Chapter 2: Classifying and Evaluating Arguments

A Little More Logical | Brendan Shea, Ph.D. (Brendan.Shea@rctc.edu)

1 Contents

2 TWO TYPES OF ARGUMENTS: DEDUCTIVE AND INDUCTIVE

The last chapter introduced the basic ideas behind logic, arguments, statements, premises, and conclusions and discussed the importance of putting arguments in standard form using the principle of charity. You also learned about common types of non-argument (such as reports, explanations, statements of belief, and so on). Arguments are distinguished from non-arguments by a claimed *inferential link* between the premises and conclusion. In this chapter, you'll explore how this inferential link works and learn about two types of inferential claims that people can make). We'll answer the following questions:

1. What is the difference between a **deductive argument** and an **inductive argument**?
2. How can you determine whether an argument is deductive or inductive?
3. What are some common forms of deductive arguments? Can you explain why each type is deductive?
4. What are some common forms of inductive arguments? Can you explain why each type is inductive?

The central idea of this chapter: To determine whether an argument is successful, we need to figure out what the arguer (who might be us!) is trying to *do*. This will bring us to the distinction between deductive and inductive arguments.

2.1 DEFINING DEDUCTION AND INDUCTION

There are two fundamentally different types of arguments, or ways of reasoning. Each is judged by distinct criteria.

A **deductive argument** is an argument that incorporates the inferential claim that it is *literally impossible* for the premises to be true and the conclusion to be false. So, if you can convince the person of the truth of your premises, they MUST accept your conclusion with 100% certainty. Deductive arguments either work or do no work; there is no middle ground. Deductive reasoning plays a central role in areas such as mathematics and computer science (and philosophy!) but a more limited role in other areas of life. (This isn't to say that we don't use deductive reasoning; it's just that many of our most challenging problems in life tend to require we use induction).

Much of our reasoning in everyday life (including nearly all of science, history, etc.) involves inductive

arguments. An **inductive argument** is an argument in which it is only claimed that it is *unlikely* for the premises to be true and the conclusion false. Inductive arguments come in various strengths and can (unlike deductive arguments) be weakened or strengthened by adding new premises (new evidence makes a difference). When reasoning inductively, you aim to show the person that *if* your premises are true and *if* you haven't left anything important out, your conclusion is probable.

Once you get the hang of the idea, you'll find that many arguments are clearly inductive or clearly deductive. In unclear cases, use the **principle of charity**—represent the argument in whichever way it has the best chance of working. For example, here are two deductive arguments, which implicitly involve the claim that the conclusion *must* be true if the premises are true:

- All clownfish love romance novels. Nemo is a clown fish. So, Nemo loves romance novels. (GOOD form, deductively "valid")
- All clownfish love romance novels. All sharks love romance novels. So, all clownfish are sharks. (BAD form, deductively "invalid")

By contrast, here are two inductive arguments, which implicitly involve the claim that the conclusion is *probably* true if the premises are true:

- Most clownfish love romance novels. Nemo is a clown fish. [We know nothing about Nemo that suggests he wouldn't like romance novels…]. So, Nemo probably loves romance novels. (GOOD form, inductively "strong").

- A few clown fish enjoy romance novels. Nemo is a clown fish. So, Nemo probably likes romance novels. (BAD form, inductively "weak").

Notice that deductive validity and inductive strength have NOTHING WHATSOEVER to do with whether the premises are true. (In all of these examples, the premises are false) However, *if* the premises of a valid or strong argument are true, then we have good reason to believe the conclusion (this is why it's worth caring about validity or strength in the first place).

[Question: Give an example from your life where you have used (1) deductive reasoning and (2) inductive reasoning.]

Figure 1 Alice and Sherlock play chess. Chess relies on both deductive reasoning (remembering and applying rules) and inductive reasoning (predicting what your opponent will do next). Art: Brendan Shea x Dall-E

2.2 How to Determine the Type of Argument: Some Rules of Thumb

Here are some "rules of thumb" for determining whether a given argument is deductive or inductive:

1. The argument is likely deductive if it really is impossible for the premises to be true and the conclusion false. By contrast, if you notice that it is improbable (but still possible) for the premises to be true and the conclusion false, then the argument is likely to be inductive.
2. If the context requires absolute certainty (e.g., mathematics), the argument will likely be deductive. If absolute certainty seems unreasonable (e.g., making predictions about the weather, politics, sports scores, your love life, etc.), the argument is likely to be inductive.
3. Deductive arguments often contain words like *necessarily, certainly,* or *absolutely*. Inductive arguments often include terms like *probably, likely,* or *it is reasonable to believe that*. (This isn't always reliable since people often claim "certainty" about things for which they have only inductive support.)
4. We can also classify specific argument "types" as deductive or inductive. We'll talk more about this in the next section.

It is important to remember that none of these rules is 100% foolproof and that it's often best to use them in combination. However, they provide a good starting point.

2.3 Common Types of Deductive Arguments

1. In an **argument from mathematics,** the conclusion can be derived from the premises using only mathematical reasoning (such as arithmetic or geometry).
   a. Ex: Since Ted William hit over .400 in 1941, it follows that he got at least at least four hits for every ten official at bats..
   b. Ex: We know that $F = m \times a$. Let's also assume that $m = 2\ kg$ and that $a = 3\ m \cdot s^{-2}$. We can conclude that $F = 6\ N$.
2. In an **argument from definition,** the conclusion can be derived from the premises using only knowledge of definitions.
   a. Ex: The sin of hubris is ubiquitous in the United States. Therefore, many proud people live in this country.
   b. Ex: Sally is a bachelorette. So, Sally isn't married.
3. A **syllogism** is a two-premise type of deductive argument. **Categorical syllogisms** have premises and conclusions that all involve claims about "some", "all", or "no" members of a category.
   a. Ex: All pigs are sentient. No sentient creatures should be eaten. So, no pigs should be eaten.
   b. Ex: All bats are mammals. Some bats fly. So, some mammals fly.
4. **Hypothetical syllogisms** have premises or conclusions that are all conditional ("if-then") statements.
   a. If a siren sounds, you should seek shelter. This follows from that facts that if a siren sounds, a tornado has been spotted, and if a tornado has been spotted, you should seek shelter.
5. **Disjunctive syllogisms** have the form: "Either X or Y is true. But X is false. So, Y." (*Disjunction* means "OR")
   a. Jones is either an insomniac or a vampire. But Jones isn't an insomniac. So, he must be a vampire.

[Question: Choose one (or two) of the forms above, and give an original argument based on it. Put the argument in standard form. Do you think this argument is "good" or "bad"? Why?]

