Traditional logic

Aristotelian Logic

Aristotle was one of the foremost thinkers of the classical world, and his approach to logic and thinking is still in use today. Aristotelian logic is described in his books *Prior Analytics* and *De Interpretatione*. His collected works on the subject are known as the *Organon*.

Traditional logic, as originated by Aristotle, obeys formal rules and is *bivalent* -- that is, it is about truth and falsehood with nothing in between.

A logical flaw or fallacy is one in which the laws of logic are not followed (irrespective of whether there is real truth there or not). This can often be seen through the use of Set Theory.

An argument that has a logical flaw in it is *invalid*. A valid argument that is actually true is also *sound*.

Logical arguments fall down when the premises are false. It is also possible to get snared in a complex logical argument that seems to follow logical rules, but is in fact a fallacy.

Three ways to persuade

Aristotle, perhaps the most famous arguer, described three routes to change the mind of the other person.

Ethos

Ethos uses trust, and focuses first on the speaker. showing the speaker

Reputation

The reputation of a person depends on their past, and what is known and spoken about them. Note that, although there is usually a close relationship between reputation and reality, this is not always so. Politicians, for example, guard their reputation carefully, yet many still have skeletons in the closet. Leveraging reputation often means reminding others of your illustrious past, perhaps through stories of your successes, of how you have helped others and been able to see the truth where others have not.

Credibility

Credibility, depends both on expertize and how this is portrayed. If you want people to believe you, you must first show that you believe yourself. To use credibility, position yourself as an expert. Talk as if you cannot be challenged. Show how others look up to you. Use powerful gesture, eye contact and so on to position yourself as a leader.

Pathos

Pathos appeals to the emotions of the listener, seeking to excite them or otherwise arouse their interest. Emotions are our feelings. A basic of much emotional arousal is that there is a *goal* at stake somewhere. Our emotions thus cause us to want and not want. And when we have what we wanted, we then have emotions about owning it.

An effective way of arousing passions is in appeal to values. Values should not be confused with 'value' as in the value you get from buying a cheap, but well-built house. Values are, in fact powerful drivers of how we think and behave. Tell stories of poor values, for example where innocent people are harmed. Use Ethos to show your own values and how you put others before yourself. You can also work with their goals and interests or even challenge their beliefs. Language has a significant effect on emotion, and key words (fire, child, anger, smooth, etc.) can trigger senses and feelings.

Logos

Logos focuses first on the argument, using cool logic and rational explanation, as well as demonstrable evidence.

Evidence

Science and scientific proof are based on the use of empirical evidence. The word 'empirical' comes from the Greek word *empeiria*, meaning 'experience', and its history goes back to Plato and the Sophists (which has the same root as 'sophisticated'). The basic principle of empiricism is that *truth* comes only from direct experience. To believe something, the empiricist needs justification and hence evidence. If you argue without evidence, a scientist would dismiss your argument as metaphysical (literally, outside the physical world). Empiricists oppose intuition, rationality, authority or other concepts. They particularly reject Rationalism, arguing that thought is not enough and empirical evidence is necessary to prove truth.

Evidence cannot be refuted, as courts of law seek to demonstrate. If you show, then it is very difficult to deny without calling into question the validity of the evidence produced.

Evidence can include statistics, pictures and recounted experience (especially first hand). Pathos may also be evoked when giving evidence as you give it an emotional spin. Ethos is also important to establish the credibility of the witness.

Reason

The basic principle of rationalism is that *truth* can be best discovered through reason and rational thought. Reason uses rational points that call on accepted truths and proven theories. Where evidence does not exist, reason may still prevail. A common tool in reasoning is to link two items together, for example by cause and effect.

Rationalists assume that the world is deterministic, and that cause and effect hold for all events.

They also assume that these can be understood through sufficient understanding and thought. *A priori* (prior to experience) or rational insight is a source of much knowledge. Sense experience, on the other hand, is seen as being too confusing and tentative. **Logic** and **mathematics** are classic rational disciplines, as is **philosophy**.

