Notes on types of Arguments (for Philosophy of Science) – by Justin C. Fisher

1. Arguments

An ***argument*** is a set of statements (called "premises") offered in support of a conclusion. Philosophers typically write the premises first, then a horizontal line, then the conclusion.

1. Any set of statements offered in support of a conclusion is an argument. **2.** This is a set of statements offered in support of a conclusion.	Premises
C. So, this is an argument.	Conclusion

An argument's conclusion is often the most controversial claim in the argument. The job of the premises is to ease people into accepting the conclusion. Conclusions are often indicated by words like "therefore", "thus", "hence" or "so."

To be good, an argument must have true premises and the premises must offer support for the conclusion. The strongest possible support would provide an absolute guarantee that the conclusion will be true (presuming, of course, that the premises are true). We'll consider that sort of support first, but then move on to consider some weaker sorts of support as well.

2. Deductively Valid Arguments

One especially useful sort of argument is a ***deductively valid argument****.* (This is often abbreviated as "valid argument" or sometimes as "deductive argument".[1]) Deductively valid arguments are arguments in which the premises, if true, would be the strongest possible evidence that the conclusion is true. Indeed these arguments provide the following guarantee: *if the premises are true, then the conclusion must be true as well*.

To understand this guarantee, it may help to consider an analogy. Suppose the SmoothieMaster 2000 comes with a guarantee: *if you put only edible ingredients in, then you'll get an edible smoothie out.* This guarantee tells you that if you put ordinary edible ingredients like bananas, strawberries and yogurt in, then the resulting smoothie will be edible. It also tells you that if you put in stranger, but still edible, ingredients – things like cauliflower, jelly beans, and walnuts – you'll also get an edible smoothie out.

However, as soon as you put in a single inedible ingredient, the SmoothieMaster's guarantee no longer tells you what to expect – all bets are off. When you put in inedible ingredients, you *might* get lucky and end up with an edible smoothie. Cardboard is pretty inedible, but maybe the SmoothieMaster will break it down into something edible. Rat poison is also inedible, but if you mix in the antidote too, you might still end up with an edible smoothie. Perhaps more often, if you put any inedible ingredients in, the SmoothieMaster might generate a smoothie that isn't edible. If you drink an arsenic, staples, and toenail-clippings smoothie, you'll likely find it quite inedible. When this happens, you'll have no right to complain, because SmoothieMaster's guarantee doesn't say anything at all about what will happen if

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[1] Some people use the label "deductive" to include all arguments that are put forward as being deductively valid, even if they actually aren't. For example, consider this argument: "If LeBron was injured, then he lost. He lost. Therefore LeBron was injured." At first glance, this argument might look valid, but it actually isn't. (LeBron might have lost for some other reason, so there's no guarantee that he was injured, even if the premises are true.) Still, many people would count this as a "deductive" argument, just an "invalid" one.

any of your ingredients aren't edible. If you want to sue SmoothieMaster for false advertising, you'll need to have put only edible ingredients in.

The guarantee for deductively valid arguments works in very much the same way as did the guarantee for the SmoothieMaster 2000. Both of these guarantees say that, if you put only good stuff in, then you'll get good stuff out. In the case of valid arguments, premises are the "stuff" you're putting in, and premises count as "good stuff" when they're true.

What is it for a statement to be ***true***? Here are three quick answers. A statement is true if it says something that an all-knowing god would know. A statement is true if the right answer to put next to it on a true/false exam is T. A statement is true if, when you turn it into a yes/no question, the right answer is "yes". For example, to decide if you think the statement "The earth is round" is true, you could ask yourself, "Is the earth round?", and if your answer is "yes" then you think it's true that the earth is round. Whether this statement *actually is* true depends upon whether the earth actually is round, and not upon whether people think the earth is round. Thousands of years ago, nobody thought the earth was round, but even then, it was true that the earth was round.

So the guarantee on valid arguments tells us, if we put only true premises in, then we'll get a true conclusion out. What if one or more of our premises aren't true? This is just like the case where we put rat poison in the SmoothieMaster – all bets are off. Maybe you'll get lucky, and have a true conclusion, despite having false premises – people sometimes make bad arguments for good conclusions. But perhaps more often, an argument with one or more false premises might have a false conclusion too. Once again, when this happens, you can't fault the *validity* of the argument, for *validity* is just a guarantee that *if the premises were true,* the conclusion would have to be true. Validity doesn't tell you anything at all about what will happen in cases where one or more of the premises aren't true.

Validity depends only upon the way in which the premises are connected to the conclusion, and not upon whether the premises are actually true. Consider the following argument:

1. Obama florgs.

2. Everything that florgs is a rogon.

C. So Obama is a rogon.

Hopefully, after you examine this argument for a moment, you'll see that this argument is valid: *if* the premises of this argument are true, then (guaranteed) the conclusion has to be true as well – there's no way that Obama could fail to be a rogon if it's true (1) that he florgs and (2) that everything that florgs is a rogon. You can see that this argument is valid without even knowing what the words "florg" and "rogon" mean, much less knowing whether the premises are actually true. E.g., maybe "florgs" means "floats at the bottom of the ocean" and "rogon" is a sort of jellyfish. If that's what those words mean, then the premises and conclusion of our argument are false, but that doesn't stop our argument from being valid. Valid arguments can have almost any combination of true or false premises and true or false conclusions. The only combination a valid argument can never have is all true premises yet a false conclusion – valid arguments come with a guarantee that you'll never get this combination.