2.4 Common Types of Inductive Arguments

1. **Predictions** have premises involving the past or present, and conclusions involving the future. Arguments of this sort are common in science and everyday life.
   a. Ex: Because the sun came up the last 1,000,000 days in a row, it will come up tomorrow.
2. **Generalizations** draw conclusions about large groups (or **populations**) based on premises concerning smaller subgroups (or **samples**).

    a. Ex: 9 out of 10 consumers who were surveyed preferred Colgate toothpaste. Therefore, around 90% of all consumers prefer Colgate toothpaste.
3. **Causal inferences** draw conclusions about causes or effects based on premises that don't (directly) concern causal matters.
    a. Ex: Since the incidence of lung cancer is much higher among smokers than nonsmokers, it's safe to conclude that smoking causes lung cancer.
4. **Arguments from analogy** have premises concerning the similarities between 2+ more objects and conclude that they must be similar in some other way.
    a. Ex: Since Britain, Russia, and the US were great powers who failed to win wars in Afghanistan, the next great power that attempts to win a war in Afghanistan will probably fail as well.
5. **Arguments from authority** conclude that something is true because a subject-matter expert (or group of experts) said it was true.
    a. Ex: My astronomy textbook says the sun is around 93 million miles from the earth; we can conclude that is probably correct.
6. **Arguments from signs** conclude that something holds because of a sign left by an intelligent being.
    a. Ex: Every map I've seen shows Minneapolis as north of Chicago. So, your claim that Minneapolis is south of Chicago is just plain crazy.
7. **Arguments to the best explanation** conclude that a hypothesis is true because it is the best explanation for a known fact.
    a. Ex: Shelley missed class today. The best explanation for Shelley missing class is that she is sick. So, she probably really is sick.

[Question: Choose one (or two) of the forms above, and give an original argument based on it. Put the argument in standard form. Do you think this argument is "good" or "bad"? Why?]

2.5 Solved Problem: Deductive Versus Inductive

Passage	Inductive, Deductive, or Not an Argument?
Mario and Luigi are brothers. Therefore, they have at least one parent in common.	This is deductive since the conclusion follows from the definitions of the word "brother" and "parents." While we might need to do some work to determine whether the premise is true ("Are Mario and Luigi really brothers?"), once we've
Mario speaks with an Italian accent. Since Luigi was raised with Mario, Luigi probably speaks with one too.	Inductive. We reason that because Mario and Luigi have certain similarities (they were raised together), they must have other similarities (speaking with the same accent.) This is an argument by analogy.
Mario and Luigi went to plumbing school in the 1970s together. Mario mainly got Bs, while Luigi got mostly As.	This is not an argument at all.
All people with evil-sounding names are evil. "Wario" is an evil-sounding name. So, Wario is evil.	This is deductive and looks like a categorical argument (with the word "All"). *While the* argument is valid, the premise that "All people with evil-sounding names are evil" is false.
I've looked all over this castle, but I simply can't find Princess Peach. So, the Princess must be in some other castle.	This is inductive and looks like an argument to the best explanation. (We want a reason for Peach's absence; the best one we can think of is that she is in another castle.)
The last 100 times I encountered a Koopa Troopa, it tried to bite me. So, the next Koopa Troopa I meet will certainly try to bite me as well.	Inductive-prediction/generalization. While words like "certainly" sometimes signal deductive argumentation, they don't in this case. After all, we can't use information about the past to predict the

	future with 100% certainty (as deductive argumentation requires).
I saw a sign saying, "This way to Bowser's castle." So, if we want to go to Bowser's castle, we should go that way.	Inductive—argument from signs. Whenever you make an inference from "a sign says this" to "it's true," you are making an inductive leap (after all, maybe Bowser has been putting up fake signs to mislead people about the location of his castle).
There are precisely 8 levels in *Super Mario Brothers.* I have beat 7 of them. So, if I complete one more, I will have finished the game.	Deductive—argument from mathematics. The conclusion here follows from "8 – 7." Again, it's important to note I might be wrong about my premises (e.g., maybe there are more than 8 levels). However, on the assumption that my premises are TRUE, my conclusion follows simply from the math.
If you like *Super Mario Brothers,* then you will also like *Sonic the Hedgehog.*	This isn't an argument! It is a conditional statement claiming that liking *Mario* is a sufficient condition for liking *Sonic*. (And that liking *Sonic* follows necessarily from liking *Mario*.)
I will beat the level if I continue playing video games for 30 minutes. If I beat the level, I will be happy forever. So, if I continue playing video games for 30 more mins, I will be happy forever.	Deductive—hypothetical syllogism. (Again, this is a deductively "valid" argument. However, validity doesn't guarantee the premises' truth.)
The question box must contain a mushroom, given that it either contains a mushroom or flower, and it doesn't contain a flower..	Deductive-disjunctive syllogism.
Luigi couldn't beat Bowser before he bought himself a Racoon Suit. After he bought a Racoon Suit, he beat Bowser with ease. So, the Racoon Suit must have been a cause of his beating Bowser.	Inductive—argument about causes and effects. Arguments about causes/effects are inherently uncertain since there will *always* be other possibilities we haven't accounted for. (E.g., maybe Luigi just got lucky this time, or his previous practice paid off, or he'd just had a cup of coffee, or whatever).
Toad told me that Princess Peach is thinking of becoming a race car driver and that she's sick of being a princess. Since Toad is one of Peach's best friends, I think we can trust him.	Inductive—argument from authority. Every time we believe something on the basis that a person/group/book told us it was true, we are reasoning inductively. (Obviously, this accounts for a massive chunk of our beliefs!).

2.6 Review Questions

1. Identify the conclusion of the following arguments and classify them as deductive or inductive. Explain why you think this.
    a. There's a good chance Kate will have to take off work for a funeral this week. I know that Anna and Kate were good friends, and Vronsky just told me that Anna recently jumped in front of a train.
    b. Two equal things cannot be different. However, humans differ in terms of properties such as intelligence and physical strength. Therefore, humans are fundamentally unequal.
    c. No terrestrial (i.e., non-flying) mammals are native to oceanic islands. We can conclude from this that the ancestors of the mammals on those islands must have come from nearby continents since terrestrial mammals are precisely the animals that never could cross the ocean.
    d. I can predict the future if I am a master of inductive arguments. I am a master of inductive arguments. So, I can predict the future.

e. Nearly all of the basketball players I’ve met are taller than me. So, it’s probably the case that most of the ones I haven’t met are taller than me, as well.
f. The sign on the door shows a picture of a man. So, that’s probably the door to the men’s restroom.
g. Since a square is a type of rectangle, and all rectangles have four sides, we can conclude that squares have four sides.
h. All of my friends said that Dr. Smith is a tough teacher. Therefore, I would probably struggle to get an A in her class.

2. For a long time (until about 1700 CE), scientists hoped they would be able to do science using only DEDUCTIVE reasoning. (So, science would work a lot like math does). However, nearly all scientists now agree that this is impossible, and that science relies on INDUCTIVE reasoning as well. Can you give some examples of ways that science involves inductive reasoning?
3. Let’s say that an (evil) genie approached you and said that she would take away either your ability to reason deductively for the rest of the day OR your ability to reason inductively for the rest of the day. Which type of reasoning would you choose to sacrifice? Why?

3 ARGUMENT EVALUATION

Figure 2 Our reasons for believing that "smoking is bad for you" are inductive in nature, not deductive. (Brendan Shea x Dall--E).

