Basic Concepts in Logic and Argumentation

Contents

Critical Thinker Academy

Introduction

This is where almost every course in critical thinking begins, with a discussion of the most basic and foundational concepts necessary for argument analysis. What is an *argument*? What is a *premise*? What is a *conclusion*? What is a *good* argument? What is a *bad* argument?

This lecture series introduces the single most important distinction in argument analysis, the distinction between the *truth or falsity of the premises* of an argument, and the *logical relationship between the premises and the conclusion*. The logical relationships we'll be looking at include the distinction between *valid* versus *invalid* arguments, and *strong* versus *weak* arguments. The last section discusses two important classes of argument, *deductive arguments* and *inductive arguments*, and how they relate to scientific reasoning.

Elsewhere I have argued that most critical thinking textbooks place too much emphasis on argument analysis at the expense of other important skills and concepts, like rhetoric and communication skills, or the psychology of persuasion and belief. But that doesn't mean that I don't think argument analysis is important. On the contrary, it's *fundamental* for critical thinking — you will be *seriously impaired* as a critical thinker if you don't have a good grasp of basic concepts of logic and argument analysis.

At the very least this material will give you the essential vocabulary for talking about arguments and the different ways that arguments can succeed and fail, and will serve as a jumping-off point for further studies in logic and argument analysis (for example, the study of formal and informal fallacies, and the analysis of more complex arguments).

Part 1: What is an Argument?

1. What is an Argument?

Since arguments are at the heart of logic and argumentation it's natural to start with this question.

The first thing to say about arguments is that, as this term is used in logic, it isn't intended to imply anything like an emotional confrontation, like when I say that "an argument broke out at a bar" or "I just had a huge argument with my parents about my grades". In logic an “argument” is a technical term. It doesn't carry any connotation about conflict or confrontation.

Here's our definition. It will have three parts:

(1) An argument is a set of "claims", or "statements".

We'll have more to say about what a claim or statement is later, but for now it's enough to say that a claim is the sort of thing that can be true or false.

(2) One of the claims is singled out for special attention. We call it the "conclusion". The remaining claims are called the "premises".

(3) The premises are interpreted as offering reasons to believe or accept the conclusion.

That's it, that's the definition of an argument.

Now let's have a look at one:

1. All musicians can read music.
2. John is a musician.
Therefore, John can read music.

Premises 1 and 2 are being offered as reasons to accept the conclusion that John can read music.

This may not be a particularly good argument actually, since that first premise makes a pretty broad generalization about all musicians that isn't

very plausible. I'm sure there are a few great musicians out there that don't read sheet music. But it's an argument nonetheless.

Now, notice how it's written. The premises are each numbered and put on separate lines, and the conclusion is at the bottom and set off from the rest by a line and flagged with the word "therefore".

This is called putting an argument in **standard form** and it can be useful when you're doing argument analysis.

In ordinary language we're almost never this formal, but when you're trying to analyze arguments, when you're investigating their logical properties, or considering whether the premises are true or not, putting an argument in standard form can make life a lot easier.

Now just to highlight this point, here's another way of saying the same thing:

"Can John read music? Of course, he's a musician, isn't he?"

This expresses the very same argument as the written in standard form above. But notice how much easier it is to see the structure of the argument when it's written in standard form. In this version you have to infer the conclusion, "John can read music", from the question and the "of course" part.

And you have to fill in a missing premise. What you're given is "John is a musician", but the conclusion only follows if you assume that all musicians, or most musicians, can read music, which is not a given, it's just a background assumption. *The argument only makes sense because you're filling in the background premise automatically*. You can imagine that this might become a problem for more complex arguments. You can't always be sure that everyone is filling in the same background premise.

So, standard form can be helpful, and we're going to be using it a lot.

2. What is a Claim, or Statement?

Arguments are made up of "claims", or "statements". In this section I want to say a few words about what this means and why it's important for logic.

Here's a definition you might see in a logic text:

A *claim* is a sentence that can be true or false (but not both).

Actually in logic texts the more commonly used term is "statement" or "proposition". These are all intended to mean the same thing. A claim, or a statement, or a proposition, is a bit of language whose defining characteristic is that it makes an assertion that could be true or false but not both.

The "true or false" part of this definition expresses a principle of classical logic that's called the **Principle of Bivalence**. This principle asserts that a claim can only assume one of two truth values, "true" or "false"; there's no third option like "half-true" or "half-false", or "almost true".

The "but not both" part of this definition expresses a different principle of classical logic called the **Principle of Non-Contradiction**. This principle states that a claim can't be both true and false at the same time, it's either one or the other. To assert otherwise is to assert a contradiction.

(Actually there are systems of logic where both the Principle of Bivalence and the Principle of Non-Contradiction are relaxed. Logicians can study different systems of reasoning that don't assume these principles. But in classical logic they hold, and in what follows we're going to assume that they hold.)

Now, you might ask why defining claims in this way is important. Here are two reasons.

1. **Not all sentences can function as claims for argumentative purposes.**

For example, *questions* don't count as claims, since they don't assert anything that can be true or false. If you have a question like "Do you like mushrooms on your pizza?", that's a request for information, it doesn't assert that such-and-such is true or false.

Another type of sentence that doesn't count as a claim is a *command*, or an imperative, like "Step away from the car and put your hands behind your head!". That's a request to perform an action, it makes no sense to ask whether the action or the command is true or false.

So, not every bit of language counts as a claim, and so not every bit of language can play the role of a premise or a conclusion of an argument.

Here's a second reason why this definition of a claim is important:

2. **The definition gives us a way of talking about clarity and precision in our use of language.**

This is because in saying that a sentence can function as a claim in an argument, what we're saying is that all the relevant parties, both the person giving the argument and the intended audience of the argument, *have a shared understanding of the meaning of that sentence*.

In this context, what it *means* to *understand* the meaning of a sentence is to understand *what it would mean for the sentence to be true or false*. That is, it involves being able to recognize and distinguish in your mind the state of affairs in which the sentence is true from the state of affairs in which the sentence is false.

So, in the context of logic and argumentation, for a sentence to be able to function as a claim, for it to be able to function as a premise or a conclusion of an argument, there has to be a shared understanding of what the sentence is asserting.

Consequently, if the sentence is *too vague* or its meaning is *ambiguous*, then it can't function as a claim in an argument, because in this case we literally don't know what we're talking about.

The requirement that a sentence be able to function as a claim is not a trivial one. It's actually pretty demanding. Not all bits of language make assertions, and not all assertions are sufficiently clear in their meaning to function as claims.

This is important. Before we can even begin to ask whether an argument is good or bad, we need to have a shared understanding of what the argument actually is, and this is the requirement that you're expressing when you say that an argument is made up of claims that can be true or false.

What this means in practice is that, ideally, you want everyone to have a shared understanding of what the argument is about and what the premises are asserting. If people can't agree on what the issue is, or what's being asserted then you have to go back and forth can clarify the issue and clarify the arguments so that all parties finally have a shared understanding of the argument.

Only then can you have a rational discussion of the strengths and weaknesses of the argument.

Questions and Comments[1]

1. Sometimes a statement can be expressed using a question, can't it?

That's true. A good example is "rhetorical questions", which are really statements.

For example, if you ask me whether I'm going to study for the final exam, and I look at you say **"What do you think I am, an idiot?"**, I'm not actually asking whether you think I'm an idiot. It's a rhetorical question, used to (sarcastically) assert the statement **"Yes, I'm going to study for the final exam"**.

This example illustrates a general point, that identifying arguments in ordinary language requires paying attention to rhetorical forms and

1. Note: This section is not included in the video tutorial from which the previous material is derived.

stylistic conventions in speech and in writing. A complex writing style, or a failure to understand the rhetorical context in which an argument is given (for example, failing to recognize SATIRE), can lead to confusion about what is being asserted.

