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A CONTEXTUAL ACCOUNT OF EXPLANATION IN LOGIC

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Abstract. Recent approaches to the epistemology of logic, under the title of "anti-exceptionalism about logic", explicitly adopt what is asserted to be the method of theory choice and the correct account of explanation in the sciences. Without embracing such a doctrine, but still keeping within a broad anti-exceptional trend, the current discussion proposes a contextual theory of explanation in logic, based on Bas van Fraassen's framework of why-questions, which neither claims that logic is a science, nor relies on the metaphysical assumption of a validity-phenomenon to give account of the methodology of logic.

Keywords: logic • epistemology • explanation • anti-exceptionalism • van Fraassen

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1. Introduction

Anti-exceptionalism about logic claims logic to be a discipline similar to the other sciences, concerning itself with the same kind of knowledge or governing itself by similar methodological principles. Self-proclaimed anti- exceptionalists usually hold that logic shares with science the same principles of theory revision/choice, and that the evidence for such revision is (largely and for the most part) of the same type.

> We can use normal scientific standards of theory comparison in comparing the theories generated by rival consequence relations. (Williamson 2017, p.14)
>
> The model I will propose is one that is familiar, in many ways, from the philosophy of science. It is applied whenever we have to choose rationally between competing theories. (Priest 2016, p.32)
>
> As anti-exceptionalists, we maintain that logic, *qua* the study of consequence, is just like every other science: it is subject to the same methodological pressures as other sciences, and the same epistemological questions. (Payette and Wyatt 2018, p.157)

As logic converges towards science, questions of the philosophy of science inevitably seep into the philosophy of logic. One such concern is that of explanation: theories are

not mere descriptions, but rather provide explanation of some phenomena; "different models of explanation provide different accounts of what the contrast between the explanatory and merely descriptive consists in" (Woodward 2019, p.4). The idea is then that logic is also susceptible to such models of explanation. Related is the issue of theory choice, inasmuch as one might think that one theory is better than another if it provides a better explanation.

Woodward (2019) draws a difference between a "traditional" conception of explanation and pragmatic accounts.[1] Traditional conceptions focus on the scientific character of explanation, and "largely share a common overall conception of what the project of constructing a theory of explanation should involve and (to a considerable extent) what criteria such a theory should satisfy if it is to be successful" (Woodward 2019, p.60). In contrast, pragmatic accounts

> typically stress the point that whether provision of a certain body of information to some audience produces understanding or a sense of intelligibility or is appropriate or illuminating for that audience depends on the background knowledge and interests of the audience members and on other factors having to do with the local context. (Woodward 2019, p.61)

Pragmatic accounts not only consider it valuable to incorporate a pragmatic dimension to explanation, but take it that any model of explanation which does not do so will be unsuccessful, "because pragmatic or contextual factors play a central and ineliminable role in explanation in a way that resists incorporation into models of the traditional sort" (Woodward 2019, p.62).

The current literature of anti-exceptionalism in logic adopts the traditional conception of explanation. Logical theories are taken to provide "explanations of the putatively philosophically important phenomenon—'validity'" (Martin 2021, p.605). Moreover, these accounts take "the goal of a theory of explanation, as capturing the notion of a correct explanation" (Woodward 2019, p.60), rather than taking explanation as relative to context. The present essay suggests some reasons why the current anti-exceptionalist accounts of explanation might not be suitable, proposing a fresh account of explanation in logic based on van Fraassen's (1980) contextual account of explanation.

The essay runs as follows. Section 2 presents and casts doubts on the current anti-exceptionalist accounts of explanation in logic; Section 3 sketches a contextual account of explanation in logic; Section 4 uses this account to illuminate logical disputes; Section 5 compares the account to that of "inference to the best explanation" as well as to functional analysis of explanation in logic; and finally, Section 6 concludes with remarks about anti-exceptionalism and logical explanation.

2. Explanation in logic

The most common anti-exceptionalist view is that of logical abductivism,[2] which is presented as the correct method for theory choice in logic by borrowing "inference to the best explanation"[3] (IBE hereinafter) from the philosophy of science as the guiding principle in scientific theory choice.

> Theories of logic, not unlike scientific theories in general, are chosen on the basis of abductive arguments. (Hjortland 2017, p.2)
>
> We make the standard assumption that scientific theory choice follows a broadly abductive methodology. Scientific theories are compared with respect to how well they fit the evidence, of course, but also with respect to virtues such as strength, simplicity, elegance, and unifying power. We may speak loosely of inference to the best explanation (...). (Williamson 2017, p.334)
>
> Arguably, the correct theory has to be determined by abduction (...). (Priest 2021, p.1)

On the abductivist view, there are theoretical virtues guiding theory choice in logic; based on the kinds of evidence accepted,[4] a best theory is chosen.

While IBE, as used by anti-exceptionalists, focuses on the point of theory choice, a full account of IBE first needs to account for what an explanation is and what it means for one explanation to be better than another. Specifically, IBE should be thought of as "Inference to the Best Explanation if the Best is Sufficiently Good" (Lipton 1993, p.92). IBE is an account of scientific inference,[5] where explanation is taken to be an indication of good inference: if T_1 explains some evidence better than T_2, then T_1 is more likely to be the correct theory. Scientific inference is intrinsically related to theory assessment and theory choice: "explanation is prior to inference" (Lipton 2000, p.185).