You can show that an argument is *invalid* the same way that you would go about suing SmoothieMaster for false advertising. You'd need to find a case where the advertised guarantee doesn't hold up: a case where you could put only good stuff in, and yet would get a bad result out. If you can find a possible combination of edible ingredients that yields an inedible smoothie, then you can take SmoothieMaster to court. And if you can find a possible scenario in which all the premises of an argument would be true, but its conclusion false, then you'll know that argument isn't deductively valid.

Let's practice this ***first test for invalidity*** on the following argument.

1. All great singers look hot.

2. Robin Thicke looks hot.

C. So Robin Thicke is a great singer.

To decide whether this argument is valid or not, we want to try to imagine a scenario in which the premises are true, but the conclusion is false. One way to do this would be to describe some possible world starting from scratch, perhaps completely different from our own. Another (often easier) way to do this is to start with our world, and simply imagine what sorts of changes we'd need to make in order to make the premises true and the conclusion false.

What would we have to change about our world in order to make premise 1 true? Well, somehow, we'll need to "take care of" all the great singers who don't look hot. We could give them extreme makeovers so they would look hot or we could stop them from being great singers. A simple (but drastic) solution would be to kill off any great singers who don't look hot. Well, all of them except for Robin, anyway, because we need him for premise 2.

What would we need to do to make premise 2 true? This depends on how Robin looks already. Perhaps he looks hot already. Or perhaps he'll need a diet, exercise, makeup, and/or surgery to look hot. We should imagine doing whatever it takes to make Robin look hot.

So now we've imagined how to make both the premises true. Now we need to go one step further, and imagine how the conclusion could be false (while still keeping the premises true). To make the conclusion false, we'd somehow need to ensure that Robin isn't a great singer, without stopping him from looking hot (because he needs to look hot for premise 2 to be true). You can probably imagine lots of ways to stop someone from being a great singer without affecting his appearance, but a simple one would be just to remove his vocal cords.

Now we've imagined exactly the sort of scenario we need. We killed off all the ugly great singers, so premise 1 is true. We've given Robin a makeover so premise 2 is true. But we've removed his vocal cords so conclusion C is false. In this imagined scenario, the premises would be true, but the conclusion false. This tells us that this argument provides no guarantee that true premises will yield a true conclusion. And this means the argument is <u>not valid</u>.

What if you can't imagine a scenario where the premises of an argument would be true and its conclusion false? Well, one possibility is that the argument really is valid – for a valid argument you'll never be able to come up with such a scenario. But another possibility is that you just haven't tried hard enough yet. Until you're sure you've considered all the relevant possibilities, you won't be able to be sure an argument really is valid.

Here's a ***second test*** you can use if you aren't sure whether an argument is valid. Whether an argument is valid or not depends only on its *logical structure* and not on the particular people or things it happens to be about. This means that we can substitute in other people or things without changing an argument's validity. Sometimes making these substitutions helps make it easier to tell whether an argument is valid. This test can be especially useful when you're considering an argument whose conclusion you agree with. It's usually a lot easier to see problems in an argument whose conclusion you don't agree with, so it's often a good idea to try out a substitution that turns the conclusion into one you don't agree with, and see if the argument still looks valid.

Let's try this test on the above argument about Robin. One substitution you could make is to replace Robin with someone who looks hot but clearly isn't a great singer. Let's pretend Vinn Diesel is somebody like that. So let's go through the original argument and substitute in Vinn Diesel everywhere Robin appeared:

1. All great singers look hot.

2. Vinn Diesel looks hot.

C. So Vinn Diesel is a great singer.

This new argument has exactly the same logical structure as the original argument. This means the new argument is just as valid (or just as invalid) as the original was. Even if you thought Robin was a great singer, it now should be easier to see that the argument isn't valid. Even if all great singers look hot (as premise 1 says), and even if Vinn looks hot (as premise 2 says), this provides no guarantee that Vinn is even a singer at all, much less a great one. Thus the Vinn argument is clearly not valid. Since the Robin argument had exactly the same structure, it can't have been valid either.

We can do substitutions like this on other terms or phrases besides names. For example, here's what we get if we substitute "female stripper" for "great singer" in the original argument.

1. All female strippers look hot.

2. Robin Thicke looks hot.

C. So Robin Thicke is a female stripper.

This new argument also has exactly the same logical structure as the original argument, so it too is just as valid (or invalid) as the original. But after this substitution it should be very clear that the premises of this argument don't guarantee that the conclusion is true. Premise 1 tells us all members of some category look hot. Premise 2 tells us that Robin looks hot too, but it doesn't tell us whether he's a member of that category, or whether he might instead just be someone else who looks hot. This is why the premises can't guarantee that the conclusion is true. This becomes especially clear once we think of the category in question as “female strippers” rather than as one that it was somewhat more believable that Robin might belong to (“great singers”).

Sometimes an extreme version of this substitution test is useful. In this extreme version, we substitute in simple letters for as many words as we can in the argument. We can do this for most names, nouns, and adjectives, but *not* for logical terms like ‘all’, ‘some’, ‘and’, ‘or’, ‘if’, ‘then’, ‘not’, ‘the’, ‘a’, ‘is’ or ‘are’. Here’s what we get if we substitute ‘S’ for ‘great singer’, ‘H’ for ‘looks hot’ and ‘R’ for Robin.