2. What's the difference between a sentence being VAGUE and a sentence being AMBIGUOUS?

If I ask my daughter when she'll be back from visiting friends and she says "Later", that's a VAGUE answer. It's not specific enough to be useful.

On the other hand, if I ask her which friend she'll be visiting, and she says "Kelly", and she has three friends named Kelly, then that's an AMBIGUOUS answer, since I don't know which Kelly she's talking about. The problem isn't one of specificity, it's about identifying which of a set of well-specified meanings is the one that was intended.

Note that *all natural language suffers from vagueness to some degree*. If I say that the grass is looking very green after last week's rain, one could always ask which *shade* of green I'm referring to. But it would be silly to think that you don't understand what I'm saying just because I haven't specified the shade of green.

For purposes of identifying claims in arguments, the question to ask isn't "Is this sentence vague?", but rather, "Is this sentence TOO vague, given the context?".

If all I'm doing is trying to determine whether the grass needs watering or not, the specific shade of green probably doesn't matter. But if I'm trying to pick a green to paint a room in my house, specifying the shade will be more important.

3. What is a Good Argument? (I)

An argument is an attempt to persuade, **but the goal of logic and argumentation isn't simply to persuade — it's to persuade for good reasons.**

The most basic definition of a **good** argument is straightforward: **it's an argument that gives us good reasons to believe the conclusion.**

There's not much we can do with this definition, though. It's too vague. We have to say more about what we mean by "good reasons" obviously.

To do this we'll start by looking at some ways that arguments can fail to be good, and from these we'll extract a couple of necessary conditions for an argument to be good.

Here's an argument:

1. All actors are robots.
2. Tom Cruise is an actor.

Therefore, Tom Cruise is a robot.

Here's another argument:

1. All tigers are mammals.
2. Tony is a mammal.

Therefore, Tony is a tiger.

Both of these are bad arguments, as you might be able to see. But they're bad in different ways.

In the first argument on top, the problem is obviously that the first premise is *false* — all actors are not robots. But that's the only problem with this argument.

In particular, the logic of this argument is perfectly good. When I say that the logic is good what I mean is that the premises logically support or imply the conclusion, or that the conclusion follows from the premises.

In this case it's clear that if the premises of this argument were all true then the conclusion would have to be true, right? If all actors were robots, and if Tom Cruise is an actor, then it would follow that Tom Cruise would have to be a robot. The conclusion does follow from these premises.

Now let's look at the other argument:

1. All tigers are mammals.
2. Tony is a mammal.

Therefore, Tony is a tiger.

First question: Are all the premises true?

Are all tigers mammals? Yes they are. Is Tony a mammal? Well in this case we have no reason to question the premise so we can stipulate that it's true. So in this argument all the premises are true.

Now what about the logic?

This is where we have a problem. Just because all tigers are mammals and Tony is a mammal, it doesn't follow that Tony has to be a tiger. Tony could be a dog or a cat or a mouse. So even if we grant that all the premises are true, those premises don't give us good reason to accept that conclusion.

So this argument has the opposite problem of the first argument. The first argument has good logic but a false premise. This argument has all true premises but bad logic. **They're both bad arguments but they're bad in different ways.** And these two distinct ways of being bad give us a pair of conditions that an argument must satisfy if it's going to be good.

First condition:

If an argument is good then all the premises must be true.

We'll call this the "**Truth Condition**".

Second condition:

> **If an argument is good then the conclusion must follow from the premises.**
>
> We'll call this the "**Logic Condition**".

Note that at the top I called these "necessary conditions". What this means is that any good argument has to satisfy these conditions. If an argument is good then it satisfies both the Truth Condition and the Logic Condition.

But I'm not saying that they're "sufficient" conditions. By that I mean that they don't by themselves guarantee that an argument is going to be good. An argument can satisfy both conditions but still fail to be good for other reasons.

Still, these are the two most important conditions to be thinking about when you're doing argument analysis.

In later lectures we'll look more closely at both the Truth Condition and the Logic Condition, and we'll also look at ways in which an argument can satisfy both conditions and still fail to be good.

Questions and Comments

1. What's the difference between "persuading" and "persuading for good reasons"?

If my only goal is to persuade you to accept my conclusion, then I might use all kinds of rhetorical tricks to achieve that goal. I might choose to outright lie to you. If mere persuasion is the ultimate goal then there would be no normative distinction between argumentation and using lies, rhetorical tricks and psychological manipulation to persuade.

Mere persuasion is NOT the ultimate goal of argumentation, at least as this term is used in philosophy and rhetoric. **Argumentation is about persuasion *for good reasons***. Precisely what this means is not obvious, and it will take us some time to work it out work, but at a minimum it

involves offering premises that your audience is willing to accept, and demonstrating how the conclusion follows logically from those premises.

Here's another way to think about argumentation. From a broader perspective, to argue with a person, as opposed to merely trying to persuade or influence a person, is to treat that person as a rational agent capable of acting from, and being moved by, reasons. It's part of what it means to treat a person as an "end" in themselves, rather than as a mere means to some other end.

In this respect, theories of argumentation are normative theories of *how we ought to reason, if we're treating our audience as rational agents.* They're a component of a basic moral stance that we adopt toward beings who we recognize as capable of rational thought.

2. How can an argument satisfy both the Truth Condition and the Logic Condition and still fail to be good?

I said I would consider this question in a later lecture, but just to give an example, arguments that commit the fallacy of "begging the question" may satisfy both these conditions but fail to be good.

Consider this argument:

1. Capital punishment involves the killing of a person by the state as punishment for a crime.
2. It is morally unjustified for the state to take the life of a person as punishment for a crime.
Therefore, capital punishment is morally unjustified.

Let's grant that the conclusion follows from the premises. Could this count as a good argument?

The problem is that the second premise simply *asserts* what is precisely *at issue* in the debate over capital punishment. It "begs the question" about the ethics of capital punishment by assuming as a premise that it's wrong. Such arguments are also called "circular", for obvious reasons — the conclusion simply restates what is already asserted in the premises.

The problem with this kind of argument isn't that the premises are obviously false. The problem is that they don't provide any independent reasons for accepting that conclusion.

Logic and critical thinking texts will treat this kind of argument as fallacious, a bad argument. *What makes this argument bad isn't captured by violating the Truth Condition or the Logic Condition*.

Arguments that beg the question in this way may well have all true premises and good logic, but they would still be judged as bad arguments due to their circularity.

So this is an example of how an argument may be judged bad even though it satisfied both the Truth Condition and the Logic Condition. And this is what it means to say that these are merely necessary conditions for a good argument, *not sufficient conditions*. All good arguments will satisfy these two conditions, but not all arguments that satisfy these two conditions will be good.

Still, the distinctions captured by the Truth Condition and the Logic Condition are absolutely central to argument analysis.

3. You keep using arguments with only two premises. Do all arguments only have two premises?

I can see how people might initially get this impression, since so many of the introductory examples you see in logic and critical thinking texts are short two-premise arguments. For the purpose of introducing new logical concepts, the short two-premise argument forms are very useful.

But you can have arguments with five, ten or a hundred premises. In longer and more complex arguments what you usually see are nested sets of sub-arguments where each sub-argument has relatively few premises, but the overarching argument (when you expand it all out) might be very long.

You see this kind of progression learning almost any complex skill. You start out by rehearsing the most elementary concepts or skill elements (basic programming statements in computer languages; the positions and

moves of the chess pieces in chess, forehand and backhand strokes in tennis; basic statement types and argument forms in logic, etc.), and then combine them to create more complex structures or perform more complex tasks. Learning logic and argument analysis isn't any different.

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4. Identifying Premises and Conclusions

Argument analysis would be a lot easier if people gave their arguments in standard form, with the premises and conclusions flagged in an obvious way.

