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**
- ◆ **Truth and Validity**
- ◆ **Various Fallacies**
- ◆ **The Notion of a Conditional: The Heart of Logic**
- ◆ **Logic: What Is It All About?**
- ◆ **Mathematical Logic**
- ◆ **Various Philosophical Logics**

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Reasoning: What Is It and Why Study It ?

Reasoning: What Is It and Why Study It ?

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Definitions of 'Reasoning' in Dictionaries

- ◆ **"The process by which one judgment is deduced from another or others which are given." [The Oxford English Dictionary (OED), 2nd Edition]**
- ◆ **"The drawing of inferences or conclusions through the use of reason." [Longman Dictionary of the English Language]**
- ◆ **"The drawing of inferences or conclusions through the use of reason." [Webster's Third New International Dictionary of the English Language]**
- ◆ **"The process of forming conclusions, judgments, or inferences from facts or premises." [The Random House Dictionary of the English Language, 2nd Edition]**
- ◆ **"Use of reason, especially to form conclusions, inferences, or judgments." [The American Heritage Dictionary of the English Language, 3rd Edition]**

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Reasoning: An Example

♣ **A good reasoning example**

(1) All rational numbers are expressible as a ratio of integers.

(2) π is not expressible as a ratio of integers.

Therefore,

(3) π is not a rational number.

(4) π is a number.

Therefore,

(5) There exists at least one non-rational number.

♣ **A question**

- ◆ What do you think of swaps (1) and (4)?

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The Importance of Reasoning Ability

♣ **Reasoning ability as the most fundamental attribute of human intelligence**

- ◆ The great ability to reason, in particular, to reason conceptually, is the most fundamental attribute of human intelligence, and therefore, the most intrinsic difference between human being and animals.

♣ **The importance of reasoning ability**

- ◆ The ability to reason conceptually, is extremely important in our daily lives because it is the way of getting most of our knowledge.
- ◆ Most of our knowledge is inferential; it is gained not through direct observation, but by inferring one thing from another.
- ◆ The ability to reason conceptually, is our only way to predict various dangers for avoiding natural or man-made disasters.

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Reasoning: What Is It?

♣ **Reasoning as a process of drawing new conclusions**

- ◆ *Reasoning* is the *process* of drawing *new conclusions* from given *premises*, which are already known facts or previously assumed hypotheses to provide some *evidence* for the conclusions.

♣ **Notes**

- ◆ "process", "new conclusions", "premises", "evidence"

♣ **Reasoning as an ordered process**

- ◆ In general, a reasoning consists of a number of *arguments* (*inferences*) in a certain *order*, i.e., a reasoning is an ordered process.

♣ **Notes**

- ◆ "arguments", "inferences", "order"

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Reasoning: What Is It?

♣ **Reasoning as a way to acquire new knowledge**

◆ Reasoning is the process of going from what we do know or we assume (the premises) to what we previously did not know (the new conclusions).

♣ **Reasoning as a way to expand our knowledge**

◆ Reasoning is intrinsically *ampliative*, i.e., it has the function of enlarging or extending some things, or adding to what is already known or assumed.

The Characteristics of Reasoning

♣ **Relevant/Evidential relation between premises and conclusions**

◆ The premises of a reasoning are supposed to present evidence for the conclusions of that reasoning.

◆ Though the premises of a reasoning are intended to provide some evidence for the conclusions of that reasoning, they need not actually do so.

◆ Provided => good/correct; Not provided => bad/incorrect

♣ **New conclusions**

◆ The conclusions of a reasoning are supposed to be new to the premises of that reasoning.

◆ How to define the notion of 'new' formally and satisfactorily is still a difficult philosophical problem until now.

The Characteristics of Reasoning

♣ **The correctness and/or validity of reasoning**

◆ Good and bad reasoning (about a concrete reasoning)

◆ Correct and incorrect reasoning (about a concrete reasoning)

◆ Valid and invalid reasoning (about an abstract reasoning form)

♣ **Fundamental problems about reasoning**

◆ What is a good, correct, valid reasoning and how we do it?

◆ What is the criterion by which one can decide whether or not the premises of a reasoning really provide some evidence for the conclusions of that reasoning?

◆ What is the criterion by which one can decide whether or not the conclusion of a reasoning is really new to the premises of that reasoning?

Reasoning and Logic

♣ **Where can we find the solutions to the fundamental problems about reasoning?**

◆ It is logic that deals with the correctness and/or validity of reasoning in a general theory.

◆ Note: validity, generality

♣ **Reasoning and logic**

◆ Logic is primarily about inferring, about reasoning; in particular, it is the study of what constitutes correct reasoning.

◆ Logic is the study of the methods and principles used to distinguish good (correct) from bad (incorrect) reasoning.

◆ Formal logic deal with "formal reasoning" and/or "reasoning form".

Proving: What Is It ?

