

# CHAPTER 1

## The Basics of Logical Analysis

### I. What Is Logic?

In Logic, the object of study is *reasoning*. This is an activity that humans engage in—when we make claims and back them up with reasons, or when we make inferences about what follows from a set of statements.

Like many human activities, reasoning can be done well, or it can be done badly. The goal of logic is to distinguish good reasoning from bad. Good reasoning is not necessarily effective reasoning; in fact, as we shall see, bad reasoning is pervasive and often extremely effective—in the sense that people are often persuaded by it. In Logic, the standard of goodness is not effectiveness in the sense of persuasiveness, but rather *correctness* according to logical rules.

In logic, we study the rules and techniques that allow us to distinguish good, correct reasoning from bad, incorrect reasoning.

Since there is a variety of different types of reasoning, since it's possible to develop various methods for evaluating each of those types, and since there are different views on what constitutes correct reasoning, there are many approaches to the logical enterprise. We talk of logic, but also of *logics*. A logic is just a set of rules and techniques for distinguishing good reasoning from bad. There are many logics; the purpose of this book is to give an overview of some of the most basic ones.

So, the object of study in logic is human reasoning, with the goal of distinguishing the good from the bad. It is important to note that this approach sets logic apart from an alternative way of studying human reasoning, one more proper to a different discipline: psychology. It is possible to study human reasoning in a merely *descriptive* mode: to identify common patterns of reasoning

and explore their psychological causes, for example. This is not logic. Logic takes up reasoning in a *prescriptive* mode: it tells how we *ought* to reason, not merely how we in fact typically do.<sup>1</sup>

## II. Basic Notions: Propositions and Arguments

Reasoning involves claims or statements—making them and backing them up with reasons, drawing out their consequences. *Propositions* are the things we claim, state, assert.

Propositions are the kinds of things that can be true or false. They are expressed by declarative sentences.<sup>2</sup> ‘This book is boring’ is a declarative sentence; it expresses the proposition that this book is boring, which is (arguably) true (at least so far—but it’s only the first page; wait until later, when things get exciting! You won’t believe the cliffhanger at the end of Chapter 3. Mind-blowing.).

Other kinds of sentences do not express propositions. Imperative sentences issue commands: ‘Sit down and shut up’ is an imperative sentence; it doesn’t make a claim, express something that might be true or false; either it’s obeyed or it isn’t. Interrogative sentences ask questions: ‘Who will win the World Cup this year?’ is an interrogative sentence; it does not assert anything that might be true or false either.

Only declarative sentences express propositions, and so they are the only kinds of sentences we will deal with at this stage of the study of logic. (More advanced logics have been developed to deal with imperatives and questions, but we won’t look at those in an introductory textbook.)

The fundamental unit of reasoning is the *argument*. In logic, by ‘argument’ we don’t mean a disagreement, a shouting match; rather, we define the term precisely:

Argument = a set of propositions, one of which, the conclusion, is (supposed to be) supported by the others, the premises.

If we’re reasoning by making claims and backing them up with reasons, then the claim that’s being backed up is the conclusion of an argument; the reasons given to support it are the argument’s premises. If we’re reasoning by drawing an inference from a set of statements, then the inference we draw is the conclusion of an argument, and the statements from which it’s drawn are the premises.

We include the parenthetical hedge—“supposed to be”—in the definition to make room for bad arguments. Remember, in Logic, we’re evaluating reasoning. Arguments can be good or bad, logically correct or incorrect. A bad argument, very roughly speaking, is one where the premises fail to support the conclusion; a good argument’s premises actually do support the conclusion.

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<sup>1</sup> Psychologists have determined, for example, that most people are subject to what is called “confirmation bias”—a tendency to seek out information to confirm one’s pre-existing beliefs, and ignore contradictory evidence. There are lots of studies on this effect, including even brain-scans of people engaged in evaluating evidence. All of this is very interesting, but it’s psychology, not logic; it’s a mere descriptive study of reasoning. From a logical, prescriptive point of view, we simply say that people should try to avoid confirmation bias, because it can lead to bad reasoning.

<sup>2</sup> We distinguish propositions from the sentences that express them because a single proposition can be expressed by different sentences. ‘It’s raining’ and ‘Es regnet’ both express the proposition that it’s raining; one sentence does it in English, the other in German. Also, ‘John loves Mary’ and ‘Mary is loved by John’ both express the same proposition.

To support the conclusion means, again very roughly, to give one good reasons for believing it. This highlights the *rhetorical purpose* of arguments: we use arguments when we're disputing controversial issues; they aim to persuade people, to convince them to believe their conclusion.<sup>3</sup> As we said, in logic, we don't judge arguments based on whether or not they succeed in this goal—there are logically bad arguments that are nevertheless quite persuasive. Rather, the logical enterprise is to identify the kinds of reasons that *ought* to be persuasive (even if they sometimes aren't).

### III. Recognizing and Explicating Arguments

Before we get down to the business of evaluating arguments—deciding whether they're good or bad—we need to develop some preliminary analytical skills. The first of these is, simply, the ability to recognize arguments when we see them, and to figure out what the conclusion is (and what the premises are).

What we want to learn first is how to *explicate* arguments. This involves writing down a bunch of declarative sentences that express the propositions in the argument, and clearly marking which of these sentences expresses the conclusion.

Let's start with a simple example. Here's an argument:

You really shouldn't eat at McDonald's. Why? First of all, they pay their workers very low wages. Second, the animals that go into their products are raised in deplorable, inhumane conditions. Third, the food is really bad for you. Finally, the burgers have poop in them.<sup>4</sup>

The passage is clearly argumentative: its purpose is to convince you of something, namely, that you shouldn't eat at McDonald's. That's the conclusion of the argument. The other claims are all reasons for believing the conclusion—reasons for not eating at McDonald's. Those are the premises.

To *explicate* the argument is simply to clearly identify the premises and the conclusion, by writing down declarative sentences that express them. We would explicate the McDonald's argument like this:

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<sup>3</sup> Reasoning in the sense of drawing inferences from a set of statements is a special case of this persuasive activity. When we draw out reasonable conclusions from given information, we're convincing *ourselves* that we have good reasons to believe them.

<sup>4</sup> I know, I know. But it's almost certainly true. Consumer Reports conducted a study in 2015, in which they tested 458 pounds of ground beef, purchased from 103 different stores in 26 different cities; all of the 458 pounds were contaminated with fecal matter. This is because most commercial ground beef is produced at facilities that process thousands of animals, and do it very quickly. The quickness ensures that sometimes—rarely, but sometimes—a knife-cut goes astray and the gastrointestinal tract is nicked, releasing poop. It gets cleaned up, but again, things are moving fast, so they don't quite get all the poop. Now you've got one carcass—again, out of hundreds or thousands—contaminated with feces. But they make ground beef in a huge vat, with meat from all those carcasses mixed together. So even one accident like this contaminates the whole batch. So yeah, those burgers—basically all burgers, unless you're grinding your own meat or sourcing your beef from a local farm—have poop in them. Not much, but it's there. Of course, it won't make you sick as long as you cook it right: 160° F is enough to kill the poop-bacteria (E-coli, etc.), so, you know, no big deal. Except for the knowledge that you're eating poop. Sorry.

McDonald's pays its workers very low wages.  
 The animals that go into their products are raised in deplorable, inhumane conditions.  
 McDonald's food is really bad for you.  
Their burgers have poop in them.  
 ∴ You shouldn't eat at McDonald's.

We separate the conclusion from the premises with a horizontal line, and we put a special symbol in front of the conclusion, which can be read as “therefore.”