We now know that every argument must have both premise(s) and a conclusion, and there must be a claimed inferential link between these. We can classify the argument as either deductive or inductive, depending on how strong this claims inferential link is. In deductive argument, the arguer claims the premises *prove* the truth of the conclusion. By contrast, in inductive arguments, the arguer claims the premises make the conclusion probable. With this background, we can finally start talking about what it means for arguments to succeed or fail, or (more broadly) what it means to reason well or poorly.

1. What two tests must every good argument pass?
2. What does it mean to say that a deductive argument is **valid** or **sound**? What is the relationship between validity and soundness?
3. Why are deductively valid arguments are "risk-free" or "truth-preserving"?
4. What does it mean to say that an inductive argument is **strong** or **cogent**? What is the relationship between strength and cogency?

The concepts covered today can be tricky, at least partially because ordinary people tend to use the words here (a "valid" or "sound" argument, a "true" conclusion") in ways that don't always match with what logicians mean. With this in mind, it's crucial that we pay attention to the precise *details* of these definitions since understanding them is a necessary first step for evaluating real-world arguments' success or failure.

3.1 HOW CAN YOU TELL WHETHER AN ARGUMENT IS GOOD OR BAD?

Any good argument (whether inductive or deductive) must pass two separate tests. Any argument that fails *either* test fails to be a good argument. Moreover, it’s important to note that *neither* test asks, "Is the conclusion true?" or "Do you agree with the conclusion?" This is because determining whether or not to believe the conclusion should be something that we arrive at only after we analyze the argument. It shouldn't be something that we start out by assuming.

TEST 1: If we *assume* the premises are true, do they support the conclusion? Since deductive vs. inductive arguments involve different sorts of claims about evidential support, this test works differently for each type.

- For a deductive argument, the conclusion should follow *necessarily*. It shouldn't even be possible to tell a coherent *story* where the premises are all true, and the conclusion ends up being false. A deductive argument that meets this requirement is called a *valid* argument (it has "good form"), while a deductive argument that fails this test is called "invalid."
- For an inductive argument, the conclusion should be at least *probable*. Unlike a deductive argument, the person can grant there is some chance that the evidence is what they say it is, but they still end up being wrong about the conclusion. An inductive argument that meets this requirement is called "strong" (since the premises, if true, provide "strong" reasons to believe the conclusion). An inductive argument that fails this test is called *weak*.
- Logicians spend most of their time worrying about this area of argument evaluation since it doesn't require determining whether particular premises are true or false (which might require a great deal of content knowledge). Moreover, if an argument fails this test, it is *irrelevant* whether the premises are true or false (test 2).

[Question: Give an example of an argument [in standard form] that fails test 1. Hint: Give an argument with TRUE premises but a FALSE conclusion.]

TEST 2: Are the premises, in fact, true? Are they likely to be acceptable to the target audience? One should always aim to use evidence that the intended audience would accept since the whole point is to convince them! It's ineffective to use premises that "beg the question" in your own favor.

[Question: Give an example of an argument [in standard form] that passes test 1, but fails test 2. This argument should have premises that are false/questionable.]

3.1.1 Evaluating Deductive Arguments: Validity and Soundness

In a **valid** deductive argument**,** IF the premises are true, THEN the conclusion can't be false. An **invalid** argument fails test 1. In this case, it doesn't matter whether the premises (or even the conclusion) are true or false—it's simply a bad argument.

- Ex: All chickens speak French. Some tigers are chickens. Therefore, some tigers speak French. (VALID but UNSOUND)
- Ex: All chickens speak French. All chickens are tigers. Therefore, all tigers speak French. (INVALID. All invalid arguments are unsound.)

A **sound** deductive argument is valid with all true premises. A valid but **unsound** argument fails test 2. An invalid argument can never be sound.

- Ex: Princess Zelda is either a video game character or a philosophy instructor at RCTC. Princess Zelda is not a philosophy instructor at RCTC. So, Princess Zelda is a video game character. (VALID and SOUND—a "good" deductive argument.)

Valid arguments sometimes have false conclusions, and invalid arguments sometimes have true ones. However, valid arguments (unlike invalid arguments) are entirely "risk-free" or "truth-preserving"—one never risks starting from true premises and ending up with a false conclusion. Finally, a weird fact. If you look closely at the definition of validity, you'll notice that any argument with premises that contradict one another is guaranteed to be valid (but unsound). It doesn't matter *whether* the conclusion is true or false!

- Ex: God both really exists and really does not exist. So, pigs can fly. (VALID and UNSOUND—contradictory premises)

[Question: One example of a valid, deductive argument form is modus ponens: "If P, then Q. P. Therefore Q." Give one example of a modus ponens argument—in standard form, of course!—that is SOUND and one that is UNSOUND on a topic of your choosing.]

[Question: The argument form "If P then Q. Q. Therefore P" is not valid. However, this doesn't mean it has a false conclusion! Give one example of an argument of this form with a true conclusion and another one with a false conclusion. Put both in standard form.]

3.1.2 Evaluating Inductive Arguments: Strength and Cogency

In a **strong** inductive argument, if the premises are true, then it is *improbable* for the conclusion to be false. A **weak** argument fails test 1.

- Ex: 99% of all chickens speak French. Foghorn Leghorn is a chicken. Therefore, Foghorn Leghorn speaks French. (STRONG but UNCOGENT, since the premises are false)
- Ex: A few chickens speak French. Foghorn Leghorn is a chicken. Therefore, Foghorn Leghorn speaks French. (WEAK. All weak arguments are uncogent, regardless of whether their premises are true or false.)

Remember that all inductive arguments are *risky*—there is always a chance the conclusion will be false, even if the argument is strong with all true premises (i.e. it is cogent). Inductive strength, unlike deductive validity, admits of degrees. There will always be *some* possibility the conclusion of a cogent argument is false, however remote.

In general, we can say that an inductive argument is **strong** if and only if:

1. The conclusion is likely to be true (>50%), SUPPOSING that the premises are true. Stronger arguments have a higher probability.
2. The premises are *relevant* to the conclusion, in the sense that finding out the premises were true would *raise* the probability the conclusion was true.
3. The argument meets the **total evidence requirement**, which states that any known, significant evidence for the falsity of the conclusion must be considered. A strong argument shouldn't leave out obviously relevant evidence.

A **cogent** inductive argument is strong with all true premises. A strong but **uncogent** argument fails test 2.

- It is almost always warmer in Miami, FL, than in Fargo, MN, in February. So, it will probably be warmer in Miami than in Fargo his coming Feb. 11. (STRONG and COGENT—a "good" inductive argument).

[Question: Give an example of a "cogent" argument that you have made (maybe just to yourself) within the last week. Present this argument in standard form.

I guarantee you've done this—just think about all the times you've made predictions about the future, made generalizations, and relied on your knowledge of cause and effect to get around.]

[Question: Think about a time you believed something that you ended up regretting. Try to represent the "reasoning" that led you to this belief as an argument in standard form (my bet is that the argument in question is probably inductive and weak…). Explain what went wrong.]