Lipton (2000) articulates what a good explanation is in terms of the notions of the "likeliest" explanation and the "loveliest" explanation. Likeliest is the explanation more probable to be true; loveliest is the one "that would, if correct, provide the greatest degree of understanding" (Lipton 2000, p.187). The main argument of IBE is that loveliness is a guide to likeliness, that is,

> [IBE] claims that scientists judge that the theory which would, if correct, provide the best explanation of the available evidence is also the theory that is likeliest to be correct. (Lipton 1993, p.91)

As indicated by Lipton (2000), IBE must face the challenge of identifying explanatory virtues that provide a greater degree of understanding (the "identifying challenge"); show that loveliness matches likeliness (the "matching challenge"); and show that

scientists are in fact guided by loveliness to reach likeliness (the "guiding challenge"). Lipton (2000) presents a solution to these issues for science. The *identifying challenge* is met by accepting the explanatory virtues of scope, precision, mechanism, unification and simplicity (Lipton 2000, p.187). The *matching challenge* is met by observing that the explanatory virtues translate well to inferential virtues, that is, a hypothesis that is explanatory is also likely to be correct. And the *guiding challenge*, by arguing that scientists do actually take theories to be correct because they are more explanatory, rather than some other factor.

The extent to which these challenges can be equally met by logic remains to be seen, no account of IBE in logic having explicitly done so.

In particular, logic seems to fail the first challenge, that of identifying theoretical virtues which aid in understanding. For IBE to be plausible, it is assumed that there are uncontroversial theoretical virtues upon which the scientific community agrees. Alas, no such agreement exists among logical abductivists, and moreover, they claim that no such agreement is even needed.

> As Priest points out, such a model [of theory selection] can be devised in any number of ways. It should be clear, however, that even if we agreed on the general outline of a model for theory selection, we need not agree on the criteria or their weights. (Hjortland 2017, p.4)

The identifying challenge seems to be dismissed by the account of IBE in logic calling for some kind of justification.

Furthermore, the virtue of strength (always mentioned by abductivists) raises a particular issue for logic, since "strength" can be understood either as deductive strength or as expressive power, diametrically opposed virtues.[6] In particular, though Williamson (2017) adopts deductive strength as a virtue, Priest (2016) favors towards expressive power. This major point of disagreement between them (see section 4 below) leads Williamson and Priest to choose competing explanations from their IBE methodology. Moreover, Gillian G. Russell (2018) argues that logical strength is neither virtue nor vice, and that it does not entail scientific strength.

Directly applying the virtues which select the best explanation in science may be inappropriate for selecting explanations in logic. Perhaps there are different explanatory virtues which select the best logical explanation; and if this were the case, it needs to be argued. The failure of meeting the identifying challenge makes it doubtful whether IBE in logic can further meet the matching and the guiding challenges. For lack of further support, this limitation might suggest that IBE is not a fit account of explanation in logic.[7]

An alternative to IBE in logic has been explored by Payette and Wyatt (2018), who articulate a "functional account of explanation" (FAE hereinafter) for logic, based on the model of scientific explanation proposed by Andrea Woody. For Payette and

Wyatt, while explanation is also taken to be a two-place relation between *explanans* and *explanandum*, logical laws need not be true to have an explanatory role. FAE understands logical laws not as universal truths, but as idealizations which allow for a community to share a common conceptual framework.

> Even when such abstract 'laws' do not predict or describe validity, they are part of the scaffolding on which we give explanations for why they do not hold. They need not be epistemically basic, or even valid, to play an explanatory role (...). (Payette and Wyatt 2018, p.165–166)

In this regard, Payette and Wyatt take the explanatory role of logical laws to be similar to explanation in science, which, according to their preferred account, also does not require the truth of theories. They focus specifically on the issue of the explanation of argument in natural language, where a logic is used to explain particular inferences. The validy or invalidity of arguments are explained in terms of properties of formal systems (which are composed of a rich syntax, model and proof theory).

> First, explanatory discourse is social and involves laws as idealizations that articulate, not universal truths, but 'inferential scaffolding' that allows those in the relevant community to formulate a common conceptual framework. Second, members of a given discipline or sub-discipline share a set of exemplary explanations, which serve to set standards for explanation for that community. (Payette and Wyatt 2018, p.162)

They go as far as to claim that "[l]ogical truths and schematic validities are epiphenomena of the norms of explanatory practice in logic" (Payette and Wyatt 2018, p.166).[8] They argue that because "[c]ounterexamples exist for any proposed law of logic" (Payette and Wyatt 2018, p.158), an account of explanation in logic should make sense of this. While Payette and Wyatt do not discuss IBE directly,[9] it is fair to say they would reject the account given that for IBE, explanation is taken as a guide to truth, while in their preferred account truth and explanation are detached.

Their anti-exceptionalist account of logic, while disagreeing with IBE on what validity is, still relies on an account of explanation similar to IBE, in that it takes an explanation to be a two-place relation,[10] and explicitly adopts a scientific standard of explanation in logic. On this point, Payette and Wyatt have been criticized by Martin (2021), who argues that the analogy drawn by them is unsuccessful, for classical logic has no privileged status, nor is its role one of "scaffolding". Many classical principles are not unanimously accepted; for instance, "relevant logicians reject the account of validity as truth preservation, glutty logicians reject the exclusivity of truth and falsity" (Martin 2021, p. 616).