But people don't usually talk this way, or write this way. Sometimes the conclusion of an argument is obvious, but sometimes it's not. Sometimes the conclusion is buried or implicit and we have to reconstruct the argument based on what's given, and it's not always obvious how to do this.

In this lecture we're going to look at some principles that will help us identify premises and conclusions and put natural language arguments in standard form. This is a very important critical thinking skill.

Here's an argument:

"Abortion is wrong because all human life is sacred."

Question: which is the conclusion?

"Abortion is wrong"?

or

"All human life is sacred"?

For most of us the answer is clear. "**Abortion is wrong"** is the *conclusion*, and "**All human life is sacred"** is the *premise*.

How did we know this? Well, two things are going on.

First, we're consciously, intentionally, *reading for the argument*, and when we do this we're asking ourselves, "what claim are we being asked to believe or accept, and what other claims are being offered as reasons to accept that claim?".

Second, we *recognize the logical significance of the word "because"*. "Because" is what we call an **indicator word**, a word that indicates the logical relationship of claims that come before it or after it. In this case it indicates that the claim following it is being offered as a reason to accept the claim before it.

So, rewriting this argument in standard form, it looks like this ...

1. All human life is sacred.
Therefore, abortion is wrong.

At this point we could start talking about whether this is a good argument or not, but that's not really our concern right now. Right now we're more concerned with identifying premises and conclusions and getting the logical structure of an argument right.

Here are some key words or phrases that indicate a **CONCLUSION**:

therefore, so, hence, thus, it follows that, as a result, consequently,

and of course there are others.

This argument gives an example using "so":

It's flu season and you work with kids, SO you should get a flu shot.

Now, keywords like these make it much easier to identify conclusions, but not all arguments have keywords that flag the conclusion. Some arguments have no indicator words of any kind. In these cases you have to rely on your ability to analyze context and read for the argument.

Here's a more complex argument that illustrates this point:

"We must reduce the amount of money we spend on space exploration. Right now, the enemy is launching a massive military buildup, and we need the additional money to purchase military equipment to match the anticipated increase in the enemy's strength."

Notice that there are no indicator words that might help us flag the conclusion.

So, which claim is the conclusion of this argument?

Is it ...

"We must reduce the amount of money we spend on space exploration."?

Is it ...

"The enemy is launching a massive military buildup"?

Or is it ...

"We need the additional money to purchase military equipment to match the anticipated increase in the enemy's strength"?

The answer is ...

"We must reduce the amount of money we spend on space exploration."

Most people can see this just by looking at the argument for a few seconds, but from experience I know that some people have a harder time seeing logical relationships like this.

If it's not obvious, the way to work the problem is this: for each claim asserted in the argument you have to ask yourself,

"Is this the main point that the arguer is trying to convey?"

or,

"Is this a claim that is being offered as a reason to believe another claim?"

If it's being offered as a *reason* to believe *another* claim, then it's functioning as a *premise*. If it's expressing the *main point* of the argument, what the argument is trying to persuade you to accept, then it's the conclusion.

There are words and phrases that indicate **premises** too. Here are a few:

since, if, because, from which it follows, for these reasons,

and of course there are others.

And here's an example that uses "since":

"John will probably receive the next promotion SINCE he's been here the longest."

"Since" is used to indicate that John's being here the longest is a reason for thinking that he will probably receive the next promotion.

So, let's summarize:

- Arguments in natural language aren't usually presented in standard form, so we need to know how to extract the logical structure from the language that's given.
- To do this, we look at each of the claims in the argument and we ask ourselves, is this the main point that the arguer is trying to convey, or is this being offered as a reason to accept some other claim?
- The claim that expresses the main point is the conclusion.
- The claims that are functioning as reasons to accept the main point are the premises.
- And finally, premises and conclusions are often flagged by the presence of indicator words. Paying attention to indicator words can really help to simplify the task of reconstructing an argument.

Review and Discussion Questions

In the lectures in "Part 1: What is an Argument?" we introduced the basic definition of an argument, discussed the nature of "claims" (or "statements", or "propositions"), introduced the concept of a good argument, and reviewed some tips for identifying and distinguishing premises and conclusions.

The questions below will help you review and test your understanding of these concepts. Some of them have clear answers, others are more open-ended and are meant to stimulate thought and discussion.

What is an Argument?

1. What is the definition of an argument? How does this definition differ from more common usages like "I had a big argument with my parents last night."?

2. What does it mean to put an argument in "standard form"? Why is this helpful?

3. Write the following argument in standard form:

> **"Obviously, Dick loves the smell of used underwear. He loves the smell of peanuts, and peanuts smell like used underwear!"**

What is a Claim?

1. What is the definition of a "claim" (or "statement", or "proposition")?

2. Can a *question* function as a claim in an argument?

3. If the meaning of a sentence is "too vague" then it can't function as a claim in an argument. But what determines when a statement is "too vague"?

4. If the meaning of a sentence is *ambiguous* then it can't function as a claim in an argument. What's the difference between saying a sentence is "vague" and saying it's "ambiguous"?

5. "**I'm loving it.**" (McDonald's ad slogan)
   "**Coke: It's the real thing.**" (Coca Cola ad slogan)
   "**I am what I am.**" (Reebok ad slogan)
   "**The heartbeat of America.**" (Chevrolet ad slogan)

   Do any of these make claims? If not, what is it that these slogans are communicating?

6. For each sentence below, can it function as a claim in an argument? Why or why not?

   - **"In 1975, Barack Obama was the President of the United States."**
   - "**John loves Mary.**"
   - **"God is love.**"
   - "**There is a God who is the all-powerful, all-knowing and all-good creator of the universe.**"

What is a Good Argument?

1. At the highest level of generality, what is the definition of a good argument?

2. What is the Truth Condition? What is the Logic Condition?

3. For the following arguments, indicate whether the problem is with the logic of the argument, the truth of the premises, or both.

   i. **1. Tigers are mammals.**
   2. Dogs are mammals.
   Therefore, tigers are dogs.

   ii. **1. All professors are right-handed.**
   2. Janice is a professor.
   Therefore, Janice is right-handed.

iii. **1. If a child goes to an expensive preschool they'll be successful in life.**
2. Kurt has been successful in life.
Therefore, Kurt went to an expensive preschool as a child.

4. Rhetoric is the "art of persuasive speech". The ultimate goal of rhetoric is persuasion. What is the ultimate goal of *argumentation*, and how does it differ from the goal of rhetoric?

Identifying Premises and Conclusions

1. Mark which of the blanks would normally be filled with a premise (P) and which with a conclusion (C).

   (a) i ____, ii _____, iii, _____, therefore, iv _____.

   (b) i _____, since, ii _____, iii _____, and iv _____.

   (c) From i _____, and ii_____, we can derive iii _____.

   (d) We can be sure that i _____, because ii_____, and iii ____ .

   (e) Since i _____, and ii_____, it follows that iii _____.

2. Write the following arguments in **standard form**. If the argument relies on an implicit background premise, make that premise explicit.

   i. Jim: "Don't bother, the car won't start."
   Sharon: "Why not?"
   Jim: "Because there's no gas in it."

   ii. Maria: "Is this plate clean?"
   Chris: "It's been through the dishwasher, so yes, it's clean."

Part 2: What is a Good Argument?

1. The Truth Condition

The Truth Condition is a necessary condition for an argument to be good. We stated it as the condition that all the premises of an argument have to be true. In this lecture I want to talk about what this condition amounts to in real world contexts where arguments are used to persuade specific audiences to accept specific claims.

I'm going to try to show why we actually need to modify this definition somewhat to capture what's really important in argumentation. I'll offer a modification of the definition that I think does a better job of capturing this.

Here's our **current definition of the Truth Condition**:

All premises must be true.

I'm going to use a simple example to illustrate the problem with this definition.

Consider this claim:

"The earth rotates on its axis once every 24 hours".