Proving: What Is It ?

Proving: What Is It?

♣ **Definitions of 'proving' in dictionary** [The OED, 2nd Edition]

◆ "The action of showing to be true, genuine, or valid; demonstration."

◆ "The action of establishing a claim."

♣ **Proving**

◆ *Proving* is the process of finding a *justification* for an explicitly *specified statement* from given premises, which are already known facts or previously assumed hypotheses.

◆ A *proof* is a *description* of a found justification.

♣ **Notes**

◆ "process", "justification", "specified statement", "given premises"

Proving: What Is It?

♣ **Proving and logic**

◆ *Classical Mathematical Logic* (**CML**) was established in order to provide formal languages for describing the structures with which mathematicians work, and the methods of proof available to them; its principal aim is a precise and adequate understanding of the notion of mathematical proof.

♣ **Logically valid proving**

◆ A *logically valid proving* is a proving such that it is justified based on some logical validity criterion in order to obtain a correct proof.

◆ Note: Any "correctness" must be depend on a certainly defined criterion.

Reasoning vs. Proving: What Is the Difference ?

Reasoning vs. Proving: What Is the Difference ?

Reasoning and Proving: Intrinsic Difference?

♣ **Nature**

◆ The most intrinsic difference between reasoning and proving is that the former is intrinsically prescriptive and predictive while the latter is intrinsically descriptive and non-predictive.

♣ **Aim**

◆ The purpose of reasoning is to find some new statement previously unknown or unrecognized, while the purpose of proving is to find a justification for some statement previously known or assumed.

♣ **Goal (specified statement)**

◆ Proving has an explicitly specified target as its goal while reasoning does not.

Reasoning and Proving: Intrinsic Difference?

♣ **Typical pattern of reasoning**

◆ From A, B, C, …, what we can say?

◆ Before reasoning, we do not know what conclusion we can draw from the premises.

♣ **Typical pattern of proving**

◆ From A, B, C, …, can we say D?

◆ Before proving, we do know what statement we have to justify from the premises.

Discovery: What Is It ?

Discovery: What Is It ?

Discovery: What Is It?

♣ **Definitions of 'discovery' in dictionary** [The OED, 2nd Edition]

◆ "The action of uncovering or fact of becoming uncovered."

◆ "The finding out or bringing to light of that which was previously unknown; making known: also with a and pl., an instance of this."

◆ "Exploration, investigation, reconnoitring, reconnaissance."

♣ **Discovery**

◆ *Discovery* is the process to find out or bring to light of that which was previously *unknown*.

◆ For any discovery, both the discovered thing and its truth must be unknown before the end of the discovery process.

♣ **Notes**

◆ "process", "find out or bring to light", "unknown"

Discovery and Reasoning

♣ **Discovery must invoke reasoning**
- ◆ Reasoning is the only way to draw new conclusions from given premises.
- ◆ There is no discovery process that does not invoke reasoning, because the discovered thing and its truth in a discovery process is unknown before the completion of the discovery process.

♣ **Discovery must be based on correct reasoning**
- ◆ Since any discovery process has no completely explicitly specified target, the only criterion the discovery process must act according to is to reason correct conclusions from the premises.

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Prediction: What Is It ?

Prediction:
What Is It ?

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Prediction: What Is It?

♣ **Definitions of 'prediction' in dictionary** [The OED, 2nd Edition]
- ◆ "The action of predicting or foretelling future events; also, an instance of this, a prophecy."
- ◆ "A statement made beforehand."

♣ **Prediction**
- ◆ *Prediction* is the process to make some *future event* known in advance, especially on the basis of special knowledge.
- ◆ For any prediction, both the predicted event and its occurrence must be unknown before the end of the prediction process.

♣ **Notes**
- ◆ "process", "future event", "known in advance"

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Prediction and Reasoning

♣ **Prediction must invoke reasoning**
- ◆ Reasoning is the only way to draw new conclusions from given premises.
- ◆ There is no prediction process that does not invoke reasoning, because the predicted event and its occurrence in a prediction process is unknown before the completion of the prediction process.

♣ **Prediction must be based on correct reasoning**
- ◆ Since any prediction process has no completely explicitly specified target, the only criterion the prediction process must act according to is to reason correct conclusions from the premises.

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Logic: What Is It and Why Study It?

- ◆ Logic: What Is It and Why Study It?
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- ◆ Mathematical Logic
- ◆ Various Philosophical Logics

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Arguments: What Are They and Why Study Them ?

Arguments:
What Are They
and
Why Study Them ?

