Meeting 16: Functions

Today
Quiz 4 Discussion
Closure Conversion
Go over Explicate for HW 4

HW 4: Time: 40.4 hours mean, 27.6 hours
Hard: 5.4 mean, 6 med

HW 3: Time: 21.7 hours mean, 11.2 hours
Hard: 4.7 mean, 5 median
Your rating

Homework 4 Notes
Hard: debugging explicite (with notes were available sooner),
understanding all the coding, nothing theoretically difficult but integrating lots of code hard!
Class: digital whiteboard good!

About You!:
- And swung dancer
- Backed into grill as kid
- Studied CS in New Zealand
- Performed at dance shows
- Played baseball in college
- Likes traveling, Japanese culture, and food
- Language fanatic: Russian, Japanese, Hebrew

Homework 3 Notes
Hard: x86 IL design, debugging, going back to old code
"pretty easy", like an algorithms homework

Homework 2 Notes

thoughtful design

Closure Conversion

def f(x):
    y = 4
    return (lambda x: x + y + z)
def Bob(z):
    return x + y + z

a possible
lines of
code

\[ g = f(1) \]
\[ h = f(2) \]
\[ i = f(input()) \]

return e

(1) lambda a, b: ...
(2) (lambda x: .... )
            (lambda x: .... )
            return a

function

lambda a, b: ...
return a
def f(x):
    y = lambda w: w+1
    return lambda z: x + y(x) + z

C-level

- Top-level functions and no "outer variables" \(\rightarrow\) closure conversion

\[ \mathbb{P}_2 \rightarrow \mathbb{R} \text{ for functions} \]

X86 world

Bob: Code for loop

```
\equiv
```

values of
list of "outer variables"

Runtime value
(\(\rightarrow\) new and \text{p/obj}/\text{h-prob})
def f(x):
    y = x
    return lambda z: x + y + z

g = f(1)
print g(3)

C-level
Bob:

P2AST closure conversion

def Bob1(\( \text{freevars1, z} \)):
    y = freevars1
    x = freevars1
    return \( \lambda z \). return \( x + y + z \)
def Bob2(\( \text{freevars2, x} \)):
    y = 4
    return create_closure(Bob1, \( (y, x) \))
\[
\begin{align*}
\text{f = create_closure(Bob2, 3)} \\
\text{g = get_funptr(f)} \\
\text{(get_freevars (f), 1)} \\
\text{Call Func} \\
\text{print get_funptr(g)} \\
\text{(get_freevars (g), 3)} \\
\end{align*}
\]

"outer variable" 11

free variable

\[
\begin{align*}
x + (\text{lambda } z : (z + x)(3)) \\
\text{bound: } z \\
\text{free: } x \\
\end{align*}
\]

\[
\begin{align*}
\text{z, x free} \\
\text{no bound} \\
\text{def f(x):} \\
\text{y =} \\
\text{z =} \\
\text{(def f(x):)} \\
\text{var y, z}
\end{align*}
\]