What is more, many of the key features of classical logic have been developed before, or independently of it, only then to be incorporated into the account. Classical logic is then only "a particularly successful theory which some members of the

community think can be improved upon" (Martin 2021, p. 616), rather than a privileged theory. If Martin has it right, Payette and Wyatt's account of explanation ill fits logic.[11]

To take stock, neither of these two traditional accounts of explanation (IBE and FAE) have been found to be particularly well suited to logic. Counter the anti-exceptionalist intuition, it seems that adopting the methodology of science for logic might not be an easy task. In particular, Martin (2021) raises a challenge for an account of explanation in logic, claiming that one must not assume that logic is explanatory in the manner of any specific area of science. Were logic indeed explanatory, this must be shown independently of a scientific account of explanation. That is, "one requires a well-evidenced appreciation of logic's aims and methodology prior to drawing a connection with explanatory practices in other fields" (Martin 2021, p.316).

Martin's challenge is undertaken in this essay by adopting van Fraassen's (1980) account of explanation. His view seems appropriate to heed Martin's caveat, since as Woodward (2019) notes, van Fraassen

> explicitly denies that there is anything distinctive about the category of scientific explanation that has to do with its structure or form—instead, a scientific explanation is simply an explanation that makes use of information that is (or at least that is treated as) grounded in a "scientific" theory. (Woodward 2019, p.76)

By separating explanation and science, an account of explanation in logic becomes available, one which does not rely on an analogy to scientific explanation.[12] While explanation is an important feature both in science and in logic, this similarity is not because science has a special grasp on explanation.

Van Fraassen provides in *The Scientific Image* a criticism of Scientific Realism and IBE,[13] while also putting forth his account of scientific methodology, "constructive empiricism", and a new suitable account of explanation. He argues that when scientific theories have implications beyond what is observable, such theories cannot be said to be true and do not warrant belief (counter Scientific Realism). Rather, scientific theories are merely empirically adequate and warrant only acceptance as such. As the aim of scientific theories is empirical adequacy, no theoretical virtues, such as explanatory power, factor in theory choice.

Van Fraassen still grants that explanation plays a significant role in science and thus offers an alternative account of explanation to that of IBE.

> The discussion of explanation went wrong at the very beginning when explanation was conceived of as a relationship like description: a relation between theory and fact. Really it is a three-term relation, between theory, fact, and context. (van Fraassen 1980, p.156)

The current essay explores this contextual account of explanation as it relates to logic. In separating the aim of science from explanation, van Fraassen's framework allows for an account of logic which is not metaphysically laden and which nonetheless accounts for the practice of logicians. Hopefully, the account presented here takes logic to be a more flexible discipline than just one dedicated to honing in on the one-true-logic, encompassing "*extra*systemic", "*intra*systemic" and "pedagogical" explanations (using the terminology of Martin (2021)).

3. The contextual account

Van Fraassen's account of science and explanation grants that explanatory power is a virtue of theory, but only a pragmatic one, and has naught to do with a theory's measure of empirical adequacy. So while there is an aspect in which scientific theories have an explanatory role, it is not their essential one (again, scientific theories aim only to be empirically adequate). Logical theories, though not being empirically adequate, might still have such an explanatory role. This section will articulate a theory of why-questions in logic and propose a natural fit of explanation in logic to this contextual account, and in so doing will deal with the same issues meddled by the anti-exceptionalists: actual practice of logicians, the disagreements between them, and the (tentative) truth of logical principles.

3.1. Asking why-questions in logic

As Martin and Hjortland (2021) highlight, one way logicians start their investigation is by looking at real logical arguments from mathematical practice, and generalize their argument form, such as this proof step:

$$\frac{\text{If not } \psi \text{ then not } \varphi}{\text{If } \varphi \text{ then } \psi}$$

In doing so, Martin and Hjortland say that logicians postulate the hypothesis of the validity of this argument form. When asked, "Why are arguments of this form valid?", the answer given by them is: because given a defined Theory A, the argument is truth preserving. Of course, many such toy-theories can be built to explain the validity of this argument form, and their view goes on to propose that theories be compared in terms of predicting which argument forms reasoners (in particular, mathematicians) go on to use. So far so good. Their anti-exceptionalist account, however, goes on to propose that the regularity of the forms of arguments accepted by reasoners is due to an unobservable phenomena, namely, validity, which somehow explains why reasoners reason the way they do. While their account starts off asking the right

question, it quickly resorts to inflationary metaphysics.[14] The question, "Why are arguments of this form valid?", is better addressed by van Fraassen's pragmatics of explanation, without needing to postulate an unobservable phenomenon to account for explanation.

On van Fraassen's view, an explanation is an answer to a why-question, which takes the form "Why P?", where P, a proposition, is the topic of the question. The same topic can be formulated as different explanation requests, which are given in terms of contrast classes, such that a why-question is really "Why P in contrast to other members of X?", where X is the contrast class and $x_i \in X$ are propositions. Interpreting the contrast class differently, the same question can be a request of different explanations. For example, when asking "Why did Adam eat the apple?", the same topic can be interpreted as:

- Why was it Adam who ate the apple, rather than Eve?
- Why was it the apple Adam ate, rather than a pear?
- Why did Adam eat the apple, rather than give it back?

(van Fraassen 1980, p.127, itemization removed)

The contrast class is then the *first* contextual element of this account of explanation. While interpreting what is the X that P is being compared to leads to X being context dependent, "[i]n general, the contrast-class is not explicitly described because, in context, it is clear to all discussants what the intended alternatives are" (van Fraassen 1980, p.128).

The *second* contextual element is the relevant relation,[15] which is used to pick out an answer. A is a relevant answer to Q if it bears the R relation to $\langle P_i, X\rangle$. An explanation takes then the form "P_i in contrast to the rest of X because A". It is noteworthy that these two elements cannot be taken independently.

