Logic is the study of good reasoning

The drums are louder than the bass.
The guitar is louder than the drums.
Therefore, the guitar is louder than the bass.

I told the bass player to turn it down or I'd punch his head in.
Therefore, the guitar is louder than the bass.

Is the reasoning in these two examples good? Why, or why not?
Logic seeks theories of good reasoning, to give answers and explanations to questions like these.

Logic provides tools for precise work with ideas

- Formal logics are now often implemented in computer systems. Reasoning can be fully or partly automated and used to verify hardware designs, safety critical software etc.
- Important mathematical questions have been resolved with the help of computer reasoning: the four colour theorem, and the Kepler conjecture
- Philosophers use formal logic to
  - remove apparent problems caused only by the confusion of English (and other natural languages)
  - propose logical foundations for metaphysics
  - analyse concepts into more basic ideas
**Statements, situations and truth**

A statement is a sentence which is true or false, depending on the situation.

- Questions are not statements
  “Where are my keys?”
- Exclamations are not statements
  “Oh damn and blast!”
- Usually, we evaluate statements in the real world, but in logic, we must consider other possibilities
  “If I was rich, I would take a holiday in the South of France.”
- Hence, we should not simply say “statement \( P \) is true” but instead “statement \( P \) is true in situation \( w \)”

**Arguments**

An argument is some statements called premises and a statement called the conclusion.

- Note that sometimes people say “argument” for the reasoning, that is the steps that take you from the premises to the conclusion. In logic, we just mean the premises and the conclusion.
- An argument might have no premises. That is, by “some” we mean “zero or more.”
- Arguments are everywhere, but not usually carefully presented as premises and conclusion. We must determine what are the premises and what is the conclusion. Look for key phrases like “therefore” “it follows that” “hence” ...

**Validity**

An argument is valid if its conclusion is true in every situation where all its premises are true.

- If a valid argument also has true premises, we say it is sound.
  (that is, premises true in the real world)
- If we want to show that an argument is invalid (not valid), we can describe a situation which makes the premises all true, and the conclusion false. This is called a counterexample.

**Systems of Formal Logic**

A formal logic has 3 parts: syntax, semantics and deduction.

- Syntax means grammar, it defines what the sentences or formulae of the language are
- Semantics is meaning, in formal logic we give a mathematically precise meaning to each of our formulae
- Deduction is the method of proof, this is a system of strict rules by which we may obtain one formula from some others, these rules are the building blocks of all reasoning in that system
Syntax of Propositional Logic PL

See Tomassi, Chapter 3.X, Page 114

- definition of a formal language is usually *recursive*, giving basic formulae, and operations by which formulae can be constructed from other formulae
- example: basic formula \( a \), formation rule: *if \( X \) is a formula and \( Y \) is a formula, then \( XY \) is a formula* - result: the language is all strings of \( a \)'s of length 1 or more

Exercises

In class and homework exercises will be taken from Tomassi
Exercise 1.1 Page 26
Exercise 2.1, Page 42

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<td>specify the scope of every connective there</td>
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