Speaking of ‘therefore’, it’s one of the words to look out for when identifying and explicating arguments. Along with words like ‘consequently’ and ‘thus’, and phrases like ‘it follows that’ and ‘which implies that’, it indicates the presence of the conclusion of an argument. Similarly, words like ‘because’, ‘since’, and ‘for’ indicate the presence of premises.

We should also note that it is possible for a single sentence to express more than one proposition. If we added this sentence to our argument—‘McDonald’s advertising targets children to try to create lifetime addicts to their high-calorie foods, and their expansion into global markets has disrupted native food distribution systems, harming family farmers’—we would write down two separate declarative sentences in our explication, expressing the two propositions asserted in the sentence—about children and international farmers, respectively. Indeed, it’s possible for a single sentence to express an entire argument. ‘You shouldn’t eat at McDonald’s because they’re a bad corporate actor’ gives you a conclusion and a premise at once. An explication would merely separate them.

## Paraphrasing

The argument about McDonald’s was an easy case. It didn’t have a word like ‘therefore’ to tip us off to the presence of the conclusion, but it was pretty clear what the conclusion was anyway. All we had to do was ask ourselves, “What is this person trying to convince me to believe?” The answer to that question is the conclusion of the argument.

Another way the McDonald’s argument was easy: all of the sentences were declarative sentences, so when we explicated the argument, all we had to do was write them down. But sometimes argumentative passages aren’t so cooperative. Sometimes they contain non-declarative sentences. Recall, arguments are sets of propositions, and only declarative sentences express propositions; so if an argumentative passage contains non-declarative sentences (questions, commands, etc.), we need to change their wording when we explicate the argument, turning them into declarative sentences that express a proposition. This is called *paraphrasing*.

Suppose, for example, that the McDonald’s argument were exactly as originally presented, except the first sentence were imperative, not declarative:

Don’t eat at McDonald’s. Why? First of all, they pay their workers very low wages. Second, the animals that go into their products are raised in deplorable, inhumane conditions. Third, the food is really bad for you. Finally, the burgers have poop in them.

We just switched from ‘You shouldn’t eat at McDonald’s’ to ‘Don’t eat at McDonald’s.’ But it makes a difference. The first sentence is declarative; it makes a claim about how things are (morally, with respect to your obligations in some sense): you shouldn’t do such-and-such. It’s possible to disagree with the claim: Sure I should, and so should everybody else; their fries are delicious! ‘Don’t eat at McDonald’s’, on the other hand, is not like that. It’s a command. It’s possible to disobey it, but not to disagree with it; imperative sentences don’t make claims about how things are, don’t express propositions.

Still, the passage is clearly argumentative: the purpose remains to persuade the listener not to eat at McDonald’s. We just have to be careful, when we explicate the argument, to paraphrase the first sentence—to change its wording so that it becomes a declarative, proposition-expressing sentence. ‘You shouldn’t eat at McDonald’s’ works just fine.

Let’s consider a different example:

I can’t believe anyone would support a \$15 per hour minimum wage. Don’t they realize that it would lead to massive job losses? And the strain such a policy would put on small businesses could lead to an economic recession.

The passage is clearly argumentative: this person is engaged in a dispute about a controversial issue—the minimum wage—and is staking out a position and backing it up. What is that position? Apparently, this person opposes the idea of raising the minimum wage to \$15.

There are two problems we face in explicating this argument. First, one of the sentences in the passage—the second one—is non-declarative: it’s an interrogative sentence, a question. Nevertheless, it’s being used in this passage to express one of the person’s reasons for opposing the minimum wage increase—that it would lead to job losses. So we need to paraphrase, transforming the interrogative into a declarative—something like ‘A \$15 minimum wage would lead to massive job losses’.

The other problem is that the first sentence, while a perfectly respectable declarative sentence, can’t be used as-is in our explication. For while it’s clearly being used by to express this person’s main point, the conclusion of his argument against the minimum wage increase, it does so indirectly. What the sentence literally and directly expresses is not a claim about the wisdom of the minimum wage increase, but rather a claim about the speaker’s personal beliefs: ‘I can’t believe anyone would support a \$15 per hour minimum wage’. But that claim isn’t the conclusion of the argument. The speaker isn’t trying to convince people that he believes (or can’t believe) a certain thing; he’s trying to convince them to believe the same thing he believes, namely, that raising the minimum wage to \$15 is a bad idea. So, despite the first sentence being a declarative, we still have to paraphrase it. It expresses a proposition, but not the conclusion of the argument.

Our explication of the argument would look like this:

Increasing the minimum wage to \$15 per hour would lead to massive job losses.  
The policy would put a strain on small businesses that might lead to a recession.  
∴ Increasing the minimum wage to \$15 per hour is a bad idea.

## Enthymemes: Tacit Propositions

So sometimes, when we explicate an argument, we have to take what's present in the argumentative passage and change it slightly, so that all of the sentences we write down express the propositions that are in the argument. This is paraphrasing. Other times, we have to do even more: occasionally, we have to fill in missing propositions; argumentative passages might not state all of the propositions in an argument explicitly, and in the course of explicating their arguments, we have to make these implicit, tacit propositions explicit by writing down the appropriate declarative sentences.

There's a fancy Greek word for argumentative passages that leave certain propositions unstated: *enthymemes*. Here's an example:

Hillary Clinton has more experience in public office than Donald Trump; she has a much deeper knowledge of the issues; she's the only one with the proper temperament to lead our country. I rest my case.

Again, the argumentative intentions here are plain: this person is staking out a position on a controversial topic—a presidential election. But notice, that position—that one should prefer Clinton to Trump—is never stated explicitly. We get *reasons* for having that preference—the premises of the argument are explicit—but we never get a statement of the conclusion. But since this is clearly the upshot of the passage, we need to include a sentence expressing it in our explication:

Clinton has more experience than Trump.

Clinton has deeper knowledge of issues than Trump.

Clinton has the proper temperament to lead the country, while Trump does not.

∴ One should prefer Clinton to Trump in the presidential election.

In that example, the conclusion of the argument was tacit. Sometimes, premises are unstated and we should make them explicit in our explication of the argument. Now consider this passage:

The sad fact is that wages for middle-class workers have stagnated over the past several decades. We need a resurgence of the union movement in this country.

This person is arguing in favor of labor unions; the second sentence is the conclusion of the argument. The first sentence gives the only explicit premise: the stagnation of middle-class wages. But notice what the passage doesn't say: what connection there might be between the two things. What do unions have to do with middle-class wages?

There's an implicit premise lurking in the background here—something that hasn't been said, but which needs to be true for the argument to go through. We need a claim that connects the premise to the conclusion—that bridges the gap between them. Something like this: A resurgence of unions would lead to wage growth for middle-class workers. The first sentence identifies a problem; the second sentence purports to give a solution to the problem. But it's only a solution if the tacit

premise we've uncovered is true. If unions don't help raise middle-class wages, then the argument falls apart.

This is the mark of the kinds of tacit premises we want to uncover: if they're false, they undermine the argument. Often, premises like this are unstated for a reason: they're controversial claims on their own, requiring a lot of evidence to support them; so the arguer leaves them out, preferring not to get bogged down. When we draw them out, however, we can force a more robust dialectical exchange, focusing the argument on the heart of the matter. In this case, a discussion about the connection between unions and middle-class wages would be in order. There's a lot to be said on that topic.

## Arguments vs. Explanations

One final item on the topic of "Recognizing and Explicating Arguments." We've been focusing on explication; this is a remark about the recognition side. Some passages may superficially resemble arguments—they may, for example, contain words like 'therefore' and 'because', which normally indicate conclusions and premises in argumentative passages—but which are nevertheless not argumentative. Instead, they are explanations. Consider this passage:

Because female authors of her time were often stereotyped as writing light-hearted romances, and because her real name was well-known for other (sometimes scandalous) reasons, Mary Ann Evans was reluctant to use her own name for her novels. She wanted her work to be taken seriously and judged on its own merits. Therefore, she adopted the pen name 'George Eliot'.

