the word, is debatable.

Take, by way of comparison, modern physics. Here, too, we can encounter lots of highly complicated mathematics. But here the mathematics is never an end in itself – the results of any computations must be "translated" into the language of physics and tell us something about the physical world. If the role of mathematics in logic is to be similar, then the results reached in the books on mathematical logic also require "translating" so that they tell us something about the correctness of our reasoning.[1]

There is an explanation for this lack of the final "translation" of the mathematical results of logic into a theory of human reasoning: the investigations have changed their nature and become pure mathematics. This may happen in any field of theory – trying to build mathematical models leads us to new mathematics, which, apart from throwing light on the original domain, may become interesting in its own right, and some theoreticians begin pursuing it not for the sake of modeling the original problem, but simply for the sake of

[1] To avoid misunderstanding, of course that *any* mathematical theory can be seen as telling us how to use the concepts it is based on – and especially how to reason with them. It must be based on *definitions* of the concepts and the definitions can be seen as instructions for use. But this is the usage of specific concepts on which the theory is based – not of reasoning in general, which is supposed to be the subject matter of logic. If the point of the new concepts is to help us reason better, or at least to better understand how we reason, then if the result is just to master the new concepts, it is radically unsatisfactory.

investigating the new mathematical structures. (And, indeed, a lot of the mathematics inspired by physics has become the ultimate subject matter of purely mathematical studies; but who would consider this as *replacing* physics?)

There is no doubt that much of what is now being done under the heading of "logic", and especially "mathematical logic" (cf. Barwise 1977; Crossley 2011), is a branch of mathematics, with no intention of analyzing, elucidating or improving how we actually reason. And doing mathematics is, of course, a respectable business. The only problem is that there is still a need for theories holding to the traditional agenda of logic.

Not all of contemporary logic declares itself as mathematical. Some protagonists of logical investigations are keen to distance themselves from wholly embedding logic into mathematics; they want to do "non-mathematical" logic (which does not, of course, preclude them from using some mathematics as a tool!). The term "philosophical logic" is occasionally used to distinguish their kind of logic from the mathematical one. The problem, however, is that the term "philosophical logic" is so ambiguous that it is not very useful.

In some cases, the adjective "philosophical" is to be taken at face value, in that the term "philosophical logic" is employed to refer to "philosophy of logic" (see Haack 1978; Grayling 1998) or "philosophy done with the help of logic" (cf. Goble 2001; Jacquette 2002). In other contexts, it has acquired a rather technical sense, in which "philosophical logic" refers to investigations (including purely mathematical) of systems of the so-called "non-classical logic" (cf. Burgess 2009). And it is only in the remaining cases that it is used simply to mark the logic that is referred to as not a pure mathematics, but rather working towards the traditional aims of logic.

The fact that logicians do not seem to be univocally interested in the agenda of correct reasoning and argumentation has also invoked a large movement of those who want to take up this task straightforwardly at face value. The so-called "theories of argumentation" (van Eemeren & Grootendorst 2003; Walton et al. 2008), "informal logics" (Walton 1989; Copi & Burgess-Jackson 1996) or "critical thinking" (Paul & Elder 2002; Bowell & Kemp 2002) are usually very practical enterprises on the boundary between logic and a kind of "technology" of reasoning and argumentation, which does not distinguish between the domain that has been traditionally assigned to logic, and other domains traditionally covered by rhetoric etc.

4. Logical laws

As asking about the nature of logic is mostly asking about the nature of logical laws, it is good to clarify what exactly is meant by these. One of the most traditional claims that has come to be called *logical law* is the principle of non-contradiction, stating that no *a* can be both *P* and not-*P*, or, more generally, that nothing can both hold and not hold at the same time. Using the symbolism of modern logic, we can record it as

(NC) $\neg(A \wedge \neg A)$.

The complementary law stating that anything must either hold or not hold, the so-called law of excluded middle (which is accepted by far not as univocally as (NC)), is then

(EM) $A \vee \neg A$.[2]

Aside of laws of this kind, there are laws which do not have a form of a statement, but rather of an inference, a transition from statements (premises) to statements (conclusion). A typical example is *modus ponens*, the inference from *if A, then B* and *A* to *B*, symbolically