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Definitions of 'Inference' in Dictionaries

◆ "The action or process of inferring; the drawing of a conclusion from known or assumed facts or statements; *esp.* in *Logic*, the forming of a conclusion from data or premises, either by inductive or deductive methods; reasoning from something known or assumed to something else which follows from it. Also (with *pl.*), a particular act of inferring; the logical form in which this is expressed." [The Oxford English Dictionary (OED), 2nd Edition]

◆ "The act or an instance of passing from one proposition accepted as true to another whose truth is believed to follow from that of the former." [Longman Dictionary of the English Language]

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Definitions of 'Inference' in Dictionaries

◆ "The act of passing from one or more propositions, statements, or judgments considered as true to another the truth of which is believed to follow from that of the former." [Webster's Third New International Dictionary of the English Language]

◆ "The process of deriving the strict logical consequences of assumed premises." [The Random House Dictionary of the English Language, 2nd Edition]

◆ "The act or process of deriving logical conclusions from premises known or assumed to be true." [The American Heritage Dictionary of the English Language, 3rd Edition]

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Definitions of 'Argument' in Dictionaries

◆ "A statement or fact advanced for the purpose of influencing the mind; a reason urged in support of a proposition; *spec.* in *Logic*, the middle term in a syllogism." "A connected series of statements or reasons intended to establish a position (and, hence, to refute the opposite); a process of reasoning; argumentation." "Statement of the reasons for and against a proposition; discussion of a question; debate." [The Oxford English Dictionary (OED), 2nd Edition]

◆ "A reason given in proof or rebuttal." "The act or process of arguing; argumentation, debate." "A coherent series of reasons offered." [Longman Dictionary of the English Language]

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Definitions of 'Argument' in Dictionaries

◆ "A reason or matter for dispute or contention." [The American Heritage Dictionary of the English Language, 3rd Edition]

◆ "A course of reasoning aimed at demonstrating truth or falsehood." [The American Heritage Dictionary of the English Language, 3rd Edition]

◆ "A fact or statement put forth as proof or evidence." [The American Heritage Dictionary of the English Language, 3rd Edition]

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Statements (Declarative Sentences)

♣ **Statement**

◆ A *statement* is an assertion that is either *true* or *false* and is typically expressed by a declarative sentence.

♣ **Declarative sentence**

◆ A *declarative sentence* is a grammatically correct sentence that can be put in place of '...' in the sentence 'Is it true that ...?' with the effect that the resulting sentence is a grammatically correct question.

◆ A declarative sentence typically expresses an assertion that is either *true* or *false*, as opposed to questions, commands, or exclamations.

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Statements (Declarative Sentences)

♣ **Examples**

◆ "Mary is a student" is a declarative sentence, but "How pretty Mary is!" is not a declarative sentence.

◆ Dogs do not fly. (generally true)

◆ Snow is red. (generally false)

◆ My daughter is a student. (true or false is dependent on what fact is)

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Argument: What Is It?

♣ **Argument as a set of statements**

- ◆ An *argument* is a set of *statements* (or *declarative sentences*) of which one statement is *intended* as the *conclusion*, and one or more statements, called "*premises*," are *intended* to provide some *evidence* for the conclusion.
- ◆ Formal definition of an argument: $A =_{df} (P, c)$ where P is a set of statements (*premises*) and c is a statement (*conclusion*).

♣ **Argument as an evidential relation**

- ◆ In an argument, a *claim* is being made that there is some sort of *evidential/inferential relationship* between its premises and its conclusion: the conclusion is supposed to *follow from* the premises, or equivalently, the premises are supposed to *entail* the conclusion.
- ◆ Only good arguments successfully establish that claim.

Definitions of Arguments [C&C]

♣ **Proposition**

- ◆ A statement; what is typically asserted using a declarative sentence, and hence always either true or false -- although its truth or falsity may be unknown.
- ◆ Propositions are the building blocks of our reasoning.

♣ **Statement**

- ◆ A proposition; what is typically asserted by a declarative sentence, but not the sentence itself. Every statement must be either true or false, although the truth or falsity of a given statement may be unknown.
- ◆ The term statement is not an exact synonym of proposition, but it is often used in logic in much the same sense.

Definitions of Arguments [C&C]

♣ **Inference**

- ◆ A process by which one proposition is arrived at and affirmed on the basis of some other proposition or propositions.

♣ **Propositions, inference, and argument**

- ◆ With propositions as building blocks, we construct arguments.
- ◆ In any argument we affirm one proposition on the basis of some other propositions.
- ◆ In doing this, an inference is drawn.
- ◆ Inference is a process that may tie together a cluster of propositions. Some inferences are warranted (or correct); others are not. The logician analyzes these clusters, examining the propositions with which the process begins and with which it ends, as well as the relations among these propositions. Such a cluster of propositions constitutes an argument.
- ◆ Arguments are the chief concern of logic.

Definitions of Arguments [C&C]

♣ **Argument**

- ◆ Any group of propositions of which one is *claimed* to *follow from* the others, which are regarded as providing *support* or *grounds* for the truth of that one.

♣ **Conclusion**

- ◆ In any argument, the proposition to which the other propositions in the argument are claimed to give support, or for which they are given as reasons.