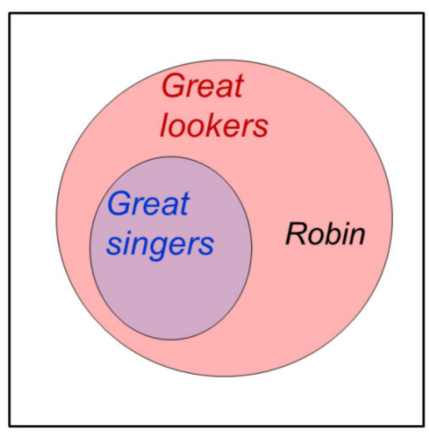
1. All S’s are H’s.

2. R is an H.

C. So R is an S.

This is the underlying logical form of the original Robin argument (and also of the Vinn argument, and of the female strippers argument). For some people, seeing this pure logical form is initially confusing. But with a little practice, you can get used to thinking about the logical form of an argument and seeing whether or not the premises really can guarantee that the conclusion is true. Looking at an argument this way often helps to simplify it and to keep us from getting distracted by any background beliefs we might have had about Robin or singers or whatever. In our class, we won’t do much that requires looking at pure logical forms like this, but it can be a very useful skill to develop, and if you go on to take a class in logic (in philosophy, math, or computer science), you’ll end up spending a lot of time working with logical forms like this.

A ***third way of testing for invalidity*** is to use Venn diagrams to map out different ways that the things discussed in the argument might be, and to find some possible way that the premises could be true but the conclusion false. A ***Venn diagram*** displays many different possible things as points in a two-dimensional space, and displays properties or groupings of things by drawing an outline around them.

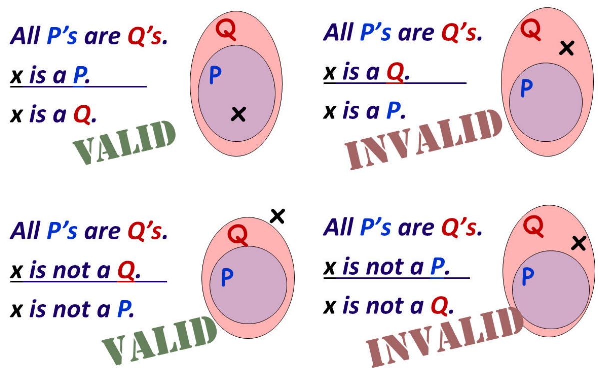


In the Venn diagram to the right, you could imagine all the people in the world as tiny little points crammed into that square. All the great looking people are herded together into the larger circle, while all the ugly people are in the white area outside of it.

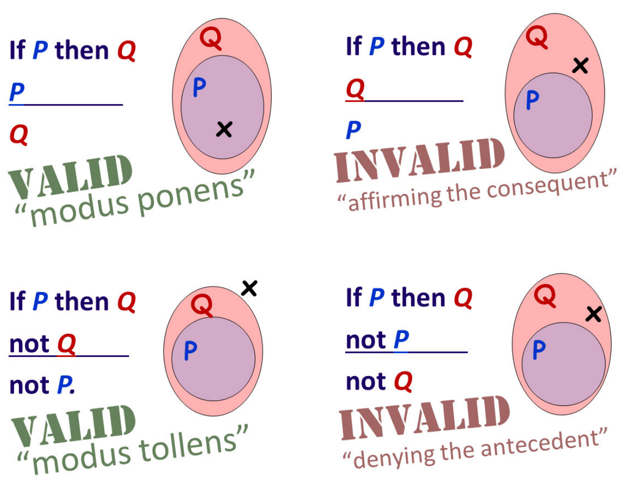
Similarly, all the great singers are together inside the smaller circle, and all the tone-deaf people are somewhere outside of it. Premise 1 of our argument claimed that all the great singers are also great lookers. The only way that this could be true is if the smaller circle is entirely contained within the larger circle, so that’s why I drew it that way in the diagram. Remember we’re trying to draw the diagram in such a way that the premises will be true, but the conclusion false.

Premise 2 of our argument told us that Robin is a great looker. This means that wherever Robin is in the diagram, he’ll need to be somewhere within the larger circle, but premise 2 doesn’t tell us *where exactly* Robin will be. Premise 2 allows that Robin might be inside both circles, one of the lucky people who is both a great singer and a great looker. But Premise 2 also leaves open the possibility that Robin might instead be where I put him in the diagram, within the larger circle of great lookers, but not within the smaller circle of great singers. The way I drew the diagram, both of the premises would be true (all the great singers are great lookers, and Robin is a great looker) but yet the conclusion would be false (Robin wouldn't be a great singer). That shows us that the truth of the premises is not enough to guarantee that the conclusion will be true too, so this argument must be invalid.

Here are four common argument types, together with Venn diagrams showing why they are valid or invalid. You'll notice that our Robin argument was the upper-right-hand type.



