Marie Skłodowska-Curie Individual Fellowship
Project No.: 797507

The Unknown Science:
Understanding the Epistemology of Logic through Practice (EpiLog)

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Abstract. We take ourselves to know certain logical claims, for example that no contradictions are true. However, we currently fail to have an adequate account of how we possess logical knowledge. Historical attempts to explain this knowledge, such as appeals to intuition, have been found to be ultimately unsatisfactory, either because they are metaphysically obscure or fail to explain logical disagreements. Yet, it is imperative that we have a complete understanding of logical knowledge. While we use logic to form beliefs in all areas of life, such as when testing scientific theories and engaging in rational debate, we now have many competing logics at our disposal to do so, all of which lead us to reasoning differently in certain situations. So, in order to ensure we reason correctly, it is paramount that we choose the right logic. Yet, in order to make these choices, we require suitable criteria to adjudicate between the logics, which can only be developed with a full understanding of what constitutes logical evidence. Without an account of logical evidence, we lack the resources to make principled and holistic decisions about the correct logic to use. EpiLog solves these problems, by: i) Advancing a theory of logical epistemology, called *logical abductivism*, which proposes that, contrary to historical consensus, we come to know logical truths similarly to how scientists know truths about the world; and, ii) Developing a set of criteria for the logical community to use to successfully adjudicate between competing logics. To support its findings, EpiLog uses a *practice-based* approach, inferring from logicians' practice the underlying methods through which we gain logical knowledge. While this approach has been successful in elucidating how we gain empirical knowledge in the sciences, it has yet to be extensively used in the study of logic. Consequently, EpiLog addresses an important gap in the literature, transferring techniques from methodological studies of the sciences to logic.

Project Outline

We take ourselves to know certain logical claims. For example, that Socrates is wise and just only if he's wise, and that Canberra is either the capital of Australia or not. Yet, currently we fail to have a viable explanation of how we possess logical knowledge. This problem is caused predominantly by the fact that logical knowledge seems to be epistemically *basic*, in that much of our other knowledge presupposes it. We require logic to establish mathematical truths, test our scientific theories, and engage in rational debate. Consequently, our other knowledge simply presumes we possess logical knowledge, and so cannot be relied upon to either support or undermine our logical beliefs.

Two explanations of logical knowledge have dominated the philosophical landscape. Firstly, that we recognise logical truths through a form of mental insight (MacFarlane, 2002), and secondly that logical knowledge is a sheer product of linguistic proficiency, with logical truths guaranteed by the meaning of certain special logical terms (Carnap, 1937). Both accounts, however, are ultimately inadequate; while logical intuition is mysterious, appeals to linguistic proficiency are unable to explain logical disagreements (Casullo, 2003; Williamson, 2007). Consequently, we need a new, more complete, explanation of logical knowledge.

Nor is the need for a new explanation purely theoretical. We use logic to form beliefs in all areas of life, and we now have many competing logics at our disposal to do so, all of which would lead us to reasoning differently in certain situations. For example, it is currently unsettled how we ought to reason with inconsistent beliefs. While the predominant logic of the last century, *classical logic*, dictates that any proposition whatsoever follows from an inconsistency, *paraconsistent logics* allow individuals to hold inconsistent beliefs and make informative inferences from them (da Costa, 1974). Thus, while for the classical logician discovering an inconsistency in one's beliefs necessitates making no further inferences until the inconsistency can be removed, as one inference would be as good as any other, paraconsistent logicians argue such an approach is unrealistic and irrational. It is often not apparent how to remove the inconsistency, and we can only subsequently recognise our mistake and remove the inconsistency *by making inferences* from these beliefs to further consequences (Jennings & Schotch, 2009).

Consequently, in order to ensure we reason correctly, both in this and other circumstances, it is paramount that we choose the right logic. Yet, in order to make these choices, we require tools that we currently fail to possess. Namely, effective criteria to adjudicate between competing logics, which can only be formulated once we have an adequate understanding of what constitutes logical evidence.