3.2 SEVEN KEY POINTS TO REMEMBER

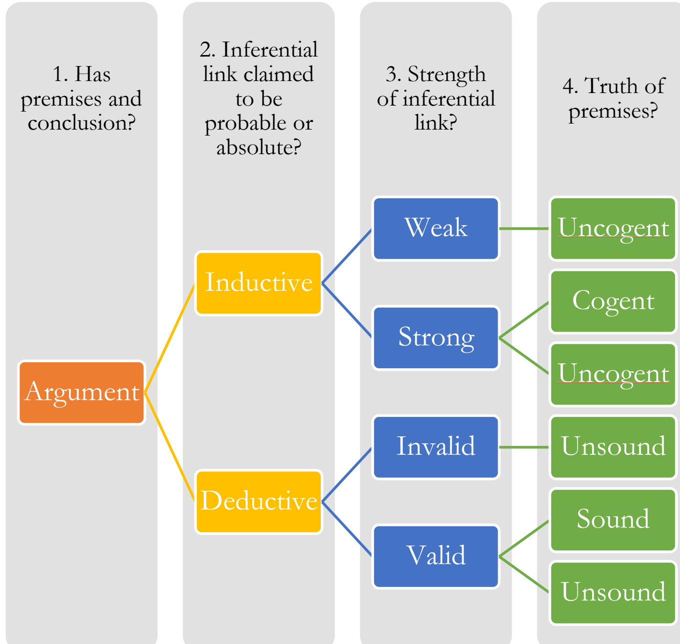
We've covered a lot of new terms here, which can be a bit difficult to keep track of. With that in mind, it's worth restating what we've learned so far:

1. Depending on what the arguer is trying to do, every argument is either deductive (it is attempting to "prove" a conclusion) or inductive (it is attempting to provide "evidence" for a conclusion without proving it).
2. In a deductive argument, we demand that it be LITERALLY IMPOSSIBLE (you couldn't even imagine it!) to have all true premises and end up with a false conclusion. An argument that meets this criterion is called "valid."
3. Valid arguments might still have false conclusions, but only if they have false premises. A deductive, valid argument with true premises is called "sound." **The only thing we can NEVER have is a valid argument with true premises and a false conclusion.**
4. We use different terms to describe good/bad inductive arguments. Inductive arguments aren't valid (or invalid) or sound (or unsound). These terms are not appropriate to apply to them, since the person making the inductive arguments isn't trying to "prove" anything.
5. In inductive arguments, we just want to know whether the conclusion is *probably* true, given that the premises are true (withholding for the moment our judgment on whether the premises are true). If so, the argument is "strong." And if we have an inductive, strong argument with true premises, we can say it is "cogent."
6. While cogent inductive arguments and deductive sound arguments are both "good" arguments, there is a crucial difference. In a deductive, sound argument, the conclusion CANNOT be wrong (this is why mathematicians, computer scientists, and logicians are so interested in studying deductive logic). By contrast, while the conclusion of a cogent argument represents something we "ought" to believe, we might end up being wrong as new evidence comes to light.
7. A huge amount of our everyday reasoning is inductive, rather than deductive. When evaluating these arguments, use the appropriate concepts (strength, cogency). Don't expect/demand deductive proof, or use the concepts applicable to this (validity, soundness).

[Question: How would you answer the following questions, in your own words, and using examples from your own life:

1. **"What is the difference between deductive and inductive reasoning?"**
2. **"What is the difference between valid and invalid deductive arguments?"**
3. **What is the difference between weak and strong inductive argument?"**

3.3 Argument Evaluation Visualized



3.4 Common Deductive Argument Types: Valid and Invalid

Note: It's often tough to tell just by looking whether a deductive argument is valid or invalid (if it were, logicians, computer scientists, and mathematicians would all be out of jobs. Luckily, there are many common argument forms we know are valid or invalid. (This can be helpful when trying to make valid arguments!).

Argument Type	**Valid Examples**	**Invalid Examples**
Categorical Syllogisms	• All P are M. All S are M. So, all S are P. • All M are P. Some M are S. So, some S are P. • No P are M. Some M are S. So, some S are not P. • All P are M. Some M are not S. So, some S are not P. • Some M are P. All M are S. So, some S are P.	• All M are P. All M are S. So, all S are P. • Some M are P. Some S are M. So, some S are P. • No P are M. No S are M. So, no S are P. • All P are M. Some S are not M. So, some S are P. • Some P are not M. Some S are M. So, some S are P.
Mathematical Args.	• X is greater than 3. So, X is greater than 1. • X is a triangle. So, X has three sides. • $x \times 3 = 6$. So, $X = 2$.	• X is greater than 3. So, X is less than 100. • X is a triangle. So, X's sides are of equal length. • 2X = 6. So, X = 3. (X might also be -3)
Args from Definition	Jones is a bachelor. So, Jones is male.	Jones and Jenny are of different genders. So, Jones and Jenny are not equal. (**FALLACY: Equivocation**)

Propositional Logic	• If P, then Q. P. So, Q. (**Modus Ponens)** • If P, then Q. Not P. So, not Q. **(Modus Tollens)** • P or Q. Not P. So, not Q. **(Disjunctive Syllogism)** • If P then Q. If Q then R. So, if P then R. **(Hypothetical Syllogism)** • P is true. So, P or Q. **(Addition)** • P is true. Q is true. So, P and Q. **(Conjunction)** • P and Q are both true. So, P is true. **(Simplification)**	• If P, then Q. Q. So, P. **(FALLACY: Affirming the Consequent)** • If P, then Q. Not P. So, not Q. **(FALLACY: Denying the Antecedent)** • P or Q. Not P. So, not Q. **(Using the wrong definition of "or")** • P is true. So, P and Q are both true. • P or Q. So, P is true.

[Question: Give T.W.O. or more examples of valid, deductive arguments, based on the forms given above. So, you should fill in variables like P and Q with specific statements.]

[Question: Now, give T.W.O. or more examples of invalid, deductive arguments.]

3.5 COMMON INDUCTIVE ARGUMENTS: STRONG AND WEAK

In contrast to deductive argument forms, the strength or weakness of an inductive argument is not determined by its "form." Instead, it's often determined by the amount of evidence we include (or fail to include) in the premises. Stronger inductive arguments have more (and better) evidence than weak arguments.

