Introduction

The typical compulsory introduction to logic is odd: it's an odd course in a humanities curriculum, and it's particularly odd in a philosophy curriculum. What makes it somewhat odd in the humanities curriculum is the fact that it introduces a mathematical theory and methodology without much discussion of its scope and limits. There aren't many topics in the humanities that have been subject to rigorous mathematical analysis, and in the few cases in which scientists attempted to develop a mathematical model of their subject matter, the models are highly contested. However, logic courses seem unashamedly formal with little or no discussion of the approach's limits.

Within a philosophy curriculum, this situation is even stranger. Logic is supposed to be a universal methodology for doing philosophy, and logic is also a philosophical subdiscipline which has its origins in the work of Aristotle. Philosophy is a discipline that takes nothing for granted, and in which students are trained to develop a critical attitude towards any kind of claim. Nevertheless, in introductions to logic there is little room for argument, criticism or debate. Unlike pretty much any other course in the philosophy curriculum, logic is taught like a mathematics course.

It's not as if there weren't good reasons for doing it that way. Logic is one of the few subdisciplines of philosophy in which there has been considerable progress and convergence over the past 150 years. Much of this is due to the fact that – largely thanks to Gottlob Frege – modern logic is a rich mathematical theory. Introducing that theory and training students in it to a degree that enables them to apply the formal apparatus when analysing arguments for their validity, etc. is quite time consuming. Also, some of the most interesting questions about the scope and limits of logic can only be properly assessed when one knows at least a little bit about what logic

actually is. Thus, it is well justified to postpone the critical discussion of logic for later and to limit introductions to logic to somewhat uncritical training courses in a formal methodology.

Nevertheless, this is unsatisfactory for the student of logic. She, for sure, would like to learn more about this discipline's philosophical foundations. But courses in philosophy of logic are unfortunately rare, witnessed or perhaps partly caused by the fact that there are almost no contemporary textbooks for such courses. This book is our attempt to fill that lacuna and provide a contemporary introduction to the central questions in the philosophy of logic.

What is the Philosophy of Logic?

This book is not an introduction to logic and it's not an introduction to philosophical logic either. As we will explain in the next chapter, philosophical logics are mathematical theories with a specific intended interpretation and application. This book presupposes acquaintance with an introduction to (philosophical) logic, as it is standardly taught in undergraduate programmes in philosophy all over the world. In particular, we assume a certain amount of familiarity with propositional logic and first-order (polyadic)[1] predicate logic. A good introduction to standard logic is Halbach (2010).

This book is also not intended as an introduction to the metatheory of standard logic or to non-classical deviations from standard logic. We will not presuppose acquaintance with metalogical results, or with deviant logics (and will try to introduce their gist when relevant), but this is not the place to discuss such matters in any (formal) detail. Good introductions to metalogic or deviant logic can be found instead in Sider (2010) and Priest (2008).

What the philosophy of logic is concerned with are the philosophical questions that relate to logic. For example, in the introductory course

[1] A predicate logic is "polyadic", if it contains in addition to one-place predicates also n-place relations. Thus, if you encountered formulas like '$\forall x \forall y \exists z(Rxy \rightarrow Rxz)$' in addition to formulas like '$\forall x(Fx \rightarrow Gx)$', you probably studied polyadic predicate logic. Predicate logic with only one-place predicates is called "monadic".

you learned to work with one specific logic, so-called "standard" or "classical" logic. There are alternatives to this logic: so-called "deviant" or "non-classical" logics. Why are there such alternatives? Is there reason to be discontent with classical logic? Is only one logic correct, or could several of these turn out to be correct? What does the correctness of a logic consist in? Getting the logical facts right? What are these facts? Are these mind-independent facts, are these facts about languages or conventions? How can we have knowledge of these facts? Do we know what's true in logic *a priori*? Could we be mistaken in our beliefs about logic? Could we detect such mistakes? Could we revise our beliefs about logic?

These and other questions will be discussed in this book (a detailed overview is in the next subsection). These questions concern the metaphysics, the epistemology and the methodology of logic. Some of these questions are similar to questions in related philosophical disciplines, such as the philosophy of language or the philosophy of mathematics. And if you are already familiar with these fields, you will recognize some of the arguments and moves from there. However, the philosophy of logic is a subdiscipline of philosophy by itself and not to be subsumed under either philosophy of language or philosophy of mathematics. That the questions that arise for logic are often unique is something that we hope you will learn from this book.