EpiLog solves these important problems, advancing: i) a theory of logical epistemology, *logical abductivism*, and ii) a set of criteria that the logical community can use to adjudicate between competing logics. EpiLog achieves these goals using a *practice-based approach*, yet to be used in the study of logic, by considering a prominent logical debate and extracting from the debate methodological principles logicians appeal to within their arguments. EpiLog's importance and novelty, therefore, is found not only in its results, producing an account of logical knowledge that logicians can use to solve present and future logical disputes, but in the method used to reach those results.

While using the practice of researchers has proven a useful method to study how knowledge is acquired in the natural sciences (Burian, 2001; Kuhn, 1962) and mathematics (Mancosu, 2008), the same method has yet to be extensively used in the study of logic. EpiLog addresses this important gap in the literature, transferring techniques from methodological studies of the sciences and mathematics to build an account of how we gain logical knowledge. Just as philosophers of science have used historical scientific experiments and disputes as their data to infer how we come to know empirical claims, so EpiLog's practice-based method takes logical arguments as its data, inferring from these, first, the methodological principles that logical arguments rely upon, and then constructing a theory of logical epistemology that best fits these principles. The rationale for using practice to inform an epistemology of logic is the presumption that generally, as with scientists, logicians provide suitable reasons for their claims even if, ultimately, they are not wholly satisfactory. Thus, we should expect logicians' arguments to provide insight into how we can come to know logical truths.

In examining logical practice, EpiLog focuses on one of the most significant debates within modern logic as a case study; the dispute between classical logic and dialetheism over the truth of inconsistent theories (Priest *et al*., 2004). Since Aristotle offered a defence of the Law of Non-Contradiction over 2000 years ago, the wider philosophical and logical communities have almost universally taken it for granted that contradictions cannot be true. However, important discoveries by Bertrand Russell (Garciadiego, 1992) and Alfred Tarski (1983) in the previous century on the nature of sets and truth, respectively, have placed considerable pressure on this widely held principle, with both showing that the existence of *self-referential sentences* appears to inevitably lead to contradictions. While Russell showed that formulations of naïve set theory entailed a contradiction by admitting the existence of a set containing all and only those sets that do not contain themselves, Tarski recognised that, based on plausible assumptions, natural languages will always contain sentences that deny their own truth, and thus entail a contradiction.

Considerable attempts have been made to resolve these paradoxical findings. For example, to resist the inconsistency of our everyday linguistic practices, philosophers have proposed that self-referential sentences such as 'This sentence is false' are ultimately unproblematic, as they are either meaningless or lack a truth-value (Field, 2008). Yet, with the arrival of Graham Priest's (2006) *In Contradiction*, these previous solutions to the paradoxes were challenged. Priest's position, dialetheism, argues that attempts to avoid true contradictions are bound to fail, either because they place too great a theoretical burden upon us, or because any such solution will simply lead to more pernicious cases, and thus further contradictions arising. Instead, we must admit that our fundamental mathematical and linguistic practices entail true contradictions; ensuring that we should endorse a logic that is not only paraconsistent, allowing one to make informative inferences from inconsistent propositions, but dialetheic by allowing contradictories to be true.

The rationale for using the classical logic-dialetheism (CD) debate as EpiLog's data, rather than other logical arguments, is threefold: i) The debate is detailed, extended and diverse. Thus, there is a rich source of arguments, and replies, to draw from; ii) Initial results from pilot studies, applying the proposed practice-based approach to the debate, have been fruitful (see below); iii) I have expertise in the debate, having published on the subject. However, while the choice to use the CD debate in EpiLog is well-motivated, the practice-based method is extendable, and can eventually be used to consider further historical logical debates, notably between classical and intuitionistic logics. In other words, like any good method, EpiLog's practice-based approach will be used beyond this project to collect further data to (dis)confirm its findings. Thus, EpiLog's results will not ultimately be biased by the choice of arguments considered.