We all agree that this claim is true. It's an accepted part of our modern scientific understanding of the world.

But, say, 500 years ago, this claim would have been regarded by almost everyone as *obviously false*. The common understanding was that the earth does not move. Most everyone believed that the planets and everything else in the universe revolved around the earth, which his fixed at the center of the universe.

And *they had good reason to believe this*. When we look outside we see the moon and the sun and the stars and planets all moving around us. It certainly doesn't seem like we're all moving at hundreds of miles an hour toward the east. Around the equator it would be closer to a thousand miles an hour, as fast as a rifle bullet. If the earth was really rotating that

fast, why don't centrifugal forces make us fly off the surface of the earth? Or why don't we experience perpetual hurricane-force winds as the rotating earth drags us through the atmosphere at hundreds of miles per hour?

These are the sorts of arguments that medievals might have given, and did give, to support their contention that the earth in fact does not move. For their time, given what they knew about physics and astronomy, these seem like they would be compelling arguments.

So, *for a medieval audience*, any argument that employed this claim as a premise — the claim that the earth rotates once every 24 hours — or that argued for it as a conclusion, would have been judged as a *bad* argument, because for them the claim is clearly false.

Now, why does this situation pose a problem for our version of the Truth Condition? It poses a problem because if we read "true" as REALLY true, true IN ACTUALITY, and we think it's really true that the earth rotates, and it's really false that it's fixed at the center of the universe, then *this version of the Truth Condition makes it so that no medieval person can have a good argument for their belief that the earth does not move.*

And this just seems wrong. It seems like we want to say that yes, they were wrong about this, but *at the time they had perfectly good reasons to think they were right*.

And if they had *good reasons*, that means they had *good arguments*. But this version of the Truth Condition doesn't allow us to acknowledge that they had good arguments for their belief that the earth does not move.

So, we need to modify our phrasing of the Truth Condition so that it's sensitive to the background beliefs and assumptions of particular audiences.

This is a natural modification that does the trick:

We'll call a claim **plausible** (for a given audience — plausibility is always relative to a given audience even if we don't specifically say so) **if that audience believes they have good reason to think it's true.**

So to say that a claim is *plausible* for a given audience is just to say that the audience is willing to grant it as a premise, that they're not inclined to challenge it, since they think they have good reason to believe it's true.

What we're doing here is pointing out that in real-world argumentation, when someone is offering reasons for someone else to believe or accept something, an argument will only be persuasive if the target audience is willing to grant the premises being offered. Premises have to be plausible to *them*, not just plausible to the arguer, or some hypothetical audience.

So here are our conditions for an argument to be good, with the truth condition modified in the way that I've just suggested.

Condition one: **The Truth Condition**

All premises must be true (where "true" is read as "plausible")

Condition two: **The Logic Condition**

The conclusion most follow from the premises.

Just to note, for the rest of these lectures I'll keep using the expression "Truth Condition", even though it's really a "plausibility" condition, just because the language of "truth" is so commonly used in logic and critical thinking texts when describing this feature of good arguments.

Just remember, when we talk about evaluating the premises of an argument to see if the argument satisfies the Truth Condition — when I give an argument and I ask, are all the premises true? — what I'm *really* asking is whether the intended audience of the argument would be willing to grant those premises. In other words, whether they would find those premises *plausible*.

A Possible Objection

Let me just wrap up with an objection to this modification that some of my students will usually offer at this point.

Some people might object that what I've done here is redefined the concept of truth into something purely relative and subjective, that I'm denying the existence of objective truth.

This isn't what I'm saying. All I'm saying is that the *persuasive* power of an argument isn't a function of the *actual* truth of its premises. It's a function of the subjective plausibility of its premises for a given audience. A premise may be genuinely, objectively true, but if no one believes it's true, then no one will accept it as a premise, and any argument that employs it is guaranteed to fail, in the sense that it won't be judged by anyone as offering good reasons to accept it.

This point doesn't imply anything about the actual truth or falsity of the claims. We can say this and still say that claims or beliefs can be objectively true or false. *The point is just that the objective truth or falsity of the claims isn't the feature that plays a role in the actual success or failure of real world arguments*. It's the subjective plausibility of premises that plays a role, and that's what this reading of the Truth Condition is intended to capture.

2. The Logic Condition

The **Logic Condition** is another necessary condition for an argument to be "good".

In the tutorial that introduced the notion of a "good argument" we defined the Logic Condition in very general terms: **an argument satisfies the Logic Condition if the conclusion "follows from" the premises.**

The main point I wanted to make in that discussion was to distinguish arguments that are bad because of false premises, from arguments that are bad because of bad logic. These are two distinct ways in which an argument can fail to provide good reasons to believe the conclusion.

But we need to say a lot more about the Logic Condition, and what it means to say that an argument has good logic.

In fact, this lecture and the next two lectures are devoted to it. The concepts that we'll be looking at are absolutely central to logic.

The Hypothetical Character of the Logic Condition

I want to highlight the hypothetical character of the Logic Condition, and how it differs from the Truth Condition.

We say that an argument satisfies the Logic Condition if the conclusion "follows from" the premises, or equivalently, if the premises "support" the conclusion.

The following two arguments give examples of good logic and bad logic, respectively.

1. All tigers are mammals.
2. Tony is a tiger.
Therefore, Tony is a mammal.

In this first argument the conclusion clearly follows from the premises. If all tigers are mammals and if Tony is a tiger then it follows that Tony is a mammal.

1. All tigers are mammals.
2. Tony is a mammal.

Therefore, Tony is a tiger.

In this second argument the conclusion **doesn't** follow. If all tigers are mammals and if Tony is a tiger we can't infer that Tony is a tiger. Those premises may be true but they don't support the conclusion.

I want to draw attention to the way in which we make these kinds of judgments. In judging the logic of the argument we ask ourselves this hypothetical question:

"**IF all the premises WERE true, WOULD they give us good reason to believe the conclusion?**"

- If the answer is "yes" then the logic is good, and the argument satisfies the Logic Condition.
- If the answer is "no" then the logic is bad, and the argument doesn't satisfy the Logic Condition.

This gives us a more helpful way of phrasing the Logic Condition. **An argument satisfies the Logic Condition if it satisfies the following hypothetical condition**:

If the premises are all true, then we have good reason to believe the conclusion.

The key part of this definition is the hypothetical "IF".

When we're evaluating the *logic* of an argument, we're not interested in whether the premises are *actually* true or false. The premises might all be false, but that's *irrelevant* to whether the logic is good or bad. What matters to the logic is only this hypothetical "if". IF all the premises WERE true, WOULD the conclusion follow?

So, when evaluating the logic of an argument we just ASSUME the premises are all true, and we ask ourselves what follows from these premises?

This is fundamentally different from the Truth Condition, where what we're interested in is the *actual* truth or falsity of the premises themselves (or as we talked earlier, the "plausibility" or "implausibility" of premises).

The Truth Condition and the Logic Condition are focusing on very different properties of arguments.

In fact you can have arguments with *all false premises* that satisfy the Logic Condition. Here's an example:

1. If the moon is made of green cheese, then steel melts at room temperature.
2. The moon is made of green cheese.
Therefore, steel melts at room temperature.

This argument satisfies the Logic Condition, even though both premises are clearly false. Why? Because IF the first premise WAS true, and IF the second premise WAS true, then the conclusion WOULD follow.

In fact, this argument is an instance of a well known argument FORM that *always* satisfies the Logic Condition:

1. If A then B
2. A
Therefore, B

If A is true then B is true; A is true, therefore B is true. ANY argument that instantiates this argument form is going to satisfy the Logic Condition.

Here's another example:

1. All actors are billionaires.
2. All billionaires are women.
Therefore, all actors are women.

Each claim in this argument is false, so it's a bad argument, but the logic is airtight. This argument fails the Truth Condition but satisfies the Logic Condition.