This passage has the words 'because' (twice), and 'therefore', which typically indicate the presence of premises and a conclusion, respectively. But it is not an argument. It's not an argument because it does not have the *rhetorical purpose* of an argument: the aim of the passage is not to convince you of something. If it were an argument, the conclusion would be the claim following 'therefore', namely, the proposition that Mary Ann Evans adopted the pen name 'George Eliot'. But this claim is not the conclusion of an argument; the passage is not trying to persuade us to believe that Evans adopted a pen name. That she did so is not a controversial claim. Rather, that's a fact that's assumed to be known already. The aim of the passage is to *explain* to us *why* Evans made that choice. The rhetorical purpose is not to convince; it is to inform, to edify. The passage is an explanation, not an argument.

So, to determine whether a given passage is an argument or an explanation, we need to figure out its rhetorical purpose. Why is the author saying these things to me? Is she trying to convince me of something, or is she merely trying to inform me—to give me an explanation for something I already knew? Sometimes this is easy, as with the George Eliot passage; it's hard to imagine someone saying those things with persuasive intent. Other times, however, it's not so easy. Consider the following:

Many of the celebratory rituals [of Christmas], as well as the timing of the holiday, have their origins outside of, and may predate, the Christian commemoration of the birth of

Jesus. Those traditions, at their best, have much to do with celebrating human relationships and the enjoyment that this life has to offer. As an atheist, I have no hesitation in embracing the holiday and joining with believers and nonbelievers alike to celebrate what we have in common.<sup>5</sup>

Unless we understand a little bit more about the context of this passage, it's difficult to determine the speaker's intentions. It may appear to be an argument. That atheists should embrace a religious holiday like Christmas is, among many, a controversial claim. Controversial claims are the kinds of claims that we often try to convince skeptical people to believe. If the speaker's audience for this passage is a bunch of hard-line atheists, who vehemently reject anything with a whiff of religiosity, who consider Christmas a humbug, then it's pretty clear that the speaker is trying to offer reasons for them to reconsider their stance; he's trying to convince them to embrace Christmas; he's making an argument. If we explicated the argument, we would paraphrase the last sentence to represent the controversial conclusion: 'Atheists should have no hesitation embracing and celebrating Christmas'.

But in a different context, with a different audience, this may not be an argument. If we leave the claim in the final sentence as-is—'As an atheist, I have no hesitation in embracing the holiday and joining with believers and nonbelievers alike to celebrate what we have in common'—we have a claim about the speaker's personal beliefs and inclinations. Typically, as we saw above, such claims are not suitable as the conclusions of arguments; we don't usually spend time trying to convince people *that* we believe such-and-such. But what is more typical is providing people with *explanations* for *why* we believe things. If the author of our passage is an atheist, and he's saying these things to friends of his, say, who know he's an atheist, we might have just such an explanation. His friends know he's not religious, but they know he loves Christmas. That's kind of weird. Don't atheists hate religious holidays? Not so, says our speaker. Let me *explain* to you why I have no problems with Christmas, despite my atheism.

Again, the difference between arguments and explanations comes down to rhetorical purpose: arguments try to convince people; explanations try to inform them. Determining whether a given passage is one or the other involves figuring out the author's intentions. To do this, we must carefully consider the context of the passage.

## EXERCISES

1. Identify the conclusions in the following arguments.

- (a) Every citizen has a right—nay, a duty—to defend himself and his family. This is all the more important in these increasingly dangerous times. The framers of the Constitution, in their wisdom, enshrined the right to bear arms in that very document. We should all oppose efforts to restrict access to guns.

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<sup>5</sup> John Teehan, 12/24/2006, "A Holiday Season for Atheists, Too," *The New York Times*. Excerpted in Copi and Cohen, 2009, *Introduction to Logic* 13e, p. 25.



(b) Totino's pizza rolls are the perfect food. They have all the great flavor of pizza, with the added benefit of portability!

(c) Because they go overboard making things user-friendly, Apple phones are inferior to those with Android operating systems. If you want to change the default settings on an Apple phone to customize it to your personal preferences, it's practically impossible to figure out how. The interface is so dumbed down to appeal to the "average consumer" that it's super hard to find where the controls for advanced settings even are. On Android phones, though, everything's right there in the open.

(d) The U.S. incarcerates more people per capita than any other country on Earth, many for non-violent drug offenses. Militarized policing of our inner cities has led to scores of unnecessary deaths and a breakdown of trust between law enforcement and the communities they are supposed to serve and protect. We need to end the "War on Drugs" now. Our criminal justice system is broken. The War on Drugs broke it.

(e) The point of a watch is to tell you what time it is. Period. Rolexes are a complete waste of money. They don't do any better at telling the time, and they cost a ton!

2. Explicate the following arguments, paraphrasing as necessary.

(a) You think that if the victims of the mass shooting had been armed that would've made things better? Are you nuts? The shooting took place in a bar; not even the NRA thinks it's a good idea to allow people to carry guns in a drinking establishment. And don't be fooled by the fantasy that "good guys with guns" would prevent mass murder. More likely, the situation would've been even bloodier, with panicked people shooting randomly all over the place.

(b) The heat will escape the house through the open door, which means the heater will keep running, which will make our power bill go through the roof. Then we'll be broke. So stop leaving the door open when you come into the house.

(c) Do you like delicious food? How about fun games? And I know you like cool prizes. Well then, Chuck E. Cheese's is the place for you.

3. Write down the tacit premises that the following arguments depend on for their success.

(a) Cockfighting is an exciting pastime enjoyed by many people. It should therefore be legal.

(b) The president doesn't understand the threat we face. He won't even use the phrase "Radical Islamic Terror."

4. Write down the tacit conclusion that follows most immediately from the following.

(a) If there really were an all-loving God looking down on us, then there wouldn't be so much death and destruction visited upon innocent people.

(b) The death penalty is immoral. Numerous studies have shown that there is racial bias in its application. The rise of DNA testing has exonerated scores of inmates on death row; who knows how many innocent people have been killed in the past? The death penalty is also impractical. Revenge is counterproductive: “An eye for an eye leaves the whole world blind,” as Gandhi said. Moreover, the costs of litigating death penalty cases, with their endless appeals, are enormous. The correct decision for policymakers is clear.

5. Decide whether the following are arguments or explanations, given their context. If the passage is an argument, write down its conclusion; if it is an explanation, write down the fact that is being explained.

(a) Michael Jordan is the best of all time. I don’t care if Kareem scored more points; I don’t care if Russell won more championships. The simple fact is that no other player in history displayed the stunning combination of athleticism, competitive drive, work ethic, and sheer jaw-dropping artistry of Michael Jordan. [Context: Sports talk radio host going on a “rant”]

(b) Because different wavelengths of light travel at different velocities when they pass through water droplets, they are refracted at different angles. Because these different wavelengths correspond to different colors, we see the colors separated. Therefore, if the conditions are right, rainbows appear when the sun shines through the rain. [Context: grade school science textbook]

(c) The primary motivation for the Confederate States in the Civil War was not so much the preservation of the institution of slavery, but the preservation of the sovereignty of individual states guaranteed by the 10<sup>th</sup> Amendment to the U.S. Constitution. Southerners of the time were not the simple-minded racists they were often depicted to be. Leaders in the southern states were disturbed by the over-reach of the Federal government into issues of policy more properly decided by the states. That slavery was one of those issues is incidental. [Context: excerpt from *Rebels with a Cause: An Alternative History of the Civil War*]

(d) This is how natural selection works: those species with traits that promote reproduction tend to have an advantage over competitors and survive; those without such traits tend to die off. The way that humans reproduce is by having sex. Since the human species has survived, it must have traits that encourage reproduction—that encourage having sex. This is why sex feels good. Sex feels good because if it didn’t, the species would not have survived. [Context: excerpt from *Evolutionary Biology for Dummies*]

## IV. Deductive and Inductive Arguments

As we noted earlier, there are different logics—different approaches to distinguishing good arguments from bad ones. One of the reasons we need different logics is that there are different kinds of arguments. In this section, we distinguish two types: deductive and inductive arguments.

