Welcome!

We have 10 weeks to learn different paradigms and fundamental concepts of programming languages.

With diligence, patience, and an open mind, this course makes you a much better programmer (in languages we won’t use).

Today in class:

- Course mechanics
- Course overview
- Dive into ML (homework 1 soon)

Credits

This version of the course is heavily based versions by Dan Grossman, Hal Perkins, Keunwoo Lee and others. Look at previous webs for a good idea of where we’re going.

Who and What

- 3 class meetings (slides, code, and questions)
  - Material on-line (subject to change), but take notes.
- 1 section (Jonah Cohen)
  - Essential material on tools, style, examples, language-features, ...
- Office hours (Ting-You Wang, Jonah, me)
  - Use them!!!
- Course “dictionary” online
  - To help with terminology; feedback welcome
Homeworks

- Approximately 6 total
- Doing the homework involves:
  1. Understanding the concepts being addressed
  2. Writing code demonstrating understanding of the concepts
  3. Testing your code to ensure you understand
  4. “Playing around” with variations, incorrect answers, etc.
You turn in only (2), but focusing on (2) makes the homework harder

Collaboration: The Gilligan’s Island Rule
Extra Credit: Terrible use of your time grade-wise, but great otherwise

Exams

- Midterm: Yes, tentatively Friday, 4/28
- Final: 8:30-10:20 a.m. Thursday, Jun. 8, 2006
Same concepts, but very different format from homework.

Now where were we?
Meetings, homeworks, and exams... about what?

Programming languages:
- Essential concepts relevant in any language
- Specific examples "in natural setting" using ML, Scheme, and Smalltalk
- Focus on "functional languages" because they are simpler, very powerful, and teach good practices

First half of course uses ML:
- Gives us time to build knowledge before "starting over"
- But we need to get comfortable with the basics and environment as soon as possible
- "Let go of Java" for now (we will return to it)

A strange environment
The ML part of the course uses:
- The emacs editor
- A read-eval-print loop for evaluating programs
- Available on Windows and UNIX in the lab, but remotely via UNIX — also can be installed on your own Windows, Linux, or Mac OS X machine
We have prepared "getting started" materials, but leave plenty of time for the content of homework 1.
- Read the materials
- Attend section
- Then ask questions fast (wasted hours are wasted hours)
Adjusting to new environments is a "CS life skill"
Before we dive in

We'll return to the course goals and "why learn something other than C/C++/Java/Perl" later.

(There are many good reasons ...)

ML, from the beginning

- Two key concepts: bindings & environment
- A program is a sequence of bindings
- One kind of binding is a variable binding
  \[ \text{val } x = e \] (semicolon optional in a file)
- A program is evaluated by evaluating the bindings in order
- A variable binding is evaluated by:
  - Evaluating the expression in the environment created by the previous bindings. This produces a value.
  - Extending the (top-level) environment to bind the variable to the value.

Much easier to understand with an example...

That was a lot at once

- Values so far: integers, true, false, ()
- Non-value expressions so far: addition, subtraction, less than, conditionals
- Types: every expression has a type. So far, int, bool, unit
- The read-eval-print loop:
  - Enter a sequence of bindings. For each, it tells you the value and type of the new binding
  - If you just enter \(e;\), then that is the same as \text{val } it = e;
  - use "foo.sml" enters the bindings in a file, and then binds it to (\), which has type unit
  - Ignore messages like "GC #0.0.0.0.1.18: (0 ms)"
  - Expressions that don't type-check lead to (bad) error messages and no change to the environment

Parts worth repeating

Our very simple program demonstrates many critical language concepts:

- Expressions have a syntax (written form)
  - E.g.: A constant integer is written as a digit-sequence
  - E.g.: Addition expression is written \( e1 + e2 \)
- Expressions have types given their context
  - E.g.: In any context, an integer has type int
  - E.g.: If \(e1\) and \(e2\) have type int in the current context, then \(e1 + e2\) has type int
- Expressions evaluate to values given their environment
  - E.g.: In any environment, an integer evaluates to itself
  - E.g.: If \(e1\) and \(e2\) evaluate to \(e1\) and \(e2\) in the current environment, then \(e1 + e2\) evaluates to the sum of \(e1\) and \(e2\)
More expression forms

What are the syntax-rules, typing-rules, and evaluation-rules for:

- variables
- less-than comparisons
- conditional expressions

Lots more to do

We have many more types, expression forms, and binding forms to learn before we can write “anything interesting”.

Must develop resilience to mistakes and bad messages. Example gotcha: \( x = 7 \) instead of \( \text{val } x = 7 \).

For homework 1: functions, pairs, lists, options, and local bindings (earlier problems require less)

But there are some things we will not add:

- mutation (a.k.a. assignment): changing the value of an environment binding
  - make a new binding instead
- statements: expressions will do just fine, thank you
- loop-constructs: recursive functions are more powerful

What is a programming language?

Here are separable concepts for defining and evaluating a language:

- syntax: how do you write the various parts of the language?
- semantics: what do programs mean? (One way to answer: what are the evaluation rules?)
- idioms: how do you typically use the language to express computations?
- libraries: does the language provide “standard” facilities such as file-access, hashtables, etc.? How?
- tools: what is available for manipulating programs in the language? (e.g., compiler, debugger, REP-loop)

Our focus

This course: focus on semantics and idioms to make you a better programmer

Reality: Good programmers know semantics, idioms, libraries, and tools

Libraries are crucial, but you can learn them on your own.