And like the previous example it's an instance of an argument FORM that always satisfies the Logic Condition:

1. All A are B.
2. All B are C.
Therefore, all A are C.

Alternately, you can have arguments that have all true premises but FAIL the Logic Condition, like this one:

1. If I live in Iowa then I live in the United States.
2. I live in the United States.
Therefore, I live in Iowa.

The premises are true (at the time of writing this), but the conclusion doesn't follow, because even if they're all true it doesn't follow that I have to live in Iowa, or even that it's likely that I live in Iowa. I might live in New York or Florida or any of the other fifty states.

So, to **summarize**:

- We can rephrase the Logic Condition in a more helpful way by emphasizing the hypothetical character of the property that we're interested in, which is the LOGICAL RELATIONSHIP between premises and conclusion: If the premises are all true, then we have good reason to accept the conclusion.
- The actual truth or falsity of the premises is irrelevant to the logic of the argument.
- Argument analysis is a two-stage process. When we evaluate the logic of the argument we're not concerned about the actual truth or falsity of the premises. All we're concerned with is whether the conclusion follows from those premises.
- Once we've evaluated the logic, then we can ask whether the premises are actually true or plausible.

- If you confuse these steps, and make the mistake of judging the logic of an argument in terms of the truth or falsity of the premises, then you won't be able to properly evaluate an argument.

This distinction, between TRUTH and LOGIC, is arguably the most important distinction for critical argument analysis.

3. Valid vs Invalid Arguments

An argument has to satisfy the Logic Condition in order for it to qualify as a good argument. But there are two importantly different ways in which an argument can satisfy the Logic Condition.

One way is if the argument is **valid**. Another way is if the argument is **strong**.

"Validity" and "strength" are technical terms that logicians and philosophers use to describe the logical "glue" that binds premises and conclusions together. Valid arguments have the strongest logical glue possible.

In this lecture we're going to talk about "validity" and the difference between "valid" versus "invalid" arguments. In the next lecture we'll talk about "strength" and the difference between "strong" versus "weak" arguments.

Together, these two concepts, validity and strength, will help us to specify precisely what it means for an argument to satisfy the Logic Condition.

Valid vs Invalid

We've seen valid arguments before. Recall the Tom Cruise argument:

1. All actors are robots.
2. Tom Cruise is an actor.

Therefore, Tom Cruise is a robot.

This is an example of a valid argument.

Here's the **standard definition of a valid argument**:

An argument is VALID if it has the following hypothetical or conditional property:

IF all the premises are true, then the conclusion CANNOT be false.

In this case we know that in fact the first premise is false (not all actors are robots) but the argument is still valid because IF the premises were true it would be IMPOSSIBLE for the conclusion to be false.

In other words, *in a hypothetical world* where all actors are robots, and Tom Cruise also happens to be an actor, then it's logically impossible for Tom Cruise NOT to be a robot.

THAT is the distinctive property of this argument that we're pointing to when we call it "valid" — that it's *logically impossible* for the premises to be true and the conclusion false. Or to put it another way, the truth of the premises *guarantees* the truth of the conclusion.

These are all different ways of saying the same thing. Validity is the strongest possible logical glue you can have between premises and conclusion.

Here's an example of an INVALID argument:

1. All actors are robots.
2. Tom Cruise is a robot.
Therefore, Tom Cruise is an actor.

The first premise is the same, "All actors are robots". But the second premise is different. Instead of assuming that Tom Cruise is an actor, we're assuming that Tom Cruise is a robot.

Now, if these premises are both true, does it follow that Tom Cruise HAS to be an actor? *No, it does not follow*. It would follow if we said that ONLY actors are robots, but the first premise doesn't say that.

All we can assume is that in this hypothetical world, anyone in the acting profession is a robot, but robots might be doing lots of *different* jobs besides acting. They might be mechanics or teachers or politicians or whatever. So in this hypothetical world the fact that Tom Cruise is a robot doesn't guarantee that he's also an actor.

And THAT is what makes this an invalid argument.

An argument is INVALID just in case it's NOT VALID.

What this means is that even if all the premises are true, it's still possible for the conclusion to be false. The truth of the premises doesn't guarantee the truth of the conclusion.

That's ALL it means to call an argument "invalid".

In particular, **it *doesn't* imply that the argument is *bad*.** As we'll see in the next lecture, ***invalid arguments can still be good arguments***. Even if they don't guarantee the conclusion they can still give us good reasons to believe the conclusion, so they can still satisfy the Logic Condition.

But like I said, we'll talk more about this later.

A Cautionary Note About the Terminology

I'll end with a cautionary note about this terminology.

We're using the terms "valid" and "invalid" in a very specific technical sense that is commonly used in logic and philosophy but not so common outside of these fields.

As we all know in ordinary language the word "valid" is used in a bunch of different ways. Like when we say "that contract is valid", meaning something like the contract is “legally legitimate” or that it's “executed with proper legal authority”.

Or when we say "You make a valid point", we mean that the point is “relevant” or “appropriate”, or it has some justification behind it.

These are perfectly acceptable uses of the term "valid". But I just want to emphasize that *this isn’t how we’re using the term in logic when we’re doing argument analysis*. It's important to keep the various meanings of "valid" and "invalid" distinct so there's no confusion.

Note for example that when we use the terms valid and invalid in logic we're talking about *properties of whole arguments, not of individual claims.*

If we're using the terms in the way we've defined them in this tutorial then **it makes NO SENSE to say that an individual premise or claim is valid or invalid**.

Validity is a property that describes the logical relationship between premises and conclusions. It's a feature of arguments taken as a whole. Still, it's very common for students who are new to logic to confuse the various senses of valid and invalid, and make the mistake of describing a premise as invalid when what they mean is simply that it's false or dubious.

So that's just a cautionary note about the terminology. If you keep the logical definition clear in your mind then you shouldn't have a problem.

4. Strong vs Weak Arguments

There are two importantly different ways in which an argument can satisfy the Logic Condition. One way is if the argument is **VALID**. Another way is if the argument is **STRONG**. We've talked about validity. Now let's talk about strength.

Here's an argument:

1. All humans have DNA.
2. Pat is human.
Therefore, Pat has DNA.

This is a valid argument. If the premises are true the conclusion can't possibly be false.

Now take a look at this argument:

1. 50% of humans are female.
2. Pat is human.
Therefore, Pat is female.

The percentage isn't exact, but we're not interested in whether the premises are actually true. We're interested in whether, if they were true, the conclusion would follow.

In this case the answer is clearly NO. Knowing that Pat is human doesn't give any good reason to think that he or she is female.

This is an example of an argument that does NOT satisfy the Logic Condition.

Now take a look at this argument:

1. 90% of humans are right-handed.
2. Pat is human.
Therefore, Pat is right-handed.

This argument is different. In this case the premises make it *very likely* — 90% likely — *that the conclusion is true*. They don't guarantee that Pat is right-handed, but we might still want to say that *they provide good reasons to think* that Pat is right-handed.

And if that's the case then we should say that *this argument satisfies the Logic Condition*. Because it has the property that, if all the premises are true, they give us good reason to believe the conclusion.

This difference is what the distinction between *weak* and *strong* arguments amounts to.

- The first argument is what we call a logically **WEAK** argument. It **does not** satisfy the Logic Condition and so it can't be a good argument.
- The second argument is a logically **STRONG** argument. It **does** satisfy the Logic Condition so it can be a good argument.

This is what distinguishes these arguments, but note what they have in common. **They're both logically INVALID**.

In a valid argument if the premises are true the conclusion can't possibly be false. Neither of these arguments guarantees certainty. They're both fallible inferences. Even if the premises are true you could still be wrong about the conclusion.

The difference is that in a STRONG argument the premises make the conclusion VERY LIKELY true. A WEAK argument doesn't even give us this.

