Logic: What Is It and Why Study It?

- Logic: What Is It and Why Study It?
- Reasoning, Proving, Discovery, and Prediction
- Arguments, Deduction, Induction, and Abduction
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Truth and Validity: What Are They and Why Study Them?

Truth & Validity: What Are They and Why Study Them ?

Truth and (Classical) Validity

- The truth/falsehood of a proposition/statement
  - *Truth* is the attribute of any proposition/statement that asserts what really is the case.
  - *Truth* and *falsity* are intrinsic attributes of any individual proposition/statement; they can never apply to any argument by itself.
- The (classical) validity/invalidity of a deductive argument
  - *Validity* is a characteristic of any deductive argument whose premises, IF they were all *true*, would provide conclusive grounds for the *truth* of its conclusion. Such a deductive argument is said to be *valid*.
  - *Validity* and *invalidity* are intrinsic attributes of deductive arguments; they can never apply to any single proposition/statement by itself (as well as other types of arguments).

Truth and (Classical) Validity

- Sound arguments
  - A *valid* deductive argument is said to be *sound* IF all of its premises are *true*.
  - The conclusion of a *sound* argument obviously must be *true* -- and only a *sound* argument can establish the *truth* of its conclusion absolutely.
  - If a deductive argument is not *sound* (i.e., *unsound*) -- that is, if the argument is not *valid* or if not all of its premises are *true* -- it fails to establish the *truth* of its conclusion absolutely, even if in fact the conclusion is *true*.
- Valid/Sound reasoning
  - A reasoning is *valid/sound* ONLY IF all of its arguments are *valid/sound*.

Truth and (Classical) Validity

- Fundamental problems about truth and validity
  - Is there the only one kind of truth/validity, or are there many kinds? If there are many kinds, what are the intrinsic differences between them?
  - How to define truth/validity formally?
  - How to evaluate truth/validity?
- Truth and validity in logic
  - Both truth and validity are central concepts in logic.
  - To define truth/validity formally is one of central tasks of formal logic.
  - To evaluate truth/validity is one of central tasks of formal logic.

Definitions of Validity [C&C]

- Validity as a characteristic of any deductive argument
  - *Validity* is a characteristic of any deductive argument whose premises, IF they were all *true*, would provide conclusive grounds for the *truth* of its conclusion. Such an argument is said to be *valid*.
  - *Validity* is a formal characteristic; it applies only to arguments, as distinguished from *truth* which applies to propositions.
  - When the claim is made that the premises of an argument (IF *true*) provide incontrovertible grounds for the *truth* of its conclusion, that claim will be either correct or not correct. If it is correct, that argument is *valid*. If it is not correct (that is, if the premises when *true* fail to establish the conclusion irrefutably although claiming to do so), that argument is *invalid*.

Definitions of Validity [C&C]

♣ Validity vs. invalidity

- For logicians the term *validity* is applicable only to deductive arguments. To say that a deductive argument is *valid* is to say that it is not possible for its conclusion to be *false* IF its premises are *true*. Thus we define *validity* as follows: A deductive argument is *valid* when, IF its premises are *true*, its conclusion must be *true*.
- Although every deductive argument makes the claim that its premises guarantee the *truth* of its conclusion, not all deductive arguments live up to that claim. Deductive arguments that fail to do so are *invalid*.
- Because every deductive argument either succeeds or does not succeed in achieving its objective, every deductive argument is either *valid* or *invalid*. This point is important: If a deductive argument is not *valid*, it must be *invalid*; if it is not *invalid*, it must be *valid*.

Definitions of Validity [C&C]

♣ Validity: a valid argument does not need additional premises

- Deductive arguments either succeed or they do not succeed in exhibiting *a compelling relation* between premises and conclusion.
- If a deductive argument is *valid*, no additional premises can possibly add to the strength of that argument.
- The conclusion that follows with certainty from the premises of a *valid* deductive argument follows from any enlarged set of premises with the same certainty, regardless of the nature of the premises added.
- If an argument is *valid*, nothing in the world can make it more *valid*; if a conclusion is *validly* inferred from some set of premises, nothing can be added to that set to make that conclusion follow more strictly, or more *validly*.

Definitions of Validity [C&C]

♣ Validity example: a valid argument does not need additional premises

- For example, if all humans are mortal and Socrates is human, we may conclude without reservation that Socrates is mortal -- and that conclusion will follow from those premises no matter what else may be true in the world, and no matter what other information may be discovered or added.
- If we come to learn that Socrates is ugly, or that immortality is a burden, or that cows give milk, none of those findings nor any other findings can have any bearing on the validity of the original argument.

Definitions of Validity [C&C]

♣ Validity can never apply to any single proposition

- A deductive argument is *valid* when it succeeds in linking, with logical necessity, the conclusion to its premises. Its *validity* refers to *the relation between its propositions* -- between the set of propositions that serve as the premises and the one proposition that serves as the conclusion of that argument. If the conclusion follows with logical necessity from the premises, we say that the argument is *valid*.
- Therefore *validity* can never apply to any single proposition by itself, because the needed relation cannot possibly be found within any one proposition.
- The relations between *true* (or *false*) propositions and *valid* (or *invalid*) arguments are critical and complicated. Those relations lie at the heart of deductive logic.

Definitions of Validity [C&C]

♣ Validity depends only on the relation of the premises to the conclusion: a valid argument may have false premises

- Lincoln's logical point is correct and important: An argument may be *valid* even when its conclusion and one or more of its premises are *false*. The *validity* of an argument, we emphasize once again, depends only on the relation of the premises to the conclusion.
- This point was made dramatically by Abraham Lincoln (林肯) in 1858 in one of his debates with Stephen Douglas.

♣ Validity of an argument and truth of its conclusion

- A viewpoint of non-classical validity: The *truth* or *falsity* of an argument's conclusion does not by itself determine the *validity* or *invalidity* of that argument.
- The fact that an argument is *valid* does not guarantee the *truth* of its conclusion.

Combinations of True/False premises and conclusions in valid/invalid arguments [C&C]

♣ Possible combinations of true and false premises and conclusions in both valid and invalid arguments

- There are many possible combinations of true and false premises and conclusions in both valid and invalid arguments.
- Here follow seven illustrative arguments, each prefaced by the statement of the combination (of truth and validity) that it represents.

♣ Example I. Some valid arguments contain only true propositions -- true premises and a true conclusion:

- All mammals (哺乳动物) have lungs (肺).
  All whales (鲸鱼) are mammals.
  Therefore, all whales have lungs.

