LOGIC FOR THE LSAT: a brief tutorial for BIPOC considering Law School

The aim of this course is to provide BIPOC with information and skills required for the LSAT. This course will focus on the Logical Reasoning portion of the LSAT only.

Preliminary notes:

- The language in these questions is intentionally intimidating.
- Questions may address sensitive issues.

What Is Logic?

Logic is the study of **arguments**. In logic, **'argument**' has a specific definition. An **argument** is at least two **propositions** (a sentence that is either true or false), exactly one of which, the **conclusion**, follows from the other(s), called **premise(s)**. **Premises** provide support for the conclusion, or reasons to believe the conclusion to be true. Logic is interested in the relationship between the premises and the conclusion. This relationship is called **entailment.** The truth of the conclusion follows from (is entailed by) the truth of the premises.

Common **premise indicators**:

- Because
- Since
- Given that
- As indicated by
- For the reason that
- Owing to

Common **conclusion indicators**:

- Therefore
- Thus
- It must be
- Hence
- Entails that
- Accordingly
- Consequently
- We may infer

Argument Structure:

Premise		Premise
Conclusion	or	Premise
		Conclusion

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The degree to which the truth of the premises is supposed to entail the truth of the conclusion determines whether we evaluate the argument according to **formal** or **informal** standards of evaluation. If we evaluate according to **formal** standards, that means that entailment claim is one of **logical necessity**. That means that **if** the premises are true, **then** the conclusion **must** be true. This is **must** in the strongest sense: it is **impossible** to imagine a situation where the premises are true and the conclusion false. The strength of the entailment comes from the **structure** (or **form**) of the argument. If it is impossible for a conclusion to be false, given the truth of its premises, an argument is considered **valid**. Likewise, if it is possible for the premises to be true and the conclusion be false, that argument is **invalid**. It is possible to have a **valid argument** with actually false premises. For an argument to be **valid**, it needs to be the case that **IF** the premises are true, the conclusion must be true. The premises don't actually need to be true for an argument to be **valid**. **Validity** is determined by the **form**, not the content of the argument. A **valid** argument with actually true premises is called a **sound** argument. It is worth noting that formal arguments are, in a sense, uninformative. That is to say, a sound argument won't produce any new information. The truth of the conclusion is there in the truth of the premises. It is because no new information is brought in that the truth of the conclusion can be absolutely guaranteed.

Kinds of **formal** arguments:
- Arguments from math
- Arguments from definition
- Syllogisms (exactly 2 premises and 1 conclusion)
    - Categorical syllogism (All..No..Some)
    - Hypothetical syllogism (If...then)
    - Disjunctive syllogism (Either..or)

Formal evaluation indicator words:
- Necessarily
- Certainly
- Absolutely
- Definitely
- Must

When we evaluate arguments according to **informal** standards, we are not assuming the truth of the premises means the conclusion must necessarily be true. With **informal arguments** we assess the **strength** of entailment by how **likely** or **probable** the conclusion is to be true, given the truth of the premises. A **strong argument** is one where if the premises are true, the conclusion is very **likely** to be true. A strong argument with actually true premises is called **cogent.**

Informal evaluation indicator words:
- Probably/probable/improbable
- Plausible/implausible

- Likely/unlikely

There are several common forms that **informal arguments** might take:
- **Predictions**: knowledge of past supports claim about future
- **Argument from analogy**: similarities between two things/situations is basis for conclusion
    - Associated fallacy: weak analogy (conclusion not supported because not similar enough/similarity irrelevant)
- **Generalization:** going from knowledge about a sample to knowledge about the whole
    - Associated fallacy: hasty generalization (too small/not representative sample)
- **Argument from authority**: something presumed true because expert says so
    - Associated fallacy: appeal to unqualified authority (source not a relevant expert)
- **Causal inference**: goes from knowledge about cause to claim about an effect, or from knowledge about effect to claim about the cause
    - Associated fallacy: assuming causation from correlation

More on fallacies:

A fallacy is a defect in an argument other than having a false premise. The various **informal fallacies** can be grouped according to the ways in which the premises fail to support the conclusions:

Fallacies of Relevance: these occur when the premises aren't relevant to the truth of the conclusions. This happens when arguers get off topic, attack the person instead of the argument, appeal to force or pity, miss the point, try to apply rules to situations they don't apply to etc.