♣ **Premises**

- ◆ In an argument, the propositions upon which *inference* is based; the propositions that are claimed to provide grounds or reasons for the conclusion.

Definitions of Arguments [C&C]

♣ **Conclusion indicator**

- ◆ A word or phrase (such as "*therefore*" or "thus") appearing in an argument and usually indicating that what follows it is the conclusion of that argument.

♣ **A partial list of conclusion indicators**

therefore	for these reasons
hence	it follows that
so	I conclude that
accordingly	which shows that
in consequence	which means that
consequently	which entails that
proves that	which implies that
as a result	which allows us to infer that
for this reason	which points to the conclusion that
thus	we may infer

Definitions of Arguments [C&C]

♣ **Premise indicator**

- ◆ In an argument, a word or phrase (like "*because*" and "since") that normally signals that what follows it are statements serving as premises.

♣ **A partial list of premise indicators**

since	as indicated by
because	the reason is that
for	for the reason that
as	may be inferred from
follows from	may be derived from
as shown by	may be deduced from
inasmuch as	in view of the fact that

Definitions of Arguments [Hurley]

♣ **Arguments**

- ◆ An *argument*, in its most basic form, is a group of statements, one or more of which (the *premises*) are *claimed to provide support* for, or *reasons* to believe, one of the others (the *conclusion*).
- ◆ A *statement* is a *sentence* that is either true or false -- in other words, typically a *declarative sentence* or a sentence component that could stand as a declarative sentence.

♣ **Good arguments vs. bad arguments**

- ◆ All arguments may be placed in one of two basic groups: those in which the premises **really do support** the conclusion and those in which they do not, even though they are claimed to.
- ◆ The former are said to be *good arguments* (at least to that extent), the latter *bad arguments*.

Definitions of Arguments [Hurley]

♣ **Distinguishing premises from conclusions**

- ◆ One of the most important tasks in the analysis of arguments is being able to distinguish premises from conclusions.
- ◆ If what is thought to be a conclusion is really a premise, and vice versa, the subsequent analysis cannot possibly be correct.

♣ **Typical conclusion indicators**

Some typical **conclusion indicators** are

therefore	accordingly	entails that
wherefore	we may conclude	hence
thus	it must be that	it follows that
consequently	for this reason	implies that
we may infer	so	as a result

Definitions of Arguments [Hurley]

♣ **Typical premise indicators**

If an argument does not contain a conclusion indicator, it may contain a premise indicator. Some typical **premise indicators** are

since	in that	seeing that
as indicated by	may be inferred from	for the reason that
because	as	in as much as
for	given that	owing to

♣ **Inference and proposition**

- ◆ Closely related to the concepts of argument and statement are those of inference and proposition.
- ◆ An inference, in the narrow sense of the term, is the reasoning process expressed by an argument. In the broad sense of the term, "inference" is used interchangeably with "argument."
- ◆ A proposition, in the narrow sense, is the meaning or information content of a statement. For the purposes of this book, however, "proposition" and "statement" are used interchangeably.

Definitions of Arguments [Kelley]

♣ **Argument and Inference**

- ◆ A set of *premises* together with a *conclusion* is called an *argument*.
- ◆ In logic, the term argument is used to mean an appeal to *evidence* in support of a conclusion.
- ◆ It means a set of propositions in which some propositions (the *premises*) are asserted as *support* or *evidence* for another (the *conclusion*).
- ◆ Another way to put this is to say that the conclusion is *inferred from* the premises.
- ◆ Thus an argument can also be described as an *inference*, and we will use those terms interchangeably.

Definitions of Arguments [Kelley]

♣ **Premise and conclusion indicators**

STRATEGY **Indicator Words**

To identify premises and conclusions, look for the following indicator words:

Premise indicators	*Conclusion indicators*
Since	Therefore
Because	Thus
As	So
For	Consequently
Given that	As a result
Assuming that	It follows that
Inasmuch as	Hence
The reason is that	Which means that
In view of the fact that	Which implies that

Definitions of Arguments [Layman]

♣ **Statement**

- ◆ A *statement* is a sentence that is either true or false.

♣ **Argument**

- ◆ An *argument* is a set of statements, one of which, called the *conclusion*, is affirmed on the basis of the others, which are called the *premises*.
- ◆ The premises of an argument are offered as *support* (or *evidence*) for the conclusion, and that support (or evidence) may be adequate or inadequate in a given case.
- ◆ But the set of statements counts as an argument as long as one statement is affirmed on the basis of others.

Definitions of Arguments [Layman]

♣ **Well-constructed arguments vs. poorly-constructed arguments**

◆ The *premises* of an *argument* are the statements on the basis of which the *conclusion* is *affirmed*; the *conclusion* is the statement that is *affirmed* on the basis of the premises.