♣ **Example II. Some valid arguments contain only false propositions -- false premises and a false conclusion**

- **All four-legged creatures (四足动物) have wings (翅膀).**
  All spiders (蜘蛛) have exactly four legs.
  Therefore, all spiders have wings.
- **This argument is valid because, if its premises were true, its conclusion would have to be true also -- even though we know that in fact both the premises and the conclusion of this argument are false.**

♣ **Example III. Some invalid arguments contain only true propositions -- all their premises are true, and their conclusions are true as well**

- **If I owned all the gold in Fort Knox (诺克斯堡), then I would be wealthy.**
  I do not own all the gold in Fort Knox.
  Therefore, I am not wealthy.
- **The true conclusion of this argument does not follow from its true premises.**

♣ **Example IV. Some invalid arguments contain only true premises and have a false conclusion**

- **If Bill Gates (比尔盖茨) owned all the gold in Fort Knox, then Bill Gates would be wealthy.**
  Bill Gates does not own all the gold in Fort Knox.
  Therefore, Bill Gates is not wealthy.
- **The premises of this argument are true, but its conclusion is false. Such an argument cannot be valid because it is impossible for the premises of a valid argument to be true and its conclusion to be false.**

♣ **Example V. Some valid arguments have false premises and a true conclusion**

- **All fishes are mammals (哺乳动物).**
  All whales (鲸鱼) are fishes.
  Therefore, all whales are mammals.
- **The conclusion of this argument is true, as we know; moreover, it may be validly inferred from these two premises, both of which are wildly false.**

♣ **Example VI. Some invalid arguments also have false premises and a true conclusion**

- **All mammals (哺乳动物) have wings (翅膀).**
  All whales (鲸鱼) have wings.
  Therefore, all whales are mammals.
- **From Examples V and VI taken together, it is clear that we cannot tell from the fact that an argument has false premises and a true conclusion whether it is valid or invalid.**

♣ **Example VII. Some invalid arguments contain all false propositions -- false premises and a false conclusion**

- **All mammals (哺乳动物) have wings (翅膀).**
  All whales (鲸鱼) have wings.
  Therefore, all mammals are whales.

♣ **Notes**

- **These examples make it clear that there are valid arguments with false conclusions (Example II), as well as invalid arguments with true conclusions (Examples III and VI).**
- **Hence it is clear that the truth or falsity of an argument's conclusion does not by itself determine the validity or invalidity of that argument.**
- **Moreover, the fact that an argument is valid does not guarantee the truth of its conclusion (Example II).**

Two tables (referring to the seven preceding examples) will make very clear the variety of possible combinations. The first table shows that *invalid* arguments can have every possible combination of true and false premises and conclusions:

Invalid Arguments		
	True Conclusion	**False Conclusion**
True Premises	Example III	Example IV
False Premises	Example VI	Example VII

The second table shows that *valid* arguments can have only three of those combinations of true and false premises and conclusions:

Valid Arguments		
	True Conclusion	**False Conclusion**
True Premises	Example I	—
False Premises	Example V	Example II

Combinations of True/False premises and conclusions in valid/invalid arguments [C&C]

♣ **Facts**

- If an argument is valid and its premises are true, we may be certain that its conclusion is true also.
- If an argument is valid and its conclusion is false, not all of its premises can be true.
- Some perfectly valid arguments do have false conclusions, but any such argument must have at least one false premise.

♣ **Notes**

- To test the truth or falsehood of premises is the task of mathematics and/or empirical sciences in general, because premises may deal with any subject matter at all.
- The logician is not (professionally) interested in the truth or falsehood of propositions so much as in the logical relations between them.

Definitions of Soundness [C&C]

♣ **Sound arguments**

- When an argument is *valid* and all of its premises are *true*, we call it *sound*.
- The conclusion of a *sound* argument obviously must be *true* -- and only a *sound* argument can establish the *truth* of its conclusion.
- If a deductive argument is not *sound* -- that is, if the argument is not *valid* or if not all of its premises are *true* -- it fails to establish the *truth* of its conclusion even if in fact the conclusion is *true*.

Definitions of Validity [Hurley]

♣ **Validity**

- A *valid* deductive argument is an argument in which it is impossible for the conclusion to be *false* given that the premises are *true*.
- In these arguments the conclusion follows with strict necessity from the premises.
- Conversely, an *invalid* deductive argument is a deductive argument in which it is possible for the conclusion to be *false* given that the premises are *true*.
- An immediate consequence of these definitions is that there is no middle ground between *valid* and *invalid*.
- There are no arguments that are "almost" *valid* and "almost" *invalid*.

Evaluating/Testing Validity [Hurley]

♣ **Evaluating/Testing validity**

- To evaluate/test an argument for *validity* we begin by assuming that all the premises are *true*, and then we determine if it is possible, in light of that assumption, for the conclusion to be *false*.
- In general, *validity* is not something that is uniformly determined by the actual *truth* or *falsity* of the premises and conclusion. Rather, *validity* is something that is determined by *the relationship between premises and conclusion*.
- The question is not whether the premises and conclusion are *true* or *false*, but whether the premises *support* the conclusion.

Combinations of True/False Premises and Conclusions in Valid/Invalid Arguments [Hurley]

TABLE 1.1 DEDUCTIVE ARGUMENTS

	Valid	Invalid
True premises True conclusion	All wines are beverages. Chardonnay is a wine. Therefore, chardonnay is a beverage. [sound]	All wines are beverages. Chardonnay is a beverage. Therefore, chardonnay is a wine. [unsound]
True premises False conclusion	None exist.	All wines are beverages. Ginger ale is a beverage. Therefore, ginger ale is a wine. [unsound]
False premises True conclusion	All wines are soft drinks. Ginger ale is a wine. Therefore, ginger ale is a soft drink. [unsound]	All wines are whiskeys. Chardonnay is a whiskey. Therefore, chardonnay is a wine. [unsound]
False premises False conclusion	All wines are whiskeys. Ginger ale is a wine. Therefore, ginger ale is a whiskey. [unsound]	All wines are whiskeys. Ginger ale is a whiskey. Therefore, ginger ale is a wine. [unsound]

Evaluating/Testing Validity [Hurley]

♣ **Evaluating/Testing validity**

- There is one arrangement of *truth* and *falsity* in the premises and conclusion that does determine the issue of *validity*: Any deductive argument having actually *true* premises and an actually *false* conclusion is *invalid*.
- This short summary table reinforces the point that merely knowing the *truth* or *falsity* of the premises and conclusion tells us nothing about *validity* except in the one case of *true* premises and *false* conclusion. Any deductive argument having *true* premises and a *false* conclusion is *necessarily invalid*.

♣ **Question (important!)**

- What do you think of the above statements?