> [W]e cannot properly ask what is relevant to this topic, or what is relevant to this contrast class. Instead we must say of a given proposition that it is or is not relevant (in this context) to the topic with respect to that contrast class. (van Fraassen 1980, p.142)

An explanation, thus, is not a simple relation between fact and theory, but among fact, theory and context.

In postulating a why-question, some things are presupposed, namely, that:

(a) its topic is true

(b) in its contrast-class, only its topic is true

(c) at least one of the propositions that bears its relevance relation to its topic and contrast-class, is also true.

(van Fraassen 1980, p.144–145)

So for the question "Why are arguments of this form valid?", and interpreting the contrast class to be $X = \{$arguments of this form are valid in L, arguments of this form are invalid in $L\}$, (where L is a formal logic picked by the context), it is presupposed that:

- "Arguments of this form are valid in L" is true.
- "Arguments of this form are invalid in L" is false.
- "Why are arguments of this form valid?" has a correct answer.

Of course, it could be that one disagrees with "Arguments of this form are valid in L" being true, in some other context, but given that the question has been meaningfully formulated and understood, one should keep in mind that it is true.

In formal terms, a why-question (Q) is a triple $Q = \langle P_i, X, R\rangle$, where P_i is the topic of the question; $X = \{P_1, \ldots, P_n\}$ of propositions, is a contrast-class, and R is a relevance relation. For now, here is a toy example:

Question: "Why is LEM valid?"

$Q = \langle$LEM is valid in L, {LEM is valid in L, LEM is not valid in $L\}$,
$\{\langle A, \langle$LEM is valid in L, {LEM is valid in L, LEM is not valid in $L\}\rangle\}\rangle$

P_i: LEM is valid

X: LEM is not-valid, LEM is valid

In this example, the question, "Why is LEM valid?", is contextually interpreted as, "Why is LEM valid in L, rather than not valid in L?", it is assumed that only "LEM is valid in L" is true, and there is a true answer to this explanation request (denoted by A).

3.2. Answering why-questions in logic

The last section lays out how an explanation request is formulated and understood. This section explores how the relevance relation picks out an answer to this request. Here, a *third* contextual element is introduced, namely, the background knowledge (K).

> This is a factor in the context, since it depends on who the questioner and audience are. It is this background which determines whether or not the question arises; hence a question may arise (or conversely, be rightly rejected) in one context and not in another. (van Fraassen 1980, p.145)

Moreover, in evaluating an answer, not all of K is used, only the part of that knowledge which bears on the question Q. Call this $K(Q)$, such that "the answer Because A to question Q proceeds with reference only to a certain part $K(Q)$ of K" (van Fraassen 1980, p.147). A is the answer to Q if $K(Q)$ plus A implies P, and implies the falsity of $X - P$. Completing the toy example:

> A: There is a proof of LEM in L.
>
> K: Some logical theory that includes L.

This is read as "the logical theory L together with the fact that 'there is a proof of LEM in L', implies that 'LEM is valid in L' is true, and that 'LEM is not valid in L' is false". If one finds that this explanation is lacking, either one disagrees about the background knowledge, or has a different contrast class or, yet again, has a different relevance relation in mind.

A possible response to a why-question is to reject the explanation request by denying the topic of the question. That is, to deny the truth of P. This move seems to be related to the shared background knowledge between both parties. Once accepting the explanation request, the contrast class is already implicit, inasmuch as the question is only meaningful given this contrast class. As seen in the example, the contrast class can be interpreted as "validity-in-L". Another contrast class to the same "Why is this argument valid?" question may be formulated in which it is the form of this argument that is in dispute, not its validity, such that $X = \{\varphi \vdash \psi, \varphi \vdash \neg\psi\}$, and the question is "Why is $\varphi \vdash \psi$ true rather than $\varphi \vdash \neg\psi$?".

More to the point for answering a why-question in logic is the context-dependence arising from the choice of the relevance relation of the explanation, that is, what kind of answer is the question requesting. "Relevance relation" is short for "A explains why P, rather than $X - P$, is true". Within logical practice, this question could be seen as a question about a number of things. For instance, as requesting a metaphysical cause ("Why is (φ or not-φ) a logical truth? Because the structure of reality is such that…"), related to a specific choice of semantics ("Why is this argument valid? Because there is no model in which …"), regarding proofs ("Why is this a good proof? Because there is a cut-free derivation…"), and so on.

This account fits nicely with the story presented by G. Russell (2014) of someone who holds that LEM is a logical truth. The story has four parts, and goes as follows. *First*, in a pre-logic setting, where the hero of the story has not had any formal logic