How Strong Does the Inference Have to Be to Satisfy the Logic Condition?

Now these examples immediately raise an important question:

HOW strong does the inference have to be for the argument to satisfy the Logic Condition and qualify as a strong argument?

To put it another way, *with what probability* must the conclusion follow from the premises for the argument to qualify as strong?

50% is clearly too weak. 90% is clearly strong enough. But where's the cut-off, what's the threshold that the strength of the logical inference has to meet o count as satisfying the Logic Condition?

Well, it turns out that *there is no principled answer to this question*.

The distinction between valid and invalid arguments is a sharp one. Every argument is either valid or invalid. There are no "degrees" of validity. Validity is like pregnancy — you can't be almost pregnant or a little bit pregnant.

The distinction between strong and weak arguments, on the other hand, *is a matter of degree*. It does make sense to say that an argument is very strong, or moderately strong, or moderately weak or very weak.

But the threshold between weak and strong arguments isn't fixed or specified by logic. It is, in fact, a conventional choice that we make. We decide when the premises provide sufficient evidence or reason to justify accepting the conclusion. There are no formal principles of logic that make this decision for us.

This is actually a big topic. It needs a lot more space to properly discuss (it really belongs in a course on inductive and scientific reasoning).

Valid, Strong and Weak Argument Forms

There are some common argument forms that people generally recognize as valid, strong or weak that are helpful to know.

Here are some simple argument forms that are recognized as valid, strong or weak respectively.

VALID:

1. ALL A are B.
2. x is an A.

Therefore, x is a B.

An example of a valid argument of this form is

1. All actors are robots.
2. Tom is an actor.

Therefore, Tom is a robot.

STRONG:

If we change "ALL" to "MOST" we get an invalid but strong argument:

1. Most A are B.
2. x is an A.
Therefore, x is a B.

Here's an instance of this argument form:

1. Most actors are robots.
2. Tom is an actor.
Therefore, Tom is a robot.

The conclusion doesn't follow with certainty, but we're stipulating that "most" means "enough to make it reasonable to believe the conclusion".

WEAK:

If we switch from "most" to "some" we get a weak argument form:

1. Some A are B.
2. x is an A.
Therefore, x is a B.

Here's an instance of this argument form:

1. Some actors are robots.
2. Tom is an actor.
Therefore, Tom is a robot.

"Some actors are robots" doesn't even guarantee 50-50 odds. The way this term is commonly used in logic, "some" just means that AT LEAST ONE actor is a robot.

Summary

These definitions summarize what we've seen so far:

- VALID: If all the premises are true, the conclusion follows with certainty.

- STRONG: If all the premises are true, the conclusion follows with high probability.
- WEAK: If all the premises are true, the conclusion follows neither with certainty nor with high probability.

Validity, strength and weakness are logical properties of arguments that characterize the logical relationship between the premises and the conclusion.

Both valid and strong arguments satisfy the Logic Condition for an argument to be good. Weak arguments fail to satisfy the Logic Condition and so are automatically ruled out as bad.

5. What is a Good Argument (II)?

Now that we've discussed the Truth Condition and the Logic Condition in more detail, we can state the conditions for an argument to be good with more precision than in our first attempt.

The Concept of a Good Argument

The basic concept is straightforward:

> **An argument is good if it offers its intended audience good reasons to accept the conclusion.**

What we've been trying to do in this lecture series is clarify what we mean by "good reasons". We broke it down into two different components, one relating to the truth of the premises, another relating to the logical relationship between the premises and the conclusion.

First Pass

Our first pass at a clarification of what "good reasons" means was stated in terms of two necessary conditions that must be fulfilled for the argument to count as good:

The Truth Condition:

The argument has all true premises

The Logic Condition:

The conclusion follows from the premises.

This is helpful, but it needed further analysis to clarify what we mean by "true" and what we mean by "follows from".

Second Pass

The last four lectures have introduced a set of concepts that let us articulate more clearly the conditions that an argument must satisfy for it to count as good:

The Truth Condition:

All the premises are *plausible* (to the intended audience)

The Logic Condition:

The argument is either *valid* or *strong*.

This is much more specific, and for purposes of argument analysis, much more helpful.

We use "plausible" to highlight the fact that a given premise might be regarded as true by one audience but as false by another, and what we want are premises that are regarded as true by the target audience of the argument. A **plausible** premise is one where the audience *believes it has good reason to think it's true, and so is willing to grant it as a premise*. This helps to distinguish a plausible premise from a reading of "true premise" that's defined in terms of correspondence with the objective facts. We'd like our premises to be true in this sense, but what really matters to argument evaluation is whether they're regarded as plausible or not by the intended audience of the argument.

We use "valid" and 'strong" to help specify precisely what we mean when we say that the conclusion *follows from* the premises. A **valid** argument is one where the conclusion follows with absolute certainty from the premises, where the truth of the premises logically necessitates the truth of the conclusion. A **strong** argument is one where the conclusion follows not with absolute certainty, but with some high probability. Together, these help to clarify what we mean when we say that an argument satisfies the Logic Condition.

Altogether, these definitions of plausibility, validity and strength give us a helpful set of tools for assessing the quality of arguments.

Review and Discussion Questions

In the lectures in "Part 2: What is a Good Argument?" we elaborated on the Truth Condition and the Logic Condition, distinguished between *valid*, *strong* and *weak* arguments, and between *deductive* and *inductive* arguments.

The questions below will help you review and test your understanding of these concepts. Some of them have clear answers, others are more open-ended and are meant to stimulate thought and discussion.

The Truth Condition

1. In this section we argued that the Truth Condition should really be viewed as a "plausibility" condition. What's the difference between saying that a claim is "true" and saying that it's "plausible"?

2. Give an example of a claim that might be *plausible* to a particular audience, but that (in your estimation) is nevertheless *false*.

3. Give an example of a claim that may *not* be plausible for a particular audience, but that (in your estimation) is nevertheless *true*.

4. Why is it *more important* to focus on the plausibility of a premise for a given audience, rather than the truth of the premise, when constructing persuasive arguments?

The Logic Condition

1. We say that an argument satisfies the Logic Condition if the conclusion "follows from" the premises. We also took a first step in unpacking what "follows from" means. What does it mean?

2. The most important point in this section is this: when we evaluate the logic of an argument, *we're not interested in the actual truth or falsity of the premises*. We're only interested in the logical relationship between the premises and the conclusion.

   What does this mean? How can we evaluate the logical relationship between the premises and the conclusion without considering the actual truth of the premises?

3. Give an example of an argument that has GOOD LOGIC but has at least one FALSE premise.

4. Give an example of an argument that has BAD LOGIC but has ALL TRUE premises.

Valid versus Invalid Arguments

1. What is the definition of a "valid" argument?

2. What is the definition of an "invalid" argument?

3. Give an *example* of a valid argument.

4. Give an *example* of an invalid argument.

5. Does it make sense to describe a *premise* as "valid" or "invalid"? Explain.

6. If an argument is *valid*, does that automatically make it a *good* argument?

7. If an argument is *invalid*, does that automatically make it a *bad* argument?

Part 3: Deduction, Induction and Scientific Reasoning

1. Deductive Arguments and Valid Reasoning

In this final series of lectures we're going to look at the distinction between **deductive** arguments and **inductive** arguments, and see how they relate to the concepts of validity and strength that we've previously introduced.

Both of these terms, "deductive" and "inductive", have a life outside of their usage in logic, and they can be used in different ways so it's helpful to be familiar with the various ways they're used.

In this lecture we'll look at the relationship between deduction and valid arguments.

Deduction and Valid Reasoning

In ordinary logic, the term "deductive argument" or "deductive inference" is basically a synonym for "valid argument" or "valid inference". The terms are often used interchangeably.