## Deductive Arguments

First, deductive arguments. These are distinguished by their aim: a *deductive argument* attempts to provide premises that guarantee, necessitate its conclusion. Success for a deductive argument, then, does not come in degrees: either the premises do in fact guarantee the conclusion, in which case the argument is a good, successful one, or they don't, in which case it fails. Evaluation of deductive arguments is a black-and-white, yes-or-no affair; there is no middle ground.

We have a special term for a successful deductive argument: we call it *valid*. Validity is a central concept in the study of logic. It's so important, we're going to define it three times. Each of these three definitions is equivalent to the others; they are just three different ways of saying the same thing:

An argument is *valid* just in case...

- (i) its premises guarantee its conclusion; i.e.,
- (ii) IF its premises are true, then its conclusion must also be true; i.e.,
- (iii) it is impossible for its premises to be true and its conclusion false.

Here's an example of a valid deductive argument:

All humans are mortal.  
Socrates is a human.  
 ∴ Socrates is mortal.

This argument is valid because the premises do in fact guarantee the conclusion: if they're true (as a matter of fact, they are), then the conclusion must be true; it's impossible for the premises to be true and the conclusion false.

Here's a surprising fact about validity: what makes a deductive argument valid has nothing to do with its content; rather, validity is determined by the argument's *form*. That is to say, what makes our Socrates argument valid is not that it says a bunch of accurate things about Socrates, humanity, and mortality. The content doesn't make a difference. Instead, it's the form that matters—the pattern that the argument exhibits.

Later, when undertake a more detailed study of deductive logic, we will give a precise definition of logical form.<sup>6</sup> For now, we'll use this rough gloss: the form of an argument is what's left over when you strip away all the non-logical terms and replace them with blanks.<sup>7</sup>

Here's what that looks like for our Socrates argument:

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<sup>6</sup> Definitions, actually. We'll study two different deductive logics, each with its own definition of form.

<sup>7</sup> What counts as a "logical term," you're wondering? Unhelpful answer: it depends on the logic; different logics count different terms as logical. Again, this is just a rough gloss. We don't need precision just yet, but we'll get it eventually.

All A are B.  
x is A.  
 $\therefore$  x is B.

The letter are the blanks: they're placeholders, variables. As a matter of convention, we're using capital letters to stand for groups of things (humans, mortals) and lower case letters to stand for individual things (Socrates).

The Socrates argument is a good, valid argument because it exhibits this good, valid form. Our third way of wording the definition of validity helps us see why this is a valid form: it's impossible for the premises to be true and the conclusion false, in that it's impossible to plug in terms for A, B, and x in such a way that the premises come out true and the conclusion comes out false.

A consequence of the fact that validity is determined entirely by an argument's form is that, given a valid form, every single argument that has that form will be valid. So any argument that has the same form as our Socrates argument will be valid; that is, we can pick things at random to stick in for A, B, and x, and we're guaranteed to get a valid argument. Here's a silly example:

All apples are bananas.  
Donald Trump is an apple.  
 $\therefore$  Donald Trump is a banana.

This argument has the same form as the Socrates argument: we simply replaced A with 'apples', B with 'bananas', and x with 'Donald Trump'. That means it's a valid argument. That's a strange thing to say, since the argument is just silly—but it's the form that matters, not the content. Our second way of wording the definition of validity can help us here. The standard for validity is this: IF the premises are true, then the conclusion must be. That's a big 'IF'. In this case, as a matter of fact, the premises are not true (they're silly, plainly false). However, IF they were true—if in fact apples were a type of banana and Donald Trump were an apple—then the conclusion would be unavoidable: Trump would have to be a banana. The premises aren't true, but if they were, the conclusion would have to be—that's validity.

So it turns out that the actual truth or falsehood of the propositions in a valid argument are completely irrelevant to its validity. The Socrates argument has all true propositions and it's valid; the Donald Trump argument has all false propositions, but it's valid, too. They're both valid because they have a valid form; the truth/falsity of their propositions don't make any difference. This means that a valid argument can have propositions with almost any combination of truth-values: some true premises, some false ones, a true or false conclusion. One can fiddle around with the Socrates' argument's form, plugging different things in for A, B, and x, and see that this is so. For example, plug in 'ants' for A, 'bugs' for B, and Beyoncé for x: you get one true premise (All ants are bugs), one false one (Beyoncé is an ant), and a false conclusion (Beyoncé is a bug). Plug in other things and you can get any other combination of truth-values.

Any combination, that is, but one: you'll never get true premises and a false conclusion. That's because the Socrates' argument's form is a valid one; by definition, it's impossible to generate true premises and a false conclusion in that case.

This irrelevance of truth-value to judgments about validity means that those judgments are immune to revision. That is, once we decide whether an argument is valid or not, that decision cannot be changed by the discovery of new information. New information might change our judgment about whether a particular proposition in our argument is true or false, but that can't change our judgment about validity. Validity is determined by the argument's form, and new information can't change the form of an argument. The Socrates argument is valid because it has a valid form. Suppose we discovered, say, that as a matter of fact Socrates wasn't a human being at all, but rather an alien from outer space who got a kick out of harassing random people on the streets of ancient Athens. That information would change the argument's second premise—Socrates is human—from a truth to a falsehood. But it wouldn't make the argument invalid. The form is still the same, and it's a valid one.

It's time to face up to an awkward consequence of our definition of validity. Remember, logic is about evaluating arguments—saying whether they're good or bad. We've said that for deductive arguments, the standard for goodness is validity: the good deductive arguments are the valid ones. Here's where the awkwardness comes in: because validity is determined by form, it's possible to generate valid arguments that are nevertheless completely ridiculous-sounding on their face. Remember, the Donald Trump argument—where we concluded that he's a banana—is valid. In other words, we're saying that the Trump argument is good; it's valid, so it gets the logical thumbs-up. But that's nuts! The Trump argument is obviously bad, in some sense of 'bad', right? It's a collection of silly, nonsensical claims.

We need a new concept to specify what's wrong with the Trump argument. That concept is *soundness*. This is a higher standard of argument-goodness than validity; in order to meet it, an argument must satisfy two conditions.

An argument is *sound* just in case (i) it's valid, AND (ii) its premises are in fact true.<sup>8</sup>

The Trump argument, while valid, is not sound, because it fails to satisfy the second condition: its premises are both false. The Socrates argument, however, which is valid and contains nothing but truths (Socrates was not in fact an alien), is sound.

The question now naturally arises: if soundness is a higher standard of argument-goodness than validity, why didn't we say that in the first place? Why so much emphasis on validity? The answer is this: we're doing logic here, and as logicians, we have no special insight into the soundness of arguments. Or rather, we should say that as logicians, we have only partial expertise on the question of soundness. Logic can tell us whether or not an argument is valid, but it cannot tell us whether or not it is sound. Logic has no special insight into the second condition for soundness, the actual truth-values of premises. To take an example from the silly Trump argument, suppose you weren't sure about the truth of the first premise, which claims that all apples are bananas (you have very little experience with fruit, apparently). How would you go about determining whether that claim was true or false? Whom would you ask? Well, this is a pretty easy one, so you could ask pretty much anybody, but the point is this: if you weren't sure about the relationship between

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<sup>8</sup> What about the conclusion? Does it have to be true? Yes: remember, for valid arguments, if the premises are true, the conclusion has to be. Sound arguments are valid, so it goes without saying that the conclusion is true, provided that the premises are.

apples and bananas, you wouldn't think to yourself, "I better go find a logician to help me figure this out." Propositions make claims about how things are in the world. To figure out whether they're true or false, you need to consult experts in the relevant subject-matter. Most claims aren't about logic, so logic is very little help in determining truth-values. Since logic can only provide insight into the validity half of the soundness question, we focus on validity and leave soundness to one side.