Each of these arguments used a ***containment premise*** of the form "All P's are Q's". Other common forms of argument instead use ***conditional premises*** of the form "If P then Q". It turns out that conditional arguments are equivalent to containment arguments, so we can use Venn Diagrams to evaluate their validity too. To do this, we'll need to think about all the tiny points in the diagram as representing possible ways the world could be. The conditional "If P then Q" is equivalent to the containment claim "All ways that P could be true are also ways that Q would also be true." In a Venn Diagram this would show up as the same nested circles that we saw in the arguments above. Below I've listed some common conditional arguments, re-using the same Venn diagrams as above. Each of these is valid or invalid for basically the same reason as the corresponding containment argument was.



Each of these conditional arguments occurs often enough that philosophers have come up with names for them, like "modus ponens", also included in the above diagrams. The arguments on the right are known as ***logical fallacies*** because they aren't actually valid.

Two of these conditional arguments are especially relevant in Philosophy of Science. In both of them we will suppose that P is some scientific hypothesis, and Q is some prediction that that hypothesis makes. Since hypothesis P predicts Q, we have the conditional premise "If P then Q" – i.e., any way that hypothesis P could turn out to be true would be a way in which its prediction Q is also true. In one argument, we'll suppose that the prediction Q turns out to be true; in the other we'll suppose it turns out to be false.

When hypothesis P predicts Q, and that prediction comes *true*, that might make you inclined to conclude that hypothesis P was true. This is the upper right-hand argument, the one labeled "affirming the consequent". (The ***consequent*** of a conditional is the clause after the "then", in this case Q. The second premise of this argument ***affirms*** that Q is true. The ***antecedent*** is the clause that comes after the "if", in this case P. Technically, we could have labeled *modus ponens* "affirming the antecedent" and *modus tollens* "denying the consequent" but philosophers still use the Latin names for these instead. Maybe they think it makes them sound smarter.) However, this form of argument is not deductively valid, because it could be that Q happened for some other reason, without P being true. E.g., it could be that the way things actually are is the way marked by an X in the diagram. If that's how things are then the two premises would still be true: any way that P could be true would still be a way that Q would be true, and the way things actually are would be a way that Q would be true. But the conclusion could still be false: Q could be true in some other way, not in a way that would make P be true too. It might help to imagine someone with a really dumb hypothesis that still happens to make a few good predictions. This illustrates the very important idea that, ***even if a hypothesis' predictions came true, this isn't enough to guarantee that the hypothesis itself is true.*** To think otherwise is make the fallacy of *affirming the consequent*.

Second, let us consider the case in which hypothesis P predicts that Q will be true, but instead it turns out that Q is false. When a hypothesis' prediction turns out to be false, you might therefore be inclined to conclude that the hypothesis itself must have been false too. This is the lower-left argument type, the one labeled *modus tollens*. This form of argument is valid. If it really is true that (1) the only way P can be is if Q is true too, but (2) Q isn't true, then that is enough to guarantee the conclusion that P isn't true either. The philosopher of science Karl Popper thought that this sort of use of *modus tollens* was the primary form of scientific reasoning. Popper thought that successful predictions can never prove a hypothesis *true* (as we saw above, this would be affirming the consequent), but failed predictions actually can prove that a hypothesis is false. (In class we'll consider some objections to Popper's view including the Quine-Duhem problem. Quine and Duhem object to the conditional premise "If P then Q". Without that premise, Popper obviously wouldn't be able to make a *modus tollens* argument.)

3. Sound Arguments

We noted above that a valid argument might have false premises, and if it does have false premises, then it might also have a false conclusion (much as the Smoothie Master can have inedible ingredients put into it, and if it does, then it might yield an inedible smoothie). However, philosophers often talk about a special sort of valid argument, a valid argument with true premises. In order for an argument to count as ***sound***, an argument needs to meet two criteria. (#1) Every sound argument is valid. And (#2) the premises of a sound argument need to actually be true.

It follows from these two criteria that (#3) every sound argument also has a true conclusion. Remember that (#1) every sound argument is valid, which means every sound argument comes with a guarantee that, if its premises are true, then its conclusion has to be true as well. To count as sound, an argument also needs (#2) to have true premises. This means that the validity guarantee from (#1) will kick in, so (#3) every sound argument is guaranteed to have a true conclusion as well.

To show that an argument is *not* sound, you could show that it fails to meet one of these criteria: (#1) you could show that the argument isn't valid, perhaps by using the two tests for validity we talked about above, and/or (#2) you could show that at least one of the premises isn't true. In theory, you could also (#3) show that the argument's conclusion is false, as that would be enough to show that the argument is not sound. However, any argument that has a false conclusion must also fail to meet either criterion #1 and/or criterion #2, so if you want to convince someone who likes an argument that it actually isn't sound, you'll often have more luck trying to convince them that it isn't valid or that one of the premises isn't true, rather than just trying to convince them that their conclusion is false without explaining how or why their argument fails.

This discussion helps to reveal why valid arguments are often very useful. Once someone puts forward a valid argument, there are only three ways to respond.

#1. You could argue that the argument isn't actually valid after all.

#2. You could argue that one or more of the premises isn't true.

#3. Or you can accept that the conclusion of the argument is true.

If you don't take option #1 or option #2, then you'll have to admit that the argument is sound, and hence that it has a true conclusion. If the person making the argument was careful to give a valid argument, then your only real way of resisting the argument will be to reject one of the premises. Deciding which premise to reject can help to make more clear exactly what you and the person making the argument disagree about, and sometimes this can help point the way towards resolving your disagreement, at least if you can agree on some way to determine whether that premise is true or false.