Rationalism was particularly challenged by Positivism, which seeks empirical evidence rather than relying on the perceived unreliability of individual thinking. The basic principle of Positivism is that all factual knowledge is based on the "positive" information gained from observable experience, and that any ideas beyond this realm of demonstrable fact are *metaphysical*. The roots of Positivism lie particularly with Empiricism, which works only with observable facts, seeing that beyond this is the realm of logic and mathematics. In the history of social understanding, Positivism originated out of the French Enlightenment, with French philosopher Auguste Comte, who sought to the replace the 'brainpower approach' of Rationalism by leveraging the principles of the natural sciences (such as Physics, Chemistry and Biology). At the time of Comte, science was having a huge impact and was steadily replacing religion as the key authority for knowledge about what was true or false. Even today, when something is pronounced 'scientific' then it is generally held to be irrefutable.

Only analytic statements are allowed to be known as true through reason alone. Thus 'Roses are flowers' is analytic, whilst 'Roses are fragrant' is synthetic and requires evidence.

The six tenets of Positivism are:

Tenet	Meaning
Naturalism	The principles of the natural sciences should be used for social science.
Phenomenalism	Only observable phenomena provide valid information.
Nominalism	Words of scientific value have fixed and single meanings. The existence of a word does not imply the existence of what it describes.
Atomism	Things can be studied by reducing them to their smallest parts (and the whole is the sum of the parts).
Scientific laws	The goal of science is to create generalized laws (which are useful for such as prediction).
Facts and values	Facts are to be sought. Values have no meaning for science.

Positivism seeks *empirical regularities*, which are correlations between two variables. This does not need to be causal in nature, but it does allow laws to be defined and predictions made. *Logical Positivism* places particular emphasis on sense experience and observation and attempted to eradicate metaphysics and synthetic statements. Promoted by the 'Vienna Circle'. For each object, a definitive 'mimetic' statement can be made to accurately reflect the object. They used inductive approaches, collecting data and building theories on this. Logical Positivists include early Wittgenstein, Bertrand Russell and Alfred Whitehead (*Principia Mathematica*) and

Rudolph Carnap. Although Positivism has since been shown to be inadequate to study the full range of human experience, it has been hugely influential and still affects the significant use of experiments and statistics in social research.

Reasoning often uses syllogisms that include a major premise, a minor premise and a conclusion based on the combination of the two premises.

Types of reasoning

Reasoning within an argument gives the rationale behind why one's choice, for example, should be selected over another. Types of reasoning include:

Abduction: the process of creating explanatory hypotheses. A is observed. If B were true, then A would be true. Therefore B *may* be true.

Abduction, or **inference to the best explanation**, is a method of reasoning in which one chooses the hypothesis that would, if true, best explain the relevant evidence. Abductive reasoning starts from a set of accepted facts and infers their most likely, or best, explanations. It creates a *hypothesis* that may or may not be true and which may require further work to verify. The term *abduction* is also sometimes used to just mean the generation of hypotheses to explain observations or conclusions, but the former definition is more common both in philosophy and computing. The process of abduction may well have a significant subconscious element, for example where an expert draws on tacit knowledge to explain a new phenomenon. Nobel Prize-winner Henri Poincaré said ‘It is through science that we prove, but through intuition that we discover.’

Example

A doctor, meeting a set of symptoms not met before, considers diseases that have similar symptoms and wonders if the presented condition is something similar.

A detective homes in on what seem to be important clues to a crime.

Analogical reasoning: relating things to novel other situations. A is like B. M is in A. N is in B. So M is like N.

In analogical reasoning, an analogy for a given thing or situation is found, where the analogy is *like* the given thing in some way. Other attributes of the analogical situation are then taken to also represent other attributes of the given thing.

To use an analogy:

- Start with a target domain where you want to create new understanding.
- Find a general matching domain where some things are similar to the target domain.
- Find specific items from the matching domain.
- Find related items in the target domain.

- Transfer attributes from the matching domain to the target domain.

Example

This company is like a racehorse. It's run fast and won the race, and now it needs feed and rest for a while.

Cause-and-effect reasoning: showing causes and resulting effect.

