First Lecture and Introductions

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Outline

Hello!

Welcome to CS251!

- Topics

Logical Systems

- The Languages
- Metalanguage and Object Language
- Object Languages in CS251
- The Logic of the Metalanguage

Hello!

I am happy to be back to guest teach your class again!

How was your winter?

What have you been learning in the meantime?

How many of your are coming to PSU?

Welcome to CS251!

Instructor: David Lu
Email: dlu@pdx.edu
Textbook: *A Concise Introduction to Logic*
Author: Craig DeLancey
`http://textbooks.opensuny.org/concise-introduction-to-logic/`

Another good textbook: *Forall x*
AUthor: P.D. Magnus
`https://www.fecundity.com/logic/`

Notice both of these are philosophers.

Topics

CS251 is primarily about one topic: Formal Logic

In this course, we will be studying a number of logical systems, also known as logical theories or logical systems.

Logic is important in all areas of study. It's not just for computer science students. Why?

Logical Systems

A logical system consists of four things:

1. A vocabulary of primitive signs used in the language of that system.
2. A list or set of rules governing what strings of signs (called *formulas*) are grammatically or syntactically well-formed in the language of that system.
3. A list of axioms, or a subset of the well-formed formulas, considered as basic and unprovable principles taken as true in the system.
4. A specification of what inferences, or inference patterns or rules, are taken as valid in that system.

The Languages

Because we always start discussing a logical system by discussing the language it uses, it is worth pausing to discuss the notion of using language to study language.

These comprise the first two parts of the logical system: a vocabulary and a syntax or grammar.

Metalanguage and Object Language

The languages of the systems we study are symbolic logical languages. They use symbols such as $\rightarrow$ and $\vee$, not found in ordinary English or Chinese.

However, we will talk and read *about* these logical languages in ordinary English or Chinese.

Whenever one language is used to discuss ot study another, we can distinguish between the language that is being studied, called the **object language**, from the language in which we conduct the study, called the **metalanguage**.

What one is the object language and which one is the metalanguage for this course?

Object Languages in CS251

In this course, the object languages will be propositional logic (sometimes called sentential logic) and predicate calculus.

In CS250, set theory was the main object language you studied.

The Logic of the Metalanguage

Often we will use the metalanguage (English and Chinese) to prove things about the object language.

Proving things already requires logical vocabulary!

Fortunately English (and Chinese) has words like *all*, *or*, *and*, *if*, and so on. These are some of the logical vocabulary of English.

The Propositional Logic

For the first part of this class, we will study the Propositional Logic (PL).

Logical Vocabulary

The Propositional Logic, like any language contains a volcabulary. In this case, it is pretty small, so it is easy to study.

Logical Connectives: $\neg$, $\wedge$, $\vee$, $\rightarrow$, and $\equiv$ (sometimes $\leftrightarrow$)

Atomic Propositions: Uppercase letters: A, B, C, ... P, Q, R

Sentence Schema (sentence variables): lowercase letters: *p*, *q*, *r*

Parentheses: ( ) [ ] { }

Syntax

Any atomic proposition, P, is syntactically well-formed.

For any well-formed proposition, *p*, $\neg p$, is well-formed.

For any well-formed propositions, *p* and *r*, $p \wedge r$, $p \vee r$, $p \rightarrow r$, and $p \leftrightarrow r$ are well-formed.

Precision

Why do we study these logical languages?

Precision

Answer: We want to use them very precisely.

Consider the precision needed to program a computer.
Computers are very dumb. They do exactly what you tell them to.
Computer languages are very much like our logical languages – they are precise.

Vagueness

Natural languages like English and Chinese contain lots of imprecision.

Consider the sentence: *The train is moving too fast.*

Is this true or not?

Ambiguity

How about this one: *The professor from PSU is very nice.*

This one contains ambiguity and vagueness!

Exercises

Try some exercises from chapter 1 of the textbook

Exercise 1

Vagueness arises when the conditions under which a sentence might be true are not clear.

Come up with five sentences in English that are vague.

Exercise 2

Ambiguity arises when a word or phrase has several different meanings.

Come up with five sentences in English that are ambiguous.

Hint: This will require that you identify a homonym, two words that sound the same but have different meanings.

Exercise 3

We can often make a vague sentence precise by giving a specific interpretation for the vague term.

For each of the five vague sentences, try to come up with an interpretation that makes the sentence no longer vague.

Exercise 4

Again we can often make ambiguuos sentences precise by specifying which meaning we intended for the ambiguous term.

For each of the five ambiguous sentences, make it precise.

Exercise 5

Come up with five examples of English sentences that are not declarative sentences.

References

Questions?