training, "[i]f we were to ask her whether LEM is a logical truth, she might not understand the questions" (G. Russell 2014, p.170). To the case in point, if asked "Why is LEM a logical truth?", she would reject this request, because she does not understand what logical truths are. *Second*, the hero goes on to enroll in an introductory logic course and learns the theory of classical first-order logic (FOL). If asked "Why is LEM a logical truth?", since "she can now prove that LEM is a logical truth" (G. Russell 2014, p.171), she would reply, "Because there is a proof of LEM in FOL" (since she know only one logic, and thus the contrast class contains only the options of LEM being valid or invalid in the logic she knows). *Third*, the hero takes a course on non-classical logics and learns the theory of a 3-valued logic, call it K3. In doing so, she learns of a new context, and now if asked "Why is LEM a logical truth?", depending on the context she can keep her old reply regarding the truth of LEM in FOL (if she accepts the request, and thus takes the topic to be true), or deny the request in the context of K3 (since the topic would not be true). In the example, the student loses "her belief that the law of excluded middle is a logical truth" (G. Russell 2014, p.171), since she understands the context of the question to be that of K3. But she still knows LEM to be a logical truth in FOL, this does not change. The only thing that changes is the context that the student picks for her answer. *Fourth*, she goes on to learn about another 3-valued logic, LP. With this new context available, the student can keep her two previous responses (accept the truth of LEM and explain it in relation to FOL, or reject the request in K3), but she can now also accept the truth of LEM in LP, thus while accepting the topic to be true, the contrast class she considers expands to {LEM is valid in FOL, LEM is valid in LP, LEM is invalid in FOL, LEM is invalid in LP}. She can thus say,"Because there is a proof of LEM in LP". In the original example, the student rejects LP and reverts back to FOL. G. Russell claims that the example shows how "logical beliefs are given up as well as gained" (G. Russell 2014, p.171). In the example presented here, the student did not lose the beliefs about FOL, K3 or LP. What happened is that she chose different contexts in which to give an answer to a request for explanation.

There is no denying that logicians (and not only specifically logicians within philosophical logic!) are in the business of asking why-questions. The account of explanation presented here offers a unified account of explanation in logic, not restricted to extra-theoretical why-questions. Understanding the context in which an explanation is requested and answered can shed light on logical disputes more broadly, including intra-theoretical and pedagogical explanations.

4. Logical disputes

Having developed the contextual account of explanation in logic (CAE hereinafter), this section presents some case studies of disputes in logic. It is worth highlighting that according to this account, logical theories do not need to be true, because the relation between explanation and theory is "quite independently of whether the theory is true or false, believed, accepted, or totally rejected" (van Fraassen 1980, p.101). The attitude that one holds towards a theory does not impact the role it has in explanation.

The *first* case study is that of the dispute between classical and intuitionistic logic. The disagreement between a classical logician and an intuitionistic logician is not that they do not understand what the other one is saying (it is not a mere verbal disagreement). So when the question asked is "Why $\varphi \vdash_c \psi$?", both logicians would agree on the validity of the argument form. When asked "Why $\varphi \vdash \psi$?", however, each one picks their preferred contrast class and relevant relation, so they might have different responses to the same explanation request.

While a classical logician might say "Because there is a proof_{L_c} of $\varphi \vdash \psi$", the intuitionist might simply reject the explanation request, as she does not know that there is a proof of $\varphi \vdash \psi$ in L_i.[16] Depending on the form of the argument, they might both provide a different positive answer, "[a]fter all, classical and intuitionist logicians agree that all instances of *modus ponens* are valid, but disagree on why" (Martin and Hjortland 2021, p.13). In this case, the intuitionist logician would reply, "Because there is a proof_{L_i} of $\varphi \vdash \psi$". This dispute can be perfectly modeled by adopting CAE, as a case of lasting disagreement in logic.

It is worth keeping in mind that the contrast class of the question plays a role in determining how adequate or how good an explanation is. The question "Why $\varphi \vdash_i \psi$?", if understood as "Why $\varphi \vdash_i \psi$, rather than $\varphi \vdash_c \psi$?", could simply be answered by "Because there is a constructive proof of $\varphi \vdash_i \psi$ in L_i", and the existence of this constructive proof is more explanatory than a classical proof. If were there a "universal" standard for explanation in logic, then it seems that L_i would always be preferred in detriment of L_c. Yet this begs the question against the classical logician, who does not need a constructive proof in order to understand why ψ follows from φ. While this argument is one which an intuitionistic logician might use in favor of her favorite logic, the issue at stake should not be settled by an account of logical explanation.

The *second* case study is that of the dispute between Williamson and Priest regarding the "one-true-logic".[17] This is also not a case of mere verbal disagreement, for they both understand many of the same explanation requests. To wit, when asked, "Why is LEM valid?", both would accept this request for explanation, but give different answers. Priest would answer in the context of a theory which contains LP, while

Williamson would answer in the context of a theory which contains classical logic. Were the context specified in the questions, they would both agree ("Why is LEM true in LP?"), but given that they may each choose the context in which they give their reply, they give different answers. Their disagreement lies in the background knowledge of their theories, specifically related to Priest preferring a theory which can account for the transparent truth predicate and Williamson a theory which can easily account for classical mathematics.

The dispute occurs because each has different background theories in mind. While Priest prefers to include in his logical theory the transparent truth predicate, Williamson chooses to keep classical mathematics. When answering each of these why-questions, they might even pick out the same $K(Q)$ most of the time. When they do not, however, it is because they disagree on the logical theory. Of course, there might be a fact of the matter about which of them is correct, but this dispute need not be adjudicated by an account of explanation, but rather by an account of logic. That logical disputes are settled by background knowledge is not unique to CAE. In fact, Hlobil (2020), resisting much anti-exceptionalist dogma, argues that one's favored logic already determined the evidence which is used in an abductive argument, and thus of course one's favored logic will be the best theory selected abductively. "Logical evidence" is not neutral in regards to theory choice. Logical disputes are thus not about competing explanations of the same data, but rather about competing background knowledge, and IBE does not do much work in settling logical disputes.

A *third* disagreement which can be clarified by CAE is one between exceptionalist versus anti-exceptionalists regarding, for example, "Why is classical logic correct?". The topic of the questions can be understood in contrast with other logics, or it can be understood as relating to the justification of correctness. While an exceptionalist might answer that it is because one can intuit *a priori* the correct forms of reasoning (which is classical), an anti-exceptionalist might answer that it is because there is some non-*a priori* evidence which allows them to describe the most general aspect of reality, which conforms to classical logic. The CAE account is neutral on this dispute.