Argument Type	Strong	Weak
Analogical Argument	Case D is like cases A, B, and C in all relevant respects. A, B, and C all have property P. So, D likely has property P as well.	Case D is like case A in a few not very relevant respects. A has property P. So, D likely has property P as well. **(FALLACY: Weak Analogy)**
Prediction	Events of type X have occurred thousands of times. They have (almost) always been followed by events of type Y. An event of type X just happened. So, an event of type Y will probably happen soon.	In a few cases, events of type Y have followed events of type X. An event of type X just occurred. So, an event of type will probably happen soon. **(FALLACY: False Cause)**
Generalization	In a large, representative sample, around X% had property P. So, it is probably true that around X% of the whole population has property.	In a small or biased sample, around X% had property P. So, it is probably true that around X% of the whole population has property. **(FALLACY: Hasty Generalization)**
Causal Argument	In repeated, controlled experiments, changing the value of X has been found to change the value of Y. So, X is likely a cause of Y.	X often precedes Y. So, X causes Y. **(FALLACY: False Cause)**
Arg. to Possible/Best Explanation	Scientific theory T is the *best* explanation for phenomena P. So, T is likely to be true.	Scientific theory T is one *possible* explanation for phenomena P. So, T is likely to be true. **(Pseudoscience)**
Arg. From Authority	A well-qualified, unbiased authority says that P is true. So, P is probably true.	An unqualified or biased authority says that P is true. So, P is probably true. **(FALLACY: Unqualified Authority)**

Slippery Slope	It is highly probable that A will lead to B, and that B will lead to C. So, A will probably lead to C.	It is somewhat plausible that A will lead to B, that B will lead to C,….(lots of steps until we get to Z). So, it is likely that A will lead to Z. **(FALLACY: Slippery Slope)**
Bad People!	Person A has often been a jerk in the past. So, person A will continue to be a jerk in the future.	Person A is a jerk. Person A has argued that we should believe C. So, we can safely ignore this argument (**FALLACY: Ad hominem).**
Hopes and Fears		People will accept me if I believe P. So, P. **(FALLACY: Appeal to the People)** I am afraid of what will happen to me if I don't believe P. So, P. **(FALLACY: Appeal to Force)** Someone I care about will be sad if I don't believe P. So, P. **(FALLACY: Appeal to Pity)**

[Question: Give two examples of strong inductive arguments, based on the forms above. So, you should fill in variables like P and Q with specific statements. Now, give two examples of weak inductive arguments.]

3.6 Sample Problem: Evaluating Arguments

Determine whether the following are arguments. If they are, determine whether they are inductive or deductive. If they are inductive, decide whether or not they are weak or strong; if they are deductive, determine whether they are valid or invalid. Finally, use your knowledge of the truth of the premises to determine whether the arguments are cogent (for inductive arguments) or sound (for deductive arguments).

Passage	Analysis
All penguins are birds. Some birds fly. So, some penguins fly.	This is deductive (a categorical syllogism). It is also invalid (the fact that the premises are true and the conclusion false is a dead giveaway for this). All invalid arguments are unsound.
I think penguins are really cute. By contrast, I firmly believe that ostriches are the scariest animals on earth.	This isn't an argument. (Remember, saying what you "think" or "believe" isn't an argument.)
Penguins' bodies have been shaped by millions of years of evolution to be expert swimmers. Humans have not. So, it is likely that the average penguin can swim better than the average human.	This is inductive (it looks like a prediction). It is also strong with true premises. Because of this, it is cogent (and is a "good" argument").
Penguins are expert swimmers. So, it is likely that all birds are good swimmers.	This is inductive (more specifically, it looks like a generalization). The premise is true, but the argument is weak. No weak arguments are cogent.
Either penguins are mammals or penguins are fish. They are not mammals. Hence, they must be fish.	This is deductive (a disjunctive syllogism), and it is actually valid (it has a good "form"). However, since it has false premises, it is not sound. (Penguins are actually birds, not mammals or fish).
Both cats and penguins eat fish, and both are small and cute. Since cats make good pets, penguins would make good pets as well.	This is inductive (argument from analogy). Again, the premises are true, but the argument is weak (and thus, uncongent).

All penguins are birds. All penguins have wings. So, all birds have wings.	This is deductive (a type of categorical syllogism), but invalid (and uncogent). Importantly, it DOES NOT MATTER whether the premises or conclusion is true. The important thing is that the premises *could* be true without the conclusion being true.
As everyone knows, penguins live in Antarctica. In recent years, the ice around Antarctica has been melting faster than in years past. From this, we can conclude that the ice melting is being caused by something the penguins did.	The argument is inductive (it is a causal argument), but it is weak (and uncogent).
It is likely that penguins and swans are more closely related to each other than either are to humans. After all, both swans and penguins have wings and lay eggs, while humans don't. The best explanation is that swans and penguin are descended from an (egg-laying, wing-having) common ancestor. By contrast, their common ancestor with humans must be more distant.	This is an inductive argument to the best explanation. It looks relatively strong, but it could be improved with more evidence. It makes use of a scientific theory (in this case, the theory of evolution) plus various facts about the world (regarding penguins, swans, and humans) to defend a particular conclusion (regarding how closely related penguins and swans are, relative to how closely related they are to humans.
If penguins are mammals, then penguins are fish. Penguins are, in fact, mammals. However, no fish are mammals. We can conclude that Wonder Woman is real.	This is a deductively valid argument, but an odd one. The premises contradict one another, which means that there is NO POSSIBLE WAY they could all be true simultaneously. This means that it *automatically* satisfies the definition of validity (impossible to have all true premises with a true conclusion). Since the premises can't possibly all be true, however, the argument is not sound.

4 READING: THREE WAYS OF GETTING IT WRONG: INDUCTION IN WONDERLAND

Brendan's Note: I wrote this chapter on deductive and inductive logic for the following book: Richard Davis (ed.), 2010, *Alice in Wonderland and Philosophy: Curiouser and Curiouser.* The Blackwell Philosophy and Pop Culture Series. Hoboken, NJ: John Wiley and Sons. It's based on Lewis Carroll's (a famous logician) children's story "Alice in Wonderland", but I think (or hope!) that you'll be able to follow the main ideas here even if you're not familiar with Alice 😊.

Alice encounters at least three problems in her struggles to understand and navigate Wonderland. The first arises when she attempts to predict what will happen in Wonderland based on what she has experienced outside of Wonderland. In many cases, this proves difficult—she fails to predict that babies might turn into pigs or that a grin could survive without a cat. Alice's second problem involves her efforts to figure out the basic nature of Wonderland. So, for example, it is difficult for Alice to see how she could *prove* that her experiences were the result of her dreaming and not something else. The final problem is manifested by Alice's attempts to understand what the various residents of Wonderland mean when they speak to her. In Wonderland, "mock turtles" are real creatures and people go places with a "porpoise" (and not a purpose).

All three of these problems concern Alice's attempts to infer information about unobserved events or objects from those she has observed. In philosophical terms, they all involve *induction*.

Induction, it turns out, is hugely important to our daily lives. It is inductive reasoning that allows us to figure out which foods nourish and which poison; induction guides our conviction of criminals and pardoning of the innocent; induction is the basis of all scientific knowledge. Induction also provides our sole basis for understanding *language*. The problem with induction, as Alice learns, is that one always risks being wrong. In Wonderland, many of Alice's inductively supported beliefs turn out suddenly to be false, and she is forced to start from scratch. Her successes and failures in doing so offer a window into the working of inductive reasoning, and should therefore be of real interest to us.

4.1 Believing Impossible Things: Induction and Deduction

Induction, as it is usually understood by philosophers, is a type of reasoning that stands in explicit contrast to *deduction*. In order to reason deductively from known facts to a conclusion, one must show that it is *impossible* for the conclusion to be false on the assumption that the original facts are as we thought. Lewis Carroll offers the following example of a deductive argument in his *Symbolic Logic*: "All cats understand French; some chickens are cats" therefore, "Some chickens understand French."[i] The conclusion is, of course, false. However, if one *assumes* that the first sentence is true, there is *no way* the second sentence could be false. In using deduction, one never really goes beyond what one knows—one merely restates it in new (and sometimes interesting) ways.

