

Critical Thinking & Innovation

JAKE CHANDLER

Deductive Reasoning, Part 1



DEDUCTION: FIRST STEPS

Deductively valid arguments

- One of the two features of a good argument:
The premises **support** the conclusion
- The gold standard for support:
Deductive validity: The truth of the premises would (100%)
guarantee that of the conclusion

Example: Square

(P₁) The shape has four equal sides

(P₂) The shape's inner angles are ninety degrees

(C) The shape is a square

Deductive *invalidity*

- If an argument is deductively **invalid**, it could have possible for premises to be true but the conclusion false

Example: Square #2

(P₁) The shape has four equal sides

(C) The shape is a square

(Relevant possibility: the shape is a diamond, so that (P₁) is true but (C) false)

- Let's test our judgments about deductive validity...

Deductive validity vs invalidity: examples

Example: Treats

(P₁) Isaac either got a cookie or got an ice-cream.

(P₂) Isaac got a cookie.

(C) Isaac didn't get an ice-cream.

Example: Steroids

(P₁) If steroids were taken, the test will come out positive.

(P₂) Sam's test came out positive.

(C) Sam took steroids.

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Deductive validity vs invalidity: examples (ctd.)

Example: Penknife

(P₁) If Billy's dad found his penknife, he's in deep trouble.

(P₂) Billiy's dad didn't find his penknife.

(C) Billy isn't in deep trouble.

Example: Cluedo

(P₁) Either Professor Plum did it, or Colonel Mustard did.

(P₂) Professor Plum didn't do it.

(C) Colonel Mustard did it.

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Deductive validity vs invalidity: examples (ctd.)

Example: Prison

(P₁) Some residents of the prison went to the zoo.

(P₂) All prisoners are residents of the prison.

(C) Some prisoners went to the zoo.

Example: Hooligans

(P₁) Some football fans are hooligans.

(P₂) All hooligans are bad-tempered.

(C) Some football fans are bad-tempered.

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Inductive validity

- It doesn't follow from the fact that an argument isn't deductively valid, that it isn't a good argument!
- There are good reasons that fall short of *guaranteeing* truth.

Example: Marseille

(P₁) The past ten times that I've been to Marseille, my car has been broken into.

(C) The next time I go to Marseille, my car will be broken into.

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Inductive validity (ctd)

Example: Covid

(P₁) My rapid antigen test came out positive

(C) I have covid.

- Above, (P₁) seems to provide a good enough reason to expect (C), but doesn't *guarantee* its truth (I might be lucky)
- These arguments are **inductively valid**
- More on this later

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Validity & soundness

- Premise support for the conclusion is only one of two requirements for an argument's being good
- There is more to a good deductive argument than mere validity:

Example: Intergalactic Renegades

(P₁) Jake teaches CTO

(P₂) If you teach CTO, then you're an Intergalactic Renegade

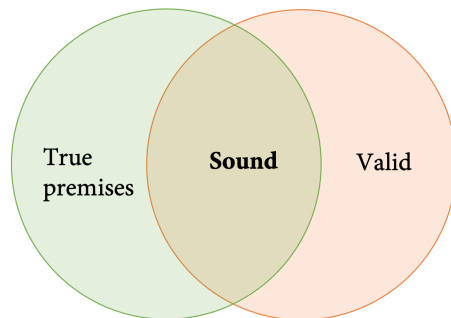
(C) Jake is an Intergalactic Renegade

- Valid: the truth of (P₁) and (P₂) would guarantee that of (C)
- But unpersuasive: (P₂) is clearly false

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Validity & soundness (ctd)

- A **sound** argument is an argument (i) that is valid *and* (ii) whose premises are all true



- So every sound argument has a true conclusion. (But *not* all arguments with true conclusions are sound!!!)

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Deductive Reasoning, Part 1

INTRODUCING FORMAL LOGIC

A coincidence?

Example: Cluedo

(P₁) Either Professor Plum did it, or Colonel Mustard did.

(P₂) It isn't the case that Professor Plum did it.

(C) Colonel Mustard did it.

Example: Keys

(P₁) Either my car keys are at home, or they are in the office.

(P₂) It isn't the case that my car keys are at home.

(C) My car keys are in the office.

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A coincidence? (ctd)

Example: Still out and about

(P₁) If he was back, then the lights would be on.

(P₂) It is not the case that the lights are on.

(C) It isn't the case that he is back.

Example: Departure

(P₁) If he had been planning on leaving, then he would have contacted Sam.