(MP) $\dfrac{A \qquad A \rightarrow B}{B}$

We can consider other laws of this kind, such as

($\wedge$I) $\dfrac{A \qquad B}{A \wedge B}$

[2] It is a peculiar fact that within classical propositional logic, the two laws formulated in this way turn out to be equivalent. (Indeed, as $\neg(A \wedge B) \leftrightarrow (\neg A \vee \neg B)$, $\neg(A \wedge \neg A)$ is equivalent with $\neg A \vee \neg\neg A$, and as $\neg\neg A \leftrightarrow A$, this is further equivalent with $\neg A \vee A$.) But this should not be construed as the proof that the two laws say the same, but rather as a demonstration of the restricted expressive power of this logical system.

or

$$(\vee\text{I}) \quad \frac{A}{A \vee B}$$

All these laws contain *logical constants*: ¬, ∧, →, … (or, perhaps, in their informal articulation, "logical" words of natural language, such as *not*, *and*, *if-then*, …). So the elucidation of the nature of logical laws clearly involves an elucidation of the nature of these constants.

There are several ways to view logical constants. One possibility is to consider them as primarily elements of the "furniture of the universe", as potential constituents of facts making up our world. (Our signs then being their – better or worse – representations; the natural language words being not very faithful, whereas the signs of our formal languages being much better.) The statement of the form "$A \rightarrow B$", for example, can be seen as expressing a worldly fact, perhaps concerning some kind of (causal?) dependence of B on A. If we view logical constants in this way, the laws of logic will be something akin to natural laws.

Another possibility is to consider logical constants as primarily constituents of thoughts. (Then again, our signs are their representations.) Given this, logical laws are some kind of laws of thought (perhaps directives how to think so as to arrive at the truth?) On this construal, "$A \rightarrow B$" expresses a specific kind of thought.

Then there is the possibility to locate logical constants in our language, the "logical words" of natural languages being their tentative versions, while those of the artificial languages the versions that has been regimented and stabilized (see Peregrin & Svoboda forthcoming). Given this construal, logical constants are not entities *represented* by these signs; rather they are these very signs (perhaps the regimented kind). However, the fact that logical constants do not represent anything should not be read as saying that they are meaningless – they have meanings in that they have certain uses within our language games, especially they have certain roles with respect to the inferential rules governing the sentences containing the constants. Construed thus, "$A \rightarrow B$" is an element of an artificial language, characterized by its inferential role (e.g. that we can infer from $A \rightarrow B$ and A to B).

5. Logic and the world

Let us now turn our attention to the viability of various notions of logic based on the various understanding of logical constants sketched above. We will try to indicate that the *prima facie* most plausible construals of the nature of logic are in fact *not* viable and that the question of what exactly modern logic is useful for is not quite easy to answer.

Let us start from the relationship between the laws of logic and the laws of nature. Could the former be akin to the latter, as the survey showed they are often taken to be? (Adherents of this view can appeal to the patronage of no lesser person than a key founding father of modern logic, Bertrand Russell, who in Russell (1919, 169-170) famously claimed that logic "is concerned with the real world just as truly as zoology, though with its more abstract and general features".) Natural laws deal with a certain kind of necessity or impossibility (which is clearly the other side of necessity): they tell us, we can say, that some things that might appear to be possible are in fact impossible. So let us consider the concept of impossibility.

It is, for example, impossible for me to speak Portuguese right now, because I have not learned the language. This is an impossibility stemming from the contingencies of my life; should it have run slightly otherwise, it might have been that I would have learned Portuguese. Then there are impossibilities that appear to be somewhat more categorical. I cannot, for example, fly like a bird. This has nothing to do with the course of my life, it is a necessity which we can call *physiological*. My organism is simply not made to make this possible. But then there is an even more categorical kind of impossibility: I cannot move faster than light. This has nothing to do with my particular physiology, it is a rather of the physical law discovered by Einstein. We can call it *physical* necessity.

Now logic might perhaps be seen as dealing with an even more categorical kind of necessity: *logical* necessity. I cannot, for example, run and at the same time not run. This might be said to be excluded by (NC). However, what is it that this law excludes? The previous kinds of necessity tell me that I cannot do something that I could have imagined I would be able to do. In principle, I could imagine experiments in which I tried to check whether I really cannot do what I am told I cannot. But what would it be to run and not to run? How could I try to do so to check whether it is really impossible?

Maybe, then, the necessity logic spells out is a matter of conception or imagination. I cannot imagine myself running and at the same time not running.

But here we must be careful. I clearly can imagine myself running and also I can imagine myself not running, and perhaps I can do this at the same time (e.g. superimposing two pictures before the mind's eye). Hence, what I cannot do is not *imagine that I-am-running* and, and at the same time, *imagine that I-am-not-running*, but rather *imagine that I-am-running-and-at-the-same-time-not-running*. But again, what is it that I cannot imagine? What is it *to-be-running-and-not-running*?