Fallacies of Weak Inductions: these occur when the premises are relevant, but don't actually provide the support for the conclusion they claim to. This includes appeals to unqualified authority, hasty generalizations, assuming causal connections that aren't there, presuming an unlikely chain of events, drawing on weak analogies. These resemble good arguments but are ultimately weak because the premises don't provide adequate support for the conclusion.

Fallacies of Ambiguity: these occur when ambiguities in language are exploited. Equivocation is when the arguer shifts between different meanings of a word or phrase. Amphiboly is when a grammatically ambiguous statement is misinterpreted.

Don't worry about knowing the names of the different fallacies. Focus on understanding the way in which these flaws weaken the claim that the premises support the conclusion.

*__Formal fallacies__ will be addressed in the **propositional logic** section.

<u>Logic and the LSAT</u>

In order to succeed at the LSAT, it is important to be able to **identify** and **evaluate arguments.** Two kinds of **formal logic** we can use to do this are **propositional logic** and

categorical logic. **Propositional logic** has **propositions** (true/false sentences) as units, while **categorical logic** applies to the relations between categories (groups/kinds of things). We will begin with **propositional logic.**

Once again, in **formal logic**, **validity** is solely a function of the form of the argument. It is the **form** of the argument we're concerned with. The units that make up the form of arguments in propositional are **propositions** (true/false sentences: not questions, exclamations! or commands). **Propositions** can be either **simple statements** or **compound statements**. **Simple statements** do not contain any other statements as components. **Compound statements** have at least one simple statement as a component.

For example: "I like blueberries" is a simple statement while "I like blueberries or I like strawberries" and "I like blueberries but not raspberries" are compound statements. Notice how in the first one, the truth of the statement is determined by one state of affairs; whether or not I like blueberries. In the other two, the truth value of the proposition as a whole is determined by the relations between more than one state of affairs. For "I like blueberries but not raspberries" to be true, it has to be the case that 1) I like blueberries and 2) I don't like raspberries.

Because we're concerned with the **form** of the argument, it is useful to be able to translate propositions so that we can more clearly focus on the structure, not the content of the argument.

<u>Translation</u>

To represent a **simple statement** we will use upper-case letters. (In logic, the lower-case letters ***p,q,r,s*** are used to represent statement forms/they're variables holding the place of statements).

For example, if we were to translate "I like blueberries" we could go with a **B**.

In translating **compound statements** there are five **logical operators** that we will use. These represent the relations operating on the components of the sentence, thus determining the truth value of the entire proposition. These operations are **negation, conjunction, disjunction, material implication** and **material equivalence.**

The first operation we will look at is **negation**. A negation indicates that the truth is the opposite of that of what it's operating on. In logic the **~** (tilde) is used to represent negation. We use this to translate propositions that use language such as "not", "it is not the case that", "it's false that"…

Example: I do not like blueberries.

~B

The **truth table** showing the truth conditions for **negations (Insert photot)**

The next operation we will consider is **conjunction**. A conjunction joins two simple statements under the claim that both are true. In logic either a dot or ampersand (&) can be used to represent a conjunction. Conjunctive statements use language such as "and" "both" "but" (in logic, 'and' and 'but' are truth-functionally the same). A conjunction is true when both parts (conjuncts) are true; otherwise it is false.

Example: I like blueberries and I like strawberries.