For example, suppose an opponent of abortion makes the following argument:

1. Abortion kills something with a beating heart.

2. It is wrong to kill something with a beating heart.

C. So abortion is wrong.

This argument seems to be valid, so the "pro-choice" advocate probably needs to reject either premise 1 or premise 2 (or both). If the "pro-choicer" questions premise 1, this disagreement might potentially be resolved by talking to doctors, or even by using equipment to listen for a heartbeat in embryos. If the "pro-choicer" instead questions premise 2, that might lead us to think more carefully about how we treat other creatures with beating hearts, including the many animals that people kill for food. Perhaps we'll end up deciding that it is indeed wrong to kill all such creatures, and that we should therefore ban both abortion and killing animals for food. Or perhaps we'll decide that killing creatures with beating hearts isn't necessarily so bad after all, which would then force the opponent of abortion to seek a different argument against abortion or to decide that perhaps abortion isn't that bad after all.

Regardless of which way this ends up working out, considering this valid argument helps both sides to better understand their disagreement, and might even help them resolve it.

Although valid arguments can be very useful, they also suffer significant drawbacks. We'll talk about two. First, it's often very difficult to find premises that are sufficient to guarantee that a controversial conclusion is true, but aren't equally controversial themselves. The best you can usually hope to do is to find premises that are each less controversial than the conclusion you're trying to establish, and ideally to splinter your opponents into different groups that disagree about which premise they should reject.

Second, as a general rule, valid arguments cannot draw simple conclusions[2] about anything that wasn't already mentioned somewhere in the premises. The reason for this is that the premises of a valid argument need to guarantee that their conclusion will be true, but they can't really do that if they don't even mention the things that the conclusion is about. This drawback means that valid arguments often can't do the work that we would like arguments to do.

Consider, for example, the conclusion that electrons exist. Our reasons for believing in electrons have to do with various observations that make a lot more sense if we believe electrons are causing them. It starts to makes sense that the light bulb glows when we close the switch if we suppose that tiny electrons move through the closed switch and make the filament in the light-bulb glow. Similarly, transfer of electrons help us to explain why, if you rub a balloon on your hair, the balloon will then stick to the wall. Notice that our observations here (bulbs glowing when we flip switches, balloons being rubbed on hair and then sticking to the wall) do not mention electrons at all. This means these observations are not enough to guarantee that electrons actually do exist – it could be that something other than electrons is making the bulbs glow and the balloons stick. What makes us believe in electrons isn't a valid argument. Instead, if we want to use observations of one thing (like glowing bulbs) to draw conclusions about something else (like electrons), we'll need a different sort of argument. [In this case, an *abductive* argument would probably work. We'll talk about that later.]

Consider another example. Scientists often try to draw *general* conclusions, e.g., about how a drug will work in *all* patients, or how strong gravitation is for *all* planets. But scientists don't have time to check the drug in all patients, or to go visit all the planets and see whether gravitation works the same way at all of them. It could turn out that, even though a drug worked fine in the patients we tried it on, it still would cause complications in other patients. It could also turn out that gravitation works a bit differently in some parts of the universe. At any rate, nothing about the things we've observed *guarantees* that things won't turn out this way. These are further examples of scientific conclusions that probably can't be supported just by deduction. [In these cases, *induction* would probably work. That's our next topic.]

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[2] There are ways to use deductive arguments to draw logically *complex* conclusions that mention things that weren't mentioned in the premises. E.g., any premises that compose a deductively valid argument for the conclusion "I have hair" would also compose a deductively valid argument for the conclusion "Either I have hair or God hates ice cream" even if those premises don't even mention God or ice cream. This is because all it takes to guarantee that a disjunction (that's philosopher-speak for "or"-statement) is true is to guarantee that *one* of the disjuncts is true (e.g., "I have hair"), so that leaves us free to pack whatever we want into the other disjunct without threatening the validity of the argument. However, we can't do this if the conclusion is simple, and hence doesn't contain anything like "or". (Other words that can generate complex conclusions and thereby sometimes enable us to sneak new concepts into the conclusions of valid arguments include "unless" and "if".)

4. Inductive Arguments

Here is an example of an inductive argument.

> **P1.** The 12 swans I've seen have all been white.
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> **C1.** Therefore all swans are white.

This argument starts with a ***sample***: the 12 swans that I have seen. It notes that the members of this sample each have the same ***trait***: whiteness. This argument generalizes from the sample, and concludes that the same trait will also be possessed by a ***target group***: all the swans in the world. Since all the swans in our sample had the trait of being white, we're concluding that the all the swans in the target group will (probably) have this trait too.

In general, ***Inductive arguments*** are arguments whose premises note that some ***trait*** is possessed by the things in some ***sample***, and whose conclusion then generalizes from that sample to say that similar traits would be possessed by the thing(s) in some ***target*** group.

Inductive arguments are one of our most common ways of supporting expectations about the future.

> **P2.** The sun has risen every day of my life so far.
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> **C2.** So the sun will rise tomorrow.

Here, the ***sample*** is all the days in my life up until now, the ***target*** that I'm generalizing to is tomorrow, and the ***trait*** that is being generalized is the trait of having the sun rise. Since other days had the sun rise, we're concluding that tomorrow will probably have the sun rise too.

Another common sort of inductive argument involves polls.

