CSE 341: Programming Languages

Spring 2007

Lecture 20 — Macros

Today

- What are macros and what do they mean?
  - Why do they have a bad reputation?
- Scheme's macro system and hygiene
  - Free variables in macros
  - Bound variables in macros
  - Why hygiene is usually what you want
- What macros are good and not good for

Macros

To oversimplify, a macro is just a rule for rewriting programs as a prepass to evaluation: it's very syntactic.

The "level" at which macros are defined affects their usefulness.

- "Sublexical" e.g.: Replace `car` with `hd` turns `cart` into `hdt`.
  - Macro-expander should recognize program tokens.
- "Pre-parsing" e.g., in C/C++ :

```
#define PI          3 + .14
#define add(x, y)   x + y
r = add(5 * a, b) * c;        ==>  r = 5 * a + b * c
circumference = 2 * PI * r;   ==>  2 * 3 + .14 * r
```

- "Pre-binding" e.g.: Replace `car` with `hd` would turn `(let* ([hd 0] [car 1]) hd)` into `(let* ([hd 0] [hd 1]) hd)`.
  - Few macro systems let bindings shadow macros; Scheme does

The bad news

- Macros are very hard to use well.
- Most macro systems are so impoverished they make it harder.
- Actual uses of macros often used to ameliorate shortcomings in the underlying language.

But:

- Macros have some good uses
- Scheme has a very sensible, integrated macro system
- So today's goal is to see them.

Hygiene

A "hygienic" macro system:

- Gives fresh names to local variables in macros *at each use* of the macro
- Binds free variables in macros *where the macro is defined*

Without hygiene, macro programmers:

- Get very creative with local-variable names
- Get creative with helper-function names too
- Try to avoid local variables, which conflicts with predictable effects

Hygiene is a big idea for macros, but sometimes is not what you want.

Note: Letting variables shadow macros is also useful, but a separate issue.

Why macros

Non-reasons:

- Anything where an ordinary binding would work just as well.
- Including manual control of inlining. (Among other reasons, probably prevents compiler analysis/control of encapsulation.)

Reasons:

- Cosmetics
- "Compiling" a domain-specific language
  - But error messages a tough issue
- Changing evaluation-order rules
  - Function application will not do here
- Introducing binding constructs
  - A function here makes no sense