However, it's also common to describe an argument as a deductive argument even if the argument fails to be valid.

For example, someone might give an argument like this one:

1. If the match is burning then there is oxygen in the room.
2. The match is not burning.
Therefore, there is no oxygen in the room.

and they might *intend* for this argument to be valid. They believe the conclusion follows with certainty from the premises.

But in this case they've made a *mistake* — this argument isn't valid, it's invalid. Just because the match isn't burning it doesn't follow that there's no oxygen in the room.

So this is an invalid argument, but it was intended as a valid argument. In this case, we'll still want to call it a deductive argument, but it's *a failed deductive argument*, a deductive argument that is guilty of a formal fallacy, a mistake in reasoning.

So, while the terms "deductive" and "valid" are sometimes used interchangeably, they aren't strict synonyms.

- When you describe an argument as *valid* you're saying something about the logic of the argument itself.
- When you describe an argument as *deductive* you're saying something about the conscious intentions of the person presenting the argument, namely, that they are *intending to offer* a valid argument.

You need to draw this distinction in order for it to be meaningful to say things like "this is a valid deductive argument" or "this is an invalid deductive argument", which is a pretty common thing to say in logic.

2. Inductive Arguments and Strong Reasoning

In logic there's a close relationship between deductive and valid arguments, and there's a similar relationship between inductive and strong arguments.

In standard logic, the term "inductive argument" basically means "an argument that is intended to be strong rather than valid".

So, when you give an inductive argument for a conclusion, you're not intending it to be read as valid. You're acknowledging that the conclusion doesn't follow with certainty from the premises, but you think the inference is strong, that the conclusion is very likely true, given the premises.

Here's an example of a strong argument:

1. Most Chinese people have dark hair.
2. Julie is Chinese.
Therefore, Julie has dark hair.

We would call this an inductive argument because it's obvious that the argument is intended to be strong, not valid. Since the argument is in fact strong, it counts as a *successful* inductive argument.

And as with deductive arguments, we also want to be able to talk about *FAILED* inductive arguments, arguments that are intended to be strong but are in fact weak.

Like this one:

1. Most Chinese people have dark hair.
2. Julie has dark hair.
Therefore, Julie is Chinese.

Here we're supposed to infer that, simply because Julie has dark hair, she's probably Chinese. This is a weak argument.

But we still want to call it an inductive argument if the *intention* was for it to be strong. In this case the word "most" indicates that the inference is

intended to be strong rather than valid. We would call this a WEAK inductive argument.

So the terms “strong” and “inductive” have a relationship similar to the terms “valid” and “deductive”.

- To call an argument STRONG is to say something about the logical properties of the argument itself (that if the premises are true, the conclusion is very likely true).
- To call an argument INDUCTIVE is to say something about the INTENTIONS of the arguer (that the argument is intended to be strong).

3. Inductive Arguments and Scientific Reasoning

In the terminology of standard textbook logic an inductive argument is one that's intended to be strong rather than valid. But this terminology isn't necessarily standard outside of logic.

In the **sciences** in particular there is a more common reading of **induction** that means something like "**making an inference from particular cases to the general case**".

In this lecture we're going to talk about this reading of the term and how it relates to the standard usage in logic, and the role of inductive reasoning in the sciences more broadly.

The Standard Scientific Meaning of "Induction"

In the sciences the term "induction" is commonly used to describe inferences from particular cases to the general case, or from a finite sample of data to a generalization about a whole population.

Here's the prototype argument form that illustrates this notion of induction:

1. a_1 is B.
2. a_2 is B.
:
n. a_n is B.
Therefore, all A are B

You note that some individual of a certain kind, a_1, has a property B. An example would be "This swan is white".

Then you note that some other individual of the same kind, a_2,has the same property — "This OTHER swan is white".

And you keep doing this for all the individuals available to you this. THIS swan is white, and THIS swan is white, and THIS SWAN OVER THERE is white, and so on.

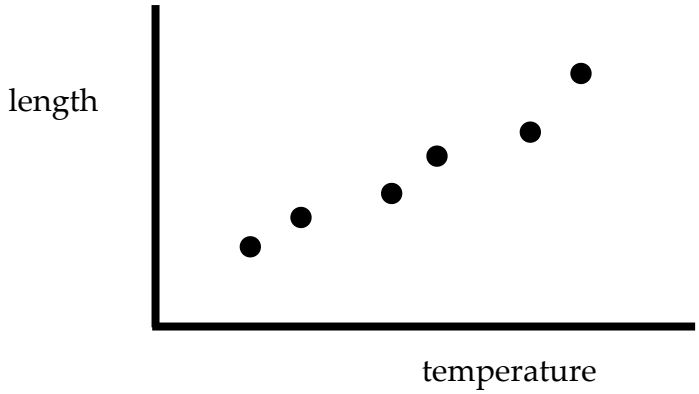
So you've observed n swans, and all of them are white. From here the inductive move is to say that ALL swans, EVERYWHERE are white. Even the swans that you haven't observed and will never observe.

This is an example of an **inductive generalization**.

Arguments of this form, or that do something similar — namely, infer a general conclusion from a finite sample — exemplify the way the term "induction" is most commonly used in science.

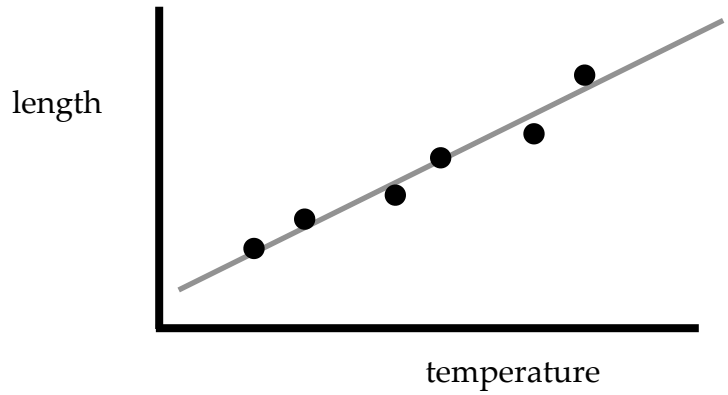
Another example that illustrates inductive reasoning in this sense is the reasoning involved in inferring a functional relationship between two variables based on a finite set of data points.

Let's say you heat a metal rod. You observe that it expands the hotter it gets. So for various temperatures you plot the length of the rod against the temperature. You get a spread of data points that looks like this:



What you may want to know, though, is how length varies with temperature generally, so that for any value of temperature you can then predict the length of the rod.

To do that you might try to draw a curve of best fit through the data points, like so:

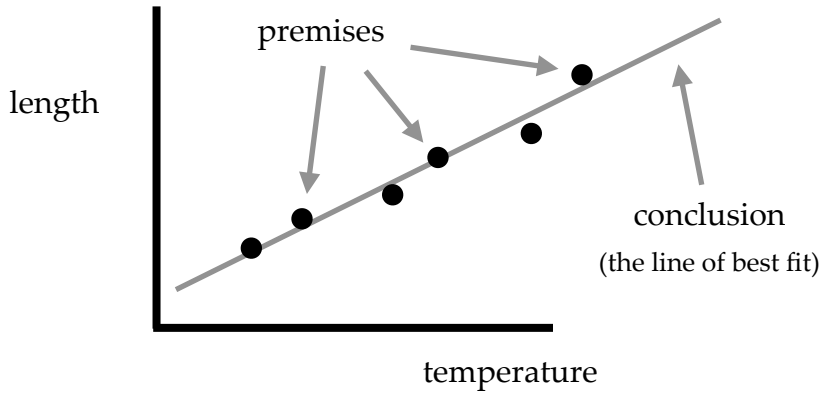


It looks like a pretty linear relationship, so a straight line with a slope like this seems like it'll give a good fit to the data.

