Chapter 1

What Is This Thing Called Logic?

In This Chapter

- Seeing the world from a logical point of view
- Using logic to build valid arguments
- Applying the laws of thought
- Understanding the connection between math and logic

You and I live in an illogical world. If you doubt this fact, just flip on the evening news. Or really listen to the guy sitting at the next barstool. Or, better yet, spend the weekend with your in-laws.

With so many people thinking and acting illogically, why should you be any different? Wouldn't it be more sensible just to be as illogical as the rest of the human race?

Well, okay, being illogical on purpose is probably not the best idea. For one thing, how can it possibly be sensible to be illogical? For another, if you've picked this book up in the first place, you're probably not built to be illogical. Let's face it — some folks thrive on chaos (or claim to), while others don't.

In this chapter, I introduce you to the basics of logic and how it applies to your life. I tell you a few words and ideas that are key to logic. And, I touch very briefly on the connections between logic and math.

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Getting a Logical Perspective

Whether you know it or not, you already understand a lot about logic. In fact, you already have a built-in logic detector. Don't believe me? Take this quick test to see whether you're logical:

Q: How many pancakes does it take to shingle a doghouse?

A: 23, because bananas don't have bones.

If the answer here seems illogical to you, that's a good sign that you're at least on your way to being logical. Why? Simply because if you can spot something that's illogical, you must have a decent sense of what actually is logical.

In this section, I start with what you *already* understand about logic (though you may not be aware of it), and build towards a foundation that will help you in your study of logic.

Bridging the gap from here to there

Most children are innately curious. They always want to know *why* everything is the way it is. And for every *because* they receive, they have one more *why*. For example, consider these common kid questions:

Why does the sun rise in the morning?

Why do I have to go to school?

Why does the car start when you turn the key?

Why do people break the law when they know they could go to jail?

When you think about it, there's a great mystery here: Even when the world doesn't make sense, why does it feel like it should?

Kids sense from an early age that even though they don't understand something, the answer must be somewhere. And they think, "If I'm here and the answer is there, what do I have to do to get there?" (Often, their answer is to bug their parents with more questions.)

REMEMBER

Getting from here to there — from ignorance to understanding — is one of the main reasons logic came into existence. Logic grew out of an innate human need to make sense of the world and, as much as possible, gain some control over it.

Understanding cause and effect

One way to understand the world is to notice the connection between cause and effect.

As you grow from a child to an adult, you begin to piece together how one event causes another. Typically, these connections between cause and effect can be placed in an *if-statement*. For example, consider these if-statements:

If I let my favorite ball roll under the couch, *then* I can't reach it.

If I do all of my homework before Dad comes home, *then* he'll play catch with me before dinner.

If I practice on my own this summer, *then* in the fall the coach will pick me for the football team.

If I keep asking her out really nicely and with confidence, *then* eventually she will say yes.

Understanding how if-statements work is an important aspect of logic.

Breaking down if-statements

Every if-statement is made up of the following two smaller statements called *sub-statements*: The *antecedent,* which follows the word *if,* and the *consequent,* which follows the word *then*. For example, consider this if-statement:

If it is 5 p.m., *then* it's time to go home.

In this statement, the antecedent is the sub-statement

It is 5 p.m.

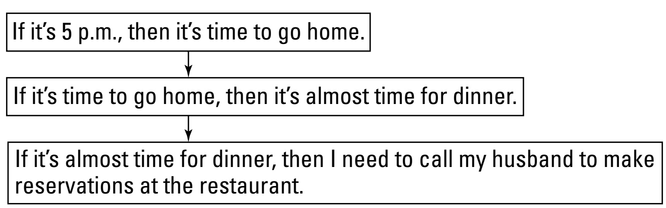
The consequent is the sub-statement

It's time to go home

Notice that these sub-statements stand as complete statements in their own right.

Stringing if-statements together

In many cases, the consequent of one if-statement becomes the antecedent of another. When this happens, you get a string of consequences, which the Greeks called a *sorites* (pronounced sore-it-tease). For example:



In this case, you can link these if-statements together to form a new if-statement:

If it's 5 p.m., then I need to call my husband to make reservations at the restaurant.