When you are presenting an argument, show the cause-and-effect that is in operation. Help the other person see why things have happened or will happen as they do.

Show purpose: Link things to higher values. Show the inevitable linkage between what happens first and what happens next. Go beyond correlation (that may show coincidence) to giving irrefutable evidence of causality. If you cannot show causal linkage, then you may be successful just by asserting it, because few people will challenge a cause-and-effect assertion.

Example

Say this	Not this
If I help you, you will be more successful.	I will help you.
When the moon is high, things are abroad.	Things are sometimes abroad.
The new additive to fuel makes your car go so much further.	Add our new fuel additive to your car.

We have deep needs for explanation and to be able to predict what will happen. We also need to be able to appear rational to others, and that they appear rational to us. When a person explains cause and effect, we are reassured that they are, indeed, reasonable people, and we hence trust them and their arguments more than we might otherwise do.

This need leads to psychological effects where you can offer a cause-and-effect argument that clearly has no real causal connection, yet it is surprising how many people will accept your argument without question.

- Cause-to-effects reasoning: starting from the cause and going forward.

When describing a cause-effect situation, start with the cause and then add the effect or effects afterwards. This is particularly concerned with words in a single sentence, although the logic applies if spread across sentences.

Example

Say this	Not this
The girl slapped the boy.	The boy was slapped by the girl.

If you send me the money, I will send you the goods.	I will send you the goods if you send me the money.
The people kicked the ball out of the field. It hit a passing police car.	A police-car was hit by a ball. It had been kicked out of the field.
Poverty is on the increase. People are desperate. Crime rates are rising.	Crime rates are rising because people are desperate due to increasing poverty.

Cause-and-effect reasoning is generally persuasive as it helps answer the question 'why' something happens, making a statement objective and rational rather than a blind assertion.

Starting with the cause is often linguistically easier than starting with the effect, making the sentence easier to both say and understand.

Starting with the cause builds creative tension as an expectation is set up that something will happen because of it. This can make your audience more interested in what you are saying.

There is also an assumption in this argument that one cause can have multiple effects. This can be used to show the power of a simple action.

False cause-to-effects happens when we do not like something (for example handguns) and seek to create an effect to justify our beliefs (for example that having handguns will lead to many people becoming criminals).

- Effects-to-cause reasoning: starting from the effect and working backward.

When describing a cause-effect situation, start with the effect or effects and then work back to the cause of these. You can do this by asking 'why did this happen', creating curiosity and then explaining why. Using the word 'because' to connect effects to cause can be particular effective. 'If you want...then...' can also be useful.

Example

Say this	Not this
You lost the game because you did not listen to me.	You did not listen to me so you lost the game.
The economy is suffering. The President is too concerned with foreign policy.	The President's foreign policy is causing the economy to suffer.
If you want to rule the world, you have got to work hard now.	Work hard now and you will be able to rule the world.
Can I have a cup of coffee? I am very thirsty.	I am very thirsty. Can I have a cup of coffee?

Putting the effects first anchors the statement in reality. It makes a statement that cannot be denied as it is a statement of known effects. The truth of the effects is then reflected into what may well be a hypothetical cause. When something happens, there is a deep need to explain and answer why it has happened. Thus if you present a problem, people will start wondering why, thus making themselves more ready for your answer.

Comparative reasoning: comparing one thing against another.

Comparative reasoning establishes the importance of something by comparing it against something else. The size of the gap between the things compared indicates importance. Compare against a high standard to make something look undesirable. Compare it against a weak example to make it look good.

To create a logical argument, first establish the validity of the comparison benchmark. For less logic, the benchmark may be assumed. There are many ways to compare, for example:

- Compare what people have got (or not got) against what others have.
- Compare the past with the future.
- Compare what is actual with what is ideal.
- Compare words and actions against values.

Example

Say this	Not this
I guess your wife will want something good-looking. How about this one?	This is the right one for you!
How will we know when we have succeeded? Let's discuss this first...	Success means maximum profits.
Our manifesto says we must help those who cannot help themselves. Now, can this person help himself?	We should not help this man.