Premises	Conclusion	Validity
T	T	?
T	F	Invalid
F	T	?
F	F	?

Definitions of Soundness [Hurley]

♣ **Sound arguments**

- A *sound* argument is a deductive argument that is *valid* and has *all true premises*.
- An *unsound* argument is a deductive argument that is *invalid*, has one or more *false premises*, or both.
- Because a *valid* argument is one such that it is impossible for the premises to be *true* and the conclusion *false*, and because a *sound* argument does in fact have *true* premises, it follows that every *sound* argument, by definition, will have a *true* conclusion as well.
- A *sound* argument, therefore, is what is meant by a "good" deductive argument in the fullest sense of the term.

Definitions of Soundness [Hurley]

♣ **Sound arguments**

- For a valid argument to be *unsound*, the *false* premise or premises must actually be needed to support the conclusion.
- No addition of a *false* superfluous premise to an originally *sound* argument can make the argument *unsound*, because such a premise would be superfluous and should not be considered part of the argument.

Sound argument	=	Valid argument	+	All true premises

Argument Forms [Hurley]

♣ **Argument forms**

- An *argument form* is an arrangement of letters and words such that the uniform substitution of words or phrases in the place of the letters results in an argument.
- The *form of an argument* illustrates the argument's internal structure or pattern of reasoning.
- If the pattern of reasoning is good, the argument will be valid; if not, it will be invalid.
- The validity of a deductive argument is determined by the argument form of that deductive argument.
- Consider the arguments about wines and beverages presented in Table 1.1. All the arguments in the valid column in Table 1.1 have the same form, and all the arguments in the invalid column have the same form.

Combinations of True/False Premises and Conclusions in Valid/Invalid Arguments [Hurley]

TABLE 1.1 DEDUCTIVE ARGUMENTS

	Valid	Invalid
True premises **True conclusion**	All wines are beverages. Chardonnay is a wine. Therefore, chardonnay is a beverage. [sound]	All wines are beverages. Chardonnay is a beverage. Therefore, chardonnay is a wine. [unsound]
True premises **False conclusion**	None exist.	All wines are beverages. Ginger ale is a beverage. Therefore, ginger ale is a wine. [unsound]
False premises **True conclusion**	All wines are soft drinks. Ginger ale is a wine. Therefore, ginger ale is a soft drink. [unsound]	All wines are whiskeys. Chardonnay is a whiskey. Therefore, chardonnay is a wine. [unsound]
False premises **False conclusion**	All wines are whiskeys. Ginger ale is a wine. Therefore, ginger ale is a whiskey. [unsound]	All wines are whiskeys. Ginger ale is a whiskey. Therefore, ginger ale is a wine. [unsound]

Argument Forms: Examples [Hurley]

♣ **An example of valid argument forms**

- In reference to Table 1.1, all the valid arguments have this *valid argument form*:
  All A are B. All C are A. Therefore, All C are B.
- If A, B, and C are thought of as referring to groups of things, it is easy to see that this form is valid. Assume, by the second premise, that the Cs (whatever they might be) are included in the As, and, by the first premise, that the As (whatever they might be) are included in the Bs.
- Then it necessarily follows that the Cs are included in the Bs, which is what the conclusion asserts.

♣ **Fact**

- Any *substitution instance* of a valid argument form must be a valid argument.

Argument Forms: Examples [Hurley]

♣ **An example of invalid argument forms**

- The following is an *invalid argument form*:
  All A are B. All C are B. Therefore, All A are C.
- In this argument form, if we assume that the As are in the Bs and that the Cs are in the Bs, it does not necessarily follow that the As are in the Cs. It would not follow if the As were in one part of the Bs and the Cs were in another part.

♣ **Fact**

- Any substitution instance of an invalid argument form almost is an invalid argument.

Argument Forms: Examples [Hurley]

- Notes
  - It is not the case that every substitution instance of an invalid form is an invalid argument. The reason is that some substitution instances of invalid forms are also substitution instances of valid forms.
  - Any substitution instance of an invalid form is an invalid argument provided that it is not a substitution instance of any valid form.

Argument Forms: Examples [Hurley]

- A substitution instance invalid/valid argument forms
  - All bachelors (单身汉) are men.
    All unmarried men are man.
    Therefore, All bachelors are unmarried men.
  - Invalid/valid argument form:
    All A are B. All C are B. Therefore, All A are C.
  - Valid/valid argument form:
    All A are B. All A are B. Therefore, All A are A.
- Notes
  - A = C in ordinary languages.
  - Cases of ordinary language arguments that can be interpreted as substitution instances of both valid and invalid forms are very rare, therefore, we can choose to ignore them.

Counter-example Method [Hurley]

- Counter-example method
  - A substitution instance of an argument form having true premises and a false conclusion is called a *counter-example*.
  - The *counter-example method* consists of isolating the form of an argument and then constructing a substitution instance having true premises and a false conclusion. This proves the form invalid, which in turn proves the argument invalid.
- Notes
  - The counter-example method can be used to prove the invalidity of any invalid argument, but it cannot prove the validity of any valid argument.
  - Thus, before the counter-example method is applied to an argument, the argument must be known or suspected to be invalid in the first place.

Counter-example Method [Hurley]

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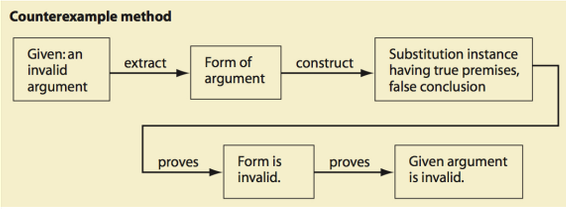
  - The *counter-example method* consists of isolating the form of an argument and then constructing a substitution instance having true premises and a false conclusion. This proves the form invalid, which in turn proves the argument invalid.



Counter-example Method: An Example [Hurley]

- Example: invalid categorical syllogism
  - "Since some employees are not social climbers (社交攀爬者，趋炎附势向上爬的人) and all vice presidents are employees, we may conclude that some vice presidents are not social climbers."
  - This argument is invalid because the employees who are not social climbers might not be vice presidents.
- Applying the counter-example method
  - Accordingly, we can prove the argument invalid by constructing a substitution instance having true premises and a false conclusion.
  - We begin by isolating the form of the argument:
    Some E are not S. All V are E.
    Therefore, Some V are not S.

Counter-example Method: An Example [Hurley]

- Applying the counter-example method
  - Next, we select three terms to substitute in place of the letters that will make the premises true and the conclusion false. The following selection will work:
    E = animals, S = mammals, V = dogs
  - The resulting substitution instance is this:
    Some animals are not mammals.
    All dogs are animals.
    Therefore, some dogs are not mammals.
  - The substitution instance has true premises and a false conclusion and is therefore invalid.
  - Because the substitution instance is invalid, the form is invalid, and therefore the original argument is invalid.