I can say that I cannot imagine myself *himbajsing*. Indeed, I cannot, for I simply do not know what it is. But surely this is just a dull fact, pointing out no limitations of my imagination. And the fact that I cannot imagine myself running-and-not-running does not seem to be significantly different in this respect: again, I cannot imagine something simply because I do not know what it is (the difference being only that while *himbajsing* is utterly nonsensical, *running-and-not-running* is composed of meaningful parts, though in a way which makes the whole meaningless).[3]

Hence, perhaps it is not *imagination*, but rather *belief* the boundaries of which are drawn out by logic? Can I believe that I am running-and-not-running? Again, it seems that I *can* believe that I am running and at the same time believe that I am not running – this would, to be sure, not be a very frequent situation, but people are known to be able to harbor contradictory beliefs, so though improbable, it may seem not utterly impossible. Now, what about the belief that I am running-and-not-running? Again the same situation as before: I cannot believe something that does not make sense.

The upshot seems to be that, unlike the laws of nature, laws of logic cannot be straightforwardly and transparently derived from the world. To say that they are akin to the laws of nature brings about many more questions than it can answer.

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[3] This was pointed out already by Wittgenstein (1922), who took logical necessities and impossibilities as pathologic by-products of logical vocabulary, which otherwise helps enhance the representational capacities of our language. See also Coffa (1991, chap. 8). In his later writings, Wittgenstein was even more explicit about this. Note, for example, what Wittgenstein (1956, I.§132) has to say about the law of identity: "Frege calls it 'a law about what men take for true' that 'It is impossible for human beings … to recognize an object as different from itself'. – When I think of this as impossible for me, then I think of *trying* to do it. So I look at my lamp and say: 'This lamp is different from itself'. (But nothing stirs.) It is not that I see it is false, I can't do anything with it at all."

6. Logic and acquiring true beliefs

Hence the notion that the laws of logic are kind of natural laws (perhaps the most general one?), that the laws tell us what is impossible despite being seemingly possible (be it in the world or in our thought) does not seem to stand up to scrutiny. We must, it seems, discard the notion that the laws of logic are of the kind of natural laws, despite its popularity. And as the view that logical laws are akin to social norms is neither appealing, nor popular, the outcome appears to be that we should accept that the laws of logic are best viewed as *instrumental* rules, telling us how we should reason in an efficient way.

This may seem to be a welcome happy-end: we have already seen that this view of logic, *viz*. the view of logic as a theory of correct reasoning, is almost generally accepted and insofar as the view of laws of logic as natural laws is not compatible with it, then the popularity of this latter view must be a matter of some delusion, and we should be happy to relinquish it. However, to see this as a happy-end would be premature. The notion of logic as a theory of reasoning, as the pursuit of reasoning correct in an instrumental sense, raises some very awkward questions.

First, if the kind of correctness involved here is to be instrumental correctness, then it must be derived from a goal at which the whole enterprise of reasoning is aiming – indeed the instrumental "correct" is nothing other than "effectively helping us achieve a goal". Hence, according to this view, logic tells us how to reason to reach a goal. But what is the goal?

Answering this question may not be as easy as it might look at first sight. What comes to mind immediately is something like acquiring true beliefs. But does this mean that logic is to help us acquire *only* beliefs that are true, or rather that it helps us acquire *as many* true beliefs *as possible*? Neither response holds water. If the task of logic were to prevent us from acquiring beliefs that are not true, then it could accomplish it simply by instructing us to acquire *no* beliefs at all; whereas if the task were acquiring as many true beliefs as possible, then it could well instruct us to acquire an arbitrary trivial true belief, conjoin it with itself and continue further conjunctions with the original belief *ad infinitum*.

In reality it would seem that what we need is some *reasonable* collection of *relevant* true beliefs. We certainly do not need all true beliefs, and we probably should not despair about acquiring some exceptional non-true beliefs. What is the precise sense of the "reasonable" and "relevant" in the "*reasonable*

collection of *relevant* true beliefs"? Well, it seems to be highly context-dependent – what is useful to know may differ quite radically from one context to another. Anyway, to find out what is thus useful is a vital part of our art of steering clear of the perils of our world; and logic does not seem to offer us any clear instructions how to do this.

All of this is not to say that construing logic as a theory of correct reasoning is utterly misguided, but it does indicate that if we propose this construal, it is very blurry what exactly it is we are proposing. It is obvious that in some cases logic may help us acquire new and useful beliefs; but much of the reasoning we perform is either stimulated or influenced by factors which are beyond the boundaries of logic; and, conversely, a lot of the reasoning logic sanctions as correct is of no use for us.

