More Information on the New Curriculum

To satisfy	You can take these current courses
• CS106B/X	Same course
• CS107	Current CS107 satisfies new CS107
• CS110	If you've taken CS108 and (CS140 or CS143) prior to Spring 08-09, CS108 will satisfy CS110 (but you'll need 1 extra unit in track + electives) If you've taken CS108, but not (CS140 or CS143) prior to Spring 08-09, can count CS108 as elective, but still need to satisfy CS110 requirement
• CS103	CS103A/B or CS103X satisfies new CS103. If you took CS103X you'll need 1 additional unit in track + electives
• CS109	Stat116 (or equivalent) taken prior to Spring 2008-09 satisfies CS109
• CS161	Current CS161 satisfies new CS161 (but may need 1 extra unit in tracks + electives)

More Information on the New Curriculum

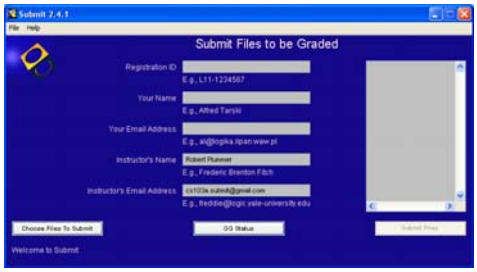
There is much more to the new curriculum than we have discussed. In particular, each CS major must choose a "track" (an area of specialization) and fulfill the appropriate depth requirements.

If you are considering the CS major, you should subscribe to our mailing list. You can do this at

https://mailman.stanford.edu/mailman/listinfo/considering_cs

There is a curriculum information session

Friday, September 26th, 4:30-5:30pm in Gates 104



When submitting homework electronically, use the following:

Instructor's Name: Robert Plummer
Instructor's Email: cs103a.submit@gmail.com

Also, be sure to download the Hints and Solutions from lpl.stanford.edu

SCPD Students

-- Submit your assignments electronically using the Submit program

-- Fax or email written portions to SCPD; they will forward them to us

-- Be sure you have an exam monitor if you are not coming to campus for exams

Discrete Mathematics

Formal logic and proof techniques

Number theory—properties of integers

Combinatorics—problems of counting

Analysis of algorithms

Discrete structures—sets, relations, trees, graphs

Computability and decidability

Introduction to First Order Logic

Some alternate names:

-- Predicate calculus

-- Lower predicate calculus

-- FOL

We will use the term FOL, and we will begin by examining the language of first order logic.

The Language of First Order Logic

We will use FOL to talk about and reason about the world.

The grammar or syntax of our language will always be the same.

We will tailor the language so that we can describe the particular domain of interest.

The Language of First Order Logic

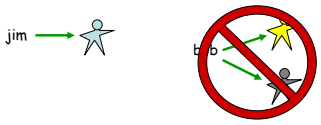
We will use names, called constants, to refer to objects in the world. An object is anything we can make claims about in the world of interest.

Here are the rules:

-- Every constant must name an actual object

-- No constant can name more than one object

-- An object can have more than one name, or no name



The Language of First Order Logic

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Here are the rules:

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The Language of First Order Logic

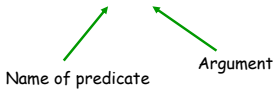
In addition to being able to refer to objects, we need to say that

-- objects have certain properties

-- objects relate to one another in certain ways

To do this, we have predicates in our language.

Jim is tall Tall(jim)



The Language of First Order Logic

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-- objects have certain properties

-- objects relate to one another in certain ways

To do this, we have predicates in our language.

Jim is tall	Tall(jim)
Mary is a student	Student(mary)
Bob is taller than Mary	Taller(bob, mary)
Bob sold Jim's house to Mary	SoldHouse(bob, jim, mary)

The Language of First Order Logic

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To do this, we have predicates in our language.

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Bob sold Jim's house to Mary	SoldHouse(bob, jim, mary)

The number of arguments is called the arity of the predicate.

The Language of First Order Logic

We write the arguments of a predicate in parentheses after the name of the predicate, except for the special predicate for equality:

a = b

An alternate notation would be

Equal(a, b)

The Language of First Order Logic

We will use FOL to talk about and reason about the world.

The grammar or syntax of our language will always be the same.

We will tailor the language so that we can describe the particular domain of interest.

This means that we will choose constants and predicates appropriate for the domain that we are dealing with.

We create an FOL language when we make these choices.

The Language of First Order Logic

Martha sold her car on 1/10/06.

The Language of First Order Logic

Bob shook hands with Patrick.

AIDS is less contagious than influenza.

Jan is between Marcia and Cindy in size.

Max fed Scruffy at 2:00.

The Language of First Order Logic

Atomic Sentences

Atomic Sentences correspond to the simplest sentences of English, sentences consisting of one or more names and a predicate.

An Atomic Sentence is a predicate followed by the right number of names (as defined by the arity of the predicate), which makes a claim that must be either true or false.

Sentences	Not Sentences
Happy(ramesh)	ramesh
Taller(michael jordan, isabel)	Taller(isabel)
Taller(isabel, michael jordan)	

not the same

The Language of First Order Logic

Function Symbols

Given a name, it is often convenient to be able to refer to another object that is uniquely connected to the first name in some way.

For example, if we are talking about Jim, we might also like to talk about Jim's father.

In FOL, we do this using Function Symbols. For the example above, we would write

father(jim)

Function Symbol — Argument

Function symbols can have arity > 1

The Language of First Order Logic

Terminology

jim	term
father(jim)	complex term
mother(father(jim))	complex term

Complex terms refer to individual objects and can be used anywhere that names are expected. For example, a complex term can be the argument to a predicate:

Taller(jim, father(jim))

To help distinguish them, we will capitalize predicates and use lower case for function symbols.

Arguments

An argument is a series of statements in which one (called the conclusion) is meant to follow from, or be supported by, the others (called the premises).

An argument is valid if the conclusion must be true in any circumstances in which the premises are all true. In that case, we say that the conclusion is a logical consequence of the premises.

An argument is sound if it is valid and all its premises are true.

Arguments

If you overslept, you'll be late.
You aren't late.

Therefore:

(a) You did oversleep.
(b) You didn't oversleep.
(c) You're late.
(d) None of these follows.

Arguments

If you overslept, you'll be late.
You aren't late.

Therefore:

(a) You did oversleep.
(b) You didn't oversleep.
(c) You're late.
(d) None of these follows.

If you overslept, you'll be late.
You didn't oversleep.

Therefore:

(a) You're late.
(b) You aren't late.
(c) You did oversleep.
(d) None of these follows.

Valid Arguments

If you overslept, you'll be late.
You aren't late.

Therefore:

You didn't oversleep.

If you are in France, you're in Europe.
You aren't in Europe.

Therefore:

You aren't in France.

Valid Arguments

If you overslept, you'll be late.
You aren't late.

Therefore:

You didn't oversleep.

If you are in France, you're in Europe. If P, then Q.
You aren't in Europe. Not-Q.

Therefore: Therefore:

You aren't in France. Not-P

Modus tollens

Invalid Arguments

If you overslept, you'll be late.
You didn't oversleep.

Therefore:

You aren't late.

If you are in France, you're in Europe.
You aren't in France.

Therefore:

You aren't in Europe.

Invalid Arguments

If you overslept, you'll be late.
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Not-P.

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