Fourth, and less contentiously, is how CAE can account for intra-theoretic disagreement, that is, disagreement regarding the field's own artifacts. Among the many proof systems available, there is disagreement about which one is preferable both pedagogically and heuristically. "Why is this argument truth preserving?" can be answered in various contexts, depending on one's audience and aims.[18] If the topic of this question is understood in the e context of an argument being truth-preserving rather than not,[19] the answer given might differ depending on the audience. In an introductory logic class, truth preservation is usually presented in terms of simple truth tables and model theoretic semantics; while in more advanced contexts this could be done, for instance, in the full glory of algebraic semantics. Some logicians skip semantics altogether and answer in terms of proof theory, to the dismay of many

colleagues. Cue in the clash between semanticists and proof theorists: "Why does φ entail ψ?" (rather than $\neg\psi$), "Why is this argument valid in L_1?" (rather than in L_2) and "Why is this a good proof?" (rather than a poor one) are explanation requests which will receive different answers depending on shared background knowledge and on the understood context.

New artifacts are often created with one specific purpose, such as sequent calculus (which was introduced by Gerhard Gentzen in 1934 as a tool for studying consistency of natural deduction systems), but caught on as a mainstream technique, to the point that some logicians only accept a result once there is a cut-free derivation of it. Sequent calculus has also opened up a whole new field of study, substructural logics, which was developed in order to break apart common assumptions about properties of logic validity ("Why is logical validity reflexive?" is a request of explanation that could be rejected: validity need not have this property).

Intra-theoretical disagreements are a driving force to proving many results regarding soundness and completeness, as well as equivalence between different systems and logics. While some proof systems or strategies are preferred for pragmatic or theoretical reasons, there is no recourse to a one-true-logic. This circumstance does not make disagreements regarding logical artifacts any less heated than extra-theoretical disagreements. Intra-theoretical explanation requests are just as interesting as extra-theoretical ones, and an account of explanation in logic should make sense of both.

Pedagogically, CAE also accounts for the different explanation contexts between beginner and advanced logic texts. In the latter, proofs are often deemed "trivial" or left to the reader, because, again, there is no universal best explanation. Pedagogical contexts require detailed proofs, while in the context of advanced discussion more background knowledge is assumed by the parties involved. An explanation is successful in a context only if there is understanding.

While the cases just analyzed are a small fragment of the common disputes within the broader area of logic, they advance the issue of explanation in logic by illustrating how a theory of explanation can be used beyond merely explaining how a logical theory can accommodate some inference form. Traditional accounts of explanation in logic are restricted in this sense, not acknowledging different contexts in which logical explanation happens.

5. Comparing theories of explanation in logic

Granting that the account presented here is a plausible fit for logic, it is worth exploring how CAE compares with IBE and FAE. While FAE and CAE can be seen as compatible (perhaps even complementary, in some sense), CAE and IBE are com-

peting accounts and cannot be conflated (which is a move that a logical abductivist might be tempted to make).

Clearly, the conceptual "scaffolding" used in FAE is relevant to some contexts within logic (for example, pedagogically), while not being relevant to others. While FAE assumes a kind of "scientific context" in which explanation occurs, if allowing for other contexts in which explanation might occur, the "conceptual scaffolding" might be akin to the "background knowledge" used in explanation in CAE.

As to IBE and CAE, one simple way to turn CAE into an account similar to IBE is to accept that explanation is given in terms of why-questions, but expect an answer "for all contexts" For instance, when asking, "Why is this argument valid?", the answer would not be given in the understood context of classical logic, but with regard to the one-true-logic. This answer, however, completely misses the point of CAE, since according to CAE there is no universal context. If one assumes there is such one-true-logic, this is part of the background knowledge, and not of a framework of explanation.

Granting further that IBE is a plausible account of explanation in logic (counter what was argued in Section 2), it is interesting to compare IBE and CAE on two points: regarding the metaphysical burden of each view and regarding the role logic itself plays in explanation.

First, the anti-exceptionalist account which relies on IBE (logical abductivism) become entrenched with Scientific Realism.[20] In particular to the point of whether (scientific) theories should be taken to be true and warrant belief (the scientific realist view) or if theories should be taken to be merely empirically adequate (the constructive empiricist view).[21]

IBE as a method in science takes it that explanation is a guide to truth (and, as such, goes hand-in-hand with Scientific Realism). Scientific realists take scientific theories "to describe reality even beyond the realm of observable things and regularities, so that theories can be regarded as statements having a truth value" (Niiniluoto 2015, p.13), and hold that "there are good reasons to believe that well-supported theories are likely to be at least approximately true" (Lipton 2000, p.191).

It is at least plausible to think that logical abductivism and scientific realism share the aim of seeking the truth (as opposed to a weaker epistemological standard, such as empirical adequacy) of theories. Specifically, it would not be contentious to say that abductivists in logic take logic to be a science, in the sense that they "maintain that science is a progressive activity with respect to the aim of truth, even if scientists are never in a position to assert rationally that the best theory of the moment is actually true" (Lipton 1993, p.93). Logical abductivists aim to revise logical theories in search for theories which become ever closer to the truth (similarly to scientific realism).[22]

> Truths in a logical theory are as hard-won as any scientific truth, and as subject to revision. (Hjortland 2017, p.6)

Assumptions that theories are true come with realist commitments about unobservable entities, insofar as there are true claims which are not directly observed. In the case of logic, the unobservable phenomenon is that of validity. Such a phenomenon has properties which logicians aim at describing.

