Getting Started

Atomic Sentences, LPL Software & More on Arguments

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Announcements

For 01.22

1. The class is full, special permission numbers have been exhausted
2. The textbook is available at NJ Books
3. Digital copies are available on Sakai, but you still have to buy the book
4. HW1 is due Tuesday 01.27
5. Remember to do the reading; check the syllabus for reading assignments

Outline

About our Approach

Methodological Points

- The central concepts in logic are:
  1. Inference
  2. Proof
  3. Truth
- Our goal in this course will be to develop precise and adequate definitions of these concepts
- Today, we'll take the first step towards defining an inference
- We've already learned that an inference consists of some premises and a conclusion
- So, to investigate what inference is, we are going to have to look harder at premises and conclusions first

About our Approach
First-Order Logic

- Premises and conclusions are ordinary sentences of natural language
- This creates a difficulty:
  - Natural languages are intricate and complicated things used to do many things other than state inferences
  - But we want to focus on the features of sentences that are relevant to inference only
- To achieve this goal we will learn how to represent premises and conclusions in a simplified **artificial language** called First-Order Logic, or FOL
- FOL offers a simple picture of the inferential properties of premises and conclusions
- Today we will learn the very basics of this picture

Remember Monty Python
Real Arguments

- Remember the Monty Python skit:
  - Real arguments are different from abuse, name-calling or fisticuffs
  - The point of a real argument is to establish a conclusion by showing how it follows from some more basic claims or premises

Example

- Every human is mortal (Premise)
- Burt Reynolds is human (Premise)
- So, Burt Reynolds is mortal (Conclusion)

The Anatomy of An Argument
Premises & Conclusions

- So, an argument is composed of two basic parts:
  1. Premise(s)
  2. A Conclusion
- To represent an argument we need to learn how to represent its parts, namely premises and conclusions
- This forces us to answer a question:
  - What are premises and conclusions?

Premises & Conclusions?

- Both premises and conclusions are expressed with declarative sentences
  - Example: *Burt Reynolds is mortal*
- These kinds of sentences are used to make factual claims that are true or false
  - Contrast:
    - Stop sleeping!
    - Why is there a cat in my sleeping bag?

Declarative Sentences
The Simplest Kind

- There are many different kinds of declarative sentences
- Over the course of the semester we will be learning how to represent these different kinds of declarative sentences in FOL
- Today, we are going to start at the beginning by considering the simplest kind: atomic sentences

Declarative Sentences
Atomic Sentences

Examples of Atomic Sentences

1. Mars is red
   - Name: *Mars*
   - Predicate: *is red*
2. Eric saw Kristen
   - Names: *Eric, Kristen*
   - Predicate: *saw Kristen*
3. Sandra gave Fluffy to Sarah
   - Names: *Sandra, Fluffy, Sarah*
   - Predicate: *gave Fluffy to Sarah*

- Atomic sentences consist of one or more names and a predicate
- Names pick out things
- Predicates say stuff about those things
- Let's learn how to translate these into FOL!

Atomic Sentences
From English to FOL

Translation of Examples into FOL

English	FOL Translation
Mars is red	Red(mars)
Alex saw Mary	Saw(alex, mary)
Sandra gave Fluffy to Sarah	Gave(sandra, fluffy, sarah)

- For each each English name, there is a corresponding name in FOL
- For each English predicate, there is a corresponding predicate symbol in FOL
- The subject goes first, the direct object second & the indirect object third (order matters!)

Names
Aka Individual Constants

- Names in FOL are often called *individual constants* or *singular terms*

What Individual Constants Are For

Individual Constants are symbols used to refer to a fixed individual object

- This is reflected in our translations:
  - mars refers to Mars, just as the English name *Mars* does
- The version of FOL found in Tarski's World uses a-f & $n_1, n_2, n_3, \ldots$ as individual constants

Predicate Symbols
The Basics

The Purpose of Predicate Symbols

The **predicate symbols** of FOL used to express one of two things:

1. A property of one object
2. A relation between multiple objects (or an object and itself)

- This is reflected in FOL's way of writing them:
  - Red( ) has one place for an individual constant
    - It says that an object has the property of redness
  - Saw(,) has two places for individual constants
    - It says of two objects that one saw the other

Predicate Symbols
Arity

Arity

The number of places a predicate symbol has for individual constants is called its arity

- For example:
  - The arity of Red( ) is 1
  - The arity of Gave(, ,) is 3
- In FOL every predicate symbol has a fixed arity
- This is not true of English:
  1. Sandra gave
  2. Sandra gave Fluffy
  3. Sandra gave Fluffy to Sarah
  4. Sandra gave Fluffy to Sarah in Michigan