In contrast to deductive reasoning, inductive reasoning attempts to go beyond what is already known. So, for example, were Alice to reason from *No rabbits have ever spoken to me before today* to the conclusion that *No rabbits will speak to me today* she would be reasoning inductively. This is because, as Alice discovers, it is *possible* that the first sentence could be true and the second false.

Most, if not all, of all our everyday beliefs about the world have been arrived at by inductive reasoning. Alice provides a few good examples of inductively supported beliefs when she considers drinking the bottle labeled DRINK ME:

It was all very well to say "Drink me" but the wise little Alice was not going to do that in a hurry. "No, I'll look first," she said, "and see whether its marked 'poison' or not"; for she had read several nice stories about children who got burnt, and eaten up by wild beasts, and other unpleasant things, all because they would not remember the simple rules their friends had taught them: such as, that a red-hot poker will burn you if you hold it too long; and that, if you cut your finger very deeply it usually bleeds; and she had never forgotten that, if you drink much from a bottle marked 'poison,' it is almost certain to disagree with you, sooner or later.[ii]

All of the rules Alice cites are good (if simple) ones. Nevertheless, we have only inductive reasoning to support them. For instance, the reason we think that fires will burn us in the future is because we know that they have burned us in the past. The same holds true any time we believe something on the authority of some reliable teacher, parent or book. In fact, nearly all of our basic beliefs about history, science or other people have been arrived at by inductive reasoning.

4.2 Down the Rabbit Hole: Hume's Problem with Prediction

One common type of inductive reasoning involves our attempts to *predict* what we will experience in the future based on what has happened in the past. For example, most of us believe that rabbits will not begin talking nor babies suddenly become pigs. But suppose that somebody (we'll pretend it is Humpty Dumpty) disagrees with us about these beliefs—Humpty claims that, at 6:00am tomorrow morning, the world we know will suddenly turn into Wonderland. Animals will talk, playing cards will hold trials, and people will change size dramatically when they eat food. What, if anything, could we say to convince Humpty that he is wrong?

In his famous book *An Enquiry Concerning Human Understanding*, David Hume (1711-1776) argues that there is nothing we could say to rationally persuade someone like Humpty that he is wrong. Hume's argument (now called the **Problem of Induction)** proceeds as follows. First, he divides the types of knowledge one can have into two categories: that pertaining to *Relations of Ideas* and that pertaining to *Matters of Fact.*[iii] Hume thinks that knowledge of the former category is possible, but it pertains only to truths we can figure by reflecting on the nature of our own ideas. For example, Hume thinks we can know that all triangles have three sides and that all bachelors are unmarried, but this knowledge doesn't depend on the *existence* of any triangles or bachelors. Even if every male in the world were married, for example, it would remain true that *if* there were a bachelor, he would be unmarried. This is guaranteed by our idea of bachelor-hood. Hume might be quite happy with Humpty's observation that we are the "master" of our words.[iv] According to Humpty's story, we can figure out whether "all triangles have three sides" is true or false simply by considering what we mean by words like 'triangle.'

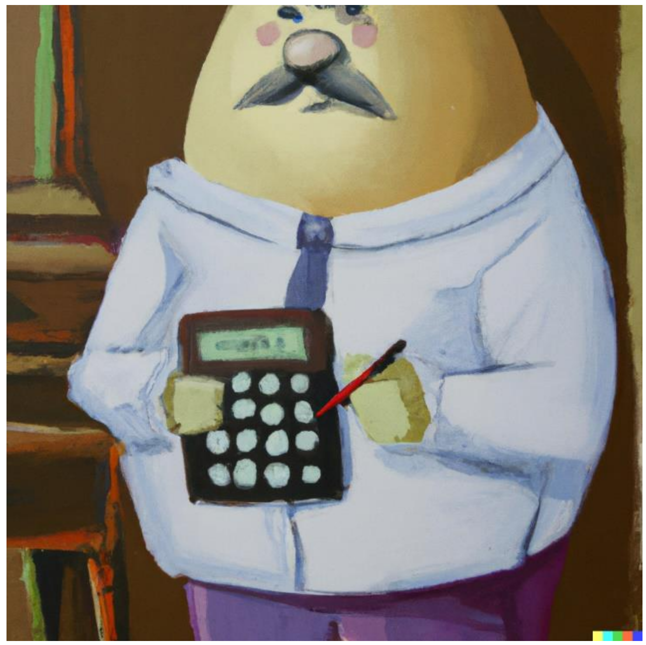


Figure 3 Humpty's calculator might help with deductive reasoning, but it won't be enough to save him. (Art: Brendan Shea x Dall-E)

In addition to our knowledge of Relations of Ideas, Hume grants that we can have knowledge about the Matters of Fact we have already *observed.* For example, we know that we have not up until now observed rabbits talking or playing cards holding trials. Hume's problem of prediction concerns the possibility of knowing about *unobserved* Matters of Fact. Humpty's challenge is just a more specific version of this problem. We have not yet observed what will happen at 6:00am tomorrow; Humpty challenges us to justify our belief the world will not suddenly change into Wonderland.

The difficulty of Hume's problem becomes apparent when we consider how we might do this. When we defend claims about Relations of Ideas, we can appeal to the unimaginability of its being false for our justification. So, for instance, it is impossible to imagine a non-three-sided triangle or a female bachelor. But Humpty's claim that the world will become Wonderland isn't impossible to imagine; in fact, we visualize Wonderland whenever we read Carroll's work. As Hume notes, we can imagine *any* matter of fact being different: "*That the sun will not rise tomorrow* is no less intelligible a proposition, and implies no more contradiction, than the affirmation, *that it will rise.*"[v] Nor can we defend our prediction as we do our beliefs about Matters of Fact we have already observed. Our beliefs about observed Matters of Fact are based on what we have seen, smelt, touched, and tasted. We can't sense the future in this way.

According to Hume, the only reason we don't think that the world will radically change tomorrow is that it hasn't ever changed in this way *before.* In fact, Hume thinks all of our beliefs about unobserved matters rest on one key assumption—*that the future will resemble the past.* The problem is that this assumption is *itself* a belief about an unobserved matter of fact. Moreover, it is precisely what Humpty was asking us to defend. He agrees that, up until today, the world has never radically changed. He just thinks that, starting tomorrow, it will. And it seems we have no rational way of convincing him he is wrong.