Comparison is a very natural form of judgment as we find it difficult to evaluate something on a stand-alone basis. We want to know if it is better or worse -- but better or worse than what? If you can establish the benchmark, then the rest follows naturally. Not only is there an assumption that the benchmark item is the right thing to compare against, but the assessment of how much better or worse things are is also assumed to depend on the size of the gap between the item being compared and the benchmark.

Criteria reasoning: comparing against established criteria.

Start by defining the criteria by which the outcome of a decision will be judged, and then identify the best decision, given these constraints. In a logical argument, you will spend much time establishing the criteria as valid first. In a less logical situation, you may assume the criteria are correct, minimizing the time spent on any discussion about them.

Criteria which appeal to common values are likely to be easily accepted. Establishing criteria provides legitimacy for any future argument, as the criteria form the rules by which right and wrong are judged, even when criteria are assumed to be true without discussion. The easier criteria are to accept as reasonable, the less likely it will be that people will question them. Using common values helps this.

Conditional reasoning: using if...then...

Conditional reasoning is based on an 'if A then B' construct that posits B to be true if A is true.

Note that this leaves open the question of what happens when A is false, which means that in this case, B can logically be either true or false. A classic form of conditional reasoning is in using syllogisms, where a general major premise is combined with a more specific minor premise to form a conclusion. Syllogisms are easy to get wrong and there are many fallacies.

The card trap

A classic trap was used by Wason and Johnson-Laird (1972) to show how poor we really are at reasoning. Four cards are laid out as below:

E	K	4	7

The conditional statement is now given: 'If a card has one vowel on one side, then it has an even number on the other side.' The question is to decide which are the minimum cards that need to be turned over to prove that the conditional statement is true.

More than half of people questioned said E and 4.

To affirm the antecedent, E is correct. E is a vowel and thus should have an even number on the other side. If there was an odd number on the other side, the statement would be false, so E must be turned over to check for this.

But choosing 4 is affirming the consequent. Even though 4 is even, it can have a vowel or consonant on the other side and the statement is not falsified.

Only 4% said E and 7. The 7 could deny the consequent and hence must be checked. If there was a vowel on the other side, the statement would be false.

Be careful about if-then statements, both in your own use and in those that others use. It does, of course also mean that you can make statements that are logically false and few people will challenge you.

Decompositional reasoning: understand the parts to understand the whole.

Break the item in question down into its component parts. Analyze those parts and how they fit together. And then draw conclusions about the whole.

Example
I want to find out how a rubic cube operates. I pull it apart to see its hidden workings. By reassembling it slowly, I am able to explain its apparently magical cohesion as a whole in terms of three-dimensional geometry.
I listen to your argument and take note of each element. I then argue against each element in turn. Having destroyed the parts, I then assume I have destroyed the whole argument.

Much of science takes a decompositional approach to things, breaking them down into parts, atoms and smaller still. The notion that a thing is the sum of its parts and no more thus has a highly credible air. A problem with decompositional thinking is that the whole thing can easily be more than the sum of its parts. A person is more than bone and muscle. You cannot understand a car by studying each item in isolation.

A trick in effective decompositional reasoning is to use it as lens, understanding the parts but not assuming that they fully describe the whole. The biggest trick is in understanding the relationship between the parts. The problem with this is that relationships increase with the square of the number of parts, making full understanding of even a simple device potentially very difficult. Decomposition is a very useful lens and often does tell the whole story, but there are many situations where this is an inadequate approach.

Deductive reasoning: starting from the general rule and moving to specifics.

Deductive reasoning, or *deduction*, starts with a general case and deduces specific instances.

Deduction starts with an assumed hypothesis or theory, which is why it has been called 'hypothetico-deduction'. This assumption may be well-accepted or it may be rather more shaky -- nevertheless, for the argument it is not questioned. Deduction is used by scientists who take a general scientific law and apply it to a certain case, as they assume that the law is true. Deduction can also be used to test an induction by applying it elsewhere, although in this case the initial theory is assumed to be true only temporarily.