Definitions of Validity [Layman]

- **Validity**
  - A *valid* argument is one in which the premises *support* the conclusion *completely*.
  - More formally, a *valid* argument has its essential feature: It is *necessary* that IF the premises are *true*, THEN the conclusion is *true*.
- **The first key aspect of the definition of validity**
  - In a *valid* argument, there is *necessary connection* between the the premises and the conclusion.
  - The conclusion does not just happen to be *true* given the premises; rather, the *truth* of the conclusion is *absolutely guaranteed* given the *truth* of the premises.
  - A *valid* argument has this characteristic: It is *impossible* for the conclusion to be *false* assuming that the premises are *true*.

Definitions of Validity [Layman]

- **The second key aspect of the definition of validity**
  - Note the conditional (IF-THEN) aspect of the definition. It does not say that the premises and conclusion of a *valid* argument are in fact *true*.
  - Rather, the definition says that, *necessarily*, IF the premises are *true*, THEN conclusion is *true*. In other words, if an argument is *valid*, then on the assumption that its premises are *true*, its conclusion must be *true* also.
- **The validity logicians focus their attention on**
  - Logicians focus their attention on the linkage between the premises and the conclusion rather than on the actual truth or falsity of the statements composing the argument.

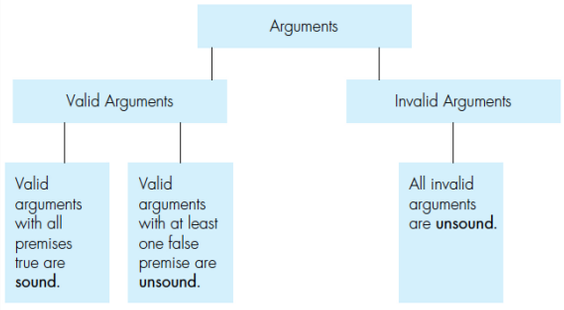
Definitions of Validity [Layman]

- **Some cases**
  - An argument can have one or more *false* premises and still be valid.
  - We cannot rightly conclude that an argument is *valid* simply on the grounds that its premises are all *true*.
  - If an argument is *valid* an has a *false* conclusion, then it necessarily have at least one *false* premise.
  - *Validity* preserves *truth*; that is, if we start with *truth* and reason in a *valid* fashion, we will always wind up with *truth*.
  - *Validity* does not preserve *falsehood*; in fact, *false* premises plus *valid* reasoning may lead to either *truth* or *falsity*, depending on the case.

Definitions of Validity [Layman]

- **Invalid arguments**
  - An *invalid* argument has its essential feature: It is *not necessary* that IF the premises are *true*, THEN the conclusion is *true*; in other words, even on the assumption that the premises are true, the conclusion could still be false.
- **Sound/Unsound arguments**
  - A *sound* argument has two essential features: It is *valid*, and all its premises are *true*.
  - A *sound* argument cannot have a *false* conclusion.
  - Valid + All Premises True = Sound
  - An *unsound* argument is one that either is *invalid* or has at least one *false* premise.

Definitions of Validity [Layman]



Argument Forms [Layman]

- **Argument forms**
  - An *argument form* is a pattern of argument that can be used to establish that an argument is valid or invalid.
- **Substitution instance of an argument form**
  - An argument that results from uniformly replacing letters in an argument form with terms (or statements) is called a *substitution instance* of that argument form.
- **Argument form examples**
  - Form 1 (valid, why?)
    - 1. All A are B.
    - 2. All B are C.
    - Therefore, 3. All A are C.

Argument Forms [Layman]

- Argument form examples
  - Form 2 (valid, why?)
    - 1. All A are B.
    - 2. Some C are not B.
    - Therefore, 3. Some C are not A.
  - Form 3 (invalid, why?)
    - 1. All A are B.
    - 2. All C are B.
    - Therefore, 3. All A are C.

Argument Forms [Layman]

- Argument form examples
  - Form 4 (invalid, why?)
    - 1. All A are B.
    - 2. Some B are not C.
    - Therefore, 3. Some C are not A.
  - Form 5 (invalid, why?)
    - 1. No A are B.
    - 2. All B are C.
    - Therefore, 3. No A are C.

Important/Famous Argument Forms [Layman]

- Important/famous argument forms
  - Modus Ponens (valid)
    - 1. IF A, THEN B.
    - 2. A.
    - Therefore, 3. B.
  - Modus Tollens (valid)
    - 1. IF A, THEN B.
    - 2. Not B.
    - Therefore, 3. Not A.

Important/Famous Argument Forms [Layman]

- Important/famous argument forms
  - Fallacy of Denying the Antecedent (invalid)
    - 1. IF A, THEN B.
    - 2. Not A.
    - Therefore, 3. Not B.
  - Fallacy of Affirming the Consequent (invalid)
    - 1. IF A, THEN B.
    - 2. B.
    - Therefore, 3. A.

Important/Famous Argument Forms [Layman]

- Important/famous argument forms
  - Hypothetical Syllogism (valid)
    - 1. IF A, THEN B.
    - 2. IF B, THEN C.
    - Therefore, 3. IF A, THEN C.
  - Disjunctive Syllogism (valid)
    - 1. Either A or B.
    - 2. Not A.
    - Therefore, 3. B.

Important/Famous Argument Forms [Layman]

- Important/famous argument forms
  - Constructive Syllogism (valid)
    - 1. Either A or B.
    - 2. IF A, THEN C.
    - 3. IF B, THEN D.
    - Therefore, 4. Either C or D.

Important/Famous Argument Forms [Layman]

Summary of Forms

Valid Forms

Modus ponens: If *A*, then *B*. *A*. So, *B*.
Modus tollens: If *A*, then *B*. Not *B*. So, not *A*.
Hypothetical syllogism: If *A*, then *B*. If *B*, then *C*. So, if *A*, then *C*.
Disjunctive syllogism: Either *A* or *B*. Not *A*. So, *B*.
Constructive dilemma: Either *A* or *B*. If *A*, then *C*. If *B*, then *D*. So, either *C* or *D*.

Invalid Forms

Denying the antecedent: If *A*, then *B*. Not *A*. So, not *B*.
Affirming the consequent: If *A*, then *B*. *B*. So, *A*.