Returning to validity, then, we're now in a position to do some actual logic. Given what we know, we can *demonstrate invalidity*; that is, we can prove that an invalid argument is invalid, and therefore bad (it can't be sound, either; the first condition for soundness is validity, so if the argument's invalid, the question of actual truth-values doesn't even come up). Here's how:

To *demonstrate the invalidity* of an argument, one must write a down a new argument with the same form as the original, whose premises are in fact true and whose conclusion is in fact false. This new argument is called a *counterexample*.

Let's look at an example. The following argument is invalid:

Some mammals are swimmers.  
All whales are swimmers.  
 ∴ All whales are mammals.

Now, it's not really obvious that the argument is invalid. It does have one thing going for it: all the claims it makes are true. But we know that doesn't make any difference, since validity is determined by the argument's form, not its content. If this argument is invalid, it's invalid because it has a bad, invalid form. This is the form:

Some A are B.  
All C are B.  
 ∴ All C are A.

To prove that the original whale argument is invalid, we have to show that this form is invalid. For a valid form, we learned, it's impossible to plug things into the blanks and get true premises and a false conclusion; so for an invalid form, it's *possible* to plug things into the blanks and get that result. That's how we generate our counterexample: we plug things in for A, B, and C so that the premises turn out true and the conclusion turns out false. There's no real method here; you just use your imagination to come up with an A, B, and C that give the desired result.<sup>9</sup> Here's a counterexample:

Some lawyers are American citizens.  
All members of Congress are American citizens.  
 ∴ All members of Congress are lawyers.

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<sup>9</sup> Possibly helpful hint: universal generalizations (All \_\_\_\_ are \_\_\_\_ ) are rarely true, so if you have to make one true, as in this example, it might be good to start there; likewise, particular claims (Some \_\_\_\_ are \_\_\_\_ ) are rarely false, so if you have to make one false—you don't in this particular example, but if you had one as a conclusion, you would—that would be a good place to start.

For A, we inserted ‘lawyers’, for B we chose ‘American citizens’, and for C, ‘members of Congress’. The first premise is clearly true. The second premise is true: non-citizens aren’t eligible to be in Congress. And the conclusion is false: there are lots of people in Congress who are non-lawyers—doctors, businesspeople, etc.

That’s all we need to do to prove that the original whale-argument is invalid: come up with one counterexample, one way of filling in the blanks in its form to get true premises and a false conclusion. We only have to prove that it’s *possible* to get true premises and a false conclusion, and for that, you only need one example.

What’s far more difficult is to prove that a particular argument is valid. To do that, we’d have to show that its form is such that it’s *impossible* to generate a counterexample, to fill in the blanks to get true premises and a false conclusion. Proving that it’s possible is easy; you only need one counterexample. Proving that it’s impossible is hard; in fact, at first glance, it looks impossibly hard! What do you do? Check all the possible ways of plugging things into the blanks, and make sure that none of them turn out to have true premises and a false conclusion? That’s nuts! There are, literally, infinitely many ways to fill in the blanks in an argument’s form. Nobody has the time to check infinitely many potential counterexamples.

Well, take heart; it’s still early. For now, we’re able to do a little bit of deductive logic: given an invalid argument, we can demonstrate that it is in fact invalid. We’re not yet in the position we’d like to be in, namely of being able to determine, for any argument whatsoever, whether it’s valid or not. Proving validity looks too hard based on what we know so far. But we’ll know more later: in chapters 3 and 4 we will study two deductive logics, and each one will give us a method of deciding whether or not any given argument is valid. But that’ll have to wait. Baby steps.

## Inductive Arguments

That’s all we’ll say for now about deductive arguments. On to the other type of argument we’re introducing in this section: *inductive arguments*. These are distinguished from their deductive cousins by their relative lack of ambition. Whereas deductive arguments aim to give premises that guarantee/necessitate the conclusion, inductive arguments are more modest: they aim merely to provide premises that make the conclusion more probable than it otherwise would be; they aim to support the conclusion, but without making it unavoidable.

Here is an example of an inductive argument:

I’m telling you, you’re not going to die taking a plane to visit us. Airplane crashes happen far less frequently than car crashes, for example; so you’re taking a bigger risk if you drive. In fact, plane crashes are so rare, you’re far more likely to die from slipping in the bathtub. You’re not going to stop taking showers, are you?

The speaker is trying to convince her visitor that he won’t die in a plane crash on the way to visit her. That’s the conclusion: you won’t die. This claim is supported by the others—which emphasize how rare plane crashes are—but it is not guaranteed by them. After all, plane crashes sometimes

do happen. Instead, the premises give reasons to believe that the conclusion—you won't die—is very probable.

Since inductive arguments have a different, more modest goal than their deductive cousins, it would be unreasonable for us to apply the same evaluative standards to both kinds of argument. That is, we can't use the terms 'valid' and 'invalid' to apply to inductive arguments. Remember, for an argument to be valid, its premises must guarantee its conclusion. But inductive arguments don't even try to provide a guarantee of the conclusion; technically, then, they're all invalid. But that won't do. We need a different evaluative vocabulary to apply to inductive arguments. We will say of inductive arguments that they are (relatively) *strong* or *weak*, depending on how probable their conclusions are in light of their premises. One inductive argument is stronger than another when its conclusion is more probable than the other, given their respective premises.

One consequence of this difference in evaluative standards for inductive and deductive arguments is that for the former, unlike the latter, our evaluations are subject to revision in light of new evidence. Recall that since the validity or invalidity of a deductive argument is determined entirely by its form, as opposed to its content, the discovery of new information could not affect our evaluation of those arguments. The Socrates argument remained valid, even if we discovered that Socrates was in fact an alien. Our evaluations of inductive arguments, though, are not immune to revision in this way. New information might make the conclusion of an inductive argument more or less probable, and so we would have to revise our judgment accordingly, saying that the argument is stronger or weaker. Returning to the example above about plane crashes, suppose we were to discover that the FBI in the visitor's hometown had recently been hearing lots of "chatter" from terrorist groups active in the area, with strong indications that they were planning to blow up a passenger plane. Yikes! This would affect our estimation of the probability of the conclusion of the argument—that the visitor wasn't going to die in a crash. The probability of not dying goes down (as the probability of dying goes up). This new information would trigger a re-evaluation of the argument, and we would say it's now weaker. If, on the other hand, we were to learn that the airline that flies between the visitor's and the speaker's towns had recently upgraded its entire fleet, getting rid of all of its older planes, replacing them with newer, more reliable model, while in addition instituting a new, more thorough and rigorous program of pre- and post-flight safety and maintenance inspections—well, then we might revise our judgment in the other direction. Given this information, we might judge that things are even safer for the visitor as it regards plane travel; that is, the proposition that the visitor won't die is now even more probable than it was before. This new information would strengthen the argument to that conclusion.