> According to *logical predictivism*, logical theories aim to explain a certain phenomenon, validity (...)[23] (Martin and Hjortland 2021, p.3)

Such a positive attitude regarding the existence of non-observables is fine as a metaphysical view in logic, but it should not come as a result of adopting a theory of explanation. Yet by accepting "uncontroversial claims about scientific methodology" (Martin and Hjortland 2021, p.2), one enters on a particularly slippery slope towards some form of realism. Adopting CAE, however, does not require the truth of theories for them to have an explanatory role, and CAE is thus compatible with both anti-realism and realism about logic.

> Although it seems to me that realists and anti-realists need not disagree about the pragmatic aspects of theory acceptance, I have mentioned it here because I think that typically they do. We shall find ourselves returning time and again, for example, to requests for explanation to which realists typically attach an objective validity which anti-realists cannot grant. (van Fraassen 1980, p.15)

So while IBE inflates the metaphysics of logic, CAE does not. Postulating the existence of a validity phenomena to explain why particular logical arguments hold is not necessary. A view which allows for both realism and anti-realism seems to be better than one bound to some type of realism. As an account of explanation in logic, CAE stays clear of the issue of metaphysics, while leaving one free to adopt any "ism" that suits one's fancy.

Second, these two accounts can be compared to how each view deals with the role of logic in explanation. It is known that IBE in logic faces the logic in the background problem (Woods 2018, Martin and Hjortland 2022). Since logic is used in theory revision, if one aims to revise the current one-true-logic, it is not clear which logic should be used to revise logic (the "current logic" or the new contender). This is the major open issue for this account, one which has not been particularly well resolved.[24] In CAE, logic also plays a prominent role in the theory of explanation. This, however, is only an instrumental use of logic.[25] Since there is no "validity phenomena" to be accounted for, there is also no canonical application of logic, and this same logic need not be used for revising itself. There is no privileged entailment relation,

and thus the theory choice for the implication relation of the model can be based on pragmatic criteria, or reached through "reflective equilibrium".[26]

Van Fraassen's account of explanation uses logic explicitly (rather than using logic as the background theory to choose a "best explanation"). He defines explanation as an answer to a why-question,[27] and a given answer is always relative to a background theory. At this point, the choice of logical theory becomes pertinent. In van Fraassen's approach to explanation, many aspects of natural language become idealized, as expected: "there will be (. . .) assumptions taken for granted, theories accepted, world-pictures or paradigms adhered to, in that context" (van Fraassen 1980, p.137). The choice of "correct logic" or "best logic", does not seriously arise, it being just another "simplifying hypothesis". While how these hypotheses are settled is somewhat related to the choice of the instrumental logic, it is not strictly tied into the same picture.

One might think that the use of logic in such a manner is a problem akin to the logic in the background problem. This, however, is not so. While for the abductivists, who assume that there is a one-true-logic, this logic must be the one used for all adequate purposes, those willing to adopt the CAE account are unconstrained by this need. This instrumental use of logic is not incompatible with the empiricist's commitments, and CAE handles the logic of explanation perfectly well. Van Fraassen (1980) does not settle on a specific logic towards this end, but seems to be favor Anderson and Belnap's FDE (First Degree Entailment).

In the face-off between IBE and CAE, the latter wins on both rounds, as it does not require an inflationary metaphysics to account for explanation in logic, and also is not susceptible to the logic in the background problem.

Finally, one plausible criticism of a contextual account of explanation as it relates to disputes within a field is that it does not offer guidance in settling these disputes,[28] and is hence a rather deflationary account.

> [T]he obvious rejoinder that might be made on van Fraassen's behalf is that no more ambitious treatment that would satisfy the expectations associated with more traditional accounts of explanation (including a demarcation of candidate explanations into those that are "correct" and "incorrect") is possible—a theory like van Fraassen's is as good as it gets. (Woodward 2019, p.70–71)

Even if taking such a problem seriously for science, where generally it is currently accepted that practitioners aim to develop true theories (and thus guidance might be a necessary feature of an account of explanation), the same is not true in logic. As pointed out, for example, by Resnik (2004), within the field of logic there are many different projects which logicians work on, and not all of them aim at truth. He highlights four such projects: discovering true laws of logic, codifying inferential practice of competent speakers, developing formal logical systems in a purely creative way,

and systematizing intuitions with regard to specific inferences and putative logical truths within a logical theory. Explanation might be employed in any of these aims, but not all of them are interested in the truth of the theories they study.

6. Conclusion

The current essay adapts van Fraassen's (1980) account of explanation to deal with explanation in logic, showing this account fits well with the practice of logicians, and arguing that it is more suitable than the two other available accounts (IBE and FAE). Taking the discipline of logic more broadly than logicians trying to explain the notions of logical consequence, it is clear that it benefits from a contextual account of explanation. The CAE accommodates the diversity of practice of logicians, and the many contexts in which explanations are requested and how these requests are understood, without limiting the logician's task to the codification of natural language reasoning or to engaging in metaphysical speculation. The essay concludes by discussing the implications of CAE to anti-exceptionalism.