Definitions of Validity [Jeffrey]

♣ **Validity**

- ◆ **A *valid* argument is one whose conclusion is *true* in every case in which all its premises are *true*.**
- ◆ **Arguments from *false* premises are defective even if *valid*, and even if their conclusions are *true*.**
- ◆ **A *sound* argument is one that is *valid* and has no *false* premises.**
- ◆ **It is *soundness* of an argument that ensures *truth* of the conclusion; mere *validity* carries no such guarantee, nor does mere *truth* of all premises.**
- ◆ **An argument can be *unsound* because not all premises are *true* or because the conclusion does not follow.**

Definitions of Validity [Johnson]

♣ **Good arguments**

- ◆ **A *good* argument is one in which (A) given the premises, the conclusion *follows from* them either with *deductive validity* or *inductive strength*, and (B) the premises are *true*.**

♣ **Notes**

- ◆ **A conclusion *follows from* with *deductive validity* IF, given the premises, the conclusion follows "*necessarily*".**
- ◆ **A conclusion *follows from* with *inductive strength* IF, given the premises, the conclusion follows "*probably*," that is, it is more likely to be *true* than not.**
- ◆ ***Deductive validity* or *inductive strength* are two different standards of inferential strength.**
- ◆ **The two requirements – that the premises are *true* and the conclusion *follows from* them – are logically independent of one another.**

Definitions of Validity [Johnson]

♣ **Validity**

- ◆ **An argument is *deductively valid* IF AND ONLY IF, given the premises, the conclusion *necessarily follows*; in other words, if we assume the premises are *true*, then it *must follow* that the conclusion is *true*, the conclusion cannot be *false*.**
- ◆ **The logical fact about *deductively valid* argument: a valid argument will yield a logical contradiction if you assert the premises and deny the conclusion.**
- ◆ **An *invalid* argument does not logically compel acceptance of the conclusion.**

Strong and Weak Inductive Arguments [Hurley]

♣ **Strong inductive arguments**

- ◆ **A *strong inductive argument* is an inductive argument in which it is improbable that the conclusion be false given that the premises are true.**
- ◆ **In such arguments, the conclusion does in fact follow probably from the premises.**

♣ **Weak inductive arguments**

- ◆ **A *weak inductive argument* is an argument in which the conclusion does not follow probably from the premises, even though it is claimed to.**

The Uniformity of Nature [Hurley]

♣ **The uniformity of nature**

- ◆ **All inductive arguments depend on what philosophers call *the uniformity of nature*.**
- ◆ **According to this principle, the future tends to replicate the past, and regularities that prevail in one spatial region tend to prevail in other regions.**
- ◆ **The uniformity of nature is the ultimate basis for our judgments about what we naturally expect to occur.**

♣ **Good inductive arguments**

- ◆ **Good inductive arguments are those that accord with the uniformity of nature. They have conclusions that we naturally expect to turn out true.**
- ◆ **If the conclusion of such an argument should turn out to be false, in violation of our expectations, this occurrence would cause us to react with surprise.**

Evaluating/Testing the Strength of Inductive Arguments [Hurley]

- **Evaluating/Testing the strength of inductive arguments**
  - The procedure for testing the strength of inductive arguments runs parallel to the procedure for deduction.
  - First we assume the premises are true, and then we determine whether, based on that assumption, the conclusion is probably true.
  - This determination is accomplished by linking up the premises with regularities that exist in our experiential background.
  - In such arguments, the conclusion does in fact follow probably from the premises.
- **An important note**
  - In general, the strength or weakness of an inductive argument results not from the actual truth or falsity of the premises and conclusion, but from the probabilistic support the premises give to the conclusion.

Combinations of True/False Premises and Conclusions in Strong/Weak Arguments [Hurley]

TABLE 1.2 INDUCTIVE ARGUMENTS

	Strong	Weak
True premise **Probably true conclusion**	All previous U.S. presidents were older than 40. Therefore, probably the next U.S. president will be older than 40. [cogent]	A few U.S. presidents were lawyers. Therefore, probably the next U.S. president will be older than 40. [uncogent]
True premise **Probably false conclusion**	None exist	A few U.S. presidents were unmarried. Therefore, probably the next U.S. president will be unmarried. [uncogent]
False premise **Probably true conclusion**	All previous U.S. presidents were TV debaters. Therefore, probably the next U.S. president will be a TV debater. [uncogent]	A few U.S. presidents were dentists. Therefore, probably the next U.S. president will be a TV debater. [uncogent]
False premise **Probably false conclusion**	All previous U.S. presidents died in office. Therefore, probably the next U.S. president will die in office. [uncogent]	A few U.S. presidents were dentists. Therefore, probably the next U.S. president will be a dentist. [uncogent]

The Strength of an Inductive Argument [Hurley]

- **The strength of an inductive argument**
  - The relationship between the strength of an inductive argument and the truth or falsity of its premises and conclusion is summarized as following table.
  - This this brief table reinforces the point that merely knowing the truth conditions of the premises and conclusion tells us nothing about the strength of an argument except in the one case of true premises and probably false conclusion. Any inductive argument having true premises (in the sense just explained) and a probably false conclusion is weak.
- **Question (important!)**
  - What do you think of the above statements?

Premises	Conclusion	Strength
T	prob. T	?
T	prob. F	Weak
F	prob. T	?
F	prob. F	?

Cogent Arguments [Hurley]

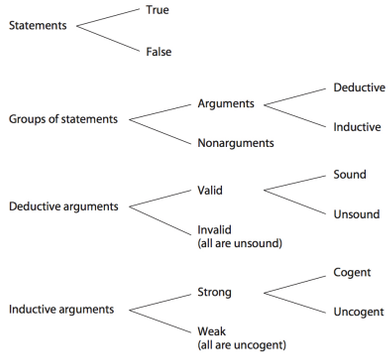
- **Cogent arguments**
  - A *cogent argument* is an inductive argument that is strong and has all true premises.
  - Also, the premises must be true in the sense of meeting the total evidence requirement.
  - If any one of these conditions is missing, the argument is uncogent.
- **Uncogent arguments**
  - An *uncogent argument* is an inductive argument that is weak, has one or more false premises, fails to meet the total evidence requirement, or any combination of these.

Cogent Arguments [Hurley]

- **Cogent arguments**
  - A cogent argument is the inductive analogue of a sound deductive argument and is what is meant by a "good" inductive argument without qualification.
  - Because the conclusion of a cogent argument is genuinely supported by true premises, it follows that the conclusion of every cogent argument is probably true in the actual world in light of all the known evidence.