Example

Say this	Not this
Gravity makes things fall. The apple that hit my head was due to gravity.	The apple hit my head. Gravity works!
They are all like that -- just look at him!	Look at him. They are all like that.
Toyota make wonderful cars. Let me show you this one.	These cars are all wonderful. They are made by Toyota, it seems.
There is a law against smoking. Stop it now.	Stop smoking, please.

Deductive reasoning assumes that the basic law from which you are arguing is applicable in *all* cases. This can let you take a rule and apply it perhaps where it was not really meant to be applied. Scientists will prove a general law for a particular case and then do many deductive experiments (and often get PhDs in the process) to demonstrate that the law holds true in many different circumstances. In set theory, a deduction is a subset of the rule that is taken as the start point. If the rule is true and deduction is a true subset (not a conjunction) then the deduction is almost certainly true. Using deductive reasoning usually is a credible and 'safe' form of reasoning, but is based on the assumed truth of the rule or law on which it is founded.

Validity and soundness

Deductive conclusions can be *valid* or *invalid*. Valid arguments obey the initial rule. For validity, the truth or falsehood of the initial rule is not considered. Thus valid conclusions need not be true, and invalid conclusions may not be false. When a conclusion is both valid and true, it is considered to be *sound*. When it is valid, but untrue, then it is considered to be *unsound*.

The **deductive method**, begins with an accepted generalization--an already formulated or established general truth and applies it to discover a new logical relationship. That is, through deduction we can come to understand or establish the nature of something strange or uncertain by associating or grouping it with something known or understood.

Deductive arguments are formed in two ways:

1. General to particular. This is the kind most people think of when they think of deduction. For example, the classic syllogism:

All men are mortal.
Socrates is a man.
Therefore, Socrates is mortal.

2. General to General. Another kind of deduction arrives at new generalizations through the syllogism. For example:

All trees have root systems.
All root systems need nitrogen.
Therefore, All trees need nitrogen.

In both of these examples we can discern three parts: a beginning statement of the generalization, an ultimate conclusion, and an intermediate step which associates the first statement with the conclusion. Notice also that three different identities or concepts (called "terms") are present: in the second example they are "trees," "root systems," and "[things that] need nitrogen." Deduction, then, associates or relates two terms by means of a common third (or middle or intermediate) term, so that we can understand how the first two terms are related to each other. The final statement of relationship is called a conclusion, and it expresses either convergence (identity) or divergence (non-identity)--either "X is Y" or "X is not Y," or some similar statement. Another way to express this process is to say that deduction begins with two judgments sharing a common concept (term), and that by relating the two judgments to each other *through* the common term, a third judgment necessarily follows. Thus we have a three-part argument: judgment, judgment, conclusionary judgment. When this three-part deductive argument is arranged into a proper form (or structure), the argument is called a syllogism.

But before we get into syllogistic analysis, a little more needs to be said about deduction as a whole. We said earlier that deduction begins with an accepted generalization. Such a statement raises two questions: (1) Where do these generalizations come from and (2) Why are they accepted or assumed to be true?

The generalizations used in deductive thinking come from several sources:

- Inductive thinking
- Other deductive arguments (of the general to general type)
- Revelation
- Assumption (*a priori* givens that cannot be proved but that are assumed. All knowledge must begin with belief.)

In all four of these cases, the immediate source may be authority rather than personal experience. That is, the inductive conclusion, the deductive argument, the revelation, or the assumption may have been achieved by a third party who presents the generalization to us for acceptance on the basis of authority, in which case we take it on faith. You may not be able to do a large scale inductive experiment to find out whether a certain generalization is true, so you look in a book and accept the generalization of the authority.

To clarify the second question about why the generalizations are accepted, it should be said that a given generalization in an argument is *assumed* to be stabilized or true or agreeable to all parties *unless* challenged. Any given generalization may be false or unacceptable for the purpose of argument, so that any conclusion deduced from it, while perhaps formally valid (structurally all right), will be untrue. The generalizations used in deduction are often the products of induction, and are thus subject to every danger and error of the inductive process.