Thickening the plot

With more life experience, you may find that the connections between cause and effect become more and more sophisticated:

> *If* I let my favorite ball roll under the couch, *then* I can't reach it, *unless* I scream so loud that Grandma gets it for me, *though if* I do that more than once, *then* she gets annoyed and puts me back in my highchair.
>
> *If* I practice on my own this summer *but* not so hard that I blow my knees out, *then* in the fall the coach will pick me for the football team *only if* he has a position open, *but if* I do *not* practice, *then* the coach will *not* pick me.

Everything and more

As you begin to understand the world, you begin to make more general statements about it. For example:

> All horses are friendly.
>
> All boys are silly.
>
> Every teacher at that school is out to get me.
>
> Every time the phone rings, it's for my sister.

REMEMBER

Words like *all* and *every* allow you to categorize things into *sets* (groups of objects) and *subsets* (groups within groups). For example, when you say "All horses are friendly," you mean that the set of all horses is *contained within* the set of all friendly things.

Existence itself

You also discover the world by figuring out what *exists* and *doesn't exist.* For example:

> Some of my teachers are nice.
>
> There is at least one girl in school who likes me.
>
> No one in the chess club can beat me.
>
> There is no such thing as a Martian.

REMEMBER

Words like *some, there is,* and *there exists* show an overlapping of sets called an *intersection.* For example, when you say, "Some of my teachers are nice," you mean that there's an intersection between the set of your teachers and the set of nice things.

Similarly, words like *no, there is no,* and *none* show that there's no intersection between sets. For example, when you say "No one in the chess club can beat me," you mean that there's no intersection between the set of all the chess club members and the set of all the chess players who can beat you.

A few logical words

As you can see, certain words show up a lot as you begin to make logical connections. Some of these common words are:

if . . . then	and	but	or
not	unless	though	every
all	every	each	there is
there exists	some	there is no	none

Taking a closer look at words like these is an important job of logic because when you do this, you begin to see how these words allow you to divide the world in different ways (and therefore understand it better).

Building Logical Arguments

When people say "Let's be logical" about a given situation or problem, they usually mean "Let's follow these steps:"

1. Figure out what we know to be true.
2. Spend some time thinking about it.
3. Find the best course of action.

In logical terms, this three-step process involves building a *logical argument.* An argument contains a set of premises at the beginning and a conclusion at the end. In many cases, the premises and the conclusion will be linked by a series of intermediate steps. In the following sections, I discuss them in the order that you're likely to encounter them.

Generating premises

The *premises* are the facts of the matter: The statements that you know (or strongly believe) to be true. In many situations, writing down a set of premises is a great first step to problem solving.

For example, suppose you're a school board member trying to decide whether to endorse the construction of a new school that would open in September. Everyone is very excited about the project, but you make some phone calls and piece together your facts, or premises.

Premises:

> The funds for the project won't be available until March.
>
> The construction company won't begin work until they receive payment.
>
> The entire project will take at least eight months to complete.

So far, you only have a set of premises. But when you put them together, you're closer to the final product — your logical argument. In the next section, I show you how to combine the premises together.

Bridging the gap with intermediate steps

Sometimes an argument is just a set of premises followed by a conclusion. In many cases, however, an argument also includes *intermediate steps* that show how the premises lead incrementally to that conclusion.

Using the school construction example from the previous section, you may want to spell things out like this:

> According to the premises, we won't be able to pay the construction company until March, so they won't be done until at least eight months later, which is November. But, school begins in September. Therefore. . .

The word *therefore* indicates a conclusion and is the beginning of the final step, which I discuss in the next section.

Forming a conclusion

The *conclusion* is the outcome of your argument. If you've written the intermediate steps in a clear progression, the conclusion should be fairly obvious. For the school construction example I've been using, here it is:

Conclusion:

> The building won't be complete before school begins.

If the conclusion isn't obvious or doesn't make sense, something may be wrong with your argument. In some cases, an argument may not be valid. In others, you may have missing premises that you'll need to add.