Cogent argument = Strong argument + All true premises

Various Arguments [Hurley]



A General Definition for the Validity of Deductive Arguments

- **A general definition for the validity of deductive arguments**
  - A deductive argument is *valid* IF AND ONLY IF it is necessary that its conclusion *follows from* its premises, or, equivalently, its premises *entail* its conclusion.
- **Important notes**
  - Traditional formal/informal logic did not distinguish different definitions of validity.
  - To define the notion of validity of deductive arguments formally is nothing more than to define "follows from" and/or "entail" formally.
  - According to the definition of "follows from" and/or "entail", there may be different definitions of validity which may lead to different logic systems.
  - Different definitions of validity => different logic systems

The Classical Account of Validity

- **The *classical account of validity* (CAV)**
  - A deductive argument is *valid* IF AND ONLY IF it is impossible for all its premises to be *true* while its conclusion is *false*.
- **Important notes**
  - "CLASSICAL": the idea appeared in ancient Greek.
  - What 'TRUE' and 'FALSE' mean have to be defined.
  - "IF AND ONLY IF": The CAV is defined as a sufficient and necessary condition for the validity of argument.
  - The TRUTH (NOT false) of the conclusion of an argument is by itself sufficient for the CAV of that argument.
  - The CAV says nothing about how the premises are RELEVANT/EVIDENTIAL (!) to the conclusion.

The Classical Account of Validity

- **Fundamental questions about the CAV**
  - What is 'true' and what is 'false'?
    - Answer: Definitions are dependent on logic system
  - How can we define 'true' and 'false' formally?
    - Answer: Formal semantics of logic system
  - Is the CAV satisfactory to the validity of deductive arguments in scientific reasoning as well as our everyday reasoning?
    - Answer: No
  - Is the CAV a primitive, absolute first-principle or assumption of logic?
    - Answer: No

Classically Valid and Invalid Arguments

- **Classical validity of deductive arguments**
  - A deductive argument is *classically valid* IF AND ONLY IF it is necessary that IF all its premises are true, THEN its conclusion is true
  - A deductive argument is *classically valid* IF AND ONLY IF it is impossible for all the premises to be true while the conclusion is false.
- **Classical invalidity of deductive arguments**
  - A deductive argument is *classically invalid* IF AND ONLY IF its conclusion may be false when all its premises are true.

Classically Valid and Invalid Arguments: Examples

- **Example 1**
  - { (1) NEU is located in ShenYang,
    (2) ShenYang is in LaoNing }
    => (3) NEU is located in LaoNing
  - Note: (1), (2), (3) are true, and this argument is correct and/or reasonable. (Valid)
- **Example 1**
  - { (1) SUSTech is located in ShenZhen,
    (2) ShenZhen is in GuangDong }
    => (3) SUSTech is located in GuangDong
  - Note: (1), (2), (3) are true, and this argument is correct and/or reasonable. (Valid)

Classically Valid and Invalid Arguments: Examples

- **Example 2**
  - { (1) NEU is located in ShenYang,
    (2) ShenYang is in LaoNing }
    => (3) NEU is located in JiLin
  - Note: (1), (2) are true, but (3) is false, and this argument is incorrect and/or unreasonable. (Invalid)
- **Example 2**
  - { (1) SUSTech is located in ShenZhen,
    (2) ShenZhen is in GuangDong }
    => (3) SUSTech is located in FuJian
  - Note: (1), (2) are true, but (3) is false, and this argument is incorrect and/or unreasonable. (Invalid)

Classically Valid and Invalid Arguments: Examples

♣ Example 3

- { (1) NEU is located in ShenYang,
  (2) ShenYang is in JiLin }
  => (3) NEU is located in LaoNing
- Note: (1), (3) are true, but (2) is false, and this argument is incorrect and/or unreasonable. (Valid)

♣ Example 3

- { (1) SUSTech is located in ShenZhen,
  (2) ShenZhen is in FuJian }
  => (3) SUSTech is located in GuangDong
- Note: (1), (3) are true, but (2) is false, and this argument is incorrect and/or unreasonable. (Valid)

Classically Valid and Invalid Arguments: Examples

♣ Example 4

- { (1) NEU is located in ChangChun,
  (2) ShenYang is in LiaoNing }
  => (3) NEU is located in LiaoNing
- Note: (2), (3) are true, but (1) is false, and this argument is incorrect and/or unreasonable. (Valid)

♣ Example 4

- { (1) SUSTech is located in FuZhou,
  (2) ShenZhen is in GuangDong }
  => (3) SUSTech is located in GuangDong
- Note: (2), (3) are true, but (1) is false, and this argument is incorrect and/or unreasonable. (Valid)

Classically Valid and Invalid Arguments: Examples

♣ Example 5

- { (1) NEU is located in ShenYang,
  (2) ShenYang is in JiLin }
  => (3) NEU is located in JiLin
- Note: (1) is true, but (2), (3) are false, and this argument is correct and/or reasonable! (Valid)

♣ Example 5

- { (1) SUSTech is located in ShenZhen,
  (2) ShenZhen is in FuJian }
  => (3) SUSTech is located in FuJian
- Note: (1) is true, but (2), (3) are false, and this argument is correct and/or reasonable! (Valid)

Classically Valid and Invalid Arguments: Examples

♣ Example 6

- { (1) NEU is located in ChangChun,
  (2) ChangChun is in JiLin }
  => (3) NEU is located in JiLin
- Note: (2) is true, but (1), (3) are false, and this argument is correct and/or reasonable! (Valid)

♣ Example 6

- { (1) SUSTech is located in FuZhou,
  (2) FuZhou is in FuJian }
  => (3) SUSTech is located in FuJian
- Note: (2) is true, but (1), (3) are false, and this argument is correct and/or reasonable! (Valid)

Classically Valid and Invalid Arguments: Examples

♣ Example 7

- { (1) NEU is located in ShenYang,
  (2) ShenYang is in LaoNing,
  (3) 1 + 1 = 2 }
  => (4) NEU is located in LaoNing
- Note: (1), (2), (3), (4) are true, (3) is irrelevant to (1), (2), (4), and this argument is considered to be incorrect and/or unreasonable in our everyday life, but is correct and/or reasonable in CML! (Valid)

♣ Example 7

- { (1) SUSTech is located in ShenZhen,
  (2) ShenZhen is in GungDong,
  (3) 1 + 1 = 2 }
  => (4) SUSTech is located in GuangDong
- Note: (1), (2), (3), (4) are true, (3) is irrelevant to (1), (2), (4), and this argument is considered to be incorrect and/or unreasonable in our everyday life, but is correct and/or reasonable in CML! (Valid)

Classically Valid and Invalid Arguments: Examples

♣ Example 8

- { (1) NEU is located in ShenYang,
  (2) ShenYang is in LaoNing }
  => (3) NEU is located in LaoNing or (4) 1 + 1 = 2
- Note: (1), (2), (3), (4) are true, (4) is irrelevant to (1), (2), (3), and this argument is considered to be incorrect and/or unreasonable in our everyday life, but is correct and/or reasonable in CML! (Valid)