Using its practice-based method, EpiLog has two main goals:

Goal 1. *Formulate and provide evidence for a theory of logical epistemology called 'logical abductivism', which shows that logical methodology is akin to the empirical scientific method.*

By analysing the arguments advanced on both sides of the CD debate, EpiLog will show that the methodological principles appealed to in these arguments support a new theory of logical epistemology, *logical*

abductivism, recently discussed in the work of Hjortland (2017), Priest (2014), and Williamson (2013), with Quine's (1951) empirical holism as its progenitor. According to *logical abductivism*, the epistemology of logic is similar to that of the natural sciences. Just as science proceeds by advancing theories that attempt to best explain the relevant data, by a process known as *abduction* (McMullin, 1992), so logic proposes theories to explain its own domain of data as lucidly and coherently as possible. Thus, we come to be justified in our logical beliefs by recognising which available logical theory best explains the relevant data.

Goal 2. *Provide clear and detailed criteria for logical theory choice.*

At present, there is little agreement between versions of *logical abductivism* over what constitutes these *relevant data* that logical theories must explain. Yet, without a detailed account of what these data are, *logical abductivism* cannot hope to provide the means to adjudicate between competing logics. We need to know what type of data, exactly, logical theories must explain. EpiLog solves this problem by using logical practice to pinpoint the types of data logical theories attempt to explain. Just as any account of scientific methodology should be able to demarcate good scientific practice from bad, so EpiLog will provide criteria by which to judge how successful a logical theory is, serving as a tool for the logical community to adjudicate between competing logics.

To meet its goals, EpiLog's research is split into three work packages (**WP**s), each with its own objectives and hypotheses. In the first (**WP1**), arguments from the CD debate will be examined, with these arguments serving as EpiLog's data. The project will clarify the content of each argument and then identify the methodological principles that each relies upon. Arguments from both sides of the debate that **WP1** will consider include, that: i) Definitions of terms in the debate, such as 'contradiction', preclude the truth of contradictions (Slater. 1995); ii) Dialetheic logics cannot successfully underpin scientific enquiry (Tennant, 2004); iii) Dialetheic logics don't allow us to express certain concepts, such as disagreement (Shapiro, 2004); iv) Dialetheic semantics are as pathological as classical logic (Littmann & Simmons, 2004); v) Dialetheism entails unacceptable metaphysical commitments (Martin, 2015); vi) Classical logic cannot accommodate the expressive power of natural languages (Beall, 2009); and, vii) Dialetheic logics offer the simplest solution to logical paradoxes (Priest, 2006). **WP1** contains two hypotheses: *Firstly*, that methodological principles will be identified in the examined arguments and, *secondly*, that similar principles will be identified in multiple arguments.

Following **WP1**'s findings, EpiLog's second stage (**WP2**) has two objectives: *Firstly*, establish which theory of logical epistemology best fits these methodological principles from the CD debate and, *secondly*, provide criteria by which to judge the success of competing logics. These objectives, jointly, have associated hypotheses. Firstly, that the arguments examined in **WP1** provide evidence, consistent with *logical abductivism*, that logics are theories with their own distinctive data and puzzles, including linguistic norms and paradoxes, which they attempt to explain while exhibiting theoretical virtues, such as simplicity. In addition, that the principles identified in **WP1** demonstrate that the logical community test logics for their ability to produce fruitful results in other fields, such as mathematics and the sciences. Consequently, historically popular theories of logical knowledge, such as appeals to intuition and linguistic proficiency, fail to adequately fit **WP1**'s data. Instead, logical practice supports *logical abductivism*; logic's methodology is akin to that of the empirical sciences, while possessing its own distinctive data set.

WP2's second hypothesis is that we can use the methodological principles discovered in **WP1** to infer criteria for logical theory choice. A fundamental motivation for any theory of logical epistemology is that it provides the logical and wider academic community with the tools to adjudicate between the competing logics before us. Yet, providing this guidance requires a detailed account of the data logical theories must accommodate, and how we measure a theory's success in accommodating this data. A strength of EpiLog's method is that by considering logical practice, the data logical theories should be accommodating can be identified.

The proposed success of EpiLog's method is supported not only by its past success in other fields, but through preliminary findings presented at international conferences.[1] At these conferences, I have argued that logical disputes cannot reasonably be understood in purely definitional or intuitional terms. Taking as an initial study Priest's arguments for dialetheism, I have shown that three methodological principles are relied upon: firstly, that linguistic and mathematical puzzles can form part of a logical theory's *explanandum*; secondly, that linguistic norms form part of logical evidence; and, thirdly, that mathematical results form part of logical evidence. As noted, EpiLog hypothesises that these same methodological principles are endorsed by Priest's opponents, providing clear criteria to guide future logical theory choices.

