CSE 341: Programming Languages

Dan Grossman
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Lecture 13—Introduction to Scheme
Scheme

- Like ML, functional focus with imperative features
  - anonymous functions, closures, no return statement, etc.
  - but every binding is mutable
- A really minimalist syntax/semantics
  - In the LISP tradition
  - Current standard is 50 pages
- Dynamically typed
  - Less “compile-time” checking
  - Accepts more perfectly reasonable programs
- Some “advanced” features for decades
  - Programs as data, hygienic macros, continuations
Which Scheme?

Scheme has a few dialects and many extensions.

We will use “PLT → Pretty Big” for the language and DrScheme as a convenient environment.

- Version 371 is installed, 372 is current, the difference shouldn’t matter to us.

Most of what we do will be “pure Scheme”.

Exceptions include define-struct and the DrScheme module system.
Scheme syntax

Syntactically, a Scheme term is either an atom (identifier, number, symbol, string, ...) or a sequence of terms \((t1 \ldots tn)\).

Note: Scheme used to get (still gets?) “paren bashed”, which is hilarious in an XML world.

Semantically, identifiers are resolved in an environment and other atoms are values.

The semantics of a sequence depends on \(t1\):

- certain character sequences are “special forms”
- otherwise a sequence is a function application (semantics same as ML)
Some special forms

- define
- lambda
- if, cond, and, or
- let, let*, letrec
Some predefined values

- #t, #f
- (), cons, car, cdr, null?, list
- a “numeric tower” with math operations (e.g., +) defined on all of them
- tons more (strings vs. symbols discussed later)

Note: Prefix and variable-arity help make lots of things functions.
Parens Matter

Every parenthesis you write has meaning – get used to that fast!

Correct:

(define (fact n) (if (= n 0) 1 (* n (fact (- n 1))))

Incorrect:

(define (fact n) (if (= n 0) 1 (* n (fact (- n 1)))))
(define (fact n) (if = n 0 (1) (* n (fact (- n 1))))
(define fact (n) (if (= n 0) 1 (* n (fact (- n 1))))
(define (fact n) (if (= n 0) 1 (* n fact (- n 1))))
(define (fact n) (if (= n 0) 1 (* n ((fact) (- n 1)))))
Dynamic Typing

Many things that the “type-checker” forbids in Java or ML are run-time errors in Scheme (like a Java NullPointerException):

• Calling a function with the wrong number of arguments
• Passing a “cons cell” to +
• Passing a function to car
• ...

Don’t need datatype/class definitions, etc. to appease the type-checker

• Just return a boolean or a number; caller can use predicates to determine at run-time what it got
• Make a list that can hold numbers or other lists or whatever
• ...

Most of a later lecture will consider pros/cons of static checking
Local bindings

There are 3 forms of local bindings with different semantics:

- `let`
- `let*`
- `letrec`

(Also, in function bodies, a sequence of `defines` is the same as `letrec`.)

But at top-level, redefinition is assignment!

- And unlike ML, forward references work fine, as long as they are evaluated "later" (under a function body)

This makes it ghastly hard to encapsulate code, but in practice:

- people assume non-malicious clients
- implementations provide access to "real primitives"

For your homework, assume top-level definitions are immutable.