♣ Example 8

- { (1) SUSTech is located in ShenZhen,
  (2) ShenZhen is in GuangDong }
  => (3) SUSTech is located in GuangDong or (4) 1 + 1 = 2
- Note: (1), (2), (3), (4) are true, (4) is irrelevant to (1), (2), (3), and this argument is considered to be incorrect and/or unreasonable in our everyday life, but is correct and/or reasonable in CML! (Valid)

Classically Valid and Invalid Arguments: Examples

♣ **Example 9**

- { (1) NEU is located in ShenYang,
  (2) ShenYang is in LaoNing,
  (3) 1 + 1 = 3 }
  => (4) NEU is located in LaoNing
- Note: (1), (2), (4) are true, (3) is false and irrelevant to (1), (2), (4), and this argument is considered to be incorrect and/or unreasonable in our everyday life, but is correct and/or reasonable in CML! (Valid)

♣ **Example 9**

- { (1) SUSTech is located in ShenZhen,
  (2) ShenZhen is in GuangDong,
  (3) 1 + 1 = 3 }
  => (4) SUSTech is located in GuangDong
- Note: (1), (2), (4) are true, (3) is false and irrelevant to (1), (2), (4), and this argument is considered to be incorrect and/or unreasonable in our everyday life, but is correct and/or reasonable in CML! (Valid)

Classically Valid and Invalid Arguments: Examples

♣ **Example 10**

- { (1) NEU is located in ShenYang,
  (2) ShenYang is in LaoNing }
  => (3) NEU is located in LaoNing or (4) 1 + 1 = 3
- Note: (1), (2), (3) are true, (4) is false and irrelevant to (1), (2), (3), and this argument is considered to be incorrect and/or unreasonable in our everyday life, but is correct and/or reasonable in CML! (Valid)

♣ **Example 10**

- { (1) SUSTech is located in ShenZhen,
  (2) ShenZhen is in GuangDong }
  => (3) SUSTech is located in GuangDong or (4) 1 + 1 = 3
- Note: (1), (2), (3) are true, (4) is false and irrelevant to (1), (2), (3), and this argument is considered to be incorrect and/or unreasonable in our everyday life, but is correct and/or reasonable in CML! (Valid)

Classically Valid and Invalid Arguments: Examples

♣ **Example 11**

- { (1) NEU is located in ShenYang,
  (2) ShenYang is in LaoNing,
  (3) 1 + 1 = 3 }
  => (4) NEU is located in JiLin
- Note: (1), (2) are true, (3), (4) are false, (3) is irrelevant to (1), (2), (4), and this argument is considered to be incorrect and/or unreasonable in our everyday life, but is correct and/or reasonable in CML! (Valid)

♣ **Example 11**

- { (1) SUSTech is located in ShenZhen,
  (2) ShenZhen is in GuangDong,
  (3) 1 + 1 = 3 }
  => (4) SUSTech is located in FuJian
- Note: (1), (2) are true, (3), (4) are false, (3) is irrelevant to (1), (2), (4), and this argument is considered to be incorrect and/or unreasonable in our everyday life, but is correct and/or reasonable in CML! (Valid)

Classically Valid and Invalid Arguments: Examples

♣ **Example 12**

- { (1) NEU is located in ShenYang,
  (2) ShenYang is in JiLin }
  => (3) NEU is located in JiLin or (4) 1 + 1 = 3
- Note: (1) is true, (2), (3), (4) are false, (4) is irrelevant to (1), (2), (3), and this argument is considered to be incorrect and/or unreasonable in our everyday life, but is correct and/or reasonable in CML! (Valid)

♣ **Example 12**

- { (1) SUSTech is located in ShenZhen,
  (2) ShenYang is in FuJian }
  => (3) SUSTech is located in FuJian or (4) 1 + 1 = 3
- Note: (1) is true, (2), (3), (4) are false, (4) is irrelevant to (1), (2), (3), and this argument is considered to be incorrect and/or unreasonable in our everyday life, but is correct and/or reasonable in CML! (Valid)

Classically Valid and Invalid Arguments: Examples

♣ **Example 13**

- { (1) NEU is located in ShenYang,
  (2) ShenYang is in LaoNing,
  (3) ShenYang is NOT in LaoNing }
  => (4) NEU is located in LaoNing
- Note: (1), (2), (4) are true, (3) is false, and this argument is considered to be incorrect and/or unreasonable in our everyday life, but is correct and/or reasonable in CML! (Valid)

♣ **Example 13**

- { (1) SUSTech is located in ShenZhen,
  (2) ShenZhen is in GuangDong,
  (3) ShenZhen is NOT in GuangDong }
  => (4) SUSTech is located in GuangDong
- Note: (1), (2), (4) are true, (3) is false, and this argument is considered to be incorrect and/or unreasonable in our everyday life, but is correct and/or reasonable in CML! (Valid)

Classically Valid and Invalid Arguments: Examples

♣ **Example 14**

- { (1) NEU is located in ShenYang,
  (2) ShenYang is in LaoNing,
  (3) ShenYang is NOT in LaoNing }
  => (4) NEU is NOT located in LaoNing
- Note: (1), (2) are true, (3), (4) are false, and this argument is considered to be incorrect and/or unreasonable in our everyday life, but is correct and/or reasonable in CML! (Valid)

♣ **Example 14**

- { (1) SUSTech is located in ShenZhen,
  (2) ShenZhen is in GuangDong,
  (3) ShenZhen is NOT in GuangDong }
  => (4) SUSTech is NOT located in GuangDong
- Note: (1), (2) are true, (3), (4) are false, and this argument is considered to be incorrect and/or unreasonable in our everyday life, but is correct and/or reasonable in CML! (Valid)

Consistent and Inconsistent Arguments

- ***Consistency*** **of arguments**
  - **An argument is *consistent* IF AND ONLY IF its conclusion may be true when all its premises are true.**
- ***Inconsistency*** **of arguments**
  - **An argument is *inconsistent* IF AND ONLY IF is not consistent, i.e., its conclusion must be false when all its premises are true.**
- **Notes**
  - **Classically invalid arguments may be either consistent or inconsistent.**
  - **Consistent arguments may be either classically valid or classically invalid.**

Sound and Unsound Arguments

- ***Soundness*** **of arguments**
  - **A deductive argument is *sound* IF AND ONLY IF it is *valid* and all its premises are *actually true*.**
- ***Unsoundness*** **of arguments**
  - **A deductive argument is *unsound* IF AND ONLY IF it is not sound, i.e., either it is *invalid* or at least one of its premises is *actually false*.**
- **Notes**
  - **Sound arguments must be valid; invalid arguments must be unsound.**
  - **Valid arguments may be either sound or unsound.**