B & S

The third operation is **disjunction**, which is used to translate "either/or" statements. In logic the wedge, **v**, is usually used to translate disjunctive statements. The disjunction is true when at least one of the components (disjuncts) is true, otherwise it is false. "Neither/nor" statements are the negation of a disjunction. Such statements can also be translated as a conjunction with both conjuncts negated. (If neither *this* nor *that* is true, then both *this* and *that* are false)

Example: I like blueberries or I like strawberries.

B v S

Example: I like neither blueberries nor strawberries.

~(B v S) or **~B & ~S**

"If/then" statements (**if** *this* condition is met, **then** *this* will be the case) are called **conditional statements** and express a relation called **material implication**. The components are called the **antecedent** (if…) and the **consequent** (then…). In logic, the horseshoe, ⊃ , or rightwards arrow, ⟶, is used to translate material implication. Other language to express implication includes "given that," "provided that," "on the condition that" etc. (Note: we usually talk about implication in terms of the relationship between premises and conclusion of an argument. An argument can be expressed as a conditional with a conjunction of the premises as antecedent and the conclusion as consequent.)

Example: If I'm hungry, then I will eat blueberries.

H ⊃ B

The horseshoe can also be used to translate statements that express **necessary** and **sufficient conditions**. A condition ***A*** is said to be a **sufficient condition** for ***B*** when ***A*** is enough to make it the case that ***B***. ***A*** is a **necessary condition** for ***B*** when ***A*** is required for ***B***; ***B*** cannot be the case without ***A***. When translating statements of necessary and sufficient conditions, the sufficient condition is the antecedent (before/left of the horseshoe) and the necessary condition is the consequent (after/right of the horseshoe). Remember that it looks like SUN.

H ⊃ B

The language that indicates **sufficient conditions** include "is enough for" or "suffices." "Cannot exclusively account for" means that a condition is not sufficient. Language that indicates a **necessary condition** includes "requires," "needs," "must," "imperative that." "Only if" indicates a necessary condition.

Example: If you have a party, I'll make a cake.

P ⊃ C

Example: I need blueberries if I am going to make this pie.

P ⊃ B

The conditional is only false if the antecedent is true and the consequent is false. Conditionals make the claim that if the antecedent is true, then the consequent must also be true. The truth of the antecedent *implies* the truth of the consequent. If the antecedent is true, but the consequent is false, that means the claim of implication is false.

The last operator is the triple bar, **≡** which represents the relationship of **material equivalence** (such statements are also called **biconditionals**). The triple bar is used to translate statements that use the language "if and only if" (**iff**) or "is both necessary and sufficient for." The **biconditional** is true when both conditions have the same truth value, either both true or both false.

Example: I will bake a pie if and only if I have fresh blueberries.

P ≡ F

Statements may use multiple operators. To determine the truth value of the statement, look to the **main operator**. The **main operator** is the operator that governs over the most components.

Example: If I have either blueberries or strawberries, then I will make cake but not pie.

(B v S) ⊃ (C & ~P)

Truth tables

Once we have translated our statements, we can use these translations to evaluate the relationship between propositions and the validity of arguments. To show the truth conditions of the logical operators, we used **truth tables. Truth tables** are graphic representations that show us all the possible truth values for a proposition given the possible truth values of its components and the truth conditions of the operators. We can also use truth tables to show the relationships between propositions and to evaluate the validity of an argument. A full truth shows us all the possible truth values in a given situation. The number of lines in a full truth table is 2 to the power of the number of propositional components (letters)(two because there are two possible truth values (true and false). If we were to create a truth table for the proposition "I like blueberries and I like strawberries" the full truth table would have four lines (two simple statements **B** and **S**, so two to the second power (squared) is four). They would show the four possible truth values given then parts of proposition: the truth value when both parts are true, the truth value when one is true but not the other, switch that around, and when they're both false.