It is of no help to claim that logic equips us with a useful *tool*, and the question of what we do with the tool, whether we are able to achieve something valuable with its help, is not its business. The point is that we cannot say that a tool is useful until we know what useful end it can serve as a means. Hence again, the question is *a tool for what*? And if the answer is as simple as *for acquiring new true beliefs*, then it does not seem quite satisfactory.

7. Logic as sanctioning selected inferences

Given this, we may try to reduce the role of logic to an acceptable minimum. Perhaps logic does not tell us how to acquire the reasonable collection of relevant true beliefs we need to cope with the world successfully; perhaps it only helps us with some partial aspect of this process. Perhaps the only thing that logic is able to do is to tell us that certain ways of going from beliefs already had to a belief to be acquired are impeccable in the sense that if the former beliefs are true, then the latter is true too.

In comparison to the role of logic considered in the previous section, this role is truly minimalistic. Logic tells us nothing about which beliefs to acquire or how to acquire them; it only tells us that if we choose certain ways of acquiring them, we will not fail. (But perhaps there are ways of acquiring beliefs that are better than those sanctioned by logic, perhaps ways that are not quite impeccable, but much more effective?)

It may seem that though assigning this task to logic may look, to many, as its denigration, at least this is what logic really does. But I am afraid that even

this is not as straightforward as it might *prima facie* seem. For consider the inferences we usually find in logical textbooks. Take, for example, such laws as (∧I) or (∨I) above, i.e. the rule that $A \wedge B$ is inferable form A and B; or that $A \vee B$ is inferable form A. What is the use of such inferences? Do we ever, when we reason, consider them so that we could use the fact that logic tell us that we can use them safely?

The answer is not quite clear. At least *prima facie*, if we have the beliefs A and B, we do not need the extra belief that $A \wedge B$. If I have the belief that *it rains* and that *it is dark*, why would I need the extra belief that *It rains and it is dark*? I know that when I get out it may be useful to take an umbrella and a flashlight already on the basis of the former beliefs, I do not need the latter. More generally, whatever I can infer from the latter one I can infer already from the former.

The situation is even more problematic in case of the inference from A to $A \vee B$. Here I not only do not gain anything, but I do loose something. It is hard to imagine that it would ever be useful to make such a step in reasoning. Well, of course we cannot see through all possible twists and turns our reasoning may take and we cannot exclude that even such inference, in combination with other ones, might be useful; however, the picture that logical laws are useful and impeccable ways of acquiring new true beliefs, in general, does not seem to stand to scrutiny.

8. So what is logic about?

The brief discussions presented in the previous sections are not to be taken as a substitute for a thorough analysis of the relationship between logic and reasoning.[4] My point was to indicate that the *prima facie* plausible view of logic as a theory of reasoning, on closer inspection, is by far not as satisfactory as it might seem. We surveyed some popular approaches and indicated that some ways of understanding the nature and agenda of logic lead us up alleys that, if not quite blind, are nevertheless tortuous and shady. It is not clear

[4] See, e.g., Harman (1986); Perkins (2002); Milne (2009); Stenning & Van Lambalgen (2008); and see Peregrin (2014, especially chap. 10 and 11) for my fuller discussion of this topic.

whether the *prima facie* most plausible ways are ultimately viable. Now the question that may strike us is whether we have a viable way left at all.

To indicate that we do, let us consider the third of the possibilities of construing the nature of logical laws. Aside of taking them as akin to laws of nature and as seeing them as instrumental rules of efficient reasoning, we can look at them as at a kind of social rules. This, to be sure, seems *prima facie* quite absurd: is the law of contradiction akin to the rules telling me whom to greet, or those telling that I should help the poor? Despite this, I believe that even this option is worth being investigated.

The point is that some of our social rules are constitutive of useful social tools and institutions. Certain social rules, for example, constitute the institution of police, which is, needless to say, immensely helpful when it comes to human interaction and its pathological aspects. Other rules constitute, for example, loans, which may be an immensely useful tool for everybody short of money. Could it not be that the laws of logic constitute something useful in this way? And I think that we might consider a positive answer to this question: namely that logic constructs and provides us with certain "cognitive tools", which open up for us new modes of thinking. We usually do not register this, for as a species we have become too accustomed to these new modes.