The Relevant Account of Validity

- ***Relevance*** **in arguments**
  - **For any correct and meaningful (deductive, inductive, and abductive) argument in scientific reasoning as well as our everyday reasoning, its premises must somehow be *relevant* to its conclusion, and vice versa.**
  - **In general, we do not accept irrelevant statements as premises and/or conclusion in a correct and meaningful argument.**
- **The *relevant account of validity* (RAV)**
  - **For an argument to be *valid/good* there must be some *connection* of meaning, i.e., some *relevance*, between its premises and its conclusion.**

The Relevant Account of Validity

- **Notes**
  - **What the terms 'relevant' and 'relevance' mean have to be defined.**
  - **"MUST BE": The RAV is defined as a necessary (but not sufficient) condition for the validity/goodness of arguments.**
  - **The relevance between the premises and conclusion of an argument is by itself insufficient for the "validity/goodness" of that argument, because it is only a necessary condition but not a sufficient condition.**
  - **The RAV says nothing about truth of the premises and truth of the conclusion.**

Fundamental Problems about the RAV

- **Fundamental problems about the RAV**
  - **What is 'relevance'?**
    - **Answer: Something is said in both premises and conclusion**
  - **How can we define 'relevance' formally?**
    - **Answer: Formal semantics of relevant logic systems, variable-sharing**
  - **Is the RAV satisfactory to the validity of deductive arguments in scientific reasoning as well as our everyday reasoning?**
    - **Answer: No**
  - **Is the RAV is a primitive, absolute first-principle or assumption of logic?**
    - **Answer: No**

Relevant and Irrelevant Arguments

- ***Relevance*** **of arguments**
  - **An argument is *relevant* IF AND ONLY IF its conclusion is relevant in some way to each of its premises.**
- ***Irrelevance*** **of arguments**
  - **An argument is *irrelevant* IF AND ONLY IF it is not relevant, i.e., its conclusion is not relevant at all in any way to its premises.**
- **Notes**
  - **Classically valid/invalid arguments may be either relevant or irrelevant.**
  - **Relevant arguments may be either classically valid or classically invalid.**

Logically Valid (Deductive) Reasoning

- **Logically valid (deductive) reasoning**
  - A *logically valid reasoning* is a reasoning such that its arguments are justified based on some *logical validity criterion* provided by a logic system in order to obtain correct conclusions.
- **Notes**
  - A reasoning may be valid on a logical validity criterion but invalid on another.
  - The term 'correct' does not mean 'true'; a logically valid reasoning with some false premise may draw a false conclusion.

Logically Valid (Deductive) Reasoning

- **Fundamental problems about logical validity criteria**
  - What should we consider in establishing a logical validity?
    - Answer: true/false, relevance, …?
  - How can we establish various logical validity criteria to underlie various reasoning?
    - Answer: Investigate various correct, meaningful, and useful reasoning in the real world
  - How can we formalize a logical validity criterion?
    - Answer: Axiomatization

Truth-preserving Reasoning

- ***Truth-preserving reasoning***
  - For any correct argument in a deductive reasoning, the conclusion of the argument must be *true* IF all premises of that argument are *true*.
- **Notes**
  - "MUST BE": a necessary (but not sufficient) condition.
  - What the term 'true' means has to be defined.
  - The above 'truth-preserving reasoning' says only about truths of premises and conclusion but does not take other things into account.

Fundamental Problems about Truth-preserving Reasoning

- **Fundamental problems about truth-preserving reasoning**
  - How can we define truth formally?
  - How can we formalize the truth-preserving criterion?
  - Is the truth-preserving criterion both sufficient and necessary to scientific reasoning as well as our everyday reasoning?
  - Is the truth-preserving criterion satisfactory to scientific reasoning as well as our everyday reasoning?
- **Where can we find the solutions?**
  - Note: The truth-preserving criterion is NOT a primitive, absolute first-principle or assumption of logic.
  - It is logic that deals with the validity of arguments and reasoning in a general theory.

Relevant Reasoning

- ***Relevant reasoning***
  - For any correct argument in scientific reasoning as well as our everyday reasoning, its premises must be *relevant* to its conclusion, and vice versa.
- **Notes**
  - "MUST BE": a necessary (but not sufficient) condition.
  - What the term 'relevant' means has to be defined.
  - The above 'relevant reasoning' says only about relevance between premises and conclusion but does not take other things into account.

Fundamental Problems about Relevant Reasoning

- **Fundamental problems about relevant reasoning**
  - How can we define relevance formally?
  - How can we formalize the relevance criterion?
  - Is the relevance criterion both sufficient and necessary to scientific reasoning as well as our everyday reasoning?
  - Is the relevance criterion satisfactory to scientific reasoning as well as our everyday reasoning?
- **Where can we find the solutions?**
  - Note: The relevance criterion is NOT a primitive, absolute first-principle or assumption of logic.
  - It is logic that deals with the validity of arguments and reasoning in a general theory.

Paraconsistent Reasoning

♣ *Paraconsistent reasoning* (*Reasoning under inconsistency, Reasoning with inconsistent knowledge*)

- For any correct argument in scientific reasoning as well as our everyday reasoning, the conclusion of the argument SHOULD NOT BE an arbitrary sentence when (even if) the premises of that argument is inconsistent.

♣ Note

- Reasoning with inconsistent knowledge is the rule rather than the exception in our everyday life and all scientific disciplines.

♣ Fundamental problems about paraconsistent reasoning

- What may be the conclusion of inconsistent premises?
- How can we establish a formal logical validity criterion to underlie paraconsistent reasoning?

Paracomplete Reasoning

♣ *Paracomplete reasoning* (*Reasoning under uncertainty, Reasoning with incomplete knowledge*)

- For any correct argument in scientific reasoning as well as our everyday reasoning, the conclusion of the argument SHOULD NOT BE the negation of a sentence when (even if) the sentence is not a conclusion of that argument.

♣ Note

- Reasoning with incomplete knowledge is the rule rather than the exception in our everyday life and all scientific disciplines.

♣ Fundamental problems

- What may be the conclusion of incomplete premises?
- How can we establish a formal logical validity criterion to underlie paracomplete reasoning?

Logic: What Is It and Why Study It?

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- Reasoning, Proving, Discovery, and Prediction
- Arguments, Deduction, Induction, and Abduction
- Truth and Validity
- Various Fallacies
- The Notion of a Conditional: The Heart of Logic
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