We can also use **indirect truth tables** to assess whether certain combinations for truth values are possible. Truth tables show us *all* the possible truth values for a given set of conditions, but often there are only certain combinations of truth values we're interested in. **Indirect truth tables** are a method by which we save time by just attempting to generate the truth values we're interested in. For instance, when checking for validity, we're only concerned about the possibility of all true premises and a false conclusion, and so we can jump to that combination. We assume the premises to be true and the conclusion false and see if it is possible to assign truth values without reaching a contradiction. If that is possible, we know the argument is invalid.

Truth tables can also be used to assess the relationships between statements. When we compare the possible truth values of statements, if it is possible that all statements be true, that means the statements are **consistent**. If there is no combination of truth values in which all statements are true, those statements are **inconsistent**. If statements have exactly the same truth values given the same truth conditions, those statements are **logically equivalent**. **Logically equivalent statements** can be swapped for one another because they have identical truth conditions. If statements have the exact opposite truth values given the same truth conditions, those statements are **contradictory**. By examining the truth tables for the statements we are comparing, we can tell if they are logically equivalent or contradictory by whether the truth values are exactly the same or exactly opposite. We can tell if they are consistent or inconsistent by whether or not there is a combination of truth values in which all the statements are true. We can use **indirect truth tables** to test for consistency. Since we want to know whether or not all the statements in question can be true, we assume all those statements to be true and see if we can do so without generating a contradiction. We try to create the line of the truth table that would be informative. If we are able to create such a line (if it's possible they all be true) those statements are consistent.

Natural Deduction

Natural deduction is a method to establish the validity of arguments. It illustrates how the truth of the premises, applying the sanctioned **rules of inference**, guarantees the truth of the conclusion. Being able to establish the validity isn't really something you're going to need to be able to do on the LSAT. If you were ever to have to test for validity, the best way to do so would be to use an indirect truth table. **Natural deduction** is a method for showing *why* a valid argument is valid. An indirect truth table is the best method to answer the question "Is this argument valid?" **Natural deduction** gives a more detailed explanation as to *why* an argument is valid. Though there isn't really much in the way of proving validity by natural deduction on the LSAT, there are still components of natural deduction that will be incredibly useful to understand. **Natural deduction** uses **rules of inference** to prove a conclusion follows from its premises. Some **rules of inference** are **valid argument forms**. A **valid argument form** is an argument structure (combination of premises) such that in virtue of the structure of the parts, implication is guaranteed. Every instance of a **valid argument form** is a valid argument. So when proving an argument, inferences are justified because they are instances of a valid argument form. Being able to recognize these **valid argument forms** will be incredibly helpful for the LSAT.

The **valid argument forms** we will address are ***modus ponens***, ***modus tollens***, **hypothetical syllogism**, and **disjunctive syllogism**. Any instance of these argument forms is a valid argument. Knowing these forms will help us recognize the inferences that we can legitimately draw.

Valid Argument Forms/Rules of Inference

Modus Ponens

A ⊃ B
A

B

The form of ***modus ponens*** is a conditional, the confirmation of the antecedent, and the conclusion of the consequent. It's impossible that it be true that if *A* is sufficient for *B*, and we have *A*, that we don't also have *B*. Like informal arguments, formal arguments can have fallacious counterparts. An argument form consisting of a conditional, the confirmation of the consequent, and the conclusion of the antecedent is an **invalid argument form**, the fallacy of using it called **affirming the consequent.**

A ⊃ B
B

A (invalid)

Modus tollens

A ⊃ B
~B

———

~A

The form of ***modus tollens*** is a conditional, the denial of the consequent, and the conclusion of the denial of the antecedent. If *B* is necessary for *A*, and we don't have *B,* we don't have *A*. The argument form which consists of a conditional, the denial of the antecedent, and the conclusion of the denial of the consequent is an **invalid form,** the fallacy of use being called **denying the antecedent.**

A ⊃ B
~A

———

~ B (invalid)

Disjunctive syllogism

(A syllogism is a three line argument)

A v B
~A

———

B

The form of the **disjunctive syllogism** is a disjunctive claim that either one or the other statements is true, the claim that one of the statements is false, and the conclusion that the other statement must be true then. Either *A* or *B* is true, it's not *A*, so it has to be *B*.