Reasonable follow-up question: *how much* is the argument strengthened or weakened by the new information imagined in these scenarios? Answer: how should I know? Sorry, that's not very helpful. But here's the point: we're talking about probabilities here; sometimes it's hard to know what the probability of something happening really is. Sometimes it's not: if I flip a coin, I know that the probability of it coming up tails is 0.5. But how probable is it that a particular plane from Airline X will crash with our hypothetical visitor on board? I don't know. And how much more probable is a disaster on the assumption of increased terrorist chatter? Again, I have no idea. All I know is that the probability of dying on the plane goes up in that case. And in the scenario in which Airline X has lots of new planes and security measures, the probability of a crash goes down. Sometimes, with inductive arguments, all we can do is make *relative* judgments about strength



and weakness: in light of these new facts, the conclusion is more or less probable than it was before we learned of the new facts. Sometimes, however, we can be precise about probabilities and make *absolute* judgments about strength and weakness: we can say precisely how probable a conclusion is in light of the premises supporting it. But this is a more advanced topic. We will discuss inductive logic in chapters 5 and 6, and will go into more depth then. Until then, patience. Baby steps.

## EXERCISES

1. Determine whether the following statements are true or false.

- (a) Not all valid arguments are sound.
- (b) An argument with a false conclusion cannot be sound.
- (c) An argument with true premises and a true conclusion is valid.
- (d) An argument with a false conclusion cannot be valid.

2. Demonstrate that the following arguments are invalid.

- (a) Some politicians are Democrats.  
Hillary Clinton is a politician.  
 $\therefore$  Hillary Clinton is a Democrat.

The argument's form is:

Some A are B.  
x is A.  
 $\therefore$  x is B.

[where 'A' and 'B' stand for groups of things and 'x' stands for an individual]

- (b) All dinosaurs are animals.  
Some animals are extinct.  
 $\therefore$  All dinosaurs are extinct.

The argument's form is:

All A are B.  
Some B are C.  
 $\therefore$  All A are C.

[where 'A', 'B', and 'C' stand for groups of things]

3. Consider the following inductive argument (about a made-up person):

Sally Johansson does all her grocery shopping at an organic food co-op. She's a huge fan of tofu. She's really into those week-long juice cleanse thingies. And she's an active member of PETA. I conclude that she's a vegetarian.

- (a) Make up a new piece of information about Sally that weakens the argument.
- (b) Make up a new piece of information about Sally that strengthens the argument.

## V. Diagramming Arguments

Before we get down to the business of *evaluating* arguments—of judging them valid or invalid, strong or weak—we still need to do some preliminary work. We need to develop our analytical skills to gain a deeper understanding of how arguments are constructed, how they hang together. So far, we've said that the premises are there to support the conclusion. But we've done very little in the way of analyzing the structure of arguments: we've just separated the premises from the conclusion. We know that the premises are supposed to support the conclusion. What we haven't explored is the question of just *how* the premises in a given argument do that job—how they work together to support the conclusion, what kinds of relationships they have with one another. This is a deeper level of analysis than merely distinguishing the premises from the conclusion; it will require a mode of presentation more elaborate than a list of propositions with the bottom one separated from the others by a horizontal line. To display our understanding of the relationships among premises supporting the conclusion, we are going to *depict* them: we are going to draw diagrams of arguments.

Here's how the diagrams will work. They will consist of three elements: (1) circles with numbers inside them—each of the propositions in the argument we're diagramming will be assigned a number, so these circled numbers in the diagram will represent the propositions; (2) arrows pointed at circled numbers—these will represent relationships of support, where one or more propositions provide a reason for believing the one pointed to; and (3) horizontal brackets—propositions connected by these will be interdependent (in a sense to be specified below).

Our diagrams will always feature the circled number corresponding to the conclusion at the bottom. The premises will be above, with brackets and arrows indicating how they collectively support the conclusion and how they're related to one another. There are a number of different relationships that premises can have to one another. We will learn how to draw diagrams of arguments by considering them in turn.

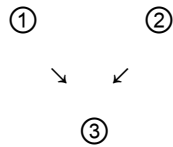
### Independent Premises

Often, different premises will support a conclusion—or another premise—individually, without help from any others. When this is the case, we draw an arrow from the circled number representing that premise to the circled number representing the proposition it supports.

Consider this simple argument:

① Marijuana is less addictive than alcohol. In addition, ② it can be used as a medicine to treat a variety of conditions. Therefore, ③ marijuana should be legal.

The last proposition is clearly the conclusion (the word ‘therefore’ is a big clue), and the first two propositions are the premises supporting it. They support the conclusion *independently*. The mark of independence is this: each of the premises would still provide support for the conclusion even if the other weren’t true; each, on its own, gives you a reason for believing the conclusion. In this case, then, we diagram the argument as follows:



## Intermediate Premises

Some premises support their conclusions more directly than others. Premises provide more indirect support for a conclusion by providing a reason to believe another premise that supports the conclusion more directly. That is, some premises are intermediate between the conclusion and other premises.

Consider this simple argument:

① Automatic weapons should be illegal. ② They can be used to kill large numbers of people in a short amount of time. This is because ③ all you have to do is hold down the trigger and bullets come flying out in rapid succession.

The conclusion of this argument is the first proposition, so the premises are propositions 2 and 3. Notice, though, that there’s a relationship between those two claims. The third sentence starts with the phrase ‘This is because’, indicating that it provides a reason for another claim. The other claim is proposition 2; ‘This’ refers to the claim that automatic weapons can kill large numbers of people quickly. Why should I believe that they can do that? Because all one has to do is hold down the trigger to release lots of bullets really fast. Proposition 2 provides immediate support for the conclusion (automatic weapons can kill lots of people really quickly, so we should make them illegal); proposition 3 supports the conclusion more indirectly, by giving support to proposition 2. Here is how we diagram in this case:



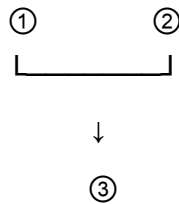
## Joint Premises

Sometimes premises need each other: the job of supporting another proposition can't be done by each on its own; they can only provide support together, jointly. Far from being independent, such premises are interdependent. In this situation, on our diagrams, we join together the interdependent premises with a bracket underneath their circled numbers.

There are a number of different ways in which premises can provide joint support. Sometimes, premises just fit together like a hand in a glove; or, switching metaphors, one premise is like the key that fits into the other to unlock the proposition they jointly support. An example can make this clear:

- ① The chef has decided that either salmon or chicken will be tonight's special. ② Salmon won't be the special. Therefore, ③ the special will be chicken.

Neither premise 1 nor premise 2 can support the conclusion on its own. A useful rule of thumb for checking whether one proposition can support another is this: read the first proposition, then say the word 'therefore', then read the second proposition; if it doesn't make any sense, then you can't draw an arrow from the one to the other. Let's try it here: "The chef has decided that either salmon or chicken will be tonight's special; therefore, the special will be chicken." That doesn't make any sense. What happened to salmon? Proposition 1 can't support the conclusion on its own. Neither can the second: "Salmon won't be the special; therefore, the special will be chicken." Again, that makes no sense. Why chicken? What about steak, or lobster? The second proposition can't support the conclusion on its own, either; it needs help from the first proposition, which tells us that if it's not salmon, it's chicken. Propositions 1 and 2 need each other; they support the conclusion jointly. This is how we diagram the argument:



The same diagram would depict the following argument:

- ① John Le Carre gives us realistic, three-dimensional characters and complex, interesting plots. ② Ian Fleming, on the other hand, presents an unrealistically glamorous picture of international espionage, and his plotting isn't what you'd call immersive. ③ Le Carre is a better author of spy novels than Fleming.

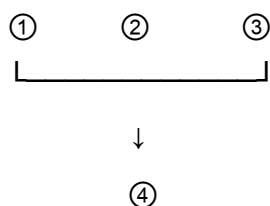
In this example, the premises work jointly in a different way than in the previous example. Rather than fitting together hand-in-glove, these premises each give us half of what we need to arrive at the conclusion. The conclusion is a comparison between two authors. Each of the premises makes

claims about one of the two authors. Neither one, on its own, can support the comparison, because the comparison is a claim about both of them. The premises can only support the conclusion together. We would diagram this argument the same way as the last one.