EpiLog's final stage (**WP3**) answers two significant philosophical challenges facing its methodology and the theory it supports, *logical abductivism*: Firstly, it may be argued that, contrary to EpiLog's presumption, the fact

[1] Martin, B. (April, 2017). "The Dialetheism Debate: Motivating a New Epistemology of Logic," *2017 Meeting of the Nordic Network on the Philosophy of Science*, Copenhagen; Martin, B. (Dec., 2017). "Learning from Practice," *3rd Anti-Exceptionalism Workshop: Theory-Choice in Logic*, MCMP, Munich, Germany.

that practice within the CD debate best fits *logical abductivism* fails to provide substantial support for the theory, as members of the debate may have been engaged in inappropriate epistemological practice all along. Secondly, it may be argued that *logical abductivism* is implausible for allowing logical theories to be informed by empirical data. After all, there are good reasons for denying that empirical data can provide evidence for a logical theory, as we must *use logic* to infer the consequences of empirical evidence; thus, we end up having to presuppose a logical theory by using such empirical evidence, rather than the empirical evidence directly providing support for a logic (Shapiro, 2000).

WP3's associated hypotheses are, firstly, that the methodological principles found in the CD debate do indeed provide *prima facie* evidence for *logical abductivism* on the assumption that logical practice has been, in general, successful in improving our logical theories, and arriving at more true logical claims. Further, that evidence from other logical disputes will provide additional support to *logical abductivism*, decreasing the probability that practice within the CD debate is unrepresentative of logical practice as a whole. A strength of EpiLog is that its findings, as is scientifically appropriate, can be challenged by extending its method to further case studies, thereby promoting collaboration between European researchers in future projects. **WP3**'s second hypothesis is that historical concerns over empirical evidence supporting logical theories are unfounded. Using empirical evidence to motivate a logical theory does not require the use of the deductive inferences which the evidence is ultimately motivating.

EpiLog provides *three* major innovative results. Firstly, it will provide evidence for a novel theory of logical epistemology which shows that logical knowledge is akin to that of the natural sciences. This is significant, given that historically logical knowledge has been considered special, and distinct from scientific knowledge, in being wholly *a priori*. Secondly, EpiLog will provide guidelines to resolve outstanding and future logical disputes, a virtue no historical account of logical knowledge possesses. This result has significance beyond logic, extending to other fields using logic. To highlight one example, there is ongoing disagreement over the best logic to model reasoning in robots, without any agreed criteria to judge the most successful logic (Hertzberg & Chatila, 2008). EpiLog's results are applicable to these debates in Computer Science, Engineering and further industry, providing clear criteria to judge both a logic's *narrow* success, in solving the problem at hand, and *wider* success, in solving further but connected problems. Many logics are proposed to solve local problems within industry, however complex technological challenges often require the solution of multiple local problems at once, utilising distinct logics. EpiLog raises the possibility of subsuming these local logics under more wide-ranging logical theories, allowing for a smoother interface. Without these criteria, the community lacks the resources to make principled and holistic decisions for choosing one logic over another. Finally, EpiLog will demonstrate that a practice-based approach can be fruitful in understanding logical knowledge, with the potential to extend the method to further debates in future projects.

EpiLog is in a vibrant research area, with two projects on logical epistemology attracting funding in the past four years.[2] Additionally, leading researchers in logic, such as Timothy Williamson (2007) and Graham Priest (2014), have recently written on the importance of having a well-articulated understanding of its epistemology, both to understand the wider aims of logical research and to aid in solving logical disputes. This project is, therefore, timely and in line with current European research trends.

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[2] *The Metaphysical Basis of Logic* (https://www.abdn.ac.uk/research/contradiction/project/), 2013-2015. PI: Francesco Berto. Funded by the AHRC, based at The Northern Institute of Philosophy, University of Aberdeen; *Anti-Exceptionalism About Logic* (http://www.uib.no/en/antiex), 2016-2020. PI: Ole Hjortland. Funded by the Norwegian Research Council, based at the University of Bergen.

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