◆ In a *well-constructed argument*, the *premises* give good *reasons* for believing that the *conclusion* is true.

◆ But a *poorly-constructed argument* is still an argument.

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Definitions of Arguments [Johnson]

♣ **Argument**

◆ An *argument* is a group of statements, one of which is *claimed* to *follow from* the others.

◆ The statement, which is claimed to *follow*, is called the *conclusion* of the argument.

◆ Every argument has at least one statement *supporting* the conclusion. A statement that *provides a reason* for the conclusion is called a *premise*.

◆ According to the above definition, every argument has one conclusion and at least one premise, from which the conclusion *is claimed to follow*.

◆ Only good arguments successfully establish that claim.

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Definitions of Arguments [Johnson]

♣ **The inferential relationship in an argument**

◆ The statements of an argument are in a special relationship, in which one or more statements provide reason for another, is called an *inferential relationship*.

◆ We say that there is an *inference* from the premises to the conclusion, or the conclusion in inferred from the premises.

◆ Thus, an earmark of an argument is the presence of that inferential relationship.

♣ **Arguments in logic**

◆ In logic, an argument is an identifiable piece of reasoning in which a point is expressed and reasons are offered for that point.

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Definitions of Arguments [Johnson]

♣ **Conclusion clue words**

◆ Therefore, Thus, Hence, It follows that, It must be that, We may conclude that, We may infer that, Implies that, Entails that, Consequently, So.

♣ **Premise clue words**

◆ Since, Because, For, For the reason that, In that, Due to the fact that, Given that, May be concluded from.

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Argument Example: The Most Classical One

♣ **Premises**

▾ All humans are mortal.

▾ Socrates is a human.

♣ **Conclusion**

▾ Therefore, Socrates is mortal.

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Argument Example: An Argument by Sherlock Holmes

♣ **Premises**

▾ This is a large hat.

▾ Someone is the owner of this hat.

▾ The owners of large hats are people with large heads.

▾ People with large heads have large brains.

▾ People with large brains are highly intellectual.

♣ **Conclusion**

▾ Therefore, the owner of this large hat is highly intellectual.

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Terminology

◆**Classical Mathematical Logic (CML)**

◆**Relevant Logic (RL)**

◆**Strong Relevant Logic (SRL)**

Argument Examples

♣**Example 7**

◆ { (1) NEU is located in ShenYang,
  (2) ShenYang is in LiaoNing,
  (3) 1 + 1 = 2 }
  => (4) NEU is located in LiaoNing

◆ Note: (1), (2), (3), (4) are true, and (3) is completely irrelevant to (1), (2), (4); this argument is considered to be incorrect / unreasonable in our everyday life.

◆ Note: This argument is considered to be correct in CML as well as RL! But it is considered to be incorrect in SRL.

Argument Examples

♣**Example 7**

◆ { (1) SUSTech is located in ShenZhen,
  (2) ShenZhen is in GuangDong,
  (3) 1 + 1 = 2 }
  => (4) SUSTech is located in GuangDong

◆ Note: (1), (2), (3), (4) are true, and (3) is completely irrelevant to (1), (2), (4); this argument is considered to be incorrect / unreasonable in our everyday life.

◆ Note: This argument is considered to be correct in CML as well as RL! But it is considered to be incorrect in SRL.

Argument Examples

♣**Example 8**

◆ { (1) NEU is located in ShenYang,
  (2) ShenYang is in LiaoNing }
  => (3) NEU is located in LiaoNing or (4) 1 + 1 = 2

◆ Note: (1), (2), (3), (4) are true, as the conclusion, (3) and (4) is partly irrelevant to (1), (2), and (4) is completely irrelevant to (1), (2), (3); this argument is considered to be incorrect / unreasonable in our everyday life.

◆ Note: This argument is considered to be correct in CML as well as RL! But it is considered to be incorrect in SRL.

Argument Examples

♣**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, as the conclusion, (3) and (4) is partly irrelevant to (1), (2), and (4) is completely irrelevant to (1), (2), (3); this argument is considered to be incorrect / unreasonable in our everyday life.

◆ Note: This argument is considered to be correct in CML as well as RL! But it is considered to be incorrect in SRL.

Argument Examples

♣**Example 9**

◆ { (1) NEU is located in ShenYang,
  (2) ShenYang is in LiaoNing,
  (3) 1 + 1 = 3 }
  => (4) NEU is located in LiaoNing

◆ Note: (1), (2), (4) are true, and (3) is false and completely irrelevant to (1), (2), (4); this argument is considered to be incorrect / unreasonable in our everyday life.

◆ Note: This argument is considered to be correct in CML as well as RL! But it is considered to be incorrect in SRL.

Argument Examples

♣ **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, and (3) is false and completely irrelevant to (1), (2), (4); this argument is considered to be incorrect / unreasonable in our everyday life.
- ◆ Note: This argument is considered to be correct in CML as well as RL! But it is considered to be incorrect in SRL.