Another common pattern for joint premises is when *general* propositions need help to provide support for *particular* propositions. Consider the following argument:

- ① People shouldn't vote for racist, incompetent candidates for president. ② Donald Trump seems to make a new racist remark at least twice a week. And ③ he lacks the competence to run even his own (failed) businesses, let alone the whole country. ④ You shouldn't vote for Trump to be the president.

The conclusion of the argument, the thing it's trying to convince us of, is the last proposition—you shouldn't vote for Trump. This is a particular claim: it's a claim about an individual person, Trump. The first proposition in the argument, on the other hand, is a general claim: it asserts that, generally speaking, people shouldn't vote for incompetent racists; it makes no mention of an individual candidate. It cannot, therefore, support the particular conclusion—about Trump—on its own. It needs help from other particular claims—propositions 2 and 3—that tell us that the individual in the conclusion, Trump, meets the conditions laid out in the general proposition 1: racism and incompetence. This is how we diagram the argument:



Occasionally, an argumentative passage will only explicitly state one of a set of joint premises because the others “go without saying”—they are part of the body of background information about which both speaker and audience agree. In the last example, that Trump was an incompetent racist was not uncontroversial background information. But consider this argument:

- ① It would be good for the country to have a woman with lots of experience in public office as president. ② People should vote for Hillary Clinton.

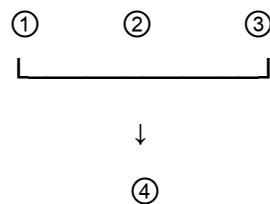
Diagramming this argument seems straightforward: an arrow pointing from ① to ②. But we've got the same relationship between the premise and conclusion as in the last example: the premise is a general claim, mentioning no individual at all, while the conclusion is a particular claim about Hillary Clinton. Doesn't the general premise “need help” from particular claims to the effect that the individual in question, Hillary Clinton, meets the conditions set forth in the premise—i.e., that she's a woman and that she has lots of experience in public office? No, not really. Everybody

knows those things about her already; they go without saying, and can therefore be left unstated (implicit, tacit).

But suppose we had included those obvious truths about Clinton in our presentation of the argument; suppose we had made the tacit premises explicit:

① It would be good for the country to have a woman with lots of experience in public office as president. ② Hillary Clinton is a woman. And ③ she has deep experience with public offices—as a First Lady, U.S. Senator, and Secretary of State. ④ People should vote for Hillary Clinton.

How do we diagram this? Earlier, we talked about a rule of thumb for determining whether or not it's a good idea to draw an arrow from one number to another in a diagram: read the sentence corresponding to the first number, say the word 'therefore', then read the sentence corresponding to the second number; if it doesn't make sense, then the arrow is a bad idea. But if it does make sense, does that mean you *should* draw the arrow? Not necessarily. Consider the first and last sentences in this passage. Read the first, then 'therefore', then the last. Makes pretty good sense! That's just the original formulation of the argument with the tacit propositions remaining implicit. And in that case we said it would be OK to draw an arrow from the general premise's number straight to the conclusion's. But when we add the tacit premises—the second and third sentences in this passage—we can't draw an arrow directly from ① to ④. To do so would obscure the relationship among the first three propositions and misrepresent how the argument works. If we drew an arrow from ① to ④, what would we do with ② to ③ in our diagram? Do they get their own arrows, too? No, that won't do. Such a diagram would be telling us that the first three propositions each independently provide a reason for the conclusion. But they're clearly not independent; there's a relationship among them that our diagram must capture, and it's the same relationship we saw in the parallel argument about Trump, with the particular claims in the second and third propositions working together with the general claim in the first:



The arguments we've looked at thus far have been quite short—only two or three premises. But of course some arguments are longer than that. Some are much longer. It may prove instructive, at this point, to tackle one of these longer bits of reasoning. It comes from the (fictional) master of analytical deductive reasoning, Sherlock Holmes. The following passage is from the first Holmes story—*A Study in Scarlet*, one of the few novels Arthur Conan Doyle wrote about his most famous character—and it's a bit of early dialogue that takes place shortly after Holmes and his longtime associate Dr. Watson meet for the first time. At that first meeting, Holmes did his typical Holmes-y thing, where he takes a quick glance at a person and then immediately makes some startling

inference about them, stating some fact about them that it seems impossible he could have known. Here they are—Holmes and Watson—talking about it a day or two later. Holmes is the first to speak:

“Observation with me is second nature. You appeared to be surprised when I told you, on our first meeting, that you had come from Afghanistan.”

“You were told, no doubt.”

“Nothing of the sort. I knew you came from Afghanistan. From long habit the train of thoughts ran so swiftly through my mind, that I arrived at the conclusion without being conscious of intermediate steps. There were such steps, however. The train of reasoning ran, ‘Here is a gentleman of a medical type, but with the air of a military man. Clearly an army doctor, then. He has just come from the tropics, for his face is dark, and that is not the natural tint of his skin, for his wrists are fair. He has undergone hardship and sickness, as his haggard face says clearly. His left arm has been injured. He holds it in a stiff and unnatural manner. Where in the tropics could an English army doctor have seen much hardship and got his arm wounded? Clearly in Afghanistan.’ The whole train of thought did not occupy a second. I then remarked that you came from Afghanistan, and you were astonished.”<sup>10</sup>

This is an extended inference, with lots of propositions leading to the conclusion that Watson had been in Afghanistan. Before we draw the diagram, let’s number the propositions involved in the argument:

1. Watson was in Afghanistan.
2. Watson is a medical man.
3. Watson is a military man.
4. Watson is an army doctor.
5. Watson has just come from the tropics.
6. Watson’s face is dark.
7. Watson’s skin is not naturally dark.
8. Watson’s wrists are fair.
9. Watson has undergone hardship and sickness.
10. Watson’s face is haggard.
11. Watson’s arm has been injured.
12. Watson holds his arm stiffly and unnaturally.
13. Only in Afghanistan could an English army doctor have been in the tropics, seen much hardship and got his arm wounded.

Lots of propositions, but they’re mostly straightforward, right from the text. We just had to do a bit of paraphrasing on the last one—Holmes asks a rhetorical question and answers it, the upshot of which is the general proposition in 13. We know that proposition 1 is our conclusion, so that goes at the bottom of the diagram. The best thing to do is to start there and work our way up. Our

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<sup>10</sup> Also excerpted in Copi and Cohen, 2009, *Introduction to Logic 13e*, pp. 58 - 59.

next question is: Which premise or premises support that conclusion most directly? What goes on the next level up on our diagram?

It seems fairly clear that proposition 13 belongs on that level. The question is whether it is alone there, with an arrow from 13 to 1, or whether it needs some help. The answer is that it needs help. This is the general/particular pattern we identified above. The conclusion is about a particular individual—Watson. Proposition 13 is entirely general (presumably Holmes knows this because he reads the paper and knows the disposition of Her Majesty’s troops throughout the Empire); it does not mention Watson. So proposition 13 needs help from other propositions that give us the relevant particulars about the individual, Watson. A number of conditions are laid out that a person must meet in order for us to conclude that they’ve been in Afghanistan: army doctor, being in the tropics, undergoing hardship, getting wounded. That Watson satisfies these conditions is asserted by, respectively, propositions 4, 5, 9, and 11. Those are the propositions that must work jointly with the general proposition 13 to give us our particular conclusion about Watson:



Next, we must figure out how what happens at the next level up. How are propositions 4, 5, 13, 9, and 11 justified? As we noted, the justification for 13 happens off-screen, as it were. Holmes is able to make that generalization because he follows the news and knows, presumably, that the only place in the British Empire where army troops are actively fighting in tropics is Afghanistan. The justification for the other propositions, however, is right there in the text.