What does the rule that we can reason from A to $A \vee B$ actually tell us? How to effectively manage our systems of beliefs in that we should extend it by $A \vee B$ whenever it contains A? We have already noted that except perhaps in some extenuating circumstances, we never reason to a disjunction from its disjunct. (Why adopt a belief that is a mere dilution of what we already know?) So what is the use of this rule? The answer I propose as worth considering is that the rule is *not* an instruction how to reason or how to manage our system of beliefs, but rather a rule constitutive of a tool *by means of which* we reason – in this case, disjunction. It allows us to say things and think thoughts of a usefully unspecific nature. ("Either we mend this, or we are doomed.")

The most instructive case is that of implication, a tool which represents an entering wedge into the hypothetical ways of argumentation and reasoning, and which, needless to say, offers a formidable upgrade to our thinking powers. Conditional statements, formed with the help of implication, allow us to say not only what is the case, but what is the case *if something else is the case*, which paves the way to counterfactuals (although the classical, material implication is not strictly speaking a counterfactual, there is a close connection to genuine counterfactuals).

In this case, we must keep in mind that on this construal, logical constants, and consequently logical laws, are not any entities beyond the words of natural language or the sign of an artificial ones – they are directly the linguistic items (understood as governed by certain laws). And it is vital to see that this conception of logic differs from the conception discussed in previous sections more fundamentally than it might *prima facie* seem. This point can be illustrated by comparing logic with chess. With respect to chess, we can consider two kinds of rules: the "constitutive" ones that delimit the moves that are legal, and the "strategic" ones that indicate moves that are good in the sense of being likely to lead to victory. The latter, strategic rules presuppose that we already have the chess pieces (that are, as such, constituted by the constitutive rules) and we are consequently in a position to put them to an effective use. Now, the notion of logic as the science of reasoning discussed in previous sections, took the laws of logic as the strategic kind of rules, hence it presupposed that we already had the logical concepts and it was telling us how to make an efficient use of them. By contrast, the notion considered at in this section takes the laws of logic as constitutive, rather than tactical rules: they produce the basic logical tools that open up new spaces for our argumentation and reasoning, without "strategic" advice about how to steer through them.

But are ways of thinking "social tools" or "institutions"? Are they not a matter of individual psychologies? Part and parcel of this way of looking at logic is the conviction that they are not; that they are imprints of social practices – that the kinds of tools exemplified by that logical constants are forged in social mold. This might seem strange, but the view that human covert reasoning is based on inter-human overt argumentation (rather than vice versa) can be backed by arguments of both philosophers and social scientists.[5]

I think that if we accept this, we could embrace the notion of logic as a theory of reasoning only on a very specific reading. According to this view, logic does not tell us how to reason in the sense of instructing us how to weave our webs of our beliefs effectively. It makes explicit the constitution of the

[5] As for the philosophical arguments, I think that the clearest ones were formulated by Davidson (1991), who argues that that the very fact of propositional thought (including reasoning) presupposes communication. See also Dutilh Novaes (2015); and for a more empirically grounded account see, e.g., Mercier & Sperber (2011). For a more detailed exposition see Peregrin (2014, chap. 11).

most powerful, and most general, cognitive tools we have – disjunction, implication, negation etc. – and in this way it makes for the very possibility of having beliefs and weaving their web. In one sense this is not very much – we need a lot of additional rules or experiences to put these tools to effective use. In another sense, it is quite a lot – without these basic tools, there would be no space within which such instructions would help us steer (see Peregrin 2014, chap. 10 for a further elaboration).

9. Conclusion

Modern logic is in a paradoxical situation. On the one hand, it has inherited at least part of the prestige logic has always enjoyed, and, moreover, it has introduced logical investigations into unprecedented mathematical intricacies; on the other hand, it has become unclear what exactly it thereby brings us and how exactly it is useful to us. This situation can only be overcome by in-depth analyses of the nature of logic and its achievements. We can no longer make do with received wisdoms such as "logic tells us how to reason", not because these are completely false, but because they are misleading and often engender a mere illusion of explanation. We must clarify which results of modern logic are to be seen as part of mathematics and which bring us something more – and what exactly this "something more" is.

In this paper, I have proposed that the most adequate way of viewing logical laws, and consequently logic, is to view them not as strategic rules telling us how to manage our beliefs effectively, but rather as certain constitutive rules, rules that open up, for us, certain modes of reasoning by constituting the "cognitive tools" on which these modes rest. I have argued that to think otherwise is akin to mistaking the rules constitutive of chess, rules telling us which moves are allowed for which piece, for strategic rules advising us how to play so as to win.

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