(P₂) It isn't the case that he contacted Sam.

(C) It isn't the case that he was planning on leaving.

A coincidence? (ctd)

Example: Hiding

(P₁) He either stayed in Damascus or went to Aleppo.

(P₂) If he stayed in Damascus, then he will have been arrested.

(P₃) If he went to Aleppo, then he will have been murdered.

(C) He will have been arrested or murdered.

Example: Nightclub

(P₁) Either it'll be crowded or it'll be empty.

(P₂) If it's crowded, then it'll be too hot.

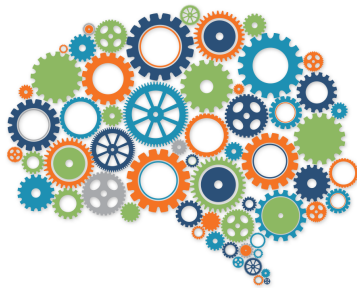
(P₃) If it's empty, it'll be boring.

(C) It'll either be boring or too hot.

Formal validity

- All these arguments are valid
- But their validity doesn't seem to depend on *what they are about*
- It looks like it's just the **form** (pattern, structure,...) that matters.
(Note: whether or not the arguments are *sound*, however, will also depend on subject matter!)
- You can't obtain true premises but a false conclusion by changing the content but preserving the form!

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Formal validity (ctd.)

- Argument form can be described at two levels of detail
 - (i) **Sentential** form (less detailed)
 - (ii) **Sub-sentential** form (more detailed)
- Our examples above are valid simply because of their sentential forms

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SENTENTIAL FORM

Sentences and sub-sentences

- A **complex** sentence is a sentence built up from other sentences
- These sentential building blocks, which can themselves be complex, are known as **sub-sentences**
- Not all sentences are complex, however
- An **atomic sentence** is a sentence that has no further component sub-sentences

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Atomic vs complex sentences

Example

Atomic sentences:

It'll be crowded.

He stayed in Damascus.

The lights are on.

Complex sentences (sub-sentences in italics):

Either *it'll be crowded* or *it'll be empty*.

If *he stayed in Damascus*, then *he will have been arrested*.

It is not the case that *the lights are on*.

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Connectives

- In the examples we have just seen, some parts of the complex sentences were not sub-sentences.
- These elements are known as **sentential connectives**.
- They take one or more sentences as an input and produce a complex sentence as an output.
- There are *many* connectives, but the following five are key:
 - ...and...
 - ...or...
 - if..., then...
 - ...if and only if...
 - It is not the case that...

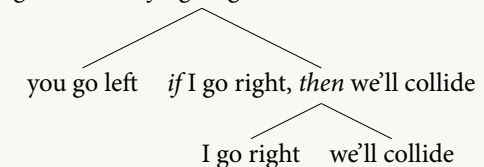
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Parse trees

- A **parse tree** shows how complex sentences are built up from atomic ones

Example

If you go left, then if I go right, then we'll collide.



- The **main connective** of a complex sentence is the last connective used in constructing it

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Types of complex sentences

- We give special names to certain types of sentences based on their main connective.

Main Connective	Sentence name	Input name
...and...	conjunction	conjuncts
...or...	disjunction	disjuncts
if..., then...	conditional	antecedent / consequent
...if and only if...	biconditional	left-hand term / right-hand term
it is not the case that...	negation	negand

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Rewriting complex sentences

- Often, you need to rewrite sentences in an equivalent way to “bring out” the sentential structure
- But beware: appearances can be misleading!

Examples (conjunction)

Sylvia and Sophie like cheesecake.

⇒ Sylvia likes cheesecake and Sophie likes cheesecake.

Sylvia and Sophie got married.

≠ Sylvia got married and Sophie got married.

One more mistake and he'll be fired.

≠ He'll make one more mistake and he'll be fired.

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Rewriting complex sentences (ctd)

Examples (conditionals)

If Hewan will be there, Faisal will be there.

Faisal will be there if Hewan will be there.

Hewan will be there only if Faisal will be there.

⇒ If Hewan will be there, then Faisal will be there.

One more mistake and he'll be fired.

⇒ If he makes one more mistake, then he'll be fired.

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Rewriting complex sentences (ctd)

Examples (negations)

Not all Belgian administrators are very cheerful.

⇒ It is not the case that all Belgian administrators are very cheerful.

All Belgian administrators are not very cheerful.

≠ It is not the case that all Belgian administrators are very cheerful.

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