A deductive argument is valid if

Method of reasoning by which premises understood to be true produce logically certain conclusions Deductive reasoning, also deductive logic, is the process of reasoning from one or more statements (premises) to reach a logical conclusion.[1] Deductive reasoning goes in the same direction as that of the conditionals, and links premises with conclusions. If all premises are true, the terms are clear, and the rules of deductive logic are followed, then the conclusion reached is necessarily true. Deductive reasoning ("top-down logic") contrasts with inductive reasoning ("bottom-up logic"): in deductive reasoning, a conclusion is reached reductively by applying general rules which hold over the entirety of a closed domain of discourse, narrowing the range under consideration until only the conclusion(s) remains. In deductive reasoning there is no uncertainty.[2] In inductive reasoning, the conclusion is reached by generalizing or extrapolating from specific cases to general rules resulting in a conclusion that has epistemic uncertainty.[2] The inductive reasoning is not the same as induction used in mathematical proofs – mathematical induction is actually a form of deductive reasoning. Deductive reasoning differs from abductive reasoning by the direction of the reasoning relative to the conditionals. The idea of "deduction" popularized in Sherlock Holmes stories is technically abduction, rather than deductive reasoning. Deductive reasoning goes in the same direction as that of the conditionals, whereas abductive reasoning goes in the direction contrary to that of the conditionals. Reasoning with modus ponens, modus tollens, and the law of syllogism Modus ponens Main article: Modus ponens Modus ponens (also known as "affirming the antecedent" or "the law of detachment") is the primary deductive rule of inference. It applies to arguments that have as first premise a conditional statement (P → Q {\displaystyle P\rightarrow Q}) and as second premise the antecedent (P {\displaystyle P}) of the conditional statement. It obtains the consequent (Q {\displaystyle Q}) of the conditional statement as its conclusion. The argument form is listed below: P → Q {\displaystyle P\rightarrow Q}   (First premise is a conditional statement) P {\displaystyle P}   (Second premise is the antecedent) Q {\displaystyle Q}   (Conclusion deduced is the consequent) In this form of deductive reasoning, the consequent (Q {\displaystyle Q}) obtains as the conclusion from the premises of a conditional statement (P → Q {\displaystyle P\rightarrow Q}) and its antecedent (P {\displaystyle P}). However, the antecedent (P {\displaystyle P}) cannot be similarly obtained as the conclusion from the premises of the conditional statement (P → Q {\displaystyle P\rightarrow Q}) and the consequent (Q {\displaystyle Q}). Such an argument commits the logical fallacy of affirming the consequent. The following is an example of an argument using modus ponens: If an angle satisfies 90° < A {\displaystyle A} < 180°, then A {\displaystyle A} is an obtuse angle. A {\displaystyle A} = 120°. A {\displaystyle A} is an obtuse angle. Since the measurement of angle A {\displaystyle A} is greater than 90° and less than 180°, we can deduce from the conditional (if-then) statement that A {\displaystyle A} is an obtuse angle. However, if we are given that A {\displaystyle A} is an obtuse angle, we cannot deduce from the conditional statement that 90° < A {\displaystyle A} < 180°. It might be true that other angles outside this range are also obtuse. Modus tollens Main article: Modus tollens Modus tollens (also known as "the law of contrapositive") is a deductive rule of inference. It validates an argument that has as premises a conditional statement (formula) and the negation of the consequent (¬ Q {\displaystyle \lnot Q}) and as conclusion the negation of the antecedent (¬ P {\displaystyle \lnot P}). In contrast to modus ponens, reasoning with modus tollens goes in the opposite direction to that of the conditional. The general expression for modus tollens is the following: P → Q {\displaystyle P\rightarrow Q} . (First premise is a conditional statement) ¬ Q {\displaystyle \lnot Q} . (Second premise is the negation of the consequent) ¬ P {\displaystyle \lnot P} . (Conclusion deduced is the negation of the antecedent) The following is an example of an argument using modus tollens: If it is raining, then there are clouds in the sky. There are no clouds in the sky. Thus, it is not raining. Law of syllogism In term logic the law of syllogism takes two conditional statements and forms a conclusion by combining the hypothesis of one statement with the conclusion of another. Here is the general form: P → Q {\displaystyle P\rightarrow Q} Q → R {\displaystyle Q\rightarrow R} Therefore, P → R {\displaystyle P\rightarrow R} . The following is an example: If the animal is a Yorkie, then it's a dog. If the animal is a dog, then it's a mammal. Therefore, if the animal is a Yorkie, then it's a mammal. We deduced the final statement by combining the hypothesis of the first statement with the conclusion of the second statement. We also allow that this could be a false statement. This is an example of the transitive property in mathematics. Another example is the transitive property of equality which can be stated in this form: A = B {\displaystyle A=B} . B = C {\displaystyle B=C} . Therefore, A = C {\displaystyle A=C} . Simple example An example of an argument using deductive reasoning: All men are mortal. (First premise) Socrates is a man. (Second premise) Therefore, Socrates is mortal. (Conclusion) The first premise states that all objects classified as "men" have the attribute "mortal." The second premise states that "Socrates" is classified as a "man" – a member of the set "men." The conclusion then states that "Socrates" must be "mortal" because he inherits this attribute from his classification as a "man." Validity and soundness Argument terminology Deductive arguments are evaluated in terms of their validity and soundness. An argument is "valid" if it is impossible for its premises to be true while its conclusion is false. In other words, the conclusion must be true if the premises are true. An argument can be "valid" even if one or more of its premises are false. An argument is "sound" if it is valid and the premises are true. It is possible to have a deductive argument that is logically valid but is not sound. Fallacious