CISC 260: Programming Paradigms
Lecture 2

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Functional programming in the “real world”


• (CUPF = Commercial Users of Functional Programming conference)
Functional programming in the “real world”

• also, parts of Firefox (if we count Rust)
Some examples of stepping

• Also called “calculation” (the textbook) or “tracing”
2 + 2
⇒
(2 + 2) + (3 + 4)
1 / 3

⇒
$2 + 3 \times 4$

$\Rightarrow$

$\Rightarrow$
Checking our expectations in GHCi
**GHCi**

- "read-eval-print loop"
  - also found in Python
  - not found in Java, C, C++

1. **read** input
2. **evaluate**
3. **print** result
4. loop back to 1
GHCi

• To load definitions from a file (.hs, "Haskell script")

:load filename.hs

• To reload previous definitions:

:reload
Functions

• An anonymous function ("lambda" \( \lambda; \backslash \) looks sort of like \( \lambda \))

\( \lambda x \rightarrow x + 1 \)

But we can call this function:

\( (\lambda x \rightarrow x + 1) \ 6 \)

or use it inside a definition
**Terminology**

\( \lambda x \rightarrow \) body is a lambda
  \( x \) is the *bound variable*, body is the *body*

A lambda is a function.

If \( f \) is a function, then

\( f \ \text{arg} \)

is a *function call* or *function application*:
  “apply \( f \) to \( \text{arg} \)”
Stepping rule for function application

If

\[ f \] is a function,
and the bound variable of \( f \) is \( x \),
and the body of \( f \) is \( \text{body} \),
then

\[ f \ arg \Rightarrow \text{body with } \text{arg} \text{ substituted for } x \]
Stepping rule for function application

If

\( f \) is a function,
and the bound variable of \( f \) is \( x \),
and the body of \( f \) is \( \text{body} \),
then

\( f \ \text{arg} \Rightarrow \text{body with arg substituted for } x \)

Example:

\((x \rightarrow x + 1) \ 6\)
\Rightarrow \ x + 1 \ \text{with } 6 \ \text{substituted for } x
\Rightarrow \ 6 + 1
\Rightarrow \ 7\)
Stepping rule for function application

If

\( f \) is a function,
and the bound variable of \( f \) is \( x \),
and the body of \( f \) is \( \text{body} \),
then

\[ f \ arg \Rightarrow \text{body with arg substituted for } x \]

Example:

\[
(\langle yow \to yow + 1 \rangle) \ 6
\]
\[ \Rightarrow yow + 1 \text{ with } 6 \text{ substituted for } yow \]
\[ = 6 + 1 \]
\[ \Rightarrow 7 \]
Stepping rule for function application

If

\[ f \] is a function,
and the bound variable of \( f \) is \( x \),
and the body of \( f \) is \( \text{body} \),
then

\[ f \ arg \Rightarrow \text{body with arg substituted for } x \]

Example:

\[ (\lambda y \rightarrow y + y) \ 6 \]
\[ \Rightarrow y + y \text{ with } 6 \text{ substituted for } y \]
\[ = 6 + 6 \]
\[ \Rightarrow 12 \]
Defining functions

• Most functions are named

functionname boundvar = body
Stepping rule for function application

If

\( f \) is a function,
and the bound variable of \( f \) is \( x \),
and the body of \( f \) is \( \text{body} \),
then

\( f \ \text{arg} \Rightarrow \text{body with arg substituted for } x \)

double \( x = x + x \)