> **P3.** 60% of the voters I polled prefer Hilary over Rick.
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> **C3.** So 60% of all voters prefer Hilary over Rick.

Here the ***sample*** is composed of the voters that were polled, and the ***target*** is the set of all voters. In this case it's a bit trickier to say exactly what ***trait*** is being generalized, but it's something like *having a 60% chance of preferring Hilary over Rick*. When we're talking about probabilistic traits like this, we can also use induction to generalize from a sample to a subset of that sample, or even to a single member of the sample.

> **P4a.** 90% of black voters voted for Obama.
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> **P4b.** Alfonso is a black voter.
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>
> **C4.** So there is a 90% chance that Alfonso voted for Obama.

Like deductive arguments, inductive arguments re-use key terms or concepts in the conclusion that were also there in the premise, especially terms for whatever trait is being generalized from the sample to the target. However, inductive arguments typically draw a conclusion about a target that differs from the sample, and often wasn't even included in the sample. Because of this, inductive arguments typically can't *guarantee* that the conclusion will be true even if all the premises were true, so inductive arguments typically aren't valid.[3] There is typically some risk that an inductive argument might yield a false conclusion even if all the premises were true. Even if the hundred people the pollster called all happened to support Hilary, it could still be that a majority of the other voters in the electorate actually prefer Rick. Inductive arguments typically provide *some reason* to believe that a conclusion is *probably* true, but they typically don't provide any *guarantees*.

Here are three tests that are useful in judging the strength of an inductive argument.

Test #1. How large is the sample? Size matters, at least when it comes to inductive arguments. A poll of 1000 voters is a much better predictor of election outcomes than a poll of just 10 voters.

Test #2. How representative is the sample of the target? For most inductive arguments, the ideal would be to have an ***unbiased sample*** – a bunch of randomly chosen things drawn from the target group, where each member of the target group had an equal chance of being included in the sample. When you instead have a ***biased sample*** inductive arguments will be weaker.

For example, many political pollsters generate their sample by calling land-line telephones. This sample is biased, because not everybody is equally likely to get called. Some voters don't have a phone at all. Some voters have only a cell-phone so can't be reached by land-line. Some voters have land-lines but aren't home in the evenings when pollsters typically call. Furthermore, the way in which this sample is biased actually makes it much more likely to include Republicans rather than Democrats, because Republicans tend to be older, to go out less in the evenings, and to have land-lines rather than cell-phones or no phones at all. Because of these biases, raw percentages drawn from telephone polls often don't do very well at predicting actual percentages at the voting booth. Most political polls you see on TV don't simply report raw percentages of the people they sampled, but instead smuggle in lots of sophisticated corrections trying to cancel out the well-known biases that are inherent in using telephones for polling, as well as other biases involving the fact that some people who answer their phone are more likely to go vote than others. When you sometimes hear pundits trying to "unskew"

[3] In the case where 100% of the sample have a trait, and the target is completely included in the sample, then there is a guarantee that the target will have the trait too. There is also a form of argument called "mathematical induction" which does guarantee that the conclusion will be true if the premises are true. To make an argument by mathematical induction, you need to show (base case) that some claim holds for the first member of a series, and (inductive step) that, *if that claim holds for* some arbitrarily chosen member of the series, then it will also hold for the next member (if there is one). If you can show both of those things, that is enough to guarantee that the claim will hold for every single member of the series. For example, suppose we want to prove that domino #43 in a chain of dominoes will fall. To show this, we could show (base case) that the domino #1 will fall, e.g. because we pushed it, and (inductive step) that, for any value of N, if domino #N falls, then domino #N+1 will fall too, e.g., because we can see that all the dominos are spaced close enough together that each would knock the next down. Those two premises are enough to guarantee that domino #43 will fall. "Mathematical induction" is sort of like (philosophical) induction in that it involves generalizing from a couple of samples (domino #1, and some hypothetical domino #N+1) to conclude that what was true of these samples is also true of the whole series. But there's a sense in which the "inductive step" effectively samples every single member of the series, so this is actually just another case in which the target is completely included in the sample.

political polls, they typically are claiming that the wrong sorts of sophisticated corrections have been used to try to correct for these biases. (You can study these sorts of sophisticated corrections for bias in statistics or political science, but I won't try to go into them here.)

Test #3. Do we have other information about the target? If you have a *deductively valid* argument for a conclusion and you're sure that the premises are true, then you typically don't need to consider whether you have any other information about the topic, because your premises are already be enough to guarantee that the conclusion is true.[4] Things get more complicated in the case of inductive arguments. If you know that Alfonso is a Texan, you might be tempted to conclude that Alfonso is likely to vote Republican, because a majority of Texans vote Republican. But if you also know that Alfonso is Black, then you should probably instead conclude that Alfonso will probably vote Democratic, because a majority of Blacks, and even a majority of Black Texans vote Democratic. If you have yet further information about Alfonso, e.g., that he is an NRA member, or that he is Gay, this might further alter your prediction as to how he will vote. In general, it's usually better to uses the narrower samples that match your target rather than broader ones – e.g., to draw conclusions about Alfonso, it'd be better to use your information about Black Texans, rather than your information about Blacks in general or Texans in general.