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Argument Examples

♣ **Example 10**

- ◆ { (1) NEU is located in ShenYang,
  (2) ShenYang is in LiaoNing }
  => (3) NEU is located in LiaoNing or (4) 1 + 1 = 3
- ◆ Note: (1), (2), (3) are true, as the conclusion, (3) and (4) is partly irrelevant to (1), (2), and (4) is false and completely irrelevant to (1), (2), (3); this argument is considered to be incorrect / unreasonable in our everyday life.
- ◆ Note: This argument is considered to be correct in CML as well as RL! But it is considered to be incorrect in SRL.

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Argument Examples

♣ **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, as the conclusion, (3) and (4) is partly irrelevant to (1), (2), and (4) is false and completely irrelevant to (1), (2), (3); this argument is considered to be incorrect / unreasonable in our everyday life.
- ◆ Note: This argument is considered to be correct in CML as well as RL! But it is considered to be incorrect in SRL.

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Argument Examples

♣ **Example 11**

- ◆ { (1) NEU is located in ShenYang,
  (2) ShenYang is in JiLin,
  (3) 1 + 1 = 3 }
  => (4) NEU is located in JiLin
- ◆ Note: (1) is true, (2), (3), (4) are false, and (3) is completely irrelevant to (1), (2), (4); this argument is considered to be incorrect / unreasonable in our everyday life.
- ◆ Note: This argument is considered to be correct in CML as well as RL! But it is considered to be incorrect in SRL.

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Argument Examples

♣ **Example 11**

- ◆ { (1) SUSTech is located in ShenZhen,
  (2) ShenZhen is in FuJian,
  (3) 1 + 1 = 3 }
  => (4) SUSTech is located in FuJian
- ◆ Note: (1) is true, (2), (3), (4) are false, and (3) is completely irrelevant to (1), (2), (4); this argument is considered to be incorrect / unreasonable in our everyday life.
- ◆ Note: This argument is considered to be correct in CML as well as RL! But it is considered to be incorrect in SRL.

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Argument 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, as the conclusion, (3) and (4) is partly irrelevant to (1), (2), and (4) is completely irrelevant to (1), (2), (3); this argument is considered to be incorrect / unreasonable in our everyday life.
- ◆ Note: This argument is considered to be correct in CML as well as RL! But it is considered to be incorrect in SRL.

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Argument Examples

♣ **Example 12**

◆ { (1) SUSTech is located in ShenZhen,
    (2) ShenZhen is in FuJian }
 => (3) SUSTech is located in FuJian or (4) 1 + 1 = 3

◆ Note: (1) is true, (2), (3), (4) are false, as the conclusion, (3) and (4) is partly irrelevant to (1), (2), and (4) is completely irrelevant to (1), (2), (3); this argument is considered to be incorrect / unreasonable in our everyday life.

◆ Note: This argument is considered to be correct in CML as well as RL! But it is considered to be incorrect in SRL.

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Argument Examples

♣ **Example 13**

◆ { (1) NEU is located in ShenYang,
    (2) ShenYang is in LiaoNing,
    (3) ShenYang is NOT in LiaoNing }
 => (4) NEU is located in LiaoNing

◆ Note: (1), (2), (4) are true, and (3) is false; this argument is considered to be incorrect / unreasonable in our everyday life.

◆ Note: This argument is considered to be correct in CML as well as RL! But it is considered to be incorrect in SRL.

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Argument Examples

♣ **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, and (3) is false; this argument is considered to be incorrect / unreasonable in our everyday life.

◆ Note: This argument is considered to be correct in CML as well as RL! But it is considered to be incorrect in SRL.

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Argument Examples

♣ **Example 14**

◆ { (1) NEU is located in ShenYang,
    (2) ShenYang is in LiaoNing,
    (3) ShenYang is NOT in LiaoNing }
 => (4) NEU is NOT located in LiaoNing

◆ Note: (1), (2) are true, and (3), (4) are false; this argument is considered to be incorrect / unreasonable in our everyday life.

◆ Note: This argument is considered to be correct in CML as well as RL! But it is considered to be incorrect in SRL.

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Argument Examples

♣ **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, and (3), (4) are false; this argument is considered to be incorrect / unreasonable in our everyday life.

◆ Note: This argument is considered to be correct in CML as well as RL! But it is considered to be incorrect in SRL.

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The Characteristics of Arguments

♣ **The evidential relation between premises and conclusion**

◆ The premises of an argument are supposed to present evidence for the conclusion of that argument.

◆ Though the premises of an argument are intended to provide some evidence for the conclusion of that argument, they not necessarily actually do so.

♣ **The correctness of arguments**

◆ The correctness of an argument is a matter of the connection between its premises and its conclusion, and concerns the strength of the evidential relation between them.