Deciding whether the argument is valid

After you've built an argument, you need to be able to decide whether it's *valid,* which is to say it's a good argument.

REMEMBER

To test an argument's validity, assume that all of the premises are true and then see whether the conclusion follows automatically from them. If the conclusion automatically follows, you know it's a valid argument. If not, the argument is *invalid*.

Understanding enthymemes

The school construction example argument may seem valid, but you also may have a few doubts. For example, if another source of funding became available, the construction company may start earlier and perhaps finish by September. Thus, the argument has a hidden premise called an *enthymeme* (pronounced en-thim-eem)*,* as follows:

> There is no other source of funds for the project.

TIP

Logical arguments about real-world situations (in contrast to mathematical or scientific arguments) almost always have enthymemes. So, the clearer you become about the enthymemes hidden in an argument, the better chance you have of making sure your argument is valid.

Uncovering hidden premises in real-world arguments is more related to *rhetoric*, which is the study of how to make cogent and convincing arguments. I touch upon both rhetoric and other details about the structure of logical arguments in Chapter 3.

Making Logical Conclusions Simple with the Laws of Thought

As a basis for understanding logic, philosopher Bertrand Russell set down three laws of thought. These laws all have their basis in ideas dating back to Aristotle, who founded classical logic more than 2,300 years ago. (See Chapter 2 for more on the history of logic.)

All three laws are really basic and easy to understand. But, the important thing to note is that these laws allow you to make logical conclusions about statements even if you aren't familiar with the real-world circumstances that they're discussing.

The law of identity

The *law of identity* states that every individual thing is identical to itself.

For example:

Susan Sarandon is Susan Sarandon.

My cat, Ian, is my cat, Ian

The Washington Monument is the Washington Monument.

Without any information about the world, you can see from logic alone that all of these statements are true. The law of identity tells you that any statement of the form "*X* is *X*," must be true. In other words, everything in the universe is the same as itself. In Chapter 19, you'll see how this law is explicitly applied to logic.

The law of the excluded middle

The *law of the excluded middle* states that every statement is either true or false.

For example, consider these two statements:

My name is Mark.

My name is Algernon.

Again, without any information about the world, you know logically that each of these statements is either true or false. By the law of the excluded middle, no third option is possible — in other words, statements can't be partially true or false. Rather, in logic, every statement is either completely true or completely false.

As it happens, I'm content that the first statement is true and relieved that the second is false.

The law of non-contradiction

The *law of non-contradiction* states that given a statement and its opposite, one is true and the other is false.

For example:

> My name is Algernon.
>
> My name is not Algernon.

Even if you didn't know my name, you could be sure from logic alone that one of these statements is true and the other is false. In other words, because of the law of contradiction, my name can't both be and not be Algernon.

Combining Logic and Math

Throughout this book, many times I prove my points with examples that use math. (Don't worry — there's nothing here that you didn't learn in fifth grade or before.) Math and logic go great together for two reasons, which I explain in the following sections.

Math is good for understanding logic

Throughout this book, as I'm explaining logic to you, I sometimes need examples that are clearly true or false to prove my points. As it turns out, math examples are great for this purpose because, in math, a statement is always either true or false, with no gray area between.

On the other hand, sometimes random facts about the world may be more subjective, or up for debate. For example, consider these two statements:

> George Washington was a great president.
>
> *Huckleberry Finn* is a lousy book.

Most people would probably agree in this case that the first statement is true and the second is false, but it's definitely up for debate. But, now look at these two statements:

> The number 7 is less than the number 8.
>
> Five is an even number.

Clearly, there's no disputing that the first statement is true and that the second is false.

Logic is good for understanding math

As I discuss earlier in this chapter, the laws of thought on which logic is based, such as the law of the excluded middle, depend on black-and-white thinking. And, well, nothing is more black and white than math. Even though you may find areas such as history, literature, politics, and the arts to be more fun, they contain many more shades of gray.

Math is built on logic as a house is built on a foundation. If you're interested in the connection between math and logic, check out Chapter 22, which focuses on how math starts with obvious facts called *axioms* and then uses logic to form interesting and complex conclusions called *theorems.*