The dangers of deduction, then, are two:

1. The premises (generalizations) are not true, or are not adequate representations of reality, either because they have been derived through erroneous inductions or because they are false on the face. (ARGUMENT NOT TRUE)

2. A formal error of procedure has been committed. (ARGUMENT NOT VALID)

The advantage deduction has over induction is mostly one of form: if the premises (or generalizations) are granted, and if the procedure is correct, then the conclusion *necessarily follows*. (Note that the strength of a deductive conclusion cannot be changed, though the conclusion can be overthrown.) Again, however, the quality of the conclusion is directly dependent on the quality of the generalizations on which it is based; and since inductively obtained generalizations are almost always somewhat tentative, we can seldom make absolutely inarguable deductions. Sherlock Holmes frequently makes valid deductions based on rather wild premises (which, of course, nearly always turn out to be correct); we cannot hope to be so lucky, so we have to be more careful.

All of us in our ordinary thinking combine induction and deduction to help us understand our world. We continually add facts together and then subtract the totals from each other to reach some final conclusion. The study of logic assures that our conclusions will be as accurate and sound as possible. As consumers, voters, researchers, jurors, writers, and so forth we especially want our conclusions to be worthwhile and trustworthy and reasonable (with all that implies), and for this some care and exactness and a good scrutinizing ability are necessary.

As you can see, the conclusions of both inductive thinking and deductive thinking can be wrong. In the case of induction, the leap can be too far or incorrect: probability always includes the negative possibility. In the case of deduction, the premises used in the argument might not be true after all. Truly, "To know is to risk being wrong," for "Now we know only in part. . . ."

Inductive reasoning: starting from specifics and deriving a general rule.

Inductive reasoning, or induction, is reasoning from a specific case or cases and deriving a general rule. It draws inferences from observations in order to make generalizations.

Inference can be done in four stages:

1. *Observation*: collect facts, without bias.
2. *Analysis*: classify the facts, identifying patterns o of regularity.
3. *Inference*: From the patterns, infer generalizations about the relations between the facts.
4. *Confirmation*: Testing the inference through further observation.

In an argument, you might:

- Derive a general rule in an accepted area and then apply the rule in the area where you want the person to behave.
- Give them lots of detail, then explain what it all means.
- Talk about the benefits of all the parts and only get to the overall benefits later.
- Take what has happened and give a plausible explanation for why it has happened.

Inductive arguments can include:

- *Part-to-whole*: where the whole is assumed to be like individual parts (only bigger).
- *Extrapolations*: where areas beyond the area of study are assumed to be like the studied area.
- *Predictions*: where the future is assumed to be like the past.

Example

Say this	Not this
Look at how those people are	Those people are all mad.

behaving. They must be mad.	
All of your friends are good. You can be good, too.	Be good.
The base costs is XXX. The extras are XXX, plus tax at XXX. Overall, it is great deal at YYY.	It will cost YYY. This includes XXX for base costs, XXX for extras and XXX for tax.
Heating was XXX, lighting was YYY, parts were ZZZ, which adds up to NNN. Yet revenue was RRR. This means we must cut costs!	We need to cut costs, as our expenditure is greater than our revenue.

Early proponents of induction, such as Francis Bacon, saw it as a way of understanding nature in an unbiased way, as it derives laws from neutral observation.

In argument, starting with the detail anchors your persuasion in reality, starting from immediate sensory data of what can be seen and touched and then going to the big picture of ideas, principles and general rules.

Starting from the small and building up to the big can be less threatening than starting with the big stuff.

Scientists create scientific laws by observing a number of phenomena, finding similarities and deriving a law which explains all things. A good scientific law is highly generalized and may be applied in many situations to explain other phenomena. For example the laws of gravity was used to predict the movement of the planets.

Inductive arguments are always open to question as, by definition, the conclusion is a bigger bag than the evidence on which it is based.

In set theory, an inductively created rule is a superset of the members that are taken as the start point. The only way to prove the rule is to identify all members of the set. This is often impractical. It may, however, be possible to calculate the probability that the rule is true.

In this way, inductive arguments can be made to be more valid and probable by adding evidence, although if this evidence is selectively chosen, it may falsely hide contrary evidence. Inductive reasoning thus needs trust and demonstration of integrity more than deductive reasoning.