arguments often take that form. The following is an example of an argument that is "valid", but not "sound": Everyone who eats carrots is a quarterback. John eats carrots. Therefore, John is a quarterback. The example's first premise is false – there are people who eat carrots who are not quarterbacks – but the conclusion would necessarily be true, if the premises were true. In other words, it is impossible for the premises to be true and the conclusion false. Therefore, the argument is "valid", but not "sound". False generalizations – such as "Everyone who eats carrots is a quarterback" – are often used to make unsound arguments. The fact that there are some people who eat carrots but are not quarterbacks proves the flaw of the argument. In this example, the first statement uses categorical reasoning, saying that all carrot-eaters are definitely quarterbacks. This theory of deductive reasoning – also known as term logic – was developed by Aristotle, but was superseded by propositional (sentential) logic and predicate logic.[citation needed] Deductive reasoning can be contrasted with inductive reasoning, in regards to validity and soundness. In cases of inductive reasoning, even though the premises are true and the argument is "valid", it is possible for the conclusion to be false (determined to be false with a counterexample or other means). Probability of Conclusion The probability of the conclusion of a deductive argument cannot be calculated by figuring out the cumulative probability of the argument's premises. Dr. Timothy McGrew, a specialist in the applications of probability theory, and Dr. Ernest W. Adams, a Professor Emeritus at UC Berkeley, pointed out that the theorem on the accumulation of uncertainty designates only a lower limit on the probability of the conclusion. So the probability of the conjunction of the argument's premises sets only a minimum probability of the conclusion. The probability of the argument's conclusion cannot be any lower than the probability of the conjunction of the argument's premises. For example, if the probability of a deductive argument's four premises is ~0.43, then it is assured that the probability of the argument's conclusion is no less than ~0.43. It could be much higher, but it cannot drop under that lower limit.[3][4] There can be examples in which each single premise is more likely true than not and yet it would be unreasonable to accept the conjunction of the premises. Professor Henry Kyburg, who was known for his work in probability and logic, clarified that the issue here is one of closure – specifically, closure under conjunction. There are examples where it is reasonable to accept P and reasonable to accept Q without its being reasonable to accept the conjunction (P&Q). Lotteries serve as very intuitive examples of this, because in a basic non-discriminatory finite lottery with only a single winner to be drawn, it is sound to think that ticket 1 is a loser, sound to think that ticket 2 is a loser,...all the way up to the final number. However, clearly it is irrational to accept the conjunction of these statements; the conjunction would deny the very terms of the lottery because (taken with the background knowledge) it would entail that there is no winner.[5][4] Dr. McGrew further adds that the sole method to ensure that a conclusion deductively drawn from a group of premises is more probable than not is to use premises the conjunction of which is more probable than not. This point is slightly tricky, because it can lead to a possible misunderstanding. What is being searched for is a general principle that specifies factors under which, for any logical consequence C of the group of premises, C is more probable than not. Particular consequences will differ in their probability. However, the goal is to state a condition under which this attribute is ensured, regardless of which consequence one draws, and fulfilment of that condition is required to complete the task. This principle can be demonstrated in a moderately clear way. Suppose, for instance, the following group of premises: {P, Q, R} Suppose that the conjunction ((P & Q) & R) fails to be more probable than not. Then there is at least one logical consequence of the group that fails to be more probable than not – namely, that very conjunction. So it is an essential factor for the argument to "preserve plausibility" (Dr. McGrew coins this phrase to mean "guarantee, from information about the plausibility of the premises alone, that any conclusion drawn from those premises by deductive inference is itself more plausible than not") that the conjunction of the premises be more probable than not.[4] History This section needs expansion. You can help by adding to it. (January 2015) Aristotle, a Greek philosopher, started documenting deductive reasoning in the 4th century BC.[6] René Descartes, in his book Discourse on Method, refined the idea for the Scientific Revolution. Developing four rules to follow for proving an idea deductively, Decartes laid the foundation for the deductive portion of the scientific method. Decartes' background in geometry and mathematics influenced his ideas on the truth and reasoning, causing him to develop a system of general reasoning now used for most mathematical reasoning. Similar to postulates, Decartes believed that ideas could be self-evident and that reasoning alone must prove that observations are reliable. These ideas also lay the foundations for the ideas of rationalism.[7] See also Philosophy portal Web portal Abductive reasoning Analogical reasoning Argument (logic) Argumentation theory Correspondence theory of truth Decision making Decision theory Defeasible reasoning Fallacy Fault tree analysis Geometry Hypothetico-deductive method Inference Inquiry Legal syllogism Logic and rationality Logical consequence Logical reasoning Mathematical logic Natural deduction Peirce's theory of deductive reasoning Propositional calculus Retroductive reasoning Scientific method Subjective logic Theory of justification References ^ Sternberg, R. J. (2009). Cognitive Psychology. Belmont, CA: Wadsworth. pp. 578. ISBN 978-0-495-50629-4. ^ a b Zi, Jan (2019), Models of 6-valued measures: 6-kinds of information, Kindle Direct Publishing Science ^ Adams, Ernest W. (1998). A Primer of Probability Logic. Cambridge University Press. pp. 31–34. ISBN 157586066X. ^ a b c McGrew, Timothy J.; DePoe, John M. 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