Now, given the equation for this functional relationship, you can now plug in a value for the temperature and derive a value for the length.

The equation for the straight line is an inductive generalization you've inferred from the finite set of data points.

The data points in fact are functioning as **premises** and the straight line is the general **conclusion** that you're inferring from those premises.



When you plug in a value for the temperature and derive a value for the length of the rod based on the equation for the straight line, you're deriving a prediction about a specific event based on the generalization you've inferred from the data.

This example illustrates just how common inductive generalizations are in science, so it's not surprising that scientists have a word for this kind of reasoning.

In fact, the language of induction used in this sense can be traced back to people like Francis Bacon who back in the 17th century articulated and defended this kind of reasoning as a general method for doing science.

Scientific vs Logical Senses of Induction

So how does this kind of reasoning relate to the definition of induction used in logic?

Recall, in standard logic an argument is inductive *if it's intended to be strong rather than valid.*

The key thing to note is that **this is a much broader definition than the one commonly used in the sciences**. *That* definition focuses on arguments of a specific form, those where the premises are claims about particular things or cases, and the conclusion is a generalization from those cases.

But if you take the standard logical definition of an inductive argument you find that *many different kinds of arguments* will qualify as inductive, not just arguments that infer generalizations from particular cases.

So, for example, on the *logical* definition, a prediction about the future based on past data will count as an inductive argument.

1. The sun has risen every day in the east for all of recorded history.
Therefore, the sun will rise in the east tomorrow.

The sun has risen every day for as long as the earth has existed, as far as we know. So we expect the sun to rise tomorrow as well.

This is an inductive argument on our definition because we acknowledge that even with this reliable track record it's still possible for the sun to not rise tomorrow. Aliens, for example, might blow up the earth or the sun overnight.

So this inference from the past to the future is inductive, and most of us would say that it's a strong inference. *But notice that it's not an argument from the particular to the general*. The conclusion *isn't* a generalization, it's a claim about *a particular event*, the rising of the sun tomorrow.

So this kind of argument wouldn't count as inductive under the standard science definition, but it does count under the standard logical definition.

Here's a second example that illustrates the difference:

1. 90% of human beings are right-handed.
2. John is a human being.
Therefore, John is right-handed.

Notice that the main premise is a general claim, while the conclusion is a claim about a particular person. On the standard *science* definition this *isn't* an inductive argument, since it's moving from the *general* to the *particular* rather than from the particular to the general. But on the *logical* definition of induction this argument *does* count, since the argument is intended to be strong, not valid.

The relationship between the two definitions is a relation of set to subset. The arguments that qualify as inductive under the standard science definition are a *subset* of the arguments that qualify as inductive under the standard logical definition.

So from a logical point of view there's no problem with calling an inference from the particular to the general an inductive argument since all such arguments satisfy the basic logical definition.

But scientists are sometimes confused when they see the term "induction" used to describe other forms of reasoning than the ones they normally associate with inductive inferences. There shouldn't be any

confusion as long as you keep the two senses in mind and distinguish them when it's appropriate.

But if you don't distinguish them then you may run into discussions like this one that contradict themselves. Below are the first two senses of the Wikipedia entry on "induction" at the time this lecture was first written (2010):

> Induction or inductive reasoning, sometimes called inductive logic, is the process of reasoning in which the premises of an argument are believed to support the conclusion but do not entail it, i.e. they do not ensure its truth. Induction is a form of reasoning that makes generalizations based on individual instances.

The first sentence presents the standard *logical* definition — inductive reasoning is defined as strong reasoning, reasoning that doesn't guarantee truth. The second sentence presents the standard *science* definition of induction, defining it as reasoning from the particular to the general.

Later on in the article the authors present a number of examples of inductive arguments that satisfy the logical definition but not the scientific definition, such as inferences from correlations to causes, or predictions of future events based on past events, and so on. These examples flat out contradict the definition of induction in the second sentence[2].

Summary

Now let's summarize some key points of this discussion.

First, we should be aware that there is a difference between the way the term "induction" is defined in general scientific usage and the way it's defined in logic. The logical definition is much broader — it's basically synonymous with "non-deductive" inference. The scientific usage is narrower, and focuses on inferences from the particular to the general.

Second, induction in the broader logical sense is fundamental to scientific reasoning in general. Inductive reasoning is risky reasoning, it's

2. Update: The Wikipedia entry at the time of this writing (2013) is now called “inductive reasoning” and has been significantly improved.

fallible reasoning, where you're moving from known facts about observable phenomena, to a hypothesis or a conclusion about the world beyond the observable facts.

The distinctive feature about this reasoning is that you can have all the observable facts right, and you can still be wrong about the generalizations you draw from those observations, or the theoretical story you tell to try to explain those observations. **It's a fundamental feature of scientific theorizing that it's revisable in light of new evidence and new experience.**

It follows from this observation that **scientific reasoning is broadly speaking inductive reasoning** — that scientific arguments should aim to be strong rather than valid, and that it's both unrealistic and confused to expect them to be valid.

Disciplines that trade in valid arguments and valid inferences are fields like mathematics, computer science and formal deductive logic. The natural and social sciences, on the other hand, deal with fallible, risky inferences. They aim for strong arguments.

Review and Discussion Questions

In the lectures in "Part 3: Deduction, Induction and Scientific Reasoning" we introduced the distinction between *deductive* and *inductive* arguments, how these concept related to *valid* and *strong* reasoning (respectively), and elaborated on the differences in how logicians and philosophers think of induction, and how scientists (often) think of induction.

The questions below will help you review and test your understanding of these concepts. Some of them have clear answers, others are more open-ended and are meant to stimulate thought and discussion.

Deductive Arguments and Valid Reasoning

1. In this section we distinguished between *valid* arguments and *deductive* arguments. What is the distinction, and why do we have to make it?

Inductive Arguments and Strong Reasoning

1. In this section we distinguished between *invalid* arguments, *strong* arguments and *inductive* arguments. What is an inductive argument? How is calling an argument "inductive" different from calling it "strong"?

Inductive Arguments and Scientific Reasoning

1. In the ***scientific*** literature an "inductive argument" is often interpreted as an argument that ***draws a general conclusion from a finite sample of data***.

   e.g. "Mercury, Venus, Earth and Mars move in elliptical orbits around the sun. Therefore, it is very likely that *all the planets in the solar system* move in elliptical orbits around the sun."

   This kind of inference is sometimes called an "inductive generalization".

   Question: How does this definition of induction differ from the *logical definition* we introduced in the *previous* section?

2. The set of arguments that satisfies the logical definition of induction INCLUDES the set of arguments that satisfies the scientific definition. Use the example above to explain why this is the case.

3. In this section we claimed that in general, *scientific reasoning is inductive reasoning*. Why did we say this?

4. The fictional detective Sherlock Holmes is often described as having tremendous powers of "deductive reasoning". He is often able to discern facts about a person that amaze the people he speaks with. Consider the following example[3]:

> "From South Africa, sir, I perceive."
> "Yes, sir," he answered, with some surprise.
> "Imperial Yeomanry, I fancy."
> "Exactly."
> "Middlesex Corps, no doubt."
> "That is so, Holmes, you are a wizard."
> I smiled at his bewildered expression.
> "When a gentleman of virile appearance enters my room with such tan upon his face as an English sun could never give, and with his handkerchief in his sleeve instead of his pocket, it is not difficult to place him. You wear a short beard, which shows that you were not a regular. You have the cut of a riding-man. As to Middlesex, your card has already shown me that you are a stockbroker from Throgmorton Street. What other regiment would you join?"
> "You see everything."
> "I see no more than you, but I have trained myself to notice what I see."

Question: Using our definitions of these terms, is it accurate to describe what Holmes is doing here as "deductive reasoning"? Explain.

3. "The Adventure of the Blanched Soldier", Sir Arthur Conan Doyle, 1926.