Inductive reasoning is also called *Generalizing* as it takes specific instances and creates a general rule.

Modal logic: arguing about necessity and possibility.

Describe things in terms of possibility and necessity. Also explore how there intertwine.

Do not state things in terms of absolute truth, but say *how* likely it is.

For necessity, talk about *how* necessary something is. Thus use words like *can, may, should, ought, must, have to*.

Talking about *how* true or necessary something is gives you more potential in arguments as you now have an analogue continuity of alternatives, rather than the black-and-white binary decision of simply whether something is true or false, necessary or unnecessary.

Example

Say this	Not this
The door might be open.	The door is open.
You must do it.	You do it.
They could come here.	They will come here.

Traditional logic is based on *extension*, in that the truth of the logic is found within the supporting statements. Modal logic are based on *intention*, in that truth is where you find it, and that the reality of many situations is that it is impossible to determine exact truth.

Thus:

- A sentence is *possible* if it *might* be true (or might be false).
- A sentence is *necessary* if it *must* be true (and cannot possibly be false).
- A sentence is contingent if it *not necessarily* true. (a contingent truth is true in the given case, but might not have been true).

Necessity and possibility have aspects of a Boolean relationship in that:

It is not necessary that X is true = It is possible that X is not true

It is not possible that X is true = It is necessary that X is not true

The modalities of possibility and necessity are also known as *alethic modalities.*

Deontic logic is the specific logic about duty, where necessity is has a moral quality to it.

Traditional logic: assuming premises are correct.

Start with premises that are assumed to be true. Then use only logical rationale to derive a conclusion. Be careful that it is applied correctly. Keep emotion well out of it.

Example

Say this	Not this
All people have potential. You are a person. You have potential.	Some people have potential. You are a person. You have potential.
Some bananas are yellow. Some	Some bananas are yellow. Some

bananas are green. I don't know if there are any green and yellow bananas.	bananas are green. Therefore some bananas are green and yellow.
Murder is wrong. Shooting someone dead is murder. Therefore shooting someone dead is wrong.	Shooting someone dead is murder. Murder is wrong. Therefore shooting someone dead is wrong.

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A logical flaw or fallacy is one in which the laws of logic are not followed (irrespective of whether there is real truth there or not). This can often be seen through the use of Set Theory.

An argument that has a logical flaw in it is *invalid*. A valid argument that is actually true is also *sound*.

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Pros-vs-cons reasoning: using arguments both for and against a case.

Pros-vs-cons reasoning seeks to weigh up the arguments for a case (pros) against the arguments against the case (cons).

The argument will usually end up with a conclusion of whether the pros or cons are stronger, thus precipitating a 'reasonable' conclusion. Things that will make a 'pro' stronger (and vice versa) include:

- More logical arguments.
- More evidence being displayed (including actions and perceptions of other people).
- Greater emphasis being put on key words.
- *More* arguments for the case.

Starting with the favored side allows you to fill the other person's mind with the key points, such that the second list becomes less easy to absorb. Starting with the disfavored side allows you to make it sound reasonable, then knock down each of the disfavored arguments with stronger arguments for the contrary case.

You can also choose between giving all of one side and all of another or alternating between each side (the latter is good for comparing related for-and-against arguments).

Example

Say this	Not this
It is useful and cheap, but on the other hand it won't last long and will make you look ungenerous.	It won't last long and will make you look ungenerous.
James likes it, Jan likes it, Bill likes it, Fred likes it. Only Sam and Alice don't like it.	Most people like it.
Look at the list of features on this...But when you try it at home, you may find that...	When you try it at home, you may find that...

Offering arguments both for and against a case makes the arguer seem even-handed, neutral and hence trustworthy. It also takes the wind out of the sails of a counter-argument if you have already discussed the point. Quantity and quality may be confused, and *more* arguments for one side can make it look like that side is the better choice.

Set-based reasoning: based on categories and membership relationships.

Set-based reasoning is founded on Set Theory. Its arguments range around whether things are members of named groups or not, thus 'A dog is an animal but not a vegetable'.