Hume's conclusion is not that we have no basis for making predictions, but rather that our ability to do so successfully is quite independent of our deductive reasoning ability. Alice, for instance, shows little evidence of being an expert on deductive logic. However, she uses inductive reasoning with great success. In learning how to change her size by the consumption of various foods and drinks, for example, Alice is using inductive reasoning in order to make successful predictions. Her use of evidence about past events to predict and control the future course of nature is prototypical of "scientific" reasoning, and gives some idea of just how important prediction is to our everyday lives. Humpty Dumpty, who by contrast seems fairly competent at deductive logic, provides a good example of a poor inductive reasoner. When Alice first encounters Humpty, he is singing a song about how all the King's men won't be able to put him back together again. When queried by Alice, however, Humpty seems oblivious to the obvious predictive relevance of such a song, and refuses to move from his precarious perch. Humpty, despite his argumentative acumen, seems destined for a poor end.

4.3 WHOSE DREAM IS THIS, ANYWAY? THE UNDERDETERMINATION OF THEORY BY EVIDENCE

From now on, let's suppose we've solved Hume's problem, and have managed to become perfect predictors. That is, let's suppose we're perfect at predicting what will happen to *us* in the future–what we will see, touch, taste and smell for the rest of our lives. We now come to a new problem concerning induction involving our ability to use this knowledge to justify beliefs about things we *can't* sense in this way. Consider Alice's dilemma at the end of *Through the Looking Glass*, when she is trying to determine whether her experiences were the result of *her* dream or whether they were the result of the *Red King's* dream. It seems obvious to us, of course, that it must have been Alice's dream. The problem for Alice, however, is to explain to a skeptic (like Tweedledee) *why* she is justified in believing that it is her dream.

Alice's problem is a special case of what philosopher W.V. Quine (1908-2000) calls the **problem of *underdetermination* of theory by evidence**[vi]. Here, a person's *theory* is simply the collection of all of her beliefs about the world. Alice's theory, for instance, includes such beliefs as *London is located in England* and *I am not a character in the Red King's dream*. Tweedledee's competing theory, by contrast, includes the belief that *Alice is a character in the Red King's dream*. Someone's *evidence*, in Quine's sense, consists of everything that she can sense. Alice's evidence, for example, includes her memory of seeing the Red King sleeping and her memory of apparently "waking up." The problem, according to Quine, is that no matter how much evidence we gather, there will always be multiple incompatible theories that can explain all of it.

Consider Alice's experience of "waking up," for instance. This might seem to rule out Tweedledee's theory. After all, if Alice woke up, it must have been her dream, right? Tweedledee has an easy response, however—the reason that it seems to Alice that she is real and has woken up is because this is exactly what the Red King is dreaming. Tweedledee makes just this point when refuting Alice's claim that her tears show her reality: "I hope you don't suppose those are *real* tears."[vii] In fact, it turns out there is no possible piece of evidence that Tweedledee cannot accommodate by making suitable changes elsewhere in his theory. On the basis of such considerations, Quine concludes that nearly any statement can be reconciled with any piece of evidence: "any statement can be held true come what may, if we make drastic enough adjustments elsewhere in the system."[viii] No amount of evidence-gathering, it appears, will allow Alice to prove Tweedledee wrong.

The relevance of underdetermination to everyday life becomes apparent when one notes that Tweedledee's style of argument can be applied to challenge *any* belief we have about things that can't be directly sensed. And we have lots of such beliefs. Many scientific theories, for example, posit the existence of things too small or strange to be directly sensed: quarks, gamma rays, electrons, and gravitational forces. Scientists, using inductive reasoning, believe that these things exist because their existence explains the types of things we can examine with our senses. The problem of underdetermination states that there will always be some *other* theory (incompatible with ours) that could *also* explain this evidence.

It is not just scientists who believe in things they can't see. Alice, for example, believes that drinking the potion caused her to shrink and not the rest of the world to grow. However, there is nothing she could sense that would allow her to determine which process is actually happening. Alice, like the rest of us, also believes in object *permanence*. So, for example, she believes that the Duchess she encounters at the Queen's party is the *same* Duchess she saw earlier. But this isn't the only theory that could explain Alice's experience. One might alternatively think that the world is being destroyed and instantaneously created anew each second. We don't remember any such destructions, of course, but that is only because we were created so as to have (false) memories of a continuous experience. According to this theory, Alice is in fact seeing a different Duchess than the one she remembers meeting. Once again, there is nothing Alice could ever do to discover whether such a theory was true or false.

Like Hume, Quine does not intend for his problem to induce skepticism about the value and legitimacy of scientific inquiry or our ordinary ways of doing things. Instead, he is merely pointing out that successful inductive reasoning requires more than 1) deductive reasoning or 2) making successful predictions. Quine goes on to suggest three criteria by which we decide which theories we adopt.[ix] First, we need to make sure our theory doesn't contain false claims about our sensory experiences. For example, Alice shouldn't adopt the theory that she's never had a Wonderland-experience. Second, we should adopt theories that are as *simple* as possible. It's simpler, all things considered, to believe that there was only was only *one* Duchess instead of two. Finally, when we add new beliefs to our theory, we ought to change as *few* of our old beliefs as possible. If Alice were to believe that she was a character in the Red King's dream, for instance, she would have to change nearly every other belief she had (all of which presumed that she was real). The belief that the land beyond the looking glass was her own dream, in comparison, fits quite well with the rest of Alice's beliefs.

In the end, of course, there is no way of *ensuring* that one's theory is correct, just as there is no system for making perfect predictions. It might simply turn out that both Alice and Tweedledee, even after comparing evidence, are both justified in their respective beliefs, despite these beliefs contradicting one another. The correct response to this, according to Quine, is simply to note that that one *must* continue to believe in the truth of *some* theory; without it, one couldn't get around in the world. Alice's solution of recognizing the problem and simply going about her life is thus perfectly fine.

4.4 THERE'S NO MEANING IN IT, AFTER ALL: THE INDETERMINACY OF MEANING

Before moving onto the final problem, let's pretend that we've solved the first two. We're perfect at predicting what will happen to us, and we've come up with a complete, true theory of how the physical world works. The last problem of induction asks us to take this knowledge and use it to determine what various people *mean* by their words. This is a source of constant frustration to Alice, who has to deal with such nonsensical characters as the Mad Hatter, the Queen of Hearts, and Humpty Dumpty. Almost every character in Wonderland and beyond the looking glass misuses or equivocates on some key English word or phrase, and Alice is tasked with using her inductive reasoning skills to figure out what is meant *in English* by Wonderland words such as 'Time,' 'whiting,' and so on.

Quine takes up the problem of determining what people mean by their words in a book called *Word and Object*. In order to simplify matters, he supposes that a hypothetical translator finds himself (like Alice) alone in an environment in which it is unclear what various people mean by their words. The translator has no dictionary and no access to any bilinguals who speak both English and the native language (which I'll call Wonderese). After a careful consideration of the process by which this translation might proceed, Quine concludes that there will always be multiple incompatible ways to translate Wonderese words into English–that is, it is *indeterminate* what people mean by their words. To see how he arrives at this strange conclusion, it will help to consider Alice's struggles in a little more detail.