Let’s take them one at a time. First, proposition 4: Watson is an army doctor. How does Holmes support this claim? With propositions 2 and 3, which tell us that Watson is a medical and a military man, respectively. This is another pattern we’ve identified: these two proposition jointly support 4, because they each provide half of what we need to get there. There are two parts to the claim in 4: army and doctor. 2 gives us the doctor part; 3 gives us the army part. 2 and 3 jointly support 4.

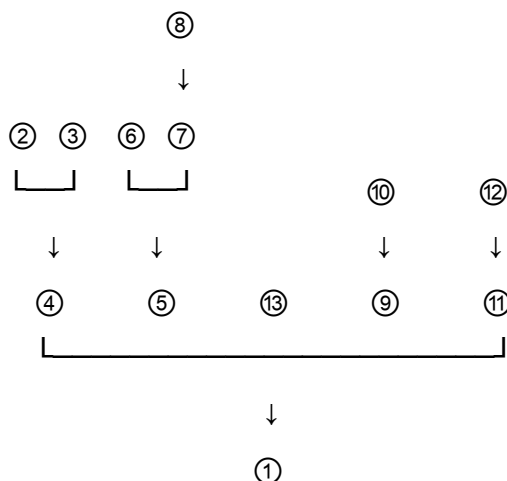
Skipping 5 (it’s a bit more involved), let’s turn to 9 and 11, which are easily dispatched. What’s the reason for believing 9, that Watson has suffered hardship? Go back to the passage. It’s his haggard face that testifies to his suffering. Proposition 10 supports 9. Now 11: what evidence do we have that Watson’s arm has been injured? Proposition 12: he holds it stiffly and unnaturally. 12 supports 11.

Finally, proposition 5: Watson was in the tropics. There are three propositions involved in supporting this one: 6, 7, and 8. Proposition 6 tells us Watson’s face is dark; 7 tells us that his skin isn’t naturally dark; 8 tells us his wrists are fair (light-colored skin). It’s tempting to think that 6 on its own—dark skin—supports the claim that he was in the tropics. But it does not. One can have dark skin and not visited the tropics, provided one’s skin is naturally dark. What tells us Watson has been in the tropics is that he has a tan—that his skin is dark *and* that’s not its natural tone. 6



and 7 jointly support 5. And how do we know Watson's skin isn't naturally dark? By checking his wrists, which are fair: proposition 8 supports 7.

So this is our final diagram:



And there we go. An apparently unwieldy passage—thirteen propositions!—turns out not to be so bad. The lesson is that we must go step by step: start by identifying the conclusion, then ask which proposition(s) most directly support it; from there, work back until all the propositions have been diagrammed. Every long argument is just composed out of smaller, easily analyzed inferences.

## EXERCISES

Diagram the following arguments.

- ① Hillary Clinton would make a better president than Donald Trump. ② Clinton is a tough-minded pragmatist who gets things done. ③ Trump is a thin-skinned maniac who will be totally ineffective in dealing with Congress.
- ① Donald Trump is a jerk who's always offending people. Furthermore, ② he has no experience whatsoever in government. ③ Nobody should vote for him to be president.
- ① Human beings evolved to eat meat, so ② eating meat is not immoral. ③ It's never immoral for a creature to act according to its evolutionary instincts.

4. ① We need new campaign finance laws in this country. ② The influence of Wall Street money on elections is causing a breakdown in our democracy with bad consequences for social justice. ③ Politicians who have taken those donations are effectively bought and paid for, consistently favoring policies that benefit the rich at the expense of the vast majority of citizens.

5. ① Voters shouldn't trust any politician who took money from Wall Street bankers. ② Hillary Clinton accepted hundreds of thousands of dollars in speaking fee from Goldman Sachs, a big Wall Street firm. ③ You shouldn't trust her.

6. ① There are only three possible explanations for the presence of the gun at the crime scene: either the defendant just happened to hide from the police right next to where the gun was found, or the police planted the gun there after the fact, or it was really the defendant's gun like the prosecution says. ② The first option is too crazy a coincidence to be at all believable, and ③ we've been given no evidence at all that the officers on the scene had any means or motivation to plant the weapon. Therefore, ④ it has to be the defendant's gun.

7. ① Golden State has to be considered the clear favorite to win the NBA Championship. ② No team has ever lost in the Finals after taking a 3-games-to-1 lead, and ③ Golden State now leads Cleveland 3-to-1. In addition, ④ Golden State has the MVP of the league, Stephen Curry.

8. ① We should increase funding to public colleges and universities. First of all, ② as funding has decreased, students have had to shoulder a larger share of the financial burden of attending college, amassing huge amounts of debt. ③ A recent report shows that the average college student graduates with almost \$30,000 in debt. Second, ④ funding public universities is a good investment. ⑤ Every economist agrees that spending on public colleges is a good investment for states, where the economic benefits far outweigh the amount spent.

9. ① LED lightbulbs last for a really long time and ② they cost very little to keep lit. ③ They are, therefore, a great way to save money. ④ Old-fashioned incandescent bulbs, on the other hand, are wasteful. ⑤ You should buy LEDs instead of incandescent bulbs.

10. ① There's a hole in my left shoe, which means ② my feet will get wet when I wear them in the rain, and so ③ I'll probably catch a cold or something if I don't get a new pair of shoes. Furthermore, ④ having new shoes would make me look cool. ⑤ I should buy new shoes.

11. Look, it's just simple economics: ① if people stop buying a product, then companies will stop producing it. And ② people just aren't buying tablets as much anymore. ③ The CEO of Best Buy recently said that sales of tablets are "crashing" at his stores. ④ Samsung's sales of tablets were down 14% this year alone. ⑤ Apple's not going to continue to make your beloved iPad for much longer.

12. ① We should increase infrastructure spending as soon as possible. Why? First, ② the longer we delay needed repairs to things like roads and bridges, the more they will cost in the future. Second, ③ it would cause a drop in unemployment, as workers would be hired to do the work. Third, ④ with interest rates at all-time lows, financing the spending would cost relatively little. A fourth reason? ⑤ Economic growth. ⑥ Most economists agree that government spending in the current climate would boost GDP.

13. ① Smoking causes cancer and ② cigarettes are really expensive. ③ You should quit smoking. ④ If you don't, you'll never get a girlfriend. ⑤ Smoking makes you less attractive to girls: ⑥ it stains your teeth and ⑦ it gives you bad breath.

14. ① The best cookbooks are comprehensive, well-written, and most importantly, have recipes that work. This is why ② Mark Bittman's classic *How to Cook Everything* is among the best cookbooks ever written. As its title indicates, ③ Bittman's book is comprehensive. Of course it doesn't literally teach you how to cook everything, but ④ it features recipes for cuisines from around the world—from French, Italian, and Spanish food to dishes from the Far and Middle East, as well as classic American comfort foods. In addition, ⑤ he covers almost every ingredient imaginable, with all different kinds of meats—including game—and every fruit and vegetable under the sun. ⑥ The book is also extremely well-written. ⑦ Bittman's prose is clear, concise, and even witty. Finally, ⑧ Bittman's recipes simply work. ⑨ In my many years of consulting *How to Cook Everything*, I've never had one lead me astray.

15. ① Logic teachers should make more money than CEOs. ② Logic is more important than business. ③ Without logic, we wouldn't be able to tell when people were trying to fool us: ④ we wouldn't know a good argument from a bad one. ⑤ But nobody would miss business if it went away. ⑥ What do businesses do except take our money? ⑦ And all those damned commercials they make; everybody hates commercials. ⑧ In a well-organized society, members of more important professions would be paid more, because ⑨ paying people is a great way to encourage them to do useful things. ⑩ People love money.