The basic assumption is one of membership, that an item can be categorized into a given group or set. This also assumes that both the item and the set exist in the first place. The following argument then may include consideration of the overlap between sets and the implications of this.

Set reasoning often thus includes statements along the lines of:

- A is a B
- If A is a B then...
- A is not a B, but it is a C
- A is both C and D, therefore...

Example

Say this	Not this
He works for Microsoft. Microsoft people are intelligent. Therefore he is intelligent.	He works for Microsoft and is intelligent.
If this is an international standard CD then it will use ISO standard encryption coding.	ISO encryption will be used here.
If he is both Italian and lives in New York, then he is likely to be fond of	He probably likes pizza.

pizza.	

Set theory makes careful distinction about what a thing is and what it is not. It is thus very precise about definitions and puts a lot of focus here. It also is concerned with membership relationships and hierarchies, seeking higher and lower members of an order.

The verb 'to be' is important here. When we say an item 'is' a member of a set, we assume it has *all* the attributes of the set. A common error set-based is when we say to a person something like 'you are silly'. The person (or others) may take this description to indicate that they are nothing but silly, having all the attributes of silliness. This can cause significant psychological effects.

Systemic reasoning: the whole is greater than the sum of its parts.

Understand something by considering it as a whole system. Analyze not just the parts but also the relationships between the parts.

You can use decompositional reasoning to identify parts, but go beyond this in considering the additional things beyond just the parts.

Example

I argue for a new square in the middle of town by considering the aesthetics of space and the relationships between the empty square and the tall buildings around it. I also consider the dynamics of movement and pauses of people during parts of the day and weekend.

A 'system' is a set of connected parts, each of which may be considered as system in its own right. An individual part can have any number of different relationships with any other part of the system. Thus there are relationships between me and the seat I am sitting on based on space, friction, electromagnetism, gravity, and so on.

A *closed system* assumes that there is no external influences. Science likes closed systems as this allows totally deterministic answers.

An *open system* assumes that everything can be connected to everything else. The ultimate open system is the universe, with any part being able to influence any other part. This is much harder to analyze and understand, but it is also much more real.

Systems also may consider whether or not each part of the system has purpose and will. Thus, for example, a company is made up of people, all of whom may have purpose beyond that of the company (and thus making achieving the company's purpose more complex than it might at first seem).

Syllogistic reasoning: drawing conclusions from premises.

Syllogistic reasoning is concerned with using syllogisms to draw conclusions from premises.

Syllogistic traps

We each make many statements in conversation and written statements, implying logical connections between them. Sadly, the logic and truth that we assume is not always there.

Consider the following statements and conclusion:

Statement 1: All men are animals

Statement 2: Some animals are aggressive

Conclusion: Some men are aggressive

This seems to be a reasonable conclusion, but then consider the following:

Statement 1: All men are animals

Statement 2: Some animals are female

Conclusion: Some men are female

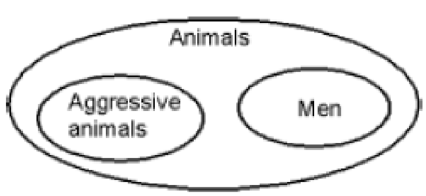
Now the conclusion appears to be ridiculous and false - *yet the reasoning is exactly the same as in the first example*. The first example thus has a false conclusion. The animals who are aggressive are *not necessarily* men.

What is happening here is that we are using what we know to be true as a *substitute* for the logic of the statement. In less certain situations, we use the same unspoken assumptions and beliefs to less acceptable ends.

There are a number of other syllogistic fallacies that can trap the unwary logician.

Using Venn diagrams

Syllogistic reasoning uses rational logic and hence set theory applies and the best way to visualize it is to draw a Venn Diagram. The diagram below is a valid drawing that explains the first two statements in the example.



The conclusion of the example falls into the traps of making the assumption that the 'aggressive animals' and 'men' subsets *necessarily* overlap, whereas there is no necessity for this in statements one and two. Although the conclusion *could* be true it does not have to be true.

Note that these are not all mutually exclusive methods and several give different lenses onto overlapping areas. In classical argument, for example, all arguments are framed as either inductive or deductive.