The first step in any translation is to establish which native sounds mean *yes* and *no*. Alice herself notes the reason for this when she fails in her attempt to translate her kittens' sounds into English:

It is a very inconvenient habit of kittens (Alice had once made the remark) that, whatever you say to them, they always purr. 'If they would only purr for 'yes' and mew for 'no,' or any rule of that sort,' she had said, 'so that one could keep up a conversation! But how can you talk with a person if they always say the same thing?[x]

Once we have figured out which native sounds mean *yes* and *no*, we can ask the natives questions to determine what they mean by various other sounds. It is through this process, for instance, that Alice discovers that 'whiting' is the stuff used to polish shoes beneath the ocean and that 'Time' is somebody that the Mad Hatter knows.

The problem arises, according to Quine, when one realizes that there will always be multiple English translations that can explain the answers Wonderland residents give to Alice's questions. So, suppose that Alice is trying to figure out whether the Wonderese speakers mean the same thing she does by 'rabbit.' She first points to the White Rabbit and asks a group of them 'Rabbit?' They respond affirmatively. In order to be extra careful, Alice points to the White Rabbit and his rabbit relatives at various times and places, and under all sorts of conditions. The Wonderland inhabitants continue to agree. However, Alice cannot establish that the Wonderese word 'rabbit' means the same thing as the English word until she rules out the possibility that the Wonderland inhabitants are referring to something that is *co-located* with rabbits. Some things that are co-located with the White Rabbit, for example, are all of his various *parts* (arms, legs, and so on). Perhaps the Wonderese word 'rabbit' refers only to some essential part of a rabbit (the heart, for example) when this part is attached to the rest of the rabbit. It is in this spirit that Quine writes "Point to a rabbit and you have pointed to a stage of a rabbit, to an integral part of a rabbit, to the rabbit fusion, and to where rabbithood is manifested."[xi]

The problem becomes even worse when one is trying to figure out the meanings of abstract words such as 'intelligence,' 'courage,' or 'acceleration.' The things that these words refer to are quite difficult (or impossible) to point to. The Dormouse's question "did you ever see such thing as a drawing of a muchness!"[xii] might strike us as quite silly, but it presents a significant problem for Quine's translator. In the case of sayings like 'much of a muchness,' there might be quite a number of sayings in other languages that could serve as adequate "translations."

As was the case with the underdetermination of theories, there are some limits on the translations we can adopt. In particular, we shouldn't adopt translations that get the natives' patterns of assent and dissent wrong. For example, Alice has good reasons not to translate the Wonderese 'rabbit' as meaning *mouse*. The problem is that, once we have satisfied this minimal constraint, we have no grounds for convincing someone who has a *different* translation that she ought to adopt ours, instead. Suppose, for instance, that the Red Queen were to visit Wonderland with Alice. She would presumably try to come up with a translation that made the connections to her own language as simple (Looking-Glass-ish) and straightforward as possible, while Alice would try to do the same with English. In the end, the translations may disagree, even after she and Alice have carefully settled all the facts not related to meaning.

In the real world, there are a variety of factors that keep us from disagreeing on translations of particular languages. It is very difficult, after all, to inductively reason our way to a translation based solely on our observations of native speakers. It is much easier to rely on dictionaries or textbooks, many of which are based on decades of careful research by linguists. In Wonderland, by contrast, this indeterminacy presents a much more obstinate and obvious problem. Wonderland residents repeatedly misunderstand both Alice and each other in strange (and sometimes malicious) ways. When Alice objects that the note in the knave's trial means nothing, for example, the king exclaims "If there's no meaning in it that saves a world of trouble, you know, as we needn't try to find any"[xiii] before launching into his own biased translation. Humpty Dumpty seems to have much the same philosophy when he offers Alice a translation of "Jabberwocky."

Not surprisingly, Alice's actions again suggest the best path for us to follow. In most cases, she strives to translate people's words in the way that she would want her own words understood. If it seems crazy to Alice that people would mean a certain thing by a particular word, she usually assumes that they *don't* mean that until their actions prove her wrong. Her attempts to provide translations are thus based on her sense of *charity*—Alice presumes that other people agree with her on the types of things that she takes to be true. This assumption cannot be established by perfect prediction, nor by scientific investigation, but must be assumed as a starting point for translation.

4.5 WONDERLAND AND THE REAL WORLD

At the end of her adventures, Alice wakes up and returns to a world more similar to the one that we are familiar with. It would be a mistake, however, to suppose that Alice need leave behind all she has learned about Wonderland, or that her experiences have nothing to teach us. Wonderland presents us with a weird sort of parallel earth where our expectations fail us and we must figure out everything anew. In doing so, we come to see the importance of inductive reasoning for surviving our daily lives, for uncovering the nature of the world around us, and for understanding one another. These are projects that we, like Alice, cannot help but care about.

As readers, we can look to Alice for a model of what it takes to be a good inductive reasoner. Alice, unlike the strange creatures she encounters, learns to control her size, and does not fall prey to the fatalistic belief that she lives only in the dream of another. In contrast to the jurors in the knave's trial, Alice realizes how preposterous the interpretation of the note really is. And she does all of this in the face of repeated challenges to her justification for reasoning as she does. In the end, Alice serves as a good reminder that not *all* reasoning is pointless or silly, and that a good reasoner is much more than an expert in the verbal gymnastics practiced by the residents of both Wonderland and our own world.

4.6 REVIEW QUESTIONS

1. What is the difference between a deductive and inductive argument? Can you give an example of a time you've reasoned in each of these ways?
2. What is David Hume's *Problem of Induction?* Do your best to explain it in your own words. How much do you think this problem should worry us? (Hume argued that it means that induction *can't* be rationally justified, even though we need to use it to survive!)
3. What is the "underdetermination of theory by evidence?" What problems does this raise for science?
4. What is the problem of the "indeterminacy of reference"? How does this differ from the Problem of Induction or the Underdetermination problem?

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i Lewis Carroll. *Symbolic Logic* (London: MacMillan, 1896), p. 64.
ii Lewis Carroll. "Alice's Adventures in Wonderland". In: *The Annotated Alice*. Ed. by Martin Gardner (Bungay: Penguin Books, 1965), p. 31.

iii David Hume. *An Enquiry Concerning Human Understanding*. Ed. by Eric Steinberg. 2nd ed (Indianapolis: Hackett Publishing Company, 1993), p. 14.

iv Lewis Carroll. "Through the Looking Glass". In: *The Annotated Alice*. Ed. by Martin Gardner (Bungay: Penguin Books, 1965), p. 269.

vHume, p. 15.
vi Quine discusses this problem in (W.V. Quine. *Word and Object*. Cambridge, MA: M.I.T. Press, 1960) and (W.V. Quine. "Two Dogmas of Empiricism". In: F*rom a Logical Point of View*. Cambridge, MA: Harvard University Press, 1980, pp. 20-47)

viiCarroll, "Through the Looking Glass", p. 239.
viiiQuine, "Two Dogmas of Empiricism", p. 43.
ixQuine, *Word and Object,* pp. 19-22.
xCarroll, "Through the Looking Glass", p. 341.
xiQuine, *Word and Object*, pp. 52-53.
xiiCarroll, "Alice's Adventures in Wonderland", p. 103.
xiiiCarroll, "Alice's Adventures in Wonderland", p. 159.