Overview of the Contents of this Book

Then let's dive into an overview of the topics we cover in this book. Of course, we couldn't cover every topic in the philosophy of logic, not even at the very introductory level this book is at. In our selection of material, we have tried to identify topics that we think are either the central questions of the philosophy of logic, or else closely related to them and in the centre of the contemporary discussion. For example, we haven't included a discussion of theories of truth or the reference of proper names in this book, because we didn't consider these topics to belong to the philosophy of logic (or at least not to its central questions). We also haven't included a detailed discussion of the philosophical controversy over the status of quantified modal logic, or the case for quantum logic, even though these topics belong to philosophy of logic. We felt that the relevant issues in these, the

supposed metaphysical neutrality of logic, and the empirical revisability of logic, can be discussed in their own right, abstracting away from the specific logics.

We have divided the topics that we selected for inclusion into 10 somewhat equal-sized chapters.

1 The Nature and Tools of Logic

This chapter introduces the core terminology we will use in the book. What are we talking about when we talk about "logic"? Are we talking about certain mathematical theories or structures, or about a discipline? Can we make a distinction between *pure* and *applied* logic, in the way in which we can make that distinction for geometry? We also introduce a little bit of technical apparatus, borrowed from set theory, which we use for some of the more technical examples throughout the book. Most of these technicalities will be familiar to the reader, but we go over them to make sure that we are on the same page in terminology and notation. Finally, we present a general framework to talk about logic from a model-theoretic and a proof-theoretic point of view. Both perspectives will be relevant in later chapters.

2 The Standard Story and its Rivals

The second chapter introduces the main features of standard logic, reviews some arguments for and against them and presents some of the alternatives to standard logic. Some of the features of standard logic are so common that they might seem essential to logic. As we shall see in this chapter, but also in many of the later chapters, most of these features have been challenged.

3 Is Second-Order Logic Proper Logic?

In this chapter we continue to investigate deviations from standard logic. Here we will focus on the case of second-order logic. We sketch the standard and the Henkin semantics of second-order logic, and extend our proof system with rules for the second-order quantifiers. This chapter explains the differences between first-order logic with identity and

second-order logic and the notion of categoricity. In many respects second-order logic seems just like a straightforward extension of standard logic, but it does come with some strange properties. Does that matter for whether second-order logic is logic? What makes a formal system a logic?

4 Logical Constants

What is the meaning of a logical connective? How is that meaning determined, and does it remain fixed across different logics? We present different ways of spelling out what the meaning of a logical constant is, Quine's classical argument for meaning-variance across logics and some attempts to block it.

What is usually regarded as the *problem of logical constants* is that of giving a principled demarcation between expressions that determine the logical form of an argument and those that do not. In the second half of Chapter 4, we discuss this problem, its motivation, potential solutions and some possible stances on its importance.

5 The Metaphysics of Logic

Logical realism is the view that logic is based on facts that are independent of us, our psychological make-up, inferential practices or conventions. Logical realism is perhaps a default view about logic; however, there are important alternatives. Psychologism about logic is the view that facts about our mind/brains ground logic. A further alternative to full-blooded realism and plain psychologism is to ground the logical facts in our rationality. This is a form of Kantianism about logic, recently defended by authors like Robert Hanna (2006a).

Another way of avoiding the idea that logic is made true by some fundamental features of reality, rationality or our minds is to hold that logical truths are "true by convention". This view was famously held by the logical positivists about both the laws of logic and those of mathematics. In Chapter 5 we will discuss the different options and introduce some of the main arguments of this debate about the metaphysical status of logic.

6 The Epistemology of Logic

If we follow the distinction between *logica docens*, *logica utens* and *logica ens* (as introduced in the first chapter), then we can distinguish three different questions about the revisability of logic. The first is the question of whether our beliefs about logic and our theories of logic can be revised, and what evidence there might be that could motivate us to such revision. The question of whether the logic we use is also revisable is already harder to answer. At least it seems as if training in (a particular) logic can influence our ways of reasoning. But can we rationally revise logic? Wouldn't that require to have a view from nowhere, which is a point of view that is impossible to take, since we always reason *in* a logic? Perhaps encountering problems within your own logic, for example by facing paradoxes that seem unacceptable by our own lights, might convince us that our logic needs revision. But how can we rationally evaluate the alternatives?

Closely related to the question of how we can rationally revise the logic we use is the question of how we can *justify* the logic we endorse. In this chapter we will explore what the problem of rule-circularity is and discuss possible answers to it: for example Nelson Goodman's suggestion that the laws of logic are justified because they are in reflective equilibrium with our judgements about instances of rule-application and the idea that we are default justified in applying the rules of logic and can hence escape the circle (or, rather, its viciousness).