♣ **Notes**

◆ An argument may be correct even if its premises includes some actually false statements; an argument may be incorrect even if its all premises are actually true.

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The Characteristics of Arguments

♣ **Possible evaluative criteria for arguments**

- ◆ (1) Whether all the premise are **true**;
- ◆ (2) Whether the conclusion is at least **probable**, given the truth of the premises;
- ◆ (3) Whether the premises are **relevant(!)** to the conclusion, and vice versa;
- ◆ (4) Whether the conclusion is **vulnerable** to new evidence.

♣ **Notes**

- ◆ Though an argument may have many objectives, its chief purpose is usually to demonstrate that a conclusion is true or at least likely to be true.
- ◆ Not all of the above criteria are applicable to all arguments.

The Characteristics of Arguments

♣ **The correctness of arguments**

- ◆ Good and bad arguments
- ◆ Rational and irrational arguments
- ◆ Correct and incorrect arguments

♣ **Fundamental problems about arguments**

- ◆ What is a good/rational/correct argument and how we do it?
- ◆ What is the criterion by which one can decide whether or not the conclusion of an argument really does follow from its premises?
- ◆ Is there the only one criterion, or are there many criteria?
- ◆ If there are many criteria, what are the intrinsic differences between them?

Arguments and Logic

♣ **Where can we find the solutions to the fundamental problems about argument?**

- ◆ It is logic that deals with the correctness and/or validity of argument in a general theory.

♣ **Arguments and logic**

- ◆ Logic may be defined as the science that evaluates arguments.
- ◆ The purpose of logic, as the science that evaluates arguments, is thus to develop methods and techniques that allow us to distinguish good/rational/correct arguments from bad/irrational/incorrect ones.

Deduction, Induction, and Abduction

Deduction, Induction, and Abduction

Deduction

♣ **Definitions of 'deduction' in dictionary** [The OED, 2nd Edition]

- ◆ "The process of deducing or drawing a conclusion from a principle already known or assumed; spec. in Logic, inference by reasoning from generals to particulars; opposed to induction."

♣ **Deductive arguments (reasoning)**

- ◆ A *deductive argument* is an argument in which the premises are intended to provide *absolute support (evidence)* for the conclusion, i.e., its conclusion *follows necessarily from* its premises.
- ◆ Ex. : If A then B, A, therefore B.
- ◆ Note: The conclusion must be true, if the premises are all true.

Induction

♣ **Definitions of 'induction' in dictionary** [The OED, 2nd Edition]

- ◆ "The process of inferring a general law or principle from the observation of particular instances (opposed to deduction, q.v.)."

♣ **Inductive arguments (reasoning)**

- ◆ An *inductive argument* is an argument in which the premises are intended to provide *some degree of support (evidence)* for the conclusion, i.e., its conclusion is *not necessarily follows from* its premises.
- ◆ Ex. : If A_1 is a B, A_2 is a B, …, A_n is a B, therefore maybe all A_{n+1}, A_{n+2}, …, are also B.
- ◆ Note: The conclusion will be false, once a counter-example, A_{n+k} is NOT B, is found.

Abduction

♣ **Definitions of 'abduction' in dictionary** [The OED, 2nd Edition]

◆ "A syllogism, of which the major premiss is certain, and the minor only probable, so that the conclusion has only the probability of the minor."

♣ **Abductive arguments (reasoning)**

◆ An *abductive argument* is an argument in which the premises are intended to provide a *hypothesis* as the conclusion.

◆ "The surprising fact, *C*, is observed. But if *A* were true, *C* would be a matter of course. Hence, there is reason to suspect that *A* is true." [C. S. Peirce]

◆ Ex. : If *A* then *C*, *C*, therefore maybe *A*.

◆ Note: The conclusion will be false, once a counter-example, if *B* then *C* and if *B* then NOT *A*, is found.

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Deduction, Induction, and Abduction

♣ **The conditional "if … then …" in deduction, induction, and abduction**

◆ If *A* then *B*, *A*, therefore *B*.

◆ If A_1 is a *B*, A_2 is a *B*, …, A_n is a *B*, therefore maybe all *A* are *B*.

◆ If *A* then *C*, *C*, therefore maybe *A*.

♣ **The logic of scientific discovery: three major approaches**

◆ The hypothetico-deductive account [Popper, Hempel]

◆ The inductive-probability account [Reichenbach, Salmon]

◆ The abductive inference account [Peirce, Hanson]

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Deductive and Inductive Arguments [C&C]

♣ **Deductive arguments**

◆ One of the two major types of argument traditionally distinguished, the other being the inductive argument.

◆ A *deductive argument* claims to provide *conclusive grounds* for its conclusion. If it does provide such grounds, it is *valid*; if it does not, it is *invalid*.

◆ A deductive argument is one whose conclusion is claimed to *follow from its premises with absolute necessity*, this necessity not being a matter of degree and not depending in any way on whatever else may be the case.