Hypothetical Syllogism

A ⊃ B
B ⊃ C

———

A ⊃ C

The form of the **hypothetical syllogism** is two conditionals sharing a term that is a necessary condition for one and a sufficient for the other, the conclusion being a conditional in which the sufficient condition for the shared term is a sufficient condition for the third term. If *A* is sufficient for *B***,** and *B* is sufficient for *C*, if we have *A* then we have *C*.

Categorical Logic

Logic can be used to perform operations on units other than propositions. There will most likely be questions where the relationships in question are between **categories** (grouping of things). These questions contain language such as "all," "no," "some" to refer to either groups as a whole or at least one member of that group. It's important to keep in mind that the "all" might not be explicitly stated, but if the statement is best interpreted as being universal (about all) then when translating, translate with all. Like with propositional logic, we can translate categorical statements into forms that allow us to work with them to examine the underlying structure of the arguments they form.

Categorical forms
All A are B
No A are B
Some A are B
Some A are not B

Venn Diagrams

Venn Diagrams are an incredibly useful tool for representing the relationships between categorical propositions. Venn Diagrams use overlapping circles to visually represent the relationships between categories. Parts of the circle can be **shaded** to show that nothing is in that area, and **x**'s can be used to indicate that something exists in a certain area. When you graph the premises of a valid categorical argument, you graph the conclusion as well. If you graph the premises of an argument and the conclusion is not definitively shown, the argument is invalid. This highlights the fact that no new information comes out of a valid argument. When you graph the premises of a valid argument, the conclusion is graphed in the process. The conclusion of a valid argument is the same facts under a new description.

What to do with all this

The LSAT consistently features specific kinds of questions, and logic skills and understanding can be utilized in many different ways. I will describe the kinds of questions as I've categorised them and suggest how logic can help with those questions.

Structural questions/parallel forms: these questions require that you be able to abstract the form of the argument and identify arguments that have the same form. Being able to translate statements into logical notation will be incredibly helpful in isolating the form of the argument.

Strengthen/weaken: these questions require that you be able to understand the entailment relationship between the premises and conclusion, and know what would and would not make the conclusion more or less likely to be true. Understanding necessary and sufficient conditions can be helpful here. Whether or not conditions obtain can determine facts relevant to the truth of the conclusion.

Find the flaw: these questions will ask you to identify the flaw in a fallacious argument. Knowing the informal and formal fallacies will be incredibly useful. Learn to recognize these identifiable flaws because there will likely be at least one on the LSAT.

Missing premise/(what's needed?): these questions will require you to identify a missing premise or in an argument. The missing premises questions might be worded to ask what **assumptions** are needed/required. This is asking what premise is needed to make the argument work. Being able to translate arguments can help more clearly analyze the truth conditions to determine what needs to be the case for the conclusion to follow.

Inference questions: there will be questions about what can be properly inferred from given premises. If the question asks what can be "properly inferred" the argument is best interpreted according to deductive standards/formally evaluated. These questions will be most benefited by the skills in this course. Propositional and categorical logic can be used to prove which inferences are valid.

Principle questions: there will likely be questions asking you to identify a principle and/or identify which situations are applications of the principle, or identify a principle that is analogous in structure. It can be helpful to think of a principle (a theorem, a law) in terms of conditions. A principle stipulates the conditions for a rule or description to be satisfied. Consider the principle "If you have more than you need or want, you should share." It stipulates the conditions (either having more than needed or having more than wanted) and stipulates what should happen (what these conditions should suffice), namely that sharing should occur.

I will continue to update and improve this document. Good luck on the LSAT and best wishes for your Law School journey.

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