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

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**Macros**

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

The “level” at which macros are defined affects their usefulness.

- “Sublexical” e.g.: Replace $\text{car}$ with $\text{hd}$ would turn $\text{car}$ into $\text{hd}$.
  - No macro system does this; so macro-expander must know how to break programs into tokens.
- “Pre-parsing” e.g.: Replace $\text{add}(x, y)$ with $x + y$ (where $x$ and $y$ stand for expressions) would turn $\text{add}(x, y) * z$ into $x + y * z$.
  - Some macro systems are this “dumb” (i.e., token-based); macro writers use more parens than Schemers.
- “Pre-binding” e.g.: Replace $\text{car}$ with $\text{hd}$ would turn $(\text{let*} \ ([\text{hd} 0] [\text{car} 1]) \ \text{hd})$ into $(\text{let*} \ ([\text{hd} 0] [\text{hd} 1]) \ \text{hd})$.
  - Few macro systems let bindings shadow macros; Scheme does

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**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 let’s “do macros justice” for the day.
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.

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