Atomic Sentences
Summary

- An atomic sentence is composed of:
  1. A predicate symbol, e.g. Red( )
  2. One or more individual constants, e.g. mars
- Individual constants refer to particular individuals
- Predicate symbols express properties or relations
- Atomic sentences express claims that are true or false

Atomic Sentences
Tarski's World

Let's solidify these ideas by looking at the Tarski's World application

Check List:

- The *blocks language*
- Multiple names
- Properties vs. relations
- Order of names matters

An Overview

- Our textbook comes with four pieces of software:
  1. Tarski's World (language & the world)
  2. Fitch (proof)
  3. Boole (truth tables)
  4. Submit (homework submission)
- We will use **all four** of these programs
- What to do if you are having problems with the software:
  1. Visit the textbook website: `http://ggww2.stanford.edu/GUS/lpl/index.jsp`
  2. If you can't get an answer to your question there, *then* contact me

Tarski's World & Submit

Getting Familiar

Demo Time!
Check list:

- Sentence Files vs. World Files
- World Panel:
  - Add/Remove Blocks, Select, Change Shape, Move, 2-D View, Rotate
- Sentence Panel:
  - Writing Formulas, Creating List, Verifying
- Exercises 1.5 & 1.9

Submit & Homework

Turning-In Your Homework

- Our homework exercises come in three varieties:
  1. Written: ✎
     - Physical copy handed-in to me
  2. Electronic: ➹
     - Submitted to Grade Grinder w/Submit
  3. Combo: ➹|✎
     - A handed-in component & an electronic component
- Exercises 1.5 & 1.9 are marked with ➹, so let's send them to the Grade Grinder
- This is done using the Submit application
- Let's try it

What Do We Know?

Not Enough!

- We know that arguments/inferences consist of premises and conclusions
- But how do we determine if some sentence is intended as a premise or a conclusion?
  - Maybe premises come first and the conclusion last?
  - No, consider:

Argument 1

1. Pat is mortal (Conclusion)
2. After all, Pat is a man (Premise)
3. And, all men are mortal (Premise)

Some Tricks of the Trade
Key Words

- As it turns out, the premises and conclusion can occur in pretty much any order
- However, they are usually tagged with some key words:

Identifying Words

Conclusion Identifiers	Premise Identifiers
hence	*because*
thus	*since*
so	*after all*
consequently	
therefore	

Examples
So What?

Argument 2

1. All grandmothers are omnipotent
2. Letticia is a grandmother
3. So Letticia is omnipotent

- Note the use of *so* in 3
  - *So* indicates that 3 is the conclusion of Argument 2
  - In that case, 1 & 2 must be the premises!

Examples
After all

Argument 1

1. Pat is mortal (Conclusion)
2. After all, Pat is a man (Premise)
3. And, all men are mortal (Premise)

- Recall that *after all* marks premises, so 2 must be a premise
- In 3 *And* suggests that 2 & 3 are intended to play the same role in the argument
- So, 1 must be the conclusion
  - That seems right. The point of the argument seems to be that Pat is mortal

Chopping Up Arguments
Summary

- So, premises and conclusions occur in many different places
  - Identifier words such as *since*, *therefore* and *so* organize this mess
- This works for everyday purposes, but when you are really analyzing an argument it's nice to have a more explicit notation
- One very nice way of writing arguments is called Fitch Format
  - Let's learn it!

Fitch Format
What it Looks Like

Argument 1

1. Pat is mortal (Conclusion)
2. After all, Pat is a man (Premise)
3. And, all men are mortal (Premise)

Fitch Format for Argument 1

1	Pat is a man
2	All men are mortal
3	Pat is mortal

Fitch Format
It's Easy

Fitch Format for Argument 1

1	Pat is a man
2	All men are mortal
3	Pat is mortal

- The horizontal bar is called the Fitch Bar
  - It separates the premises from the conclusion
- This format let's us do without words like *therefore*
- It also allows us to understand the exact structure of the argument from a quick glance

Summary
And a Look at What's Next

- Today, we've learned how to represent some very basic premises & conclusions in FOL
- We've also learned some helpful techniques for 'chopping up' and representing arguments
- On Thursday we'll take the next step in understanding the kinds of arguments that can be built from atomic sentences:
  - We will study the relationships that must hold between premises and conclusions in order for them to form a good argument (logical consequence)
  - We'll also study the techniques that can be used to show whether or not those relationships hold (proof)

Homework 1
Due Tuesday 01.27

Homework 1

Due by class on **Tuesday 01.27**:

1. Purchase the textbook/software bundle (again, don't get it used)
2. Read the introduction (pp.1-10) of the textbook and pp.1-12 of the software manual
3. **Do exercises 1.1, 1.2, 1.3, 1.4**

- The LPL website has partial solutions to selected exercises, take a look!
- Also remember to do the reading for next class: §§2.1, 2.2