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Deductive and Inductive Arguments [C&C]

♣ **Inductive arguments**

◆ One of the two major types of argument traditionally distinguished, the other being the deductive argument.

◆ An *inductive argument* claims that its premises give only *some degree of probability*, but not certainty, to its conclusion.

◆ An inductive argument is one whose conclusion is claimed to *follow from its premises only with probability*, this probability being a matter of degree and dependent on what else may be the case.

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Deductive and Inductive Arguments [C&C]

♣ **Deductive arguments vs. Inductive arguments**

◆ The distinction between deduction and induction rests on the nature of the claims made by the two types of arguments about the relations between their premises and their conclusions.

◆ A deductive argument makes the claim that its conclusion is supported by its premises conclusively. An inductive argument, in contrast, does not make such a claim.

◆ Therefore, if we judge that in some passage a claim for conclusiveness is being made, we treat the argument as deductive; if we judge that such a claim is not being made, we treat it as inductive.

◆ Because every argument either makes this claim of conclusiveness (explicitly or implicitly) or does not make it, every argument is either deductive or inductive.

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Deductive and Inductive Arguments [Hurley]

♣ **Deductive arguments**

◆ A *deductive argument* is an argument incorporating the claim that it is *impossible* for the conclusion to be *false* given that the premises are *true*.

◆ Deductive arguments are those that involve *necessary reasoning*.

♣ **Inductive arguments**

◆ An *inductive argument* is an argument incorporating the claim that it is *improbable* that the conclusion be *false* given that the premises are *true*.

◆ Inductive arguments involve *probabilistic reasoning*.

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Deductive and Inductive Arguments: Examples [Hurley]

♣ **Deductive argument example**

◆ "The meerkat is a member of the mongoose family. All members of the mongoose family are carnivores. Therefore, it necessarily follows that the meerkat is a carnivore."

◆ "All entertainers are extroverts. David Letterman is an entertainer. Therefore, David Letterman is an extrovert."

♣ **Inductive argument example**

◆ "The meerkat is closely related to the suricat. The suricat thrives on beetle larvae. Therefore, probably the meerkat thrives on beetle larvae."

◆ "The vast majority of entertainers are extroverts. David Letterman is an entertainer. Therefore, David Letterman is an extrovert."

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Deductive and Inductive Arguments [Kelley]

♣ **Deductive arguments**

◆ A *deductive argument* attempts to show that its conclusion makes explicit the information implicit in the premises, so that the conclusion must be *true* if the premises are.

◆ A deductive argument is either *valid* or *invalid*.

◆ If it is *valid*, then it is *impossible* for all of its premises to be *true* and its conclusion to be *false*. Otherwise it is *invalid*.

◆ If it is *valid* and all of its premises are *true*, the argument is *sound*.

◆ Deduction: Sound = Valid + True premises

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Deductive and Inductive Arguments [Kelley]

♣ **Inductive arguments**

◆ An *inductive argument* attempts to show that the conclusion is supported by the premises even though the conclusion amplifies -- it goes beyond -- what the premises state.

◆ As a result, the truth of the premises does not guarantee the truth of the conclusion; there is some possibility, however small, that the conclusion is false.

◆ Inductive arguments have degrees of strength, and a given argument can be *strengthened* or *weakened* through additional evidence.

◆ If the argument is *strong* and all of its premises are *true*, it is *cogent*.

◆ Induction: Cogent = Strong + True premises

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Deductive and Inductive Arguments [Kelley]

♣ **Inductive arguments**

◆ An *inductive argument* attempts to show that the conclusion is supported by the premises even though the conclusion amplifies -- it goes beyond -- what the premises state.

♣ **Ampliativity**

◆ Logicians sometimes describe this feature of induction by saying that it is *ampliative*: The conclusion amplifies -- it goes beyond -- what the premises state.

♣ **Note**

◆ The ampliativity is a general property of arguments/ reasoning that is applicable to not only induction but also other arguments/reasoning.

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Deductive and Inductive Arguments: Examples [Kelley]

♣ **Deductive argument example**

◆ "A detective investigating a murder notices that nothing was taken from the victim's wallet. He might reason as follows: (1) If robbery was the motive, the money would have been taken, but (2) the money was not taken, so (3) robbery was not the motive."

♣ **Inductive argument example**

◆ "A scientist investigating an outbreak of disease examines a random sample of the victims. She discovers (1) that all of them had recently eaten strawberries from California, and, as far as she can tell, (2) that the people in the sample had nothing else in common. The scientist concludes (3) that something in the strawberries was causing the disease in all the victims."

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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

◆ **Truth and Validity**

◆ Various Fallacies

◆ The Notion of a Conditional: The Heart of Logic

◆ Logic: What Is It All About?

◆ Mathematical Logic

◆ Various Philosophical Logics

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