7 Logical Pluralism

Plurality and logic may meet in different ways, from the now relatively uncontroversial 'There are many pure logics' to the highly controversial 'Some domains require different canonically applied logics' and 'There can be more than one correct logic canonically applied even to the same domain'. We probe these combinations and rank them according to their *prima facie* plausibility.

Perhaps the most interesting version of logical pluralism would be one in which logics are canonically applied to the same domain. In this chapter we explore the possible criteria that this kind of logical pluralism should meet to be (not trivially) true, or at least, to not be at a disadvantage vis-à-vis logical monism.

8 Logic, Reasoning and Rationality

If logic is a descriptive theory of (perhaps) the laws of truth or (perhaps) some very general features of metaphysical reality then we probably *should* reason along the laws of logic in the same sense as we should reason along the laws of physics when reasoning about physical subject matter.

However, there is a second way in which logic is often taken to be normative for thought. In this second way, logic is taken to be normative in a direct way, by understanding the laws of logic as telling us normatively how we ought to reason. As Gilbert Harman (1986) and other authors have pointed out, this doesn't seem right. If we understand logic in this way, then it would command us to conclude every arbitrary thing if we believed a single contradiction; and it would in any case clutter our belief box with all logical consequences of our beliefs, even though most of these consequences have no relevance to us whatsoever.

In the second half of Chapter 8 we will look at some of the puzzles that logic and our logical knowledge give rise to in epistemic logic and the semantics of propositional attitude reports. Perhaps logic is *a priori*, but certainly that doesn't mean that everyone *knows* all logical truths, right? Are there ways to distinguish different levels of logical knowledge? How can we characterize the increase in understanding as we proceed in proving a logical deduction?

9 Beyond Truth-Preservation

Some authors have argued that the most immediate justification of the idea that logical consequence preserves truth (from premises to conclusions) requires all the resources that yield a version of Curry's Paradox, so it could not be coherently required that valid arguments preserve truth. We survey here different arguments for and against the abandonment of truth-preservation based on such a paradox of validity. We also explore ways of logically relating premises and conclusions other than truth-preservation, that are mainly derived from the use of cognitive states like acceptance and rejection (or their linguistic expressions, assertion and denial) in the definition of validity.

10 The Place of Logic in Science

Perhaps the most evident role of logic in the empirical sciences is that of an inferential device used to extract information from certain bodies of beliefs or knowledge. However, there are other significant roles of logic in the sciences. Logic plays an important role in theoretical linguistics (for example, in the form of formal semantics), and as a theory of reasoning in cognitive science.

Mathematics is the paradigmatic case of logic working as an inferential device. But besides the problem of identifying a logic for mathematics given that seemingly one can do mathematics based on the logic one wishes, there is the problem of whether logic should be more properly thought of as a branch of mathematics, or as based on it, rather than the other way around.

In philosophy, formal logic is used as a tool. We use logic (and its symbolism) for disambiguation, the formal reconstruction of arguments, and for modelling. Especially in the last two functions, it seems that logic needs to satisfy special adequacy requirements: it must be philosophically neutral, and it must allow philosophers to express the kind of claims they intend to make.

Finally, we look at logic as a science itself. Is logic an exception in the family of sciences? If so, what makes it special? If not, how does it fit in?

How to Read the Book

As we said before, we presuppose familiarity with the contents of a standard introductory course in logic. It's possible to read the book to some extent without this familiarity, but we doubt that you will gain much insight from that. If you are not familiar with standard logic, we recommend reading Halbach (2010). This is a contemporary introduction to logic which uses similar terminology to ours.

The book is conceived as a course that can be read from beginning to end. However, the chapters are actually for the most part self-contained (and otherwise contain explicit references to earlier chapters). Chapter 1 introduces some of the core terminology we use, and Chapter 2 gives a quick recap about some of the main properties of standard logic. If you have read these two chapters, you should be able to jump to whatever topic interests you.

When using this book for self-study, we recommend to think about the questions at the end of the chapters and formulate answers to them. Even without external feedback this will probably give you an indication of how well you have understood the chapter.

How to Teach the Book

The course is conceived as a 10-week course with a lecture based on the textbook, and a seminar based on further readings, covering one chapter per week. If you have less time, you can concentrate on the textbook only and take the questions at the end of each chapter as starting points for discussion in the classroom. As we said above, Chapters 1 and 2 introduce and explain some of the terminology that is used and presupposed in other chapters. Other than that, you can freely pick and choose from the other chapters what you want to cover in your course.