Van Fraassen's framework of why-questions is explicitly not an account of "scientific explanation", and so CAE does not rely on scientific methodology or a model of scientific explanation to account for explanation in logic. Such a deflationary account of explanation is, by design, not sufficient to guide any kind of theory choice in science, and might thus be rejected by anti-exceptionalists. By accepting CAE, it might thus be fruitful to reject the anti-exceptionalist predicament of demarcating logic within science in any strong sense. Yet, as has been argued, it need not be claimed that logic adheres to scientific methodology in order to advance an account of its explanations. There is nothing exceptional about logic, just as there is nothing exceptional about explanation.

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Notes

[1]The sense of "traditional" used by Woodward (2019) is not the same sense used by Payette and Wyatt (2018). Payette and Wyatte call "traditional" the deductive-nomological model, while Woodward considers, more broadly, accounts which do not take into account pragmatic aspects.

[2]Not all anti-exceptionalists are abductivists. For example, Penelope Maddy could be considered an anti-exceptionalist (Hjortland 2017), while not being an abductivist.

[3]First proposed by C. S. Peirce, abduction is the mode of inference which, together with deduction and induction, constitute scientific inquiry (Rodrigues 2011). In particular, abduction generates hypotheses, from which consequences are deductively drawn and inductively tested. In recent literature, however, this term has lost its original meaning and has come to be employed in the justification of theory selection, as "inference to the best explanation"; see Douven (2017). For a comparison of abduction in Peirce's sense and IBE, see Mohammadian (2019).

[4]For a survey on logical evidence, see Hjortland (2019) and Martin and Hjortland (2022).

[5]Regarding how to infer a general law or theory from particular instances of evidence, Harman (1965) argues that induction is a specific case of the more general inference of abduction, or IBE.

[6]In the sense that a logic which can express contradictions, for instance, will have fewer valid arguments.

[7]Without implying anything about the fitness of IBE in its original scope.

[8]This deflationary account is not the same as other anti-exceptionalists views, who rather talk about validity on more realist terms, saying for example, that "both scientific and logical theories [are] engaged in a process of providing explanations for a given phenomenon" (Martin and Hjortland 2021, p.29). Given that validity is unobservable, the phenomena is postulated, in the manner of scientific realism. More on this in Section 5 below.

[9]The first part of the essay discusses the DN-model of explanation and how this ill fits logic, but no anti-exceptionalist has yet claimed that it does.

[10]As opposed to a three-place relation, for instance, such as in the the contextual account discussed in Section 3 below.

[11] Martin also argues that Payette and Wyatt's account is unsuccessful in general, as it does not solve the logic in the background problem, for more on this, see Martin (2021, section 4).

[12]The present essay stops short of endorsing van Fraassen's account of explanation as adequate for science. For present purposes, it suffices that his account is plausible for "extra-

scientific" explanation.

[13]Scientific Realism and IBE are discussed more specifically in Section 5 below.

[14] Whether "validity" can be postulated as a "common cause" to account for the regularity of certain argument forms or not is beside the point. For constructive empiricism, the postulation of a common cause should be resisted, as it does not play a role in explanation. As such, the contextual account of explanation presented herein also does not need to postulate this common cause.

[15]Not to be mistaken with "relevance relation" from relevant logics.

[16]Were there no proof of $\varphi \vdash \psi$ in L_i, the explanation request would be rejected, simply because it is not known that $\varphi \vdash_i \psi$ is true, as this proof has not been yet found. Another possible case is one in which there is a proof that there is no proof of $\varphi \vdash \psi$ in L_i, yet the explanation request could still be rejected.

[17]Such a logical theory is one which has to accommodate at the same time at least Peano's arithmetic and the transparent truth predicate (Hjortland 2019).

[18]Dutilh Novaes (2021) relates this point to deduction's property of perspicuity, where a proof must fulfill the epistemic function of justification.

[19]The same question could be understood in terms of "Why is this argument truth preserving, rather than that other one?".

[20]Scientific Realism is not the only view which adopts a realist attitude towards the unobservable aspects of scientific theories. It is, however, the view that does so through an account of explanation.

[21]The scientific realist view is criticized most extensively by van Fraassen (1980), and defended by many authors, such as Lipton (1993, 2000) and Psillos (1996). It is not the aim of the current essay to adjudicate this dispute, but merely comment that logical abductivists seem to fall to one side of the debate.

[22]Again, in opposition of revising theories to become ever more empirically adequate.

[23]It seems somewhat unclear from the anti-exceptionalist account if logical theories explain the phenomenon of validity (which is simply postulated as existing), or of logical theories explain particular instances of valid arguments by postulating the existence of a phenomenon which explains the particular instances.

[24]For one solution, see Woods (2018). This problem is one which FAE claims to solve, by rejection the DN-model of explanation. It seems plausible that Payette and Wyatt (2018) would reject IBE as a model of explanation in logic, exactly because it faces this problem.

[25]The choice for best logic for an instrumental purpose is not the same as choosing "the best" logic abductivelly in anti-exceptionalist fashion, with the aim being to find the one-true-logic. The instrumental choice is merely a pragmatic one, unrelated to a "canonical application".

[26]It has been proposed by Prawitz (2007) and Resnik (1999) that reflective equilibrium is the correct method for choosing the most suitable logical principles. This method does not rely on the notion of "explanation", as one can understand principles with which one does not agree. The method is based on reaching an equilibrium between particular instances of arguments and general logical laws that might represent them. It is possible to reach two different states of equilibrium, so theory choice is not univocal.

[27]Instead of in terms of grounds for belief, statistical relevance, the counterfactual conditional or causal interaction, for instance.

[28]One point in favor of IBE is that such guidance is a major feature of the account.

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