Unfortunately, in many cases, you won't have good data for a narrow sample that fully matches your target – e.g., you might not have any polls of Gay Black Texan NRA members. In these cases, it's often quite tricky to figure out how exactly to combine together the different sorts of data that you do have. Sometimes it makes sense to think of these as factors pulling in different directions in a sort of tug-of-war. The facts that Alfonso is a Texan and an NRA member pull in the direction of thinking he might vote Republican, but the facts that Alfonso is Black and Gay instead pull in the direction of thinking he might vote Democratic. If you can judge the strength of these different factors, you might be able to judge the likely outcome of a tug-of-war between them. Unfortunately, it's often hard to judge the strength of different factors and there are some cases where factors combine in surprising ways: e.g., as far as I know, older people tend to vote Republican and parents with young children tend to vote Republican, but older parents with young children actually tend to vote Democratic. Philosophers and statisticians have derived very complicated ways of combining different sorts of data in different circumstances, but I won't try to go into those here.

Summary. Inductive arguments generalize from a sample to a target, concluding that some trait that was present in the sample will probably be present in the target too. Inductive arguments are stronger (1) the bigger the sample is, (2) the more representative (or less biased) the sample is, and (3) the less additional information you have that suggests a different conclusion.

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[4] Things are more complicated for deductive arguments when you *aren't sure* the premises are true. If you aren't sure the premises are true, and you have other information that strongly suggests that the conclusion of your deductive argument is false, then this information should usually lead you to further doubt the premises. So even in the case of deductively valid arguments, you should often ask yourself whether you have other reasons to doubt the conclusion, because those other reasons might help you to identify faulty premises.

5. Arguments from Analogy

An ***argument from analogy*** is an inductive argument in which the sample is a single thing that is (hopefully) highly representative of the target you're trying to draw a conclusion about. Here's an example, based on an argument from analogy by the philosopher Peter Singer in his famous paper "Famine, Affluence and Morality".

> **P1a.** Not sending money to life-saving charities is like watching a child drown in a shallow pool.
>
> **P1b.** It would be wrong to stand by and watch a child drown in a shallow pool.
>
> --
>
> **C1.** So it would be wrong not to send money to life-saving charities.

In this argument, the ***sample*** is the action of watching a child drown in a shallow pool, the ***target*** is the action of refraining from sending money to a life-saving charity, and the ***trait*** that is being generalized is the trait of being morally wrong. Watching the child drown would clearly be wrong. Letting kids die from easily treatable diseases is morally very similar – it too is a way of standing idly by and letting someone die when you could have saved them at very little cost. So, Singer concludes, it must also be wrong to refrain from donating to life-saving charities.

When we talked about other inductive arguments, we said bigger was better – the larger your sample size the stronger your inductive argument is. Arguments from analogy use a single thing as their sample, so their ***sample size*** is incredibly small: n=1. This is basically the worst possible sample size you could have, while still having a sample! This suggests that arguments from analogy will typically be very weak. If an argument from analogy is going to have any strength, the sample it uses will need to be ***very highly representative*** of the target you're trying to draw conclusions about.

The key question in evaluating arguments from analogy is this: *when two things are similar in the various ways we know our sample and target to be similar, how likely is it that they'd also be similar with respect to the trait we're trying to draw a conclusion about*? The more probable it is that they would also be alike with respect to this trait, the stronger an argument from analogy will be. For example, when doctors are trying out new medicines for humans, it's better to test them in rats than in fish, because rats are more similar to humans than fish are, and hence it's more likely that side effects on humans would show up in rats than in fish. Of course, chimpanzees are even more similar to humans than rats are, so trials in chimpanzees provide even stronger evidence regarding whether a drug will be safe for humans.[5]

It's worth noting that some particular sample might be highly relevant for concluding whether a target has one trait, but not at all relevant for determining whether that target has some other trait. If you want to know what innate physical traits I have, my brother is a strongly analogous to me because we have many of the same genes and hence are likely to share many innate physical traits. But if you want

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[5] This case is a bit complicated because we might use, say, a sample size of n=1000 rats to make a strong argument by induction that a drug is safe in rats, and then use a sample size of n=1 species (rats) to make a weaker argument by analogy that the drug will probably also be safe in a different species (humans). Even though numerous rats were sampled in the trial, the move from rats to humans basically involves a sample size of just n=1 species.

to know what my hobbies are or what sort of car I drive, it will be a lot less useful to use my brother as an analogy because it's a lot less likely that my brother and I would share these traits.

If you disagree with an argument from analogy, it's often useful (1) to try to point out ways in which the sample differs from the target, and then (2) to argue that these ***disanalogies*** make it less likely that the two things would share the trait in question. E.g., if somebody tried to use an argument from analogy to argue that I probably drive the same model of car as my brother, relevant disanalogies might include the fact that one of us makes more money than the other, that one of us has a lot more kids than the other, or that one of us lives in a much colder climate than the other. All these differences make it much less likely that we would be alike with respect to what sort of car we drive. In contrast, if the trait we're talking about is height, then differences in income, climate or family size would not be relevant disanalogies, because none of these differences makes it less likely that we would be the same height.

It may also be worth noting that, just like other inductive arguments, it's also important to consider whether we have other evidence about the target of our argument. If you have a yard stick, that can provide much better evidence regarding how tall I am than any lame analogy to my brother. Arguments from analogy are usually most useful as a last resort when we don't have any better way of drawing conclusions about a target.

Let's practice the above lessons by going back to Singer's argument for donating to charity. The relevant question to ask is this: *is sending money to charity enough like rescuing a child from a shallow pool that the same moral evaluations should apply in both cases*? In his paper, Singer argues that these two cases are very much alike in every way that matters to morality. Both cases involve a child who is at risk of dying, a child whom you could easily save at very little cost to yourself. (Many charities can provide life-saving medicines for less than the cost of the pair of shoes you would wreck wading in to save the drowning child.) Sure there are some differences between these cases – differences in what exactly is threatening to kill the children, or in where exactly the children happen to be located – but Singer argues that these differences don't make any difference to questions about whether these kids' lives are worth saving. If you think it'd be wrong to stand idly by and watch a child drown rather than risking wrecking your new pair of shoes, but you think there's nothing wrong with spending your money to buy extra shoes rather than using it to save children's lives, then you'll probably want to find some relevant disanalogy between these cases. Singer does a brilliant job at arguing that none of the differences between the cases really are morally relevant. In fact he did such a good job that I now feel guilty whenever I spend money on extra shoes or other items I don't really need.

6. Abductive Arguments (Inferences to the best explanation)

Inference to the best explanation (aka. "abduction") always starts with some observation(s) to be explained.

O: Outside the victim's window, there are size 12 footprints in the mud.

We then need to compare multiple ***hypotheses*** that might (or might not) explain the observations.

H1. Big Bart is the culprit.

H2. Tiny Tim is the culprit.

The ***Prediction Principle*** tells us that an observation weighs most strongly in favor of whichever hypothesis most strongly predicted that observation. H1 predicts that we would likely see large footprints in the mud, whereas H2 predicts that we would see smaller footprints. When we observe the large footprints, this weights in favor of H1 over H2.

The Prediction Principle tells us that, when we observe O, we should shift our confidence towards H1, but it doesn't tell us exactly how far to shift our confidence. If previously you thought there was only a 10% chance that Big Bart did it, it might be that the big footprints should just make you a bit more suspicious of him, perhaps 15% confident now. As further evidence against him piles up, the Prediction Principle tells you to keep taking H1 more and more seriously, until eventually you might become quite confident that H1 is true. ***Bayes' Rule*** is a more complicated version of the Prediction Principle which tells you exactly how much probability you should add to H1 when you observe O. This rule is known to work very well, and is commonly used, e.g., by insurance companies in calculating how probable it is that someone like you will get in an accident. But we needn't worry about those details in our class.

Ockham's Razor is a tie-breaker to use when you have two ***"predictively equivalent" hypotheses***: two hypotheses that do equally well at predicting the observations that you've made, and hence are equally good in the eyes of the Prediction Principle. ***Ockham's Razor*** tells us that we should assign more probability to *simpler* hypotheses than to *more complicated* hypotheses. For example, consider the following hypotheses:

> **H3.** There is nothing dancing on the table in front of me.
>
> **H4.** There is a leprechaun dancing on the table in front of me, but he is wearing an invisibility cloak, he is so light of foot that he makes no sounds and doesn't disturb the dust, and he is fast enough to dodge or even teleport away if you try to reach out and grab him.

Both H3 and H4 do an equally good job at predicting our observations, so the Prediction Principle can't tell us which to prefer. But Ockham's Razor tells us to prefer H3 because it is simpler – it doesn't require believing in all the complexities involving leprechaun, invisibility cloak, etc…

It's sometimes quite difficult to tell which of two hypotheses should be counted as "simpler". In general, ***hypotheses are taken to be "simpler"* when they posit fewer *things*** (e.g., zero leprechauns versus one), **fewer *types* of things** (e.g., *ordinary physical objects* versus *ordinary physical objects* + *leprechauns*), **and fewer *lucky coincidences*** (e.g., that the leprechaun happened to dance away right when you reached your hand out). There is a great deal of ongoing work in philosophy and statistics trying to figure out exactly how to measure simplicity, and when and why simplicity should be a virtue in an explanation.

(The Prediction Principle, Bayes' Rule, and even Ockham's Razor are fairly uncontroversial. Some theorists have thought that other standards might also be used to determine which hypothesis counts as the "best" explanation: e.g., factors like *elegance*, *unifiedness*, or *symmetry*. These other standards tend to be much more controversial, and we probably won't go into them much in our class.)

One good way of responding to an inference to the best explanation is to ***suggest some other hypothesis*** that provides a better explanation than any of the ones we had been considering. For example, we might consider the hypothesis that some third suspect besides Big Bart and Tiny Tim might be the culprit. Similarly, Darwin undercut the old design argument for the existence of God by suggesting that a third hypothesis – evolution by natural selection – might provide a better explanation for the traits of living organisms than did either of the hypotheses that had previously been considered: divine creation and a completely random process.

A second way of responding to an inference to the best explanation is to ***draw attention to further observations*** that your favorite hypothesis did a better job of predicting than did competing hypotheses. (Note how this response uses the Prediction Principle.) E.g., if we find a pair of muddy size-12 overshoes in Tiny Tim's basement, this observation should shift our probability back toward thinking that Tiny Tim is likely the culprit. Similarly, evolutionists often draw attention to imperfect designs, like the human appendix, which are predictable vestiges of our evolutionary history but would be quite surprising features for a loving creator to have stuck us with.